



Contract for Work

“Vacuum interaction chambers for experimental programmes and experimental local vacuum control systems”

concluded in accordance with Section 2586 *et seq* of Act No. 89/2012 Coll., Civil Code (hereinafter the “Civil Code”) (hereinafter the “Contract”).

I. Contractual Parties:

1. Client:

Fyzikální ústav AV ČR, v. v. i.,
With its seat at: Na Slovance 2
Post code 182 21 Praha 8
Represented by: prof. Jan Řídký, DrSc. - Director

Registered in the public research institutions registry maintained by the Ministry of Education, Youth and Sports of the Czech Republic,

Banking details:
Československá obchodní banka, a.s.,
Account No.: 2106551053/2700

ID No.: 68378271
VAT No.: CZ68378271
(hereinafter the “Client” or “Contracting Authority” or the “Customer”)
and

2. Contractor:

FANTINI SUD S.p.A
with its registered office at Strada Provinciale 12 km 3,300/ N. 52 – 03012 – Anagni (FR) – Italy

registered in the Commercial Register of Frosinone (Italy) (C.C.I.A.A.), No. 01691740607,
represented by Luigi Fantini, function/acting as Amministratore Unico (CEO),
Bank: Banka Popolare di Ancona – seat of Villa Adriana (RM) Italy
IBAN code: IT 19Y 05308 39451 00000 0000456
Id. No.: 01691740607
Tax Id. No.: 01691740607
(Hereinafter the “Contractor” or the “Supplier”; the Client and the Contractor may be referred to herein jointly as the “Contractual Parties” or with respect to each individually as the “Contractual Party”).



II. FUNDAMENTAL PROVISIONS:

1. The Client is the recipient of funding provided by the Ministry of Education, Youth and Sports of the Czech Republic for the Project "ELI: Phase 2", project application No. 1cVzhP, granted within the framework of the Operational Program Research, Development and Education ("OP RDE")(hereinafter the "ELI-Beamlines Project").
2. The aim of the ELI-Beamlines Project is to construct and operate an international research laboratory (research facility) using the latest generation of laser Technology and to subsequently implement a number of future projects in basic and applied research..
3. The ELI-Beamlines Project is one of the pillars within the so-called ESFRI Roadmap created by the European Strategy Forum on Research Infrastructures which was formed at the behest of the European Commission to establish a network of pan-European research centres at the most advanced scientific levels whose aim is to facilitate, within the framework of specific scientific focus of each such research centre, a fully open access into these facilities to scientific workers exclusively on the basis of their scientific excellence (i.e. without regard to the legal or commercial status of institutions or corporations they may come from).
4. In order to successfully implement the ELI-Beamlines Project it will be necessary to execute certain work according to this Contract. The executed work shall form an integral part of the infrastructure for research, development and innovations of ELI-Beamlines in Dolní Břežany (hereinafter the "ELI-Beamlines Infrastructure" or "ELI-Beamlines research centre") and shall be further used to implement research projects in the area of interaction of highly intensive laser radiation with materials.
5. The Contractor was selected as the winner of a public procurement procedure announced by the Client in accordance with Sec. 27 Act No. 137/2006 Coll., on Public Procurement, as amended, for the public contract called "**Vacuum interaction chambers for experimental programmes and experimental local vacuum control systems (reissue)**" (hereinafter the "**Procurement Procedure**") and preliminary published (preliminary information notice) in the Official Journal of the European Union under the evidence number of the Procurement Procedure 7401021096534.
6. The Contractor acknowledges that the Client considers the Contractor's participation in the Procedure, provided that the Contractor complies with all qualification requirements, as the confirmation of the fact that the Contractor is capable, within the meaning of Sec 5(1) of the Civil Code, of providing performance under the Contract with such knowledge, diligence and care that is associated and expected of the Contractor's profession, and that the Contractor's potential performance lacking such professional care would give rise to corresponding liability on the Contractor's part. The Contractor is prohibited from misusing his qualities as the expert or his economic position in order to create or exploit dependency of the weaker party or to establish an unjustified imbalance in the mutual rights and obligation of the parties.



7. The Contractor acknowledges that the Client is not, in connection to the subject of this Contract, an entrepreneur, and also that the subject of this Contract is not related to any business activities of the Client.
8. The documentation necessary for the execution of work consists of following annexes:
- a) Scope of Work, which forms an integral Annex No. 1 hereof and contains the detailed description of the subject of delivery pursuant hereof (hereinafter the **"Annex 1"** or the **"Scope of Work"**) including a set of partial deliverables of the Work (hereinafter individually the **"Deliverable"**) and its parts (hereinafter each separately **"part of Deliverable"**);
 - b) Technical specifications for the Contract form an integral part hereof as its Annex No. 2 (hereinafter the **"Annex 2"** or **"Technical specification"** or **"RSD"**) and the part of Technical specification containing conceptual design of Devices hereof as the **"Conceptual design"**. This Technical specification also formed a part of the tender documentation for the Procurement Procedure in the form of Annex No. 5;
 - c) Schedule of Deliverables, which forms an integral Annex No. 3 hereof (hereinafter the **"Annex 3"** or the **"Schedule of Deliverables"**) and contains the schedule of delivery of Deliverables and its parts hereof;
 - d) The Contractor's bid submitted for the Procurement Procedure in its parts which describes the work in technical detail (hereinafter the **"Contractor's Bid"**); the Contractor's Bid forms Annex No. 4 (hereinafter the **"Annex 4"**) to this Contract and an integral part hereof.
 - e) Quality plan pursuant to Art. VI par. 3 hereof, which becomes integral Annex No. 5 hereto (hereinafter the **"Annex 5"** or the **"Quality plan"**);
 - f) Verification plans of Devices pursuant to Art. VI par. 5 hereof, which becomes integral Annex No. 6 hereto (hereinafter the **"Annex 6"** or the **"Verification plan"**);
 - g) The breakdown of the Price of Work and Payments Schedule, which forms an integral Annex No. 7 hereof (hereinafter the **"Annex 7"** or **"The breakdown of the Price of Work and Payments Schedule"**) and contains the price of individual performances hereof.
9. The Contractor declares that he possesses all professional qualifications to execute the work therefore he is authorized to carry out activities foreseen hereunder, and—there are no obstacles on his part that would prevent him from executing the work contracted hereunder.
10. The Contractor is fully aware that the deadlines for the execution of the work or its parts—are vital for the Client with regard to the EU-Beamlines Project—Thus, damages may arise to the Client if the mentioned execution of works or parts of the work fail to meet the delivery deadlines that are tied into ELI overall project schedule. The Client has notified the



Contractor what are the tie-in projects' deadlines specified hereunder in connection with the ELI-Beamlines Project deadlines – see www.eli-beams.eu.

11. The Contractor declares that he accepts the “risk of changed circumstances” within the meaning of Sec 1765(2) of the Civil Code.

III. WORK SUBJECT – MATTER; WORK SCOPE

1. The subject-matter hereof is namely:

- A. the obligation of the Contractor to perform for the Client duly and on time, in accordance with the terms hereof, on its own account and liability, and within the deadlines agreed upon herein, design, manufacture, assemble, test, deliver and install to the Client in the place of delivery hereof devices specified in integral Annex 1 hereto and reaching parameters stated in Technical specification and Contractor's Bid (hereinafter each device individually as the “Device” or “ECU” and all devices collectively as the “Devices”) and provide for the Client out of warranty services listed in Annex 1 hereto (The Devices and the other parts of the work hereof are hereinafter also referred to as the “Work”).

and

- (B) the obligation of the Client to pay the Contractor, under the terms and conditions hereof, the agreed upon price for the execution of the Work.
2. The Contractor is bound to perform the Work in parts described in the Scope of Work and designated as Deliverable or its part.
3. The subject-matter of the Work, included in the Price of the Work hereof, are also changes in the extent specified in the Annex 1 par. 3 hereto, which the Contractor is obliged to perform.
4. The Contractor's obligations hereunder, performance of which has been included in the Price of the Work, shall also include:
- i. Training of persons designated by the Client, in the extent of minimum 3 training days (a training day shall be understood a working day), in such a way that these persons (after training) will be able to safely operate, manage, maintain, assemble and disassemble the Device, and know the essential information that every owner and user should know.

IV. EQUIPMENT REQUIRED TO EXECUTE WORK:

The Contractor shall secure such equipment that may be required to execute the Work defined hereunder, unless this Contract stipulates otherwise.



V. PROVISION OF OUT-OF-WARRANTY SERVICE

1. The Out-of-Warranty service specified in the Scope of Work, shall be provided by the Contractor for the Client upon individual written orders of the Client (hereinafter the "Order" or the "Orders"). The individual contract for work is concluded between Contractual Parties by acceptance of the Client's Order by the Contractor.
2. The Client shall be entitled to cancel his Order at anytime; in such an event the Client shall be obliged to pay to the Contractor that part of the price which will correspond to costs which were demonstrably and effectively expended by the Contractor by the time the Order will have been cancelled. The Contractor shall be obliged to demonstrate what these costs were.
3. The Contractor acknowledges and agrees that the Client shall not be obliged hereunder to order performance from the Contractor in the value equal to the total amount of the price for Out-of-Warranty Service as defined in the Contractor's bid. The Contractor thus cannot claim on the Client that the Client makes any order or requires performance hereunder, nor claim on the Client any payment or compensation except for the price to be paid for the actually ordered and duly completed Orders.
4. Should an Order contain a requirement, which exceeds the agreed framework herein or in the tender documentation or the Contractor's bid submitted within the Procurement procedure, which the Contractor has not agreed to perform, the Contractor shall be obliged to notify the Client of such excess requirement within five business days of receiving the Order, otherwise it shall be understood that the Contractor agrees with such additional performance, without any claim to increase the price.
5. The Contractor shall provide the Out-of-Warranty service within the period of 15 (fifteen) calendar days from acceptance of the Order by the Contractor or within another time agreed by the Contractual Parties in the Order.

VI. RECORDING THE RESULTS OF THE WORK:

1. The outcome of Deliverables D1 i), D2 i), D3 i), D4 i), D5 i), D6 i) a D7 i) shall be **technical reports** containing preliminary design of Device including all its parts, which shall contain, in particular:
 - a. the drawings of parts of Device including 3 CAD models of Device;
 - b. Bill of Materials;
 - c. FEM Device analysis as stipulated in Technical specification;
 - d. Surface cleaning procedure proposal for the Device;
 - e. Proposal of the verification plan of each Device as stipulated below (hereinafter the "Proposal of verification plan of Device");
 - f. Verification matrix of each Device as stipulated below (hereinafter the "VM");
 - g. Quality Plan;
 - h. Interface Control Document of each Device as stipulated below (hereinafter the "ICD");
 - i. Preliminary design of vacuum local control system (hereinafter the "preliminary design of Device").



2. **Proposal of verification plan of Device** shall contain especially the overall verification approach, the model philosophy, the product matrix, the verification strategies for the Client's requirements (the interrelation between different methods and levels of verification to be used to demonstrate status of compliance to requirements), the test, inspection, analysis and review-of-design programme with the relevant activity sheets and planning, the verification tools, the verification control methodology, the involved documentation, the verification management and organization and must also fulfil at least the Client's requirements listed in the Technical specification. **VM** shall contain for each requirement of the Client the corresponding verification method at the applicable verification level. **ICD** shall define and describe all external interface aspects of the Device (Electrical/Mechanical/Thermal/Optical), including physical, functional, performance and operational constraints.
3. The Quality Plan must meet the minimum requirements of the Client stated in the Technical Specification. The Quality plan after approval by the Client becomes an integral **Annex 5** hereto and the Contractor is obliged to follow it.
4. The outcome of Deliverables D1 ii), D2 ii), D3 ii), D4 ii), D5 ii), D6 ii) a D7 ii) shall be **technical reports** containing detailed plan of Device including all its parts, which shall contain, in particular:
 - a) Final drawings of all parts of Device (as a whole) including 3D design;
 - b) Manufacturing drawings of individual parts of Device;
 - c) Verification plan for Device (including the update of the Proposal of verification plan of Device);
 - d) Verification control document for Device as stipulated below (hereinafter the "**VCD**");
 - e) drafts of all manuals, analysis and procedures and specified in Technical specification (e.g. for transport, installation, handling, manipulation, operating procedures manual and so on) ;
 - f) installation plan of Device;
 - g) final design of vacuum local control system (hereinafter the "**detailed plan of Device**").
5. The Client shall comment on each verification plan for the Device (pursuant Art. VI par 4 letter c) hereof) within thirty (30) days from the date on which it was delivered. If the Client shall not make any comments or suggestions in the above mentioned time limit, nor in the above mentioned time limit confirms in writing its consent to the verification plan of Device, it shall be deemed that the Client consents to it and the verification plan for each Device shall be attached as **Annex 6** to this Contract ("**Verification plan**"). If the Client for any justified reason does not agree with the verification plan of Device, the Contractor shall modify it according to the Client's instructions and after its modification by the Contractor it shall become integral part of this Contract as Annex 6 as mentioned above.
6. **VCD** shall be in the form of matrix. For each requirement of the Client concerning the Device **VCD** shall contain especially i) requirement identifier pursuant Technical specification, ii) requirement revision, iii) requirement text, iv) HW/SW code – identifier according the Contractor technical documentation, iv) verification methods, v) close-out



status (no –open/yes –closed), v) link to the relevant section of the Verification plan and any planning document, vi) references to any documentation that demonstrates compliance to the Client's technical requirements.

7. The outcome of Deliverables D1 iii), D2 iii), D3 iii), D4 iii), D5 iii), D6 iii) a D7 iii) shall be **protocols on testing of Devices at the Contractor's place/Reports on the process of Testing** (as stated in Art. VII par. 3 hereof). Protocols on testing of Devices hereof shall contain at least: i) the Client's and the Contractor's information, ii) description of the Device, iii) confirmation of the performed tests pursuant to the Verification plan and analysis of results achieved, as defined in the Technical specification, iv) updated version of ICD hereof, v) updated version of VCD and vi) date of execution by the Contractual Parties (hereinafter the "**Protocol on testing of Device**"). This provision shall apply adequately also on the extent of all Reports on the process of Testing and Protocols on testing of Devices at the research center ELI-Beamlines as stated below.
8. The outcome of each Deliverable D1 iv), D2 iv), D3 iv), D4 iv), D5 iv), D6 iv) a D7 iv) shall be delivered and tested Device in place of performance documented by **Protocols on testing of Devices at the research center ELI-Beamlines**, as stated in Art. VII par. 3 hereof and **protocols on the handover of Devices**.
9. All submitted documents executed pursuant hereof shall be well-structured and provided in such level of detail so that a professional in the given area shall be able to assess the correctness of the Contractor's approach in solutions used for the Work or its part and the possibility of achieving the required technical parameters defined in this Contract by the methods used. Furthermore, the documents must contain all the facts required by this Contract and its annexes. All submitted documents executed pursuant hereof shall be prepared for the Client in Czech and English language.

VII. ACCEPTANCE PROCEDURE AND FULFILMENT OF COVENANTS:

1. Verification Control Board:

The Client shall set up a v Verification Control Board to carry out preliminary and final assessment of the results of the Contractor's activities hereunder (hereinafter the "**Verification Control Board**"); the Client shall notify the Contractor of the panel's composition. The Verification Control Board reviews and assesses the execution of the Work from its technical perspective.

2. Acceptance procedure of technical reports as outputs of Deliverables or their parts, as stated in Art. VI hereof:

a) Preliminary assessment

- i. In order to preliminarily assess the technical reports as outputs of Deliverables hereof or their parts, the Contractor undertakes to provide the Client with the draft of technical report relating to the respective individual deliverable or its part, and corresponding to mid- and final stages of the progress in execution of each particular Deliverable or its part.



- ii. The Client shall provide the Contractor with his comments to the submitted draft reports or draft proposals which the Contractor shall be obliged to take into account, i.e. the Contractor shall accept all justified and materially correct comments and requirements made by the Client. Should the Contractor consider some of the comments or requirements made by the Client as materially incorrect or unacceptable, the Contractor shall specify his reasons for refusing to accept such in writing. In the case that the Client will not provide the Contractor with its comments within this deadline it shall be deemed that the Client has no comments and that he is obliged to issue the acceptance protocol within the meaning of letter b) of this Art VII. par. 2 of this Contract.
- iii. Should the Client reach a conclusion that a personal meeting with the Contractor is required in order to properly execute any Deliverable or its part, the Client shall invite the Contractor to attend such a meeting at the Client's registered offices. The Contractor shall be obliged to attend such meeting at the Client's registered offices, at least once in connection with execution of each Order and at least once in connection with execution of each Deliverable or its part hereof. Upon Contractor's request the meeting may be replaced by videoteleconference. The Contractual Parties shall prepare a protocol documenting every such meeting. Should the protocol contain comments, the Contractor shall be obliged to follow procedure outlined in point ii. above.

b) Acceptance Certificate

Should the technical reports comply with requirements of the Client and contain essentials as set forth herein, the Client shall issue to the Contractor, without undue delay, a confirmation attesting to their acceptance (hereinafter the "**Report Acceptance Certificate**").

The Contractor's obligation arising on the basis of technical report Deliverable or its part as specified in Art. VI hereof shall be deemed to have been fulfilled by the issue of the Report Acceptance Certificate confirming the completeness of the technical report prepared pursuant to this Contract.

3. Acceptance procedure of Protocol on testing of Devices at Contractor's place/Report on the process of testing at Contractor's place/Protocol on testing of Device at the research center ELI-Beamlines, as outputs of deliverables or its parts, as stated in Art. VI hereof:

a) Testing of Devices

- i. The Contractor shall invite sufficiently in advance the Client to participate at the testing of Device, at least ten (10) working days prior to the testing pursuant to the Verification plan.
- i. During testing the compliance of the Devices with the Technical specification and Contractor's Bid, and inspections and tests of Devices shall be verified in accordance with the Verification plan.
- ii. The process of testing and its results shall be documented by the Contractor in a



Protocol on testing of Devices at the Contractor's place/at the research center ELI-Beamlines, which shall be signed by both Contractual Parties. Should the Protocol on testing of Devices contain any comments of the Client on the results of the testing, the Contractor shall respond to such comments, i.e. the Contractor shall accept all materially correct and legitimate comments or requirements of the Client. Should the Contractor some of the comments or requirements consider materially incorrect or unacceptable the Contractor must specify reasons for their refusal in writing.

- iii. In the case of Deliverables D1 iii), D2 iii), D3 iii), D4 iii), D5 iii), D6 iii) a D7 iii) the Client is not obliged to be present during the testing; in such a case the Contractor shall prepare a report on the process of testing and its results (hereinafter the **„Report on the process of testing“**) and hand it over to the Client. In such a case the provisions of Art. VII par. 2 letter a) point ii) and iii) and letter b) of this Contract shall analogically apply on the evaluation and acceptance of the Report on the process of testing .
- b) If the output of Deliverable hereof is the Report on the process of testing/Protocol on testing of Devices at the Contractor's place, the Client shall issue to the Contractor, without undue delay, a confirmation on the proper execution of Deliverable or its part (hereinafter the **“Acceptance Certificate on testing of Devices at the Contractor's place“**), if the results of testing of Device are in accordance with the Verification plan and the results of testing presented in the Report on the process of testing/Protocol on the testing of Devices at the Contractor's place show that Devices fulfil in every aspect the requirements of the Client stipulated in the Technical specification and in the Contractor's Bid.
- c) In the case of Deliverables, whose output is the Protocol on testing of Devices at the research centre ELI – Beamlines, the Client shall issue to the Contractor, without undue delay, a confirmation on the proper execution of such partial performance (hereinafter the **“Acceptance Certificate on testing of Devices at the Research centre ELI-Beamlines“**) provided that the following conditions have been simultaneously satisfied:
 - i. The Contractor shall deliver Device to the Client without defects or unfinished works;
 - ii. Device shall be assembled at the Research centre ELI-Beamlines and installed pursuant to the Technical specification;
 - iii. the results of testing of Device pursuant to the Verification plan demonstrate that the Device fulfil in every aspect the requirements of the Client specified in the Technical specification and reach required technical parameters;
 - iv. the Contractor handed over to the Client the filled VCD concerning relevant Device;
 - v. the Contractor handed over to the Client a declaration that the Device complies with the applicable legal regulations of EU or Czech Republic, technical norms, Technical specification and Contractor's Bid;
 - vi. the Contractor delivered to the Client the operating procedures manual for the operations of the Device in accordance with this Contract;
 - vii. the Contractor realised the training of persons designated by the Client pursuant hereto;
 - viii. The Contractor fulfilled all requirements of the Client stipulated in Technical specification and this Contract.

If the Contractor does not deliver to the Client all the above listed documents, the Deliverable shall not be duly completed and eligible for handover.



d) **The fulfilment of obligations**

Deliverable, whose output is the Protocol on testing of Devices at the Contractor's place/Report on the process of testing/Protocol on testing of Devices at the research centre ELI – Beamlines, shall be considered as complete by issuing the Acceptance Certificate on testing of Devices at the Contractor's place / Acceptance Certificate on testing of Devices at the research centre ELI – Beamlines by the Client.

4. **Joint provisions for the acceptance procedure and fulfilment of obligations:**

- a) The Client shall not be obliged, during the course of the acceptance procedure, to verify the correctness of any calculations or details of the proposed technical solutions.
- b) The assessment and subsequent acceptance of the individual parts of Work/ Deliverables does not release the Contractor from his liability for the correctness and completeness of the entire Work.
- c) Should it be necessary to modify any part of the already accepted Deliverable of the Work in order to meet the parameters expected of the completed Work, the Contractor undertakes to perform such modifications and accepts that the costs related thereto are included in the Price as agreed in Art. XI par. 1 hereof.
- d) The Contractual Parties may replace meetings in person by other forms of communication (e.g. videoconference), as long as they agree on such in writing.
- e) Each Contractual Party shall bear its expenditures related to their participation in meetings at the other Contractual party's registered offices; costs which would however arise due to error, faulty performance or breach of contractual provisions of the Contractual Parties shall be borne by that Contractual Party which caused such breach.

VIII. TERM – TIME SCHEDULING

The Contractor undertakes to perform the Work and its part in terms stated in the integral Schedule of Deliverables .

IX. PLACE OF DELIVERY:

Unless the Contract stipulates otherwise, the place of handover and takeover of the Work or its part hereof shall be (by Client's choice) the address of the planned ELI-Beamlines research centre in Dolní Břežany or another address within 50 km from Prague centre; the Client shall notify to the Contractor the specific place of delivery hereof sufficiently in advance before the date of performance hereof. In the event that the Client will not do it sufficiently in advance before the term stated in the Schedule of Deliverables , the Contractor is obliged to ask the Client for the statement in writing about the exact place of delivery.

X. TRANSFER OF OWNERSHIP RIGHTS



The ownership rights to the Work or its parts shall pass to the Client upon the physical handover of each respective performance (Device or its part) by the Contractor. The risk of damage shall not pass to the Client before the ownership rights.

XI. PRICE OF WORK; INVOICING; PAYMENT:

1. The total (maximum) price of Work has been set forth on the basis of the Contractor's bid in the amount not exceeding the maximum possible amount of CZK 33.871.400,00 excluding VAT, in words: *thirty three million eight hundred seventy one thousand four hundred Czech crowns*, excluding VAT (hereinafter the "Price of the Work").
2. The price of Deliverables is stated for the purposes of this Contract in integral **Annex 7** hereto (The breakdown of the Price of Work and Payments Schedule).
3. The Price of the Work shall cover any and all performance provided by the Contractor in order to fulfil all of the Client's requirements to properly execute and deliver the Work hereunder, and includes all costs accrued by the Contractor during the execution of the Work and its handover at the registered offices of the Client incl. all fees, customs duties and insurance as well, etc.
4. Contractual Parties have agreed that the Contractor shall be authorized to invoice the Price of the Work in accordance with Annex 7 hereto.
5. VAT shall be imposed on top of all payments made hereunder according to valid legislation, if applicable.
6. The due date of all invoices issued hereunder shall be thirty (30) days from the date of their delivery to the Client (hereinafter the "Due Date"). A payment of the amounts invoiced shall be understood to be effected on the day such are remitted to the bank account of the Contractor. The tax documents – invoices issued by the Contractor hereunder shall in compliance with all applicable legal regulations of the Czech Republic include especially the following data:
 - a) Commercial name and seat of the Client,
 - b) Tax identification number of the Client,
 - c) Commercial name and seat of the Contractor,
 - d) Tax identification number of the Contractor,
 - e) Number of the tax document – invoice,
 - f) Quantity (extent) and nature of performance supplied or services rendered,
 - g) The date of issue of the tax document – invoice,
 - h) The day of the supply of goods or services or the date of the payment on account, whichever comes sooner, in so far as they differ from the date of issue of the tax document – invoice,
 - i) Due Date,
 - j) The price,
 - k) Statement that the performance is provided in connection with the "ELI: EXTREME LIGHT INFRASTRUCTURE" Project, Reg. No. CZ.1.05/1.1.00/02.0061,



and, furthermore, the tax documents – invoices shall also be in compliance with agreements on avoidance of double taxation, if applicable in particular cases.

7. The Contractor is obliged to issue invoice stipulated herein without delay, after all requirements are met. The last invoice of each calendar year must be delivered by the Contractor to the Client's mail room no later than on December 15 of that calendar year. Should a tax document – invoice not be issued in compliance with payment terms defined herein or should it not meet the statutory requirements, or if it should not be delivered to the Client by deadlines set hereunder, the Client is entitled to return the tax document -invoice back to the Contractor as incomplete, or incorrectly issued, for its correction, or re-issue, within five (5) business days from the date of its delivery to the Client. In such a case, the Client shall not be in default with the remittance of the Price of the Work or any portion thereof, and the Contractor shall issue a corrected invoice with a new identical due date which shall commence to run on the day of delivery of the corrected or re-issued tax document - invoice to the Client.
8. The Client's invoicing details are given in Art. I hereof.

XII. WARRANTY, WARRANTY AND OUT-OF-WARRANTY SERVICE:

1. The Work shall be deemed to be defective if its implementation or its parts fail to correspond to the results defined herein.
2. The Contractor shall be liable for any defects on the Work or any of its parts at the time of its handover and acceptance, as well as for defects that may be discovered on the Work or its parts during the entire warranty period (quality guarantee).
3. The Contractor shall provide quality warranties for the Devices in the following extent:
 - a) Device material quality for 24 months,
 - b) Device components mechanical functionality for 24 months,
 - c) Device vacuum chamber(s) vacuum tightness and in particular the tightness of all welds, for 24 months,
 - d) Device vacuum equipment controllers functionality (modular system electronic control) for 12 months.
4. The warranty period starts running as of fulfilment of the Work hereof.
5. Any requests to remove defects on the Work or its part during the warranty period shall be exercised in writing by the Client against the Contractor without undue delay after such



were discovered, no later than on the last day of the warranty period (hereinafter the "Warranty Claim"). Warranty Claim transmitted by the Client even on the last day of the warranty period shall be deemed to have been exercised on time.

6. The Contractor shall review all submitted Warranty Claims, notify the Client whether he recognizes the claim, and inform the Client in writing on the deadline for the removal of the defect within one week of the date on which the claim was delivered to him by the Client.
7. The Contractor undertakes to remedy any claimed defects on the Work or its parts free of charge and without undue delay.
8. Unless the Parties agree otherwise (in writing), the maximum period for removal of a defect shall be 15 (fifteen) business days from the date the Warranty Claim was submitted to the Contractor.
9. The Contractor shall be obliged to remove defects on the Work also in instances when the Contractor is of the opinion that he is not liable for such defects.
10. Cost accrued in connection with the removal of defects in these disputable cases shall be borne by the Contractor until such dispute is resolved.
11. Removal/remedy of claimed defect shall be subject to a protocol in which the Contractual Parties confirm the defect's removal. The warranty period shall extend by any period that passed between the claim notification and removal of the defect.
12. By Out-of-Warranty Service shall be understood a removal / remedy of defects as if during the warranty period in cases where the Contractor has no obligation to remove / remedy the defects within the framework of the warranty itself.
13. Acts of the Contractual Parties shall constitute claims under this Article if made in writing or by electronic means of communication by one of the representatives of the Contractual Parties pursuant to Art. XVIII par. 1 and 2 hereof and delivered to the address of the other Contractual Party pursuant to Art. I or Art. XVIII. par. 1 or 2 hereof.

XIII. INTELLECTUAL PROPERTY RIGHTS

1. The Contractor, while performing the work in the accordance herewith shall not act in a breach of the rights of third parties, arising to such third parties from intellectual property rights, namely author's rights pursuant to Act. No. 121/2000 Coll., on Copyrights, Rights Related to Copyright and on amendment of certain other Acts, as amended (hereinafter referred to as the "Copyright Act") and from industrial rights pursuant to dedicated legislation of the Czech Republic and of other states as well as from International treaties on intellectual property rights protection.



2. In the event that in the connection with the execution of this Contract the Work as a whole or its part shall constitute a copyrighted work within the meaning of the Copyright Act, the Contractor grants to the Client by signing of this Contract a nonexclusive, royalty-free licence to use the copyrighted work (or any of its parts), to which the Contractor undertook on the basis thereof and which is or will be protected by the Copyright Act, in the unlimited extent and for all manners of use specified in Section 12 of Copyright Act on the territory of the whole word. The Contractor explicitly acknowledges that he grants to the Client a nonexclusive, royal-free licence to use all designs of Devices, as results of performance hereof, for the manufacture of an unlimited number of such devices, and for the period of duration of proprietary rights to such parts of Work .
3. Copyrighted work (Art. XIII par. 2) and industrial rights (Art. XIII par. 3) are jointly referred to, for the purposes hereof, as intellectual property rights. In the event that the execution of this Contract will result into Work or any part thereof, which the Contractor is entitled to register through any form of industrial rights (i.e. trademark, patent or invention, utility or industrial design etc.) protected according to the valid legal regulation in the Czech Republic or in another country, or international or supra-national body, the Contractor shall grant the Client a royalty-free license to use the Work for the purposes of the ELI-Beamlines Project for the duration of the protection period granted to that particular intellectual property right, and for the purposes of further use of the Work in research and educational activities, as well as for the purposes of this Contract on the territory of the entire World.
4. The Contractor hereby grants to the Client the consent with provision of rights constituting a licence hereof on need to know basis to a third party, i.e. a sub-licence with respect to its main scope of activities and/or the operation of ELI-Beamlines centre.
5. The intellectual property rights according to Art. XIII shall pass to the legal successor of the Client or operator of the ELI-Beamlines Infrastructure.

XIV. PUBLICATION ACTIVITIES

1. The Contractor shall refer all publications arising as a direct result of this Contract to the Client, at least 20 (twenty) calendar days before the publication is submitted to scientific journal, proceedings or other periodicals. Client and Contractor will agree that comments or amendments suggested by the Client will be added to the text of such publication.
2. The Contractor shall acknowledge in the publications this Contract and the ELI-Beamlines Project as the source of funding supporting the work reported, in the Acknowledgments section of the publication.
3. The Contractor shall observe any applicable regulations governing publicity arising from the binding documentations under OP RDE.

XV. RIGHTS AND OBLIGATIONS OF THE CONTRACTUAL PARTIES



1. The Contractor shall fulfil all of its covenants entered into hereunder with professional care, at its own cost and risk, and to observe the deadlines imposed in Art. VIII hereof and in the Schedule of Deliverables , for the Price of the Work set forth in Art. XI. hereof.
2. The Client shall deliver to the Contractor any and all source documents, materials or other information, which are necessary for the execution of the Work and which the Contractor can reasonably request from the Client under the condition that the Contractor raised any such requirements with sufficient advance ensuring fulfilment of the deadlines for delivery of the Work as defined herein.
3. The Contractor shall be obliged to take into account, in the execution of the Work hereunder, all requirements of the Client that are aimed at achieving the highest quality of the objectives hereof, unless such are contrary to the law.
4. The Contractor shall be obliged to inform the Client on the progress achieved in the Work's execution, at least once a month, in the form of an e-mail report.
5. Under the terms and conditions of this Contract and in the accordance with instructions issued by the Client, the Contractor, using all necessary professional care, shall:
 - i. duly archive all written material prepared in connection with the execution of the Work hereunder and to provide access to the Client to these archived documents until 2021. The Client shall be entitled to take possession of these documents after ten years from the completion of the Work hereunder from the Contractor free of charge;
 - ii. cooperate during financial inspections carried out in accordance with Act No. 320/2001 Coll., on Financial Inspections, as amended, i.e. to allow the Managing Authority of the Operational Program Research, Development and Education (hereinafter the "Sponsor") to access also those portions of the tender (bid) submitted within the Procurement Procedure, the Contract, Orders and related documents which may be protected by special legal regulation, given that all requirements set forth by legal regulation with respect to the manner of executing such inspections will have been observed; the Contractor shall bind any of its sub-contractors to comply with this obligation accordingly.
6. The Contractor undertakes to fulfil all the Client's requirements stipulated in this Contract
7. The Contractor is fully responsible for damage caused by his subcontractors to the Client.

XVI. LIABILITY, SANCTIONS

1. In the case where the Contractor shall be in delay with any of the part of Deliverables D1 ii), D 2 ii), D3 ii), D4 ii), D5 ii), D6 ii) and D7 ii), the Contractor is obliged to pay to the Client contractual penalty in the amount of 0,1% from the price of Deliverable pursuant to par. 1



of Annex 7 hereto, with which is in delay, and for each case of breach of such obligation and for each day of delay.

2. In the case where the Contractor shall be in delay with any of the part of Deliverables D1 iv), D 2 iv), D3 iv), D4 iv), D5 iv), D6 iv) and D7 iv), the Contractor is obliged to pay to the Client contractual penalty in the amount of 0,3% from the price of Deliverable pursuant to par. 1 of Annex 7 hereto, with which is in delay, and for each case of breach of such obligation and for each day of delay.
3. In the case where the Contractor shall be in delay with provision of Out-of-Warranty service within the period under Art. V par. 5, i.e. the Contractor will not provide Out-of-Warranty service to the Client within the deadline of 15 (fifteen) calendar days from acceptance of the Order by the Contractor or within the agreed time in the Order, the Contractor shall be obliged to pay contractual penalty in the amount of 15.000 CZK for each day of delay.
4. In the case where the Contractor shall a) fail to remove the warranty-claimed defects of the Device within the period stipulated by Art. XII par. 8, and/or b) fail to send the Client the report on progress achieved in the Work's execution pursuant to Art. XV par. 4 hereof, and/or refuse to attend any meeting pursuant Art VII hereof, the Contractor shall be obliged to pay contractual penalty in the amount of 5.000 CZK for each case of breach of such obligation for each day of delay.
5. The Client is entitled to offset any of its claims to contractual penalty in accordance with this Art. XVI hereof against any claims of the Contractor to payment of any part of the price in accordance herewith.
6. The Parties exclude use of Sec. 2050 of the Civil Code. By the payment of contractual penalty in accordance with this Art XVI hereof, no claim of the Client to damage compensation shall be excluded, neither affected.

XVII. TERMINATION OF THE CONTRACT, VIS MAJOR:

1. This Contract may be terminated by its fulfilment / completion, by agreement of the Contractual Parties or by withdrawal from the Contract for reasons specified in law or in this Contract.
2. The Client shall be entitled to withdraw from the Contract without sanction should any of the below specified events occur:
 - a) any expenditure or any part thereof, which may arise on basis of this Contract, are declared by the Sponsor or other controlling body to be ineligible, or
 - b) the Client's financial support (aid) provided toward implementation of the ELI-Beamlines Projects is withdrawn;



- c) The Contractor at least two times breached any conditions stated by this Contract; or
 - d) The Device during acceptance procedure pursuant to Art. VII par. 3 hereof within the testing phase does not fulfil requirements of the Client on the Device defined in the Technical specification, even after three repetitions.
3. In case of termination of the Contract due to reasons given in par. 2 of this Article, the Contractor shall be eligible for payment for the actually executed part of the Work delivered to the Client, if such had been executed in accordance with the terms and conditions hereof.
4. In the event of termination of this Contract by the Client for other reasons than for the reasons of a breach of obligations on the part of the Contractor, the Contractor shall have the right to payment of the part of the Price representing the costs which he accrued in connection with the fulfilment of his obligations hereunder prior to the Contract termination by the Client, and which could demonstrably not be cancelled in time and if such costs accrued by the Contractor are not covered from other external sources.
5. Things, rights and any other values, whose price was paid for by the Client to the Contractor according to par. 4 of this Article, shall pass, by payment, into the ownership of the Client and the Contractor shall be obliged to allow the Client to dispose with such accordingly. The risk of damage shall pass to the Client upon handover.
6. The act of withdrawal from the Contract shall become effective on the day of delivery of the notification in writing from one Contractual Party to the other with consequences of the Contract termination effective in the "ex nunc" regime.
7. Circumstances precluding liability shall be deemed to have been constituted by such circumstances / obstacles which arose independently of the will of the obliged Contractual Party, and which prevent fulfilment of that Contractual Party's obligation, provided that it could not be reasonably expected that the obliged Contractual Party could overcome or avert this obstacle or its consequences, and furthermore that such Contractual Party could foresee such obstacle when it entered into the respective covenants (hereinafter "Vis major"). Liability cannot be precluded by obstacles that arose only after the obliged Contractual Party was in default with fulfilment of its obligations, or which arose in connection with its economic situation. The effects precluding liability shall be limited to the period during which the obstacles causing these effects persist.
8. Should a situation occur, which a Contractual Party could reasonably consider to constitute Vis major, and which could affect fulfilment of its obligations hereunder, such Contractual Party shall immediately notify the other Contractual party and attempt to continue in its performance hereunder in a reasonable degree. Simultaneously, such Contractual Party shall inform the other of any and all its proposals, including alternative modes of performance, however, without consent of the other Contractual Party, it shall not proceed to effect such alternative performance.



9. If a situation constituting Vis major occurs, the deadlines imposed hereunder shall be extended by the period of the duration of the said Vis major event.

XVIII. REPRESENTATIVES, NOTICES:

1. The Contractor has appointed the following representatives responsible for the management and performance of the Work hereunder and communication with the Client:

In technical matters:

Ing. Giampiero Santin

E-mail: giampierosantin@fantinispa.it

Tel.: +39 345 2578 670

In contractual matters:

Ing. Francesco Fantini

E-mail: francescofantini@fantinispa.it

Tel.: +39 348 3857 303

2. The Client has appointed the following representatives responsible for communication with the Contractor for the purposes of realization of the Work:

In technical matters:

Ing. Pavel Korouš

E-mail: Pavel.Korous@eli-beams.eu

Tel.: + 420 702 004 85

In contractual matters:

prof. Jan Řídký, DrSc.

Tel: +420 266 052 121,

Email: ridky@fzu.cz

3. Any and all notices transmitted between the Contractual Parties hereunder must be made in writing and delivered to the other Contractual Party by an internationally recognized courier service (Federal Express, DHL, etc.), delivered in person (with a written confirmation of receipt), by a registered letter or in the form of electronic communication carrying electronic signature sent to epodatelna@fzu.cz for the Client and to fantinisud@mailcert.it for the Contractor.
4. In expert or technical matters (matters related to preliminary assessment of the delivery of Work, Warranty Claims, etc.) electronic communication will be acceptable between the appointed representatives for technical matters to e-mail addresses as provided in par. 2 here above.



XIX. DISPUTES:

1. This Contract and any and all legal relations arising herefrom shall be governed by the laws and regulations of the Czech Republic.
2. The Contractual Parties acknowledge and recognize that areas not explicitly regulated hereby shall be regulated by the respective provisions of the Civil Code (Czech Act. No. 89/2012 Coll.).
3. Any and all disputes arising in connection herewith shall be resolved by the Contractual Parties by negotiations. In cases where a dispute cannot be resolved by negotiation within sixty (60) days, such a dispute shall be decided upon a motion of one of the Contractual Parties by a competent court in the Czech Republic.

XX. INSURANCE:

1. The Contractor declares that he is adequately insured for any liability in respect of compensation for damages in connection with the performance of this Contract, for the company Societa Cattolica di Assicurazione (Verona-Italy), to the amount of the Price of Work. The Contractor shall maintain in force insurance contracts, as stated in first sentence hereof from the date of implementation of the Work and for at least four (4) years after its completion. The Contractor shall submit to the Client the insurance contract at his request. Failure to submit an insurance contract is a material breach of the Contract and the Client is entitled to cancel the contract.

XXI. CONCLUDING AND OTHER COVENANTS:

1. This Contract with all annexes represents a complete agreement between the Client and the Contractor.
2. In the event that any of the provisions of this Contract shall later be shown or determined to be invalid, putative, ineffective or unenforceable, then such invalidity, putativeness, ineffectiveness or unenforceability shall not cause the invalidity, putativeness, ineffectiveness, or unenforceability of the Contract as a whole. In such event the Contractual Parties undertake without any undue delay to subsequently clarify any such provision using Sec 553 (2) of the Civil Code, or to replace after mutual agreement such invalid, putative, ineffective or unenforceable provision of the Contract by a new provision, that in the extent permitted by the laws and regulations of the Czech Republic, relates as closely as possible to the intentions of the Contractual Parties to the Contract at the time of creation hereof.
3. This Contract becomes valid and comes into force on the date of its signature by the authorized representatives of both Contractual Parties.



4. This Contract may be amended or modified exclusively in the form of written and numbered amendments specifying the time and place thereof, and signed by the authorized representatives of the Contractual Parties. The Contractual parties expressly reject, within the bounds of Sec 564 of the Civil Code, modification of the Contract in any other manner.
5. This Contract was made out in two (2) counterparts, each having the force of original. Each Contractual Party shall receive two (1) counterparts..
6. The Annexes listed below form an integral part of this Contract:

Annex 1: Scope of Work

Annex 2: Technical specification

Annex 3 : Schedule of Deliverables

Annex 4: the Contractor's Bid

Annex 5: Quality plan (shall be attached pursuant to Art. VI par. 3 hereof after signing of the Contract

Annex 6: Verification plan

Annex 7: The breakdown of the Price of Work and Payments Schedule

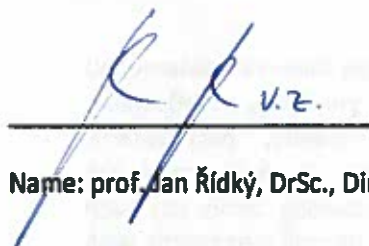
7. By attaching their signature hereto the Contractual Parties express their consent with the content hereof in its entirety.

In Prague on 29/12/2015

In ANAGNI on 23/12/2015

In behalf of the Client:

Fyzikální ústav AV ČR, v.v.i.



Name: prof. Jan Řídký, DrSc., Director

In behalf of the Contractor:

FANTINI SUD S.p.A



Name: Ing. Luigi Fantini (CEO)

Annex 1 – Scope of Work

The detailed description of the subject matter of the Contract:

1. According to the Contract and for the Price of Work the Contractor shall design, manufacture, assemble, test, deliver and install in the place of delivery stipulated in the Contract following Devices including local vacuum control systems that fulfill the requirements of the Technical specification of the Client and the Contractor's Bid:

Items	Device	Quantity (unit)
1.	ELIMAIA plasma mirror chamber unit (hereinafter "ELIMAIA I unit")	1
2.	ELIMAIA interaction chamber unit (hereinafter "ELIMAIA II unit")	1
3.	HELL interaction chamber unit (hereinafter "HELL I unit")	1
4.	HELL focusing chamber unit (hereinafter "HELL II unit")	1
5.	Connection of HELL chambers (hereinafter "HELL III connection")	1
6.	LUX focusing chamber unit (hereinafter "LUX unit")	1
7.	Betatron interaction chamber unit (hereinafter "unit Betatron unit")	1

2. The Work according to the Contract shall consist of following Deliverables and their parts as are listed below in the table designated as *"The description of the subject matter of the Contract"*, which the Contractor undertakes to perform:

The description of the subject matter of the Contract

Deliverable	The description of the parts of Deliverable
D1: The Contractor shall design, manufacture, assemble, test, deliver and install to the Client 1 pcs of ELIMAIA I unit (hereinafter	Within this Deliverable D1 the Contractor shall: a) develop the Conceptual design of ELIMAIA I unit presented by the Client, so that the <u>preliminary design of this Device</u> including all its parts is created (hereinafter "Deliverable D1 i");

"Deliverable D1").	b) develop preliminary proposal design of this Device approved by the Client in Deliverable D1 i) into <u>detailed plan of Device</u> including all its parts (hereinafter "Deliverable D1 ii)"); c) manufacture and assemble Device in accordance with the detailed plan of Device approved by the Client within Deliverable D1 ii) and shall test this Device pursuant to the Verification plan (hereinafter "Deliverable D1 iii)"); d) deliver, assemble, install and test this Device pursuant to the Verification plan in the Research center ELI-Beamlines (hereinafter "Deliverable D1 iv)");
D2: The Contractor shall design, manufacture, assemble, test, deliver and install to the Client 1 pcs of ELIMAIA II unit (hereinafter "DeliverableD2")).	Within this Deliverable D2 the Contractor shall: a) develop the Conceptual design of ELIMAIA II unit presented by the Client, so that the <u>preliminary design of this Device</u> including all its parts is created (hereinafter "Deliverable D2 i)"); b) develop preliminary proposal design of this Device approved by the Client in Deliverable D2 i) into <u>detailed plan of Device</u> including all its parts (hereinafter "Deliverable D2 ii)"); c) manufacture and assemble Device in accordance with the detailed plan of Device approved by the Client within Deliverable D2 ii) and shall test this Device pursuant to the Verification plan (hereinafter "Deliverable D2 iii)"); d) deliver, assemble, install and test this Device pursuant to the Verification plan in the Research center ELI-Beamlines (hereinafter "Deliverable D2 iv)");
D3: The Contractor shall design, manufacture, assemble, test, deliver and install to the Client 1 pcs of HELL I unit (hereinafter "DeliverableD3")).	Within this Deliverable D3 the Contractor shall: a) develop the Conceptual design of HELL I unit presented by the Client, so that the <u>preliminary design of this Device</u> including all its parts is created (hereinafter "Deliverable D3 i)"); b) develop preliminary proposal design of this Device approved by the Client in Deliverable D3 i) into <u>detailed plan of Device</u> including all its parts (hereinafter "Deliverable D3 ii)"); c) manufacture and assemble Device in accordance with the detailed plan of Device approved by the Client within Deliverable D3 ii) and shall test this Device pursuant to the Verification plan (hereinafter "Deliverable D3 iii)");

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	d) deliver, assemble, install and test this Device pursuant to the Verification plan in the Research center ELI-Beamlines (hereinafter “Deliverable D3 iv”).
D4: The Contractor shall, design, manufacture, assemble, test, deliver and install to the Client 1 pcs of HELL II unit (hereinafter “DeliverableD4”).	Within this Deliverable D4 the Contractor shall: a) develop the Conceptual design of HELL II unit presented by the Client, so that the <u>preliminary design of this Device</u> including all its parts is created (hereinafter “Deliverable D4 i”); b) develop preliminary proposal design of this Device approved by the Client in Deliverable D4 i) into <u>detailed plan of Device</u> including all its parts (hereinafter “Deliverable D4 ii”); c) manufacture and assemble Device in accordance with the detailed plan of Device approved by the Client within Deliverable D4 ii) and shall test this Device pursuant to the Verification plan (hereinafter “Deliverable D4 iii”); d) deliver, assemble, install and test this Device pursuant to the Verification plan in the Research center ELI-Beamlines (hereinafter “Deliverable D4 iv”).
D5: The Contractor shall, design, manufacture, assemble, test, deliver and install to the Client HELL III connection (hereinafter “DeliverableD5”).	Within this Deliverable D5 the Contractor shall: a) develop the Conceptual design of HELL III connection presented by the Client, so that the <u>preliminary design of this Device</u> including all its parts is created (hereinafter “Deliverable D5 i”); b) develop preliminary construction proposal design of this Device approved by the Client in Deliverable D5 i) into <u>detailed plan of Device</u> including all its parts (hereinafter “Deliverable D5 ii”); c) manufacture and assemble Device in accordance with the detailed plan of Device approved by the Client within Deliverable D5 ii) and shall test this Device pursuant to the Verification plan (hereinafter “Deliverable D5 iii”); d) deliver, assemble, install and test this Device pursuant to the Verification plan in the Research center ELI-Beamlines (hereinafter “Deliverable D5 iv”).
D6: The Contractor shall design, manufacture, assemble, test, deliver and install to	Within this Deliverable D6 the Contractor shall: a) develop the Conceptual design of LUX unit presented by the Client, so that the <u>preliminary design of this Device</u> including all its parts is

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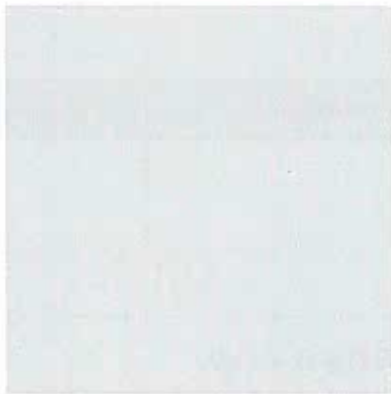
the Client 1 pcs of LUX unit (hereinafter "DeliverableD6").	created (hereinafter "Deliverable D6 i"); b) develop preliminary proposal design of this Device approved by the Client in Deliverable D6 i) into <u>detailed plan of Device</u> including all its parts (hereinafter "Deliverable D6 ii"); c) manufacture and assemble Device in accordance with the detailed plan of Device approved by the Client within Deliverable D3 ii) and shall test this Device pursuant to the Verification plan (hereinafter "Deliverable D6 iii"); d) deliver, assemble, install and test this Device pursuant to the Verification plan in the Research center ELI-Beamlines (hereinafter "Deliverable D6 iv").
D7: The Contractor shall design, manufacture, assemble, test, deliver and install to the Client 1 pcs of BETATRON unit (hereinafter "DeliverableD7").	Within this Deliverable D7 the Contractor shall: a) develop the Conceptual design of BETATRON unit presented by the Client, so that the <u>preliminary design of this Device</u> including all its parts is created (hereinafter "Deliverable D7 i"); b) develop preliminary proposal design of this Device approved by the Client in Deliverable D7 i) into <u>detailed plan of Device</u> including all its parts (hereinafter "Deliverable D7 ii"); c) manufacture and assemble Device in accordance with the detailed plan of Device approved by the Client within Deliverable D7 ii) and shall test this Device pursuant to the Verification plan (hereinafter "Deliverable D7 iii"); d) deliver, assemble, install and test this Device pursuant to the Verification plan in the Research center ELI-Beamlines (hereinafter "Deliverable D7 iv").
D8: The provision of Out-of-Warranty service, (i.e. services outside the scope of Warranty services)	On the basis of the Contract the Contractor undertakes to provide services outside the scope of warranty services in connection with Devices as is stipulated in Art. V and XII par. 12 of the Contract, in the extent of maximum 3 service days ("Out-of-Warranty service")

3. In accordance with Art. III par. 3 of the Contract the Client is entitled until the term for delivery of detailed manufacturing plan of each Device (as stated in in Annex 3 hereof) to ask the Contractor to modify the Work that shall be included in the Price of Work and shall consist of these requirements for changes of each Device:

- a. up to 6 inlets DN100 or DN160 per the ECU lateral panel (incl flanges);
- b. up to 3 inlets DN100 or DN160 per each Device (incl flanges);
- c. up to 3 inlets DN250 per each Device (incl flanges);
- d. 1 inlet DN400 per each Device (incl flanges);
- e. Change of panel size up to $\pm 10\%$.

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Annex 2. Technical Specification

Confidentiality Level	BL - Restricted for internal use	TC ID / Revision	00104402 / F
Document Status	Document Reviewed	Document No.	Specific Document code
WBS code	5.1 - RP2 - X-ray sources driven by rep-rate ultrashort laser pulses		
PBS code	E.E2.BETA - (RA2) Betatron beamline		
<i>Requirements Specification Document (RSD)</i>			
<i>ECU BETATRON interaction chamber</i>  Keywords Put keywords related to the document content.			
	Position	Name	
Responsible person	Group Leader RP3	Daniele Margarone	
Prepared by	Chief Engineer	Pavel Korouš	

<i>RSS TC ID/revision</i>	<i>Date of Creation</i>	<i>Date of Last Modification</i>	<i>Systems Engineer</i>
001385 / E	09-12-2014 21:21	11-12-2014	Pavel Korouš
001385 / F	27-02-2015 16:49	02-03-2015	Aleksei Kuzmenko

Reviewed By			
<i>Name (Reviewer)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Approved by			
<i>Name (Approver)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Revision History / Change Log				
<i>Change No.</i>	<i>Made by</i>	<i>Date</i>	<i>Change description, Pages, Chapters</i>	<i>TG rev.</i>

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1. ECU (Experimental Chamber Unit)

ECU is an abbreviation for **Experimental Chamber Unit** which in contract text is called by **Device**. **ECU** is defined for this specification purpose as a self-contained unit providing controlled pumping and venting together with provision of stable area for optical layout.

2. Functional and Performance Requirements

REQ-002659/A

ECU shall allow vacuum pumping and venting for experimental set-up.
Verification method: FD - functional demonstration

REQ-002660/A

ECU shall reach vacuum level 10^{-6} mbar.
Verification method: T - test

REQ-002662/A

ECU vacuum equipment shall be capable reaching 10^{-5} mbar vacuum level in 60 minutes.
Verification method: T - test

REQ-002663/A

Preventive maintenance time shall not exceed 8 hours.
Verification method: R - review

REQ-002664/A

The **ECU** shall provide pumping and venting sequences.
Verification method: FD - functional demonstration

3. Operational design requirements

REQ-002665/A

ECU shall comply with frequency of opening/closing 2-times a day.
Verification method: R - review

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4. Design requirements

4.1. General

REQ-003503/A

Enclosed **ECU** tender .pdf drawings shall be taken into account as a concept for preliminary design.

Verification method: R - review

REQ-002666/A

Interaction Chamber Unit (**ECU**) shall provide space for customer provided optical equipment.

Verification method: R - review

REQ-002667/A

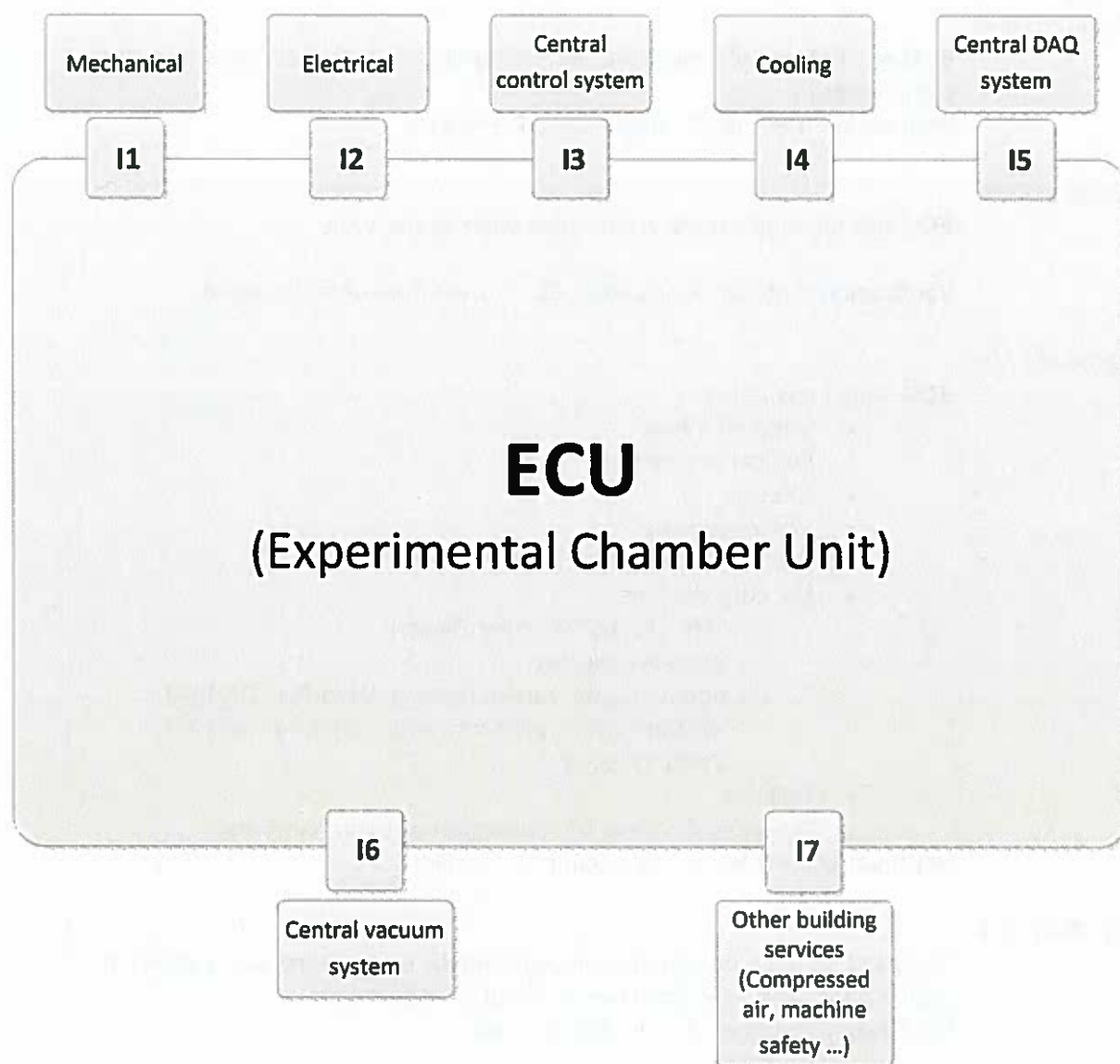
ECU shall provide for the following interfaces:

- TMP's (Turbo Molecular Pumps)
- Gauges
- Feedthrough
- Diagnostics
- Remote control
- Central Vacuum System (CVS)
- Beam Transport (BT)
- ELI Building
- ELI Building services

Verification method: R - review

REQ-003411/A

Supplier shall provide **ECU** Interface Control Document (**ICD**).



Verification method: R - review

REQ-002668/A

ECU shall allow positioning according to **Reference Mechanical System (RMS)**.

Verification method: R - review

REQ-002669/A

RCS and its relation to the **RMS** shall be set up together with supplier during the preliminary design phase.

Verification method: R - review

Py

REQ-002670/A

ECU shall allow safe handling and manipulation with internal and external components.

Verification method: I - inspection, R - review

REQ-002671/A

ECU design shall assure a safe operation of the unit.

Verification method: R - review, FD - functional demonstration

REQ-002672/A

ECU shall consist of:

- Vacuum vessel
- Optical breadboard
- Chassis
- Vessel chassis
- Optical breadboard chassis
- Vacuum devices:
 - TMP (TurboMolecular Pump)
 - Vacuum gauges
 - Vacuum gate valves (main inlet/outlet DN400)
 - Vacuum gate valve for rough vacuum (DN100)
 - Venting valve
- Bellows
- Pipework (in case of connection of two chambers)

Verification method: I - inspection, R - review

REQ-002673/A

The **ECU** shall be designed to accommodate laser beam axis 1300 mm above floor level (see attached conceptual drawings).

Verification method: R - review, T - test

REQ-002674/A

Tools used during manufacture shall not contaminate the vacuum surface.

Verification method: T - test

REQ-003510/A

All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.

Verification method: R - review, T - test

4.2. Operational design requirements

REQ-002675/A

ECU shall be a modular unit allowing extension in longitudinal direction.

Verification method: R - review, I - inspection

REQ-002676/A

ECU breadboard and vacuum vessel shall be decoupled.

Verification method: I - inspection, R - review

REQ-002677/A

Decoupling of **ECU** breadboard and vacuum vessel shall be made by using edge welded bellows.

Verification method: R - review, I - inspection

REQ-003190/A

Double bellows decoupling system shall be applied on **ECU** breadboard chassis.

Verification method: R - review

4.3. ECU design requirements

4.3.1. ECU Vacuum vessel design

REQ-002678/A

ECU frame shall be made of stainless steel following types:

- AISI 304L or
- AISI 304

Verification method: I - inspection, R - review

REQ-002679/A

ECU panels shall be made of aluminum following types:

- Al2219
- Al3003
- Al5083
- Al6082
- Al2090
- Al2219
- Al7005

Verification method: R - review, I - inspection

Py

REQ-002680/A

Final choice of **ECU** vessel materials shall be made in preliminary design phase.

Verification method: R - review

REQ-002681/A

ECU panels shall be designed as a modular system.

Verification method: R - review, I - inspection

REQ-002682/B

Maximum size of modular aluminium panels shall be 1x1.5 m. *Technical note: Increase of dimension from 1.5 m up to 2 m is acceptable in access optical breadboard area.*

Verification method: R - review, I - inspection

REQ-002683/A

Thickness of **ECU** modular aluminium panels shall be in bounded interval 40 + 50 mm.

Verification method: R - review, T - test

REQ-002684/A

All **ECU** panels shall be equipped by Lifting eyes interfaces.

Verification method: R - review, I - inspection

REQ-002685/A

ECU panels close to main optical components shall be equipped with small doors with minimal width 600 mm and high 500 mm.

Verification method: R - review, I - inspection

REQ-002686/A

Openings of **ECU** shall be closed by aluminium blank flanges.

Verification method: R - review, I - inspection

REQ-002687/A

Stainless steel screws with Allen heads shall be used on **ECU** panels.

Verification method: I - inspection, R - review

REQ-002688/A

ECU small doors shall be equipped with hinges.

Verification method: R - review, I - inspection

REQ-002689/A

Maximal deformations of **ECU** panels under vacuum shall be lower than 3 mm in comparison to the vented status.

Verification method: A - analysis, R - review, T - test

REQ-002690/A

Deformations of **ECU** panels in selected coordinates under vacuum shall be lower than 2 mm in comparison to the vented status.

Verification method: A - analysis, T - test

REQ-002691/A

All **ECU** removable panels shall be equipped with guiding pins to allow proper panel seating.

Verification method: R - review, I - inspection

REQ-002692/A

Sealing of **ECU** panels shall be made of fluorelastomer polymer (FPM) material.

Verification method: R - review, I - inspection

REQ-002693/B

Hardness of **ECU** sealing o-rings shall be 60 or 70 HSC (Shore).

Verification method: I - inspection, R - review

REQ-002694/A

ECU shall be equipped with roughing inlet interface (DN100).

Verification method: R - review, I - inspection

REQ-002696/A

Surface treatment of inner **ECU** vacuum vessel surfaces compatible with 10^{-6} mbar shall be applied.

Verification method: R - review, I - inspection

4.3.2. Vacuum Vessel Chassis

REQ-002697/A

ECU vacuum vessel chassis shall allow **z** (vertical) positioning.

Verification method: I - inspection, R - review

REQ-002698/A

Range of **ECU** vacuum vessel chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: R - review, T - test

REQ-002699/A

ECU vacuum vessel chassis shall be made of stainless steel or extruded aluminium profiles.

Verification method: R - review, I - inspection

Py

REQ-002700/A

ECU chassis shall allow for installation of TMP's.
Verification method: R - review, I - inspection

REQ-002701/A

ECU chassis shall allow for floor fixing.
Verification method: R - review, I - inspection

REQ-002702/A

ECU vacuum vessel chassis shall be equipped with removable transportation wheels.
Verification method: R - review, I - inspection

4.3.3. ECU Optical breadboard design

4.3.3.1. General

REQ-002703/B

Supplier shall provide static FEM analysis and vibration study according to customer inputs.
Technical note: The latest results of building vibration measurement will be provided by customer after contract signature.
Verification method: A - analysis, R - review

4.3.3.2. Optical breadboard

REQ-002704/A

ECU optical breadboard shall allow connection of multiple modular breadboards.
Verification method: I - inspection, R - review

REQ-002705/A

ECU optical breadboard shall have threaded hole pattern with 25 mm spacing.
Verification method: R - review, T - test

REQ-002706/A

Threaded holes of **ECU** breadboard shall be M6 size.
Verification method: R - review, T - test

REQ-002707/A

ECU optical breadboard shall be made of aluminium following types:
• Al2219

- AI3003
- AI5083
- AI6082
- AI7005

Verification method: R - review, I - inspection

REQ-002708/A

Final choice of **ECU** optical breadboard materials shall be made in preliminary design phase.

Verification method: R - review, I - inspection

REQ-002709/A

Minimum thickness of **ECU** breadboard plate shall be 50 mm.

Verification method: A - analysis, R - review, T - test

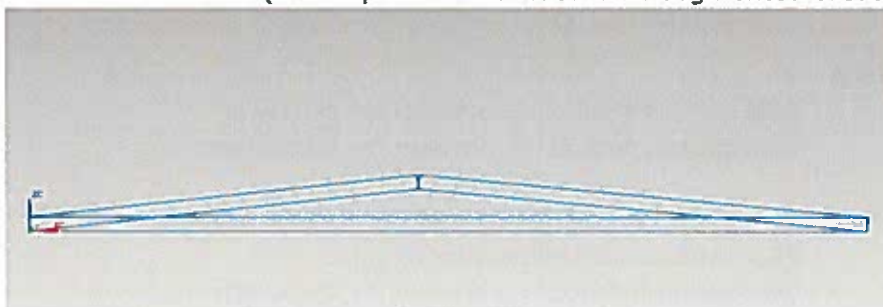
REQ-002710/A

Maximal thickness of whole **ECU** breadboard (plate with reinforcing ribs) shall be 130 mm.

Verification method: A - analysis, R - review, T - test

REQ-002711/B

Maximum misalignment after connection of breadboard segments shall be lower than 1 mrad. (in comparison with ideal non-segmented breadboard)



Technical note: This requirement is valid only in case of using segmented optical table.

Verification method: T - test

REQ-002712/A

Maximum z direction misalignment after connection of breadboard segments shall be lower than 1 mm.

Verification method: T - test, FD - functional demonstration

REQ-002713/A

Supplier shall provide procedure of misalignment measurement.

Verification method: R - review, T - test

Ray

4.3.3.3. Optical Breadboard Chassis

REQ-002714/A

ECU chassis shall be designed as modular unit.

Verification method: R - review, I - inspection

REQ-002715/A

Only one chassis shall be applied for more connected **ECU** breadboards.

Verification method: R - review, I - inspection

REQ-002716/A

ECU optical breadboard chassis shall allow **z** (vertical) positioning.

Verification method: R - review, I - inspection

REQ-002717/A

Range of **ECU** optical breadboard chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: I - inspection, T - test

REQ-002718/A

ECU optical breadboard chassis shall be made of stainless steel or aluminium extruded profiles.

Verification method: R - review, I - inspection

REQ-002719/A

ECU chassis shall allow installation of TMP's.

Verification method: R - review, I - inspection

REQ-002720/A

ECU chassis shall allow floor fixing.

Verification method: R - review, I - inspection

REQ-002721/A

The **ECU** optical breadboard chassis shall be equipped with removable transportation wheels.

Verification method: R - review, I - inspection

REQ-003197/A

The **ECU** optical breadboard chassis shall have interface for vibration dumping system.

Verification method: R - review

4.3.4. ECU Vacuum equipment

4.3.4.1. TMP (Turbomolecular pump)

REQ-002722/A

Only new **ECU** TMP with full warranty shall be used.
Verification method: I - inspection

REQ-002723/A

ECU shall be installed in accordance to the installation manual of TMP supplier.
Verification method: R - review, I - inspection

REQ-002724/A

ECU TMP shall be water cooled.
Verification method: R - review, I - inspection

REQ-002725/A

ECU TMP coolant shall be demineralized water.
Verification method: I - inspection

REQ-002726/A

ECU TMP shall be equipped with fittings for water cooling.
Verification method: I - inspection

REQ-002727/A

ECU TMP shall be equipped with protective screen.
Verification method: I - inspection

REQ-002728/A

ECU TMP shall be compatible with power supply 230V, 50 Hz.
Verification method: I - inspection

REQ-002729/A

ECU TMP inlet flange shall be ISO-F according to ISO 1609:1986.
Verification method: I - inspection

REQ-002730/A

ECU TMP outlet flange shall be ISO-KF according to ISO 2861:2013.
Verification method: I - inspection

REQ-002731/A

Maximum noise of **ECU** TMP shall be 60 dB.
Verification method: R - review

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REQ-002732/A

ECU TMP with minimum pumping speed 1500 l/sec shall be used.
Verification method: R - review, I - inspection

REQ-002733/A

ECU TMP set up shall be equipped with separation gate valve.
Verification method: I - inspection

REQ-002734/A

ECU TMP shall be equipped with electrically operated venting valve.
Verification method: I - inspection

REQ-002735/A

ECU TMP shall be equipped with power supply unit and control unit.
Verification method: I - inspection

REQ-002736/A

ECU TMP shall be equipped with 19" equipment rack mountable controllers.
Verification method: I - inspection

REQ-002737/A

The minimum required lifetime of TMP shall be 50 000 working hours.
Verification method: R - review

REQ-002738/A

The TMP shall be able to operate continuously at a maximum inlet pressure of 0.05 mbar.
Verification method: R - review

REQ-002739/A

The TMP shall be able to operate continuously at a maximum exhaust pressure of 0.5 mbar.
Verification method: R - review

REQ-002740/A

The TMP shall be protected against damage from sudden temperature rise.
Verification method: R - review, I - inspection

REQ-002741/A

TMP and their accessories (including liquid cooling fittings) must be in compliance with the following standards:

- ISO 1609:1986 - Vacuum technology - Flange dimension
- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings

- ISO 5302:2003 - Vacuum technology - Turbomolecular pumps - Measurement of performance characteristic

Verification method: R - review

4.3.4.2. Gauges

REQ-002742/A

Measurement range of combined gauge shall be $1000 \text{ mbar} \div 1 \times 10^{-6} \text{ mbar}$ with maximum accuracy $\pm 30\%$.

Verification method: R - review, I - inspection

REQ-002743/A

Mechanical interface of ECU Vacuum gauges shall be ISO KF according to ISO 2861:2013.

Verification method: R - review, I - inspection

REQ-002744/A

Vacuum connection of the gauges must be in compliance with the following standards:

- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings.

Verification method: R - review, I - inspection

REQ-002745/A

Power supply of **ECU** vacuum gauges shall be 24VDC.

Verification method: R - review, I - inspection

REQ-002746/A

Interval of output **ECU** vacuum gauges signal shall be $0 \div 11 \text{ VDC}$.

Verification method: R - review, I - inspection

4.3.4.3. Gate valves

REQ-002747/A

ECU gate valve separating TMP shall be made of stainless steel (body material).

Verification method: R - review, I - inspection

REQ-002748/A

Main **ECU** inlet/outlet gate (DN400) valves shall be made of aluminium (body material).

Verification method: R - review, I - inspection

Pug

REQ-002749/A

The **ECU** gate valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

REQ-002750/A

Minimal open/close cycles of **ECU** gate valves until first service shall be 200 000.

Verification method: R - review

REQ-002751/A

ECU gate valve shall be equipped with ISO F flange according to ISO 1609:1986.

Verification method: I - inspection

REQ-002752/A

ECU gate valves shall be equipped with blank flange from atmosphere side.

Verification method: I - inspection

4.3.4.4. Venting valves

REQ-002753/A

ECU shall be equipped with venting valve.

Verification method: I - inspection

REQ-002754/A

Automatic venting valve shall be used on **ECU**.

Verification method: I - inspection

REQ-002755/A

The **ECU** venting valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

4.3.4.5. Bellows (connection of two chambers)

REQ-002756/A

Edge welded bellows shall be used on **ECU**.

Verification method: I - inspection, R - review

REQ-002757/A

ECU bellows shall be equipped with threaded rods.

Verification method: I - inspection, R - review

REQ-002758/A

Compensation range of ECU connecting bellows shall be:

- Axial ± 15 mm
- Lateral ± 5 mm
- Angular $\pm 2^\circ$

Verification method: R - review, I - inspection, T - test

4.3.4.6. Vacuum clamps

REQ-002759/A

All **ECU** vacuum clamps shall be permanent set free after assembling.

Verification method: I - inspection, FD - functional demonstration

REQ-002760/A

Clamp slots shall defect free.

Verification method: I - inspection

4.3.4.7. Local & remote vacuum control and safety system

REQ-002761/A

ECU local control system shall be designed and verified as an autonomous manually controlled system with interfaces to ELI – control system.

Verification method: R - review, I - inspection

REQ-002762/A

All ECU TMP's, vacuum gauges and valves shall be delivered with the **associated controllers**.

Verification method: I - inspection

REQ-002763/A

The controllers shall provide a reliable control interface to ELI central control system via LC optical fibers or RJ45 metallic connections.

Verification method: I - inspection

REQ-002764/A

The communication protocol shall be available and compatible with Linux OS.

Verification method: R - review

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REQ-002765/A

Documentation for the protocol shall be provided.
Verification method: I - inspection

REQ-002766/A

Safety interface based on digital I/O (24V DC signals) shall be provided for redundancy in addition to REQ-002770/A.
Verification method: R - review

REQ-002767/A

The controllers shall have local and remote access capabilities.
Verification method: I - inspection

REQ-002768/A

The controllers shall provide separate interlock capabilities via dry C-shape contacts.
Verification method: I - inspection

REQ-002769/A

All valves shall be supplied with open/closed limit switches wired to standard DIN connectors with mating plugs.
Verification method: I - inspection

REQ-002770/A

The supplied controls shall provide a safe pumping and venting sequence including interlocks in the local and remote mode of operation.
Verification method: I - inspection

4.3.5. Data acquisition

REQ-002771/A

Following data shall be readable from the ECU:

- Temperature on TMP
- Level of vacuum
- rpm of TMP rotor
- Hours of TMP operation
- Levitation of TMP rotor (if maglev is used)

Verification method: R - review, T - test

4.3.6. EMC/EMP

REQ-002772/A

The **ECU** design shall comply with EU standards of electro-magnetic compatibility.

Verification method: R - review

5. System Transportation and installation requirements

5.1. General requirements

REQ-002773/A

Supplier shall provide procedures for transportation and installation of **ECU**.

Verification method: R - review

REQ-002774/A

Supplier shall provide procedures for handling and manipulation of **ECU**.

Verification method: R - review

REQ-007163/A

The transportation and installation personnel shall follow the customer's facility regulations.

NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.

Verification method: R - review

REQ-007164/A

The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in clean environment of ISO class 7, if not agreed otherwise.

Verification method: R - review, I - inspection

REQ-007165/A

All transportation and installation tools and equipment entering the clean rooms shall be cleaned and reviewed by the customer's approved methods.

NOTE: Some tools can be provided by the customer upon agreement.

Verification method: I - inspection, T - test

Hy

REQ-007166/A

The transportation to the final destination and the installation of the technologies and the instruments shall be conducted by the vendor. The methods shall be discussed and reviewed by the customer's installation officer and shall be compliant with the customer's installation regulations.
NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.
Verification method: R - review

REQ-007167/A

The main parts of the mechanical structure shall be equipped with positioning/alignment marks for industrial 3D-measurements/survey. The specific type of the positioning/alignment marks, their number and location shall be agreed with the customer.
Verification method: R - review, I - inspection

5.2. Transportation

REQ-002775/A

The supplier shall provide supervision by transport **ECU** to defined position in ELI – Beamlines experimental room.
Verification method: R - review, I - inspection

REQ-002777/A

All Parts shall be identified according to technical documentation.
Verification method: R - review

5.3. Installation

REQ-002779/A

Connection of **ECU** to the ELI- Beamlines facility services shall be made under supervision of supplier.
Verification method: R - review, I - inspection

REQ-002780/A

Assembling of **ECU** on supplier side shall be made in cleanroom ISO7.
Verification method: I - inspection

REQ-002781/A

All specific equipment and tools necessary for installation of the **ECU** shall be subject of the supplier delivery.
Verification method: I - inspection, R - review

REQ-002782/A

Maximum dimensions of goods going through experimental entrance area shall be 3000x2000x2000 mm (length x with x high)

Verification method: R - review, T - test

6. Handling and Manipulation

REQ-002784/A

Supplier shall provide an approved methodological document describing safe handling and manipulation of the product.

Verification method: R - review

7. Maintenance

REQ-002785/A

Supplier shall provide an approved methodological document describing maintenance procedures of the product.

Verification method: R - review

8. Safety Requirements

REQ-002786/A

The **ECU** design of relevant parts shall comply with Czech and EU regulations regarding safety domain.

NOTE: Application of Czech regulations will be subject of preliminary design.

Verification method: R - review

REQ-002787/A

Supplier shall perform hazard identification and risk assessment of system prior to design.

Verification method: A - analysis, R - review

REQ-002788/A

All **ECU** manufactured parts shall be free of sharp edges.

Verification method: I - inspection

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REQ-002789/A

All **ECU** manufactured parts shall be burr free.
Verification method: I - inspection

9. Quality

9.1. Quality Management

9.1.1. Quality organization and responsibilities

9.1.1.1. Organization

REQ-002790/A

The supplier shall identify the personnel responsible for implementing and performing QA management plan and other Quality Controls disciplines.
Verification method: R - review

REQ-002791/A

The supplier shall assign a project Quality manager reporting to the project manager who has an unimpeded access to higher management.
Verification method: R - review

REQ-002792/A

The appointed project Quality manager, irrespective of other responsibilities, shall have organizational authority to establish and implement a quality assurance programme in accordance with the project quality assurance requirements.
Verification method: R - review

REQ-002793/A

The project Quality Manager shall act as the primary contact person within the project concerning Quality matters.
Verification method: R - review

REQ-007178/A

The supplier shall apply international recognized standards or best practice where applicable for quality assurance programme.
Verification method: R - review

9.1.1.2. Responsibility and authority

REQ-002794/A

The supplier shall define and document the responsibility, the authority and the interrelation of personnel who manage, perform and verify work affecting quality assurance.

Verification method: R - review

REQ-002795/A

The supplier shall define and document the responsibilities and the interfaces of the Quality functions, either external or internal, involved in a project.

Verification method: R - review

REQ-002796/A

When the supplier's Quality organization delegates quality assurance tasks to another organization it shall be done in a documented and controlled way monitored by the Quality organization.

Verification method: R - review

9.1.2. Quality plan and its implementation

REQ-002797/A

The supplier shall prepare, maintain and implement a plan of the QA (Quality Assurance) activities in accordance with the customer QA requirements.

Verification method: R - review

REQ-002800/A

The supplier management shall ensure that the inputs used by the Quality functions are consistent and complete, and available in line with the project schedule.

Verification method: R - review

REQ-002801/A

The supplier QA management shall ensure that the QA functions perform the tasks described in the QA Plan in line with the project schedule.

Verification method: R - review

REQ-002802/A

The supplier QA management shall ensure that the outputs produced by the QA functions are consistent and complete, and delivered in line with the project schedule.

Verification method: R - review

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REQ-002803/A

The supplier QA management shall ensure the application of processes defined in applicable project plans and documents.

Verification method: R - review

9.1.3. Documentation and data control

REQ-002804/B

The supplier shall provide following type of documents:

- 3D model (format: *.step; *.stp)
- 2D drawings (format: *.dwg)
- Printable format for text documents

Verification method: I - inspection

10. Environmental conditions

REQ-002805/A

Final cleanliness shall be compatible with ISO 7.

Verification method: I - inspection

11. Verification process

REQ-002806/A

The verification process shall demonstrate that the deliverable product meets the specified customer requirements and is capable of sustaining its operational role through:

1. Verification planning;
2. Verification execution and reporting;
3. Verification control and close-out.

Verification method: R - review

REQ-002807/A

The supplier shall define the verification approach by conducting the following steps:

1. Identify and agree with the customer the set of requirements to be subject of the verification process.
2. Select the methods and levels of verification, associated model philosophy and verification tools.

3. Identify the stages and events in which the verification is implemented.
Verification method: R - review

REQ-002808/A

The verification approach shall be defined by the supplier in the Verification Plan (VP) for approval by the customer prior to implementation.
Verification method: R - review

11.1. Verification methods

11.1.1. General

REQ-002810/A

Verification shall be accomplished by one or more of the following verification methods:

1. test (including functional demonstration);
2. analysis (including similarity);
3. review-of-design;
4. inspection.

Verification method: R - review

REQ-002811/A

All safety critical functions shall be verified by test.
Verification method: R - review

REQ-002812/A

Verification of software shall include testing in the target hardware environment.
Verification method: R - review

11.1.2. Test

REQ-002813/A

Verification by test shall consist of measuring product performance and functions under representative simulated environments.
Verification method: R - review

REQ-002814/A

The analysis of data derived from testing shall be an integral part of the test and the results included in the test report.
Verification method: R - review

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REQ-002815/A

When the test objectives include the demonstration of qualitative operational performance, the execution shall be observed and results recorded (functional demonstration).

Note: Functional demonstration is a subset of tests.

Verification method: R - review

REQ-002816/A

A test programme shall be prepared for each product in conformance with Verification Plan.

Verification method: R - review

REQ-002817/A

The test programme shall be coordinated with the integration flow.

Verification method: R - review

REQ-002818/A

Tests performed as part of the integration flow to check quality and status of the in-progress configuration (including interfaces), having a formal verification purpose, shall be included in the test programme.

Verification method: R - review

REQ-002819/A

The test programme shall be defined in the specific chapter of the Verification Plan.

Verification method: R - review

REQ-002820/A

Test Programme shall be approved by the Customer.

Verification method: R - review

11.1.3. Analysis

REQ-002822/A

Verification by analysis shall consist of performing theoretical or empirical evaluation using techniques agreed with the Customer.

NOTE: Techniques comprise systematic, statistical and qualitative design analysis, modelling and computational simulation.

Verification method: R - review

REQ-002825/A

An analysis programme shall be defined in the Verification Plan (VP).

Verification method: R - review

11.1.4. Review-of-design (ROD)

REQ-002826/A

Verification by Review-of-design (ROD) shall consist of using approved records or evidence that unambiguously show that the requirement is met.

NOTE Examples of such approved records are design documents and reports, technical descriptions, and engineering drawings.

Verification method: R - review

REQ-002827/A

A review-of-design programme shall be defined in the Verification Plan (VP).

Verification method: R - review

REQ-002828/A

A review-of-design programme shall only be applicable in stages (phases) before starting the manufacturing.

Verification method: R - review

11.1.5. Inspection

REQ-002829/A

Verification by inspection shall consist of visual determination of physical characteristics.

NOTE: Physical characteristics include constructional features, hardware conformance to document drawing or workmanship requirements, physical conditions, software source code conformance with coding standards.

Verification method: R - review

REQ-002830/A

An inspection programme shall be defined in the Verification Plan (VP).

Verification method: R - review

12. Qualification (if needed)

N/A

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13. Acceptance

REQ-002831/A

In the acceptance stage the verification shall demonstrate that the product is free of fabrication errors and is ready for the intended operational use.

Verification method: R - review

REQ-002832/A

Acceptance shall be carried out on the final hardware and software

Verification method: R - review

14. Verification process phasing

REQ-002835/A

The verification process shall be phased with the project life cycle defined as a contract execution phases (preliminary design, detailed design, manufacturing and deployment of deliverable product(s) see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002836/A

Verification planning to assess feasibility and support programmatic shall start in the early phases (see Annex I – ECU Contract Phases).

NOTE: programmatic means support equipment and verification timescale estimation.

Verification method: R - review

REQ-002837/A

The preliminary verification planning shall cover all products and requirements by the end of preliminary design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002838/A

Verification planning shall be completed by the end of detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002839/A

Verification execution and reporting shall be incrementally carried out through the project life cycle starting from detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002840/A

Verification control shall start with the initial issue of the verification control document (VCD) during detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002841/A

Verification close out status shall be assessed and approved by the customer for each product at the end of each stage (see Annex I – ECU Contract Phases).

Verification method: R - review

15. Verification plan (VP)

REQ-002842/A

The supplier shall provide a Verification plan (VP) for the reviews as agreed with the customer

NOTE Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-002843/A

The contents of the Verification plan (VP) shall be approved by the Customer

Verification method: R - review

16. Verification Control Document (VCD)

REQ-002844/A

The supplier shall provide a Verification Control Document (VCD) for the reviews as agreed with the customer

NOTE: Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-002845/A

The contents of the initial issue of the Verification Control Document (VCD) shall be in conformance with ELI verification matrix.

Verification method: R - review

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17. Verification execution and reporting

17.1. General

REQ-002847/A

The supplier shall assign clear responsibility for the implementation of the verification plan.

Verification method: R - review

REQ-002848/A

The test preparation and execution (including Test Readiness Review (TRR) and Post Test Review (PTR)) shall be reviewed by the Customer.

Verification method: R - review

REQ-002849/A

The verification results shall be recorded by the supplier in reports for review by the Verification Control Board (VCB) through the VCD.

Verification method: R - review

17.2. Verification execution and reporting documentation

17.2.1. Test report (TRPT)

REQ-002850/A

The test report (TRPT) shall be submitted to the Verification Control Board (VCB) after the test completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002851/A

The content of the Test report (TRPT) shall be agreed with the Customer.

Verification method: R - review

REQ-002852/A

The supplier shall provide the Test reports (TRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002853/A

A Test report (TRPT) shall be provided for each test verification task as identified in the VP.

Verification method: R - review

17.2.2. Analysis report (ARPT)

REQ-002854/A

The Analysis report (ARPT) shall be submitted to the Verification Control Board (VCB) after analysis completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002855/A

The supplier shall provide an Analysis report (ARPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002856/A

An Analysis report (ARPT) shall be provided for each Analysis verification task identified in the VP.

Verification method: R - review

17.2.3. Review-of-design report (RRPT)

REQ-002857/A

The Review-of-design report (RRPT) shall be submitted to the Verification Control Board (VCB) after the Review-of-Design completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002858/A

The supplier shall provide a Review-of-design report (RRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002859/A

A Review-of-design report (RRPT) shall be provided for each Review-of-design verification task identified in the VP.

Verification method: R - review

17.2.4. Inspection report (IRPT)

REQ-002860/A

The Inspection report (IRPT) shall be submitted to the Verification Control Board (VCB) after the inspection completion, within the time frame agreed with the customer.

Verification method: R - review

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REQ-002861/A

The supplier shall provide an Inspection report (IRPT) for the reviews as agreed with the customer
Verification method: R - review

REQ-002862/A

An Inspection report (IRPT) shall be provided for each Inspection verification task identified in the VP.
Verification method: R - review

17.2.5. Verification report (VRPT)

REQ-002863/A

The supplier shall prepare a Verification report (VRPT) when more than one of the defined verification methods are utilized to verify a requirement or a specific set of requirements.
Verification method: R - review

REQ-002864/A

The content of Verification report (VRPT) shall be agreed by the Customer
Verification method: R - review

REQ-002865/A

The Verification report (VRPT) shall be submitted to the Verification Control Board (VCB) after the completion of the last contributing verification activities, within the time frame agreed with the customer.
Verification method: R - review

REQ-002866/A

The supplier shall provide a Verification report (VRPT) for the reviews as agreed with the customer
Verification method: R - review

17.2.6. Other verification execution and reporting Document

REQ-002867/A

The supplier shall provide the Test specifications (TSPE) for the reviews as agreed with the customer
Verification method: R - review

REQ-002868/A

The supplier shall provide the Test procedures (TPRO) for the reviews as agreed with the customer

Verification method: R - review

REQ-002869/A

The rules for the analysis, inspection and review of design shall be defined in writing before their execution.

NOTE For example, analysis, inspection or review of design procedures.

Verification method: R - review

18. Verification control and close-out

18.1. General

REQ-002870/A

The implementation of the verification process shall be monitored by the Verification Control Board (VCB).

Verification method: R - review

REQ-002871/A

The verification process control shall be supported by a computer based verification database.

Verification method: R - review

REQ-002872/A

The verification database shall be delivered to the customer in an electronic form to be agreed with the customer.

Verification method: R - review

REQ-002873/A

The supplier shall provide to the customer verification evidence for the customer's applicable requirements agreed to be verified, independently from the level where verification has been accomplished.

Verification method: R - review

18.2. Verification control board (VCB)

REQ-002874/A

A Verification Control Board (VCB), with participation of customer representatives, shall be established to incrementally assess the achievements and status of the verification process.

Verification method: R - review

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REQ-002875/A

The verification process shall be considered completed when the Verification Control Board (VCB) confirms that:

1. documented evidence is recorded in the VCD,
2. identified requirements have been verified
3. associated product verification objectives are reached

Verification method: R - review

REQ-002876/A

The conclusions of the VCB shall be submitted for approval to the customer's contractual authority.

Verification method: R - review

REQ-002877/A

The Verification Control Board (VCB) shall assess the verification status with a periodicity agreed with the customer, along the project life cycle.

Verification method: R - review

REQ-002878/A

The Verification Control Board (VCB) shall endorse the final issue of the Verification Control Document (VCD).

Verification method: R - review

18.3. Re-verification

REQ-002879/A

The extent of the re-verification to be performed shall be determined by Supplier and agreed with the Customer, in the following cases:

1. failure and repair as decided by Nonconformance Review Board (NRB)
2. unplanned disassembly or demounting
3. refurbishment, maintenance or design changes
4. changes of requirements after initial verification
5. long duration storage

Verification method: R - review

REQ-002880/A

The Verification Control Document (VCD) shall be updated by the supplier to record as open, those requirements subject to re-verification until this is performed and closeout agreed by the customer.

Verification method: R - review

18.4. Verification control and close-out documentation

18.4.1. Verification Control Document (VCD)

REQ-002881/A

The content of the completed Verification Control Document (VCD) shall be agreed by the Customer

Verification method: R - review

REQ-002882/A

The supplier shall update the Verification database within one week of the approval of a report.

Verification method: R - review

REQ-002883/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current status of the verification database, shall be made available to the Verification Control Board (VCB) upon request.

Verification method: R - review

REQ-002884/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current verification and compliance status, shall be delivered at each formal review as agreed with the customer

Verification method: R - review

REQ-002885/A

The final issue of the Verification Control Document (VCD) shall be submitted to the Verification Control Board (VCB) after the approval of the last report, within the time frame agreed with the customer.

Verification method: R - review

18.4.2. Other close-out documents

REQ-002886/A

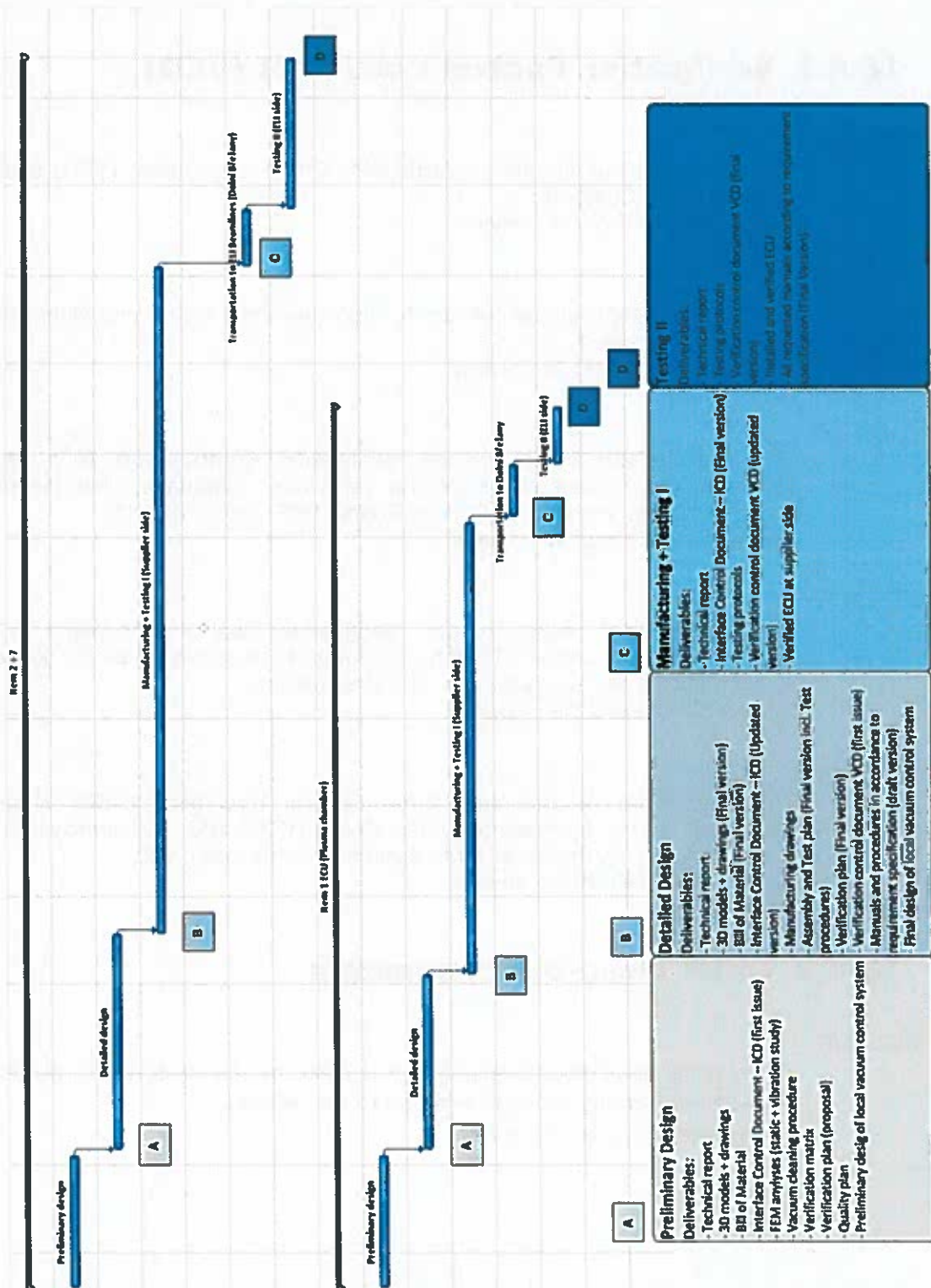
The supplier shall make available to the customer for consultation the VCD's supporting documentation in addition to the reports.

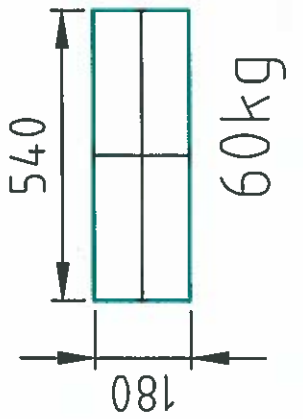
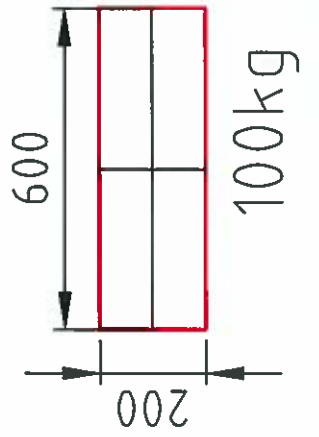
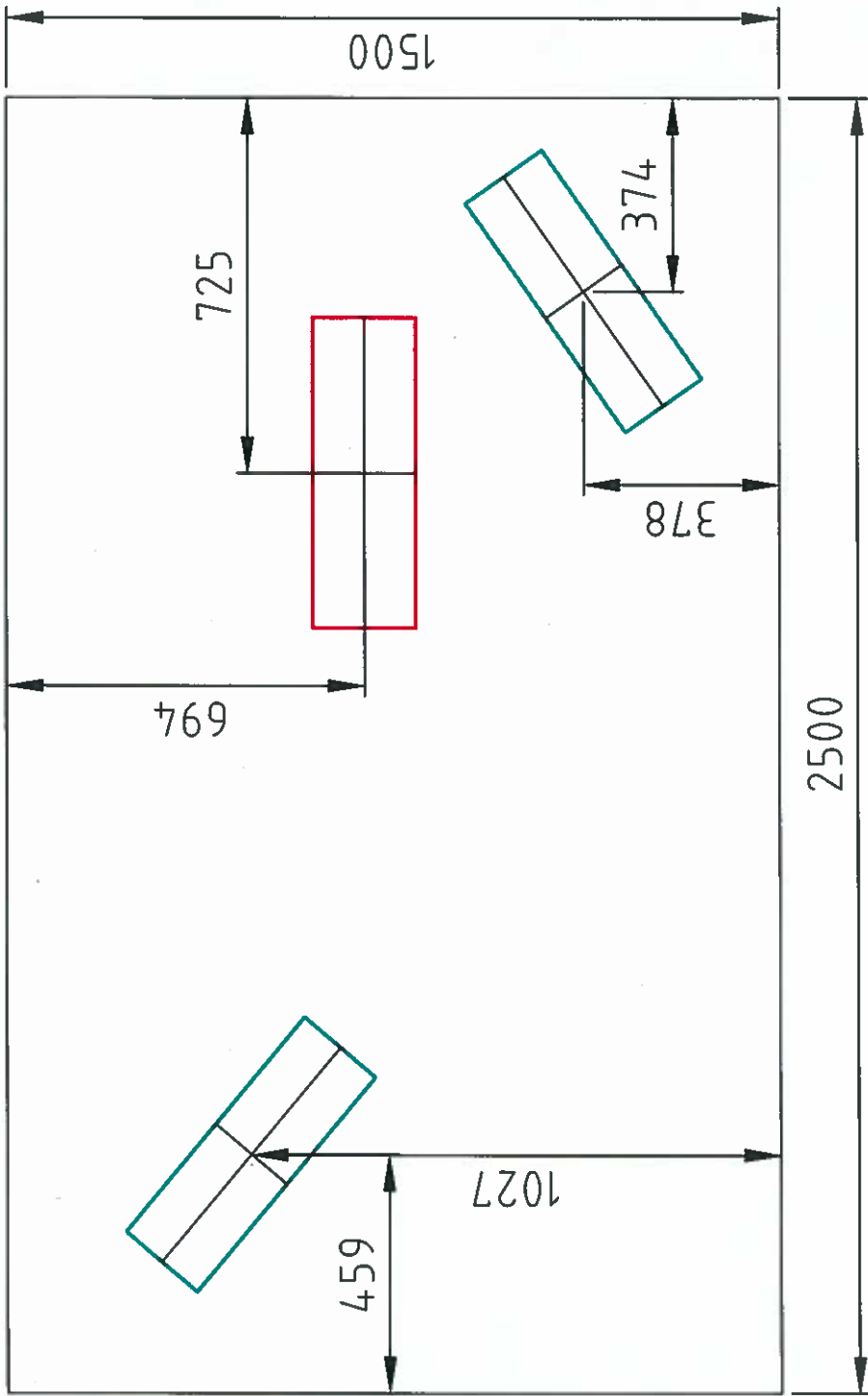
Verification method: R - review

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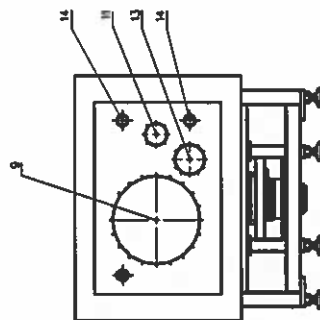
19. Annex I

ECU - Contract Phases





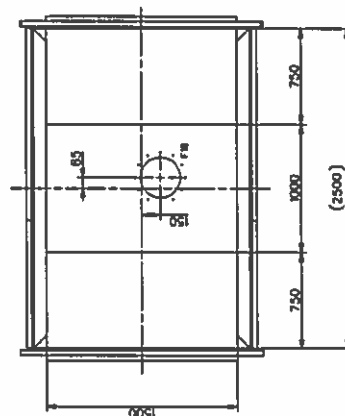
Any



Quantity	Description
1	TURBOMOLECULAR PUMP DN250
1	GATE VALVE DN250
2	WALVE DN160
4	VACUUM GAUGE DN25 ISO-RF
4	VACUUM GAUGE DN25 ISO-RF
1	VENT VALVE DN25 ISO-RF
5	1
2	REDUCER DN63 ISO-K/DN175 ISO-RF
7	1
6	PIPE DN250 ISO-F
8	1
8	PIPE DN160 ISO-F
9	1
10	BLIND FLANGE DN630
11	2
11	BLIND FLANGE DN400
12	1
12	BLIND FLANGE DN160
13	2
13	BLIND FLANGE DN250
14	1
14	BLIND FLANGE DN700
15	3
15	BLIND FLANGE DN63
16	3
16	VIEW POST

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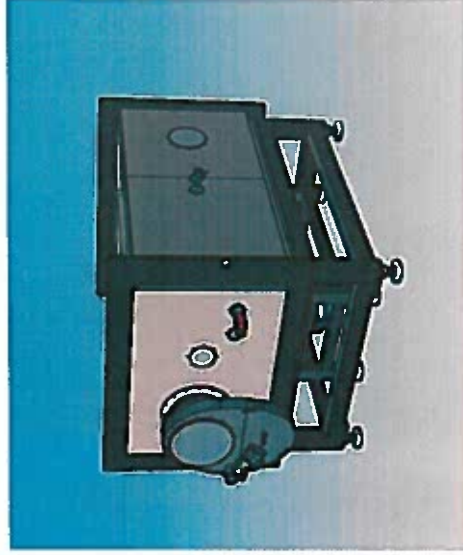
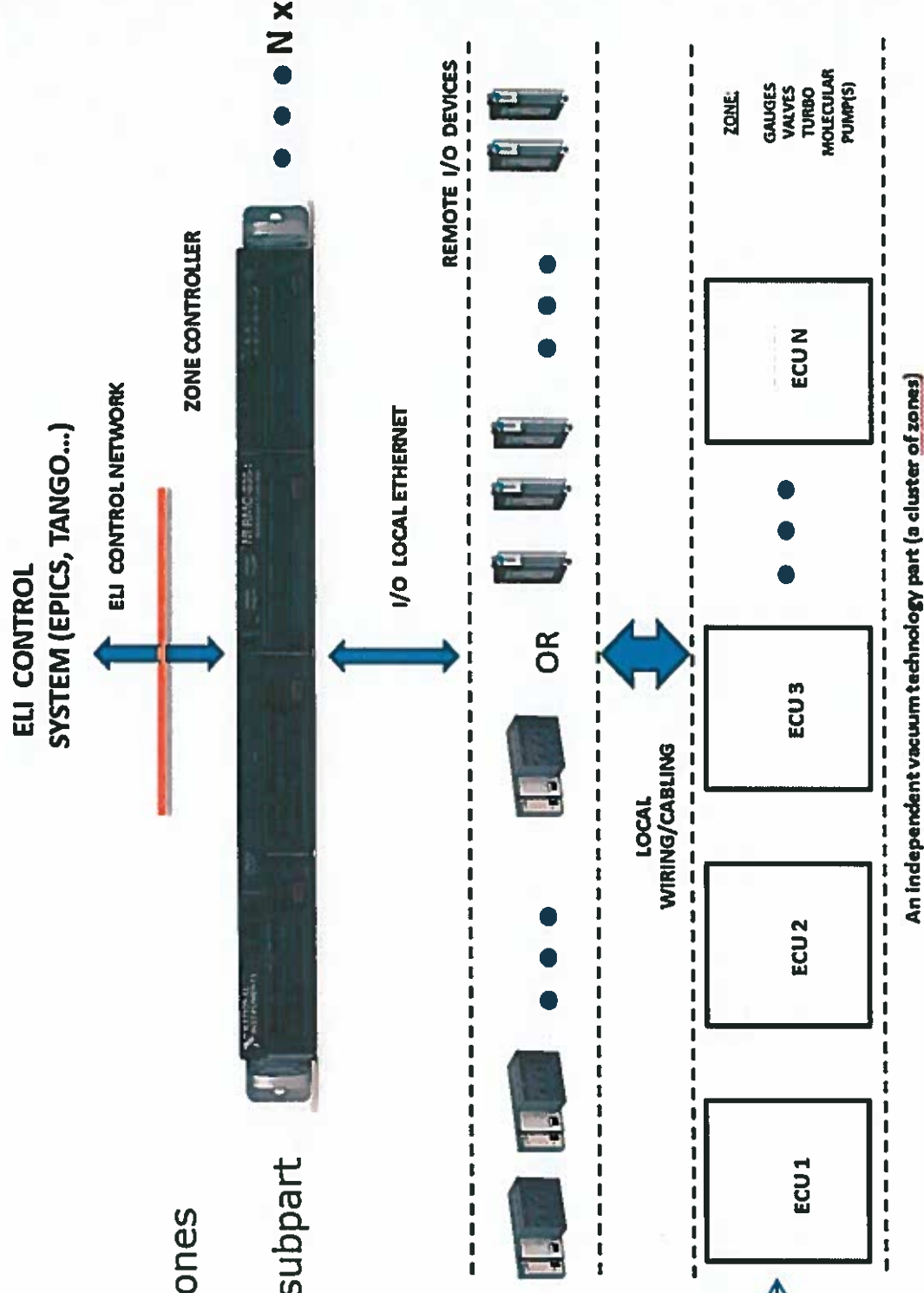
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- N zone controllers
- Each zone controller responsible for a set of zones
- A zone is an elementary subpart of the vacuum system



Confidentiality Level	BL - Restricted for internal use	TC ID / Revision	00104398 / F
Document Status	Document Reviewed	Document No.	Specific Document code
WBS code	5.2 - RP3 Particle acceleration by lasers		
PBS code	E.E4.ELMA - (RA3) ELIMAIA (ELIMED + ION acceleration)		
Requirements Specification Document (RSD)			
ECU ELIMAIA interaction chamber  Keywords Put keywords related to the document content.			
	Position	Name	
Responsible person	Group Leader RP3	Daniele Margarone	
Prepared by	Chief Engineer	Pavel Korouš	

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<i>RSS TC ID/revision</i>	<i>Date of Creation</i>	<i>Date of Last Modification</i>	<i>Systems Engineer</i>
000981 / E	09-12-2014 21:21	11-12-2014	Pavel Korouš
000981 / F	27-02-2015 16:49	02-03-2015	Aleksei Kuzmenko

Reviewed By			
<i>Name (Reviewer)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Approved by			
<i>Name (Approver)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Revision History / Change Log				
<i>Change No.</i>	<i>Made by</i>	<i>Date</i>	<i>Change description, Pages, Chapters</i>	<i>TC rev.</i>

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1. ECU (Experimental Chamber Unit)

ECU is an abbreviation for **Experimental Chamber Unit** which in contract text is called by **Device**. **ECU** is defined for this specification purpose as a self-contained unit providing controlled pumping and venting together with provision of stable area for optical layout.

2. Functional and Performance Requirements

REQ-001518/A

ECU shall allow vacuum pumping and venting for experimental set-up.
Verification method: FD - functional demonstration

REQ-001519/A

ECU shall reach vacuum level 10^{-6} mbar.
Verification method: T - test

REQ-001521/A

ECU vacuum equipment shall be capable reaching 10^{-5} mbar vacuum level in 60 minutes.
Verification method: T - test

REQ-001522/A

Preventive maintenance time shall not exceed 8 hours.
Verification method: R - review

REQ-001523/A

The **ECU** shall provide pumping and venting sequences.
Verification method: FD - functional demonstration

3. Operational design requirements

REQ-001524/A

ECU shall comply with frequency of opening/closing 2-times a day.
Verification method: R - review

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4. Design requirements

4.1. General

REQ-003500/A

Enclosed **ECU** tender .pdf drawings shall be taken into account as a concept for preliminary design.

Verification method:

REQ-001525/A

Interaction Chamber Unit (**ECU**) shall provide space for customer provided optical equipment.

Verification method: R - review

REQ-001526/A

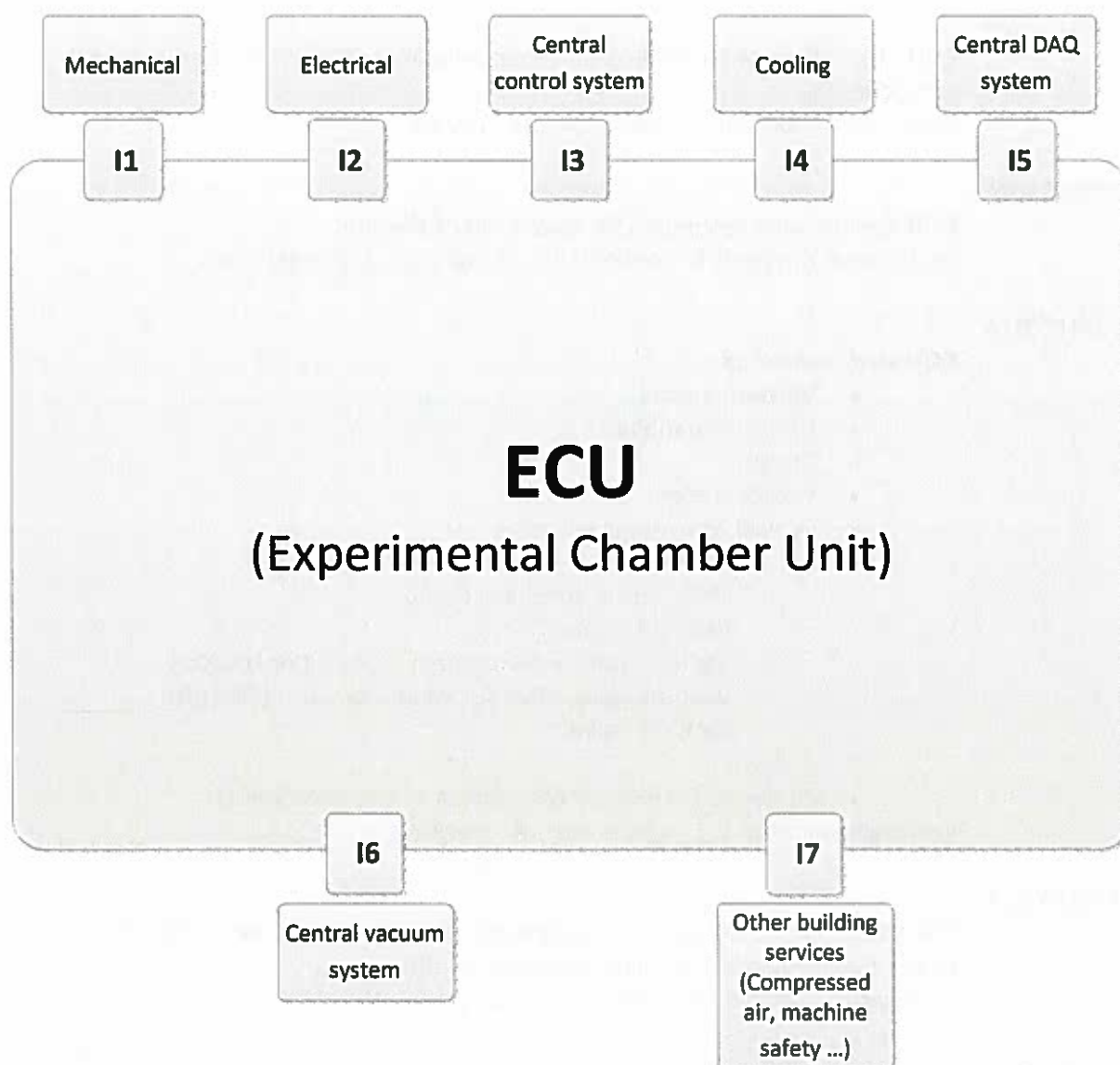
ECU shall provide for the following interfaces:

- TMP's (Turbo Molecular Pumps)
- Gauges
- Feedthrough
- Diagnostics
- Remote control
- Central Vacuum System (CVS)
- Beam Transport (BT)
- ELI Building
- ELI Building services

Verification method: R - review

REQ-003408/A

Supplier shall provide **ECU** Interface Control Document (**ICD**).



Verification method: R - review

REQ-001527/A

The supplier shall define the **Reference Coordinate System (RCS)** of the **ECU** which shall allow positioning the **ECU** in customer's experimental hall according to **Reference Mechanical System** of the hall (**RMS**).

Verification method: R - review

REQ-001528/A

RMS shall be set up together with supplier during the preliminary design phase.

Verification method: R - review

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REQ-001529/A

ECU shall allow safe handling and manipulation with internal and external components.

Verification method: I - inspection, R - review

REQ-001530/A

ECU design shall assure a safe operation of the unit.

Verification method: R - review, FD - functional demonstration

REQ-001531/A

ECU shall consist of:

- Vacuum vessel
- Optical breadboard
- Chassis
- Vessel chassis
- Optical breadboard chassis
- Vacuum devices:
 - TMP (TurboMolecular Pump)
 - Vacuum gauges
 - Vacuum gate valves (main inlet/outlet DN400)
 - Vacuum gate valve for rough vacuum (DN100)
 - Venting valve
- Bellows
- Pipework (in case of connection of two chambers)

Verification method: I - inspection, R - review

REQ-001532/A

The **ECU** shall be designed to accommodate laser beam axis 1300 mm above floor level (see attached conceptual drawings).

Verification method: R - review, T - test

REQ-001533/A

Tools used during manufacture shall not contaminate the vacuum surface.

Verification method: T - test

REQ-003507/A

All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.

Verification method: R - review, T - test

4.2. Operational design requirements

REQ-001534/A

ECU shall be a modular unit allowing extension in longitudinal direction.

Verification method: R - review, I - inspection

REQ-001535/A

ECU breadboard and vacuum vessel shall be decoupled.
Verification method: I - inspection, R - review

REQ-001536/A

Decoupling of **ECU** breadboard and vacuum vessel shall be made by using edge welded bellows.
Verification method: R - review, I - inspection

REQ-003187/A

Double bellows decoupling system shall be applied on **ECU** breadboard chassis.
Verification method: R - review

4.3. ECU design requirements

4.3.1. ECU Vacuum vessel design

REQ-001537/A

ECU frame shall be made of stainless steel following types:

- AISI 304L or
- AISI 304

Verification method: I - inspection, R - review

REQ-001538/A

ECU panels shall be made of aluminum following types:

- Al2219
- Al3003
- Al5083
- Al6082
- Al2090
- Al2219
- Al7005

Verification method: R - review, I - inspection

REQ-001539/A

Final choice of **ECU** vessel materials shall be made in preliminary design phase.
Verification method: R - review

REQ-001540/A

ECU panels shall be designed as a modular system.
Verification method: R - review, I - inspection

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REQ-001541/B

Maximum size of modular aluminium panels shall be 1x1.5 m. *Technical note: Increase of dimension from 1.5 m up to 2 m is acceptable in access optical breadboard area.*

Verification method: R - review, I - inspection

REQ-001542/A

Thickness of **ECU** modular aluminium panels shall be in bounded interval 40 + 50 mm.

Verification method: R - review, T - test

REQ-001543/A

All **ECU** panels shall be equipped by Lifting eyes interfaces.

Verification method: R - review, I - inspection

REQ-001544/A

ECU panels close to main optical components shall be equipped with small doors with minimal width 600 mm and high 500 mm.

Verification method: R - review, I - inspection

REQ-001545/A

Openings of **ECU** shall be closed by aluminium blank flanges.

Verification method: R - review, I - inspection

REQ-001546/A

Stainless steel screws with Allen heads shall be used on **ECU** panels.

Verification method: I - inspection, R - review

REQ-001547/A

ECU small doors shall be equipped with hinges.

Verification method: R - review, I - inspection

REQ-001548/A

Maximal deformations of **ECU** panels under vacuum shall be lower than 3 mm in comparison to the vented status.

Verification method: A - analysis, R - review, T - test

REQ-001549/A

Deformations of **ECU** panels in selected coordinates under vacuum shall be lower than 2 mm in comparison to the vented status.

Verification method: A - analysis, T - test

REQ-001550/A

All **ECU** removable panels shall be equipped with guiding pins to allow proper panel seating.

Verification method: R - review, I - inspection

REQ-001551/A

Sealing of **ECU** panels shall be made of fluorelastomer polymer (FPM) material.

Verification method: R - review, I - inspection

REQ-001552/B

Hardness of **ECU** sealing o-rings shall be 60 or 70 HSC (Shore).

Verification method: I - inspection, R - review

REQ-001553/A

ECU shall be equipped with roughing inlet interface (DN100).

Verification method: R - review, I - inspection

REQ-001555/A

Surface treatment of inner **ECU** vacuum vessel surfaces compatible with 10^{-6} mbar shall be applied.

Verification method: R - review, I - inspection

4.3.2. Vacuum Vessel Chassis

REQ-001556/A

ECU vacuum vessel chassis shall allow **z** (vertical) positioning.

Verification method: I - inspection, R - review

REQ-001557/A

Range of **ECU** vacuum vessel chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: R - review, T - test

REQ-001558/A

ECU vacuum vessel chassis shall be made of stainless steel or extruded aluminium profiles.

Verification method: R - review, I - inspection

REQ-001559/A

ECU chassis shall allow for installation of TMP's.

Verification method: R - review, I - inspection

11/4

REQ-001560/A

ECU chassis shall allow for floor fixing.
Verification method: R - review, I - inspection

REQ-001561/A

ECU vacuum vessel chassis shall be equipped with removable transportation wheels.
Verification method: R - review, I - inspection

4.3.3. ECU Optical breadboard design

4.3.3.1. General

REQ-001562/B

Supplier shall provide static FEM analysis and vibration study according to customer inputs.
Technical note: The latest results of building vibration measurement will be provided by customer after contract signature.
Verification method: A - analysis, R - review

4.3.3.2. Optical breadboard

REQ-001563/A

ECU optical breadboard shall allow connection of multiple modular breadboards.
Verification method: I - inspection, R - review

REQ-001564/A

ECU optical breadboard shall have threaded hole pattern with 25 mm spacing.
Verification method: R - review, T - test

REQ-001565/A

Threaded holes of **ECU** breadboard shall be M6 size.
Verification method: R - review, T - test

REQ-001566/A

ECU optical breadboard shall be made of aluminium following types:

- Al2219
- Al3003
- Al5083
- Al6082

- AI7005

Verification method: R - review, I - inspection

REQ-001567/A

Final choice of **ECU** optical breadboard materials shall be made in preliminary design phase.

Verification method: R - review, I - inspection

REQ-001568/A

Minimum thickness of **ECU** breadboard plate shall be 50 mm.

Verification method: A - analysis, R - review, T - test

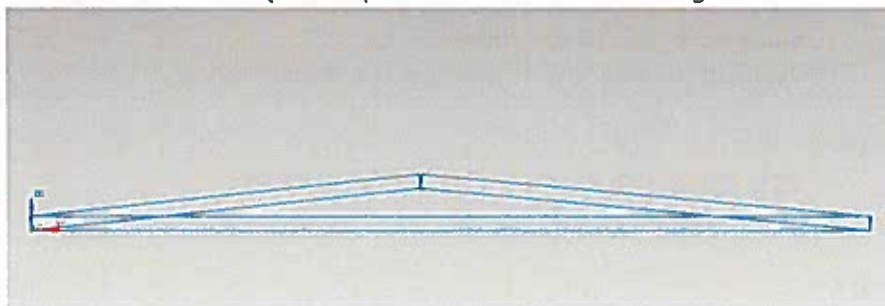
REQ-001569/A

Maximal thickness of whole **ECU** breadboard (plate with reinforcing ribs) shall be 130 mm.

Verification method: A - analysis, R - review, T - test

REQ-001570/B

Maximum misalignment after connection of breadboard segments shall be lower than 1 mrad. (in comparison with ideal non-segmented breadboard)



Technical note: This requirement is valid only in case of using segmented optical table.

Verification method: T - test

REQ-001571/A

Maximum z direction misalignment after connection of breadboard segments shall be lower than 1 mm.

Verification method: T - test, FD - functional demonstration

REQ-001572/A

Supplier shall provide procedure of misalignment measurement.

Verification method: R - review, T - test

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4.3.3.3. Optical Breadboard Chassis

REQ-001573/A

ECU chassis shall be designed as modular unit.

Verification method: R - review, I - inspection

REQ-001574/A

Only one chassis shall be applied for more connected **ECU** breadboards.

Verification method: R - review, I - inspection

REQ-001575/A

ECU optical breadboard chassis shall allow **z** (vertical) positioning.

Verification method: R - review, I - inspection

REQ-001576/A

Range of **ECU** optical breadboard chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: I - inspection, T - test

REQ-001577/A

ECU optical breadboard chassis shall be made of stainless steel or aluminium extruded profiles.

Verification method: R - review, I - inspection

REQ-001578/A

ECU chassis shall allow installation of TMP's.

Verification method: R - review, I - inspection

REQ-001579/A

ECU chassis shall allow floor fixing.

Verification method: R - review, I - inspection

REQ-001580/A

The **ECU** optical breadboard chassis shall be equipped with removable transportation wheels.

Verification method: R - review, I - inspection

REQ-003194/A

The **ECU** optical breadboard chassis shall have interface for vibration dumping system.

Verification method: R - review

4.3.4. ECU Vacuum equipment

4.3.4.1. TMP (Turbomolecular pump)

REQ-001581/A

Only new **ECU** TMP with full warranty shall be used.
Verification method: I - inspection

REQ-001582/A

ECU shall be installed in accordance to the installation manual of TMP supplier.
Verification method: R - review, I - inspection

REQ-001583/A

ECU TMP shall be water cooled.
Verification method: R - review, I - inspection

REQ-001584/A

ECU TMP coolant shall be demineralized water.
Verification method: I - inspection

REQ-001585/A

ECU TMP shall be equipped with fittings for water cooling.
Verification method: I - inspection

REQ-001586/A

ECU TMP shall be equipped with protective screen.
Verification method: I - inspection

REQ-001587/A

ECU TMP shall be compatible with power supply 230V, 50 Hz.
Verification method: I - inspection

REQ-001588/A

ECU TMP inlet flange shall be ISO-F according to ISO 1609:1986.
Verification method: I - inspection

REQ-001589/A

ECU TMP outlet flange shall be ISO-KF according to ISO 2861:2013.
Verification method: I - inspection

REQ-001590/A

Maximum noise of **ECU** TMP shall be 60 dB.
Verification method: R - review

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REQ-001591/A

ECU TMP with minimum pumping speed 1500 l/sec shall be used.
Verification method: R - review, I - inspection

REQ-001592/A

ECU TMP set up shall be equipped with separation gate valve.
Verification method: I - inspection

REQ-001593/A

ECU TMP shall be equipped with electrically operated venting valve.
Verification method: I - inspection

REQ-001594/A

ECU TMP shall be equipped with power supply unit and control unit.
Verification method: I - inspection

REQ-001595/A

ECU TMP shall be equipped with 19" equipment rack mountable controllers.
Verification method: I - inspection

REQ-001596/A

The minimum required lifetime of TMP shall be 50 000 working hours.
Verification method: R - review

REQ-001597/A

The TMP shall be able to operate continuously at a maximum inlet pressure of 0.05 mbar.
Verification method: R - review

REQ-001598/A

The TMP shall be able to operate continuously at a maximum exhaust pressure of 0.5 mbar.
Verification method: R - review

REQ-001599/A

The TMP shall be protected against damage from sudden temperature rise.
Verification method: R - review, I - inspection

REQ-001600/A

TMP and their accessories (including liquid cooling fittings) must be in compliance with the following standards:

- ISO 1609:1986 - Vacuum technology - Flange dimension
- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings

- ISO 5302:2003 - Vacuum technology - Turbomolecular pumps - Measurement of performance characteristic

Verification method: R - review

4.3.4.2. Gauges

REQ-001601/A

Measurement range of combined gauge shall be $1000 \text{ mbar} \div 1 \times 10^{-6} \text{ mbar}$ with maximum accuracy $\pm 30\%$.

Verification method: R - review, I - inspection

REQ-001602/A

Mechanical interface of ECU Vacuum gauges shall be ISO KF according to ISO 2861:2013.

Verification method: R - review, I - inspection

REQ-001603/A

Vacuum connection of the gauges must be in compliance with the following standards:

- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings.

Verification method: R - review, I - inspection

REQ-001604/A

Power supply of **ECU** vacuum gauges shall be 24VDC.

Verification method: R - review, I - inspection

REQ-001605/A

Interval of output **ECU** vacuum gauges signal shall be $0 \div 11 \text{ VDC}$.

Verification method: R - review, I - inspection

4.3.4.3. Gate valves

REQ-001606/A

ECU gate valve separating TMP shall be made of stainless steel (body material).

Verification method: R - review, I - inspection

REQ-001607/A

Main **ECU** inlet/outlet gate (DN400) valves shall be made of aluminium (body material).

Verification method: R - review, I - inspection

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REQ-001608/A

The **ECU** gate valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

REQ-001609/A

Minimal open/close cycles of **ECU** gate valves until first service shall be 200 000.

Verification method: R - review

REQ-001610/A

ECU gate valve shall be equipped with ISO F flange according to ISO 1609:1986.

Verification method: I - inspection

REQ-001611/A

ECU gate valves shall be equipped with blank flange from atmosphere side.

Verification method: I - inspection

4.3.4.4. Venting valves

REQ-001612/A

ECU shall be equipped with venting valve.

Verification method: I - inspection

REQ-001613/A

Automatic venting valve shall be used on **ECU**.

Verification method: I - inspection

REQ-001614/A

The **ECU** venting valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

4.3.4.5. Bellows (connection of two chambers)

REQ-001615/A

Edge welded bellows shall be used on **ECU**.

Verification method: I - inspection, R - review

REQ-001616/A

ECU bellows shall be equipped with threaded rods.

Verification method: I - inspection, R - review

REQ-001617/A

Compensation range of ECU connecting bellows shall be:

- Axial ± 15 mm
- Lateral ± 5 mm
- Angular $\pm 2^\circ$

Verification method: R - review, I - inspection, T - test

4.3.4.6. Vacuum clamps

REQ-001618/A

All **ECU** vacuum clamps shall be permanent set free after assembling.

Verification method: I - inspection, FD - functional demonstration

REQ-001619/A

Clamp slots shall defect free.

Verification method: I - inspection

4.3.4.7. Local & remote vacuum control and safety system

REQ-001620/A

ECU local control system shall be designed and verified as an autonomous manually controlled system with interfaces to ELI – control system.

Verification method: R - review, I - inspection

REQ-001621/A

All ECU TMP's, vacuum gauges and valves shall be delivered with the **associated controllers**.

Verification method: I - inspection

REQ-001622/A

The controllers shall provide a reliable control interface to ELI central control system via LC optical fibers or RJ45 metallic connections.

Verification method: I - inspection

REQ-001623/A

The communication protocol shall be available and compatible with Linux OS.

Verification method: R - review

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REQ-001624/A

Documentation for the protocol shall be provided.

Verification method: I - inspection

REQ-001625/A

Safety interface based on digital I/O (24V DC signals) shall be provided for redundancy in addition to REQ-001629/A.

Verification method: R - review

REQ-001626/A

The controllers shall have local and remote access capabilities.

Verification method: I - inspection

REQ-001627/A

The controllers shall provide separate interlock capabilities via dry C-shape contacts.

Verification method: I - inspection

REQ-001628/A

All valves shall be supplied with open/closed limit switches wired to standard DIN connectors with mating plugs.

Verification method: I - inspection

REQ-001629/A

The supplied controls shall provide a safe pumping and venting sequence including interlocks in the local and remote mode of operation.

Verification method: I - inspection

4.3.5. Data acquisition

REQ-001745/A

Following data shall be readable from the ECU:

- Temperature on TMP
- Level of vacuum
- rpm of TMP rotor
- Hours of TMP operation
- Levitation of TMP rotor (if maglev is used)

Verification method: R - review, T - test

4.3.6. EMC/EMP

REQ-001630/A

The **ECU** design shall comply with EU standards of electro-magnetic compatibility.

Verification method: R - review

5. System Transportation and installation requirements

5.1. General requirements

REQ-001631/A

Supplier shall provide procedures for transportation and installation of **ECU**.

Verification method: R - review

REQ-001632/A

Supplier shall provide procedures for handling and manipulation of **ECU**.

Verification method: R - review

REQ-007148/A

The transportation and installation personnel shall follow the customer's facility regulations.

NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.

Verification method: R - review

REQ-007149/A

The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in clean environment of ISO class 7, if not agreed otherwise.

Verification method: R - review, I - inspection

REQ-007150/A

All transportation and installation tools and equipment entering the clean rooms shall be cleaned and reviewed by the customer's approved methods.

NOTE: Some tools can be provided by the customer upon agreement.

Verification method: I - inspection, T - test

REQ-007151/A

The transportation to the final destination and the installation of the technologies and the instruments shall be conducted by the vendor. The

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methods shall be discussed and reviewed by the customer's installation officer and shall be compliant with the customer's installation regulations.
NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.
Verification method: R - review

REQ-007152/A

The main parts of the mechanical structure shall be equipped with positioning/alignment marks for industrial 3D-measurements/survey. The specific type of the positioning/alignment marks, their number and location shall be agreed with the customer.
Verification method: R - review, I - inspection

5.2. Transportation

REQ-001633/A

The supplier shall provide supervision by transport **ECU** to defined position in ELI – Beamlines experimental room.
Verification method: R - review, I - inspection

REQ-001635/A

All Parts shall be identified according to technical documentation.
Verification method: R - review

5.3. Installation

REQ-001637/A

Connection of **ECU** to the ELI- Beamlines facility services shall be made under supervision of supplier.
Verification method: R - review, I - inspection

REQ-001638/A

Assembling of **ECU** on supplier side shall be made in cleanroom ISO7.
Verification method: I - inspection

REQ-001639/A

All specific equipment and tools necessary for installation of the **ECU** shall be subject of the supplier delivery.
Verification method: I - inspection, R - review

REQ-001640/A

Maximum dimensions of goods going through experimental entrance area shall be 3000x2000x2000 mm (length x with x high)
Verification method: R - review, T - test

6. Handling and Manipulation

REQ-001642/A

Supplier shall provide an approved methodological document describing safe handling and manipulation of the product.

Verification method: R - review

7. Maintenance

REQ-001643/A

Supplier shall provide an approved methodological document describing maintenance procedures of the product.

Verification method: R - review

8. Safety Requirements

REQ-001644/A

The **ECU** design of relevant parts shall comply with Czech and EU regulations regarding safety domain.

NOTE: Application of Czech regulations will be subject of preliminary design.

Verification method: R - review

REQ-001645/A

Supplier shall perform hazard identification and risk assessment of system prior to design.

Verification method: A - analysis, R - review

REQ-001646/A

All **ECU** manufactured parts shall be free of sharp edges.

Verification method: I - inspection

REQ-001647/A

All **ECU** manufactured parts shall be burr free.

Verification method: I - inspection

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9. Quality

9.1. Quality Management

9.1.1. Quality organization and responsibilities

9.1.1.1. Organization

REQ-001648/A

The supplier shall identify the personnel responsible for implementing and performing QA management plan and other Quality Controls disciplines.

Verification method: R - review

REQ-001649/A

The supplier shall assign a project Quality manager reporting to the project manager who has an unimpeded access to higher management.

Verification method: R - review

REQ-001650/A

The appointed project Quality manager, irrespective of other responsibilities, shall have organizational authority to establish and implement a quality assurance programme in accordance with the project quality assurance requirements.

Verification method: R - review

REQ-001651/A

The project Quality Manager shall act as the primary contact person within the project concerning Quality matters.

Verification method: R - review

REQ-007175/A

The supplier shall apply international recognized standards or best practice where applicable for quality assurance programme.

Verification method: R - review

9.1.1.2. Responsibility and authority

REQ-001652/A

The supplier shall define and document the responsibility, the authority and the interrelation of personnel who manage, perform and verify work affecting quality assurance.

Verification method: R - review

REQ-001653/A

The supplier shall define and document the responsibilities and the interfaces of the Quality functions, either external or internal, involved in a project.

Verification method: R - review

REQ-001654/A

When the supplier's Quality organization delegates quality assurance tasks to another organization it shall be done in a documented and controlled way monitored by the Quality organization.

Verification method: R - review

9.1.2. Quality plan and its implementation

REQ-001655/A

The supplier shall prepare, maintain and implement a plan of the QA (Quality Assurance) activities in accordance with the customer QA requirements.

Verification method: R - review

REQ-001658/A

The supplier management shall ensure that the inputs used by the Quality functions are consistent and complete, and available in line with the project schedule.

Verification method: R - review

REQ-001659/A

The supplier QA management shall ensure that the QA functions perform the tasks described in the QA Plan in line with the project schedule.

Verification method: R - review

REQ-001660/A

The supplier QA management shall ensure that the outputs produced by the QA functions are consistent and complete, and delivered in line with the project schedule.

Verification method: R - review

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REQ-001661/A

The supplier QA management shall ensure the application of processes defined in applicable project plans and documents.

Verification method: R - review

9.1.3. Documentation and data control

REQ-001662/B

The supplier shall provide following type of documents:

- 3D model (format: *.step; *.stp)
- 2D drawings (format: *.dwg)
- Printable format for text documents

Verification method: I - inspection

10. Environmental conditions

REQ-001663/A

Final cleanliness shall be compatible with ISO 7.

Verification method: I - inspection

11. Verification process

REQ-001664/A

The verification process shall demonstrate that the deliverable product meets the specified customer requirements and is capable of sustaining its operational role through:

1. Verification planning;
2. Verification execution and reporting;
3. Verification control and close-out.

Verification method: R - review

REQ-001665/A

The supplier shall define the verification approach by conducting the following steps:

1. Identify and agree with the customer the set of requirements to be subject of the verification process.
2. Select the methods and levels of verification, associated model philosophy and verification tools.

3. Identify the stages and events in which the verification is implemented.
Verification method: R - review

REQ-001666/A

The verification approach shall be defined by the supplier in the Verification Plan (VP) for approval by the customer prior to implementation.
Verification method: R - review

11.1. Verification methods

11.1.1. General

REQ-001668/A

Verification shall be accomplished by one or more of the following verification methods:

1. test (including functional demonstration);
2. analysis (including similarity);
3. review-of-design;
4. inspection.

Verification method: R - review

REQ-001669/A

All safety critical functions shall be verified by test.
Verification method: R - review

REQ-001670/A

Verification of software shall include testing in the target hardware environment.
Verification method: R - review

11.1.2. Test

REQ-001671/A

Verification by test shall consist of measuring product performance and functions under representative simulated environments.
Verification method: R - review

REQ-001672/A

The analysis of data derived from testing shall be an integral part of the test and the results included in the test report.
Verification method: R - review

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REQ-001673/A

When the test objectives include the demonstration of qualitative operational performance, the execution shall be observed and results recorded (functional demonstration).

Note: Functional demonstration is a subset of tests.

Verification method: R - review

REQ-001674/A

A test programme shall be prepared for each product in conformance with Verification Plan.

Verification method: R - review

REQ-001675/A

The test programme shall be coordinated with the integration flow.

Verification method: R - review

REQ-001676/A

Tests performed as part of the integration flow to check quality and status of the in-progress configuration (including interfaces), having a formal verification purpose, shall be included in the test programme.

Verification method: R - review

REQ-001677/A

The test programme shall be defined in the specific chapter of the Verification Plan.

Verification method: R - review

REQ-001678/A

Test Programme shall be approved by the Customer.

Verification method: R - review

11.1.3. Analysis

REQ-001680/A

Verification by analysis shall consist of performing theoretical or empirical evaluation using techniques agreed with the Customer.

NOTE Techniques comprise systematic, statistical and qualitative design analysis, modelling and computational simulation.

Verification method: R - review

REQ-001683/A

An analysis programme shall be defined in the Verification Plan (VP).

Verification method: R - review

11.1.4. Review-of-design (ROD)

REQ-001684/A

Verification by Review-of-design (ROD) shall consist of using approved records or evidence that unambiguously show that the requirement is met.

NOTE Examples of such approved records are design documents and reports, technical descriptions, and engineering drawings.

Verification method: R - review

REQ-001685/A

A review-of-design programme shall be defined in the Verification Plan (VP).

Verification method: R - review

REQ-001686/A

A review-of-design programme shall only be applicable in stages (phases) before starting the manufacturing.

Verification method: R - review

11.1.5. Inspection

REQ-001687/A

Verification by inspection shall consist of visual determination of physical characteristics.

NOTE Physical characteristics include constructional features, hardware conformance to document drawing or workmanship requirements, physical conditions, software source code conformance with coding standards.

Verification method: R - review

REQ-001688/A

An inspection programme shall be defined in the Verification Plan (VP).

Verification method: R - review

12. Qualification (if needed)

N/A

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13. Acceptance

REQ-001689/A

In the acceptance stage the verification shall demonstrate that the product is free of fabrication errors and is ready for the intended operational use.
Verification method: R - review

REQ-001690/A

Acceptance shall be carried out on the final hardware and software
Verification method: R - review

14. Verification process phasing

REQ-001693/A

The verification process shall be phased with the project life cycle defined as a contract execution phases (preliminary design, detailed design, manufacturing and deployment of deliverable product(s) see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-001694/A

Verification planning to assess feasibility and support programmatics shall start in the early phases.
NOTE: programmatics means support equipment and verification timescale estimation.
Verification method: R - review

REQ-001695/A

The preliminary verification planning shall cover all products and requirements by the end of preliminary design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-001696/A

Verification planning shall be completed by the end of detailed design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-001697/A

Verification execution and reporting shall be incrementally carried out through the project life cycle starting from detailed design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-001698/A

Verification control shall start with the initial issue of the verification control document (VCD) during detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-001699/A

Verification close out status shall be assessed and approved by the customer for each product at the end of each stage (see Annex I – ECU Contract Phases).

Verification method: R - review

15. Verification plan (VP)

REQ-001700/A

The supplier shall provide a Verification plan (VP) for the reviews as agreed with the customer

NOTE Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-001701/A

The contents of the Verification plan (VP) shall be approved by the Customer

Verification method: R - review

16. Verification Control Document (VCD)

REQ-001702/A

The supplier shall provide a Verification Control Document (VCD) for the reviews as agreed with the customer

NOTE: Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-001703/A

The contents of the initial issue of the Verification Control Document (VCD) shall be in conformance with ELI verification matrix.

Verification method: R - review

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17. Verification execution and reporting

17.1. General

REQ-001705/A

The supplier shall assign clear responsibility for the implementation of the verification plan.

Verification method: R - review

REQ-001706/A

The test preparation and execution (including Test Readiness Review (TRR) and Post Test Review (PTR)) shall be reviewed by the Customer.

Verification method: R - review

REQ-001707/A

The verification results shall be recorded by the supplier in reports for review by the Verification Control Board (VCB) through the VCD.

Verification method: R - review

17.2. Verification execution and reporting documentation

17.2.1. Test report (TRPT)

REQ-001708/A

The test report (TRPT) shall be submitted to the Verification Control Board (VCB) after the test completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-001709/A

The content of the Test report (TRPT) shall be agreed with the Customer.

Verification method: R - review

REQ-001710/A

The supplier shall provide the Test reports (TRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-001711/A

A Test report (TRPT) shall be provided for each test verification task as identified in the VP.

Verification method: R - review

17.2.2. Analysis report (ARPT)

REQ-001712/A

The Analysis report (ARPT) shall be submitted to the Verification Control Board (VCB) after analysis completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-001713/A

The supplier shall provide an Analysis report (ARPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-001714/A

An Analysis report (ARPT) shall be provided for each Analysis verification task identified in the VP.

Verification method: R - review

17.2.3. Review-of-design report (RRPT)

REQ-001715/A

The Review-of-design report (RRPT) shall be submitted to the Verification Control Board (VCB) after the Review-of-Design completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-001716/A

The supplier shall provide a Review-of-design report (RRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-001717/A

A Review-of-design report (RRPT) shall be provided for each Review-of-design verification task identified in the VP.

Verification method: R - review

17.2.4. Inspection report (IRPT)

REQ-001718/A

The Inspection report (IRPT) shall be submitted to the Verification Control Board (VCB) after the inspection completion, within the time frame agreed with the customer.

Verification method: R - review

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REQ-001719/A

The supplier shall provide an Inspection report (IRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-001720/A

An Inspection report (IRPT) shall be provided for each Inspection verification task identified in the VP.

Verification method: R - review

17.2.5. Verification report (VRPT)

REQ-001721/A

The supplier shall prepare a Verification report (VRPT) when more than one of the defined verification methods are utilized to verify a requirement or a specific set of requirements.

Verification method: R - review

REQ-001722/A

The content of Verification report (VRPT) shall be agreed by the Customer

Verification method: R - review

REQ-001723/A

The Verification report (VRPT) shall be submitted to the Verification Control Board (VCB) after the completion of the last contributing verification activities, within the time frame agreed with the customer.

Verification method: R - review

REQ-001724/A

The supplier shall provide a Verification report (VRPT) for the reviews as agreed with the customer

Verification method: R - review

17.2.6. Other verification execution and reporting Document

REQ-001725/A

The supplier shall provide the Test specifications (TSPE) for the reviews as agreed with the customer

Verification method: R - review

REQ-001726/A

The supplier shall provide the Test procedures (TPRO) for the reviews as agreed with the customer

Verification method: R - review

REQ-001727/A

The rules for the analysis, inspection and review of design shall be defined in writing before their execution.

NOTE: For example, analysis, inspection or review of design procedures.

Verification method: R - review

18. Verification control and close-out

18.1. General

REQ-001728/A

The implementation of the verification process shall be monitored by the Verification Control Board (VCB).

Verification method: R - review

REQ-001729/A

The verification process control shall be supported by a computer based verification database.

Verification method: R - review

REQ-001730/A

The verification database shall be delivered to the customer in an electronic form to be agreed with the customer.

Verification method: R - review

REQ-001731/A

The supplier shall provide to the customer verification evidence for the customer's applicable requirements agreed to be verified, independently from the level where verification has been accomplished.

Verification method: R - review

18.2. Verification control board (VCB)

REQ-001732/A

A Verification Control Board (VCB), with participation of customer representatives, shall be established to incrementally assess the achievements and status of the verification process.

Verification method: R - review

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REQ-001733/A

The verification process shall be considered completed when the Verification Control Board (VCB) confirms that:

1. documented evidence is recorded in the VCD,
2. identified requirements have been verified
3. associated product verification objectives are reached

Verification method: R - review

REQ-001734/A

The conclusions of the VCB shall be submitted for approval to the customer's contractual authority.

Verification method: R - review

REQ-001735/A

The Verification Control Board (VCB) shall assess the verification status with a periodicity agreed with the customer, along the project life cycle.

Verification method: R - review

REQ-001736/A

The Verification Control Board (VCB) shall endorse the final issue of the Verification Control Document (VCD).

Verification method: R - review

18.3. Re-verification

REQ-001737/A

The extent of the re-verification to be performed shall be determined by Supplier and agreed with the Customer, in the following cases:

1. failure and repair as decided by Nonconformance Review Board (NRB)
2. unplanned disassembly or demounting
3. refurbishment, maintenance or design changes
4. changes of requirements after initial verification
5. long duration storage

Verification method: R - review

REQ-001738/A

The Verification Control Document (VCD) shall be updated by the supplier to record as open, those requirements subject to re-verification until this is performed and closeout agreed by the customer.

Verification method: R - review

18.4. Verification control and close-out documentation

18.4.1. Verification Control Document (VCD)

REQ-001739/A

The content of the completed Verification Control Document (VCD) shall be agreed by the Customer
Verification method: R - review

REQ-001740/A

The supplier shall update the Verification database within one week of the approval of a report.
Verification method: R - review

REQ-001741/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current status of the verification database, shall be made available to the Verification Control Board (VCB) upon request.
Verification method: R - review

REQ-001742/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current verification and compliance status, shall be delivered at each formal review as agreed with the customer
Verification method: R - review

REQ-001743/A

The final issue of the Verification Control Document (VCD) shall be submitted to the Verification Control Board (VCB) after the approval of the last report, within the time frame agreed with the customer.
Verification method: R - review

18.4.2. Other close-out documents

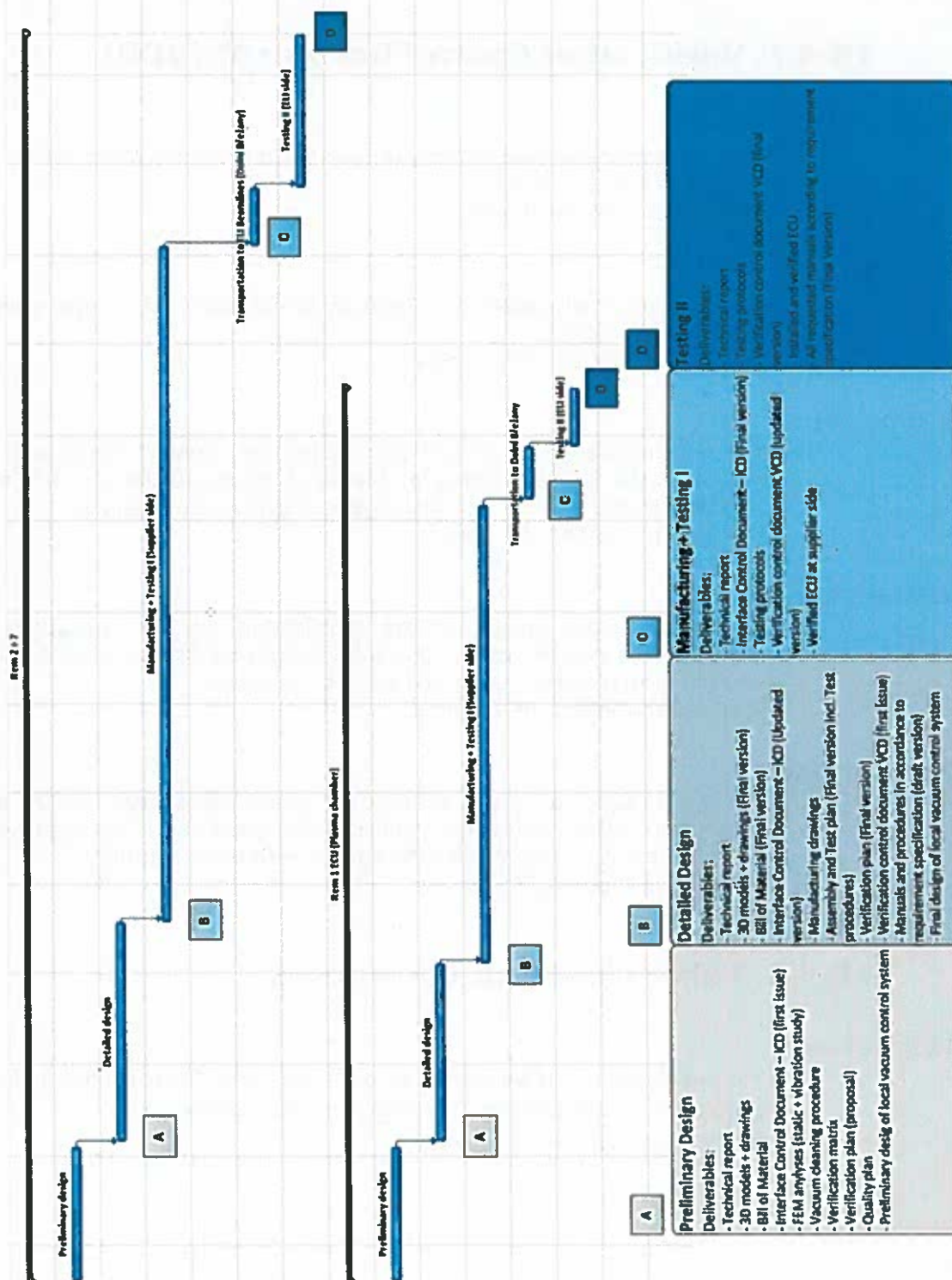
REQ-001744/A

The supplier shall make available to the customer for consultation the VCD's supporting documentation in addition to the reports.
Verification method: R - review

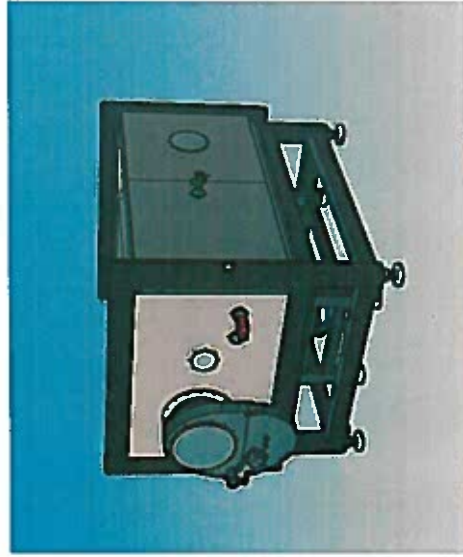
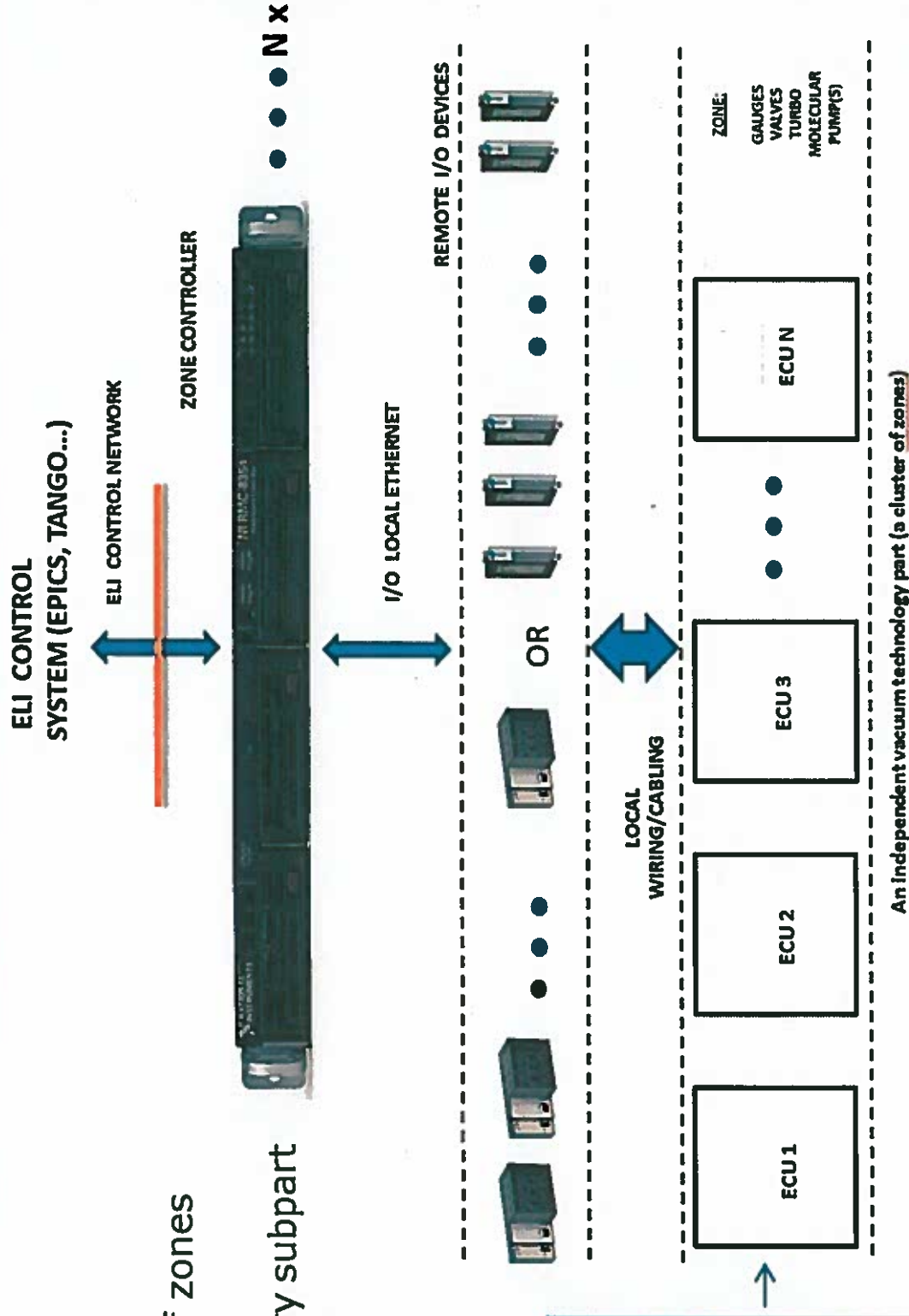
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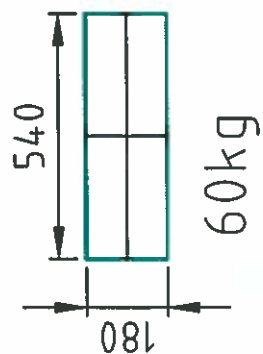
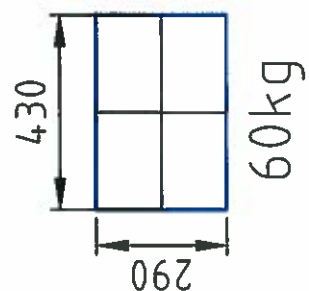
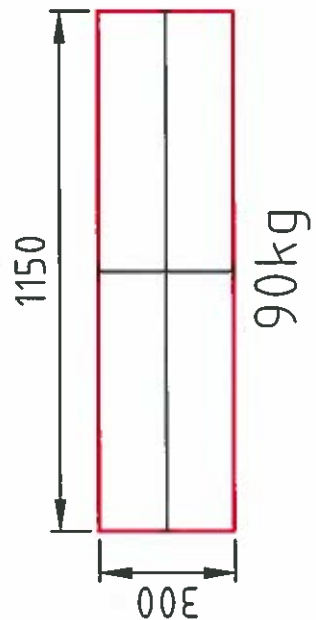
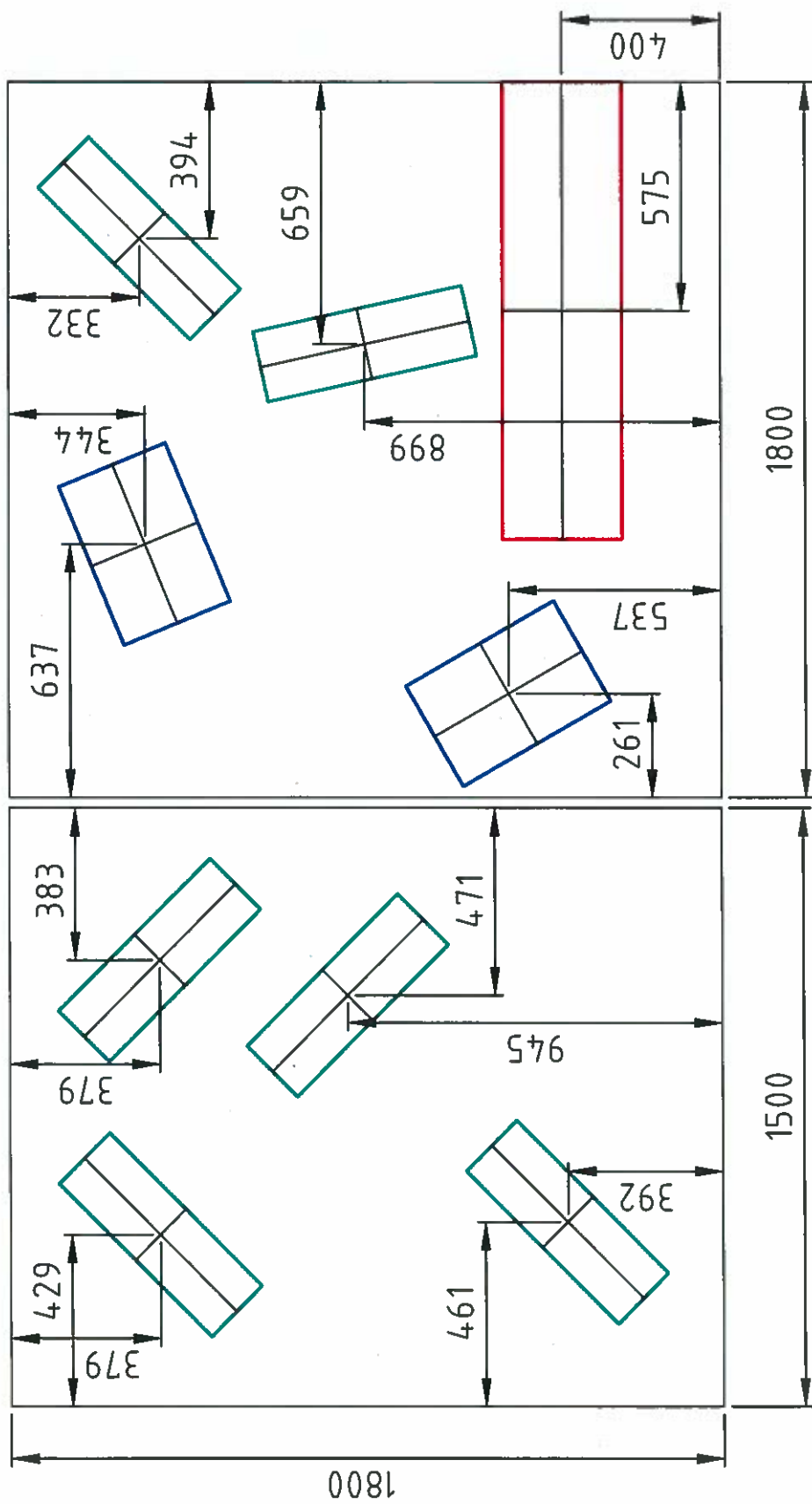
19. Annex I

ECU - Contract Phases

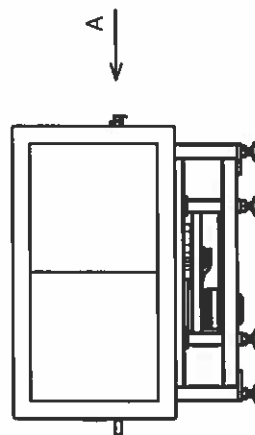


- N zone controllers
- Each zone controller responsible for a set of zones
- A zone is an elementary subpart of the vacuum system





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Number	Quantity	Description
1	2	TURBOMOLECULAR PUMP DN750
2	2	GATE VALVE DN250
3	1	VALVE DN80
4	1	VALVE DN60
5	1	VACUUM GAUGE DN25 ISO-KF
6	1	VENT VALVE DN25 ISO-KF
7	2	REDUCER DN15 ISO-4/DN25 ISO-KF
8	1	PPE DN400 ISO-F
9	2	PPE DN250 ISO-F
10	1	PPE DN80 ISO-F
11	2	BELAD FLANGE DN400
12	3	BELAD FLANGE DN60
13	2	BELAD FLANGE DN250
14	7	BELAD FLANGE DN15

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Datum za izvedbo: 2023/02/28
Stran 137

Confidentiality Level	BL - Restricted for internal use	TC ID / Revision	00104397 / F
Document Status	Document Reviewed	Document No.	Specific Document code
WBS code	5.2 - RP3 Particle acceleration by lasers		
PBS code	E.E4.ELMA - (RA3) ELIMAIA (ELIMED + ION acceleration)		
<i>Requirements Specification Document (RSD)</i>			
<i>ECU ELIMAIA plasma mirror chamber</i>  Keywords Put keywords related to the document content.			
	Position	Name	
Responsible person	Group Leader RP3	Daniele Margarone	
Prepared by	Chief Engineer	Pavel Korouš	

Vky

<i>RSS TC ID/revision</i>	<i>Date of Creation</i>	<i>Date of Last Modification</i>	<i>Systems Engineer</i>
001117 / E	09-12-2014 21:21	11-12-2014	Pavel Korouš
001117 / F	27-02-2015 16:49	02-03-2015	Aleksei Kuzmenko

Reviewed By			
<i>Name (Reviewer)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Approved by			
<i>Name (Approver)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Revision History / Change Log				
<i>Change No.</i>	<i>Made by</i>	<i>Date</i>	<i>Change description, Pages, Chapters</i>	<i>TC rev.</i>

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1. ECU (Experimental Chamber Unit)

ECU is an abbreviation for **Experimental Chamber Unit** which in contract text is called by **Device**. **ECU** is defined for this specification purpose as a self-contained unit providing controlled pumping and venting together with provision of stable area for optical layout.

2. Functional and Performance Requirements

REQ-001747/A

ECU shall allow vacuum pumping and venting for experimental set-up.
Verification method: FD - functional demonstration

REQ-001748/A

ECU shall reach vacuum level 10^{-6} mbar.
Verification method: T - test

REQ-001750/A

ECU vacuum equipment shall be capable reaching 10^{-5} mbar vacuum level in 60 minutes.
Verification method: T - test

REQ-001751/A

Preventive maintenance time shall not exceed 8 hours.
Verification method: R - review

REQ-001752/A

The **ECU** shall provide pumping and venting sequences.
Verification method: FD - functional demonstration

3. Operational design requirements

REQ-001753/A

ECU shall comply with frequency of opening/closing 2-times a day.
Verification method: R - review

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4. Design requirements

4.1. General

REQ-003501/A

Enclosed **ECU** tender .pdf drawings shall be taken into account as a concept for preliminary design.

Verification method: R - review

REQ-001754/A

Interaction Chamber Unit (**ECU**) shall provide space for customer provided optical equipment.

Verification method: R - review

REQ-001755/A

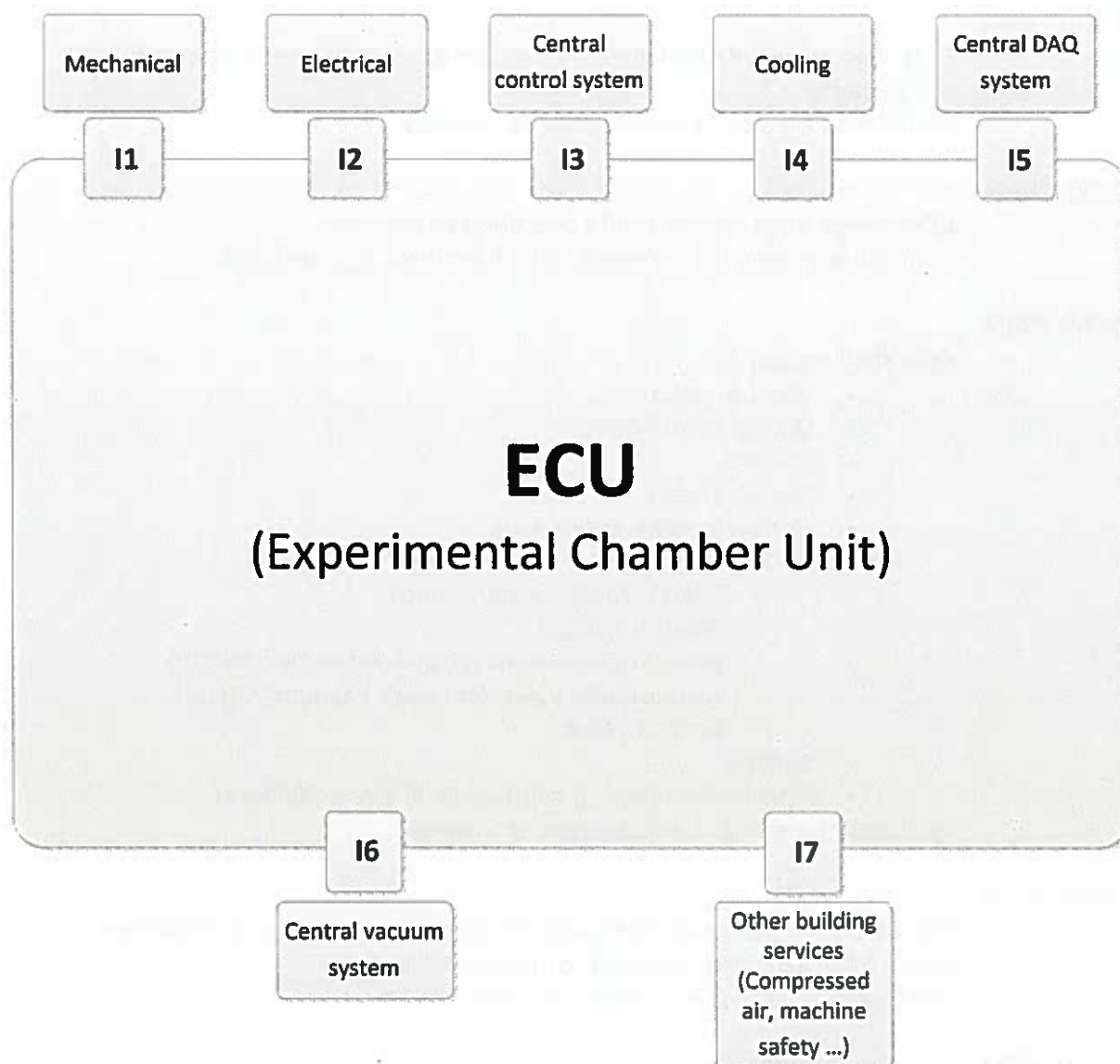
ECU shall provide for the following interfaces:

- TMP's (Turbo Molecular Pumps)
- Gauges
- Feedthrough
- Diagnostics
- Remote control
- Central Vacuum System (CVS)
- Beam Transport (BT)
- ELI Building
- ELI Building services

Verification method: R - review

REQ-003409/A

Supplier shall provide **ECU** Interface Control Document (**ICD**).



Verification method: R - review

REQ-001756/A

The supplier shall define the **Reference Coordinate System (RCS)** of the **ECU** which shall allow positioning the **ECU** in customer's experimental hall according to **Reference Mechanical System** of the hall (**RMS**).

Verification method: R - review

REQ-001757/A

RMS shall be set up together with supplier during the preliminary design phase.

Verification method: R - review

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REQ-001758/A

ECU shall allow safe handling and manipulation with internal and external components.

Verification method: I - inspection, R - review

REQ-001759/A

ECU design shall assure a safe operation of the unit.

Verification method: R - review, FD - functional demonstration

REQ-001760/A

ECU shall consist of:

- Vacuum vessel
- Optical breadboard
- Chassis
- Vessel chassis
- Optical breadboard chassis
- Vacuum devices:
 - TMP (TurboMolecular Pump)
 - Vacuum gauges
 - Vacuum gate valves (main inlet/outlet DN400)
 - Vacuum gate valve for rough vacuum (DN100)
 - Venting valve
- Bellows
- Pipework (in case of connection of two chambers)

Verification method: I - inspection, R - review

REQ-001761/A

The **ECU** shall be designed to accommodate laser beam axis 1300 mm above floor level (see attached conceptual drawings).

Verification method: R - review, T - test

REQ-001762/A

Tools used during manufacture shall not contaminate the vacuum surface.

Verification method: T - test

REQ-003508/A

All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.

Verification method: R - review, T - test

4.2. Operational design requirements

REQ-001763/A

ECU shall be a modular unit allowing extension in longitudinal direction.

Verification method: R - review, I - inspection

REQ-001764/A

ECU breadboard and vacuum vessel shall be decoupled.
Verification method: I - inspection, R - review

REQ-001765/A

Decoupling of **ECU** breadboard and vacuum vessel shall be made by using edge welded bellows.
Verification method: R - review, I - inspection

REQ-003188/A

Double bellows decoupling system shall be applied on **ECU** breadboard chassis.
Verification method: R - review

4.3. ECU design requirements

4.3.1. ECU Vacuum vessel design

REQ-001766/A

ECU frame shall be made of stainless steel following types:

- AISI 304L or
- AISI 304

Verification method: I - inspection, R - review

REQ-001767/A

ECU panels shall be made of aluminum following types:

- Al2219
- Al3003
- Al5083
- Al6082
- Al2090
- Al2219
- Al7005

Verification method: R - review, I - inspection

REQ-001768/A

Final choice of **ECU** vessel materials shall be made in preliminary design phase.
Verification method: R - review

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REQ-001769/A

ECU panels shall be designed as a modular system.

Verification method: R - review, I - inspection

REQ-001770/B

Maximum size of modular aluminium panels shall be 1x1.5 m. *Technical note: Increase of dimension from 1.5 m up to 2 m is acceptable in access optical breadboard area.*

Verification method: R - review, I - inspection

REQ-001771/A

Thickness of **ECU** modular aluminium panels shall be in bounded interval 40 + 50 mm.

Verification method: R - review, T - test

REQ-001772/A

All **ECU** panels shall be equipped by Lifting eyes interfaces.

Verification method: R - review, I - inspection

REQ-001773/A

ECU panels close to main optical components shall be equipped with small doors with minimal width 600 mm and high 500 mm.

Verification method: R - review, I - inspection

REQ-001774/A

Openings of **ECU** shall be closed by aluminium blank flanges.

Verification method: R - review, I - inspection

REQ-001775/A

Stainless steel screws with Allen heads shall be used on **ECU** panels.

Verification method: I - inspection, R - review

REQ-001776/A

ECU small doors shall be equipped with hinges.

Verification method: R - review, I - inspection

REQ-001777/A

Maximal deformations of **ECU** panels under vacuum shall be lower than 3 mm in comparison to the vented status.

Verification method: A - analysis, R - review, T - test

REQ-001778/A

Deformations of **ECU** panels in selected coordinates under vacuum shall be lower than 2 mm in comparison to the vented status.

Verification method: A - analysis, T - test

REQ-001779/A

All **ECU** removable panels shall be equipped with guiding pins to allow proper panel seating.

Verification method: R - review, I - inspection

REQ-001780/A

Sealing of **ECU** panels shall be made of fluorelastomer polymer (FPM) material.

Verification method: R - review, I - inspection

REQ-001781/B

Hardness of **ECU** sealing o-rings shall be 60 or 70 HSC (Shore).

Verification method: I - inspection, R - review

REQ-001782/A

ECU shall be equipped with roughing inlet interface (DN100).

Verification method: R - review, I - inspection

REQ-001784/A

Surface treatment of inner **ECU** vacuum vessel surfaces compatible with 10^{-6} mbar shall be applied.

Verification method: R - review, I - inspection

4.3.2. Vacuum Vessel Chassis

REQ-001785/A

ECU vacuum vessel chassis shall allow **z** (vertical) positioning.

Verification method: I - inspection, R - review

REQ-001786/A

Range of **ECU** vacuum vessel chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: R - review, T - test

REQ-001787/A

ECU vacuum vessel chassis shall be made of stainless steel or extruded aluminium profiles.

Verification method: R - review, I - inspection

REQ-001788/A

ECU chassis shall allow for installation of TMP's.

Verification method: R - review, I - inspection

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REQ-001789/A

ECU chassis shall allow for floor fixing.
Verification method: R - review, I - inspection

REQ-001790/A

ECU vacuum vessel chassis shall be equipped with removable transportation wheels.
Verification method: R - review, I - inspection

4.3.3. ECU Optical breadboard design

4.3.3.1. General

REQ-001791/B

Supplier shall provide static FEM analysis and vibration study according to customer inputs.
Technical note: The latest results of building vibration measurement will be provided by customer after contract signature.
Verification method: A - analysis, R - review

4.3.3.2. Optical breadboard

REQ-001792/A

ECU optical breadboard shall allow connection of multiple modular breadboards.
Verification method: I - inspection, R - review

REQ-001793/A

ECU optical breadboard shall have threaded hole pattern with 25 mm spacing.
Verification method: R - review, T - test

REQ-001794/A

Threaded holes of **ECU** breadboard shall be M6 size.
Verification method: R - review, T - test

REQ-001795/A

ECU optical breadboard shall be made of aluminium following types:

- Al2219
- Al3003
- Al5083
- Al6082

- AI7005

Verification method: R - review, I - inspection

REQ-001796/A

Final choice of **ECU** optical breadboard materials shall be made in preliminary design phase.

Verification method: R - review, I - inspection

REQ-001797/A

Minimum thickness of **ECU** breadboard plate shall be 50 mm.

Verification method: A - analysis, R - review, T - test

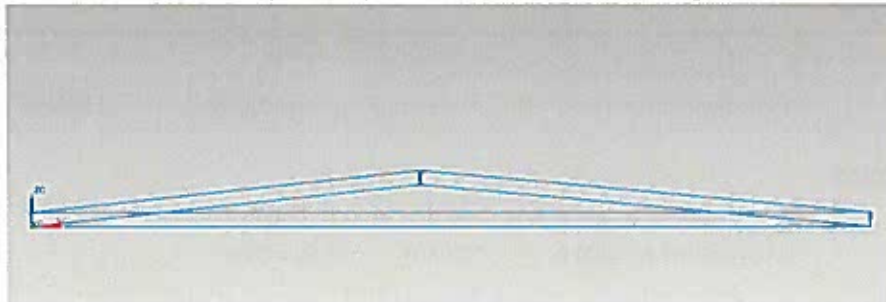
REQ-001798/A

Maximal thickness of whole **ECU** breadboard (plate with reinforcing ribs) shall be 130 mm.

Verification method: A - analysis, R - review, T - test

REQ-001799/B

Maximum misalignment after connection of breadboard segments shall be lower than 1 mrad. (in comparison with ideal non-segmented breadboard)



Technical note: This requirement is valid only in case of using segmented optical table.

Verification method: T - test

REQ-001800/A

Maximum z direction misalignment after connection of breadboard segments shall be lower than 1 mm.

Verification method: T - test, FD - functional demonstration

REQ-001801/A

Supplier shall provide procedure of misalignment measurement.

Verification method: R - review, T - test

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4.3.3.3. Optical Breadboard Chassis

REQ-001802/A

ECU chassis shall be designed as modular unit.

Verification method: R - review, I - inspection

REQ-001803/A

Only one chassis shall be applied for more connected **ECU** breadboards.

Verification method: R - review, I - inspection

REQ-001804/A

ECU optical breadboard chassis shall allow **z** (vertical) positioning.

Verification method: R - review, I - inspection

REQ-001805/A

Range of **ECU** optical breadboard chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: I - inspection, T - test

REQ-001806/A

ECU optical breadboard chassis shall be made of stainless steel or aluminium extruded profiles.

Verification method: R - review, I - inspection

REQ-001807/A

ECU chassis shall allow installation of TMP's.

Verification method: R - review, I - inspection

REQ-001808/A

ECU chassis shall allow floor fixing.

Verification method: R - review, I - inspection

REQ-001809/A

The **ECU** optical breadboard chassis shall be equipped with removable transportation wheels.

Verification method: R - review, I - inspection

REQ-003195/A

The **ECU** optical breadboard chassis shall have interface for vibration dumping system.

Verification method: R - review

4.3.4. ECU Vacuum equipment

4.3.4.1. TMP (Turbomolecular pump)

REQ-001810/A

Only new **ECU** TMP with full warranty shall be used.
Verification method: I - inspection

REQ-001811/A

ECU shall be installed in accordance to the installation manual of TMP supplier.
Verification method: R - review, I - inspection

REQ-001812/A

ECU TMP shall be water cooled.
Verification method: R - review, I - inspection

REQ-001813/A

ECU TMP coolant shall be demineralized water.
Verification method: I - inspection

REQ-001814/A

ECU TMP shall be equipped with fittings for water cooling.
Verification method: I - inspection

REQ-001815/A

ECU TMP shall be equipped with protective screen.
Verification method: I - inspection

REQ-001816/A

ECU TMP shall be compatible with power supply 230V, 50 Hz.
Verification method: I - inspection

REQ-001817/A

ECU TMP inlet flange shall be ISO-F according to ISO 1609:1986.
Verification method: I - inspection

REQ-001818/A

ECU TMP outlet flange shall be ISO-KF according to ISO 2861:2013.
Verification method: I - inspection

REQ-001819/A

Maximum noise of **ECU** TMP shall be 60 dB.
Verification method: R - review

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REQ-001820/A

ECU TMP with minimum pumping speed 1500 l/sec shall be used.

Verification method: R - review, I - inspection

REQ-001821/A

ECU TMP set up shall be equipped with separation gate valve.

Verification method: I - inspection

REQ-001822/A

ECU TMP shall be equipped with electrically operated venting valve.

Verification method: I - inspection

REQ-001823/A

ECU TMP shall be equipped with power supply unit and control unit.

Verification method: I - inspection

REQ-001824/A

ECU TMP shall be equipped with 19" equipment rack mountable controllers.

Verification method: I - inspection

REQ-001825/A

The minimum required lifetime of TMP shall be 50 000 working hours.

Verification method: R - review

REQ-001826/A

The TMP shall be able to operate continuously at a maximum inlet pressure of 0.05 mbar.

Verification method: R - review

REQ-001827/A

The TMP shall be able to operate continuously at a maximum exhaust pressure of 0.5 mbar.

Verification method: R - review

REQ-001828/A

The TMP shall be protected against damage from sudden temperature rise.

Verification method: R - review, I - inspection

REQ-001829/A

TMP and their accessories (including liquid cooling fittings) must be in compliance with the following standards:

- ISO 1609:1986 - Vacuum technology - Flange dimension
- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings

- ISO 5302:2003 - Vacuum technology - Turbomolecular pumps - Measurement of performance characteristic

Verification method: R - review

4.3.4.2. Gauges

REQ-001830/A

Measurement range of combined gauge shall be $1000 \text{ mbar} \div 1 \times 10^{-6} \text{ mbar}$ with maximum accuracy $\pm 30\%$.

Verification method: R - review, I - inspection

REQ-001831/A

Mechanical interface of ECU Vacuum gauges shall be ISO KF according to ISO 2861:2013.

Verification method: R - review, I - inspection

REQ-001832/A

Vacuum connection of the gauges must be in compliance with the following standards:

- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings.

Verification method: R - review, I - inspection

REQ-001833/A

Power supply of **ECU** vacuum gauges shall be 24VDC.

Verification method: R - review, I - inspection

REQ-001834/A

Interval of output **ECU** vacuum gauges signal shall be $0 \div 11 \text{ VDC}$.

Verification method: R - review, I - inspection

4.3.4.3. Gate valves

REQ-001835/A

ECU gate valve separating TMP shall be made of stainless steel (body material).

Verification method: R - review, I - inspection

REQ-001836/A

Main **ECU** inlet/outlet gate (DN400) valves shall be made of aluminium (body material).

Verification method: R - review, I - inspection

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REQ-001837/A

The **ECU** gate valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

REQ-001838/A

Minimal open/close cycles of **ECU** gate valves until first service shall be 200 000.

Verification method: R - review

REQ-001839/A

ECU gate valve shall be equipped with ISO F flange according to ISO 1609:1986.

Verification method: I - inspection

REQ-001840/A

ECU gate valves shall be equipped with blank flange from atmosphere side.

Verification method: I - inspection

4.3.4.4. Venting valves

REQ-001841/A

ECU shall be equipped with venting valve.

Verification method: I - inspection

REQ-001842/A

Automatic venting valve shall be used on **ECU**.

Verification method: I - inspection

REQ-001843/A

The **ECU** venting valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

4.3.4.5. Bellows (connection of two chambers)

REQ-001844/A

Edge welded bellows shall be used on **ECU**.

Verification method: I - inspection, R - review

REQ-001845/A

ECU bellows shall be equipped with threaded rods.

Verification method: I - inspection, R - review

REQ-001846/A

Compensation range of ECU connecting bellows shall be:

- Axial ± 15 mm
- Lateral ± 5 mm
- Angular $\pm 2^\circ$

Verification method: R - review, I - inspection, T - test

4.3.4.6. Vacuum clamps

REQ-001847/A

All **ECU** vacuum clamps shall be permanent set free after assembling.

Verification method: I - inspection, FD - functional demonstration

REQ-001848/A

Clamp slots shall defect free.

Verification method: I - inspection

4.3.4.7. Local & remote vacuum control and safety system

REQ-001849/A

ECU local control system shall be designed and verified as an autonomous manually controlled system with interfaces to ELI – control system.

Verification method: R - review, I - inspection

REQ-001850/A

All ECU TMP's, vacuum gauges and valves shall be delivered with the **associated controllers**.

Verification method: I - inspection

REQ-001851/A

The controllers shall provide a reliable control interface to ELI central control system via LC optical fibers or RJ45 metallic connections.

Verification method: I - inspection

REQ-001852/A

The communication protocol shall be available and compatible with Linux OS.

Verification method: R - review

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REQ-001853/A

Documentation for the protocol shall be provided.
Verification method: I - inspection

REQ-001854/A

Safety interface based on digital I/O (24V DC signals) shall be provided for redundancy in addition to REQ-001858/A.
Verification method: R - review

REQ-001855/A

The controllers shall have local and remote access capabilities.
Verification method: I - inspection

REQ-001856/A

The controllers shall provide separate interlock capabilities via dry C-shape contacts.
Verification method: I - inspection

REQ-001857/A

All valves shall be supplied with open/closed limit switches wired to standard DIN connectors with mating plugs.
Verification method: I - inspection

REQ-001858/A

The supplied controls shall provide a safe pumping and venting sequence including interlocks in the local and remote mode of operation.
Verification method: I - inspection

4.3.5. Data acquisition

REQ-001859/A

Following data shall be readable from the ECU:

- Temperature on TMP
- Level of vacuum
- rpm of TMP rotor
- Hours of TMP operation
- Levitation of TMP rotor (if maglev is used)

Verification method: R - review, T - test

4.3.6. EMC/EMP

REQ-001860/A

The **ECU** design shall comply with EU standards of electro-magnetic compatibility.

Verification method: R - review

5. System Transportation and installation requirements

5.1. General requirements

REQ-001861/A

Supplier shall provide procedures for transportation and installation of **ECU**.

Verification method: R - review

REQ-001862/A

Supplier shall provide procedures for handling and manipulation of **ECU**.

Verification method: R - review

REQ-007153/A

The transportation and installation personnel shall follow the customer's facility regulations.

NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.

Verification method: R - review

REQ-007154/A

The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in clean environment of ISO class 7, if not agreed otherwise.

Verification method: R - review, I - inspection

REQ-007155/A

All transportation and installation tools and equipment entering the clean rooms shall be cleaned and reviewed by the customer's approved methods.

NOTE: Some tools can be provided by the customer upon agreement.

Verification method: I - inspection, T - test

REQ-007156/A

The transportation to the final destination and the installation of the technologies and the instruments shall be conducted by the vendor. The

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methods shall be discussed and reviewed by the customer's installation officer and shall be compliant with the customer's installation regulations.
NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.
Verification method: R - review

REQ-007157/A

The main parts of the mechanical structure shall be equipped with positioning/alignment marks for industrial 3D-measurements/survey. The specific type of the positioning/alignment marks, their number and location shall be agreed with the customer.
Verification method: R - review, I - inspection

5.2. Transportation

REQ-001863/A

The supplier shall provide supervision by transport **ECU** to defined position in ELI – Beamlines experimental room.
Verification method: R - review, I - inspection

REQ-001865/A

All Parts shall be identified according to technical documentation.
Verification method: R - review

5.3. Installation

REQ-001867/A

Connection of **ECU** to the ELI- Beamlines facility services shall be made under supervision of supplier.
Verification method: R - review, I - inspection

REQ-001868/A

Assembling of **ECU** on supplier side shall be made in cleanroom ISO7.
Verification method: I - inspection

REQ-001869/A

All specific equipment and tools necessary for installation of the **ECU** shall be subject of the supplier delivery.
Verification method: I - inspection, R - review

REQ-001870/A

Maximum dimensions of goods going through experimental entrance area shall be 3000x2000x2000 mm (length x with x high)
Verification method: R - review, T - test

6. Handling and Manipulation

REQ-001872/A

Supplier shall provide an approved methodological document describing safe handling and manipulation of the product.

Verification method: R - review

7. Maintenance

REQ-001873/A

Supplier shall provide an approved methodological document describing maintenance procedures of the product.

Verification method: R - review

8. Safety Requirements

REQ-001874/A

The **ECU** design of relevant parts shall comply with Czech and EU regulations regarding safety domain.

NOTE: Application of Czech regulations will be subject of preliminary design.

Verification method: R - review

REQ-001875/A

Supplier shall perform hazard identification and risk assessment of system prior to design.

Verification method: A - analysis, R - review

REQ-001876/A

All **ECU** manufactured parts shall be free of sharp edges.

Verification method: I - inspection

REQ-001877/A

All **ECU** manufactured parts shall be burr free.

Verification method: I - inspection

8/14

9. Quality

9.1. Quality Management

9.1.1. Quality organization and responsibilities

9.1.1.1. Organization

REQ-001878/A

The supplier shall identify the personnel responsible for implementing and performing QA management plan and other Quality Controls disciplines.
Verification method: R - review

REQ-001879/A

The supplier shall assign a project Quality manager reporting to the project manager who has an unimpeded access to higher management.
Verification method: R - review

REQ-001880/A

The appointed project Quality manager, irrespective of other responsibilities, shall have organizational authority to establish and implement a quality assurance programme in accordance with the project quality assurance requirements.
Verification method: R - review

REQ-001881/A

The project Quality Manager shall act as the primary contact person within the project concerning Quality matters.
Verification method: R - review

REQ-007176/A

The supplier shall apply international recognized standards or best practice where applicable for quality assurance programme.
Verification method: R - review

9.1.1.2. Responsibility and authority

REQ-001882/A

The supplier shall define and document the responsibility, the authority and the interrelation of personnel who manage, perform and verify work affecting quality assurance.

Verification method: R - review

REQ-001883/A

The supplier shall define and document the responsibilities and the interfaces of the Quality functions, either external or internal, involved in a project.

Verification method: R - review

REQ-001884/A

When the supplier's Quality organization delegates quality assurance tasks to another organization it shall be done in a documented and controlled way monitored by the Quality organization.

Verification method: R - review

9.1.2. Quality plan and its implementation

REQ-001885/A

The supplier shall prepare, maintain and implement a plan of the QA (Quality Assurance) activities in accordance with the customer QA requirements.

Verification method: R - review

REQ-001888/A

The supplier management shall ensure that the inputs used by the Quality functions are consistent and complete, and available in line with the project schedule.

Verification method: R - review

REQ-001889/A

The supplier QA management shall ensure that the QA functions perform the tasks described in the QA Plan in line with the project schedule.

Verification method: R - review

REQ-001890/A

The supplier QA management shall ensure that the outputs produced by the QA functions are consistent and complete, and delivered in line with the project schedule.

Verification method: R - review

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REQ-001891/A

The supplier QA management shall ensure the application of processes defined in applicable project plans and documents.

Verification method: R - review

9.1.3. Documentation and data control

REQ-001892/B

The supplier shall provide following type of documents:

- 3D model (format: *.step; *.stp)
- 2D drawings (format: *.dwg)
- Printable format for text documents

Verification method: I - inspection

10. Environmental conditions

REQ-001893/A

Final cleanliness shall be compatible with ISO 7.

Verification method: I - inspection

11. Verification process

REQ-001894/A

The verification process shall demonstrate that the deliverable product meets the specified customer requirements and is capable of sustaining its operational role through:

1. Verification planning;
2. Verification execution and reporting;
3. Verification control and close-out.

Verification method: R - review

REQ-001895/A

The supplier shall define the verification approach by conducting the following steps:

1. Identify and agree with the customer the set of requirements to be subject of the verification process.
2. Select the methods and levels of verification, associated model philosophy and verification tools.
3. Identify the stages and events in which the verification is implemented.

Verification method: R - review

REQ-001896/A

The verification approach shall be defined by the supplier in the Verification Plan (VP) for approval by the customer prior to implementation.

Verification method: R - review

11.1. Verification methods

11.1.1. General

REQ-001898/A

Verification shall be accomplished by one or more of the following verification methods:

1. test (including functional demonstration);
2. analysis (including similarity);
3. review-of-design;
4. inspection.

Verification method: R - review

REQ-001899/A

All safety critical functions shall be verified by test.

Verification method: R - review

REQ-001900/A

Verification of software shall include testing in the target hardware environment.

Verification method: R - review

11.1.2. Test

REQ-001901/A

Verification by test shall consist of measuring product performance and functions under representative simulated environments.

Verification method: R - review

REQ-001902/A

The analysis of data derived from testing shall be an integral part of the test and the results included in the test report.

Verification method: R - review

1/4

REQ-001903/A

When the test objectives include the demonstration of qualitative operational performance, the execution shall be observed and results recorded (functional demonstration).

Note: Functional demonstration is a subset of tests.

Verification method: R - review

REQ-001904/A

A test programme shall be prepared for each product in conformance with Verification Plan.

Verification method: R - review

REQ-001905/A

The test programme shall be coordinated with the integration flow.

Verification method: R - review

REQ-001906/A

Tests performed as part of the integration flow to check quality and status of the in-progress configuration (including interfaces), having a formal verification purpose, shall be included in the test programme.

Verification method: R - review

REQ-001907/A

The test programme shall be defined in the specific chapter of the Verification Plan.

Verification method: R - review

REQ-001908/A

Test Programme shall be approved by the Customer.

Verification method: R - review

11.1.3. Analysis

REQ-001910/A

Verification by analysis shall consist of performing theoretical or empirical evaluation using techniques agreed with the Customer.

NOTE Techniques comprise systematic, statistical and qualitative design analysis, modelling and computational simulation.

Verification method: R - review

REQ-001913/A

An analysis programme shall be defined in the Verification Plan (VP).

Verification method: R - review

11.1.4. Review-of-design (ROD)

REQ-001914/A

Verification by Review-of-design (ROD) shall consist of using approved records or evidence that unambiguously show that the requirement is met.

NOTE Examples of such approved records are design documents and reports, technical descriptions, and engineering drawings.

Verification method: R - review

REQ-001915/A

A review-of-design programme shall be defined in the Verification Plan (VP).

Verification method: R - review

REQ-001916/A

A review-of-design programme shall only be applicable in stages (phases) before starting the manufacturing.

Verification method: R - review

11.1.5. Inspection

REQ-001917/A

Verification by inspection shall consist of visual determination of physical characteristics.

NOTE: Physical characteristics include constructional features, hardware conformance to document drawing or workmanship requirements, physical conditions, software source code conformance with coding standards.

Verification method: R - review

REQ-001918/A

An inspection programme shall be defined in the Verification Plan (VP).

Verification method: R - review

12. Qualification (if needed)

N/A

1/4

13. Acceptance

REQ-001919/A

In the acceptance stage the verification shall demonstrate that the product is free of fabrication errors and is ready for the intended operational use.

Verification method: R - review

REQ-001920/A

Acceptance shall be carried out on the final hardware and software

Verification method: R - review

14. Verification process phasing

REQ-001923/A

The verification process shall be phased with the project life cycle defined as a contract execution phases (preliminary design, detailed design, manufacturing and deployment of deliverable product(s) see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-001924/A

Verification planning to assess feasibility and support programmatic shall start in the early phases.

NOTE: programmatic means support equipment and verification timescale estimation.

Verification method: R - review

REQ-001925/A

The preliminary verification planning shall cover all products and requirements by the end of preliminary design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-001926/A

Verification planning shall be completed by the end of detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-001927/A

Verification execution and reporting shall be incrementally carried out through the project life cycle starting from detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-001928/A

Verification control shall start with the initial issue of the verification control document (VCD) during detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-001929/A

Verification close out status shall be assessed and approved by the customer for each product at the end of each stage (see Annex I – ECU Contract Phases).

Verification method: R - review

15. Verification plan (VP)

REQ-001930/A

The supplier shall provide a Verification plan (VP) for the reviews as agreed with the customer

NOTE Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-001931/A

The contents of the Verification plan (VP) shall be approved by the Customer

Verification method: R - review

16. Verification Control Document (VCD)

REQ-001932/A

The supplier shall provide a Verification Control Document (VCD) for the reviews as agreed with the customer

NOTE: Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-001933/A

The contents of the initial issue of the Verification Control Document (VCD) shall be in conformance with ELI verification matrix.

Verification method: R - review

1/4

17. Verification execution and reporting

17.1. General

REQ-001935/A

The supplier shall assign clear responsibility for the implementation of the verification plan.

Verification method: R - review

REQ-001936/A

The test preparation and execution (including Test Readiness Review (TRR) and Post Test Review (PTR)) shall be reviewed by the Customer.

Verification method: R - review

REQ-001937/A

The verification results shall be recorded by the supplier in reports for review by the Verification Control Board (VCB) through the VCD.

Verification method: R - review

17.2. Verification execution and reporting documentation

17.2.1. Test report (TRPT)

REQ-001938/A

The test report (TRPT) shall be submitted to the Verification Control Board (VCB) after the test completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-001939/A

The content of the Test report (TRPT) shall be agreed with the Customer.

Verification method: R - review

REQ-001940/A

The supplier shall provide the Test reports (TRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-001941/A

A Test report (TRPT) shall be provided for each test verification task as identified in the VP.

Verification method: R - review

17.2.2. Analysis report (ARPT)

REQ-001942/A

The Analysis report (ARPT) shall be submitted to the Verification Control Board (VCB) after analysis completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-001943/A

The supplier shall provide an Analysis report (ARPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-001944/A

An Analysis report (ARPT) shall be provided for each Analysis verification task identified in the VP.

Verification method: R - review

17.2.3. Review-of-design report (RRPT)

REQ-001945/A

The Review-of-design report (RRPT) shall be submitted to the Verification Control Board (VCB) after the Review-of-Design completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-001946/A

The supplier shall provide a Review-of-design report (RRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-001947/A

A Review-of-design report (RRPT) shall be provided for each Review-of-design verification task identified in the VP.

Verification method: R - review

17.2.4. Inspection report (IRPT)

REQ-001948/A

The Inspection report (IRPT) shall be submitted to the Verification Control Board (VCB) after the inspection completion, within the time frame agreed with the customer.

Verification method: R - review

1/4

REQ-001949/A

The supplier shall provide an Inspection report (IRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-001950/A

An Inspection report (IRPT) shall be provided for each Inspection verification task identified in the VP.

Verification method: R - review

17.2.5. Verification report (VRPT)

REQ-001951/A

The supplier shall prepare a Verification report (VRPT) when more than one of the defined verification methods are utilized to verify a requirement or a specific set of requirements.

Verification method: R - review

REQ-001952/A

The content of Verification report (VRPT) shall be agreed by the Customer

Verification method: R - review

REQ-001953/A

The Verification report (VRPT) shall be submitted to the Verification Control Board (VCB) after the completion of the last contributing verification activities, within the time frame agreed with the customer.

Verification method: R - review

REQ-001954/A

The supplier shall provide a Verification report (VRPT) for the reviews as agreed with the customer

Verification method: R - review

17.2.6. Other verification execution and reporting Document

REQ-001955/A

The supplier shall provide the Test specifications (TSPE) for the reviews as agreed with the customer

Verification method: R - review

REQ-001956/A

The supplier shall provide the Test procedures (TPRO) for the reviews as agreed with the customer

Verification method: R - review

REQ-001957/A

The rules for the analysis, inspection and review of design shall be defined in writing before their execution.

NOTE: For example, analysis, inspection or review of design procedures.

Verification method: R - review

18. Verification control and close-out

18.1. General

REQ-001958/A

The implementation of the verification process shall be monitored by the Verification Control Board (VCB).

Verification method: R - review

REQ-001959/A

The verification process control shall be supported by a computer based verification database.

Verification method: R - review

REQ-001960/A

The verification database shall be delivered to the customer in an electronic form to be agreed with the customer.

Verification method: R - review

REQ-001961/A

The supplier shall provide to the customer verification evidence for the customer's applicable requirements agreed to be verified, independently from the level where verification has been accomplished.

Verification method: R - review

18.2. Verification control board (VCB)

REQ-001962/A

A Verification Control Board (VCB), with participation of customer representatives, shall be established to incrementally assess the achievements and status of the verification process.

Verification method: R - review

1/4

REQ-001963/A

The verification process shall be considered completed when the Verification Control Board (VCB) confirms that:

1. documented evidence is recorded in the VCD,
2. identified requirements have been verified
3. associated product verification objectives are reached

Verification method: R - review

REQ-001964/A

The conclusions of the VCB shall be submitted for approval to the customer's contractual authority.

Verification method: R - review

REQ-001965/A

The Verification Control Board (VCB) shall assess the verification status with a periodicity agreed with the customer, along the project life cycle.

Verification method: R - review

REQ-001966/A

The Verification Control Board (VCB) shall endorse the final issue of the Verification Control Document (VCD).

Verification method: R - review

18.3. Re-verification

REQ-001967/A

The extent of the re-verification to be performed shall be determined by Supplier and agreed with the Customer, in the following cases:

1. failure and repair as decided by Nonconformance Review Board (NRB)
2. unplanned disassembly or demounting
3. refurbishment, maintenance or design changes
4. changes of requirements after initial verification
5. long duration storage

Verification method: R - review

REQ-001968/A

The Verification Control Document (VCD) shall be updated by the supplier to record as open, those requirements subject to re-verification until this is performed and closeout agreed by the customer.

Verification method: R - review

18.4. Verification control and close-out documentation

18.4.1. Verification Control Document (VCD)

REQ-001969/A

The content of the completed Verification Control Document (VCD) shall be agreed by the Customer

Verification method: R - review

REQ-001970/A

The supplier shall update the Verification database within one week of the approval of a report.

Verification method: R - review

REQ-001971/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current status of the verification database, shall be made available to the Verification Control Board (VCB) upon request.

Verification method: R - review

REQ-001972/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current verification and compliance status, shall be delivered at each formal review as agreed with the customer

Verification method: R - review

REQ-001973/A

The final issue of the Verification Control Document (VCD) shall be submitted to the Verification Control Board (VCB) after the approval of the last report, within the time frame agreed with the customer.

Verification method: R - review

18.4.2. Other close-out documents

REQ-001974/A

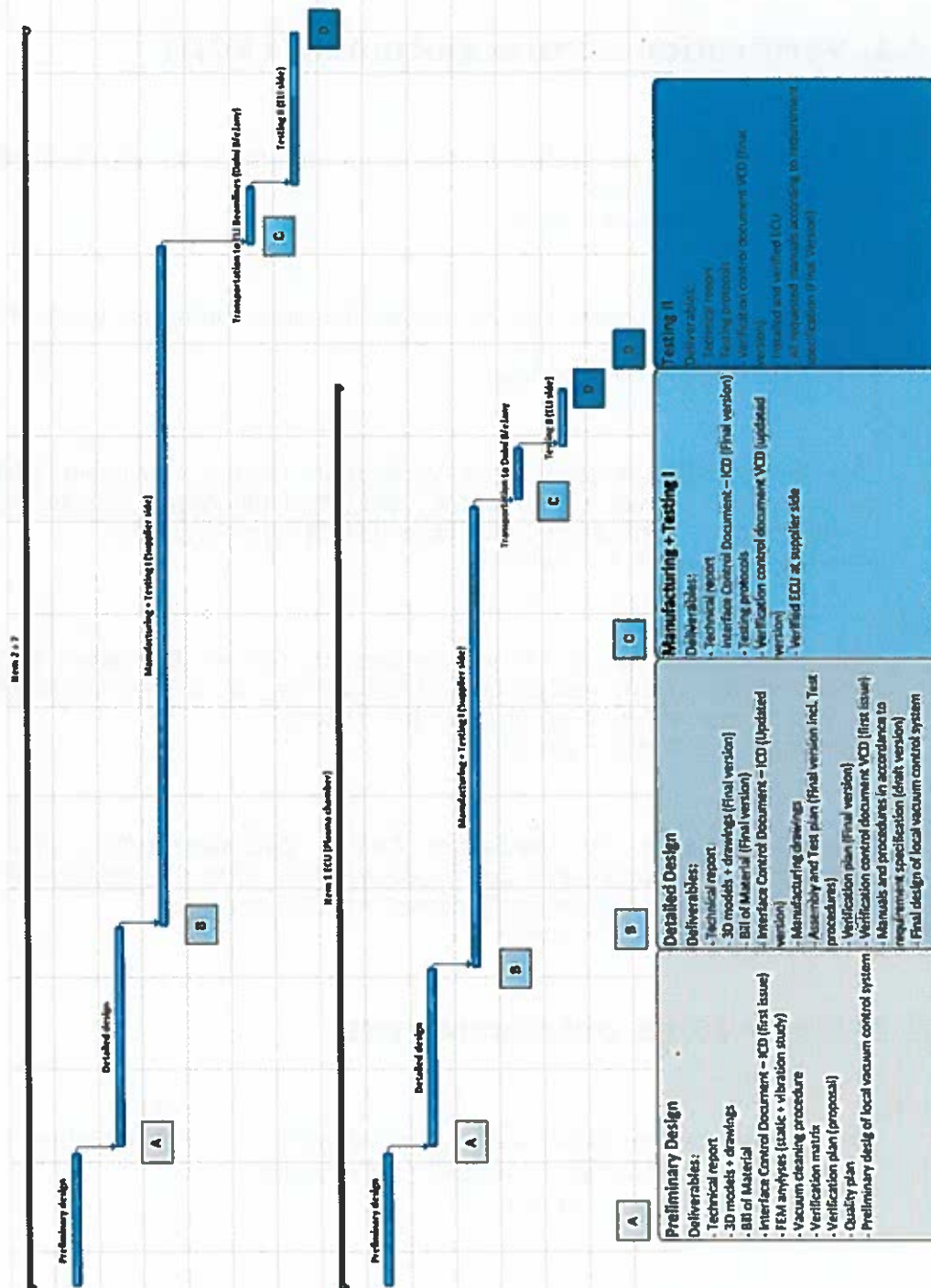
The supplier shall make available to the customer for consultation the VCD's supporting documentation in addition to the reports.

Verification method: R - review

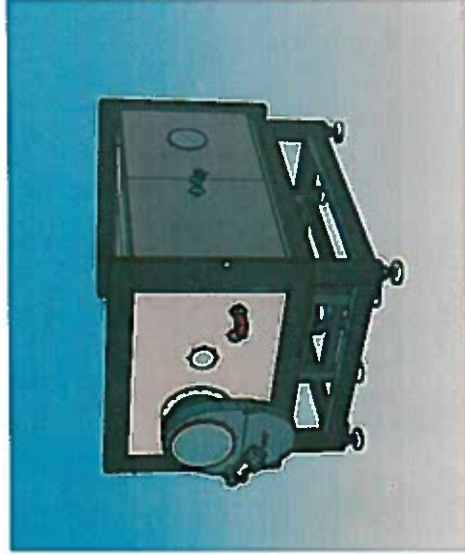
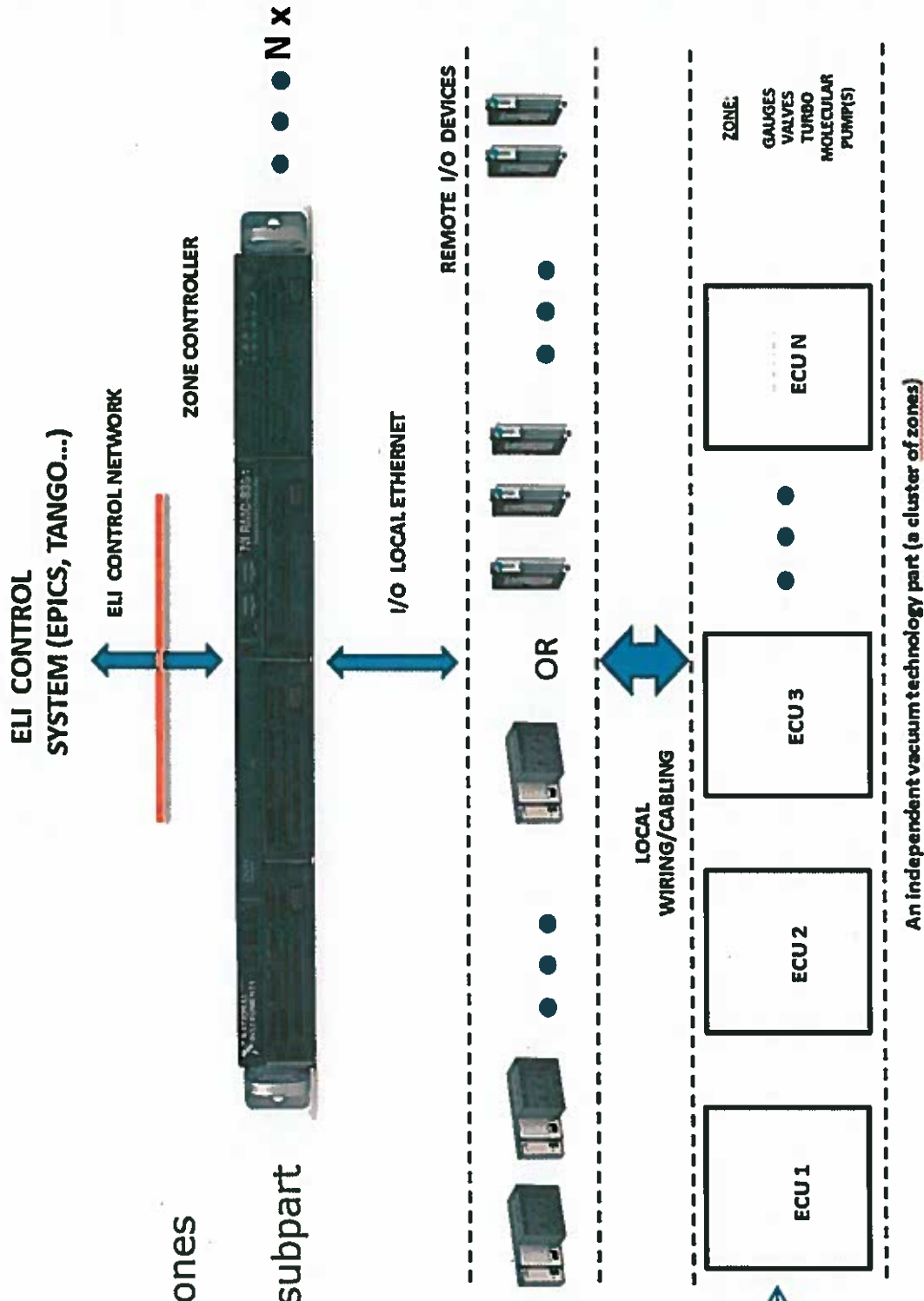
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19. Annex I

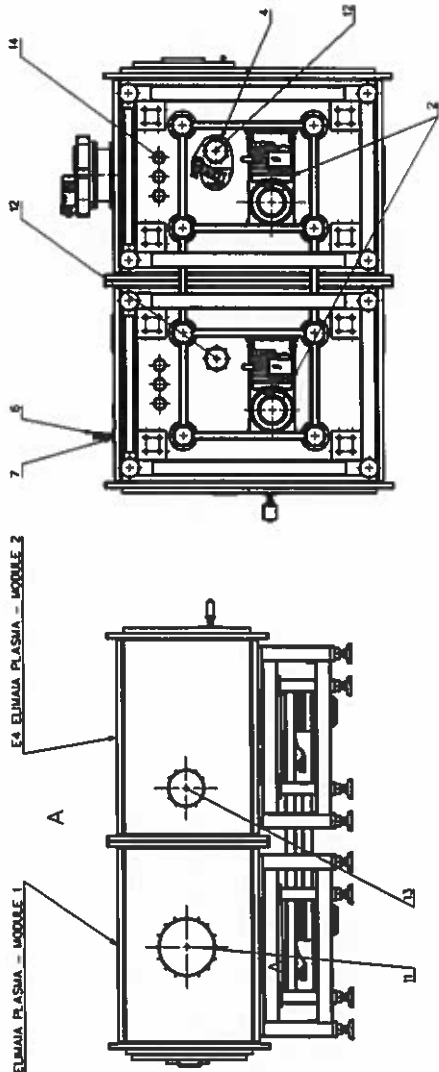
ECU - Contract Phases



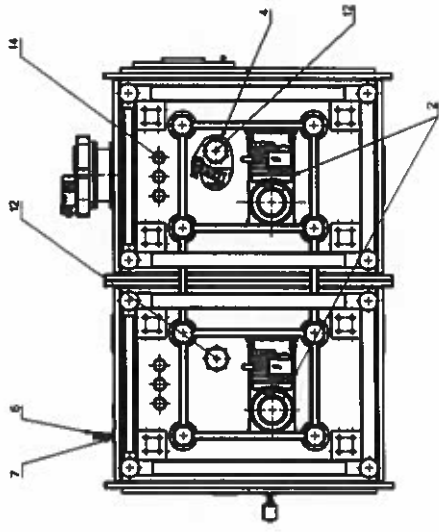
- N zone controllers
- Each zone controller responsible for a set of zones
- A zone is an elementary subpart of the vacuum system



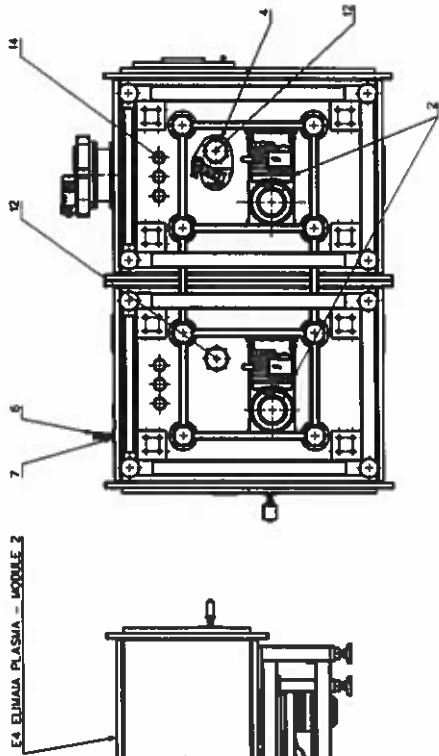
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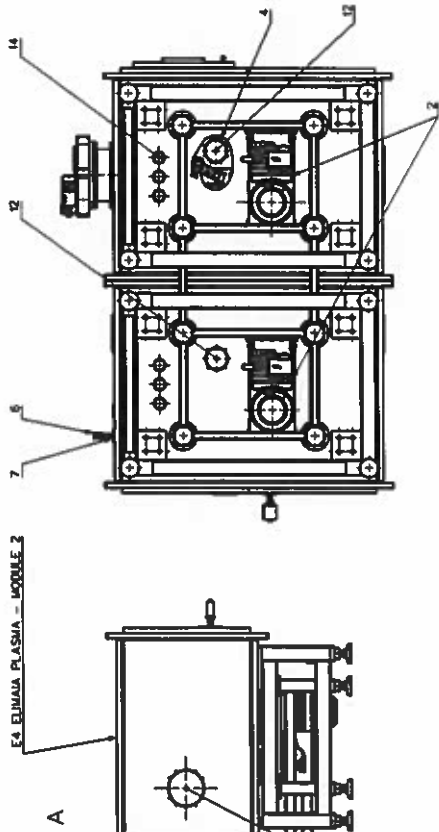
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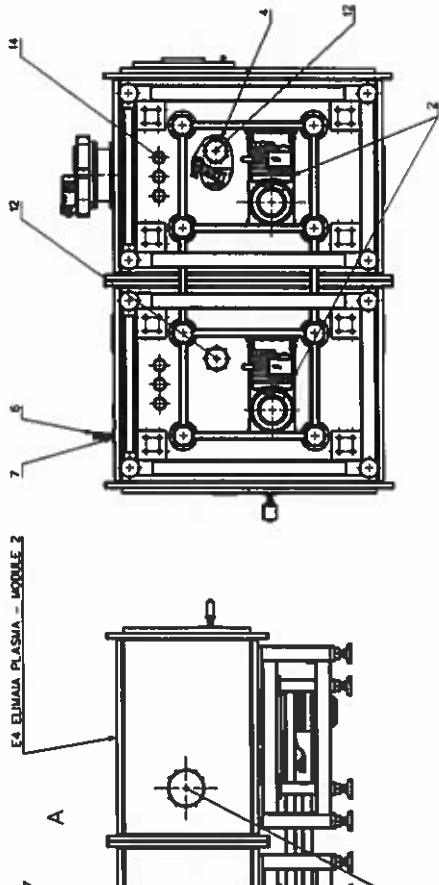
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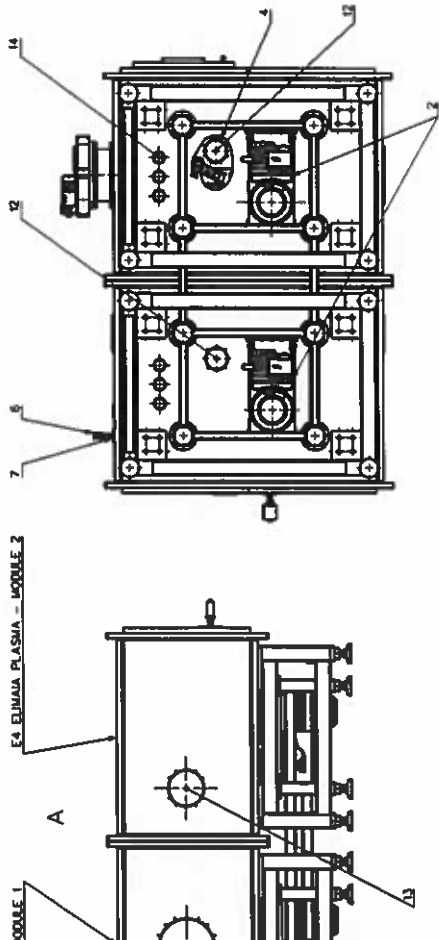
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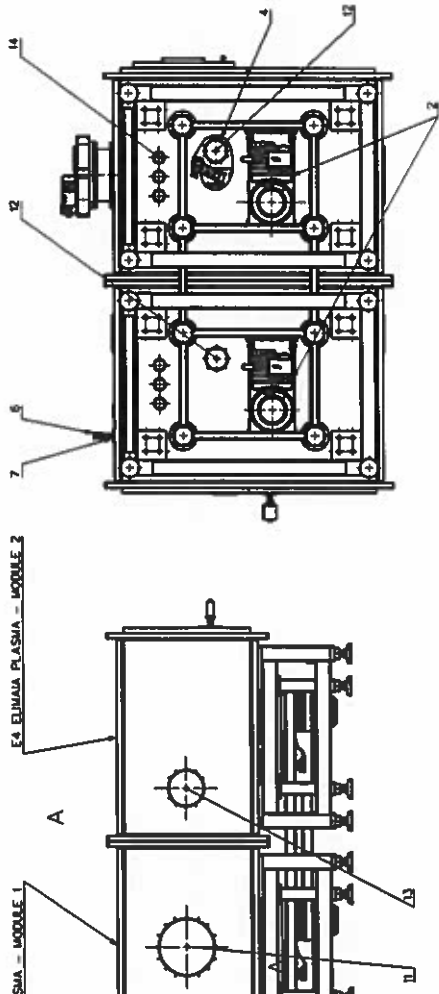
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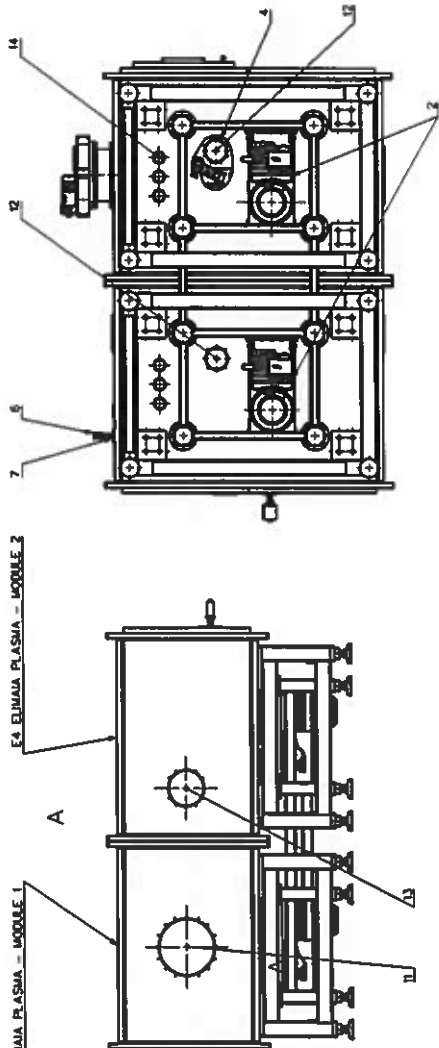
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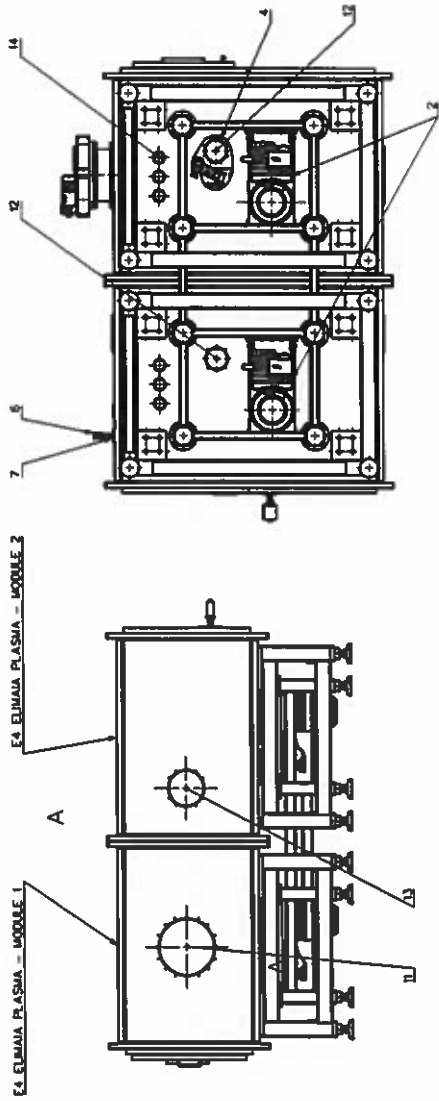
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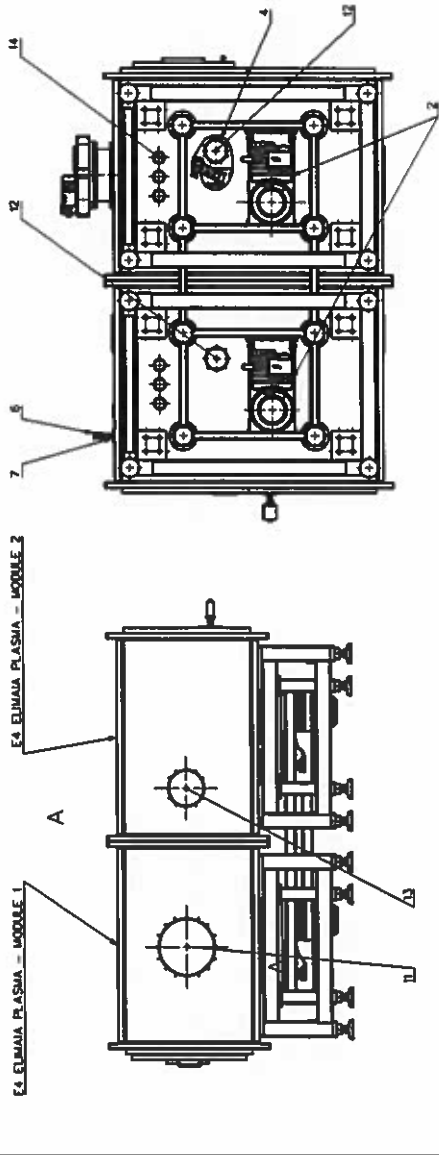
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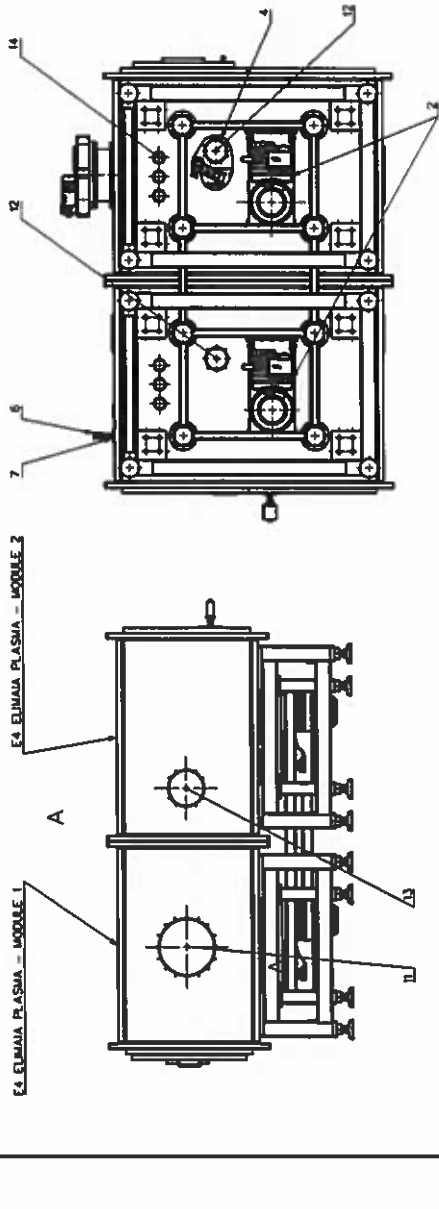
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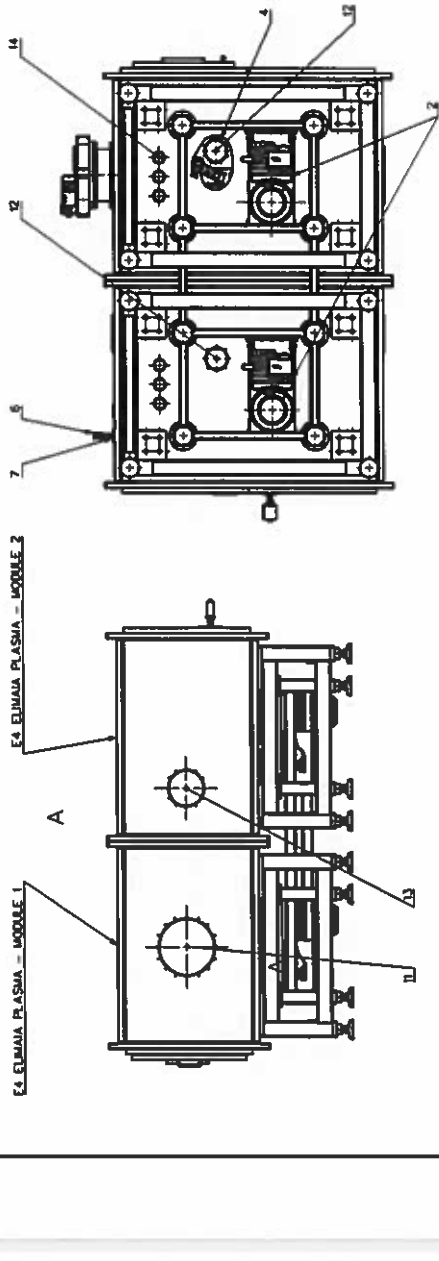
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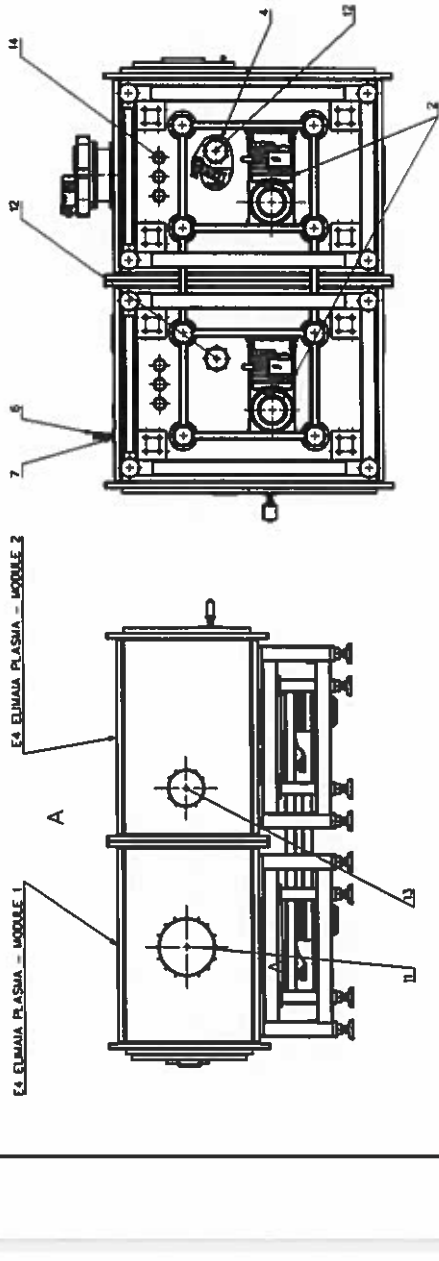
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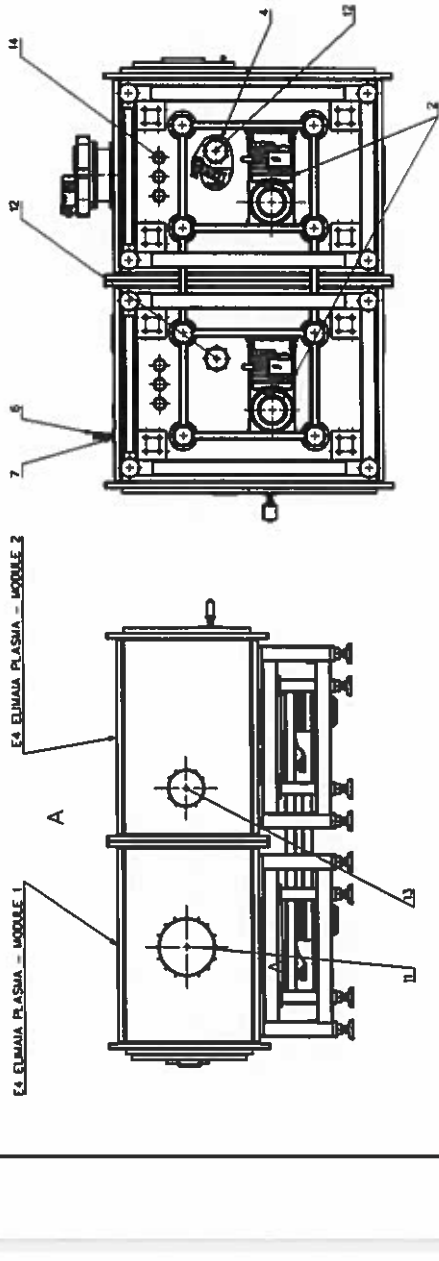
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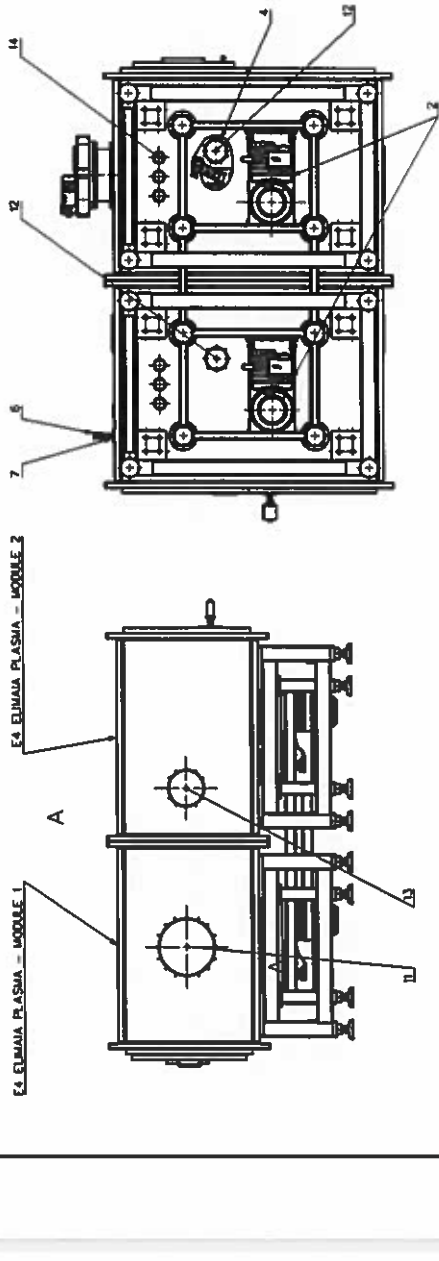
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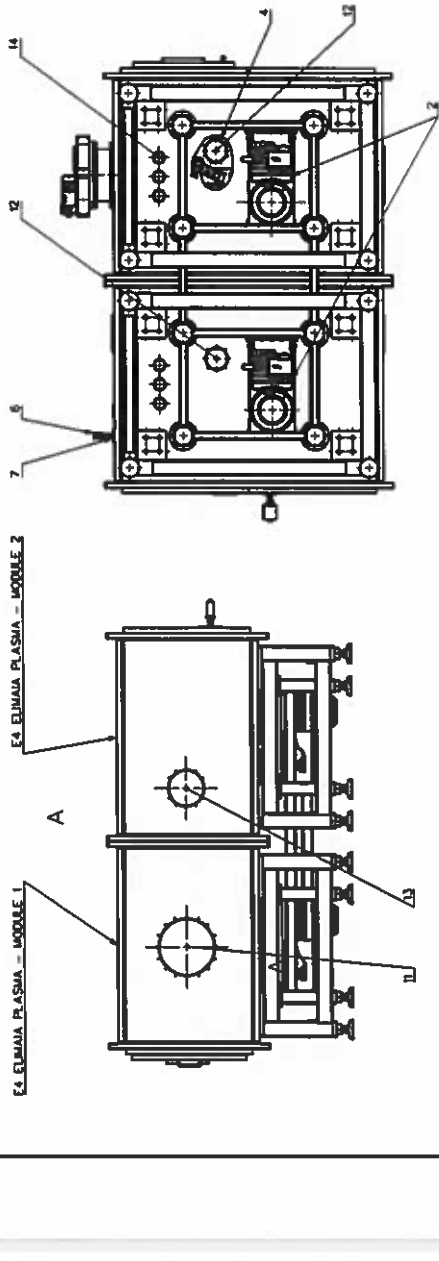
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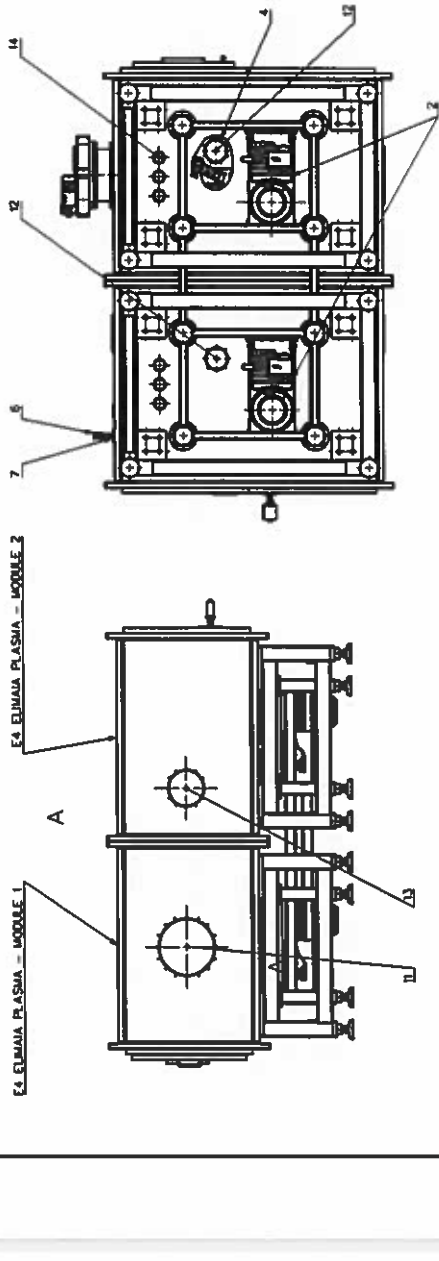
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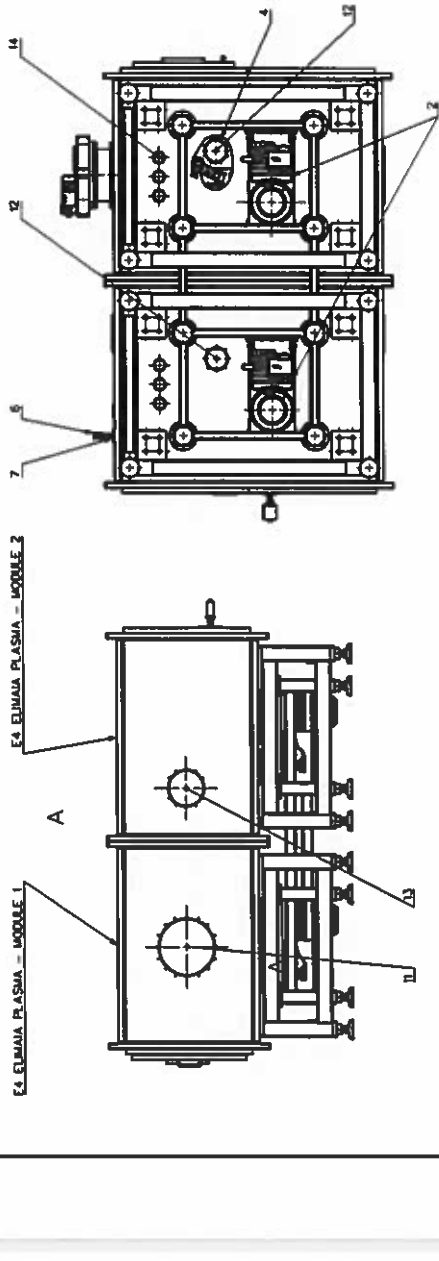
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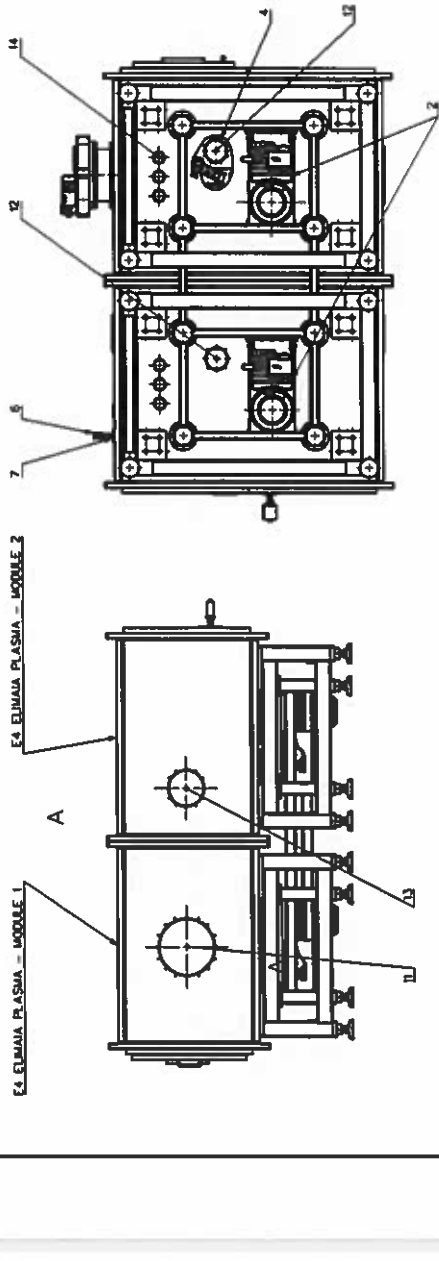
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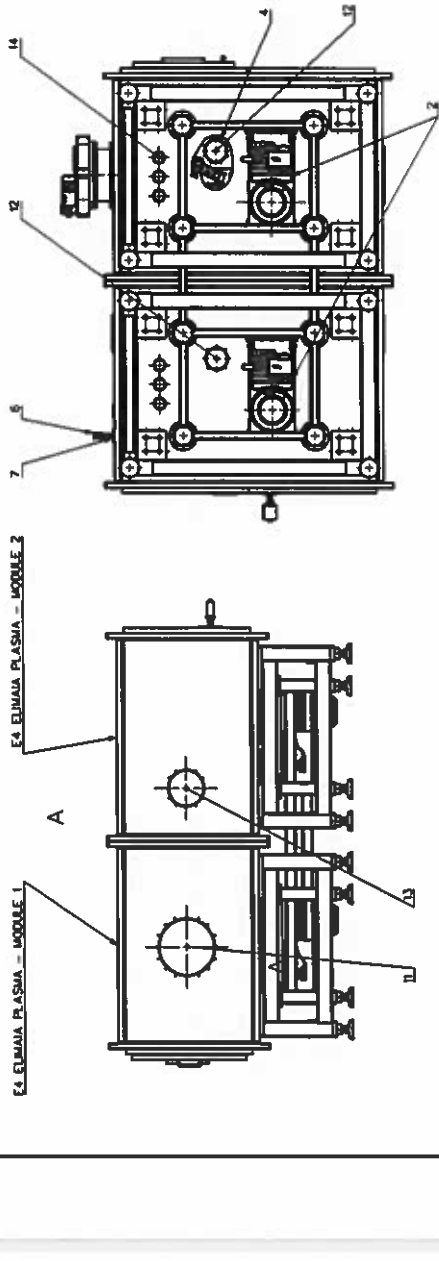
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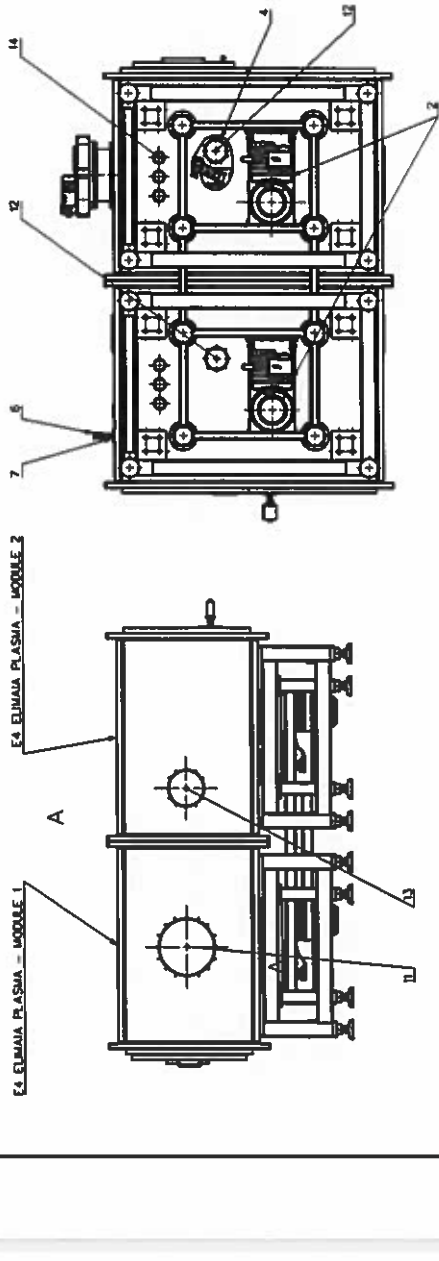
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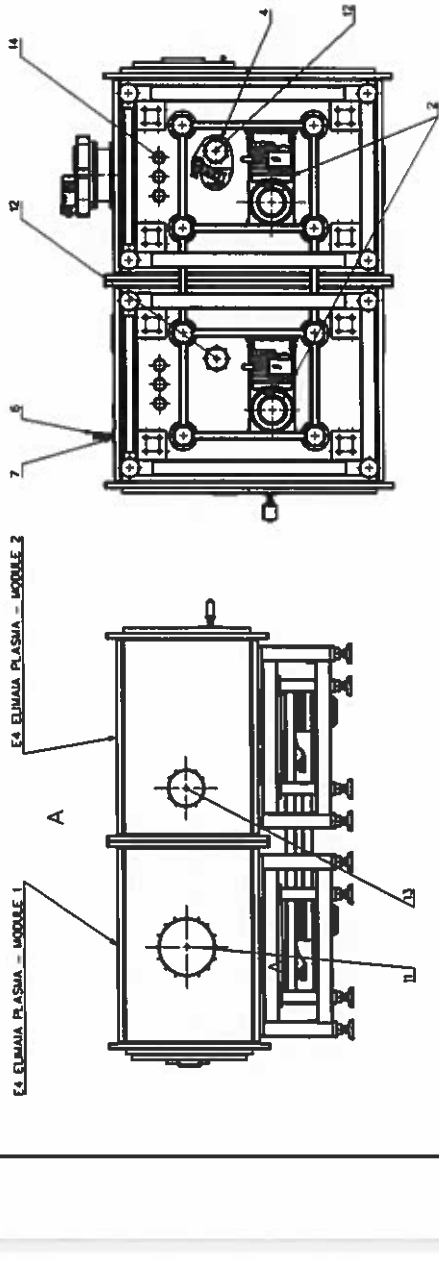
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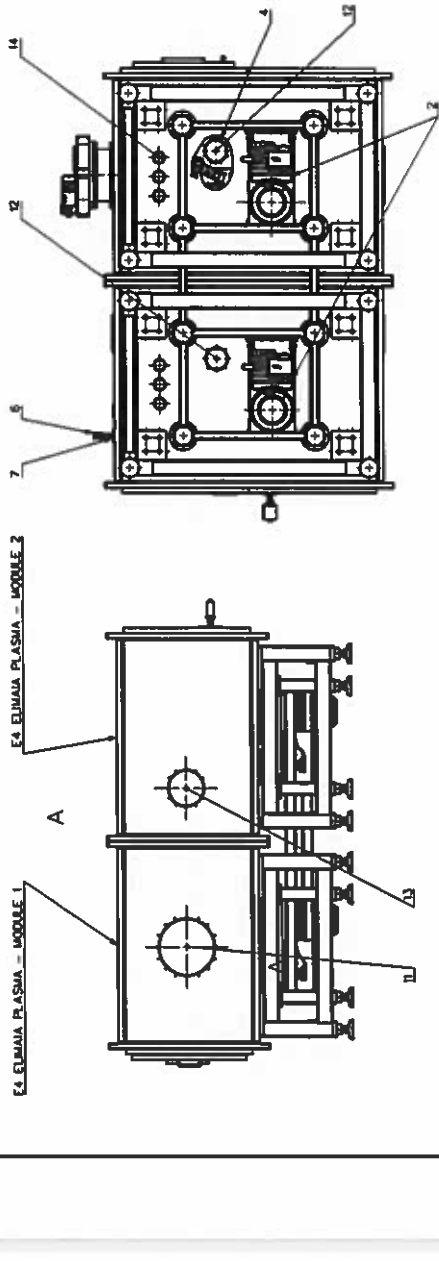
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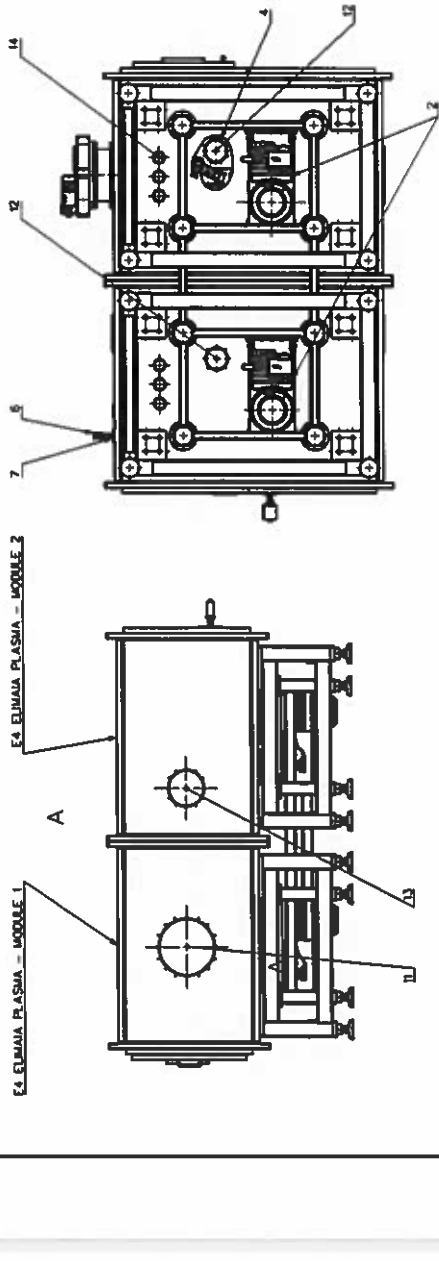
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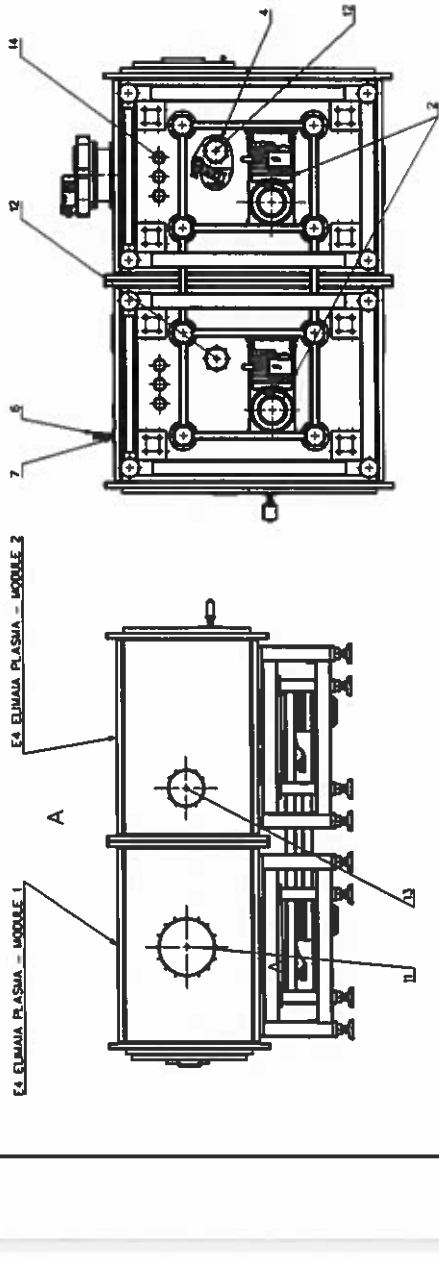
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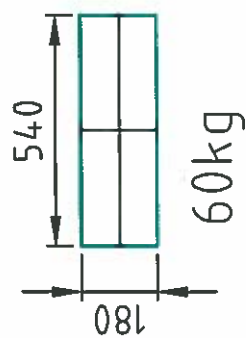
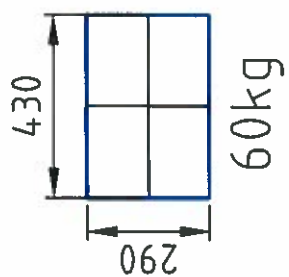
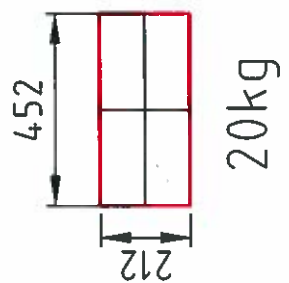
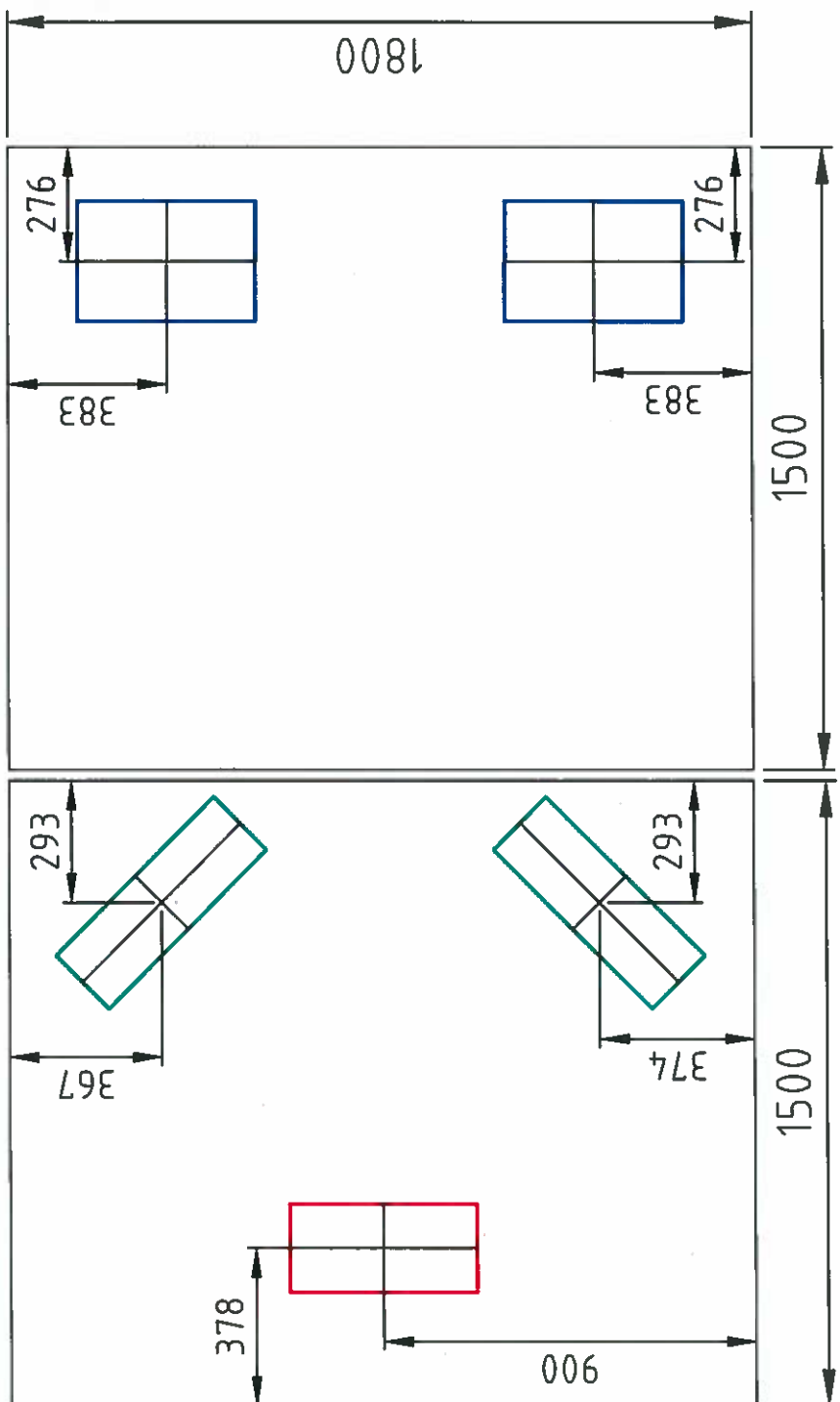


E4 ELIMIA PLASMA - MODULE 24



E4 ELIMIA PLASMA - MODULE 25





Confidentiality Level	BL - Restricted for internal use	TC ID / Revision	00104400 / F
Document Status	Document Reviewed	Document No.	Specific Document code
WBS code	5.2 - RP3 Particle acceleration by lasers		
PBS code	E.E5.HELL - (RP3) High Energy Electron Beamline		

Requirements Specification Document (RSD)

ECU HELL auxiliary chamber



Keywords

Put keywords related to the document content.

	Position	Name
Responsible person	Group Leader RP3	Daniele Margarone
Prepared by	Chief Engineer	Pavel Korouš

<i>RSS TC ID/revision</i>	<i>Date of Creation</i>	<i>Date of Last Modification</i>	<i>Systems Engineer</i>
001251 / E	09-12-2014 20:48	11-12-2014 21:30	Pavel Korouš
001251 / F	27-02-2015 15:05	02-03-2015 20:43	Aleksei Kuzmenko

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Revision History / Change Log

<i>Change No.</i>	<i>Made by</i>	<i>Date</i>	<i>Change description, Pages, Chapters</i>	<i>TC rev.</i>

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1. ECU (Experimental Chamber Unit)

ECU is an abbreviation for **Experimental Chamber Unit** which in contract text is called by **Device**. **ECU** is defined for this specification purpose as a self-contained unit providing controlled pumping and venting together with provision of stable area for optical layout.

2. Functional and Performance Requirements

REQ-002203/A

ECU shall allow vacuum pumping and venting for experimental set-up.
Verification method: FD - functional demonstration

REQ-002204/A

ECU shall reach vacuum level 10^{-6} mbar.
Verification method: T - test

REQ-002206/A

ECU vacuum equipment shall be capable reaching 10^{-5} mbar vacuum level in 60 minutes.
Verification method: T - test

REQ-002207/A

Preventive maintenance time shall not exceed 8 hours.
Verification method: R - review

REQ-002208/A

The **ECU** shall provide pumping and venting sequences.
Verification method: FD - functional demonstration

3. Operational design requirements

REQ-002209/A

ECU shall comply with frequency of opening/closing 2-times a day.
Verification method: R - review

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4. Design requirements

4.1. General

REQ-003499/A

Enclosed **ECU** tender .pdf drawings shall be taken into account as a concept for preliminary design.

Verification method: R - review

REQ-002210/A

Interaction Chamber Unit (**ECU**) shall provide space for customer provided optical equipment.

Verification method: R - review

REQ-002211/A

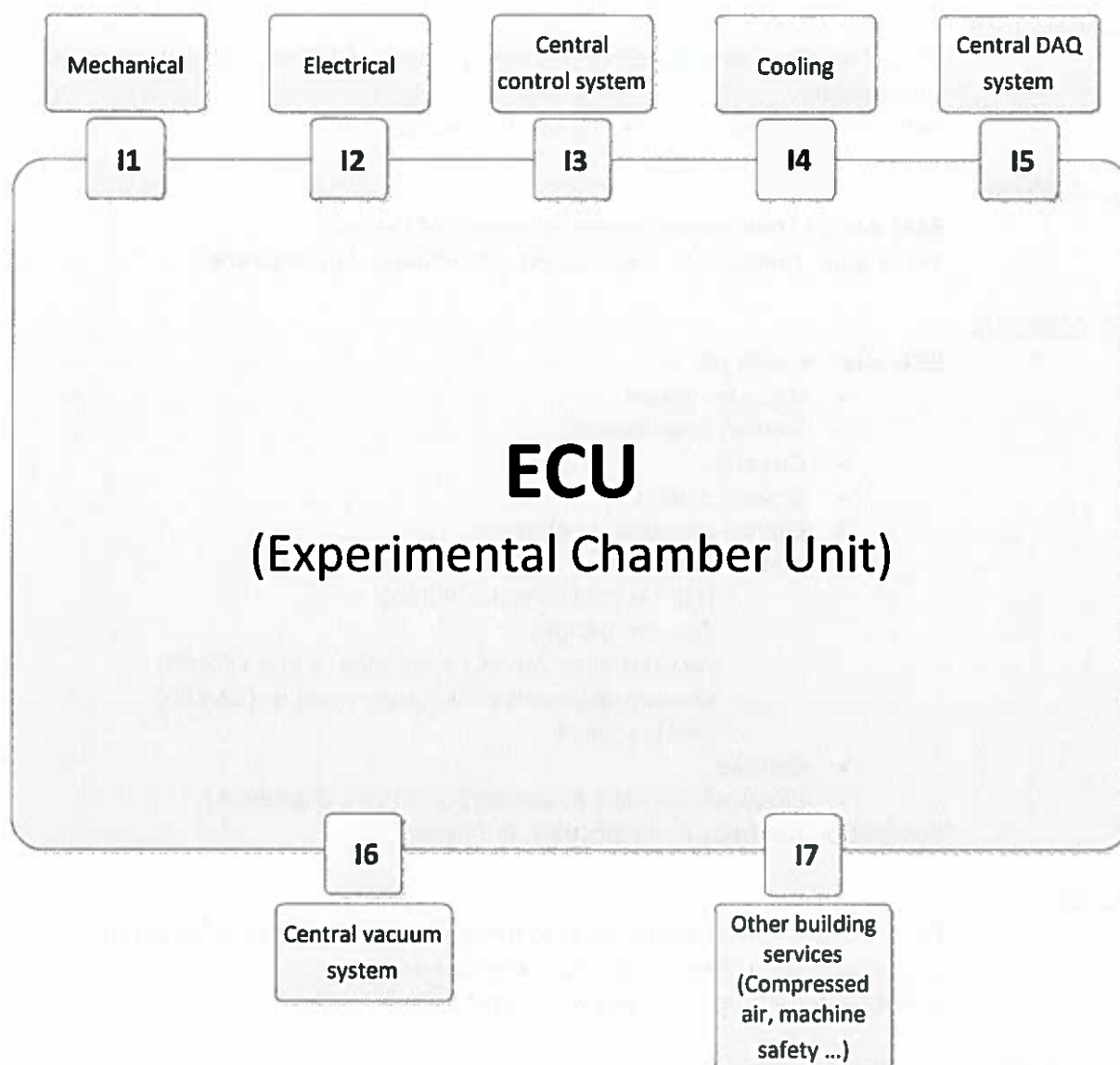
ECU shall provide for the following interfaces:

- TMP's (Turbo Molecular Pumps)
- Gauges
- Feedthrough
- Diagnostics
- Remote control
- Central Vacuum System (CVS)
- Beam Transport (BT)
- ELI Building
- ELI Building services

Verification method: R - review

REQ-003407/A

Supplier shall provide **ECU** Interface Control Document (**ICD**).



Verification method: R - review

REQ-002212/A

The supplier shall define the **Reference Coordinate System (RCS)** of the **ECU** which shall allow positioning the **ECU** in customer's experimental hall according to **Reference Mechanical System** of the hall (**RMS**).

Verification method: R - review

REQ-002213/A

RCS and its relation to the **RMS** shall be set up together with supplier during the preliminary design phase.

Verification method: R - review

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REQ-002214/A

ECU shall allow safe handling and manipulation with internal and external components.

Verification method: I - inspection, R - review

REQ-002215/A

ECU design shall assure a safe operation of the unit.

Verification method: R - review, FD - functional demonstration

REQ-002216/A

ECU shall consist of:

- Vacuum vessel
- Optical breadboard
- Chassis
- Vessel chassis
- Optical breadboard chassis
- Vacuum devices:
 - TMP (TurboMolecular Pump)
 - Vacuum gauges
 - Vacuum gate valves (main inlet/outlet DN400)
 - Vacuum gate valve for rough vacuum (DN100)
 - Venting valve
- Bellows
- Pipework (in case of connection of two chambers)

Verification method: I - inspection, R - review

REQ-002217/A

The **ECU** shall be designed to accommodate laser beam axis 1300 mm above floor level (see attached conceptual drawings).

Verification method: R - review, T - test

REQ-002218/A

Tools used during manufacture shall not contaminate the vacuum surface.

Verification method: T - test

REQ-003506/A

All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.

Verification method: R - review, T - test

4.2. Operational design requirements

REQ-002219/A

ECU shall be a modular unit allowing extension in longitudinal direction.

Verification method: R - review, I - inspection

REQ-002220/A

ECU breadboard and vacuum vessel shall be decoupled.
Verification method: I - inspection, R - review

REQ-002221/A

Decoupling of **ECU** breadboard and vacuum vessel shall be made by using edge welded bellows.
Verification method: R - review, I - inspection

REQ-003186/A

Double bellows decoupling system shall be applied on **ECU** breadboard chassis.
Verification method: R - review

4.3. ECU design requirements

4.3.1. ECU Vacuum vessel design

REQ-002222/A

ECU frame shall be made of stainless steel following types:

- AISI 304L or
- AISI 304

Verification method: I - inspection, R - review

REQ-002223/A

ECU panels shall be made of aluminum following types:

- Al2219
- Al3003
- Al5083
- Al6082
- Al2090
- Al2219
- Al7005

Verification method: R - review, I - inspection

REQ-002224/A

Final choice of **ECU** vessel materials shall be made in preliminary design phase.
Verification method: R - review

REQ-002225/A

ECU panels shall be designed as a modular system.
Verification method: R - review, I - inspection

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REQ-002226/B

Maximum size of modular aluminium panels shall be 1x1.5 m. *Technical note: Increase of dimension from 1.5 m up to 2 m is acceptable in access optical breadboard area.*

Verification method: R - review, I - inspection

REQ-002227/A

Thickness of **ECU** modular aluminium panels shall be in bounded interval 40 + 50 mm.

Verification method: R - review, T - test

REQ-002228/A

All **ECU** panels shall be equipped by Lifting eyes interfaces.

Verification method: R - review, I - inspection

REQ-002229/A

ECU panels close to main optical components shall be equipped with small doors with minimal width 600 mm and high 500 mm.

Verification method: R - review, I - inspection

REQ-002230/A

Openings of **ECU** shall be closed by aluminium blank flanges.

Verification method: R - review, I - inspection

REQ-002231/A

Stainless steel screws with Allen heads shall be used on **ECU** panels.

Verification method: I - inspection, R - review

REQ-002232/A

ECU small doors shall be equipped with hinges.

Verification method: R - review, I - inspection

REQ-002233/A

Maximal deformations of **ECU** panels under vacuum shall be lower than 3 mm in comparison to the vented status.

Verification method: A - analysis, R - review, T - test

REQ-002234/A

Deformations of **ECU** panels in selected coordinates under vacuum shall be lower than 2 mm in comparison to the vented status.

Verification method: A - analysis, T - test

REQ-002235/A

All **ECU** removable panels shall be equipped with guiding pins to allow proper panel seating.

Verification method: R - review, I - inspection

REQ-002236/A

Sealing of **ECU** panels shall be made of fluorelastomer polymer (FPM) material.

Verification method: R - review, I - inspection

REQ-002237/B

Hardness of **ECU** sealing o-rings shall be 60 or 70 HSC (Shore).

Verification method: I - inspection, R - review

REQ-002238/A

ECU shall be equipped with roughing inlet interface (DN100).

Verification method: R - review, I - inspection

REQ-002240/A

Surface treatment of inner **ECU** vacuum vessel surfaces compatible with 10^{-6} mbar shall be applied.

Verification method: R - review, I - inspection

4.3.2. Vacuum Vessel Chassis

REQ-002241/A

ECU vacuum vessel chassis shall allow **z** (vertical) positioning.

Verification method: I - inspection, R - review

REQ-002242/A

Range of **ECU** vacuum vessel chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: R - review, T - test

REQ-002243/A

ECU vacuum vessel chassis shall be made of stainless steel or extruded aluminium profiles.

Verification method: R - review, I - inspection

REQ-002244/A

ECU chassis shall allow for installation of TMP's.

Verification method: R - review, I - inspection

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REQ-002245/A

ECU chassis shall allow for floor fixing.

Verification method: R - review, I - inspection

REQ-002246/A

ECU vacuum vessel chassis shall be equipped with removable transportation wheels.

Verification method: R - review, I - inspection

4.3.3. ECU Optical breadboard design

4.3.3.1. General

REQ-002247/B

Supplier shall provide static FEM analysis and vibration study according to customer inputs. *Technical note: The latest results of building vibration measurement will be provided by customer after contract signature.*

Verification method: A - analysis, R - review

4.3.3.2. Optical breadboard

REQ-002248/A

ECU optical breadboard shall allow connection of multiple modular breadboards.

Verification method: I - inspection, R - review

REQ-002249/A

ECU optical breadboard shall have threaded hole pattern with 25 mm spacing.

Verification method: R - review, T - test

REQ-002250/A

Threaded holes of **ECU** breadboard shall be M6 size.

Verification method: R - review, T - test

REQ-002251/A

ECU optical breadboard shall be made of aluminium following types:

- Al2219
- Al3003
- Al5083
- Al6082
- Al7005

Verification method: R - review, I - inspection

REQ-002252/A

Final choice of **ECU** optical breadboard materials shall be made in preliminary design phase.

Verification method: R - review, I - inspection

REQ-002253/A

Minimum thickness of **ECU** breadboard plate shall be 50 mm.

Verification method: A - analysis, R - review, T - test

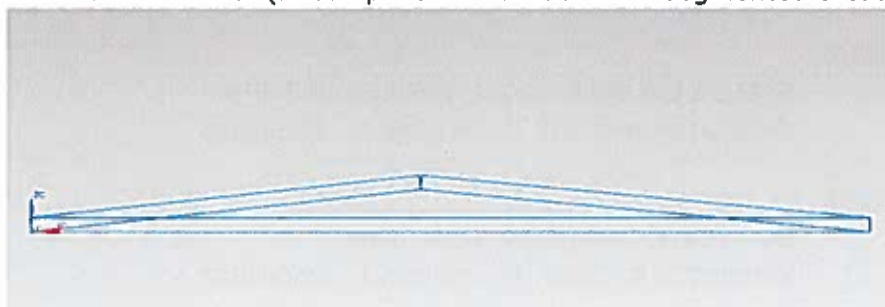
REQ-002254/A

Maximal thickness of whole **ECU** breadboard (plate with reinforcing ribs) shall be 130 mm.

Verification method: A - analysis, R - review, T - test

REQ-002255/B

Maximum misalignment after connection of breadboard segments shall be lower than 1 mrad. (in comparison with ideal non-segmented breadboard)



Technical note: This requirement is valid only in case of using segmented optical table.

Verification method: T - test

REQ-002256/A

Maximum z direction misalignment after connection of breadboard segments shall be lower than 1 mm.

Verification method: T - test, FD - functional demonstration

REQ-002257/A

Supplier shall provide procedure of misalignment measurement.

Verification method: R - review, T - test

4.3.3.3. Optical Breadboard Chassis

REQ-002258/A

ECU chassis shall be designed as modular unit.

Verification method: R - review, I - inspection

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REQ-002259/A

Only one chassis shall be applied for more connected **ECU** breadboards.
Verification method: R - review, I - inspection

REQ-002260/A

ECU optical breadboard chassis shall allow **z** (vertical) positioning.
Verification method: R - review, I - inspection

REQ-002261/A

Range of **ECU** optical breadboard chassis positioning in **z** (vertical) direction shall be 20 mm.
Verification method: I - inspection, T - test

REQ-002262/A

ECU optical breadboard chassis shall be made of stainless steel or aluminium extruded profiles.
Verification method: R - review, I - inspection

REQ-002263/A

ECU chassis shall allow installation of TMP's.
Verification method: R - review, I - inspection

REQ-002264/A

ECU chassis shall allow floor fixing.
Verification method: R - review, I - inspection

REQ-002265/A

The **ECU** optical breadboard chassis shall be equipped with removable transportation wheels.
Verification method: R - review, I - inspection

REQ-003193/A

The **ECU** optical breadboard chassis shall have interface for vibration dumping system.
Verification method: R - review

4.3.4. ECU Vacuum equipment

4.3.4.1. TMP (Turbomolecular pump)

REQ-002266/A

Only new **ECU** TMP with full warranty shall be used.
Verification method: I - inspection

REQ-002267/A

ECU shall be installed in accordance to the installation manual of TMP supplier.

Verification method: R - review, I - inspection

REQ-002268/A

ECU TMP shall be water cooled.

Verification method: R - review, I - inspection

REQ-002269/A

ECU TMP coolant shall be demineralized water.

Verification method: I - inspection

REQ-002270/A

ECU TMP shall be equipped with fittings for water cooling.

Verification method: I - inspection

REQ-002271/A

ECU TMP shall be equipped with protective screen.

Verification method: I - inspection

REQ-002272/A

ECU TMP shall be compatible with power supply 230V, 50 Hz.

Verification method: I - inspection

REQ-002273/A

ECU TMP inlet flange shall be ISO-F according to ISO 1609:1986.

Verification method: I - inspection

REQ-002274/A

ECU TMP outlet flange shall be ISO-KF according to ISO 2861:2013.

Verification method: I - inspection

REQ-002275/A

Maximum noise of **ECU** TMP shall be 60 dB.

Verification method: R - review

REQ-002276/A

ECU TMP with minimum pumping speed 1500 l/sec shall be used.

Verification method: R - review, I - inspection

REQ-002277/A

ECU TMP set up shall be equipped with separation gate valve.

Verification method: I - inspection

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REQ-002278/A

ECU TMP shall be equipped with electrically operated venting valve.

Verification method: I - inspection

REQ-002279/A

ECU TMP shall be equipped with power supply unit and control unit.

Verification method: I - inspection

REQ-002280/A

ECU TMP shall be equipped with 19" equipment rack mountable controllers.

Verification method: I - inspection

REQ-002281/A

The minimum required lifetime of TMP shall be 50 000 working hours.

Verification method: R - review

REQ-002282/A

The TMP shall be able to operate continuously at a maximum inlet pressure of 0.05 mbar.

Verification method: R - review

REQ-002283/A

The TMP shall be able to operate continuously at a maximum exhaust pressure of 0.5 mbar.

Verification method: R - review

REQ-002284/A

The TMP shall be protected against damage from sudden temperature rise.

Verification method: R - review, I - inspection

REQ-002285/A

TMP and their accessories (including liquid cooling fittings) must be in compliance with the following standards:

- ISO 1609:1986 - Vacuum technology - Flange dimension
- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings
- ISO 5302:2003 - Vacuum technology - Turbomolecular pumps - Measurement of performance characteristic

Verification method: R - review

4.3.4.2. Gauges

REQ-002286/A

Measurement range of combined gauge shall be $1000 \text{ mbar} \div 1 \times 10^{-6} \text{ mbar}$ with maximum accuracy $\pm 30\%$.

Verification method: R - review, I - inspection

REQ-002287/A

Mechanical interface of ECU Vacuum gauges shall be ISO KF according to ISO 2861:2013.

Verification method: R - review, I - inspection

REQ-002288/A

Vacuum connection of the gauges must be in compliance with the following standards:

- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings.

Verification method: R - review, I - inspection

REQ-002289/A

Power supply of **ECU** vacuum gauges shall be 24VDC.

Verification method: R - review, I - inspection

REQ-002290/A

Interval of output **ECU** vacuum gauges signal shall be $0 \div 11 \text{ VDC}$.

Verification method: R - review, I - inspection

4.3.4.3. Gate valves

REQ-002291/A

ECU gate valve separating TMP shall be made of stainless steel (body material).

Verification method: R - review, I - inspection

REQ-002292/A

Main **ECU** inlet/outlet gate (DN400) valves shall be made of aluminium (body material).

Verification method: R - review, I - inspection

REQ-002293/A

The **ECU** gate valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

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REQ-002294/A

Minimal open/close cycles of **ECU** gate valves until first service shall be 200 000.

Verification method: R - review

REQ-002295/A

ECU gate valve shall be equipped with ISO F flange according to ISO 1609:1986.

Verification method: I - inspection

REQ-002296/A

ECU gate valves shall be equipped with blank flange from atmosphere side.

Verification method: I - inspection

4.3.4.4. Venting valves

REQ-002297/A

ECU shall be equipped with venting valve.

Verification method: I - inspection

REQ-002298/A

Automatic venting valve shall be used on **ECU**.

Verification method: I - inspection

REQ-002299/A

The **ECU** venting valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

4.3.4.5. Bellows (connection of two chambers)

REQ-002300/A

Edge welded bellows shall be used on **ECU**.

Verification method: I - inspection, R - review

REQ-002301/A

ECU bellows shall be equipped with threaded rods.

Verification method: I - inspection, R - review

REQ-002302/A

Compensation range of ECU connecting bellows shall be:

- Axial ± 15 mm

- Lateral ± 5 mm
- Angular $\pm 2^\circ$

Verification method: R - review, I - inspection, T - test

4.3.4.6. Vacuum clamps

REQ-002303/A

All **ECU** vacuum clamps shall be permanent set free after assembling.

Verification method: I - inspection, FD - functional demonstration

REQ-002304/A

Clamp slots shall defect free.

Verification method: I - inspection

4.3.4.7. Local & remote vacuum control and safety system

REQ-002305/A

ECU local control system shall be designed and verified as an autonomous manually controlled system with interfaces to ELI – control system.

Verification method: R - review, I - inspection

REQ-002306/A

All ECU TMP's, vacuum gauges and valves shall be delivered with the **associated controllers**.

Verification method: I - inspection

REQ-002307/A

The controllers shall provide a reliable control interface to ELI central control system via LC optical fibers or RJ45 metallic connections.

Verification method: I - inspection

REQ-002308/A

The communication protocol shall be available and compatible with Linux OS.

Verification method: R - review

REQ-002309/A

Documentation for the protocol shall be provided.

Verification method: I - inspection

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REQ-002310/A

Safety interface based on digital I/O (24V DC signals) shall be provided for redundancy in addition to REQ-002314/A.

Verification method: R - review

REQ-002311/A

The controllers shall have local and remote access capabilities.

Verification method: I - inspection

REQ-002312/A

The controllers shall provide separate interlock capabilities via dry C-shape contacts.

Verification method: I - inspection

REQ-002313/A

All valves shall be supplied with open/closed limit switches wired to standard DIN connectors with mating plugs.

Verification method: I - inspection

REQ-002314/A

The supplied controls shall provide a safe pumping and venting sequence including interlocks in the local and remote mode of operation.

Verification method: I - inspection

4.3.5. Data acquisition

REQ-002315/A

Following data shall be readable from the ECU:

- Temperature on TMP
- Level of vacuum
- rpm of TMP rotor
- Hours of TMP operation
- Levitation of TMP rotor (if maglev is used)

Verification method: R - review, T - test

4.3.6. EMC/EMP

REQ-002316/A

The **ECU** design shall comply with EU standards of electro-magnetic compatibility.

Verification method: R - review

5. System Transportation and installation requirements

5.1. General requirements

REQ-002317/A

Supplier shall provide procedures for transportation and installation of **ECU**.
Verification method: R - review

REQ-002318/A

Supplier shall provide procedures for handling and manipulation of **ECU**.
Verification method: R - review

REQ-007168/A

The transportation and installation personnel shall follow the customer's facility regulations.
NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.
Verification method: R - review

REQ-007169/A

The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in clean environment of ISO class 7, if not agreed otherwise.
Verification method: R - review, I - inspection

REQ-007170/A

All transportation and installation tools and equipment entering the clean rooms shall be cleaned and reviewed by the customer's approved methods.
NOTE: Some tools can be provided by the customer upon agreement.
Verification method: I - inspection, T - test

REQ-007171/A

The transportation to the final destination and the installation of the technologies and the instruments shall be conducted by the vendor. The methods shall be discussed and reviewed by the customer's installation officer and shall be compliant with the customer's installation regulations.
NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.
Verification method: R - review

REQ-007172/A

The main parts of the mechanical structure shall be equipped with positioning/alignment marks for industrial 3D-measurements/survey. The

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specific type of the positioning/alignment marks, their number and location shall be agreed with the customer.

Verification method: R - review, I - inspection

5.2. Transportation

REQ-002319/A

The supplier shall provide supervision by transport **ECU** to defined position in ELI – Beamlines experimental room.

Verification method: R - review, I - inspection

REQ-002321/A

All Parts shall be identified according to technical documentation.

Verification method: R - review

5.3. Installation

REQ-002323/A

Connection of **ECU** to the ELI- Beamlines facility services shall be made under supervision of supplier.

Verification method: R - review, I - inspection

REQ-002324/A

Assembling of **ECU** on supplier side shall be made in cleanroom ISO7.

Verification method: I - inspection

REQ-002325/A

All specific equipment and tools necessary for installation of the **ECU** shall be subject of the supplier delivery.

Verification method: I - inspection, R - review

REQ-002326/A

Maximum dimensions of goods going through experimental entrance area shall be 3000x2000x2000 mm (length x with x high)

Verification method: R - review, T - test

6. Handling and Manipulation

REQ-002328/A

Supplier shall provide an approved methodological document describing safe handling and manipulation of the product.

Verification method: R - review

7. Maintenance

REQ-002329/A

Supplier shall provide an approved methodological document describing maintenance procedures of the product.

Verification method: R - review

8. Safety Requirements

REQ-002330/A

The **ECU** design of relevant parts shall comply with Czech and EU regulations regarding safety domain.

NOTE: Application of Czech regulations will be subject of preliminary design.

Verification method: R - review

REQ-002331/A

Supplier shall perform hazard identification and risk assessment of system prior to design.

Verification method: A - analysis, R - review

REQ-002332/A

All **ECU** manufactured parts shall be free of sharp edges.

Verification method: I - inspection

REQ-002333/A

All **ECU** manufactured parts shall be burr free.

Verification method: I - inspection

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9. Quality

9.1. Quality Management

9.1.1. Quality organization and responsibilities

9.1.1.1. Organization

REQ-002334/A

The supplier shall identify the personnel responsible for implementing and performing QA management plan and other Quality Controls disciplines.

Verification method: R - review

REQ-002335/A

The supplier shall assign a project Quality manager reporting to the project manager who has an unimpeded access to higher management.

Verification method: R - review

REQ-002336/A

The appointed project Quality manager, irrespective of other responsibilities, shall have organizational authority to establish and implement a quality assurance programme in accordance with the project quality assurance requirements.

Verification method: R - review

REQ-002337/A

The project Quality Manager shall act as the primary contact person within the project concerning Quality matters.

Verification method: R - review

REQ-007174/A

The supplier shall apply international recognized standards or best practice where applicable for quality assurance programme.

Verification method: R - review

9.1.1.2. Responsibility and authority

REQ-002338/A

The supplier shall define and document the responsibility, the authority and the interrelation of personnel who manage, perform and verify work affecting quality assurance.

Verification method: R - review

REQ-002339/A

The supplier shall define and document the responsibilities and the interfaces of the Quality functions, either external or internal, involved in a project.

Verification method: R - review

REQ-002340/A

When the supplier's Quality organization delegates quality assurance tasks to another organization it shall be done in a documented and controlled way monitored by the Quality organization.

Verification method: R - review

9.1.2. Quality plan and its implementation

REQ-002341/A

The supplier shall prepare, maintain and implement a plan of the QA (Quality Assurance) activities in accordance with the customer QA requirements.

Verification method: R - review

REQ-002344/A

The supplier management shall ensure that the inputs used by the Quality functions are consistent and complete, and available in line with the project schedule.

Verification method: R - review

REQ-002345/A

The supplier QA management shall ensure that the QA functions perform the tasks described in the QA Plan in line with the project schedule.

Verification method: R - review

REQ-002346/A

The supplier QA management shall ensure that the outputs produced by the QA functions are consistent and complete, and delivered in line with the project schedule.

Verification method: R - review

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REQ-002347/A

The supplier QA management shall ensure the application of processes defined in applicable project plans and documents.

Verification method: R - review

9.1.3. Documentation and data control

REQ-002348/B

The supplier shall provide following type of documents:

- 3D model (format: *.step; *.stp)
- 2D drawings (format: *.dwg)
- Printable format for text documents

Verification method: I - inspection

10. Environmental conditions

REQ-002349/A

Final cleanliness shall be compatible with ISO 7.

Verification method: I - inspection

11. Verification process

REQ-002350/A

The verification process shall demonstrate that the deliverable product meets the specified customer requirements and is capable of sustaining its operational role through:

1. Verification planning;
2. Verification execution and reporting;
3. Verification control and close-out.

Verification method: R - review

REQ-002351/A

The supplier shall define the verification approach by conducting the following steps:

1. Identify and agree with the customer the set of requirements to be subject of the verification process.
2. Select the methods and levels of verification, associated model philosophy and verification tools.
3. Identify the stages and events in which the verification is implemented.

Verification method: R - review

REQ-002352/A

The verification approach shall be defined by the supplier in the Verification Plan (VP) for approval by the customer prior to implementation.
Verification method: R - review

11.1. Verification methods

11.1.1. General

REQ-002354/A

Verification shall be accomplished by one or more of the following verification methods:

1. test (including functional demonstration);
2. analysis (including similarity);
3. review-of-design;
4. inspection.

Verification method: R - review

REQ-002355/A

All safety critical functions shall be verified by test.

Verification method: R - review

REQ-002356/A

Verification of software shall include testing in the target hardware environment.

Verification method: R - review

11.1.2. Test

REQ-002357/A

Verification by test shall consist of measuring product performance and functions under representative simulated environments.

Verification method: R - review

REQ-002358/A

The analysis of data derived from testing shall be an integral part of the test and the results included in the test report.

Verification method: R - review

REQ-002359/A

When the test objectives include the demonstration of qualitative operational performance, the execution shall be observed and results recorded (functional demonstration).

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Note: Functional demonstration is a subset of tests.

Verification method: R - review

REQ-002360/A

A test programme shall be prepared for each product in conformance with Verification Plan.

Verification method: R - review

REQ-002361/A

The test programme shall be coordinated with the integration flow.

Verification method: R - review

REQ-002362/A

Tests performed as part of the integration flow to check quality and status of the in-progress configuration (including interfaces), having a formal verification purpose, shall be included in the test programme.

Verification method: R - review

REQ-002363/A

The test programme shall be defined in the specific chapter of the Verification Plan.

Verification method: R - review

REQ-002364/A

Test Programme shall be approved by the Customer.

Verification method: R - review

11.1.3. Analysis

REQ-002366/A

Verification by analysis shall consist of performing theoretical or empirical evaluation using techniques agreed with the Customer.

NOTE: Techniques comprise systematic, statistical and qualitative design analysis, modelling and computational simulation.

Verification method: R - review

REQ-002369/A

An analysis programme shall be defined in the Verification Plan (VP).

Verification method: R - review

11.1.4. Review-of-design (ROD)

REQ-002370/A

Verification by Review-of-design (ROD) shall consist of using approved records or evidence that unambiguously show that the requirement is met.

NOTE: Examples of such approved records are design documents and reports, technical descriptions, and engineering drawings.

Verification method: R - review

REQ-002371/A

A review-of-design programme shall be defined in the Verification Plan (VP).

Verification method: R - review

REQ-002372/A

A review-of-design programme shall only be applicable in stages (phases) before starting the manufacturing.

Verification method: R - review

11.1.5. Inspection

REQ-002373/A

Verification by inspection shall consist of visual determination of physical characteristics.

NOTE: Physical characteristics include constructional features, hardware conformance to document drawing or workmanship requirements, physical conditions, software source code conformance with coding standards.

Verification method: R - review

REQ-002374/A

An inspection programme shall be defined in the Verification Plan (VP).

Verification method: R - review

12. Qualification (if needed)

N/A

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13. Acceptance

REQ-002375/A

In the acceptance stage the verification shall demonstrate that the product is free of fabrication errors and is ready for the intended operational use.
Verification method: R - review

REQ-002376/A

Acceptance shall be carried out on the final hardware and software
Verification method: R - review

14. Verification process phasing

REQ-002379/A

The verification process shall be phased with the project life cycle defined as a contract execution phases (preliminary design, detailed design, manufacturing and deployment of deliverable product(s) see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-002380/A

Verification planning to assess feasibility and support programmatic shall start in the early phases (see Annex I – ECU Contract Phases).
NOTE: programmatic means support equipment and verification timescale estimation.
Verification method: R - review

REQ-002381/A

The preliminary verification planning shall cover all products and requirements by the end of preliminary design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-002382/A

Verification planning shall be completed by the end of detailed design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-002383/A

Verification execution and reporting shall be incrementally carried out through the project life cycle starting from detailed design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-002384/A

Verification control shall start with the initial issue of the verification control document (VCD) during detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002385/A

Verification close out status shall be assessed and approved by the customer for each product at the end of each stage (see Annex I – ECU Contract Phases).

Verification method: R - review

15. Verification plan (VP)

REQ-002386/A

The supplier shall provide a Verification plan (VP) for the reviews as agreed with the customer

NOTE Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-002387/A

The contents of the Verification plan (VP) shall be approved by the Customer

Verification method: R - review

16. Verification Control Document (VCD)

REQ-002388/A

The supplier shall provide a Verification Control Document (VCD) for the reviews as agreed with the customer

NOTE: Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-002389/A

The contents of the initial issue of the Verification Control Document (VCD) shall be in conformance with ELI verification matrix.

Verification method: R - review

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17. Verification execution and reporting

17.1. General

REQ-002391/A

The supplier shall assign clear responsibility for the implementation of the verification plan.

Verification method: R - review

REQ-002392/A

The test preparation and execution (including Test Readiness Review (TRR) and Post Test Review (PTR)) shall be reviewed by the Customer.

Verification method: R - review

REQ-002393/A

The verification results shall be recorded by the supplier in reports for review by the Verification Control Board (VCB) through the VCD.

Verification method: R - review

17.2. Verification execution and reporting documentation

17.2.1. Test report (TRPT)

REQ-002394/A

The test report (TRPT) shall be submitted to the Verification Control Board (VCB) after the test completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002395/A

The content of the Test report (TRPT) shall be agreed with the Customer.

Verification method: R - review

REQ-002396/A

The supplier shall provide the Test reports (TRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002397/A

A Test report (TRPT) shall be provided for each test verification task as identified in the VP.

Verification method: R - review

17.2.2. Analysis report (ARPT)

REQ-002398/A

The Analysis report (ARPT) shall be submitted to the Verification Control Board (VCB) after analysis completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002399/A

The supplier shall provide an Analysis report (ARPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002400/A

An Analysis report (ARPT) shall be provided for each Analysis verification task identified in the VP.

Verification method: R - review

17.2.3. Review-of-design report (RRPT)

REQ-002401/A

The Review-of-design report (RRPT) shall be submitted to the Verification Control Board (VCB) after the Review-of-Design completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002402/A

The supplier shall provide a Review-of-design report (RRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002403/A

A Review-of-design report (RRPT) shall be provided for each Review-of-design verification task identified in the VP.

Verification method: R - review

17.2.4. Inspection report (IRPT)

REQ-002404/A

The Inspection report (IRPT) shall be submitted to the Verification Control Board (VCB) after the inspection completion, within the time frame agreed with the customer.

Verification method: R - review

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REQ-002405/A

The supplier shall provide an Inspection report (IRPT) for the reviews as agreed with the customer
Verification method: R - review

REQ-002406/A

An Inspection report (IRPT) shall be provided for each Inspection verification task identified in the VP.
Verification method: R - review

17.2.5. Verification report (VRPT)

REQ-002407/A

The supplier shall prepare a Verification report (VRPT) when more than one of the defined verification methods are utilized to verify a requirement or a specific set of requirements.
Verification method: R - review

REQ-002408/A

The content of Verification report (VRPT) shall be agreed by the Customer
Verification method: R - review

REQ-002409/A

The Verification report (VRPT) shall be submitted to the Verification Control Board (VCB) after the completion of the last contributing verification activities, within the time frame agreed with the customer.
Verification method: R - review

REQ-002410/A

The supplier shall provide a Verification report (VRPT) for the reviews as agreed with the customer
Verification method: R - review

17.2.6. Other verification execution and reporting Document

REQ-002411/A

The supplier shall provide the Test specifications (TSPE) for the reviews as agreed with the customer
Verification method: R - review

REQ-002412/A

The supplier shall provide the Test procedures (TPRO) for the reviews as agreed with the customer

Verification method: R - review

REQ-002413/A

The rules for the analysis, inspection and review of design shall be defined in writing before their execution.

NOTE: For example, analysis, inspection or review of design procedures.

Verification method: R - review

18. Verification control and close-out

18.1. General

REQ-002414/A

The implementation of the verification process shall be monitored by the Verification Control Board (VCB).

Verification method: R - review

REQ-002415/A

The verification process control shall be supported by a computer based verification database.

Verification method: R - review

REQ-002416/A

The verification database shall be delivered to the customer in an electronic form to be agreed with the customer.

Verification method: R - review

REQ-002417/A

The supplier shall provide to the customer verification evidence for the customer's applicable requirements agreed to be verified, independently from the level where verification has been accomplished.

Verification method: R - review

18.2. Verification control board (VCB)

REQ-002418/A

A Verification Control Board (VCB), with participation of customer representatives, shall be established to incrementally assess the achievements and status of the verification process.

Verification method: R - review

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REQ-002419/A

The verification process shall be considered completed when the Verification Control Board (VCB) confirms that:

1. documented evidence is recorded in the VCD,
2. identified requirements have been verified
3. associated product verification objectives are reached

Verification method: R - review

REQ-002420/A

The conclusions of the VCB shall be submitted for approval to the customer's contractual authority.

Verification method: R - review

REQ-002421/A

The Verification Control Board (VCB) shall assess the verification status with a periodicity agreed with the customer, along the project life cycle.

Verification method: R - review

REQ-002422/A

The Verification Control Board (VCB) shall endorse the final issue of the Verification Control Document (VCD).

Verification method: R - review

18.3. Re-verification

REQ-002423/A

The extent of the re-verification to be performed shall be determined by Supplier and agreed with the Customer, in the following cases:

1. failure and repair as decided by Nonconformance Review Board (NRB)
2. unplanned disassembly or demounting
3. refurbishment, maintenance or design changes
4. changes of requirements after initial verification
5. long duration storage

Verification method: R - review

REQ-002424/A

The Verification Control Document (VCD) shall be updated by the supplier to record as open, those requirements subject to re-verification until this is performed and closeout agreed by the customer.

Verification method: R - review

18.4. Verification control and close-out documentation

18.4.1. Verification Control Document (VCD)

REQ-002425/A

The content of the completed Verification Control Document (VCD) shall be agreed by the Customer
Verification method: R - review

REQ-002426/A

The supplier shall update the Verification database within one week of the approval of a report.
Verification method: R - review

REQ-002427/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current status of the verification database, shall be made available to the Verification Control Board (VCB) upon request.
Verification method: R - review

REQ-002428/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current verification and compliance status, shall be delivered at each formal review as agreed with the customer
Verification method: R - review

REQ-002429/A

The final issue of the Verification Control Document (VCD) shall be submitted to the Verification Control Board (VCB) after the approval of the last report, within the time frame agreed with the customer.
Verification method: R - review

18.4.2. Other close-out documents

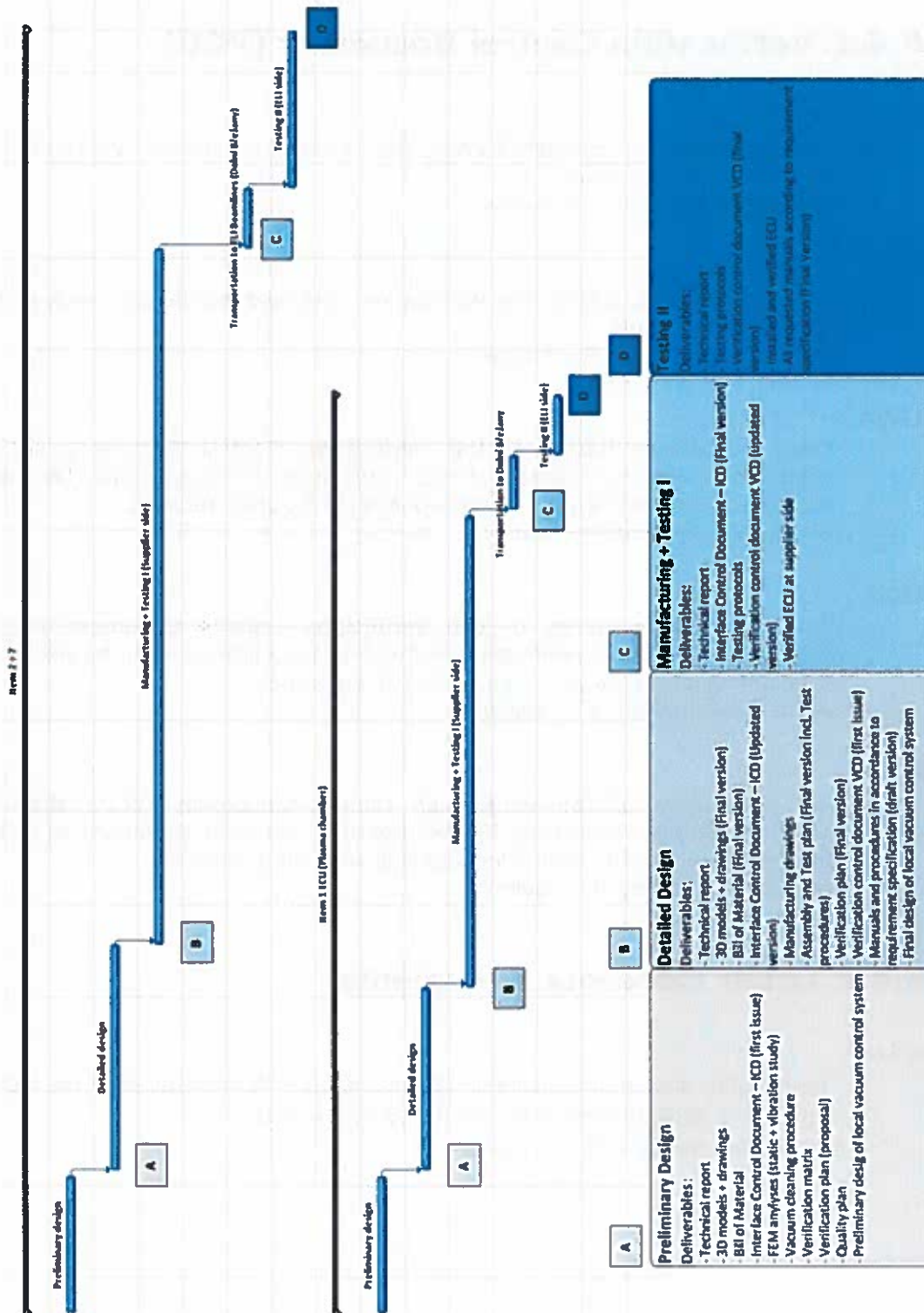
REQ-002430/A

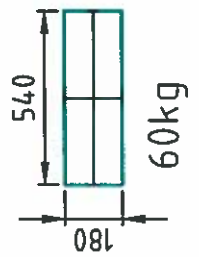
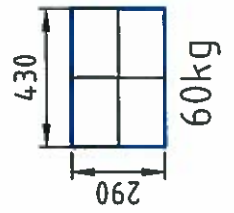
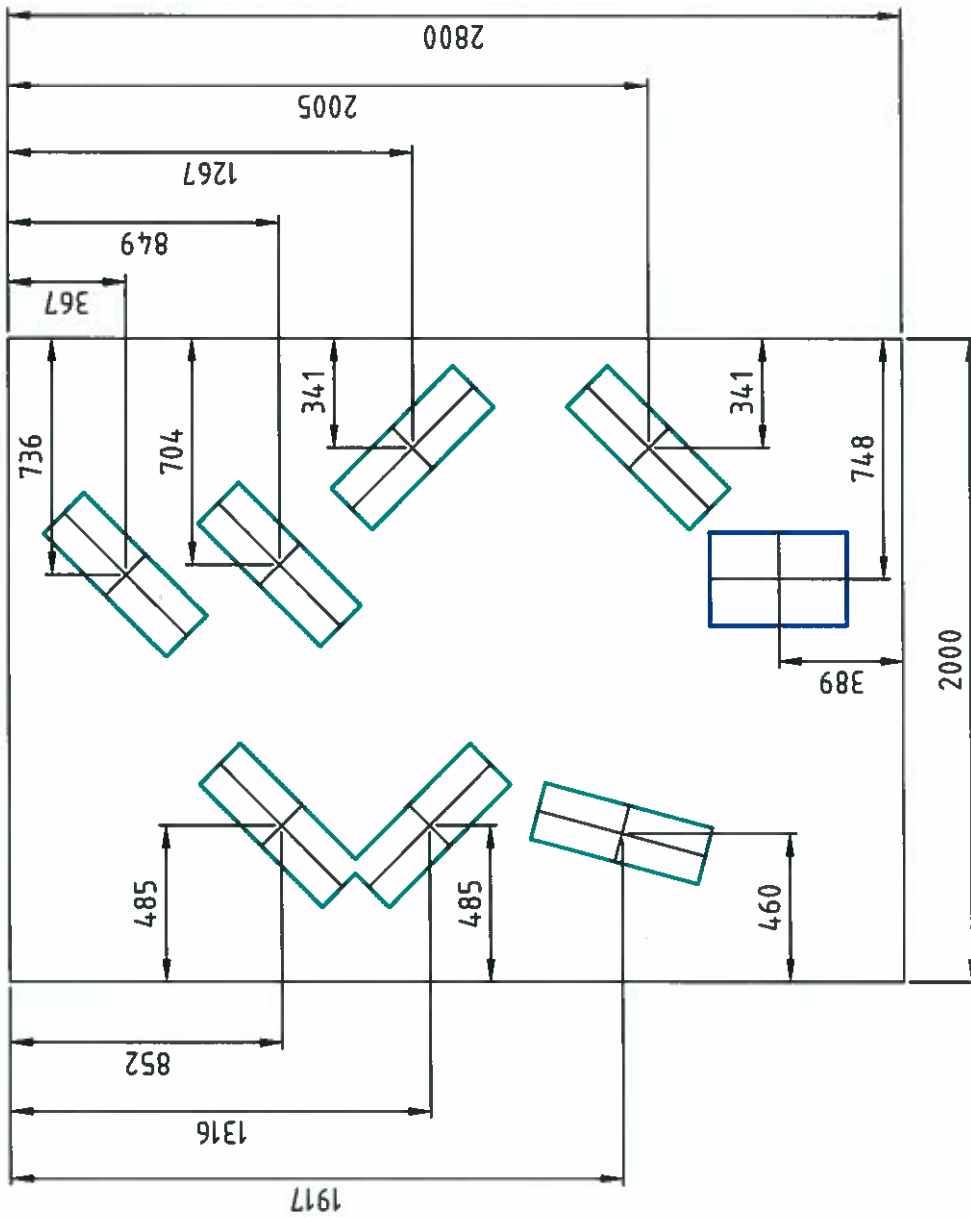
The supplier shall make available to the customer for consultation the VCD's supporting documentation in addition to the reports.
Verification method: R - review

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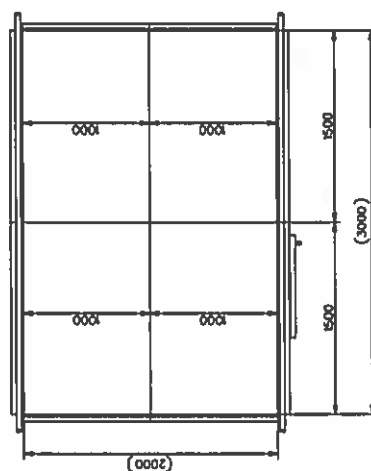
19. Annex I

ECU - Contract Phases

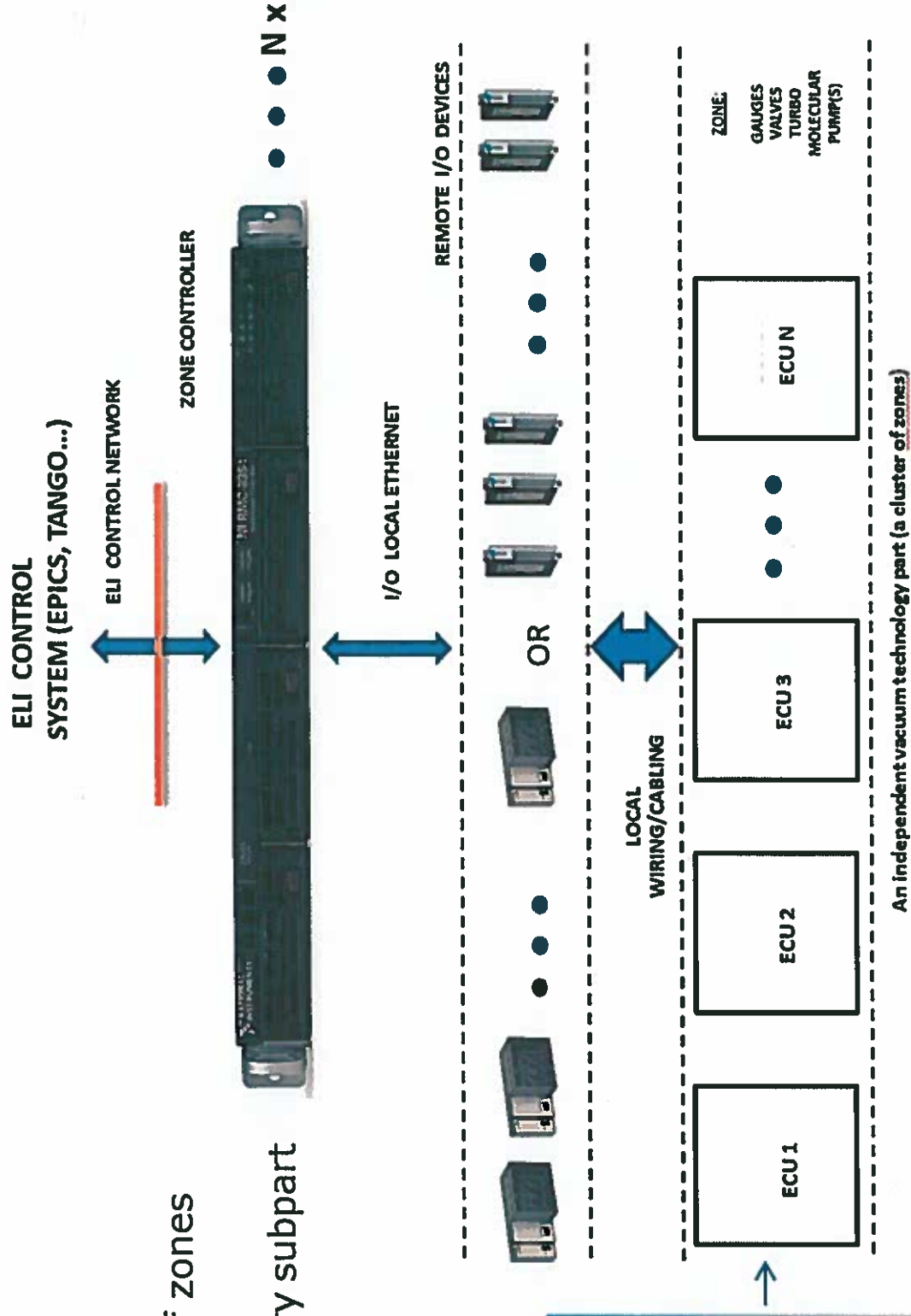


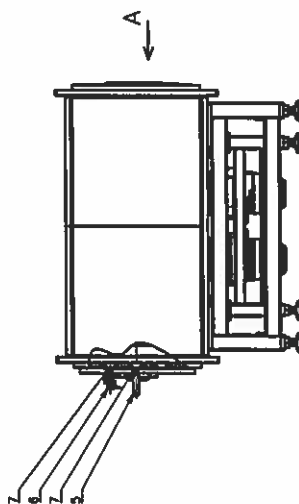
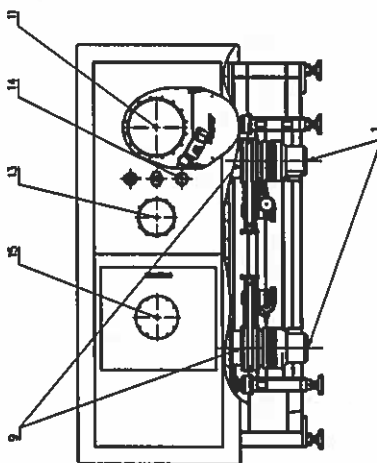
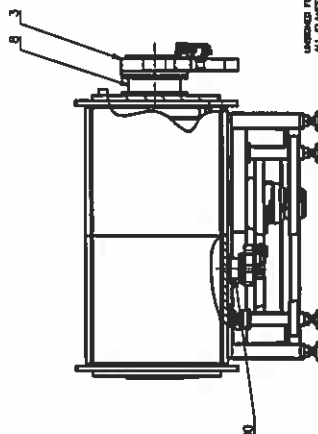
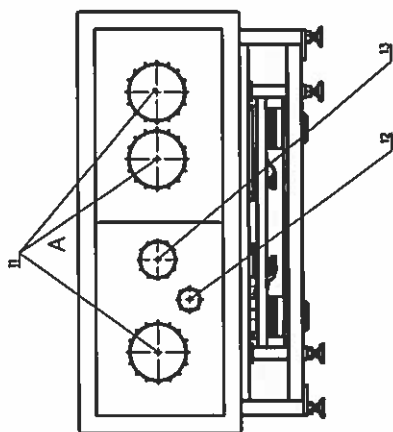
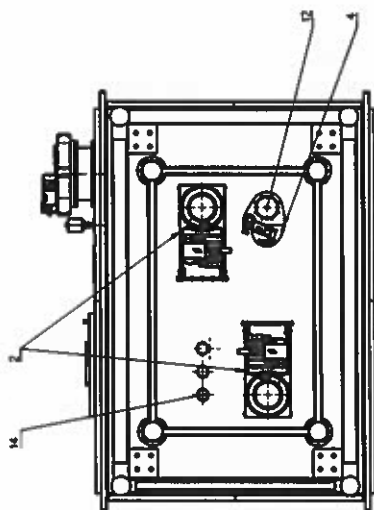


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- N zone controllers
- Each zone controller responsible for a set of zones
- A zone is an elementary subpart of the vacuum system





UNIONED FLANGES - ISO-K
ALL FLANGES ACCORDING TO STANDARDS ISO 500 (ISO-K), ISO-71 OR ISO 2001 (ISO-K)

Number	Quantity	Description
1	2	TURBOMOLECULAR PUMP DN250
2	2	GATE VALVE DN250
3	1	VALVE DN400
4	1	VALVE DN150
5	1	VACUUM GAUGE DN25 ISO-KF
6	1	VENT VALVE DN25 ISO-KF
7	2	SEPARATOR DN25 ISO-K/DN25 ISO-KF
8	1	PIPE DN400 ISO-K
9	2	PIPE DN250 ISO-K
10	1	PIPE DN250 ISO-K
11	4	BLIND FLANGE DN400
12	2	BLIND FLANGE DN250
13	2	BLIND FLANGE DN150
14	4	BLIND FLANGE DN150
15	1	VIEW PORT

The following information is for
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 any other purpose.

Scale: 1:20
 Drawing No.: 00104162/00
 Project: 00 004
 Revision: 00104162/00

Assembly
 Assembly
 Assembly

Fyzikální ústav
 Institute of Physics
 Academy of Sciences of the Czech Republic

Confidentiality Level	BL - Restricted for internal use	TC ID / Revision	00104399 / F
Document Status	Document Reviewed	Document No.	Specific Document code
WBS code	5.2 - RP3 Particle acceleration by lasers		
PBS code	E.E5.HELL - (RP3) High Energy Electron Beamline		

Requirements Specification Document (RSD)

ECU HELL interaction chamber



Keywords

Put keywords related to the document content.

	Position	Name
Responsible person	Group Leader RP3	Daniele Margarone
Prepared by	Chief Engineer	Pavel Korouš

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<i>RSS TC ID/revision</i>	<i>Date of Creation</i>	<i>Date of Last Modification</i>	<i>Systems Engineer</i>
001184 / E	09-12-2014 20:32	17-12-2014	Pavel Korouš
001184 / F	26-02-2015 19:36	02-03-2015	Aleksei Kuzmenko

Reviewed By

<i>Name (Reviewer)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Approved by

<i>Name (Approver)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Revision History / Change Log

<i>Change No.</i>	<i>Made by</i>	<i>Date</i>	<i>Change description, Pages, Chapters</i>	<i>TC rev.</i>

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1. ECU (Experimental Chamber Unit)

ECU is an abbreviation for **Experimental Chamber Unit** which in contract text is called by **Device**. **ECU** is defined for this specification purpose as a self-contained unit providing controlled pumping and venting together with provision of stable area for optical layout.

2. Functional and Performance Requirements

REQ-001975/A

ECU shall allow vacuum pumping and venting for experimental set-up.
Verification method: FD - functional demonstration

REQ-001976/A

ECU shall reach vacuum level 10^{-6} mbar.
Verification method: T - test

REQ-001978/A

ECU vacuum equipment shall be capable reaching 10^{-5} mbar vacuum level in 60 minutes.
Verification method: T - test

REQ-001979/A

Preventive maintenance time shall not exceed 8 hours.
Verification method: R - review

REQ-001980/A

The **ECU** shall provide pumping and venting sequences.
Verification method: FD - functional demonstration

3. Operational design requirements

REQ-001981/A

ECU shall comply with frequency of opening/closing 2-times a day.
Verification method: R - review

Hy

4. Design requirements

4.1. General

REQ-003498/A

Enclosed **ECU** tender .pdf drawings shall be taken into account as a concept for preliminary design.

Verification method: R - review

REQ-001982/A

Interaction Chamber Unit (**ECU**) shall provide space for customer provided optical equipment.

Verification method: R - review

REQ-001983/A

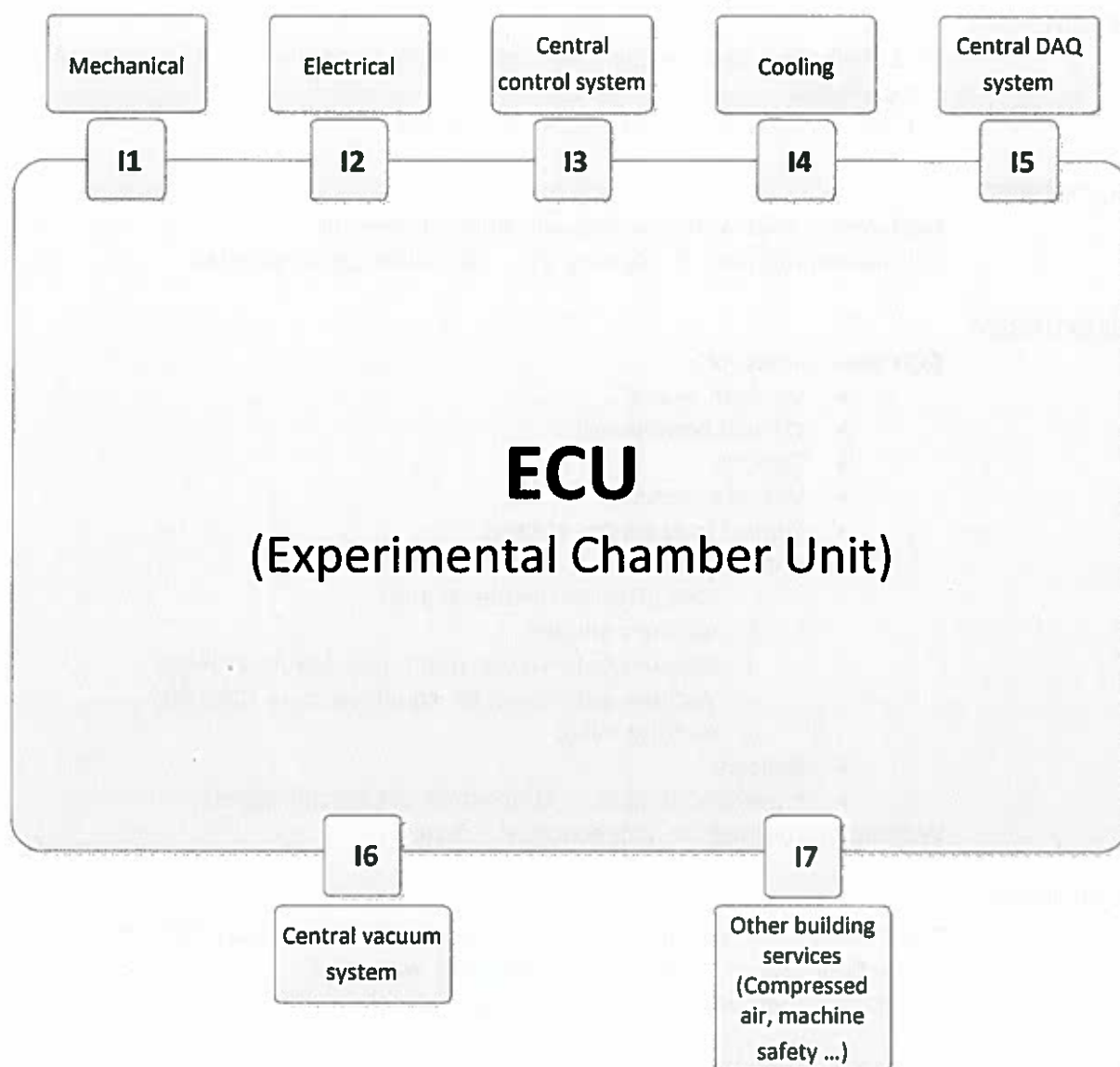
ECU shall provide for the following interfaces:

- TMP's (Turbo Molecular Pumps)
- Gauges
- Feedthrough
- Diagnostics
- Remote control
- Central Vacuum System (CVS)
- Beam Transport (BT)
- ELI Building
- ELI Building services

Verification method: R - review

REQ-003406/A

Supplier shall provide **ECU Interface Control Document (ICD)**.



Verification method: R - review

REQ-001984/A

The supplier shall define the **Reference Coordinate System (RCS)** of the **ECU** which shall allow positioning the **ECU** in customer's experimental hall according to **Reference Mechanical System** of the hall (**RMS**).

Verification method: R - review

REQ-001985/A

RCS and its relation to the **RMS** shall be set up together with supplier during the preliminary design phase.

Verification method: R - review

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REQ-001986/A

ECU shall allow safe handling and manipulation with internal and external components.

Verification method: I - inspection, R - review

REQ-001987/A

ECU design shall assure a safe operation of the unit.

Verification method: R - review, FD - functional demonstration

REQ-001988/A

ECU shall consist of:

- Vacuum vessel
- Optical breadboard
- Chassis
- Vessel chassis
- Optical breadboard chassis
- Vacuum devices:
 - TMP (TurboMolecular Pump)
 - Vacuum gauges
 - Vacuum gate valves (main inlet/outlet DN400)
 - Vacuum gate valve for rough vacuum (DN100)
 - Venting valve
- Bellows
- Pipework (in case of connection of two chambers)

Verification method: I - inspection, R - review

REQ-001989/A

The **ECU** shall be designed to accommodate laser beam axis 1300 mm above floor level (see attached conceptual drawings).

Verification method: R - review, T - test

REQ-001990/A

Tools used during manufacture shall not contaminate the vacuum surface.

Verification method: T - test

REQ-003505/A

All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.

Verification method: R - review, T - test

4.2. Operational design requirements

REQ-001991/A

ECU shall be a modular unit allowing extension in longitudinal direction.

Verification method: R - review, I - inspection

REQ-001992/A

ECU breadboard and vacuum vessel shall be decoupled.

Verification method: I - inspection, R - review

REQ-001993/A

Decoupling of **ECU** breadboard and vacuum vessel shall be made by using edge welded bellows.

Verification method: R - review, I - inspection

REQ-003185/A

Double bellows decoupling system shall be applied on **ECU** breadboard chassis.

Verification method: R - review

4.3. ECU design requirements

4.3.1. ECU Vacuum vessel design

REQ-001994/A

ECU frame shall be made of stainless steel following types:

- AISI 304L or
- AISI 304

Verification method: I - inspection, R - review

REQ-001995/A

ECU panels shall be made of aluminum following types:

- Al2219
- Al3003
- Al5083
- Al6082
- Al2090
- Al2219
- Al7005

Verification method: R - review, I - inspection

REQ-001996/A

Final choice of **ECU** vessel materials shall be made in preliminary design phase.

Verification method: R - review

REQ-001997/A

ECU panels shall be designed as a modular system.

Verification method: R - review, I - inspection

1/4

REQ-001998/B

Maximum size of modular aluminium panels shall be 1x1.5 m.

Technical note: Increase of dimension from 1.5 m up to 2 m is acceptable in access optical breadboard area.

Verification method: R - review, I - inspection

REQ-001999/A

Thickness of **ECU** modular aluminium panels shall be in bounded interval 40 + 50 mm.

Verification method: R - review, T - test

REQ-002000/A

All **ECU** panels shall be equipped by Lifting eyes interfaces.

Verification method: R - review, I - inspection

REQ-002001/A

ECU panels close to main optical components shall be equipped with small doors with minimal width 600 mm and high 500 mm.

Verification method: R - review, I - inspection

REQ-002002/A

Openings of **ECU** shall be closed by aluminium blank flanges.

Verification method: R - review, I - inspection

REQ-002003/A

Stainless steel screws with Allen heads shall be used on **ECU** panels.

Verification method: I - inspection, R - review

REQ-002004/A

ECU small doors shall be equipped with hinges.

Verification method: R - review, I - inspection

REQ-002005/A

Maximal deformations of **ECU** panels under vacuum shall be lower than 3 mm in comparison to the vented status.

Verification method: A - analysis, R - review, T - test

REQ-002006/A

Deformations of **ECU** panels in selected coordinates under vacuum shall be lower than 2 mm in comparison to the vented status.

Verification method: A - analysis, T - test

REQ-002007/A

All **ECU** removable panels shall be equipped with guiding pins to allow proper panel seating.

Verification method: R - review, I - inspection

REQ-002008/A

Sealing of **ECU** panels shall be made of fluorelastomer polymer (FPM) material.

Verification method: R - review, I - inspection

REQ-002009/B

Hardness of **ECU** sealing o-rings shall be 60 or 70 HSC (Shore).

Verification method: I - inspection, R - review

REQ-002010/A

ECU shall be equipped with roughing inlet interface (DN100).

Verification method: R - review, I - inspection

REQ-002012/A

Surface treatment of inner **ECU** vacuum vessel surfaces compatible with 10^{-6} mbar shall be applied.

Verification method: R - review, I - inspection

4.3.2. Vacuum Vessel Chassis

REQ-002013/A

ECU vacuum vessel chassis shall allow **z** (vertical) positioning.

Verification method: I - inspection, R - review

REQ-002014/A

Range of **ECU** vacuum vessel chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: R - review, T - test

REQ-002015/A

ECU vacuum vessel chassis shall be made of stainless steel or extruded aluminium profiles.

Verification method: R - review, I - inspection

REQ-002016/A

ECU chassis shall allow for installation of TMP's.

Verification method: R - review, I - inspection

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REQ-002017/A

ECU chassis shall allow for floor fixing.

Verification method: R - review, I - inspection

REQ-002018/A

ECU vacuum vessel chassis shall be equipped with removable transportation wheels.

Verification method: R - review, I - inspection

4.3.3. ECU Optical breadboard design

4.3.3.1. General

REQ-002019/B

Supplier shall provide static FEM analysis and vibration study according to customer inputs.

Technical note: The latest results of building vibration measurement will be provided by customer after contract signature.

Verification method: A - analysis, R - review

4.3.3.2. Optical breadboard

REQ-002020/A

ECU optical breadboard shall allow connection of multiple modular breadboards.

Verification method: I - inspection, R - review

REQ-002021/A

ECU optical breadboard shall have threaded hole pattern with 25 mm spacing.

Verification method: R - review, T - test

REQ-002022/A

Threaded holes of **ECU** breadboard shall be M6 size.

Verification method: R - review, T - test

REQ-002023/A

ECU optical breadboard shall be made of aluminium following types:

- Al2219
- Al3003
- Al5083
- Al6082

- AI7005

Verification method: R - review, I - inspection

REQ-002024/A

Final choice of **ECU** optical breadboard materials shall be made in preliminary design phase.

Verification method: R - review, I - inspection

REQ-002025/A

Minimum thickness of **ECU** breadboard plate shall be 50 mm.

Verification method: A - analysis, R - review, T - test

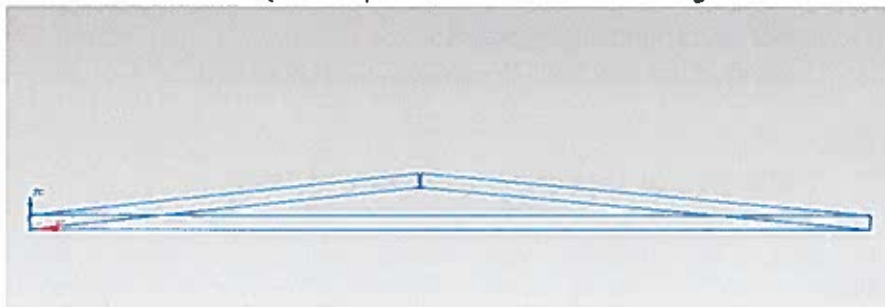
REQ-002026/A

Maximal thickness of whole **ECU** breadboard (plate with reinforcing ribs) shall be 130 mm.

Verification method: A - analysis, R - review, T - test

REQ-002027/B

Maximum misalignment after connection of breadboard segments shall be lower than 1 mrad. (in comparison with ideal non-segmented breadboard)



Technical note: This requirement is valid only in case of using segmented optical table.

Verification method: T - test

REQ-002028/A

Maximum z direction misalignment after connection of breadboard segments shall be lower than 1 mm.

Verification method: T - test, FD - functional demonstration

REQ-002029/A

Supplier shall provide procedure of misalignment measurement.

Verification method: R - review, T - test

May

4.3.3.3. Optical Breadboard Chassis

REQ-002030/A

ECU chassis shall be designed as modular unit.

Verification method: R - review, I - inspection

REQ-002031/A

Only one chassis shall be applied for more connected **ECU** breadboards.

Verification method: R - review, I - inspection

REQ-002032/A

ECU optical breadboard chassis shall allow **z** (vertical) positioning.

Verification method: R - review, I - inspection

REQ-002033/A

Range of **ECU** optical breadboard chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: I - inspection, T - test

REQ-002034/A

ECU optical breadboard chassis shall be made of stainless steel or aluminium extruded profiles.

Verification method: R - review, I - inspection

REQ-002035/A

ECU chassis shall allow installation of TMP's.

Verification method: R - review, I - inspection

REQ-002036/A

ECU chassis shall allow floor fixing.

Verification method: R - review, I - inspection

REQ-002037/A

The **ECU** optical breadboard chassis shall be equipped with removable transportation wheels.

Verification method: R - review, I - inspection

REQ-003192/A

The **ECU** optical breadboard chassis shall have interface for vibration dumping system.

Verification method: R - review

4.3.4. ECU Vacuum equipment

4.3.4.1. TMP (Turbomolecular pump)

REQ-002038/A

Only new **ECU** TMP with full warranty shall be used.
Verification method: I - inspection

REQ-002039/A

ECU shall be installed in accordance to the installation manual of TMP supplier.
Verification method: R - review, I - inspection

REQ-002040/A

ECU TMP shall be water cooled.
Verification method: R - review, I - inspection

REQ-002041/A

ECU TMP coolant shall be demineralized water.
Verification method: I - inspection

REQ-002042/A

ECU TMP shall be equipped with fittings for water cooling.
Verification method: I - inspection

REQ-002043/A

ECU TMP shall be equipped with protective screen.
Verification method: I - inspection

REQ-002044/A

ECU TMP shall be compatible with power supply 230V, 50 Hz.
Verification method: I - inspection

REQ-002045/A

ECU TMP inlet flange shall be ISO-F according to ISO 1609:1986.
Verification method: I - inspection

REQ-002046/A

ECU TMP outlet flange shall be ISO-KF according to ISO 2861:2013.
Verification method: I - inspection

REQ-002047/A

Maximum noise of **ECU** TMP shall be 60 dB.
Verification method: R - review

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REQ-002048/A

ECU TMP with minimum pumping speed 1500 l/sec shall be used.
Verification method: R - review, I - inspection

REQ-002049/A

ECU TMP set up shall be equipped with separation gate valve.
Verification method: I - inspection

REQ-002050/A

ECU TMP shall be equipped with electrically operated venting valve.
Verification method: I - inspection

REQ-002051/A

ECU TMP shall be equipped with power supply unit and control unit.
Verification method: I - inspection

REQ-002052/A

ECU TMP shall be equipped with 19" equipment rack mountable controllers.
Verification method: I - inspection

REQ-002053/A

The minimum required lifetime of TMP shall be 50 000 working hours.
Verification method: R - review

REQ-002054/A

The TMP shall be able to operate continuously at a maximum inlet pressure of 0.05 mbar.
Verification method: R - review

REQ-002055/A

The TMP shall be able to operate continuously at a maximum exhaust pressure of 0.5 mbar.
Verification method: R - review

REQ-002056/A

The TMP shall be protected against damage from sudden temperature rise.
Verification method: R - review, I - inspection

REQ-002057/A

TMP and their accessories (including liquid cooling fittings) must be in compliance with the following standards:

- ISO 1609:1986 - Vacuum technology - Flange dimension
- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings

- ISO 5302:2003 - Vacuum technology - Turbomolecular pumps - Measurement of performance characteristic

Verification method: R - review

4.3.4.2. Gauges

REQ-002058/A

Measurement range of combined gauge shall be $1000 \text{ mbar} \div 1 \times 10^{-6} \text{ mbar}$ with maximum accuracy $\pm 30\%$.

Verification method: R - review, I - inspection

REQ-002059/A

Mechanical interface of ECU Vacuum gauges shall be ISO KF according to ISO 2861:2013.

Verification method: R - review, I - inspection

REQ-002060/A

Vacuum connection of the gauges must be in compliance with the following standards:

- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings.

Verification method: R - review, I - inspection

REQ-002061/A

Power supply of **ECU** vacuum gauges shall be 24VDC.

Verification method: R - review, I - inspection

REQ-002062/A

Interval of output **ECU** vacuum gauges signal shall be $0 \div 11 \text{ VDC}$.

Verification method: R - review, I - inspection

4.3.4.3. Gate valves

REQ-002063/A

ECU gate valve separating TMP shall be made of stainless steel (body material).

Verification method: R - review, I - inspection

REQ-002064/A

Main **ECU** inlet/outlet gate (DN400) valves shall be made of aluminium (body material).

Verification method: R - review, I - inspection

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REQ-002065/A

The **ECU** gate valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

REQ-002066/A

Minimal open/close cycles of **ECU** gate valves until first service shall be 200 000.

Verification method: R - review

REQ-002067/A

ECU gate valve shall be equipped with ISO F flange according to ISO 1609:1986.

Verification method: I - inspection

REQ-002068/A

ECU gate valves shall be equipped with blank flange from atmosphere side.

Verification method: I - inspection

4.3.4.4. Venting valves

REQ-002069/A

ECU shall be equipped with venting valve.

Verification method: I - inspection

REQ-002070/A

Automatic venting valve shall be used on **ECU**.

Verification method: I - inspection

REQ-002071/A

The **ECU** venting valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

4.3.4.5. Bellows (connection of two chambers)

REQ-002072/A

Edge welded bellows shall be used on **ECU**.

Verification method: I - inspection, R - review

REQ-002073/A

ECU bellows shall be equipped with threaded rods.

Verification method: I - inspection, R - review

REQ-002074/A

Compensation range of ECU connecting bellows shall be:

- Axial ± 15 mm
- Lateral ± 5 mm
- Angular $\pm 2^\circ$

Verification method: R - review, I - inspection, T - test

4.3.4.6. Vacuum clamps

REQ-002075/A

All **ECU** vacuum clamps shall be permanent set free after assembling.

Verification method: I - inspection, FD - functional demonstration

REQ-002076/A

Clamp slots shall defect free.

Verification method: I - inspection

4.3.4.7. Local & remote vacuum control and safety system

REQ-002077/A

ECU local control system shall be designed and verified as an autonomous manually controlled system with interfaces to ELI – control system.

Verification method: R - review, I - inspection

REQ-002078/A

All ECU TMP's, vacuum gauges and valves shall be delivered with the **associated controllers**.

Verification method: I - inspection

REQ-002079/A

The controllers shall provide a reliable control interface to ELI central control system via LC optical fibers or RJ45 metallic connections.

Verification method: I - inspection

REQ-002080/A

The communication protocol shall be available and compatible with Linux OS.

Verification method: R - review

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REQ-002081/A

Documentation for the protocol shall be provided.

Verification method: I - inspection

REQ-002082/A

Safety interface based on digital I/O (24V DC signals) shall be provided for redundancy in addition to REQ-002086/A.

Verification method: R - review

REQ-002083/A

The controllers shall have local and remote access capabilities.

Verification method: I - inspection

REQ-002084/A

The controllers shall provide separate interlock capabilities via dry C-shape contacts.

Verification method: I - inspection

REQ-002085/A

All valves shall be supplied with open/closed limit switches wired to standard DIN connectors with mating plugs.

Verification method: I - inspection

REQ-002086/A

The supplied controls shall provide a safe pumping and venting sequence including interlocks in the local and remote mode of operation.

Verification method: I - inspection

4.3.5. Data acquisition

REQ-002087/A

Following data shall be readable from the ECU:

- Temperature on TMP
- Level of vacuum
- rpm of TMP rotor
- Hours of TMP operation
- Levitation of TMP rotor (if maglev is used)

Verification method: R - review, T - test

4.3.6. EMC/EMP

REQ-002088/A

The **ECU** design shall comply with EU standards of electro-magnetic compatibility.

Verification method: R - review

5. System Transportation and installation requirements

5.1. General requirements

REQ-002089/A

Supplier shall provide procedures for transportation and installation of **ECU**.

Verification method: R - review

REQ-002090/A

Supplier shall provide procedures for handling and manipulation of **ECU**.

Verification method: R - review

REQ-007143/A

The transportation and installation personnel shall follow the customer's facility regulations.

NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.

Verification method: R - review

REQ-007144/A

The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in clean environment of ISO class 7, if not agreed otherwise.

Verification method: R - review, I - inspection

REQ-007145/A

All transportation and installation tools and equipment entering the clean rooms shall be cleaned and reviewed by the customer's approved methods.

NOTE: Some tools can be provided by the customer upon agreement.

Verification method: I - inspection, T - test

REQ-007146/A

The transportation to the final destination and the installation of the technologies and the instruments shall be conducted by the vendor. The

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methods shall be discussed and reviewed by the customer's installation officer and shall be compliant with the customer's installation regulations.
NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.
Verification method: R - review

REQ-007147/A

The main parts of the mechanical structure shall be equipped with positioning/alignment marks for industrial 3D-measurements/survey. The specific type of the positioning/alignment marks, their number and location shall be agreed with the customer.
Verification method: R - review, I - inspection

5.2. Transportation

REQ-002091/A

The supplier shall provide supervision by transport **ECU** to defined position in ELI – Beamlines experimental room.
Verification method: R - review, I - inspection

REQ-002093/A

All Parts shall be identified according to technical documentation.
Verification method: R - review

5.3. Installation

REQ-002095/A

Connection of **ECU** to the ELI- Beamlines facility services shall be made under supervision of supplier.
Verification method: R - review, I - inspection

REQ-002096/A

Assembling of **ECU** on supplier side shall be made in cleanroom ISO7.
Verification method: I - inspection

REQ-002097/A

All specific equipment and tools necessary for installation of the **ECU** shall be subject of the supplier delivery.
Verification method: I - inspection, R - review

REQ-002098/A

Maximum dimensions of goods going through experimental entrance area shall be 3000x2000x2000 mm (length x with x high)
Verification method: R - review, T - test

6. Handling and Manipulation

REQ-002100/A

Supplier shall provide an approved methodological document describing safe handling and manipulation of the product.

Verification method: R - review

7. Maintenance

REQ-002101/A

Supplier shall provide an approved methodological document describing maintenance procedures of the product.

Verification method: R - review

8. Safety Requirements

REQ-002102/A

The **ECU** design of relevant parts shall comply with Czech and EU regulations regarding safety domain.

NOTE: Application of Czech regulations will be subject of preliminary design.

Verification method: R - review

REQ-002103/A

Supplier shall perform hazard identification and risk assessment of system prior to design.

Verification method: A - analysis, R - review

REQ-002104/A

All **ECU** manufactured parts shall be free of sharp edges.

Verification method: I - inspection

REQ-002105/A

All **ECU** manufactured parts shall be burr free.

Verification method: I - inspection

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9. Quality

9.1. Quality Management

9.1.1. Quality organization and responsibilities

9.1.1.1. Organization

REQ-002106/A

The supplier shall identify the personnel responsible for implementing and performing QA management plan and other Quality Controls disciplines.
Verification method: R - review

REQ-002107/A

The supplier shall assign a project Quality manager reporting to the project manager who has an unimpeded access to higher management.
Verification method: R - review

REQ-002108/A

The appointed project Quality manager, irrespective of other responsibilities, shall have organizational authority to establish and implement a quality assurance programme in accordance with the project quality assurance requirements.
Verification method: R - review

REQ-002109/A

The project Quality Manager shall act as the primary contact person within the project concerning Quality matters.
Verification method: R - review

REQ-007173/A

The supplier shall apply international recognized standards or best practice where applicable for quality assurance programme.
Verification method: R - review

9.1.1.2. Responsibility and authority

REQ-002110/A

The supplier shall define and document the responsibility, the authority and the interrelation of personnel who manage, perform and verify work affecting quality assurance.

Verification method: R - review

REQ-002111/A

The supplier shall define and document the responsibilities and the interfaces of the Quality functions, either external or internal, involved in a project.

Verification method: R - review

REQ-002112/A

When the supplier's Quality organization delegates quality assurance tasks to another organization it shall be done in a documented and controlled way monitored by the Quality organization.

Verification method: R - review

9.1.2. Quality plan and its implementation

REQ-002113/A

The supplier shall prepare, maintain and implement a plan of the QA (Quality Assurance) activities in accordance with the customer QA requirements.

Verification method: R - review

REQ-002116/A

The supplier management shall ensure that the inputs used by the Quality functions are consistent and complete, and available in line with the project schedule.

Verification method: R - review

REQ-002117/A

The supplier QA management shall ensure that the QA functions perform the tasks described in the QA Plan in line with the project schedule.

Verification method: R - review

REQ-002118/A

The supplier QA management shall ensure that the outputs produced by the QA functions are consistent and complete, and delivered in line with the project schedule.

Verification method: R - review

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REQ-002119/A

The supplier QA management shall ensure the application of processes defined in applicable project plans and documents.

Verification method: R - review

9.1.3. Documentation and data control

REQ-002120/B

The supplier shall provide following type of documents:

- 3D model (format: *.step; *.stp)
- 2D drawings (format: *.dwg)
- Printable format for text documents

Verification method: I - inspection

10. Environmental conditions

REQ-002121/A

Final cleanliness shall be compatible with ISO 7.

Verification method: I - inspection

11. Verification process

REQ-002122/A

The verification process shall demonstrate that the deliverable product meets the specified customer requirements and is capable of sustaining its operational role through:

1. Verification planning;
2. Verification execution and reporting;
3. Verification control and close-out.

Verification method: R - review

REQ-002123/A

The supplier shall define the verification approach by conducting the following steps:

1. Identify and agree with the customer the set of requirements to be subject of the verification process.
2. Select the methods and levels of verification, associated model philosophy and verification tools.
3. Identify the stages and events in which the verification is implemented.

Verification method: R - review

REQ-002124/A

The verification approach shall be defined by the supplier in the Verification Plan (VP) for approval by the customer prior to implementation.

Verification method: R - review

11.1. Verification methods

11.1.1. General

REQ-002126/A

Verification shall be accomplished by one or more of the following verification methods:

1. test (including functional demonstration);
2. analysis (including similarity);
3. review-of-design;
4. inspection.

Verification method: R - review

REQ-002127/A

All safety critical functions shall be verified by test.

Verification method: R - review

REQ-002128/A

Verification of software shall include testing in the target hardware environment.

Verification method: R - review

11.1.2. Test

REQ-002129/A

Verification by test shall consist of measuring product performance and functions under representative simulated environments.

Verification method: R - review

REQ-002130/A

The analysis of data derived from testing shall be an integral part of the test and the results included in the test report.

Verification method: R - review

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REQ-002131/A

When the test objectives include the demonstration of qualitative operational performance, the execution shall be observed and results recorded (functional demonstration).

Note: Functional demonstration is a subset of tests.

Verification method: R - review

REQ-002132/A

A test programme shall be prepared for each product in conformance with Verification Plan.

Verification method: R - review

REQ-002133/A

The test programme shall be coordinated with the integration flow.

Verification method: R - review

REQ-002134/A

Tests performed as part of the integration flow to check quality and status of the in-progress configuration (including interfaces), having a formal verification purpose, shall be included in the test programme.

Verification method: R - review

REQ-002135/A

The test programme shall be defined in the specific chapter of the Verification Plan.

Verification method: R - review

REQ-002136/A

Test Programme shall be approved by the Customer.

Verification method: R - review

11.1.3. Analysis

REQ-002138/A

Verification by analysis shall consist of performing theoretical or empirical evaluation using techniques agreed with the Customer.

NOTE Techniques comprise systematic, statistical and qualitative design analysis, modelling and computational simulation.

Verification method: R - review

REQ-002141/A

An analysis programme shall be defined in the Verification Plan (VP).

Verification method: R - review

11.1.4. Review-of-design (ROD)

REQ-002142/A

Verification by Review-of-design (ROD) shall consist of using approved records or evidence that unambiguously show that the requirement is met.

NOTE Examples of such approved records are design documents and reports, technical descriptions, and engineering drawings.

Verification method: R - review

REQ-002143/A

A review-of-design programme shall be defined in the Verification Plan (VP).

Verification method: R - review

REQ-002144/A

A review-of-design programme shall only be applicable in stages (phases) before starting the manufacturing.

Verification method: R - review

11.1.5. Inspection

REQ-002145/A

Verification by inspection shall consist of visual determination of physical characteristics.

NOTE Physical characteristics include constructional features, hardware conformance to document drawing or workmanship requirements, physical conditions, software source code conformance with coding standards.

Verification method: R - review

REQ-002146/A

An inspection programme shall be defined in the Verification Plan (VP).

Verification method: R - review

12. Qualification (if needed)

N/A

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13. Acceptance

REQ-002147/A

In the acceptance stage the verification shall demonstrate that the product is free of fabrication errors and is ready for the intended operational use.

Verification method: R - review

REQ-002148/A

Acceptance shall be carried out on the final hardware and software

Verification method: R - review

14. Verification process phasing

REQ-002151/A

The verification process shall be phased with the project life cycle defined as a contract execution phases (preliminary design, detailed design, manufacturing and deployment of deliverable product(s) see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002152/A

Verification planning to assess feasibility and support programmatics shall start in the early phases.

NOTE: programmatics means support equipment and verification timescale estimation.

Verification method: R - review

REQ-002153/A

The preliminary verification planning shall cover all products and requirements by the end of preliminary design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002154/A

Verification planning shall be completed by the end of detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002155/A

Verification execution and reporting shall be incrementally carried out through the project life cycle starting from detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002156/A

Verification control shall start with the initial issue of the verification control document (VCD) during detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002157/A

Verification close out status shall be assessed and approved by the customer for each product at the end of each stage.

Verification method: R - review

15. Verification plan (VP)

REQ-002158/A

The supplier shall provide a Verification plan (VP) for the reviews as agreed with the customer

NOTE Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-002159/A

The contents of the Verification plan (VP) shall be approved by the Customer

Verification method: R - review

16. Verification Control Document (VCD)

REQ-002160/A

The supplier shall provide a Verification Control Document (VCD) for the reviews as agreed with the customer

NOTE: Guidelines for VP preparation shall be provided by the Customer.

Verification method: R - review

REQ-002161/A

The contents of the initial issue of the Verification Control Document (VCD) shall be in conformance with ELI verification matrix.

Verification method: R - review

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17. Verification execution and reporting

17.1. General

REQ-002163/A

The supplier shall assign clear responsibility for the implementation of the verification plan.

Verification method: R - review

REQ-002164/A

The test preparation and execution (including Test Readiness Review (TRR) and Post Test Review (PTR)) shall be reviewed by the Customer.

Verification method: R - review

REQ-002165/A

The verification results shall be recorded by the supplier in reports for review by the Verification Control Board (VCB) through the VCD.

Verification method: R - review

17.2. Verification execution and reporting documentation

17.2.1. Test report (TRPT)

REQ-002166/A

The test report (TRPT) shall be submitted to the Verification Control Board (VCB) after the test completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002167/A

The content of the Test report (TRPT) shall be agreed with the Customer.

Verification method: R - review

REQ-002168/A

The supplier shall provide the Test reports (TRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002169/A

A Test report (TRPT) shall be provided for each test verification task as identified in the VP.

Verification method: R - review

17.2.2. Analysis report (ARPT)

REQ-002170/A

The Analysis report (ARPT) shall be submitted to the Verification Control Board (VCB) after analysis completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002171/A

The supplier shall provide an Analysis report (ARPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002172/A

An Analysis report (ARPT) shall be provided for each Analysis verification task identified in the VP.

Verification method: R - review

17.2.3. Review-of-design report (RRPT)

REQ-002173/A

The Review-of-design report (RRPT) shall be submitted to the Verification Control Board (VCB) after the Review-of-Design completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002174/A

The supplier shall provide a Review-of-design report (RRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002175/A

A Review-of-design report (RRPT) shall be provided for each Review-of-design verification task identified in the VP.

Verification method: R - review

17.2.4. Inspection report (IRPT)

REQ-002176/A

The Inspection report (IRPT) shall be submitted to the Verification Control Board (VCB) after the inspection completion, within the time frame agreed with the customer.

Verification method: R - review

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REQ-002177/A

The supplier shall provide an Inspection report (IRPT) for the reviews as agreed with the customer
Verification method: R - review

REQ-002178/A

An Inspection report (IRPT) shall be provided for each Inspection verification task identified in the VP.
Verification method: R - review

17.2.5. Verification report (VRPT)

REQ-002179/A

The supplier shall prepare a Verification report (VRPT) when more than one of the defined verification methods are utilized to verify a requirement or a specific set of requirements.
Verification method: R - review

REQ-002180/A

The content of Verification report (VRPT) shall be agreed by the Customer
Verification method: R - review

REQ-002181/A

The Verification report (VRPT) shall be submitted to the Verification Control Board (VCB) after the completion of the last contributing verification activities, within the time frame agreed with the customer.
Verification method: R - review

REQ-002182/A

The supplier shall provide a Verification report (VRPT) for the reviews as agreed with the customer
Verification method: R - review

17.2.6. Other verification execution and reporting Document

REQ-002183/A

The supplier shall provide the Test specifications (TSPE) for the reviews as agreed with the customer
Verification method: R - review

REQ-002184/A

The supplier shall provide the Test procedures (TPRO) for the reviews as agreed with the customer

Verification method: R - review

REQ-002185/A

The rules for the analysis, inspection and review of design shall be defined in writing before their execution.

NOTE For example, analysis, inspection or review of design procedures.

Verification method: R - review

18. Verification control and close-out

18.1. General

REQ-002186/A

The implementation of the verification process shall be monitored by the Verification Control Board (VCB).

Verification method: R - review

REQ-002187/A

The verification process control shall be supported by a computer based verification database.

Verification method: R - review

REQ-002188/A

The verification database shall be delivered to the customer in an electronic form to be agreed with the customer.

Verification method: R - review

REQ-002189/A

The supplier shall provide to the customer verification evidence for the customer's applicable requirements agreed to be verified, independently from the level where verification has been accomplished.

Verification method: R - review

18.2. Verification control board (VCB)

REQ-002190/A

A Verification Control Board (VCB), with participation of customer representatives, shall be established to incrementally assess the achievements and status of the verification process.

Verification method: R - review

11/14

REQ-002191/A

The verification process shall be considered completed when the Verification Control Board (VCB) confirms that:

1. documented evidence is recorded in the VCD,
2. identified requirements have been verified
3. associated product verification objectives are reached

Verification method: R - review

REQ-002192/A

The conclusions of the VCB shall be submitted for approval to the customer's contractual authority.

Verification method: R - review

REQ-002193/A

The Verification Control Board (VCB) shall assess the verification status with a periodicity agreed with the customer, along the project life cycle.

Verification method: R - review

REQ-002194/A

The Verification Control Board (VCB) shall endorse the final issue of the Verification Control Document (VCD).

Verification method: R - review

18.3. Re-verification

REQ-002195/A

The extent of the re-verification to be performed shall be determined by Supplier and agreed with the Customer, in the following cases:

1. failure and repair as decided by Nonconformance Review Board (NRB)
2. unplanned disassembly or demounting
3. refurbishment, maintenance or design changes
4. changes of requirements after initial verification
5. long duration storage

Verification method: R - review

REQ-002196/A

The Verification Control Document (VCD) shall be updated by the supplier to record as open, those requirements subject to re-verification until this is performed and closeout agreed by the customer.

Verification method: R - review

18.4. Verification control and close-out documentation

18.4.1. Verification Control Document (VCD)

REQ-002197/A

The content of the completed Verification Control Document (VCD) shall be agreed by the Customer

Verification method: R - review

REQ-002198/A

The supplier shall update the Verification database within one week of the approval of a report.

Verification method: R - review

REQ-002199/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current status of the verification database, shall be made available to the Verification Control Board (VCB) upon request.

Verification method: R - review

REQ-002200/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current verification and compliance status, shall be delivered at each formal review as agreed with the customer

Verification method: R - review

REQ-002201/A

The final issue of the Verification Control Document (VCD) shall be submitted to the Verification Control Board (VCB) after the approval of the last report, within the time frame agreed with the customer.

Verification method: R - review

18.4.2. Other close-out documents

REQ-002202/A

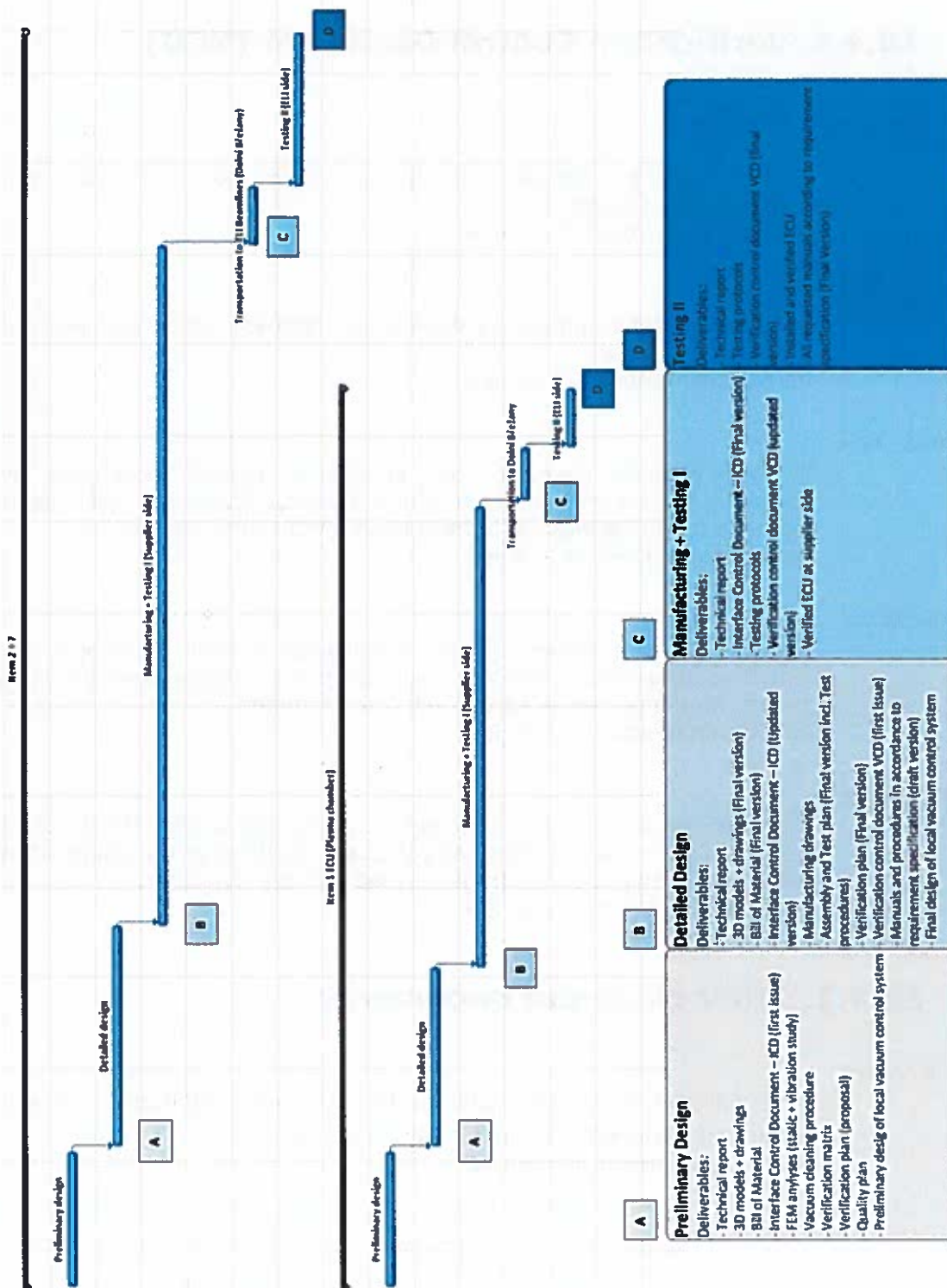
The supplier shall make available to the customer for consultation the VCD's supporting documentation in addition to the reports.

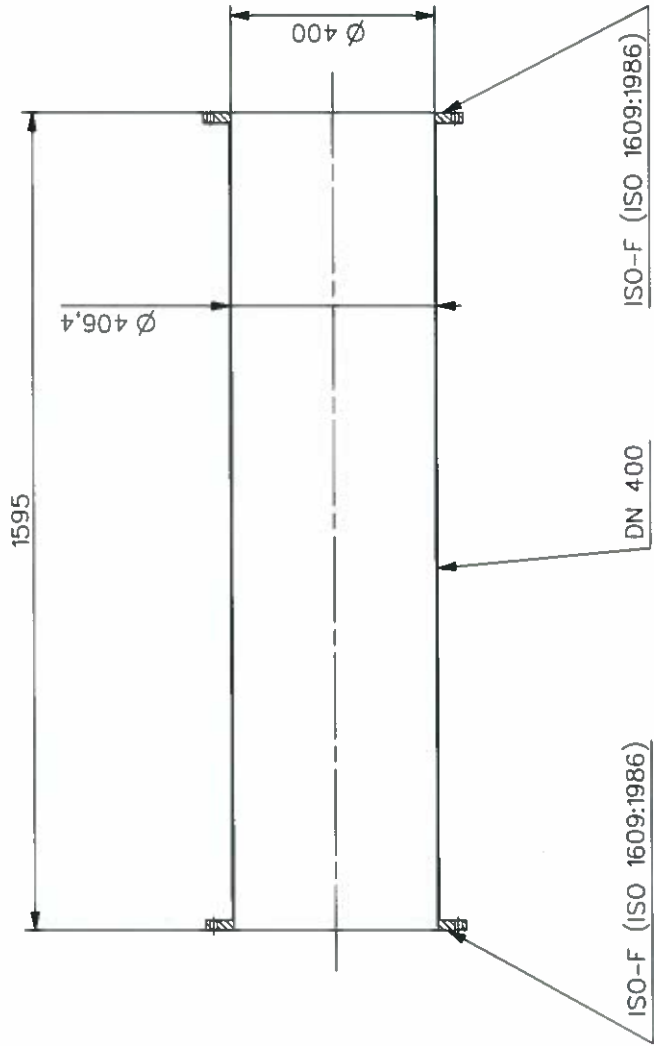
Verification method: R - review

11-4

19. Annex I

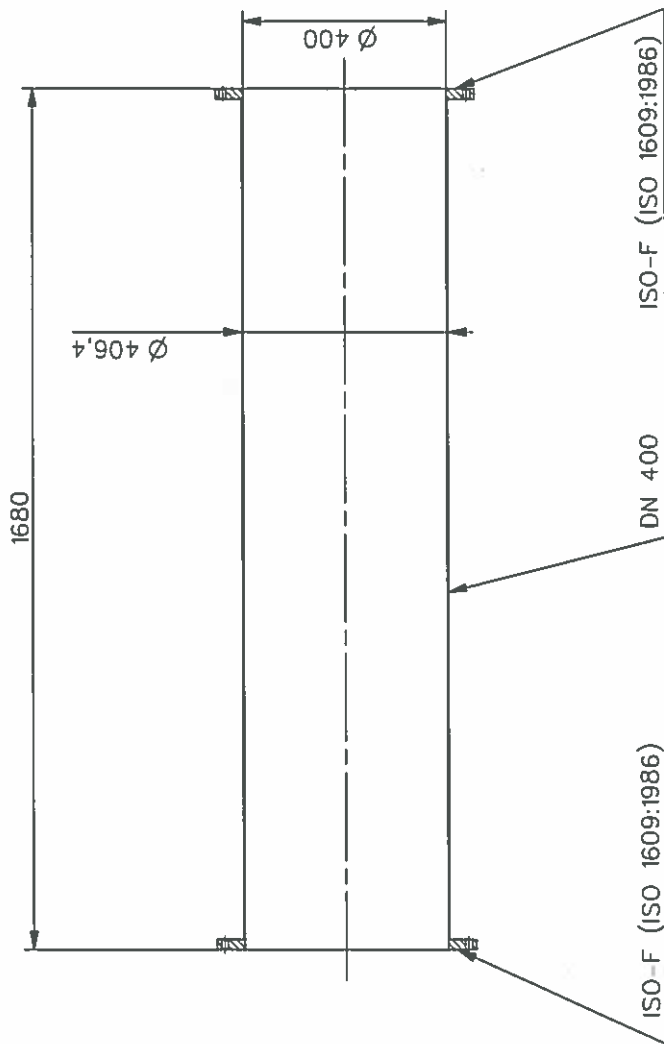
ECU - Contract Phases



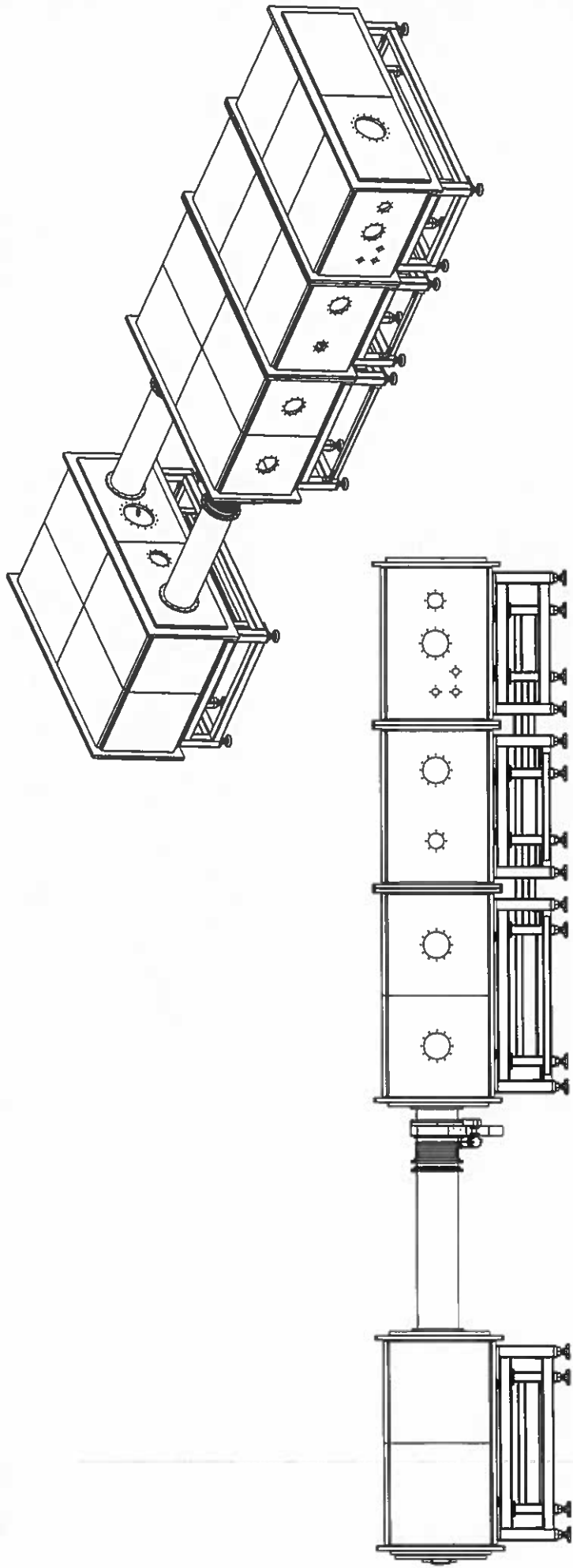


The information contained in this drawing is the sole property of FZUL. Any reproduction is prohibited	Projection 		 beamlines	 Fyzikální ústav Akademie věd ČR, v. v. i.	Dwg. title
					HELL_pipe_DN400_2
Drawn by: martin.bucka	Comments	Scale 1:10	Dwg. no.	00102978-00	Sheet 1 of 1
Checked by:					
Date: 6.11.2014					
Material: Ocel korozivzdorná	All dimensions in mm				
Raw mat.:	Tolerance: ISO2768-mk				
Weight: 72.352	Application				

by

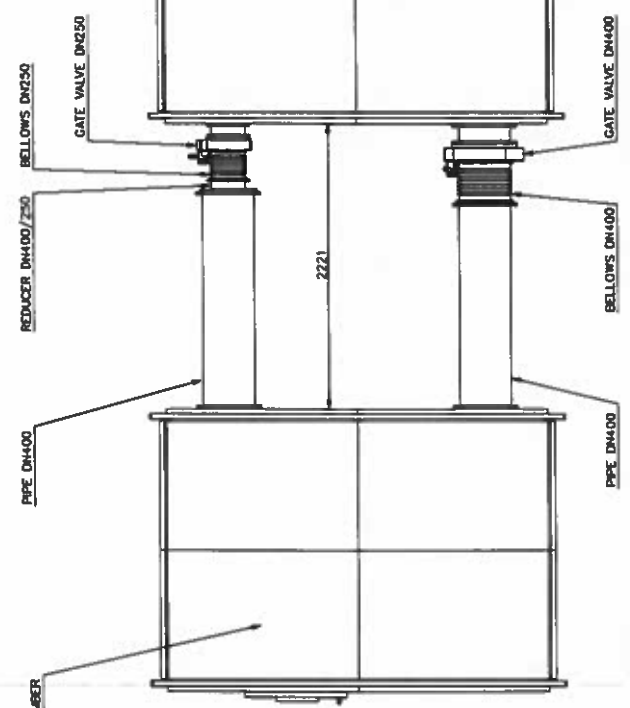


The information contained in this drawing is the sole property of FZIL Any reproduction is prohibited		Projection 		 beamlines	 Fyzikální ústav Akadémie vied ČR, v. v. i.
Drawn by: martin.bucka	Comments	Scale 1:10	Dwg. title HELL_pipe_DN400	Dwg. no. 00102978-00	Sheet 1 of 1
Checked by:					
Date: 6.11.2014					
Material: Ocel korozivzdorná	All dimensions in mm				
Raw mat.:	Tolerance: ISO2768-mk				
Weight: 74.964	Application				



WELL MAIN CHAMBER

WELL AUXILIARY CHAMBER



REDUCER DN400/250

BELLOWS DN250

GATE VALVE DN250

PIPE DN400

2221

BELLOWS DN400

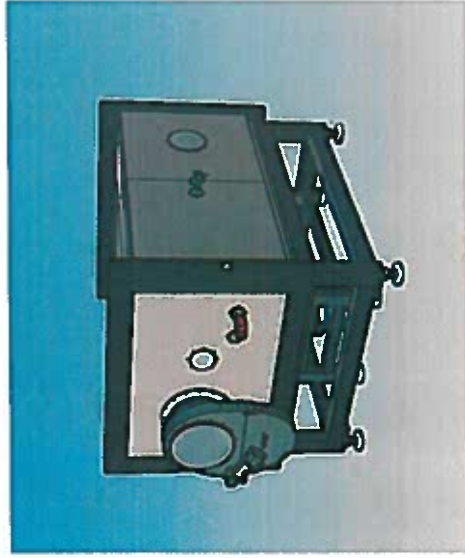
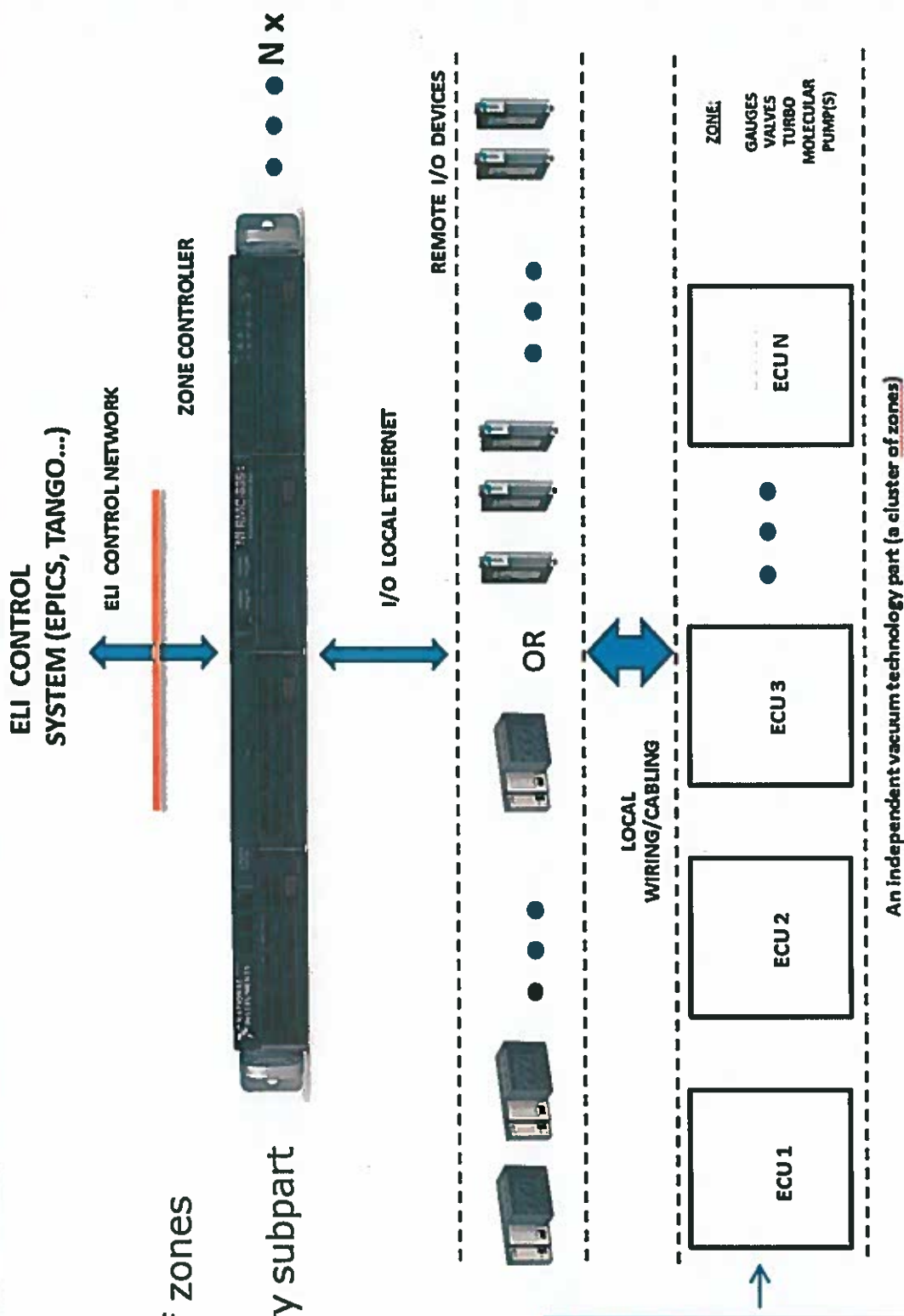
GATE VALVE DN400

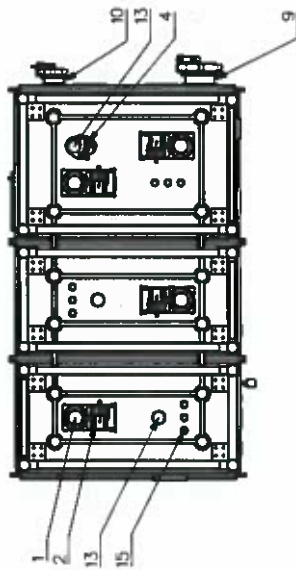
PIPE DN400

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Drawn by 0000209-00	Checked by 0000209-00	Date 01.01.2011	Project 0000209-00	Drawing No. 0000209-00
PZKávní ústav, s.r.o. PZKávní ústav, s.r.o. PZKávní ústav, s.r.o.				

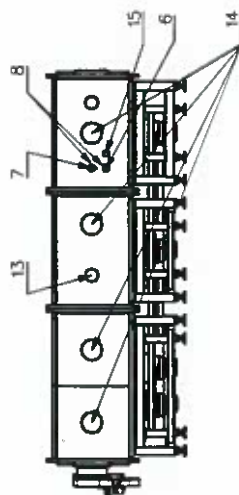
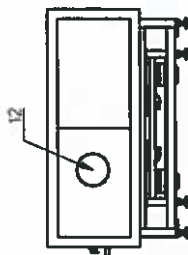
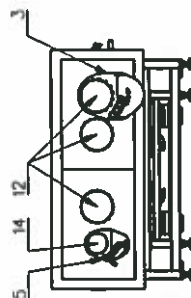
May

- N zone controllers
- Each zone controller responsible for a set of zones
- A zone is an elementary subpart of the vacuum system





HELI MAIN CHAMBER - MODULE 1
HELI MAIN CHAMBER - MODULE 2
HELI MAIN CHAMBER - MODULE 3



UNSPECIFIED FLANGES - ISO-K
ALL FLANGES ACCORDING TO STANDARDS ISO 1609 (ISO-K, ISO-F) OR ISO 28612/13 (ISO-KF)

Number	Quantity	Description
1	4	TURBOMOLECULAR PUMP DN250
2	4	GATE VALVE DN250
3	1	VALVE DN400
4	1	VALVE DN160
5	1	VALVE DN250
6	1	VACUUM GAUGE DN25 ISO-KF
7	1	VENT VALVE DN25 ISO-KF
8	2	REDUCER DN63 ISO-K/DN25 ISO-KF
9	1	PIPE DN400 ISO-F
10	5	PIPE DN250 ISO-F
11	1	PIPE DN160 ISO-F
12	4	BLIND FLANGE DN400
13	5	BLIND FLANGE DN160
14	5	BLIND FLANGE DN250
15	10	BLIND FLANGE DN63

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Drawn by: Kunturbaev		Checked by:	1:50	HELI MAIN CHAMBER ASSEMBLY
Date: 31.10.2014		All dimensions in mm	Tolerance ISO 28612/13	Drawing no.
Material:		Application:	Weight:	00104132/00
Sheet 2 of 2		FZU		

Confidentiality Level	BL - Restricted for internal use	TC ID / Revision	00104401 / F
Document Status	Document Reviewed	Document No.	Specific Document code
WBS code	5.1 - RP2 - X-ray sources driven by rep-rate ultrashort laser pulses		
PBS code	E.E5 - E5 (RA2 & RA3)		

Requirements Specification Document (RSD)

ECU LUX chamber



Keywords

Put keywords related to the document content.

	Position	Name
Responsible person	Group Leader RP3	Daniele Margarone
Prepared by	Chief Engineer	Pavel Korouš

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<i>RSS TC ID/revision</i>	<i>Date of Creation</i>	<i>Date of Last Modification</i>	<i>Systems Engineer</i>
001318 / E	09-12-2014 21:21	11-12-2014	Pavel Korouš
001318 / F	27-02-2015 16:49	02-03-2015	Aleksei Kuzmenko

Reviewed By

<i>Name (Reviewer)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Approved by

<i>Name (Approver)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>

Revision History / Change Log

<i>Change No.</i>	<i>Made by</i>	<i>Date</i>	<i>Change description, Pages, Chapters</i>	<i>TC rev.</i>

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4. Design requirements	Chyba! Záložka není definována.
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5. System Transportation and Installation requirements .	Chyba! Záložka není definována.
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6. Handling and Manipulation	Chyba! Záložka není definována.
7. Maintenance	Chyba! Záložka není definována.
8. Safety Requirements	Chyba! Záložka není definována.
9. Quality	Chyba! Záložka není definována.
9.1. Quality Management	Chyba! Záložka není definována.
9.1.1. Quality organization and responsibilities	Chyba! Záložka není definována.
9.1.2. Quality plan and its implementation	Chyba! Záložka není definována.
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10. Enviromental conditions	Chyba! Záložka není definována.
11. Verification process	Chyba! Záložka není definována.
11.1. Verification methods	Chyba! Záložka není definována.
11.1.1. General	Chyba! Záložka není definována.
11.1.2. Test	Chyba! Záložka není definována.
11.1.3. Analysis	Chyba! Záložka není definována.
11.1.4. Review-of-design (ROD)	Chyba! Záložka není definována.
11.1.5. Inspection	Chyba! Záložka není definována.
12. Qualification (if needed)	Chyba! Záložka není definována.
13. Acceptance	Chyba! Záložka není definována.
14. Verification process phasing	Chyba! Záložka není definována.
15. Verification plan (VP)	Chyba! Záložka není definována.
16. Verification Control Document (VCD)	Chyba! Záložka není definována.
17. Verification execution and reporting	Chyba! Záložka není definována.

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17.1. General	Chyba! Záložka není definována.
17.2. Verification execution and reporting documentation	Chyba! Záložka není definována.
17.2.1. Test report (TRPT)	Chyba! Záložka není definována.
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18. Verification control and close-out	Chyba! Záložka není definována.
18.1. General	Chyba! Záložka není definována.
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1. ECU (Experimental Chamber Unit)

ECU is an abbreviation for **Experimental Chamber Unit** which in contract text is called by **Device**. **ECU** is defined for this specification purpose as a self-contained unit providing controlled pumping and venting together with provision of stable area for optical layout.

2. Functional and Performance Requirements

REQ-002431/A

ECU shall allow vacuum pumping and venting for experimental set-up.
Verification method: FD - functional demonstration

REQ-002432/A

ECU shall reach vacuum level 10^{-6} mbar.
Verification method: T - test

REQ-002434/A

ECU vacuum equipment shall be capable reaching 10^{-5} mbar vacuum level in 60 minutes.
Verification method: T - test

REQ-002435/A

Preventive maintenance time shall not exceed 8 hours.
Verification method: R - review

REQ-002436/A

The **ECU** shall provide pumping and venting sequences.
Verification method: FD - functional demonstration

3. Operational design requirements

REQ-002437/A

ECU shall comply with frequency of opening/closing 2-times a day.
Verification method: R - review

114

4. Design requirements

4.1. General

REQ-003502/A

Enclosed **ECU** tender .pdf drawings shall be taken into account as a concept for preliminary design.

Verification method: R - review

REQ-002438/A

Interaction Chamber Unit (**ECU**) shall provide space for customer provided optical equipment.

Verification method: R - review

REQ-002439/A

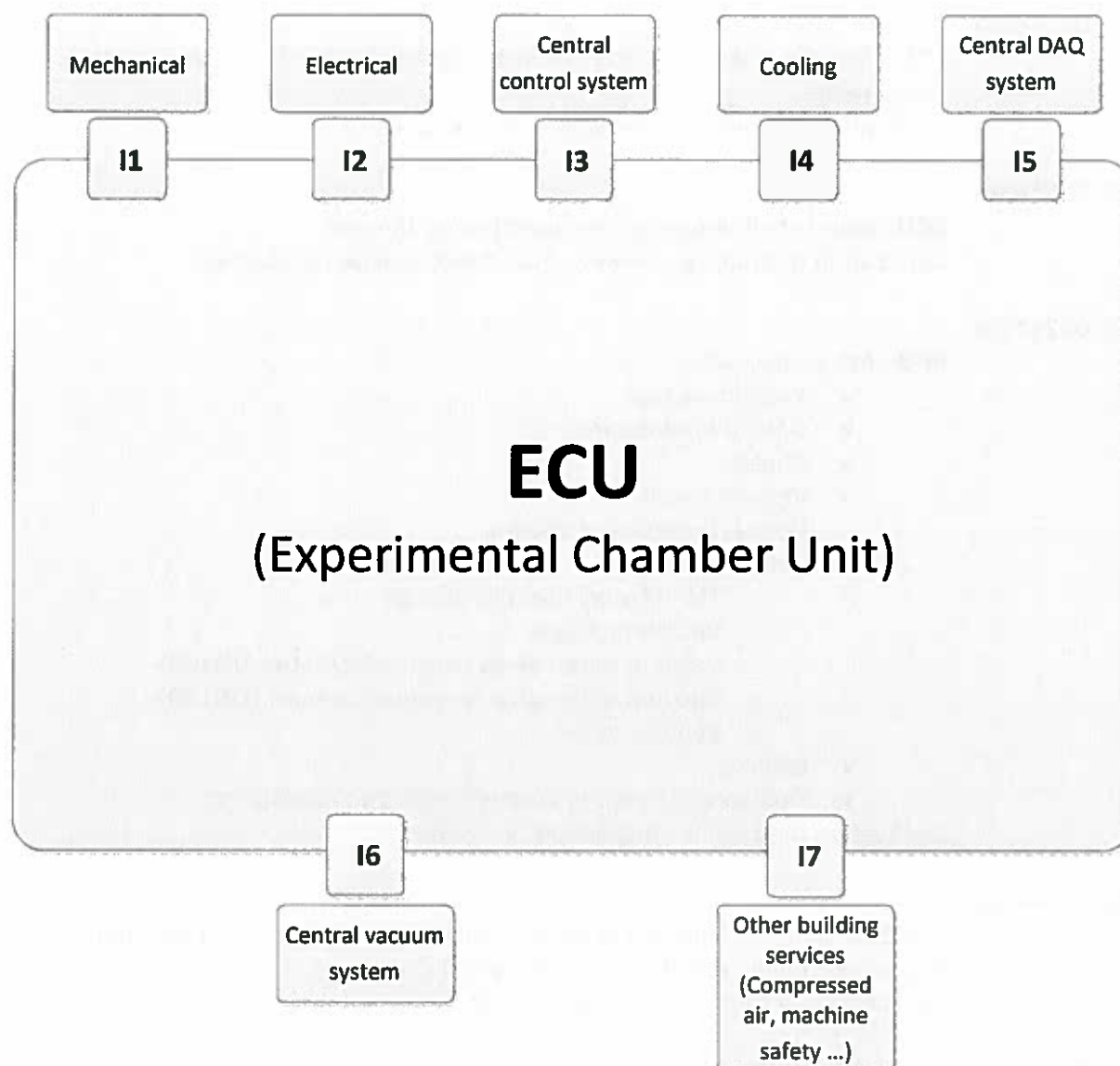
ECU shall provide for the following interfaces:

- TMP's (Turbo Molecular Pumps)
- Gauges
- Feedthrough
- Diagnostics
- Remote control
- Central Vacuum System (CVS)
- Beam Transport (BT)
- ELI Building
- ELI Building services

Verification method: R - review

REQ-003410/A

Supplier shall provide **ECU** Interface Control Document (**ICD**).



Verification method: R - review

REQ-002440/A

The supplier shall define the **Reference Coordinate System (RCS)** of the **ECU** which shall allow positioning the **ECU** in customer's experimental hall according to **Reference Mechanical System** of the hall (**RMS**).

Verification method: R - review

REQ-002441/A

RCS and its relation to the **RMS** shall be set up together with supplier during the preliminary design phase.

Verification method: R - review

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REQ-002442/A

ECU shall allow safe handling and manipulation with internal and external components.

Verification method: I - inspection, R - review

REQ-002443/A

ECU design shall assure a safe operation of the unit.

Verification method: R - review, FD - functional demonstration

REQ-002444/A

ECU shall consist of:

- Vacuum vessel
- Optical breadboard
- Chassis
- Vessel chassis
- Optical breadboard chassis
- Vacuum devices:
 - TMP (TurboMolecular Pump)
 - Vacuum gauges
 - Vacuum gate valves (main inlet/outlet DN400)
 - Vacuum gate valve for rough vacuum (DN100)
 - Venting valve
- Bellows
- Pipework (in case of connection of two chambers)

Verification method: I - inspection, R - review

REQ-002445/A

The **ECU** shall be designed to accommodate laser beam axis 1300 mm above floor level (see attached conceptual drawings).

Verification method: R - review, T - test

REQ-002446/A

Tools used during manufacture shall not contaminate the vacuum surface.

Verification method: T - test

REQ-003509/A

All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.

Verification method: R - review, T - test

4.2. Operational design requirements

REQ-002447/A

ECU shall be a modular unit allowing extension in longitudinal direction.

Verification method: R - review, I - inspection

REQ-002448/A

ECU breadboard and vacuum vessel shall be decoupled.

Verification method: I - inspection, R - review

REQ-002449/A

Decoupling of **ECU** breadboard and vacuum vessel shall be made by using edge welded bellows.

Verification method: R - review, I - inspection

REQ-003189/A

Double bellows decoupling system shall be applied on **ECU** breadboard chassis.

Verification method: R - review

4.3. ECU design requirements

4.3.1. ECU Vacuum vessel design

REQ-002450/A

ECU frame shall be made of stainless steel following types:

- AISI 304L or
- AISI 304

Verification method: I - inspection, R - review

REQ-002451/A

ECU panels shall be made of aluminum following types:

- Al2219
- Al3003
- Al5083
- Al6082
- Al2090
- Al2219
- Al7005

Verification method: R - review, I - inspection

REQ-002452/A

Final choice of **ECU** vessel materials shall be made in preliminary design phase.

Verification method: R - review

REQ-002453/A

ECU panels shall be designed as a modular system.

Verification method: R - review, I - inspection

Hay

REQ-002454/B

Maximum size of modular aluminium panels shall be 1x1.5 m. *Technical note: Increase of dimension from 1.5 m up to 2 m is acceptable in access optical breadboard area.*

Verification method: R - review, I - inspection

REQ-002455/A

Thickness of **ECU** modular aluminium panels shall be in bounded interval 40 + 50 mm.

Verification method: R - review, T - test

REQ-002456/A

All **ECU** panels shall be equipped by Lifting eyes interfaces.

Verification method: R - review, I - inspection

REQ-002457/A

ECU panels close to main optical components shall be equipped with small doors with minimal width 600 mm and high 500 mm.

Verification method: R - review, I - inspection

REQ-002458/A

Openings of **ECU** shall be closed by aluminium blank flanges.

Verification method: R - review, I - inspection

REQ-002459/A

Stainless steel screws with Allen heads shall be used on **ECU** panels.

Verification method: I - inspection, R - review

REQ-002460/A

ECU small doors shall be equipped with hinges.

Verification method: R - review, I - inspection

REQ-002461/A

Maximal deformations of **ECU** panels under vacuum shall be lower than 3 mm in comparison to the vented status.

Verification method: A - analysis, R - review, T - test

REQ-002462/A

Deformations of **ECU** panels in selected coordinates under vacuum shall be lower than 2 mm in comparison to the vented status.

Verification method: A - analysis, T - test

REQ-002463/A

All **ECU** removable panels shall be equipped with guiding pins to allow proper panel seating.

Verification method: R - review, I - inspection

REQ-002464/A

Sealing of **ECU** panels shall be made of fluorelastomer polymer (FPM) material.

Verification method: R - review, I - inspection

REQ-002465/B

Hardness of **ECU** sealing o-rings shall be 60 or 70 HSC (Shore).

Verification method: I - inspection, R - review

REQ-002466/A

ECU shall be equipped with roughing inlet interface (DN100).

Verification method: R - review, I - inspection

REQ-002468/A

Surface treatment of inner **ECU** vacuum vessel surfaces compatible with 10^{-6} mbar shall be applied.

Verification method: R - review, I - inspection

4.3.2. Vacuum Vessel Chassis

REQ-002469/A

ECU vacuum vessel chassis shall allow **z** (vertical) positioning.

Verification method: I - inspection, R - review

REQ-002470/A

Range of **ECU** vacuum vessel chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: R - review, T - test

REQ-002471/A

ECU vacuum vessel chassis shall be made of stainless steel or extruded aluminium profiles.

Verification method: R - review, I - inspection

REQ-002472/A

ECU chassis shall allow for installation of TMP's.

Verification method: R - review, I - inspection

Hay

REQ-002473/A

ECU chassis shall allow for floor fixing.
Verification method: R - review, I - inspection

REQ-002474/A

ECU vacuum vessel chassis shall be equipped with removable transportation wheels.
Verification method: R - review, I - inspection

4.3.3. ECU Optical breadboard design

4.3.3.1. General

REQ-002475/B

Supplier shall provide static FEM analysis and vibration study according to customer inputs.
Technical note: The latest results of building vibration measurement will be provided by customer after contract signature.
Verification method: A - analysis, R - review

4.3.3.2. Optical breadboard

REQ-002476/A

ECU optical breadboard shall allow connection of multiple modular breadboards.
Verification method: I - inspection, R - review

REQ-002477/A

ECU optical breadboard shall have threaded hole pattern with 25 mm spacing.
Verification method: R - review, T - test

REQ-002478/A

Threaded holes of **ECU** breadboard shall be M6 size.
Verification method: R - review, T - test

REQ-002479/A

ECU optical breadboard shall be made of aluminium following types:

- Al2219
- Al3003
- Al5083
- Al6082

- AI7005

Verification method: R - review, I - inspection

REQ-002480/A

Final choice of **ECU** optical breadboard materials shall be made in preliminary design phase.

Verification method: R - review, I - inspection

REQ-002481/A

Minimum thickness of **ECU** breadboard plate shall be 50 mm.

Verification method: A - analysis, R - review, T - test

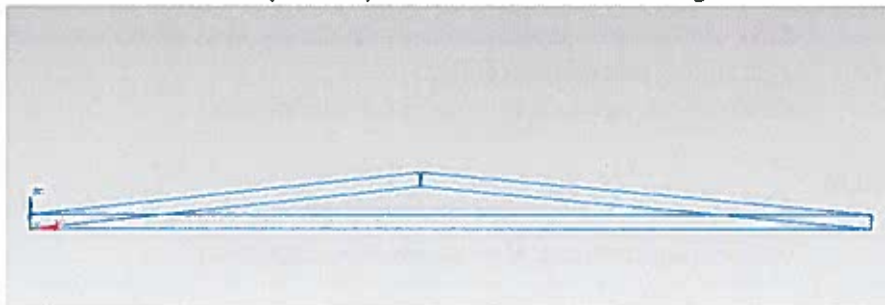
REQ-002482/A

Maximal thickness of whole **ECU** breadboard (plate with reinforcing ribs) shall be 130 mm.

Verification method: A - analysis, R - review, T - test

REQ-002483/B

Maximum misalignment after connection of breadboard segments shall be lower than 1 mrad. (in comparison with ideal non-segmented breadboard)



Technical note: This requirement is valid only in case of using segmented optical table.

Verification method: T - test

REQ-002484/A

Maximum z direction misalignment after connection of breadboard segments shall be lower than 1 mm.

Verification method: T - test, FD - functional demonstration

REQ-002485/A

Supplier shall provide procedure of misalignment measurement.

Verification method: R - review, T - test

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4.3.3.3. Optical Breadboard Chassis

REQ-002486/A

ECU chassis shall be designed as modular unit.

Verification method: R - review, I - inspection

REQ-002487/A

Only one chassis shall be applied for more connected **ECU** breadboards.

Verification method: R - review, I - inspection

REQ-002488/A

ECU optical breadboard chassis shall allow **z** (vertical) positioning.

Verification method: R - review, I - inspection

REQ-002489/A

Range of **ECU** optical breadboard chassis positioning in **z** (vertical) direction shall be 20 mm.

Verification method: I - inspection, T - test

REQ-002490/A

ECU optical breadboard chassis shall be made of stainless steel or aluminium extruded profiles.

Verification method: R - review, I - inspection

REQ-002491/A

ECU chassis shall allow installation of TMP's.

Verification method: R - review, I - inspection

REQ-002492/A

ECU chassis shall allow floor fixing.

Verification method: R - review, I - inspection

REQ-002493/A

The **ECU** optical breadboard chassis shall be equipped with removable transportation wheels.

Verification method: R - review, I - inspection

REQ-003196/A

The **ECU** optical breadboard chassis shall have interface for vibration dumping system.

Verification method: R - review

4.3.4. ECU Vacuum equipment

4.3.4.1. TMP (Turbomolecular pump)

REQ-002494/A

Only new **ECU** TMP with full warranty shall be used.
Verification method: I - inspection

REQ-002495/A

ECU shall be installed in accordance to the installation manual of TMP supplier.
Verification method: R - review, I - inspection

REQ-002496/A

ECU TMP shall be water cooled.
Verification method: R - review, I - inspection

REQ-002497/A

ECU TMP coolant shall be demineralized water.
Verification method: I - inspection

REQ-002498/A

ECU TMP shall be equipped with fittings for water cooling.
Verification method: I - inspection

REQ-002499/A

ECU TMP shall be equipped with protective screen.
Verification method: I - inspection

REQ-002500/A

ECU TMP shall be compatible with power supply 230V, 50 Hz.
Verification method: I - inspection

REQ-002501/A

ECU TMP inlet flange shall be ISO-F according to ISO 1609:1986.
Verification method: I - inspection

REQ-002502/A

ECU TMP outlet flange shall be ISO-KF according to ISO 2861:2013.
Verification method: I - inspection

REQ-002503/A

Maximum noise of **ECU** TMP shall be 60 dB.
Verification method: R - review

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REQ-002504/A

ECU TMP with minimum pumping speed 1500 l/sec shall be used.
Verification method: R - review, I - inspection

REQ-002505/A

ECU TMP set up shall be equipped with separation gate valve.
Verification method: I - inspection

REQ-002506/A

ECU TMP shall be equipped with electrically operated venting valve.
Verification method: I - inspection

REQ-002507/A

ECU TMP shall be equipped with power supply unit and control unit.
Verification method: I - inspection

REQ-002508/A

ECU TMP shall be equipped with 19" equipment rack mountable controllers.
Verification method: I - inspection

REQ-002509/A

The minimum required lifetime of TMP shall be 50 000 working hours.
Verification method: R - review

REQ-002510/A

The TMP shall be able to operate continuously at a maximum inlet pressure of 0.05 mbar.
Verification method: R - review

REQ-002511/A

The TMP shall be able to operate continuously at a maximum exhaust pressure of 0.5 mbar.
Verification method: R - review

REQ-002512/A

The TMP shall be protected against damage from sudden temperature rise.
Verification method: R - review, I - inspection

REQ-002513/A

TMP and their accessories (including liquid cooling fittings) must be in compliance with the following standards:

- ISO 1609:1986 - Vacuum technology - Flange dimension
- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings

- ISO 5302:2003 - Vacuum technology - Turbomolecular pumps - Measurement of performance characteristic

Verification method: R - review

4.3.4.2. Gauges

REQ-002514/A

Measurement range of combined gauge shall be $1000 \text{ mbar} \div 1 \times 10^{-6} \text{ mbar}$ with maximum accuracy $\pm 30\%$.

Verification method: R - review, I - inspection

REQ-002515/A

Mechanical interface of ECU Vacuum gauges shall be ISO KF according to ISO 2861:2013.

Verification method: R - review, I - inspection

REQ-002516/A

Vacuum connection of the gauges must be in compliance with the following standards:

- ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings.

Verification method: R - review, I - inspection

REQ-002517/A

Power supply of **ECU** vacuum gauges shall be 24VDC.

Verification method: R - review, I - inspection

REQ-002518/A

Interval of output **ECU** vacuum gauges signal shall be $0 \div 11 \text{ VDC}$.

Verification method: R - review, I - inspection

4.3.4.3. Gate valves

REQ-002519/A

ECU gate valve separating TMP shall be made of stainless steel.

Verification method: R - review, I - inspection

REQ-002520/A

Main **ECU** inlet/outlet gate (DN400) valves shall be made of aluminium.

Verification method: R - review, I - inspection

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REQ-002521/A

The **ECU** gate valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

REQ-002522/A

Minimal open/close cycles of **ECU** gate valves until first service shall be 200 000.

Verification method: R - review

REQ-002523/A

ECU gate valve shall be equipped with ISO F flange according to ISO 1609:1986.

Verification method: I - inspection

REQ-002524/A

ECU gate valves shall be equipped with blank flange from atmosphere side.

Verification method: I - inspection

4.3.4.4. Venting valves

REQ-002525/A

ECU shall be equipped with venting valve.

Verification method: I - inspection

REQ-002526/A

Automatic venting valve shall be used on **ECU**.

Verification method: I - inspection

REQ-002527/A

The **ECU** venting valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions with possibility of connection to control system.

Verification method: I - inspection

4.3.4.5. Bellows (connection of two chambers)

REQ-002528/A

Edge welded bellows shall be used on **ECU**.

Verification method: I - inspection, R - review

REQ-002529/A

ECU bellows shall be equipped with threaded rods.

Verification method: I - inspection, R - review

REQ-002530/A

Compensation range of ECU connecting bellows shall be:

- Axial ± 15 mm
- Lateral ± 5 mm
- Angular $\pm 2^\circ$

Verification method: R - review, I - inspection, T - test

4.3.4.6. Vacuum clamps

REQ-002531/A

All **ECU** vacuum clamps shall be permanent set free after assembling.

Verification method: I - inspection, FD - functional demonstration

REQ-002532/A

Clamp slots shall defect free.

Verification method: I - inspection

4.3.4.7. Local & remote vacuum control and safety system

REQ-002533/A

ECU local control system shall be designed and verified as an autonomous manually controlled system with interfaces to ELI – control system.

Verification method: R - review, I - inspection

REQ-002534/A

All ECU TMP's, vacuum gauges and valves shall be delivered with the **associated controllers**.

Verification method: I - inspection

REQ-002535/A

The controllers shall provide a reliable control interface to ELI central control system via LC optical fibers or RJ45 metallic connections.

Verification method: I - inspection

REQ-002536/A

The communication protocol shall be available and compatible with Linux OS.

Verification method: R - review

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REQ-002537/A

Documentation for the protocol shall be provided.

Verification method: I - inspection

REQ-002538/A

Safety interface based on digital I/O (24V DC signals) shall be provided for redundancy in addition to REQ-002542/A.

Verification method: R - review

REQ-002539/A

The controllers shall have local and remote access capabilities.

Verification method: I - inspection

REQ-002540/A

The controllers shall provide separate interlock capabilities via dry C-shape contacts.

Verification method: I - inspection

REQ-002541/A

All valves shall be supplied with open/closed limit switches wired to standard DIN connectors with mating plugs.

Verification method: I - inspection

REQ-002542/A

The supplied controls shall provide a safe pumping and venting sequence including interlocks in the local and remote mode of operation.

Verification method: I - inspection

4.3.5. Data acquisition

REQ-002543/A

Following data shall be readable from the ECU:

- Temperature on TMP
- Level of vacuum
- rpm of TMP rotor
- Hours of TMP operation
- Levitation of TMP rotor (if maglev is used)

Verification method: R - review, T - test

4.3.6. EMC/EMP

REQ-002544/A

The **ECU** design shall comply with EU standards of electro-magnetic compatibility.

Verification method: R - review

5. System Transportation and installation requirements

5.1. General requirements

REQ-002545/A

Supplier shall provide procedures for transportation and installation of **ECU**.

Verification method: R - review

REQ-002546/A

Supplier shall provide procedures for handling and manipulation of **ECU**.

Verification method: R - review

REQ-007158/A

The transportation and installation personnel shall follow the customer's facility regulations.

NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.

Verification method: R - review

REQ-007159/A

The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in clean environment of ISO class 7, if not agreed otherwise.

Verification method: R - review, I - inspection

REQ-007160/A

All transportation and installation tools and equipment entering the clean rooms shall be cleaned and reviewed by the customer's approved methods.

NOTE: Some tools can be provided by the customer upon agreement.

Verification method: I - inspection, T - test

REQ-007161/A

The transportation to the final destination and the installation of the technologies and the instruments shall be conducted by the vendor. The

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methods shall be discussed and reviewed by the customer's installation officer and shall be compliant with the customer's installation regulations.
NOTE: These regulations shall be defined by customer and provided to the supplier after contract signature and before detailed design contract phase.
Verification method: R - review

REQ-007162/A

The main parts of the mechanical structure shall be equipped with positioning/alignment marks for industrial 3D-measurements/survey. The specific type of the positioning/alignment marks, their number and location shall be agreed with the customer.
Verification method: R - review, I - inspection

5.2. Transportation

REQ-002547/A

The supplier shall provide supervision by transport **ECU** to defined position in ELI - Beamlines experimental room.
Verification method: R - review, I - inspection

REQ-002549/A

All Parts shall be identified according to technical documentation.
Verification method: R - review

5.3. Installation

REQ-002551/A

Connection of **ECU** to the ELI- Beamlines facility services shall be made under supervision of supplier.
Verification method: R - review, I - inspection

REQ-002552/A

Assembling of **ECU** on supplier side shall be made in cleanroom ISO7.
Verification method: I - inspection

REQ-002553/A

All specific equipment and tools necessary for installation of the **ECU** shall be subject of the supplier delivery.
Verification method: I - inspection, R - review

REQ-002554/A

Maximum dimensions of goods going through experimental entrance area shall be 3000x2000x2000 mm (length x with x high)
Verification method: R - review, T - test

6. Handling and Manipulation

REQ-002556/A

Supplier shall provide an approved methodological document describing safe handling and manipulation of the product.

Verification method: R - review

7. Maintenance

REQ-002557/A

Supplier shall provide an approved methodological document describing maintenance procedures of the product.

Verification method: R - review

8. Safety Requirements

REQ-002558/A

The **ECU** design of relevant parts shall comply with Czech and EU regulations regarding safety domain.

NOTE: Application of Czech regulations will be subject of preliminary design.

Verification method: R - review

REQ-002559/A

Supplier shall perform hazard identification and risk assessment of system prior to design.

Verification method: A - analysis, R - review

REQ-002560/A

All **ECU** manufactured parts shall be free of sharp edges.

Verification method: I - inspection

REQ-002561/A

All **ECU** manufactured parts shall be burr free.

Verification method: I - inspection

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9. Quality

9.1. Quality Management

9.1.1. Quality organization and responsibilities

9.1.1.1. Organization

REQ-002562/A

The supplier shall identify the personnel responsible for implementing and performing QA management plan and other Quality Controls disciplines.

Verification method: R - review

REQ-002563/A

The supplier shall assign a project Quality manager reporting to the project manager who has an unimpeded access to higher management.

Verification method: R - review

REQ-002564/A

The appointed project Quality manager, irrespective of other responsibilities, shall have organizational authority to establish and implement a quality assurance programme in accordance with the project quality assurance requirements.

Verification method: R - review

REQ-002565/A

The project Quality Manager shall act as the primary contact person within the project concerning Quality matters.

Verification method: R - review

REQ-007177/A

The supplier shall apply international recognized standards or best practice where applicable for quality assurance programme.

Verification method: R - review

9.1.1.2. Responsibility and authority

REQ-002566/A

The supplier shall define and document the responsibility, the authority and the interrelation of personnel who manage, perform and verify work affecting quality assurance.

Verification method: R - review

REQ-002567/A

The supplier shall define and document the responsibilities and the interfaces of the Quality functions, either external or internal, involved in a project.

Verification method: R - review

REQ-002568/A

When the supplier's Quality organization delegates quality assurance tasks to another organization it shall be done in a documented and controlled way monitored by the Quality organization.

Verification method: R - review

9.1.2. Quality plan and its implementation

REQ-002569/A

The supplier shall prepare, maintain and implement a plan of the QA (Quality Assurance) activities in accordance with the customer QA requirements.

Verification method: R - review

REQ-002572/A

The supplier management shall ensure that the inputs used by the Quality functions are consistent and complete, and available in line with the project schedule.

Verification method: R - review

REQ-002573/A

The supplier QA management shall ensure that the QA functions perform the tasks described in the QA Plan in line with the project schedule.

Verification method: R - review

REQ-002574/A

The supplier QA management shall ensure that the outputs produced by the QA functions are consistent and complete, and delivered in line with the project schedule.

Verification method: R - review

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REQ-002575/A

The supplier QA management shall ensure the application of processes defined in applicable project plans and documents.

Verification method: R - review

9.1.3. Documentation and data control

REQ-002576/B

The supplier shall provide following type of documents:

- 3D model (format: *.step; *.stp)
- 2D drawings (format: *.dwg)
- Printable format for text documents

Verification method: I - inspection

10. Environmental conditions

REQ-002577/A

Final cleanliness shall be compatible with ISO 7.

Verification method: I - inspection

11. Verification process

REQ-002578/A

The verification process shall demonstrate that the deliverable product meets the specified customer requirements and is capable of sustaining its operational role through:

1. Verification planning;
2. Verification execution and reporting;
3. Verification control and close-out.

Verification method: R - review

REQ-002579/A

The supplier shall define the verification approach by conducting the following steps:

1. Identify and agree with the customer the set of requirements to be subject of the verification process.
2. Select the methods and levels of verification, associated model philosophy and verification tools.
3. Identify the stages and events in which the verification is implemented.

Verification method: R - review

REQ-002580/A

The verification approach shall be defined by the supplier in the Verification Plan (VP) for approval by the customer prior to implementation.

Verification method: R - review

11.1. Verification methods

11.1.1. General

REQ-002582/A

Verification shall be accomplished by one or more of the following verification methods:

1. test (including functional demonstration);
2. analysis (including similarity);
3. review-of-design;
4. inspection.

Verification method: R - review

REQ-002583/A

All safety critical functions shall be verified by test.

Verification method: R - review

REQ-002584/A

Verification of software shall include testing in the target hardware environment.

Verification method: R - review

11.1.2. Test

REQ-002585/A

Verification by test shall consist of measuring product performance and functions under representative simulated environments.

Verification method: R - review

REQ-002586/A

The analysis of data derived from testing shall be an integral part of the test and the results included in the test report.

Verification method: R - review

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REQ-002587/A

When the test objectives include the demonstration of qualitative operational performance, the execution shall be observed and results recorded (functional demonstration).

Note: Functional demonstration is a subset of tests.

Verification method: R - review

REQ-002588/A

A test programme shall be prepared for each product in conformance with Verification Plan.

Verification method: R - review

REQ-002589/A

The test programme shall be coordinated with the integration flow.

Verification method: R - review

REQ-002590/A

Tests performed as part of the integration flow to check quality and status of the in-progress configuration (including interfaces), having a formal verification purpose, shall be included in the test programme.

Verification method: R - review

REQ-002591/A

The test programme shall be defined in the specific chapter of the Verification Plan.

Verification method: R - review

REQ-002592/A

Test Programme shall be approved by the Customer.

Verification method: R - review

11.1.3. Analysis

REQ-002594/A

Verification by analysis shall consist of performing theoretical or empirical evaluation using techniques agreed with the Customer.

NOTE: Techniques comprise systematic, statistical and qualitative design analysis, modelling and computational simulation.

Verification method: R - review

REQ-002597/A

An analysis programme shall be defined in the Verification Plan (VP).

Verification method: R - review

11.1.4. Review-of-design (ROD)

REQ-002598/A

Verification by Review-of-design (ROD) shall consist of using approved records or evidence that unambiguously show that the requirement is met.

NOTE: Examples of such approved records are design documents and reports, technical descriptions, and engineering drawings.

Verification method: R - review

REQ-002599/A

A review-of-design programme shall be defined in the Verification Plan (VP).

Verification method: R - review

REQ-002600/A

A review-of-design programme shall only be applicable in stages (phases) before starting the manufacturing.

Verification method: R - review

11.1.5. Inspection

REQ-002601/A

Verification by inspection shall consist of visual determination of physical characteristics.

NOTE: Physical characteristics include constructional features, hardware conformance to document drawing or workmanship requirements, physical conditions, software source code conformance with coding standards.

Verification method: R - review

REQ-002602/A

An inspection programme shall be defined in the Verification Plan (VP).

Verification method: R - review

12. Qualification (if needed)

N/A

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13. Acceptance

REQ-002603/A

In the acceptance stage the verification shall demonstrate that the product is free of fabrication errors and is ready for the intended operational use.
Verification method: R - review

REQ-002604/A

Acceptance shall be carried out on the final hardware and software
Verification method: R - review

14. Verification process phasing

REQ-002607/A

The verification process shall be phased with the project life cycle defined as a contract execution phases (preliminary design, detailed design, manufacturing and deployment of deliverable product(s) see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-002608/A

Verification planning to assess feasibility and support programmatics shall start in the early phases (see Annex I – ECU Contract Phases).
NOTE: programmatics means support equipment and verification timescale estimation.
Verification method: R - review

REQ-002609/A

The preliminary verification planning shall cover all products and requirements by the end of preliminary design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-002610/A

Verification planning shall be completed by the end of detailed design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-002611/A

Verification execution and reporting shall be incrementally carried out through the project life cycle starting from detailed design phase (see Annex I – ECU Contract Phases).
Verification method: R - review

REQ-002612/A

Verification control shall start with the initial issue of the verification control document (VCD) during detailed design phase (see Annex I – ECU Contract Phases).

Verification method: R - review

REQ-002613/A

Verification close out status shall be assessed and approved by the customer for each product at the end of each stage (see Annex I – ECU Contract Phases).

Verification method: R - review

15. Verification plan (VP)

REQ-002614/A

The supplier shall provide a Verification plan (VP) for the reviews as agreed with the customer

NOTE Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-002615/A

The contents of the Verification plan (VP) shall be approved by the Customer

Verification method: R - review

16. Verification Control Document (VCD)

REQ-002616/A

The supplier shall provide a Verification Control Document (VCD) for the reviews as agreed with the customer

NOTE: Guidelines for VP preparation shall be provided by the Customer

Verification method: R - review

REQ-002617/A

The contents of the initial issue of the Verification Control Document (VCD) shall be in conformance with ELI verification matrix.

Verification method: R - review

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17. Verification execution and reporting

17.1. General

REQ-002619/A

The supplier shall assign clear responsibility for the implementation of the verification plan.

Verification method: R - review

REQ-002620/A

The test preparation and execution (including Test Readiness Review (TRR) and Post Test Review (PTR)) shall be reviewed by the Customer.

Verification method: R - review

REQ-002621/A

The verification results shall be recorded by the supplier in reports for review by the Verification Control Board (VCB) through the VCD.

Verification method: R - review

17.2. Verification execution and reporting documentation

17.2.1. Test report (TRPT)

REQ-002622/A

The test report (TRPT) shall be submitted to the Verification Control Board (VCB) after the test completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002623/A

The content of the Test report (TRPT) shall be agreed with the Customer.

Verification method: R - review

REQ-002624/A

The supplier shall provide the Test reports (TRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002625/A

A Test report (TRPT) shall be provided for each test verification task as identified in the VP.

Verification method: R - review

17.2.2. Analysis report (ARPT)

REQ-002626/A

The Analysis report (ARPT) shall be submitted to the Verification Control Board (VCB) after analysis completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002627/A

The supplier shall provide an Analysis report (ARPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002628/A

An Analysis report (ARPT) shall be provided for each Analysis verification task identified in the VP.

Verification method: R - review

17.2.3. Review-of-design report (RRPT)

REQ-002629/A

The Review-of-design report (RRPT) shall be submitted to the Verification Control Board (VCB) after the Review-of-Design completion, within the time frame agreed with the customer.

Verification method: R - review

REQ-002630/A

The supplier shall provide a Review-of-design report (RRPT) for the reviews as agreed with the customer

Verification method: R - review

REQ-002631/A

A Review-of-design report (RRPT) shall be provided for each Review-of-design verification task identified in the VP.

Verification method: R - review

17.2.4. Inspection report (IRPT)

REQ-002632/A

The Inspection report (IRPT) shall be submitted to the Verification Control Board (VCB) after the inspection completion, within the time frame agreed with the customer.

Verification method: R - review

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REQ-002633/A

The supplier shall provide an Inspection report (IRPT) for the reviews as agreed with the customer
Verification method: R - review

REQ-002634/A

An Inspection report (IRPT) shall be provided for each Inspection verification task identified in the VP.
Verification method: R - review

17.2.5. Verification report (VRPT)

REQ-002635/A

The supplier shall prepare a Verification report (VRPT) when more than one of the defined verification methods are utilized to verify a requirement or a specific set of requirements.
Verification method: R - review

REQ-002636/A

The content of Verification report (VRPT) shall be agreed by the Customer
Verification method: R - review

REQ-002637/A

The Verification report (VRPT) shall be submitted to the Verification Control Board (VCB) after the completion of the last contributing verification activities, within the time frame agreed with the customer.
Verification method: R - review

REQ-002638/A

The supplier shall provide a Verification report (VRPT) for the reviews as agreed with the customer
Verification method: R - review

17.2.6. Other verification execution and reporting Document

REQ-002639/A

The supplier shall provide the Test specifications (TSPE) for the reviews as agreed with the customer
Verification method: R - review

REQ-002640/A

The supplier shall provide the Test procedures (TPRO) for the reviews as agreed with the customer

Verification method: R - review

REQ-002641/A

The rules for the analysis, inspection and review of design shall be defined in writing before their execution.

NOTE: For example, analysis, inspection or review of design procedures.

Verification method: R - review

18. Verification control and close-out

18.1. General

REQ-002642/A

The implementation of the verification process shall be monitored by the Verification Control Board (VCB).

Verification method: R - review

REQ-002643/A

The verification process control shall be supported by a computer based verification database.

Verification method: R - review

REQ-002644/A

The verification database shall be delivered to the customer in an electronic form to be agreed with the customer.

Verification method: R - review

REQ-002645/A

The supplier shall provide to the customer verification evidence for the customer's applicable requirements agreed to be verified, independently from the level where verification has been accomplished.

Verification method: R - review

18.2. Verification control board (VCB)

REQ-002646/A

A Verification Control Board (VCB), with participation of customer representatives, shall be established to incrementally assess the achievements and status of the verification process.

Verification method: R - review

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REQ-002647/A

The verification process shall be considered completed when the Verification Control Board (VCB) confirms that:

1. documented evidence is recorded in the VCD,
2. identified requirements have been verified
3. associated product verification objectives are reached

Verification method: R - review

REQ-002648/A

The conclusions of the VCB shall be submitted for approval to the customer's contractual authority.

Verification method: R - review

REQ-002649/A

The Verification Control Board (VCB) shall assess the verification status with a periodicity agreed with the customer, along the project life cycle.

Verification method: R - review

REQ-002650/A

The Verification Control Board (VCB) shall endorse the final issue of the Verification Control Document (VCD).

Verification method: R - review

18.3. Re-verification

REQ-002651/A

The extent of the re-verification to be performed shall be determined by Supplier and agreed with the Customer, in the following cases:

1. failure and repair as decided by Nonconformance Review Board (NRB)
2. unplanned disassembly or demounting
3. refurbishment, maintenance or design changes
4. changes of requirements after initial verification
5. long duration storage

Verification method: R - review

REQ-002652/A

The Verification Control Document (VCD) shall be updated by the supplier to record as open, those requirements subject to re-verification until this is performed and closeout agreed by the customer.

Verification method: R - review

18.4. Verification control and close-out documentation

18.4.1. Verification Control Document (VCD)

REQ-002653/A

The content of the completed Verification Control Document (VCD) shall be agreed by the Customer

Verification method: R - review

REQ-002654/A

The supplier shall update the Verification database within one week of the approval of a report.

Verification method: R - review

REQ-002655/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current status of the verification database, shall be made available to the Verification Control Board (VCB) upon request.

Verification method: R - review

REQ-002656/A

The intermediate issues of the Verification Control Document (VCD), reflecting the current verification and compliance status, shall be delivered at each formal review as agreed with the customer

Verification method: R - review

REQ-002657/A

The final issue of the Verification Control Document (VCD) shall be submitted to the Verification Control Board (VCB) after the approval of the last report, within the time frame agreed with the customer.

Verification method: R - review

18.4.2. Other close-out documents

REQ-002658/A

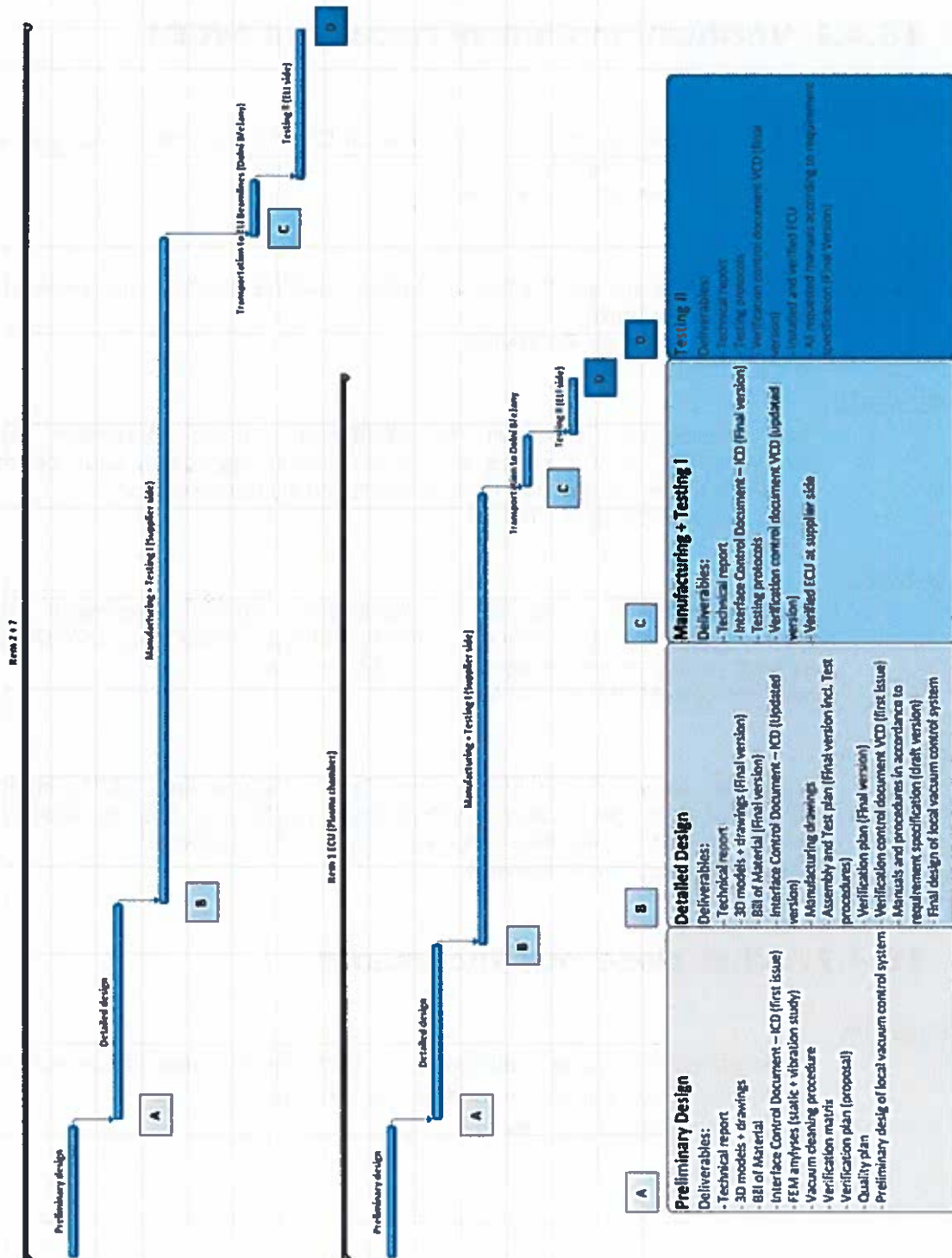
The supplier shall make available to the customer for consultation the VCD's supporting documentation in addition to the reports.

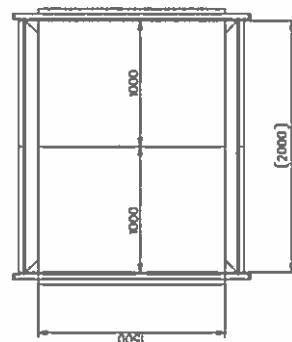
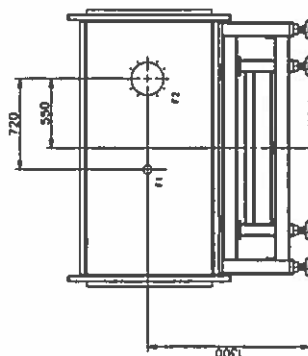
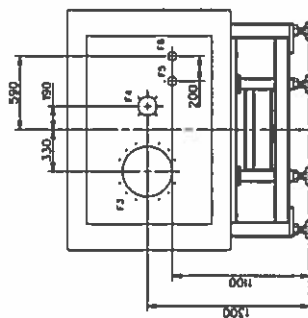
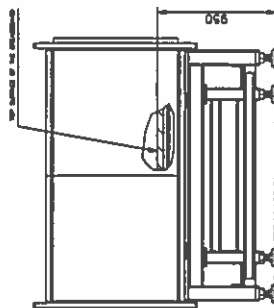
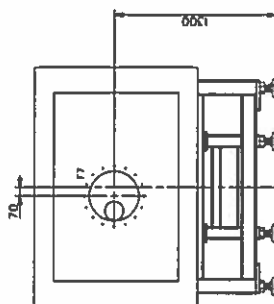
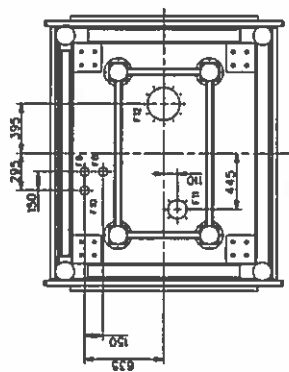
Verification method: R - review

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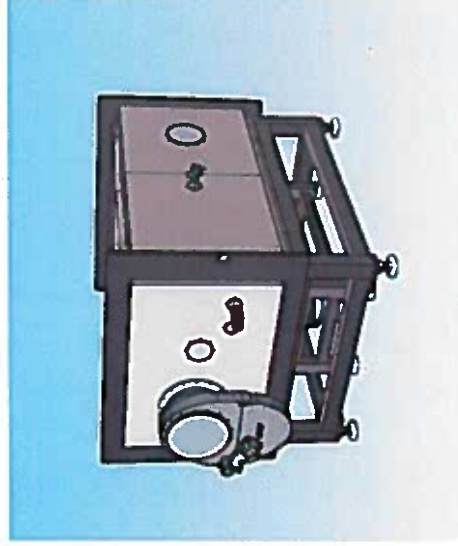
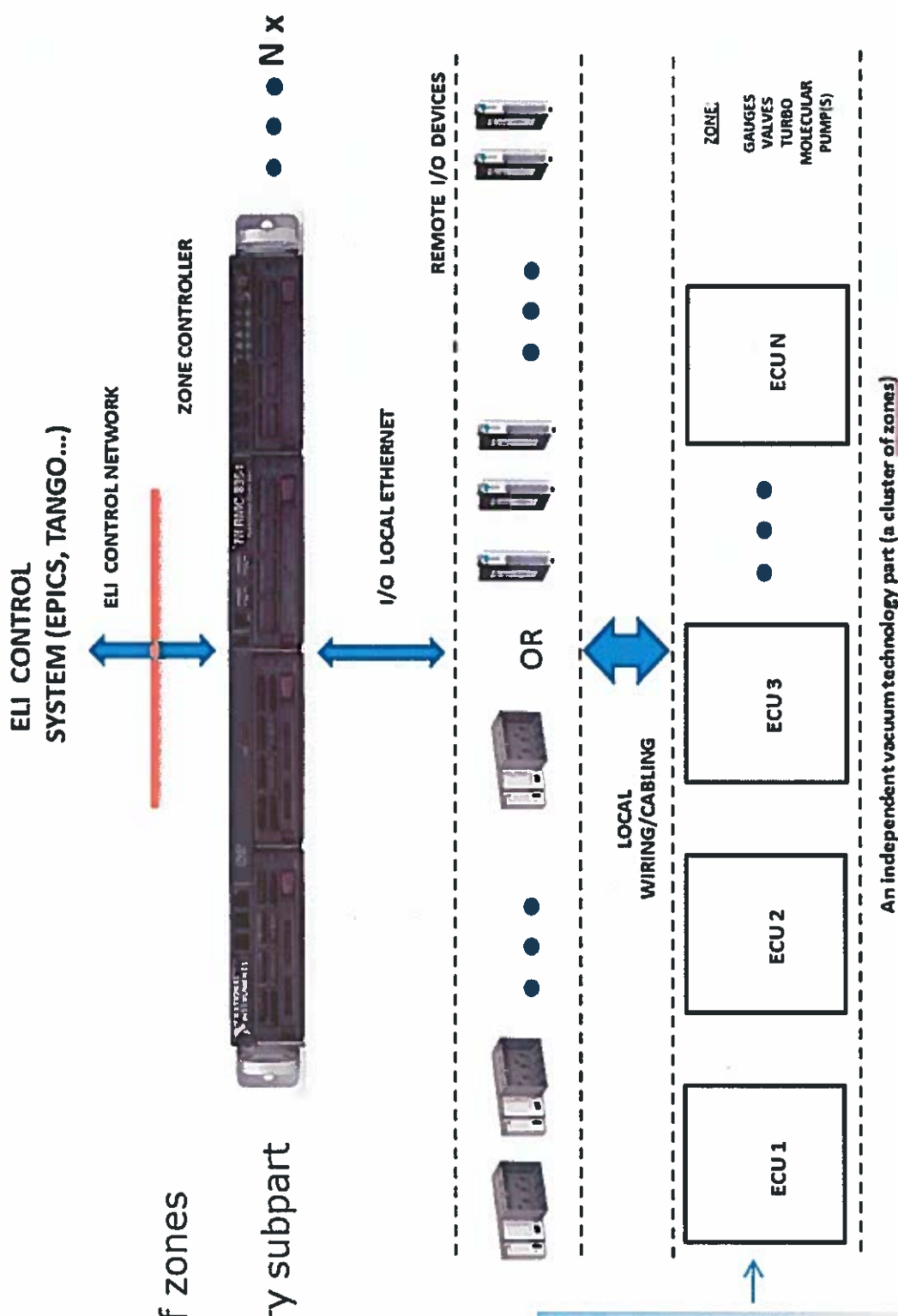
19. Annex I

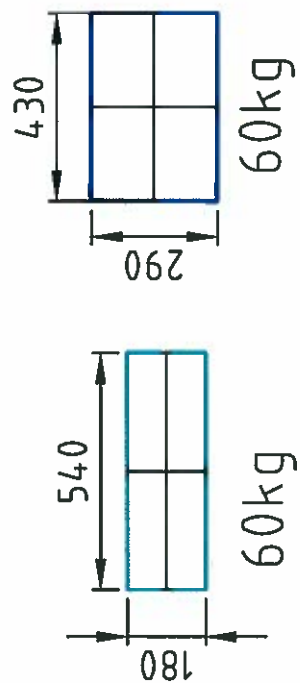
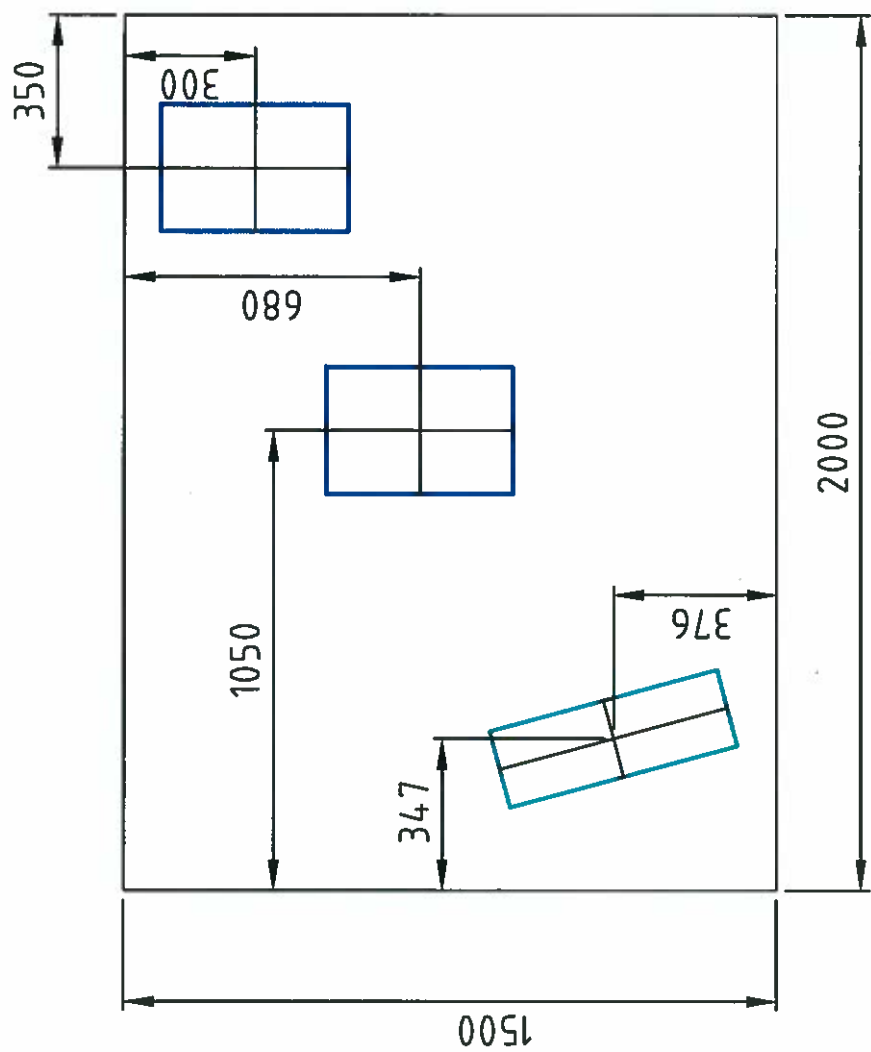
ECU - Contract Phases



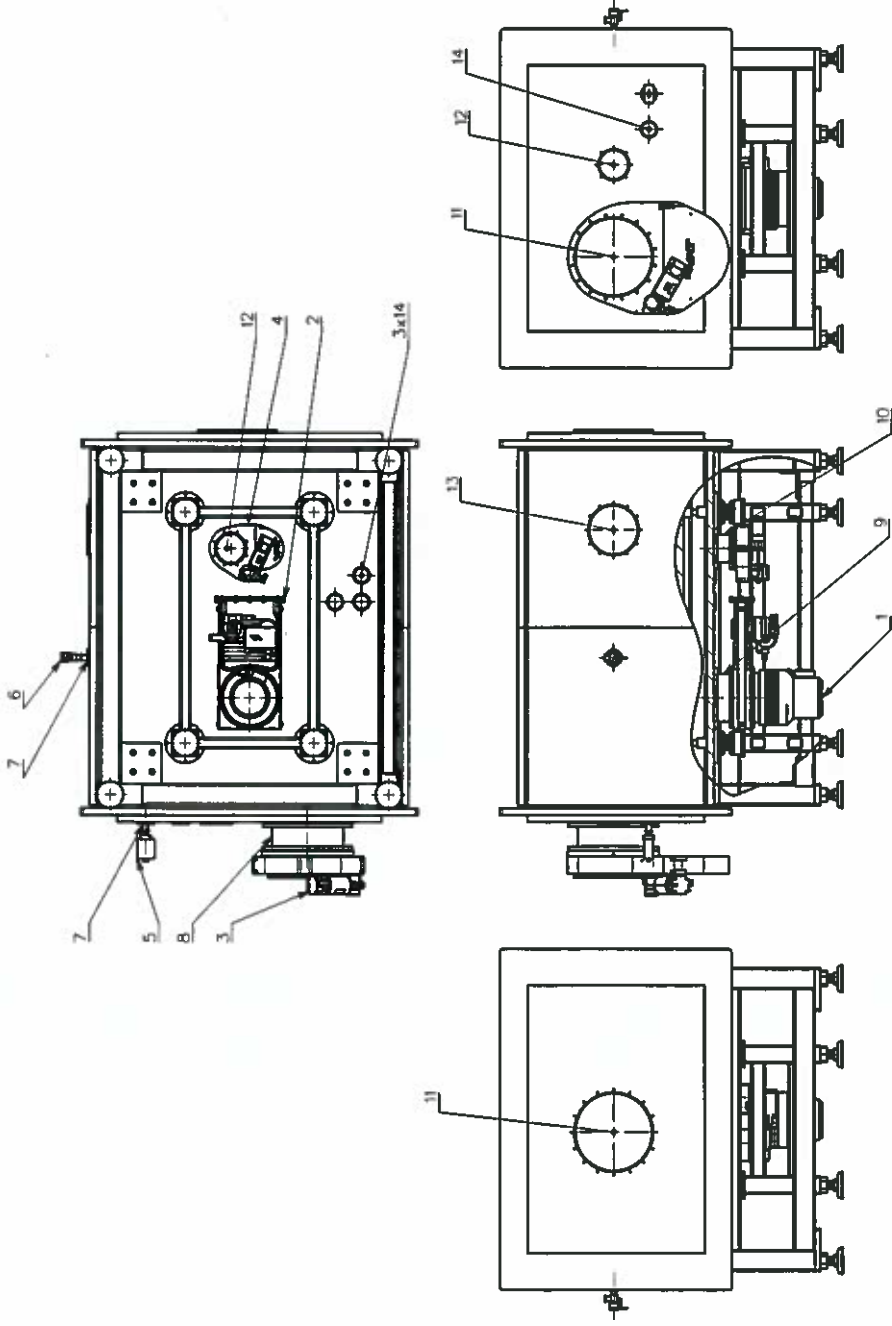
[illegible]

- N zone controllers
- Each zone controller responsible for a set of zones
- A zone is an elementary subpart of the vacuum system





Py



UNSIGNED FLANGES = ISO-K
ALL FLANGES ACCORDING TO STANDARDS ISO 8009 (ISO-K, ISO-F) OR ISO 28612013 (ISO-KF)

Number	Quantity	Description
1	1	TURBOMOLECULAR PUMP DN250
2	1	GATE VALVE DN250
3	1	VALVE DN400
4	1	VALVE DN160
5	1	VACUUM GAUGE DN25 ISO-KF
6	1	VENT VALVE DN25 ISO-KF
7	2	REDUCER DN63 ISO-K/DN25 ISO-KF
8	1	PIPE DN400 ISO-F
9	1	PIPE DN250 ISO-F
10	1	PIPE DN160 ISO-F
11	2	BLIND FLANGE DN400
12	2	BLIND FLANGE DN160
13	1	BLIND FLANGE DN250
14	4	BLIND FLANGE DN63

The information contained in this drawing is the sole property of FÚV and its reproduction is prohibited.		Scale: 1:20	
Drawn by: mrazek.jd	Checked by:	Comments:	Drawing title: LUX CHAMBER ASSEMBLY
Date: 6.11.2014	Material:	All dimensions in mm.	Drawing no.: 00104110/00
Row mod.:	Weight: 02.209	Application:	Sheet 1 of 1

Annex 3 – Schedule of Deliverables

Deliverable, its part	Step	Result	Deadline
D1 i)	Provide preliminary design of ELIMAIA I unit	Technical report	1.5 month from contract signature
D1 ii)	Provide detailed plan of ELIMAIA I unit	Technical report	3.5 months from contract signature
D1 iii)	Manufacture, assemble and test Device by the Contractor	Protocol on testing of Devices at Contractor's place/Report on testing at Contractor's place	8 months from contract signature
D1 iv)	Deliver, assemble, install and test Device by the Client	Protocol on testing of Device at the research center ELI-Beamlines	9.5 months from contract signature
D2 i)	Provide preliminary design of ELIMAIA II unit	Technical report	1.5 month from contract signature
D2 ii)	Provide detailed plan of ELIMAIA II unit	Technical report	4 months from contract signature
D2 iii)	Manufacture, assemble and test Device by the Contractor	Protocol on testing of Devices at Contractor's place/Report on testing at Contractor's place	12 months from contract signature
D2 iv)	Deliver, assemble, install and test Device by the Client	Protocol on testing of Device at the research center ELI-Beamlines	13.5 months from contract signature
D3 i)	Provide preliminary design of HELL I unit	Technical report	1.5 month from contract signature
D3 ii)	Provide detailed plan of HELL I unit	Technical report	4 months from contract signature
D3 iii)	Manufacture, assemble and test Device by the Contractor	Protocol on testing of Devices at Contractor's place/Report on testing at Contractor's place	12 months from contract signature
D3 iv)	Deliver, assemble, install and test Device by the Client	Protocol on testing of Device at the research center ELI-Beamlines	13.5 months from contract signature
D4 i)	Provide preliminary design of HELL II unit	Technical report	1.5 month from contract signature
D4 ii)	Provide detailed plan of HELL II unit	Technical report	4 months from contract signature
D4 iii)	Manufacture, assemble and test Device by the Contractor	Protocol on testing of Devices at Contractor's place/Report on testing at Contractor's place	12 months from contract signature
D4 iv)	Deliver, assemble, install and test Device by the Client	Protocol on testing of Device at the research center ELI-Beamlines	13.5 months from contract signature
D5 i)	Provide preliminary design of HELL III connection	Technical report	1.5 month from contract signature
D5 ii)	Provide detailed plan of HELL III connection	Technical report	4 months from contract signature
D5 iii)	Manufacture, assemble and test Device by the Contractor	Protocol on testing of Devices at Contractor's place/Report on testing at Contractor's place	12 months from contract signature
D5 iv)	Deliver, assemble, install and test Device by the Client	Protocol on testing of Device at the research center ELI-Beamlines	13.5 months from contract signature

D6 i)	Provide preliminary design of LUX unit	Technical report	1.5 month from contract signature
D6 ii)	Provide detailed plan of LUX unit	Technical report	4 months from contract signature
D6 iii)	Manufacture, assemble and test Device by the Contractor	Protocol on testing of Devices at Contractor's place/Report on testing at Contractor's place	12 months from contract signature
D6 iv)	Deliver, assemble, install and test Device by the Client	Protocol on testing of Device at the research center ELI-Beamlines	13.5 months from contract signature
D7 i)	Provide preliminary design of BETATRON unit	Technical report	1.5 month from contract signature
D7 ii)	Provide detailed plan of BETATRON unit	Technical report	4 months from contract signature
D7 iii)	Manufacture, assemble and test Device by the Contractor	Protocol on testing of Devices at Contractor's place/Report on testing at Contractor's place	12 months from contract signature
D7 iv)	Deliver, assemble, install and test Device by the Client	Protocol on testing of Device at the research center ELI-Beamlines	13.5 months from contract signature
D8	Provision of Out of Warranty service	Protocol on provision of Out of Warranty services	

Annex 4. Contractor's Bid

Technical Description

Pursuant to Paragraph II.8.d of the "Binding Draft Contract"

Bidder's business name incl. legal form	FANTINI SUD S.p.A. (joint-stock company)
Seat / place of business	Strada Provinciale 12 km 3,300 / N. 52 – 03012 – Anagni (FR) - Italy
ID	Commercial Register of Frosinone (Italy) (C.C.I.A.A.) No. 01691740607
Authorized representative	Ing. Luigi Fantini (CEO)

Subject: Supply of a set of Vacuum Interaction Chambers (7 deliverables) for experimental programmes and of the related local vacuum control systems (reissue II)

Contract form: Above-the-threshold public contract for supplies under Act No. 137/2006 Coll., on Public Contracts.

Contracting Authority: Institute of Physics of the Czech Academy of Sciences, public research institution.

Applicant: FANTINI SUD S.p.A.

Legal form: Joint-stock company

Registered office: Strada Provinciale 12 km 3,300 / N. 52 – 03012 – Anagni (FR) - Italy

Company Id. No.: 01691740607 - Commercial Register of Frosinone (Italy) (C.C.I.A.A.)

Tax Id. No.: 01691740607

Company Web site: www.fantinispa.it

INDEX

1. Scope of supply
2. Applicable requirements for the bid
3. Statement of compliancy to the requirements
4. Turbo-molecular pumps (TMP)
5. Gate valves lifetime
6. Technical data about commercial components

LIST OF ANNEXES

VACUUM COMPONENTS

- V1 Turbo-molecular pump TMP ATH 2300 M
- V2 Gate valve 590-60106 for vacuum (body in AISI 304 stainless steel)
- V3 Large pendulum valve for vacuum - series 16.8 (body in aluminum alloy)
- V4 Pendulum valve for vacuum - series 16.2 (body in aluminum alloy)
- V5 Vacuum gauge

LOCAL VACUUM CONTROL SYSTEMS

- W1 National Instruments cRIO-9035 controller
- W2 National Instruments FPT 1015 15" touch screen
- W3 National Instruments 9403 32 digital I/O module
- W4 National Instruments 9215 10 analog inputs module
- W5 National Instruments 9871 RS232/485 module
- W6 National Instruments RMC 8354 zone controller

1. SCOPE OF SUPPLY

The scope of supply of the bid is referring to eight deliverable items.

Seven of these items will be physical objects: six items will be parallelepiped vacuum chambers (see items D1 - D2 - D3 - D4 - D6 - D7 here below) and one item will be made by two connecting ducts (item D5 here below).

As a general statement, each of the a.m. six chambers can be split in the following main sub-assemblies:

- tailored structures and panels,
- mechanical components,
- mechanisms,
- commercial vacuum components,
- electrical board with electrical and electronic devices inside (for powering and control of the vacuum components) and with control software stored and running in them;
- on board service tubing and cabling;
- other ancillaries.

The eighth item will be a technical service activity performed by the bidder's (in the role of main contractor) technicians at the ELI premises in Prague (with a maximum of 3 days of service) and applied at the a.m. supplies after their installation.

The seven physical deliverable items will be the following:

ITEM	NICK NAME	FULL NAME
D1	ELIMAIA I	ELIMAIA plasma mirror chamber
D2	ELIMAIA II	ELIMAIA interaction chamber
D3	HELL I	HELL interaction chamber
D4	HELL II	HELL focusing chamber
D5	HELL III	HELL connecting ducts (2 units)
D6	LUX	LUX focusing chamber
D7	BETATRON	BETATRON interaction chamber

Items D1 and D2 will be installed together in the same experimental hall.

Items D3 and D4 will be installed together in another experimental hall and connected each to the other by means of two horizontal ducts (item D5).

Items D6 and D7 will be installed in other two separated halls.

2. APPLICABLE REQUIREMENTS FOR THE BID

Our bid has been set-up according to the following documentation issued by the Contracting Authority (In the following CfW stands for "Contract for Work"):

- a. Tender Documentation (Reissue II) with annexes
- b. Annex 1 to CfW
- c. Annex 3 to CfW
- d. Annex 5 – Technical Specifications
- e. Conceptual design package (Includes drawings and schemes)
- f. Annex 6 – CfW (Binding Draft Contract)
- g. Annex 7 to CfW
- h. Additional Information 1 (reissue II) from Otidea (12/06/2015)
- i. Additional Information 2 (reissue II) from Otidea (22/06/2015)
- j. Additional Information 3 (reissue II) from Otidea (25/06/2015)
- k. Additional Information 4 (reissue II) from Otidea (02/07/2015)

3. STATEMENT OF COMPLIANCY TO THE REQUIREMENTS

From a general point of view, each of the a.m. six chambers (Items D1-D2-D3-D4-D6-D7 here above) will be made of the following sub-assemblies:

- internal caged chassis;
- external chamber vessel (vacuum vessel, made of separate flat panels);
- chamber supporting basement structure;
- internal breadboard plate;
- breadboard supporting basement structure (independent from the chamber basement);
- commercial vacuum components: motor-driven turbo-molecular (TMP) pumps (blowers), electro-pneumatic valves (gate and pendulum types) of various sizes, solenoid valves, pressure transducers (gauges), flanges, bellows, reducers, view-ports, gaskets, clamps, centering rings, etc.;
- on-board piping for compressed air and demi water;
- local vacuum control system (programmable electronics, power supply drivers, interface devices, HMI's) installed inside a dedicated forced-air-cooled electrical board; one control system board can be shared by two chambers in the case that they are installed in the same hall.

It is here stated that we formally accept the content of documents enlisted in previous paragraph 2.

It is here also stated that, from the technical point of view, each of the a.m. supplied item shall be compliant with the applicable "Requirements Specification Document" (RDS). The executive (detailed) design of each item shall be developed using the drawings which are enclosed in the ELI's tender enquiry as guidelines (configuration and sizes).

Please find here below some clarification and detailing statements, which are part of our bid.

- a. All structural frames (i.e.: internal chassis, chamber supporting structure and breadboard supporting frame) will be manufactured in AISI 304L (1.4307) stainless steel.
- b. The list of the commercial vacuum components, which will be installed and/or supplied together with each deliverable item, is shown in the table here below. Data-sheets or equivalent technical documents of the most important vacuum components of the list are annexed to this document.
- c. Data about the turbo-molecular pumps (TMP) which will be supplied to equip the deliverable chambers are discussed in the next paragraph 4.
- d. The list of parts (hardware and software) belonging to the local vacuum control systems of the deliverable items is shown in the table here below. Data-sheets or equivalent technical documents of the most important vacuum components of the list are annexed to this document.
- e. During the whole construction cycle of each item a special attention will be paid to avoid contamination of structures, parts and components by dirt, uncontrolled oil, lubricants and chemicals and particles of other kind of metals and their oxides (mainly of carbon steel). Therefore, the storage, welding, machining, assembly and testing areas devoted to the a.m. items in the factory shall be maintained clean and separated from the other production activities in the factory.
- f. Before the vacuum tightness test the subjected component, sub-assembly or assembly will be accurately cleaned from any solid or liquid contamination, water and moisture.
- g. Before the final shipment of each item to ELI, it will be cleaned again up to the ISO class 7 level and immediately packed according to the requirement no. REQ-007154/A of the applicable RDS.
- h. Installation of deliverable ECU's (Experimental Chamber Units) in the ELI laboratory halls shall be performed according to the answer to Question no. 10 in the "Additional Information 1" issued by Otidea on 12/06/2015.

4. TURBO-MOLECULAR PUMPS (TMP)

The vacuum chambers dubbed as D1 – D2 – D3 – D4 – D6 – D7 altogether will be equipped with 12 turbo-molecular pumps of the same kind.

The selected TMP is the following:

manufacturer	Pfeiffer Vacuum
model	ATH 2300 M
pumping speed	2.150 liters/sec (N ₂)
rotor support	5-axis magnetically levitated ("maglev")
cooling	demineralized water cooling

More data are shown in the Annex V1.

We would like to underline that pumping speed of the selected TMP (2.150 liters/sec of N₂) is quite higher than the RSD requirement no. REQ-001820/A (1.500 liters/sec minimum).

5. GATE VALVES LIFETIME

According to RSD requirement no. REQ-001838/A the gate valves will be granted for minimum 200.000 open/close cycles until first service.

6. TECHNICAL DATA ABOUT COMMERCIAL COMPONENTS

Data-sheets of the most important components are annexed to this document as follows:

VACUUM COMPONENTS	annexes from V1 to V5
LOCAL VACUUM CONTROL COMPONENTS	annexes from W1 to W6

COMPONENT DESCRIPTION	ELJMAIA I ELJMAIA PLASMA MIRROR CH.	ELJMAIA II ELJMAIA INTERACTION CHAMBER	HELL I HELL INTERACTION CHAMBER	HELL II HELL FOCUSING CHAMBER	HELL III HELL CONNECTING DUCTS (2)	LUX FOCUSING CHAMBER	BETATRON BETATRON INTERACTION CHAMBER	transport blind flanges	TOTAL
maglev TRP ATH 2300 M DN250 ISO-F 2150 V/s (N2)	2	2	4	2		1	1		12
gate valve DN250 (as body) 200,000 cycles	2	2	4	2		1	1		12
pendulum valve DN400 (Al body) VAT 16852-PA44	1	1	1	1		1			5
pendulum valve DN250 (Al body) VAT 16248-PA41			2						1
pendulum valve DN160 (Al body) VAT 16244-PA41	1	1	1	1		1	1		6
blind flange DN630							1		1
blind flange DN400 ISO-K	2	2	4	4		2	4		18
blind flange DN250 ISO-F	2	2	4	2		1	1	12	12
blind flange DN250 ISO-K	2	2	5	2		1	2		14
blind flange DN200 ISO-K							1		1
blind flange DN160 ISO-K	3	3	5	2		2	2		17
blind flange DN63 ISO-K	7	7	10	4		4	5		37
blind flange DN25 ISO-KF	2	2	2	2		2	2	12	12
pipe DN400 ISO-F L=150 mm	1	1	1	1		1			5
pipe DN400 ISO-F angle=70°							1		1
pipe DN250 ISO-F L=102 mm	2	2	5	2		1	1		13
pipe DN160 ISO-F L=102 mm	1	1	1	1		1	1		6
reducer DN400 ISO-K/DN250					1				1
reducer DN63 ISO-K/DN25 ISO-KF	2	2	2	2		2	2		12
solenoid valve DN25 ISO-KF	1	1	1	1		1	1		6
vacuum gauge PKR 251 DN25 ISO-KF	1	1	1	1		1	1		6
view port DN320 ISO-F pletiglas							1		1
view port DN250 ISO-F pletiglas	1			1					2
flex. bellow DN400 L=330 mm					1				1
flex. bellow DN250 L=200 mm					1				1
flex. bellow DN63 ISO-F AL=1/-20 mm edge welded	8	8	12	4		4	4		40
set of gaskets, centering rings, clamps	1	1	1	1	1	1	1		7

VACUUM COMPONENTS SUMMARY

LOCAL VACUUM CONTROL SYSTEMS

SUMMARY TABLE

#	DELIVERABLE	Q.TY	LOCAL VACUUM CONTROL SYSTEM DESCRIPTION
D1 ELIMAIA I D2 ELIMAIA II		1	c-RIO Controller NI-9035, 8 slots
		1	Monitor touch-screen 15" LED, XGA resolution
		64	Digital I/O, suitable to be set as input or output in groups of 8, opto-isolation up to 4,5 kV, external protection against electrical shocks according to IEC61000-4-5
		4	+/-10V Analog I/O, resolution 16 bits, symultaneous sampling @ 100 kS/sec, external protection against electrical shocks according to IEC61000-4-5
		4	Serial ports RS-422/485, isolated up to 60 V, external protection against electrical shocks according to IEC61000-4-2
		1	Power supply 24 Vdc -150 W (input 90-240 Vac) for c-RIO and monitor
		1	Power supply 24 Vdc -100 W (Input 90-240 Vac) for auxiliaries and field
		1	Electronic board/cabinet, dimensions 2000x600x600 mm, standard frame suitable for 19" racks 42U, transparent front door, rear blind panel, cooling system in the roof with 6 axial fans and air re-cycling from basement, 2U extractable drawer with keyboard and touch-pad, 2 3U drawers for internal power distribution devices, front panel for 19" racks, 3U ancillaries for installation of TMP pump drivers, modified 8U panel to install Panel-PC or Monitor, rear plate to support electronic control devices and terminal boxes to the field, 4 eyelets on the roof, assembling, internal harness/cabling and shop testing
D3 HELL I D4 HELL II		1	c-RIO Controller NI-9035, 8 slots
		1	Monitor touch-screen 15" LED, XGA resolution
		64	Digital I/O, suitable to be set as input or output in groups of 8, opto-isolation up to 4,5 kV, external protection against electrical shocks according to IEC61000-4-5
		4	+/-10V Analog I/O, resolution 16 bits, symultaneous sampling @ 100 kS/sec, external protection against electrical shocks according to IEC61000-4-5
		8	Serial ports RS-422/485, isolated up to 60 V, external protection against electrical shocks according to IEC61000-4-2
		1	Power supply 24 Vdc -150 W (Input 90-240 Vac) for c-RIO and monitor
		1	Power supply 24 Vdc -100 W (Input 90-240 Vac) for auxiliaries and field
		1	Electronic board/cabinet, dimensions 2000x600x600 mm, standard frame suitable for 19" racks 42U, transparent front door, rear blind panel, cooling system in the roof with 6 axial fans and air re-cycling from basement, 2U extractable drawer with keyboard and touch-pad, 2 3U drawers for internal power distribution devices, front panel for 19" racks, 3U ancillaries for installation of TMP pump drivers, modified 8U panel to install Panel-PC or Monitor, rear plate to support electronic control devices and terminal boxes to the field, 4 eyelets on the roof, assembling, internal harness/cabling and shop testing

#	DELIVERABLE	Q.TY	LOCAL VACUUM CONTROL SYSTEM DESCRIPTION
D6 LUX		1	c-RIO Controller NI-9035, 8 slots
		1	Monitor touch-screen 15" LED, XGA resolution
		32	Digital I/O, suitable to be set as Input or output in groups of 8, opto-isolation up to 4,5 kV, external protection against electrical shocks according to IEC61000-4-5
		4	+/-10V Analog I/O, resolution 16 bits, simultaneous sampling @ 100 kS/sec, external protection against electrical shocks according to IEC61000-4-5
		4	Serial ports RS-422/485, isolated up to 60 V, external protection against electrical shocks according to IEC61000-4-2
		1	Power supply 24 Vdc -150 W (Input 90-240 Vac) for c-RIO and monitor
		1	Power supply 24 Vdc -100 W (Input 90-240 Vac) for auxiliaries and field
		1	Electronic board/cabinet, dimensions 2000x600x600 mm, standard frame suitable for 19" racks 42U, transparent front door, rear blind panel, cooling system in the roof with 6 axial fans and air re-cycling from basement, 2U extractable drawer with keyboard and touch-pad, 2 3U drawers for internal power distribution devices, front panel for 19" racks, 3U ancillaries for installation of TMP pump drivers, modified 8U panel to install Panel-PC or Monitor, rear plate to support electronic control devices and terminal boxes to the field, 4 eyelets on the roof, assembling, internal harness/cabling and shop testing
D7 BETATRON		1	c-RIO Controller NI-9035, 8 slots
		1	Monitor touch-screen 15" LED, XGA resolution
		32	Digital I/O, suitable to be set as Input or output in groups of 8, opto-isolation up to 4,5 kV, external protection against electrical shocks according to IEC61000-4-5
		4	+/-10V Analog I/O, resolution 16 bits, simultaneous sampling @ 100 kS/sec, external protection against electrical shocks according to IEC61000-4-5
		4	Serial ports RS-422/485, isolated up to 60 V, external protection against electrical shocks according to IEC61000-4-2
		1	Power supply 24 Vdc -150 W (Input 90-240 Vac) for c-RIO and monitor
		1	Power supply 24 Vdc -100 W (Input 90-240 Vac) for auxiliaries and field
		1	Electronic board/cabinet, dimensions 2000x600x600 mm, standard frame suitable for 19" racks 42U, transparent front door, rear blind panel, cooling system in the roof with 6 axial fans and air re-cycling from basement, 2U extractable drawer with keyboard and touch-pad, 2 3U drawers for internal power distribution devices, front panel for 19" racks, 3U ancillaries for installation of TMP pump drivers, modified 8U panel to install Panel-PC or Monitor, rear plate to support electronic control devices and terminal boxes to the field, 4 eyelets on the roof, assembling, internal harness/cabling and shop testing

#	DELIVERABLE	Q.TY	LOCAL VACUUM CONTROL SYSTEM DESCRIPTION
ZONE CONTROLLER		1	NI RMC-8354 1U Ctrlr, Core i7-860, HD 1x500 GB, Win7 - 32 bit
		1	Replacement/Upg 4 GB of DDR3 RAM for NI RMC-8354 (1x4 GB DIMM)
CONTROL SOFTWARE			Programs for the operational sequences in both automatic and manual/local mode, to be loaded on each unit controllers
			MMI software for c-RIO and monitors touch-screen in executable format (LabView 2014 RT ambient)
			Data-log software for PC RMC computer in executable format (LabView 2014 RT ambient for Windows 32/64)


 Fantini Sud S.p.A.
 Ing. Luigi Fantini (CEO)

TECHNICAL DESCRIPTION

VACUUM COMPONENTS

ANNEX V1

Turbo-molecular pump TMP ATH 2300 M

Pun



ATH 2300 M

5-axis magnetically levitated turbopump with
drag stage for a pump speed of up to 2150 l/s for
 N_2

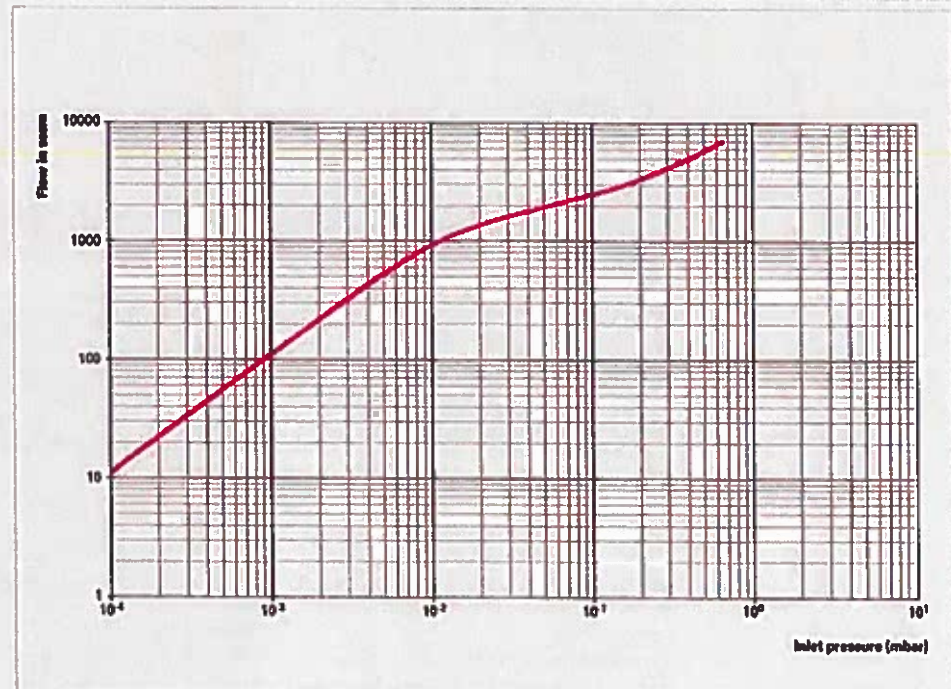
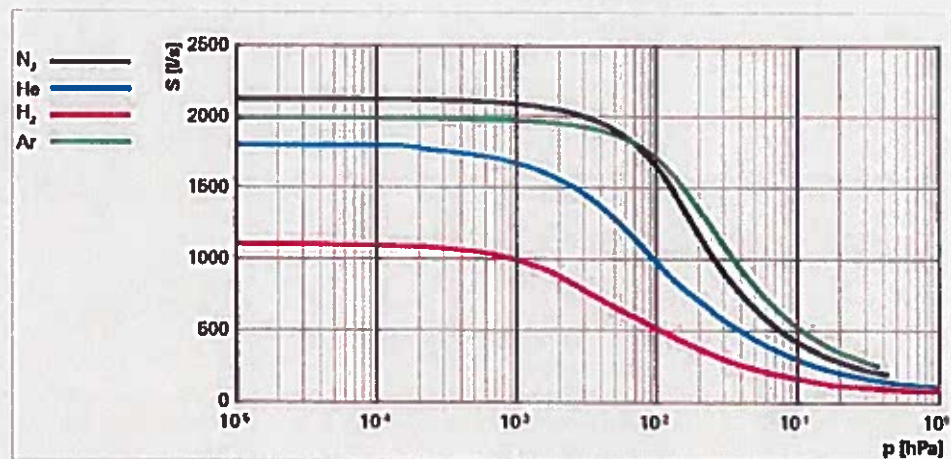




Similar Image

ATH 2303 M, DN 250 ISO-F, OBC V4 integrated drive electronics, Remote, Water cooled, Non-heated

- 5-axis magnetically levitated turbopump with drag stage for a pump speed of up to 2150 l/s for N_2
- DN 250 ISO-F Inlet flange
- Operation with OBC V4 integrated drive electronics
- Installation in any orientation
- Remote, Water cooled, Non-heated
- CE marked and ROHS compliant



Dimensions



H 343.5 mm

Technical Data	
	ATH 230J M, DN 250 ISO-F, OBC V4 integrated drive electronics, Remote, Water cooled, Non-heated
Bearing	Magnetically Levitated
Compression ratio for Ar	$> 1 \cdot 10^6$
Compression ratio for H ₂	$> 1 \cdot 10^3$
Compression ratio for He	$> 3 \cdot 10^4$
Compression ratio for N ₂	$> 1 \cdot 10^3$
Cooling method	Water
Cooling water consumption	1.0 l/min
Cooling water temperature	15-25 °C 59-77 °F 288-298 K
Cooling water temperature max.	40 °C 104 °F 313 K
Electronic drive unit	Integrated drive electronics
Flange (in)	DN 250 ISO-F
Flange (out)	DN 40 ISO-KF
Fore-vacuum max. for N ₂	2.9 hPa 2.17 Torr 2.9 mbar
Gas throughput for Ar	25.4 hPa l/s 19.05 Torr l/s 25.4 mbar l/s
Gas throughput for H ₂	> 67.6 hPa l/s > 50.7 Torr l/s > 67.6 mbar l/s
Gas throughput for He	> 67.6 hPa l/s > 50.7 Torr l/s > 67.6 mbar l/s
Gas throughput for N ₂	67.6 hPa l/s 50.7 Torr l/s 67.6 mbar l/s
Integrated power supply	yes
Interfaces	Remote
Mounting orientation	In any orientation
Operating voltage	200-240 V AC, 50/60 Hz
Power consumption at ultimate pressure	350 W
Protection category	IP 54
Pumping speed for Ar	2000 l/s
Pumping speed for H ₂	1100 l/s
Pumping speed for He	1800 l/s
Pumping speed for N ₂	2150 l/s
Rotation speed $\pm 2\%$	31000 min ⁻¹
Run-up time	< 8 min
Sound pressure level	≤ 47 dB (A)
Ultimate pressure	$< 6 \cdot 10^{-9}$ hPa $< 4.5 \cdot 10^{-9}$ Torr $< 6 \cdot 10^{-9}$ mbar
Weight	60 kg 132.28 lb

Order number

ATH 2300 M

XJ66215A

Accessories

Electronic controllers

Hand Held Remote (HHR) with cable

114461

Inlet screen

Aluminum Inlet screen kit for DN250

111640

Stainless Inlet screen kit for DN250 - M 5

108762

Mounting kits

Mounting bolts for ISO-F (for ATH 2300 M, DN 250; ATH 2800 M, DN 250) with centering ring

110034

Mounting bolts for ISO-F (for ATH 500 M, DN180; ATH 1800 M, DN 200/250; ATH 2300 M, DN 250; ATH 2800 M, DN 250) without centering ring

110676S

Venting valves and other accessories

Air venting valve (for OBC V4 and Magpower)

114280

Dust filter

106229

Purge valve 50 sccm

1119218

Water Inlet valve 24 V DC

108668

A PASSION FOR PERFECTION

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14

TECHNICAL DESCRIPTION

VACUUM COMPONENTS

ANNEX V2

**Gate valve 590-60106 for vacuum
(body in AISI 304 stainless steel)**

P/N 590-60106

DN250 ISO-F HV pneumatic gate valve

Materials

Edge welded bellow: AM350

Body: SS AISI 304

Bonnet seal: Viton

Gate seal: Viton

Low vibration, lowest outgasing

Proprietary vacuum brazing process

Vacuum

Leak rate: $<2 \times 10^{-9}$ mbar.l/sec

Pressure range: 1×10^{-9} mbar

Differential pressure closed: 1 Bar in either direction

max pressure before opening: 30 mbar

Bakeout temp.

Body 150 °C

Actuator 60 °C

Mechanism

Pneumatic air service 4-7 bar

Solenoid voltage 24 V DC

Reed switch position indicator 28 V max

Mounting position

any

Cycles until service

200,000

Multi application use

Cryopumps, turbo pumps, ion pumps



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VAT N° 811820363

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Non catalogue items manufactured according to Allectra UHV procedures, copy available upon request

Py

**High Quality Gate valves: 16CF ... 350CF
16KF ... 50KF
ISO63 ... ISO600**

.. 259

Allectra offers a full range of gate valves for HV and UHV applications. They are available in a manual version and with pneumatic actuators. They are available with CF flanges for UHV and KF / ISO flanges for HV. Versions with ANSI and JIS flanges are available on request.

General Specifications

Housing material	Stainless Steel 1.4301 (SS 304)
Bellows material	Stainless Steel AM-350
Gate seal	Viton®
Bonnet seal	UHV: OFHC Cu / HV: Viton®
Helium Leak rate	< 2x 10 ⁻¹⁰ mbar l /s
Pressure range	HV: 10 ⁻⁹ mbar UHV 10 ⁻¹⁰ mbar
Differential pressure	1bar in either direction
Opening pressure	< 30 mbar
Bakeout (without solenoid)	HV: 150°C UHV: open 200°C, closed 150°C
Bakeout actuator	60°C (manual and pneumatic)
Cycles until first service	100.000 (application dependent)
Pneumatic	
Standard Solenoid	24V DC, 4W
Position Indicator	28V DC, 20mA (REED Switch)
Actuator	Double action Option up to 75mm Ø: Air open, spring close
Options	Roughing ports 1.000.000 cycles version other Solenoids other O-ring materials Micro switches



On the following pages, you will find the drawing for most common sizes up to DN200.
Available are as well the rarely used sizes 50CF / 75CF / 125CF / 275CF and the larger sizes 250CF / 300CF / 350CF and the equivalent ISO-sizes.
ISO-F Versions are available in addition in size 500 and 600
Please ask for drawings, if required.

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Manual

1.49 [37.8] dia.

1.80 [45.7]

1.75 [44.5]

1.88 [47.8]

4.21 [106.9]

4.97 [126.2]

1.50 [38.1]

1.58 [39.6]

.64 [16.3]

1.31 [33.3]

Pneumatic

1.00 [25.4] dia.

2.55 [64.8]

1.50 [38.1]

1.58 [39.6]

.99 [25.1]

Flange dimensions

O.D. =	1.33	[33.8]
I.D. =	.625	[15.88]
Thickness =	.285	[7.24]
No. of holes =	6, B-32	[#14]
Bolt circle =	1.062	[26.97]

Conductance = 12 liter/sec

Manual

1.49 [37.8] da.

1.80 [45.7]

1.75 [44.5]

.64 [16.3]

1.31 [33.3]

1.88 [47.8]

4.21 [108.9]

Pneumatic

1.00 [25.4] da.

4.97 [126.2]

2.55 [64.8]

1.50 [38.1]

.99 [25.1]

2.96 [75.2]

1.33 [33.8] da., 2 places

Flange dimensions
 KF-18
 O.D. = 1.18 [30.0]
 I.D. = .625 [15.88]
 Assembly = Hinged clamp
 Conductance = 13 Bar/sec

The image contains two technical drawings of actuators. The left drawing is for a 'Manual' actuator, showing a red handwheel on top of a circular flange. The right drawing is for a 'Pneumatic' actuator, showing a blue cylindrical body. Both drawings include dimensions in inches and millimeters.

Manual Actuator Dimensions:

- Handwheel diameter: 1.98 [50.2] dia.
- Handwheel height: 3.51 [91.7]
- Flange thickness: 3.39 [86.1]
- Flange outer diameter: 2.46 [62.5]
- Flange inner diameter: 1.30 [33.0]
- Flange mounting hole diameter: 0.837 [21.26]

Pneumatic Actuator Dimensions:

- Actuator body diameter: 1.97 [50.0] dia.
- Actuator body height: 5.29 [134.4]
- Actuator body mounting hole diameter: 0.837 [21.26]
- Actuator body mounting hole spacing: 2.03 [51.8]
- Actuator body mounting hole diameter: 1.03 [26.2]

Flange dimensions

O.D. =	2.73	[69.3]
I.D. =	1.50	[38.1]
Thickness =	.50	[12.7]
No. of holes =	6, 1/4-28	[1/8 x 1]
Bolt circle =	2.312	[58.72]
Conductance =	128	Reich

Manual

1.98 [50.2] da.

3.61 [91.7]

3.39 [86.1]

1.30 [33.0]

2.46 [62.5]

3.31 [84.1]

Pneumatic

1.97 [50.0] dia.

5.29 [134.4]

9.89 [253.7]

8.31 [211.1]

2.47 [62.7] dia., 2 places

2.00 [50.7]

1.03 [26.2]

Flange dimensions

KF-40

O.D. = 2.16 [54.9]

I.D. = 1.50 [38.1]

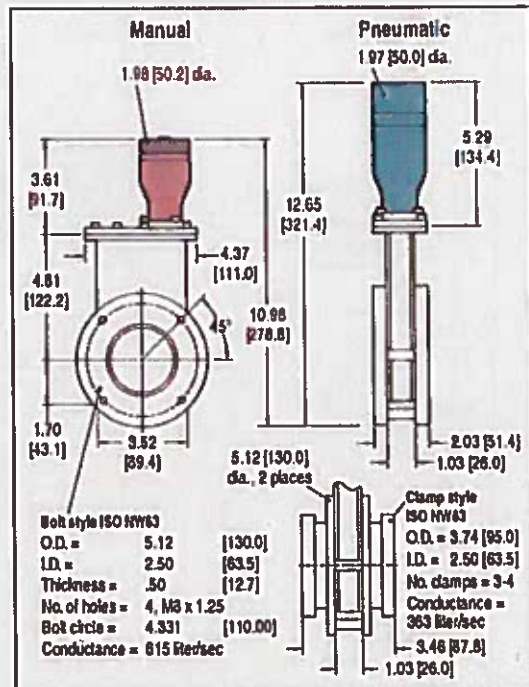
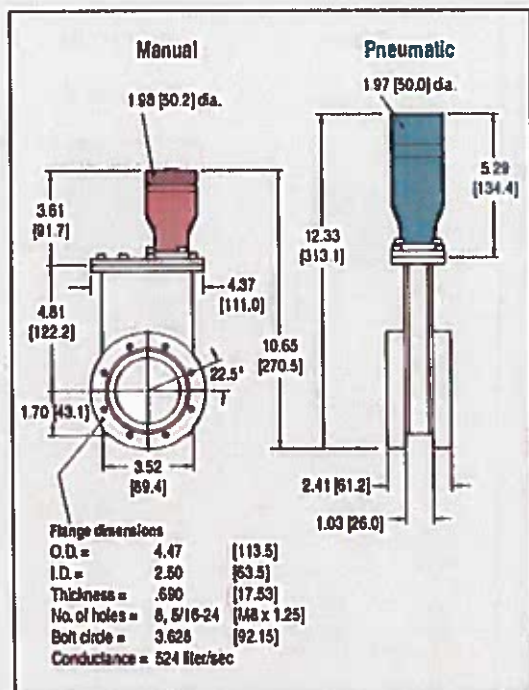
Assembly = Hinged clamp

Conductance = 88 ltr/sec

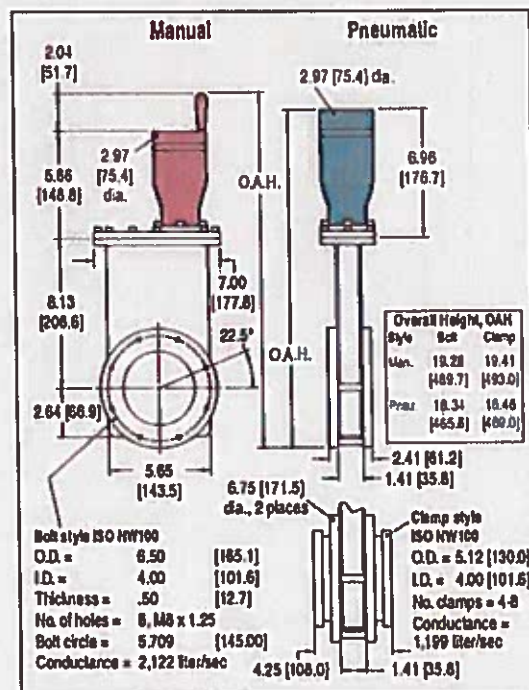
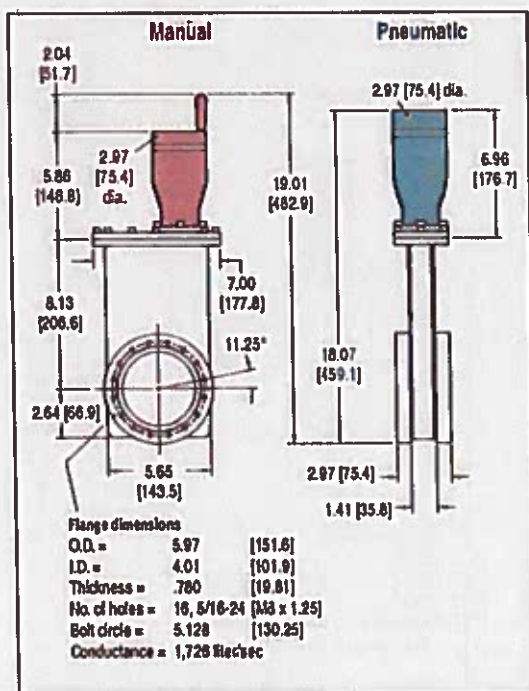
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Size 63 (63CF / ISO-F 63 / ISO-K 63)



Size 100 (100CF / ISO-F 100 / ISO-K 100)



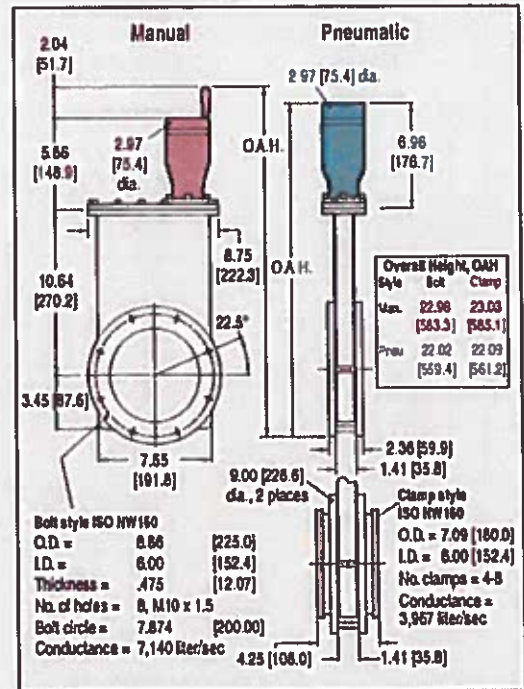
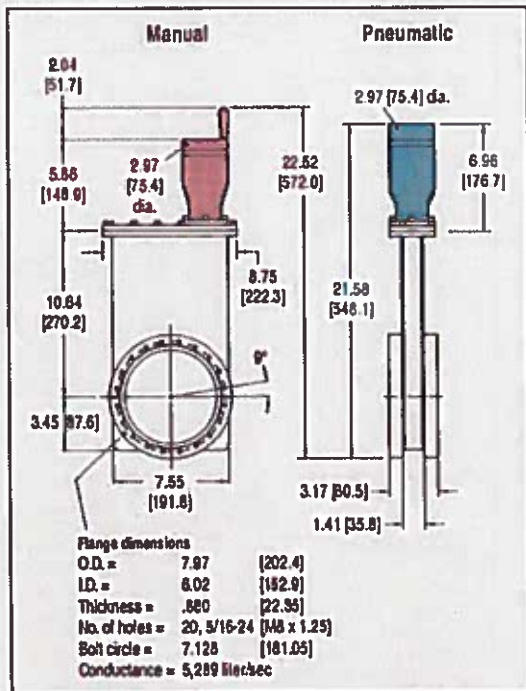
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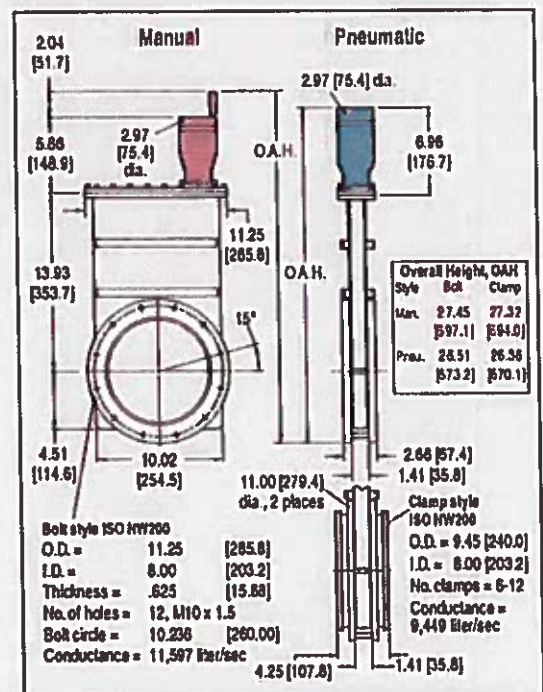
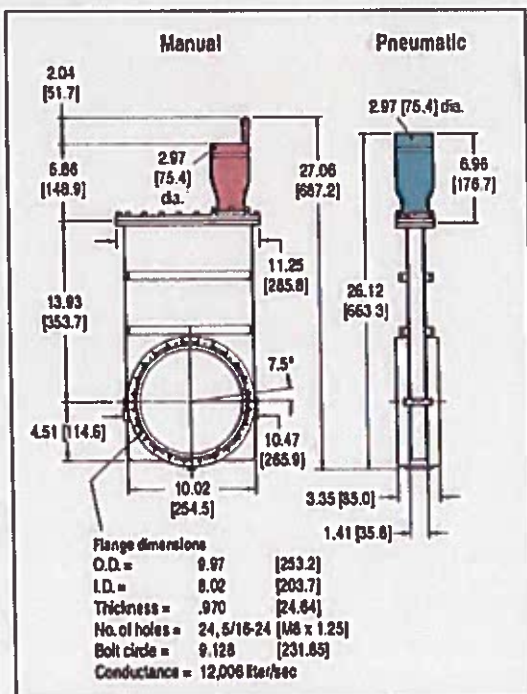
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Size 160 (160CF / ISO-F 160 / ISO-K 160)



Size 200 (200CF / ISO-F 200 / ISO-K 200)



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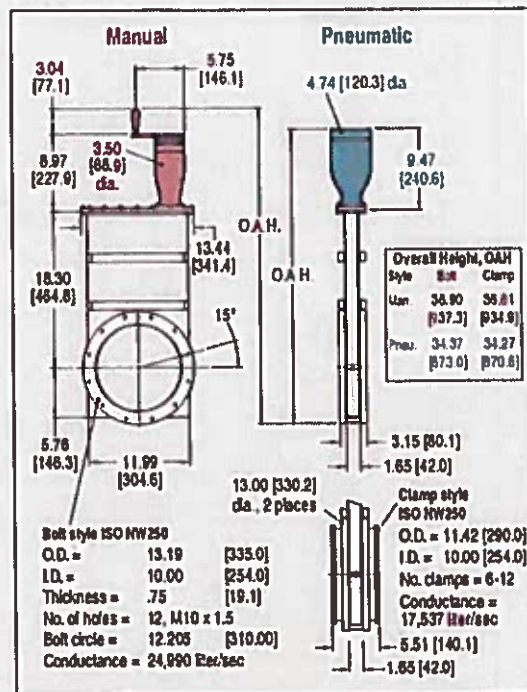
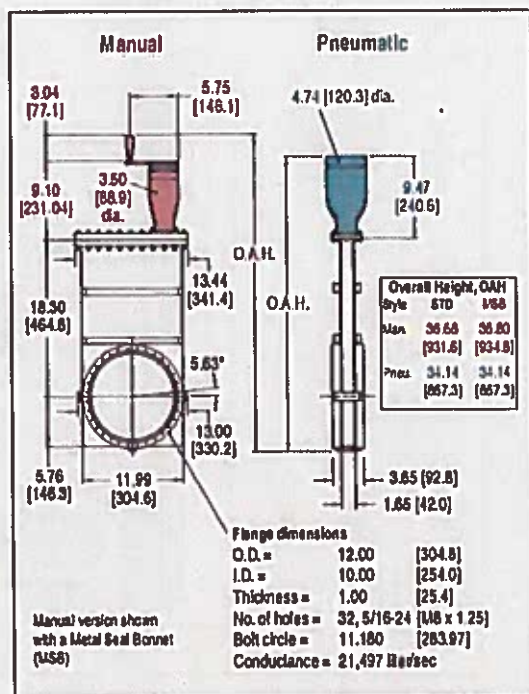
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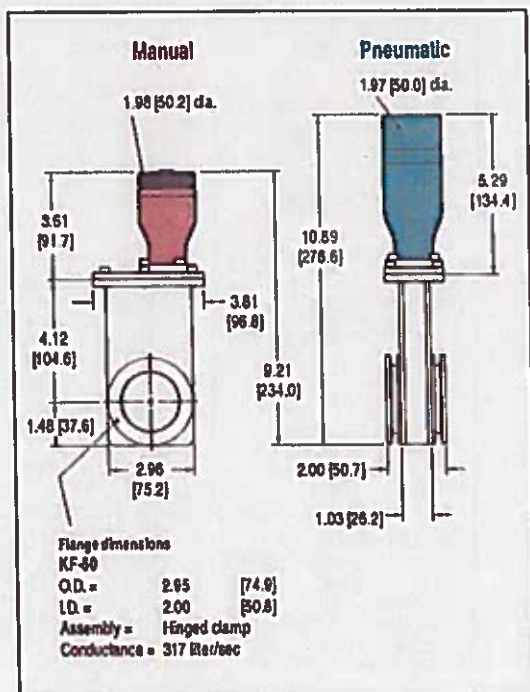
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Size 200 (200CF / ISO-F 200 / ISO-K 200)



Size 50 (KF50)



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TECHNICAL DESCRIPTION

VACUUM COMPONENTS

ANNEX V3

**Large pendulum valve for vacuum
series 16.8
(body in aluminum alloy)**

Py

Large pendulum valve

VAT Series 16

Series 16.8

Main applications

Applications requiring a compact design
in larger DN sizes

Especially suited to large coating and
FPD production systems



Ordering Information

Valve with pneumatic actuator
double acting
without solenoid valve
with position indicator

DN		Ordering numbers		
mm	inch	ISO-F	ASA	JIS
400	16	16852-PA24	on request	16852-JA24
500	20	16854-PA24	16854-AA24	16854-JA24

without solenoid valve, without position indicator: 168 . . . A14

with solenoid valve, with position indicator: 168 . . . A44 (specify control voltage)

Valve with 3-position
pneumatic actuator
double acting
without solenoid valve
with position indicator

DN		Ordering numbers		
mm	inch	ISO-F	ASA	JIS
400	16	16852-PA28	on request	16852-JA28
500	20	16854-PA28	16854-AA28	16854-JA28

with solenoid valve, with position indicator: 168 . . . A48 (specify control voltage)

Spare parts

- Seals
on request (specify fabrication number of valve)

Accessories

- Flange connections
for installation of the valve: see series 32

Features

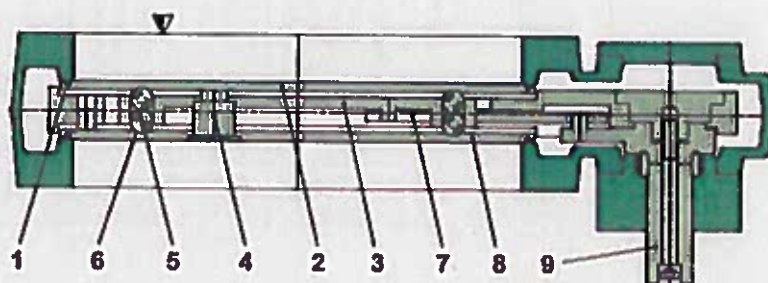
Body material: aluminum

Compact

Low vibration level during operation

Split body design for easy maintenance

Functional principle



1 Plate seal	4 Spring package	7 Actuating lever
2 Plate	5 Ball pairs	8 Counter-plate
3 Ball guidance	6 Ball tracks	9 Actuator shaft
		▽ Valve seat side

Technical data

Leak rate: valve body, valve seat	$< 1 \cdot 10^{-9}$ mbar ls ⁻¹
Pressure range	1 · 10 ⁻² mbar to 1.2 bar (abs)
Differential pressure on the plate	≤ 1.2 bar
Differential pressure at opening	≤ 30 mbar
Cycles until first service	100000
Temperature °	
– Valve body	≤ 120 °C
– Actuator	≤ 80 °C
– Solenoid valve	≤ 50 °C
– Position indicator	≤ 80 °C
Heating and cooling rate	≤ 30 °C hr ⁻¹
Material	
– Valve body	EN AC-42100 (3.2371)
– Plate	EN AW-6082 (3.2315)
– Feedthrough (parts in contact with media)	EN AW-6082 (3.2315), AISI 303 (1.4301)
Seat: bonnet, plate, feedthrough	FKM (Viton®)
Feedthrough	rotary feedthrough
Mounting position	any
Solenoid valve	24VDC, 5.4W (others on request)
Position Indicator: contact rating	
– Voltage	≤ 50VAC/DC
– Current	≤ 3A
Valve position indication	visual (mechanical)

* Maximum values: depending on operating conditions and sealing materials

Further technical data on next page

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Large pendulum valve

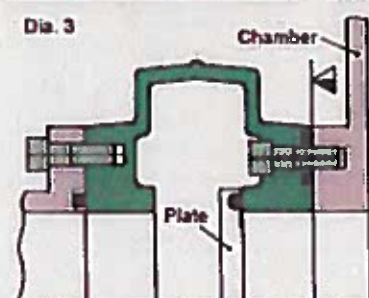
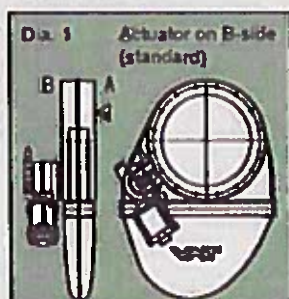
VAT Series 16

Continued Technical data

DN (nominal I.D.)		Standard flanges	Conductance (molecular flow) (depending on A-dimension and flange type)	Minimum adjust- able conductance with 3-pos. pneu- matic actuator	Max. differential pressure in closed position	Compressed air min. - max. overpressure			Volume of pneu- matic actuator		Closing or opening time *	Weight	
mm	inch		ls ⁻¹	ls ⁻¹	mbar	bar	psi		l	ft ³	s	kg	lbs
400	16	See Page 89	50000	150	1200	5-7	73-102		2.0	0.071	12	85	187
457	18		68000	200	1200	5-7	73-102		3.3	0.118	14	125	276
500	20		90000	200	1200	5-7	73-102		3.3	0.118	14	115	254

* extended closing / opening time with 3-position pneumatic actuator

Options



▽ Valve seat side

Actuator

- Other solenoid valve voltage (standard: 24VDC)
- Actuator on A-side (Dia. 2). B-side is standard.

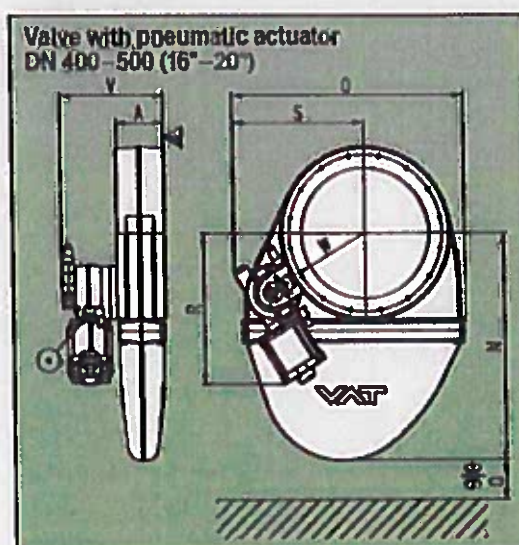
Valve

- Customer specified flanges
- Splinter shield grid for turbo pump
- For direct mounting to chamber (Dia. 3)
- Ports in valve body for roughing (by-pass), venting or for gauges
- Window in plate

Ordering information for options:

Ordering No. of valve-X
(e. g. (16852-PA24-X, X = window in plate)

Main dimensions



DN	mm	inch	400	500
	mm	inch	160	170
A	mm	inch	6.91	6.69
N	mm	inch	698	850
	mm	inch	27.48	33.46
O	mm	inch	716	854
	mm	inch	28.19	33.62
Q	mm	inch	200	230
	mm	inch	7.87	9.06
R	mm	inch	461	612
	mm	inch	18.15	24.09
S	mm	inch	418	468
	mm	inch	16.14	18.35
V	mm	inch	322	337
	mm	inch	12.68	13.27
W	mm	inch	260	320
	mm	inch	10.24	12.60

▽ Valve seat side

* Required for dismantling

○ Compressed air connection

TECHNICAL DESCRIPTION

VACUUM COMPONENTS

ANNEX V4

**Pendulum valve for vacuum
series 16.2
(body in aluminum alloy)**

Py

Pendulum valve

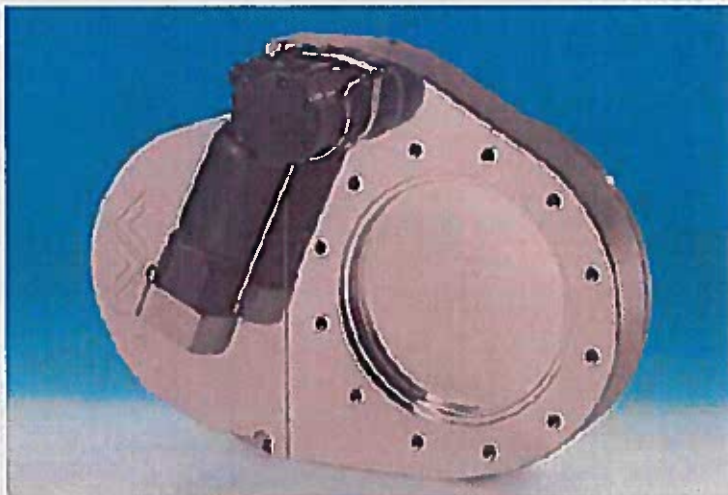
VAT Series 16

Series 16.2

Main applications

Applications requiring a compact design

Especially suited to demanding corrosive processes



Ordering information

Valve with pneumatic actuator
single acting with closing spring (NC)
without solenoid valve
with position indicator

DN		Ordering numbers		
mm	inch	ISO-F	ASA-LP	JIS
63	2 1/2	16236-PA21	16236-TA21	16236-JA21
100	4	16240-PA21	16240-TA21	16240-JA21
160	6	16244-PA21	16244-TA21	16244-JA21
200	8	16246-PA21	16246-TA21	16246-JA21
250	10	16248-PA21	16248-TA21	16248-JA21
320	12	16250-PA21	16250-TA21	16250-JA21
350	14	-	16251-TA21	16251-JA21
400	16	16252-PA21	16252-TA21	16252-JA21
500	20	16254-PA21	16254-TA21	16254-JA21
650	22	on request	on request	on request

without solenoid valve, without position indicator: 162 ... A11

with solenoid valve, without position indicator: 162 ... A31 (specify control voltage)

with solenoid valve, with position indicator: 162 ... A41 (specify control voltage)

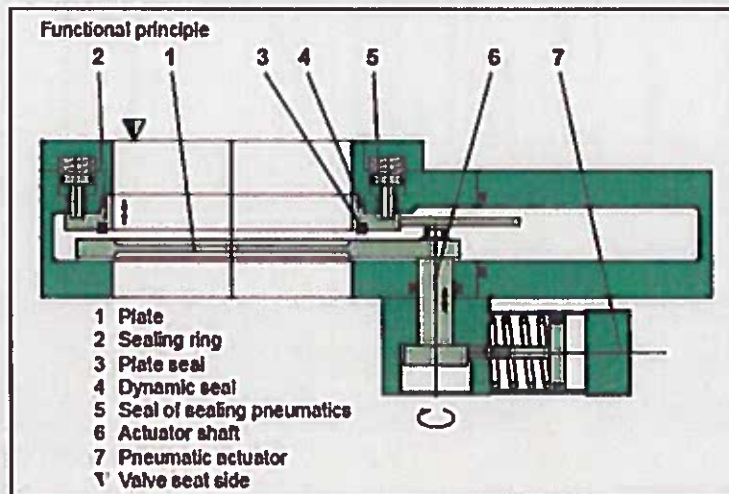
Valve with 3-position
pneumatic actuator
single acting with closing spring (NC)
without solenoid valve
with position indicator

DN		Ordering numbers		
mm	inch	ISO-F	ASA-LP	JIS
63	2 1/2	16236-PA28	16236-TA28	16236-JA28
100	4	16240-PA28	16240-TA28	16240-JA28
160	6	16244-PA28	16244-TA28	16244-JA28
200	8	16246-PA28	16246-TA28	16246-JA28
250	10	16248-PA28	16248-TA28	16248-JA28
320	12	16250-PA28	16250-TA28	16250-JA28
350	14	-	16251-TA28	16251-JA28
400	16	16252-PA28	16252-TA28	16252-JA28
500	20	16254-PA28	16254-TA28	16254-JA28
650	22	on request	on request	on request

with solenoid valve, with position indicator: 162 ... A48 (specify control voltage)

Features

- Body material: aluminum
- Compact
- Low vibration level and low particle count during operation
- Split body design for easy maintenance
- No readjustment after cleaning



Technical data

Leak rate: valve body, valve seat	$< 1 \cdot 10^{-8}$ mbar ls ⁻¹
Pressure range	$1 \cdot 10^{-4}$ mbar to 1.2 bar (abs)
Differential pressure on the plate	≤ 1.2 bar
Differential pressure at opening	
– DN 63–100	≤ 30 mbar
– DN 160–200	≤ 10 mbar
– DN 250–500	≤ 5 mbar
Cycles until first service	200 000
Temperature °	
– Valve body	≤ 120 °C
– Actuator	≤ 80 °C
– Solenoid valve	≤ 50 °C
– Position indicator	≤ 80 °C
Heating and cooling rate	≤ 30 °C h ⁻¹
Material	
– Valve body, plate, sealing ring	
– DN 63–400	EN AW-5083 (3.3547), -6082 (3.2315)
– DN 500	EN AC-42100 (3.2371)
– Feedthrough (parts in contact with media)	AISI 303 (1.4305), AISI 304 (1.4301)
Seal	
– Bonnet, plate, dynamic, feedthrough	FKM (Viton®)
Feedthrough	rotary feedthrough
Mounting position	any
Solenoid valve	24VDC, 5.4W (others on request)
Position indicator: contact rating	
– Voltage	≤ 50 VAC/DC
– Current	≤ 1.2 A
Valve position indication	visual (mechanical)

^{*)} Maximum values: depending on operating conditions and sealing materials

Further technical data on next page →

Any

Pendulum valve

VAT Series 16

Continued Technical data

DN (nominal I.D.)		Standard flanges	Conductance (molecular flow) (depending on A-dimension and flange type)	Minimum adjustable conductance with 3-position pneumatic actuator	Max. differential pressure in closed position	Compressed air min.-max. overpressure		Volume of pneumatic actuator		Closing or opening time *	Weight	
mm	inch		ls ⁻¹	ls ⁻¹	mbar	bar	psi	l	ft ³	s	kg	lbs
63	2 1/2	See page 85	440	6,6	1200	5-7	73-102	0.20	0.007	3	13	28.7
100	4		1700	7,6	1200	5-7	73-102	0.20	0.007	3	13	28.7
160	6		4700	12,6	1200	5-7	73-102	0.25	0.009	3	20	44.1
200	8		11000	15	1200	5-7	73-102	0.30	0.010	4	23	50.7
250	10		21700	22	1200	5-7	73-102	0.35	0.012	4	30	66.1
320	12		32600	34	1200	5-7	73-102	0.55	0.020	5	56	123.5
350	14		41500	42	1200	5-7	73-102	0.60	0.021	5	65	143.3
400	16		61000	69	1200	5-7	73-102	0.65	0.023	5.5	76	167.6
500	20		101500	100	1200	5-7	73-102	1.40	0.047	10	120	264.6

* extended closing/opening time with 3-position pneumatic actuator

Easy and fast
maintenance

- Split body design
- Removable plate and sealing ring
- No readjustment after cleaning



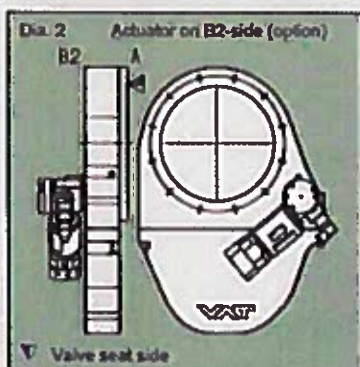
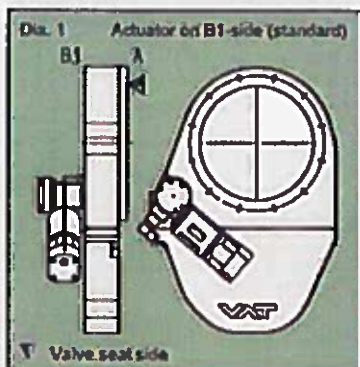
Spare parts

- Seals
on request (specify fabrication number of valve)

Accessories

- Flange connections
for installation of the valve: see series 32

Options

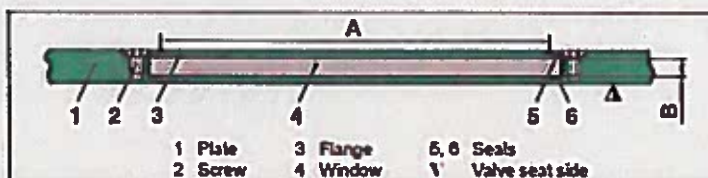


Actuator

- Other solenoid valve voltage (standard: 24VDC)
- Actuator on B2-side (Dia. 2). B1-side is standard.

Valve

- Customer specified flanges
- Other sealing materials
- Heater with insulation and overtemperature switch (Pic. 3)
- Valve body hard anodized or nickel-plated
- Helicoids for valve flanges
- Ports in valve body for roughing (by-pass), venting or for gauges
- Window in plate (Pic. 4):
window material: borosilicate or sapphire, elastomer seals



The window is put between two seals (5, 6) and clamped into the plate (1) by means of a flange (3).

	DN valve	mm	63	100	150	200	250	320	350	400	500
		inch	2 1/2	4	6	8	10	12	14	16	20
Borosilicate	Optically free diameter «A»	mm	63	80	100	130	130	150	150	150	150
		inch	2.48	3.15	3.94	5.12	5.12	5.91	5.91	5.91	5.91
	Thickness of glass «B»	mm	6	6	6	6	6	8	8	8	8
		inch	0.20	0.20	0.24	0.24	0.24	0.31	0.31	0.31	0.31
Sapphire	Optically free diameter «A»	mm	63	80	112	170	200	250	250	250	250
		inch	2.48	3.15	4.41	6.69	7.87	9.84	9.84	9.84	9.84
	Thickness of glass «B»	mm	4	4	4	5	6	6	6	6	6
		inch	0.16	0.16	0.16	0.20	0.24	0.24	0.24	0.24	0.24

Above specification includes the largest possible windows. Smaller windows on request.
Due to the weight of the window, it is not possible to mount any valve in any position.

Ordering information for options:

Ordering No. of valve-X (e. g. 15246-PA21-X, X = window in plate)

Py

TECHNICAL DESCRIPTION

VACUUM COMPONENTS

ANNEX V5

Vacuum gauge



PKR 251, FPM sealed, DN
25 ISO-KF



14

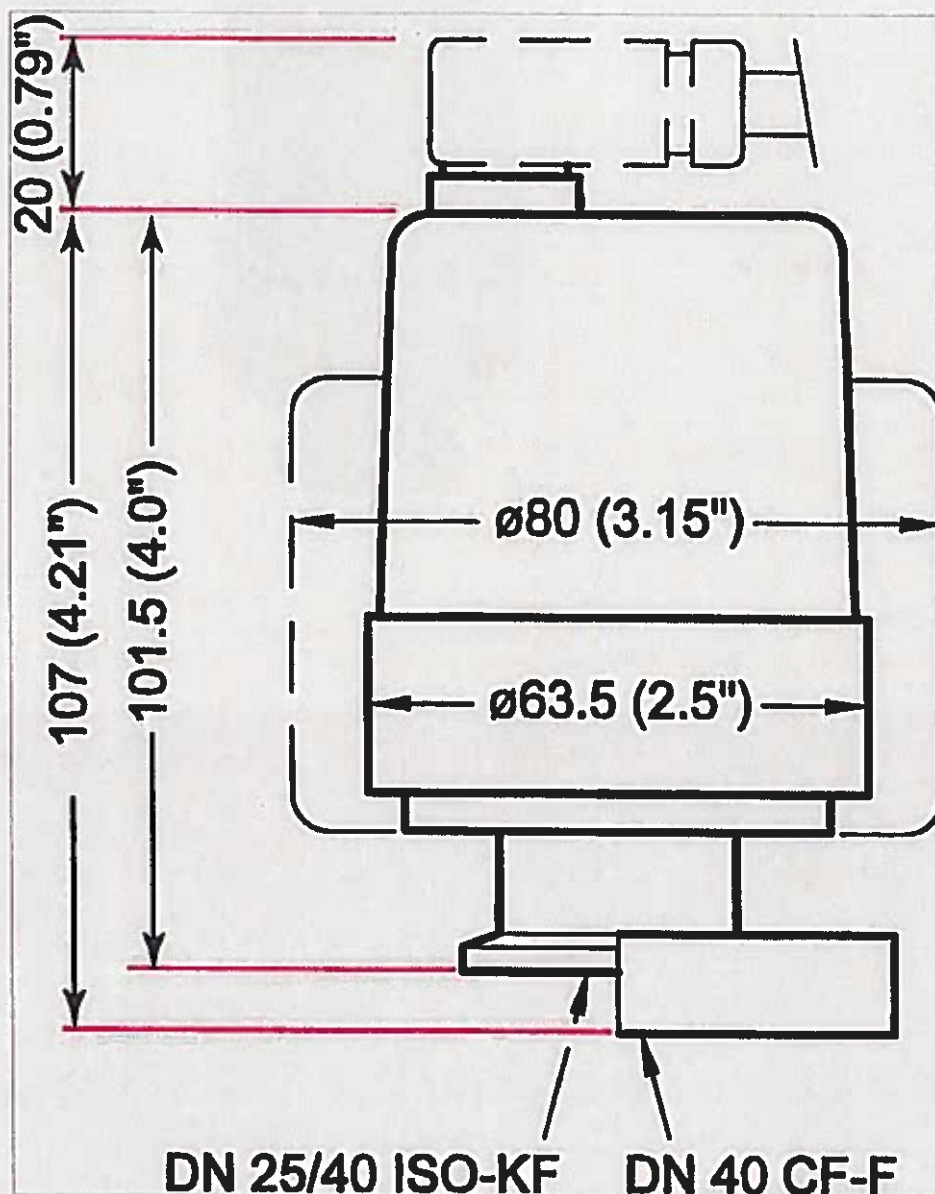


Similar Image

PKR 251, FPM sealed, DN 25 ISO-KF

- FullRange gauge with two sensors in one housing
- Display range from $5 \cdot 10^{-9}$ to 1000 hPa
- Flange size: DN 25 ISO-KF
- Maximum pressure refers to inert gases and temperatures of less than 55 °C
- Corrosion-resistant

Dimensions



Technical Data

Accuracy: 10^{-3} - 10^2 hPa
Anode

PKR 251, FPM sealed, DN 25 ISO-KF

± 30 %
Molybdenum

Technical Data		PKR 251, FPM sealed, DN 25 ISO-KF	
Bakeout temperature		Electronic removed, 150 °C	
		Electronic removed, 302 °F	
		Electronic removed, 423 K	
Feature		Interior FPM sealed	
Feedthrough		Al ₂ O ₃ , Glass	
Filament		Tungsten	
Flange		Stainless steel	
Measurement range max.		1,000 hPa 750 Torr 1,000 mbar	
Measurement range min.		5 · 10 ⁻⁹ hPa 3.75 · 10 ⁻⁹ Torr 5 · 10 ⁻⁹ mbar	
Method of measurement		Pirani/Cold Cathode	
Nominal diameter		DN 25 ISO-KF	
Output signal: Minimum load		10 k	
Output signal: Pressure range		1.8 - 8.6 V	
Output signal: Sensor error above		9.5 V	
Output signal: Sensor error below		0.5 V	
Pressure max.		10,000 hPa 7,500 Torr 10,000 mbar	
Repeatability: 10 ⁻⁸ - 10 ² hPa		± 5 %	
Seal		FPM	
Sensor cable length		300 m	
Supply: Power consumption max.		2 W	
Supply: Voltage		15-30 V DC	
Temperature: Operating		5-55 °C 41-131 °F 278-328 K	
Temperature: Storage		-40-85 °C -40-149 °F 233-338 K	
Volume		20 cm ³	
Weight		700 g	

Order number	
PKR 251	PT R26 000

Accessories	
Accessory for ActiveLine gauges and controllers	
Mating connector	B 4707 283 MA
Sensor cable, 3 m	PT 448 250 -T

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TECHNICAL DESCRIPTION

LOCAL VACUUM CONTROL SYSTEMS

ANNEX W1

National Instruments cRIO-9035 controller

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SPECIFICATIONS

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NI cRIO-9035

Embedded CompactRIO Controller with Real-Time Processor and Reconfigurable FPGA

This document lists the specifications for the National Instruments cRIO-9035. The following specifications are typical for the -20 °C to 55 °C operating temperature range unless otherwise noted.



Caution Do not operate the cRIO-9035 in a manner not specified in this document. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to NI for repair.

Processor

CPU.....Intel Atom E3825

Number of cores.....2

CPU frequency.....1.33 GHz

On-die L2 cache.....1 MB (shared)

Operating System



Note For minimum software support information, visit ni.com/info and enter the Info Code softwareversion.

Supported operating system.....NI Linux Real-Time (64-bit)

Software requirements

Application software

LabVIEW.....LabVIEW 2014 SP1 or later,
LabVIEW Real-Time Module 2014 SP1 or later,
LabVIEW FPGA Module 2014 SP1 or later¹,

C/C++ Development Tools.....Eclipse Edition 2014 or later
for NI Linux Real-Time²

Driver software.....NI-RIO February 2015 or later

280

Network/Ethernet Port

Number of ports.....2
Network interface.....10Base-T, 100Base-TX, and
1000Base-T Ethernet
Compatibility.....IEEE 802.3
Communication rates.....10 Mbps, 100 Mbps,
1000 Mbps auto-negotiated
Maximum cabling distance.....100 m/segment

RS-232 Serial Port

Maximum baud rate.....115,200 bps
Data bits.....5, 6, 7, 8
Stop bits.....1, 2
Parity.....Odd, Even, Mark, Space
Flow control.....RTS/CTS, XON/XOFF, DTR/DSR
RI wake maximum low level.....0.8 V
RI wake minimum high level.....2.4 V
RI overvoltage tolerance.....±24 V

¹ LabVIEW FPGA Module is not required when using Scan Interface mode. To program the user-accessible FPGA on the cRIO-9035

² C/C++ Development Tools for NI Linux Real-Time is an optional interface for C/C++ programming of the cRIO-9035 processor. Visit ni.com/info and enter Info Code RIOCDdev for more information about the C/C++ Development Tools for NI Linux Real-Time.

Aug

RS-485/422 (DTE) Serial Port

281

Maximum baud rate.....115,200 bps
Data bits.....5, 6, 7, 8
Stop bits.....1, 2
Parity.....Odd, Even, Mark, Space
Flow control.....XON/XOFF
Wire mode.....4-wire, 2-wire, 2-wire auto
Isolation voltage.....60 VDC continuous, port to earth ground



Note The RS-485 serial port ground and shield are not connected to chassis ground. This isolation is intended to prevent ground loops and does not meet UL ratings for safety isolation.

Cable requirement.....Unshielded, 30 m max length (limited by EMC/surge)



Note RS-485 is capable of 1.2 km (4,000 ft) length without surge limitation.

USB Ports

Number of ports

Device ports.....1 standard B connector
Host ports.....2 standard A connectors



Note The USB device port is intended for use in device configuration, application deployment, debug, and maintenance.

USB interface.....USB 2.0, Hi-Speed
Maximum data rate.....480 Mb/s per port
Maximum current (USB host ports).....1 A (aggregate)

Mini DisplayPort

Maximum resolution.....2560 × 1600 at 60 Hz

SD Card Slot

... 282

SD card support.....SD and SDHC standards

Memory

Nonvolatile³

SD removable (user supplied).....Up to 32 GB

Solid-state drive.....4 GB



Note Visit ni.com/info and enter the Info Code **ssdbp** for information about the life span of the nonvolatile memory and about best practices for using nonvolatile memory.

Volatile

Processor memory

Density.....1 GB

Type.....DDR3L

Maximum theoretical data.....8.533 GB/s
rate

Data throughput

System memory to SD.....10 MB/s
removable storage⁴

Module slots to system memory.....20 MB/s, application and system dependent

Reconfigurable FPGA

FPGA type.....Xilinx Kintex-7 7K70T

Number of flip-flops.....82,000

Number of 6-input LUTs.....41,000

Number of DSP slices.....240
(18 x 25 multipliers)

Available block RAM.....4,860 kbits

³ 1 MB is equal to 1 million bytes. 1 GB is equal to 1 billion bytes; formatted capacity might be less.

⁴ Consult the SD removable storage manufacturer's specifications.

ny

Number of DMA channels.....	16
Number of logical interrupts.....	32

Internal Real-Time Clock

Accuracy.....200 ppm; 40 ppm at 25 °C

CMOS Battery

Typical battery life with power.....10 years
applied to power connector

Typical battery life in storage up to.....7.8 years
25 °C

Typical battery life in storage up to.....5.4 years
85 °C

Power Requirements



Note Some C Series modules have additional power requirements. For more information about C Series module power requirements, refer to the C Series module(s) documentation.

Voltage input range (measured at the
cRIO-9035 power connector)

V1.....9 V to 30 V

V2.....9 V to 30 V

Maximum power consumption.....46 W



Note The maximum power consumption specification is based on a fully populated system running a high-stress application at elevated ambient temperature, and with all C Series modules and USB devices consuming the maximum allowed power.

Typical standby power consumption.....3.4 W at 24 VDC input

Recommended power supply 100 W, 24 VDC

Typical leakage current from secondary power input (V2) while system is powered from primary power input (V1)

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At 9 V.....0.4 mA
At 30 V.....1.93 mA



Caution Do *not* connect V2 to a DC MAINS supply or to any supply requiring a connecting cable longer than 3 m (10 ft). A DC MAINS supply is a local DC electricity supply network in the infrastructure of a site or building.

EMC ratings for inputs as described in IEC 61000

V1.....Short lines, long lines, and DC distributed networks
V2.....Short lines only

Power input connector.....4-position 3.5 mm pitch-pluggable screw terminal with screw locks, Sauro CTF04BV8-AN000A

Physical Characteristics

If you need to clean the cRIO-9035, wipe it with a dry towel.



Tip For two-dimensional drawings and three-dimensional models of the cRIO-9035, visit ni.com/dimensions and search by module number.

Weight (unloaded).....2,250 g (4 lbs, 15 oz)
Dimensions (unloaded).....328.8 mm × 88.1 mm × 109.2 mm
(12.94 in. × 3.47 in. × 4.30 in.)

Screw-terminal wiring

Gauge.....0.5 mm² to 2.1 mm² (20 AWG to 14 AWG)
copper conductor wire with 6 mm (0.24 in.) of insulation stripped from the end
Temperature rating.....85 °C
Torque for screw terminals.....0.20 N · m to 0.25 N · m
(1.8 lb · in. to 2.2 lb · in.)
Wires per screw terminal.....One wire per screw terminal

Py

Connector securement

Securement type.....	Screw flanges provided
Torque for screw flanges.....	0.20 N · m to 0.25 N · m (1.8 lb · in. to 2.2 lb · in.)

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Safety Voltages

Connect only voltages that are below these limits.

V1 terminal to C terminal.....30 VDC max, Measurement Category I

V2 terminal to C terminal.....30 VDC max, Measurement Category I

Chassis ground to C terminal.....30 VDC max, Measurement Category I

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as *MAINS* voltage. *MAINS* is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.



Caution Do not connect the cRIO-9035 to signals or use for measurements within Measurement Categories II, III, or IV.



Note Measurement Categories CAT I and CAT O are equivalent. These test and measurement circuits are not intended for direct connection to the *MAINS* building installations of Measurement Categories CAT II, CAT III, or CAT IV.

Environmental

Temperature (IEC-60068-2-1 and IEC-60068-2-2)

Operating.....-20 °C to 55 °C

Storage.....-40 °C to 85 °C



Caution Failure to follow the mounting instructions in the *NI cRIO-9035 User Manual* can cause temperature derating. Visit ni.com/info and enter Info Code *criomounting* for more information about mounting configurations and temperature derating.

Ingress protection.....IP 20

Operating humidity.....10% RH to 90% RH, noncondensing
(IEC 60068-2-56)

Storage humidity (IEC 60068-2-56).....5% RH to 95% RH, noncondensing

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Pollution Degree (IEC 60664).....2

Maximum altitude.....5,000 m

Indoor use only.

Hazardous Locations

U.S. (UL).....Class I, Division 2, Groups A, B, C, D, T4;
Class I, Zone 2, AEx nA IIC T4

Canada (C-UL).....Class I, Division 2, Groups A, B, C, D, T4;
Class I, Zone 2, Ex nA IIC T4

Europe (DEMKO).....Ex nA IIC T4 Gc

Shock and Vibration

To meet these specifications, you must mount the cRIO-9035 system directly on a flat, rigid surface as described in the *NI cRIO-9035 User Manual*, affix ferrules to the ends of the terminal wires, install an SD card cover (SD Door Kit, 783660-01), and use retention accessories for the USB host ports (NI Industrial USB Extender Cable, 152166-xx), USB device port (NI Locking USB Cable, 157788-01), and mini DisplayPort connector (NI Retention Accessory for Mini DisplayPort, 156866-01). All cabling should be strain relieved near input connectors. Take care to not directionally bias cable connectors within input connectors when applying strain relief.

Operating vibration

Random (IEC 60068-2-64).....5 g_{rms}, 10 Hz to 500 Hz

Sinusoidal (IEC 60068-2-6).....5 g, 10 Hz to 500 Hz

Operating shock (IEC 60068-2-27).....30 g, 11 ms half sine; 50 g, 3 ms half sine;
18 shocks at 6 orientations

Safety and Hazardous Locations Standards

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1
- EN 60079-0:2012, EN 60079-15:2010

- IEC 60079-0: Ed 6, IEC 60079-15; Ed 4
- UL 60079-0; Ed 5, UL 60079-15; Ed 3
- CSA 60079-0:2011, CSA 60079-15:2012



Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326-1): Class A emissions; Industrial immunity
- EN 61000-6-2: Immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- EN 55022 (CISPR 22): Class A emissions
- EN 55024 (CISPR 24): Immunity
- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions



Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in heavy-industrial locations.



Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.



Note For EMC declarations and certifications, and additional information, refer to the *Online Product Certification* section.

CE Compliance

This product meets the essential requirements of applicable European Directives, as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)
- 94/9/EC; Potentially Explosive Atmospheres (ATEX)

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *Minimize Our Environmental Impact* web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)



EU Customers At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit ni.com/environment/weee.

Battery Replacement and Disposal



Battery Directive This device contains a long-life coin cell battery. If you need to replace it, use the Return Material Authorization (RMA) process or contact an authorized National Instruments service representative. For more information about compliance with the EU Battery Directive 2006/66/EC about Batteries and Accumulators and Waste Batteries and Accumulators, visit ni.com/environment/batterydirective.

电子信息产品污染控制管理办法（中国 RoHS）



中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息, 请登录 ni.com/environment/rohs_china。(For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

My

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376935A-02 Feb15

Puy

TECHNICAL DESCRIPTION

LOCAL VACUUM CONTROL SYSTEMS

ANNEX W2

National Instruments
FPT 1015 15" touch screen

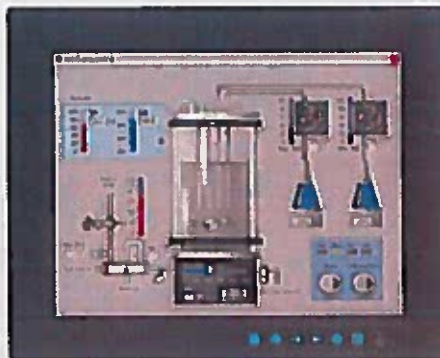
Industrial 15 in. Flat Panel Touch Screen Monitor

NI FPT-1015

- Rugged industrial monitor for PXI and NI Compact Vision Systems
- 15 in. XGA TFT color LCD flat panel monitor
- Resistive touch screen for PXI
 - 1024 x 768 maximum resolution
 - 250 cd/m² maximum luminance
 - Abrasion-resistant tempered glass
 - Front-panel controls for display settings
- Standard VGA interface
 - Autorecognition of input signal
 - Up to 40 m extended-length VGA cable(s)
- Communication ports
 - Device side USB for touch screen control
- Works with Windows 2000/NT/XP drivers
- Stainless steel chassis with Al-Mg front panel
- NEMA4/IP65-compliant front panel
- Panel wall, or desk mount
- Extended temperature range to 50 °C
- CE and UL certifications

Accessories

- Rack-mount kit
- Wall/desk-mount kit



Overview

The National Instruments FPT-1015 is an industrial 15 in. color TFT LCD flat panel touch screen monitor. Its large display area, VGA compatibility, and interactive touch screen interface make it the ideal human-machine interface (HMI) for high-performance PXI test applications and machine vision applications based on the NI CVS-145x systems.

Rugged Industrial Design

The NI FPT-1015 features a rugged design with a stainless steel chassis, aluminum front panel housing, and integrated NEMA4/IP65-compliant touch screen flat panel display. Its compact industrial design conserves space – an important consideration for the typically crowded plant floor – and its reduced mounting depth is well-suited for 19 in. rack-mount cabinets. It has a 15 in. TFT LCD color display with resistive analog touch screen with tempered, antiglare glass that is also NEMA4/IP65-compliant.

The FPT-1015 features high shock, vibration, and temperature ratings, and it meets global safety standards and agency certifications. To meet special application requirements, both rack-mount and extended-length VGA cables are available.

HMI for PXI-Based Systems

National Instruments PXI embedded controllers, which feature high-performance Pentium M processors, are fully compatible with other PXI systems. These embedded controllers – when integrated into a PXI chassis with choice of communication, I/O, or signal conditioning modules – create a compact, rugged PC-based platform well-suited for deployment in harsh environments. With its rugged industrial design and operator-friendly touch screen interface, the FPT-1015 is an ideal HMI for both PXI and real-time compact vision systems.

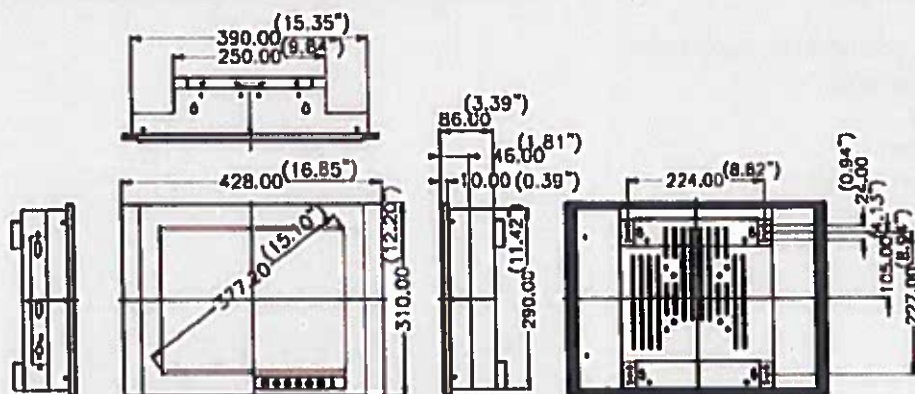


Figure 1. NI FPT-1015 Dimensions

Ray

Industrial 15 in. Flat Panel Touch Screen Monitor

Typical Applications

PXI-Based Industrial Data Logging with HMI



Figure 2. FPT-1015 HMI for PXI Industrial I/O with LabVIEW Data logging and Supervisory Control Module

In this data-logging application, a PXI system is monitoring high-speed analog inputs that require isolation. Additional application requirements include:

- Data display in real time in multiple formats
- Integration of bus-level devices (for example, DeviceNet)
- Real-time sharing of data enterprise wide

Using the FPT-1015, connected directly to the PXI controller, the operator can quickly choose between display formats.

PXI-Based Factory Floor QA/QC with HMI

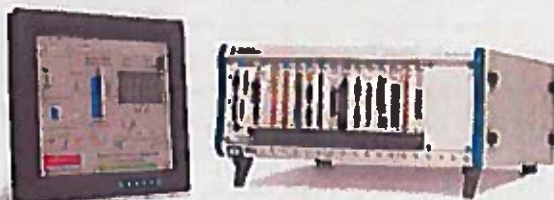


Figure 3. FPT-1015 with a PXI Factory Floor Test System

In this application, a PXI system conducts end-of-line functional testing. Additional application requirements include:

- Touch screen for operator input
- Keyboard/mouse for numeric input
- Large, easy-to-read display for alarm conditions
- Locate the display 20 m from the PXI chassis

With the FPT-1015 extended VGA cable, you can locate the system at the end of the production line and the FPT-1015 close to the machine operator's station.

HMI for NI CVS-1454 System



Figure 4. FPT-1015 with Compact Vision System

The National Instruments CVS-1454 compact vision system combines a high-performance processor with an onboard FPGA, digital I/O, and three IEEE 1394 (FireWire) ports in a compact industrial design. This fully integrated system features built-in functionality for communicating with external devices. It can read quadrature encoder inputs, generate strobe pulses, read/write digital I/O, and directly interface with more than 80 industrial cameras. Additionally, the CVS-145x resident VGA output can directly interface with the FPT-1015 to provide real-time displays, based on NI LabVIEW or Vision Builder for Automated Inspection, of the product under test as well as pass/fail and inspection data. Compact vision systems do not work with the FPT-1015 touch screen.

Ordering Information

NI FPT-1015	778580-01
Rack mount kit	779572-01
Desk mount kit	779573-01

BUY NOW!

For complete product specifications, pricing, and accessory information, call (800) 813 3693 (U.S.) or go to ni.com/pxi

BUY ONLINE at ni.com or CALL (800) 813 3693 (U.S.)

Industrial 15 in. Flat Panel Touch Screen Monitor

Specifications

Display

Description	XGA TFT LCD flat panel
Size	15 in.
Front-panel (bezel)	Al-Mg, NEMA4/IP65-compliant
Touch screen	8 wire, analog resistive with antireflective tempered glass
Resolution	1024 x 768 (16.7 million colors)
Viewing angle	140 deg (H), 120 deg (V)
Luminance	250 cd/m ²
Contrast ratio	500:1
OSD controls	Brightness, contrast, horizontal/vertical position, system video information, and system reset
OS compatibility	Windows 2000/XP
Video interface	VGA
Screen control	USB
Keyboard/mouse	None
Backlight lifetime	40,000 hours
Touch screen lifetime	1 million touches @ single point

Power Requirements

External	42 W
Power supply (included)	100 to 240 VAC input 3.5 A @ 12 VDC output
Power consumption	
5 V	100 mA (USB)

Physical

Dimensions (w by h by d)	383 by 307 by 48 mm (15 by 12 by 1.9 in.)
Gross weight	3.7 kg (8.2 lb)
Mounting	Panel (standard), rack, wall, desk VESA mount supported

Environment

Operating temperature	0 to 50 °C (32 to 122 °F)
Storage temperature	-20 to 60 °C (32 to 140 °F)
Relative humidity	5 to 95% (noncondensing)
Vibration, operating	5 to 17 Hz, double-amplitude displacement 17 to 500 Hz, 1.0 g peak-to-peak

Safety and EMC/EMI Compliance

EMC/EMI	CE and FCC
Ratings	NEMA Type 4, IP65
Certifications	CCC, CE, and UL certifications

Py

NI Services and Support



NI has the services and support to meet your needs around the globe and through the application life cycle – from planning and development through deployment and ongoing maintenance. We offer services and service levels to meet customer requirements in research, design, validation, and manufacturing. Visit ni.com/services.

Training and Certification

NI training is the fastest, most certain route to productivity with our products. NI training can shorten your learning curve, save development time, and reduce maintenance costs over the application life cycle. We schedule instructor-led courses in cities worldwide, or we can hold a course at your facility. We also offer a professional certification program that identifies individuals who have high levels of skill and knowledge on using NI products. Visit ni.com/training.

Professional Services

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.



OEM Support

We offer design-in consulting and product integration assistance if you want to use our products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Local Sales and Technical Support

In offices worldwide, our staff is local to the country, giving you access to engineers who speak your language. NI delivers industry-leading technical support through online knowledge bases, our applications engineers, and access to 14,000 measurement and automation professionals within NI Developer Exchange forums. Find immediate answers to your questions at ni.com/support.

We also offer service programs that provide automatic upgrades to your application development environment and higher levels of technical support. Visit ni.com/ssp.

Hardware Services

NI Factory Installation Services

NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI extends the standard warranty by one year on hardware components (controllers, chassis, modules) purchased with FIS. To use FIS, simply configure your system online with ni.com/pxiadvisor.

Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit ni.com/calibration.

Repair and Extended Warranty

NI provides complete repair services for our products. Express repair and advance replacement services are also available. We offer extended warranties to help you meet project life-cycle requirements. Visit ni.com/services.



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2005-8175-101-101

TECHNICAL DESCRIPTION

LOCAL VACUUM CONTROL SYSTEMS

ANNEX W3

National Instruments
9403 32 digital I/O module

Py

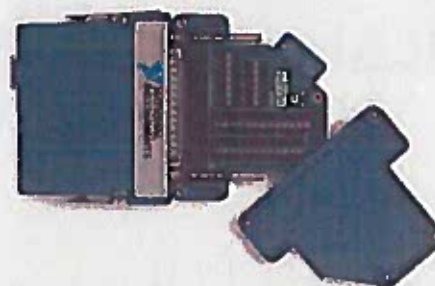


Technical Sales

(888) 531-8285
orders@ni.com

Ordering Information | Detailed Specifications | Pinouts/Front Panel Connections
For the most current information, visit the product page resources tab on ni.com.

Last Revised: 2014-11-08 07:14:25.0

NI 9403**5 V/TTL, Bidirectional Digital I/O, 32 Ch Module**

- 32-channel, 7 μ S, digital I/O
- 5 V/TTL, sinking/sourcing digital I/O
- Bidirectional, configurable by line with shift-on-the-fly capability
- 60 VDC, CAT I isolation
- Industry-standard 37-pin D-SUB connector
- -40 °C to 70 °C operating, 5 g vibration, 50 g shock

Overview

The NI 9403 is a 32-channel, 7 μ s bidirectional digital I/O module for any NI CompactDAQ or CompactRIO chassis. You can configure the direction of each digital line on the NI 9403 for input or output. Each channel is compatible with 5 V/TTL signals and features 1,000 Vrms transient isolation between the I/O channels and the backplane. The NI 9403 also features $\pm$ 30 V overvoltage protection and can source up to 2 mA output current per channel.

In an NI CompactDAQ chassis, you can use the NI 9403 as only a static (software-timed) digital I/O module. Starting in NI-DAQmx 9.3, you can use the NI 9403 in buffered tasks for a single direction (either input or output). Due to the serial transfer of data, you cannot use these modules to route timing or triggering signals. With the NI 9403 in a CompactRIO chassis, you can use LabVIEW FPGA to program the NI 9403 for implementing custom counter/timers, pulse generation, and much more.

Recommended Accessories

-NI 9923 (or other 37-pin D-SUB connector)

Box Contents

-1 NI 9403 C Series module
-1 NI 9403 Operating Instructions and Specifications manual

[Back to Top](#)**Comparison Tables**

Product Name	Signal Levels	Direction	Channels	Update Rate	Isolation	Connectivity
NI 9401	5 V/TTL	Bidirectional	8	100 ns	60 VDC Ch-Earth	25-Pin D-SUB
NI 9402	LVTTTL	Bidirectional	4	55 ns	None	BNC
NI 9403	5 V/TTL	Bidirectional	32	7 μ s	60 VDC Ch-Earth	37-Pin D-SUB

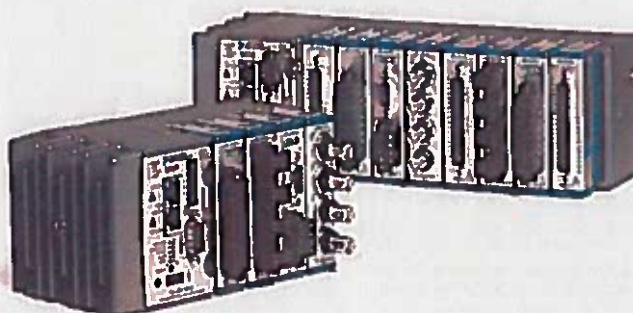
[Back to Top](#)**Application and Technology****NI C Series Overview**



NI C Series modules are engineered to provide high-accuracy measurements to meet the demands of advanced DAQ and control applications. Each module contains measurement-specific signal conditioning to connect to an array of sensors and signals, bank and channel-to-channel isolation options, and support for wide temperature ranges to meet a variety of application and environmental needs all in a single rugged package. You can choose from more than 100 C Series modules for measurement, control, and communication to connect your applications to any sensor on any bus.

Most C Series I/O modules work with both the NI CompactDAQ and CompactRIO platforms. The modules are identical, and you can move them from one platform to the other with no modification.

NI CompactRIO Platform



Powered by the LabVIEW RIO architecture, CompactRIO combines an open embedded architecture with small size, extreme ruggedness, and hot-swappable industrial I/O modules. Each system contains an FPGA for custom timing, triggering, and processing with a wide array of available modular I/O to meet any embedded application requirement.

[Configure Your Complete CompactRIO System](#)

NI CompactDAQ Platform



NI CompactDAQ is a portable, rugged DAQ platform that integrates connectivity and signal conditioning into modular I/O for directly interfacing to any sensor or signal. Using NI CompactDAQ with LabVIEW, you can easily customize how you acquire, analyze, present, and manage your measurement data. From research to development to validation, NI provides programmable software, high-accuracy measurements, and local technical support to help ensure you meet your exact measurement application requirements.

[Configure Your Complete NI CompactDAQ System](#)

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

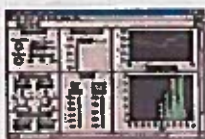
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Products	Part Number	Recommended Accessories	Part Number
NI 9403			
NI 9403 with DSub Front-Mounted Accessories Requires 1 Terminal Block	779787-01	Terminal Block: screwTerminal - NI 9923 Front-mount D-SUB to screw terminals	781503-01

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Software Recommendations

LabVIEW Professional Development System for Windows



- Advanced software tools for large project development
- Automatic code generation using DAQ Assistant and Instrument I/O Assistant
- Tight integration with a wide range of hardware
- Advanced measurement analysis and digital signal processing
- Open connectivity with DLLs, ActiveX, and .NET objects
- Capability to build DLLs, executables, and MSI installers

NI LabVIEW FPGA Module



- Design FPGA applications for NI reconfigurable I/O (RIO) hardware targets
- Program with the same graphical environment used for desktop and real-time applications
- Execute control algorithms with loop rates up to 300 MHz
- Implement custom timing and triggering logic, digital protocols, and DSP algorithms
- Incorporate existing HDL code and third-party IP including Xilinx CORE Generator functions
- Included in the LabVIEW Embedded Control and Monitoring Suite

NI LabVIEW Real-Time Module



- Design deterministic real-time applications with LabVIEW graphical programming
- Download to dedicated NI or third-party hardware for reliable execution and a wide selection of I/O
- Take advantage of built-in PID control, signal processing, and analysis functions
- Automatically take advantage of multicore CPUs or set processor affinity manually
- Includes real-time OS, development and debugging support, and board support
- Purchase individually or as part of a LabVIEW suite

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
- **Online Community** - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

- **Classroom training** in cities worldwide - the most comprehensive hands-on training taught by engineers.
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NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

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Detailed Specifications

The following specifications are typical for the range -40 to 70 °C unless otherwise noted. All voltages are relative to COM unless otherwise noted.

Input/Output Characteristics

Number of channels	32 DIO channels
Input/output type	TTL, single-ended
Default power-on line direction	Input
Digital logic levels	
Input	
Voltage	-0.25 to 5.25 V
High, V_{IH}	2.2 V min
Low, V_{IL}	0.8 V max
Hysteresis, V_H	0.2 V min
Output	
High, V_{OH} (5.2 V max)	
Sourcing 100 μ A	4.75 V min
Sourcing 2 mA	4.4 V min
Low, V_{OL}	
Sinking 100 μ A	0.1 V max
Sinking 2 mA	0.25 V max
Input current (0 V $\leq V_{in} \leq$ 4.5 V)	± 250 μ A max
Module output current ¹	64 mA max
Input capacitance	30 pF
Timing	
Input	
Setup time ²	10 ns min
Hold time ³	60 ns min
Output	
Propagation delay ⁴	330 ns max

Channel-to-channel skew ⁵	265 ns max
Update/transfer time ⁶	
cRIO-9151 R Series Expansion chassis	8 μ S max
All other chassis	7 μ S max
Direction change time ⁶	18 μ S max
Overvoltage protection Channel-to-COM	± 30 V max on up to 8 channels at a time; however, continued use at this level will degrade the life of the module.
MTBF	763,325 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method



Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis

Active mode	1 W max
Sleep mode	25 μ W max

Thermal dissipation (at 70 °C)

Active mode	1 W max
Sleep mode	25 μ W max

Physical Characteristics

If you need to clean the module, wipe it with a dry towel.

Weight	150 g (5.3 oz)

Safety

Safety Voltages

Connect only voltages that are within the following limits.

Channel-to-COM	± 30 V max on up to 8 channels at a time, Measurement Category I

Isolation

Channel-to-channel	None
Channel-to-earth ground	
Continuous	60 VDC, Measurement Category I
Withstand	1,000 V _{rms} , verified by a 5 s dielectric withstand test

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS⁷ voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.



Caution Do not connect the NI 9403 to signals or use for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1



Note For UL and other safety certifications, refer to the product label or the [Online Product Certification](#) section.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4
Europe (DEMKO)	Ex nA IIC T4

Environmental

National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 to 85 °C
Ingress protection	IP 40
Operating humidity (IEC 60068-2-56)	10 to 90% RH, noncondensing

Storage humidity (IEC 60068-2-58)	5 to 95% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree (IEC 60664)	2

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64)	5 g _{rms} , 10 to 500 Hz
Sinusoidal (IEC 60068-2-6)	5 g, 10 to 500 Hz

Operating shock (IEC 60068-2-27)	30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements, Industrial Immunity
- EN 55011 Emissions, Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions, Class A

 Note For EMC compliance, operate this device with shielded cables.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC, Low-Voltage Directive (safety)
- 2004/108/EC, Electromagnetic Compatibility Directive (EMC)

 Note For the standards applied to assess the EMC of this product, refer to the [Online Product Certification](#) section.

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

 EU Customers At the end of their life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.

电子信息产品污染控制管理办法（中国 RoHS）

 中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请参见 ni.com/environment/rohs_china。(For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

Calibration

You can obtain the calibration certificate for this device at ni.com/calibration.

Calibration interval	1 year

¹ Module output current is the maximum guaranteed current that the module can drive from all the I/O lines without going into an overcurrent state.

² Setup time is the amount of time input signals must be stable before reading from the module.

³ Hold time is the amount of time input signals must be stable after initiating a read from the module.

⁴ Propagation delay is the amount of time after writing to the module that the output signals become valid.

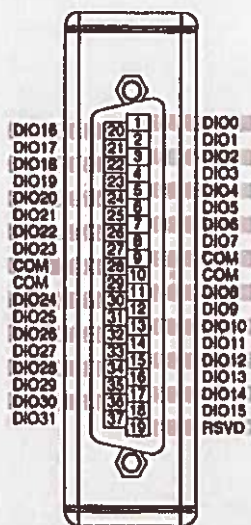
⁵ Channel-to-channel skew is the amount of time between the first output signal updating and the last output signal updating.

⁶ The update/transfer and direction change times are valid when the module is used in a CompactRIO system. When used in other systems, driver software and latencies impact these times.

⁷ MAINS is defined as the (hazardous live) electrical supply system to which equipment is designed to be connected for the purpose of powering the equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

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Pay



NI 8403 Pin Assignments

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TECHNICAL DESCRIPTION

LOCAL VACUUM CONTROL SYSTEMS

ANNEX W4

National Instruments
9215 10 analog inputs module

Py

Ordering Information | Detailed Specifications | Pinouts/Front Panel Connections
For more information and to order, visit the product page resource, labcreation.com

Last Revised: 2014-11-06 07:14:15.0

NI 9215

±10 V, Simultaneous Analog Input, 100 kS/s, 4 Ch Module



- 4 differential channels, 100 kS/s per channel sample rate
- ±10 V measurement range, 16-bit resolution
- 250 Vrms channel-earth, CAT II (screw terminal), or 60 VDC channel-earth, CAT I (BNC) Isolation
- 10-position screw-terminal or BNC connectors available
- -40 °C to 70 °C operating, 5 g vibration, 60 g shock

Overview

The NI 9215 module for use with NI CompactDAQ and CompactRIO chassis includes four simultaneously sampled analog input channels and successive approximation register (SAR) 16-bit analog-to-digital converters (ADCs). The NI 9215 contains NIST-traceable calibration, a channel-to-earth ground double isolation barrier for safety and noise immunity, and high common-mode voltage range.

Recommended Accessories

-NI 9927 strain relief and operator protection (for screw-terminal variant)

Optional Accessories

-NI 9936 extra screw-terminal block (for screw-terminal variant)

-NI 9980 spring terminal block (for screw-terminal variant)

Note: The NI 9980 is not compatible with the NI 9927 and must be used with low- or non-hazardous voltages or installed in a properly rated enclosure.

-BNC male to BNC male cables, 4 pack (2 m; for BNC variant)

Box Contents

-1 NI 9215 C Series module

-1 NI 9215 Operating Instructions and Specifications manual

-1 NI 9936 10-position screw-terminal connector (for screw-terminal variant)

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Comparison Tables

Product Name	Signal Ranges	Channels	Sample Rate	Simultaneous	Resolution	Isolation	Connectivity
NI 9201	±10 V	8 Single-Ended	600 kS/s	No	12-Bit	250 Vrms Ch-Earth (Screw Terminal), 60 VDC Ch-Earth (D-SUB)	Screw Terminal, 25-Pin D-SUB
NI 9205	±200 mV, ±1 V, ±5 V, ±10 V	32 Single-Ended, 16 Differential	250 kS/s	No	16-Bit	250 Vrms Ch-Earth (Spring Terminal), 60 VDC Ch-Earth (D-SUB)	Spring Terminal, 37-Pin D-SUB
NI 9206	±200 mV, ±1 V, ±5 V, ±10 V	32 Single-Ended, 16 Differential	250 kS/s	No	16-Bit	600 VDC Ch-Earth	Spring Terminal
NI 9215	±10 V	4 Differential	100 kS/s/ch	Yes	16-Bit	250 Vrms Ch-Earth (Screw Terminal), 60 VDC Ch-Earth (BNC)	Screw Terminal, BNC
NI 9220	±10 V	16 Differential	100 kS/s/ch	Yes	16-Bit	250 Vrms Ch-Earth (Spring Terminal), 60 VDC Ch-Earth (D-SUB)	Spring Terminal, 37-Pin D-SUB

Product Name	Signal Ranges	Channels	Sample Rate	Simultaneous	Resolution	Isolation	Connectivity
NI 9221	± 60 V	8 Single-Ended	800 kS/s	No	12-Bit	250 Vrms Ch-Earth (Screw Terminal), 60 VDC Ch-Earth (D-SUB)	Screw Terminal, 25-Pin D-SUB
NI 9222	± 10 V	4 Differential	500 kS/s/ch	Yes	16-Bit	60 VDC Ch-Ch	Screw Terminal
NI 9223	± 10 V	4 Differential	1 MS/s/ch	Yes	16-Bit	60 VDC Ch-Ch	Screw Terminal
NI 9229	± 60 V	4 Differential	60 kS/s/ch	Yes	24-Bit	250 Vrms Ch-Ch (Screw Terminal), 60 VDC Ch-Ch (BNC)	Screw Terminal, BNC
NI 9239	± 10 V	4 Differential	50 kS/s/ch	Yes	24-Bit	250 Vrms Ch-Ch (Screw Terminal), 60 VDC Ch-Ch (BNC)	Screw Terminal, BNC

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Application and Technology

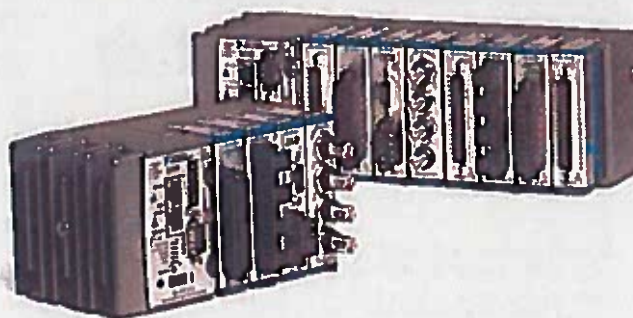
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NI CompactRIO Platform

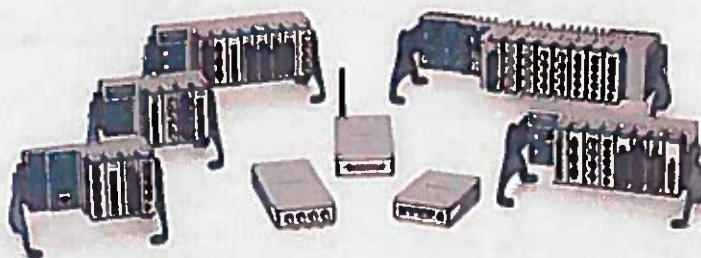


Powered by the NI LabVIEW reconfigurable I/O (RIO) architecture, NI CompactRIO combines an open embedded architecture with small size, extreme ruggedness, and hot-swappable industrial I/O modules. Each system contains an FPGA for custom timing, triggering, and processing with a wide array of modular I/O to meet any embedded application requirement.

[Configure Your Complete NI CompactRIO System](#)

NI CompactDAQ Platform

Py



NI CompactDAQ is a portable, rugged data acquisition platform that integrates connectivity and signal conditioning into modular I/O to directly interface with any sensor or signal. Using NI CompactDAQ with LabVIEW, you can easily customize how you acquire, analyze, present, and manage your measurement data. From research to development to validation, NI provides programmable software, high-accuracy measurements, and local technical support to help ensure you meet your exact measurement application requirements.

[Configure Your Complete NI CompactDAQ System](#)

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
NI 9215 Voltage Input Module			
NI 9215 with Screw Terminals Requires: 1 Connectivity Accessories:	779011-01	Connectivity Accessories: screw terminal - NI 9927 Strain relief, operator protection (qty 1)	782715-01

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Software Recommendations

LabVIEW Professional Development System for Windows



- Advanced software tools for large project development
- Automatic code generation using DAQ Assistant and Instrument I/O Assistant
- Tight integration with a wide range of hardware
- Advanced measurement analysis and digital signal processing
- Open connectivity with DLLs, ActiveX, and .NET objects
- Capability to build DLLs, executables, and MSI installers

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- Automatically take advantage of multicore CPUs or set processor affinity manually
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- Purchase individually or as part of a LabVIEW suite

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. To ensure the ongoing accuracy of your measurement hardware, NI offers basic or detailed recalibration service that provides ongoing ISO 9001 audit compliance and confidence in your measurements. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit ni.com/calibration.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
- **Online Community** - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

- **Classroom training** in cities worldwide - the most comprehensive hands-on training taught by engineers.
- **On-site training** at your facility - an excellent option to train multiple employees at the same time.
- **Online instructor-led training** - lower-cost, remote training if classroom or on-site courses are not possible.
- **Course kits** - lowest-cost, self-paced training that you can use as reference guides.
- **Training memberships and training credits** - to buy now and schedule training later.

Visit ni.com/training for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

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Detailed Specifications

The following specifications are typical for the range -40 to 70 °C unless otherwise noted.

Input Characteristics

Number of channels	4 analog input channels
ADC resolution	18 bits
Type of ADC	Successive approximation register (SAR)
Input range	±10.0 V
Input voltage ranges (AI+ to AI-) ¹	
Minimum Measurement Voltage (V) ²	±10.2
Typical Measurement Voltage (V)	±10.4

Ray

Maximum Measurement Voltage (V)	±10.6
Maximum working voltage (signal + common mode)	
With screw terminal	Each channel must remain within ±10.2 V of common
With BNC	All inputs must remain within ±10.2 V of the average AI- inputs
Overvoltage protection	±30 V
Conversion time	
Channel 0 only	4.4 µs
Channels 0 and 1	6 µs
Channels 0, 1, and 2	8 µs
Channels 0, 1, 2, and 3	10 µs

Accuracy		
Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range (Offset Error) ³
Calibrated max (-40 to 70 °C)	0.2%	0.082%
Calibrated, typ (25 °C, ±5 °C)	0.02%	0.014%
Uncalibrated max (-40 to 70 °C)	1.05%	0.82%
Uncalibrated typ (25 °C, ±5 °C)	0.6%	0.38%

Stability	
Offset drift	60 µV/°C
Gain drift	10 ppm/°C
CMRR (at 60 Hz)	-73 dB min
Input bandwidth (-3 dB)	420 kHz min
Input impedance	
Resistance	
With screw terminal	1 GΩ
With BNC (between any two AI- terminals)	200 kΩ
Input bias current	10 nA
Input noise	
RMS	1.2 LSB _{rms}
Peak-to-peak	7 LSB
Crosstalk	-60 dB
Settling time (to 2 LSBs)	
With screw terminal	
10 V step	10 µs
20 V step	15 µs
With BNC	
10 V step	25 µs
20 V step	35 µs
No missing codes	15 bits guaranteed
DNL	-1.9 to 2 LSB max
INL	±6 LSB max
MTBF	1,167,174 hours at 25 °C; Bellcore Issue 6, Method 1, Case 3, Limited Part Stress Method



Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis (full-scale input, 100 kS/s)

Active mode	560 mW, max
Suspend mode	25 μ W, max

Thermal dissipation (at 70 °C)

Active mode	560 mW, max
Suspend mode	25 μ W, max

Physical Characteristics

If you need to clean the module, wipe it with a dry towel.

Screw terminal wiring	12 to 24 AWG copper conductor wire with 10 mm (0.39 in.) of insulation stripped from the end
Torque for screw terminals	0.5 to 0.8 N · m (4.4 to 5.3 lb · in.)
Ferrules	0.25 mm ² to 2.5 mm ²
Weight	
With screw terminal	150 g (5.3 oz)
With BNC	173 g (6.1 oz)

Safety

Safety Voltages

NI 9215 with Screw Terminal Safety Voltages

Connect only voltages that are within these limits.

Channel-to-COM	± 30 V max

Isolation

Channel-to-channel	No isolation between channels

Channel-to-earth ground

Continuous	250 V _{rms} , Measurement Category II
Withstand	2,300 V _{rms} , verified by a 5 s dielectric withstand test

Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system (MAINS⁴). This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (for example, 115 AC voltage for U.S. or 230 AC voltage for Europe). Examples of Measurement Category II are measurements performed on household appliances, portable tools, and similar hardware.



Caution Do not connect the NI 9215 with screw terminal to signals or use for measurements within Measurement Categories III or IV.

NI 9215 with BNC Safety Voltages

Connect only voltages that are within these limits.

AI+ to AI-	± 30 V max

Isolation

Channel-to-channel	No isolation between channels

Channel-to-earth ground

Continuous	60 VDC, Measurement Category I
Withstand	1,500 V _{rms} , verified by a 5 s dielectric withstand test

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS⁵ voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special hardware, limited-energy parts of hardware, circuits powered by regulated low-voltage sources, and electronics.



Caution Do not connect the NI 9215 with BNC to signals or use for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1



Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nC IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nC IIC T4
Europe (DEMCO)	EEx nC IIC T4

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Environmental

National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature

(IEC 60068-2-1 and IEC 60068-2-2) -40 to 70 °C

Storage temperature

(IEC 60068-2-1 and IEC 60068-2-2) -40 to 85 °C

Ingress Protection

IP 40

Operating humidity

(IEC 60068-2-58) 10 to 90% RH, noncondensing

Storage humidity

(IEC 60068-2-58) 5 to 95% RH, noncondensing

Maximum altitude

2,000 m

Pollution Degree (IEC 60664)

2

Shock and Vibration

To meet these specifications, you must panel mount the system. If you are using the NI 9215 with screw terminal, you must also either affix ferrules to the ends of the terminal wires or use the NI 9932 backshell kit to protect the connections.

Operating vibration

Random (IEC 60068-2-34) 5 g_{rms}, 10 to 500 Hz

Sinusoidal (IEC 60068-2-6) 5 g, 10 to 500 Hz

Operating shock

(IEC 60068-2-27) 30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; Industrial Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A



Note For EMC compliance, operate this device with shielded cables.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)



Note For the standards applied to assess the EMC of this product, refer to the [Online Product Certification](#) section.

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)



EU Customers At the end of their life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.

Calibration

You can obtain the calibration certificate for this device at ni.com/calibration.

Calibration Interval

1 year

¹ Refer to the *Safety Guidelines* section of the *NI 9215 Operating Instructions and Specifications* for more information about safe operating voltages.

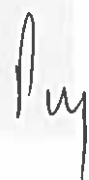
² The minimum measurement voltage range is the largest voltage the device is guaranteed to accurately measure.

³ Range equals 10.4 V.

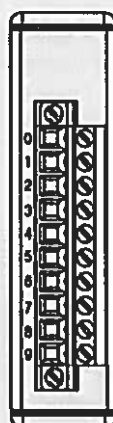
⁴ MAINS is defined as a hazardous live electrical supply system that powers hardware. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

⁵ MAINS is defined as a hazardous live electrical supply system that powers hardware. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

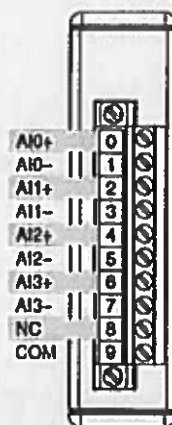
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Pinouts/Front Panel Connections



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TECHNICAL DESCRIPTION

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LOCAL VACUUM CONTROL SYSTEMS

ANNEX W5

National Instruments 9871 RS232/485 module



Technical Sales

(866) 531-6285
orders@ni.com

Requirements and Compatibility | Ordering Information | Detailed Specifications | Pinouts/Front Panel Connections

For the manuals and literature that are right for you, visit the product page resources at ni.com.

Last Revised: 2014-11-08 07:14:00.0

NI 9870, NI 9871

- 4 RS232 (TIA/EIA-232) or 4 RS485/RS422 serial ports for CompactRIO
- Baud rates from 14 bit/s to 921.6 kbit/s
- Individual 64 B UART FIFO buffers per port
- Data bits: 5, 6, 7, 8; Stop bits: 1, 1.5, 2; Flow control: XON/OFF, RTS/CTS, None
- 8 to 28 VDC externally powered; PC-MF4-PT cable included
- -40 to 70 °C operating range

Overview

The NI 9870 and NI 9871 C Series serial modules add four RS232 or RS485/RS422 serial ports, respectively, to NI CompactRIO systems. Using an NI LabVIEW FPGA API, you can access the four ports directly from the CompactRIO field-programmable gate array (FPGA) to achieve flexibility in communicating with serial devices. The modules have individual 64 B buffers on every port that save CompactRIO FPGA space and simplify programming. These C Series modules support standard start bit, stop bit, and handshaking settings and feature baud rates up to 921.6 kbit/s per port. You can pass up to 2 Mbit/s of data between these modules and CompactRIO.

[Back to Top](#)**Requirements and Compatibility****OS Information**

- Linux®
- Mac OS X
- Windows
- Windows 7
- Windows Vista
- Windows XP

Driver Information

- C-Series Serial
- NI-RIO

Software Compatibility

- LabVIEW Development System
- LabVIEW FPGA Module
- Visual C#
- Visual C++

[Back to Top](#)**Application and Technology****NI C Series Chassis****NI CompactDAQ Platform**

NI CompactDAQ delivers the simplicity of USB to sensor and electrical measurements on the benchtop, in the field, and on the production line. By combining the ease of use and low cost of a data logger with the performance and flexibility of modular instrumentation, NI CompactDAQ offers fast, accurate measurements in a small, simple, and affordable system. Flexible software options make it easy to use NI CompactDAQ to log data for simple experiments or to develop a fully automated test or control system. The modular design can measure up to 256 channels of electrical, physical, mechanical, or acoustical signals in a single system. In addition, per-channel ADCs and individually isolated modules ensure fast, accurate, and safe measurements.



Figure 1. NI CompactDAQ Platform

NI CompactRIO Platform

When used with the small, rugged CompactRIO embedded control and data acquisition system, C Series analog input modules connect directly to reconfigurable I/O (RIO) field-programmable gate array (FPGA) hardware to create high-performance embedded systems. The reconfigurable FPGA hardware within CompactRIO provides a variety of options for custom timing, triggering, synchronization, filtering, signal processing, and high-speed decision making for all C Series analog input modules. For instance, with CompactRIO, you can implement custom triggering for any analog sensor type on a per-channel basis using the flexibility and performance of the FPGA and the numerous arithmetic and comparison function blocks built into the NI LabVIEW FPGA Module.

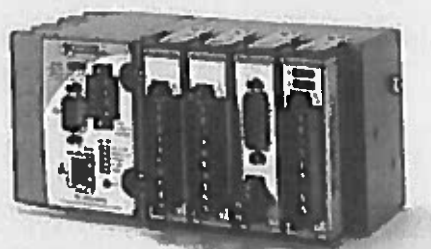


Figure 2. NI CompactRIO Platform

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
NI 9870 Serial Module			
NI 9870 4-Port RS232 Serial Module	779891-02	No accessories required.	
NI 9871 Serial Module			
NI 9871 4-Port RS485 Serial Module	779892-02	No accessories required.	

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Software Recommendations

NI LabVIEW Full Development System for Windows

- Fully integrated graphical system design software
- Support for a wide range of measurement hardware, I/O, and buses
- Custom, event-driven user interfaces for measurement and control
- Extensive signal processing, analysis, and math functionality
- Advanced compiler to ensure high-performance execution and code optimization

NI LabVIEW FPGA Module



- Design FPGA applications for NI reconfigurable I/O (RIO) hardware targets
- Program with the same graphical environment used for desktop and real-time applications
- Execute control algorithms with loop rates up to 300 MHz
- Implement custom timing and triggering logic, digital protocols, and DSP algorithms



Includes SSP for professional technical support, online training, and software upgrades

- Incorporate existing HDL code and third-party IP including Xilinx CORE Generator functions
- Included in the LabVIEW Embedded Control and Monitoring Suite

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Repair

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Training and Certifications

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- **Course kits** - lowest-cost, self-paced training that you can use as reference guides.
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Extended Warranty

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Alliance

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Detailed Specifications

The following specifications are typical for the range -40 to 70 °C unless otherwise noted.

NI 8870

Maximum baud rate

921.6 kbps

Maximum cable length

250 pF equivalent

Py

 Note Cable capacitance greater than 250 pF may adversely affect the maximum baud rate and thermal dissipation.

Maximum RS232 Receive signal (RXD, CTS, DSR, DCD, RI) Continuous Voltage ± 8 V

 Note Continuous RS232 input voltages in excess of ± 8 V may cause excessive thermal dissipation.

Data line ESD protection (human body model) ± 15 kV

MTBF 448,008 hours at 25 °C; Bellcore Issue 6, Method 1, Case 3, Limited Part Stress Method

 Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

NI 9871

Maximum baud rate 3.6864 Mbps

Maximum cable length 1.2 km (4,000 ft.)

Data line ESD protection (human body model) ± 15 kV

MTBF 514,018 hours at 25 °C; Bellcore Issue 6, Method 1, Case 3, Limited Part Stress Method

 Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis

0.5 W max

Active mode

50 μ W max

Sleep mode

Thermal dissipation (at 70 °C)

1.5 W max

Active mode

0.5 W max

NI 9870 Sleep mode

NI 9871 Sleep mode

55 mW max

+8 to +28 VDC

Required external supply voltage range (V_{SUP})

Power supply consumption from external supply V_{SUP}

NI 9870

Typical

0.5 W

Maximum

2 W

NI 9871

Typical

1 W

Maximum

3.5 W

Physical Characteristics

If you need to clean the module, wipe it with a dry towel.

Weight

Approx. 154 g (5.4 oz)

Safety

NI 9870 Maximum Voltage ¹

Connect only voltages that are within these limits.

RS232 Receive Signal-to-COM (RXD, CTS, DSR, DCD, RI)

± 25 V max, Measurement Category I

RS232 Transmit Signal-to-COM (TX, RTS, DTR)

± 13.2 V max, Measurement Category I

V_{SUP} -to-COM

± 28 V max, Measurement Category I

NI 9871 Maximum Voltage ¹

RS485/RS422 Port-to-COM

-8 to +13 VDC max, Measurement Category I

V_{SUP} -to-COM

± 28 V max, Measurement Category I

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.



Caution Do not connect to signals or use for measurements within Measurement Categories II, III, or IV.

Isolation Voltages

Port-to-earth ground

Withstand

1000 V_{rms}, verified by a dielectric withstand test, 5 s

Continuous

60 VDC, Measurement Category I

Hazardous Locations

U.S. (UL)

Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA II T4

Canada (C-UL)

Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA II T4

Europe (DEMKO)

Ex nA IIC T4

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1



Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

Emissions

EN 55011 Class A at 10 m FCC Part 15A above 1 GHz

Immunity

Industrial levels per EN 61326-1:1997 + A2 2001, Table A.1

EMC/EMI

CE, C-Tick, and FCC Part 15 (Class A) Compliant



Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.



Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

To obtain product certifications and the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Shock and Vibration

To meet these specifications, you must panel mount the CompactRIO system.

Operating vibration, random (IEC 60068-2-64)

5 g_{rms}, 10 to 500 Hz

Operating shock (IEC 60068-2-27)

30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Operating vibration, sinusoidal (IEC 60068-2-6)

5 g, 10 to 500 Hz

Environmental

CompactRIO modules are intended for indoor use only. For outdoor use, mount the CompactRIO system in a suitably rated enclosure. Refer to the installation instructions for the chassis you are using for more information about meeting these specifications.

Operating temperature

-40 to 70 °C

Storage temperature

-40 to 85 °C

Ingress protection

IP 30

Operating humidity

10 to 90% RH, noncondensing

Storage humidity

5 to 95% RH, noncondensing

Maximum altitude

2,000 m

Pollution Degree (IEC 60684)

2

Environmental Management

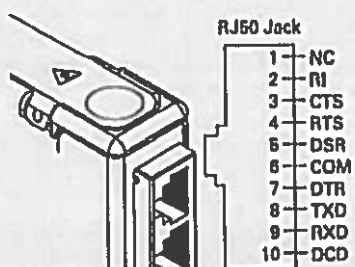
NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

¹ The maximum voltage that can be applied or output without creating a safety hazard.

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RS232 Port Pinout

RJ-45 Pin	Signal Name*
1	No Connect
2	RI
3	CTS
4	RTS
5	DSR
6	GND
7	DTR
8	TXD
9	RXD
10	DCD

* These signals are shared by all four RJ-45 connectors on the NI 8870.

Gigabit Ethernet	2
High-Speed USB	4
PS/2 Ports	2
Video	VGA
Expansion Slot	1
Expansion Slot Type	x16 Gen2
Rack-Mount Rails	Yes
Installed OS Options	Windows 7 (32-64-Bit), Windows XP FES (32-Bit), LabVIEW Real-Time

Connectivity to PXI or PXI Express Systems

The NI RMC-8354 controller features an empty x16 Gen 2 PCI Express expansion slot. You can populate this slot with a MXI-Express remote controller to create a software-transparent link, which requires no programming, to a PXI or PXI Express chassis. Refer to the PXI advisor for all possible configurations at ni.com/pxidvisor.

Quad-Core Processor

The RMC-8354 includes the quad-core Intel Core i7-860QM processor. Quad-core processors contain four cores, or computing engines, in one physical package. To increase the number of threads that you can process, the RMC-8354 takes advantage of Intel Hyper-Threading Technology that takes each of the four physical cores and splits them into two virtual cores, for a total of eight virtual cores. These eight virtual cores can execute eight computing tasks, which is advantageous in multitasking environments such as Windows 7. Multithreaded system development environments, such as NI LabVIEW, can take full advantage of the processing cores on the RMC-8354 by automatically separating their tasks into independent threads.

Intel Turbo Boost Technology

Previously, to fully exercise all the physical cores on a multicore CPU, applications had to be architected to create four independent execution threads by implementing programming strategies such as task parallelism, data parallelism, and pipelining. However, Intel introduced Turbo Boost Technology to provide performance benefits for all types of applications without requiring the application to be optimized for multicore processors. The RMC-8354 has a 2.8 GHz base clock frequency, and, with Intel Turbo Boost Technology, the frequency automatically increases based on the application type. For example, when running applications that generate only a single processing thread, the CPU places the three unused cores into an idle state and increases the active core's clock frequency from 2.8 to 3.46 GHz.¹ For applications that are processing two threads, the CPU places the two unused cores into an idle state and increases the active core's clock frequency from 2.8 to 3.3 GHz.¹ For applications using four threads, the CPU increases from 2.8 to 2.93 GHz.¹ Turbo Boost provides performance increases for all types of applications and can significantly reduce test times for applications that are processor-intensive.

¹Processor should not throttle CPU frequency under reasonable, worst-case processor workloads in high operating temperatures.

High Data and Memory Bandwidth

To create high-performance test and measurement systems, two system controller features, data and memory bandwidth, are critically important. The RMC-8354 features a x16 Gen 2 PCI Express expansion slot that, when paired with National Instruments high-bandwidth remote controllers, allows high data throughput from PXI Express chassis. The RMC-8354 also features up to 16 GB of dual-channel DDR3 1333 MHz RAM that perfectly complements the high-throughput expansion slot by providing sufficient memory capacity and fast memory access rates.

RAID Configurations

Redundant array of independent disk (RAID) data storage schemes divide and/or replicate data among multiple hard drives. They are used to provide increased data reliability and/or increased I/O performance. The RMC-8354 (Windows version) works with a variety of RAID configurations such as RAID-0/1/5/10 with multiple SATA II hard drives. A RAID-0 configuration increases the rate at which a computer can write data to and read data from disk by evenly distributing data among multiple hard drives. This is beneficial in applications that require high-speed data streaming to/from disk. RMC-8354 controller versions with multiple hard drives are shipped with factory-configured RAID-5 configurations.

Deterministic Performance With Real-Time OS

National Instruments offers a version of the RMC-8354 rack-mount controller that works with the LabVIEW Real-Time OS. With this development platform, you can build real-time measurement and control applications with high determinism. You develop your LabVIEW application with the LabVIEW Real-Time Module on Windows and download the program to your RMC-8354 real-time controller via Ethernet. The embedded code executes on a real-time OS, so you can use powerful and flexible LabVIEW development tools to build reliable, real-time solutions.

Better Acoustic Performance

Rack-mount controllers from National Instruments are designed with powerful quad-core processors that typically have high heat dissipation. Using these processors in their specified operating environments requires the controller to provide sufficient air cooling. The RMC-8354 features a new cooling design that the older-generation NI 8353 rack-mount controllers do not offer. This new design allows for significantly reduced acoustic emission, making it much quieter during operation than an NI 8353.

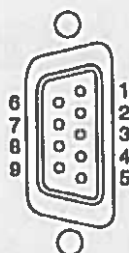
RMC-8354 Kits

Kit Part Number	Operating System	Default System RAM	Default Hard Drives
781850-01	Windows XP FES (32-Bit)	1 GB	1 x 500 GB
781851-01	Windows XP FES (32-Bit)	2 GB	4 x 500 GB (RAID-5)
781850-04	Windows 7 (32-Bit)	1 GB	1 x 500 GB
781851-04	Windows 7 (32-Bit)	2 GB	4 x 500 GB (RAID-5)
781852-04	Windows 7 (64-Bit)	2 GB	4 x 500 GB (RAID-5)
781850-33	LabVIEW Real-Time	1 GB	1 x 500 GB

RMC-8354 Images



Figure 1. RMC-8354 Front View With Bezel



Pin Assignments for RS232 DB-9 Male Connector

Pin	Signal
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

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TECHNICAL DESCRIPTION

LOCAL VACUUM CONTROL SYSTEMS

ANNEX W6

National Instruments RMC 8354 zone controller

Last Revised: 2014-11-06 07:13:45.0

NI RMC-8354**1U Quad-Core Rack-Mount Controller**

- Intel Core i7-860 quad-core processor
- 2.8 GHz base frequency (3.46 GHz single-core Turbo frequency)
- 1/2 GB of 1333 MHz DDR3 RAM standard
- 16 GB of 1333 MHz DDR3 RAM maximum
- Up to 4 x 500 GB SATA 3.5 in. hard drives (2 TB total storage maximum)
- Support for RAID-0/1/5 hard-drive configurations

- Single PCI Express expansion slot (x16 Gen2, unpopulated)
- Built-in DVD-ROM standard, with optional DVD-RW available
- Optimized for installation in 1U height in a 19 in. rack
- Universal AC power supply
- OS, drivers, and hard-drive based recovery software preinstalled
- MXI-Express remote control kits not included

Overview

The NI RMC-8354 is a high-performance, Intel Core i7 quad-core processor-based, server-class controller for use in PXI or PXI Express systems. In addition to high-computing performance, these controllers provide high sustainable I/O bandwidth when bundled with an NI MXI-Express remote control kit. With support for redundant array of independent disk (RAID)-configured hard drives for Windows-based systems, these controllers are ideal for high-end test and measurement applications.

[Back to Top](#)**Requirements and Compatibility****OS Information**

- PharLap
- Windows 7
- Windows 7 64-bit
- Windows XP

[Back to Top](#)**Application and Technology****NI RMC-8354 Detailed Features**

Features	NI RMC-8354
Processor	Intel Core i7-860
CPU Cores	4
Base Frequency	2.8 GHz
Single-Core Turbo Frequency	3.46 GHz
L2 Cache	8 MB
Memory Standard	1 or 2 GB
Memory Maximum	16 GB
Memory Type	DDR3 1333 MHz
Hard Drive	1 or 4 x 500 GB SATA II 3.5 in.
Removable Hard Drive	Yes



Gigabit Ethernet	2
High-Speed USB	4
PS/2 Ports	2
Video	VGA
Expansion Slot	1
Expansion Slot Type	x16 Gen2
Rack-Mount Rails	Yes
Installed OS Options	Windows 7 (32-/64-Bit), Windows XP FES (32-Bit), LabVIEW Real-Time

Connectivity to PXI or PXI Express Systems

The NI RMC-8354 controller features an empty x16 Gen 2 PCI Express expansion slot. You can populate this slot with a MXI-Express remote controller to create a software-transparent link, which requires no programming, to a PXI or PXI Express chassis. Refer to the PXI advisor for all possible configurations at ni.com/pxiadvisor.

Quad-Core Processor

The RMC-8354 includes the quad-core Intel Core i7-860QM processor. Quad-core processors contain four cores, or computing engines, in one physical package. To increase the number of threads that you can process, the RMC-8354 takes advantage of Intel Hyper-Threading Technology that takes each of the four physical cores and splits them into two virtual cores, for a total of eight virtual cores. These eight virtual cores can execute eight computing tasks, which is advantageous in multitasking environments such as Windows 7. Multithreaded system development environments, such as NI LabVIEW, can take full advantage of the processing cores on the RMC-8354 by automatically separating their tasks into independent threads.

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781852-04	Windows 7 (64-Bit)	2 GB	4 x 500 GB (RAID-5)
781850-33	LabVIEW Real-Time	1 GB	1 x 500 GB

RMC-8354 Images



Figure 1. RMC-8354 Front View With Bezel



Figure 2. RMC-8354 Front View Without Bezel



Figure 3. RMC-8354 Rear View

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
Upgrades, Spares, and Accessories			
FPM-1017 17 In. Flat Panel Monitor With VGA Input for PCs	779559-01	No accessories required.	
FPM-1019, 19 In. Widescreen Flat Panel Monitor, DVI Input for PCs	781002-01	No accessories required.	
2 GB DDR3 RAM for NI RMC-8354 (1 x 2 GB DIMM)	781653-01	No accessories required.	
4 GB DDR3 RAM for NI RMC-8354 (1 x 4 GB DIMM)	781654-01	No accessories required.	
Spare 500 GB Hard Drive and Drive Bay for NI RMC-8354	781727-01	No accessories required.	
USB English Keyboard and Optical USB Mouse	779560-01	No accessories required.	
NI MKD-1117 Rack-Mount 1U LCD Monitor, Keyboard, Mouse Drawer	779872-01	No accessories required.	
FPT-1015 15 In. Flat Panel Touch Screen With VGA Interface and USB	779560-01	No accessories required.	
NI RMC-8354 Kits			
NI RMC-8354, Windows XP, 1 GB RAM, 1 x 500 GB HDD	781650-01	No accessories required.	
NI RMC-8354, Windows XP, 2 GB RAM, 4 x 500 GB HDD	781651-01	No accessories required.	
NI RMC-8354, Windows 7 (32-bit), 1 GB RAM, 1 x 500 GB HDD	781650-04	No accessories required.	
NI RMC-8354, Windows 7 (32-bit), 2 GB RAM, 4 x 500 GB HDD	781651-04	No accessories required.	
NI RMC-8354, Windows 7 (64-bit), 2 GB RAM, 4 x 500 GB HDD	781652-04	No accessories required.	
NI RMC-8354, LabVIEW Real-Time OS, 1 GB RAM, 1 x 500 GB HDD	781650-33	No accessories required.	

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
- **Online Community** - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Pay

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

- Classroom training in cities worldwide - the most comprehensive hands-on training taught by engineers.
- On-site training at your facility - an excellent option to train multiple employees at the same time.
- Online instructor-led training - lower-cost, remote training if classroom or on-site courses are not possible.
- Course kits - lowest-cost, self-paced training that you can use as reference guides.
- Training memberships and training credits - to buy now and schedule training later.

Visit ni.com/training for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

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Detailed Specifications

This appendix lists the NI RMC-8354 electrical, mechanical, and environmental specifications.

Electrical	
AC Input	
Input voltage range	100–240 VAC
Operating voltage range ¹	90–264 VAC
Input frequency	50/60 Hz
Operating frequency range ¹	47–63 Hz
Input current rating	5 A max
Power disconnect	The AC power cable provides main power disconnect. Depressing the front panel power switch enables or inhibits the internal power supply.
Power Requirements	
Measured, peak inrush (power ON)	197 W
Measured, idle	92 W
Measured, active (100% CPU)	203 W
Mainboard	
Socket	LGA 1156
Chipset	Intel 3420 chipset
Memory Slots	Four 240-pin DIMM slots, three per channel, 1066/1333 16 GB max memory
PCI Express	One PCI Express 2.0 x16 slot
SATA	Six SATA ports compliant with the Serial-ATA 2.0 specification.
USB ports	Four USB 2.0 ports
Keyboard	PS/2 keyboard port
Mouse	PS/2 mouse port
Video	VGA port, onboard Matrox G200eW 16 MB DDR2 (max resolution 1280 × 1024)

Serial	One RS-232 serial port
LAN	Two RJ45 LAN jacks
Onboard LAN controller	Intel 82574L Gigabit Ethernet controller
CPU	
CPU	Intel i7 860 Quad Core
Clock speed	2.86 GHz
Max turbo frequency (single core)	3.46 GHz
Intel Smart Cache	8 MB
Package	LGA 1156
Hard Disk Drive	
Capacity	500 GB in one, two, or four-drive configurations for maximum capacity of 2 TB (maximum usable capacity shown by Windows in RAID 5 is 1.36 TB)
Interface	Serial-ATA
Memory	
Standard memory	1/2 x 1 GB (128 M x 72 bit), DDR-III SDRAM, ECC 1333 MHz
4 GB memory upgrade	2 x 2 GB (128 M x 72 bit), DDR-III SDRAM, ECC 1333 MHz
8 GB memory upgrade (64-bit OS)	4 x 2 GB (128 M x 72 bit), DDR-III SDRAM, ECC 1333 MHz
16 GB memory upgrade (64-bit OS)	4 x 4 GB (512 M x 72 bit), DDR-III SDRAM, ECC 1333 MHz
Mechanical	
Overall dimensions (standard chassis)	
Height	1U
Width	437 mm (17.2 in.)
Depth	503 mm (19.8 in.)
Weight (with four 500 GB drives)	10.75 kg (23.7 lbs)
Environmental	
 Caution If installed in a closed or multiunit rack assembly, the rack environment operating ambient temperature may be greater than room ambient temperature. Therefore, install the equipment in an environment compatible with the maximum ambient temperature (T _{max}) the manufacturer specifies.	
Operating temperature	5 to 35 °C (Tested in accordance with IEC-60068-2-1.)
Storage temperature	-40 to 70 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)
Relative humidity (tested in accordance with IEC-60068-2-56)	
Operating	10 to 90% noncondensing
Nonoperational (storage)	5 to 95% noncondensing
Operating location	Indoor use
Altitude	2,000 m
Installation Category	II
Pollution Degree	2
Acoustic Emissions ²	
Sound pressure level (at operator position)	



Minimum	53.9 dBA
Maximum	64.9 dBA
Sound power	
Minimum	51.9 dBA
Maximum	72.0 dBA

Safety

This product is designed to meet the requirements of the following standards of safety for information technology equipment:

- IEC 60950-1, EN 60950-1
- UL 60950-1, CSA 60950-1



Caution Overloading the circuits may damage supply wiring. Do not exceed the ratings on the equipment nameplate when connecting equipment to the supply circuit.



Note For UL and other safety certifications, refer to the product label or the [Online Product Certification](#) section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326-1): Class A emissions; Basic immunity
- EN 65011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions



Note For EMC declarations and certifications, refer to the [Online Product Certification](#) section.



Note When operating this product, use shielded cables and accessories.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC, Low-Voltage Directive (safety)
- 2004/108/EC, Electromagnetic Compatibility Directive (EMC)

Online Product Certification

To obtain product certifications and the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)



EU Customers At the end of the product life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste Electrical and Electronic Equipment, visit ni.com/environment/weee.htm.

Battery Replacement and Disposal



Battery Directive This device contains a long-life coin cell battery. If you need to replace it, use the Return Material Authorization (RMA) process or contact an authorized National Instruments service representative. For more information about compliance with the EU Battery Directive 2006/66/EC about Batteries and Accumulators and Waste Batteries and Accumulators, visit ni.com/environment/batterydirective.

电子信息产品污染控制管理办法 (中国 RoHS)

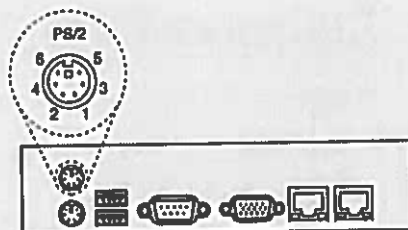


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¹ Operating range is guaranteed by design.

² Typical data. Tested in accordance with ISO 7779; meets MIL-PRF-28800F requirements.

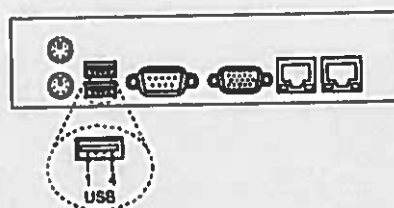
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PS/2 Connector Location and Pinout

PS/2 Connector Signals		
Pin	Signal Name	Signal Description
1	DATA	Data Keyboard
2	NC	Data Mouse
3	GND	Ground
4	VCC	VCC
5	CLK	Clock Keyboard
6	NC	Clock Mouse

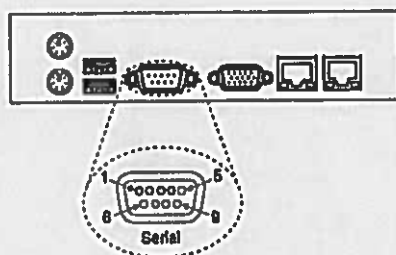
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USB Connector Location and Pinout

USB Connector Signals

Pin	Signal Name	Signal Description
1	VCC	Cable Power (+5 V)
2	-Data	USB Data-
3	+Data	USB Data+
4	GND	Ground

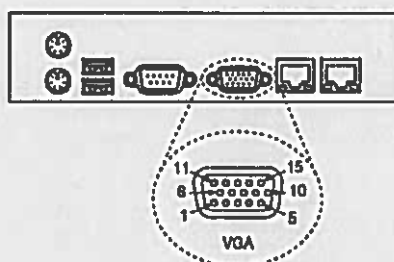


Serial Connector Location and Pinout

Serial Connector Signals

Pin	Signal Name	Signal Description
1	DCD*	Data Carrier Detect
2	SIN*	Receive Data
3	SOUT*	Transmit Data
4	DTR*	Data Terminal Ready
5	GND	Ground
6	DSR*	Data Set Ready
7	RTS*	Ready to Send
8	CTS*	Clear to Send
9	RI*	Ring Indicator

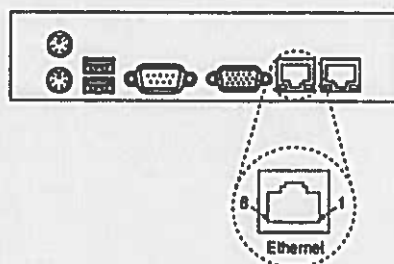
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VGA Connector Location and Pinout

VGA Connector Signals

Pin	Signal Name	Signal Description
1	R	Red
2	G	Green
3	B	Blue
4	NC	Not Connected
5	GND	Ground
6	GND	Ground
7	GND	Ground
8	GND	Ground
9	+5V	5 V
10	GND	Ground
11	NC	Not Connected
12	SD	Serial Data
13	HSync	Horizontal Sync
14	VSynC	Vertical Sync
15	SC	Serial Clock



Ethernet Connector Location and Pinout

Ethernet Connector Signals

Pin	Signal Name	Signal Description
1	D0P	Differential Pair 0+
2	D0N	Differential Pair 0-
3	D1P	Differential Pair 1+
4	D2P	Differential Pair 2+
5	D2N	Differential Pair 2-
6	D1N	Differential Pair 1-
7	D3P	Differential Pair 3+
8	D3N	Differential Pair 3-

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Annex 7 -The breakdown of the Price of the Work and the Payment Schedule

1. Price of Deliverables hereof

Deliverable	Price of Deliverable excl. VAT - CZK	VAT in %	Price of Deliverable incl. VAT
D1	5.519.600,00 CZK	not applicable	not applicable
D2	5.578.700,00 CZK	not applicable	not applicable
D3	10.034.100,00 CZK	not applicable	not applicable
D4	5.111.800,00 CZK	not applicable	not applicable
D5	448.000,00 CZK	not applicable	not applicable
D6	3.549.800,00 CZK	not applicable	not applicable
D7	3.588.600,00 CZK	not applicable	not applicable
D8	rate per service day* 13.600 CZK/service day, maximum number of service days 3	not applicable	not applicable

*rate per service day shall be invoiced on the basis of actual work carried out and includes any costs on the part of the Contractor excluding travel costs; these can be invoiced by the Contractor only upon a prior written consent of the Client. Such Client's consent shall not be unreasonably withheld in the cases where these travel

costs will be within the standards of currently eligible costs under the **OP RF**.

2. Contractual Parties have agreed that the Contractor shall be authorized to invoice the Price of the Work as follows:

Deliverable	Invoicing (invoice issue)
D1	20% of the Price of D1 after fulfillment of the partial deliverable D1 i), 30% of the Price of D1 after fulfillment of the partial deliverable D1 ii), 30% of the Price of D1 after fulfillment of the partial deliverable D1 iii), 20% of the Price of D1 after fulfillment of the partial deliverable D1 iv).

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D2	20% of the Price of D2 after fulfillment of the partial deliverable D2 i), 30% of the Price of D2 after fulfillment of the partial deliverable D2 ii), 30% of the Price of D2 after fulfillment of the partial deliverable D2 iii), 20% of the Price of D2 after fulfillment of the partial deliverable D2 iv).
D3	20% of the Price of D3 after fulfillment of the partial deliverable D3 i), 30% of the Price of D3 after fulfillment of the partial deliverable D3 ii), 30% of the Price of D3 after fulfillment of the partial deliverable D3 iii), 20% of the Price of D3 after fulfillment of the partial deliverable D3 iv).
D4	20% of the Price of D4 after fulfillment of the partial deliverable D4 i), 30% of the Price of D4 after fulfillment of the partial deliverable D4 ii), 30% of the Price of D4 after fulfillment of the partial deliverable D4 iii), 20% of the Price of D4 after fulfillment of the partial deliverable D4 iv).
D5	20% of the Price of D5 after fulfillment of the partial deliverable D5 i), 30% of the Price of D5 after fulfillment of the partial deliverable D5 ii), 30% of the Price of D5 after fulfillment of the partial deliverable D5 iii), 20% of the Price of D5 after fulfillment of the partial deliverable D5 iv).
D6	20% of the Price of D6 after fulfillment of the partial deliverable D6 i), 30% of the Price of D6 after fulfillment of the partial deliverable D6 ii), 30% of the Price of D6 after fulfillment of the partial deliverable D6 iii), 20% of the Price of D6 after fulfillment of the partial deliverable D6 iv).
D7	20% of the Price of D7 after fulfillment of the partial deliverable D7 i), 30% of the Price of D7 after fulfillment of the partial deliverable D7 ii), 30% of the Price of D7 after fulfillment of the partial deliverable D7 iii), 20% of the Price of D7 after fulfillment of the partial deliverable D7 iv).
D8	Always on the day following the fulfilment of the respective partial obligation based on the Order.

Fyzikální ústav AV ČR, v. v. i.

Dozorčí rada

Na Slovance 1999/2, 182 21 Praha 8

Prof. Jan Řídký, DrSc.
ředitel FZÚ AV ČR, v. v. i.

V Praze dne 20. února 2015

**Věc: Předchozí písemný souhlas s uzavřením smlouvy o dílo na návrh, výrobu, sestavení ,
otestování, dodání a instalaci vakuových komor**

Dozorčí rada FZÚ AV ČR, v.v.i., dne 20. února 2015 uzavřela per rollam projednávání návrhu smlouvy o dílo na návrh, výrobu, sestavení , otestování, dodání a instalaci vakuových komor včetně kontrolního systému.

Všichni členové Dozorčí rady se k návrhu smlouvy vyjádřili a neměli k němu žádné připomínky.

Dozorčí rada Fyzikálního ústavu AV ČR, v. v. i., proto podle ustanovení §19, odst. (1), písm. b), bod 2 zákona č. 341/2005 Sb.

**uděluje předchozí písemný souhlas s uzavřením smlouvy o dílo
na návrh, výrobu, sestavení , otestování, dodání a instalaci vakuových komor
včetně kontrolního systému.**



RNDr. Jan Šafanda, CSc.
předseda DR FZÚ AV ČR, v. v. i.

Souhlas zřizovatele

Akademie věd České republiky se sídlem Praha 1, Národní 1009/3, IČ 60165171, jako zřizovatel Fyzikálního ústavu AV ČR, v. v. i., se sídlem Praha 8, Na Slovance 1999/2, IČ 68378271,

uděluje ve smyslu § 15 písm. k) zákona č. 341/2005 Sb., o veřejných výzkumných institucích, předchozí souhlas k uzavření smlouvy o dílo na realizaci veřejné zakázky s názvem „Vacuum interaction chambers for experimental programmes and experimental local vacuum control systems“, zadávané pro projekt ELI, mezi Fyzikálním ústavem AV ČR, v. v. i., a vybraným uchazečem o tuto zakázku, a to za cenu v maximální výši 35.000.000 Kč + DPH.

O udělení souhlasu k uzavření smlouvy o dílo rozhodla Akademická rada AV ČR na svém 26. zasedání konaném dne 17. února 2015.

V Praze 24. února 2015
Čj.: KAV-614/MK/2015



prof. Ing. Jiří Drahoš, DrSc., dr. h. c.
předseda AV ČR