



EUROPEAN UNION
European Structural and Investing Funds
Operational Programme Research,
Development and Education



MINISTRY OF EDUCATION,
YOUTH AND SPORTS

PURCHASE CONTRACT

This purchase contract ("**Contract**") was concluded pursuant to section 2079 *et seq.* of the act no. 89/2012 Coll., Civil Code ("**Civil Code**"), on the day, month and year stated below by and between:

- (1) **Institute of Physics of the Academy of Sciences of the Czech Republic, a public research institution,**

with its registered office at: Na Slovance 2, Praha 8, PSČ: 182 21,

registration no.: 68378271,

represented by: RNDr. Michael Prouza, Ph.D., director

("Buyer"); and

- (2) **Lastronics GmbH,**

with its registered office at: Lastronics Jena GmbH

with its registered office at: Moritz-von-Rohr-Straße 9, 07745 Jena, Germany

registration no.: Jena HRB 504004, ID 19604077

represented by: Dr. Thomas Töpfer ("**Seller**").

(The Buyer and the Seller are hereinafter jointly referred to as "**Parties**" and individually as "**Party**".)

WHEREAS

- (A) The Buyer is a public contracting authority and the beneficiary of public grants for projects within the Operational Programme Research, Development and Education.
- (B) For the successful realization of projects it is necessary to purchase the Object of Purchase (as defined below) in accordance with the act no. 134/2016 Coll., on public procurement, and Rules for the Selection of Suppliers within the Operational Programme Research, Development and Education.
- (C) The Seller wishes to provide the Object of Purchase to the Buyer for consideration.
- (D) The Seller's bid for the public procurement entitled "*Pump diode module for half Joule multipass amplifier TP20_117*", whose purpose was to procure the Object of Purchase ("**Public Procurement**"), was selected by the Buyer as the most suitable.

IT WAS AGREED AS FOLLOWS:



1. BASIC PROVISIONS

- 1.1 Under this Contract the Seller shall hand over to the Buyer a pump diode module (including all accessories) that is described in Annex 1 (*Technical Specification*) to this Contract in the quality described therein (“**Object of Purchase**”) and shall transfer to the Buyer ownership right to the Object of Purchase, and the Buyer shall take over the Object of Purchase and shall pay the Seller the Purchase Price (as defined below), all under the terms and conditions stipulated in this Contract.
- 1.2 Under this Contract the Seller shall also:
- a) verify that Object of Purchase meet all requirements stipulated in this Contract;
 - b) transport the Object of Purchase to the place of delivery under the conditions stipulated in Annex 1 (*Technical Specification*);
 - c) install the Object of Purchase at the place of delivery and demonstrate its functionality;
 - d) to elaborate and hand over to the Buyer operational and maintenance manuals of the Object of Purchase in the extent specified in Annex 1 (*Technical Specification*) or other documents which are necessary for the proper takeover and use of the Object of Purchase in Czech or English language;
 - e) carry out other activities specified in Annex 1 (*Technical Specification*); and
 - f) cooperate with the Buyer during the performance of this Contract
- (“**Related Activities**”).

2. THE PLACE OF DELIVERY

The place of delivery is at the address: Fyzikální ústav AV ČR v.v.i/ELI beamlines, Průmyslová 836, post code 252 41, Dolní Břežany, Czech Republic.

3. THE TIME OF DELIVERY

- 3.1 The Seller shall deliver and install the Object of Purchase within 6 months from the effectiveness of this Contract. The Buyer is entitled to postpone the time of delivery by 1 month, if the premises at the place of delivery are not due to construction reasons prepared for acceptance of the Object of Purchase.

The Buyer shall extend the time of delivery at the request of the Seller, if the Seller is not able to fulfill this Contract due to circumstances that the Seller had no control over and such circumstances were hard to anticipate and are hard to overcome (e.g. covid-19 measures). In order for the Buyer to extend the time of delivery, the Seller must prove to the Buyer that such circumstances happened and explain how it adversely impacted the Seller. In case of doubts, the Buyer may also ask the Seller to support its claims with an



adequate evidence. The Buyer shall extend the time of delivery by the period corresponding to the time that is necessary for obstacles to disappear or to be overcome by the Seller.

4. **THE OWNERSHIP RIGHT**

The ownership right to the Object of Purchase shall be transferred to the Buyer upon the acceptance of the Object of Purchase by the Buyer.

5. **PRICE AND PAYMENT TERMS**

- 5.1 The purchase price for the Object of Purchase is 58 680,- EUR ("**Purchase Price**") without value added tax ("**VAT**"). VAT will be paid in accordance with the applicable legal regulations.
- 5.2 The Purchase Price cannot be exceeded and includes all costs and expenses of the Seller related to the performance of this Contract. The Purchase Price includes, among others, all expenses related to the handover and acceptance of the Object of Purchase and execution of Related Activities, costs of copyright, insurance, customs, warranty service and any other costs and expenses connected with the performance of this Contract.
- 5.3 The Purchase Price for the Object of Purchase shall be paid in EUR on the basis of a tax document – invoice, to the account of the Seller designated in the invoice.
- 5.4 The Purchase Price shall be paid in the following matter:
- a) 25% of the Purchase Price shall be paid after the signature of this Contract; and
 - b) 75% of the Purchase Price shall be paid after the acceptance of the Object of Purchase by the Buyer.
- 5.5 The Buyer shall realize payments on the basis of duly issued invoices within 30 days from their receipt (maturity period). The invoice shall be considered to be paid for on the day when the invoiced amount is deducted from the Buyer's account on behalf of the Seller's account. To avoid any doubts Parties declare that if on the invoice is stated a maturity period that is shorter than 30 days, then such maturity period may be disregarded by the Buyer.
- 5.6 The invoice issued by the Seller as a tax document must contain all information required by the applicable laws of the Czech Republic. Invoices issued by the Seller in accordance with this Contract shall contain in particular following information:
- a) name and registered office of the Buyer,
 - b) tax identification number of the Buyer,
 - c) name and registered office of the Seller,
 - d) tax identification number of the Seller,



- e) registration number of the tax document,
- f) scope of the performance (including the reference to this Contract),
- g) the date of the issue of the tax document,
- h) the date of the fulfilment of the Contract,
- i) Purchase Price,
- j) registration number of this Contract, which the Buyer shall communicate to the Seller based on Seller's request prior to the issuance of the invoice,
- k) declaration that the performance of the Contract is for the purposes of a specific project (the number and the title of the project shall be communicated to the Seller based on Seller's request prior to the issuance of the invoice).

5.7 The Buyer prefers electronic invoicing on the following address: efaktery@fzu.cz.

5.8 In case that the invoice shall not contain the above mentioned information, the Buyer is entitled to return it to the Seller during its maturity period and this shall not be considered as a default. The new maturity period shall begin from the receipt of the supplemented or corrected invoice to the Buyer.

6. SELLER'S DUTIES

6.1 The Seller shall ensure that the Object of Purchase and Related Activities are in compliance with this Contract including all its annexes and applicable legal (e.g. safety), technical and quality norms.

6.2 During the performance of this Contract the Seller proceeds independently. If the Seller receives instructions from the Buyer, the Seller shall follow such instructions unless these are against the law or in contradiction to this Contract. If the Seller finds out or should have found out if professional care was exercised that the instructions are for any reason inappropriate or illegal or in contradiction to this Contract, then the Seller must notify the Buyer.

6.3 All things necessary for the performance of this Contract shall procure the Seller, unless this Contract stipulates otherwise.

6.4 The Seller is aware that the Buyer does not have at its disposal premises for the storage of packaging and, therefore, shall not store packaging of the Object of Purchase. The absence of original packaging cannot be an excuse for refusal of elimination of defects of the Object of Purchase.

7. HANDOVER AND ACCEPTANCE OF THE OBJECT OF PURCHASE

7.1 If the Seller fails to duly carry out all Related Activities or if the Object of Purchase does not meet requirements of this Contract, the Buyer is entitled to refuse the acceptance of



the Object of Purchase. In such a case the Seller shall remedy the deficiencies within ten (10) working days, unless Parties agree otherwise. The Buyer is entitled (but not obliged) to accept the Object of Purchase despite the above mentioned deficiencies, in particular if such deficiencies do not prevent the Buyer in the proper operation of the Object of Purchase. In such a case the Buyer shall notify the deficiencies to the Seller. The Seller shall remove the deficiencies within ten (10) working days, unless Parties (due to the nature of deficiencies) agree otherwise.

8. **WARRANTY**

- 8.1 The Seller shall provide a warranty of quality of the Object of Purchase for the period of 24 months or for the first 1 000 000 000 shots, whichever occurs earlier. If on the warranty list or other document is the warranty period of longer duration, then this longer warranty period shall have priority over the period stated in this Contract.
- 8.2 The warranty period shall begin on the day of the acceptance of the Object of Purchase by the Buyer.
- 8.3 The Seller shall remove defects that occur during the warranty period free of charge and in the terms stipulated in this Contract.
- 8.4 If the Buyer ascertains a defect of the Object of Purchase during the warranty period, the Buyer shall notify such defect without undue delay to the Seller. Defects may be notified on the last day of warranty period, at the latest.
- 8.5 The Buyer notifies defects in writing via e-mail. The Seller shall accept notifications of defects on the following e-mail address: **rb@lastronics.com**. The Seller shall confirm within 24 hours from the receipt of the notification.
- 8.6 In the notification the Buyer shall describe the defect and the manner of removal of the defect. The Buyer has the right to:
- a) ask for the removal of the defect by the delivery of new Object of Purchase or its individual parts, or
 - b) ask for the removal of the defect by repair, or
 - c) ask for the reasonable reduction of the Purchase Price.

The choice among the above mentioned rights belongs to the Buyer. The Buyer shall take into account the recommendation of the Seller.

- 8.7 The Seller shall remove the defect within 10 working days from its notification, unless Parties agree otherwise due to the nature of the defect or special circumstances of the case.
- 8.8 Parties shall execute a protocol on the removal of the defect, which shall contain the description of the defect and the confirmation that the defect was removed. The warranty



period shall be extended by a period of time that elapses between the notification of the defect until its removal.

- 8.9 In case that the Seller does not remove the defect within stipulated time or if the Seller refuses to remove the defect, then the Buyer is entitled to remove the defect at his own costs and the Seller shall reimburse these costs within 10 days after the Buyer's request to do so.
- 8.10 The warranty does not cover defects caused by unprofessional manipulation or by the failure to follow Seller's instructions for the operation and maintenance of the Object of Purchase.

9. **PENALTIES**

- 9.1 If the Seller is in delay with the removal of the defect, the Seller shall pay to the Buyer a contractual penalty in the amount of 0,05% of the Purchase Price for every (even commenced) day of delay.
- 9.2 The Seller shall pay contractual penalties within fifteen (15) days from the day, on which the Buyer enumerated its claims. The payment of contractual penalties shall not affect the right of the Buyer to damages even to the extent to which such damages exceeds the contractual penalty.
- 9.3 The total amount of contractual penalties imposed on the Seller shall not exceed 7% of the Purchase Price.
- 9.4 The Buyer is entitled to unilaterally set off claims arising from the contractual penalties against the claim of the Seller for the payment of the Purchase Price.

10. **RIGHT OF WITHDRAWAL**

- 10.1 The Buyer is entitled to withdraw from this Contract without any penalties, if any of the following circumstances occur:
- a) the Seller shall be in delay with the fulfilment of this Contract and such delay lasts more than 4 weeks;
 - b) the insolvency proceeding is initiated against the Seller; or
 - c) the Buyer ascertains that the Seller provided in its bid for the Public Procurement information or documents that do not correspond to the reality and that had or could have had impact on the result of the tendering procedure, which preceded the conclusion of this Contract.

11. **SPECIAL PROVISIONS**

By signing this Contract, the Seller becomes a person that must cooperate during the finance control within the meaning of Section 2 letter e) of the act no. 320/2001 Coll., on



finance control in the public administration, and shall provide to the Directing Body of the Operational Programme Research, Development and Education or other control bodies access to all parts of the bid, Contract or other documents that are related to the legal relationship formed by this Contract. This duty also covers documents that are subject to the protection in accordance with other acts (business secrets, secret information, etc.) provided that control bodies fulfil requirements stipulated by these acts. The Seller shall secure that all its subcontractors are also obliged to cooperate with control bodies in the above stipulated extent. The possibility of effective control must be preserved until the year 2033.

12. FINAL PROVISIONS

- 12.1 This Contract is governed by the laws of the Czech Republic, especially by the Civil Code.
- 12.2 The terms and conditions of this Contract represent the whole agreement between the Parties regarding the subject matter of this Contract and any prior or oral agreements have been either consolidated into this Contract or are disregarded by the Parties.
- 12.3 Parties acknowledge that this Contract shall be published in the Register of Contracts in accordance with the Act no. 340/2015 Coll., on the Register of Contracts.
- 12.4 All disputes arising out of this Contract or out of legal relations connected with this Contract shall be preferably settled by a mutual negotiation. In case that the dispute is not settled within sixty (60) days, such dispute shall be decided by courts of the Czech Republic in the procedure initiated by one of the Parties.
- 12.5 The Seller is not entitled to set off any of its claims or his debtor's claims against the Buyer's claims. The Seller is not entitled to transfer its claims against Buyer that arose on the basis or in connection with this Contract on third parties. The Seller is not entitled to transfer rights and duties from this Contract or its part on third parties.
- 12.6 All modifications and supplements of this Contract must be in writing.
- 12.7 If any of provisions of this Contract are invalid or ineffective, the Parties are bound to change this Contract in such a way that the invalid or ineffective provision is replaced by a new provision that is valid and effective and to the maximum possible extent correspond to the original invalid or ineffective provision.
- 12.8 This Contract is executed in four (4) counterparts and every Party shall receive two (2) counterparts.
- 12.9 An integral part of this Contract is Annex 1 (*Technical Specification*) including all its annexes. If Annex 1 (*Technical Specification*) uses the term "Contracting Authority", it means Buyer and if it uses the term "Supplier", it means Seller.
- 12.10 This Contract shall be valid on the date of the signature of both Parties and effective on the day, on which it is published in the Register of Contracts.



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IN WITNESS WHEREOF attach Parties their handwritten signatures:

Buyer

Signature: _____

Name: RNDr. Michael Prouza, Ph.D., director

Position: director

Date:

Seller

Signature: _____

Name: Dr. Thomas Töpfer

Position: CEO

Date:



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ANNEX 1

TECHNICAL SPECIFICATION

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[RSD product category B]

***Pump diode module for half Joule multipass amplifier
TP20_117***



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Revision History / Change Log

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1. Introduction

1.1. Purpose

This Requirements Specification Document (RSD) lists the technical requirements and constraints for the selection of a high energy, high average power pump diode module which is to be delivered to a laboratory at ELI Beamlines. This diode module will be used within the scope of the DUHA project.

1.2. Scope

This RSD contains all of the technical requirements: functional, performance and design, delivery, safety and quality requirements for the following product (tender number: TP20_117): **Pump diode module for half Joule multipass amplifier** (further "module").

The diode will be in the L2 laser hall and will drive pre-amplifier the main pump laser for the DUHA beamline within the scope of the DUHA project. The products are registered in the PBS database under the following PBS code: RA1.L2.L2_1.PL.FE.PA3.DRV.

This product is a **Category B product** according to the ELI Beamlines RSD categories. The category B does not require any design modifications of the product. Delta verification (test) program shall be decided and performed on a case-by-case basis.

Furthermore, all items may be subject to testing and verification upon delivery to the ELI Beamlines facility by qualified personnel. All non-conformances (if any) must be addressed by the supplier in a timely manner.

1.3. Terms, Definitions and Abbreviations

For the purpose of this document, the following abbreviations apply:

Abbreviation	Meaning
ELI	Extreme Light Infrastructure
RSD	Requirements Specification Document
CA	Contracting Authority (Institute of Physics AV CR, v. v. i.)
FWHM	Full width Half Maximum
HR	High Reflectivity
TTL	Transistor–transistor logic
BNC	Bayonet Neill-Concelman coaxial connector
RMS	Root Mean Square
V DC	Volts, Direct Current
PLC	Programmable Logic Controller: a specific type of industrial ruggedized digital computer
LXI	LAN (Local Area Network) eXtensions for Instrumentation: a specific open standard for text-based instrument control over a network

Abbreviation	Meaning
TCP/IP	Transmission Control Protocol/Internet Protocol: a specific network communication protocol
OPC UA	OLE (Object Linking and Embedding) for Process Control, Unified Architecture: a specific machine-machine communication protocol
REST API	REpresentational State Transfer, Application Programming Interface: a specific web service architectural style
HTTP	HyperText Transfer Protocol: a specific web application protocol
Modbus	Modicon bus: a specific serial communications protocol
SCPI	Standard Commands for Programmable Instruments: a specific open standard for text based instrument control
JSON	JavaScript Object Notation: a specific open standard for data objects text representation
XML	Extensible Markup Language: a specific open standard for document markup
CDA	Clean dry air
PV	peak to valley

1.4. References to standards

If this document includes references to standards or standardized/standardizing technical documents the CA allows/permits also another equal solution to be offered. If a supplier offers another equal solution the CA shall not reject its bid, once the supplier by appropriate means in the bid proves that the offered supplies, services or works meet in an equivalent manner the requirements including references to standards or technical documents.

2. Functional, Performance and Design requirements

2.1. General requirements for the module

REQ-030389/A

The module shall meet the general requirements defined in **Table 1**.

Table 1 Technical Parameters of laser diode modules

#	Parameter	Required value (description)
1.1	Repetition rate (Hz)	1 - 50, tunable Nominal rep rate: 50 Hz
1.2	Minimum pulsed peak power (kW)	4
1.3	Pulse duration (ms)	0.8 – 1.0 tunable
1.4	Central wavelength for average output powers between 160 W and 200 W (wavelength above and below which 50% of the total energy is contained), λ_0 (nm)	940
1.5	Maximum drift over 6 h in central wavelength after warm up for fixed duty cycle and pulse energy (nm)	± 0.5
1.6	Bandwidth	>30 % of total energy contained with ± 1 nm of λ_0 >70 % of total energy contained within -3.5 nm and +2.5 nm of λ_0
1.7	Polarization	Horizontal with respect to optical table plane, 90 % polarization extinction ratio
1.8	Distance to working plane from final optical element of pump coupling, i.e. folding mirror, imaging lens, etc. (mm)	>200
1.9	Profile shape in working plane	Circular top hat, super-Gaussian
1.10	FWHM diameter in the working plane (mm)	5 ± 0.1
1.11	Slope of spatial profile sides $\frac{\Delta r_{90\%-10\%}}{\text{FWHM}}$	<5%
1.12	Plateau homogeneity as percentage of plateau intensity (peak to valley)	5%
1.13	Beam height above table (mm)	120 ± 1
1.14	Temporal pulse shape (integrated over spatial profile)	Flat
1.15	Rise/fall times of pulses (10% - 90% peak intensity)	< 60 μ s

#	Parameter	Required value (description)
1.16	Pulse to pulse energy stability for 10 000 pulses (PV with respect to the average of all pulses)	< 2%
1.17	Long term average power stability (6 hour) measured with thermal power meter or shot to shot meter with 3 s moving average (PV)	< 3%
1.18	Variation of instantaneous output power within the temporal plateau of the pulse at maximum output pulse duration and nominal output power	< 3%
1.19	Spatial deviation of profile centroid position in target plane over 8h	< 0.5 mm

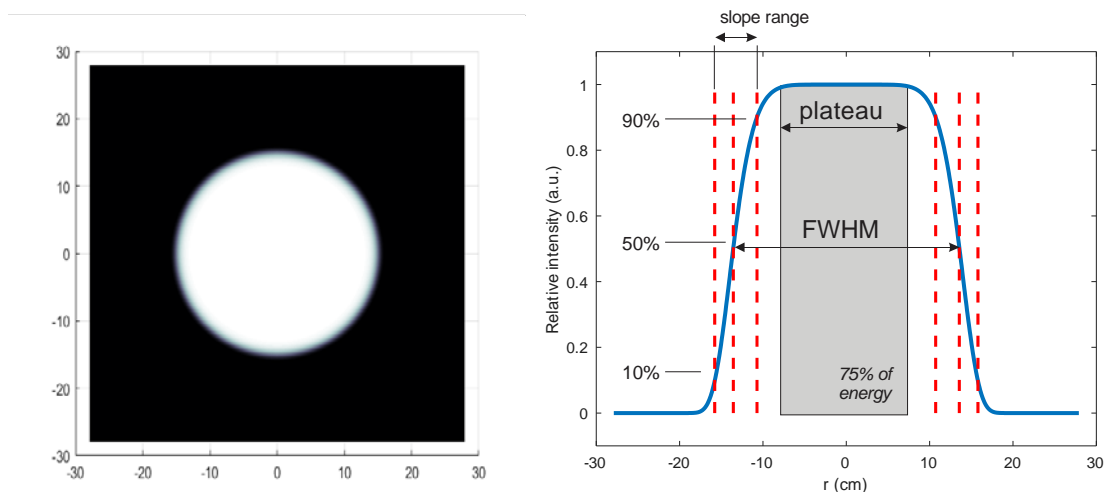


Figure 1 The desired spatial profile is a circular super-Gaussian. The cross section shown (not to scale) illustrates what is meant by the slope and plateau of the profile. The plateau is the area, concentric to the profile, which encompasses 75% of the energy of the beam. The slope is considered between 10% and 90% of the average intensity of the plateau. The FWHM is taken at the width at 50% the average intensity of the plateau.

REQ-030390/A

The performance and stability parameters of the module specified in **Table 1** shall be satisfied for the following ambient environmental conditions and lab infrastructure:

- 1) Room temperature 20 °C, stability ± 0.5 °C, humidity 50 %
- 2) Facility water provided to chillers: 16 °C, inlet pressure max 5 bar on input, differential pressure between input and output: 1.5 bar
- 3) CDA purity: Class 1:1:1 by ČSN ISO 8573-1:2013 (equivalent to ISO 8573-1:2010), pressure adjustable up to 6 bar, flow adjustable up to 100l/min (preferred interface is Swagelok compression fitting or G1/4 female parallel thread)

REQ-030391/A

The plateau of the beam profile (referred to in subsequent specifications) shall be defined as the circular area of the spatial profile concentric with the center which contains 75% of the integrated total energy of the profile. See **Figure 1**.

REQ-030392/A

Spectral, spatial and temporal characteristics and stability as defined in Table 1 shall be satisfied simultaneously over the full range of required repetition rates and pulse durations specified in Table 1.

REQ-030393/A

The parameters in **Table 1** shall be taken after the final optical element of the module.

REQ-030394/A

The full divergence angle in a region extending ± 200 mm around the target plane in both horizontal and vertical direction shall be no more than 8.5 degrees in order to avoid clipping on dichroic mirrors. The situation is sketched in **Figure 2**. The divergence angle is given by the change of the beam width over distance, with the beam width defined as that containing 95% of the total energy. In the bid, the supplier shall provide calculated intensity distributions for:

- 1) the near field beam profile in the target plane
- 2) near field ± 15 mm away from the target plane
- 3) far field
- 4) a calculation of the beam diameter between the final optical element of the module and the working plane.

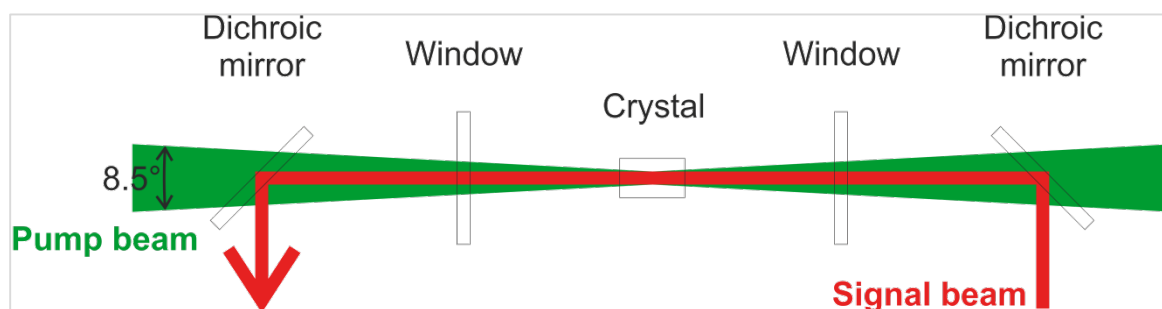


Figure 2 Pump beam's divergence (for dimensions see **Figure 3**).

REQ-030396/A

- 1) Diodes shall be tolerant of optical feedback at the operation wavelength (940 nm) of up to 10% of the maximum output power without degradation of performance.
- 2) Diodes shall tolerate feedback in the form of a collimated 1030 nm laser beam with a circular profile, 5 mm in diameter, with a pulse duration down to 5 ns and pulse energy up to 1 mJ. To achieve this,

the exit windows of the diode modules should have HR coatings ($R > 99\%$) at $1030 \text{ nm} \pm 2 \text{ nm}$, and should be tilted by at least one degree relative to the optical axis.

NOTE: The source may be exposed to on-axis optical feedback both at the pump wavelength and at 1030 nm.

2.2. Mechanical Requirements and constraints

REQ-030397/A

The pump beam shall be split by a 50/50 beam splitter and guided to the laser head with folding mirrors as proposed in **Figure 3**.

REQ-030398/A

The module and all optical elements (apertures, imaging lenses, folding mirrors, etc.) which are not an integral part of the module shall fit within a rectangular space with its size and position with respect to the crystal head sketched in the layout in **Figure 3**. The position of both dichroic mirrors with respect to the crystal head is fixed. No optical element is allowed between each of the dichroic mirrors and the crystal head.

REQ-030399/A

A thorough description of an alignment procedure shall be provided also explaining how positions and mutual distances of coupling optics affect the beam size at the working plane and divergence.

REQ-030400/A

All optics between the diodes and the dichroic mirrors before the laser crystal shall be provided by the supplier. These optics shall be mounted on suitable posts which can be rigidly clamped to the table. All materials required for clamping to the table must be provided.

REQ-030401/A

Suitable cables or conductors with minimal length carrying the pulsed diode current shall be easily connected/disconnected, unless the source and the pulsed power supply form an integrated unit that does not need to be disassembled for transport. The layout of supporting electronics for pulsed power supply shall be agreed upon with the CA. All cables should be shielded to reduce electromagnetic emissions. Cable lengths from the rack mounted power supply to the diode should be $12 \pm 0.2 \text{ m}$ in length.

REQ-030402/A

The module shall be water-cooled (no fans are permitted). The temperature of the internal module cooling water cannot be outside the range of 19°C to 32°C .

REQ-030403/A

All additional equipment (e.g., power supply) shall be mounted in 19 in equipment racks and must consume no more than 10 U (Racks shall be provided by the Client). The maximum total heat dissipation into the air inside the racks must be less than 500 W per module. Water cooling should be used to reduce the air heat load of this equipment. The cable distance between these racks and the optical table is 12 ± 0.2 meters.

REQ-030404/A

Microchannel water cooling should be avoided (*i.e.*, all cooling channels and tubing shall be $\frac{1}{4}$ in inner diameter or larger).

REQ-030405/A

The chiller for the module will be provided by the CA and will be the model HIB RFCS-9HE.

REQ-030406/A

All connections between the module and rack mounted support systems shall be clearly labeled and straightforward to connect and disconnect.

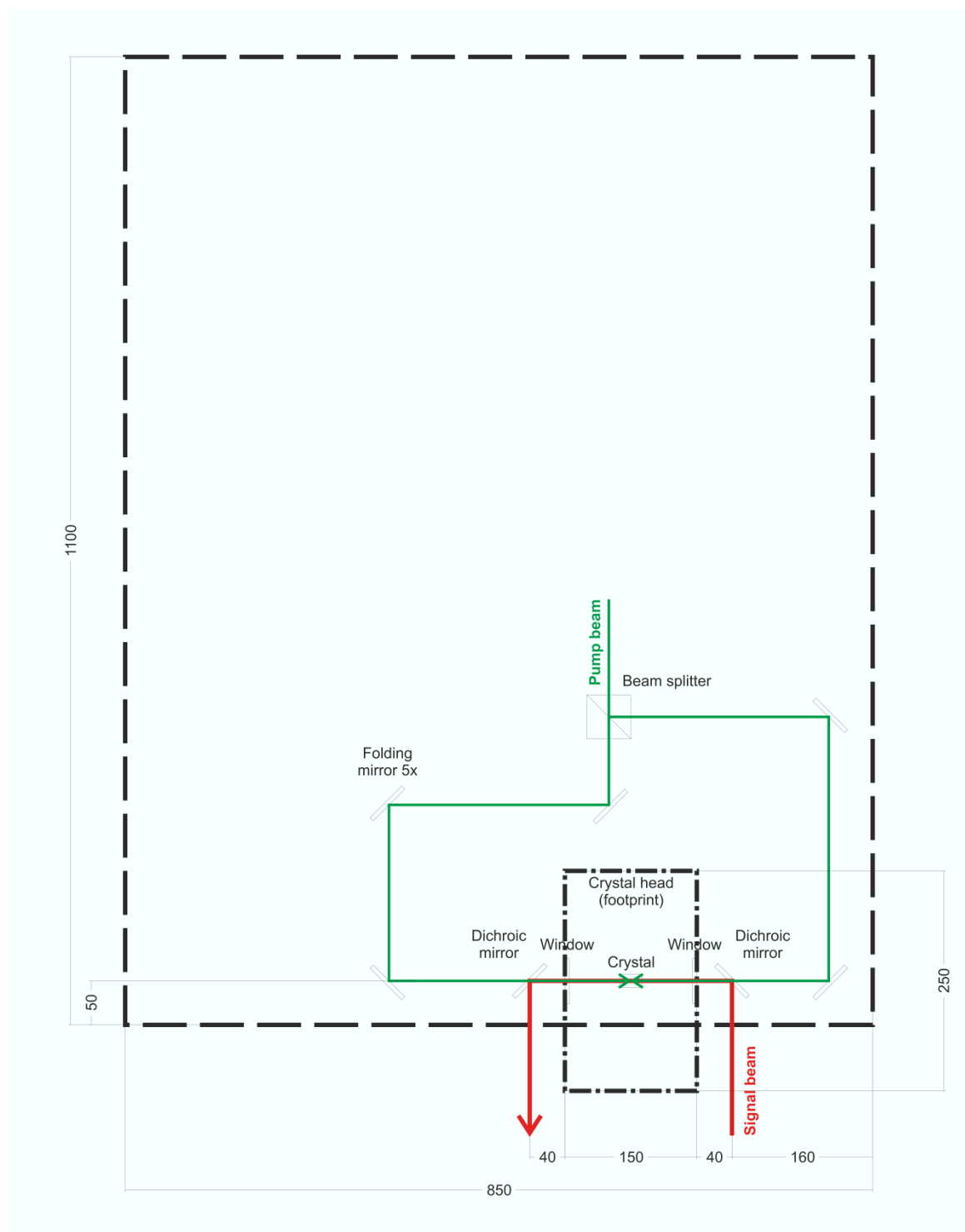


Figure 3 Amplifier head layout. The large rectangle (thick dashed line) with its size and position with respect to the crystal head (thick dash-dotted) delimits the space for placing the module and all other optical elements. Position of both dichroic mirrors with respect to the crystal head is fixed. Dimensions are in millimeters.

2.3. Diagnostics and Control interface

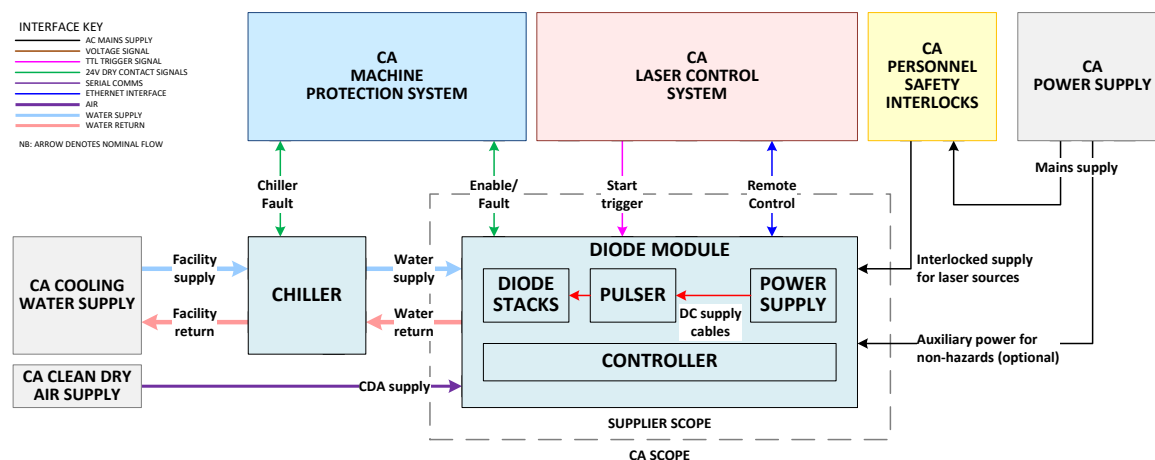


Figure 4: System integration block diagram with interfaces and scope definition

2.3.1. Preferred implementation

REQ-030407/A

The Pulser used in the diode module shall be a commercially available off-the-shelf single 19-inch rack-mount device no more than 2U high with water-cooling and safety interlock, front-panel key enable and E-stop push button, and front-panel display with manual control option. It must have an Ethernet control interface and must be compatible with the CA's LabVIEW-based control system. Within two weeks from the signature of this Contract, the Supplier shall communicate to the CA, what specific product intends to use to fulfil the requirements mentioned above. The Supplier may proceed with the manufacturing only after such product is approved by the CA. The CA shall approve of the specific product only after the Supplier demonstrates to the CA that all the relevant requirements are met.

REQ-030408/A

The Power Supply used in the diode module shall be a commercially available off-the-shelf single 19-inch rack-mount device no more than 4U high with water-cooling and safety interlock, front-panel start and stop buttons, and a front-panel display with manual control option that can be disabled if remote control is used. It must have an Ethernet control interface and must be compatible with the CA's LabVIEW-based control system. Within two weeks from the signature of this Contract, the Supplier shall communicate to the CA, what specific product intends to use to fulfil the requirements mentioned above. The Supplier may proceed with the manufacturing only after such product is approved by the CA. The CA shall approve of the specific product only after the Supplier demonstrates to the CA that all the relevant requirements are met.

REQ-030409/A

The controller shall perform all functions necessary for normal operation of the module that are not otherwise provided by other specifically labelled devices in **Figure 4**. The Controller shall be a commercially available off-the-shelf embedded controller with a real-time operating system and must include reliable FPGA-based processing of critical analog and digital signals. The Controller must have an Ethernet control interface and must be compatible with the CA's LabVIEW-based control system. Within two weeks from the signature of this Contract, the Supplier shall communicate to the CA, what specific product intends to use to fulfil the requirements mentioned above. The Supplier may proceed with the manufacturing only after such product is approved by the CA. The CA shall approve of the specific product only after the Supplier demonstrates to the CA that all the relevant requirements are met.

REQ-030410/A

The CA shall provide reasonable assistance regarding the configuration and programming in LabVIEW of the Pulser, Power Supply and the Controller.

2.3.2. Triggering

REQ-030411/A

The module shall have a START trigger input compatible with TTL logic level signals with 50 Ohm BNC connector. The trigger input should be optically coupled for galvanic isolation. A rising edge on this trigger input shall cause the diodes to output a laser pulse of the pre-configured length (see Table 3), with the pulse leading edge aligned to this trigger with RMS jitter no more than 10 ns.

REQ-030412/A

The module shall support triggering at repetition rates defined in **Table 1** including single-shot.

REQ-030413/A

The module shall not be damaged in the event of spurious triggering occurring at any repetition rate or by the sudden absence of one or more triggers at any repetition rate.

REQ-030414/A

When the module is not externally triggered, it shall be impossible by design for a laser pulse to be output (*i.e.*, it must not be possible to accidentally set a self-triggered or CW mode or for the module to startup up in such a mode due to a fault).

REQ-030415/A

Regardless of any configuration settings on the pulse length, it shall be impossible to emit a pulse longer than 2 ms under any conditions (*i.e.*, physical limitation, not software setting).

2.3.3. Controls interface to chillers

REQ-030416/A

The chiller providing cooling water to the module is out of scope of the supplier. The CA shall monitor all required chillers and shall be responsible for ensuring that the Machine Protection Enable (see § 2.3.6) input to the module is open-contact in the event that a fault with the chiller is detected. The Supplier shall ensure that no electronic interfaces between the chillers and the diode modules are necessary for full operation of the diode modules.

2.3.4. Fast amplitude control input control

REQ-030417/A

The relationship between the SETPOINT and the laser output peak power shall be given by a measured reference curve that shall be provided to the CA as part of the documentation, to an accuracy < 10% and repeatability < 3% over 6 hours. This accuracy must be maintained for at least 24 months from delivery or 1 billion shots (whichever is sooner).

Note: The scaling curve shall be fixed and not change if the Peak Power Limit (see Table 3) is changed.

2.3.5. Automation and Remote Control Interface

REQ-030418/A

The module shall be able to start up, initialize, operate, shutdown, and otherwise fulfil all requirements of this document, without requiring any direct manual user interaction (except for essential safety mechanisms, *i.e.*, key switches and E-stops).

REQ-030419/A

All necessary operations required to use the module to its full capacity shall be performed via the Remote Control Interface. No HMIs, GUIs, touch panels, push buttons, control PCs, laptops, displays or similar are permitted to be required in order to use the module to its full capacity.

REQ-030420/A

The module shall be provided with a Remote Control Interface. This interface must allow the CA's control system to monitor key system Status Variables (Table 2), set key Configuration Parameters (Table 3) and allow it to start and shut down the module remotely.

REQ-030421/A

The Remote Control Interface shall be Ethernet and use one of the following communications protocols/standards, in order of preference:

LXI (TCP/IP), OPC UA (HTTP), REST API (HTTP), Modbus TCP/IP or ASCII-based string commands over TCP/IP or UDP. Commands and responses must be formatted as human-readable strings (*e.g.*, SCPI, JSON, XML). Alternative communication protocols must be explicitly approved by the CA.

REQ-030422/A

Full documentation on the entire list of supported commands and responses from the device over the Remote Control Interface shall be provided to the CA, including any additional to those listed in (Table 2) and (Table 3).

REQ-030423/A

Status Variables (Table 2) shall be measured by the electronic controller and their values shall be updated and made available over the Remote Control Interface at the specified minimum update rate. Unless otherwise specified, all physical parameters reported must be accurately calibrated and within < 10% error of the real physical value when in an operational regime.

REQ-030424/A

If the Status Variables (Table 2) include an error code or error readout, a list of the possible error codes, their description and suggested remedial measures shall be provided to the CA in the Documentation.

REQ-030425/A

It shall be possible to read back any Configuration Parameter (Table 3) on demand via the Remote Control Interface.

REQ-030426/A

All Configuration Parameters (Table 3) shall be permanently retained and restored automatically in the event of a power cycle, with the exception Output Enable parameters, which must default to off/disabled on restoration of power.

REQ-030427/A

It shall be impossible to set a Configuration Parameter (Table 3) to a value that is outside of the achievable range or to a value that could cause damage to the module.

Table 2: Required Status Variables for readout via the Remote Control Interface

Category	Name	Description	Min. update rate	Format
Photodiodes	Output monitor	Optical power of the module output pulse	10 Hz	Scalar numeric, with conversion to calibrated Watts peak
Temperature	Inlet cooling water		1 Hz	Celsius, scalar numeric
	Outlet cooling water		1 Hz	Celsius, scalar numeric
	Diode block	From sensor in direct contact with the diode emitters	1 Hz	Celsius, scalar numeric
Enclosure environment	Dew point	<i>e.g.</i> , readout from a Vaisala DMT152 sensor	1 Hz	Celsius, scalar numeric
	Air temperature		1 Hz	Celsius, scalar numeric
Cooling circuit	Outlet flow switch		10 Hz	Good/Bad status
General	Overall health status	Overall system health (or health of each system component independently)	10 Hz	Good/Bad status, optional error code/description
	Operational mode	One of a limited set of operational modes, <i>e.g.</i> , Standby, Warmup, Ready, Error	1 Hz	Short string from a finite, known set

Table 3: Required Configuration Parameters to be set via the Remote Control Interface

Name	Description	Format
Peak Power Limit	Configurable upper limit for the output pulse peak power (regardless of analog SETPOINT control value)	Calibrated Watts peak
Pulse Length	Configurable pulse length	FWHM in microseconds,
Output Enable	Enable or disable the emission of the main output beam	Binary enable/disable

2.3.6. Machine Protection

REQ-030428/A

The module shall have internal detection and protection against, or be inherently resistant to sustaining damage from, the following failure modes:

1. Loss of cooling water flow or pressure
2. Cooling water excess pressure

3. Overheating or thermal runaway of diode stacks
4. Condensation of water vapor in the housing
5. Excessive humidity in the housing
6. Leakage of cooling water into the housing
7. Sudden loss of external power on any supply
8. Sudden loss of any external control signal or interface
9. Overvoltage or overcurrent of internal power supply
10. Short-circuit or open-circuit fault of a diode stack
11. Back reflections up to 10%
12. Random failure of electronic controller

REQ-030429/A

The module shall include a Machine Protection Enable input. An externally provided closed contact (suitable for 24V DC signals) must be required at all times for the module to operate. Opening these external contacts must cause the module to stop operating within 10 ms of the open-circuit event. The preferred connector types for this interface are DSUB-9 female or M12 female. The CA will ensure that failures of externally provided services, such as cooling water or dry air, result in open-contact of this input.

REQ-030430/A

The module shall include a Machine Protection Fault output (or multiple outputs for every individual device). Internal dry contacts or a 24V DC signal output must be provided that are closed in normal operation and opened in the event of any detected internal fault, failure or off-normal condition. The preferred connector types for this interface are DSUB-9 or M12. Use of other connector type shall be discussed with the CA. The connector may be shared with the Enable input or it may be separate.

2.3.7. Laser Safety

REQ-030431/A

The module should be supplied as an 'OEM component' product requiring further integration into a laser system by the CA at their facility. Therefore, it may not be necessary for the module to satisfy the full regulatory safety standards that would be required for an off-the-shelf product.

REQ-030432/A

Upon delivery of the module to the CA, the CA has the responsibility to implement a laser safety interlock for use of the module in the CA's laboratory in accordance with relevant standards from IEC 60825 series. The Supplier shall provide the CA with all necessary information about the module to ensure the compliance of the fully integrated laser system with these standards.

REQ-030433/A

The CA intends to satisfy laser interlock requirements by directly disconnecting the mains power to the module. It shall be physically impossible for the module to emit laser radiation in the absence of mains power.

REQ-030434/A

Sudden disconnection and restoration of the interlocked mains power to the module power supply shall not result in damage.

Note: an auxiliary non-interlocked mains supply may be provided to maintain power to electronic controllers and ancillary devices that do not produce a laser hazard. The chiller will also be provided with a dedicated mains power connection which will be UPS-backed. This requirement does not apply to either of this power supply.

REQ-030435/A

The Client shall supply power to the module in the format requested by the Supplier up to a maximum of four single phase 230 VAC, 16 A in accordance with Czech Republic national standards. Each circuit may be of interlocked or auxiliary type as specified by the Supplier in order to meet all laser safety requirements above. Each circuit will be fitted with a circuit breaker by the CA. The Supplier should not provide their own mains power distribution as part of the delivery.

3. Delivery & Installation requirements

REQ-030436/A

The transportation, to the final destination, installation and demonstration of functionality shall be conducted by the Supplier.

NOTE 1: The bid price will be considered by the CA as the final price, including transportation cost.

NOTE 2: The Supplier will provide all necessary documentation detailing procedures for safe and proper installation (see REQ-024525/A).

4. Safety Requirements

REQ-030437/A

The Supplier shall supply a Declaration of Conformity or any other equivalent document legally recognized and accepted in the Czech Republic for each product type if the appropriate legislation determines the Supplier's obligation to have a Declaration of Conformity (or the equivalent document) for the purposes of a Product sale in the Czech Republic to fulfil the requirements of 2001/95/EC directive or applicable Czech law.

5. Quality Requirements

5.1. General Quality Requirements

REQ-030438/A

The Supplier shall provide the Product Manual as part of the delivered Device. Completeness of the Manual shall be approved by the CA. The Manual shall include the instructions and descriptions regarding the following procedures:

- transport;
- handling;
- storage;
- installation;
- safe operation and maintenance procedures.

REQ-030439/A

The Supplier shall provide a declaration of conformity with technical requirements defined by the product RSD and ensure completeness of the products.

REQ-030440/A

The Supplier shall provide verification protocols outlining the results of tests executed for **the module** before its delivery at ELI Beamlines premises to confirm specification conformity (see REQ-030439/A).
NOTE: The content of the verification protocols shall be agreed with the CA.

REQ-030441/A

The Supplier shall establish and maintain a nonconformity control system compatible with ČSN EN ISO 9001 (or equivalent, e.g. EN ISO 9001) or equivalent.

5.2. Acceptance

Acceptance will be carried out by the CA upon delivery and final verification of the Tables at ELI Beamlines premises. The basis for acceptance will be verification protocols summarizing the overall verification results together with relevant documentation supporting the verification (see REQ-030438/A, REQ-030439/A, REQ-030440/A and REQ-030441/A).

In case of successful acceptance phase, the CA will provide to the Supplier signed acceptance protocol. In case of unsuccessful acceptance stage, the CA will provide to the Supplier Nonconformity Report (NCR) and process in accordance with REQ-030441/A will be applied.

REQ-030442/A

The Acceptance phase shall demonstrate the following:

- Final Products have been successfully verified by the Supplier and the results of this process have been documented in an appropriate way through verification protocols (see REQ-030440/A);
- All detected nonconformities have been solved in accordance with REQ-030441/A;