

PRODEX EXPERIMENT ARRANGEMENT

ARTICLE 1: DEFINITIONS - PURPOSE OF THE ARRANGEMENT - APPENDICES

- 1 Throughout the present Arrangement, the terms laid down in the left column shall have the meaning set out opposite:
 - “Funds”:
“Project”:
 - Maximum budget for the present Arrangement, as defined in Article 2
Institute’s project specified in Appendix 1, certified by the Agency’s PRODEX Office as eligible for financial support according to the Financial Plan (Appendix 2) approved by the relevant Participating State
 - “Costs”:
Allowable cost of these categories, incurred by the Institute in execution of the Project:
 - Labour cost
 - Operational costs as defined in Appendix 2
 - Travel expenses
 -
- 2 By entering into the PRODEX Experiment Arrangement, hereinafter referred to as Arrangement or P.E.A., the Agency undertakes to reimburse the Institute certain costs incurred in the execution of the Project. The purpose of this arrangement is the detailed implementation of the said undertaking.
Any other arrangement or agreement by which the Institute undertakes to carry out the Project remains unaffected by the present arrangement, save that the Agency acquires hereunder the rights to access, to audit, and to obtain certain licenses in intellectual property rights; details are specified in Article 4.
- 3 The Institute may claim the Funds subject to the provisions set forth in Articles 2 through 4 below.
- 4 The Institute shall utilise the Funds and any part thereof exclusively for defraying, in due time, the Cost incurred during the term of the Project defined in Article 3.1 below.
- 5 Appendix 1 (Work Description) and Appendix 2 (Financial Plan) address the programme of work, schedule, deliverables and financial plan of the Project.
Appendix 1, Appendix 2 and Appendix 3 (PRODEX Experiment Arrangement Change Notice) shall form an integral part of this Arrangement.

ARTICLE 2: FUNDS AND PAYMENT

2.1 Funds

1. The Funds available for the present Arrangement amount to (see cover letter).
2. The above amount is stated to be a limit of liability in the sense defined in sections 4 and 5 of Annex II to the ESA “General Conditions”, referred to in Article 4.
3. The above amount excludes profit for the Institute (not allowed) and value added tax on the costs charged to the Agency (so far as the Agency is exempted from VAT applied by the Agency’s Member States).

4. The above amount is broken down into subtotals per cost category and/or per year as specified in Appendix 2 hereto.

2.2 Payments

1. Payments shall be made by the Agency in EURO to the account specified by the Institute. Such account information shall clearly indicate the IBAN (International Bank Account Number) and BIC/SWIFT (Bank Identification Code).
2. The Institute undertakes to provide further supporting documentation as required by the Contract, together with the electronic invoices and confirmations supporting the claims.
3. Any special charges related to the execution of payments will be borne by the Institute.
4. The Institute shall ensure that all invoices and confirmations are submitted for payment exclusively through the Agency's ESA-P system.
5. The Institute undertakes to adhere strictly to the instructions contained in ESA-P (including those for billing taxes and duties, where applicable) when submitting invoices and confirmations through the ESA-P system.
6. The Agency reserves the right to visit the Institute's premises and ascertain the progress of the work being performed under the Contract, prior to making the payment concerned.
7. ESA-P Information can be found at <http://esa-p-help.sso.esa.int/>. Any questions concerning the operation or operating status of ESA-P shall be addressed to the ESA Helpdesk (esait.service.desk@esa.int). Any questions concerning the latest status of due invoices can be addressed to the ESA Payment Officer (esa.payment.officer@esa.int).

ARTICLE 3: TERM OF THE PROJECT

1. Term of the Project shall be the time period stated in the cover letter.
2. Cost incurred outside said term shall not entitle the Institute any payment under this Arrangement.

ARTICLE 4: OTHER CONDITIONS

The ESA "General Conditions" (General Clauses and Conditions to ESA Contracts-GCCs), available from emits.esa.int, shall apply, with the amendments or replacements set forth in the **Articles** of the Arrangement. The applicable General Conditions shall be construed and interpreted with due regard to the specific nature of this Arrangement and its Article 1 in particular. The Institute signatory of the Arrangement (P.E.A.) shall be deemed the "Contractor" wherever mentioned in those General Conditions and in the rest of this document.

CLAUSE 1: APPLICABILITY OF CLAUSES AND CONDITIONS

The present General Clauses and Conditions to ESA Contracts (GCC) shall apply to Contracts placed by the Agency insofar as not stated otherwise in the relevant Contract. Furthermore, specific clauses and conditions may be set out or invoked in a Contract and its annexes and/or appendices. The annexes and/or appendices form an integral part of the Contract. **PART 1 of GCC is applicable with the following amendments.**

CLAUSE 2: APPROVAL AND ENTRY INTO FORCE

Offers and acceptances with regard to arrangements are not binding on the Agency unless approved in writing by its Director General or his authorised representative. For the purpose of this arrangement the authorised representative of the Agency's Director General is:

Dr. M. Lazerges,
Head of the PRODEX Office.
He is authorised by the Agency to sign the present arrangement on his behalf.

CLAUSE 5: THE PARTIES REPRESENTATIVES

The Agency shall have the right to check the performance of the Project, and for this purpose, the Agency nominates its representatives identified here below.

The Institute shall in this respect and in accordance with any relevant security regulations, give the representatives of the Agency access to its premises and shall give all other necessary assistance in order that they may fulfil their task.

All correspondence for either party shall be sent to the address and the representative in charge identified herein below, with a copy to the other representative(s) where any mixed nature of the matter so requires:

For the Agency to:

ESTEC
P.O. Box 299
NL-2200 AG Noordwijk

See cover letter.

For the Institute to:

The Institute's representative(s) is (are) as stated in the cover letter.

See cover letter.

CLAUSE 17: N/A.

CLAUSE 28: PAYMENT

28.1 The following is added to clause 28.1 of the GCCs.

Within the limits specified in Article 2, the Institute may claim in arrears payment of the Cost incurred. The Agency shall effect such payment after receipt of the respective invoice, which must identify the cost category/ies concerned and bear a statement by the Institute's financial controller that the invoiced costs are fair and reasonable, do not include profit and have been incurred exclusively in execution of the Project as defined in Article 1 and during the term specified in Article 3.

Any payment which is not the final payment of the contract is called "progress payment".

28.3 N/A

28.4.1 N/A

CLAUSE 30: (TERMINATION) GENERAL RULE

The following is added to clause 30, before the text in the GCC.

Notwithstanding any other provision of this Arrangement, the Agency shall have the right to terminate a Contract either wholly or in part by giving written notice by registered mail. This may include the case where the Participating State representatives having approved Appendix 2 demand the termination of the activities in writing.

CLAUSE 33: TERMINATION IN SPECIAL CASES

The following is added to clause 33, before 33.1

Notwithstanding any other provision of this Arrangement, the Agency may:

- i) Cease to effect any payments not already fallen due under this arrangement in case of unsatisfactory progress within the Project, provided the Participating State representatives having approved Appendix 2 demand cessation of payments in writing;
- ii) Cease to effect any payments in any of the following cases:
 - a situation as per Clause 33.1 lit. a) of the General Conditions occurs;
 - a situation as specified in Paragraph iv) below occurs.
- iii) The Agency may require the Institute to return to the Agency payments effected under this arrangement if and to the extent an audit carried out by the Agency or by the relevant national audit authority reveals any incorrectness of invoices or unauthorised use of Funds.
- iv) The Agency may require the Institute to return to the Agency all payments effected under this arrangement in case a situation as per Clause 33.1 lit. b) of the General Conditions occurs.

CLAUSE 34: APPLICABLE LAW

The arrangement shall be governed by the laws of the country of residence of the Institute.

CLAUSE 35: DISPUTE RESOLUTION

The arbitration proceedings referred to in Clause 35.2 shall take place in the capital city of the country of residence of the Institute.

PART II OPTION A of the GCC is applicable with the following amendments:

CLAUSE 37.1: Deliverables are identified in the specific section of Appendix 1 (Deliverables).

CLAUSE 39: Clause 39.2 lit. a) is not applicable.

CLAUSE 40: Clauses 40.4 to 40.6 are not applicable.

CLAUSE 41: Cancelled and replaced by the following.

CLAUSE 41: USE OF INTELLECTUAL PROPERTY RIGHTS

Use/Licensing

41.1 All Intellectual Property Rights arising from work performed under the Agency Contract shall be available to:

a) The Agency to use on a free, worldwide licence for the Agency's Own Requirements (such licence to be granted by the Contractor as set out in the standard licence which the licensee shall be entered into if required);

b) Participating States and Persons and Bodies to use on Financial Conditions for the Agency's Own Requirements (such licence to be granted by the Contractor as set out in the standard licence which the licensee shall enter into if required);

c) Any Third Party on Market Conditions to use for purposes other than the Agency's Own Requirements providing the Contractor agrees such use is not contrary to its Legitimate Commercial Interests.

41.2 For the avoidance of doubt the term "use" for the purposes of software includes use to operate, integrate, validate, maintain and modify software developed under the Agency Contract.

41.3 Where the Contractor relies on its Legitimate Commercial Interests, unless specified in the Contract it shall demonstrate those interests continue to apply every 3 years or within any other timeframe specified in the Contract.

CLAUSE 45: N/A unless specified in Appendix 1 under "Evaluation of Technology".

CLAUSE 46: Fees – cancelled. Replaced by the following.

"The Contractor shall not be required to pay a fee to the Agency if it sells a product, application, or result developed under the Agency Contract or if it licenses or assigns Intellectual Property Rights arising from work performed under the Agency Contract".

CLAUSE 47.9: N/A

Personal Data “Controller to Controller” Annex (the “PDCC”) of the European Space Agency (“ESA” or the “Agency”)

This “Controller to Controller” Annex governs the processing of Personal Data exchanged by the Parties, acting as separate Controllers, in the frame of the Contract. Such Annex forms an integral part of the Contract. In case of conflict between the terms and conditions of the Contract and the terms and conditions of this Annex, the terms and conditions of this Annex shall prevail.

This Annex survives the expiration or termination of the Contract for as long as the Personal Data are protected by the Data Privacy Regulations.

1. DEFINITIONS

The following specific definitions apply:

- (i) “Agreed Territory” (of Processing) means:
 - a) ESA Member States, as they are listed in the ESA website at URL: http://www.esa.int/About_Us/Welcome_to_ESA/New_Member_States;
 - b) European Union;
 - c) countries recognized by the European Commission as ensuring an Adequate Level of Protection of Personal Data under the European Union’s legal framework.

- (ii) “Data Privacy Regulations” means respectively:
 - a) ESA PDP Framework, i.e. the Personal Data Protection Framework applicable to ESA and available on ESA website at URL: http://www.esa.int/About_Us/Law_at_ESA/Highlights_of_ESA_rules_and_regulations
 - b) the Personal Data protection laws and regulations applicable to the Contractor in the Agreed Territory of Processing which provide an Adequate Level of Protection under the ESA PDP Framework (e.g EU Regulations in the field of personal data protection, including but not limited to Regulation (EU) nr. 2016/679).

- (iii) “Personnel” means:
 - a) with respect to the Contractor: any employee, agent or representative acting under the responsibility of the Contractor or, if subcontracting is permitted, of Contractor’s subcontractors;
 - b) with respect to ESA: any employee, agent or representative acting under the responsibility of ESA (e.g. staff members and seconded agents, consultants experts or employees of third parties).

With respect to terms used with capitals in this Annex (e.g. “Controller”, “Personal Data” etc.) but not defined above, reference is made to the definitions set forth in the Data Privacy Regulations applicable according to Article 2 below.

2. GENERAL

2.1 Each Party is individually and separately responsible for complying with the level of protection resulting from its Data Privacy Regulations in relation to Personal Data, being recognised that:

- a) the Contractor is governed by the Personal Data protection laws and regulations applicable to the Contractor in the Agreed Territory of Processing, which provide an Adequate Level of Protection

under the ESA PDP Framework (e.g. EU Regulations in the field of personal data protection, including but not limited to Regulation (EU) nr. 2016/679).

- b) ESA is governed by PDP Framework, i.e. the Personal Data Protection Framework applicable to ESA and available on ESA website at the URL:
http://www.esa.int/About_Us/Law_at_ESA/Highlights_of_ESA_rules_and_regulations

2.2. The Parties are considered separate Data Controllers of the Personal Data, with each Party being able to determine the purpose and means of Processing the Personal Data under its control in accordance with its privacy statement.

- 2.3 The Personal Data exchanged by the Parties in the frame of this Contract will only be processed for:
- a) the performance of the Contract, including implementation, management, monitoring, audits and the fulfilment of the obligations set out in this Annex;
 - b) the management of the relationship of the Parties in relation to the Contract, notably for administrative, financial, audit or for communication purposes;
 - c) the compliance with any legal or regulatory obligation to which a Party is subject;
 - d) the compliance, in case the performance of the Contract requires access to the Parties' premises, with the health, safety and security requirements, legal or regulatory obligations applicable to the respective Party in such matters.

3. PERSONAL DATA EXCHANGED BY THE PARTIES

In the performance of this Contract each Party may disclose to the other Party data which may qualify as "Personal Data" under its Data Privacy Regulations as follows:

- a) the Agency shall communicate to the Contractor only the Personal Data concerning ESA representatives/contact persons including name, work address, email and telephone numbers;
- b) the Contractor shall communicate to the Agency only:
 - (i) Personal Data concerning the Contractor's representatives/contact persons including name, work address, email and telephone numbers;
 - (ii) Personal Data concerning the Contractor's key Personnel, including title, name, work address, email, telephone numbers, education, professional experience, description of the person's job and responsibilities and the precise assignment of the person to the activity under the Contract.

4. PARTY'S OBLIGATIONS

- 4.1 Each Party is individually and separately responsible for complying with the level of protection resulting from its Data Privacy Regulations in relation to Personal Data, including the collection and update of the Personal Data that it communicates to the other Party, the lawfulness and the quality of such Personal Data and for the means by which they were collected. Should the legal basis for the collection of the Personal Data cease to exist or the quality of the Personal Data be affected, the Party will inform the other Party without undue delay.

- 4.2 The Parties shall preserve the rights and legal remedies of the Data Subject as recognised and protected in the Data Privacy Regulations applicable respectively to each Party. In particular, the Data Controller which disclosed the Personal Data to the other Party will respond to enquiries from Data Subjects and, as the case may be, from any competent authority concerning the data processing of the relevant Personal Data.
- 4.3 In case the Parties engage Processors to support their internal operations, including the Processing of the Personal Data exchanged, it is the responsibility of that Party to ensure that its Processors assume obligations consistent with the Data Privacy Regulations applicable to the respective Party, in order to guarantee an adequate level of protection of Personal Data.
- 4.4 The Party having received the other Party's Personal Data under the Contract shall Process such Personal Data only in the Agreed Territory of Processing.

5. DATA RETENTION

- 5.1 The Parties shall not retain or process the Personal Data exchanged longer than is necessary to carry out the purpose described in Article 2.3 herein, unless required otherwise:
- a) under the Data Privacy Regulations, (e.g. in the frame of audits, inspections and incidents) or
 - b) under the Party's statutory obligations.
- 5.2 The retention period shall be defined in the privacy notices of the Parties.
- 5.3 All Personal Data must be, effectively destroyed/deleted upon expiration of the retention period, unless conservation of such data is required for compliance with any legal or regulatory obligation to which the Party having received the Personal Data from the other Party is subject.

6. CONFIDENTIALITY

The Parties shall ensure the confidentiality of the Personal Data processed by protecting them against unauthorized or unlawful access, acquisition, use and disclosure, in particular by:

- a) limiting access to the Personal Data of the other Party only to their Personnel, that:
 - are required or authorized to access such Personal Data;
 - have committed themselves to confidentiality or are under a statutory obligation of confidentiality;
 - have received the appropriate Personal Data protection training.
- b) taking into consideration, in terms of IT tools, product, applications, the principles of personal data protection by design and by default.

7. SECURITY

The Parties shall adopt appropriate technical and organisational security measures, giving due regard to the risks inherent in the Processing and to the nature, scope, context and purpose of the Processing, in order to ensure the following as appropriate:

- a) the on-going confidentiality, integrity, availability and resilience of Processing systems and services;
- b) measures to protect Personal Data from accidental, unlawful or unauthorized access, use, destruction, loss, modification or transfer.

8. DATA PROTECTION OFFICER/CONTACT POINT

For any Personal Data protection matters, the Parties shall involve their specific contact points identified in the Contract.

9. TRANSFER

The Party having received the other Party's Personal Data under the Contract shall Process (and have processed by its authorised subcontractors or sub-processors) such Personal Data only in the Agreed Territory of Processing. No transfer of Personal Data outside the Agreed Territory is allowed without prior written approval of the other Party.

10. SUB-CONTRACTORS

10.1 The Contractor is authorised to disclose Personal Data received from the Agency to its Sub-contractors provided that:

- a) sub-contracting is specifically authorised by Contract and the Sub-contractors are indicated in the Contract;
- b) all the general conditions set forth in this Annex are fulfilled; in particular the Processing of the Personal Data by the Sub-contractors is performed for the purpose described in Article 2.3 herein and the Personal Data are not transferred outside the Agreed Territory.

10.2 Disclosure of the Agency's Personal Data to other third Parties requires prior approval of the Agency.

11. PERSONAL DATA BREACHES

11.1 After becoming aware of a Personal Data Protection Breach falling in its area of responsibility, and affecting the Personal Data communicated by the other Party, the Party shall notify the other Party within 48 hours.

- 11.2 The Parties will provide each other reasonable assistance to facilitate the handling of the Personal Data Breach and accurate information about the breach, in particular (but not only) in case a complaint is, or likely to be, lodged by a Data Subject in relation to the Breach.

12. LAW – DISPUTE RESOLUTION

Concerning Personal Data protection matters, notwithstanding any other provisions on the governing law set forth elsewhere in the Contract, the provisions set forth in the Data Privacy Regulations, as defined herein, will apply as mentioned in Article 2 herein and will prevail in case of conflict. Without prejudice to the foregoing, disputes between the Parties on Personal Data protection matters shall be settled in accordance with Clause 35 of the Contract.

PRODEX Experiment Arrangement

Guidelines for the preparation of Appendix 1 (Work Description) and Appendix 2 (Financial Plan)

Part I – Appendix 1

1. Work Description

The Work Description shall identify the Project, i.e. the work in execution of which reimbursable cost will be incurred by the Institute during the term of the Arrangement.

Length: One page should be sufficient but in no way be regarded as a firm limit.

2. Distinctions as to 'who' and 'when'

The work to be carried out by the Institute and to be paid for by ESA under the PRODEX Experiment Arrangement (the Project) is to be clearly separated from the work to be carried out by other parties (if the latter is mentioned at all).

The work to be carried out during the term specified in the PRODEX Experiment Arrangement must be clearly separated from the work planned outside said term (if the latter is mentioned at all).

3. Compatibility with other Applicable Documents

Subject to sections 1) and 2) above, the Work Description must correspond to the work description submitted to the relevant national authority in support of the Financial Plan, and is covered by the Institute Agreement.

4. Conventions

- In this contract, the term “Contractor” means the Institute or University signatory of the present PRODEX Experiment Arrangement (PEA) or its Change Notices (CN)
- The present PRODEX Experiment Arrangement is here after designated as “the Contract”
- The term “Project” means the activity covered by the Contract.

Part II – Appendix 2

1. Content

The Financial Plan's minimum content will encompass:

- a) Title of the Project and identification of the Institute
- b) Cost categories such as:
 - Salaries [please specify employee(s) name(s)]
 - Travel
 - Miscellaneous
 - Overheads: Please note that for Belgium, overheads can only be charged for a **maximum of 5%**.
 - Equipment purchased directly by Institute/University
 - etc.
- c) Amounts: all figures should be mentioned in Euro and should be exclusive of VAT in the Agency's Member States.
- d) Project Term (Project time periods).

2. Procurement of VAT exempt equipment, services, or other items

This category should not be integrated into the Financial Plan, but should be listed separately, e.g. in table 2 of Appendix 2, clearly separated from the Financial Plan (i.e. Table 1 of Appendix 2 and its exhibits). The procurements listed in Table 2 of Appendix 2 can be established via the PRODEX Office by means of a Purchase Order placed by the Agency, or by equivalent means (for purchases above 5 000 Euro). This approach has the advantage of ensuring that the goods or services purchased for the purpose of the Project are exempt from VAT.

Work Description

Development of FSUA for LISA mission – Phase B1

1. PROJECT DESCRIPTION

1.1. General description – Objectives of the project

Laser Interferometer Space Antenna (LISA) mission is the large spaceborn gravitational-wave mission, which has been selected by ESA within its Cosmic Vision 2015-2035 program, to address the 'Gravitational Universe' theme. It is a world-class international ESA project with significant participation from NASA. (<https://www.lisamission.org/>)

Czech scientists are already active in the scientific preparation of the mission. The aim of this proposal for the PRODEX Implementation Contract is to strengthen our scientific participation in the mission by joining the instrumentation team of the Consortium and contributing to the hardware development of the mission-critical mechanism (FSUA – Fibre Switch Unit Actuator) onboard each of the spacecrafts. We request here to obtain funding for phase B1.

LISA observatory will consist of three spacecraft following Earth-trailing heliocentric orbits and creating an almost equilateral triangular constellation, whose sides on average will be 2.5 million km long and the angles will not change more than one degree. The distance of the test masses relative to each other will be measured using laser interferometry. Gravitational waves will be detected as tiny distance variations of the test masses. The LISA spacecrafts will be trailing Earth at a distance between 50 and 65 million km from Earth. After their launch the spacecrafts are expected to arrive at their operating positions in approximately 15 months and the mission is expected to last for 4 years nominal, with the possibility to extend up to 10 years. LISA is scheduled to be launched in 2034, however, the mission has already tested some of its needed key technologies through the successful LISA pathfinder mission in 2016.

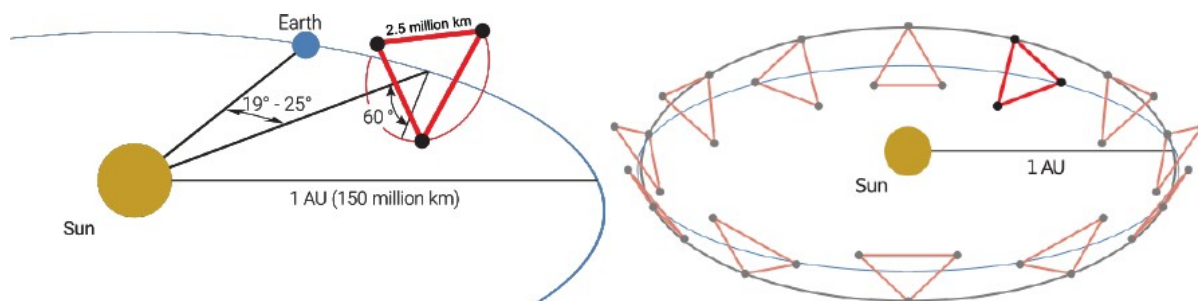


Figure 1-1: Baseline for LISA spacecrafts location/orbits.

The space-based LISA detector design has been, and is being, optimized to detect gravitational wave sources in the low-frequency (mHz) regime. This regime cannot be covered by the terrestrial gravitational wave observatories, which are limited by Earth's seismic vibrations and gravity gradient noise to operate above the one Hz regime. This part of The Gravitational Universe will unveil sources spanning from those already observed by terrestrial observatories (i.e., stellar mass compact object binaries) to binary systems with almost a billion solar masses. A detailed catalogue of the scientific objectives can be found in the proposal in response to the ESA call for L3 mission concepts (arXiv:1702.00786); below we provide just a brief summary.

In our own galaxy, we will be able to study the formation and the evolution of binary compact objects by measuring their period, spatial and mass distributions. These binaries mainly consist of white dwarfs and emit continuous and almost monochromatic gravitational waves. They are so numerous that at the frequency band from 0.5 mHz to a few mHz we expect to be limited by unresolved sources of this kind. Several known binary systems can be used as verification sources thanks to existing electromagnetic observations. LISA will detect and localize stellar binaries also outside the Galaxy; these binaries will cross into the terrestrial observatories' band weeks to months later. Hence, synergies between electromagnetic and terrestrial gravitational observatories on phenomena like merging neutron stars can be planned in advance.

LISA will be able to detect signal from sources merging at eras before the cosmic reionisation. This implies that we should be able to search for the seed black holes that evolved in to the massive black holes occupying the centers of galaxies and study their growth through their merger history. At lower redshifts we will be able to localize these mergers in the sky and observe their electromagnetic counterparts allowing us to study their astrophysical environment. After the merger, LISA will be able to detect the ring down characteristics of the remaining massive black hole; this ring down signal will allow us to test different aspects of GR, including the no-hair theorem.

An Extreme Mass Ratio Inspiral (EMRI) is another binary system promising to test General Relativity. An EMRI consists of a stellar compact object inspiraling in to a supermassive black hole. During the inspiral phase, LISA will have the sensitivity to trace the path of the stellar object, which will allow the exploration of the multipolar structure of the spacetime around the massive black hole. LISA is expected to detect at least one EMRI per year, and potentially many more.

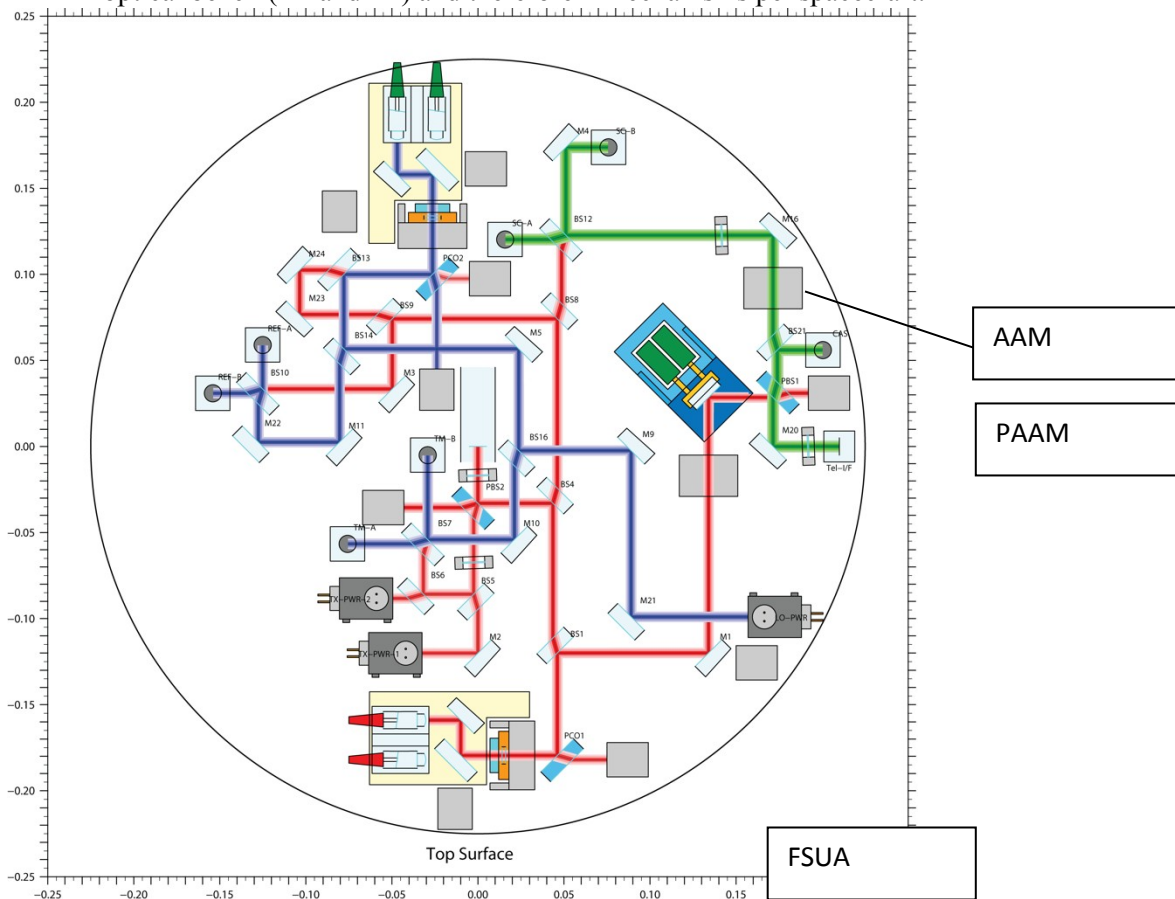
LISA will allow us to probe cosmology. Namely, it will allow us to measure the dimensionless Hubble parameter by gravitational wave signals only; it will test the presence of massive fields arising in Dark Matter models around massive black holes; it will attempt to detect the cosmological stochastic gravitational wave background and provide its spectral shape.

In 2018 researchers from ASU, FZU and the Institute of Theoretical Physics of the Charles University have created the Prague Relativity Group (PRG) in order to join the LISA consortium. LISA consortium consists of several Working Groups (WGs), like the Astrophysics WG, the Cosmology WG, the Fundamental Physics WG and the Waveform WG, to which the PRG members have enlisted. One of the most critical WG for the mission's success is the Waveform one, since the detection or not of gravitational waves from the aforementioned systems depends on the quality of the waveforms that will be developed during the preparation stage. In Waveform WG the PRG participates with three full members and few associate ones.

1.2. Hardware Description

There are several mechanisms onboard each of the spacecrafts directly connected to the scientific payload:

- PAAM – Point-Ahead Angle Mechanism** – The purpose of the PAAM is to compensate for the periodic variation in the out-of-plane point ahead angle – the difference in angle between the incoming and outgoing beams due to the relative velocity between the LISA spacecrafts. There is one PAAM mechanism per optical bench, two per spacecraft.
- FSUA – Fibre Switch Unit Actuator** – there are two beams coming from each of the spacecrafts, each directed to one of the other two spacecrafts. Each of the optical benches which prepare these beams has two laser sources due to redundancy. Switching between the laser sources is performed using a $\lambda/2$ waveplate, which rotates the polarization of the incoming beam. By rotating this waveplate and with combination of different polarizations of incoming beams and polarizing filters at the output, one can effectively select which of the beams is going to be used. In addition, the two optical benches on each Spacecraft are connected via an optical fibre to allow the phase of the light sent out on each arm to be compared. These so-called back-link fibre also needs a suitable level of redundancy and this will likely be implemented using the same FSUA mechanism. There are four FSUA mechanisms per spacecraft.
- AAM – Active Aperture Mechanism** – this mechanism is intended to hold the aperture stops working as the internal pupil of the telescopes. The precise alignment of these aperture stops is one of the main contributors to Tilt-to-Length (TTL) coupling – this is the effect by which misalignments of the optical system introduce cross-coupling from rotations to path-length. There are two AAM mechanisms per optical bench (Rx and Tx) and therefore 4 mechanisms per spacecraft.



LISA OB Concept Layout (A-Side) V0.3, Ewan Fitzsimons, 31/05/2019

Figure 1-2: Current schema of the optical workbench onboard each of the satellites (one side of the work bench) with mechanism locations. The scheme is taken from the Instrument Design Description from the MCR data pack. **The unit dimension on axes are in meters.**

FSUA – Fibre Switch Unit Actuator

There is a list of requirements, according to the current baseline, which should be fulfilled by the FSUA design (based on Reference Documents RD1 and RD2, see Section 11):

- $\lambda/2$ waveplate with diameter 12mm can be set arbitrary position with 1 degree tolerance within full 360 degree range is required.
- The beam stability has to be $<1 \mu\text{rad}$ during waveplate rotation.
- The mechanism actuation/detection has to be redundant.
- The expected lifetime is 11 years (in-flight), 600-700 cycles (in-flight).
- The mechanism envelope should be 42x22x70 mm, with the beam axis approx. 20mm above the base. Electronics is not part of this envelope.
- The mechanism has to be non-ferromagnetic and has to be UHV compatible (minimize outgassing).
- It has to hold its position during the launch or be able to find the correct position in-orbit as needed.
- The mechanism has to work in the air as well as in the vacuum.

There are several design options, which are going to be studied within this project. One of them is shown Figure 1-3. Generally, we are considering the following concept:

- The FSUA actuator will be made from titanium main block.
- Slip-stick mechanisms based on piezos will be used to be able to perform a full 360deg motion.
- Guidance will be done either using the slip-stick mechanism itself (as shown in the figure) or using precise bearing.
- Redundancy for the motion will be achieved either by sufficient number of actuators (three are shown in the figure, but if more are used, than damage of some of them is not affecting the overall results), or a “two-stage” design.
- Measurement is expected to be performed using two independent optical encoders (because of redundancy).
- Repeatability will be achieved using closed loop movement using built-in capacitive sensors.

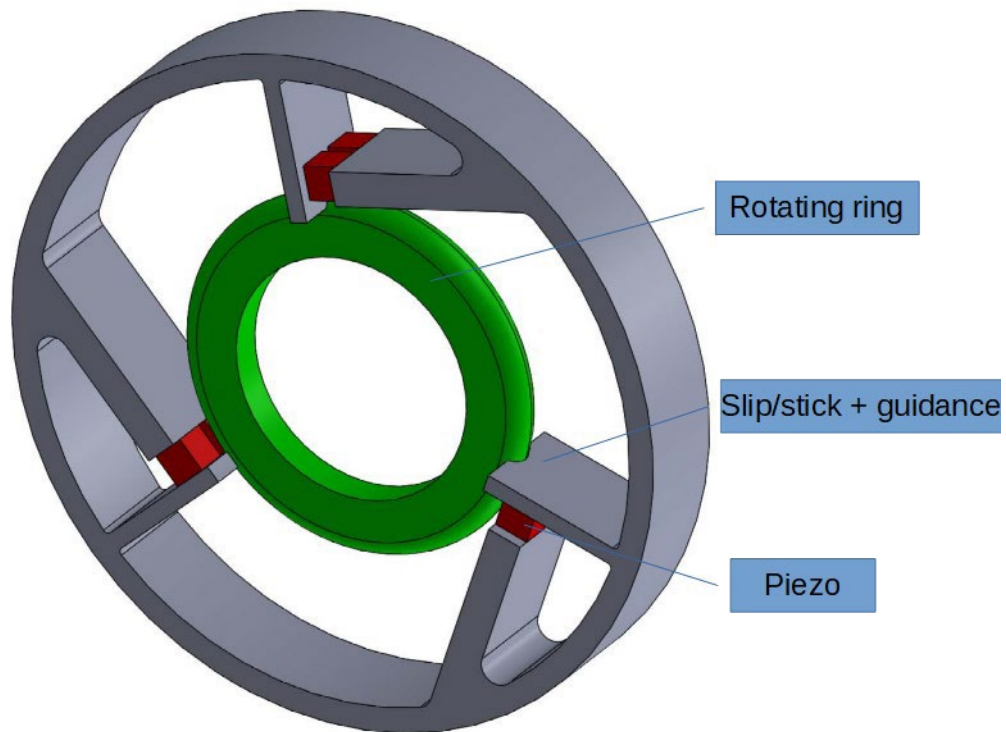


Figure 1-3: One of the conceptual schemes to be studied within the phase B1. **Internal ring has 12mm inner diameter (required clear aperture for $\lambda/2$ wave plate).**

2. PROJECT ORGANISATION AND INTERFACES

Czech LISA FSUA consortium organization structure is shown in Figure 2-1:

- There is a project PI, who has the responsibility to communicate with the international LAD consortium and manages the whole project.
- There is a board, which the project PI can use for discussions and decisions.
- There is a prime that is the main target for industrial subcontractors.

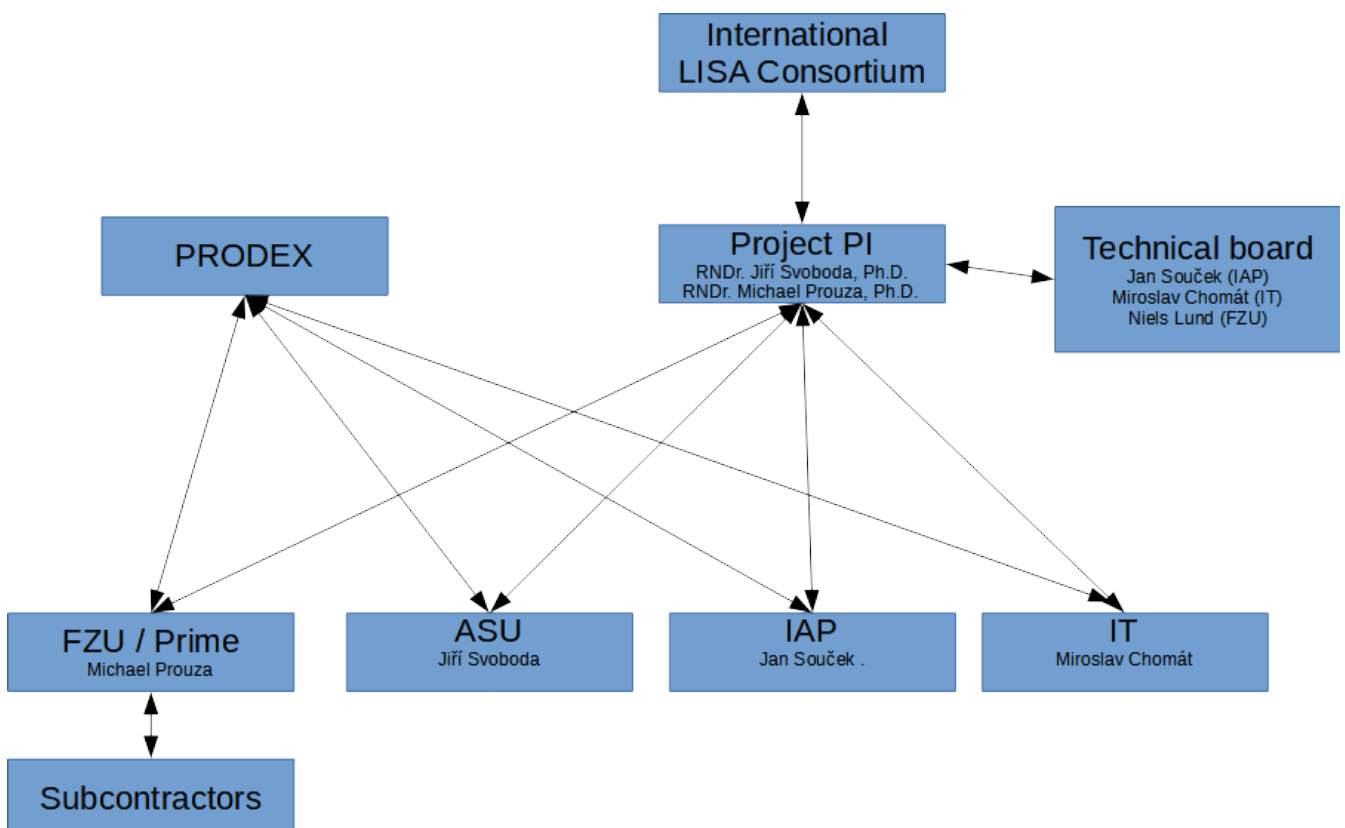


Figure 2-1: Basic organization structure of the project.

2.1. Contact information

- Investigator title and full name: **Assoc. Prof. Miroslav Chomát, Ph.D.**
- Institute/University: **Institute of Thermomechanics of the Czech Academy of Sciences**
- Department: **Electrical Engineering and Electrophysics**
- Address: **Dolejšková 1402/5, 182 00 Praha 8, Czech Republic**
- Phone, e-mail: **+420 266 053 146, chomat@it.cas.cz**
- Head of Institute / Department endorsing the Project (name, function, e-mail): Assoc. Prof. Miroslav Chomát, Ph.D., interim director, chomat@it.cas.cz

2.2. Team members role in the Project

The project will be cooperated by two scientific Co-PIs:

- **RNDr. Jiří Svoboda, Ph.D.** (Astronomical Institute of the Czech Academy of Sciences)
- **RNDr. Michael Prouza, Ph.D.** (Institute of Physics of the Czech Academy of Sciences)

The first mentioned Co-PI will be the main contact point for the project.

The role of two Co-PIs will be following:

Jiří Svoboda will be the main investigator and will be responsible for communication with ESA, PRODEX Office, Czech PRODEX Committee, Czech delegation to ESA and the LISA consortium.

Michael Prouza will be the second main investigator of the project and will be responsible for the Project Management, development of the proposed space hardware contribution to LISA and contracts with the industrial partners.

The team members and their responsibilities will be:

- Astronomical Institute of the Czech Academy of Sciences (ASU)
 - Provide communication with the ESA, international partners of the consortium
 - To coordinate the study and development of the hardware contribution between the national industrial partner and the international consortium partners.
- Institute of Physics of the Czech Academy of Sciences (FZU)
 - Prime contractor
 - Preliminary mechanics design
 - Thermal calculations
 - Vibration simulations
 - Some of specialized thermal and vibration calculations might be subcontracted, as well as some other specific space related consultancy services
- Institute of Atmospheric Physics of the Czech Academy of Sciences (IAP)
 - Preliminary electronics design
- Institute of Thermomechanics of the Czech Academy of Sciences (IT)
 - Microvibrations preliminary analysis
 - Tribology support

○ **Astronomical Institute of the Czech Academy of Sciences**

The ASU has a broad experience in the development of astrophysical models for strong gravity regime, performance of complex simulations and also from successful management of the past and currently running space projects (e.g., Solar Orbiter, Athena). The scientific participation in future gravitational-wave missions is at a very high priority at ASU. Team members are actively participating in LISA's scientific consortium. In particular, G. Loukes-Gerakopoulos and V. Skoupy are full members of the Waveform Working Group (WG). Their work is to produce waveform templates, which will be used for mock data simulations during the preparation of the mission and for detecting the gravitational waves during the mission. Jiří Svoboda is a

member of the Astrophysics Working Group. He is experienced in the space project leads (Athena X-IFU, eXTP) and will be coordinating this project together with Michal Prouza from the Institute of Physics.

○ **Institute of Physics of the Czech Academy of Sciences**

The FZU is the largest institute of the Czech Academy of Sciences, currently with more than 1300 employees. Its expertise covers a very broad range of physics – from astronomy, cosmology and astroparticle physics, over condensed matter physics up to plasma and laser physics. There are several high-tech workshops at the institute, and there is very wide experience in production of very precise mechanical and optomechanical components, and with the operation of vacuum chambers, and with the automatic testing e.g. of electrical components, various detectors and optical detectors (we currently perform e.g. an extensive testing of the detectors for the LHC ATLAS upgrade, new electronics for the Pierre Auger Collaboration or we have been included in the characterization of CCD sensors for the Large Synoptic Survey Telescope). FZU has also a wide experience with participation in large European and worldwide projects (unique laser centers ELI Beamlines and HiLASE were established as part of FZU in recent years, SOLID21 project in solid state physics currently brings new building with high-tech laboratories). FZU participates as one of the most important Czech members in CERN (LHC, ATLAS, ALICE), FERMILAB and BNL. FZU is also very active in astroparticle physics (Pierre Auger Observatory, Cherenkov Telescope Array). FZU actively collaborates with ASU on several projects, including Cherenkov Telescope Array, as well as on the topic of multi-messenger studies. FZU collaborates also with IT on several projects, especially in the areas of solid state physics and optics. In 2017, there was established the Central European Institute for Cosmology (CEICO) as part of the FZU, which became a largest research body dedicated to the research in cosmology and gravitation. Several leading experts in the area of gravitational physics (Constantinos Skordis, Lorenzo Reverberi) are currently working at CEICO and they are also active within the LISA scientific consortium. In line with other activities of CEICO, where we cover both theoretical and experimental aspects of the work, FZU is now preparing also its experimental activities in the area of gravitational wave detection. For the current proposal we are currently establishing the dedicated position of mechanical designer and engineer, and we have already hired a renowned expert in the design of piezo-elements for space applications, Niels Lund, previously Technical University of Denmark. The FZU team will be led by Michael Prouza, who is a senior scientist in astroparticle physics and astronomy, the long-term member of ESO Scientific and Technical Committee, the Czech representative in the LSST project, the member of the CCF Board of the Cherenkov Telescope Array Consortium, and currently also the director of FZU.

○ **Institute of Atmospheric Physics of the Czech Academy of Sciences**

IAP has a strong heritage in building space electronics, in particular for measurements and digital processing of electromagnetic quantities, gained in previous projects. The team has recently provided flight electronic subunits to Solar Orbiter RPW instrument (ESA), TARANIS IME-HF instrument (CNES) and Exomars 2020 Maigret instruments (ESA/Roskosmos). The Department of space physics at IAP is now developing a wave analyzer module for JUICE RPWI instrument and a control unit for the X-IFU instrument on the Athena space telescope. The hardware provided for LISA is in many respects similar to those projects and the heritage is fully transferable.

The institute has qualified technical and scientific and engineering staff as well as facilities to perform electronic development and testing, as demonstrated in previous projects. The main facilities include a state of the art electronics laboratory, an ISO7 class clean room with a thermal test chamber, mechanical workshop and a vibration test setup. Additional test facilities can be rented from Czech industrial subjects, such as VZLU.

The IAP team will be lead by Jan Souček and the following team members will contribute to the development: Ondřej Santolík, Ivana Kolmašová, Radek Lán, Luděk Uhlíř, David Píša, Jiří Jánský.

○ **Institute of Thermomechanics of the Czech Academy of Sciences**

IT is a scientific and research institution of the Czech Academy of Sciences. The Institute conducts interdisciplinary basic and applied research in the following areas: fluid dynamics, thermodynamics, dynamics of mechanical systems, solid mechanics, interactions of fluids and solids, environmental aerodynamics, biomechanics, mechatronics, electrophysics, electrical machines, drives and electronics and material diagnostics.

IT is actively collaborating with Institute of Atmospheric Physics (see section 2.3) on flight hardware development, namely mechanical calculations.

The IT team will participate in the project mainly in the fields of microvibrations calculations and tests (leading researcher: Igor Zolotarev), tribology support (leading researcher: Dušan Gabriel). The IT team will be coordinated by Miroslav Chomát, the deputy director of IT.

3. PROJECT TERM COVERED BY THE PRODEX EXPERIMENT ARRANGEMENT

The planned start and end dates of the contract are: **January 2021 – end of March 2022**

4. APPLICABLE (AD) AND REFERENCE (RD) DOCUMENTS

4.1. Applicable Documents

The following documents are applicable to the Contract.

N/A

4.2. Reference Documents

The following documents can be used as a reference to the Contract.

[RD 1]	ESA-L3-EST-INST-DD-001 - LISA Design description
[RD 2]	LISA-UKOB-INST-TN-005 - LISA Mechanism Summary

...

5. WORK BREAKDOWN STRUCTURE (WBS)

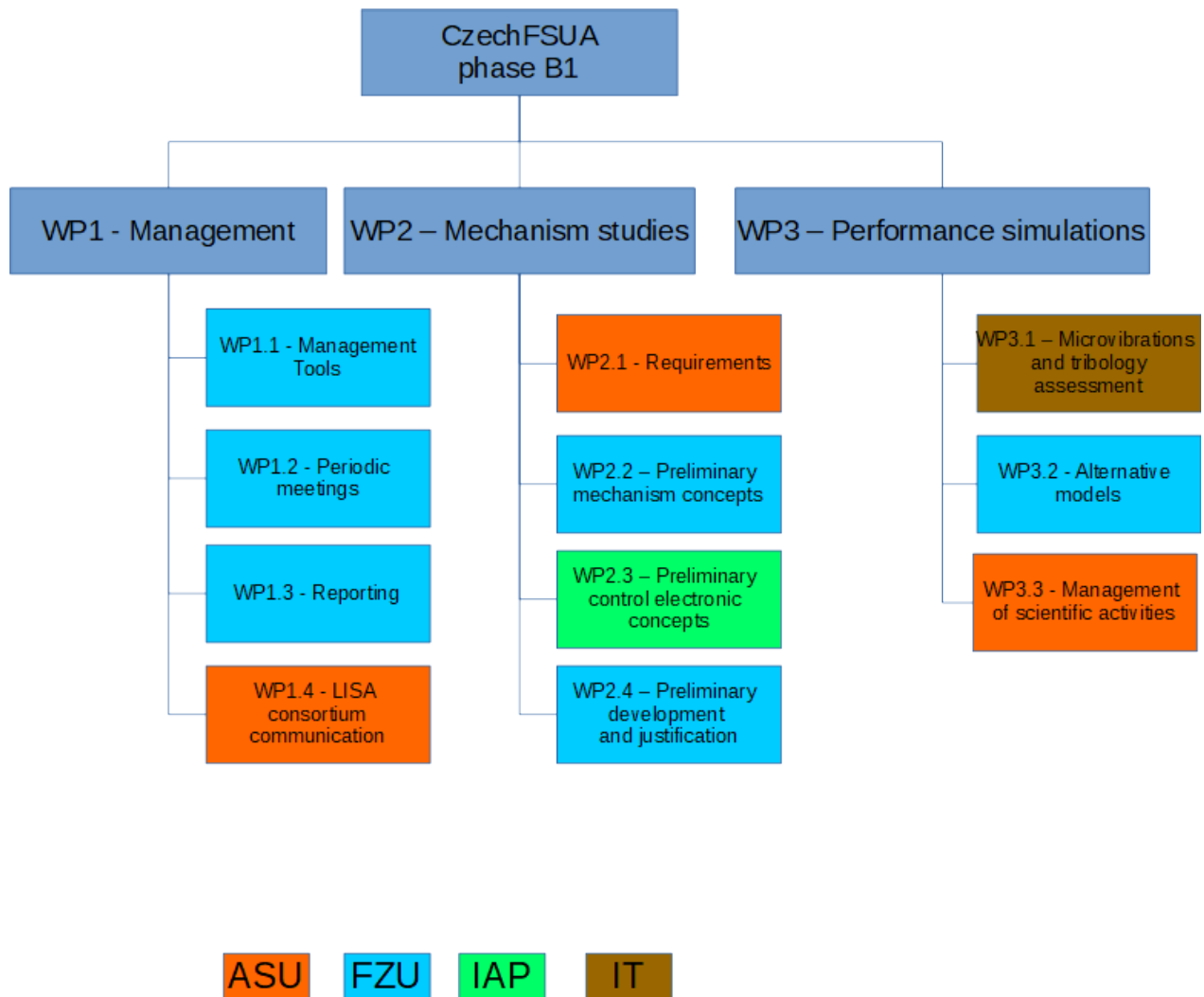


Figure 4-1 – Proposed Czech LISA FSUA B1 contribution WBS.

The Work Break Down Structure (WBS) is described in Figure 4-1. The WP1 includes the management activities related to the organisation of this project, including setup of management tools, organisation of periodic meetings and reports, and communication with the LISA Consortium. The WP2 aims at the mechanism studies and design. It includes gathering of requirements, preliminary mechanism and control electronic concepts, as well as thermal and vibration calculations of the mechanism design. The goal of WP3 is to perform simulations of the microvibration and tribology assessment, and to organise the scientific team within the LISA Consortium. The performance of simulations of expected scientific data ensures the full membership in the LISA Consortium to the scientific members of the team. The work packages 3.2 and 3.3 are included in this project with the aim to ensure collaboration between the Czech scientific and engineering team, and because only the hardware contribution will not be sufficient for us to become full members of the LISA Consortium. The cost requirements for the organisation of the scientific team within our project is relatively low to be requested for in a separate proposal.

6. WORK PACKAGE

6.1. IT Workpackages

Work Package number:	WP3.1
Work Package Title:	Microvibrations and tribology assessment
Responsible Institute:	IT
Local Managers:	Miroslav Chomát
Project phases:	B
Objectives: The goal is to perform simulations related to the microvibrations during setup and operation.	
<p>Inputs:</p> <ul style="list-style-type: none"> ● D1: CzechFSUA requirements report ● D2: CzechFSUA design concepts report ● D3: CzechFSUA concepts tradeoff report <p>Description of work:</p> <ul style="list-style-type: none"> ● Microvibration effects assessment ● Tribology assesment <p>Excluded tasks:</p> <ul style="list-style-type: none"> ● N/A <p>Milestones:</p> <ul style="list-style-type: none"> ● M4 – Design Review Update 	
<p>Deliverables:</p> <ul style="list-style-type: none"> ● Updated D2: Czech FSUA design concepts report ● Updated D3: CzechFSUA concepts tradeoff report ● Updated D5: CzechFSUA test plan <p>Non-deliverables:</p> <ul style="list-style-type: none"> ● N/A 	

6.2. Workpackages of other project partners

Table 1: Work-Package description

Work Package number:	WP1.1
Work Package Title:	Management tools
Responsible Institute:	FZU
Local Managers:	Michael Prouza
Project phases:	B
Objectives: The goal is to setup all management tools to be used during the project	
<p>Inputs:</p> <ul style="list-style-type: none"> • N/A <p>Description of work:</p> <ul style="list-style-type: none"> • Setup/start issue tracking system • Setup/start central documentation system • Setup/start central repository • Setup/start issue teleconference environment <p>Excluded tasks:</p> <ul style="list-style-type: none"> • N/A <p>Milestones:</p> <ul style="list-style-type: none"> • M1 - Kickoff 	
<p>Deliverables:</p> <ul style="list-style-type: none"> • N/A <p>Non-deliverables:</p> <ul style="list-style-type: none"> • MoM (documentation system) 	

Work Package number:	WP1.2
Work Package Title:	Periodic meetings managed
Responsible Institute:	FZU
Local Managers:	Michael Prouza
Project phases:	B
Objectives: The goal is to organize/manage periodic meetings	
<p>Inputs:</p> <ul style="list-style-type: none"> • N/A <p>Description of work:</p> <ul style="list-style-type: none"> • Organization of all periodic meetings • Organization of all sprint meetings • Preparing MoM of the meetings <p>Excluded tasks:</p> <ul style="list-style-type: none"> • N/A <p>Milestones:</p> <ul style="list-style-type: none"> • N/A 	
<p>Deliverables:</p> <ul style="list-style-type: none"> • CzechFSUA kickoff report (documentation system) <p>Non-deliverables:</p> <ul style="list-style-type: none"> • MoM (documentation system) 	

Work Package number:	WP1.3
Work Package Title:	Reporting
Responsible Institute:	FZU
Local Managers:	Michael Prouza
Project phases:	B
Objectives: The goal is to prepare all official reports needed by the financing agency	
Inputs: <ul style="list-style-type: none"> • N/A Description of work: <ul style="list-style-type: none"> • Monthly reports will be prepared and submitted to ESA PRODEX. Excluded tasks: <ul style="list-style-type: none"> • N/A Milestones: <ul style="list-style-type: none"> • N/A 	
Deliverables: <ul style="list-style-type: none"> • Regular progress reports Non-deliverables: <ul style="list-style-type: none"> • N/A 	

Work Package number:	WP1.4
Work Package Title:	LISA Consortium communication
Responsible Institute:	ASU
Local Managers:	Jiří Svoboda
Project phases:	B
Objectives: The goal is to officially communicate with the LISA international Consortium and the National Project Manager Board during the whole project.	
Inputs: <ul style="list-style-type: none"> • LISA Consortium documentation Description of work: <ul style="list-style-type: none"> • Communication with the LISA Consortium • Active participation in the National Project Manager Board 	



Deliverables:

- Reports to the National Project Manager Board

Work Package number:	WP2.1
Work Package Title:	Requirements
Responsible Institute:	ASU
Local Managers:	Jiří Svoboda
Project phases:	B
<p>Objectives: The goal is to gather as much requirements on the FSUA mechanism from the international consortium as possible to start the work.</p>	
<p>Inputs:</p> <ul style="list-style-type: none"> • [RD 1] • [RD 2] • Documentation from the LISA Instrumentation Group <p>Description of work:</p> <ul style="list-style-type: none"> • Gather all available documentation from international consortium • Communication with LISA Instrumentation Group <p>Excluded tasks:</p> <ul style="list-style-type: none"> • N/A <p>Milestones:</p> <ul style="list-style-type: none"> • M2 – Requirements review 	
<p>Deliverables:</p> <ul style="list-style-type: none"> • D1: CzechFSUA requirements report (documentation system) <p>Non-deliverables:</p> <ul style="list-style-type: none"> • N/A 	

Work Package number:	WP2.2
Work Package Title:	Preliminary mechanism concepts
Responsible Institute:	FZU
Local Managers:	Michael Prouza
Project phases:	B
<p>Objectives: The goal is to prepare concepts of FSUAB1-piezo, FSUAB1-actuator, FSUAB1-encoder, FSUAB1-optics possible variants and tradeoffs.</p>	
<p>Inputs:</p> <ul style="list-style-type: none"> ● D1: CzechFSUA requirements report <p>Description of work:</p> <ul style="list-style-type: none"> ● Prepare concepts of FSUAB1-piezo ● Prepare concepts of FSUAB1-actuator ● Prepare concepts of FSUAB1-encoder ● Prepare concepts of FSUAB1-optics ● Analyze tradeoffs of different concepts. ● FMECA (Failure mode, effects, and criticality analysis) <p>Excluded tasks:</p> <ul style="list-style-type: none"> ● N/A <p>Milestones:</p> <ul style="list-style-type: none"> ● M3 – Design Review ● M4 – Design Review Update 	
<p>Deliverables:</p> <ul style="list-style-type: none"> ● Updated D1: CzechFSUA requirements report ● D2: CzechFSUA design concepts report (documentation system) ● D3: CzechFSUA concepts tradeoff report (documentation system) <p>Non-deliverables:</p> <ul style="list-style-type: none"> ● CAD models (repository) 	

Work Package number:	WP2.3
Work Package Title:	Preliminary control electronic concepts
Responsible Institute:	IAP
Local Managers:	Jan Souček
Project phases:	B
Objectives: The goal is to prepare the FSUAB1-Controller concepts.	
<p>Inputs:</p> <ul style="list-style-type: none"> ● D1: CzechFSUA requirements report ● D2: CzechFSUA design concepts report ● D5: CzechFSUA test plan <p>Description of work:</p> <ul style="list-style-type: none"> ● Prepare piezo mechanism drive concepts ● Analyze proposed communication standards and other interface requirements ● Prepare concepts (draft schematics) of FSUAB1-controller, including SPICE simulations (as needed) ● Identify main electronic components <p>Excluded tasks:</p> <ul style="list-style-type: none"> ● N/A <p>Milestones:</p> <ul style="list-style-type: none"> ● M3 – Design Review ● M4 – Design Review Update 	
<p>Deliverables:</p> <ul style="list-style-type: none"> ● D4: CzechFSUA controller concepts report (documentation system) ● Inputs to D2: CzechFSUA design concepts report ● Inputs to D5: CzechFSUA test plan <p>Non-deliverables:</p> <ul style="list-style-type: none"> ● N/A 	

Work Package number:	WP2.4
Work Package Title:	Preliminary development and justification
Responsible Institute:	FZU
Local Managers:	Michael Prouza
Project phases:	B
Objectives: The goal is to perform all required thermal and vibration calculations on the mechanical designs.	
<p>Inputs:</p> <ul style="list-style-type: none"> ● D1: CzechFSUA requirements report ● D2: CzechFSUA design concepts report ● D3: CzechFSUA concepts tradeoff report ● CAD models <p>Description of work:</p> <ul style="list-style-type: none"> ● Building block qualification plan ● Test plan preparation ● Preliminary thermal calculations ● Preliminary mechanical calculations ● Life-time assessment <p>Excluded tasks:</p> <ul style="list-style-type: none"> ● N/A <p>Milestones:</p> <ul style="list-style-type: none"> ● M4 – Design Review Update 	
<p>Deliverables:</p> <ul style="list-style-type: none"> ● Updated D2: CzechFSUA design concepts report ● Updated D3: CzechFSUA concepts tradeoff report ● D5: CzechFSUA test plan ● D6: CzechFSUA qualification plan <p>Non-deliverables:</p> <ul style="list-style-type: none"> ● FEM models 	

Work Package number:	WP3.2
Work Package Title:	Alternative models
Responsible Institute:	FZU
Local Managers:	Constantinos Skordis
Project phases:	B
Objectives: The goal is to provide gravitational waveforms in the framework of Alternative theories of Gravity.	
<p>Inputs:</p> <ul style="list-style-type: none"> • N/A <p>Description of work:</p> <ul style="list-style-type: none"> • Developing codes. • Simulations of gravitational wave production and propagation in the alternative framework <p>Excluded tasks:</p> <ul style="list-style-type: none"> • N/A <p>Milestones:</p> <ul style="list-style-type: none"> • M3 – Design Review • M4 – Design Review Update 	
<p>Deliverables:</p> <ul style="list-style-type: none"> • N/A <p>Non-deliverables:</p> <ul style="list-style-type: none"> • Codes and gravitational waveforms in the framework of Alternative theories of Gravity. 	

Work Package number:	WP3.3
Work Package Title:	Management of scientific activities
Responsible Institute:	ASU
Local Managers:	Georgios Loukes Gerakopoulos
Project phases:	B
<p>Objectives: The main goal is to manage the Czech scientific contribution in the LISA Consortium and coordinate activities between the scientific and technical team. A secondary goal is to produce waveform templates.</p>	
<p>Inputs:</p> <ul style="list-style-type: none"> • N/A <p>Description of work:</p> <ul style="list-style-type: none"> • Organisation of the activities of the Czech scientific team in the LISA Consortium. • Development of gravitational waveform templates needed for the detection of gravitational waves from an Extreme Mass Ratio Inspiral by LISA. <p>Excluded tasks:</p> <ul style="list-style-type: none"> • N/A <p>Milestones:</p> <ul style="list-style-type: none"> • M3 – Design Review • M4 – Design Review Update 	
<p>Deliverables:</p> <ul style="list-style-type: none"> • N/A <p>Non-deliverables:</p> <ul style="list-style-type: none"> • Organisation of the regular meetings between the scientific and engineering teams within this project • Codes producing Gravitational Waveforms for Extreme Mass Ratio Inspirals • Gravitational Waveform templates for Extreme Mass Ratio Inspirals. 	

7. STANDARD MANAGEMENT REQUIREMENTS

7.1. Conditions for Employment

All personnel allocated to the Project shall be employed by the Contractor (Institute/University signatory of the Contract).

7.2. Communications

All communications to the Agency shall be addressed to the Agency's representatives identified in the Cover Letter.

Communications on technical and programmatic matters shall in addition be addressed to the entities identified here after:

N/A

7.3. Management requirements

The management requirements listed here after are the ESA “Standard requirements for management, reporting, meetings and deliverables”, Annex 3 to ESA contracts, rev. 5: 2018-10. They are tailored to the present contract and retain the same numbering as in the original text.

The parameters of section 7.3 that are specific to the present contract (item 2.6: Frequency of progress reports, item 3 lit. b: Frequency of progress meetings, item 4: Deliverables) are defined in section 8.

1. MANAGEMENT

1.1. General

The Contractor shall implement effective and economical management for the Project. Its nominated Project Manager shall be responsible for the management and execution of the work to be performed and, when applicable, for the coordination and control of the team's work.

Decisions reached during the present contract having technical baseline, cost or planning consequences, shall require formal Agency approval before implementation.

1.2. Access

- a) During the course of the Contract the Agency shall be afforded free access to any plan, procedure, specification or other documentation relevant to the programme of work. Areas and equipment used during the development/testing activities associated with the Contract shall also be available for inspection and audit.
- b) The Contractor shall notify the Agency at least three (3) weeks before the start of any test programme, or as mutually agreed, in order to enable the Agency to select those tests that it wishes to witness. The Agency shall notify the Contractor of its visit at least one (1) week in advance.

2. REPORTING

2.1. Minutes of meeting

- a) The Contractor is responsible for the preparation and distribution of minutes of meetings (see ECSS-M-ST-10C Rev. 1 section 5.2.2 for more details) held in connection with the Contract. Electronic version shall be issued and distributed to all participants, not later than ten (10) days after the meeting concerned.
- b) The minutes shall clearly identify all agreements made and actions accepted at the meeting together with an update of the Action Item List (AIL) and the Document List. The minutes shall be signed.

Note: This clause may be restricted to progress meetings if specifically expressed.

2.2. Documents List

The Contractor shall create and maintain a Document List, recording all the documents produced during the work, including reports, specifications, plans and minutes. The list shall indicate the document reference (with unique identifier), type of document, date of issue, status (draft or approved by the Agency), confidentiality level and distribution. This list shall be maintained under configuration control.

2.3. Action Item List (AIL)

The Contractor shall maintain an Action Item List (AIL, see ECSS-M-ST-10C rev. 1, section 5.2.2.1 for more details), recording all actions agreed with the Agency. Each item shall be uniquely identified with reference to the minutes of the meeting at which the action was agreed and will record generation date, due date, originator and the person instructed to take action. The AIL shall be reviewed at each progress meeting.

2.4. Bar-Chart Schedule

- a) The Contractor shall be responsible for maintaining the bar-chart for work carried out under the Contract, as agreed with the Agency.
- b) The Contractor shall present an up-to-date chart for review at all consequent meetings, indicating the current status of the Contract activity (WP's completed, documents delivered, etc.).
- c) Modifications of the schedule shall be contractually binding only if approved in writing by the Agency's representative for contractual and administrative matters.

2.5. Risk Register

- a) The Contractor shall be responsible for maintaining a risk register, agreed at the kick-off meeting. This register shall identify potential risks, their likelihood and severity, and propose meaningful mitigation measures (one can refer to ECSS-M-ST-80C for more details).
- b) The Contractor shall present an up-to-date risk register in its progress reports for review at progress meetings.

2.6. Progress Reports

Every ... (see section 8.2.1 - Documentation), the Contractor shall provide a Progress Report to the Agency's representatives, covering the activities carried out under the Contract (one can refer to ECSS-M-ST-10C Rev.1 section 5.2.2.2 for more details). This report shall refer to the current activities shown on the latest issued bar-chart and shall include the following topics:

- .1 action items completed during the reporting period
- .2 a status report on all long lead or critical delivery items
- .3 a description of the progress of the work: actual progress vs. planned schedule, milestones and events accomplished

- .4 reasons for slippages and/or problem areas, if any, and corrective actions planned and/or taken, with revised completion date per task
- .5 events anticipated during the next reporting period (e.g. milestones reached)
- .6 expected date for major schedule items
- .7 milestone payment status
- .8 status of the risks.

2.7. Fixed assets N/A

2.8. Problem Notification

The Contractor shall notify the Agency's representatives (Technical Officer and Contracts Officer) of any problem likely to have a major effect on the time schedule of the work or to significantly impact the scope of the work to be performed (due to e.g. procurement problems, unavailability of facilities or resources, etc.).

2.9. Technical Documentation

- a) As they become available and not later than the dates in the delivery plan, the Contractor shall submit, for the Agency's approval, technical notes, engineering drawings, manufacturing plans, test plans, test procedures, specifications and Task/WP reports.
- b) Technical documentation to be discussed at a meeting with the Agency shall be submitted two (2) weeks prior to the meeting.
- c) Technical documents from Subcontractors shall be submitted to the Agency only after review and acceptance by the Contractor and shall be passed to the Agency via the Contractor's formal interface to the Agency.
- d) Tests carried out under the Contract shall be performed according to test plans and test procedures approved by the Agency's Technical Officer (see ECSS-E—ST-10-02C and ECSS-Q-20C Rev.1 for more details).

3. MEETINGS

- a) N/A
- b) Progress Meetings shall be held every ... (see section 8.1 - Frequency of Progress meetings), either by teleconference or in person if deemed necessary by the Agency.
- c) N/A
- d) Additional meetings may be requested either by the Agency or by the Contractor.
- e) The Contractor shall give to the Agency prior notice of any meetings with Third Party(ies) to be held in connection with the Contract. The Agency reserves the right of participation in such meetings.
- f) With due notice to the Contractor, the Agency reserves the right to invite Third Parties to meetings, in order to facilitate information exchange.
- g) For all meetings with the Agency, the Contractor shall ensure that proper notice is given at least two (2) weeks in advance. For all other meetings, the Contractor shall inform the Agency, which reserves the right to participate. The Contractor is responsible for ensuring the participation of its personnel and those of the Subcontractor(s), as needed.
- h) For each meeting, the Contractor shall propose an agenda in electronic form and shall compile and distribute hand-outs of any presentation given at the meeting.

4. DELIVERABLES

4.1. Documentation

The Contractor shall submit to the Agency the documentation listed here below, for Agency review and, where required, approval. Documentation shall be submitted as per the milestones listed here below.

Documentation deliverables are listed in section 8.2.1 - Documentation. The following provisions apply:

- a) All documentation deliverables (including all their constituent parts) shall also be delivered in electronic form in a format agreed by the Agency (searchable PDF format and the native format, and in other exchange formats, to be agreed with the Agency, where relevant, e.g. in case of CAD, drawings, models, databases).
- b) All the documentation shall be delivered on computer readable media, as agreed with the Agency.
- c) The draft version of the documentation shall be sent to the Technical Officer in electronic format not later than two (2) weeks before the documentation is to be presented. The final version shall be provided in a number of copies specified in the Statement of Work.
- d) All documents shall bear the appropriate copyright notice. In all cases, this shall include the title, ESA Contract number, deliverable number, date, status (draft), version and/or revision number. This information shall be repeated consistently in the header or footer of every page.

4.1.1. N/A

4.1.2. Technical Data package:

The Technical Data Package consists of the final versions of all approved technical documents, delivered during the execution of the Project (See section 4.1).

4.1.3. Summary Report

For each (design and development) Contract, one Summary Report shall be produced. It shall summarise the findings of the Contract concisely and, informatively. The Summary Report shall be approximately twenty (20) pages or six thousand (6000) words and shall be self-standing, i.e. it shall not rely on references to other documents to be understood. This document shall not contain confidential information as it is releasable to the public.

4.1.4. to 4.1.8. N/A

4.2. Hardware

Hardware (including test equipment and control electronics) built or purchased under the Contract, together with an Operation Manual, shall be a deliverable item after completion of the associated activities at the Contractor's premises, unless otherwise agreed in writing by the Agency.

The Contractor will deliver the following hardware listed here after as part of the Project:

The hardware elements to be delivered as part of the present project are listed under section 8.2.2 - Hardware

4.3. Computer Programs and Models

Computer programmes, mathematical models of any type (e.g. closed-form, worksheets, XML, CAD/CAE) and HDL models developed or procured under the Contract shall be a deliverable, unless the Agency agrees otherwise in writing. Re-used or proprietary software embedded in the deliverable product and required for its correct functioning shall also be deliverable.

The Contractor will deliver the following Computer Programs or Models as part of the Project. The computer programmes, mathematical models, or other software elements to be delivered as part of the present project are listed under section 8.2.3 - Computer Programs and Models.

Ownership of Hardware and Software deliverables:

As a rule, the Agency, acting on behalf of the participating States, shall be the owner of the hardware and software identified under the Contract and its CN, and accepted by the Agency, for a period of 5 years following their respective delivery.

4.4 Project Web Page: N/A

5. Commercial evaluation: N/A

End of “Standard requirements for management, reporting, meetings and deliverables”. Sequential Numbering resumed.

8. PARAMETERS OF SECTION 7.3 “MANAGEMENT REQUIREMENTS”

8.1. Frequency of Progress meetings

Refers to section 7.3, point 3 lit. b): Progress Meetings shall be held every month, either by teleconference or in person if deemed necessary by the Agency.

The provisions of section 7.3 “Management requirements” apply.

8.2. Deliverables

8.2.1. Documentation

Refers to section 7.3, point 2.6 (Progress reports) and point 4.1 (Documentation): The documentation listed hereafter is a deliverable of the present Contract. The provisions of section 7.3 “Management requirements” apply.

The Table 2 summarises the planned list of Documentations to respective milestones that are defined in detail in Section 12 Schedule (M1 = Kickoff, M2 = Requirements review, M3= Design Review, M4 = Design Review Update). X=initial version, update, F=final version.

Table 2: Deliverable Documentation

	Milestone (delivery event/date)				
	M1	M2	M3	M4	
Management Documentation					
Progress report (monthly)	X	X	X	F	
Schedule	X	X	X	F	
Action Items List	X	X	X	F	
Deliverable Items List	X	X	X	F	
Summary report				F	
Technical Documentation					
D1: CzechFSUA requirements report		X	X	F	
D2: CzechFSUA design concepts report			X	F	
D3: CzechFSUA concepts tradeoff report			X	F	
D4: CzechFSUA controller concepts report			X	F	
D5: CzechFSUA test plan			X	F	
D6: CzechFSUA qualification plan			X	F	
PA Documentation					
DCLs, LLI lists					
Non-Conformance Report(s)					
NCR Status list					
Request for Waiver					

Request for Deviation					
Change Requests					

The documentation prepared by the **Institute of Physics of the Czech Academy of Sciences** in the context of the CzechFSUA, phase B1 shall be made available to the Agency for use in preparation of future Invitation To Tenders.

8.2.2. Hardware

Section 7.3, point 4.2 (Hardware): The Hardware elements listed hereafter are a deliverable of the present Contract. The provisions of section 7.3 “Management requirements” apply.

No HW deliverables are proposed.

8.2.3. Computer Programs and Models

Section 7.3, point 4.3 (Computer Programs and Models): The Computer Programs and Models listed hereafter are a deliverable of the present Contract. The provisions of section 7.3 “Management requirements” apply.

No SW deliverables are proposed.

9. INTERFACES

The Contractor acknowledges that changes to the ICDs (IRDs) or more generally to any document listed under the “Applicable Documents” section may be proposed upon the initiative of each Interface Responsible (i.e. the party responsible of each side of the interface). Interface changes shall be processed and change requests raised when necessary, as per the Product Assurance requirements applicable to the Project.

Approval of changes to the Applicable Documents (including changes to IRDs or ICDs):

Although PRODEX approves the contractual documentation, PRODEX will request a visa from the higher-level Interface Responsible(s) before approving any Change Requests to the ICDs or to other Applicable Documents to the Contract.

The final authority to accept ICDs as per list of Applicable Documents in case of interface conflicts between partnering institutes lies at the Instrument Prime, **Institute of Physics of the Czech Academy of Sciences**, since they are at the highest level of integration.

The responsibility for performing the updates of the ICDs as list in the Applicable Documents table are between the two interfacing parties under the authority of the Prime Institute.

The Institute shall submit at agreed milestones (as per section 3 on the deliverable documents) the Documents – including updated applicable documents (i.e. ICDs) which are under the responsibility by the Prime Institute - to the Agency for review.

10. AVAILABILITY OF DOCUMENTATION FOR FUTURE PHASES

The Contractor acknowledges that documentation not labelled “confidential”, deliverable to the Agency in the frame of the Project, may be used by the Agency for instance in preparation of future Invitation To Tenders or for any other Agency activity.

11. SCHEDULE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WP1.1 - Management tools started															
M1 - Kickoff															
WP1.2 - Periodic meetings															
WP1.3 - Reporting															
WP1.4 - LISA cons. Communication															
WP2.1 - Requirements															
M2 - Requirements review															
WP2.2 – Preliminary mechanism concepts															
M3 – DM Design review															
WP2.3 – Preliminary control electronic concepts															
WP2.4 – Preliminary development and justification															
WP3.1 – Microvibrations and tribology assessment															
WP3.2 – Alternative models															
WP3.3 – Management of scientific activities															
M4 – Design review update															

Figure 11-1: Project schedule shown in the Gantt chart diagram. The columns show months from the kick-off. The milestones are emphasised by red colour in the diagram.

12. INVOICING

The Contractor will be asked to submit invoices when the corresponding costs are accrued and the following conditions are met.

- The last invoice of the year will be paid only when the deliverables planned for that year - as defined in section 8.2 here above, or in a Change Notice (CN) signed by both parties (Contractor and ESA) - have been accepted by ESA.
- The final invoice will be paid upon acceptance by ESA of all the deliverables of the activity - as defined in section 8.2 here above, or in a Change Notice (CN) signed by both parties (Contractor and ESA) - have been accepted by ESA.

We expect that the institutes will submit invoices after the corresponding costs are accrued. Typically, two invoices per institute per calendar year will be submitted.

13. PROJECT CHECK POINTS

Project progress and deliverables will be checked according to Table 3.

Table 1: Check points for deliverables readiness.

Check-Point number	Planned date	Description
1	M1	Kickoff meeting – start of the activity
2	M3	Requirements review
3	M9	Design review
4	M15	Design review update

14. EXPORT CONTROL

N/A.

15. BACKGROUND INTELLECTUAL PROPERTY RIGHTS

N/A

16. CUSTOMER FURNISHED ITEMS (CFIS)

N/A.

17. ITEMS MADE AVAILABLE BY THE AGENCY

N/A.

FINANCIAL PLAN

Project Name: **Development of FSUA for LISA mission – Phase B1**

Institute of Thermomechanics of the Czech Academy of Sciences, Miroslav Chomát

Starting date: 01/01/2021

Ending date: 31/03/2022

Table 1: Institute Costs in Euro

Table 1 below: (1): FTE = Full Time Equivalent allocation per year (1 full year of work is 1 FTE).

INSTITUTE COSTS	2021		2022		YEAR		TOTAL
	FTE ⁽¹⁾	Costs	FTE	Costs	FTE	Costs	(Costs)
M. Chomát, researcher	0.1	3 550	0.016	600			4 150
D. Gabriel, researcher	0.1	3 550	0.016	600			4 150
R. Kolman, researcher	0.1	3 550	0.016	600			4 150
L. Pešek, researcher	0.1	3 550	0.016	600			4 150
J. Šonský, researcher	0.1	3 550	0.016	600			4 150
I. Zolotarev, researcher	0.1	3 550	0.016	600			4 150
							-
							-
Total Manpower	-	21 300	-	3 600	-	-	24 900
Travel cost							-
(* Exhibit A to Table 1)							-
Cost of items purchased by Institute, funded from PEA							-
(** Exhibit B to Table 1)							-
Miscellaneous costs		2 120		300			2 420
(*** Exhibit C to Table 1)							
Overheads (state % and costs they apply to):	Rate:	Overhads	Rate:	Overhads	Rate:	Overhads	
	9.8%	2 300	9.7%	380			2 680,00
Grand Total		25 720		4 280			30 000

The overhead rate is calculated from the costs of manpower and miscellaneous costs of the project.

Exhibits: See next pages - PSS forms can be appended after Table 2.

For information: Items to be purchased by ESA on behalf of the Institute:

	Year	Year	Year	Total
Details: See Table 2				0

Table 1b: Manpower costs.

N/A

(1): FTE = Full Time Equivalent allocation per year (1 full year of work is 1 FTE).

Exhibit A to Table 1: Travel plan

N/A

Exhibit B to Table 1 - Items purchased by the Institute.

N/A

Exhibit C to Table 1 – Miscellaneous costs.

<i>Year</i>	<i>Miscellaneous cost, designation</i>	<i>Total Price (EURO)</i>
2021	Small equipment and components <5000 EUR	2 120
Total 2021		2 120
2022	Small equipment and components <5000 EUR	300
Total 2022		300
Total		-
Grand Total		2 420

Small equipment and components will be purchased in order to produce the test models of the functional mechanisms and for necessary customization of the available test stands used for the experimental verification of the proposed designs.

For information only

Table 2: Items to be purchased via ESA (above 5 000 Euro)

N/A

Appendix 3

GUIDELINES for the preparation of Appendix 3 (CHANGE PROCEDURE)

A PRODEX Experiment Arrangement Change Procedure shall apply at least to any modifications of the Agency's financial commitment (Articles 2 of the Arrangement) and of the Term (Article 3 of the Arrangement).

1. Introduction of a Change

For all changes, whether requested by the Agency or initiated by the Institute, the latter shall submit a proposal for a PRODEX Experiment Arrangement Change Notice (CN) on the form (Appendix 3) attached hereto. The CN shall be filled in completely, and boxes or lines which are not applicable shall be so designated by use of the letters "N/A". The form shall be signed by the Institute's authorised representative(s) and be submitted to the Agency's representative for contractual and administrative matters.


The Institute shall ensure that each change proposal is fully co-ordinated with Appendices 1 and 2 to the arrangement and that all reasonably foreseeable implications of the change have been considered. If the space on the form is not sufficient to describe the change and its consequences, the additional information shall be annexed to the form. The Institute shall, on request of the Agency, provide additional documentary evidence.

2. Approval or Rejection of the Arrangement Change Notice

Upon receipt of a CN signed by the Institute, the Agency shall consider it as regards its acceptability. Should the CN be approved, it will be signed by the ESA PRODEX Office's authorised representative and a copy be returned to the Institute. Should a CN be rejected for any reason, the Institute shall be informed accordingly, together with the reasons for the rejection.

3. Implementation and Status of Approved Arrangement Change Notices

Upon signature of a CN by both parties, the CN has immediate effect and constitutes a binding contractual agreement for which the contractual clauses of the main contract which are not modified by the approved CN, remain applicable.

 PRODEX EXPERIMENT ARRANGEMENT CHANGE NOTICE	
PEA: Institute: Project:	CN No:
Title of area affected	Article(s) of the Arrangement: Initiator of change:
Description of change:	
Reason for change	
Funds <i>in addition to / in deduction of / in replacement of</i> those stipulated in Article 2.1 (write “Cost Neutral” if cost neutral CN): EURO: See updated Financial Plan in annex. Total amount LoL including present CN:	
Effect on other Arrangement provisions: N/A	Commencement of Term: End of Term:
Institute	
Institute’s representative(s):	Date
ESA	
PRODEX Office representative(s):	Date

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