PURCHASE CONTRACT

This purchase contract ("**Contract**") was concluded pursuant to Sec. 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: prof. Jan Řídký, DrSc. – director

("**Client**"); and

(2) **DELONG INSTRUMENTS a.s.**

with its registered office at: Palackého třída 3019/153b, Královo pole, 612 00 Brno

registration No.: 469 03 879

represented by: Ing. Tomáš Papírek, member of the board of directors *(člen představenstva)*

("**Supplier**").

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

WHEREAS

(A) The Client is a public contracting authority and the beneficiary of grants of the Ministry of Education, Youth and Sports of the Czech Republic for projects *„ELI: Extreme Light Infrastructure"* and *"ELI: Phase 2"* ("**Projects**"), within the Operational Programme Research and Development for Innovations and Operational Programme Research, Development and Education (hereinafter the "**Operational Programmes**").

(B) For the successful realization of the Projects it is necessary to purchase the Object of Purchase (as defined below) in accordance with the Act No. 137/2006 Coll., on public procurement, and binding rules of the Operational Programmes.

(C) The Supplier's bid for the public procurement titled *"Vacuum compressor of PW laser pulses for the ELI-Beamlines L3 system,"* whose purpose was to procure the Object of Purchase (hereinafter the "**Bid**" and "**Public Procurement**"), was selected by the Client as the most suitable and relevant parts thereof describing the Delivery (as defined

4.

below) from the technical and quality perspective form Annex 4 (*Supplier's Bid*) to this Contract.

IT WAS AGREED AS FOLLOWS:

1. **BASIC PROVISIONS**

1.1 Under this Contract the Supplier shall design, manufacture, test, deliver, handover to the Client and install at the Client's facility a vacuum laser pulse Compressor and a Beam Injector for the ELI-Beamlines L3 high-average power short-pulse PW laser, including large optomechanical mounts and the control systems, as specified in Annex 1 (*Summary of Deliverables, Time Schedule and Payments*), Annex 2 (*Detailed Technical Specifications*) and Annex 3 (*Quality and Verification Plan*) to this Contract (**"Object of Purchase"**) and shall transfer to the Client ownership right to the Object of Purchase, and the Client shall take over the Object of Purchase and shall pay the Supplier the Purchase Price (as defined below), all under the terms and conditions stipulated herein.

1.2 Under this Contract the Supplier shall specifically carry out following major activities (**"Activities"**):

a) Develop a detailed schedule of project activities and all corresponding quality plans and work procedures;

b) Develop a detailed engineering drawings and detailed 3D model based on the preliminary design drawings and 3D model supplied by the Client, provide structural verification of the compressor chamber, elaborate design of specific details, develop Failure Mode and Effect Analysis;

c) Develop production (manufacturing) drawings for major components of the Compressor and Beam Injector;

d) Manufacture, assembly and factory test the compressor vacuum vessel and the internal optical table, including functional verification of the vacuum control system, manufacture, assemble and factory test Beam Injector System;

e) Transport, install at ELI-Beamlines and verify performance of the Compressor vacuum vessel and of the internal optical table, and of the Beam Injector;

f) Manufacture, assembly and factory test the optomechanical mounts, including the motion controls, deliver to ELI-Beamlines and verify performance of these mounts;

g) If activated, deliver the optional components according to Annex 1 (*Summary of Deliverables, Time Schedule and Payments*); (hereinafter **"Option 1: Optional components"**)

h) Provide additional post-installation technical support on a call-off basis, up to 30 man-days according to Annex 1 (*Summary of Deliverables, Time Schedule and Payments*); (hereinafter **"Option 2: Optional post-installation technical support"**)

i) Provide extra technical optomechanical design and/or electronic control system design works, on a call-off basis, up to 80 man-days according to Annex 1 (*Summary of Deliverables, Time Schedule and Payments*); (hereinafter **"Option 3: Optional design works"**)

j) Carry out transport of the compressor vacuum chamber including related components through ELI-Beamlines laser building to the L3 laser hall, positioning and bolting to the floor as described in Annex 1 hereto (D6 Deliverable description) according to Annex 1 (*Summary of Deliverables, Time Schedule and Payments*); (hereinafter **"Option 4: Optional transport of the compressor vacuum chamber"**),

(Options 1, 2, 3 a 4 hereinafter together as the **"Options"**),

(The Object of Purchase and the Activities are hereinafter jointly referred to as the **"Delivery"**.)

1.3 The Supplier promises to the Client that if for the fulfilment of the requirements of the Client under this Contract or the proper operation of the Object of Purchase are necessary other deliveries and activities not expressly mentioned in this Contract, the Supplier shall procure such deliveries or shall carry out such activities at its own expense without any effect on the Purchase Price.

1.4 During the performance of this Contract, the Client is entitled to further specify or clarify the requirements stipulated in Annex 2 (*Detailed Technical Specification*). Such further specifications can be requested by the Client no later than one month before the scheduled completion of the D3 Deliverable, with the exception of the vacuum control system where further specifications can be requested to up to one month before the scheduled completion of the D5 Deliverable, and for optomechanical mounts where further specifications can be requested to up to two months before the scheduled completion of the D8 Deliverable. These further specifications shall be binding for the Supplier. Under this provision, the Client is not entitled to substantially change the existing requirements stipulated in Annex 2 (*Detailed Technical Specifications*). Should any request for change result in increase of Purchase Price such request is binding for the Supplier only if the Purchase Price modification is agreed between Parties and such modification is in accordance with the Act No. 137/2006 Coll., on public procurement, and binding rules of the Operational Programmes.

1.5 The Object of Purchase and its components and parts shall be delivered new (i.e. not remanufactured).

1.6 The final cleaning of the vacuum components and testing of vacuum performance, integration of vacuum chambers with internal optomechanical assembly, and integration of the instrumentation with critical control systems shall not be performed by a subcontractor.

1.7 The Supplier shall deliver the Object of Purchase and provide the Activities in accordance with the Deliverables defined in Annex 1 (*Summary of Deliverables, Time Schedule and Payments*).

2. SUPPLIER'S DUTIES

2.1 The Supplier shall ensure that the Object of Purchase complies with all technical specifications and performance requirements stipulated in Annex 2 (*Detailed Technical Specifications*). The Supplier is responsible that the Object of Purchase and/or its subsystems meet valid safety, technical and quality Czech and EU standards.

2.2 During the performance of this Contract the Supplier proceeds independently, unless hereunder stated otherwise. If the Supplier receives instructions from the Client, the Supplier shall follow such instructions unless these are against the law or in contradiction to this Contract. If the Supplier finds out or should have found out by exercising professional care that the instructions are inappropriate or contradicting valid Czech or EU standards or are in contradiction to this Contract, then the Supplier must notify the Client.

3. CLIENT'S CONFIDENTIAL INFORMATION

3.1 For the purposes of detailed design and manufacture, the Client may provide to the Contractor conceptual drawings, 3D model, schemes and other materials related to the Object of Purchase, which are of confidential nature and which will be labelled as "Confidential and Proprietary" (**"Client's Confidential Information"**). The Supplier acknowledges that the Client's Confidential Information is of proprietary and confidential nature and that such information might be protected under laws that cover industrial or other intellectual property and that disclosure of such information may cause damage or other harm to the Client. The Supplier may use the Client's Confidential Information only and solely for the purposes of the fulfilment of this Contract, i.e. for the manufacture and assembly of the Object of Purchase for the Client.

3.2 The Supplier must ensure that Client's Confidential Information will be accessed only by persons (e.g. employees and/or subcontractors) that need such access for the fulfilment of this Contract. The Supplier shall take all reasonable steps to ensure that the Client's Confidential Information will not be accessed by any third party and/or by any unauthorized person.

3.3 Should the Supplier breach any of his duties stipulated in this Article 3 the Client is entitled to charge him with contractual penalty in the amount of 4 000 EUR for each case of such breach.

4. DESIGN AND MANUFACTURE OF THE OBJECT OF PURCHASE

4.1 The detailed engineering drawings developed by the Supplier in the Deliverable D2 must comply with the requirements of this Contract and shall be approved by the Client prior to proceeding to elaboration of the production (manufacture) drawings. If the

Client suggests modifications to these drawings, the Supplier shall incorporate such modifications or shall explain in writing the reason for refusing to incorporate them.

4.2 The Supplier must act in such a way that this Contract is performed in time and in due manner.

5. LICENCE OF THE SUPPLIER

5.1 If any part of the Delivery forms an object protected by intellectual property rights laws and/or forms the related know-how, the Supplier grants to the Client a right to use such part of the Delivery, including related documentation (**"Supplier's Proprietary Information"**) in the original or modified version (**"Licence"**) for the purposes listed in Art. 5.3.

5.2 The License is granted:

a) royalty free worldwide;

b) for the period of validity of the rights to each of the licensed intellectual property objects, which applies adequately to the related know-how

5.3 The Licence includes the right to use the Object of Purchase for purposes of the Projects as defined by grant decisions issued within the Operational Programmes and comprises particularly the right to use the Object of Purchase for research and development activities including necessary modifications to the Object of Purchase including software and limited handover of necessary documentation upon signature of a non-disclosure agreement to third parties for the purposes of operation, servicing and further development of the Object of Purchase.

5.4 This granted License also includes the Supplier's permission to the Client to modify and/or alter and/or otherwise change any part of the Supplier's Proprietary Information; either by itself or with assistance of any third party. This permission shall apply *mutatis mutandis* to the Supplier's entitlement to combine and/or merge any part of the Supplier's Proprietary Information with any other work; either by itself or with assistance of any third party.

5.5 The Client is entitled to transfer/ assign the License on any third party if the ownership of International Laser Research Facility ELI Beamlines shall pass on such third party. The Client shall inform the Supplier within undue delay thereabout. The Client is entitled to grant wholly or partially the License to any third party (sublicense) if the right to use the Object of Purchase is granted to such third party.

5.6 The Client is s not required to use the Licence, unless the maintaining of the right depends on the exercise thereof.

5.7 The Supplier hereby represents and warrants to the Client that:

a) is entitled to use and enforce all intellectual property rights to the Supplier's Proprietary Information, in order to be ensured that the Client may use the Supplier's Proprietary Information properly and without any interference; and

b) is entitled to grant License to the Client in the extent specified in this Contract.

5.8 If the Licence is endangered or infringed, the Client shall inform the Supplier accordingly without undue delay after ascertaining this fact. The Supplier shall provide the Client with cooperation to ensure the legal protection of the Licence. It is hereby explicitly agreed that the Supplier shall give the Client consent to enforce the industrial property rights and/or related know-how rights covered by the License.

6. MONITORING AND IMPLEMENTATION OF THE INSPECTION PLAN

6.1 The Supplier undertakes to enable the Client exercising inspections of the performance of this Contract. For this purpose, the Supplier shall provide to the Client all information regarding the status of the design and manufacture of the Object of Purchase at the request of the Client, anytime during performance of this Contract.

6.2 The Supplier shall provide to the Client all cooperation, assistance and information that the Client needs for the purposes of full evaluation of the status of the design or manufacture of the Object of Purchase.

6.3 If the Client, especially during an inspection, ascertains any breach of the Supplier's duties under this Contract, the Client shall notify in written the Supplier of such breaches. The Supplier has to respond to such notification and suggest, in appropriate detail, remedying the deficiencies, within fourteen (14) calendar days, unless the Parties agree otherwise.

6.4 Each Party shall invite the other Party to attend a meeting in writing at least 14 calendar days in advance. The Parties may upon mutual agreement replace meetings in person by other forms of communication, as long as they agree on such in writing. Each Party shall bear its expenditures related to their participation in meetings at the other Party's facility; however, cost which would arise due to error, faulty performance or breach of contractual provisions of the Parties shall be borne by that Party which caused it.

6.5 The Supplier shall follow the Quality and Verification Plan according to Annex 3 (*Quality and Verification Plan*) and shall invite the Client at least 14 calendar days in advance to participate in all relevant activities of this Plan.

6.6 If the Client does not participate in an inspection and/or verification activity according to Annex 3 (*Quality and Verification Plan*) at the date communicated in accordance with Art. 6.5 the Supplier is not entitled to carry out respective activities in absence of the Client. However, in such a case the Supplier is not in delay with delivery of the corresponding Deliverable and subsequent Deliverables with proven dependency on the corresponding Deliverable and delivery periods of such Deliverables shall be extended by the time of the Client´s delay, unless the Parties agree otherwise.

7. THE PLACE AND TIME OF DELIVERY

The place of delivery shall be the International Research Laser Facility ELI-Beamlines located in Dolní Břežany (Central Bohemia), Czech Republic (hereinafter also **"ELI Beamlines"** or **"ELI Beamlines site"**).

7.1 The Supplier shall perform individual Deliverables in terms stipulated in Annex 1 (*Summary of Deliverables, Time Schedule and Payments*).

7.2 The Supplier shall carry out performance and verification tests of the major subsystems of the Object of Purchase at his premises (factory acceptance tests), in relation with Deliverables D4, D5 and D8, on the dates agreed with the Client in accordance with Art. 6.5, according to Annex 3 (*Quality and Verification Plan*).

7.3 The Supplier shall deliver, install, assemble, test and handover the Object of Purchase at the ELI-Beamlines site, in the extent stipulated in Annex 1 (*Summary of Deliverables, Time Schedule and Payments)*. The Client shall provide to the Supplier for this purpose necessary cooperation.

7.4 Prior to transport and installation of the individual subsystems of the Object of Purchase related to Deliverables D6, D7 and D9 the Supplier (at the request of the Client) shall inspect the ELI-Beamlines premises for installation of the respective parts of the Object of Purchase, in order to verify readiness of the premises for installation of the Object of Purchase.

7.5 For the purpose of determination of individual deadlines stipulated hereby the **Commencement Day** shall be the day upon ten calendar days after the Contract is concluded (i.e. signed by the second of the Parties).

8. PRICE AND PAYMENT TERMS

8.1 The total purchase price for the Delivery excluding Options is **41 178 000,-** Czech Crowns (CZK) without value added tax (**"VAT"**)(**"Purchase Price"**). The Purchase Price represents the Supplier's binding maximum price as offered in the Supplier's Bid. The Purchase Price consists of the price for the Object of Purchase and Activities excluding price of Options as stipulated in the Bid. VAT shall be imposed on top of all payments made hereunder according to valid legislation.

8.2 The Purchase Price and prices of Options cannot be exceeded.

8.3 The Purchase Price includes all costs and expenses of the Supplier related to the performance of this Contract excluding Options. The Purchase Price include especially all expenses related to the design, manufacture, assembly, factory testing, delivery, installation, on-site performance verification at ELI-Beamlines and handover of the Object of Purchase, costs of the Licence, insurance, warranty service and any other costs and expenses connected with the performance of this Contract excluding Options. Similar provisions shall *mutatis mutandis* apply for the prices of Options.

8.4 The Purchase Price and prices of Options may be changed only in accordance with the Act No. 137/2006 Coll., on public procurement, as amended.

8.5 The Purchase Price and prices of Options shall be paid on the basis of tax documents – invoices, to the account of the Supplier designated in the invoice. The Purchase Price shall be paid following the payment schedule set in Annex 1 (*Summary of Deliverables, Time Schedule and Payments*). The prices of Options shall be paid according to Annex 1. The Supplier is entitled to issue any invoice no sooner than on the moment the corresponding part of the Delivery, i.e. the Deliverable or Option, is duly delivered to and accepted by the Client in accordance with this Contract, as regards the Deliverables namely with its Art. 9.2 and/or 9.4.

8.6 The Client shall realize payments on the basis of duly issued invoices within 30 days from their receipt. The invoice shall be considered to be paid for on the day when the invoiced amount is deducted from the Client's account on behalf of the Supplier's account.

8.7 The invoice issued by the Supplier as a tax document must contain all information required by the applicable laws of the Czech Republic. Invoices issued by the Supplier in accordance with this Contract shall contain in particular following information:

a) name and registered office of the Client,

b) tax identification number of the Client,

c) name and registered office of the Supplier,

d) tax identification number of the Supplier,

e) registration number of the tax document,

f) Quantity (extent) and nature of performance supplied or services rendered(including the reference to this Contract),

g) the date of issue of the tax document,

h) the date of the supply of goods or services or the date of the payment on account, whichever comes sooner, in so far as they differ from the date of issue of the tax document – invoice,

i) due date,

j) the price,

k) registration number of this Contract, which the Client shall communicate to the Supplier based on Supplier's request before the issuance of the invoice,

l) declaration that the performance of the Contract is for the purposes of Projects,

and must comply with the double tax avoidance agreements, if applicable.

8.8 In case that the invoice shall not contain the above mentioned information, the Client is entitled to return it to the Supplier 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 Client.

8.9 Last invoice of every calendar year must be delivered to the Client no later than December 15 of that calendar year.

9. ACCEPTANCE OF DELIVERABLES AND HANDOVER OF THE OBJECT OF PURCHASE

9.1 Upon receiving technical reports related to Deliverables D1, D2, D3, D4, D5 and D8 the Client shall provide the Supplier within 10 working days with his comments to the submitted reports. The Supplier shall be obliged to take the Client's comments into account, i.e. the Supplier shall accept all justified and materially correct comments and requirements for changes made by the Client. Should the Supplier consider some of the comments or requirements made by the Client as materially incorrect or unacceptable, the Supplier shall specify in writing his reasons for refusing to accept them. The Supplier will produce final technical report containing all justified and materially correct comments and requirements for changes raised by the Client.

9.2 Should the final technical reports related to the Deliverables D1, D2, D3, D4, D5 and D8 comply with the requirements of the Client and contain essentials as set forth herein the Client shall issue to the Supplier, without undue delay, a confirmation on the due execution of the corresponding Deliverable (hereinafter the **"Deliverable Acceptance Protocol"**). Notwithstanding to it the Client shall not be obliged to verify the correctness of all calculations and/or technical solution details during the course of the acceptance of the Deliverables relating to the detailed design and fabrication process (D2, D3, D4, D5 and D8). Acceptance of these individual Deliverables D2, D3, D4, D5 and D8 does not release the Supplier from his liability for the technical compliance and completeness of the entire Delivery.

9.3 Should it be necessary to modify any part of the already accepted Deliverable in order to meet the parameters expected of the Deliverables D6, D7 and D9, the Supplier undertakes to perform such modifications and accepts that the costs related thereto are included in the Purchase Price.

9.4 Handover and takeover of the Object of Purchase related to Deliverables D6, D7 and D9 shall be realized on the basis of a handover protocol, which shall contain following information (**"Handover Protocol"**):

a) identification of the Supplier, Client and subcontractors, if there are any;

b) description of the corresponding Deliverable;

c) declaration of the Client that he received from the Supplier all technical information related to the corresponding Deliverable;

d) statement of the Client on acceptance of the corresponding Deliverable; and

e) date of the signature.

9.5 The Handover Protocol must contain the following annexes, which shall be provided by the Supplier:

a) list of items (accessories) handed over in the corresponding Deliverable;

b) protocols with full results of all design and/or manufacturing inspection and performance verification testing, carried out according to Annex 3 (*Quality and Verification Plan*);

c) drawings, 3D models, software codes and other contractually required information corresponding to the specific Deliverable; and declaration of the Supplier that the respective Deliverable being part of the Object of Purchase is in accordance with this Contract, applicable laws and technical norms.

9.6 In case of deficiencies (i.e. defects and backlogs) of the delivered subsystems related to Deliverables D6, D7 and D9, e.g. if the Supplier does not hand over to the Client all the above mentioned documents, or if the respective Deliverable does not meet the Requirements Specifications according to Annex 2 (*Detailed Technical Specifications*), the Client is entitled to refuse the takeover of that Deliverable. Whenever technically possible the Supplier shall remedy the deficiencies within ten (10) working days, unless Parties agree otherwise; however these periods do not imply that the Supplier is not in delay with delivery of any Deliverable. The Client is entitled at his discretion (but not obliged) to take over the respective Deliverable despite the above mentioned deficiencies, in particular if such deficiencies do not prevent the Client in the proper operation of the Object of Purchase. In such a case the Supplier and the Client shall list the deficiencies in the Handover Protocol, including the manner and the date of their removal (remedy). If the Parties do not reach agreement in the Handover Protocol regarding the date of the removal (particularly due to the fact that period of 10 working days is technically impossible) , the Supplier shall remove the deficiencies within ten (10) working days. Till the remedy of the deficiencies the Client shall be entitled to postpone the payment up to the amount corresponding to the significance of the deficiency.

9.7 Upon completion of Deliverables D6, D7 and D9, namely when the delivered subsystems are fully complying with the requirements of Annex 2 (*Detailed Technical Specifications*) the Client shall issue to the Supplier, without undue delay, a confirmation on the due execution of the respective Delivery (hereinafter the **"Delivery Acceptance Protocol"**).

10. THE OWNERSHIP RIGHT

The ownership right to the subsystems of the Object of Purchase, corresponding to the Deliverables D6, D7 and D9, shall pass to the Client upon its handover and takeover confirmed by the signature of the Handover Protocol by both Parties. The Handover Protocol will be signed for the compressor vessel and the internal optical table upon completing Deliverable D6, for the Beam Injector System and the vacuum control system upon completing Deliverable D7, and for the optomechanical mounts and the motion control system upon completing Deliverable D9.

11. WARRANTY

11.1 The Supplier shall provide a warranty of quality of the Delivery for the period of two (2) years upon its handover, except the turbomolecular pumps, vacuum valves (TMPs) and other equipment specified in Annex 2 for which the warranty period is defined differently therein. If on the warranty list or other document submitted by the Supplier the warranty period is of longer duration, then this longer warranty period shall have priority over the period stated in this Contract.

11.2 The warranty period for each part of Delivery consisting of Deliverable D6, D7 and D9 shall begin on the day of the signature of the corresponding Handover Protocol by both Parties. If the Handover Protocol lists any deficiencies, the warranty period shall begin on the day, which follows the day, in which the last deficiency was removed.

11.3 The Supplier shall remove defects for which he is responsible according hereto that occur during the warranty period free of charge and in the terms stipulated in this Contract. The Supplier shall bear all the expenses (e.g. travelling, accommodation expenses and price of equipment rental or purchase) related with removal of the defects.

11.4 If the Client ascertains a defect of the Delivery during the warranty period, the Client shall notify such defect without undue delay to the Supplier. Defects may be notified on the last day of warranty period, at the latest.

11.5 The Client notifies defects in writing via e-mail. The Supplier shall accept notifications of defects on the following e-mail address: service@dicomps.com. The Supplier shall confirm receipt of the notification within five working days.

11.6 In the notification the Client shall describe the defect and the manner of removal of the defect. The Client has the right to:

a) ask for the removal of the defect by the delivery of a replacement individual part that may be required,

b) ask for the removal of the defect by repair, or

c) ask for the adequate reduction of the price, i.e. the Purchase Price or the price of Option, particularly in case of irremovable defects.

11.7 The Supplier shall remove the defect within 21 calendar days from its notification, unless Parties agree otherwise. The Client shall agree an extended deadline for defect removal with the Supplier if the Supplier submits evidence (e.g. subcontractors bid etc.) that removal of the defect within 21 calendar days is impossible for objective reasons (i.e. independent of the will of the Supplier), or if technical nature of the defect makes not possible its removal within 21 calendar days.

11.8 The Supplier shall remove the defect within terms stipulated in this Contract even if the notification of the defect is in his opinion unjustified. In such a case the Supplier is entitled to ask for reimbursement of the costs of removal of the defect. If Parties disagree on whether the notification of the defect is justified or not, the Client shall ask

an expert for opinion. If the expert considers the notification to be unjustified, then the Client shall reimburse the Supplier for verifiably and effectively incurred costs of removal of the defect.

11.9 Parties shall sign 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 the period of time that elapses between the notification of the defect and its removal.

11.10 In case that the Supplier does not remove the defect within the stipulated or mutually agreed period or if the Supplier refuses to remove the defect, then the Client is entitled to remove the defect at his own costs and the Supplier shall reimburse these costs within 30 days after the Client's request to do so. In such a case the existing warranty remains intact.

12. REPRESENTATIONS AND WARRANTIES OF THE SUPPLIER

12.1 The Supplier represents and warrants to the Client that

a) he possesses all professional qualifications to provide the Delivery, has all the professional prerequisites necessary for the proper fulfilment of this Contract and is able to carry out activities foreseen hereunder with the due care, skill and knowledge of well-experienced experts in his particular professional field,

b) is fully authorized to perform this Contract, and

c) there are no obstacles on his side that would preclude him from the due performance of this Contract.

12.2 The Supplier is aware of the importance to the Client of the fulfilment of this Contract in terms of quality, performance and schedule. In the event of a failure by the Supplier to meet them (e.g. in case of delay with delivery of Deliverables and/or in the case if the Object of Purchase does not meet the performance requirements), substantial damage may arise to the Client.

13. PENALTIES

13.1 If the Supplier is in delay with the Deliverables D1, D2, and D3 for more than two months, the Supplier shall pay to the Client a contractual penalty in the amount of 0.05% of the Purchase Price for every even incomplete day of delay.

13.2 If the Supplier is in delay with the Deliverables D6, D7 and D9, the Supplier shall pay to the Client a contractual penalty in the amount of 0.1% of the Purchase Price for every even incomplete day of delay.

13.3 If the Supplier is in default with the removal of a defect of the Delivery preventing the Client from proper operation of the Object of Purchase, the Supplier shall pay to the Client a contractual penalty in the amount of 0.05% of the Purchase Price for every even incomplete day of delay. In case of defects that do not prevent the Client from

proper operation of the Object of Purchase the contractual penalty shall amount to 0.02% of the Purchase Price for every even incomplete day of delay.

13.4 The Supplier shall pay any of the contractual penalties charged under this Contract within thirty (30) days from the day, on which the Client enumerated its claim for the contractual penalty. The payment of contractual penalties shall not affect the right of the Client to damages in the extent in which such damages exceed the contractual penalty, thus the Client shall be entitled to claim the exceeding damages.

13.5 Total amount of contractual penalties for delay with delivery of Deliverables D6, D7 and D9 shall not exceed 2% of the Purchase Price in relation to each Deliverable D6, D7 and D9, i.e. in total 6 % of the Purchase Price.

13.6 The Client is entitled to unilaterally set off claims arising from the contractual penalties against the claim of the Supplier for the payment of the Purchase Price or prices of Options.

14. RIGHT OF WITHDRAWAL AND VIS MAJOR

14.1 The Client is entitled to withdraw from this Contract without any penalties, if any of the following circumstances occur:

a) the Supplier breaches this Contract in a substantial manner;

b) the Supplier fails to follow the mandatory activities of the Quality and Verification Plan, stipulated in Annex 3, and/or does not allow the Client to inspect the Supplier's premises for the purposes of ascertaining status of fulfilment of the Contract;

c) the Supplier is in delay with any contractual Deliverable stipulated in Annex 1 for a period exceeding 3 (three) calendar months, except where the delay has been caused by the Client;

d) results of the factory testing, even after third testing attempt, do not meet the requirements stipulated in Annex 2 (*Detailed technical specifications*);

e) the expenses or the part of the expenses that will arise on the basis of this Contract will be found by the Provider of the funding of the Projects or other control body as ineligible;

f) the Client loses funding for the realization of the Projects;

g) the insolvency proceeding is initiated against the Supplier; or

h) the Client ascertains that the Supplier 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.

14.2 The Supplier is entitled to withdraw from this Contract in the following cases:

a) the Client breaches this Contract in a substantial manner;

b) the Client is in delay with the payment of any Deliverable for a period longer than 3 calendar months; or

c) the Client refuses his attendance at the respective activities of the Quality and Verification Plan, stipulated in Annex 3.

14.3 The act of withdrawal from the Contract shall become effective on the day of delivery of the notification in writing from one Party to the other with consequences of the Contract termination effective in the "ex tunc" regime.

14.4 Circumstances precluding liability shall be deemed to have been constituted by such circumstances / obstacles which arose independently of the will of the obliged Party, and which prevent fulfilment of that Party's obligation, provided that it could not be reasonably expected that the obliged Party could overcome or avert this obstacle or its consequences, and furthermore that such Party could foresee such obstacle when it entered into the respective covenants. Liability cannot be precluded by obstacles that arose only after the obliged Party was in default with fulfilment of its obligations, or which arose in connection with its economic situation. The effects precluding liability shall be limited to the period during which the obstacles causing these effects persist.

14.5 Should a situation occur, which a Party could reasonably consider to constitute vis major (force majeure), and which could affect fulfilment of its obligations hereunder, such Party shall immediately notify the other Party and attempt to continue in its performance hereunder in a reasonable degree. Simultaneously, such Party shall inform the other one of any and all its proposals, including alternative modes of performance, however, without the other Party's consent, the Party shall not proceed to carry out such alternative performance. If a situation constituting vis major occurs, the deadlines imposed hereunder shall be extended by the period of the duration of the said vis major.

15. SPECIAL PROVISIONS

The Supplier undertakes, under the terms and conditions hereof, in accordance with instructions issued by the Client, to

a) Archive all written material prepared in connection with fulfilment of this Contract so that its compliance with the archiving principles required within the framework of the Operational Programmes and to provide access to the Client to these archived documents until 2025. The Client shall be entitled to take possession of these documents after ten years from the completion of the performance hereunder from the Supplier free of charge;

b) Cooperate during financial inspections carried out in accordance with Act No. 320/2001 Coll., on Financial Inspections, as amended, i.e. among others to allow the Ministry of Education, Youth and Sports of the Czech Republic to access also those portions of the Supplier's Bid submitted within the Public Procurement, the Contract and related documents which may be protected by special legal regulation, given that all requirements set forth by legal regulation with respect to

the manner of executing such inspections will have been observed; the Supplier shall bind any of its sub-contractors to comply with this obligation accordingly;

c) Enable observance of any publicity obligations stemming from the rules of Operational programmes; and

d) Provide to the Client yearly reports on sub-contractors to enable the Client to fulfil its obligations pursuant to Sec. 147a of the Act. No. 137/2006 Coll., on Public Procurement, as amended.

16. CONFIDENTIALITY

Parties shall not disclose information that shall become available to them in connection with this Contract and its performance and whose disclosure could harm the other Party. Duties of the Client ensuing for the applicable legal regulations remain unaffected.

17. REPRESENTATIVES OF THE PARTIES

17.1 The Supplier appoints following representatives for the communication with the Client:

In technical matters:

Name: Ing. Tomáš Bejdák
E-mail: tomas.bejdak@dicomps.com
Tel.: +420 549 123 506

In contractual matters:

Name: Ing. Tomáš Papírek
E-mail: tomas.papirek@dicomps.com
Tel.: +420 549 123 507

17.2 The Client appoints following representatives for the communication with the Supplier:

In technical matters:

Name: Ing. Bedřich Rus, PhD.
E-mail: rus@fzu.cz

Tel: +420 266 051 251, +420 603 570 558

In contractual matters:

Name: prof. Jan Řídký, DrSc.
E-mail: ridky@fzu.cz
Tel.: +420 266 052 121

18. FINAL PROVISIONS

18.1 This Contract is governed by the laws of the Czech Republic, especially by the Civil Code.

18.2 All disputes arising out of this Contract or out of legal relations connected with this Contract shall be preferable 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.

18.3 The Supplier takes into account that the Client is not in relation to this Contract an entrepreneur, nor the subject matter of this Contract is connected with the business activities of the Client.

18.4 The Supplier is not entitled to set off any of its claims or his debtor's claims against the Client's claims. The Supplier is not entitled to transfer its claims against the Client that arose on the basis or in connection with this Contract on third parties. The Supplier is not entitled to transfer rights and duties from this Contract or its part on third parties.

18.5 All modifications and supplements of this Contract must be in writing.

18.6 If any of provisions of this Contract are invalid or ineffective, then such invalidity, ineffectiveness or unenforceability shall not cause the invalidity, ineffectiveness, or unenforceability hereof as a whole and 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 as well as most closely reflects the intentions of the Contracting parties at the time of conclusion hereof, to an extent permitted by the laws and regulations of the Czech Republic.

18.7 If any Party breaches any duty under this Contract and knows or should have known about such breach, it shall notify it to the other Party and shall warn such Party of possible consequences of the breach.

18.8 This Contract is executed in four (4) counterparts and every Party shall receive two (2) counterparts.

18.9 An integral part of this Contract is Annex 1 (*Summary of Deliverables, Time Schedule and Payments*), Annex 2 (*Detailed Technical Specifications*), Annex 3 (*Quality and Verification Plan*) and Annex 4 (*Supplier's Bid*). In case of any discrepancy between the provisions of this Contract and the provisions of its Annexes the provisions of this Contract shall prevail, except for the provisions of Annex 4 containing conditions and specifications that are more favourable to the Client (i.e. higher technical specification values and/or more technically advanced or demanding solutions etc.), in which case such provisions of Annex 4 shall prevail. In case of any discrepancy between the provisions of Annexes the provisions containing conditions and specifications that are more favourable to the Client (i.e. higher technical specification values and/or more technically advanced or demanding solutions etc.) shall prevail.

18.10 This Contract shall be valid and effective on the date of the signature of both Parties.

IN WITNESS WHEREOF attach Parties their handwritten signatures:

Client
Signature: _____
Name: prof. Jan Řídký, DrSc.
Position: director
Date: 23. 12. 2015

Supplier
Signature: _____
Name: Ing. Tomáš Papírek
Position: member of the board of directors *(člen představenstva)*
Date: 22. 12. 2015

ANNEX 1

SUMMARY OF DELIVERABLES, TIME SCHEDULE AND PAYMENTS

Institute of Physics ASCR, v. v. i.
Na Slovance 2
182 21 Prague 8
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Annex No. 1
Summary of Deliverables, Time Schedule and Payments

Vacuum compressor and beam injector of PW laser pulses for the ELI-Beamlines L3 laser system [TP14-094]

TC ID/Revision: 00121616/B
Confidentiality: BL - Restricted for internal use
WBS code: 3.3
PBS code: RA1.L3.HAPL.CMP

Deliverable	Description	Completion	Payment
D1	Detailed schedule of project activities and all corresponding Quality and Verification Plans, and of work procedures	1 month and 15 days	10%
D2	Development of FZU concept design and 3D model and production of detailed engineering drawings for components and subsystems. Verification of structural performance of compressor chamber. Risk assessment and failure modes and effect analysis.	D2A 3 months and 15 days D2B 5 months	20%
D3	Preparation of production drawings for manufacture of principal fabrications	D3A 5 months and 15 days D3B 6 months and 15 days	20%
D4	Manufacturing, assembly and factory testing of the compressor vacuum vessel and of the internal optical table	14 months and 15 days	10%
D5	Manufacturing, assembly and factory testing of the beam injector system	16 months	10%
D6	Transport and installation of the compressor vacuum vessel and of the internal optical table at ELI-Beamlines. Compressor control systems on-site integration, testing and Client staff training.	16 months	10%
D7	Transport and installation of the beam injector at ELI-Beamlines. Beam injector control systems on-site integration, testing and Client staff training.	18 months	10%
D8	Manufacturing, assembly and factory testing of large optomechanical mounts	18 months	5%
D9	Delivery of large optomechanical mounts to ELI-Beamlines	19 months	5%

I. Contractual Deliverables description

1. **Deliverable D1: Detailed schedule of project activities and all corresponding quality plans and work procedures**

The supplier to whom the Public Contract will be awarded (hereinafter the "***Supplier***") shall provide a detailed schedule of all project activities; by which is meant a schedule that defines all the activities necessary to individually define, produce or procure and deliver every component within the scope of supply. All activities shall be resourced, allocated start / finish times and linked with relevant dependencies. The amount of detail should be sufficient to identify the longest path of activities through the entire program, thus providing confidence in the overall programme for Deliverables. The scheduled activities shall not be restricted to those of the Supplier but shall include all relevant activities of sub-suppliers, the Client or relevant third parties.

Also within the first month following the Commencement Day, the Supplier shall provide a draft set of Quality and Verification Plans and associated Work Procedures detailing all the work activities and processes required for the design, procurement, fabrication, assembly and test of all products to be supplied under the contract. This shall include aspects such as design review, inspection, analysis and test procedures (Verification Plan), and configuration management, material traceability, cleanliness control, welding procedures and qualifications (Quality Plan). The provided draft set of Quality and Verification Plans shall incorporate as a minimum all required activities listed in Annex 3 (*Quality and Verification Plan*).

Completion: 1 month and 15 days after Commencement Day

2. **Deliverable D2: Development of detailed engineering drawings and structural verification of compressor chamber**

a) The Supplier shall develop detailed engineering drawings based on the preliminary design drawings and 3D model supplied by the Client. These detailed engineering drawings produced by the Supplier will be used in the next step (D3) to make production drawings. The purpose of the detailed engineering drawings is to complete the Client's preliminary design with all necessary mechanical details and to optimize the overall design with respect to the technologies and fabrication methods that will be employed for manufacturing.

b) A part of this Deliverable D2 will be elaboration of specific details, such as:

- Closing mechanism of the large chamber side doors (including e.g. hinges) or alternative means of opening these side doors
- Lifting mechanism / lifting points of the end and top doors of the chamber
- Access bridge, handrails and ladders (complying with valid CZ/EU safety standards)
- Relief holes in the optical table and optomechanical mounts to avoid trapped air pockets
- Internal (vacuum) and external (on the outer surface) cable trays on the compressor and on the beam injector
- Mechanisms for transporting the compressor components to their final location in the ELI-Beamlines facility, and for assembling and installation of the vacuum vessel, of the internal optical table, and of the beam injector and other subsystems in the clean L3 laser hall (ISO Class 7 cleanliness) of ELI-Beamlines
- Determination of material thicknesses, configuration of stiffening ribs, nozzles and flanges, weld locations and details, surface finishes and other such matters necessary to optimize for fabrication.

c) The Supplier shall verify the stiffness and vibrational properties of the developed detailed design of the compressor vessel and major optomechanical structures and fixtures by means of FEA (Finite Element Analysis) simulations. The acceptable limit of deformations under application of vacuum (stiffness) and vibrational criteria

are included in the detailed specification of performance requirements in Annex 2 of the Tender. Analysis of the concept design made by the Client shows that the specified requirements are realistic. The calculations shall also provide evidence of the factor of safety against structural collapse of the compressor chamber under vacuum and when subjected to overpressure up to a value limited by means of a passive safety device (e.g. bursting disk). Similar, though less elaborate, calculations shall be supplied for the beam injector vacuum envelope. Results of the analysis shall be provided by Supplier to Client for review. Status of appropriate requirements to be verified by the analysis shall be tracked by the Verification Control Document (VCD), see Annex No. 3, Section 2 (Verification Requirements for Supplier, and shall be the basis for acceptance of D2.

d) A brief technical report shall be provided by the Supplier that lists all the significant changes and enhancements between the FZU concept design and the agreed detail design. For each change there shall be a brief description of the reason for change and justification of the selected solution. This will provide a means of checking that no important features of the concept design have been inadvertently lost or corrupted.

e) The Supplier shall provide an updated detailed 3D model of the compressor chamber and the beam injector with its associated components and sub-assemblies, showing the finally agreed configuration.

It is recognized that the lead-time for the Compressor will be longer than the Beam Injector so to even out the effort the Deliverable completion dates are staggered:

Completion: D2A Compressor 3 months and 15 days after Commencement Day
D2B Beam Injector 5 months after Commencement Day

3. **Deliverable D3: Preparation of production (manufacturing) drawings for major components**

Based on the results of Deliverable D2 the Supplier shall provide a full set of final production drawings (including 3D model) for all components that will be manufactured under this contract. The Supplier shall also produce associated documentation to these drawings that will include a detailed plan of verification by testing and detailed description of the testing procedures and instrumentation.

As lead times differ widely for various components Deliverable D3 is specifically applicable to the major fabricated components listed below:

- Compressor Chamber body and all parts welded to the chamber;
- All purpose-made doors and closures;
- The internal optical table including support structure and legs;
- Beam Injector vacuum envelope.

The Supplier shall provide final Quality and Verification Plan for the above components and the manufacturing drawings and other documentation will be reviewed by the Client, with reference to these Quality and Verification Plan.

As part of this Deliverable the Supplier shall provide an installation plan of the Compressor assembly at the ELI-Beamlines site.

As part of this Deliverable the Supplier shall also develop detailed engineering drawings of the individual optomechanics and their supporting structure based on the preliminary design drawings and 3D model supplied by the Client. These detailed engineering drawings will be submitted to the Client for approval along with the Beam Injector production drawings.

The provided documentation shall be reviewed by Client by means of Critical Design Review (CDR) process and its results will be recorded in a CDR Report. The verification of the Design shall be considered complete when the Client and the Supplier mutually agree that, on the basis of the CDR Report and on the basis of the Verification

Control Document (VCD) that all corresponding requirements related to the Design were closed out and that all associated verification objectives were fully achieved. The status of the requirements verified in the Review of Design shall be tracked by the Verification Control Document (VCD), see Annex No. 3, Section 2 (Verification Requirements for Supplier) and shall be the basis for acceptance of the Design.

The Supplier shall further submit a timetable of individual major steps in the manufacturing process related to D4, D5 and D8. The Client reserves the right to witness verification and testing of the individual components and subsystems at the Supplier's premises at any of the indicated steps in the manufacturing process, and to monitor implementation of the contract.

Recognizing that the lead-time for the Compressor will be longer than the Beam Injector the Deliverable completion dates are again staggered:

Completion:	D3A Compressor	5 months and 15 days after Commencement Day
	D3B Beam Injector	6 months and 15 days after Commencement Day

4. **Deliverable D4: Manufacturing, assembly and factory testing of the compressor vacuum vessel and of the internal optical table**

The Supplier shall manufacture the compressor vacuum vessel including the doors and flanges, the internal optical table, and all elements of interconnection of these subsystems, in line with the documentation produced within the D3A Deliverable. Completion of individual major steps of the manufacturing process will be witnessed by the Client according to the Quality Plan developed in Deliverable D3.

After finishing the individual phases of fabrication and cleaning, the Supplier shall install the compressor chamber in ISO Class 7 or better cleanroom at his premises, where all assembly operations will be made. Upon assembling the individual components and sub-systems this phase shall verify key parameters of the compressor assembly, namely:

- Vacuum performance and ability to achieve a pressure of 10^{-6} mbar within no more than 10 hours, $5x10^{-7}$ mbar in time comparable to 48 hours and then maintain this vacuum for a further 48 hours;
- Stability of the compressor chamber structure during pump down, quantitative measurements of deformations of the vacuum chamber body;
- Validation of the vacuum cleanliness (contaminants-free vacuum) by mass spectroscopy measurements and by another independent verification technique provided by the Client (e.g. sol-gel technique and/or microbalance);
- Determination of the leak rate of the assembled chamber with doors, port covers, blank flanges and isolation valves fitted;
- Mechanical stability of the internal optical bench in different states of the system, especially upon pump down from atmospheric pressure to low pressure (verified for example by sighting a mirror with a high precision auto-collimator);
- Functioning of integrated vacuum control system (VCS) with the Compressor.

The verification of the compressor assembly performance shall be made according to the Verification Plan. The results of this performance verification and testing will be a Protocol on Factory Testing of the Compressor Chamber and of the Internal Optical Table. The verification shall be considered complete when the Client and the Supplier mutually agree that, on the basis of the VCD and of the Protocol on Factory Testing of the Compressor Chamber and of the Internal Optical Table, all corresponding requirements were closed out and the associated verification objectives were fully achieved. The status of the requirements verified in this phase of Inspection and Testing shall be tracked by the Verification Control Document (VCD), see Annex No. 3, Section 2 (Verification Requirements for Supplier) and shall be the basis for acceptance of D4.

Completion: 14 months and 15 days after Commencement Day

5. **Deliverable D5: Manufacturing, assembly and factory testing of the Beam Injector system**

The Supplier shall manufacture all components of the Beam Injector, in line with the documentation produced within the D3B Deliverable. Completion of individual major steps of the manufacturing process will be witnessed by the Client according to the Quality Plan developed in Deliverable D3.

After finishing the individual phases of fabrication and cleaning of the Beam Injector components, the Supplier will install the Beam Injector in ISO Class 7 or better cleanroom at his premises, where all assembly operations will be made. Upon assembling the individual components and sub-systems this phase shall validate key parameters of the Beam Injector assembly, namely:

- Vacuum performance and ability to achieve a pressure of 10^{-7} mbar within no more than 6 hours, 10^{-7} mbar in time comparable to 48 hours and then maintain it for a further 48 hours;
- Mechanical stability of the final L3 beam steering mirror support during pump down of the Beam Injector chamber from atmospheric pressure to low pressure (by method as for optical table), quantitative measurements of deformations of this mirror-supporting chamber;
- Validation of the vacuum cleanliness (contaminants-free vacuum) by mass spectroscopy measurements and by another independent verification technique provided by the Client (e.g. sol-gel technique and/or microbalance);
- Determination of the leak rate of the assembled Beam Injector with flanges and isolation valves fitted;
- If Contractual Option of the water-cooled beam dump is activated, operation of the beam dump cooling system to verify absence of induced vibrations;
- Functioning of integrated vacuum control system (VCS) with the Beam Injector.

The verification of the Beam Injector performance shall be made according to the Verification Plan. The results of this performance verification and testing will be a Protocol on Factory Testing of the Beam Injector. The verification shall be considered complete when the Client and the Supplier mutually agree that, on the basis of the VCD and of the Protocol on Factory Testing of the Beam Injector, all corresponding requirements were closed out and the associated verification objectives fully achieved. The status of the requirements verified in this phase shall be tracked by the Verification Control Document (VCD), see Annex No. 3, Section 2 (Verification Requirements for Supplier) and shall be the basis for acceptance of D5.

Completion: 16 months after Commencement Day

6. **Deliverable D6: Transport of the vacuum vessel and internal optical table and installation at ELI-Beamlines**

The Supplier shall prepare for transport of the compressor vacuum chamber, the internal optical table, all elements interconnecting the vessel and the table, and all vacuum tubing necessary for connecting the chamber to the ELI-Beamlines vacuum circuits. The compressor vessel and components of the optical bench shall be packed separately.

For the duration of its transport the vacuum chamber shall be hermetically sealed under dry air or nitrogen. The initial wrapping of all parts shall be in multiple layers of plastic film (as sheet or bags) of type specifically for use in contamination controlled areas. This clean conditions wrapping will be further enclosed in robust outer packaging and transport crates as necessary for protection and handling during shipping to the ELI-Beamlines site.

The Supplier will transport the components to the ELI-Beamlines facility and will remain responsible for them (with appropriate insurance cover) until acceptance of D6. Offloading of the Compressor at the building entrance will probably require a mobile crane on hire. Other packages can be offloaded by fork lift truck. Without activation of the Contractual option 4 (Optional transport of the compressor vacuum chamber) the transport of the compressor from the ELI-Beamlines entrance through the building right up to the point of fixing down at the operational location in the L3 hall will be carried out by the Client, under Supplier's supervision. Transport through the Laser Building will involve the use of a goods lift to transition between floors and in order to fit in the lift the maximum dimensions of the chamber body (in its transport configuration) must not exceed 5.5 m (*length*)

x 5.1 m (*width*) x 2.98 m (*height*) and its weight must not exceed 10 tons. Movement through corridors and rooms will require wheels, rollers or air skates fitted to a suitable support structure, whose design and supply will be within the scope of the Supplier, as will be any floor surface protection or load spreading sheets.

At the ELI-Beamlines site, the vessel and its components will be received in a cleanroom of ISO Class 7.

Without activation of the Contractual option 4 (Optional transport of the compressor vacuum chamber) the compressor will be positioned and bolted to the floor of the L3 hall by the Client, under Supplier's supervision. Once positioned and bolted to the floor in the L3 laser hall, an enclosure of ISO Class 5 will be installed around the compressor chamber to reduce the risk of internal contamination during the subsequent installation of optomechanical equipment and their integration and alignment. This enclosure will be designed, procured and installed by the Client.

The Supplier shall connect the compressor chamber to the ELI-Beamlines primary vacuum circuits and the chamber will be pumped down. A vacuum performance equal to or better than that reported in the D4, Protocol on Factory Testing of the Compressor Chamber and of the Internal Optical Table, shall be demonstrated.

An electric overhead travelling crane with a capacity of 5 tons is installed in the L3 Laser Hall above the area where the compressor will be installed. However, no reliance shall be placed on using this crane for installation of the Compressor Chamber or the Internal Optical Table.

The compressor chamber shall be positioned in the L3 hall, with respect to the local coordinate system, with a tolerance of +/- 1 mm. This positioning will be referenced to patterns centered on the flanges of the input and output beam windows of the chamber.

The Supplier shall ensure proper integration of the internal optical table with the compressor in the L3 hall of ELI-Beamlines, and alignment of these components with respect to the L3 Hall coordinate system. Details of this procedure shall be the subject of agreement between the Client and the Supplier.

The optical table shall be positioned, with respect to the L3 hall local coordinate system, with an accuracy of +/- 0.5 mm for height and +/-0.5 mm in the horizontal plane.

The Supplier shall integrate and test the compressor vacuum control system (VCS). Details of this procedure will be the subject of agreement between the Client and the Supplier.

All required performance verification and testing associated with installation of the compressor chamber and integration of the internal optical table in the L3 hall of ELI-Beamlines shall be made according to the Verification Plan. The results of this performance verification and testing will be a Protocol on Installation of the compressor chamber and integration of the internal optical table in the L3 hall of the ELI-Beamlines facility. The status of requirements verified in this phase shall be tracked by the Verification Control Document (VCD), see Annex No. 3, Section 2 (Verification Requirements for Supplier) and shall be the basis for acceptance of D6.

Completion: 16 months after Commencement Day

7. Deliverable D7: Transport and installation of the beam injector at ELI-Beamlines

The Supplier shall package the Beam injector, its sub-assemblies, and all vacuum tubing necessary for its connection to the ELI-Beamlines vacuum circuits in a similar way to that described in D6. For the purpose of the transport to ELI-Beamlines site the Beam Injector vessel shall be hermetically sealed under dry air or nitrogen.

The Supplier shall transport the above mentioned components to the ELI-Beamlines facility.

At the ELI-Beamlines site, the Supplier shall move the Beam Injector through the Laser Building, in similar fashion to the Compressor, to be positioned and bolted to the floor in the L3 laser hall, which is a cleanroom of ISO Class 7. An enclosure of ISO Class 5 will be installed around the Beam Injector to reduce contamination during the subsequent integration and alignment. This enclosure will be designed, procured and installed by the Client.

The Supplier shall connect the Beam Injector to the ELI-Beamlines primary vacuum circuits and the Beam Injector will be pumped down. Vacuum level equal to or better than that reported in the D5, Protocol on Testing of the Beam Injector, shall be achieved.

The Supplier shall test functioning of the Vacuum Control System (VCS) with the compressor and beam injector fully integrated. Details of this procedure will be the subject of agreement between the Client and the Supplier.

All required performance verification and testing associated with installation of the Beam Injector in the L3 hall of ELI-Beamlines shall be made according to the Verification Plan. The results of this performance verification and testing will be a Protocol on Installation of the Beam Injector in the L3 hall of the ELI-Beamlines facility. The status of requirements verified in this phase be tracked by the Verification Control Document (VCD), see Annex No. 3, Section 2 (Verification Requirements for Supplier) and shall be the basis for acceptance of D7.

Completion: 18 months after Commencement Day

8. **Deliverable D8: Manufacturing, assembly and factory testing of large optomechanical mounts**

The Supplier shall develop production drawings and full 3D model of all vacuum optomechanical mounts being subject of this contract, in line with the documentation produced within the D3 Deliverable. The Supplier shall manufacture the mounts. Completion of individual major steps of the design and manufacturing process will be witnessed by the Client according to the Quality Plan, developed in Deliverable D3.The Supplier shall install the integrated optomechanical components in an ISO Class 5 or better cleanroom at his premises, where all assembly operations and testing shall be made. The Supplier shall integrate the mechanical components of the mounts with the respective manual and electrical actuators and other sensors. Upon integration with vacuum-compatible cabling and connectors, all electrically actuated optomechanical mounts shall be connected to corresponding electronic drivers.

The Supplier shall provide all equipment for the required testing of the optomechanical mounts.

The Supplier shall validate key performance parameters of the mounts at their works, first on air then in vacuum, namely:

- Demonstration of precision on individual movements of the mounts, achievement of required minimal step, demonstration of stability of each mount
- Vacuum testing showing ability to achieve pressure 10^{-7} mbar
- Validation of the vacuum cleanliness (contaminants-free vacuum) by mass spectroscopy measurements
- Determination of the outgassing rate of each mount
- Functioning of the motion control system with all electrical actuators.

The verification of the optomechanical mounts performance shall be made according to the Verification Plan. The results of this performance verification and testing will be a Protocol on Factory Testing of the optomechanical mounts. The status of requirements verified in this phase shall be tracked by the Verification Control Document (VCD), see Annex No. 3, Section 2 (Verification Requirements for Supplier) and shall be basis for acceptance of D8.

Completion: 18 months after Commencement Day

9. **Deliverable D9: Delivery of large optomechanical mounts to ELI-Beamlines**

The Supplier shall pack the optomechanical mounts and all related equipment (wiring, connectors, drivers, etc.). All mounts and components that will be installed in vacuum shall be hermetically sealed under dry air or nitrogen.

The Supplier shall transport the optomechanical mounts to the ELI-Beamlines facility.

On the ELI-Beamlines site, the mounts will be unpacked by Supplier in ISO Class 5 cleanroom, and shall first be tested in air according to the Protocol on Factory Testing of the optomechanical mounts delivered in D8 and then

correspondingly tested in vacuum after installation in the Compressor. The Supplier shall test functioning of the motion control system with all electrical actuators, with the optomechanics integrated in the compressor and beam injector, and under vacuum conditions.

All required tests associated with on-site verification of the delivered optomechanics shall be identified in the Verification Plan. The results of this deliverable will be a Protocol on Delivery of the optomechanical mounts to the ELI-Beamlines facility. The status of requirements verified in this phase shall be tracked by the Verification Control Document (VCD), see Annex No. 3, Section 2 (Verification Requirements for Supplier) and shall be the basis for acceptance of D9.

Completion: 19 months after Commencement Day

II. Contractual options

Contractual option 1 (Optional components)

The following components are agreed as contractual option herewith. Some of the components may be necessary for the factory testing of the Compressor and Beam Injector systems. The Client is entitled to order of these optional components at his full discretion before or at the time of acceptance of the D3 reports. Price of optional components is stipulated separately by the Bid and shall be paid if any optional component is required at the time of their delivery to the Supplier (hand over protocol confirming receipt of the components free of defects to be submitted to the Client as a condition of the payment) or to the Client.

- 2 pieces of pendulum vacuum valves DN400 ISO-K equipped by optical sapphire window with diameter 75 mm
- 2 flanges DN400 for optical windows and/or viewport to be mounted on the chamber body
- Water-cooled beam dump unit for the Beam Injector, according to the provided drawings in Annex 2
- Vertical vacuum section of the Beam Injector for housing the cryogenic segment
- Additional 8 pieces of optomechanical mounts (e.g. for diagnostic beams) for optics with clear aperture smaller than 75 mm
- Additional 1 piece of a 6-axis optomechanical mount for an off-axis parabolic mirror with maximum clear aperture 250x250 mm

Contractual option 2 (Optional post-installation technical support)

The following services are agreed as contractual option herewith. The Client is entitled to require provision of post-installation technical support. The Client is entitled (but has no duty to do so) to ask the Supplier for the support at its full discretion within first year after final acceptance of the Object of Purchase. Detailed conditions of provision of the support (extent, time of provision, profession of specialists etc.) shall be agreed between Contractual parties. However, the Supplier will commence provision of the support no later than 10 working days after written request by the Client. The price of optional support (as man-day price) is stipulated separately by the Bid and shall be paid if any optional support is provided after its due provision.

Contractual option 3 (Optional design works)

The following services are agreed as contractual option herewith. The Client is entitled to require provision of optional design works. The Client is entitled (but has no duty to do so) to ask the Supplier for the services at its full discretion before or at the time of acceptance of the D8 Deliverable. Detailed conditions of provision of the services (extent, subject matter of design works etc.) shall be agreed between Contractual parties. However, the Supplier will commence provision of the support no later than 10 working days after written request by the Client. The price of optional services (as man-day price) is stipulated separately by the Bid and shall be paid if any optional services are provided after their due provision.

Contractual option 4 (Optional transport of the compressor vacuum chamber)

The following services are agreed as contractual option herewith. The Client is entitled to require the Supplier to carry out transport of the compressor vacuum chamber including related components through ELI-Beamlines laser building to the L3 laser hall, positioning and bolting to the floor as described herein (D6 Deliverable description). The Client is entitled (but has no duty to do so) to ask the Supplier to exercise the option at its full discretion before or at the time of acceptance of the D5 Deliverable. Detailed conditions of the transport shall be agreed between Contractual parties before commencement of the transport. The price of the optional transport is stipulated separately by the Bid and shall be paid together with payment for Deliverable D6 if the optional transport was duly provided.

ANNEX 2

DETAILED TECHNICAL SPECIFICATIONS

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Confidentiality Level	BL - Restricted for internal use	**TC ID / Revision**	00111985 / C
Document Status	Document Released	**Document No.**	N/A
WBS code	3.3 - L3 system		
PBS code	RA1.L3.HAPL.CMP		

Requirements Specification Document (RSD)

Annex No. 2 –Detailed technical specifications

Vacuum compressor and beam injector of PW laser pulses for the ELI-Beamlines L3 laser system [TP14-094]

Keywords

N/A

	Position	Name
Responsible person	Scientific coordinator of laser technology (RP1)	Bedřich Rus
Prepared by	Scientific coordinator of laser technology (RP1)	Bedřich Rus

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OP Research and Development for Innovation

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008546/A.001	02.11.2015 10:49	03.11.2015 14:28	Marek Malý
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Reviewed By

Name (Reviewer)	*Position*	*Date*	*Signature*
Pavel Bakule	Deputy RP1 Leader		
Pavel Korouš	Chief Engineer		
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Approved by

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Revision History / Change Log

Change No.	*Made by*	*Date*	*Change description, Pages, Chapters*	*TC rev.*
1	M.Malý	02.11.2015	Document draft, preparation for internal review	A
2	M.Malý	06.11.2015	Document update, preparation for internal approval	B
3	M.Malý	27.11.2015	Final version of the document, formal updates	C

Content

1. Introduction

This Requirements Specification Document (RSD) lists technical requirements on the vacuum compressor of PW laser pulses for the ELI-Beamlines L3 system (PBS: RA1.L3.HAPL.CMP) relating to the RP1 program of the ELI-Beamlines project. The specifications include interfaces with the L3 laser system of ELI-Beamlines and with the ELI-Beamlines building. This RSD also acts as a parent document for any technical requirements specified in lower level design documentation.

2. Vacuum compressor and beam injector of PW laser pulses for the ELI-Beamlines L3 laser system

This document provides the technical information on the compressor vacuum chamber, beam injector system, internal optical table, optomechanical mounts, control systems and associated subsystems that comprise the scope of work for the "Vacuum compressor of PW laser pulses for the ELI-Beamlines L3 system" supply contract.

This document is comprised of a descriptive text that explains the purpose, function and arrangement of the equipment to be supplied and is supported by further sections that provide a summary of requirements and technical details of material that comprises the scope of supply under the contract; all materials shall be compliant with the specified details.

No laser optics (mirrors, gratings, windows, etc.) are required to be supplied under this contract. Grating mounts are also excluded from the scope of supply.

2.1. Overall view of the Compressor and Beam Injector assembly

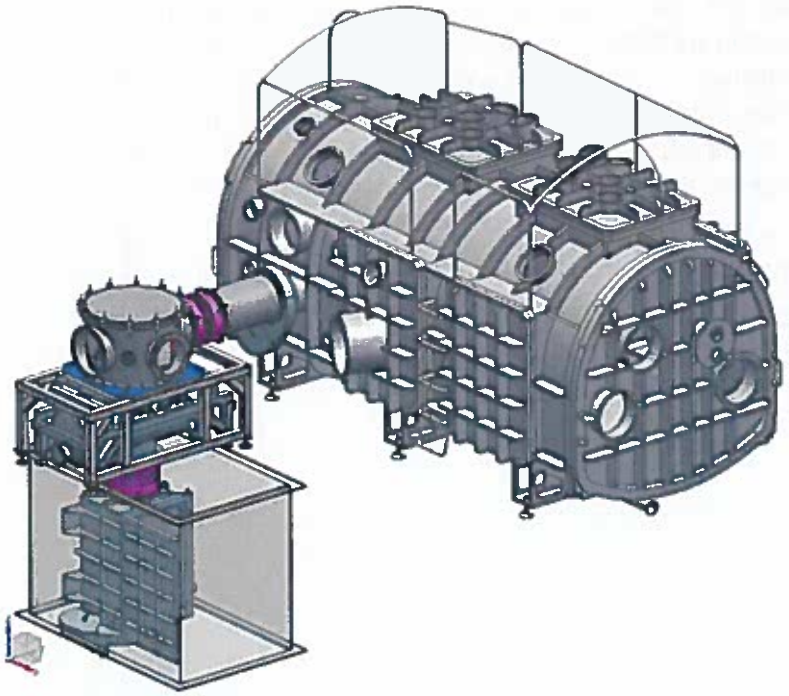


Figure 1: Overall view of the Compressor and Beam Injector assembly.

2.2. Optomechanical structure of the compressor

The compressor chamber is designed as ribbed structure. The upper part of the chamber is semi-circular in shape with radius 1 m and the lower part has a typical pressure vessel dished head shape. The net length of internal space is 4,650 mm. The maximum width and height of the internal space are both 2,000 mm (the internal optical table when mounted reduces the clear height to 1,650 mm). At both ends the chamber is equipped with large end doors with shape corresponding to the chamber section. These end doors can be removed to obtain unobstructed access to the chamber interior. Other large ports at the chamber body allow extensive access to the compressor gratings: two rectangular doors (clear opening 1,320 x 1,250 mm^2 and 1,910 x 1,250 mm^2, respectively) on the "North side" of the chamber, two rectangular doors (clear opening 900 x 1,250 mm^2) of the "South side" of the chamber, and two rectangular doors (clear opening 900 x 1,200 mm^2) on the top of the chamber body. The upper rectangular doors can be used for accessing chamber interior by the overhead crane.

All optical components are mounted on an optical table located within the vacuum chamber and supported by an optimized structural support frame. The table is mechanically de-coupled from the vacuum vessel.

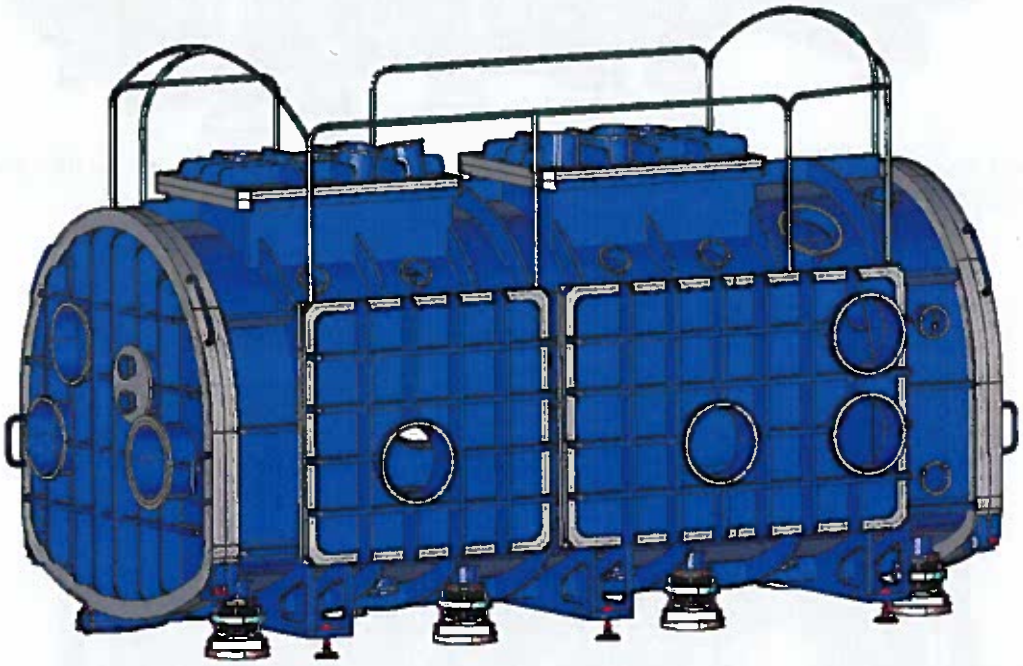


Figure 2: Compressor chamber body seen from the North-West with respect to its position in the L3 laser hall of the ELI-Beamlines facility.

The chamber body shall be manufactured from stainless steel. The chamber structure has thickness of the walls of 15 mm - the value was optimized by FEM analysis deformations due to atmospheric pressure. The Supplier shall repeat the FEM analysis of the finally detailed design. The end doors shall be manufactured from stainless steel for rigidity. The side and top doors can be manufactured either from aluminium or from stainless steel.

The chamber is equipped by footbridge, accessed by rungs, and handrails for safety of the personnel servicing the upper part of the chamber. The current design of the footbridge and handrails is conceptual and shall be developed into details by the Supplier during production of the manufacturing drawings in accordance with ISO 14122. The upper handrails will have to be partly demountable to permit crane access for removing doors D7 and D8 on the top of the chamber.

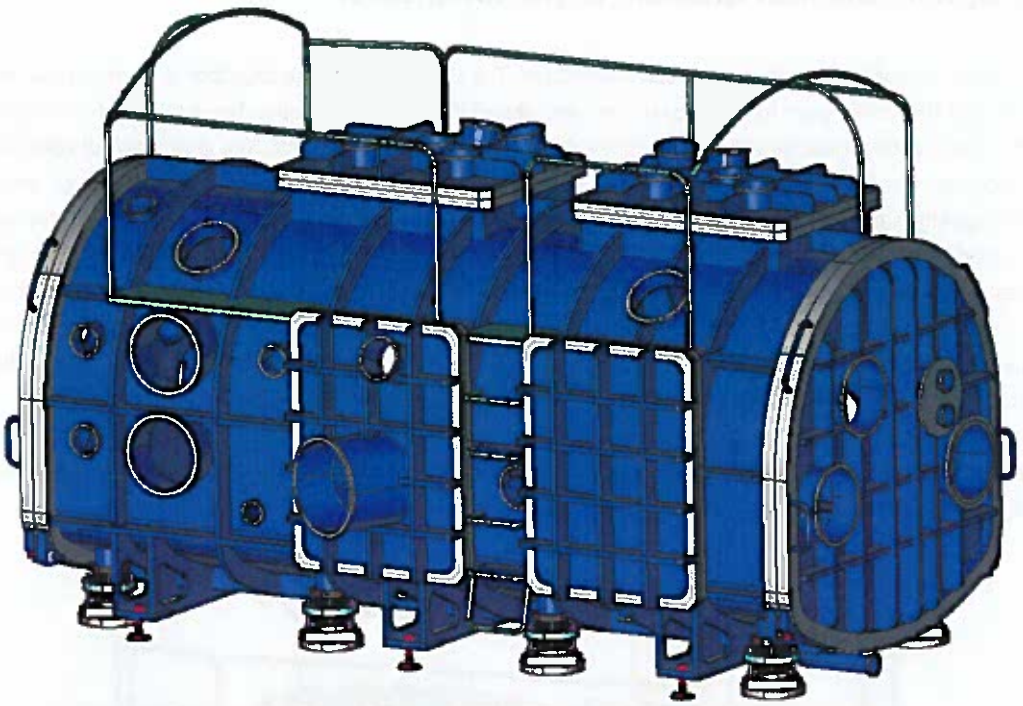


Figure 3: Compressor chamber body seen from the South-West with respect to its position in the L3 laser hall of the ELI-Beamlines facility.

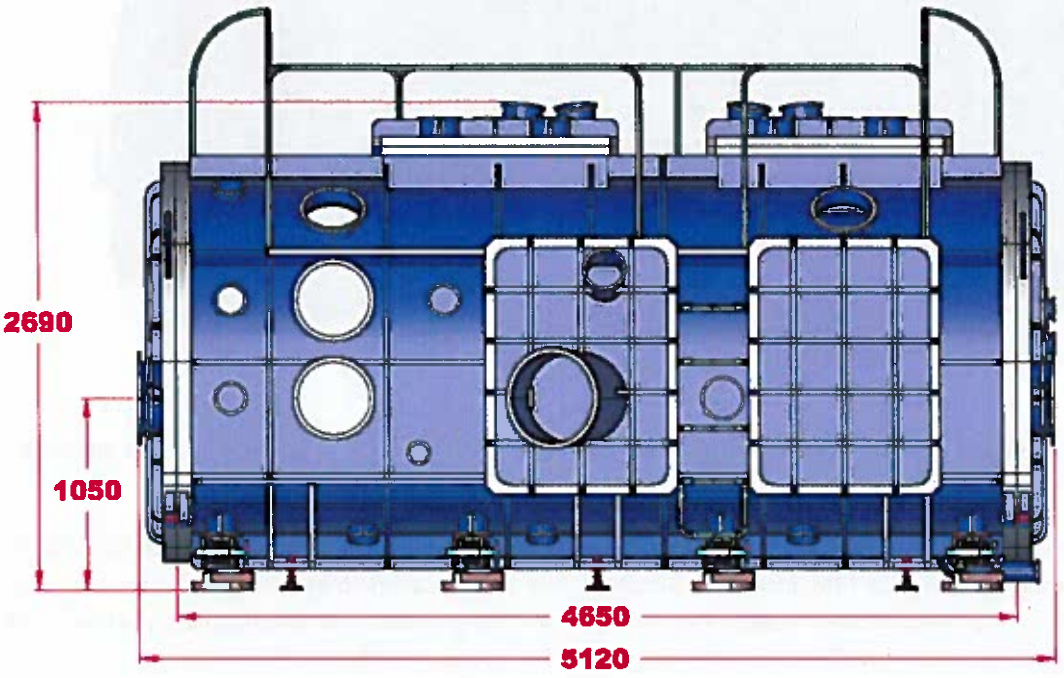


Figure 4: Compressor chamber major dimensions, with both end doors mounted; the indicated vertical dimensions are with respect to the floor level.

Figure 4 indicates the total length of the chamber equipped with all doors and flanges. The chamber dimensions indicated must not be exceeded.

The total weight of the chamber sealed by circular flanges and Al doors is approximately 9,300 kg, which provides sufficient margin for end door covers and transporting envelope / transport pallet to get within the 10 tons capacity of the cargo elevator of ELI-Beamlines.

As a working principle all operations carried out within the compressor chamber at ELI-Beamlines will be consistent with Class 100 operations. It is envisaged that the entire chamber will be enclosed in a modular Class 100 containment for initial installation at ELI-Beamlines and whenever the chamber is opened for major work. Sufficient space will be provided within this modular enclosure to remove and handle large ports and to handle items such as the grating positioning assembly. Synthetic air bleed may be used to avoid mixing the chamber environment with L3 room air.

All exposed metal parts (chamber, tubing, valves, etc.) will be electrically bonded to the facility ground for machine and personnel safety.

ELI-Beamlines is currently finishing design of the technique for online verification of alignment of the compressor diffraction gratings. Implementation of this technique will require adding several extra flanges to the side doors (D3, D4, D5 and D6) but their position is not yet fixed. The Supplier is therefore required to allow for eight additional DN ISO-K flanges to the doors D3 and/or D4 and/or D5 and/or D6, with size up to DN 250. Exact locations of these additional flanges will be specified at the latest three months after the project start.

The entire compressor chamber can be accessed by the overhead crane with the load capacity of 5 tons (see Figure 18). The maximum height to which the hook can be elevated above the floor level is 3.25 m.

The outer surface of the chamber and/or of the doors shall be locally painted or equipped by enduring sticker foils. Details will be agreed between the Supplier and FZU during the early manufacturing phase.

2.3. Optomechanical structure of the beam injection system

The Beam Injection System (BIS) is a vacuum section sitting between the Compressor output vacuum isolation valve and the vacuum isolation valve constituting the interface to the experimental systems, see Figure 5. In the BIS the PW beam output from the Pulse Compressor is reflected down through 90° by a mirror, through the floor of the L3 hall, towards the experimental chambers.

The BIS provides three functions:

- First: the BIS provides an optical and vacuum interface between the PW compressor and the downstream facility Beam Distribution System.
- Second: it allows for "standalone" operation of the L3 laser without sending the compressed PW beam beyond the L3 laser hall towards the experimental systems. To this end the vertical section of the BIS is equipped with a retractable mirror and a PW vacuum beam dump (consisting of a ceramic-coated absorbing plate) allowing the laser to run at full performance while absorbing the beam within the L3 hall. In this regime of "standalone" operation the BIS is isolated by the DN400 pendulum type isolating valve located within the floor penetration.
- Third: the BIS provides differential vacuum pumping that copes with the difference between the 10^{-5} mbar pressure in Beam Distribution System and the high-cleanliness hydrocarbon free 10^{-7} mbar vacuum of the compressor. To this end the BIS can be equipped with a cryogenic pumping segment located in the floor penetration space and providing a pumping speed of approximately 200,000 l/s.

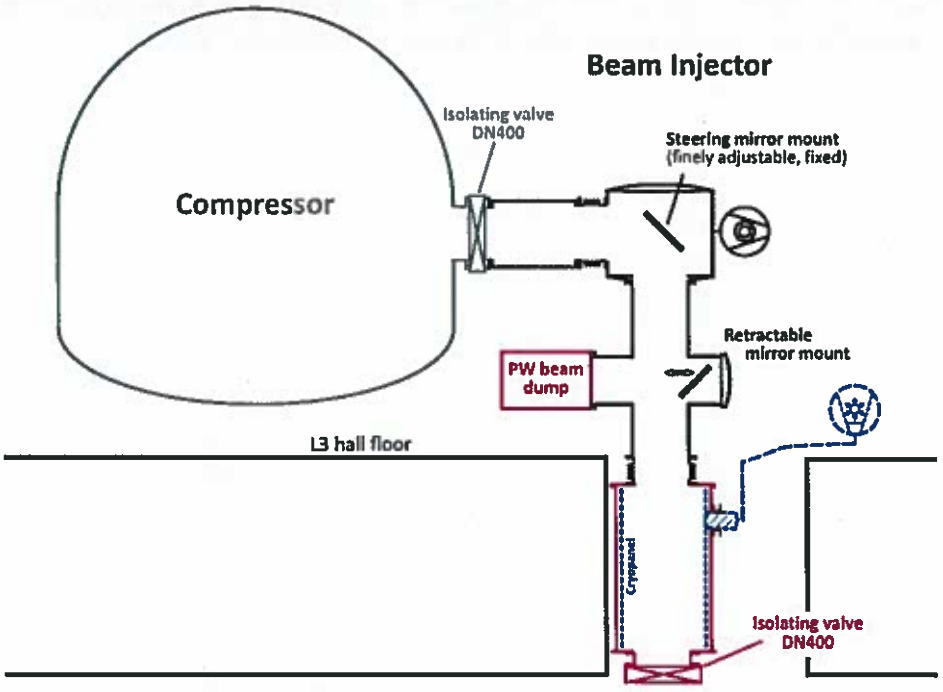


Figure 5: Block scheme of the Beam Injection System (BIS), not to scale. The cryogenic cooling (represented in dotted blue) is not part of the contract; the water-cooled PW beam dump, the vacuum section mounted in the structural ceiling penetration including the vibration isolating bellows and the output DN400 isolating valve (all represented in red) are contractual options.

The BIS shall have autonomous vacuum pumping consisting of a TMP unit of ~3000 l/s (at least 2800 l/s), and using branches of the roughing and backing vacuum circuits supplying the compressor.

The system shall also include a COTS compact quadrupole mass spectrometer, located close to the BIS output isolating valve DN400 to monitor the vacuum cleanliness. The spectrometer will be attached to a flange DN 40 CF and its small dimensions (about 30 cm) make it easily implementable onto the vertical vacuum tube as closest as possible to the L3 hall floor level. Exact location and details of implementation of this COTS mass spectrometer shall be suggested by the Supplier.

Figure 6 shows the structure of the Beam Injector. The system includes vacuum envelope, high-precision and high-stability optomechanical mount of the large steering mirror, retractable mirror system for diverting the laser beam to the PW beam dump, supporting chassis, and associated control systems.

The optomechanical mount of the steering mirror is mounted on a base which is supported by its own chassis and is decoupled from the injector vacuum envelope (vessel) by bellows modules. The injector vacuum envelope is supported by its own chassis.

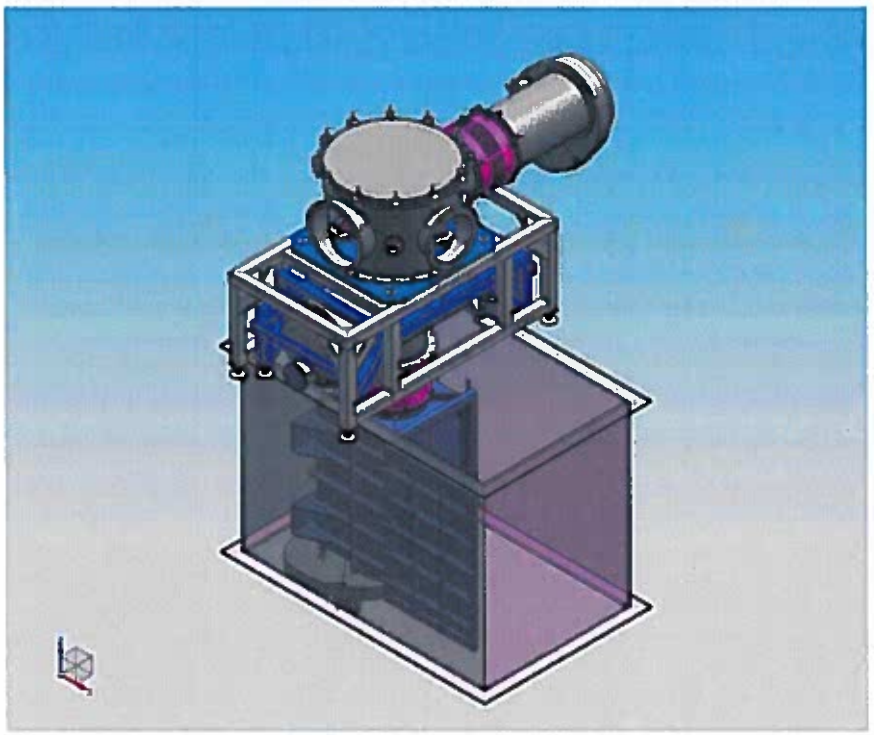


Figure 6: Structure of the Beam Injector System assembly. The vacuum envelope (vertical vacuum segment with rectangular section) in the ceiling penetration is a contractual option.

Required components of the Beam Injector included in the basic contractual scope are:

- Vacuum envelope of the Beam Injector
- Vacuum gauges, valves, TMP and other components according to Figure 11
- Corresponding part of the vacuum control system (VCS)
- Supporting chassis (independent chassis for the internal optomechanics IOM1 and for the vacuum envelope)
- Internal optomechanics IOM1 and IOM2 including actuators and motion controls
- One alignment bellows DN400 between the compressor and the Beam Injector.

Required components of the Beam Injector to be included into contractual options are:

- Water-cooled beam dump unit
- Vertical vacuum section of the Beam Injector (including the vibration isolation bellows, see Figure 5) for housing the cryogenic segment
- Output pendulum vacuum valve DN400 with pneumatic actuator, equipped by optical window with diameter of approximately 75 mm (same as compressor output isolation valve on BF1)

2.4. Optical table design and isolation from the chamber

All optical components are mounted on an optical table located within the vacuum chamber and supported by a structural support frame. The support system of the internal optical table is mechanically de-coupled from the vacuum vessel by means of bellows so that the internal optical table can be bolted directly to the laser hall floor independently of the vacuum chamber supports.

The concept of the optical table and its supporting structure is shown in Figure 7. The table has total size of 4,550 x 1,800 mm^2 and consists of three segments with dimensions 500 x 1,800 mm^2, 2,830 x 1,800 mm^2 (central segment that supports the diffraction gratings), and 1,200 x 1,800 mm^2, separated by 10 mm. The reason for partitioning the optical table into three segments is to ease manipulation with the table and to reduce manufacturing costs. The optical table is mounted on a support frame that allows accurate horizontal levelling and fine height setting.

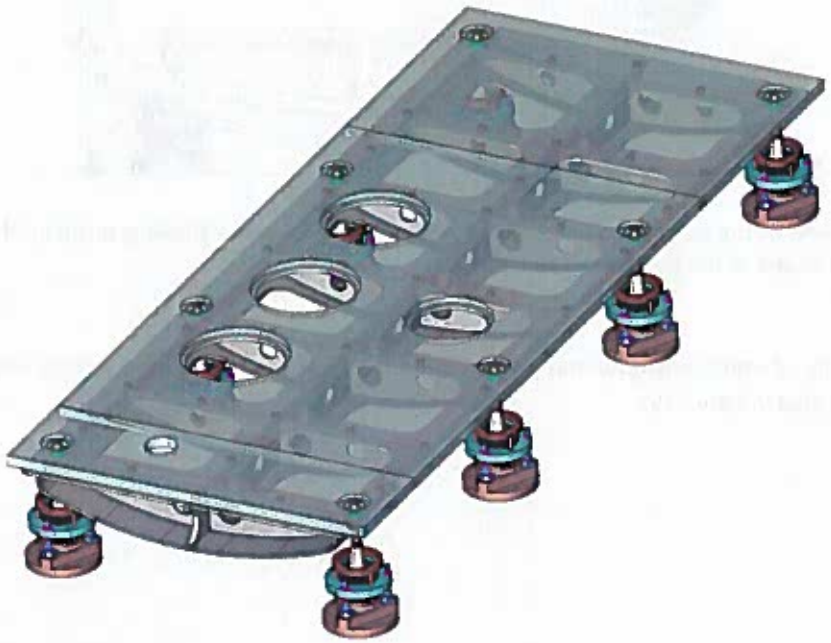


Figure 7: Concept of the internal optical table. The table is composed of three sections sitting on a high-stiffness frame supported by 8 support posts equipped with a bellows system to provide full isolation from the vacuum chamber body.

The optical table has thickness of 40 mm. It will be machined with an array of M6 tapped mounting holes on a 25 mm square grid. The table will be comprised of a stress-relieved cast aluminium slab made from high-flatness (equal or better than 0.3 mm /1,000 mm) prefabricated panels. Design of the table structure and support frame has been optimized with respect to stiffness and vibration characteristics; additional simulations shall be made by the Supplier during the phase of development of the manufacturing drawings. The manufacturing design of the table will be made, as for all other components inside the vacuum vessel, to avoid any trapped volumes of air, e.g. the mounting holes shall be tapped right through.

The central segment has four holes to give access to the electrical feedthroughs, cables and connectors under the optical table. The present position of the access holes is somewhat nominal but must avoid the grating mounts. The holes shall be recessed, with tapped holes, to allow fitting of cover plates flush with the table top.

The support frame shall be manufactured from aluminium. The Supplier is asked to adapt (e.g. thicknesses of the ribs) the current design of the frame, which was made for stainless steel, for aluminium.

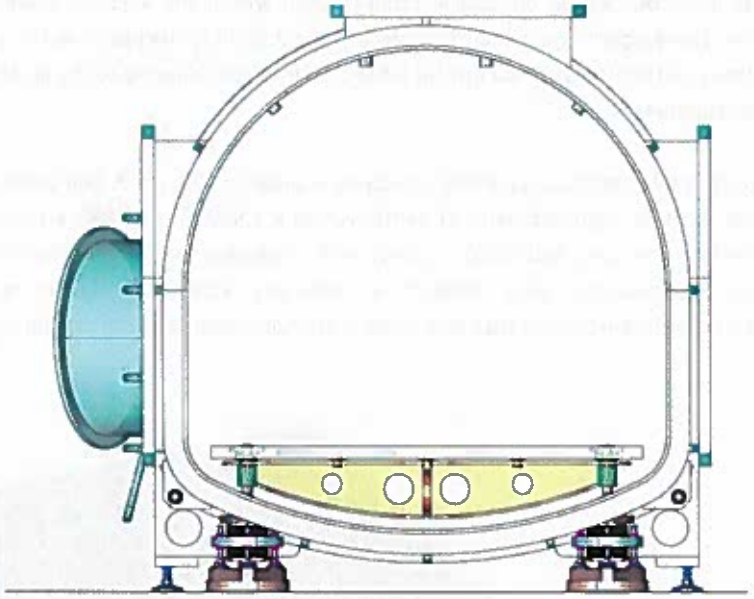


Figure 8: End view of the optical table integrated within the compressor, showing position of the optical table supports with respect to the body of the chamber.

Layout of the group of optomechanical mounts sitting on the optical table and required to be supplied within the contract is represented in Figure 15.

2.5. Compressor and injector vacuum system, connection to the central primary vacuum circuit

The compressor chamber is designed to provide vacuum conditions of 10^{-7} mbar.

Pumping of the compressor chamber to roughing vacuum (10^{-2} mbar) will be made using the centralized primary vacuum system of the ELI-Beamlines facility. This consists of stainless steel tubing (DN160 ISO-K) which emerges through a floor penetration. A separate circuit (DN100 ISO-K) is provided for maintaining backing vacuum (10^{-2} mbar) for turbomolecular pumps (TMP).

The primary vacuum circuits will provide approximately 10^{-2} mbar pressure. The circuits will be pumped by dry pumps.

The L3 Compressor Roughing Circuit is brought to the L3 hall by DN160 ISO-K tubing via the floor penetrations. The roughing circuit will be used for pumping down the PW compressor, before turbomolecular or other high-vacuum pumps will take over.

The L3 Compressor Backing Circuit is brought to the L3 laser hall by DN100 ISO-K tubing parallel with the roughing circuit. This circuit will serve to provide backing vacuum for turbomolecular pumps used to maintain high vacuum in the PW compressor.

Connection of the primary vacuum circuits of the compressor to the central primary vacuum system of ELI-Beamlines is shown in Figure 9. Three TMP units with a pumping speed ~3,000 l/s (minimum 2800 l/s) each are designed to pump the chamber to the pressure down to 10^{-7} mbar. The TMPs are included in the basic scope of the contract.

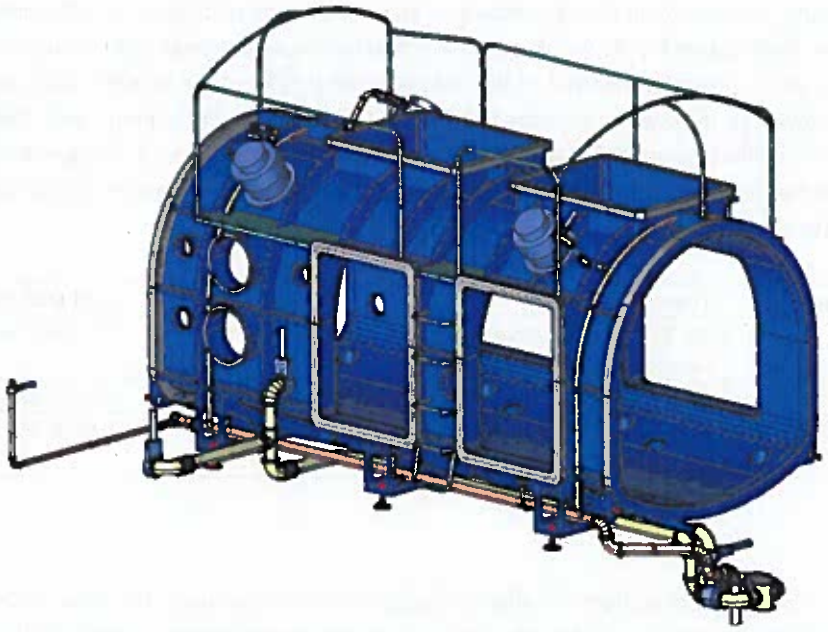


Figure 9: Layout of connection of the compressor chamber to primary vacuum circuits provided centrally by the facility (yellow: roughing vacuum, orange: backing vacuum).

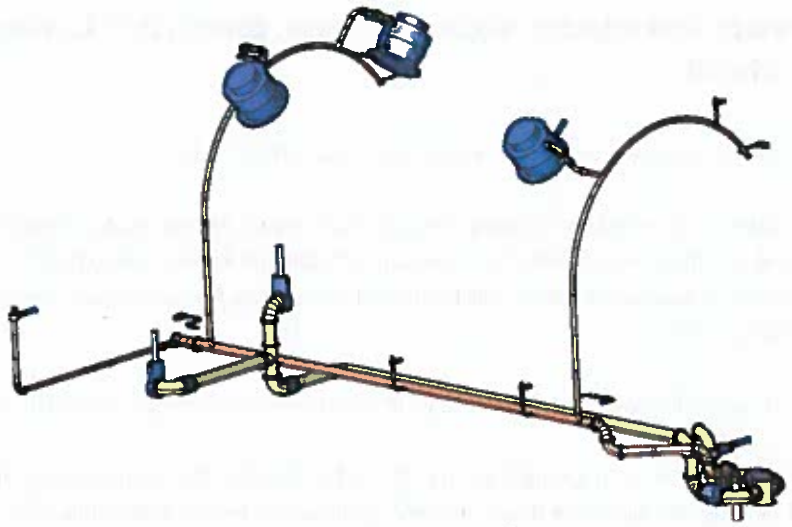


Figure 10: Primary vacuum distribution to the compressor (in yellow: roughing circuit, in orange: backing circuit). Detailed design, manufacture and integration of this primary vacuum circuit shall be included in the delivery within this contract.

The compressor chamber will use vacuum flanges of the DN ISO-K standard, sealed by Viton fluoroelastomer O-rings. The large access ports D1 to D8, i.e. end doors, rectangular ports on the chamber sides, and doors /hatches on top of the chamber, will use a double O-ring (Viton fluoroelastomer) seal arrangement. While the conceptual design developed by ELI-Beamlines fully takes into account the double O-ring arrangement, its detailed design shall be elaborated by the Supplier.

A block scheme of the vacuum circuit of the compressor chamber is shown in Figure 11. All elements indicated in this scheme, except the DN400 valve No. 34 which is a contractual option, and the valves indicated in yellow which will be provided by FZU to the Supplier by month 4 of the contract (these valves have recently been procured from VAT by FZU, see table below), are included in the basic scope of the contract. The scheme also involves the associated segment of the ELI-Beamlines primary vacuum, which will be controlled by the L3 ELI-Beamlines facility controls; it further involves elements of the beam injector unit which provides interface between the compressor (PCS) and the downstream facility systems.

Valve No in the scheme	Type description	VAT Ordering number
3, 4, 27	DN100 HV gate valve, pneumatic, end position switches	1040-PE44
8, 9, 10, 25	DN50 HV gate valve, pneumatic, end position switches	01234-KA44
11, 12, 13, 14, 15, 16, 17, 18	DN25 HV angle valve, pneumatic, end position switches	26428-KE41

Table 1

The compressor can be fully isolated from the adjacent vacuum systems by valves. The valve (23) between the compressor (PCS) and beam injector and the valve (34) between the beam injector and the facility downstream systems are important elements of the compressor machine safety. The valve (34) constitutes a critical interface between the L3 laser and other facility system.

The compressor will be equipped by a redundant set of vacuum gauges (gauge units (19) and (20); one of the sensors will involve Bayard-Alpert ionization gauge due to its inherent precision at low pressures. For comparative

measurements the compressor vacuum system will also involve a manually controlled valve providing calibrated leak rate of $1x10^{-8}$ mbar l/s, mounted on a DN 25 ISO-KF flange.
The vacuum cleanliness in the compressor will be on-line monitored by a COTS compact quadrupole mass spectrometer, providing the partial pressures of vacuum residuals including water vapour, hydrocarbons and volatile organic compounds. Readout of this spectrometer will be an important element of compressor machine safety.

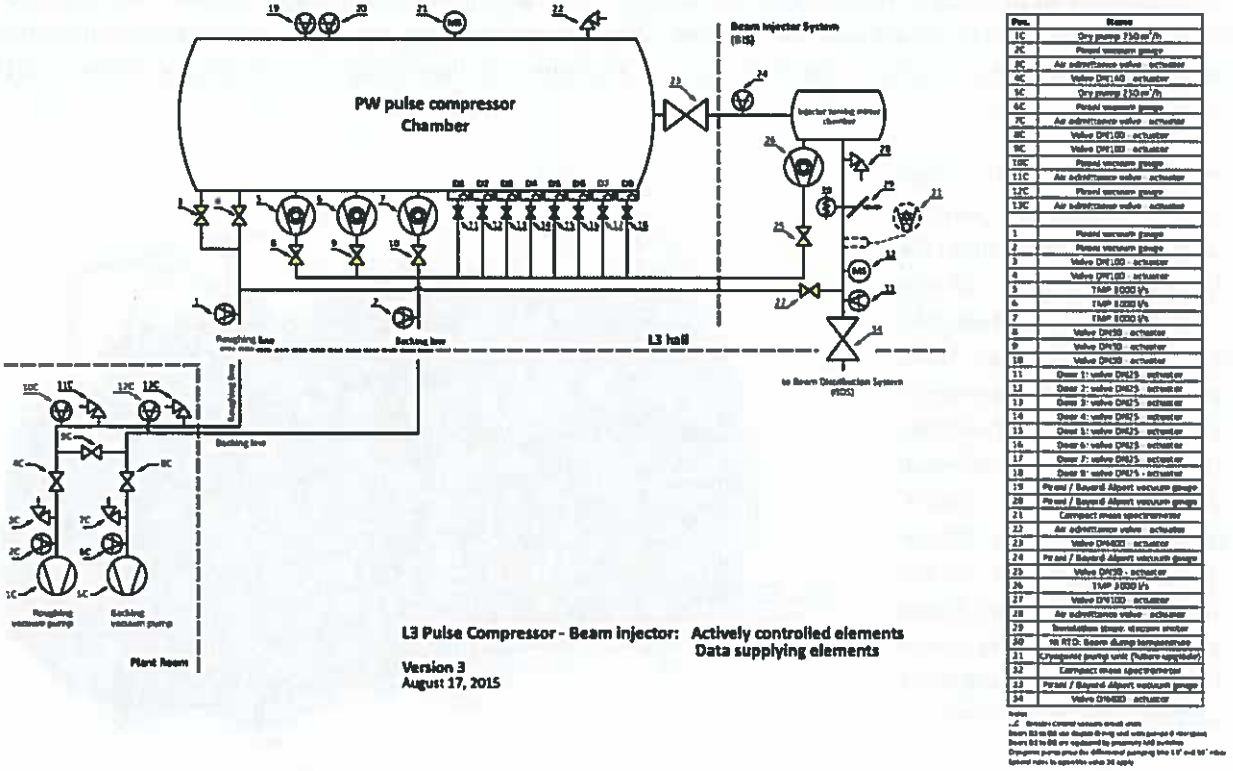


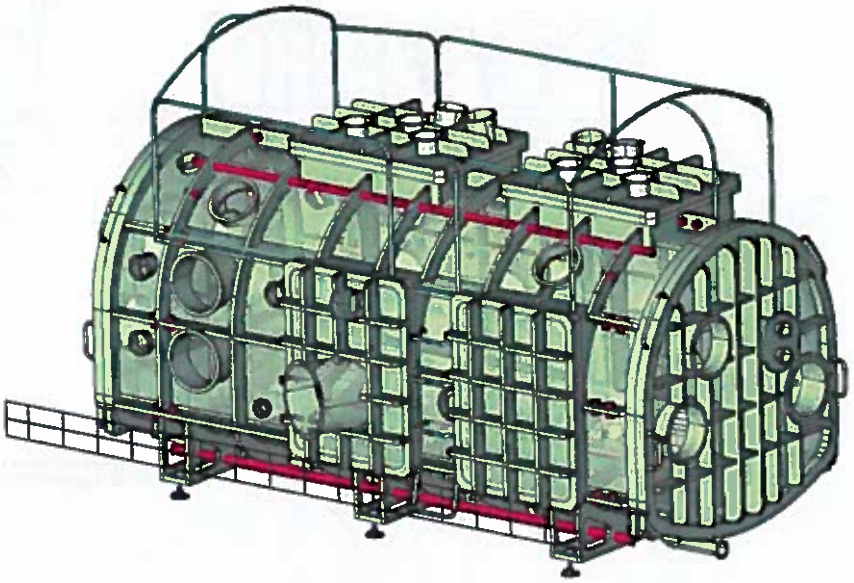
Figure 11: Block scheme of the compressor and beam injector vacuum circuit. Elements of the primary central vacuum outside the L3 hall (denoted in the scheme as "Plant Room") and the vacuum lines up to the floor level of the L3 hall are not included in the delivery. The VAT valves indicated in yellow will be provided by FZU to the Supplier.

2.6. Cable trays

The Supplier shall develop conceptual design, including location, of both external and internal cable trays.

The internal (vacuum) cable trays will serve to arrange cables from the motorized actuators of the individual optomechanics to the vacuum feedthroughs (see Section 2.10, Vacuum flange Schedule). The cable trays should be preferentially attached to the vacuum chamber body; if necessary these trays can also be attached along the optical table and/or its support structure. The trays must be accessible and their design must avoid any cavities and/or trapped volumes of air.

The external cable trays will serve to arrange the cables of motorized actuators from the feedthroughs (see Section 2.10, Vacuum flange Schedule) to the control rack. These external trays will also serve to arrange control and feedback-signal cables of the individual vacuum elements (valves, gauges, TMPs, etc.), and to distribute pressure air for the vacuum valve actuators. Finally a separate simple tray should be designed to distribute cooling water for the TMPs.



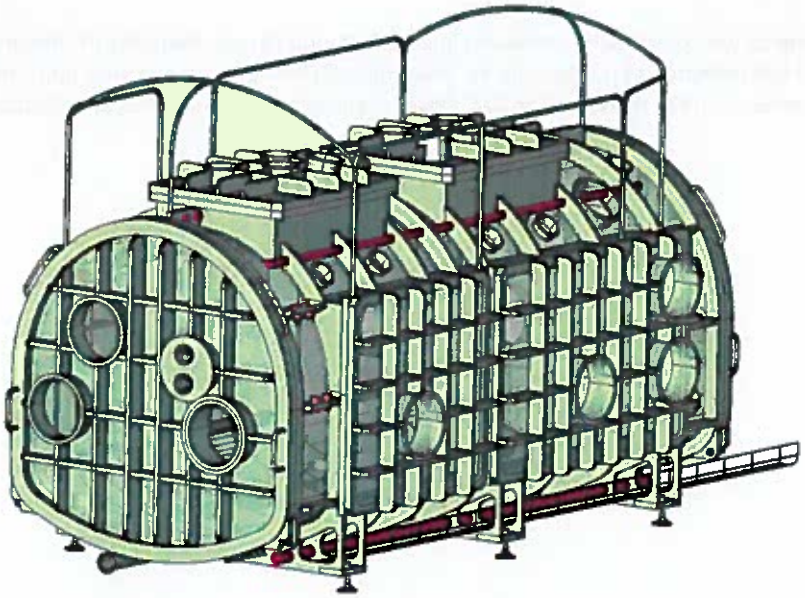


Figure 12: Suggested external cable trays and routes on the compressor chamber surface. The collecting electrical cable trays are suggested to be lead near the bottom of the chamber.

2.7. Vacuum Control System

The compressor and beam injector control system shall handle the local vacuum system control and optomechanical motion control, and the two functions will be segregated. The compressor control system shall also implement internal state machine sequencing and interface to machine safety. The controller will port process variables to the L3 laser SCADA interface. The vacuum control system will also provide for safe response to specific events such as vacuum pump failure and generic faults such as loss of electrical power. The BIS final output vacuum valve doubles as a protection device in case of failure of the PW beam dump diverting mirror. Therefore special consideration shall be given to the implementation of the closed detection of this valve, including provision of at least six redundant contacts for various safety systems.

The vacuum control system (VCS) shall be completely integrated using a Real-Time controller of type RMC-8354 (or functionally equivalent) and programmed in LabVIEW, which is the programming language used in the control system of the entire L3-HAPLS laser. Local display of VCS state, pressure, etc., shall be provided by two touch-panel PCs, one located on or very near the main compressor chamber and one inserted into the front panel of the control cabinet located along the wall of the laser hall. The touch panel PCs shall communicate with the RMC-8354 only and not directly with any other devices. The RMC-8354 controller, the associated network hardware, and a software implementation template shall be provided by IoP and delivered to the supplier prior to the end of D2. Vacuum device interface shall be based on a low-level implementation (PLC-style) but integrated with a National Instruments RIO controller with programmable FPGA, selected from the Approved Devices list. Higher-level device interface via serial and Ethernet may be direct to the Real-Time controller. However, all required devices must have a low-level interface for sequencing and machine protection purposes in addition to any high-level interface used.

The RIO platform shall be closely integrated with machine protection functions and is required to perform logical consistency checks on all vacuum states, valve positions, and pressure readings, providing permission for certain vacuum state transitions in the form of the current supply for solenoid actuators and TMP activation. It also should react to effect shut down of the laser in case of vacuum failure. The VCS shall interface to the external laser machine safety system (MSS). This interface shall be based on three simple permissions (Rough, High, Vent), and three status outputs (Rough vacuum State, High vacuum State and Vented State), corresponding to the VCS states of the compressor and BIS separately. The FPGA-based vacuum state machine and sequences, implemented on the RIO controllers, shall be regulated by the granting of the appropriate permission and reported by signaling the appropriate state. The unexpected removal of a permission is equivalent to an external interlock and the VCS shall act accordingly (usually by sealing off the chamber and going to a safe state). The FMEA shall address this behaviour and shall dictate the chosen solution as the necessary mitigation. General outputs "Compressor VCS MSS Fault" and "BIS VCS MSS Fault" are further used to signal a detected critical alarm (e.g., device over-temperature) and general input "Compressor VCS MSS Enable" and "BIS VCS MSS Enable" are used to optionally inhibit these alarms. This behaviour is independent of the permissions and status output functionality.

Compliance of the VCS solution with the following diagrams is a binding requirement. They show the required control system architecture, including the list of required control points (as a minimum – supplier may add additional control points so as to meet all other system requirements). Implementation requirements are shown in text notes in the diagram. Many control system hardware items in the diagram are required to be chosen from the Approved Devices list. If the Device Type name given in this diagram matches an item in the Approved Devices list, only the preferred devices or an equivalent alternative explicitly approved by IoP shall be used to provide this functionality. The exact number of FPGA controllers, terminals, interfaces, Ethernet ports and serial interfaces used is not important as long as all minimum and any additional control points are fully integrated and all other requirements are satisfied.

The compressor shall include an in-situ contamination monitoring system in the form of Thermoelectric Quartz Crystal Microbalance (TQCM) sensors. These measure the mass deposition due to vacuum contaminants using a cooled

surface and precision resonance-based mass measurements. The TQCMs are located close to the grating surface to provide an accurate estimate of the deposition rate on the grating. The readings from these sensors combined with the residual gas analysis shall be used to inform a machine protection based on grating contamination – if the vacuum is contaminated this shall be signalised as an MSS fault and the L3-HAPLS laser will cease operation. An in-site RF plasma cleaning system consisting of up to two RF electrodes shall also be provided. The specifics of this system are still to be determined and the supplier shall discuss the options with IoP before undertaking its design or implementation.

The system for cryopanel cooling is a later upgrade. The control system shall have sufficient spare design capacity for its control points. Other control points denoted by dashed or dotted lines are similarly to be prepared only for capacity and not for implementation for this phase of the project.

All vacuum control electronics represented between the blue dashed and red dashed lines shall be mounted in a single control cabinet of dimensions (depth 0.4m, width 0.6m, height 2m – Rittal TS 8604.500 or approved alternative) located along the wall of the laser hall. All cabling between the chambers and the cabinet shall be via the floor channel. All cables used to connect vacuum devices to the cabinet shall be shielded and have an appropriate jacket colour – grey or black for general signals, blue for machine safety interlock signals, yellow or orange for personnel safety interlock signals, with other colours for earth and mains voltage per the usual standards.

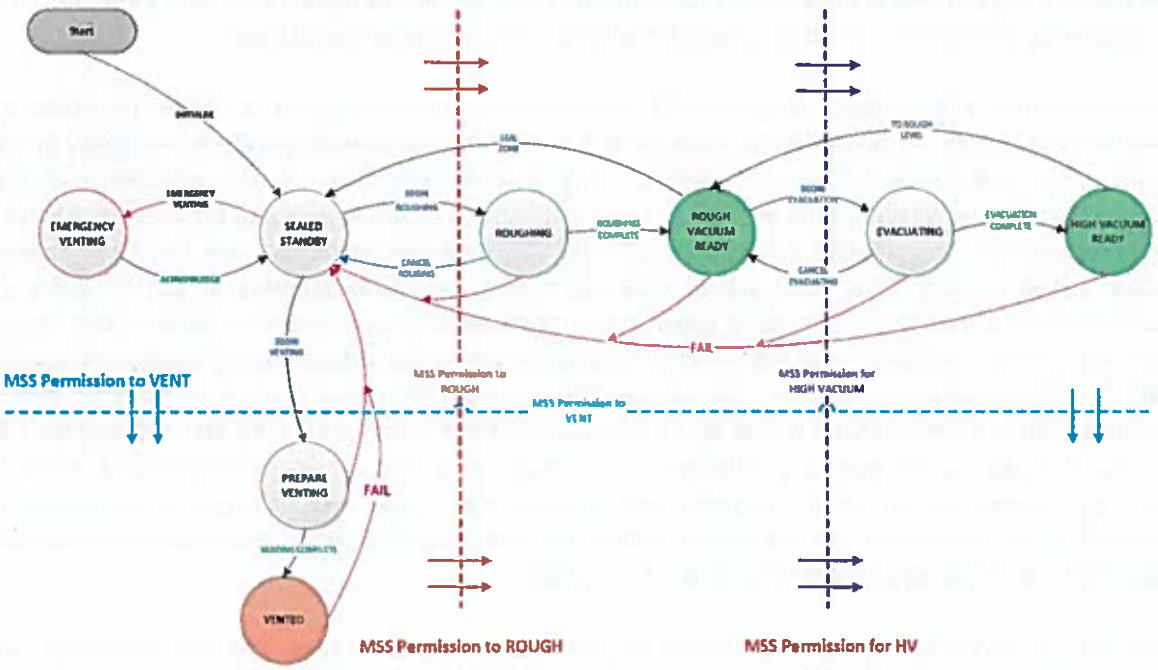


Figure 13: State diagram for compliance of the VCS with the compressor concept of operations and the MSS of the L3-HAPLS system.

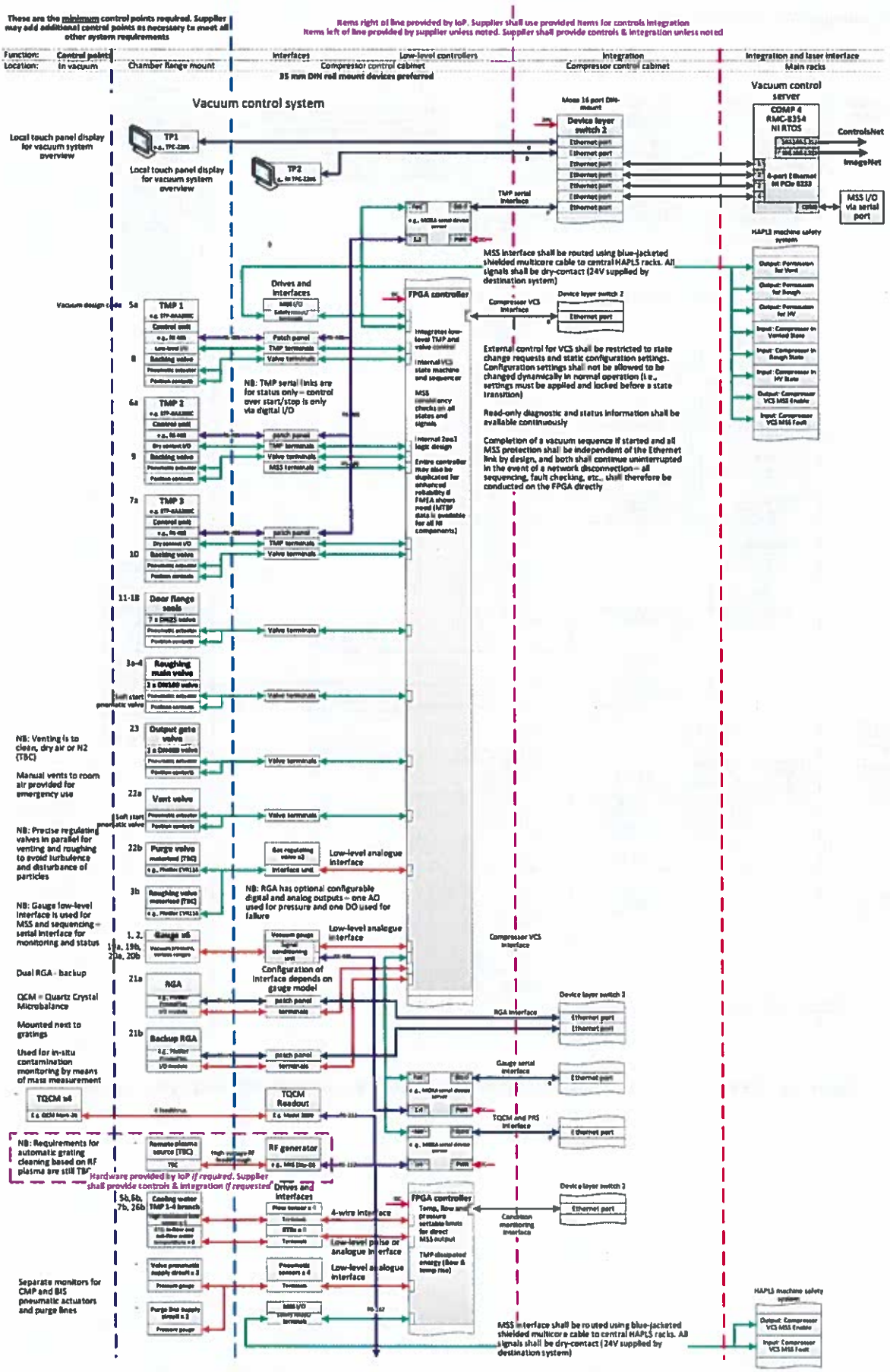

There are the minimum control points required. Supplier may add additional control points as necessary to meet all other system requirements
Items right of line provided by IoP. Supplier shall use provided items for controls integration
Items left of line provided by supplier unless noted. Supplier shall provide controls & integration unless noted
Function:
Location:
Control points in vacuum
Chamber flange mount
Interfaces
Compressor control cabinet
35 mm DIN rail mount devices preferred
Low-level controllers
Integration
Compressor control cabinet
Integration and laser interface
Main racks
Vacuum control system
Vacuum control server
COMP 4 RMC-8354 NI RTOS
Mezz 16 port DIO-mount
Device layer switch 2
ControlsNet
ImageNet
MSS I/O via serial port
HAPLS machine safety system
Local touch panel display for vacuum system overview
TP1
TP2
TMP serial interface
MSS interface shall be routed using blue-jacketed shielded multicore cable to central HAPLS racks. All signals shall be dry-contact (24V supplied by destination system)
Drives and interfaces
FPGA controller
Compressor VCS interface
External control for VCS shall be restricted to state change requests and static configuration settings. Configuration settings shall not be allowed to be changed dynamically in normal operation (i.e., settings must be applied and locked before a state transition)
Read-only diagnostic and status information shall be available continuously
Completion of a vacuum sequence if started and all MSS protection shall be independent of the Ethernet link by design, and both shall continue uninterrupted in the event of a network disconnection – all sequencing, fault checking, etc., shall therefore be conducted on the FPGA directly
Vacuum design case
5a
TMP 1
8
6a
TMP 2
9
7a
TMP 3
10
NB: TMP serial links are for status only – control over start/stop is only via digital I/O
11-18
Door flange seals
3a-4
Roughing main valve
Soft start pneumatic valve
23
Output gate valve
22a
Vent valve
22b
Purge valve motorised (TBC)
3b
Roughing valve motorised (TBC)
1, 2, 19a, 19b, 20a, 20b
Gauge x6
21a
RGA
21b
Backup RGA
TQCM x4
TQCM Readout
Low-level analogue interface
Configuration of interface depends on gauge model
RGA has optional configurable digital and analog outputs – one AO used for pressure and one DO used for failure
RGA interface
Gauge serial interface
TQCM and PRS interface
NB: Venting is to clean, dry air or N2 (TBC)
Manual vents to room air provided for emergency use
NB: Precise regulating valves in parallel for venting and roughing to avoid turbulence and disturbance of particles
NB: Gauge low-level interface is used for MSS and sequencing – serial interface for monitoring and status
Dual RGA - backup
QCM = Quartz Crystal Microbalance
Mounted next to gratings
Used for in-situ contamination monitoring by means of mass measurement
NB: Requirements for automatic grating cleaning based on RF plasma are still TBC
Remote plasma source (TBC)
RF generator
Hardware provided by IoP if required. Supplier shall provide controls & integration if requested
5b, 6b, 7b, 26b
Cooling water TMP 1-3 branch
4-wire interface
Low-level pulse or analogue interface
Low-level analogue interface
Separate monitors for CMP and BIS pneumatic actuators and purge lines
Candidate monitoring interface
MSS interface shall be routed using blue-jacketed shielded multicore cable to central HAPLS racks. All signals shall be dry-contact (24V supplied by destination system)

Figure continued from previous page

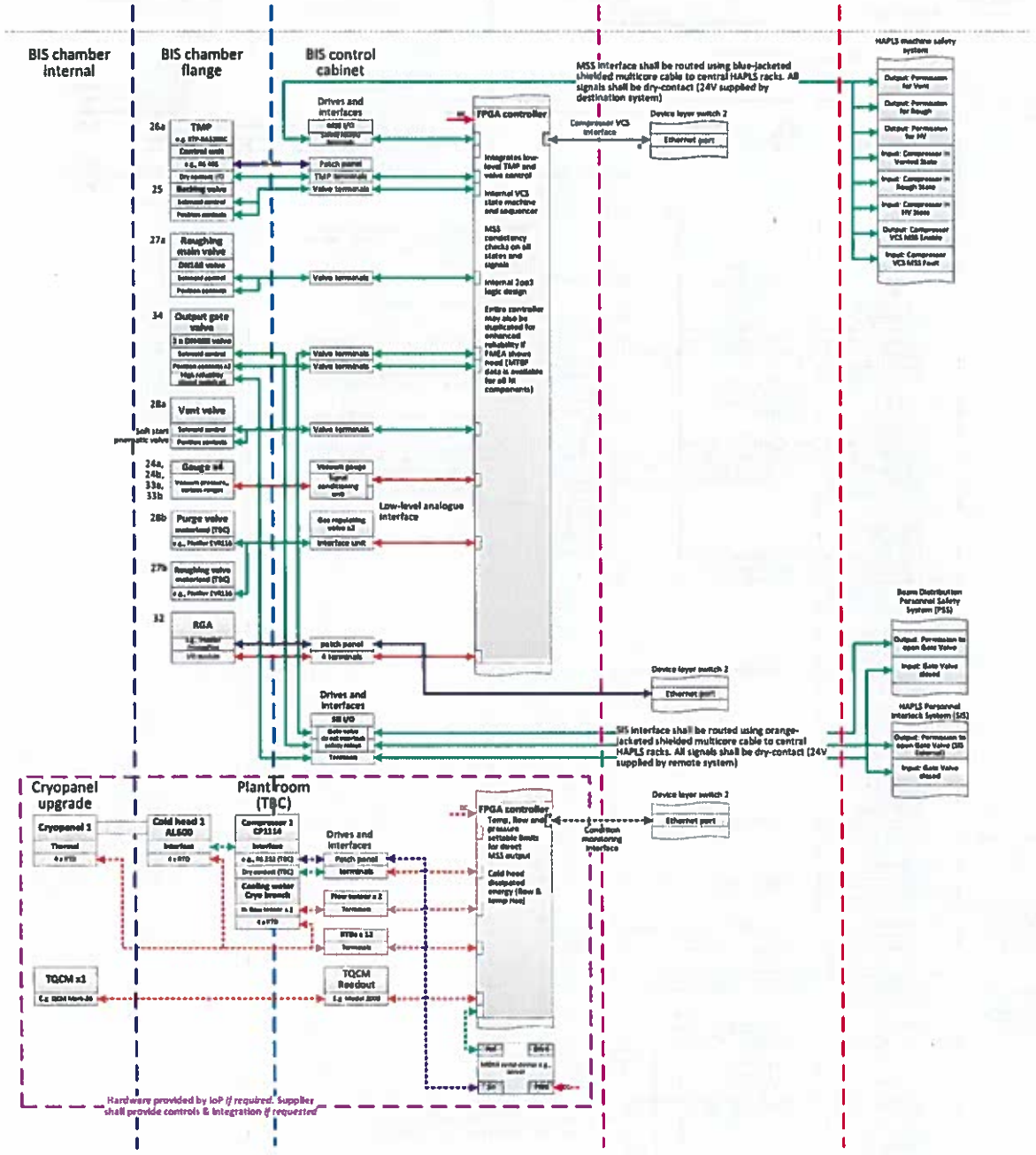


Figure 14: VCS architecture and implementation compliance diagram to be followed by the supplier.

2.8. Optomechanical mounts and motion control system

Figure 15 shows the optomechanical structures including high-precision optical mounts to be supplied within the present contract. There are four optomechanical assemblies OM1 to OM4 in the compressor each to position specific optics and involving either manual or electrical actuators; in the Beam Injector there are two additional optomechanical units IOM1 and IOM2.

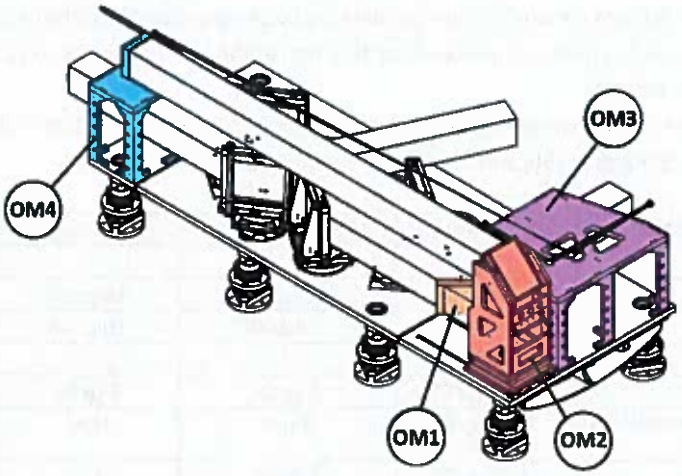


Figure 15: Compressor optomechanical positioning systems sitting on the optical table, required to be supplied within the contract.

OM1: Optomechanical mount to position single mirror with size approx. 270x415x70 mm^3

OM2: Optomechanical assembly to position two mirrors– periscope with approx. size 400x270x70 mm^3 each

OM3: Optomechanical assembly and mount to position specific high--precision curved mirror with size approx. 40x40 mm^2

OM4: Optomechanical assembly and mount to position specific high--precision curved mirror with size approx. 275x275 mm^2

IOM1: Optomechanical mount to position single mirror with size approx. 270x415x70 mm^3

IOM2: Optomechanical assembly to position, over a large travel distance (approx. 400 mm), single mirror with size approx. 270x415x70 mm^3

Conceptual drawings of the individual mounts are included in the drawing package to this document.

All axes of the optomechanics OM1, OM2, OM4, IOM1, and whenever possible in OM3, which are to be motorized (see Tables 2 and 3 below) shall be equipped by position readout systems (encoders) and by end switches. The actuators used in the conceptual design and represented in the drawings are for illustration only.

The optomechanics must allow mounting the optics with the dimensions as indicated above; the Client reserves the right to modify the indicated dimensions of the optics by +/-20mm by Month 2 of the contract. Details of the interfaces mounts-optics will be agreed between the Client and the Supplier during fulfilment of the contract, no later than by Month 4 of the contract.

The supplier is required to:

- Develop detailed design of the individual optomechanics, based on the provided conceptual drawings
- Develop design of attachment of the optomechanics to the respective optical tables; the solution should ideally use brackets not extending the optomechanics' footprint on the table
- Identify and implement suitable actuators meeting the positioning requirements (see Tables 2 and 3)
- Develop detailed design of the local elevated optical benches supporting the optomechanics OM3 and OM4, based on the provided conceptual drawings; the design should feature maximum clearance
- Design and manufacture a mounting device allowing to pre-position the optomechanics on the optical table and bolt it there, with a precision better than ±0.5 mm in the two horizontal axes and with angular precision of better than ±1 degree
- The designed method of positioning of the optomechanics, especially OM1 and OM2, on the optical table must avoid scratching the table surface during the mounting.

Optomechanical mount No.	Range	Resolution [1]	Accuracy [2]	Actuator type
OM1				
Yaw	±2°	0.5 µrad	10 µrad	Stepper motor
Pitch	±1°	0.5 µrad	10 µrad	Stepper motor
OM2 (periscope tower)				
Yaw of the tower	±0.5°	2 µrad	5 µrad	Stepper motor
Translation x (horizontal) of the tower	±5 mm	5 µm	N.A.	Manual actuator
Mirror 1 (lower) yaw	±1°	4 µrad	N.A.	Manual actuator
Mirror 2 (lower) pitch	±1°	4 µrad	N.A.	Manual actuator
Mirror 2 (upper) yaw	±1°	2 µrad	4 µrad	Stepper motor
Mirror 2 (upper) pitch	±1°	2 µrad	4 µrad	Stepper motor
OM3				
Yaw	±2°	4µrad	20 µrad	Stepper motor or piezo
Pitch	±2°	4 µrad	20 µrad	Stepper motor or piezo
Roll	±5°	10 µrad	20 µrad	Stepper motor or piezo
Translation x (horizontal)	±5 mm	5 µm	10 µm	Stepper motor
Translation y (horizontal)	±5 mm	5 µm	10 µm	Stepper motor
OM4				
Yaw	±2°	1 µrad	5 µrad	Stepper motor or piezo
Pitch	±1°	1 µrad	5 µrad	Stepper motor or piezo

Table 2: Compressor optomechanics

Optomechanical mount No.	Range	Resolution [1]	Accuracy [2]	Actuator type
IOM1				
Yaw	±1°	0.5 µrad	2 µrad	Stepper motor
Pitch	±1°	0.5 µrad	2 µrad	Stepper motor
IOM2 (diverting mirror)				
Translation between two fixed positions	400 mm	0.5 mm	end switch	Stepper motor Insertion/removal time ≤ 5 second
Yaw	±2°	1 mrad	N.A.	Manual actuator
Pitch	±2°	1 mrad	N.A.	Manual actuator

Table 3: Beam injector optomechanics

[1] *One incremental step of motorized actuator; one graduation of fine adjustment scale for micrometric screw*
[2] *Absolute position knowledge by encoder readout, bidirectional repeatability for motions without encoder*

Note to Tables 2 and 3:

Yaw: rotation around the vertical axis
Pitch: rotation around the horizontal axis parallel to the mirror surface
Roll: rotation around the horizontal axis perpendicular to the mirror surface

Optomechanical mount No.	Range	Resolution [1]	Accuracy [2]	Actuator type
GR1				
Yaw	±90°	0.5 µrad	1 µrad	Stepper motor
Pitch	±1°	1 µrad	2 µrad	Stepper motor
Roll	±1°	0.5 µrad	1 µrad	Stepper motor
GR2				
Translation	200 mm	0.5 µm	1 µm	Stepper motor
Yaw	±2°	0.5 µrad	1 µrad	Stepper motor
Pitch	±1°	1 µrad	2 µrad	Stepper motor
Roll	±1°	0.5 µrad	1 µrad	Stepper motor
GR3				
Translation	200 mm	0.5 µm	1 µm	Stepper motor
Yaw	±2°	0.5 µrad	1 µrad	Stepper motor
Pitch	±1°	1 µrad	2 µrad	Stepper motor
Roll	±1°	0.5 µrad	1 µrad	Stepper motor
GR4				
Yaw	±90°	0.5 µrad	1 µrad	Stepper motor
Pitch	±1°	1 µrad	2 µrad	Stepper motor
Roll	±1°	0.5 µrad	1 µrad	Stepper motor

Table 4: Grating mounts (indicative and for information only - the mounts will be provided by IoP)

[1] *One incremental step of motorized actuator; one graduation of fine adjustment scale for micrometric screw*
[2] *Absolute position knowledge by encoder readout, bidirectional repeatability for motions without encoder*

2.8.1. Motion controls

A significant part of the control system is dedicated to precision closed-loop motion control. In order to make the motion controls fully compatible with the control system of the L3 laser the low-level integration controls shall be based on the National Instruments RIO platform that leverages FPGA-based feedback and distributed control architecture. The requirements and architecture of the motion control system are very similar to the VCS design. A single RMC-8354 (or a functional equivalent) acts as the integration platform and shall be provided by IoP. Low-level device interface, including closed-loop motion, is performed on a programmable FPGA target. Machine safety is integrated with the FPGA control layer for high reliability. Use of sequencing and permission signals protects from laser damage due to moving key optics when the laser is running at high power.

Compliance of the motion control solution with the following diagrams is a binding requirement. They show the required control system architecture, including the list of required control points (as a minimum – supplier may add additional control points so as to meet all other system requirements). Implementation requirements are shown in text notes in the diagram. Many control system hardware items in the diagram are required to be chosen from the Approved Devices list. If the Device Type name given in this diagram matches an item in the Approved Devices list, only the preferred devices or an equivalent alternative explicitly approved by IoP shall be used to provide this functionality. The exact number of FPGA controllers, terminals, interfaces, Ethernet ports and serial interfaces used is not important as long as all minimum and any additional control points are fully integrated and all other requirements are satisfied.

As represented in the diagram, motion controls shall be implemented both for the optomechanics included in the tender (Table 2 and Table 3) as well as for the four grating mounts. The grating mount motion control consists of closed loop control of either rotation or translation and small-angle yaw. Roll and pitch control is actively stabilised with reference to gravity using a high precision clinometer and as such does not need an additional absolute encoder. This same feedback is used on the beam injector turning mirror. Accelerometers with high sensitivity and a wide frequency response shall also be included in the controls to monitor vibration.

Optional optomechanical components and other components considered as an upgrade or to de-risk uncertainties, such as an insert-able back-reflecting rooftop mirror located between grating 2 and grating 3, alignment pinholes on the SDB and TDB beams will be provided by IoP if the necessity of their use becomes apparent. In this event, the Supplier shall provide control system integration for these items. The control system should have sufficient spare design capacity to accommodate these control points, however IoP will not be able to provide detailed specifications for all of these devices prior to the decision to include them in the system design.

A large number of individual temperature control points are required to be measured, including all stepper motor temperatures and the temperature of key optical components. Grating mounts shall be temperature monitored at the bezel close to the optic and on the outside of the frame in order to provide a differential comparison. For this reason class A or higher accuracy RTDs are required (1/10 DIN preferred). Where water cooling is employed, for example in the grating mounts or the PW beam dump, differential temperature measurement combined with a precision flow rate sensor shall be combined to estimate the dissipated energy – this calculation shall be done in the FPGA so as to provide a machine safety diagnostics.

RIO modules are available with comprehensive software development kits to interface e.g., the chosen absolute position encoders via the BiSS protocol. Motor interface shall be via universal step-direction control to allow stepper power drives to be easily exchanged or upgraded later to higher precision alternatives if required. This will be assessed using data collected from the position encoders in the testing phase. Due to interlock requirements, the stepper drives cannot use microstepping to increase static positioning precision, as a continuous holding current cannot be assumed (i.e., whole-step movements must be made). Ultra-high precision geared stepper motors are

therefore preferred. Piezo steppers (e.g., Picomotors) are not permitted to be used on the primary beam optics. Most axes are required to have absolute position encoders. Some axes are permitted to use a precision home reference instead where accuracy is less critical. Regardless of positioning requirements, all motors shall have basic leaf-type limit switches for protection. The PW beam dump diverting mirror requires very high reliability position detection, especially for the closed (diverted) position – this shall receive special consideration in the FMEA. In order to reach the required SIL-3 equivalent level of availability, redundant mechanical feedthroughs to at least two SIL-3 rated switches is required.

The Supplier shall develop a demonstrative GUI (Graphical User Interface) for controlling the individual actuators for alignment purposes and for configuring the parameters of closed-loop control. The GUI shall run on a Windows or Linux PC that is connected to the RMC-8354 platform (this is a headless server and has no user interface).

All motion control electronics represented between the blue dashed and red dashed lines shall be mounted in up to two bayed control cabinets of dimensions (depth 0.4m, width 0.6m, height 2m – Rittal TS 8604.500 or approved alternative) located along the south west wall of the laser hall. All cabling between the chambers and the cabinet shall be via the floor channel. All cables used to connect devices to the cabinet shall be shielded and have an appropriate jacket colour – black for DC power, grey for general signals, blue for machine safety interlock signals, yellow or orange for personnel safety interlock signals, and colours for earth and mains voltage per the usual standards. All wires crossing the purple dashed line require vacuum feedthroughs. These shall be implemented so that both in-air and in-vacuum connectors may be easily disconnected and reconnected from a flange-mount feedthrough without special tools. All cables routed inside the vacuum chamber shall be shielded and shall be verified for HV operation and low outgassing. Cables and connectors shall be not routed within line of sight of the grating front surfaces or those of the primary mirrors.

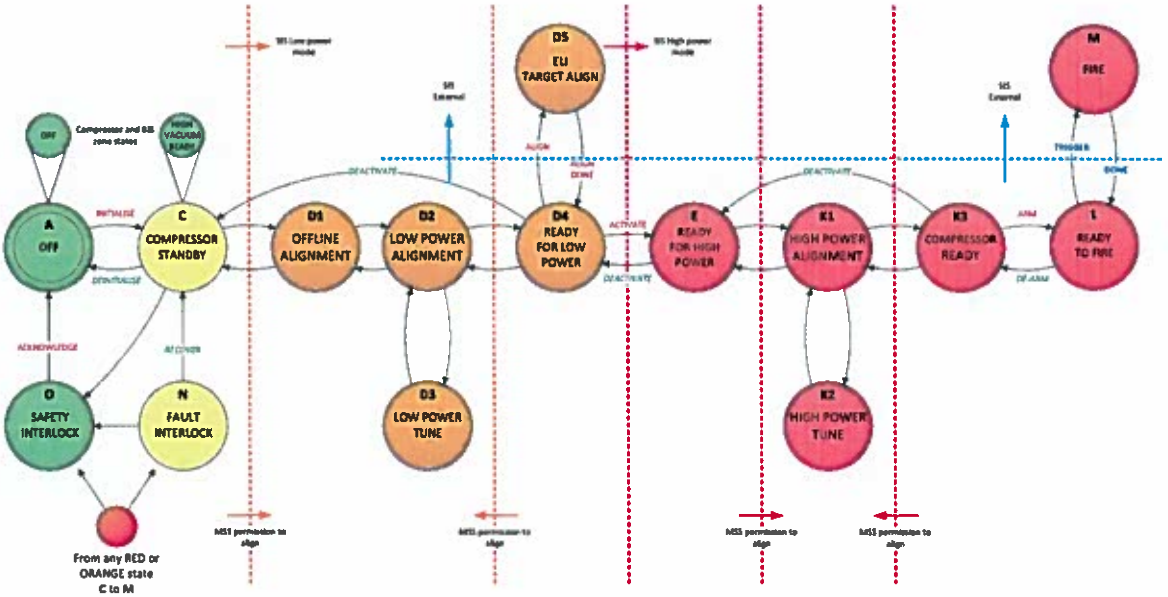
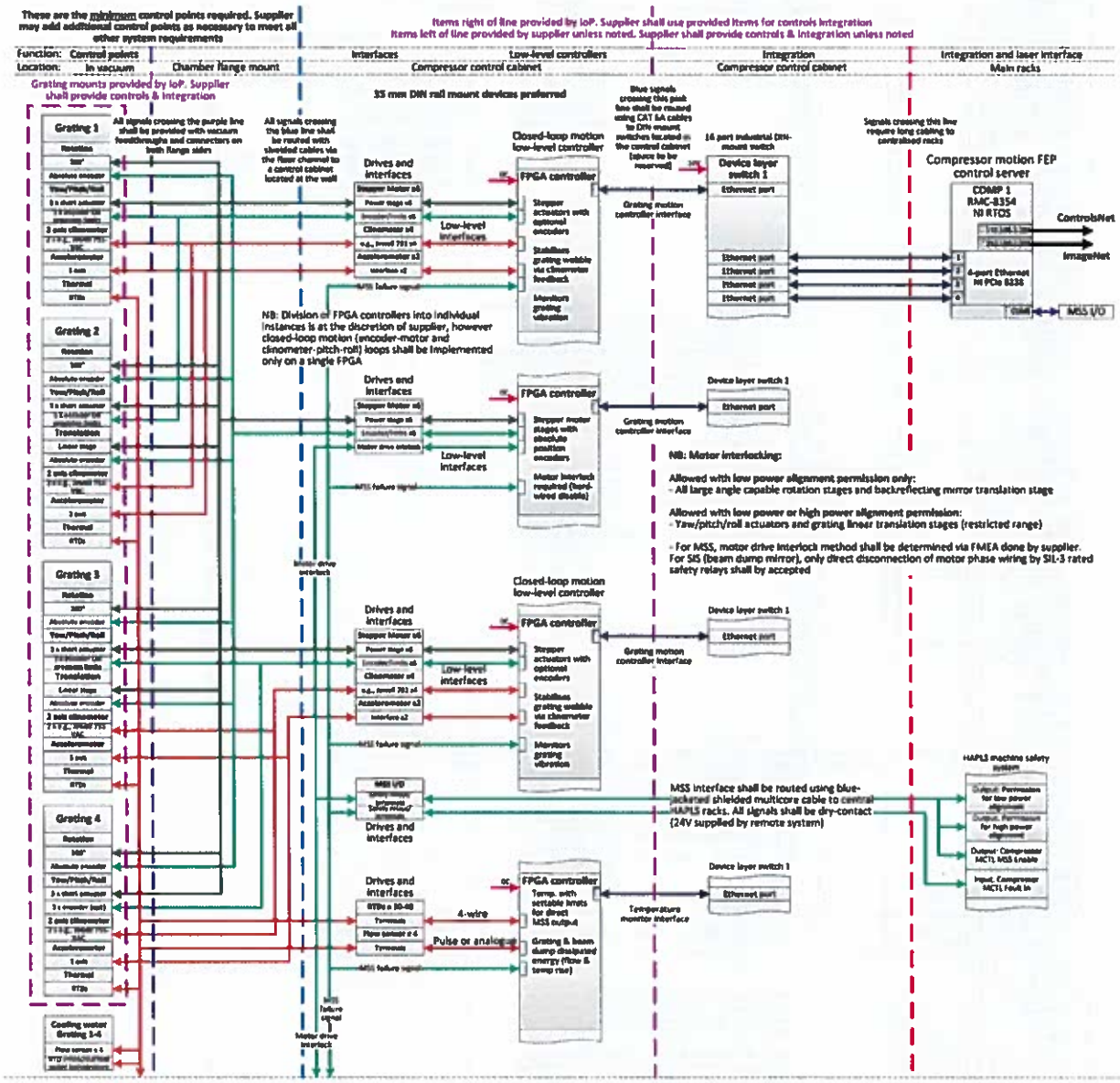


Figure 16: State diagram for compliance of the motion control system with the compressor concept of operations and the MSS of the L3-HAPLS system

There are 5 specific states to represent the compressor motion control processes which require the appropriate MSS permission signal:

- OFFLINE ALIGNMENT: Procedure consisting of rotating the gratings through large angles and optionally inserting an alignment back reflecting mirror. No light is allowed to propagate in compressor at this stage.
- LOW POWER ALIGNMENT: with L3-HAPLS in low power mode, short-pulse beam propagates through the compressor. During this state the TDB and SDB beams are aligned.
- LOW POWER TUNE: the low power mode short-pulse beam is used together with the TDB diagnostics to adjust the grating separation and other parameters in order to optimize the desired pulse length. During this phase grating roll & pitch are actively stabilised to compensate for stage runout.
- HIGH POWER ALIGNMENT: with L3-HAPLS in high power mode (with various power levels in accordance with the operating modes of the PAD/SPDP diagnostics), alignment of the gratings can be tweaked in a small range to optimize the TDB and SDB diagnostics. The range of adjustment is restricted to safe limits using a combination of hardware interlocks and software controls.
- HIGH POWER TUNE: the high power mode short-pulse beam is used together with the TDB diagnostics to tune the grating separation in a small range in order to re-optimize the desired pulse length. The range of adjustment is restricted to safe limits using a combination of hardware interlocks and software controls. During this phase grating roll & pitch are actively stabilised to compensate for stage runout.



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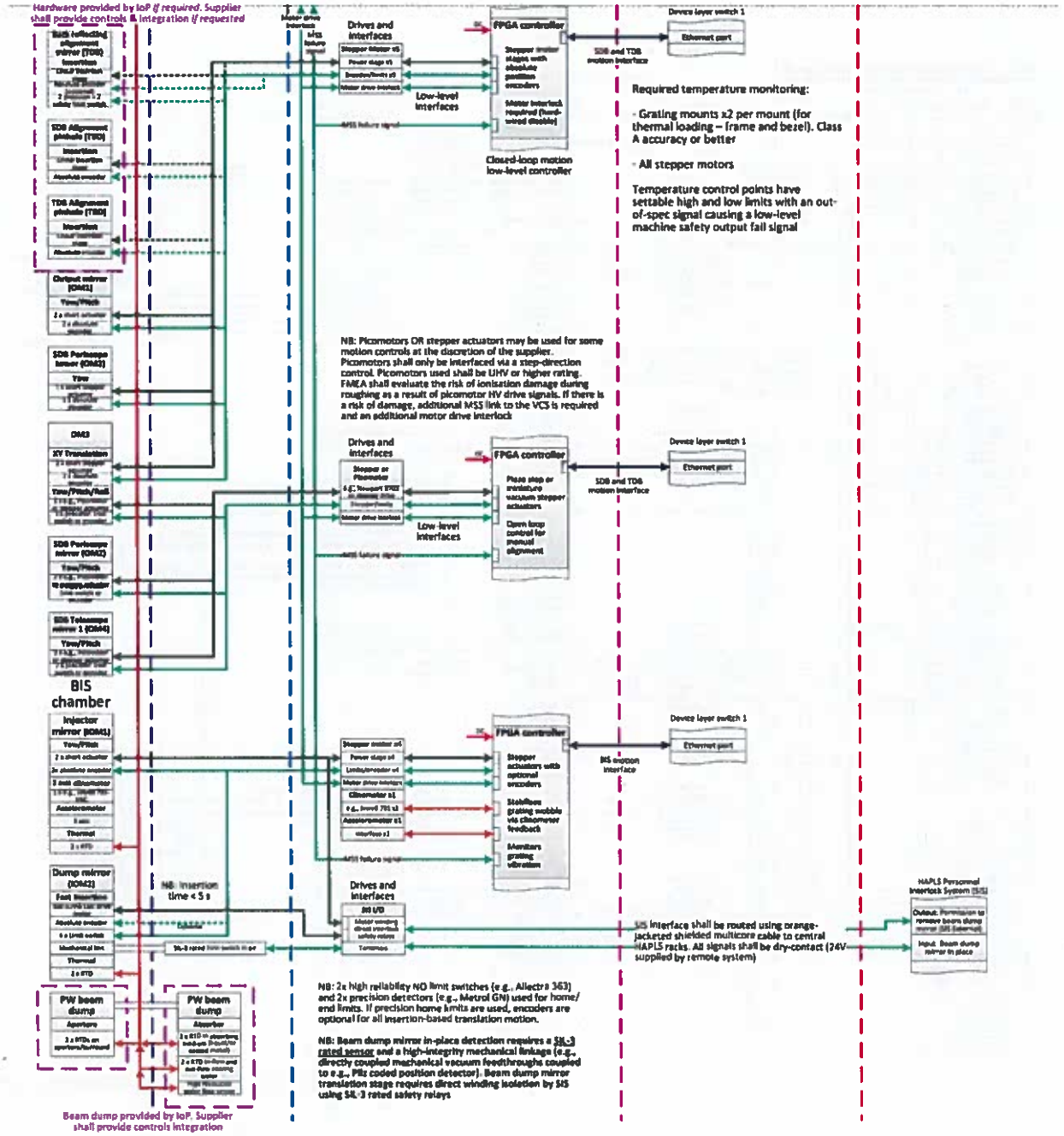

Figure 17: Motion control system architecture and implementation compliance diagram to be followed by the Supplier.

Devices not mentioned in this list may be freely selected by the supplier as necessary to satisfy all other requirements. To be approved, an alternative must have equivalent or better technical specifications or the Supplier must demonstrate that its specification is sufficient to satisfy all system requirements.

Device name	Preferred implementations	Other acceptable implementations
FPGA controller	NI 9149, NI 9147	NI 9144, NI cRIO-9066, any approved alternative
FPGA motor interface	SISU 1004, NI 9512	NI 9423 + NI 9474, any approved alternative
FPGA analogue input	NI 9239, NI 9220, NI 9234	Any approved alternative
FPGA RTD input	4-wire: NI 9216	Any approved alternative
FPGA accel. input	NI 9234	Any approved alternative
FPGA encoder input	SEA 9521	Any approved alternative
FPGA digital I/O	NI 9423 + NI 9474	NI 9477 + NI 9425, any approved alternative
Other FPGA I/O	Any NI-listed C-series module	Any approved alternative
Stepper motor power stage	Step-direction control: Phytron CLD+, Phytron CCD+	Phytron ZMX+, Phytron MSD, any approved alternative
Picomotor power stage	Step-direction control: Newport 8703	Any approved alternative
Clinometer	Jewell 755-VAC	Any approved alternative
Clinometer readout	Jewell 781	Any approved alternative
Accelerometer	PCB 356M98	Any approved alternative
Absolute encoder	Renishaw Resolute with BISS-C	Any approved alternative
Precision limit switch	Metrol GN	Any approved alternative
Protection limit switch	Allectra 363 or similar construction	Any approved alternative
Safety limit switch	Pilz PSEN cs2.2p connected directly to SIS system	Any approved alternative
TQCM	QCM Research Mark 20 with Model 2000 readout	Any approved alternative
Touch Panel PC	NI TPC-2230 12 inch	Any approved alternative

Table 5: Approved devices list.

2.9. Location of the compressor and beam injector in the ELI-Beamlines facility

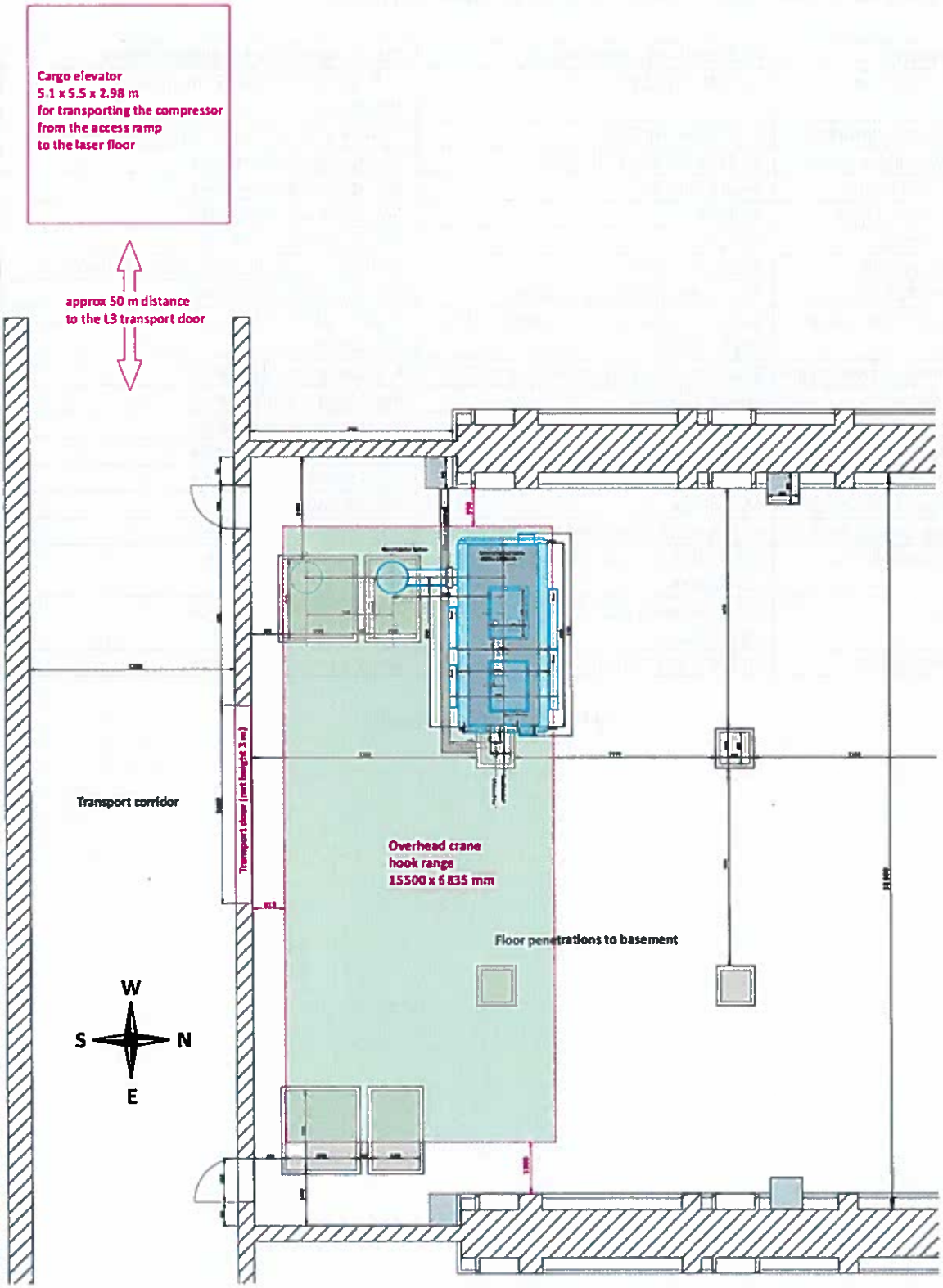

Figure 18: L3 hall of ELI-Beamlines, showing the transport corridor, distance to the transport cargo lift, area covered by the overhead crane (capacity 5 tons) and positions of the floor penetrations. The transport corridor is locally narrowed to 4.7 m by building technologies.

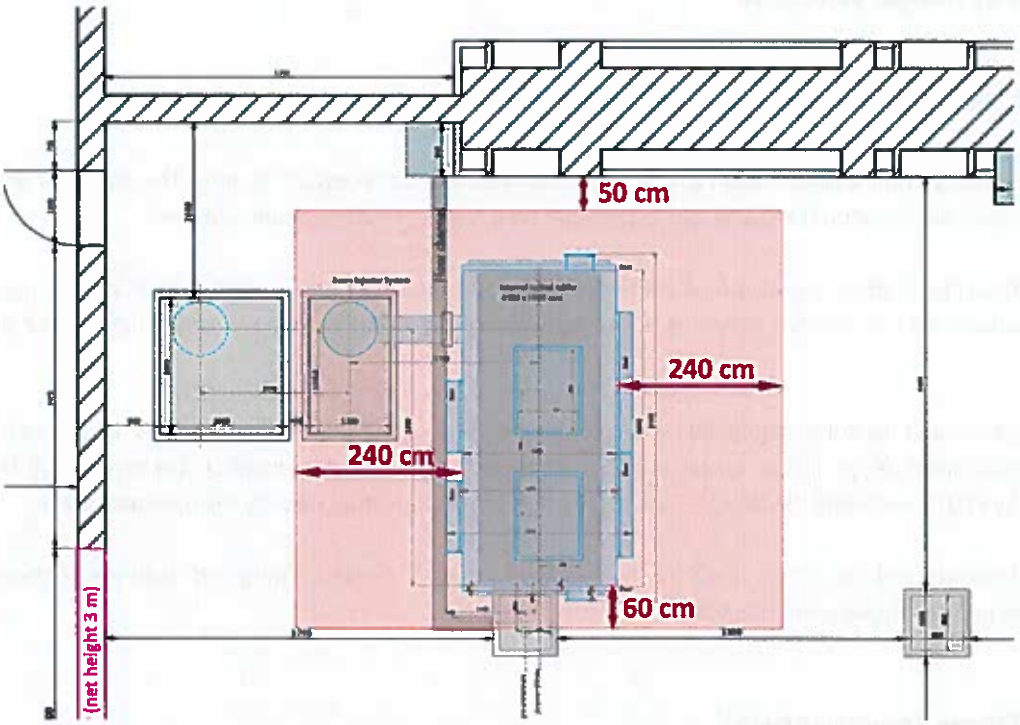

Figure 19: Designated zone for operation of the opening mechanisms of the end and side doors of the compressor.

2.10. Vacuum flange schedule

2.10.1. Chamber body

The chamber will be made from stainless steel grade 304L, with nominal thickness of 15 mm. The shape of the chamber and ribs provide high structural stiffness of the chamber with respect to atmospheric pressure.

End doors D1 and D2 will be lifted by the overhead crane, for which purpose they are equipped with lifting features. The lifting will be assisted by two persons providing a fine guidance of the door, via handles, while being lifted or lowering back.

The side doors D3, D4, D5 and D6 will be equipped by hinges and should be ideally opened without any assistance of the overhead crane. Detailed design of the hinges is asked from the Supplier of the chamber; the design will be subject to approval by FZÚ. If necessary the D3, D4, D5 and D6 doors can also be lifted clear by the overhead crane.

The top doors (hatches) D7 and D8 will be lifted by the overhead crane. If needed, lifting and lowering of these doors/hatches can be assisted by personnel standing on the footbridge.

2.10.2. Doors (access ports)

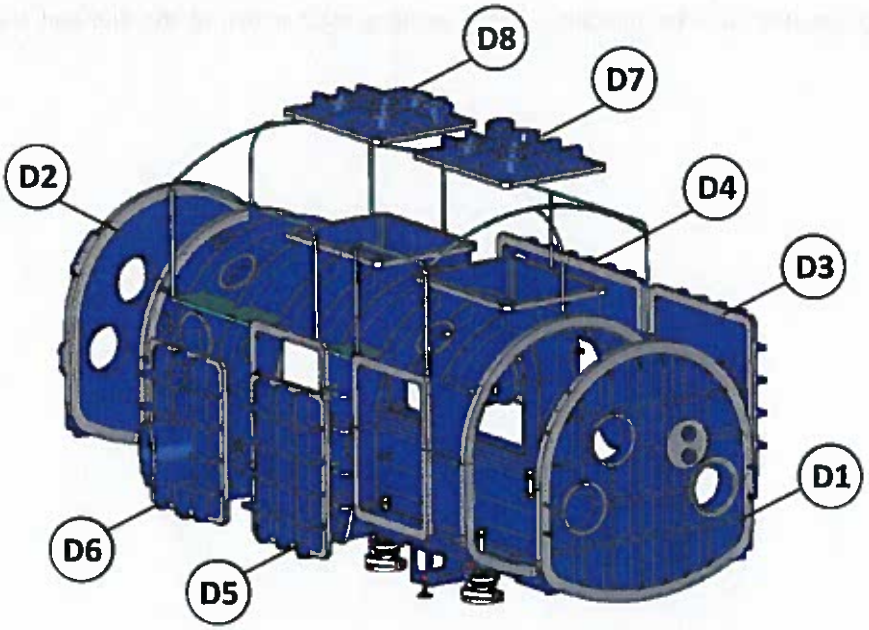

Figure 20: Axonometric view of the compressor showing the individual doors.

	Description / purpose	Size	Material	Mode of opening
D1	End door: compressor input, access to diagnostic beams optics	Chamber section shape, 2200 (w) x 2200 (h) mm outer size, clear opening 2000 (w) x 2000 (h), 15 mm thickness, ribbed	Stainless steel 304L	Overhead crane using lifting eyes. Fitted with handles for manual guidance.
D2	End door: access to diagnostic beams optics	Same as D1	Stainless steel 304L	Same as D1

D3	Side door, access to gratings #1 and #2	1480 (w) x 1410 (h) mm outer size, providing clear opening 1320 mm (w) x 1250 (h), 20 mm thickness, ribbed	Aluminium alloy *	Hinge (double hinge arrangement to avoid O-rings crushing); fitted with lifting eyes for initial installation by overhead crane.
D4	Side door, access to gratings #3 and #4	2070 (w) x 1410 (h) mm outer size, providing clear opening 1910 mm (w) x 1250 (h), 20 mm thickness, ribbed	Aluminium alloy *	Same as D3
D5	Side door, access to grating #2	1060 mm (w) x 1410 (h) mm outer size, providing clear opening 900 mm (w) x 1250 (h), 20 mm thickness, ribbed	Aluminium alloy *	Same as D3
D6	Side door, access to grating #3	1060 mm (w) x 1410 (h) mm outer size, providing clear opening 900 mm (w) x 1250 (h), 20 mm thickness, ribbed	Aluminium alloy *	Same as D3
D7	Top door (hatch), provides crane access to compressor interior for grating mounts installation	1360 mm (l) x 1060 (w) mm outer dimensions, providing clear opening 1200 (l) x 900 (w) mm, 20 mm thickness, ribbed	Aluminium alloy *	Overhead crane; fitted with lifting eyes for overhead crane.
D8	Same as D7	Same as D7	Aluminium alloy *	Same as D7.

Table 6

* Supplier of the chamber will be allowed to propose stainless steel for these doors provided that the solution is compatible with weight and maximum deformation requirements, and is vacuum compatible.

All doors D1 to D8 are vacuum sealed by using a double Viton fluoroelastomer O-ring seal arrangement minimizing effective gas load due to O-ring permeation, with the space between the O-rings actively pumped to ~10^{-2} mbar by the backing vacuum circuit. Arrangement of the tubes (diameter 12.5 mm) serving to active pumping of the space between the two O-rings shall be optimized by the Supplier during preparation of manufacturing drawings.

Flange Tolerance Grade	Tolerance Specification
A	Co-axial tolerance of ±1 mm or better and angular tolerance of ±0.5 degrees or better with respect to their ideal axis
B	Co-axial tolerance of ±3 mm or better and angular tolerance of ±2.0 degrees or better with respect to their ideal axis

Table 7: Flange Tolerance Grade

All hinges will be of double pivot arrangement to avoid crushing the O-rings when closing the door. The doors will be aligned by locating pins providing a guide for closing. The closure design will be developed in detail later by the supplier, based on requirement from IoP; in formulating these requirements IoP will capitalize on its experience with large hinged ports.

Upon removing the end doors D1 and D2 they will be parked and secured on stands fabricated from compatible metal profiles. The Supplier is requested to design, manufacture and deliver these stands.

2.10.3. Circular flanged ports

The chamber will be pumped by means of two primary roughing flanges, one located above the optical table (BF13) and one below the table (BF27), to balance pressure and accelerate the pump down.

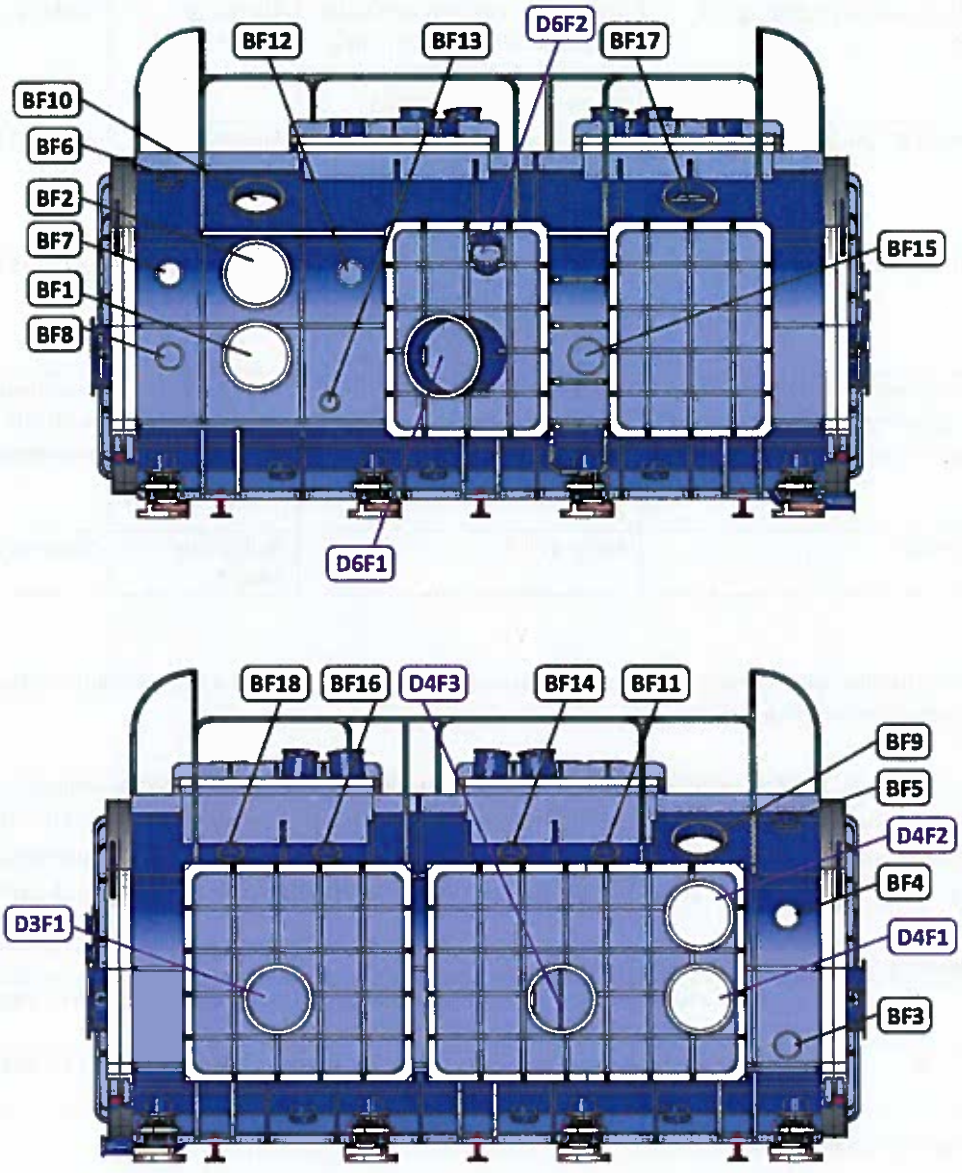

Figure 21: Side views of the compressor chamber from opposite sides.

All circular flanges in the list below are dimensioned according to the ISO-K standard and will be sealed by simple Viton fluoroelastomer O-rings. The Supplier may propose, in order to improve vacuum performance of the chamber, substituting some DN400 O-rings flanges by CF-type knife-edge flanges sealed by metal gasket. Flanges that can be equipped with the CF-type metal gasket are indicated in the below tables.

In addition to the doors there are in total 33 flanged ports on the chamber body (body flanges, BF). The table below describes the intent for using these ports during operation of the L3 laser. For works testing and delivery of the chamber to ELI-Beamlines by the supplier all flanges will be required to be blanked.

Flange	Size	Position / Purpose	Note	Tolerance	Seal type
CHAMBER BODY					
BF1	DN 400 ISO-K	Exit of the compressed L3 beam from the compressor	Fitted with pendulum HV valve	A	O-ring or metallic gasket
BF2	DN 400 ISO-K	Above BF1, spare for future upgradability.	Initially closed by blank flange	A	O-ring or metallic gasket
BF3	DN 160 ISO-K	Near the level of the internal optical table, spare flange for feedthroughs of electrical cables	Initially closed by blank flange.	B	O-ring
BF4	DN 160 ISO-K	Near top of the chamber, at approximately half chamber height, for general purposes	Initially closed by blank flange.	B	O-ring
BF5	DN 160 ISO-K	Near top of the chamber, for general purposes	Initially closed by blank flange	B	O-ring
BF6	DN 160 ISO-K	Accessible from the service footbridge, for RF electrode #1 for grating cleaning	Feedthrough type for the RF line TBD	B	O-ring
BF7	DN 160 ISO-K	Facing BF4, under the footbridge, for connection of a vacuum cleanliness monitor (mass spectrometer - quadrupole)	Will be equipped by a reduction flange to accommodate vacuum contamination detector.	B	O-ring
BF8	DN 160 ISO-K	Facing BF3 and near the level of the internal optical table, for chamber venting	Will be equipped by a reduction flange to accommodate the venting valve	B	O-ring
BF9	DN 320 ISO-K	Near top of the chamber, for TMP (3000 l/s)	TMP mounted for the test vacuum pumping	B	O-ring
BF10	DN 320 ISO-K	Near top of the chamber, accessible from the service footbridge, for TMP (3000 l/s)	TMP mounted for the test vacuum pumping	B	O-ring
BF11	DN 160 ISO-K	Above the door D4, for general purposes e.g. illumination; candidate for UV/ozone cleaning	Initially closed by blank flange	B	O-ring
BF12	DN 160 ISO-K	Under the footbridge, for general purposes	Can be equipped by viewing port / optical window	B	O-ring
BF13	DN 100 ISO-K	Near the level of the internal optical table, connection to the roughing vacuum line	Will be equipped by vacuum gate valve	B	O-ring
BF14	DN 160 ISO-K	Above the door D4, for general purposes e.g. illumination	Initially closed by blank flange	B	O-ring
BF15	DN 200 ISO-K	Between D5 and D6, for observation / visual inspection of the 1st grating	Can be equipped by viewing port / optical window	B	O-ring

Flange	Size	Position / Purpose	Note	Tolerance	Seal type
BF16	DN 160 ISO-K	Above the door D3, for general purposes e.g. illumination; candidate for UV/ozone cleaning	Initially closed by blank flange	B	O-ring
BF17	DN 320 ISO-K	Near top of the chamber, accessible from the service footbridge, for TMP (3000 l/s)	TMP mounted for the test vacuum pumping	B	O-ring
BF18	DN 160 ISO-K	Above the door D3, possible place for RF electrode #2 for grating cleaning	Feedthrough type for the RF line TBD	B	O-ring
BF19	DN 160 ISO-K	On chamber underside, for connection of bellows isolation of the internal optical table	Equipped during installation of the chamber in the L3 hall	A	O-ring
BF20	DN 160 ISO-K	Idem BF19	Idem BF19	A	O-ring
BF21	DN 160 ISO-K	Idem BF19	Idem BF19	A	O-ring
BF22	DN 160 ISO-K	Idem BF19	Idem BF19	A	O-ring
BF23	DN 160 ISO-K	Idem BF19	Idem BF19	A	O-ring
BF24	DN 160 ISO-K	Idem BF19	Idem BF19	A	O-ring
BF25	DN 160 ISO-K	Idem BF19	Idem BF19	A	O-ring
BF26	DN 160 ISO-K	Idem BF19	Idem BF19	A	O-ring
BF27	DN 100 ISO-K	On chamber underside, connection to the roughing vacuum line	Will be equipped by vacuum gate valve	B	O-ring
BF28	DN 160 ISO-K	On chamber underside, available for feedthroughs of electrical cables	Initially closed by blank flange	B	O-ring
BF29	DN 160 ISO-K	On chamber underside, available for feedthroughs of electrical cables	Initially closed by blank flange	B	O-ring
BF30	DN 160 ISO-K	On chamber underside, available for feedthroughs of electrical cables	Initially closed by blank flange	B	O-ring
BF31	DN 160 ISO-K	On chamber underside, for feedthroughs of electrical cables from optomechanical mounts	Will be equipped by cable feedthroughs	B	O-ring
BF32	DN 160 ISO-K	On chamber underside, for feedthroughs of electrical cables from grating actuators	Will be equipped by cable feedthroughs	B	O-ring
BF33	DN 160 ISO-K	On chamber underside, for feedthroughs of electrical cables from grating actuators	Will be equipped by cable feedthroughs	B	O-ring

Table 8: Chamber body; Position and tolerance of flanges

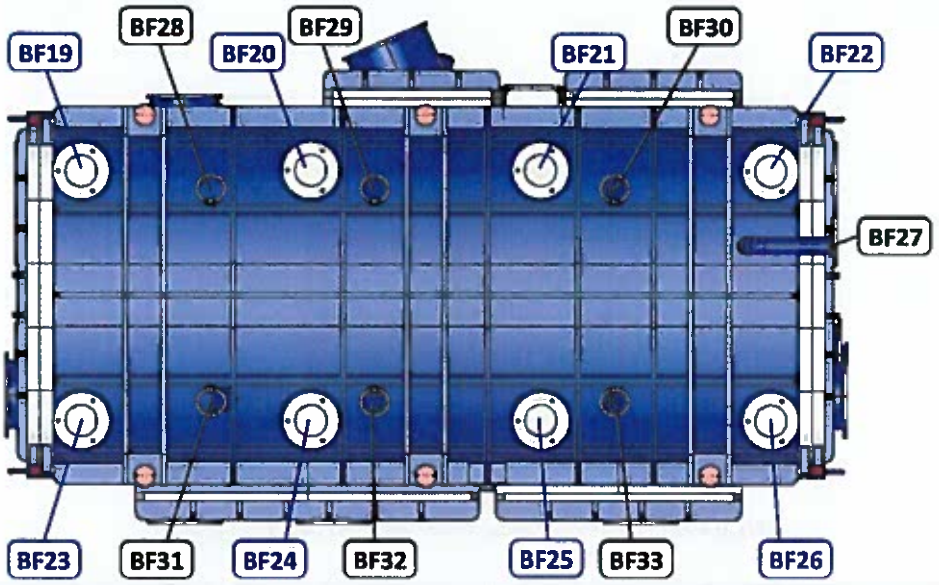

Figure 22: View of the compressor chamber belly with individual flanges.

Doors will be fitted with circular flanges as indicated in the table below.

Flange	Size	Position / Purpose	Note	Tolerance	Seal type
DOOR 1					
D1F1	DN 400 ISO-K	Entry of the uncompressed laser beam	Will be equipped with AR-coated optical window	A	O-ring or metallic gasket
D1F2	DN 400 ISO-K	Output of the Temporal Diagnostic Beam (TBD) and Spatial Diagnostic Beam (both 20x20 mm^2)	DN400 flange with 2 subsidiary flanges DN50, equipped with AR coated optical windows	A	O-ring or metallic gasket
D1F3	DN 400 ISO-K	Spare flange for future upgrades	Will be blanked in current phase	A	O-ring or metallic gasket
D1F4	DN 400 ISO-K	Spare flange for future upgrades	Will be blanked in current phase	A	O-ring or metallic gasket
DOOR 2					
D2F1	DN 400 ISO-K	Opposite to D1F1	Will be used for compressor alignment, then blanked	A	O-ring or metallic gasket
D2F2	DN 400 ISO-K	Opposite to D1F2	Will be used for compressor alignment, then blanked	A	O-ring or metallic gasket
D2F3	DN 400 ISO-K	Opposite to D1F3	Will be blanked	A	O-ring or metallic gasket
D2F4	DN 400 ISO-K	Opposite to D1F4	Will be blanked	A	O-ring or metallic gasket

Table 9: Doors D1, D2 - position and tolerance of flanges

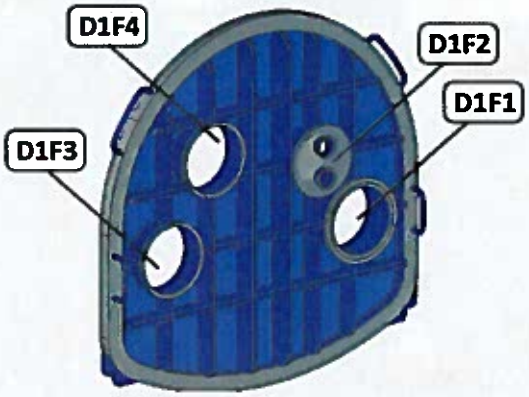

Figure 23: Flange classification on the end doors D1 and D2.

Flange	Size	Position / Purpose	Note	Tolerance	Seal type
DOOR 3					
D3F1	DN 400 ISO-K	For observation / visual inspection of the 2nd grating	Will be equipped by viewing port, e.g. MDC type	B	O-ring or metallic gasket
DOOR 4					
D4F1	DN 400 ISO-K	Facing BF1 on the other side of the chamber, for general alignment purposes	Initially closed by blank flange	A	O-ring or metallic gasket
D4F2	DN 400 ISO-K	Above D4F2 and facing BF2, spare for future upgradability.	Initially closed by blank flange	A	O-ring or metallic gasket
D4F3	DN 400 ISO-K	For observation / visual inspection of the 3rd grating	Will be equipped by viewing port, e.g. MDC type	B	O-ring or metallic gasket
DOOR 5					
-	-	No flanges	-	-	-
DOOR 6					
D6F1	DN 500 ISO-K	Co-axial with 0th order from the 1st grating, for future possible extraction of the 0th order	Initially closed by blank flange	B	O-ring
D6F2	DN 200 ISO-K	Above the flange D6F1 for 0th order extraction, for observation / visual inspection of the 4th grating	Can be equipped by viewing port / optical window	B	O-ring

Table 10: Doors D3, D4, D5, D6 - position and tolerance of flanges

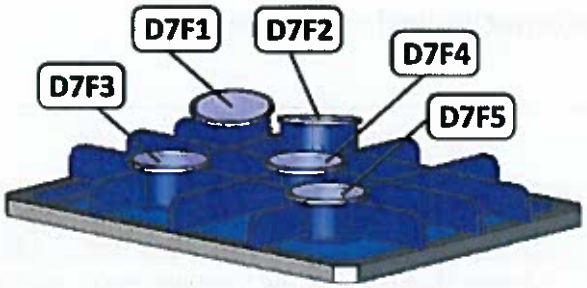

Figure 24: Flange classification on the upper doors (hatches) D7 and D8.

Flange	Size	Position / Purpose	Note	Tolerance	Seal type
DOOR 7					
D7F1	DN 200 ISO-K	For illumination of the chamber interior and/ or for illumination of gratings	Will be equipped by optical fibre feedthrough	B	O-ring
D7F2	DN 200 ISO-K	For mounting a CCD camera monitoring the interior	Will be equipped by viewing port, e.g. MDC type	B	O-ring
D7F3	DN 200 ISO-K	Spare flange	Will be blanked	B	O-ring
D7F4	DN 200 ISO-K	Spare flange	Will be blanked	B	O-ring
D7F5	DN 200 ISO-K	Spare flange	Will be blanked	B	O-ring
DOOR 8					
D8F1	DN 200 ISO-K	For illumination of the chamber interior and/ or for illumination of gratings	Will be equipped by optical fibre feedthrough	B	O-ring
D8F2	DN 200 ISO-K	For mounting a CCD camera monitoring the interior	Will be equipped by viewing port, e.g. MDC type	B	O-ring
D8F3	DN 200 ISO-K	Spare flange	Will be blanked	B	O-ring
D8F4	DN 200 ISO-K	Spare flange	Will be blanked	B	O-ring
D8F5	DN 200 ISO-K	Spare flange	Will be blanked	B	O-ring

Table 11: Doors D7, D8 - position and tolerance of flanges

3. Design and Functional requirements for the compressor

3.1. Layout and optomechanical configuration

N°	TC N°		Requirement Text	Verification By
Layout and optomechanical configuration				
R1-01	REQ-011089	A	The compressor chamber body and the beam injector system body shall be manufactured from stainless steel.	R - review of design
R1-02	REQ-011090	A	The end doors of the chamber shall be manufactured from stainless steel, the other doors shall be made from aluminium or stainless steel.	R - review of design
R1-03	REQ-011091	A	All elements of the detailed design of the compressor and of the beam injector, including vacuum controls, shall be mutually coordinated as these form one functional system.	R - review of design
R1-04	REQ-011092	A	Certain flanges on the compressor vessel and on its large doors and on the beam injector chamber shall have a co-axial tolerance of ±1 mm or better and angular tolerance of ±0.5 degrees or better with respect to their ideal axis; for reasons of critical geometry. *NOTE: Other flanges can have standard production tolerance. The required tolerance band for each flange is specified in the Vacuum Flange Schedule (section 2.10).*	T - test
R1-05/a	REQ-011093	A	The compressor vacuum chamber shall be positioned with a tolerance of ±1 mm in each axis, with respect the local coordinate system in the L3 hall. *NOTE: This positioning will be referenced with respect to patterns centred on the laser beam input and output flanges D1F1 and BF1 (see section 2.10, Vacuum Flange Schedule).*	R - review of design, T - test
R1-05/b	REQ-014017	A	Location and design of the reference patterns shall be developed by the Supplier (see R1-05/a - REQ-011093/A).	R - review of design, T - test
R1-06/a	REQ-011094	A	The height of the internal optical table above the floor shall be 600 mm, with tolerance ±0.5 mm.	R - review of design, T - test
R1-06/b	REQ-014018	A	The table shall be positioned, with respect the L3 hall local coordinate system, with an accuracy of ±0.5 mm in the horizontal plane.	R - review of design, T - test
R1-07	REQ-011095	A	The compressor detailed design shall include full coordination with the interfaces of adjacent systems, especially turbomolecular pumps, vacuum gauges, coolants cooling water, compressed air, etc. and with the ELI-Beamlines building, according to information supplied by the Client.	R - review of design
R1-08	REQ-011096	A	The Supplier shall develop design of both internal (vacuum) and external (on the outer surface) cable trays on the compressor, based on the conceptual design provided by the Client.	R - review of design

R1-09	REQ-011097	A	The compressor and all sub-systems shall be transportable in the ELI-Beamlines facility by the cargo elevator necessary to bring it from the access ramp to the L3 laser hall, i.e. maximal dimensions of the chamber body when transported (including transporting envelope and wrapping) shall not exceed 5.5 x 5.1 x2.98 m^3 and its weight shall be less than 10 tons including doors and port covers.	R - review of design
R1-10	REQ-011098	A	The compressor detailed design shall make all necessary allowance for transport of the chamber to its working location. This shall include provision of designated lifting points and jacking points and positions to support the chamber on rollers or air-skates for lateral movement, and any special tools or aids necessary for table installation inside the chamber.	R - review of design
R1-11	REQ-011099	A	The opening mechanisms of the end and side doors of the compressor shall operate only within a designated zone (see section 2.9, Location of the compressor and beam injector in the ELI-Beamlines facility) around the compressor.	R - review of design

3.2. Optomechanical mounts

N°	TC N°		Requirement Text	Verification by
Optomechanical mounts				
R2-01	REQ-011100	A	The optomechanical mounts inside the compressor shall be attachable to the optical table and shall be able to be pre-positioned (without engaging the actuators) with precision of ±1 mm.	R - review of design
R2-02	REQ-011101	A	Each individual optomechanical mount shall provide short-term and long-term angular mechanical stability (drift) of the optical element better than 10 µrad (in thermally stabilized environment).	T - test
R2-03/a	REQ-011102	A	FEM analysis of the optomechanical mounts shall be carried out by the Supplier.	A - analysis
R2-03/b	REQ-014019	A	The mounts shall not exhibit any resonant frequency below 30 Hz, and also shall not have resonant frequency close to 50 Hz.	A - analysis
R2-04	REQ-011103	A	The principal material of the mounts shall be aluminium and/or stainless steel.	R - review of design
R2-05	REQ-011104	A	The mounts design shall feature integration of electrical actuator including wirings for electrical actuators.	R - review of design
R2-06	REQ-011105	A	The manufacturing design of the mounts and any other components inside the compressor and the beam injector shall avoid any trapped volumes of air, e.g. the mounting holes shall not be blind tapped.	R - review of design
R2-07	REQ-013955	A	All actuators used in the optomechanics shall be certified for vacuum at least 10^{-6} mbar.	R - review of design
R2-08	REQ-013956	A	All edges of the optomechanical mounts shall be chamfered.	R - review of design
R2-09	REQ-013957	A	All cables for electrical actuators shall be organized into cable trays both inside the chamber and on the chamber exterior.	R - review of design
R2-10/a	REQ-013958	A	Cable from each electrical actuator shall be lead to the exterior by no more than one electrical vacuum feedthrough, using the flanges identified in Section 2.10 Vacuum Flange Schedule.	R - review of design
R2-10/b	REQ-014020	A	Best practice shall be followed in the design, type choice and implementation of the vacuum electrical feedthroughs.	R - review of design

3.3. Vacuum components

N°	TC N°		Requirement Text	Verification by
Vacuum components				
R3-01/a	REQ-011106	A	The compressor shall be designed for vacuum 10^{-7} mbar. This pressure shall be achievable with optical table installed in the chamber, using three turbomolecular vacuum pumps with pumping speed at least 2,800 l/s permanently installed on the chamber, in a time comparable to 48 hours.	A – analysis, T - test
R3-01/b	REQ-014021	A	In the compressor, the pressure 10^{-6} mbar shall be achieved, by the three turbomolecular vacuum pumps permanently installed on the chamber, in less than 10 hours from beginning of pumping from beginning of pumping at 10^{-2} mbar pressure.	A – analysis, T - test
R3-02	REQ-011107	A	The compressor chamber and the beam injector chamber shall provide structural stability resulting in deformations less than 1 mm of its walls and doors when the chambers are pumped down from atmospheric pressure.	A – analysis, T - test
R3-03	REQ-011108	A	All circular flanges at the compressor chamber and the beam injector shall be dimensioned according to the ISO-K standard and will be sealed by single fluoroelastomer O-rings or by metallic gasket (see Section 2.10, Vacuum flange schedule).	R - review of design
R3-04	REQ-011109	A	The large end doors and all rectangular doors of the compressor shall be sealed by double fluoroelastomer O-rings with the interspace evacuated. The Supplier shall develop the design of this arrangement.	R - review of design
R3-05	REQ-011110	A	All materials used inside the chamber shall comply with the regime of highly clean vacuum, ideally free of any hydrocarbons and other volatile molecules. NOTE: Special care must be taken in using any plastics (e.g. insulations of electrical wires) which have to be vacuum compatible for pressures better than 10^{-6} mbar.	R - review of design, A - analysis
R3-06	REQ-011111	A	The vacuum gauges and other elements of compressor and of the injector shall make it possible to carry out of precise measurement of vacuum level down to circa 10^{-8} mbar, and calibration measurements of leak of about than 10^{-8} mbar l/s (or smaller).	R - review of design
R3-07	REQ-011112	A	The compressor chamber and the beam injection shall be equipped with a mass spectrometer (e.g. quadrupole) making possible on-line measurements of cleanliness of the vacuum (contamination).	R - review of design
R3-08	REQ-011113	A	The compressor chamber shall be equipped with dedicated flanges for electrical feedthroughs.	R - review of design
R3-09	REQ-011114	A	The vacuum gauges in the compressor and the beam injector shall be capable to instantly detect any abrupt pressure increase coming from the downstream systems, and to feed the signal to the compressor controls.	R - review of design
R3-10	REQ-011115	A	The compressor chamber shall be equipped with an output valve DN400 ISO-F, allowing isolation of the chamber from the injector.	R - review of design
R3-11	REQ-011116	A	The beam injector shall be equipped with an output valve DN400 ISO-F, allowing isolation of the injector from the downstream systems.	R - review of design

R3-12	REQ-011117	A	The compressor detailed design shall make provision (connection points) for construction of a temporary protective surrounding tent for the period of gratings installation and/or maintenance in the L3 laser hall of ELI-Beamlines, allowing at that time to maintain ISO 5 (Class 100) cleanliness level inside the chamber. *NOTE: Design and supply of this protective surrounding is not a part of the scope of the contract.*	R - review of design
R3-13/a	REQ-011118	A	The Supplier shall develop detailed and rigorous procedures of cleaning the interior of the vacuum chamber and of all optomechanical components.	R - review of design
R3-13/b	REQ-014022	A	The procedures of cleaning shall be reviewed and agreed by the Client before use.	R - review of design
R3-14	REQ-011119	A	The turbomolecular pumps shall be water cooled; piping of the cooling water to the pumps shall be part of the chamber and injectors detailed design and supply.	R - review of design
R3-15	REQ-013959	A	The Supplier shall design, supply and install all cooling water pipework to and from the common supply point to every relevant consumer, including all pipe supports, fittings, manual isolation valves, etc. as necessary for a functional system. *NOTE: Cooling water for turbomolecular pumps and any other water cooled equipment will be provided from a single common "supply and return" connection point at the south-west corner of the compressor chamber, near to floor level.*	R - review of design
R3-16	REQ-011120	A	All vacuum valves shall be equipped with electro-pneumatic actuator with position indicator for both end positions.	T - test
R3-17	REQ-011121	A	The Supplier shall design, supply and install all air distribution pipework from the common supply point to every relevant consumer, including all pipe supports, fittings, manual isolation valves, etc. as necessary for a functional system. *NOTE: Air supply for vacuum valves and any other air operated equipment will be provided from a single common supply connection point at the south-west corner of the compressor chamber, near to floor level.*	I - inspection
R3-18/a	REQ-013961	A	Backing vacuum connections shall be provided from suitable connection points on the backing vacuum system pipework to each of the flanges identified in Section 2.10 (Vacuum flange schedule) as having a double O-ring seal.	R - review of design
R3-18/b	REQ-014023	A	The Supplier shall design, supply and install all vacuum pipework from the common supply point to every relevant flange equipped by double O-ring seal, including all pipe supports, fittings, manual isolation valves, etc. as necessary for a functional system.	R - review of design
R3-19	REQ-013963	A	The manufacturing design and the selection of all components inside the vacuum envelope of the Compressor chamber and Beam Injection System shall follow best practice to avoid any trapped volumes of air.	R - review of design
R3-20	REQ-013964	A	The manufacturing processes, surface treatment and the selection of all materials used inside the vacuum envelope of the Compressor chamber and Beam Injection System shall follow best practice to avoid the incorporation of particulates, moisture and volatile organic compounds that would affect the ability to reach vacuum pump-down specification and/or potentially contaminate gratings.	R - review of design

R3-21/a	REQ-013965	A	All electrical cables for the vacuum devices as well as compressed air and cooling water pipework shall be organized into cables trays on the compressor chamber exterior.	R - review of design
R3-21/b	REQ-014024	A	The tray(s) for cooling water shall be segregated from the electrical cable tray(s).	R - review of design
R3-22/a	REQ-014026	A	All wires and signal connections that cross the vacuum chamber boundary (denoted on the control point schedules in Figure 14 and Figure 17 by a dashed purple line) shall be provisioned by the Supplier with vacuum feedthroughs on the most appropriate flange (BF28-BF33).	R - review of design
R3-22/b	REQ-014027	A	Each logical device connection (e.g., as denoted by a line with arrows in the control point schedules Figure 14 and Figure 17) shall have an individual feedthrough connector.	R - review of design
R3-22/c	REQ-014028	A	All electrical feedthroughs shall be fully screened (360° EMC shielding) and all electrical wiring (both in vacuum and between the control cabinet and the chamber) shall be via electrically screened cables.	R - review of design
R3-23	REQ-014029	A	All flanges, feedthroughs, connectors, cables, pipes, terminals and devices shall by fully labelled with a secure, permanent method and uniquely identified according to a mutually agreed naming convention.	R - review of design
R3-24/a	REQ-014030	A	Under normal, non-emergency, conditions, venting (and purging) shall be via a pure, dry synthetic air supply that shall be introduced in a carefully controlled manner to avoid swirling air currents that could dislodge contamination (especially particulate). *NOTE: Synthetic air is available from a single common supply connection point at the south-west corner of the compressor chamber, near to floor level.*	R - review of design
R3-24/b	REQ-014031	A	The Supplier shall design, supply and install distribution pipework of the pure, dry synthetic air from the common supply point.	R - review of design
R3-24/c	REQ-014032	A	Burst-disks shall be provided on both chambers to protect against overpressure during purging and venting with synthetic air.	R - review of design
R3-25	REQ-014033	A	During the initial stages of roughing of the Compressor and BIS chambers, the evacuation of air shall be carefully controlled to avoid swirling air currents that could dislodge contamination (especially particulate). *NOTE: A motorized needle valve or similar precision actuator is suggested in parallel with a soft-start valve for this purpose.*	R - review of design

3.4. Internal Optical Table

N°	TC N°		Requirement Text	Verification by
Internal Optical Table				
R4-01/a	REQ-013966	A	The surface quality of the panels shall be compatible with the required vacuum 10^{-7} mbar. No surface machining of the panels is allowed (other than the M6 mounting holes and access ports).	R - review of design
R4-01/b	REQ-014034	A	The internal optical table top shall be comprised of a stress relieved cast aluminium slab made from high-flatness (equal or better than 0.3 mm /1000 mm) prefabricated panels in three segments with overall dimensions 4,550 mm x 1,800 mm and 40 mm thick.	R - review of design
R4-02/a	REQ-013967	A	The optical table shall be machined with an array of M6 tapped mounting holes on a 25 mm square grid over the entire face.	R - review of design
R4-02/b	REQ-014035	A	All mounting holes of the optical table shall be drilled right through and parallel tapped from the top face to a depth of at least 20 mm.	R - review of design
R4-03/a	REQ-013968	A	The optical table shall be mounted on a high-stiffness support frame that allows accurate horizontal levelling and fine height setting and provides a stable support structure over the entire horizontal face of the top slab.	A - analysis
R4-03/b	REQ-014036	A	The support frame shall be made from aluminium so that it has the same temperature coefficient of expansion as the table top.	A - analysis
R4-04	REQ-013969	A	Additional FEM simulations shall be made by the Supplier during the phase of development of the manufacturing drawings to demonstrate the response of the table face to vibration and temperature variation. *NOTE: Design of the table structure and support frame with respect to stiffness and vibration characteristics shall be provided by the Client after the contract signature.*	R - review of design
R4-05/a	REQ-013970	A	The Supplier shall design and supply a self-contained mechanical handling system to allow the internal optical table, mounted on its support frame, to be installed horizontally into the Compressor chamber through the opening of end-door D1.	R - review of design
R4-05/b	REQ-014037	A	The handling system shall be suitable to operate in a Class 100 (ISO 5) clean room environment.	R - review of design
R4-05/c	REQ-014038	A	The handling system shall not rely on the L3 Laser hall crane.	R - review of design
R4-06/a	REQ-013971	A	The internal optical table and support frame shall be mechanically de-coupled from the vacuum vessel by means of bellows so that the support posts of the internal optical table can be bolted directly to the laser hall floor independently of the vacuum chamber supports.	R - review of design
R4-06/b	REQ-014039	A	The arrangement of the support posts and bellows shall conform to a detailed design that will be provided by the Client after the contract signature, which will ensure no movement of the optical table as the chamber pressure is varied.	R - review of design

3.5. Beam Injection System

N°	TC N°		Requirement Text	Verification by
Beam Injection System				
R5-01/a	REQ-013972	A	The Beam Injector shall be designed for vacuum 10^{-7} mbar. This pressure shall be achievable using one turbomolecular vacuum pump with pumping speed at least 2,800 l/s, permanently installed on the injector chamber, in a time comparable to 48 hours.	R - review of design
R5-01/b	REQ-014040	A	In the injector chamber, the pressure 10^{-6} mbar shall be achieved using the turbomolecular pump (see REQ-013972/A) in time less than 4 hours from beginning of pumping at 10^{-2} mbar.	R - review of design
R5-02	REQ-013973	A	All vacuum flanges on the injector vessel as well as on the envelope of the cryogenic segment (contractual option) shall be ISO-K standard and shall be sealed by simple Viton fluoroelastomer O-rings. NOTE: The Supplier may propose, in order to improve vacuum performance of the chamber, substituting O-ring flanges by CF-type knife-edge flanges sealed by copper gasket.	R - review of design
R5-03	REQ-013974	A	The Beam Injector chamber shall be equipped with dedicated flange(s) for vacuum electrical feedthroughs leading signals to the electrical actuators of the optomechanical mounts IOM1 and IOM2.	R - review of design
R5-04/a	REQ-013975	A	The internal structure supporting the laser beam steering mirror IOM1 shall be mechanically de-coupled from the beam injector vacuum vessel by means of bellows so that the support posts can be bolted directly to the laser hall floor independently of the injector vacuum chamber.	R - review of design
R5-04/b	REQ-014041	A	The arrangement of the support posts and bellows shall conform to a detailed design that will be provided by the Client after the contract signature, which will ensure no movement of the mirror support structure as the injector chamber pressure is varied.	R - review of design
R5-05	REQ-013976	A	Any external cable trays on the beam injector as well as shall be coordinated with the external cable trays of the compressor chamber.	R - review of design, A - analysis
R5-06	REQ-013977	A	The compressed air and cooling water pipework on the injector shall be coordinated with the corresponding piping on the compressor chamber.	R - review of design, A - analysis

3.6. Control systems

N°	TC N°		Requirement Text	Verification by
Control systems				
R6-01	REQ-011122	A	Pumps, valves, actuators, sensors and other instrumentation shall be delivered with control systems, power and utilities connections as necessary for correct and safe operation of the Compressor, and with full English-language documentation.	R - review of design
R6-02	REQ-011123	A	All control systems hardware shall be selected from an Approved Hardware List (to be finalized with supplier) to be compatible with the hardware used for the L3 laser controls. *NOTE 1: This list contains off-the-shelf control system devices that have been verified by the Client and for which spares are maintained (manufacturers include National Instruments, Moxa, Pilz, Phytron, Renishaw, etc.).* *NOTE 2: Use of custom-made hardware or devices not on the Approved Hardware List must be justified by the Supplier and approved by the Client on a case-by-case basis.*	R - review of design
R6-03/a	REQ-011124	A	All pumps, valves, actuators, sensors and other instrumentation shall be provided with LabVIEW drivers and/or API and a basic demonstrative graphical user interface (GUI). *NOTE: Control system of the L3 laser into which the compressor controls will be integrated is LabVIEW.*	I - inspection
R6-03/b	REQ-014042	A	All drivers shall follow the National Instruments' Instrument Driver Guidelines, and shall be verified as compatible with the National Instruments Real-Time operating system (NI ETS 2014 – see KB 4LRA4IQ0) on the RMC-8354 embedded computer (the preferred integration platform of the Client).	I - inspection
R6-04/a	REQ-011125	A	All software, including but not limited to drivers (R6-03/a - REQ-011124/A and R6-03/b -REQ-014042/A) shall be provided fully open-source in LabVIEW (2014 SP1 preferred), and use only National Instruments' distributed libraries and those by 3rd parties in wide circulation via the VI Package Manager. No DLLs, COM or .NET objects or any other mechanisms for calling external code shall be used.	I - inspection
R6-04/b	REQ-014043	A	All software shall have full English-language documentation.	I - inspection
R6-05	REQ-011126	A	All critical control systems software shall run on embedded real-time computing hardware chosen from the Approved Hardware List (R6-02/a - REQ-011123/A). NOTE: Basic GUIs and non-critical software that are not essential for correct and safe operation of the Compressor may run on Windows or Linux PCs, as necessary.	R - review of design

3.7. Transportation and Installation requirements

N°	TC N°		Requirement Text	Verification by
Transportation and Installation requirements				
R7-01	REQ-013980	A	For the duration of its transport the Compressor vacuum chamber and other vacuum envelope sections shall be hermetically sealed under dry air or nitrogen. The initial wrapping of all parts shall be in multiple layers of plastic film (as sheet or bags) of type specifically for use in contamination controlled areas. This clean conditions wrapping shall be further enclosed in robust outer packaging and transport crates as necessary for protection and handling during shipping to the ELI-Beamlines site.	I - inspection
R7-02	REQ-013981	A	The Supplier shall transport the components to the ELI-Beamlines facility and shall remain responsible (with appropriate insurance cover) right up to the point of fixing down at the operational location in the ELI-Beamlines Laser Building. *NOTE: Offloading of the Compressor at the building entrance will probably require a mobile crane on hire. Other packages can be offloaded by fork lift truck.*	R - review of design
R7-03	REQ-013982	A	Transport through the Laser Building will involve the use of a goods lift to transition between floors and in order to fit in the lift the maximum dimensions of the chamber body (in its transport configuration) shall not exceed 5.5 x 5.1x2.98 m^3 and its weight shall not exceed 10 tons.	R - review of design
R7-04	REQ-013983	A	Movement through corridors and rooms will require wheels, rollers or air skates fitted to a suitable support structure, whose design and supply shall be within the scope of the Supplier, as shall be any floor surface protection or load spreading sheets.	R - review of design
R7-05	REQ-013984	A	Final bolting down of the Compressor vacuum chamber and optical bench shall be to the tolerances stated in Requirements R1-05/a - REQ-011093/A and R1-06/a -REQ-011094/A.	R - review of design
R7-06	REQ-013985	A	All activities of the Supplier's personnel at the ELI-Beamlines facility shall be undertaken in conformity with the Client's Local Procedures for Safe and Efficient Conduct of Work. To this end, all Supplier's personnel shall be required to attend up to one day of compulsory training covering at least; Conduct of persons and working procedures in ISO 14644 compliant Clean Rooms; Laser Safety and General Health and Safety, before they are permitted to work at the ELI-Beamlines facility. They shall also comply with ELI-Beamlines security policy.	T - test, I - inspection
R7-07	REQ-013986	A	All transport and installation activities at the ELI-Beamlines facility shall be pre-planned in advance by means of a written Installation Method Statement that shall be reviewed and agreed with the Client's officer in charge of such work. Transport and installation activities shall be undertaken strictly in accordance with the agreed Method Statement and subject to Client's overall control.	R - review of design, I - inspection

3.8. Testing, inspection, documentation and warranty

N°	TC N°		Requirement Text	Verification by
Testing, inspection, documentation and warranty				
R8-01/a	REQ-011133	A	The compressor chamber shall be cleaned and vacuum tested at the manufacturer's works prior to acceptance for transport to ELI-Beamlines.	T - test
R8-01/b	REQ-014044	A	Vacuum pumping tests shall prove that the vessel can be pumped down to 10^{-7} mbar and using the mass spectrometer, and shall demonstrate that volatile organic compounds (VOCs) and other impurities are not present at the lower limit of detection of this spectrometer.	T - test
R8-02	REQ-011134	A	In addition to doors and access ports, all flanges and openings of the chamber shall be provided with ISO-K closures to enable the vessel to be vacuum tested prior its final installation at ELI-Beamlines.	R - review of design
R8-03	REQ-013989	A	Only new materials and equipment with manufacturer's full warranty shall be used for the entire scope of supply.	I - inspection
R8-04	REQ-013990	A	All equipment shall be supplied with at least 24 months warranty, except turbomolecular pumps where the minimum warranty period shall be at least 12 months and vacuum valves which shall be warranted for a minimum of 100,000 open/closed cycles. *NOTE: The warranty for individual subsystems (compressor chamber, beam injector, optomechanical mounts) will be counted from the respective date of completed installation at ELI-Beamlines.*	I - inspection
R8-05	REQ-011136	A	The system shall be delivered with fully detailed operational manuals, certification and technical documentation.	R - review of design

3.9. Safety Requirements

3.9.1. General Safety Requirements

N°	TC N°		Requirement Text	Verification by
General Safety Requirements				
R9-01	REQ-011135	A	All components shall comply with all applicable EU and Czech legislative requirements, and shall have CE marking and Declaration of Conformity whenever applicable.	R - review of design
R9-02	REQ-013988	A	The supplier shall supply a Declaration of Conformity for each product type if the appropriate legislation determines the supplier's obligation to have a Declaration of Conformity for the purposes of a Device sale in the Czech Republic. In such a case the Declaration of Conformity shall comply with Act No. 22/1997 Coll., as amended.	I - inspection
R9-03	REQ-013987	A	The Declaration of Conformity shall contain the following norms: ČSN EN 61010-1 ed. 2 Safety requirements for electrical equipment for measurement, control, and laboratory use; ČSN EN 61326-1 Electromagnetic compatibility (EMC) standard for measurement, control and laboratory use.	I - inspection

3.9.2. Personal and Machine safety

N°	TC N°		Requirement Text	Verification by
Personal and Machine safety				
R9-04	REQ-011127	A	A risk-assessment and failure mode and effects analysis (FMEA), to agreed standards, shall be conducted by the manufacture for the control systems in their scope of supply. Hazards to persons and the environment, and failures exceeding €10k damages or requiring more than 8 hours down-time shall be identified and considered.	R - review of design
R9-05	REQ-011128	A	Personnel Protection Systems and Machine Protection Systems shall be provided that provide sufficient security against the hazards and failures identified in R9-04 - REQ-011127/A to a mutually acceptable risk level. Where possible, components used in these systems shall be certified to IEC 61508 SIL3 level.	I - inspection
R9-06	REQ-013978	A	If risk assessment (FMEA) shows the need for control system mitigation for personnel protection, implementation shall comply with IEC 61508 SIL 3.	R - review of design
R9-07	REQ-011129	A	For R9-04 - REQ-011127/A and R9-05 - REQ-011128/A, the hazard of asphyxiation during venting when using oxygen-depleted gases or gas mixtures shall be explicitly considered and the supplier shall demonstrate that this risk is as low as reasonably practicable.	R - review of design
R9-08	REQ-011130	A	For R9-04 - REQ-011127/A and REQ-011128/A, the hazard of persons becoming trapped in the chamber shall be explicitly considered and the supplier shall demonstrate that this risk is as low as reasonably practicable.	R - review of design
R9-09	REQ-011131	A	For R9-04 - REQ-011127/A and R9-05 - REQ-011128/A, the hazard of personnel injury when working on top of and around the sides of the chamber shall be explicitly considered and the supplier shall demonstrate that this risk is as low as reasonably practicable (e.g., hand rails and ladder elements included in design in accordance with Czech Republic Government Resolution NV 362/2005 Annex 1).	R - review of design
R9-10	REQ-011132	A	For R9-04 - REQ-011127/A and R9-05 - REQ-011128/A, the failure resulting in an abrupt pressure rise from downstream systems shall be explicitly considered and the supplier shall demonstrate that the risk of damage to Compressor gratings and chamber is as low as reasonably practicable (e.g., fast-acting isolation valves based on hard-wired pressure feedback).	R - review of design
R9-11	REQ-013979	A	All exposed metal parts (chamber, tubing, valves, etc.) shall be electrically bonded to the facility ground for machine and personnel safety.	R - review of design, I - inspection

4. List of Abbreviations

Abbreviation	Meaning
A	Analysis
BIS	Beam Injector System
CF	Conflat
COTS	Commercial off the shelf
DN	Diameter Nominal
ELI	Extreme Light Infrastructure
FD	Functional Demonstration
FEM	Finite Element Method
FMEA	Failure Modes and Effects Analysis
FPGA	Field-Programmable Gate Array
FWHM	Full Width at Half Maximum
FZU	Fyzikální ústav, Institute of Physics (IoP), Academy of Sciences of the Czech Republic
HAPLS	High average power Advanced Petawatt Laser System
I	Inspection
ICD	Interface Control Document
IoP	Institute of Physics (in Czech Fyzikální ústav, FZU)
ISO	International Standards Organization
L x W x H	Length x width x height
L3	Laser system No 3 of ELI-Beamlines
MSS	Machine Safety System
N/A	Not Applicable
OM	Optomechanics
PCS	Pulse Compressor System
PLC	Programmable Logic Controller
PW	Petawatt
R	Review of Design, Review
RCS	Reference Coordinate System
RF	Radio Frequency
RIO	Reconfigurable I/O
RMS	Reference Mechanical System
RSD	Requirement Specification Document
RTD	Resistance Temperature Detector
SCADA	Supervisory Control and Data Acquisition
SI	International System of Units
SIL	Safety Integrity Level
T	Test
TC	Teamcenter (Product Lifecycle Management System) of ELI-Beamlines
TMP	Turbo Molecular Pump
TQCM	Thermoelectric Quartz Crystal Microbalance
VCD	Verification Control Document
VCS	Vacuum Control System
VOC	Volatile Organic Compounds
VP	Verification Plan

5. List of Drawings

No.	TC ID No.	No. of sheets	Drawing Title	Description
1	00089242/10	1/5	L3_FULL ASSEMBLY	Compressor chamber axonometric views, D1 door in front
2	00089242/10	2/5	L3_FULL ASSEMBLY	Compressor chamber axonometric views, D2 door in front
3	00120391/00	1/3	L3_ASSEMBLY_chamber_July_2015	Compressor chamber: North side and front (from D1 door side) views
4	00120391/00	2/3	L3_ASSEMBLY_chamber_July_2015	Compressor chamber: North side and top views
5	00120391/00	3/3	L3_ASSEMBLY_chamber_July_2015	Compressor chamber: bottom view and North side view
6	00089242/10	5/5	L3_FULL ASSEMBLY	Compressor chamber without doors: North side and front (from D1 door side) views
7	00089242/10	4/5	L3_FULL ASSEMBLY	Optical table with full suite of compressor optomechanics: axonometric views
8	00108862/00	1/2	L3_chamber_Table_2015	Optical table: top and side views, axonometric view
9	00108862/00	2/2	L3_chamber_Table_2015	Supporting frame of the optical table: top, front and side views, axonometric view
10	00102965/04	1/5	L3 injection	Beam Injector System: top and side view, axonometric view
11	00102965/04	2/5	L3 injection	Beam Injector System: vacuum flanges description
12	00102965/04	5/5	L3 injection	Vacuum envelope of the Beam Injector System (contractual option): front and side views
13	00118947/00	1/1	Cryo_segment_L3	Vacuum envelope of the cryogenic segment: side views and top view
14	00120891/00	1/1	L3K_MBS_ASSEMBLY_ LOW	OM1 optomechanical mount: side and top views, axonometric view
15	00120944/00	1/1	L3_P2_ ASSEMBLY TOWER_PLU	OM2 optomechanical mount: side and top views, axonometric views
16	00120971/00	1/1	L3C_HYPERBOLIC MIRROR	OM3 optomechanical mount: side and top views, axonometric views
17	00092122/00	1/1	L3K_PM_ASSEMBLY 4	OM4 optomechanical mount: side and top views, axonometric views
18	00099985/01	1/1	L3_LBI_CH_ 01_asm (Mirror 45°assembly)	IOM1 optomechanical mount: side and top views, axonometric view
19	00106849/01	1/1	L3_LBI_beam_dump_asm (Sliding mirror assembly)	IOM2 optomechanical mount: side and top views, axonometric view
20	00102965/04	3/5	L3 injection	Beam Injector System (vertical lineout and top view)
21	00102965/04	4/5	L3 injection	Detail of the vacuum-cooled Beam Dump (contractual option)
22	00118736/00	1/1	paralell_tripod_OAP_mount	6-axis optomechanical mount for an off-axis parabolic mirror (contractual option)

List of Drawings

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4	00120391/00	2/3	L3_ASSEMBLY_chamber_July_2015	Compressor chamber: North side and top views
5	00120391/00	3/3	L3_ASSEMBLY_chamber_July_2015	Compressor chamber: bottom view and North side view
6	00089242/10	5/5	L3_FULL ASSEMBLY	Compressor chamber without doors: North side and front (from D1 door side) views
7	00089242/10	4/5	L3_FULL ASSEMBLY	Optical table with full suite of compressor optomechanics: axonometric views
8	00108862/00	1/2	L3_chamber_Table_2015	Optical table: top and side views, axonometric view
9	00108862/00	2/2	L3_chamber_Table_2015	Supporting frame of the optical table: top, front and side views, axonometric view
10	00102965/04	1/5	L3 injection	Beam Injector System: top and side view, axonometric view
11	00102965/04	2/5	L3 injection	Beam Injector System: vacuum flanges description
12	00102965/04	5/5	L3 injection	Vacuum envelope of the Beam Injector System (contractual option): front and side views
13	00118947/00	1/1	Cryo_segment_L3	Vacuum envelope of the cryogenic segment: side views and top view
14	00120891/00	1/1	L3K_MBS_ASSEMBLY_ LOW	OM1 optomechanical mount: side and top views, axonometric view
15	00120944/00	1/1	L3_P2_ ASSEMBLY TOWER_PLU	OM2 optomechanical mount: side and top views, axonometric views
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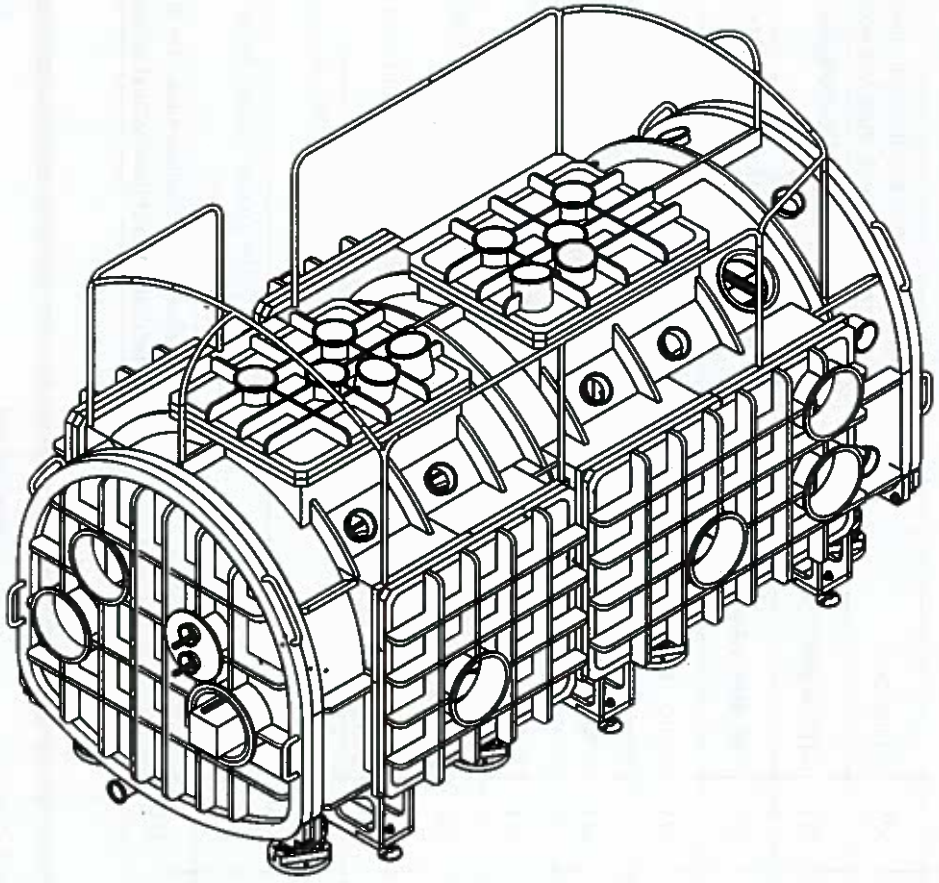

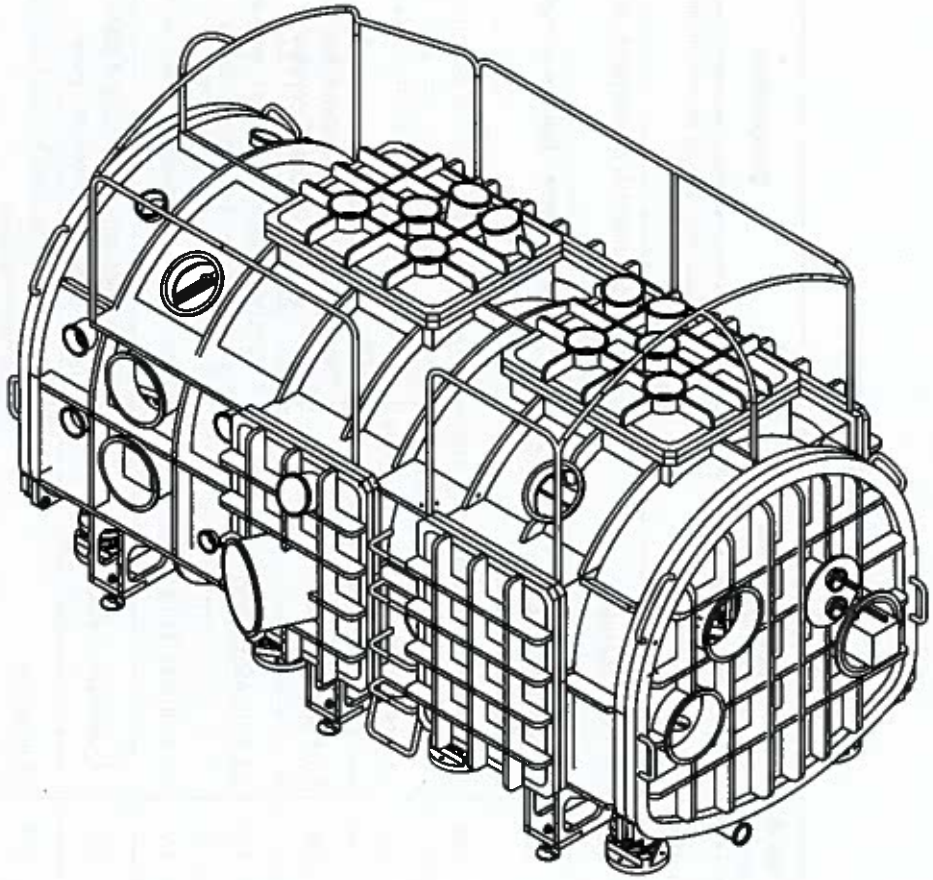

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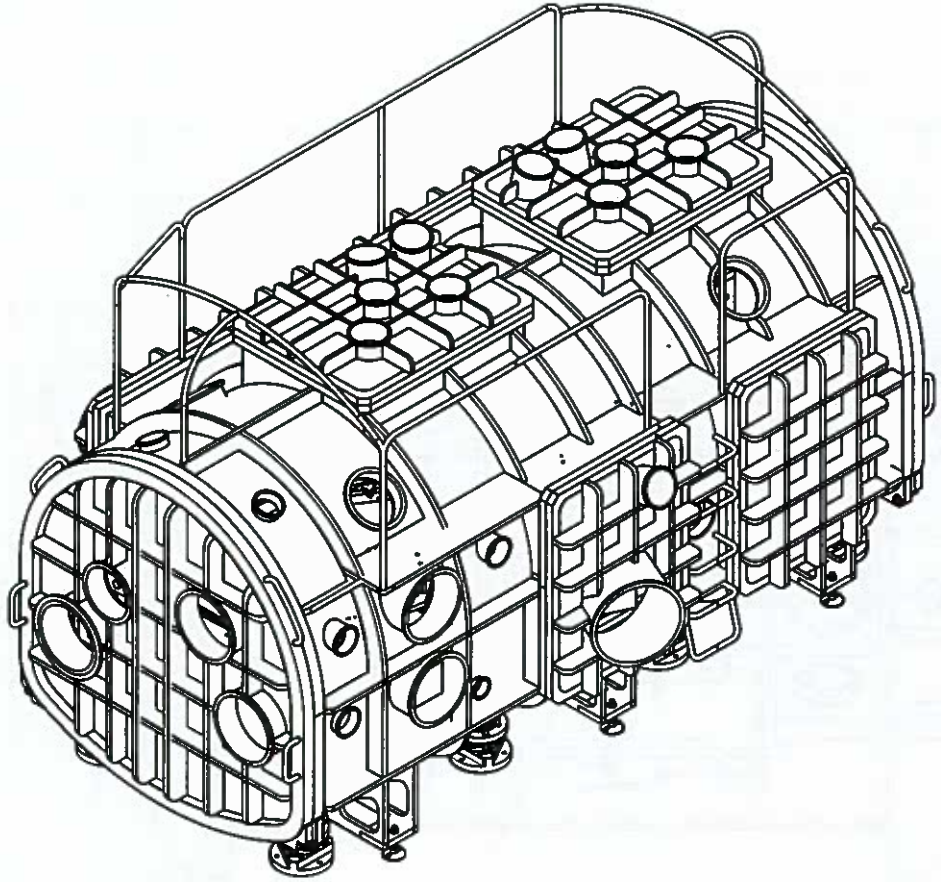

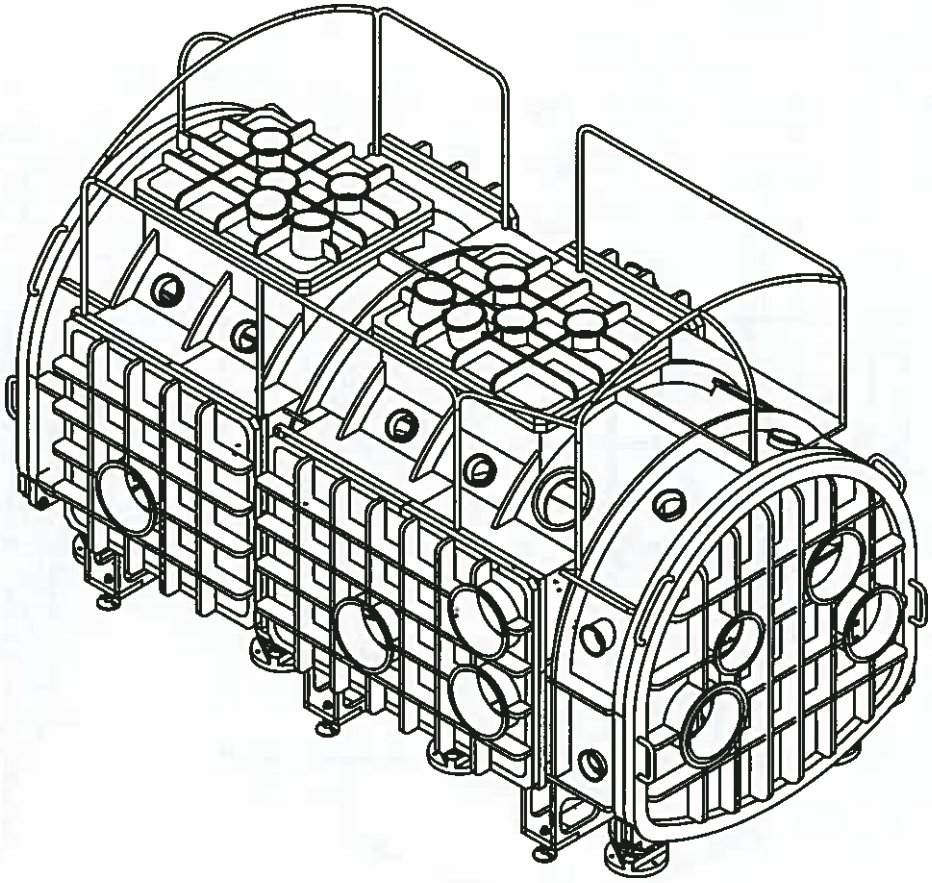

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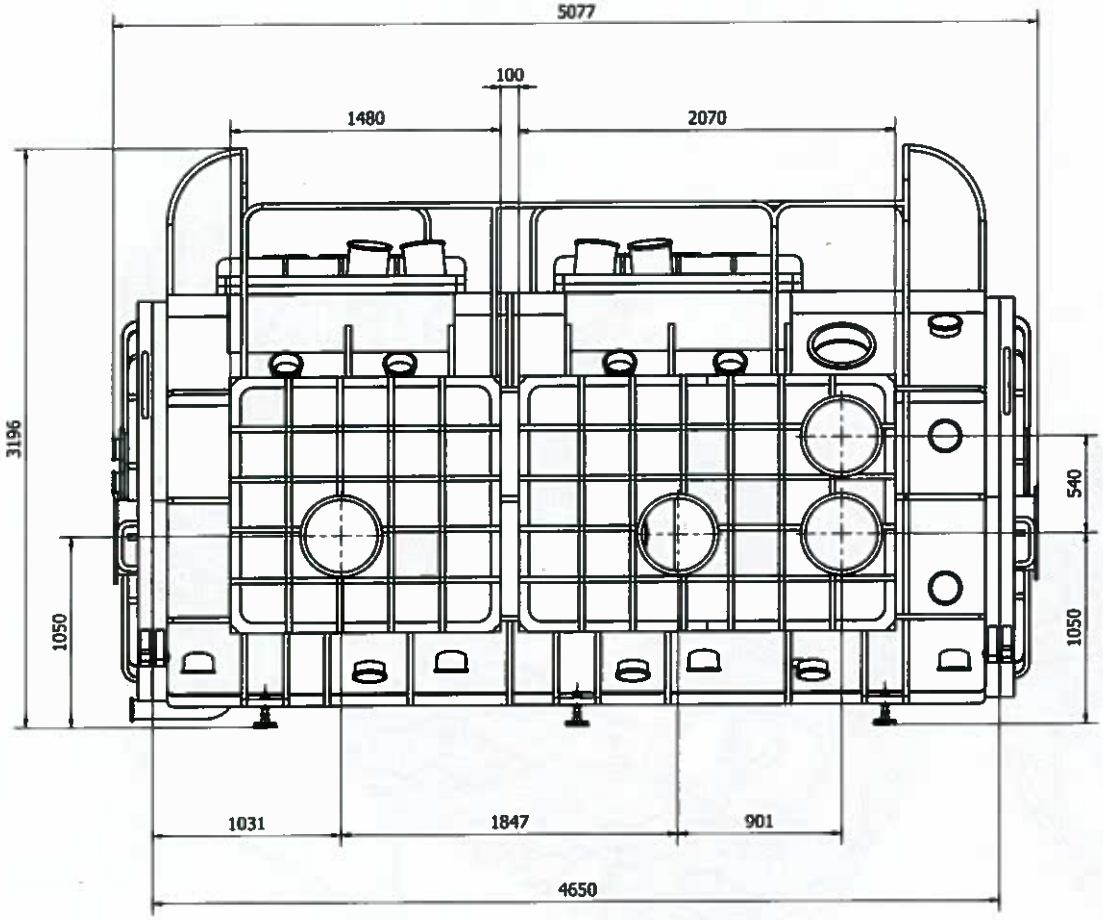

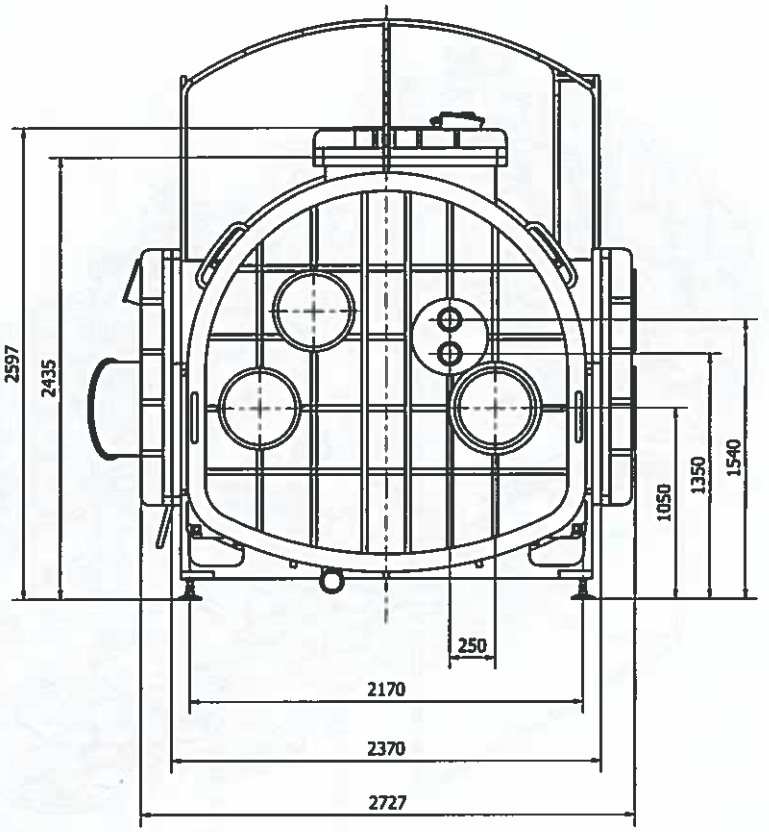

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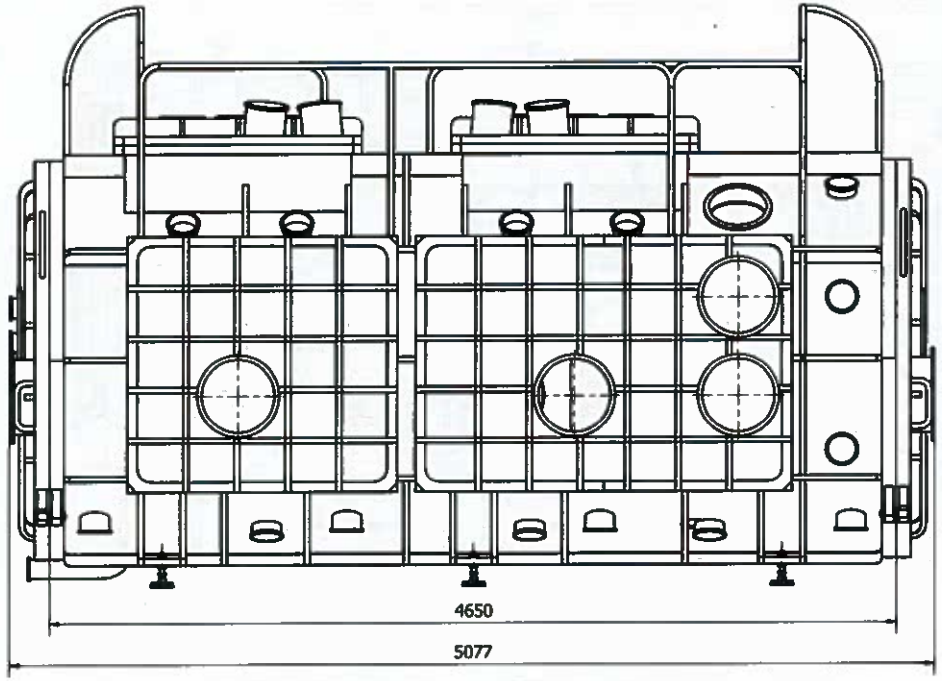

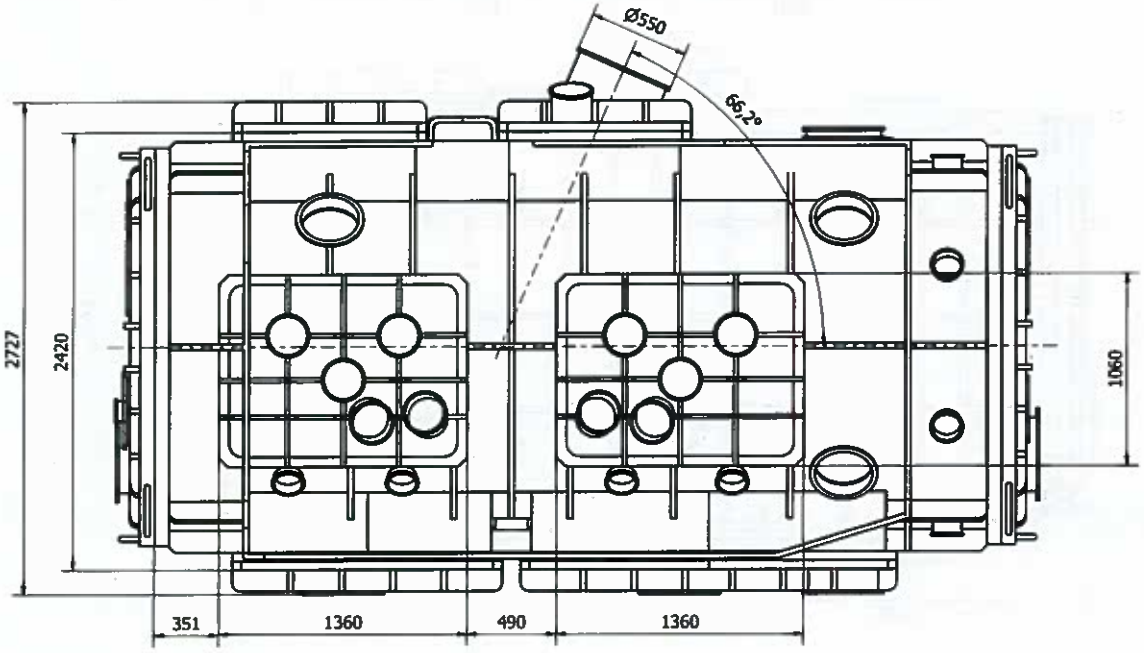

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Rev.: 00

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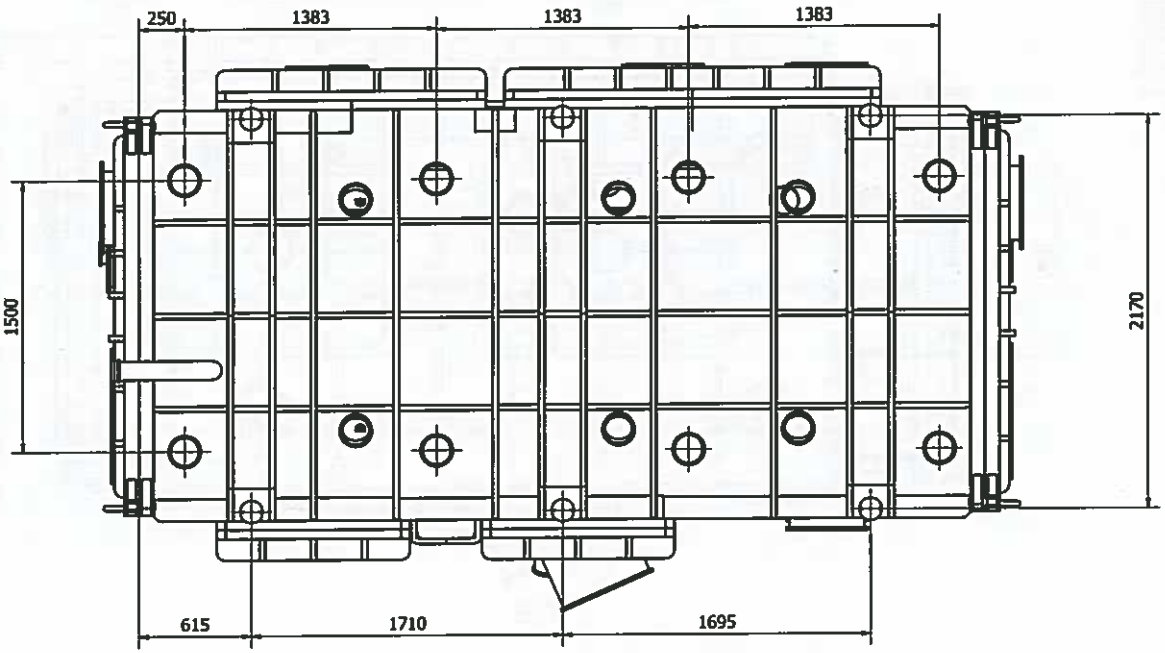

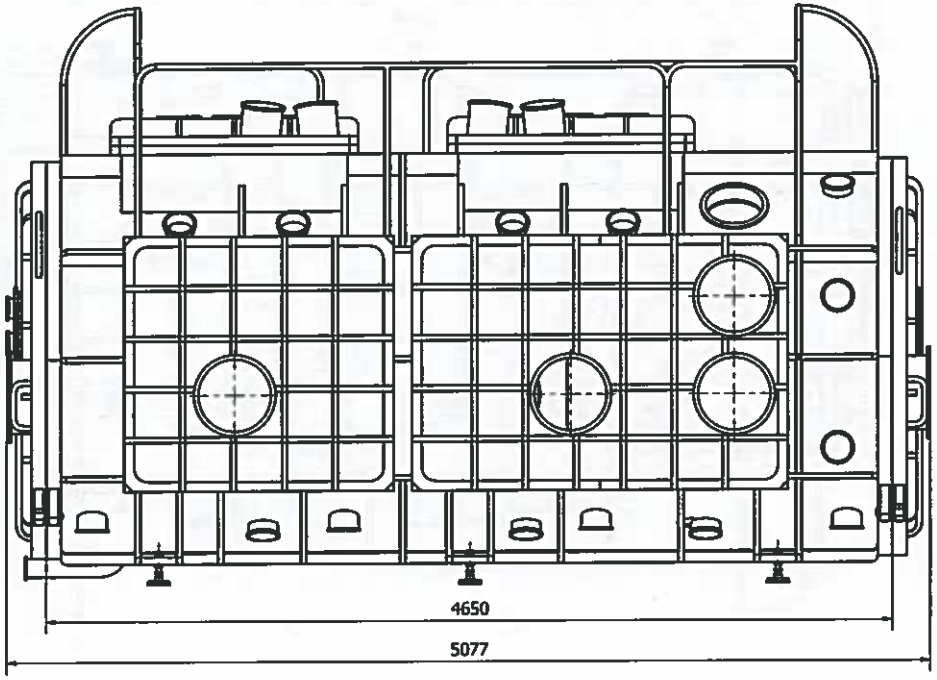

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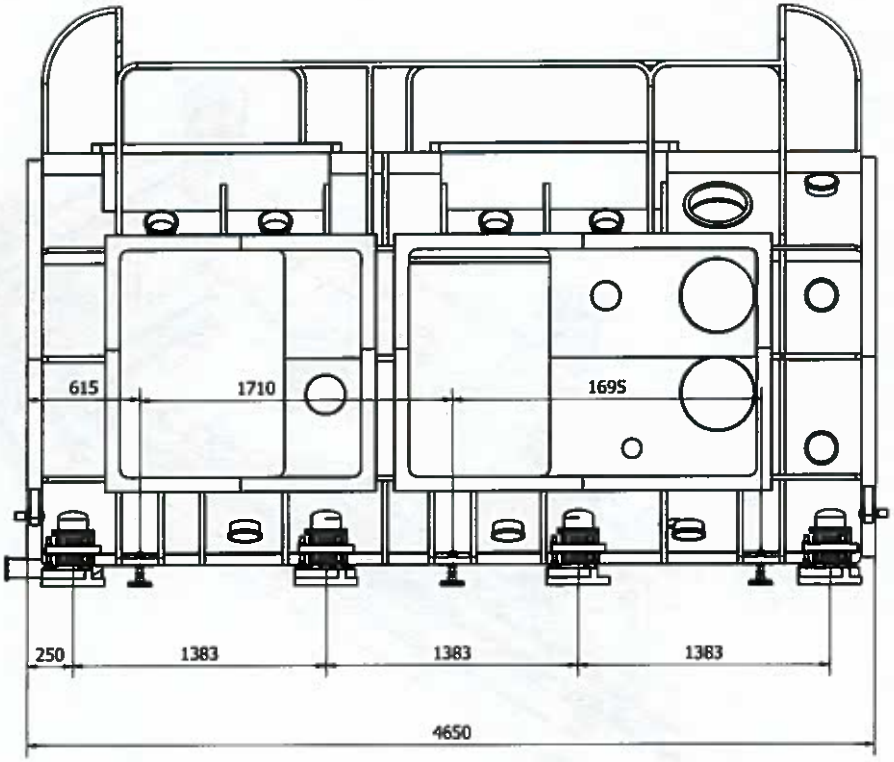

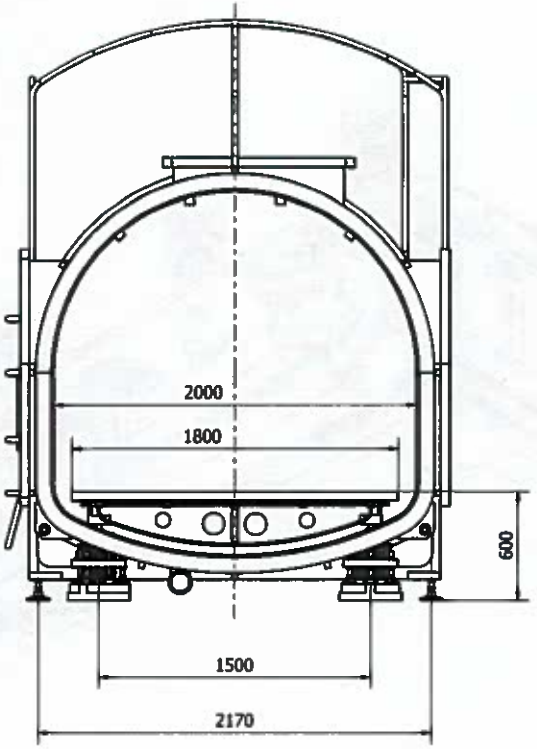

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Akademie věd ČR, v. v. i.

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Rev.: 10

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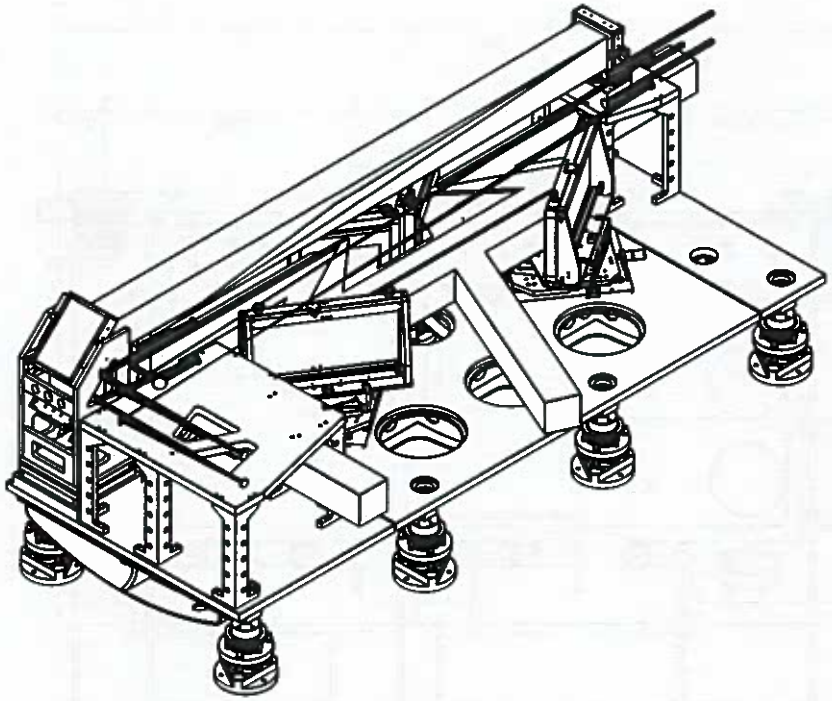

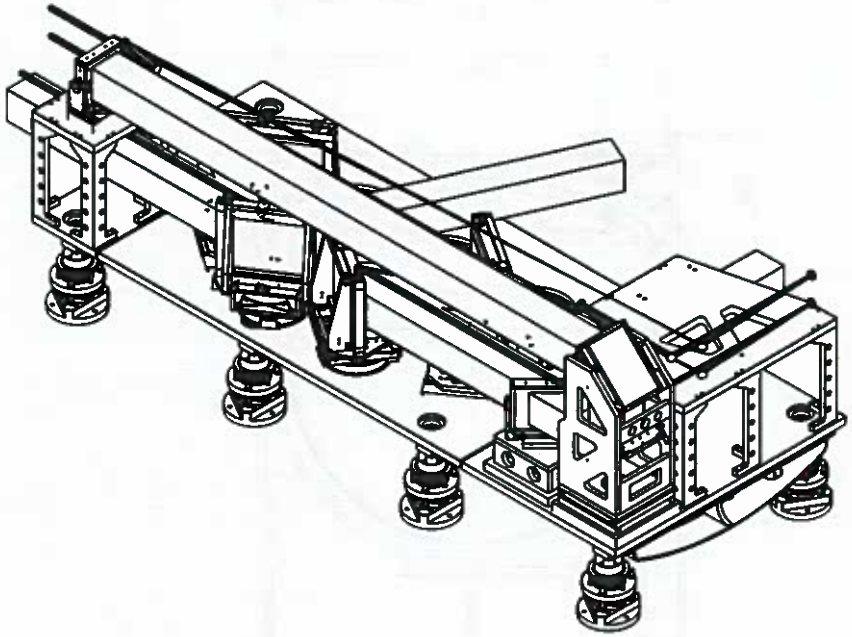

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Fyzikální ústav
Akademie věd ČR, v. v. i.

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Rev.: 10

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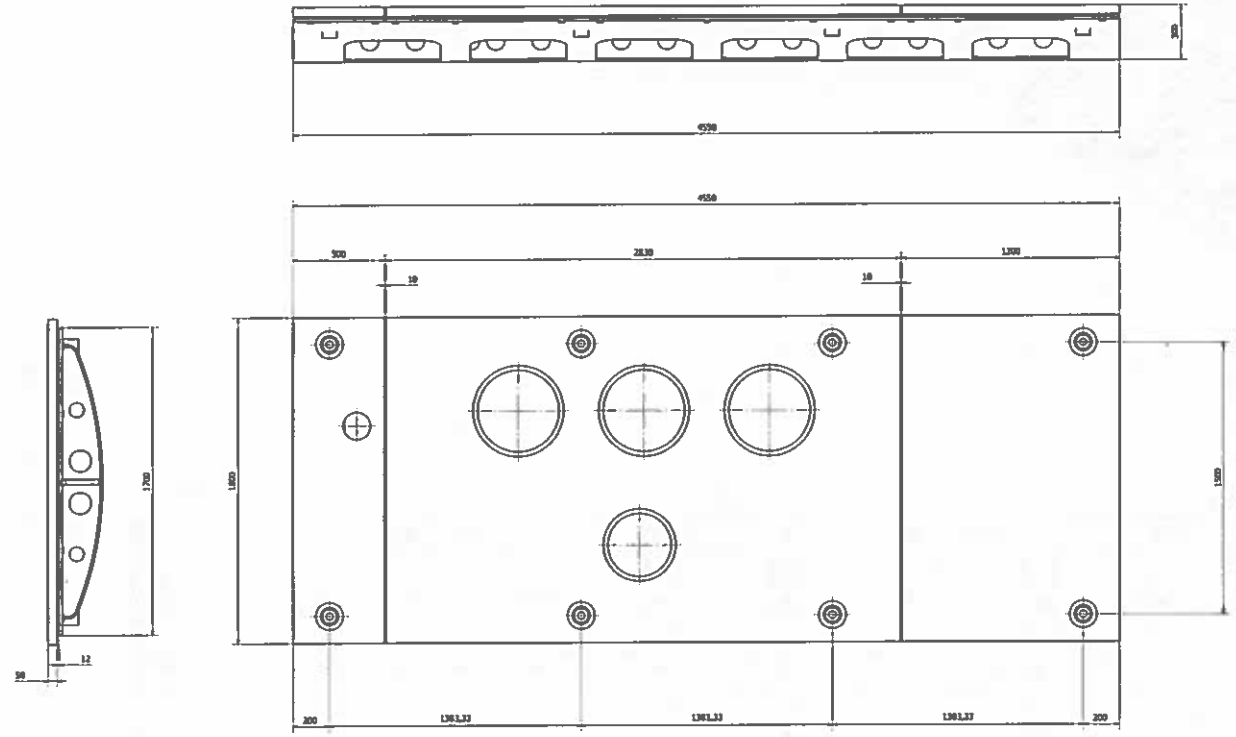

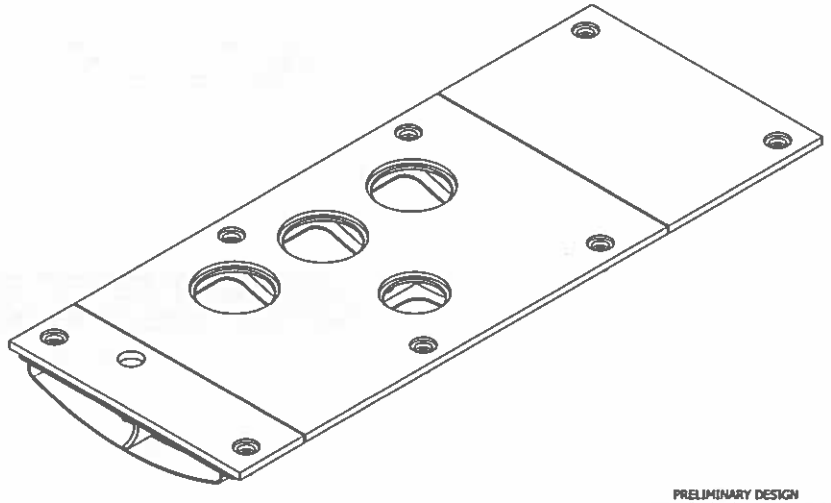

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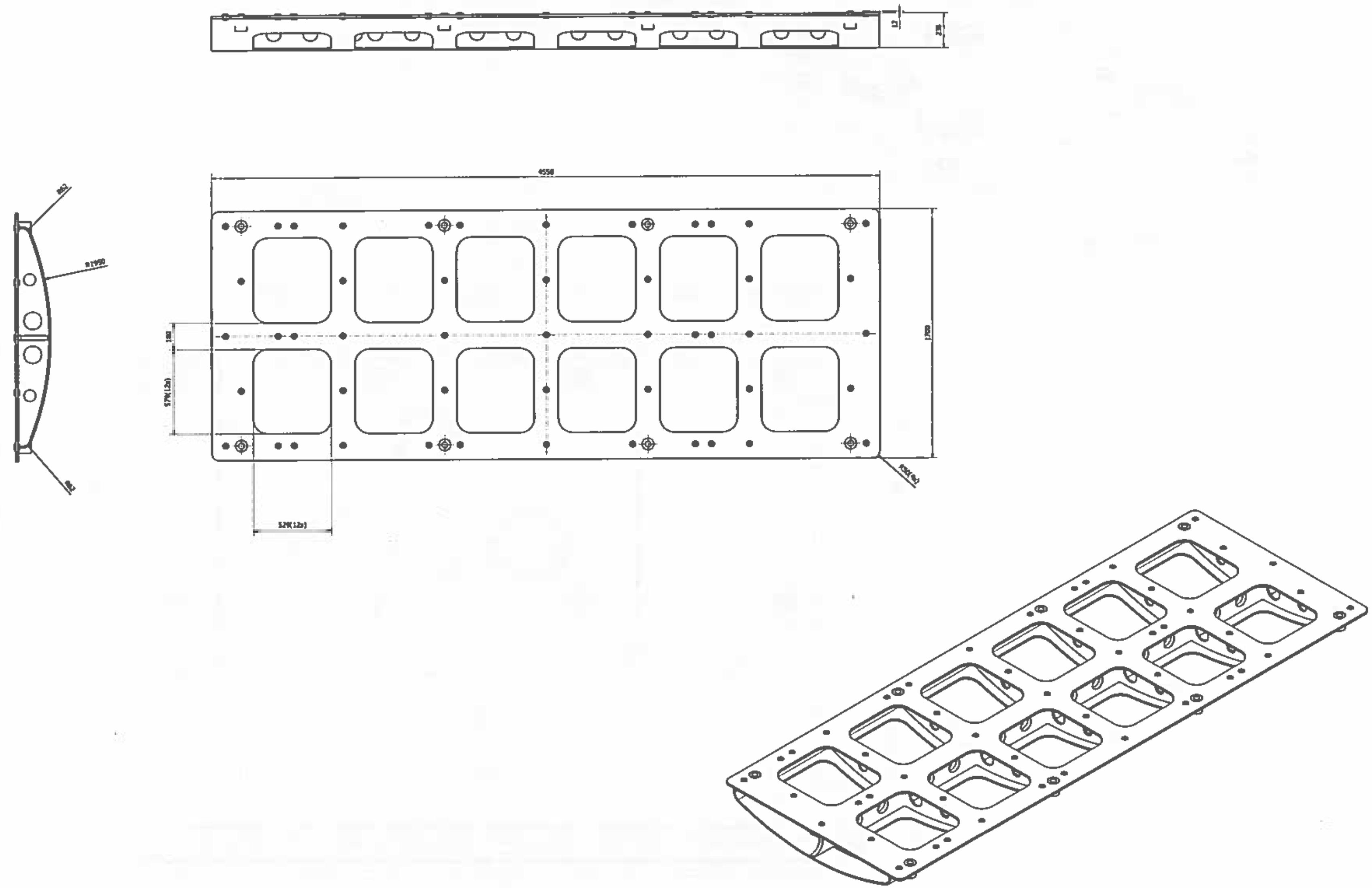

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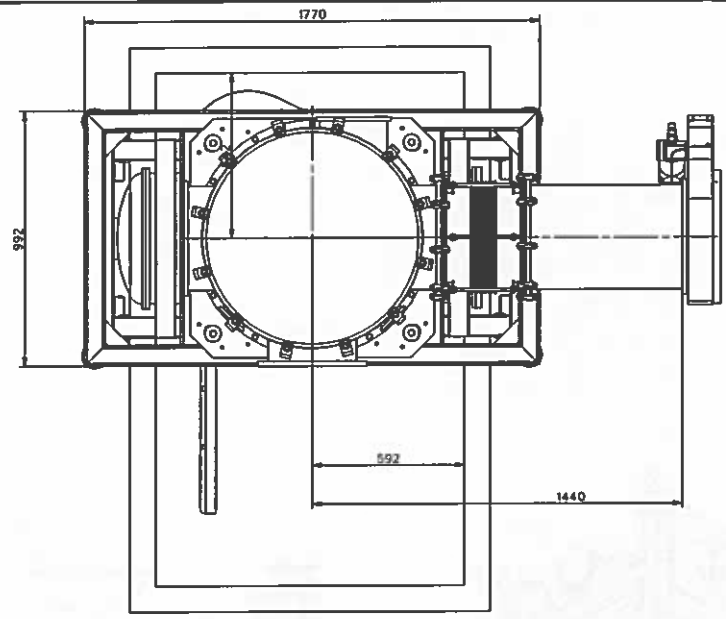

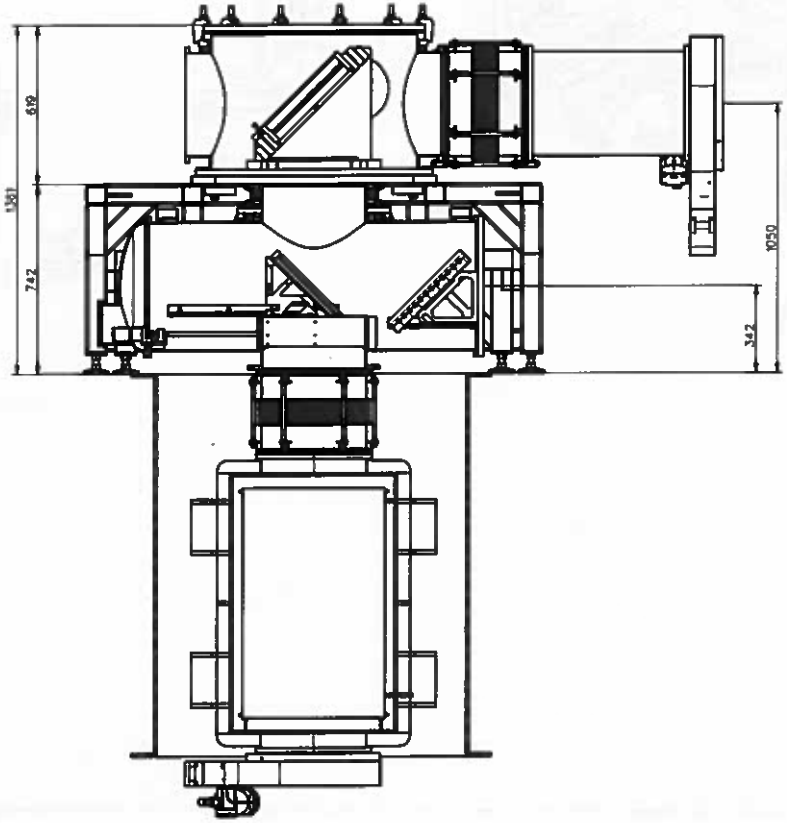

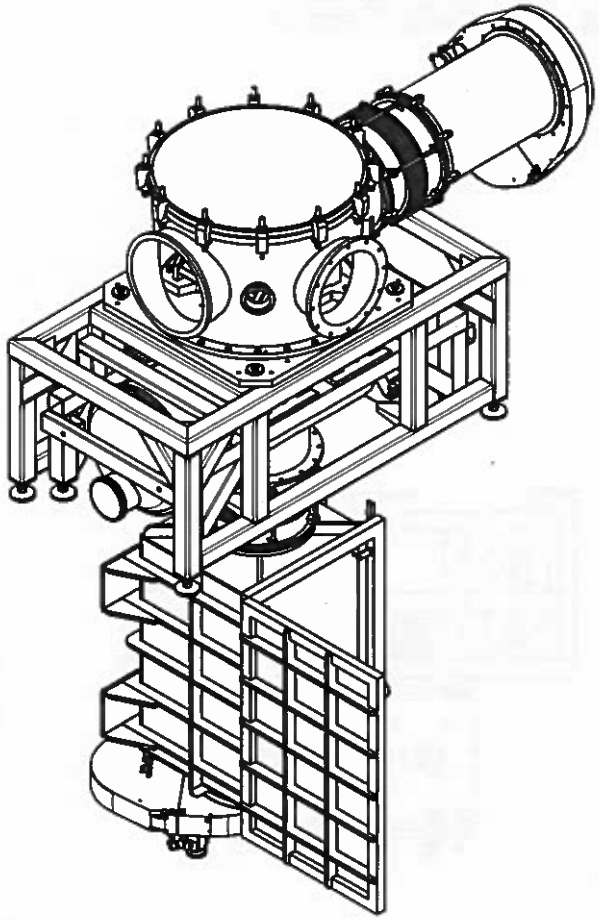

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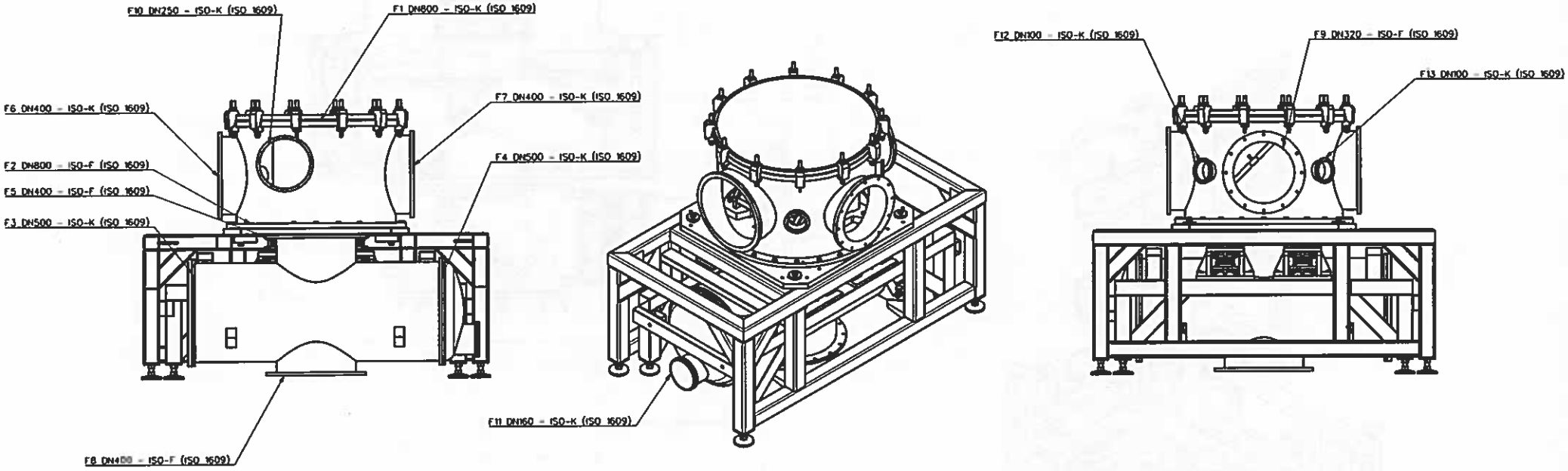
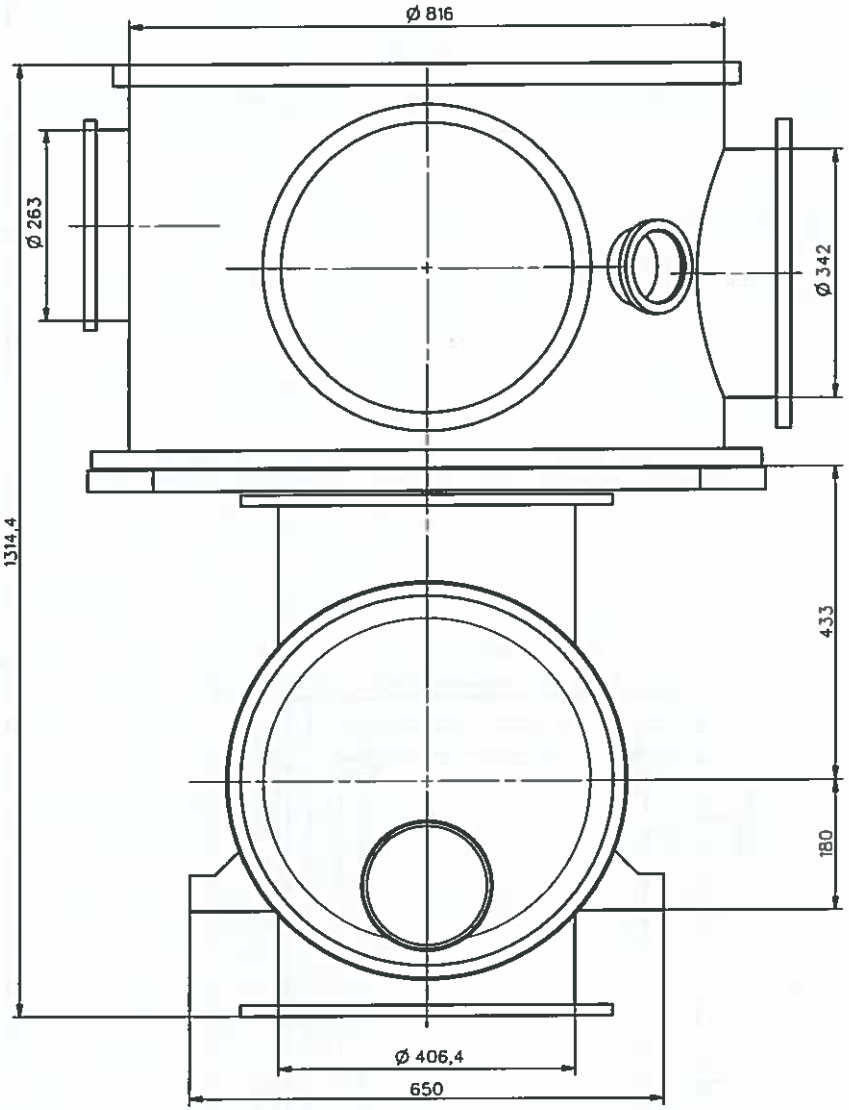
Weight:	Application:		

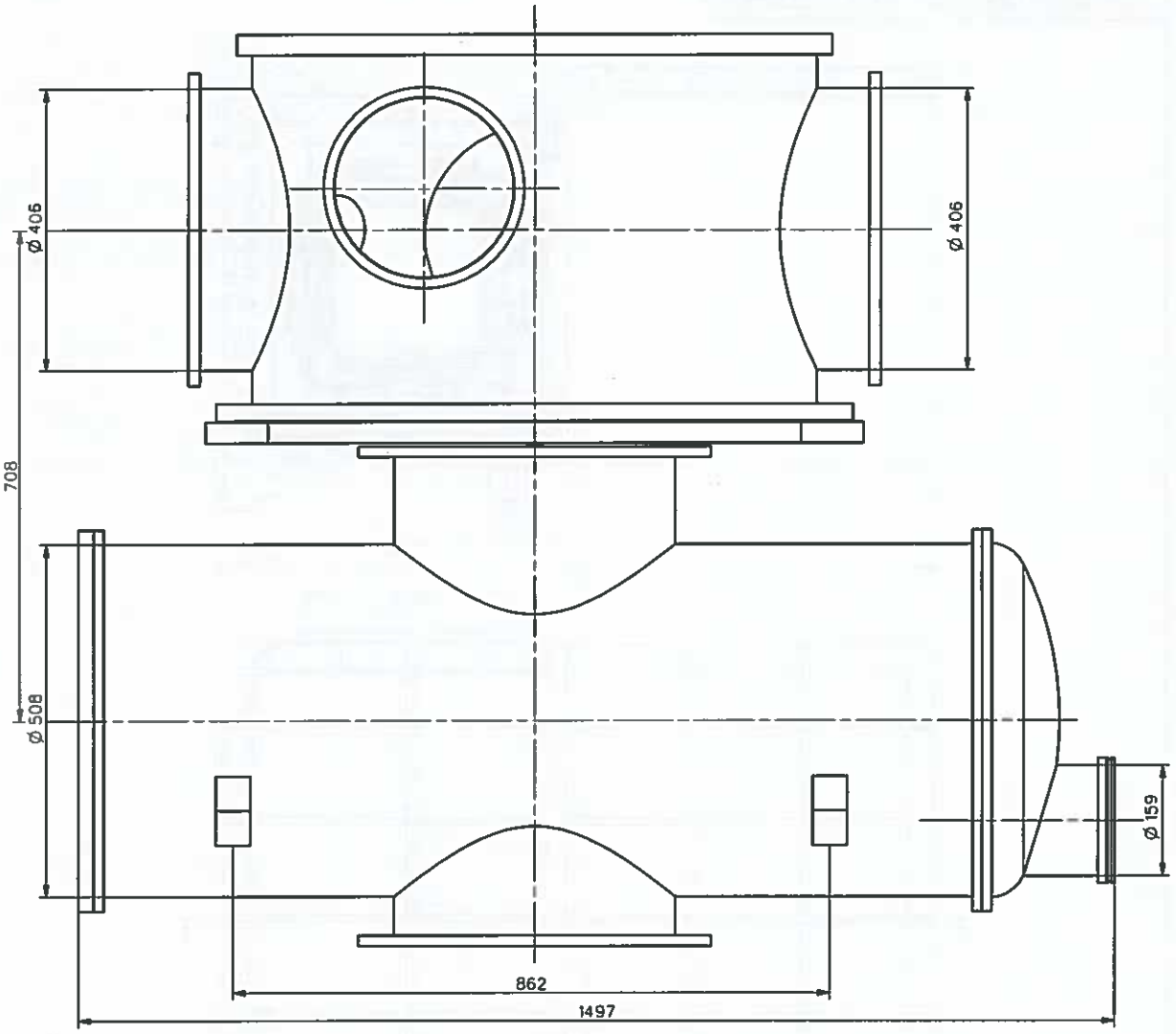
Fyzikální ústav Akademie věd ČR, v. v. i.



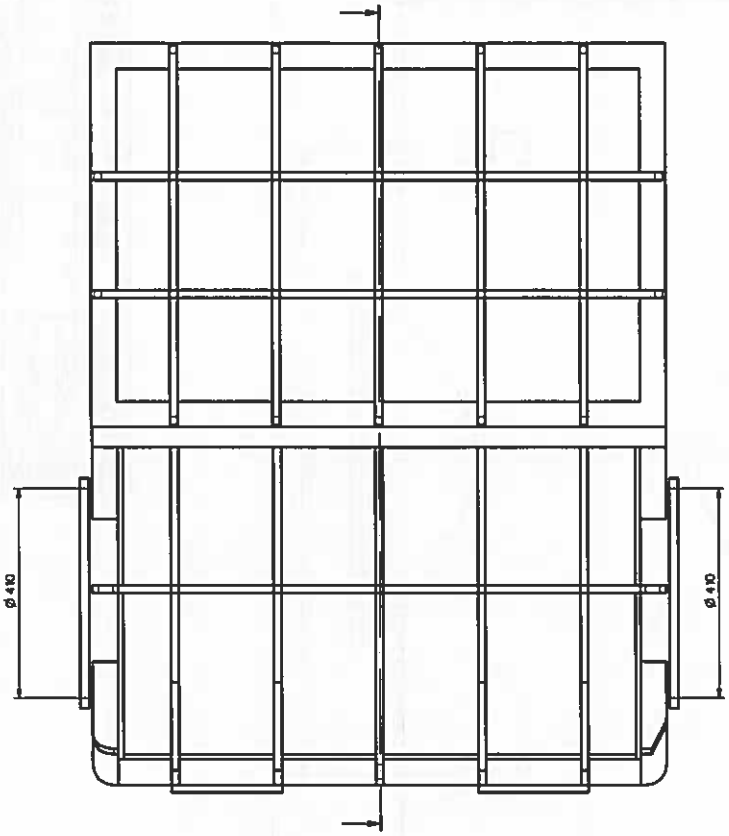
Drawn by: Aleš Lipský	Comments	Scale 1:10	Dwg title: L3 injection
Checked by:			
Date: 21.10.2015			
Material:	All dimensions in mm		Dwg no: 00102965/Sheet 2
Appr. mat:	Version: ISO 768-m		
Weight:	Application:		

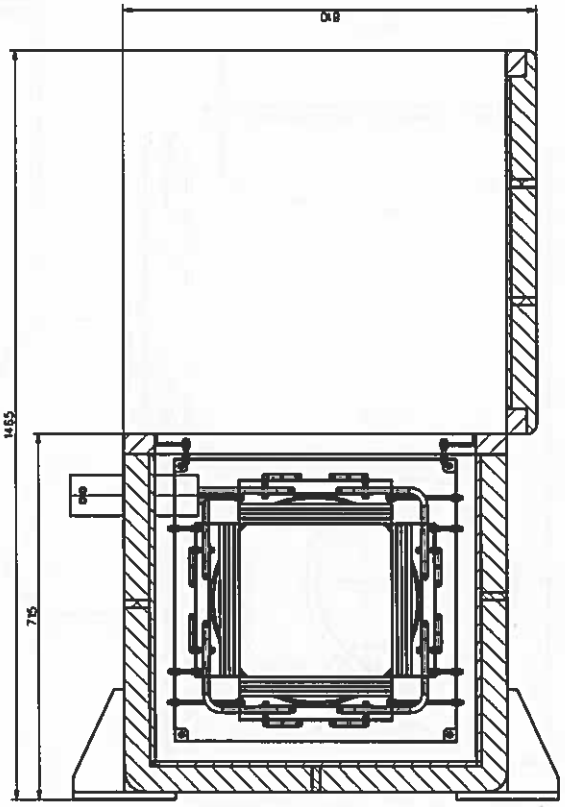
Fyzikální ústav
Akademie věd ČR, v. v. i.

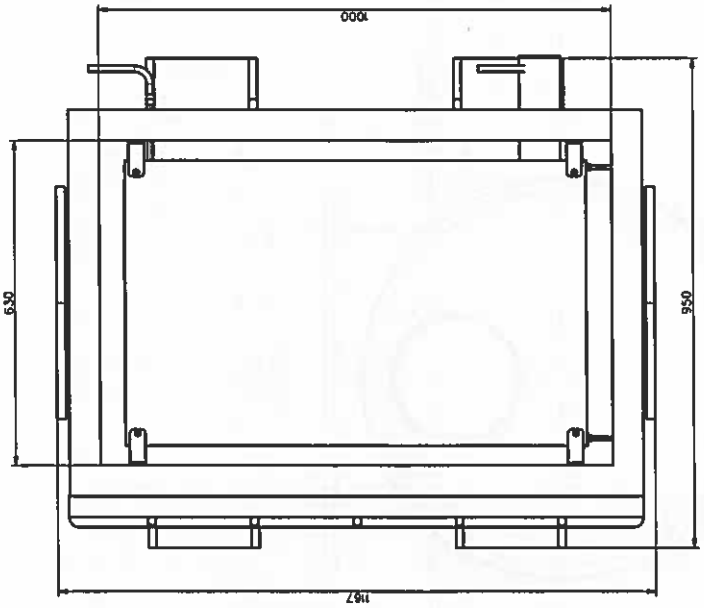




Projection	eli beamlines		Fyzikální ústav Akademie věd ČR, v. v. i.
Drawn by: Aleš Lerach	Comments	Scale 1:5	Dwg. title L3 injection
Checked by:			
Date: 21.10.2015			
Material:	All dimensions in mm		Dwg. no. 00102965/Sheet 5
Raw mat.:	Tolerance: ISO2768-mK		
Weight:	Application		





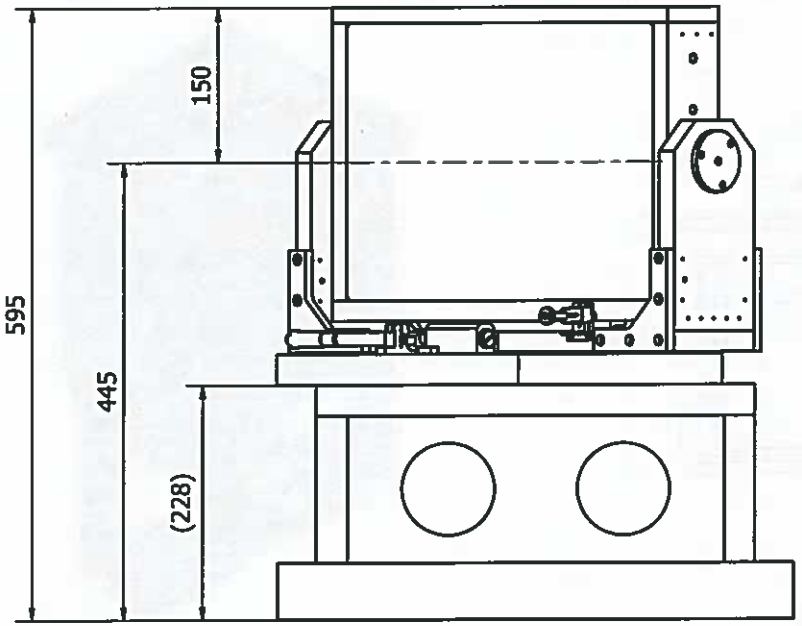


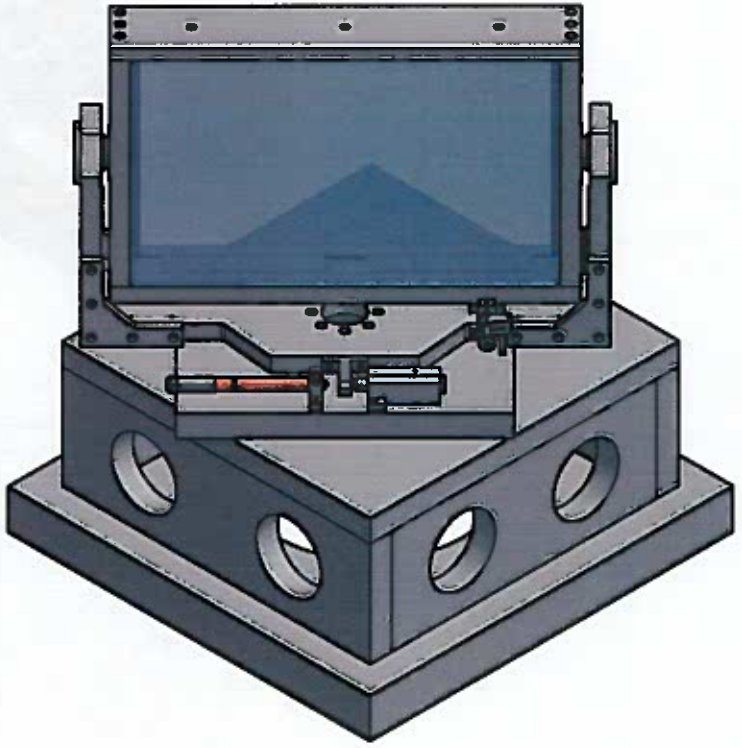
Fyzikální ústav

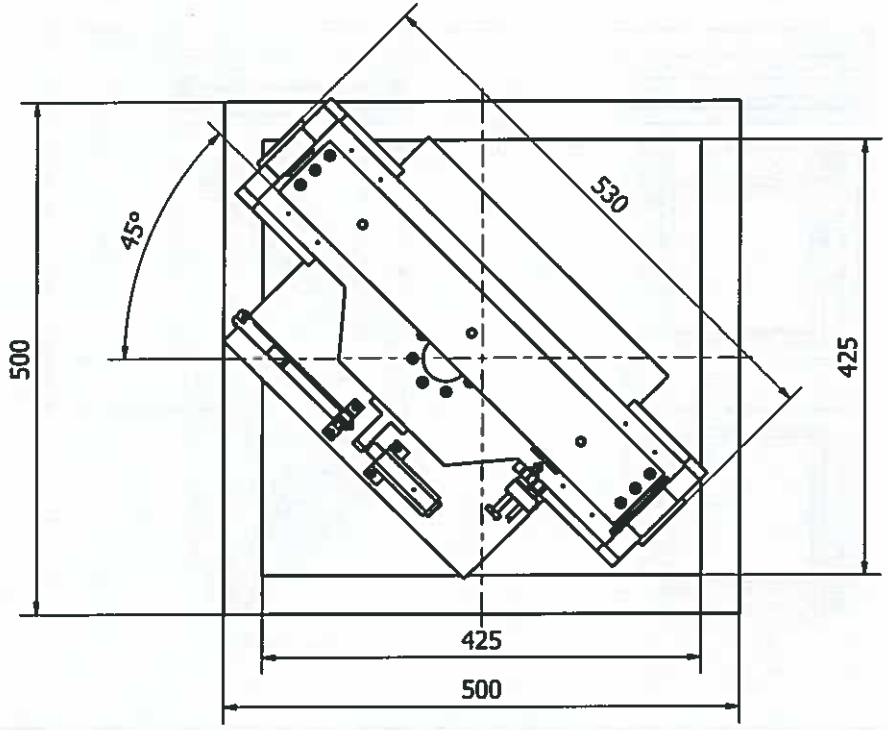
Injection - cryogenic segment
Preliminary design

Scale 1:1

Drawing No. 00118947



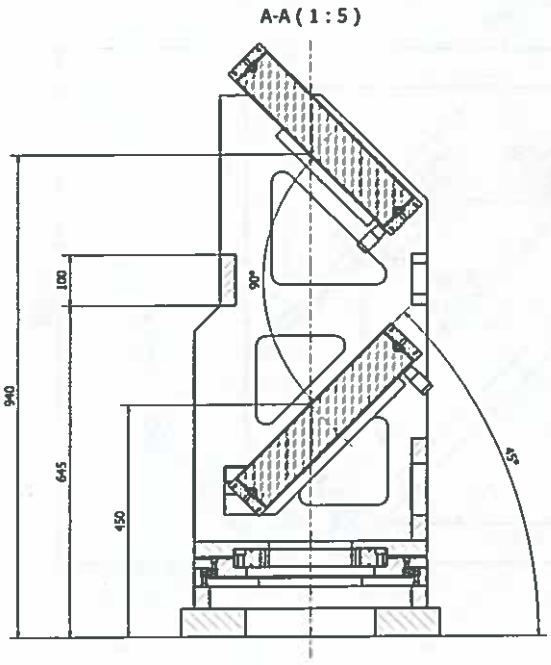


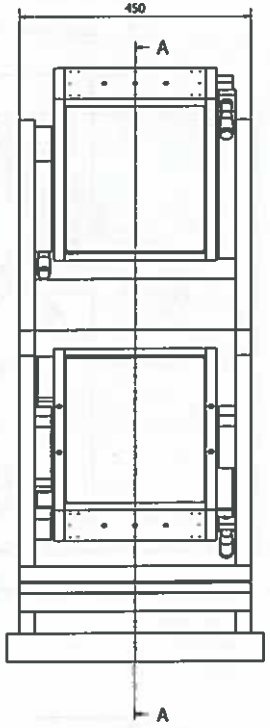


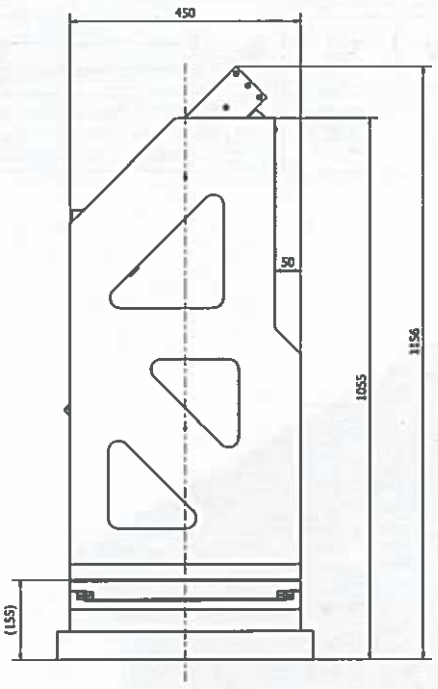
eli beamlines

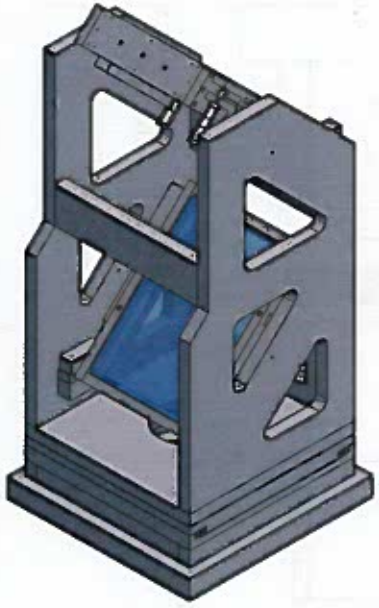
Fyzikální ústav
Akademie věd ČR, v. v. i.

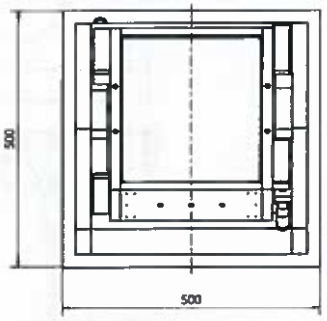
Drawn by: vaclav.orna	Projection	Scale	Sheet size	Dwg. title
Chkd by:		1:5	A3	L3K_MBS_ASSEMBLY_LOW
Date: 2.10.2015				
Material:		All dimensions in mm		Dwg. no./TC ID: 00120891 — Rev.: 00
Raw mat.:		Tolerance: ISO2768-mK		
Weight:		Note:		Eli no.: — Sheets 1 of 1

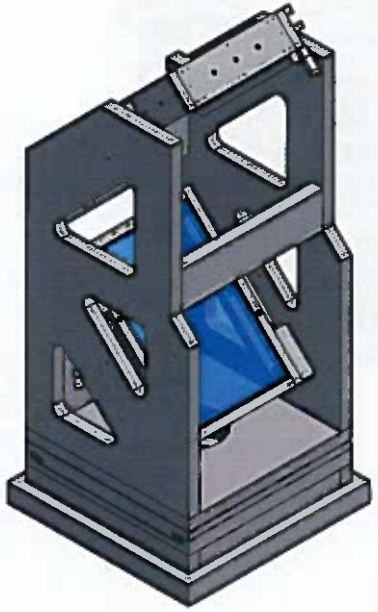




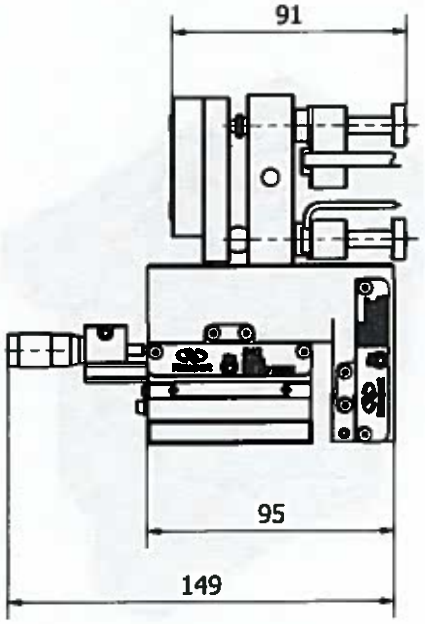


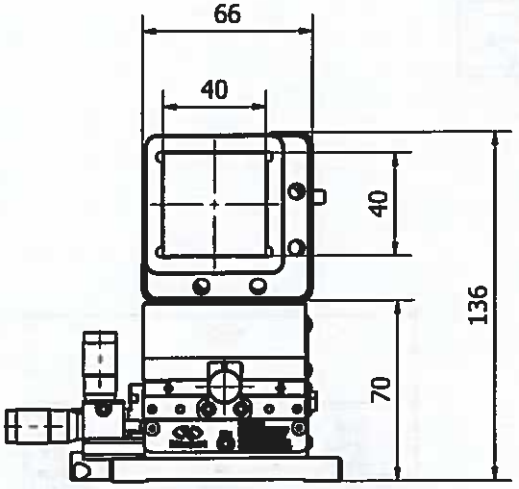


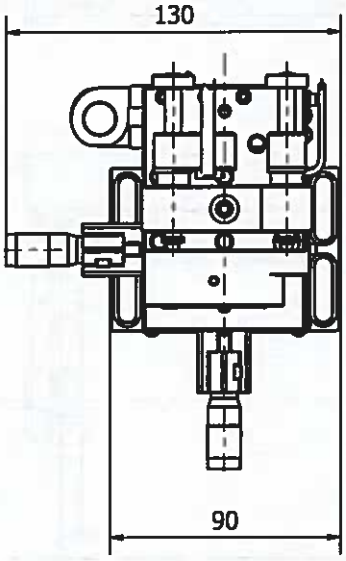


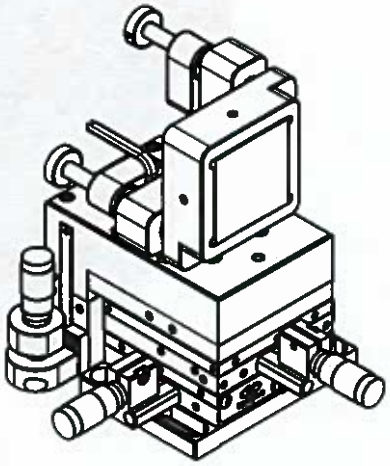


Drawn by: stefan arma
Checked by:
Date: 2.10.2015
Material:
Raw dim.:
Weight:
Projection:
Scale: 1:5
Sheet size: A1
Fyzikální ústav Akademie věd ČR, v. v. i.
Dwg. Title: L3_P2_ ASSEMBLY TOWER_PLU
Dwg. no.: 00120944
Rev.: 00
Sheet 1 of 1

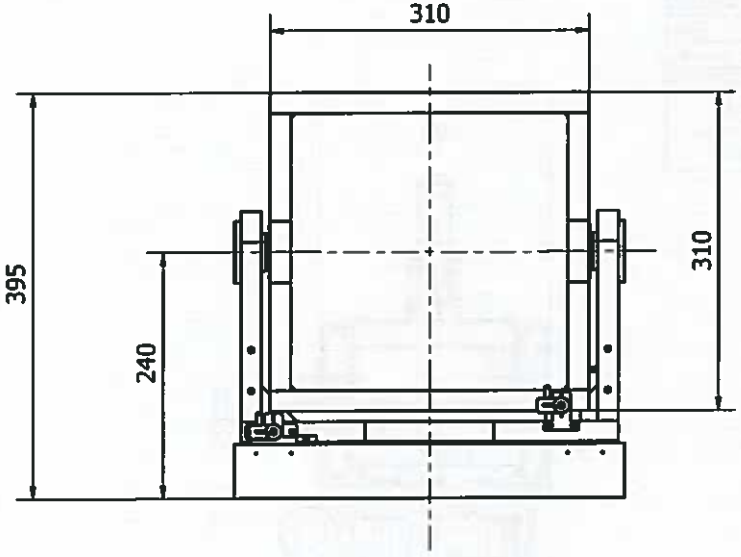


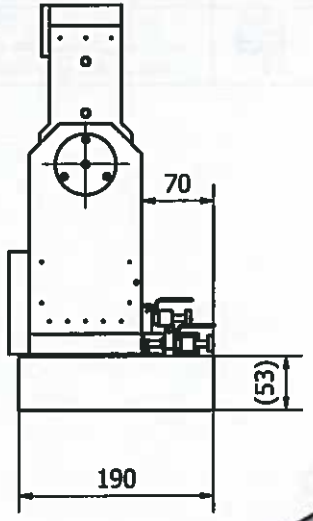


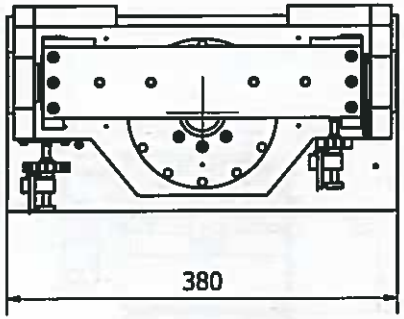


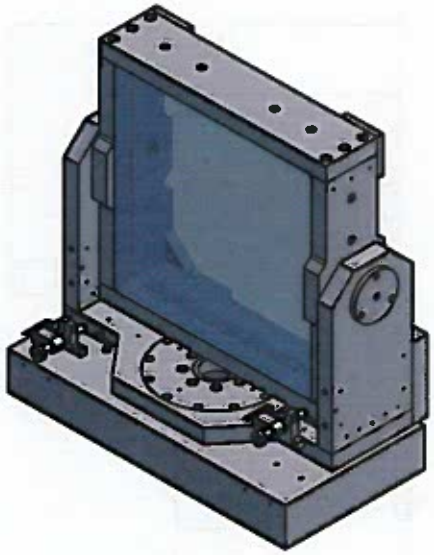


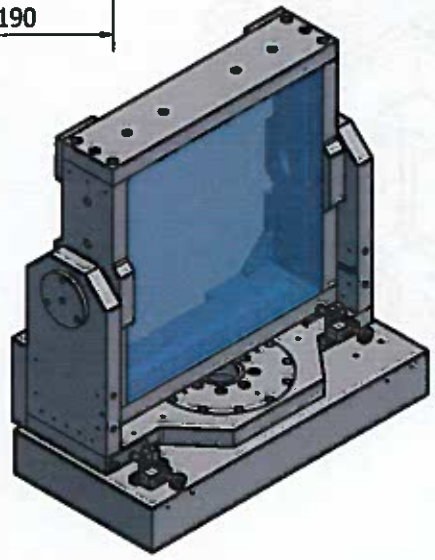
The information contained in this drawing is the sole property of FZU. Any reproduction is prohibited		eli beamlines		Fyzikální ústav Akademie věd ČR, v. v. i.
Drawn by: vaclav.orna	Projection	Scale 1:2	Sheet size A3	Dwg. title: L3C_HYPERBOLIC MIRROR
Chkd by:				
Date: 23.10.2015				
Material:		All dimensions in mm		Dwg. no./TC ID: 00120971 Rev.: 00
Raw mat.:		Tolerance: ISO2768-mK		
Weight:		Note:		Eli no.: Sheets 1 of 1



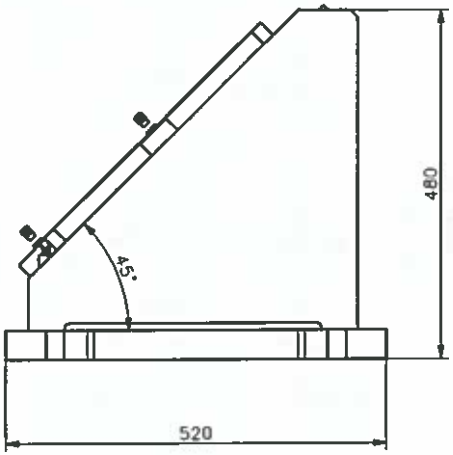


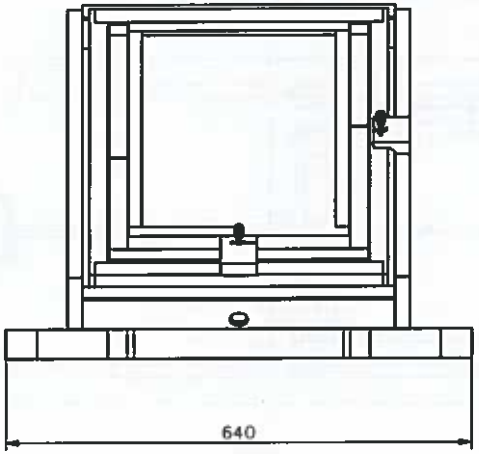


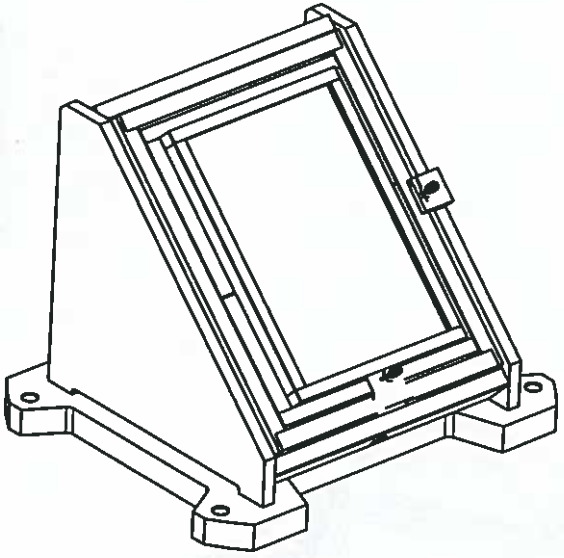


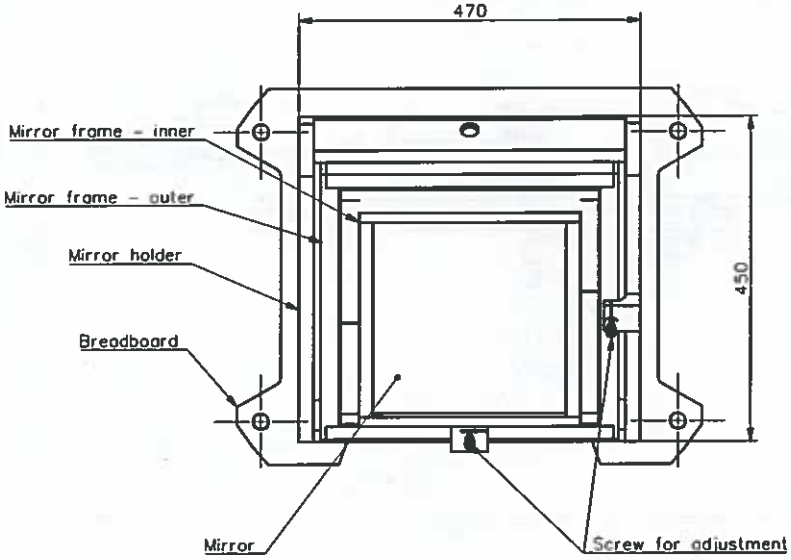


The information contained in this drawing is the sole property of FZU. Any reproduction is prohibited		eli beamlines		Fyzikální ústav Akademie věd ČR, v. v. i.
Drawn by: vaclav.orna	Projection	Scale 1:5	Sheet size A3	Dwg. title L3K_PM_ASSEMBLY 4
Chkd by:				
Date: 2.10.2015				
Material:		All dimensions in mm		Dwg. no./TC ID 00092122 Rev. 00
Raw mat.:		Tolerance: ISO2768-mK		
Weight:		Note:		Eli no.: Sheets 1 of 1

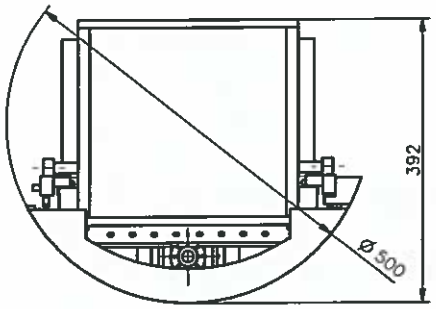


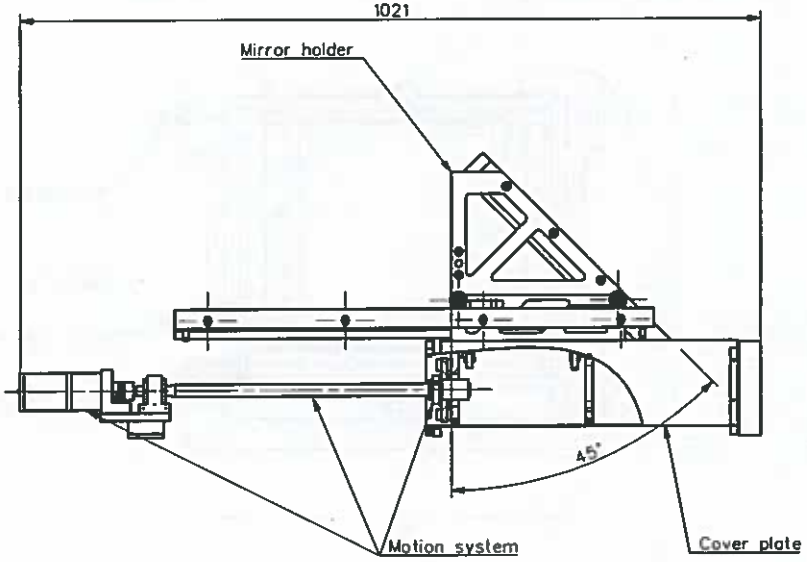


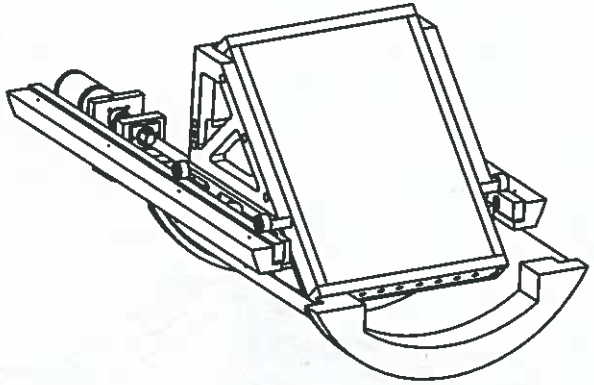


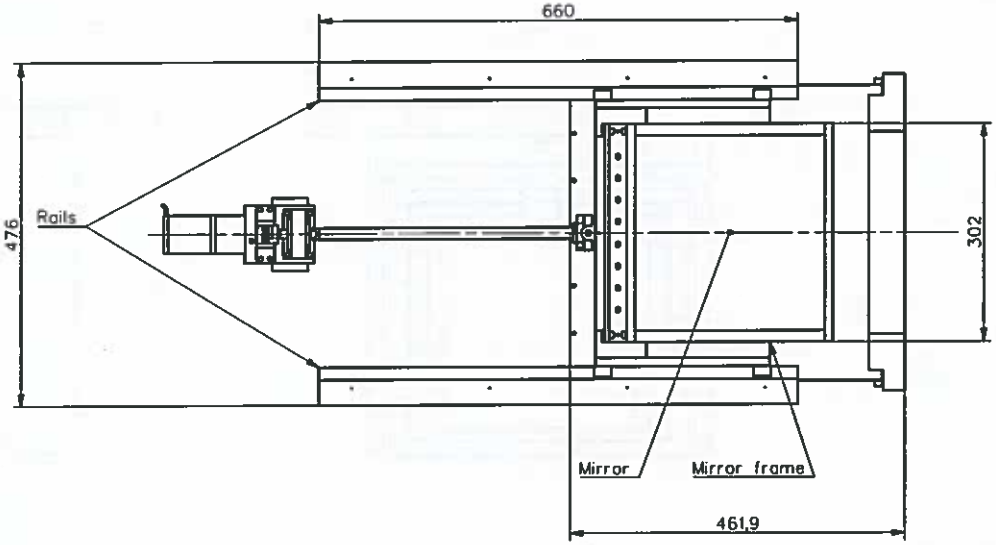


Projection	eli beamlines	Fyzikální ústav Akademie věd ČR, v. v. i.	
Drawn by: Lerach	Comments	Scale 1:5	Dwg. title: Mirror 45° assembly
Checked by:			
Date: 30.9.2015			
Material:	All dimensions in mm	Dwg. no. 00099985/Sheet 1	
Raw mat.:	Tolerance: ISO2768-mK		
Weight:	Application	Sheet 1 of 1	

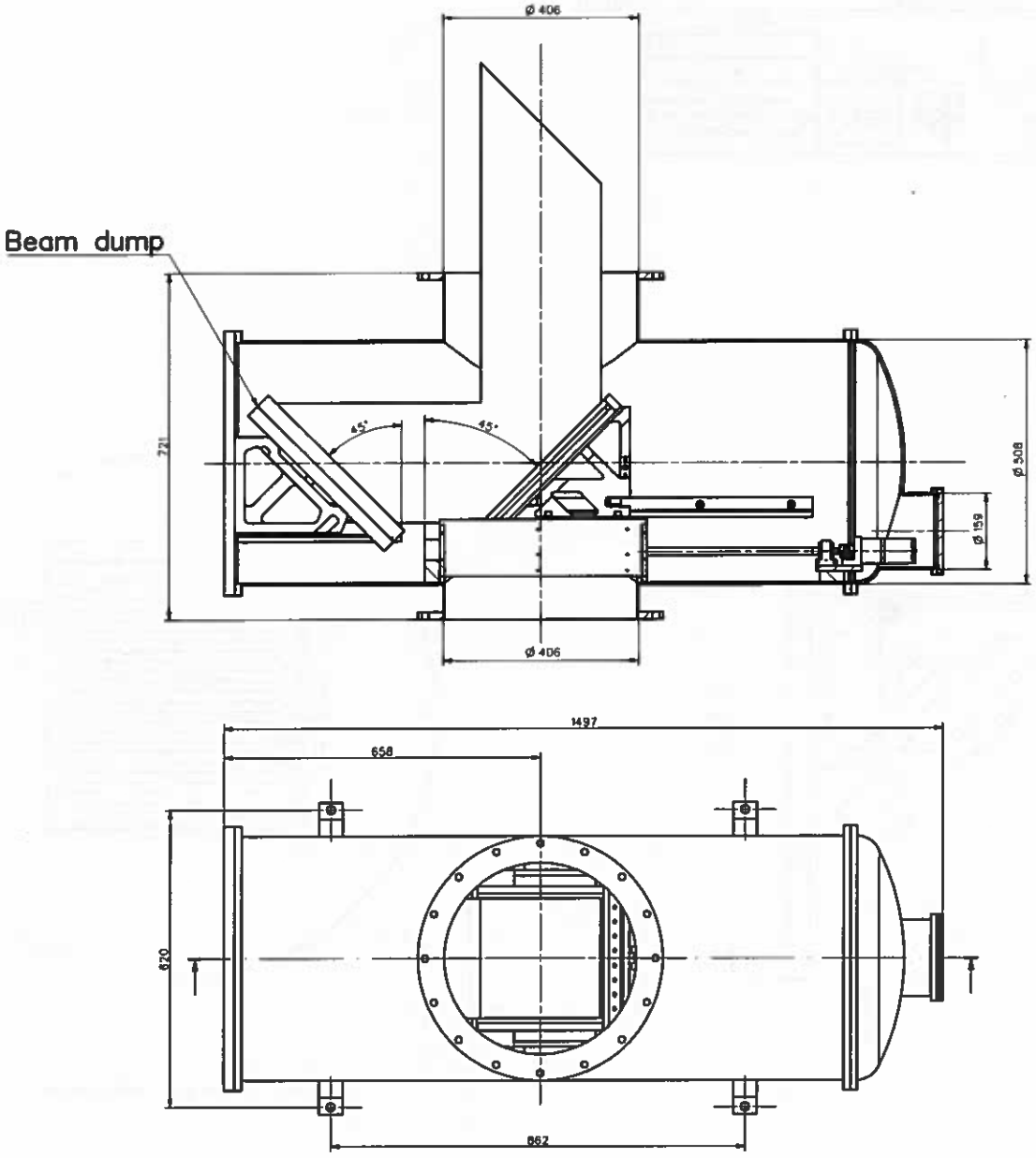




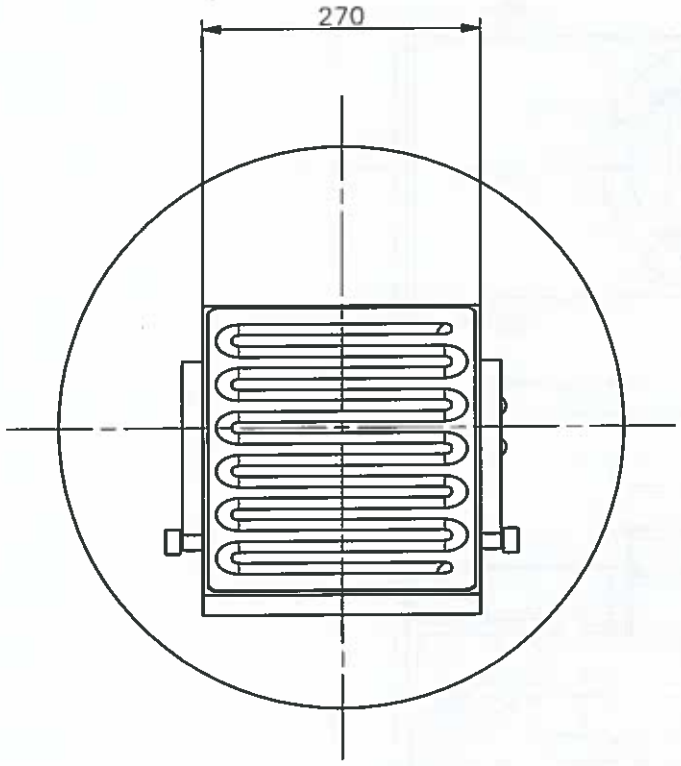


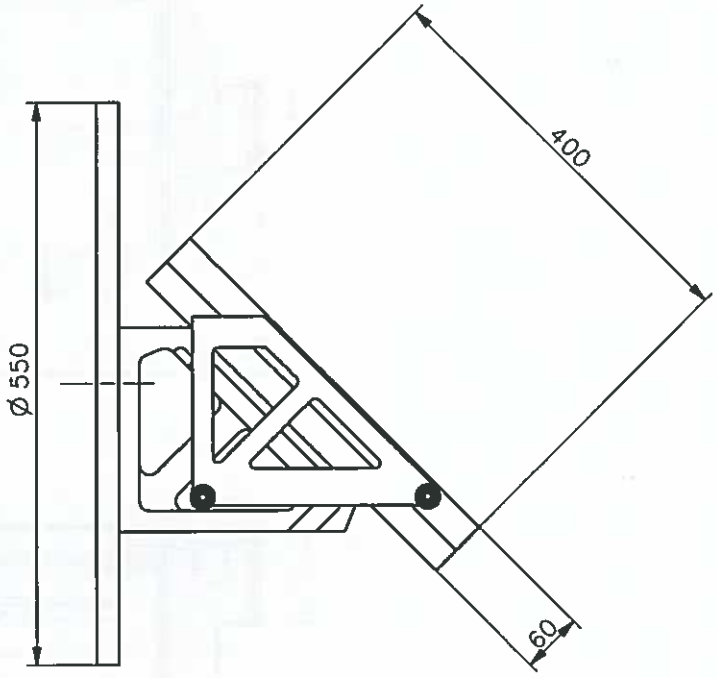


Projection	eli beamlines	Fyzikální ústav Akademie věd ČR, v. v. i.	
Drawn by: Lerach	Comments	Scale 1:5	Dwg. title: Sliding mirror assembly
Checked by:			
Date: 1.10.2015			
Material:	All dimensions in mm	Dwg. no. 00106849	
Raw mat.:	Tolerance: ISO2768-mK		
Weight:	Application		

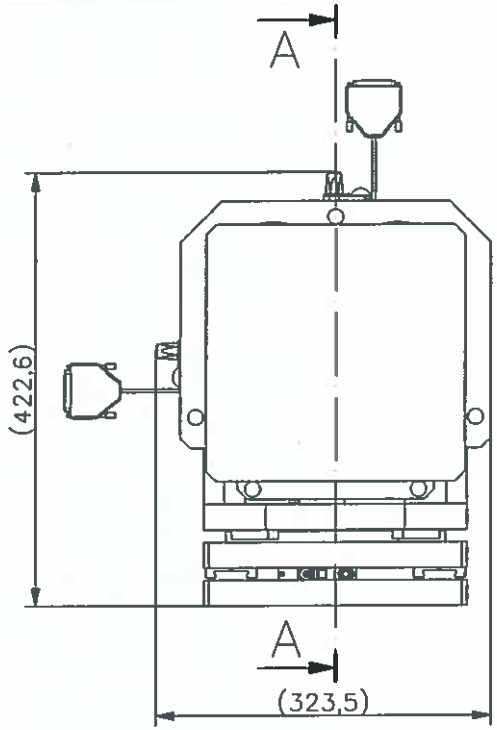


Drawn by: Lynch	Comments:	Scale: 1:5	Fyzikální ústav Akademie věd ČR, v. v. i.
Checked by:			Dwg title: L3 injection - beam dump chamber Preliminary design
Date: 7.10.2015			
Material:	All dimensions in mm		Dwg no: 00102985/Sheet 3
Appr. mat.	Tolerance ISO 768-mK		
Weight: 505.558	Application		

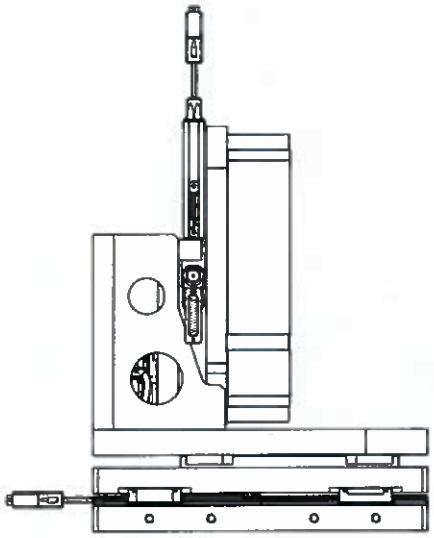


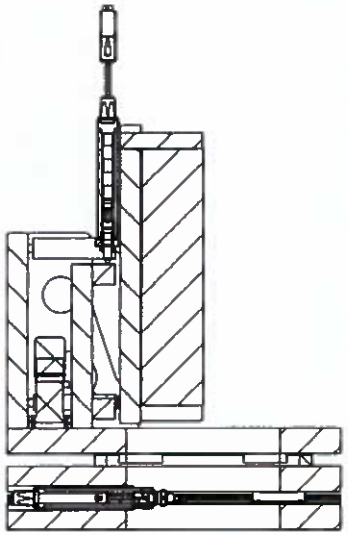


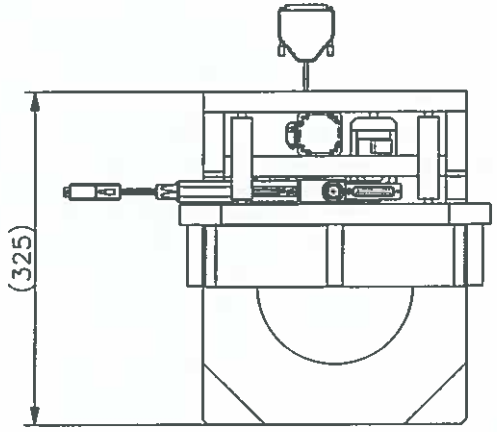
Projection	eli beamlines	Fyzikální ústav Akademie věd ČR, v. v. i.	
Drawn by: Leroch	Comments	Scale 1:5	Dwg. title L3 injection - beam dump Preliminary design
Checked by:			
Date: 22.10.2015			
Material:	All dimensions in mm		Dwg. no. 00102965/Sheet 4
Raw mat.:	Tolerance: ISO2768-mk		EU S. Nr.
Weight:	Application		

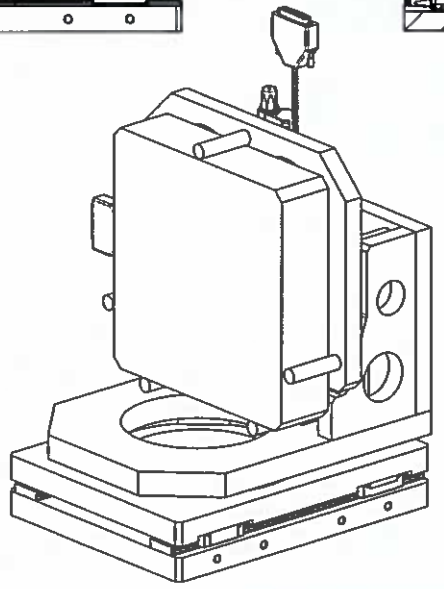


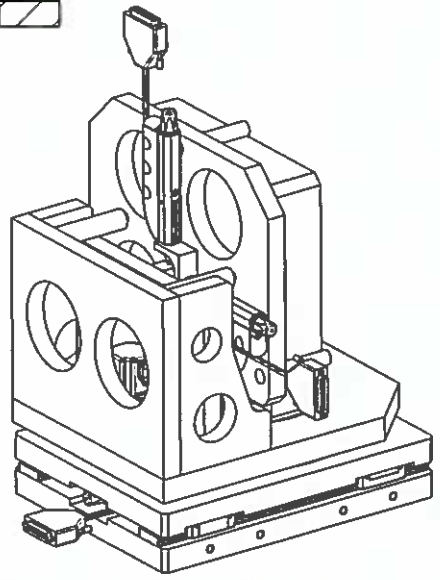
A–A (1:5)



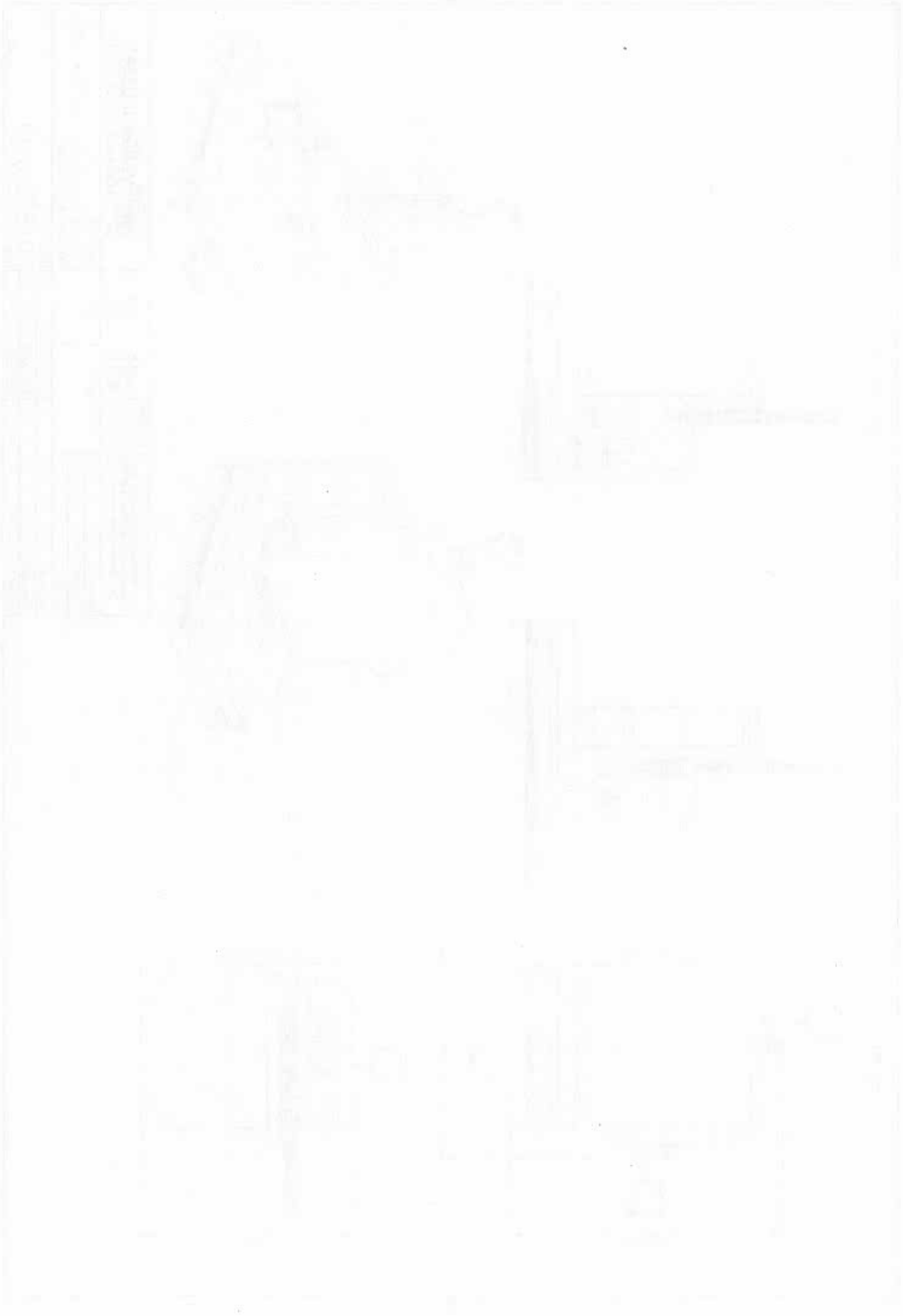








The informations contained in this drawing are the sole property of FZU. Any reproduction is prohibited	Projection	eli beamlines	Fyzikální ústav Akademie věd ČR, v. v. i.
Drawn by:	Comments	Scale 1:1	Dwg. title: 6-axis positioning unit for OAP Preliminary Design
Checked by:			
Date:			
Material:	All dimensions in mm		Dwg. no. 00118736/00
Raw mat.:	Tolerance: ISO2768-mk		
Weight: –	Application		ELI B. Nr. Sheet 1 of 1



ANNEX 3

QUALITY AND VERIFICATION PLAN

Institute of Physics ASCR, v. v. i.
Na Slovance 2
182 21 Prague 8
Czech Republic
eli-cz@fzu.cz
www.eli-beams.eu

Annex No. 3
Quality & Verification Plan

Vacuum compressor and beam injector of PW laser pulses for the ELI-Beamlines L3 laser system [TP14-094]

TC ID/Revision: 00121617/C
Confidentiality: BL - Restricted for internal use
WBS code: 3.3
PBS code: RA1.L3.HAPL.CMP

1. Quality Requirements for Supplier

1.1. Verification Control Document (VCD)

Verification of all requirements shall be tracked by the Verification Control Document (VCD). The VCD is a living document which shall be used throughout the entire contract and its phases (design, manufacturing, testing, and installation) and which specifies how and when each requirement is planned to be verified, and when it was actually verified.

N°	TC N°		Requirement	Verification by
QR1-01	REQ-014007	A	The Supplier shall provide the first version of the Verification Control Document (VCD) as a part of the D1 Deliverable. *NOTE: Binding guidelines for VCD preparation will be provided by the Client within 15 working days from the Commencement Day of the contract.*	R - review

1.2. General Quality Requirements

N°	TC N°		Requirement	Verification by
QR1-02	REQ-014045	A	The Supplier shall identify a Quality Manager for the project, responsible for implementing and performing management and other Quality disciplines and functions.	Not To Be Tracked within VCD
QR1-03	REQ-014046	A	If the Supplier delegates the quality assurance tasks to other organization it shall be done in a documented and controlled way monitored by the Supplier.	Not To Be Tracked within VCD
QR1-04	REQ-014047	A	The Supplier shall prepare, maintain and implement a Quality Plan for the product development and manufacturing to ensure that the product quality is in compliance with intended use and in conformity with requirements. *NOTE: The Client reserves the right to provide basic requirements for the Quality Plan.*	Not To Be Tracked within VCD
QR1-05	REQ-014048	A	The Quality Plan shall be submitted according to provisions of Annex 1.	Not To Be Tracked within VCD

1.3. Non-Conformity Control System

N°	TC N°		Requirement	Verification by
QR1-06	REQ-014049	A	The Supplier shall establish and maintain a non-conformity control system compatible with ČSN EN ISO 9001: 2010 edition 2.	R - review

1.4. Documentation and data control

N°	TC N°		Requirement	Verification by
QR1-07	REQ-014050	A	The Supplier shall supply the following : • Full technical documentation • Handling, installation and maintenance manuals • All approved "requests for deviation/waiver"	I – inspection
QR1-08	REQ-014051	A	All documentation shall be supplied in both hardcopy and PDF/A.	Not To Be Tracked within VCD
QR1-09	REQ-014052	A	The Supplier shall provide the following types of technical documentation: • 3D model • 2D drawings	Not To Be Tracked within VCD
QR1-10	REQ-014053	A	The Supplier shall use the following data formats: • *.JPG • *.PNG • *.PDF/A • CAD 2D: *.dwg • CAD 3D: *.stp; *.ste; *.step, *.x_t; *.x_b, or other 3D CAD formats agreed with the Client • Text processors *.doc, *.docx, OpenDocument Format • Spreadsheet processors *.xls, *.xlsx, OpenDocument Format • Presentations *.ppt, *.pptx; OpenDocument Format • *.HTML	Not To Be Tracked within VCD

2. Verification Requirements for Supplier

2.1. General

N°	TC N°		Requirement	Verification by
QR2-01	REQ-013994	A	The verification process shall be managed by the Supplier and shall proceed according to the Verification Plan (VP), see provisions of Annex 1. It shall include the following activities: 1. **Verification planning** 2. **Verification execution and reporting** 3. **Verification control and close-out**	Not To Be Tracked within VCD
QR2-02	REQ-013995	A	The Supplier shall assign clear responsibility for the implementation of the verification process including the activities defined in QR2-01 (REQ-013994/A).	R - review

2.2. Verification Planning

N°	TC N°		Requirement	Verification by
QR2-03	REQ-013997	A	The Verification Plan (VP) shall describe **HOW** and **WHEN** each of the technical requirements will be verified: *NOTE: The Client reserves the right to provide binding guidelines for establishing the VP, within 15 working days from the Commencement Day of the contract.*	Not To Be Tracked within VCD

2.3. Verification execution

N°	TC N°		Requirement	Verification by
QR2-04	REQ-013998	A	The verification execution process shall consist of the following stages according to the contract execution: • Critical Design Review as a part of the acceptance of D3; • Factory testing / performance verification at the Supplier's site, as a part of the acceptance of D4, D5 and D8; • Performance verification at the ELI-Beamlines facility, as a part of the acceptance of D6, D7 and D9. *NOTE 1: The Critical Design Review (CDR) is intended to verify that the design meets the requirements and/or to identify required corrective actions that have to be implemented before proceeding to the manufacturing phase.* *NOTE 2: The factory testing / performance verification of the manufactured subsystems is intended for confirmation that the subsystems are ready for shipment to the Client.* *NOTE3: Performance verification at the ELI Beamlines facility will be performed after the corresponding subsystems are installed.*	Not To Be Tracked within VCD
QR2-05	REQ-013999	A	In the acceptance stage the verification shall demonstrate that the product meets the specifications and that it is free of fabrication defects and is ready for the intended operational use.	Not To Be Tracked within VCD
QR2-06	REQ-014000	A	Acceptance shall be carried out on final hardware and software.	Not To Be Tracked within VCD
QR2-07	REQ-014001		Verification shall be accomplished by the Supplier through one or several of the following methods: 1. **Review of design**; Verification by Review (R) shall consist of using official project documentation (e.g. design and technical documentation, numerical analysis reports, engineering drawings, manuals and operation documentation) that unambiguously shows that the requirement is met. 2. **Inspection**; Verification by Inspection (I) shall consist of visual examination of the manufactured and/or assembled product. 3. **Test** (including functional demonstration); Verification by Test (T) shall consist of quantitatively measuring performance of the product and of its functions in a defined operating regime. 4. **Analysis**; Verification by Analysis (A) shall consist of performing numerical or empirical performance evaluation of the product using a technique defined in the VP.	Not To Be Tracked within VCD

2.4. Verification close out

N°	TC N°		Requirement	Verification by
QR2-08	REQ-014007	A	The verification process shall be considered complete for a given project phase (contractual Deliverables) when the Client approves all corresponding items in the VCD by confirming that: 1. All specified requirements for a given project phase (contractual Deliverable) have successfully been verified; 2. All detected non-conformities have been solved in accordance with QR1-06 (REQ-014049/A)	Not To Be Tracked within VCD
QR2-09	REQ-014008		In case of completed acceptance for a given project phase (contractual Deliverable) the Client shall provide to the Supplier the Delivery Acceptance Protocol, according to Section 9 of the Contract *(Acceptance of Deliverables and Handover of the Object of Purchase)*.	Not To Be Tracked within VCD
QR2-10	REQ-014009		In case when acceptance of a given requirement failed the Client shall provide to the Supplier a Non-Conformity Report (NCR) and process according to QR1-06 (REQ-014049/A) shall be applied.	Not To Be Tracked within VCD

3. Quality & Verification Plan

The table below summarizes the compulsory Quality and Verification activities of design, manufacturing, testing and installation. These activities must be included in the detailed Quality and Verification Plan developed by the Supplier.

Abbreviations:

(I) Inspection, (RoD) Review of Design; (A) Analysis; (T) Test; (FD) Functional Demonstration. Further details see QR2-04 (REQ-013998/A).

(H) Hold point. Progress shall not be made to the next sequenced activity until the Requirements of the Hold Point Activity have been met.

(W) Witness point. The activity shall be witnessed in person with appropriate advance notice having been given.

(R) Review. Relevant official project documents for a given activity shall be reviewed, and a review report issued, by a responsible person at the Client.

Seq. No.	Activity	Input Requirements / Specifications	Place	Quality process		Verification process		Contractor		ELI-BL	
				Input	Output	Input	Output	Quality	Verification	Quality	Verification
1	Detailed design and manufacturing drawings (Deliverables D1 - D3)										
1.1	Contract Kick Off and Planning Meeting	Kick off meeting agenda	Contractor	n/a	Minutes	n/a	n/a	R	n/a	R	n/a
1.2	Design of specific components and manufacturing drawings by Supplier	Supply contract Engineering drawings Detailed Technical Specifications (Annex 2 of the contract)	Contractor or ELI-BL	Manufacturing drawings (D3 Deliverable)	Critical Design Review Report (CDRR; Annex 3 of the contract) QR (Quality Report)	Manufacturing drawings (D3 Deliverable)	CDRR VP VCD (Annex 3 of the contract)	n/a	RoD	H	RoD
1.3	Review of the contractor qualifications and procedures before launching fabrication	Contractor qualifications and procedures	Contractor	contractor qualifications and procedures	Inspection report	n/a	n/a	n/a	n/a	W	I
1.4	Failure Mode and Effect Analysis (FMEA)	Detailed Technical Specifications (Annex 2 of the contract)	Contractor or ELI-BL	Detailed Technical Specifications + D3 Deliverable	Analysis Report (AR)	n/a	n/a	AR/H	A	R	RoD
1.5	Vacuum control system state machine design specification	Detailed Technical Specifications (Annex 2 of the contract)	Contractor or ELI-BL	Design documentation	RoD Report	Design documentation	RoD Report	H	RoD	R	RoD
1.6	Control system software component design and software requirements specification (SRS)	Detailed Technical Specifications (Annex 2 of the contract)	Contractor or ELI-BL	Design documentation	RoD Report	Design documentation	RoD Report	H	RoD	R	RoD

Seq. No.	Activity	Input Requirements / Specifications	Place	Quality process		Verification process		Contractor		ELI-BL	
				Input	Output	Input	Output	Quality	Verification	Quality	Verification
2	Factory testing, performance verification at the Supplier (Deliverables D4, D5 and D8)										
2.1	Welding Coordination Tasks and responsibilities	EN ISO 14731	Contractor	EN ISO 14731	Certificates	n/a	n/a	H	I	R	I
2.2	Welding personnel qualification	EN 287-1, EN ISO 9606, EN ISO 14732 or relevant	Contractor	EN 287-1, EN ISO 9606, EN ISO 14732 or relevant	Certificates	n/a	n/a	H	I	R	I
2.3	Inspection of the raw material and components, traceability	Raw material certificates and contractor traceability procedure	Contractor	Raw material certificates and contractor traceability procedure	Certificates and procedures	n/a	n/a	H	I	W	I
2.4	Welding inspection	Production drawings (D3 Deliverable), welding procedures, welding sequence plan	Contractor	Production drawings (D3 Deliverable), welding procedures, welding sequence plan	Inspection report	n/a	n/a	H	n/a	W	n/a
2.5	NDT inspection	NDT Procedures	Contractor	NDT Procedures	Inspection report	NDT specification	Test/Inspection report	H	T, I	R	R, I
2.5.a	Visual inspection 100% EN ISO 17637	EN ISO 5817, evaluation group B	Contractor	Criteria according to EN ISO 5817, evaluation group B, product to be verified	Inspection report	Criteria according to EN ISO 5817, evaluation group B, product to be verified	Inspection report	H	I	W	R, I
2.5.b	Surface crack test /PT/ all load bearing parts EN ISO 17637	EN ISO 23277 evaluation group 1	Contractor	Criteria according to EN ISO 5817, evaluation group B, product to be verified	Inspection report	Test specification	Test/Inspection report	H	T, I	W	R, I
2.6	Vacuum control system offline testing of sequences and failure mode handling	Vacuum control system state machine design specification	Contractor	Vacuum control system state machine design specification	Quality Report	Test specification	Test report	H	T	W	R, I
2.7	Machine Safety and Personnel Safety Interlock systems simulated interface functional testing	Control system design specification	Contractor	Vacuum control system state machine design specification	Quality Report	Test specification	Testing report	H	T	W	R, I

Seq. No.	Activity	Input Requirements / Specifications	Place	Quality process		Verification process		Contractor		ELI-BL	
				Input	Output	Input	Output	Quality	Verification	Quality	Verification
2	Factory testing, performance verification at the Supplier (Deliverables D4, D5 and D8)										
2.8	Motion control systems basic functional demonstration	Control system design specification	Contractor	Control system design specification	Quality Report	FD specification	Inspection report	H	FD, I	W	R, I
2.9	Inspection of the finished chamber structure including surface and dimensional control	Production drawings (D3 Deliverable) Detailed Technical Specifications (Annex 2 of the contract)	Contractor	Production drawings (D3 Deliverable) Detailed Technical Specifications	Inspection and dimensional control report	Production drawings (D3 Deliverable) Detailed Technical Specifications	Inspection and dimensional control report	H	T, I	W	R, I
2.10	Inspection of the cleaned chamber and vacuum test	Manufacturing requirements specifications including cleaning procedure Vacuum test requirements	Contractor	Manufacturing requirements specifications including cleaning procedure Vacuum test requirements	Inspection and Test reports	Manufacturing requirements specifications including cleaning procedure Vacuum test requirements	Inspection and Test reports	H	T, I	H	R
2.11	Inspection of the internal optical table including surface and dimensional control	Production drawings Cleaning procedure	Contractor	Production drawings Cleaning procedure	Inspection and dimensional control report	Production drawings Cleaning procedure	Inspection and dimensional control report	H	T, I	W	R, I
2.12	Acceptance of the whole chamber and table assembled and pumped down	Production drawings Detailed Technical Specifications (Annex 2 of the contract) Cleaning procedure	Contractor	Production drawings Detailed Technical Specifications (Annex 2 of the contract) Cleaning procedure	Inspection and Test report	Production drawings Detailed Technical Specifications (Annex 2 of the contract) Cleaning procedure	Inspection and Test report	H	T, I	W	R, I
2.13	Package for transport	Part list Shipping specifications	Contractor	Part list Shipping specifications	Shipping list	n/a	n/a	H	I	W	I

Seq. No.	Activity	Input Requirements / Specifications	Place	Quality process		Verification process		Contractor		ELI-BL	
				Input	Output	Input	Output	Quality	Verification	Quality	Verification
3	Installation and performance verification at ELI-Beamlines facility (Deliverables D6, D7 and D9)										
3.1	Shipping and receiving at ELI-BL	Shipping and receiving specifications	ELI-BL	Shipping and receiving specifications	Receiving report	n/a	n/a	W	I	H	I
3.2	Unpack, clean and prepare for installation	Unpacking and storage specifications from	ELI-BL	Unpacking and storage specifications from	Receiving report	n/a	n/a	n/a	n/a	H	I
3.3	Moving into L3 hall, installing chamber	Installation procedure	ELI-BL	Installation procedure	Installation report	n/a		W	I	H	I
3.4	Connect to ELI-BL vacuum system and verify that the chamber can be pumped down to 10^{-7} mbar	Installation procedure	ELI-BL	Installation procedure	Installation report	Installation and Test procedure	Test report	n/a	n/a	H	T,I
3.5	Install the temporary tent around the chamber	Installation procedure	ELI-BL	Installation procedure	Installation report	Installation procedure	Installation report	n/a	n/a	H	R
3.6	Install the internal optical table	Installation procedure	ELI-BL	Installation procedure	Installation report	Installation procedure	Installation report	n/a	n/a	H	R, I
3.7	Pump down including TMP and verify that the integrated chamber including internal table can be maintained at 10^{-7}	Installation procedure	ELI-BL	Installation procedure	Test report	Installation procedure	Test report	n/a	n/a	H	T

Seq. No.	Activity	Input Requirements / Specifications	Place	Quality process		Verification process		Contractor		ELI-BL	
				Input	Output	Input	Output	Quality	Verification	Quality	Verification
3	Installation and performance verification at ELI-Beamlines facility (Deliverables D6, D7 and D9)										
3.8	Acceptance of the whole chamber and table assembly	Detailed Technical Specification (Annex 2 of the contract)	ELI-BL	Detailed Technical Specification (Annex 2 of the contract)	Acceptance certificate	Detailed Technical Specification (Annex 2 of the contract)	Acceptance certificate	W	R	H	T
3.9	Validate vibration stability of the table	Optical installation procedure	ELI-BL	Optical installation procedure	Test report	Optical installation procedure	Test report	n/a	n/a	H	T
3.10	Prepare/install alignment devices and/or fiducials into the compressor	Optical installation procedure	ELI-BL	Optical installation procedure	Inspection and Test report	Optical installation procedure	Inspection and Test Report	n/a	n/a	H	T
3.11	Install optomechanical motorized positioning units for the gratings and verify they are functional	Optical installation procedure	ELI-BL	Optical installation procedure	Inspection and Test report	Optical installation procedure	Inspection and Test report	n/a	n/a	H	T

ANNEX 4

SUPPLIER'S BID

In case of any discrepancy between the following specifications and information on nature of performing the Delivery and any other provision of this Contract including all its Annexes the provisions of this Annex 4 shall prevail if and in the extent in which they are containing specifications and conditions that are more favourable to the Client (i.e. higher technical specification values and/or more technically advanced or demanding solutions etc.).

A) Offer of the Supplier reflecting partial quality evaluation criteria

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Partial quality evaluation criteria table

Criterion No.	Basic value according to tender conditions	Value offered by the bidder	Unit	Limited to	Partial criterion value (%)
Art. 6 b) of the TD: Remaining warranty duration on the TMPs	12	24	months	max 24	6
Art. 6 c) of the TD: Remaining warranty duration on the vacuum valves	100 000	200 000	open/close cycles	max 200 000	6
Art. 6 d) of the TD: Remaining warranty duration of the control systems	12	24	months	max 24	6
Art. 6 e) of the TD: Date of earlier delivery of Deliverable D9	19	18	months	min 16	3
Art. 6 f) of the TD: Cleanliness of the cleanroom for assembling and testing	ISO 7	ISO 7	ISO 14644 classes	min ISO 5	6
Art. 6 g) of the TD: Time of insertion / retraction of the translation movement of IOM2	5	2	seconds	min 1	3

In Brno on December 14, 2015

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DELONG INSTRUMENTS a.s.

B) Qualification prerequisites

The Supplier shall carry out assembly and testing works hereunder in its cleanroom space described within the Bid as follows:

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Affidavit – Technical Qualification
Cleanroom space

pursuant to Act No. 137/2006 Coll., on public contracts, as amended (hereinafter the "Act")

The Applicant – a corporation DELONG INSTRUMENTS a.s., with registered offices in Palackého třída 3019/153b, ID 46903879, acting through its member of the Boards,

we hereby solemnly declare that we have cleanroom space:

1. **Class 7** - 200 m^2 with surface dimension 18 x 12 m and height 3,5 m
   - For testing large vacuum units

2. **Class 5** - 50 m^2 with surface dimension 10 x 5 m
   - For assembling optomechanics and UHV vacuum units

In Brno on December 14, 2015

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DELONG INSTRUMENTS a.s.
Ing. Tomáš Papírek, člen představenstva

The Supplier shall use the following persons it identified within its Bid for performing this Contract while carrying out all the relevant activities hereunder:

The Supplier is allowed to use another person only if it proves such person possesses qualification and abilities conforming with Annex No. 6, Art. 5. letter c), to the tender documentation issued for purposes of Public Procurement requirements for each relevant position.

7	Ing. Josef Homolka, EWE / IWE	Welding Engineer / Welding Coordination Supervisor Svářecí inženýr / Vedoucí svářečského dozoru	2
8	Martin Pajger	Qualified welder Kvalifikovaný svářeč	2
9	Jan Landkamr	Qualified welder Kvalifikovaný svářeč	2
10	Pavel Mareš	Qualified welder Kvalifikovaný svářeč	2

In Brno on December 22, 2015

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DELONG INSTRUMENTS a.s.
Ing. Tomáš Papírek, člen představenstva

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

MINISTRY OF EDUCATION
YOUTH AND SPORTS

Affidavit – Technical Qualification

made pursuant to Act No. 137/2006 Coll., on Public Contracts, as amended (hereinafter the "Act")

Public Contract Name:	**Vacuum Compressor of PW Laser Pulses for the ELI-Beamlines L3 System**
Bidder's business name incl. legal form	DELONG INSTRUMENTS a.s.
Seat / place of business	Palackého třída 3019/153b, Královo Pole, 612 00 Brno
ID	46903879
Authorized representative	Ing. Tomáš Papírek

The above stated bidder hereby solemnly declares that for purposes of technical qualification proving (according to the Art. 5 (1) (c) of the Annex no. 2 of the Tender Documentation) we submit the following list of the technicians responsible for providing relevant services.

	Names of Persons stated in Bid	**Implementation Team Member**	**1. Internal Staff of the Bidder** **2. Subcontractor** *(i.e. STREICHER, spol. s r.o.)* **Internal Staff** **3. Subcontractor** *(choose which applicable)*
1	Ing. Tomáš Bejdák	Chief Project Manager Generální projektový manažer	1
2	Ing. Martin Hlaváč	Expert – Senior Optomechanical Designer Expert – senior konstruktér	1
3	Ing. Michal Andrys	Expert – Senior Optomechanical Designer Expert – senior konstruktér	1
4	Ing. Martin Tmej	Deputy Chief Project Manager/Senior Electronic Engineer Zástupce generálního projektového manažera/Senior elektronik	1
5	Ing. Petr Mikšík	Control Systems Expert / Senior Electronic Engineer Expert v oblasti řídících systémů / Senior elektronik	3
6	Ing. Petr Dobiáš	Electronics and Control System Expert / Senior Electronic Engineer Expert – elektronika a řídící systém / Senior elektronik	1