

Annex No. 3 –

Technical specifications (Requirements Specification Document + Verification Control Document)

TP14_143 Vacuum components branch L1-E1 including supporting frames II
(attached as a separate file)

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1. Introduction

1.1. Purpose

This Requirements Specification Document (RSD) lists the technical requirements and constraints on system applying in RA1 of ELI project. This leads to the identification of interfaces with the ELI laser systems and ELI building facility. This RSD also acts as the parent document for the technical requirements that need to be addressed in lower level design description documents.

1.2. Scope

This RSD contains all of the top level functional, performance, safety, operational, design and quality requirements for the **components of vacuum distribution L1 – E1**. In addition to the requirements specified in this RSD, this system shall comply completely with the requirements given in the Reference documents [chapter 1.4].

1.3. Terms, Definitions and Abbreviations

For the purpose of this document, the following abbreviated terms apply:

Abbreviation	Meaning
ELI	Extreme Light Infrastructure
RA1	Research activity 1
HHG	High Harmonic Generation
E1	Experimental hall 1
ESD	Electrostatic discharge
L1	Laser Hall 1
RSD	Requirement Specification Document
BT	Beam Transport
RC	Rectangular Chambers
CC	Cylindrical Chambers
CVC	Central Vacuum Control
TMP	Turbo Molecular Pump
R	Review of Design
FD	Functional Demonstration
T	Test
A	Analysis
I	Inspection
L x W x H	Length x width x height
N/A	Not Applicable
VP	Verification Plan

VCD	Verification Control Document
TRPT	Test report
ARPT	Analysis report
IRPT	Inspection report
VRPT	Verification report
TRR	Test Readiness Review
TSPE	Test specifications
PTR	Post Test Review
TPRO	Test procedures
CM	Compliance Matrix
VM	Verification Matrix
FPM	Fluorelastomer Polymer
CVS	Central vacuum system
ICD	Interface Control Document
RCS	Reference Coordinate System
RMS	Reference Mechanical System
FEM	Finite Element Method

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

- Positioning: placing of component without high precision (no special equipment needed);
- Adjustment: Placing of component with using special equipment (e.g. screws, actuators) to achieve high precision.

1.4. Reference documents

Number of document	Title of document
RD-01	TC#(00111980/A) - L1 to E1 Vacuum BT Drawings for tender
RD-02	TC#(00112523/A) – E1 Room datasheet

Detailed list of drawings including within RD-01:

Drawing File [PDF format]
00111980-A_P21_00104301_00.pdf
00111980-A_P22_00104302_00.pdf
00111980-A_P02_00104268_00.pdf
00111980-A_P05_00104281_00.pdf
00111980-A_P13_00104290_00.pdf
00111980-A_P16_00104294_00.pdf
00111980-A_L1E1_CH8_00090530_03.pdf

00111980-A_L1E1_CH9_00090538_02.pdf
00111980-A_L1E1_CH11_00090540_03.pdf
00111980-A_L1E1_F2_00109283_00.pdf
00111980-A_L1E1_F3_00109230_00.pdf
00111980-A_L1E1_F4_00110881_00.pdf
00111980-A_L1E1_F5_00101717_00.pdf
00111980-A_L1E1_F6_00104392_00.pdf
00111980-A_Pipes_length_DN250.pdf
00111980-A_Pipe_DN250.pdf

2. General system requirements

The part of the vacuum distribution consists mainly of vacuum chambers, pipes, bellows, supportive frames and fittings. Components of the vacuum distribution and verified components of the vacuum distribution are included in the delivery. Supplier is responsible for the delivery of the vacuum components specified in further chapters.

2.1. System Configuration

The beam distribution L1 – E1 ensures propagation of the laser L1 from the room L1 to the room E1 to the final experiments. The beam distribution provides sealed, clean and dry environment of pumped-down volume with the particular level of vacuum (specified further in the requirements). This volume is enclosed by vacuum chambers, pipes and bellows (Figure 1). The volume is pumped-down with the roughing pump and subsequently with TMPs. Other components as vacuum gauges and vacuum valves are also part of the distribution. Primary pumps (backing and roughing pump), vacuum valves, gauges and TMPs are not included in this contract.

The laser beam L1 is propagated further to the final experiments, by use of mirrors and other optomechanic components which are also part of the distribution (placed inside the chambers). Mirrors and other optomechanic components are not included in this contract.

2.1.1. Figure 1 Isometric view of the beam transport L1 – E1

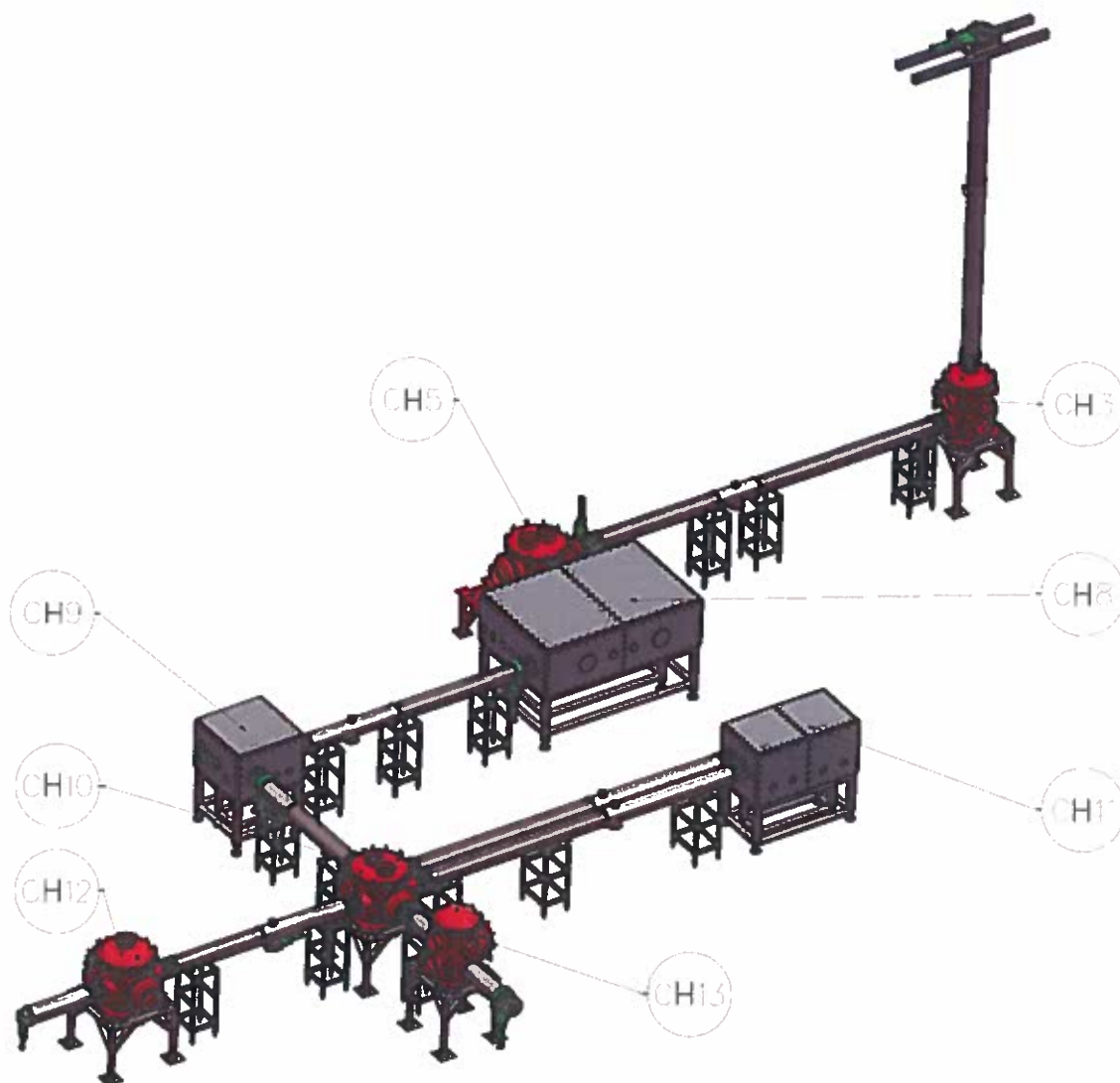


Figure 1 Isometric view of the beam transport L1 – E1
(Red marked components will be delivered by Contracting Authority.)

2.2. Interface requirements

The beam distribution starts with the electropneumatic gate valve DN250 ISO-F just before the chamber CH2 in the room L1 (CH2 is out of the scope of this RSD). The valve connects the beam distribution with the laser L1.

- The first end of the beam distribution is the electropneumatic gate valve DN250 ISO-F just behind the chamber CH13 in the room E1. The valve connects the beam distribution with the experiment HHG.

- The second end of the beam distribution is the electropneumatic gate valve DN250 ISO-F just behind the chamber CH12 in the room E1. The valve connects the beam distribution with the experiment PXS.
- Connection to the CVS is ensured with connection DN160 ISO-K (Roughing).
- The system is designed for generation of high vacuum with TMPs ATH 2303M and ATH 1603M which are connected to flanges DN250 ISO-F (safety requirements will be provided to the Supplier).
- Vacuum gauges are connected to the system with the flanges DN25 ISO-KF.
- Venting of the system is ensured with electropneumatic valves with interface DN25 ISO-KF.

3. Functional and Performance Requirements

REQ-007906/A

Vacuum components of **L1 – E1** system shall be designed for vacuum level 10^{-6} mbar.

Verification method: T - test

REQ-008117/A

Vacuum vessels shall allow vacuum pumping and venting.

Verification method: FD - functional demonstration

4. Design requirements

4.1. General design requirements

REQ-008273/A

Enclosed drawings shall be taken into account as inputs for preliminary design.

Verification method: R - review

REQ-008323/A

All relevant components (**RC** Vacuum Chambers including chassis, pipe support structures, **CC** Vacuum Vessel chassis) shall be designed to accommodate laser beam axis 1300 mm above floor level.

Verification method: R - review

REQ-007914/A

All Vacuum chamber parts heavier than 15 kg shall be equipped with lifting eyes interfaces.

NOTE: Final design of the interfaces will be part of detailed design.

Verification method: R - review

REQ-007923/A

All openings of delivered components shall be closed as follows:

- Vacuum chambers by aluminium alloy or stainless steel blank flanges;
- Vacuum pipes and bellows by plastic caps.

Verification method: I - inspection

REQ-007981/A

Outer surface finish shall be uniform Ballotini (blasting with glass beads). Other finish technologies are possible if agreed with the Contracting Authority.

Verification method: I - inspection

REQ-007982/A

Precautions shall be taken in design and assembly of all vacuum components to avoid trapped volumes in vacuum spaces which could result in virtual leaks and these spaces shall be suitably vented.

Verification method: I - inspection

REQ-007999/A

Maximum dimensions of used components and their non-dismountable sub-components shall be 1,9 x 2,9 x 2,4 m.

Verification method: R - review

REQ-008000/A

Design shall have grounding and ESD.

Verification method: R - review

REQ-008001/A

All opened profiles in frames constructions shall be covered with end caps.

Verification method: I - inspection

REQ-008010/A

Supplier shall provide final information regarding BT L1-E1 weight and weight distribution of BT L1-E1 components.

Verification method: R - review

REQ-007919/A

Vacuum Vessels shall be equipped with inlet and outlet flanges according to the listed standards:

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

Verification method: R - review

REQ-008284/A

Single leak rate for each relevant component (vacuum pipes, bellows) shall be lower than $1 \cdot 10^{-9}$ mbar·l/s per component.
Verification method: T - test

REQ-008315/A

Total leak rate for each relevant component (vacuum vessels) shall be lower than $5 \cdot 10^{-4}$ mbar·l/s per component.
Verification method: T - test

4.1.1. Cylindrical Chambers (CC)

Following chapter is defining the term of cylindrical chamber of CC type.

4.1.1.1. CC Vacuum Vessels (N/A)

4.1.1.2. CC Vacuum Vessel Chassis

Following chapter is defining the term of vacuum vessel chassis of CC type.

REQ-007993/A

CC Vacuum Vessel Chassis shall be made of stainless steel.
Verification method: R - review

REQ-008118/A

CC chassis shall allow for floor fixing.

NOTE: For further information see the document "E1 room datasheet" (RD-02).

Selected values mentioned in E1 room datasheet are:

- Max. load for floors of experimental halls is 25 kN on surface with dimensions 20x20 cm;
- Anything exceeding these values should be checked and approved by Contracting Authority.

Verification method: R - review

REQ-007997/A

Design of CC Vacuum Vessel Chassis shall allow positioning in x, y direction (horizontal plane) when fixed to floor.

NOTE: Requirement defining interfaces (e.g. bracket with holes) needed for positioning.

Verification method: R - review

REQ-007998/A

Range of **CC** Vacuum Vessel Chassis adjustment shall be:

- in z direction 30 mm

Verification method: R - review, FD - functional demonstration

REQ-007994/A

CC Vacuum Vessel Chassis shall allow x, y, z vessels adjustment.

Verification method: R - review

REQ-007995/A

Range of **CC** Vacuum Vessel adjustment shall be (see REQ-007994/A):

- in x direction 20 mm
- in y direction 20 mm
- in z direction 20 mm

Verification method: R - review, FD - functional demonstration

REQ-008008/A

Design solution using screws for adjustment shall be used (see Figure 2).

Verification method: R - review

4.1.1.2.1. Figure 2



Figure 2

(In relation to verification method of REQ-008008/A)

REQ-007996/A

CC Vacuum Vessel Chassis shall allow clash free installation of Turbomolecular pumps (TMP).

Verification method: R - review

4.1.2. Rectangular Chambers (RC)

Rectangular Vacuum Chambers are requested for larger optical set up. More complex optical layout needs more frequent opening of these rectangular chambers.

4.1.2.1. General

REQ-008316/A

RC Vacuum Chambers shall provide for the following mechanical interfaces:

- TMP's (Turbo Molecular Pumps);
- Gauges;
- Feedthroughs;
- Diagnostics;
- Remote control;
- Central Vacuum System (CVS);
- Beam Transport (BT);
- Vacuum Gate Valves;
- Vacuum Venting Valves.

Verification method: R - review

REQ-008324/A

RC Vacuum Chambers shall be a modular units allowing extension in longitudinal direction (see Figure 3).

Verification method: R - review

4.1.2.1.1. Figure 3

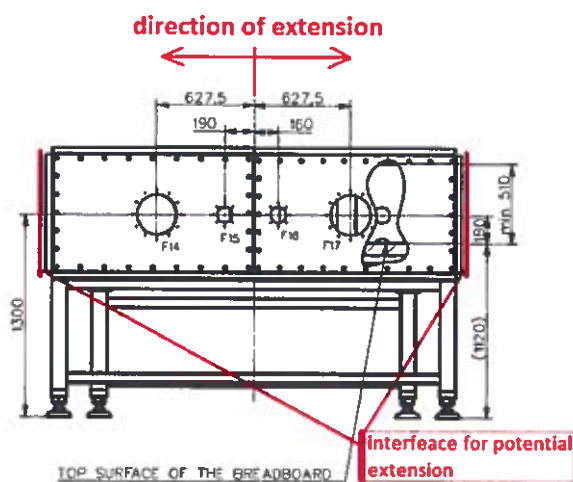


Figure 3 direction of extension

(In relation to requirement n° REQ-008324/A)

REQ-008321/A

The supplier shall define the Reference Coordinate System (**RCS**) of the **RC** Chambers which shall allow positioning these **RC** Chambers in Contracting Authority's experimental hall according to Reference Mechanical System of the hall (**RMS**).

Verification method: R - review

REQ-008322/A

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

Verification method: R - review

REQ-008005/A

RC Breadboard and **RC** Vacuum Vessel shall allow for decoupling.

Verification method: R - review

REQ-008006/A

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

Verification method: R - review

REQ-008007/A

Double bellows decoupling system shall be applied on **RC** breadboard chassis (see Figure 4).

Verification method: R - review

4.1.2.1.2. Figure 4

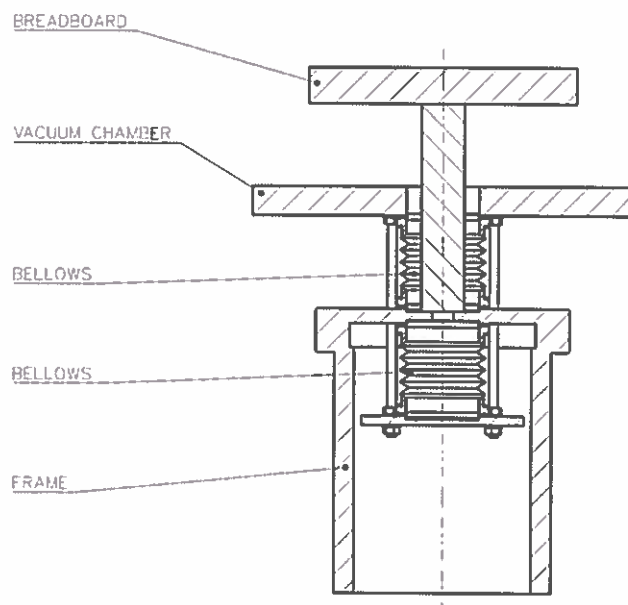


Figure 4

(In relation to requirement n° REQ-008007/A)

REQ-008276/A

All **RC** Vacuum Vessels and Vacuum Vessel Chassis shall allow installation of Turbomolecular pumps (TMP) as follows:

- Vacuum Vessel – ISO F interface Vacuum Vessel versus TMP;
- Vacuum Vessels Chassis – possibility to dismount the Chassis.

NOTE: Preferable position of TMP's is from the bottom part of Vacuum Vessel.

Verification method: R - review

4.1.2.2. RC Vacuum Vessels

REQ-007913/A

RC frame shall be made of stainless steel.

Verification method: R - review

REQ-007916/A

RC shall be equipped with roughing inlet flange (DN160 ISO -K/F).

Verification method: R - review

REQ-008274/A

RC panels and blank flanges shall be made of stainless steel or aluminium alloy following types:

- Aluminium alloy:
 - EN AW-2219
 - EN AW-3003
 - EN AW-5083
 - EN AW-6082
 - EN AW-2090
 - EN AW-2219
 - EN AW-7005
- Stainless steel
 - AISI 304
 - AISI 304L

Verification method: R - review

REQ-008275/A

Final choice of **RC** panel material shall be made in preliminary design phase.

Verification method: R - review

REQ-008004/A

RC Vessel panels shall be designed as a modular system.

Technical note: Modular system = unification of panel dimensions.

Verification method: R - review

REQ-008320/A

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

Verification method: T - test

REQ-007915/A

All **RC** removable panels shall be equipped with guiding pins for closing procedure.

Verification method: R - review

REQ-007912/A

Blind holes with thread depth $2.5d$ shall be prepared in **RC** covers/panels for all designed flanges.

Verification method: R - review

REQ-007924/A

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

Verification method: R - review

4.1.2.3. RC Vacuum Vessel Chassis

REQ-008325/A

RC Vacuum Vessel Chassis shall allow **z** (vertical) adjustment.

Verification method: R - review

REQ-008326/A

Range of **RC** Vacuum Vessel Chassis adjustment in **z** (vertical) direction shall be 20 mm.

Verification method: R - review

REQ-008002/A

RC Vacuum Vessel Chassis shall be made of stainless steel or extruded aluminium alloy profiles.

Verification method: R - review

REQ-008285/A

Design of **RC** Vacuum Vessel Chassis shall allow positioning in **x**, **y** direction (horizontal plane) when fixed to floor.

NOTE: Requirement defining interfaces (e.g. bracket with holes) needed for positioning.

Verification method: R - review

REQ-008327/A

RC Vacuum Vessel Chassis shall allow installation of Turbomolecular pumps (TMP).

Verification method: R - review

REQ-008328/A

RC Vacuum Vessel Chassis shall allow for floor fixing.

NOTE: For further information see the document "E1 room datasheet" (RD-02).

Selected values mentioned in E1 room datasheet are:

- Max. load for floors of experimental halls is 25 kN on surface with dimensions 20x20 cm;
- Anything exceeding these values should be checked and approved by Contracting Authority.

Verification method: R - review

REQ-008329/A

Each **RC** Vacuum Vessel Chassis shall be equipped with removable transportation wheels.

Verification method: R - review

4.1.2.4. RC Optical Tables

4.1.2.4.1. General

REQ-008330/A

Supplier shall provide static **FEM** analysis and vibration study according to Contracting Authority inputs.

Technical note: The latest results of building vibration measurement and simplified optical layout will be provided by Contracting Authority after contract signature.

Verification method: A - analysis

4.1.2.4.2. Optical Table design

REQ-008331/A

RC Optical Tables shall have threaded holes pattern with 25 mm spacing.

Verification method: R - review

REQ-008332/A

Threaded holes of **RC** Optical Table shall be **M6** size.

Verification method: R - review

REQ-008333/A

RC Optical Table shall be made of aluminium alloy following types:

- EN AW-2219
- EN AW-3003
- EN AW-5083
- EN AW-6082
- EN AW-7005 (must not be baked out)

The parts must not be anodized.

Verification method: R - review

REQ-008334/A

Final choice of **RC** Optical Table material shall be made in preliminary design phase.

Verification method: R - review

REQ-008335/A

Minimum thickness of **RC** Optical Table plate shall be 50 mm as a starting value. Based on **FEM** analysis and vibration study (REQ-008330/A) modification of this value is acceptable.

Verification method: R - review

REQ-008658/A

Maximum static deformation of **RC** Optical Table shall be ≤ 1 mm.

Verification method: A - analysis

REQ-008659/A

Natural frequencies of **RC** Optical Table shall be ≥ 20 Hz.

Verification method: A - analysis

4.1.2.5. RC Optical Table Chassis

REQ-008336/A

RC Optical Table Chassis shall allow **z** (vertical) adjustment.

Verification method: R - review

REQ-008337/A

Range of **RC** Optical Table Chassis adjustment in **z** (vertical) direction shall be 20 mm.

Verification method: R - review

REQ-008611/A

Design of **RC** Optical Table Chassis shall allow positioning in **x, y** direction (horizontal plane) together with Vacuum Vessel Chassis.

NOTE: Requirement defining interfaces (e.g. bracket with holes) needed for positioning. Temporary connection between two chassis is also mentioned in this requirement.

Verification method: R - review

REQ-008760/A

RC Optical Table Chassis shall allow x, y, z adjustment of **RC** Optical Table.

Verification method: R - review

REQ-008761/A

RC Optical Table adjustment shall be (see REQ-008760/A):

- in x direction 15 mm
- in y direction 15 mm
- in z direction 15 mm

Verification method: R - review

REQ-008338/A

RC Optical Table Chassis shall be made of stainless steel or aluminium alloy extruded profiles (unified with **RC** Vacuum Vessel Chassis).

Verification method: R - review

REQ-008339/A

RC Optical Table Chassis shall allow installation of TMP's.

Verification method: R - review

REQ-008340/A

RC Optical Table Chassis shall allow floor fixing.

Verification method: R - review

REQ-008341/A

RC Optical Table Chassis shall be equipped with removable transportation wheels.

Verification method: R - review

4.1.3. Sealing

REQ-007925/A

Sealing used for **BT L1-E1** system shall be made of fluorelastomer polymer (FPM) material.

NOTE: **RC** chambers applicable.

Verification method: R - review

REQ-007926/A

Hardness of **BT L1-E1** sealing o-rings shall be 60 or 70 HSC (Shore).

NOTE: **RC** chambers applicable.

Verification method: R - review

REQ-007978/A

Sealing surfaces must be in particular free of scratches or dents.

Verification method: I - inspection

REQ-007979/A

Seal faces shall be suitably protected immediately after final machining to minimise the risk of damage. This protection shall only be removed for the purposes of cleaning and inspection, prior to final assembly.

Verification method: I - inspection

REQ-007980/A

The surface finish of seal faces shall be compatible with the requirements of the ISO-K resp. ISO-F seals used.

Verification method: R - review

4.2. Operational design requirements

REQ-008281/A

Vacuum vessels shall comply with frequency of opening/closing 2-times a day.

NOTE: Based on engineering demands on operational and maintenance procedures.

Verification method: R - review, A - analysis

4.3. L1-E1 Vacuum Chambers

4.3.1. Vacuum Chamber CH3

CH3 Vacuum Vessel will be supplied by Contracting Authority. **CH3** Vacuum Vessel Chassis is in contract scope.

4.3.1.1. CH3 Vacuum Vessel (N/A)

4.3.1.2. CH3 Chassis

See drawing 00109230/00.

REQ-008314/A

CH3 Chassis shall be designed as **CC** type.

Verification method: R - review

REQ-007977/A

CH3 Chassis shall have an interface for fixation to the floor and wall.

Verification method: R - review

REQ-008313/A

CH3 Chassis shall be compatible with **CH3 Vacuum Vessel** interface (see Annex I).

Verification method: R - review

4.3.2. Vacuum Chamber CH5

CH5 Vacuum Vessel will be fully supplied by Contracting Authority.

4.3.3. Vacuum Chamber CH8

CH8 Vacuum chamber will be delivered by supplier including vacuum vessel, vacuum vessel chassis, optical table and optical table chassis. See drawing 00090530/03.

REQ-008609/A

Vacuum Chamber **CH8** shall be designed as **RC** type (see Chapter 4.1.2).

Verification method: R - review

4.3.4. Vacuum Chamber CH9

CH9 Vacuum chamber will be delivered by supplier including vacuum vessel, vacuum vessel chassis, optical table and optical table chassis. See drawing 00090538/02.

REQ-008610/A

Vacuum Chamber **CH9** shall be designed as **RC** type (see Chapter 4.1.2).

Verification method: R - review

4.3.5. Vacuum Chamber CH10

CH10 Vacuum Vessel will be supplied by Contracting Authority. **CH10** Vacuum Vessel Chassis is in contract scope.

4.3.5.1. CH10 Vacuum Vessel (N/A)

4.3.5.2. CH10 Chassis

See drawing 00109283/00.

REQ-008344/A

CH10 Chassis shall be designed as **CC** type.
Verification method: R - review

REQ-008345/A

CH10 Chassis shall be compatible with **CH10** Vacuum Vessel interface (see Annex I).
Verification method: R - review

4.3.6. Vacuum Chamber CH11

CH11 Vacuum chamber will be delivered by supplier including vacuum vessel, vacuum vessel chassis, optical table and optical table chassis. See drawing 00090540/03.

REQ-008011/A

Vacuum Chamber **CH11** shall be designed as **RC** type (see Chapter 4.1.2).
Verification method: R - review

4.3.7. Vacuum Chamber CH12

CH12 Vacuum Vessel will be supplied by Contracting Authority. **CH12** Vacuum Vessel Chassis is in contract scope.

4.3.7.1. CH12 Vacuum Vessel (N/A)

4.3.7.2. CH12 Chassis

See drawing 00109283/00.

REQ-008346/A

CH12 Chassis shall be designed as **CC** type.

Verification method: R - review

REQ-008347/A

CH12 Chassis shall be compatible with **CH12** Vacuum Vessel interface (see Annex I).

Verification method: R - review

4.3.8. Vacuum Chamber CH13

CH13 Vacuum Vessel will be supplied by Contracting Authority. **CH13** Vacuum Vessel Chassis is in contract scope.

4.3.8.1. CH13 Vacuum Vessel (N/A)

4.3.8.2. CH13 Chassis

See drawing 00109230/00.

REQ-008348/A

CH13 Chassis shall be designed as **CC** type.

Verification method: R - review

REQ-008349/A

CH13 Chassis shall be compatible with **CH13** Vacuum Vessel interface (see Annex I).

Verification method: R - review

4.4. Edge welded bellows

REQ-007908/A

Edge welded bellows shall be equipped with guiding rods for axial movement fixation.

Verification method: I - inspection

REQ-008282/A

Each edge welded bellows shall undergo a helium leak test confirmed with output protocol.

Verification method: T - test

REQ-008283/A

Each edge welded bellows shall be manufactured according to **Table 1**.

Verification method: T - test

Edge welded bellows with guiding rods - DN250		
Type of flanges		ISO-K (ISO 1609)
Inside pressure		10^{-6} mbar
Outside pressure		1 bar (atmospheric pressure)
Leak rate		10^{-9} mbar·l/s
Temperature		$20 \pm 3^{\circ}\text{C}$
Material		AISI 304, AISI 316
Lifetime		min. 10 000 cycles
Movement absorption	Axial	± 15 mm
	Lateral	± 5 mm
	Angular	$\pm 2^{\circ}$
Minimal inner diameter		258 mm
Length free		230 mm
Space for mounting (between flanges) without centering		237,8 mm

Table 1 Technical specification of edge welded bellows.

4.5. Pipes

See drawings: 00104267/00; 00104268/00; 00104269/00; 00104281/00; 00104282/00; 00104289/00; 00104290/00; 00104292/00; 00104293/00; 00104294/00; 00104296/00; 00104297/00; 00104298/00; 00104301/00; 00104302/00; 00104303/00; 00110952/00; 00110962/00.

REQ-007907/A

Pipes shall be designed with respect to standard ISO 1609:1986 - Vacuum technology - Flange dimension.

Verification method: R - review

REQ-008009/A

Vacuum pipes shall be clearly identified and labelled for assembly purpose

Verification method: R - review

4.5.1. Pipes support structures

See drawings: 00110881/00, 00101717/00, 00104392/00

REQ-008652/A

Pipes support structures shall be positioned in **x, y** direction.

Note: requirement describes positioning with relation to building resp. E1 experimental hall.

Verification method: R - review

REQ-008653/A

Pipes support structures shall allow **z** (vertical) adjustment. Exception is support structure for horizontal pipe (see drawing number 00104392/00).

Verification method: R - review

REQ-008655/A

Range of Pipes support structures adjustment in **z** (vertical) direction shall be 30 mm.

Verification method: R - review

REQ-008654/A

Pipes support structures shall be made of stainless steel or extruded aluminium alloy profiles.

Verification method: R - review

4.6. Vacuum Fittings

REQ-007904/A

The clamps shall be of suitable design and use material that prevents permanent clamp deformation after multiple use.

Verification method: R - review

REQ-007905/A

The clamps shall be of suitable design and use material that prevents damaging of the clamp slots on flanges.

Verification method: R - review

REQ-007909/A

Fittings shall be designed with respect to the listed standards:

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

Verification method: R - review

REQ-007910/A

Centering ring with outer ring shall be used for connection between fitting and chamber.

Verification method: R - review

4.7. Cleaning

REQ-007983/A

Cleaning procedure shall remove contaminants that adhere to the surface such as oils, greases, dirt, swarf, corrosion products, or finger prints.

Verification method: I - inspection

REQ-007984/A

Any assemblies shall be made up from pre-cleaned components where possible.

Verification method: R - review

REQ-007985/A

Cleanliness shall be taken into account at all stages from detailed design to installation.

Verification method: R - review

REQ-007986/A

Clean components shall be handled wearing clean, dry, lint-free gloves.

Verification method: R - review

REQ-007987/A

Supplier shall provide cleaning procedure compatible with High Vacuum (10^{-6} mbar) and using in cleanroom ISO7.

Verification method: R - review

REQ-008319/A

The cleaning procedure shall be included at minimum the following steps:

- General pre-clean, removal of gross contamination, fluxes etc. by wiping/scraping;
- Degrease with solvent by rinsing, swabbing or immersion;
- Wash with domestic water and detergent;
- Vapor degrease or soak cleaning;
- Degrease with solvent. Small and complex items shall be immersed and ultrasonically agitated;
- Wash with domestic water;
- Wash with demineralised water;
- Drying (dry air);
- Immediate packaging.

Verification method: R - review

4.8. Manufacturing

REQ-007988/A

Vacuum sealing welds made externally must have full penetration leaving a smooth surface on the vacuum side.
Verification method: R - review

REQ-007989/A

Supplier shall apply cleaning and degreased procedure. This procedure shall be provided by Supplier.
Verification method: R - review

REQ-007990/A

Shielding gases shall be used to minimise oxidation.
Verification method: R - review

REQ-007991/A

Tools used during manufacture shall not contaminate the vacuum surface.
Verification method: I - inspection

REQ-007992/A

All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.
Verification method: R - review

4.9. Electrical design requirements

N/A

4.10. EMC/EMP

REQ-008656/A

All conductive parts must be designed according to following Czech applicable standards:

- ČSN 33 2000-4-41;
- ČSN 33 2000-5-54.

Verification method: R - review

5. Transportation requirements

Supplier will provide transportation path to final destination for RC chambers during preliminary design phase (approximately transportation path is 100 meters).
For further information see the document "E1 room datasheet" (RD-02).

5.1. General requirements

REQ-008012/A

The transportation personnel shall follow the Contracting Authority's facility regulations.

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

Verification method: R - review

REQ-008013/A

The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in clean environment of ISO class 7.

Verification method: R - review, I - inspection

REQ-008014/A

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

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

Verification method: I - inspection

REQ-008015/A

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

Verification method: R - review

REQ-008016/A

The transportation procedures shall be discussed and reviewed by the Contracting Authority's installation officer and shall be compliant with the Contracting Authority's installation regulations.

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

Verification method: R - review

REQ-008017/A

The main parts of the mechanical structure shall be equipped with positioning/alignment marks for industrial 3D-measurements/survey. The specific type of the positioning/alignment marks, their number and location shall be agreed with the Contracting Authority.

Verification method: R - review, I - inspection

6. General Safety Requirements

REQ-008018/A

System or its relevant components shall comply with all applicable EU and Czech legislative requirements and where applicable shall have CE marking and Certificate of Compliance.

Verification method: R - review

REQ-008019/A

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

NOTE: Relevant for chamber design - RC chambers.

Verification method: R - review, A - analysis

REQ-008020/A

System or its relevant components shall be delivered with technical documentation where supplied specifies modes of operation: conditions for safe operation, installation and maintenance of system.

Verification method: R - review

7. Quality Requirements

7.1. Quality Management

7.1.1. Quality organization and responsibilities

7.1.1.1. Organization

REQ-008021/A

The supplier shall identify the personnel responsible (project Quality Manager) for Quality Controls disciplines.

Verification method: Not To Be Tracked within VCD

REQ-008024/A

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

Verification method: Not To Be Tracked within VCD

REQ-008025/A

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

Verification method: Not To Be Tracked within VCD

7.1.1.2. Responsibility and authority

REQ-008028/A

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

Verification method: Not To Be Tracked within VCD

REQ-008773/A

Quality workmanship procedure shall be provided by supplier and agreed by Contracting Authority.

Verification method: R - review

7.1.2. Documentation and data control

7.1.2.1. Documentation

REQ-008031/A

The supplier shall supply the following relevant manufacturing documents (extent as stipulated in contract): Operating manual (including step-by-step aligning procedure), maintenance manual, breakdown list as built, Declarations of Conformity and relevant CE markings where required by EU legislation.

Verification method: I - inspection

7.1.2.2. Formats for data exchange

REQ-008033/A

Documentation shall be supplied in all following formats: hardcopy and PDF/A.

Verification method: Not To Be Tracked within VCD

REQ-008034/A

The supplier shall provide following type of documents:

- 3D model;
- 2D drawings;
- Printable format for text documents.

Verification method: Not To Be Tracked within VCD

REQ-008035/A

The Supplier shall use following data formats.

- *.JPG;
- *.PDF/A;
- CAD 2D: *.dwg;
- CAD 3D: STEP type files (*.stp;*.step);
- text processors *.doc, *.docx, OpenDocument Format;
- spreadsheet processors *.xls, *.xlsx, OpenDocument Format;
- presentations *.ppt, *.pptx; OpenDocument Format;
- *.HTML

Verification method: Not To Be Tracked within VCD

8. Communication during contract execution

8.1. Interface management

REQ-008657/A

All interfaces of delivered components relevant for **L1 to E1** system integration shall be identified and captured on drawings.

Verification method: R - review

REQ-008762/A

All interfaces identified, captured on drawings shall be agreed by Contracting Authority.

Verification method: R - review

9. Verification process requirements

9.1. General

REQ-008350/A

The verification process shall demonstrate that the deliverable product meets the specified ELI (further Contracting Authority) requirements and is capable of sustaining its operational role through:

1. Verification planning;
2. Verification execution and reporting.

Verification method: Not To Be Tracked within VCD

REQ-008359/A

The technical consultation between supplier and the Contracting Authority shall involve agreement on the methods, levels of verification, and verification tools to be used for verifying individual requirements.

Verification method: Not To Be Tracked within VCD

9.2. Verification methods

9.2.1. General

REQ-008351/A

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

1. review;
2. inspection;
3. test;
4. functional demonstration;
5. analysis.

Verification method: Not To Be Tracked within VCD

9.2.2. Review

Verification by Review (**R**) shall consist in using approved records or evidence that unambiguously shows that the requirement is met.

NOTE: Examples of such approved records are design documents and reports, technical descriptions, and engineering drawings, manuals and accompanying operation documentation.

REQ-008763/A

A review of design programme shall be defined in the Verification Plan (VP), see chapter 9.3.

Verification method: Not To Be Tracked within VCD

REQ-008764/A

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

Verification method: Not To Be Tracked within VCD

REQ-008765/A

The results of review shall be documented in approved record and by VCD (see chapter 9.4).

Verification method: R - review

9.2.3. Inspection

Verification by Inspection (**I**) shall consist of visual determination of physical characteristics.

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

REQ-008353/A

The inspection results recorded in an Inspection report referred in VCD.

NOTE: concerning VCD see chapter 9.3 and 9.4.

Verification method: R - review

REQ-008766/A

An inspection programme shall be defined in the Verification Plan (VP), see chapter 9.3.

Verification method: Not To Be Tracked within VCD

9.2.4. Test

Verification by Test (**T**) shall consist of measuring product performance and functions under representative simulated environments.

REQ-008354/A

The measurement results shall be recorded in a Test report.

Verification method: R - review

REQ-008767/A

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

Verification method: Not To Be Tracked within VCD

REQ-008768/A

The protocol of the measurement shall be made and approved.

Verification method: R - review

REQ-008769/A

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

Verification method: Not To Be Tracked within VCD

REQ-008770/A

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

Verification method: Not To Be Tracked within VCD

REQ-008771/A

Test Programme shall be approved by the Contracting Authority.
Verification method: R - review

9.2.5. Functional demonstration

Verification via Functional demonstration (**FD**) is either test of the system's response to a subject of requirement, or demonstration of qualitative operational performance consistent with the requirement.

REQ-008355/A

The execution of functional demonstration shall be observed and results recorded in a Functional demonstration report.
Verification method: R - review

REQ-008356/A

All safety critical functions shall be identified and verified by functional demonstration.
Verification method: Not To Be Tracked within VCD

9.2.6. Analysis

Verification by Analysis (**A**) shall consist of performing theoretical or empirical evaluation using techniques agreed with the Contracting Authority.

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

REQ-008357/A

The results of analysis shall be recorded in an Analysis report.
Verification method: R - review

REQ-008772/A

An analysis programme shall be defined in the Verification Plan (VP), see chapter 9.3.
Verification method: Not To Be Tracked within VCD

9.3. Verification Control Document (VCD)

The Verification Control Document (VCD) lists for each requirement the selected method(s) of verification, overall verification result (pass/fail) and reference to relevant report where necessary. The VCD is a living (versioned) document and provides an overview of the mutually agreed verification methods during the project execution and overview of the results at the contract end to support the acceptance of all deliverables.

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

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

REQ-008774/A

Identify and agree with the Contracting Authority the set of requirements to be subject of the verification process at supplier site and at Contracting Authority site.

Verification method: Not To Be Tracked within VCD

REQ-008775/A

Select verification tools for defined methods of verification.

Verification method: Not To Be Tracked within VCD

REQ-008776/A

Identify the stages and events of the contract realization in which the verification is implemented.

Verification method: Not To Be Tracked within VCD

REQ-008358/A

The contents of the initial issue of the Verification Control Document (VCD) shall be prepared by the Contracting Authority based on technical consultations with the supplier and agreed with the supplier within the time limit specified in table 3.

Verification method: Not To Be Tracked within VCD

REQ-008362/A

Based on the agreed methods of verification and the VP proposal how the verifications should be grouped together, the supplier shall include in the VP the list of the Test reports, Analysis reports, Inspections reports, and Functional demonstration reports that the supplier proposes to be prepared as part of verification of the requirements.

(agreement by Contracting Authority)

Verification method: R - review

REQ-008363/A

The supplier shall carry out factory verification of requirements according to the VP and according to the updated VCD and record the results in the VCD before shipping the system out of factory.

(agreement by Contracting Authority)

Verification method: R - review

REQ-008364/A

The supplier shall carry out with support from the Contracting Authority the final verification of requirements at ELI facility according to the VP and VCD and record the results in the final VCD.

(agreement by Contracting Authority)

Verification method: R - review

9.4. Acceptance

REQ-008365/A

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

Verification method: Not To Be Tracked within VCD

REQ-008366/A

Acceptance shall be carried out on the final hardware.

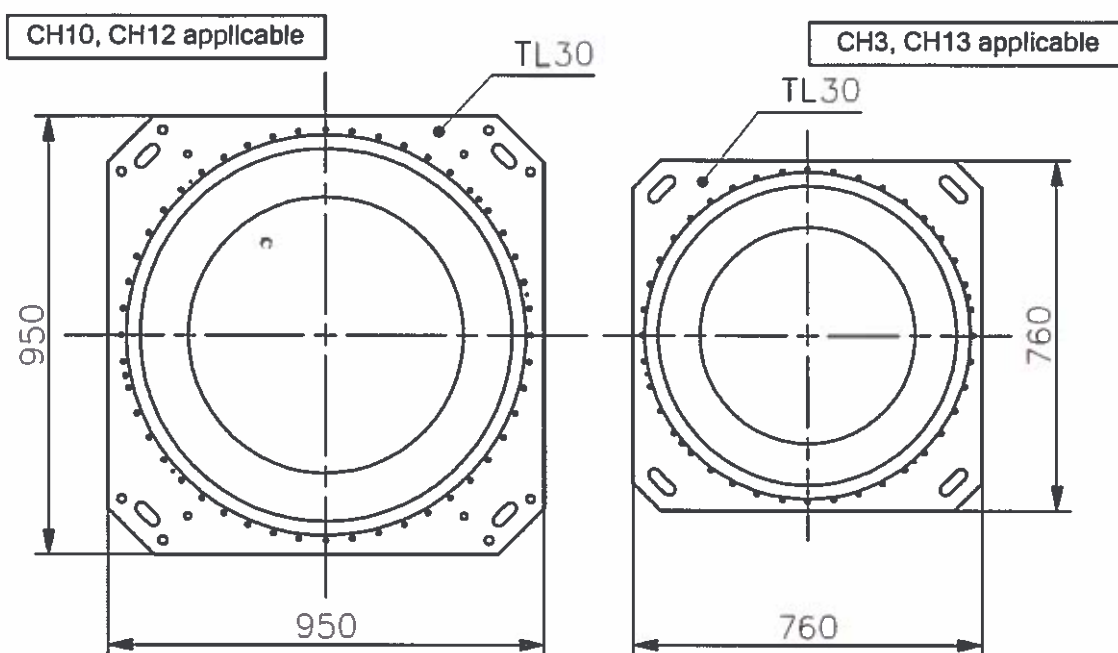
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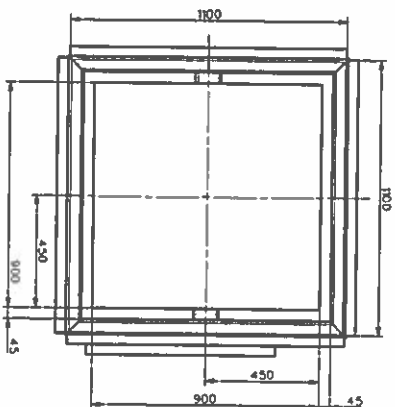
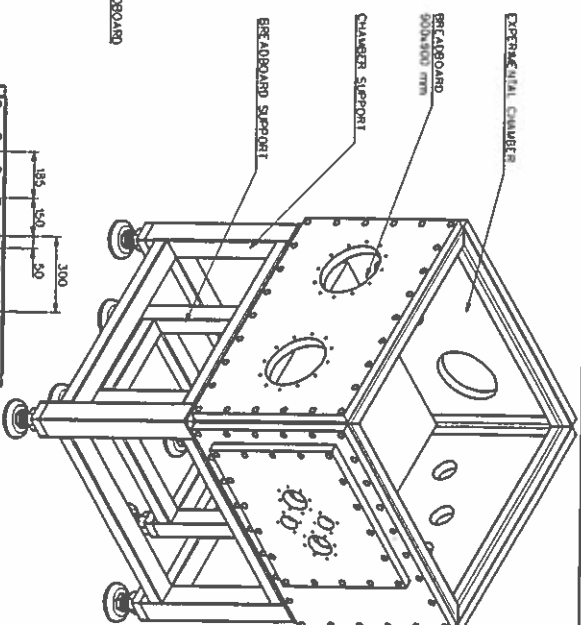
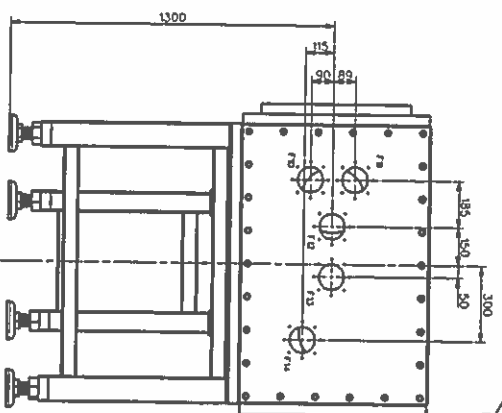
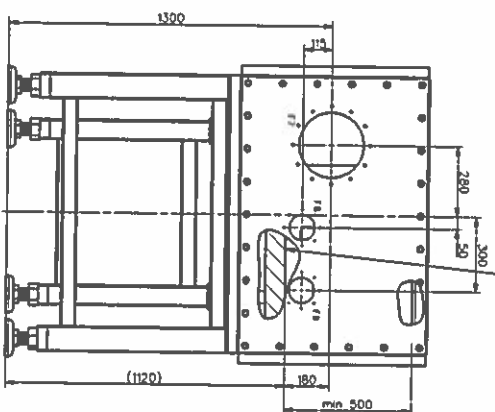
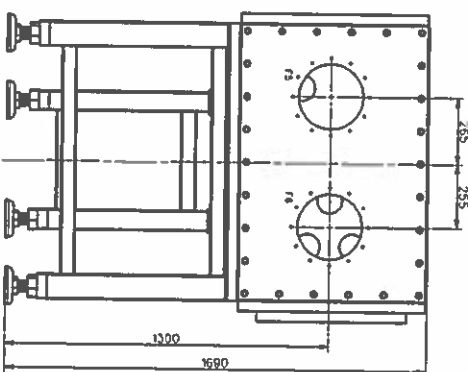
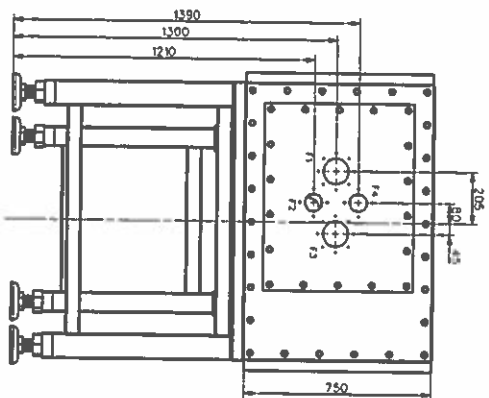
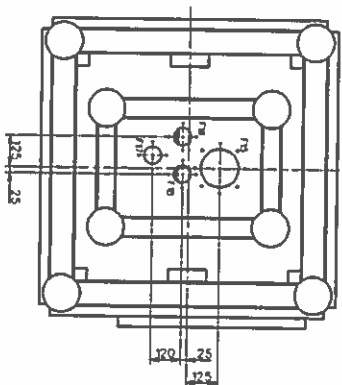
REQ-008367/A

The basis for acceptance shall be completed Verification Control Document (Chapter 9.3) summarizing the overall verification results together with relevant reports supporting the verification.

Verification method: R - review

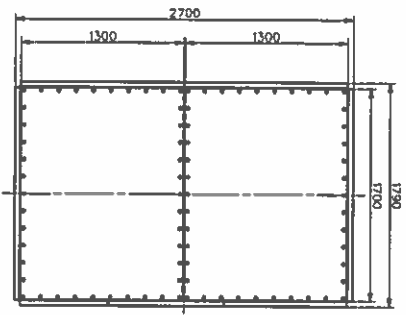
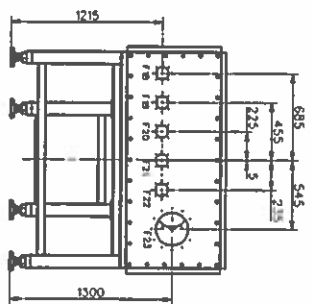
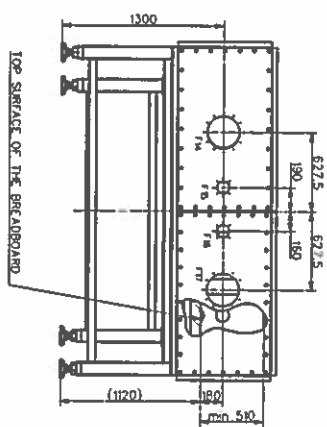
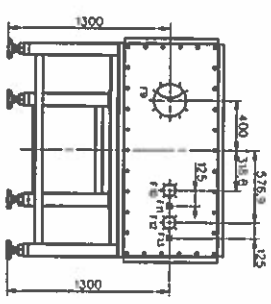
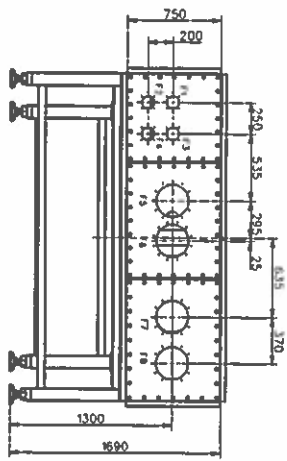
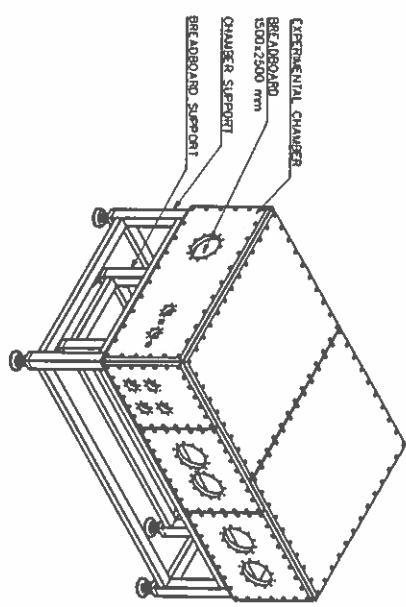
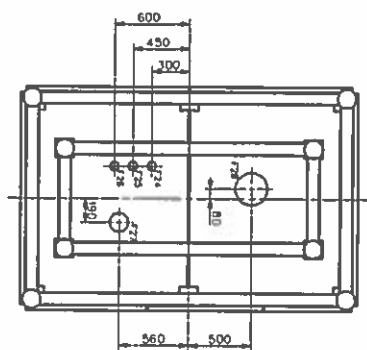
10. Annex I





No.	DIMENSION / CONNECTION	STANDARD
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F2	DI60	ISO 809
F3	DI100	ISO 809
F4	DI60	ISO 809
F5	DI100	ISO 809
F6	DI100	ISO 809
F7	DI100	ISO 809
F8	DI100	ISO 809
F9	DI100	ISO 809
F10	DI100	ISO 809
F11	DI100	ISO 809
F12	DI100	ISO 809
F13	DI100	ISO 809
F14	DI100	ISO 809
F15	DI100	ISO 809
F16	DI100	ISO 809
F17	DI100	ISO 809
F18	DI100	ISO 809

Project: 000090538/02
 Date: 1.12.2004
 Scale: 1:10
 Drawing: LEL-CH9
 Author: LEL-CH9
 Checked: LEL-CH9
 Approved: LEL-CH9
 Date: 1.12.2004
 Project: 000090538/02
 Date: 1.12.2004



Large DIMENSION/CONNECTION STANDARD	
1	DN100 ISO K09
2	DN100 ISO K09
3	DN100 ISO K09
4	DN100 ISO K09
5	DN250 ISO K09
6	DN250 ISO K09
7	DN250 ISO K09
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9	DN250 ISO K09
10	DN100 ISO K09
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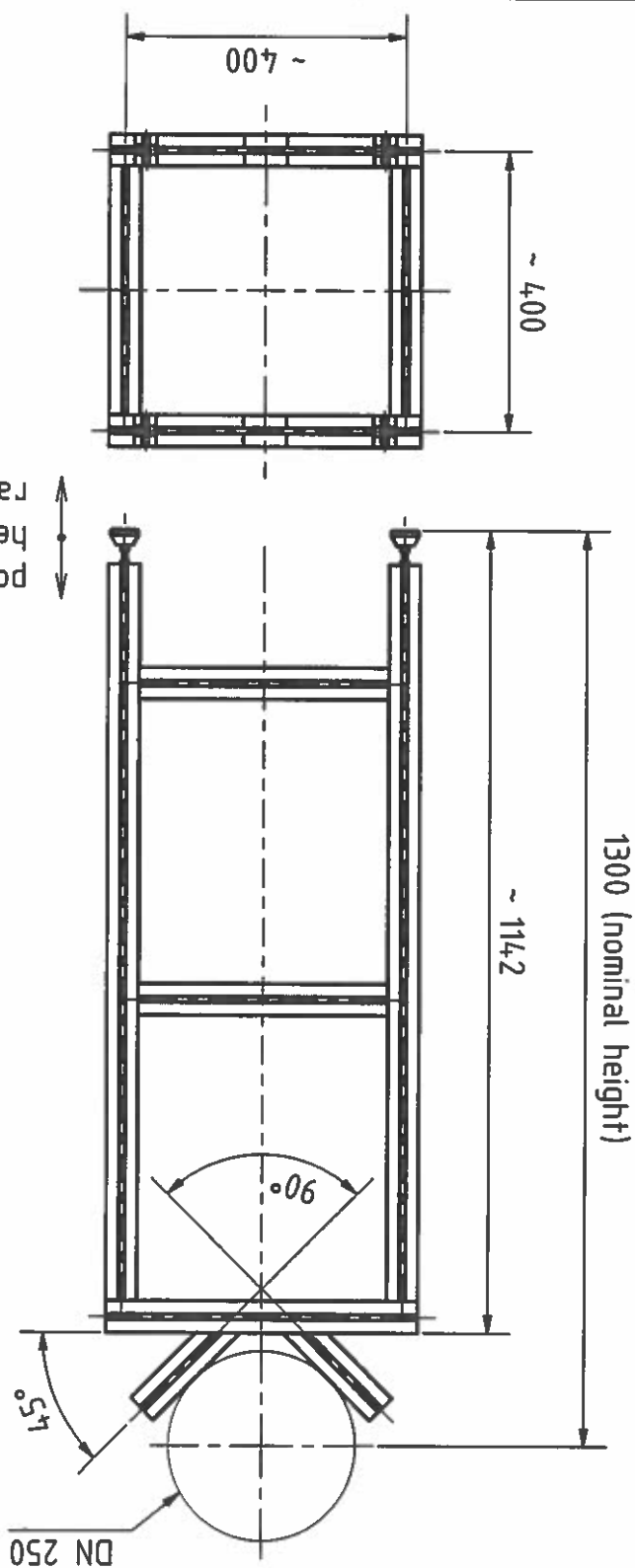
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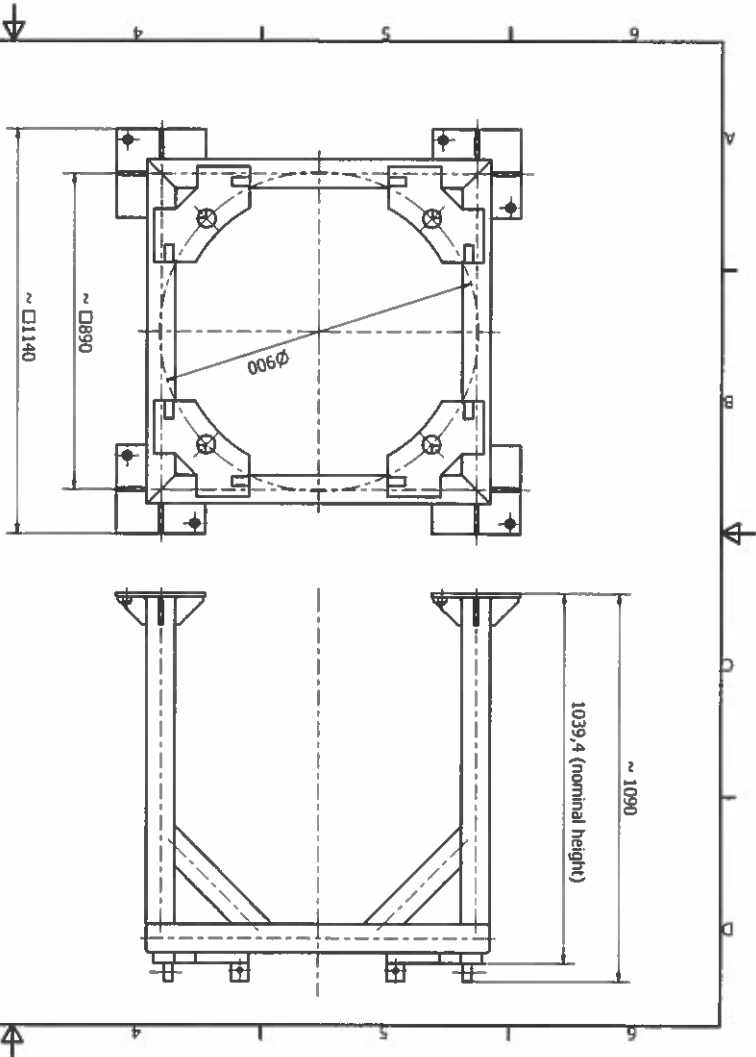
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 Project: **00000530/03**
 Revision: **01**

Fižikální ústav
 V. J. K. S.

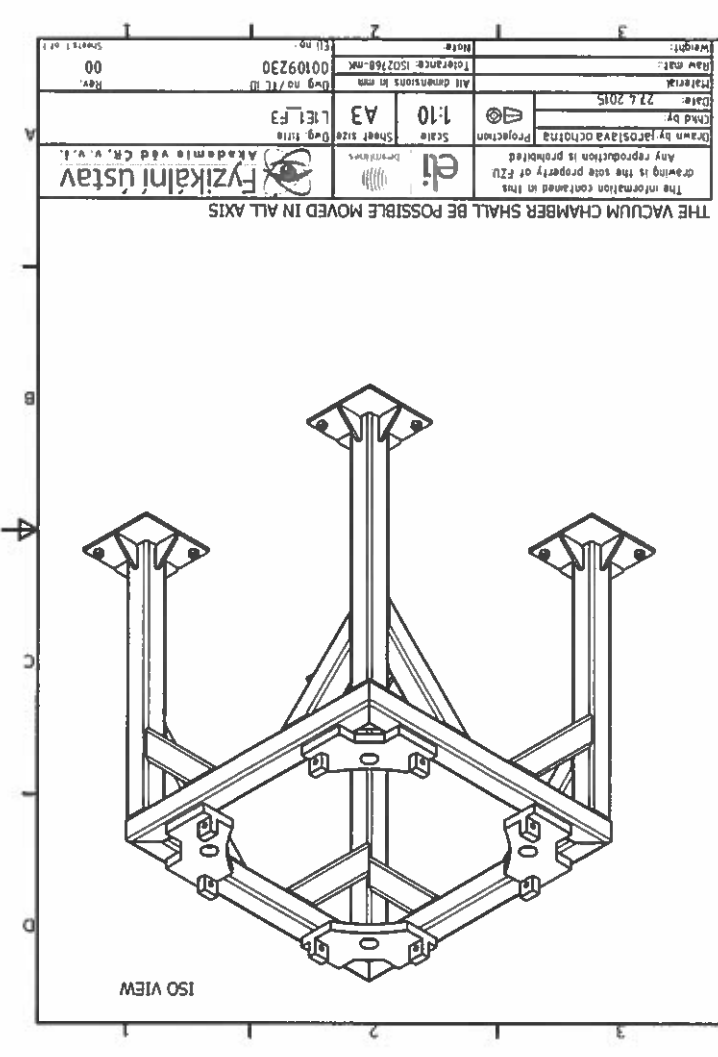
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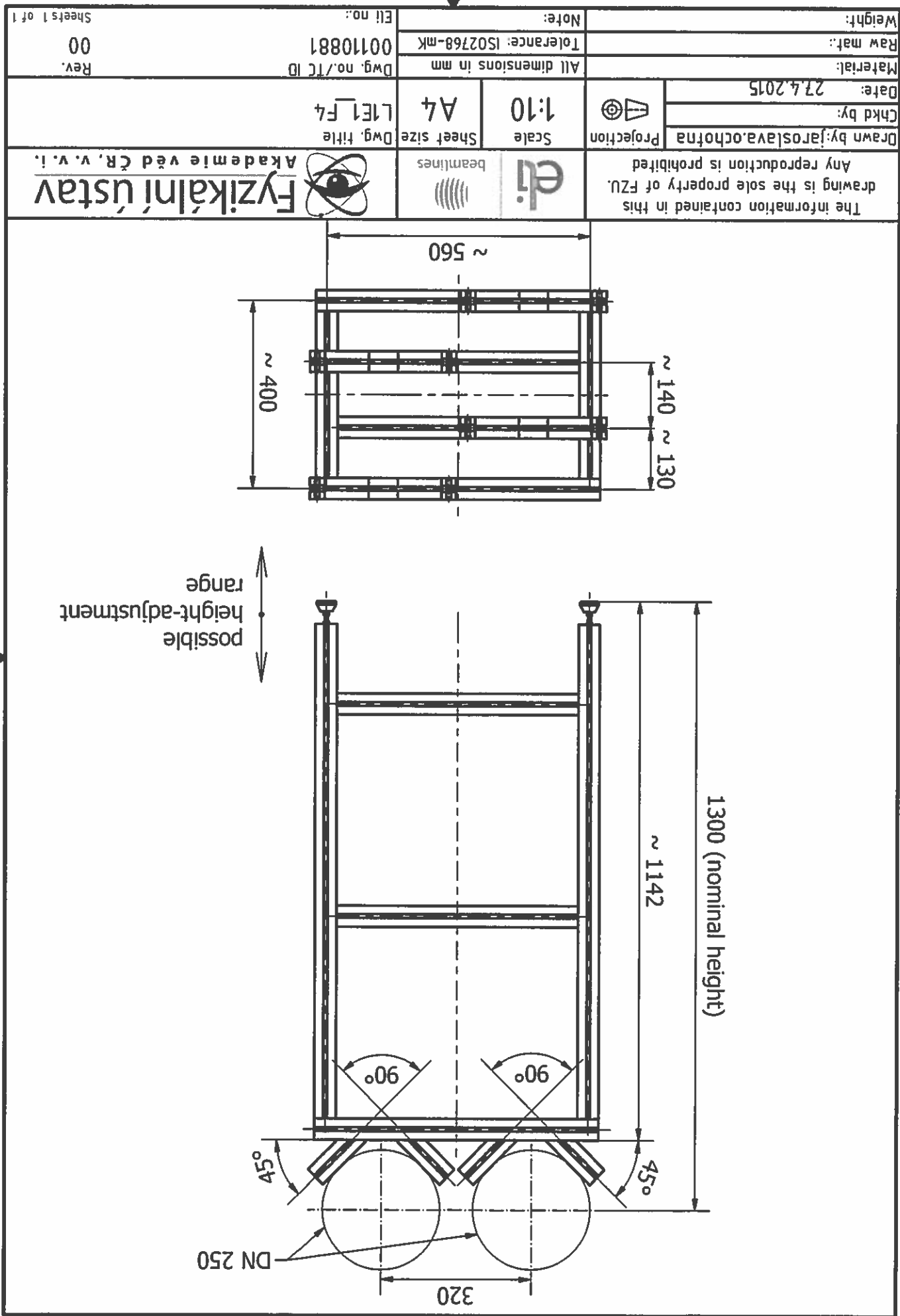
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Akademie věd ČR, v. v. i.

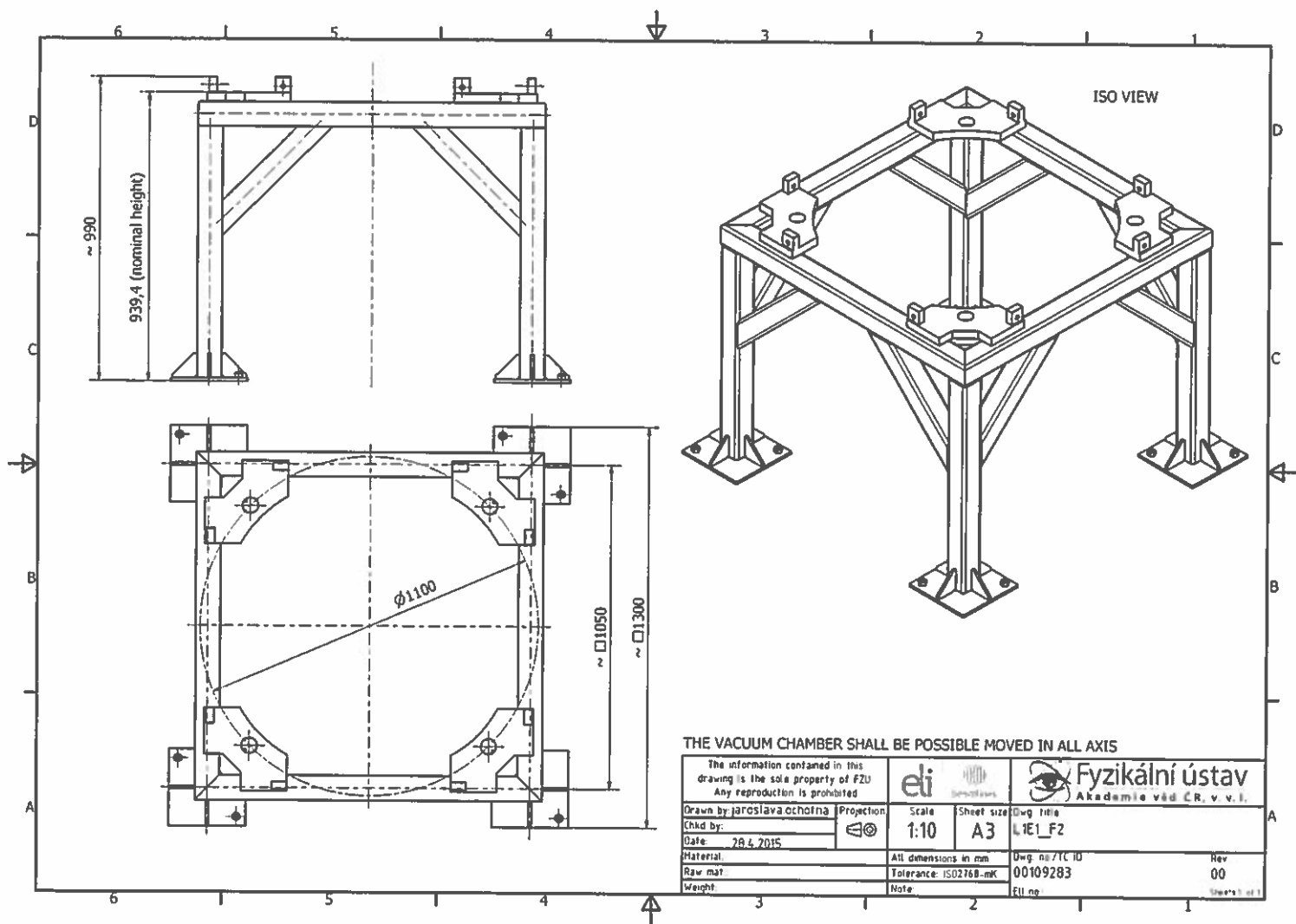


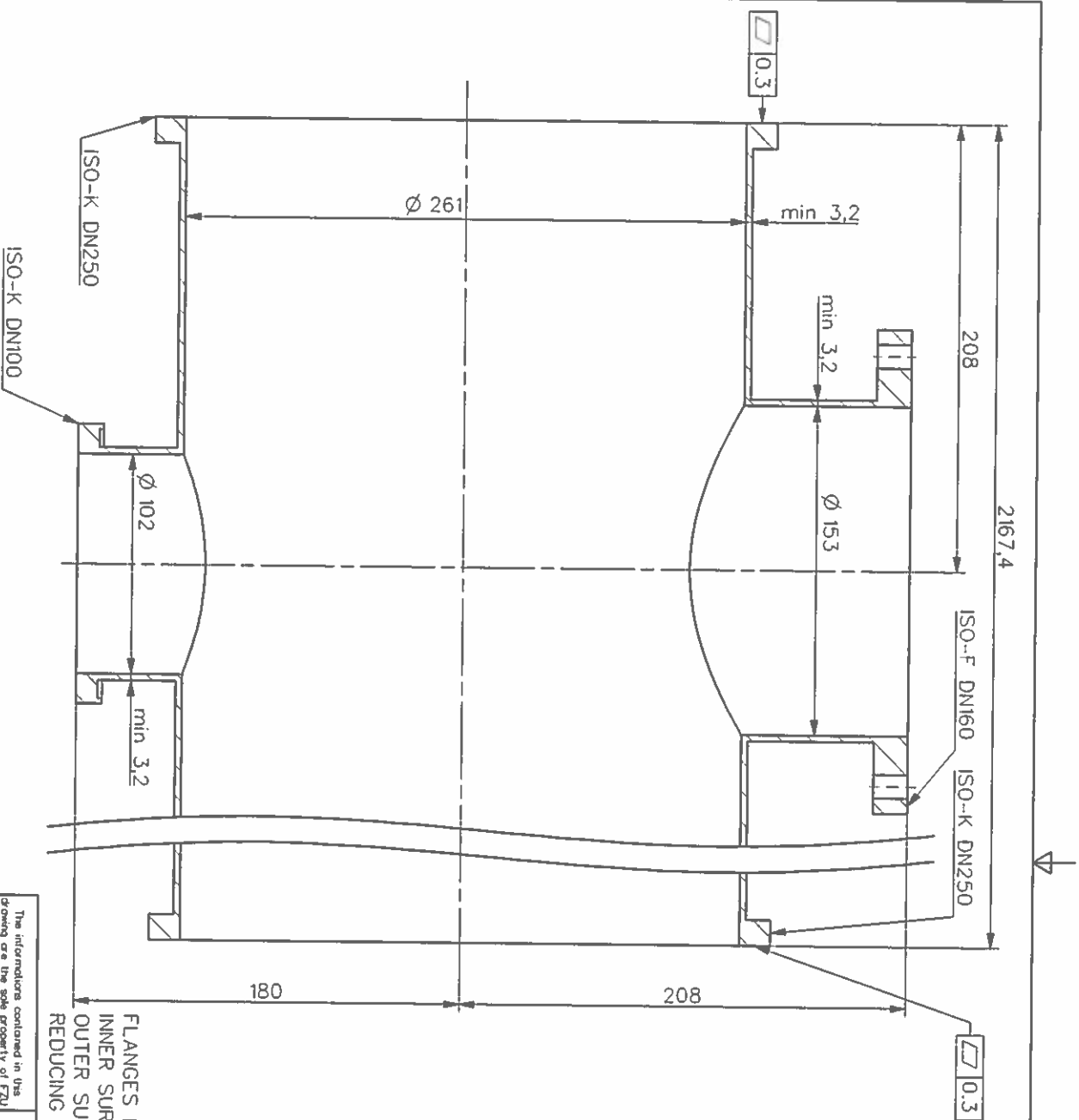


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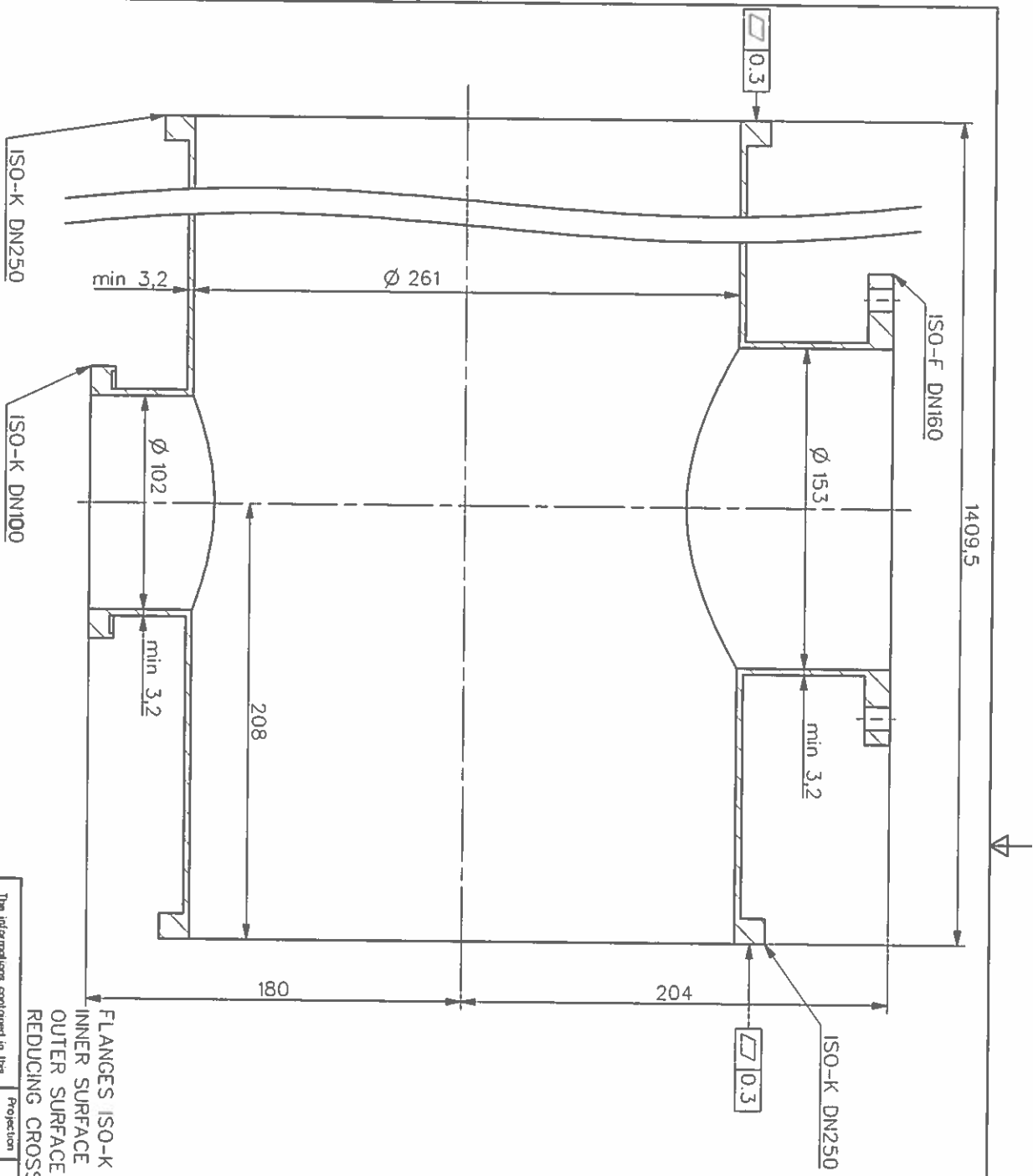






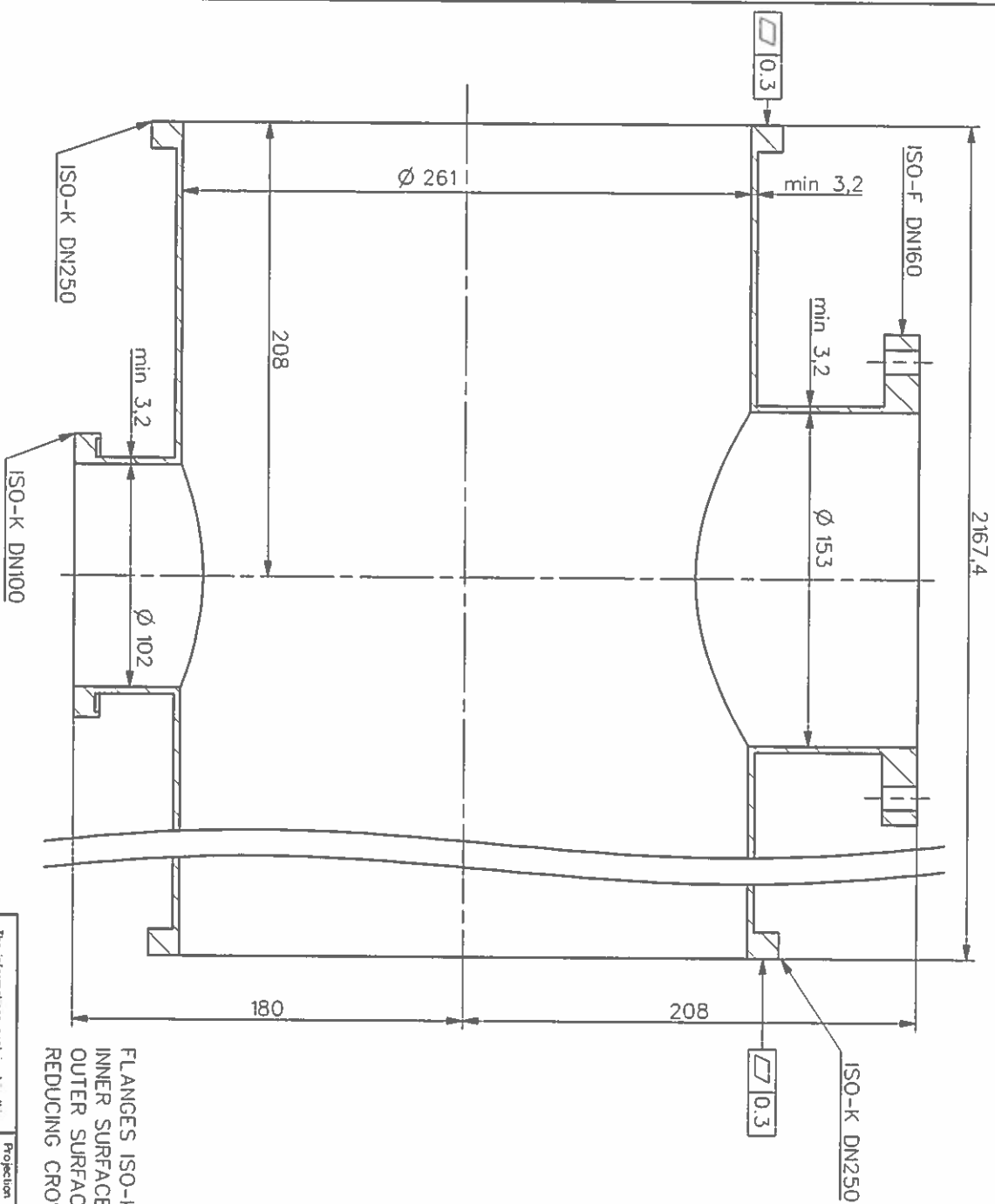
FLANGES ISO-K AND ISO-F ACCORDING TO STANDARD ISO 1609
 INNER SURFACE - POLISHING R_a 0,8
 OUTER SURFACE - BALLOTINI
 REDUCING CROSS TESTED FOR HELIUM LEAK

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Checked by:	Comments	Scale	Dwg. title
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	Application		ETI B. N.



FLANGES ISO-K AND ISO-F ACCORDING TO STANDARD ISO 1609
 INNER SURFACE - POLISHING R_a 0,8
 OUTER SURFACE - BALLOTINI
 REDUCING CROSS TESTED FOR HELIUM LEAK

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		Application				Sheet 1 of 1	



FLANGES ISO-K AND ISO-F ACCORDING TO STANDARD ISO 1609
 INNER SURFACE - POLISHING R_a 0,8
 OUTER SURFACE - BALLLOTINI
 REDUCING CROSS TESTED FOR HELIUM LEAK

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Drawn by: petr.voboril

Comments

Scale

Dwg. title

Checked by:

Scale

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L1E1_P21_CH10-11

Date: 14.5.2015

Comments

Scale

Dwg. title

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Comments

Scale

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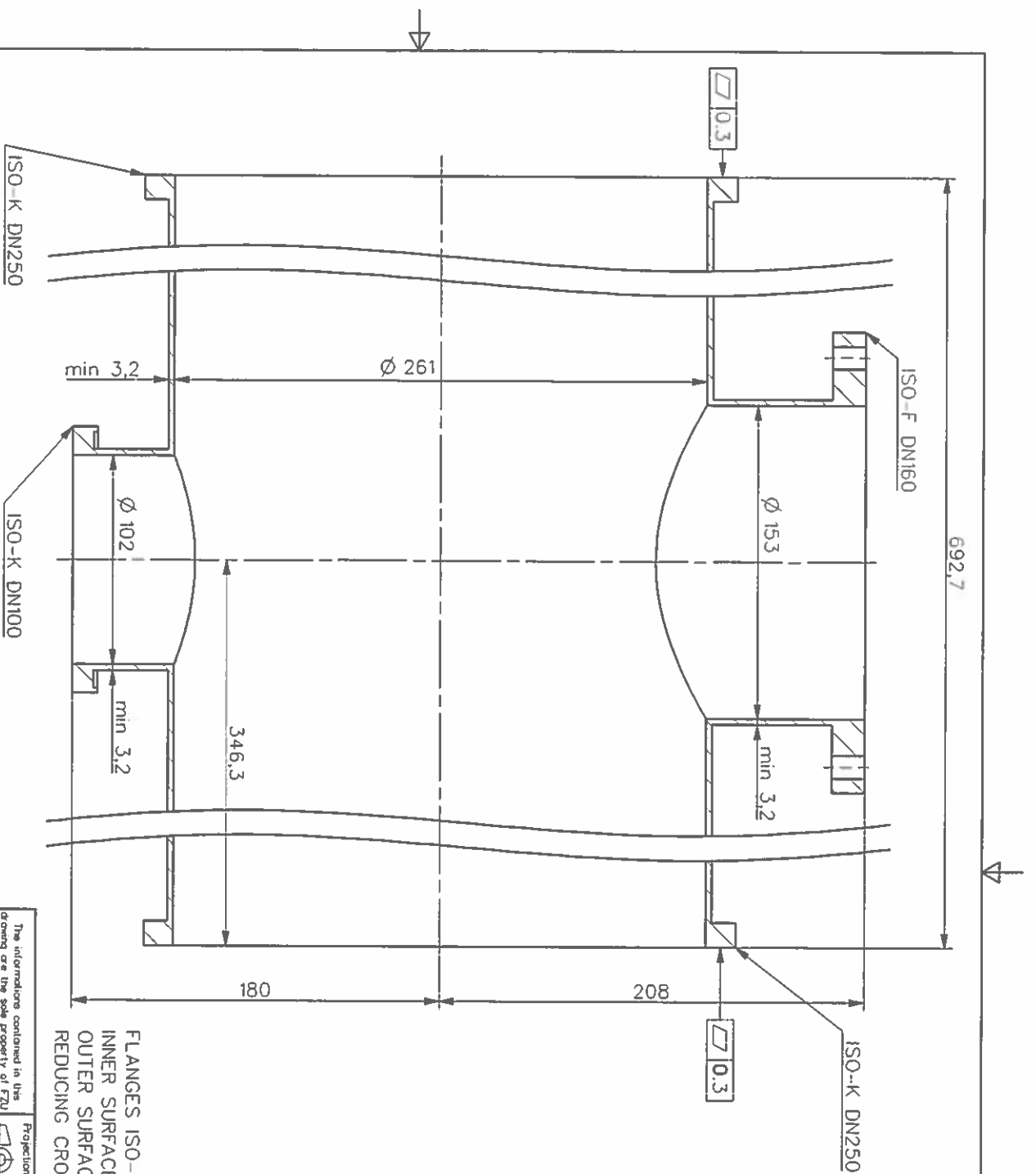
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FLANGES ISO-K AND ISO-F ACCORDING TO STANDART ISO 1609
 INNER SURFACE - POLISHING R_a 0,8
 OUTER SURFACE - BALLOTINI
 REDUCING CROSS TESTED FOR HELIUM LEAK

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beamlines



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Drawn by: petr.vaboril

Comments

Scale

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Sheet 1 of 1

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00104281/00

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Comments

Scale

Dwg. title

Dwg. no.

00104281/00

Weight:

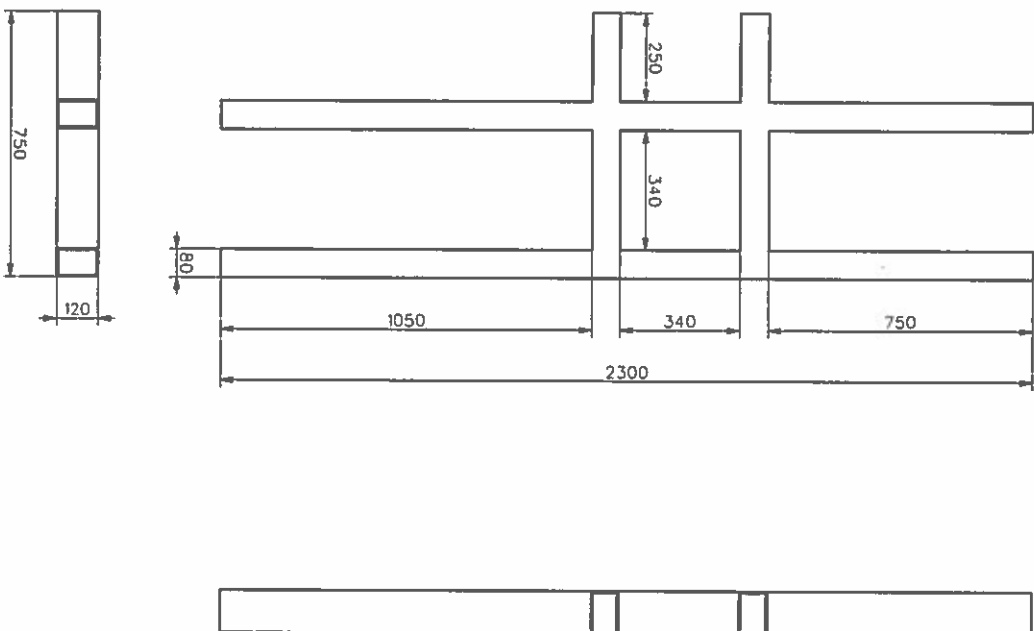
Comments

Scale

Dwg. title

Dwg. no.

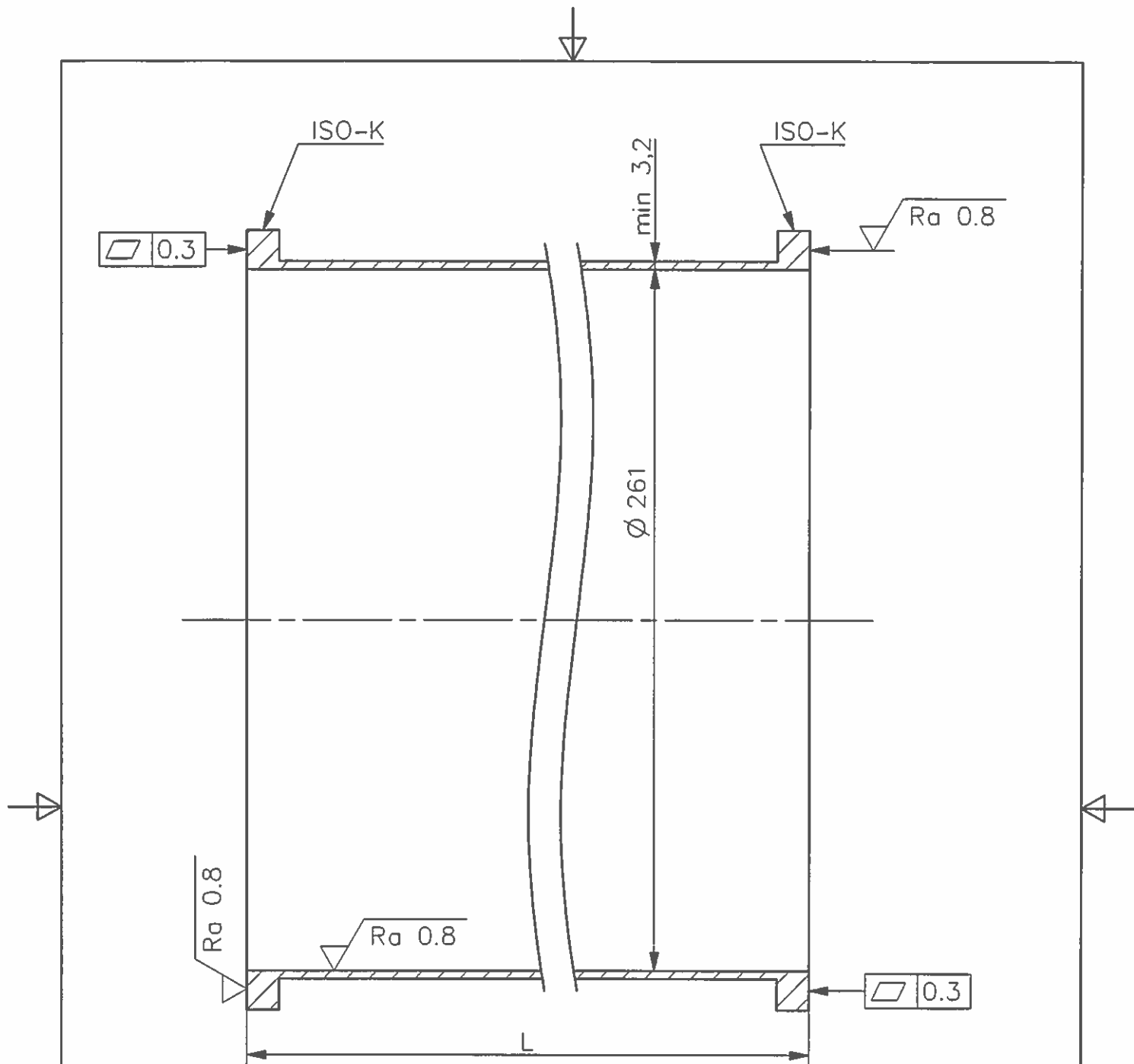
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Drawn by:	martin.iznicak	Comments		Dwg. title	
Checked by:		Scale		LE1_F6	
Date:	13.10.2015	All dimensions in mm		Dwg. no.	
Material:		Tolerance ISO 2768-mS		00104392/00	
Row no.:		Application		M.B. is	
Weight:				Sheet 1 of 1	

Dwg no. PIPE DN250			
Name	Length "L"	Between chambers	Dwg no.
L1E1_P01_CH2-3	2481,7 mm	Room L1 - CH3	00104267
L1E1_P03_CH3-5	3000 mm	CH3 - CH5	00104269
L1E1_P06_CH3-5	2000 mm	CH3 - CH5	00104282
L1E1_P12_CH8-9	2000 mm	CH8 - CH9	00104289
L1E1_P14_CH9-10	684,7 mm	CH9 - CH10	00104292
L1E1_P15_CH9-10	1500 mm	CH9 - CH10	00104293
L1E1_P18_CH10-12	1500 mm	CH10 - CH12	00104296
L1E1_P19_CH10-11	3000 mm	CH10 - CH11	00104297
L1E1_P20_CH10-11	3000 mm	CH10 - CH11	00104298
L1E1_P23_CH10-13	638,3 mm	CH10 - CH13	00104303
L1E1_P24_CH13_HHG	779,4 mm	CH13-HHG	00110952
L1E1_P25_CH12_PXS	1000 mm	CH12-PXS	00110962

SEE:Dwg no. PIPE DN250



FLANGES ISO-K ACCORDING TO STANDARD ISO 1609
 INNER SURFACE - POLISHING Ra 0,8
 OUTER SURFACE - BALLOTINI
 PIPE TESTED FOR HELIUM LEAK

The informations contained in this drawing are the sole property of FZU. Any reproduction is prohibited		Projection 		 beamlines	 Fyzikální ústav Akademie věd ČR, v. v. i.
Drawn by: marek.rajdl	Comments	Scale 1:2	Dwg. title PIPE DN250		
Checked by:					
Date:					
Material: AISI 304			All dimensions in mm		Dwg. no.
Raw mat.:			Tolerance: ISO2768-mk		PIPE DN250
Weight:			Application		ELI B. Nr.
					Sheet 1 of 1

ELI B. Nr.

Sheet 1 of 1

Program: [4.3 - Beam transport]	
Subject: [Vacuum beam transport L1 to E1 (Vacuum hardware)]. Verification Control Document (VCD)	
Specification: [TC#00111983/E - RSD Vacuum components branch L1-E1 including supporting frames TP14_143]	

003965/A; Vacuum beam transport L1 to E1 (Vacuum hardware)									
Requirement TC ID	Revision	Requirement text	Level	Verification Method	Close-out		VPD Verification Planning Document	VRD Verification Record Document	Comments
					Yes	No			
REQ-007906	A	Vacuum components of L1 - E1 system shall be designed for vacuum level 10-4 mbar.		T - test					
REQ-008117	A	Vacuum vessels shall allow vacuum pumping and venting.		FD - functional demonstration					
REQ-008273	A	Enclosed drawings shall be taken into account as inputs for preliminary design.		R - review					
REQ-008323	A	All relevant components (RC Vacuum Chambers including chassis, pipe support structures, CC Vacuum Vessel chassis) shall be designed to accommodate laser beam axis 1300 mm above floor level.		R - review					
REQ-007914	A	All Vacuum chamber parts heavier than 15 kg shall be equipped with lifting eyes interfaces NOTE: Final design of the interfaces will be part of detailed design.		R - review					
REQ-007923	A	All openings of delivered components shall be closed as follows: Vacuum chambers by aluminium alloy or stainless steel blank flanges; Vacuum pipes and bellows by plastic caps.		I - inspection					
REQ-007981	A	Outer surface finish shall be uniform Ballotini (blasting with glass beads). Other finish technologies are possible if agreed with the Contracting Authority.		I - inspection					
REQ-007982	A	Precautions shall be taken in design and assembly of all vacuum components to avoid trapped volumes in vacuum spaces which could result in virtual leaks and these spaces shall be suitably vented.		I - inspection					
REQ-007999	A	Maximum dimensions of used components and their non-dismountable sub-components shall be 1,9 x 2,9 x 2,4 m.		R - review					
REQ-008001	A	Design shall have grounding and ESD.		R - review					
REQ-008010	A	All opened profiles in frames constructions shall be covered with end caps.		I - inspection					
REQ-007919	A	Supplier shall provide final information regarding BT L1-E1 weight and weight distribution of BT L1-E1 components.		R - review					
REQ-008284	A	Vacuum Vessels shall be equipped with inlet and outlet flanges according to the listed standards: ISO 1609:1986 - Vacuum technology - Flange dimension; ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings).		R - review					
REQ-008315	A	Single leak rate for each relevant component (vacuum pipes, bellows) shall be lower than 1 · 10-9 mbar l/s per component.		T - test					
REQ-007993	A	Total leak rate for each relevant component (vacuum vessels) shall be lower than 5 · 10-4 mbar l/s per component.		T - test					
REQ-007993	A	CC Vacuum Vessel Chassis shall be made of stainless steel.		R - review					

Program: [4.3 - Beam transport]

Subject: [Vacuum beam transport L1 to E1 (Vacuum hardware)]. Verification Control Document (VCD)

Specification: [TC#0011983/E - RSD Vacuum components branch L1-E1 including supporting frames TP14_143]

003965/A: Vacuum beam transport L1 to E1 (Vacuum hardware)									
Requirement TC ID	Revision	Requirement text	Level	Verification Method	Close-out		VPD Verification Planning Document	VRD Verification Record Document	Comments
					Yes	No			
REQ-008118	A	CC chassis shall allow for floor fixing. NOTE: For further information see the document "E1 room datasheet" (RD-02). Selected values mentioned in E1 room datasheet are: Max. load for floors of experimental halls is 25 kN on surface with dimensions 20x20 cm. Anything exceeding these values should be checked and approved by Contracting Authority.		R - review					
REQ-007997	A	Design of CC Vacuum Vessel Chassis shall allow positioning in x, y direction (horizontal plane) when fixed to floor. NOTE: Requirement defining interfaces (e.g. bracket with holes) needed for positioning.		R - review					
REQ-007998	A	Range of CC Vacuum Vessel Chassis adjustment shall be in z direction 30 mm		R - review, FD - functional demonstration					
REQ-007994	A	CC Vacuum Vessel Chassis shall allow x, y, z vessels adjustment.		R - review					
REQ-007995	A	Range of CC Vacuum Vessel adjustment shall be (see REQ-007994/A) in x direction 20 mm in y direction 20 mm in z direction 20 mm.		R - review, FD - functional demonstration					
REQ-008008	A	Design solution using screws for adjustment shall be used (see Figure 2).		R - review					
REQ-007996	A	CC Vacuum Vessel Chassis shall allow clash free installation of Turbomolecular pumps (TMP).		R - review					
REQ-008316	A	RC Vacuum Chambers shall provide for the following mechanical interfaces: TMP's (Turbo Molecular Pumps); Gauges; Feedthroughs; Diagnostics; Remote control; Central Vacuum System (CVS); Beam Transport (BT); Vacuum Gate Valves; Vacuum Venting Valves.		R - review					
REQ-008324	A	RC Vacuum Chambers shall be a modular units allowing extension in longitudinal direction (see Figure 3).		R - review					
REQ-008321	A	The supplier shall define the Reference Coordinate System (RCS) of the RC Chambers which shall allow positioning these RC Chambers in Contracting Authority's experimental hall according to Reference Mechanical System of the hall (RMS).		R - review					
REQ-008322	A	RCS and its relation to the RMS shall be set up together with supplier during the preliminary design phase.		R - review					
REQ-008005	A	RC Breadboard and RC Vacuum Vessel shall allow for decoupling.		R - review					
REQ-008006	A	Decoupling of RC breadboard and vacuum vessel shall be made by using edge welded bellows.		R - review					
REQ-008007	A	Double bellows decoupling system shall be applied on RC breadboard chassis (see Figure 4).		R - review					
REQ-008276	A	All RC Vacuum Vessels and Vacuum Vessel Chassis shall allow installation of Turbomolecular pumps (TMP) as follows: Vacuum Vessel - ISO F interface Vacuum Vessel versus TMP; Vacuum Vessels Chassis - possibility to dismount the Chassis. NOTE: Preferable position of TMP's is from the bottom part of Vacuum Vessel.		R - review					
REQ-	A	RC frame shall be made of stainless steel.		R - review					

Program: [4.3 - Beam transport]	
Subject: [Vacuum beam transport L1 to E1 (Vacuum hardware)]. Verification Control Document (VCD)	
Specification: [TCH0011983/E - RSD Vacuum components branch L1-E1 including supporting frames TP14_143]	

003965/A: Vacuum beam transport L1 to E1 (Vacuum hardware)									
Requirement TC ID	Revision	Requirement text	Level	Verification Method	Close-out		VPD Verification Planning Document	VRD Verification Record Document	Comments
					Yes	No			
REQ-007916	A	RC shall be equipped with roughing inlet flange (DN160 ISO -KF).		R - review					
REQ-008274	A	RC panels and blank flanges shall be made of stainless steel or aluminium alloy following types: Aluminium alloy: EN AW-2219 EN AW-3003 EN AW-5083 EN AW-6082 EN AW-2090 EN AW-2219 EN AW-7005 Stainless steel: AISI 304 AISI 304L		R - review					
REQ-008275	A	Final choice of RC panel material shall be made in preliminary design phase.		R - review					
REQ-008004	A	RC Vessel panels shall be designed as a modular system. Technical note: Modular system = unification of panel dimensions.		R - review					
REQ-008320	A	Maximal deformations of RC Vacuum Vessel panels under vacuum shall be lower than 3 mm in comparison to the vented status.		T - test					
REQ-007915	A	All RC removable panels shall be equipped with guiding pins for closing procedure.		R - review					
REQ-007912	A	Blind holes with thread depth 2.5d shall be prepared in RC covers/panels for all designed flanges.		R - review					
REQ-007924	A	Stainless steel screws with Allen heads shall be used on RC Chamber panels.		R - review					
REQ-008325	A	RC Vacuum Vessel Chassis shall allow z (vertical) adjustment.		R - review					
REQ-008326	A	Range of RC Vacuum Vessel Chassis adjustment in z (vertical) direction shall be 20 mm.		R - review					
REQ-008002	A	RC Vacuum Vessel Chassis shall be made of stainless steel or extruded aluminium alloy profiles.		R - review					
REQ-008285	A	Design of RC Vacuum Vessel Chassis shall allow positioning in x, y direction (horizontal plane) when fixed to floor. NOTE: Requirement defining interfaces (e.g. bracket with holes) needed for positioning.		R - review					
REQ-008327	A	RC Vacuum Vessel Chassis shall allow installation of Turbomolecular pumps (TMP).		R - review					
REQ-008328	A	RC Vacuum Vessel Chassis shall allow for floor fixing NOTE: For further information see the document "E1 room datasheet" (RD-02). Selected values mentioned in E1 room datasheet are: Max. load for floors of experimental halls is 25 kN on surface with dimensions 20x20 cm. Anything exceeding these values should be checked and approved by Contracting Authority.		R - review					
REQ-008329	A	Each RC Vacuum Vessel Chassis shall be equipped with removable transportation wheels.		R - review					
REQ-008330	A	Supplier shall provide static FEM analysis and vibration study according to Contracting Authority inputs. Technical note: The latest results of building vibration measurement and simplified optical layout will be provided by Contracting Authority after contract signature.		A - analysis					
REQ-008331	A	RC Optical Tables shall have threaded holes pattern with 25 mm spacing.		R - review					
REQ-	A	Threaded holes of RC Optical Table shall be M6 size.		R - review					

Program: [4.3 - Beam transport]

Subject: [Vacuum beam transport L1 to E1 (Vacuum hardware)]. Verification Control Document (VCD)

Specification: [TC#0011983/E - RSD Vacuum components branch L1-E1 including supporting frames TP14_143]

Requirement TC ID	Revision	Requirement text	Level	Verification Method	Close-out		VPD Verification Planning Document	VRD Verification Record Document	Comments
					Yes	No			
REQ-008333	A	RC Optical Table shall be made of aluminium alloy following types:EN AW-2219EN AW-3003EN AW-5083EN AW-6082EN AW-7005 (must not be baked out)The parts must not be anodized.		R - review					
REQ-008334	A	Final choice of RC Optical Table material shall be made in preliminary design phase.		R - review					
REQ-008335	A	Minimum thickness of RC Optical Table plate shall be 50 mm as a starting value. Based on FEM analysis and vibration study (REQ-008330/A) modification of this value is acceptable.		R - review					
REQ-008658	A	Maximum static deformation of RC Optical Table shall be ≤ 1 mm.		A - analysis					
REQ-008336	A	Natural frequencies of RC Optical Table shall be ≥ 20 Hz.		A - analysis					
REQ-008337	A	RC Optical Table Chassis shall allow z (vertical) adjustment.		R - review					
REQ-008611	A	Range of RC Optical Table Chassis adjustment in z (vertical) direction shall be 20 mm. Design of RC Optical Table Chassis shall allow positioning in x, y direction (horizontal plane) together with Vacuum Vessel Chassis.NOTE: Requirement defining interfaces (e.g. bracket with holes) needed for positioning. Temporary connection between two chassis is also mentioned in this requirement.		R - review					
REQ-008760	A	RC Optical Table Chassis shall allow x, y, z adjustment of RC Optical Table.		R - review					
REQ-008761	A	RC Optical Table adjustment shall be (see REQ-008760/A):in x direction 15 mm in y direction 15 mm in z direction 15 mm		R - review					
REQ-008338	A	RC Optical Table Chassis shall be made of stainless steel or aluminium alloy extruded profiles (unified with RC Vacuum Vessel Chassis).		R - review					
REQ-008339	A	RC Optical Table Chassis shall allow installation of TMP's.		R - review					
REQ-008340	A	RC Optical Table Chassis shall allow floor fixing.		R - review					
REQ-008341	A	RC Optical Table Chassis shall be equipped with removable transportation wheels.		R - review					
REQ-007925	A	Sealing used for BT L1-E1 system shall be made of fluorelastomer polymer (FPM) material.NOTE: RC chambers applicable.		R - review					
REQ-007926	A	Hardness of BT L1-E1 sealing o-rings shall be 60 or 70 HSC (Shore) NOTE: RC chambers applicable		R - review					
REQ-007978	A	Sealing surfaces must be in particular free of scratches or dents.		I - inspection					
REQ-007979	A	Seal faces shall be suitably protected immediately after final machining to minimise the risk of damage. This protection shall only be removed for the purposes of cleaning and inspection, prior to final assembly.		I - inspection					
REQ-007980	A	The surface finish of seal faces shall be compatible with the requirements of the ISO-K resp. ISO-F seals used.		R - review					

Program: [4.3 - Beam transport]									
Subject: [Vacuum beam transport L1 to E1 (Vacuum hardware)]. Verification Control Document (VCD)									
Specification: [TC#00111983/E - RSD Vacuum components branch L1-E1 including supporting frames TP14_143]									
003965/A: Vacuum beam transport L1 to E1 (Vacuum hardware)									
Requirement TC ID	Revision	Requirement text	Level	Verification Method	Close-out		VPD Verification Planning Document	VRD Verification Record Document	Comments
					Yes	No			
REQ-008281	A	Vacuum vessels shall comply with frequency of opening/closing 2-times a day.NOTE: Based on engineering demands on operational and maintenance procedures.		R - review, A - analysis					
REQ-007977	A	CH3 Chassis shall be designed as CC type.		R - review					
REQ-008313	A	CH3 Chassis shall have an interface for fixation to the floor and wall.		R - review					
REQ-008609	A	CH3 Chassis shall be compatible with CH3 Vacuum Vessel interface (see Annex II).		R - review					
REQ-008610	A	Vacuum Chamber CH8 shall be designed as RC type (see Chapter 4.1.2).		R - review					
REQ-008345	A	Vacuum Chamber CH9 shall be designed as RC type (see Chapter 4.1.2).		R - review					
REQ-008011	A	CH10 Chassis shall be designed as CC type.		R - review					
REQ-008347	A	CH10 Chassis shall be compatible with CH10 Vacuum Vessel interface (see Annex II).		R - review					
REQ-008349	A	Vacuum Chamber CH11 shall be designed as RC type (see Chapter 4.1.2).		R - review					
REQ-007908	A	CH12 Chassis shall be designed as CC type.		R - review					
REQ-008282	A	CH12 Chassis shall be compatible with CH12 Vacuum Vessel interface (see Annex II).		R - review					
REQ-008283	A	CH13 Chassis shall be designed as CC type.		R - review					
REQ-008284	A	CH13 Chassis shall be compatible with CH13 Vacuum Vessel interface (see Annex II).		R - review					
REQ-008285	A	Edge welded bellows shall be equipped with guiding rods for axial movement fixation.		I - inspection					
REQ-008286	A	Each edge welded bellows shall undergo a helium leak test confirmed with output protocol.		T - test					
REQ-007907	A	Each edge welded bellows shall be manufactured according to Table 1.Edge welded bellows with guiding rods - DN250Type of flangesISO-K (ISO 1609)Inside pressure10-6 mbarOutside pressure1 bar (atmospheric pressure)Leak rate10-9 mbar/sTemperature20±3°CMaterialAISI 304, AISI 316LMinimum: 10 000 cyclesMovement absorptionAxial±15 mmLateral±5 mmAngular±2°Minimal inner diameter258 mmLength free230 mmSpace for mounting (between flanges) without centering237.8 mmTable 1 Technical specification of edge welded bellows.		T - test					
REQ-008009	A	Pipes shall be designed with respect to standard ISO 1609-1986 - Vacuum technology - Flange dimension.		R - review					
REQ-008652	A	Vacuum pipes shall be clearly identified and labelled for assembly purpose		R - review					
REQ-008653	A	Pipes support structures shall be positioned in x, y direction.Note: requirement describes positioning with relation to building resp. E1 experimental hall		R - review					
REQ-008654	A	Pipes support structures shall allow z (vertical) adjustment. Exception is support structure for horizontal pipe (see drawing number 00104392/00)		R - review					

Program: [4.3 - Beam transport]									
Subject: [Vacuum beam transport L1 to E1 (Vacuum hardware)]. Verification Control Document (VCD)									
Specification: [TC#0011983/E - RSD Vacuum components branch L1-E1 including supporting frames TP14_143]									
001965A: Vacuum beam transport L1 to E1 (Vacuum hardware)									
Requirement TC ID	Revision	Requirement text	Level	Verification Method	Close-out		VPO Verification Planning Document	VRD Verification Record Document	Comments
					Yes	No			
REQ-008655	A	Range of Pipes support structures adjustment in z (vertical) direction shall be 30 mm.		R - review					
REQ-008654	A	Pipes support structures shall be made of stainless steel or extruded aluminium alloy profiles.		R - review					
REQ-007904	A	The clamps shall be of suitable design and use material that prevents permanent clamp deformation after multiple use.		R - review					
REQ-007905	A	The clamps shall be of suitable design and use material that prevents damaging of the clamp slots on flanges.		R - review					
REQ-007909	A	Fittings shall be designed with respect to the listed standards: ISO 1609:1986 - Vacuum technology - Flange dimension; ISO 2861:2013 - Vacuum technology - Dimensions of clamped - type quick-release couplings.		R - review					
REQ-007910	A	Centering ring with outer ring shall be used for connection between fitting and chamber.		R - review					
REQ-007983	A	Cleaning procedure shall remove contaminants that adhere to the surface such as oils, greases, dirt, swarf, corrosion products, or finger prints.		I - inspection					
REQ-007984	A	Any assemblies shall be made up from pre-cleaned components where possible.		R - review					
REQ-007985	A	Cleanliness shall be taken into account at all stages from detailed design to installation.		R - review					
REQ-007986	A	Clean components shall be handled wearing clean, dry, lint-free gloves.		R - review					
REQ-007987	A	Supplier shall provide cleaning procedure compatible with High Vacuum (10 ⁻⁶ mbar) and using in cleanroom ISO7.		R - review					
REQ-008319	A	The cleaning procedure shall be included at minimum the following steps: General pre-clean, removal of gross contamination, fluxes etc. by wiping/scraping; Degrease with solvent by rinsing, swabbing or immersion; Wash with domestic water and detergent; Vapor degrease or soak cleaning; Degrease with solvent. Small and complex items shall be immersed and ultrasonically agitated; Wash with domestic water; Wash with demineralised water; Drying (dry air); Immediate packaging.		R - review					
REQ-007988	A	Vacuum sealing welds made externally must have full penetration leaving a smooth surface on the vacuum side.		R - review					
REQ-007989	A	Supplier shall apply cleaning and degreased procedure. This procedure shall be provided by Supplier.		R - review					
REQ-007990	A	Shielding gases shall be used to minimise oxidation.		R - review					
REQ-007991	A	Tools used during manufacture shall not contaminate the vacuum surface.		I - inspection					
REQ-007992	A	All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.		R - review					
REQ-008656	A	All conductive parts must be designed according to following Czech applicable standards CSN 33 2000-4-41, CSN 33 2000-5-54		R - review					

Program: [4.3 - Beam transport]									
Subject: [Vacuum beam transport L1 to E1 (Vacuum hardware)]: Verification Control Document [VCD]									
Specification: [TC#00111983/E - RSD Vacuum components branch L1-E1 including supporting frames TP14_143]									

003965/A: Vacuum beam transport L1 to E1 (Vacuum hardware)									
Requirement TC ID	Revision	Requirement text	Level	Verification Method	Close-out		VPD Verification Planning Document	VRD Verification Record Document	Comments
					Yes	No			
REQ-008012	A	The transportation personnel shall follow the Contracting Authority's facility regulations.NOTE: These regulations shall be defined by Contracting Authority and provided to the supplier after contract signature and before detailed design contract phase.		R - review					
REQ-008013	A	The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in clean environment of ISO class 7.		R - review, I - inspection					
REQ-008014	A	All transportation tools and equipment entering the clean rooms shall be cleaned and reviewed by the Contracting Authority's approved methods.NOTE: Some tools can be provided by the Contracting Authority upon agreement.		I - inspection					
REQ-008015	A	The transportation to the final destination of the technologies and the instruments shall be conducted by the supplier.		R - review					
REQ-008016	A	The transportation procedures shall be discussed and reviewed by the Contracting Authority's installation officer and shall be compliant with the Contracting Authority's installation regulations.NOTE: These regulations shall be defined by Contracting Authority and provided to the supplier after contract signature and before detailed design contract phase.		R - review					
REQ-008017	A	The main parts of the mechanical structure shall be equipped with positioning/alignment marks for industrial 3D-measurements/survey. The specific type of the positioning/alignment marks, their number and location shall be agreed with the Contracting Authority.		R - review, I - inspection					
REQ-008018	A	System or its relevant components shall comply with all applicable EU and Czech legislative requirements and where applicable shall have CE marking and Certificate of Compliance.		R - review					
REQ-008019	A	Supplier shall perform hazard identification and risk assessment of system prior to design.NOTE: Relevant for chamber design - RC chambers.		R - review, A - analysis					
REQ-008020	A	System or its relevant components shall be delivered with technical documentation where supplied specifies modes of operation: conditions for safe operation, installation and maintenance of system.		R - review					
REQ-008773	A	Quality workmanship procedure shall be provided by supplier and agreed by Contracting Authority.		R - review					
REQ-008031	A	The supplier shall supply the following relevant manufacturing documents (extent as stipulated in contract): Operating manual (including step-by-step aligning procedure), maintenance manual, breakdown list as built, Declarations of Conformity and relevant CE markings where required by EU legislation.		I - inspection					
REQ-008657	A	All interfaces of delivered components relevant for L1 to E1 system integration shall be identified and captured on drawings.		R - review					

Program: [4.3 - Beam transport]									
Subject: [Vacuum beam transport L1 to E1 (Vacuum hardware)]: Verification Control Document (VCD)									
Specification: [TCH00111983/E - RSD Vacuum components branch L1-E1 including supporting frames TP14_143]									

003965/A; Vacuum beam transport L1 to E1 (Vacuum hardware)									
Requirement TC ID	Revision	Requirement text	Level	Verification Method	Close-out		VPD Verification Planning Document	VRD Verification Record Document	Comments
					Yes	No			
REQ-008762	A	All interfaces identified, captured on drawings shall be agreed by Contracting Authority.		R - review					
REQ-008765	A	The results of review shall be documented in approved record and by VCD (see chapter 9.4).		R - review					
REQ-008353	A	The inspection results recorded in an inspection report referred in VCD NOTE: concerning VCD see chapter 9.3 and 9.4.		R - review					
REQ-008354	A	The measurement results shall be recorded in a Test report.		R - review					
REQ-008768	A	The protocol of the measurement shall be made and approved.		R - review					
REQ-008771	A	Test Programme shall be approved by the Contracting Authority.		R - review					
REQ-008355	A	The execution of functional demonstration shall be observed and results recorded in a Functional demonstration report.		R - review					
REQ-008357	A	The results of analysis shall be recorded in an Analysis report.		R - review					
REQ-008362	A	Based on the agreed methods of verification and the VP proposal how the verifications should be grouped together, the supplier shall include in the VP the list of the Test reports, Analysis reports, Inspections reports, and Functional demonstration reports that the supplier proposes to be prepared as part of verification of the requirements. (agreement by Contracting Authority)		R - review					
REQ-008363	A	The supplier shall carry out factory verification of requirements according to the VP and according to the updated VCD and record the results in the VCD before shipping the system out of factory. (agreement by Contracting Authority)		R - review					
REQ-008364	A	The supplier shall carry out with support from the Contracting Authority the final verification of requirements at ELI facility according to the VP and VCD and record the results in the final VCD. (agreement by Contracting Authority)		R - review					
REQ-008367	A	The basis for acceptance shall be completed Verification Control Document (Chapter 9.3) summarizing the overall verification results together with relevant reports supporting the verification.		R - review					