University of Bern
Physics institute
Space research & planetology
Sidlerstrasse 5, 3012 Bern

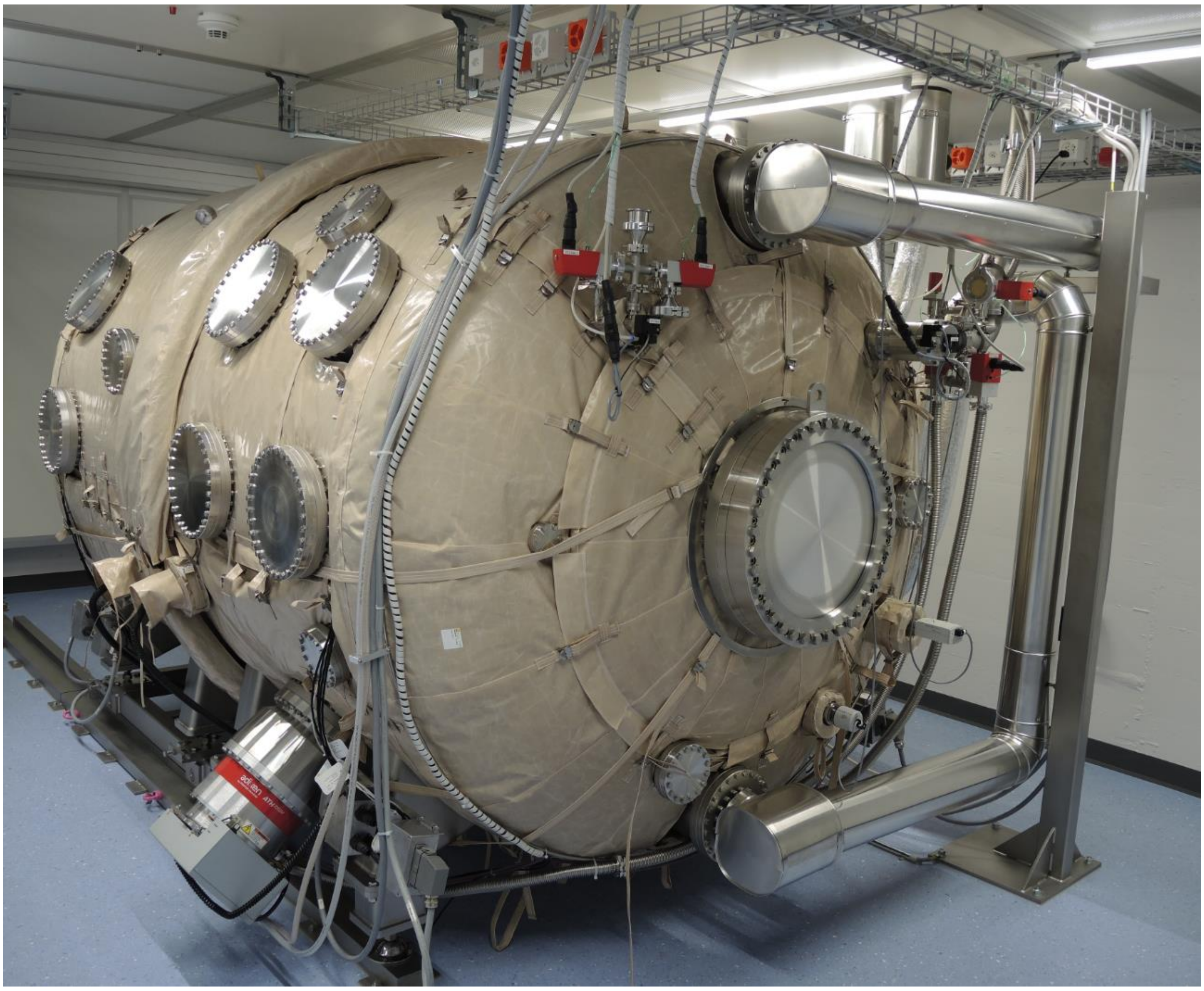
Fax: +41 (0)31 631 44 05
Tel: +41 (0)31 631 44 02

Contact: Dr. Daniele Piazza Tel: +41 (0)31 631 44 22
Thierry de Roche Tel: +41 (0)31 631 55 34
Daniel Schaedeli Tel: +41 (0)31 631 48 62

b
UNIVERSITÄT
BERN

CHEOPS THERMAL VACUUM TEST FACILITY

SYSTEM SPECIFICATION



Release 1.1 20.08.2018

Table of contents

1 Chamber ... 3
1.1 Dimensions ... 3
1.2 Flanges ... 4
1.3 Feedthroughs ... 5
1.4 Liquid nitrogen shroud ... 5
1.5 Sun simulator ... 6
2 Pumping system ... 7
2.1 Pumps ... 7
2.2 Ultimate pressure ... 7
3 Laboratory ... 7
4 Facility control ... 7
4.1 Vacuum section ... 7
4.2 Temperature control ... 8
5 Data acquisition ... 8
5.1 Temperatures ... 8
5.2 Pressures ... 9
5.3 Cleanliness monitoring equipment ... 9
5.4 Monitoring capabilities ... 9
ANNEX I Cheops thermal vacuum chamber technical drawing ... 10
ANNEX II Liquid nitrogen shroud technical drawing ... 11
ANNEX III Sun simulator technical drawing ... 12
ANNEX IV Laboratory layout ... 13
ANNEX V Block diagram of the facility vacuum system ... 14

1 Chamber

The chamber is cylindrical and horizontally oriented, consisting of a fixed and a mobile part. A liquid media circulated shroud and baseplate are mounted within the chamber with independently controlled circuits. The position of the baseplate is adjustable along the chamber axis.

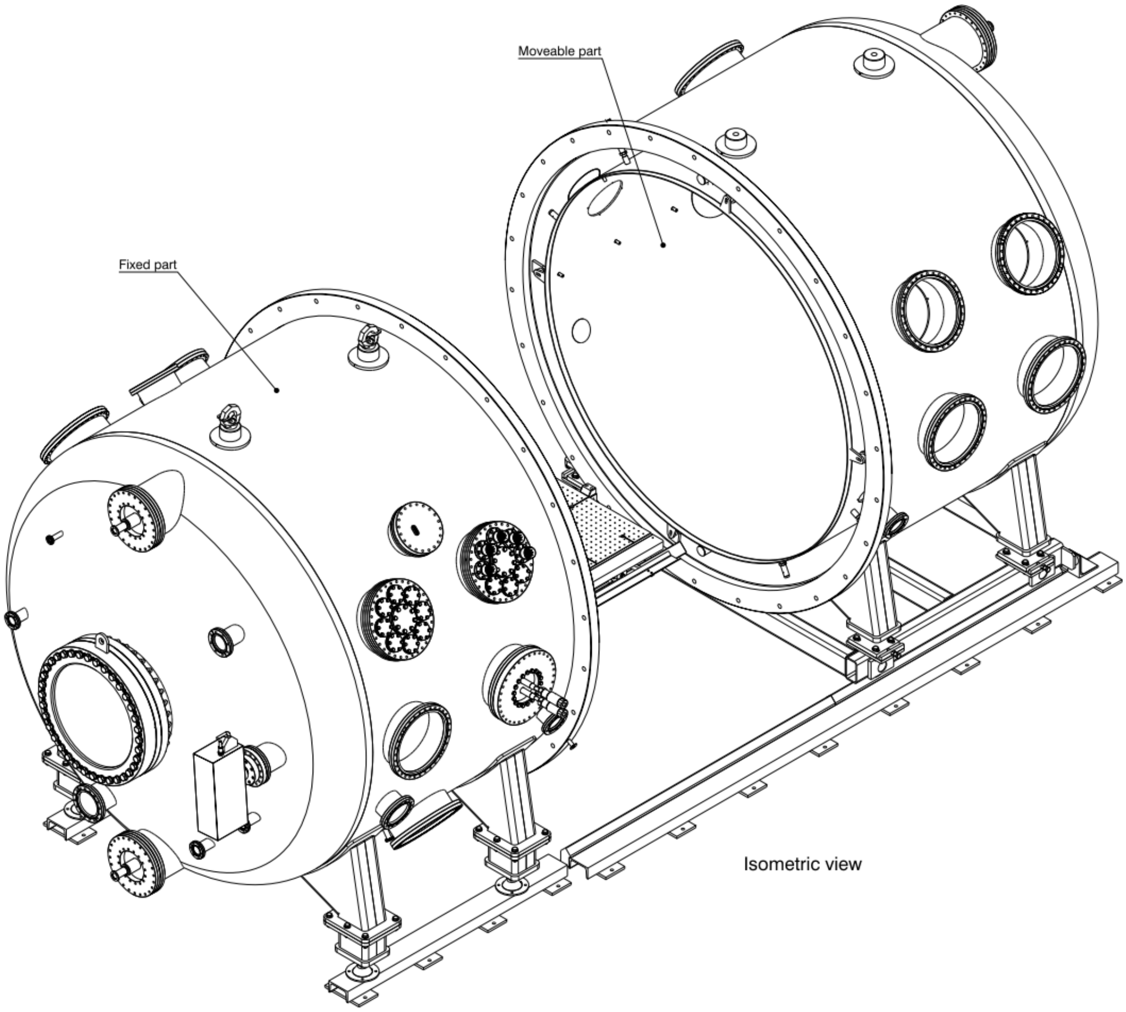


Figure 1: Isometric view of the fixed and mobile part of the chamber

1.1 Dimensions

The main dimensions of the chamber are:

- Inner diameter of the shroud: 1590 mm
- Max. length of test item: 2400 mm
- Dimension of the aluminium baseplate table: 900 mm x 680 mm
- Baseplate interface: M5x10 threads with a 25 mm pitch in both directions

3D CAD models and technical drawings of the different chamber setups are available. For more details see Annex I.

1.2 Flanges

The disposition and size of the flanges are shown in the following figure.

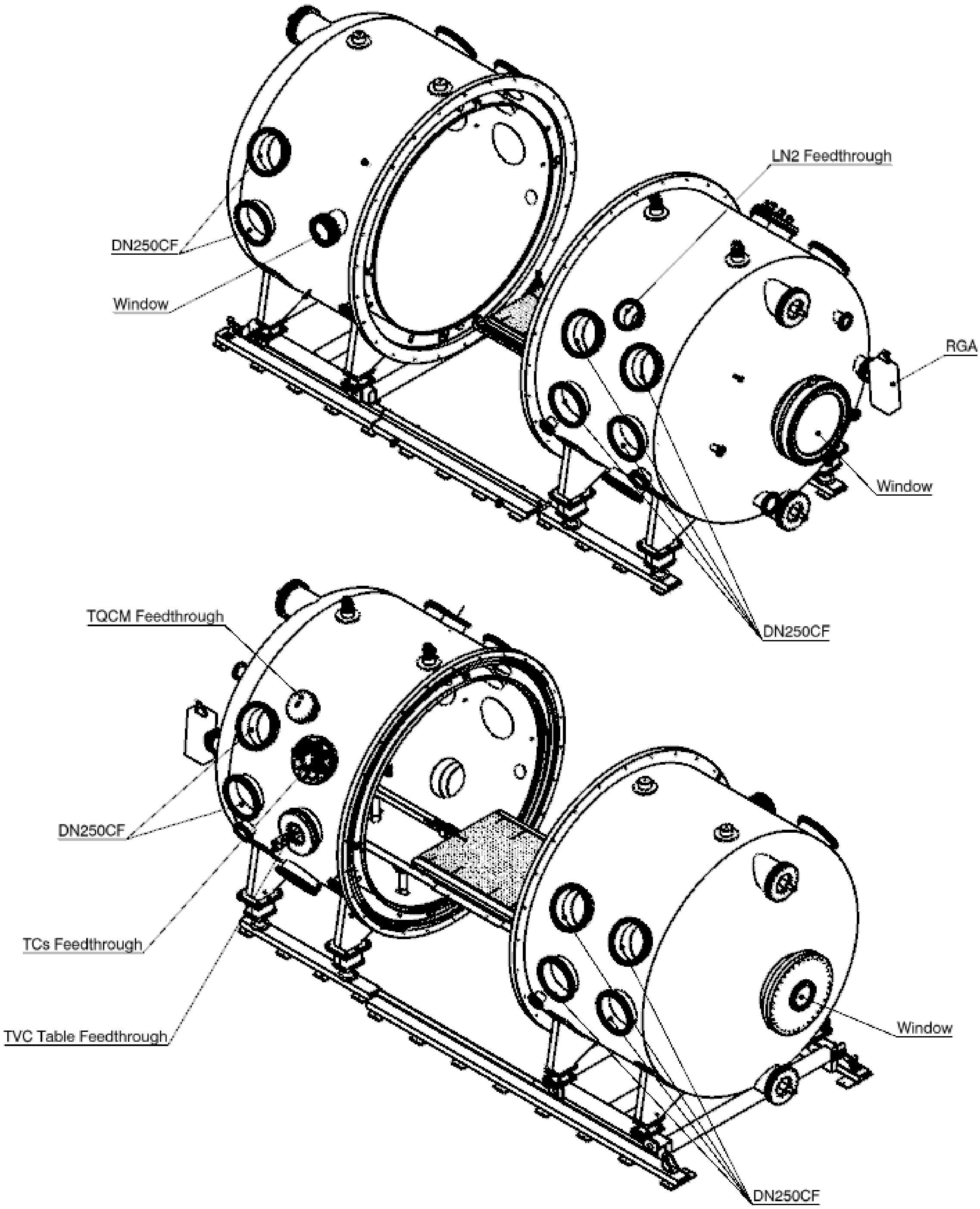


Figure 2: Flange disposition

1.3 Feedthroughs

The feedthroughs currently installed on the instrument feedthrough flanges are listed below and shown in Figure 3.

- 3x SUB-D 25 pin
- 4x SUB-D 15 pin
- 5x SUB-D 9 pin
- 2x MDM 15 pin (Vacom standard)

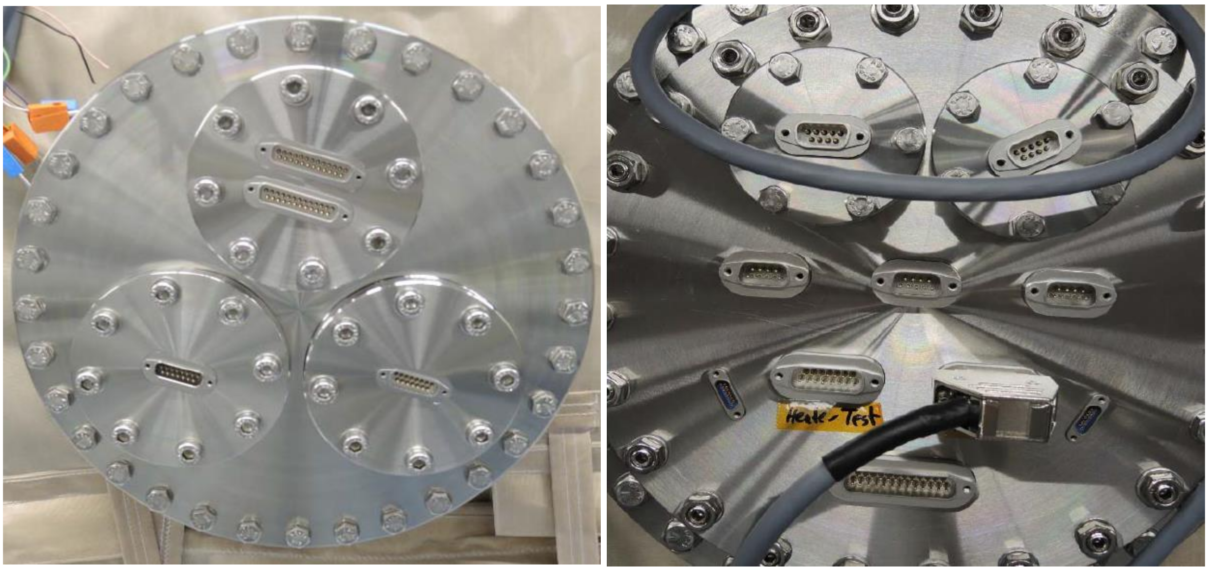


Figure 3: Instrument feedthrough flanges

1.4 Liquid nitrogen shroud

A small shroud designed to face deep space radiators is available. It was designed to be circulated by liquid nitrogen and its characteristics are listed below.

- Cooling area: 1300 mm²
- Min. temperature: -189°C (±0.1 °C)
- Cooling area surface treatment: MAP

For more information see Annex II.

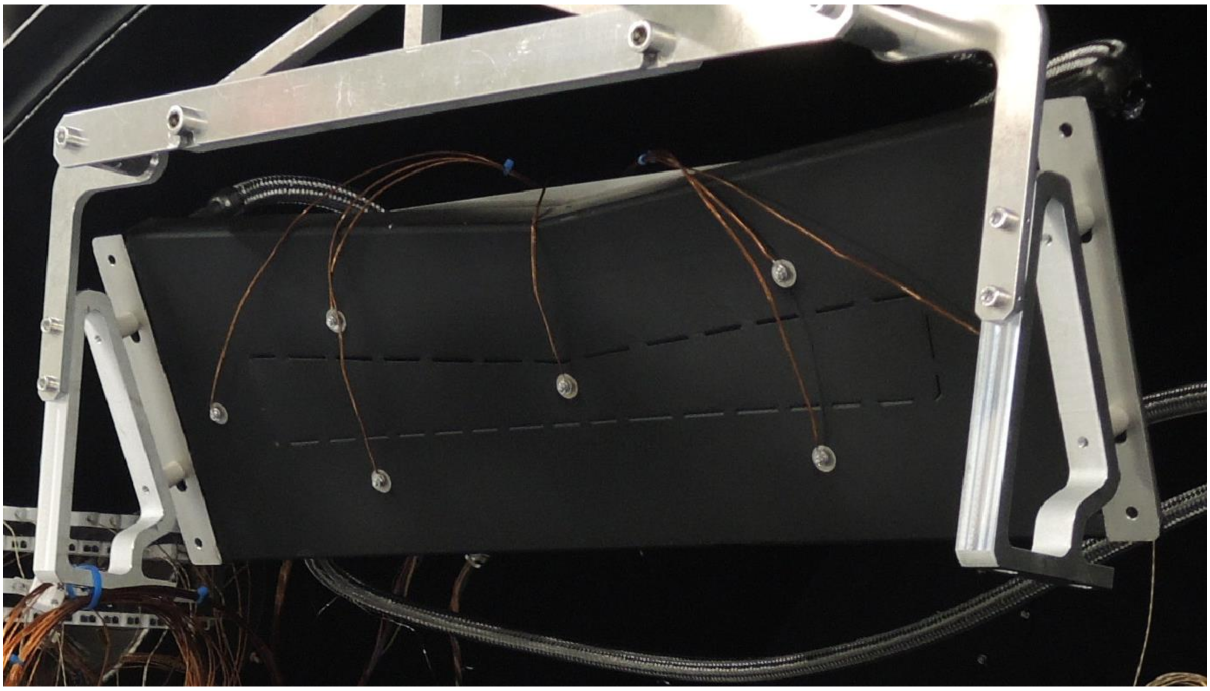


Figure 4: Liquid nitrogen shroud

1.5 Sun simulator

In order to simulate solar or planetary irradiance, a heating plate is available. Its characteristics are shown below.

- Heating area: 0.6 m² (two separate heating zones)
- Max. power: 5.2 kW_{th} (2x 2.6)

For more information see Annex III.

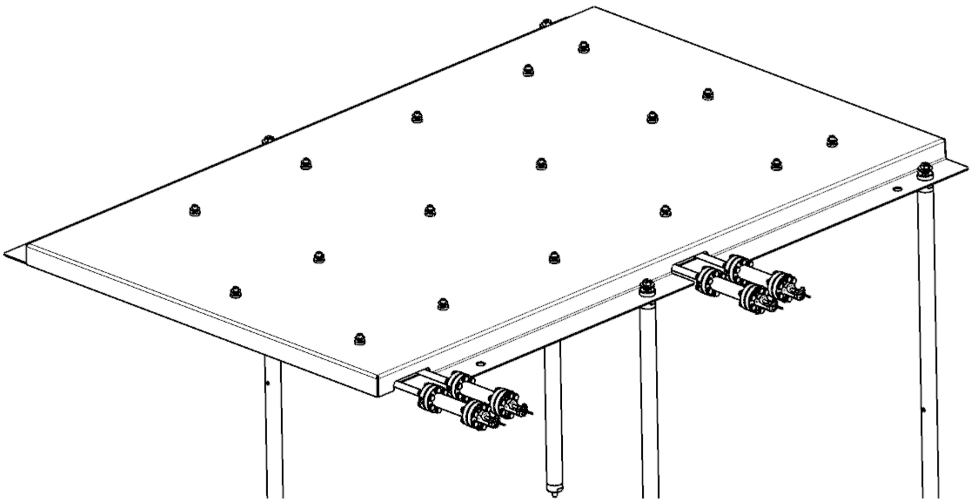


Figure 5: Isometric view of the heating plate

2 Pumping system

2.1 Pumps

Different vacuum pumps are installed in the chamber. The pumping system is completely oil free for cleanliness reasons. The main pump is a turbo molecular pump backed with either a screw pump (for a higher flow rate at the beginning of evacuation) or a scroll pump. The vacuum system of the facility is shown in Annex V.

- Prepump 1 (screw pump):
  - Type: Leybold Screwline 250
  - Pumping speed: 270 m^3/h
- Prepump 2 (scroll pump):
  - Type: ADIXEN ACP28
  - Max pumping speed: 27 m^3/h
- Turbopump (2x):
  - Type: Adixen ATH2303M
  - Pumping speed: 2150 l/s (Nitrogen)

2.2 Ultimate pressure

The ultimate pressure using the turbomolecular pumps is 1E-7 mbar at ambient temperature and with an empty chamber.

3 Laboratory

The loading section of the chamber is in a class 100 (ISO 5) laminar flow clean-room environment. A layout drawing is shown in Annex IV.

4 Facility control

4.1 Vacuum section

The complete vacuum section, including the pumps, gate valves and security systems are controlled by the TV-Chamber pump facility controller. The sequences for evacuation, switching pumps and such are predefined in the controller logic. This prevents the facility from damages due to handling errors. Failure modes like an interrupted power distribution or a damaged pump are automatically detected and will trigger a failsafe mode to conserve the vacuum and shut down systems to protect the test hardware from damages. The block diagram of the vacuum section is shown in Annex V.

4.2 Temperature control

The temperatures of the chamber shroud, instrument LN shroud and the baseplate are controlled by three independent liquid media circles. Temperature set points of chamber shroud and baseplate are regulated manually or through a web based monitoring system. For baking out the chamber, an electrical heating system is installed outside the chamber wall. All temperature control systems are equipped with independent security systems to prevent under- / overshooting of minimum / maximum temperatures.

Chamber shroud temperature control system

- Type: Huber Unistat 950w cooling/heating unit
- Heat carrier fluid: SilOil M90.055/170.03
- Temperature range: [-85°C,+120°C]
- Heating cooling rate: 1°C/min

Table temperature control system

- Type: Huber Unistat 915w cooling/heating unit
- Heat carrier fluid: SilOil M90.055/170.03
- Temperature range: [-80°C, +160°C]
- Heating cooling rate: 1°C/min

Chamber electrical heating system

- Type: Horst RA00368 - electrical resistance heating
- Temperature range: max. +120°C

5 Data acquisition

5.1 Temperatures

The temperatures for the facility operation and the experiment are measured with thermocouples and a high precision B&R temperature measurement device. All temperatures are logged by the web based monitoring system. Measurement are carried out by the X20AT6402 control system, while a X20ST4492 performs the safety monitoring. Also available is a X20AT2311, capable of temperature measurements with a resolution of 1 mK. Here in the following are the data acquisition specifications:

- Type: X20AT6402 x 17 modules:
    - Supported thermocouples: J, **K**, N, S
    - Inputs for thermocouples: 102 fully galvanic isolated
    - Accuracy: +/-0.1 K
    - Channels available for experiment: 40 K-type (chromel / alumel) thermocouples, twisted pair, AWG 30, covered with Kapton

- Type: X20AT2311 x 4 modules:
    - Supported sensor: PT-100
    - Inputs for thermocouples: 8 fully galvanic isolated
    - Accuracy: +/-1 mK
    - Channels available for optical table: 6 PT-100, twisted pair, AWG 30, covered with Kapton
- Type: X20ST4492 x 2 modules:
    - Supported thermocouples: J, K, N, S, R, C
    - Inputs for thermocouples: 8 fully galvanic isolated
    - Accuracy: +/-0.1 K

5.2 Pressures

The following pressure measurement devices are installed. All the pressures are logged by the web based monitoring system.

- Pfeiffer TPR280: prevacuum chamber, min pressure: 5E-4 mbar (M1)
- Pfeiffer PCR280: chamber, min pressure: 5E-5 mbar (M2)
- Pfeiffer PKR261: chamber, min pressure: 5E-9 mbar (M3)
- Pfeiffer PBR260: chamber, min pressure: 5E-10 mbar (M4)

5.3 Cleanliness monitoring equipment

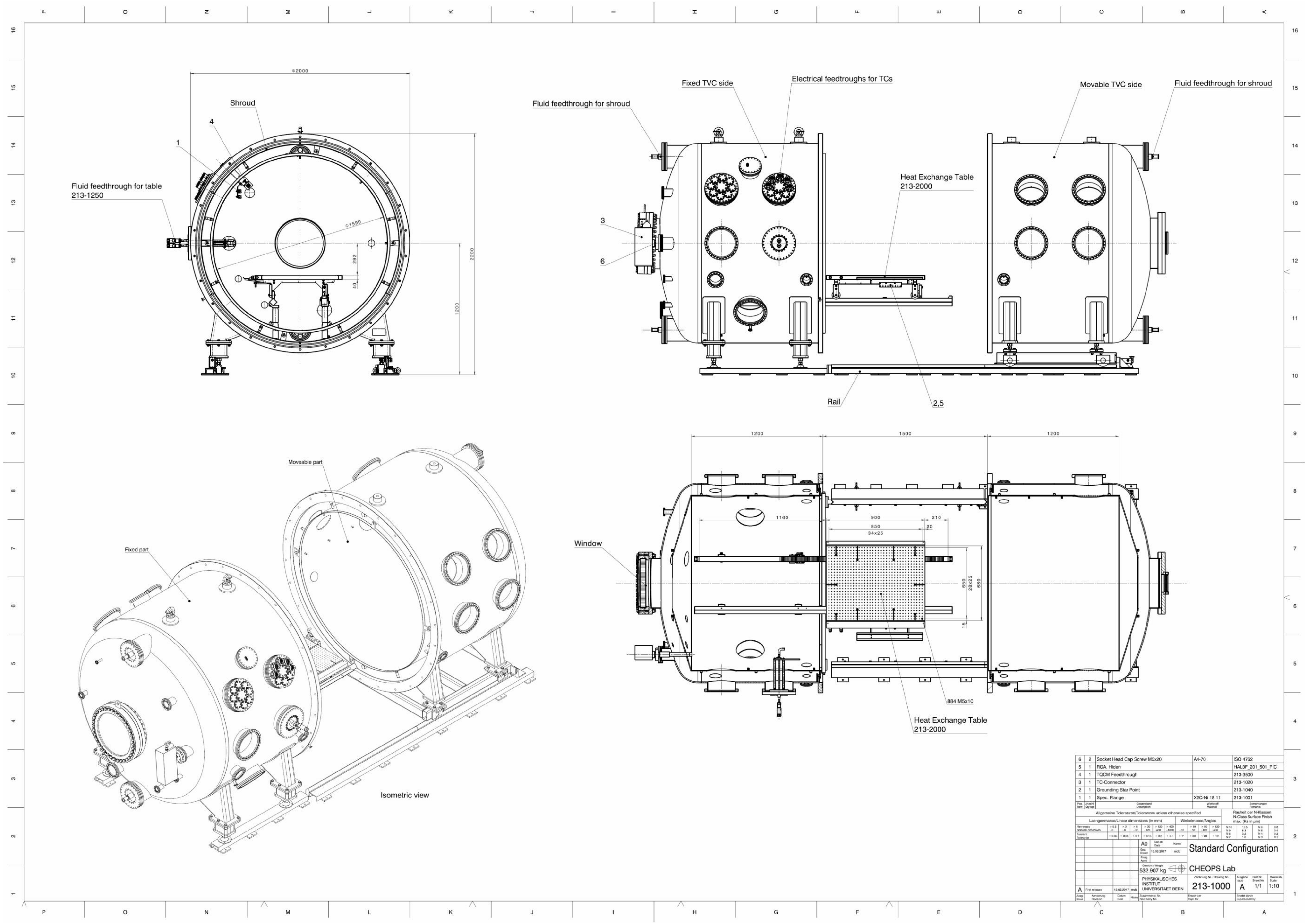
The following equipment is installed in order to monitor contaminants.

- RGA: Hiden HAL/3F 301 PIC
- TQCM: CystalTek Model 56S/T

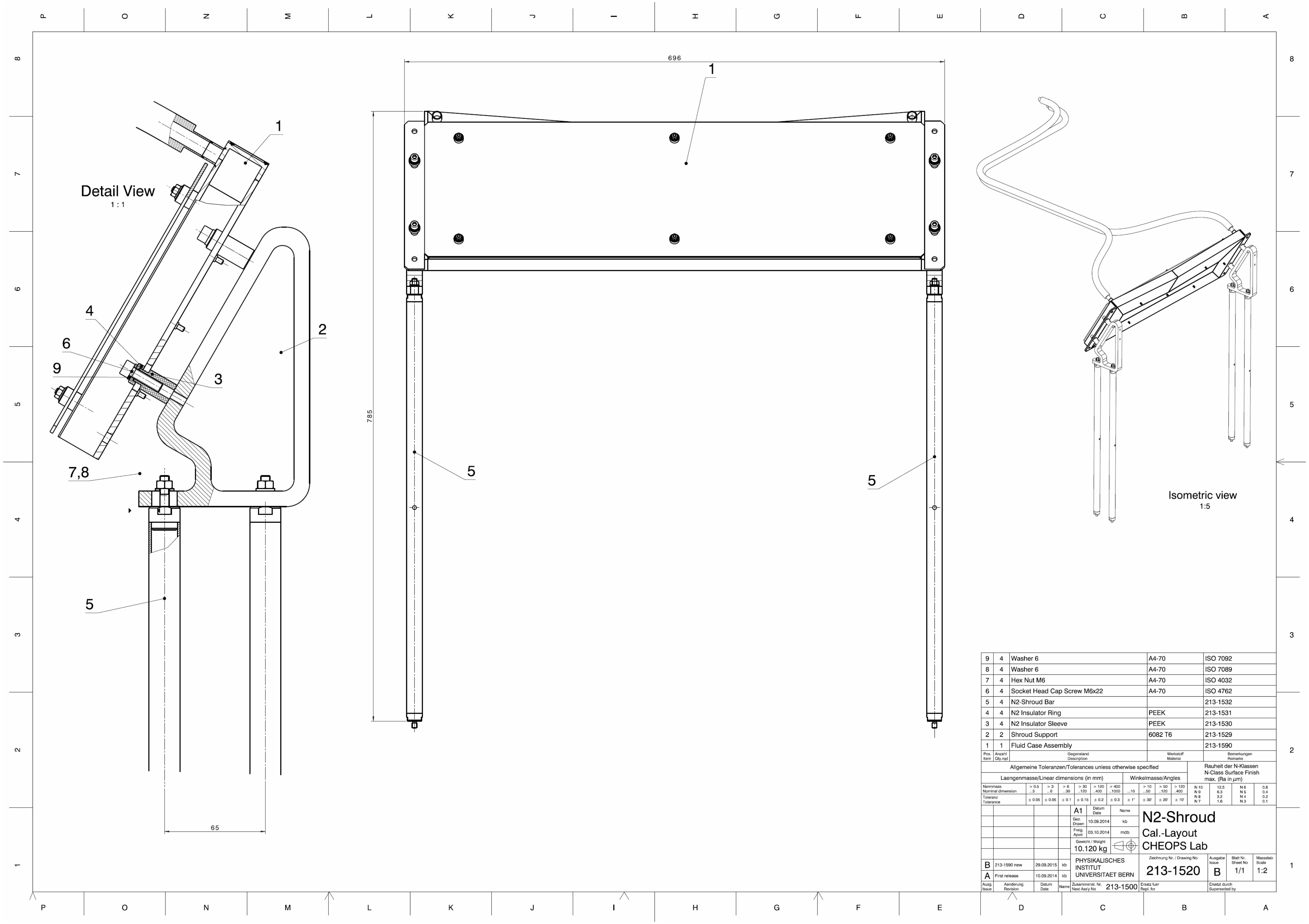
5.4 Monitoring capabilities

All data is recorded through the facility's web based monitoring system and can be viewed in real time.

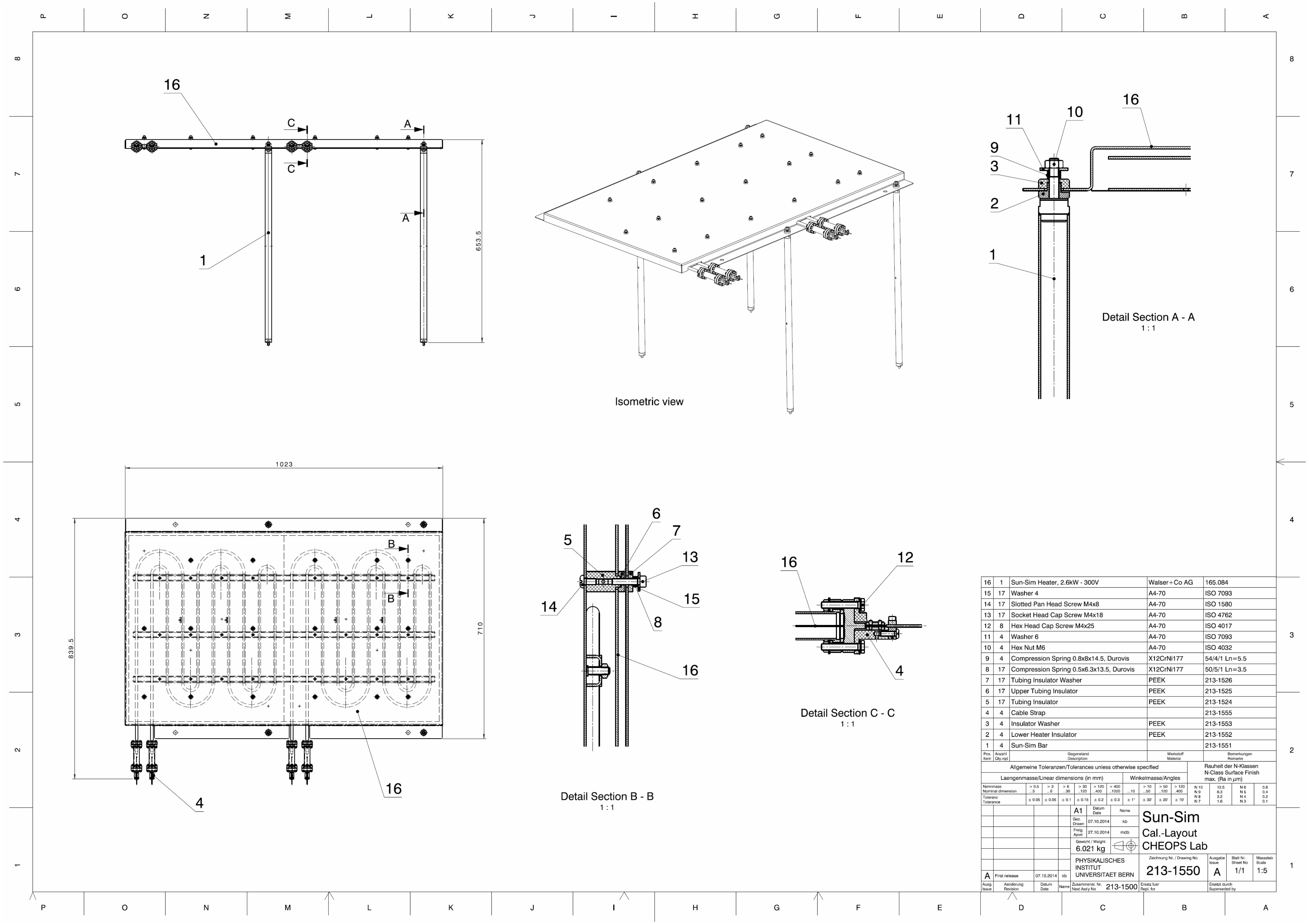
ANNEX I CHEOPS THERMAL VACUUM CHAMBER TECHNICAL DRAWING



ANNEX II LIQUID NITROGEN SHROUD TECHNICAL DRAWING

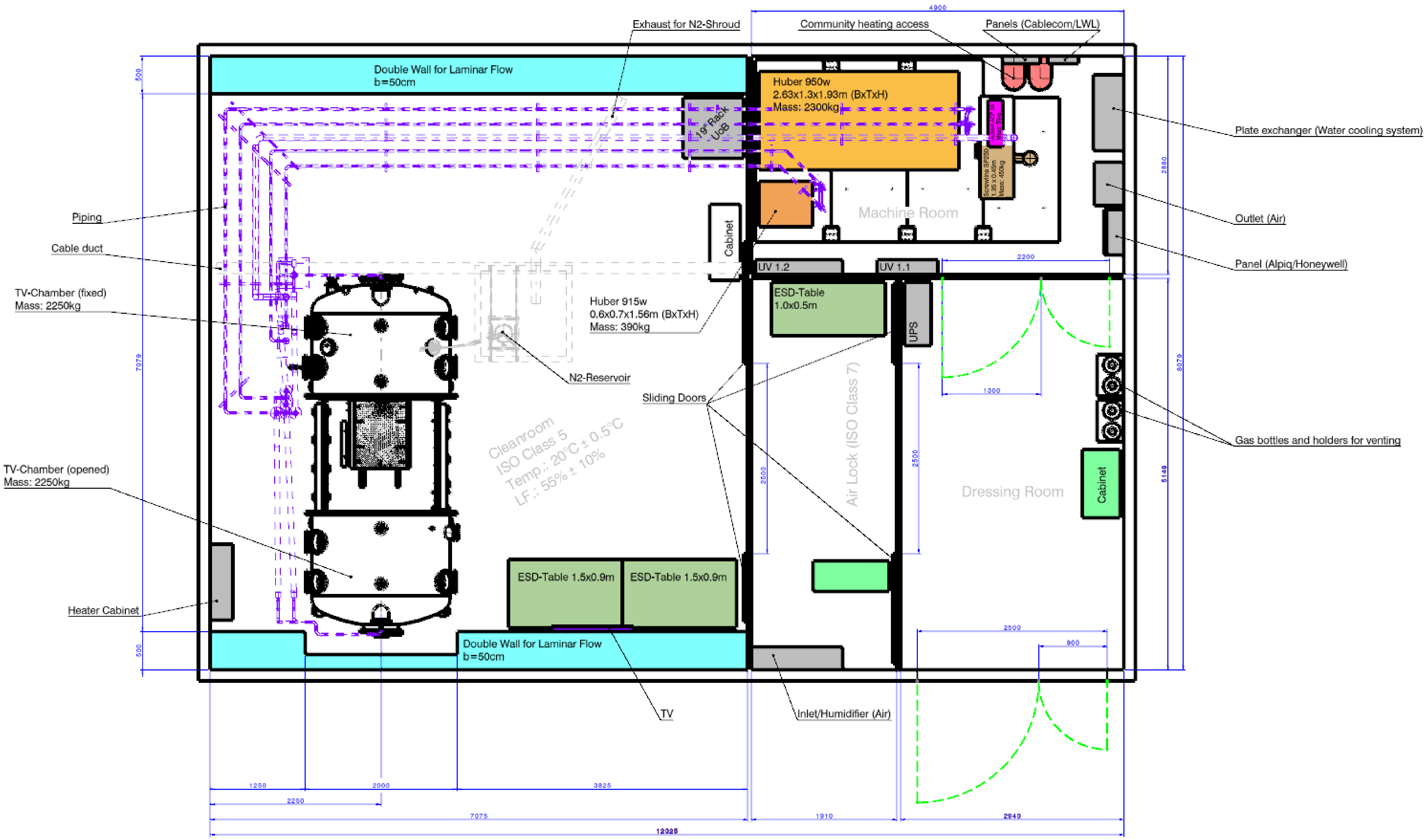


ANNEX III SUN SIMULATOR TECHNICAL DRAWING



Pos. Item	Anzahl Qty.rqd	Gegenstand Description	Werkstoff Material	Bemerkungen Remarks
16	1	Sun-Sim Heater, 2.6kW - 300V	Walser+Co AG	165.084
15	17	Washer 4	A4-70	ISO 7093
14	17	Slotted Pan Head Screw M4x8	A4-70	ISO 1580
13	17	Socket Head Cap Screw M4x18	A4-70	ISO 4762
12	8	Hex Head Cap Screw M4x25	A4-70	ISO 4017
11	4	Washer 6	A4-70	ISO 7093
10	4	Hex Nut M6	A4-70	ISO 4032
9	4	Compression Spring 0.8x8x14.5, Durovis	X12CrNi177	54/4/1 Ln=5.5
8	17	Compression Spring 0.5x6.3x13.5, Durovis	X12CrNi177	50/5/1 Ln=3.5
7	17	Tubing Insulator Washer	PEEK	213-1526
6	17	Upper Tubing Insulator	PEEK	213-1525
5	17	Tubing Insulator	PEEK	213-1524
4	4	Cable Strap		213-1555
3	4	Insulator Washer	PEEK	213-1553
2	4	Lower Heater Insulator	PEEK	213-1552
1	4	Sun-Sim Bar		213-1551

ANNEX IV LABORATORY LAYOUT



ANNEX V BLOCK DIAGRAM OF THE FACILITY VACUUM SYSTEM