Vacuum requirements and Beamline interface at the VUV-FEL User Facility

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Outline

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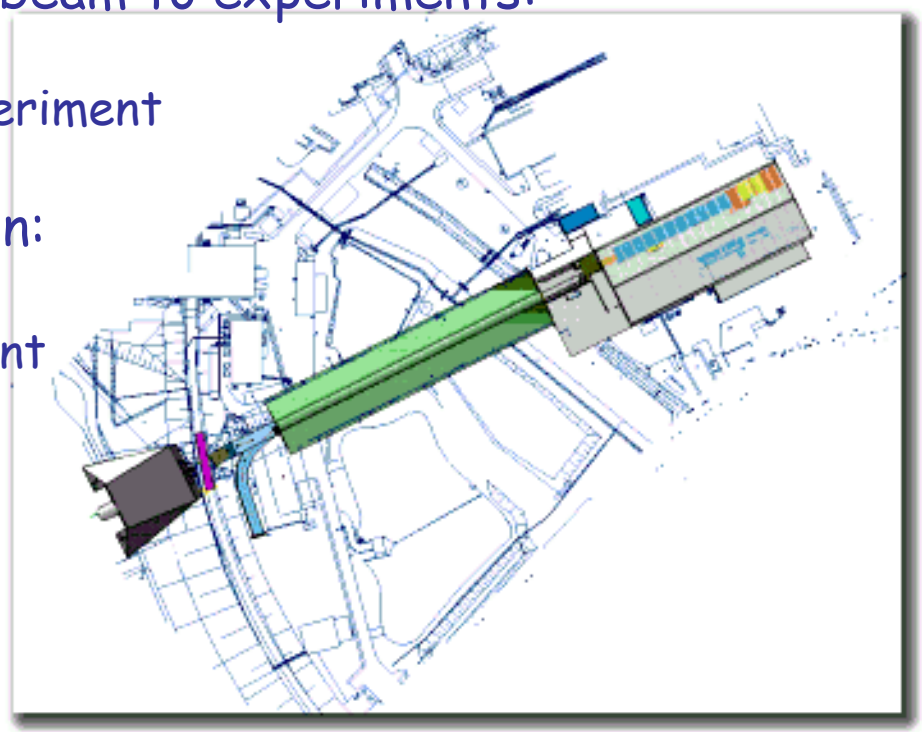
1. VUV Photon Beamline

1.1 Layout

main features:

- The VUV FEL is directly coupled to the superconducting linear accelerator.
- The beamline guides the FEL beam to experiments:
  accelerator → PETRA
  → experimental hall → experiment
- Windowless vacuum connection:
  - accelerator → experiment
  - windowless



Tasks of the beamline front end

- FEL beam diagnostic

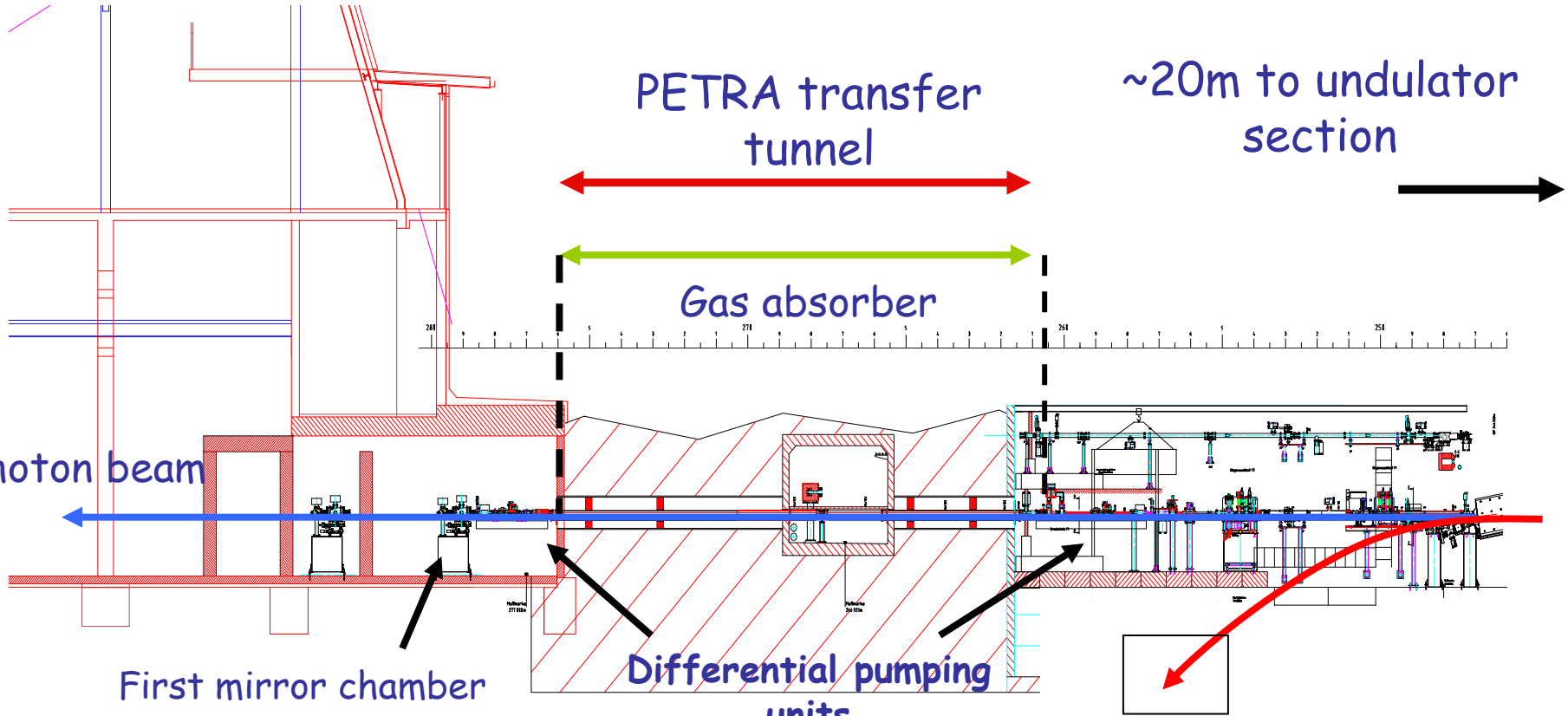
- Radiation safety- operation of the beam shutter:
  - personnel safety
  - ensures safe access to the beamline components: When the accelerator is running, the beam shutter is closed.

- Independent operation of PETRA $\leftrightarrow$ VUV-FEL

- Intensity variation when FEL in saturation
  (normal FEL operation)
  - controlled beam attenuation by gas absorber

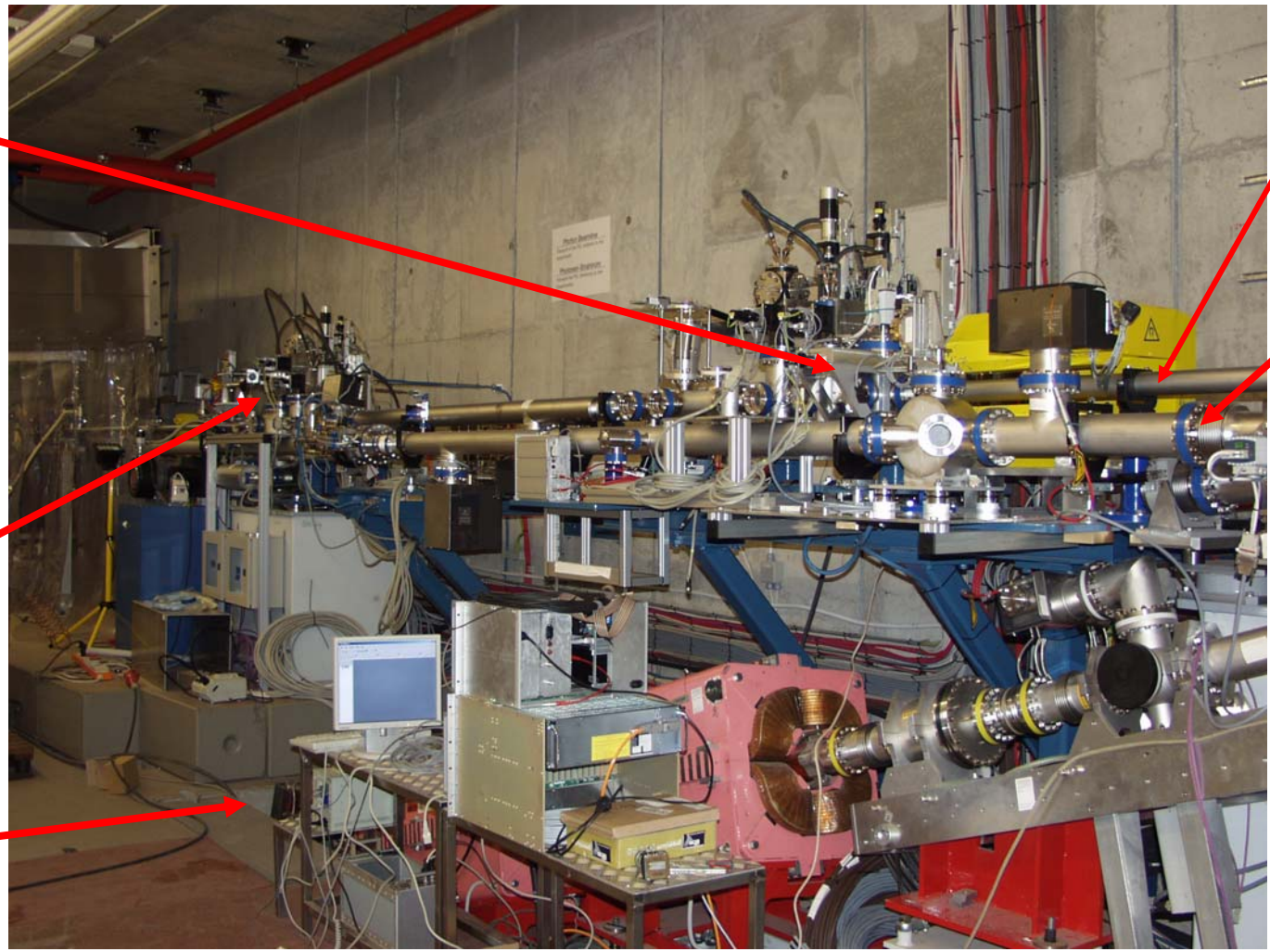
Photon beam transport:

(ultra-high vacuum - windowless)

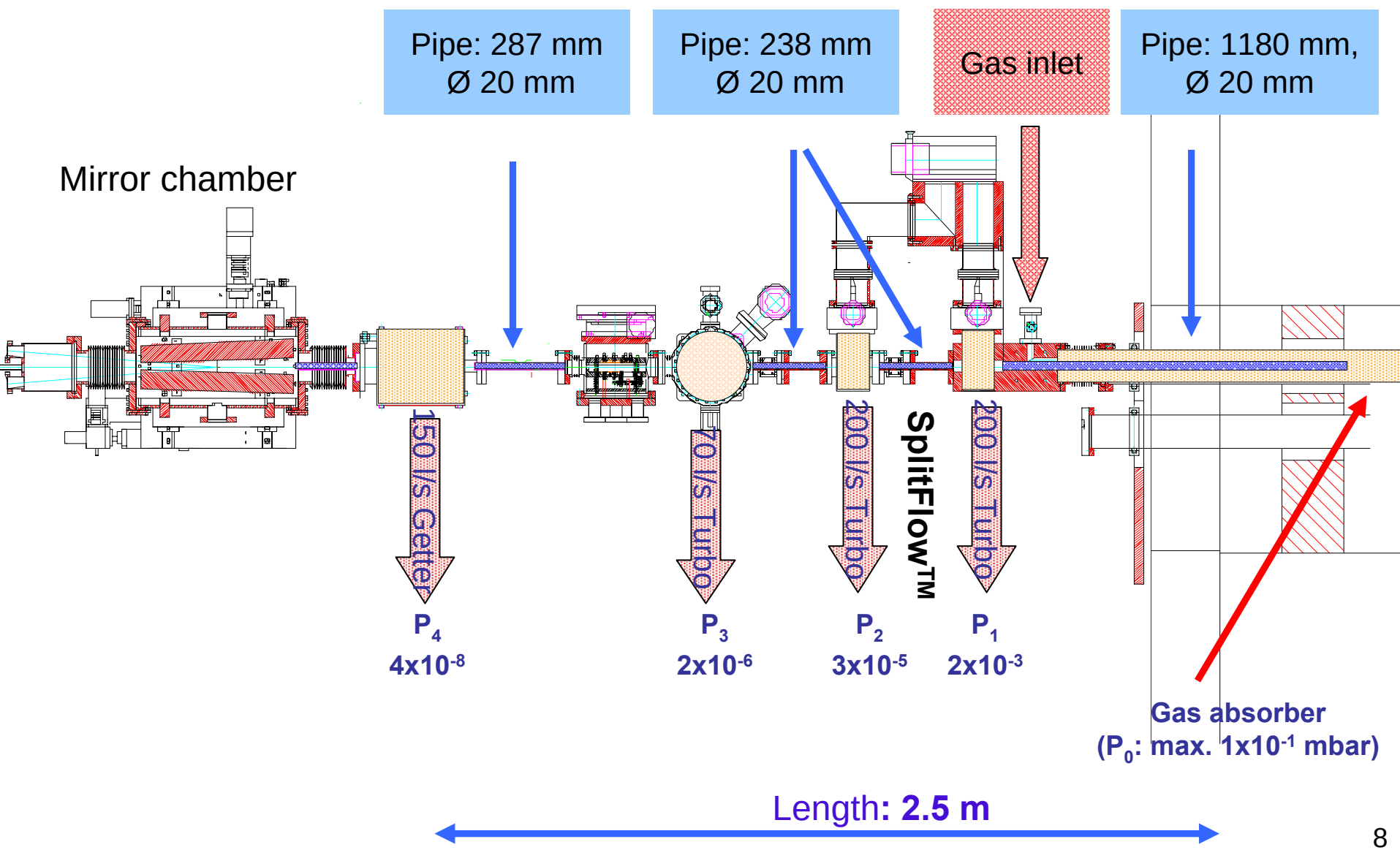


The undulator section inside the VUV-FEL tunnel

Beamlines F and S in the accelerator tunnel



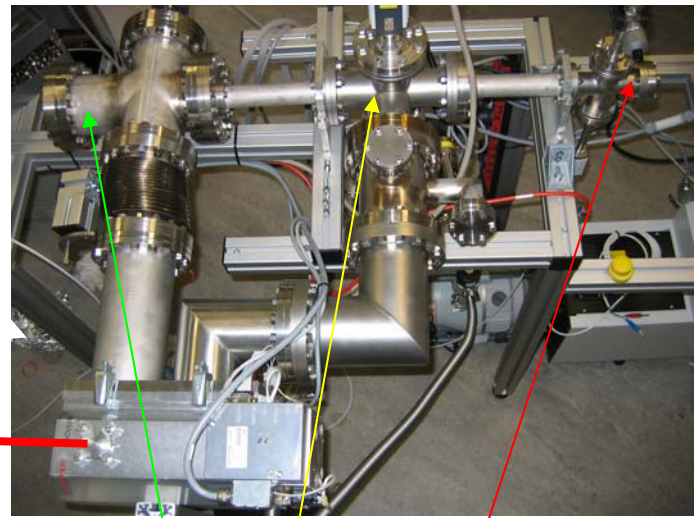
Differential Pumping Unit in the Experimental Hall



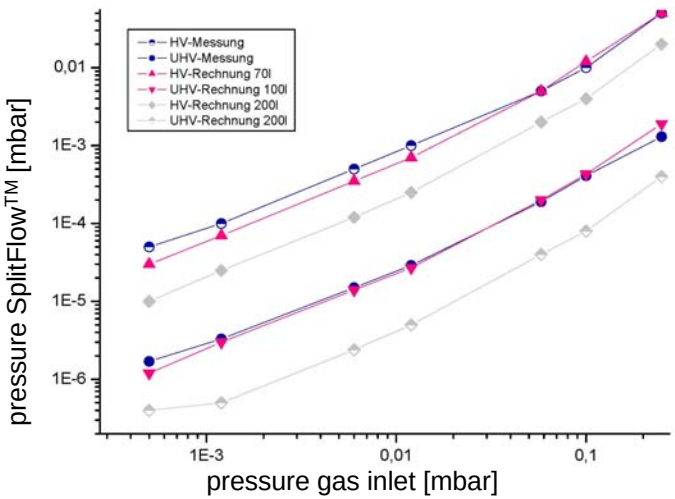
Differential pumping unit for Beamline F

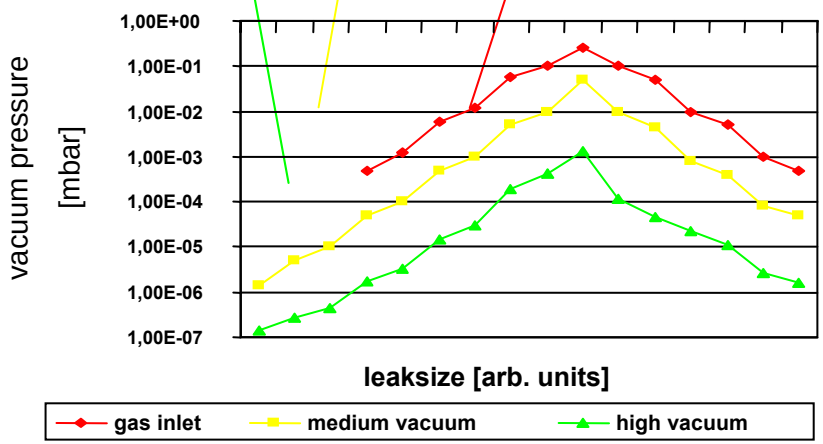
First test measurements of a SplitFlow™ pump

SplitFlow™
Turbomolecular Drag Pump



Differential pumping unit





1.2 Vacuum requirements - beamlines

- The beamline vacuum system of the VUV-FEL is directly coupled to the accelerator.
- The whole vacuum system from the FEL to the experiment has to be operated without photon beam windows.
- Mirrors deflect and tailor the photon beam according to the experimental needs.
- It is expected that hydrocarbons and dust degrade the quality of mirror surfaces and have to be kept on a minimum level.
- There are special requirements on beamline optics and the vacuum system.

- General requirements for vacuum equipment used at the HASYLAB experiments are :

  "HASYLAB Vacuum Guidelines for Beamlines and Experiments"

  http://www-hasylab.desy.de/services/vacuum/guides.htm

- There are special conditions on the VUV-FEL beamline vacuum system and the connected user experiments:

  "Vacuum Guidelines for Experiments at VUV FEL"
  http://www-hasylab.desy.de/services/vacuum/guides.htm

Requirements on the vacuum system:

Oil-free UHV and vacuum pumps:

- In order to protect optical elements in the beamline from carbon contamination the sum of the partial pressures of residual gases above 45 amu must not exceed 10^{-3} of the total pressure.
- HASYLAB will provide a residual gas analyzer (RGA) close to the experiment to check for hydrocarbons.
- Any or a combination of the following pumps may be used:
  Ion pumps, titan sublimation pumps, and oil-free turbo molecular pumps in combination with oil-free roughing pumps.
- Diffusion pumps are not permitted due to their inherent risk of oil contamination.

Dust particles:

Beamlines on free electron lasers:

- large output of coherent photons
- Dust on mirror surfaces will destroy partly the coherence properties of the beam.
- Therefore dust particles at optical surfaces should be avoided.
- There is no transport of dust particles in systems under vacuum.

For parts that cannot be cleaned please note:

- Before installation of vacuum components dust should be removed in an airflow.
- The roughing pumps have to be separated from the primary pumps by pneumatic valves controlled by the vacuum interlock system.

1.3 Vacuum interlock / beamlines

- The beamline vacuum is protected from accidental venting by a vacuum interlock system.
- The vacuum interlock system controls the operation of the beamline valves and taking into account the set points of the ion getter pumps.
- Please contact the Vacuum Group in an early stage of planned projects to fit the requirements of user experiments to the vacuum interlock of the beamline.

Layout of the VUV-FEL vacuum interlock:

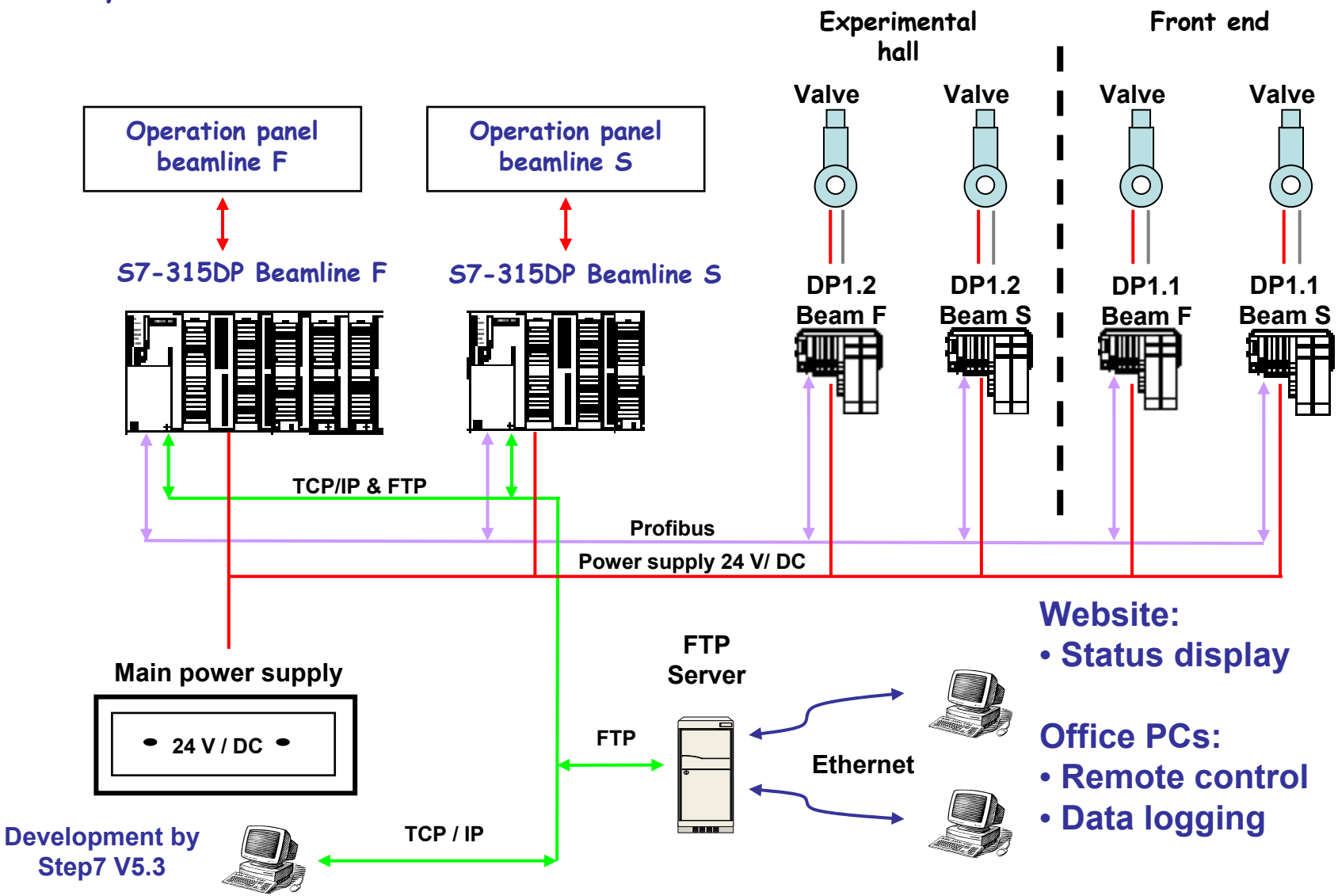
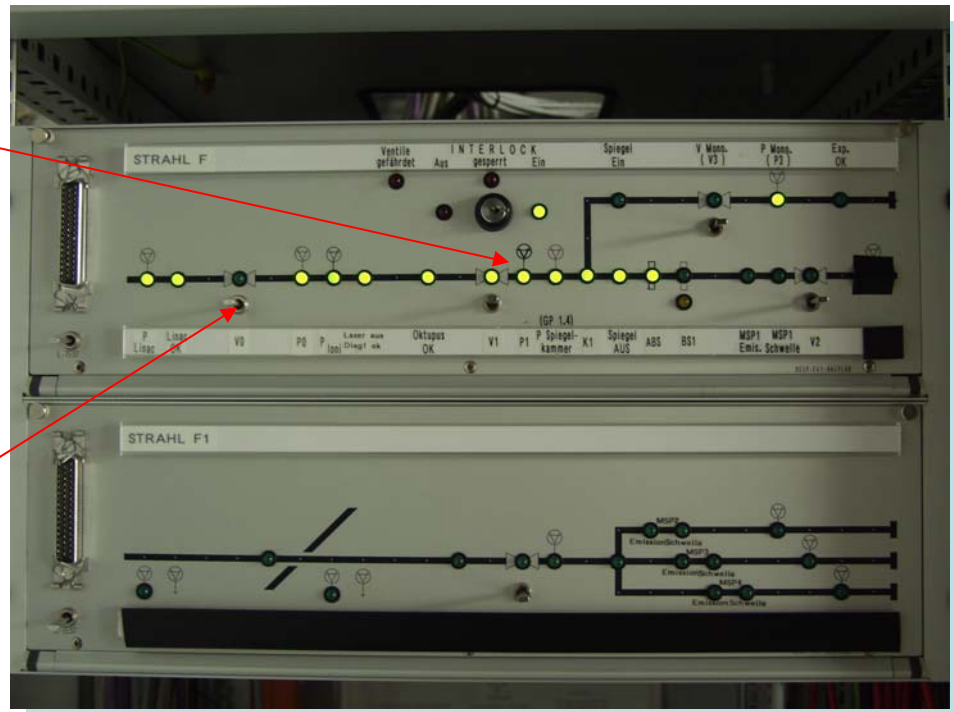


Photo of the vacuum interlock operation panel:

LEDs display the valve status (open or closed).

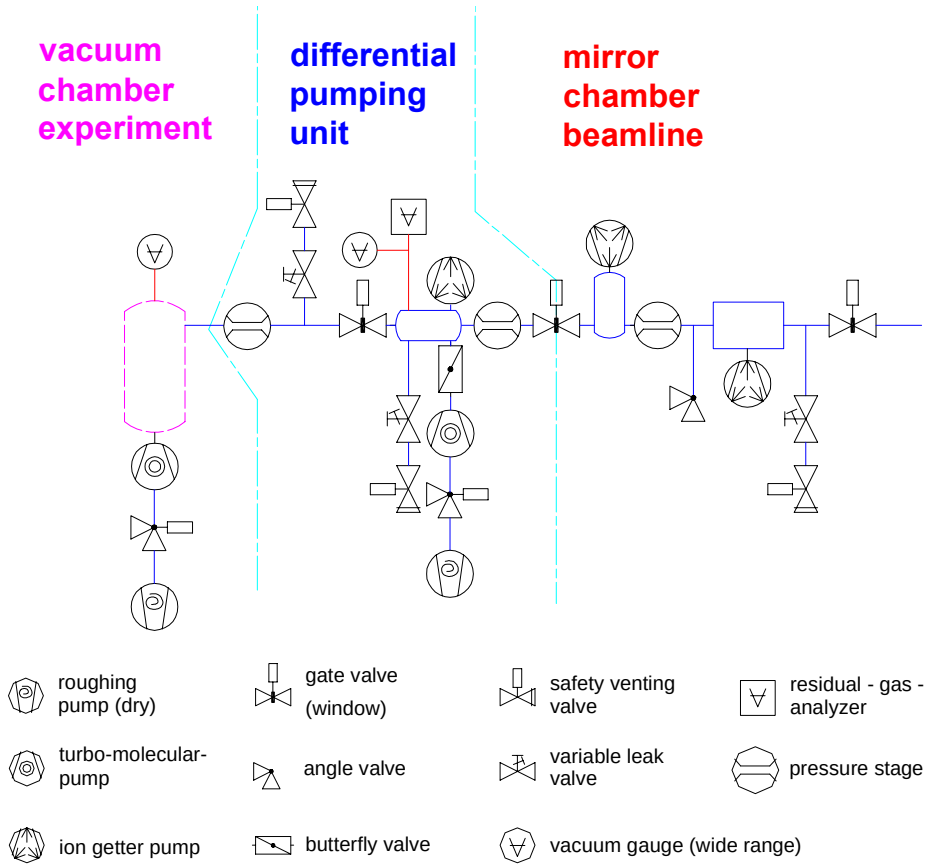


Switches for opening or closing the vacuum valves.

2. User Interface

2.1 Vacuum Interface

The interface prevents the intrusion of dust and hydrocarbons into the beamline vacuum.



- The level of hydrocarbons at the user interface must fulfill the HASYLAB vacuum guidelines for beamlines and experiments.

- In course of pumping down or venting of the vacuum system particle transport can toke place. →

    - Venting must be performed by filtered dry nitrogen.
    - The direction of venting and pump down flow must be in a way that particles moves from the last beamline valve towards the experiment.

- DESY will provide dry particle free Nitrogen.

- The user chamber will be connected to a bellow with a rotatable flange. (DN 40 CD)

- The venting has to be realized by an electropneumatical valve witch is operated by the vacuum interlock system.

- Venting through turbo molecular pumps is not permitted.

- To control the beamline valves the interlock needs information by potential free contacts from:

  - status of vacuum pressure inside the user chamber

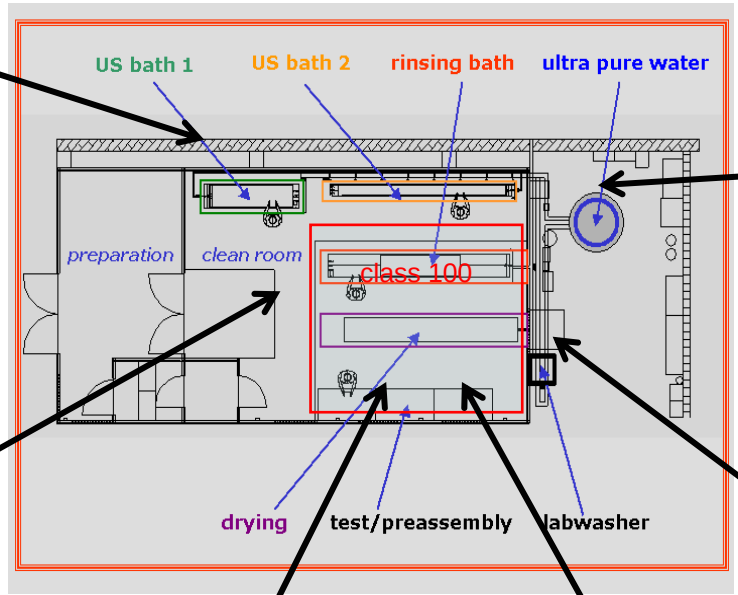
  - status of rotation speed of turbo molecular pump

2.2 Cleaning procedure for UHV components

- A cleaning facility has been installed at DESY to prepare UHV components witch are free of hydrocarbon and particles.
- The new cleaning facility installed in a clean room which fulfills class 10.000 and in its central part class 100 specifications. (US Fed. Standard 209E)
- The goal of this facility is to combine standard cleaning techniques with clean room technology in a manageable way.
- Vacuum chambers with a length of up to 4.8 m can be cleaned.

Layout of the cleaning facility:

Ultra sonic bath



Ultra pure water facility

Rinsing bath, dryer and pre-assembly area

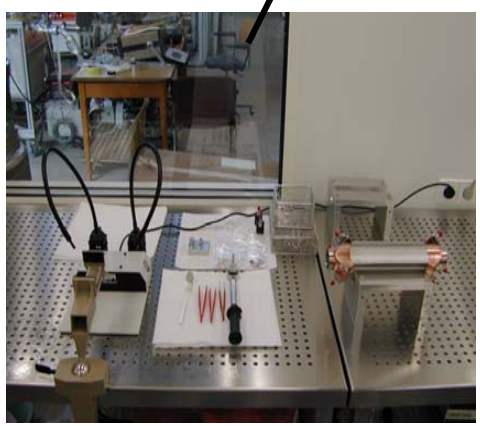


Table for preassembly

Preparation for leak check

Lab washer

Standard cleaning process:

Material:

- stainless steel/copper/aluminium

Ultra sonic bath:

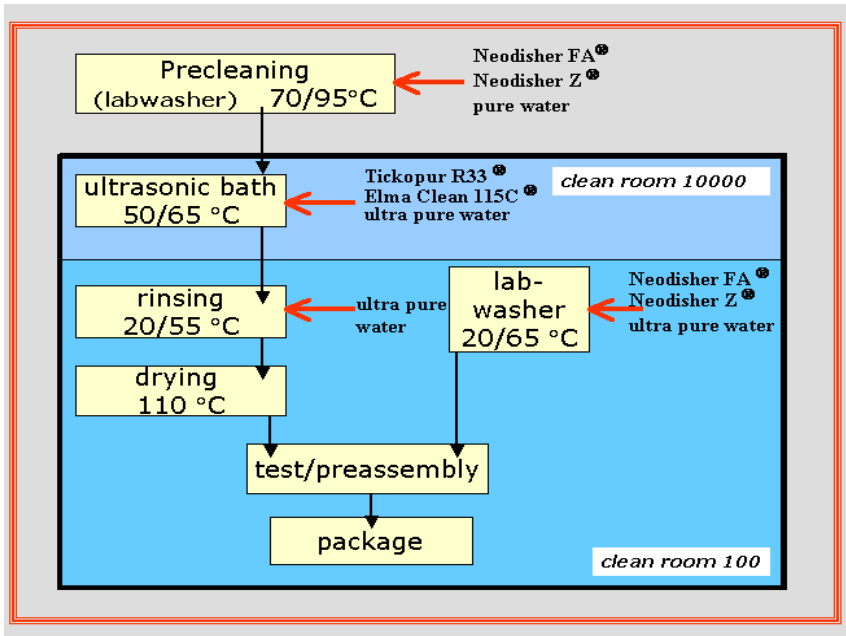
- ultra pure water
- stainless steel/copper: 1 % Tickopur R33 at 50°C and 1.5% Elma Clean 115c at 65°C
- aluminium: 2 % P3 Almeco 18 at 65° 3 to 6 x 5 min alternating with short rinsing

Rinsing bath:

- ultra pure water at 50°C or room temperature
- 12 MWcm: about 30 min at >1500 l/h

Dryer:

- particle filtered air according to CR class100
- stainless steel: > 2h at 110° C
- copper: > 0.5 h at 60 °C
- aluminium: nitrogen at 50°C >0.5h



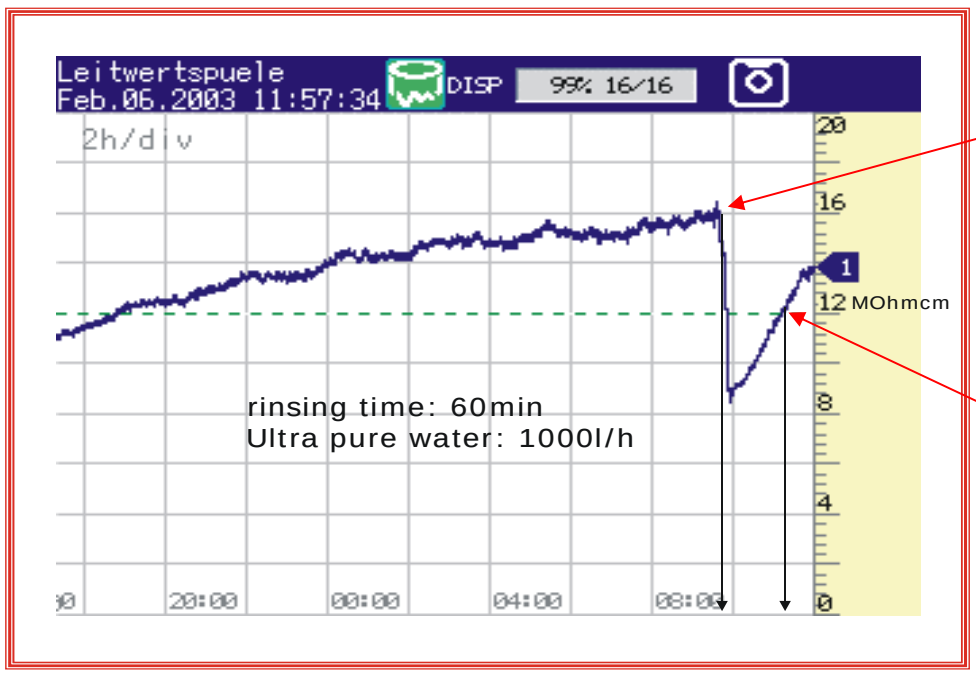
Process chart

Final treatment:

- close off and wrapping in antistatic plastic foil if necessary:
- leak check
- residual gas spectrum
- venting with dry nitrogen
  small components ➡ lab washer

Rinsing process of the VUV-FEL mirror chamber

- The rinsing runs with 1000l/h and ultra pure water.
- The limit for this process is given by a water resistance of 12 MOhm/cm.
- The rinsing process takes about 60 minutes for one cycle.

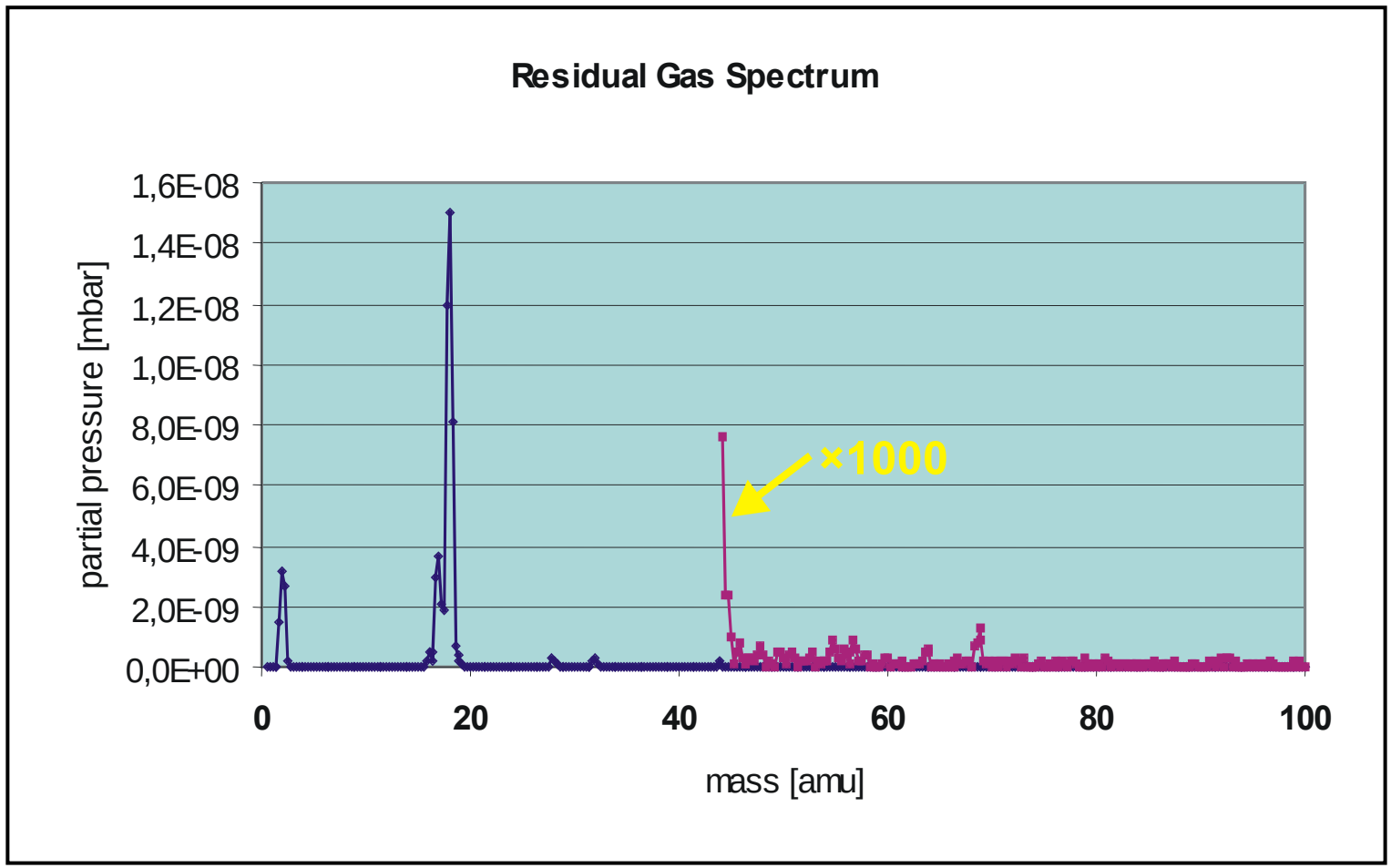


charging of rinsing bath

achievement of rinsing

- The components are dried using up to 110° C hot filtered air. (according to clean room class 100 requirements).
- Comparable cleaning results for small components are achieved using a lab washer, which is loaded from outside the clean room.
- A small preassembly area equipped with an oil-free pumping station for leak detection and residual gas analysis completes the facility.
- It is possible for guests to use our cleaning facility.

Residual gas spectrum of a mirror chamber for VUV-FEL



The intensities for masses > 45 amu are enlarged by a factor of 1000 to show the absence of hydrocarbons.

2.3 Mounting and Preassembly of UHV Components

- HASYLAB provides several clean rooms in building 28c.
  - "house in house" clean room for preassembling complete vacuum chambers
  - mobile clean room for installation chambers into the beamline
- For UHV vacuum test HASYLAB provides:
  - oil-free pumping station including RGA
  - equipment for heating and leak detection
- Preassembly of UHV vacuum chambers is possible in building 28c.

Clean room in building 28c

40 m² Clean room with class 100

Mounting of wire scanner monitors under CR conditions

The precondition for the work inside this CR is an instruction of the users.

Mobile Clean Rooms

For assembling beamline components under CR 100 conditions HASYLAB provides several mobile clean rooms.

Oil-free pumping units for use at the VUV-FEL vacuum system

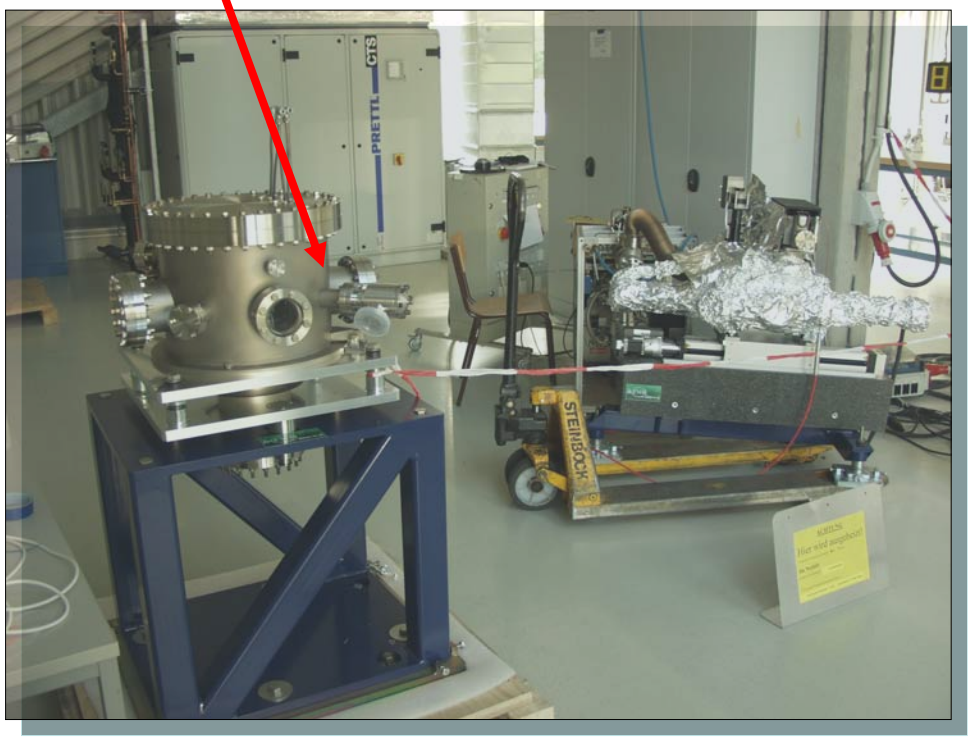
Oil-free pumping unit including residual gas analyzer (RGA)

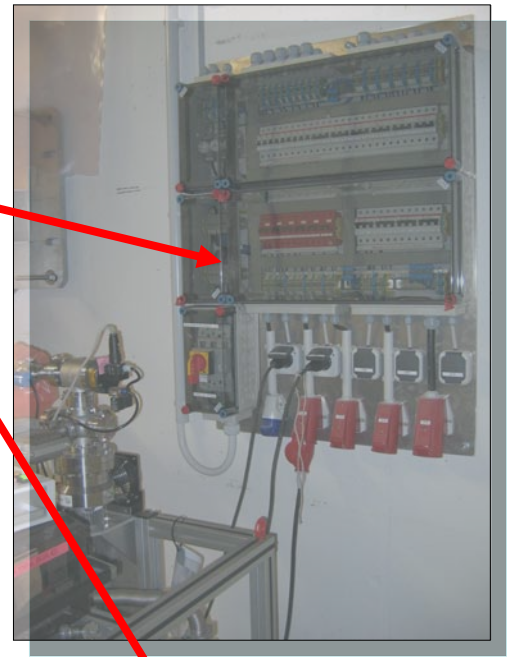
Oil-free pumping unit including leak detector

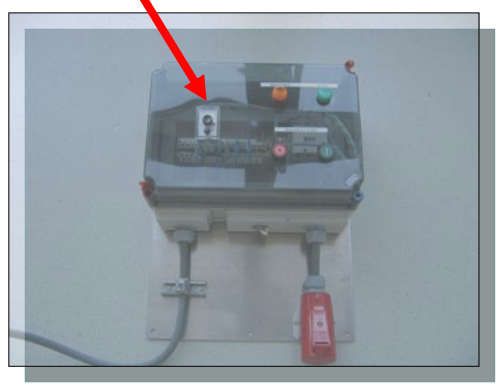
Photo of preassembling area in building 28c

Power supply for bake-out

Vacuum test for a user
chamber in operation.







List of responsible persons for miscellaneous questions:

➢ Technical infrastructure:	U. Hahn	(9-3807)
	K. Tiedtke	(2481)
➢ Photon diagnostic:	R. Treusch	(2693)
➢ Vacuum:	M. Hesse	(9-2889)
➢ General safety:	T. Wroblewski	(9-3004)

➢ General technical services in building 28c: M. Duske (9-3025)

3. Next Steps

- The general layout of the beamline vacuum system is finished. The front end system in the tunnel is installed and ready for operation.
- The production of the nine mirror chambers has started and will be completed until the beginning of 2005.
- The final vacuum system installation of the first beamline will take place in spring 2005
- The vacuum group will support the users and guests at the VUV-FEL for preparing their chambers for installation.

Thank you for your attention

and have a good time at DESY.