BGC mechanical design

Demonstrator installation stage 1 and stage 2

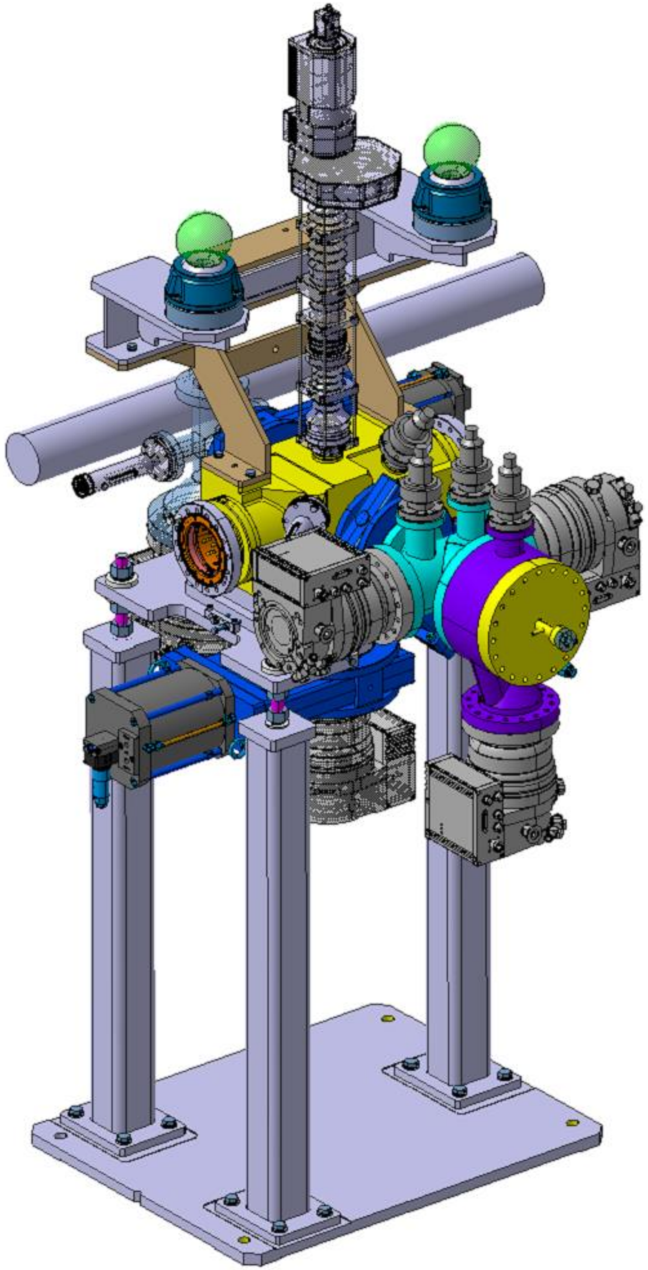
BGC design for the HEL test stand and LHC HEL

CD-nozzles

Blackening status

BGC Demonstrator

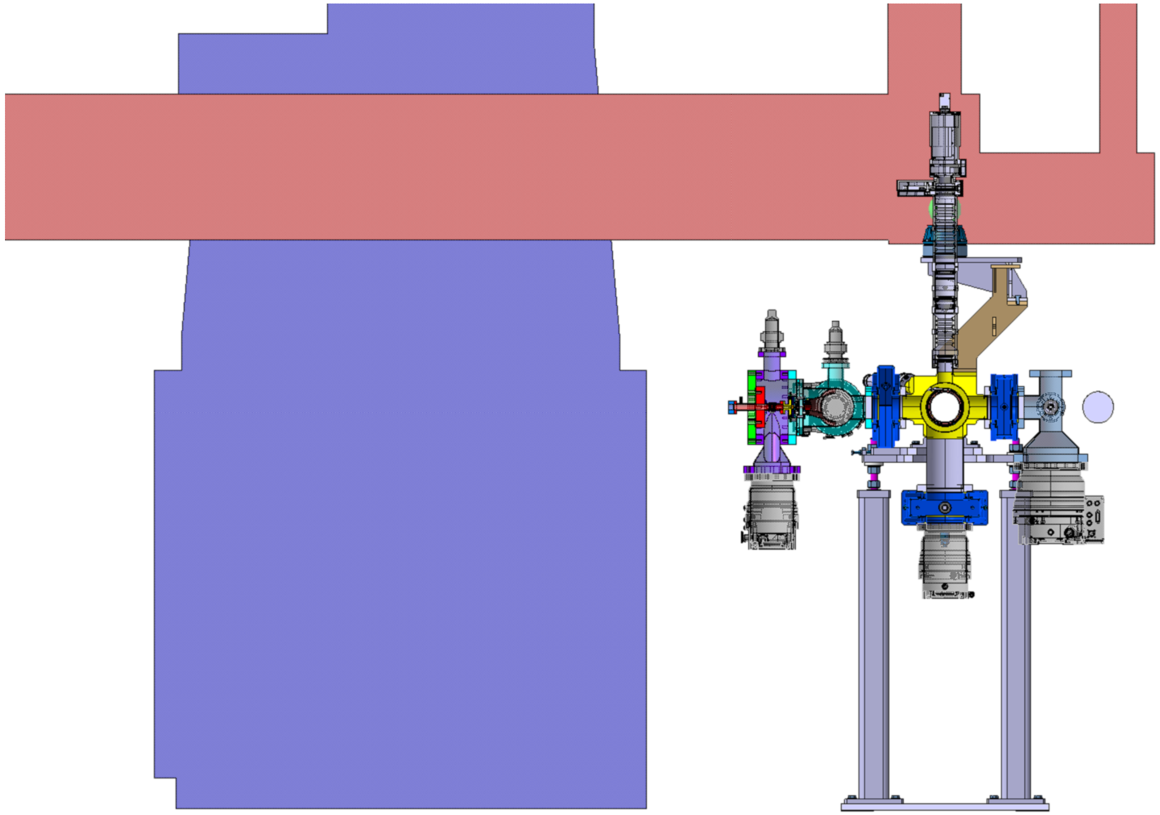
Installation in two stages
Stage 1 to be installed by February 2020



- Stage 1
  - Interaction chamber
  - BGC supports
  - Optical and geometer supports
  - Optical calibration target
- Stage 2
  - Gas injection
  - Dump
  - Pumping
  - Optics design

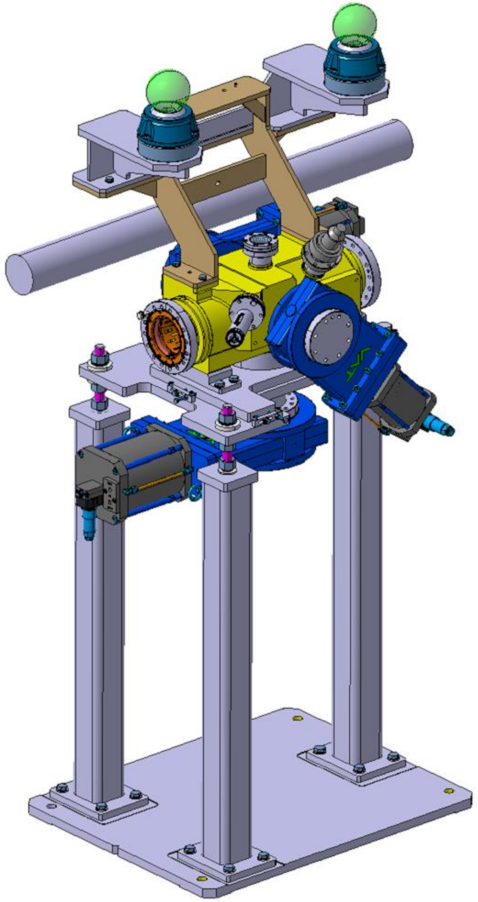
Tunnel section

- Optics are in the survey zone and need to be removed if necessary for geometer alignments
- Distance from transport zone to the window flange is 225mm → enough for an additional protection



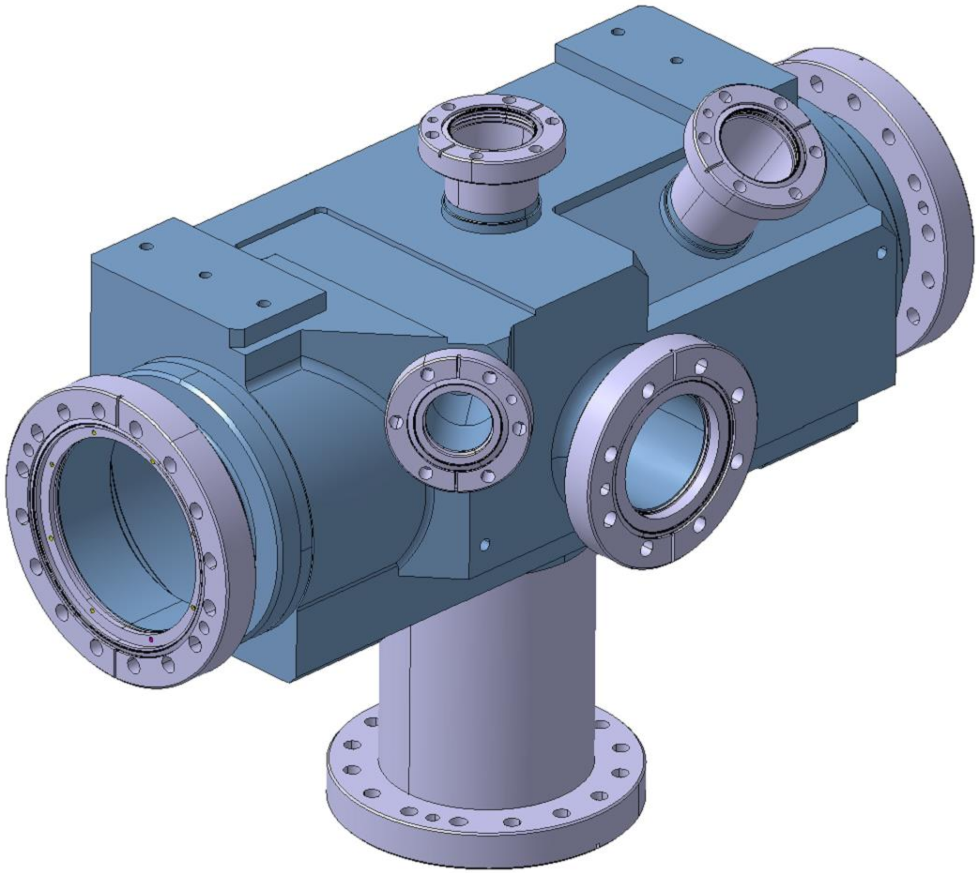
Demonstrator installation stage 1

- Interaction chamber: drawings are made, materials are ordered
- BGC support: drawings are made
- Optics and geometer support: drawings are made
- Valves: need to be ordered (2x DN 63; 1x DN 100)
- Optical target: design to be finished

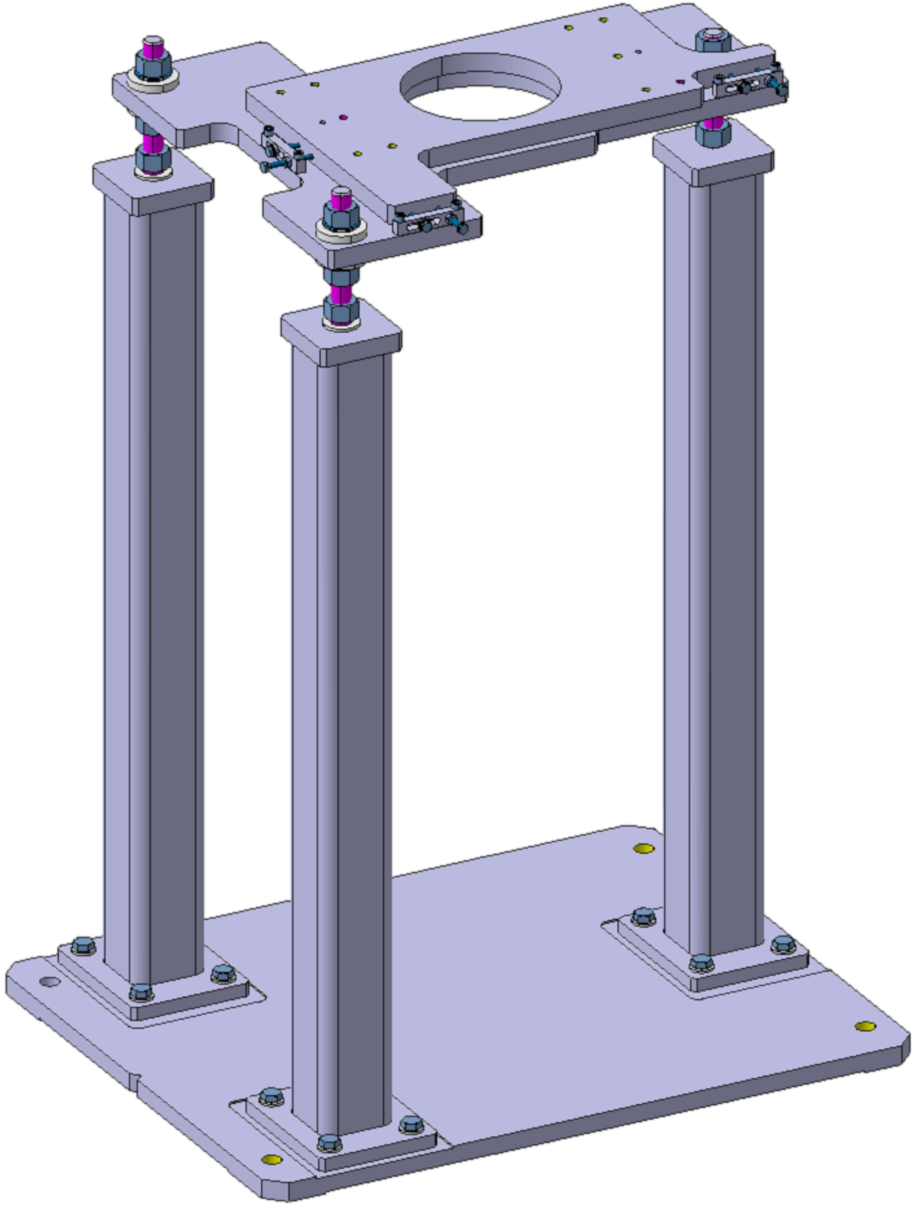


Interaction chamber design

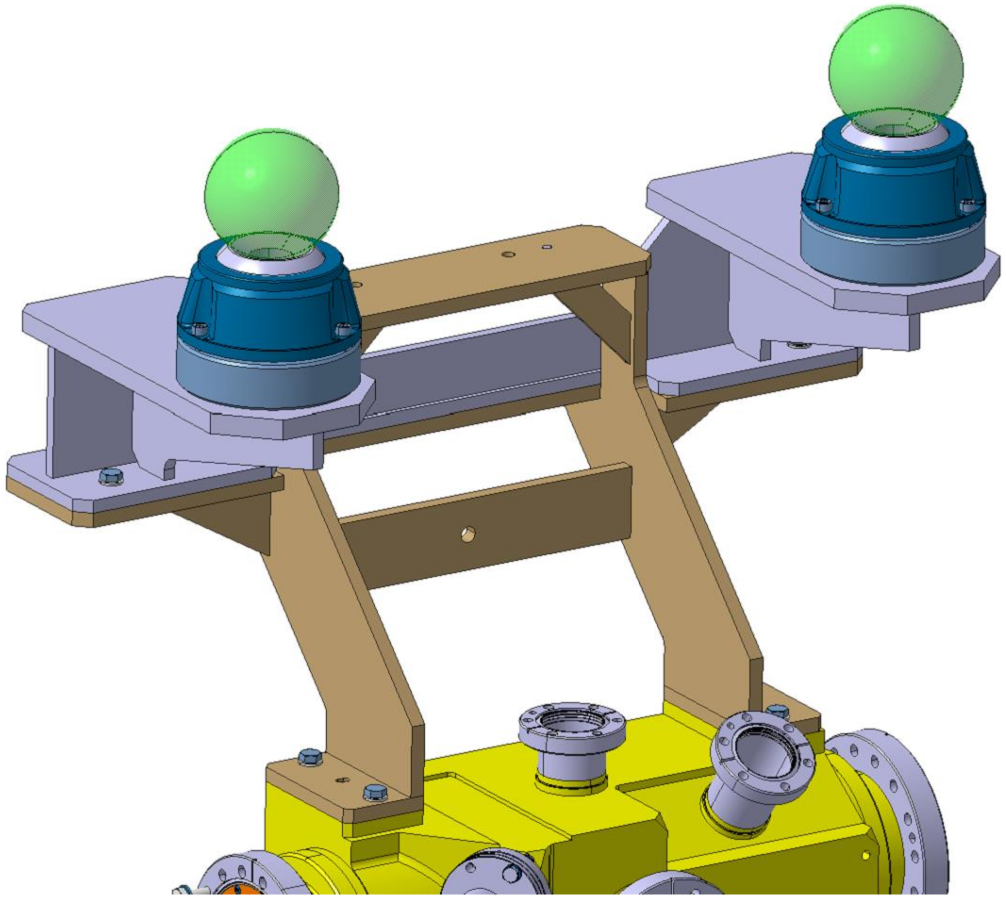
Central part machined from one 3d forged block → flange positions are made with higher precision



BGC support



Optics and geometer supports

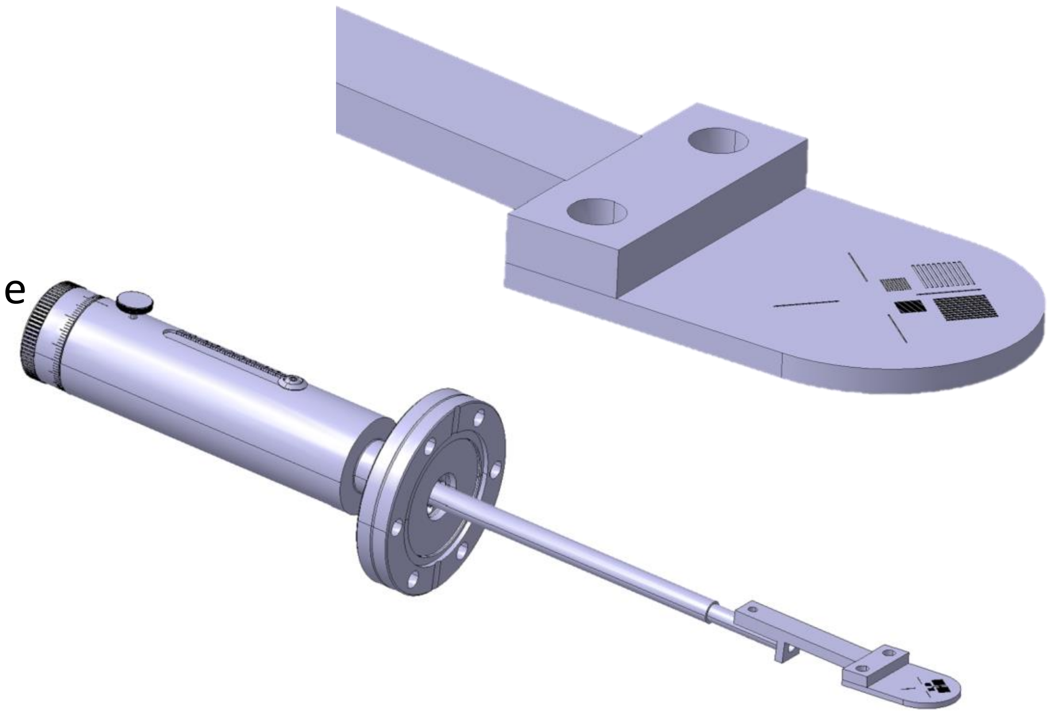


Optical calibration target

Optical calibration target can be put in the optical path by means of a linear bellow drive

Target should have stripes with 0.1mm width or narrower

Target of blackened metal (e.g. steel treated with chromium oxide) with reflective stripes → no danger of glass breaking due to thermal expansions while bake out



A device to increase the background pressure ?

If we would move the gas injection device from the fluorescence test to the BGC location, we could already prove that the optical setup is working without the stage 2. This would also prove that we can measure fluorescence if something is wrong with the gas jet

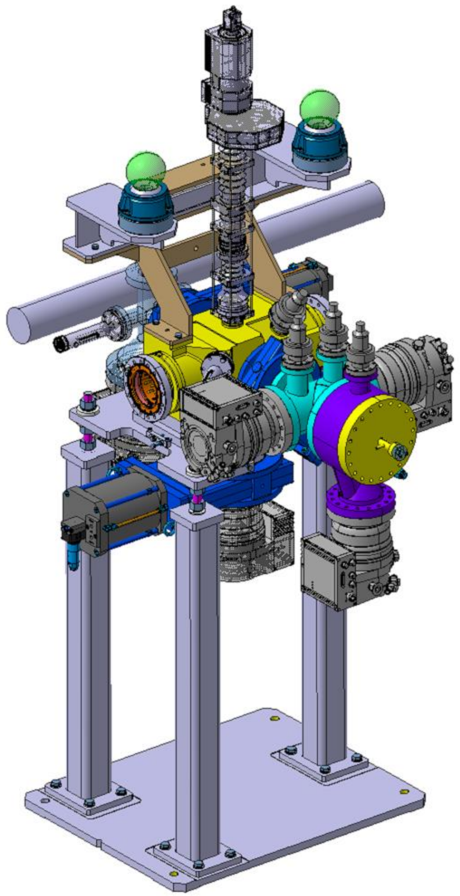
Similar to the LHC fluorescence test.

Demonstrator installation stage 2

- Gas injection side: 2 design options
- Dump side: gas jet monitoring or simple dump?
- Pumping?

Foreseen flanges

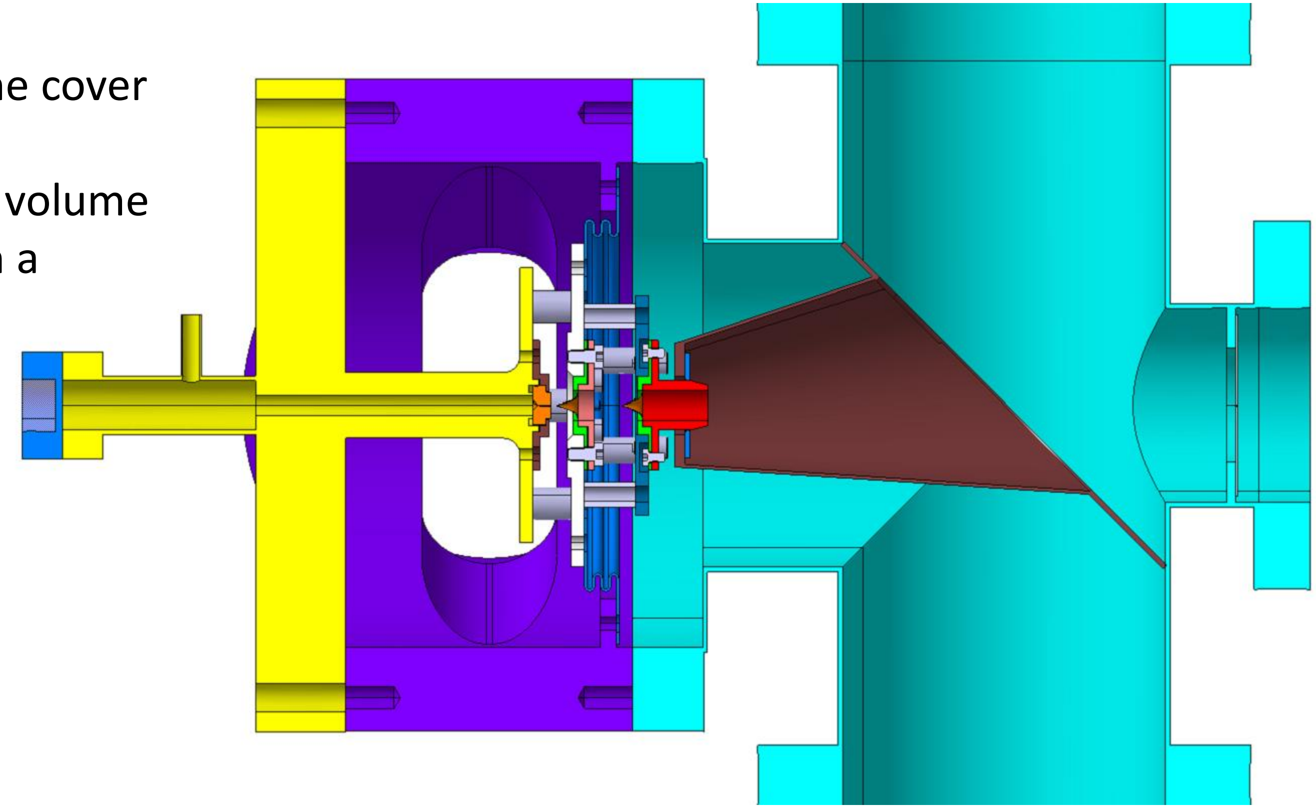
- Nozzle chamber: DN 100 (could be changed to DN 150)
- Skimmer chamber: 2x DN 100 (with gas separator)
- Interaction chamber (direct): DN 100 (valve)
- Interaction chamber (dump): DN 63 (valve)
- Dump chamber: DN 100 (diameter increase)



Options for the nozzle chamber and nozzle holder setup (1)

Option 1

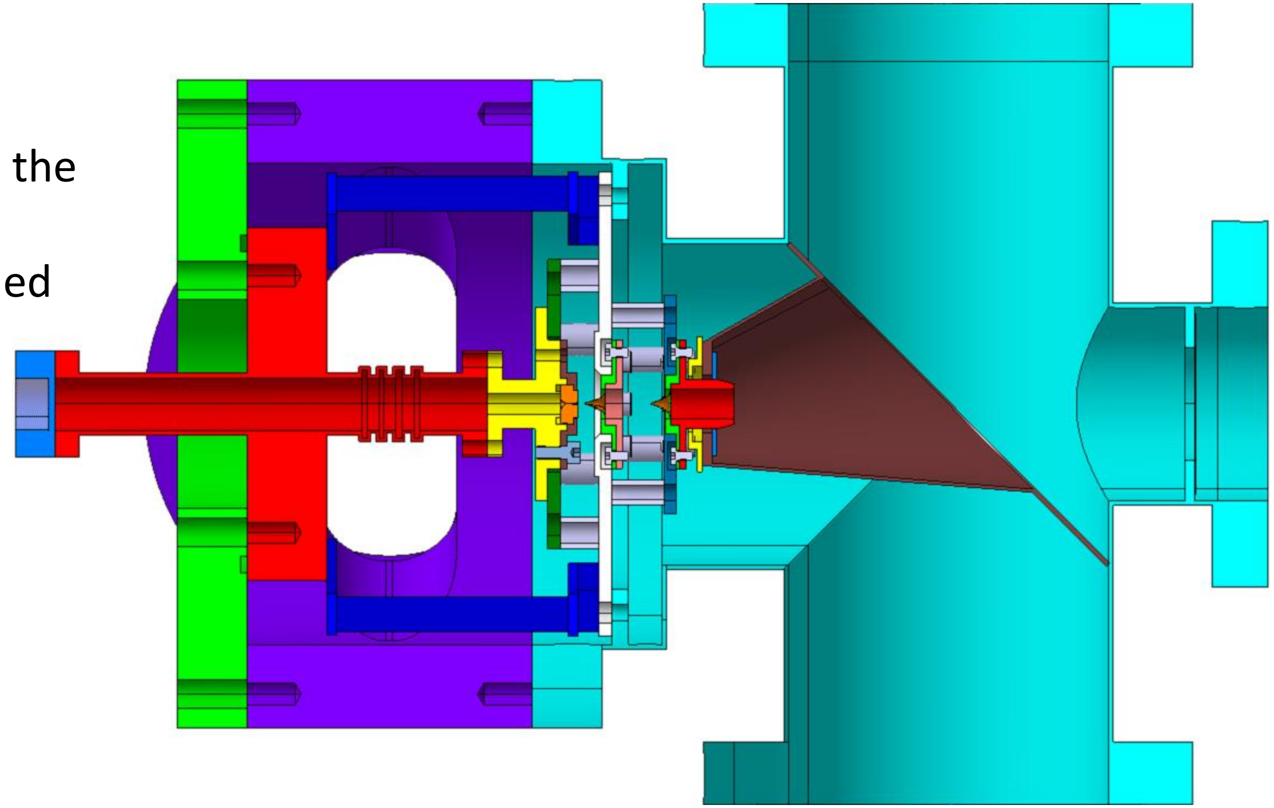
- Skimmer and nozzle setup is attached to the cover of the nozzle chamber
- The gas separation between "*after nozzle*" volume and "*after skimmer 1*" volume is done with a bellow



Options for the nozzle chamber and nozzle holder setup (2)

Option 2

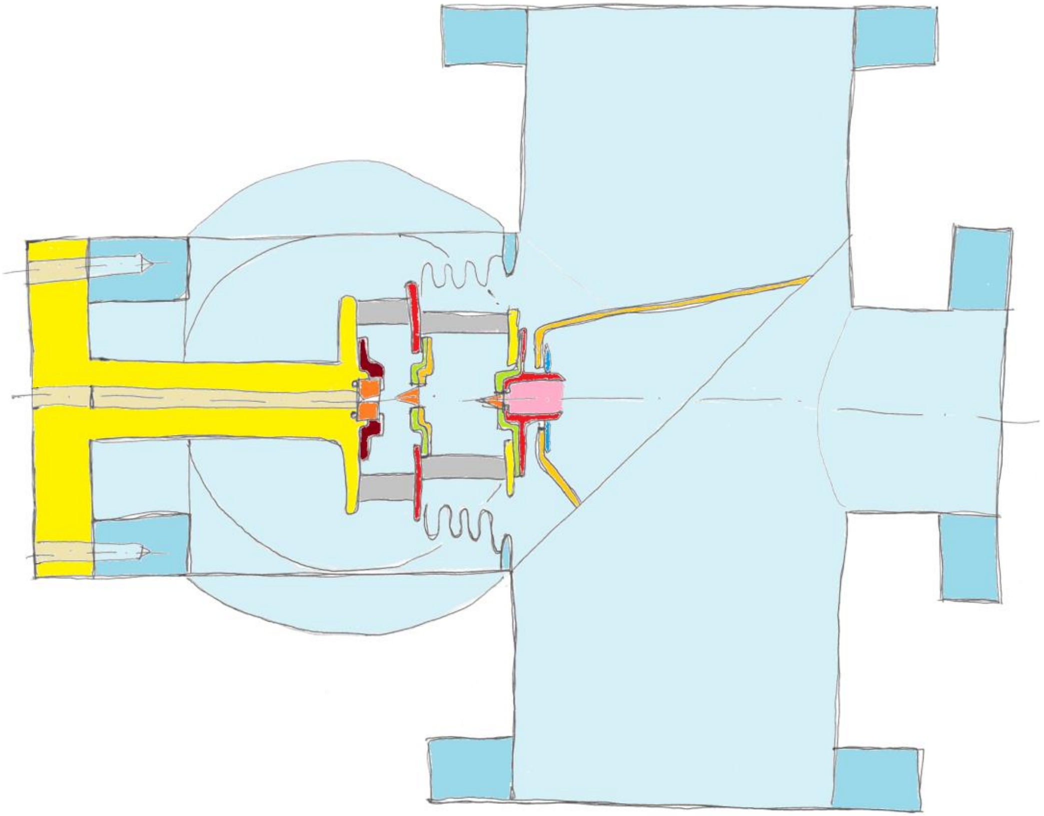
- Skimmer and nozzle setup is attached to the skimmer chamber
- The design is closest to the design installed at CI
- Comparable to option 1



Options for the nozzle chamber and nozzle holder setup (3)

Option 3

- Skimmer and nozzle chamber are joint
- Skimmer and nozzle assembly are attached to the outer flange of the chamber
- 40mm shorter than option 1



Optics supports

Requirements

- Stiff construction to avoid shaking by vibrations
- Focal plane is movable for calibration

→ Still to be designed

Dump section

Do we want a monitoring device for the gas jet?
If yes what kind?

- MCP as proposed by Serban → gas jet profile
- Schlieren → appropriate in our pressure regime?
- Optical mirror with cameras → only alignment by laser setup

The BGC for the HEL

- HEL test stand
- HEL LHC installation
  - inner beam
  - outer beam
  - central chamber designs

HEL test stand

The HEL test stand allows much more liberty in the design as the HEL LHC version

- Fastening of the screws to the vacuum pipes before the magnets are pushed together (no y-shaped pipes before and after HEL)
- No second beam pipe or transport area with space limitations

→ Design should be adjusted to the LHC HEL

The HEL test stand beam will only be in work for microseconds

→ Enough integration time for the BGC ?

LHC HEL

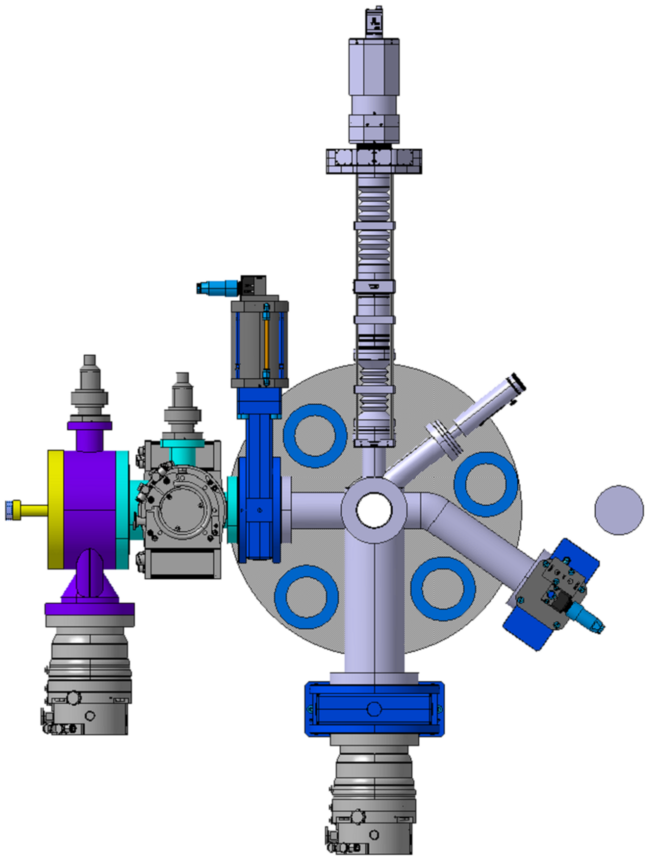
Obstacles:
- Few space for tools for fastening screws and bolts
- Magnet spacers need insulation (less space)
- Conflict of the BGC optics and the HEL helium tank

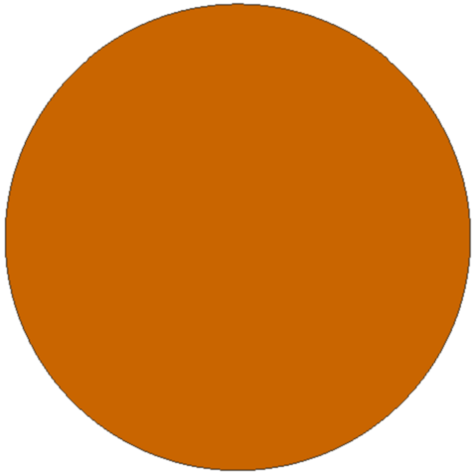
To be checked
- Reduction of the diameter needed for the magnet spacers (Antti)

Things to keep in mind:
- The distance between the magnets changes due to thermal expansion
  - → Decoupling of the beam pipes
  - → BGC installation surface should be the fixed position
- The magnet spacers need thermal insulation
- Dimensions of the spacers are not yet verified by calculation

BGC for LHC HEL inner beam

The BGC can be supported from the ends of the magnets
→ BGC stays centred in the case of thermal expansions



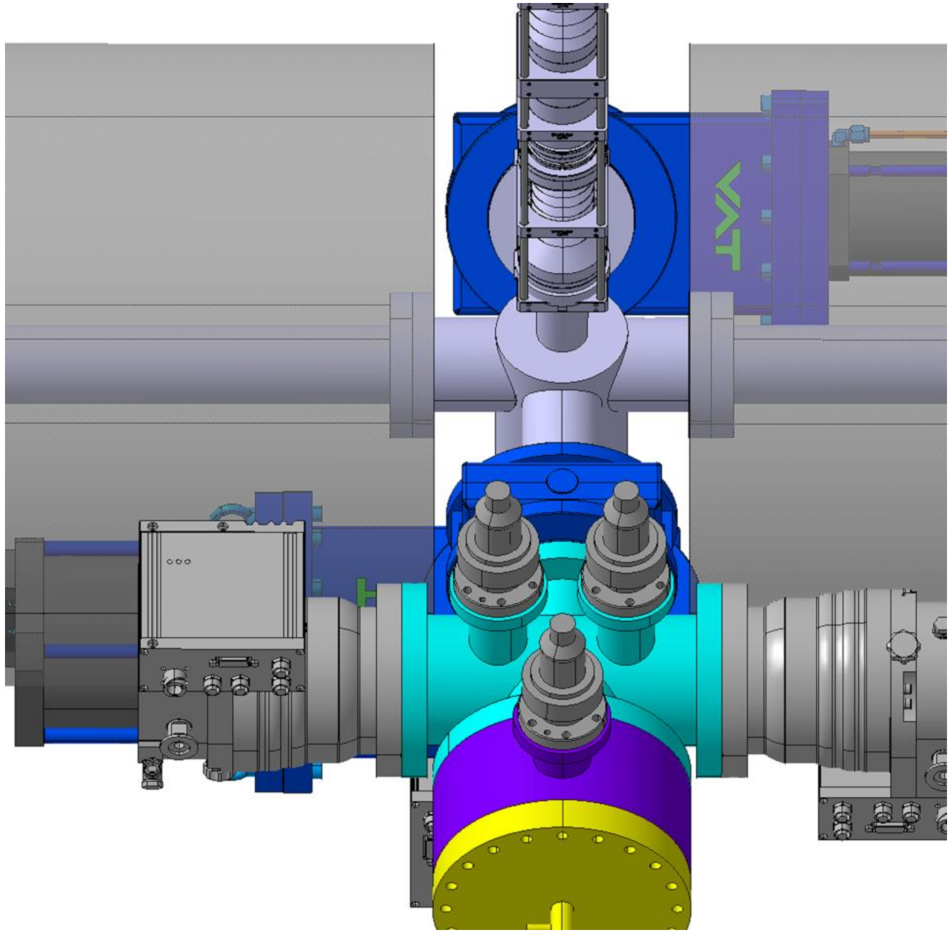


No supports are displayed here

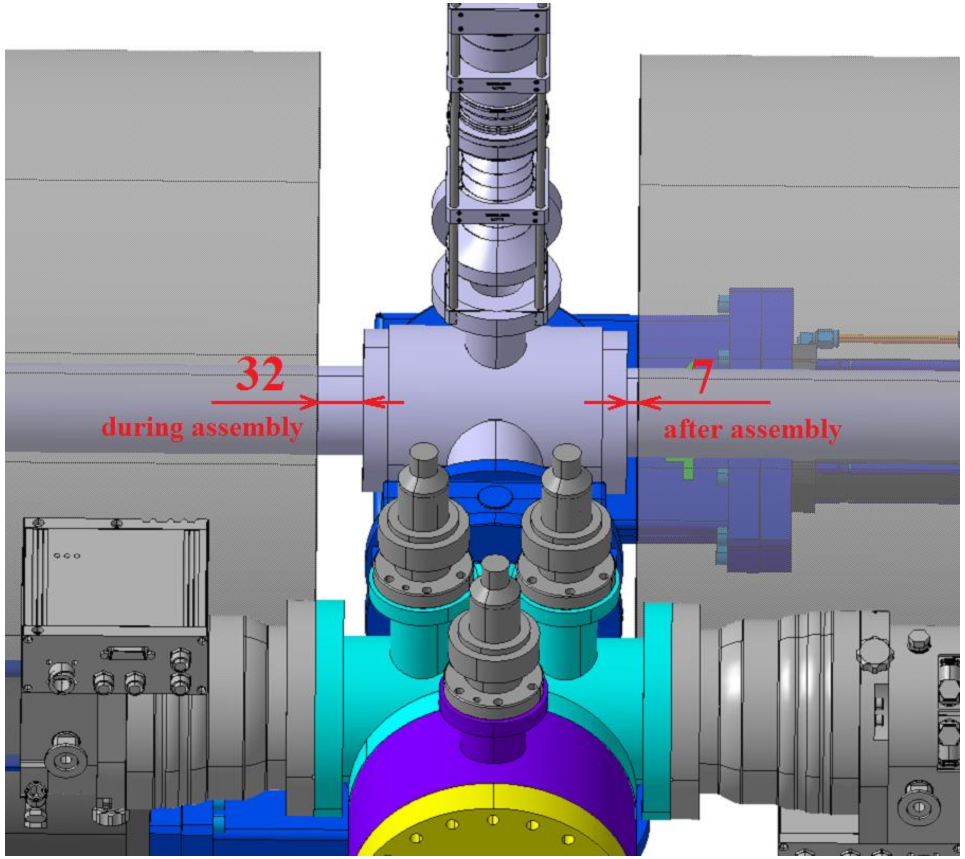
Interaction chamber design
“Classic” design

“classic” design

- The opposite side of the flanges is not accesable
- Either <u>threaded holes on the flanges </u>of the pipes <u>or nut holding mechanism</u>
    - If flange threads are damaged, the vacuum pipe must be exchanged



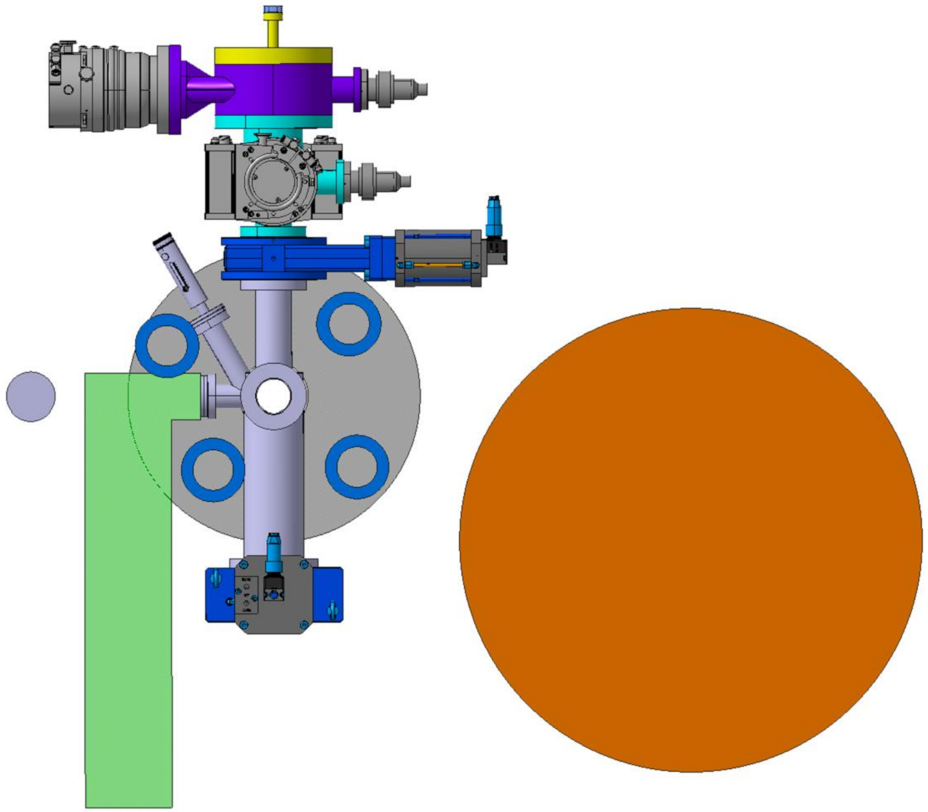
Interaction chamber design
Alternative design



Alternative design

- Threaded holes on the chamber
- With the margin during assembly it is possible to fasten nuts
- Heat release during the back out of the NEG → protection of the magnets
- Risk of a damaged thread → ruins the whole chamber

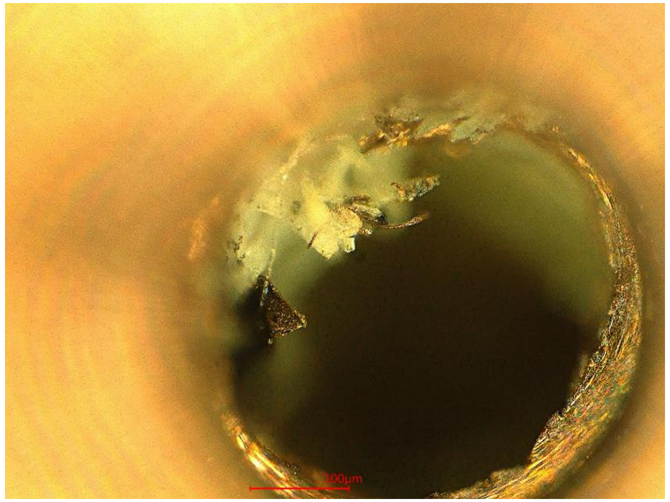
BGC for HEL outer beam



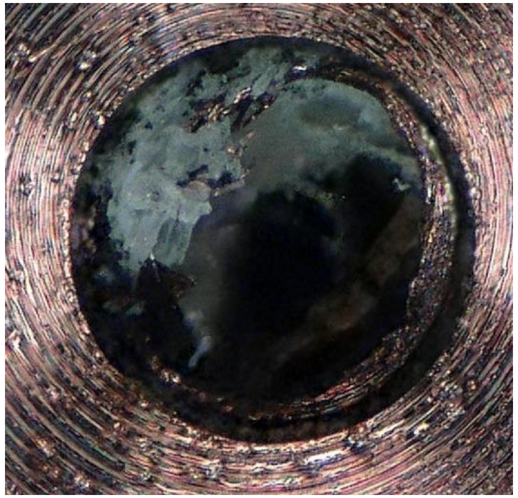
- The change of the position of the helium tank is inevitable
- Optics on a mirror has a negative effect on the efficiency
- No space for a second pump on the interaction chamber
- The gas jet can shoot directly on the dump pump
- Right now there is a conflict between the spacers insulation and the optics space/optical target
  → different calibration possible???

Convergent divergent nozzles

Collaboration with the CERN metrology



Divergent exit of the nozzle shows left overs of most likely the gold coating



After applying 3bar to the nozzle the film like structures apear still on the same position

→ Apply higher pressure to the nozzle; any ideas ?
→ second nozzle with only the divergent part should be delivered by CERN metrology

Blackening status

- Polyteknik coating for the **black insert**. Samples were accepted in an vacuum acceptance test (EDMS 2134360) (0.2%R)

- Test **chamber** will be send to InoxColor (GSI has vacuum chambers coated there) for the chromium oxide coating (15.2%R)
  → Test of the reflectivity and vacuum acceptance test of the coating technique

- The **copper liner** is foreseen to be amorphous carbon coated (13%R)
  - alternatively VSC (Marcel Himmerlich) optimized preparations of copper samples (chemical oxidation)and achieved results with <1%R (needs more testing for vacuum compatibility)

  → needs more information on back out temperatures and required outgassing values from us