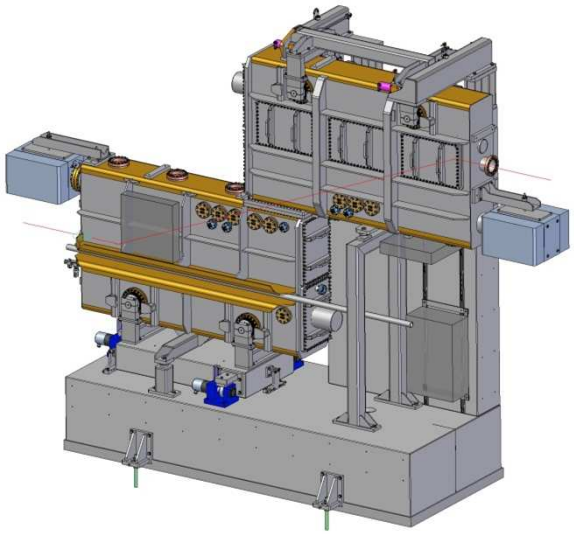
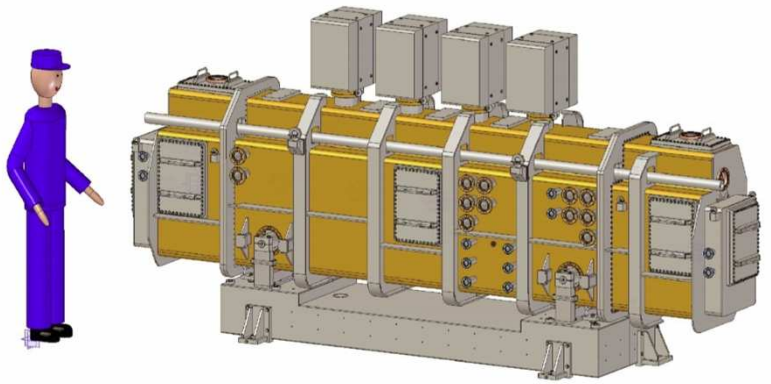
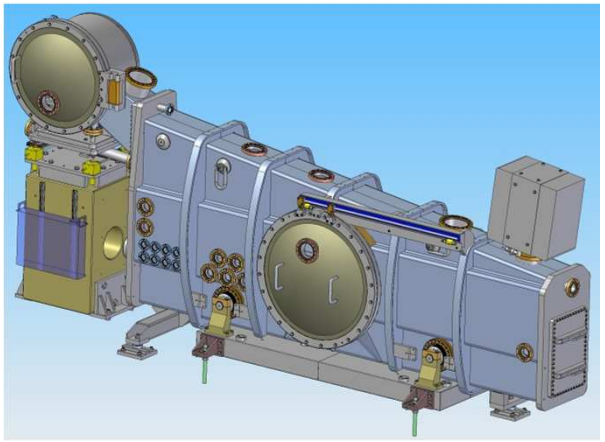
# Optical Components at Petra III

## Highlighting the challenges and solutions







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ESRF Seminar

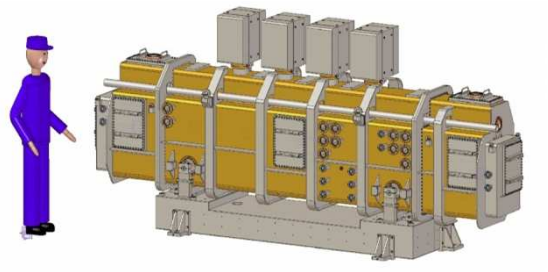
17th October 2011

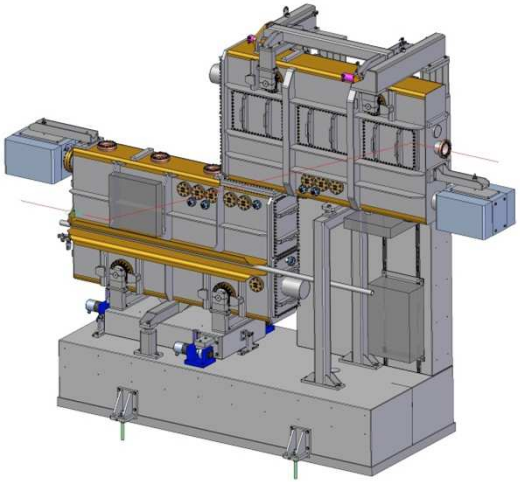
HELMHOLTZ GEMEINSCHAFT

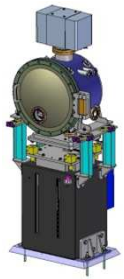
DESY

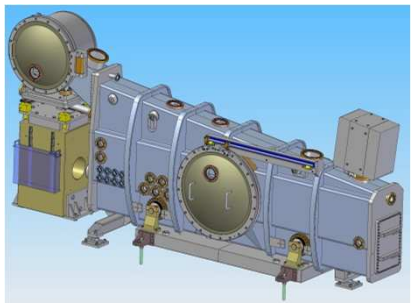
# Outline

- Overview Petra III
- Mono-P06
- LOM 500
- LOM 1250
- Diamond/Silicon Laue monochromator P02.1
- Generic high heat load monochromator
- Mirror optics
- Generic Frontend
- Outlook









# Overview Petra III

- 3rd Generation Synchrotron Radiation Source
- Accelerator perimeter: 2304 m
- Particle energy: 6 GeV
- Current in top up mode : 100 mA  (200 mA)
- Emittance: 1 nm rad
- 14 Beamlines (5° angular distance)
- 1 x 10 m undulator
- 1 x 5 m undulator
- 1 x 5 m apple undulator
- 1 x 4m in vacuum undulator
- 5 x (2 x 2 m) canted undulators (5 mrad ~ 0.29° angular distance)

Petra Extension: 10 new beamlines in 2 new experimental halls

# Overview Petra III

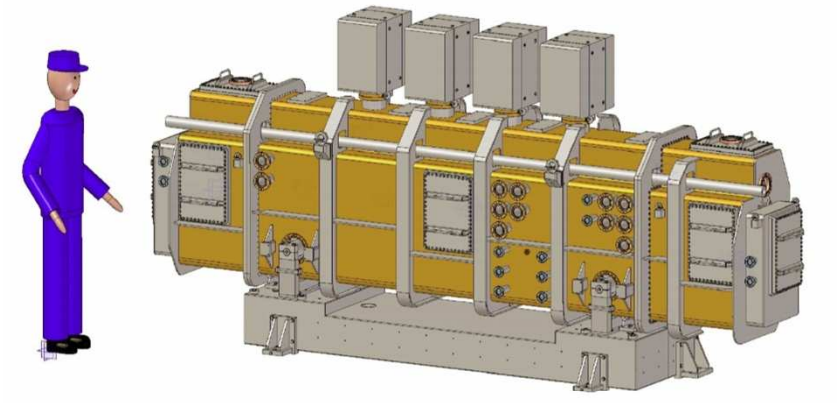
- P01: Inelastic and nuclear resonant scattering
- P02: Hard X-Ray diffraction
- P03: Micro and nano Saxs/Waxs
- P04: Variable polarization soft X-Ray
- P05: Micro- and nano-tomography (HZG)
- P06: Hard X-Ray micro probe and imaging
- P07: High energy materials science (HZG)
- P08: High resolution diffraction
- P09: Resonant scattering/diffraction
- P10: Coherence applications
- P11: Bio imaging/diffraction (HZI, MPG, Desy)
- P12: Bio small angle scattering (EMBL)
- P13: Macro molecular crystalograpy I (EMBL)
- P14: Macro molecular crystalograpy II (EMBL)

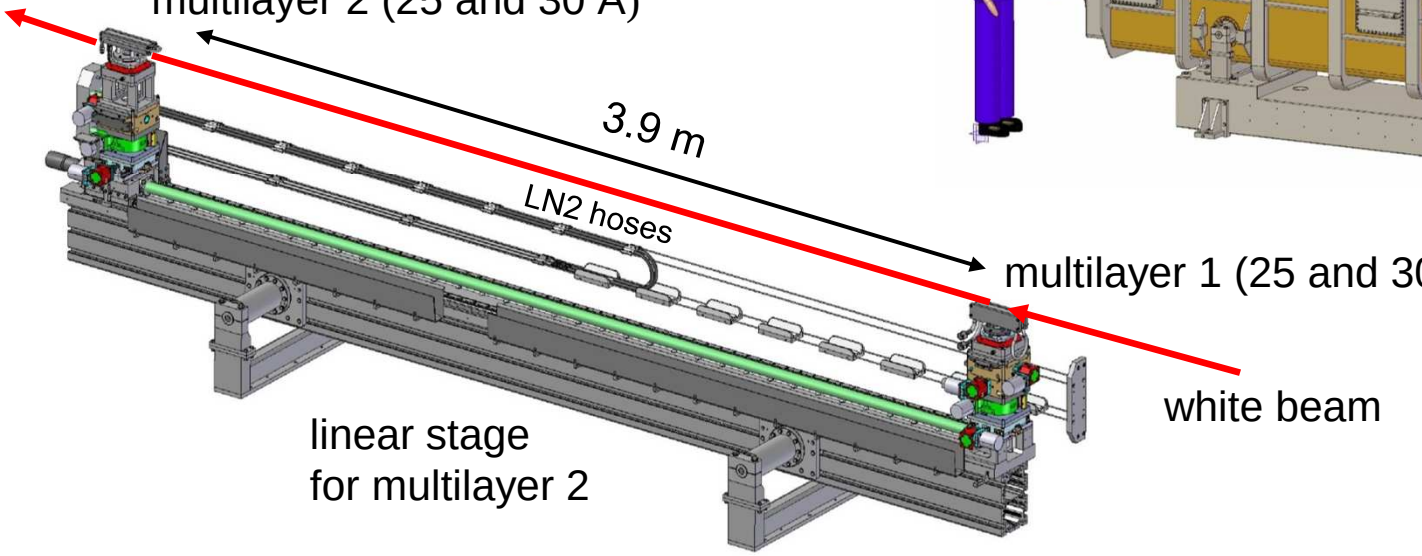
# Large Monochromator Systems: Purpose and Specifications

- Technical solution needed for canted undulator beamlines due to small angular separation
- White beam (high heat load)
- Reduction of the energetic bandwidth of a monochromatic beam
- Energy range of the monochromators adapted to beamline needs
  - P03: 8 – 25 keV
  - P06: 4.4 – 90 keV
  - P08: 5.4 – 29.4 keV

# Mono - P06 (Hard X-Ray micro probe and imaging)

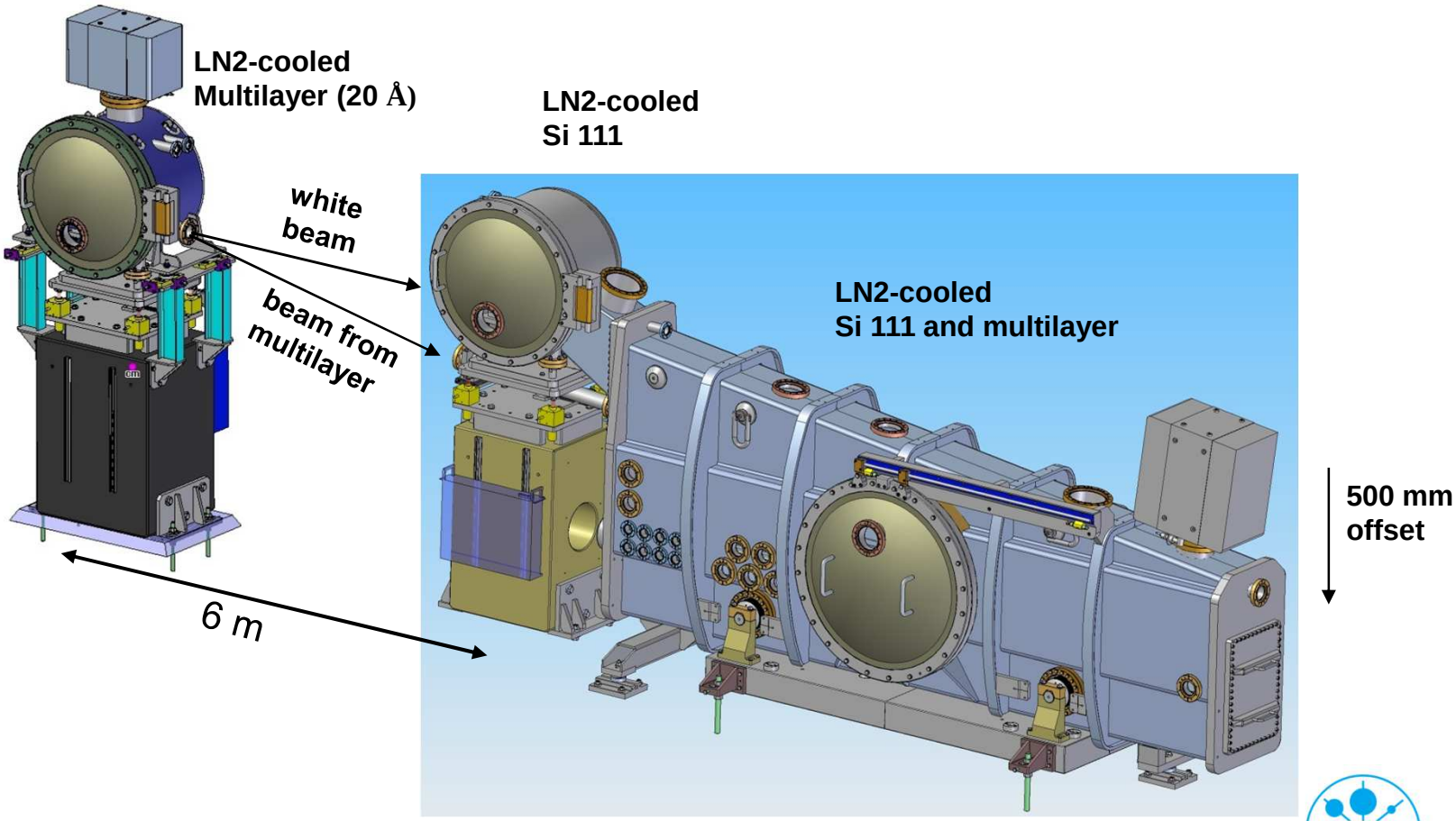
- Energy range 4.4 – 90 keV
- Both multilayers (W-Si) are cryocooled
- Deviation along the linear stage smaller than +/- 240 µrad (50 arcsec) in pitch and roll
- Fixed exit, offset 21 mm





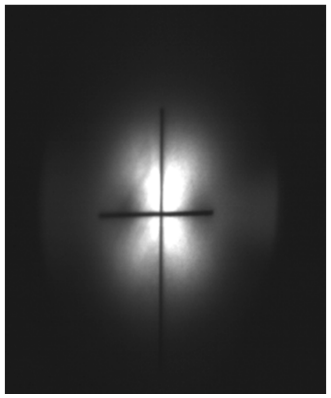
# LOM 500 - P03 (Micro and nano Saxs/Waxs)

- 2 different beam paths for Si 111 crystal set (8 – 25 keV) and multilayers (8.4 – 11.5 keV for 20 Å spacing)
- All optical components are cryocooled

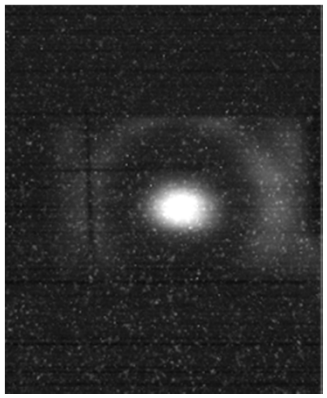


# LOM 500 - Commissioning

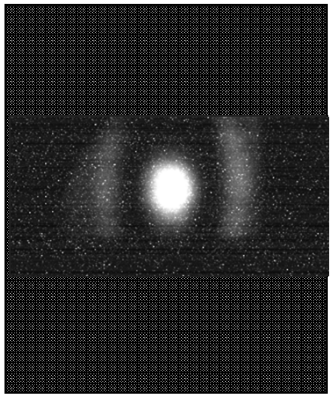
CVD diamond screens with ccd camera:



Screen 1
17 m behind
undulator

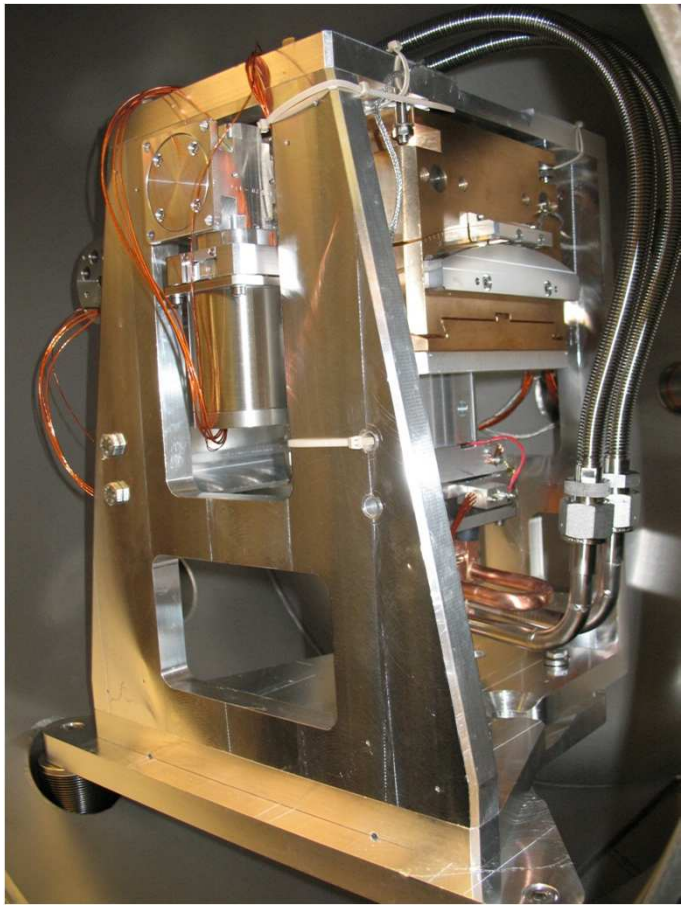


Screen 3
behind first crystal
3rd harmonic 13 keV
54 m behind undulator

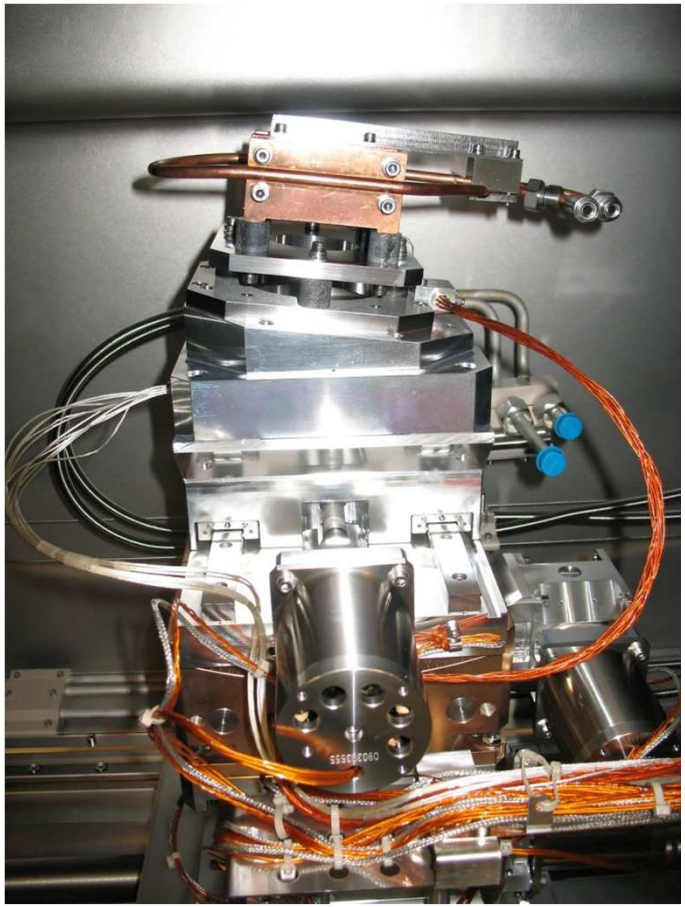


Screen 4
behind second crystal
59 m behind undulator

# LOM 500 – crystal set (Si 111)

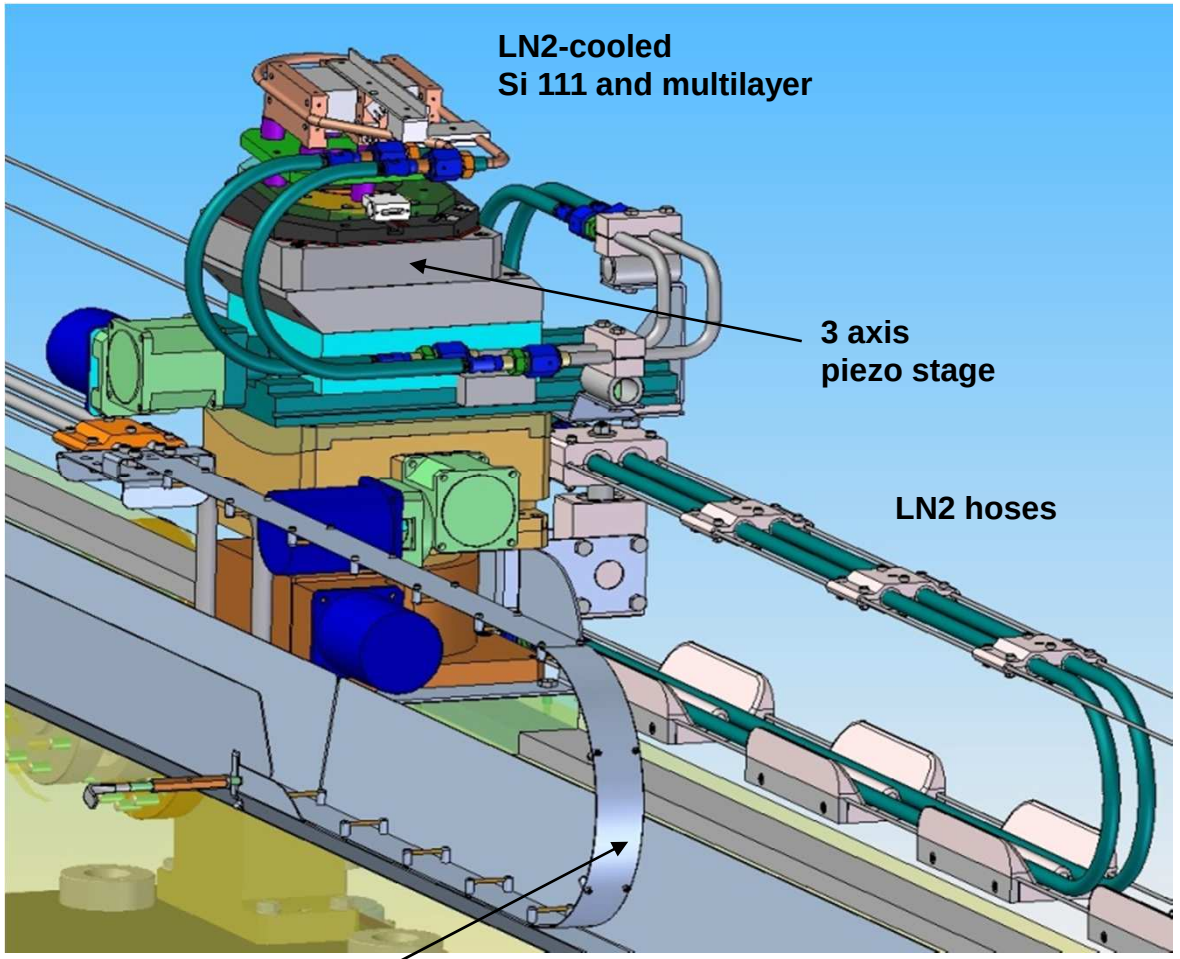


1st crystal

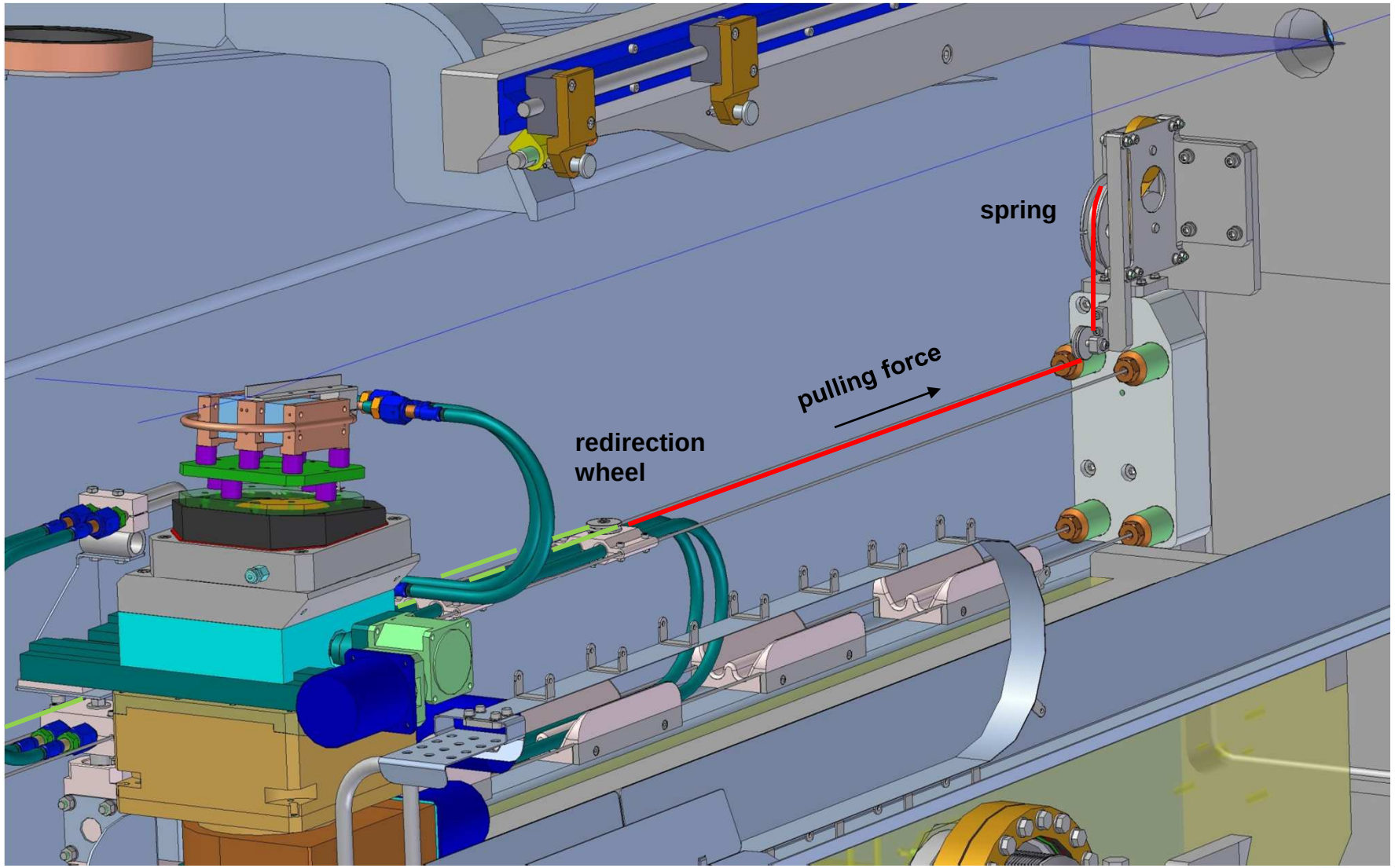


2nd crystal and multilayer
on 2.5 m translation

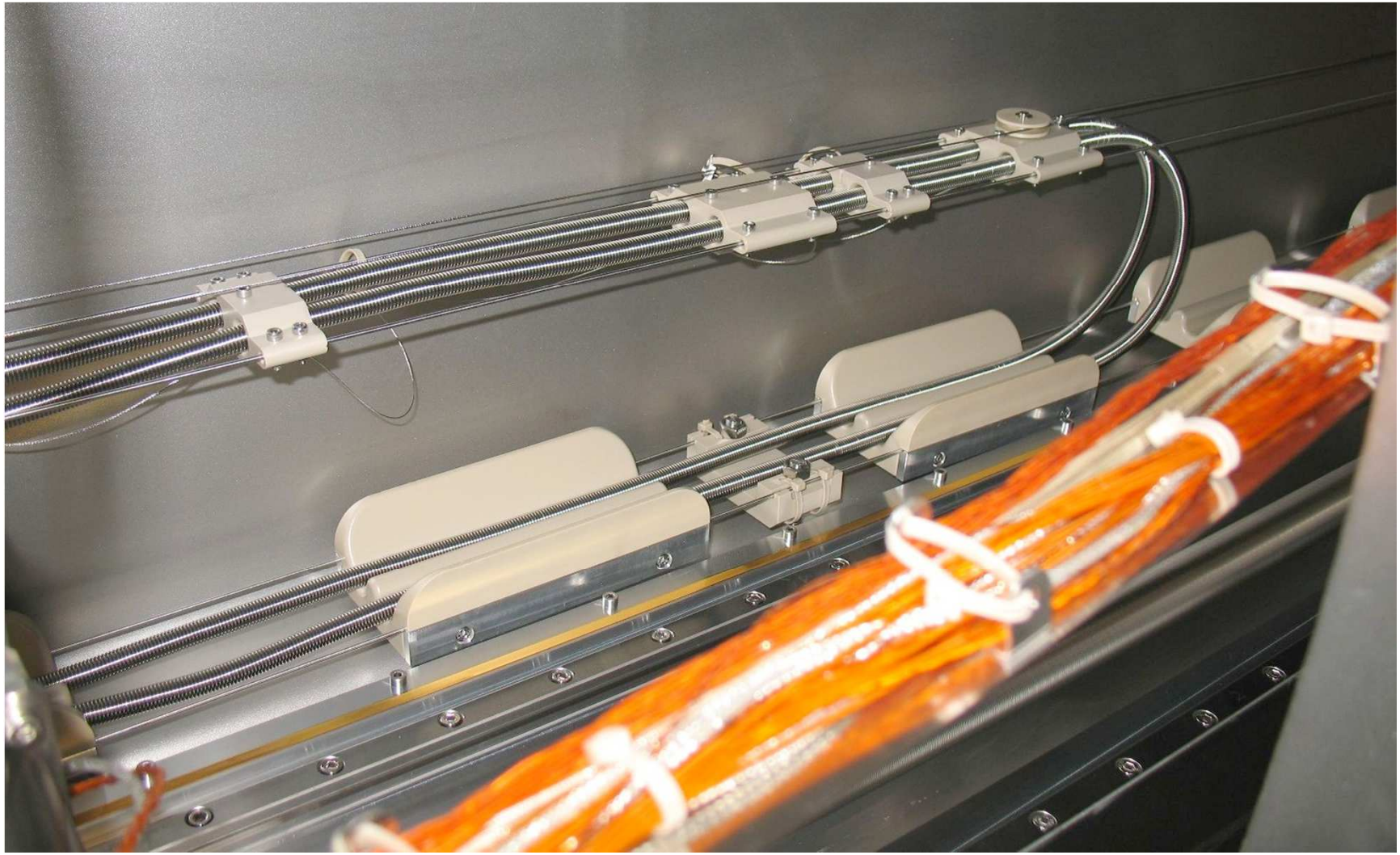
# LOM 500 – mechanical details



# LOM 500 – mechanical details – 2nd version

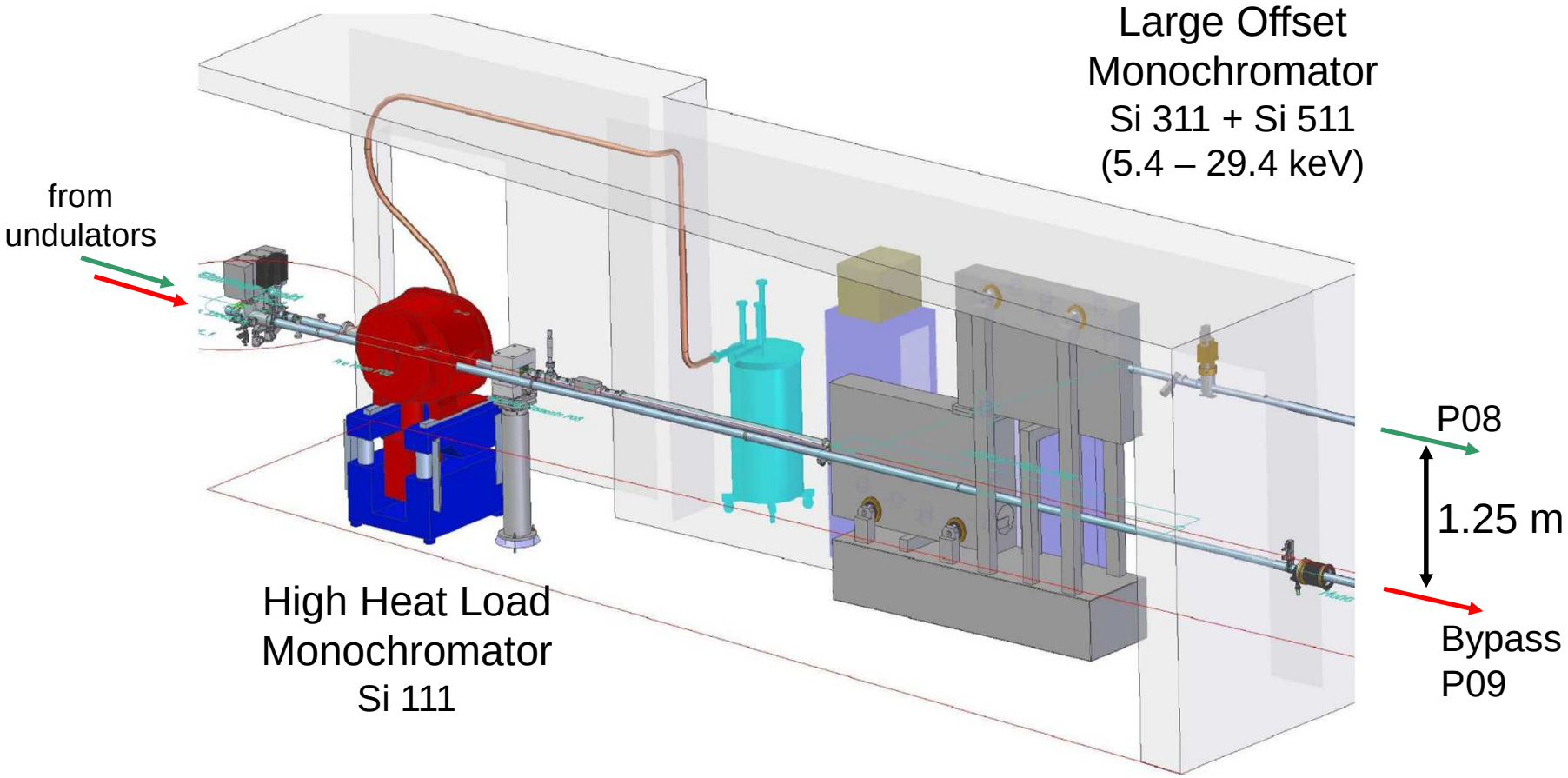


# LOM 500 – mechanical details – 3rd version



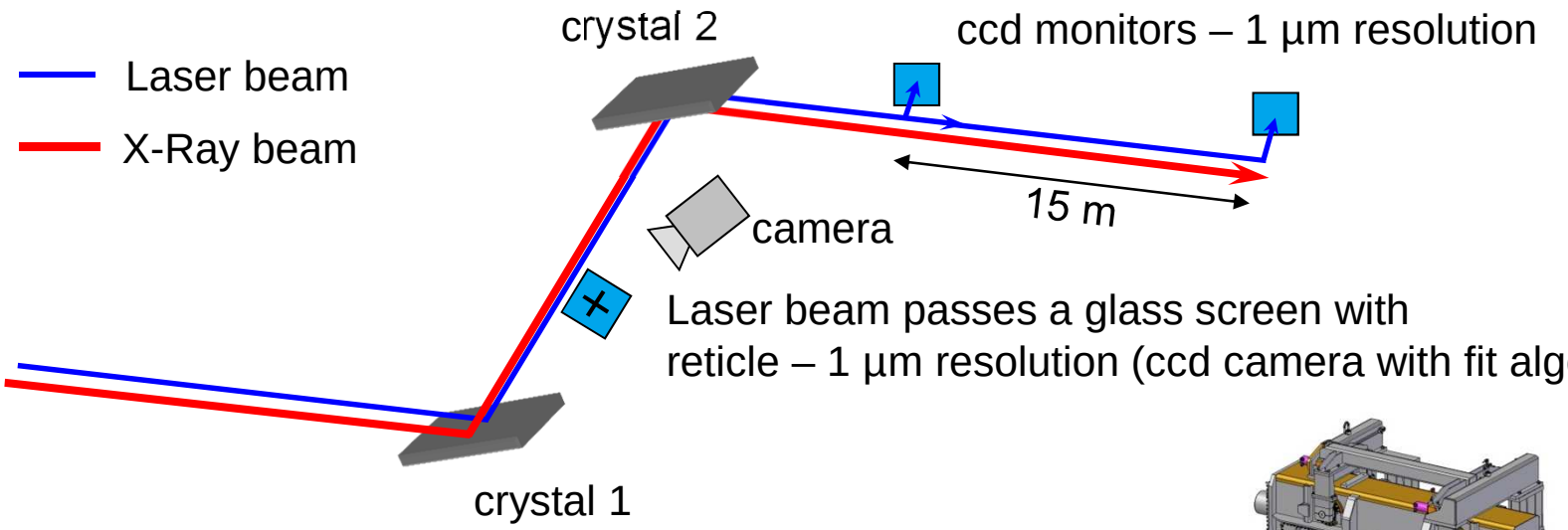
# LOM 1250 - P08 (High resolution diffraction)

- accepts monochromatic beam from Generic High Heat Load Monochromator



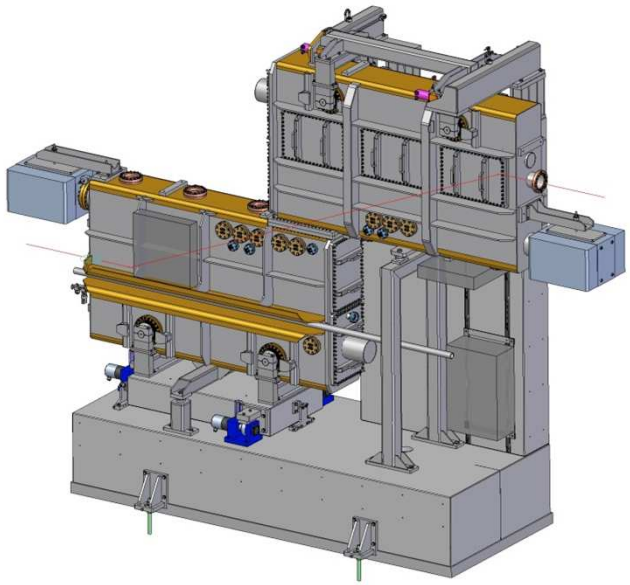
# LOM 1250

> Laser stabilisation for compensation of thermal drift




X-Ray beam stability at the experiment (20m behind the LOM 1250 ): +/- 4 µm, equal to 0.2 µrad

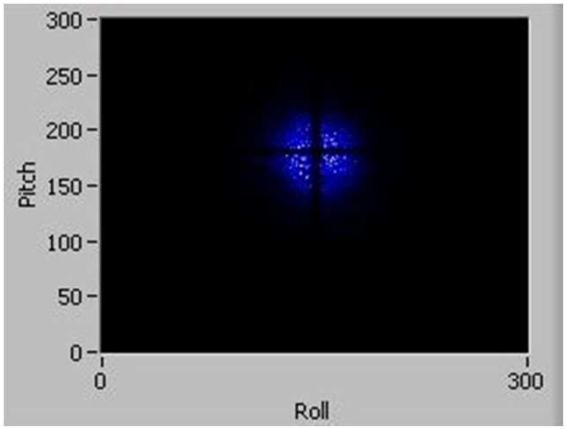
DU4



# Laser spot at glass screen with reticle

Laser diameter 3 mm

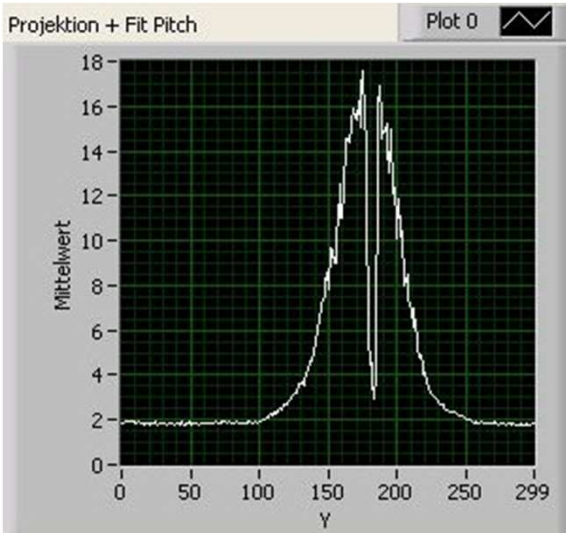
DU5




Camera resolution 50 µm / pixel

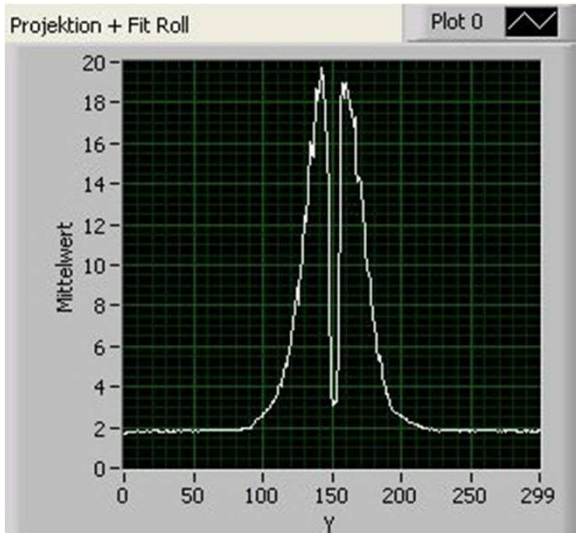
Projection in pitch direction

Projection in roll direction

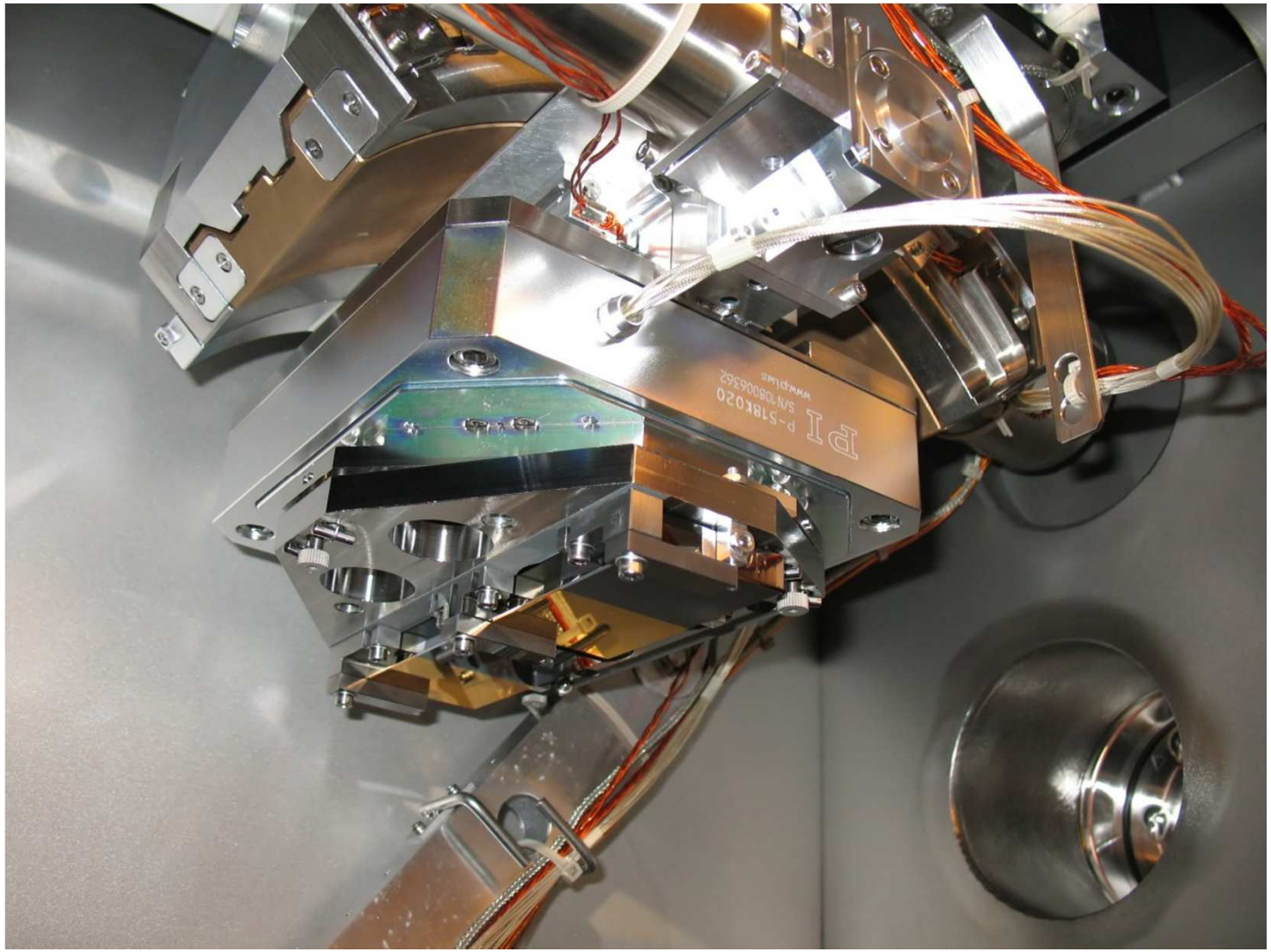



Resolution of Gaussian fit approx. 1µm.

Repetition rate approx. 5 Hz

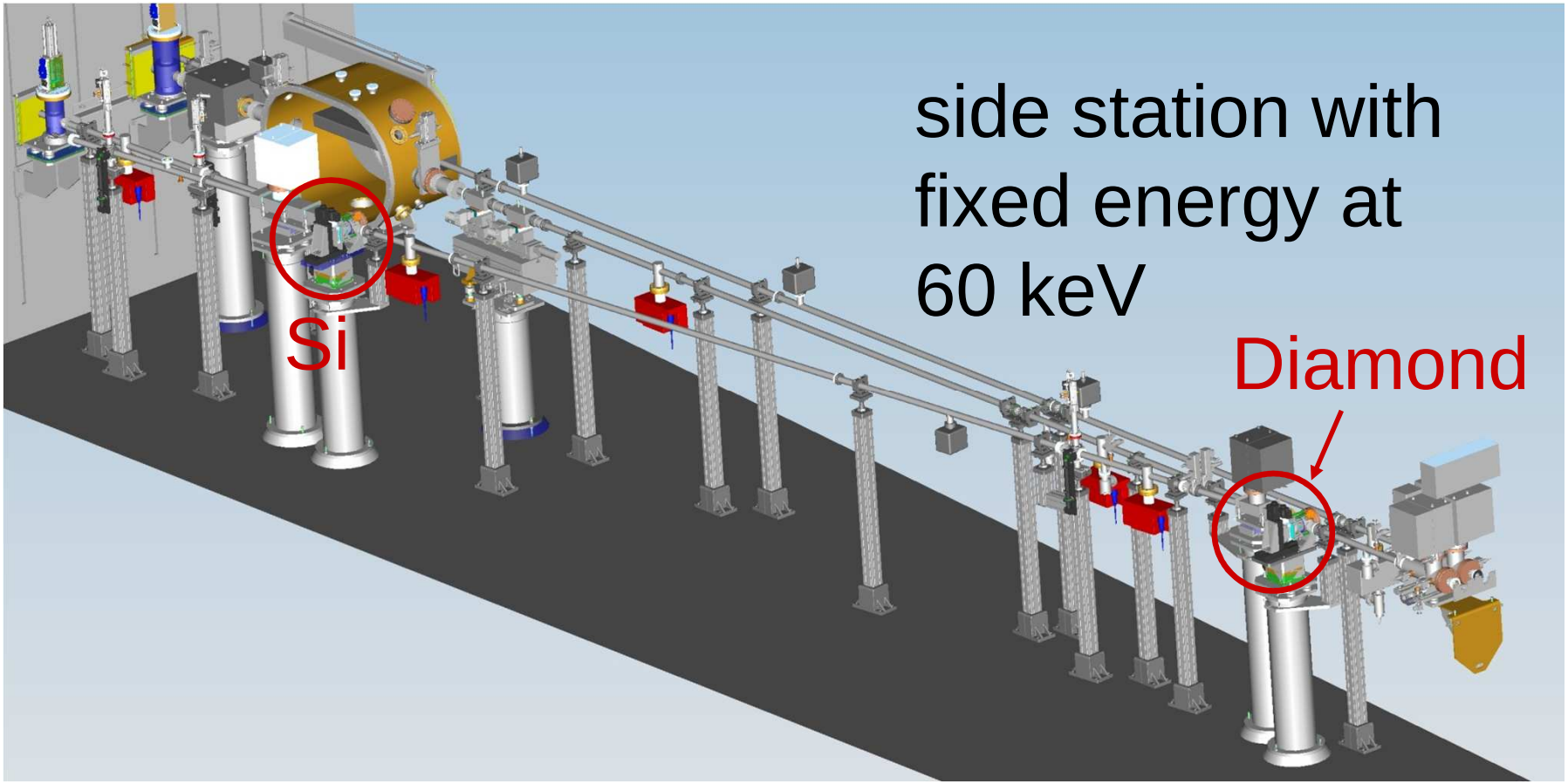


# LOM 1250 – 2nd crystal (Si 311 + Si 511)



Miscut between crystal surface and crystal planes:
Pitch: 85 µrad
Roll: 50 µrad

# Diamond / Silicon Laue Monochromator at Beamline P02.1



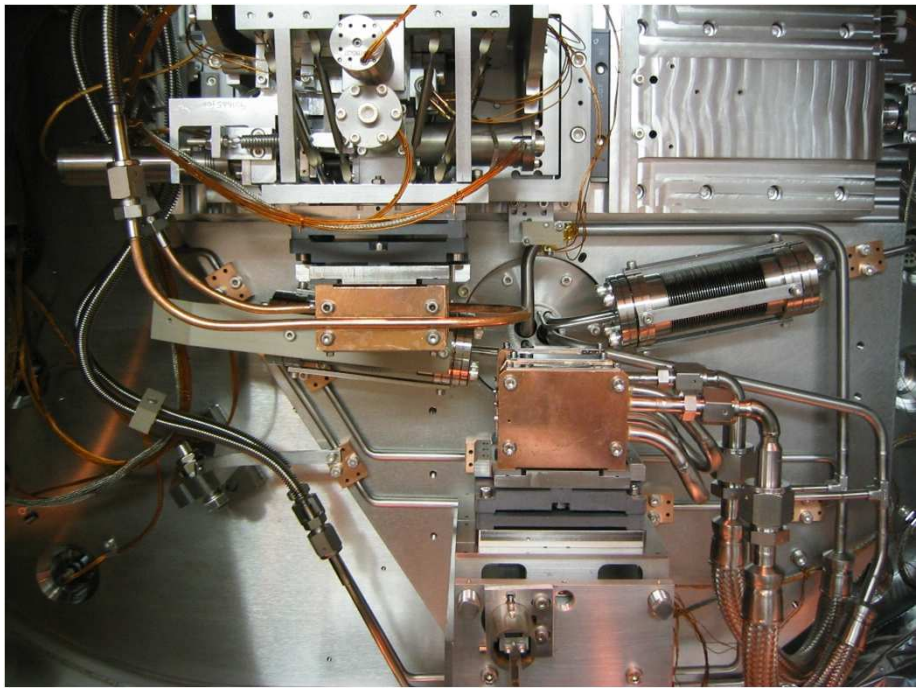
# Diamond / Silicon Laue Monochromator at Beamline P02.1

nickel plated copper
With GaIn foil at
connections

Diamond (100)
In Laue configuration (111)
Thickness 0.4 mm

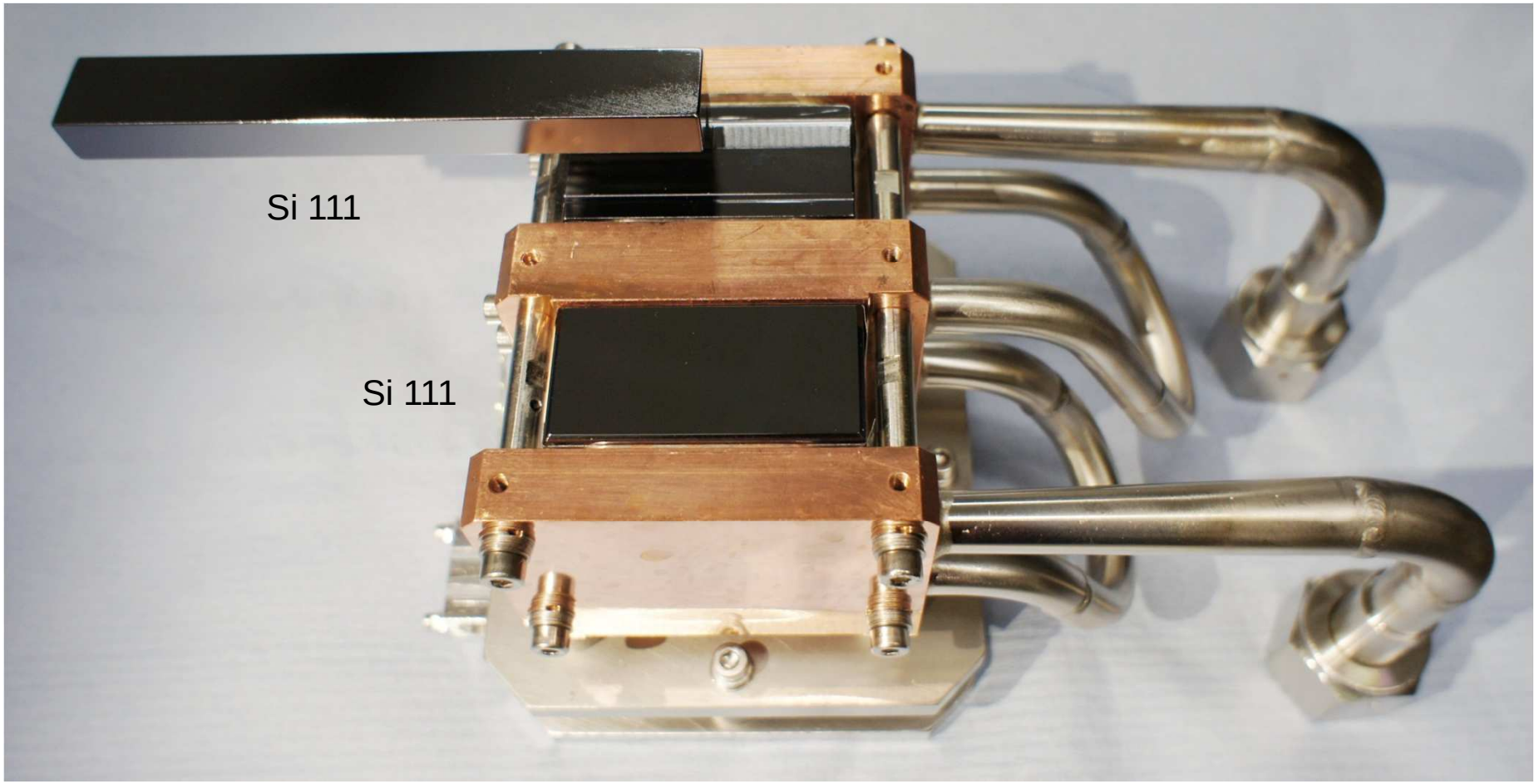
# Generic High Heat Load Monochromator


- 50 µrad resolution of bragg axis
- 18 nrad resolution of bragg piezo
- offset 21 mm upwards



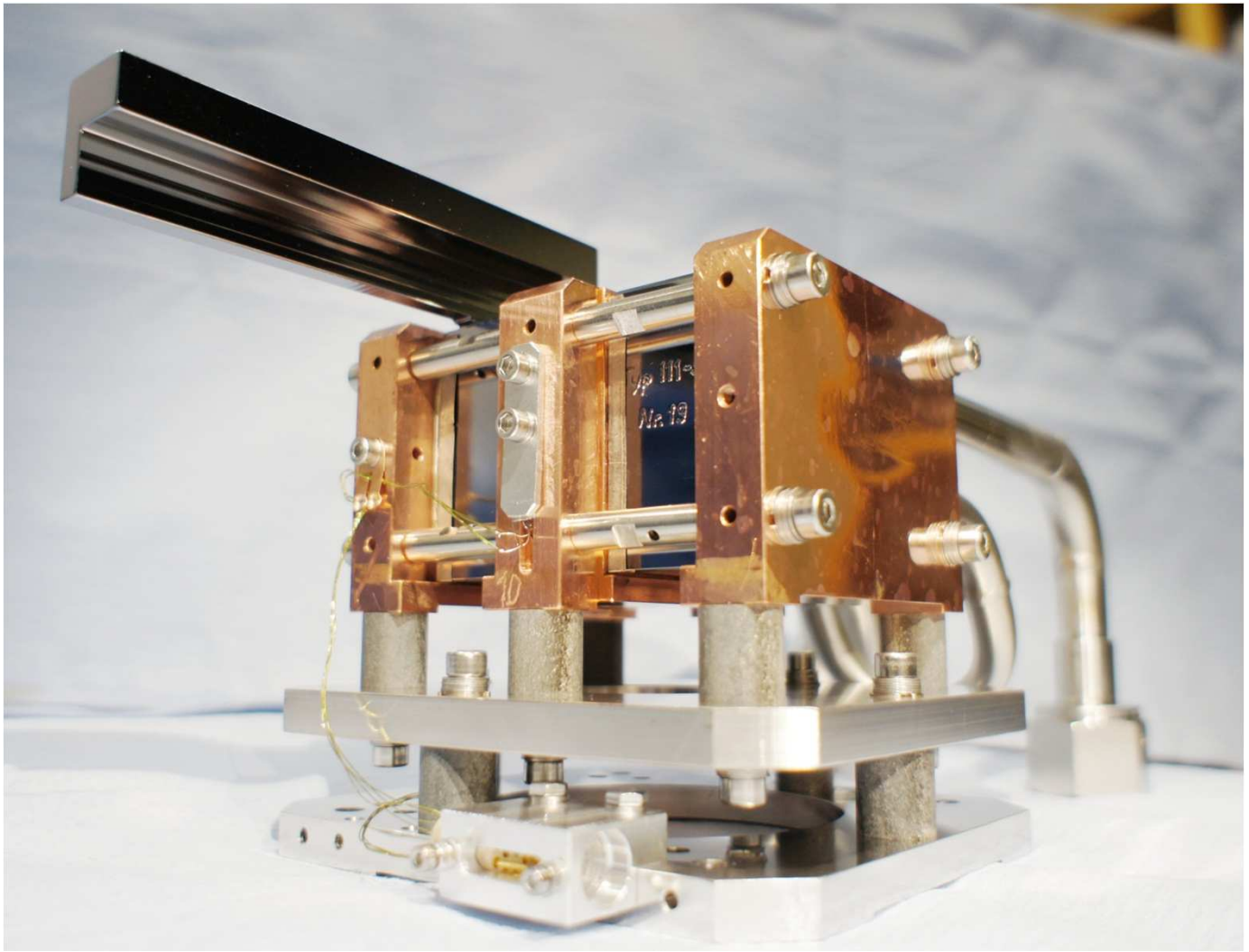
# High Heat Load Channel Cut Monochromator
# P10 (Coherence applications)

first crystal



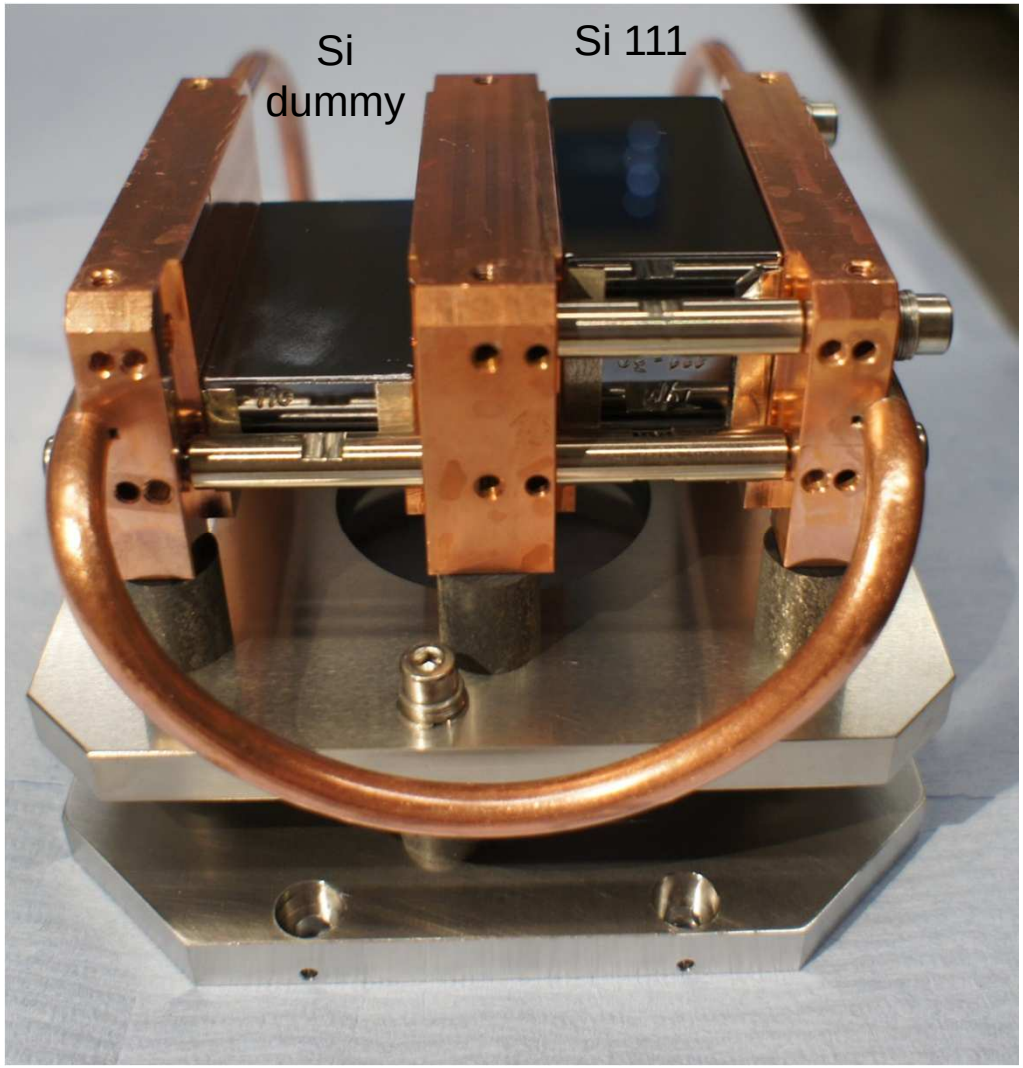
# High Heat Load Channel Cut Monochromator P10

first crystal



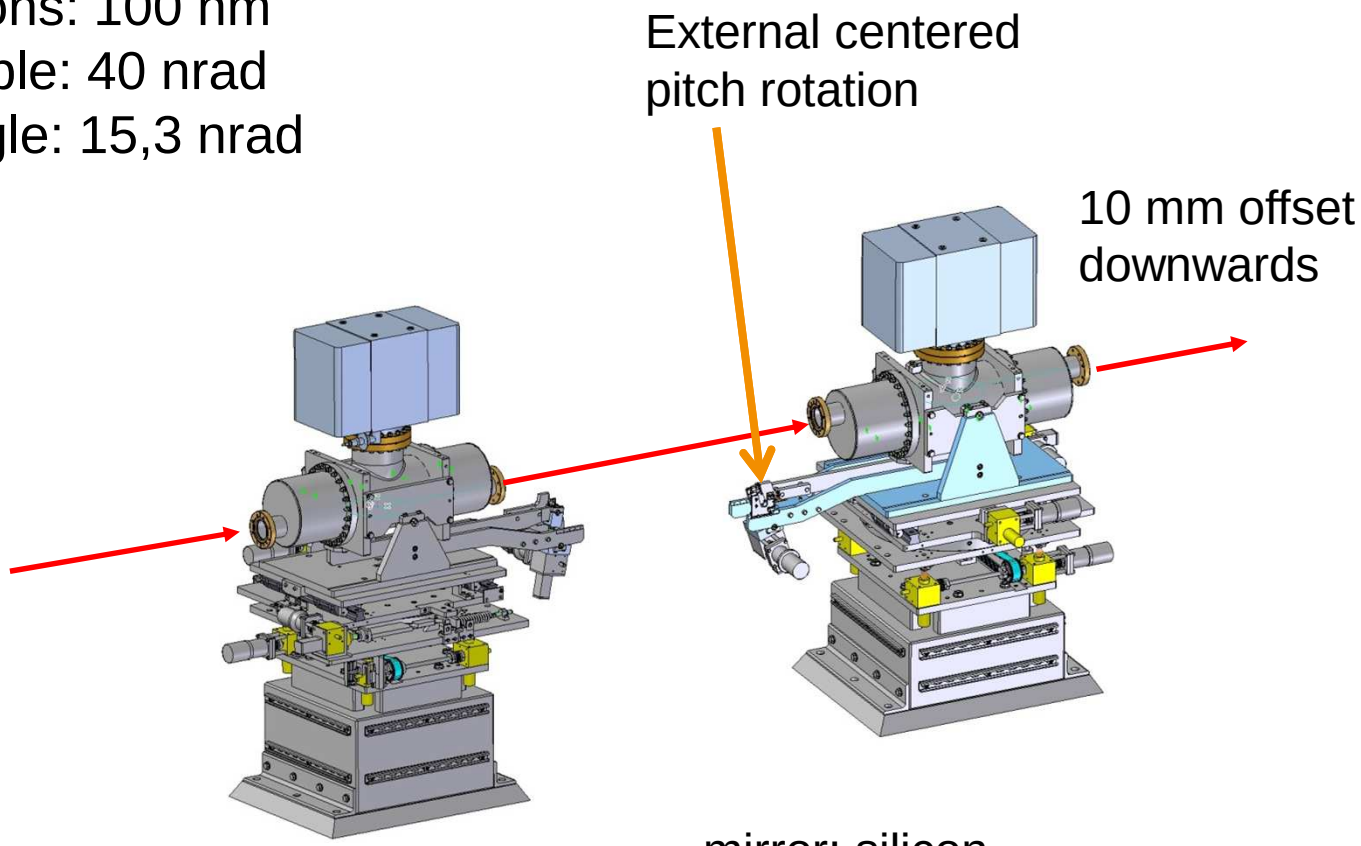
# High Heat Load Channel Cut Monochromator P10

second crystal



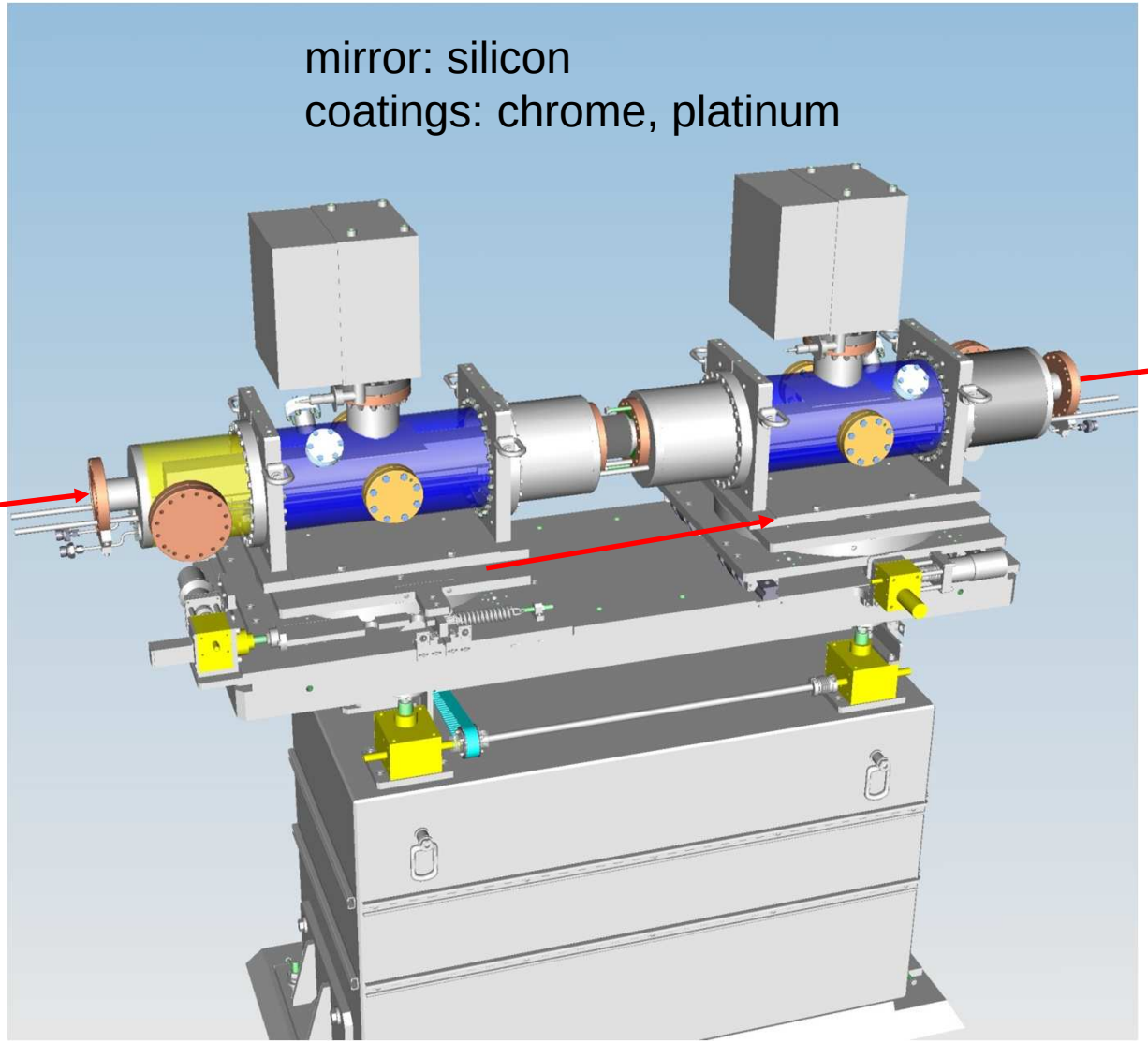
# Mirror optics – P03 M1 + M2

Resolutions for all mirror optics:
- translations: 100 nm
- rotary table: 40 nrad
- pitch angle: 15,3 nrad



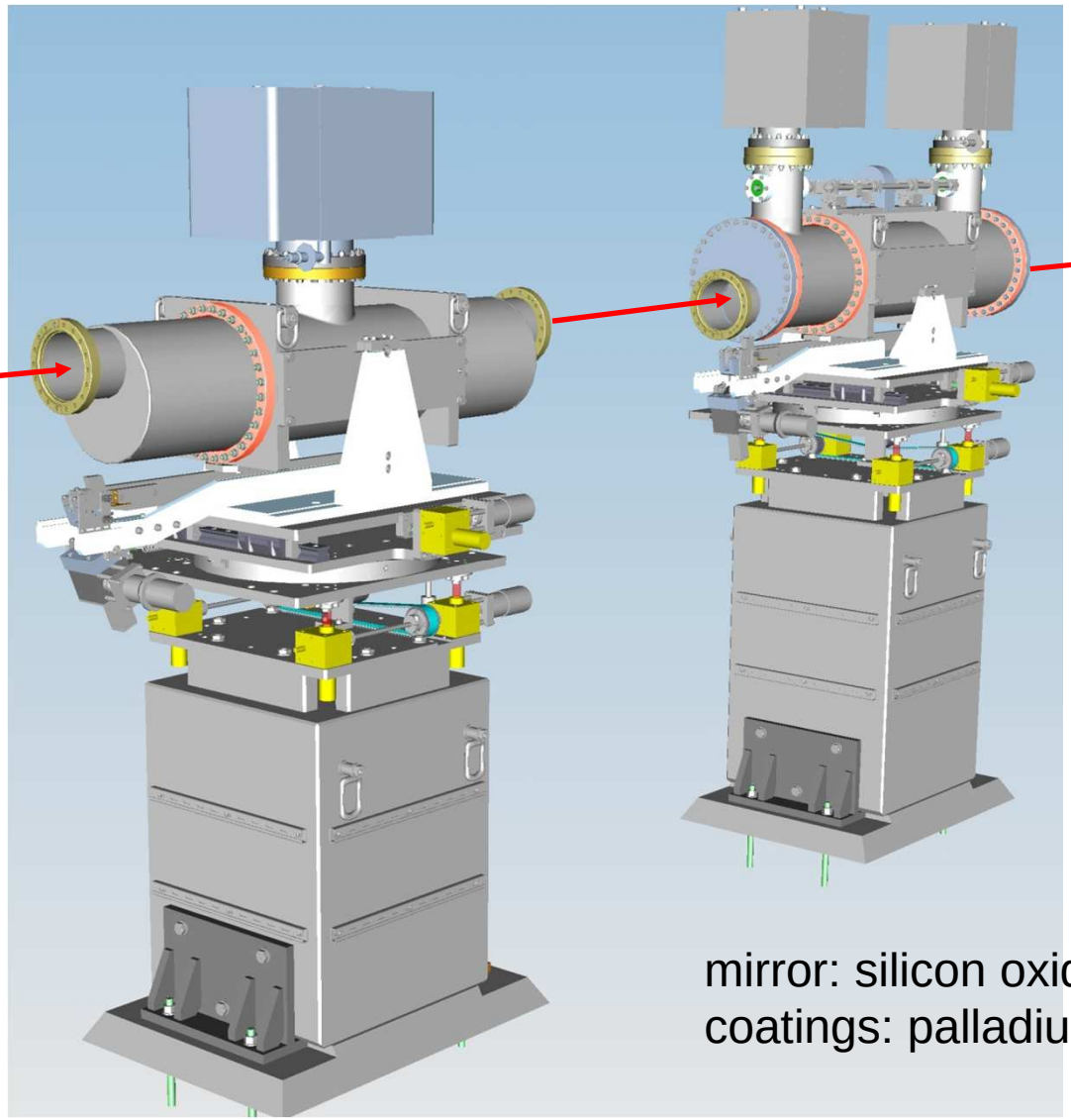

mirror: silicon
coatings: molybdenum, palladium

# Mirror optics – P06 M1 + M2




16 mm offset to the right

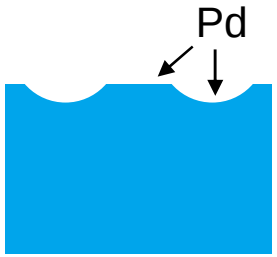
# Mirror optics – P09 M1 + M2 (Resonant scattering/diffraction)



mirror 2 is bendable (concave, radius: 5 – 50 km)

10 mm offset upwards

radius 88 mm




profile of mirror 1

radius 58 mm

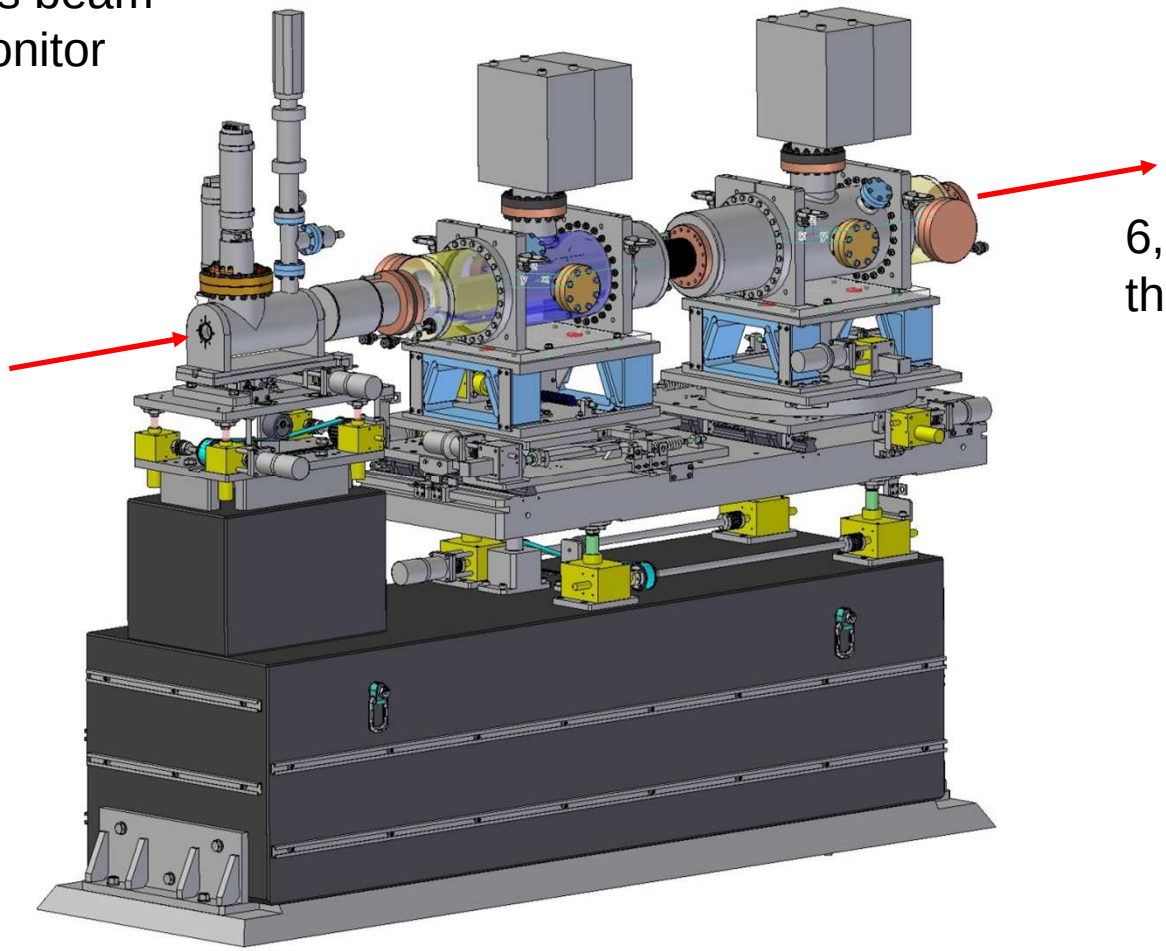

profile of mirror 2

mirror: silicon oxide (fused silica)
coatings: palladium

# Mirror optics – P10 M1 + M2

mirror: silicon oxide (fused silica)
coatings: platinum, rhodium

residual gas beam
Position monitor

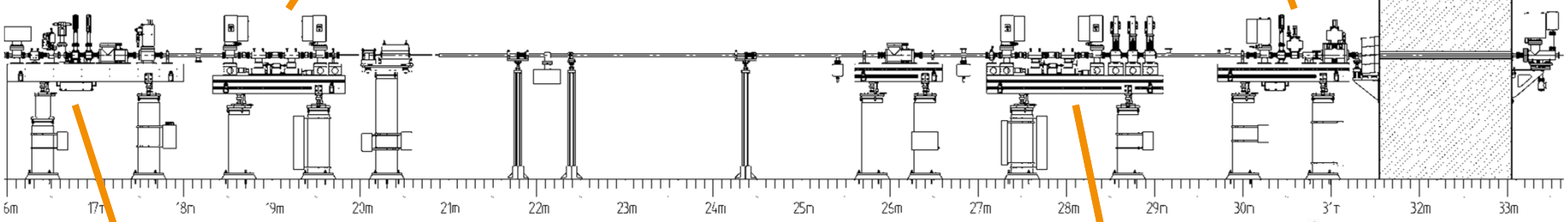


6,5 mm offset to
the left

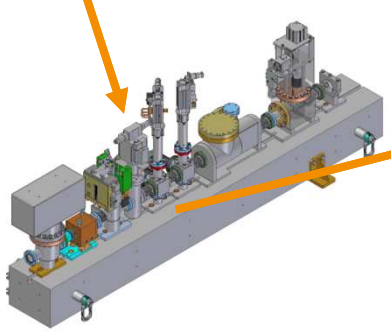
# Petra III – Generic Frontend

vertical high power slit-system

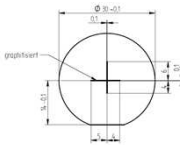
sacrificial absorber, collimator and Bremsstrahlungs beam shutter

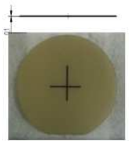


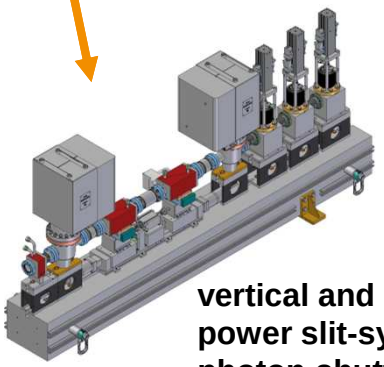
alignment laser, fluorescent screen, RGXBPM and fast acting valve



diamond fluorescent screen



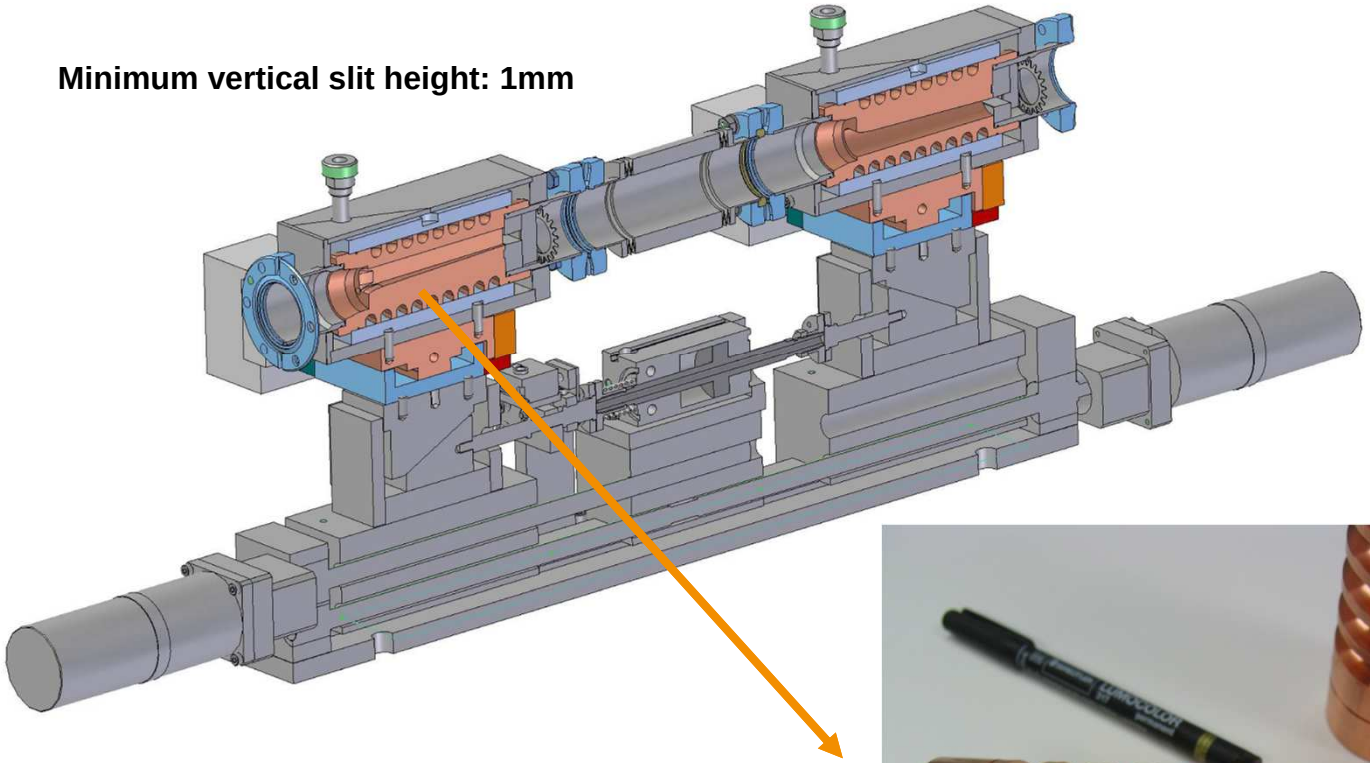




vertical and horizontal high power slit-system with photon shutter function and white beam filter units

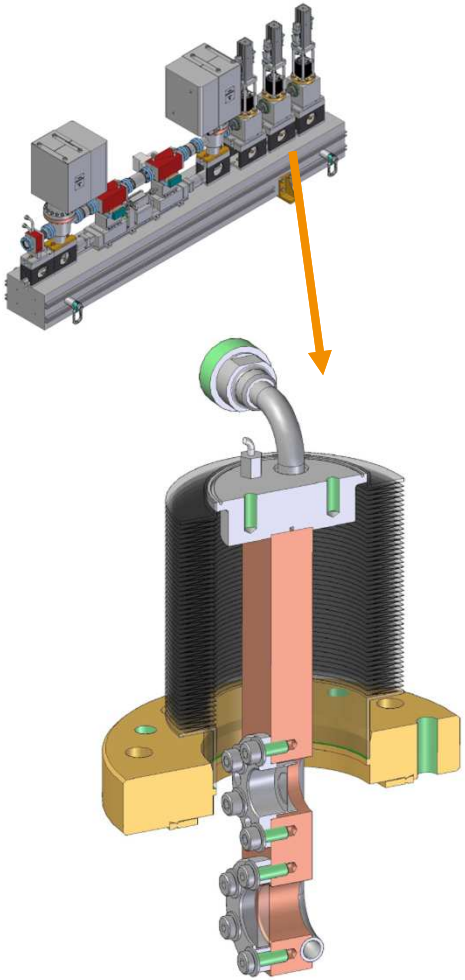
# Petra III – Generic Frontend

**Minimum vertical slit height: 1mm**

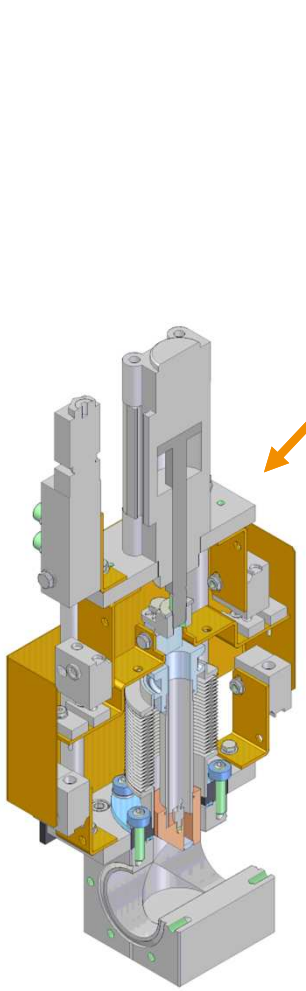


**vertical high power slit-system**

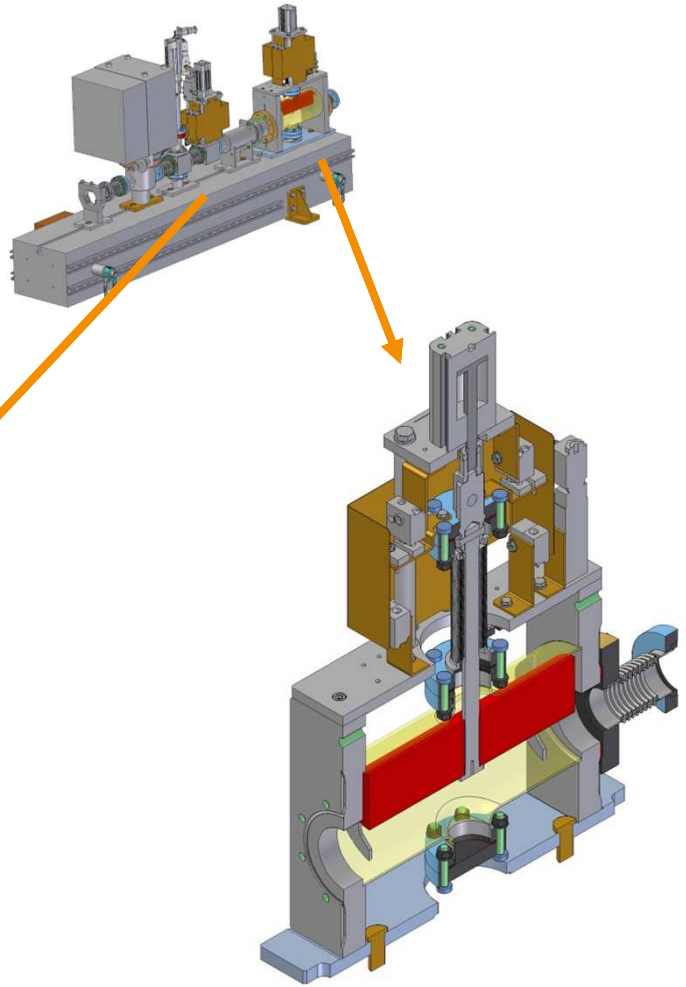
# Petra III – Generic Frontend



water cooled filter unit
glassy carbon
CVD-diamond
copper



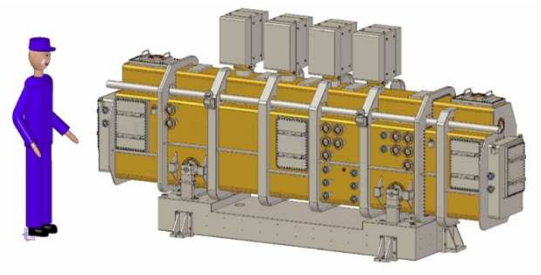
sacrificial absorber



Bremsstrahlungs beam shutter

# Conclusion and Outlook

- Large offset monochromators reach their specifications
- Stable mirror systems in different configurations
- High heat load monos with channel cut option
- New generation of high heat load monos for Petra



Extension in development

- Generic Frontend will be used for Petra Extension