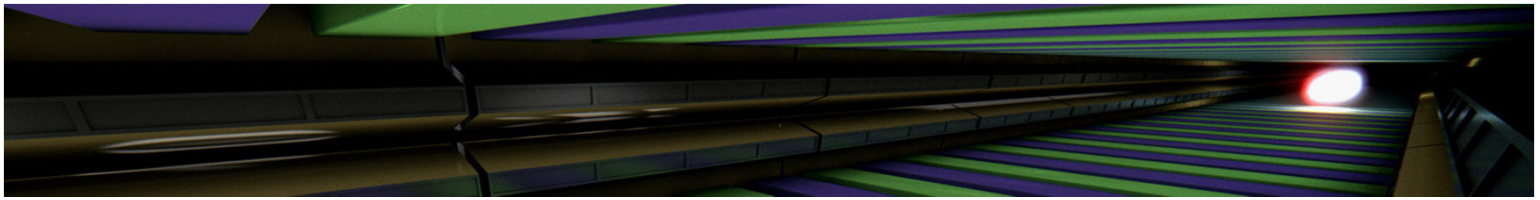


Soft X-Ray Monochromator at the European XFEL

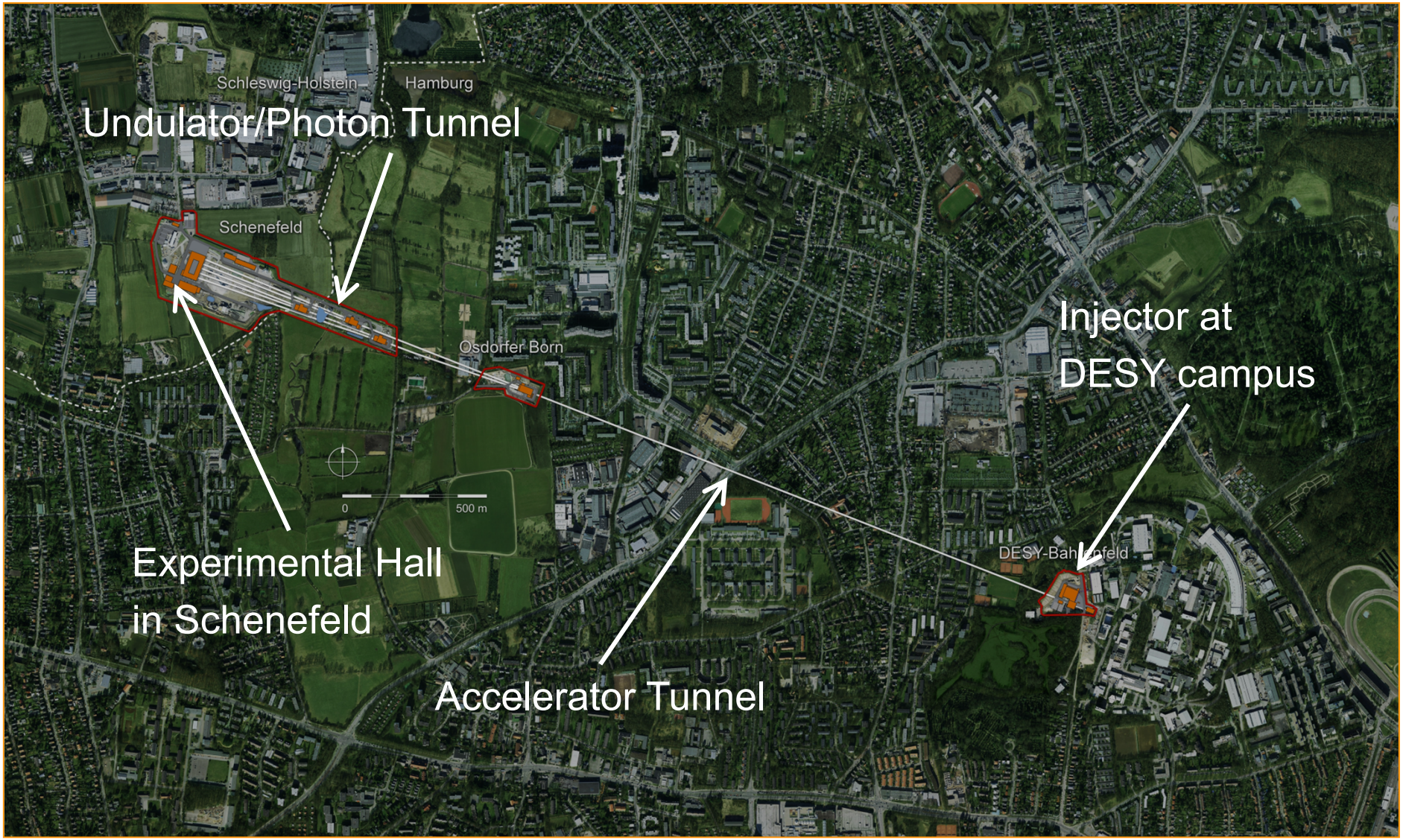
Daniele La Civita

European XFEL, X-ray Optics Group

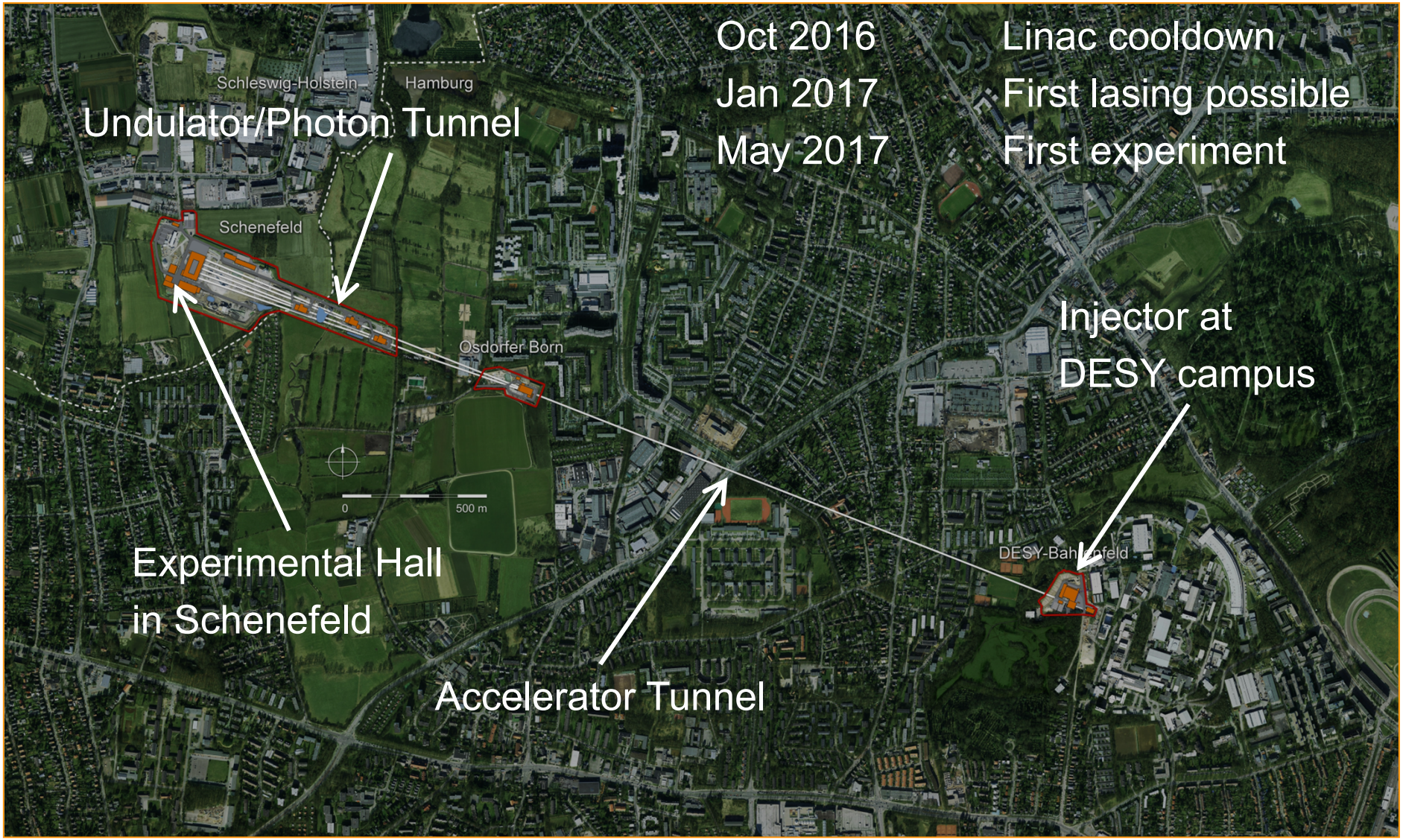
MEDSI2016 – Barcelona, Spain

European XFEL

European XFEL and milestones



European XFEL and milestones



European XFEL

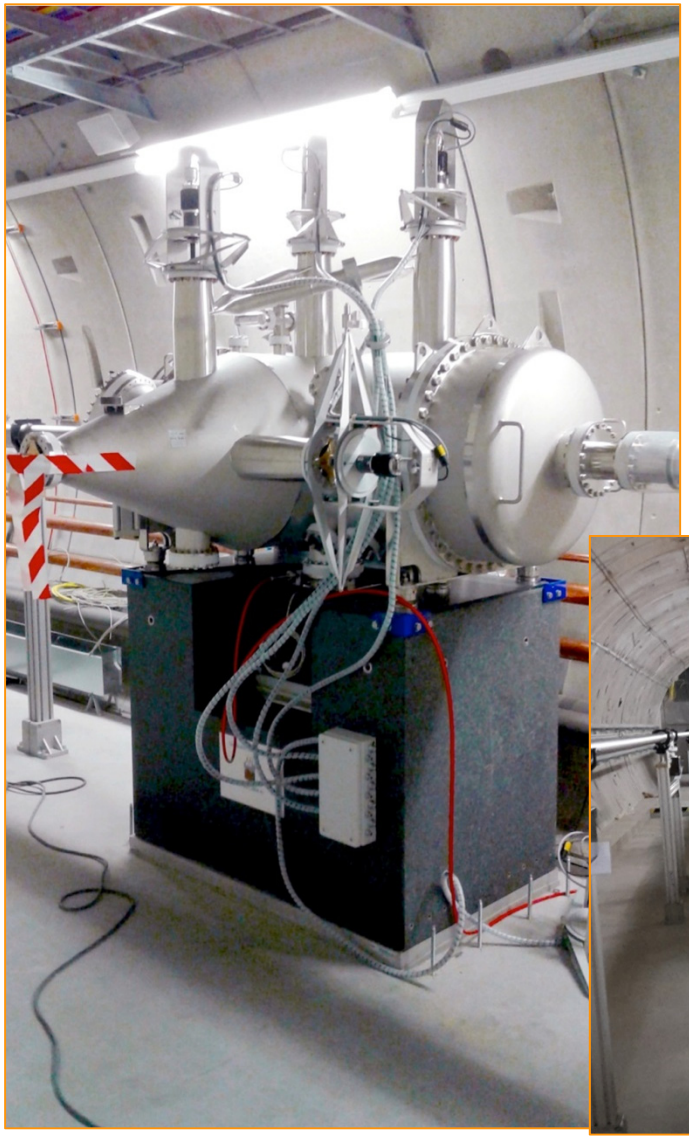
Progress on civil construction

European XFEL

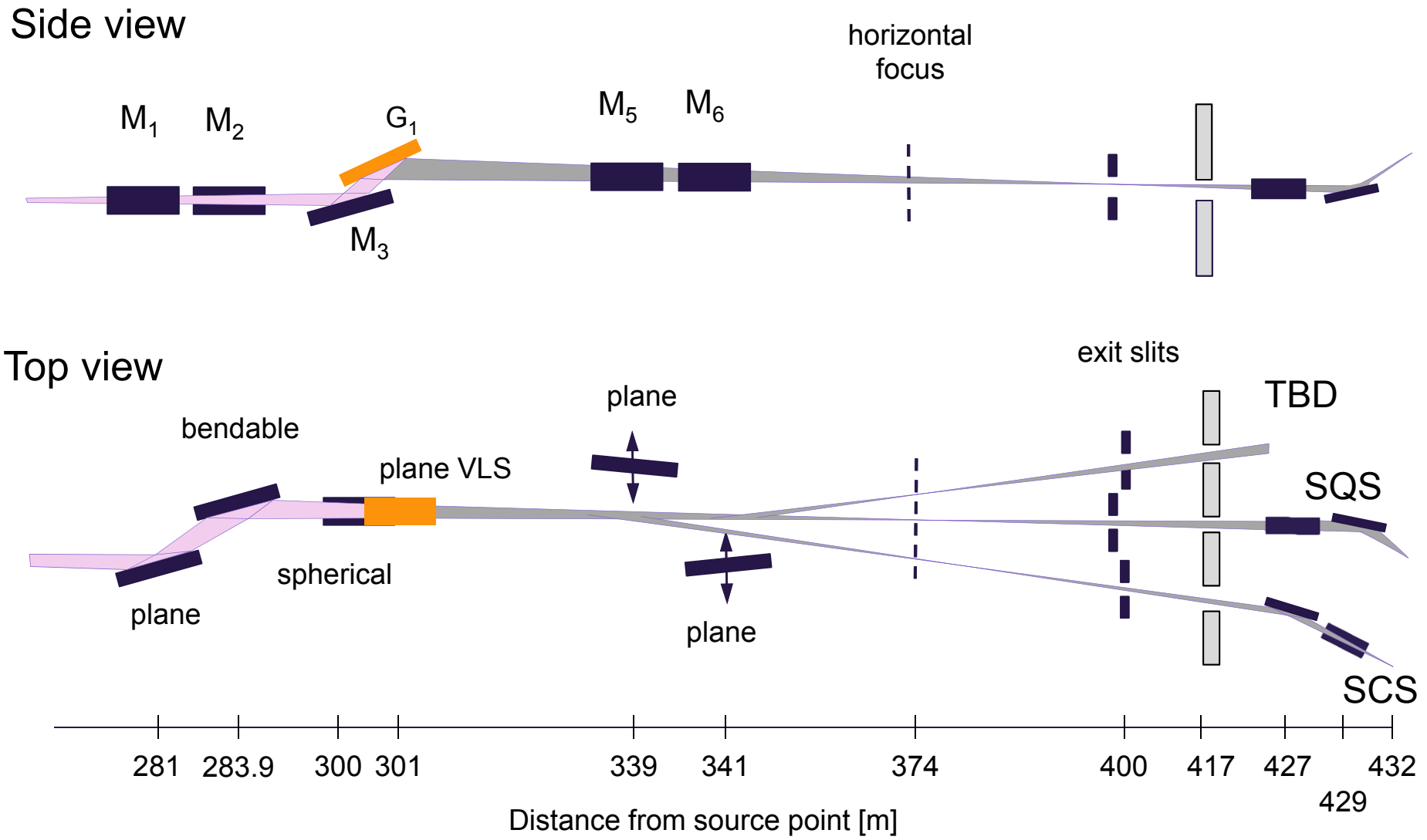
Progress on civil construction

European XFEL

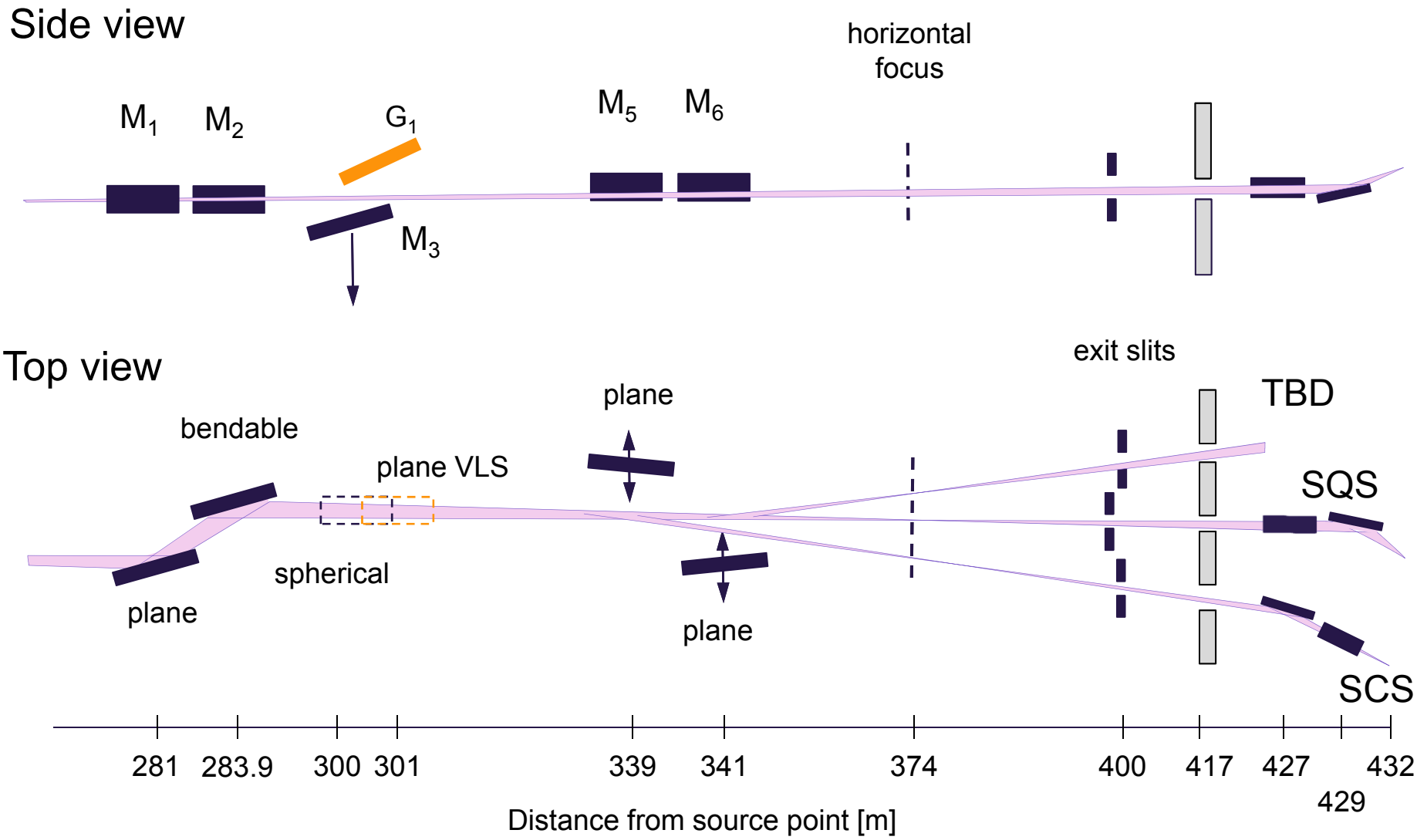
… and on the photon system installation



SASE3 optical layout

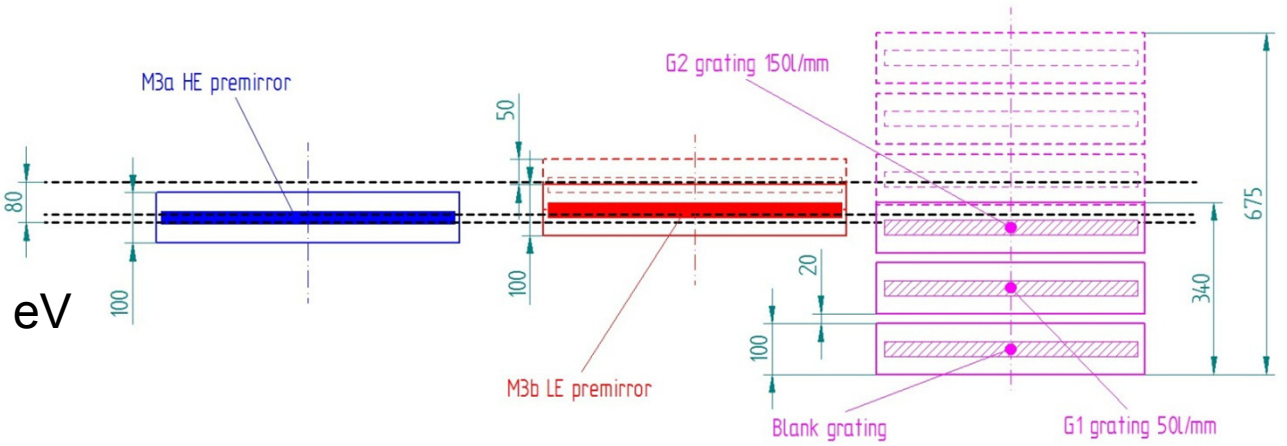


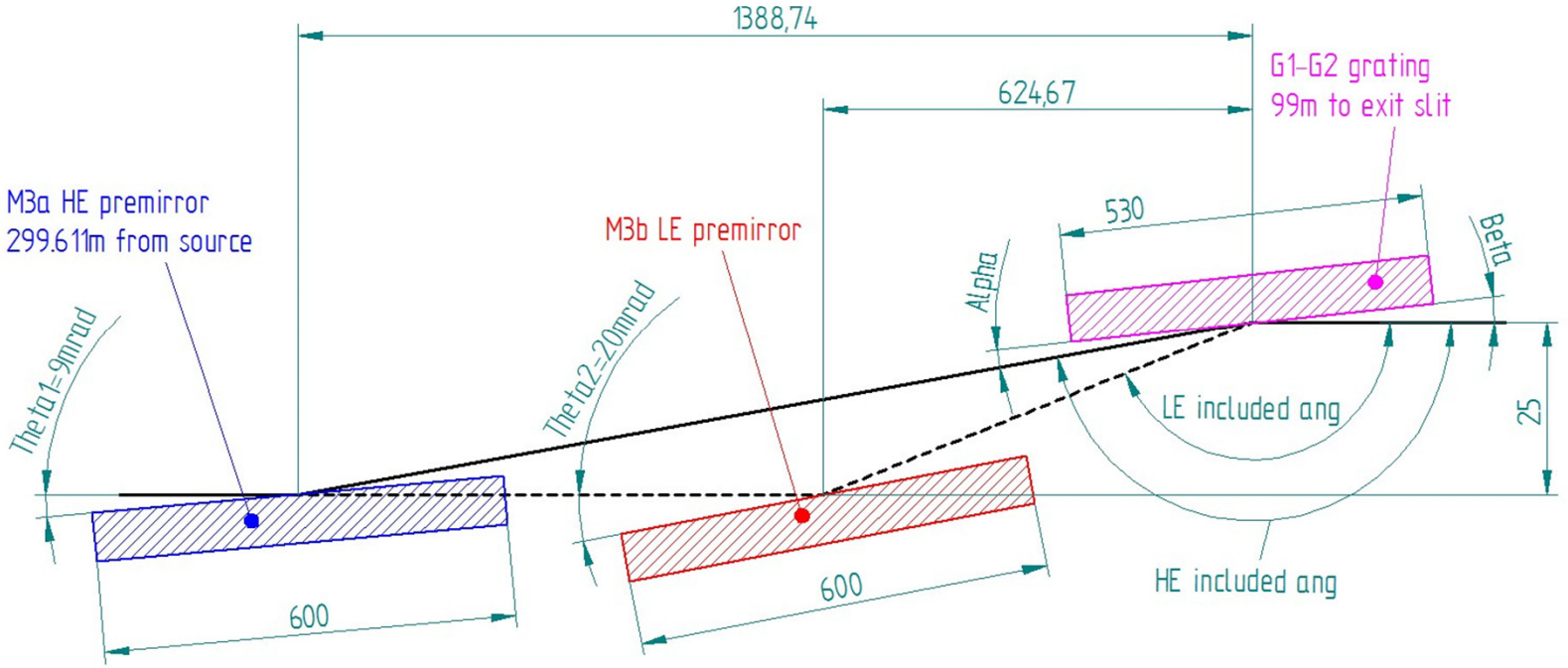
SASE3 optical layout



Monochromator conceptual design

- VLS-PGMonochromator
- Fixed included angle
- 1st Diffraction order
- Energy range: 270-3000 eV
- … 2 monos in 1

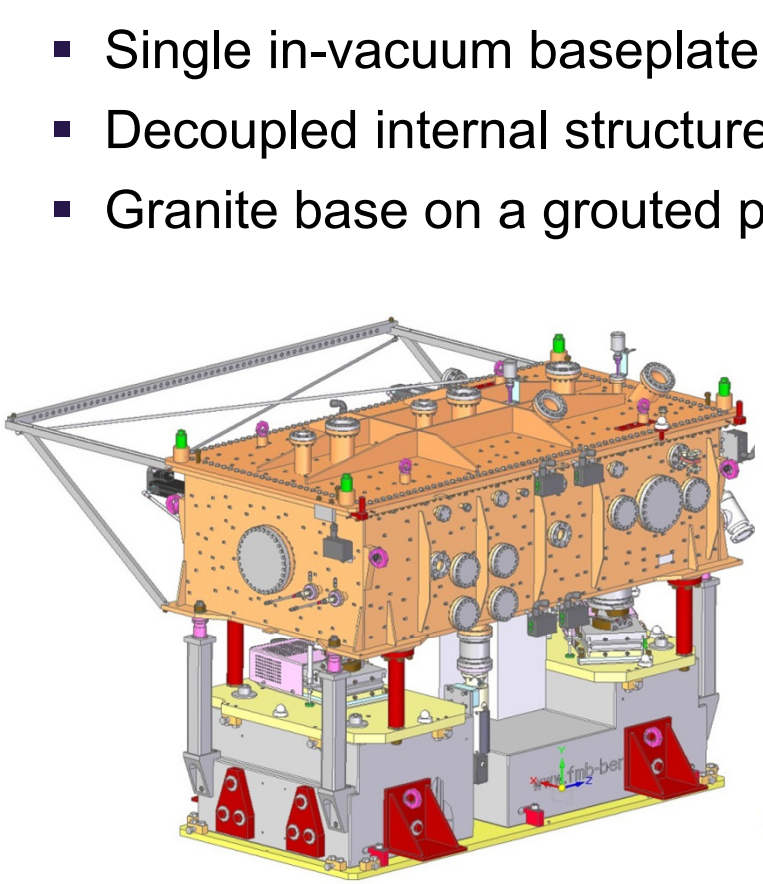


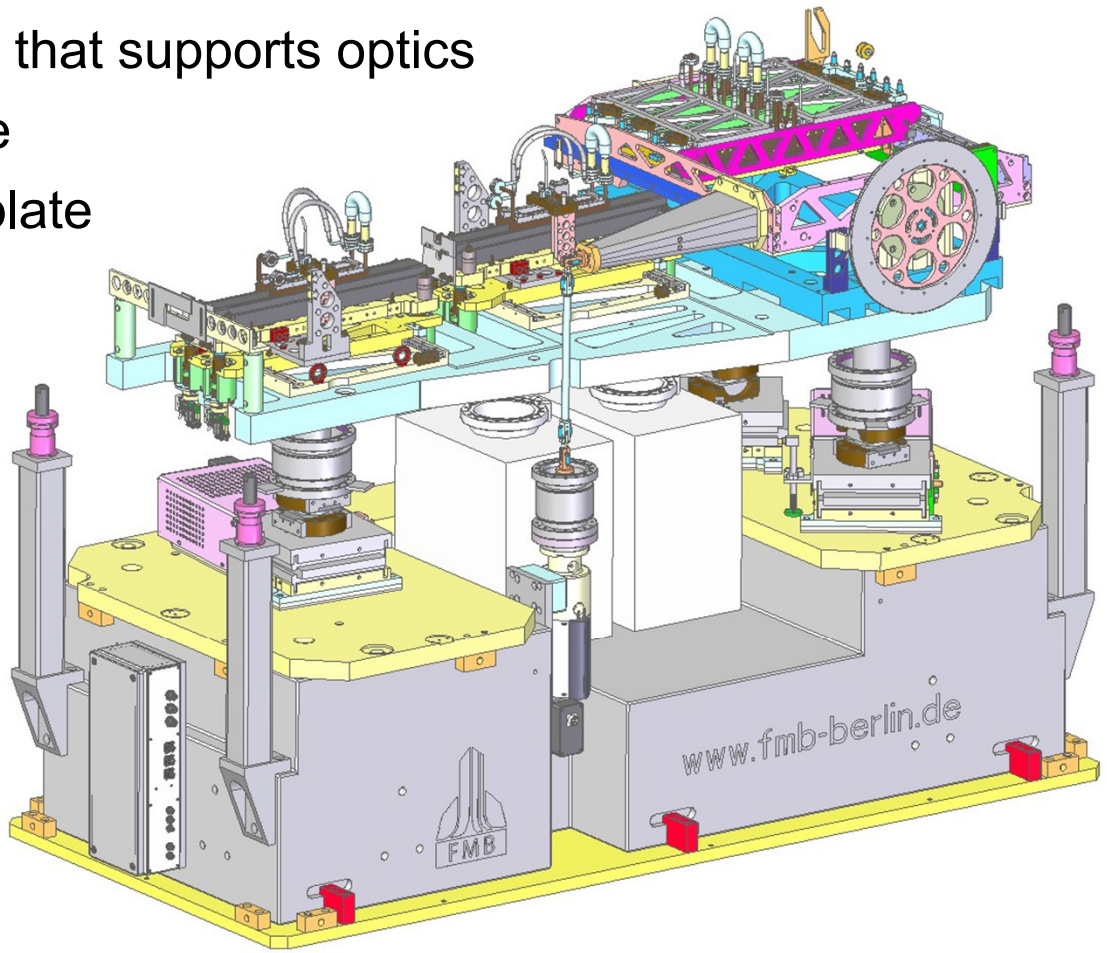


European XFEL

Technical design

- Contract awarded to FMB Berlin
- Design concept based on:
  - Single in-vacuum baseplate that supports optics
  - Decoupled internal structure
  - Granite base on a grouted plate





European XFEL

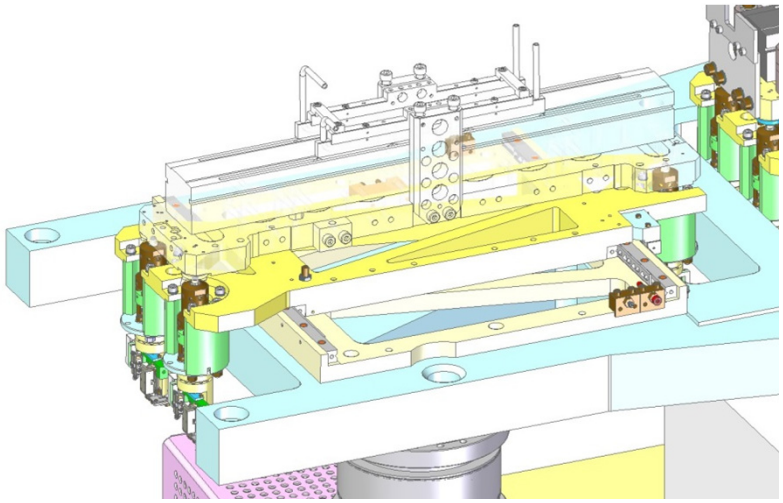
From CAD to reality

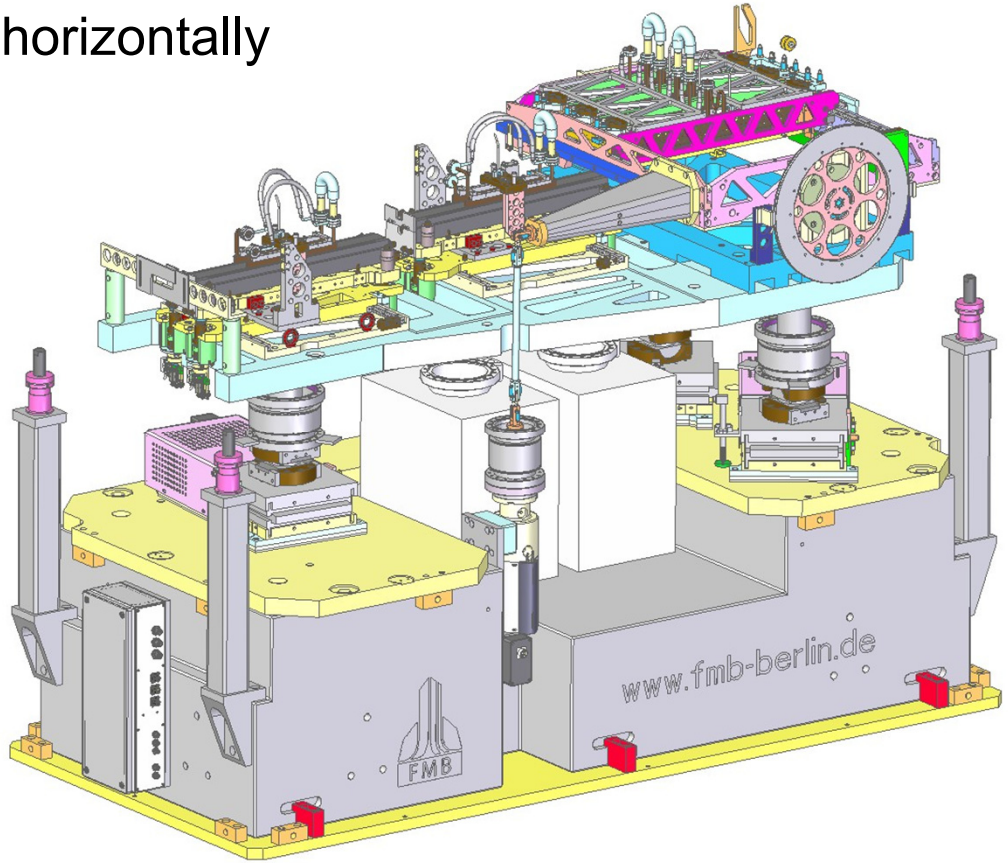
FMB Berlin

- ISO class 5 cleanroom

Monochromator degrees of freedom

- The monochromator has 13 remotely controlled axes
  - Baseplate can tilt, roll and move vertically
  - Pre-mirrors can tilt, roll and move vertically and transversally
  - Grating can pitch and translate horizontally
- Stepper motor in air
- Piezoactuator in vacuum

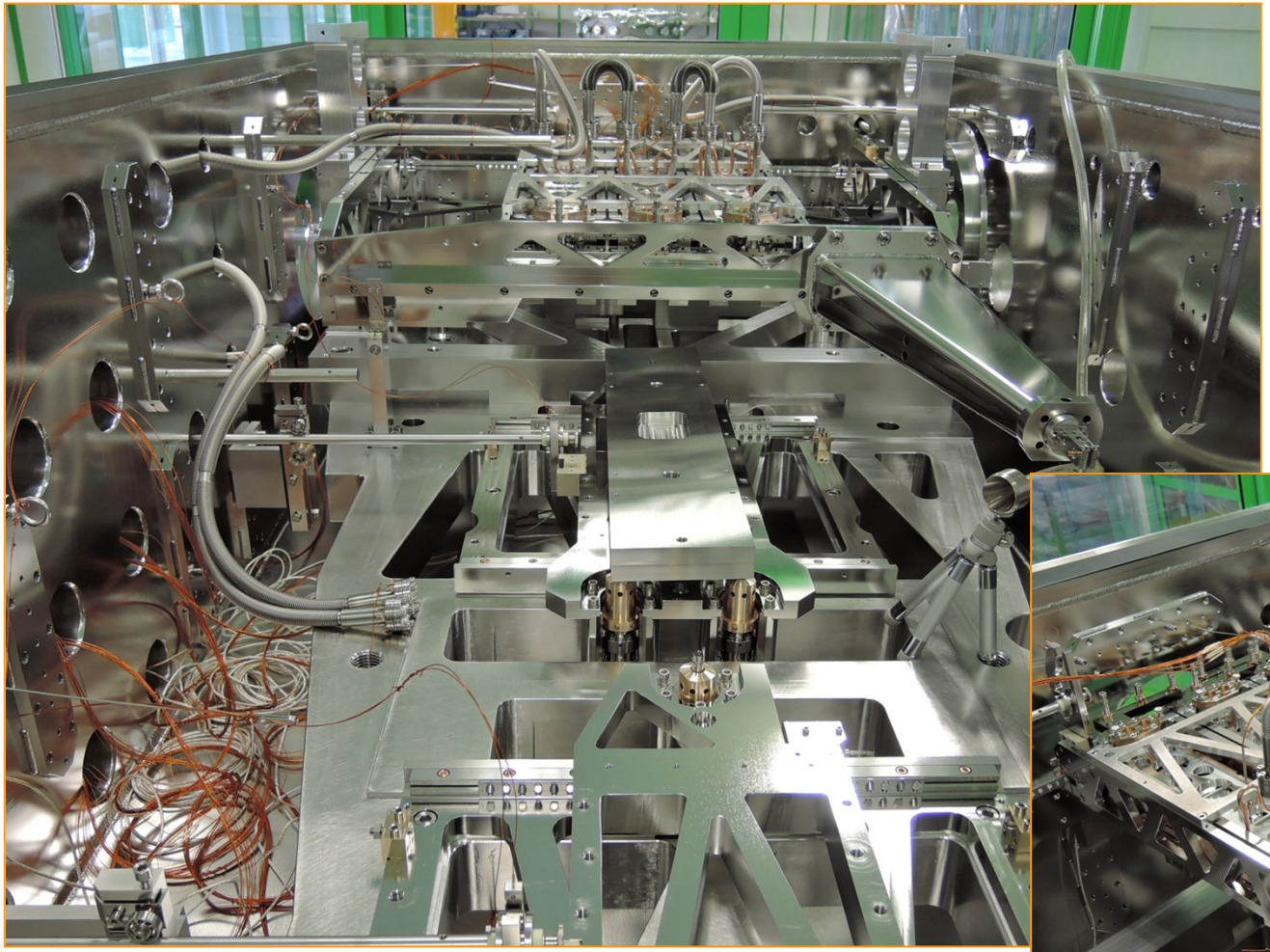


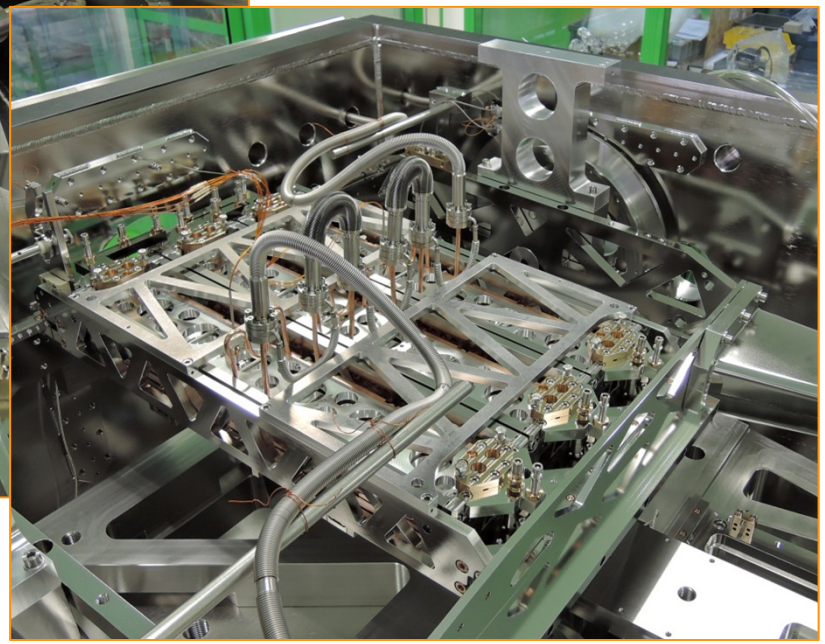


European XFEL

From CAD to reality

FMB Berlin



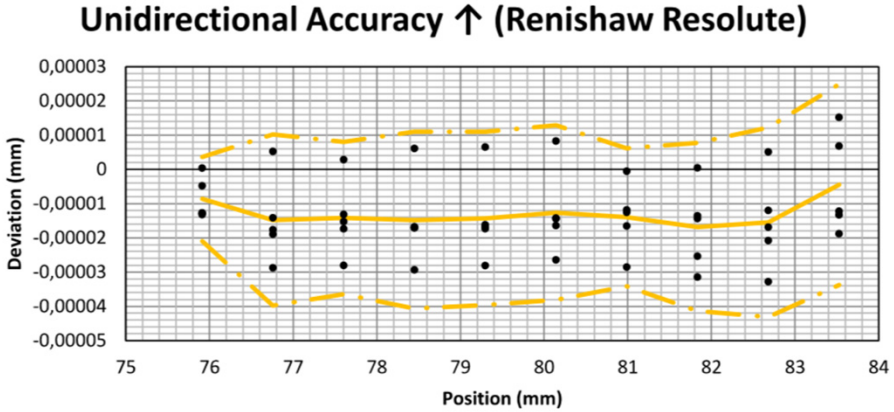


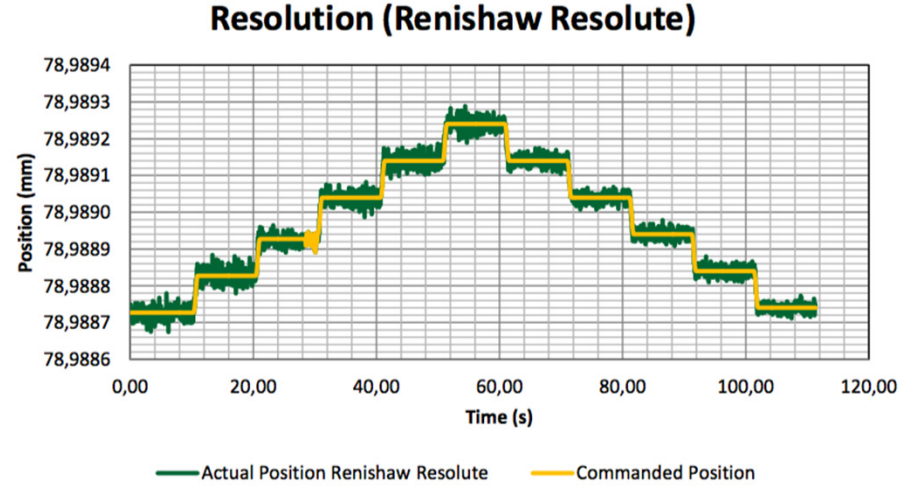
European XFEL

Pre-mirror actuators – PiezoMotors Uppsala AB

- nm-level resolution and repeatability
- UHV and particle free compatible

PiezoMotor®

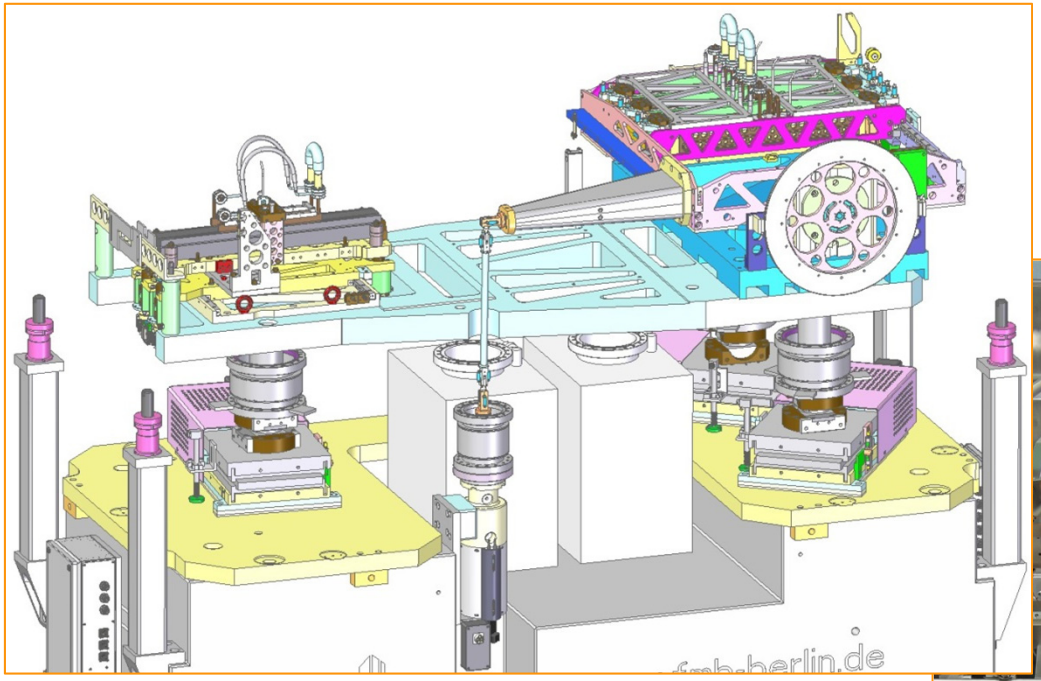


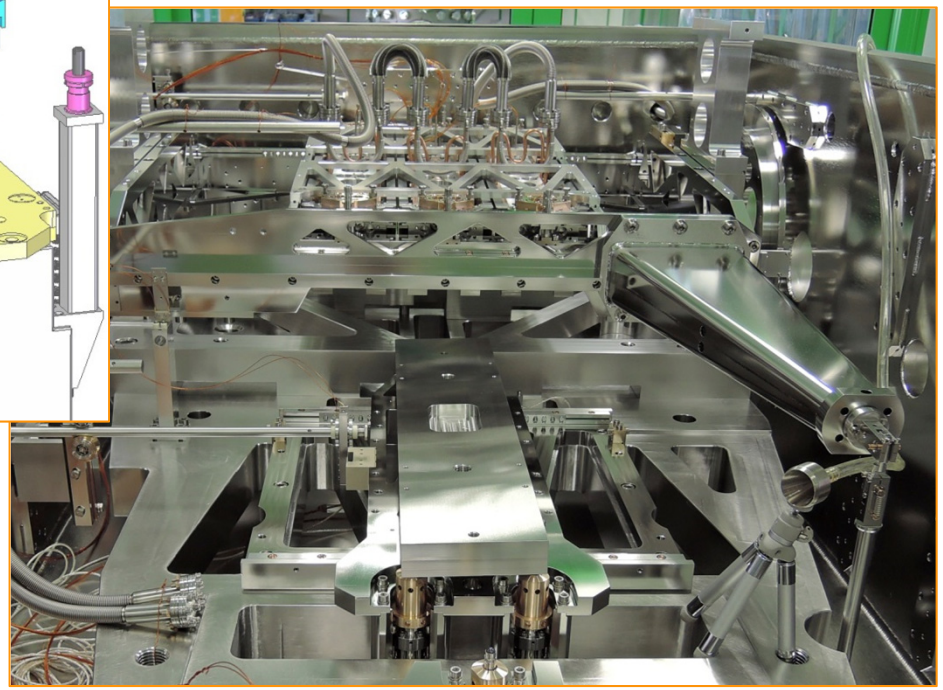


European XFEL

Grating pitch control

- Very challenging (better than 50nrad rms) specification for the angular resolution of the grating pitch

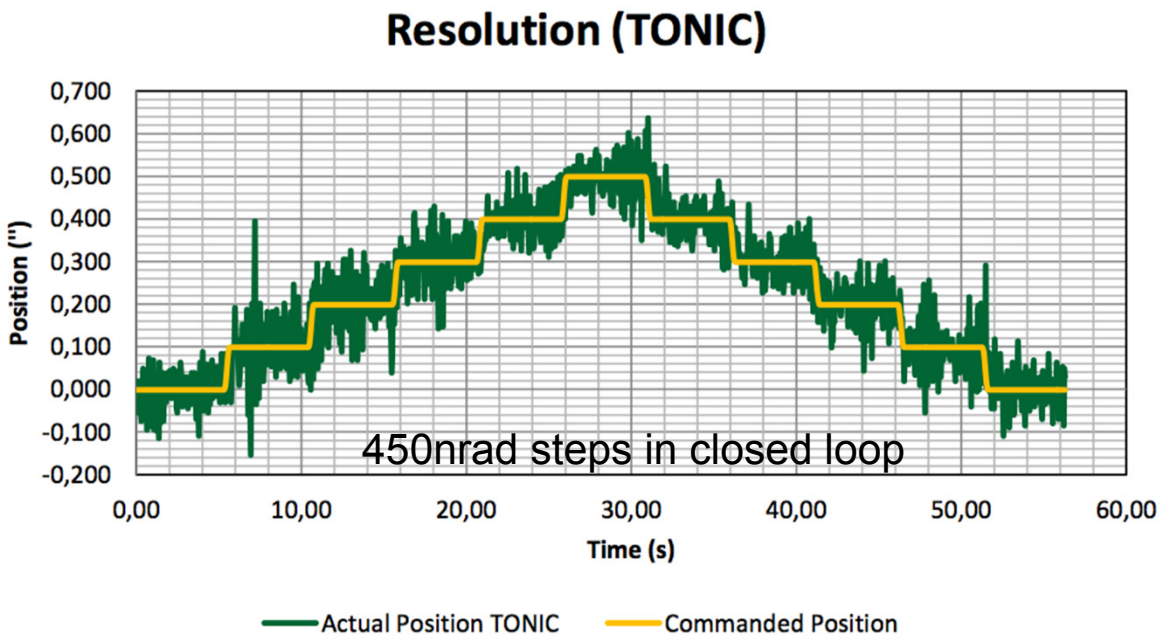




- More than 100kg cradle
- 1m long arm
- nm resolution of the actuator

Grating pitch control

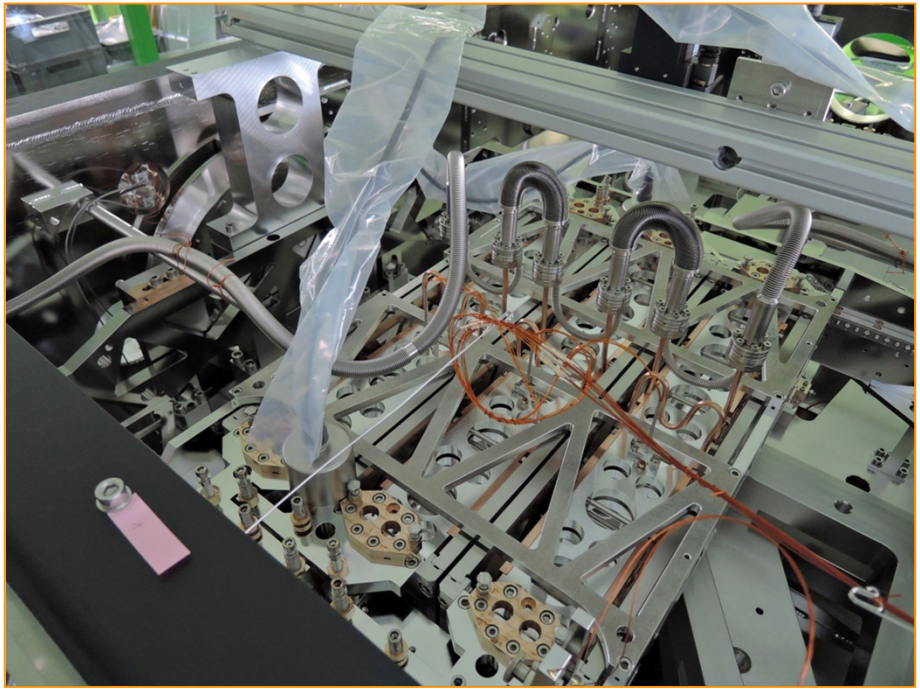
- Very challenging (better than 50nrad rms) specification for the angular resolution of the grating pitch
- … not so nice preliminary results: 150nrad rms



- Vibrational measurements campain

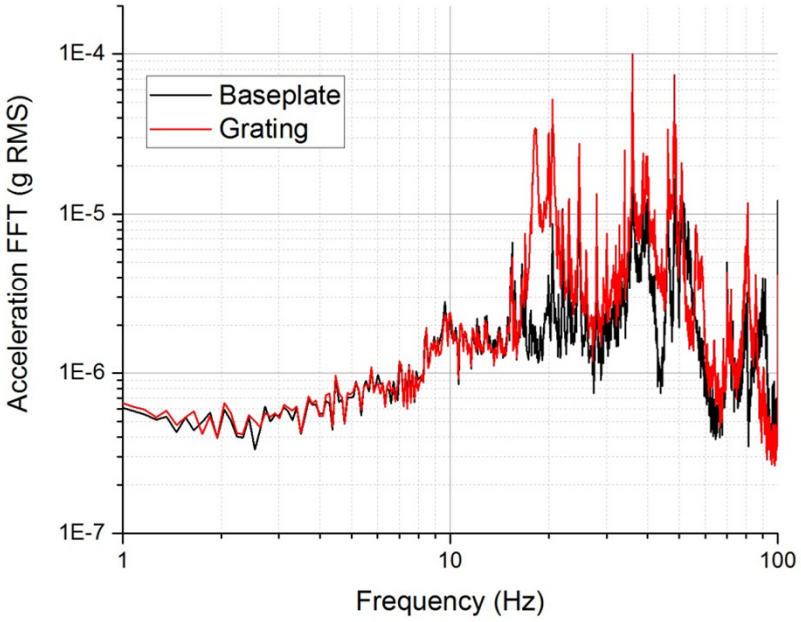
Grating pitch vibrational measurements

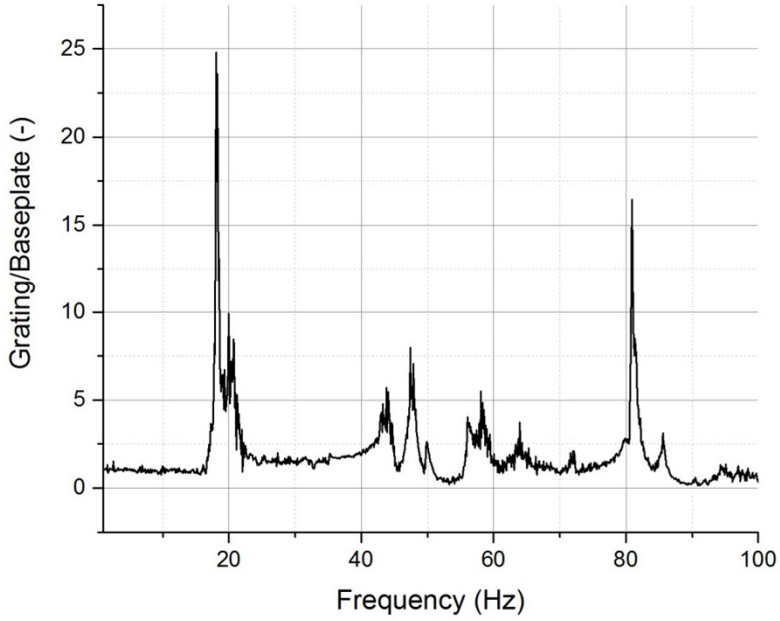
- Vibration analysis based on transfer function study
  - Baseplate vs. grating cradle
  - Front cradle vs. back cradle
  - Vertical signal recorded



Grating pitch vibrational measurements

- Baseplate vs. grating – Vertical direction

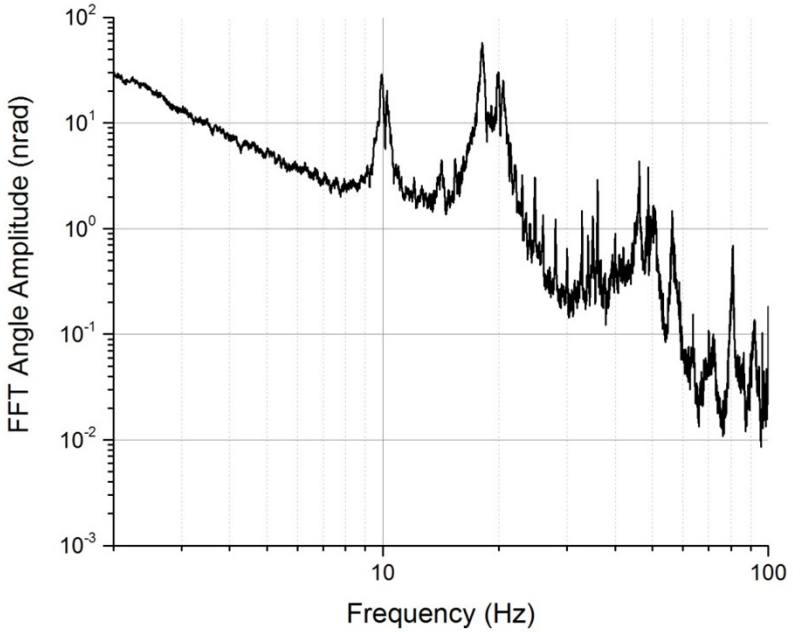


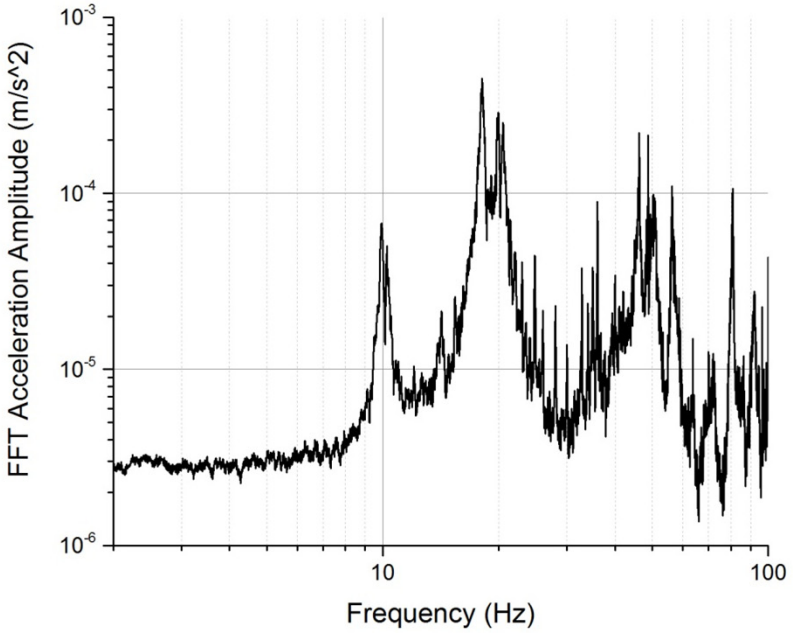


- Grating cradle has its own mode in the 20Hz area
- This mode does not come from the baseplate
- Baseplate is quite stiff in the vertical direction

Grating pitch vibrational measurements

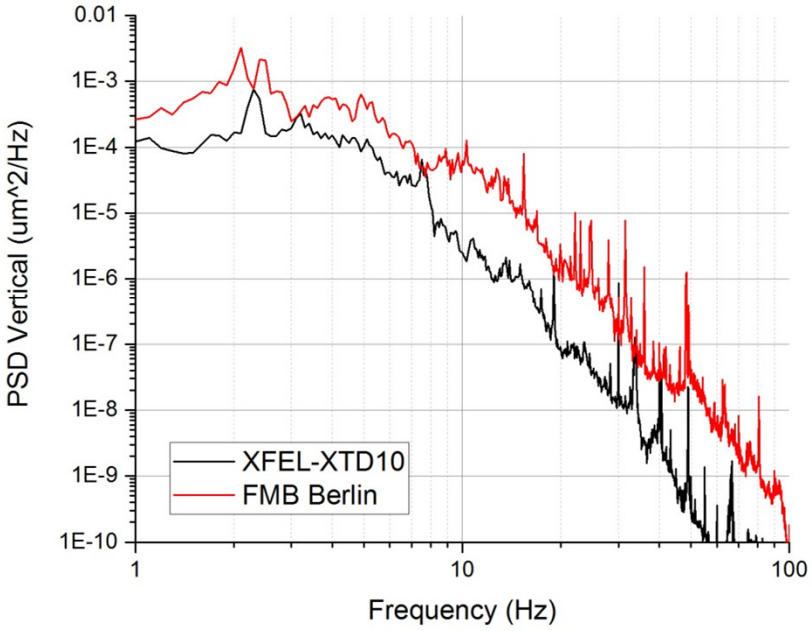
- Grating front vs. back – Vertical direction
- Difference and post-process of the time signal

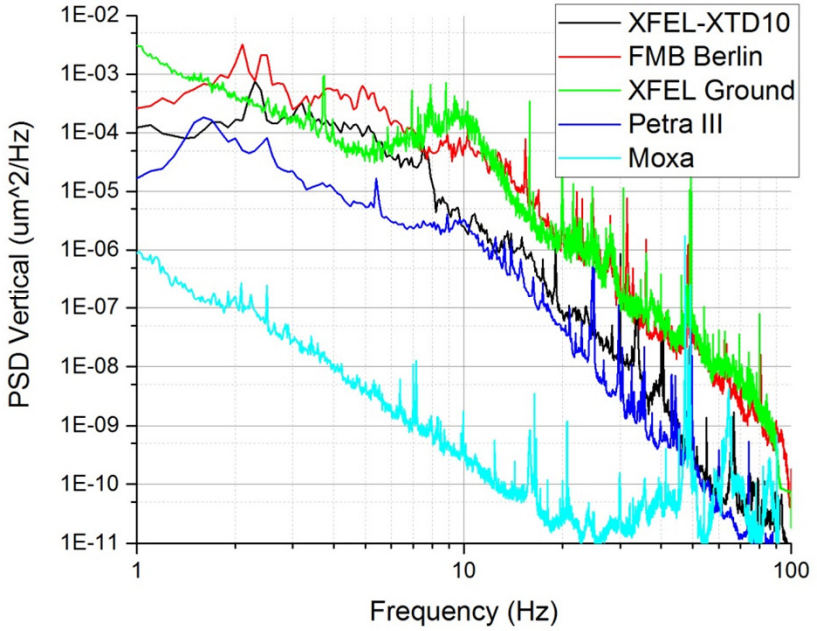




- 10Hz comes from “difference” between front and back: maybe it is not a real contribute to rotation
- 80% of the signal rms is in the 17-21Hz range

Floor noise comparison





- FMB floor is quite noisy we can expect factor 3 better
- XFEL Tunnel measurements done during construction phase
- Moxa is a site 50km southeast of Jena, Thüringen, Germany
  no street- or rail-traffic close to the station; no industry; next big city in 50km

Final remarks

- Very successful collaboration with FMB Berlin
- Monochromator ready for installation
- Grating pitch resolution has to be “improved” and verified in proper conditions and on the final floor

- Next steps
  - Installation, alignment, mirror installation
  - “In-situ” mechanical characterization
  - Commissioning with beam
  - Develop upgrade strategy based on the experiment needs

Actors involved in the project with FMB Berlin

FMB Berlin

Actors involved in the project with FMB Berlin

FMB Berlin

THANK YOU FOR YOUR ATTENTION