Interferometric and vibration measurements on the mirror chamber at European XFEL

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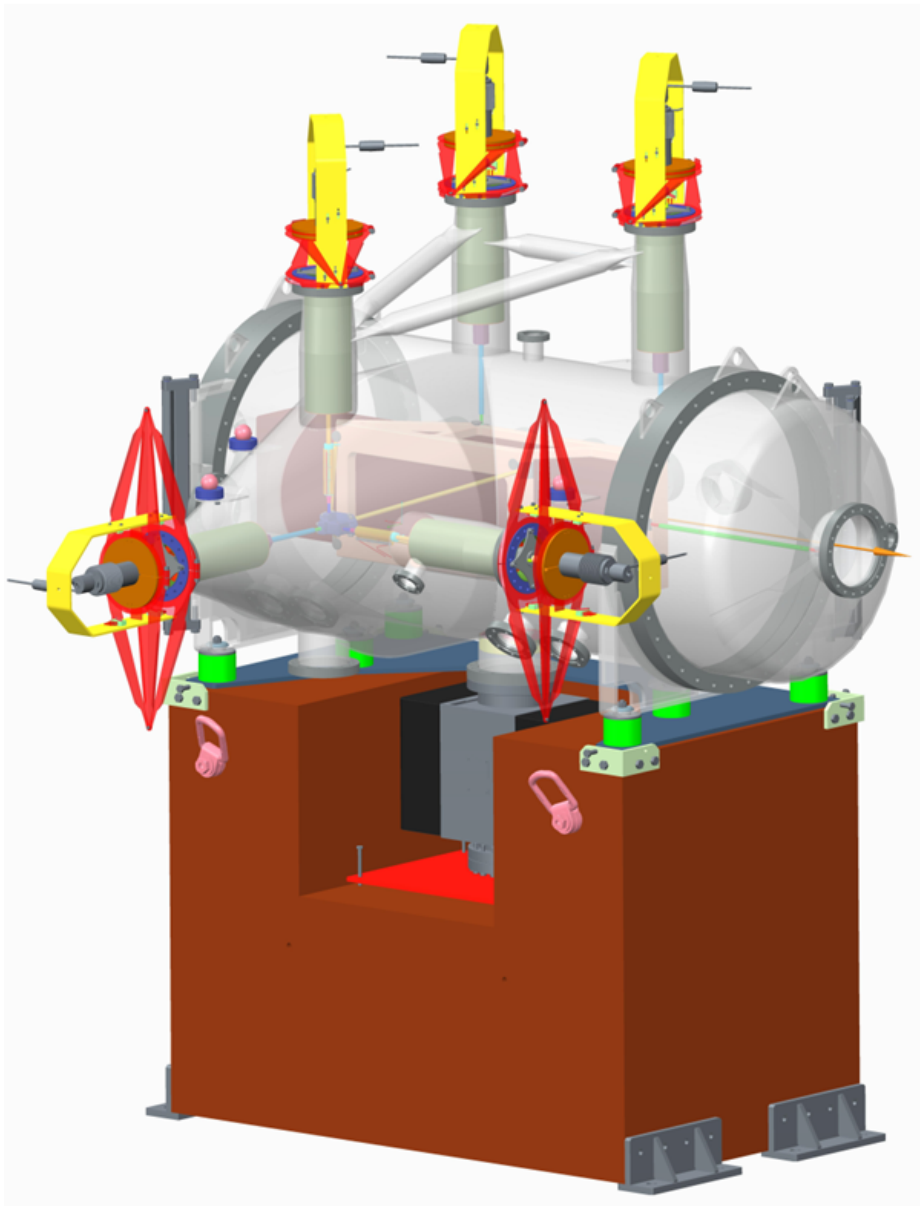
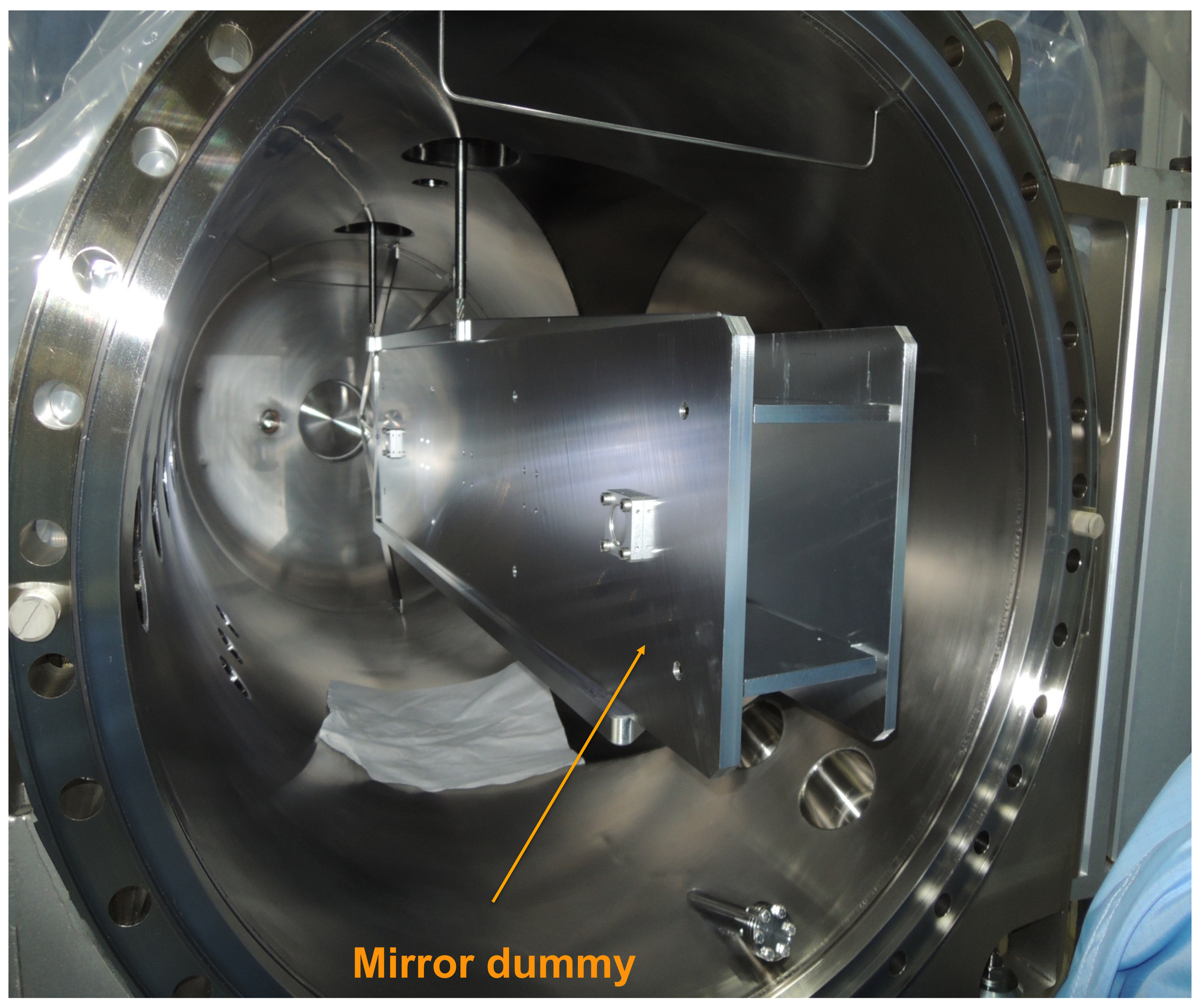
European XFEL

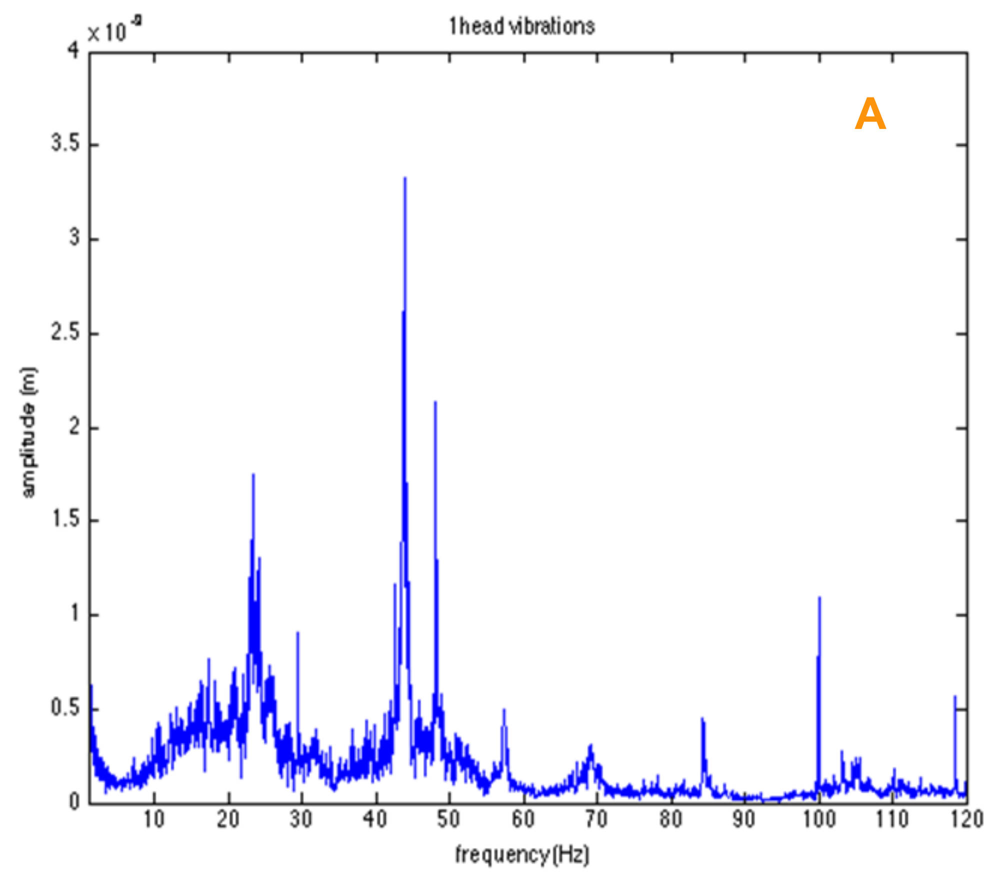
The European XFEL will deliver SASE pulses with the peak power of up to 20GW. The facility will generate extremely short and intense X-ray laser pulses of high coherence and nearly diffraction limited divergence. Guiding these X-rays beams over a distance of almost 1 km to the experiments requires an extreme precision in the angular stability of optical components like mirrors and gratings and the source dimensions will change accordingly. Readjustment of the incident angles at the offset mirrors will be needed in order to illuminate the mirrors at least with a diameter of the beam corresponding to 4σ.
For this reason, the positions and vibrations in the offset mirrors need to be investigated with high precision, in the order of 10nm in position and 20nrad in angles.

The first prototype of the mirror chamber, designed to hold one of the European XFEL mirrors



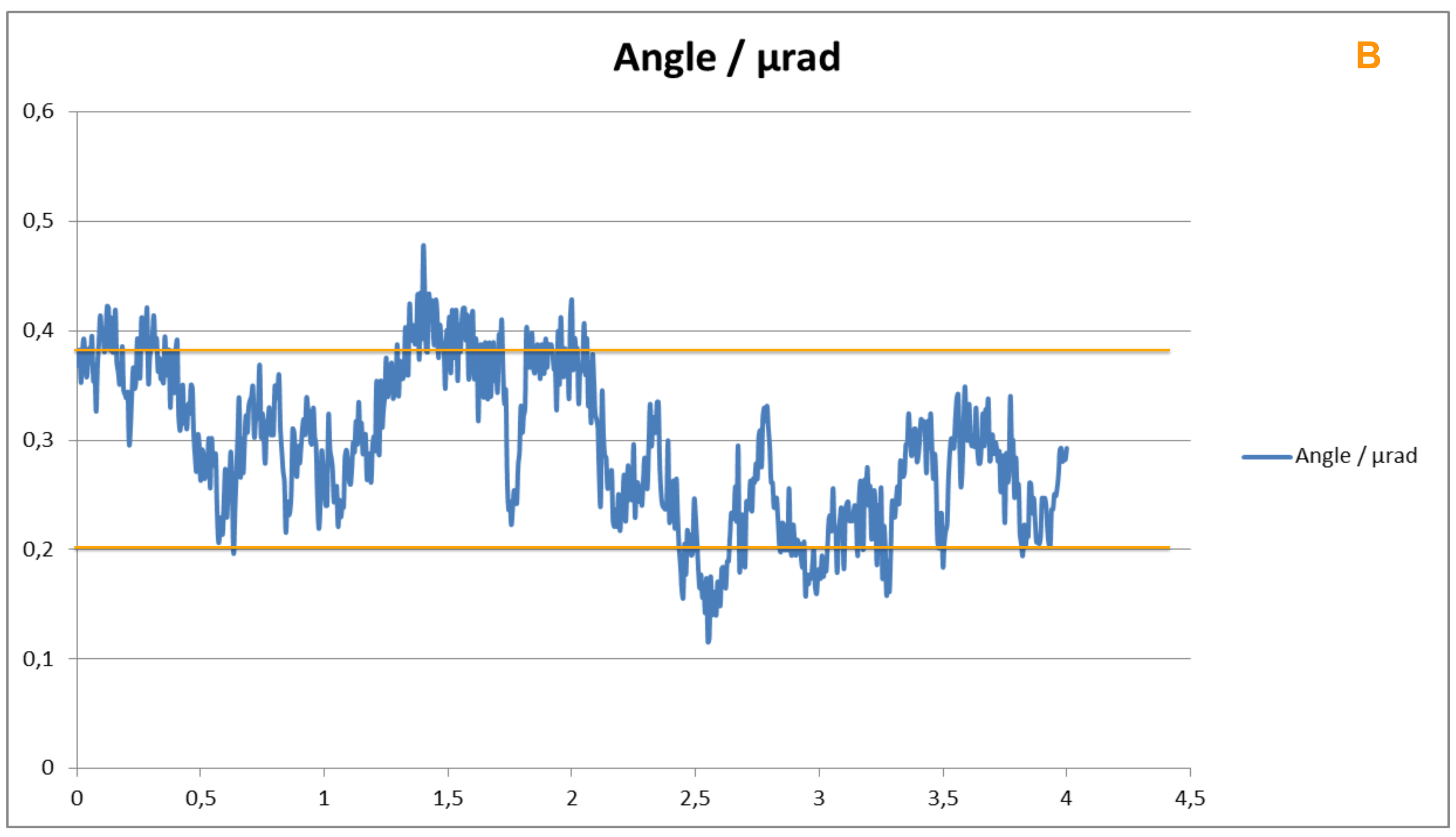
Interferometric measurements set-up

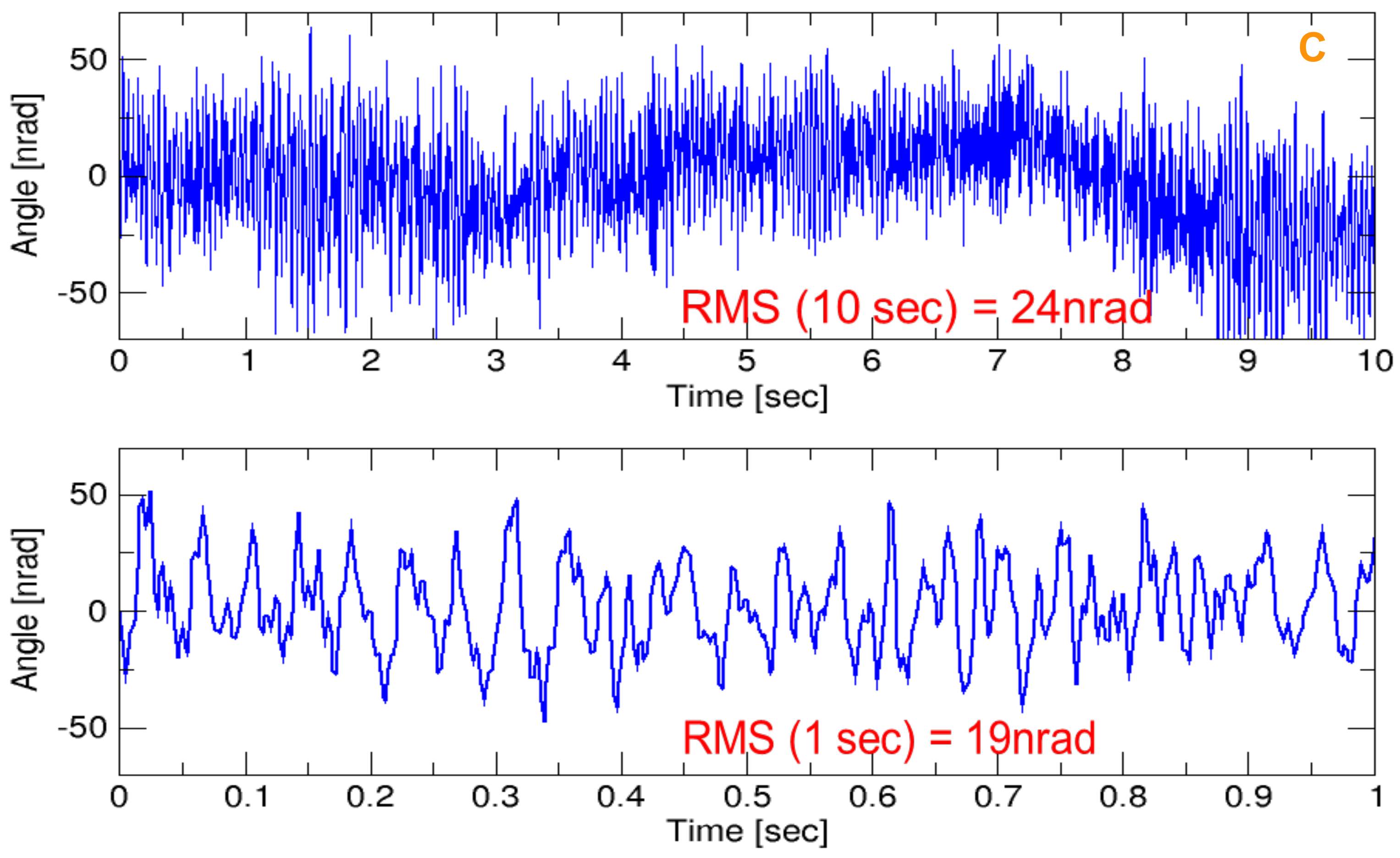




Design requirements for the mirror chamber

- Horizontal and vertical translation ±40mm
- Pitch and roll angle adjustable
- Accurate and repeatable positioning
- Long term drift comparable to *optimistic* ground diffusion
(110 µm/day in Experiment Hall = 75 nrad/day)
- Low vibration sensitivity. Achieve an stability of angles of less than 20nrad rms
- Very good UHV conditions, carbon-free, particle free. A vacuum of 10^{-9} or better is expected
- Accessible, low maintenance design. All motors outside vacuum





Interferometric measurements results

- Graph **A**: we see that we have frequency peaks at around 20Hz and 50Hz (the low frequencies affect more our system)
- Graph **B**: it is shown that the long term angular displacement of the mirror is of the order of 200nrad (100 nm drift) (without temperature stabilization)
- Graph **C**: it is shown that the short term angular displacement is of the order of 100nrad PV, 19nrad rms over 1sec.

Conclusions and further steps

- **In the short term range, we have observed displacements of about 100nrad (19nrad rms) in angle.**
- **Optimization of floor mount.**
- **Implement temperature isolation and stabilization system for the interferometer heads, + active control and air pressure correlation.**

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