Reference Measurement Methods for Planar and Helical Undulators

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IN-SITU REPLACEMENT OF THE POSITIONING ELECTRONICS

Idea: The idea behind this is that in the event of radiation damage to the electronics of the control system, such as absolute position encoders, it would be possible to replace it without removing the undulator from the tunnel.

Method:

- ► At constant gap and thickness of vacuum chamber the ∑ is constant
- ► Sub micrometer measurements reproducibility
- ► Measurements are independent from the temperature of the holder and quasi-independent from the temperature of the sensors
- ► Holder fixed using magnetic force
- ► Micro-Epsilon calibrated capacitive sensors, with 180 nm resolution

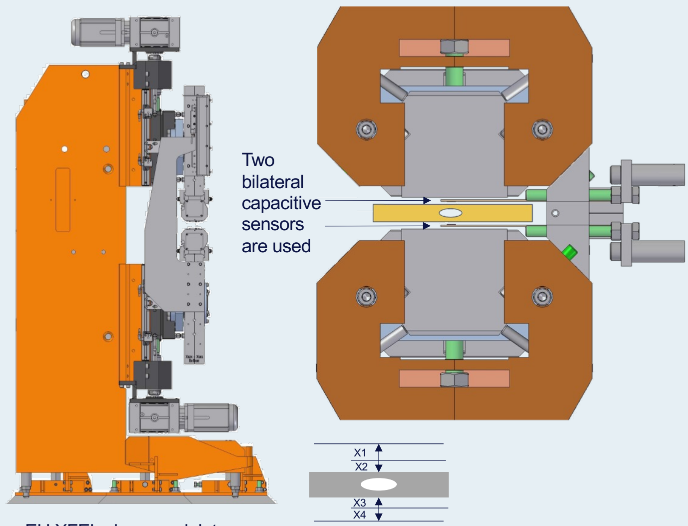
Conditions:

- ► Time-dependent temperature stability in the tunnel <1C°.
- ► Thus, the total thickness change for both sensors and the vacuum chamber <0.25µm.

Requirements:

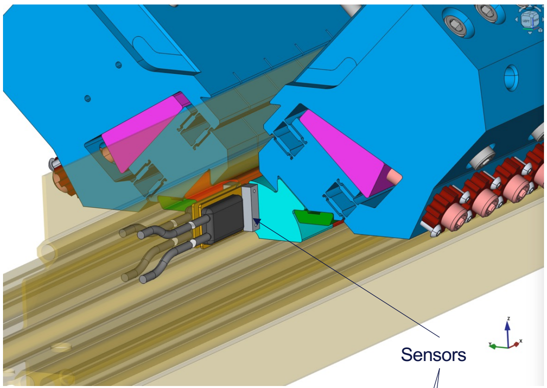
- ► For high-energy FELs the undulator K parameter - ΔK/K < 3x10e-4.
- ► Thus, the change in the undulator gap should not exceed 3 µm

Planar Insertion Devices

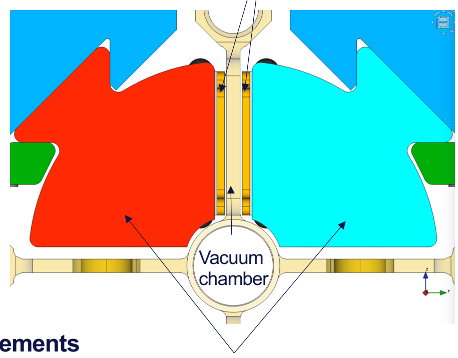


EU.XFEL planar undulator

Gap Measurements

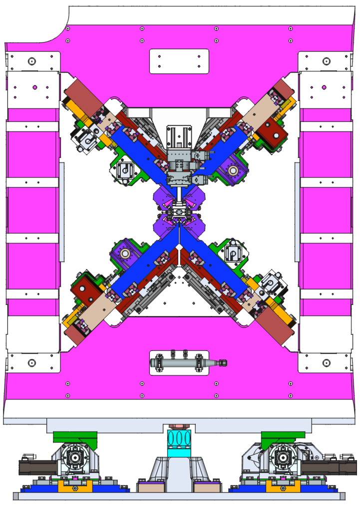


The two bilateral sensors are equipped with 0.5 mm thick steel tapes. These tapes are used for two purposes. First, the attractive force of magnets is to be used to position the sensor in the gap. The second is to create a gap of about 0.5 mm between the surface to be measured and the sensor.



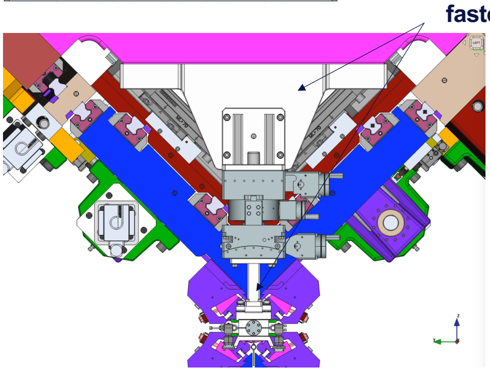
Gap Measurements

APPLE-X Helical Undulator



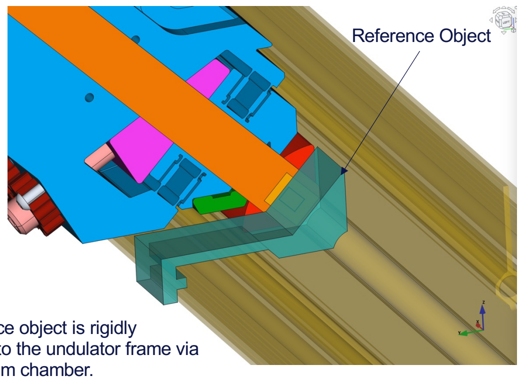
A specific design feature of the APPLE-X Helical Undulators is that the magnetic structures mounted on the girders can be moved in two directions. One direction is perpendicular to the magnetic axis of the undulator. Moving the magnetic structures in this direction changes the distance between the magnetic structures and thus the strength of the magnetic field, similar to planar undulators. Another direction is the longitudinal movement of the magnetic structures. This movement can be used to adjust the polarization of the radiation

Vacuum chamber fastening

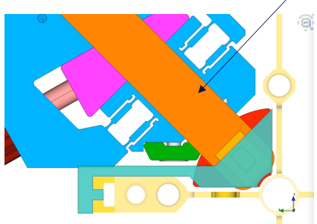


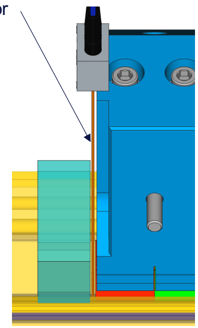
To perform reference measurements in the longitudinal direction, it is proposed to use an aluminum reference object rigidly mounted on a vacuum chamber. The end of the vacuum chamber to which the reference object is attached is rigidly connected to the undulator frame. Thus, the reference object is rigidly attached to the undulator frame and its surfaces serve as reference planes.

Shift Measurements



A reference object is rigidly attached to the undulator frame via the vacuum chamber.





A bilateral capacitive sensor is inserted into the gap between the reference object and the front plane of the magnetic structure

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