CRL optics for beam conditioning at the MID instrument of European XFEL

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Extremely high peak brilliance (10^{28}-10^{32} ph/s/mm^2/mrad^2/0.1%BW) of X-ray Free-Electron Laser (XFEL) beams poses very demanding requirements to X-ray optics, which must withstand extreme heat loads and maintain the positional stability of the beam. Among the variety of X-ray focusing optics the beryllium (Be) compound refractive lenses (CRLs) [1] offer superior stability and thermal conductivity properties making them the most suitable and robust choice for collimating and focusing of hard X-rays at the European XFEL facility [2].

The Materials Imaging and Dynamics (MID) instrument of the European XFEL will offer extended capabilities for coherent scattering and imaging experiments [3]. Full spatial coherence, exceptional flux, and ultra-short pulse duration of the XFEL beam will enable to investigate materials with unprecedented resolution in space and time. According to simulations [4], the natural divergence of SASE beam is only 1–5 μrad, depending on electron beam parameters and photon energy. Nevertheless, due to almost 1 km source-to-sample distance, the XFEL beam needs to be collimated or refocused to match the beamline optical aperture. To achieve this purpose, an optical scheme based on two CRL devices (CRL-1 and CRL-2) is implemented at the MID instrument. CRL device (designed by JJ X-Ray) is based on the transfocator concept [5, 6] and consists of 10 independent CRL stacks equipped with linear translations (40 mm vertical stroke and $\pm$2 mm horizontal stroke). Each stack can house up to 10 Be lenses with large radii of curvature ranging from 0.5 to 5.8 mm. Lenses are mounted in copper cassettes which are supplied with water cooling cycle capable of rejecting 20 W continuously on a single stack. Two temperature sensors are attached to each lens cassette to monitor the temperature of the cooling block and the B_4C mask. The CRL-1 and CRL-2 devices are positioned at 229 m and 931 m downstream the source, respectively. Beam conditioning optical schemes and achievable transmission and beam sizes using CRL optics at the MID instrument of European XFEL will be discussed.

References

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