Analysis of FLASH beamlines caustic supported by wavefront simulations

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FLASH, the soft X-ray Free Electron Laser in Hamburg provides soft X-ray pulses with high brilliance, short pulse duration and high repetition rate for user experiments. Photon beam parameters can be chosen almost independently for FLASH1 and FLASH2 by the users. The experimental stations at the beamlines BL1, BL2 and BL3 utilize the direct FEL pulses from FLASH1. For focusing the beam, BL1 is equipped with a Kirkpatrick-Baez optical system, while BL2 and BL3 use ellipsoidal mirrors. We analyzed the beam profile along the caustic (propagation along z-direction) of the beamlines BL2 and BL3 and observed that they were modulated with diffractions stripes. These stripes are consequence of the interaction of the FEL radiation with a residual corrugation of the mirror surface. Traditionally, wave-propagation for the design of coherent beamlines does not account for misalignment effects, rather assuming perfect circumstances [A. Fluerasu 2011, M. Vannoni 2019, L. Samoylova 2009]. Although some parameters are essential in the simulations, i.e. the profile of the mirrors, the design incident angle and the proper distances and curvatures, we could demonstrate that it is also required to estimate the alignment: roll, pitch and yaw values. By performing a complete simulation using WavePropaGator interface, [L. Samoylova 2016], a simulation interface based on the SRW code [O. Chubar and P. Ellaume], a good agreement between simulations and measurements along the caustic of the BL2 and BL3 beamlines was found.

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