Contribution ID: **74**

Type: **Contributed poster**

Characterization of Diamond Single-Pulse Spectrometers

Monday, 25 June 2018 18:45 (15 minutes)

Strain and stresses influence the diffraction properties of crystals significantly. We analyze the effect of strong bending on the energy resolution of a reflection using an ultra-thin, strongly bent single crystal diamond to be implemented as a spectrometer at the European XFEL. The device is designed to measure the energy distribution in the self-amplified spontaneous emission (SASE) beam with single pulse resolution [1]. The effect of strong bending is characterized by measuring rocking curves of the 440 Bragg reflection for different bending radii of the diamond device. The experiments were performed at Nuclear Resonance Beamline ID18, ESRF, using the high-resolution monochromator with an incident energy of 14.4 keV.

The meridional bending radius of a 20 µm thick diamond analyzer crystal was adjusted by a slider-driven bending mechanism to obtain the different bending radii between 6.5 and 9.5 cm.

The strain in the thin diamond spectrometer leads to significant broadening and an asymmetry in the reflection curves in comparison to the unstrained crystal. Calculations using the Tagaki-Taupin formalism for a constant strain gradient [2] are ongoing and the simulation results will be compared to the experimental data.

[1] U. Boesenberg et al., Opt. Express, vol. 25, no. 3, pp. 2852–2862, Feb. 2017.

[2] J. Gronkowski, Phys. Rep., vol. 206, no. 1, pp. 1–41, Aug. 1991.

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Session Classification: Poster session