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Characterisation of a Diamond Channel Cut Monochromator Designed for High Repetition Rate Operation at the EuXFEL

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The European X-ray Free-Electron Laser (EuXFEL) is a unique FEL facility that provides X-ray pulses of high spectral brilliance and high photon flux at MHz repetition rate. However, the high peak power, produced in trains of up 2700 femtosecond pulses at a rate of 10 Hz, induces a periodic temperature increase of the hard X-ray monochromators, thereby reducing their transmitted intensity. To address this limitation, a diamond channel cut monochromator (DCCM) was proposed as an alternative to the currently used silicon monochromators. The heat load effect of typical EuXFEL pulses at 300 K and 100 K was simulated by finite element analysis (FEA) and indicates that the significant reduction of the transmitted intensity occurs after a higher number of pulses when compared to silicon. The DCCM first prototype was manufactured from an HPHT IIa type diamond single block and characterised by rocking curve imaging (RCI). The RCI results demonstrated the high crystalline quality of the DCCM with rocking curve widths of the same order as the width predicted by the dynamical theory and a uniformly reflected intensity over the surface. The performance as a monochromator was demonstrated by measuring the double bounce reflection. The resulting images after two successive reflections showed a diffracted beam of the same size and parallel to the incident beam and confirmed its applicability.

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Primary authors: TASCA, Kelin (European XFEL GmbH); SAMOYLOVA, Liubov (European XFEL GmbH)

Co-authors: BARRETT, Raymond (European Synchrotron Radiation Facility); MADSEN, Anders (European XFEL GmbH); PETROV, Ilia (European XFEL GmbH); Dr RODRIGUEZ-FERNANDEZ, Angel (European XFEL GmbH); Dr SHAYDUK, Roman (European XFEL GmbH); TRAN THI, Thu Nhi (European Synchrotron Radiation Facility); ZOZULYA, Alexey (European XFEL GmbH); VANNONI, Maurizio (European XFEL GmbH)

Presenters: TASCA, Kelin (European XFEL GmbH); SAMOYLOVA, Liubov (European XFEL GmbH); BARRETT, Raymond (European Synchrotron Radiation Facility); MADSEN, Anders (European XFEL GmbH); PETROV, Ilia (European XFEL GmbH); Dr RODRIGUEZ-FERNANDEZ, Angel (European XFEL GmbH); Dr SHAYDUK, Roman (European XFEL GmbH); TRAN THI, Thu Nhi (European Synchrotron Radiation Facility); ZOZULYA, Alexey (European XFEL GmbH); VANNONI, Maurizio (European XFEL GmbH)

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