Pulse picker driven by a Surface Acoustic Wave

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In the last decade the development of time-controlled X-ray optics with nanosecond time resolution became even more important due to the construction of new short XUV pulse sources such as synchrotron radiation with variable pulse length (VSR) facilities and free electron X-ray lasers (FEL). X-ray time modulation by surface acoustic wave (SAW) in meridional geometry was tested for the first time at ESRF [1]. We are developing a pulse picker based on X-ray Bragg diffraction by SAW in conical geometry. SAW travels on the crystal surface, temporarily creating grating-like structures with amplitude up to one nanometer and near-sinusoidal deformation profile. In meridional diffraction the SAW grating grooves are parallel to the direction of the incoming beam, while in conical diffraction the SAW grating grooves are parallel to the direction of the incoming beam [2], and the propagation length needed for effective X-ray diffraction on SAWs is shorter due to the smaller footprint size perpendicular to optical axis. The experiment was performed by electronic pulsing of the SAW emission and synchronization with the arrival of the synchrotron X-ray pulses. This acousto-optical device, tested at the DIAMOND SR facility, pushes further the time limit of pulse-picking devices down to sub-microsecond time scale (~80 ns), Fig. a). Such a time resolution for the real synchrotron beam was reported and up to now the best time characteristics for X-ray acousto-optical devices devoted for the real implementation in SR and FEL beamlines. The first test aimed to implement Hadamard time-resolved approach taking advantage of a SAW pulse picker at P14 beamline at PetraIII will be presented, Fig b). The possibility to reduce the pulse picking window down to a few nanoseconds will be discussed.

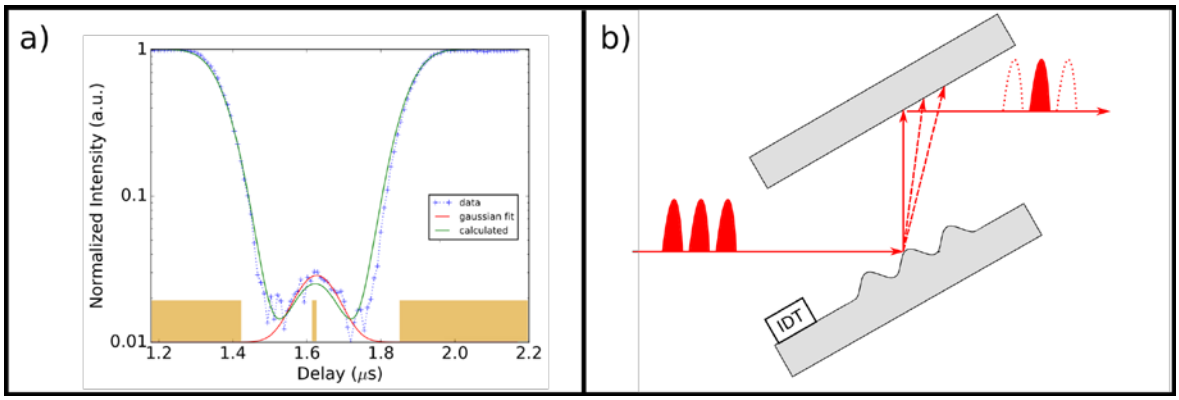

Fig. a) Measured data (blue), the Gaussian fit (red), and the calculated shape of the curve (green). The resolution of the measured curve is 10 ns. Fig. b) Proposed implementation of the pulse picker for Hadamard time resolved approach at P14 beamline at PETRAIII.

References

[1] R. Tucoulou et al., Nuclear Instruments and Methods in Physics Research B (132), 1997
[2] S. Vadilonga et al., Journal of Applied Crystallography (50), 2017