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A Piezo-Modulated Active Grating for Selection of X-ray Pulses Separated by One Nanosecond

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Synchrotron radiation is known for its stability, brilliance, and coherence, characterized by electron bunches circulating in the storage ring and generating pulsed radiation [1]. However, the MHz frequency range of these bunches often surpasses the temporal resolution required by numerous experiments. Addressing this discrepancy, we introduce a novel method for the temporal modulation of synchrotron radiation [2], suitable for time-resolved studies, developed and validated at the BESSY II synchrotron facility. This technique employs the selective modulation of X-ray pulses via Bragg reflection on a LiNbO3 piezoelectric crystal, equipped with comb-shaped electrodes of alternating polarity on its surface. The application of voltage to these electrodes induces a periodic deformation of the crystal through the converse piezoelectric effect, creating a dynamic diffraction grating for hard X-rays. This grating not only diverts the path of the X-rays but also modulates the beam intensity arriving at the experiment, offering a means to customize the temporal structure of X-ray pulses to specific experimental needs by electronically controlling the grating's amplitude.,

Our method allows a selective interaction with the synchrotron's bunch pattern, permitting the rapid selection of individual X-ray pulses. This is achieved through a pulsed electrical source driving the grating modulation being fast enough to select pulses with a temporal spacing of 1 ns. This enables unparalleled adaptability in tailoring X-ray pulse time patterns for diverse research applications at synchrotron sources. Our current setup showcases an efficiency of 34% in beam intensity management, along the impressive 1 ns time-resolution realized for experiments, a metric limited by the speed of the driving electronics and independent of X-ray beam size.

Compared to existing methodologies [3-5], our solution stands out by its simplicity, flexible tailoring of the time structure of the X-ray pulses according to the actual needs of the user's experiments at the beamline's end station and its speed.

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I plan to submit also conference proceedings

Yes

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