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Two-color delay study at SwissFEL

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Recent years particular attention has been paid to X-ray pump-X-ray probe experiments enabling, for example, excitation of selective sites in a molecule or subshell in an atom with the pump pulse and monitoring its evolution with the probe. To mitigate the jitter of X-ray pulses produced independently (i.e. in two separate instruments), different X-ray free-electron lasers (XFELs) are developing the so called *two color* scheme, where from a single electron bunch two X-ray pulses are produced. The two color mode of SwissFEL is attained with a spoiler picosecond UV pulse overlapped to the photocathode drive laser increasing the electron bunch emittance at the selected time region [1]. This leads to an inhibited FEL process in this time region and effectively to production of two X-ray subpulses rather than a single X-ray pulse.
In this study the SwissFEL was operated in the 2 color mode, delivering X-ray pulses of the average intensity of 570 μJ composed of 6937 eV and 6978 eV components (energy separation of 41 eV). The time delay between the two energy components in each X-ray pulse was measured with the THz streaking setup and was confronted with the time structure of electron bunch probed with the passive streaker installed at the end of the undulator section. The delay obtained with the THz streaking was about 1.5 −3.0 larger than the 60 fs implied from the passive streaker measurement.
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[1] C. Vicario *et al.*, *Phys. Rev. Accel. Beams* **24**, 060703 (2021).

Primary author: BŁACHUCKI, Wojciech (Institute of Nuclear Physics, Polish Academy of Sciences)

Co-authors: DIJKSTAL, Philipp (Paul Scherrer Institut); PRAT, Eduard (Paul Scherrer Institut); VICARIO, Carlo (Paul Scherrer Institut); ARRELL, Christopher

Presenter: BŁACHUCKI, Wojciech (Institute of Nuclear Physics, Polish Academy of Sciences)

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