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Absolute Characterization of sub-fs Electron Bunch-Length in SwissFEL using a Bunch-Compressor Monitor

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The shot-to-shot and non-invasive monitoring of the electron bunch length in a linac driven Free Electron Laser (FEL) relies on Bunch Compressor Monitors (BCMs). A BCM is designed to detect –and fully integrate in a given wavelength band - the radiation energy spectrum emitted at the threshold of the temporal coherence by the electron beam while crossing the last dipole of a magnetic chicane or a diffraction radiation screen placed just downstream of it. The BCM signal response is hence a direct - albeit non-absolute - function of the electron bunch length and of the beam charge as well. Due to its full non-invasiveness, a BCM is the ideal diagnostics to be integrated into the machine feedback to stabilize the bunch compression. Recently, we presented (*) a formal method for the absolute determination of the electron bunch length from the analysis of the signal readout of a BCM which is equipped with two independent detectors integrating the radiation energy pulse in two different wavelength bands. Theoretical highlights of the method as well as experimental results on the characterization in SwissFEL of electron beams with sub-fs bunch length will be presented in this contribution.

Footnotes

(*) Orlandi, G.L. Absolute and non-invasive determination of the electron bunch length in a free electron laser using a bunch compressor monitor. *Sci Rep* 14, 6319 (2024). <https://doi.org/10.1038/s41598-024-56586-1>

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Primary author: ORLANDI, Gian Luca (Paul Scherrer Institut)

Co-authors: PRAT, Eduard (Paul Scherrer Institut); Dr ADDESA, Francesca (Paul Scherrer Institut); BRANDS, Helge (Paul Scherrer Institut); Dr DIJKSTAL, Philipp (Paul Scherrer Institut); ISCHEBECK, Rasmus (Paul Scherrer Institut); SCHIETINGER, Thomas (Paul Scherrer Institut)

Presenter: ORLANDI, Gian Luca (Paul Scherrer Institut)

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