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SASE-FEL Stochastic Spectroscopy Investigation on XUV Absorption and Emission Dynamics in Silicon

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High-resolution emission/absorption spectroscopy with picosecond time resolution appears to be strategic in fundamental matter physics investigation as well as in functional materials characterization. Such a method typically requires a pulsed radiation source and high energy resolution, along with a large data statistic. In this work we demonstrate the possibility to retrieve high resolution absorption and emission spectra with picosecond time resolution, by exploiting the stochastic nature of the wide-band self-amplified FEL radiation provided by FERMI. In this work we get advantage of the two spectrometers present on the TIMEX beamline to reconstruct a 2D emission/absorption spectrum of a Si sample. To do so, we applied the singular value decomposition on the single-pulse incoming and outgoing spectra; by applying Tikhonov regularization, we were able to obtain spectra with an energy resolution of few tens of meV. In addition, we performed a time resolved characterization of the Si L23-edge and Si emission line at 99.3 eV by pumping the Si sample with visible laser below damage threshold. The result of this measurement allow us to claim for a bond softening phenomenon on the picosecond time-scale.

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