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TIME-RESOLVED PHOTOELECTRON SPECTROSCOPY USING HIGH-REPETITION RATE FREE-ELECTRON LASERS

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Free electron lasers (FEL) are unique X-ray sources regarding pulse duration, coherence properties and peak brilliance. Their potential to study ultrafast dynamics has been demonstrated in time-resolved x-ray spectroscopy experiments.
Time-resolved photoelectron spectroscopy (TR-PES) is a very valuable tool to study non-equilibrium electron dynamics of condensed matter systems. However, due to the ultra-short, very intense FEL pulses the number of photoelectrons per pulse is limited by space charge considerations. The signal-to-noise ratio in these experiments is governed by the detection efficiency and the repetition rate of the photon source. The superconducting FEL's FLASH at DESY and European XFEL operate at very high repetition rates, which is perfectly suited for TR-PES. Statistical fluctuations of the FEL's require single shot detection for ultimate time- and energy resolution. To make use of the high angular acceptance of time-of-flight electron spectrometers this translates in the necessity to have fast multi-hit capable time- and spatially resolving detectors.
Examples for time-resolved XPS from experiments at FLASH illustrating the opportunities to follow ultrafast charge rearrangement in solids and at surfaces will be discussed. New developments in terms of spectrometers and detectors for TR-PES with high-repetition rate FEL's will also be presented.

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