VUV-based trARPES at MHz repetition rates: momentum-resolved visualization of excited states

Time-resolved photoemission, combined with angle-resolved acquisition, can extend band-structure mapping to excited states which are only occupied out-of-equilibrium and evolve on a femtosecond timescale [1]. The full potential of time- and angle-resolved photoemission spectroscopy (trARPES) is reached by performing the experiment with time-bandwidth-limited pulses at high repetition rates - towards the MHz level - limiting space charge effects and data acquisition time [2]. Vacuum-ultraviolet (VUV) photon energies grant access to the whole Brillouin zone of solids, however, femtosecond sources at this wavelength rely on inefficient nonlinear processes (high-harmonic generation, HHG) or on FEL facilities (FLASH, FERMI) operating at low repetition rates, non-ideal for photoelectron spectroscopies. The proposed upgrade of the ELBE FEL to the VUV spectral range will be discussed in the context of trARPES, highlighting the requirements and unique opportunities for a user-access ARPES end-station.

[1] C. Nicholson et al., Science,362,6416,821-825,2018
[2] M. Puppin et al., Review of Scientific Instruments,90,2,023104,2019