Pushing the Temporal Resolution at an XUV-FEL: Tagging, Streaking, Seeding

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The new generation of x-ray sources based on large-scale linear accelerators provides users with intense ultrashort pulses at small wavelengths. In spite of unprecedented intensities, the applicability of these pulses for studies of ultrafast dynamics is hampered by temporal properties inferior to those of HHG sources. Although the bandwidth supports few-fs or even sub-fs pulses, the noise-based origin of the amplified pulses leads to a complex amplitude and phase evolution, strongly fluctuating from shot to shot. We adapt methods similarly to those applied in attosecond metrology in order to meet this challenge. An XUV/visible cross-correlator allows to determine the arrival time of individual XUV pulses with respect to visible pulses from an external laser system. Tagging of simultaneously acquired spectra then allows to compensate the XUV-laser jitter, thereby considerably improving the temporal resolution of dynamical studies. A strong THz field is used to realize an ac-field streak camera, sampling time information of individual pulses from the XUV-FEL FLASH. As a next step, XUV pulses from HHG will be used for seeding the SASE undulator at FLASH.