Single Shot Fluence Mapping of Free Electron Laser PulsesandRecent Advances in X-ray Holography

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A. Due to the coherence, high brightness and intensity of laser light sources, the observation and exploitation of non-linear effects in light-matter interaction has been striving research field in the last decades. Now however, free electron lasers (FELs) at soft and hard x-ray wavelengths are operational which can deliver x-ray fluences on a sample that allow to study non-linear effects in this short wavelength regime as well. Often times though, studies in this field are hampered by the fact that the actual fluence *distribution* on a sample in a focal spot is not well quantified. For solid, planar samples studied in transmission, we report on a fluence mapping concept, which allows to monitor the actual x-ray fluence on the sample either in an integral fashion [1] or in a spatially resolved way, i.e. a single shot fluence map can be recorded together with e.g. a diffraction signal from the same illuminated area.[2] The approach is based on fabricating diffraction gratings either directly on the transmissive sample itself or on a separate membrane, which can be independly positioned in the beam. The imaging properties of the diffractive structure can be chosen such that a magnified image of the fluence distribution is obtained. The fluence imaging allows for real time feedback and is easy to use not only in measurements of samples but also for quick alignment purposes.

B. Fourier transform x-ray holography (FTH) is a high-resolution imaging approach which allows to the encode the amplitude and phase of an specimen's exit wavefield without the need for iterative phase retrieval. As a brightness experiment, FTH directly benefits from developments towards brighter x-ray sources such as diffraction limited storage rings and FELs. We routinely use FTH in conjunction with x-ray circular magnetic dichroism to image nanoscale magnetic domains.[3] I will report on recent advances in the field, in particular on (i) pump-probe experiments at storage rings and FELs [4,5], enabling us to combine spatial resolution with temporal resolution in the picosecond and femtosecond regime, and (ii) multi-color imaging, where an image can be encoded at two photon energies simultaneously, e.g. in resonance with different elemental constituents in a specimen.[6]

References

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