Single-shot femtosecond x-ray streaking method with soft x-ray FEL pulses

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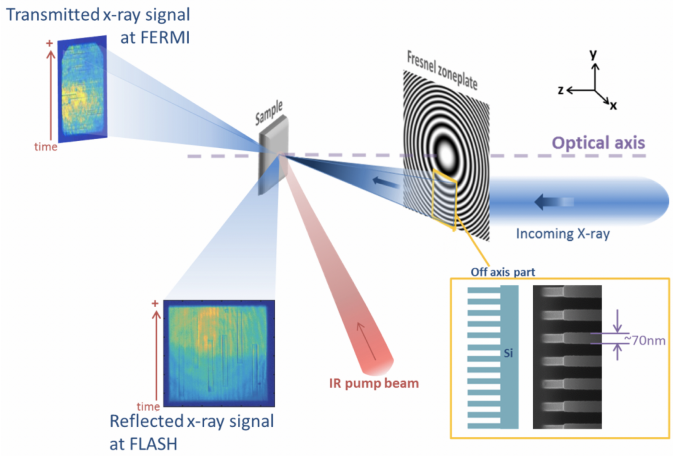
We have developed and demonstrated a soft x-ray streaking method. This setup based on a transmission grating allows for recording the full dynamics of transient phenomena, with femtoseconds time resolution, using a single x-ray FEL pulse. The method circumvents the intrinsic problems with the conventional repetitive pump-probe method, which requires multiple pump-probe cycles at different delays in order to reconstruct the full pump-induced dynamics. Instead, the demonstrated concept is characterised by alignment simplicity and achieves a high time resolution, not affected by timing jitter between probe and pump beams. The length of the time window of the continuous probing is defined by the grating and the x-ray wavelength. We have demonstrated our method in two geometries at two FEL facilities – FLASH, Hamburg [1], and FERMI, Trieste (Figure) – by looking at the ultrafast demagnetization of ferromagnetic thin films induced by an infrared pump pulse. In these cases, the accessible probing time window was 1.57 ps at an x-ray energy of 60 eV. Further possible choices and combination of the x-ray energy range, achievable probing time window, and grating materials will be discussed.



Schematic diagram of the setup concept. At FLASH the reflected probe x-ray was recorded. At FERMI, the transmitted signal was collected downstream of the sample. In both cases, the time information is encoded in spatial coordinates in the recorded images.

References

[1] M. Buzzi, M. Makita, L. Howald, A. Kleibert, B. Vodungbo, P. Maldonado, J. Raabe, N. Jaouen, H. Redlin, K. Tiedtke, P. M. Oppeneer, C. David, F. Nolting, and J. Lüning, Sci. Rep. **7**, (2017)