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Development on coherent diffraction based imaging techniques at FERMI seeded-FEL

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Free Electron Lasers (FELs) offer unprecedented opportunity for exploiting ultrafast dynamics with chemical sensitivity. Using appropriate seeding methods combined with pulse tunability, multiple polarization and multi- single or two color pulse schemes have enabled studies of dynamical responses in complex systems, by assessing how specific excitations develop and/or propagate among different sites.
Another great advantage of seeded-FELs, as FERMI@Elettra, is that they have also opened the route to X-ray coherent non-linear experiments for exploiting, among other, electronic correlations and charge transfer between different atomic constituents in the sample.
This presentation will overview different class of experiments performed at the DiProI end-station [1] taking advantage of the unique characteristics of the FERMI seeded-FEL [2]. Particular emphasis will be placed on novel imaging schemes based on wave-front coherence used to study e.g. magnetic dynamics after optical excitation at different absorptions edges, taking advantage of two-colors emission of FERMI FELs both in real space by means of time resolved holography [3] or using Fresnel zone plate to stretch the incoming X-ray pulse keeping an angular encoding of the arrival time [4]. Finally, the possibility to extend the current coherent diffraction imaging (CDI) techniques to 3 or 4 dimension using stereographic vision will be discussed in the last part of the presentation.

Fig. 1 Sequence of two colors time resolved holographic images taken simultaneously at the Co and Fe edges on a (Co/Pt)ML / TbFe bi-layer structure. The sequence shows that, 0.2 ps after the optical excitation Co-based top-layer is demagnetized, while Fe in the below TbFe magnetic structure takes more time to be excited (0.5 ps) on longer time scale (t>1ps) the maze domain structure on the sample surface is recovered.

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