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# Probing magnetic phase transitions

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Manipulation of magnetic materials induced by single laser pulses include changing the magnetic order and domain dynamics on a sub-ps time scale. In the presence of a first order phase transition, stimulated phase competition is a promising route to study the coupled dynamics of magnetic, orbital and structural order. Time-, element- and spatially resolved X-ray magnetic scattering (TR-XRMS) allows to disentangle in the time domain the relevant interactions such as Coloumb, exchange, spin-orbit and electron-phonon interactions. In the new transient phase, the coexistence of AFM and FM order as well as the correlation length (size) of the FM domains are of interest [1]. Microscopically, the channels for energy, momentum and angular momentum transfer between orbital, spin and lattice degress of freedom have to be understood. A fertile area are crystalline multiferroic solids (such as perovskite transition

metal oxides and Heusler alloys) where the magnetization, polarization and stress are generally sensitive to an abrupt change of lattice parameters (and vice versa) and where the reversibility of phase transformations may have profound technological implications. For experiments at SwissFEL we need tunable X-ray energies to reach relevant K- and L-edges of transition metals and rare earth elements [2], flexible polarization of both the pump and probe beams [3], and a phase front preserving sample environment to exploit the full transverse coherence of the X-ray beam [4]. The endstation must allow for a flexible sample environment (in terms of temperature, electric & magnetic fields and pressure) and most likely will have to incorporate X-ray timing diagnostics to perform pump-probe experiments with time resolution 10 fs in a repeatable and reliable fashion.

[1] S.O.Mariager et al. To be pulished.
[2] B.J.Kim et al. Science 323 (2009) 1329.
[3] U.Staub et al. Phys. Rev. B 82 (2010) 104411.
[4] O.G.Shpyrko et al. Nature 447 (2007) 68.

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