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Non equilibrium studies on FEL facilities

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The recent development of Free Electron Lasers (FEL), giving ultrafast, high intensity pulses in the X-ray and XUV energy range is opening new opportunities for WDM studies. Development of X-ray diagnostics such as X-ray absorption spectroscopy and X-ray scattering, has received much attention for the in situ measurement of the structure and physical properties of matter at extreme conditions [1]. Coupled to ultrafast pump - probe schemas, such diagnostics are giving new insights into out-of-equilibrium processes and thus validate current models. We report recent developments to perform few fs time resolved pump - probe experiments [2], giving access to ultrafast transient WDM states. We also present collective Thomson Scattering with soft x-ray Free Electron Laser radiation (at FLASH) as a method to track the evolution of highly transient warm dense hydrogen with around 100 fs time resolution. In addition, recent experiments at LCLS are suggesting the possibility to perform X-ray absorption spectroscopy (XANES) on FEL facilities to provide simultaneously information on the valence electrons and on the atomic local arrangement within sub-ps time scales.

[1] R.R. Fäustlin et al., Phys. Rev. Lett. 104, 125002 (2010).

[2] M.Harmand et al., Nature photonics Doi : 1010.1038/NPHOTON.2013.11