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Generation and investigation of hard x-ray free electron laser heated foils

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We report on recent experiment performed unsig the hard x-ray beamline (X-ray Pump Probe-XPP) at the Stanford Linac Coherent Light Source (LCLS) free electron laser devoted to the study of high-pressure high-energy density (HED) states.

This warm dense matter (WDM) regime, which is difficult to describe with present-day theoretical models, is poorly understood due to the difficulty of achieving these conditions in a manner that allows accurate diagnosis. The development of free electron laser instruments opens a unique opportunity to generate this regime in laboratory allowing one to efficiently and uniformly heat the matter up to ~ 5 eV in under 100 fs. This experiment is of general importance since the WDM regime is accessed in a broad array of research areas ranging from planetology to inertial fusion.

In this context, we irradiated 0.5-4 μm thick foils of Ag and Cu with a 9 keV x-ray beam of 60 fs duration that was focused using beryllium lens to an irradiance approaching 10^{16} Wcm^{-2}. The temporal evolution of the sample was monitored with two Time- And Space- Resolved Interferometry diagnostics measuring the phase and amplitude of an optical laser beam reflected from the front and the back of the sample. This measurement will provide information on the heating uniformity, as well as on the relaxation processes of a sample subjected to ultrafast x-ray heating that, at least instantaneously, creates a highly non equilibrium state.