Extreme pressure by wire implosion driven by a short-pulse Joule-level laser

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Dynamic shock compression serves as a crucial tool for creating warm and hot dense matter under extreme conditions that exist throughout the universe such as the interior of planets, supernovae, and astrophysical jets. Converging shocks are particularly valuable as they deliver energy to a small volume, resulting in the compression of material to exceedingly high densities and pressures. The generation of converging shocks requires precise design and facilities enabling laser irradiation with multiple beams such as OMEGA, NIF, or LMJ, with 10 kJ to MJ energies.

We report the discovery of a robust new technique to compress material to extreme pressures and densities, comparable to condition achievable at major international 10kJ- to MJ-class laser implosion facilities, using a table-top Joule-class short pulse laser and diagnosed with a hard X-ray Free Electron Laser. We will show how compression of a copper wire up to hundreds of Mbar can be potentially achieved with a single beam, of 30fs and just 3 J of energy. We also show compression results of other materials of planetary and stellar astrophysics interest such as carbon and iron as well as CH mixtures.

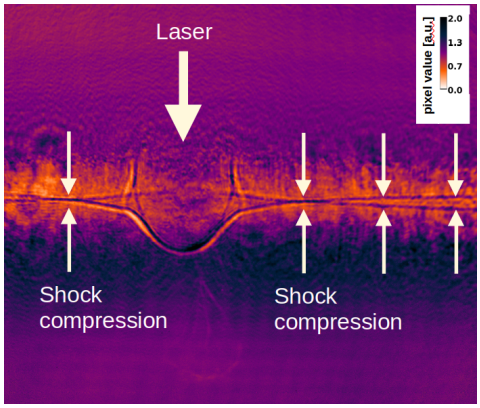

Figure 1: Implosion of a copper wire driven by an ablative shock 700 ps after the arrival of the main laser pulse