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Hard x-ray imaging of shockwaves generated by a short-pulse high-intensity 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. Thanks to the highly spatial coherence, extreme short pulse length and high brilliance of the XFEL beam, it is now possible to image transient effects with sub-micrometer spatial resolution and sub-picosecond temporal resolution. 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.

I plan to submit also conference proceedings

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