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Ultra-fast x-ray Thomson scattering measurements on dense shock-compressed plasmas[1]

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Novel x-ray Thomson scattering measurements of heating and compression of shocked solid-density plasmas are presented. These experiments apply ultra-short pulse laser produced K-α x rays to characterize plasmas at pressures above 400 GPa that are produced with a second energetic nanosecond laser. Evolution of the elastic (Rayleigh) scattering component shows rapid heating to temperatures of 2.2 eV. The measured frequency shift of collective plasmon oscillations determined the material compression, which was found to be a factor of three at 7ns after a 400J, 6ns heater beam was turned on, reaching conditions in the laboratory that are important for studying dense plasmas and astrophysics phenomena.the full characterization of strong shocks in dense matter, x-ray sources that provide picosecond temporal resolution over a small scattering volume are required. These results provide the first experimental validation of modeling of compression and heating of shocked matter with a temporal resolution of approximately 10 ps. This technique is opportune for inertial confinement fusion experiments that will achieve plasmas at extreme densities, e.g., on the National Ignition Facility, which will require high temporal resolution for characterization of short-lived states of compression.

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