

Observation of Ion Temperatures Exceeding Electron Temperatures in PetaWatt Laser-Solid Experiments

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Neutron time of flight signals have been observed with a high resolution neutron spectrometer using the PetaWatt arm of the Vulcan laser facility at Rutherford Appleton Laboratory from plastic sandwich targets containing a deuterated layer. The neutron spectra have two elements: a high-energy component generated by beam-fusion reactions and a component around 2.45 MeV, most likely to be thermonuclear in origin. The ion temperatures calculated from the neutron signal width clearly demonstrate a dependence on the front layer thickness and are significantly higher than electron temperatures measured under similar conditions. The ion heating process is intensity dependent and is not observed with laser intensities on target below 10^{20} W cm⁻². The measurements are consistent with a coupled two-step plasma instability process that cascades the laser energy directly to the ions.