USING THE ORION LASER FOR WARM DENSE MATTER EOS STUDIES

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The properties of warm dense matter (WDM), covering plasma conditions in the range of 0.1-10-times solid density and temperatures of ~1-100 eV, fall between ideal plasma and condensed matter theories. Studies have highlighted uncertainties in EoS predictions using methods based on the Thomas-Fermi, ion-cell models. In particular such models predict large departures from ideal gas behaviour for low Z material at low densities and temperatures.

In an extension of previous work [1], material has been isochorically heated using short pulse laser generated proton beams. An X-ray radiography system has been developed to diagnose the quantities necessary to infer isentropes for low Z material, via the method of Foord *et al*. [2], and provide data to validate model predictions.

Earlier measurements were limited by the 0.3 keV probe energy to relatively low densities and pressures below 1.5 Mbar, and were conducted in cylindrical geometry. More recent experiments performed at the Orion laser use a parabolic crystal imaging system in order to measure to higher pressures by probing planar expansion of aluminium foils at 1.8 keV.

The imaging system is described and results are presented showing a spatial resolution of 5 μm, which was then streaked to give a temporal resolution of 10 ps. Analysis of the foil expansion indicates a peak temperature of ~30 eV. The proton and ion spectra used to heat the sample were measured by a magnetic spectrometer and a Thomson parabola. These results are presented and the effect on the measured expansion discussed. Calculations of the proton energy deposition, based on cold stopping powers, with the radiation hydrodynamics code CORVUS are also presented. Plans for future measurements are discussed in the light of results obtained so far.

[1] D. J. Hoarty, *et al*. HEDP 8, 50 (2012)
[2] M. E. Foord, D. B. Reisman, P. T. Springer, Rev. Sci. Instrum. 75, 2586 (2004)