

“Instantaneous” Material Heating and Release: After isochoric (i.e., constant volume) heating of solid targets by energetic particles or radiation, HED conditions are generated that are inaccessible to conventional shock-wave techniques, making possible off-Hugoniot equation-of-state (EOS) measurements (see Fig. 1). High-energy-density (HED) matter releases after rapid heating, creating plasmas with unique thermodynamic properties. Picosecond-resolution streaked x-ray radiography was used to measure the release properties of metal targets heated by a powerful flux of energetic electrons generated by the OMEGA EP Laser System.

Figure 2 shows the experimental setup. The target was a 12- μm -thick Al foil, isochorically heated with electrons generated by a 10-ps pulse focused to 10^{18} W/cm². The target was backlit with x rays generated by a Ti (4.7-keV) foil irradiated with a 1-n s pulse focused to 10^{14} W/cm². X rays from the backlighter foil passed through the Al foil and were attenuated by the releasing material. The transmitted x rays were imaged with a one-dimensional (slit) streaked x-ray imaging system onto a picosecond-resolution x-ray streak camera. Figure 3 shows an example of a streaked backlit image of a releasing Al target.

These experiments show that high-entropy states can be generated on the OMEGA EP Laser System without any shocks. In conjunction with future measurements of the initial plasma temperature, the techniques developed here provide a first step toward a non-ablative off-Hugoniot EOS platform for studying HED materials and release under extreme conditions.¹

Omega Facility Operations Summary: The Omega Laser Facility conducted 181 target shots in February 2014 with an average experimental effectiveness of 91.7%: 114 on OMEGA (experimental effectiveness of 93.4%) and 67 on OMEGA EP (experimental effectiveness of 88.8%). Included in these shot counts were nine joint shots (both OMEGA and OMEGA EP). The ICF program accounted for 62 shots for experiments led by LLNL and LLE scientists. Thirty-four target shots were taken for the HED program led by LLNL and LLE scientists. The NLUF and LBS programs accounted for 32 and 53 target shots, respectively, including experiments led by Princeton University, Rice University, the University of California, Berkeley, LLNL, and LLE.

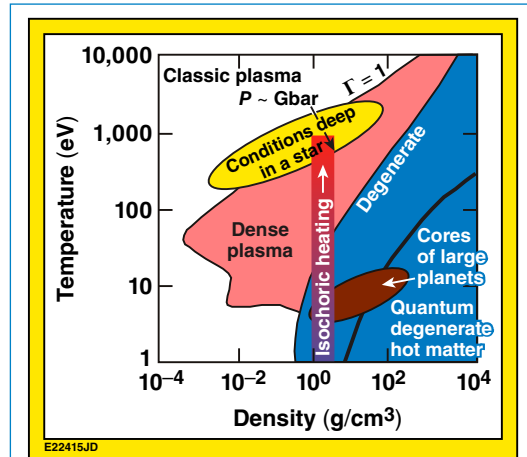


Figure 1. Isochoric heating provides a unique route to warm-dense-matter and high-energy-density conditions.

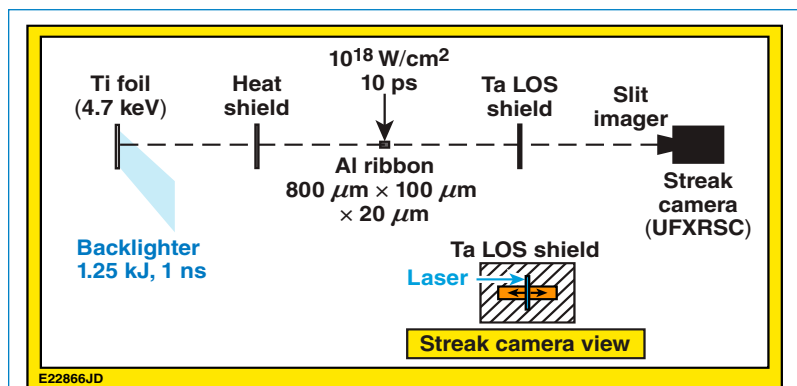


Figure 2. The experimental setup for streaked x-ray imaging on the OMEGA EP Laser System. Streaked x-ray imaging provides spatial, spectral, and temporal resolution. LOS: line of sight; UFXRSC: ultrafast x-ray streak camera.

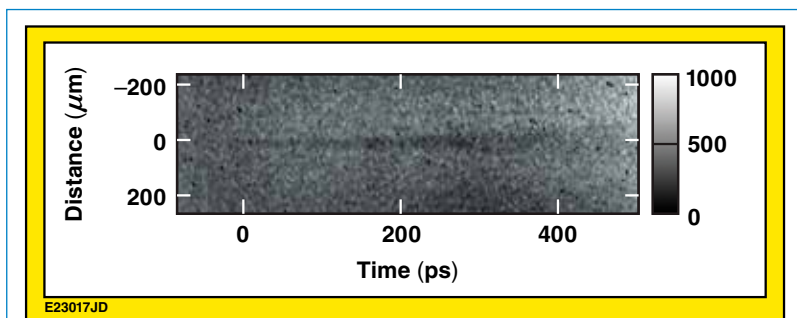


Figure 3. Streaked backlit image of a releasing Al foil heated with a 10-ps pulse from the OMEGA EP Laser System.

1. M. E. Foord, D. B. Reisman, and P. T. Springer, Rev. Sci. Instrum. **75**, 2586 (2004).