Abstract:
Experimentally, static high pressures can be applied to a sample, and the response studied, up to ~500 GPa (5 Mbar). Established techniques for dynamic loading, using a planar shock or ramp, can induce up to ~5 TPa (50 Mbar) over enough volume for the sample response to be measured. However, higher pressures are reached in planetary impacts, and the center of massive exoplanets and brown dwarfs may exceed 100 TPa (1 Gbar). We are developing a family of laser-driven loading platforms that allow the equation of state (EOS) of matter to be measured to pressures of at least 5 TPa on the Omega laser and 80 TPa at the National Ignition Facility. These pressures are reached using spherically-converging geometry, with x-ray radiography as the primary diagnostic, enabling absolute EOS measurements to be made. At pressures above ~10 TPa, the x-ray opacity of most materials drops significantly because of k-shell ionization, which would ordinarily prevent the compression from being measured. Radiographic marker layers enable the opacity and compression to be determined simultaneously. Using these techniques, we have measured the Hugoniot EOS of CH-plastic and diamond to 72 and 63 TPa respectively. Future experiments will include the study of H, Fe, and silicates.