DPP11-2011-001089
Abstract for an Invited Paper
for the DPP11 Meeting of
the American Physical Society

Plasma Gradient Piston: a new approach to precision pulse shaping

SHON T. PRISBREY, Lawrence Livermore National Laboratory

We have successfully developed a method to create shaped pressure drives from large shocks that can be applied to a wide variety of experimental platforms. The method consists of transforming a large shock or blast wave into a ramped pressured drive by utilizing a graded density reservoir that unloads across a gap and stagnates against the sample being studied. The utilization of a graded density reservoir, different materials, and a gap transforms the energy in the initial large shock into a quasi-isentropic ramped compression. Control of the ramp history is via the size of the initial shock, the chosen reservoir materials, their densities, the thickness of each density layer, and the gap size. There are two keys to utilizing this approach to create ramped drives: the ability to produce a large shock, and making the layered density reservoir. A number of facilities can produce the strong initial shock (Z, Omega, NIF, Phoenix, high explosives, NIKE, LMJ, pulsed power, . . .). We have demonstrated ramped drives from 0.5 to 1.5 Mbar utilizing a large shock created at the Omega laser facility. We recently concluded a pair of NIF drive shots where we successfully converted a hohlraum-generated shock into a stepped, ramped pressure drive with a peak pressure of ∼4 - 5 Mbar in a Ta sample. We will explain the basic concepts needed for producing a ramped pressure drive, compare experimental data with simulations from Omega (P_{max} ∼ 1 Mbar) and NIF (P_{max} ∼ 5-10 Mbar), and present designs for ramped, staged-shock designs up to P_{max} ∼ 30 Mbar. The approach that we have developed enables precision pulse shaping of the drive (applied pressure vs. time) via target characteristics, as opposed to tailoring laser power vs time or Z-pinch facility current vs time. This enables ramped, quasi-isentropic materials studies to be performed on a wide variety of HED facilities. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-ABS-490532.