DPP19-2019-000191

Abstract for an Invited Paper
for the DPP19 Meeting of
the American Physical Society

From Astrophysics to Z-Pinches: HED Science with Pulsed Power[1]

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Pulsed power accelerators compress electrical energy in time and space to provide versatile experimental platforms for high energy density and inertial confinement fusion science. The 80 TW "Z" pulsed power facility at Sandia is the largest such machine in the world today. Z discharges over 20 MJ of energy stored in its capacitor banks into a current pulse that rises in 100 ns and peaks at a current as high as 30 MA in cylindrical targets. Considerable progress has been made in the use of pulsed power as a precision tool. This talk will review scientific developments in three major areas of research on Z: (1) magneto-inertial fusion, (2) dynamic materials science, and (3) x-ray driven science. The first magnetized liner inertial fusion experiments were fielded on Z in 2014. These experiments showed unequivocally that the use of embedded magnetic fields could reduce the plasma density requirements for inertial confinement fusion. Substantial progress has been made in demonstrating the scaling of this concept with increasing drive energy, preheat energy, and magnetic field strength, resulting in >2 kJ DT-equivalent yields. Plans for the near future could take us to about 40 kJ DT-equivalent yields on Z. Scientists have demonstrated shock-ramp methods on Z that, combined with new temperature measurements, enable the study of different isentropic paths in high pressure materials experiments. The near future will see the implementation of x-ray diffraction diagnostics to measure phase transitions directly. Finally, Z has set multiple new records for x-ray outputs in various photon energy ranges in the last three years. Both our materials platforms and x-ray sources are being applied by academic researchers on Z to study a wide range of atomic physics, astrophysics, and planetary science.

[1]Sandia National Laboratories is a multimission laboratory managed and operated by National Technology Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energys National Nuclear Security Administration under contract DE-NA0003525.