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Demonstration of thermonuclear conditions in Magnetized Liner Inertial Fusion experiments

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The Magnetized Liner Inertial Fusion concept [S. A. Slutz et al., Phys. Plasmas 17, 056303 (2010)] utilizes a magnetic field and laser heating to relax the implosion requirements to achieve inertial confinement fusion. The first experiments to test the concept were recently conducted utilizing the 19 MA, 100 ns Z machine, the 2.5 kJ, 1 TW Z Beamlet laser, and the 10 T Applied B-field on Z coils. Despite the relatively slow implosion velocity (70 km/s) in these experiments, electron and ion temperatures at stagnation were approximately 3 keV, and thermonuclear DD neutron yields up to 2e12 have been produced. X-ray emission from the fuel at stagnation had a width ranging from 60-120 microns over a roughly 6 mm height and lasted approximately 2 ns. X-ray spectra from these experiments are consistent with a stagnation density of the hot fuel equal to 0.4 g/cm3. In these experiments 1-5e10 secondary DT neutrons were produced. Given that the areal density of the plasma was approximately 2 mg/cm^2, this indicates the stagnation plasma was significantly magnetized. This is consistent with the anisotropy observed in the DT neutron time of flight spectra. Control experiments where the laser and/or magnetic field were not utilized failed to produce stagnation temperatures greater than 1 keV and DD yields greater than 1e10. An additional control experiment where the fuel contained a sufficient dopant fraction to radiate away the laser energy deposited in the fuel also failed to produce a relevant stagnation temperature. The results of these experiments are consistent with a thermonuclear neutron source.

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