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Performance scaling with drive parameters in Magnetized Liner Inertial Fusion experiments

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The long-standing challenge of confining a fusion plasma can become easier by leveraging the benefits of both inertial and magnetic confinement schemes. A magneto-inertial fusion concept called Magnetized Liner Inertial Fusion (MagLIF) [S. A. Slutz, et al., Phys. Plasmas 17, 056303 (2010)] has recently demonstrated significant promise in experiments on the Z machine. In MagLIF, current from the Z-machine is used to implode a metal cylinder containing magnetized and preheated fusion fuel. The initial MagLIF experiments established the viability of magneto-inertial fusion by demonstrating thermonuclear neutron generation from fusion-relevant fuel temperatures and densities and the ability to trap charged fusion products in a highly-magnetized fuel column [M. R. Gomez, et al., Phys. Rev. Lett. 113, 155003 (2014), P. F. Schmit, et al., Phys. Rev. Lett. 113, 155004 (2014)]. These experiments were conducted with 10 T, approximately 0.5 kJ of preheat, and a 16-18 MA peak load current, and they generated 1-2e12 primary DD neutrons with ion temperatures between 1.8 and 2.5 keV. Recent efforts have been focused on developing a platform that allows for increased applied B-field (>15 T), laser energy coupling (>1 kJ), and current (>19 MA) to be delivered to the target. These improvements increased the primary neutron yield by nearly an order of magnitude to 1e13 DD neutrons and the ion temperature to 3.1 keV. The observed increase in performance follows the predicted scaling in 2D simulations, which also indicate that further gains are possible with additional improvements to the platform. Development of a >20 T, >2 kJ, and >20 MA capability is underway, and there is a path to 25-30 T, 4-6 kJ, and 21-23 MA on the Z machine, which could produce up to 100 kJ of DT-equivalent yield. *Sandia National Laboratories is a multimission laboratory managed and operated by NTESS, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. DOE's NNSA under contract DE-NA0003525.