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Electromagnet Designs on Low-Inductance Power Flow Platforms for the Magnetized Liner Inertial Fusion (MagLIF) concept at Sandia's Z Facility*

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Sandia National Laboratories is researching an inertial confinement fusion concept named MagLIF [1] –Magnetized Liner Inertial Fusion. MagLIF utilizes Sandia's Z Machine to radially compress a small cylindrical volume of pre-magnetized and laser-preheated deuterium fuel. These initial conditions appreciably relax the radial convergence requirements to realize fusion-relevant fuel conditions on the Z accelerator. The configuration of these experiments imposes unique design criteria on the external electromagnetic coils that are used to diffuse magnetic field into the Z target and bulky power flow conductors. Since 2013, several coil designs have been fielded to magnetize the ˜75cm3 target region to 10-15T while achieving field uniformity within 1% in the fuel. These Helmholtz-like coil pairs require an extension of the Z vacuum transmission lines, raising total system inductance and limiting peak current to below 18MA. The MagLIF team will study scaling of fusion yield with increased drive current, magnetic field, and deposited laser energy. Planned experimental campaigns require parallel design efforts for Z-Machine power flow hardware and electromagnets to enable 15 –20T fuel magnetization while simultaneously delivering 18-20 MA machine current. Simultaneous operation of 20 –25T with 20 - 22MA is also in development. We present the design of a new coil that achieves these field levels in the reduced-inductance Z feed geometry. In this configuration, a single solenoid's magnetic field external to the bore is used to magnetize the target. Inefficient coupling alongside high field strength requirements generate internal pressures greatly exceeding the yield strength of copper conductors, necessitating internal reinforcement. We discuss the coil design, experimental results, and efforts to understand lifetime. We will also introduce a conceptual design for a new coil pair that will achieve 25-T in a split coil topology compatible with the 20-22MA platform.

1. S. A. Slutz, et al, Pulsed-power-driven cylindrical liner implosions of laser preheated fuel magnetized with an axial field,"Phys. Plasmas 17, 056303 (2010)

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Authors: LAMPPA, Derek (Sandia National Laboratories); GOMEZ, Matthew (Sandia National Laboratories); LUCERO, Larry (Sandia National Laboratories); ROVANG, Dean (Sandia National Laboratories); KAYE, Ronald (Sandia National Laboratories); MEISSNER, Joel (Milhous Company); ALES, Matthew (Sandia National Laboratories)

Presenter: LAMPPA, Derek (Sandia National Laboratories)

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