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Magnetic-Field Driver for Magnetized Plasma –Laser Experiments on the Z Beamlet Laser Facility

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A modular pulsed-power driver has been developed to create an applied magnetic field for high-intensity laser experiments. The system is presently being using on Sandia's Z Beamlet Laser facility and was previously used at the Texas Petawatt laser facility at the University of Texas at Austin.. Its design includes use of low inductance circuit elements, a single-turn coil, up to six 3.1 μF 100 kV high energy density capacitors (15.5 kJ each), and one high voltage spark gap switch per capacitor. Each capacitor discharges via six high voltage cables into a newly-designed vacuum interface and vacuum transmission line. Current rise time is 1.7 μs with peak current that can exceed 1.2 MA at full charge voltage with six capacitors. System inductance is about 48 nH, including the single-turn coil. A major challenge has been to deliver current to the coil in vacuum without a significant inductance penalty or damage to the vacuum system. The system is presently configured with a single-turn cm-scale coil to create a magnetic field up to 20 T, which is achieved at much less than full charge voltage using 4 capacitor/switch modules. At these levels the coil is not destroyed with each shot. We will describe implementation of this system on the Z Beamlet Laser system and initial results from magnetized plasma experiments. We will also describe potential design upgrades that enable even more energetic, compact, and portable drivers.

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