OMEGA-EP LASER EXPERIMENTS FOR MAGLIF LASER-PREHEAT INVESTIGATION

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Recently, initial integrated experiments for magnetized liner inertial fusion (MagLIF) were performed at Sandia National Laboratories Z facility and achieved thermonuclear fusion yields[1,2]. In those experiments, D_2 fuel surrounded by a cylindrical Be shell called *liner* was pre-magnetized to B_z=10T and then preheated to a few 100 eV by the ZBeamlet green laser. The J_z x B_Φ force driven by 20-MA-current z-pinch compresses the line and fuel together with the axial magnetic flux. Magnetization and preheat of the fuel play key roles in MagLIF. The preheating allows the fuel to reach ignition-relevant temperature at slower implosion velocity. Axial magnetizations help not only suppress radial thermal conduction loss for efficient fuel heating, but also radially trap charged fusion products (e.g., α-particles in DT fusions, T in DD fusions) with lower ρR. Simulations and the initial integrated experiments show that many traditional performance requirements are significantly eased (e.g., v_{imp} and ρR).

To benchmark the underlying physics, focused experiments are needed. MagLIF plasma is in the regime intermediate to tokamaks and traditional laser-driven ICF plasmas, and the benchmark experiments in this regime are limited. Specifically, the laser intensity ($I\lambda^2 \sim 10^{14}$ watts-μm^2 /cm^2), long scale lengths (L~10 mm) and initial fuel density ($n_e/n_{crit} < 0.1$) of the plasma at the time of preheat are outside the typical parameter space for other magnetic and inertial confinement schemes, and the relevant physics has not been extensively explored experimentally.

Experiments were performed at OMEGA-EP facility to study 1) coupling of laser energy into D_2 fuel and 2) the effectiveness of applied B_z field to suppress the thermal conduction loss. For this purpose, 0.1-0.5% of Ar is mixed into D2 fuel, and its spectral signature is measured with Multi-purpose SPECtrometer (MSPEC). Electron temperature inferred from gated, axially resolved Ar K-shell spectra are compared with temperature simulated from the hydrodynamic simulation code, HYDRA. The analysis implication and challenges will be discussed.

[1] M.R. Gomez et al., Phys. Rev. Lett. 113, 155003 (2014).
[2] A. B. Sefkow et al., Phys. Plasmas 21, 072711 (2014).

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