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Diagnosing the Stagnation Conditions of MagLIF Implosions Using High-Resolution Spectroscopy[1]

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An inertial fusion concept known as Magnetized Liner Inertial Fusion (MagLIF) is currently being pursued on the Z-machine at Sandia National Laboratory. Electrical current from the Z-machine is directly coupled onto the outside surface of a beryllium tube known as a "liner" causing it to implode. The liner contains gaseous deuterium (D_2) fuel, which is pre-magnetized, pre-heated, and then compressed by the imploding walls of the liner. Target implosions of this type have produced thermonuclear plasmas that generated 2e12 DD neutrons [M.R. Gomez et al., PRL 113, 155003 (2014)]. For the first time we have accurately measured the space-dependent, fuel conditions at the time of stagnation. In addition, the state of the compressed Be liner was determined. This was accomplished by the simultaneous use of high-resolution, x-ray spectroscopic and imaging diagnostics. These new measurements relied on the observation of K-shell spectra emitted by microscopic iron and nickel impurities that naturally occur in the Be. The measurements currently indicate that the non-uniformity of the x-ray emission from the fuel is due to variations in the fuel conditions. Ultimately, the data provides critical insight into the performance of the MagLIF target and will further enable us to enhance the target design.

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