Multi-Objective data analysis for interpretation of Magnetized Liner Inertial Fusion experiments*

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The Magnetized Liner Inertial Fusion (MagLIF) concept is a promising route to achieving high fusion yields (>100 MJ) in the laboratory [1,2,3]. Recent experiments on the Z machine at Sandia National Laboratories have demonstrated the efficacy of laser heating and magnetic insulation for achieving Gbar pressures and magnetic flux compression for achieving confinement of fusion products at stagnation [4,5,6]. Radiation-magnetohydrodynamic simulations predict that >10 kJ yields are possible on the existing Z pulsed power facility. However, several processes, including reduced laser energy coupling, mix, and three dimensional structure contribute to degraded target performance compared to simulations. Current diagnostic analysis methods do not allow us to sufficiently constrain the relative importance of each of these degradation mechanisms. We present a new analysis methodology that allows for the self-consistent integration of multiple diagnostics including nuclear measurements, x-ray imaging, and x-ray power detectors to determine the primary stagnation parameters, such as temperature, pressure, liner areal density and mix fraction. The analysis uses a simplified model of the hot-spot in conjunction with a Bayesian inference network to determine the most probable configuration that describes the experimental observations while simultaneously revealing the principal uncertainties in the analysis. It is shown that, for a certain class of target, the mix fraction scales with the preheat energy delivered to the fuel, resulting in degraded performance at higher preheat energies, contrary to the expected behavior if mix were unimportant.

References

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