Quantifying uncertainty in energy scaling predictions of ICF implosions

Brian K. SPEARS[1], S. BRANDON[1], M. BUCHOFF[1], J. FIELD[1], J. GAFFNEY[1], J. HAMMER[1], K. HUMBIRD[2], M. KRUSE[1], D. MUNRO[1], R. NORA[1], L. PETERSON[1], P. SPRINGER[1]

1) Lawrence Livermore National Laboratory, USA
E-mail: spears9@llnl.gov
2) Texas A&M University, College Station, USA

The ICF program at Lawrence Livermore National Laboratory is focused on achieving ignition and, prior to that, on determining what scale is required to achieve it. Detailed numerical simulations are one of the key tools used to extrapolate to laser energy scales which are currently inaccessible. Associated with the extrapolation is the difficult problem of evaluating the uncertainty in these extrapolated estimates.

LLNL has been developing a computational framework to quantify these uncertainties using modern machine learning techniques to calibrate large simulation databases (~ 5PB) against observed experimental results. The product is a learned model, founded on both simulation and experiment, that predicts implosion performance and the associated uncertainty.

We will discuss the key technologies in the framework including high-frequency computing workflows, deep learning and calibration techniques, and Bayesian methods for propagating uncertainty. We will also present an application of this framework to CH ablator (high foot) and HDC ablator (BigFoot) implosion experiments at multiple scales. We will also discuss the implications of these models for ICF program goals and future modifications of these experiments.

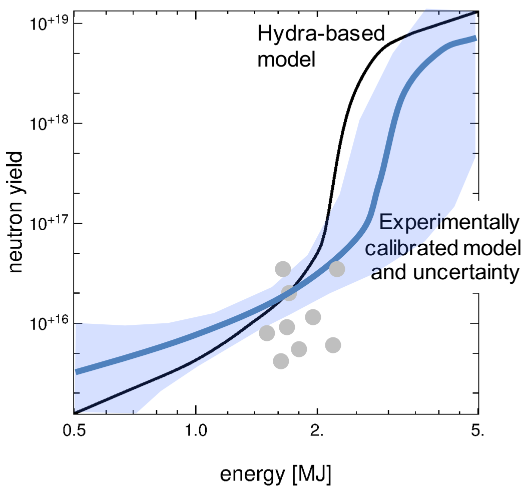

Figure 1 We will describe machine learning techniques to combine radiation hydrodynamics code predictions (black) with experimental observations (gray) to quantify the uncertainty (blue) in estimates of driver energy required to achieve ignition.

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