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A Statistical Approach to Implosion Design on the OMEGA Laser

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— The 1-D campaign on OMEGA is backed by a novel approach aimed at producing an iterative and data-driven process to design optimized cryogenic implosions and improve the accuracy of 1-D physics models. The process does not preclude the possibility of significant systematic errors on OMEGA, nor does it assume that the hydrodynamic codes used in implosion design have all the necessary physical models. It only assumes that there exists some relationship between simulation and experimental results and uses statistical methods to model this relationship. Comparisons of hydrodynamic simulations of less-accurate physical models with more-accurate ones indicate that as long as equation of state is relatively well modeled, this assumption holds. By incorporating data from over 40 experiments on OMEGA, this approach has been used to design four targets with a two-shock pulse design for the 1-D campaign, and led to pre-shot predictions of yields within 5% and ion temperatures within 3% of the experimental values. One of these implosions has also produced the highest neutron yield (1.1×10^{14}) on an OMEGA cryogenic implosion with an areal density of $\sim 105\,\mathrm{mg/cm^2}$. The region of design space in which the predictive capability of this model is valid remains an open question. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.

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