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Diagnosing and Controlling Mix in NIF Implosion Experiments[1]

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Controlling the hydrodynamic growth of capsule perturbations is essential in the optimization of NIF ignition target designs. In simulations, mode numbers up to ∼300 can have significant growth on the outer surface of CH capsules.[2] As a result, "isolated defects" on the capsule (e.g. bumps in the CH coating, the fill tube) have the potential to grow enough to penetrate the imploding shell, and produce a jet of ablator material (mass ∼ 10's ng) that enters the hot-spot. Although this amount of mix is tolerable, degradation in ignition capsule performance becomes significant at several times this amount. Our predictions of hydrodynamic growth and resulting mix have a level of uncertainty that results from uncertainties in experimental conditions, physical data (e.g. EOS), and the simulation method itself. We are developing an experimental strategy where the final requirements for ignition targets (e.g. surface finish) can be adjusted through direct measurements of mix and experimental tuning. Since the growth can be reduced by controlled reduction of the peak x-ray drive, we can use the *relative* simulated Growth Factors to help set ignition requirements. One method for inferring mix into the hot-spot is through observations of x-ray emission from the ablator material. Internal regions of the CH ablator are doped with Ge in nominal ignition designs, resulting in K-shell emission when it mixes into the hot-spot. We have observed evidence of jets entering the hot-spot in early NIF implosion experiments through the measured x-ray spectra and images, consistent with simulation predictions. Doping other regions of the ablator could provide a corresponding unique indication of mix. In addition, radiographic measurements of high-Z doped layers provide a means of measuring ρR variation in the imploding and compressed capsule.

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[2]B.A. Hammel, et al., High Energy Density Physics, 6 (2010) p.171–178