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Simultaneous diagnosis of radial profiles and mix in NIF ignition-scale implosions through X-ray spectroscopy

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In a NIF implosion, hydrodynamic instabilities may cause cold material from the imploding shell to be injected into the hot-spot (hot-spot mix), enhancing the radiative and conductive losses, which may lead to a quenching of the ignition process. The bound-bound features of the spectrum emitted by high-Z ablator dopants that gets mixed into the hot-spot have been previously used to infer the total amount of mixed mass [1,2]; however, the typical errorbars are larger than the maximum tolerable mix. We present here an improved 2D model for mix spectroscopy [3], which can be used to retrieve information on both the amount of mixed mass, and on the full imploded plasma profile. By performing radiation transfer, and simultaneously fitting all of the features exhibited by the spectra, we are able to constrain self-consistently the effect of the opacity of the external layers of the target on the emission, thus improving the accuracy of the inferred mixed mass. The model predictive capabilities are first validated by fitting simulated spectra arising from fully characterized hydrodynamic simulations, then the model is applied to previously published experimental results, providing values of mix mass in agreement with previous estimates. We show that the new self consistent procedure leads to better constrained estimates of mix, and also provides insight on the sensitivity of the hot-spot spectroscopy to the spatial properties of the imploded capsule, such as the in-flight aspect ratio of the cold fuel surrounding the hotspot.

References

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