Synthetic Diagnostic Methods to Improve Understanding of Hotspot Confinement

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The 3D radiation hydrodynamics code Chimera is used to run simulations aiming to investigate possible yield degradation mechanisms of ICF experiments. Using synthetic diagnostics alongside these simulations could reveal the observable signatures of such features and also provide an additional comparison of simulated and experimental data.

Current measurements at NIF include neutron and X-ray spectroscopy as well as gated neutron and X-ray imaging. From simulated datasets, similar synthetic images and spectra can be produced accounting for instrument response and positioning.

Neutron transport for attenuated unscattered and singly scattered neutron flux can be performed expediently via an inverse ray trace method [1]. This can be used to create 2D images at a detector. Fluence compensation can be used to decouple the effect of neutron fluence on the shape of the scattered image in order to produce an image more accurately imaging the ρR. Full neutron spectrum information is computationally expensive to transport in 3D in both the ray trace and Monte-Carlo methods. We developed a 1D spherical multigroup discrete-ordinates neutron transport code to analyze possible spectral signatures available to 1D implosions. This allows synthetic measurements of the Down Scattered Ratio (DSR) and the shape of the back-scatter edge from the DT reaction neutron source. Other neutron sources such as DD reactions can also be included, allowing for yield ratio measurements. The unscattered and n-th scattered fluxes can be isolated and the scattering kernel is handled without Legendre polynomial expansion [2].

Improvements to the atomic code SpK have been performed allowing for more accurate synthetic integrated X-ray spectra and images. The Stewart-Pyatt continuum lowering model has been included alongside the Pressure Ionized Effective Statistical (PIES) weights method. These additions amongst others allow for accurate imaging of simulated capsule implosions. Emission and absorption of both the ablator and the fuel are included and imaging can be performed along any axis.

References

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