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3D isobaric hotspot reconstruction from multiple neutron and Xray views on the NIF: quantifying radiative loss impact on DT implosion and other insights[1]

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Moving beyond spatially averaged measurements of temperature and density for the central reacting deuterium and tritium plasma in inertial confinement fusion experiments gives a more complete understanding of the properties of the assembled hot spot and provide insight into mechanisms that degrade fusion energy production. In this work, the multi-axis time-integrated neutron imaging of a layered implosion on the NIF, under an isobaric assumption, allows the three-dimensional reconstruction of the density and temperature profile of the central hotspot during burn. The measured neutron yield and spectral width constrain the stagnation pressure. One can then look for signatures of various degradation mechanisms, such as spatial temperature gradients or neutron spectrum deviation from pure Gaussian. Multi-axis synthetic Xray images are calculated using DCA DT emissivity and compared to measurements, giving a 3D reconstruction of the ablator mix penetrating the hotspot. We quantify the absolute radiative loss due to discrete, spatially resolved features such as the fill-tube induced jet and meteors. The method is validated with HYDRA simulations and applied to a series of recent high-performing HDC and CH implosions. Finally, alpha heating, effective rho-r and pressure are compared to the usual 0/1D isobaric conduction-limited approach. 3D values are 10-20% lower on average.

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