High-resolution X-ray Penumbral Imaging of Inertially Confined Fusion Plasmas at the National Ignition Facility

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Highly-resolved 3-D simulations of inertial confinement fusion (ICF) implosions predict a hot spot plasma that exhibits complex micron-scale structure in density, temperature, and flow velocity, originating from a variety of 3-D perturbations including the capsule surface roughness, support tent, and fill-tube [1]. Experimental diagnosis of these conditions requires high spatial resolution imaging techniques superior to conventional Fraunhofer diffraction and photon limited pinhole imaging (limited to ~14 μm resolution in ICF implosions on the NIF). Penumbral imaging can improve the spatial resolution while simultaneously increasing the detected photon yield [2] This enables high-resolution imaging of inertially confined fusion plasmas at x-ray energies where the ablator opacity becomes negligible.

Here we report on the first time-integrated x-ray penumbral imaging experiments of ICF capsule implosions at the National Ignition Facility (NIF) that achieved spatial resolution as high as 4 μm. Hot spot images from layered DT implosions, measured at various x-ray energies, ranging from 6 to 30 keV will be presented from a variety of experimental ICF campaigns, revealing previously unseen detail. The *2016 Inertial Confinement Fusion Program Framework Document* [3] identifies stagnation and burn as one of six Priority Research Directions until 2020. As such, it will be discussed how these and future results can be used to improve our physics understanding of inertially confined fusion plasmas by enabling spatially resolved measurements of hot spot properties, such as radiation energy, temperature or derived quantities.

References

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