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High Resolution Neutron Imaging of Inertial Fusion Targets Using Bubble Detectors[1]

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Neutron imaging of inertial fusion plasmas provides a direct measurement of the spatial location and extent of the fusion reactions and will be one of the most useful diagnostics during the early ignition studies on the National Ignition Facility. Images of the burning fuel can verify calculations of implosion physics, determine the existence of asymmetries, and allow rapid evaluation of target performance. Previous neutron imaging experiments have used scintillation detector arrays and penumbral imaging, conceptually similar to pinhole imaging except that the aperture diameter is larger than the neutron source. The geometrical limit for spatial resolution in the target plane is given by the detector resolution divided by the system magnification. It will be extremely difficult to image targets with the 5 micron resolution needed in NIF experiments using plastic scintillators, which have a resolution limited by the $\approx$ 500 500 micron range of the recoil deuteron and would require the detectors be 100 m or more from the target. Bubble detectors can potentially detect neutrons with a spatial resolution as small as 5 microns, or approximately two orders of magnitude better than the resolution in scintillation detectors. We report the results of proof-of-principle neutron imaging experiments on OMEGA. The results demonstrate that bubble detectors should revolutionize the design of penumbral and other coded aperture imaging systems. Prospects for imaging target plasmas in NIF with 5 micron spatial resolution in the target plane appear excellent.

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