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Adapting high resolution x-ray spectroscopy from MFE to temperature and density measurements in ICF*

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X-ray spectroscopy will be used in indirect drive experiments at the National Ignition Facility (NIF) to diagnose plasma conditions and mix in ignition capsules near stagnation times, thus indicating the quality of the implosion, and at various positions in the hohlraum. The electron temperature, Te, and density, ne, will be measured from dielectronic satellites and Stark broadening, respectively, by doping a surrogate capsule ("symcap") with a small amount of Kr gas. These measurements will corroborate neutron based measurement of ion temperature, Tion, assuming Te = Tion due to quick equilibration at stagnation. This direct measurement of ne will corroborate the inference of density from other measurements (Tion, neutron yield, size of hotspot, duration of burn). The Te measurement in Kr doped capsules will also benchmark other measurements from the x-ray continuum slope, which will then measure Te in igniting capsules (without Kr). Mixing of capsule ablator material and fill tube material into the fuel quickly degrades performance. X-ray spectroscopy of doped elements in the ablator will diagnose the amount of mix into the hot spot, and other effects of mix. In the hohlraum, x-ray spectroscopy will measure plasma conditions in the hot plasma where laser energy is deposited, giving insight into the underlying physics that govern hohlraum behavior, and processes that directly affect x-ray drive, symmetry and laser-hohlraum coupling. High resolution spectroscopy ($E/\Delta E$ ˜ 5000 –20000) of impurity dopant x rays is a mature technology that was developed on tokamaks for Doppler measurement of Tion and plasma flow velocity. It has been deployed on tokamaks and stellarators world wide and will be used as a primary Tion diagnostic on the international tokamak, ITER. The initial NIF instruments will be compact spectrometers mounted in positioners. The first experiments will field both von Hamos and conical crystal spectrometers to record time integrated and time resolved (> 30 ps) spectra of the Heα, Lyα and Heβ complexes of Kr. The spectrometer design and performance, based on photonics calculations using collisional radiative and atomic physics codes, will be presented. *Performed under the auspices of the U. S. DoE by LLNL under Contract DE-AC52-07NA27344 and PPPL under contract DE-AC02-09CH11466

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