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Scattered and Reflected Light Polarimetry as a Diagnostic of Multibeam Hohlraum Physics

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Scattered light provides a window into the complex laser-plasma interactions and hydrodynamics occurring within indirect-drive inertial confinement fusion (ICF) hohlraums. Understanding hohlraum physics is an important part of developing improved targets and increasing the likelihood of ignition. Measurements of the scattered light power and spectrum are routinely made on each cone of beams at the National Ignition Facility (NIF) in order to correct for coupling losses due to laser-plasma instabilities. The additional ability to probe scattered light polarization on a 30° incidence beam was recently added [1], which has produced a number of discoveries regarding multibeam hohlraum physics [2,3]. One particularly important insight is that the polarizations of an incident beam and its backscatter are affected by amplitude and phase modulations induced by crossing laser beams. The revised theory [3] describing this optical wave mixing has recently been validated by conducting a two beam pump-probe experiment under carefully controlled conditions. This effect could be utilized more generally to produce ultrafast, damage-resistant, and tunable laser-plasma wave plates, polarizers, or other photonic devices. It also enables remote polarimetry-based probing of plasma conditions such as electron temperature. To extract more quantitative feedback about crossed-beam energy transfer (CBET) from the polarimetry data in ICF experiments at the NIF, the diagnostic has been upgraded to measure the complete Stokes vector with temporal resolution [4]. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

[1] D. Turnbull et al., "Polarimetry of uncoupled light on the NIF," Rev. Sci. Inst. 85, 11E603 (2015).
[2] D. Turnbull et al., "Multibeam seeded Brillouin sidescatter in inertial confinement fusion experiments," Phys. Rev. Lett. 114, 125001 (2015).
[3] P. Michel et al., "Dynamic control of the polarization of intense laser beams via optical wave mixing in plasmas," Phys. Rev. Lett. 113, 205001 (2014).
[4] D. Turnbull et al., "Complete time-resolved polarimetry of scattered light at the National Ignition Facility," submitted to SPIE (2015).