THE PRELIMINARY DESIGN OF THE OPTICAL THOMSON SCATTERING DIAGNOSTIC FOR THE NATIONAL IGNITION FACILITY

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The National Ignition Facility (NIF) is a 192 laser beam facility designed to support the Stockpile Stewardship and Inertial Confinement Fusion programs. We report on the preliminary design of an Optical Thomson Scattering (OTS) diagnostic that has the potential to transform the community's understanding of NIF hohlraum physics by providing first principle, local, time-resolved measurements of under-dense plasma conditions. The system design allows operation with different probe laser wavelengths by manual selection of the appropriate beamsplitter and gratings before the shot. A deep-UV probe beam (λ_0 between 185-215 nm) will optimally collect Thomson scattered light from plasma densities of 5×10^{20} electrons/cm^3 while a 3ω probe will optimally collect Thomson scattered light from plasma densities of 1×10^{19} electrons/cm^3.

The OTS will be inserted into the target chamber by a Diagnostic Instrument Manipulator (DIM) which requires it to have a compact design. The baseline concept of the system includes a blast window, an unobscured collection telescope, transport and focusing optics, two crossed Czerny-Turner spectrometers and the shared use of one streak camera photocathode, located inside of an airbox. The collection telescope is an off-axis Schwarzschild design that relays a 50 μm spot (Thomson volume) to the two spectrometers. One high resolution (3/4 meter) spectrometer will measure the ion acoustic wave (IAW) feature (e.g. 206-214 nm for a 5ω probe laser) and one low resolution (1/3 meter) spectrometer will measure a 50 nm portion of the electron plasma wave (EPW) feature. The EPW spectrometer range will be tunable from 150-400 nm with the deep UV probe. The outputs of the spectrometers are relayed to a gated optical streak camera with selectable sweep speeds between 5 and 40 ns. The inherent optical path delay between the two spectrometer systems allow the output signals to be superimposed on the same photocathode having a spatial extent of 20 mm. The sweep window is selected so that the required temporal resolution is achieved over the complete Thomson recording window established by the probe laser temporal pulse shape (1-5 ns). We report on the current design status and operational performance at NIF.

*This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.
LLNL-ABS-669793