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Backscatter diagnostics at the 100-kJ laser facility for laser-driven hohlraum applications

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Laser-plasma instabilities (LPI) including the processes of stimulated Brillouin scattering (SBS) and stimulated Raman scattering (SRS) have become the major issues in the field of inertial confinement fusion (ICF) and other high-energy density physics. The instabilities are the main causes of scattering the incident laser and producing the high-energy electrons. These processes can either reduce the absorption of laser leading to the x-ray drive asymmetries or induce the preheat of the target degrading the efficiency of implosions. Besides, the behavior of cross beam energy transfer (CBET) occurs when multiple beams are overlapped. [1,2] In this work, we review the backscatter diagnostics at the 100-kJ laser facility for laser-driven hohlraum applications.

We have designed eight sets of full aperture backscattering system (FABS) and near backscattering system (NBS) installed with two on each of four beam cones at the 100-kJ laser facility.[3] FABS measures the light backscattered into the incident aperture, while NBS provides the information of light scattered outside of the FABS aperture. As shown in Fig. 1, the FABS diagnostic system employs calorimeters, fast photodiode, high-performance streak camera equipped with spectrometer, oscilloscope, and CCD to simultaneously measure the energy, power and spectrum of scattered light. For NBS measurements, large mirrors are mounted surrounding the incident apertures in the chamber to collect the scattered light with larger solid angle than that collected by the FABS.

Both FABS and NBS diagnostic systems provide two separate measurements for light with different spectral bands associated with SRS and SBS processes. As we know, SRS light is produced by electron plasma waves, which covers the wavelength of 400-700 nm, while SBS light arising from ion acoustic plasma waves has a bandwidth of 348-354 nm. The absolute calibrations are done through the entire system and spectrum. The capabilities of measuring the backscatter light enable us to investigate the laser-plasma conditions in different laser configurations and hohlraum geometries including spherical and cylindrical hohlraums.

References
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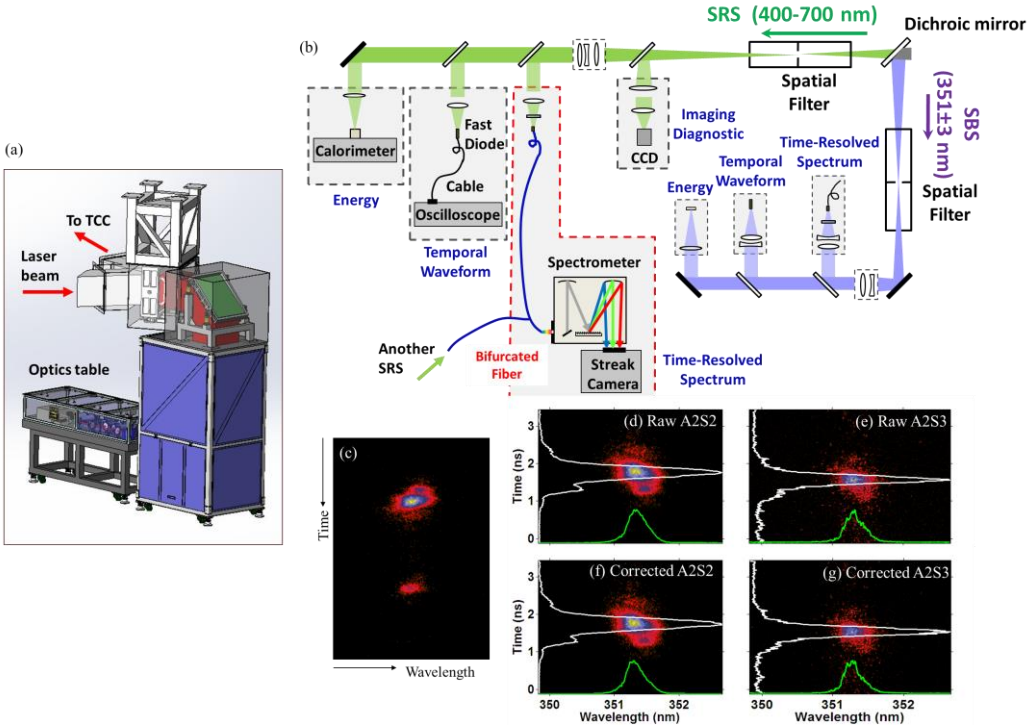

Figure 1. FABS diagnostic instrument and its applications. (a) The layout of one FABS. (b) The optical schematic of the FABS. (c) The raw data for SBS spectra recorded on a streak camera. (d) and (f) are the extracted and the corrected spectrum for beam A2S2 in (c), respectively. (e) and (g) are the extracted and the corrected spectrum for beam A2S3 in (c), respectively.