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CTH2 5:00 pm

Measurements of the optical contrast on OMEGA: A 60-beam, 30-kJ UV fusion laser

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For most direct-drive ICF experiments, it is important that the 0.5- to 4-ns laser pulses that irradiate targets on OMEGA have high optical contrast. Using a photodiode that is sensitive to intensities that are 10^{-8} of the main OMEGA pulse, the UV output of OMEGA was measured for a duration of ~ 20 ns before the arrival of the main pulse. By cross-calibrating this with the main pulse shape, we constructed the entire temporal pulse shape over 20 ns and over approximately eight orders of magnitude. To assess the tolerable level of contrast, we performed experiments that probe the Al barrier layers placed on most OMEGA targets. We also correlate the performance of imploding spherical targets with the measured optical contrast. The front surfaces of planar targets were probed with a pulsed laser that fed an interferometer whose output was coupled to an optical streak camera. When this layer was vaporized, the interferometer fringes disappeared. The time that disruption occurred was correlated with the measured contrast to determine what prepulse energies will damage the layer. These measurements are corroborated by independent measurement of the laser-damage threshold for thin layers. For imploding spherical targets, the neutron yield is a sensitive measure of performance. Plots of the neutron yield versus prepulse energy are used to determine the acceptable level of contrast.

The photodiodes that monitor the contrast in both the IR and UV portions of the system have been cross-calibrated to the signals in the main pulse and are shown to be sensitive to prepulses that are respectively 10^{-6} and 10^{-8} below the main pulse intensity. In the probe experiments six OMEGA beams irradiated CH planar targets at peak intensities of $\sim 10^{15}$ W/cm². The results indicate that the 1000-Å thick Al layer on the targets are damaged by on-target fluences of ~ 1 mJ/cm², which occur at intensities of $\sim 3 \times 10^{10}$ of the main pulse. Independent measurements confirm this. The performance of spherical implosions driven by 60 beams indicates that the neutron yield is sensitive to prepulse fluences that are 10 times

lower (0.1 J/cm²). This is because the prepulses create small-scale perturbations that affect the implosions but not the overall reflectivity of the surface layers. We present data that demonstrate the OMEGA laser routinely can produce UV pulses with on-target contrast of $>10^7$ —an acceptable level to perform precision ICF experiments.

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Advanced design of the third-harmonic generation and focusing system of the Laser Megajoule

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The Laser Megajoule is designed for delivering on target 2 MJ at 351 nm with a shaped pulse for high-energy physics experiments. To achieve this goal 240 Nd:glass amplifier chain operating at 1053 nm with 38-cm square beams will be used. These beams divided in 60 quadruplets (matrix of 2 by 2) have to be frequency tripled before being focused to irradiate the target.

The Laser Megajoule third harmonic and focusing system original design is based on high-efficiency transmitting grating. As shown on Fig. 1 the infrared beam is deviated of 50° through the infrared grating. Then the third-harmonic generation is achieved from 1053 nm (1 ω) to 526.5 nm (2 ω) with a KDP type I doubler crystal and to 351 nm (3 ω) with a DKDP type II crystal. The UV beam produced is deviated back of 50° and focused on target. The last grating allows the filtering of the unconverted light at 1 ω and 2 ω .

All the optical components for the four beams are integrated in a single mechanical structure named SCF (SCF acronym of système de conversion de fréquence et de focalization²). This SCF is an online-replaceable unit with the four 1 ω grating, the four doublers crystal, the four triplets crystal and the four 3 ω focusing grating, which are pre-aligned off line. Also the -1 reflected order of the 3 ω grating is used for accurate metrology of the beams. The transport of this 8-m-long focal length diagnostic beam is folded in the mechanical structure of the SCF with two mirrors to feed a diagnostic module. High-precision motion systems realize the cinematic of the SCF and we obtain the desired pointing accuracy on target: 50- μ m RMS. This challenging value is obtained through mechanical stability dedicated SCF structure design.

Between the SCF and the target chamber an

Thursday, May 11

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