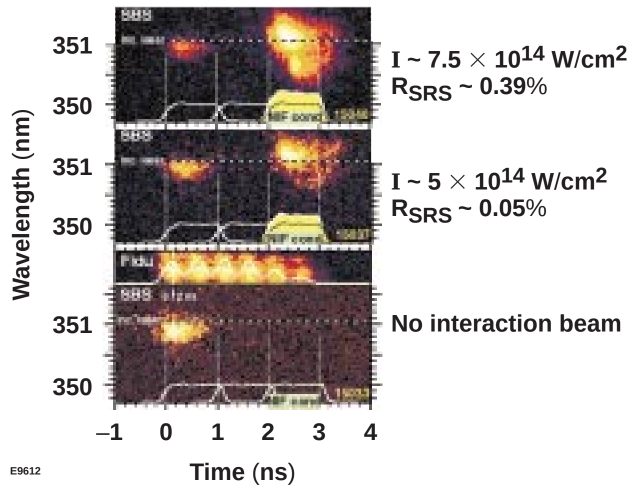
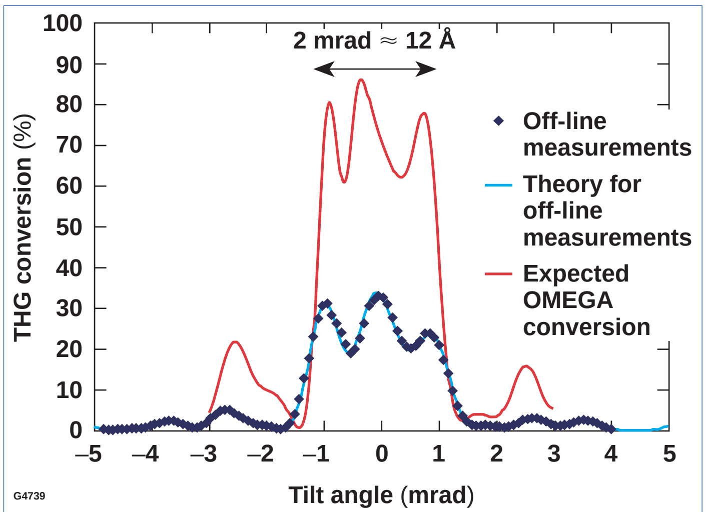
February 1999 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

Plasma Physics: On recent OMEGA experiments we investigated laser–plasma interactions (LPI) using irradiation conditions and plasmas corresponding closely to NIF direct-drive ignition experiments. The plasmas were produced using three time-staggered groups of up to ten defocused OMEGA beams, each incident on solid-CH targets. A high-intensity interaction beam was incident on the target during the last set of heating beams. All beams were equipped with phase plates, and 2-D SSD at ~0.25 THz_{UV} was used in almost all experiments. The aim was to evaluate SBS and SRS near the peak of the NIF laser pulse and in the transition region from foot pulse to main drive pulse. On NIF the overlapped total intensities on target at these times are $\sim 10^{14}$ and 2×10^{15} W/cm^2, although the intensities relevant for LPI processes are most likely ~10 times smaller and correspond to the NIF four-beam-cluster intensities. The LLE experiments showed no measurable SBS or SRS under NIF conditions at four-beam-cluster intensities. Using interaction intensities close to the total overlapped on-target intensities, the experiments yielded negligible SBS and SRS backscatter levels (≤0.5%).



Planar conditions ($2 \leq t \leq 3$ ns) corresponding to foot- to main-pulse drive transition regime for direct-drive NIF ingition experiments.

High-Bandwidth, Frequency-Tripling Cell Installation: The first of 60 high-bandwidth, frequency-tripling cells was installed on OMEGA during this reporting period. The frequency-tripling scheme for high-bandwidth conversion was proposed by D. Eimerl *et al.* [Opt. Lett. **22**, 1208 (1997)] and experimentally demonstrated by LLE last year [Opt. Lett. **23**, 927 (1998)]. The scheme uses two appropriately detuned tripling crystals and allows conversion of 1-μm radiation to its third harmonic with an overall energy-conversion efficiency of 70% and a UV bandwidth of ~1 THz. The figure shows the conversion efficiency of the first tripling cell measured immediately prior to its installation on OMEGA. Broad bandwidth is simulated by varying the angle of incidence on the crystals. Based upon this off-line measurement, the third-harmonic conversion on OMEGA at 1.5 GW/cm^2 was theoretically predicted and is also shown in the figure. Measurements of broad-bandwidth conversion efficiency are currently underway on OMEGA.



Cryogenic Fuel Target Development: Thin-wall plasma polymer (CH) capsules for use in cryogenic experiments were fabricated and tested at LLE. The thinnest-wall freestanding shell made so far is 0.3 μm thick. Shells less than 0.9 μm thick lack the necessary stiffness to resist transverse shear and bending moments that develop in the shell wall during processing. Increasing the wall thickness to 0.9 μm provides the necessary stiffness, and the buckling pressure of the shells has been measured to be 0.5±0.1 psi. These data are used to refine the processing parameters needed to field cryogenic targets.

OMEGA Operations Summary: During the reporting period, we carried out five shot campaigns and a week of quarterly maintenance work. Two LLNL campaigns totaling 19 shots were supported for shock-breakout and EOS studies. An internal Rayleigh–Taylor instability (RTI) campaign was used to characterize the hydrodynamic instability of accelerated flat foils (28 shots). The last week of the month was used to recharacterize the laser focus on target, test all LLE framing cameras (and the LLNL FXI2 camera), and run two more days of RTI (8 and 20 shots, respectively). Over the three weeks of target-shot activity, a total of 75 shots were taken. During the maintenance week the first major piece of the cryogenic target system was installed in the target bay—a 60-ft bridge across the target bay to support the upper pylon shroud-retractor system.

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