Validation of Simulations of Cryogenic Target Implosions: Significant progress has been made in modeling cryogenic target implosions. To validate the hydrodynamic codes used to design OMEGA cryogenic targets, it is crucial to match the predicted values of areal density (ρR) and ion temperature (T_i) near peak compression with experimental implosion data. To ensure that the ρR is properly modeled, the in-flight shell adiabat (α) is experimentally tuned by timing shocks launched by a series of "picket" pulses and the main drive pulse. The shock-timing accuracy is verified by measuring the velocity of the leading shock wave using a velocity interferometry system for any reflector (VISAR).[1]

Accuracy in modeling of energy coupling is verified by measuring the bang time using the neutron temporal diagnostic (NTD).[2] Currently, NTD is calibrated on OMEGA to ~50-ps absolute timing accuracy and with ~10-ps shot-to-shot timing variation. Time-resolved scattered light spectroscopy and time-integrated calorimetry are used to infer the absorption of laser light. Figure 1 compares the neutron production histories (a) and scattered light measurements (b) with predictions based on various models for a cryogenic capsule implosion. The laser absorption during the main drive is overestimated by the baseline *LILAC* hydrodynamic code calculation (the measured absorption fraction is 65±2%, while 77% is predicted). Higher predicted laser coupling results in an earlier bang time, as shown in Fig. 1(a). On average, compared to measurements, the rise of the neutron rate is shifted earlier in simulations by ~200 ps. A mechanism responsible for a reduction in energy coupling is the cross-beam energy transfer caused by stimulated Brillouin scattering (SBS).[3] When implemented into *LILAC*, beam-to-beam energy transfer, in combination with the use of a nonlocal thermal conduction model, predicts a 15% to 20% reduction in absorbed energy, in agreement with the experimental data (Fig. 1). The neutron production timing using the beam transfer and nonlocal conduction models is in very good agreement with the data. The scattered light power, however, deviates from the measurements at later times. This late-time discrepancy is due to a transfer of some of the laser energy into plasma waves caused by the two-plasmon-decay instability, which is excited in OMEGA-scale implosions at drive intensities above 5×10^{14} W/cm^2.

Figure 2 shows a comparison of the measured and predicted areal densities using the nonlocal thermal transport in combination with cross-beam transfer model. In plotting the predicted neutron-average ρR, a horizontal error bar for each point is assigned corresponding to ρR variation due to the target offset and low-ℓ mode ice roughness. The vertical error bar represents uncertainty due to limited counting statistics in magnetic recoil spectrometer (MRS) measurement. In general, there is a good agreement between the experimental data and calculations, confirming modeling accuracy.

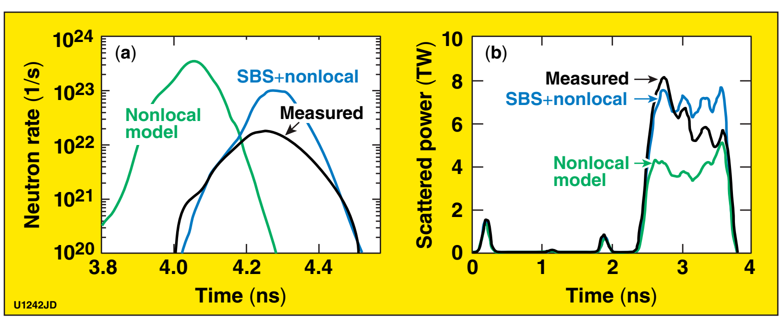

Figure 1. (a) NTD signals: green—nonlocal model; blue—simulation with SBS beam transfer plus nonlocal thermal transport; and black—actual NTD signal. (b) Scattered light signal using the same color coding.

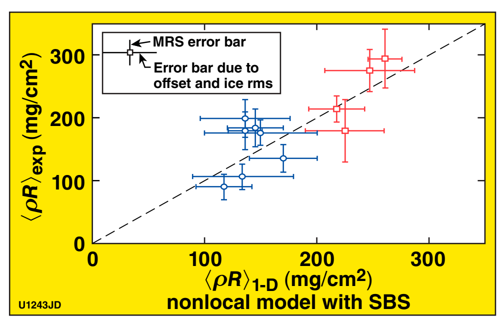

Figure 2. Measured ρR vs that predicted by *LILAC* using the nonlocal model and SBS beam energy transfer for two sets of implosions: α = 2.5 (blue circles) and α = 2 (red squares).

Omega Operations Summary: The Omega Laser Facility conducted 117 target shots in November (107 on OMEGA and 10 joint shots on OMEGA EP) with an average experimental effectiveness of 95.7% (95.8% on OMEGA and 95.0% on OMEGA EP). NIC accounted for 59 of the target shots led by teams from LLNL and LLE. Twenty-four target shots were taken for the LBS program by teams from LLE and LLNL and 34 target shots were taken by LLNL scientists for HED experiments.

1. T. R. Boehly *et al*., Phys. Plamas **16**, 056302 (2009).
2. LLE Review Quarterly Report **92**, 156, LLE/UR, Rochester, NY, LLE Doc. #DOE/SF/19460-465, NTIS Order #PB2006-106664 (2002).
3. LLE Review Quarterly Report **122**, 79, LLE/UR, Rochester, NY, LLE Doc. #DOE/NA/28302-953 (2010).

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