The role of laser-plasma interactions in laser energy coupling at the National Ignition Facility

D. E. Hinkel*
Lawrence Livermore National Laboratory, Livermore, CA, USA
**In collaboration with M. D. Rosen, E. A. Williams, R. P. J. Town, D. A. Callahan, A. B. Langdon, P. A. Michel, S. H. Langer, and C. H. Still*

Achieving nuclear fusion in the laboratory is a primary goal of the 192-beam National Ignition Facility (NIF) laser, located at Lawrence Livermore National Laboratory (LLNL). To this end, NIF's laser beams enter a high-Z cylinder or "hohlraum", which is filled with low density helium gas to reduce hohlraum wall motion. The laser beams propagate through the helium to the hohlraum wall, where their energy is converted to x-radiation. This radiation fills the target, bathing the capsule suspended in the middle of the hohlraum. The capsule consists of a central gas core composed of 50% deuterium and 50% tritium (DT) surrounded by a layer of DT ice, outside of which is a CH ablator.

Laser-plasma interactions (LPI) impact both energy coupling of the laser energy into radiation (providing sufficient drive) and the energy deposition within the hohlraum (providing symmetric radiation). Laser backscatter reduces energy coupling, and occurs via two different mechanisms. Stimulated Brillouin (Raman) backscatter occurs when the incident laser light scatters off a self-generated ion acoustic (electron plasma) wave. LPI can also modify the radiation symmetry through a variety of mechanisms, the most important of which is cross-beam energy transfer, where laser power can be transferred from one set of beams to another through a mutually shared ion acoustic wave.

Recent experiments[1] have established a platform suitable for subsequent ignition experiments. This platform provides the radiation drive and necessary low-mode symmetry required for ignition. Of the many fielded diagnostics, one provides a time-resolved wavelength spectrum of light reflected from the target by stimulated Raman scatter (SRS).

Analyses indicate that synthetic SRS diagnostics better match those of experiments when an atomic physics model with greater emissivity is utilized, along with less inhibited electron transport (higher flux, and, ideally, nonlocal electron transport). With these models[2], SRS primarily occurs in a region of the target where nearest-neighbor 23° quads significantly overlap the diagnosed 30°quad. This increases the gain at lower density (lower wavelength), a feature consistent with experimental results. Other predicted features, such as the direction and spreading of the SRS as well as its intensity, are also in better agreement with experiment.

Massively parallel beam propagation simulations[3] demonstrate that both the spatial non-uniformity of the cross-beam energy transfer, as well as the fact that overlapping quads of beams can provide additional resonant amplification, impact SRS levels. Results from these simulations as well as comparisons to experiments will be presented.

[1] N. B. Meezan *et al.,* Phys. Plasmas **17**, 056304 (2010); R. P. J. Town *et al.,* Phys. Plasmas **18**, May, 2011.
[2] M. D. Rosen, "The High Flux Model applied to some 09 implosions", Tech. Rep. LLNL-PRES-428527 3/18/10, LLNL (2010).
[3] R. L. Berger, C. H. Still, E. A. Williams, and A. B. Langdon, *Phys. Plasmas* **5**, 4337 (1998); C. H. Still, R. L. Berger, A. B. Langdon, D. E. Hinkel, L. J. Suter, and E. A. Williams, Phys. Plasmas **7**, 2023 (2000); D. E. Hinkel, D. A. Callahan, A. B. Langdon, S. H. Langer, C. H. Still, and E. A. Williams, *Phys. Plasmas* **15**, 056314 (2008).