Panel 1: Laser Propagation and X-ray Production

The “outer ” NIF laser beams enter the hohlraum, propagate towards, and primarily heat, the Au wall. They are collisionally absorbed in sub critical gold plasma, and electron thermal conduction then heats denser gold, which is the primary source of x-ray production. The x-rays are mostly sub keV (“capsule drive”) photons, plus “M-band” (2-4 keV photons) that have capsule preheat implications. The “inner” beams, on their way to the Au wall near the hohlraum midplane, must traverse a longer path of plasma, much of which consists of both low Z “hohlraum fill gas” as well as rarefied, heated, capsule ablator material.

There are many issues involved in properly modeling the large number of physical processes involved in this narrative. Due to beam overlap in the plasma, there is transfer of power from outer to inner beams. This time dependent energy transfer is being used for capsule implosion symmetry control. Accurately calculating this cross-beam transfer requires knowledge of the plasma conditions (T, n, velocity field) near the Laser Entrance Hole (LEH), as well as a good theory for the saturation mechanisms for the transfer.

As the beams propagate they are collisionally absorbed. Accurately calculating the absorption also requires knowledge of the T, n, and Z of the plasma. The non-LTE radiation processes, the non-local electron conduction, and the non-Maxwellian particle distributions all affect these quantities. The mixing of the high Z Au blow-off plasma from the wall with the low Z fill gas plasma can also be a factor in determining these quantities. The LEH itself is dynamically closing, and difficult to model properly, and magnetic fields are likely to form within its sharp gradients. The LEH affects laser beam propagation inward, as well as “Dante”, the x-ray drive diagnostic which gathers x-rays emitted through that LEH.

Laser Plasma Instabilities (LPI) also occur. Stimulated Brillouin (SBS) and Raman (SRS) instabilities scatter the light off of ion and electron waves respectively. The SRS electron plasma wave can produce hot electrons that can preheat the capsule directly, or possibly indirectly through inducing high-energy photons from the Au wall. Accurately calculating these LPI processes has been a multi-decade, and multi-scale enterprise. Accurately knowing the plasma conditions and the local laser intensity, are necessary (though possibly insufficient) inputs to understanding what LPI to expect.

As but one example of the non-linear cross-talk amongst all of the above, consider this: Cross-beam transfer can intensify just a part of an inner beam. The resulting SRS from that intense part of the inner beam can send light back, from the interior of the hohlraum, towards the LEH. That scattered light can be collisionally absorbed and heat the plasma in the LEH, thus changing the plasma conditions that can then affect the cross-beam transfer!

In this panel we will raise issues as to how to better model (and better diagnose experimentally) this panoply of issues, and discuss the implications thereof for better ignition target performance.

LLNL-MI-549511