Workshop on the Science of Fusion ignition on NIF
May 22 – May 24, 2012

http://lasers.llnl.gov/workshops/science_of_ignition/

Panel 1: Laser Propagation and X-ray Generation

May 24, 2012: Final Panel Outbriefs Plenary Session

Panel 1 Co-Leads:

Chan Joshi – University of California, Los Angeles

Mordecai Rosen – Lawrence Livermore National Laboratory

LLNL-PRES-559751

Panel 1: Beam Propagation LPI & X-rays
Goal: Identify Science directions that can help maximize drive and symmetry

1) Minimize LPI

2) Make cross beam transfer an optional rather than a necessary tool

3) Get rid of the hot electron issue

4) Get a more predictive handle on symmetry of x-ray illumination

Title of Panel

Title of Priority Research Direction

Underlying physics to be addressed

- Identify/describe the physics process or parameter
- What approximations or assumptions are made in representing it in simulations?

Learned from Recent Experiments

- How do recent experimental results bear on our understanding of this physics, and how it is represented?

Research Directions

- What can be done to address the challenge?
  - Theory
  - Code development
  - Experiments
  - Experimental platforms

Outcome and Potential Impact

- What would be the impact of a better treatment or understanding of this physics, for the simulation capability, for understanding current results, and for moving the field forward

Beam Propagation LPI & X-rays

Understand LPI Conditions 1

Underlying physics to be addressed

- Both laser and plasma conditions control LPI and beam propagation
- Complex NLTE processes & non local heat transport are part of the calculation

Learned from Recent Experiments

- SRS spectrum and symmetry behavior consistent with a "cool" Te of ~ 2.5 keV
- Better science made for a better model

Research Directions

- Improve NLTE & kinetic descriptions
  - Implement internal SRS & X-beam
  - Check numerical convergences, zoning, photon bins etc.
  - Measure Te, Ne via Thomson Scatter (2ω?) or spectroscopy at LEH, Au, SRS, waist
  - Re-optimize gas fill density/composition
  - Look for B fields
  - Interpenetrating plasma models

Outcome and Potential Impact

- Detailed understanding of the plasma conditions will allow us to concentrate on the science of the L & I of LPI for coupling & symmetry, and on beam propagation for symmetry

Beam Propagation LPI & X-rays

Understand LPI Conditions 2: Raise Te?

Underlying physics to be addressed

- Effect of increasing Te on:

  -- beam propagation

  -- cross-beam energy transfer

  -- LPI

Learned from Recent Experiments

- SRS levels are high, due in part to cooler Te
- Cross beam energy transfer is required for symmetry
- SBS on outer cones is increasing late in time with greater energy

Research Directions

- B field imposed externally to cut the conductivity and raise Te
- Dope hohlraum interior with a higher Z to raise Te (via ablator outside doping? Gas doping? Foam filled hohlraum doping?)

Outcome and Potential Impact

- Raising Te can reduce SRS and thus increase coupling.
- A hotter plasma will also allow better beam propagation and reduce the need for cross beam transfer

Electron Plasma Wave Science 1: SRS

Underlying physics to be addressed

- Raman Scatter decreases coupling
- Kinetic effects
- Electron plasma waves near quarter-critical density
- Hot electron transport

Learned from Recent Experiments

- SRS has been the major coupling loss channel
- SRS/two-plasmon decay makes hot electrons

Research Directions

- Mitigate SRS via hotter Te or 4ω
- Cross code comparisons
- Kinetic codes useful in 1-D, 2-D, 3-D
- "Ultra" temporal resolution of backscatter (~ 1 ps)
- Design SBS-dominated experiment
- pF3D improvements: (non-paraxial, …)

Outcome and Potential Impact

- Successful implosions without hot electrons could eliminate that issue
- Internal LPI may affect 4th shock rise time
- NIC may well need the extra energy saved from suppressing SRS for pushing a thicker ablator

Electron Plasma Wave Science 2: SRS

Underlying physics to be addressed

- Raman Scatter decreases coupling
- Kinetic effects
- Electron plasma waves near quarter-critical density
- Hot electron transport

Learned from Recent Experiments

- SRS has been the major coupling loss channel
- SRS/two-plasmon decay makes hot electrons

Research Directions

- Mitigate SRS via: laser bandwidth, rapid and adaptive amplitude modulated (STUD) pulses (~ 1 ps)
- SRS decrease via wave-breaking
- "One-way" light (turn off one side of beams and look at transmission/SRS)

Outcome and Potential Impact

- With understanding can come mitigation schemes
- Internal LPI may affect 4th shock rise time
- NIC may well need the extra energy saved from suppressing SRS for pushing a thicker ablator

Beam Propagation LPI & X-rays

Ion Wave Science 1: SBS

Underlying physics to be addressed

- Brillouin Scatter decreases coupling
- Kinetic effects

Learned from Recent Experiments

- SBS has been increasing in “no coast” pulses on the outer beams
- SBS competes with SRS

Research Directions

- Find ways to mitigate SBS
- Design SBS-dominated expt
- Cross code comparisons across experimental platforms
- Thomson scatter to measure ion waves
- “Ultra” temporal resolution of backscatter (< 10 ps)

Outcome and Potential Impact

- Outer cone SBS may continue to increase in future experiments
- Need to learn to “tame it” e.g. Au/B (in a DU hohlraum)

Ion Wave Science 2: Cross Beam Energy Transfer (CBET)

Underlying physics to be addressed

- Cross Beam energy transfer
- SLIP + hydro codes calculate level

Learned from Recent Experiments

- CBET has been crucial in symmetry
- Evidence that CBET decreases in time – saturation?

Research Directions

- Implement ion heating theory into code
- Implement CBET code in-line into hydro codes
- Thomson scatter to measure the ion waves, Ti & Te vs. time
- Design expt: "LEH" mock-up to monitor transmitted beam profile (Ω & NIF)
- Expt's at 1 MJ w. & w.o CBET
- Temporally interleave STUD pulses(~ 10 ps) to control CBET

Outcome and Potential Impact

- Time dependence of CBET will remain a key part of NIC
- Spatial inhomogeneity of beams can affect x-ray production and symetry

Beam Propagation LPI & X-rays

X-ray Production

Underlying physics to be addressed

- NLTE produced X-ray Drive
- M-band is important for hydro-stability
- LEH closure is a challenge to the rad-hydro

Learned from Recent Experiments

- Drive may be ~10% lower than current standard model
- LEH size affect Dante Interpretation

Research Directions

- Improve DCA to go to LTE opacity of tables
- Do hot-electron induced atomic physics
- Zoning convergences for hydro model
- Re-do experiments on Omega Gold Sphere with absorption measurements and Thomson Scatter Te

Outcome and Potential Impact

- Having a reliable “drive” can allow us to focus on capsule ablator & hydro instability issues