Workshop on the Science of Fusion ignition on NIF

May 22 – May 24, 2012

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

Panel 6: Integrated Modeling

May 24, 2012: Final Panel Outbriefs Plenary Session

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Integrated Modeling
A Science-Based Validation Campaign

Paths for Validation

- Perform directed experiments (e.g.,check replicate variability, conduct sweeps of experiment parameters, reduce experimental uncertainties for system response quantities of greatest importance)
- Identify an integrated experiment matched by the current model; start from there and march along various paths towards point design and see where model breaks down.
- Continued code-to-code verification, numerical convergence, validation is best done independent of development

Learned from NIC

- Laser power must be reduced in integrated simulation with high flux model (~13% peak). Time dependent power multipliers (41) on laser power to match Visar, bang time.
- With adjusted drive simulation is reasonably close to many experimental capsule performance parameters. Neutron yield low by factor of several to 10.
- The simulation technique has an extensive pedigree of validation, but not all comparisons/calibrations have been performed using today's codes in today's manner.

Research Directions

- Define, peer review, and document a version-controlled standard generator deck paradigm
- Define a set of canonical verification tests and validation experiments; apply the version-controlled standard generator deck paradigm and quantitatively assess match.
- By understanding uncertainties, define an optimized mix of focused and integrated experiments, physics thrusts, and high-fidelity simulations, including 3D.
- Reduce experimental uncertainties

Outcome and Potential Impact

- Greater community and customer confidence in the simulation tools being used to determine to where we jump to start a new 'tuning' approach.
- A better understanding of where the code is breaking down as we move away from no knobs 'validation' points, and better discrimination of competing hypotheses.
- A defendable, quantitatively optimized research plan based on verification, validation, and understanding uncertainties

Integrated Modeling Panel
Improved Modeling of Hohlraum Energetics

Underlying Physics To Be Addressed

- Opacities and EOS (LTE & NLTE)
- Better understanding of LPI physics – SBS, SRS, energy transfer between crossed beams
- Nonlocal electron transport

Learned from Recent Experiments

- With HFM cooler plasma temperatures obtained, better agreement with plasma condition inferred from LPI measurement
- Degraded laser drive required to match capsule implosion trajectory
- Updated accounting for LEH closure accurately gives capsule flux ~4% low on average compared to Dante

Research Directions

- Research better NLTE kinetics models (within the DCA framework) and integration into code
- Experimentally test newer inline models for cross beam transfer and backscatter for greater self consistency in energy flow
- Measure hohlraum temperature and density
- More comprehensive measurements of LPI- induced energy redirection
- Test nonlocal model against more detailed kinetic modeling (Impact,…)

Outcome and Potential Impact

- Improved predictive capability for modeling capsule drive and preheat
- Improved understanding can lead to higher drive
- Improved validation of integrated model using the new measurements

Integrated Modeling

Investigate Kinetic Effects in TN Yield

Underlying Physics To Be Addressed

- Thermonuclear yield
- Current modeling assumes standard fluid dynamics, including quasi-neutrality (so neglects electric fields); transport laws; LTE atomic physics; and uniformity of plasma properties

Learned from Recent Experiments

- Low neutron yields despite expected areal density and reasonable ion temperature

Research Directions

- Use proton radiography to measure electric fields
- Theory – boundary layer kinetic theory
- Evaluate processes in existing PIC codes, explore kinetic/hybrid and sub-grid models
- Include in integrated model, if warranted

Outcome and Potential Impact

- Identify possible causes of yield degradation (errors in non-local electron, ion transport, barodiffusion, ion tail depletion)
- Improved agreement of integrated model with neutron yield