# Workshop on the Science of Fusion ignition on NIF

## May 22 – May 24, 2012

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

## Panel 3: Implosion Hydrodynamics

## May 24, 2012: Final Panel Outbriefs


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# Panel 3: Ablation front instability

## Underlying physics to be addressed

- Ablation front instability
- Likely under predicted in present simulations for a variety of reasons

## Learned from Recent Experiments

- Strong indications from NIC that ablative instability is more aggressive than originally expected

## Research Directions

- What can be done to address the challenge?
  - Face-on radiography with roughened ablator in keyhole-like geometry with *NIC pulse*
  - Alternate ablator experiments
  - Large amp. for RM/small for RT

## Outcome and Potential Impact

- Ability to accurately predict yield cliff as a function of mass remaining and design improved target

# Panel 3: 1st picket-trough control study of instability

## Underlying physics to be addressed

- Control of ablation front instability

## Learned from Recent Experiments

- Ablation front instability strongly suspected

## Research Directions

- Design and shoot a series of targets with varying picket to trough ratios
- Possible adiabat shaping

## Outcome and Potential Impact

- An implosion less sensitive to A-RT
- Improved compression

# Panel 3: Adiabat scan to study/control mix

## Underlying physics to be addressed

- **Sensitivity of mix to ice adiabat**

## Learned from Recent Experiments

- **Yield is over-calculated and we want to blame it on mix**

## Research Directions

- **Alteration of 2nd and 3rd pickets to obtain scaling of Y.O.C.** (will require re-tune of symmetry)

## Outcome and Potential Impact

- **Resolve model – data discrepancy**
- **Illuminate a possible mix control knob in experiment**

# Panel 3: Mix control with thick ice implosions

## Underlying physics to be addressed

- Penetration of ablator material into hot-spot
- Ablator only needs to penetrate into the last 10% of ice to show up in hot-spot

## Learned from Recent Experiments

- Ablation front instability strongly suspected
- NIC urge is to thicken ablator and turn up power to compensate, but may not help

## Research Directions

- Thicken ice ~20 um to move hot-spot forming part of ice away from ablator
- Thicken ablator and ice together?
- Scaled implosions with less energy for full study

## Outcome and Potential Impact

- Improved hot-spot pressure (return shock won't have time to re-enter ablator)
- Improved yield performance

# Panel 3: Atomic level mix

## Underlying physics to be addressed

- Transition from instability to atomically mixed
- Mix cliff
- Models presently assume average in computational cell (EOS, burn-rate, opacity, etc.)

## Learned from Recent Experiments

- Mix strongly suspected, but amount/distribution/source of mix not entirely clear

## Research Directions

- What can be done to address the challenge?
  - Develop LES representation with parameter free sub-grid model (reduced numerical diffusion)
  - Separated reactant experiments (CD ablator + T fill)
  - Reaction history for lower yields is important here

## Outcome and Potential Impact

- Correct "input" for burn-phase calculation
- Improved model-data fidelity

# Panel 3: Ablation physics in planar geometry (CH and/or alternate ablator material)

## Underlying physics to be addressed

- Ablation pressure response to x-ray drive
- "Start-up" conditions up to fourth shock to *diagnose profile of ablation front*

## Learned from Recent Experiments

- Ablator may not be responding to x-ray drive as expected
- Drive or response?

## Research Directions

- Perform planar experiments in half-raum geometry with NIC-like drive and diagnose ablation profile side-on
- Use visar on face to diagnose v(t) history
- X-ray Thompson scat. in ablation plasma if possible

## Outcome and Potential Impact

- Helps unfold ablator drive/response mystery
- Helps resolve scale length questions w.r.t. instability growth
- Model validation

# Panel 3: Doped wicked foam in layered capsule

| Underlying physics to be addressed | Learned from Recent Experiments |
| --- | --- |
| ▪ Hot-spot formation and stagnation properties<br>▪ Hot-spot shape<br>▪ Cold fuel shape<br>▪ Mix | ▪ Hot-spot is under-performing |

| Research Directions | Outcome and Potential Impact |
| --- | --- |
| ▪ Improve emission imaging of hot-spot<br>▪ Radiography of cold fuel easier?<br>▪ Spectroscopy to obtain direct measurement of H.S. density | ▪ More data on hot-spot/cold fuel condition<br>▪ Model validation |

# Panel 3: High-mode (~100) "direct" 3D simulation of with known I.C. of a practical number of shots

## Underlying physics to be addressed

- HS stagnation pressure reduction due to shape and vortex flows
- Observed cliff behavior?

## Learned from Recent Experiments

- Two nominally identical targets (N120126 & N120205) that behave differently (factor of 2x in Y & DSR asymmetry)

## Research Directions

- What can be done to address the challenge?
  - Inter-comparison with various codes using simplified test problem
  - Inter-compare with theory
  - Uses existing NIC database for point of comparison
  - Demonstrate (2D) ablation setting mode 1000 as minimum req. scale

## Outcome and Potential Impact

- May explain stagnation pressure and yield reduction observations without invoking "exotic" physics

# Panel 3: Conductivity and magnetic field effects on hot-spot formation

## Underlying physics to be addressed

- Ablation of inner ice and hot-spot properties
- Presently using one "best-guess" conductivity form and no magnetic fields

## Learned from Recent Experiments

- We don't accurately capture the condition of the hot-spot in simulations

## Research Directions

- Improved conductivity tables with uncertainty
- Magnetic field source and conduction terms in model
- Combine with 2D/3D morphology of ice/hot-spot

## Outcome and Potential Impact

- Improved model fidelity with respect to hot-spot formation, setting the stage for improved modeling of burn phase