US-Japan Target Fabrication Workshop

Welcome!!!!

Target fabrication- the Challenge!

- **Targets are complex 3 dimensional mesoscale objects, with hazardous materials (Be, Tritium for example) at cryogenic temperatures with nano-fabrication tolerances!**
- **Targets are to be injected into a ~5 meter Fusion target chamber at ~5 Hz to an accuracy of ~100μm**
- **~500,000 per day at ~$ 0.25 per target**

Less than ~10% of the IFE/ICF Resources are directed to Target fabrication R&D!

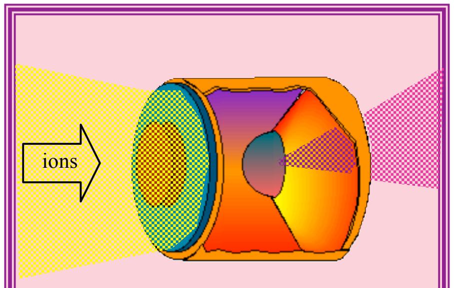
Target Fabrication-"Birth to Fusion"

- Target fabrication is more than "making the targets"
  - characterization is a major challenge (why not a dedicated workshop?)
  - materials selection must include physics requirements, ability to characterize, complete fuel cycle ("birth to waste!")
  - placement at target chamber center
  - economics

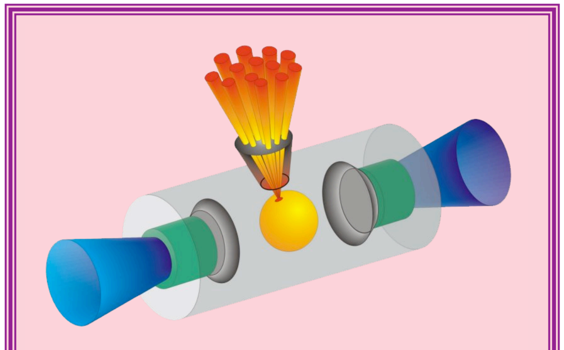
Fast Ignition presents new opportunities and challenges for Target Fabrication

- Potentially significantly reduced fabrication tolerances
- innovative cryo layering
- 3D implosion systems-i.e. cones with shells!

Fast Ignition is compatible with all drivers



Heavy Ion Beam Drive



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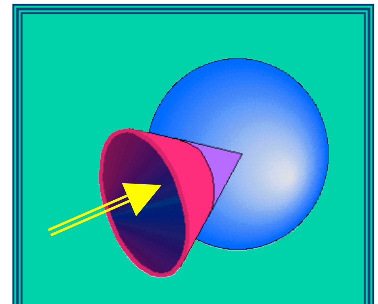
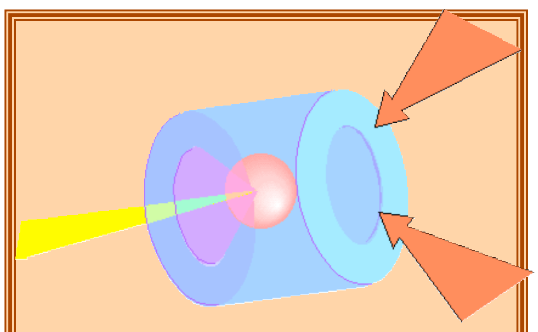


Direct Laser drive

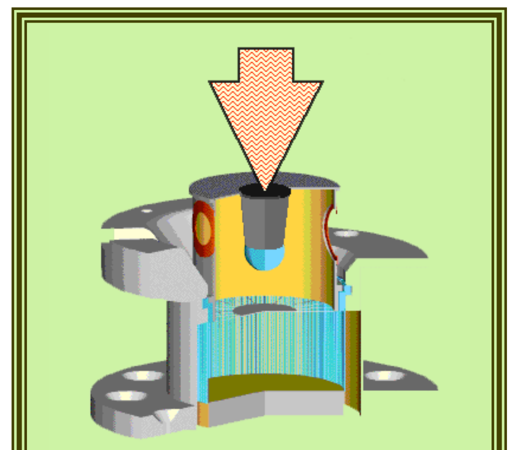
Innovative target designs
are possible

BUT

Ignition requires intense
short pulse
~30 ps
~30 kJ (absorbed)
~ 30 μm diameter



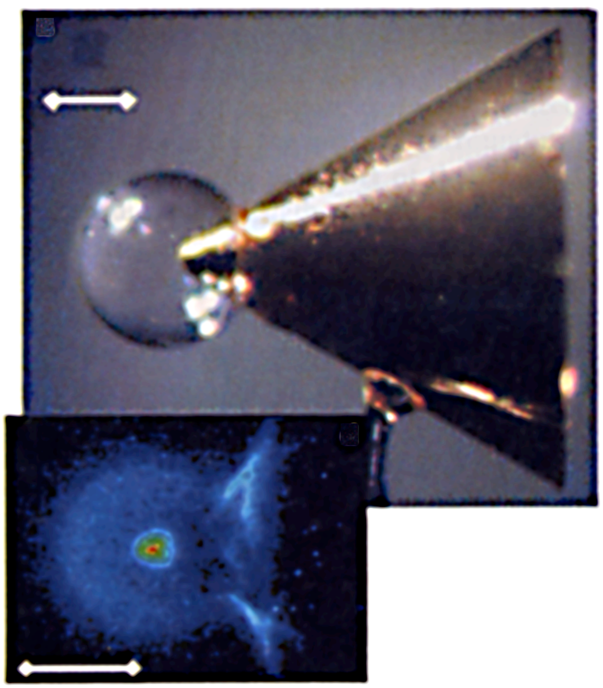
Indirect Laser drive



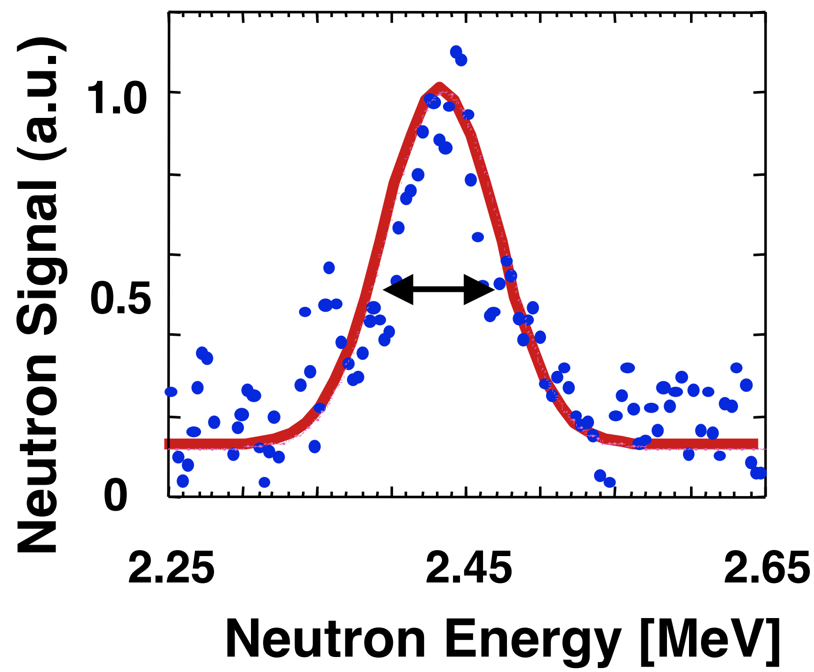
Z-pinch Drive

Neutron Time of Flight shows an increase of ~800eV in the ion temperature when the heating beam is on

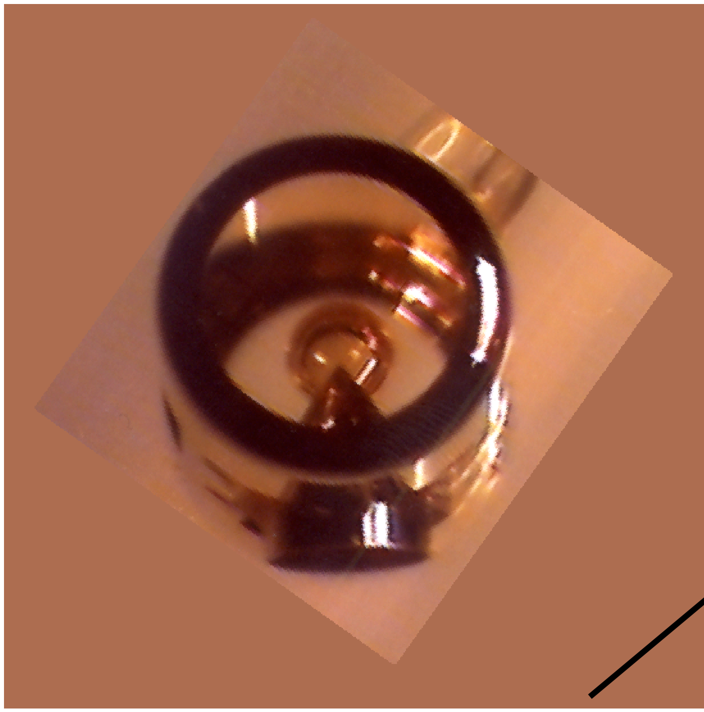
ILE Osaka

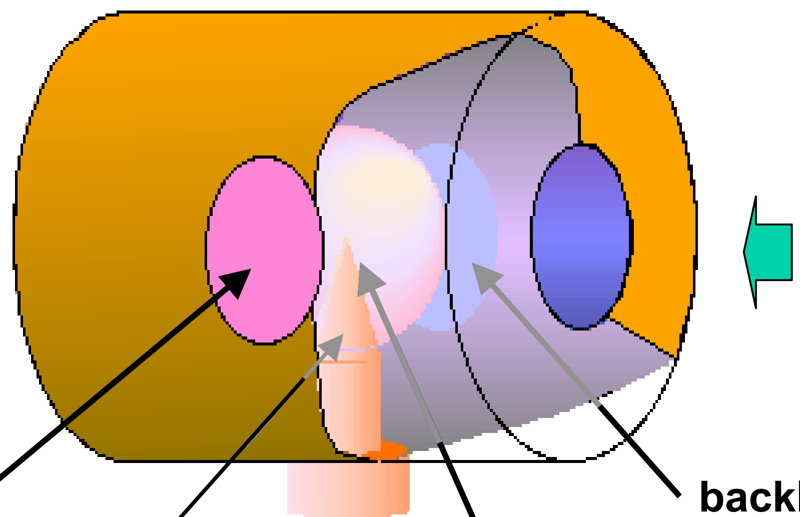


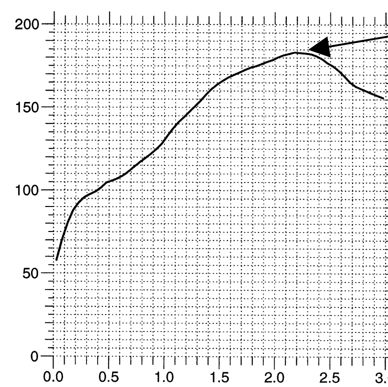
2 keV (self emission)
xray image



FI laser driven Indirect Drive implosion

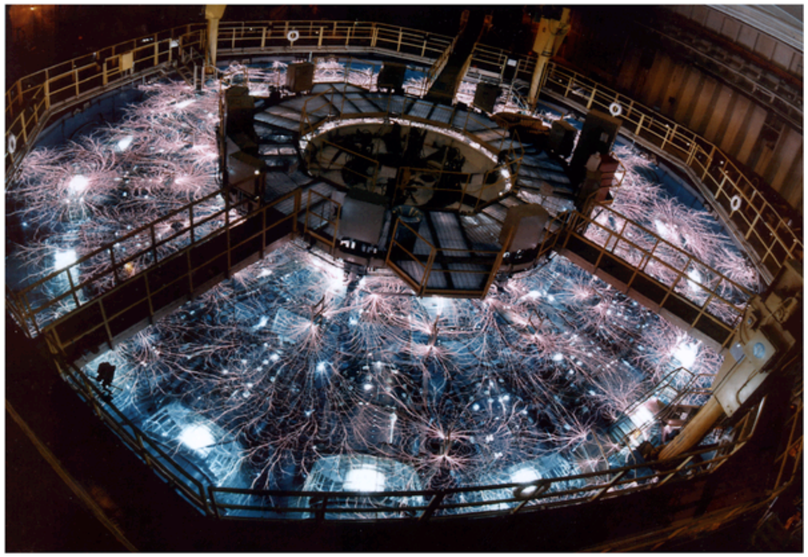


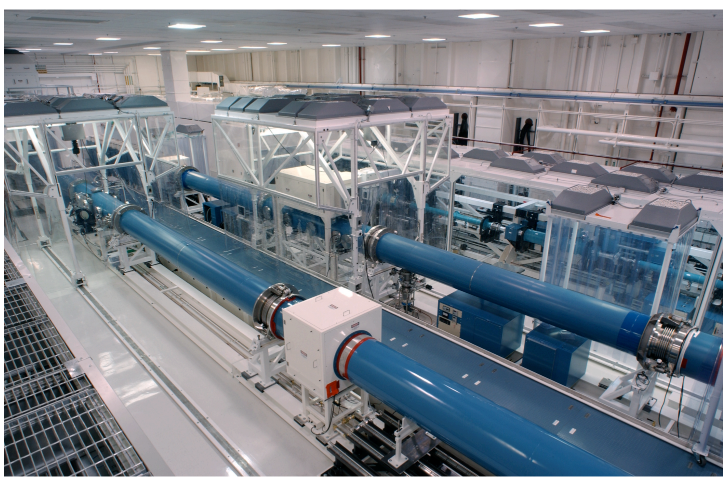




Scales to ~27 MJ yield on NIF
with ~50-80 kJ of ignition laser

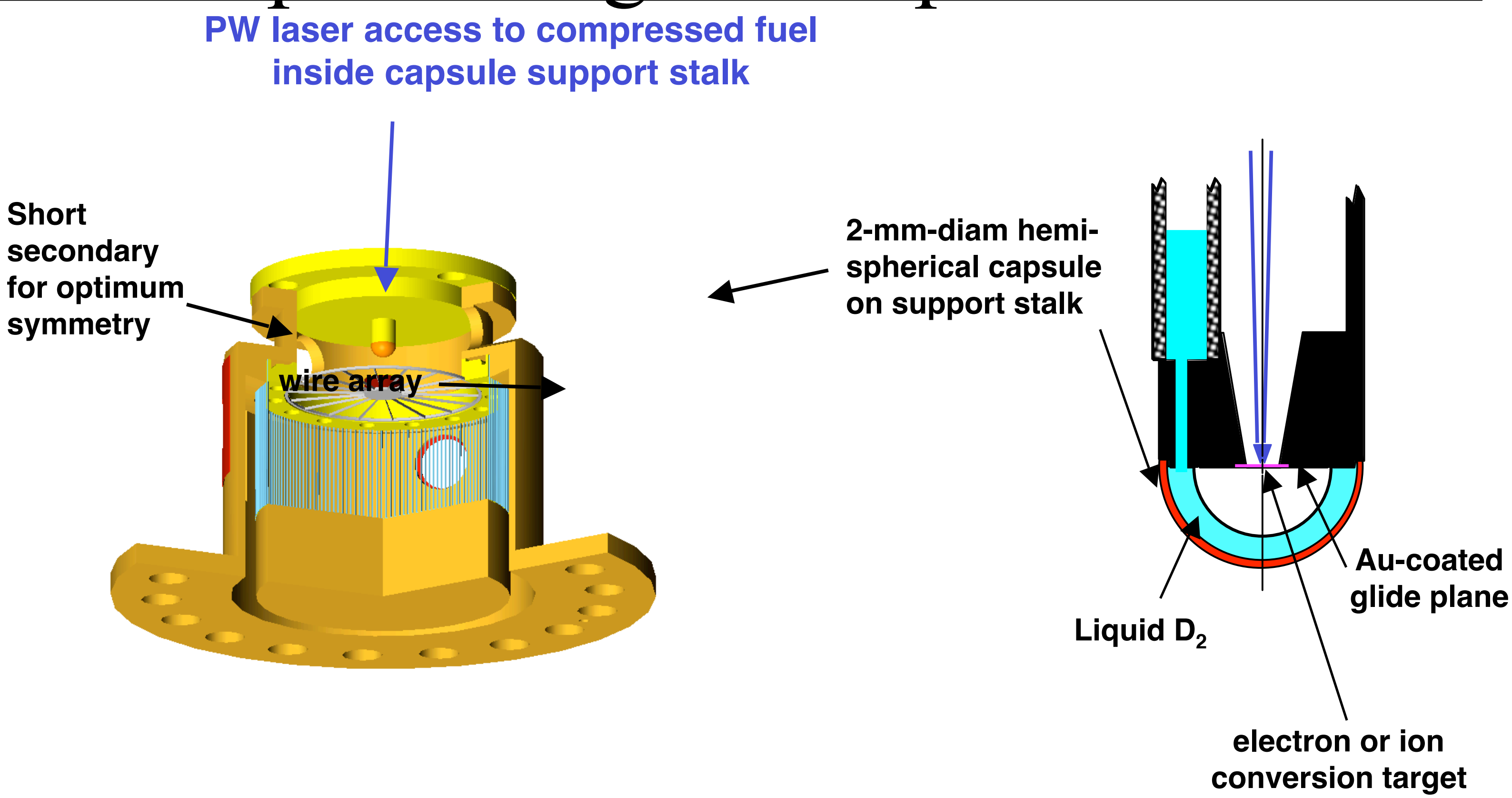
Pulsed power-a new testbed for xray driven fuel assembly FI studies





- Rapid Progress in Z pinch physics has provided ~2MJ and ~200TW of xrays for fuel assembly
- The Beamlet laser from LLNL has been successfully coupled to Z
- Modifications are underway
  - Increase xray energy to >**3 MJ**
  - **CPA** modification to beamlet
    - > 1kJ in 1-5 psec

A z-pinch driven fast-ignitor concept is being developed

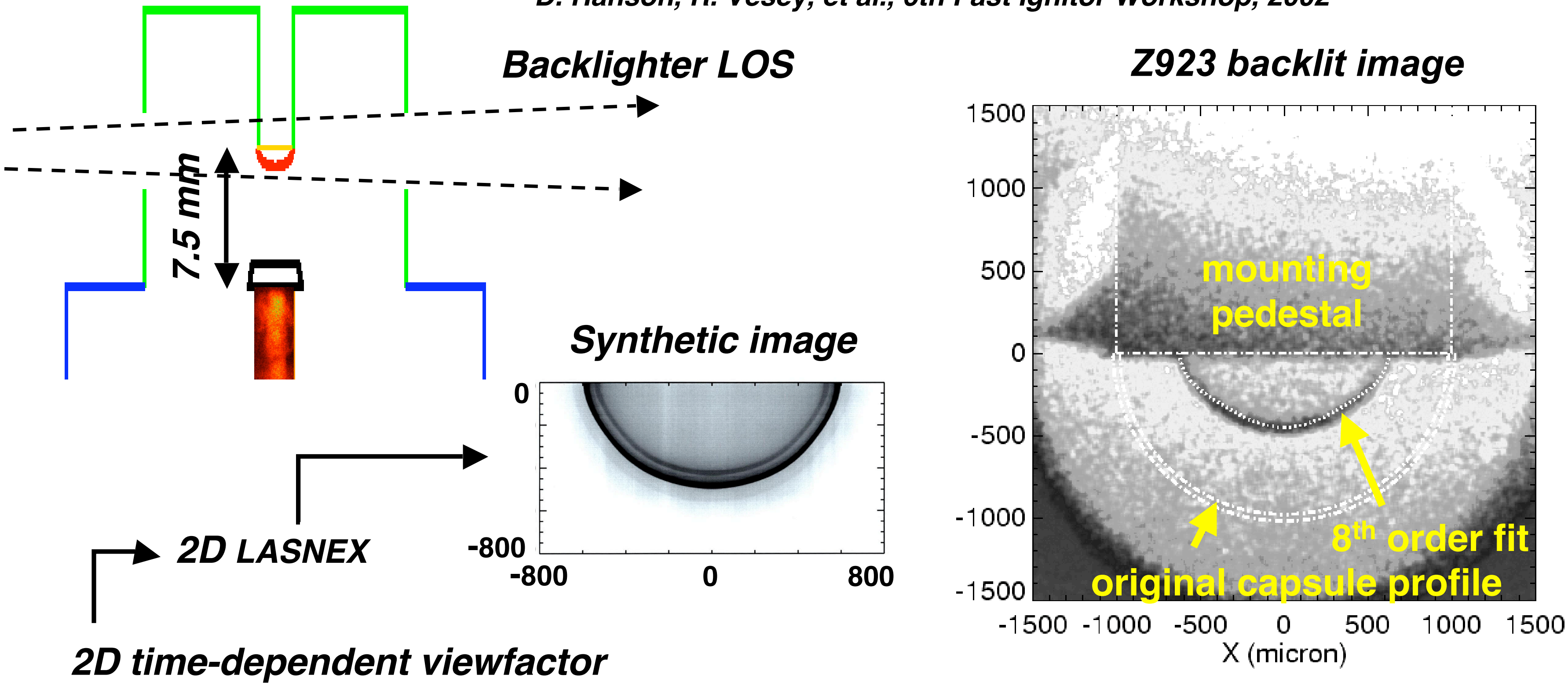


D. Hanson, R. Vesey, et al., 6th Fast Ignitor Workshop, 2002

- Z hohlraum designs should allow ρ = 90-100 g/cc, ρr = 0.4 g/cm^2
- Simulations for ZR with cryo-DT capsule give ρ = 160 g/cc, ρr = 0.65 g/cm^2

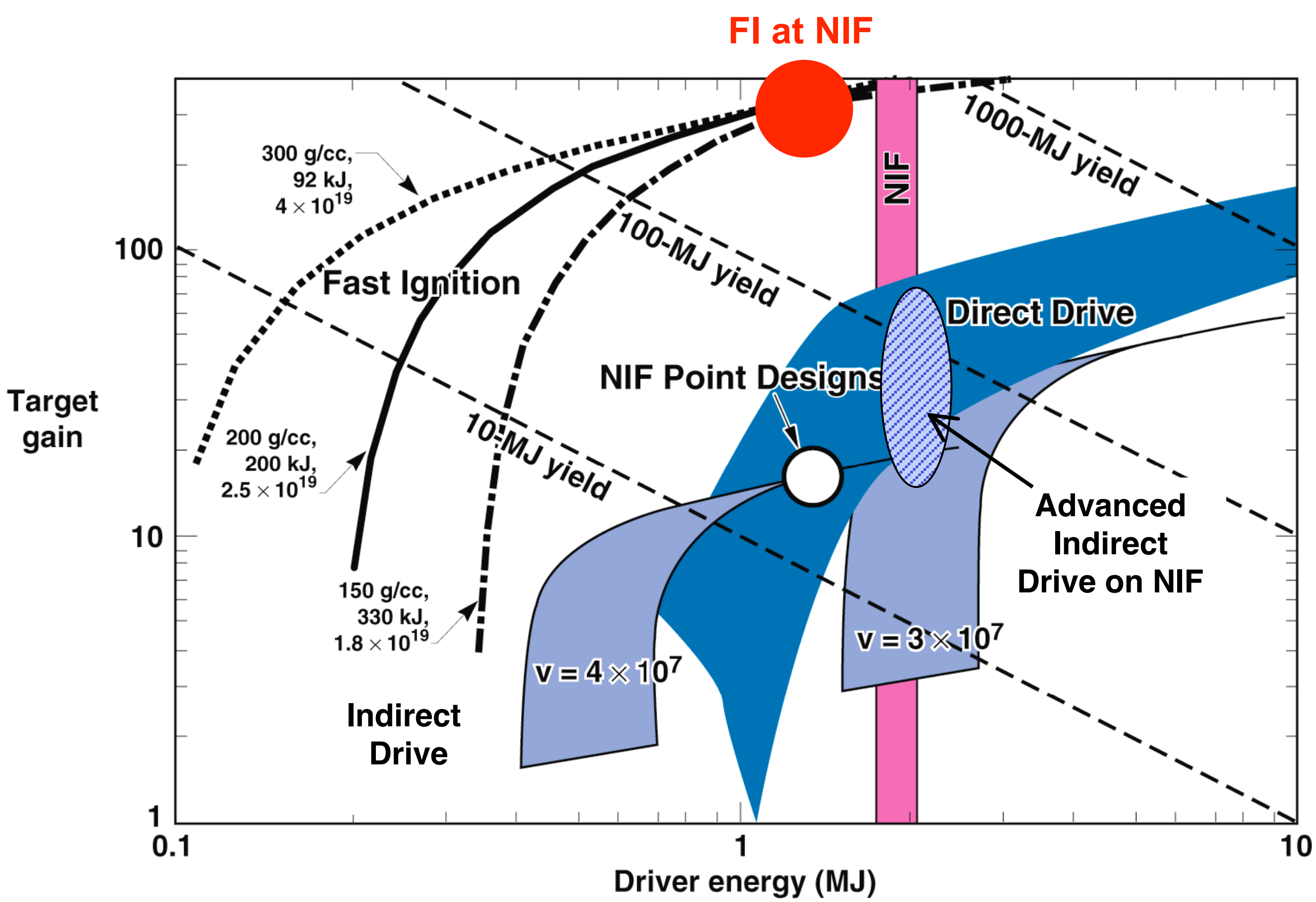
Fast ignition imploded fuel designs are being validated with experiments on Z

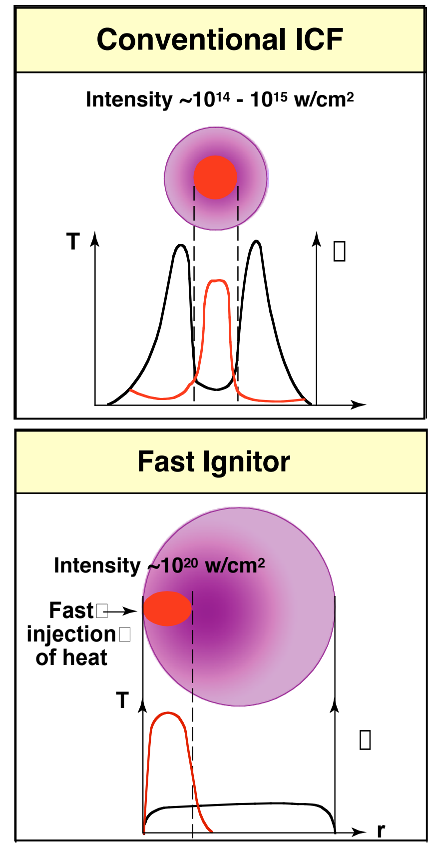
D. Hanson, R. Vesey, et al., 6th Fast Ignitor Workshop, 2002



- Preliminary image analysis agrees qualitatively with 2D simulations
- 2D simulations give polar-averaged peak ρ = 60 g/cc, ρr = 0.3 g/cm^2

Ignition and gain curves for multiple target concepts show the advantages of Fast Ignition





— Fast ignition potentially gives more gain and lower threshold energy then "Hot Spot" ICF but the science and technology are less well developed

Fast Ignition may allow longer wavelength laser implosion systems -The advantages are significant

- Efficiency
  - Typical energy efficiency for conversion of 1053 nm to 351 nm is 50% (NIF, Omega)

2x the pulsed power (or diodes!)

- Aperture
  - Damage threshold for 1053 nm is ~35 J/cm _, 532 nm is 25 J/cm _ and 351nm is ~12-15 J/cm_

40%-70% reduction in aperture!