Welcome!!!!

US-Japan Target Fabrication Workshop
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 ~100\(\mu\)m
- ~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

Innovative target designs are possible

**BUT**

Ignition requires intense short pulse

- \( \sim 30 \text{ ps} \)
- \( \sim 30 \text{ kJ (absorbed)} \)
- \( \sim 30 \mu\text{m diameter} \)
Neutron Time of Flight shows an increase of ~800eV in the ion temperature when the heating beam is on.

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

Rad Temp (ev)

E_{laser} = 14 \text{ kJ}
Pulsed power—a new testbed for x-ray driven fuel assembly FI studies

- Rapid Progress in Z pinch physics has provided ~2MJ and ~200TW of x-rays for fuel assembly
- The Beamlet laser from LLNL has been successfully coupled to Z
- Modifications are underway
  - Increase x-ray energy to >3 MJ
  - CPA modification to beamlet
    - > 1kJ in 1-5 psec
A z-pinch driven fast-ignitor concept is being developed

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

*D. Hanson, R. Vesey, et al., 6th Fast Ignitor Workshop, 2002*
Fast ignition imploded fuel designs are being validated with experiments on Z.

- Preliminary image analysis agrees qualitatively with 2D simulations.
- 2D simulations give polar-averaged peak $\bar{\rho} = 60$ g/cc, $\bar{\rho}\ell = 0.3$ g/cm$^2$. 

D. Hanson, R. Vesey, et al., 6th Fast Ignitor Workshop, 2002
Ignition and gain curves for multiple target concepts show the advantages of Fast Ignition.

— Fast ignition potentially gives more gain and lower threshold energy than “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 351 nm is ~12-15 J/cm
    
  - 40%-70% reduction in aperture!