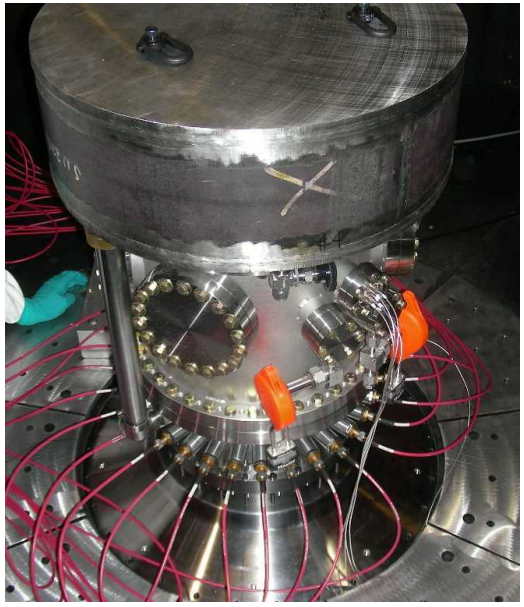
SAND2008-3118P

Sandia National Laboratories Preparations for SNM on Z

JOWOG32Mat
May 12-16, 2008



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This work represents a team effort with many contributors!

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration under Contract No. DE-AC04-94AL85000.

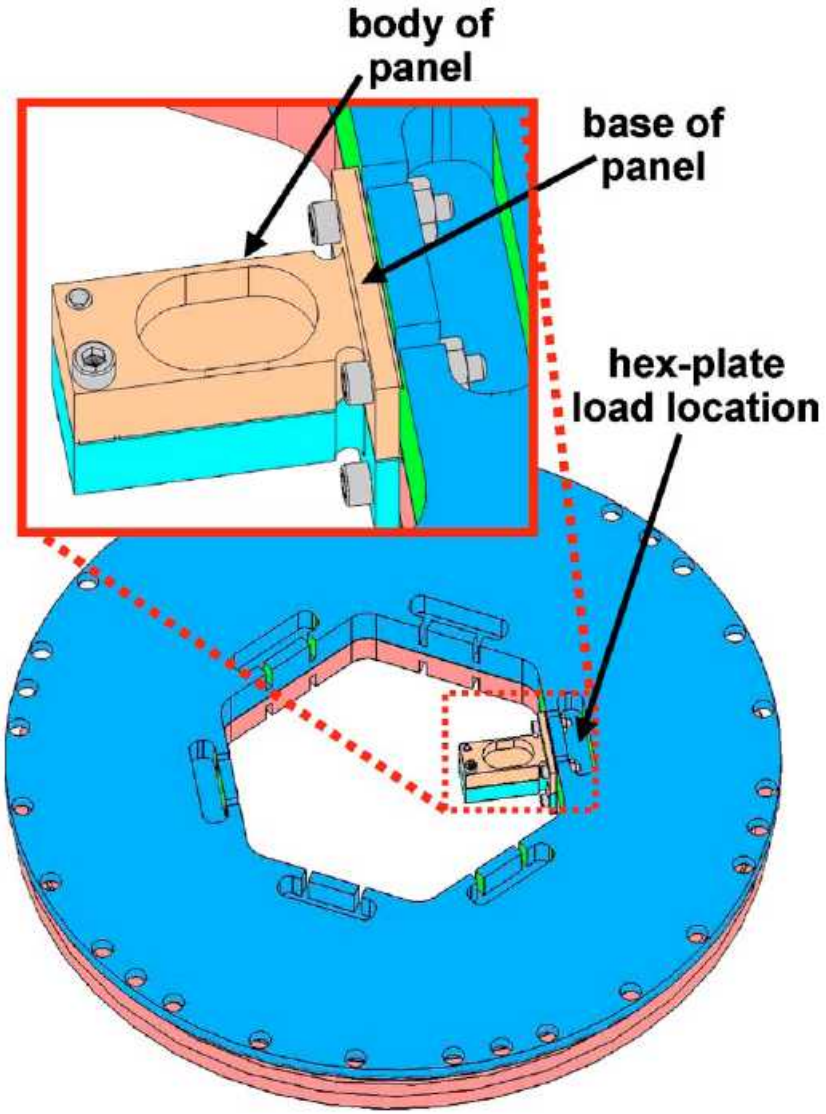
Outline

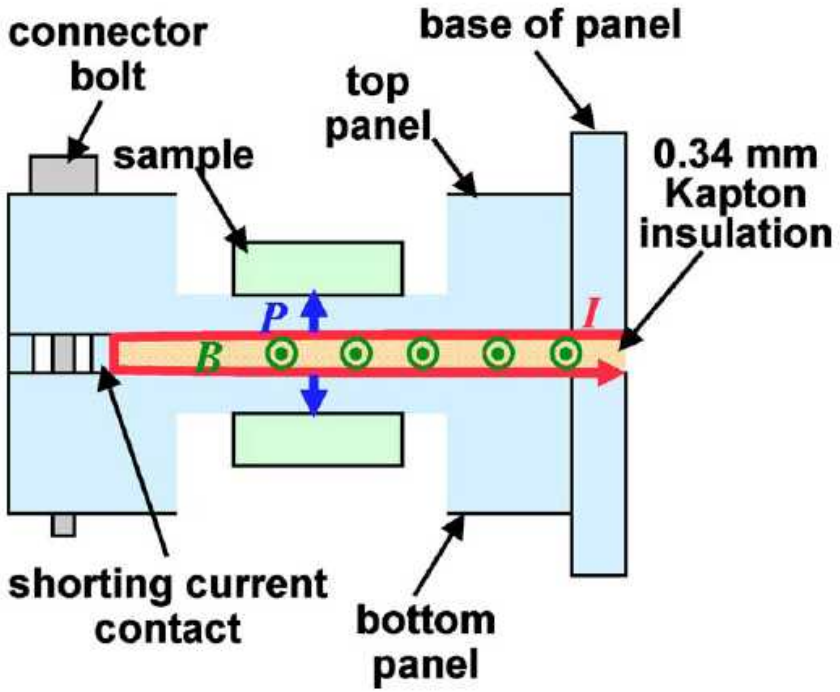
- **Preparing for SNM on Z**
  - New Z capability
  - Ongoing work that will be applied to SNM on Z
    - New strip-line load geometry
    - Temperature measurements
    - Strength work
      - *Wave profiles*
      - *Recovery*
    - High-pressure ramps
- **Containment status**

The new Z at SNL is operational

- **Machine began firing after the upgrade in October, 2008**
- **Initial shots were conservative**
  - Understand current delivery to load (form and magnitude)
    - » *long pulse mode ~ 20MA old Z, to ~ 25MA on new Z*
    - » *Concave shaped ~ 17 MA old Z to ~ 22 MA on new Z*
  - Helped develop a realistic circuit model
  - Hardware evaluations
- **In the last few months, we have begun to conduct dynamic material property measurements**
  - ICE strength measurements on Be (with LANL), Al, and LiF to extend DICE work
  - Hugoniot strength measurements on Be (with LANL)
- **2-D MHD design calculations (based on demonstrated pulse shapes) are underway for 4+Mbar measurement in Ta**

We are investigating a new load geometry based on the strip-line design of the small pulser





Strip-line design allows for samples to be placed on both the anode and cathode, and thus they both experience the same B field

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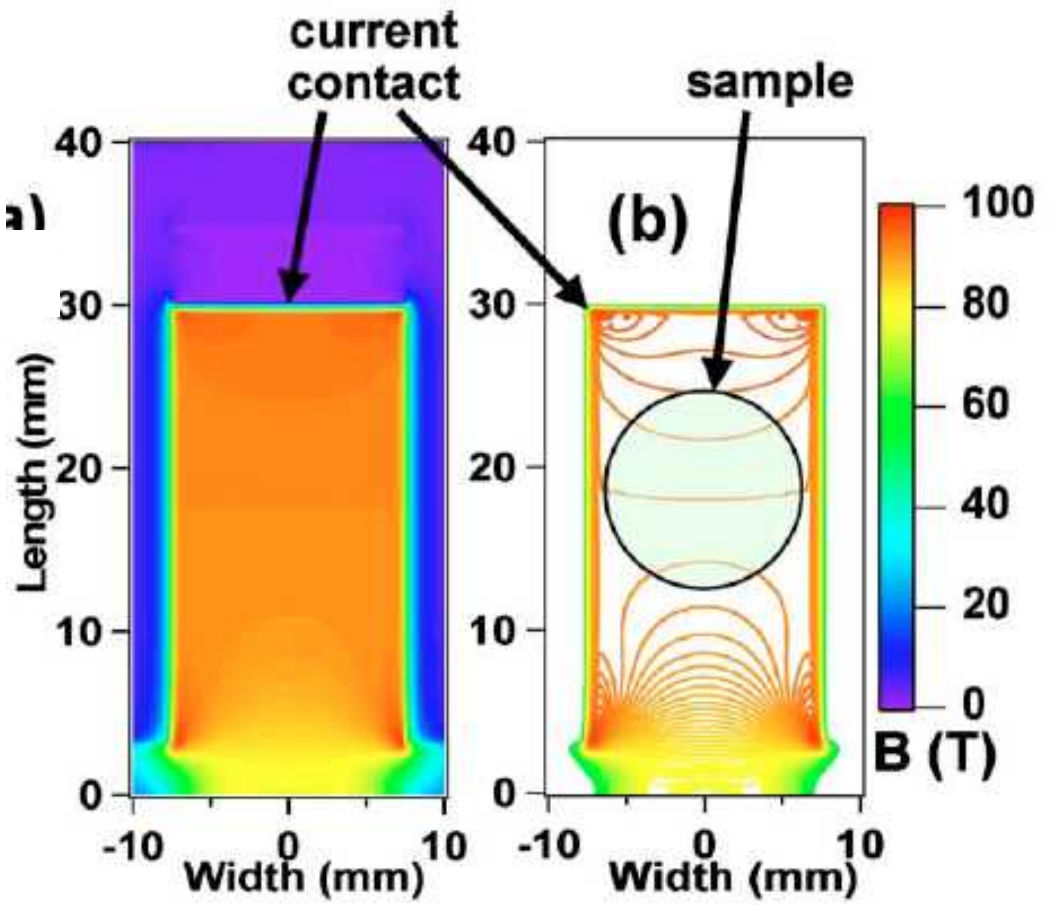
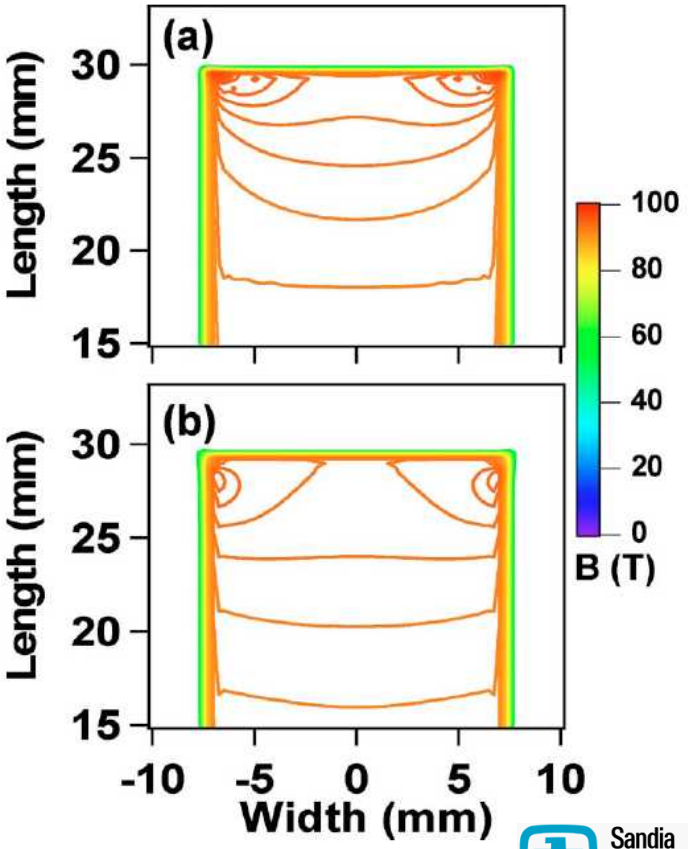
We are leveraging the MHD analysis performed for Veloce to optimize the panel geometry



Simple panel design has a field gradient along the panel length

Gradient can be mitigated through MHD guided design



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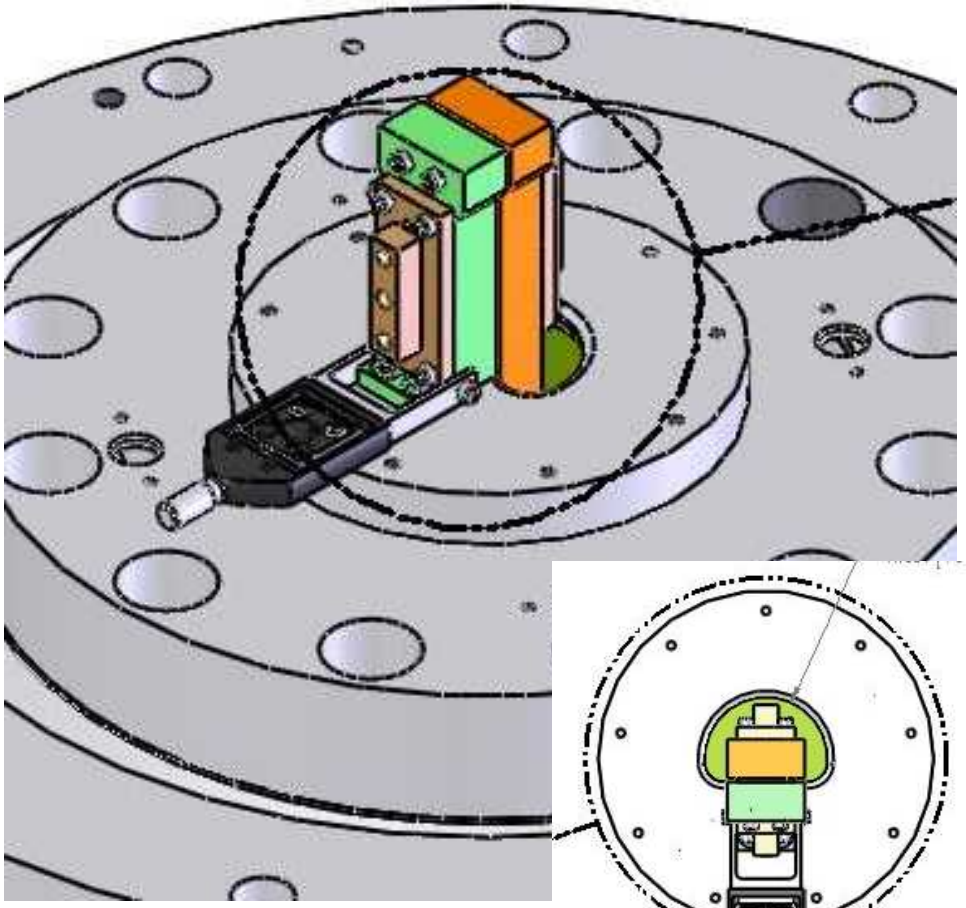
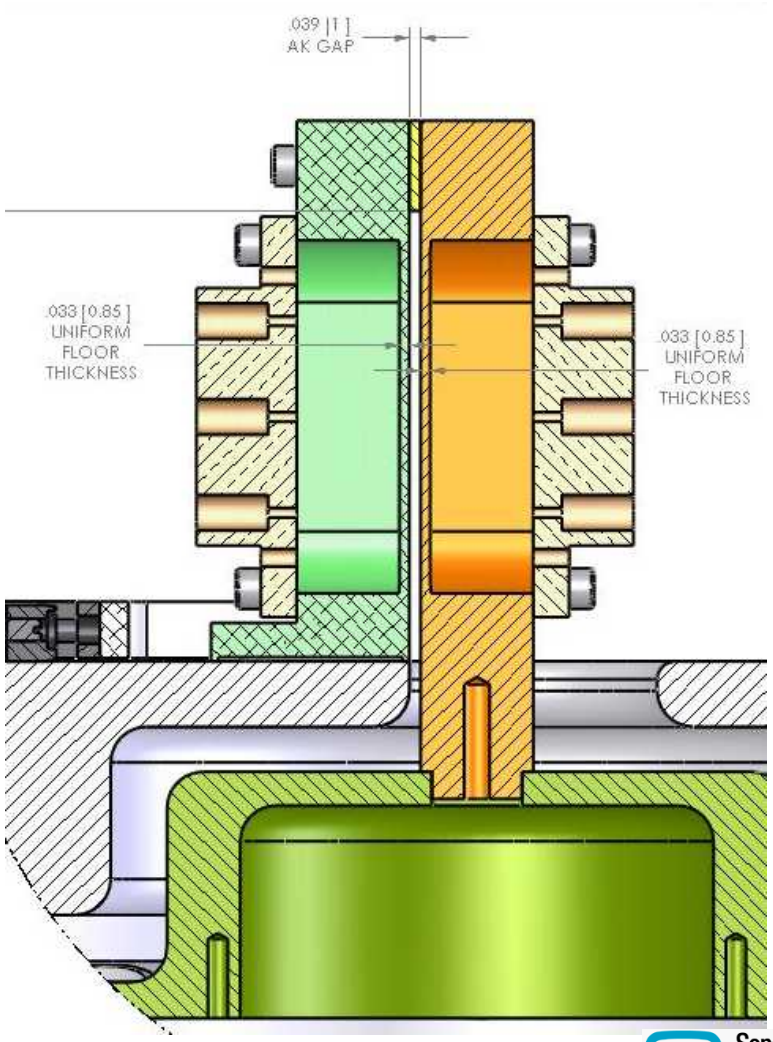
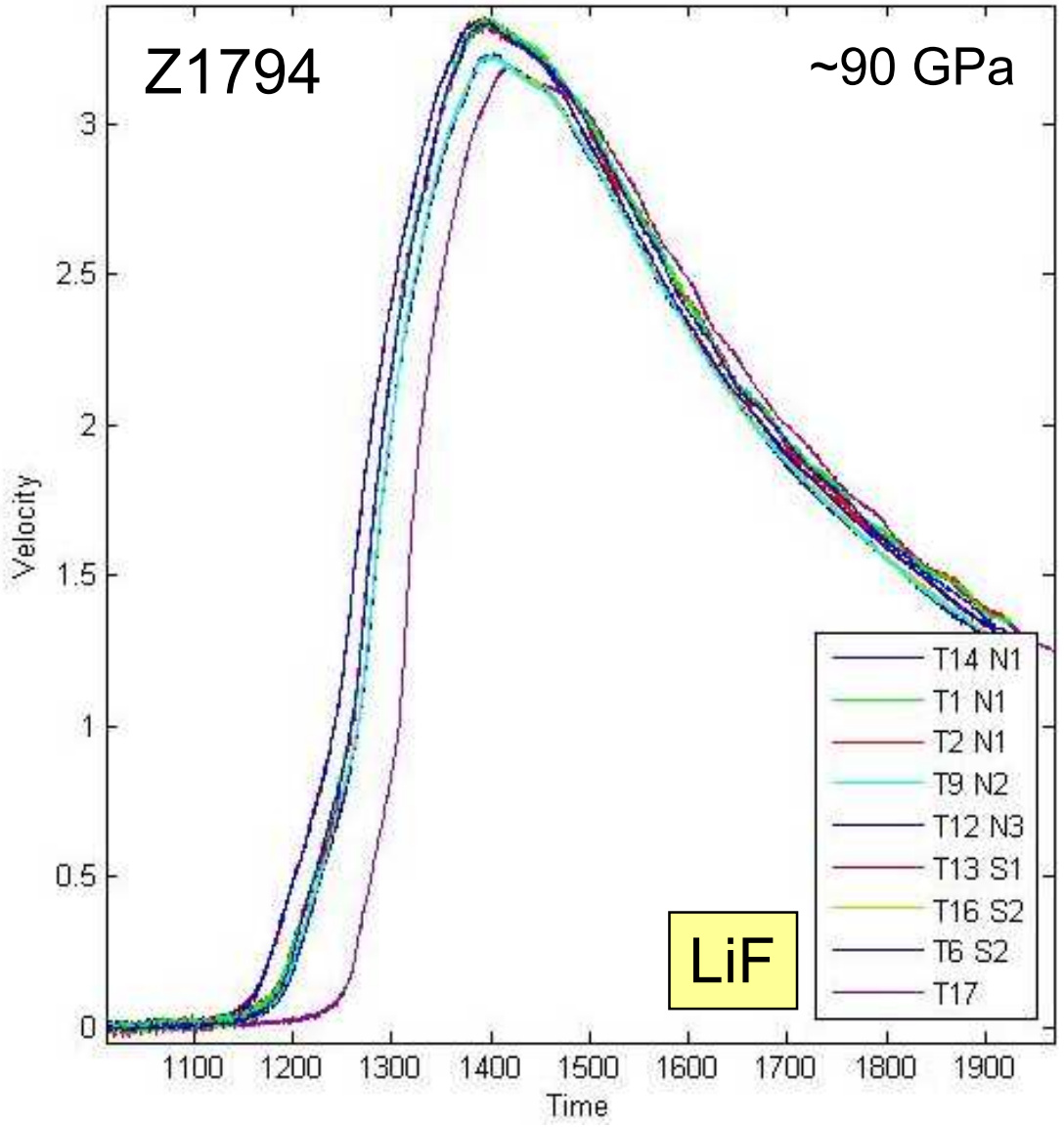
The strip-line requires a somewhat more convoluted load design on Z





We have obtained useful data with this load design on Z.



Load eliminates alignment issues between opposing sample pairs

Once fully demonstrated and modeled, we will consider incorporating this design into containment shots

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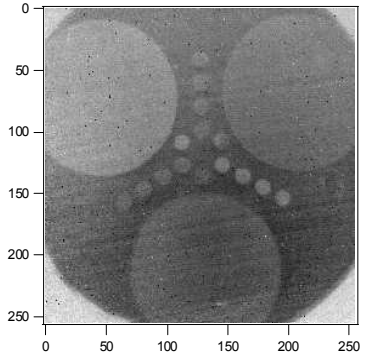
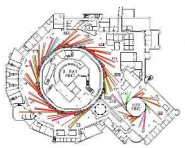
SNL is also looking at methods to improve our temperature measurement capability

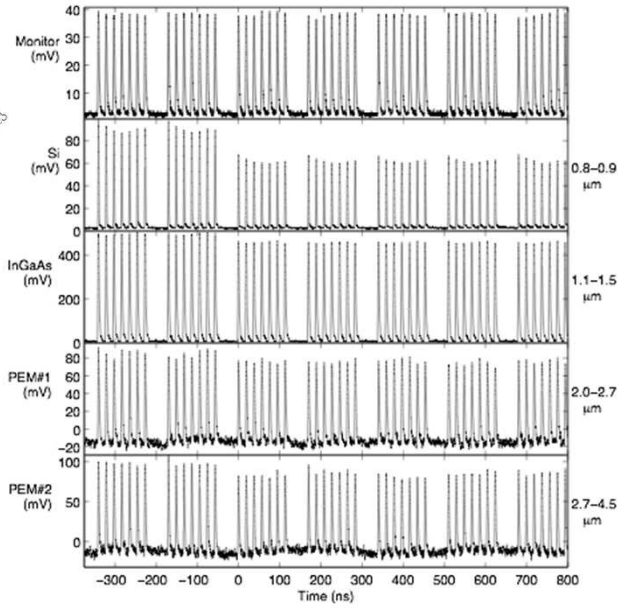
- **Primary focus: infrared pyrometry for <1000 K**
  - Infrared imaging to study radiance uniformity
  - Emissivity enhancing coatings to boost signal and reduce uncertainty
  - Dynamic reflectance measurements to infer emissivity of shocked materials (NSLS)
  - Continual target refinement to reduce extraneous effects (epoxy, etc.)
- **Secondary focus: alternate diagnostics**
  - Nano-scale thermocouples
  - Stokes/anti-Stokes Raman spectroscopy
  - Challenge: measuring the same state in each configuration (thermal conductivity)

Static IR image of Sn coated with high emissivity dots (75-300 nm thick)





Dynamic reflectance measurement of Al shocked to 8 GPa at NSLS. The apparent change in reflectance is likely due to surface and/or epoxy effects, not the Al target.



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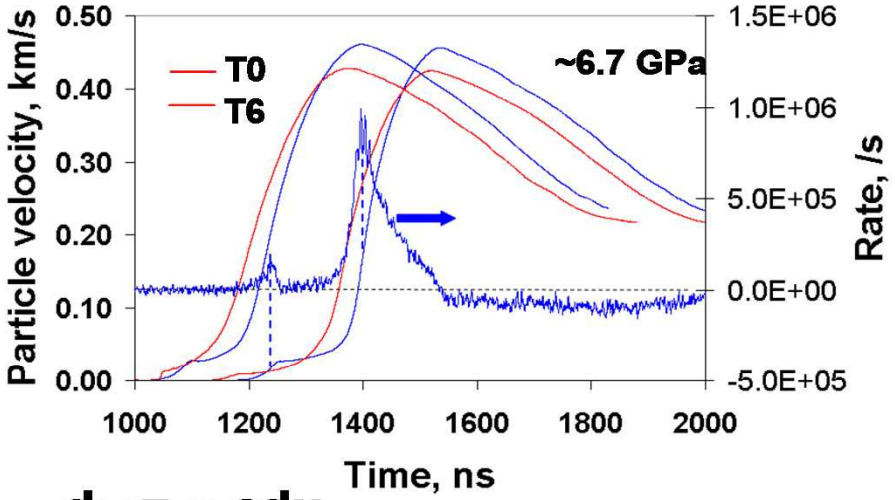
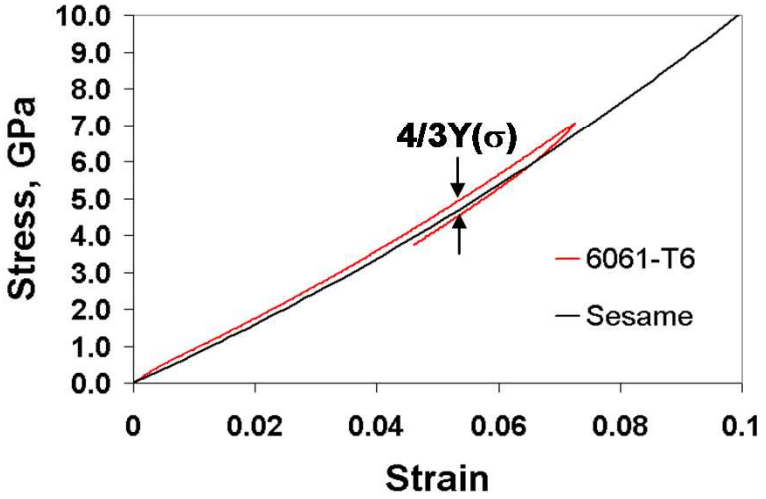
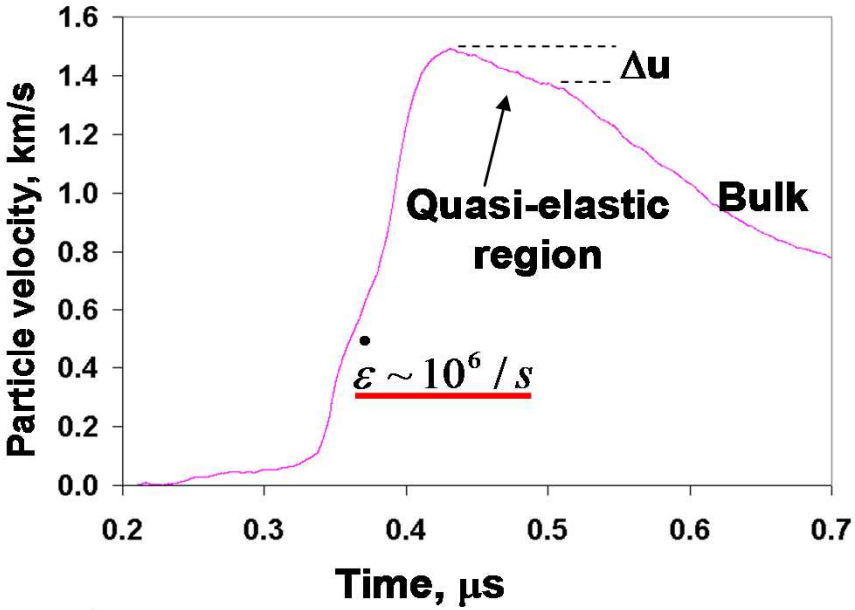
Different techniques are being evaluated to infer strength from wave profile measurements



$d\sigma = \rho_0 c du$

$d\varepsilon_e = du/c$





Q-E strength : $\Delta\tau \sim Y = \frac{3}{4}\rho_0 \int \left(c^2 - c_B^2\right) d\varepsilon_e \sim \frac{1}{2} G(\varepsilon_m) \Delta\varepsilon_T$

Q-E true strain: $\Delta\varepsilon_T \sim \frac{\rho}{\rho_0}\frac{\Delta u}{c}$

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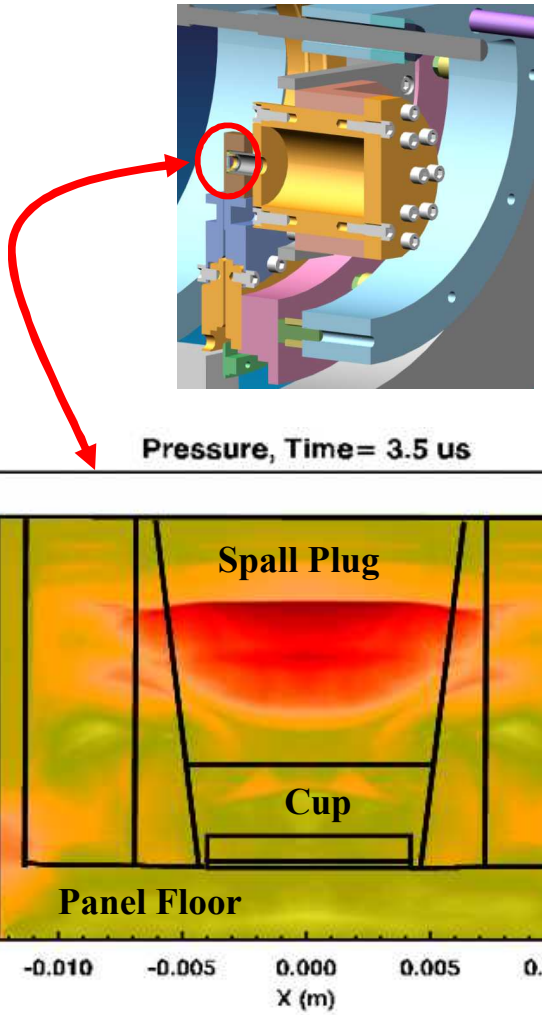
Recovery won't be applied directly to SNM, but we can learn much from the surrogate research

- Controlled deceleration and recovery of ICE-loaded samples for post-test material analyses (*e.g.*, microstructure, defects, phase transition, hardness, fracture)
  - **Peak stresses** up to ~10 GPa
- Design optimization based on **2-D Alegra** magnetohydrodynamic code simulations up to ~10 ms (10 micron cell size)
- Complementary time-resolved **drive data** acquired during same shot from opposing panel assembly
- ***Status***: Recovery canister and mounting hardware fabricated; initial 2-D simulations complete; panel-assembly design under way



Separation of cup and panel begins at ~2.3μs, cup and plug begins at ~ 3.4μs, with re-impacts at only a few m/s occurring in late time

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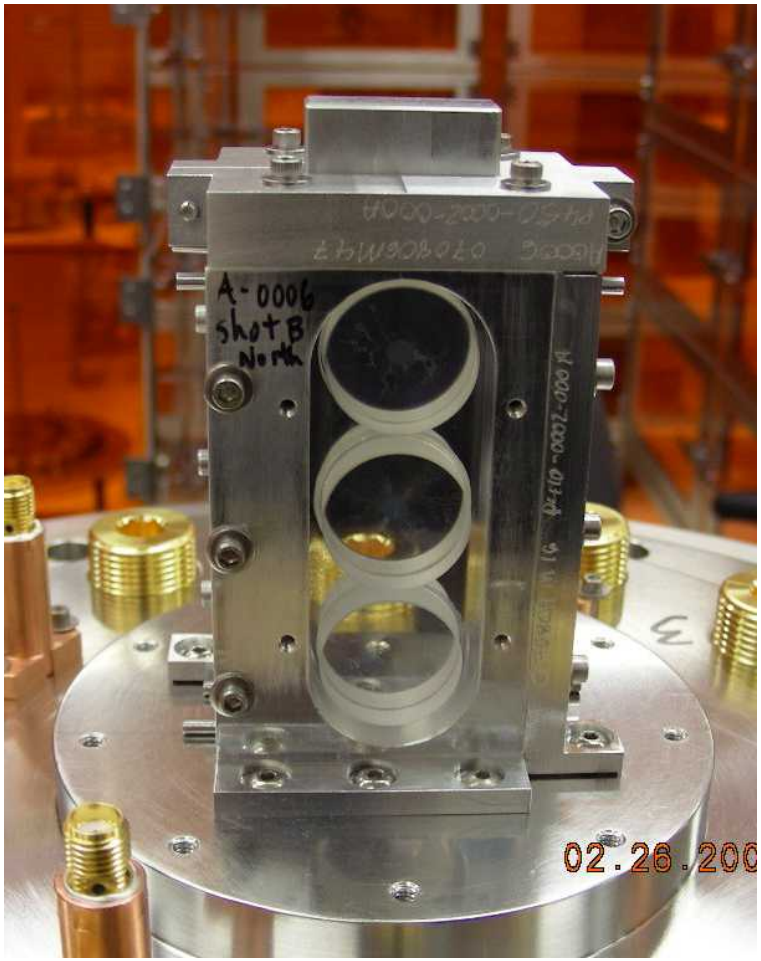
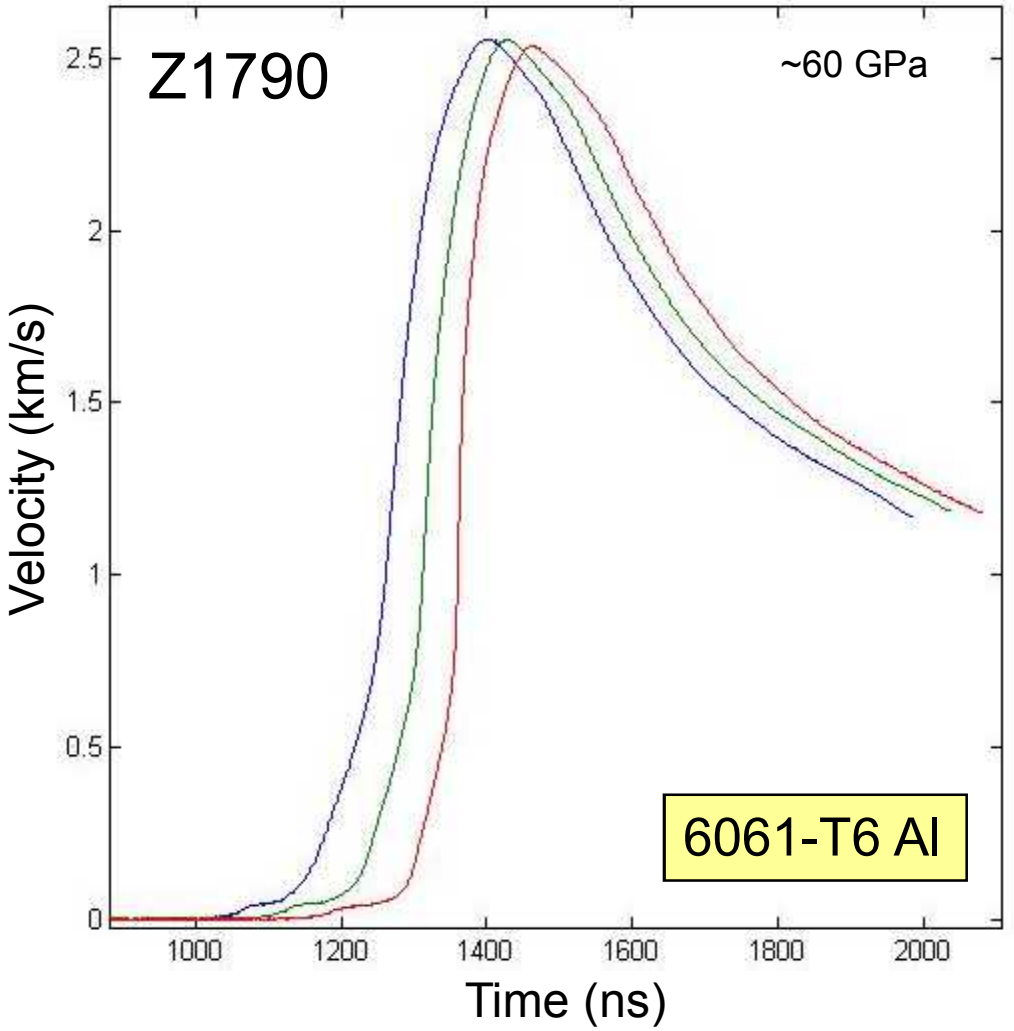
We are obtaining compression and release data on several materials





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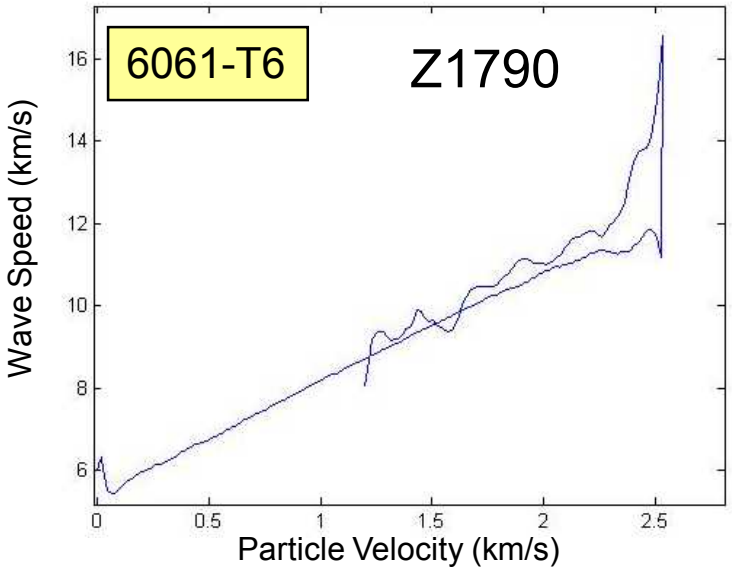
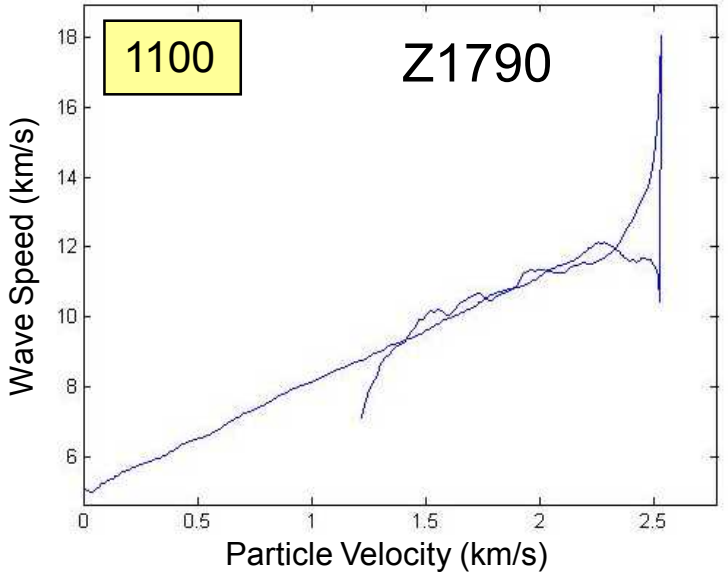
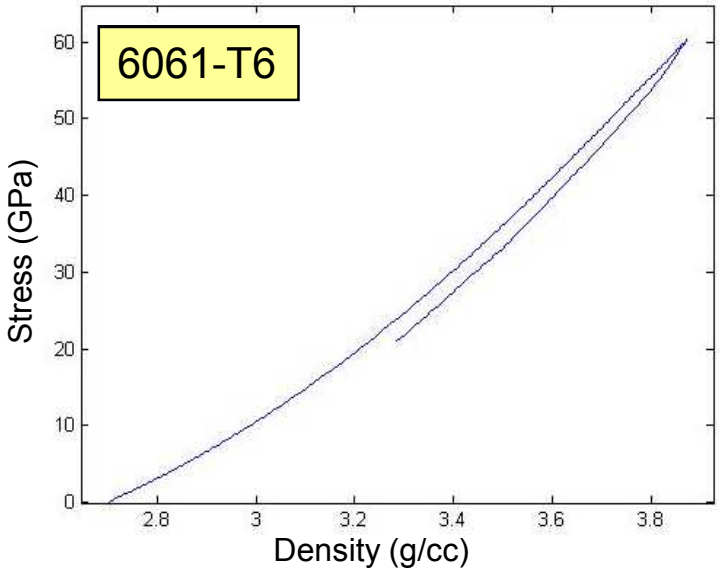
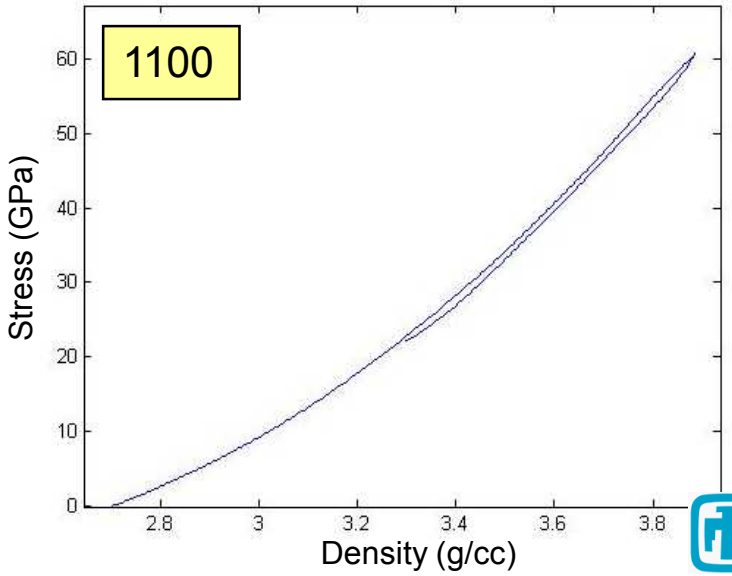
Analysis of wave profiles is providing reasonable estimates of compressive response and strength at high pressure









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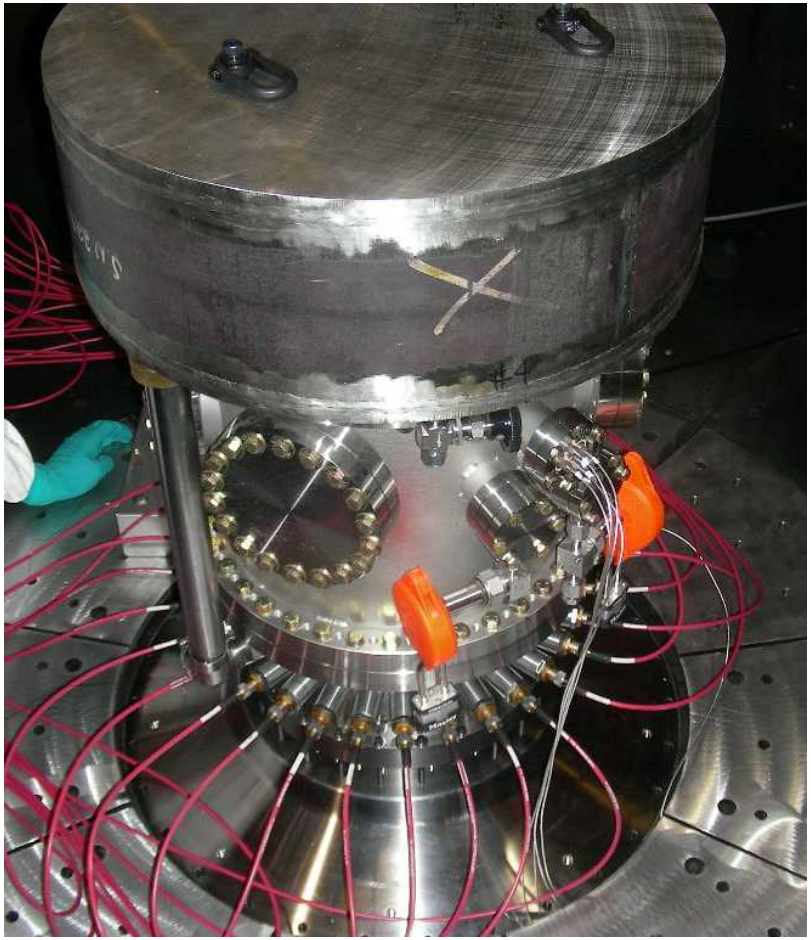
We have are reinstituting the capability to do SNM on the new Z

Z1789 Containment load



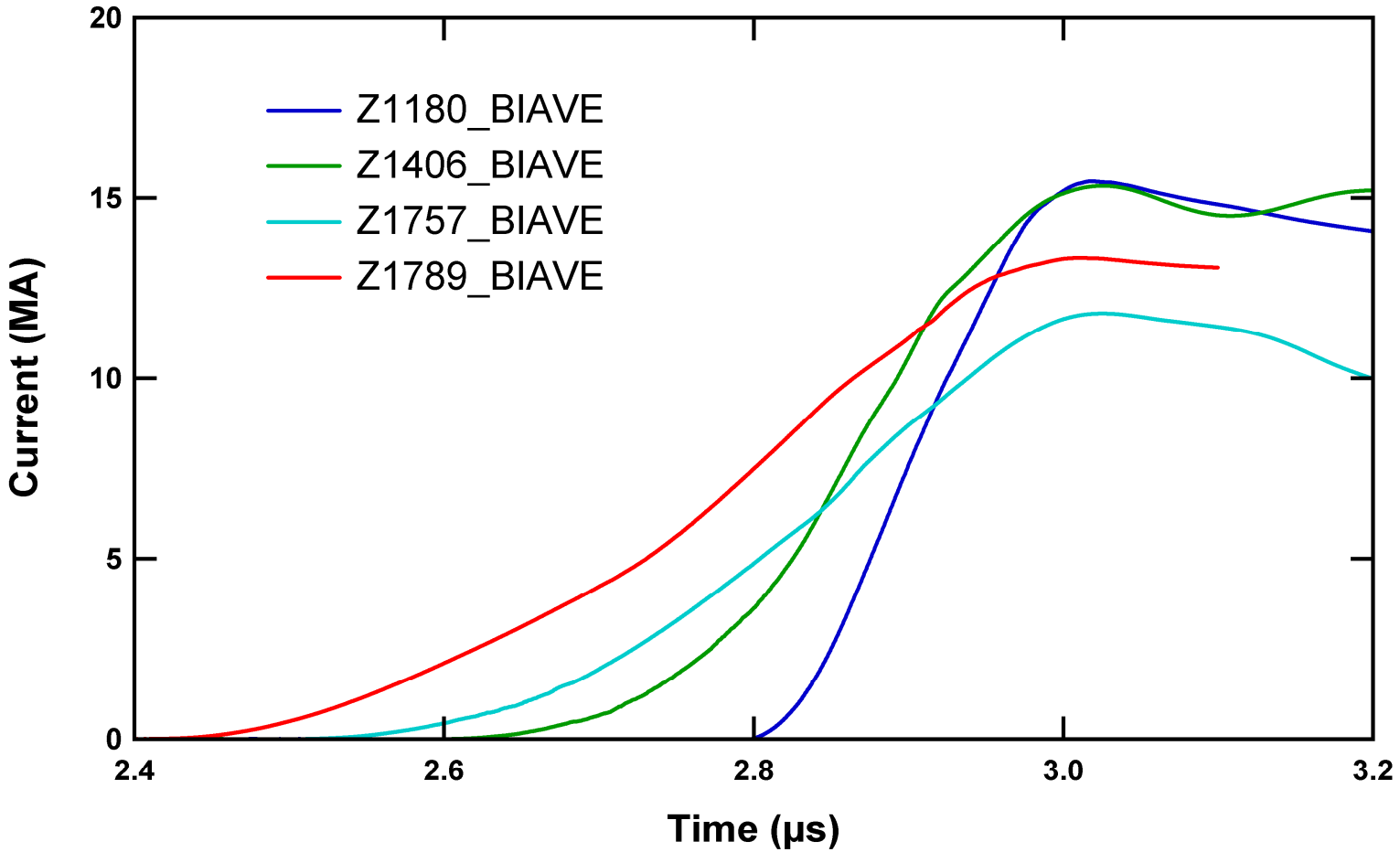
We are following two parallel paths to reinstating SNM experiments on Z

- Administratively controlling current to old Z levels with present closure valve
- Pursuing closure valve capable of withstanding full Z current levels

Z1789 was a demonstration that we could successfully integrate approved containment design with new Z

Need to conduct Class II safety review to begin routine operation

Z1789 Containment test taken at current level similar to the pre-refurb Z



Jean-Paul Davis

Summary

- The new Z is operational and taking data for dynamic material property inferences
- A new load configuration for taking dynamic material property data on Z
- Work is ongoing that will be directly applied to SNM measurements on the new Z (P-v, strength, temperature)
- Reinstitution of the containment system on the new Z will occur this FY