

# Temperature Control on the VELOCE System

Andy Shay<sup>1</sup>, Aaron Bowers<sup>1</sup>, Randy Hickman<sup>2</sup>, Andrew Lopez<sup>2</sup>, Jesse Lynch<sup>1</sup>, Jack Wise<sup>2</sup>, Mike Willis<sup>2</sup>, Seth Root<sup>2</sup>

<sup>1</sup>Ktech Corporation

<sup>2</sup>Sandia National Laboratories

Sandia National Laboratories

## VELOCE CRYO

The Sandia pulsed-power generator VELOCE has been used extensively to perform shockless compression experiments on materials. The option of controlling the initial sample temperature greatly expands the range of states accessible via the nearly-isentropic loading capability provided by VELOCE. We have established this option by developing pre-heating and pre-cooling (cryogenic) systems for VELOCE. This poster illustrates the designs and capabilities of the pre-heating and cooling systems for equation-of-state studies.

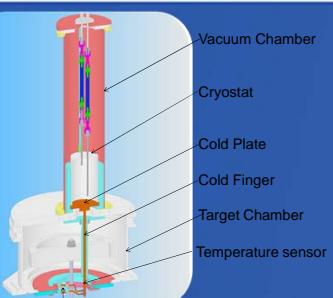
## COMPONENTS OF THE CRYO SYSTEM



Target temperature range: -50°C to -100°C.

The VELOCE Cryostat is filled via a 20psi LN2 Dewar. Multiple target chamber vacuum and nitrogen purge cycles are performed before cooling to reduce airborne impurities around the target assembly.

Temperature range is limited by the inability of VELOCE to shoot under vacuum. However, the cryostat and cold finger are able to reach acceptable vacuum levels due to the addition of a cryostat vacuum chamber extension that protrudes into the target chamber. This creates a very short distance for thermal transmission.



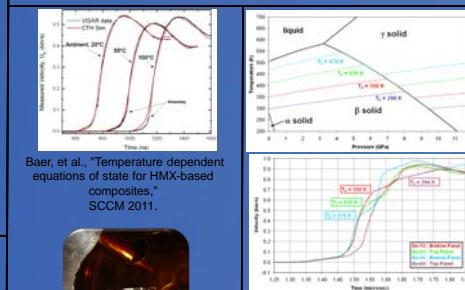
Macor Thermal Insulation Shim  
5μm Cu Coated On The Power Flow Surface

LakeShore™ Temperature Sensors



## MOTIVATION

- Shockless compression experiments allow for the exploration of regions of phase space inaccessible to traditional shock compression experiments.
- Temperature conditioning (pre-heating/pre-cooling) further expands the region of phase space that we can examine.
- From these experiments, we can better define a material's phase space behavior, examine the kinetics of phase transitions, and determine temperature effects on the constitutive properties of materials.

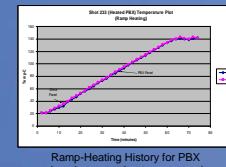
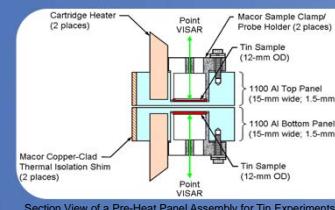


Baer, et al., "Temperature dependent equations of state for HMX-based composites," SCCM 2011.



Wise, et al., "Measurement of the temperature dependence of the  $\beta - \gamma$  transition pressure in tin using dynamic isentropic compression," SCCM 2009.

- A system for preheating test specimens prior to shock or isentropic loading was developed at Sandia's Dynamic Integrated Compression Experimental (DICE) Facility.
- A dual-output, proportional-integral-derivative (PID) controller using feedback from thermocouples regulated power supplied independently to resistive heaters so as to achieve the desired temperature(s) at selected position(s) within the test assembly.
- Thermal isolation features validated by finite element heat-transfer analyses afforded temperature uniformity across samples mounted in electrode panels for the VELOCE pulsed electromagnetic driver.



Ramp-Heating History for PBX (one hour+ to shot temperature)



10/7/2004



10/18/2005



3" Smooth

Bore

Light

Gas

Gun

Velocities to

400 m/s

VISAR, LINE

ORVIS, X-RAY

DIFFRACTION

Diagnostics

05/12/2007

