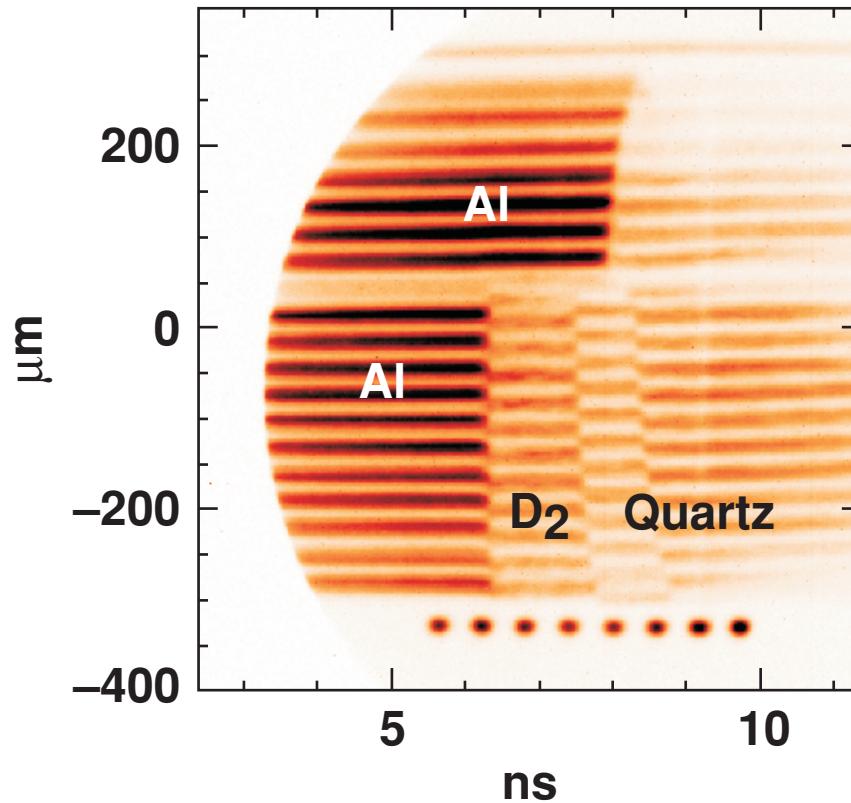


# Deuterium equation-of-state experiments on the OMEGA laser system



VISAR for shot 27934



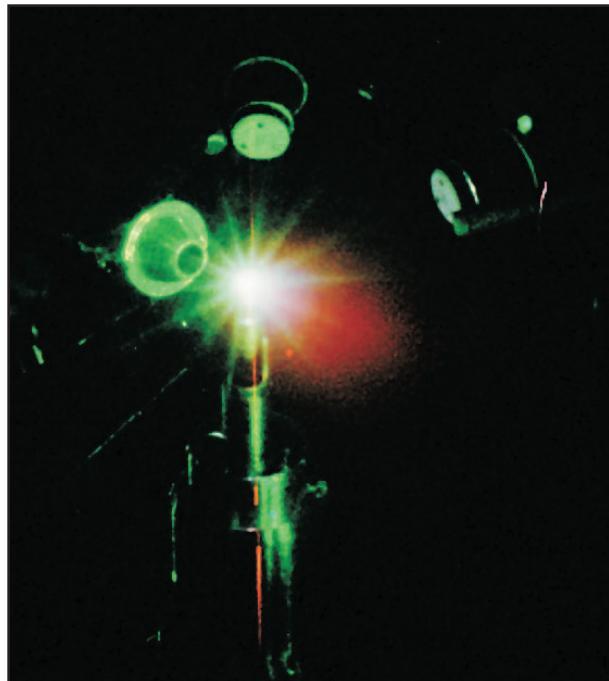
T. R. Boehly  
University of Rochester  
Laboratory for Laser Energetics

44th Annual Meeting of the  
American Physical Society  
Division of Plasma Physics  
Orlando, FL  
11–15 November 2002

# Many people contributed to the design, implementation, and execution of cryogenic-target experiments



**D. G. Hicks\***  
**T. Collins**  
**G. W. Collins\***  
**P. M. Celliers\***  
**E. Vianello**  
**D. D. Meyerhofer**  
**R. Cauble\***  
**W. Unites\***  
**D. Jacobs-Perkins**  
**R. Earley**  
**M. Bonino**  
**J. Armstrong**  
**Experimental Ops**  
 **$\Omega$  - Ops**



\* LLNL

## Summary

Preliminary results show increased D<sub>2</sub> compressibility at ~1 Mb, with “stiffer” behavior at higher pressures



- Gas gun<sup>1</sup> and laser<sup>2</sup> Hugoniot experiments show higher deuterium compressibility than predicted by *SESAME*.
- Magnetically driven<sup>3</sup> Hugoniot experiments show compressibility closer to *SESAME*.
- “Re-shock” experiments<sup>4</sup> can enhance the differences between equation-of-state models.
- Deuterium re-shock experiments on OMEGA exhibit compressibility that agrees with the Saumon-Chabrier<sup>5</sup> model.

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<sup>1</sup> N. C. Holmes *et al.*, *Phy. Rev. B.* **52**, (1995).

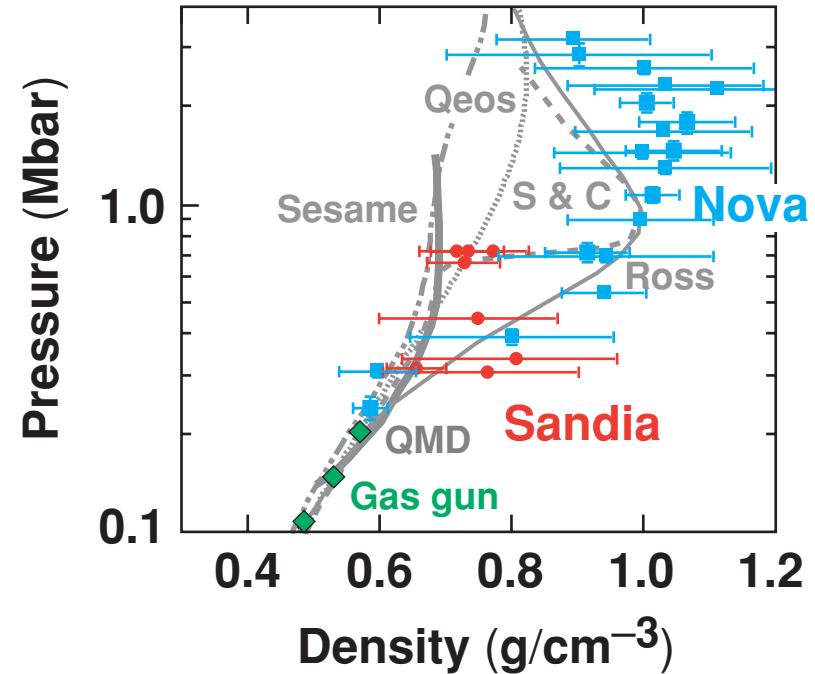
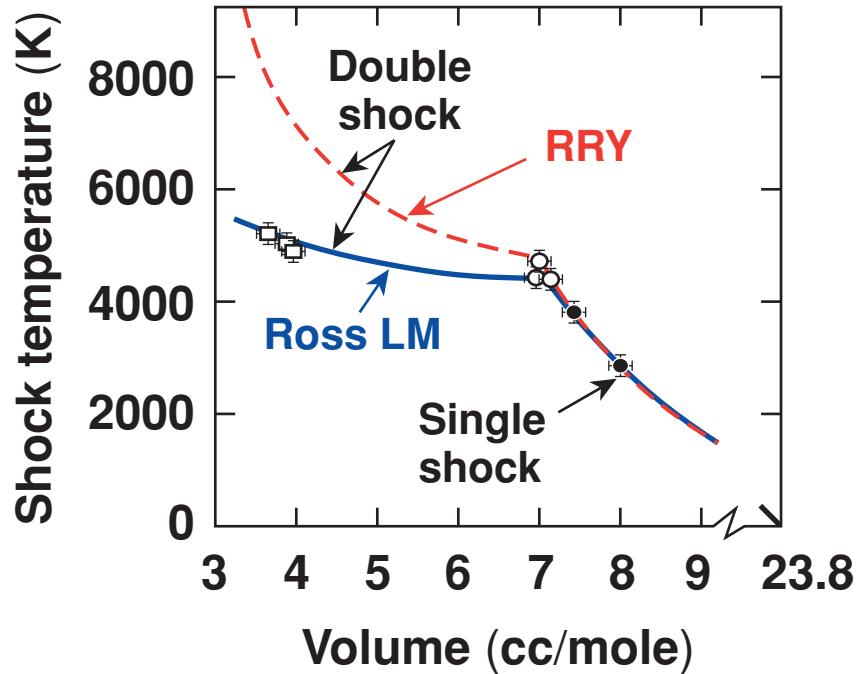
<sup>2</sup> G. W. Collins *et al.*, *Science* **281** (1998).

<sup>3</sup> M. D. Knudson, *Phys. Rev. Lett.* **87** (2001).

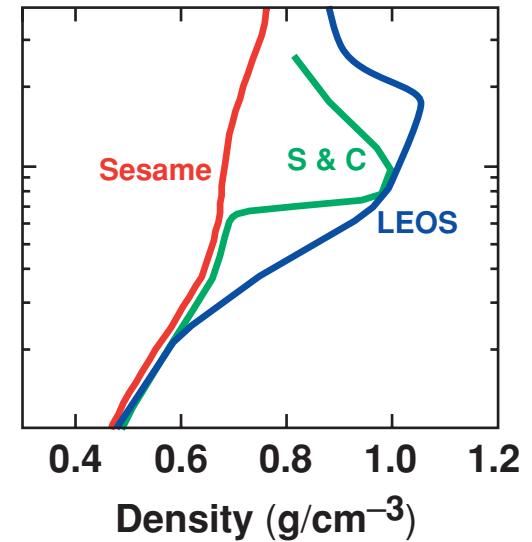
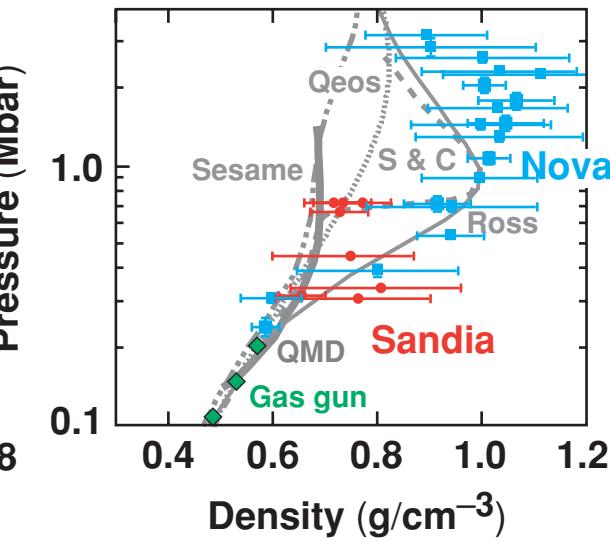
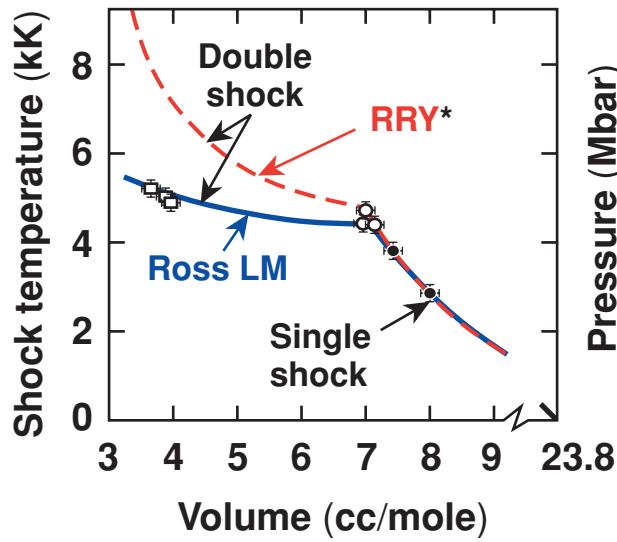
<sup>4</sup> A. Mostovych *et al.*, *PoP* **2281** (2001).

<sup>5</sup> D. Saumon, G. Chabrier, *Phy. Rev. A.* **44**, (1991).

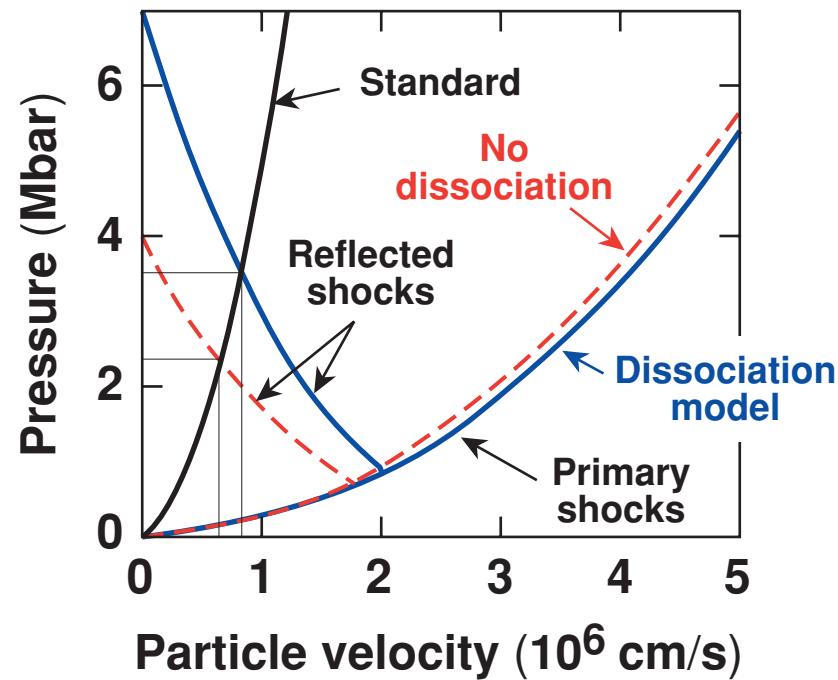
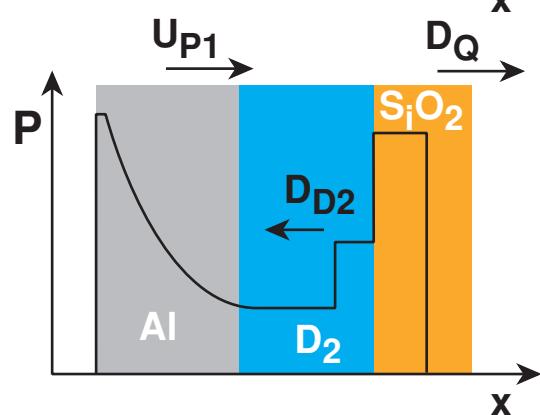
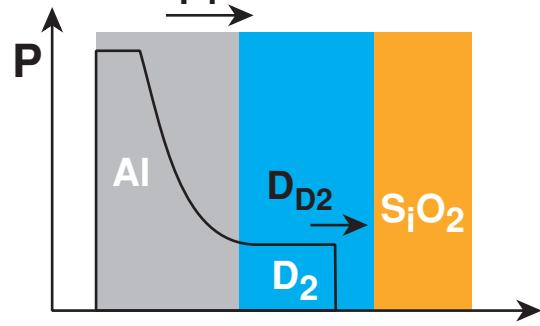
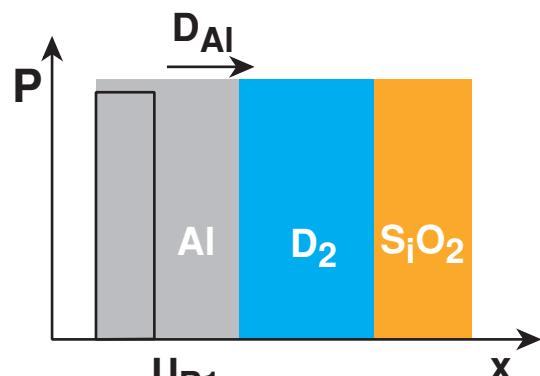
# Consensus on the compressibility of deuterium has been elusive



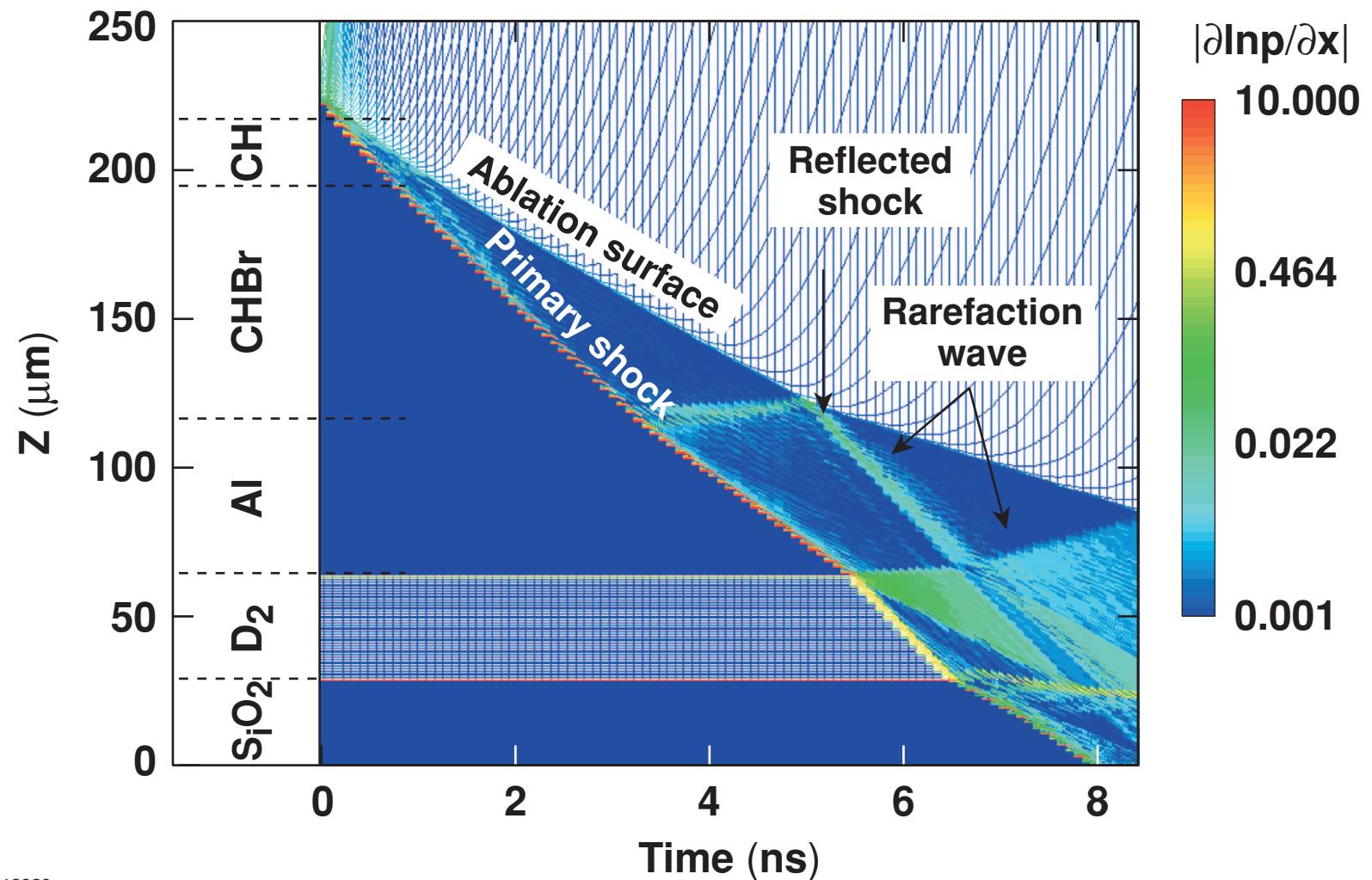
# Consensus on the compressibility of deuterium has been elusive



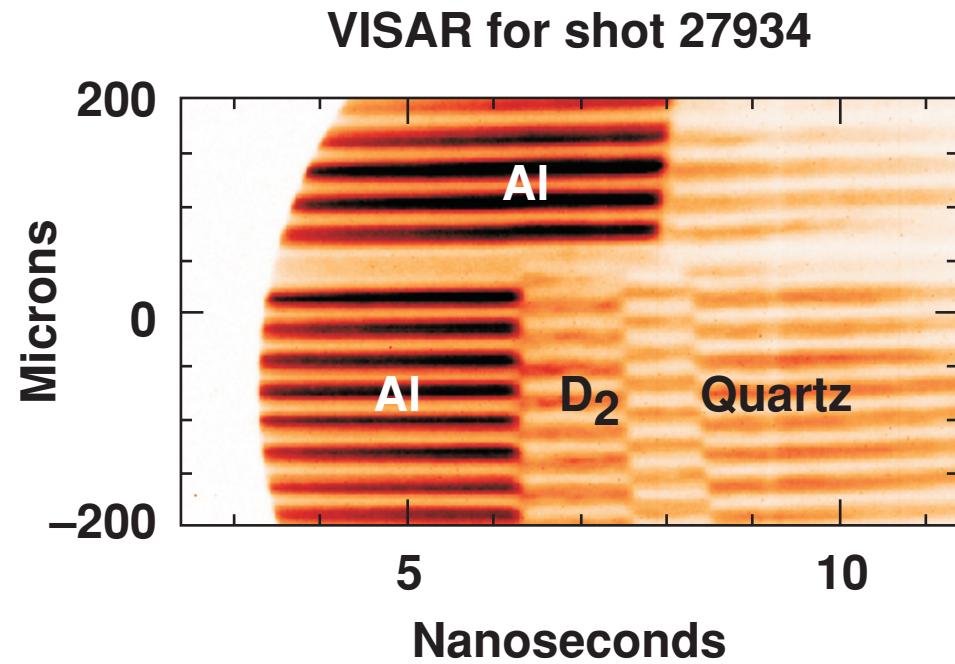
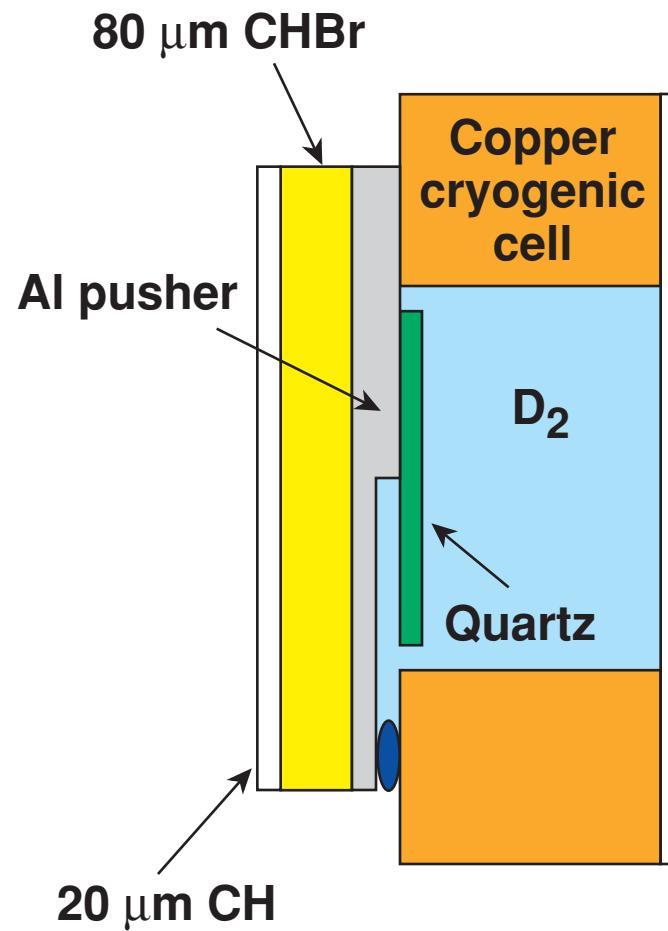
# Multi-shock experiments are useful for resolving different models for D<sub>2</sub> EOS



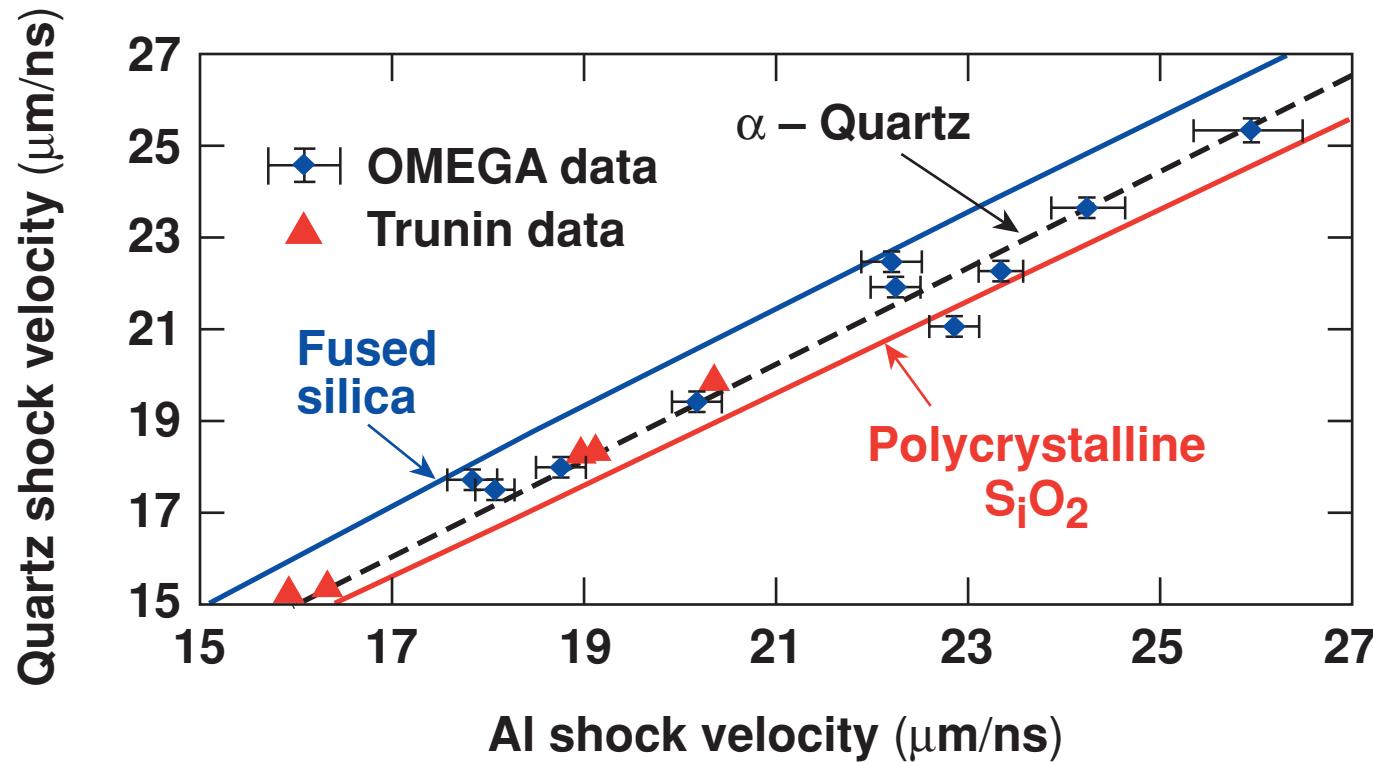
Simulations are used for target design  
to ensure only the primary shock is measured



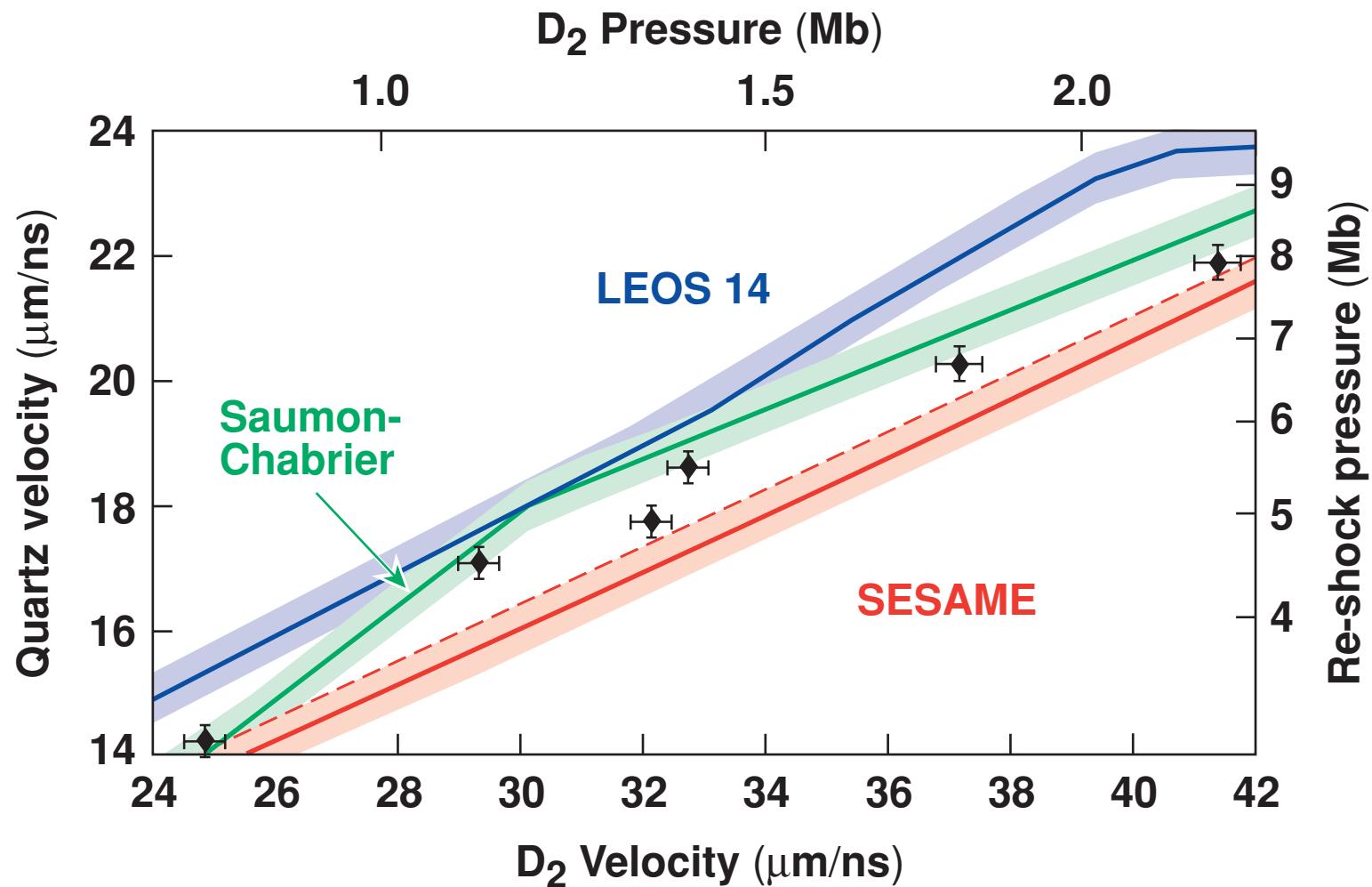
# **“Diving board” targets provide both impedance match and reshock data on cryogenic deuterium**



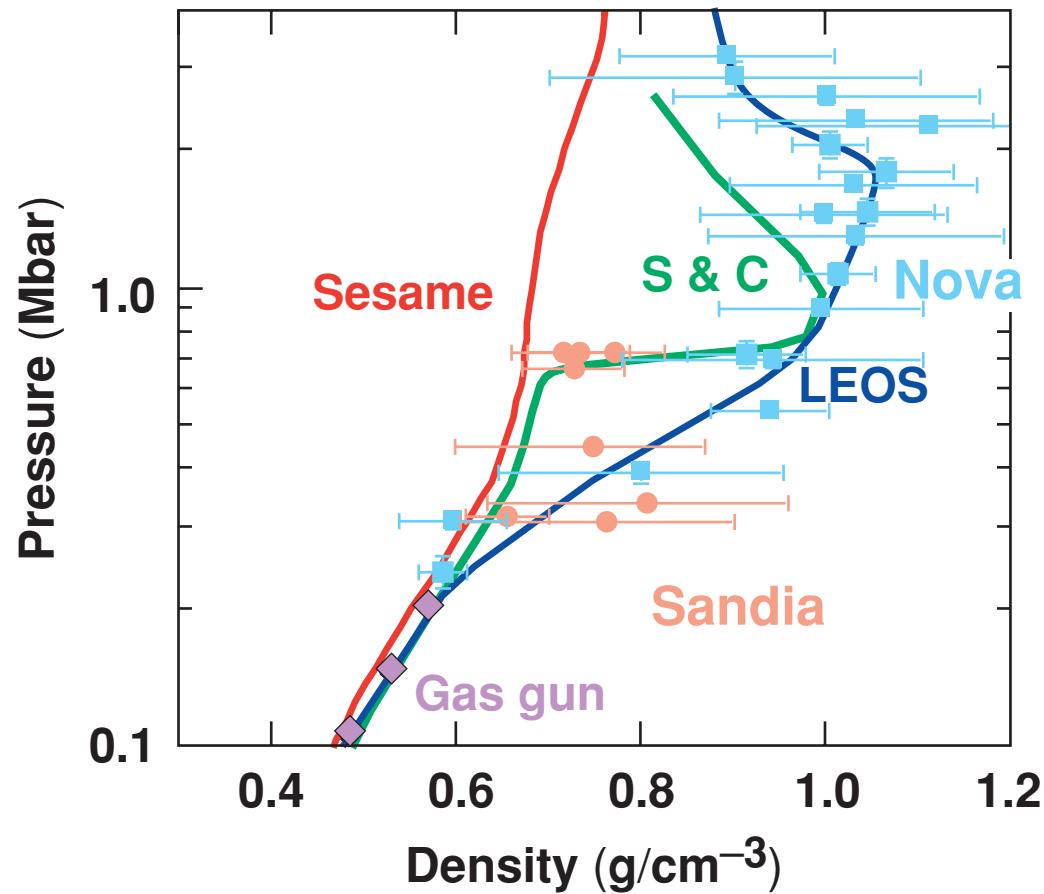
# The measured EOS for quartz matches established measurements and models



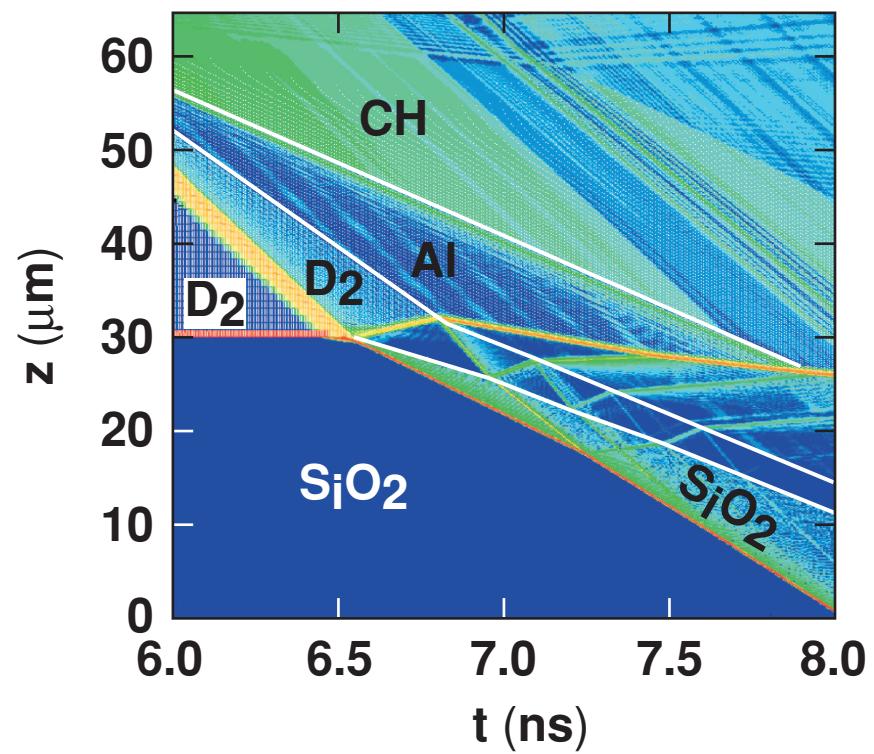
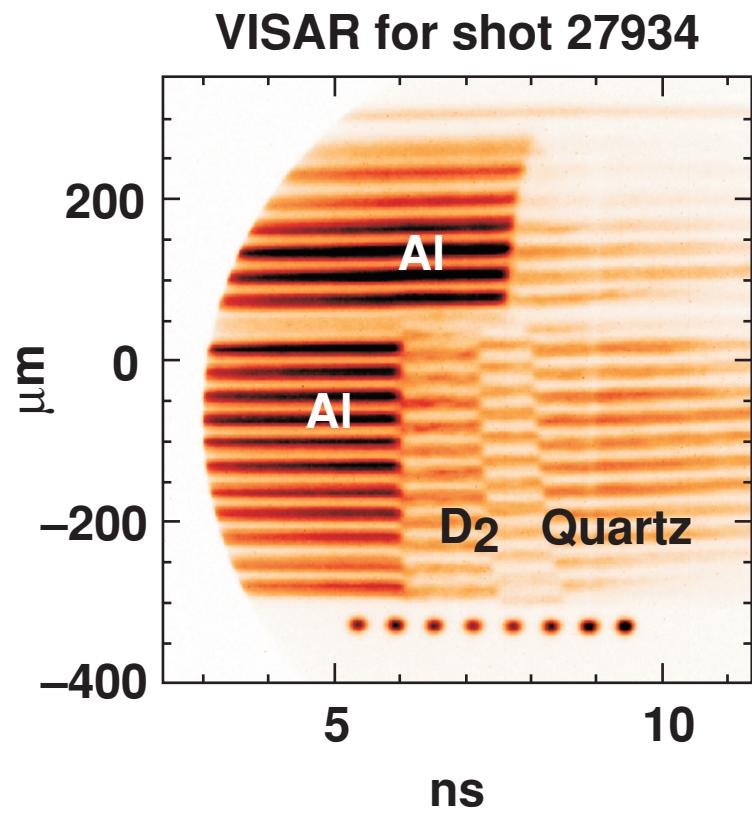
# Preliminary experiments agree with the Saumon-Chabrier model for compressibility



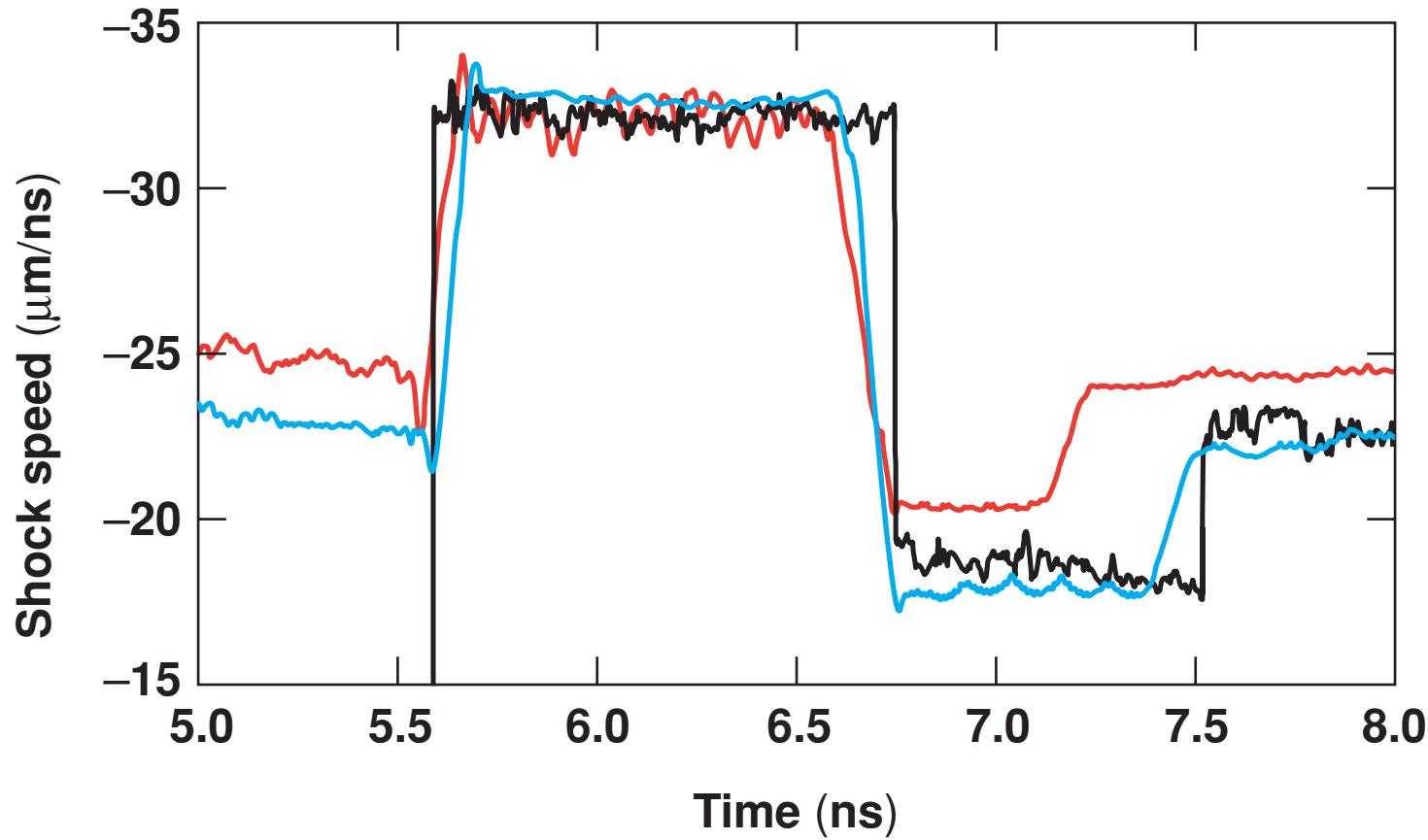
# Preliminary experiments agree with the Saumon-Chabrier model for compressibility



# Shock reverberations in the Al-D<sub>2</sub>-Quartz system are observed in the data



# Reverberation times are consistent with a stiff EOS



## Conclusions

**Preliminary results show increased D<sub>2</sub> compressibility at ~1 Mb, with “stiffer” behavior at higher pressures**



- Gas gun and laser Hugoniot experiments show higher deuterium compressibility than predicted by *SESAME*.
- Magnetically driven Hugoniot experiments show compressibility closer to *SESAME*.
- “Re-shock” experiments can enhance the differences between equation-of-state models.
- Deuterium re-shock experiments on OMEGA exhibit compressibility that agrees with the Saumon-Chabrier model.
- Future work: establish quartz as standard, study reverberation data, radiography, and temperature measurements.