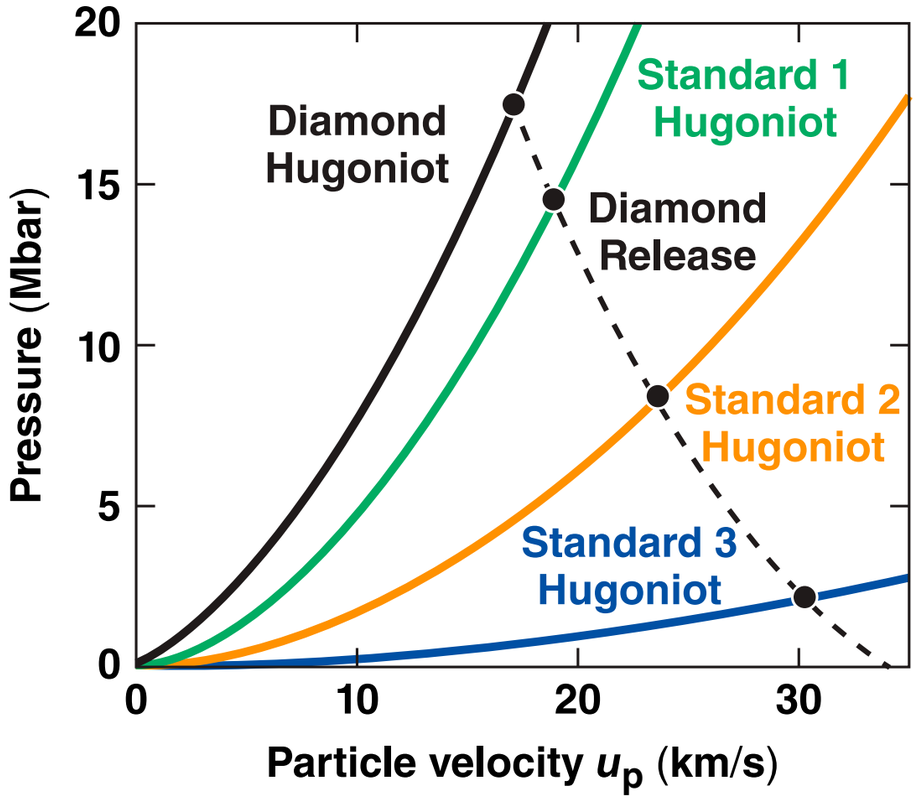
The Release Behavior of Diamond Shocked to 15 Mbar



M. C. Gregor
University of Rochester
Laboratory for Laser Energetics

45th Annual Anomalous
Absorption Conference
Ventura, CA
14–19 June 2015

Summary

The shock and release behaviors of the NIF diamond ablator material were measured

- The National Ignition Facility (NIF) uses ultra-nanocrystalline high-density carbon (HDC) ablators
- Knowledge of the diamond Hugoniot and release behavior is critical for inertial confinement fusion (ICF) ignition target designs
- Release data are obtained by impedance matching with known standards
- Models for both the single-crystal (SC) diamond and HDC release are constrained by the experimental data
- The SC diamond release into liquid deuterium is accurately modeled using *SESAME* 7830
- The release data for both SC diamond and HDC will aid in the development of more-precise models for ICF target designs

E23554a

Collaborators

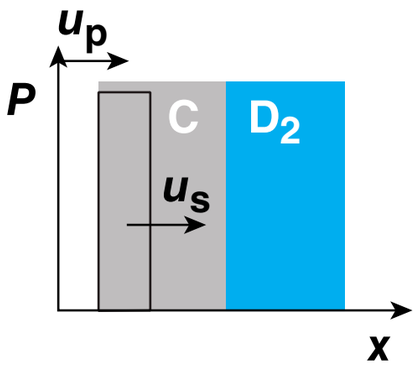
T. R. Boehly, C. A. McCoy, D. N. Polsin, and D. D. Meyerhofer

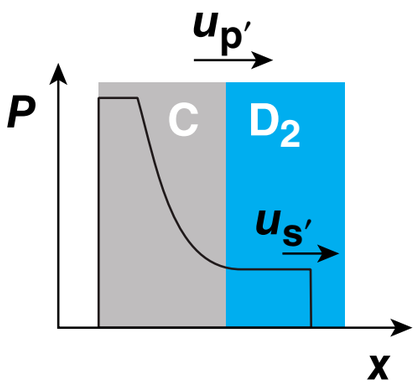
University of Rochester
Laboratory for Laser Energetics

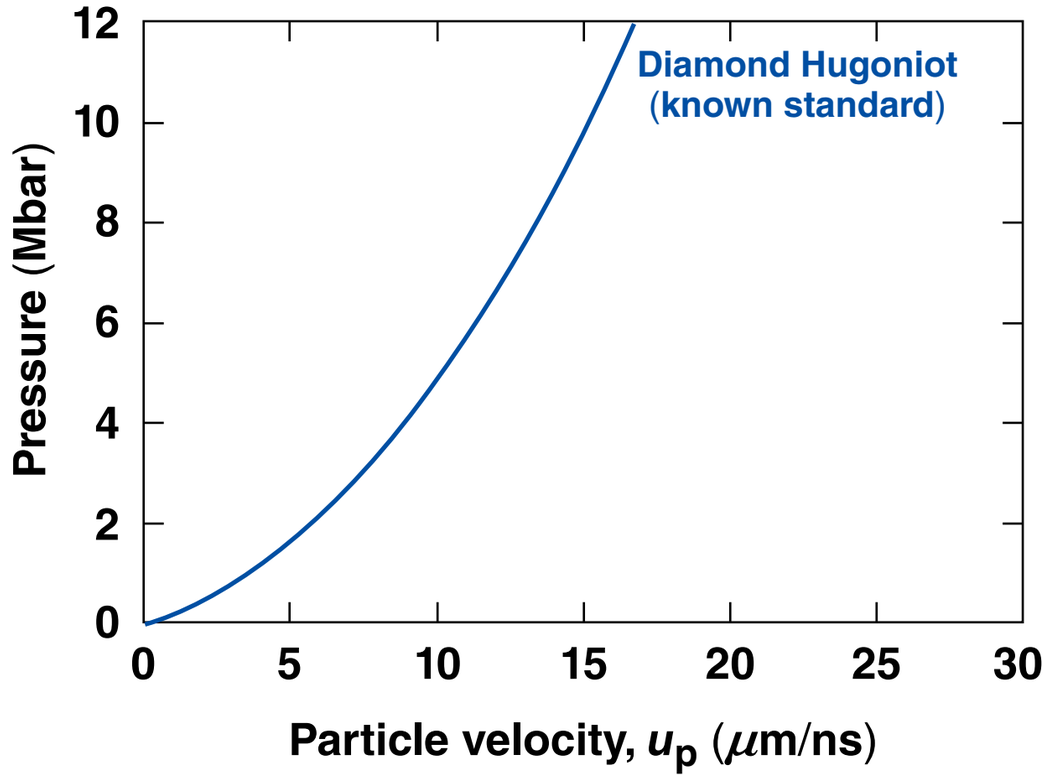
D. E. Fratanduono, P. M. Celliers, and G. W. Collins

Lawrence Livermore National Laboratory

Equation-of-state data are obtained from the impedance-matching technique

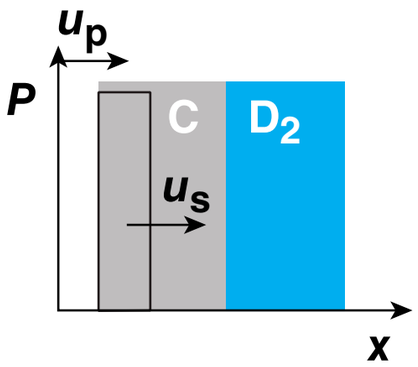


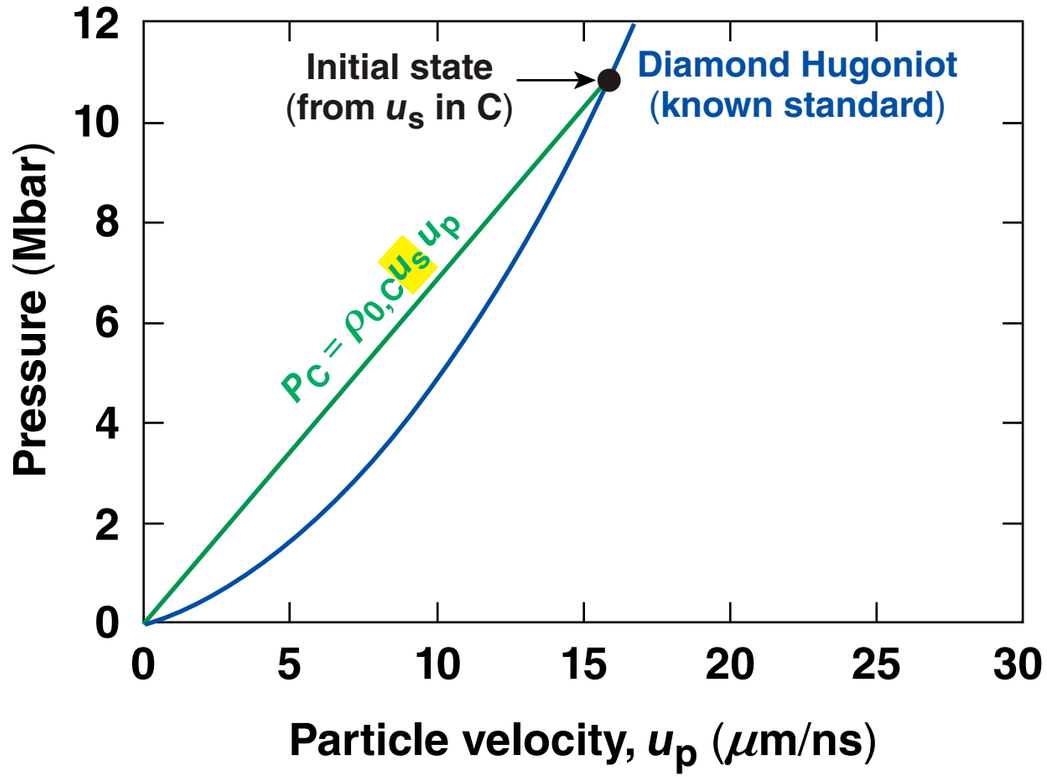




E12433h

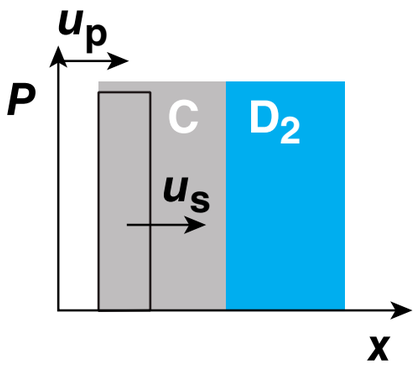
Equation-of-state data are obtained from the impedance-matching technique

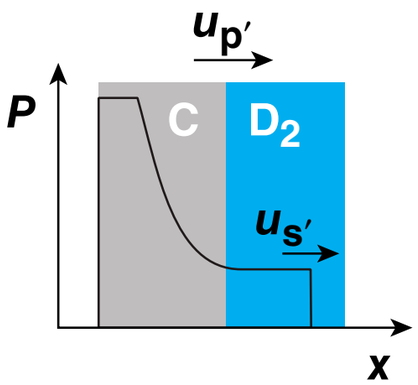


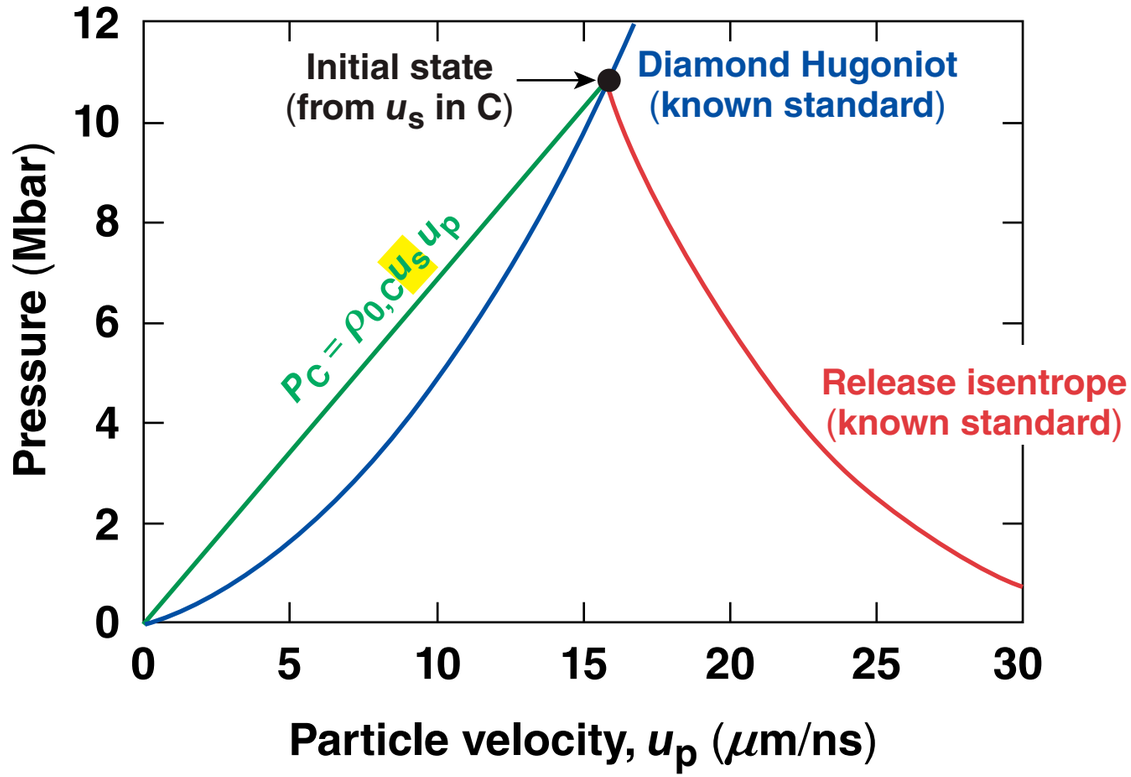


E12433i

Equation-of-state data are obtained from the impedance-matching technique

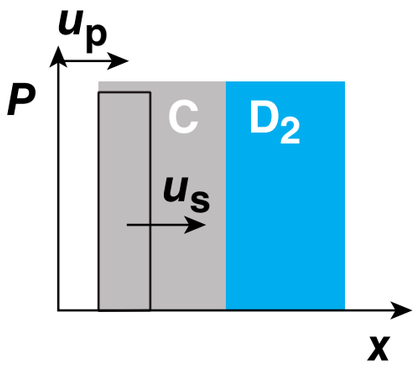


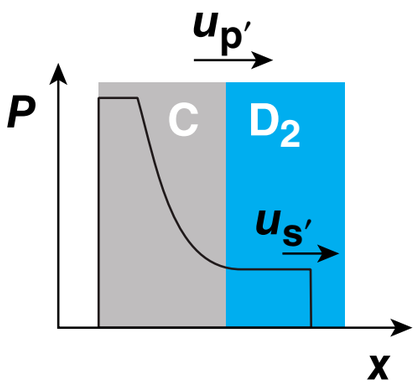


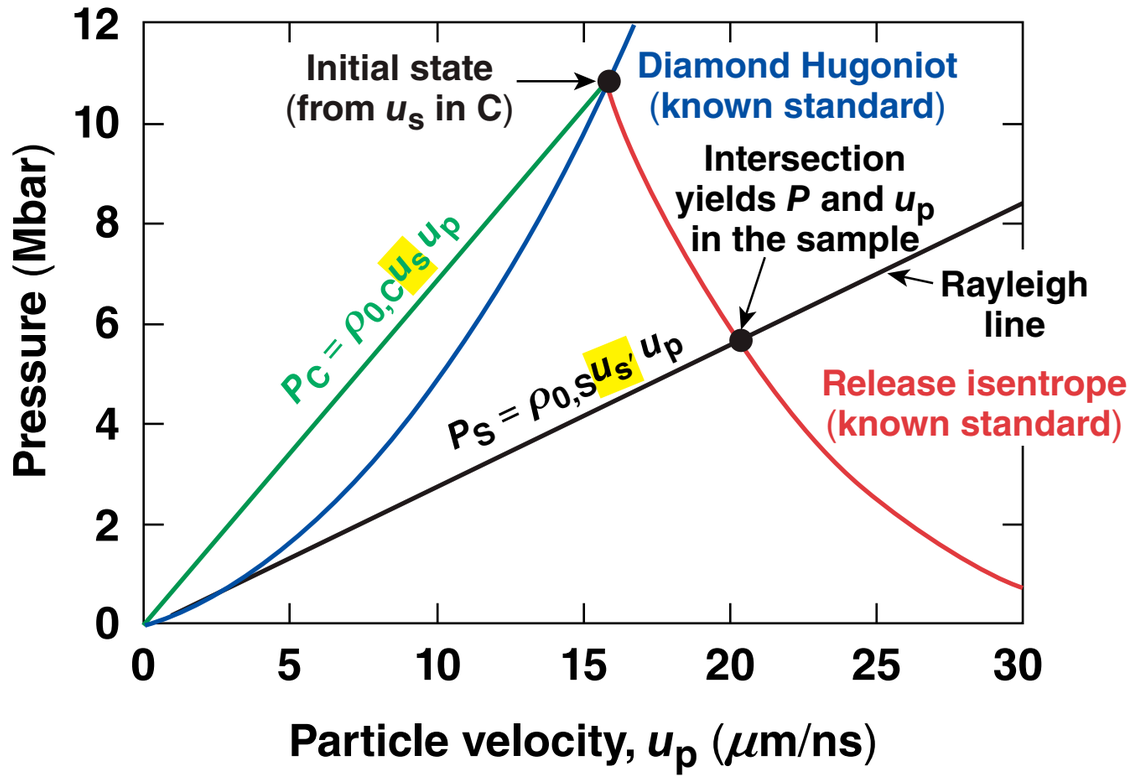


E12433j

Equation-of-state data are obtained from the impedance-matching technique

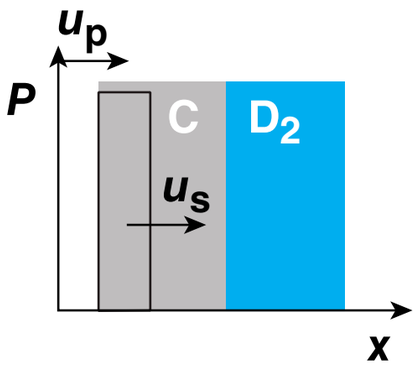


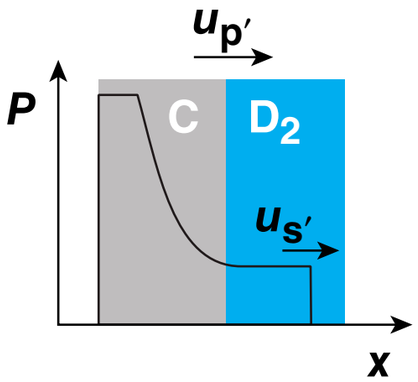


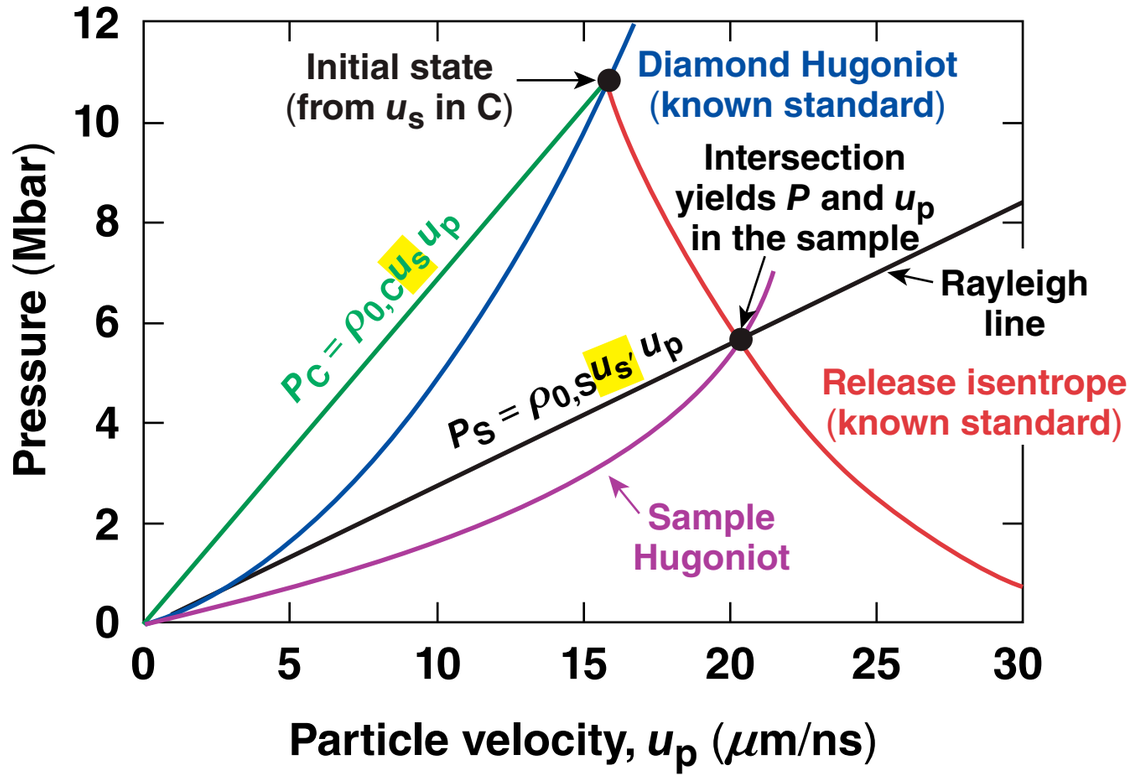


E12433k

Equation-of-state data are obtained from the impedance-matching technique

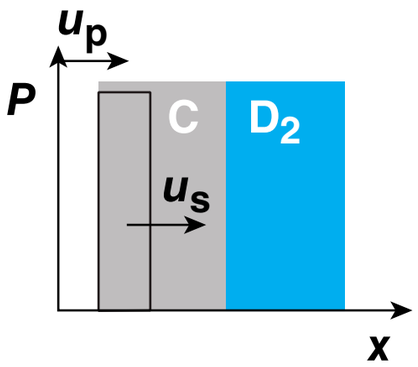


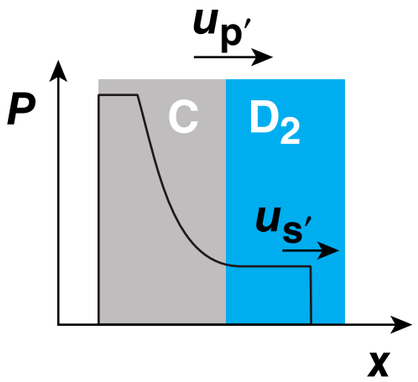


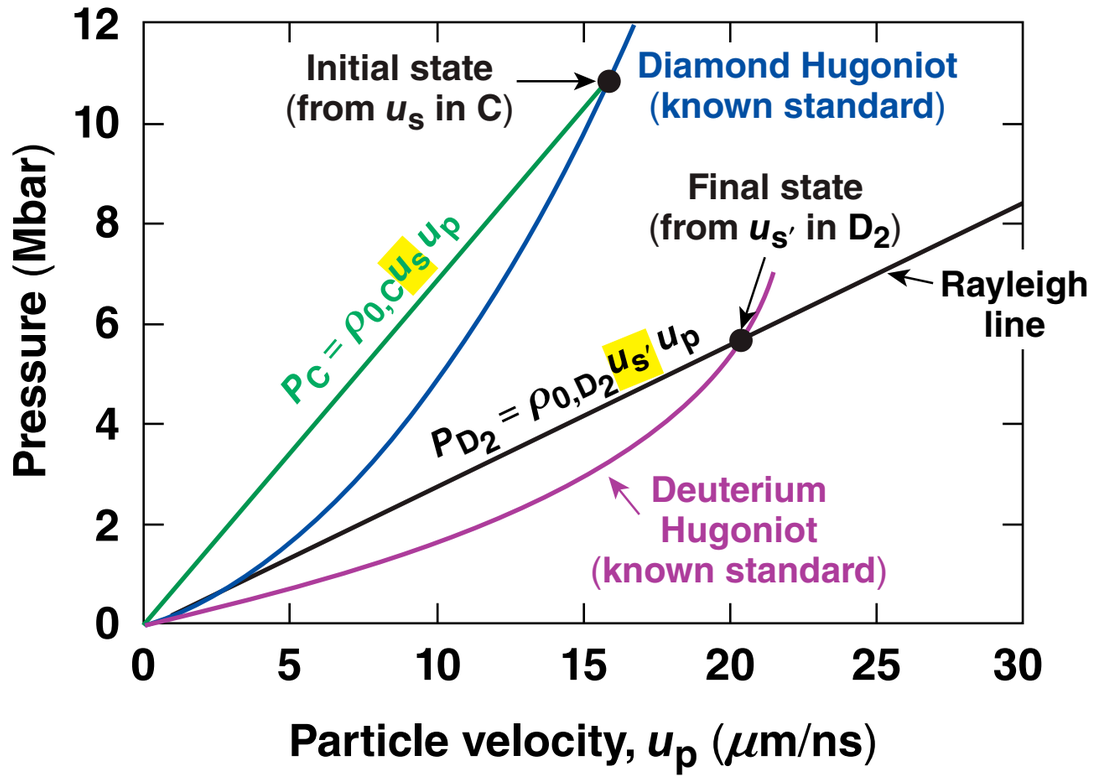


E12433I

Release data are obtained using the impedance-matching technique between known standards

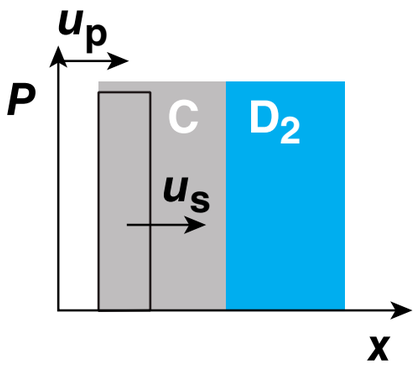


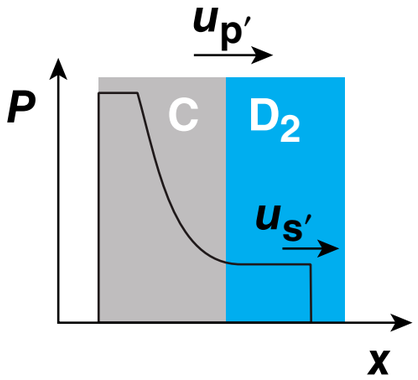


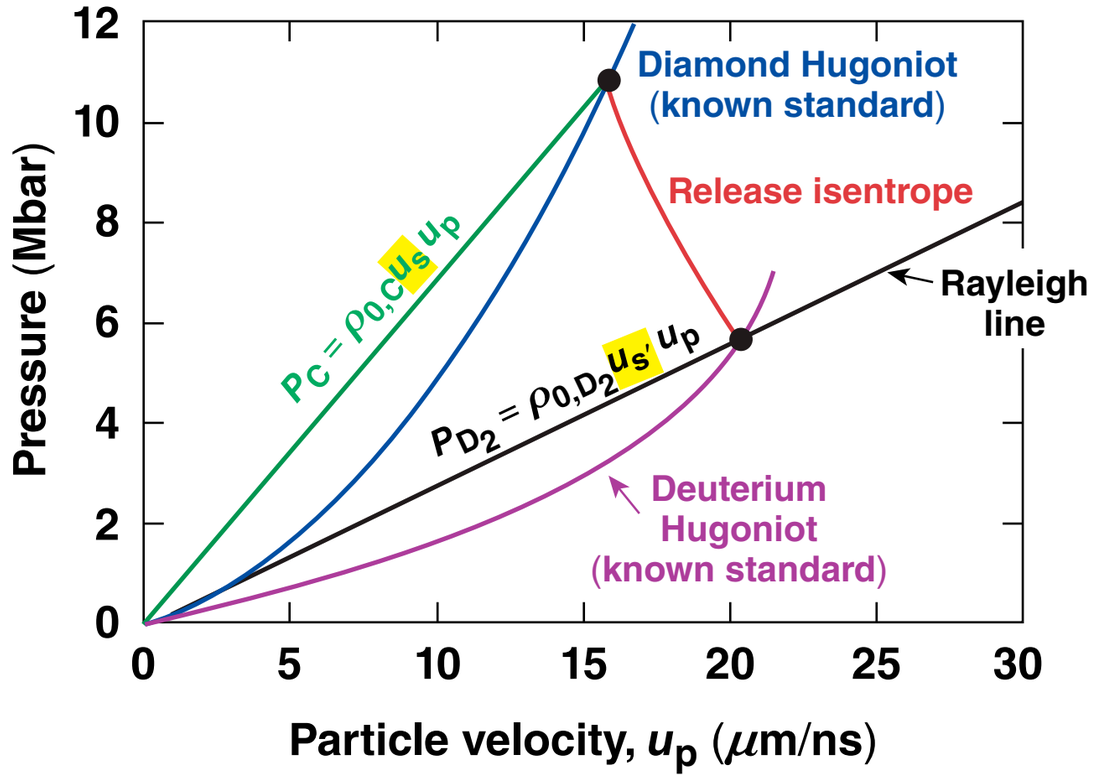


E12433m

Release data are obtained using the impedance-matching technique between known standards



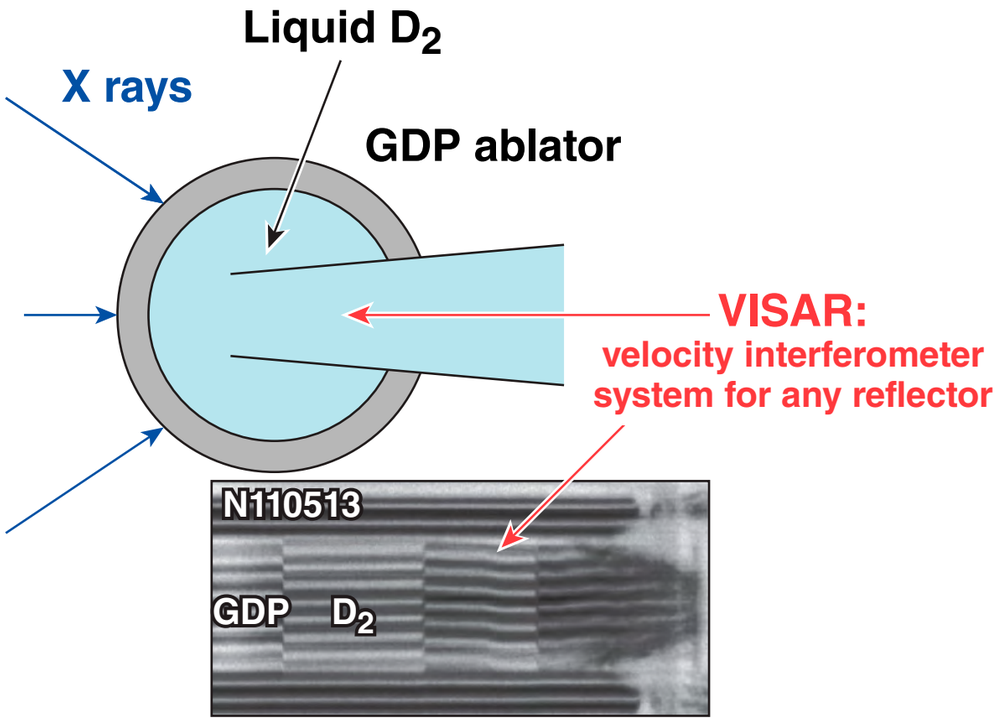


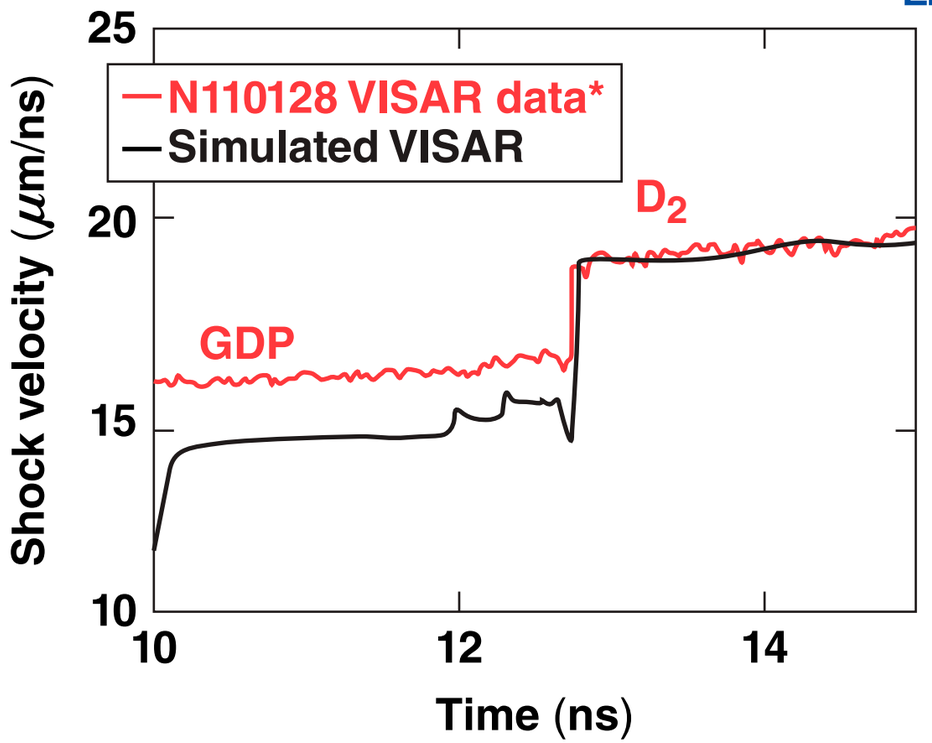


E12433n

Motivation

Initial NIF shock-timing experiments revealed inaccuracies in the ablator release model



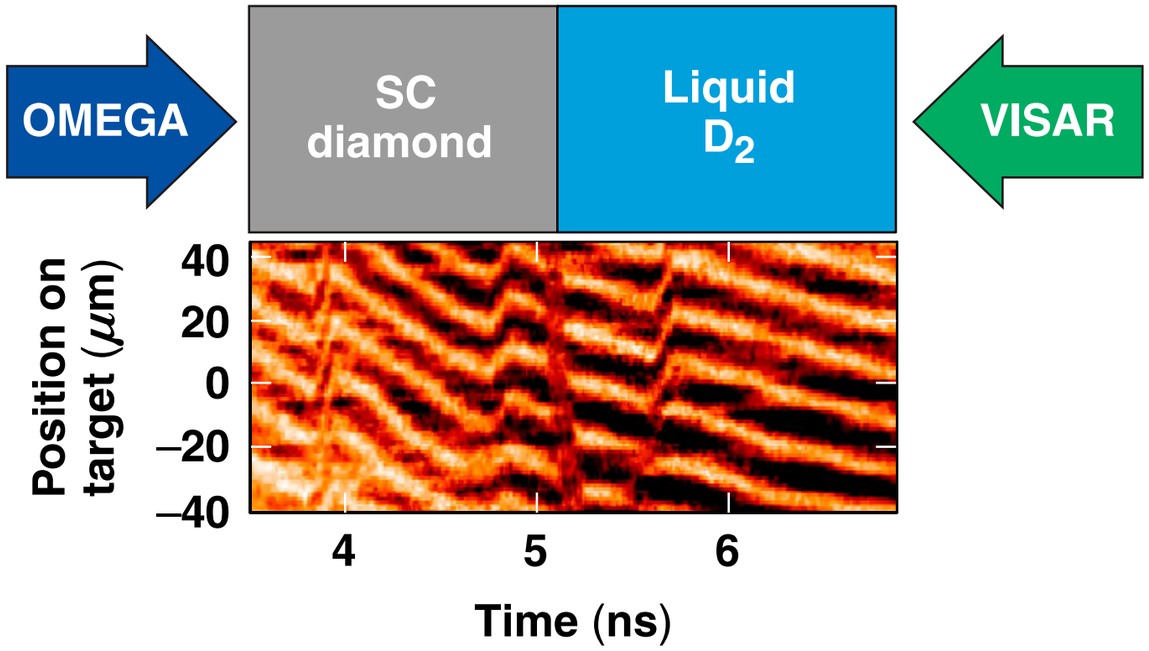


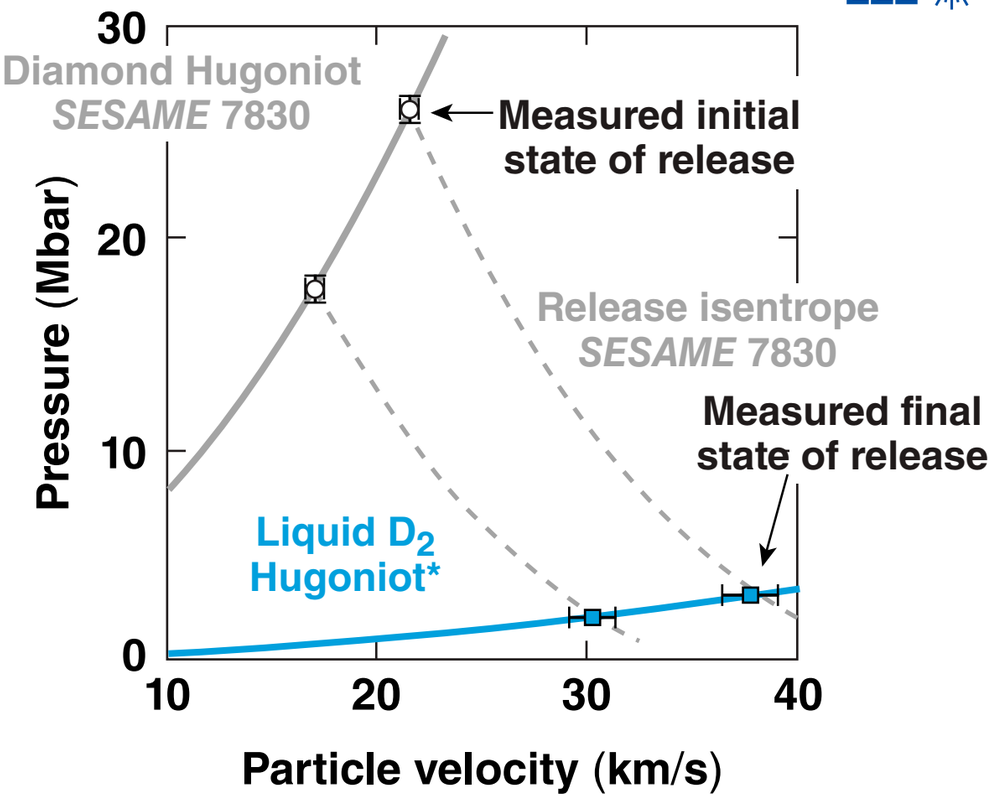
The glow-discharge polymer (GDP) equation-of-state model was corrected using release data into liquid D_2.**

*H. F. Robey *et al.*, Phys. Plasmas 19, 042706 (2012).
**S. Hamel *et al.*, Phys. Rev. B 86, 094113 (2012).

E23264b

The impedance-match method was used to measure the SC diamond release into liquid D_2



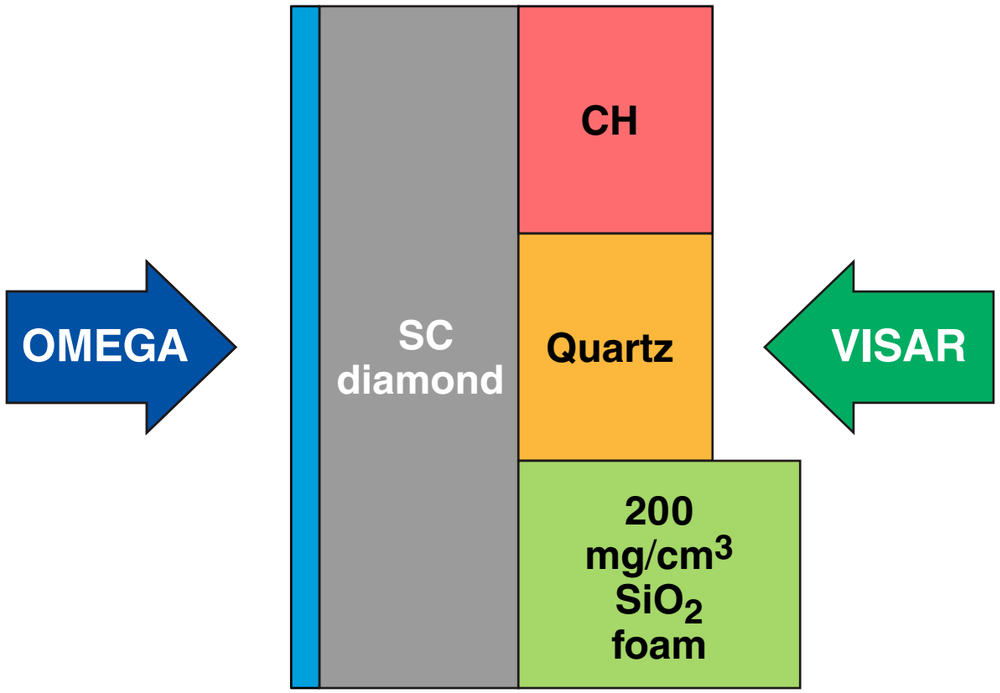


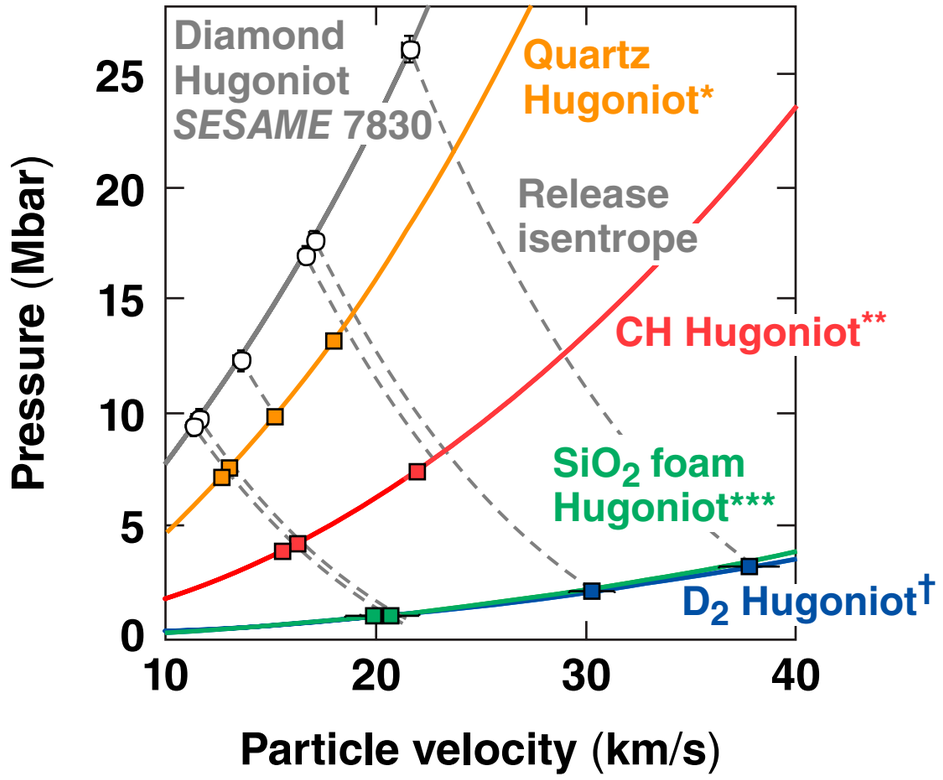
The release isentrope constructed using *SESAME* 7830 agrees with the experimental data.

E24116

*M. D. Knudson, Sandia National Laboratories, private communication (2015).

The single-crystal diamond release model is constrained using multiple standards

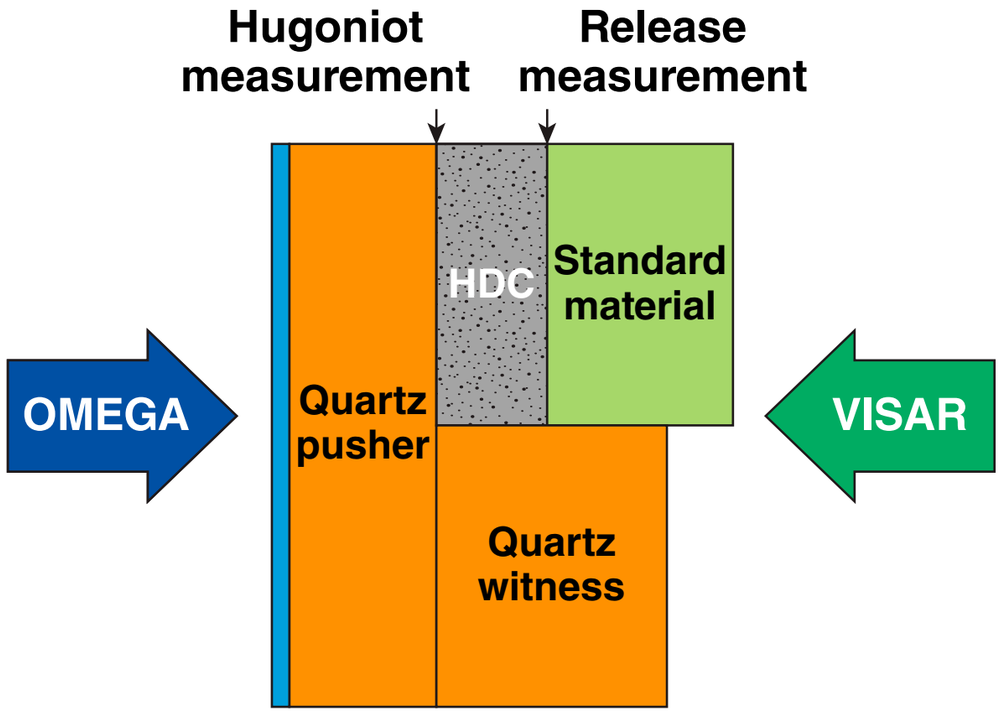


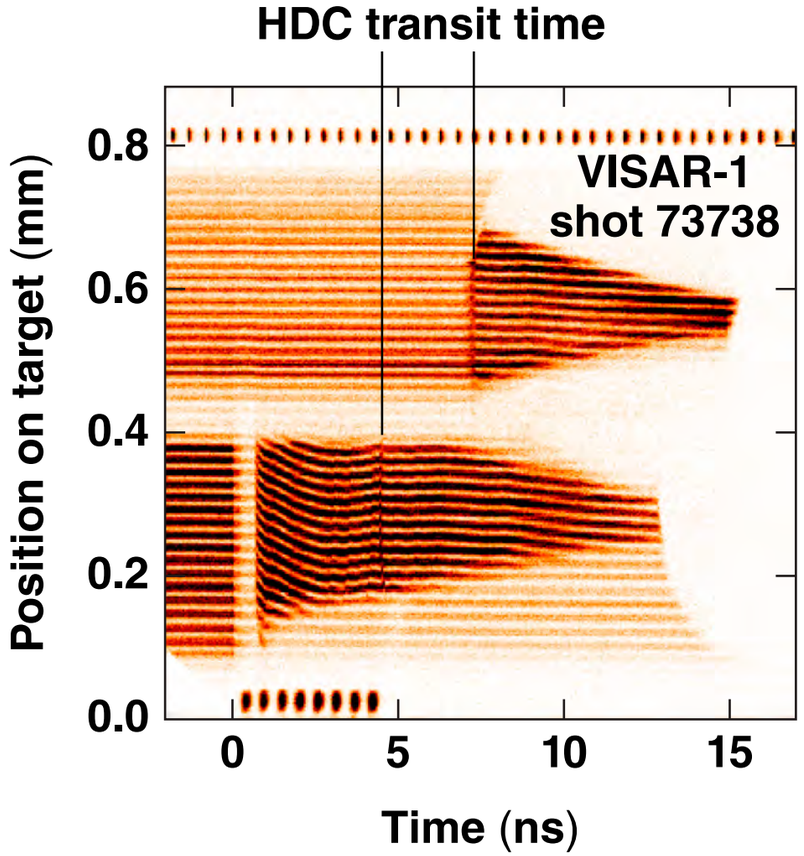


*M. D. Knudson and M. P. Desjarlais, Phys. Rev. B 88, 184107 (2013).
**M. A. Barrios *et al.*, Phys. Plasmas 17, 056307 (2010).
***M. D. Knudson and R. W. Lemke, J. Appl. Phys. 114, 053510 (2013).
†M. D. Knudson, Sandia National Laboratories, private communication (2015).

E24117a

Experiments with HDC provide both Hugoniot and release measurements



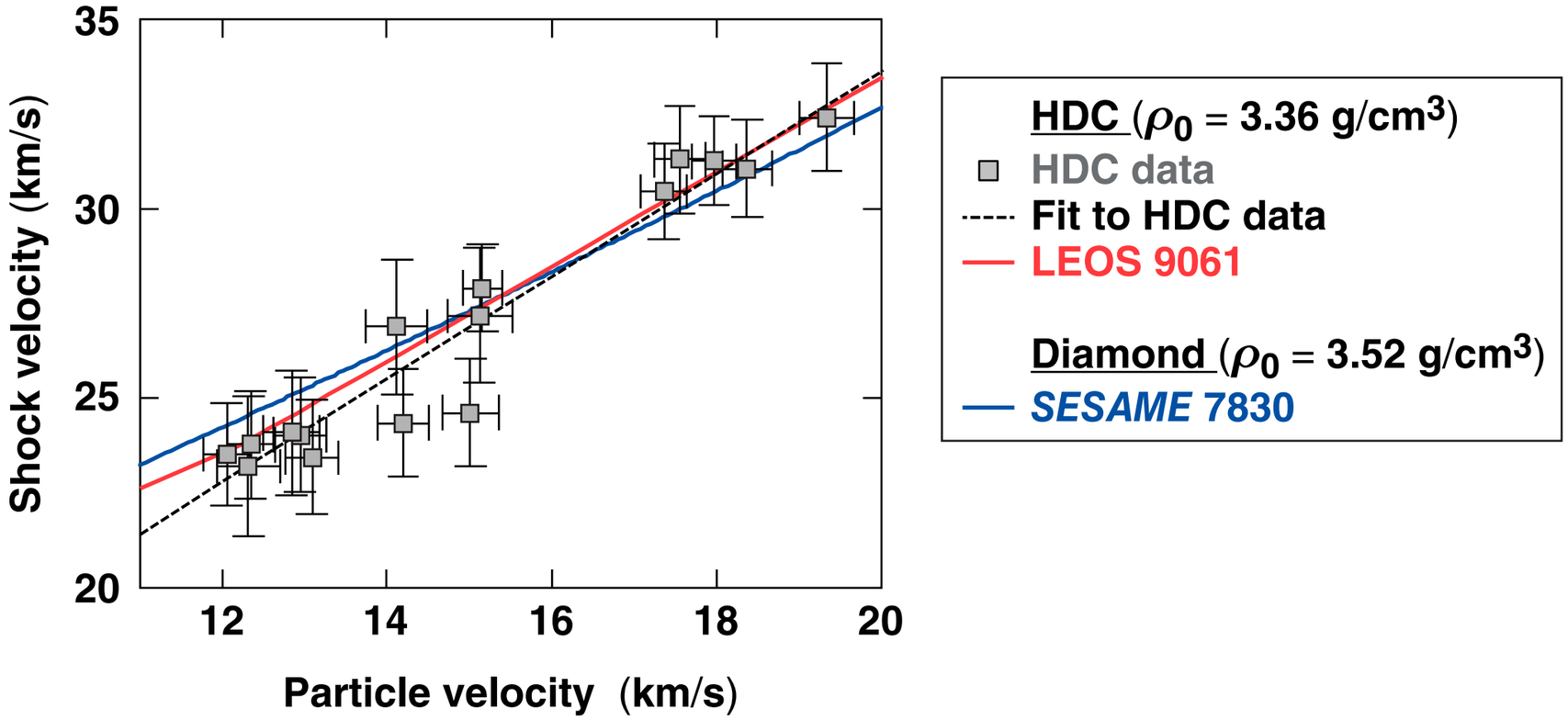


- Instantaneous shock velocities in HDC are determined using an unsteady wave correction*

*D. E. Fratanduono *et al.*, J. Appl. Phys. 116, 033517 (2014).

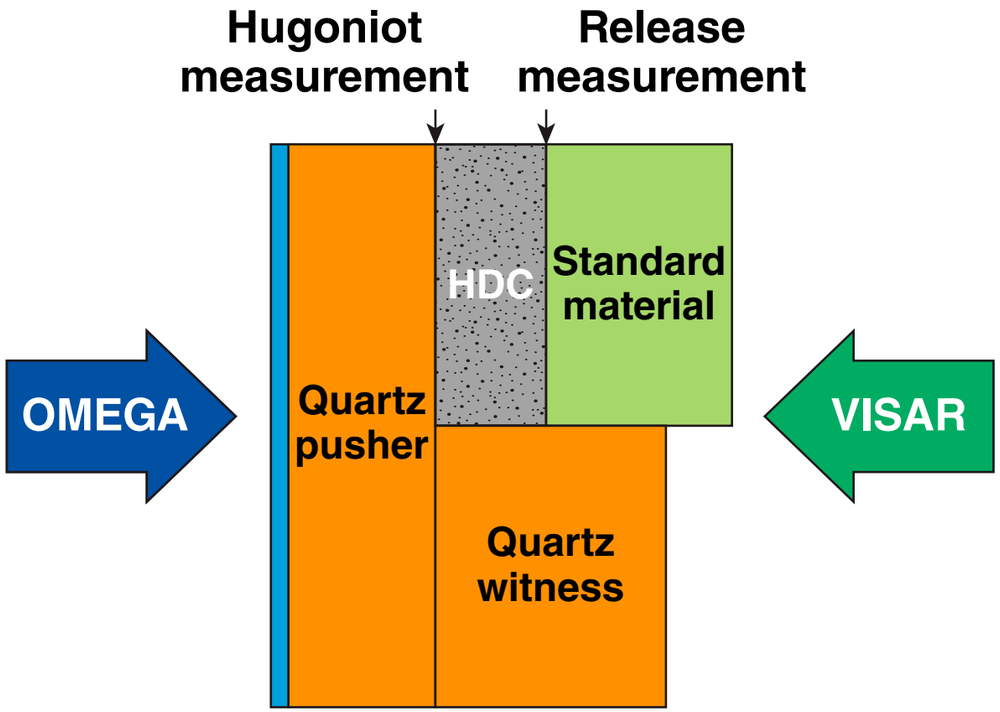
E23267b

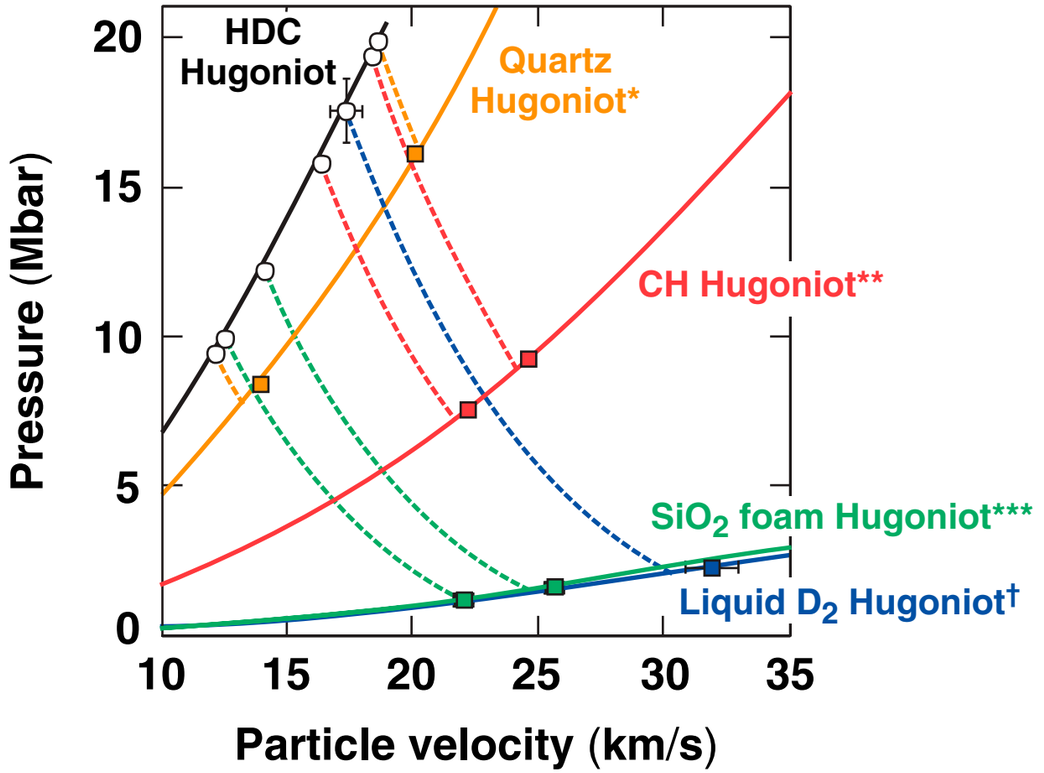
The HDC Hugoniot was measured up to 20 Mbar



E24118

The HDC release model is constrained using four materials including deuterium





*M. D. Knudson and M. P. Desjarlais, Phys. Rev. B 88, 184107 (2013).
**M. A. Barrios *et al.*, Phys. Plasmas 17, 056307 (2010).
***M. D. Knudson and R. W. Lemke, J. Appl. Phys. 114, 053510 (2013).
†M. D. Knudson, Sandia National Laboratories, private communication (2015).

E24119

Summary/Conclusions

The shock and release behaviors of the NIF diamond ablator material were measured

- The National Ignition Facility (NIF) uses ultra-nanocrystalline high-density carbon (HDC) ablators
- Knowledge of the diamond Hugoniot and release behavior is critical for inertial confinement fusion (ICF) ignition target designs
- Release data are obtained by impedance matching with known standards
- Models for both the single-crystal (SC) diamond and HDC release are constrained by the experimental data
- The SC diamond release into liquid deuterium is accurately modeled using *SESAME* 7830
- The release data for both SC diamond and HDC will aid in the development of more-precise models for ICF target designs

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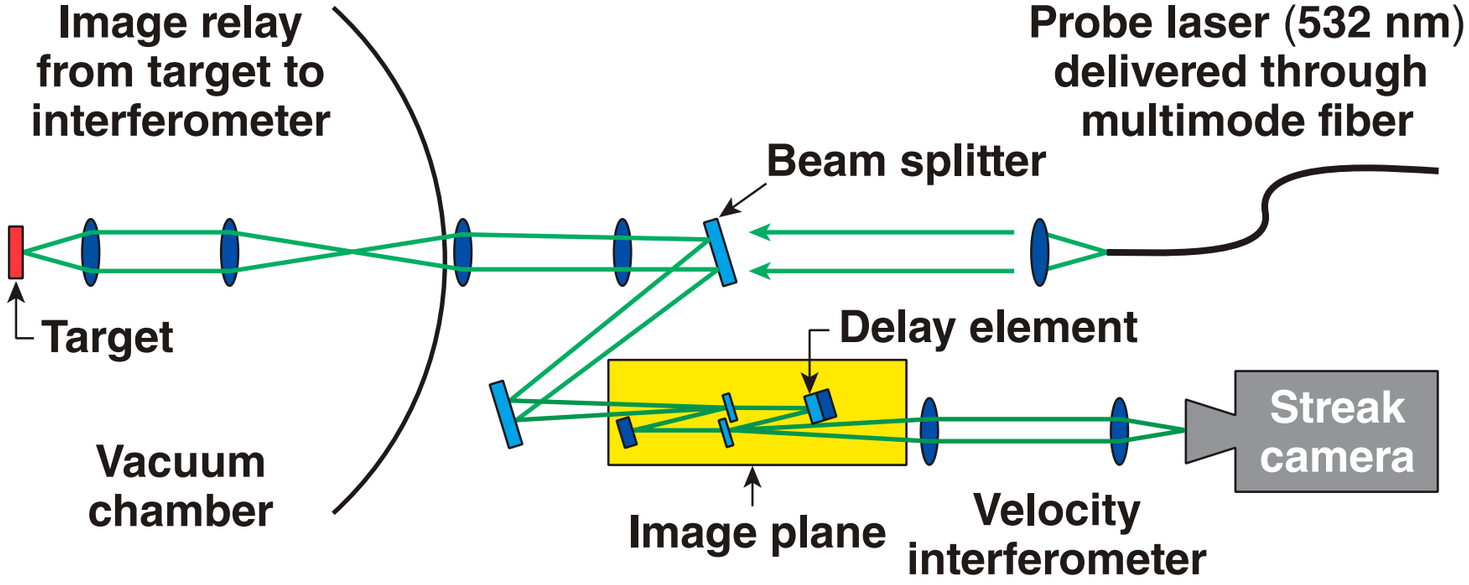
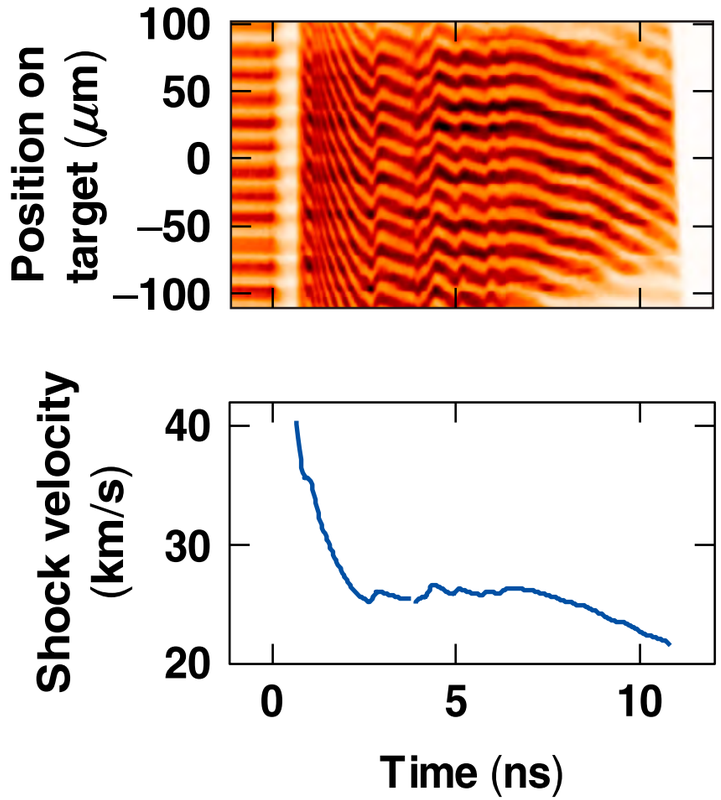
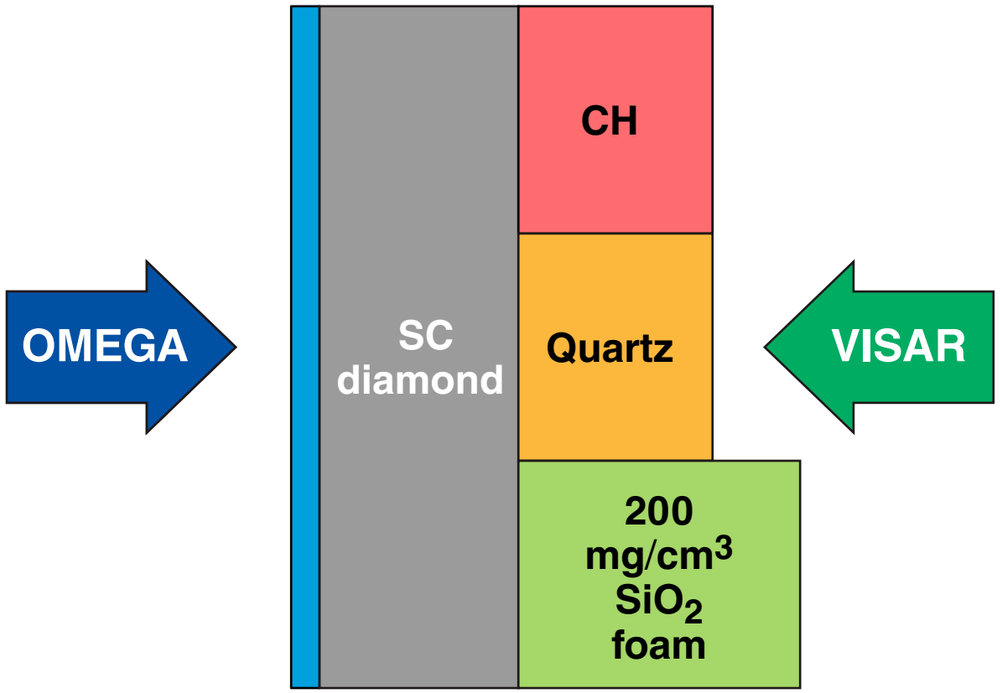
Shock velocities for impedance matching are measured using a time-resolved VISAR

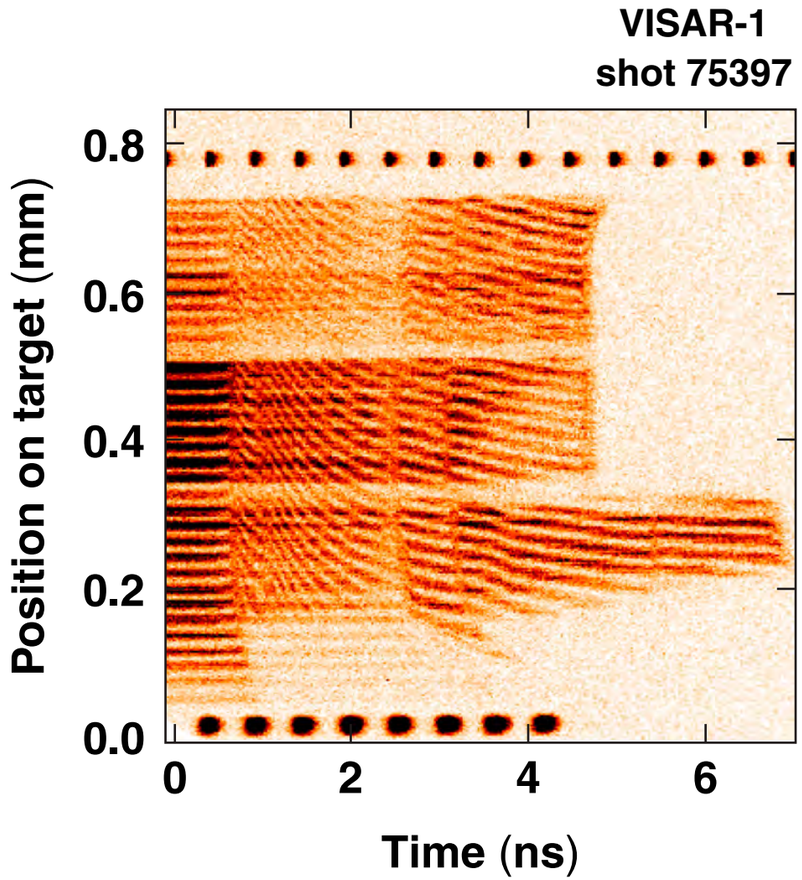




E11212h

The single-crystal diamond release model is constrained using multiple standards





E24117