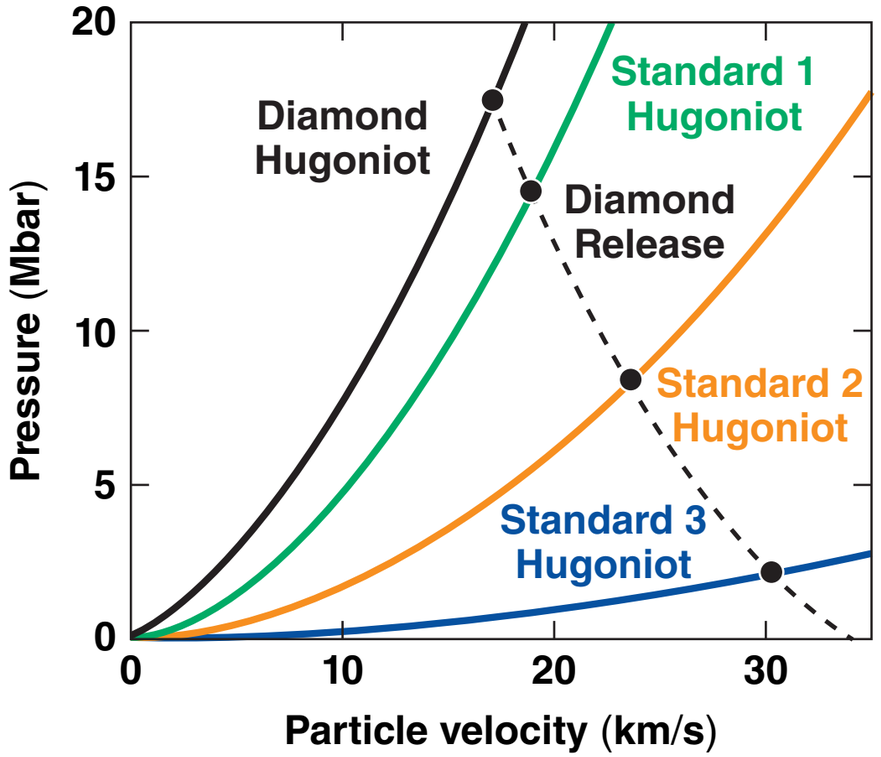
The Release Behavior of Diamond Shocked to 25 Mbar



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Division of Plasma Physics
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Summary

The shock and release behaviors of the high-density carbon (HDC) National Ignition Facility (NIF) ablator were measured

- Knowledge of the HDC Hugoniot and release behavior is critical for inertial confinement fusion (ICF) ignition target designs
- The HDC Hugoniot measurements agree with LEOS 9061
- Release data for both single-crystal (SC) diamond and HDC were obtained by impedance matching with known standards
- The SC diamond release into liquid deuterium is accurately modeled using *SESAME* 7830
- Mie–Grüneisen release models for both types of diamond are being developed

Collaborators

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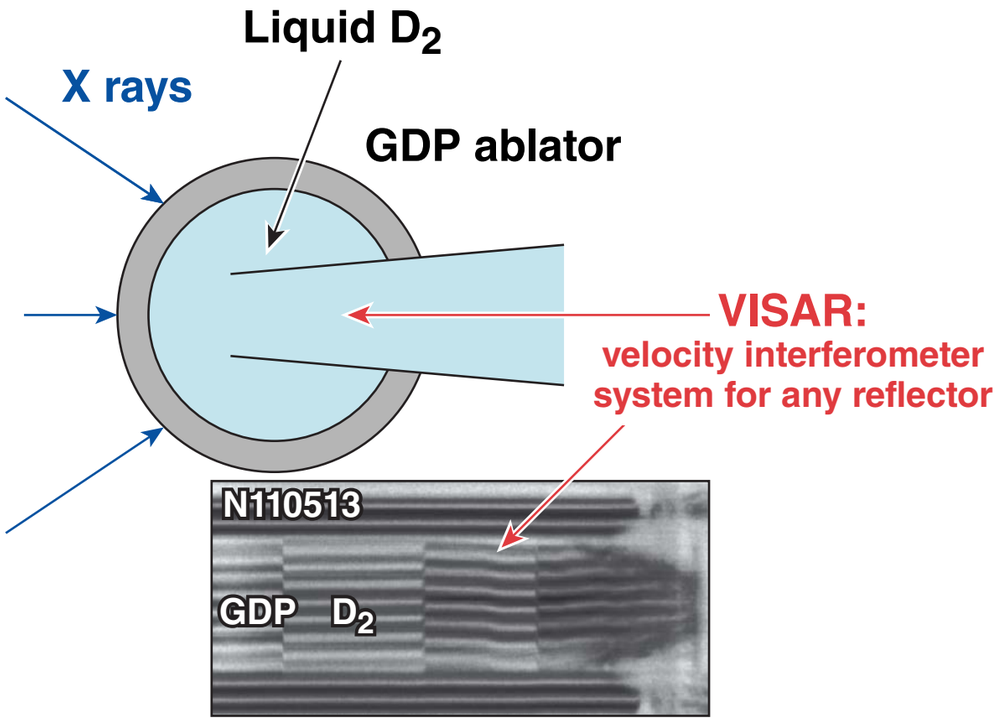
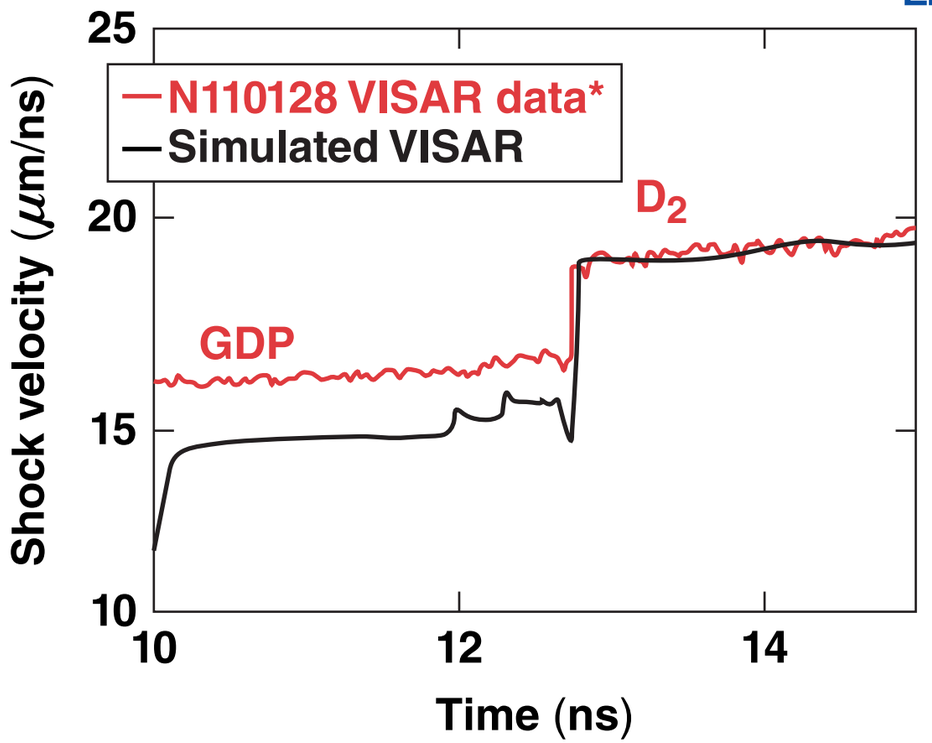
Motivation

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).

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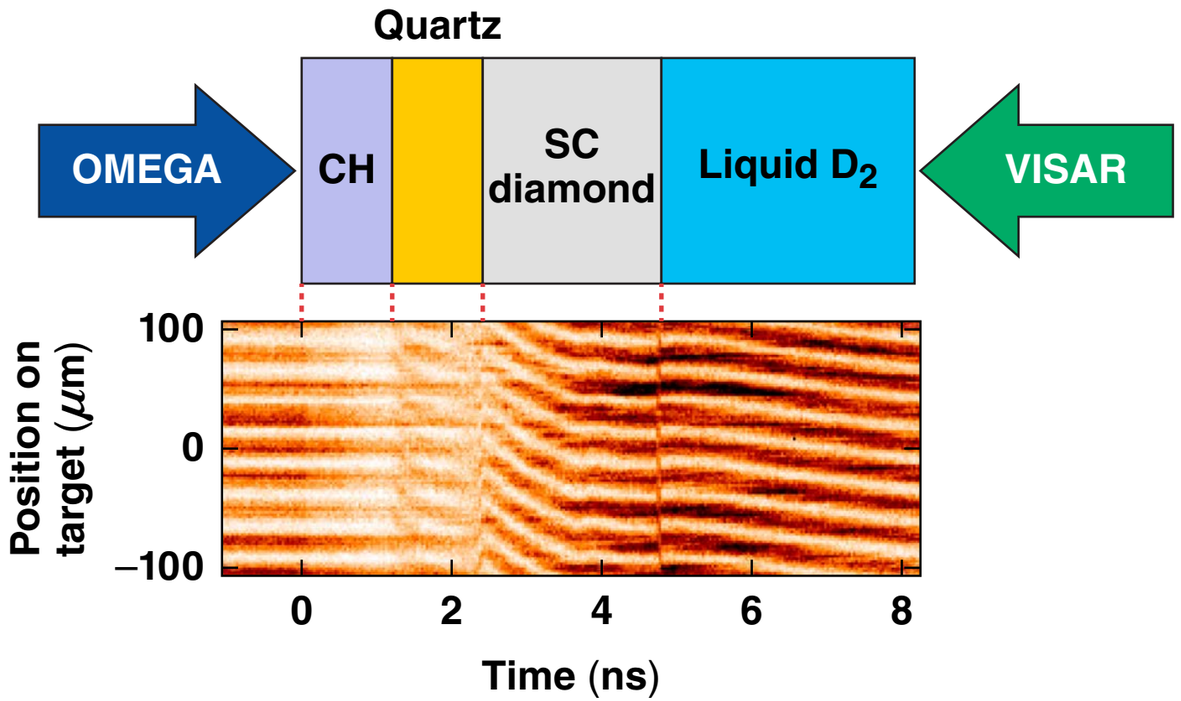
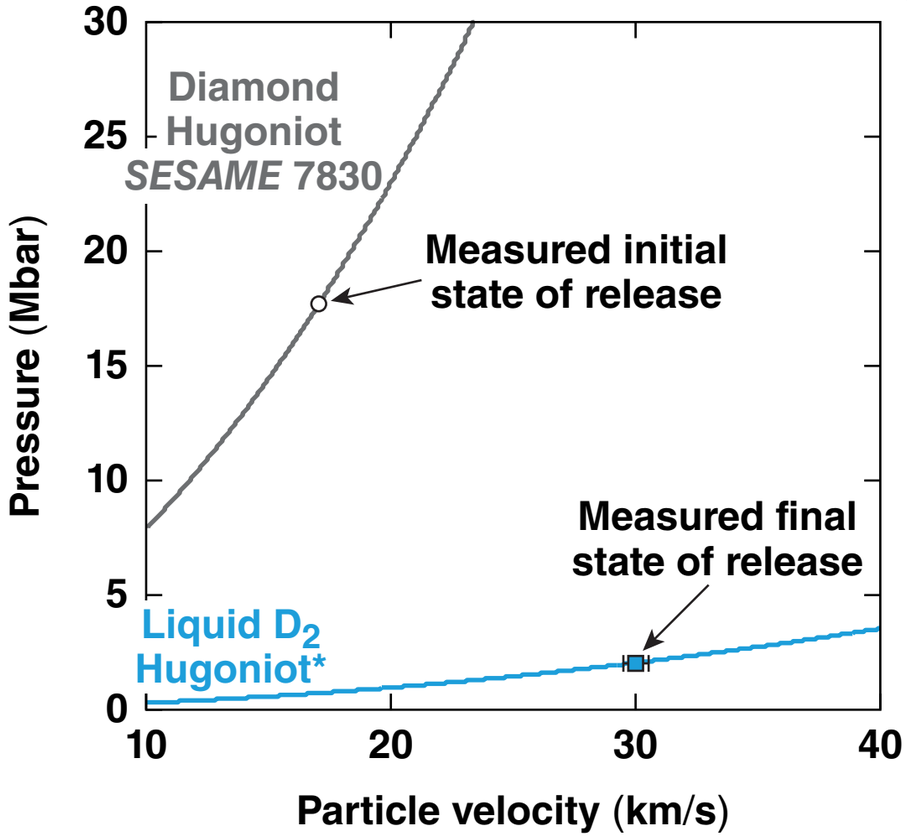
The impedance-match method was used to measure the SC diamond release into liquid deuterium





*M. D. Knudson, M. P. Desjarlais, and A. Pribram-Jones, Phys. Rev. B 91, 224105 (2015); D. G. Hicks *et al.*, Phys. Rev. B 79, 014112 (2009).

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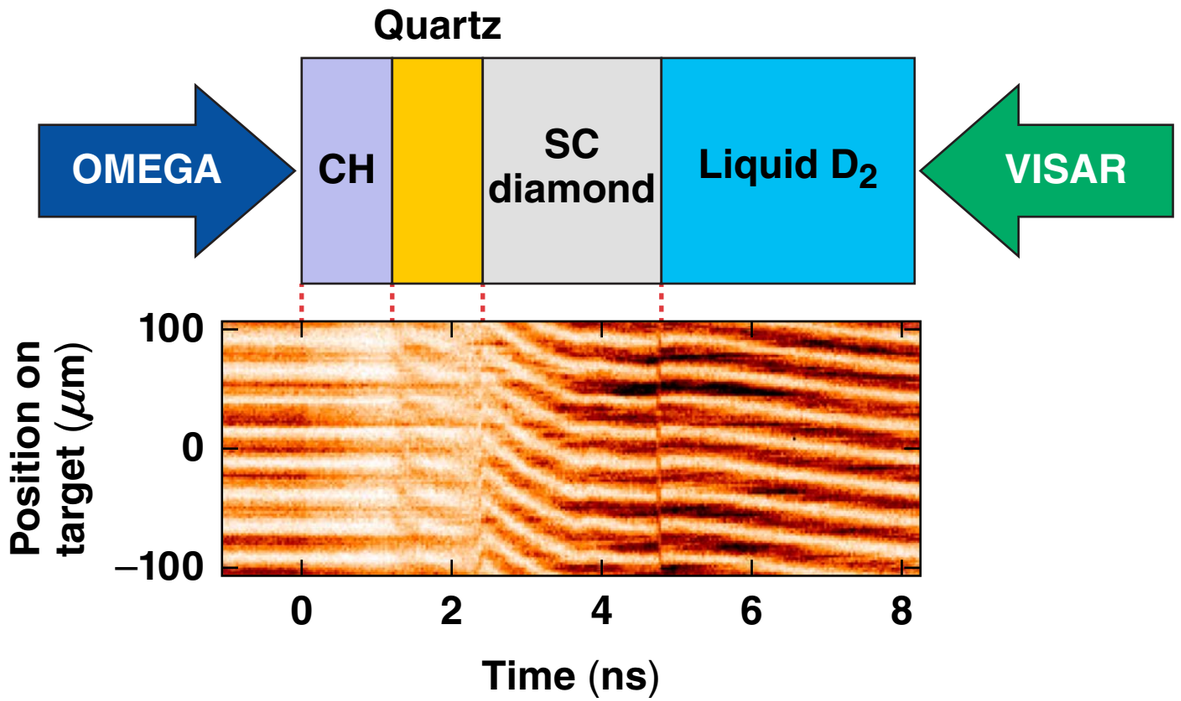

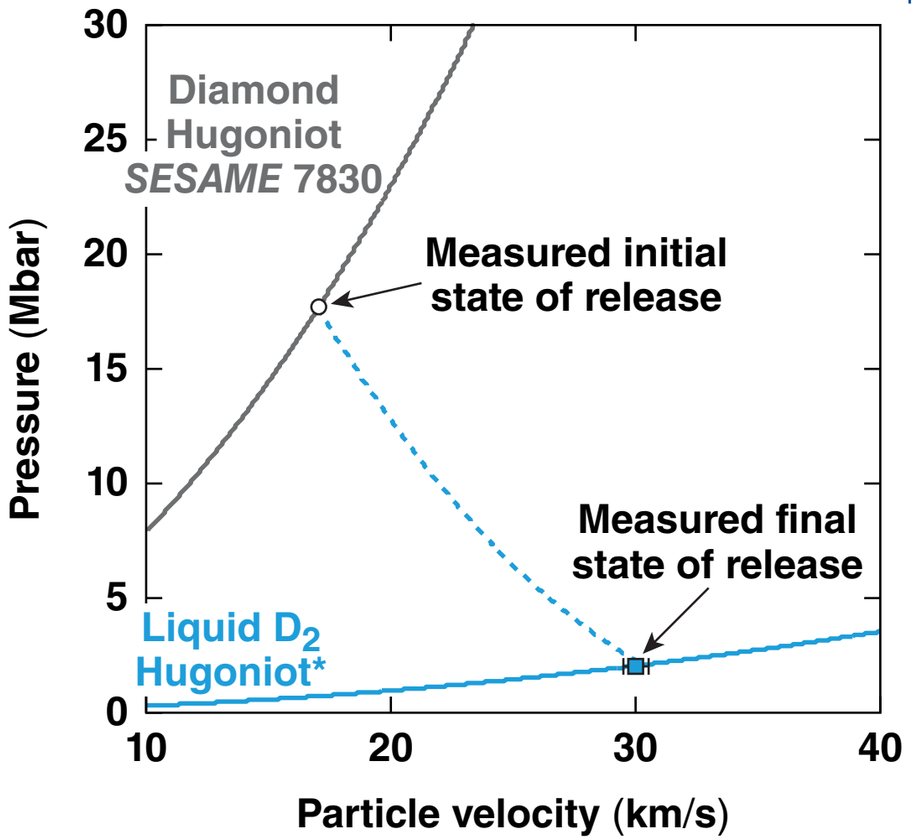

*M. D. Knudson, M. P. Desjarlais, and A. Pribram-Jones, Phys. Rev. B 91, 224105 (2015); D. G. Hicks *et al.*, Phys. Rev. B 79, 014112 (2009).

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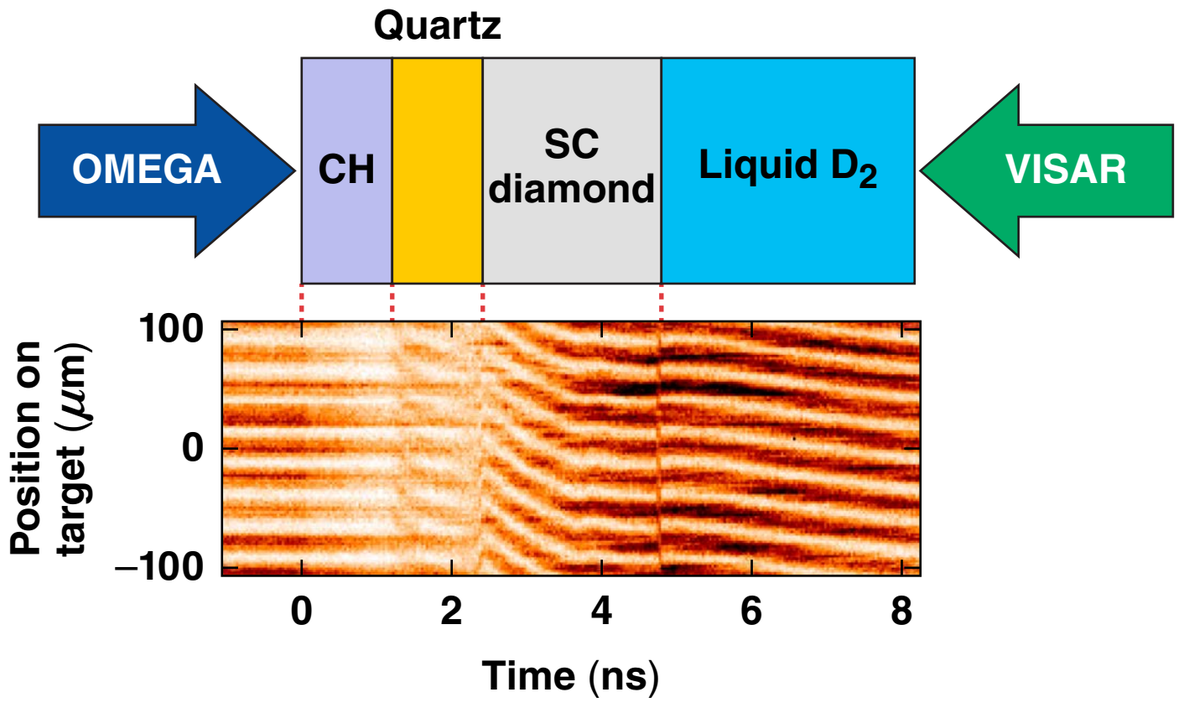

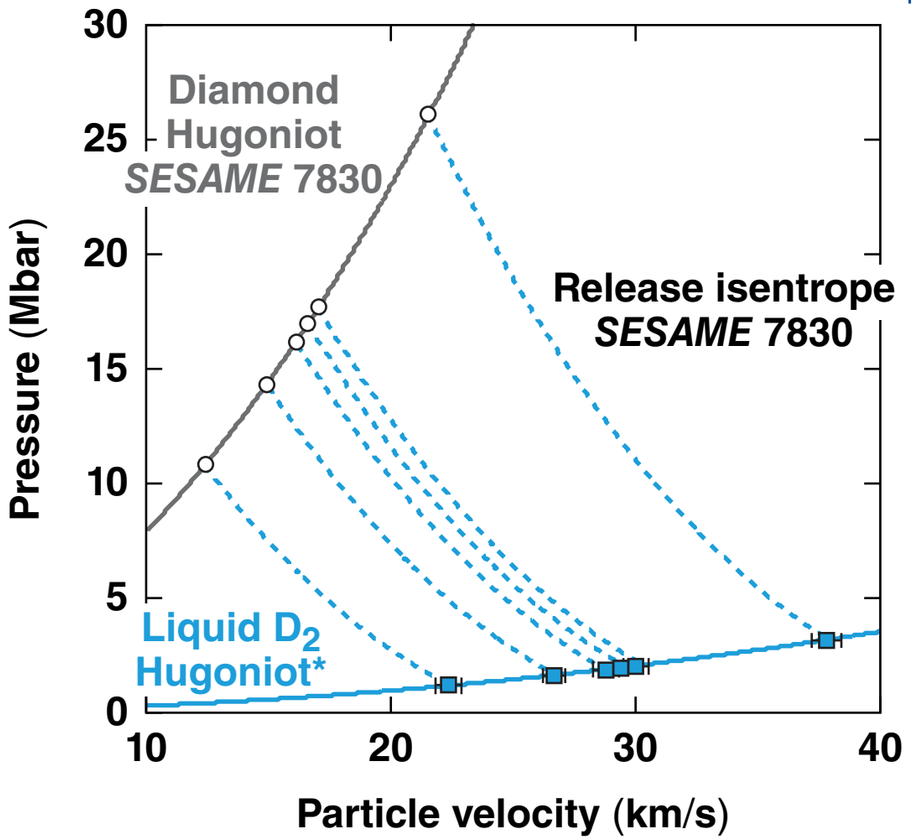

The SC diamond release into liquid D_2 is accurately modeled using *SESAME* 7830.

*M. D. Knudson, M. P. Desjarlais, and A. Pribram-Jones, Phys. Rev. B 91, 224105 (2015); D. G. Hicks *et al.*, Phys. Rev. B 79, 014112 (2009).

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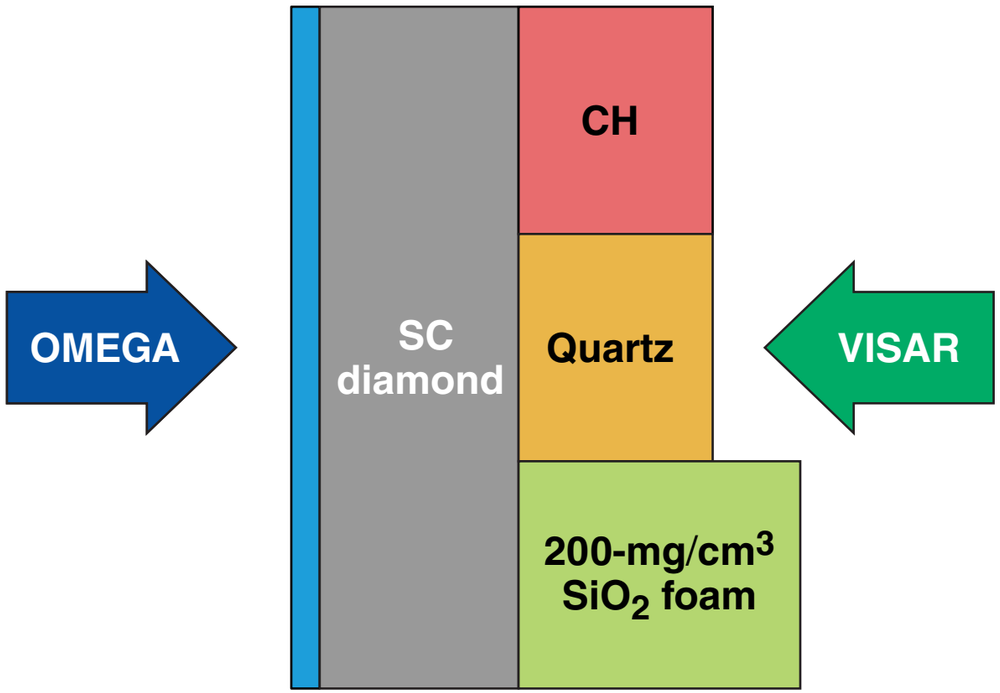
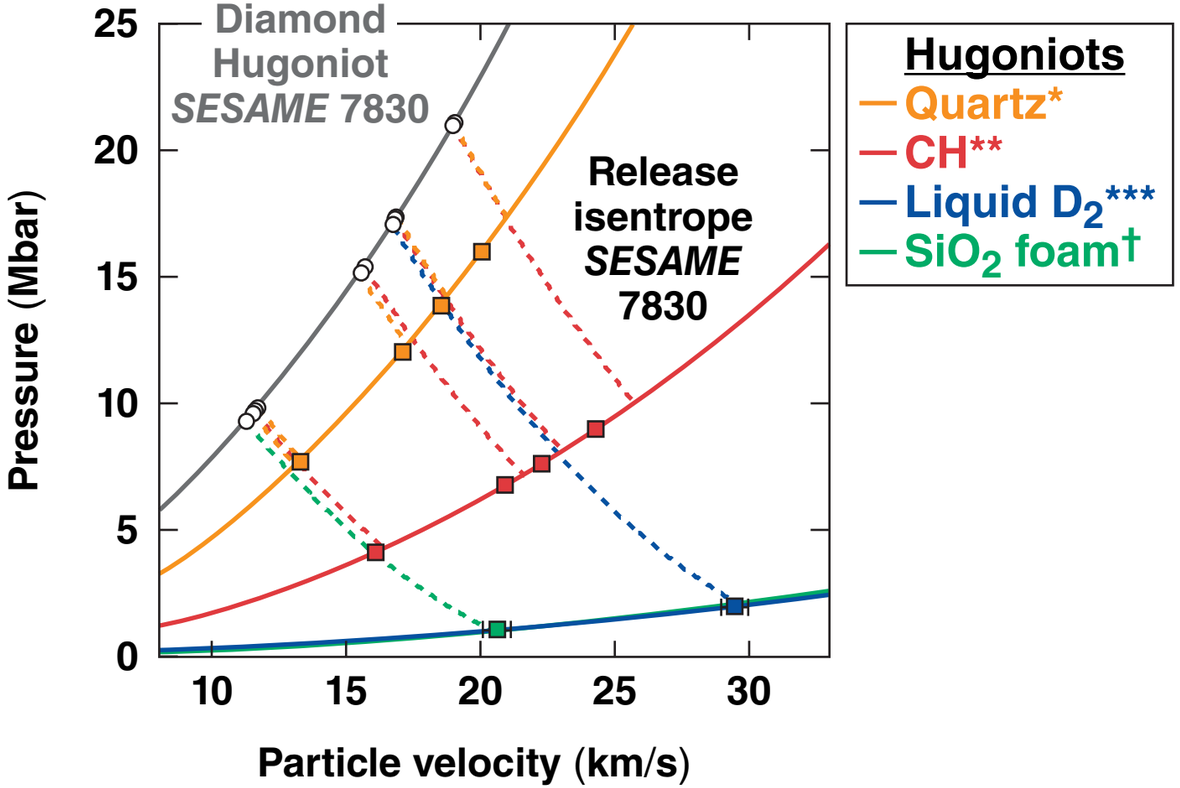
The single-crystal diamond release model is constrained using multiple standards

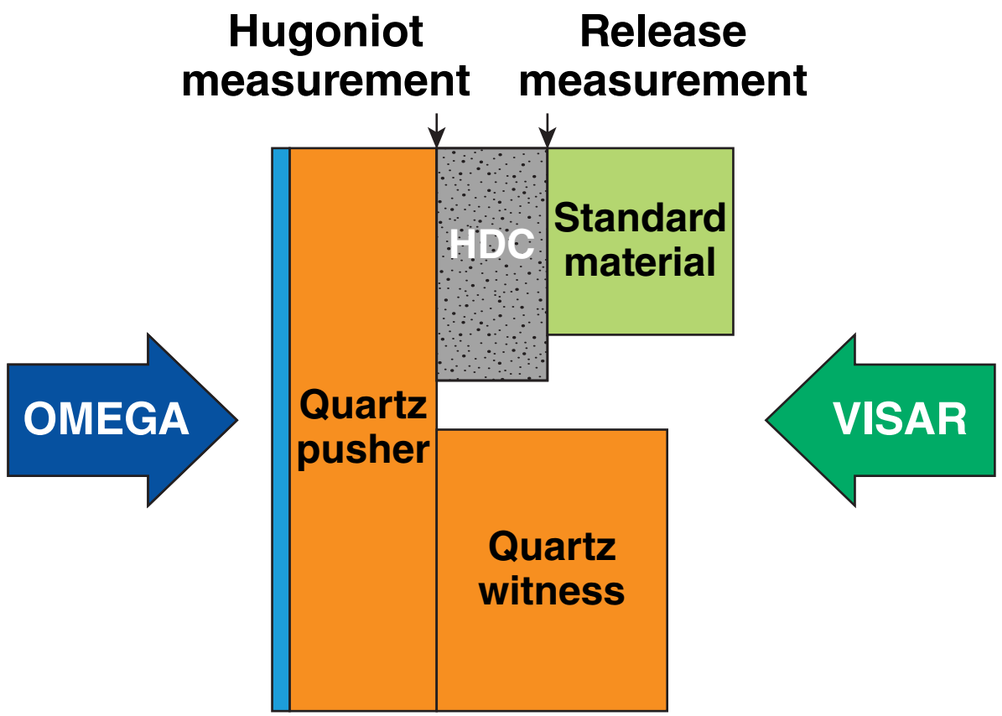


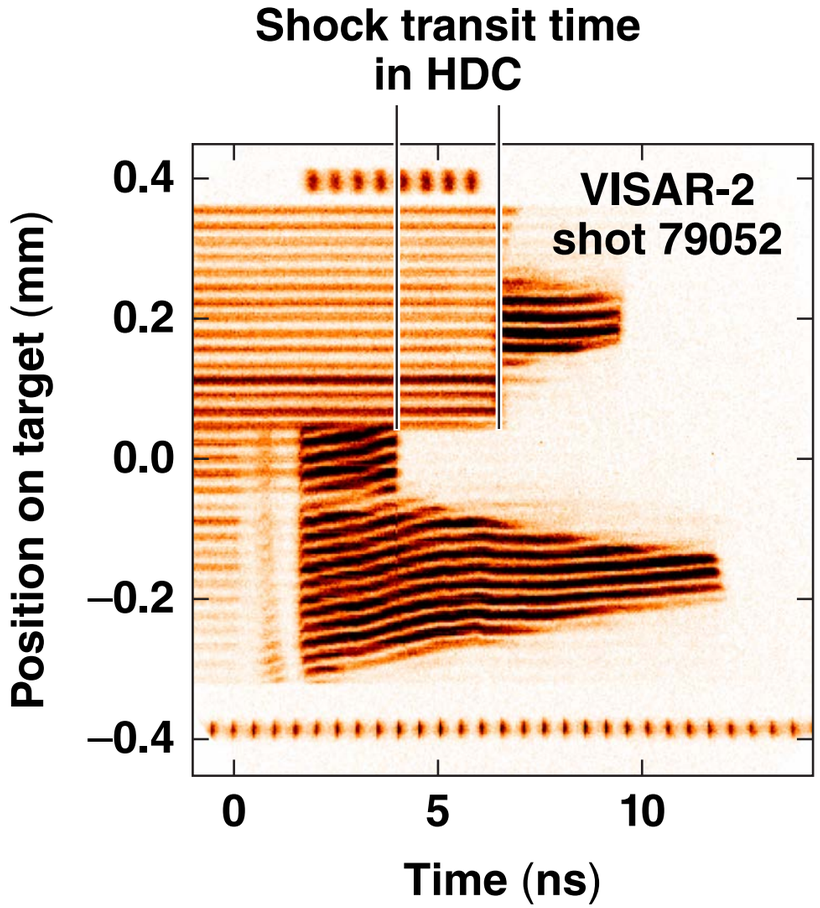


*M. D. Knudson and M. P. Desjarlais, Phys. Rev. B 88, 184107 (2013).
**M. A. Barrios *et al.*, Phys. Plasmas 17, 056307 (2010).
***M. D. Knudson, M. P. Desjarlais, and A. Pribram-Jones, Phys. Rev. B 91, 224105 (2015); D. G. Hicks *et al.*, Phys. Rev. B 79, 014112 (2009).
†M. D. Knudson and R. W. Lemke, J. Appl. Phys. 114, 053510 (2013).

E24117b

Experiments with HDC provide both Hugoniot and release measurements



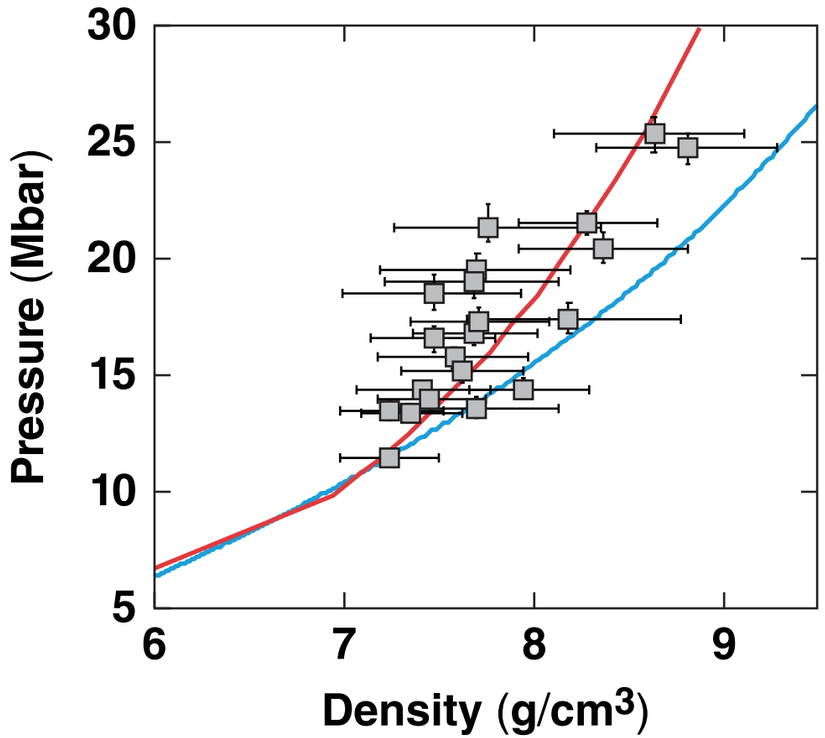


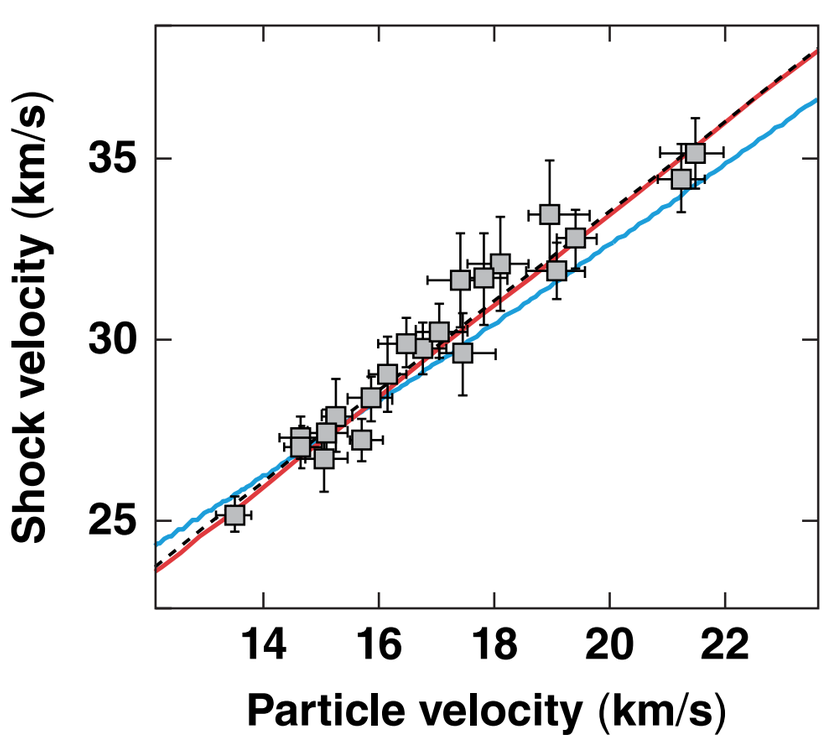
- Instantaneous shock velocities in HDC are determined using a non-steady waves correction*

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

E23267d

The HDC Hugoniot was measured up to 25 Mbar





HDC (ρ_0 = 3.36 g/cm^3)
HDC data
Fit to HDC data
LEOS 9061

SC diamond (ρ_0 = 3.51 g/cm^3)
SESAME 7830

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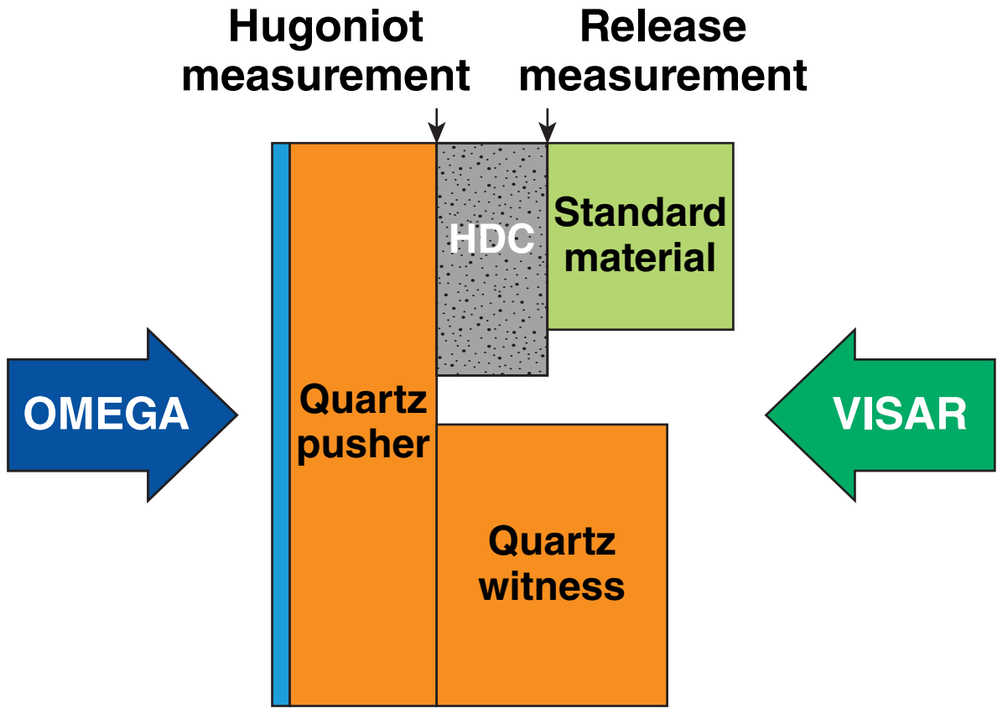
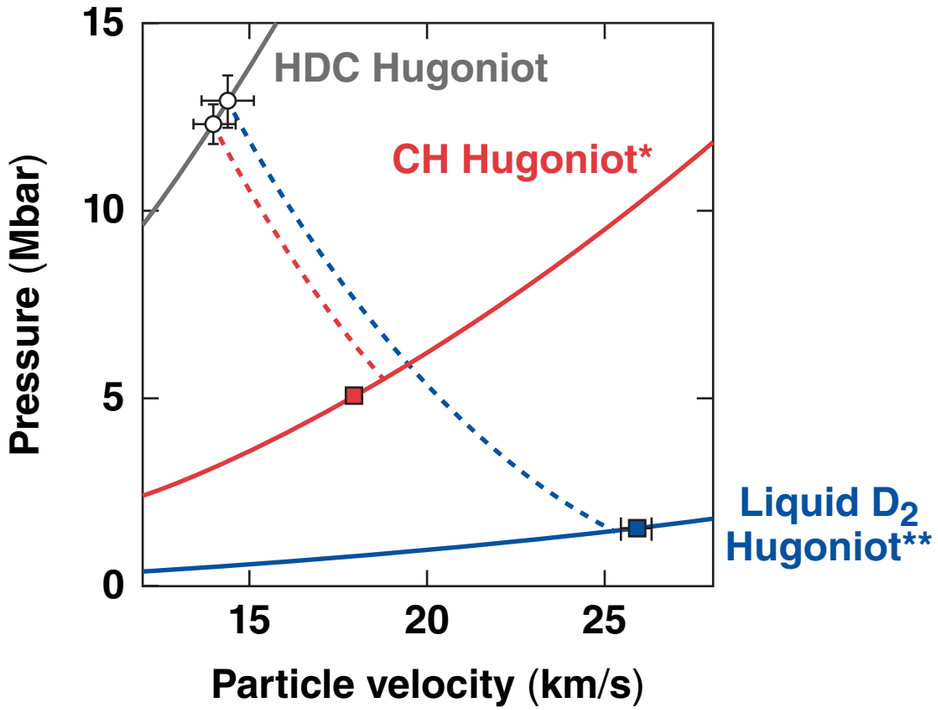
A Mie–Grüneisen release model is being developed for HDC using the experimental data





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Summary/Conclusions

The shock and release behaviors of the high-density carbon (HDC) National Ignition Facility (NIF) ablator were measured

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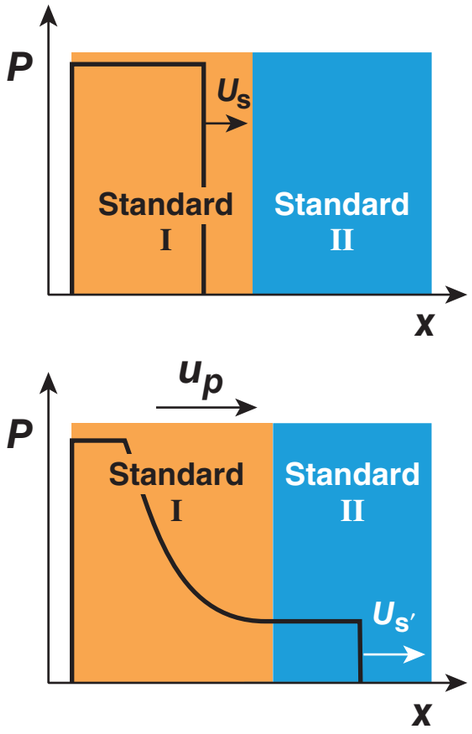
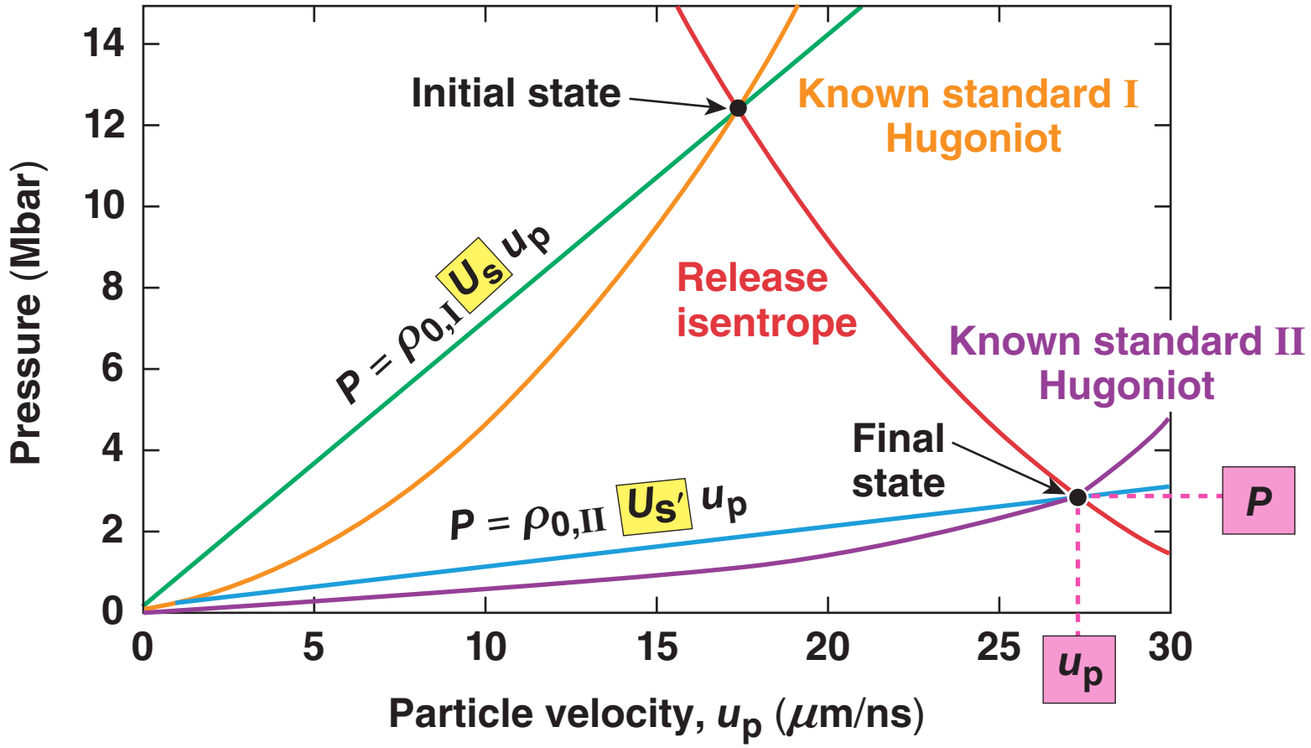
Release data are obtained using the impedance-matching technique between known standards





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