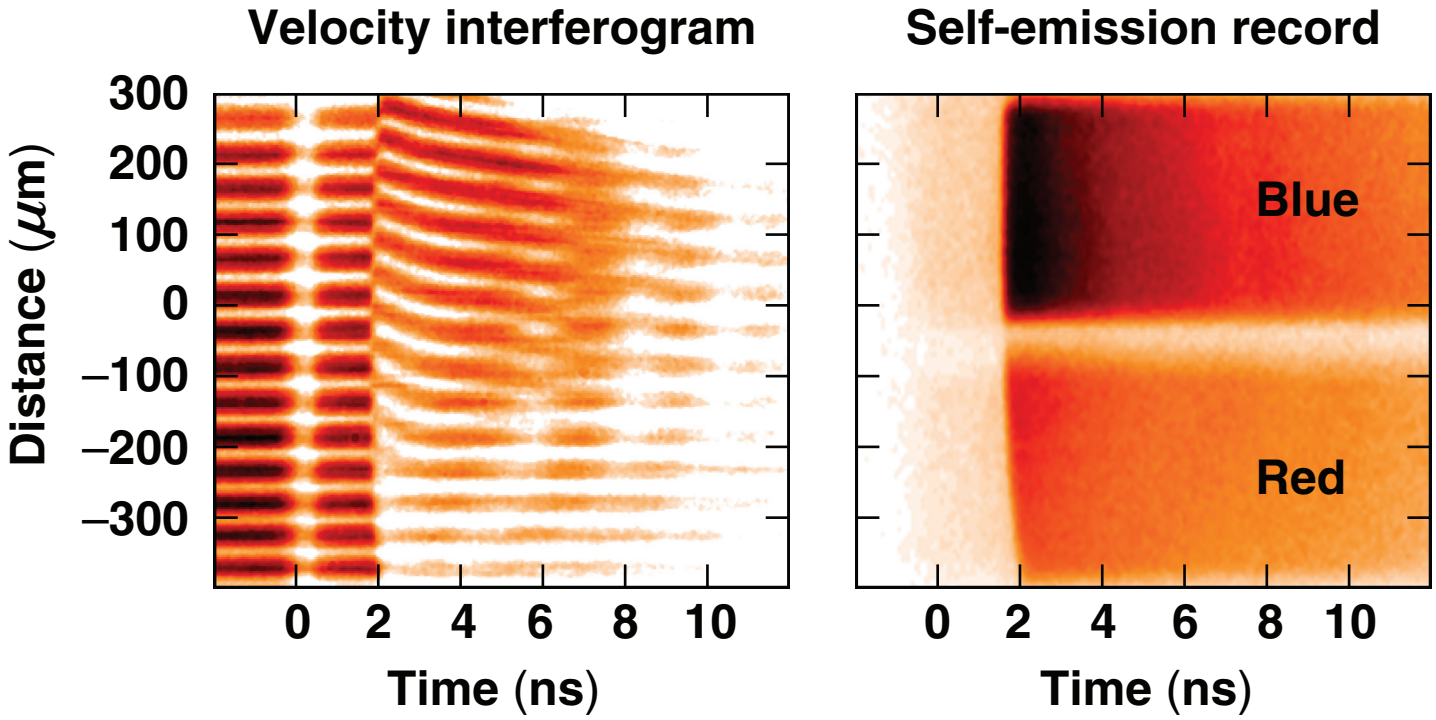
High-Pressure Equation-of-State Studies Using Laser-Driven Decaying Shocks



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American Physical Society
Division of Plasma Physics
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30 October–3 November 2006

Summary

Decaying-shock measurements have observed possible missing energetics in the Al_2O_3 *SESAME* model

UR LLE

- Decaying shocks are used to produce a wide range of conditions for EOS measurements on a single experiment.
- Simultaneous measurements of shock velocity, reflectivity, and radiance are made to relate shock temperature to wave properties.
- Measurements deviate around 10 Mbar from the current *SESAME* sapphire model.

Collaborators

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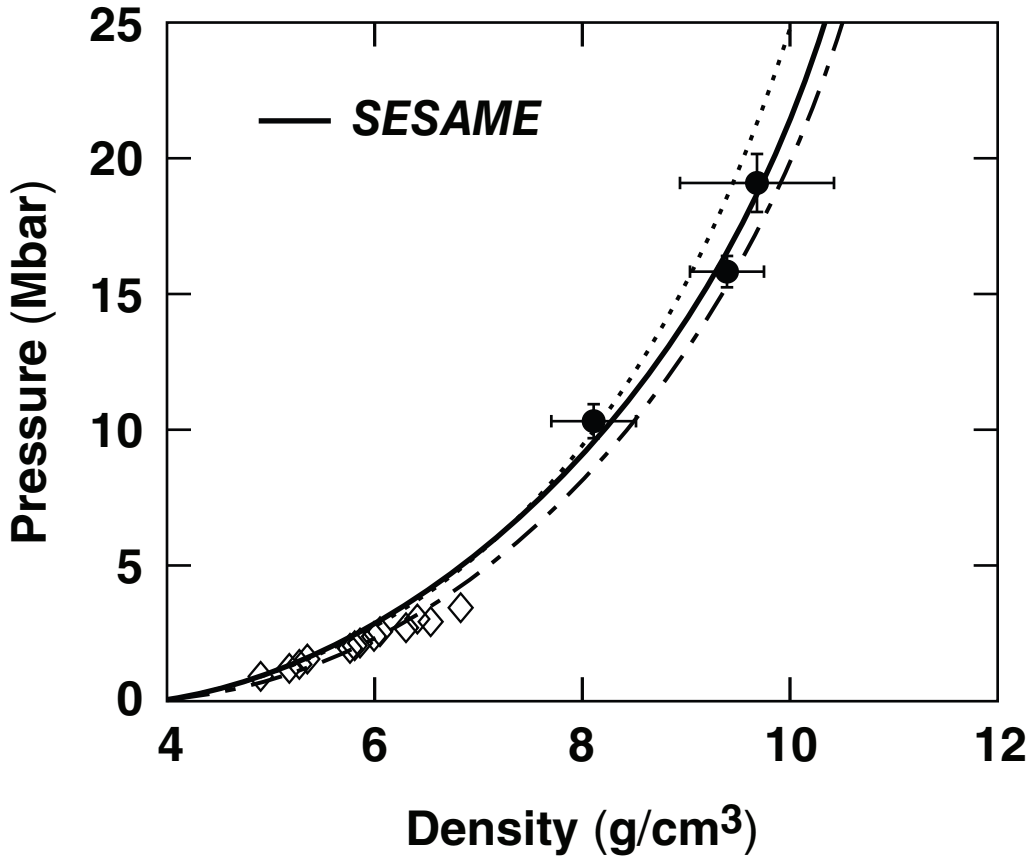
A. Melchior

Nuclear Research Center–Negev, Beer-Sheva, Israel

Sapphire

The kinematic EOS of sapphire has been measured over many Mbar

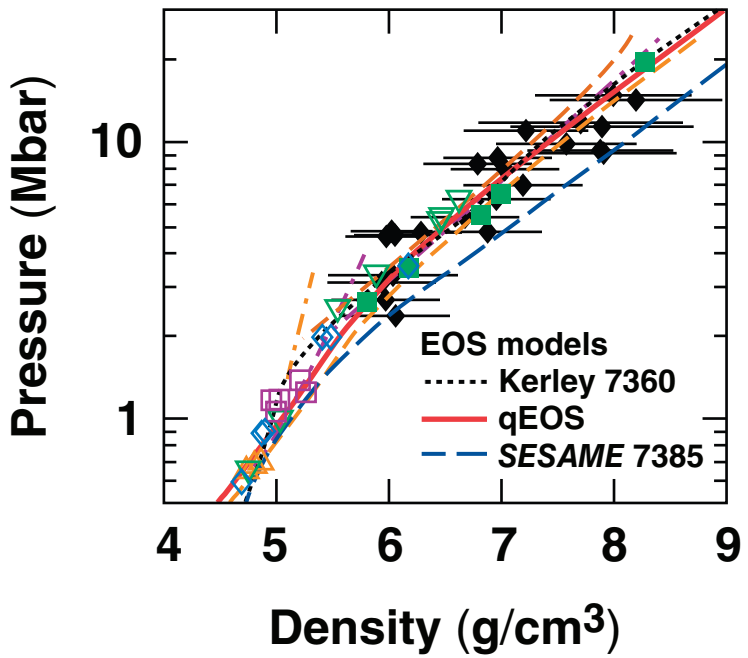


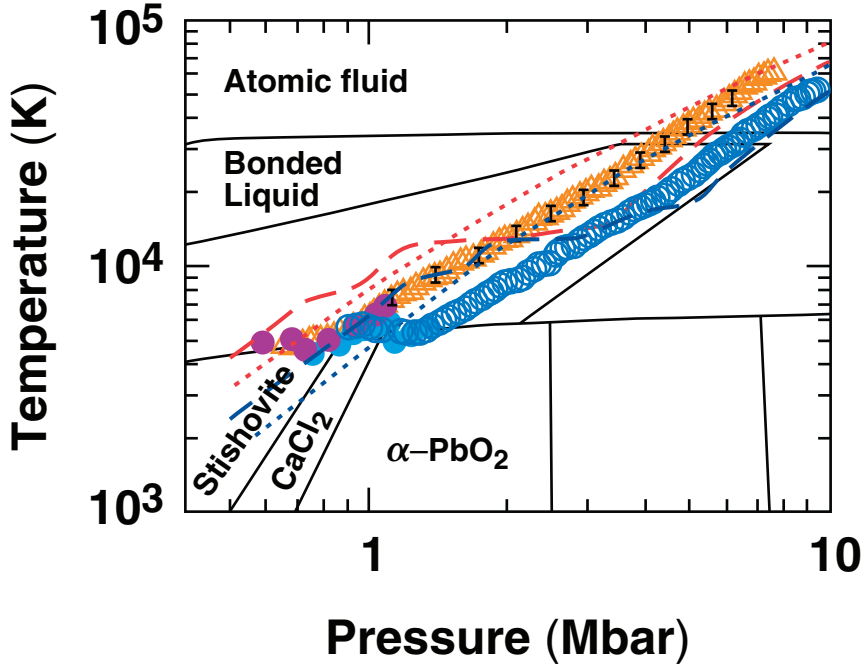
E15164

D. G. Hicks *et al.*, Phys. Rev. Lett. 91, 3 (2003).

Silica

A previous study of the thermal properties of silica was used to identify phase transitions



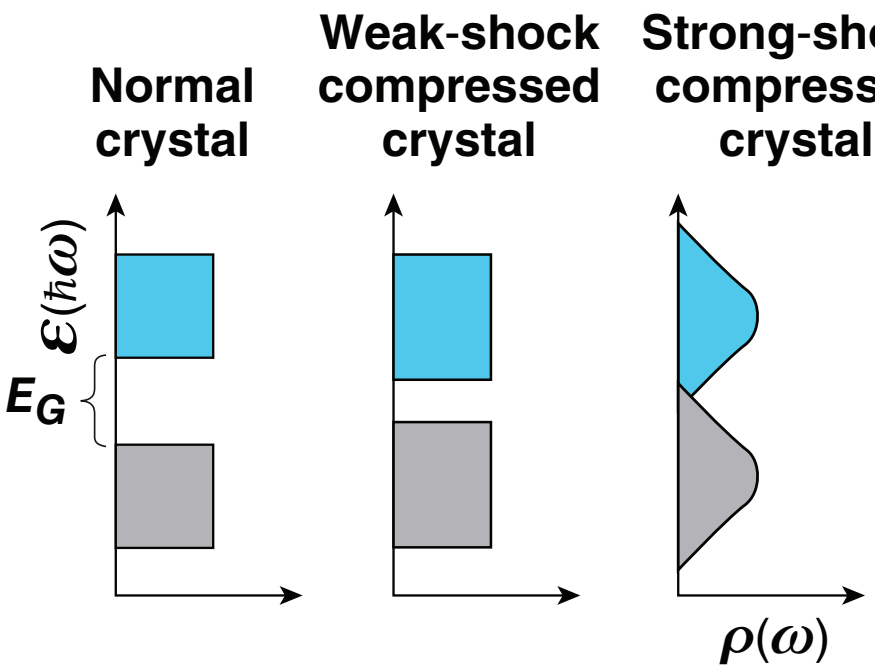


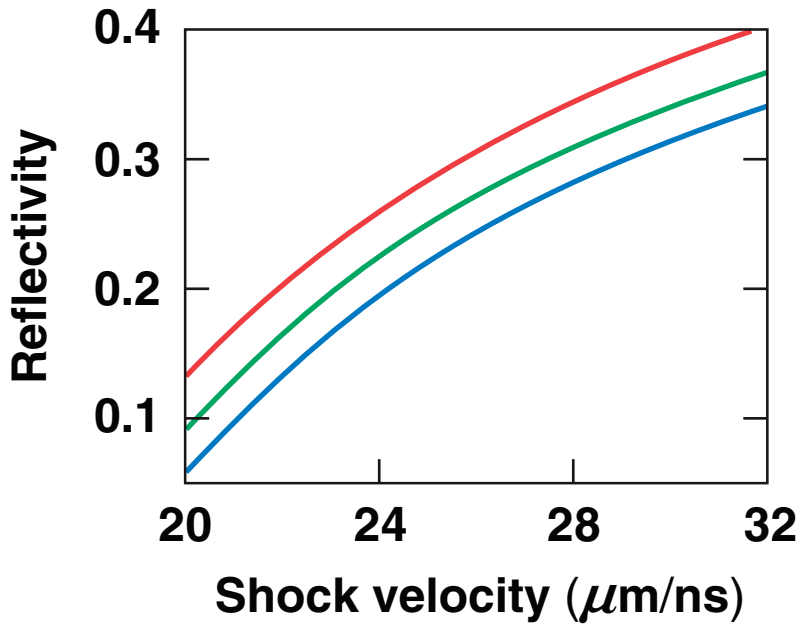
D. G. Hicks *et al.*, Phys. Plasmas 12, 082702 (2005).

D. G. Hicks *et al.*, Phys. Rev. Lett. 97, 025502 (2006).

E15165

Near metalization, the shock-front reflectivity is characterized by a Drude-like behavior





$$R = \frac{\left(n - n_{00}\right)^2 + \kappa^2}{\left(n + n_{00}\right)^2 + \kappa^2}$$

$$n + i\kappa = \sqrt{\varepsilon_B \left[1 - \frac{\omega_p \left(E_G\right)^2}{\omega^2} \frac{1}{1 - i/\omega\tau\left(E_G, \gamma\right)}\right]}$$

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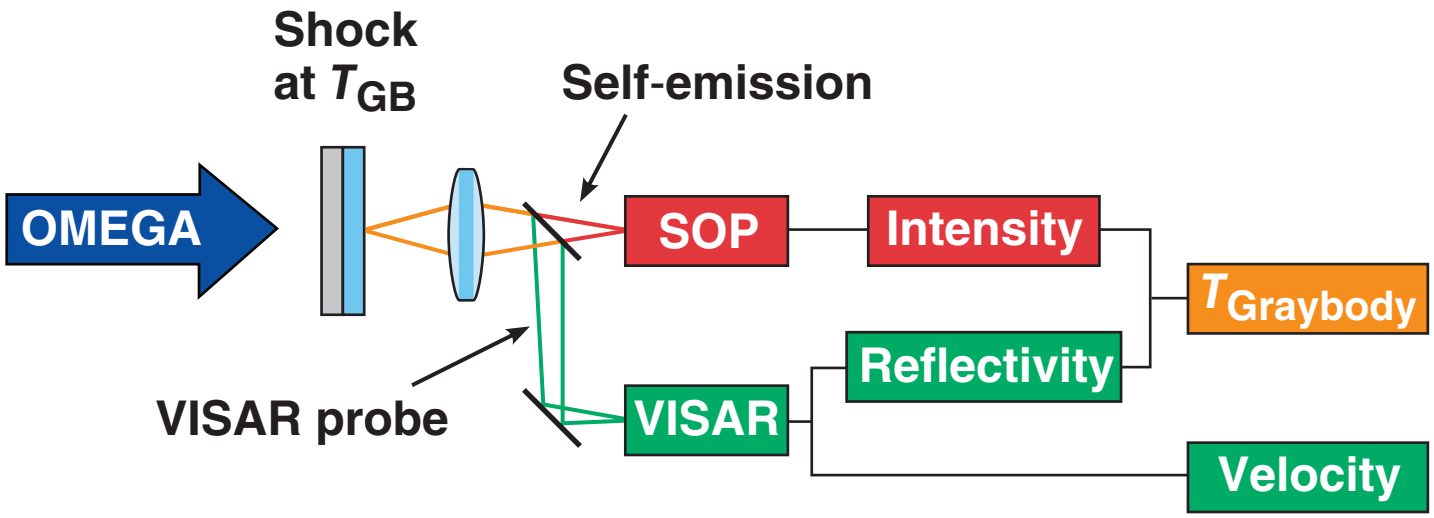
Simultaneous kinematic and thermal measurements are obtained with VISAR* and a two-channel SOP**



$$T_{GB} = \frac{T_0}{\mathrm{Ln}[1 + (1 - R) * A/I]}$$

*Velocity Interferometer System for Any Reflector

**Streaked Optical Pyrometer

E15315

Sapphire

Shock velocity, temperature, and reflectivity are simultaneously measured as the shock decays

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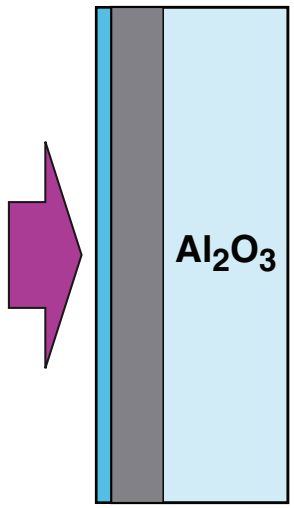
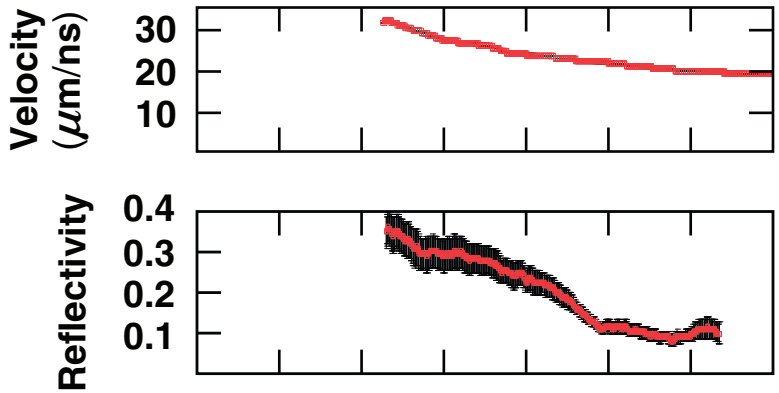
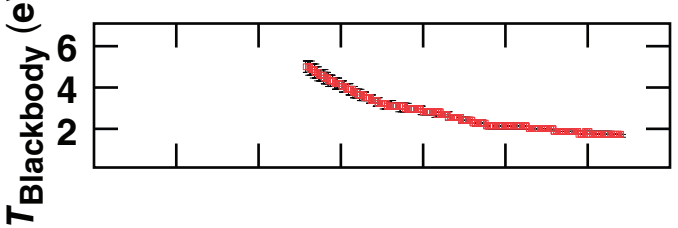
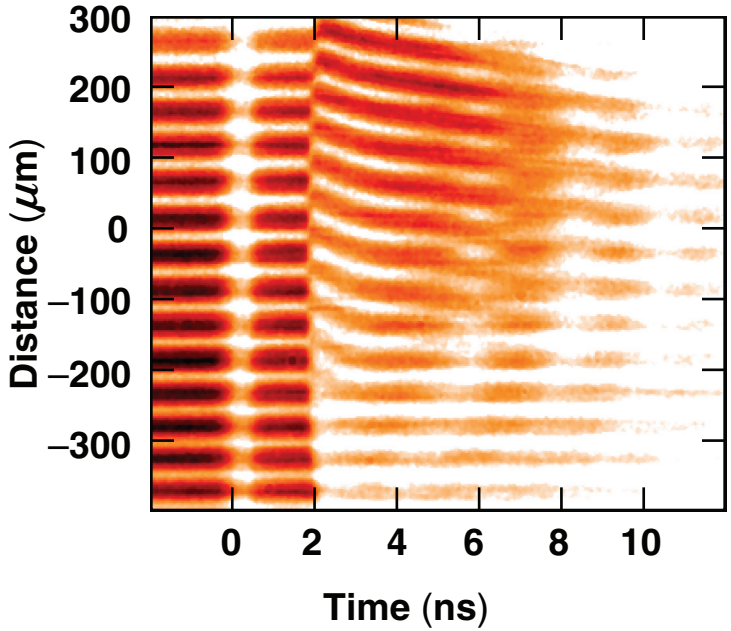
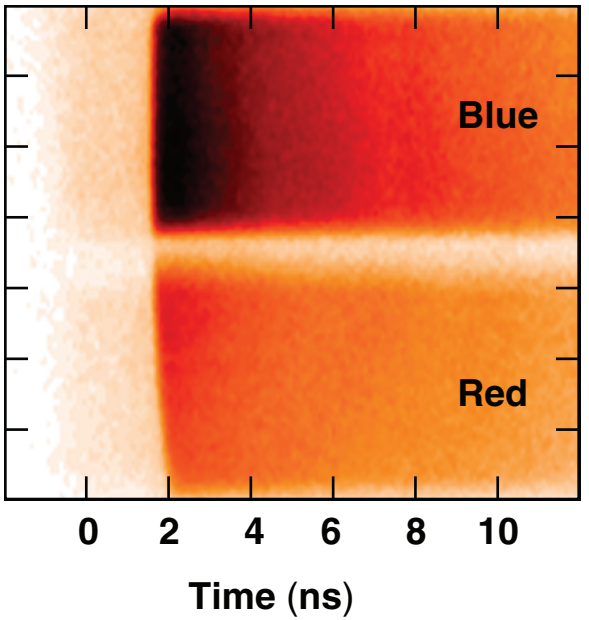
OMEGA drive
~10^{14} W/cm^2
1-ns pulse











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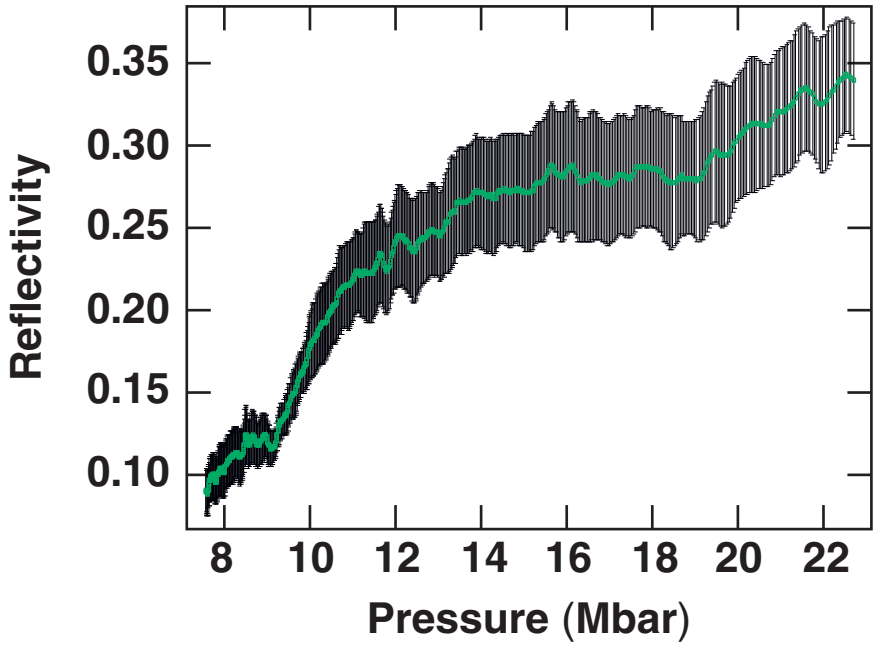
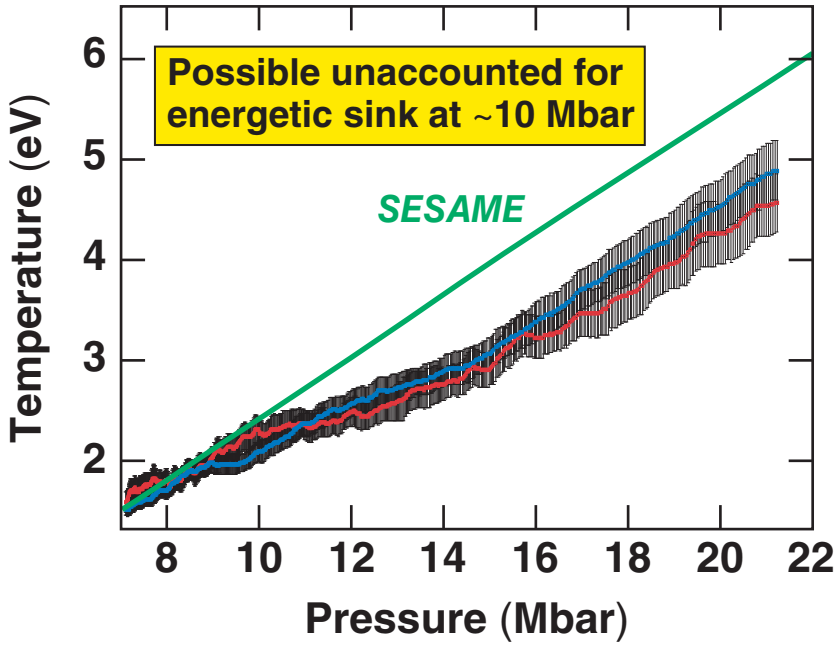
Sapphire

SESAME deviation at high pressures may indicate unaccounted for energetics





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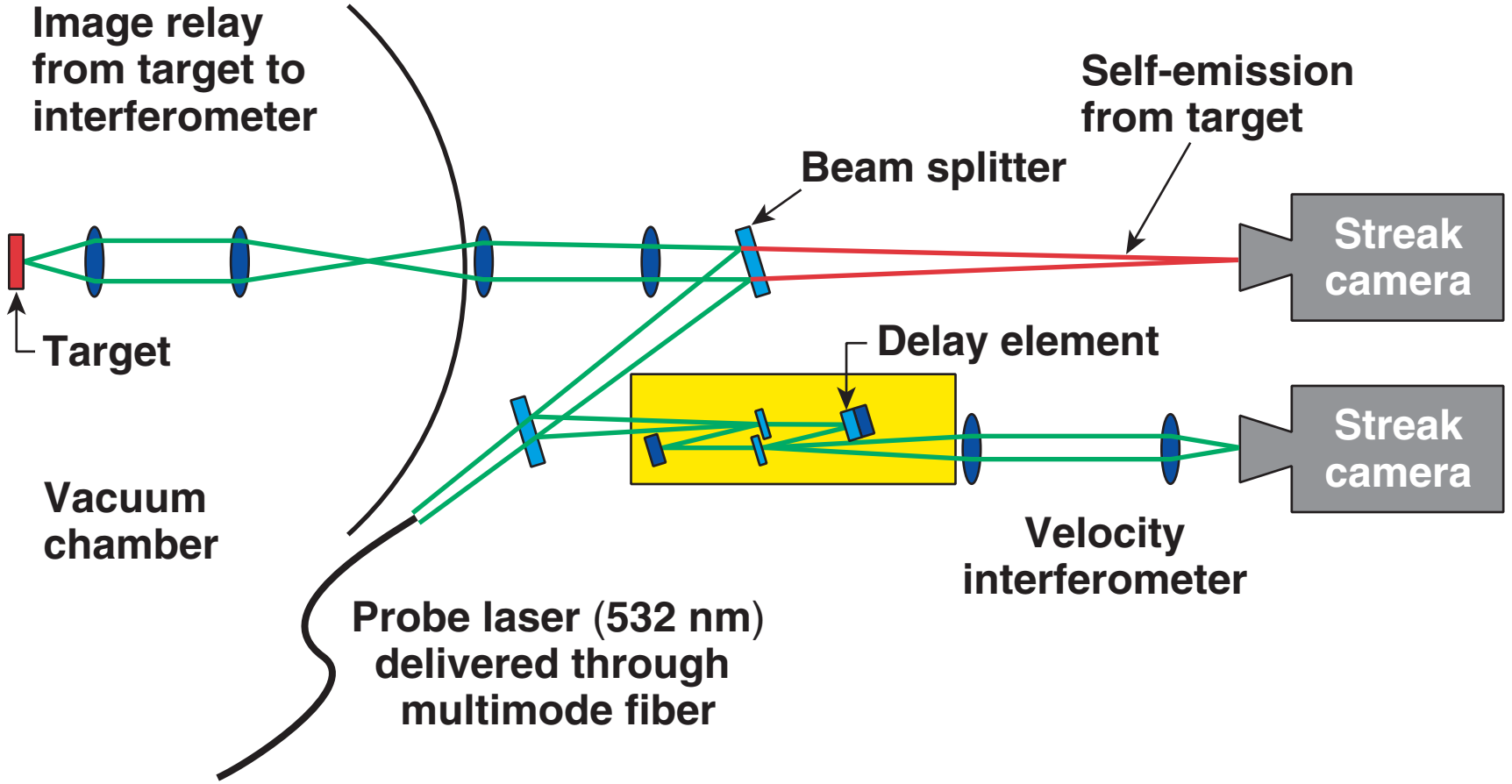
Summary/Conclusions

Decaying-shock measurements have observed possible missing energetics in the Al_2O_3 *SESAME* model

UR LLE

- Decaying shocks are used to produce a wide range of conditions for EOS measurements on a single experiment.
- Simultaneous measurements of shock velocity, reflectivity, and radiance are made to relate shock temperature to wave properties.
- Measurements deviate around 10 Mbar from the current *SESAME* sapphire model.

Shock velocity, reflectivity, and self-emission are measured using time-resolved VISAR* and SOP**

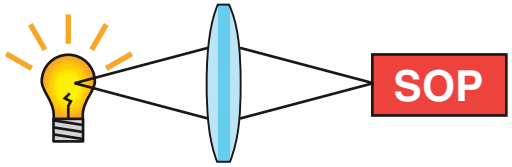


* Velocity interferometer system for any reflector (designed and implemented by LLNL)

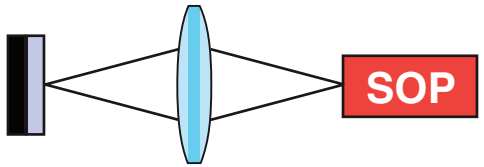
** Streaked optical pyrometer (designed and implemented by LANL, modified to current state by LLNL)

E11212a

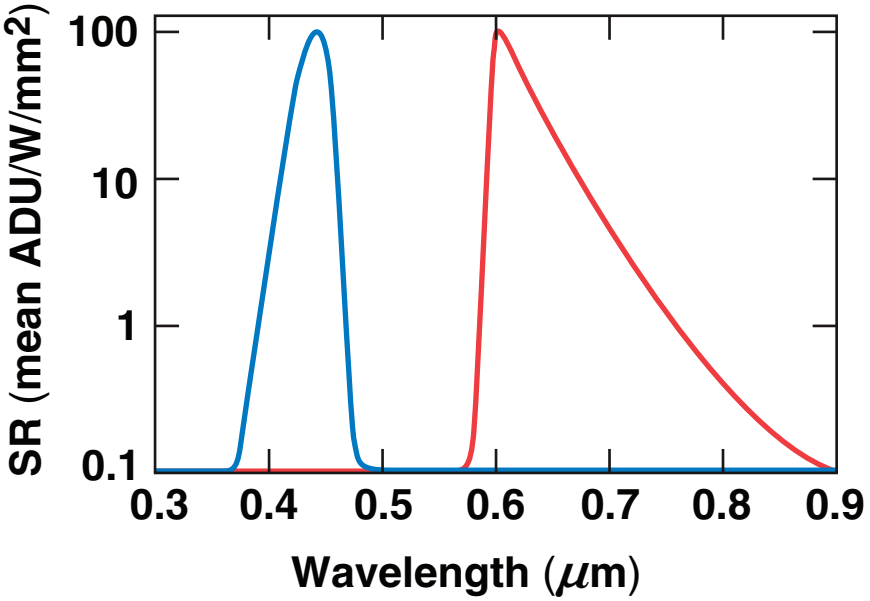
The SOP spectral response was absolutely calibrated* to relate SOP output to brightness temperature



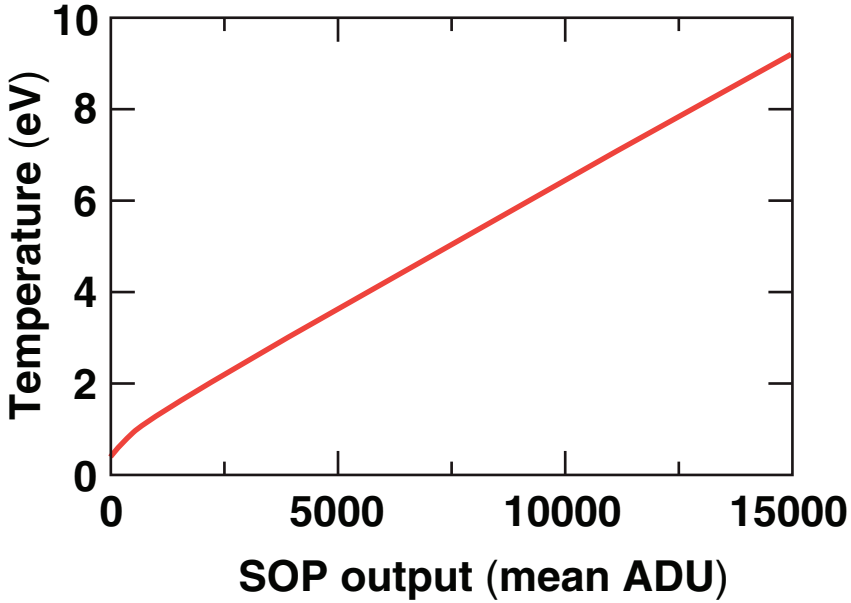
Blackbody



Spectral Response Function of the SOP



Blackbody Temperature Dependence of SOP Output



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* Using the NIST-Traceable Standard OL-550