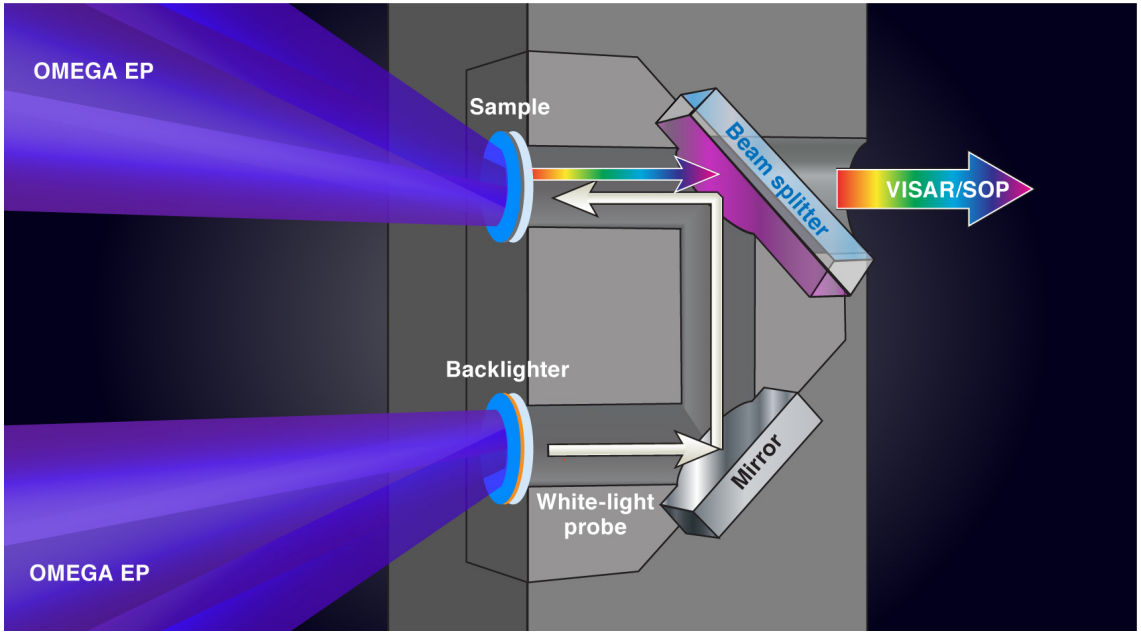
Broadband Reflectivity Diagnostic Development for Dynamic Compression Experiments on OMEGA EP



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Division of Plasma Physics
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Summary

We are developing a white light reflectivity diagnostic to explore the electronic properties of matter at extreme conditions

UR LLE

- HED reflectivity measurements are mostly monochromatic (VISAR), requiring assumptions about the wavelength dependence of electronic behavior
- We have developed a white light source by using a 9-eV shocked silica aerogel
- The reflected white light probe is used to measure the broadband (400 to 800-nm) reflectivity of ramp-compressed materials
- Preliminary experiments show sufficient signal-to-noise to resolve changes in reflectivity of matter at extreme conditions

HED: high energy density
VISAR: velocity interferometer for any reflector

Collaborators

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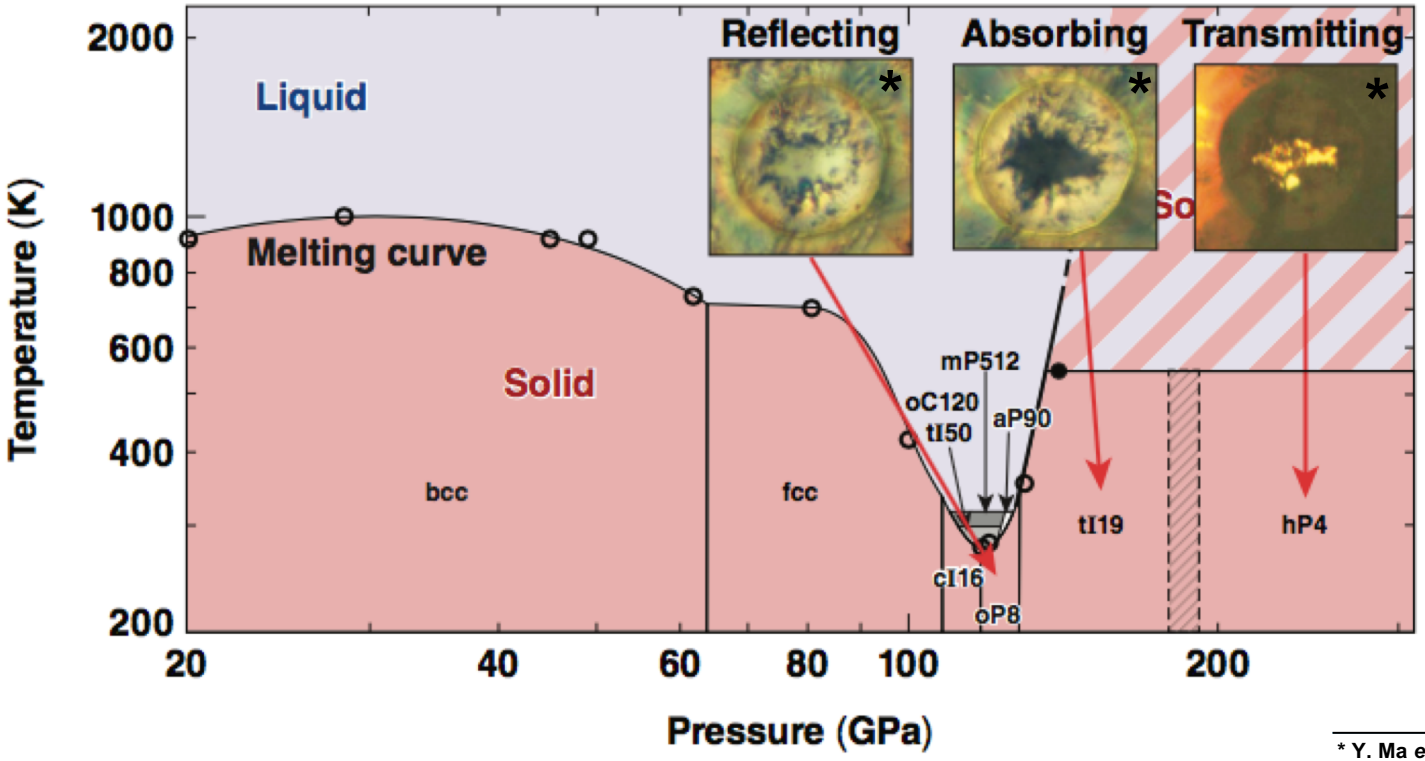
Motivation

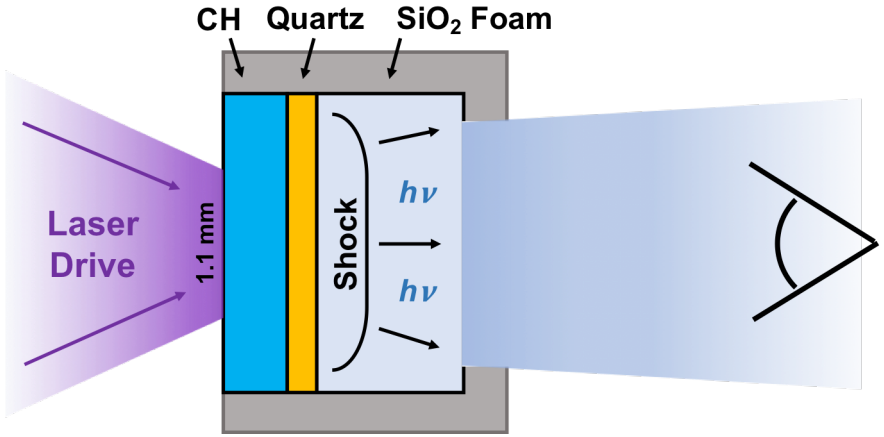
We will use a broadband reflectivity diagnostic to investigate the electronic properties of HED matter

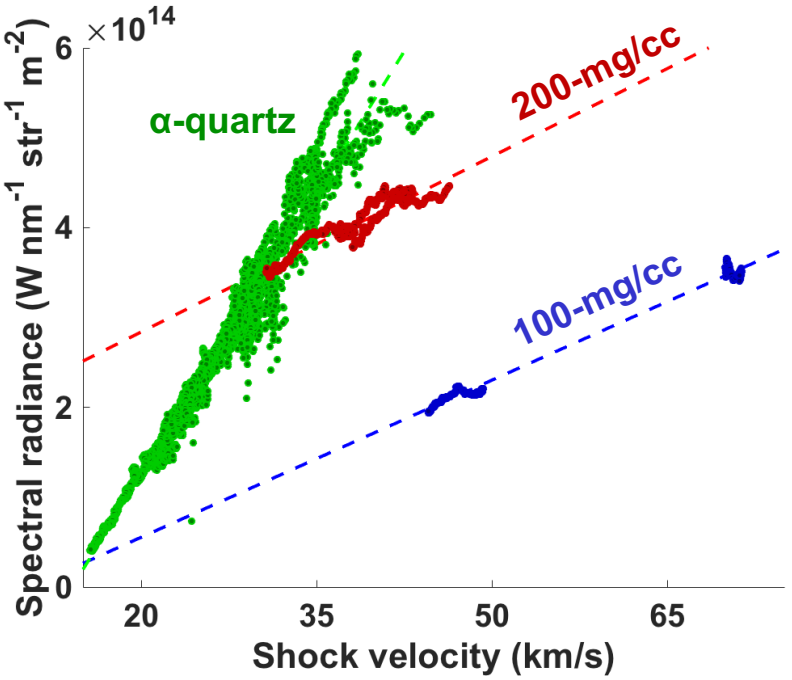


11 22.99
Na
Sodium

* Y. Ma *et al.*, Nature 458, 182 (2009).

A silica aerogel backlighter is shocked to ~9 eV, producing a bright white light source

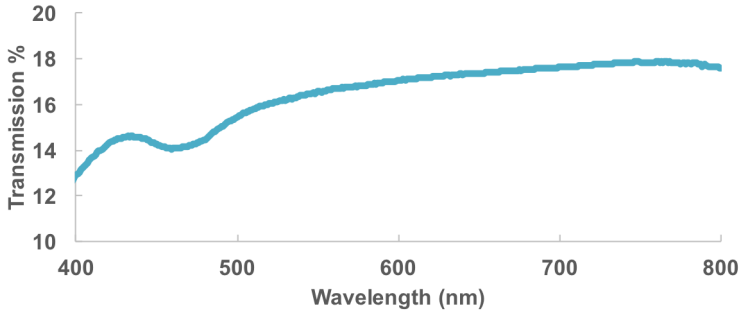


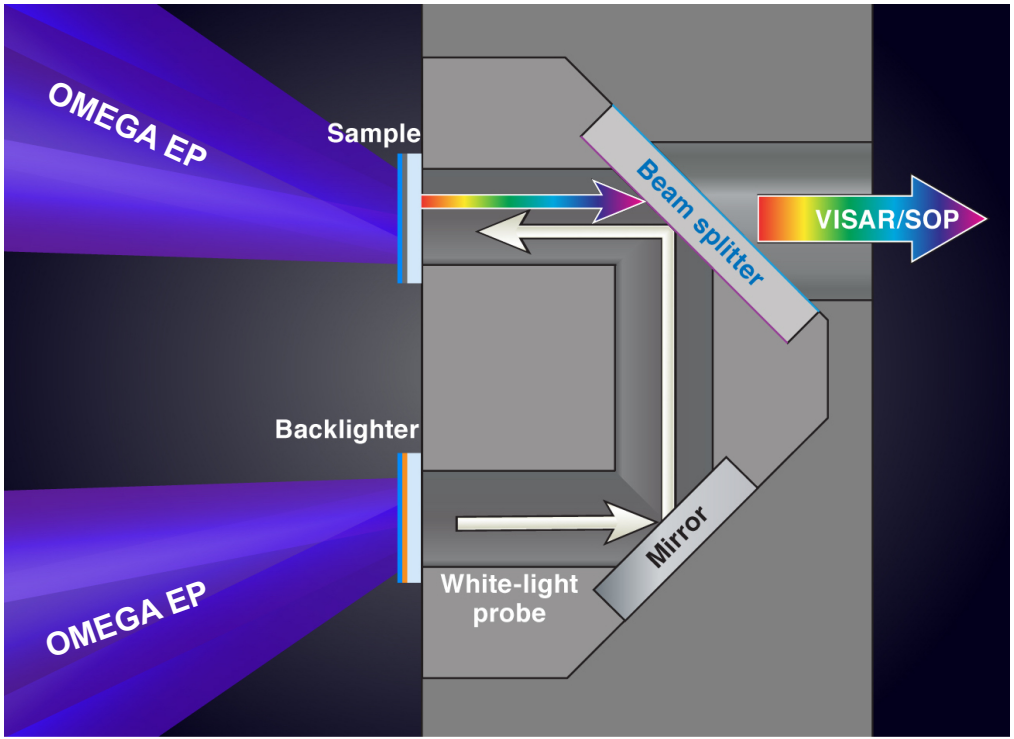


Shocked silica foam uses a less energetic input to maintain a steady, high-temperature (9-eV) profile over several nanoseconds

An *in-situ* optical train directs the white light probe onto the back surface of the sample

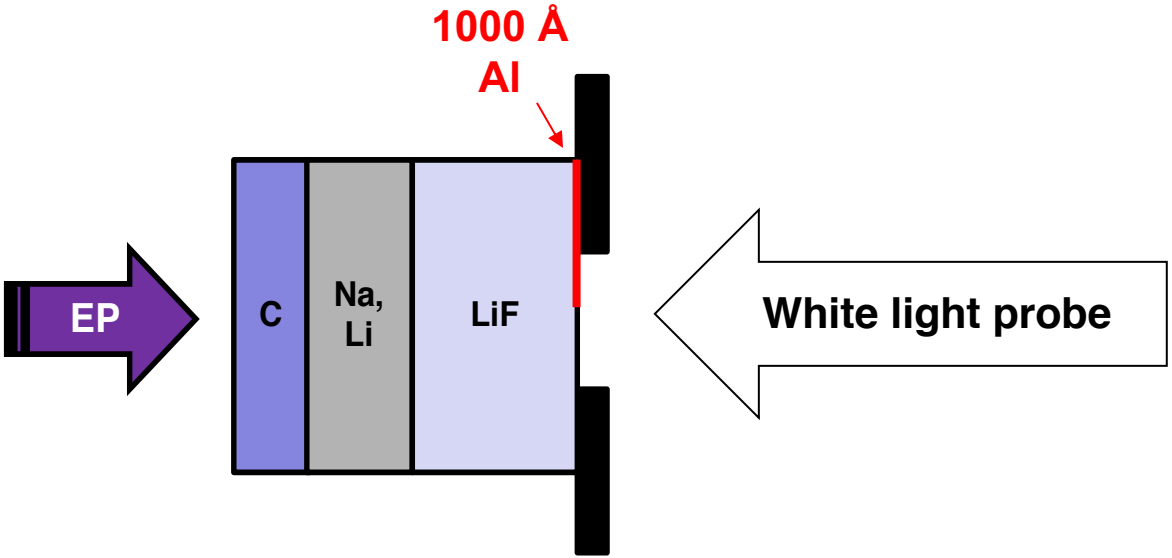
- The backlighter's shock emission is directed to the back surface of the sample
- The reflected signal is collected with an achromatic *f*/3.3 telescope and relayed to a steak camera
- VISAR simultaneously records the sample's particle velocity



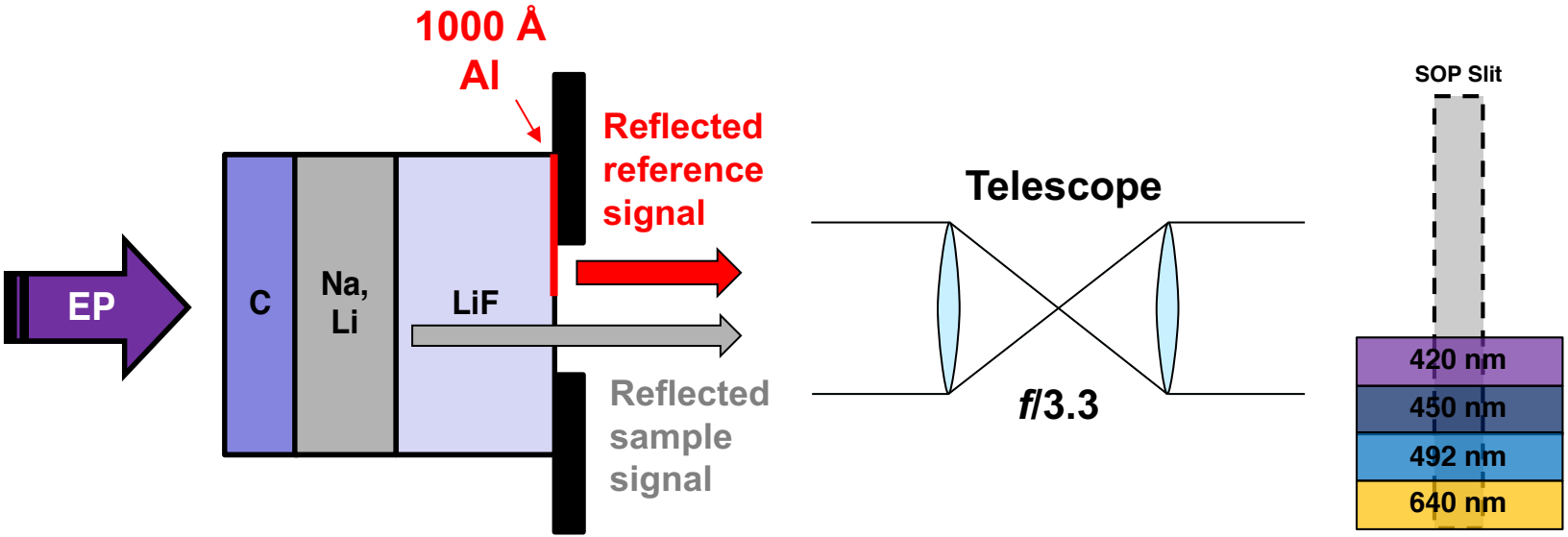


Method

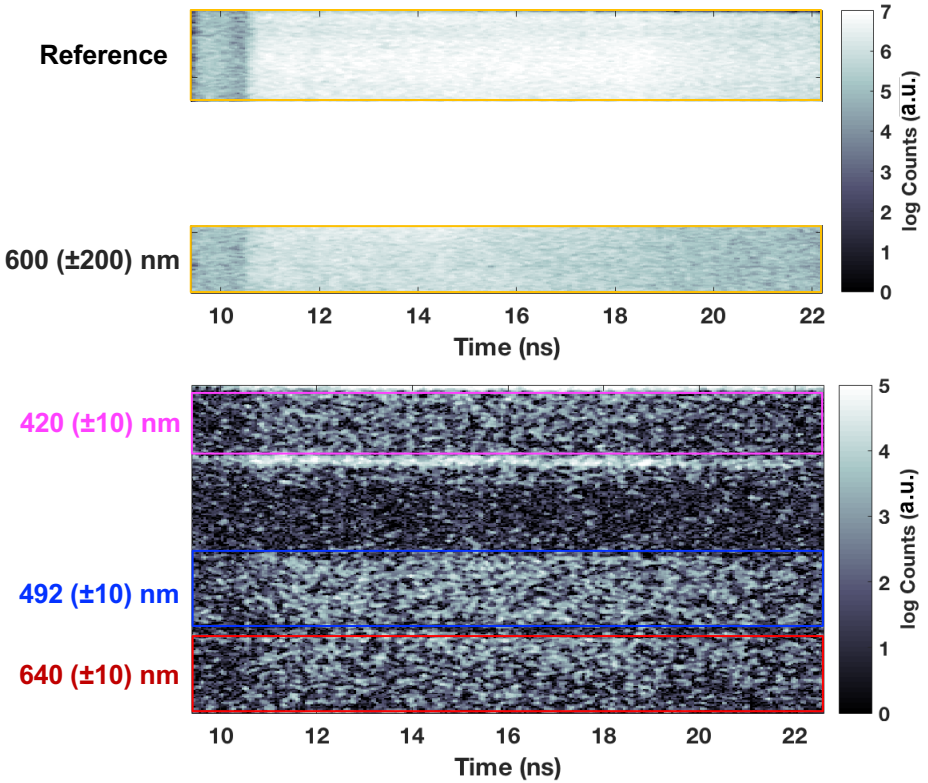
A reflective reference layer is embedded in the sample stack to provide a constant reflectivity baseline for the measurement

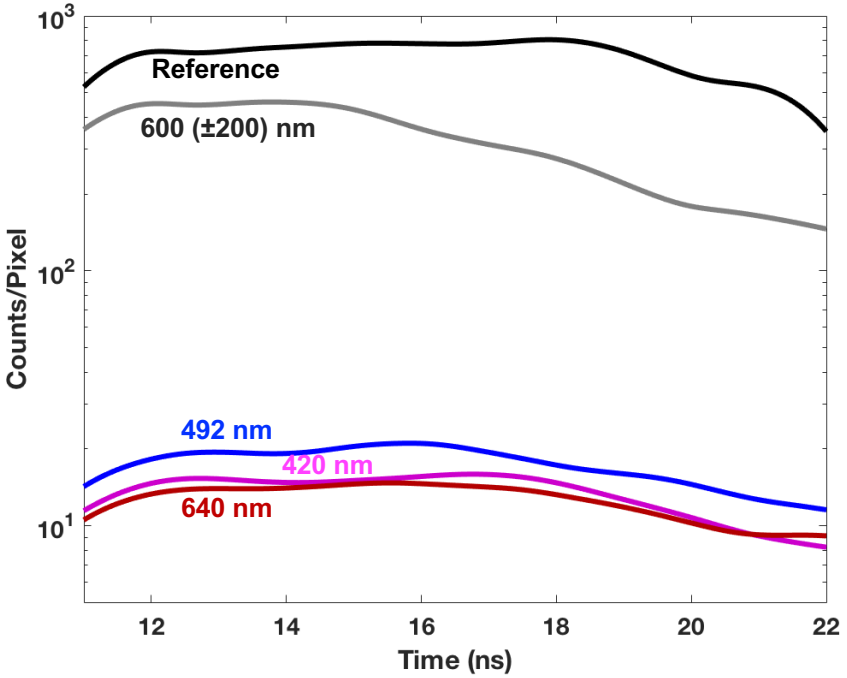


The reflected signal is filtered with a stack of narrowband filters and streaked in time

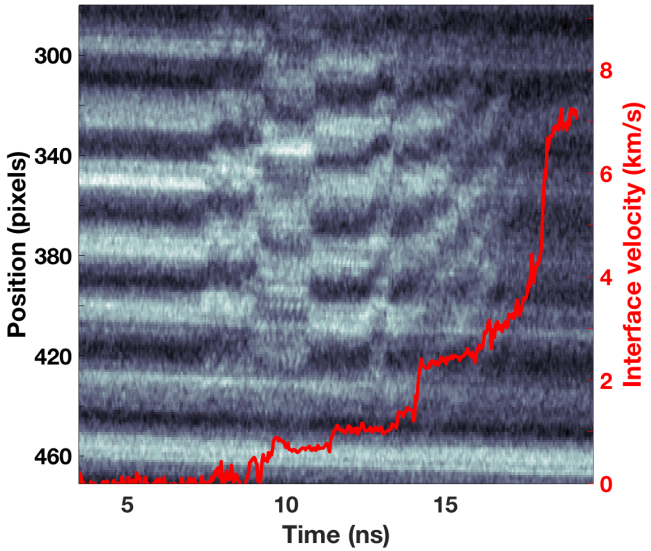


The SOP streak image shows the time-dependent reflected signal from the sample and reference

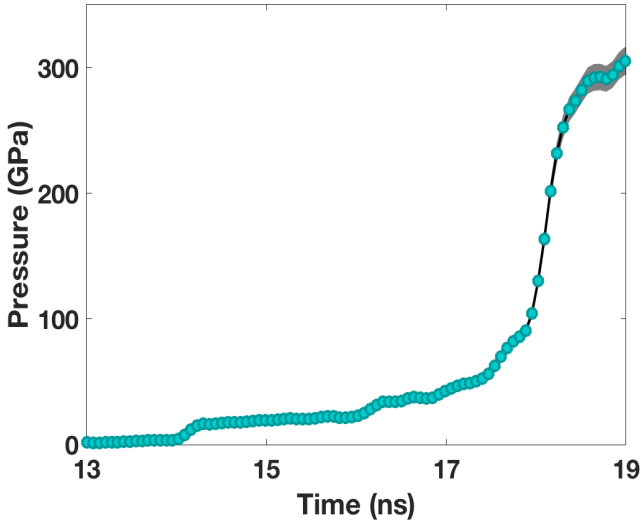




A simultaneous measurement with VISAR allows us to determine the pressure in the sample



ILA



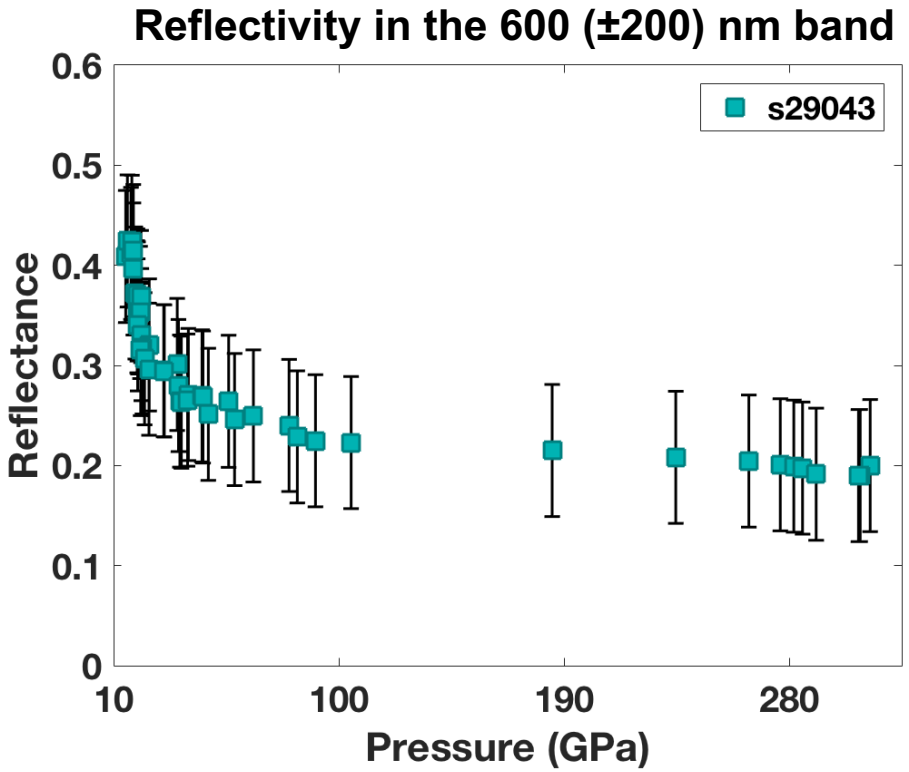
- An iterative Lagrangian analysis (ILA) determines the pressure in the Sample-LiF interface

The signal-to-noise of this method is sufficient to resolve time-dependent changes in reflectivity

Correction for LiF reflection

$$R_{\mathrm{Na/LiF}} = \frac{I_{\mathrm{band}} - \frac{R_{\mathrm{LiF}}}{R_{\mathrm{ref}}} I_{\mathrm{ref}}}{I_{\mathrm{ref}}} R_{\mathrm{ref}}$$

Reference normalization



Summary/Conclusion

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- Future experiments will incorporate a spectrometer for continuous reflectivity measurements in the wavelength domain

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