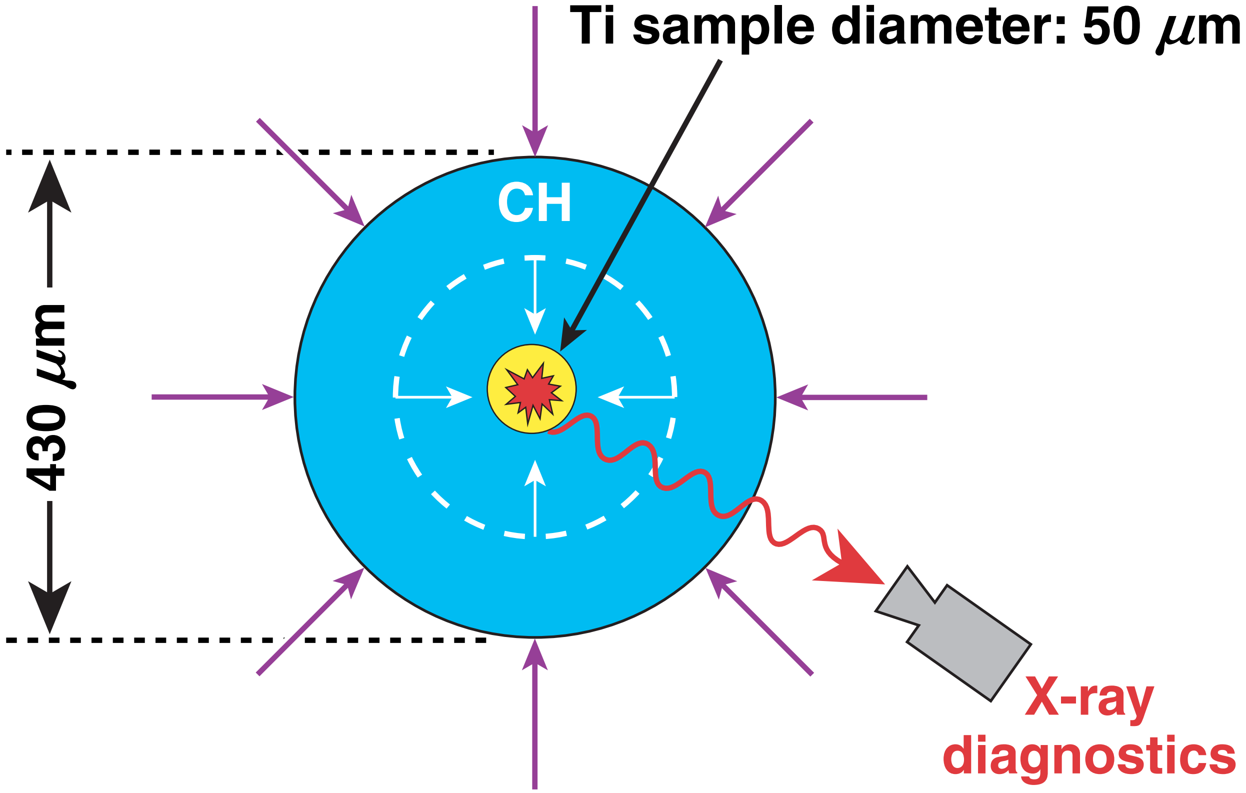
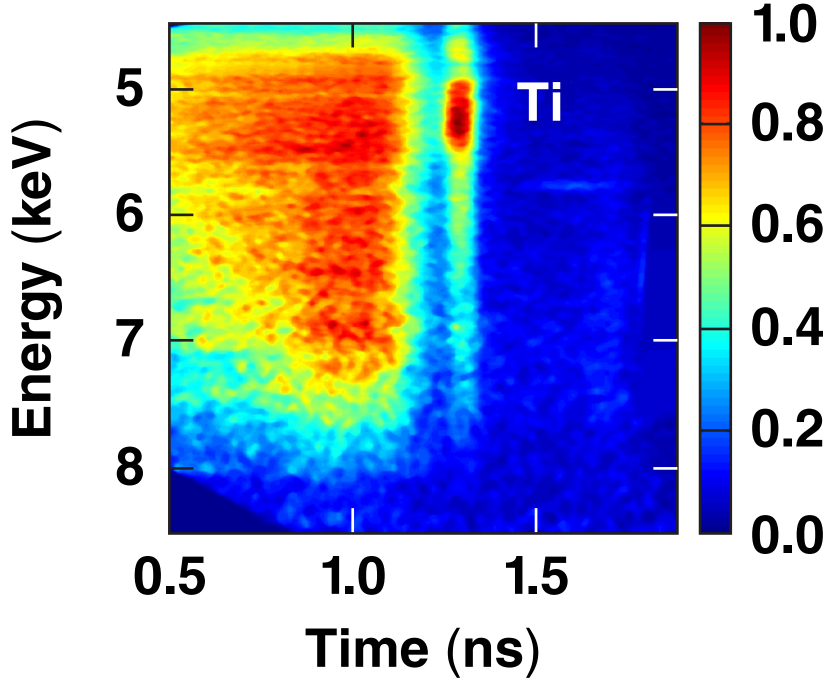
The Generation of Gigabar Pressures for High-Energy-Density Plasmas





58th Annual Meeting of the
American Physical Society
Division of Plasma Physics
San Jose, CA
31 October–4 November 2016

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A platform is developed to study Gbar pressures in sample materials (Ti and Cu) with a spherically convergent shock wave

- A temperature of >1 keV has been measured in the shock-compressed sample
- The observation of the Cu-He$_{\alpha}$ line emission from Cu samples confirm that keV temperatures were reached
- A mass density on the order of ~100 g/cm^3 is estimated from the x-ray spectrum, which together with the measured temperature indicates that Gbar pressure has been reached

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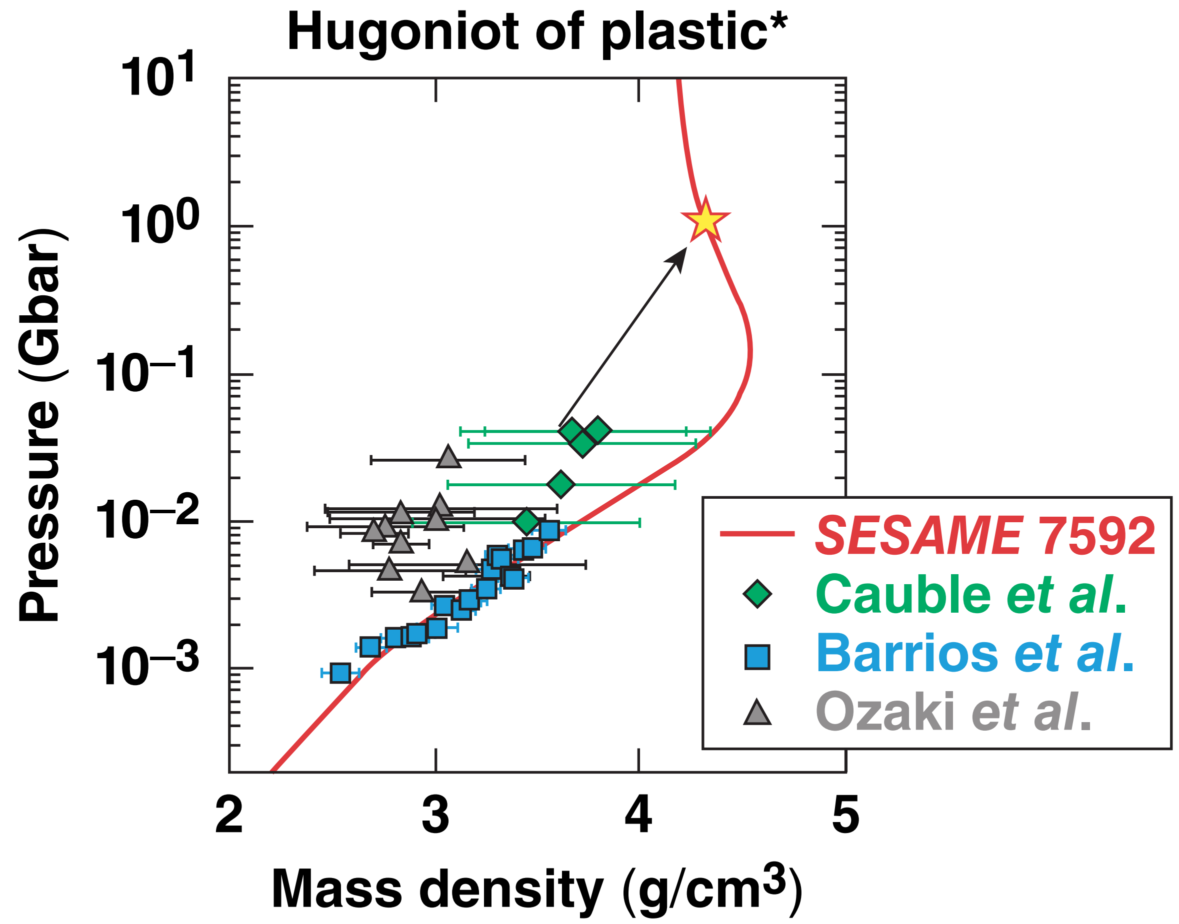
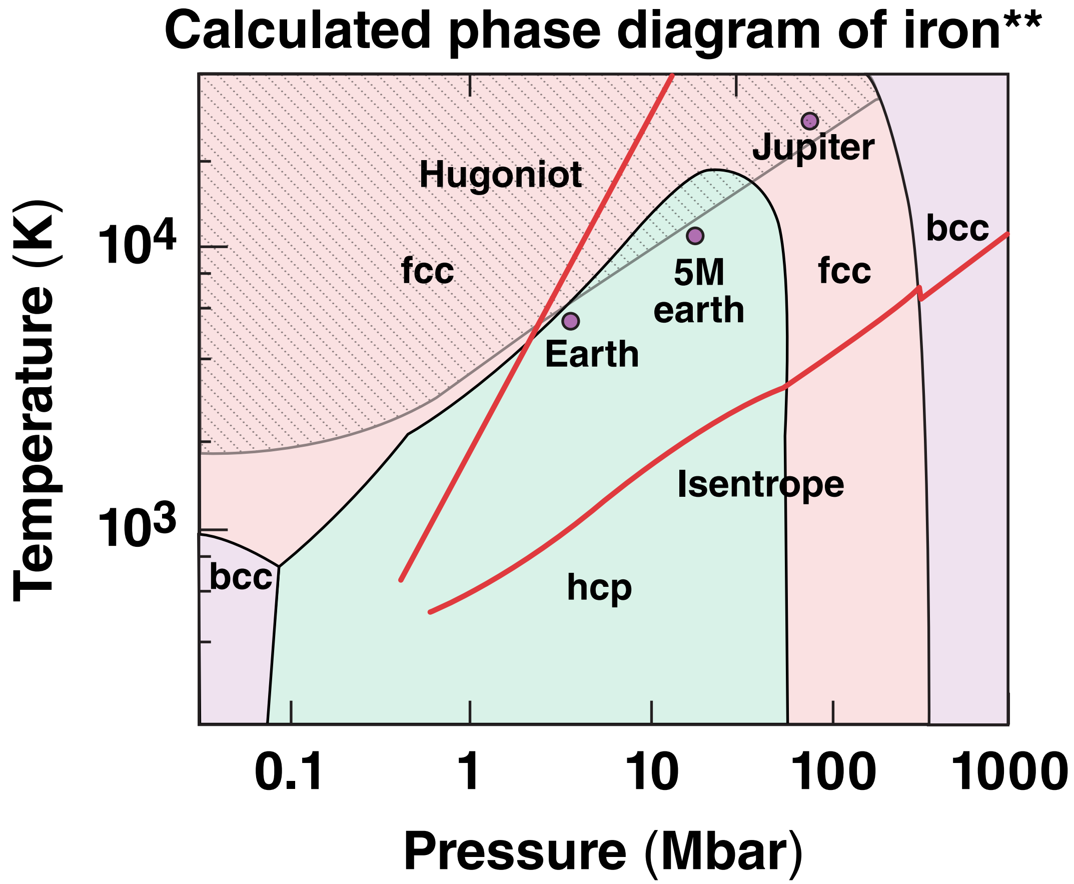
The generation of Gbar pressures opens up a new regime in high-energy-density physics





*D. Kraus *et al*., presented at the NIF and JLF User Group Meeting 2014, Livermore, CA, 9–12 February 2014.
**L. Stixrude, Phys. Rev. Lett. 108, 055505 (2012).

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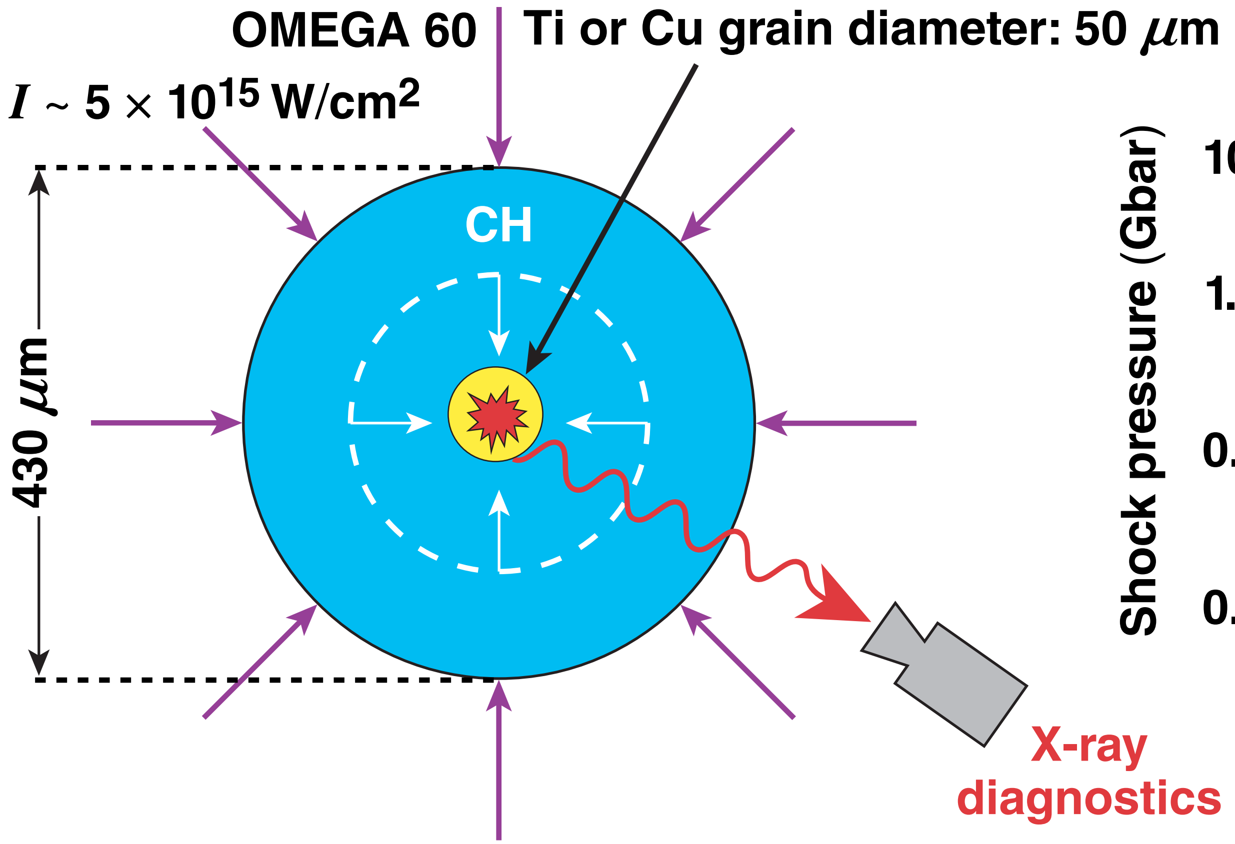
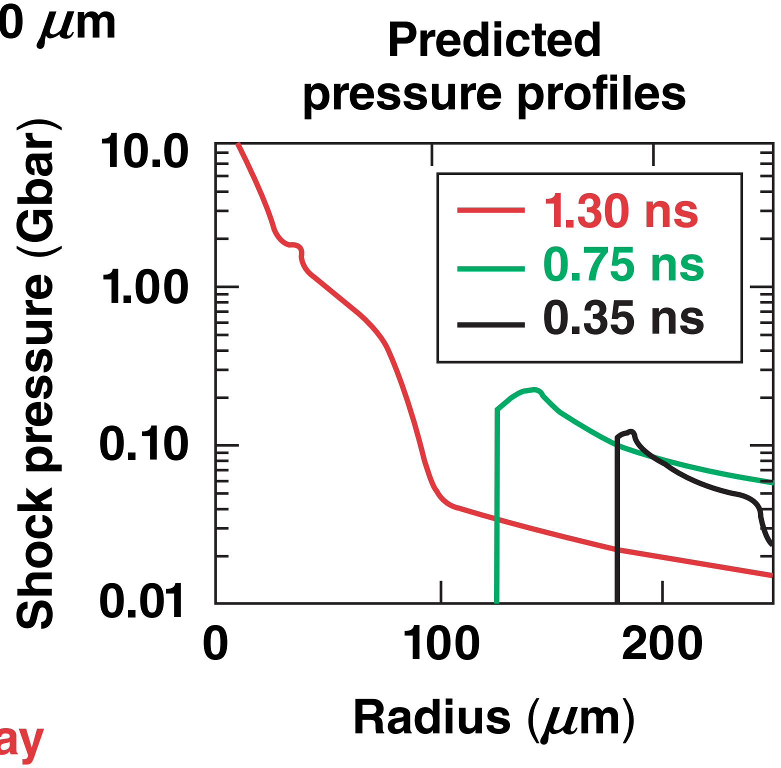
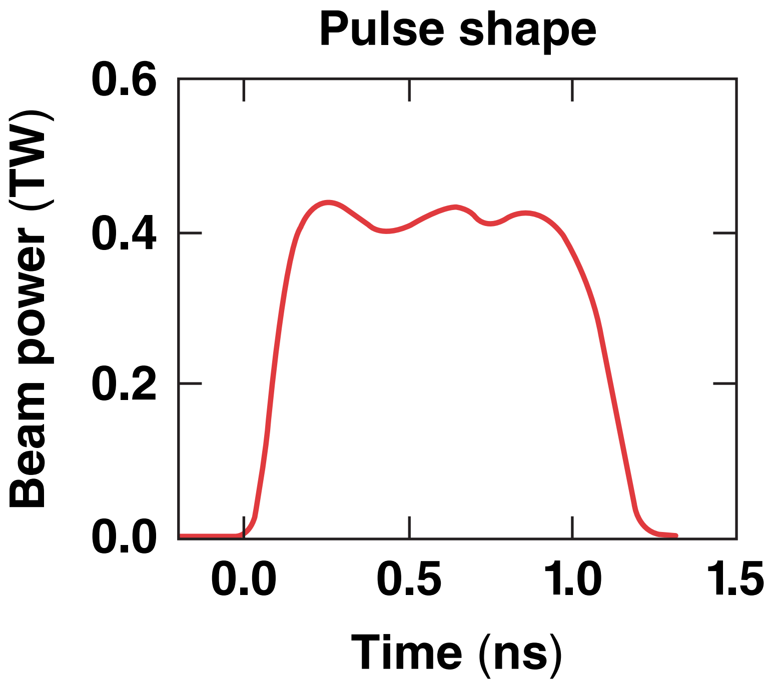
The spherical strong shock (SSS) platform* was used to shock samples to Gbar pressures







*R. Nora *et al*., Phys. Rev. Lett. 114, 045001 (2015);
W. Theobald *et al*., Phys. Plasmas 22, 056310 (2015).

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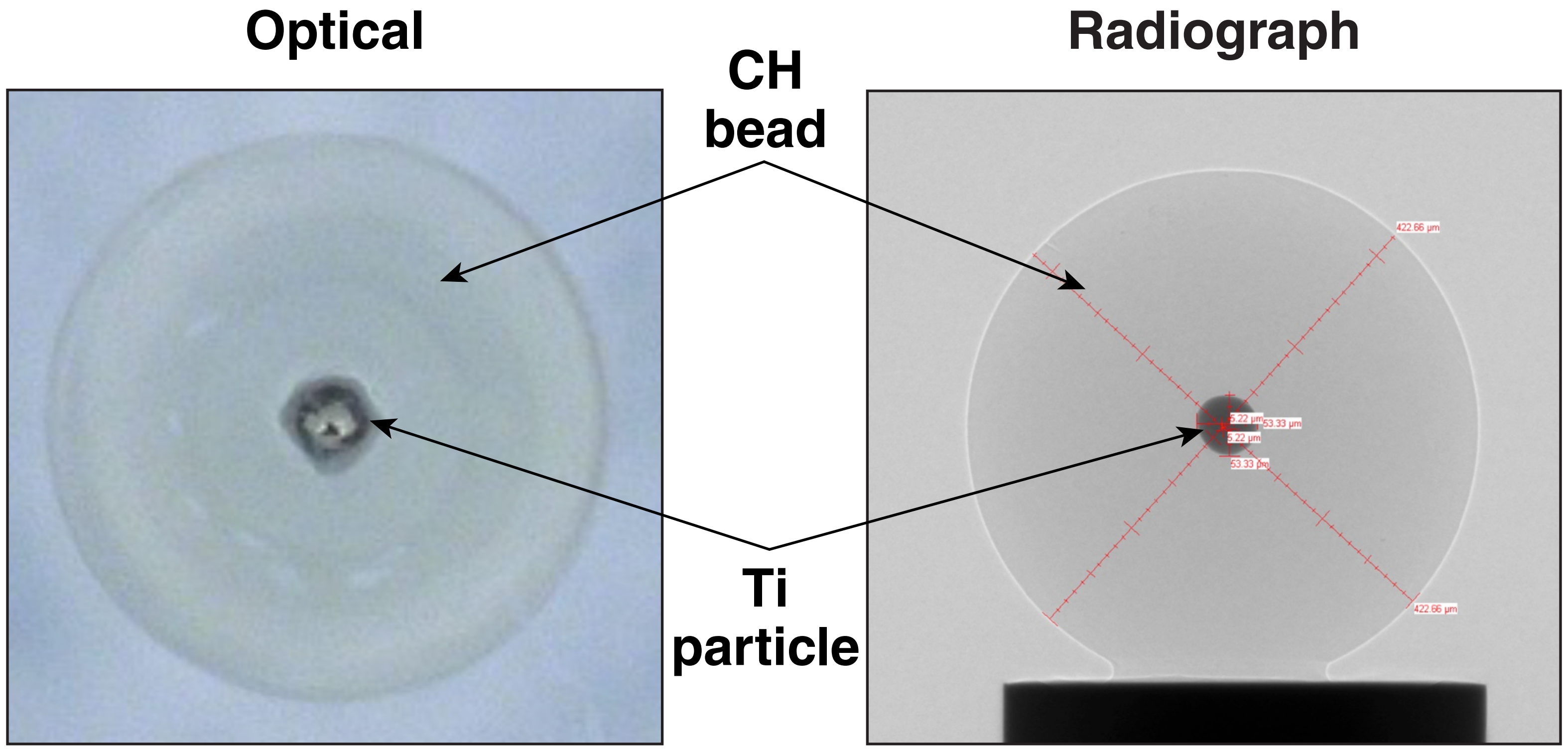
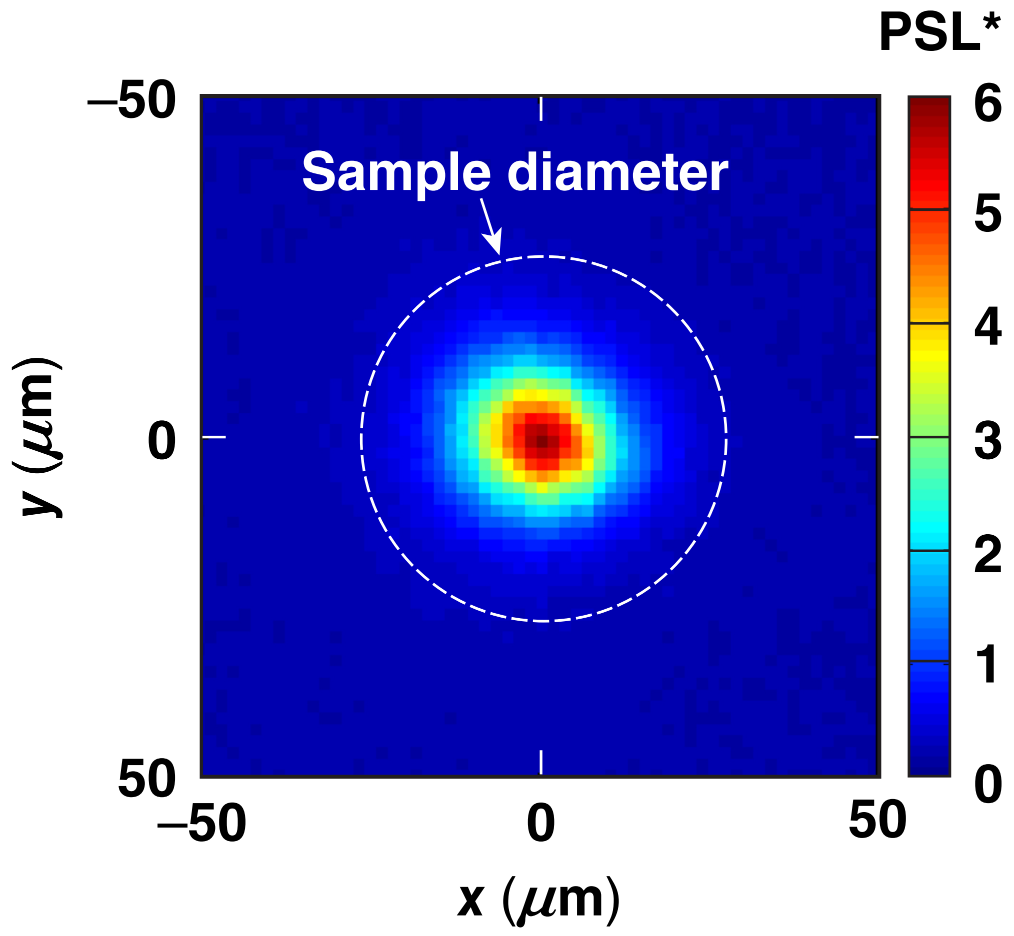
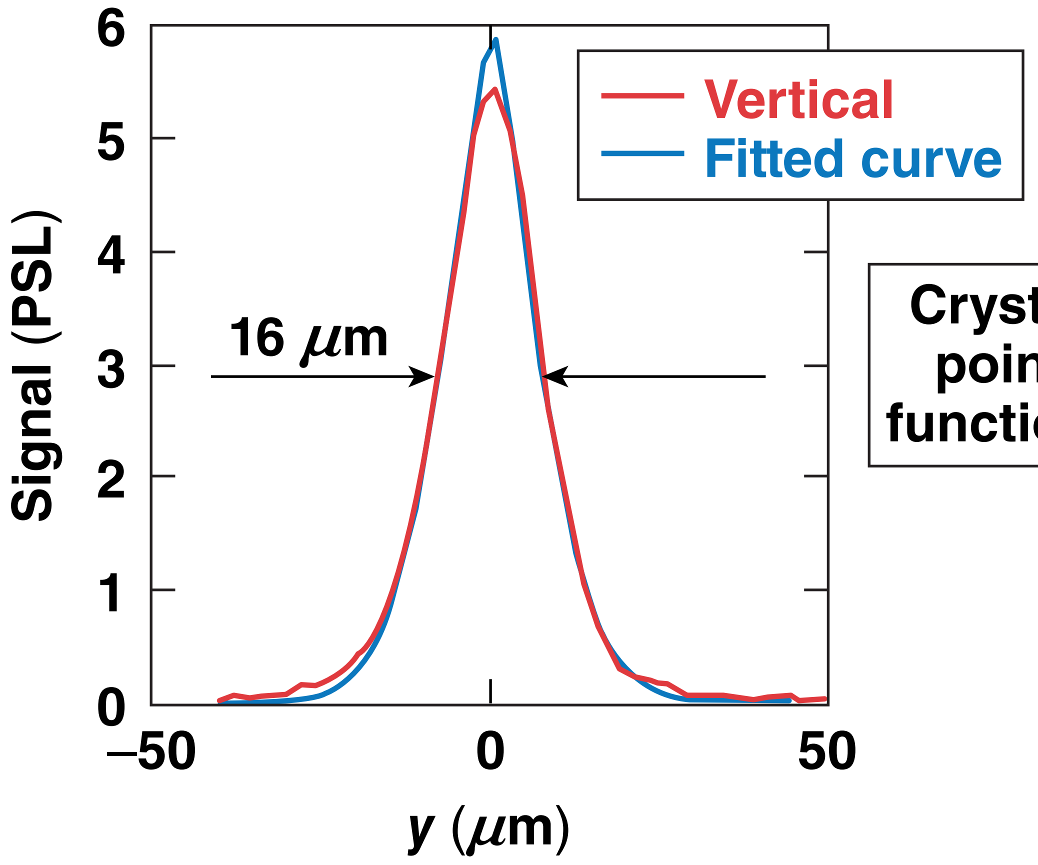
The samples were precisely placed (better than 10 μm) at the center of a spherical plastic matrix



- **Bead diameter: 422±3 μm**
- **Particle diameter: 48±1 μm**
- **Bead center offset with respect to particle center: 8±3 μm**

The spatial extent of the 8-keV x-ray emission from a Ti sample is smaller than the sample size





Crystal-imager point-spread function: 10 μm†

*PSL: photostimulated luminescence

†G. Fiksel *et al*., Bull. Am. Phys. Soc. 55, 155 (2010).

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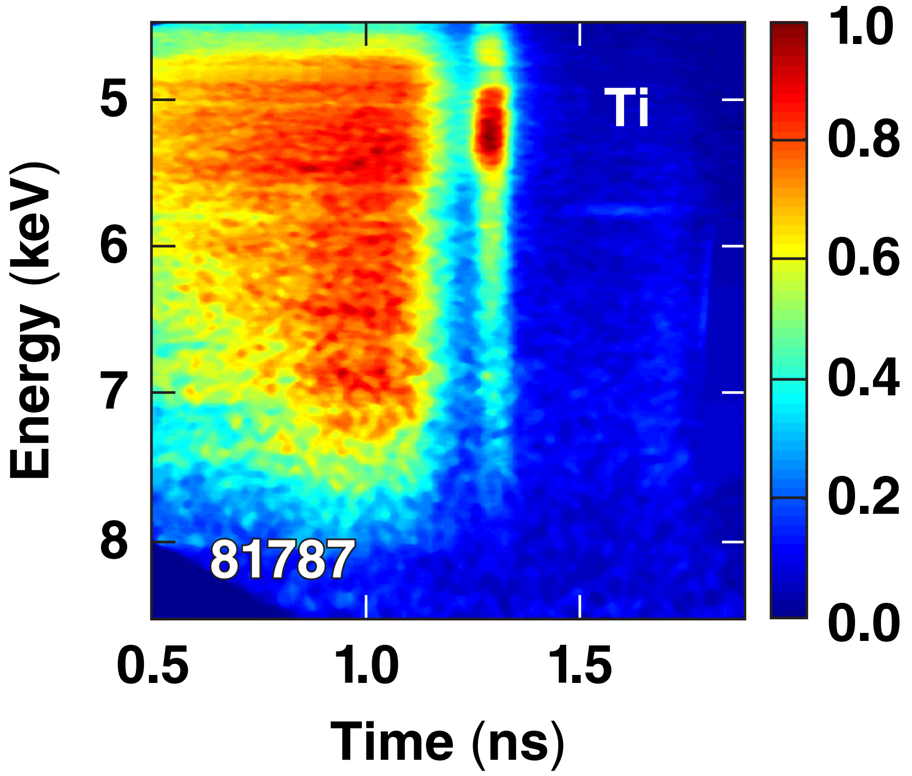
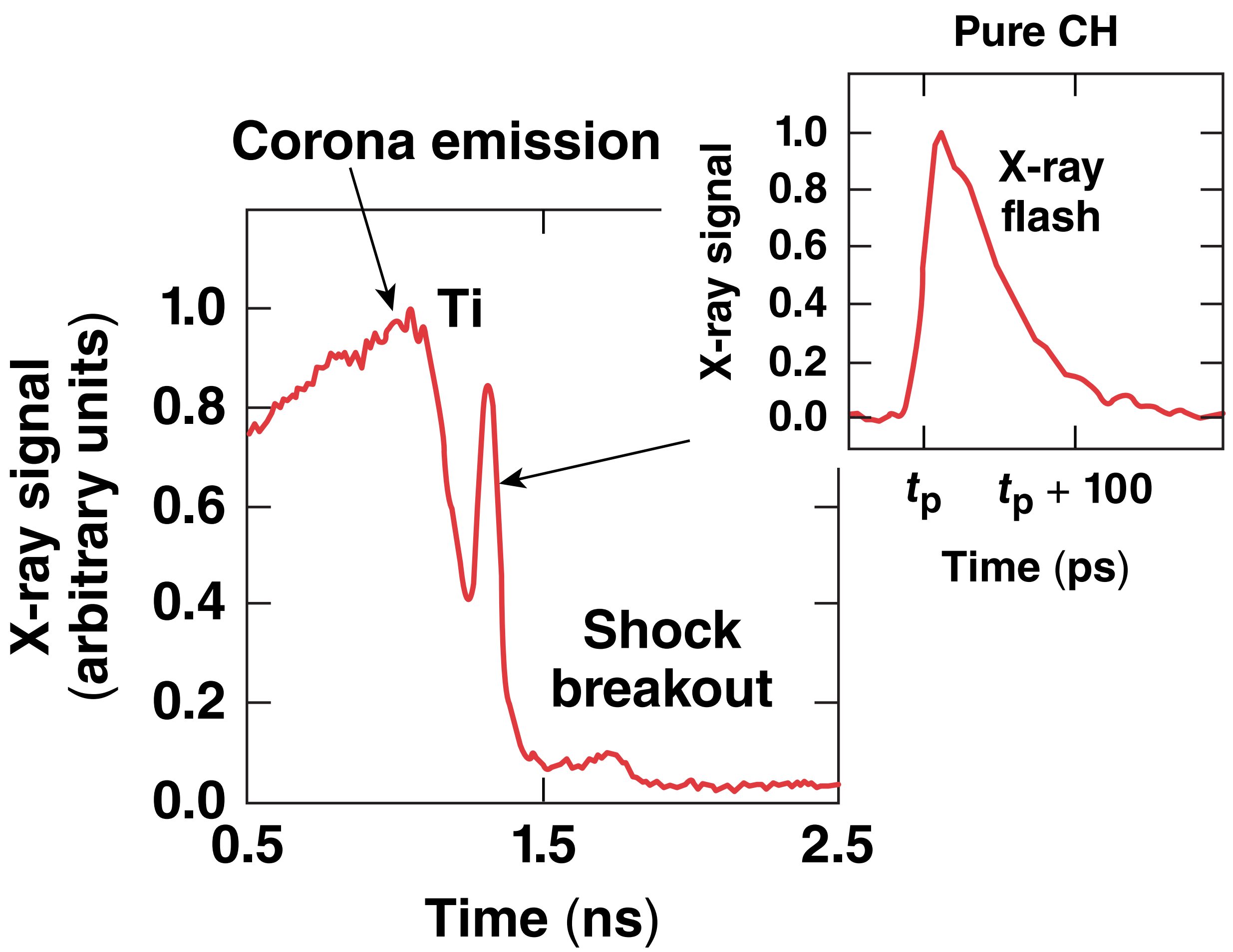
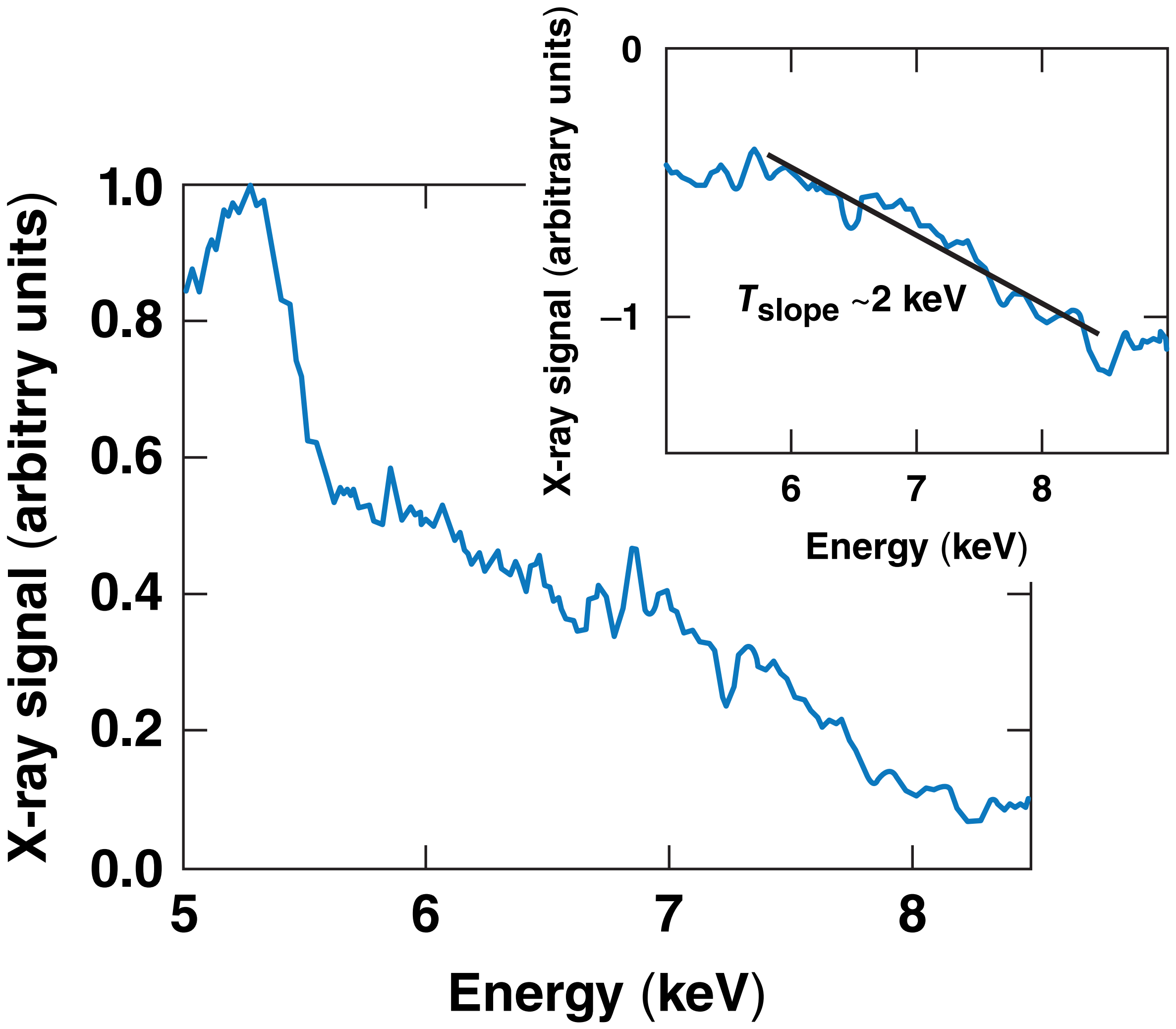
The primary and a weaker secondary x-ray flash was observed with a streaked spectrometer





A temperature of ~keV has been measured in the shock-compressed sample from the x-ray spectrum



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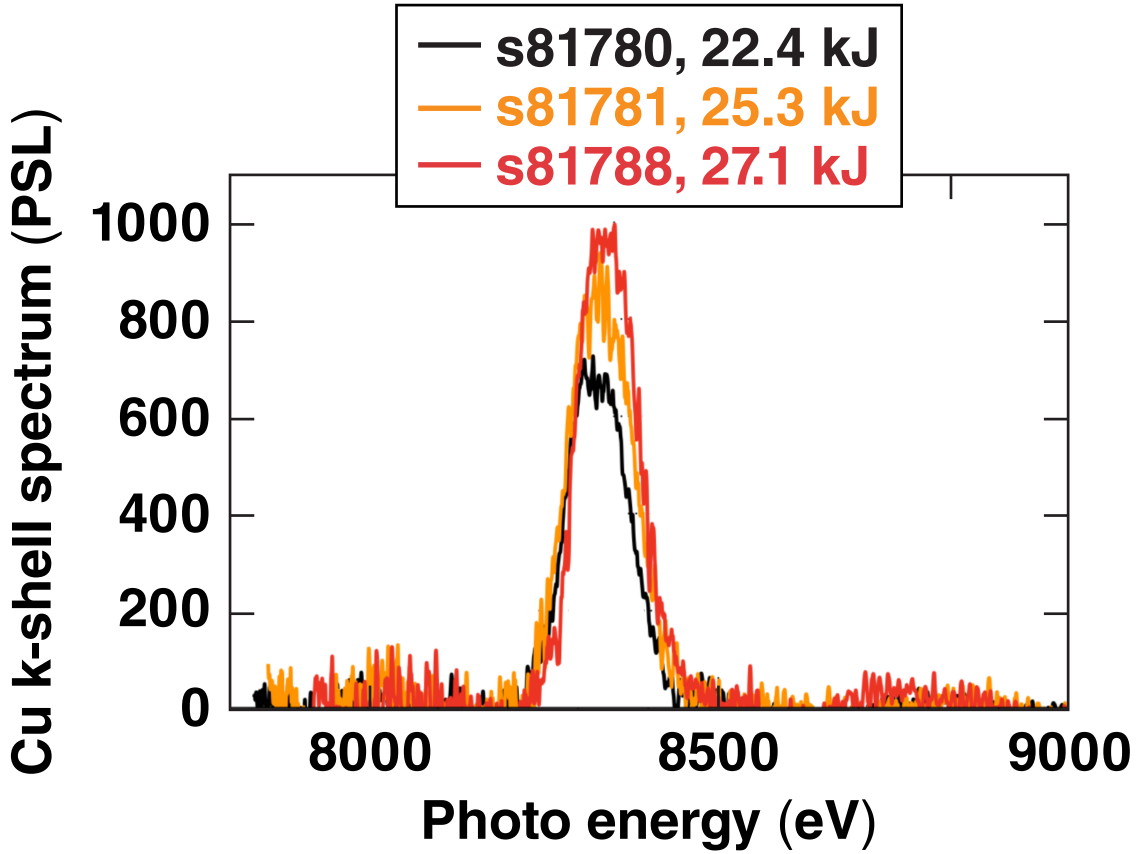
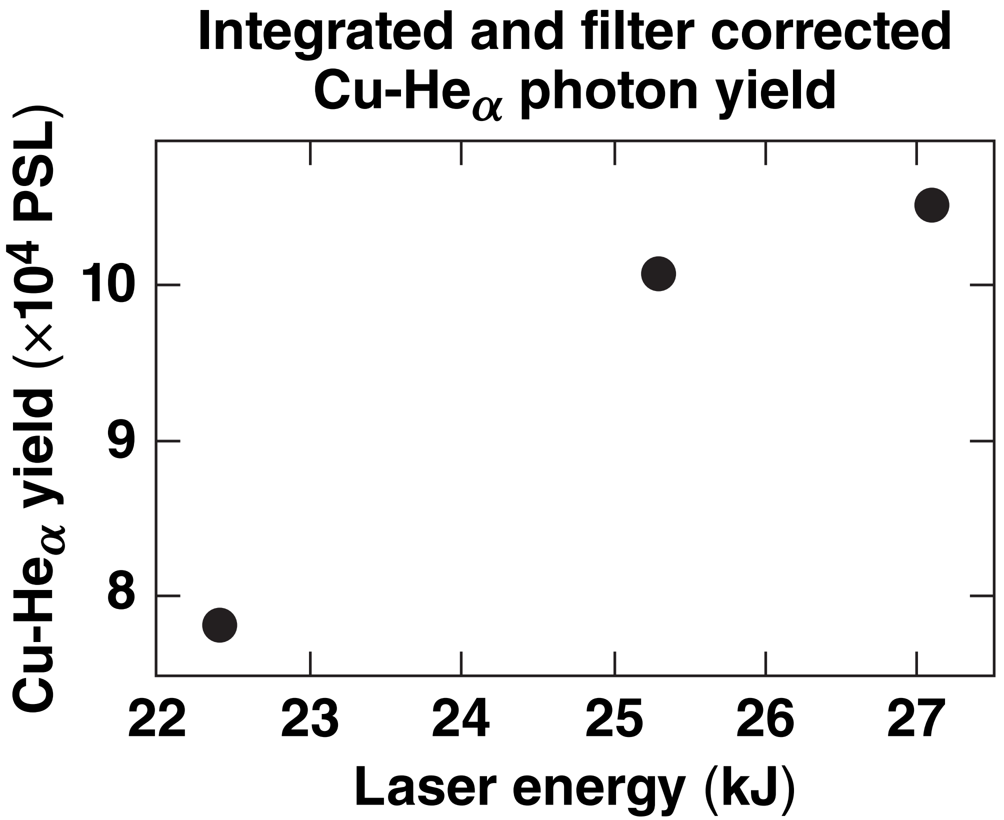
The high temperature explains the Cu-He$_\alpha$ line emission from targets with a Cu particle





The observation of the hot-ionic line and the absence of the cold Cu-K$_\alpha$ line indicates the creation of hot dense matter caused by shock heating of the Cu particle in the center.

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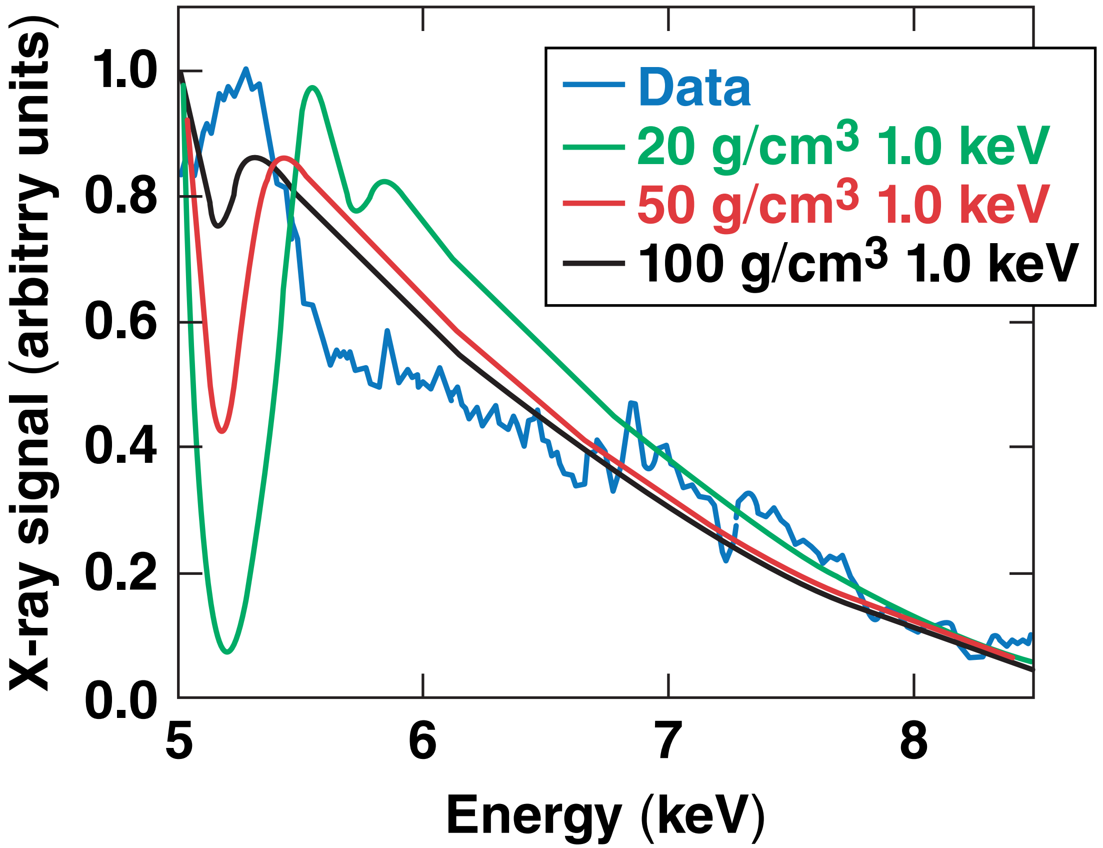
Initial analysis with *PrismSPECT** suggests that the core is compressed to a mass density of ~100 g/cm^3



A temperature of ~1 keV and a mass density of 100 g/cm^3 indicates that a pressure of Gbar has been reached inside the titanium sample.

E25668

*J. J. MacFarlane *et al.*, in Inertial Fusion Sciences and Applications 2003, edited by B. A. Hammel *et al.* (American Nuclear Society, La Grange Park, IL, 2004), pp. 457–460.

Summary Conclusions

A platform is developed to study Gbar pressures in sample materials (Ti and Cu) with a spherically convergent shock wave

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