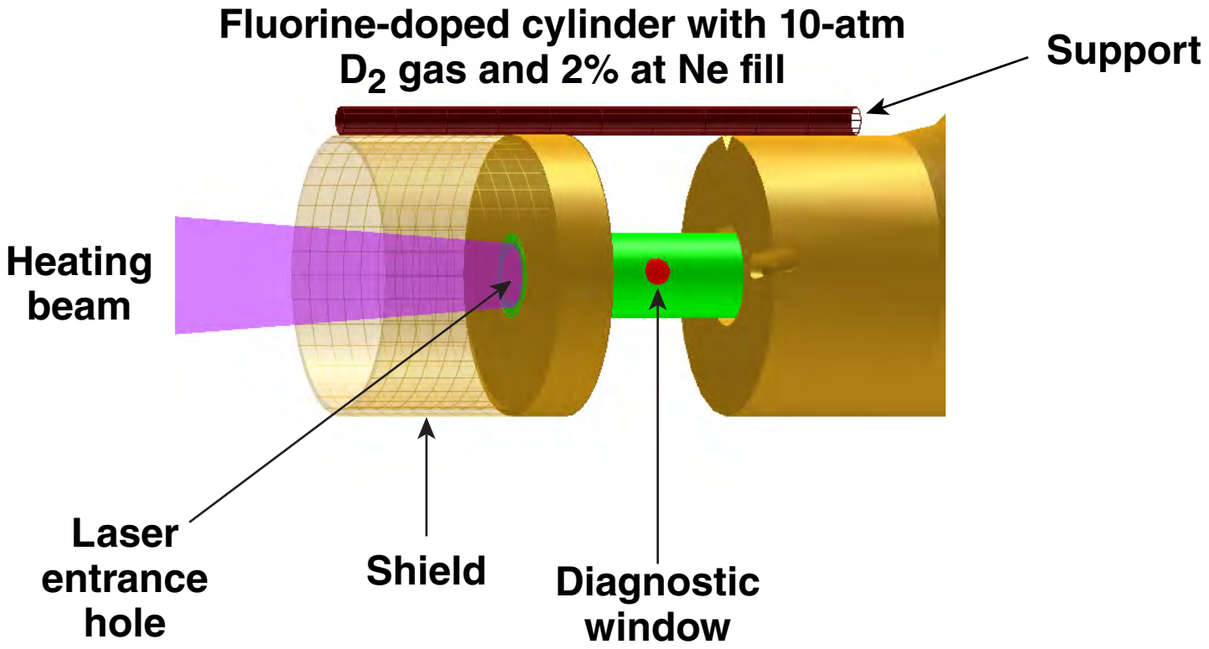
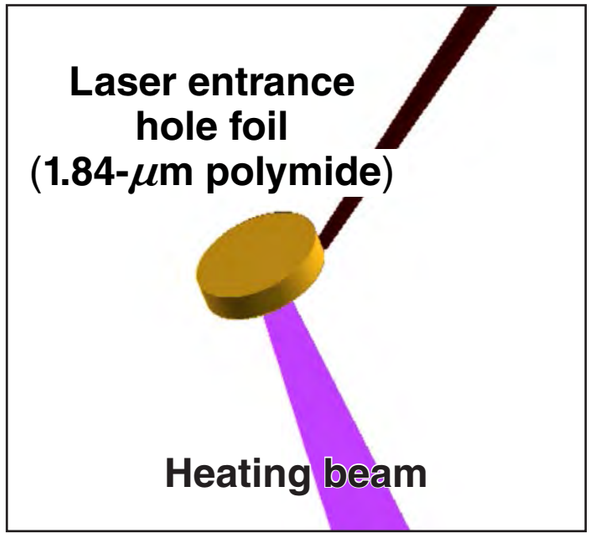
First Results from Laser-Driven MagLIF Experiments on OMEGA: Time Evolution of Laser Gas Heating Using Soft X-Ray Diagnostics





D. H. Barnak
University of Rochester
Laboratory for Laser Energetics

57th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Savannah, GA
16–20 November 2015

Summary

A minimum temperature of 100 eV in the gas region is inferred using soft x-ray diagnostics

- The soft x-ray framing camera (SXR) was used to determine a minimum possible gas temperature
- The Dante soft x-ray diode estimates the laser entrance hole (LEH) plasma conditions
- The Dante data are in good agreement with the 2-D hydrocode *FLASH**

*B. Fryxell *et al.*, Astrophys. J. Suppl. Ser. 131, 273 (2000).

Collaborators

R. Betti, E. M. Campbell, P.-Y. Chang, J. R. Davies, J. P. Knauer,
S. P. Regan, and R. Epstein

University of Rochester
Laboratory for Laser Energetics

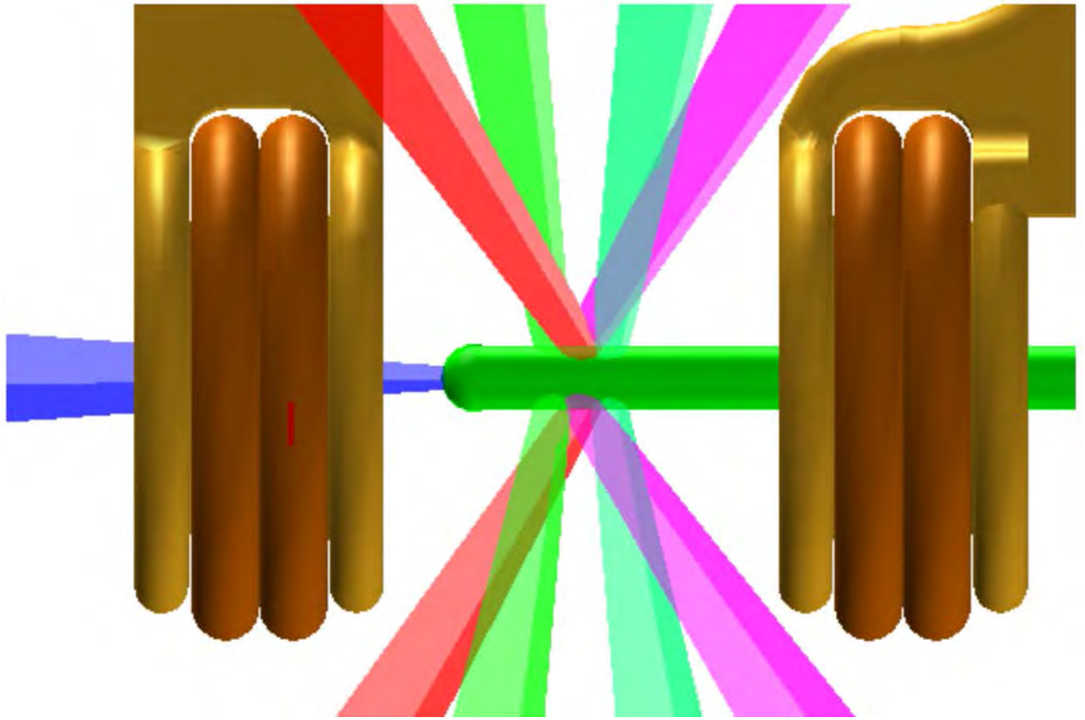
K. J. Peterson, A. B. Sefkow,
D. B. Sinars, and S. A. Slutz

Sandia National Laboratories

This project is funded by the Department of Energy's
Advanced Research Projects Agency – Energy (ARPA–E)

Scaled-down magnetized liner inertial fusion (MagLIF)* experiments are being performed using the OMEGA laser

1. Magnetization
2. Laser heating
3. Compression



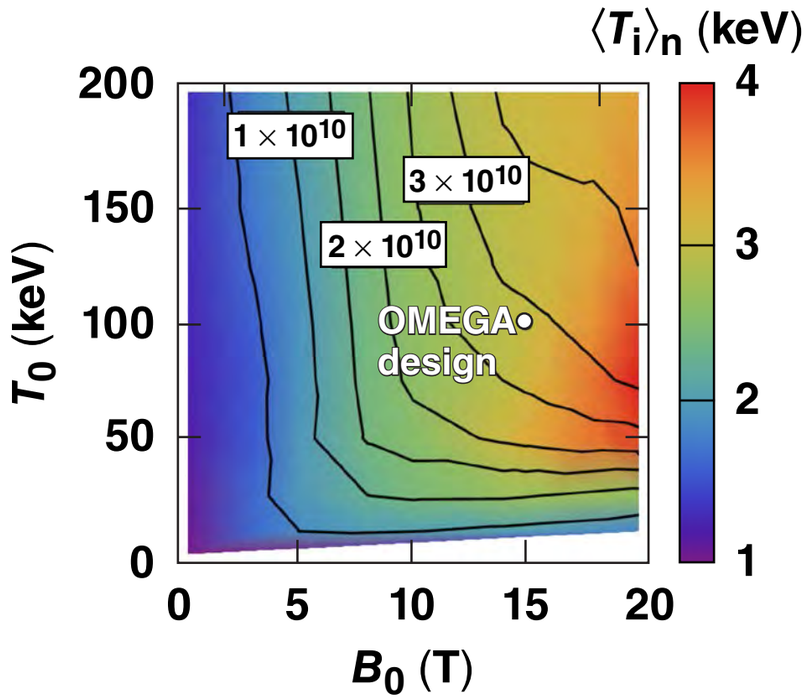
An understanding of laser heating must be developed for the success of the MagLIF fusion scheme.

*S. A. Slutz and R. A. Vesey, Phys. Rev. Lett. 108, 025003 (2012).

TC12573

One-dimensional *LILAC* magnetohydrodynamic (MHD) simulations indicate that a gas temperature of 100 eV is required to achieve adequate yield enhancement

- No further gain in yield or ion temperature is made with a higher initial gas temperature
- Gas must be heated without ablating wall material into the gas because of thermal conduction

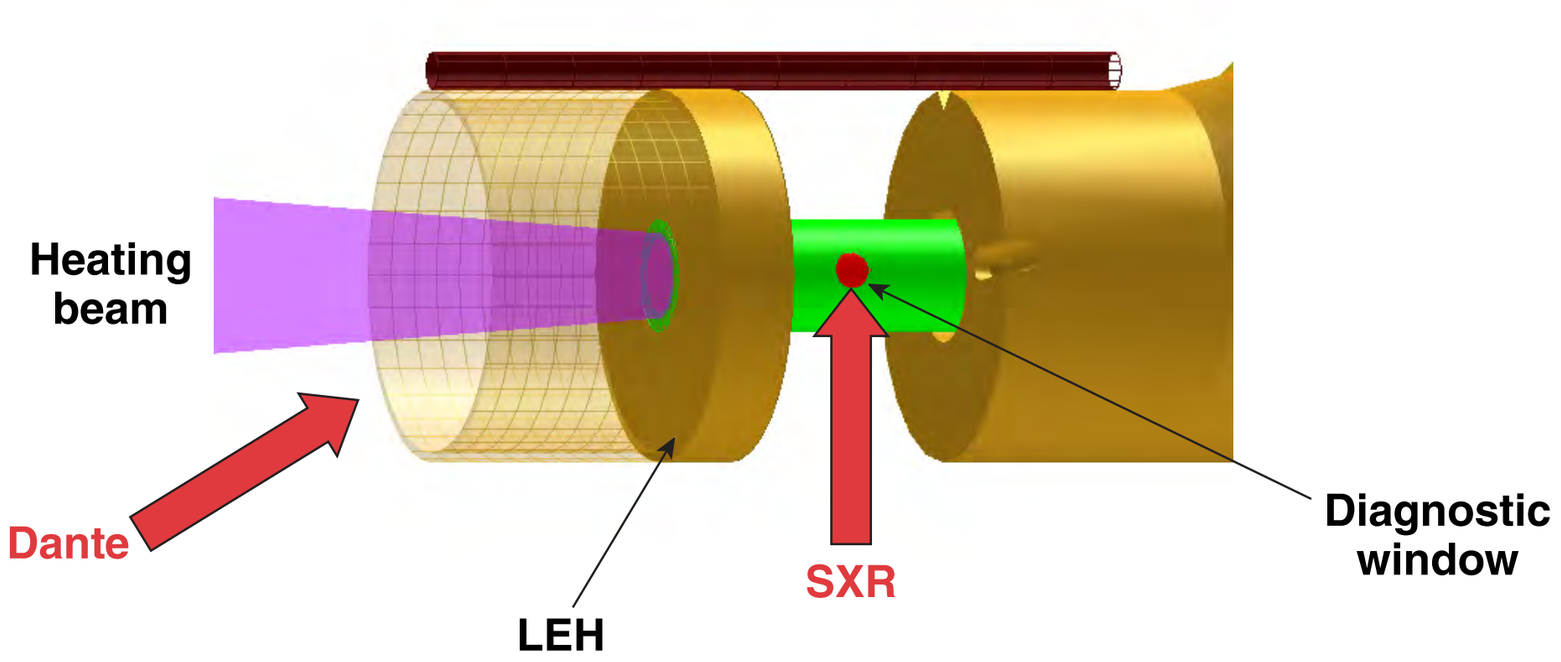


B_0 (T)	T_0 (eV)	$\langle T_i \rangle_n$ (keV)	Y_n ($\times 10^8$)
0	0	0.97	5
0	100	1.23	15
15	100	3.00	290

TC11605a

A 2.5-ns, 200-J square-pulse laser is used to heat a neon-doped deuterium capsule

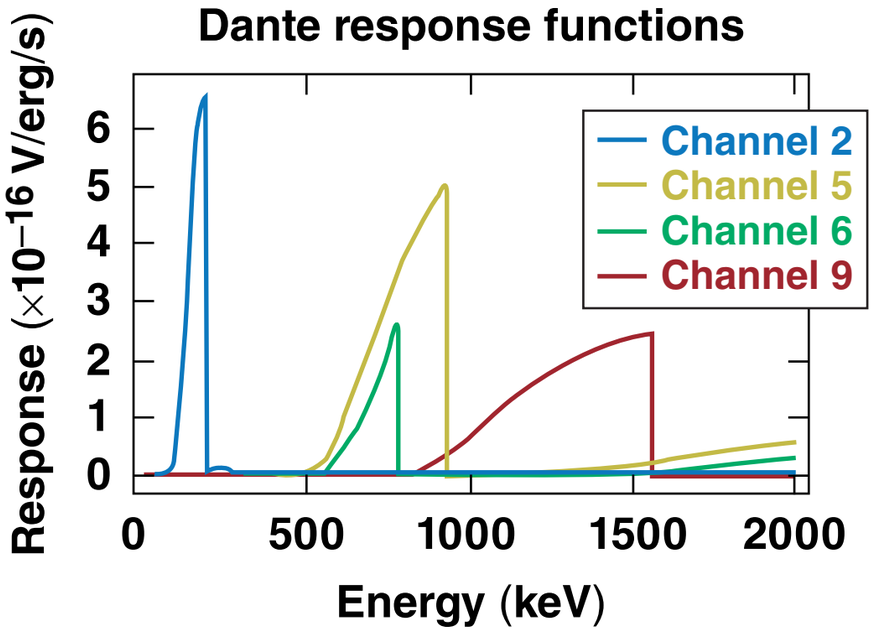
- Soft x-ray emission from the neon-doped gas was used to infer the gas temperature
- A fluorinated plastic cylinder was used to measure the wall temperature

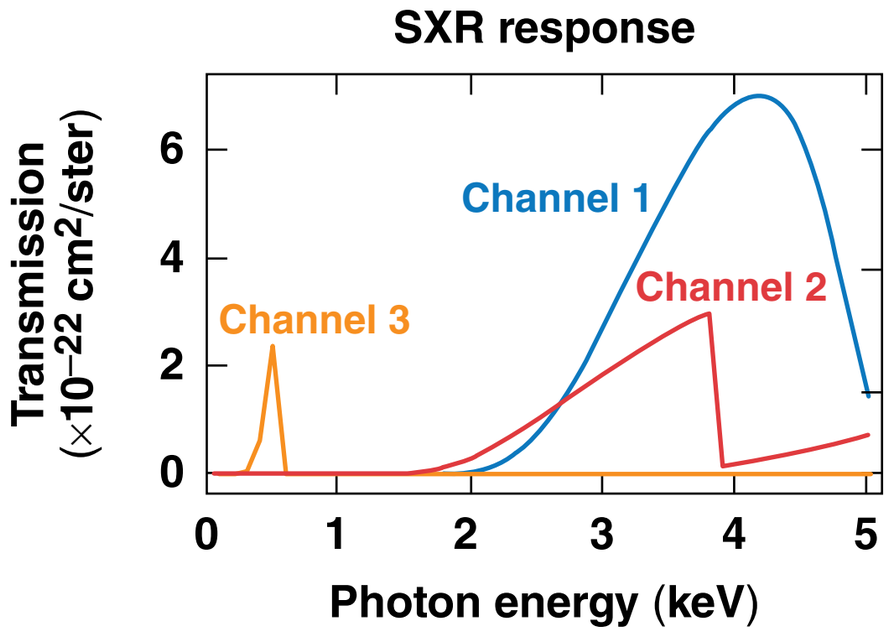


TC12658

A suite of spectrally integrated soft x-ray diagnostics characterizes the plasma during laser heating

- Dante is a multichannel filtered x-ray diode array
- SXR is a time-resolved x-ray imager with mirror-filter spectral resolution





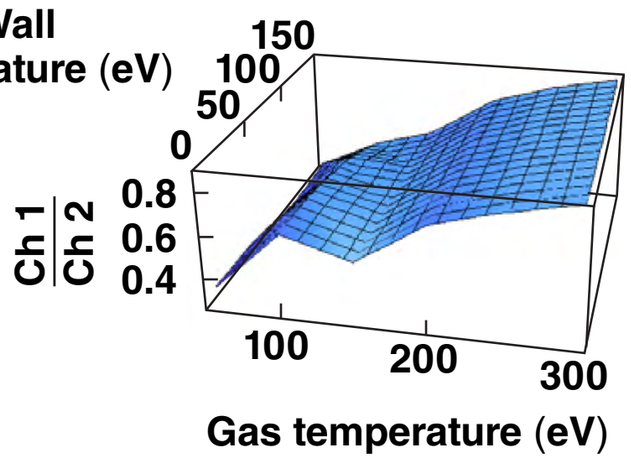
TC12574

Spect3D determines the soft x-ray spectrum and generates conversion curves for SXR and Dante

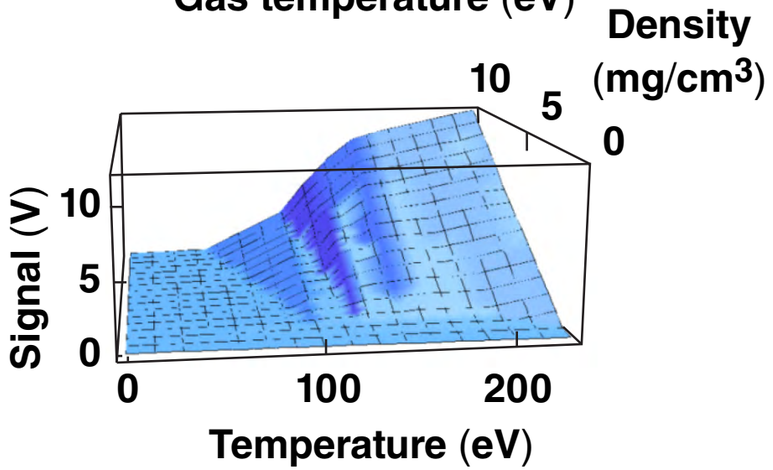
- *Spect3D* utilizes detailed atomic modeling to predict the soft x-ray spectrum of different materials at varying densities and temperatures

$$\int X_{spect}\left(T_{gas}, T_{wall}, \rho\right) R_i\left(E\right) dE$$

Channel 1
Channel 2
Channel 3

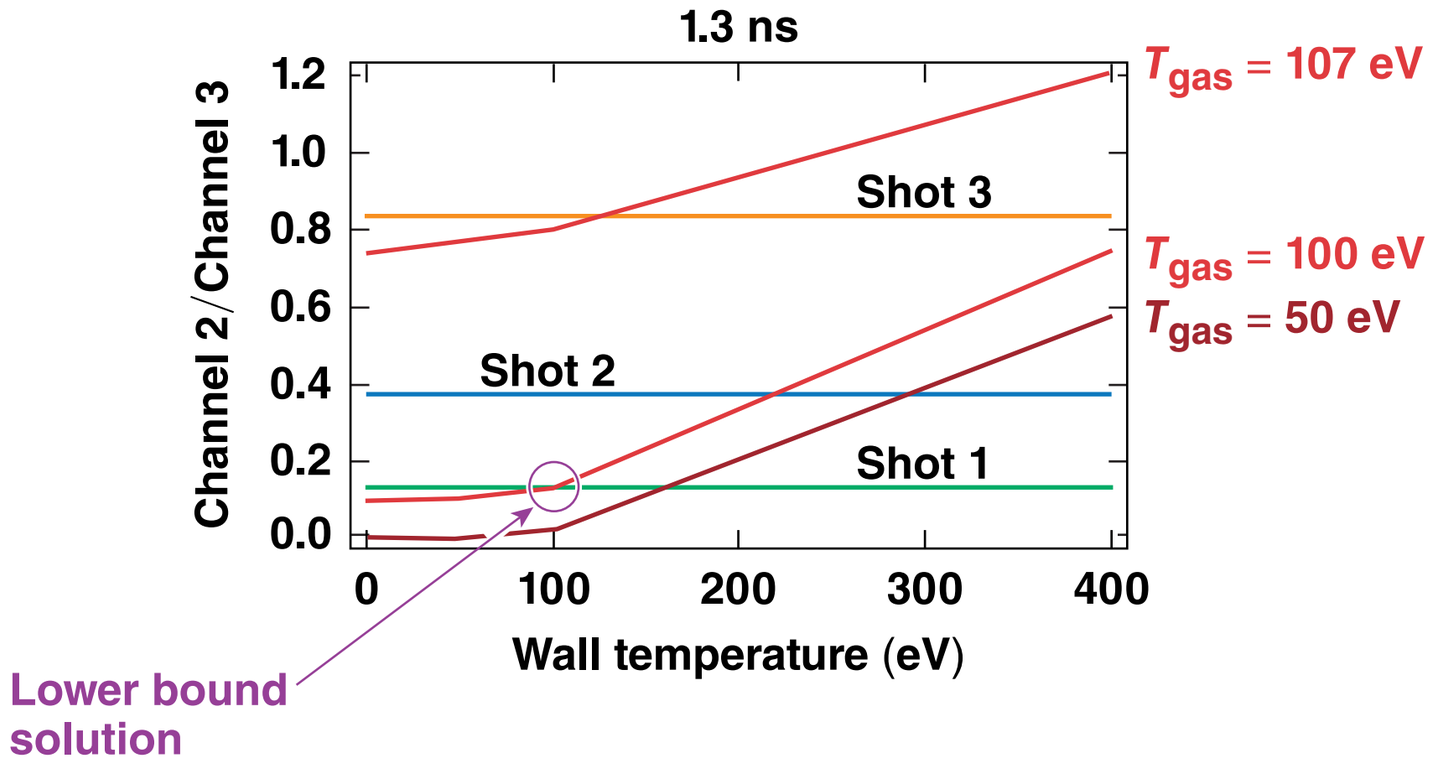


$$V(T, \rho) = \int X_{spect}\left(T, \rho\right) R_i\left(E\right) \Omega_i \, dE$$



TC12659

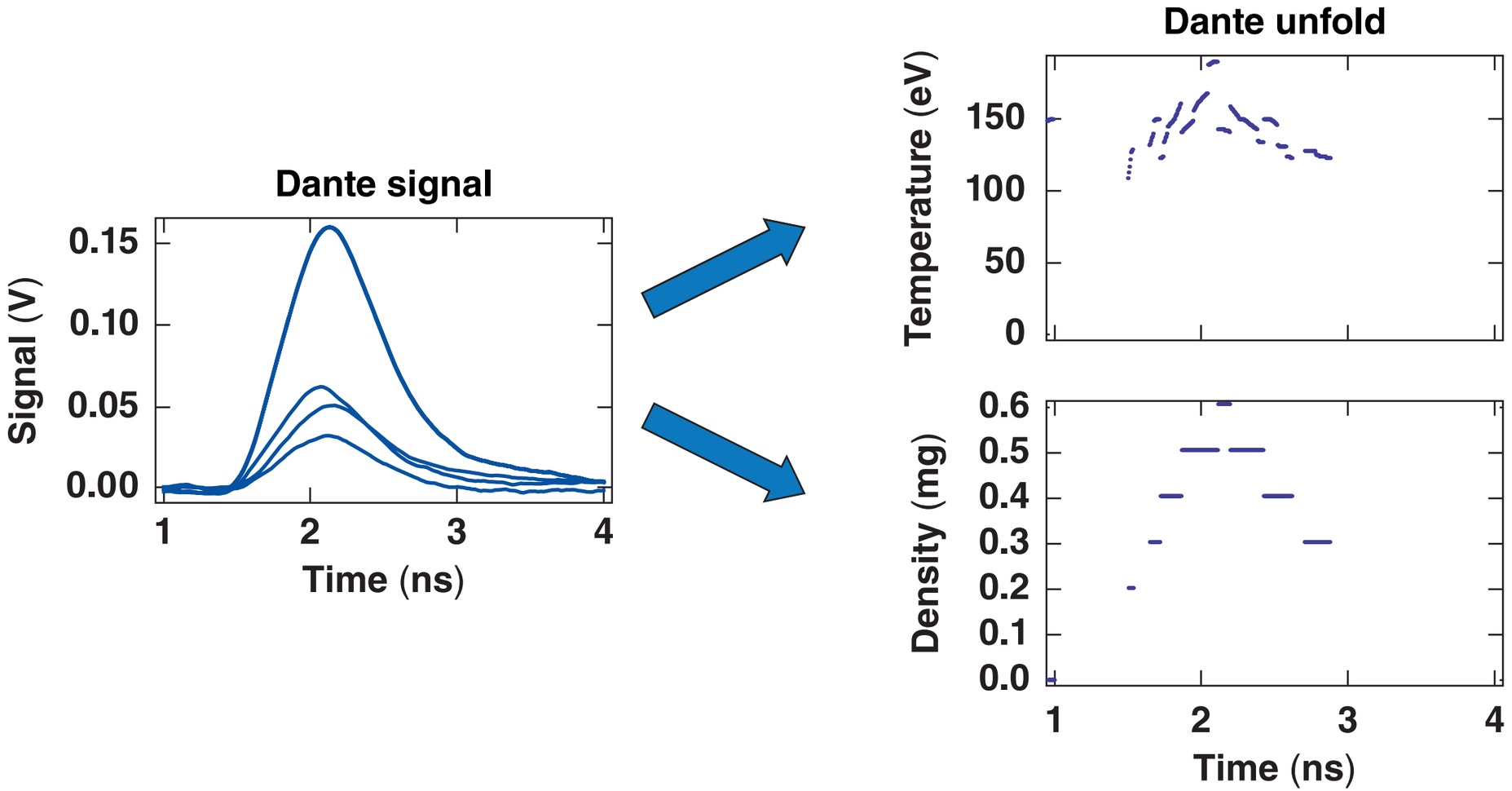
The SXR calculated channel ratios infer a minimum gas temperature of 100 eV at 1.3 ns into the laser pulse



- The conversion tables are used to estimate the average gas temperature in the capsule
- There are multiple solutions of temperature and density
  - ignore solutions where $T_{gas} > T_{wall}$

TC12571

Dante data estimate the LEH plasma conditions

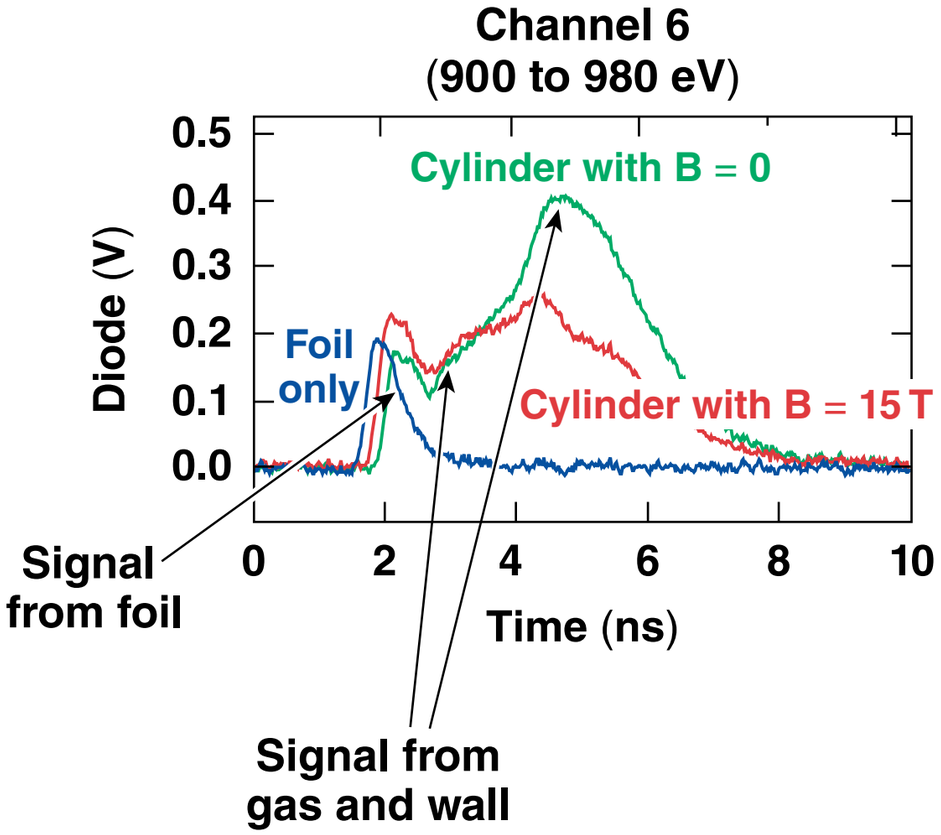


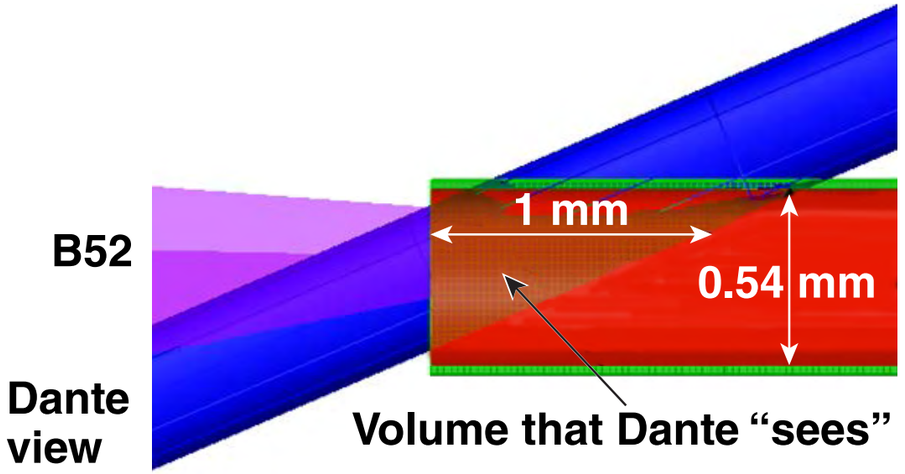
Temperature predictions are unreliable because a temperature profile is not considered.

TC12572

Comparison of LEH foil-only shots with cylinder shots indicates that heating of the gas was observed by Dante through the LEH

- It is difficult to discern between neon and fluorine emission with spectrally integrated diagnostics

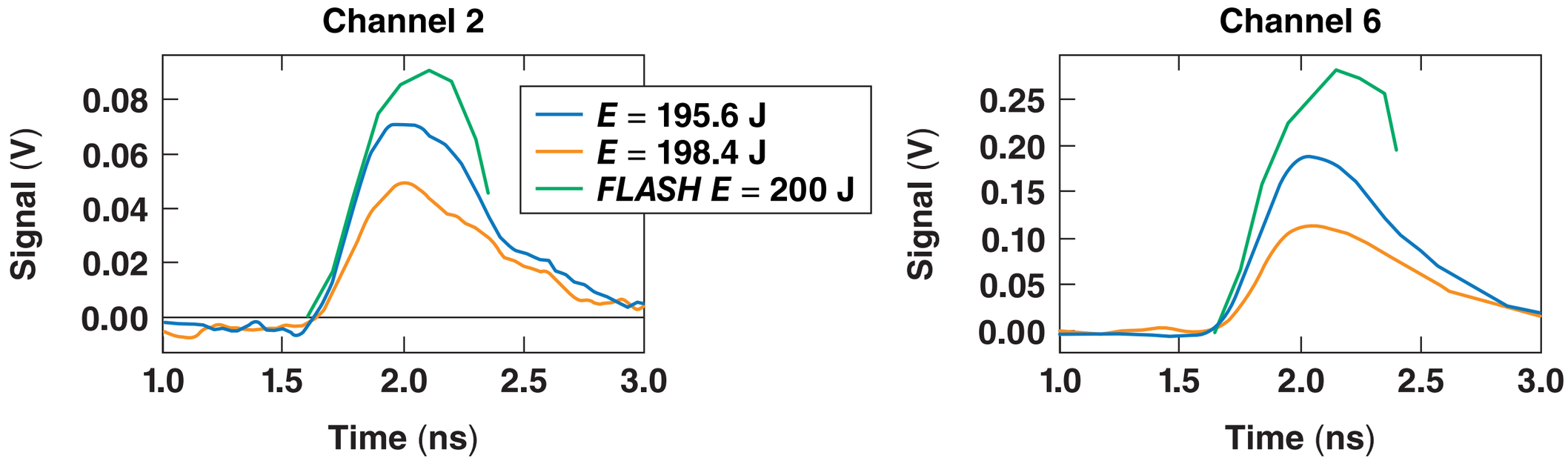




TC12575

A 2-D hydrodynamic model (*FLASH*) is in good agreement with the experimental data

- Output from the *FLASH* code is post-processed using *Spect3D* atomic modeling to generate simulated Dante traces



Dante is very sensitive to laser-energy absorption and can be used to refine hydrodynamic simulation predictions for MagLIF.

TC12576

Summary/Conclusions

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