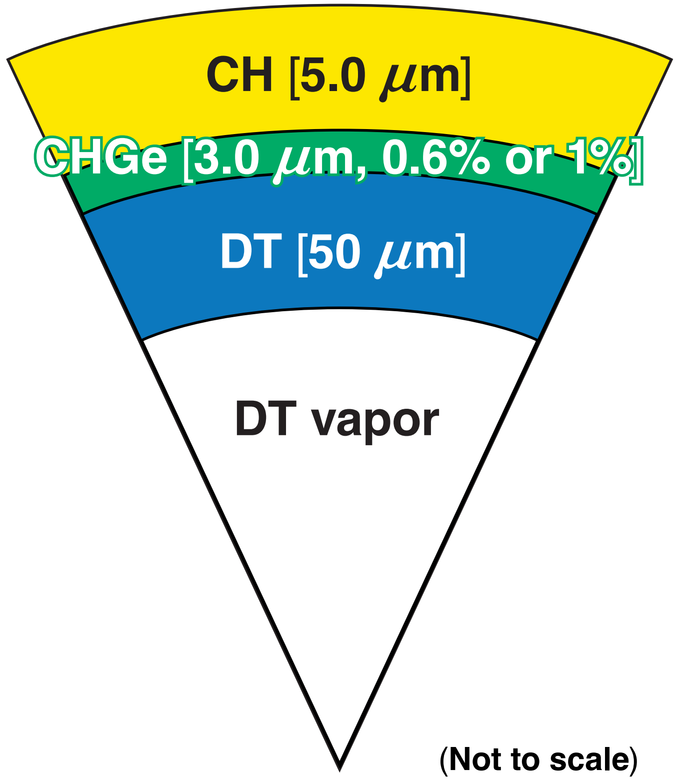
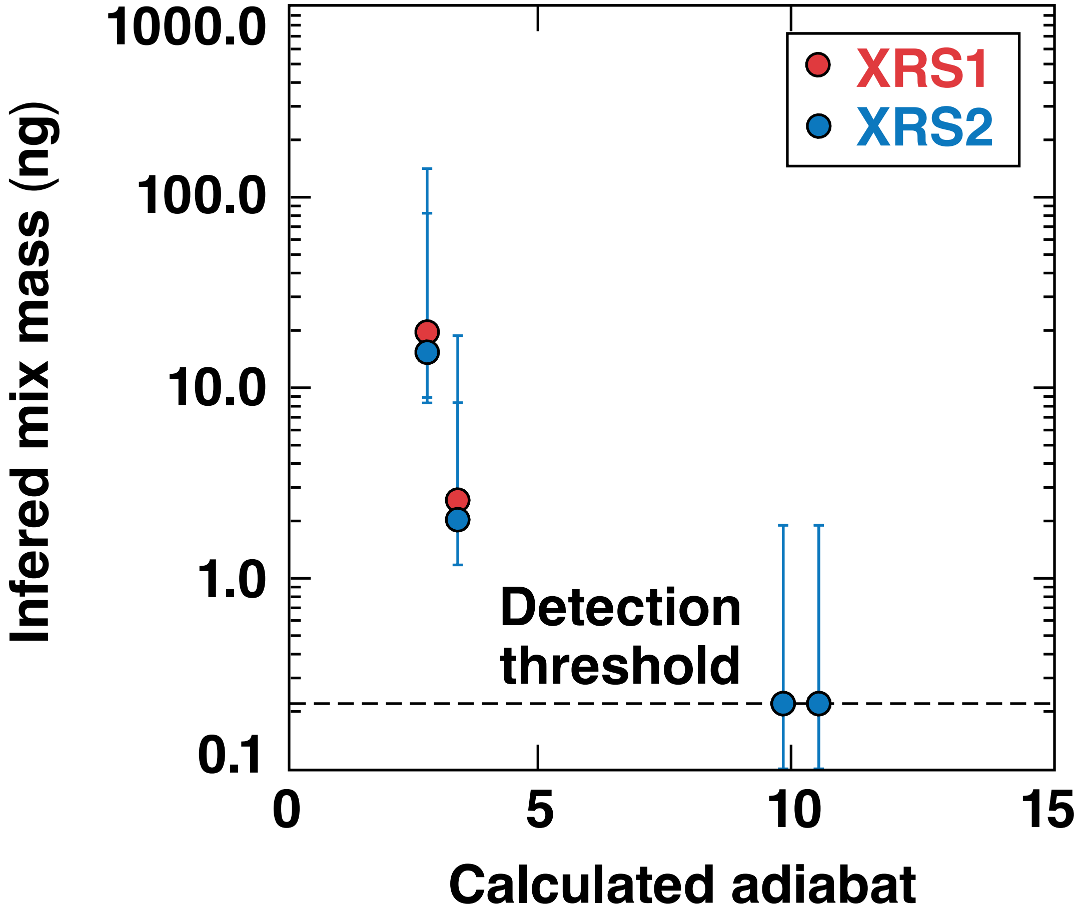
Dependence of Hot-Spot Mix in DT Cryogenic Implosions on the Design Adiabat





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Summary

The dependence of hot-spot mix* on the design adiabat ($\alpha = P_{shell}/P_{Fermi}$) for laser-direct-drive (LDD) implosions of DT cryogenic targets was measured

- The adiabat of the implosion on the OMEGA laser was controlled by adjusting the temporal shape of the laser drive pulse
- Perturbations seeded by debris, target imperfections, engineering features (e.g., stalk or fill tube), and laser imprint** are amplified by the Richtmyer–Meshkov instability during the shock transit of the shell and by the ablative Rayleigh–Taylor instability during the acceleration phase†
- The mixing of Ge-doped plastic ablator material with the interior DT fuel was diagnosed with x-ray spectroscopy at stagnation*

The experimental results show the expected trend of decreasing hot-spot mix mass as the adiabat is increased.

*S. P. Regan *et al.*, Phys. Rev. Lett. 111, 045001 (2013).
**S. X. Hu *et al.*, Phys. Plasmas 17, 102706 (2010).
†I. V. Igumenshchev *et al.*, Phys. Plasmas 20, 082703 (2013).

Collaborators

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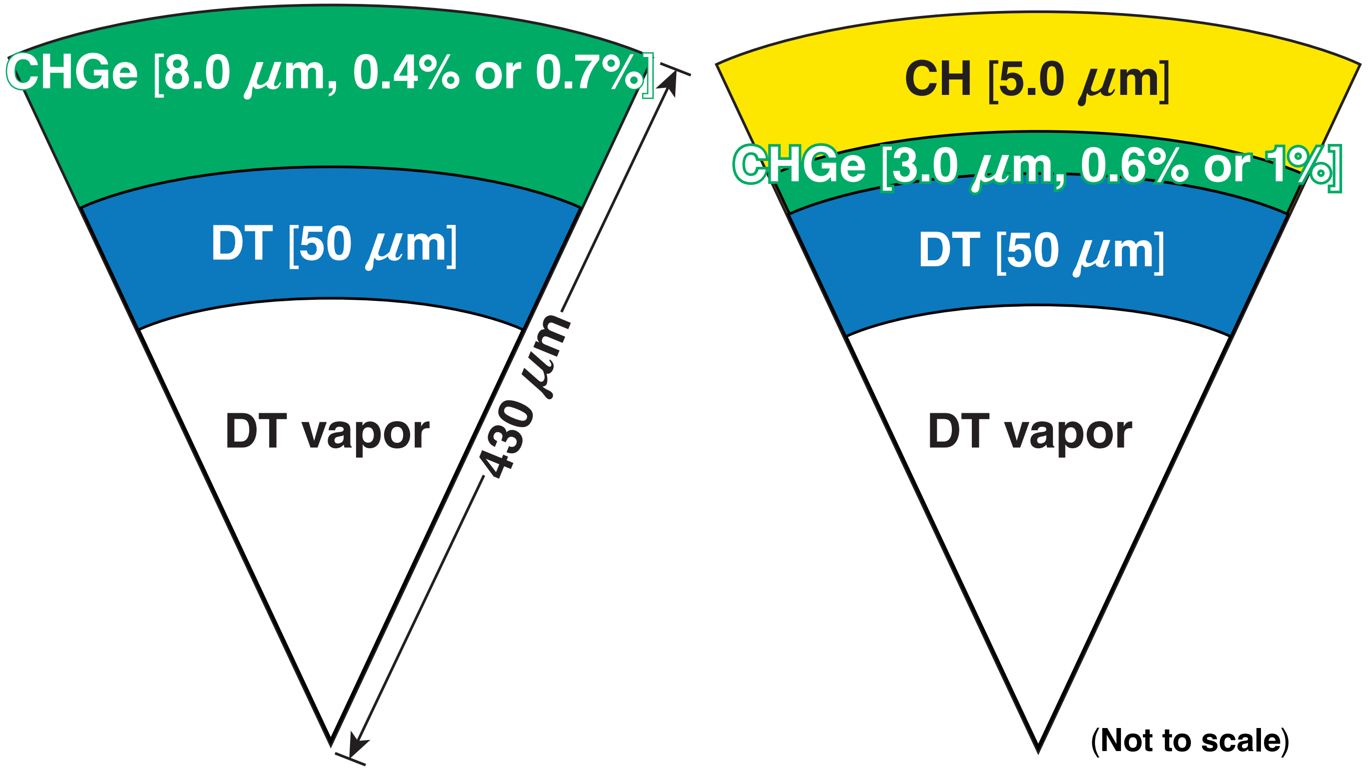
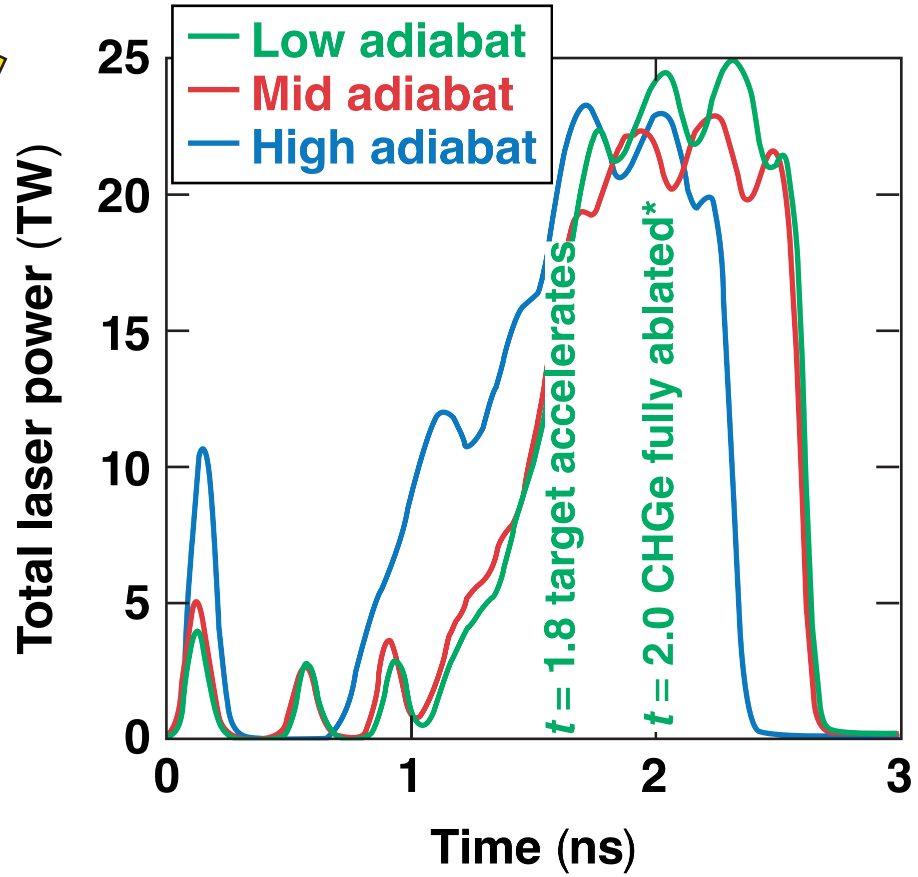
General Atomics

The adiabat of the implosion on the OMEGA laser was controlled by adjusting the temporal shape of the laser drive pulse





$$\alpha = \frac{P_{shell}}{P_{Fermi}}$$

$$\gamma = \alpha_{RT}\sqrt{kg} - \beta_{RT}\, k\, V_{abl}$$

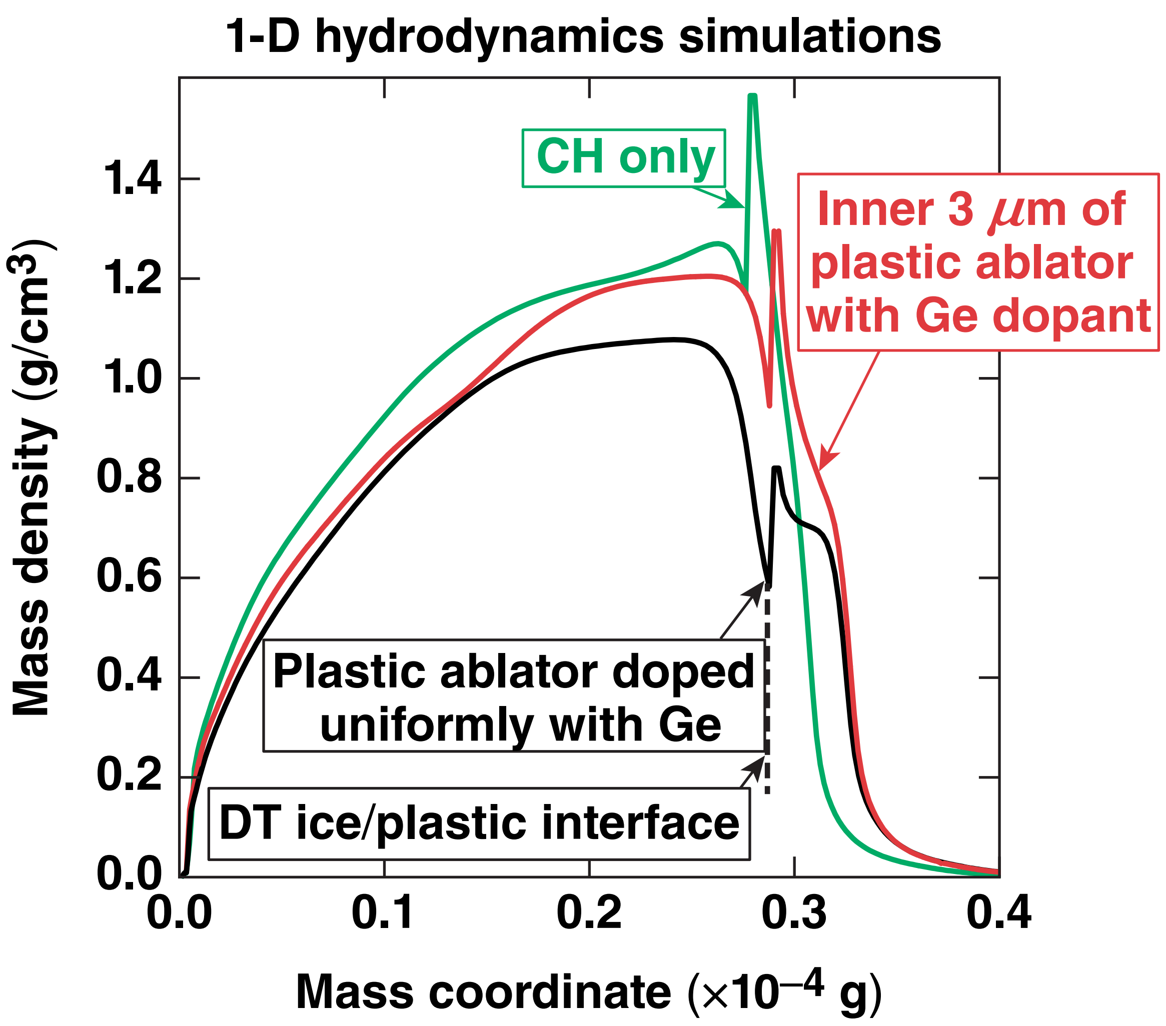
$$V_{abl} \propto \alpha^{3/5}$$

The Ge dopant in the CH ablator was localized to the inner layer to reduce radiative preheat from the coronal plasma.

TC14587

D. T. Michel *et al.*, Rev. Sci. Instrum. 83, 10E530 (2012).

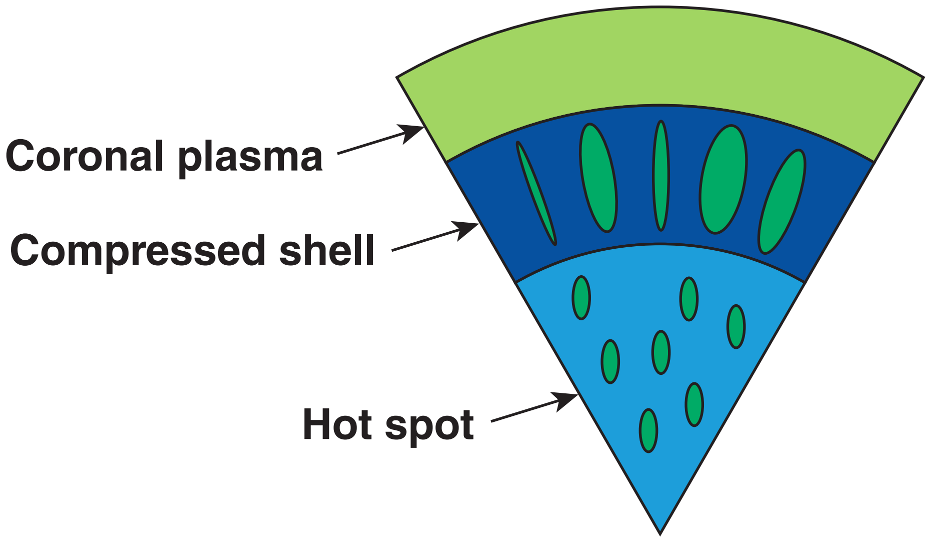
Excessive x-ray preheat from the ablated Ge shell could make the DT ice/CH ablator interface hydrodynamically unstable

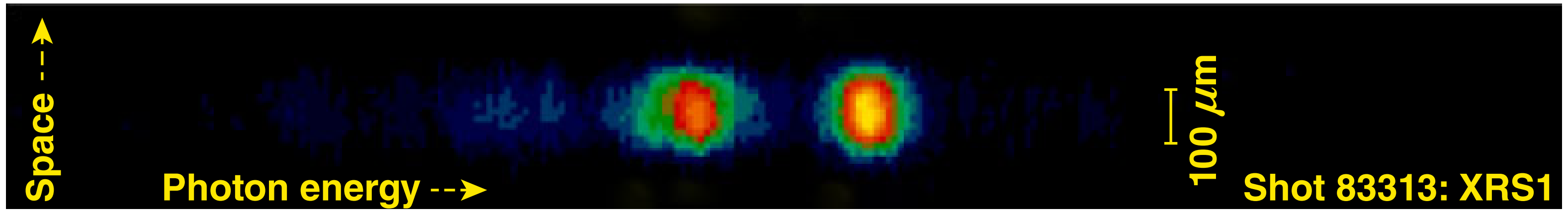


The DT ice/CH interface is not stable for the plastic ablator doped uniformly with Ge.

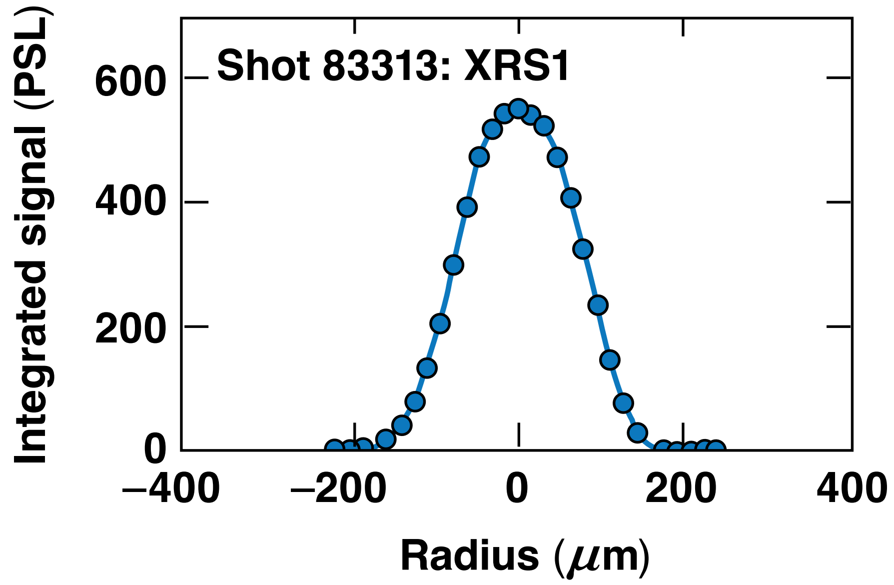
TC14588

Mixing the Ge-doped plastic ablator material with the interior DT fuel was diagnosed with x-ray spectroscopy at stagnation*





XRS1 with dx ~ 100 μm



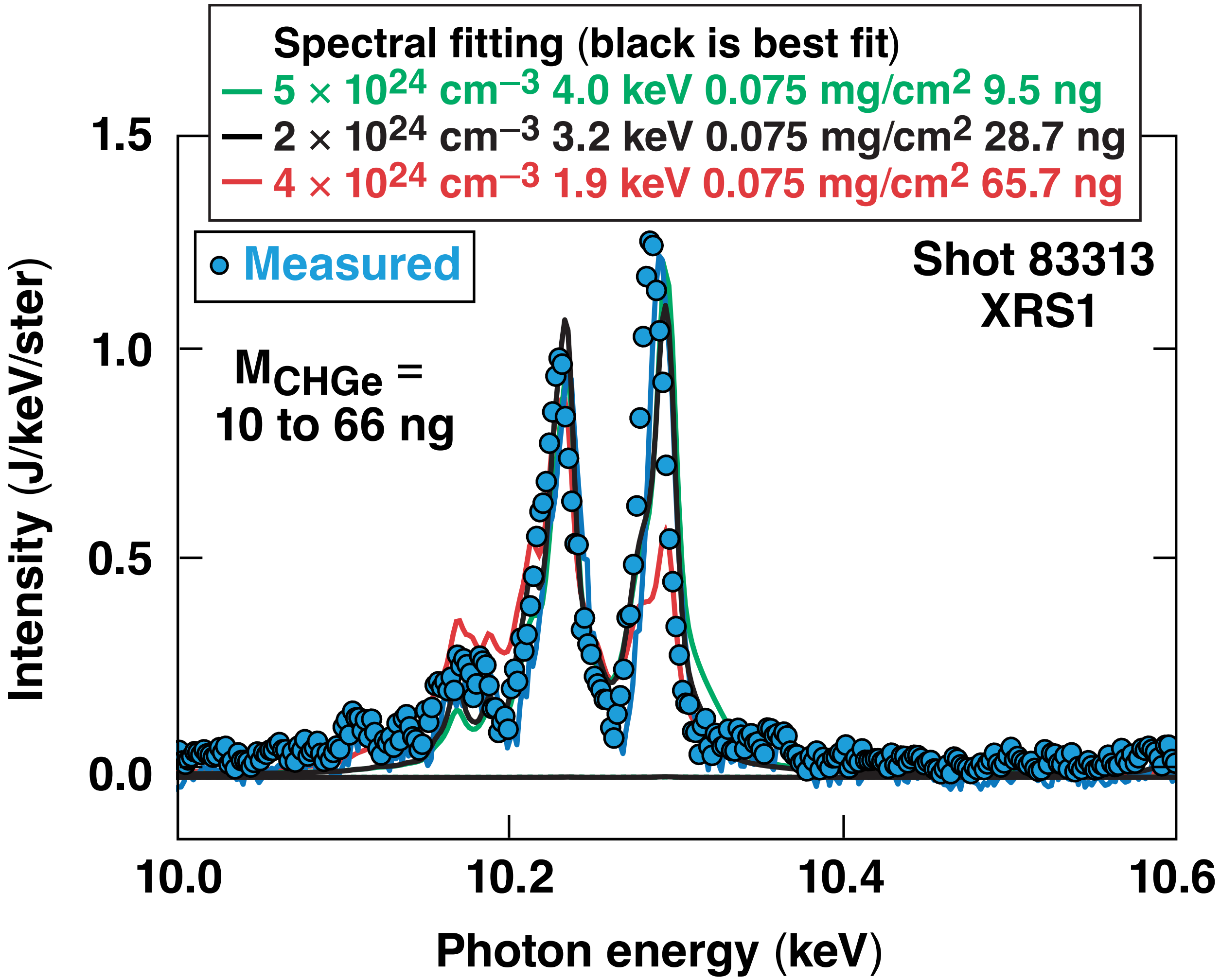
Two time-integrated 1-D imaging x-ray sprectrometers—XRS1, XRS2—were fielded on each shot.

XRS: x-ray source

*B. A. Hammel *et al.*, Phys. Plasmas 18, 056310 (2011); S. P. Regan *et al.*, Phys. Plasmas 19, 056307 (2012); S. P. Regan *et al.*, Phys. Rev. Lett. 111, 045001 (2013).

TC14589

The hot-spot mix was inferred using an atomic physics model assuming a single n_e and T_e, and an average photon escape path*

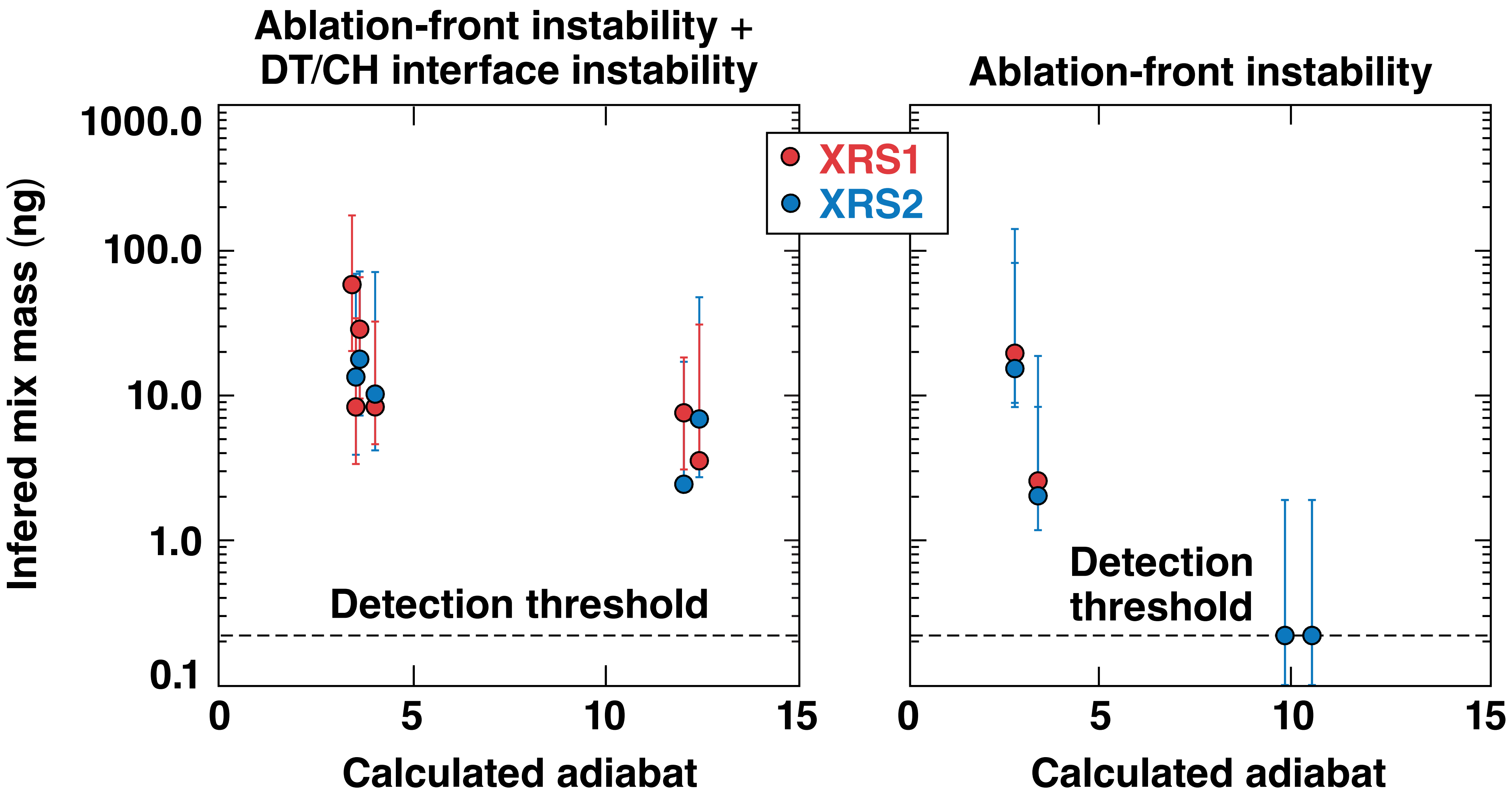


Similar spectra and hot-spot mix were diagnosed for XRS1 and XRS2.

TC14590

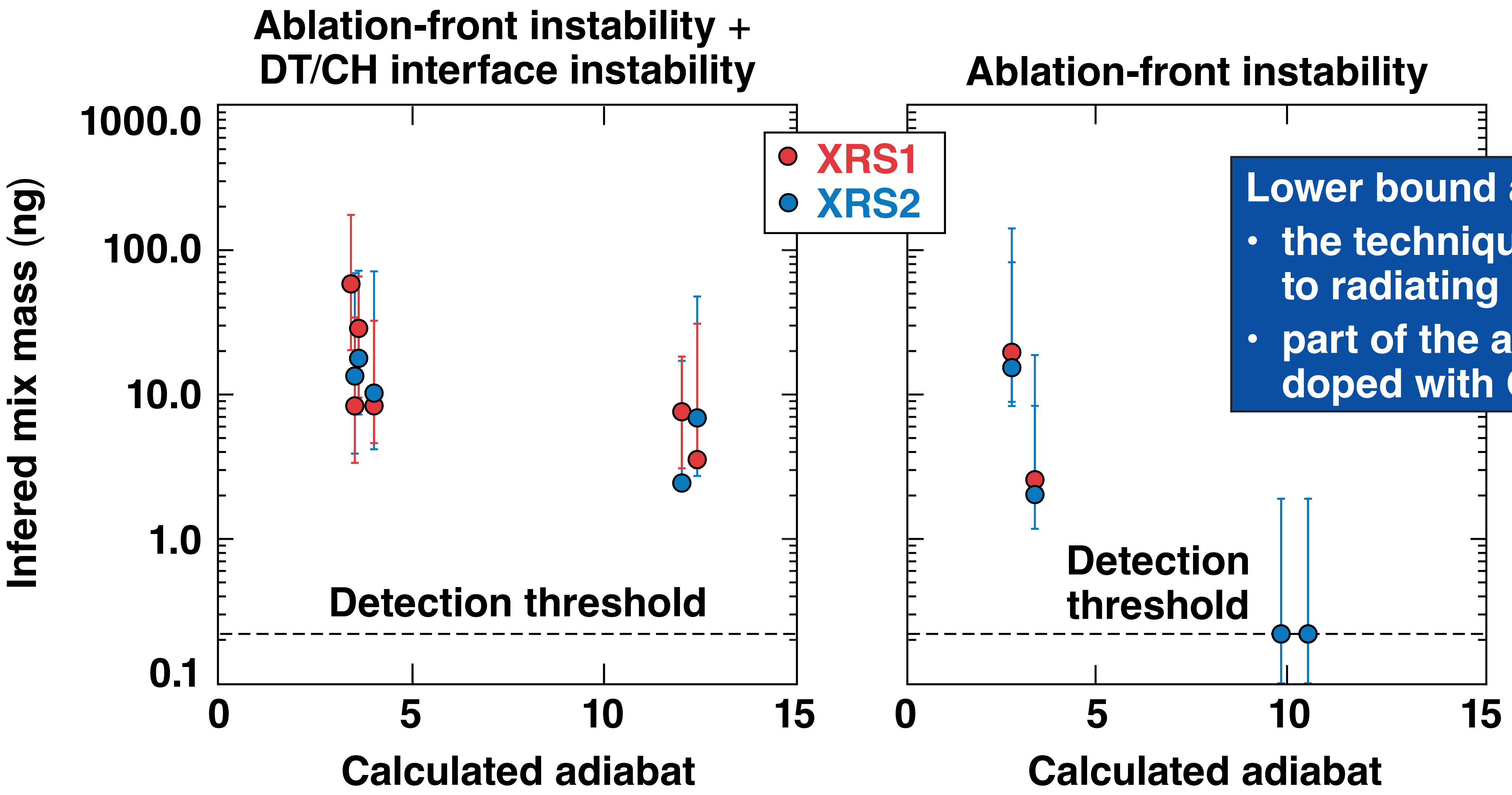
*S. P. Regan *et al.*, Phys. Rev. Lett. 111, 045001 (2013).

The experimental results show the hot-spot mix mass decreases as the adiabat increases



TC14591

The experimental results show the hot-spot mix mass decreases as the adiabat increases



Lower bound at hot-spot mix:

- the technique is only sensitive to radiating Ge
- part of the ablator was not doped with Ge

TC14591a

The dependence of hot-spot mix* on the design adiabat ($\alpha = P_{shell}/P_{Fermi}$) for laser-direct-drive (LDD) implosions of DT cryogenic targets was measured

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