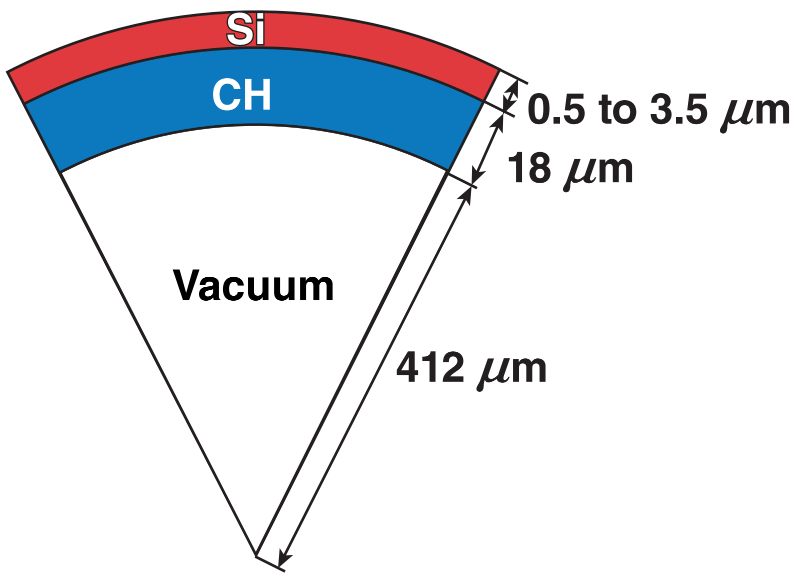
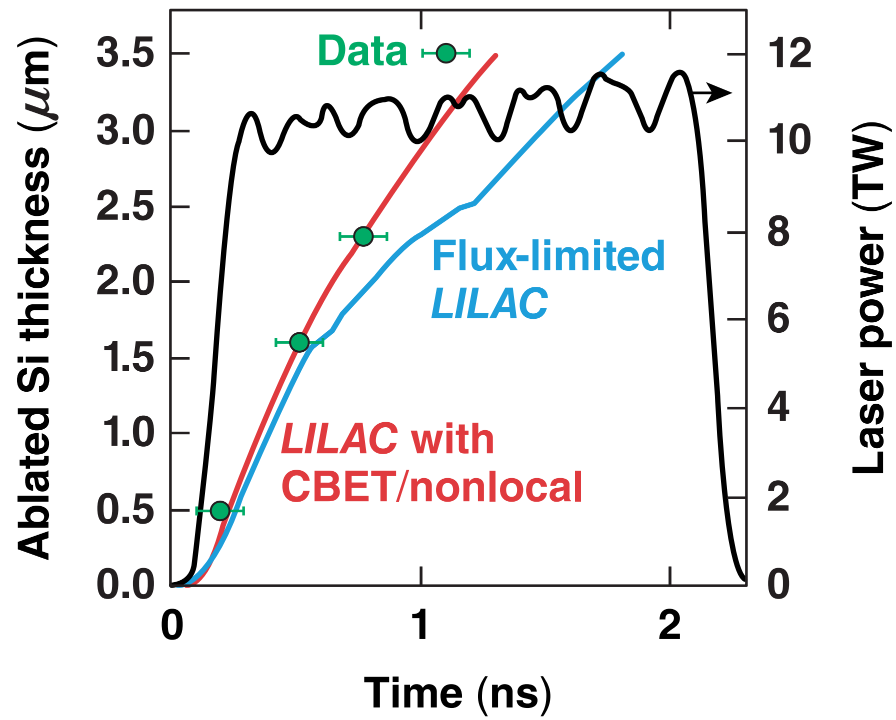
Measurement of the Si Mass Ablation Rate in Direct-Drive Implosions on the OMEGA Laser System





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Division of Plasma Physics
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Summary

CH targets coated with Si were used to measure the mass ablation rate in direct-drive implosions on OMEGA

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- Time-resolved x-ray self-emission images provide a tool to measure the time to burn through the Si outer layer
- The mass ablation rate of Si was measured by varying the thickness of the Si layer

One-dimensional simulations that include models for cross-beam energy transfer (CBET) and nonlocal thermal transport agree well with measurements.

Collaborators

D. T. Michel, I. V. Igumenshchev, R. S. Craxton, R. Epstein,
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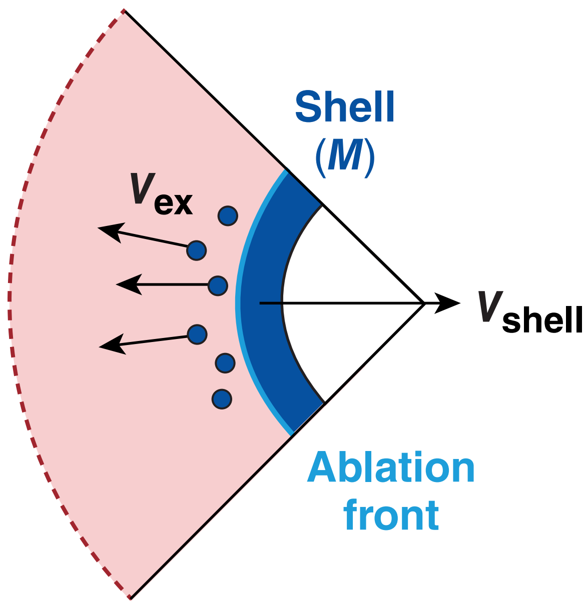
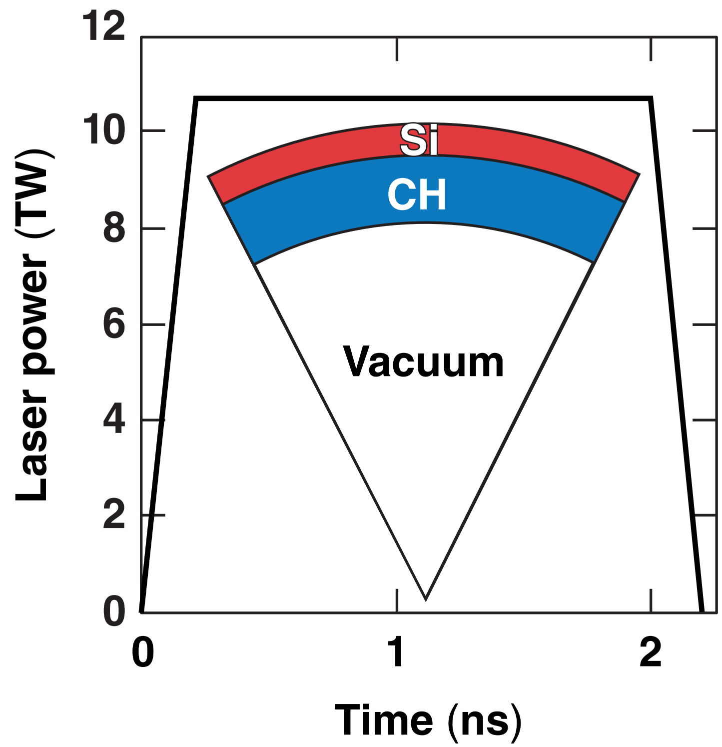
Laboratory for Laser Energetics

Direct-drive inertial confinement fusion implosions are driven by laser energy absorbed near the critical density and transported by electrons to the ablation surface



Rocket effect:

$$M\left[\frac{d(V_{shell})}{dt}\right] = -V_{ex}\frac{dM}{dt}$$



Measurements of the shell trajectory (V_{shell}) and mass ablation rate (dM/dt) constrain the coupling physics.

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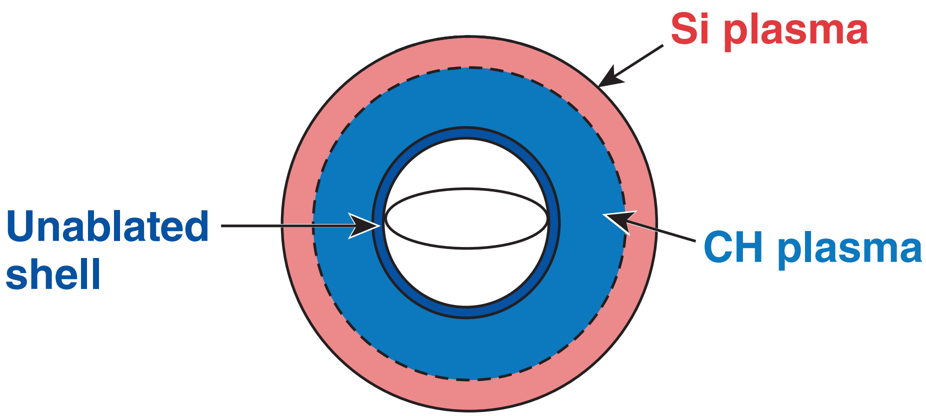
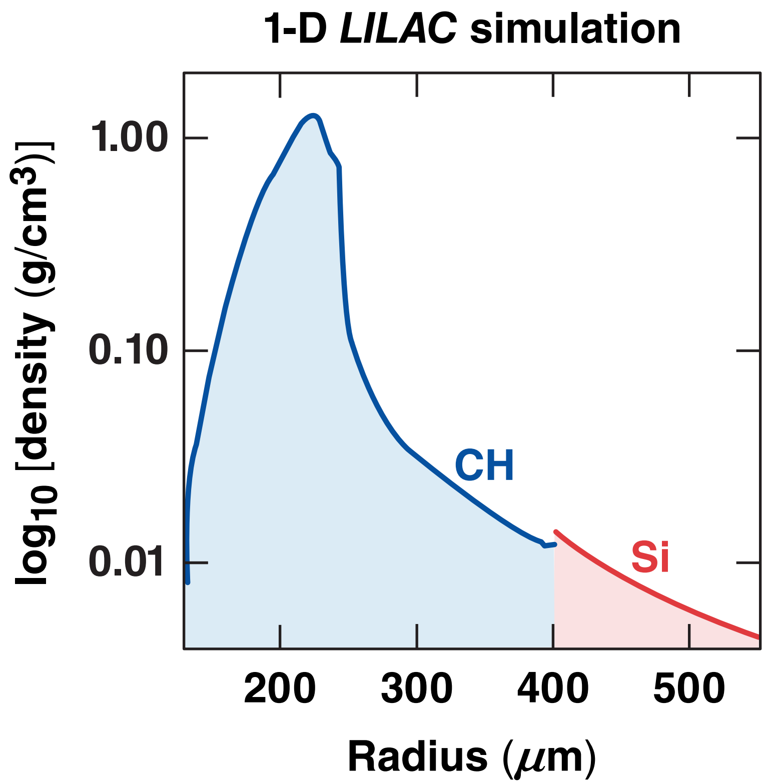
X-ray self-emission imaging provides a tool to study implosion velocity and mass ablation rate in Si/CH targets

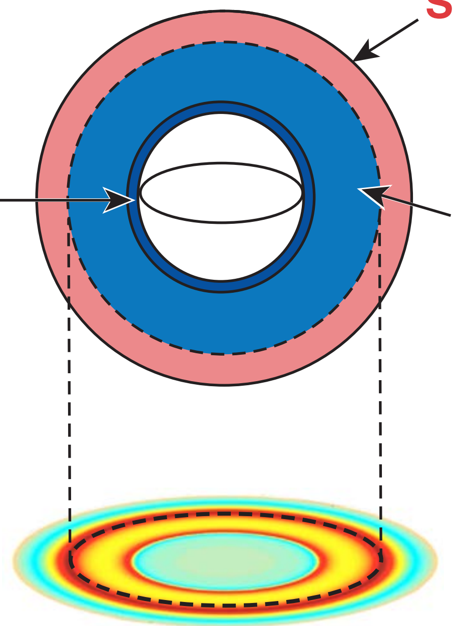


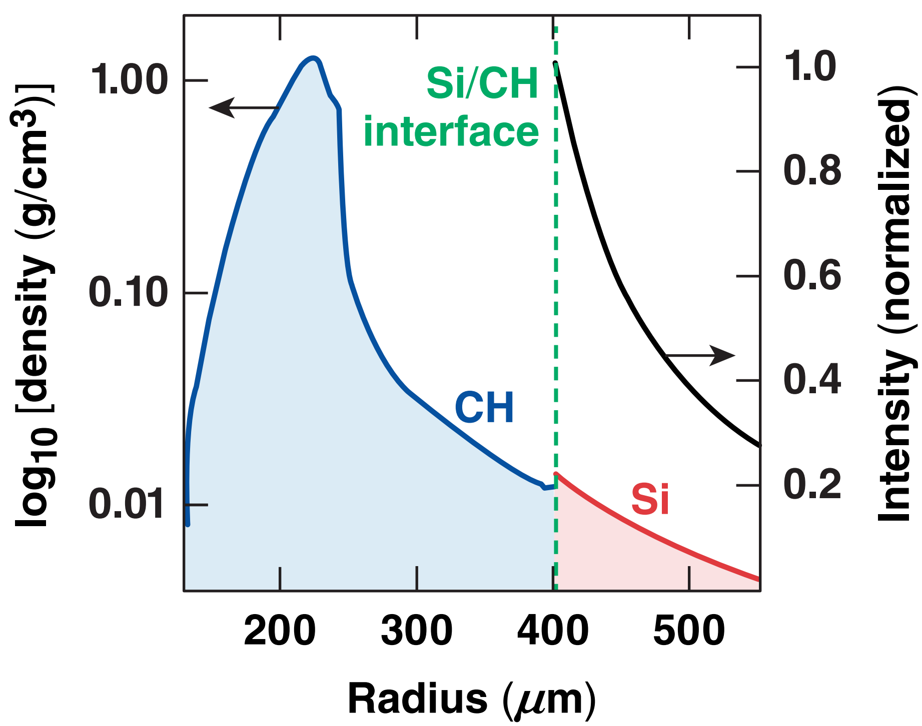


The inner peak corresponds to the ablation front* and the outer peak corresponds to the position of the Si/CH interface.

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

X-ray self-emission imaging provides a tool to study implosion velocity and mass ablation rate in Si/CH targets





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E23610a

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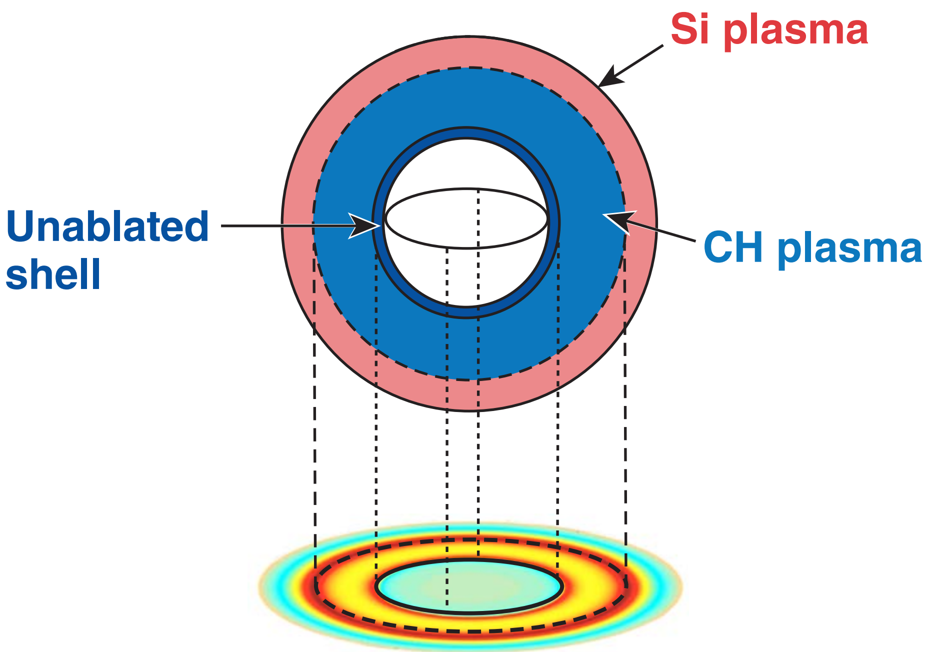

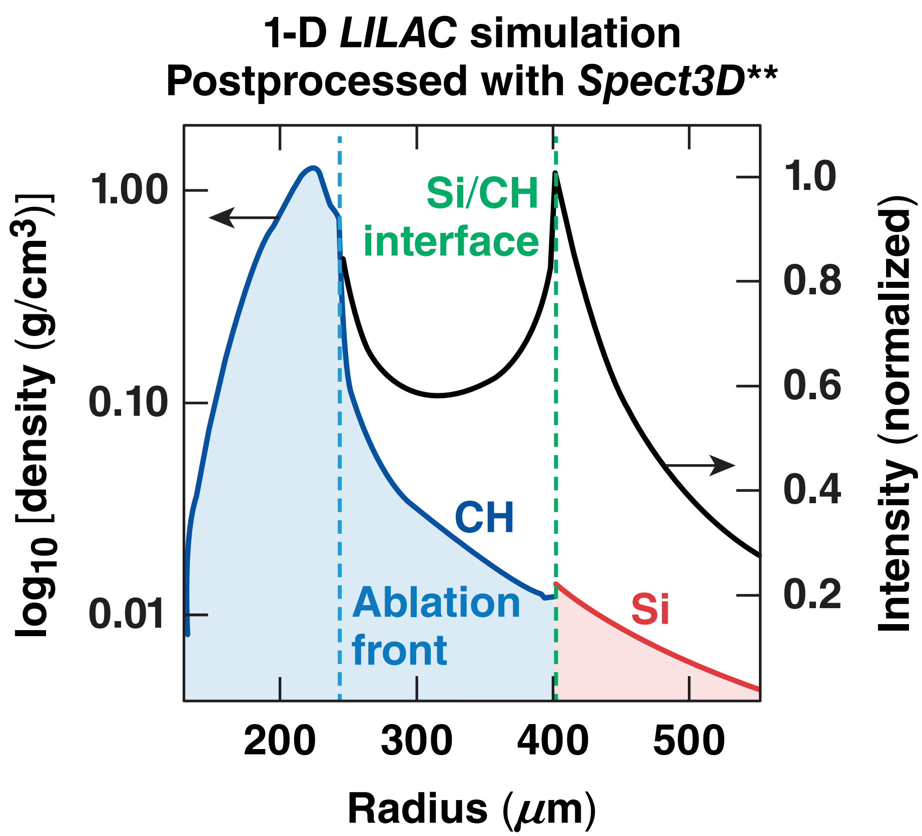

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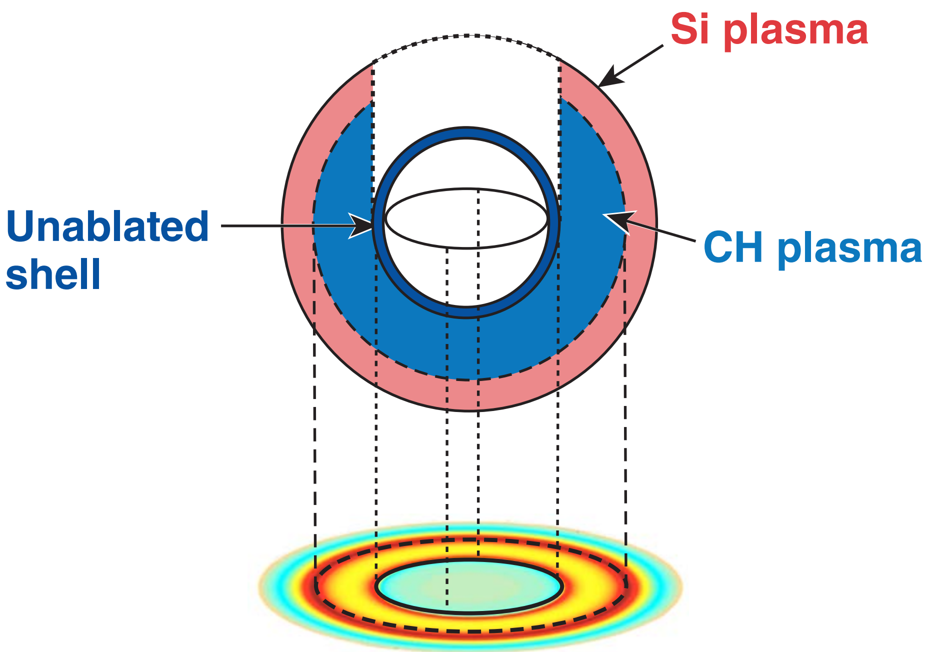
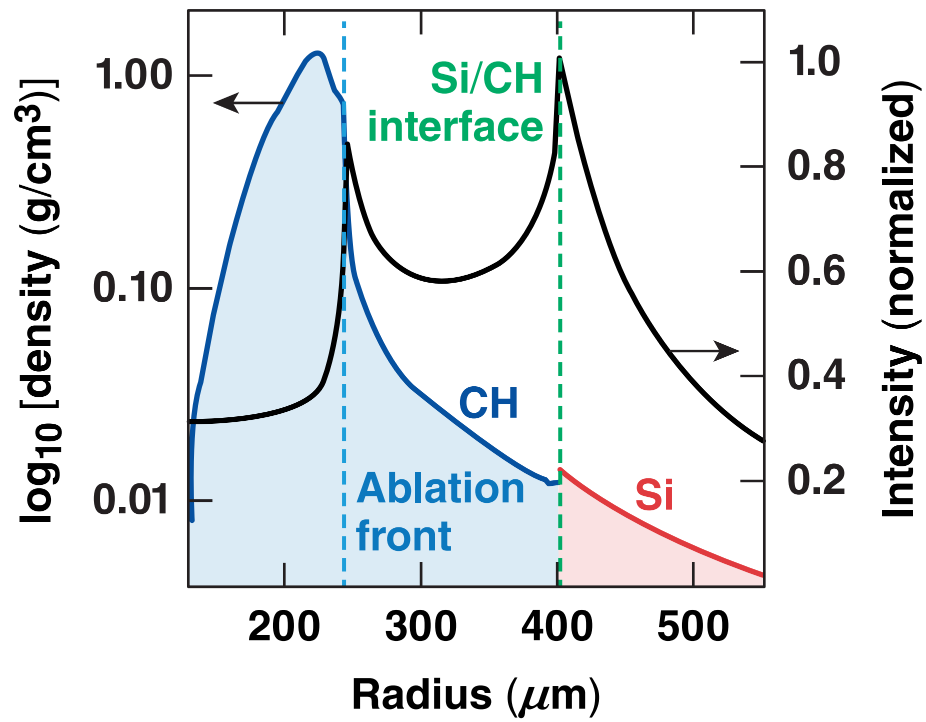


1-D *LILAC* simulation
Postprocessed with *Spect3D***



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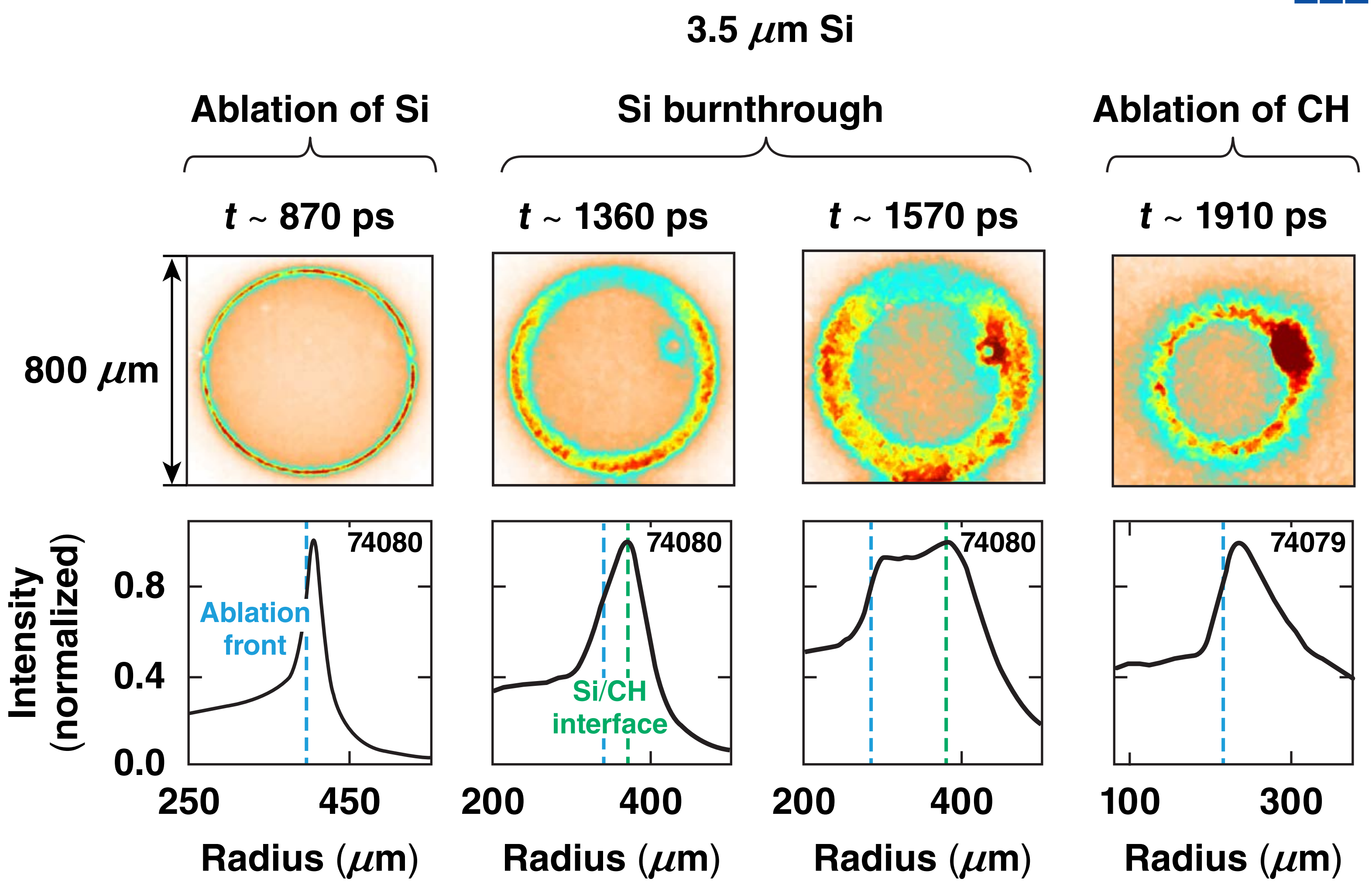
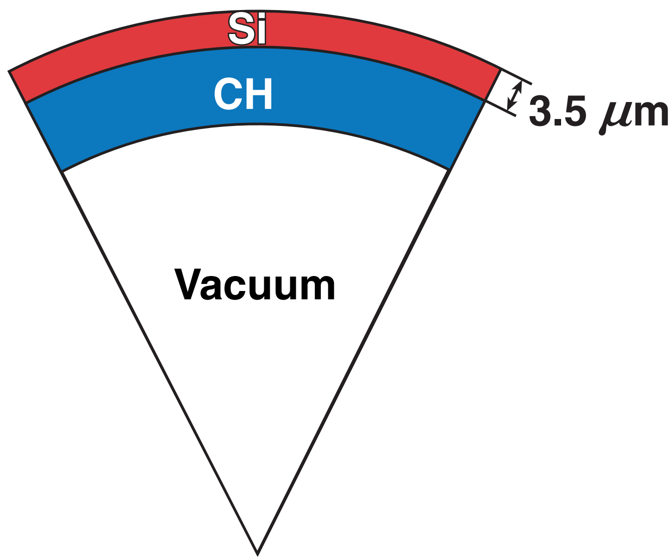
E23610c

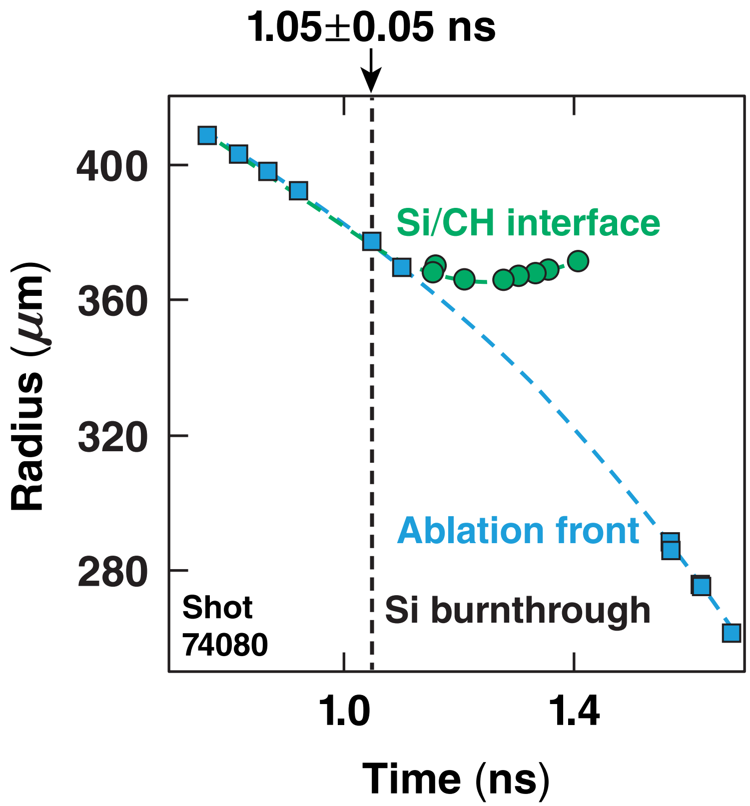
The positions of the ablation front and Si/CH interface were measured in a series of time-resolved x-ray framing camera (XRFC) images



E23586b

The Si burnthrough time corresponds to the divergence of the ablation front and Si/CH interface trajectories*





*A. K. Davis *et al*., Rev. Sci. Instrum. 85, 11D616 (2014).

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The average mass ablation rate was determined from the burnthrough times for four Si thicknesses

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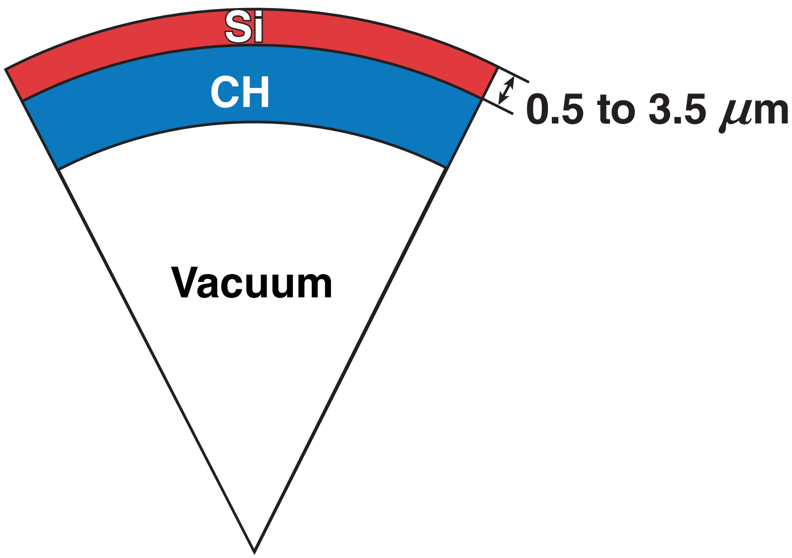
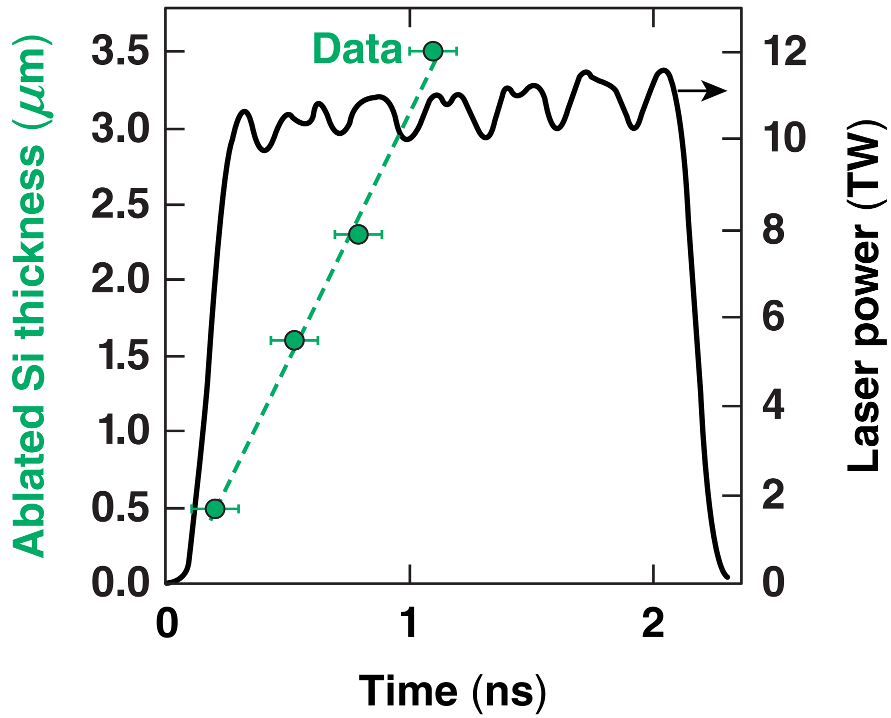
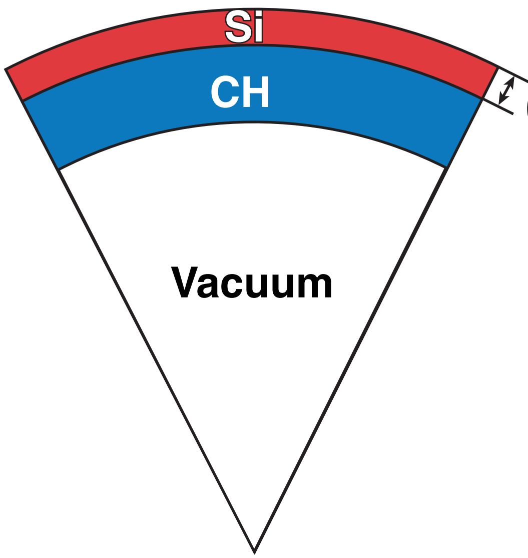


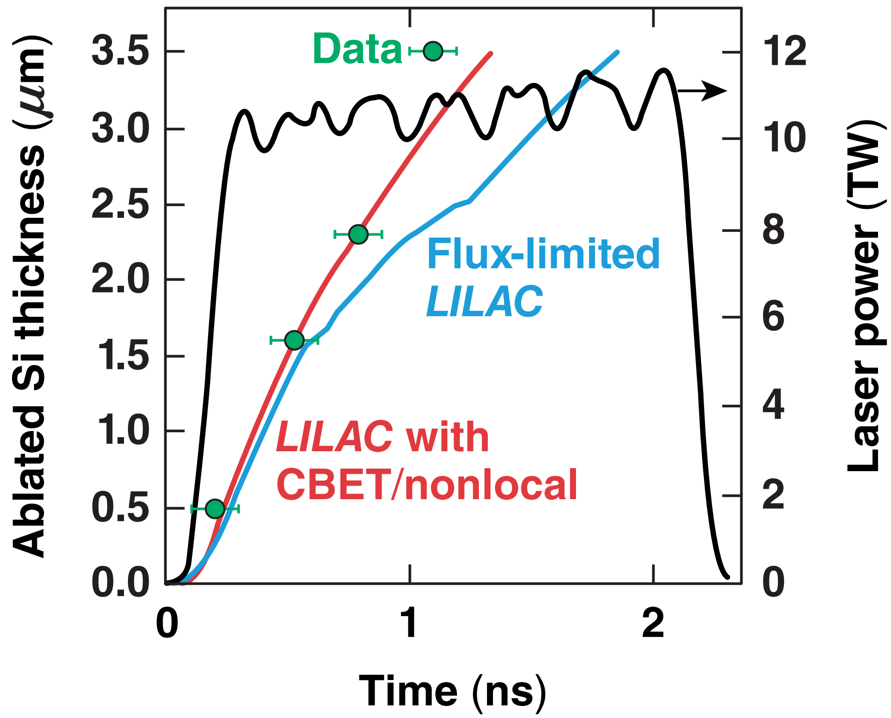


A rate of 73±15 μg/ns was calculated.

E23613

Simulations including models for CBET and nonlocal thermal transport are in good agreement with measured values





Simulations with a time-dependent flux limiter adapted to match the shell trajectory overpredict the mass and kinetic energy of the shell.

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Summary/Conclusions

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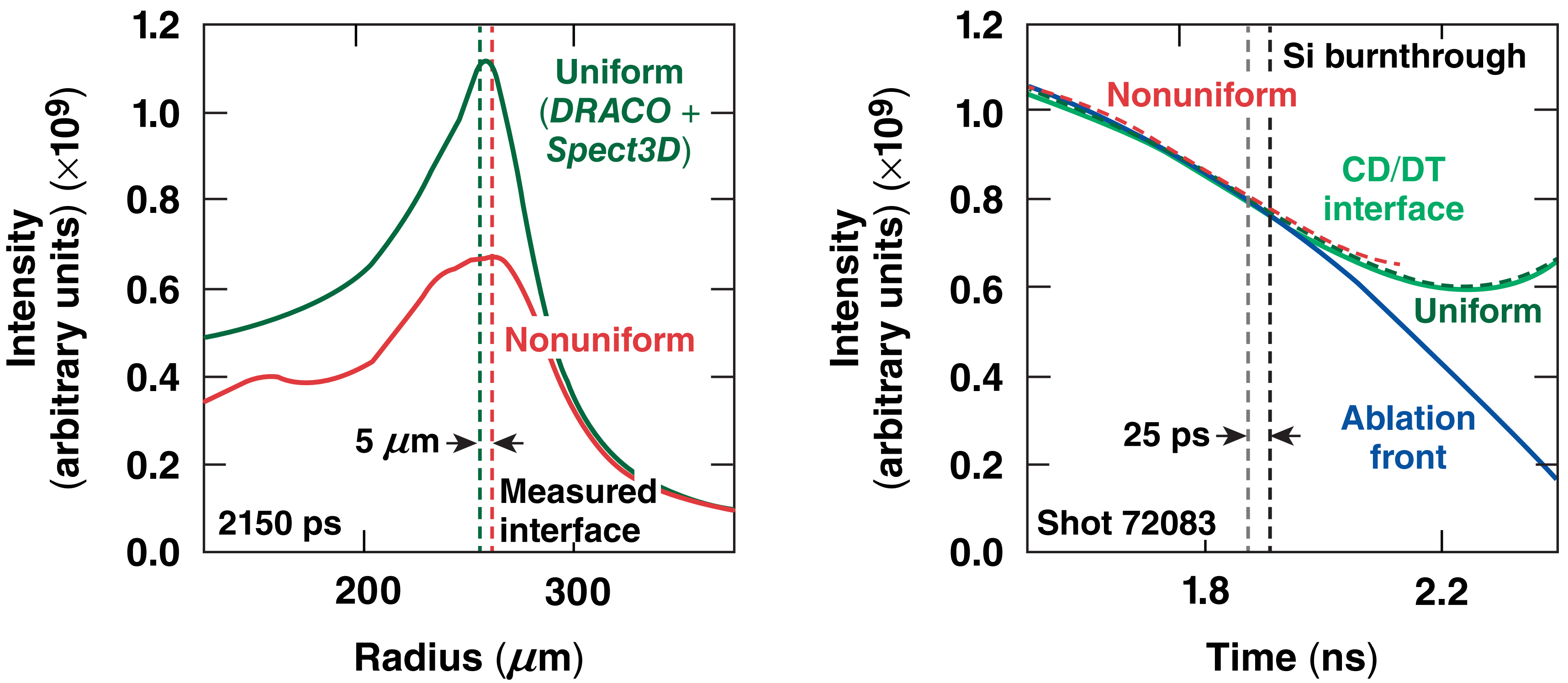
One-dimensional simulations that include models for cross-beam energy transfer (CBET) and nonlocal thermal transport agree well with measurements.

DRACO simulations of cryogenic implosions show that perturbations have a minimal impact on the measurement of the burnthrough time*



**DRACO* simulations were performed with and without perturbations seeded by target offset, DT ice roughness, and laser imprint up to mode 150.

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