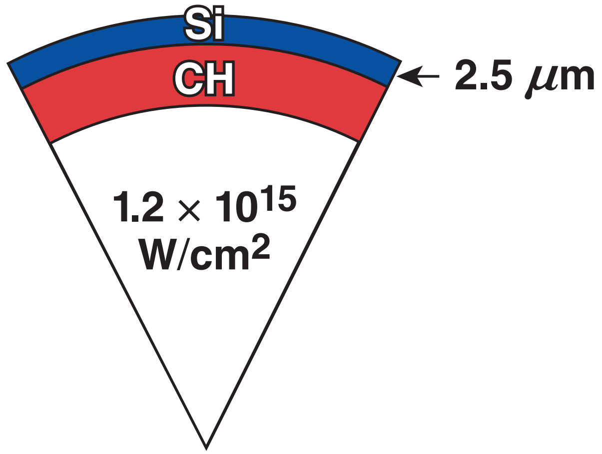
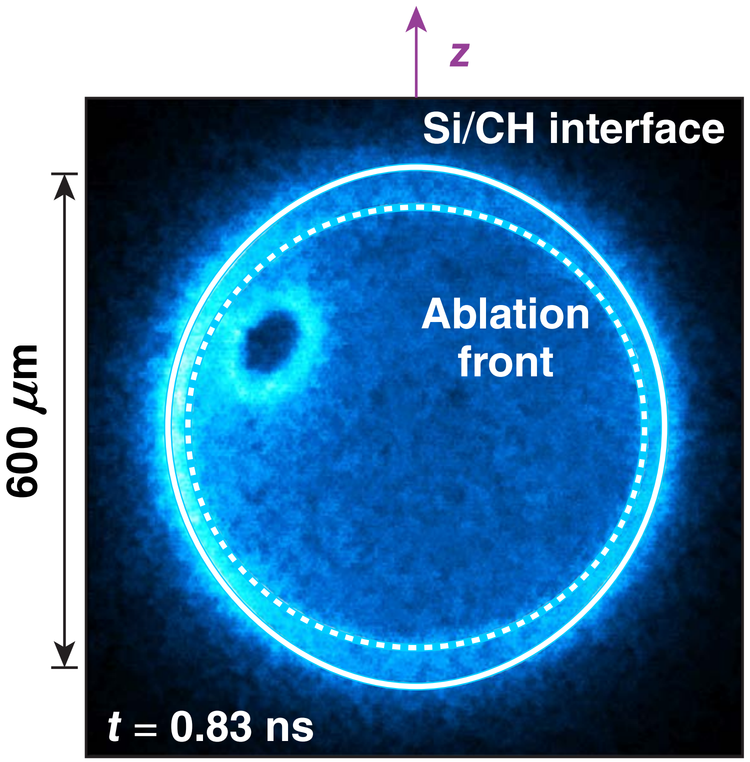
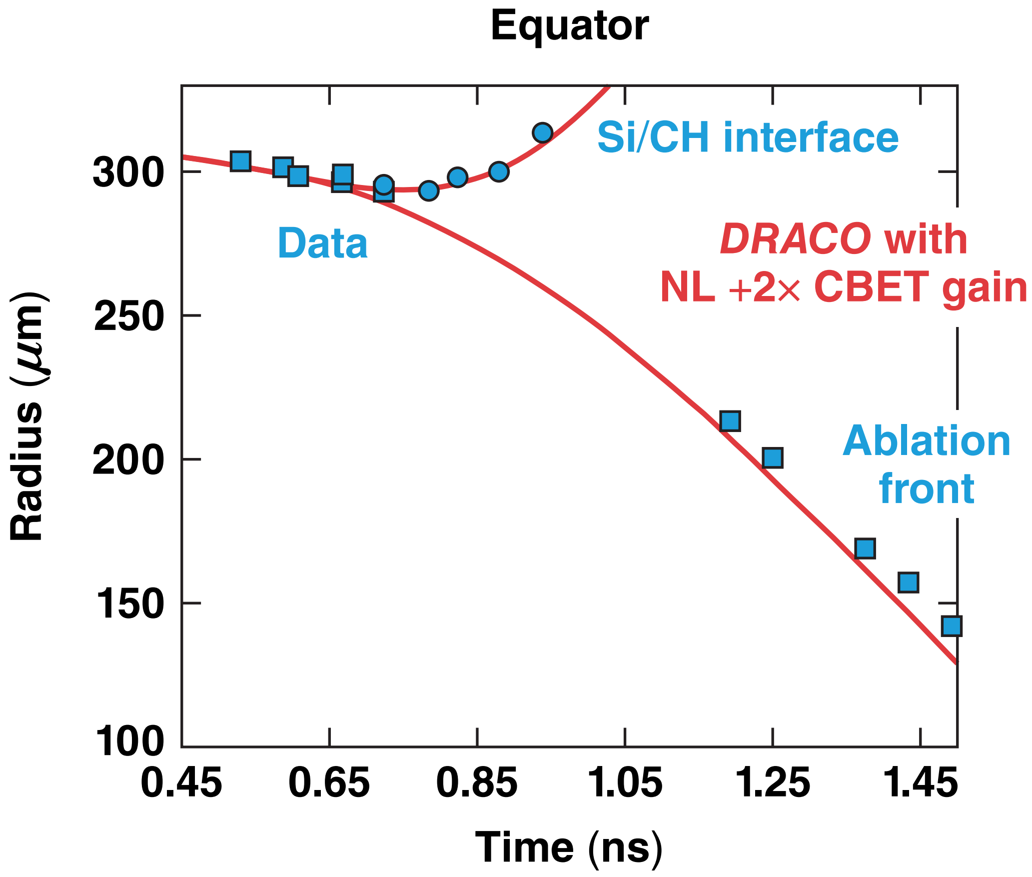
Quantifying the Growth of Cross-Beam Energy Transfer in Polar-Direct-Drive Implosions







A. K. Davis
University of Rochester
Laboratory for Laser Energetics

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Summary

Polar-direct-drive (PDD) implosions of Si-coated CH targets are used to benchmark the 2-D cross-beam energy transfer model in *DRACO*

- Self-emission images were used to measure the mass ablation rate and shell velocity in symmetric experiments to distinguish between thermal transport models in hydrodynamic simulations
- Angularly resolved measurements in PDD experiments were used to isolate the effect of cross-beam energy transport (CBET) on the laser-energy coupling
- A multiplier of two on the CBET gain calculated by the current model in the hydrodynamic code *DRACO* was required to match the experimental mass ablation rate and shell trajectory

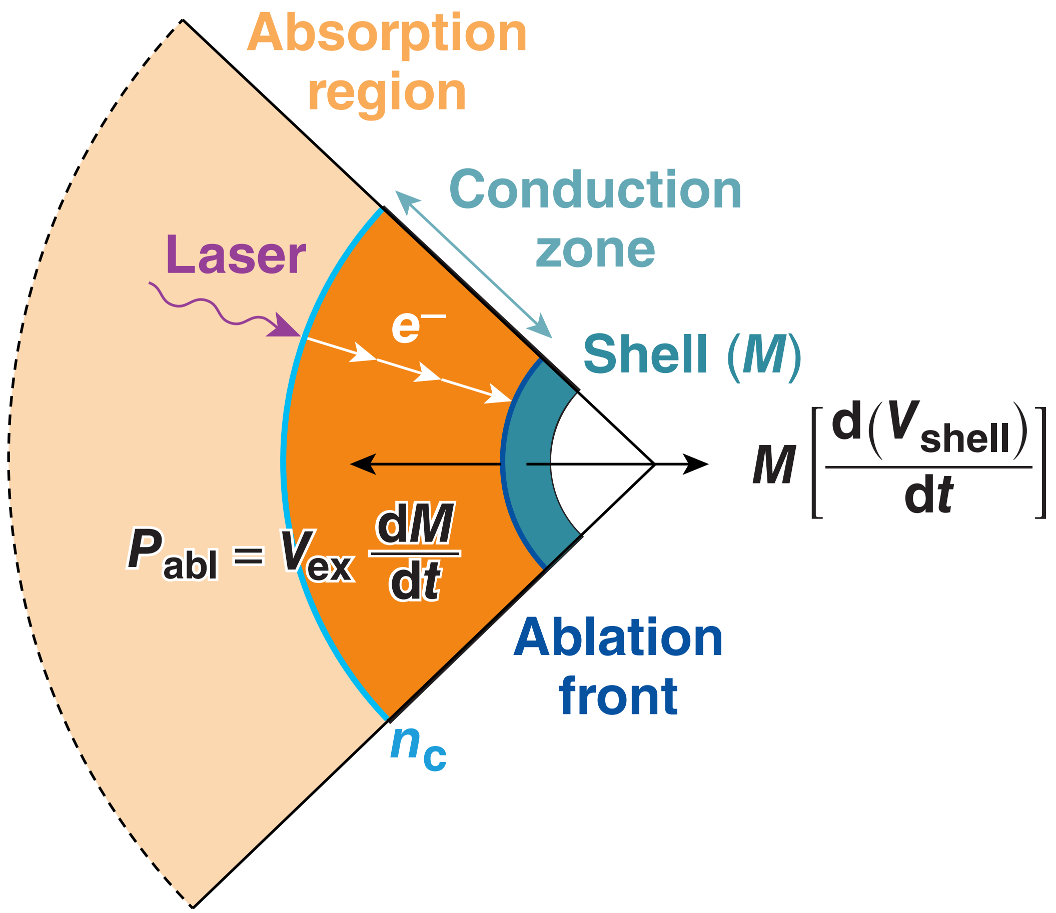
E24175

Collaborators

D. Cao, D. T. Michel, R. Epstein, V. N. Goncharov, S. X. Hu,
I. V. Igumenshchev, M. Lafon, J. A. Marozas, D. D. Meyerhofer,
P. B. Radha, T. C. Sangster, and D. H. Froula

University of Rochester
Laboratory for Laser Energetics

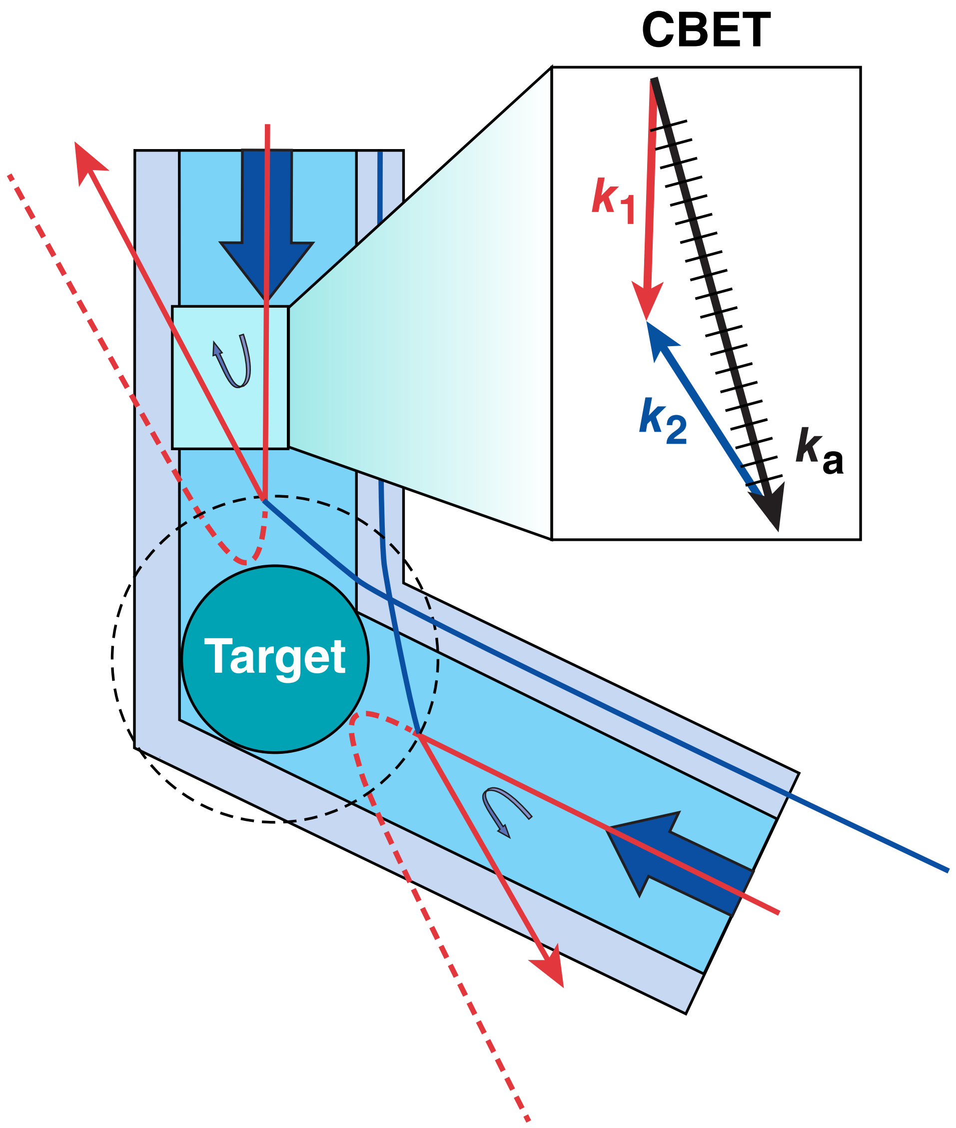
Direct-drive inertial confinement fusion implosions are driven by laser energy absorbed near the critical density and transported by electrons to the ablation surface

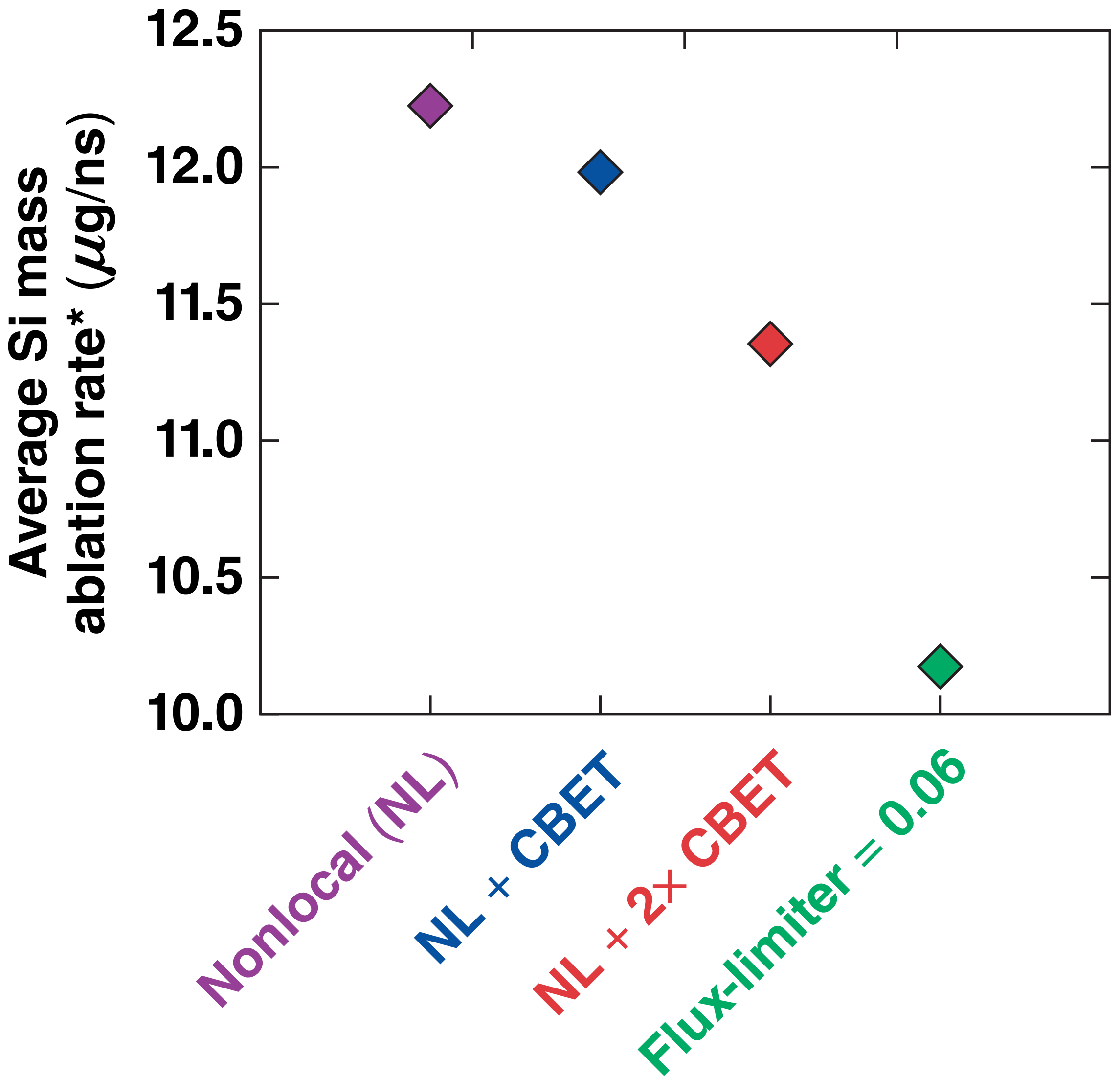


Measurements of the shell trajectory (V_{shell}) and mass ablation rate (dM/dt) constrain the coupling physics.

E23609a

Cross-beam energy transfer significantly degrades the coupling of laser energy to the target

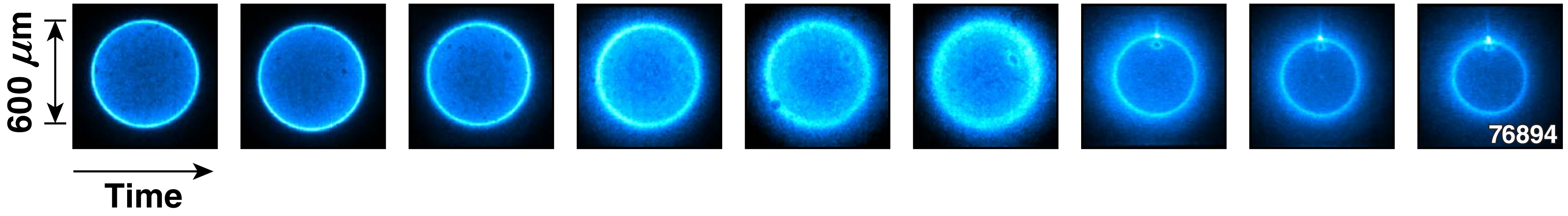


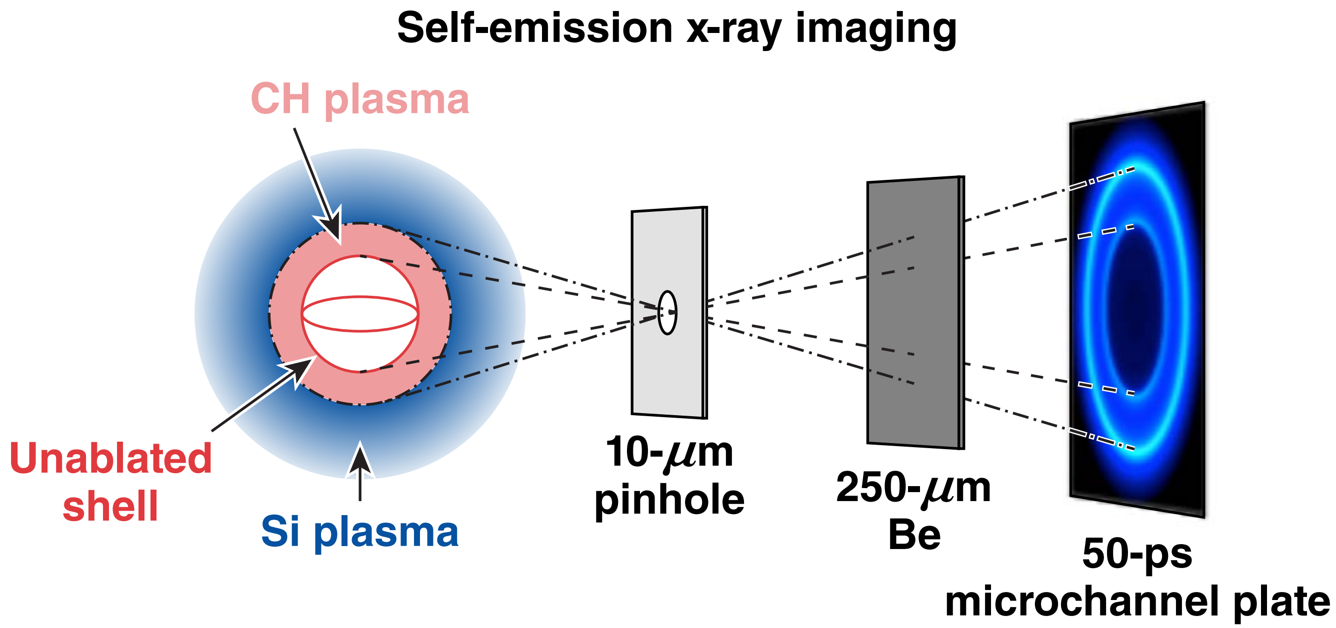


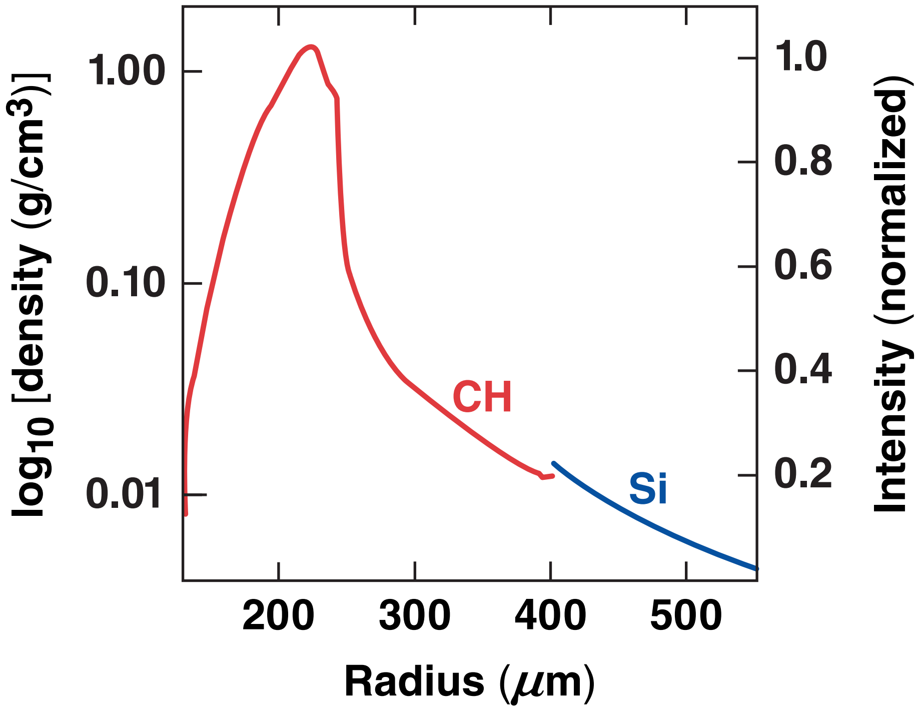
*$I = 6 \times 10^{14}$ W/cm^2

E23041j

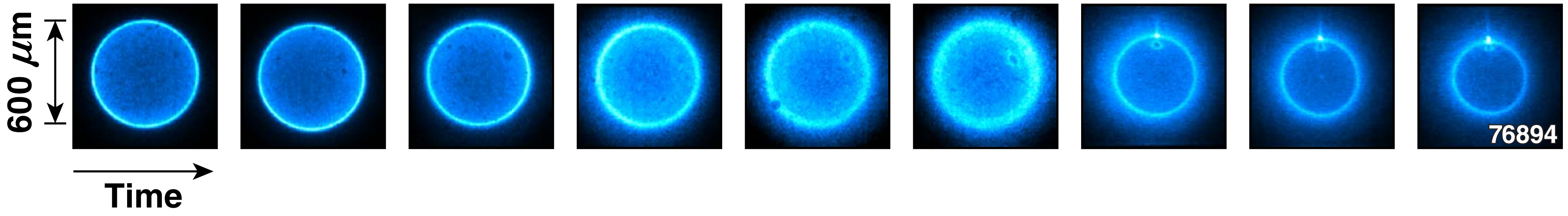
X-ray self-emission images were used to measure the mass ablation rate of the Si and the trajectory of the shell

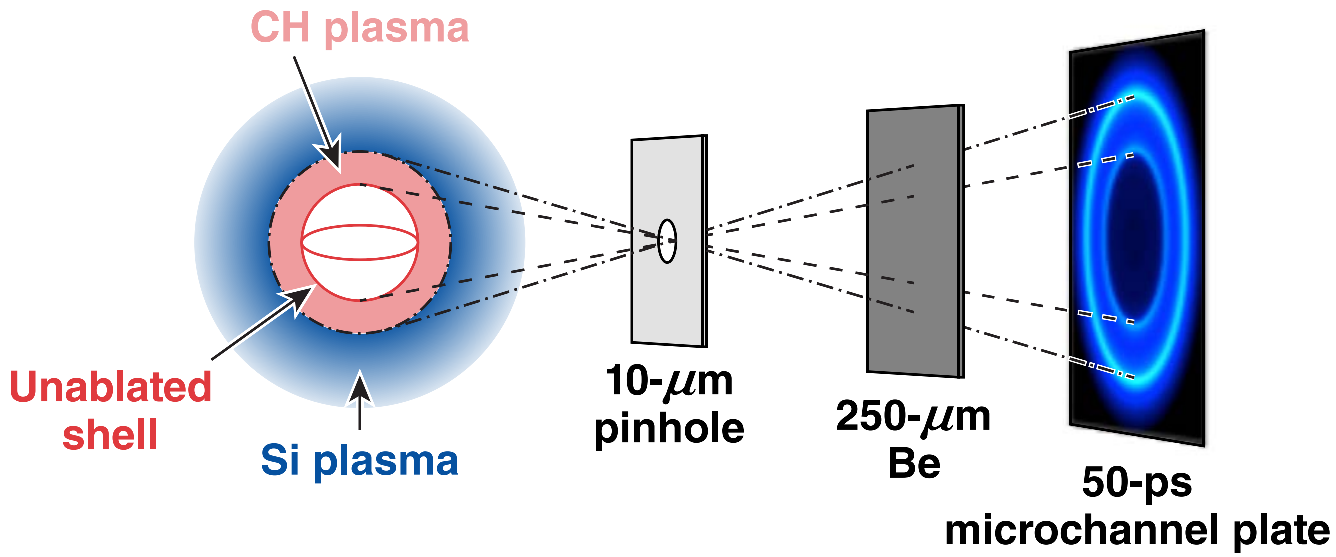


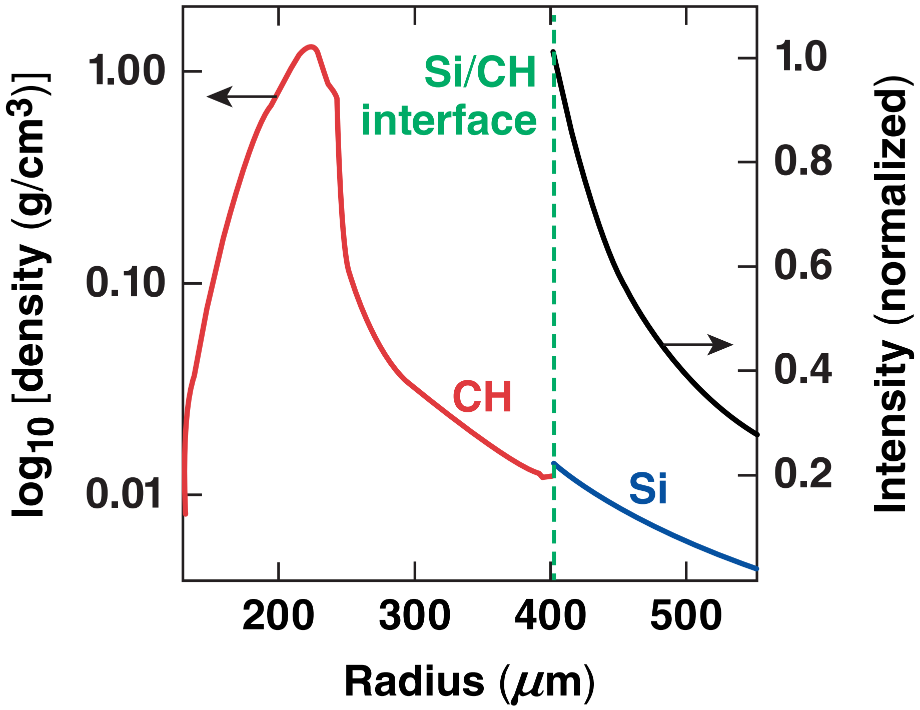




X-ray self-emission images were used to measure the mass ablation rate of the Si and the trajectory of the shell

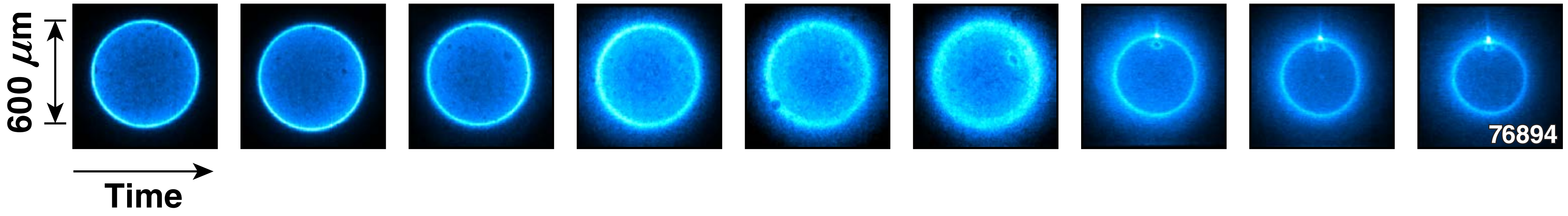


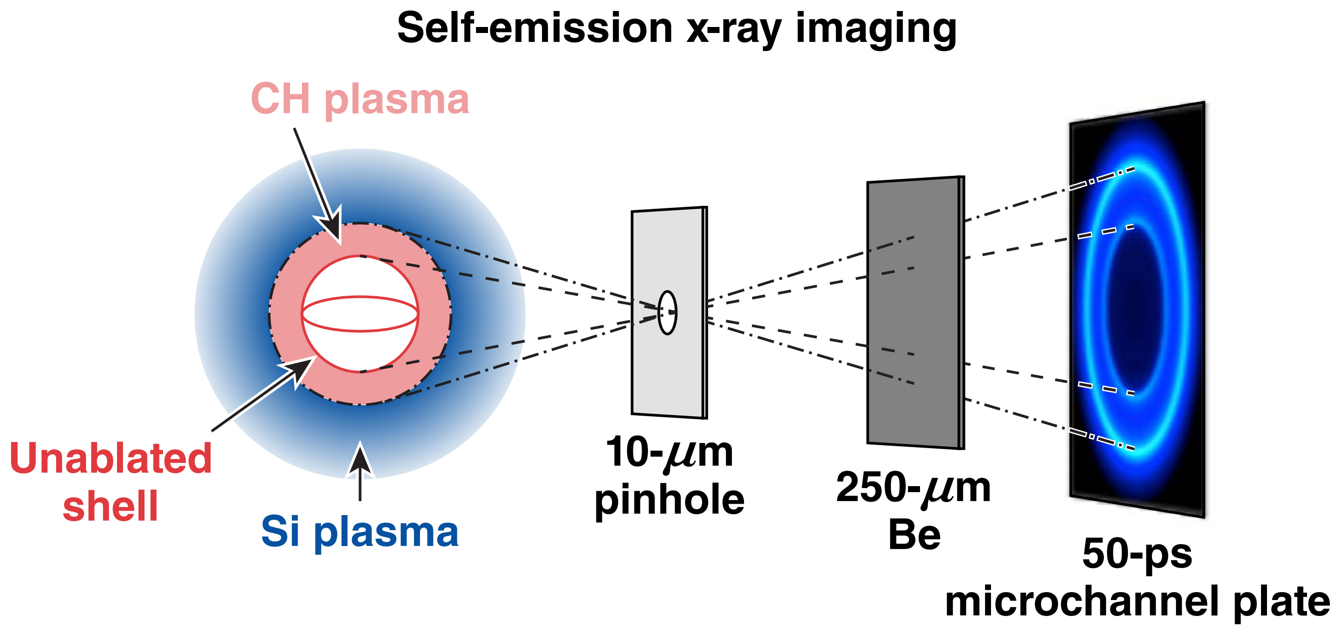


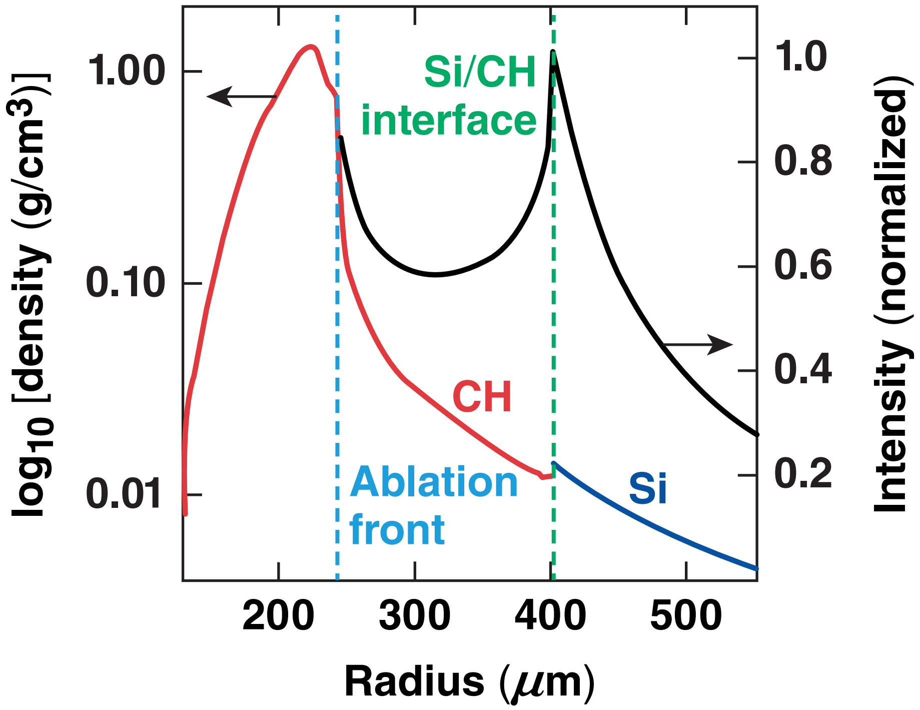


E24176a

X-ray self-emission images were used to measure the mass ablation rate of the Si and the trajectory of the shell







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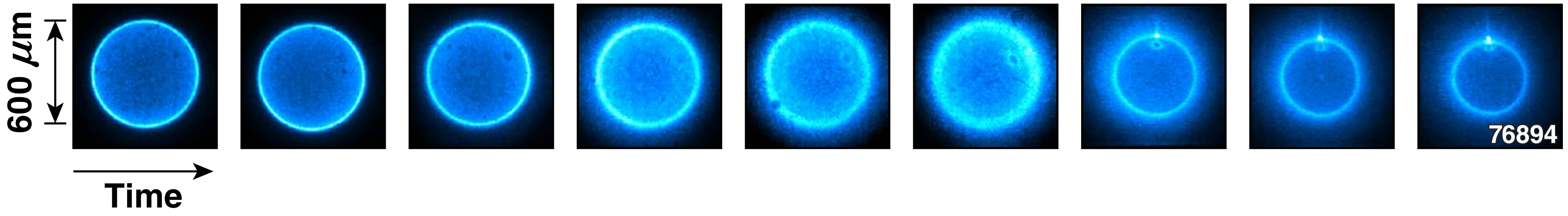
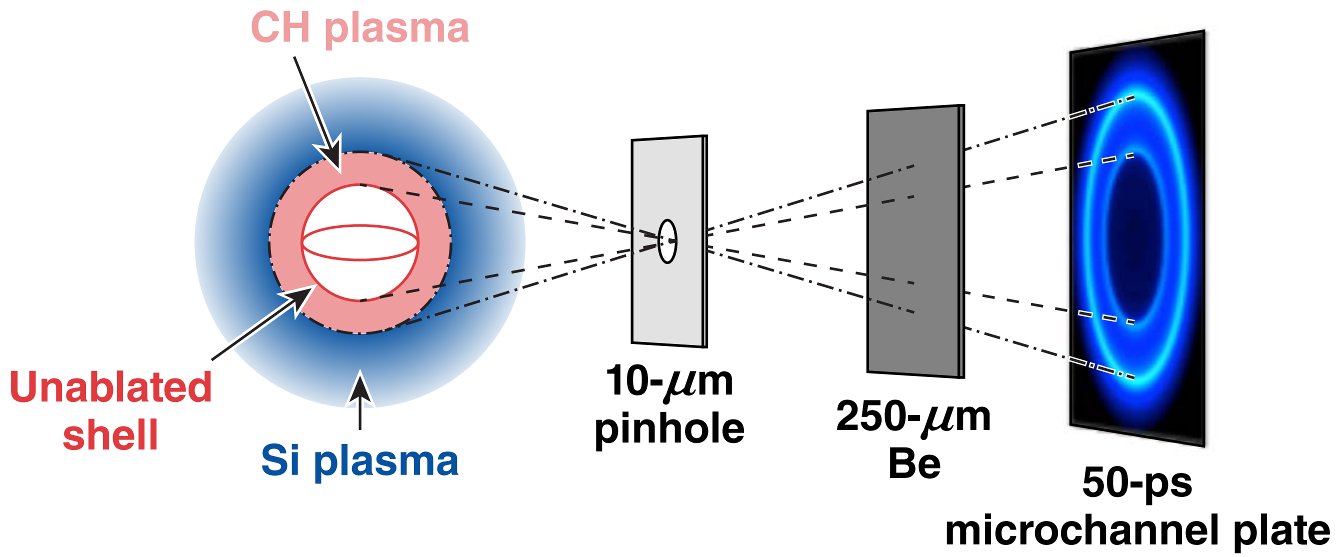
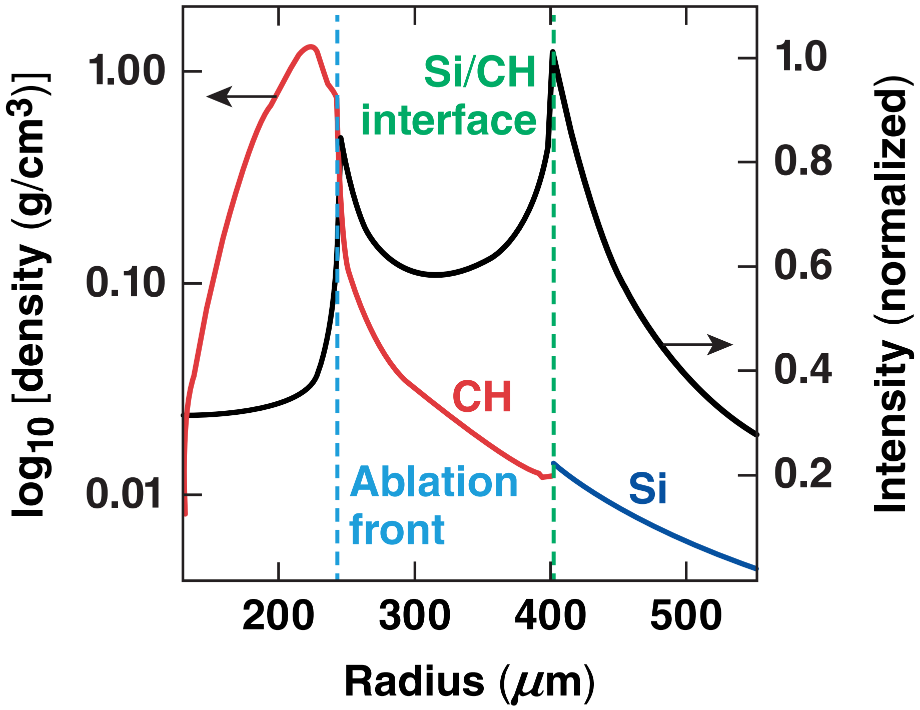
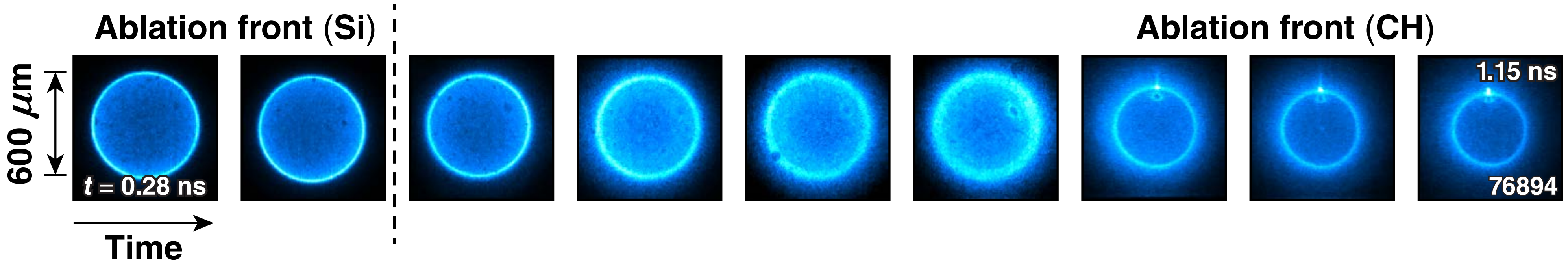


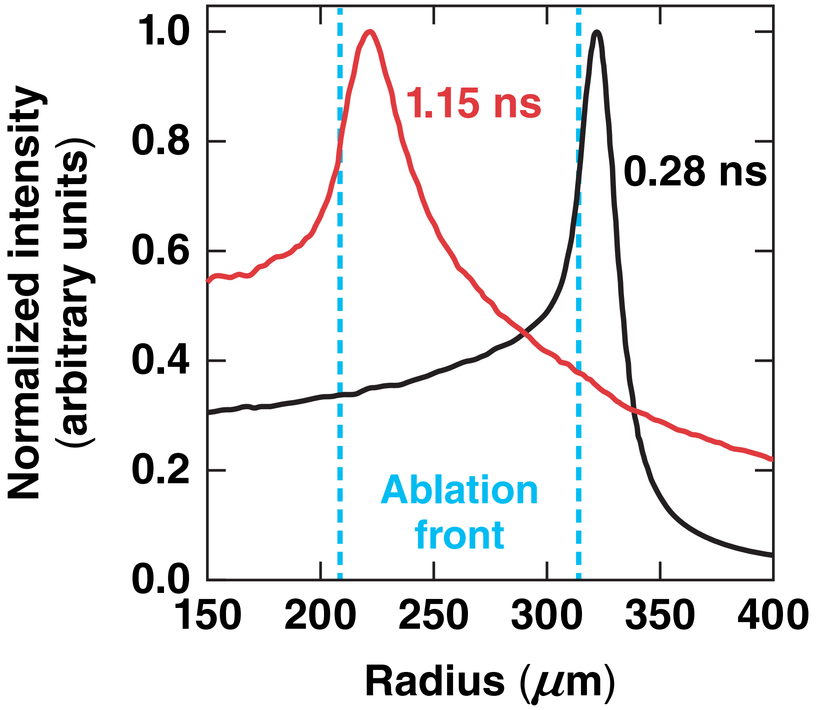


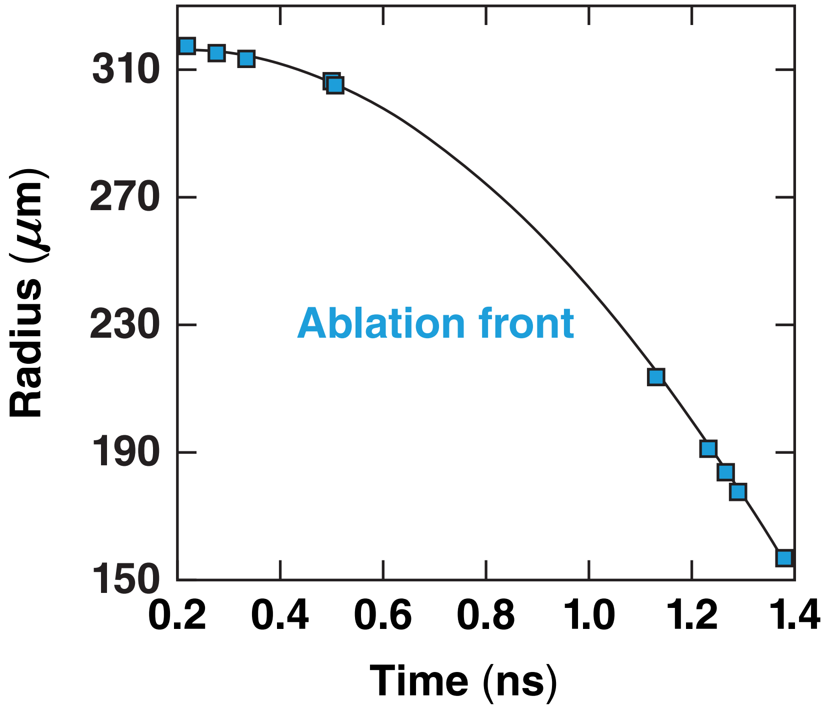


E24176c

The ablation front trajectory was measured in a series of time-resolved images

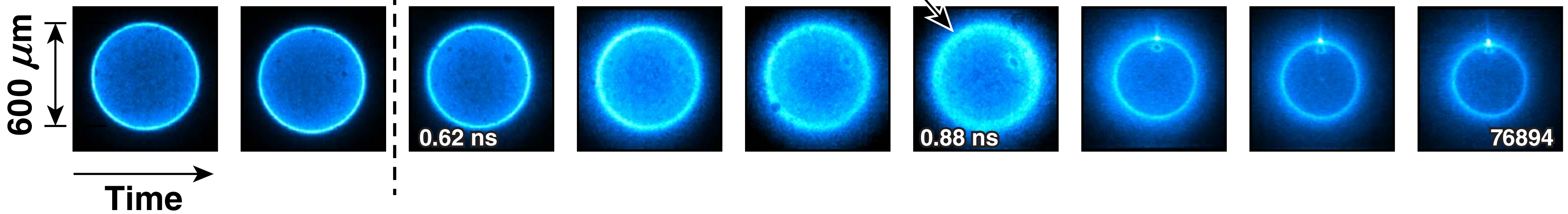


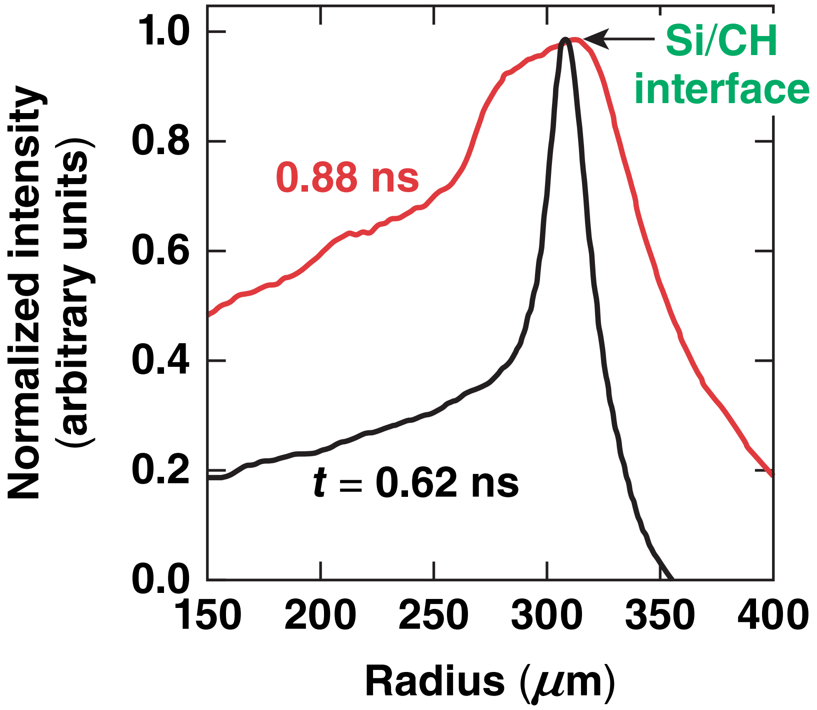


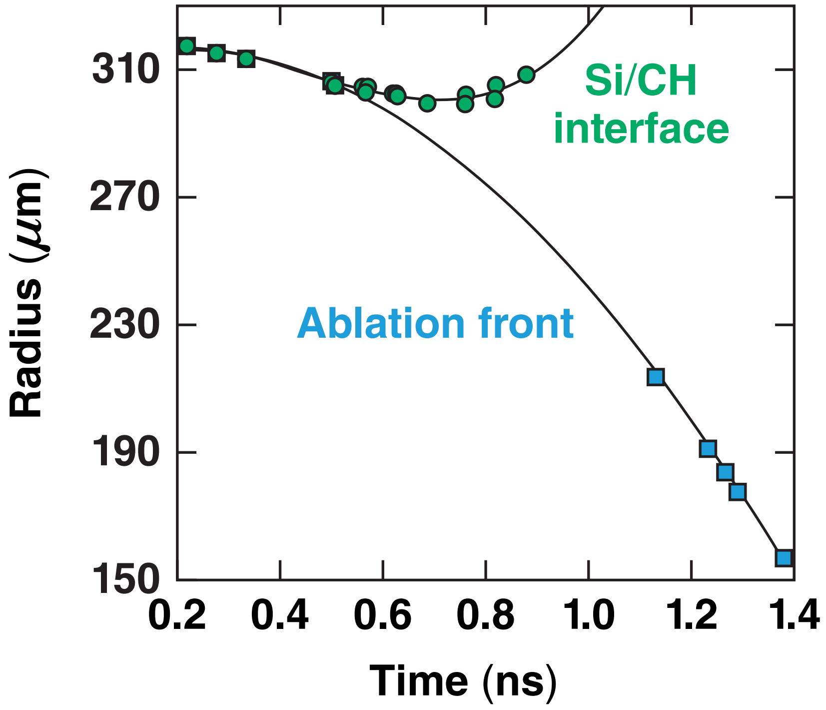


E24177

The Si/CH interface trajectory was measured in a series of time-resolved images

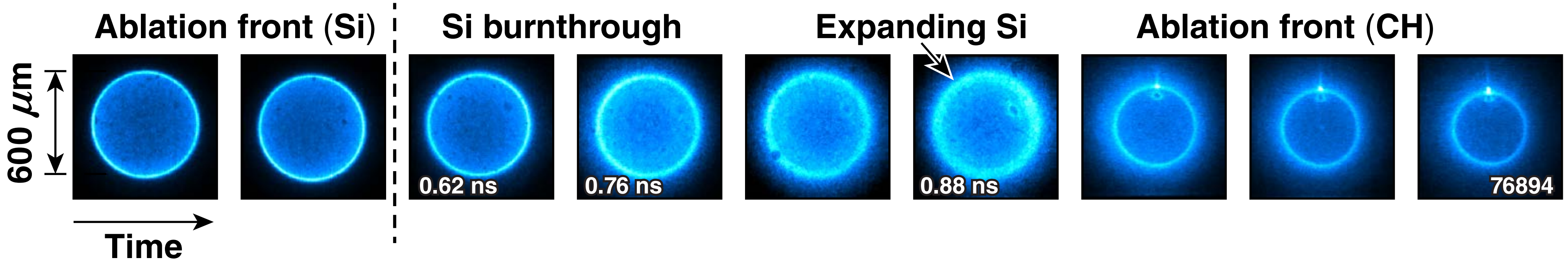


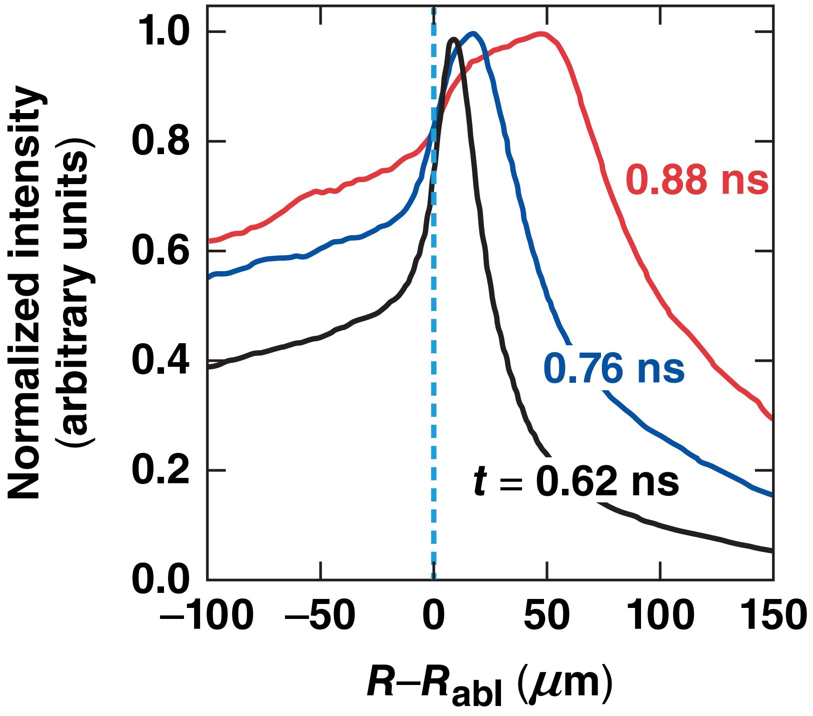


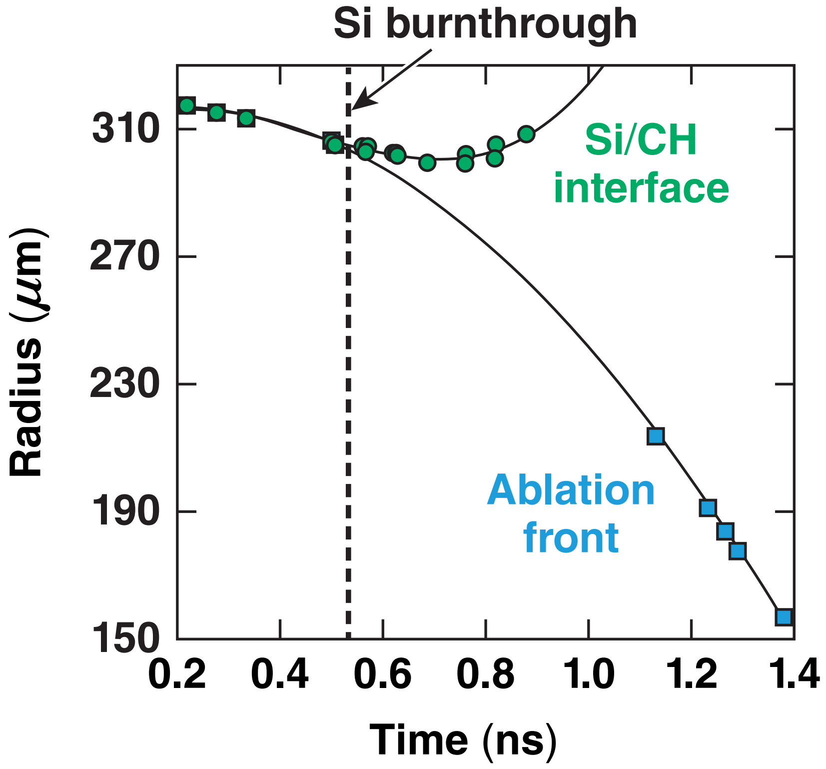


E24178

The Si/CH interface trajectory was measured in a series of time-resolved images



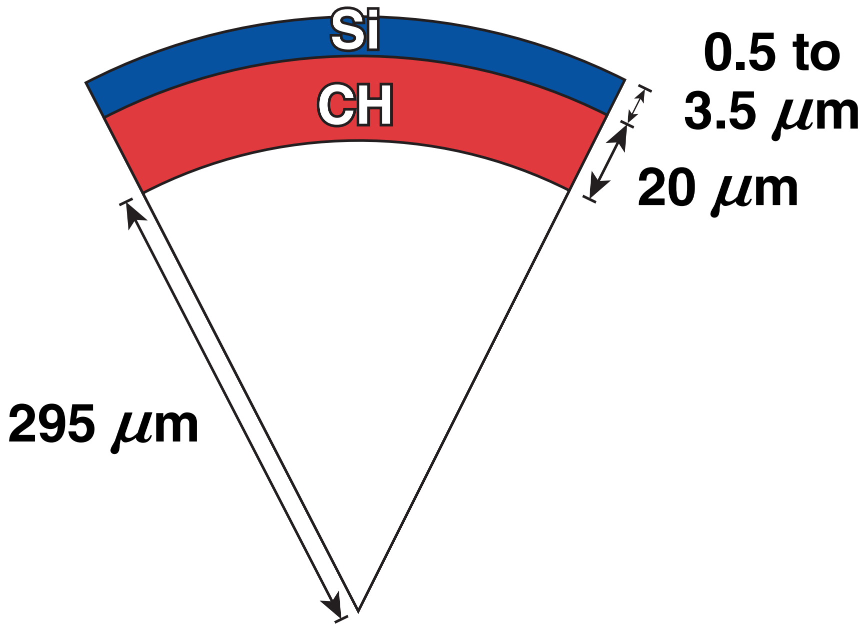


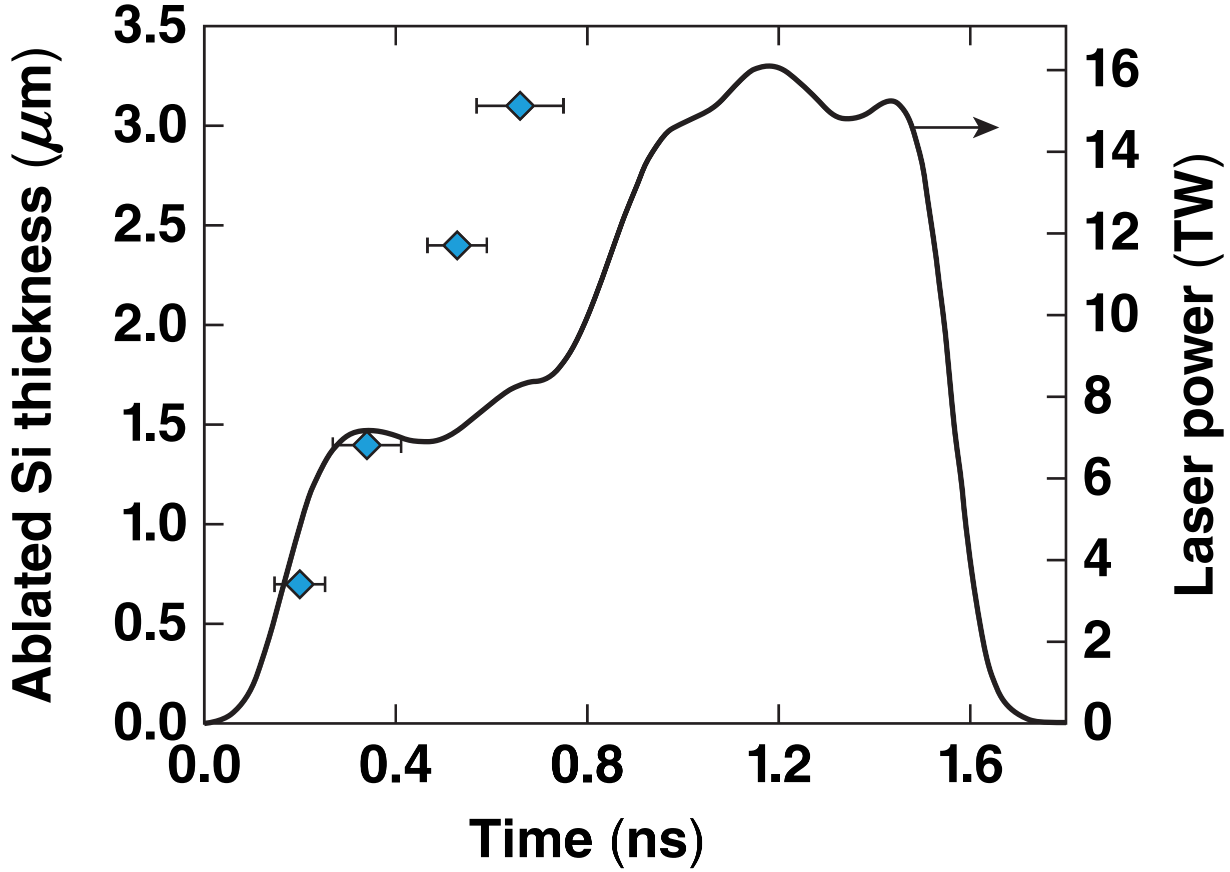


The time that the laser burns through the Si is determined from the time when the interface (outer peak) and ablation front (inner peak) separate.

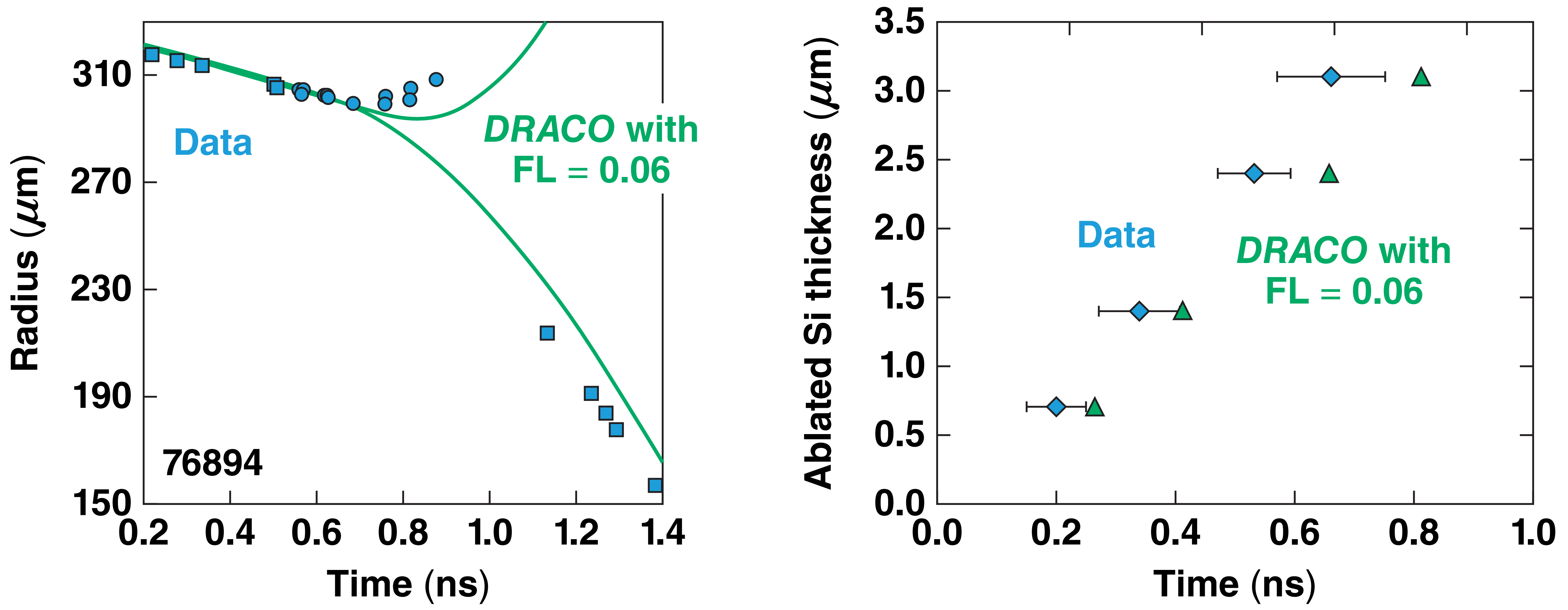
E24179

The time-resolved mass ablation rate was determined by varying the Si thickness





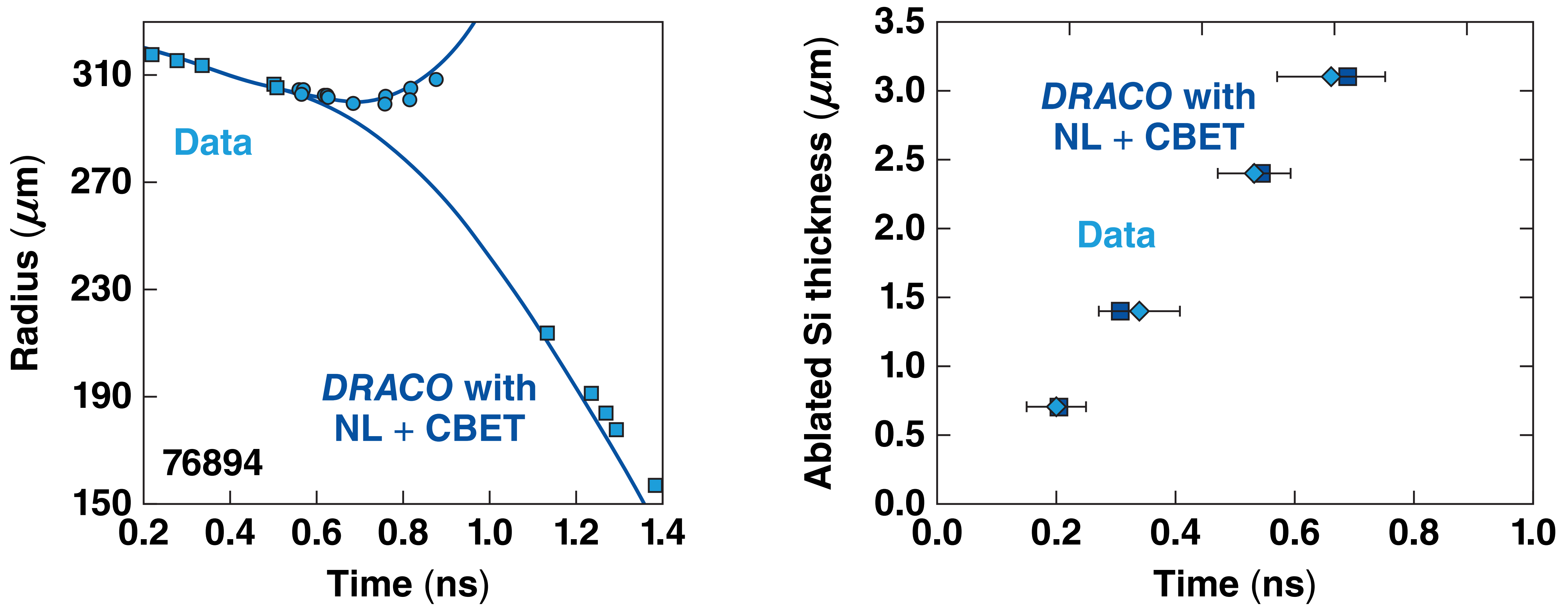
These measurements were used to distinguish between thermal transport models



The flux-limited (FL = 0.06) model predicts a slower shell velocity and lower mass ablation rate than measured.

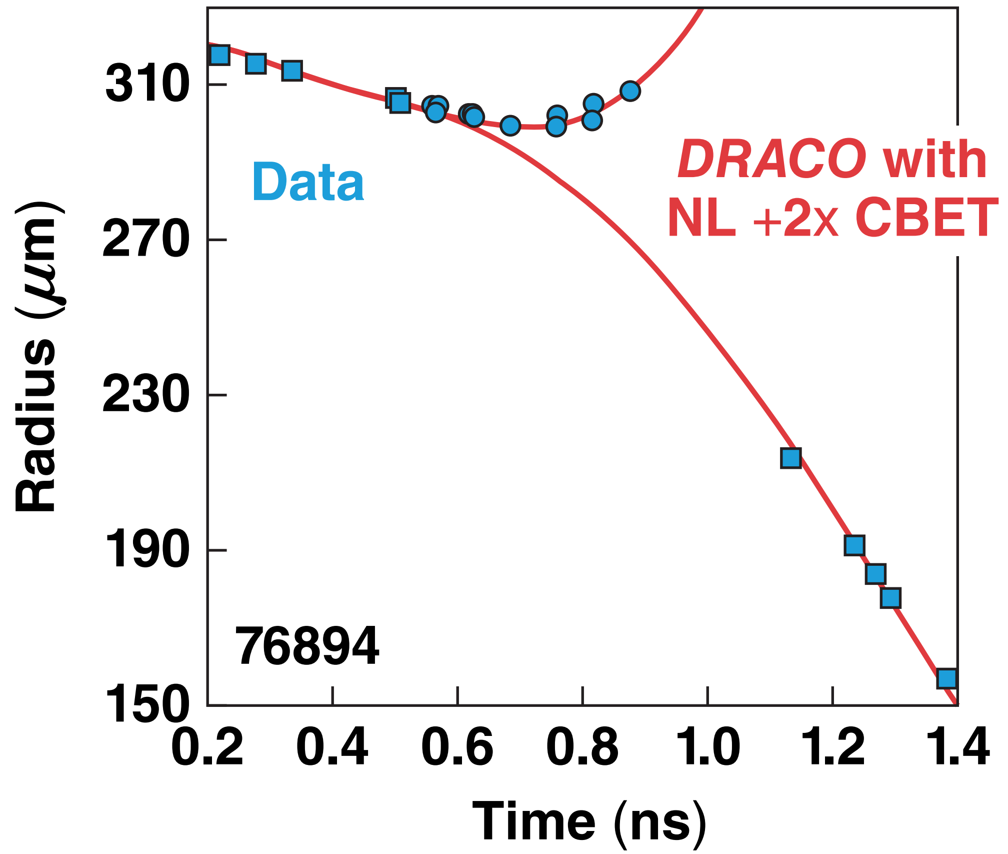
E24181

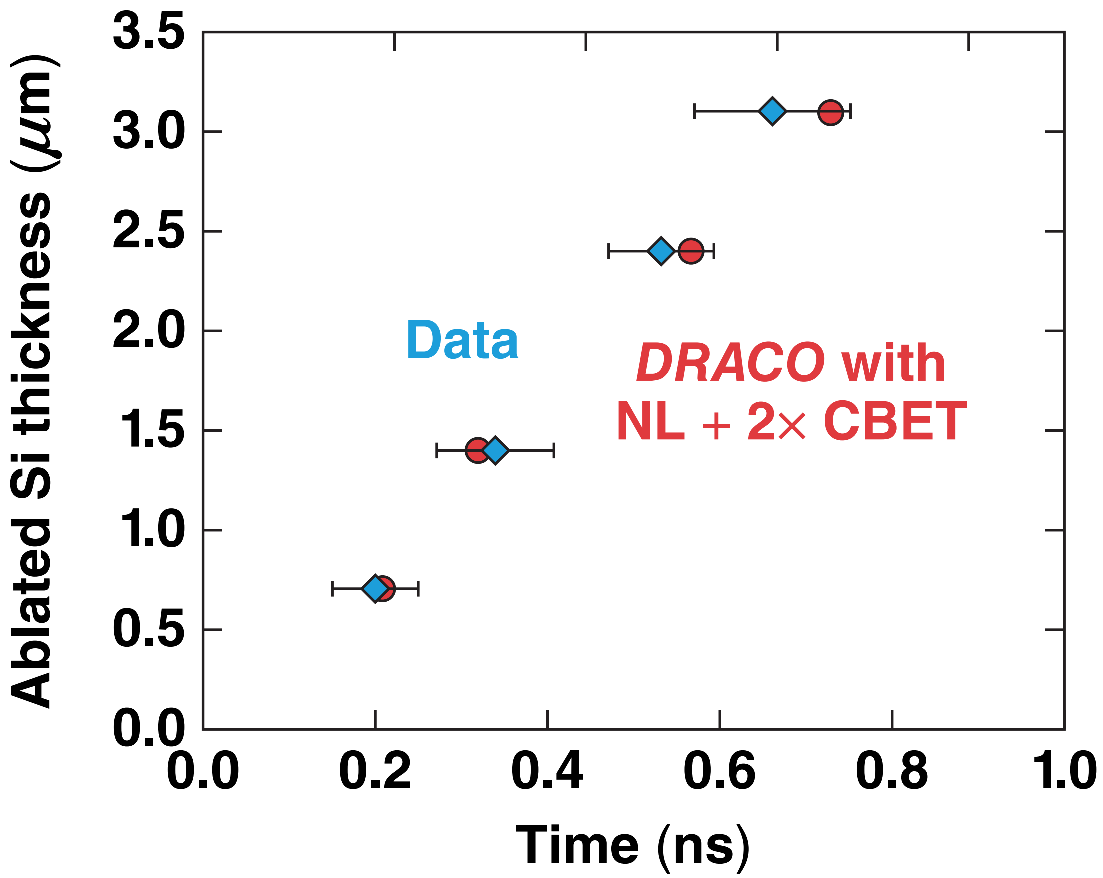
The simulation that includes models for nonlocal electron thermal transport and CBET predicts the mass ablation rate well but suggests a faster shell velocity than was measured



E24182

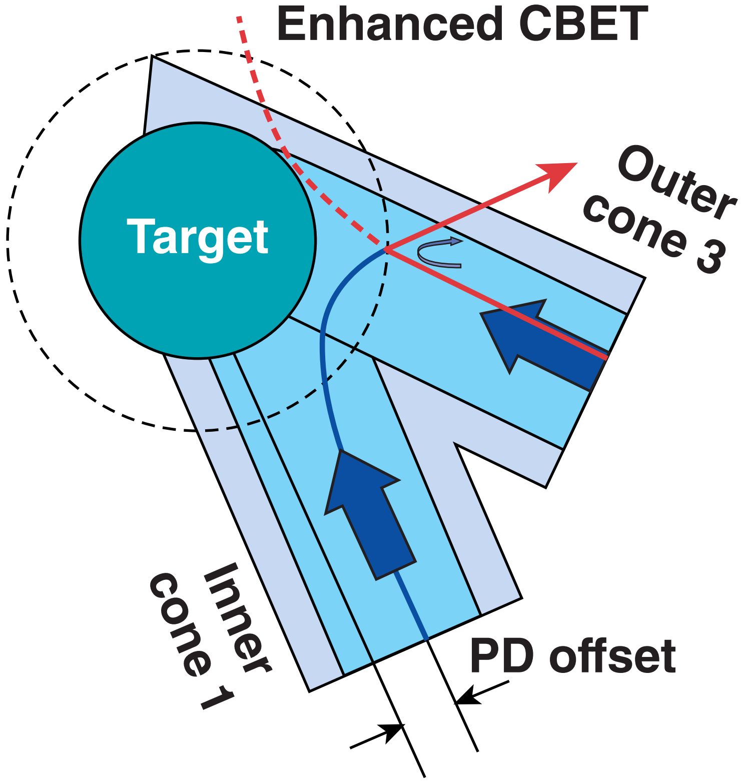
A multiplier of two on the CBET gain improves the agreement with measured trajectories

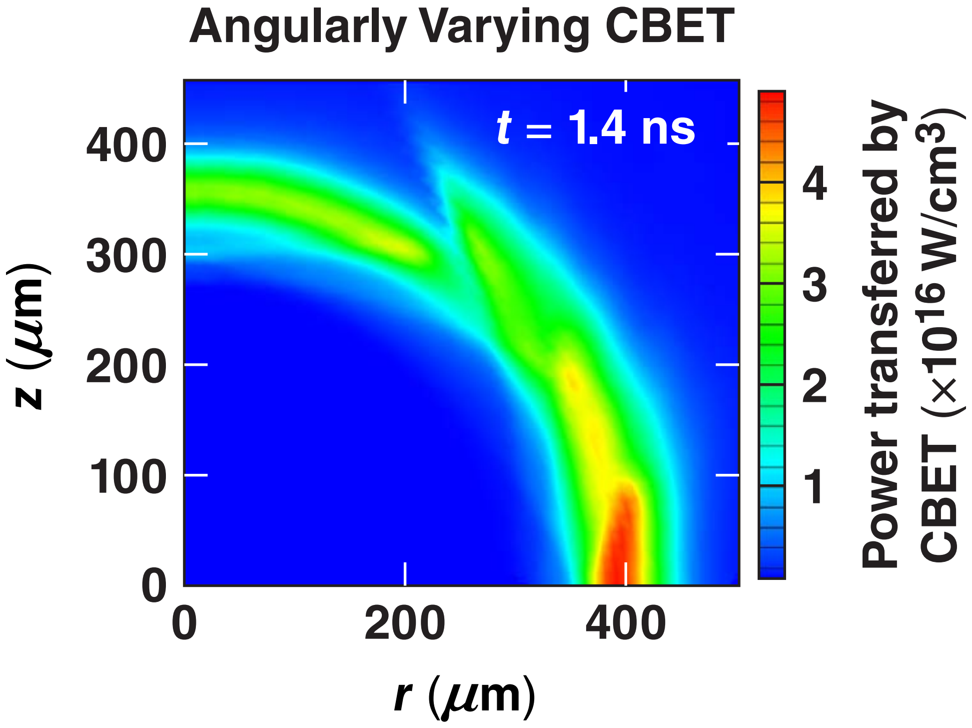


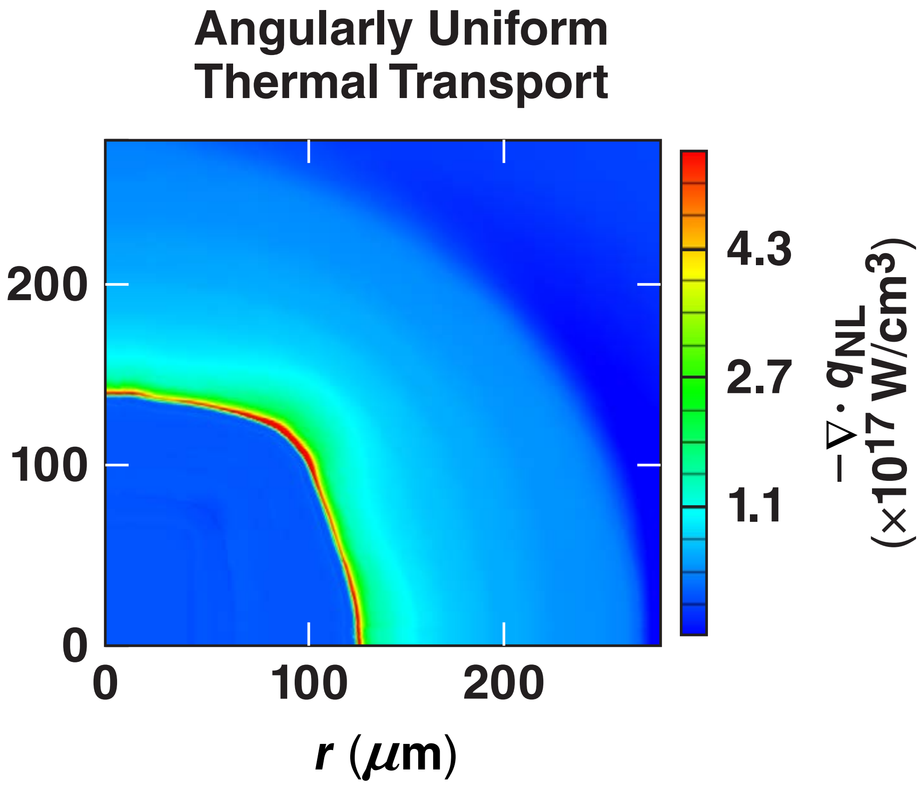


An adjustment to the nonlocal model might provide similar improvement.

PDD allows CBET and thermal transport physics to be evaluated independently



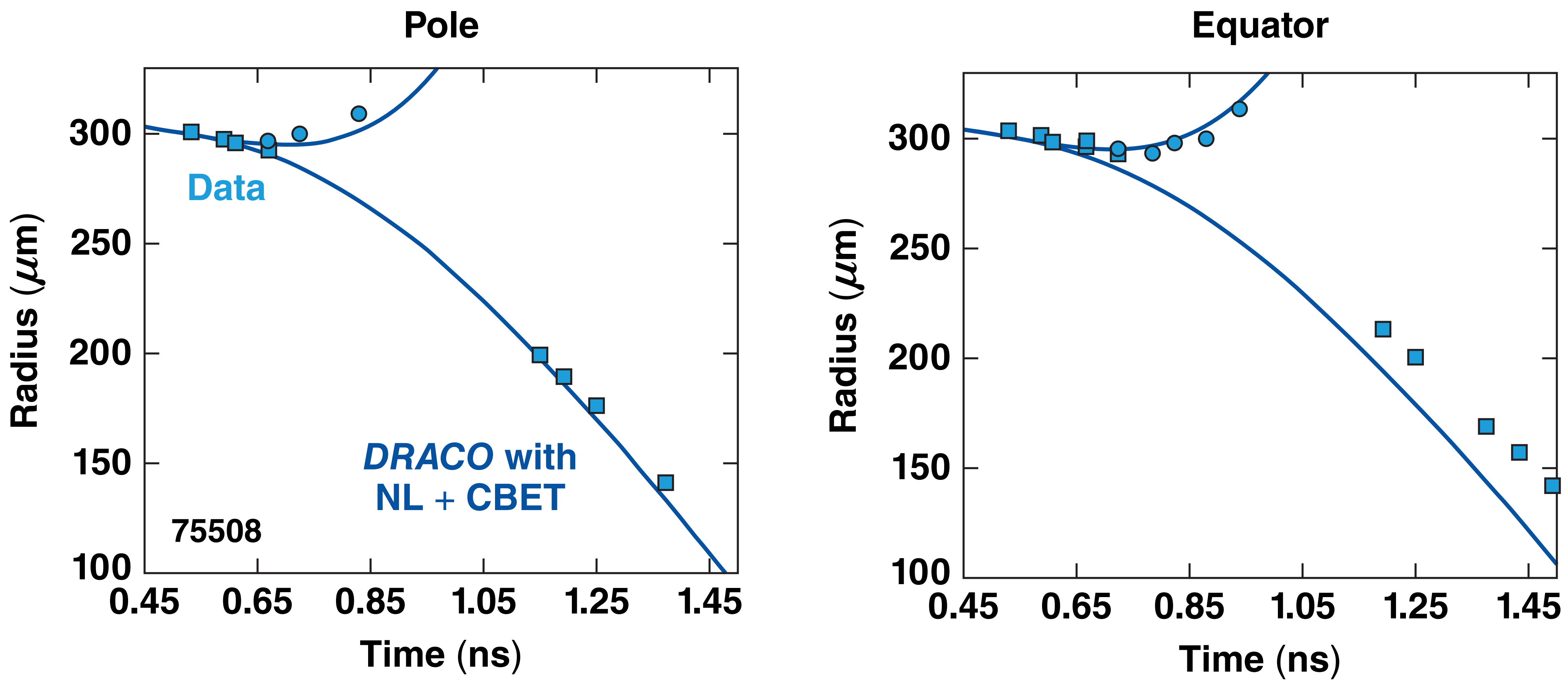




CBET primarily affects drive at the equator, while thermal transport influences drive similarly at all angles.

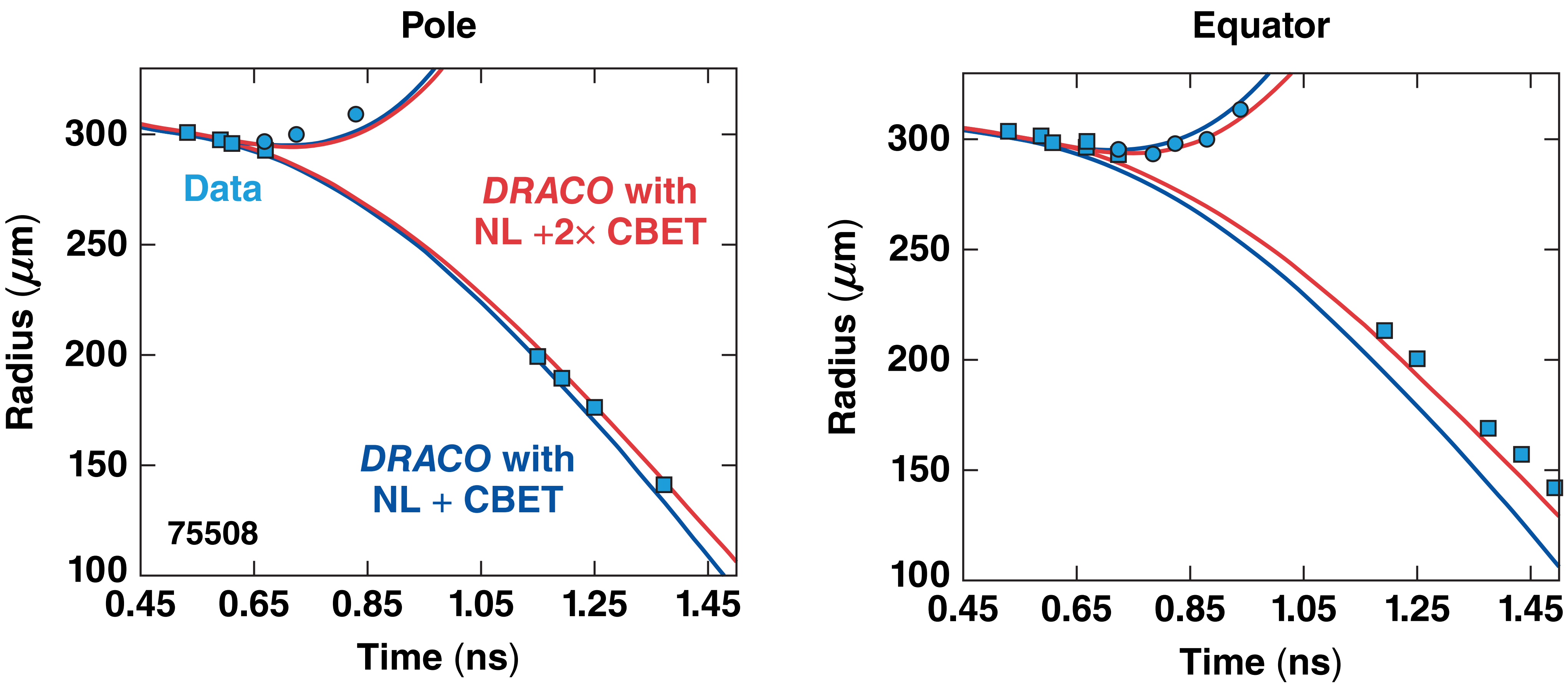
E21272b

The simulation including NL and CBET models shows good agreement with measurements at the pole but overpredicts the drive at the equator



E24184

The simulated trajectories are in good agreement with the measurements when the CBET gain was multiplied by a factor of 2



E24184a

Polar-direct-drive (PDD) implosions of Si-coated CH targets are used to benchmark the 2-D cross-beam energy transfer model in *DRACO*

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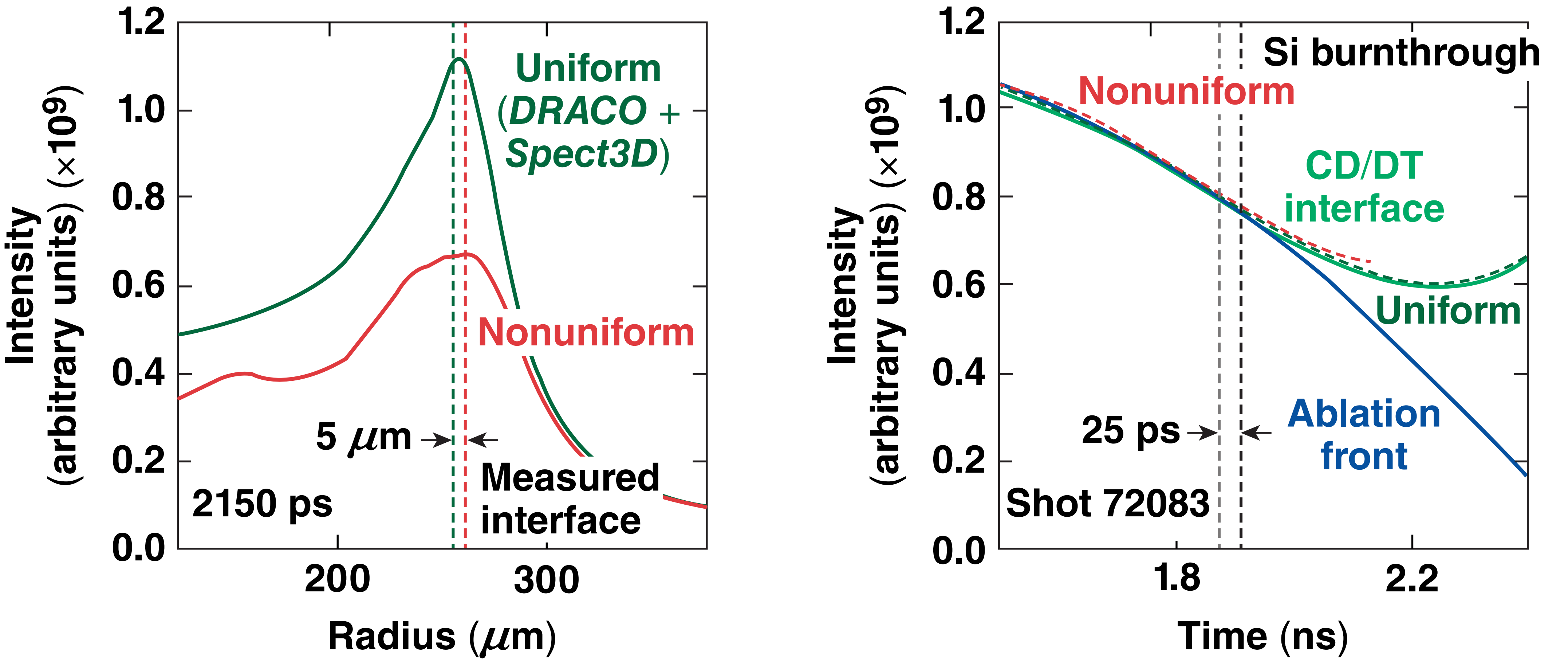
- A multiplier of two on the CBET gain calculated by the current model in the hydrodynamic code *DRACO* was required to match the experimental mass ablation rate and shell trajectory

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.

E23157c