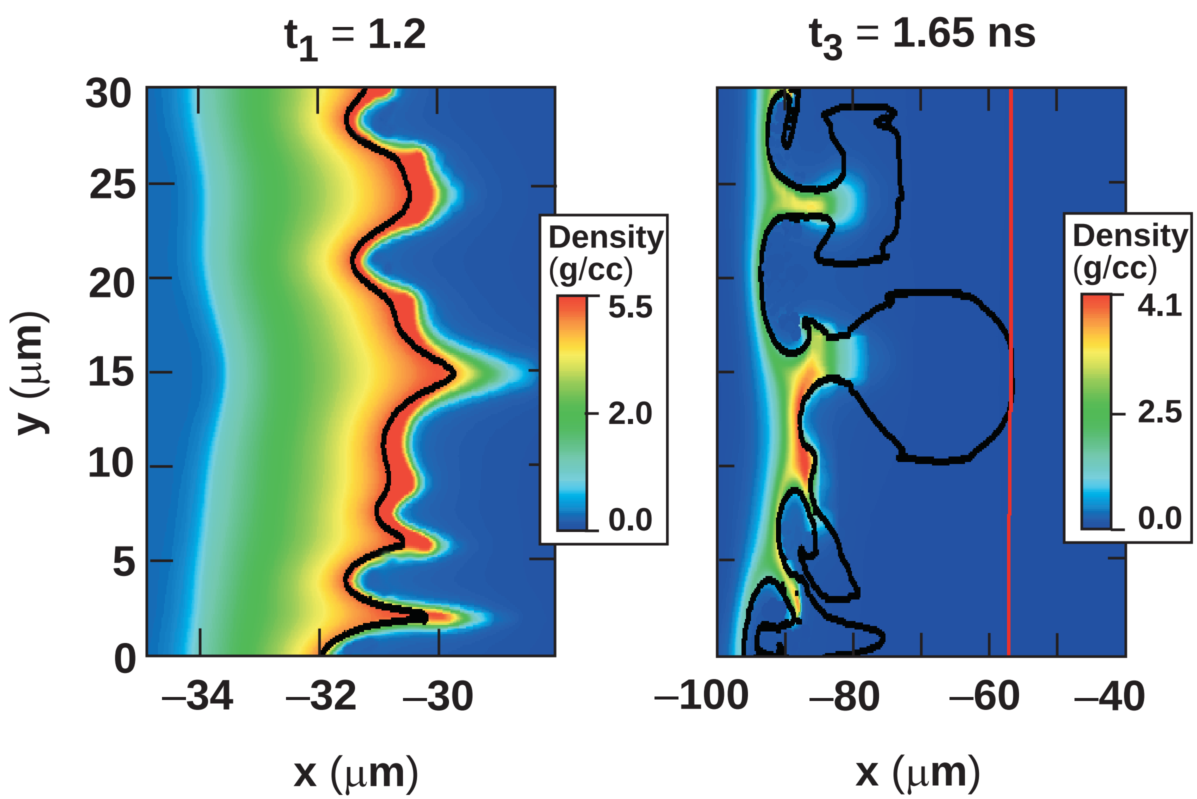
A New Model for the Analysis of Burnthrough Experiments on OMEGA



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A New Model for the Analysis of Burnthrough Experiments on OMEGA

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Burnthrough experiments have been carried out on the OMEGA laser system to quantify improvements in the laser irradiation uniformity using a target with a buried Si-doped CH layer. The irradiation nonuniformity seeds the Rayleigh-Taylor instability, which causes the Si to penetrate into the heat front earlier than predicted by 1-D simulations. In this new model, the imprint level is obtained from 2-D simulations. The modeling of the burnthrough time is based on measurements of the burnthrough electron temperature of about 750 eV and on results of 2-D *DRACO* simulations, which include material tracking. These 2-D results indicate that the Si-doped CH is ablated from the tip of the spikes toward the heat front. The burnthrough time is now defined as the sum of the time for the bubble to reach the signature layer, the time for the CH to be ablated from the spike, and the time for the Si to be convected to the 750-eV isotherm. Simulations are compared with experimental results. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC03-92SF19460.

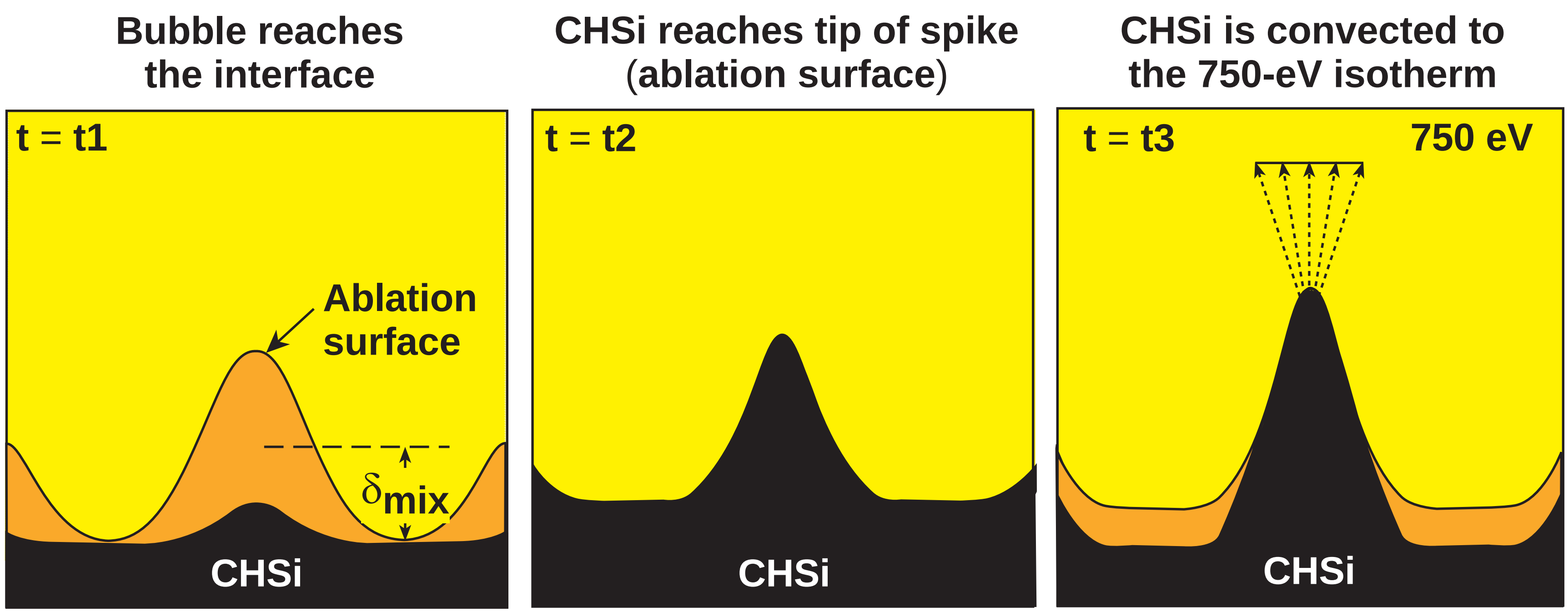
Summary

Experimental observation and 2-D simulations have led to an improved understanding of burnthrough

- The burnthrough electron temperature has been measured to be ~750 eV.
- 2-D *DRACO* simulations with interface tracking show that the substrate material is ablated at the spikes.
- A 1-D model, developed as a postprocessor to *LILAC*, agrees roughly with experiment.
- Radiation postprocessing of 2-D burnthrough simulations are needed to fully understand the burnthrough process.

Two recent observations and the ability to compute imprint spectra motivate this model

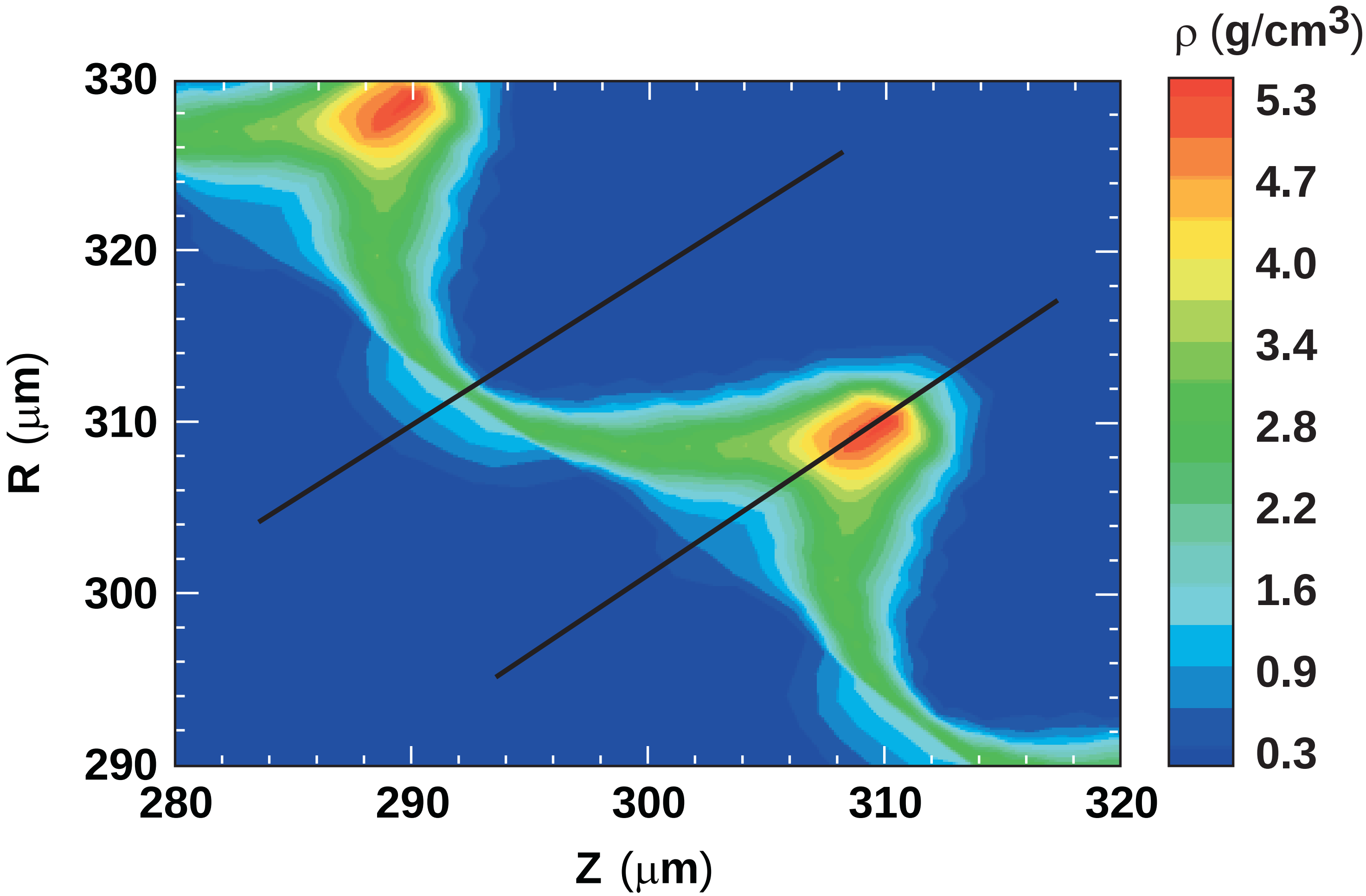
- The electron temperature is measured to be ~750 eV at burnthough time*
- 2-D *DRACO* simulations with interface tracking show that the substrate material is ablated at the spikes.
- These observations imply that burnthrough occurs after the mixed thickness equals the ablator thickness.
- The burnthrough process is divided into three parts:



* S. P. Regan *et al.*, Bull. Atomic Processes in Plasmas, Reno, NV, March 2000.

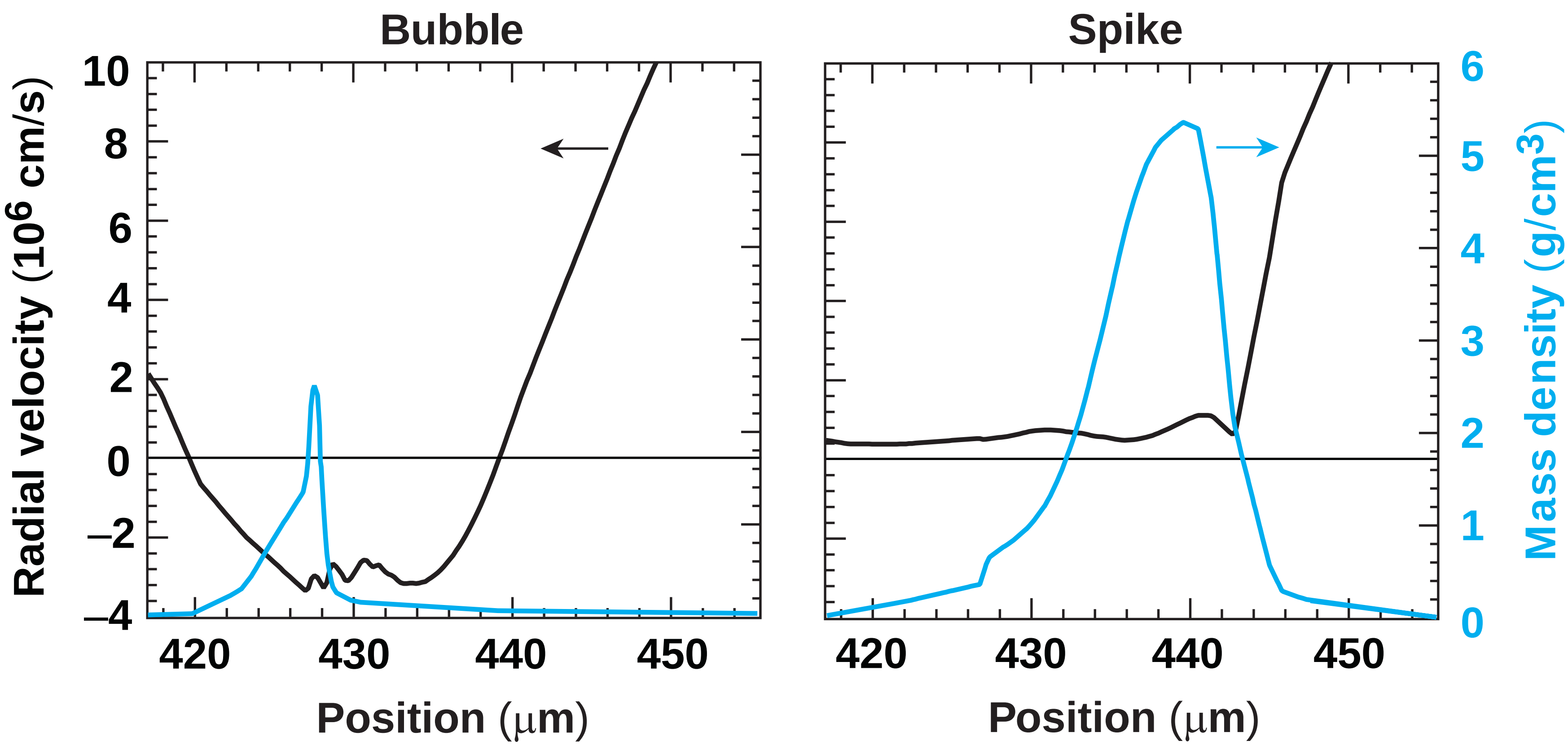
E10422b

Two lineouts were taken through a bubble and a spike in a single-mode Rayleigh–Taylor calculation



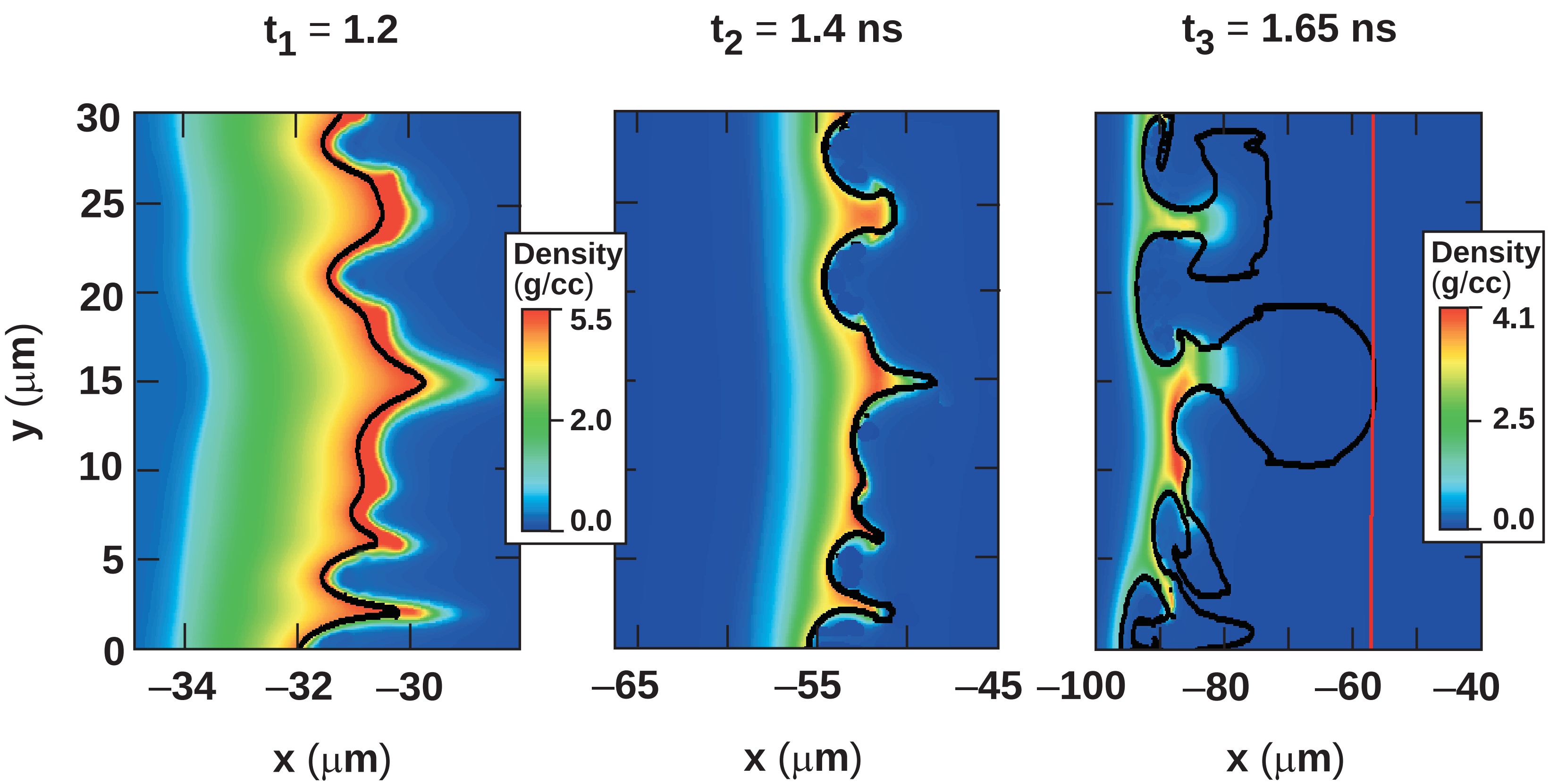
TC5486

Little or no ablation occurs at the outer bubble surface



TC5487

DRACO simulations show that the substrate material is ablated at the spike to the 700-eV isotherm



TC5488

Mixing is calculated using a multimode postprocessor to a 1-D hydrocode

- Laser imprint is calculated with the 2-D hydrocode *ORCHID*.
- Single-mode amplitudes grow using rates calculated from the Betti formula:*

$$A_\ell = A_{0\ell} e^{\gamma t}, \text{ where } \gamma = 0.98 \sqrt{\frac{kg}{1 + kL_m}} - 1.7\, kV_a$$

- Saturation is included using Haan's model.**
- Mix thickness is obtained from rms amplitude summed over all modes ($\ell \leqslant 300$).

γ = instability growth rate

$k = \frac{\ell}{r}$ is wave number of the mode

g = target acceleration

L_m = minimum density-gradient scale length

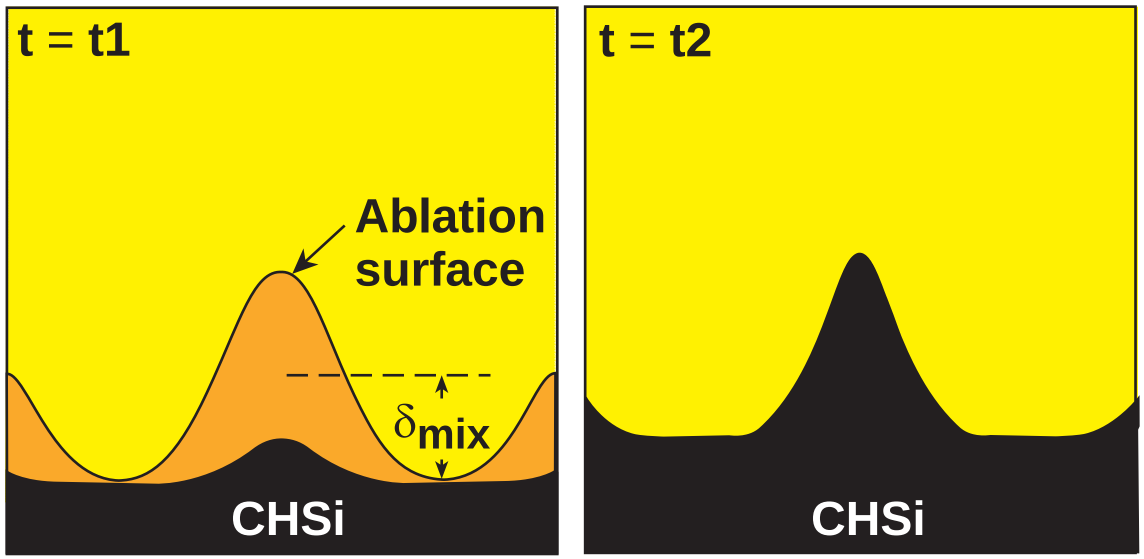
V_a = ablation velocity

* R. Betti *et al*., Phys. Plasma 5, 1446 (1998).

** S. W. Haan, Phys. Rev. A 39, 5812 (1989).

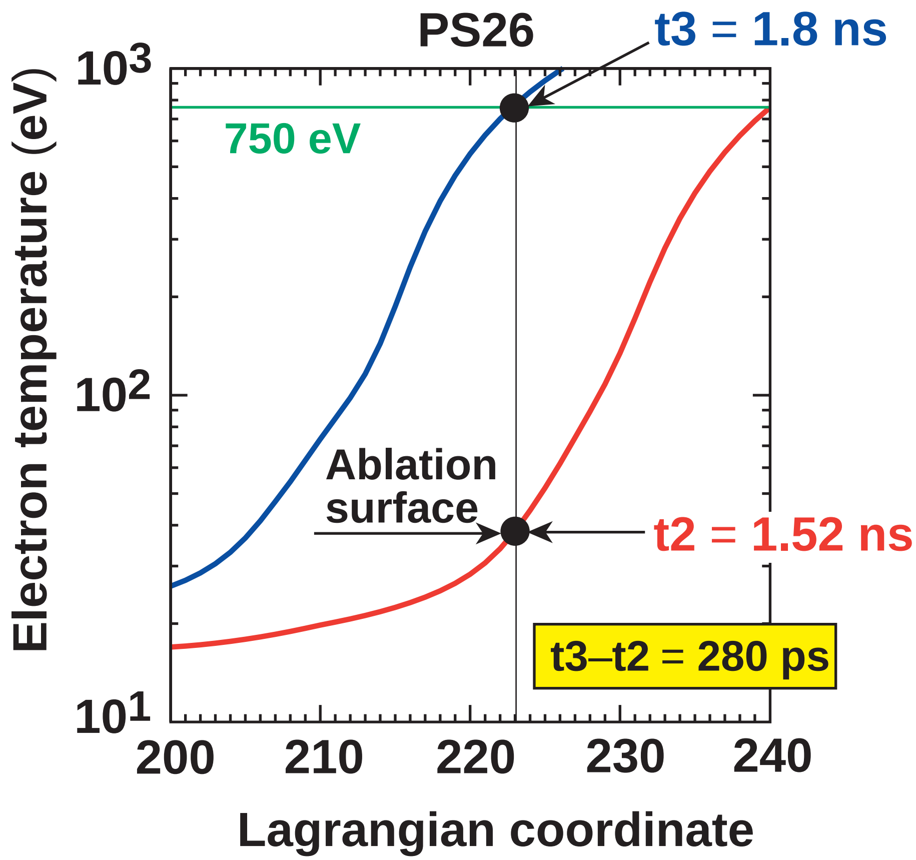
E10186b

The time interval t1 to t2 is now computed instead of obtained from normalization with experiment



The time for CHSi to reach the tip of the spike is calculated by assuming that the rate of removal of the CH in the spike is given by the 1-D mass-ablation rate.

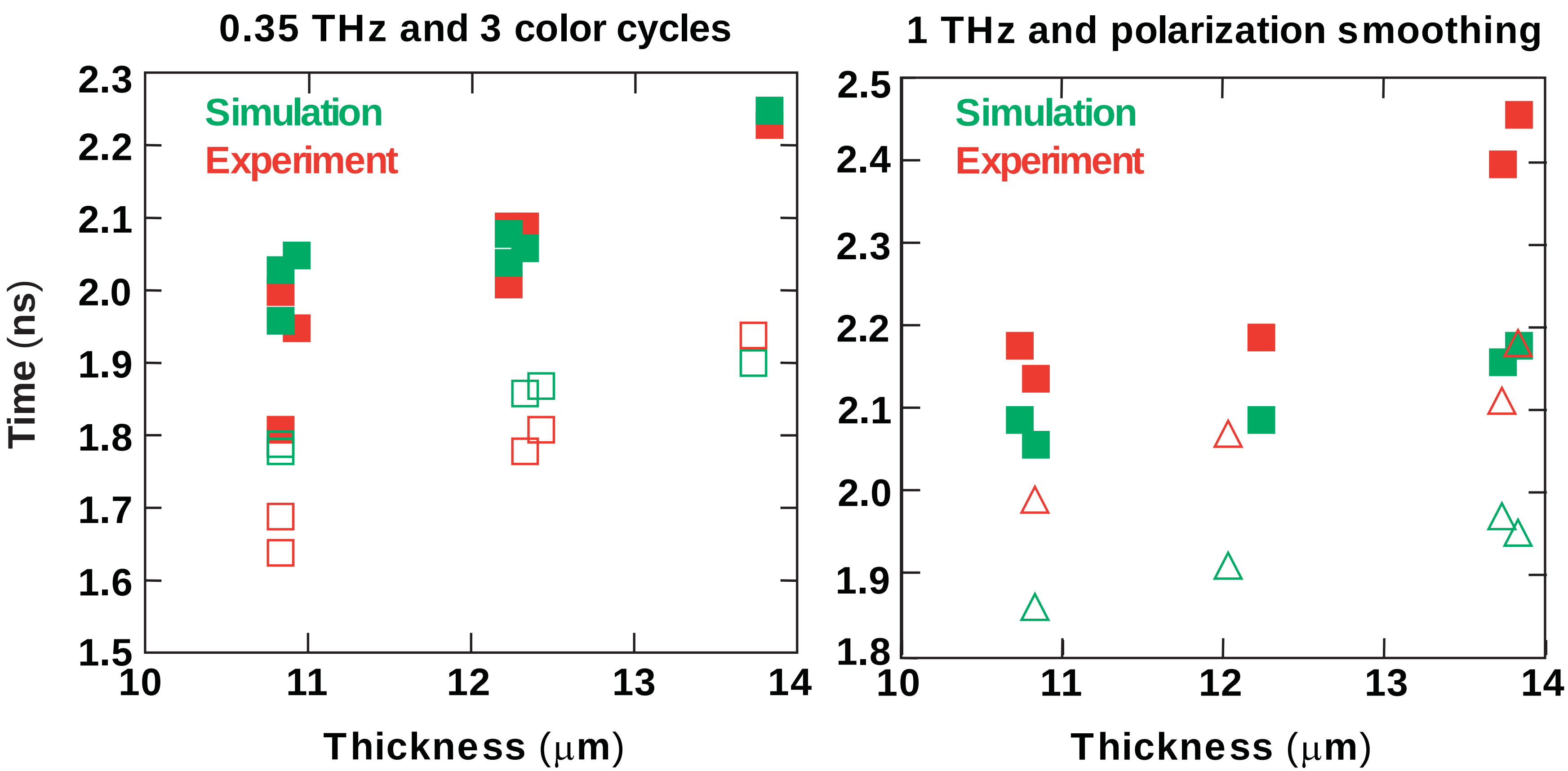
LILAC simulations indicate that a fluid element takes ~270 ps to move from the ablation surface to the 750-eV isotherm



T_e profiles at times when a fluid element is at the ablation surface (t2) and when it reaches the 750-eV isotherm (t3) .

E10428a

The new model has limited success in reproducing experimental results



Further analysis of 2-D *DRACO* simulations is required to improve the model.

TC5583

Summary/Conclusion

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