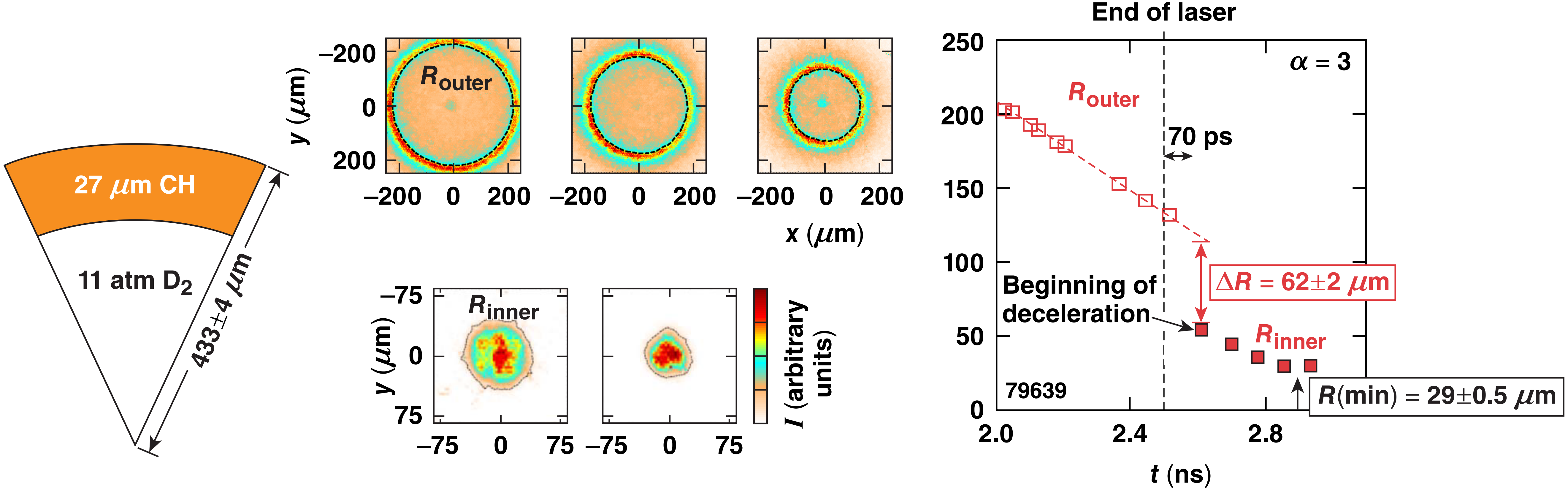
Measurements of the Effect of Adiabat on Shell Decompression in Direct-Drive Implosions on OMEGA



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Summary

A technique has been developed that shows imprint growth is modeled correctly in warm CH implosions

- For high-adiabat ($\alpha > 4$) implosions, the measured shell thicknesses and neutron yields are in agreement with 1-D simulations
- For lower-adiabat ($\alpha < 4$) implosions, significant shell decompression and reduced neutron yield are observed
- The core size was measured to decrease consistently with reducing the adiabat from 6.5 to 1.8
- Two-dimensional simulations with laser imprint reproduce the measured shell decompression

This platform can be used to investigate imprint mitigation in 60-beam implosions on OMEGA.

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Collaborators

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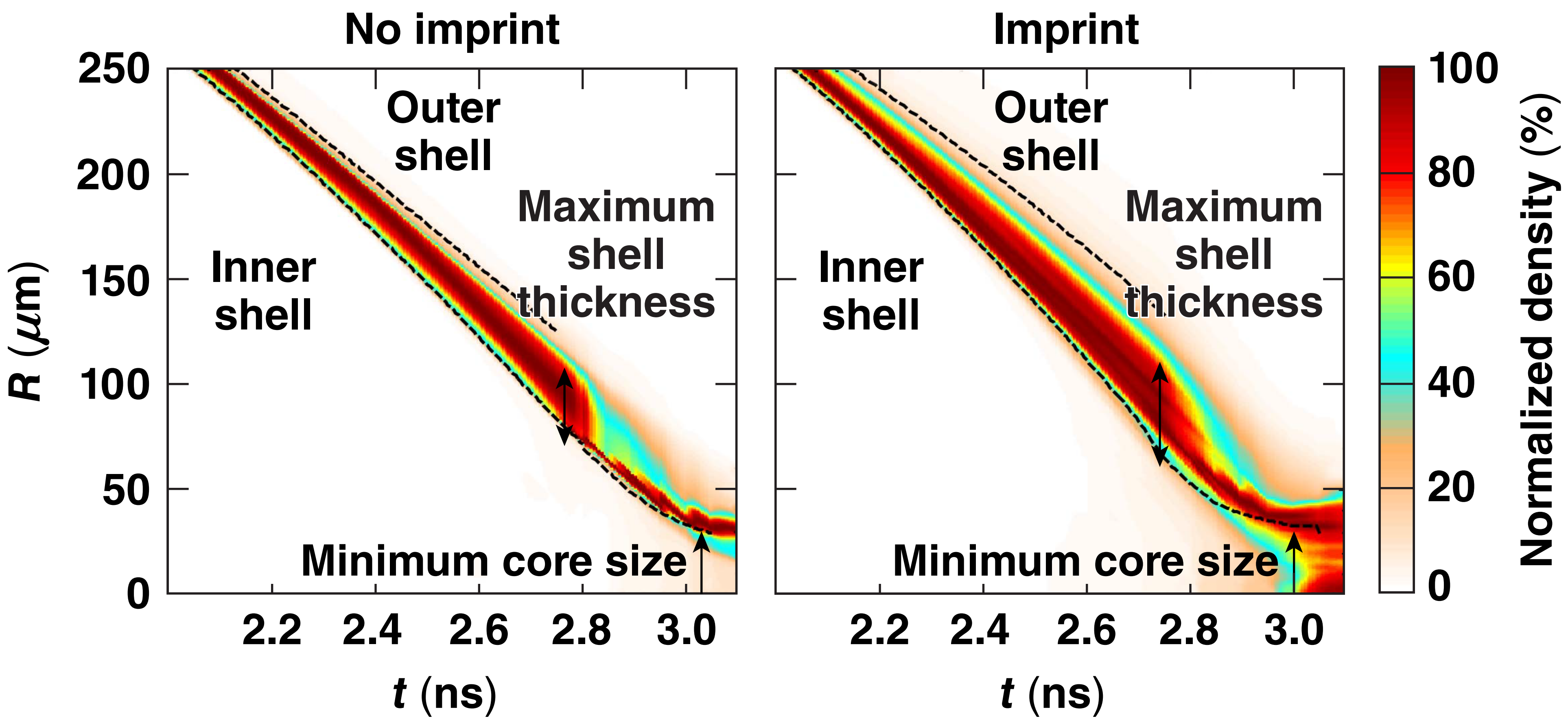
University of Rochester
Laboratory for Laser Energetics

During the capsule's acceleration, Rayleigh–Taylor growth of the laser imprint results in large nouniformities



Nonuniformities increase the thickness of the shell but not the minimum core size.

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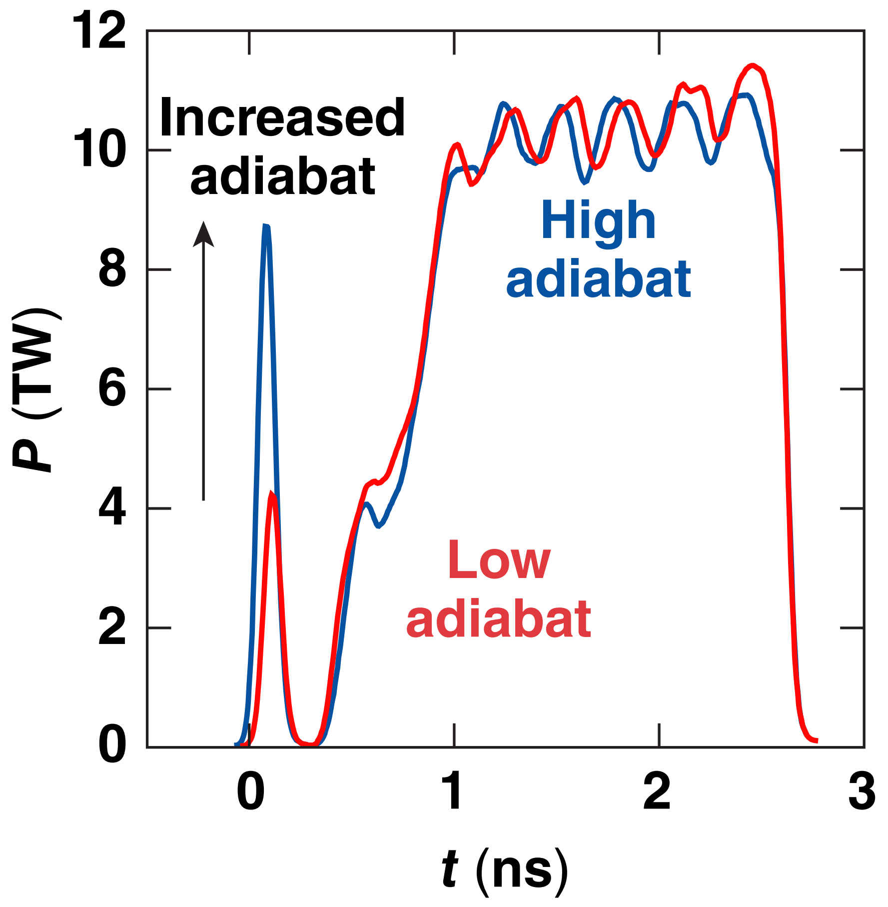
An experiment was performed on OMEGA to measure the shell thickness for various shell adiabats



The shell adiabat varied between 1.8 and 6.5 by changing the energy of the picket.

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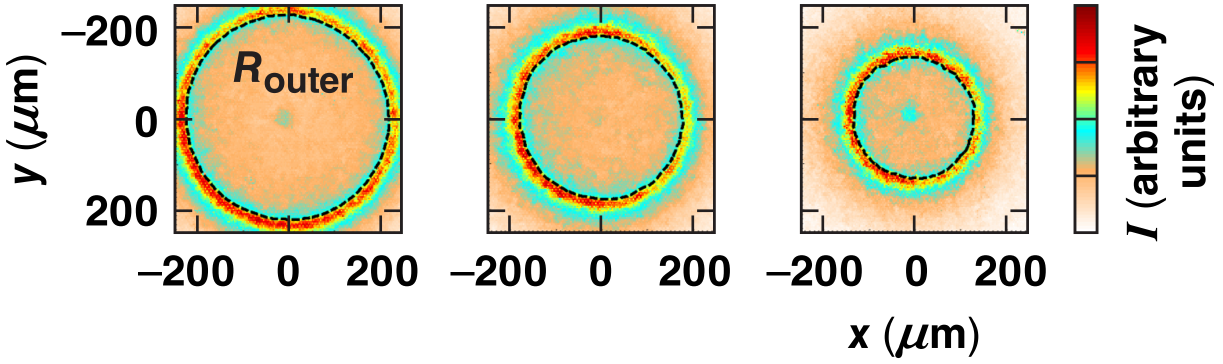
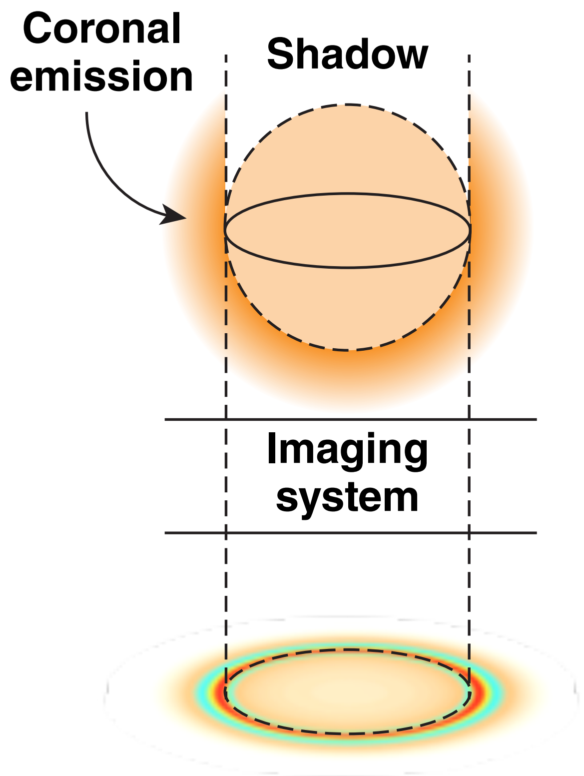
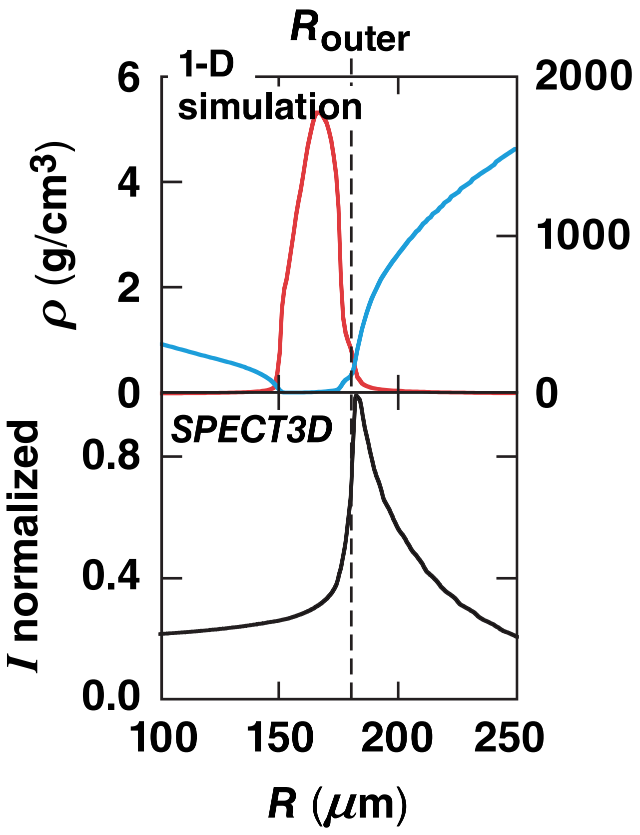
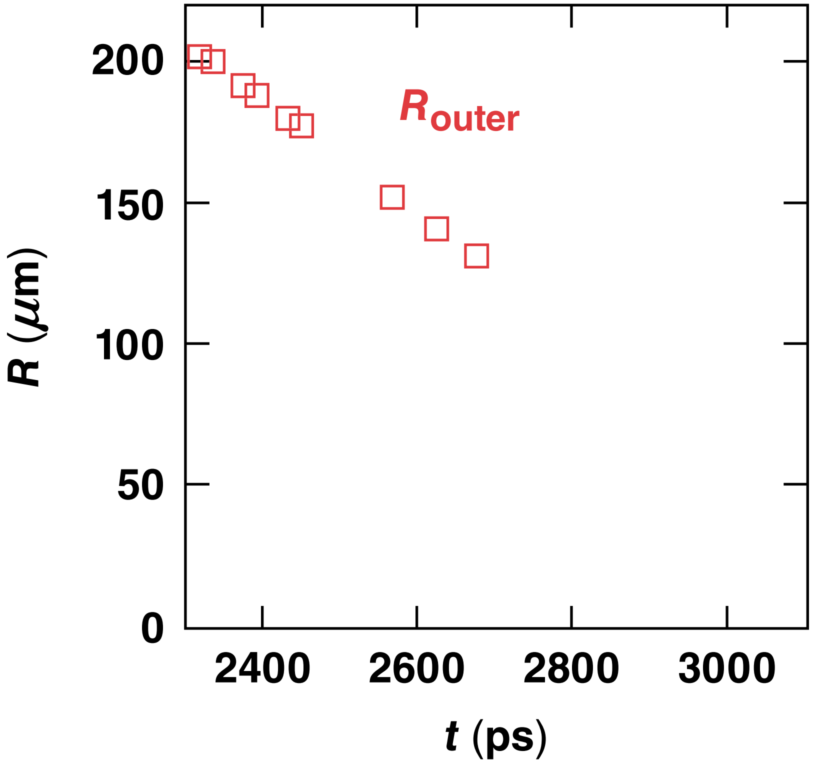
The outer and inner surfaces of the shell are measured from self-emission images within ±0.2 μm* and ±2.0 μm, respectively









*Self-emission shadowgraphy:
D. T. Michel *et al.*, Rev. Sci. Instrum. 83, 10E530 (2012);
D. T. Michel *et al.*, High Power Laser Science and Engineering 3, e19 (2015).

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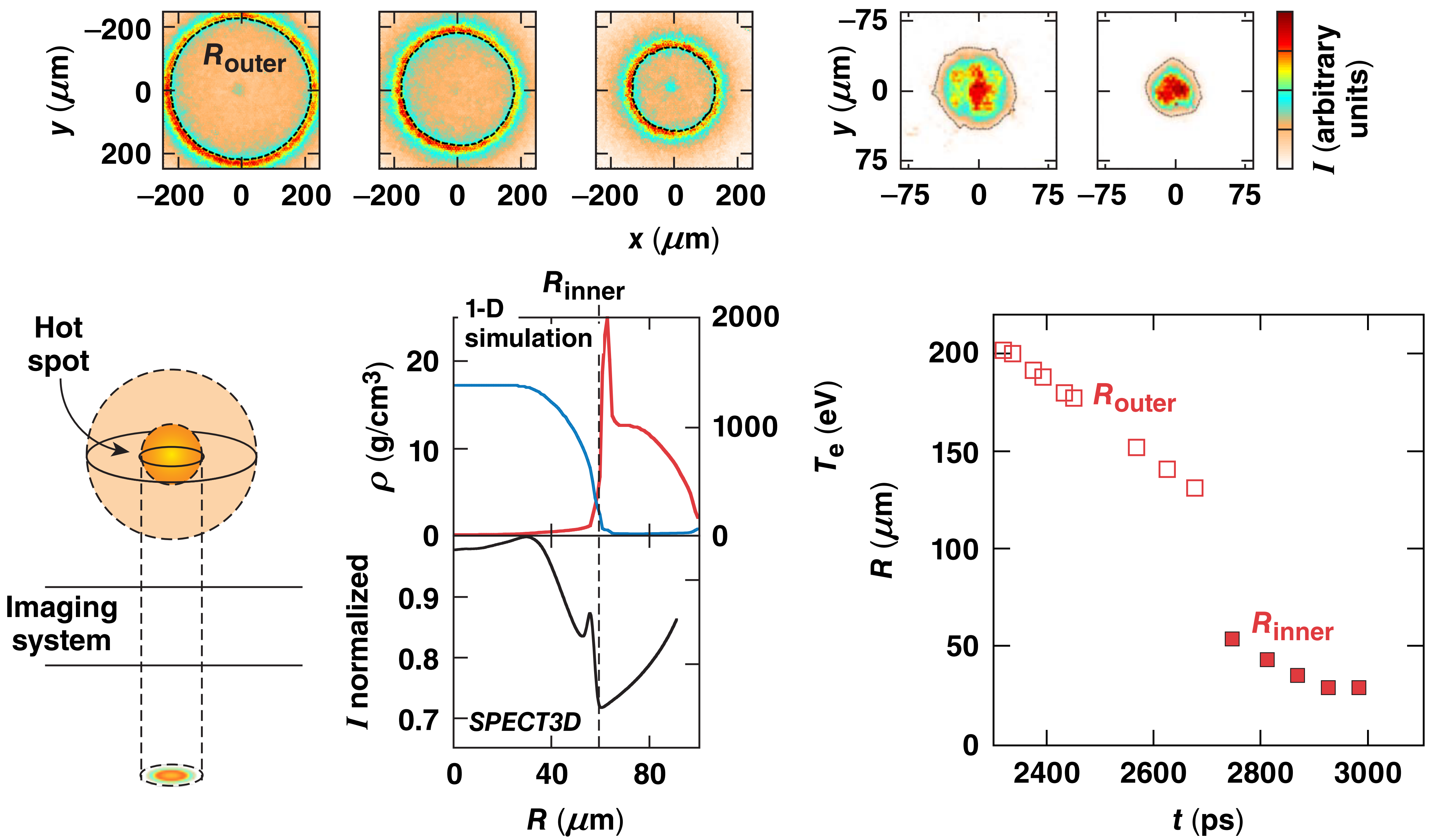
The outer and inner surfaces of the shell are measured from self-emission images within ±0.2 μm and ±2.0 μm, respectively



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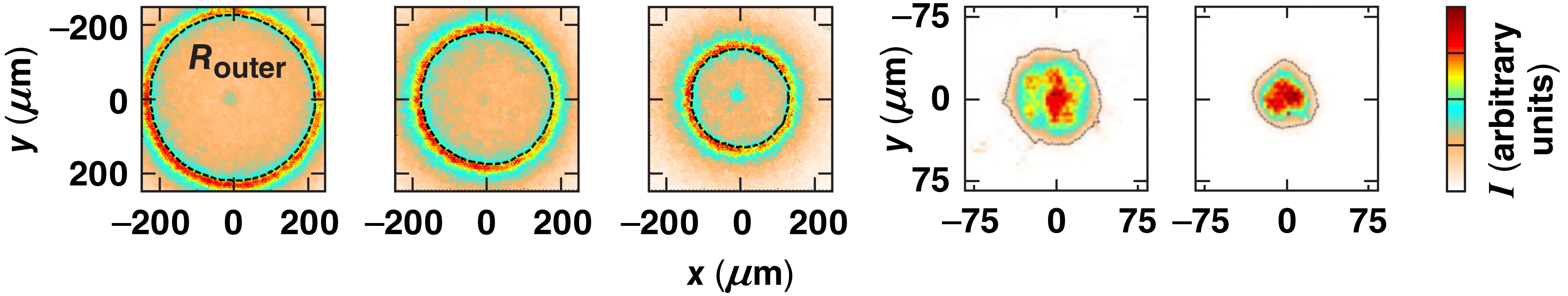
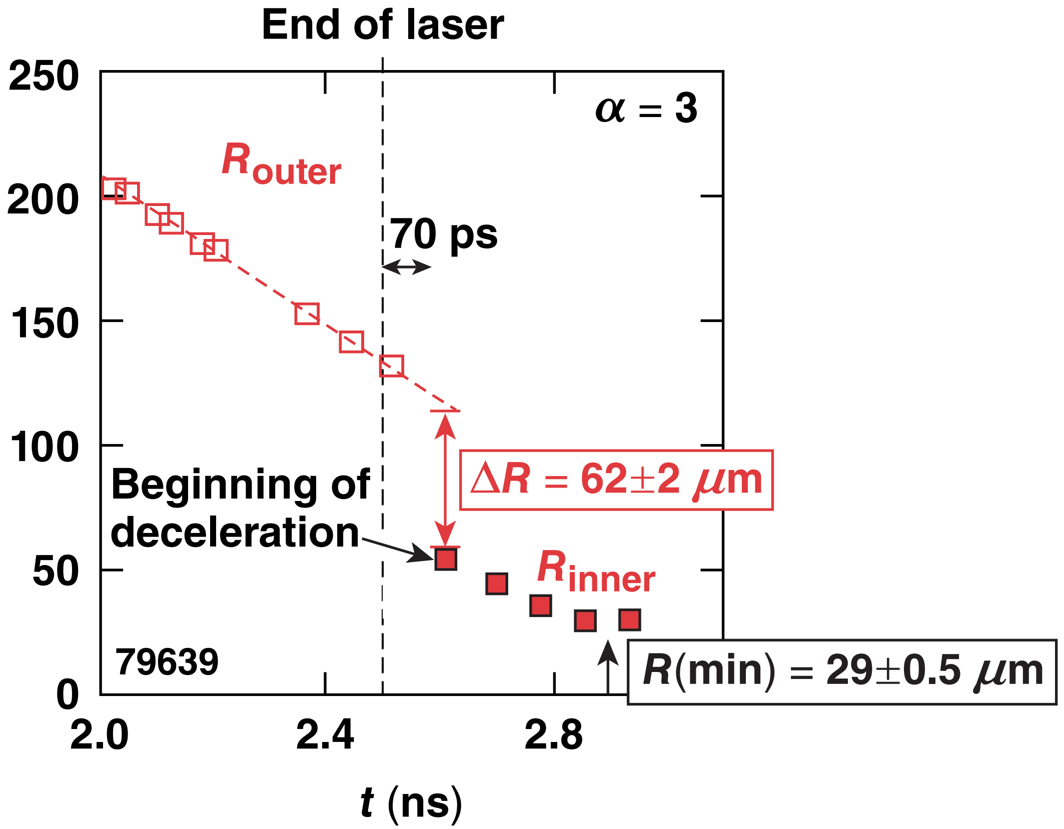
The outer and inner surfaces of the shell are measured from self-emission images within ±0.2 μm and ±2.0 μm, respectively





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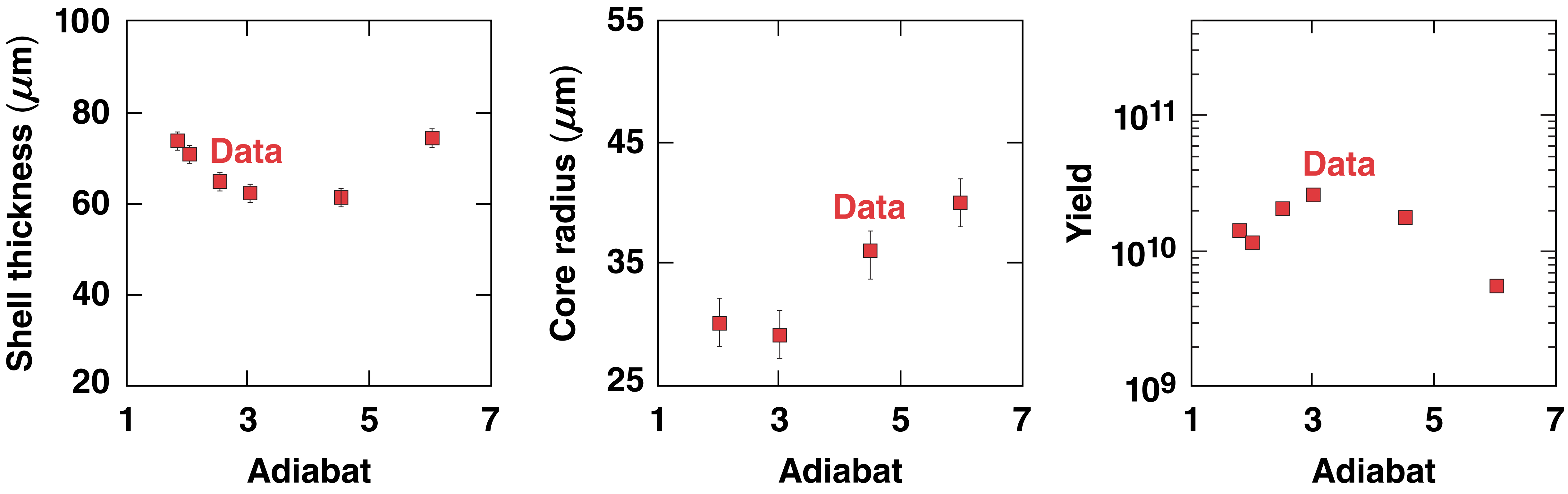
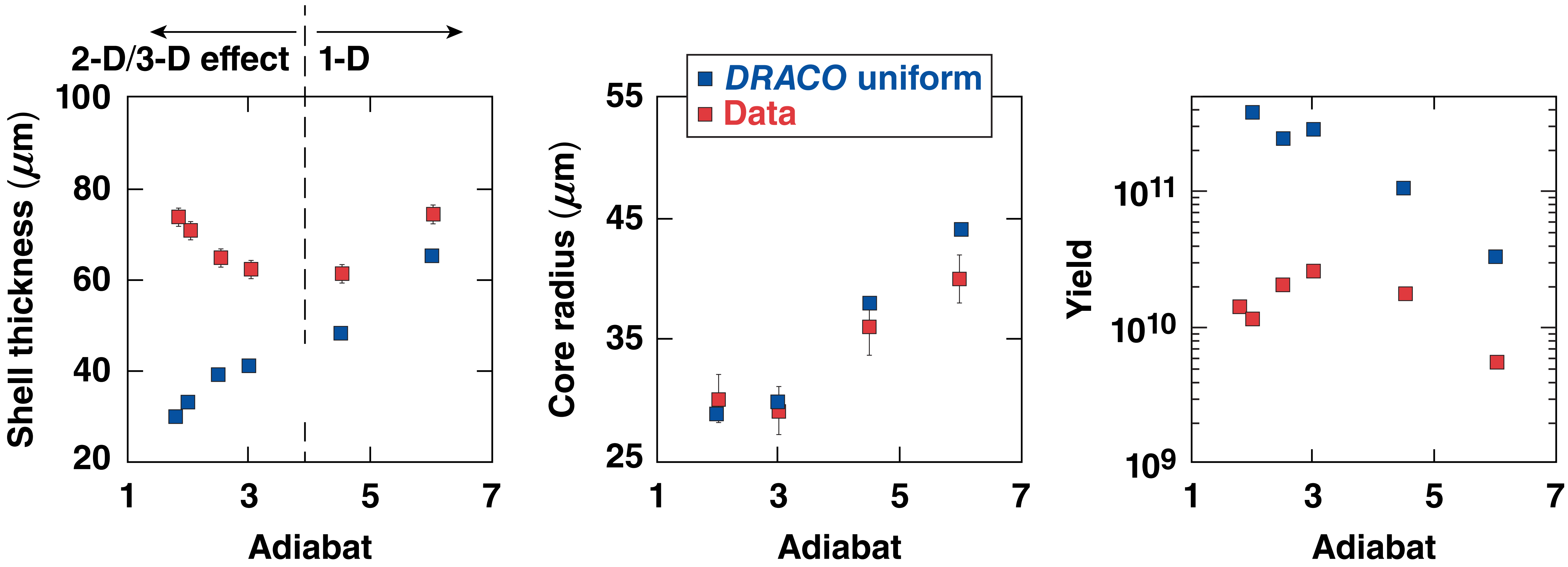
The core size was measured to decrease when reducing the adiabat, but the shell thickness increased at an adiabat less than four



This shows that the shell decompression observed for a low adiabat is not caused by an error in the adiabat calculation.

E25057b

For a high adiabat ($\alpha > 4$), the measured shell thickness and yield are in reasonable agreement with uniform 2-D *DRACO* simulations



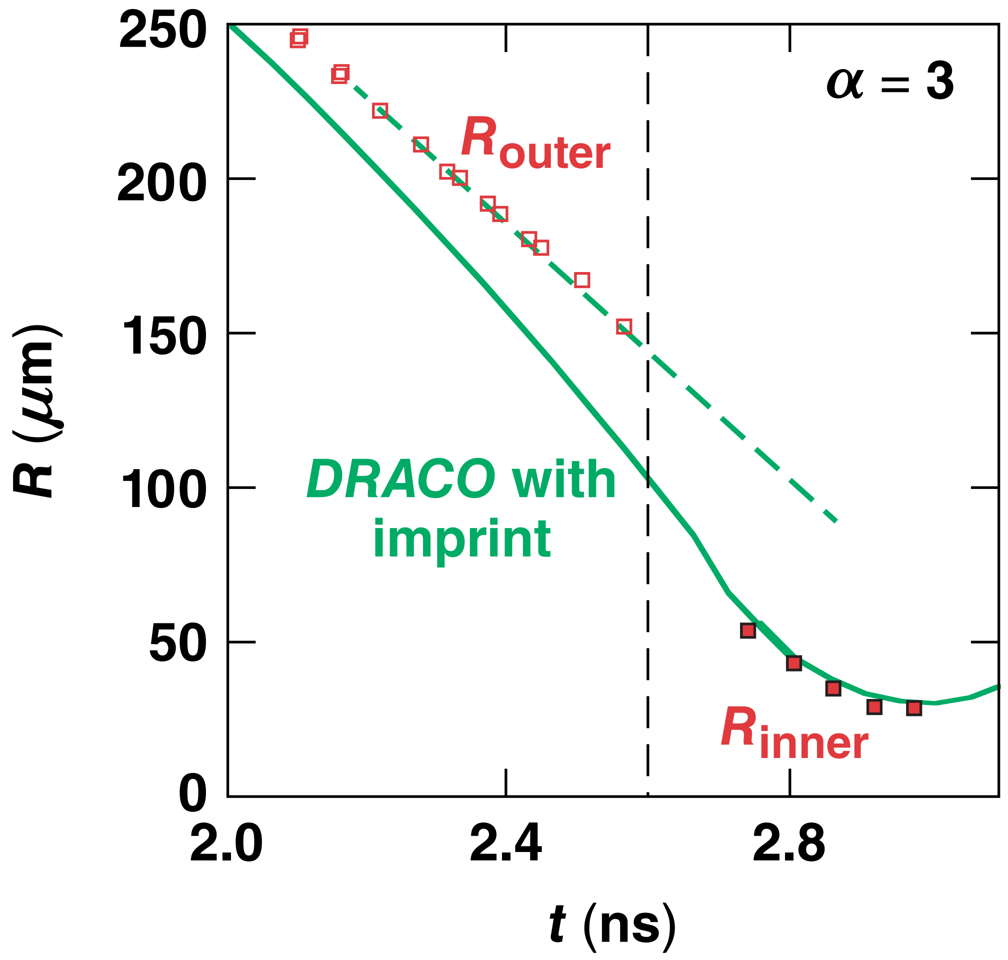
For a lower adiabat ($\alpha < 4$), significant shell decompressions are observed because of 2-D/3-D effects.

E25057c

A 2-D *DRACO* simulation with laser imprint was performed with CBET and nonlocal to correctly model the Rayleigh–Taylor growth*

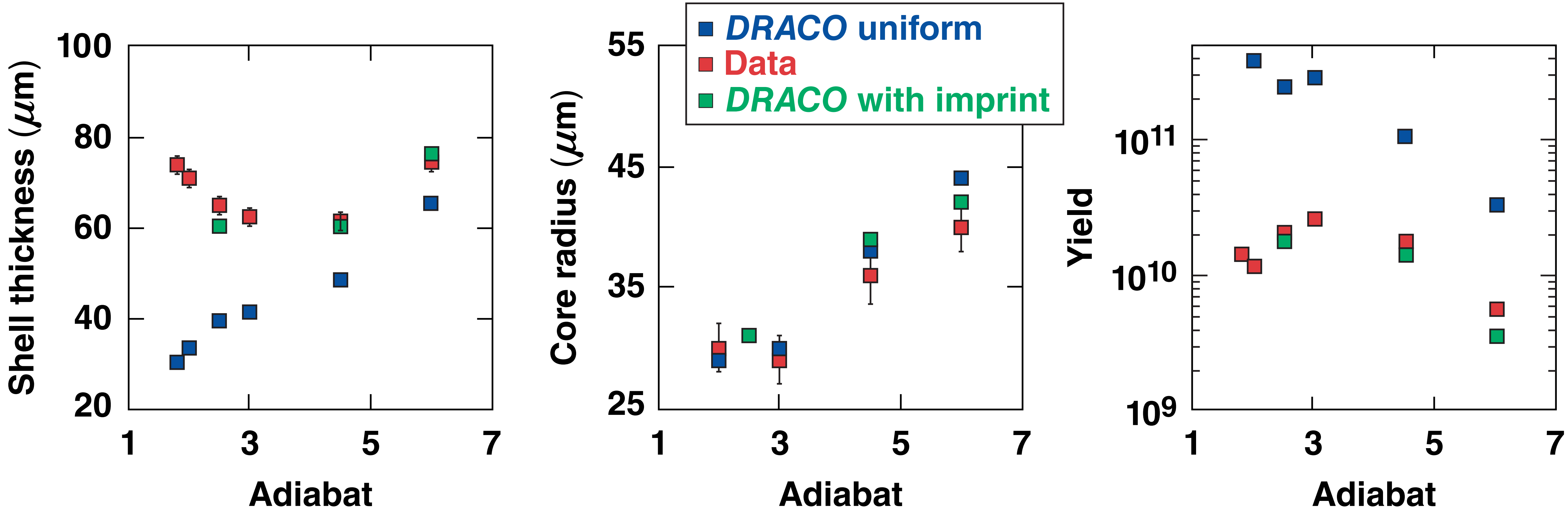
The simulation included

- Nonlocal thermal-transport model
- Cross-beam energy transfer (CBET) model
- Laser imprint up to the ℓ = mode 200



*D. T. Michel *et al.*, Phys. Rev. Lett. 114, 155002 (2015).

Two-dimensional *DRACO* simulations with laser imprint reproduced with all experimental observables



On cryogenic implosions, the effect of imprint should be less detrimental because the mass ablation rate of the DT is higher providing a stronger stabilization of the Rayleigh–Taylor instability.

*S. X. Hu *et al*., accepted in Phys. Plasmas; S. X. Hu *et al*., JO5.00001, this conference;
D. T. Michel *et al*., "Measurements of the Effect of Adiabat on Shell Decompression in Direct-Drive Implosions on OMEGA," submitted to Physical Review Letters.

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Summary/Conclusions

A technique has been developed that shows imprint growth is modeled correctly in warm CH implosions

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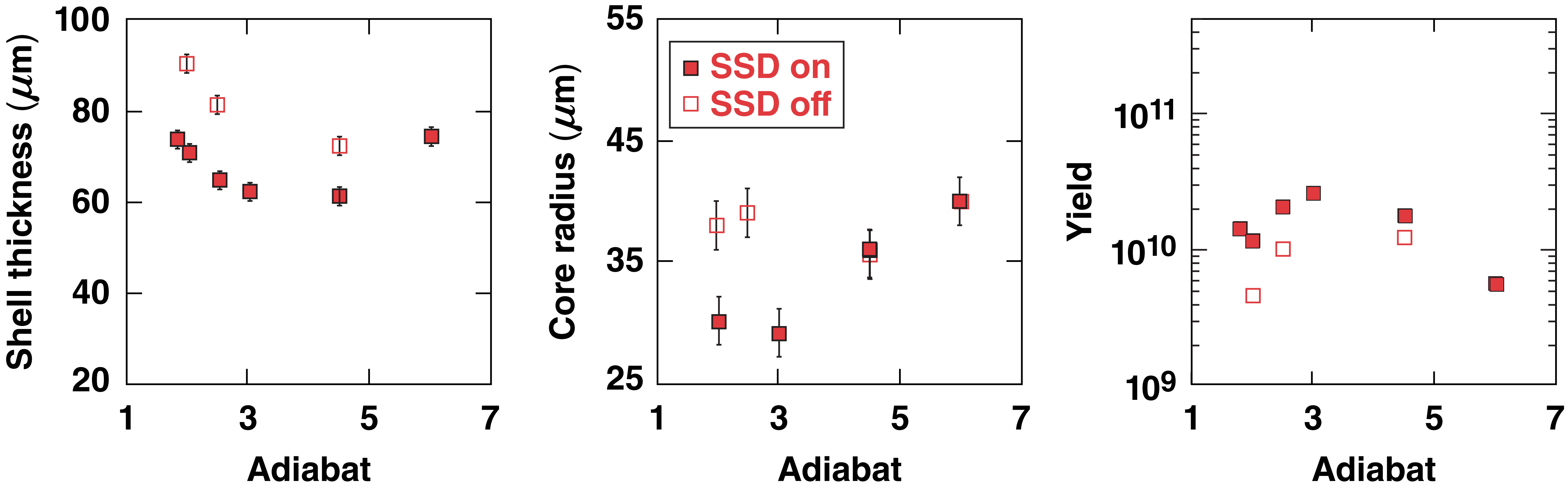
This platform can be used to investigate imprint mitigation in 60-beam implosions on OMEGA.

When increasing the laser imprint by turning off SSD, a significant increase of the shell thickness was observed for all adiabats



This demonstrates that the laser imprint causes shell decompression.