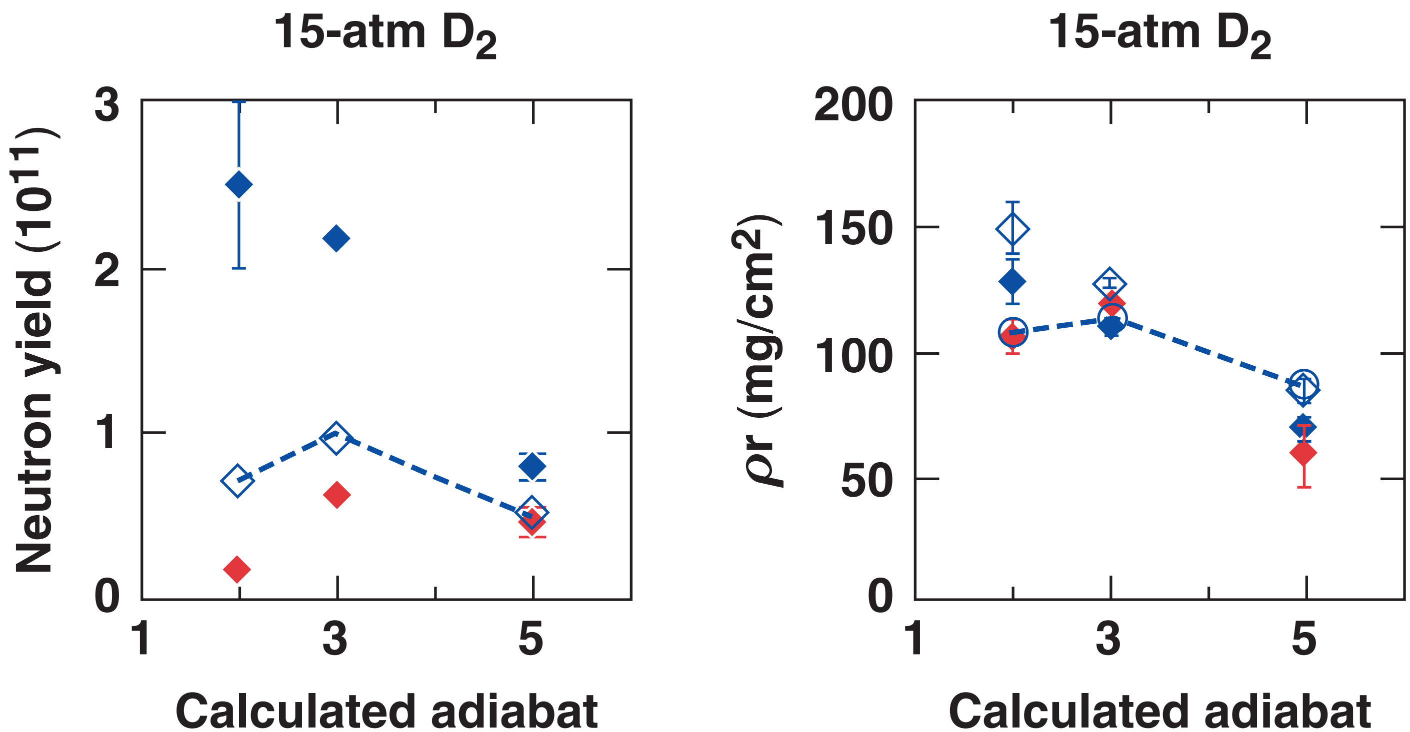
Direct-Drive, Low-Adiabat ICF Implosions



J. P. Knauer *et al.*
University of Rochester
Laboratory for Laser Energetics

47th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Denver, CO
24–28 October 2005

Summary

Low-α[1] implosions of CH targets study the difference between 1-D and multidimensional performance

- Both the flux-limited and the nonlocal electron models agree with the radius versus time data.
- Measured absorption agrees with a nonlocal electron transport model.
- 2-D simulations confirm that best target performance should occur for an adiabat of about three.
- $\alpha = 3$ implosions of 27-μm-thick shells show
  - a higher neutron yield than either the $\alpha = 2$ or $\alpha = 5$ implosions,
  - 120-mg/cm^2 ρr for 15-atm D_2-filled shells, and
  - 140-mg/cm^2 ρr for 3-atm D_2-filled shells.

[1] α(adiabat) $\equiv P/P_{Fermi}$

V. N. Goncharov BO1.001
P. B. Radha FO3.008
S. P. Regan FO3.006

E14115

Collaborators

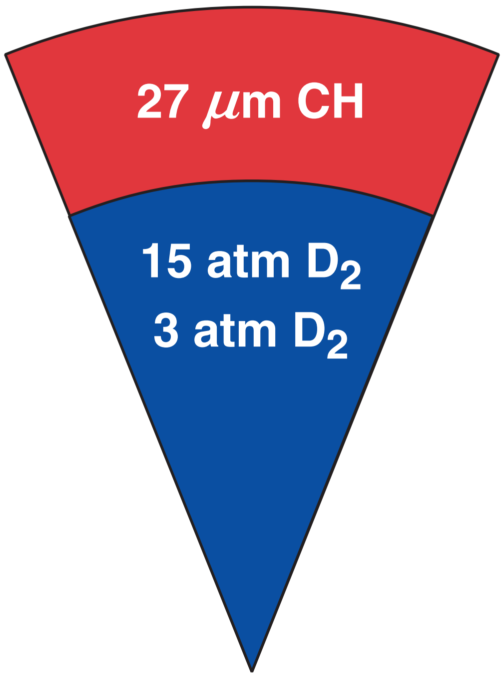
**K. Anderson, R. Betti, T. J. B. Collins, R. Epstein, V. Yu. Glebov,
V. N. Goncharov, F. J. Marshall, D. D. Meyerhofer,
P. B. Radha, S. P. Regan, T. C. Sangster, and C. Stoeckl**

**University of Rochester
Laboratory for Laser Energetics**

J. A. Frenje, C. K. Li, R. D. Petrasso, and F. H. Séguin

**Plasma Science and Fusion Center
Massachusetts Institute of Technology**

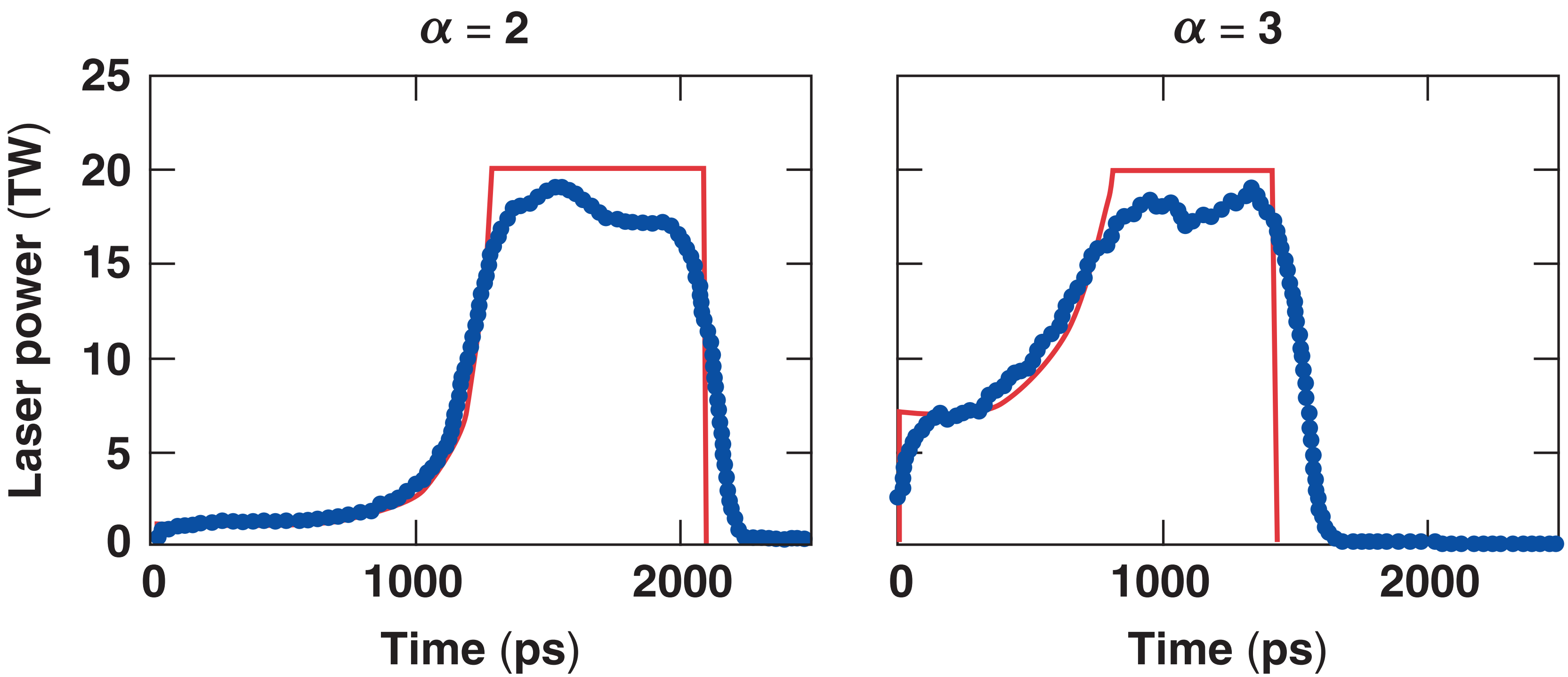
Low-adiabat implosions have been diagnosed with a large array of instruments



- Laser coupling
  - scattered laser-light calorimetry and time-dependent emission
  - plasma calorimetry
- X-ray emission
  - shell emission for radius versus time
  - implosion core shape and spectrum
- Fusion products
  - total yields
  - ion temperature
  - time-dependent emission
  - ρr from secondary 15-MeV protons

27-μm thick CH shells have been imploded with pulse shapes that result in a shell adiabat of 2 or 3

UR LLE



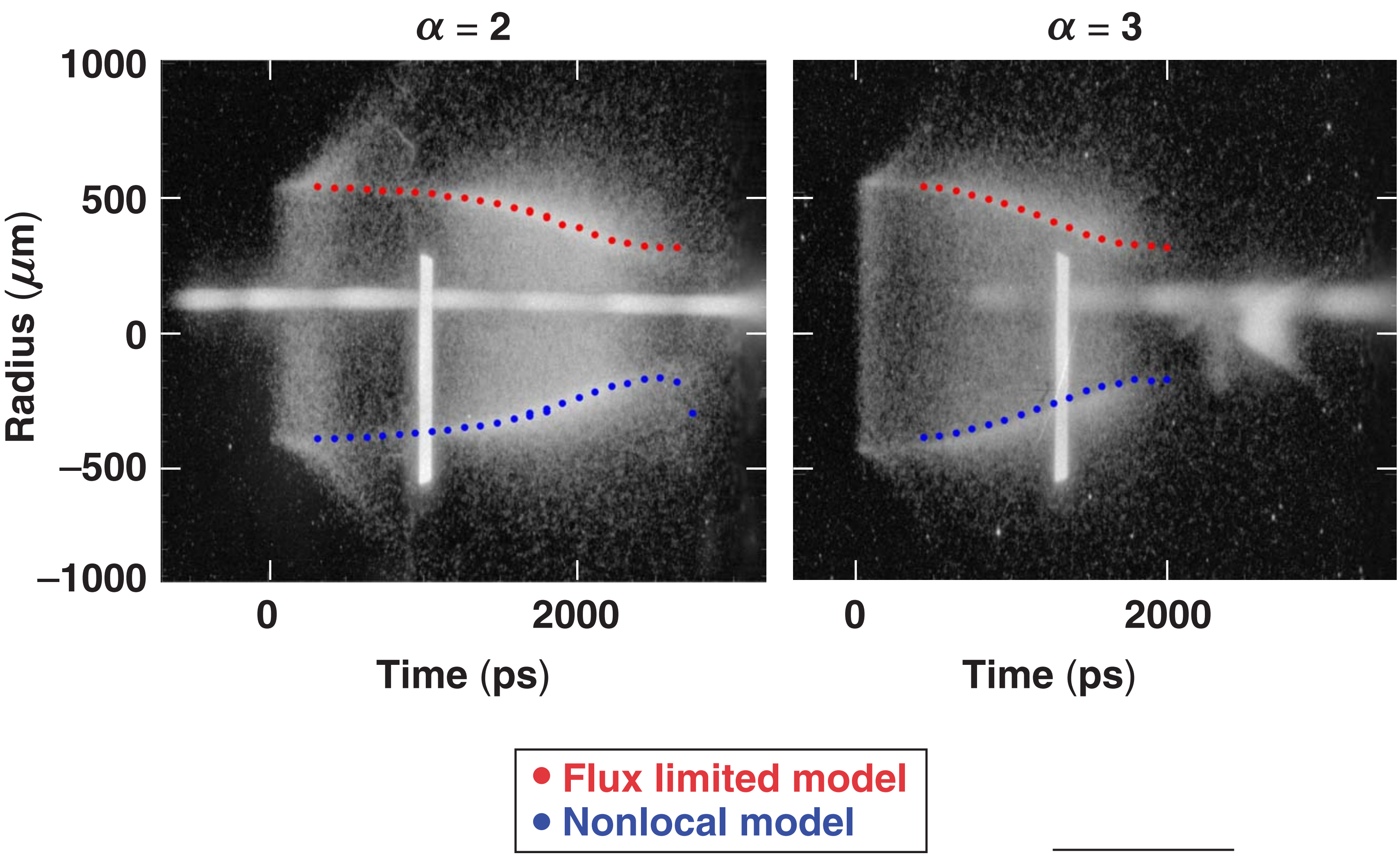
α = 2, 18.6 ± 0.2 kJ Total energy
α = 3, 20.7 ± 0.1 kJ Total energy
α = 5, 23.4 ± 0.5 kJ Total energy

A shell adiabat of 5 is established by a 1 ns square laser pulse.

E14117

S. P. Regan FO3.006

Both the flux-limited and nonlocal electron transport models agree with the radius versus time data



V. N. Goncharov BO1.001

The non-local electron transport model shows better agreement with the measured absorption

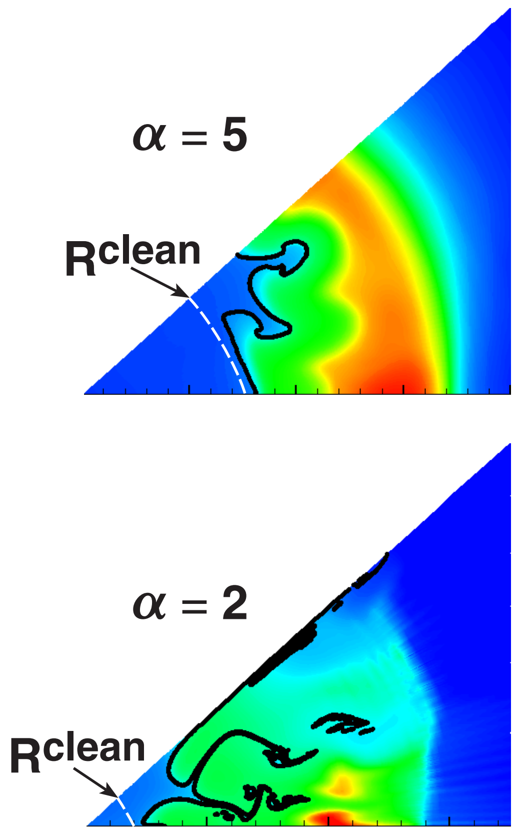
UR LLE

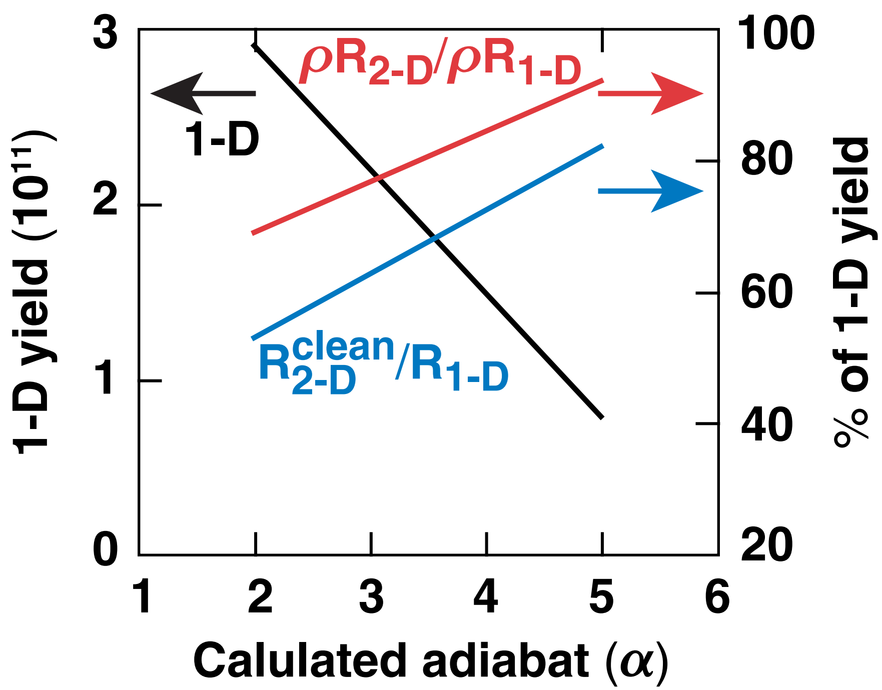
- Absorption was calculated with both a flux-limited and a nonlocal electron-transport model.
- The absorbed energy was measured with both plasma calorimeters and scattered UV calorimeters.

Adiabat	Flux limited	Nonlocal	Plasma calorimeter	UV scatter
5	0.61	0.59	0.62±0.01	0.62±0.02
3	0.77	0.74	0.73±0.01	0.74±0.01
2	0.81	0.75	0.74±0.01	0.74±0.01

DRACO simulations indicate that the best target performance should be obtained for $\alpha \sim 3$

- 2-D simulations include the effect of power balance and laser imprint.
- ρR and R^{clean} decrease with respect to 1-D due to higher nonuniformity growth in lower adiabats.

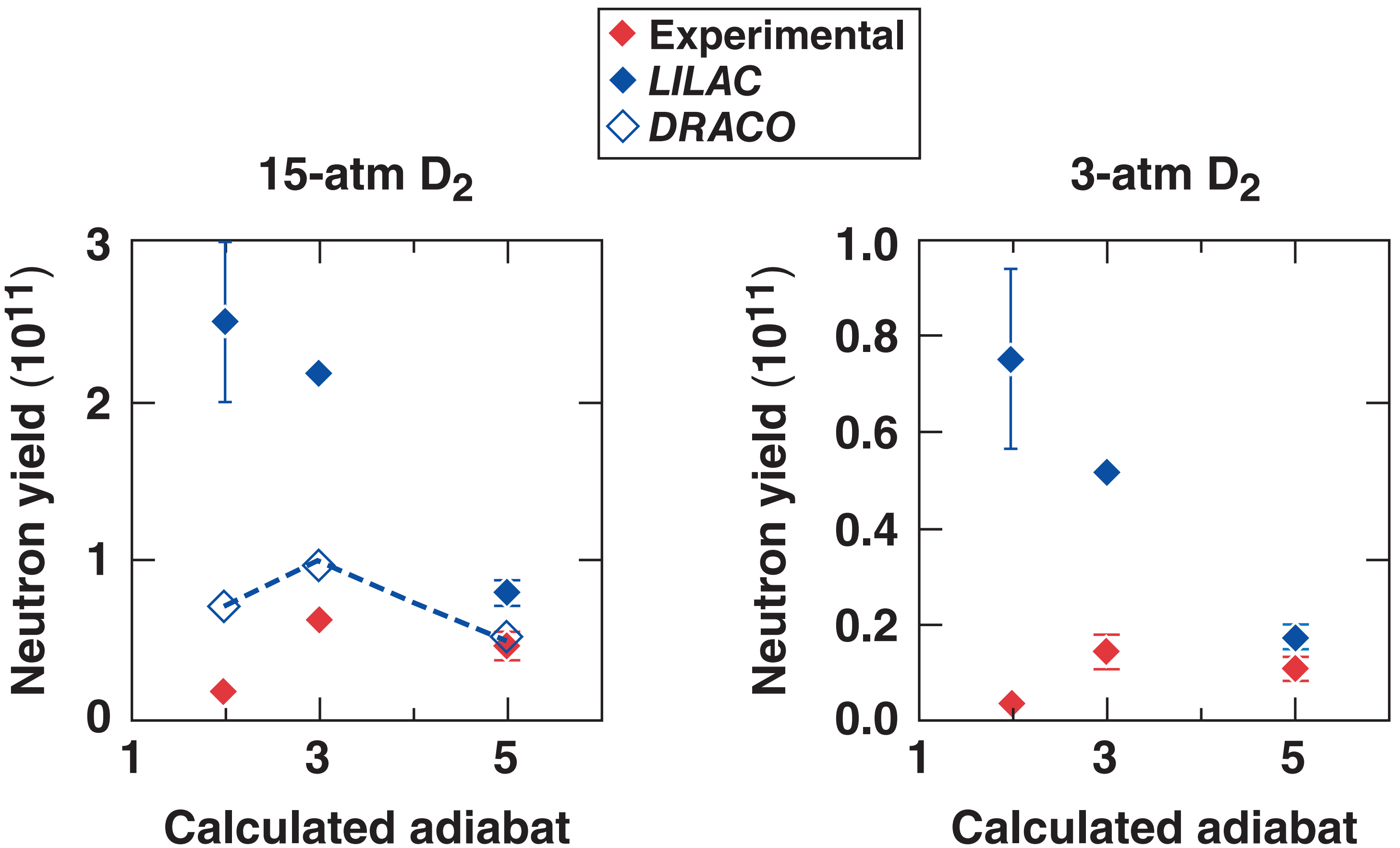




E14190

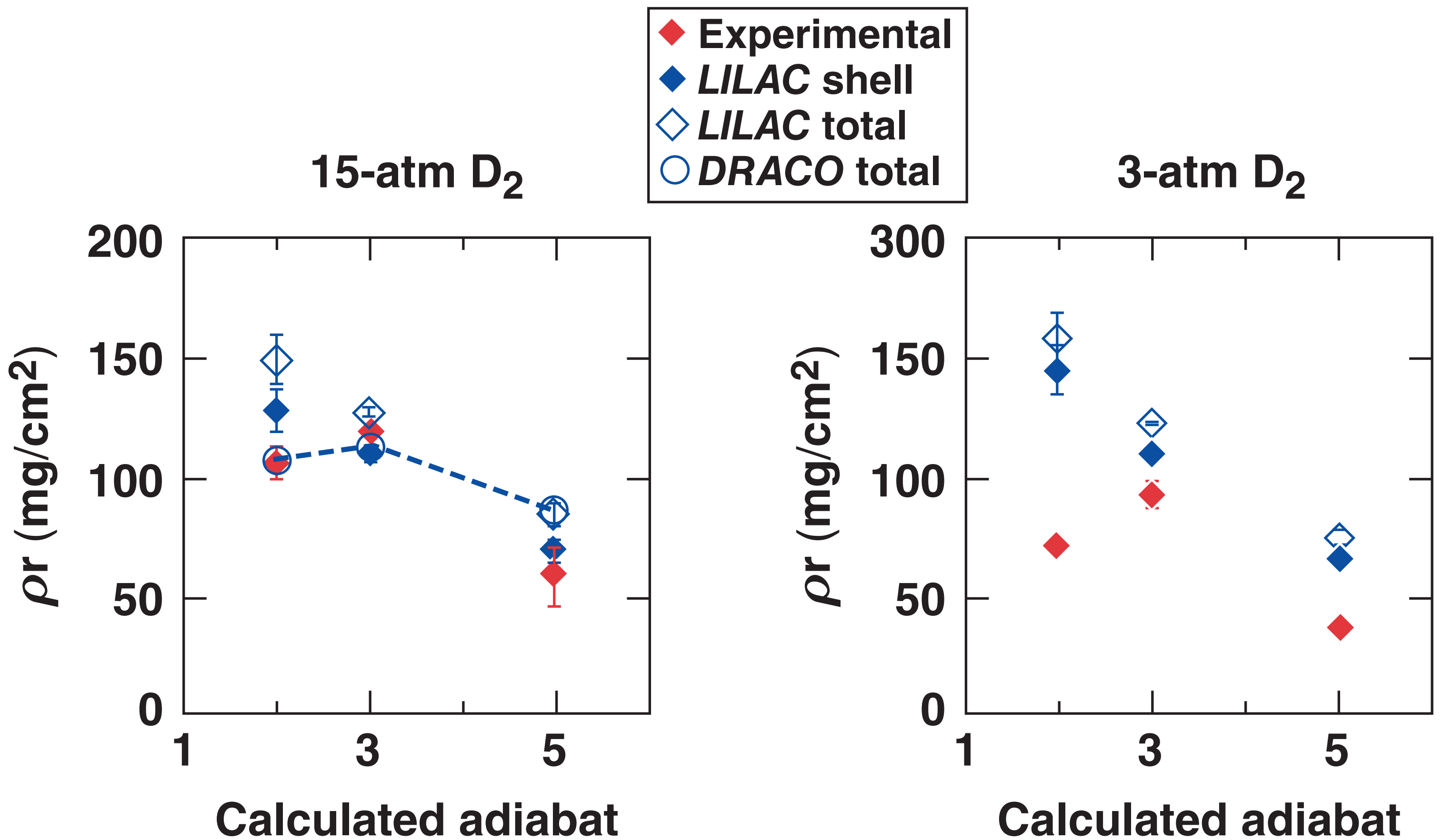
P. B. Radha FO3.008

Measured 3-MeV neutron yields peak for the $\alpha = 3$ implosions of the 27-μm-thick shells



E14121

Maximum ρr's for 15-atm and 3-atm filled 27-μm-thick shells are 120 and 140 mg/cm^2 for an α = 3 implosion



E14123

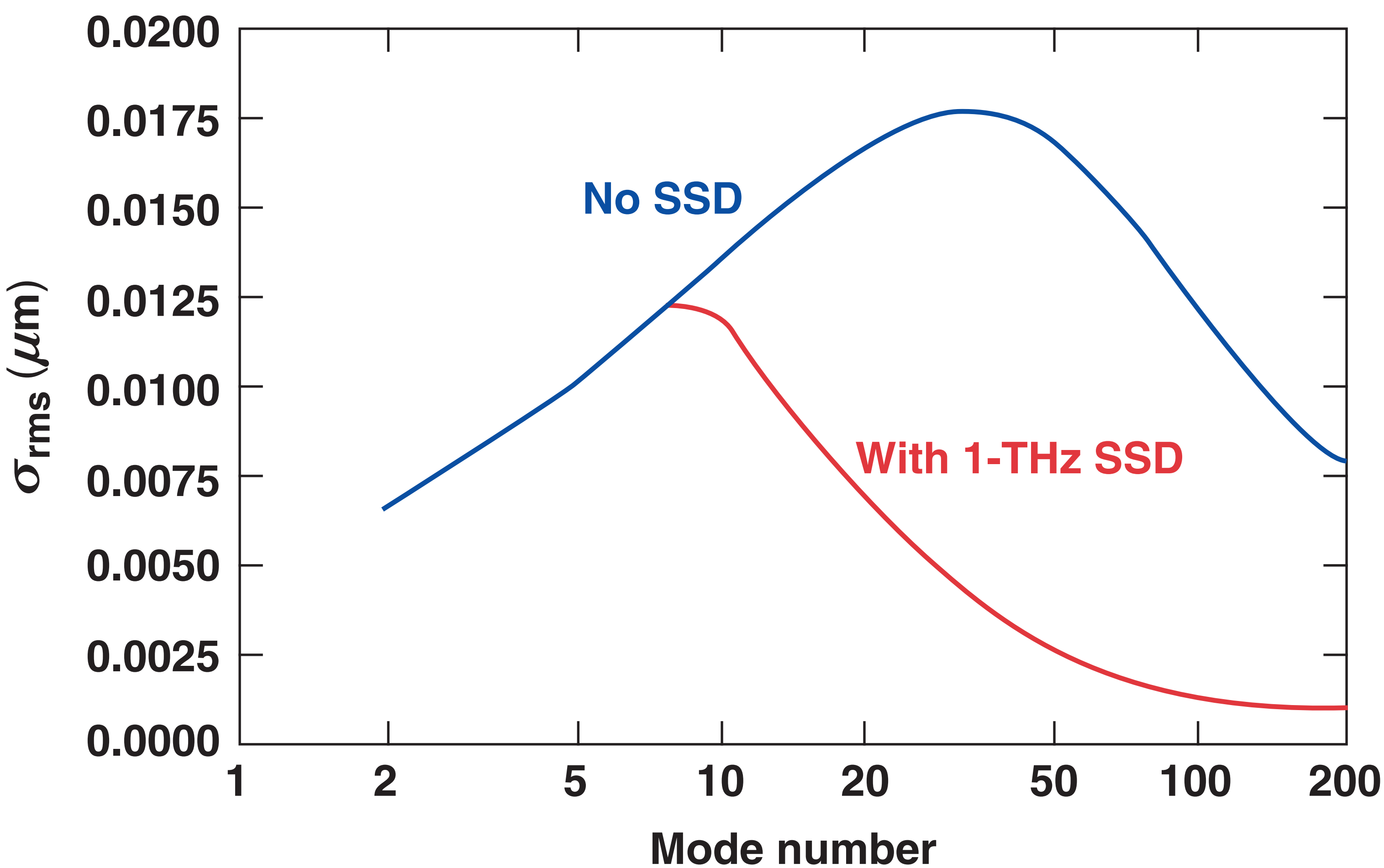
Summary/Conclusion

Low-α implosions of CH targets study the difference between 1-D and multidimensional performance

UR LLE

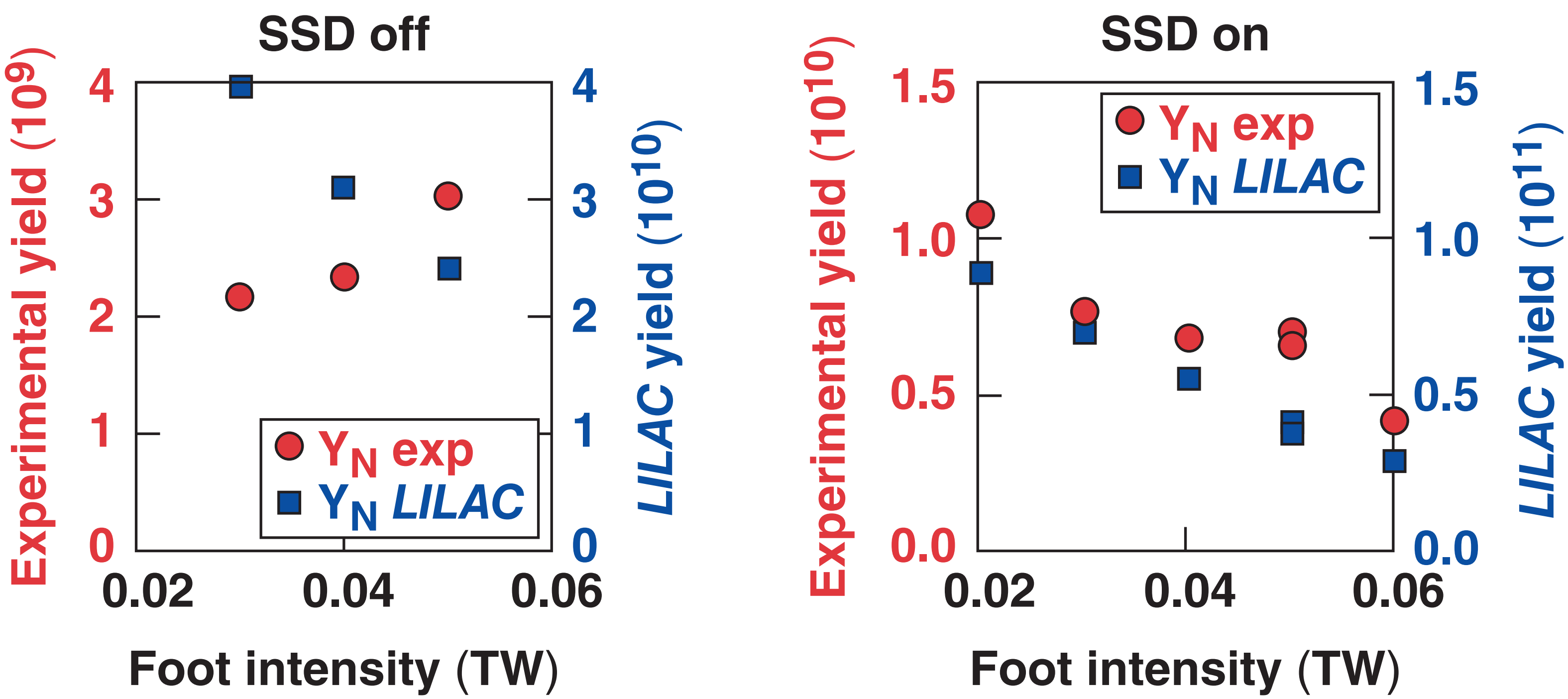
- **Both the flux-limited and the nonlocal electron models agree with the radius versus time data.**
- **Measured absorption agrees with a nonlocal electron transport model.**
- **2-D simulations confirm that best target performance should occur for an adiabat of about three.**
- **α = 3 implosions of 27-μm-thick shells show**
  - **a higher neutron yield than either the α = 2 or α = 5 implosions,**
  - **120-mg/cm^2 ρr for 15-atm D_2-filled shells, and**
  - **140-mg/cm^2 ρr for 3-atm D_2-filled shells.**

Ablation-surface perturbations were changed by switching SSD on and off



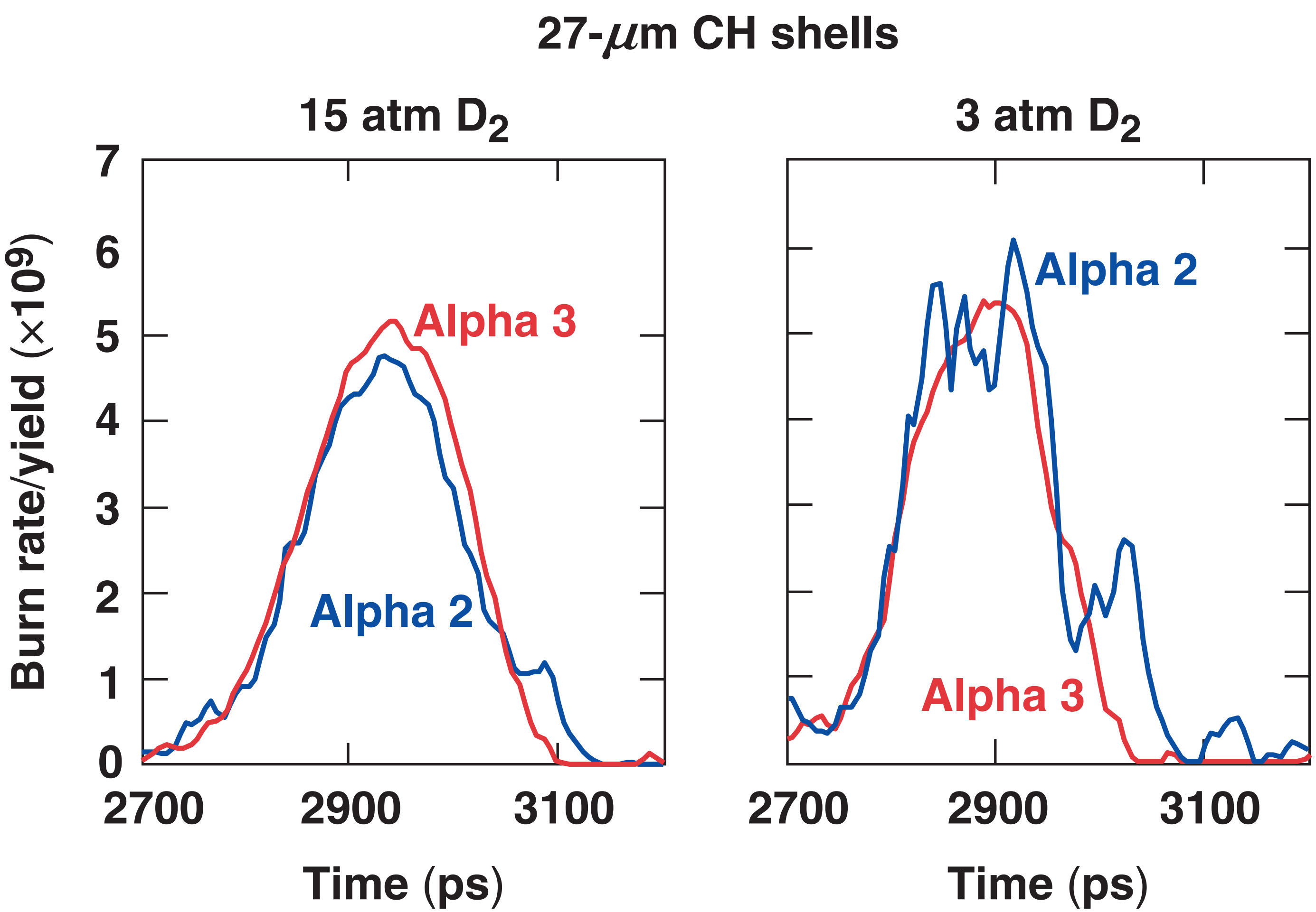
E14118

35-μm-thick shells imploded on an $\alpha = 2$ adiabat show 1-D–like behavior with SSD on



E14119

NTD data for both α = 2 and α = 3 show similar fractional burn rates



E14122