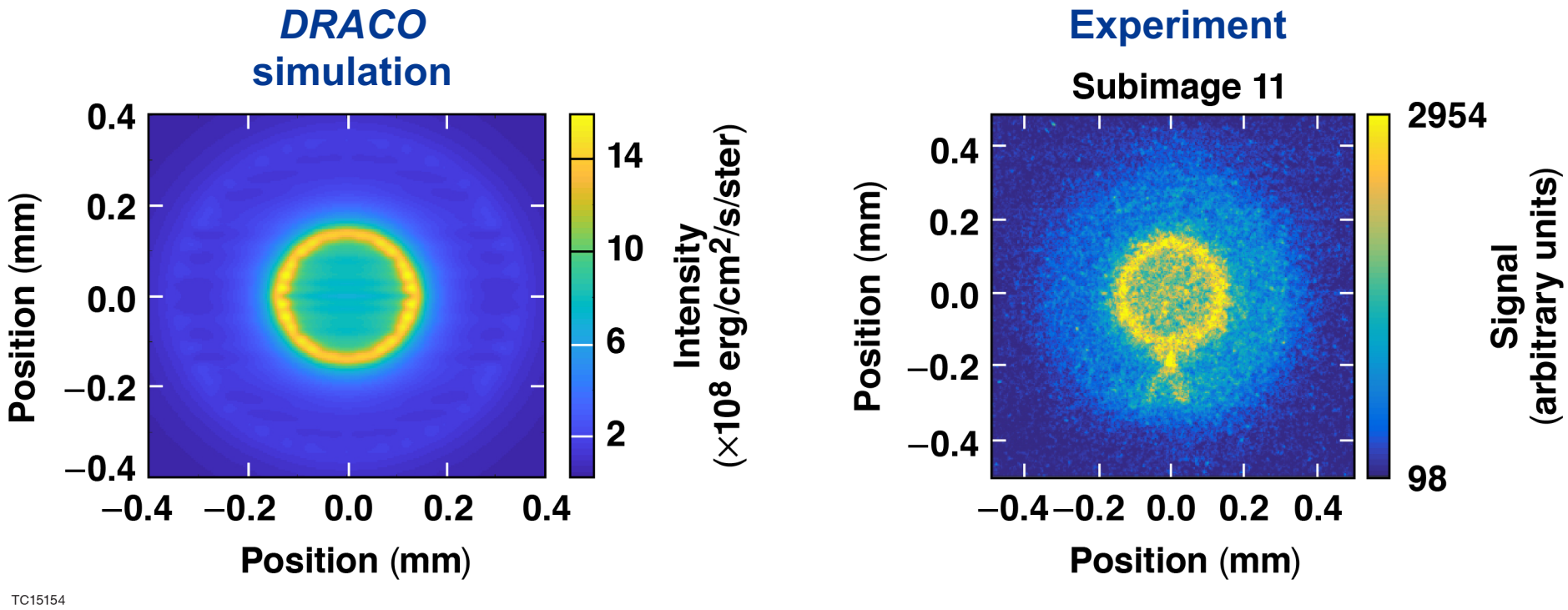
Understanding Laser-Imprint Effects on Cryogenic DT Implosions on OMEGA



S. X. Hu
University of Rochester
Laboratory for Laser Energetics

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Summary

Earlier core emission observed in low-adiabat cryo DT implosions can be explained by laser-imprint effects

- A dedicated experiment/simulation campaign has been conducted on OMEGA to quantify laser-imprint effects in cryo DT implosions
- By varying the adiabat of DT shell, we have investigated how laser imprint affects the shell integrity, inferred from the measured x-ray emission history in the hot spot and ablation front
- The earlier hot-spot emission observed in low-adiabat implosions has been reproduced by laser-imprint *DRACO* simulations

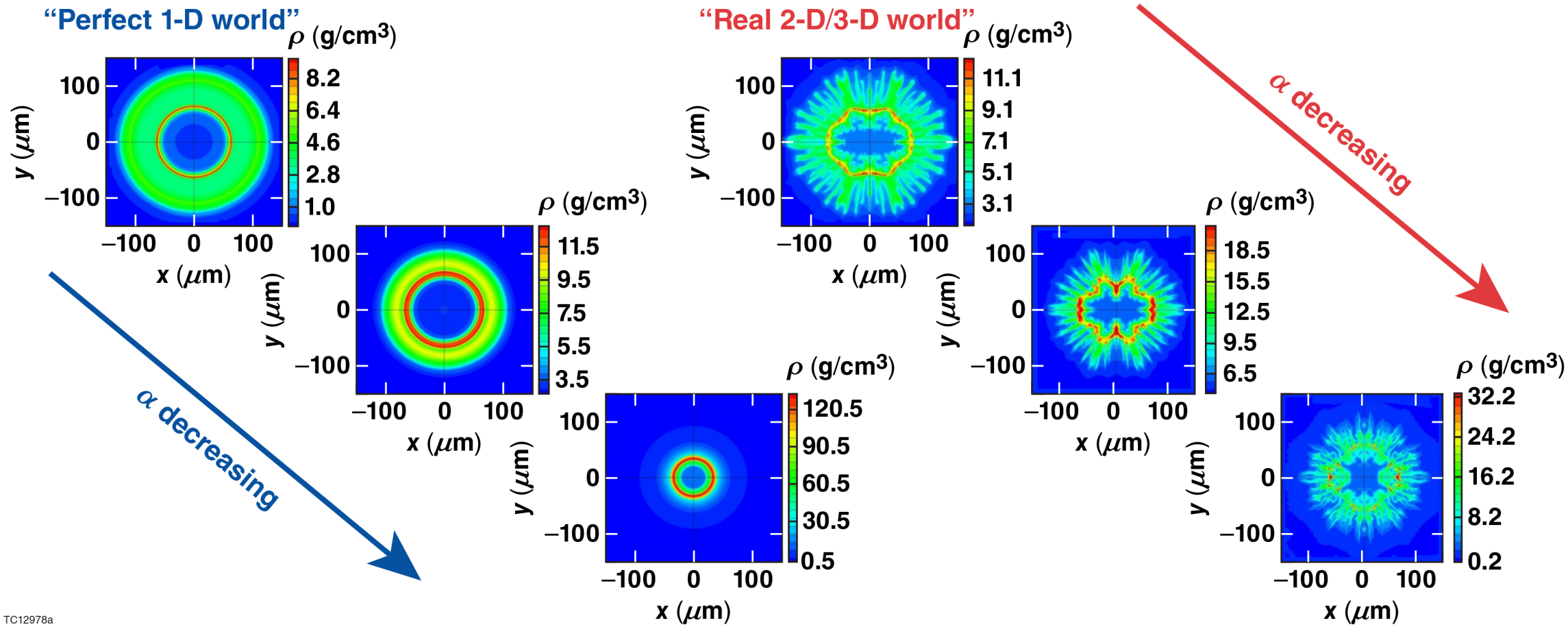
Mitigating laser imprint should be essential to enhance low-/mid-adiabat ($\alpha \leq 3.5$) target performance.

Collaborators

R. C. Shah, J. Baltazar, D. Cao, S. P. Regan, V. N. Goncharov, P. B. Radha, J. L. Peebles,
W. Theobald, R. Betti, and E. M. Campbell
University of Rochester
Laboratory for Laser Energetics

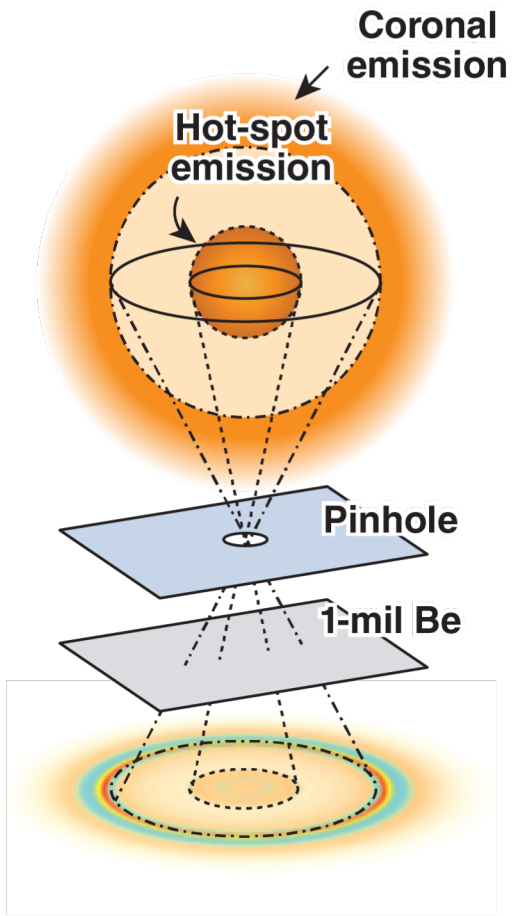
G. Duchateau, A. Casner, and V. T. Tikhonchuk
Centre Lasers Intenses et Applications,
Universite de Bordeaux-CNRS-CEA, France

Laser imprint* can seed the Rayleigh–Taylor instability, endangering the success of direct-drive–ignition attempts



* R. Ishizaki and K. Nishihara, Phys. Rev. Lett. 78, 1920 (1997);
V. A. Smalyuk *et al.*, Phys. Rev. Lett. 81, 5342 (1998);
V. N. Goncharov *et al.*, Phys. Plasmas 7, 2062 (2000);
S. Fujioka *et al.*, Phys. Rev. Lett. 92, 195001 (2004);
P. B. Radha *et al.*, Phys. Plasmas 12, 056307 (2005);
V. A. Smalyuk *et al.*, Phys. Rev. Lett. 103, 105001 (2009);
S. X. Hu *et al.*, Phys. Rev. Lett. 108, 195003 (2012);
G. Fiksel *et al.*, Phys. Plasmas 19, 062704 (2012);
A. Casner *et al.*, Phys. Plasmas 21, 122702 (2014);
M. Karasik *et al.*, Phys. Rev. Lett. 114, 085001 (2015).

The x-ray self-emission imaging technique* has been used to study laser-imprint effects on warm CH target implosions** on OMEGA



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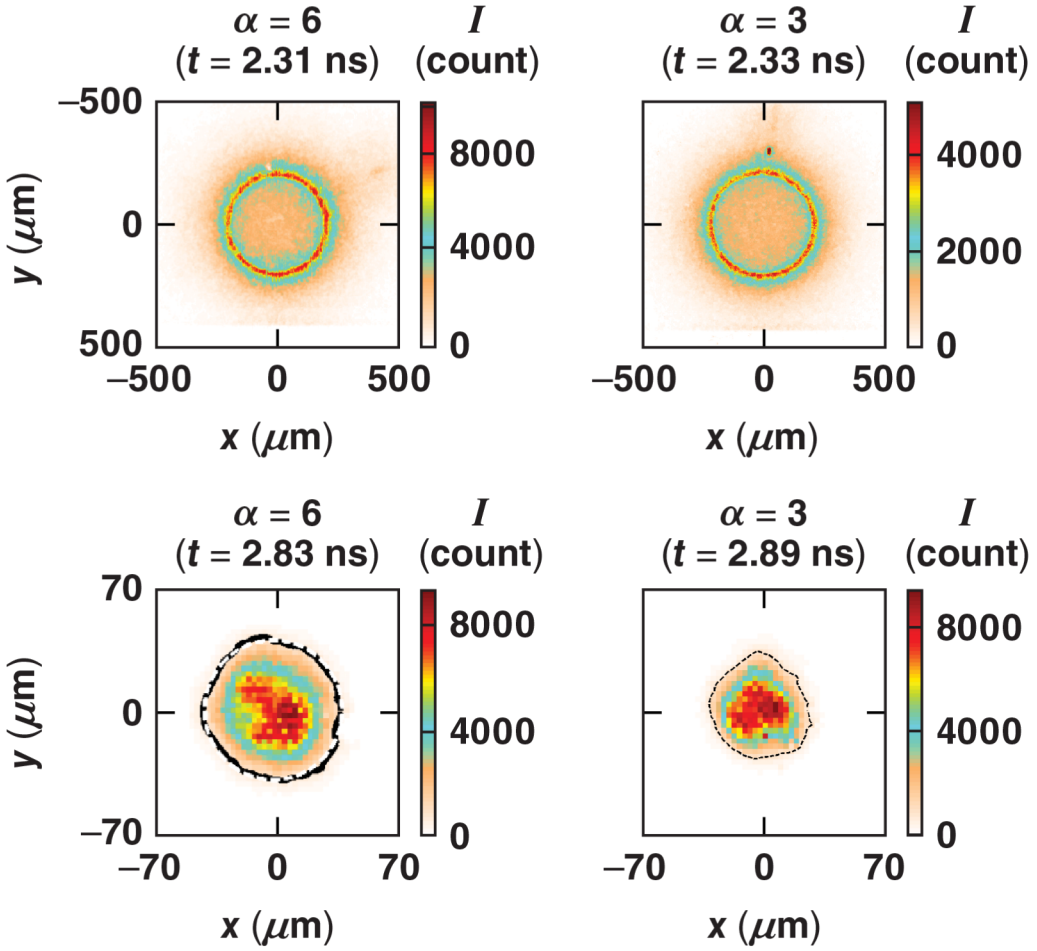
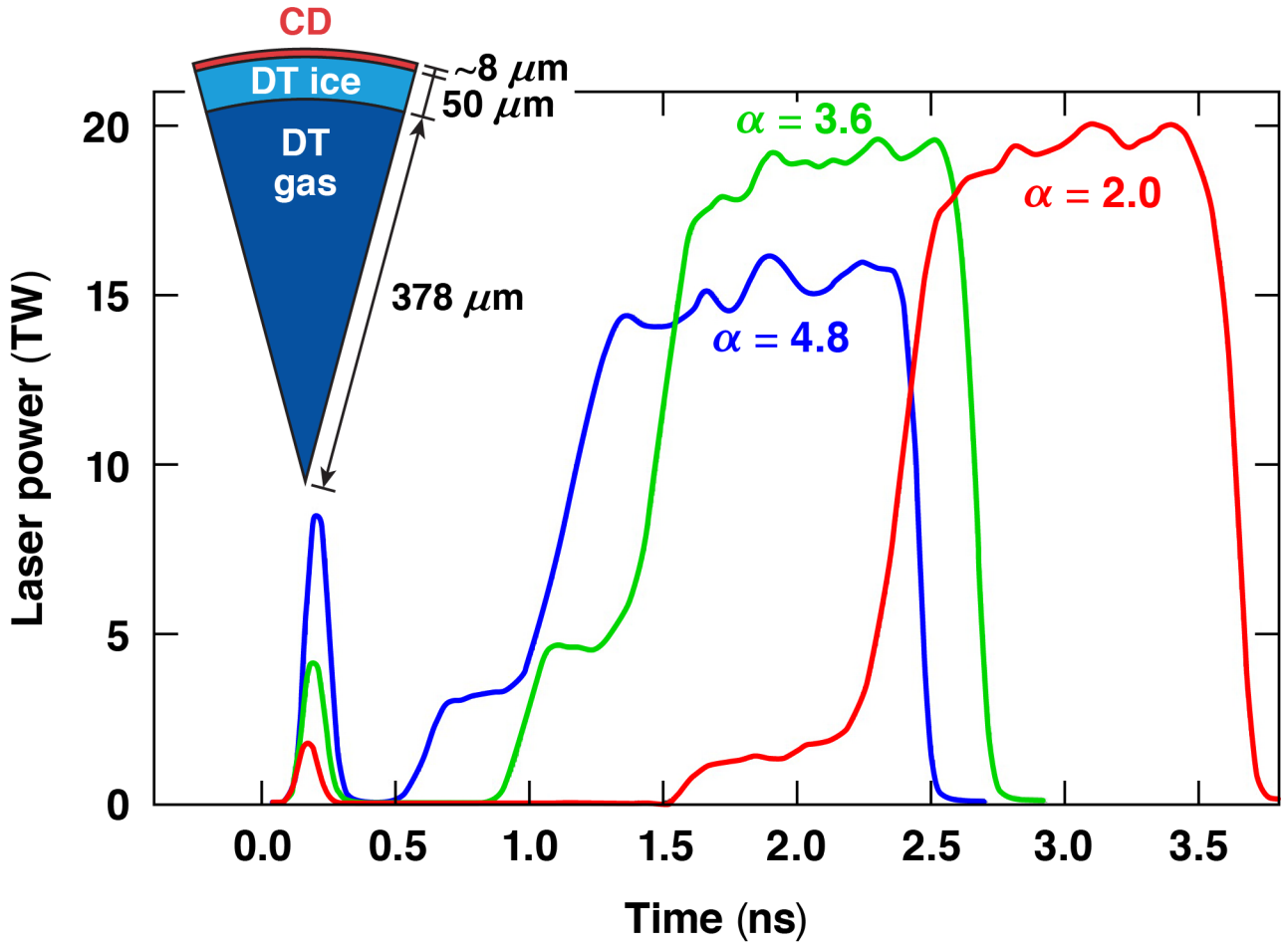


* D. T. Michel *et al.*, Rev. Sci. Instrum. 83, 10E530 (2012).
**S. X. Hu *et al.*, Phys. Plasmas 23, 102701 (2016);
D. T. Michel *et al.*, Phys. Rev. E 95, 051202(R) (2017).

Using the same self-emission imaging technique, we have investigated laser-imprint effects on cryogenic DT implosions on OMEGA

The laser -imprint effect is expected to increase for low-adiabat implosions.

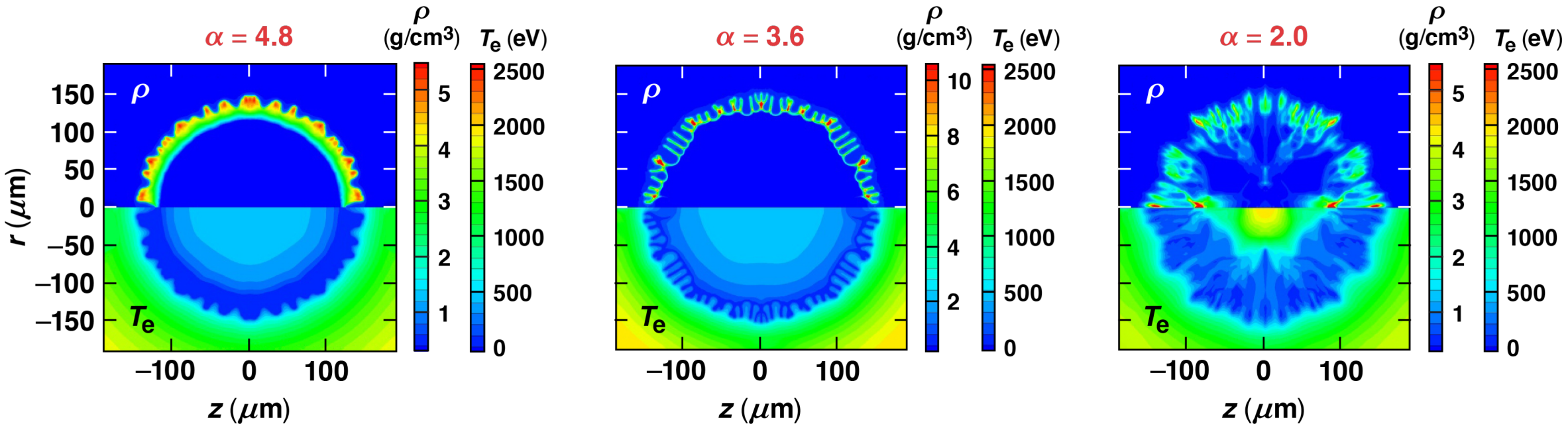


TC15155

High-mode *DRACO* simulations with laser imprint (up to $\ell_{max} = 150$) show significant distortion of the DT shell for low-adiabat implosions even with SSD on

DRACO: NL + CBET + FPMP + port geometry + ice roughness + laser imprint

Hot spot lights up earlier



TC15156

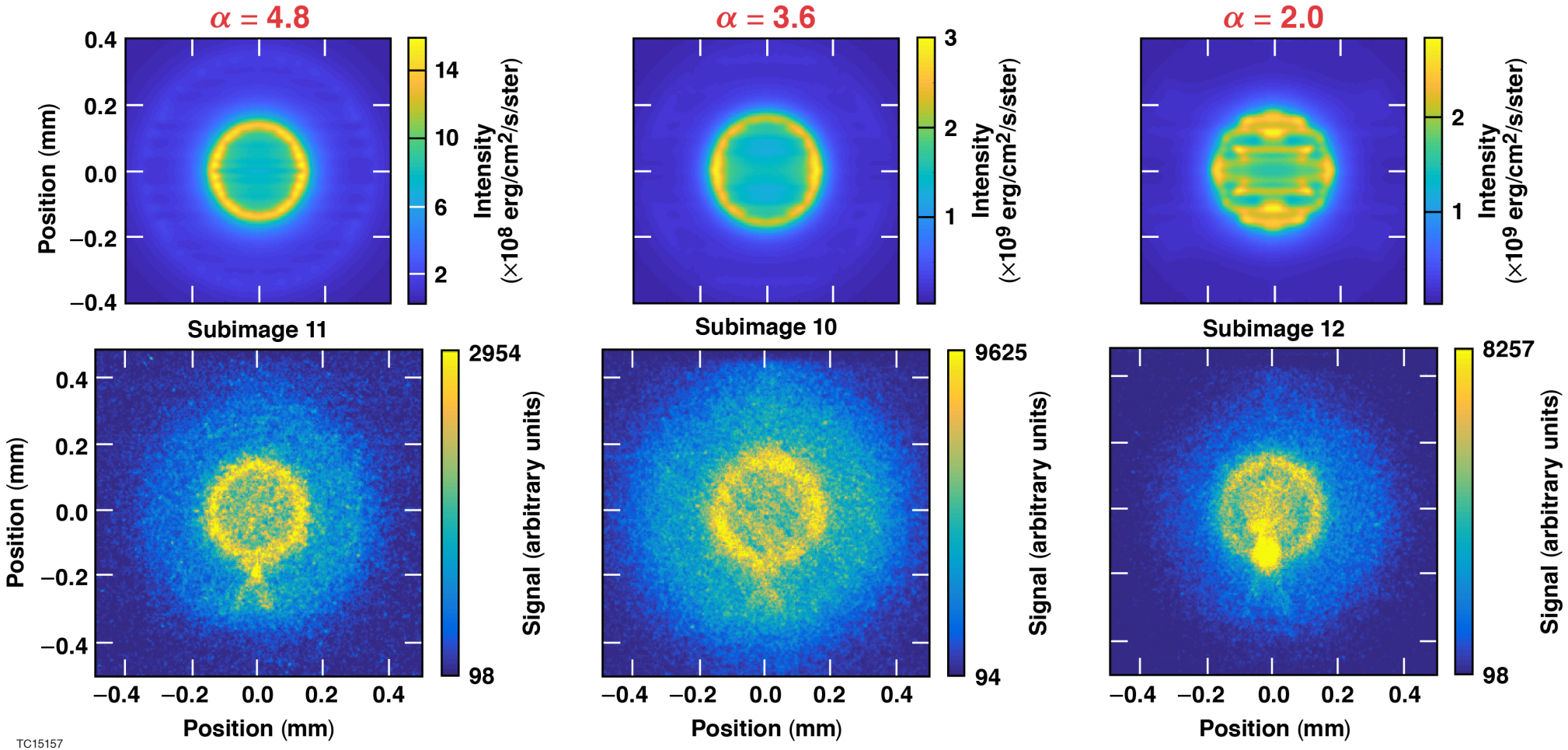
SSD: smoothing by spectral dispersion
NL: nonlocal
FPMP: first-principles material properties

Spect3D post-processing of laser-imprint *DRACO* simulations are directly compared with experimental x-ray images

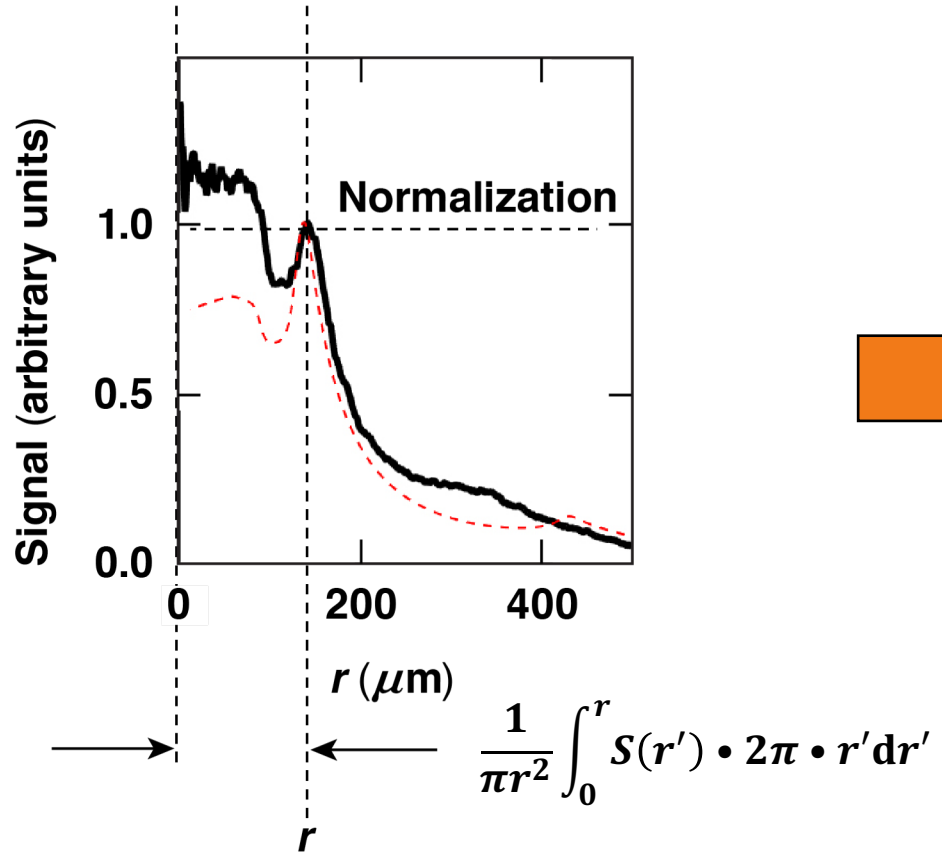
Times when the DT outer radius is converges to $R \sim 150\ \mu m$

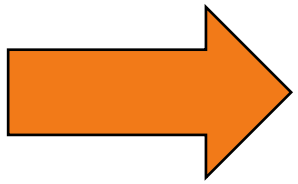
DRACO simulations

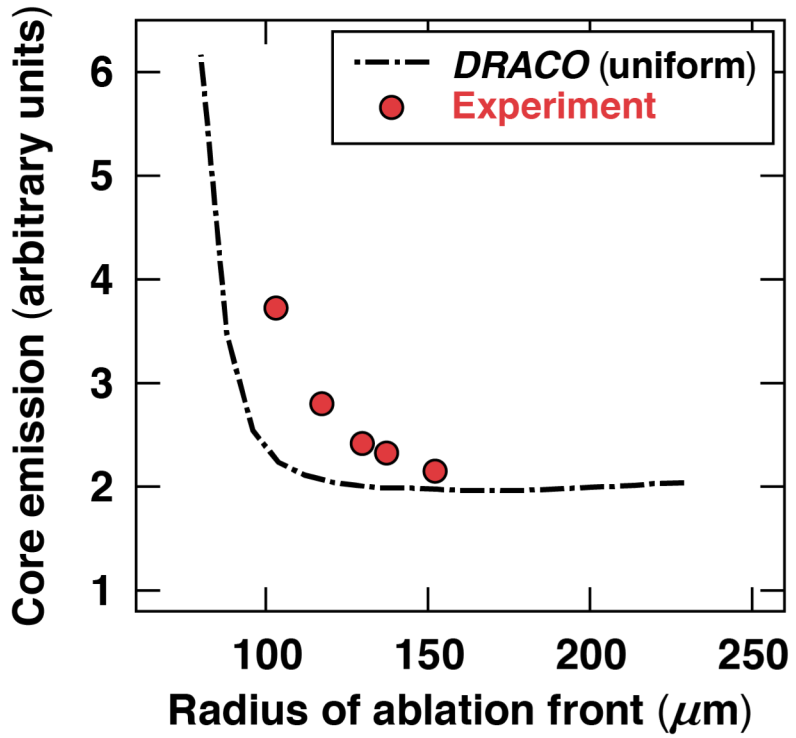
Experiments



Quantitative comparisons of x-ray emission signals from hot spots can be performed between *DRACO* simulations and experimental measurements

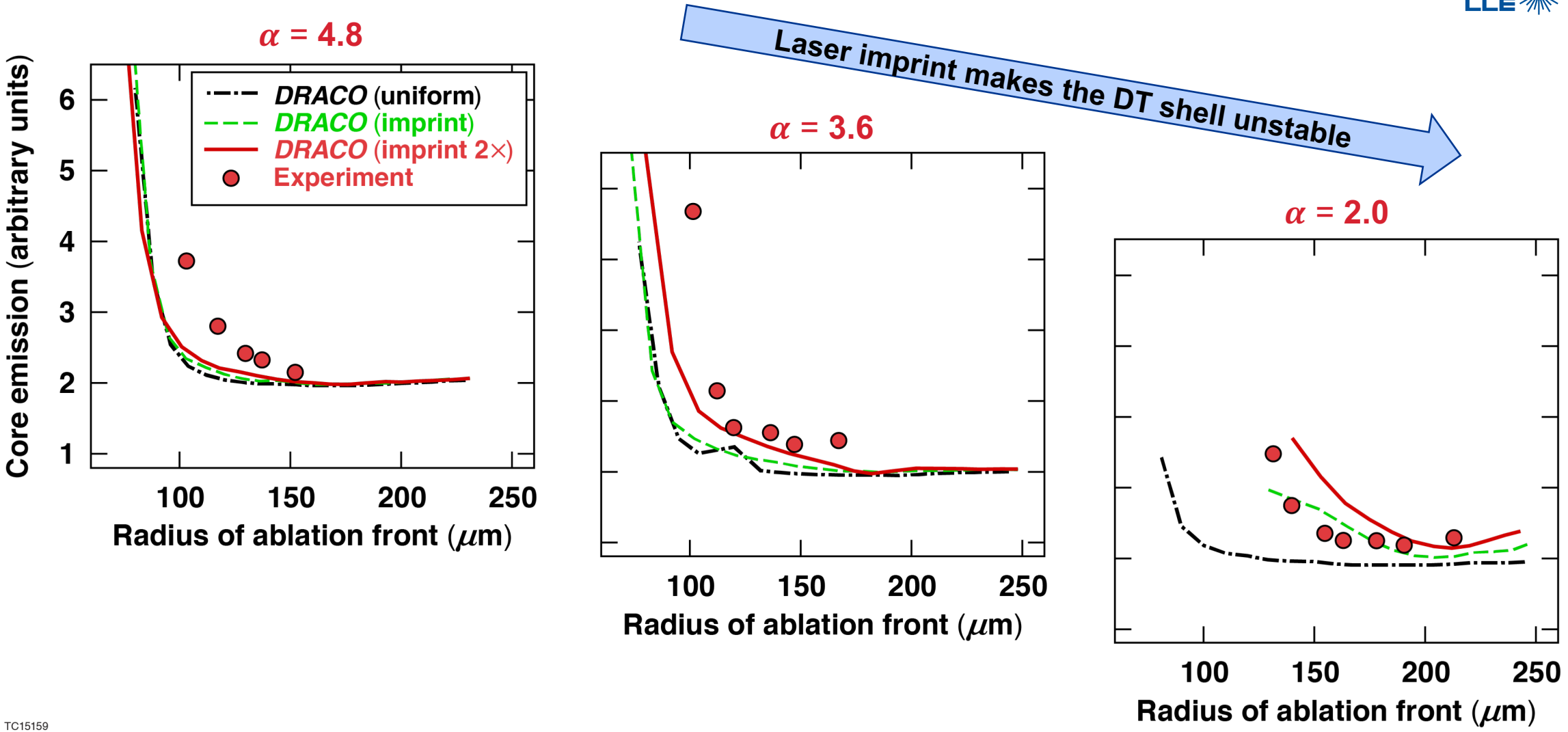






TC15158

The observed earlier core emission in low-adiabat cryo DT implosions can be explained by laser-imprint effects



TC15159

Laser-imprint effects on the degrading cryo DT target performance can be quantified in *DRACO* simulations

	α = 4.8	α = 3.6	α = 2.0
	(Uniform/imprint)	(Uniform/imprint)	(Uniform/imprint)
Neutron bang time (ns) [Width (ps)]	2.61/2.57 (61 ps/55 ps)	2.84/2.70 (52 ps/75 ps)	3.81/3.53 (50 ps/229 ps)
Yield ($\times 10^{13}$)	7.6/5.3	18.8/5.38	27.9/1.08
$\langle \rho R \rangle_n$ (mg/cm^2)	204.5/187.1	200/91.7	252.3/44.6
$\langle T_i \rangle_n$ (keV)	3.38/3.54	4.08/4.90	4.05/3.23

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Thank You

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