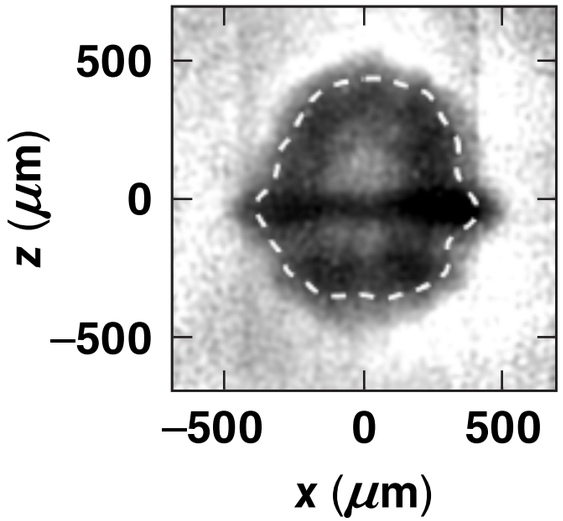
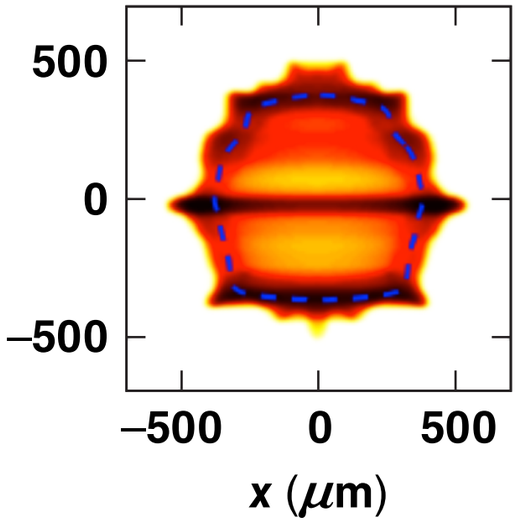
Signatures of Cross-Beam Energy Transfer Mitigation in Proof-of-Principle National Ignition Facility Direct-Drive Experiments

Radiograph of NIF direct-drive shot N160821-001

$\Delta\lambda = \pm 2.3$Å (UV)



Simulated radiograph



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58th Annual Meeting of the
American Physical Society
Division of Plasma Physics
San Jose, CA
31 October–4 November 2016

Summary

A measured ring around the equator in radiographs confirms that cross-beam energy transfer (CBET) has been reduced in direct-drive National Ignition Facility (NIF) experiments

- The first set of wavelength-detuned direct-drive NIF implosions used $\Delta\lambda = \pm 2.3$ Å (UV) for the beams crossing across the northern and southern hemispheres
- The high x-ray absorption ring at the equator was predicted and corresponds to accumulation of mass caused by the higher pressures just above and below the equator as a result of CBET mitigation
- These experiments are a first demonstration that detuning wavelengths can reduce CBET in direct drive

TC13161

J. A. Marozas *et al.*, NO5.00009, and M. Hohenberger *et al.*, UO9.00009, this conference.

Collaborators

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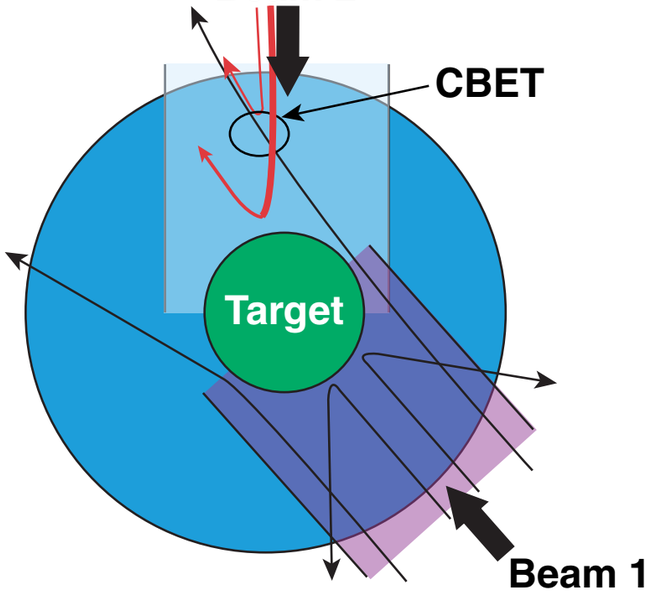
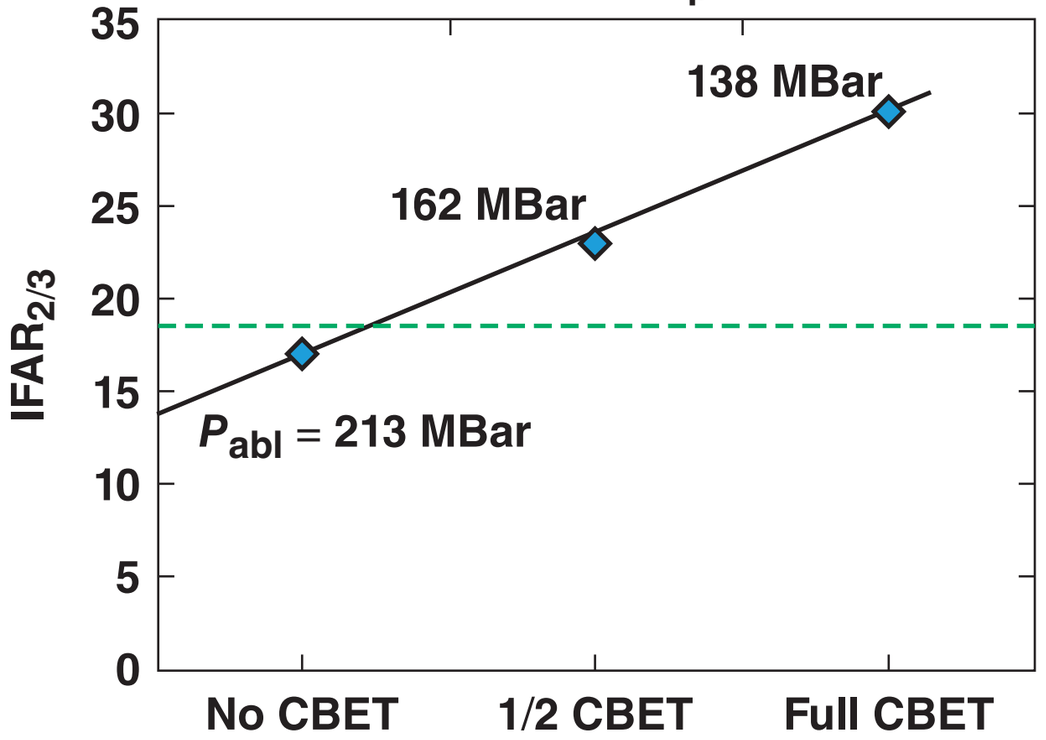
Mitigating CBET is essential for achieving stable, high-convergence direct-drive implosions

Hot-spot pressure: $P_{hs} \sim P_a \text{IFAR}^{5/3}$ IFAR = $R/\Delta R$

CBET schematic



OMEGA designs* with $V_{imp} = 3.7 \times 10^7$ cm/s

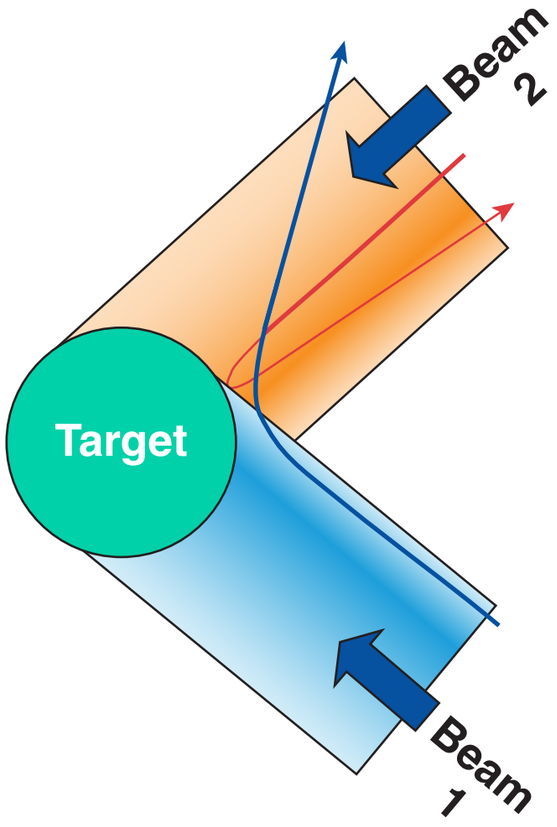


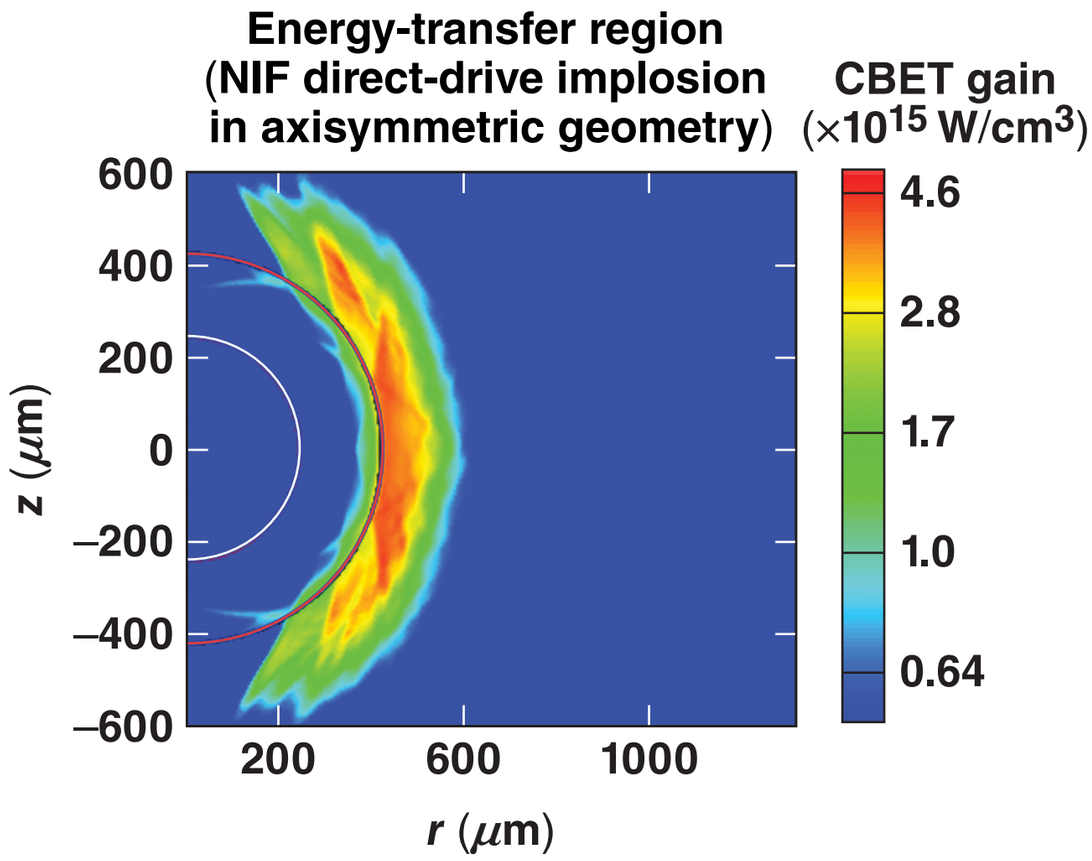
- 1/2 CBET corresponds to simulation with factor of 1/2 in CBET growth rate

V. N. Goncharov *et al.*, Phys. Plasmas 21, 056315 (2014).

TC13162

CBET is dominant near the equatorial region in the axisymmetric NIF geometry





P. B. Radha *et al.*, Phys. Plasmas 23, 056305 (2016).

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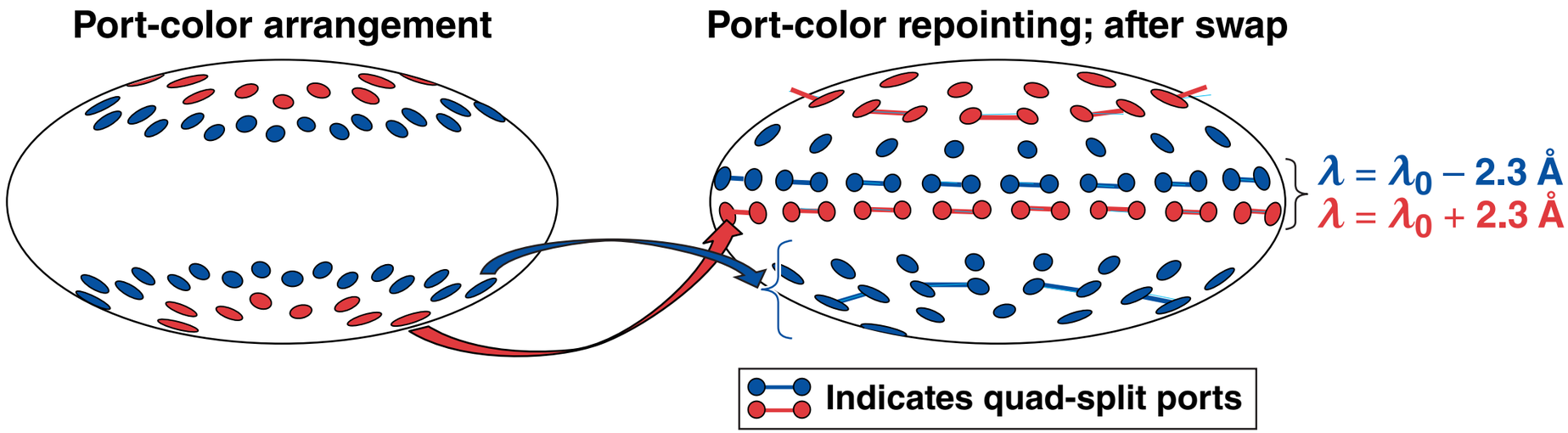
Proof-of-concept CBET mitigation direct-drive implosions were conducted on the NIF

- The NIF color arrangement can be exploited to arrange different wavelengths across the hemispheres at the equator, reducing CBET

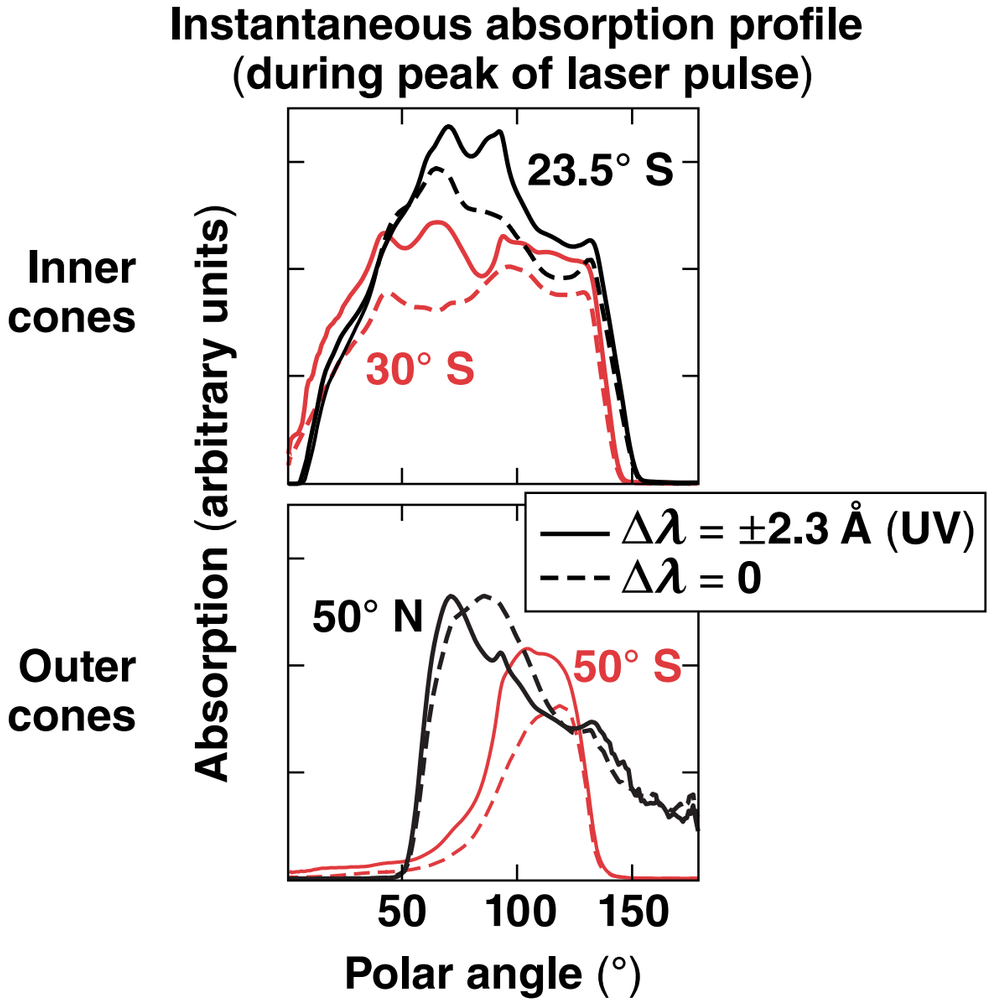


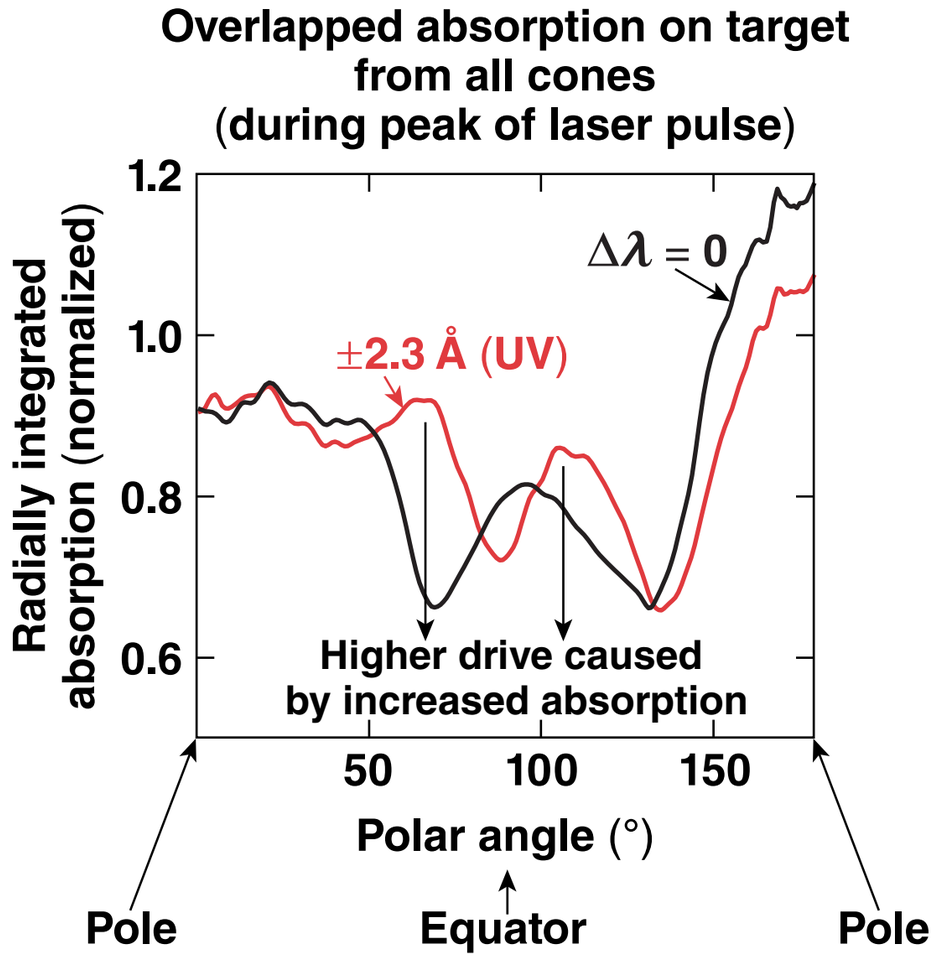
- Implosions use other NIF hardware: indirect-drive–ignition phase plates, NIF beam smoothing
- Pulse shapes are adjusted to improve symmetry
- A minimum of ±6 Å (UV) was previously used for direct-drive–ignition designs**

*S. H. Glenzer *et al.*, Science 327, 1228 (2010); P. Michel *et al.*, Phys. Rev. Lett. 102, 025004 (2009).
**T. J. B. Collins *et al.*, presented at the 57th Annual Meeting of the APS Division of Plasma Physics, Savannah, GA, 16–20 November 2015.

TC11736g

Distinct differences in the laser-absorption profile are simulated with and without wavelength detuning





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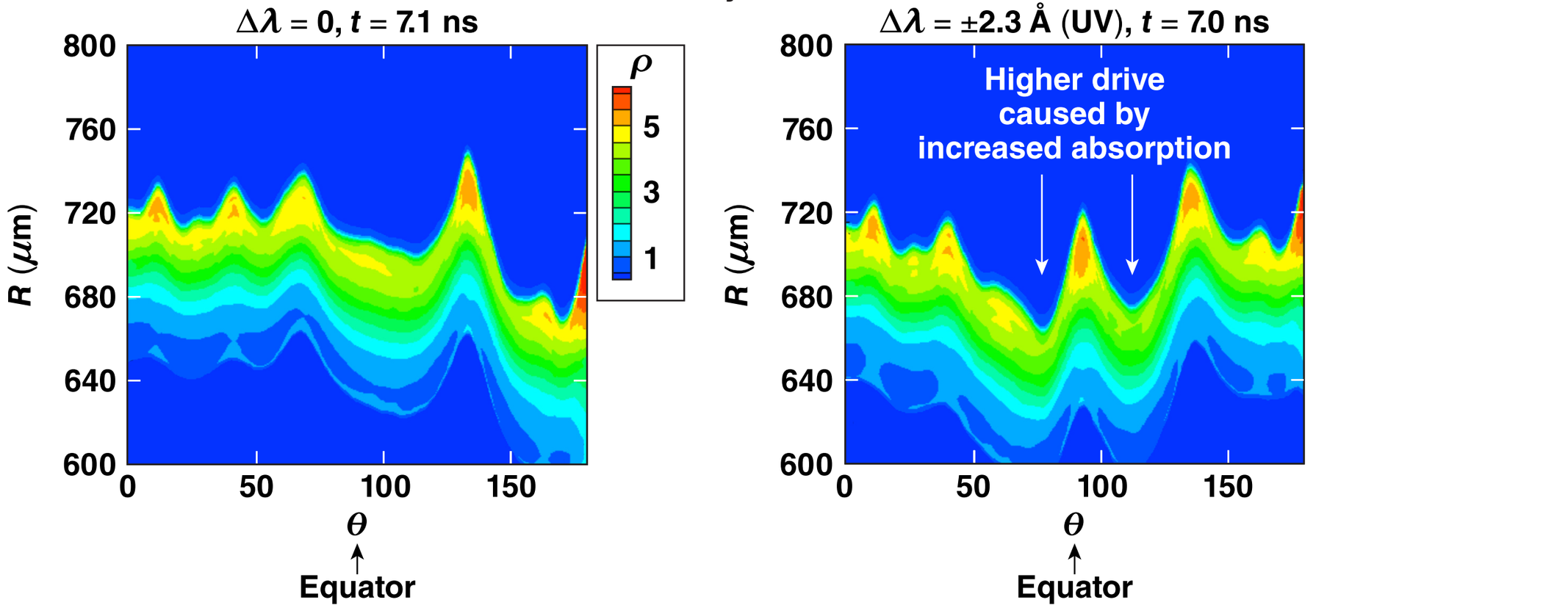
Pressure gradients caused by enhanced absorption from CBET mitigation drive mass accumulation near the equator

DRACO simulation (3-D ray trace* with CBET model,** nonlocal transport,† first-principles EOS‡)
Mass-density contours



EOS: equation of state

*J. A. Marozas *et al.*, Bull. Am. Phys. Soc. 51, 107 (2006).

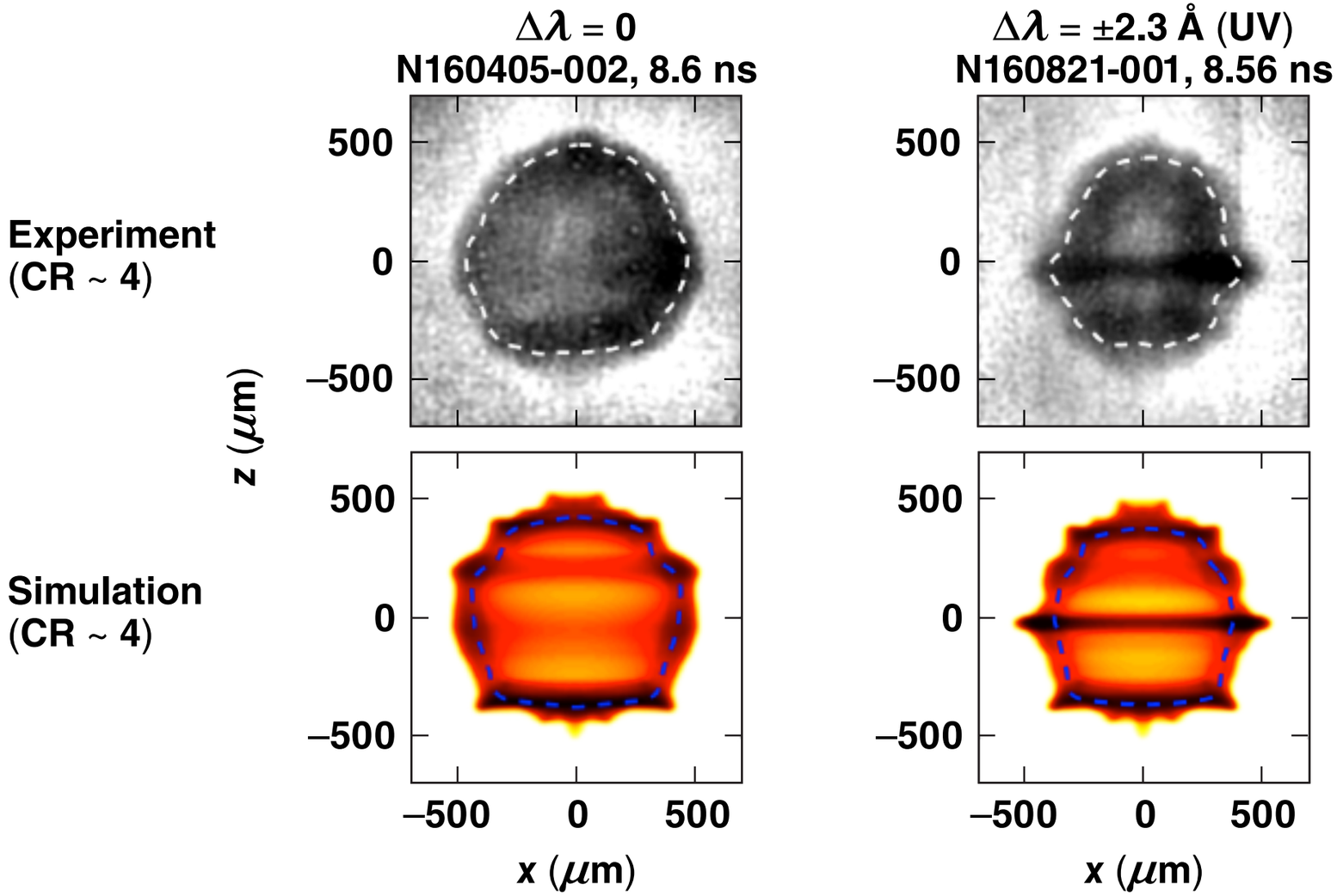
**J. A. Marozas *et al.*, Bull. Am. Phys. Soc. 56, 241 (2011).

†D. Cao, G. Moses, and J. Delettrez, Phys. Plasmas 22, 082308 (2015).

‡S. X. Hu *et al.*, Phys. Rev. Lett. 104, 235003 (2010).

TC13165

The mass accumulation around the equator is also observed in the experiment



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Summary/Conclusions

A measured ring around the equator in radiographs confirms that cross-beam energy transfer (CBET) has been reduced in direct-drive National Ignition Facility (NIF) experiments

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- The high x-ray absorption ring at the equator was predicted and corresponds to accumulation of mass caused by the higher pressures just above and below the equator as a result of CBET mitigation
- These experiments are a first demonstration that detuning wavelengths can reduce CBET in direct drive
- Variations in this ring will be studied in January 2017 with either different pointing, beam energies, or different wavelengths across the hemispheres

TC13161

J. A. Marozas *et al.*, NO5.00009, and M. Hohenberger *et al.*, UO9.00009, this conference.