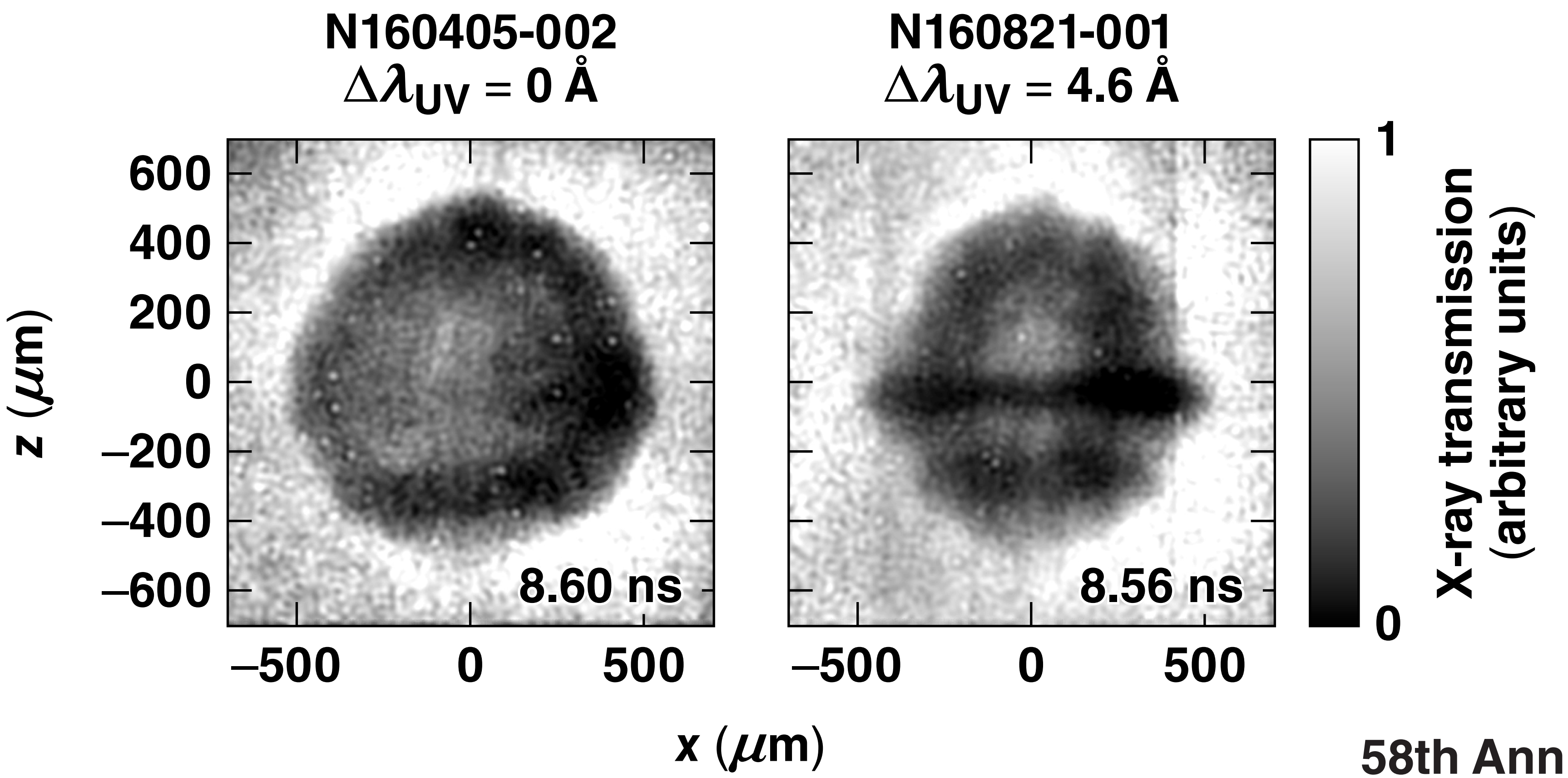
Experimental Investigation of Cross-Beam Energy Transfer Mitigation via Wavelength Detuning in Directly Driven Implosions at the National Ignition Facility



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Summary

We have successfully reduced energy losses from cross-beam energy transfer (CBET) via wavelength detuning in directly driven implosions at the National Ignition Facility (NIF)

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NIF

- CBET is a primary energy-loss mechanism in directly driven implosions
- $\Delta\lambda$ detuning of interacting beams is the main mitigation strategy for CBET, but the NIF's current capabilities for its implementation are limited
- A hemispheric $\Delta\lambda$ in polar-direct-drive (PDD) implosions was achieved by means of NIF's wavelength capabilities between inner and outer quads
- Enhanced energy coupling is observed by means of shell trajectory, shape, and hard x-ray emission

First experimental demonstration of CBET mitigation by means of wavelength detuning in direct drive.

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Collaborators

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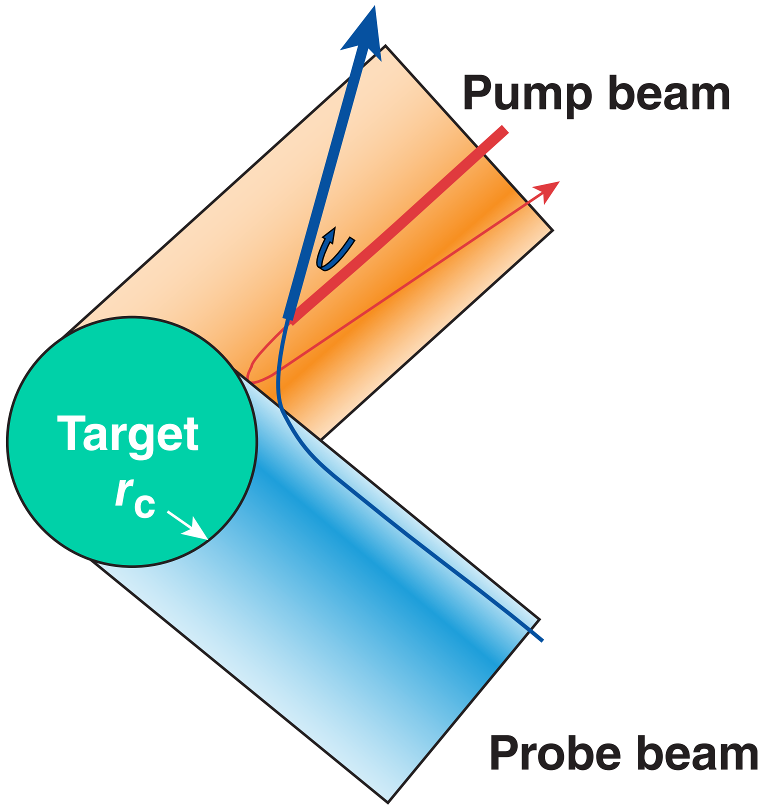
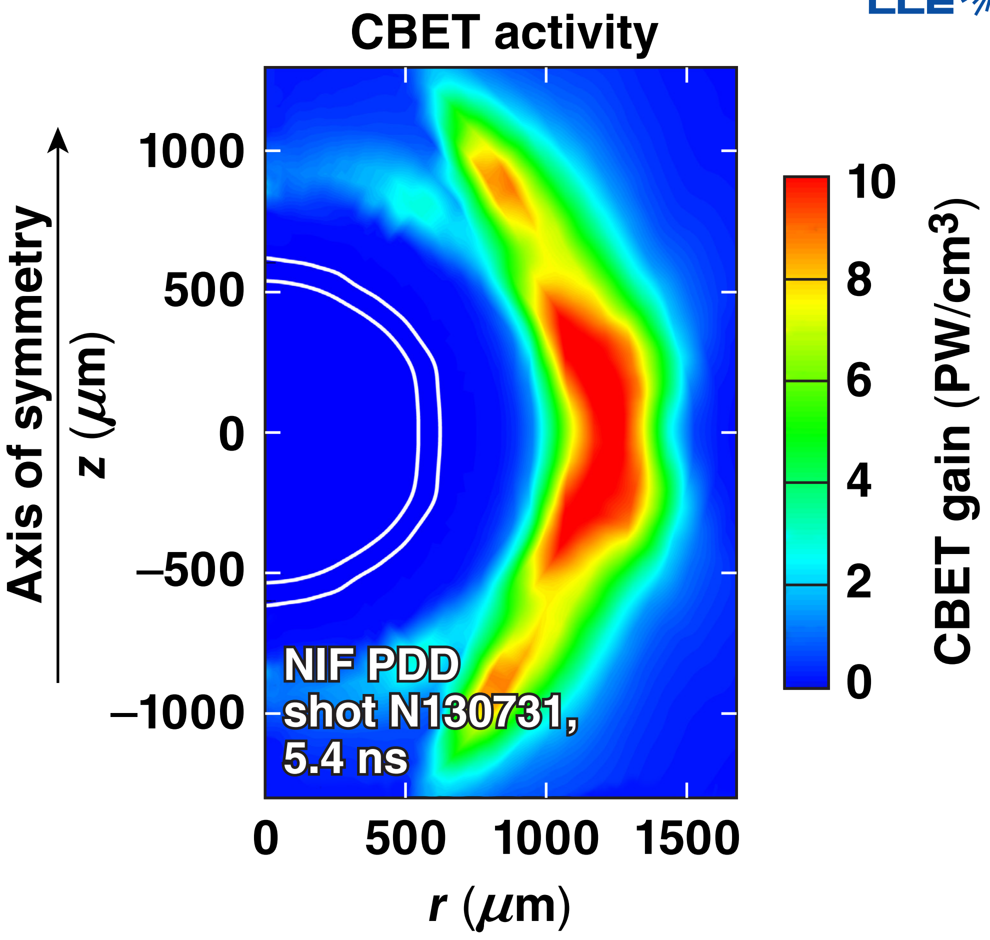
CBET is a main energy-loss mechanism in direct-drive inertial confinement fusion (ICF) experiments



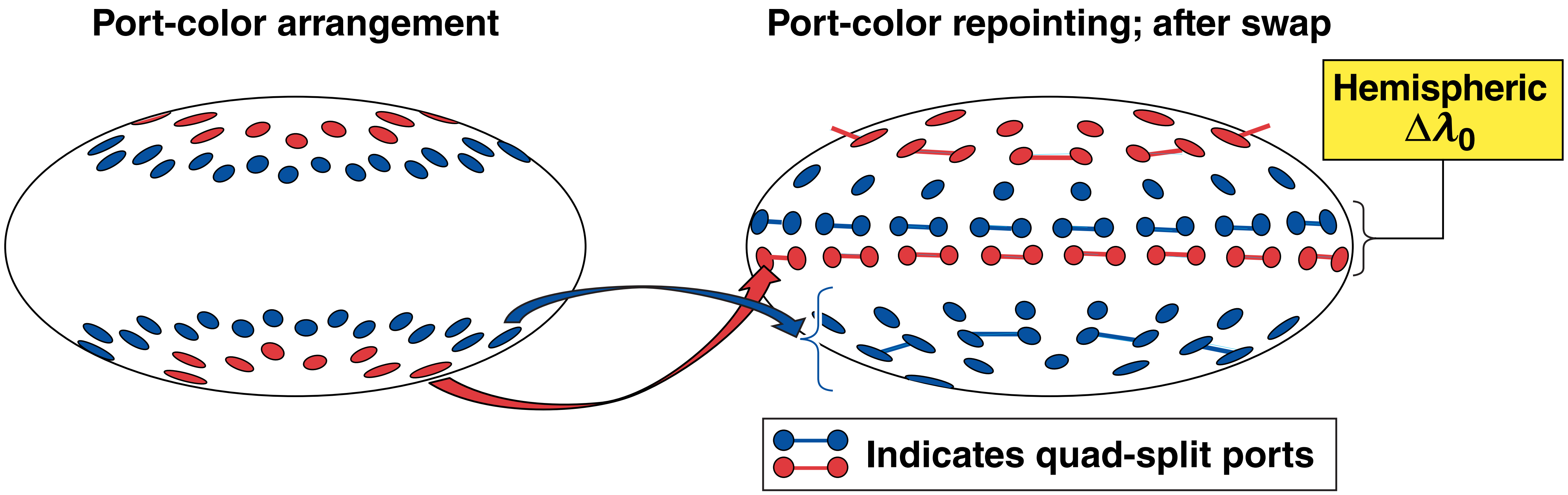


- CBET reduces laser drive energy by ~30%
- Wavelength detuning shifts the resonance location sufficiently to mitigate CBET*
- CBET mitigation increases with $\Delta\lambda$

*I. V. Igumenshchev *et al*., Phys. Plasmas 17, 122708 (2010);
J. A. Marozas *et al*., NO5.00009, this conference;
P. B. Radha *et al*., NO5.00005, this conference.

The current NIF can achieve hemispheric detuning using a cone-swapped PDD beam pointing in one hemisphere*

- $\Delta\lambda_{UV}$ = 12 Å (±6 Å) is required for CBET mitigation
- The current NIF can test hemispheric detuning using a north–south asymmetric beam pointing with up to $\Delta\lambda_{UV}$ = 4.6 Å (±2.3 Å)



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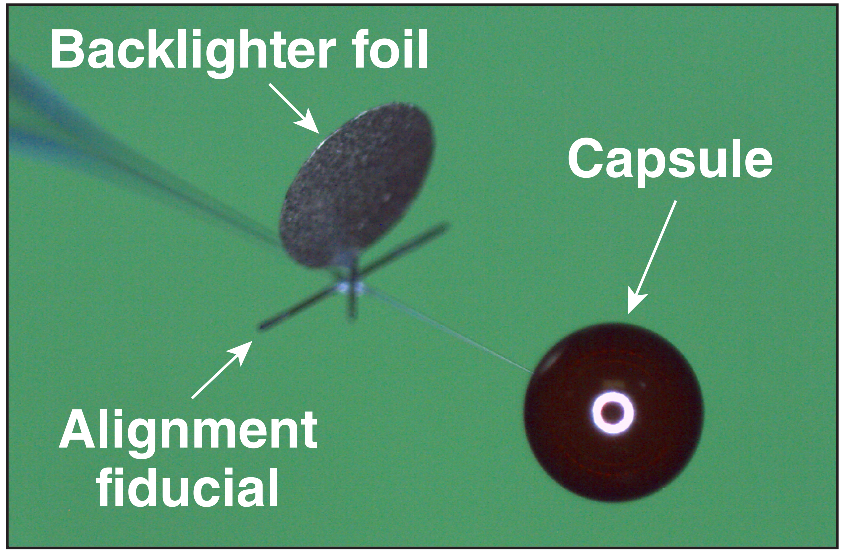
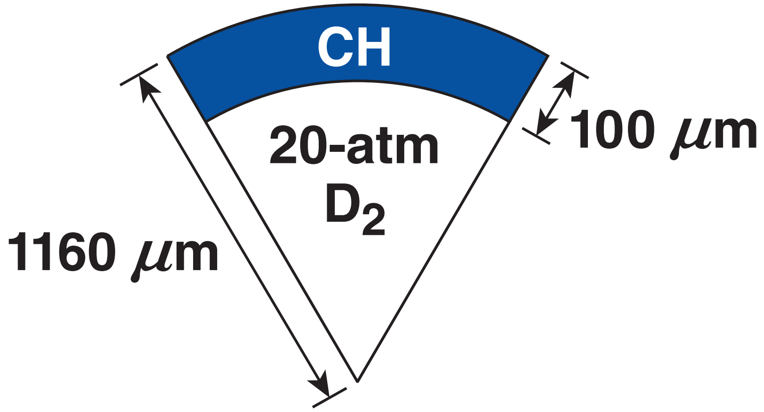
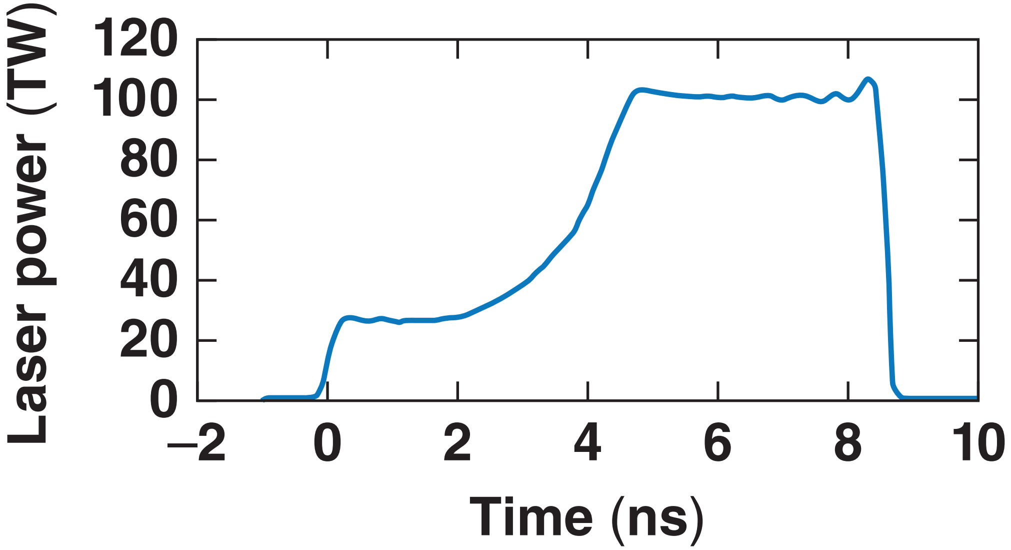
*J. A. Marozas *et al.*, NO5.00009, this conference.

CBET mitigation with hemispheric $\Delta\lambda$ was diagnosed in directly driven implosions by means of implosion trajectory and shape







- Fe backlighter for face-on, x-ray radiography (Fe He$_\alpha$ = 6.7 keV) driven by Q16T and Q41B
- Self-emission imaging without backlighter uses all 48 quads for CH implosion

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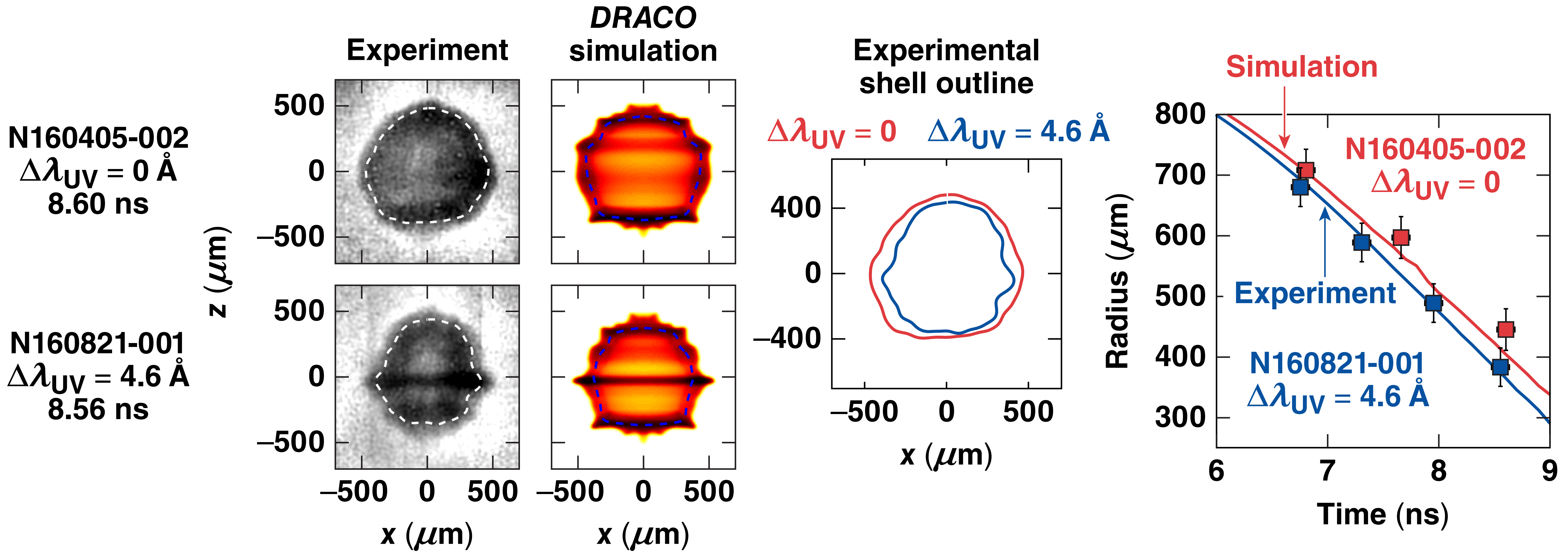
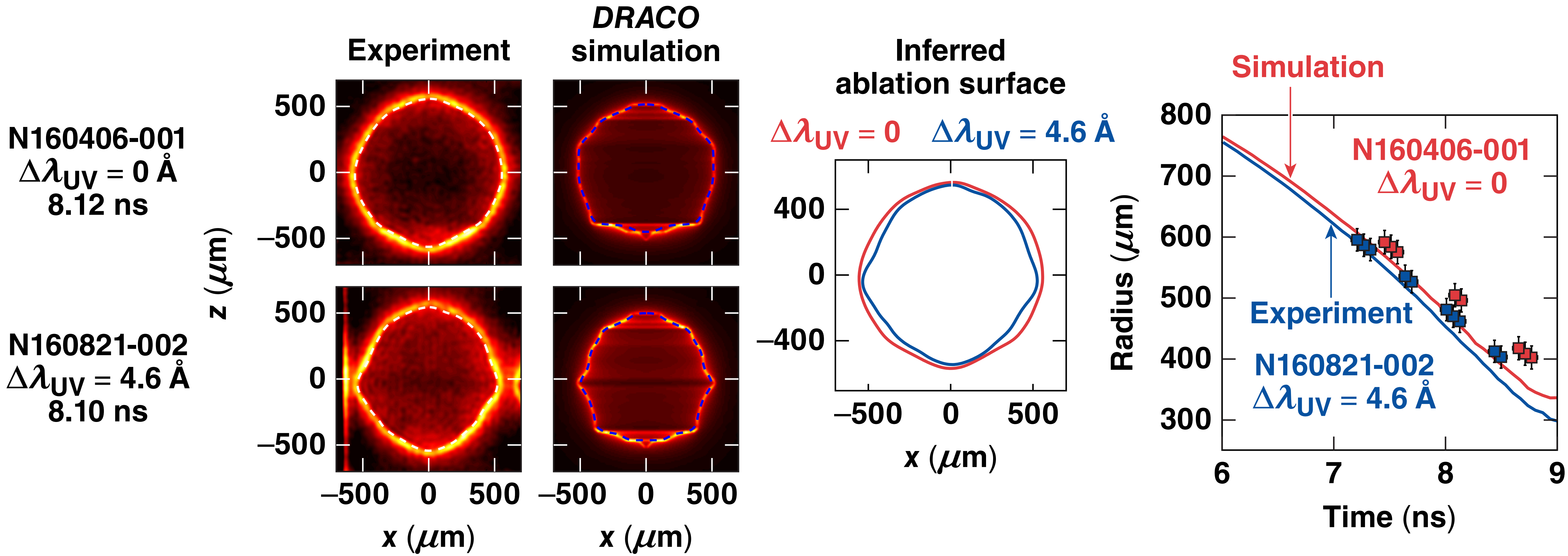
X-ray radiography data exhibit changes to the azimuthal energy absorption and an increased shell velocity in the presence of $\Delta\lambda$ = 4.6 Å



Self-emission data also exhibit increased absorption around the target equator for $\Delta\lambda$ = 4.6 Å



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

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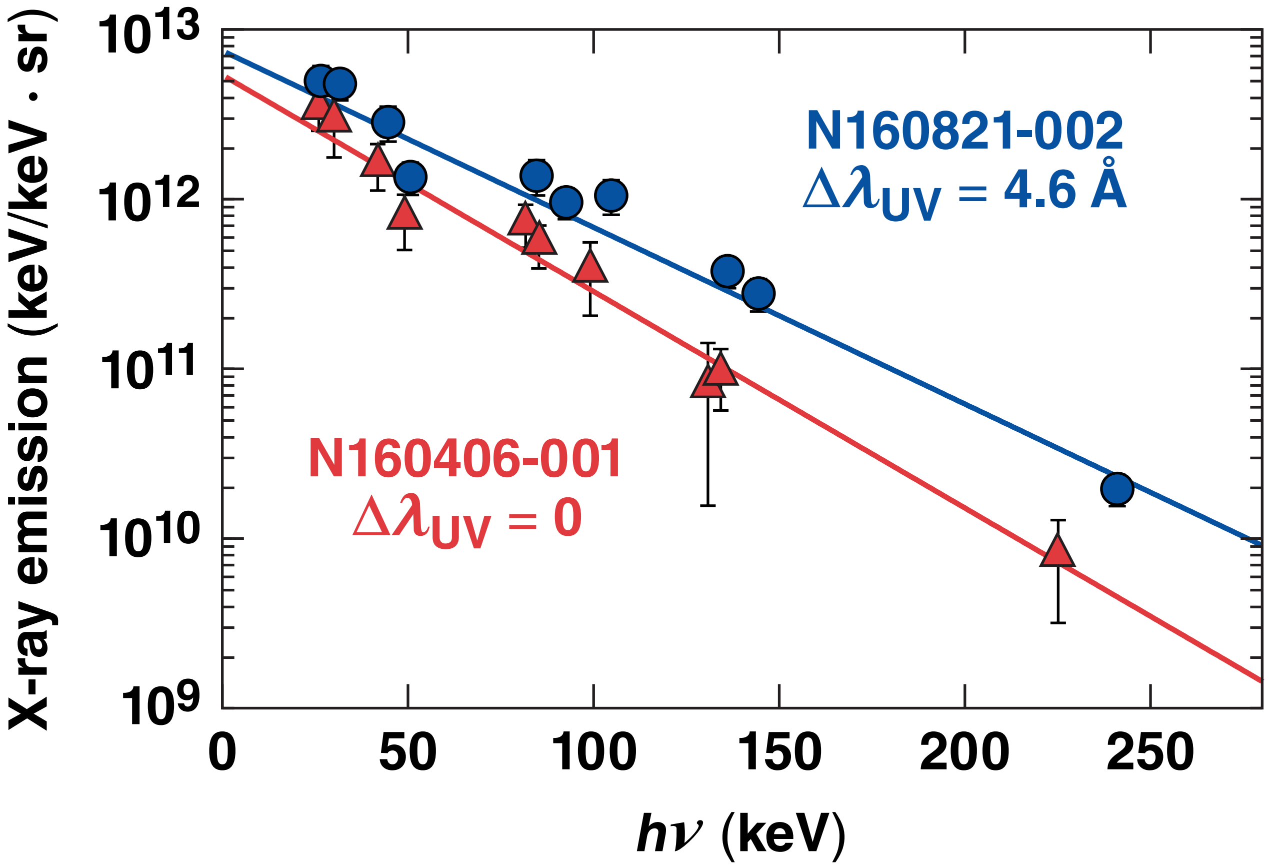
Enhanced hard x-ray emission in the presence of $\Delta\lambda$ = 4.6 Å is consistent with less laser energy lost as a result of CBET



	N160406-001 $\Delta\lambda$ = 0 Å	N160821-002 $\Delta\lambda$ = 4.6 Å
T_{hot} (keV)	34±3	42±2
E_{hot} (kJ)	0.74±0.19	1.03±0.13
f_{hot} (%)	0.13±0.03	0.17±0.02

The hot-electron fraction inferred through hard x-ray emission increases with $\Delta\lambda$ = 4.6 Å.

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