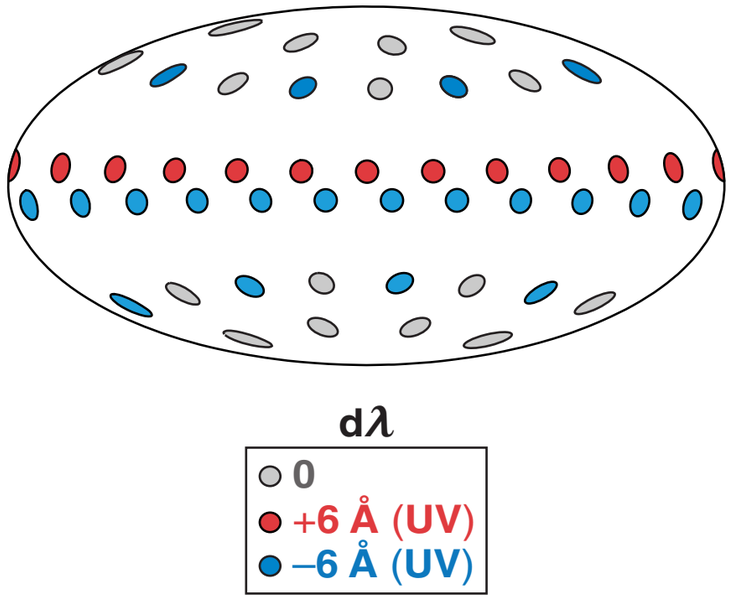
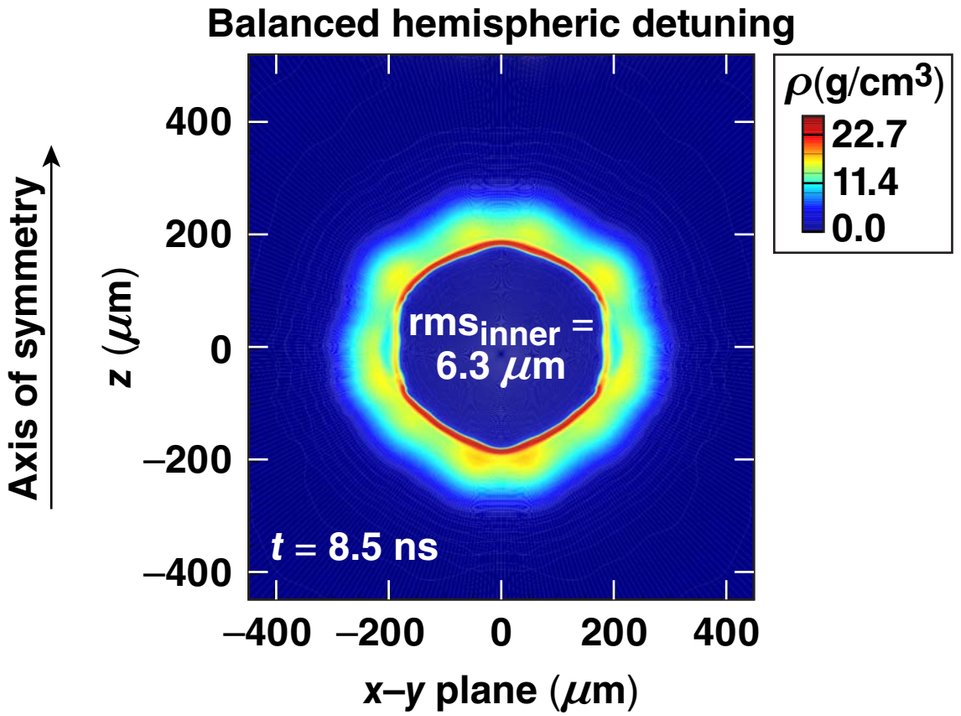
Improved Wavelength Detuning Cross-Beam Energy Transfer Mitigation Strategy for Polar Direct Drive at the National Ignition Facility





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Summary

Balanced hemispheric wavelength detuning methods increase laser absorption without detrimental long-wavelength asymmetry

- Cross-beam energy transfer (CBET) occurs primarily over the equatorial region in polar direct drive (PDD)
- Wavelength detuning mitigates CBET in PDD and symmetric direct drive (SDD) by shifting the resonances into regions of reduced-interaction cross sections
- Hemispheric detuning directs a mixture of red- and blue-shifted light over the equator to enhance CBET mitigation in PDD, which exceeds SDD
  - balanced hemispheric detuning further enhances mitigation by equalizing the hemispheres for a more-uniform implosion

Collaborators

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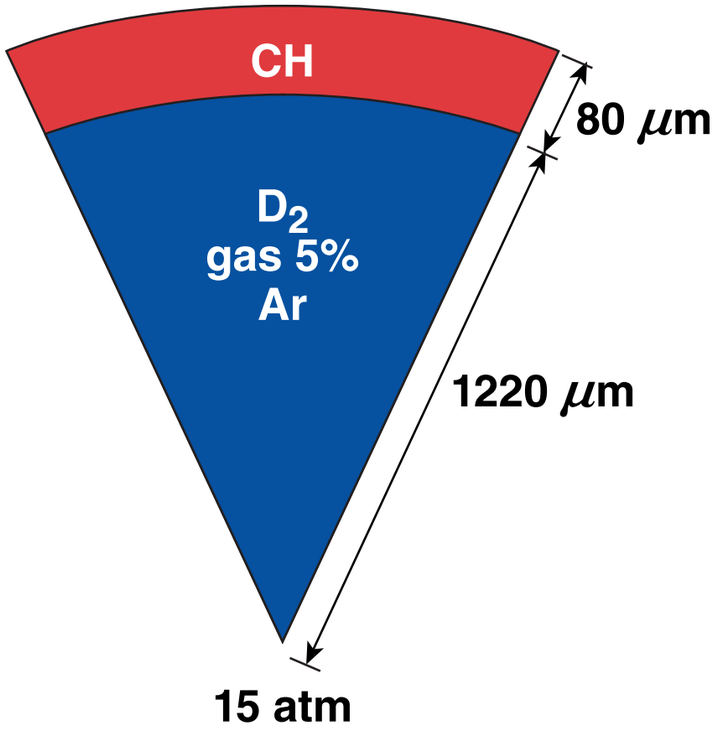
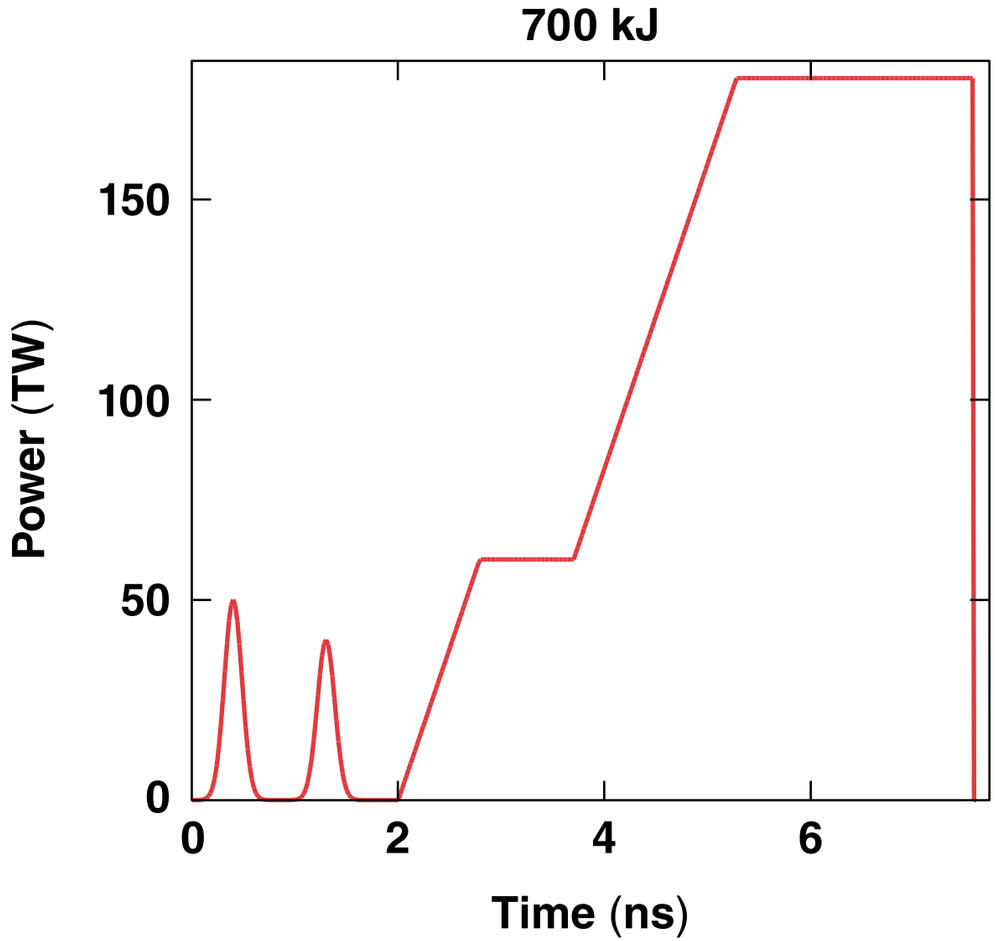
The intermediate PDD target design* for the National Ignition Facility (NIF) evaluates the performance of balanced hemispheric detuning





*D. Cao *et al.*, BO4.00014, this conference.

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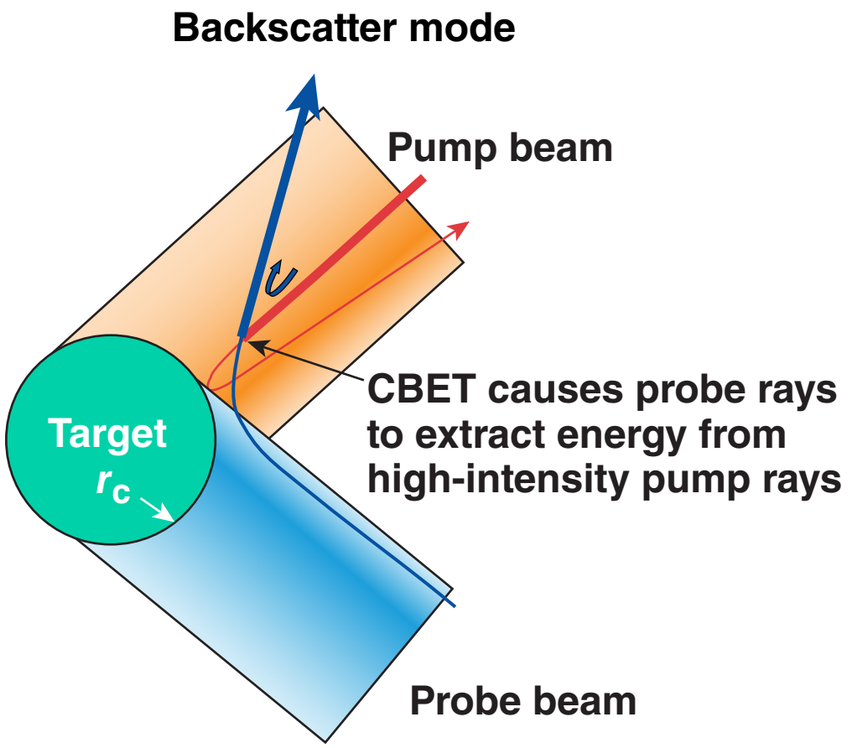
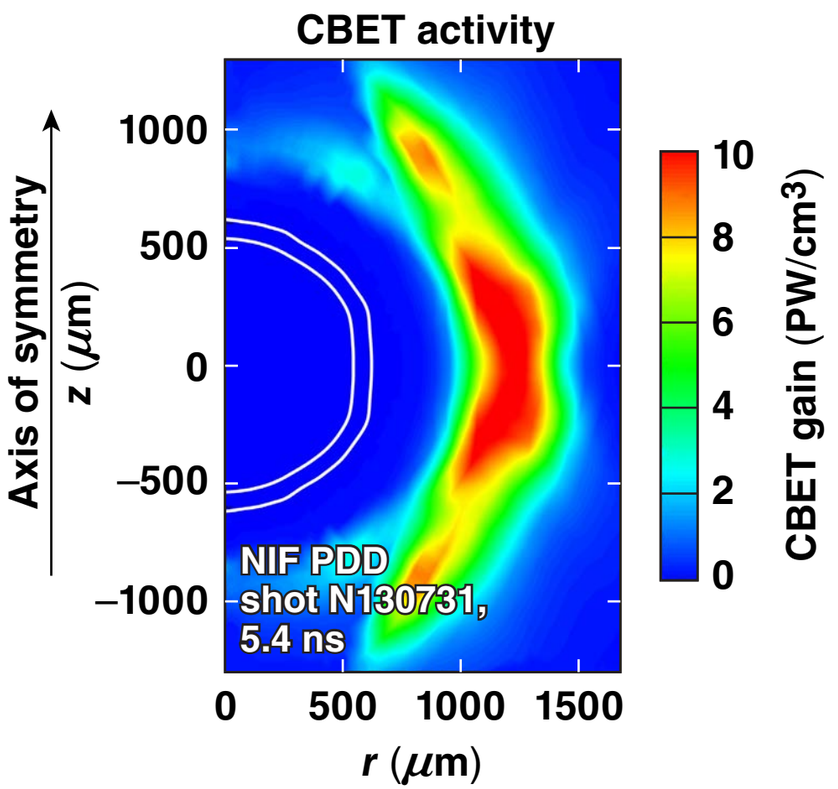
The majority of CBET occurs over the equatorial region in PDD





- The beams that would have been responsible for large CBET over the poles are absent in PDD
- CBET subtracts as much as 30% of the laser drive, making CBET mitigation the most-important design issue

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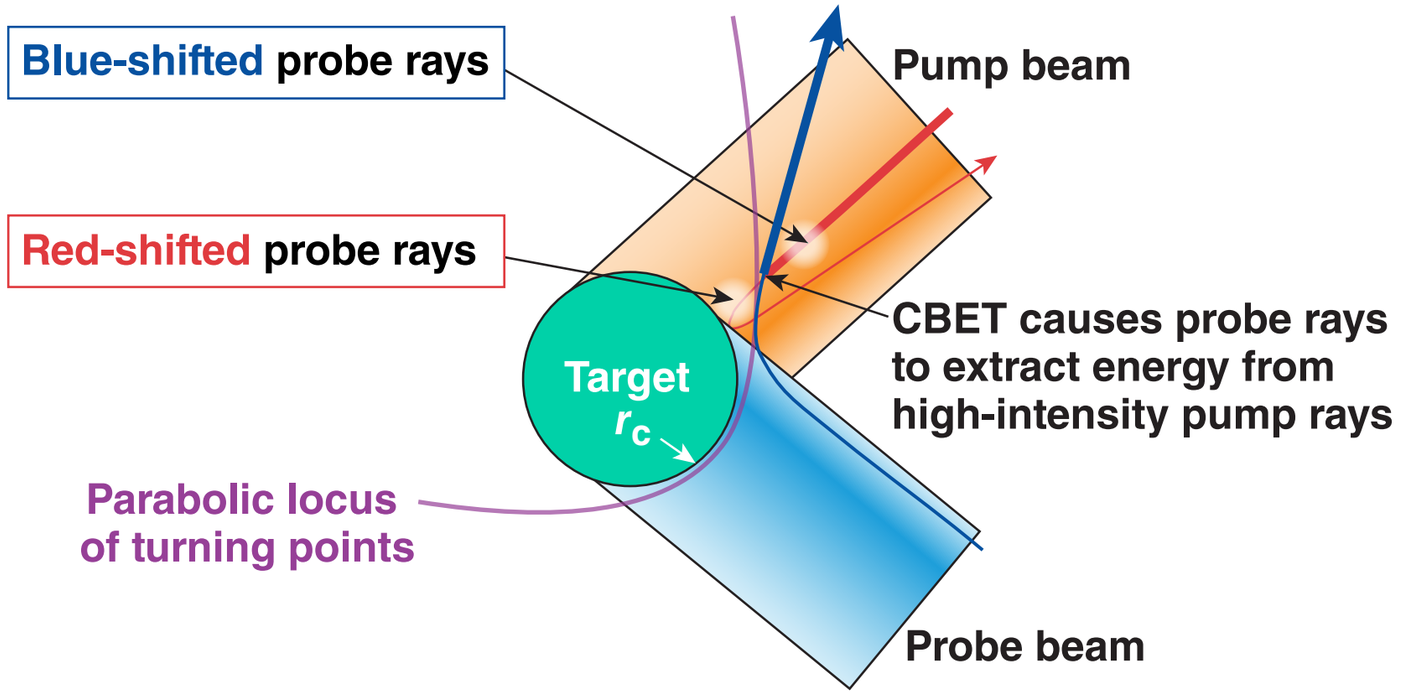
Successful wavelength detuning mitigates CBET by shifting the resonances into regions of reduced-interaction cross sections



- **Works for both PDD and SDD**
- Hemispheric detuning reduces the CBET interaction over the equator and can recover a significant portion of the lost energy in PDD

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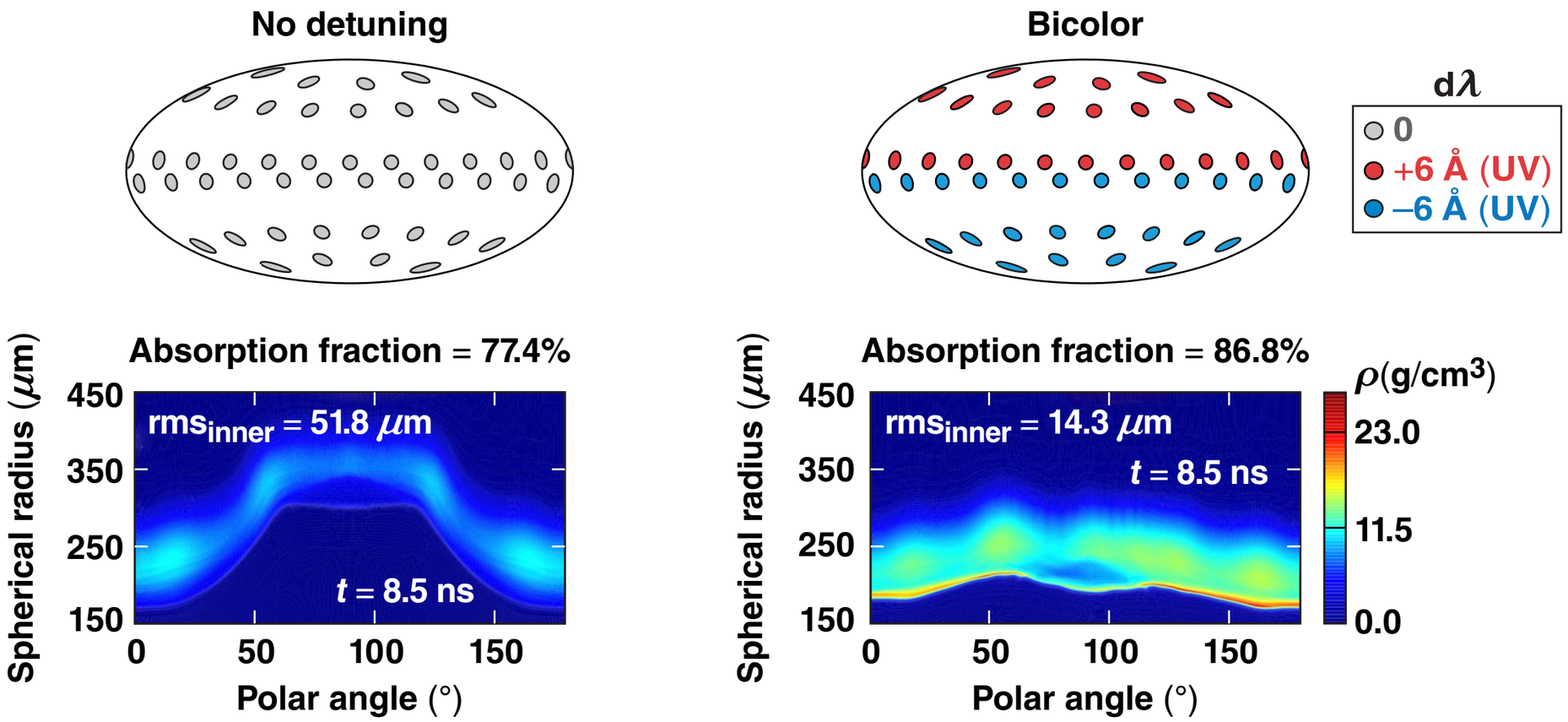
Bicolor hemispherical detuning recovers significant equatorial drive



- The detuning range fits within NIF's future capabilities

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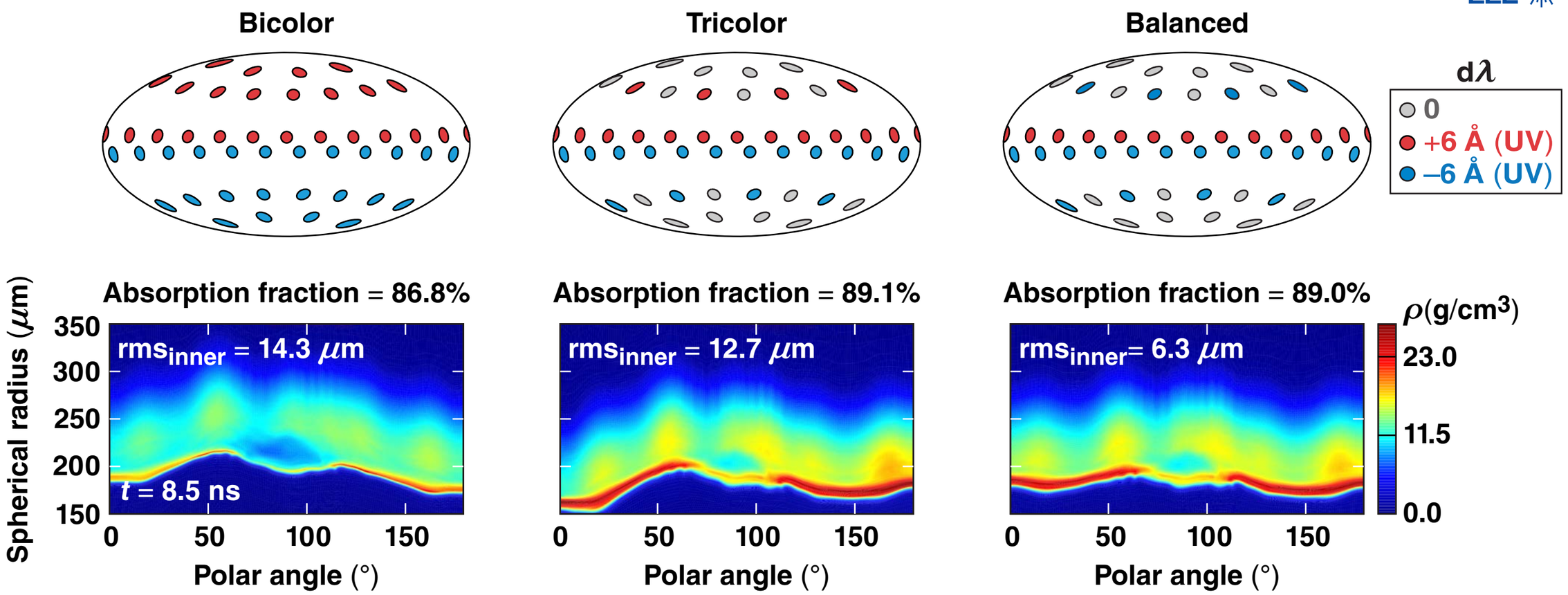
The balanced hemispheric detuning uses three wavelengths to improve drive and symmetry



- These detuning configurations all recover more laser absorption in PDD relative to SDD

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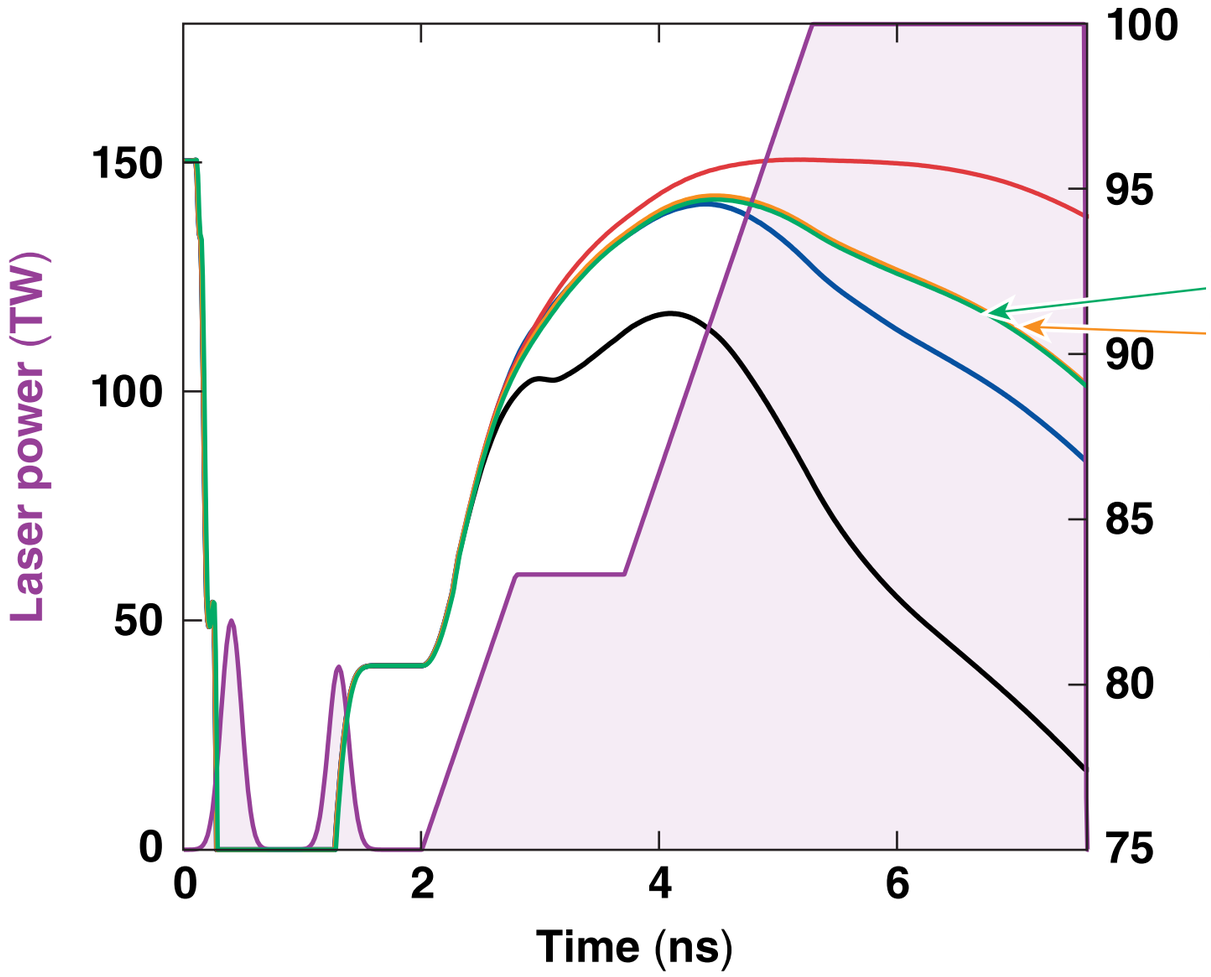
The balanced hemispheric detuning scheme outperforms the tricolor configuration because of its improved uniformity



No CBET	P_{hs} = 42 Gbar, $Y_n = 7.8 \times 10^{13}$
Balanced	P_{hs} = 34 Gbar, $Y_n = 5.5 \times 10^{13}$
Tricolor	P_{hs} = 28 Gbar, $Y_n = 3.8 \times 10^{13}$
Bicolor	P_{hs} = 24 Gbar, $Y_n = 3.2 \times 10^{13}$
No detuning	P_{hs} = 15 Gbar, $Y_n = 0.2 \times 10^{13}$

TC12468

Summary/Conclusions

Balanced hemispheric wavelength detuning methods increase laser absorption without detrimental long-wavelength asymmetry

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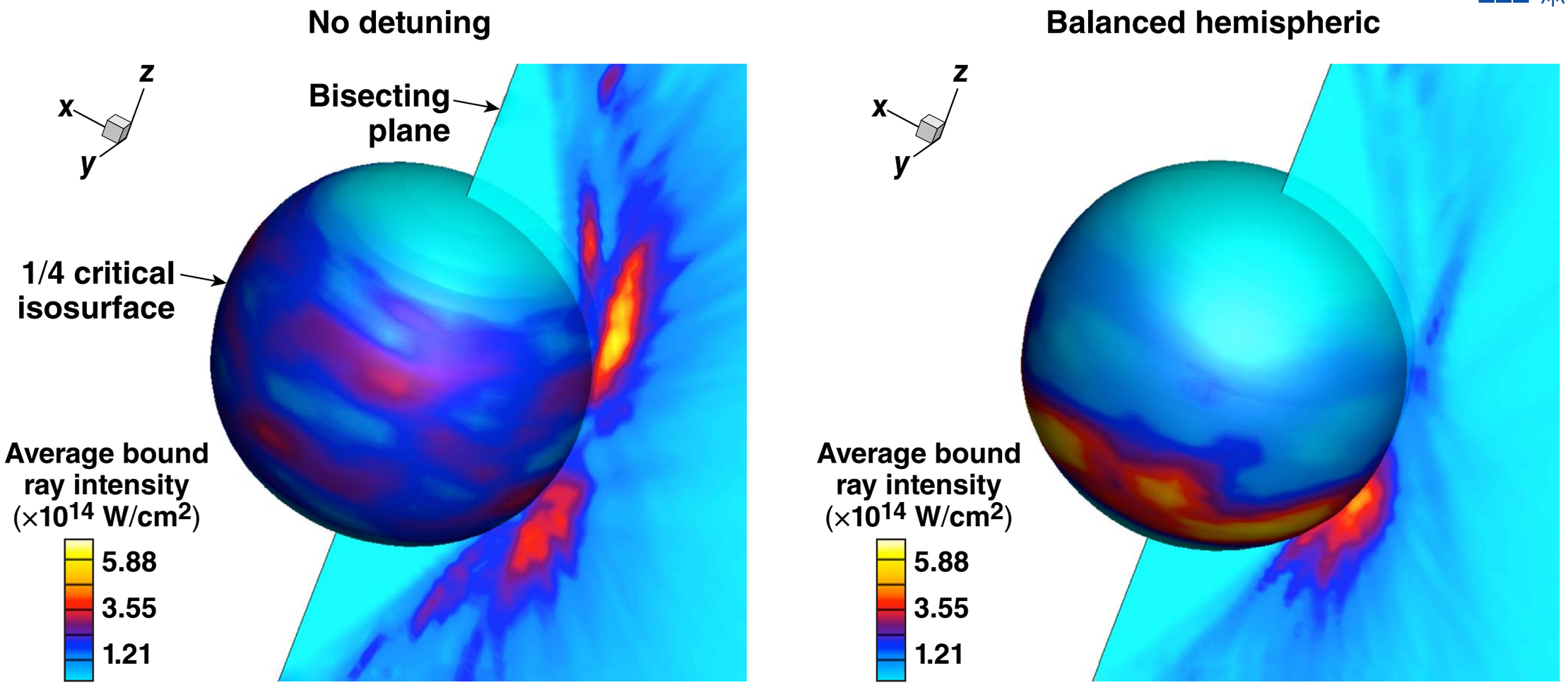
The outbound light intensity illustrates successful CBET mitigation



CBET mitigation decreases scattered light.

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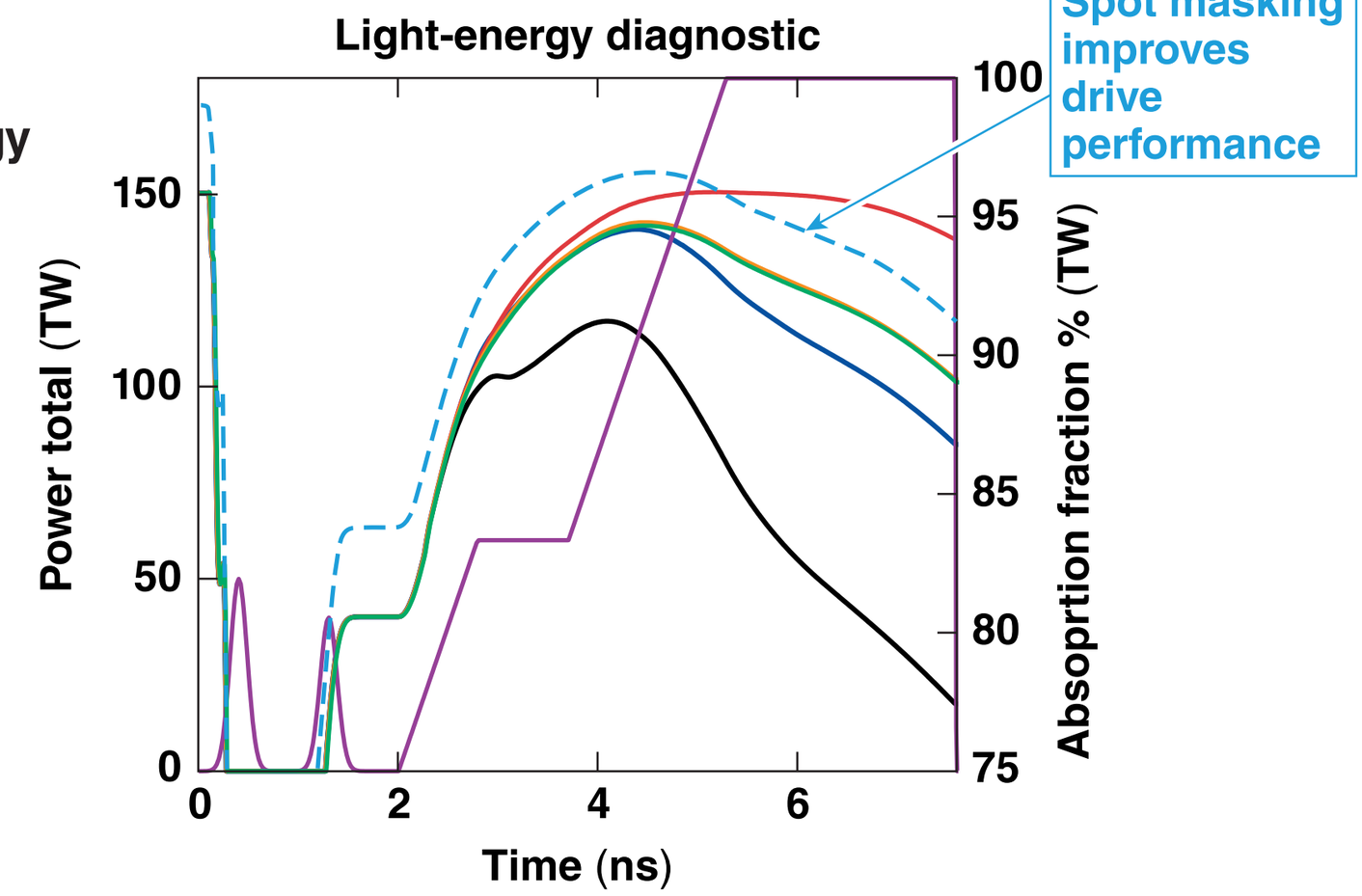
The balanced hemispheric detuning can be further improved using other strategies

- Decreased spot-masking radius
  - reduces over-the-horizon energy
  - increases on-target intensity
- Contoured shells or ice layer
- Ring pulse shaping
  - assists balancing residual $\ell = \{1, 2\}$
- Higher peak pulse power



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