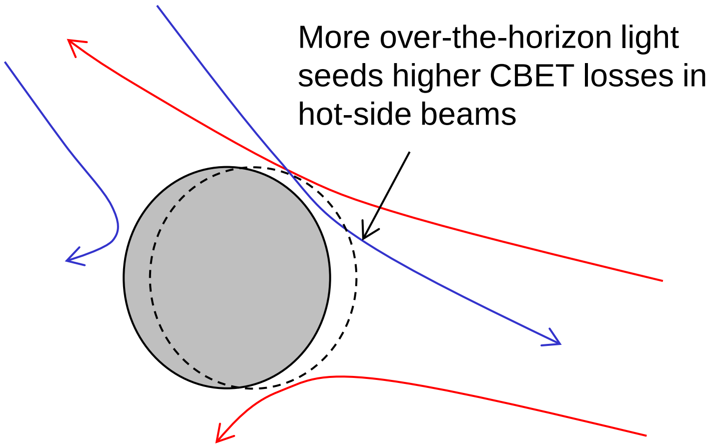
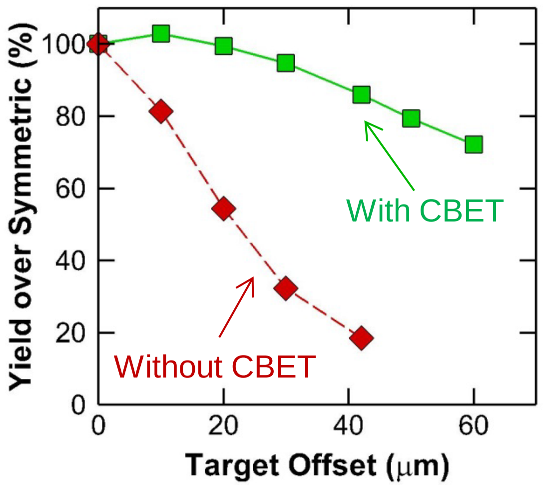
Cross-Beam Energy Transfer in Offset Implosions on OMEGA





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Cross beam energy transfer (CBET)* reduces sensitivity to target mispositioning

- Higher laser intensity leads to higher CBET gains and lower sensitivity to offset
- At higher intensities, target offset does not appear to dominate the experimental yield
- CBET mitigation techniques are predicted to enhance the sensitivity to target offset, while still improving overall performance for offsets less than 40µm

* I. V. Igumenshchev *et al*., Phys. Plasmas 17, 122708 (2010); J. A. Marozas *et al*., Phys. Rev. Lett. 120, 085001 (2018).

Collaborators

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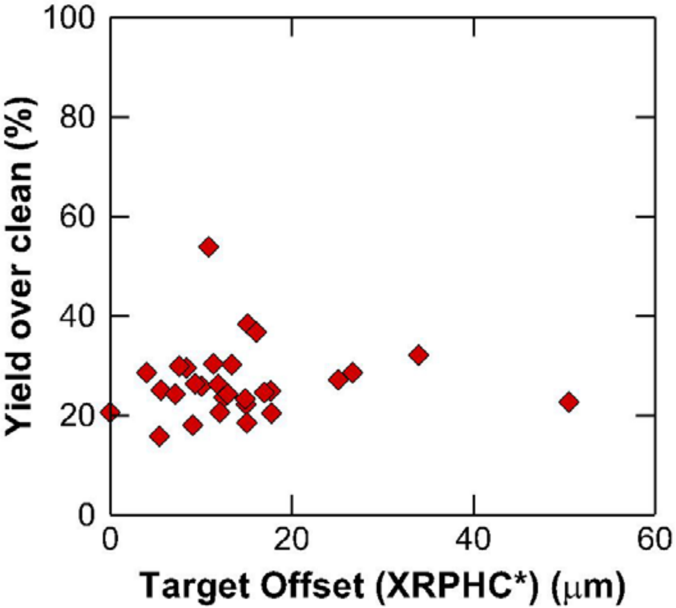
*J. A. Marozas *et al*., YO5.00010, this meeting

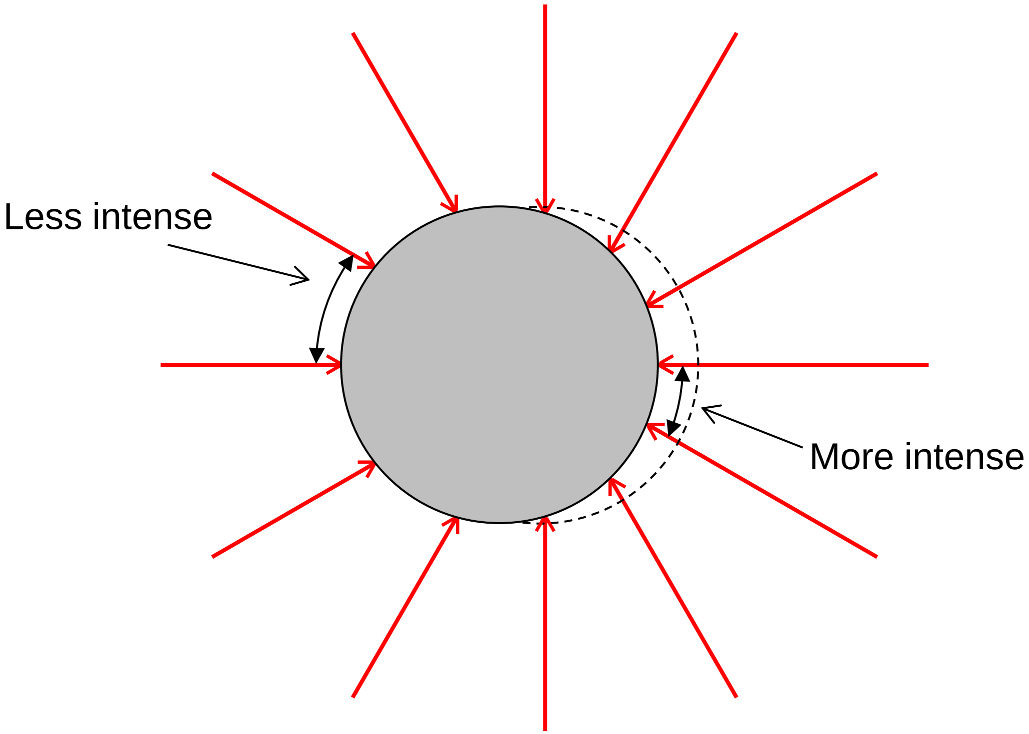
No clear correlation* exists between yield-over-clean and target offset in OMEGA cryogenic experiments with $2.5 \leq \alpha \leq 3.5$ and $14 \leq CR \leq 19$



- Other sources of nonuniformity appear to dominate YOC in cryogenic implosions
- Simulations without CBET show neutron yields have high sensitivity to target offset

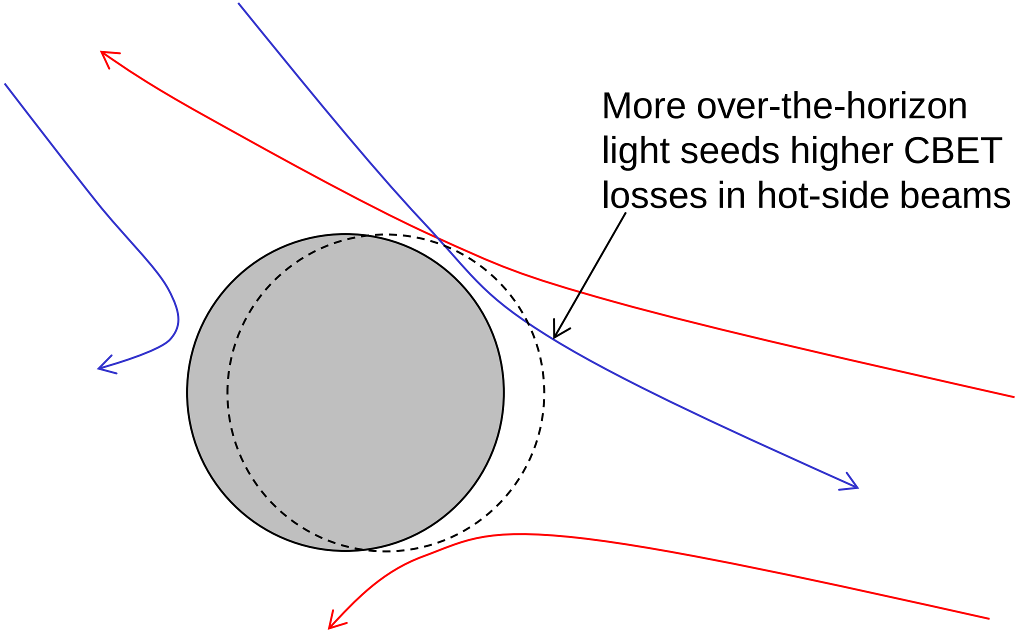
*W. Grimble, F. J. Marshall, and E. Lambrides, Phys. Plasmas 25, 072702 (2018).

Target offset causes an ℓ = 1 mode in the laser illumination pattern



- Beam centers strike the target closer together on one side than the other
- This results in a dominant ℓ = 1 mode in the illumination pattern at t = 0

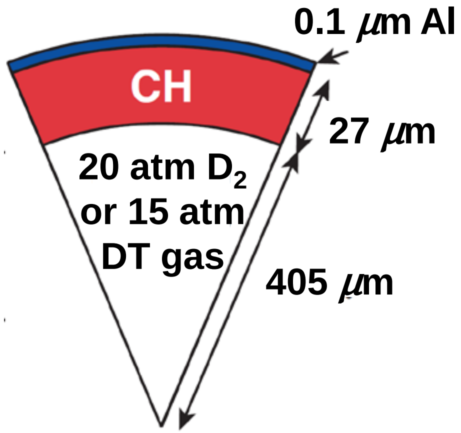
As the plasma forms, more over-the-horizon light reaches the "hot" side of the target

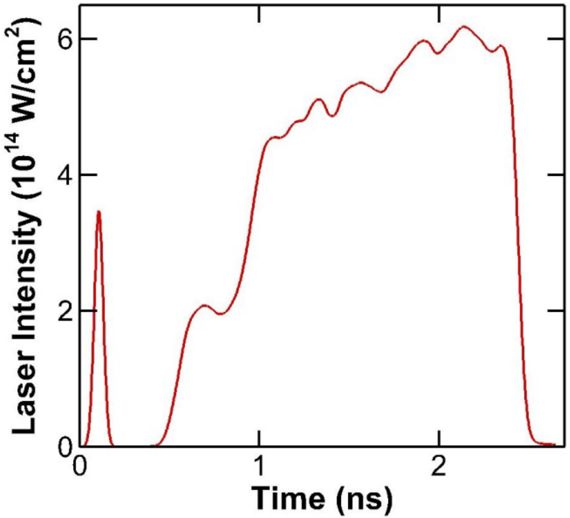


This is a geometric effect of target offset. The ℓ = 1 drive asymmetry from power imbalance is not reduced by CBET;

CBET is higher on the hot side of the target, effectively reducing the ℓ = 1 drive asymmetry from target offset.

Room-temperature experiments with prescribed target offsets are modeled better when CBET effects are included

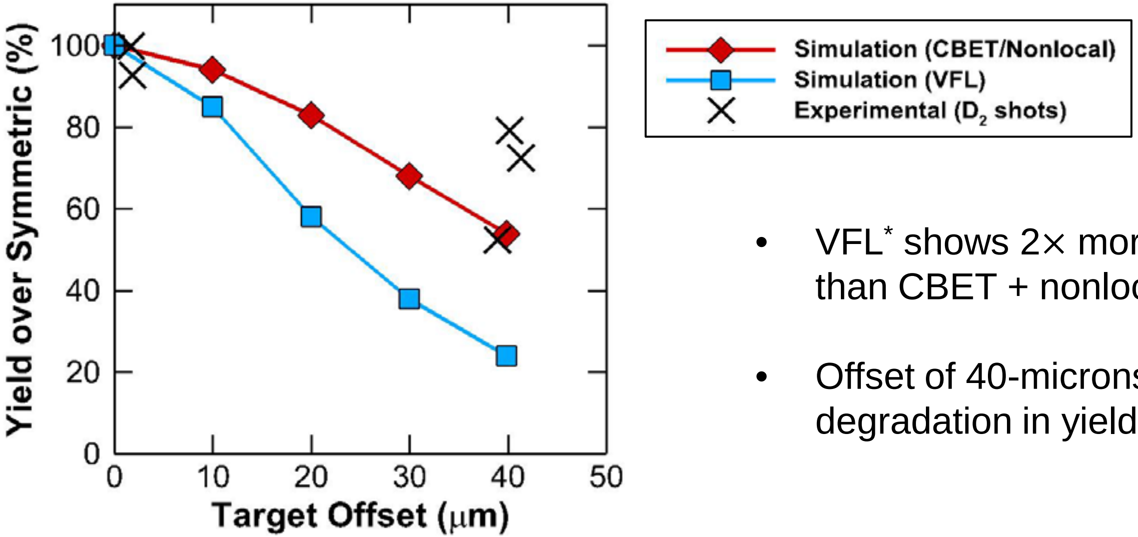




- Simulated both with CBET* + nonlocal** heat transport and with a variable flux-limited (VFL) thermal model
- Simulation including CBET data matched experimental data better
  - yields
  - compressed core offsets
  - In-flight motion of target center

*J. A. Marozas *et al*., Phys. Rev. Lett. 120, 085001 (2018).
**D. Cao *et al*., Phys. Plasmas 22, 082308 (2015).

Simulations with CBET and nonlocal thermal transport more accurately predict yield degradation from target offset



- VFL* shows 2× more yield degradation than CBET + nonlocal transport.
- Offset of 40-microns results in a 50% degradation in yield (simulated)

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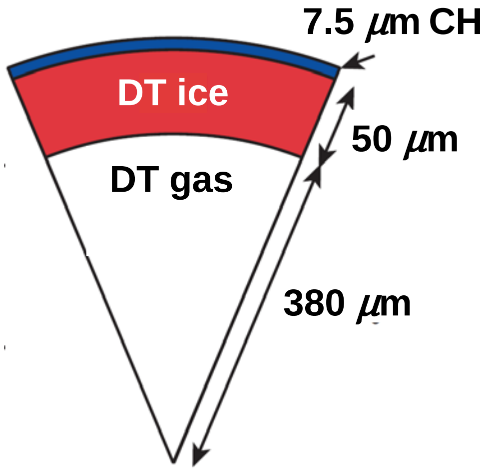
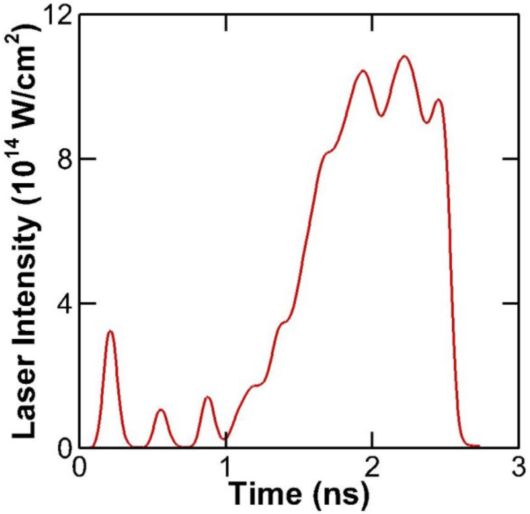
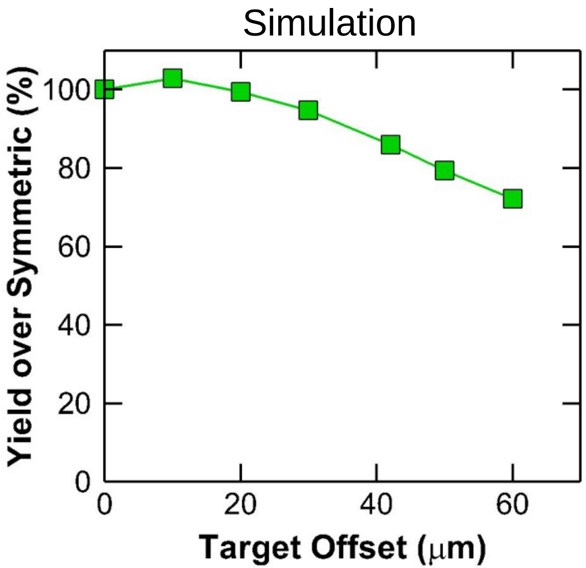
* VFL = variable flux limiter (e.g., no non-local thermal transport, no CBET)
**Experimental yield is normalized to the best-shot, no-offset experiment; simulated yield is normalized to the with-offset simulated yield for the same shot.

Cryogenic experiments with peak laser intensity of 1×10^{15} W/cm^2 show weaker sensitivity to offset







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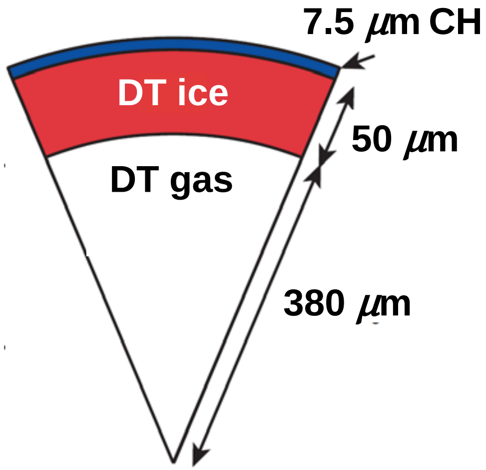
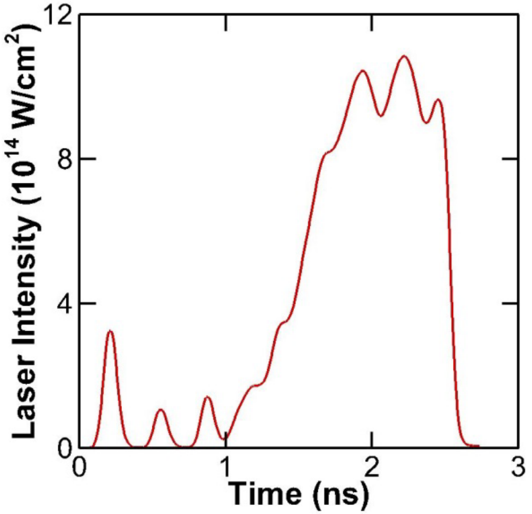
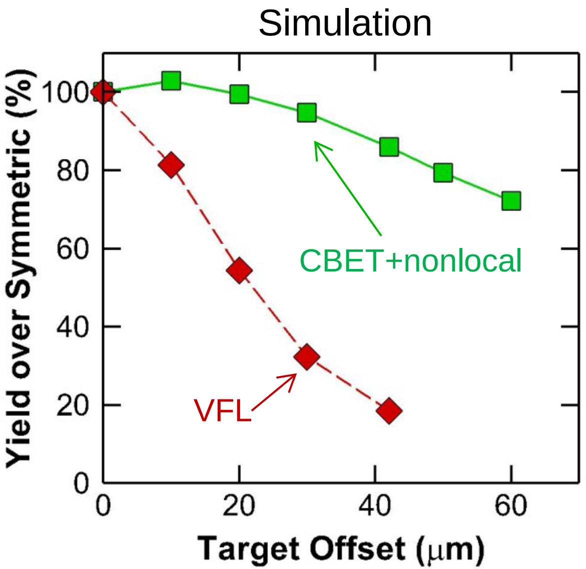
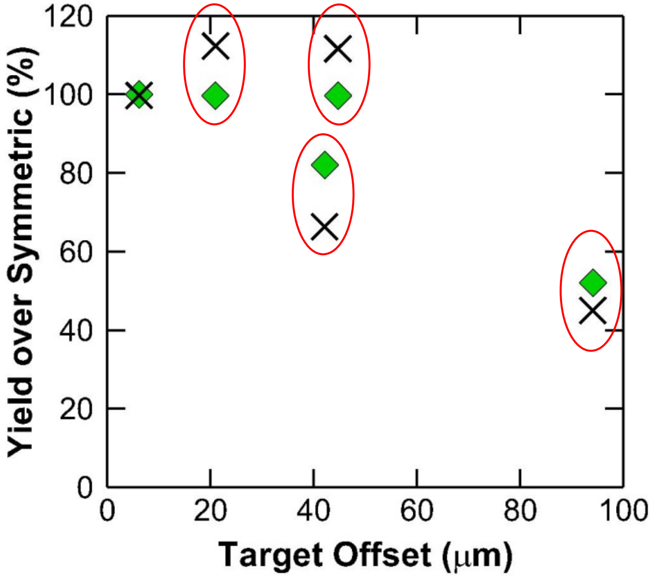






The CBET+nonlocal model predicts significantly less sensitivity to offset than the VFL model

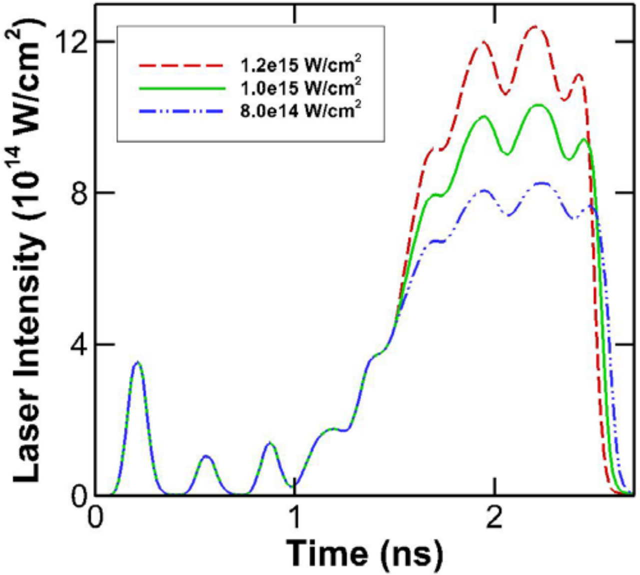
Experimental variations in yield between shots is captured well in simulations when CBET is included

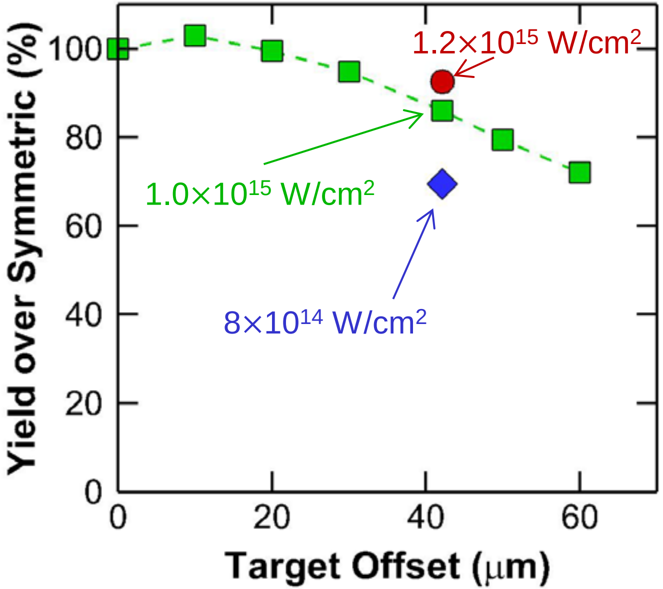


- 2-D simulations with only target offset magnitude reproduce observed yield well
- Yield variation may be related to the offset direction, especially relative to the target stalk position* (this effect is not modeled here).

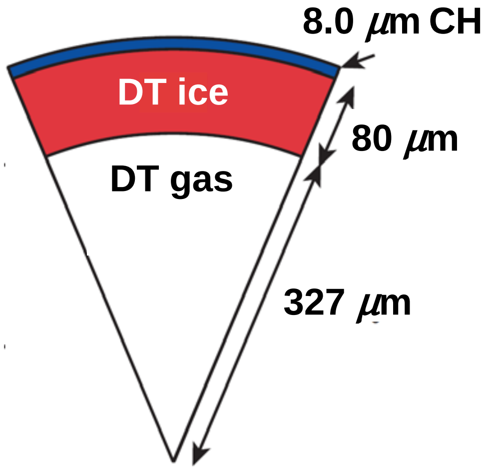
*See M. Gatu Johnson *et al*., YO5.00007, this meeting.

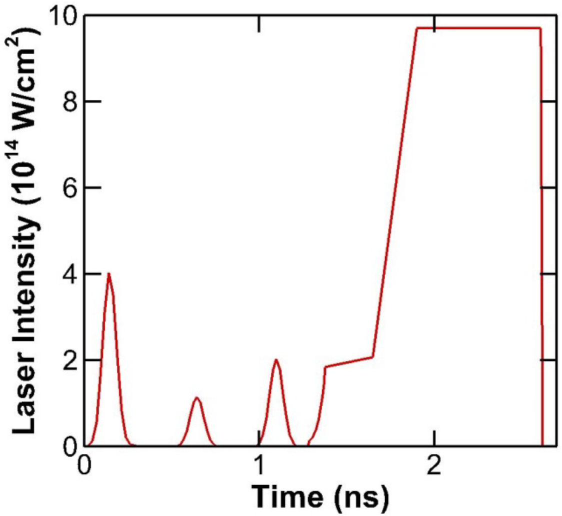
Varying the peak intensity in the laser pulse shows that the increased CBET in high-intensity pulses lowers sensitivity to target offset





OMEGA cryogenic designs including CBET mitigation have been explored*

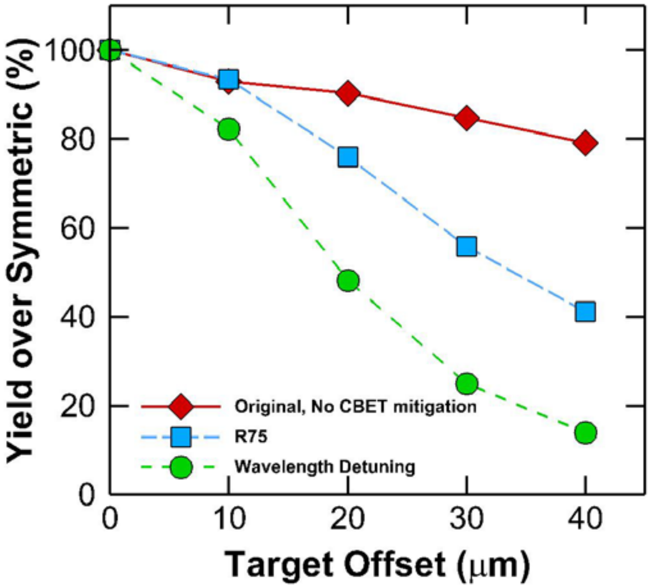


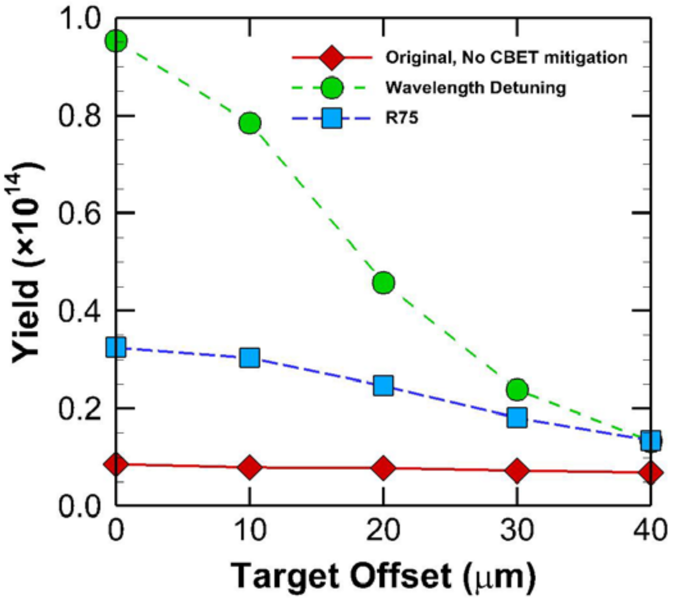


Comparison done for
- No CBET mitigation
- Smaller spot-to-capsule ratio (R75**)
- Wavelength detuning*

*J. A. Marozas *et al*., Phys. Plasmas 25, 056314 (2018).
**I. V. Igumenshchev *et al*., Phys. Plasmas 23, 052702 (2016).

CBET mitigation increases sensitivity to target offset, while increasing overall energy coupling and neutron yield



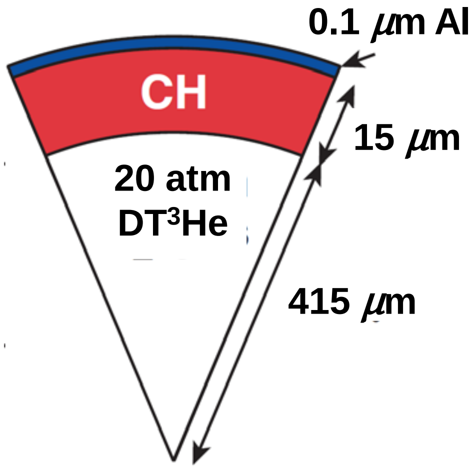


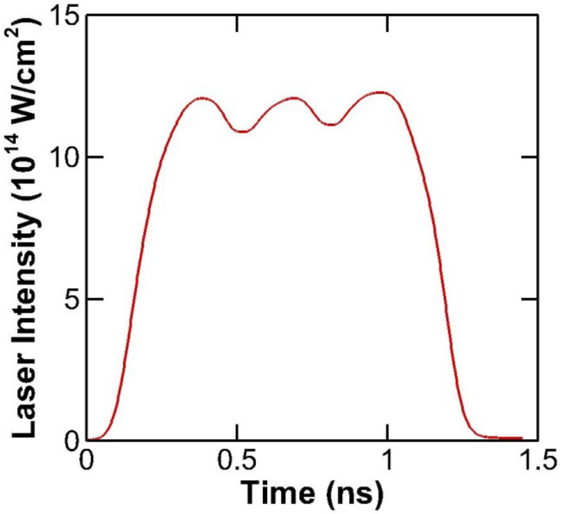
CBET mitigation techniques improve yield, even with large (~40 μm) offsets

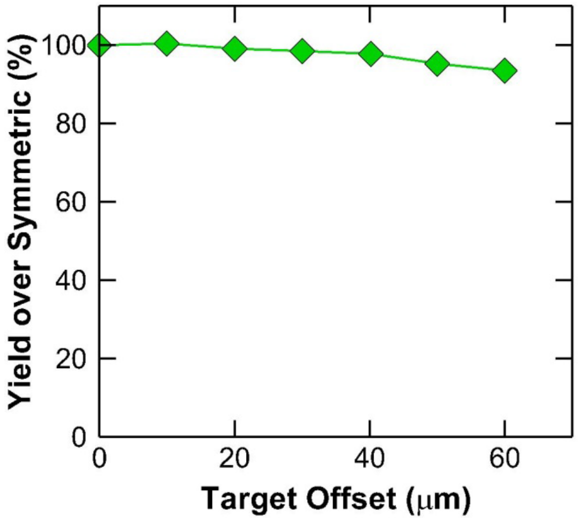
Cross beam energy transfer (CBET) reduces sensitivity to target mispositioning

- Higher laser intensity leads to higher CBET gains and lower sensitivity to offset
- At higher intensities, target offset does not appear to dominate the experimental yield
- CBET mitigation techniques are predicted to enhance the sensitivity to target offset, while still improving overall performance for offsets less than 40µm

High-intensity (1.2×10^{15} W/cm^2), low-convergence experiments show almost no sensitivity to target offset when simulated with CBET







Offset of 40-microns results in only a 2% degradation in yield (simulated)

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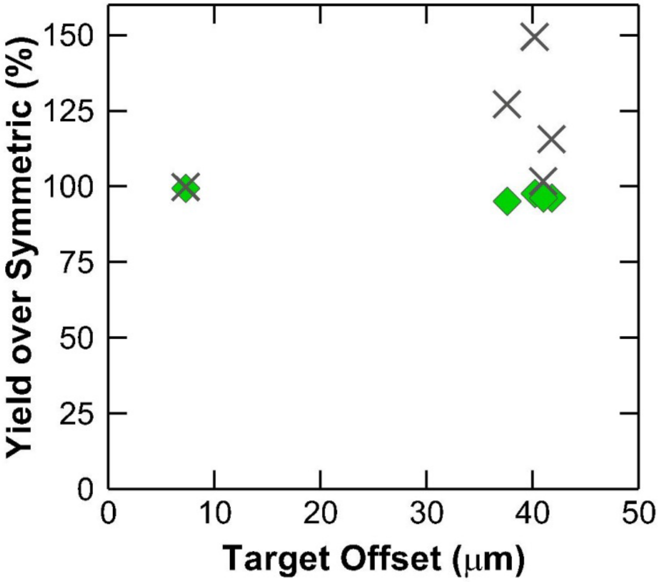

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