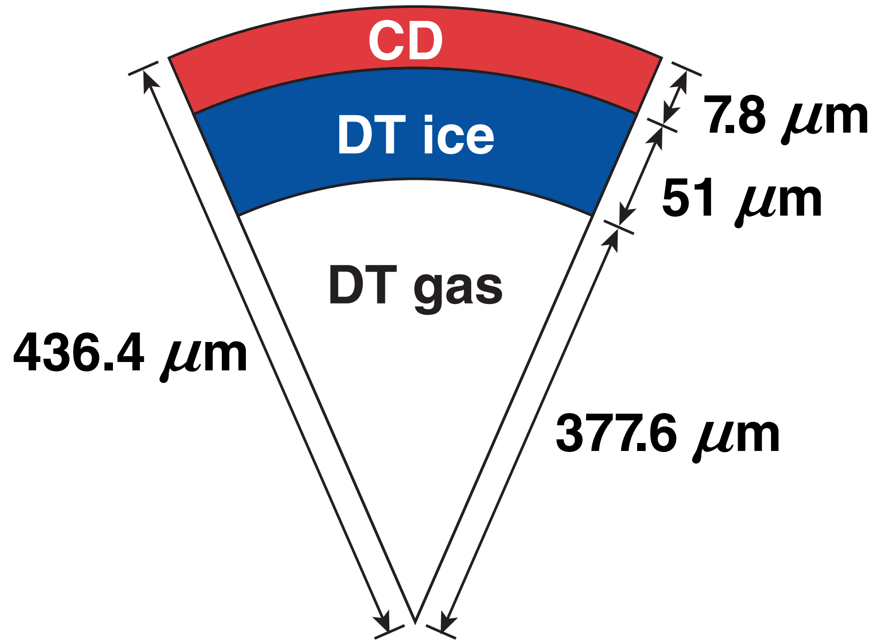
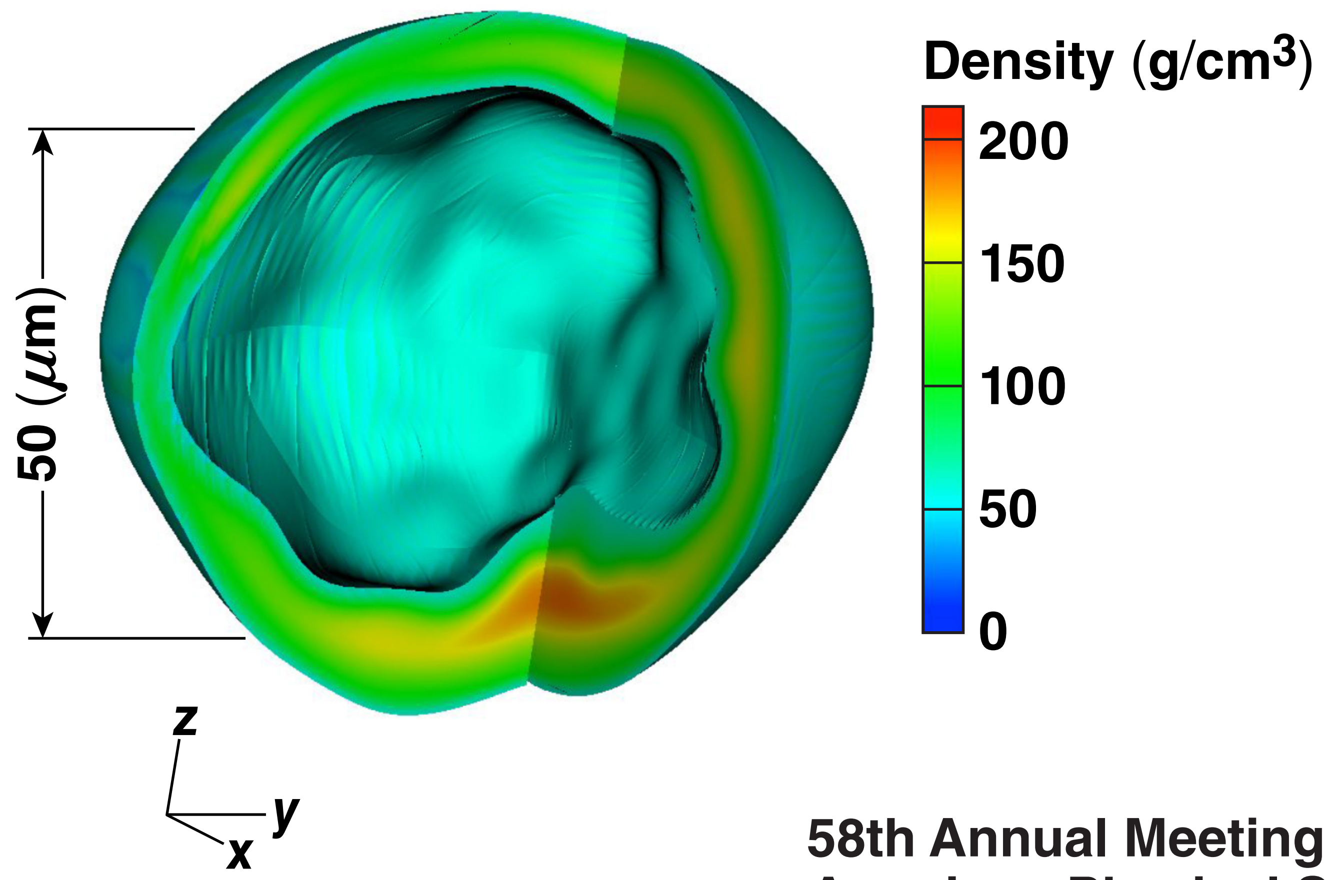
Three-Dimensional Analysis of the Effects of Low-Mode Asymmetries on OMEGA





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The sensitivity of OMEGA cryogenic implosions to various sources of low-mode asymmetry is being studied with 3-D *HYDRA** simulations

- Current parameter studies examine single-perturbation source effects on yield and other observables; studied here
  - target offset
  - beam-to-beam laser-energy imbalance during the main drive pulse
  - ice roughness (in progress)
- Yields are more degraded and inferred hot-spot temperatures** show larger variation from target offset than laser-energy imbalance (at typical OMEGA levels)
- These sources of nonuniformity generally result in predominate $\ell = 1$ modes

Our goal is to understand laser/target requirements for OMEGA cryo implosions.

*M. M. Marinak *et al.*, Phys. Plasmas 8, 2275 (2001).
**F. Weilacher and P. B. Radha, "Modeling Neutron Based Diagnostics in ICF Implosions," in preparation for Nuclear Fusion.

Collaborators

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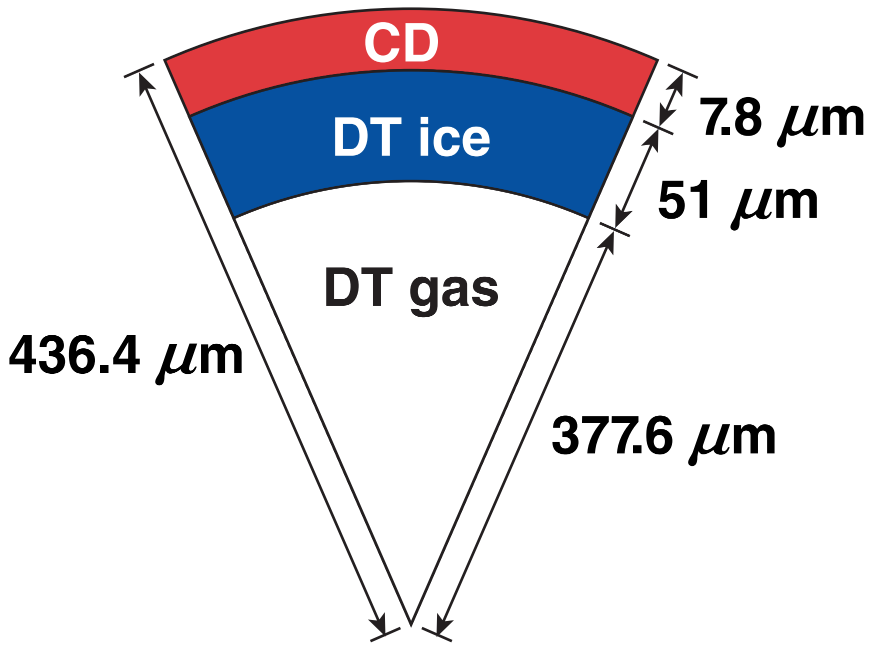
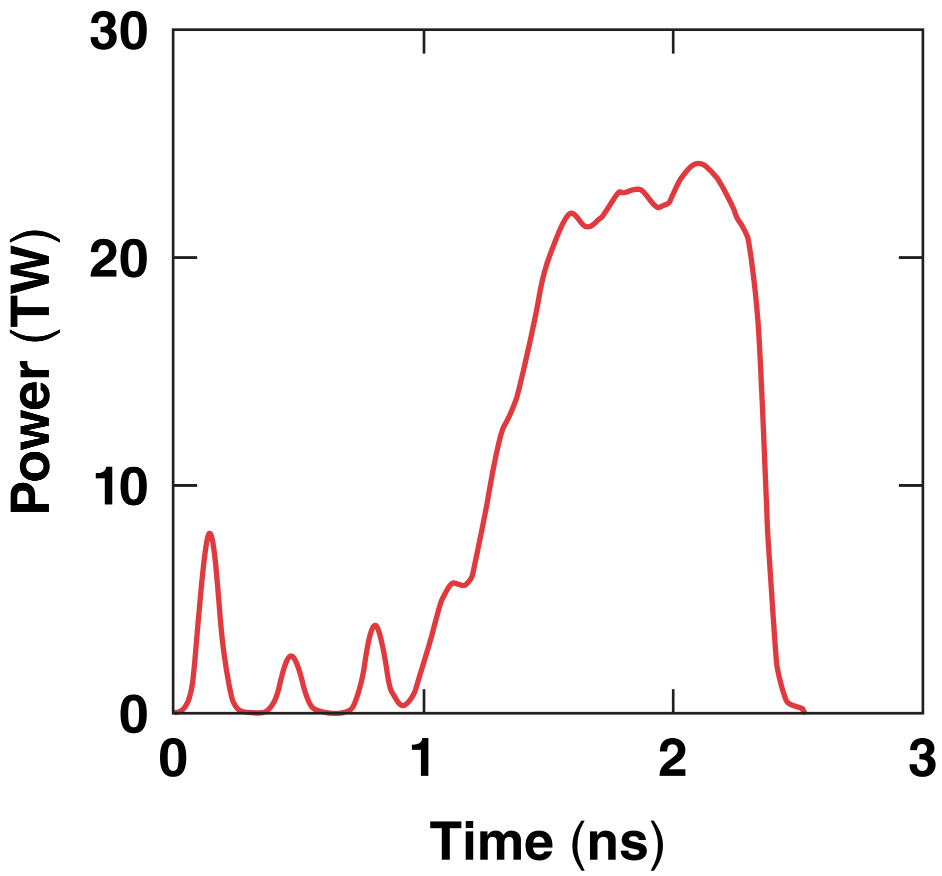
Three-dimensional *HYDRA* studies were performed for OMEGA shot 78416





E_{laser}	26 kJ
Adiabat	3
V_{imp} (cm/s)	3.5×10^7
CR = R_0/R_{hs}	22
$Yield_{1\text{-}D}$	1.4×10^{14}
$Yield_{exp}$	3.4×10^{13}
$P^*_{1\text{-}D}$ (Gbar)	106
P^*_{exp} (Gbar)	45

CR = convergence ratio
*P** = peak, neutron-weighted hot-spot pressure (not time-averaged)

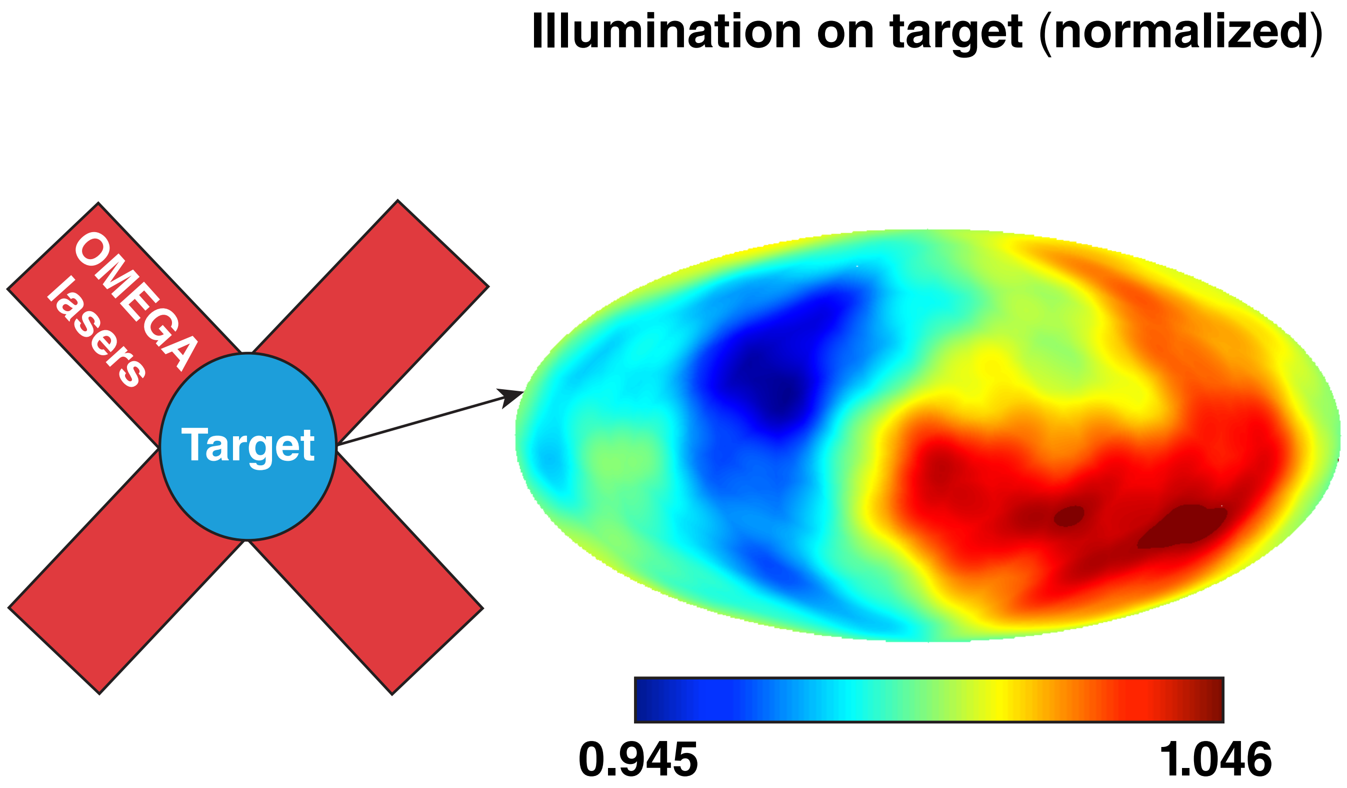
TC13153

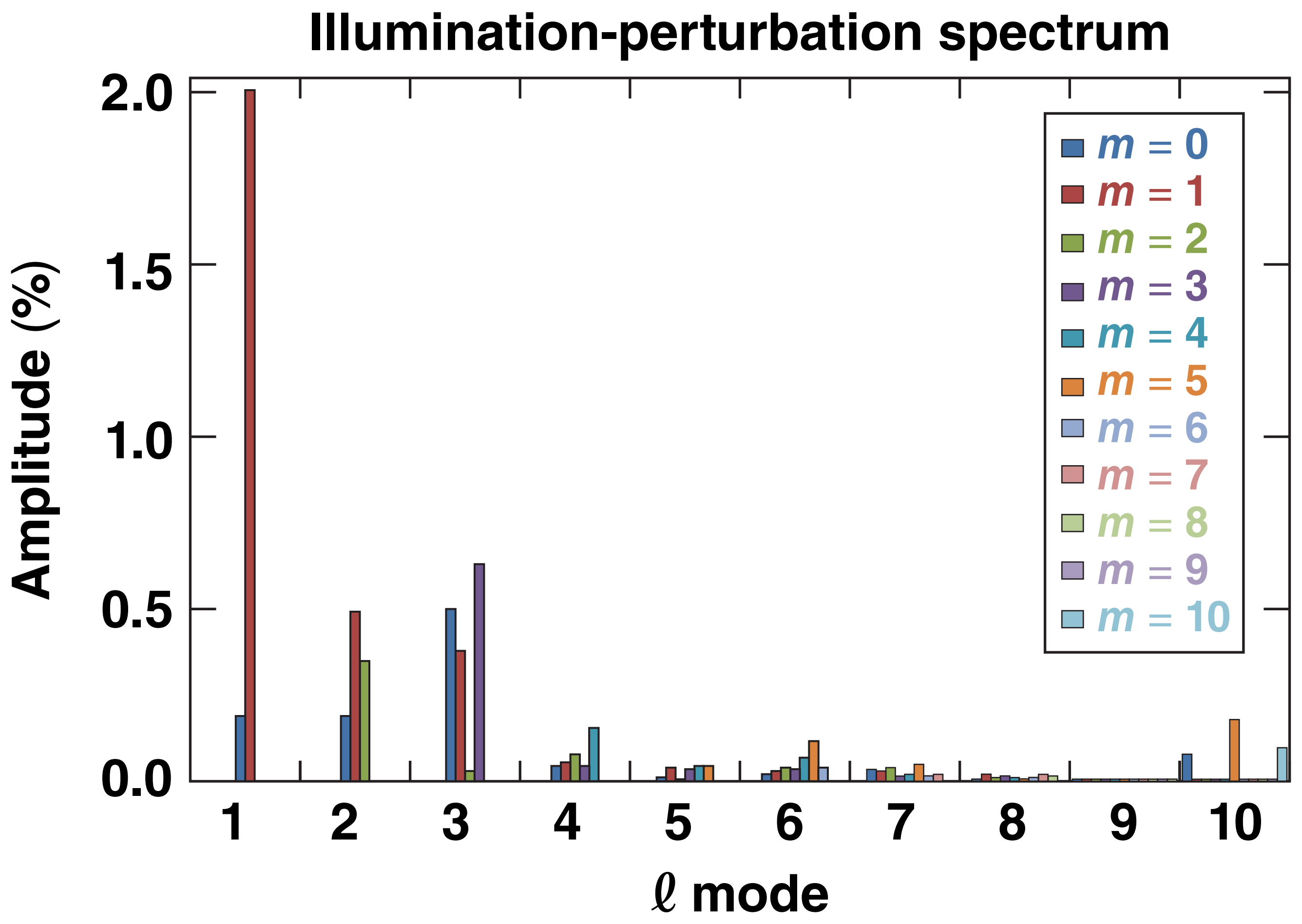
Simulation details

- 3-D simulations resolved modes up to $\ell = 10$
- A variable flux limiter was used to match shell and shock trajectories in 1-D to *LILAC* simulations with cross-beam energy transfer (CBET)* and nonlocal heat conduction
- Modeled perturbation sources were parametrically varied, not based on experimental measurements
  - beam-to-beam energy imbalance done randomly with Gaussian distribution

*Igumenshchev, *et al.*, Phys Plasmas 17, 122708 (2010).
J. A. Marozas *et al.*, presented at the 44th Annual Anomalous Absorption Conference, Estes Park, CO, 8–13 June 2014.

Illumination nonuniformity is calculated on the hard-sphere capsule surface and deposited as spherical harmonics



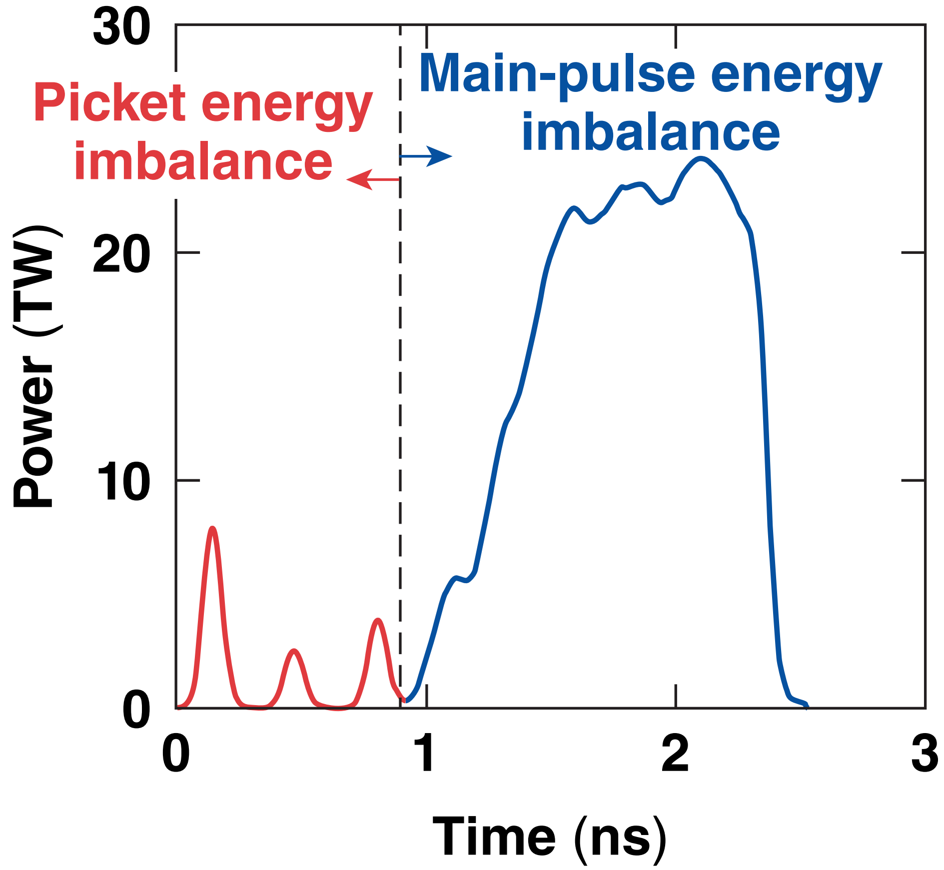


*Illumination shown is for 12% rms beam-to-beam laser-energy imbalance; beam overlap reduces illumination σ_{rms} to 2.4%.

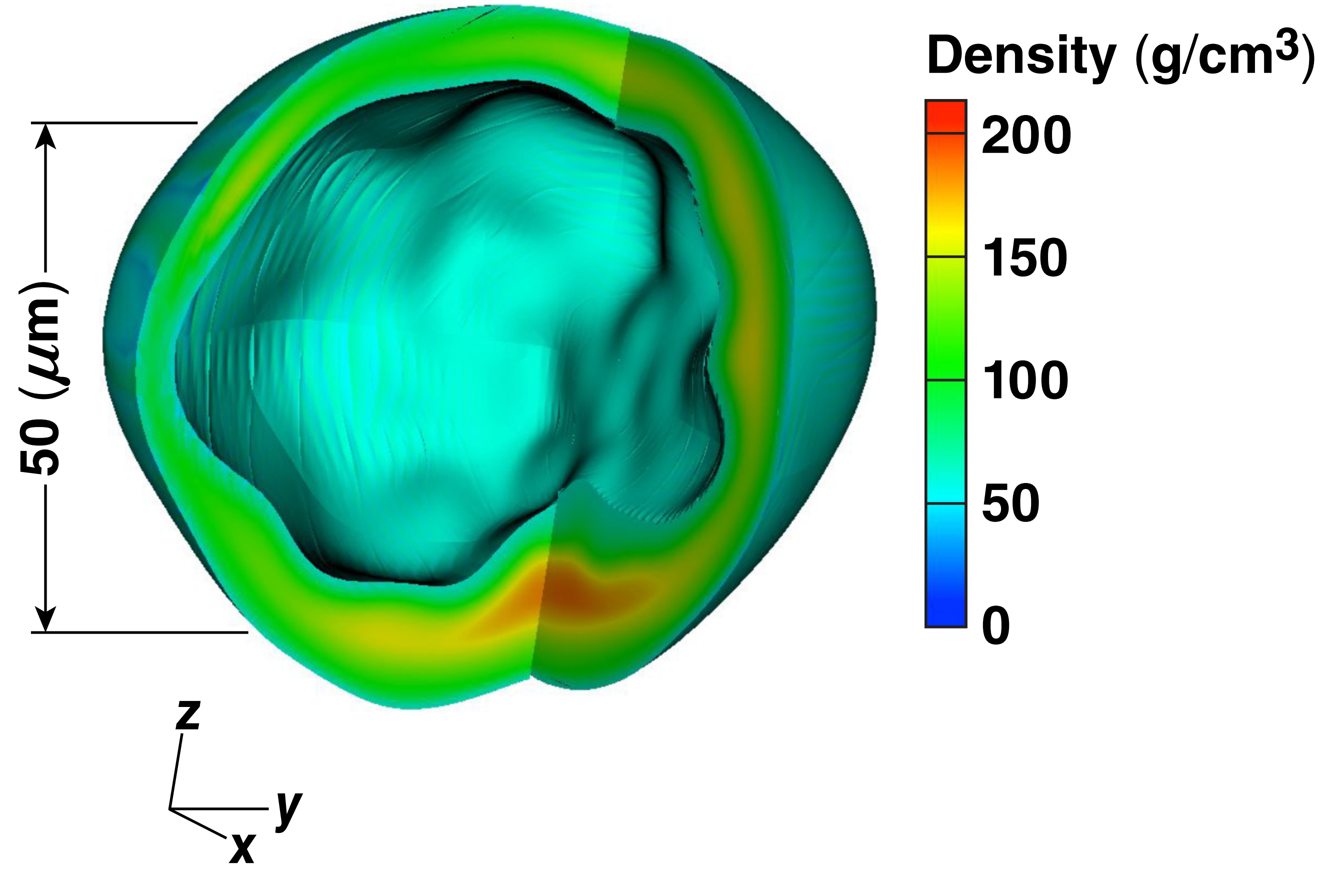
TC13155

Beam-to-beam laser-energy imbalance was studied varying both picket imbalance and main pulse imbalance independently

OMEGA energy imbalance is different during the pickets and main pulse



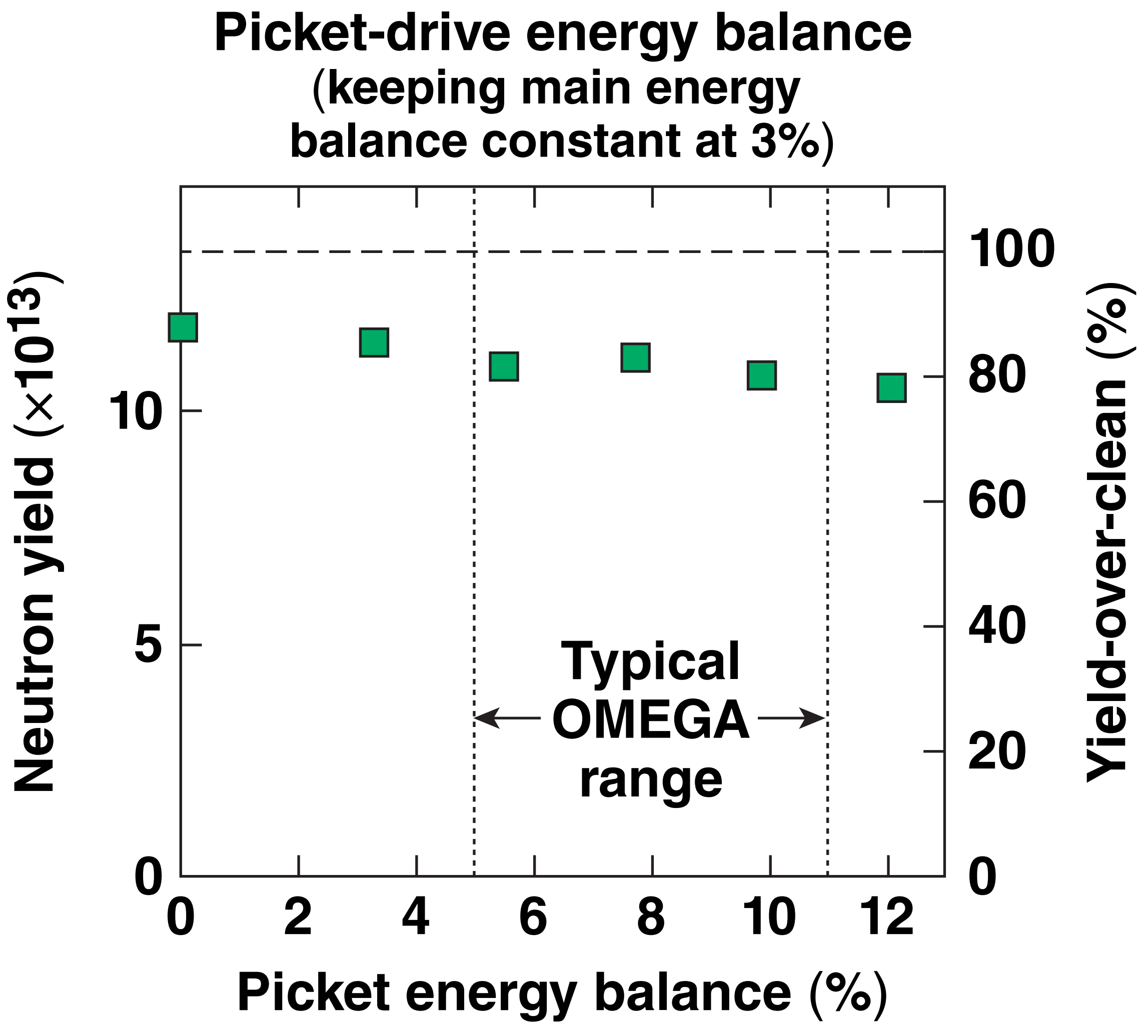
12%-rms picket and main energy imbalance, CR = 22

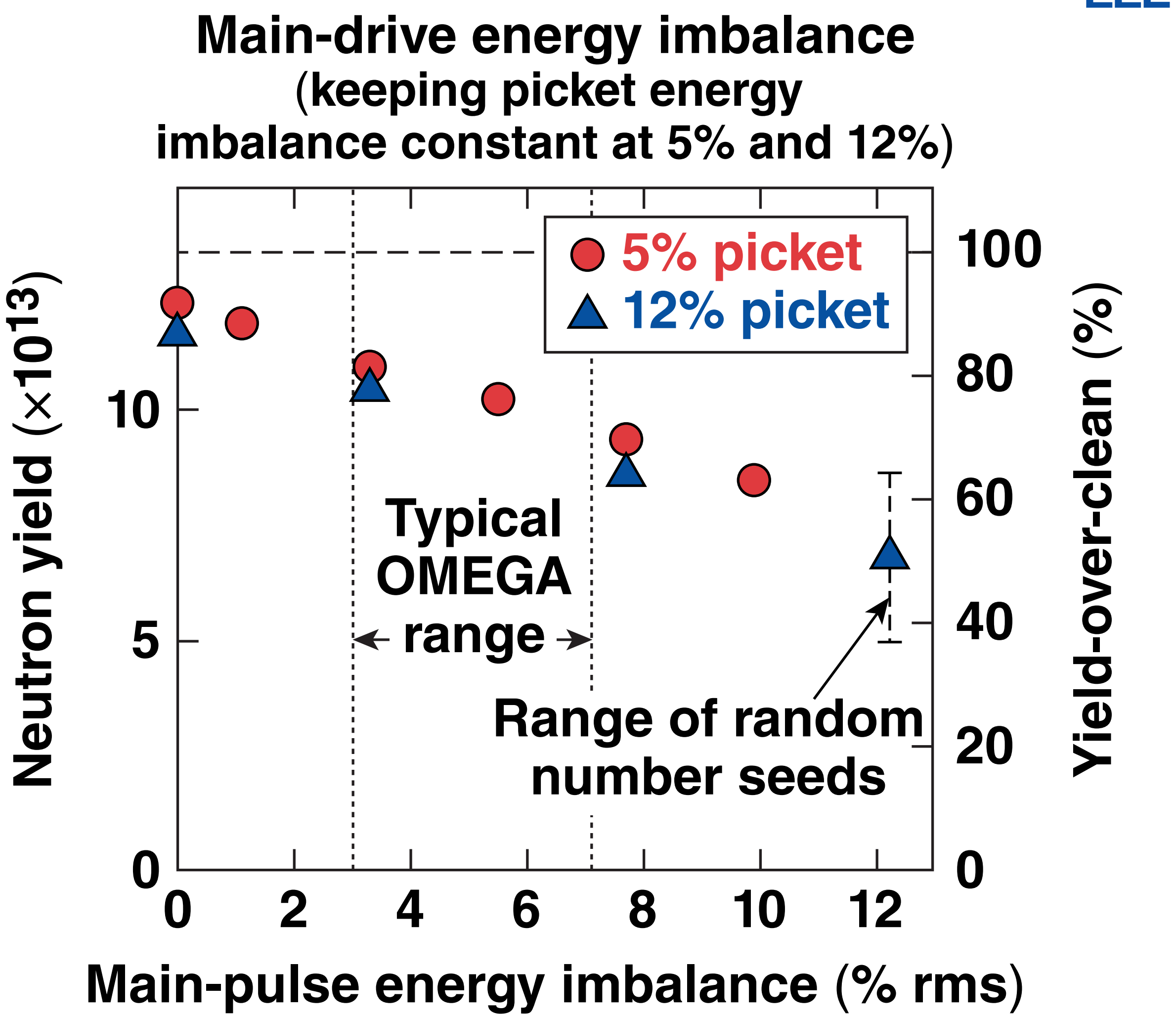


CR = convergence ratio

TC13156

Picket energy balance appears to have only a small affect on target performance (no target offset included)



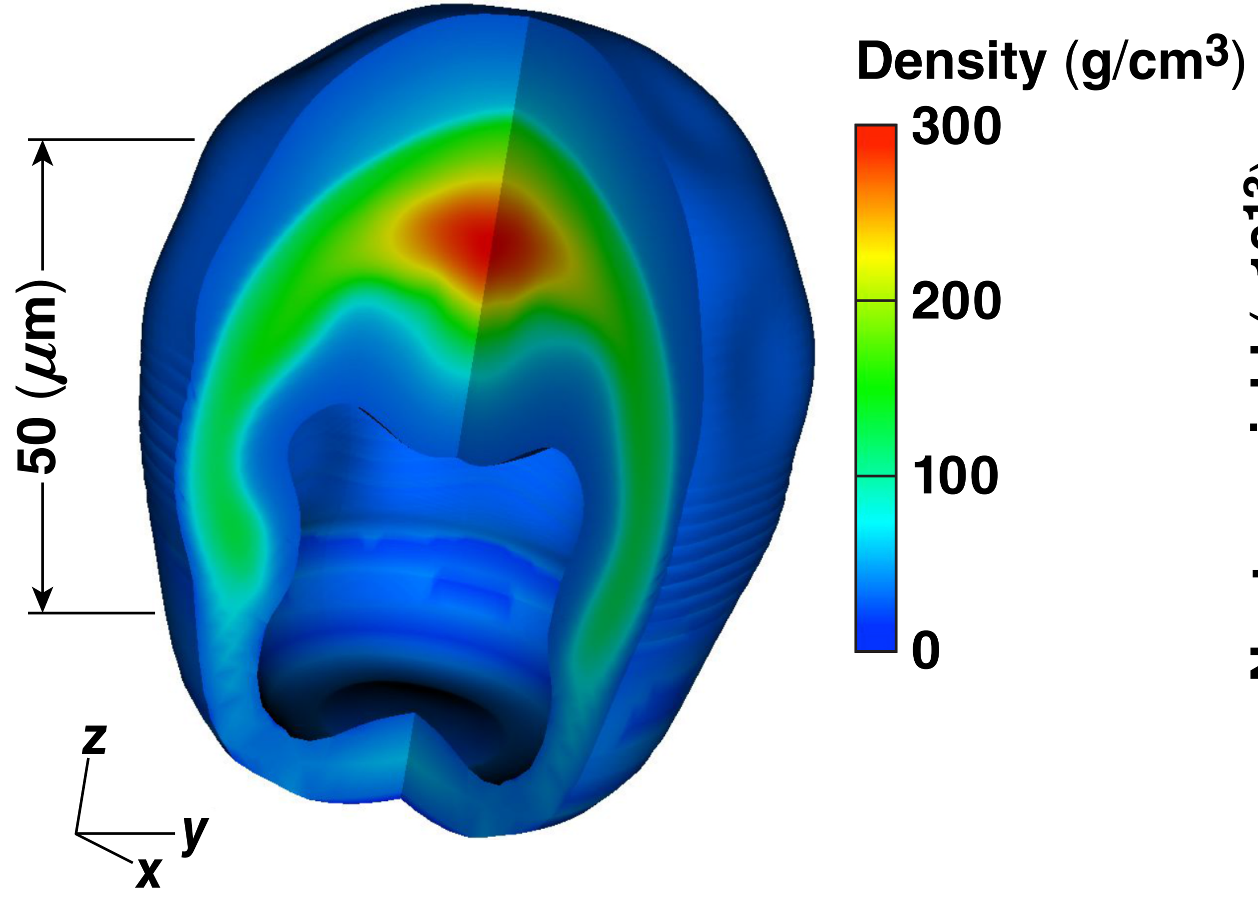


Picket energy imbalance = small total energy imbalance

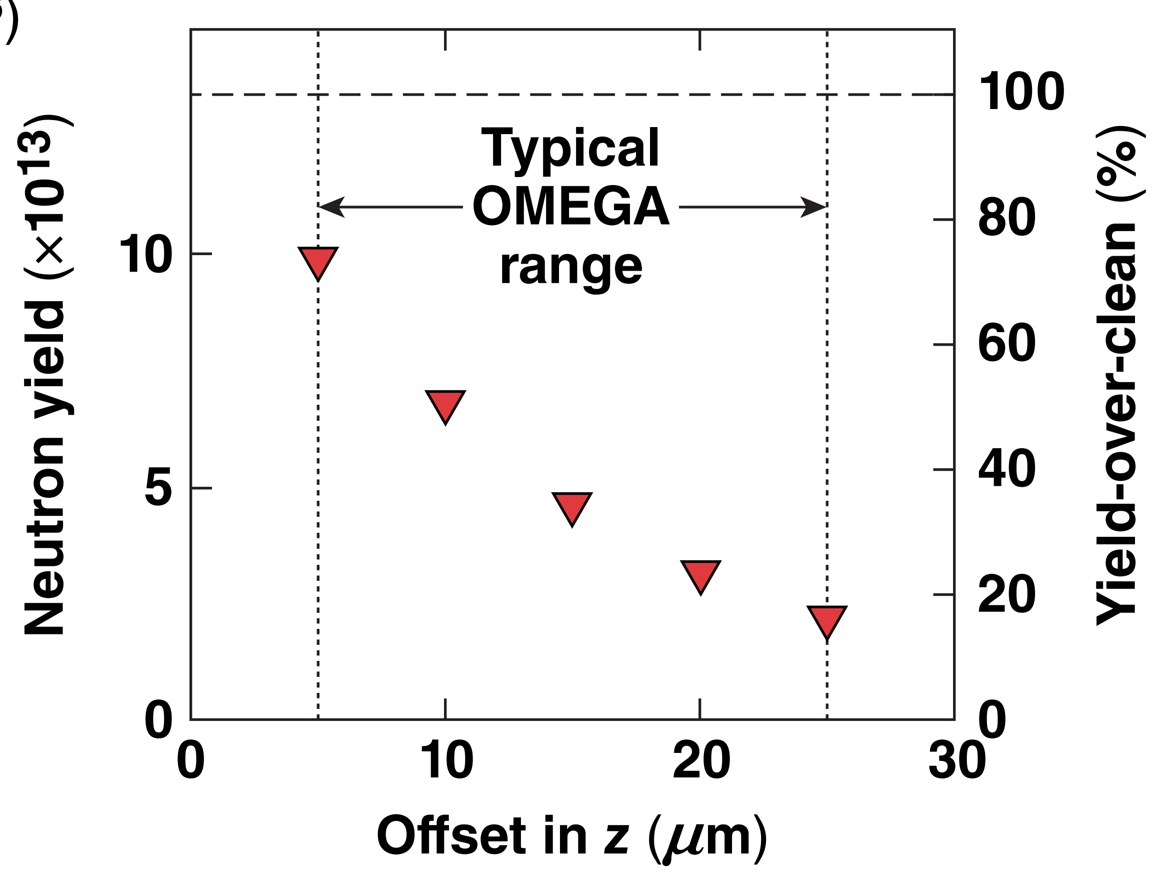
TC13157

Typical OMEGA target offsets may reduce the neutron yield by a factor of >50%

20-μm target offset in –*z*, CR = 22

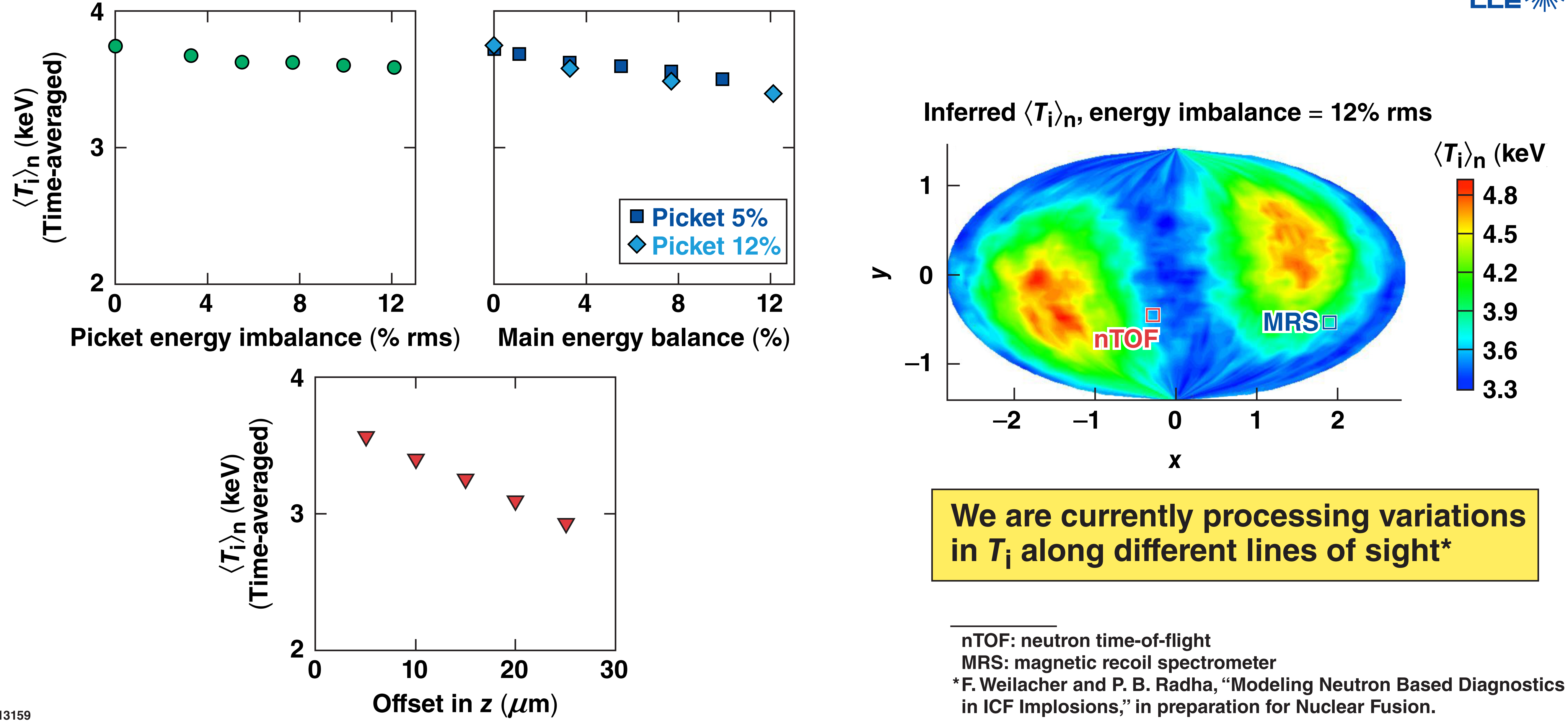


Yield versus target offset



TC13158

Inferred hot-spot temperature exhibits more sensitivity to target offset than to beam-to-beam energy imbalance



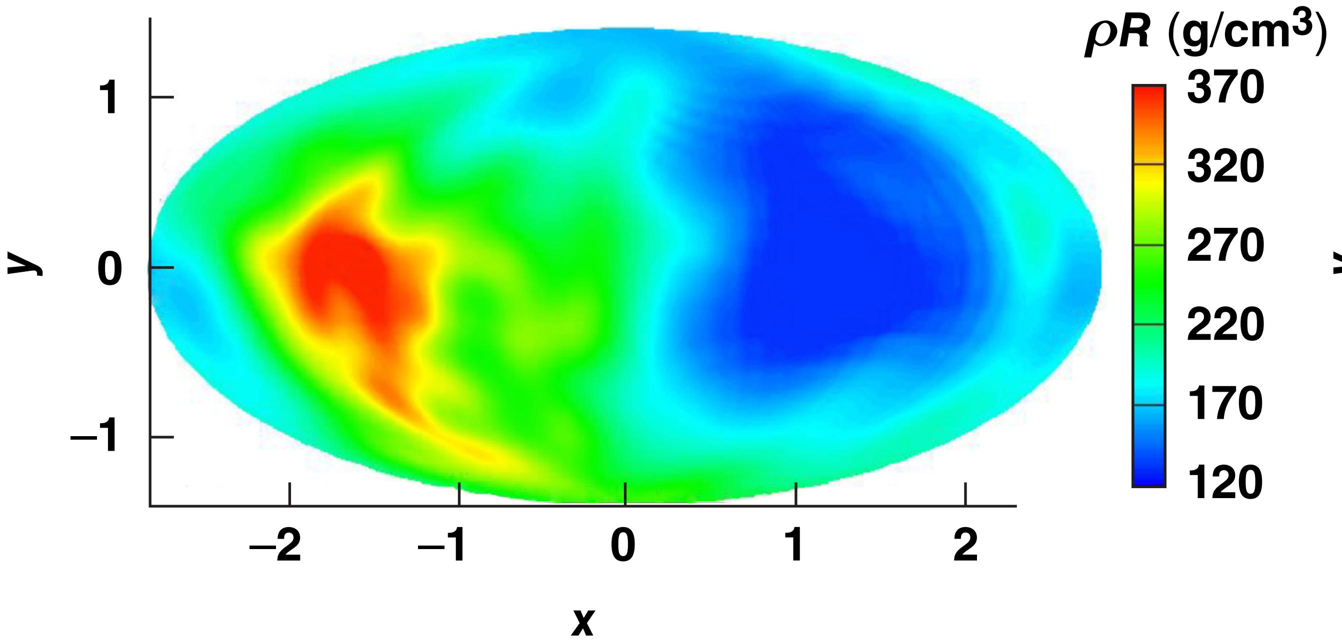
We are currently processing variations in T_i along different lines of sight*

nTOF: neutron time-of-flight
MRS: magnetic recoil spectrometer
*F. Weilacher and P. B. Radha, "Modeling Neutron Based Diagnostics in ICF Implosions," in preparation for Nuclear Fusion.

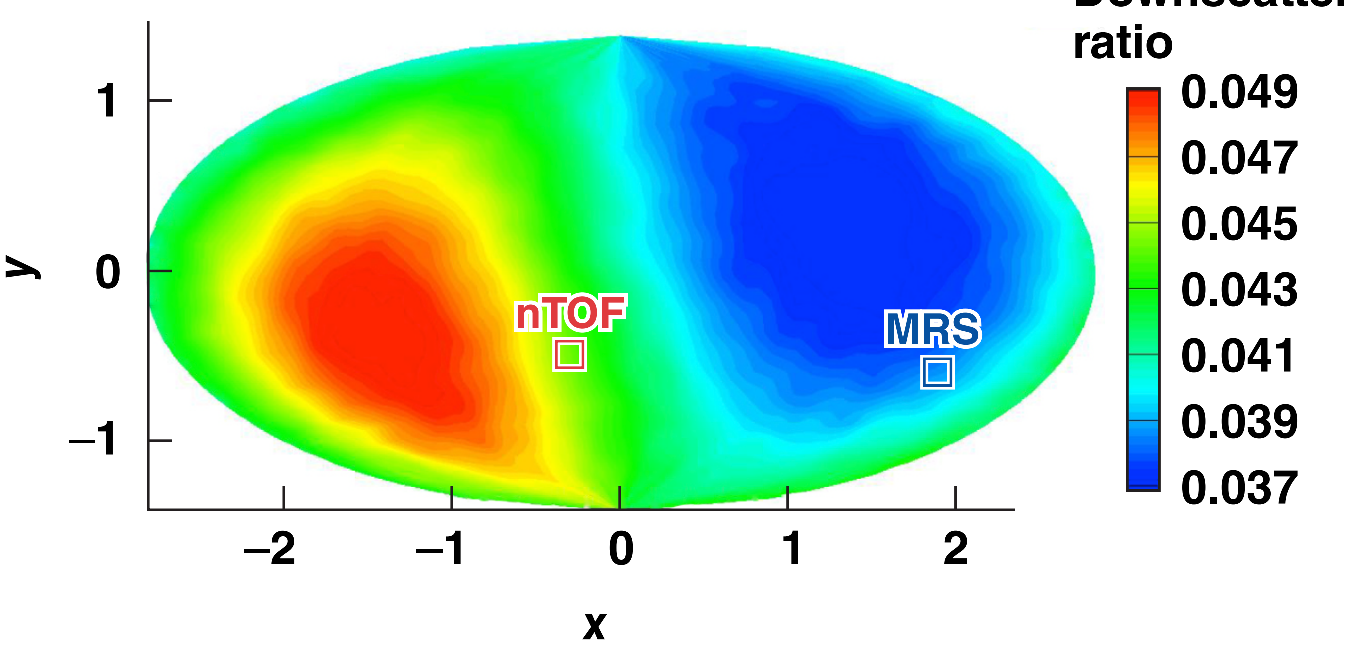
TC13159

Laser-energy imbalance and target offset generally lead to dominant $\ell = 1$ modes

Areal density versus angle at stagnation*



Neutron downscattered ratio



*12% rms beam-to-beam laser-energy imbalance

TC13160

Summary/Conclusions

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