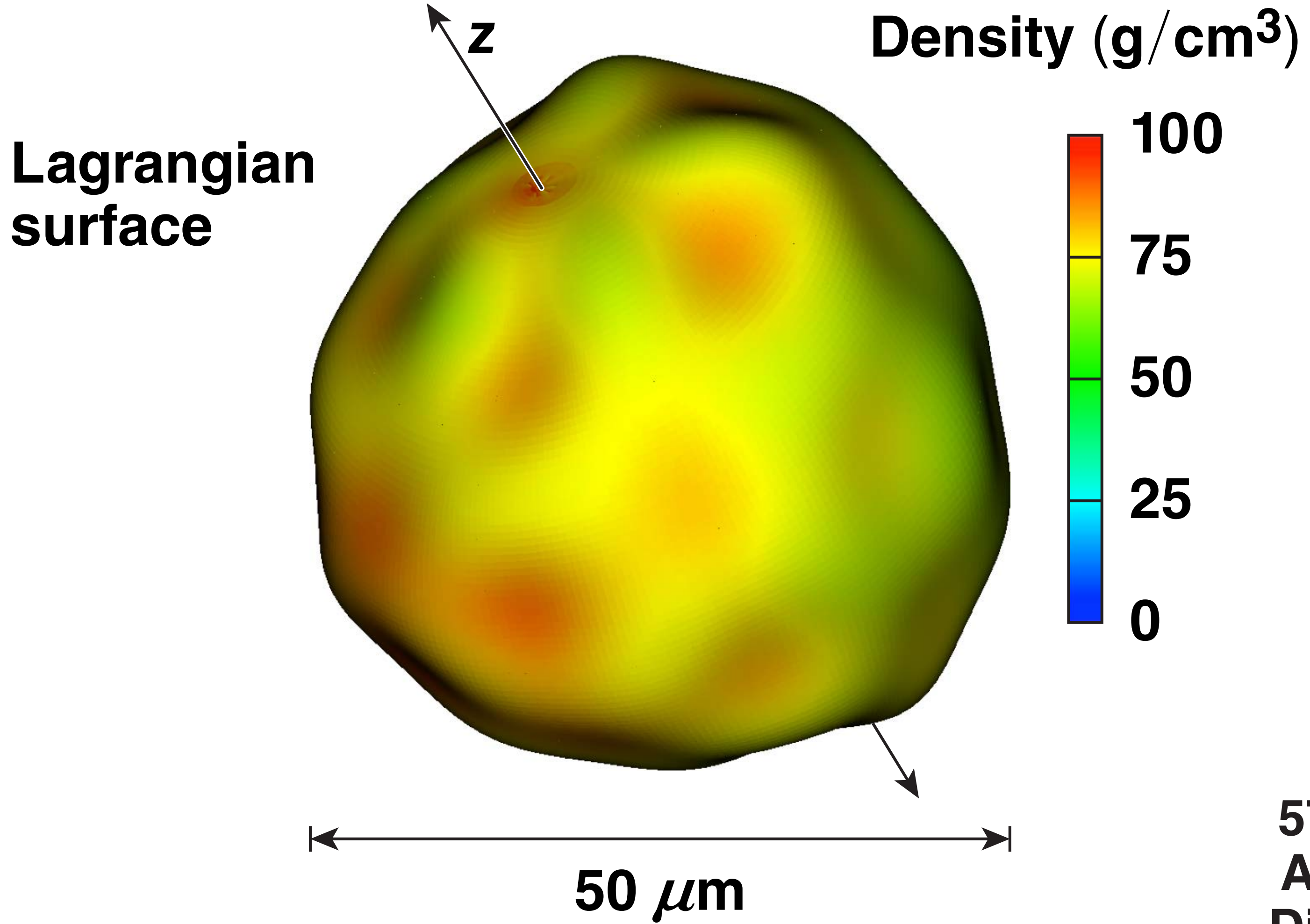
Characterizing Hot-Spot Dynamics in 3-D Direct-Drive Cryogenic Simulations for OMEGA



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We are developing a platform to study low-mode dynamics in full-sphere 3-D direct-drive implosions using *HYDRA**

- Full 4π simulations model spherical harmonic modes up to 10, resolving nonuniformities caused by beam geometry, laser spot, and target offset
- Preliminary simulations using a spherical laser ray trace are performed using Legendre-decomposed, hard-sphere illuminations as inputs
- A target offset of 10-μm increases the areal density modulation by a factor of 5× and residual fuel kinetic energy at stagnation by a factor of 2×

*M. M. Marinak *et al.*, Phys. Plasmas 8, 2275 (2001).

Collaborators

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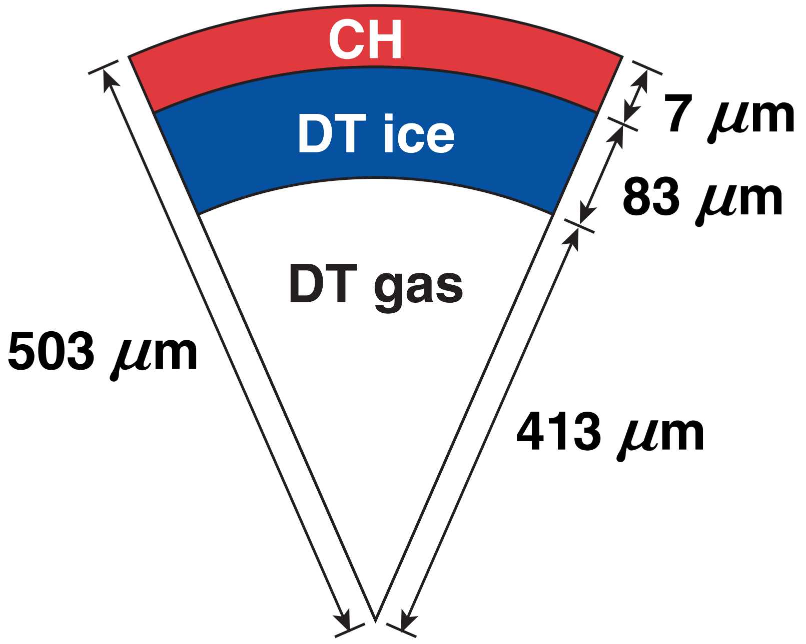
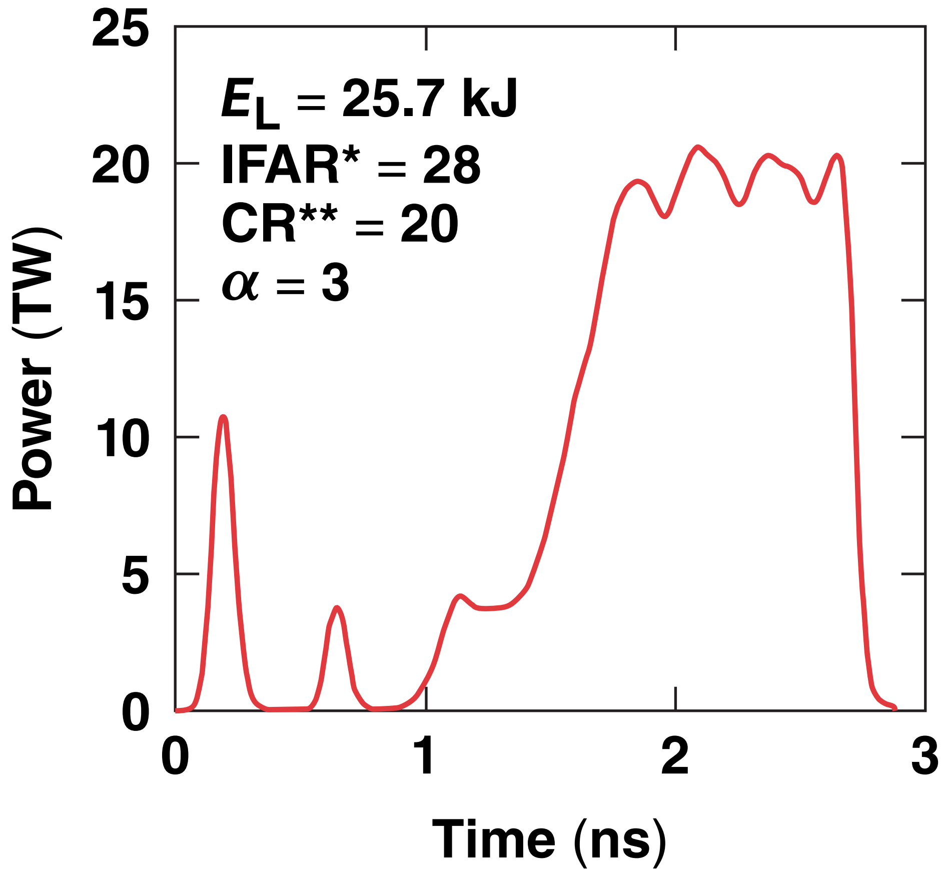
Three-dimensional, full-sphere simulations were performed for OMEGA shot 74009



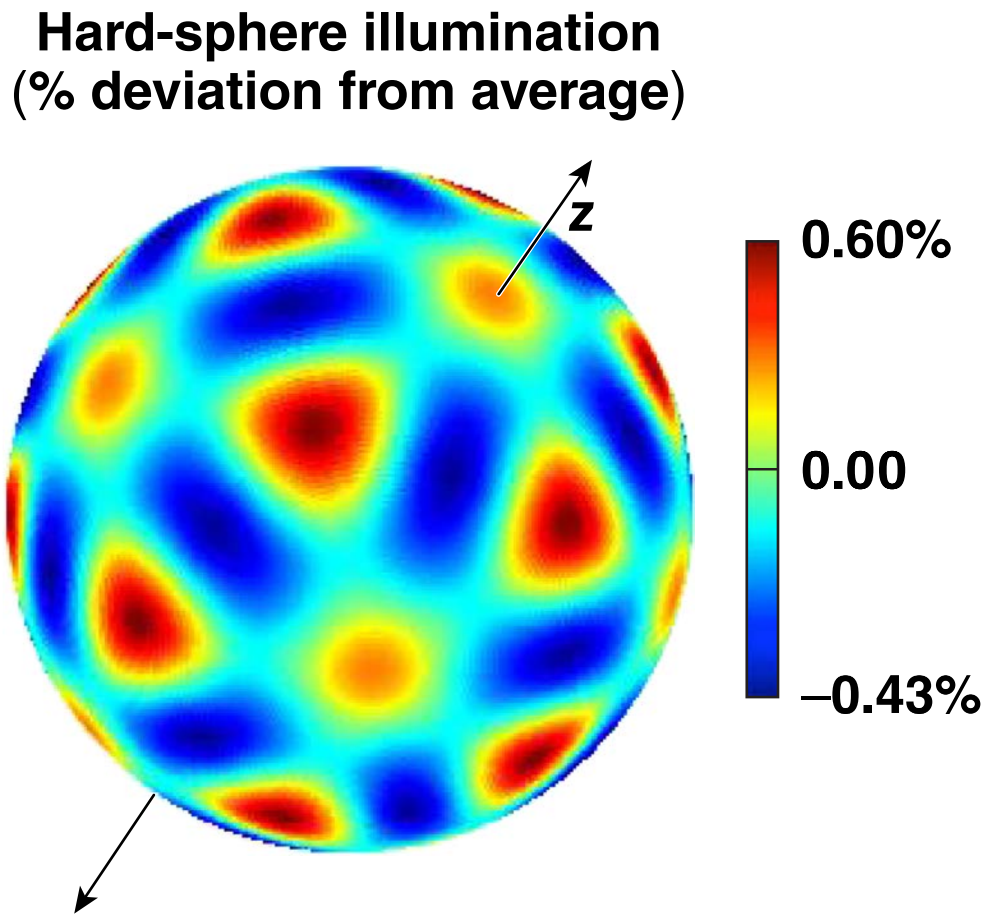


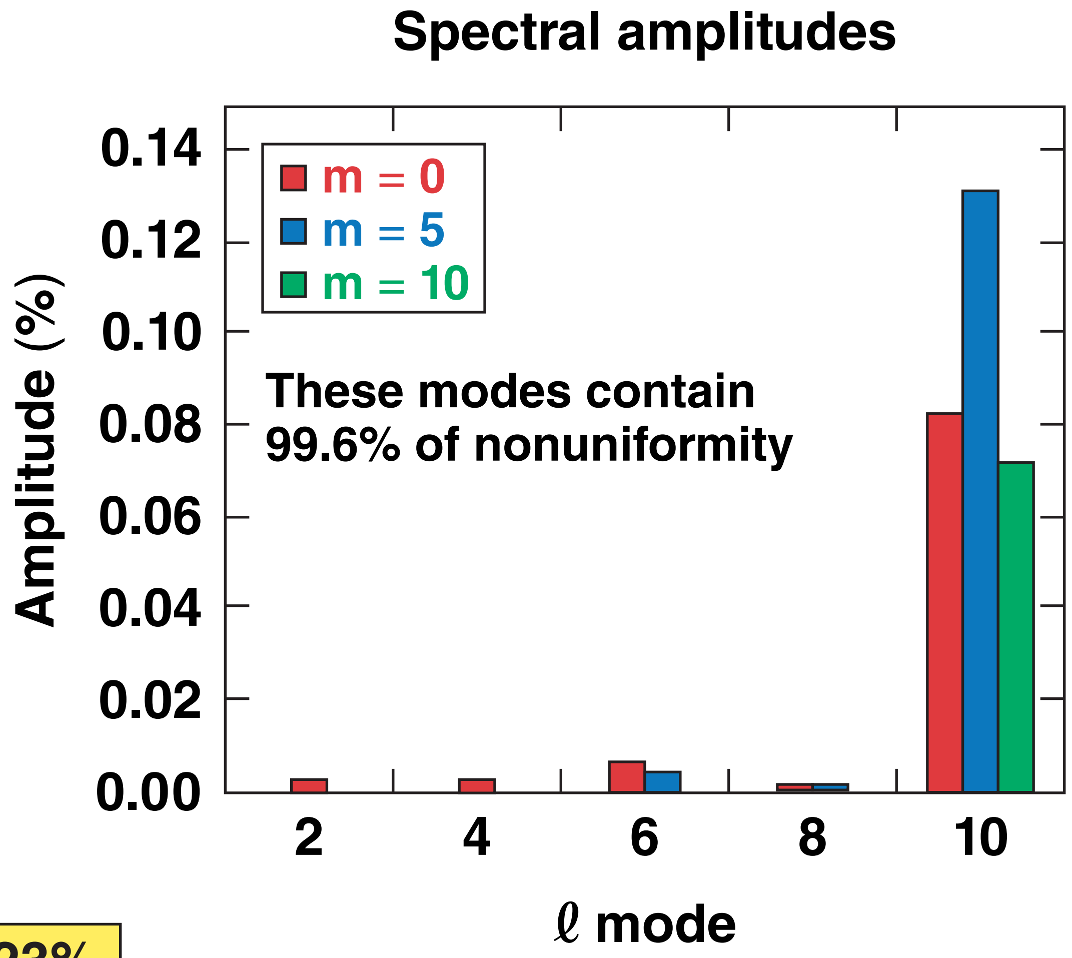
The beam-to-target ratio for this shot was 85% to reduce cross-beam energy transfer (CBET) energy losses.

*IFAR: in-flight aspect ratio
**CR: convergence ratio

TC12499

A hard-sphere calculation modeling all 60 OMEGA beams shows that mode 10 dominates the illumination nonuniformity



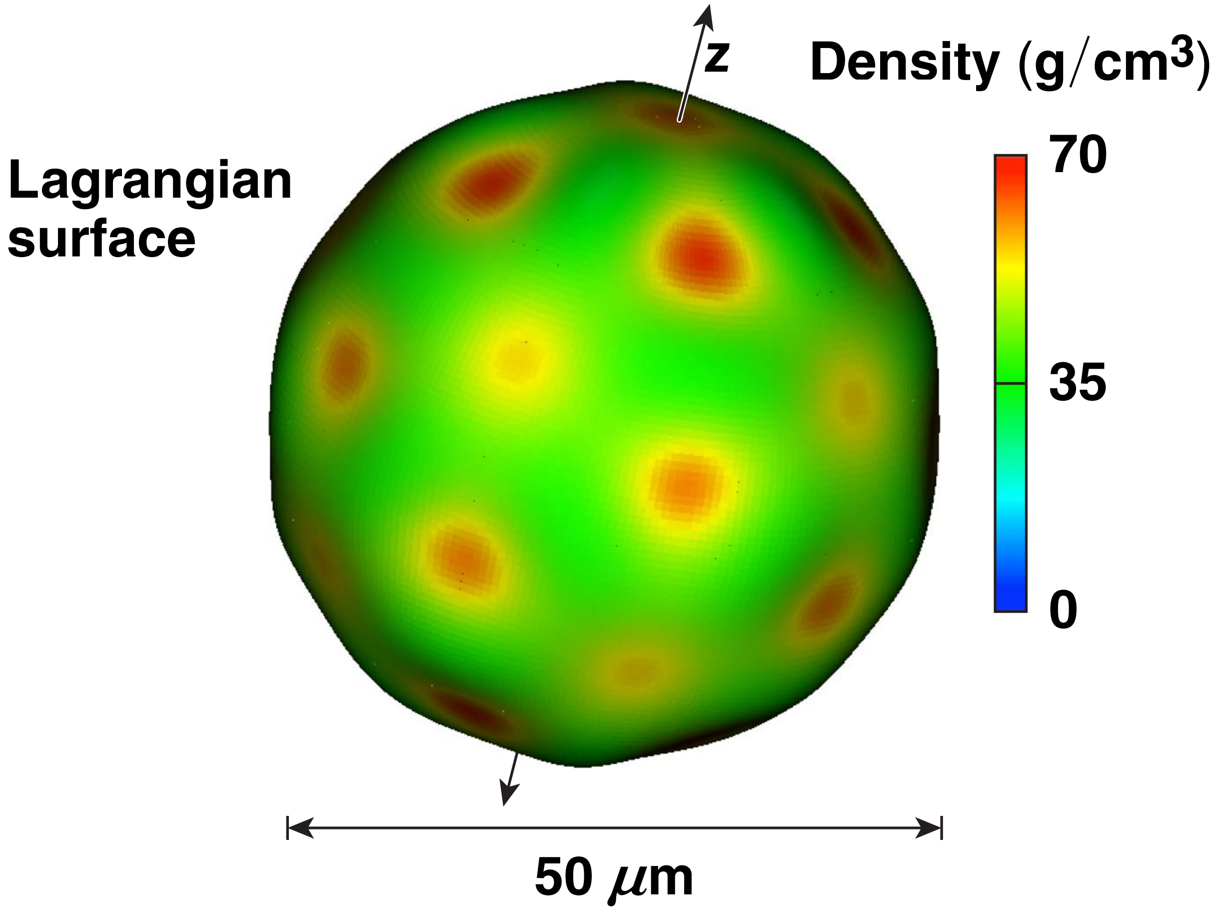


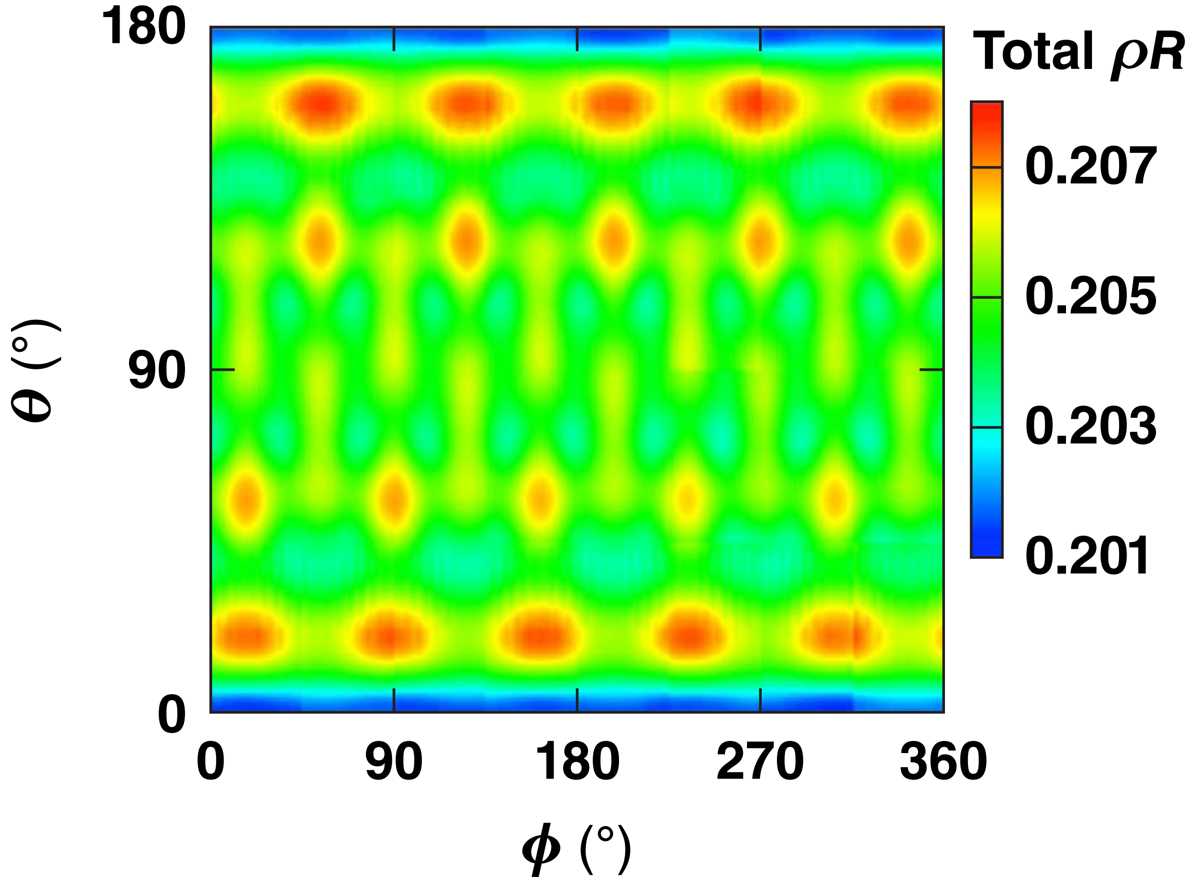
σ_{rms} = 0.23%

*cf, for 430-μm target, σ_{rms} = 0.14%

TC12500

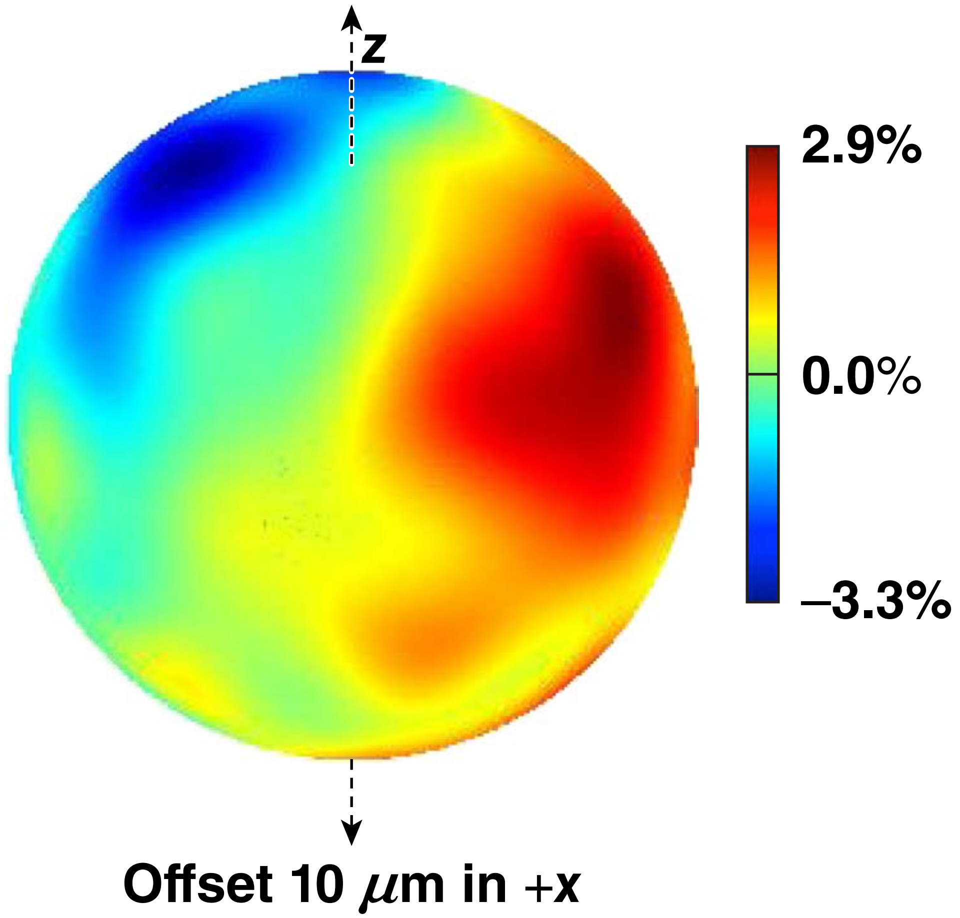
A radial ray-trace simulation modeling the hard-sphere illumination modes 1 to 10 shows that mode 10 dominates the implosion symmetry

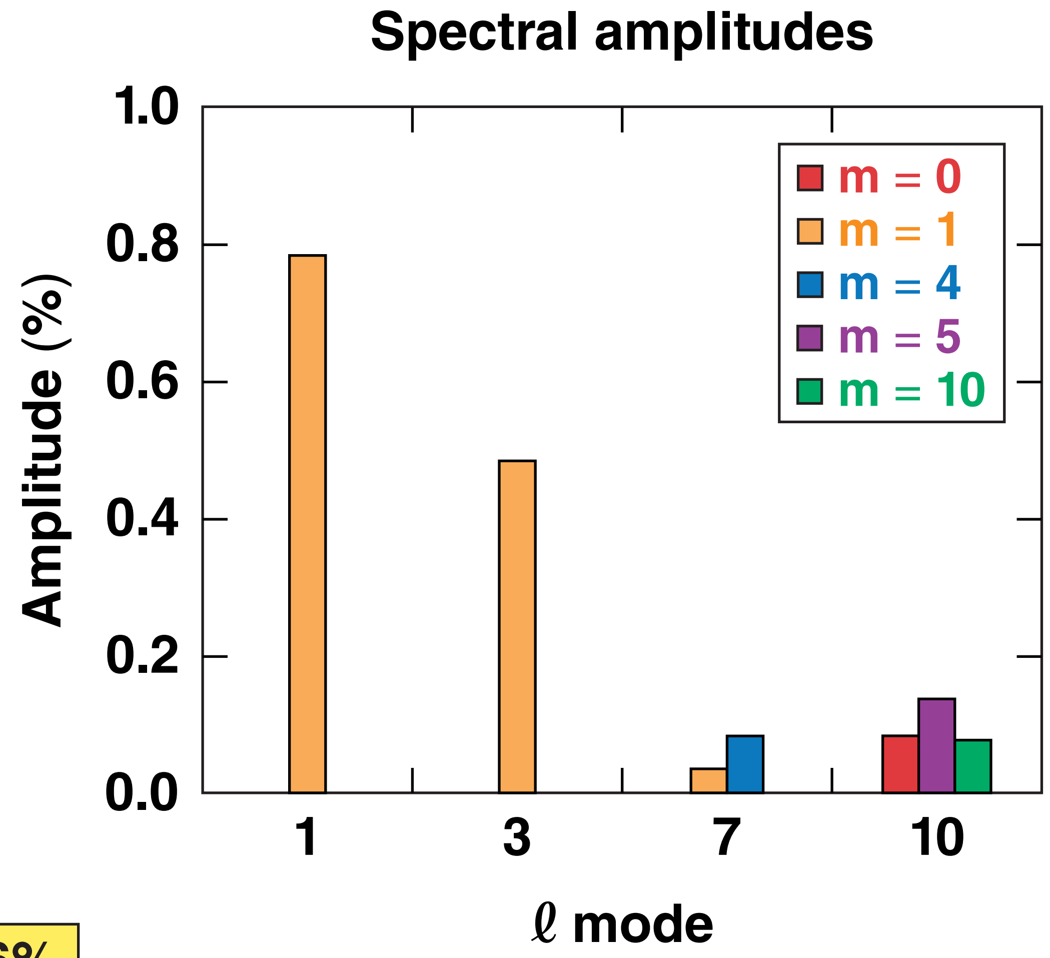




TC12523

A 10-μm target offset increases the σ_{rms} illumination nonuniformity by a factor of 10

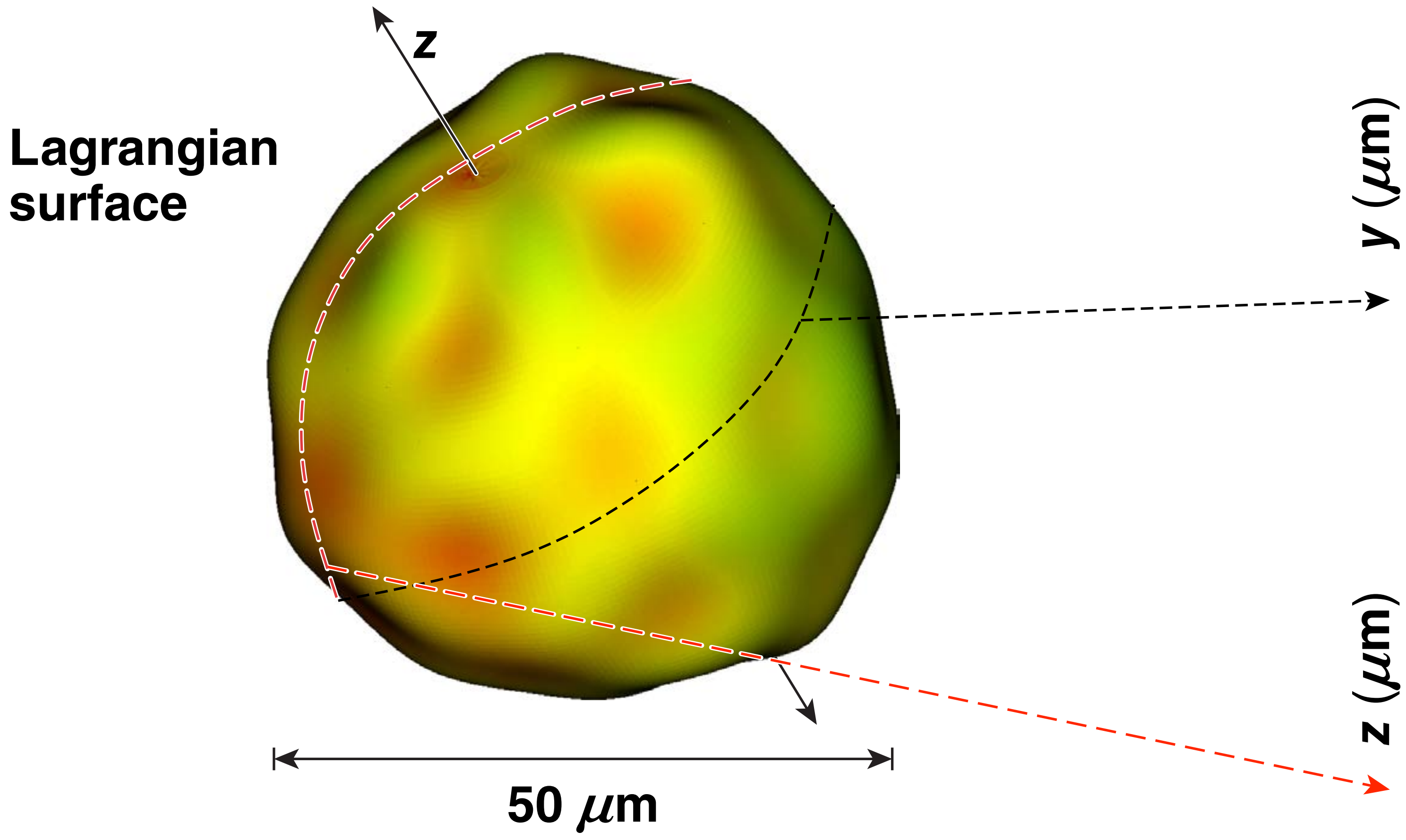


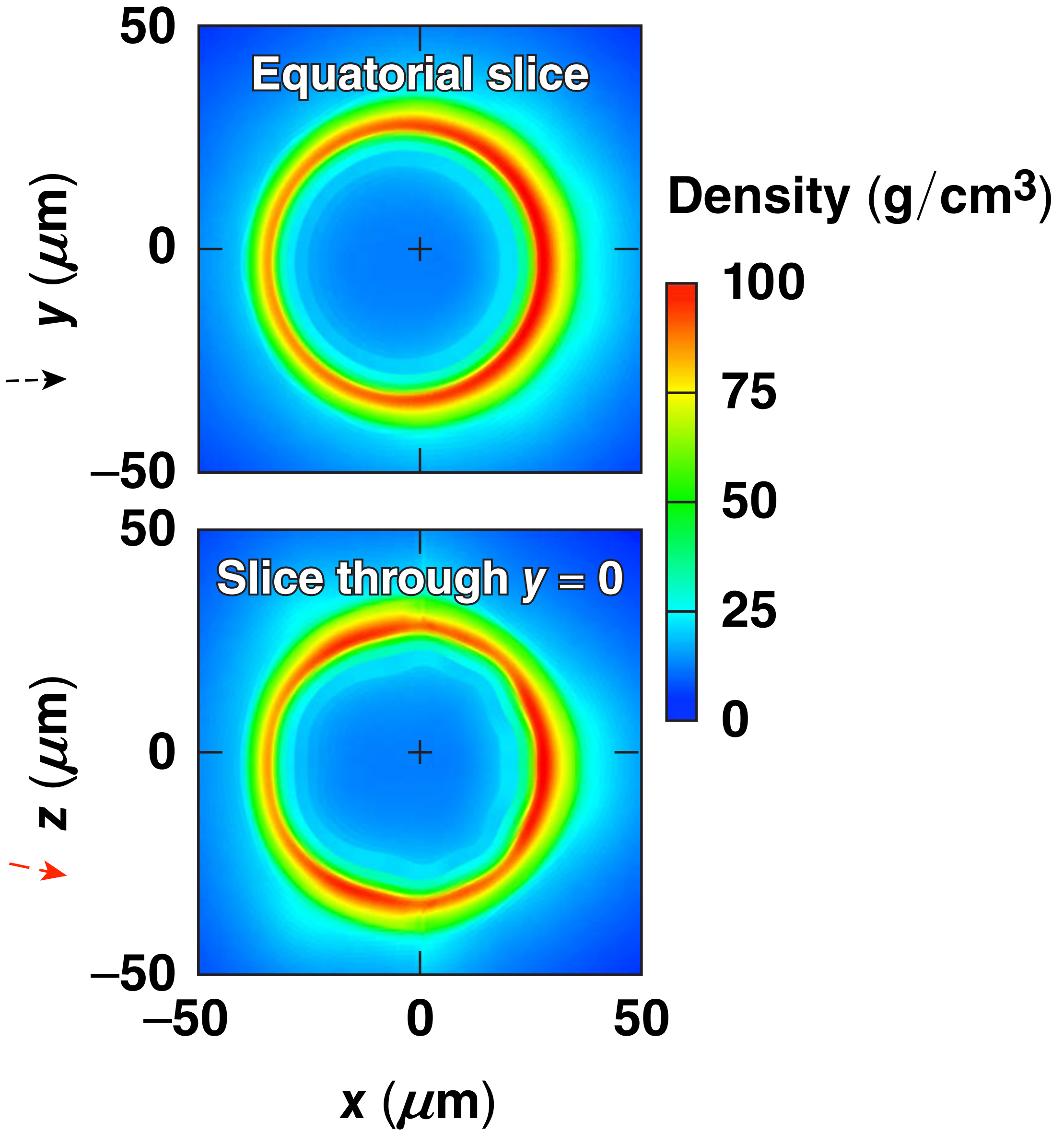


σ_{rms} = 2.6%

TC12501

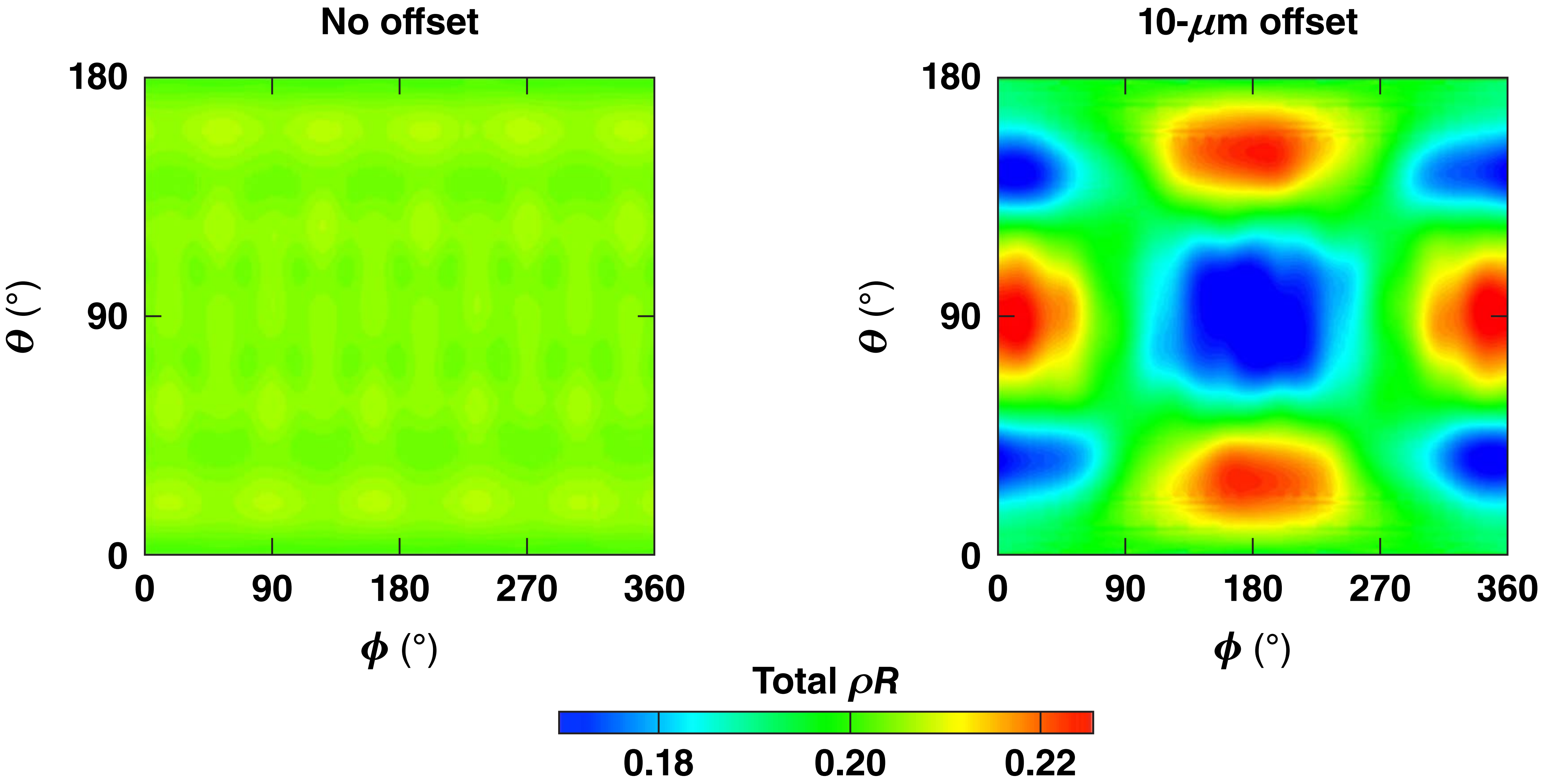
Modes 1 and 3 dominate the target offset implosion





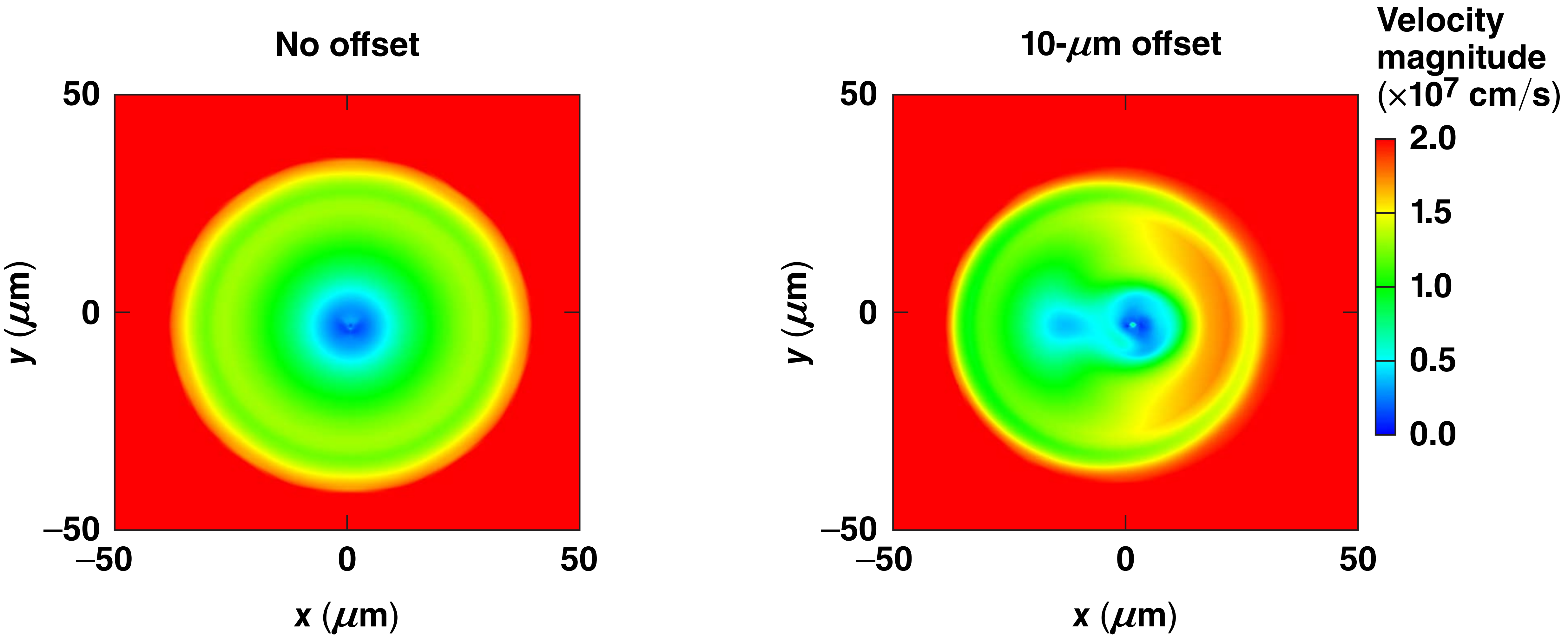
TC12524

The variation in shell areal density is substantially increased with target offset



TC12502

The residual kinetic energy (KE) in the unablated fuel increases by ~2× when the target is offset



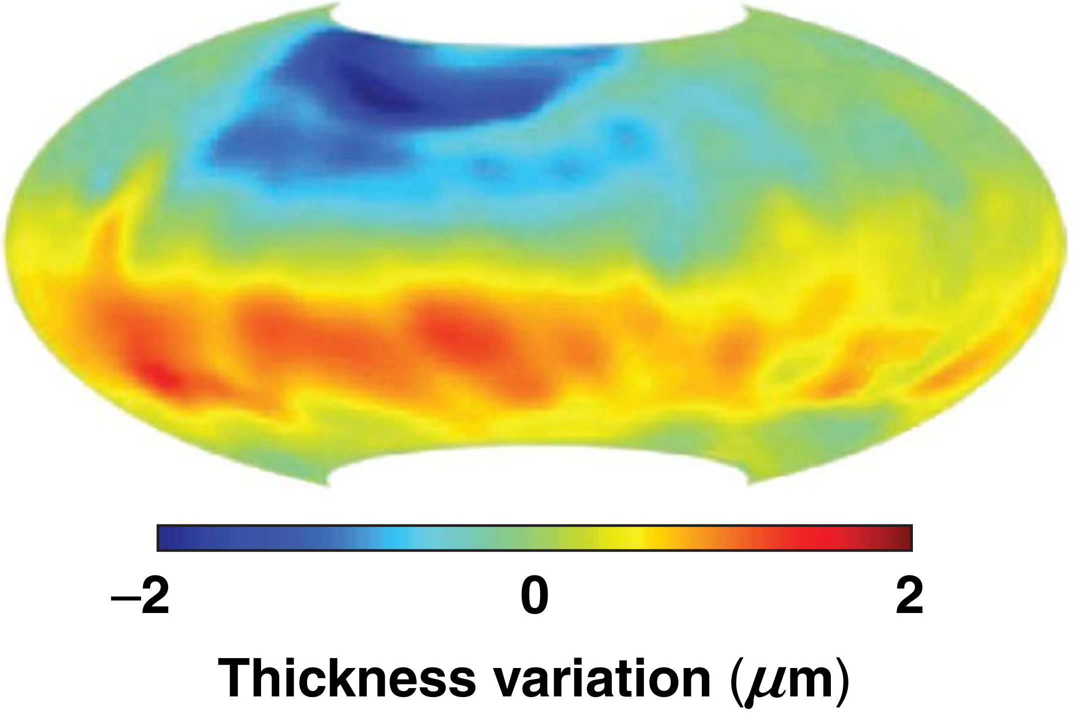
Residual fuel KE = 68 J

Residual fuel KE = 120 J

TC12525

Simulations with *HYDRA* will gradually begin to incorporate other perturbation sources

- **3-D ray-trace studies with real beam spots** (statistical noise reduction studies in progress)
- **Target offset in 3-D** (heuristically implemented with spherical ray trace)
- **On-shot power histories for individual beams, including mistiming and power imbalance**
- **Beam mispointing**
- **As-measured ice roughness** (low mode)



TC12503

We are developing a platform to study low-mode dynamics in full-sphere 3-D direct-drive implosions using *HYDRA**

UR LLE

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