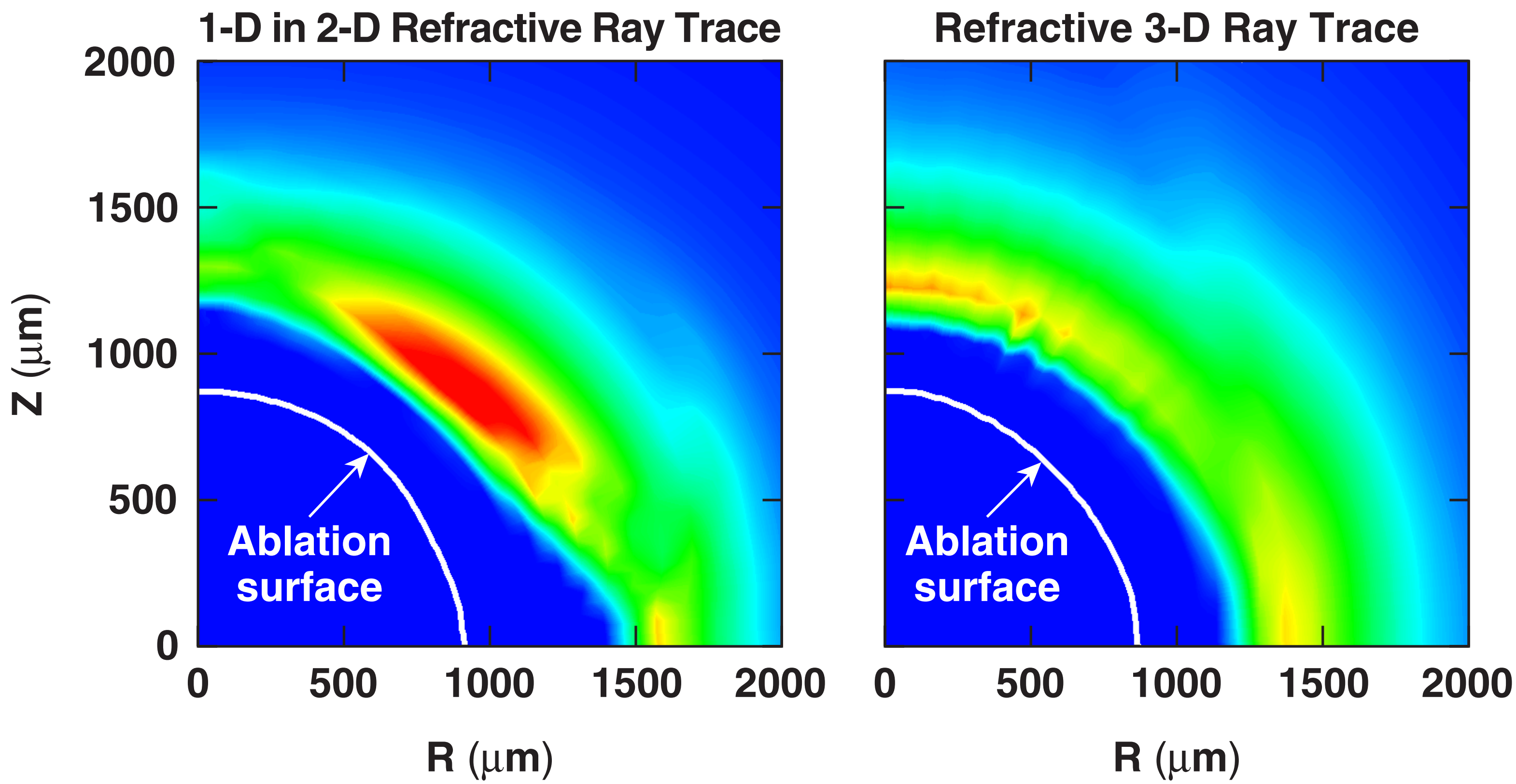
Evolution of the Laser-Deposition Region on Polar-Direct-Drive Simulations on the National Ignition Facility



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46th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Savannah, GA
15–19 November 2004

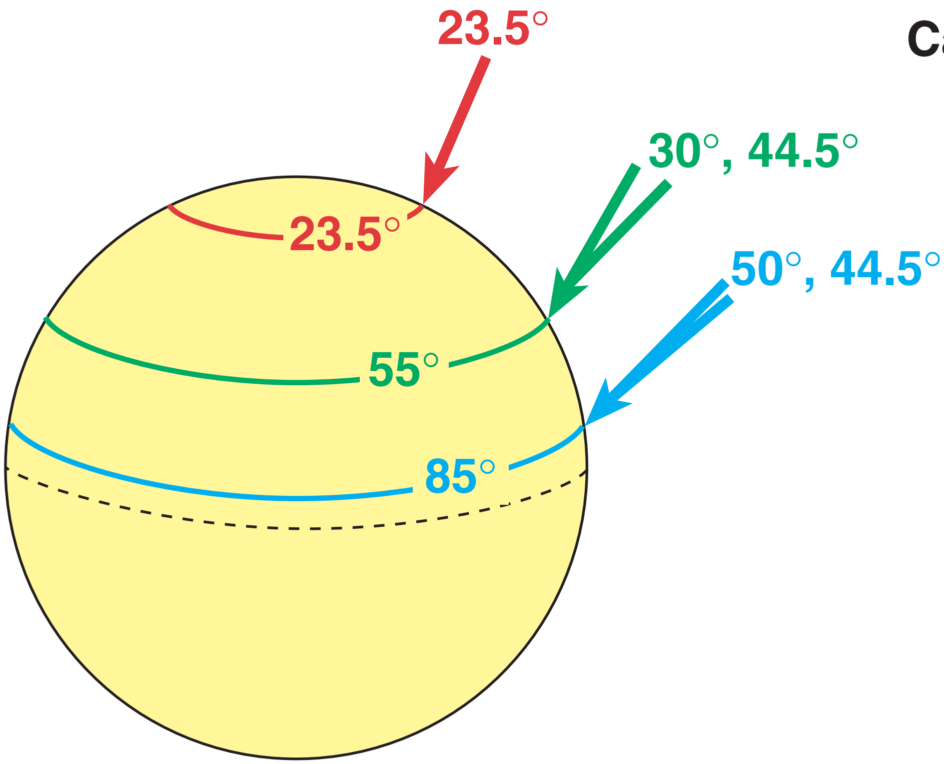
Summary

A refractive 3-D ray trace relaxes the drive requirement for polar direct drive (PDD)

- Long-scale-length plasmas limit the validity of the 1-D in 2-D ray trace
- An accurate refractive 3-D ray trace has been implemented in *DRACO*.
- This ray trace couples energy closer to the ablation surface in the equatorial region.
- PDD simulations now require less drive in the equatorial region than previously modeled.
  - Implies more available system energy

PDD enables direct-drive-ignition experiments while the NIF is in the x-ray-drive configuration

UR LLE



Caveats:

- Repointing the x-ray-drive ports leads to variations in incident angles.
- The equator requires the highest incident intensity to compensate for higher refraction losses, lower hydrodynamic efficiency, etc.
- 2-D effects also become important: lateral mass flow, lateral heat flow, etc.
- The "pointing" changes as the target compresses.

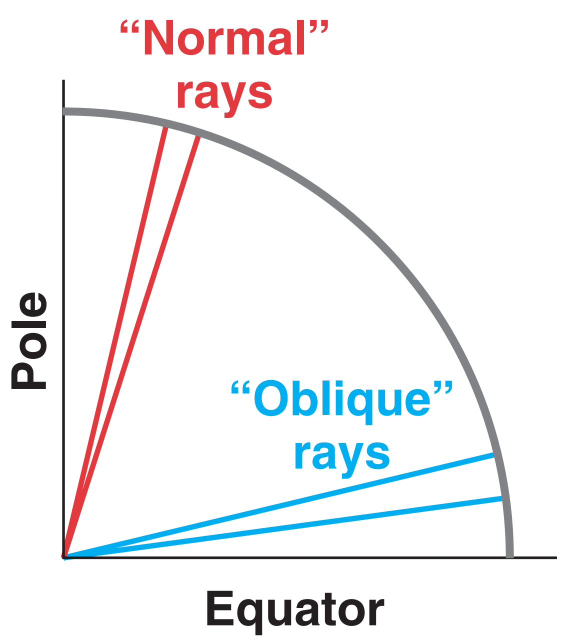
Solution:

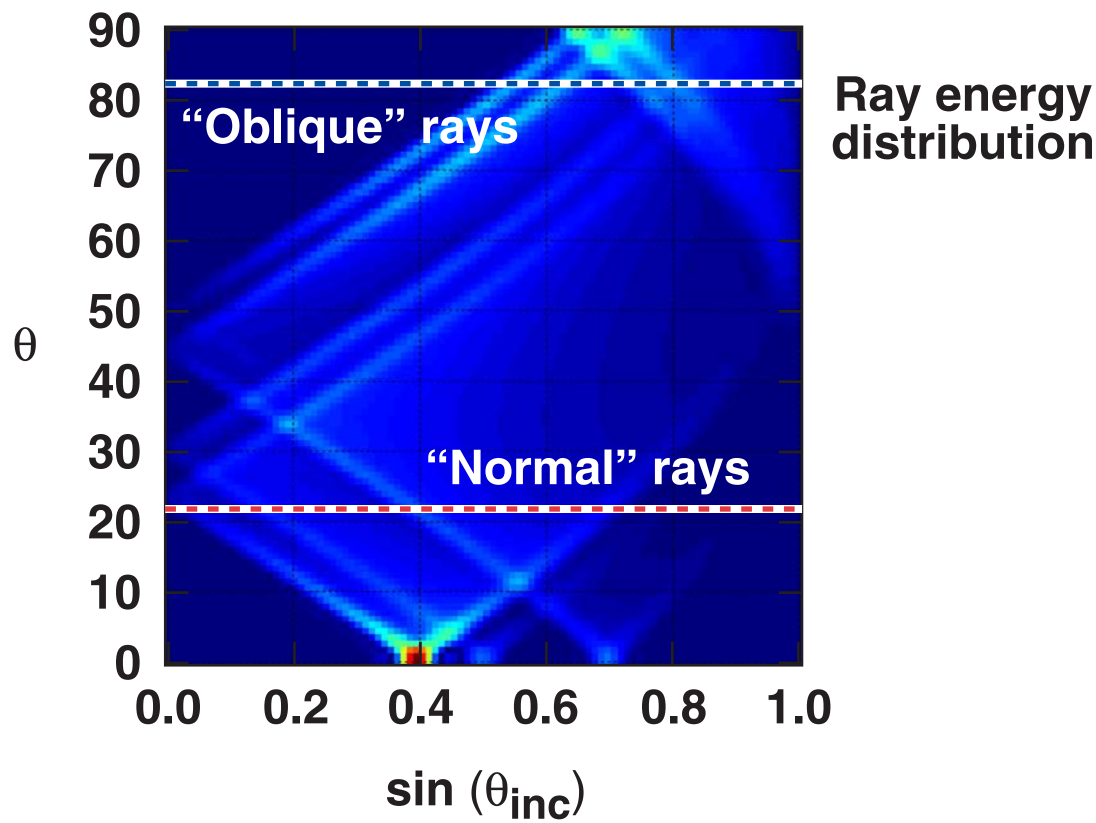
- Intensity variations on target can be manipulated through a combination of spot ellipticity and pulse shape.

TC6468

Each sector of a *DRACO* simulation is driven by an angular spectrum of rays when using the 1-D in 2-D ray trace

- The spectrum changes as a function of polar angle due to the nonuniform overlap of beams in the PDD configuration.
  - distribution is dependent on the projection radius
- The rays propagate and deposit energy within each sector as if each sector is 1-D; assumes that rays flowing in and out balance each other.



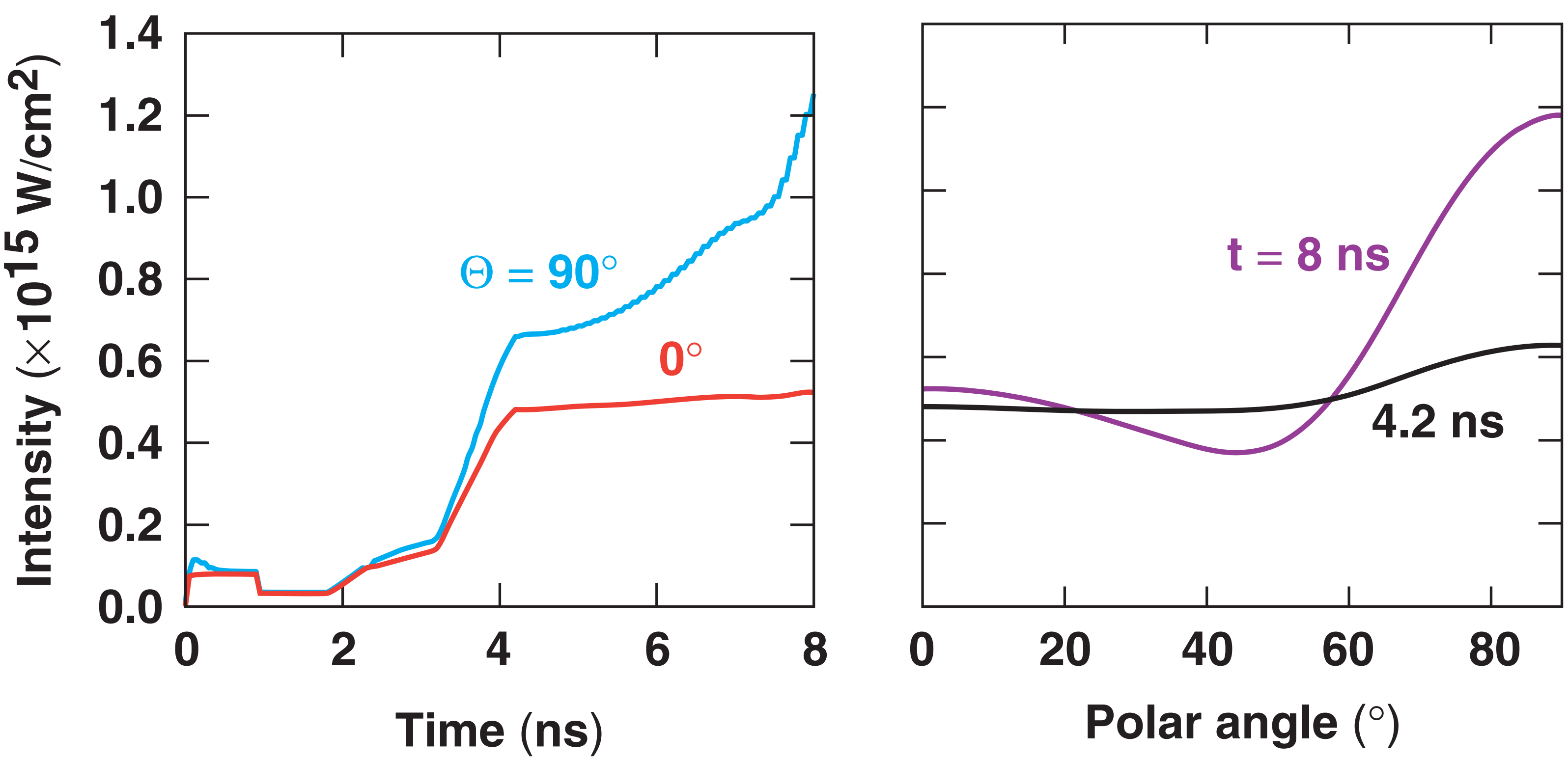


TC6391

A nonlinear feedback optimization procedure compensates for dynamic changes in absorption by monitoring the ablation surface

UR LLE

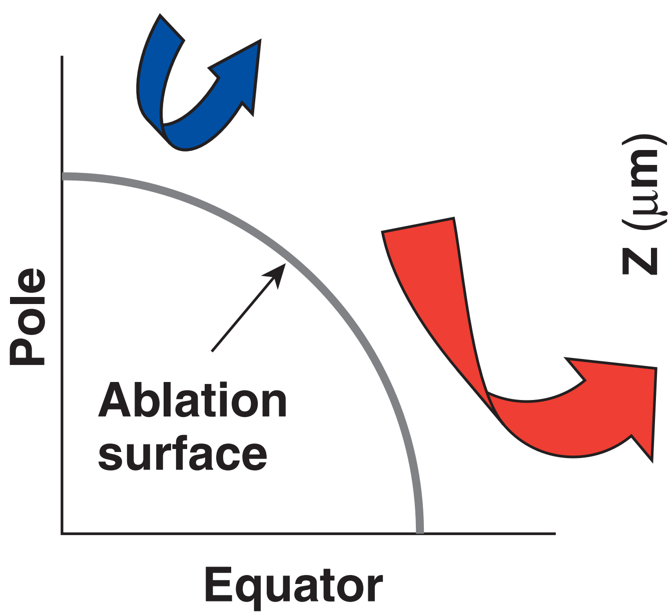
- The simple 1-D in 2-D ray trace requires a dramatic level of compensation at the equator.



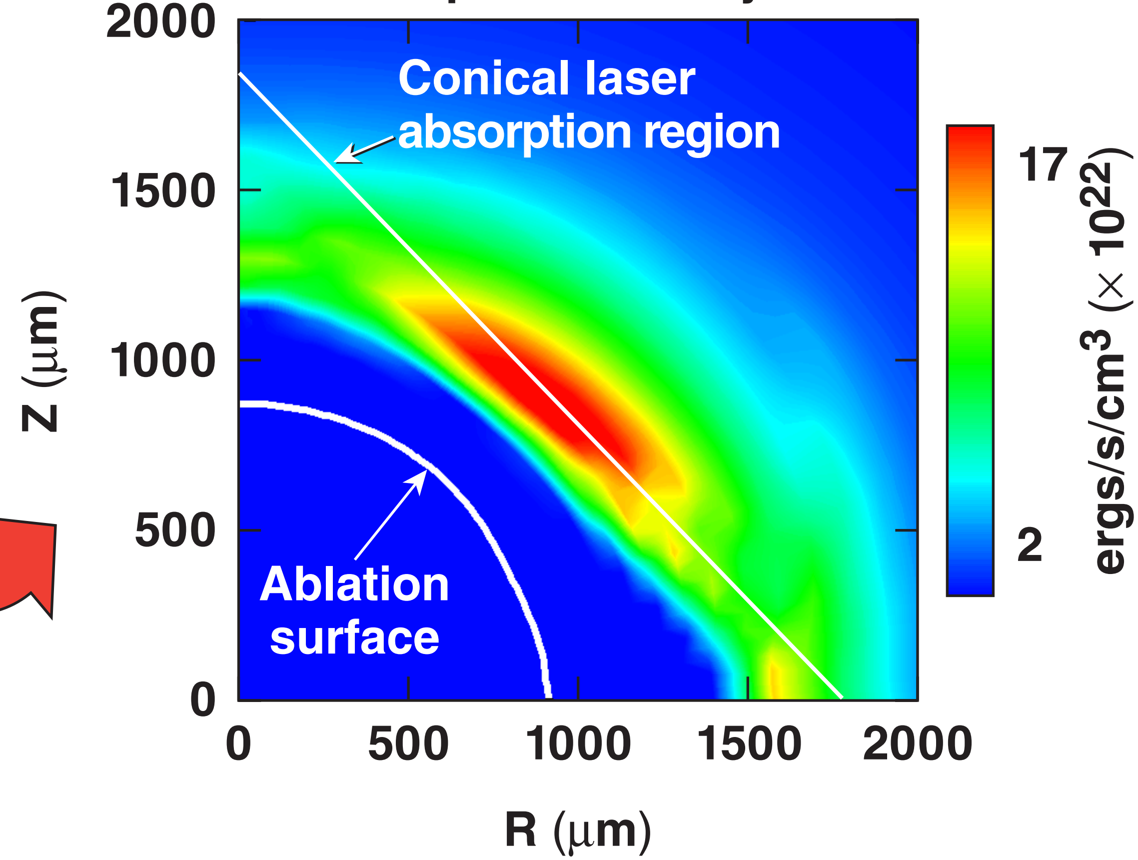
TC6396

Long-scale-length plasmas limit the validity of the 1-D in 2-D ray trace

- The angular spectrum distribution changes with polar angle and radius.
  - A fixed projection radius is not appropriate.
  - Ray flow in/out of a sector will not balance.



Absorbed laser energy at peak intensity



TC6838

A refractive 3-D ray trace has been implemented in *DRACO* to handle the aspherical plasma

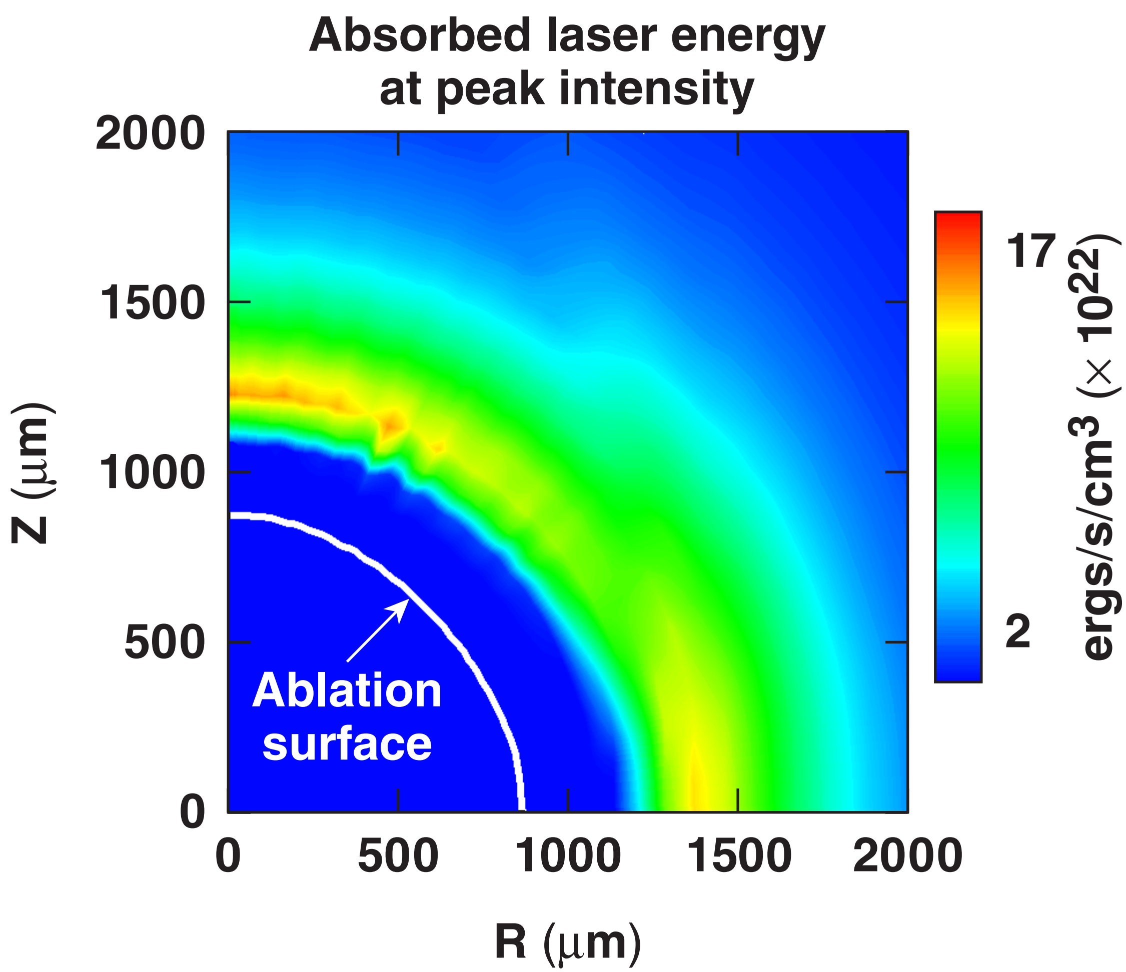
UR LLE

- Rays are traced from their respective beam ports.
  - Ray distribution is optimized to yield uniform coverage.
  - Ray positions are randomly chosen for each time step and each beam.
- The rays are correctly traced in all regions.
  - through distorted Lagrangian meshes
  - dynamically adjusted step size
    - accurately calculates trajectory and laser absorption
- Excellent agreement with *LILAC* (in the direct-drive configuration)
  - shell position and absorption

TC6839

The laser deposition region develops more spherically using the refractive 3-D ray trace

- The equatorial region remains closer to the ablation surface.
- Identical pulse shapes are used for all rings.
- This achieves a modest gain of 4.6.



Improvements to the refractive 3-D ray trace are being implemented

- Increase gain by improving shell nonuniformity
  - Tie in the nonlinear feedback optimization procedure to derive optimal pulse shapes
- Decrease laser deposition noise
  - Improve the initial ray distribution to provide uniform coverage with less rays; inverse projection.

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