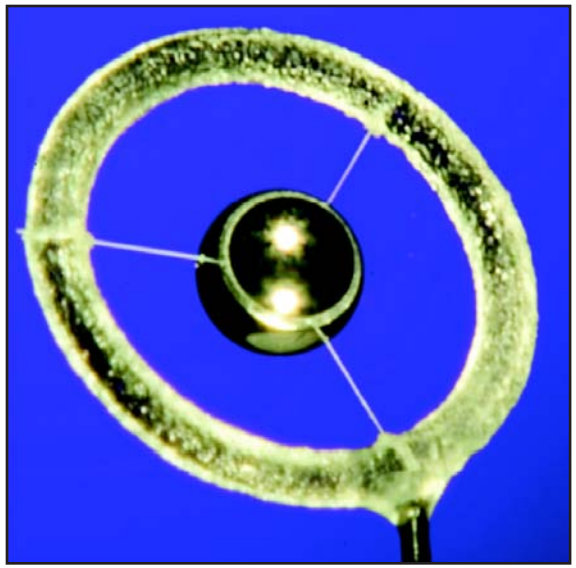
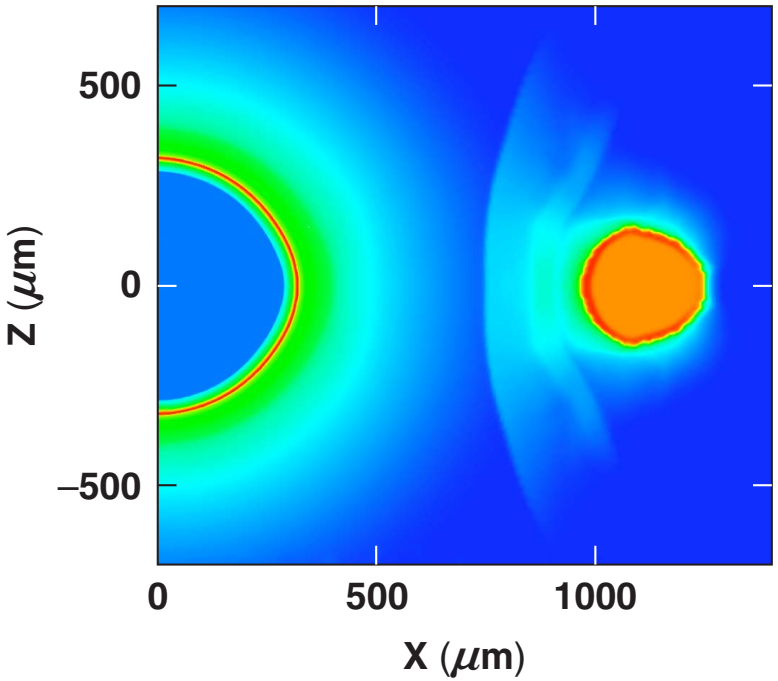
Simulation of Polar-Direct-Drive Saturn Implosions on OMEGA

UR LLE

Saturn target



Simulated density distribution, t = 1 ns



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47th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Denver, CO
24–28 October 2005

Summary

Simulations of OMEGA Saturn PDD implosions are in good agreement with experimental data

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- An Eulerian hydro option has been developed and implemented into *DRACO.*
- Laser ray refraction in the target corona has been accurately calculated using *DRACO* full 3-D ray trace.
- Different optimization techniques for PDD implosions have been examined using Eulerian *DRACO* simulations.
- Simulation results have been compared and show good agreement with experimental neutron yields and observed x-ray images of OMEGA PDD implosions.

Collaborators

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F. J. Marshall, P. W. McKenty, and S. Skupsky**

**University of Rochester
Laboratory for Laser Energetics**

In the polar-direct-drive designs, laser beams are repointed toward the equator

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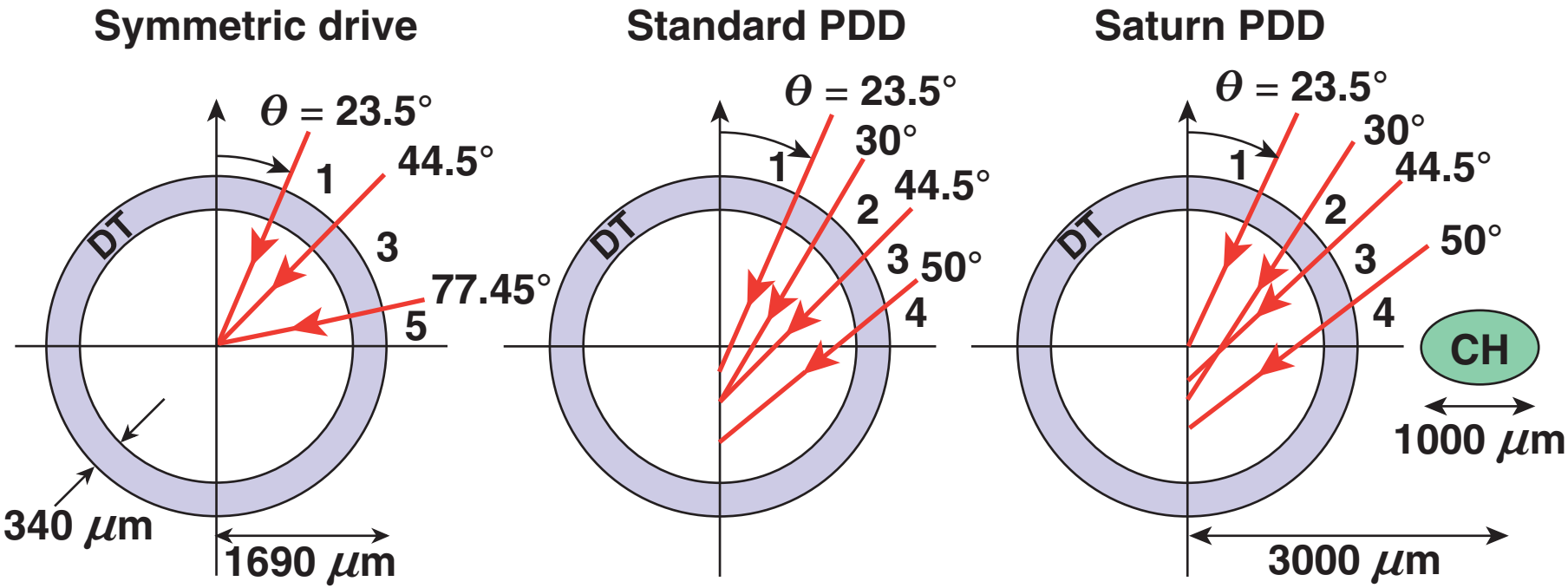
NIF configurations



Beam profile: $I(r) \propto \exp\left[-(r/\delta)^n\right]$, $n = 2.2 \sim 4.0$

PDD concepts are being tested on OMEGA.

TC7135

Eulerian hydro is required to simulate plasma flow between ring and target

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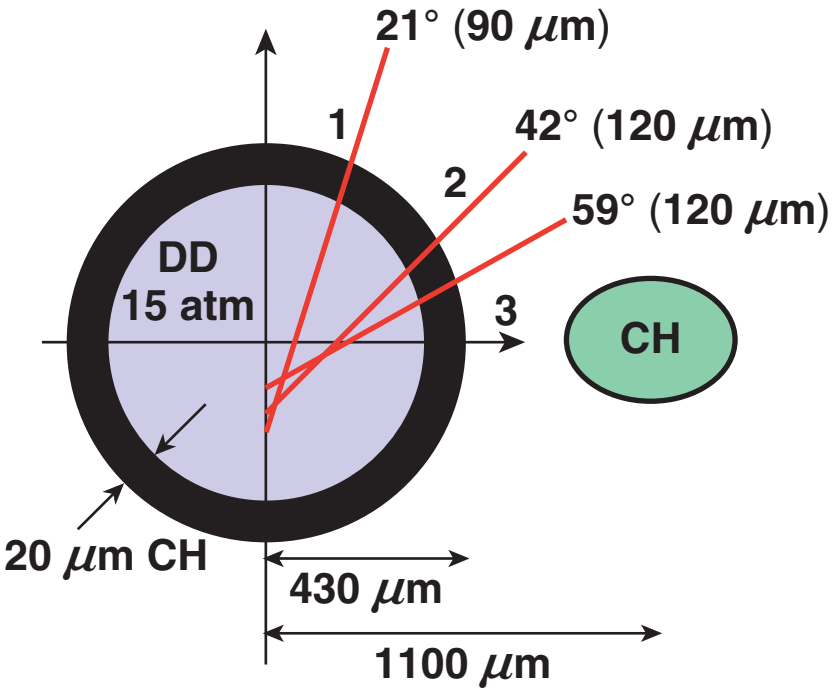
OMEGA Saturn design



40-beam 15-kJ drive
1-ns square pulse

- **The complexity of the flow makes it difficult to use ALE hydrodynamics.**
- **An Eulerian hydro option has been developed and integrated into *DRACO.***
  - **Godunov-type hydro scheme**
  - **piecewise parabolic interpolation**
  - **moving spherical numerical grid**

Full 3-D laser ray trace has been used in simulations to accurately calculate the effects of ray refraction on laser deposition uniformity

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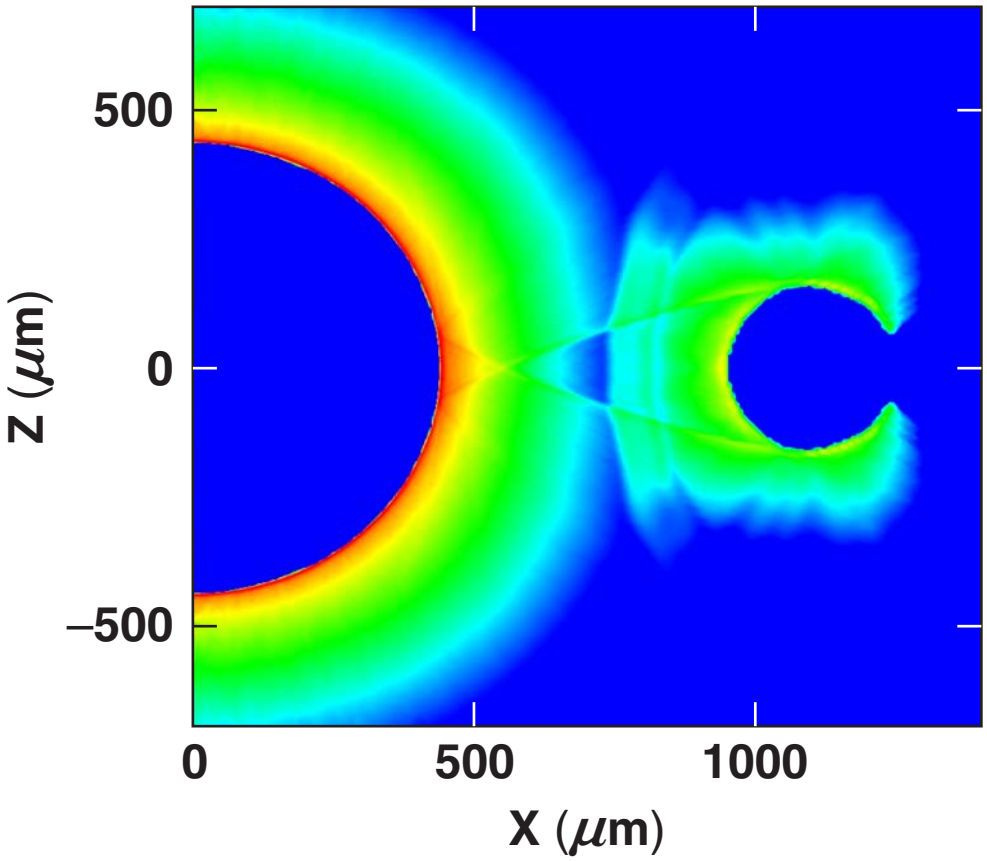
Instantaneous deposited laser energy (log scale) in Saturn target, t = 0.5 ns

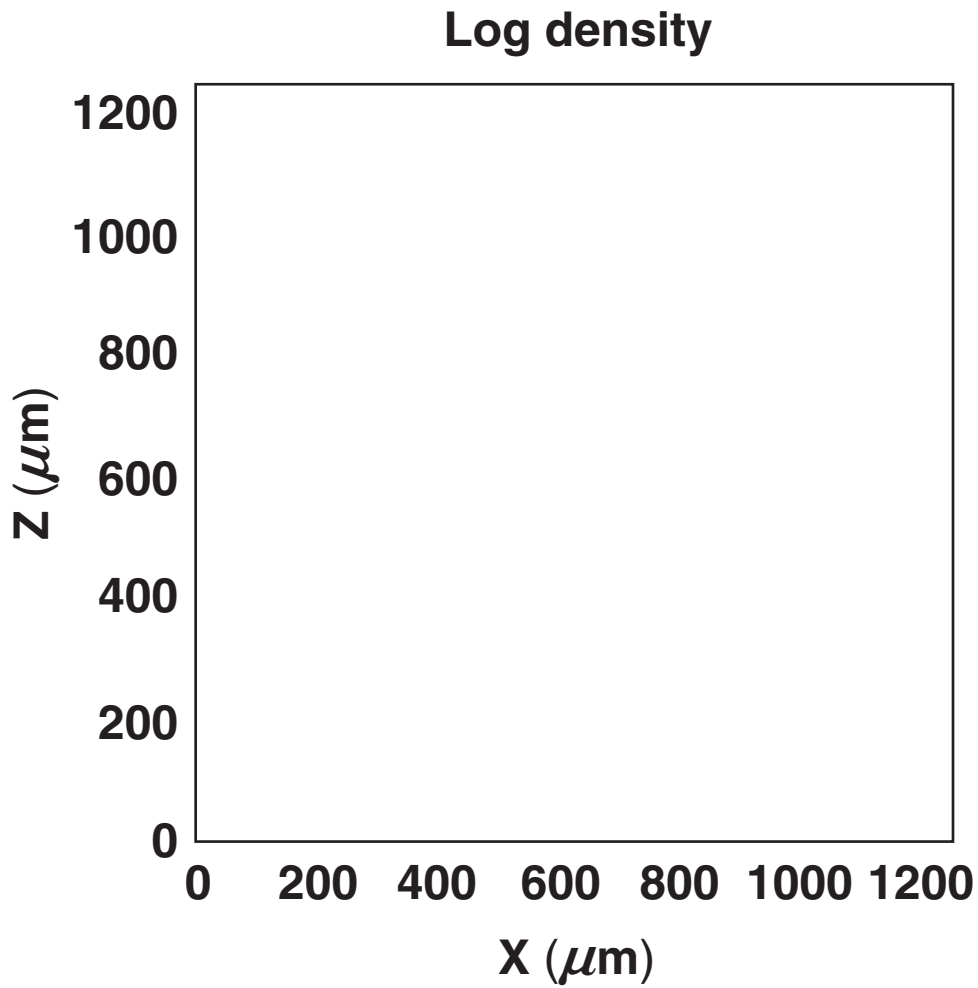


- Beam pointing and ray refraction provide nearly uniform irradiation of Saturn target
- Caustics in the laser field near the equator are the result of the refraction of beam 3 (59°, 180 μm)
- Influence of caustics is insignificant in this implosion

Plasma self-emission effects were self-consistently included using *DRACO* radiation transport.

TC7139

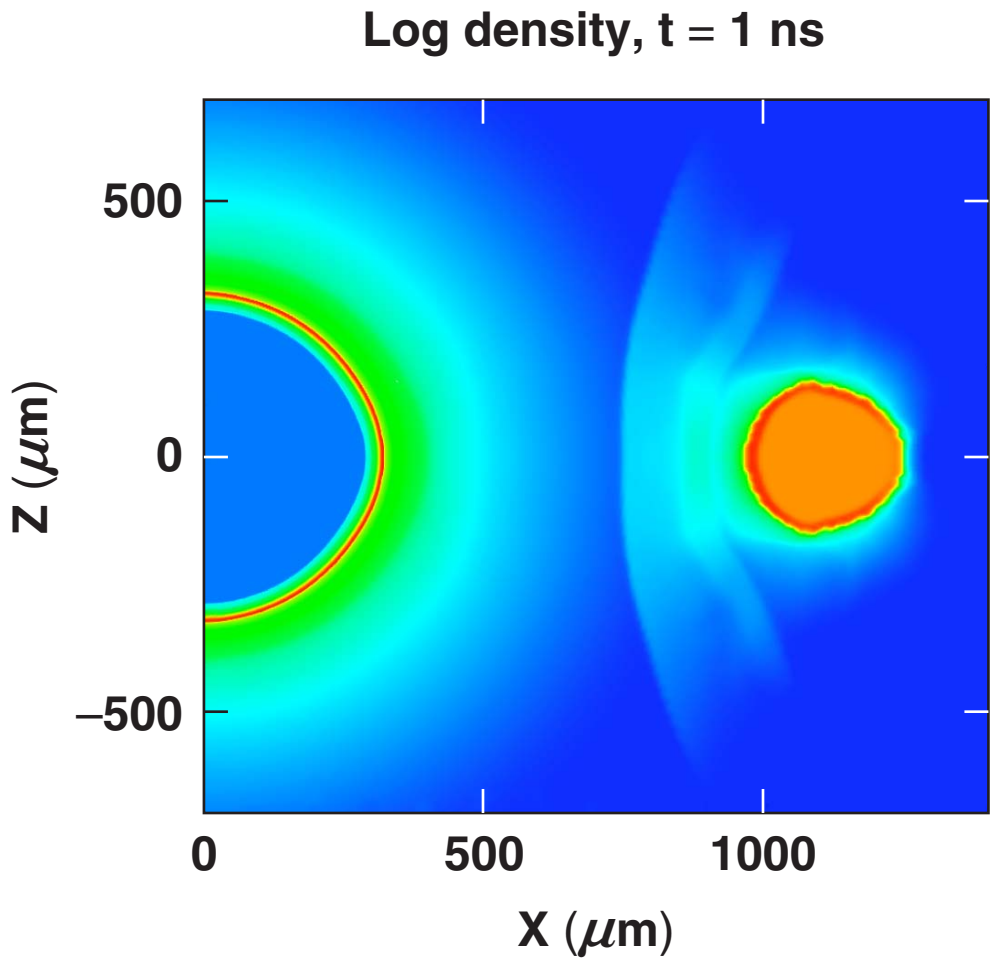
Simulations show in detail the formation of bow shock during Saturn target implosion



TC7137

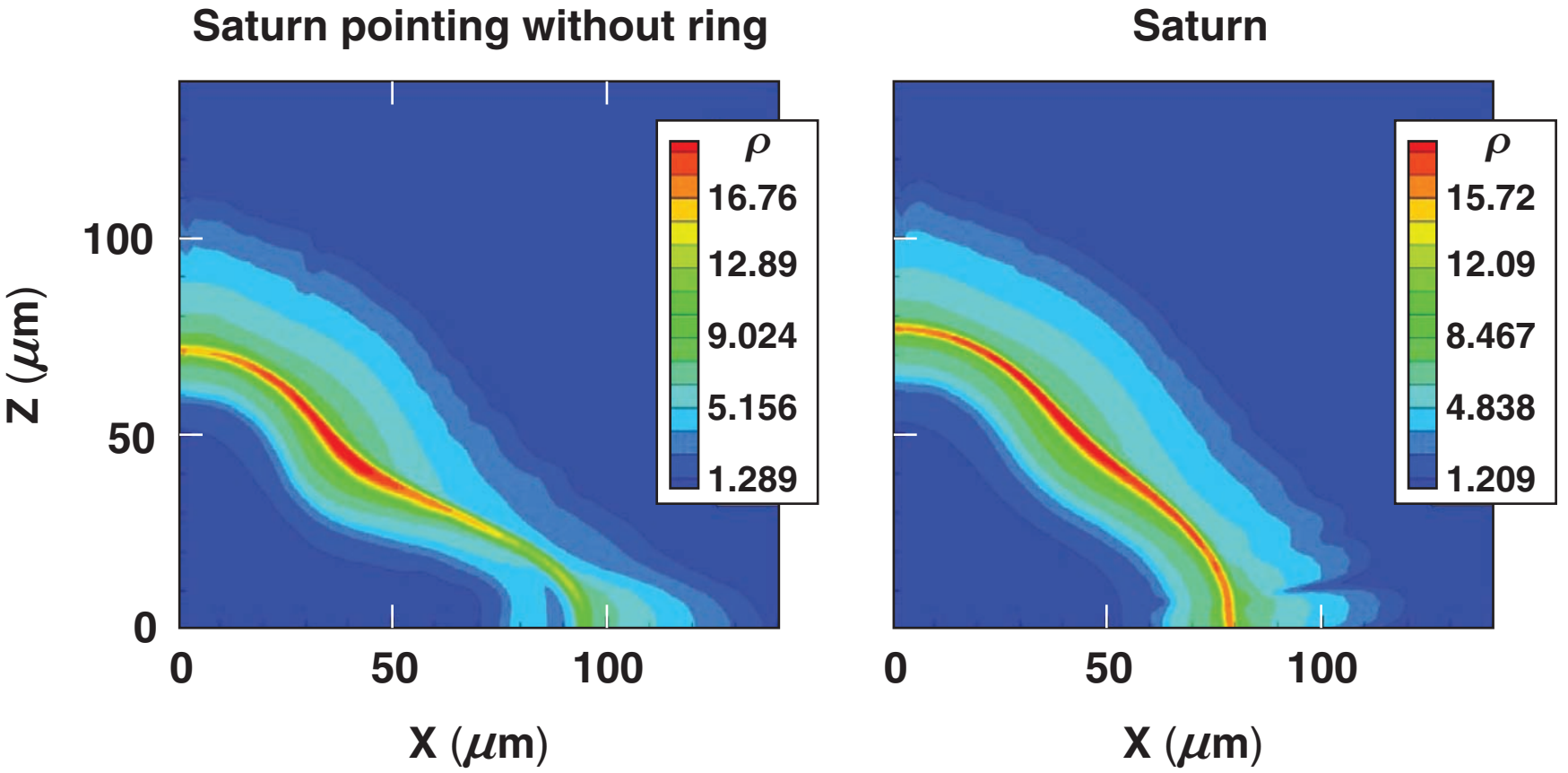
Simulations show in detail the formation of bow shock during Saturn target implosion

UR LLE



TC7111

Comparison of PDD implosion simulations with and without the ring show improvement in target uniformity



Beginning formation of hot spot, t = 1.85 ns

TC7138

DRACO simulations recover the observed relative degradation of neutron yield between PDD implosions with and without the ring

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PDD neutron yield (Y_N) relative to symmetric implosions

Target type	Observed range	Simulation
Saturn	0.64 to 0.76	0.59
Saturn pointing without ring	0.31 to 0.41	0.34

DRACO/SPECT3D images clearly reproduce the target shape and size when compared with OMEGA images

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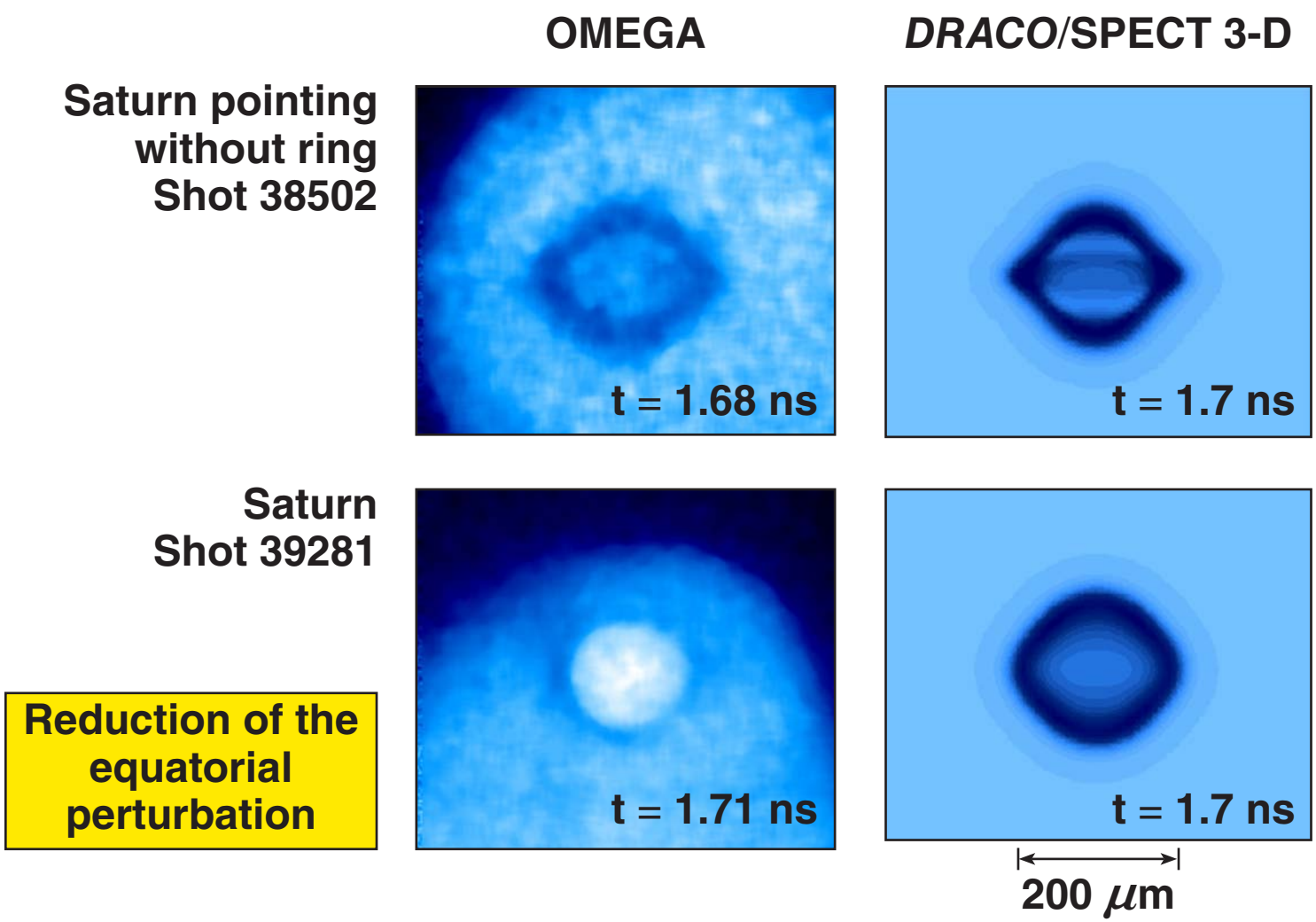

TC7109

Summary/Conclusions

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