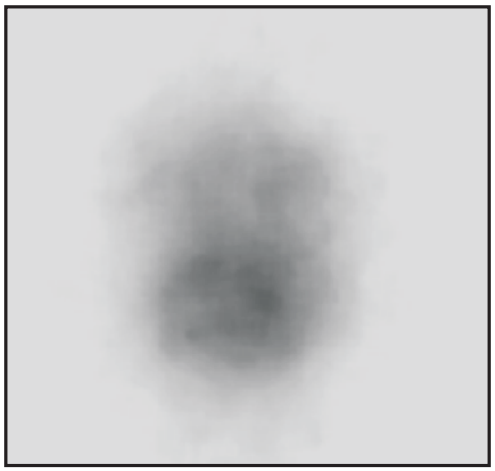
Simulations of X-Ray Core Images from OMEGA Implosions Driven with Controlled Polar Illumination

UR LLE

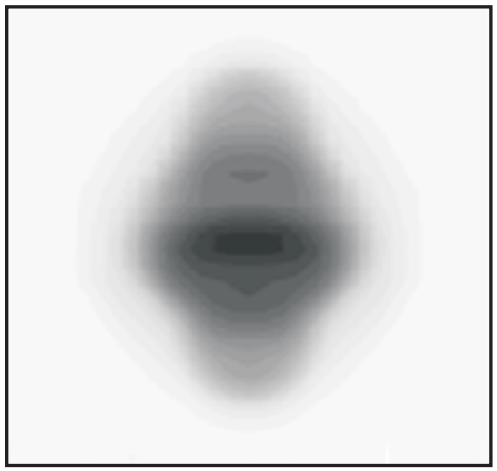
OMEGA Shot 34668, PDD, D_2(15)CH[20], 40 beams, 15.4 kJ

DD yield
2.89×10^{10}



KB3 time-integrated x-ray image

100 μm



DRACO/Spect3D

DD yield
4.11×10^{10}

R. Epstein, *et al*.
University of Rochester
Laboratory for Laser Energetics

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

Collaborators

T. J. B. Collins, R. S. Craxton, J. A. Delettrez, I. V. Igumenshchev,
F. J. Marshall, J. A. Marozas, P. W. McKenty, P. B. Radha,
S. Skupsky, and V. A. Smalyuk

Related papers: R. S. Craxton (invited) – B12-002
J. M. Soures – HO1-012
J. A. Marozas – HO1-014

Summary

2-D *DRACO*/Spect3D* simulations show good agreement with the observed effects of polar direct drive on images of implosion cores

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- Successfully attributing the low-order asymmetry of implosion images to controlled polar drive uniformity in OMEGA experiments supports ongoing PDD (polar direct-drive) design work.
- The size, asymmetry, and history of observed images are reproduced by a 2-D hydrodynamic simulation with radiation-transport postprocessing.
- Additional image asymmetry can be attributed to the viewing angle in some cases, rather than unintended illumination imbalance.

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Simulated images are obtained from 2-D hydrodynamic simulation and 3-D radiation transport postprocessing

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- *DRACO* hydrocode
  - 2-D Lagrangian hydrodynamics with interface tracking
  - PDD irradiation calculated with 2-D ray tracing approximating the plasma as an equivalent sphere for each ray
- Spect3D* radiation-transport postprocessing
  - Full 3-D straight-line integration of the equation of transfer
  - Tabulated LTE opacities valid for intended application
  - Camera filtering, response, and viewing angles included

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OMEGA experiments show the effects of known polar nonuniformities on the shape of compressed cores

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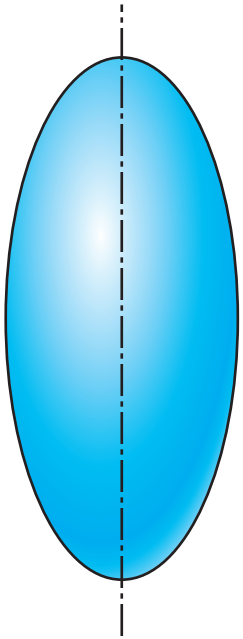
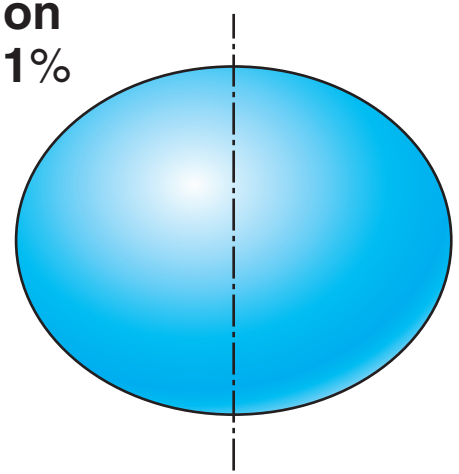
Shot 35173, prolate energy distribution

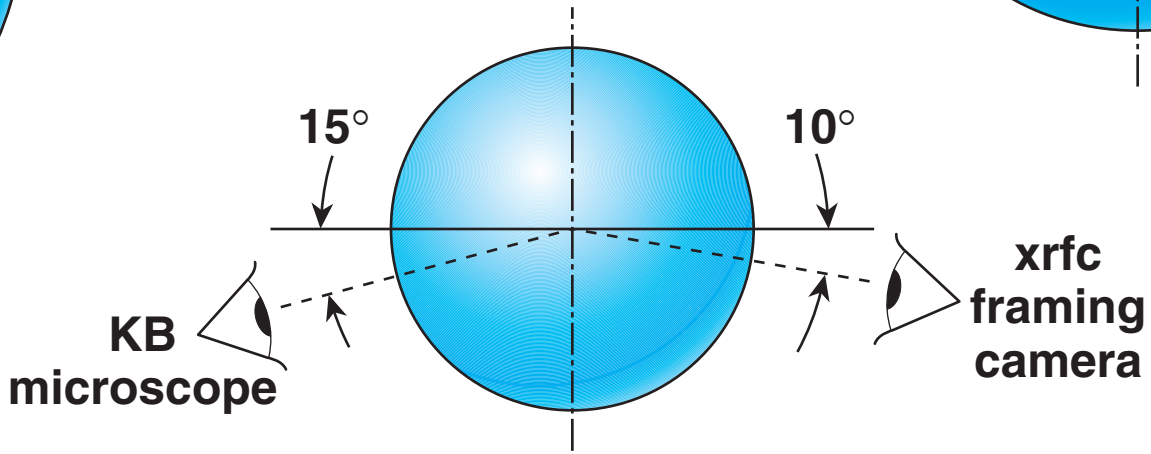
$\sigma_{\ell = 2} = 13.2\%$



Shot 35174, oblate energy distribution

$\sigma_{\ell = 2} = 7.1\%$





Viewing geometry

TC6785

Target cores imploded with controlled polar asymmetry match the size and shape of 2-D *DRACO* and Spect3D* simulations

gmxi (2 to 7 keV)
t = 1.4 ns

gmxi (4 to 7 keV)
t = 1.65 ns

Shot 35173
prolate
$\sigma_{\ell=2}$ = 13.2%

obs

sim

obs

sim

100 μm

100 μm

Shot 35174
oblate
$\sigma_{\ell=2}$ = 7.2%

obs

sim

obs

sim

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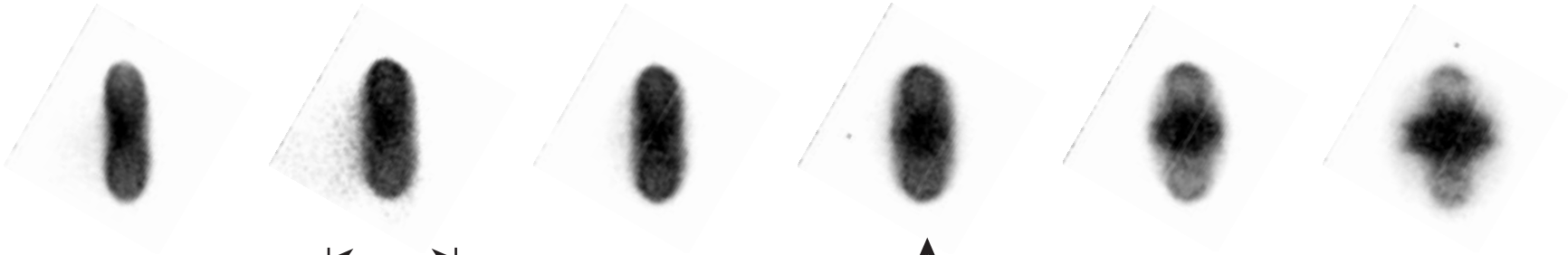
TC6786

A measured prolate core-image sequence with equatorial stagnation is reproduced with 2-D *DRACO* and Spect3D*

UR LLE

MIT

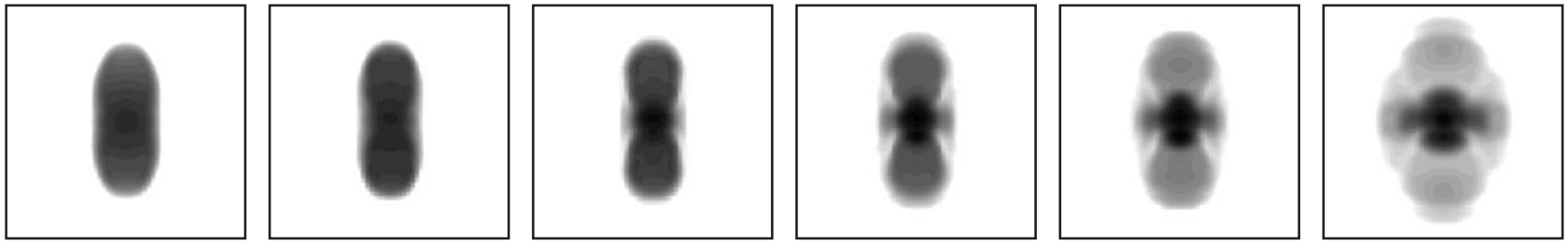
Shot 35173, prolate drive
Δt = 58 ps, $\sigma_{\ell=2}$ = 13.2%, xrfc, Be filter



200 μm

Peak compression

DRACO* and Spect3D



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OMEGA PDD Configuration

The NIF 48-quad PDD configuration was simulated on OMEGA by repointing 40 beams

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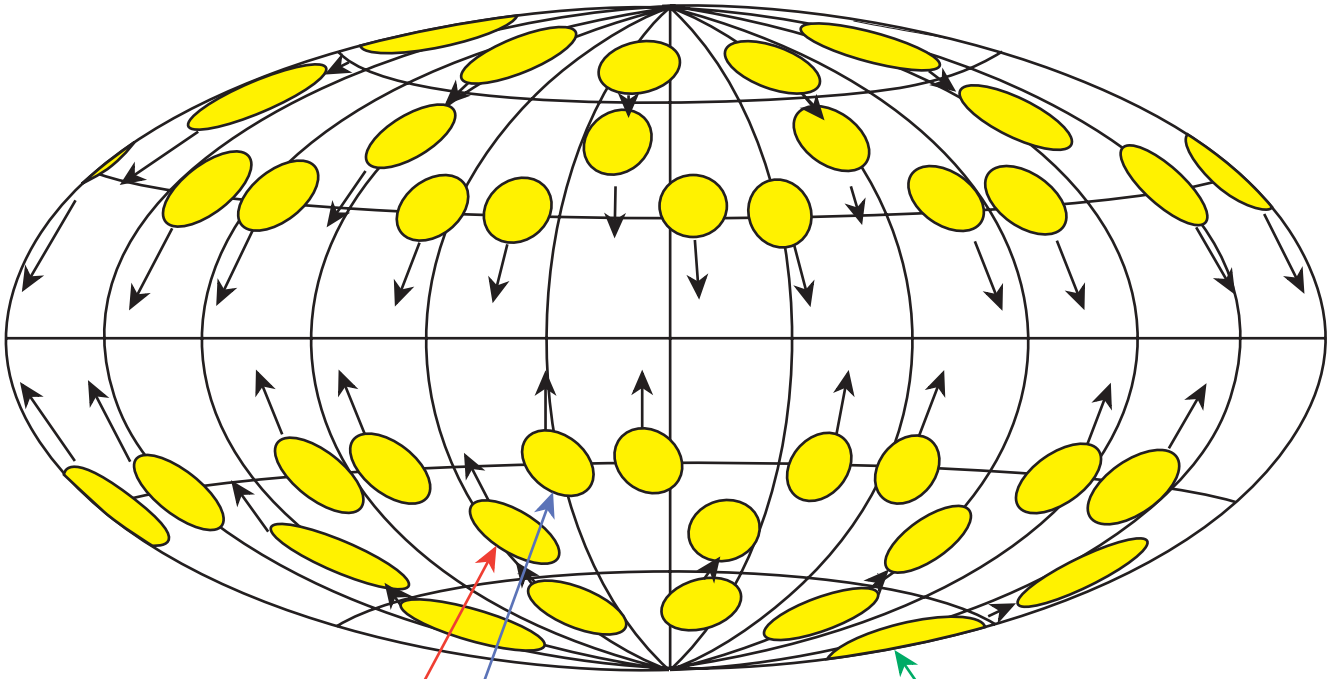

42° beams moved to 66.6°

58.8° beams moved to 83.5°

21° beams moved to 33.4°

The core-stagnation symmetry is affected by the illumination configuration

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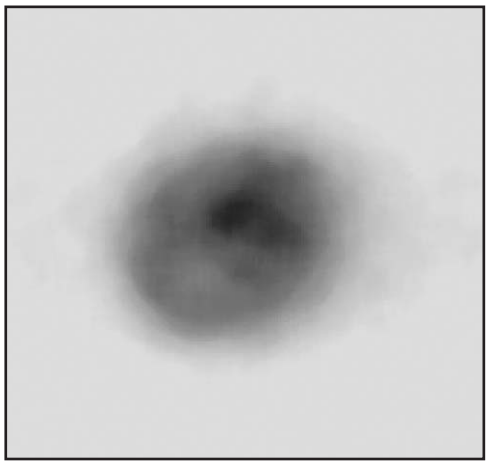
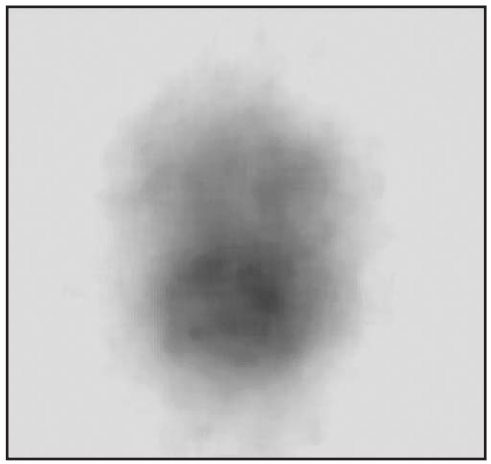
Time-integrated KB microscope images

	60 beams TCC 15.6 kJ $Y_{DD} = 8.4 \times 10^{10}$	40 beams PDD 15.4 kJ $Y_{DD} = 2.9 \times 10^{10}$
Shot 34644 / Shot 34668		

100 μm

TC6533

DRACO simulations of the PDD experiments reproduce the qualitative shape of the compressed core

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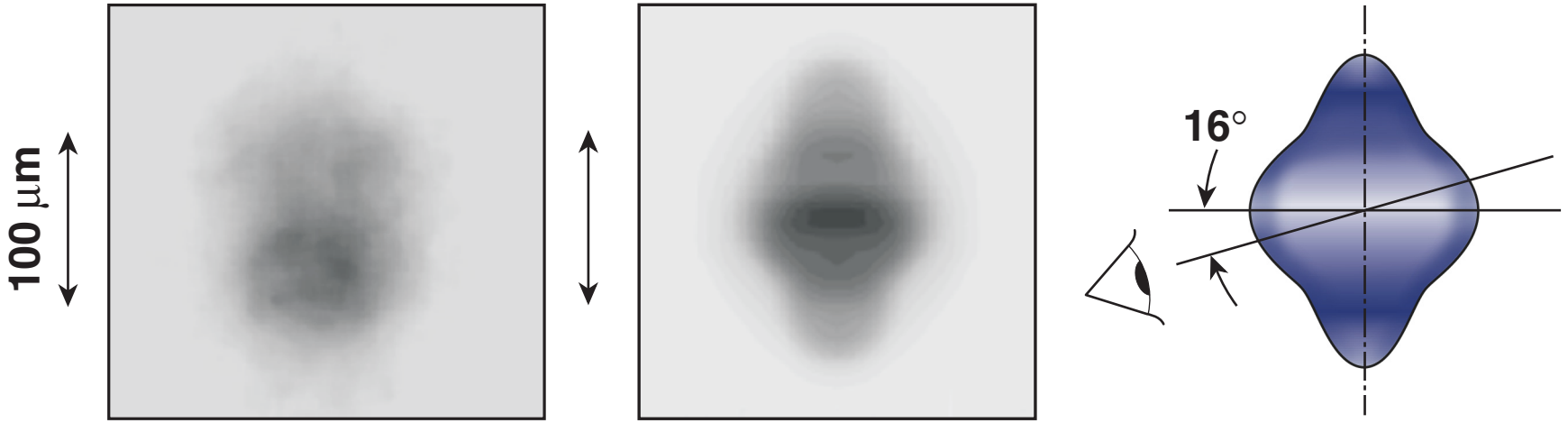
OMEGA implosions at 15-atm, D_2-filled, 20-μm-thick CH shells

40 beams
PDD shot 34668
15.4 kJ

40 beams
PDD simulation*
shot 34668

KB microscope view



DD yield
2.85×10^{10}

DD yield
4.11×10^{10}

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TC6638a

PDD x-ray image asymmetry is due to the oblique viewing angle and absorption by the shell

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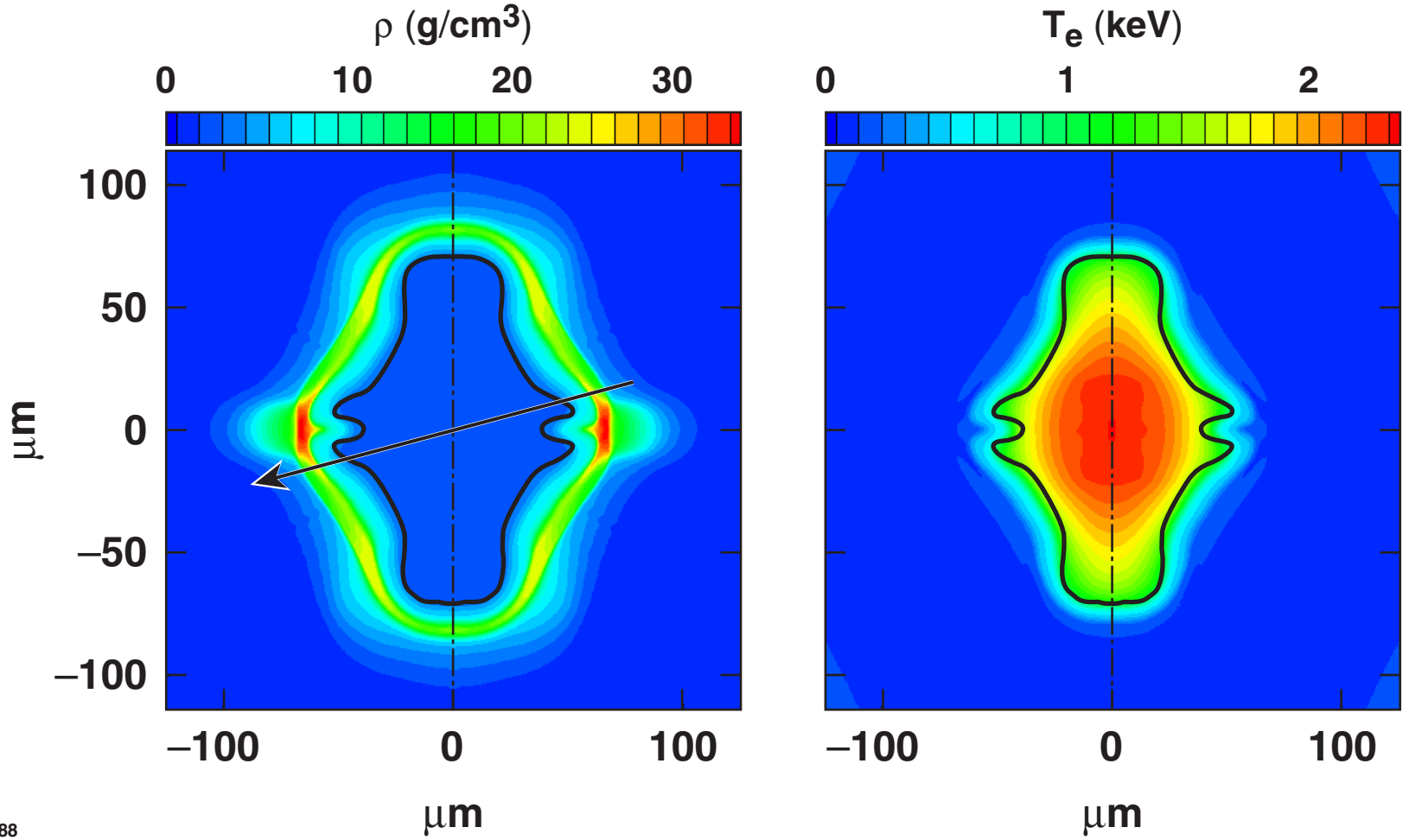
Mass density and electron temperature near peak compression
Shot 34668, t = 2.2 ns



TC6788

Summary/Conclusions

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