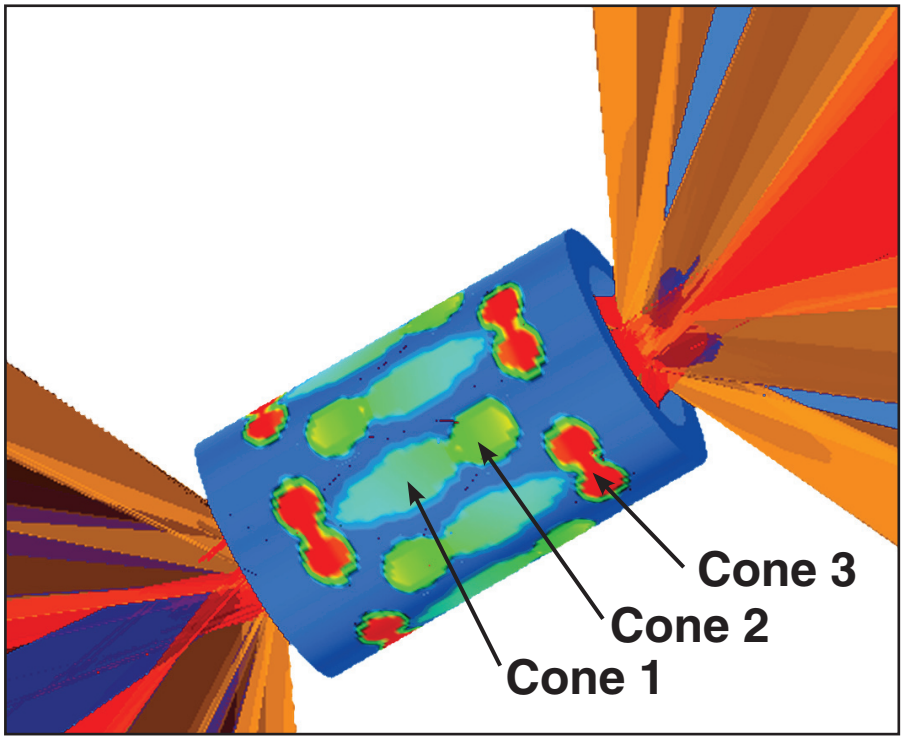
Hohlraum Energetics with Elliptical Phase Plates on OMEGA



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University of Rochester
Laboratory for Laser Energetics

48th Annual Meeting of the
American Physical Society
Division of Plasma Physics
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Summary

Improved indirect drive has been achieved with elliptical phase plates on OMEGA

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- Hohlraums were irradiated with three cones of laser beams smoothed with elliptical phase plates.
- The coupling of laser energy to x-ray drive for gas-filled hohlraums is significantly improved.
- A high-*Z* dopant in a gas-filled hohlraum reduces hard-x-ray production and FABS SRS.
- Gated hard-x-ray images of thin-walled Au hohlraums confirm the expected radiation hydrodynamics.

Elliptical phase plates are benefiting indirect-drive experiments on OMEGA.

National Ignition Campaign hohlraum energetics collaboration

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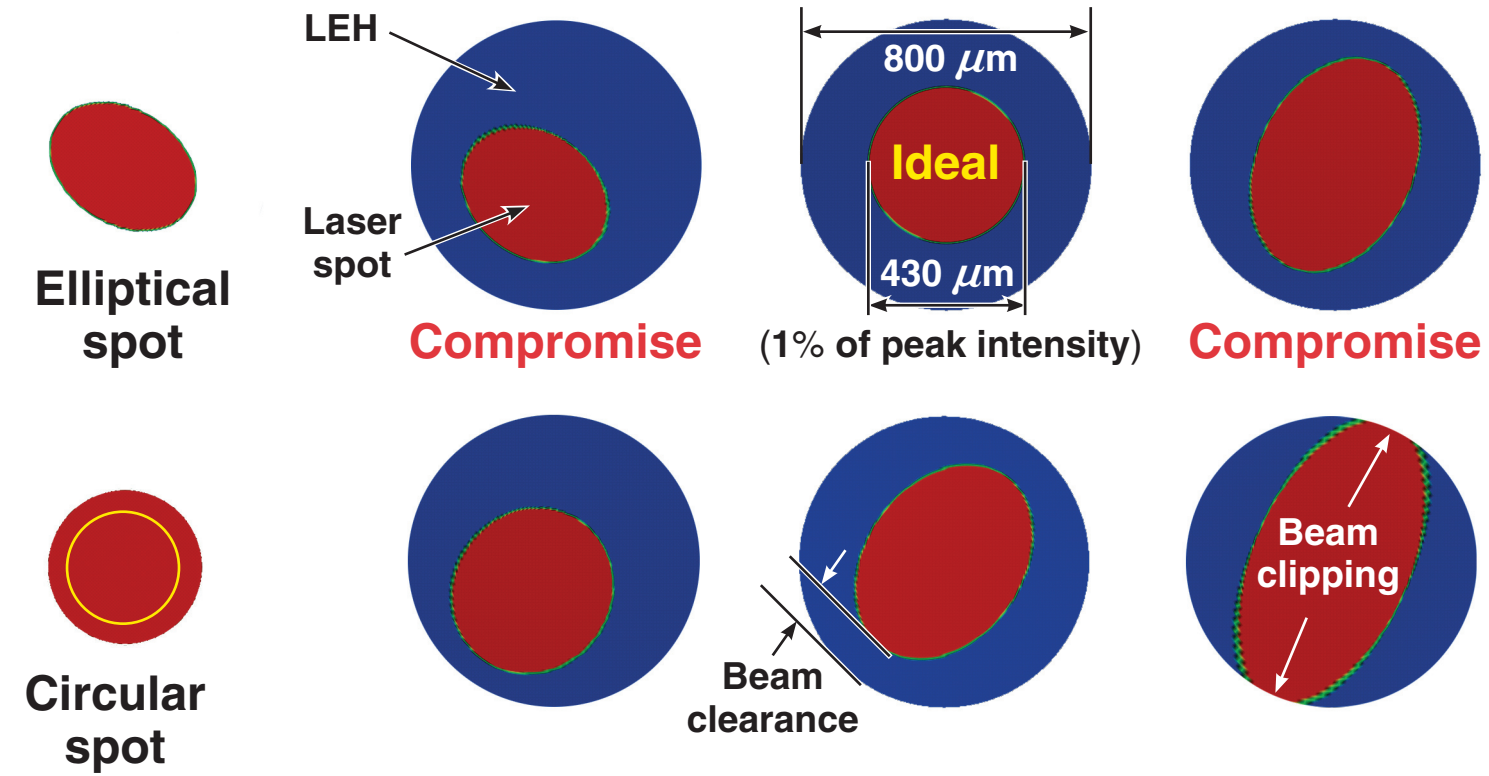
Lawrence Livermore National Laboratory

Elliptical Phase Plate

Elliptical phase plates maximize beam clearance while minimizing the peak intensity at the laser entrance hole



Filamentation and gain for SBS and SRS are reduced in hohlraum plasmas due to suppression of hot spots in the smoothed laser beams.

E15266

Elliptical Phase Plate

A new phase plate has been designed and fabricated for hohlraum experiments on OMEGA

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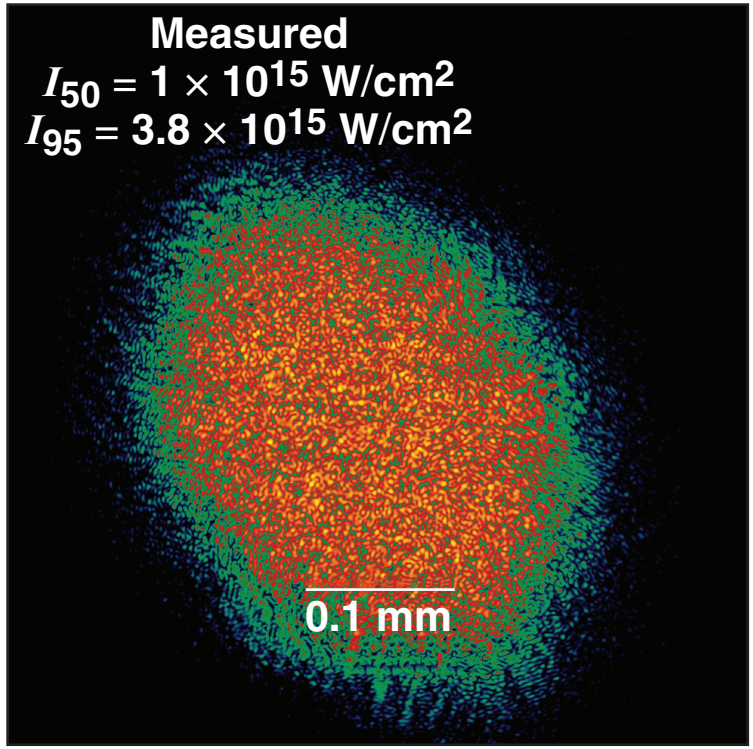
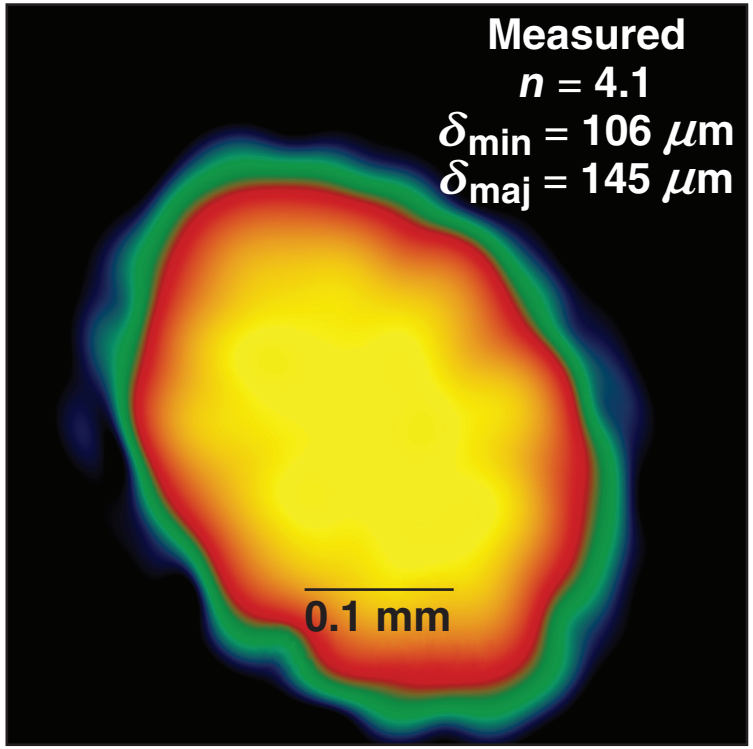
Measured far field



Super-Gaussian beam envelope



A 10-eV increase in the radiation temperature was observed on the NOVA laser using circular phase plates and a single-cone beam geometry.*

E15267

*Glenzer *et al.*, Phys. Rev. Lett. 80, 2845 (1998).

Hohlraum Energetics

Energetics experiments were conducted with and without phase plates using thin-walled, Au hohlraums

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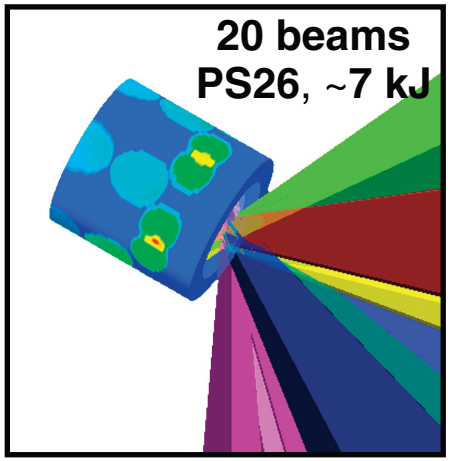
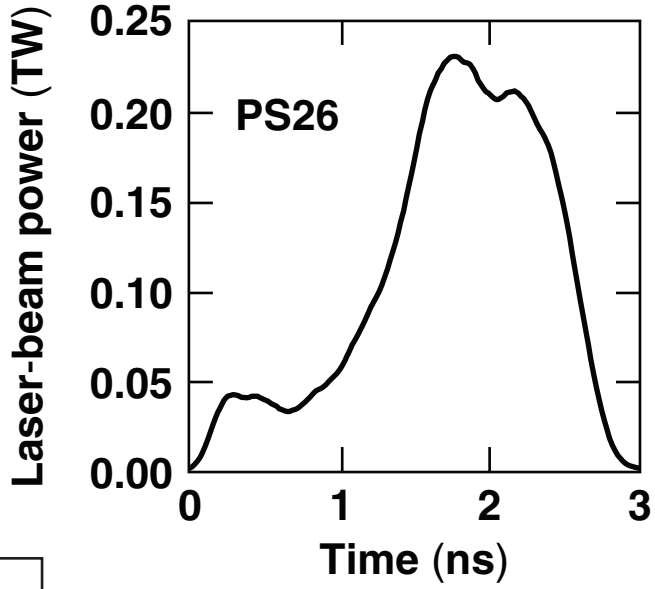
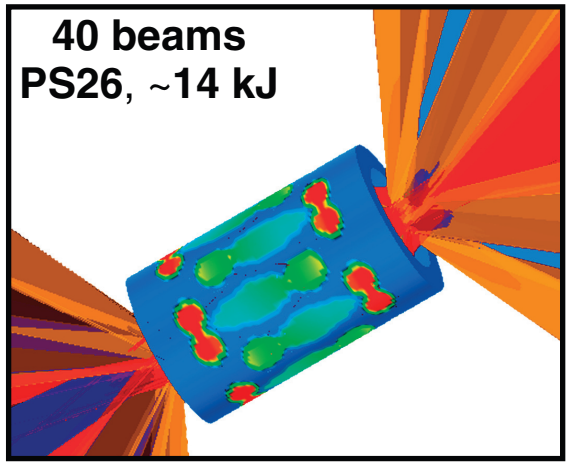
Halfraum



Laser pulse shape



Hohlraum



Scale-1 hohlraum

5-μm Au
100-μm CH
Length = 1.6/2.55 mm
Diameter = 1.6 mm
LEH = 1.067 mm

Gas fills

Vacuum
0.9 atm C_5H_{12}
0.9 atm C_5H_{12} + Ne (3% pp)
0.9 atm C_5H_{12} + Kr (3% pp)

Diagnostics

DANTE
FABS
NBI
HXRD
XRFC

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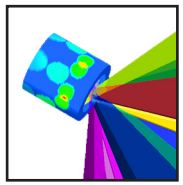
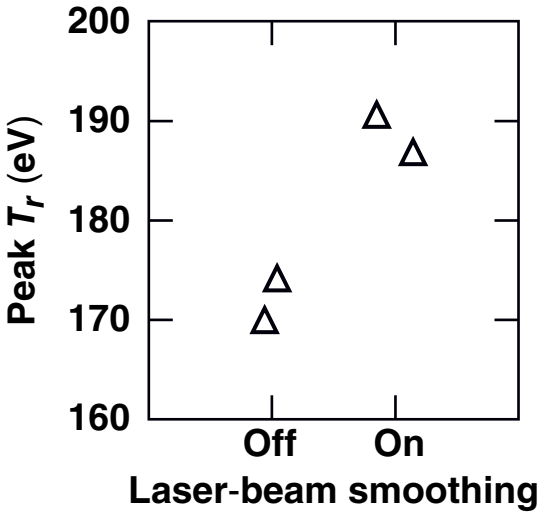
Hohlraum Energetics

The coupling of laser energy to x-ray drive is significantly improved for gas-filled halfraums with phase plates

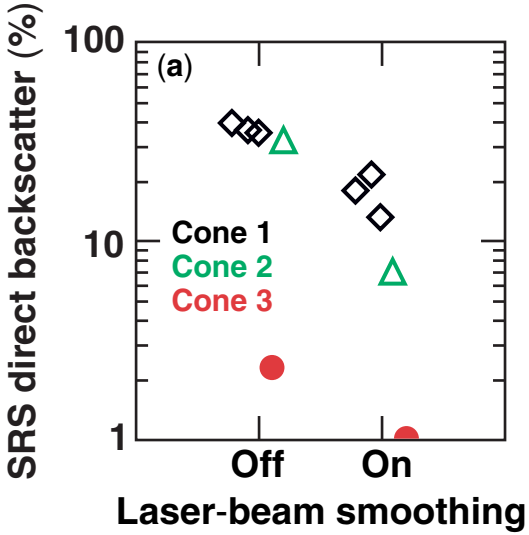


Phase-plate drive:
1. **Laser-scattering losses dropped from 25% of drive to 9%**
2. **Peak T_r increased by 17 eV**

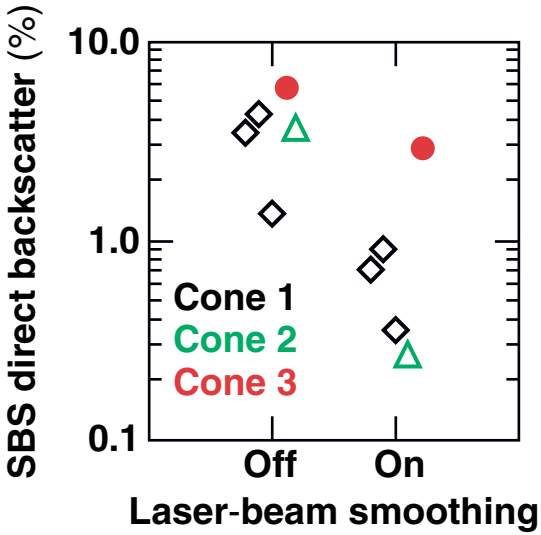
Peak radiation temperature



FABS SRS



FABS SBS



- **NBI SRS not available**
- **NBI SBS with phase plates <<1%**
- **NBI SBS without phase plates ~2%**

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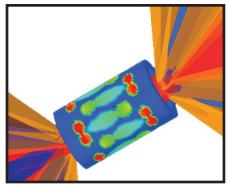
High-Z dopants in hohlraum gas fill reduce hard-x-ray production and FABS SRS with phase plates



0.9 atm C_5H_{12}
0.9 atm C_5H_{12} + Ne (3% pp)
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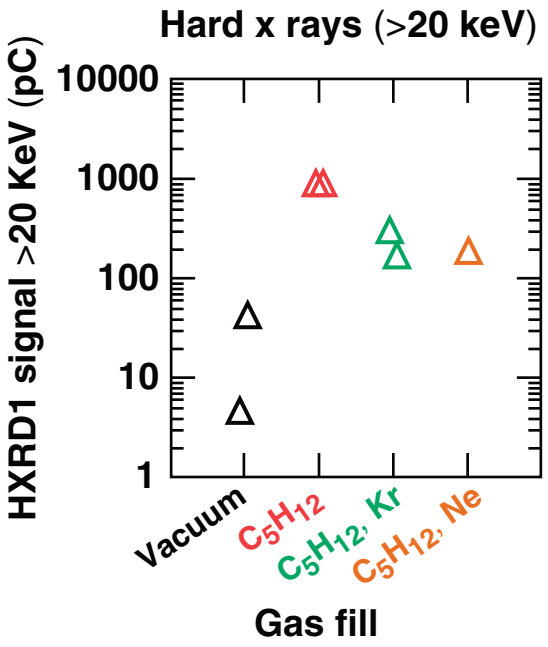

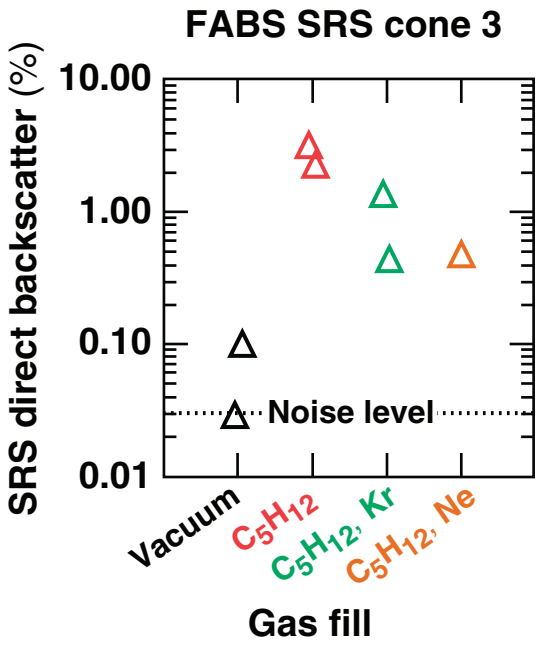

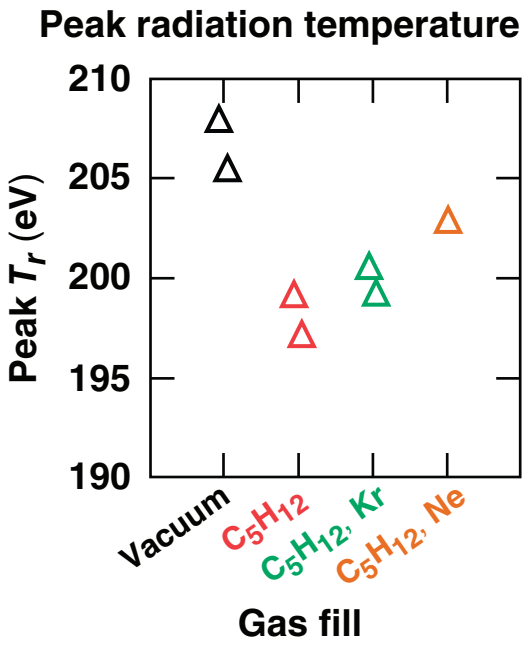

Similar trends were previously observed without phase plates on the Helen laser.*

E15277

*Stevenson *et al.*, Phys. Plasmas 11, 2709 (2004).

Radiation hydrodynamics

Gated, hard-x-ray images of vacuum, thin-walled hohlraum show stagnation of Au plasma just before peak of drive

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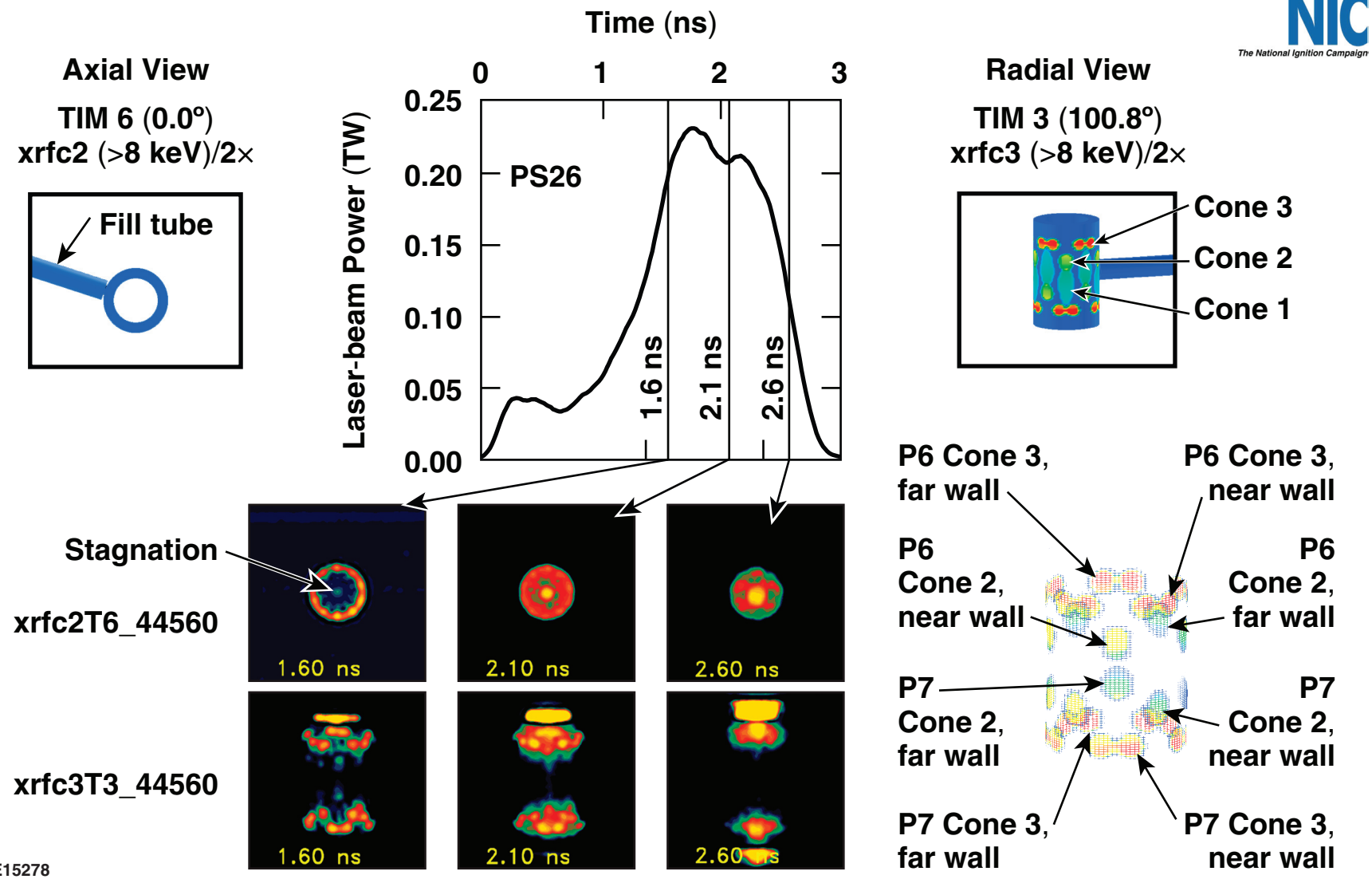

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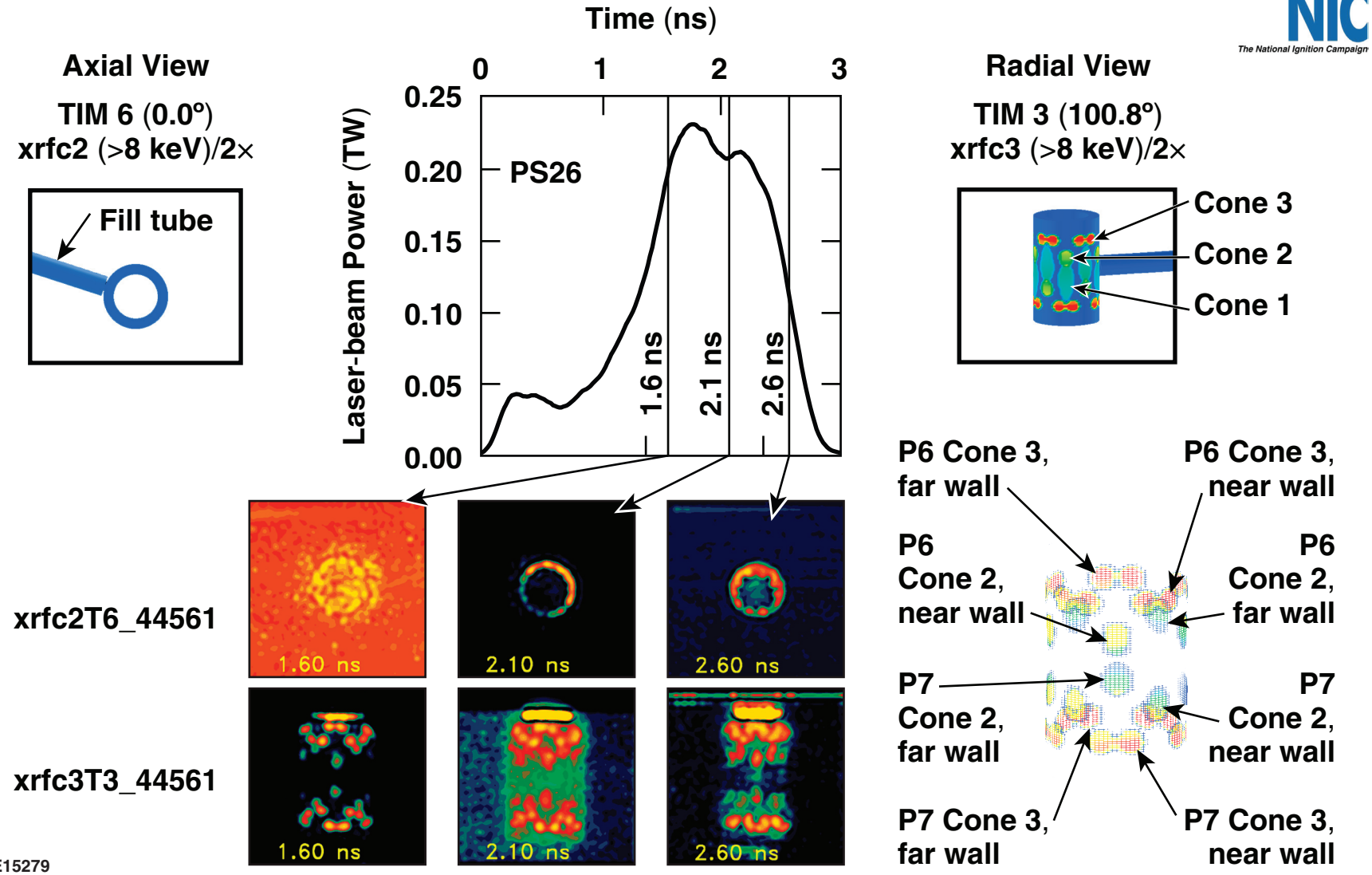
Radiation hydrodynamics

Similar views of a gas-filled, thin-walled, Au hohlraum show reduced wall motion



E15279

Summary/Conclusions

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Elliptical Phase Plate

The E-IDI-300 phase plate meets the design specifications

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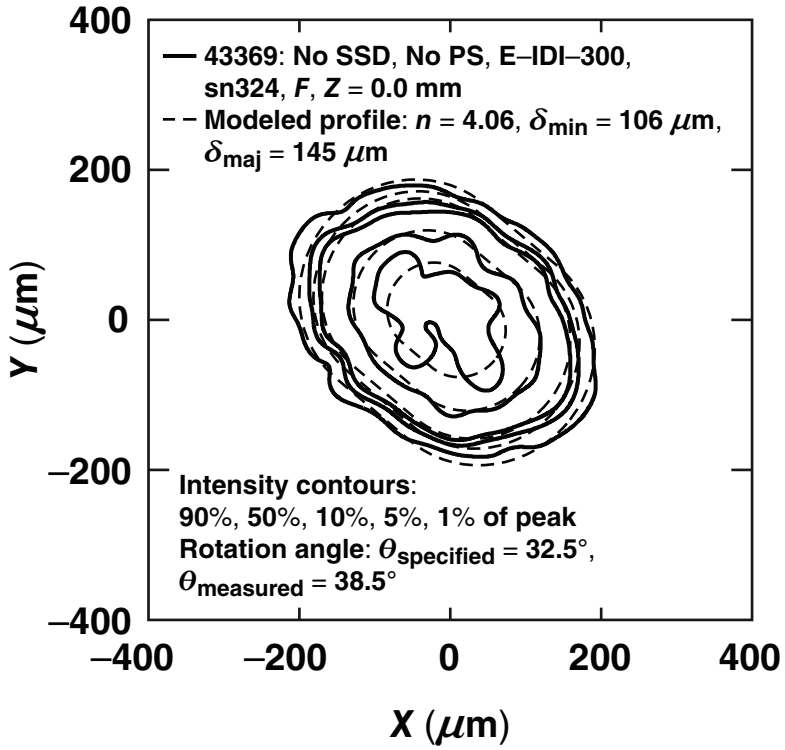
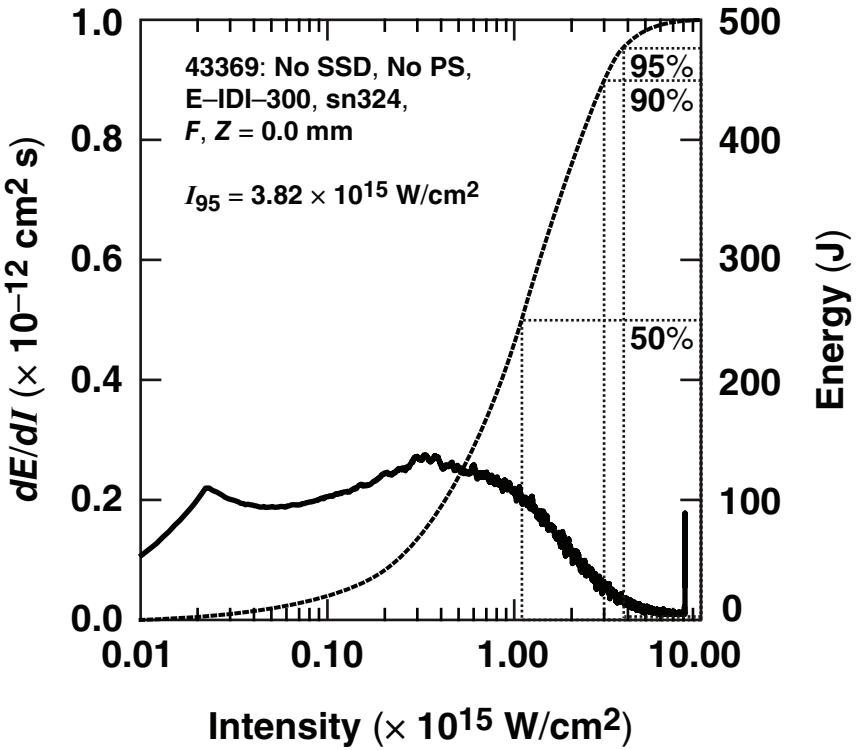
Super-Gaussian fit



Single-beam intensity



Measured	Designed
$n = 4.1$ $\delta_{min} = 106\ \mu m$ $\delta_{maj} = 145\ \mu m$	$n = 5$ $\delta_{min} = 103\ \mu m$ $\delta_{maj} = 146\ \mu m$

Measured	Designed
$I_{50} = 1 \times 10^{15}$ W/cm^2 $I_{95} = 3.8 \times 10^{15}$ W/cm^2	$I_{50} = 1.3 \times 10^{15}$ W/cm^2 $I_{95} = 4.5 \times 10^{15}$ W/cm^2

E15280