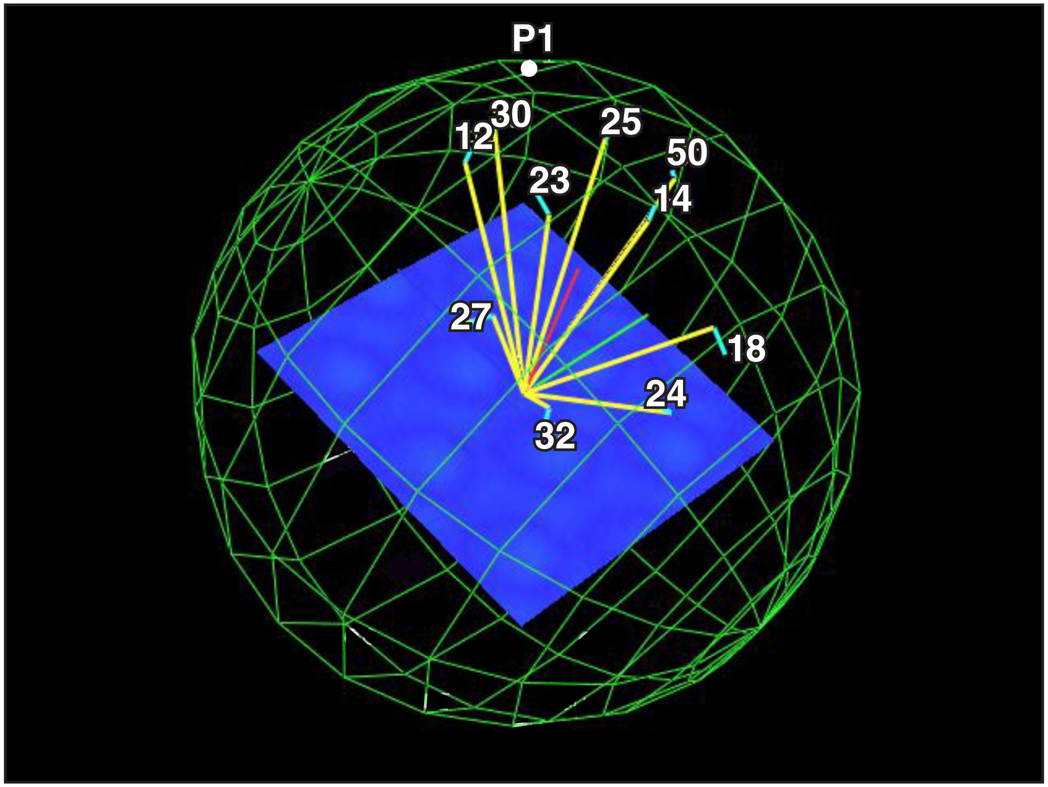
An Investigation of Two-Plasmon–Decay Localization in Spherical Implosion Experiments on OMEGA



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Summary

Three-dimensional calculations demonstrate the spatial localization of the two-plasmon–decay (TPD) instability in spherical implosions

UR LLE

- Multibeam laser–plasma instabilities (LPI's) must be studied in three dimensions
- The laser–plasma simulation environment (LPSE) code describes TPD in 3-D
  - fast, makes efficient use of memory, and extensible
  - includes 3-D visualization tools
  - three-dimensional calculations can be performed in ~1 h

The TPD localization in spherical targets is consistent with experimental observations.

Collaborators

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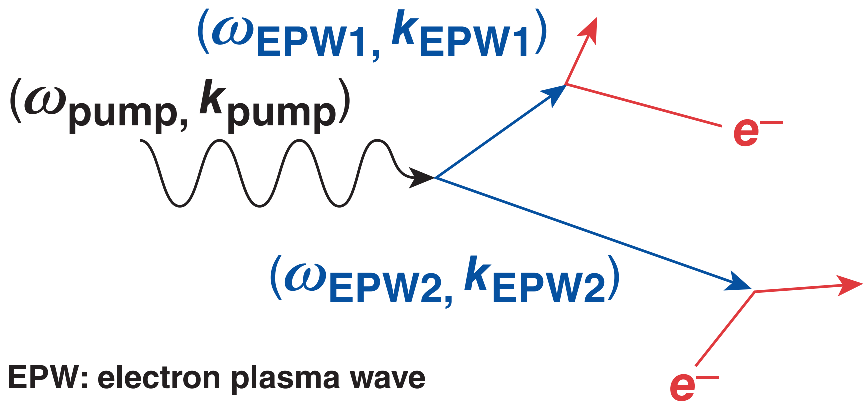
The effects of multibeam TPD on direct-drive–implosion designs must be quantified



EPW: electron plasma wave

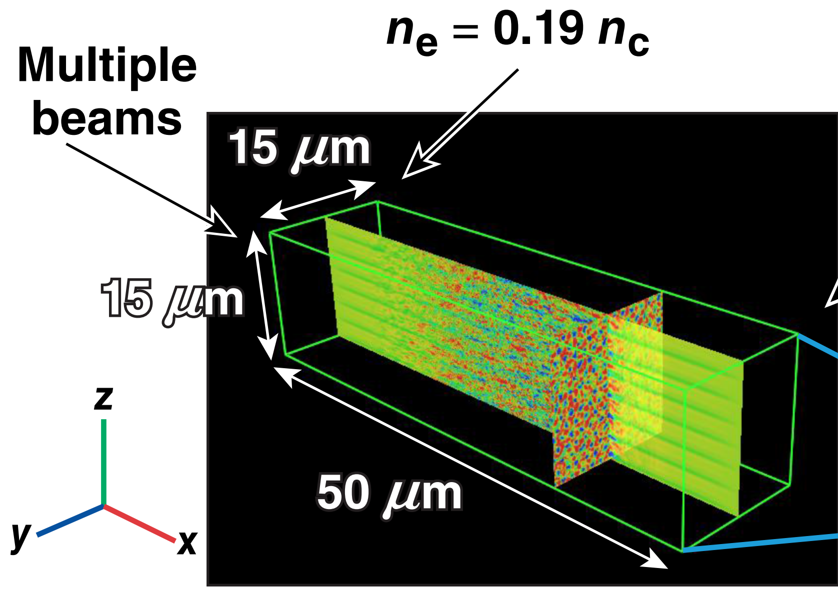
- "In-line" models of TPD that can be implemented in hydrocodes are required
  - quantify the effects of TPD on time-dependent drive
  - account for hot-electron preheat
- A model that can be used to search for and test TPD mitigation strategies is required
  - linear threshold*
  - nonlinear saturation

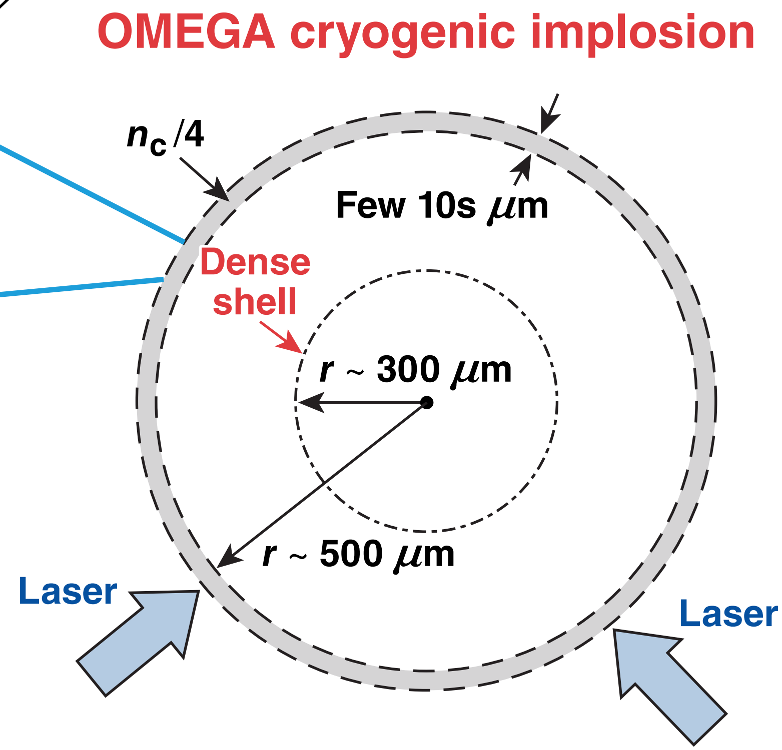
*R. W. Short *et al*., PO4.00004, this conference.

LPSE is a practical model that is being used to address these questions

- It solves the fundamental TPD equations for linear response in an arbitrary hydrodynamic profile (density, temperature, velocity) with an arbitrary number of beams
- LPSE includes nonlinear saturation mechanisms that are related to the coupling of Langmuir waves (LW's) to low-frequency density fluctuations
  – performance (one run in ~1 h on 96 Intel cores)
  – setup (either planar or spherical target simulations are automated)
  – connected to experiment via "diagnostics" package
  – tools for the exploration/visualization of large 3-D datasets
- LPSE is extensible
  – a hot-electron package has recently been implemented

The simulation volume is determined by the density scale length and the Langmuir wave correlation length





- i.e., it is a local analysis in the neighborhood of a point $r = (r,\theta,\phi)$ on the quarter-critical surface
- Times up to 100 ps

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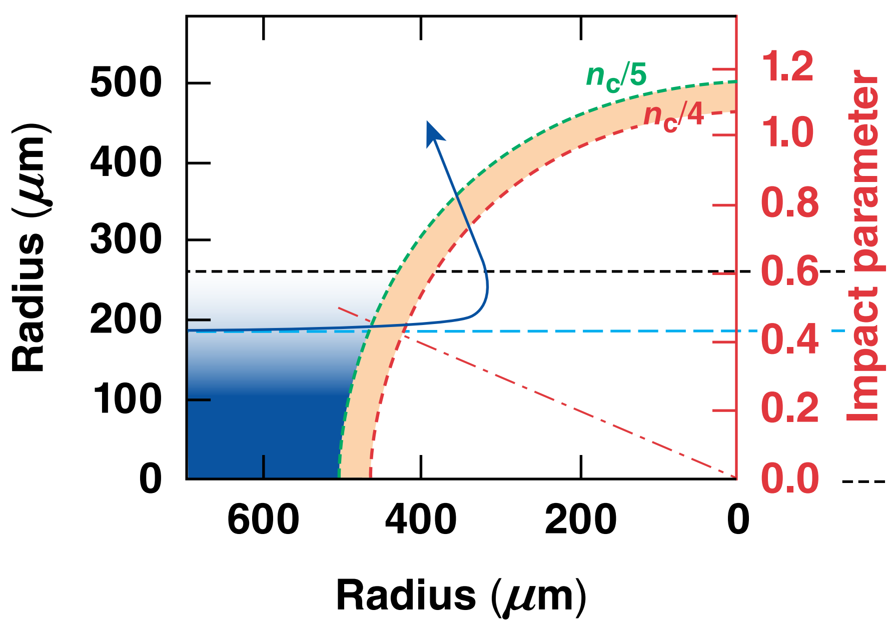
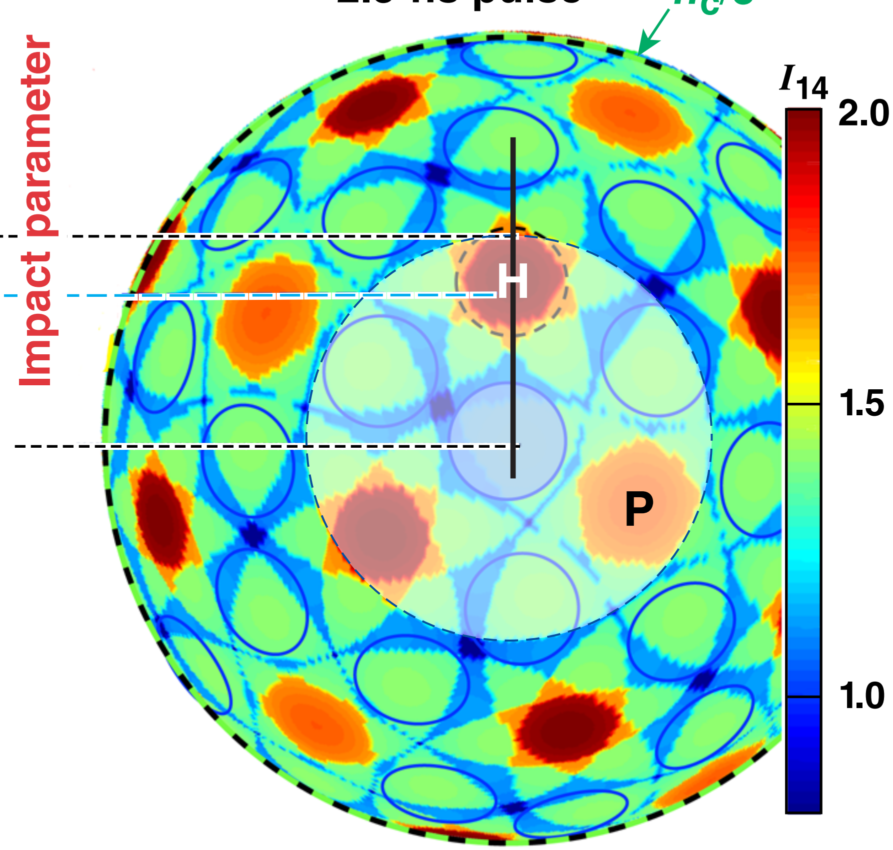
Interaction conditions vary along a path on the $n_c/4$ surface (e.g., a line of longitude) because of the beam-spot shapes and beam symmetry



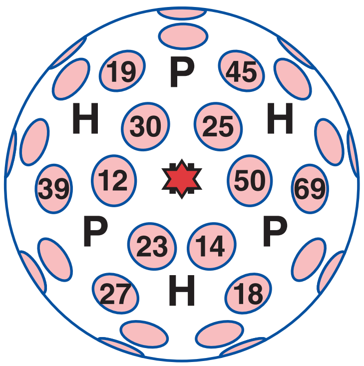


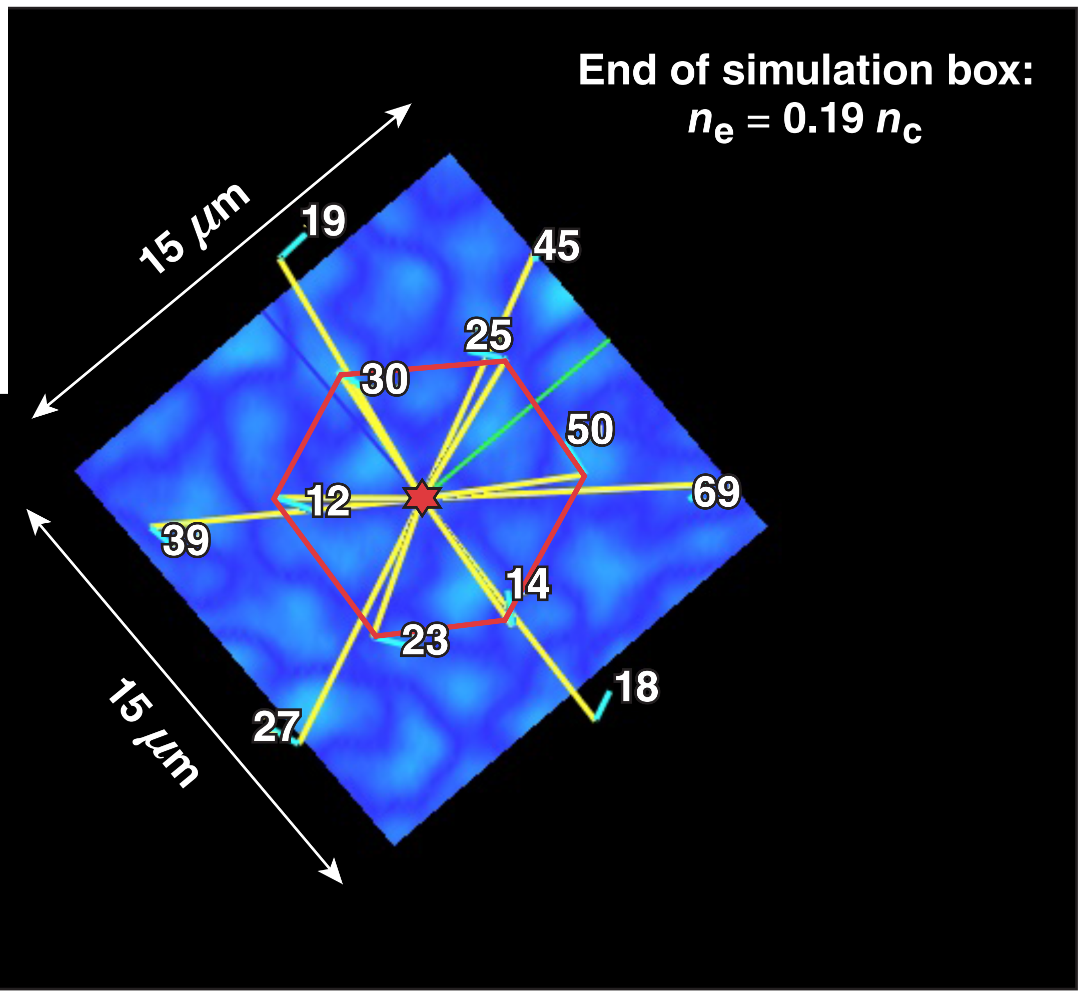
Distributed phase plate (DPP) = SG4

- Multibeam TPD favors symmetry
  - bisectors of beam pairs
  - centers of HEX or PENT ports

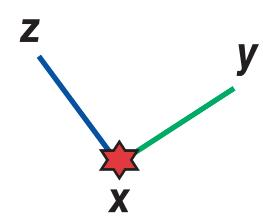
E21347e

A series of runs computed the effects of an excursion across H17 with both large (SG4) and small (SG2) spot phase plates





$R = 500\ \mu m$
$\theta = 142.6°$
$\phi = 54.0°$



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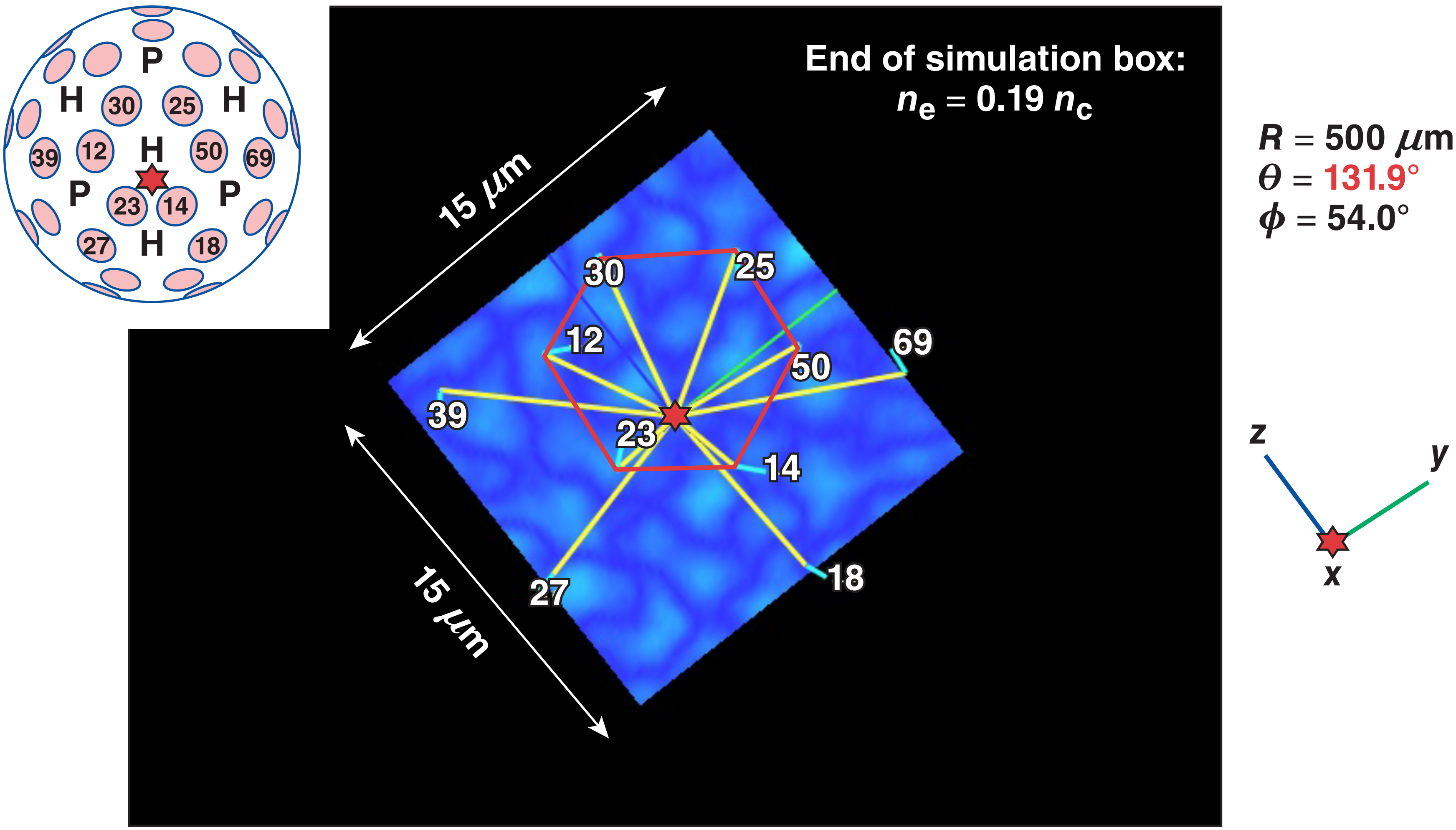
A series of runs computed the effects of an excursion across H17 with both large (SG4) and small (SG2) spot phase plates



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A series of runs computed the effects of an excursion across H17 with both large (SG4) and small (SG2) spot phase plates

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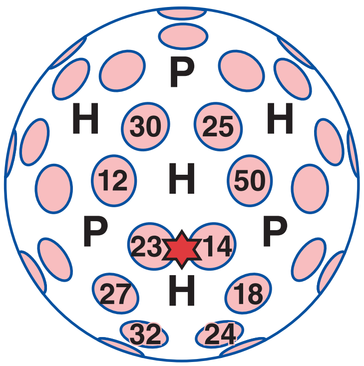

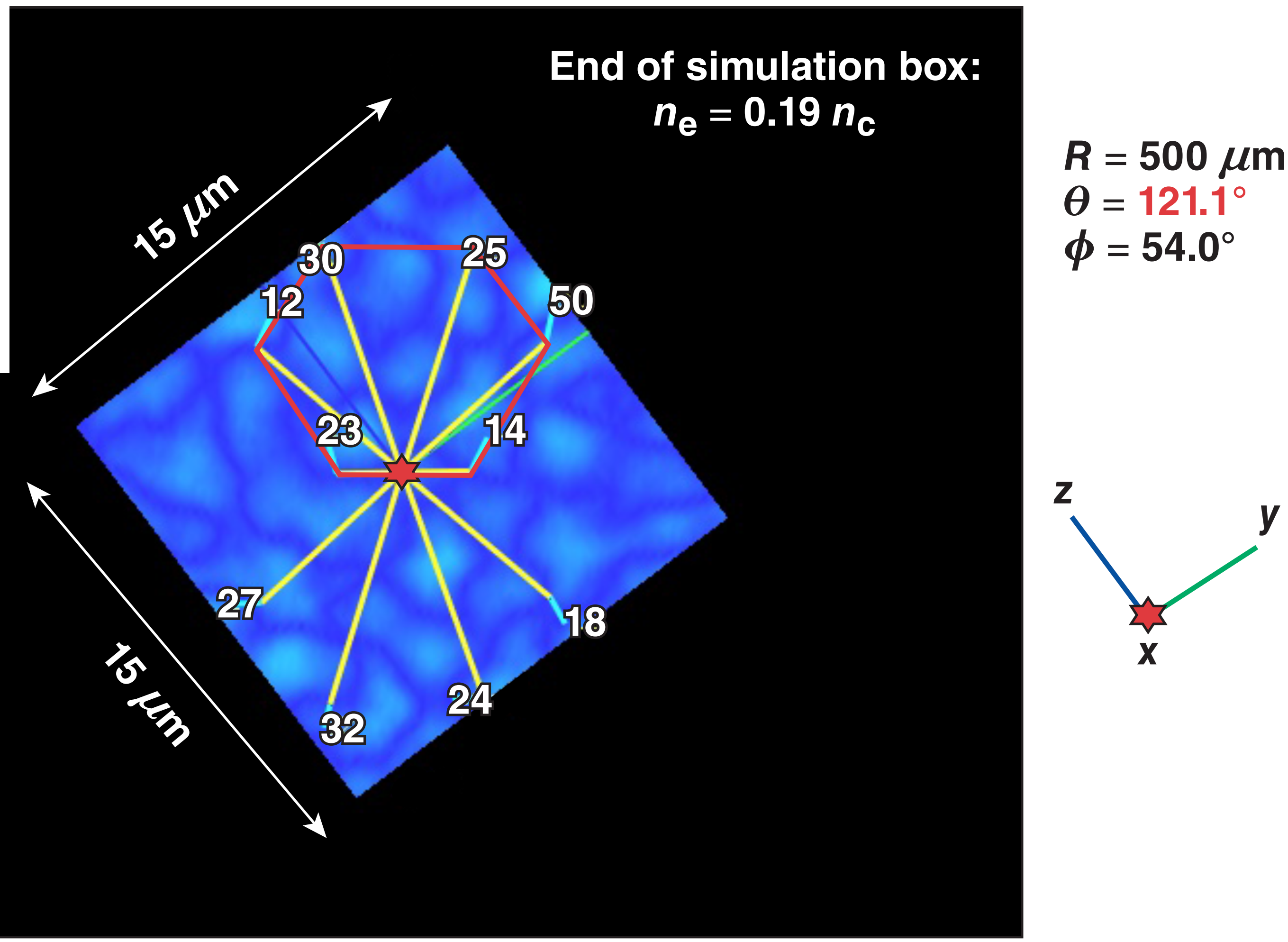

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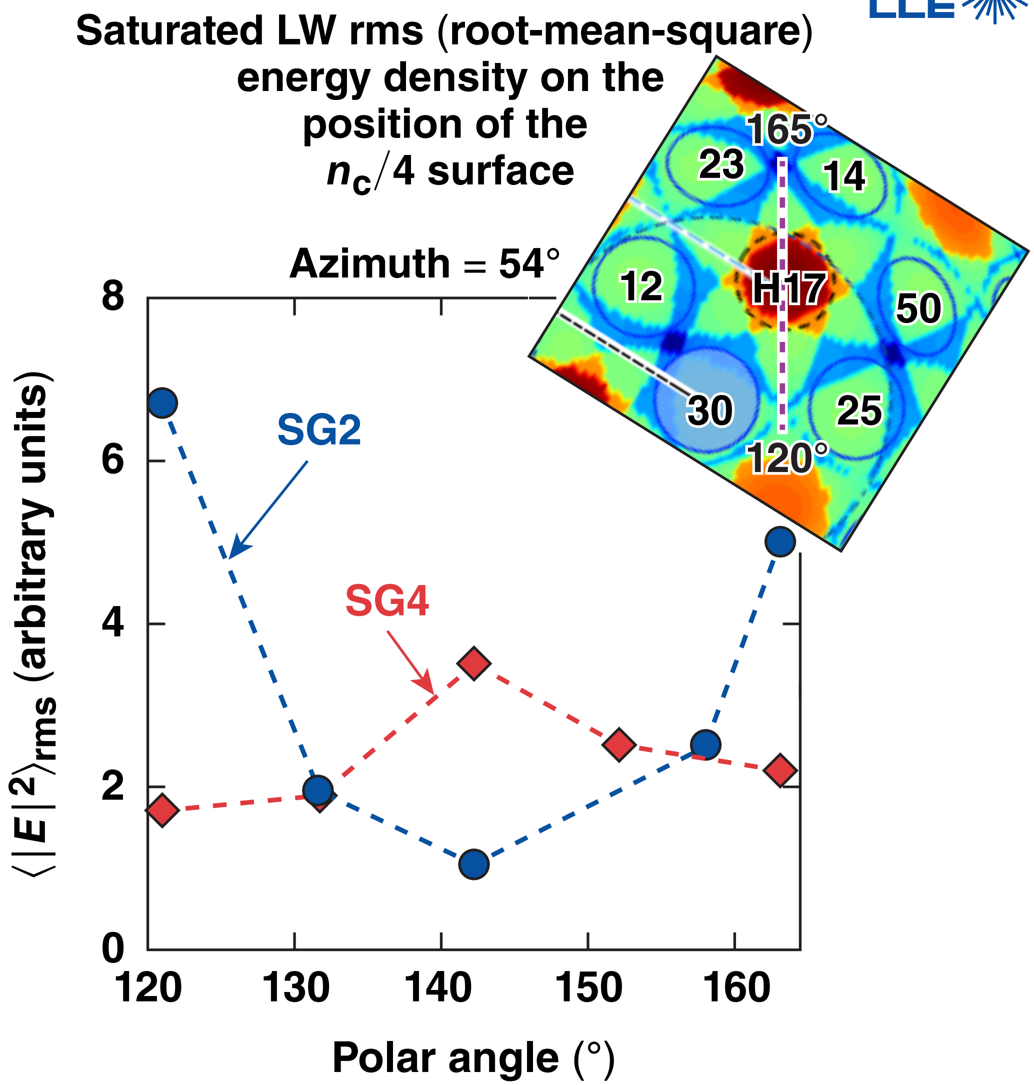
The LPSE simulations show that TPD depends on the beam spot shape (at constant power and hydrodynamics)

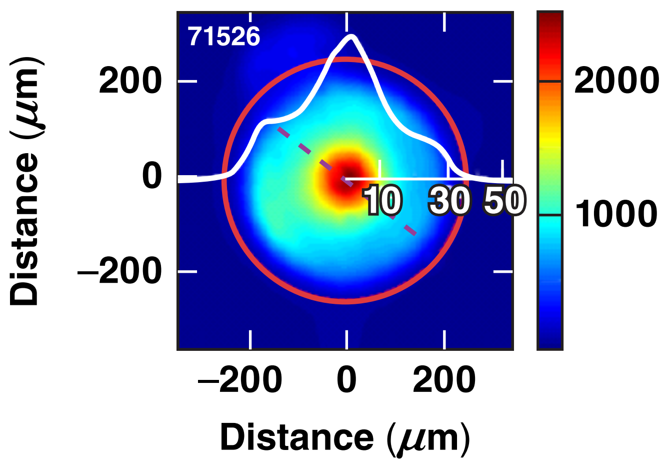
- SG4 phase plates have a focal spot that is close to the target diameter in size; SG2 phase-plate spots are roughly half the diameter
- Can be compared with the observations of local temperature "islands"*

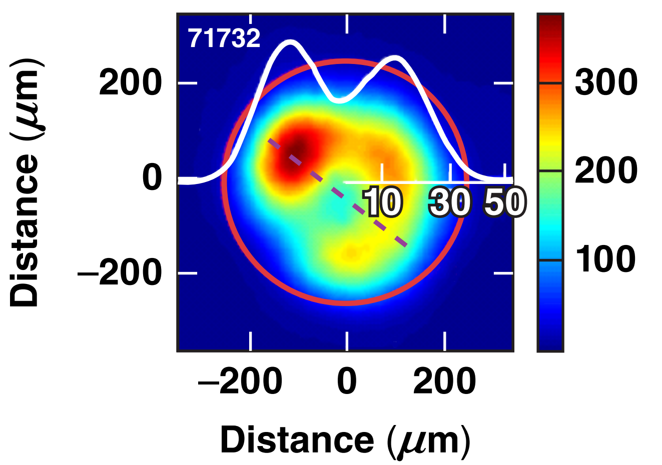


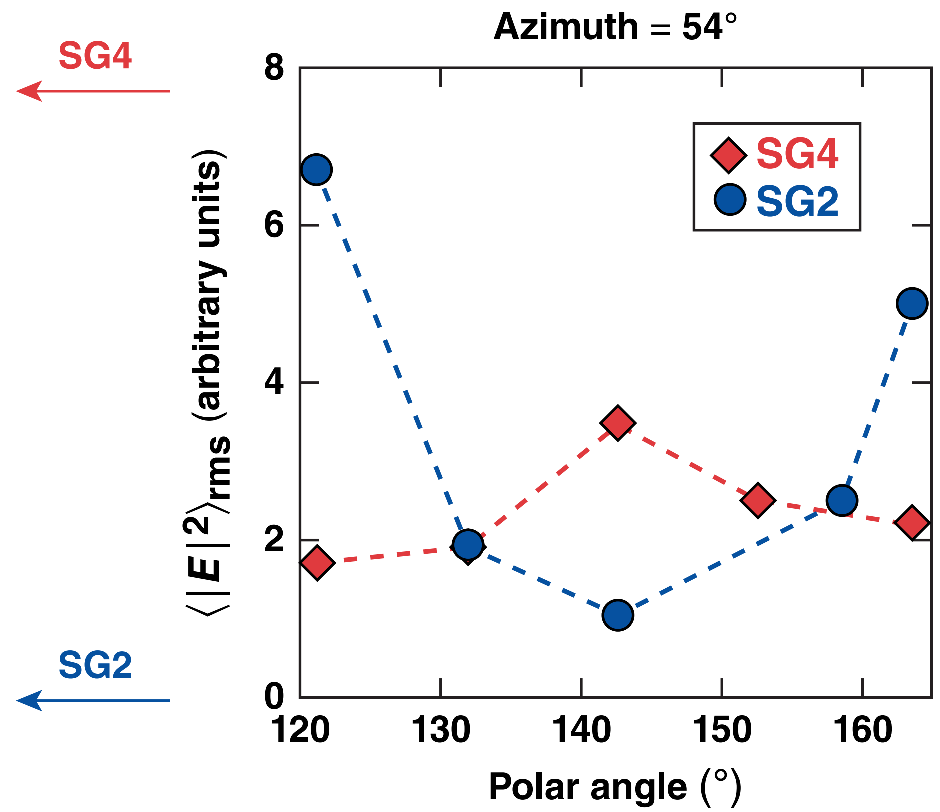
*W. Seka *et al.*, Phys. Rev. Lett. 112, 145001 (2014).

The LPSE simulations predict a similar structure to that observed in half-harmonic images* through a hex port**

Room-temperature CH target (880-μm diam), SG2, SSD off







Room-temperature CH target (870-μm diam), SG4, SSD on
2.5-ns triple-picket pulse, 126.4 kJ, I_{14} (nominal) ~ 9.5
$I_{14,\text{ single beam}}$ ~1.3

*J. Zhang *et al.*, PO4.00006, this conference.
**W. Seka *et al.*, Phys. Rev. Lett. 112, 145001 (2014);
W. Seka *et al.*, PO4.00011, this conference.

TC11255a

Summary/Conclusions

Three-dimensional calculations demonstrate the spatial localization of the two-plasmon–decay (TPD) instability in spherical implosions

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