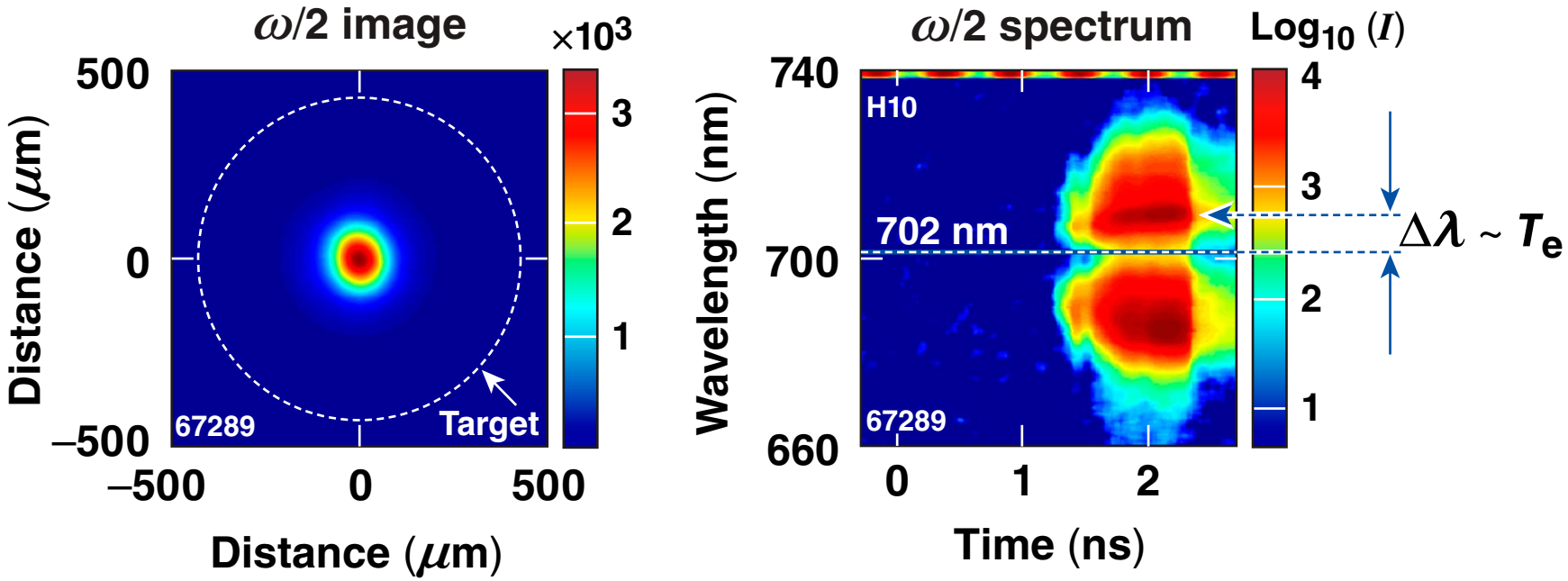
Half-Harmonic Images and Spectra Point Toward Localized, Multibeam Two-Plasmon–Decay Instability



W. Seka
University of Rochester
Laboratory for Laser Energetics

54th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Providence, RI
29 October–2 November 2012

Summary

$\omega/2$ images and spectra from implosion experiments indicate localized multibeam two-plasmon–decay (TPD) instability

UR LLE

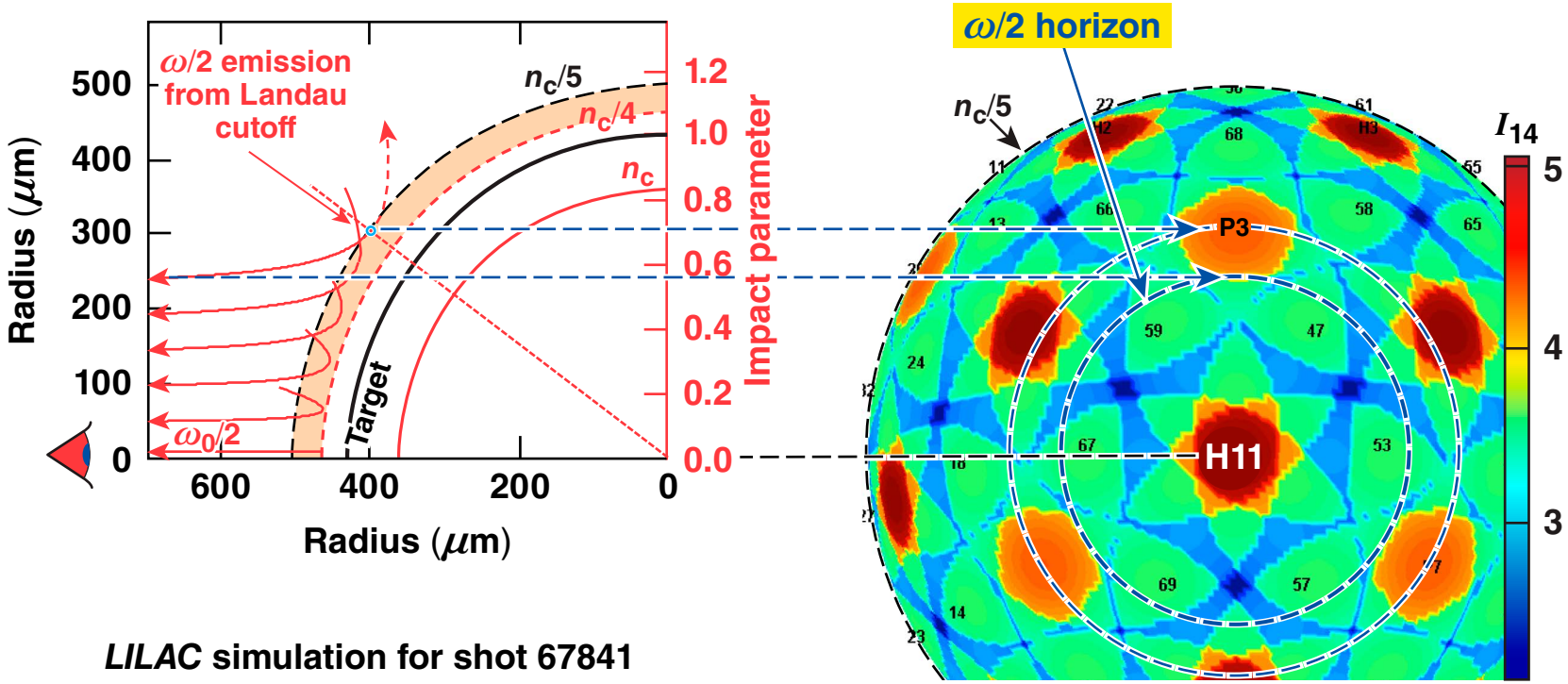
- On-target laser light nonuniformity and $\omega/2$ images indicate TPD is driven in localized areas
- The onset of the absolute TPD instability is observed at the center of six beams in a hex configuration
- T_e measurements using the sharp, red-shifted $\omega/2$ feature start at *LILAC* predictions and then exceed them
- The data are consistent with localized temperature islands near $n_c/4$ exceeding the average by 10% to 20%, and entailing $n_c/4$ surface nonuniformities

Collaborators

D. H. Edgell, D. H. Froula, J. Katz, J. F. Myatt, J. Zhang, R. W. Short, D. T. Michel, A. V. Maximov, and V. N. Goncharov

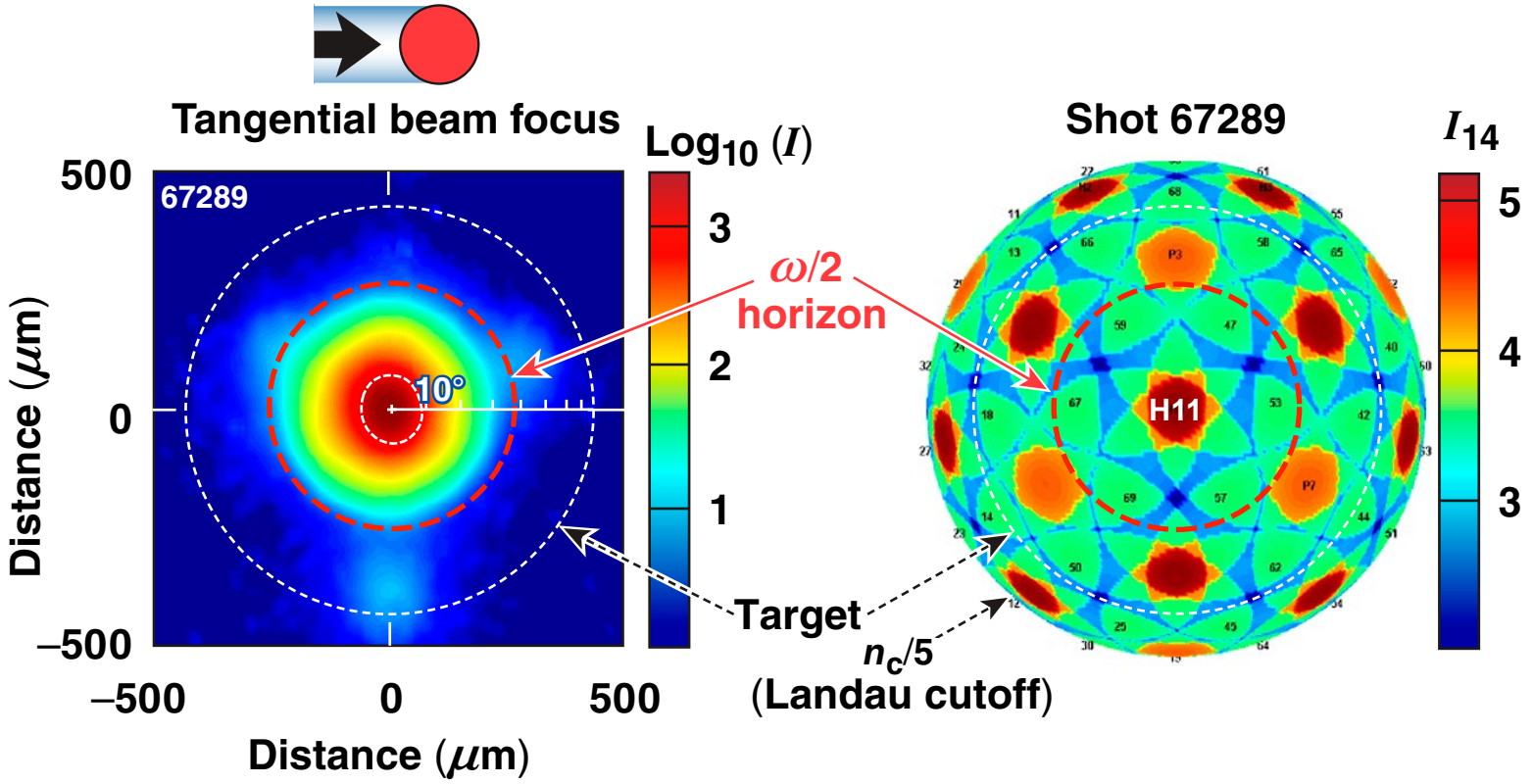
University of Rochester
Laboratory for Laser Energetics

Refraction limits $\omega/2$ images to a horizon determined by the Landau cutoff



LILAC simulation for shot 67841

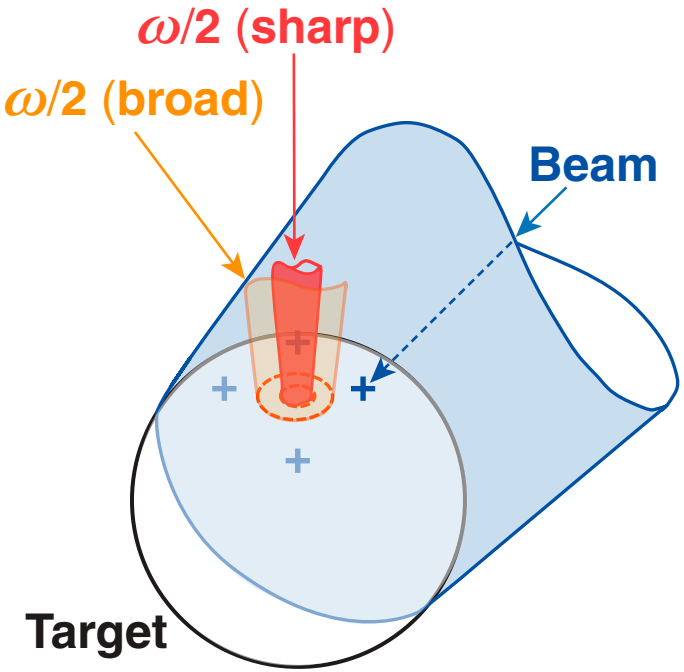
$\omega/2$ images taken at the center of a hex port are consistent with expectations based on ray tracing

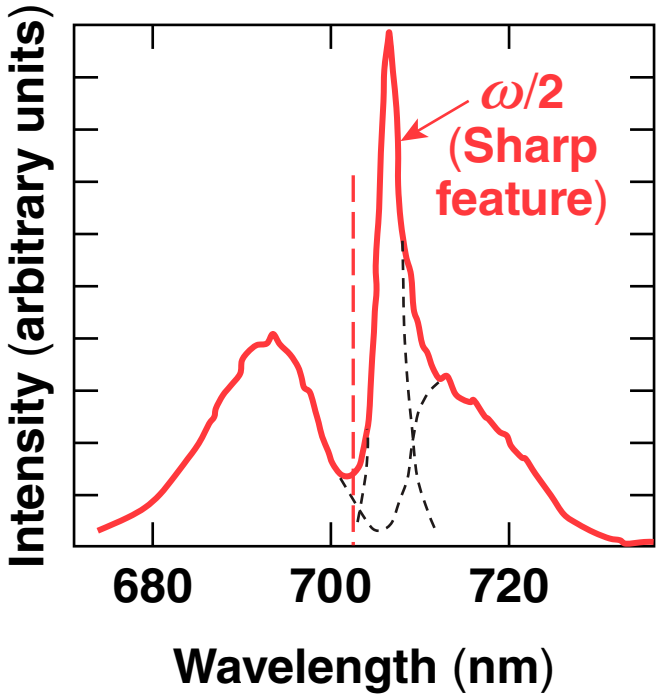


- Half-angle of $\omega/2$ emission cone: ~6°
- ~90% of $\omega/2$ emission within 15°
- Islands outside the $\omega/2$ horizon are consistent with surface perturbations around hex ports

E21669

In 1985* $\omega/2$ spectra were found to contain a valuable T_e measurement feature



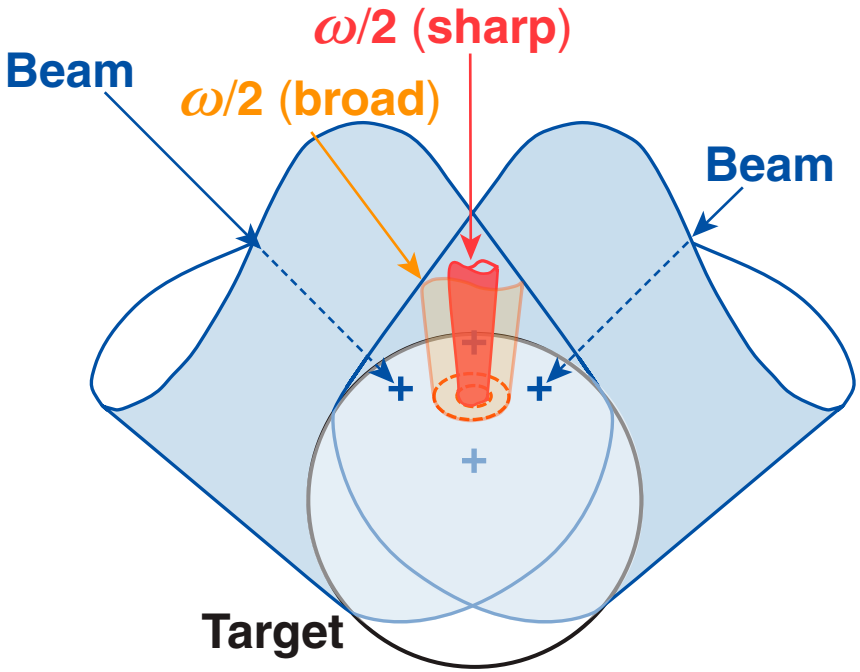


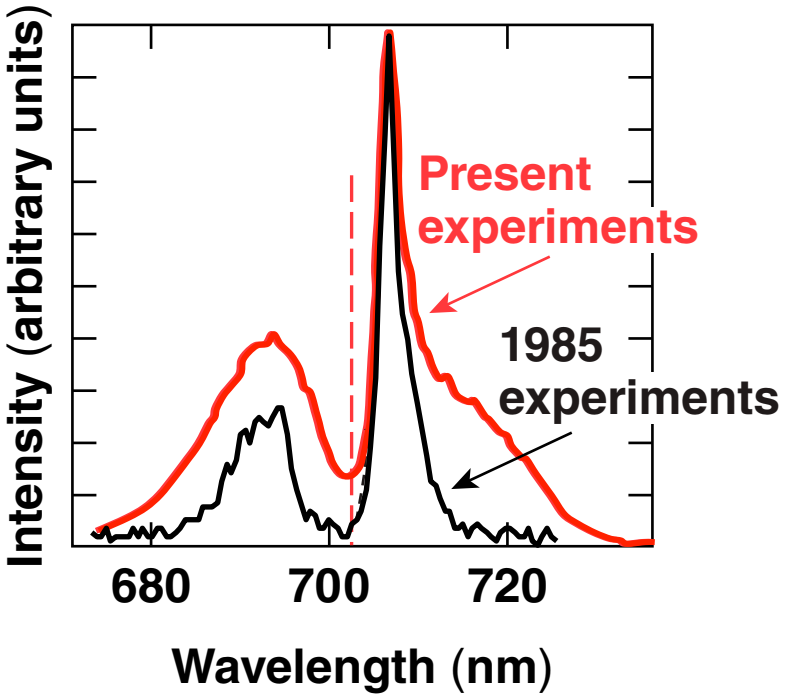
The original interpretation was based on single-beam absolute TPD instability.

E21363b

*W. Seka *et al.*, Phys. Fluids 28, 2570 (1985).

Experiments in 2003 established that the TPD instability was a multibeam instability



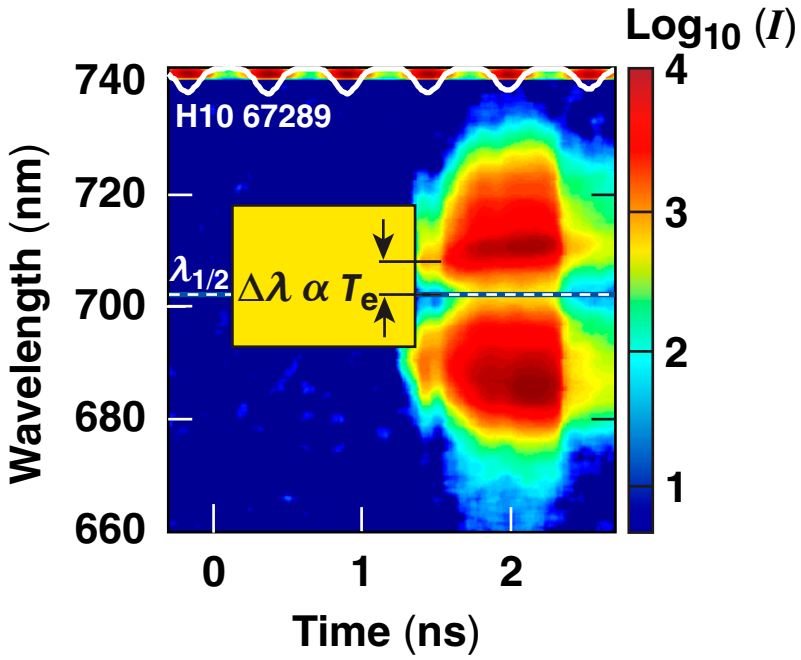


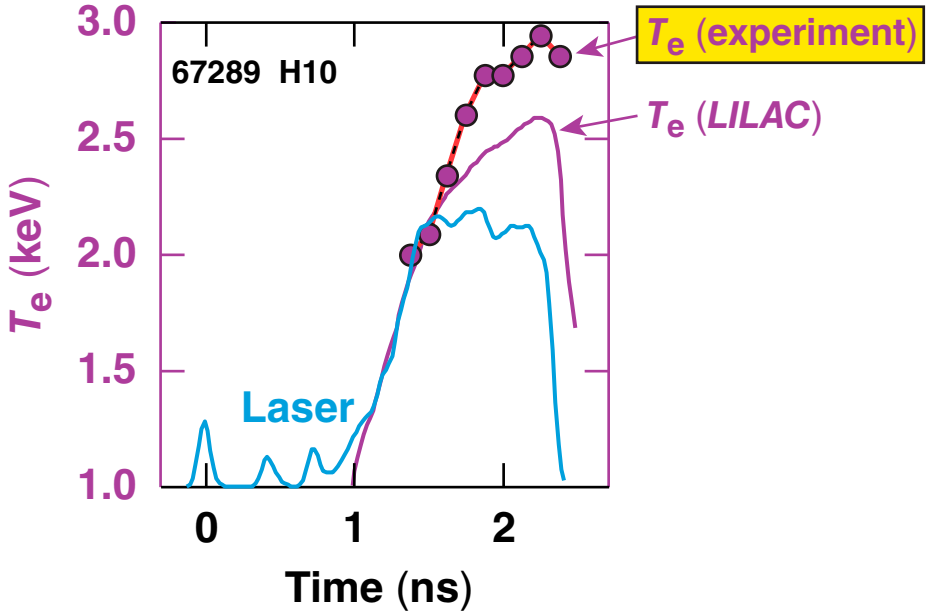
The 1985 results are consistent with four-beam–driven TPD.

E21363c

*C. Stoeckl *et al.*, Phys. Rev. Lett. 90, 235002 (2003).

The sharp red-shifted $\omega/2$ spectral feature is most easily observed when viewed at the center of six beams



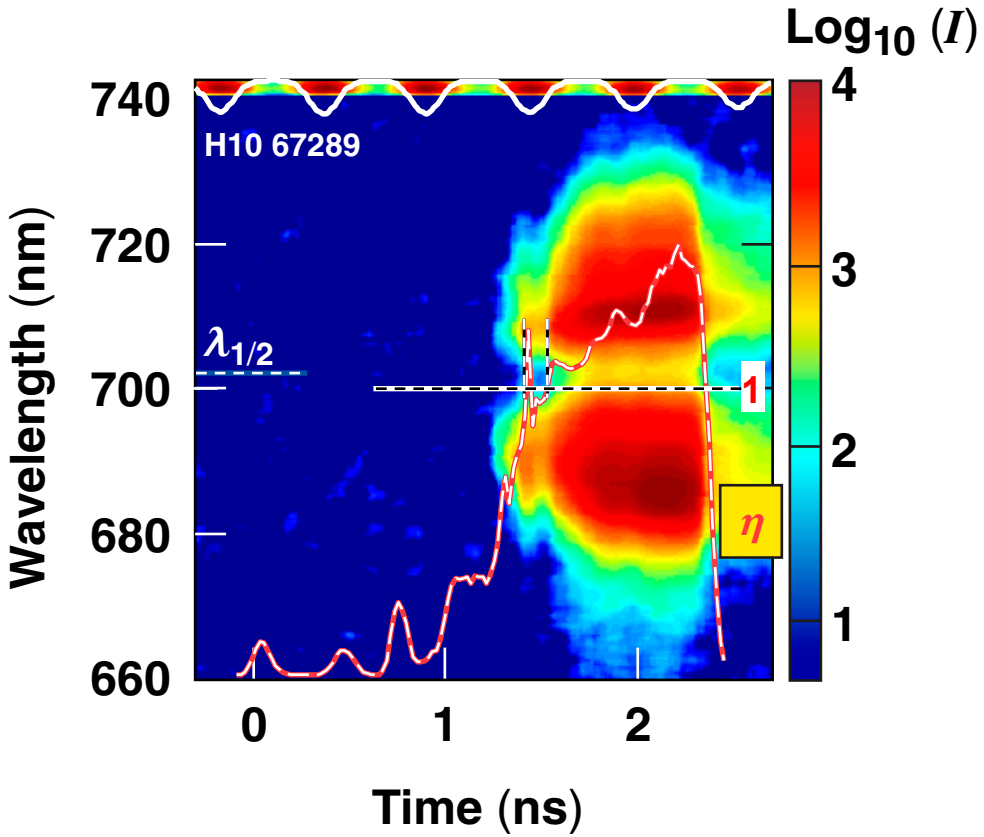


$$\Delta\lambda_{nm} = 4.4 \times 10^{-3}\, T_{e,keV}$$

Measured T_e starts at hydrodynamic predictions but then exceeds them by up to 20%.

E21668

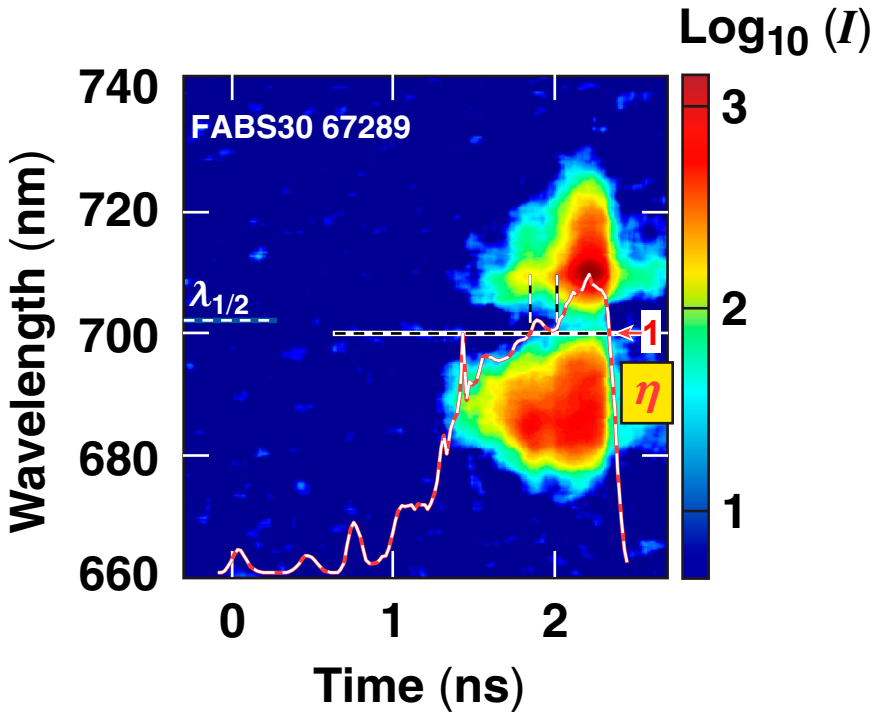
The threshold for the absolute TPD instability corresponds closely to that predicted by theory*

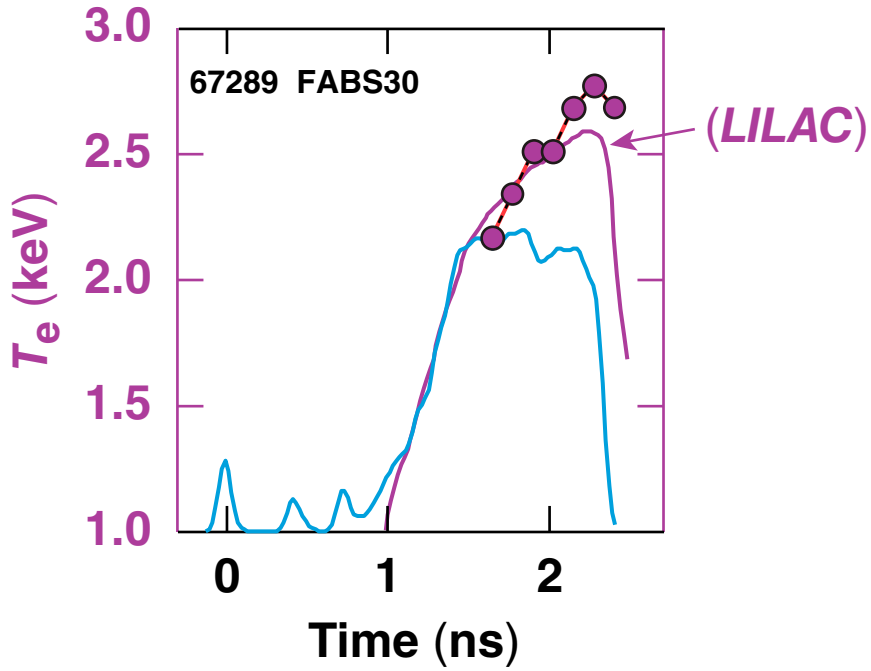


- $\eta = L_{n,\mu m} I_{14} / (230\, T_{e,keV})$
- Experimental thresholds are within 10% of predictions using six-beam overlapped intensity**

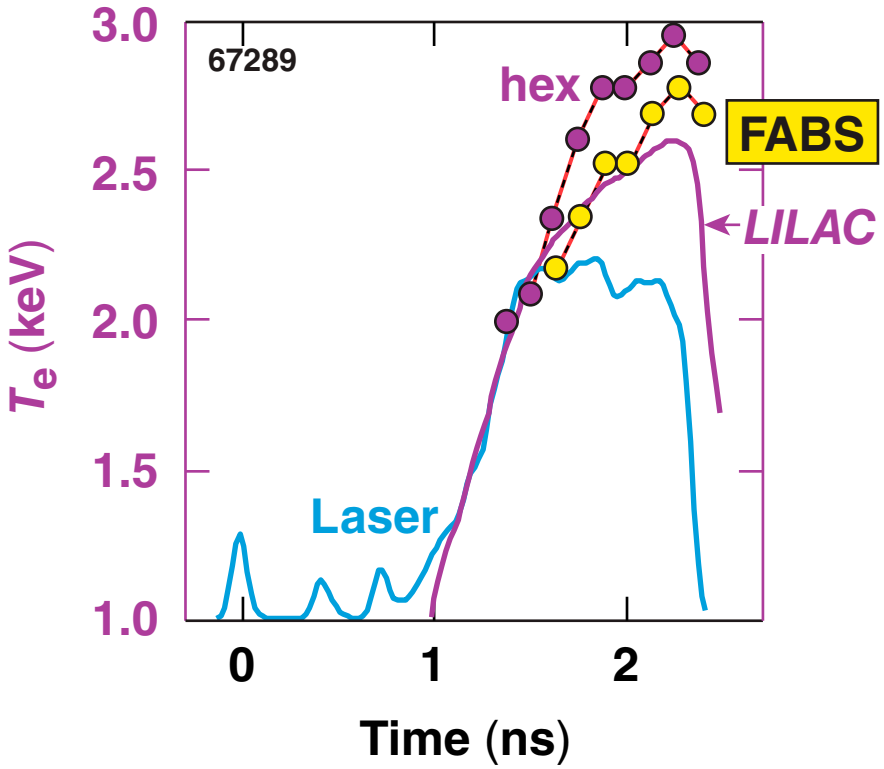
*A. Simon *et al.*, Phys. Fluids 26, 3107 (1983).
**R. W. Short, TO5.00006, this conference.

Because of refraction, $\omega/2$ spectra taken through the focusing lenses can only see the absolute TPD instability caused by four beams



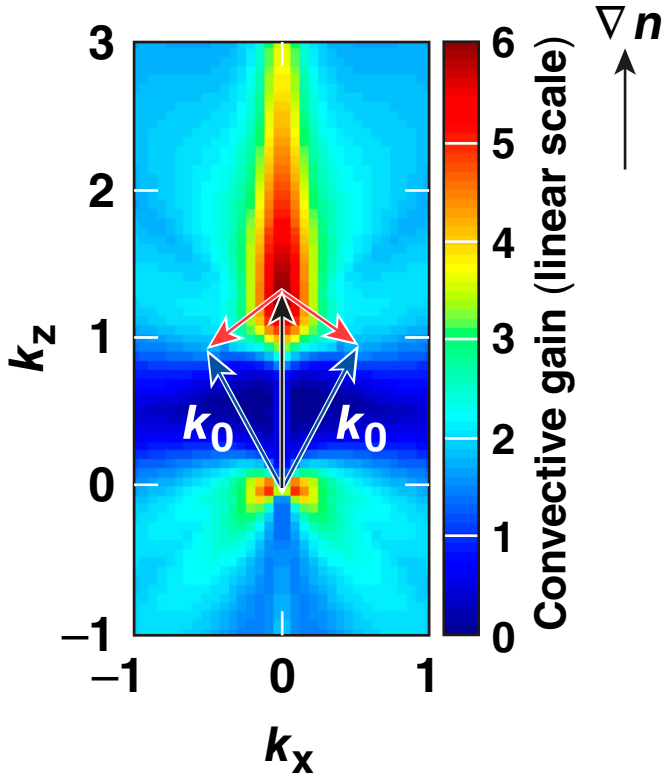


TPD onset and T_e vary across the target surface indicating the existence of elevated T_e islands

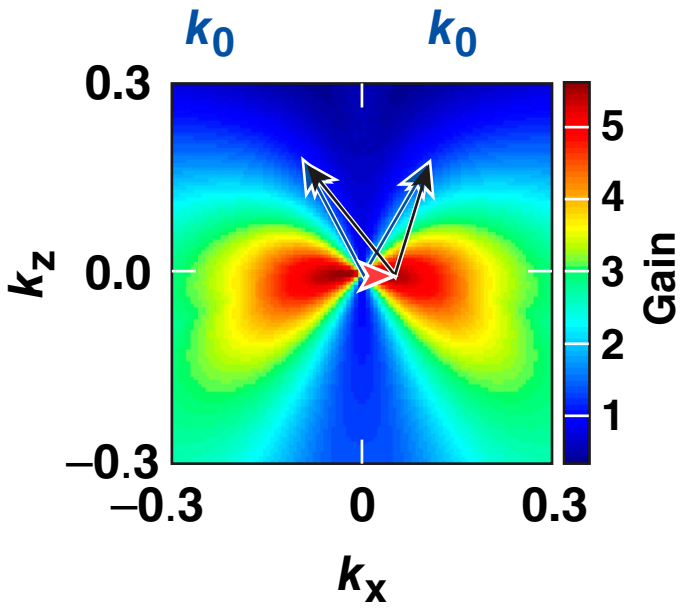


Coronal electron temperature islands imply distorted density contours consistent with $\omega/2$ images.

Three-dimensional convective TPD gain calculations* show significant multibeam gain for large- and small-$k_\perp$ decays



$G \sim 2\pi \rightarrow$ absolute TPD theshold



$I = 10^{14}$ W/cm^2, T_e = keV, $L_n = 150\ \mu$m
Six beams, polarization smoothing

*R. W. Short, TO5.00006, this conference;
for more on common wave gain: D. T. Michel, YI2.00002, this conference.

Summary/Conclusions

$\omega/2$ images and spectra from implosion experiments indicate localized multibeam two-plasmon–decay (TPD) instability

UR LLE

- On-target laser light nonuniformity and $\omega/2$ images indicate TPD is driven in localized areas
- The onset of the absolute TPD instability is observed at the center of six beams in a hex configuration
- T_e measurements using the sharp, red-shifted $\omega/2$ feature start at *LILAC* predictions and then exceed them
- The data are consistent with localized temperature islands near $n_c/4$ exceeding the average by 10% to 20%, and entailing $n_c/4$ surface nonuniformities