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

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Summary

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

- 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

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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: \( \sim 6^\circ \)
- \( \sim 90\% \) of \( \omega/2 \) emission within 15°
- Islands outside the \( \omega/2 \) horizon are consistent with surface perturbations around hex ports
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.

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

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

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

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

Measured $T_e$ starts at hydrodynamic predictions but then exceeds them by up to 20%.
The threshold for the absolute TPD instability corresponds closely to that predicted by theory*

\[ \eta = \frac{L_n \mu m I_{14}}{230 T_e \text{, keV}} \]

- Experimental thresholds are within 10% of predictions using six-beam overlapped intensity**

** 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

\[ I = 10^{14} \text{ W/cm}^2, T_e = \text{keV}, L_n = 150 \mu\text{m} \]

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

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