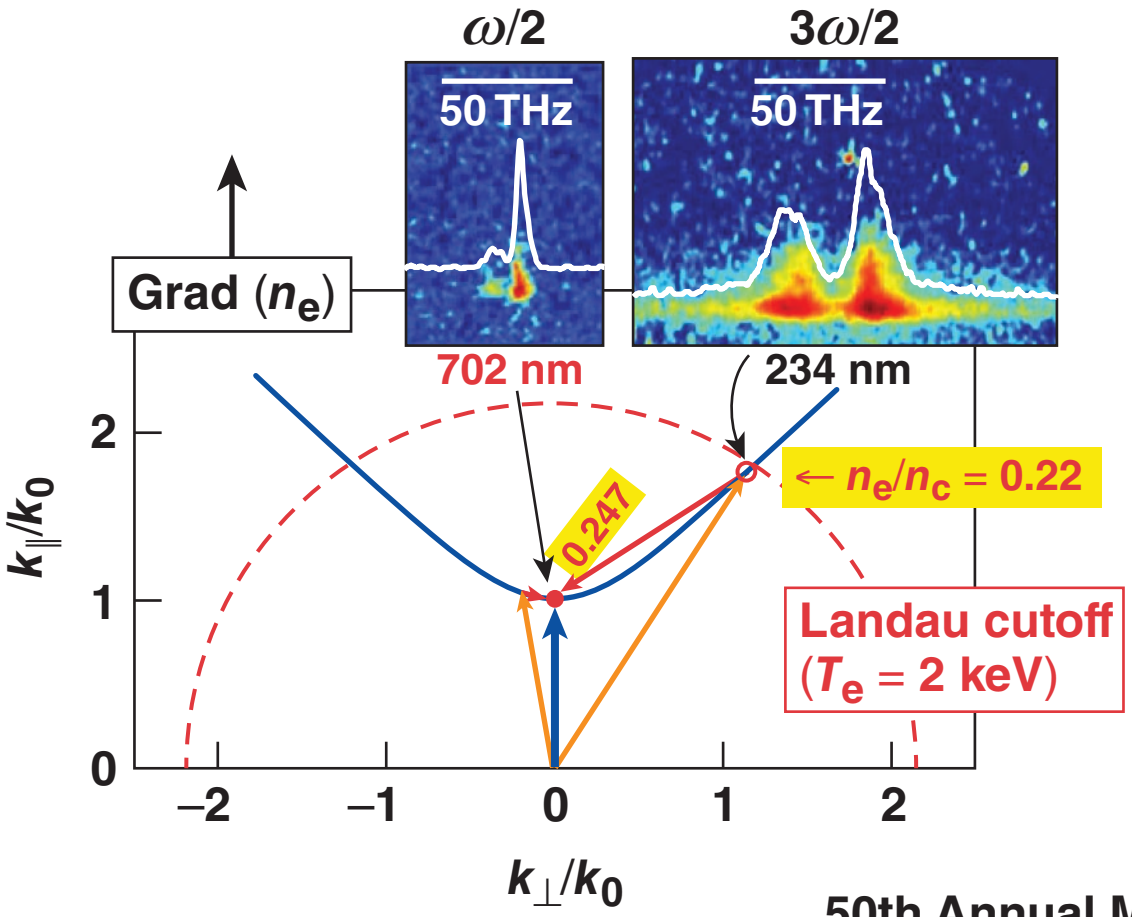
Two-Plasmon-Decay Instability in Direct-Drive-Implosion Experiments



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Summary

The two-plasmon-decay (TPD) instability is seen in most direct-drive experiments with plasmons with large range of *k*'s

UR LLE

- The TPD instability is seen via $3\omega/2$, $\omega/2$, and hard x-ray emission.
- Threshold is consistent with absolute instability.
- TPD plasmons are seen between $0.2 \leq k_{\perp}/k_0 \leq 2.0$ ($k\lambda_D < 0.25$).
- Large-*k* plasmons contradict predictions of absolute instability ($k_{\perp}/k_0 \lesssim 0.2$).

Collaborators

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The linear TPD theory provides little guidance beyond threshold

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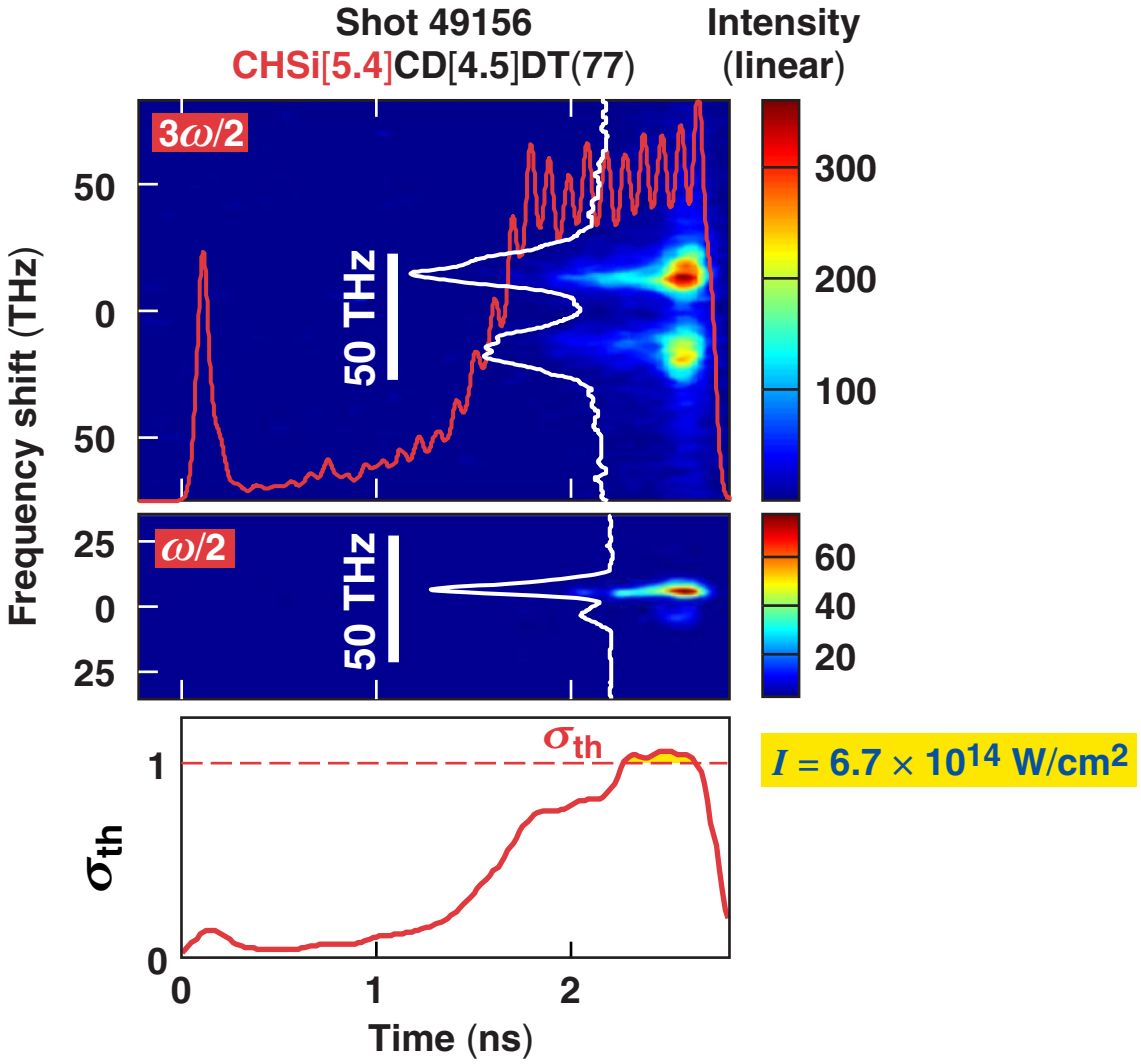
- From linear TPD theory, one obtains
  - threshold parameter $\sigma_{th} = I_{14} L_{n,\mu m} / (230 \times T_{e,keV})$

- For current ICF parameters,
  - $T_e \sim 1.5$ keV, $L_n \sim 150\ \mu$m $\rightarrow I_{th} \sim 2.0 \times 10^{14}$ W/cm^2

[1] A. Simon *et al.*, Phys. Fluids 26, 3107 (1983).

The TPD thresholds as deduced from $3\omega/2$ and $\omega/2$ emission are remarkably consistent with $\sigma_{th} = 1$ based on linear theory



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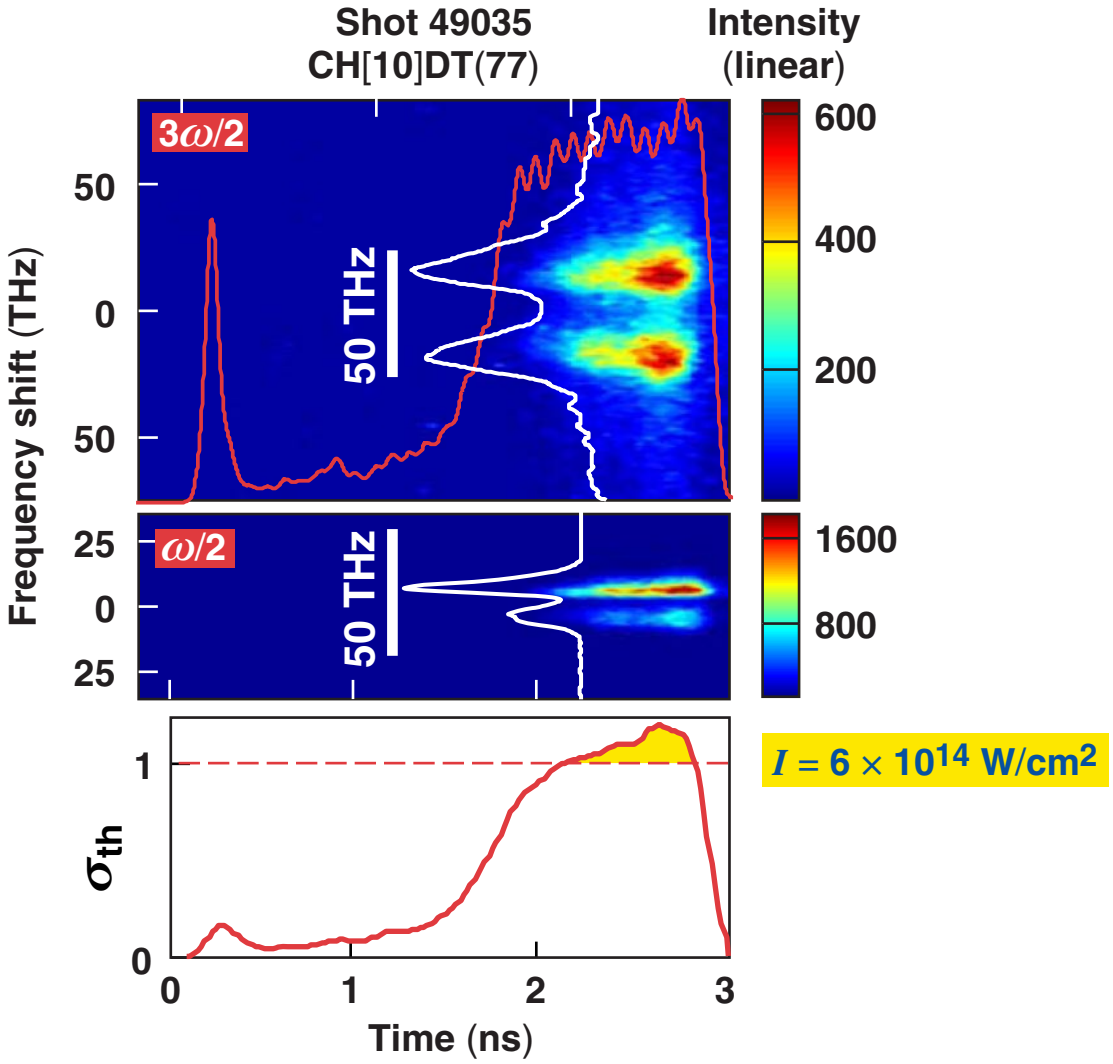
The TPD thresholds as deduced from $3\omega/2$ and $\omega/2$ emission are remarkably consistent with $\sigma_{th} = 1$ based on linear theory



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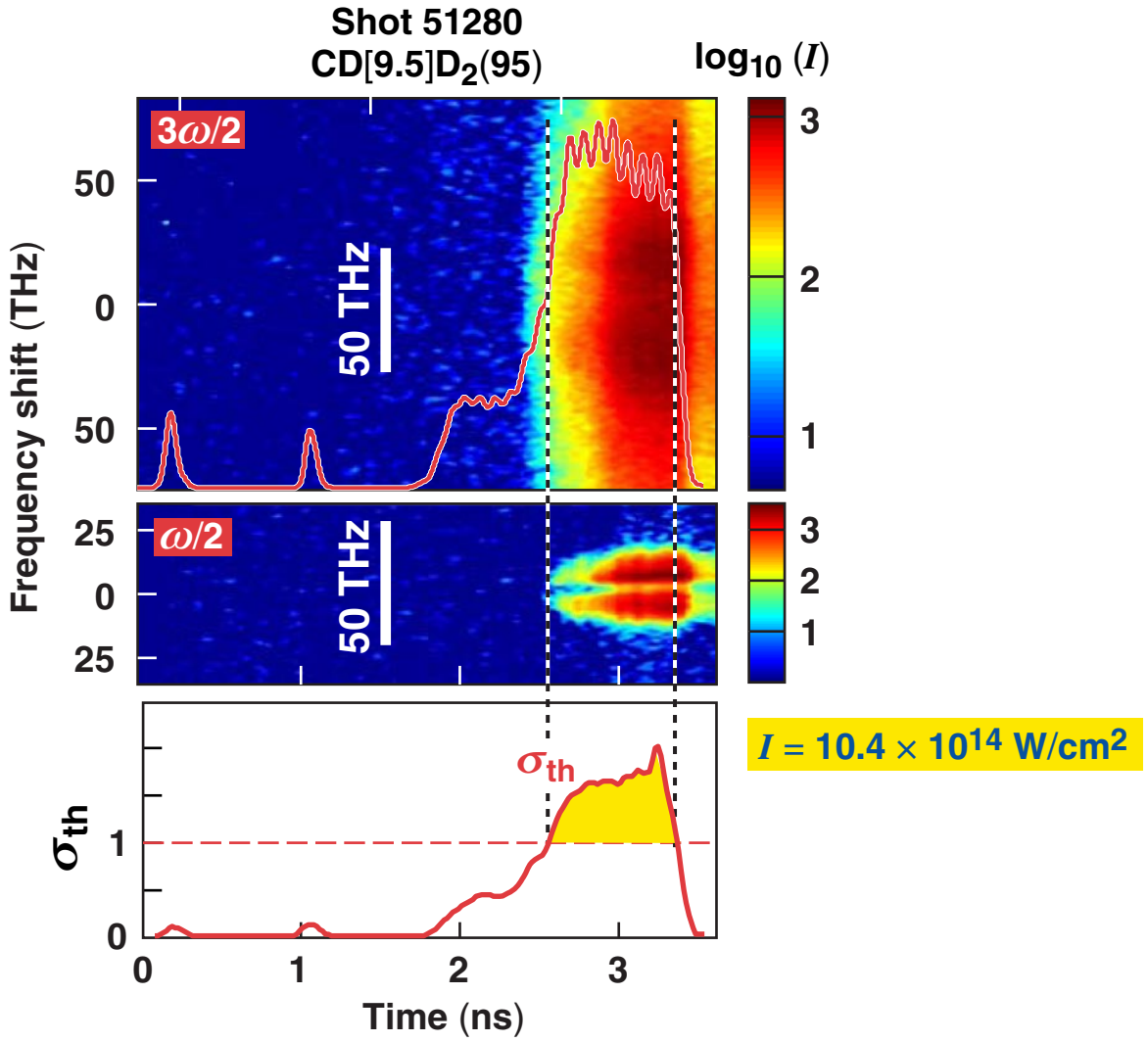
The TPD thresholds as deduced from $3\omega/2$ and $\omega/2$ emission are remarkably consistent with $\sigma_{th} = 1$ based on absolute TPD instability



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The TPD thresholds correspond to standard theory but the TPD plasma waves do not

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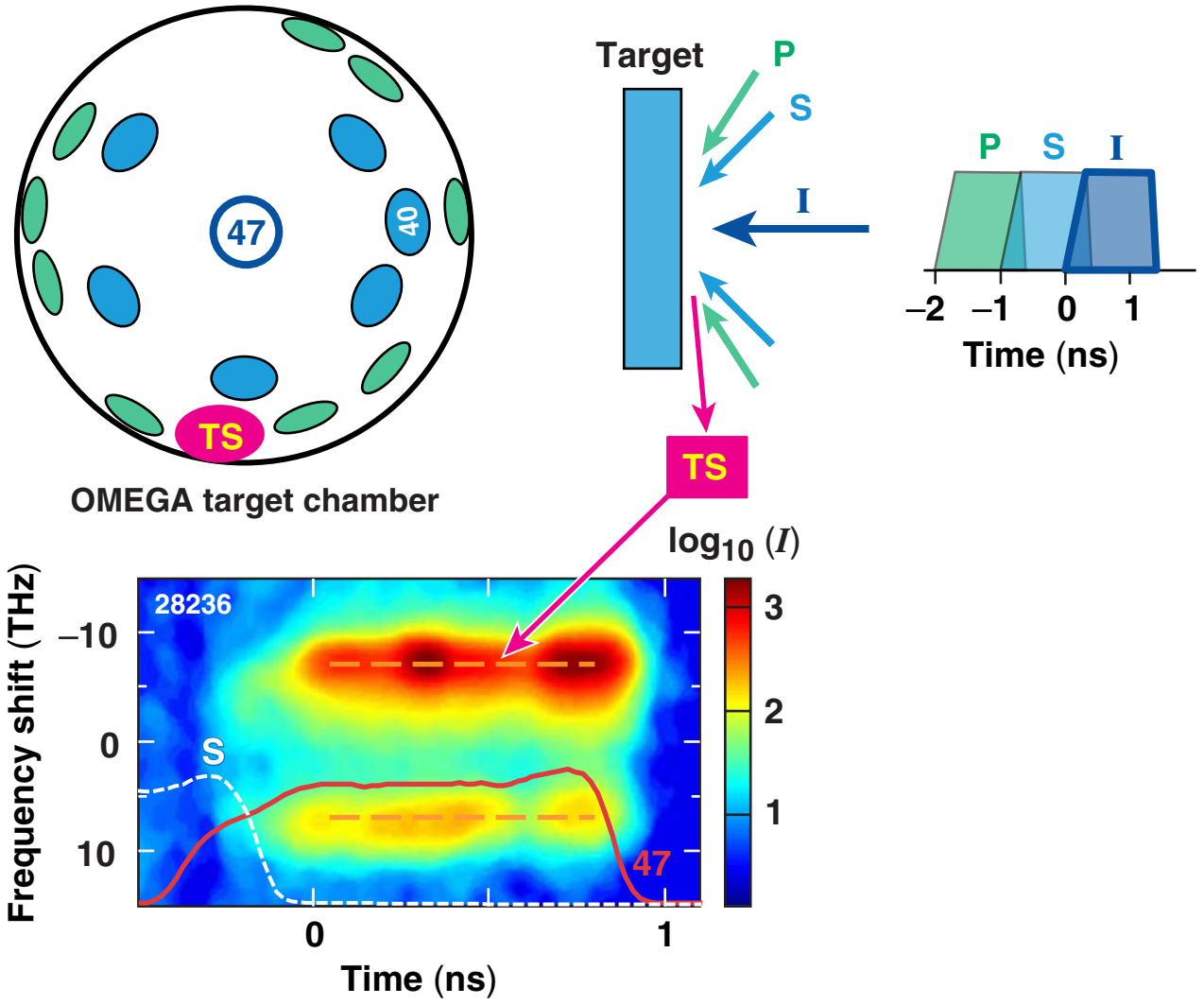
- σ_{th} based on the absolute instability is consistent with the onset of the TPD instability.
- Plasmons with small k's ($k_{\perp} \leq 0.2\ k_0$) are seen where expected in $\omega/2$ spectra.
- Plasmons with large k's ($k\lambda_{De} \sim 0.25$) are seen ubiquitously in $3\omega/2$ spectra $\rightarrow$ not predicted by standard absolute instability.

Some specific TPD issues can be addressed via Thomson scattering in planar target experiments

- The importance of the Landau cutoff stands in contrast to SRS experience

Thomson scattering off TPD plasma waves has been optimized for the red component of the $3\omega/2$ spectrum in planar target experiments on OMEGA



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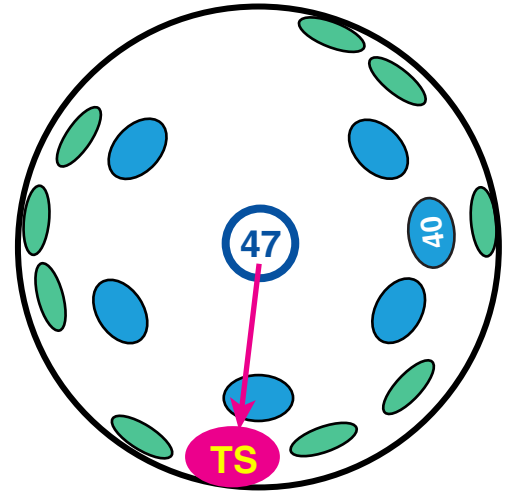
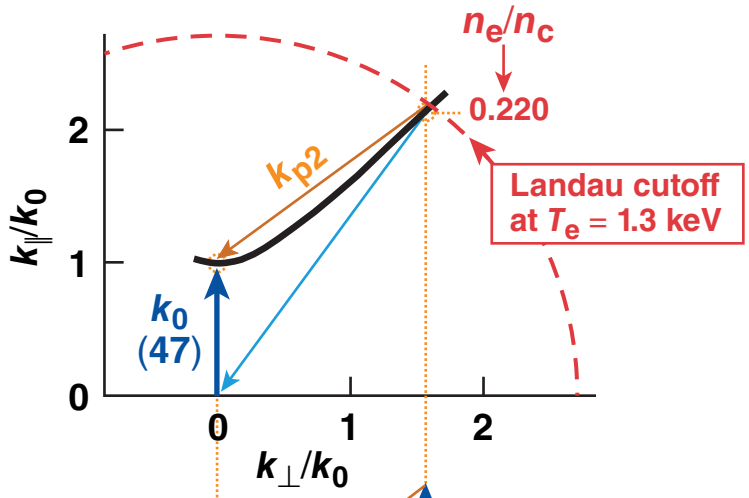
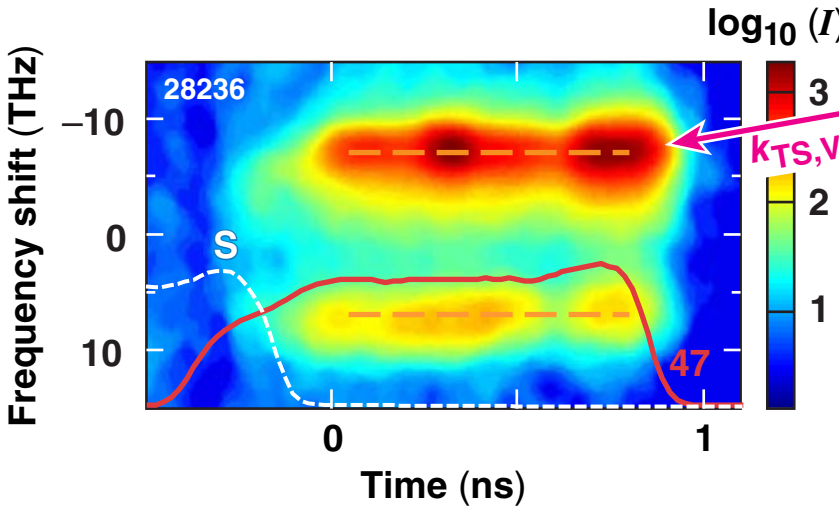
Thomson scattering off TPD plasma waves has been optimized for the red component of the 3ω/2 spectrum in planar target experiments on OMEGA



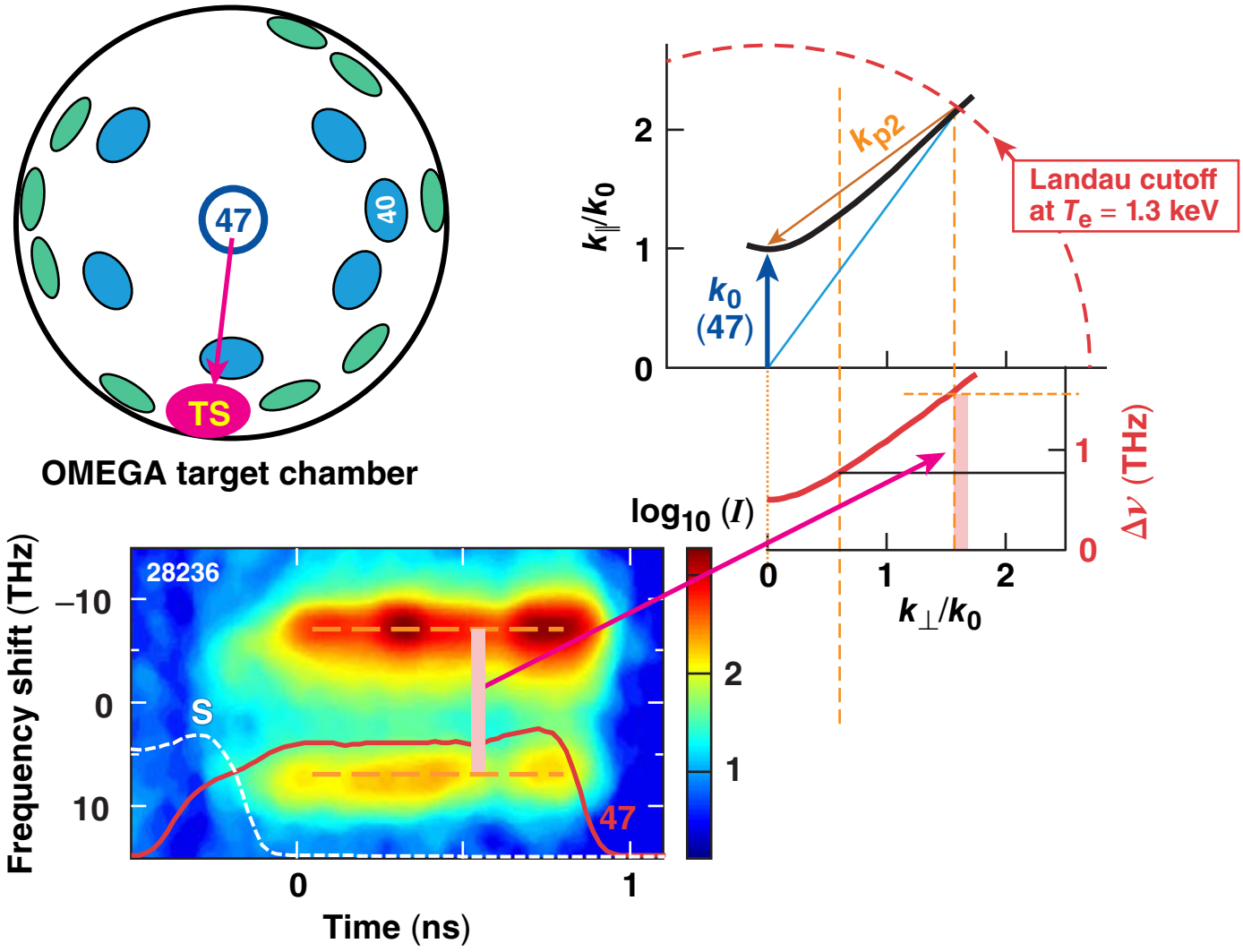
OMEGA target chamber





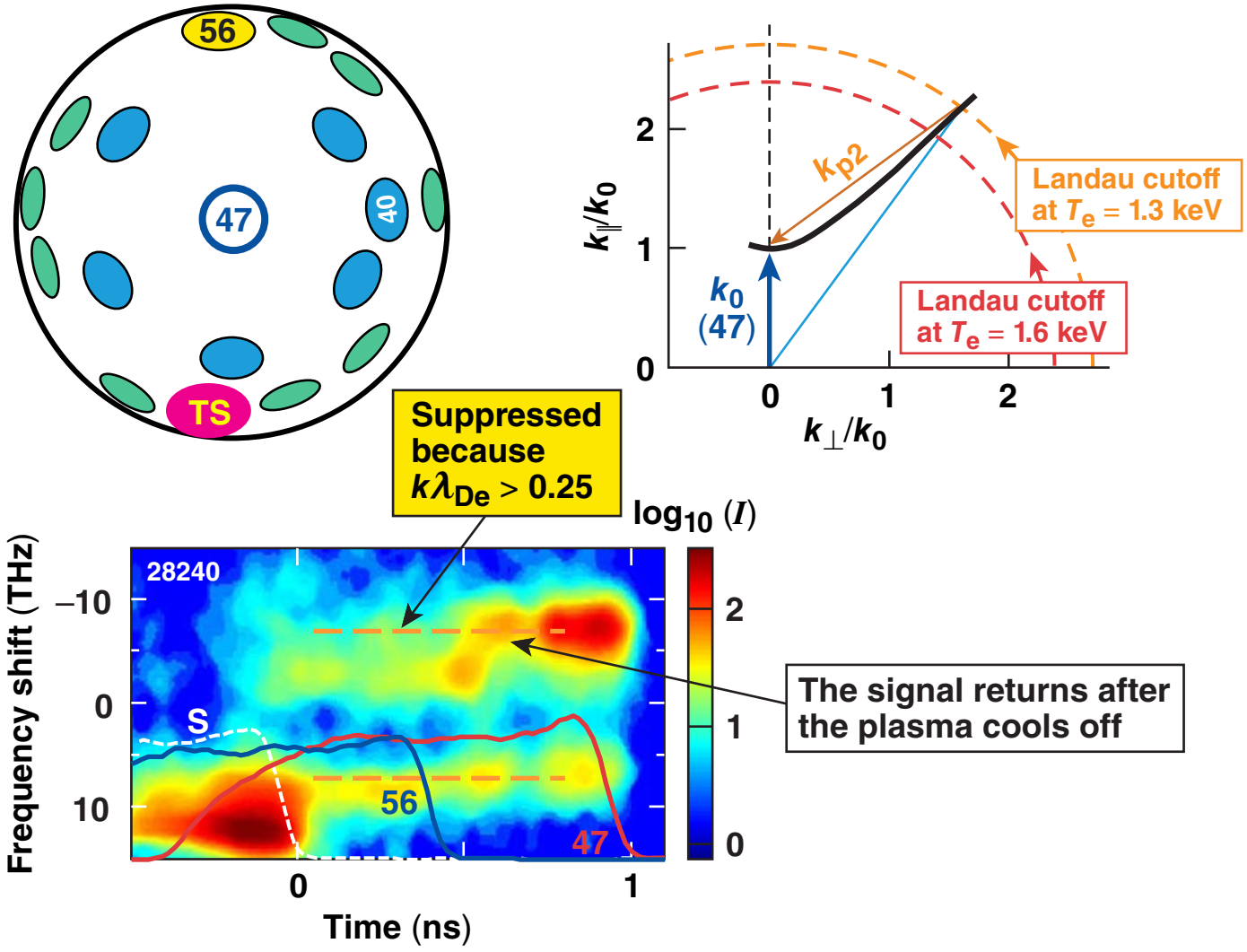
E17429a

Thomson scattering off TPD plasma waves has been optimized for the red component of the 3ω/2 spectrum in planar target experiments on OMEGA



E17429b

Heating the plasma with an additional beam raises λ_{De} and suppresses the TPD previously seen near the Landau cutoff



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Summary/Conclusions

The two-plasmon-decay (TPD) instability is seen in most direct-drive experiments with plasmons with large range of *k*'s

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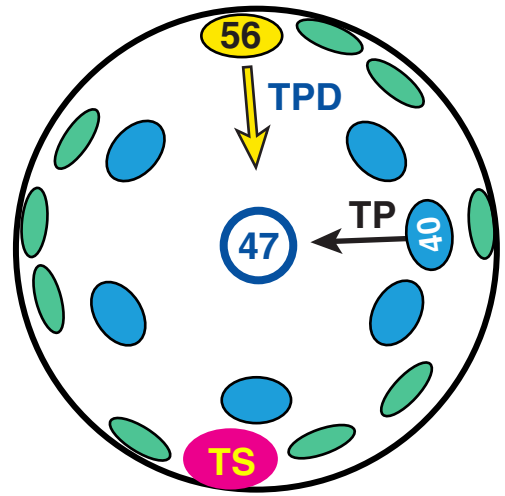
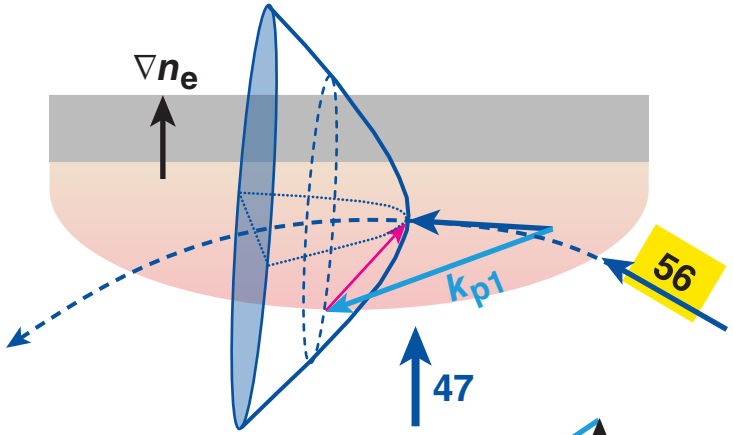
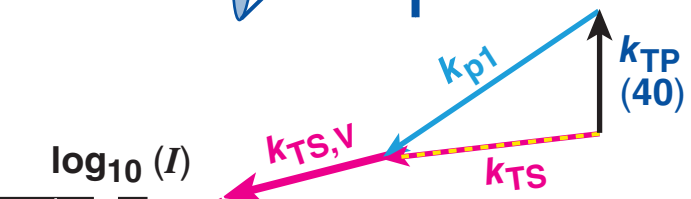
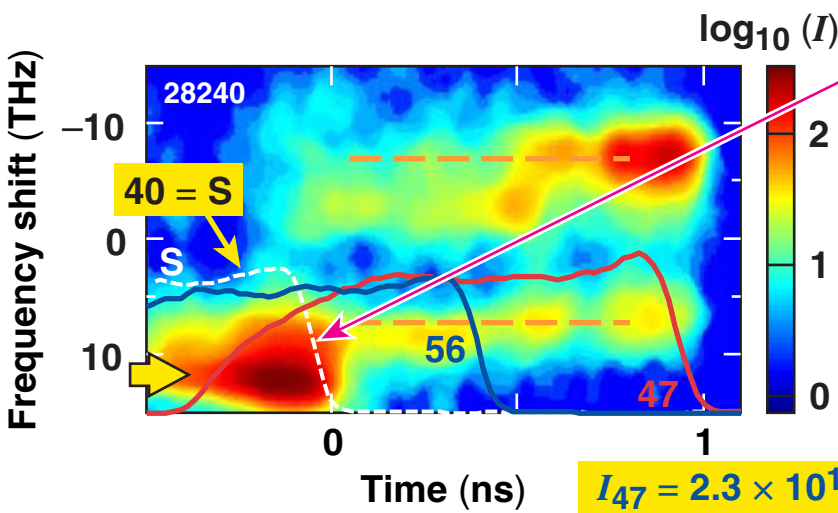
A strong blue-shifted Thomson scattered signal is produced when beam 56 TPD plasmons scatter beam 40 (Thomson probe)







Seen from above



This is a truly 3-D problem and the Zakharov model may be able to treat this.

$I_{47} = 2.3 \times 10^{14}$ W/cm^2

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