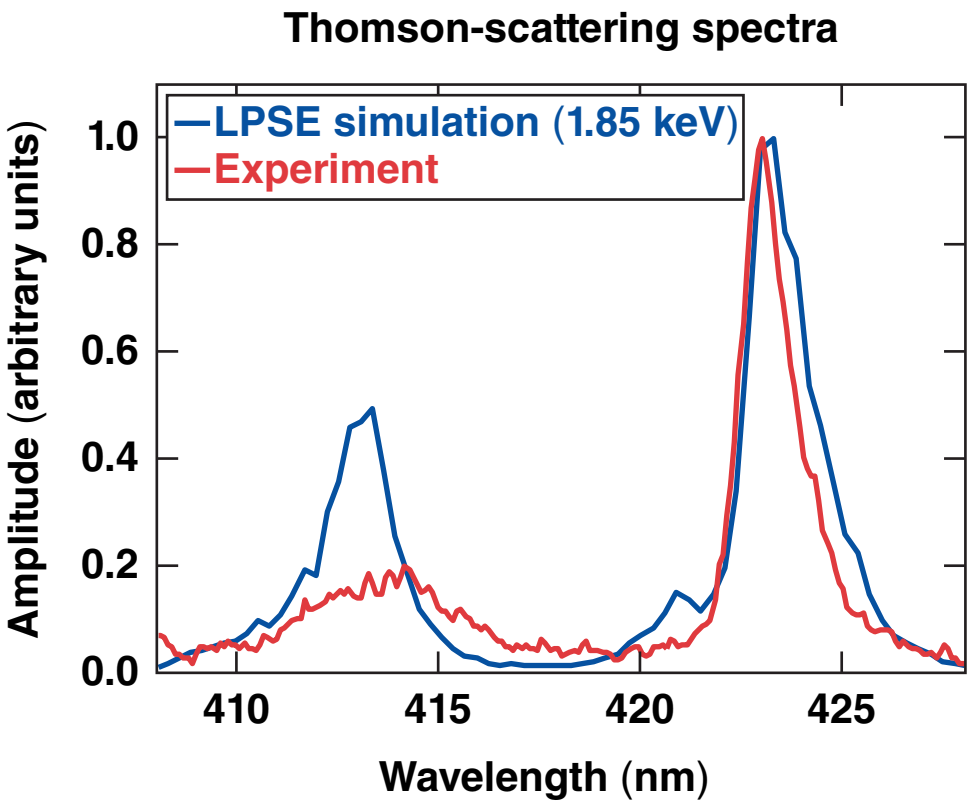
Observation of Two-Plasmon–Decay Common Plasma Waves Using UV Thomson Scattering



R. K. Follett
University of Rochester
Laboratory for Laser Energetics

56th Annual Meeting of the
American Physical Society
Division of Plasma Physics
New Orleans, LA
27–31 October 2014

Summary

Electron plasma waves (EPW's) driven by common-wave two-plasmon decay (TPD) were observed on OMEGA using UV Thomson scattering

UR LLE

- Two large-amplitude Thomson-scattering peaks are observed in the Thomson-scattering spectrum
- The highest-intensity peak corresponds to the common-wave EPW driven by five OMEGA beams
- The secondary peak corresponds to EPW's associated with the Langmuir decay instability (LDI) driven by TPD
- Three-dimensional laser–plasma simulation environment (LPSE)* simulations reproduce the observed spectra

E23505

J. F. Myatt, PO4.00001, this conference.

Collaborators

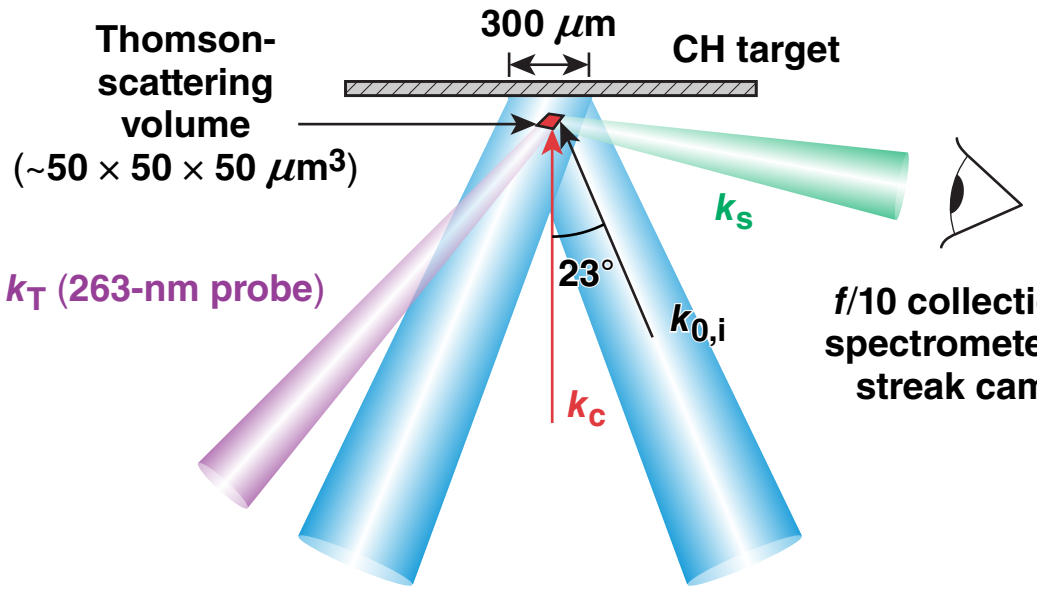
D. H. Edgell, R. J. Henchen, S. X. Hu, J. Katz, D. T. Michel, J. F. Myatt, J. Shaw, and D. H. Froula

University of Rochester
Laboratory for Laser Energetics

Thomson scattering (TS) was used to observe the common EPW driven by five OMEGA beams

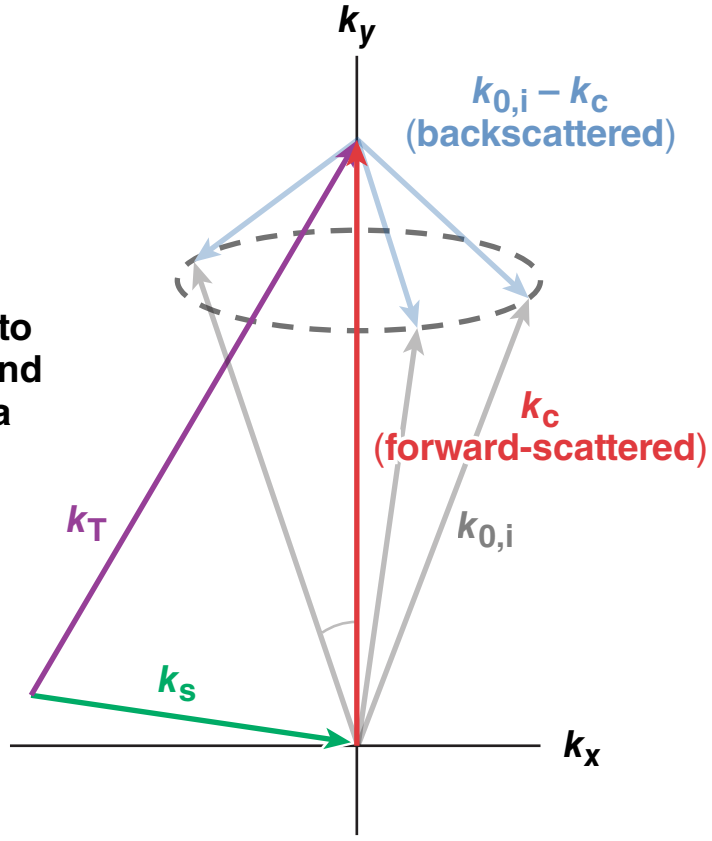
UR LLE

Experimental configuration



Five 3ω (351-nm) drive beams
(1.5 kJ, 1 ns, $I_{n_c/4} \sim 6 \times 10^{14}$ W/cm^2)

Five-beam common-wave *k* matching in the TS plane



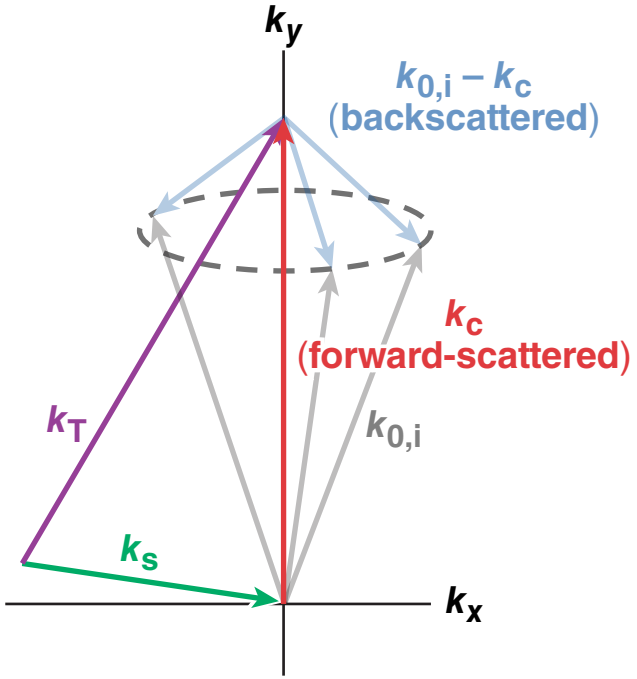
The Thomson-scattering geometry was chosen to probe the five-beam common-wave *k* vector along the target normal.

E23199a

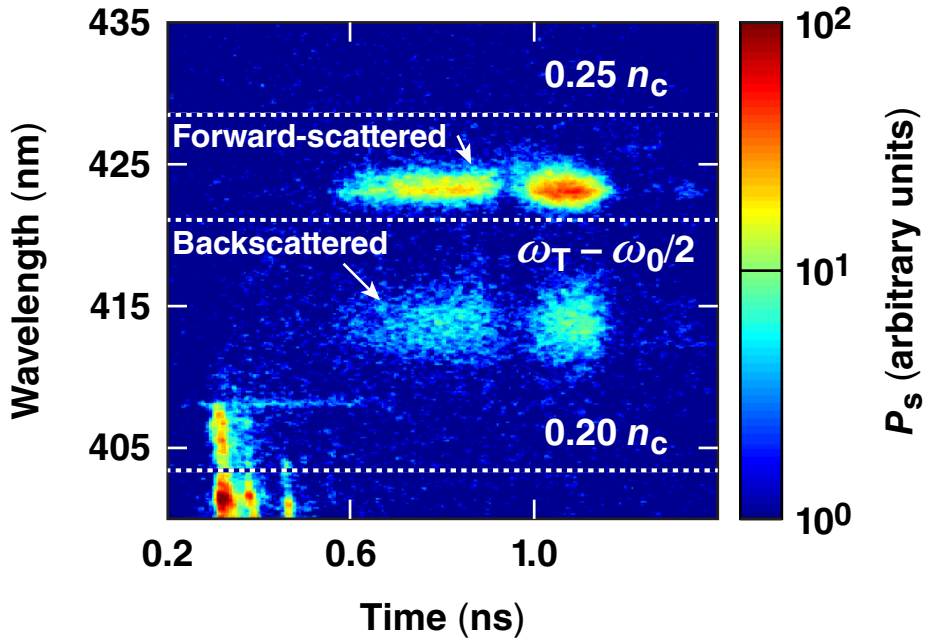
A large amplitude spectral peak was observed at a wavelength corresponding to scattering from the forward-scattered common EPW

UR LLE

Five-beam common-wave *k* matching in TS plane



Thomson-scattering spectrum
$\omega_s = \omega_T - \omega_{EPW}$



The shorter-wavelength peak corresponds to Thomson scattering from TPD backscatter, but these EPW's are not directly observable in the Thomson-scattering geometry.

E23506

LPSE* was used to simulate the region probed by Thomson scattering

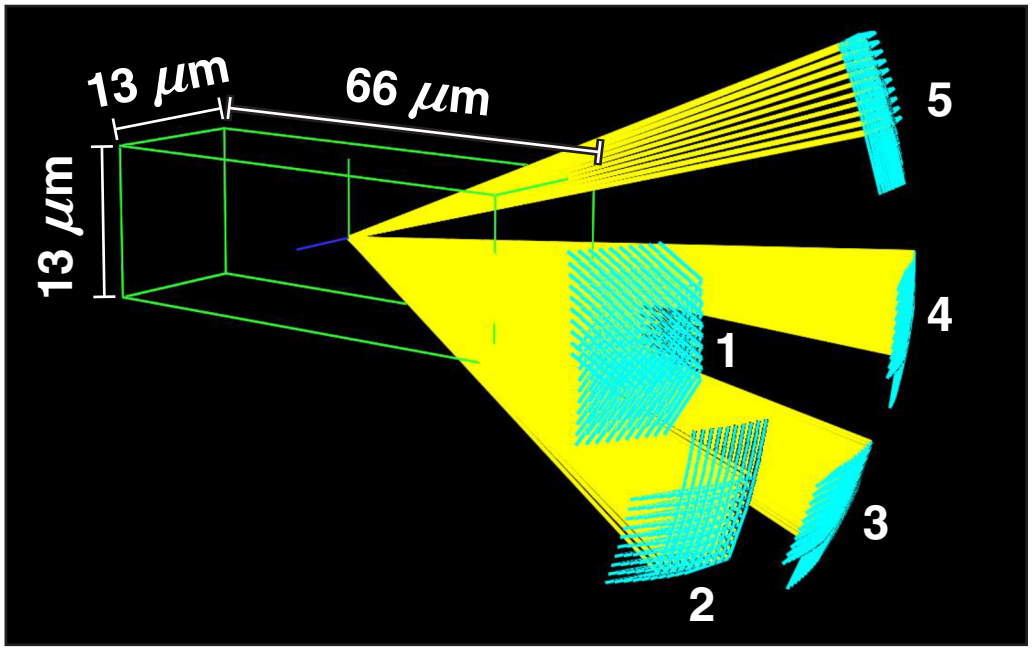
UR LLE

Zakharov equations

$$D_{EPW}\,E(\vec{x},t) = \delta nE + S_{TPD}(E^*, E_0)$$

$$D_{IAW}\,\delta n(\vec{x},t) = \nabla^2 \left| E \right|^2 + \nabla^2 \left| E_0 \right|^2$$

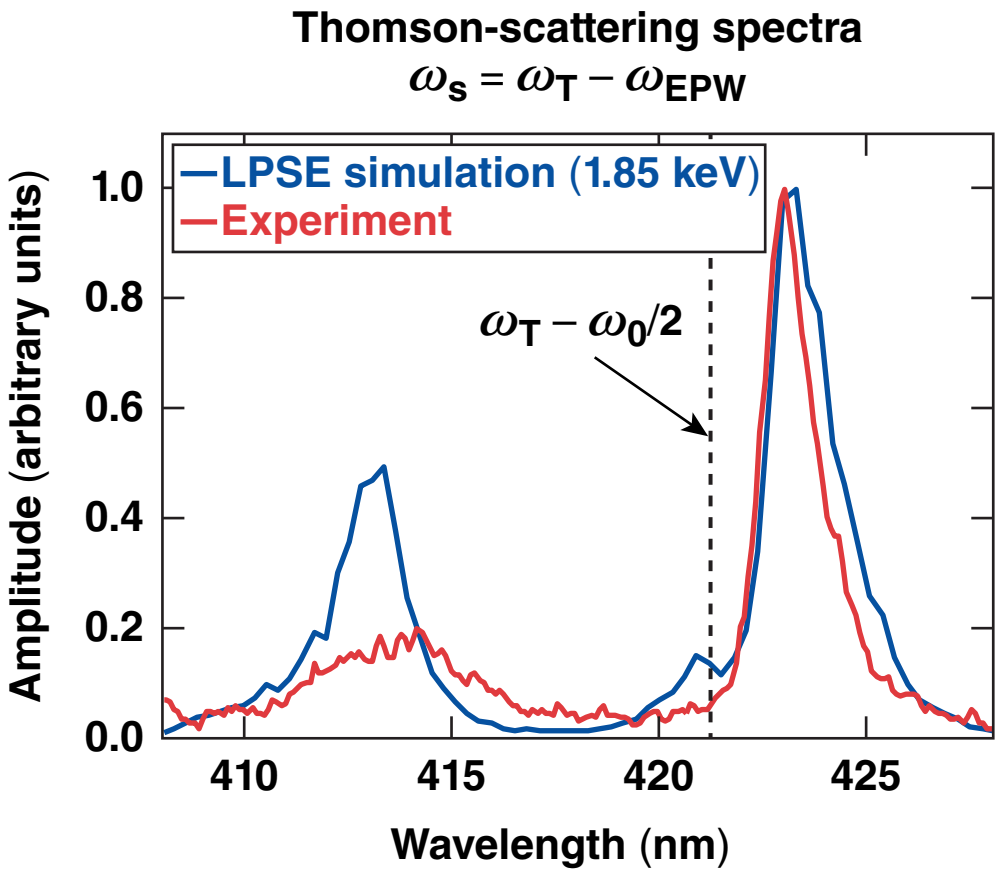
LPSE five-beam simulation geometry



J. F. Myatt, PO4.00001, this conference.

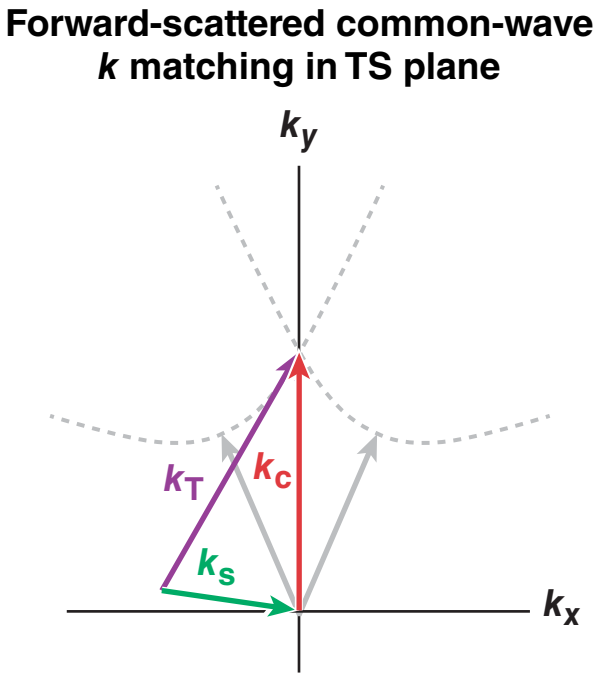
E23541

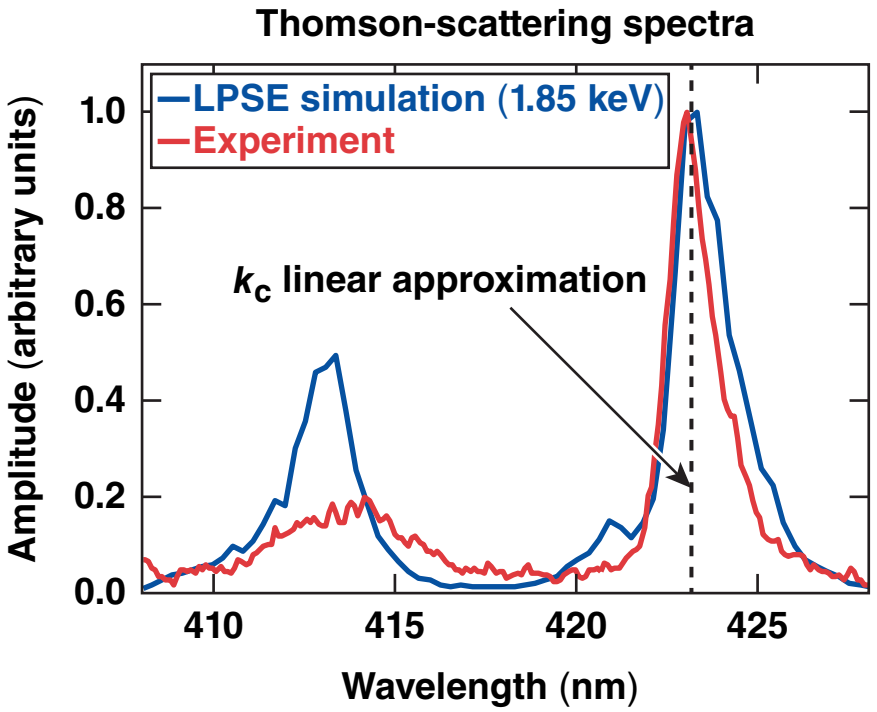
Simulated Thomson scattering from LPSE reproduces both experimentally observed spectral peaks



E23507

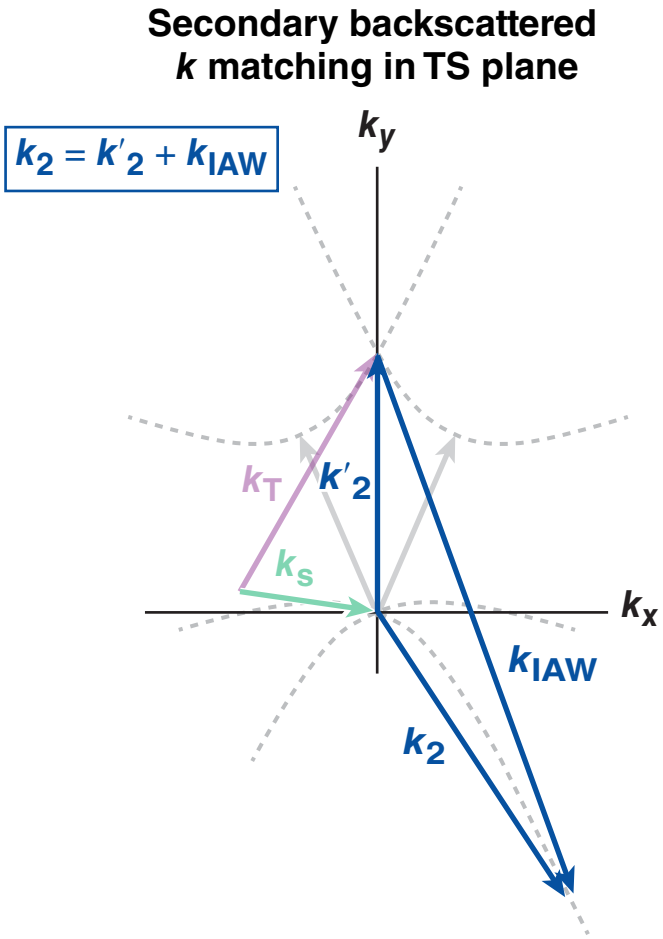
The longer-wavelength peak is a result of Thomson scattering from the forward-scattered common wave

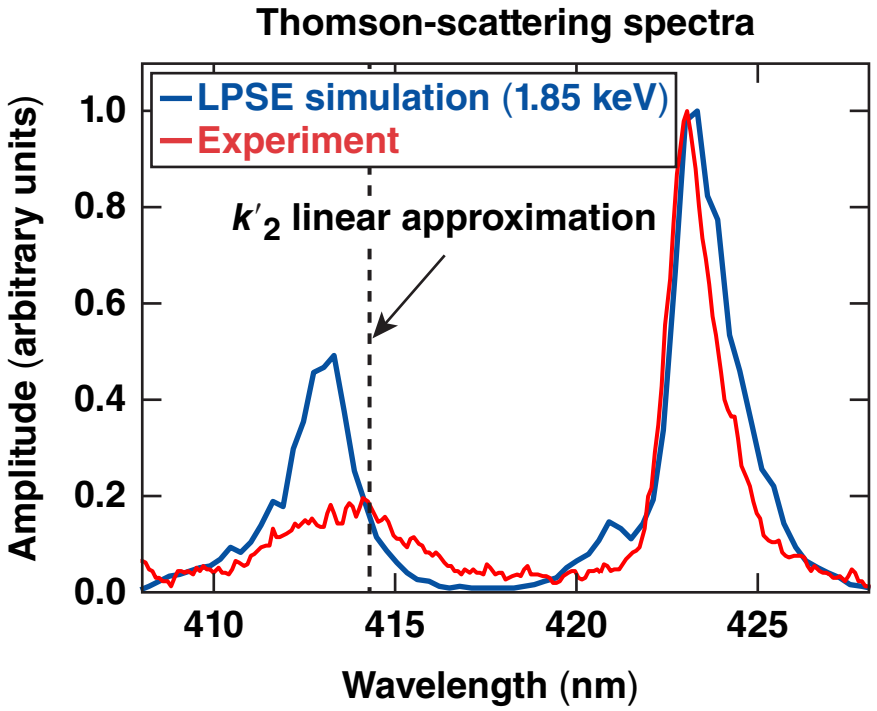




E23542

The shorter-wavelength peak is Thomson scattering from secondary backscattered TPD EPW's generated by Langmuir decay





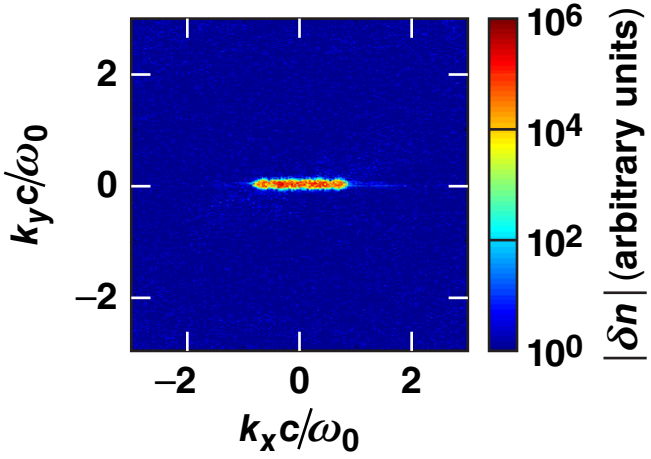
E23543

In LPSE simulations, the backscattered TPD peak appears in conjunction with the onset of large-amplitude ion-acoustic waves

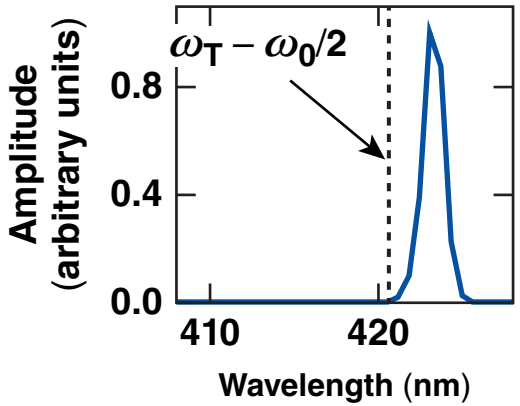
UR LLE

1.0 ps (linear regime)

Ion-acoustic wave spectrum

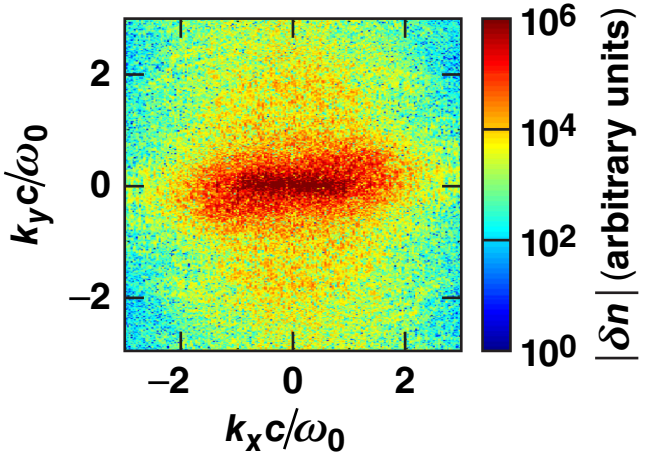


Stimulated TS spectrum

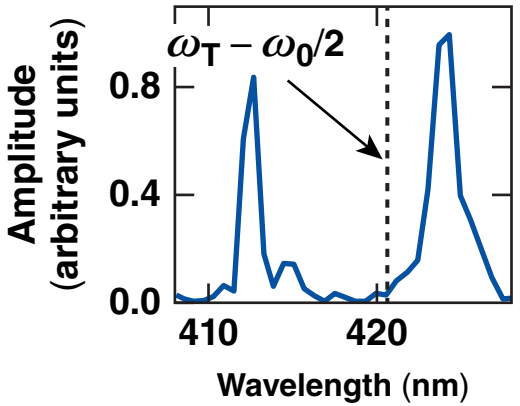


2.4 ps (nonlinear regime)

Ion-acoustic wave spectrum



Stimulated TS spectrum



E23544

Summary/Conclusions

Electron plasma waves (EPW's) driven by common-wave two-plasmon decay (TPD) were observed on OMEGA using UV Thomson scattering

UR LLE

- Two large-amplitude Thomson-scattering peaks are observed in the Thomson-scattering spectrum
- The highest-intensity peak corresponds to the common-wave EPW driven by five OMEGA beams
- The secondary peak corresponds to EPW's associated with the Langmuir decay instability (LDI) driven by TPD
- Three-dimensional laser–plasma simulation environment (LPSE)* simulations reproduce the observed spectra

E23505

J. F. Myatt, PO4.00001, this conference.