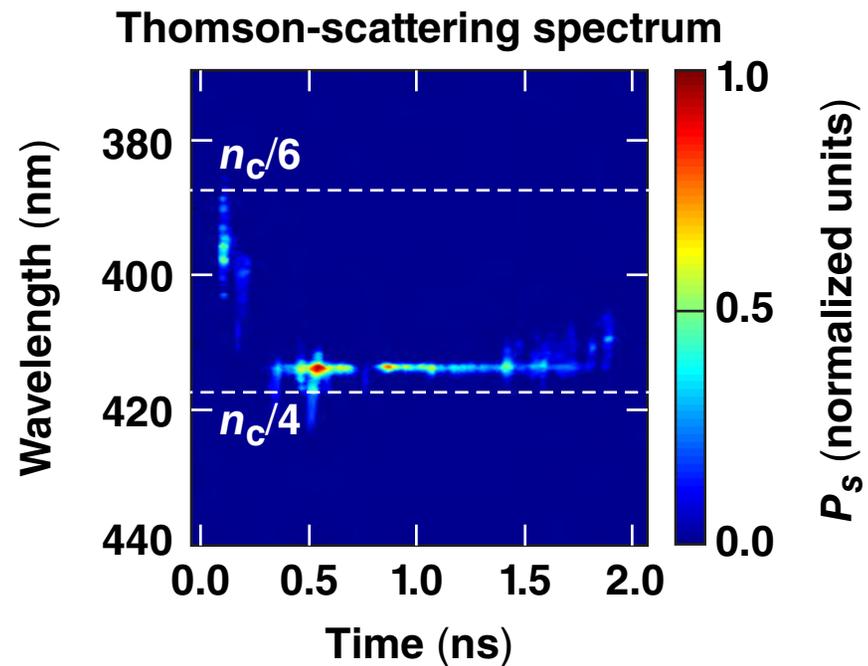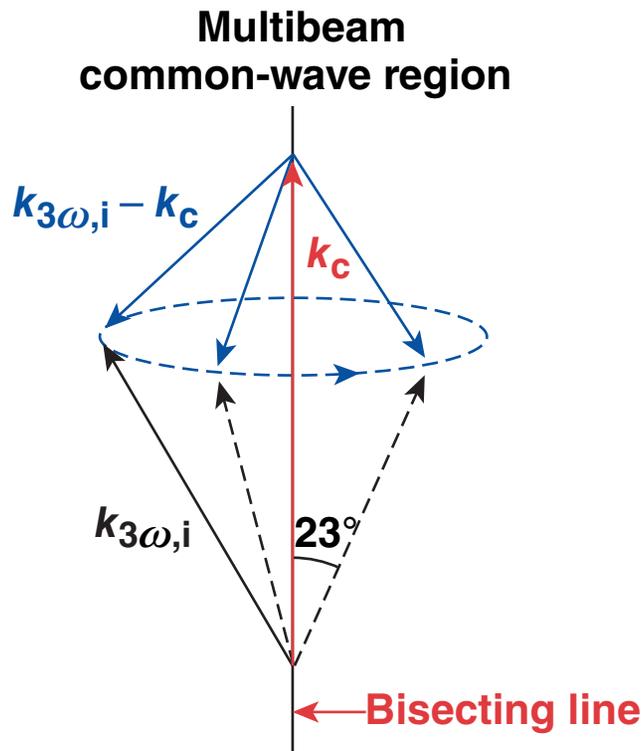# Observation of Two-Plasmon–Decay Electron Plasma Waves Driven by Multiple Beams Using UV Thomson Scattering

**Multibeam common-wave region**

$k_{3\omega,i} - k_c$

$k_c$

$k_{3\omega,i}$

23°

Bisecting line

**Thomson-scattering spectrum**



Wavelength (nm)

$n_c/6$

380

400

420

$n_c/4$

440

0.0    0.5    1.0    1.5    2.0

**Time (ns)**

$P_s$ (normalized units)

1.0

0.5

0.0

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

UNIVERSITY of ROCHESTER

**Summary**

# Two-plasmon–decay driven common electron plasma waves were observed using UV Thomson scattering

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- A narrow spectral feature is observed when scattering from electron plasma waves driven by multibeam two-plasmon decay

- The observed scattered wavelength and density satisfy the dispersion relations and two-plasmon–decay maximum-growth hyperbola

- The amplitudes of driven common electron plasma waves scale with overlapped intensity

E22591

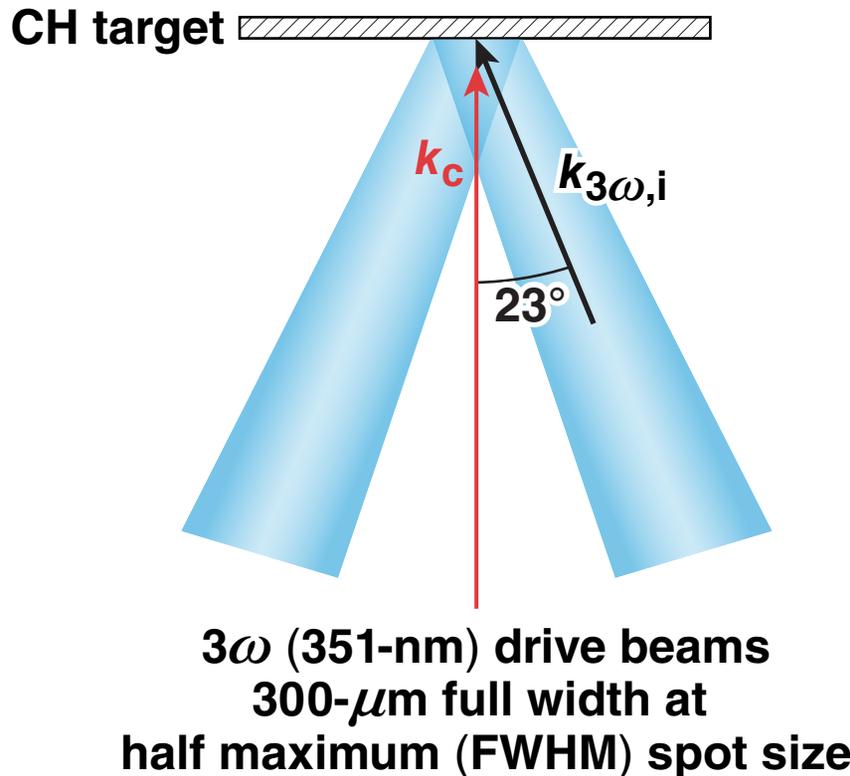UNIVERSITY of ROCHESTER

# Collaborators

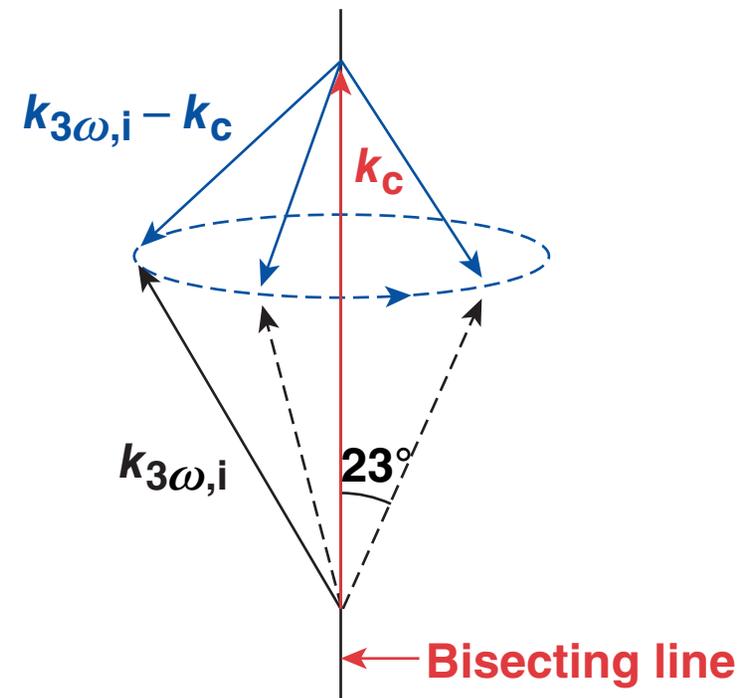**D. H. Edgell, R. Henchen, S. X. Hu, D. T. Michel, J. F. Myatt, and D. H. Froula**

**University of Rochester
Laboratory for Laser Energetics**

# The amplitude of two-plasmon–decay multibeam driven electron plasma waves was observed while varying the number of drive beams
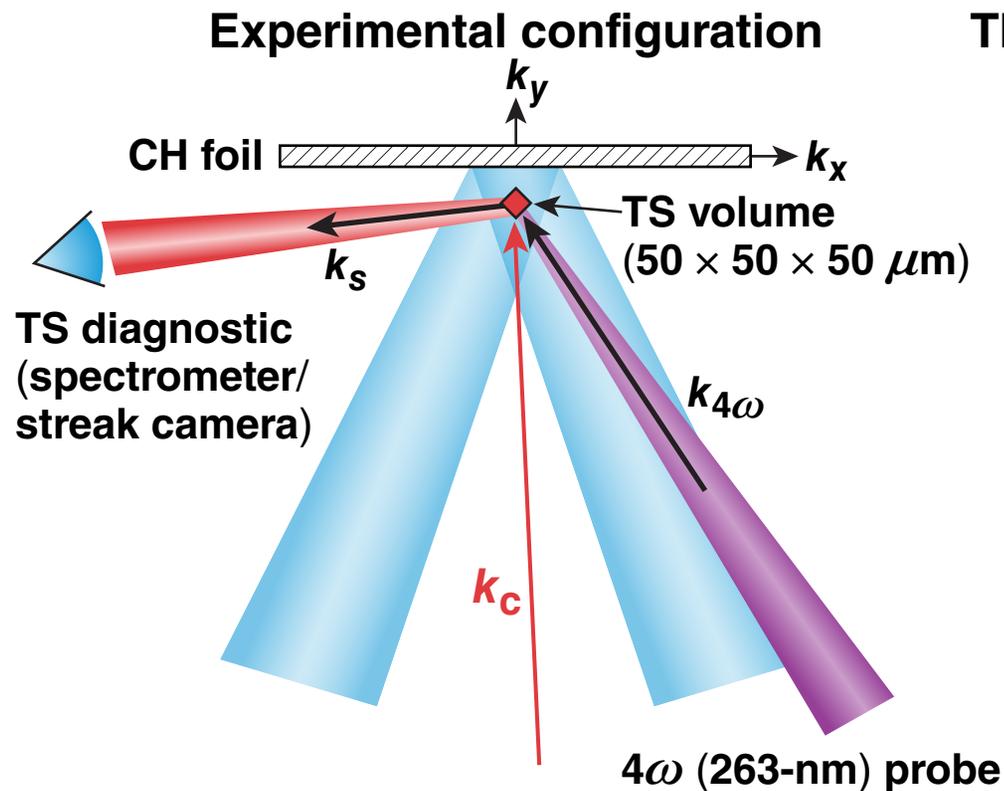
**Drive (two- to five-beam) configuration**
$$I_{overlap} = 5 \times 10^{14} \text{ W/cm}^2$$

**CH target**
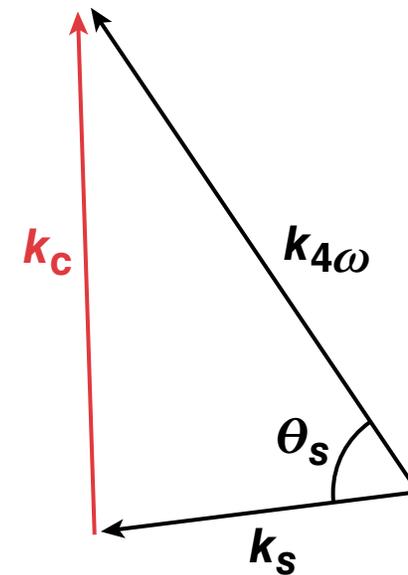
$k_c$  $k_{3\omega,i}$

**23°**

**3$\omega$ (351-nm) drive beams
300-$\mu$m full width at
half maximum (FWHM) spot size**

**Multibeam
common-wave region**

$k_{3\omega,i} - k_c$  $k_c$

$k_{3\omega,i}$  **23°**

**Bisecting line**

E22592

# Thomson scattering is used to probe the two-plasmon–decay driven common electron plasma wave (EPW) *k* vector

**Experimental configuration**

CH foil

$k_y$

$k_x$

TS volume
$(50 \times 50 \times 50 \ \mu m)$

$k_s$

TS diagnostic
(spectrometer/
streak camera)

$k_{4\omega}$

$k_c$

$4\omega$ (263-nm) probe

**Thomson scattering (TS) *k* matching**

$k_c$

$k_{4\omega}$

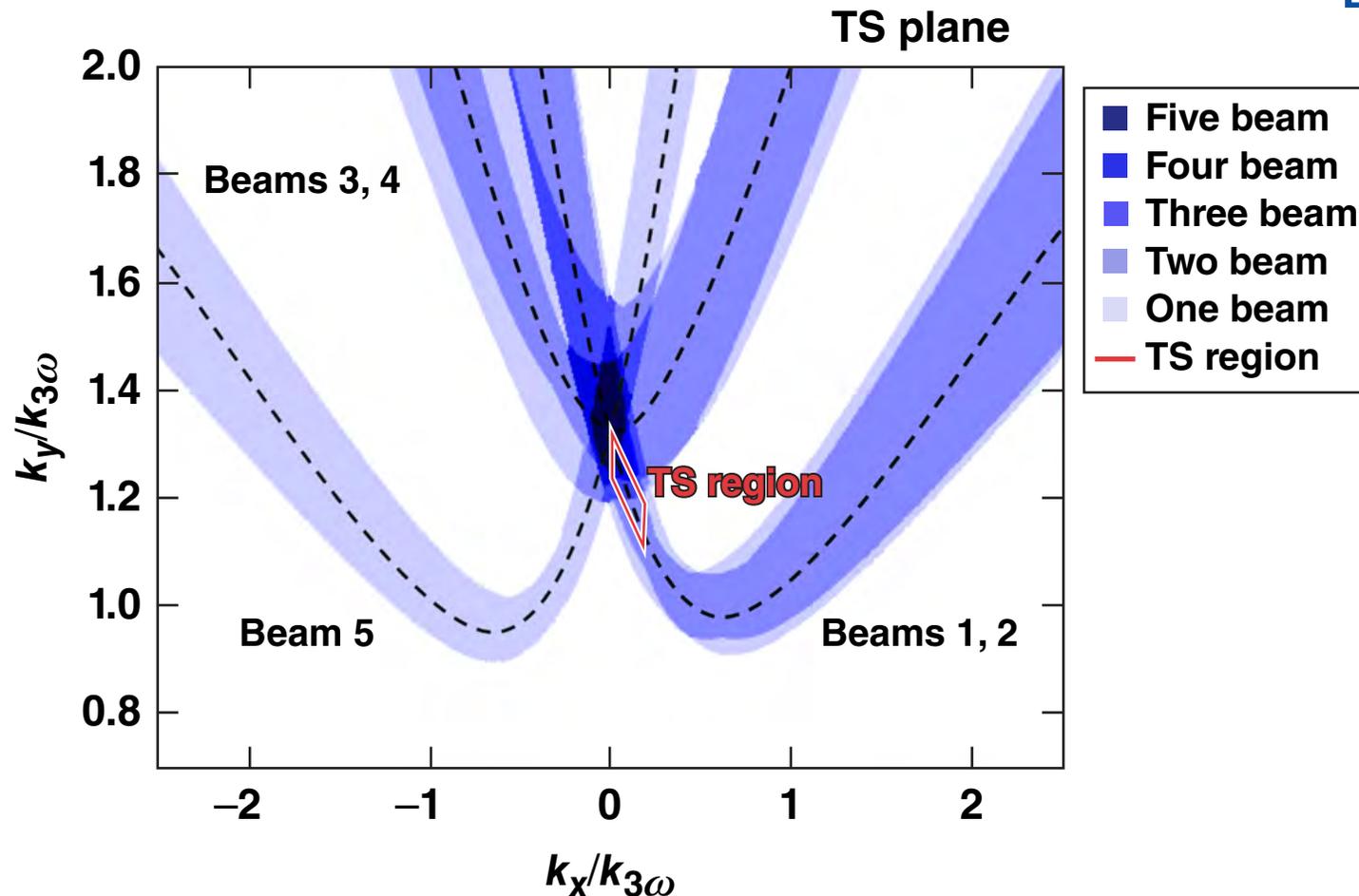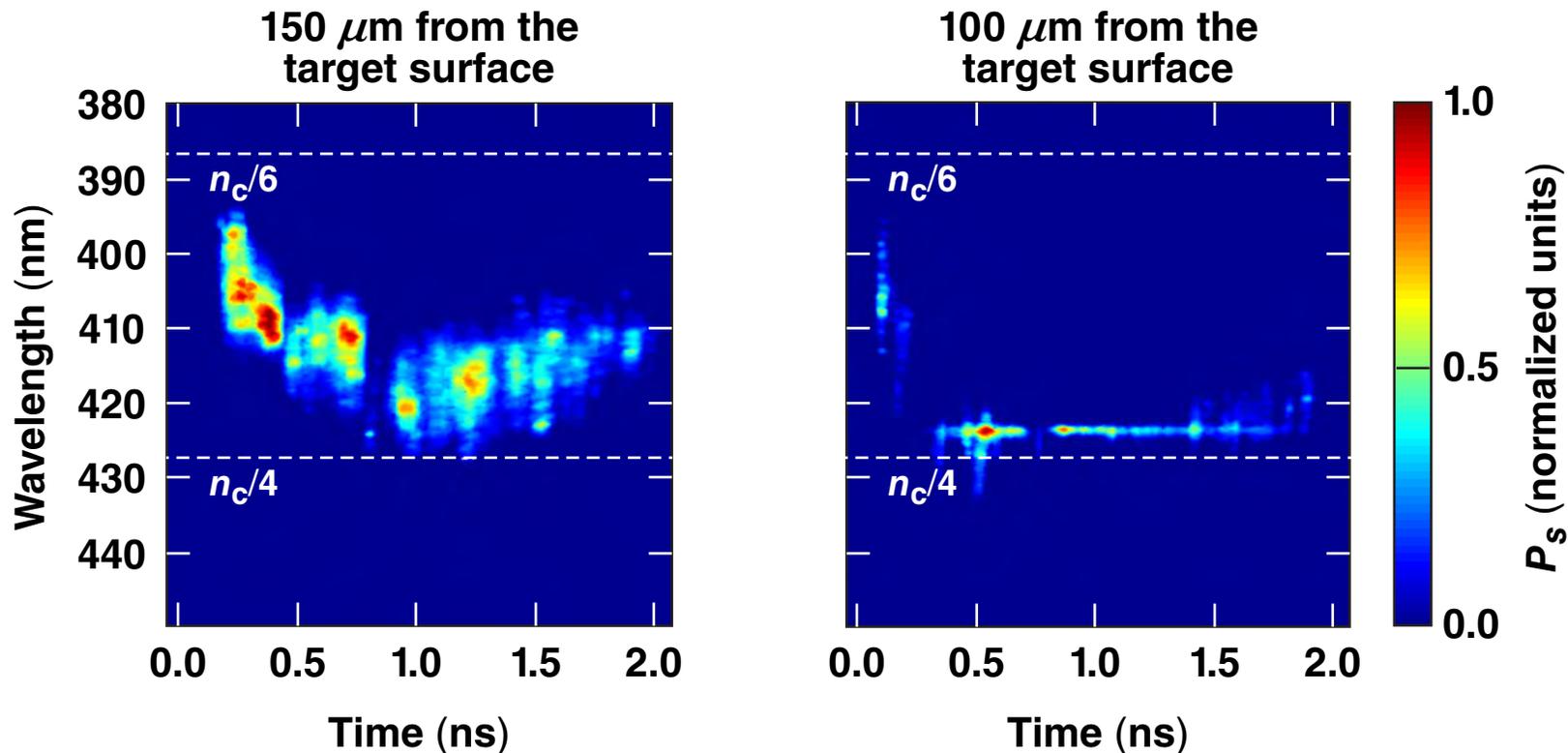$\theta_s$

$k_s$

**Two-plasmon–decay driven electron plasma waves are observed when the probed *k* vector is matched to a driven wave.**

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# The two-plasmon–decay maximum-growth hyperbola for all five drive beams intersects the Thomson-scattering plane

TS plane

Beams 3, 4

Beam 5

Beams 1, 2

TS region

$k_y/k_{3\omega}$

$k_x/k_{3\omega}$

- Five beam
- Four beam
- Three beam
- Two beam
- One beam
- — TS region

**The region of *k* space probed by Thomson scattering overlaps the five-beam common-wave region.**

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# Narrow electron plasma wave features driven by two-plasmon decay are observed when the scattering volume includes quarter-critical densities

150 $\mu$m from the target surface

100 $\mu$m from the target surface

$n_c/6$

$n_c/4$

Wavelength (nm)

Time (ns)

$P_s$ (normalized units)

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# The width of the thermal electron plasma wave feature is determined primarily by the range of densities visible in the finite Thomson-scattering volume
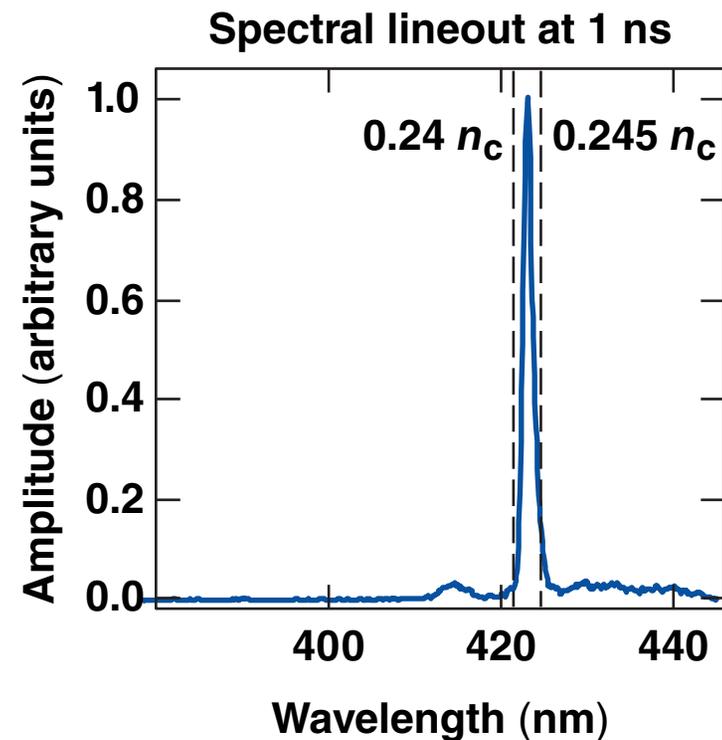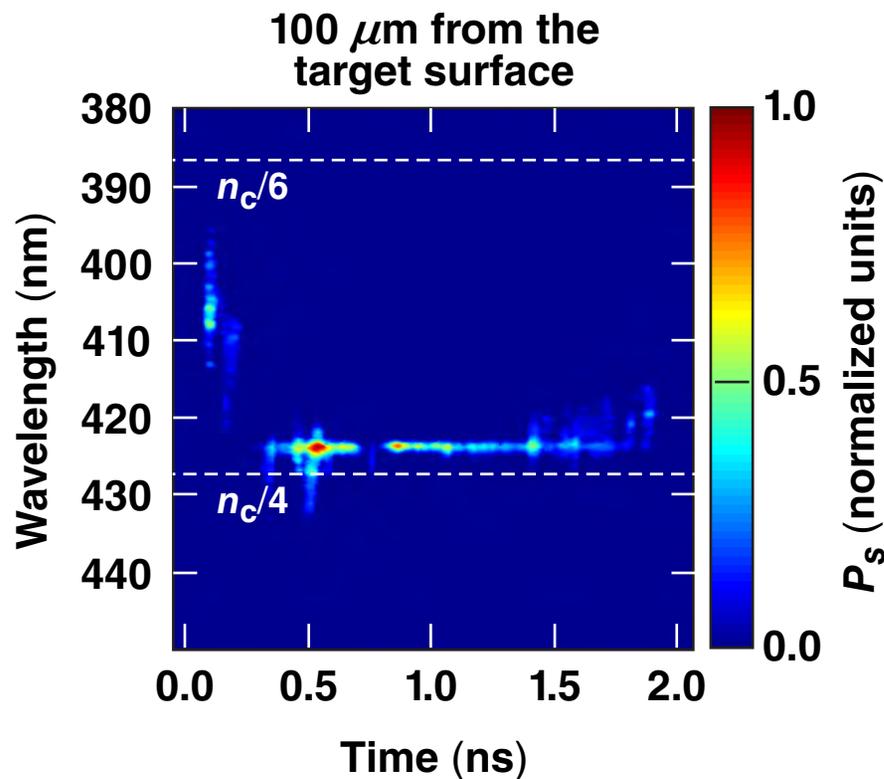
$$\omega_s = \omega_{4\omega} - \omega_{EPW}(n_e, k_{EPW})$$



150 $\mu$m from the target surface
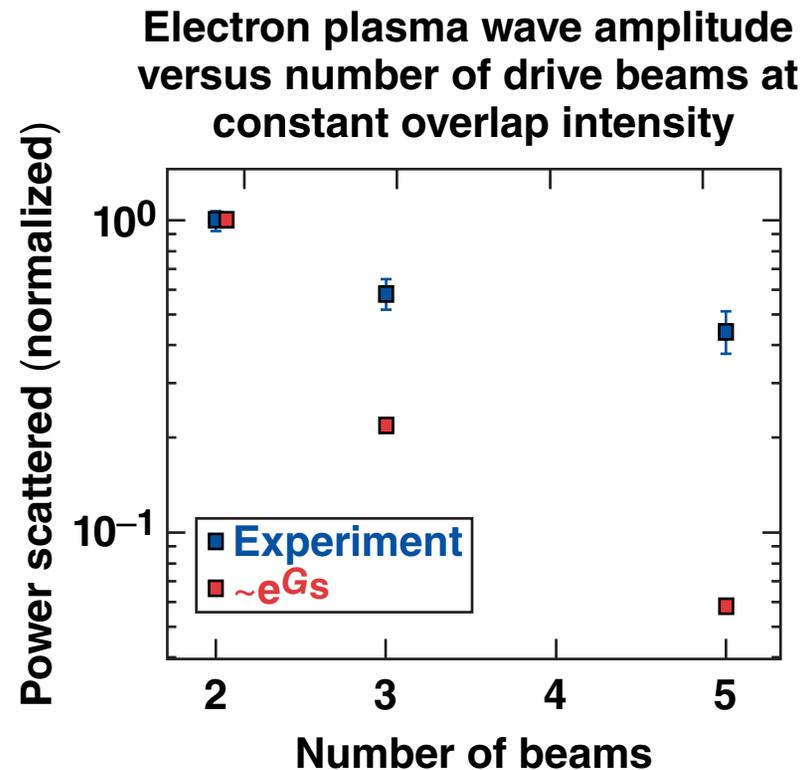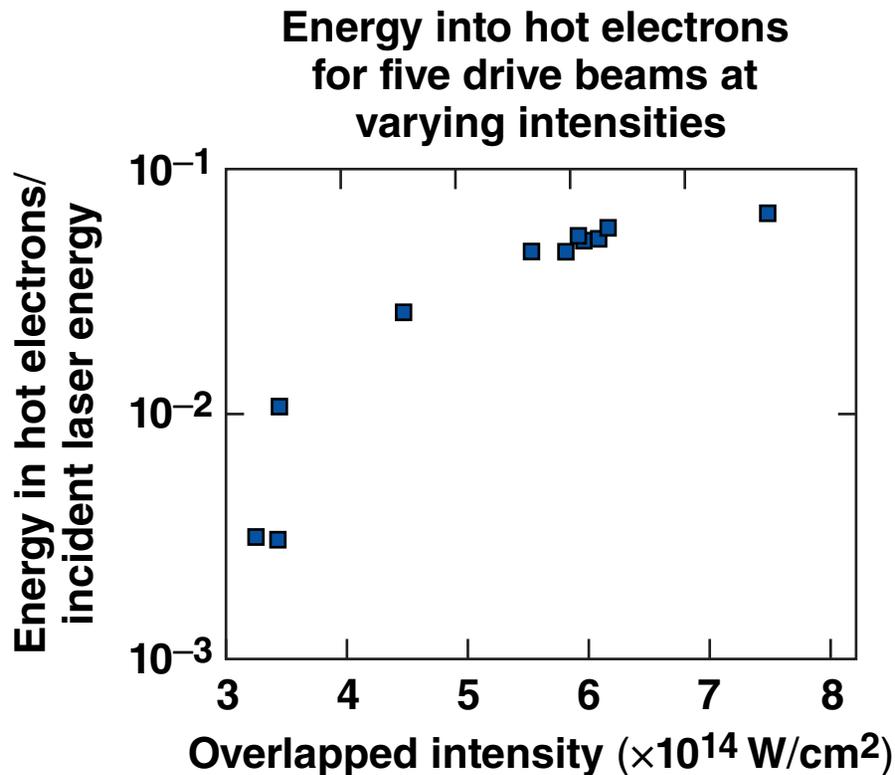
Spectral lineout at 1 ns
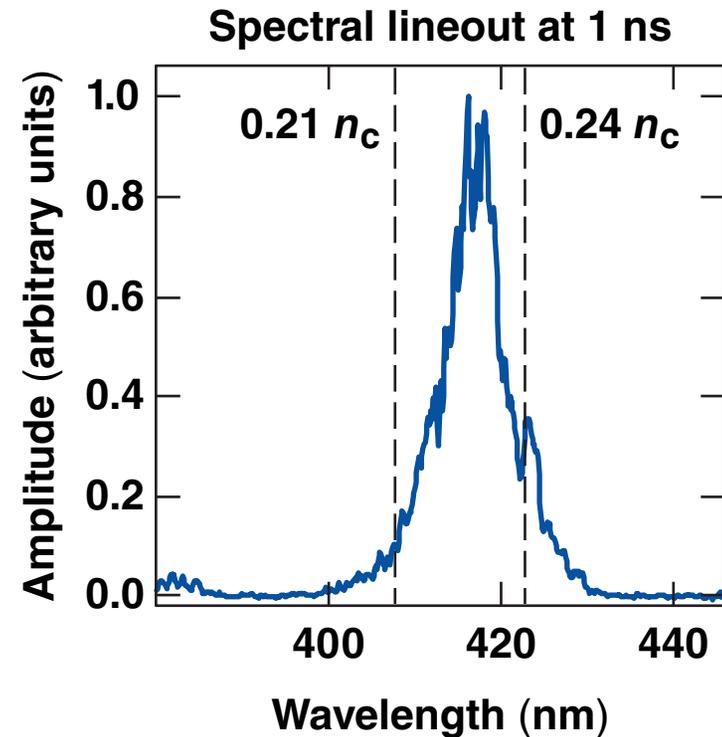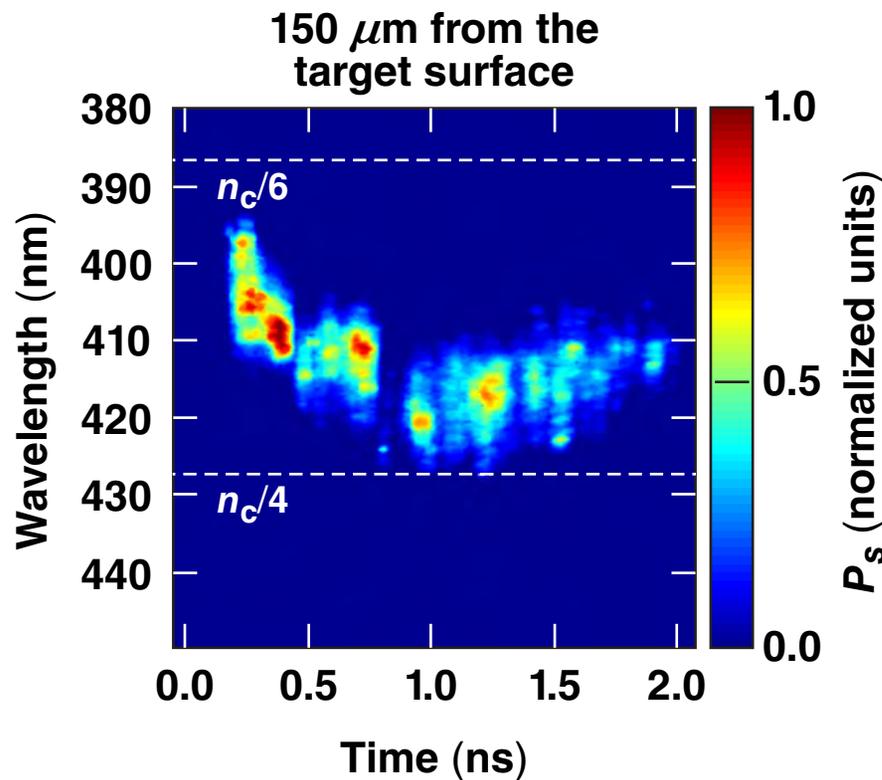
# The dispersion relations and TPD maximum-growth hyperbola are satisfied for only a small range of densities, resulting in a thin scattering feature

$$n_e \approx n_c/4 \left[1 - \frac{T_e(\text{keV})}{113}(2k^2 - 2k + 1)\right]$$

$$\omega_s = \omega_{4\omega} - \omega_{\text{EPW}}(k)$$



100 $\mu$m from the target surface

Spectral lineout at 1 ns

E22175g

# The power scattered from two-plasmon–decay driven common electron plasma waves scales with overlap intensity

**Energy into hot electrons for five drive beams at varying intensities**

**Electron plasma wave amplitude versus number of drive beams at constant overlap intensity**

The exponential scaling observed with varying overlap intensities implies that two-plasmon–decay driven electron plasma wave amplitudes are a function of overlap intensity.

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# A relatively broad scattering spectrum is observed when the Thomson diagnostic probes an electron plasma wave *k* vector off of the common-wave *k* vector

**Oblique TS**

**Oblique TS spectrum**
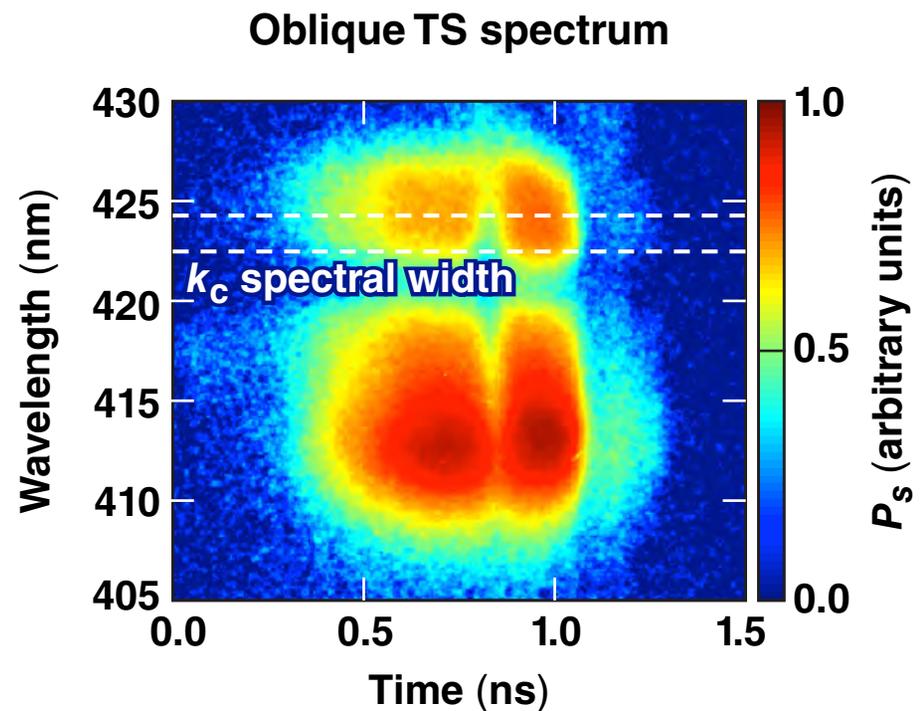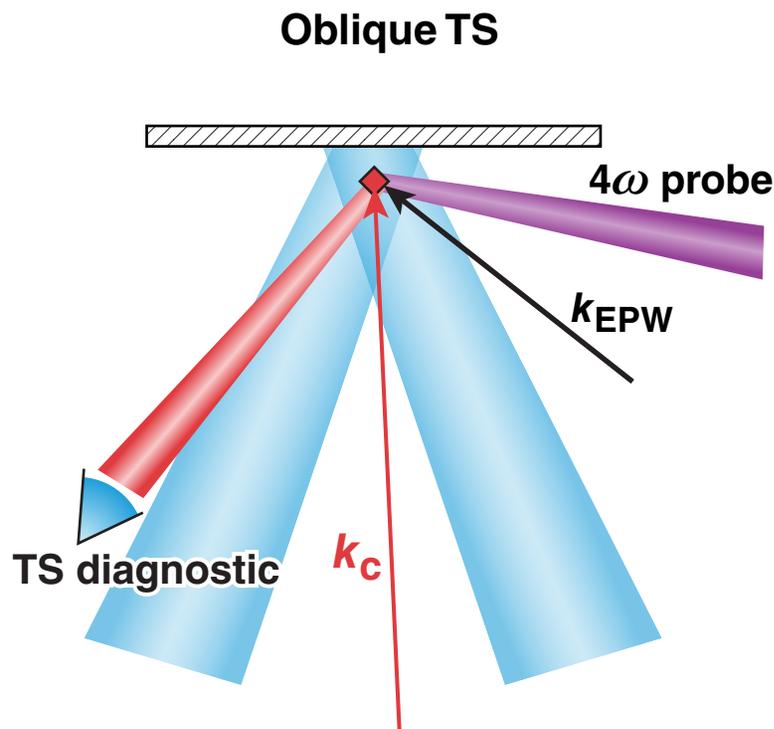


The broad feature is consistent with nonlinear two-plasmon–decay simulations and propagation of driven electron plasma waves.*

―――――
*J. F. Myatt, FR1.00001; W. Seka *et al.*, BO4.00004; R. W. Short *et al*, BO4.00009, this conference.

**Summary/Conclusions**

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