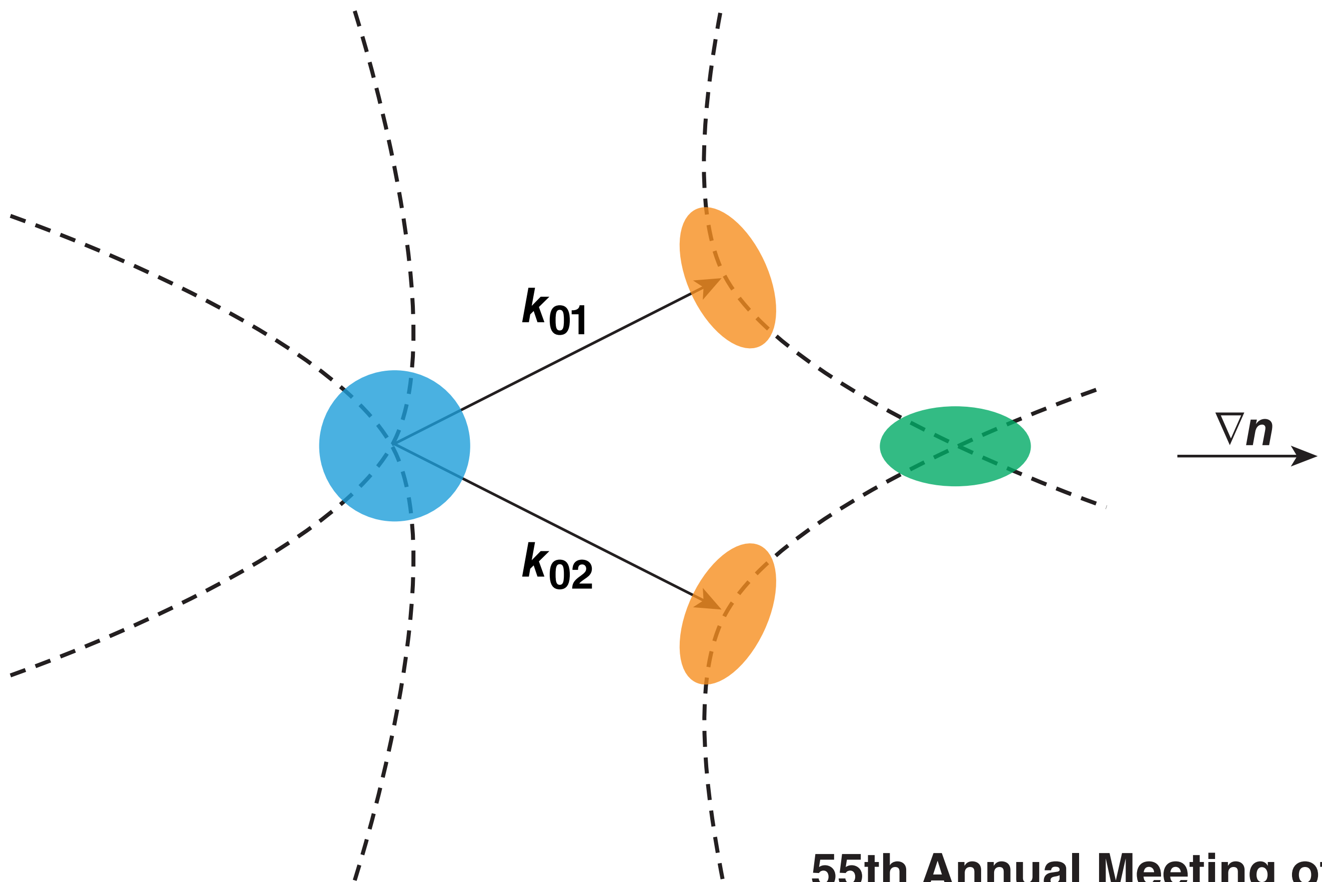
The Effects of Beam Geometry and Polarization on Two-Plasmon Decay Driven by Multiple Laser Beams



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55th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Denver, CO
11–15 November 2013

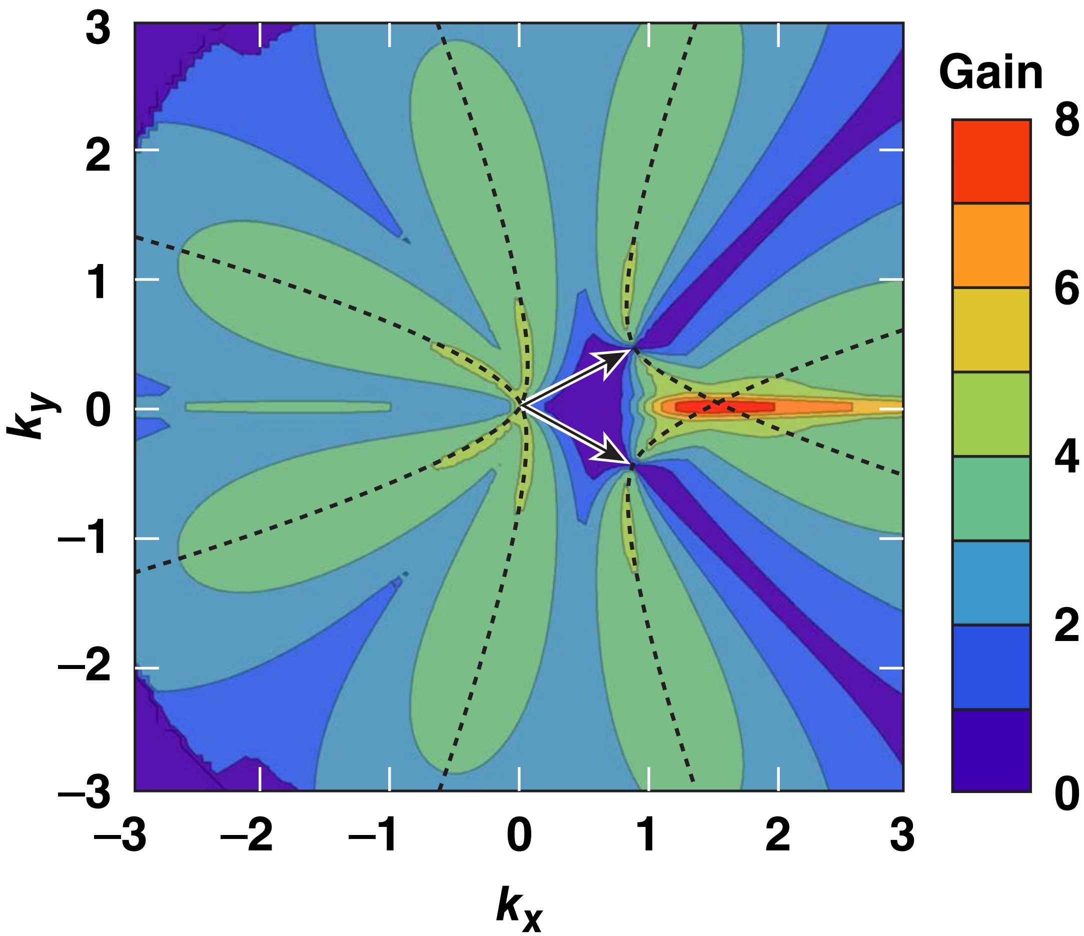
Summary

The two-plasmon–decay (TPD) threshold is sensitive to the number, orientation, and polarization of the beams

- For two beams polarized out of their common plane, a collective absolute mode near $k = 0$ dominates TPD
- For two beams polarized in their common plane there are two absolute TPD modes; the dominant one depends on angle of incidence
- The thresholds of multibeam absolute modes decrease with larger incidence angles and increased polarization components in the plane of the common wave

The absolute instability usually dominates for multibeam TPD.

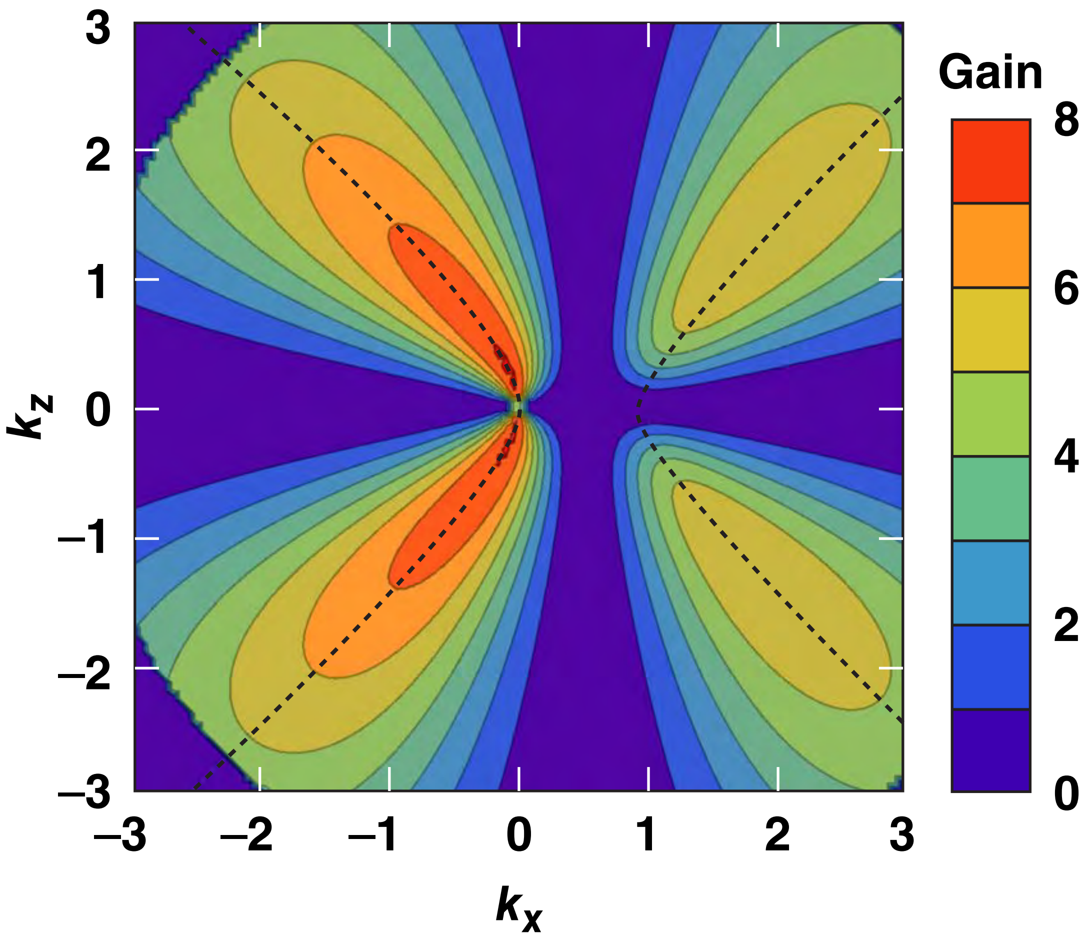
For two beams polarized in a common plane, we see the expected gain enhancement at the intersection of the hyperbolas



I_{14} (single beam) = 1.0
L_μ = 300
T_{keV} = 1.5

TC10086a

When both beams are polarized out of their common plane, enhanced gain is seen near the origin



I_{14} (single beam) = 1.0
L_μ = 300
T_{keV} = 1.5

TC10090c

The origin in *k* space corresponds to the plasma wave turning point, allowing TPD to be absolute there

- In general, instabilities can be convective only in inhomogeneous plasmas*
- Near the turning point, however, $k \rightarrow 0$ group velocities and convection decrease and there is a finite threshold for absolute instability**
- Enhanced multibeam convective gain near the origin in *k* space suggests the potential for absolute instability there

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*M. N. Rosenbluth, Phys. Rev. Lett. 29, 565 (1972).
**C. S. Liu, M. N. Rosenbluth, and R. B. White, Phys. Rev. Lett. 31, 697 (1973); A. Simon *et al*., Phys. Fluids 26, 3107 (1983).

For a single beam, the absolute TPD threshold* is lower than the Rosenbluth convective threshold

- The Simon threshold (adjusted for *s*-polarized oblique incidence) is

$$\eta \equiv \frac{I_{14} L_{\mu}}{233\, T_{\text{keV}} \cos\theta} > 1$$

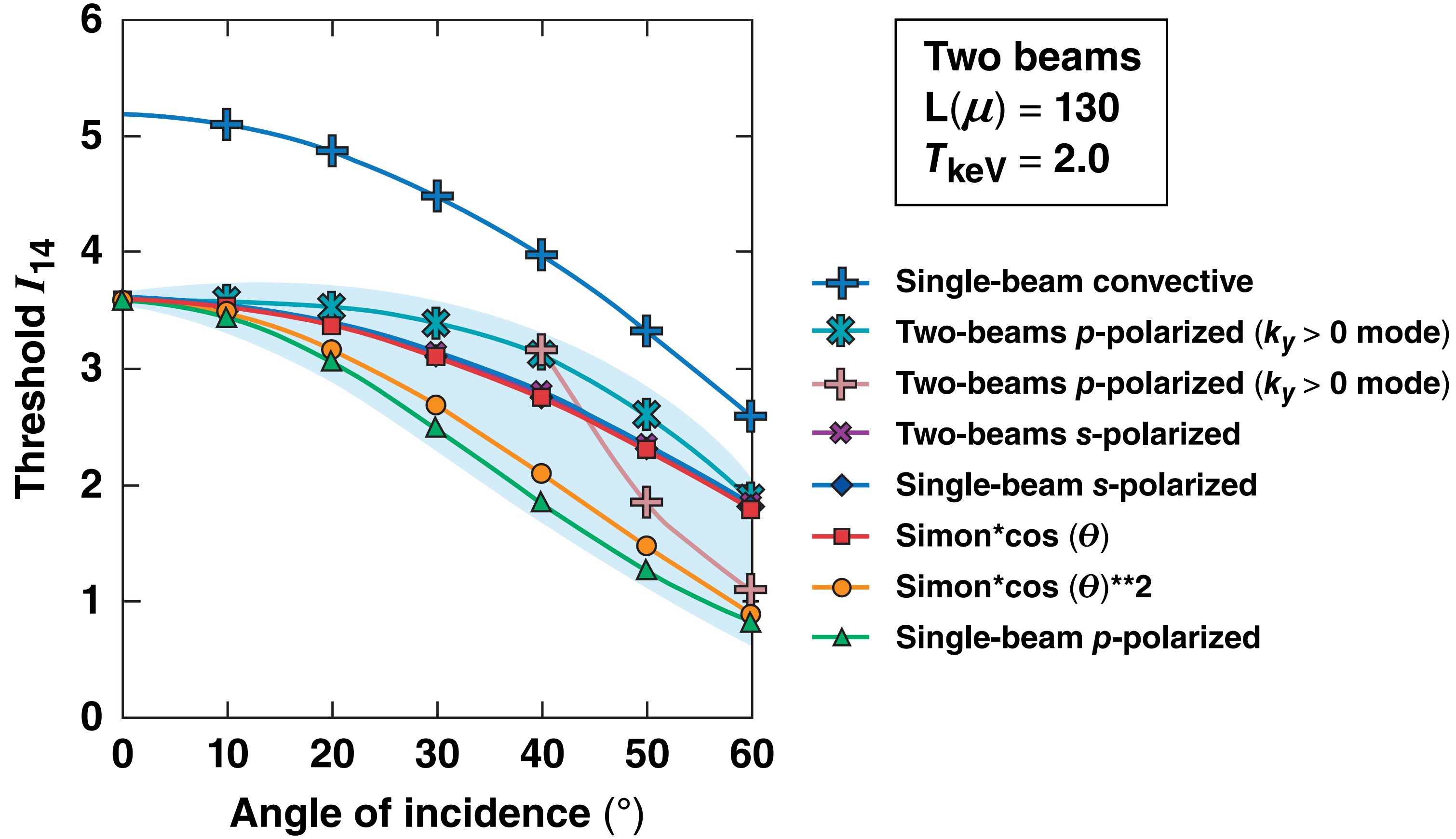
- The Rosenbluth convective gain is $G_{\text{R}} = \dfrac{2\pi\gamma_0^2}{\kappa' V_1 V_2} = \dfrac{I_{14} L_{\mu}}{53.6\, T_{\text{keV}} \cos\theta} \cong 4.35\,\eta$

- The nominal convective threshold is $G_{\text{R}} > 2\pi$ or $\eta > 1.44$

- Therefore, the absolute instability appears below the convective instability threshold; this, in general, remains true for multiple beams

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

The absolute threshold for TPD depends on the angle of incidence and polarization



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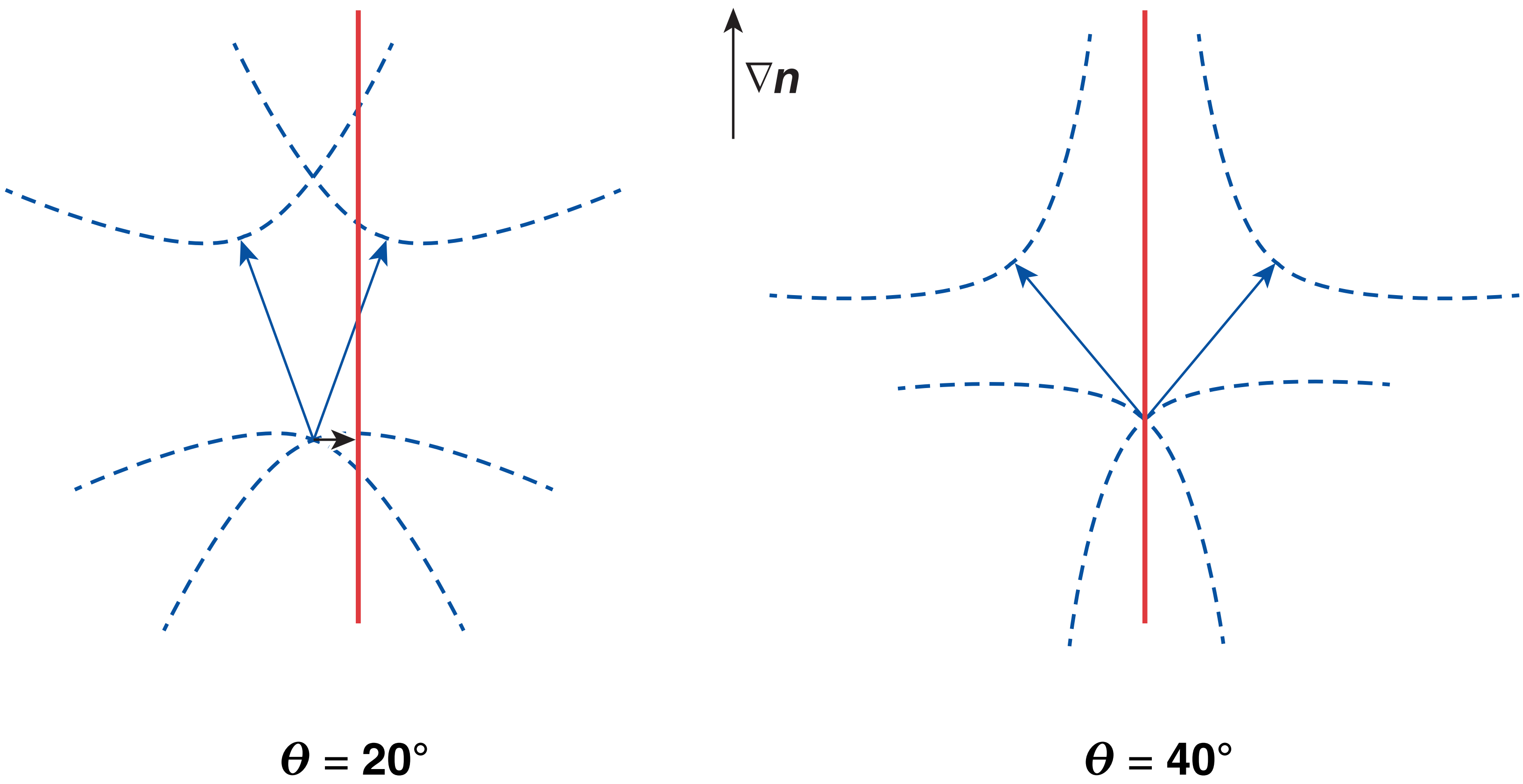
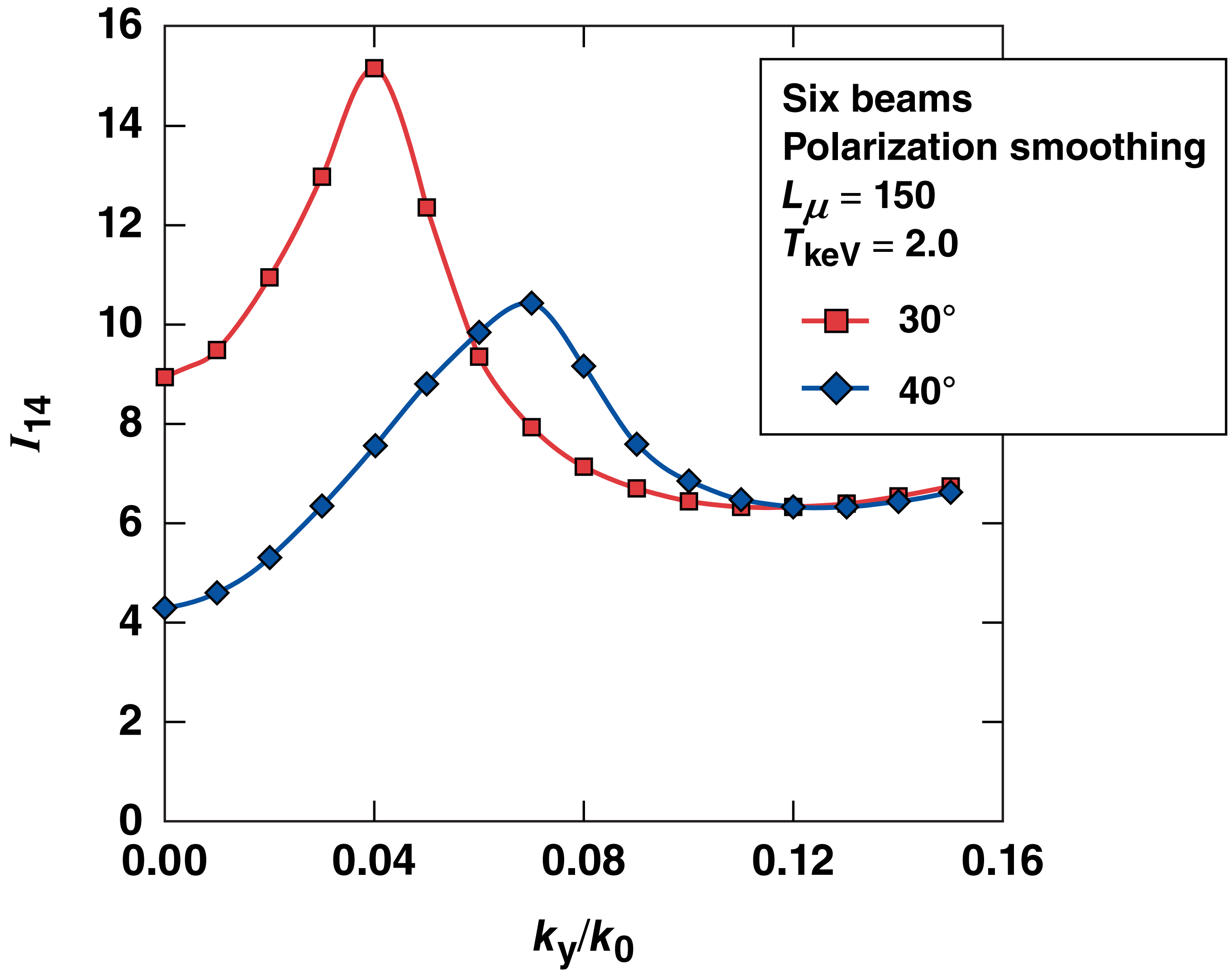
At larger angles, the on-axis mode is closer to the hyperbolas than the off-axis modes



With more beams, the absolute TPD threshold for the on-axis mode is quite sensitive to the cone angle



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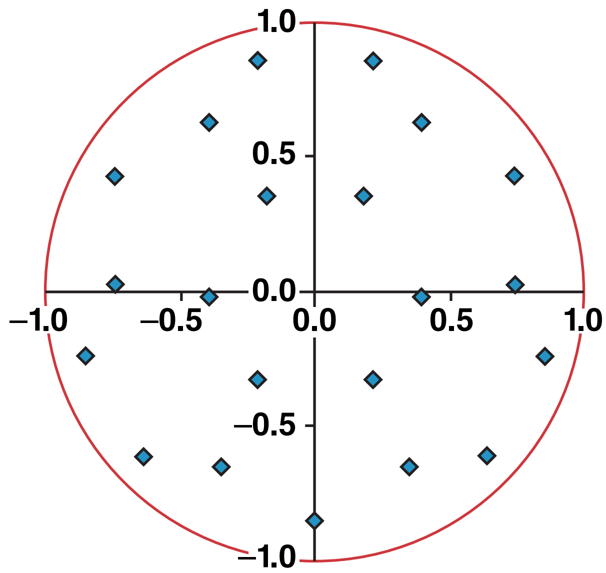
In multibeam irradiation geometries the large-angle beams make a significant contribution



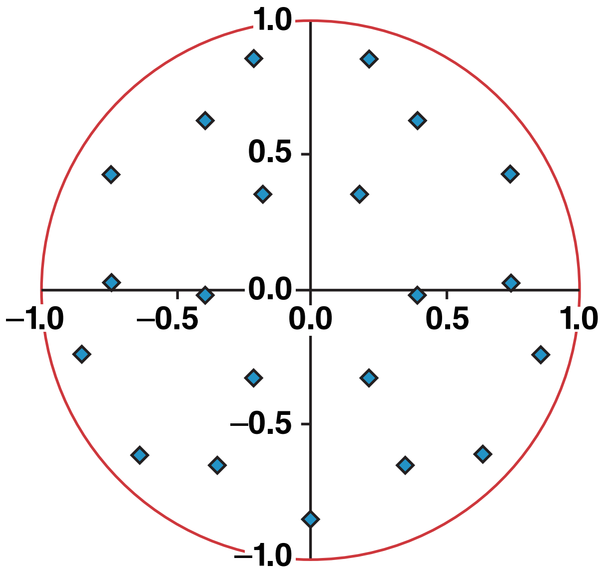
OMEGA beam configuration

$L_\mu = 150$
$T_{keV} = 2.0$
I_{14} (single beam) = 1.35

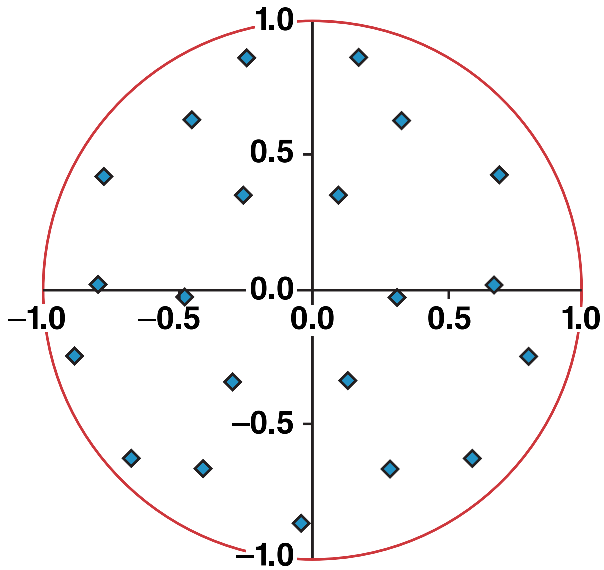
- For the "hex" location, the single-beam threshold for 21 beams with polarization smoothing is $I_{14} = 1.24$; without the outermost nine beams it rises to 1.76
- This is true even though (as a result of inverse bremsstrahlung, CBET, refraction, and beam profile) only ~6% of the nominal intensity in these outer beams reaches quarter-critical

TC11027

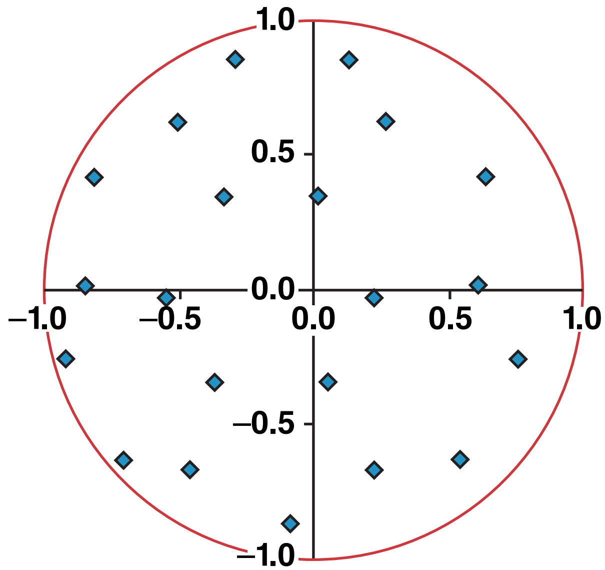
In multibeam irradiation geometries the threshold is quite sensitive to location



0°
I_{th} = 1.24



5°
I_{th} = 1.18



10°
I_{th} = 1.63

OMEGA beam configuration

L_{μ} = 150
T_{keV} = 2.0
I_{14} (single beam) = 1.35

TC11028

*W. Seka *et al*., BO4.00004, this conference.

Thresholds are lowest near points with symmetric irradiation

- At "hex" points, the single-beam threshold with polarization smoothing and L_{μ} = 150, T_{keV} = 2.0, is I_{14} = 1.24, so 1.35 is well above threshold
- For a "pent" point it rises to 1.37, marginally at threshold
- For general points the threshold is ~2, so such points should be below the absolute threshold

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