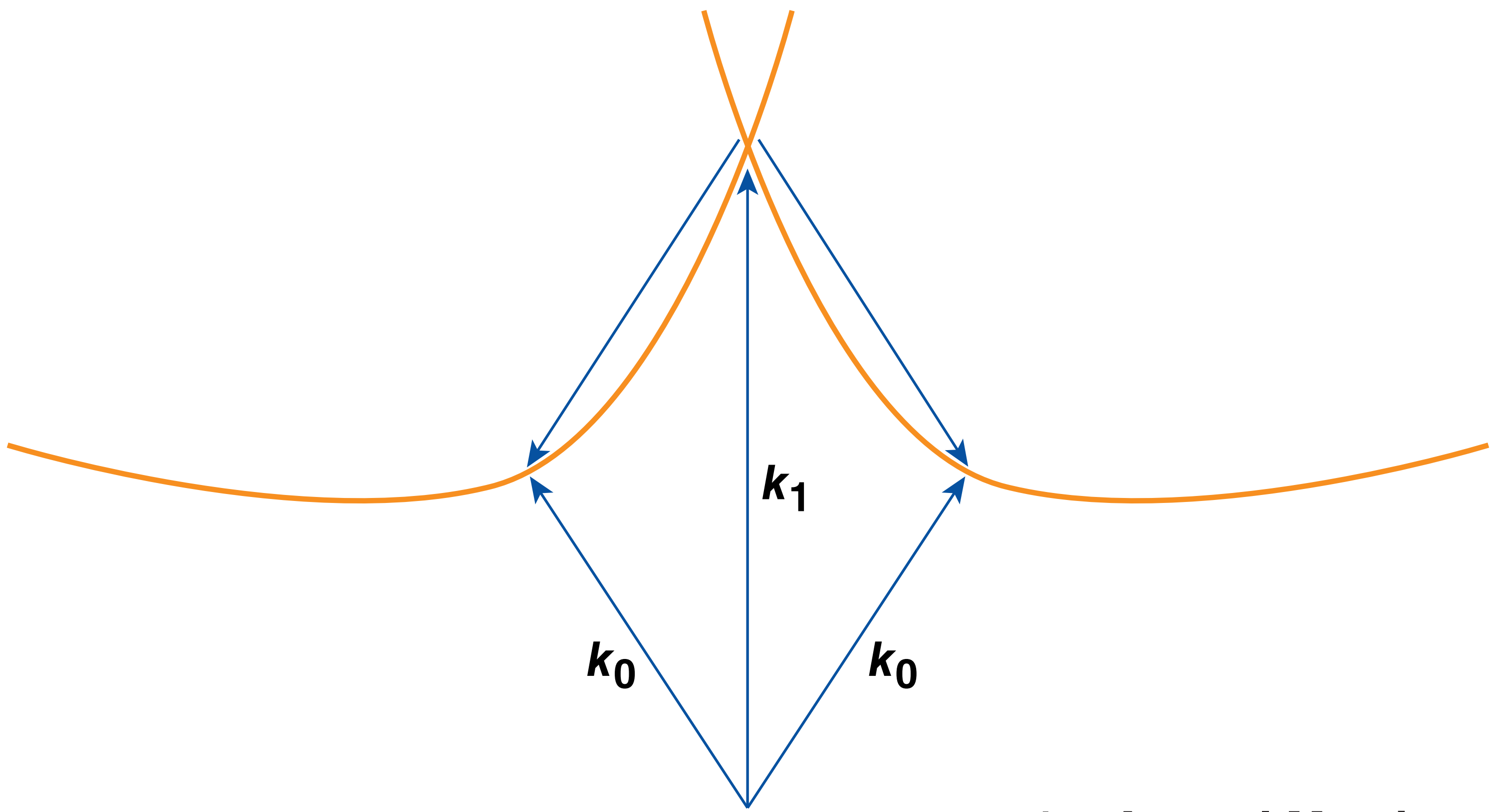
Anisotropy and Angular Dependence of Two-Plasmon Decay Driven by Multiple Overlapping Laser Beams in Direct-Drive Geometry



R. W. Short
University of Rochester
Laboratory for Laser Energetics

51st Annual Meeting of the
American Physical Society
Division of Plasma Physics
Atlanta, GA
2–6 November 2009

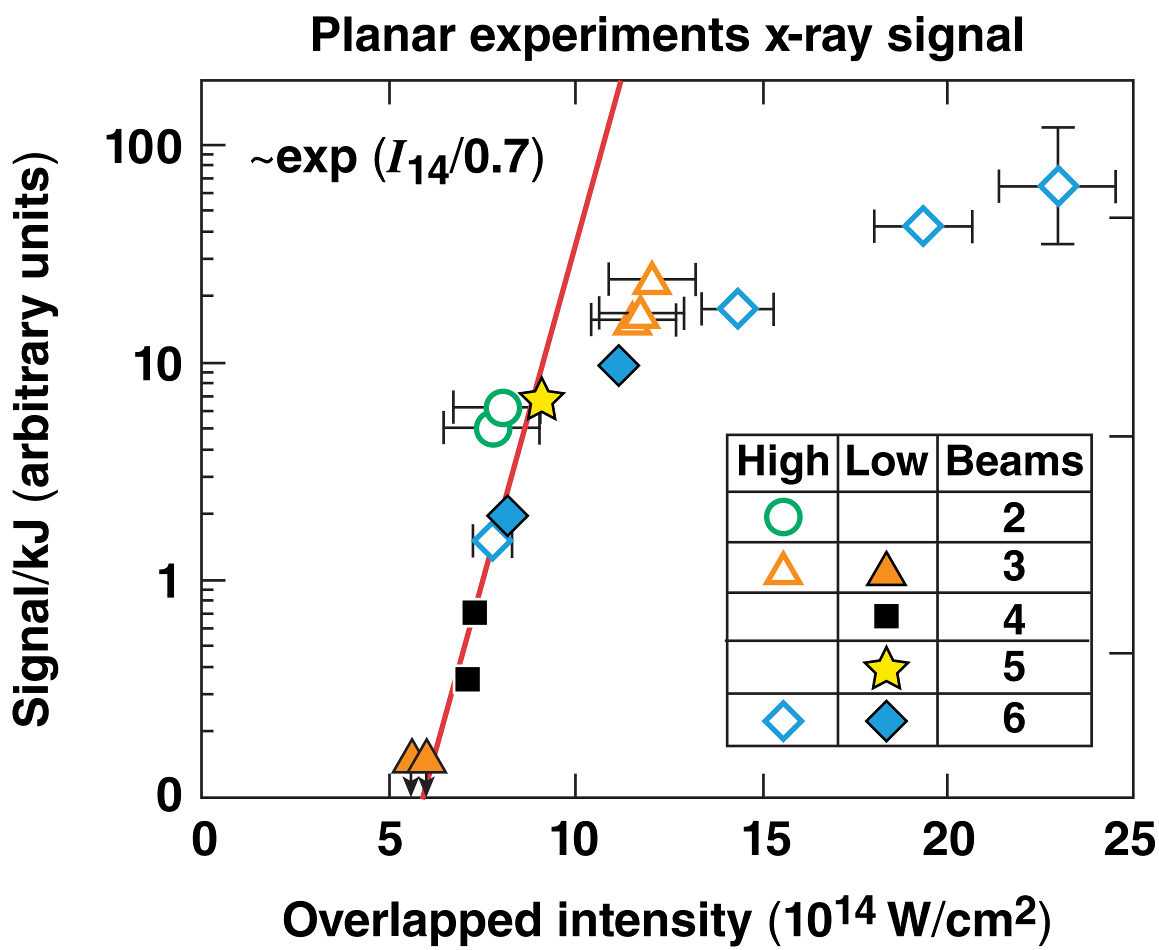
Summary

Collectively driven TPD growth diminishes away from the beam symmetry axis, but increases with angle from the density gradient

UR LLE

- Experiments on OMEGA have shown that TPD is driven by the collective intensity of several overlapping laser beams.
- A group of beams can drive a common central plasma wave and a group of secondary waves.
- The common wave is the most strongly driven and is expected to produce most of the hot electrons.
- The angular distribution of this wave will determine the anisotropy of the hot electrons produced and, therefore, their preheating efficiency.
- TPD is strongly suppressed when this wave deviates from the beam symmetry axis, but may be enhanced when the symmetry axis diverges from the density gradient.

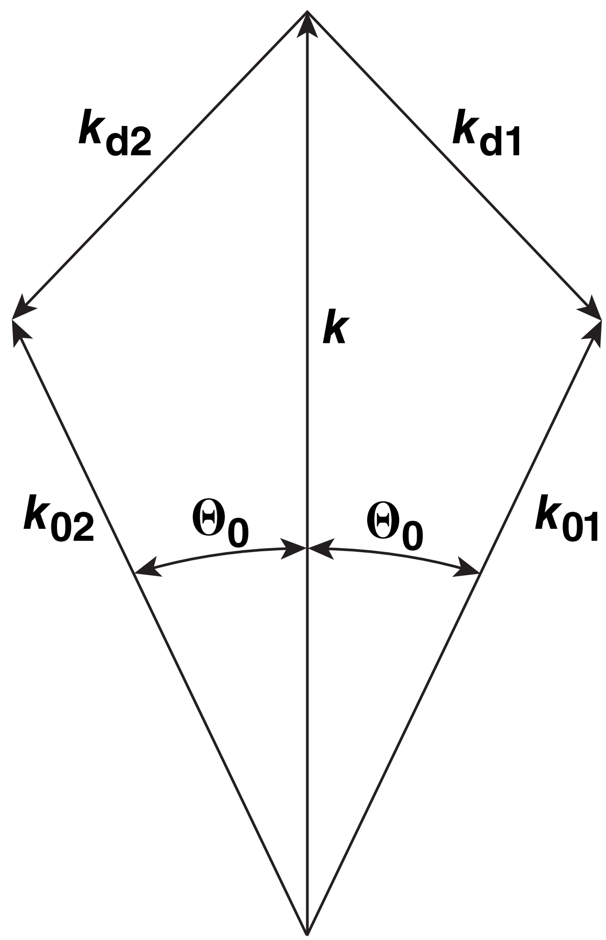
TPD is observed to depend on the overlapped intensity for multiple-beam experiments



C. Stoeckl *et al.*, Phys. Rev. Lett. 90, 235002 (2003).

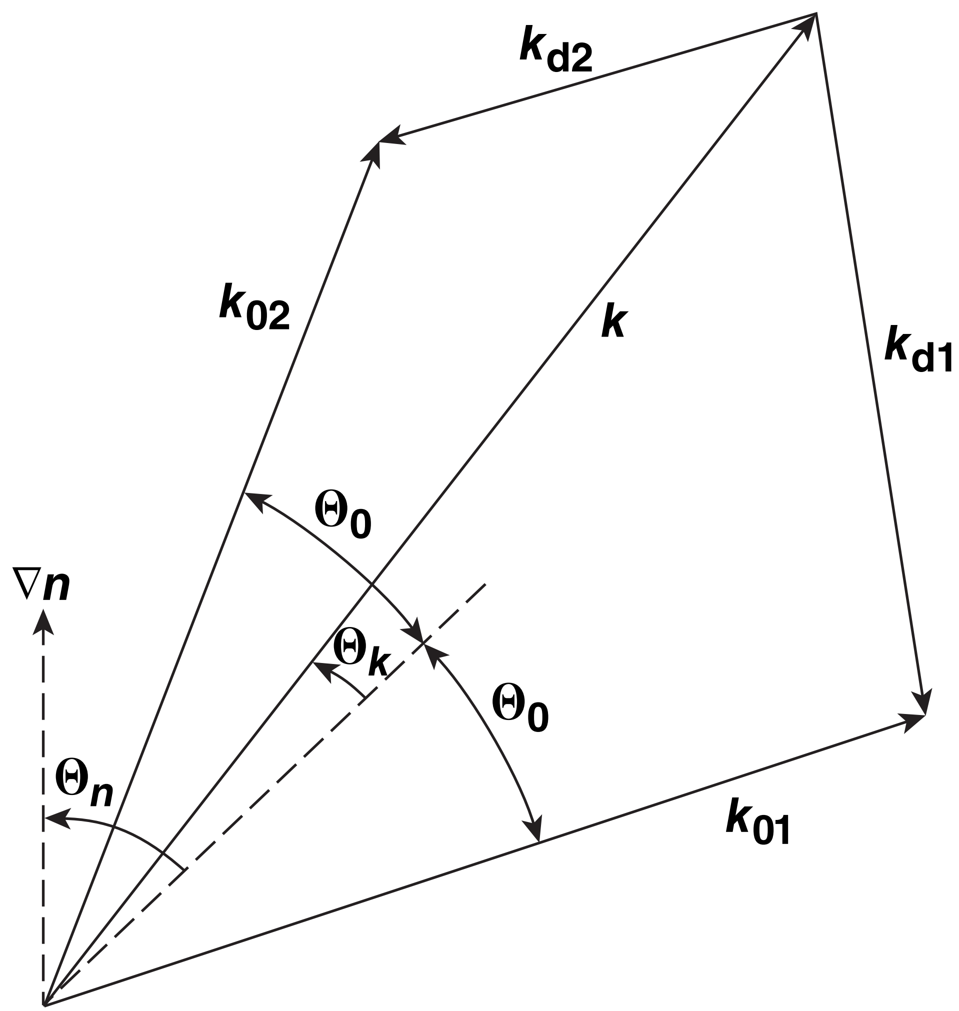
The anisotropy of multibeam TPD interaction can be studied using two beams

- Each pump wave drives a common plasma wave and a satellite; the common wave is of greatest interest.



TC8466

The common plasma wave can deviate from the centroid of the beams or from the density gradient



TC8467

Fourier analysis of the time-dependent TPD equations results in a set of first-order linear equations that can be integrated numerically

UR LLE

$$\frac{du}{dk_x} = e^{\frac{3i\upsilon_e^2 k_0 L}{\omega_p^2}\left\{\cos(\theta_0+\theta_n)(k_x-k_{rx})^2 + 2k_r\left[\cos(\theta_0+\theta_k)-\cos\theta_0\right](k_x-k_{rx})\right\}} \frac{\left(\frac{k^2-k_{d1}^2}{kk_{d1}}\right)L}{\omega_p} \left|\upsilon_{01}\right| \left(\hat{\varepsilon}_1 \cdot k\right) u_{d1}$$

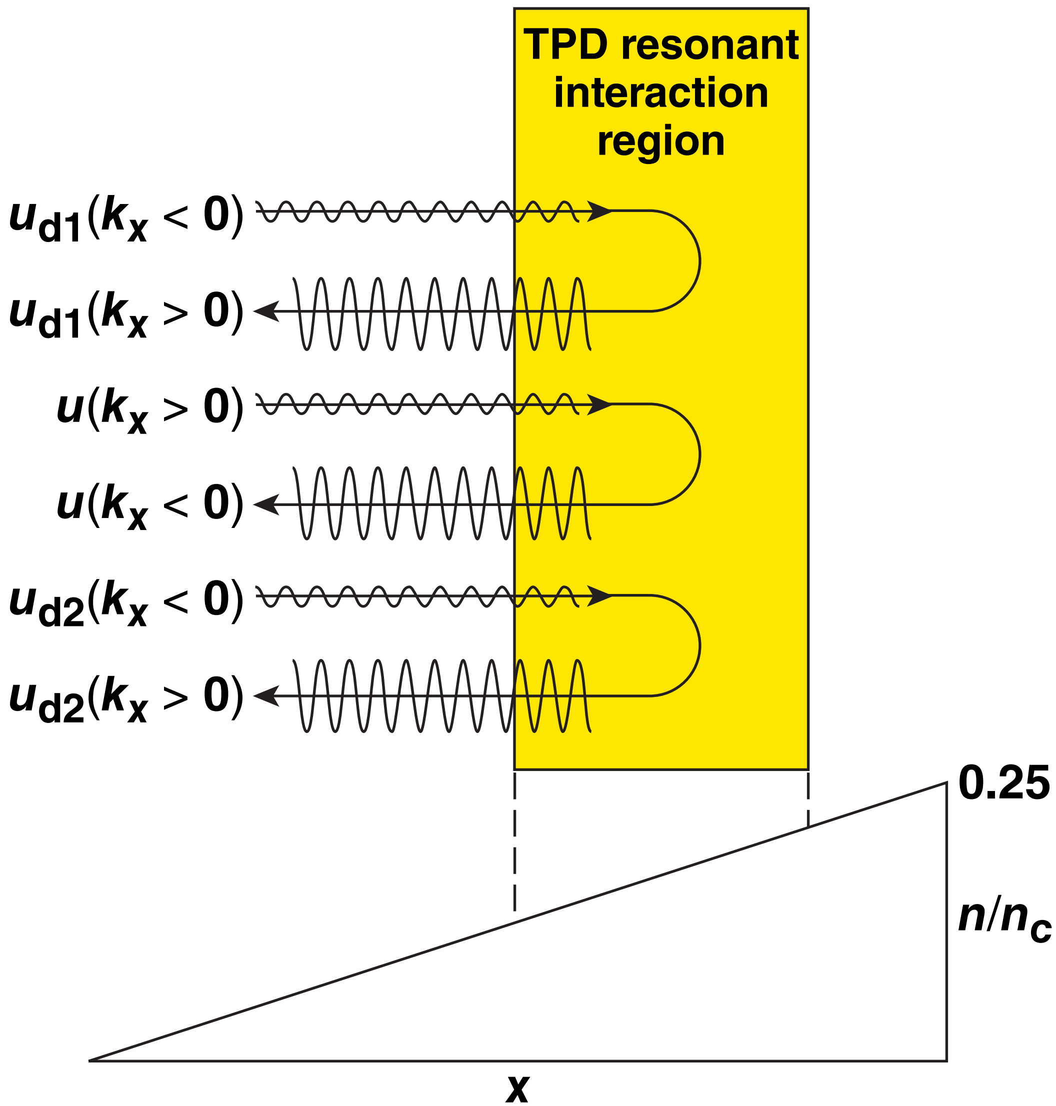
$$+ e^{\frac{3i\upsilon_e^2 k_0 L}{\omega_p^2}\left\{\cos(\theta_0-\theta_n)(k_x-k_{rx})^2 + 2k_r\left[\cos(\theta_0-\theta_k)-\cos\theta_0\right](k_x-k_{rx})\right\}} \frac{\left(\frac{k^2-k_{d2}^2}{kk_{d2}}\right)L}{\omega_p} \left|\upsilon_{02}\right| \left(\hat{\varepsilon}_1 \cdot k\right) u_{d2}$$

$$\frac{du_{d1}}{dk_x} = -e^{-\frac{3i\upsilon_e^2 k_0 L}{\omega_p^2}\left\{\cos(\theta_0+\theta_n)(k_x-k_{rx})^2 + 2k_r\left[\cos(\theta_0+\theta_k)-\cos\theta_0\right](k_x-k_{rx})\right\}} \frac{\left(\frac{k^2-k_{d1}^2}{kk_{d1}}\right)L}{\omega_p} \left|\upsilon_{01}\right| \left(\hat{\varepsilon}_1 \cdot k\right) u$$

$$\frac{du_{d2}}{dk_x} = -e^{-\frac{3i\upsilon_e^2 k_0 L}{\omega_p^2}\left\{\cos(\theta_0-\theta_n)(k_x-k_{rx})^2 + 2k_r\left[\cos(\theta_0-\theta_k)-\cos\theta_0\right](k_x-k_{rx})\right\}} \frac{\left(\frac{k^2-k_{d2}^2}{kk_{d2}}\right)L}{\omega_p} \left|\upsilon_{02}\right| \left(\hat{\varepsilon}_2 \cdot k\right) u$$

TC8468a

Spatial growth can be obtained by numerical integration of the Fourier-transformed equations



TC8470a

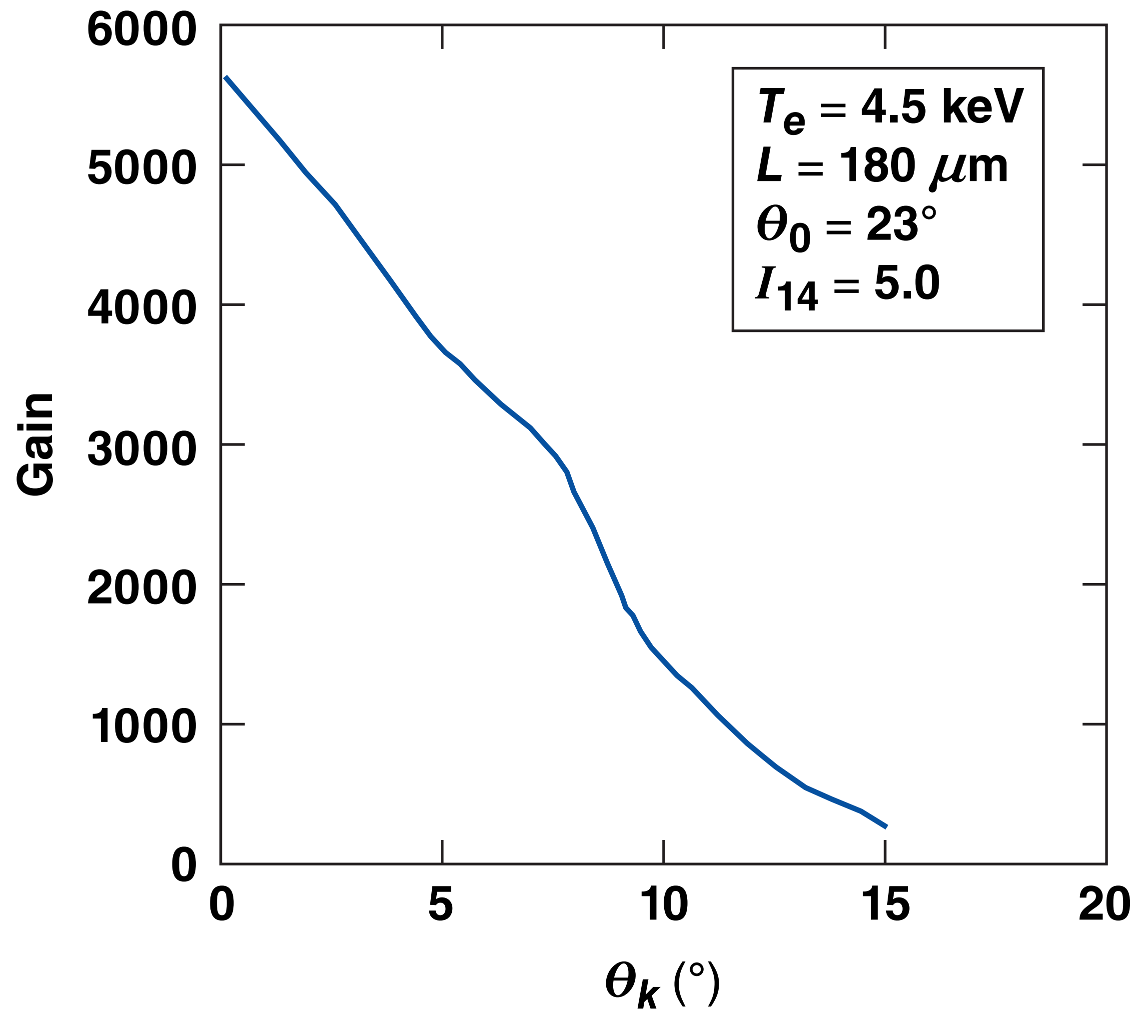
The absolute instability threshold can also be determined from the behavior of the spatial growth

- The convective gain can be found by integrating these equations over k_x from $-\infty$ to ∞.

- The gain is represented as $\text{Max}\left\{\dfrac{\left|u^{\text{out}}\right|^2}{\left|u_{d1}^{\text{in}}\right|^2+\left|u^{\text{in}}\right|^2+\left|u_{d2}^{\text{in}}\right|^2}\right\}$.

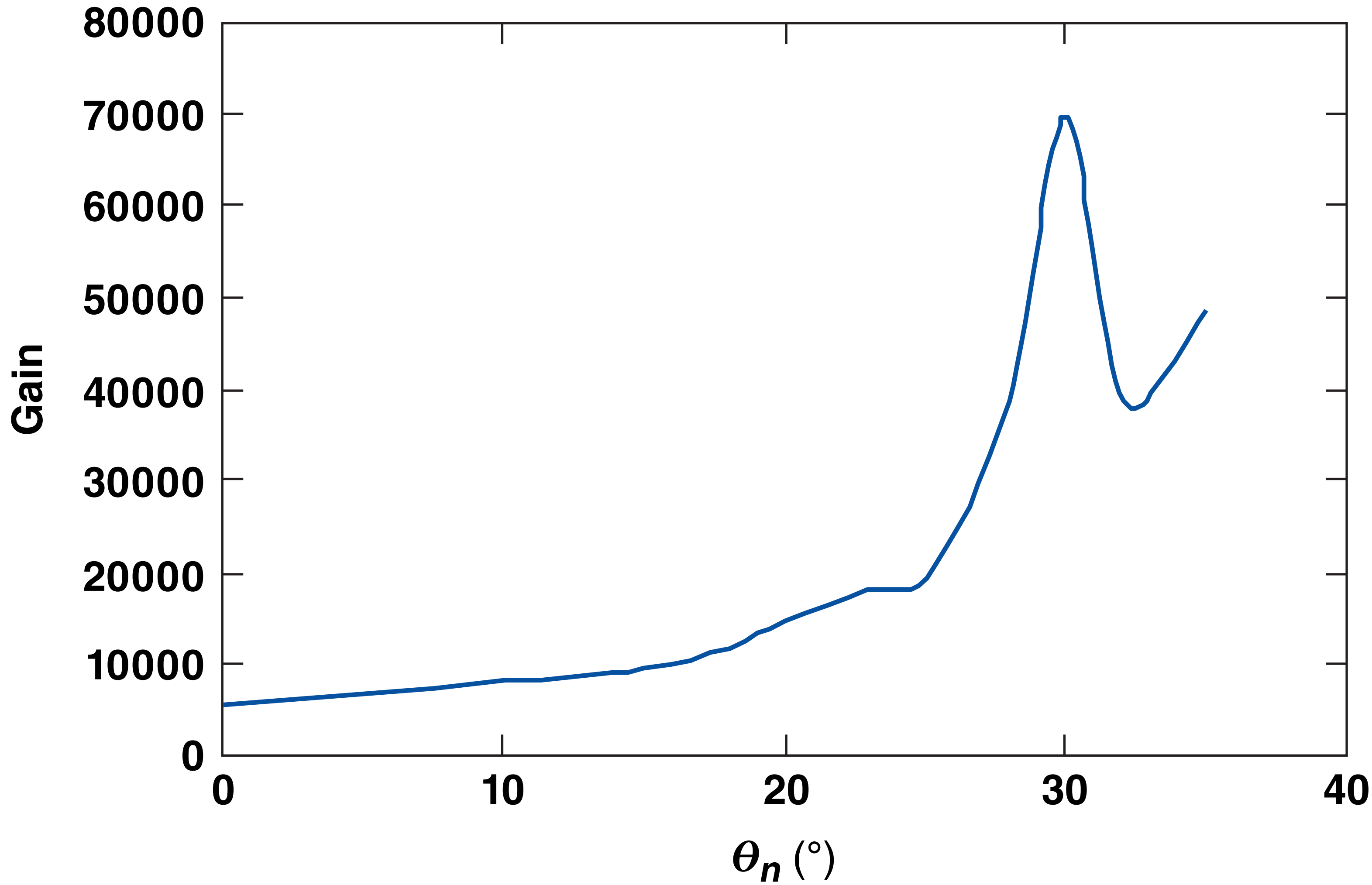
- The spatial gain may diverge with increasing input intensity. This represents the onset of absolute instability.

The gain diminishes significantly when *k* deviates from the centroid of the pump beams



TC8471

Gain increases and may lead to absolute instability as the beam centroid diverges from the density gradient



TC8472

Summary/Conclusions

Collectively driven TPD growth diminishes away from the beam symmetry axis, but increases with angle from the density gradient

UR LLE

- Experiments on OMEGA have shown that TPD is driven by the collective intensity of several overlapping laser beams.
- A group of beams can drive a common central plasma wave and a group of secondary waves.
- The common wave is the most strongly driven and is expected to produce most of the hot electrons.
- The angular distribution of this wave will determine the anisotropy of the hot electrons produced and, therefore, their preheating efficiency.
- TPD is strongly suppressed when this wave deviates from the beam symmetry axis, but may be enhanced when the symmetry axis diverges from the density gradient.