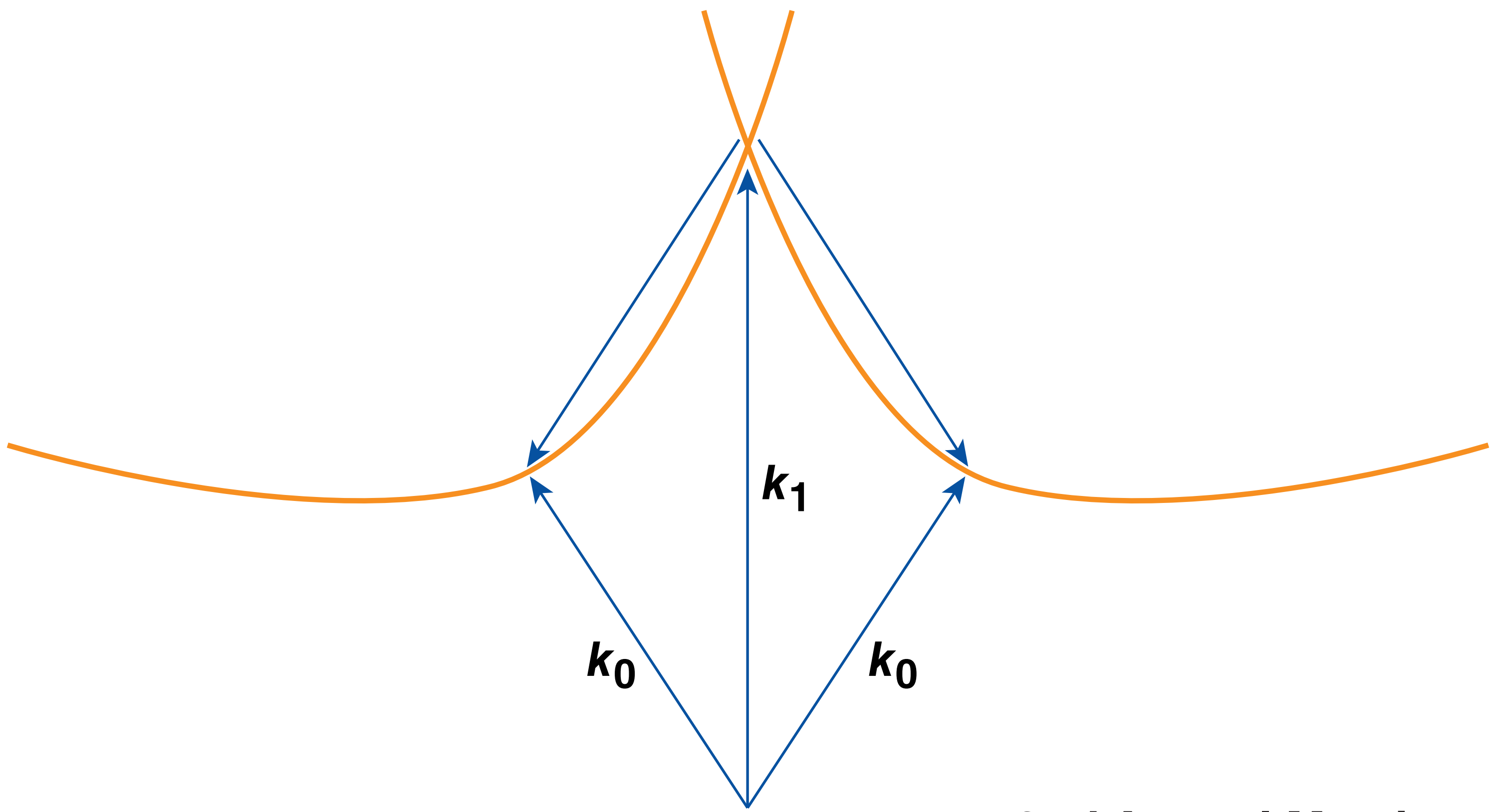
Angular Dependence of the Two-Plasmon Decay in Multibeam Direct-Drive Irradiation Geometries

UR LLE



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

52nd Annual Meeting of the
American Physical Society
Division of Plasma Physics
Chicago, IL
8–12 November 2010

Summary

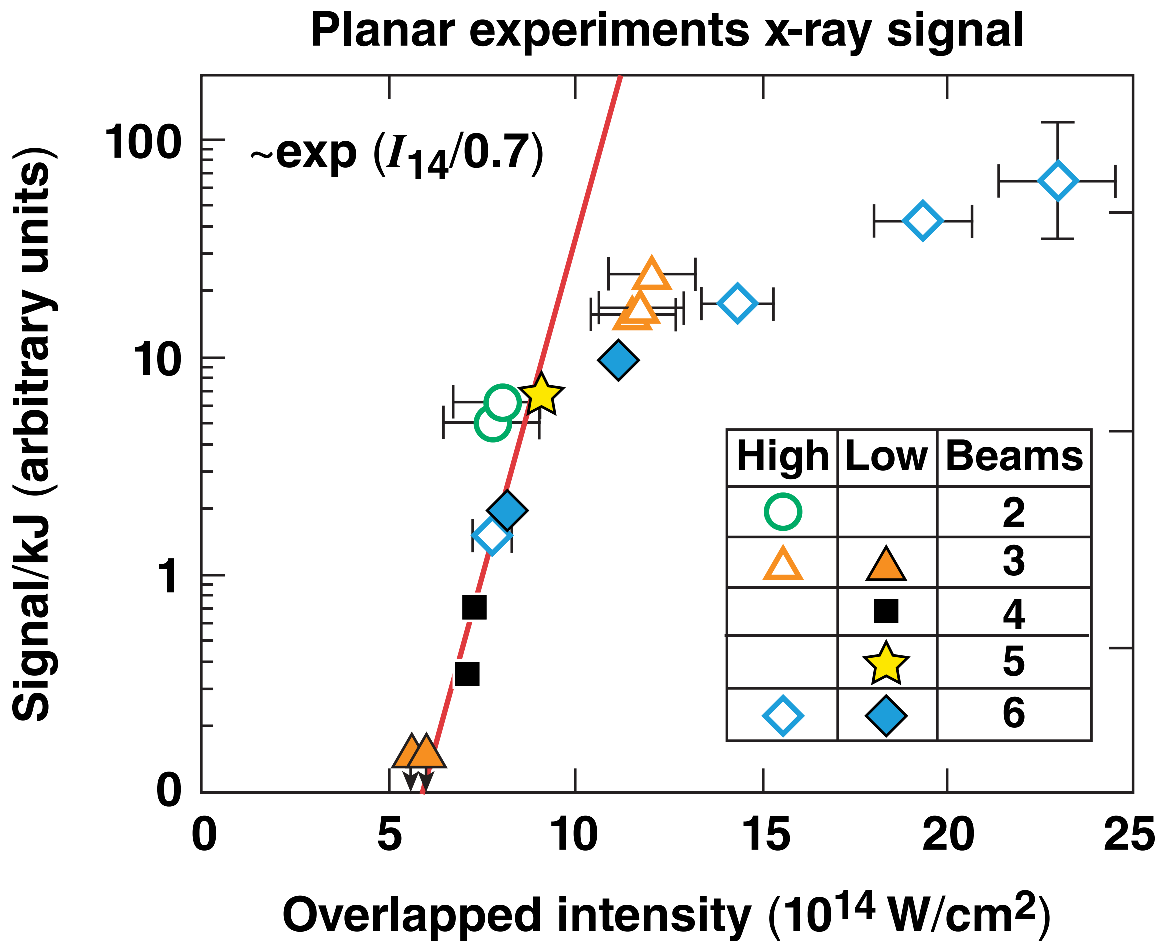
The transition of collectively driven TPD from convective to absolute occurs at very large gains and is likely to be overshadowed by nonlinear effects

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 that 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
- Hot electrons should primarily be directed inward toward the target core

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

UR LLE

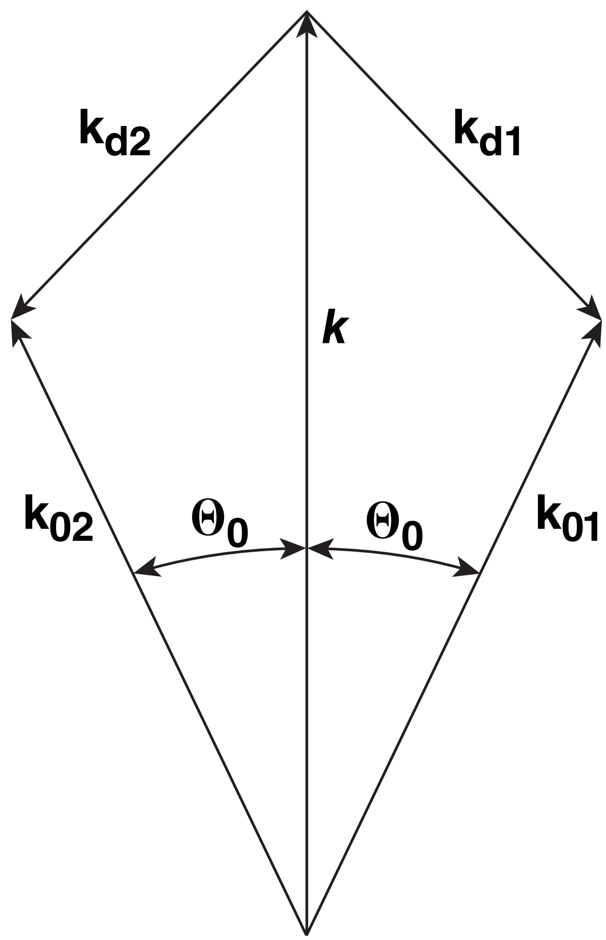


TC8117b

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

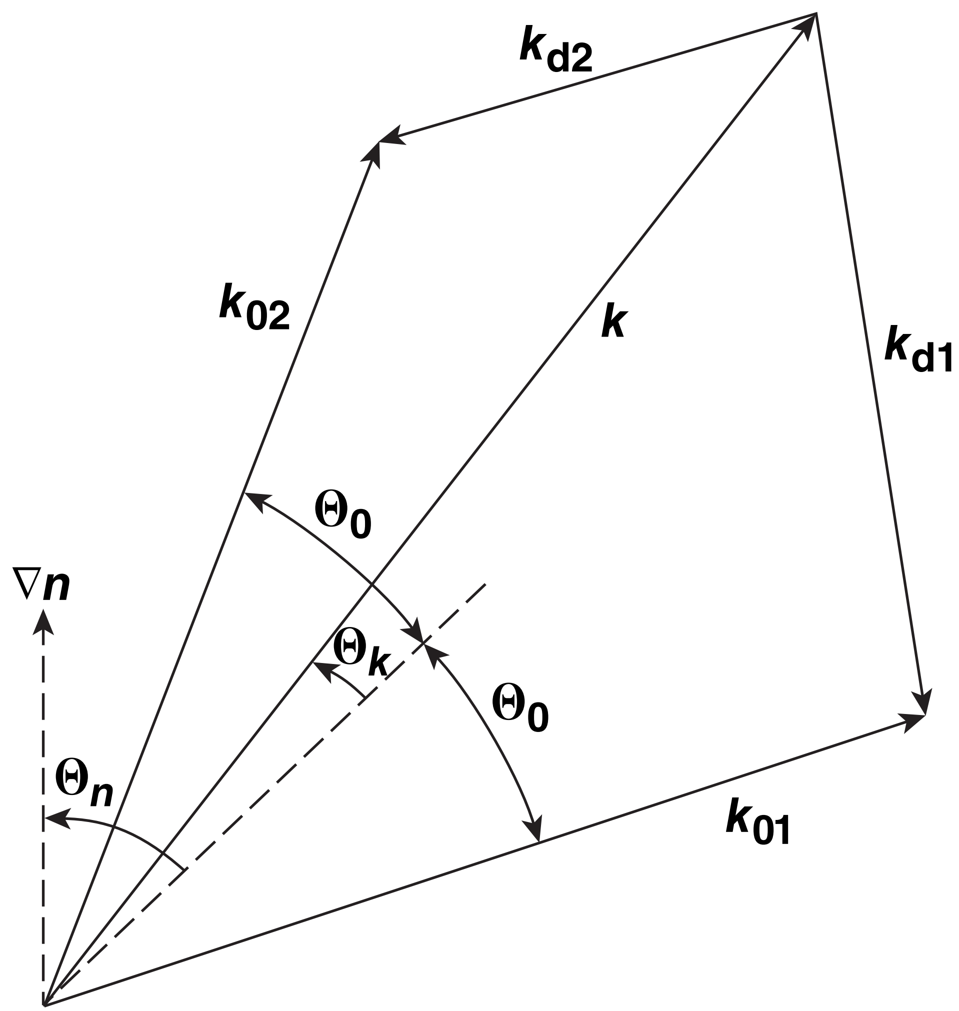
The anisotropy of multibeam TPD interaction can be studied using two beams

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



TC8466a

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



TC8467a

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

$$\frac{du}{dk_x} = e^{\,i\psi_+ \frac{\left(\frac{k^2-k_{d1}^2}{kk_{d1}}\right)L}{\omega_p}} \left|\upsilon_{01}\right| \left(\hat{\varepsilon}_1 \cdot k\right) u_{d1}$$

$$+ e^{\,i\psi_- \frac{\left(\frac{k^2-k_{d2}^2}{kk_{d2}}\right)L}{\omega_p}} \left|\upsilon_{02}\right| \left(\hat{\varepsilon}_2 \cdot k\right) u_{d2}$$

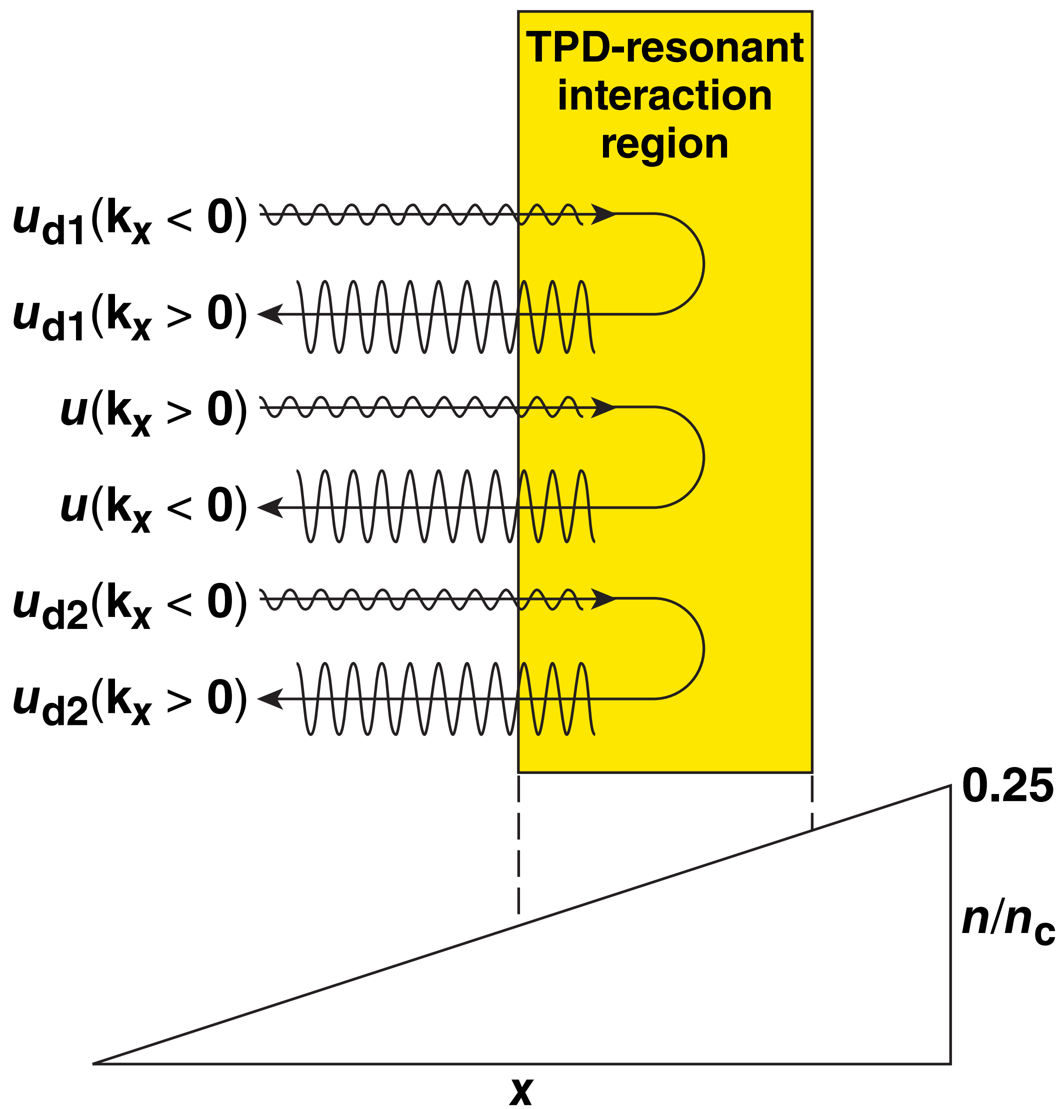
$$\frac{du_{d1}}{dk_x} = -e^{-i\psi_+ \frac{\left(\frac{k^2-k_{d1}^2}{kk_{d1}}\right)L}{\omega_p}} \left|\upsilon_{01}\right| \left(\hat{\varepsilon}_1 \cdot k\right) u$$

$$\frac{du_{d2}}{dk_x} = -e^{-i\psi_- \frac{\left(\frac{k^2-k_{d2}^2}{kk_{d2}}\right)L}{\omega_p}} \left|\upsilon_{02}\right| \left(\hat{\varepsilon}_2 \cdot k\right) u$$

$$\psi_\pm = -\frac{3\upsilon_e^2 k_0 L}{\omega_p^2} \left\{ \cos\left(\theta_0 \pm \theta_n\right) k_x^2 + 2k_r \left[\cos\left(\theta_0 \pm \theta_k\right) - \cos\theta_0\right] k_x \right\}$$

TC8468d

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



TC8470b

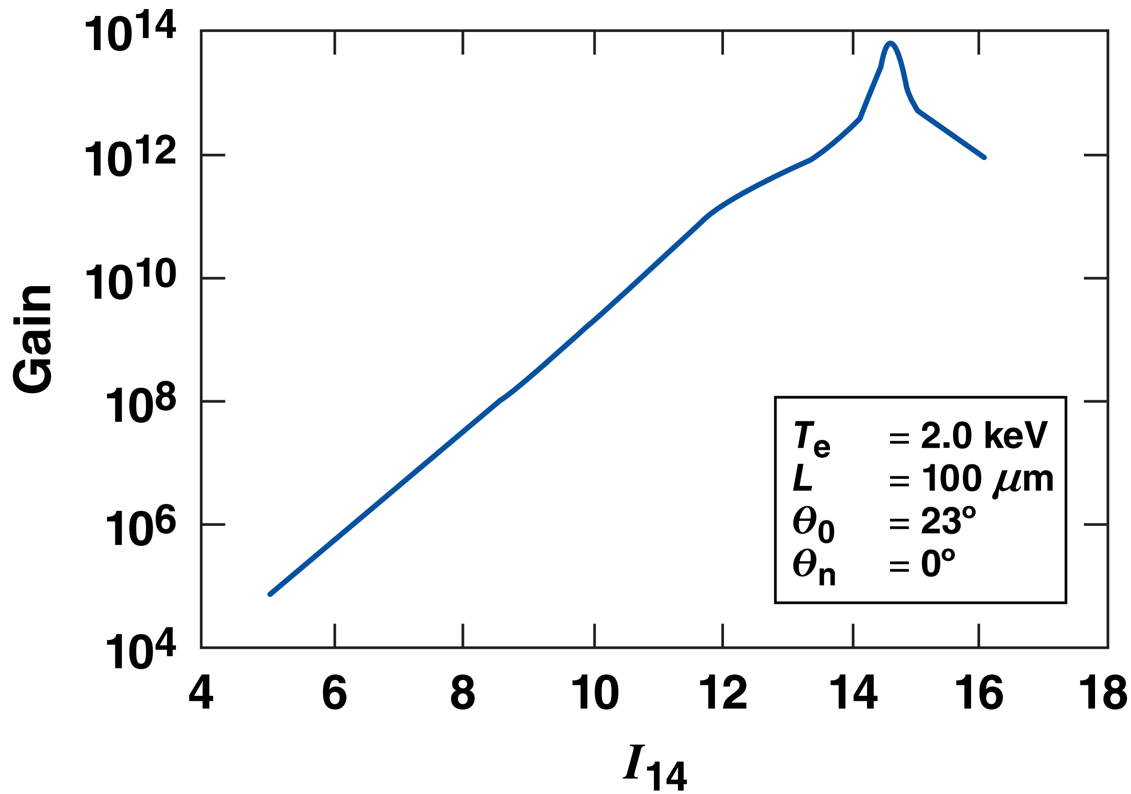
The absolute instability threshold can also be determined from the behavior of the spatial growth

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

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

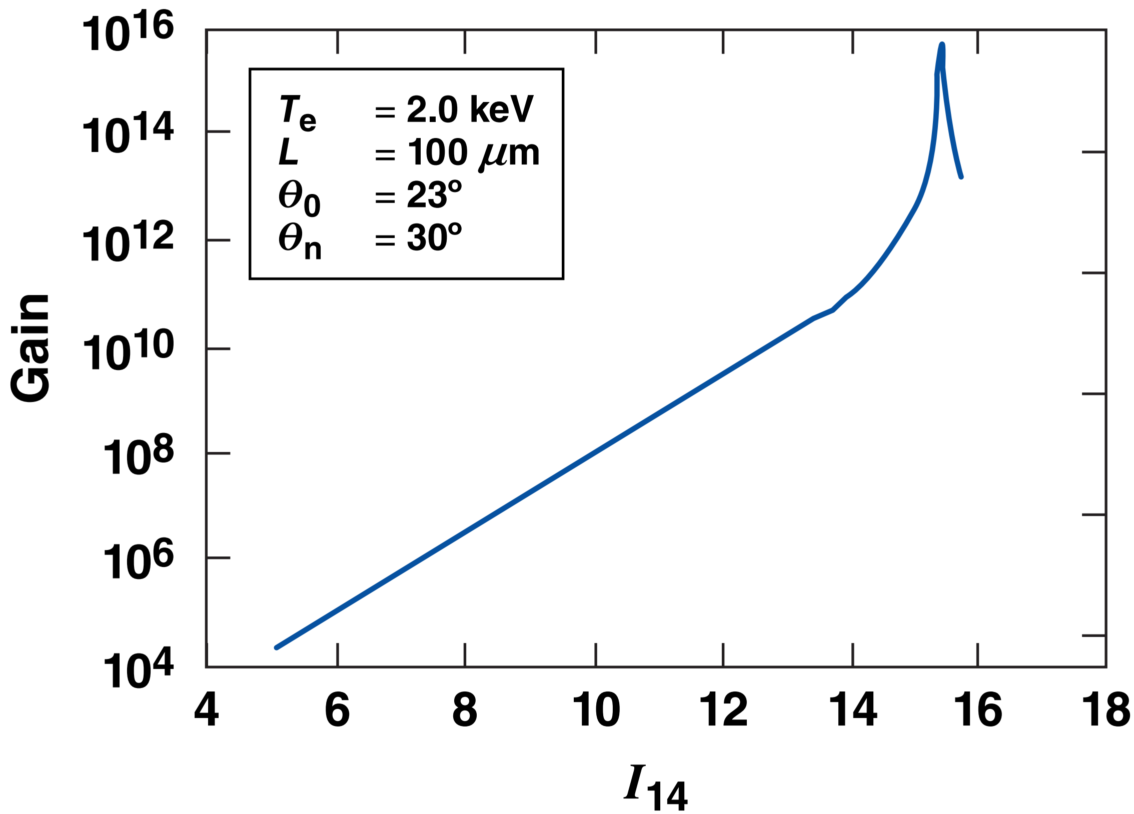
- The spatial gain may diverge with increasing input intensity. This represents the onset of absolute instability

The instability transitions from convective to absolute at large gains



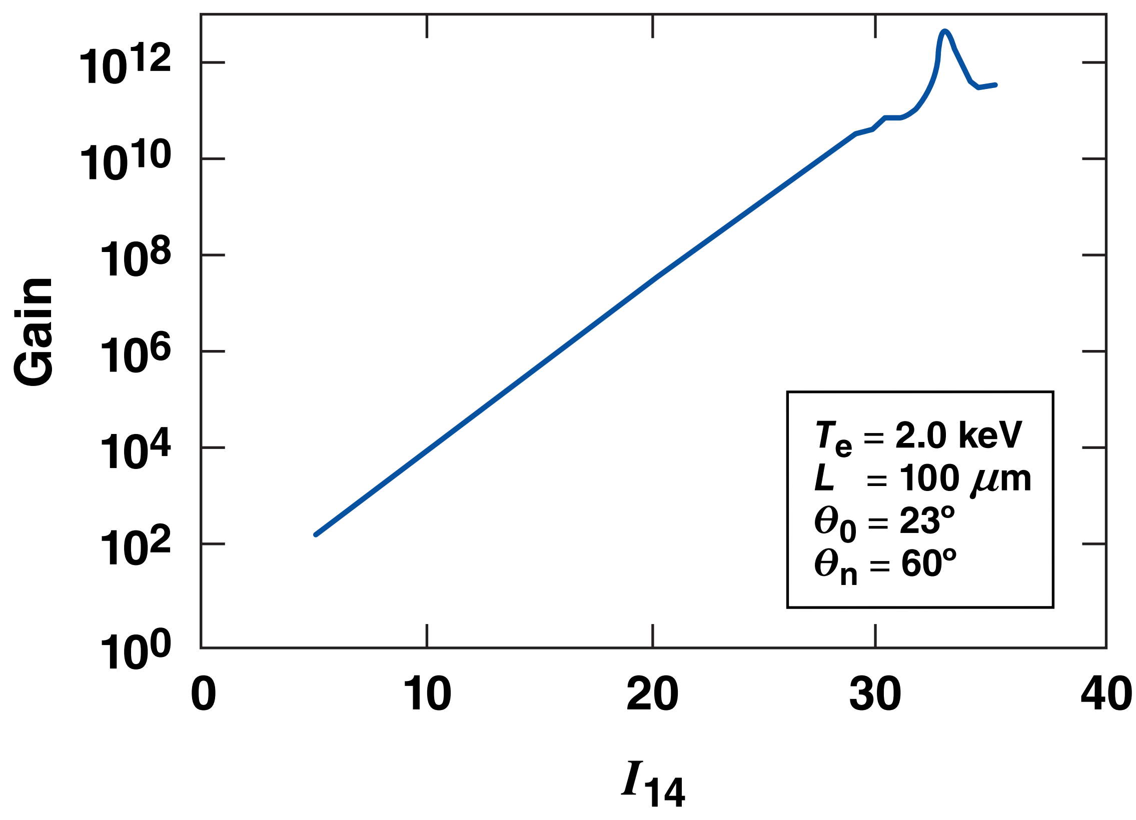
TC8859

Small deviations from the density gradient have little effect



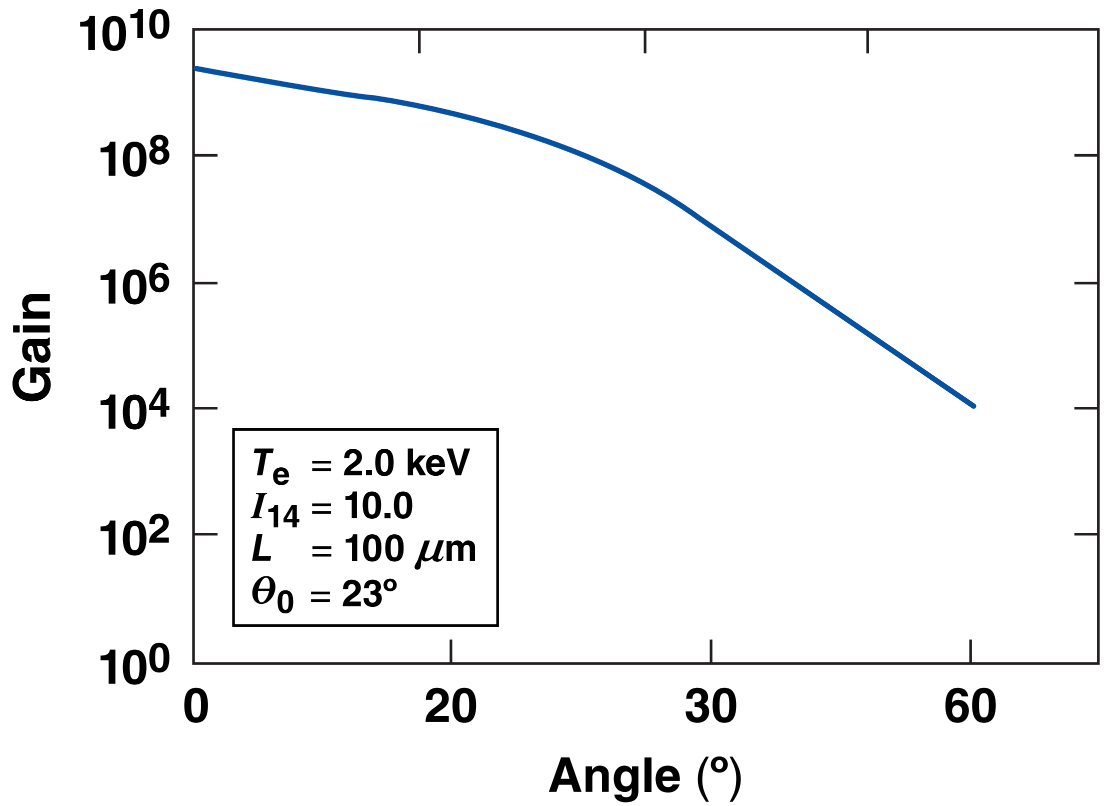
TC8860

At larger angles, the convective gain is reduced and the onset of absolute instability is not clear



TC8861

For a fixed intensity, the gain falls off rapidly with angle from density gradient



Hot electrons should be primarily directed inward toward the target core.

TC9132

Summary/Conclusions

The transition of collectively driven TPD from convective to absolute occurs at very large gains and is likely to be overshadowed by nonlinear effects

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 that 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
- Hot electrons should primarily be directed inward toward the target core