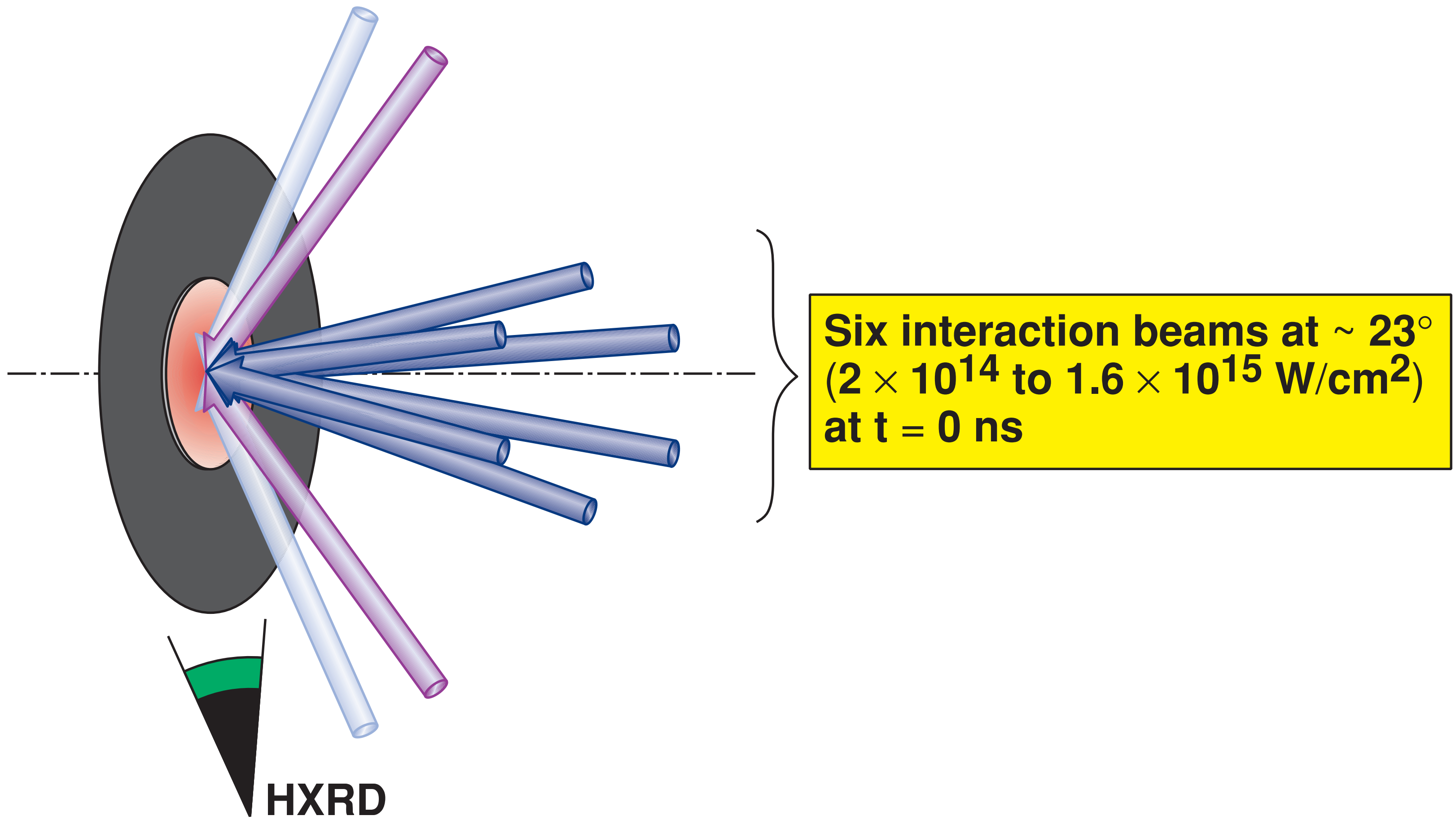
Fast Electron Preheat of Direct-Drive Targets Due to the Two-Plasmon-Decay Instability



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Summary

The two-plasmon-decay (TPD) instability appears to saturate around 10^{15} W/cm^2 under NIF direct-drive ICF conditions

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- Target preheat by fast electrons due to TPD instability appears to saturate around 10^{15} W/cm^2 at a fractional energy preheat level of ~ 0.1% for illumination conditions relevant to direct-drive ICF.
- Recent multibeam experiments showed the importance of total (overlapped) intensity for TPD-generated fast electrons.

Outline

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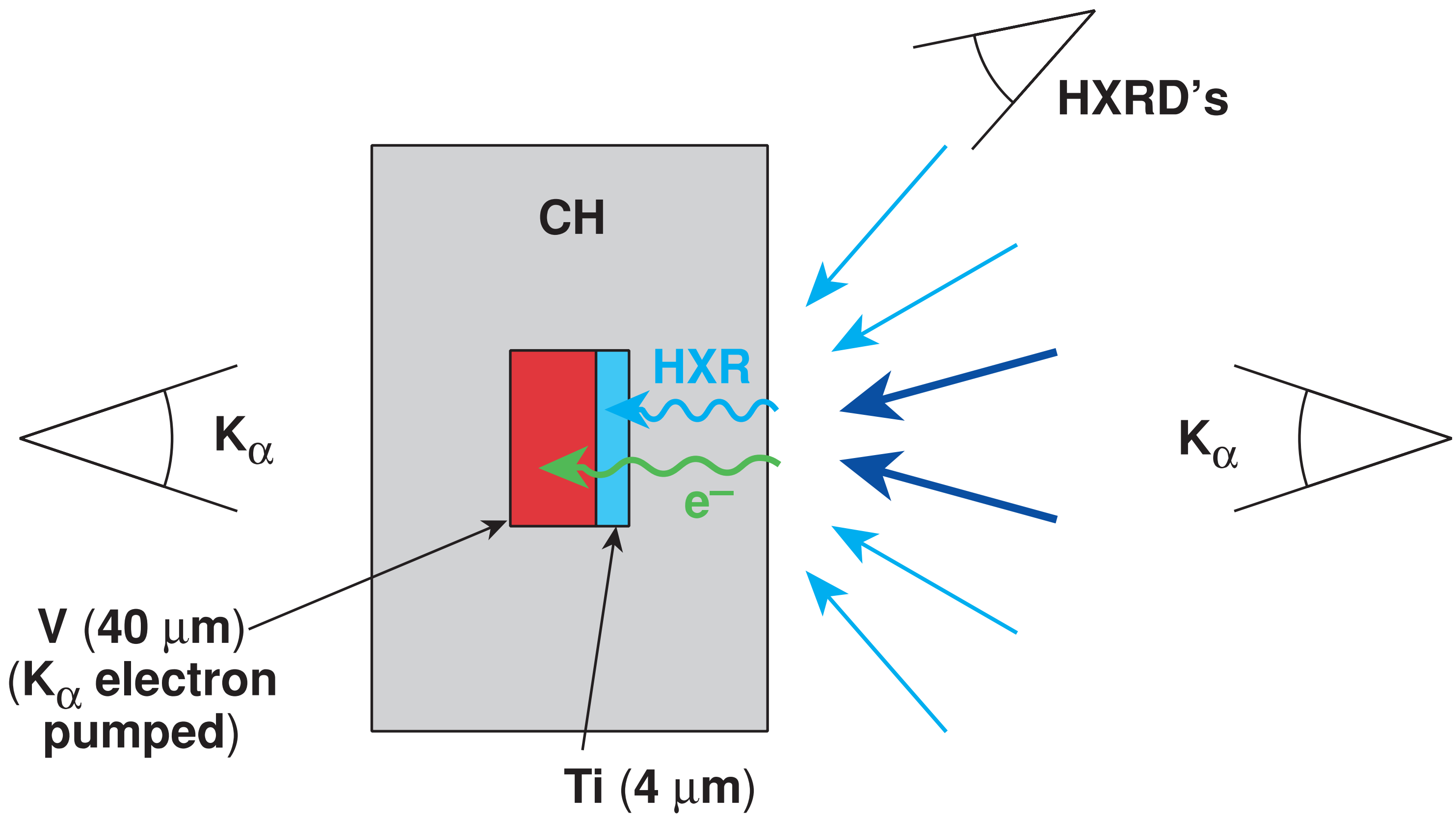
- Motivation – primary interaction processes
- Plasma conditions
- Two-plasmon-decay instability and fast-electron production in current multibeam experiments
- Summary and conclusions

Fast-electron production due to two-plasmon-decay (TPD) instability is of concern to direct-drive ignition

- TPD instability:
  - low threshold
  - generates plasmons $\rightarrow$ energetic electrons
- Time-resolved hard x-ray emission is used to determine absolute and fractional preheat levels.
- Single-beam or multiple-beam process?
  - OMEGA experiments $\rightarrow$ *multibeam process/total overlapped intensity*

Hard-x-ray detectors (scintillator-PMT) are cross-calibrated with K_α emission from special targets

- Comparison of signals and some analysis allow HXRD's to be absolutely calibrated for pure-CH or D_2 targets.



→ absorbs x rays generated in the corona
→ passes energetic electrons

Recent multibeam TPD experiments in NIF-type plasmas show the importance of total (overlapped) intensity

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- Plasmas produced by staggering three sets of beams
  - plasma-producing, plasma-heating, and interaction beams (≤ 6 beams)
- Targets: solid CH with/or without K_α signature layers
- Time-integrated (absolute) K_α spectroscopy
- Time-resolved hard-x-ray detectors (scintillator + PMT)

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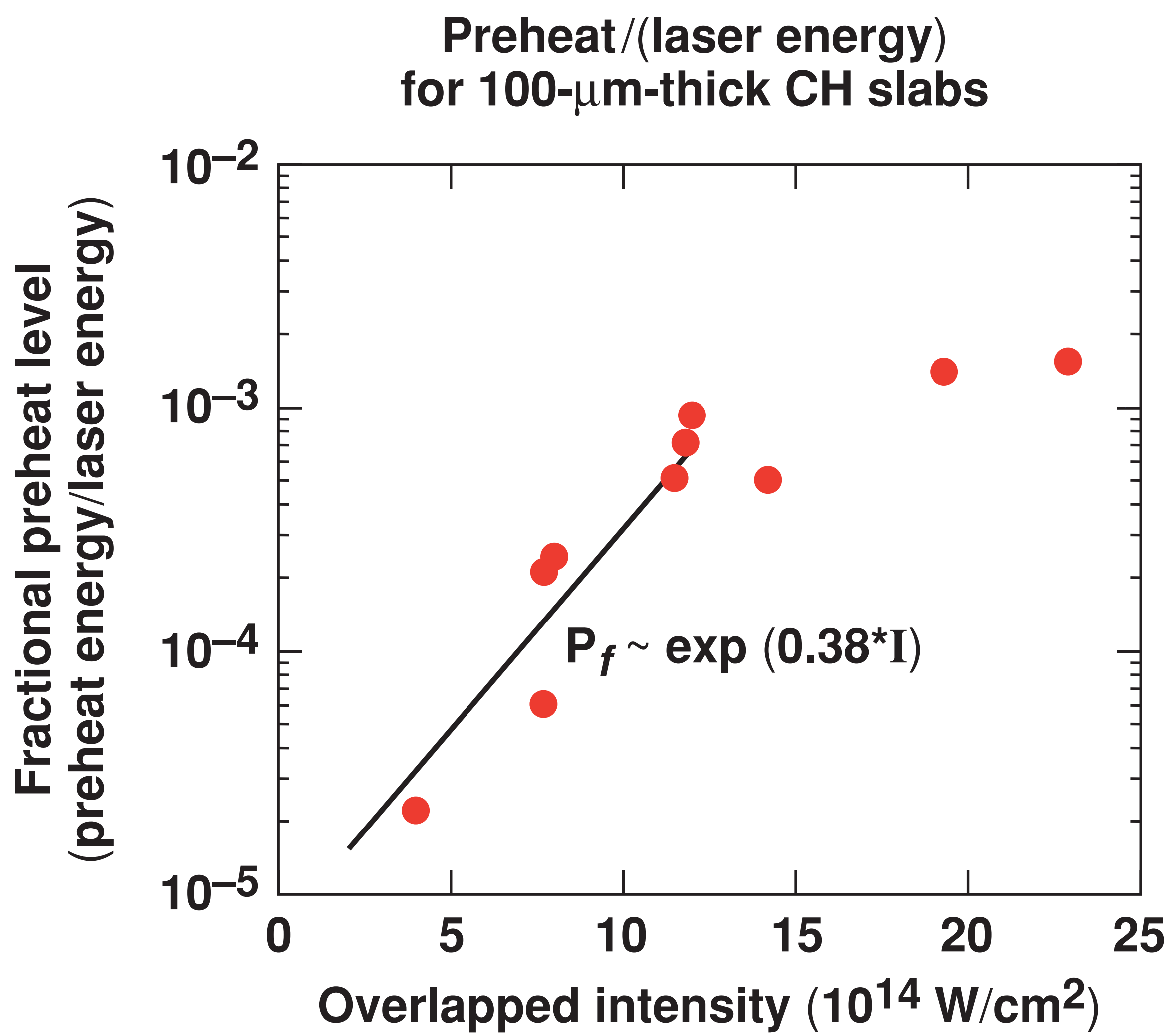
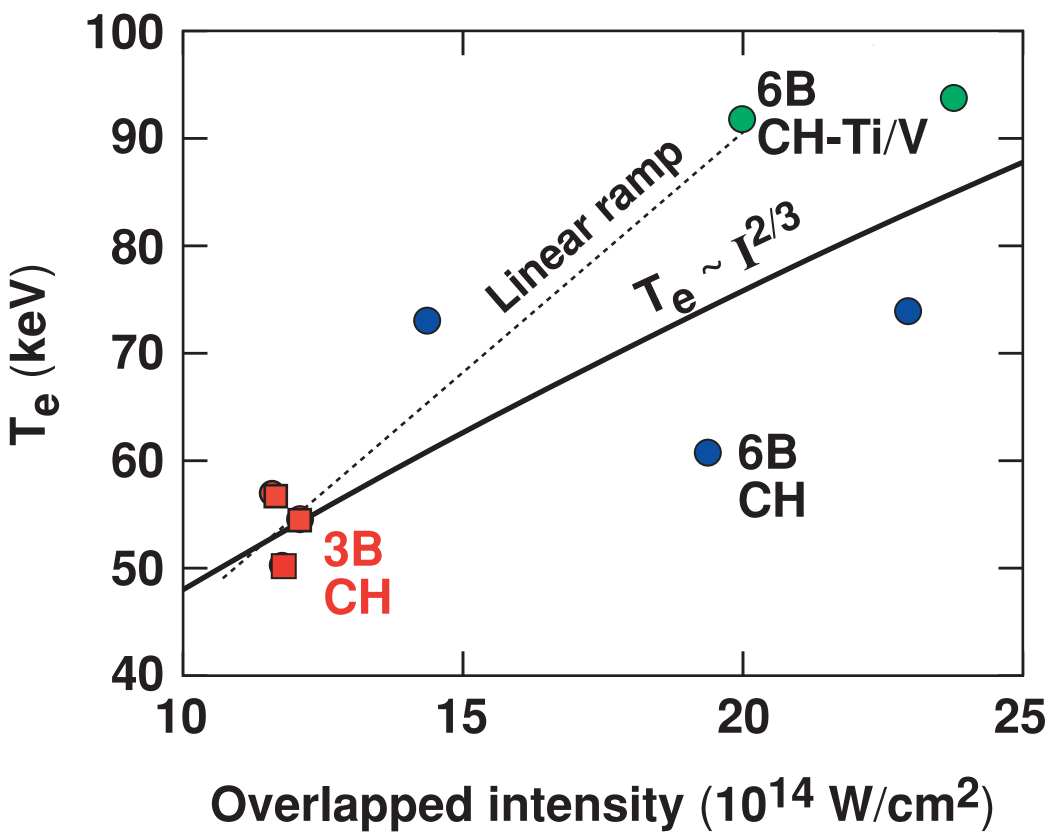
The fractional preheat level caused by energetic electrons due to TPD appears to saturate above 10^{15} W/cm^2



The hot-electron temperature increases with increasing intensity roughly as expected if the electron production occurs primarily near the Landau cutoff



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Measured electron (and hard-x-ray) spectra are shifted toward higher T_{hot} by *dE*/*dx* in the target

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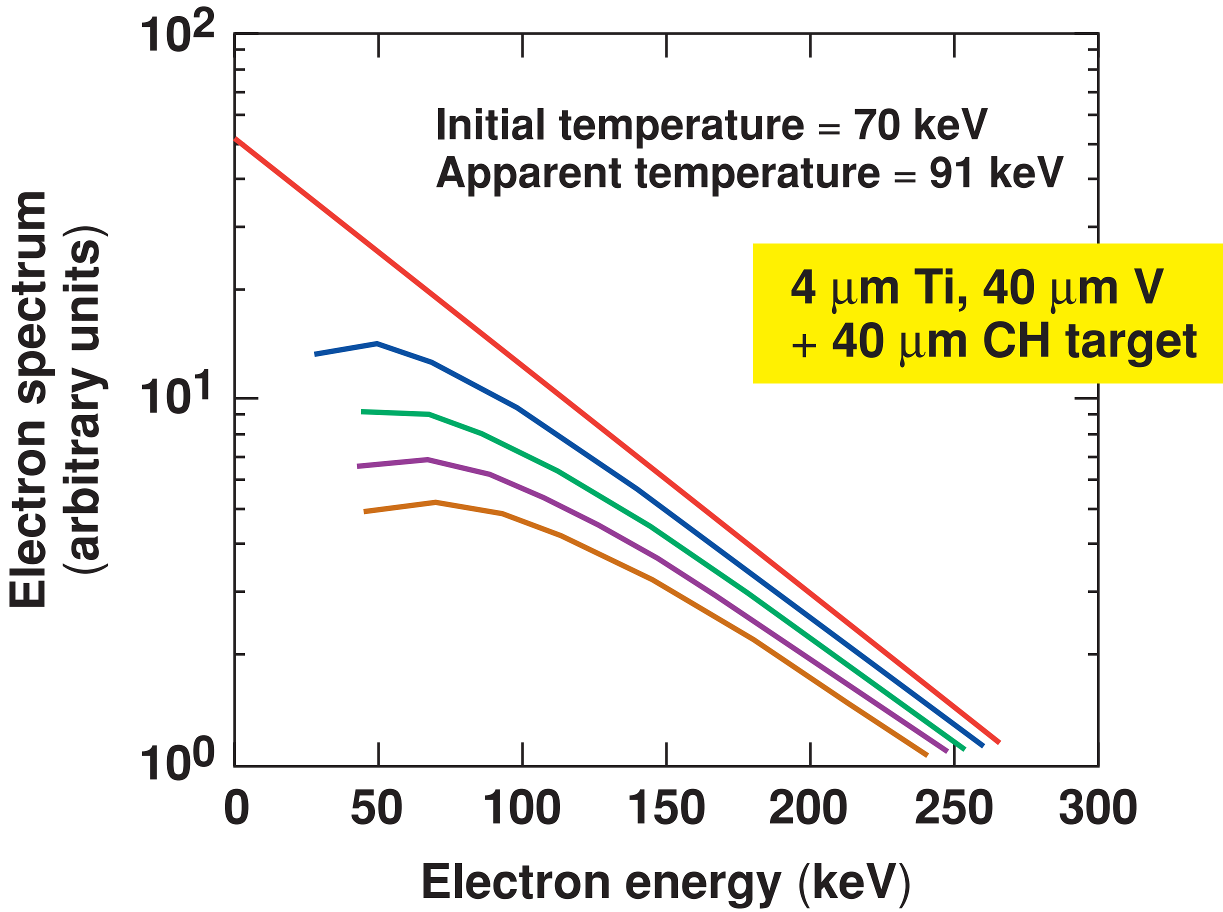

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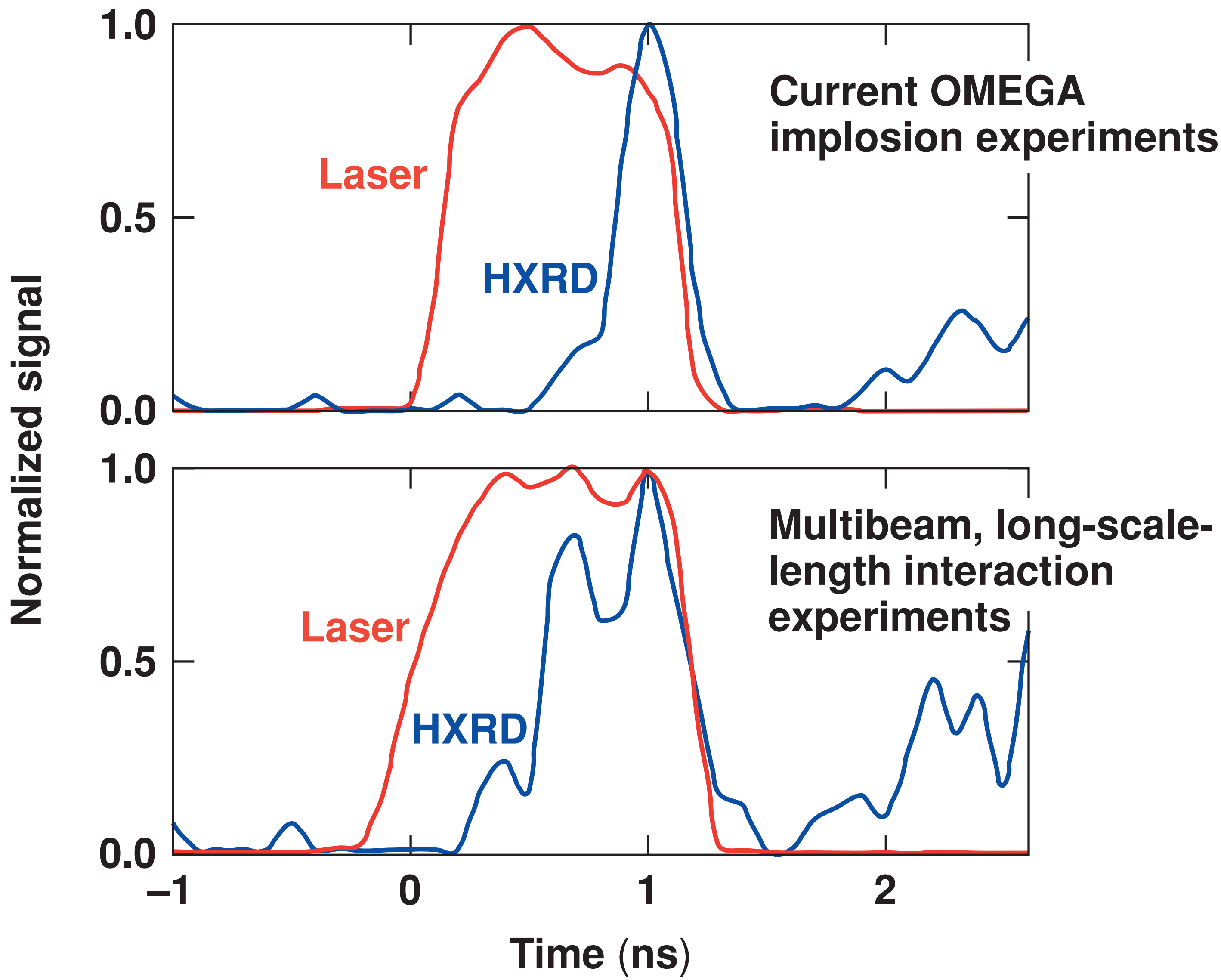
For current OMEGA implosions the temporal evolution of the hard x rays reflects the increasing density scale length



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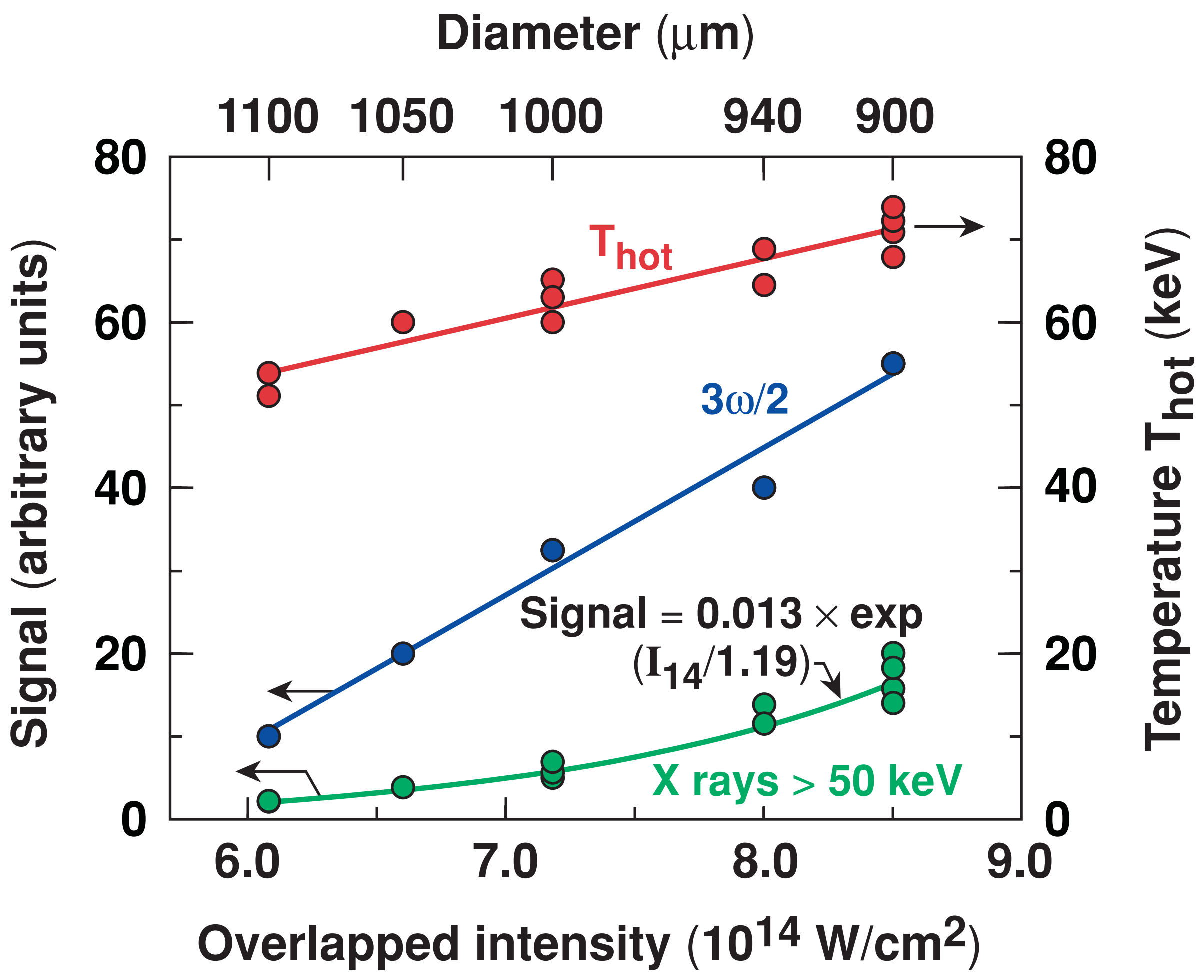
The TPD instability depends on overlapped intensity in multibeam experiments

- Data taken on 60-beam OMEGA shots with CH shells varying from 900-μm to 1100-μm diameters



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Summary/Conclusions

The two-plasmon-decay (TPD) instability appears to saturate around 10^{15} W/cm^2 under NIF direct-drive ICF conditions

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The End

Thank you