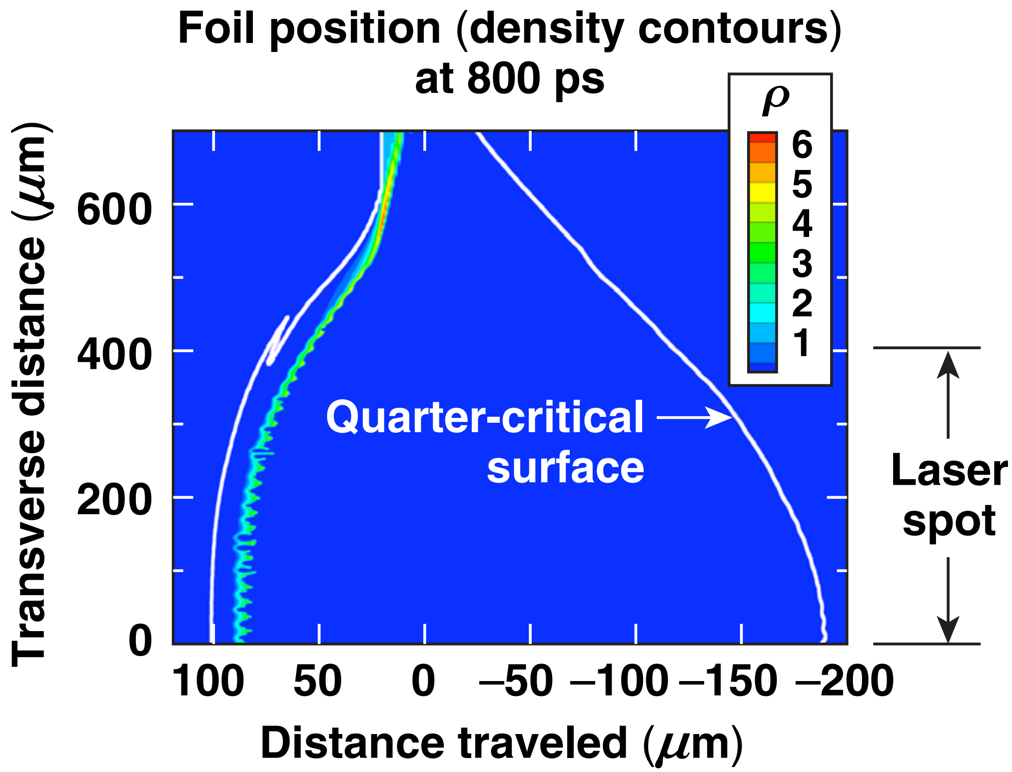
Numerical Investigation of the Effect of TPD Electron Preheat in Planar Rayleigh–Taylor Experiments



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Summary

Planar Rayleigh–Taylor (RT) experiments were simulated with *DRACO* that includes preheat from two-plasmon-decay (TPD) electrons

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- Planar experiments on the OMEGA laser showed reduced RT growth for a 20-μm-wavelength perturbation at 1×10^{15} W/cm^2 but no reduction at 5×10^{14} W/cm^2*
- A straight-line transport model was added to the 2-D hydrodynamic code *DRACO* to model the preheat from two-plasmon-decay (TPD) electrons
- The source parameters are based on those in the 1-D hydrocode *LILAC* and are computed from the local TPD threshold parameter over the entire laser spot
- The resulting preheat has little effect on RT growth in the high-intensity case but reduces the spike density—the effect is smaller in the low-intensity case

*V. A. Smalyuk *et al*., Phys. Rev. Lett. 101, 025002 (2008).

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Collaborators

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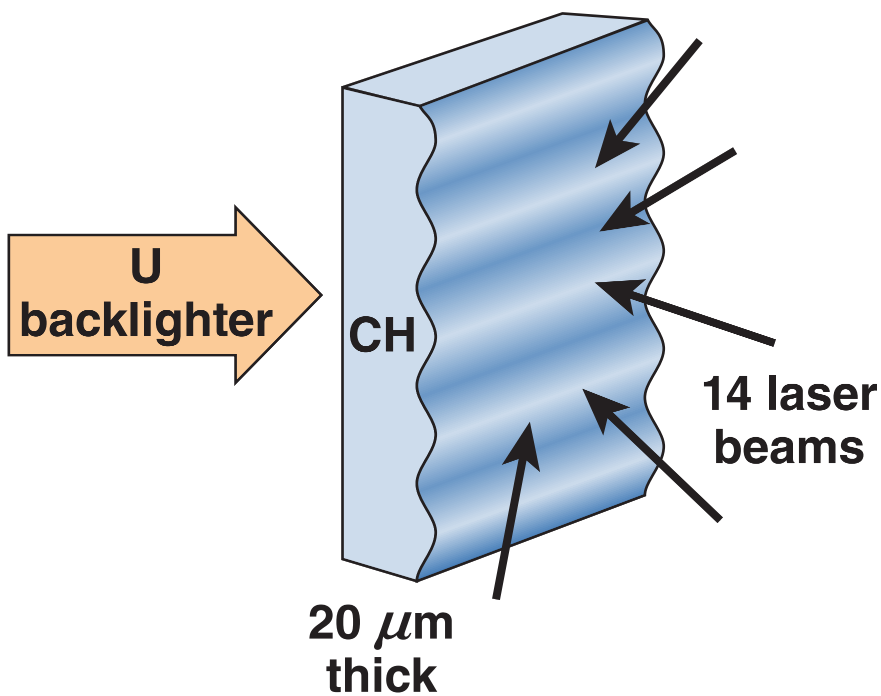
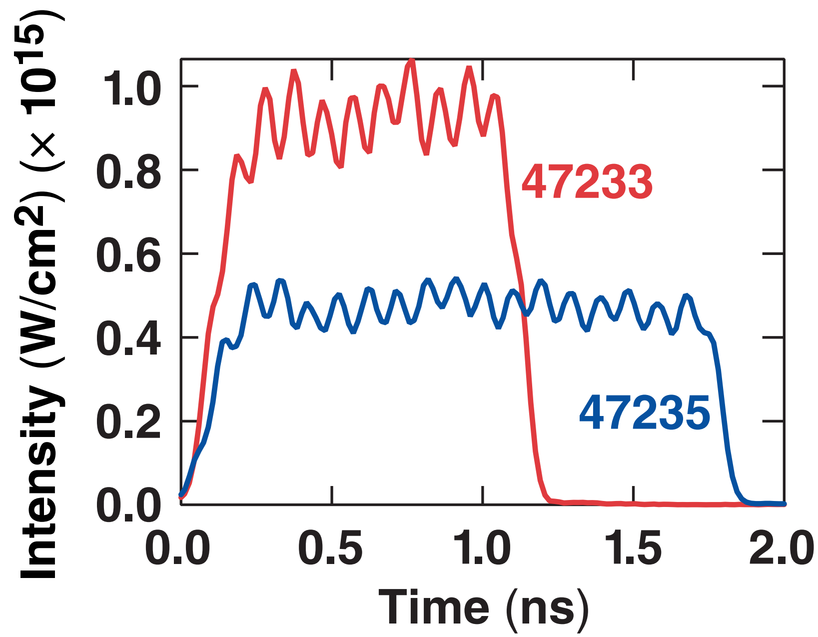
The Rayleigh–Taylor instability was studied using the acceleration of 20-μm-thick planar-CH targets





20-μm imposed-surface perturbations.

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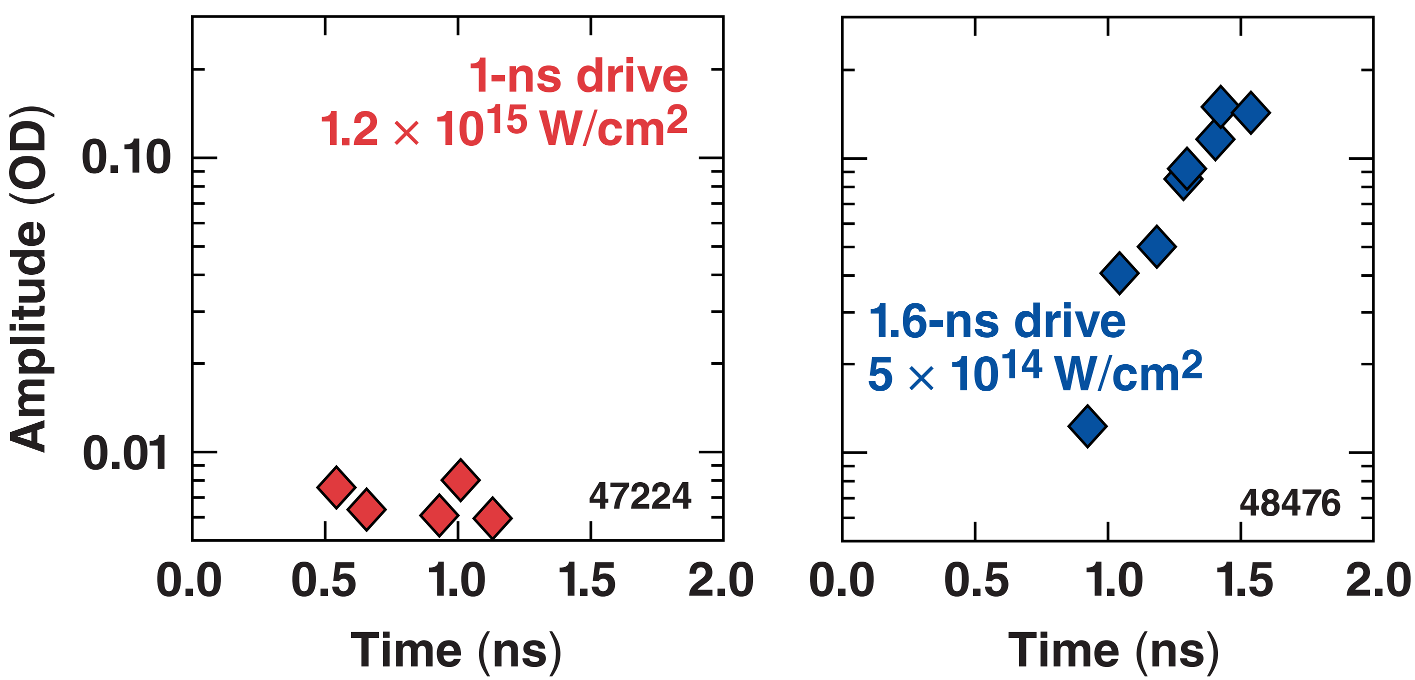
The RT growth is strongly stabilized at an intensity of 10^{15} W/cm^2 compared to 5×10^{14} W/cm^2

Wavelength 20 μm



Smalyuk *et al*. attributed the decreased growth rates to preheat from TPD electrons and nonlocal thermal-electron transport.

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The straight-line electron transport in *DRACO* uses the same source conditions as in *LILAC*[1]

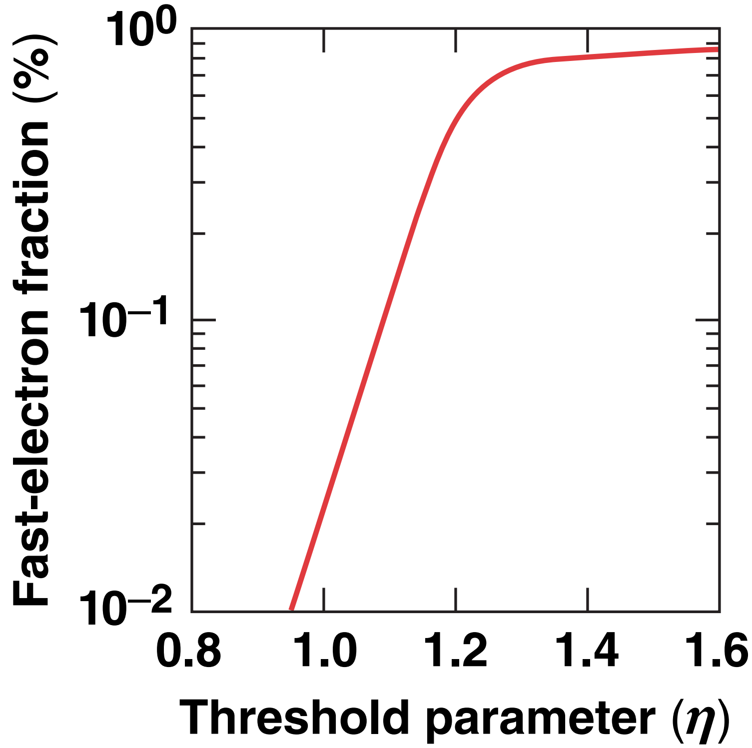
- The percentage of laser energy into TPD electrons is a function of the threshold parameter given by[2]

  $$\eta = I_{14} \times L\ (\mu\text{m})/[233 \times T\ (\text{keV})]$$

- The electrons are created at the quarter-critical surface with the temperature

  $$T_h = 10 \times I_{14}\ (\text{W/cm}^2)$$

- The electrons are given a uniform 30° spread based on previous experiments[3]
- The energy loss formula is from Li and Petrasso[4]

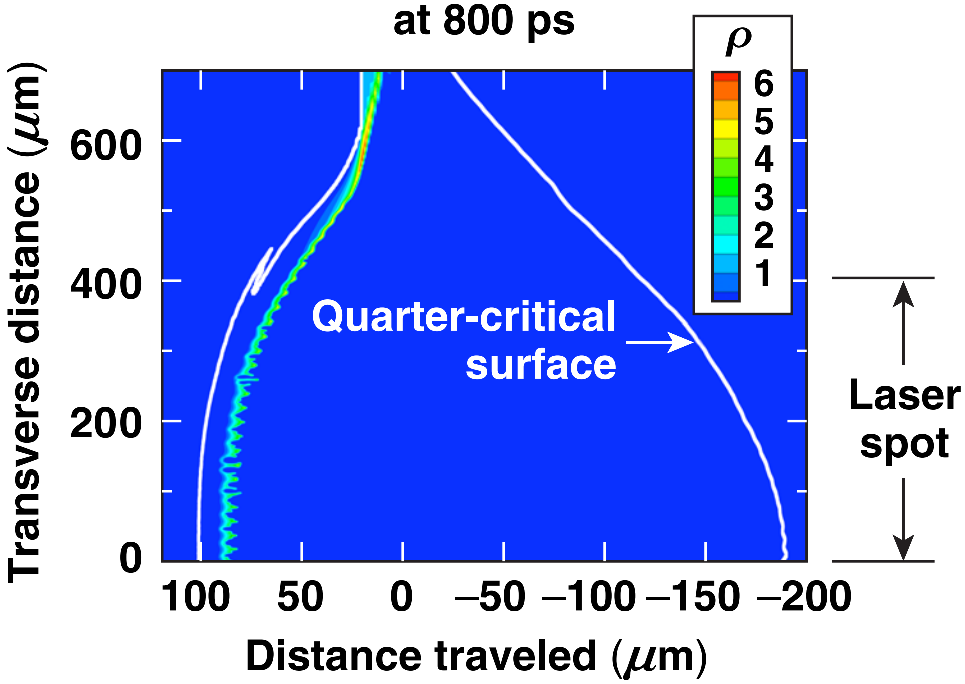


[1]J. A. Delettrez *et al*., Bull. Am. Phys. Soc. 53, 248 (2008).
[2]A. Simon *et al*., Phys. Fluids 26, 3107 (1983).
[3]J. F. Myatt *et al*., Bull. Am. Phys. Soc. 53, 168 (2008).
[4]C. K. Li and R. D. Petrasso, Phys. Rev. E 70, 067401 (2004).

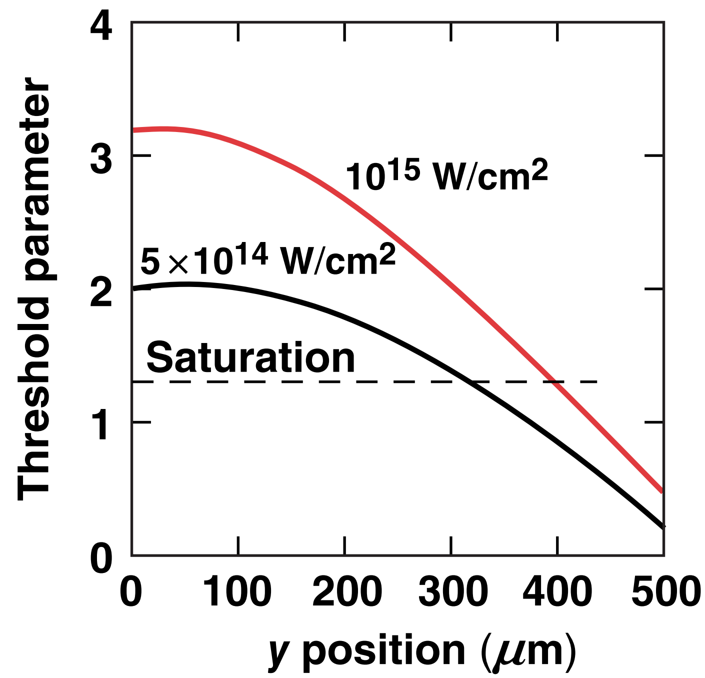
The simulation includes the entire laser spot to account for the spot-intensity profile

- $\eta(y)$ is computed at the quarter-critical surface over the laser spot
- The electrons are reflected at *y* boundaries of the plasma
- The electrons reaching the upper boundary "escape"

Foil position (density contours) at 800 ps



Threshold parameter in laser spot



The threshold parameter is large because of the long scale lengths at quarter-critical (270 μm).

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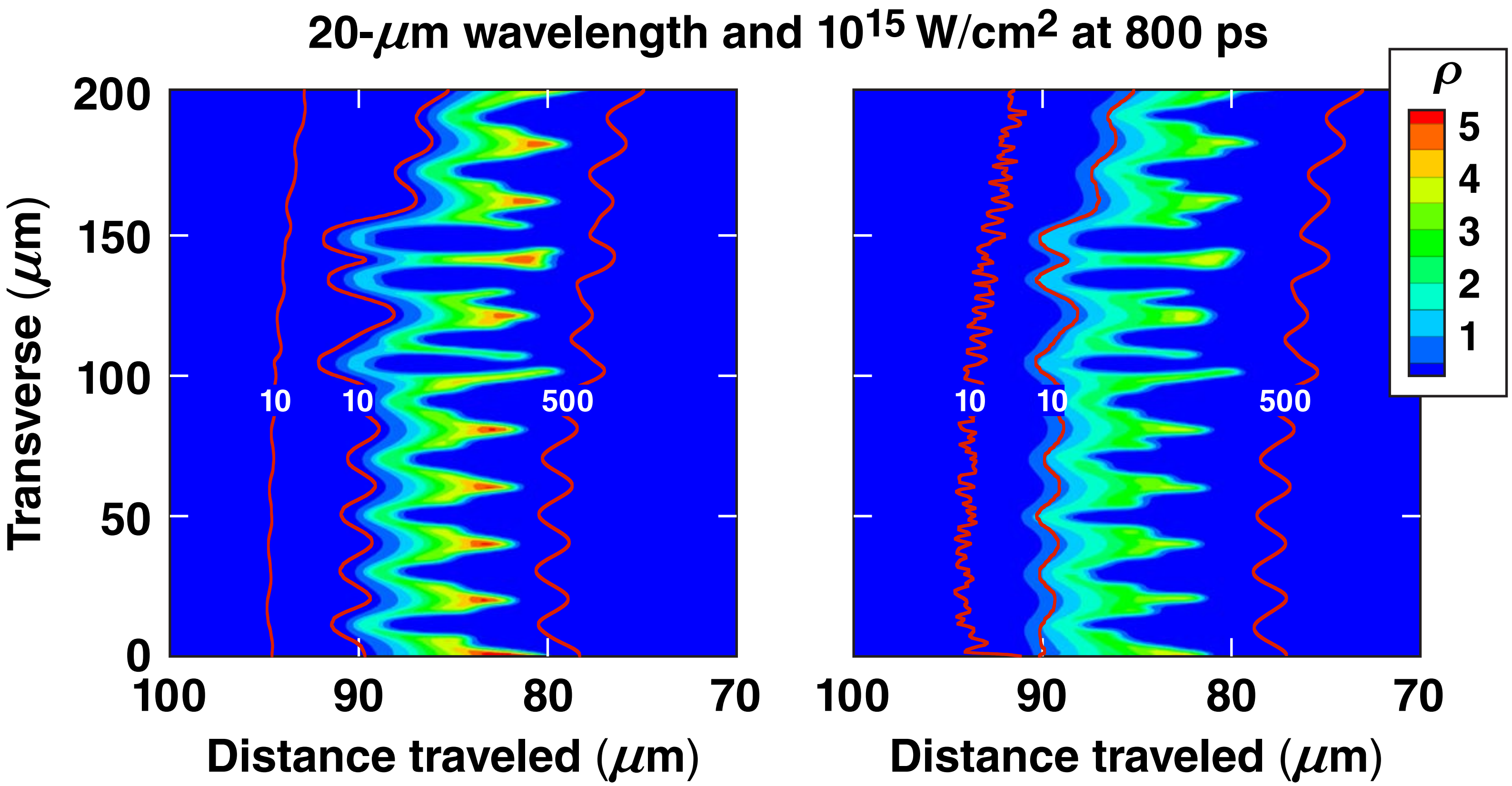
For the 20-μm-wavelength and 10^{15} W/cm^2 case, the electron preheat reduced the mass density in the RT perturbation

Mass-density and electron-temperature (eV) contours at 800 ps



TPD electrons deposited 9 J (0.2% laser energy) in the perturbed region and 16.8 J (0.4% of laser energy) in the target.

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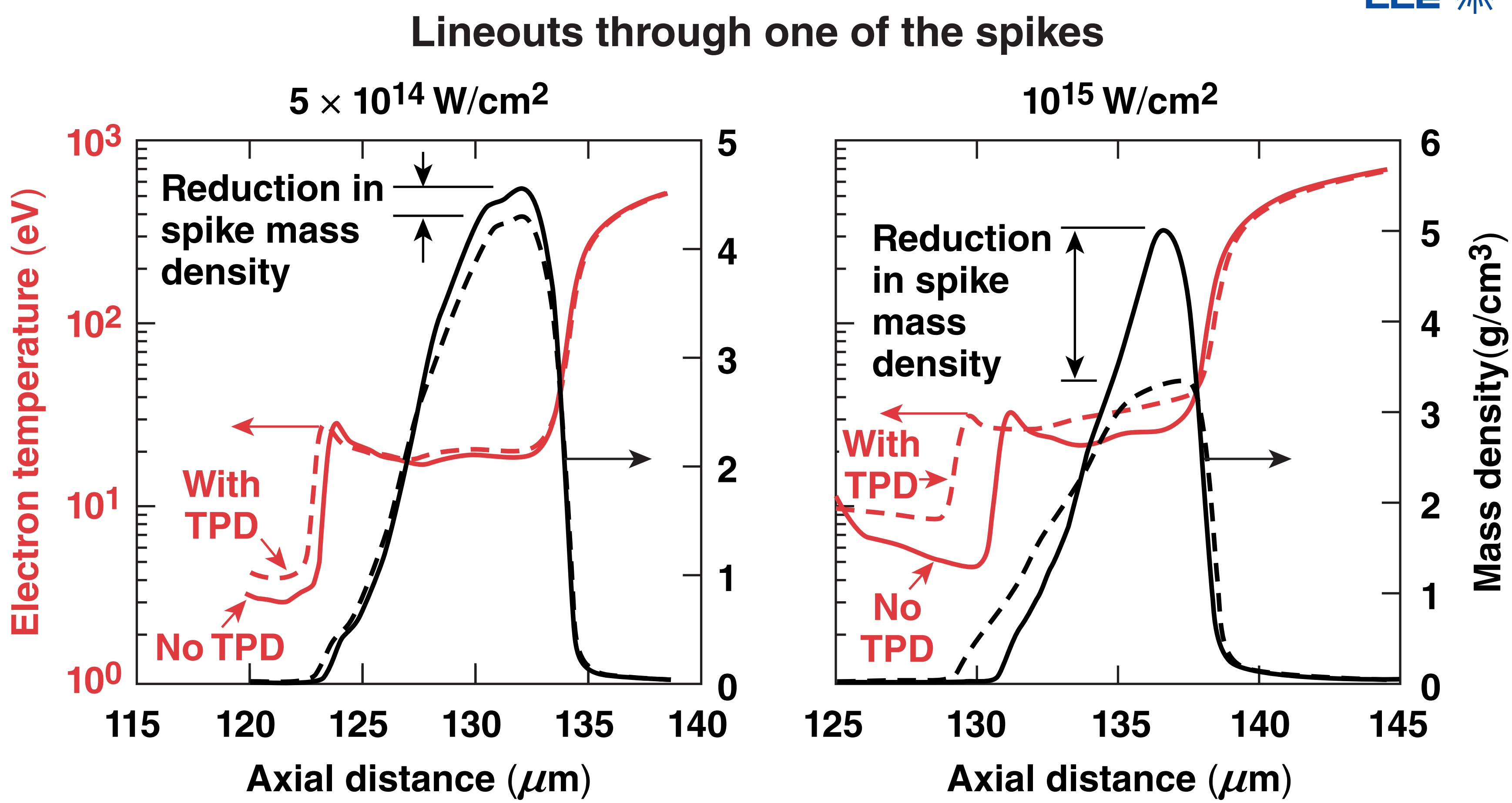
The electron preheat had a smaller effect on the RT perturbation for the low-intensity case than for the high-intensity case



The smaller effect in the low-intensity case is mostly due to a two-fold decrease in laser energy rather than to the lower-threshold parameter.

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Summary/Conclusions

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