Hot Electron Jets emission in Relativistic Laser Interaction with Wavelength-Scale Rods

NePTUN
Nuclear Photonics at Tel-aviv University research group

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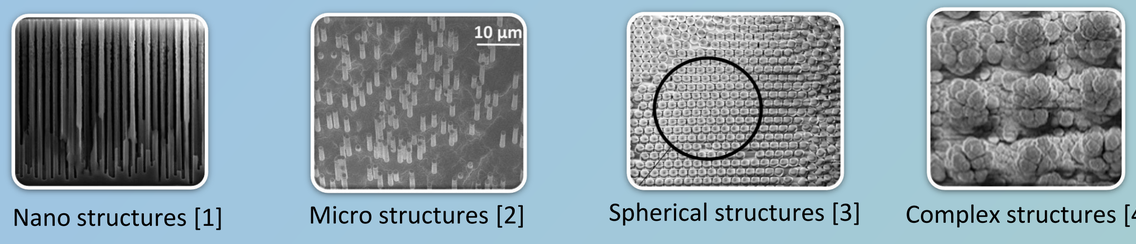
Motivation

Many intense laser irradiation experiments have shown that wavelength-scale geometrical features on the target lead to increased laser energy transfer to hot electrons.

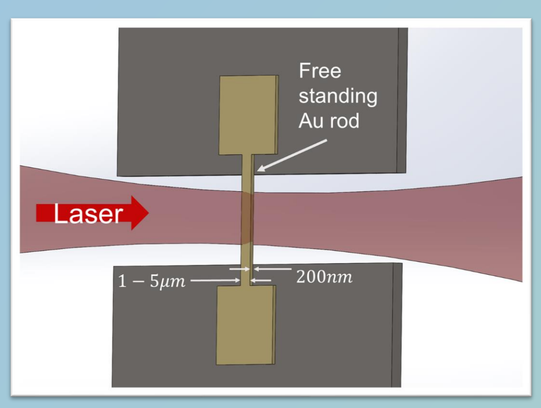


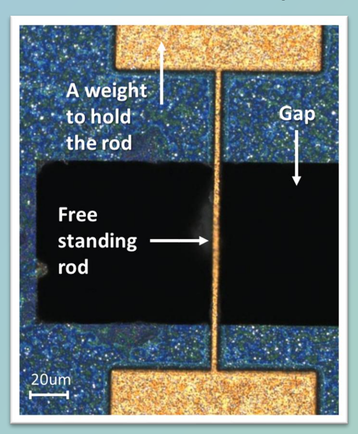
Nano structures [1] Micro structures [2] Spherical structures [3] Complex structures [4]

[1] Z. Samsonova. *et al. Phys. Rev. X* 9, 021029 (2019)
[2] D. Khaghani. *et al. Sci. Rep.* 7, 11366 (2017)
[3] H. Sumeruk. A. *et al. Phys. Rev. Lett.* 98, 045001 (2007)
[4] A. Zigler. *et al. Phys. Rev. Lett.* 110, 215004 (2013)

Our Goal

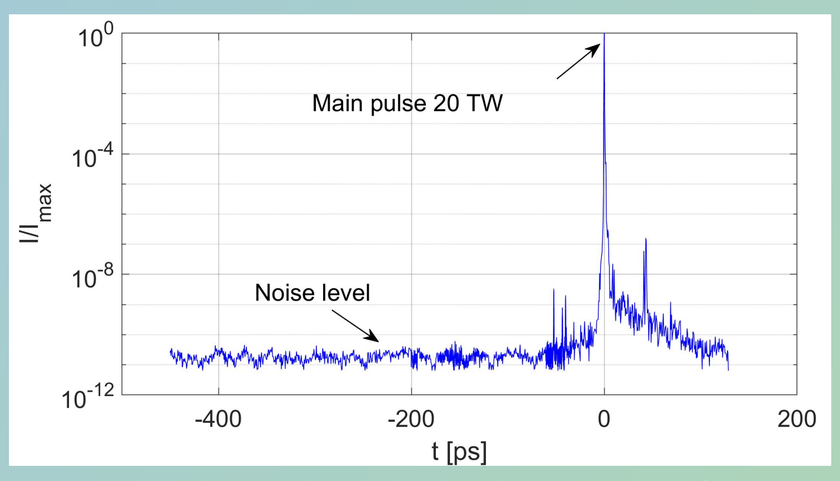
Explaining this observation by a parametric investigation of a single free standing rod irradiated by relativistic laser pulse.



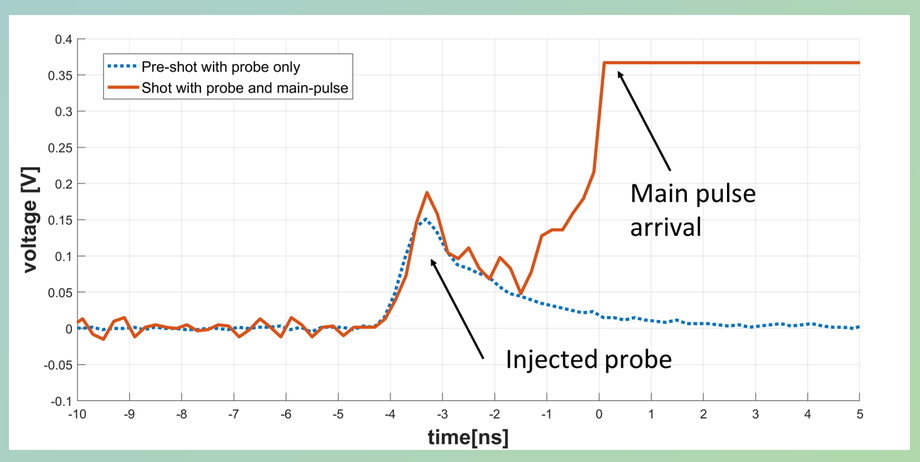


The Experimental Setup

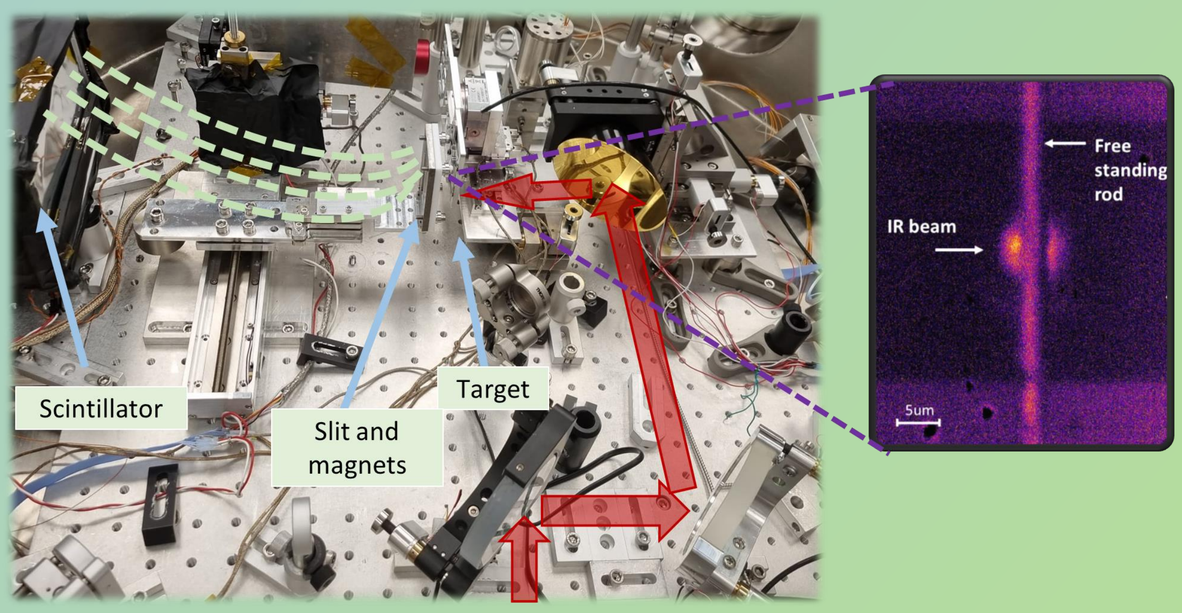
The NePTUN laser system is a $0.5\,\mathrm{J}$, 25 fs laser, based on a picosecond optical parametric chirped pulse amplification front-end, presenting ps contrast 10^{-11} @ $t = -60ps$



A probe is injected colinearly with the laser to confirm rod survival on-shot.

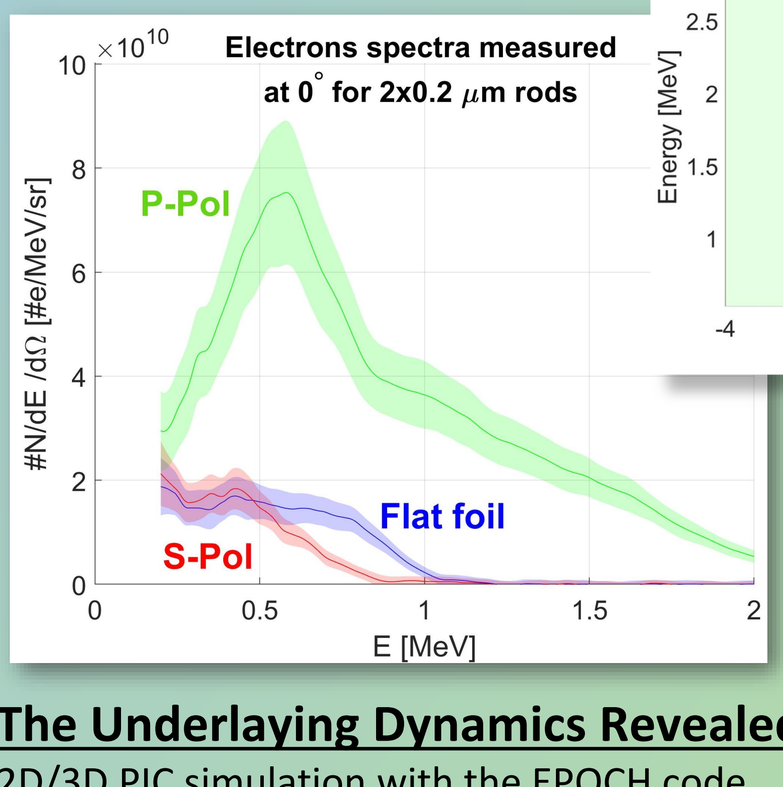


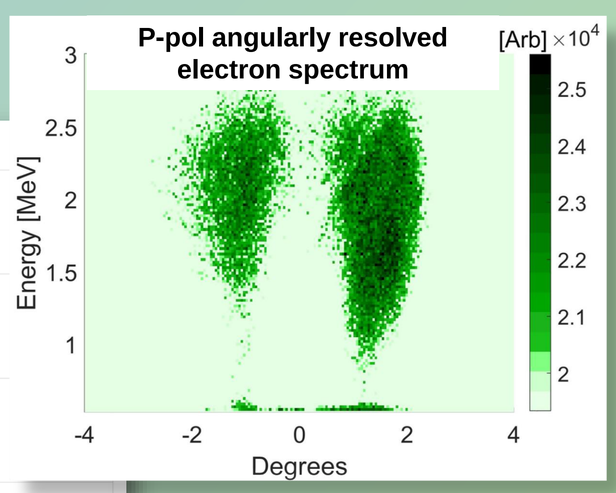
The main diagnostic is an angularly resolved electron spectrometer.

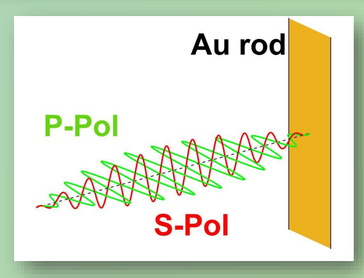


Experimental Observation

- A dramatic difference between P and S polarizations for electrons at $0°$ in relation to the laser propagation axis
- For P polarization, electrons are emitted in two lobes with a few degree separation between them



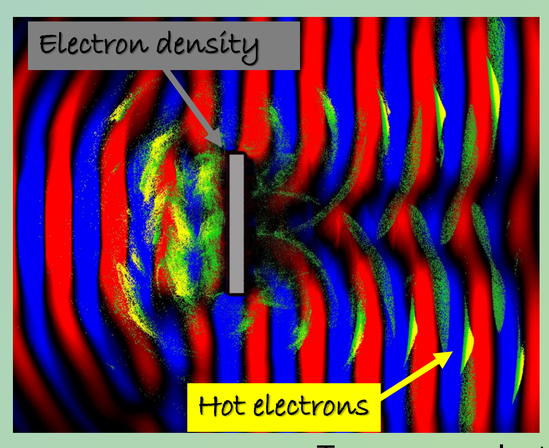


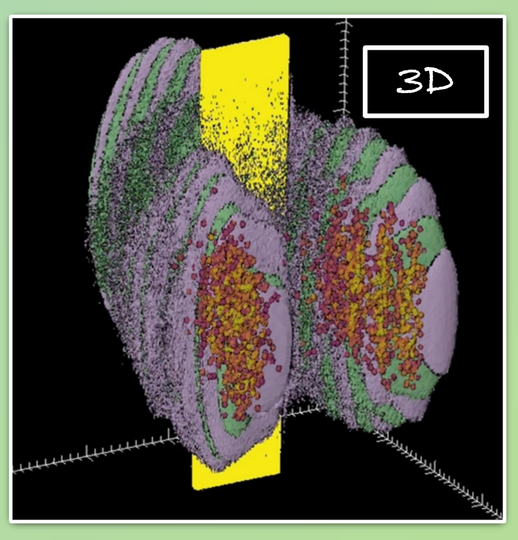


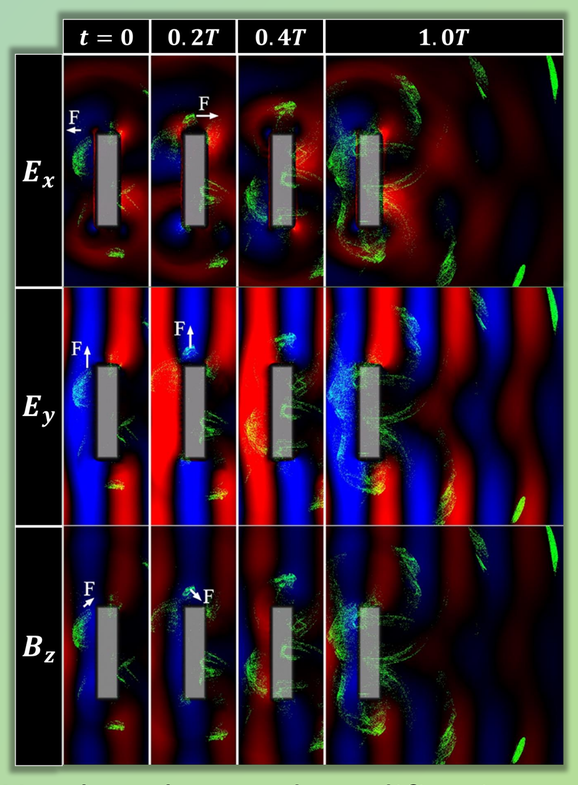
The Underlaying Dynamics Revealed by PIC

2D/3D PIC simulation with the EPOCH code

[C. S. Brady and T. A. Arber, Plasma Phys. Controlled Fusion 53, 015001 (2011).]







Step 1: The longitudinal field E_x pulls electrons from the front surface.

Step 2: The transverse field E_y pules them to the sideways.

Step 3: The magnetic field B_Z rotates them around the corner.

We also observed modifications to the electron spectrum by the laser field in vacuum, currently under study by Dr. David Blackman/UCSD.

Comparing different widths of rods from smaller-to larger-than the focal spot ($3.5\mu m$ in our experiment).