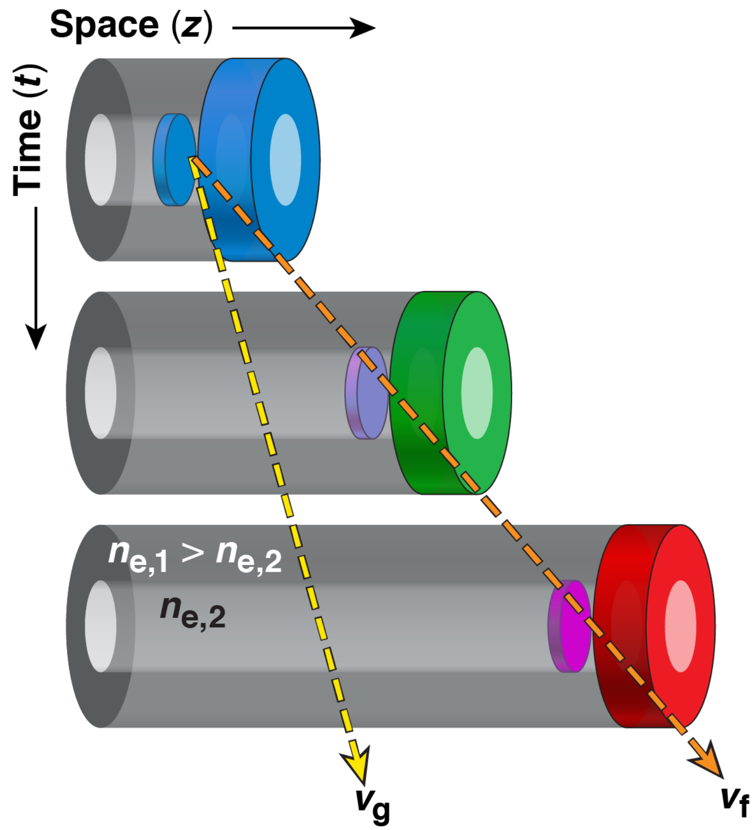
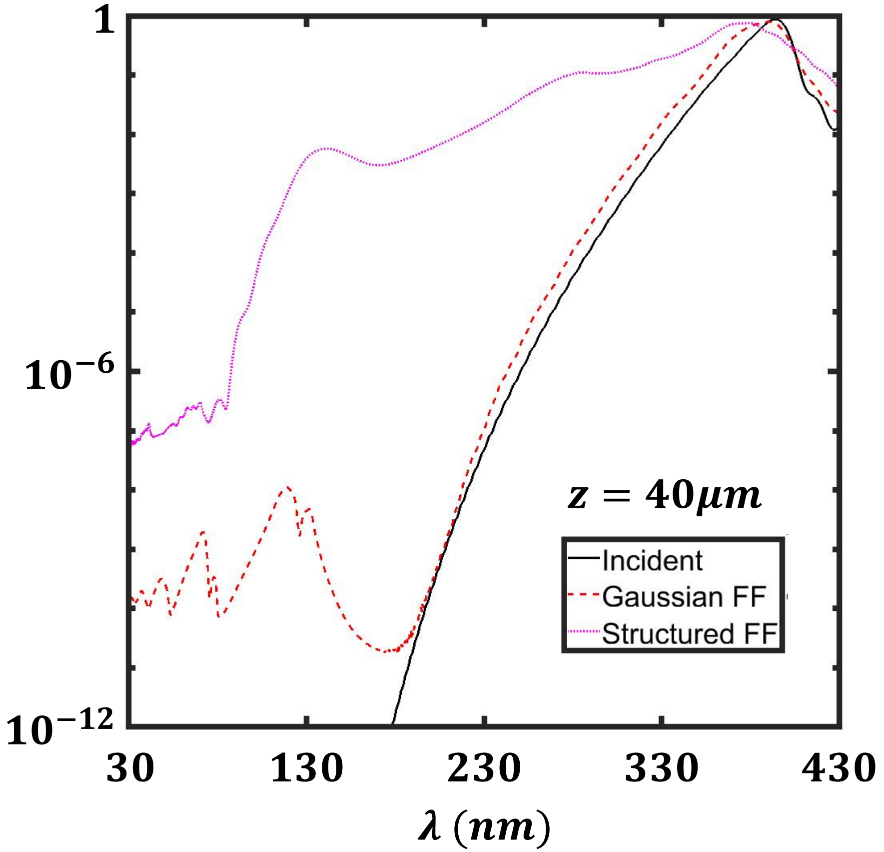
Dynamically Guided Self-Photon Acceleration

Structured flying focus



Energy Spectral Density (arb.)



Philip Franke
Laboratory for Laser Energetics
University of Rochester

62nd APS DPP
Virtual (Memphis, TN)
November 13th 2020

Summary

Structured flying focus pulses undergo self-photon acceleration, coherently shifting optical driver frequencies into the extreme ultraviolet (EUV)

- Sources of coherent EUV radiation provide novel experimental drivers and diagnostics across many scientific disciplines, including high energy density (HED) physics, atomic/molecular/optical (AMO) physics and materials science

- Combining spatiotemporal control with transverse intensity profile shaping increases the achievable frequency shift in a photon accelerator by steepening accelerating gradients and matching them to the velocity of the upshifted light over many Rayleigh lengths

- A dynamically guided self-photon accelerator can coherently shift 400nm driver light to <100nm wavelengths in less than 50μm of interaction length, a distance 200x shorter than previous results using spatiotemporal shaping alone*

* A. J. Howard, et. al. Phys. Rev. Lett. 123, 124801 (2019).

Collaborators

J. P. Palastro*, D. Ramsey**, T. T. Simpson†, D. Turnbull and D. H. Froula

University of Rochester

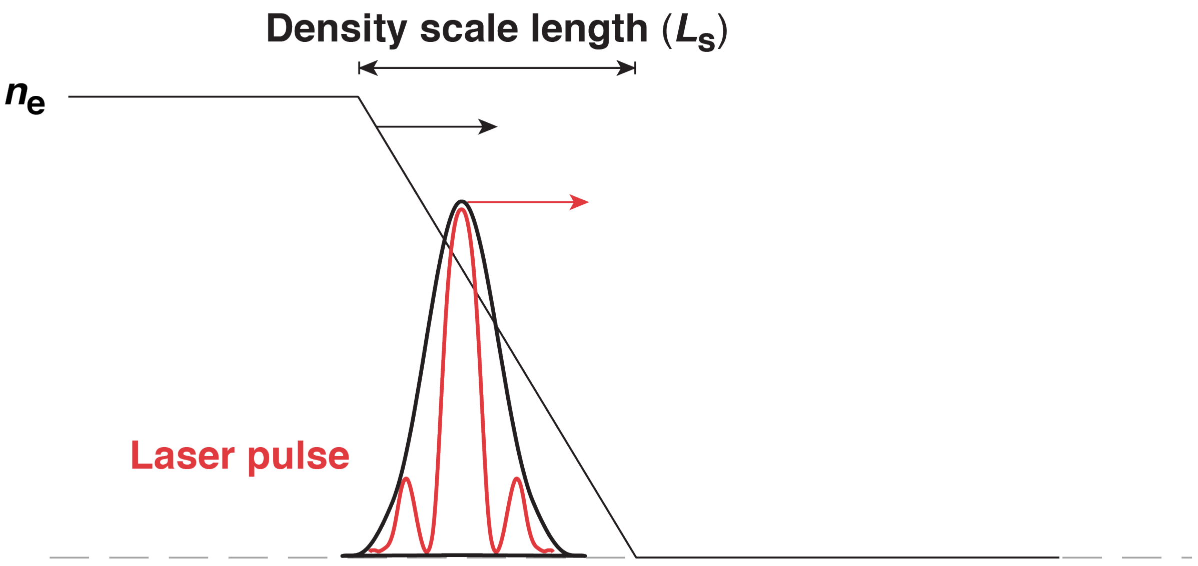
Laboratory for Laser Energetics

* MR01.00001 : Laser-Plasma Interactions Driven by Spatiotemporally Structured Light Pulses

** JO04.00009 : Vacuum Acceleration of Electrons in a Dynamic Laser Pulse

† NO08.00001 : Nonlinear Spatiotemporal Control of Laser Intensity

The achievable frequency shift in a conventional photon accelerator is limited by short interaction lengths



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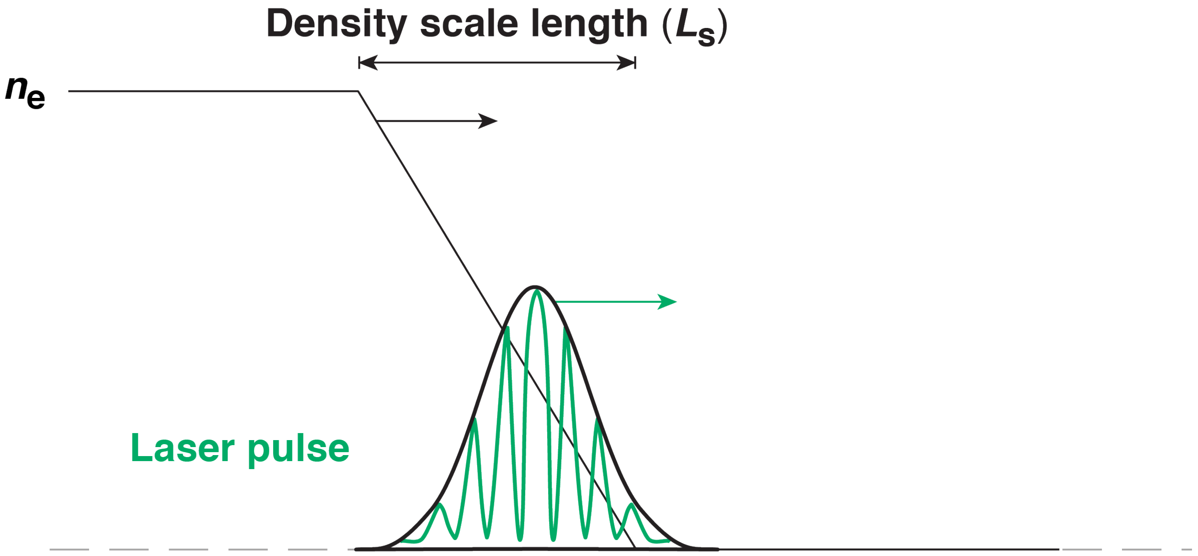

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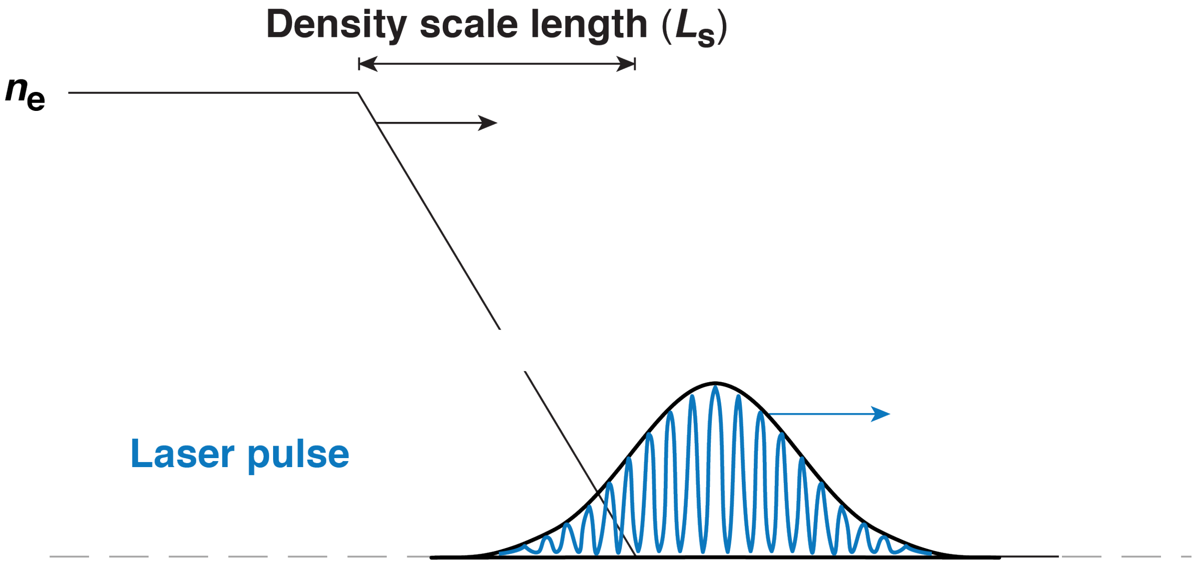

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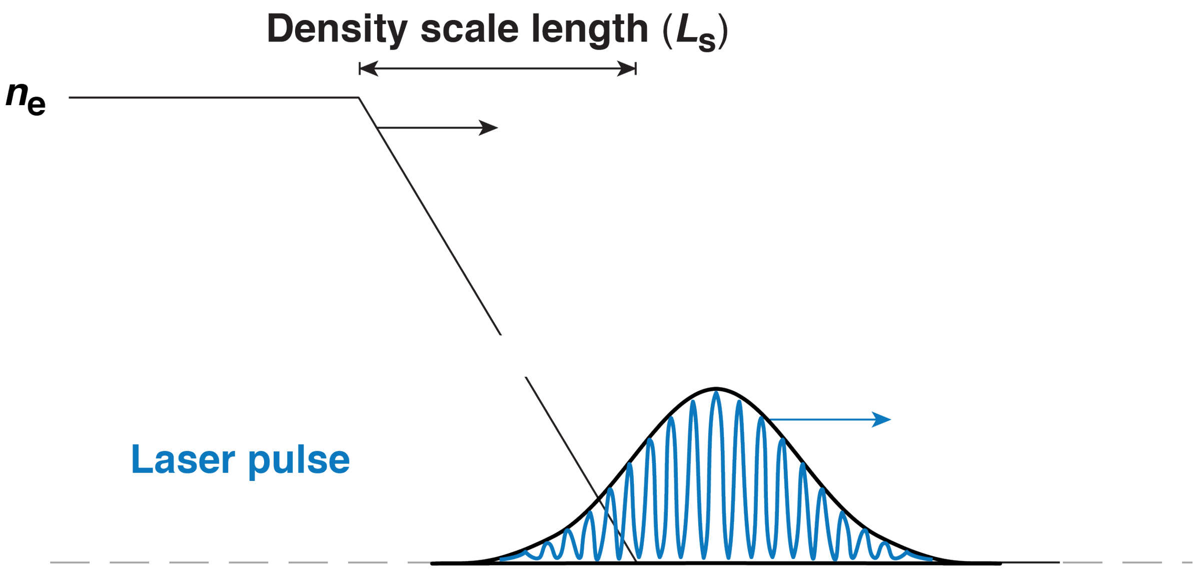
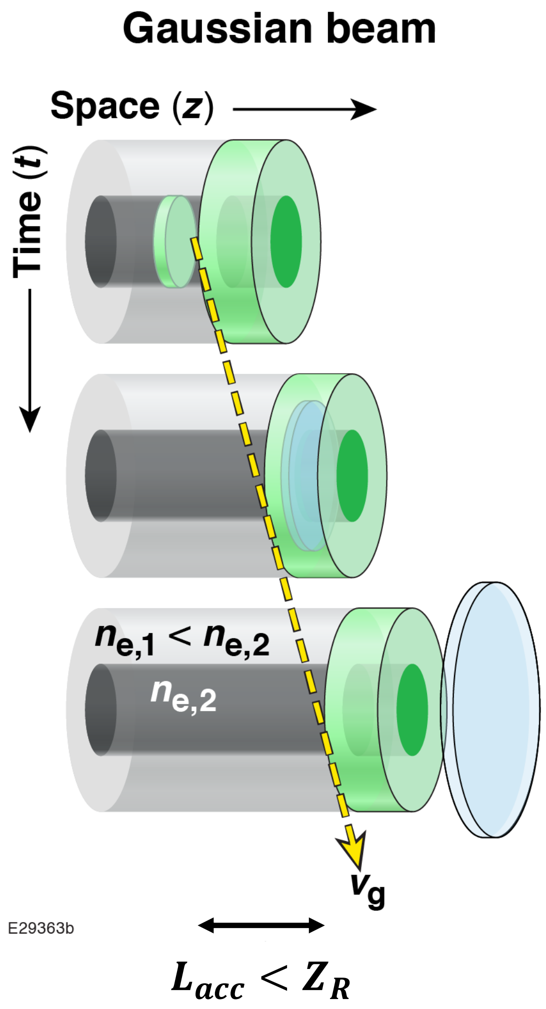
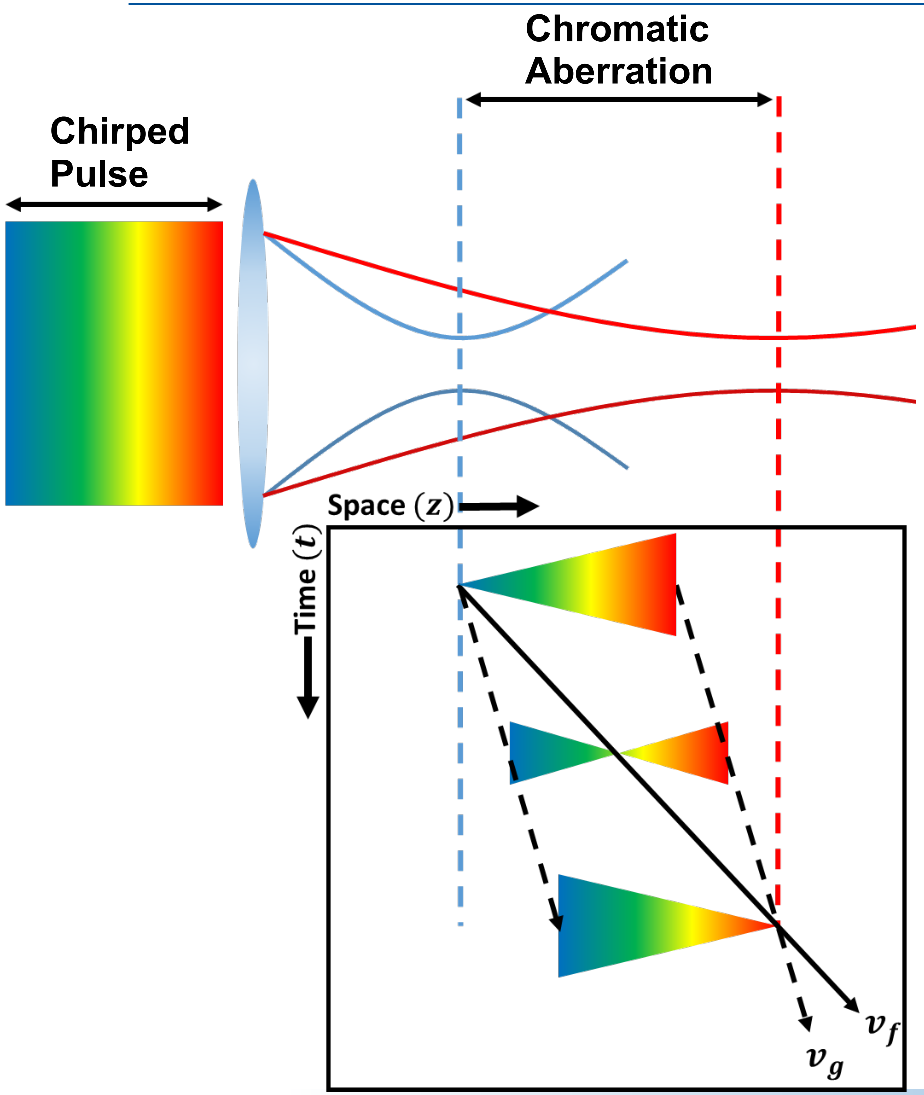




Spatiotemporal shaping combined with transverse intensity profile shaping traps light in sharp accelerating gradients over long distances



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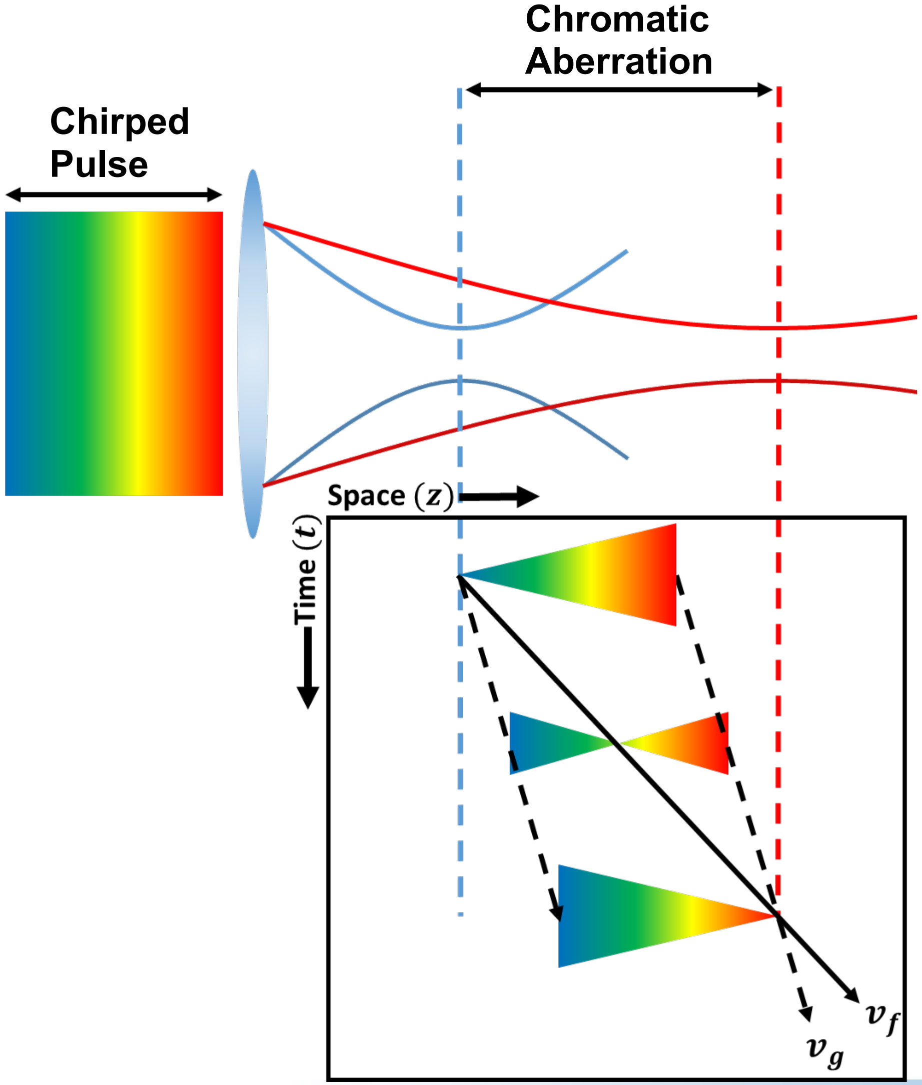

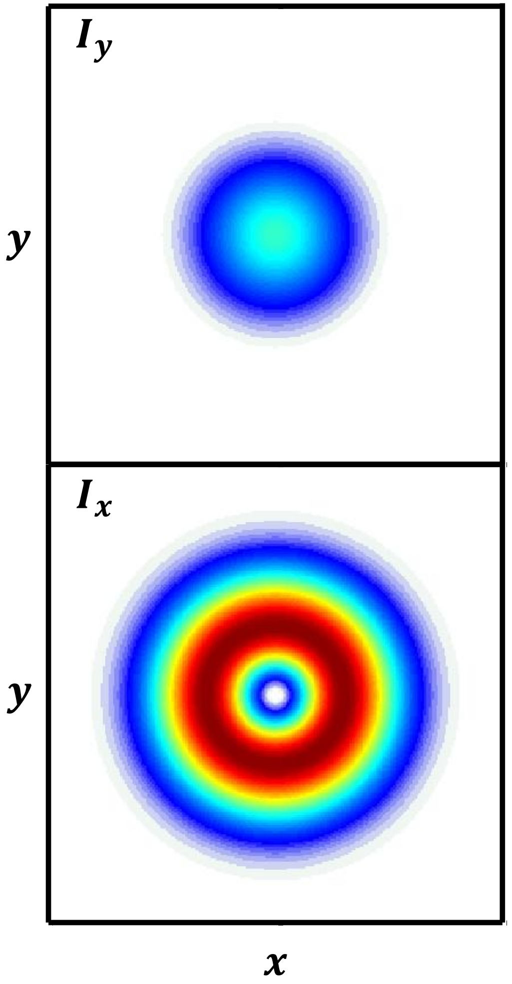

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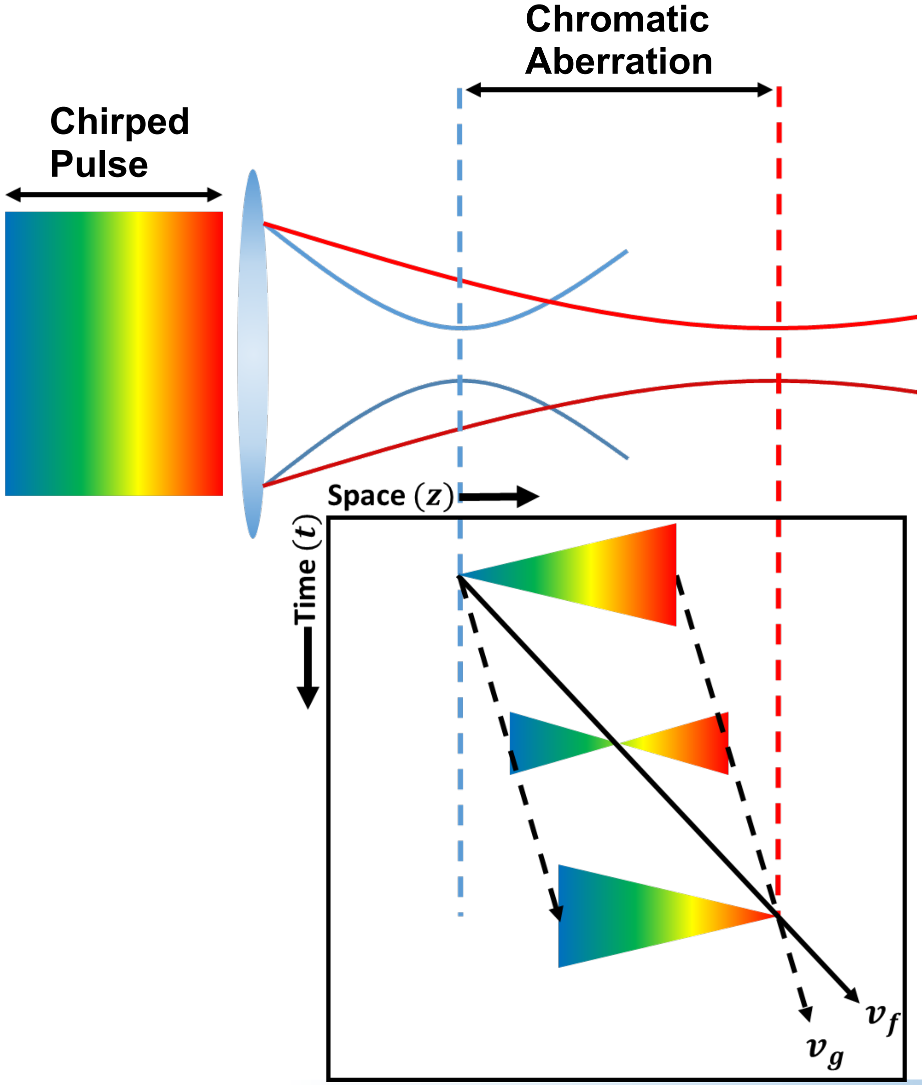

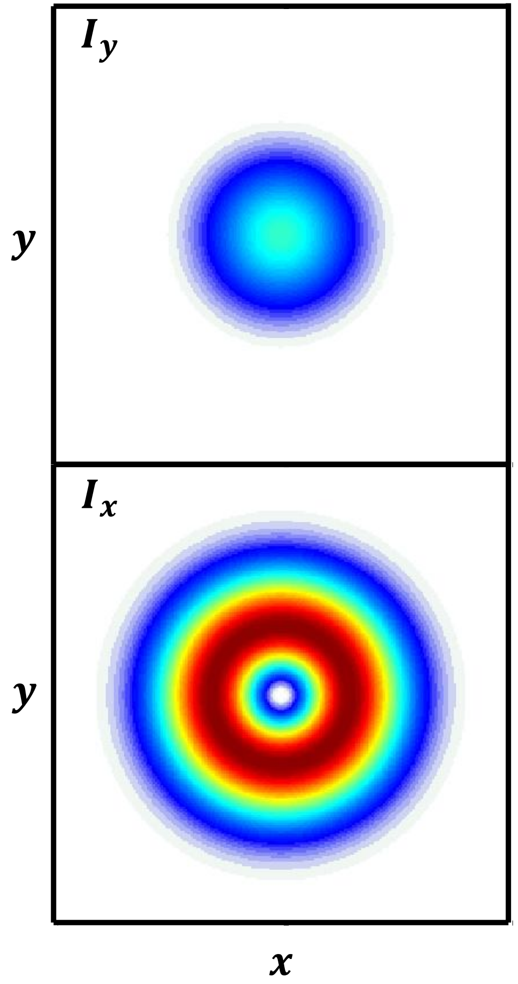

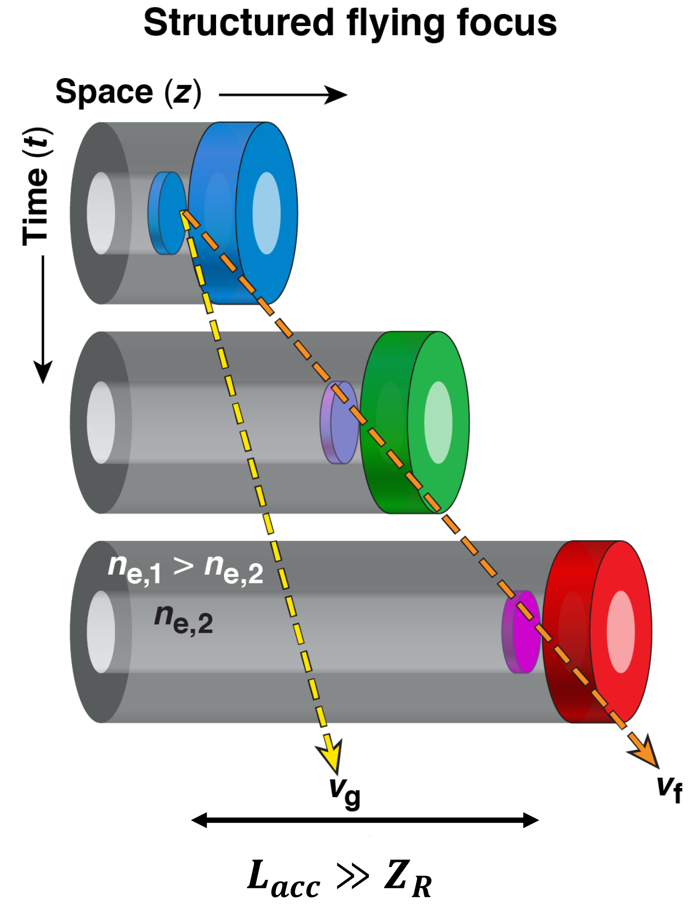

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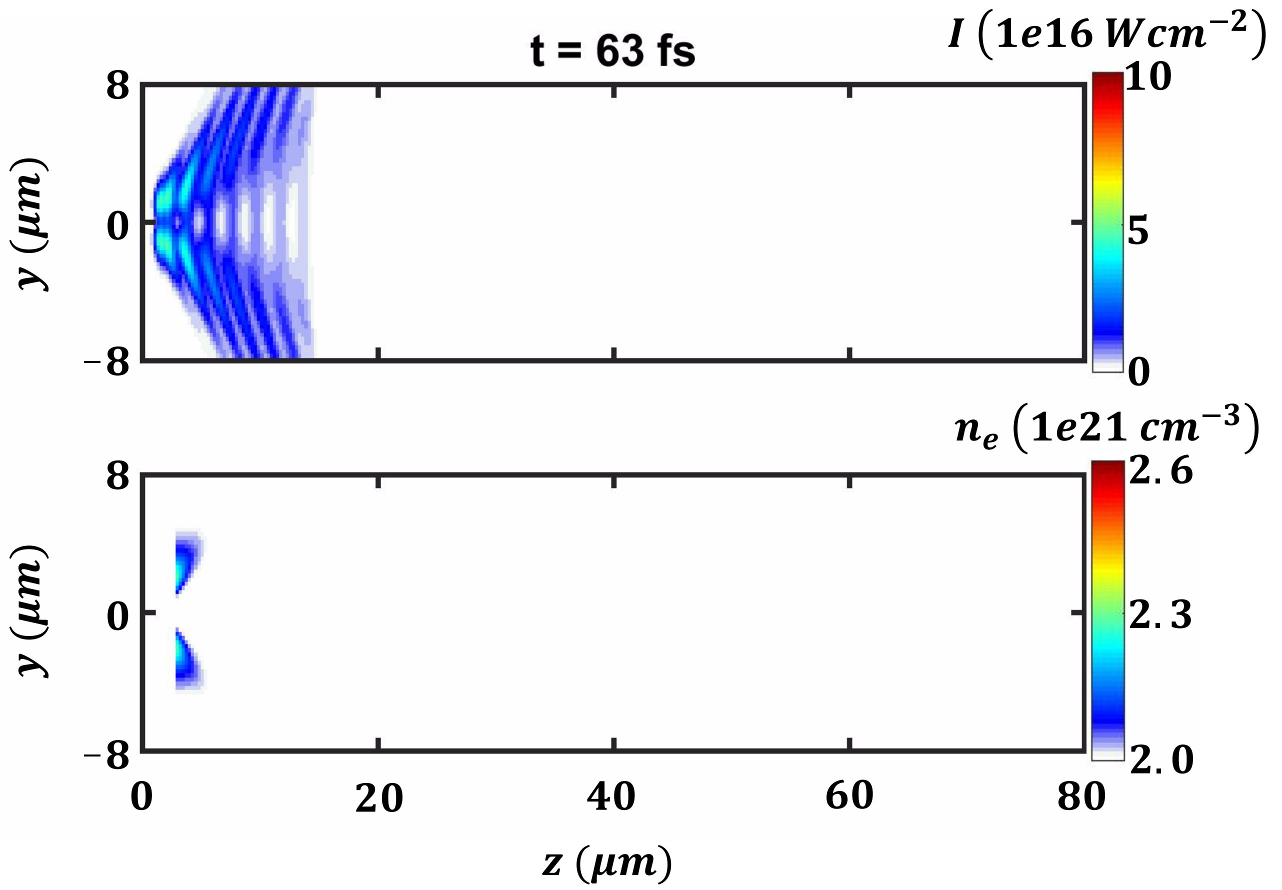
Ultrashort, structured, flying focus pulses interacting with preionized nitrogen gas were simulated using a 2D finite-difference time-domain method



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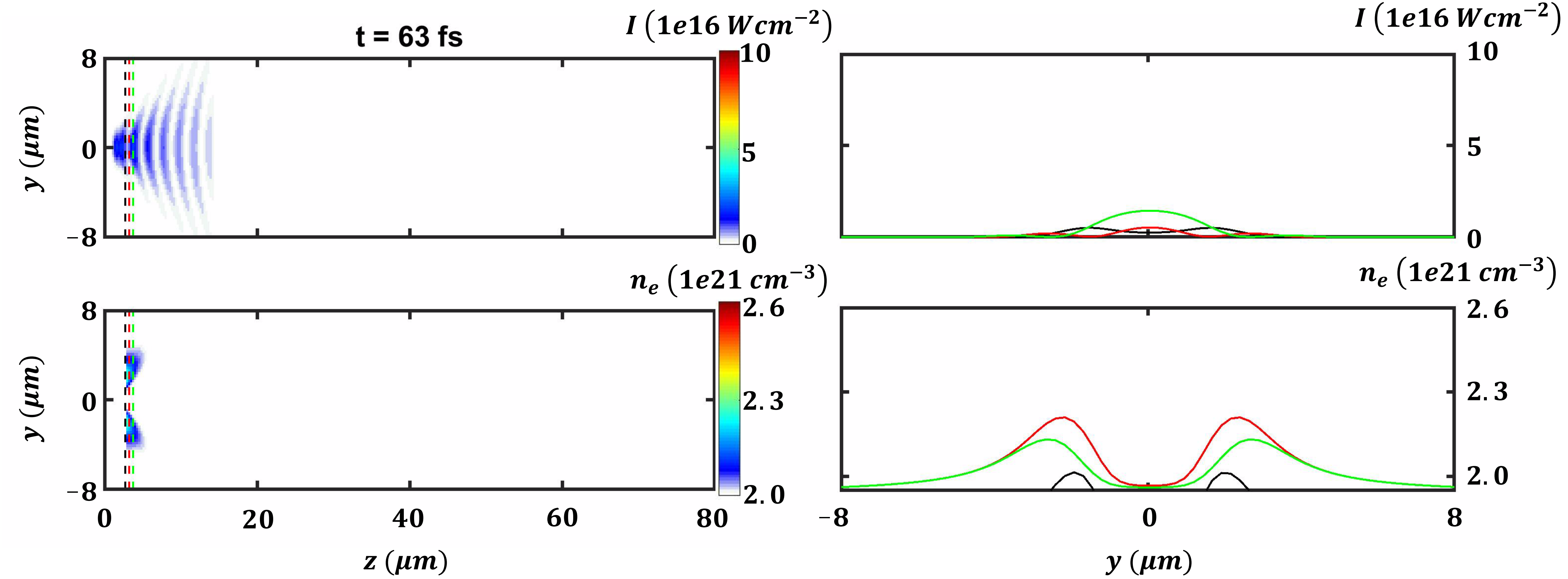
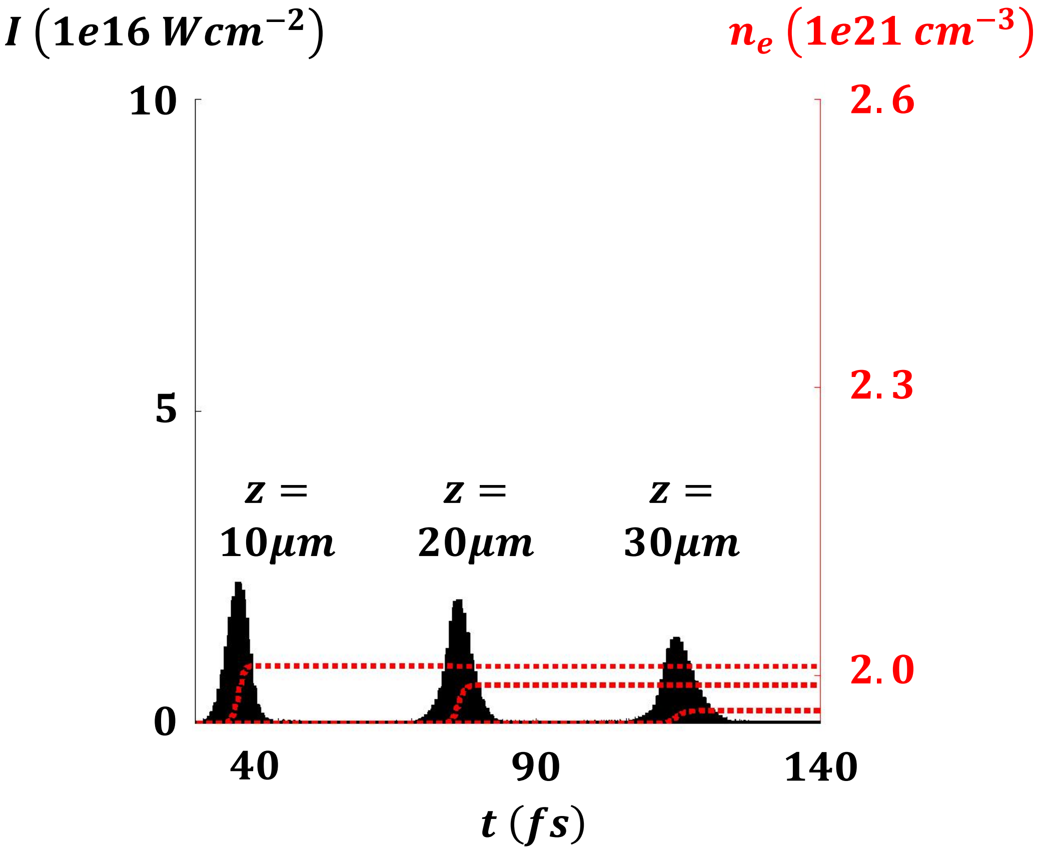


Combined shaping leads to frequency shifting and self-steepening of the ionizing beam, sharpening accelerating gradients

Gaussian Beam



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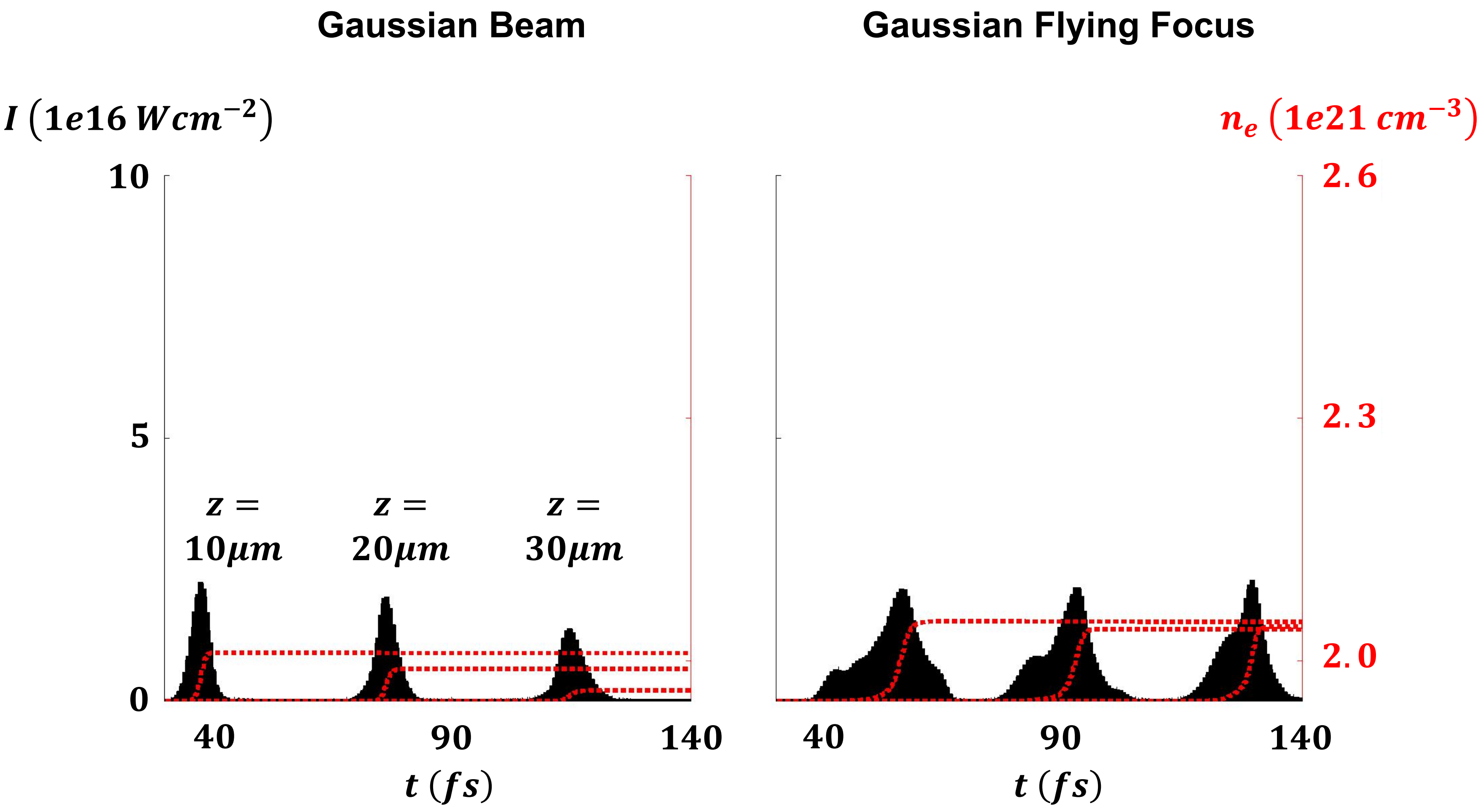

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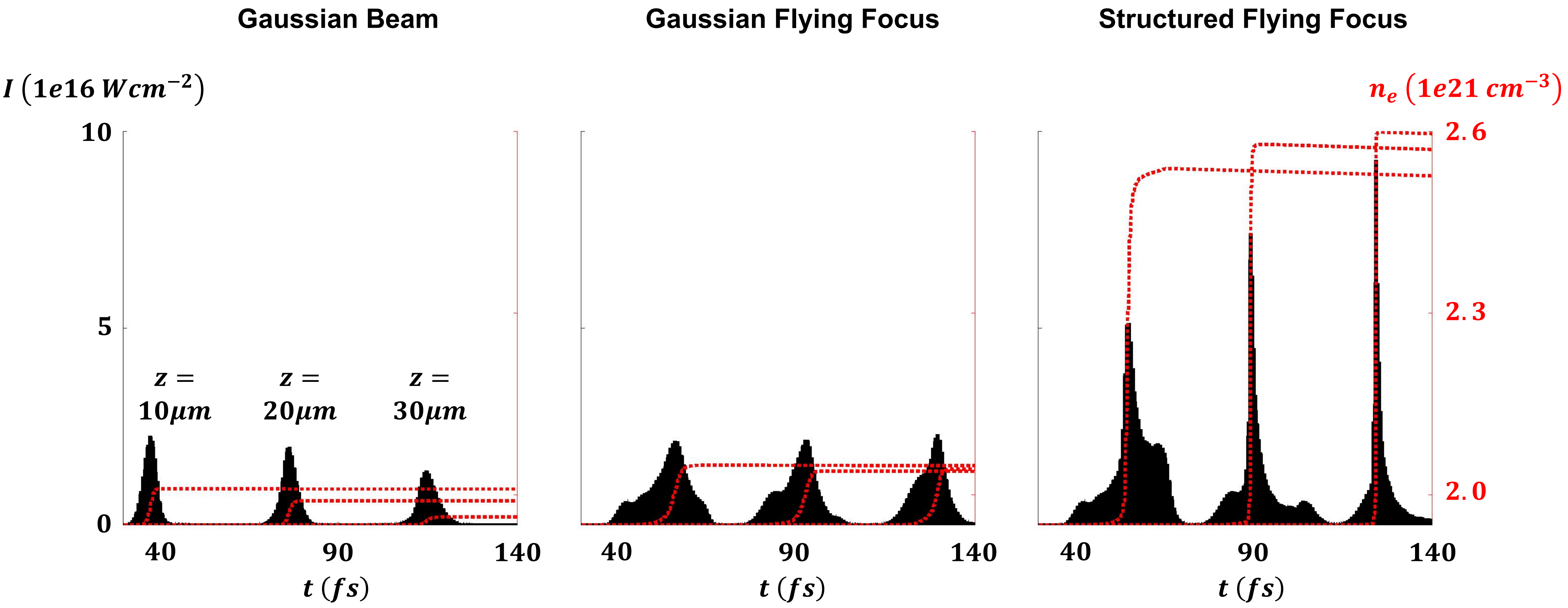
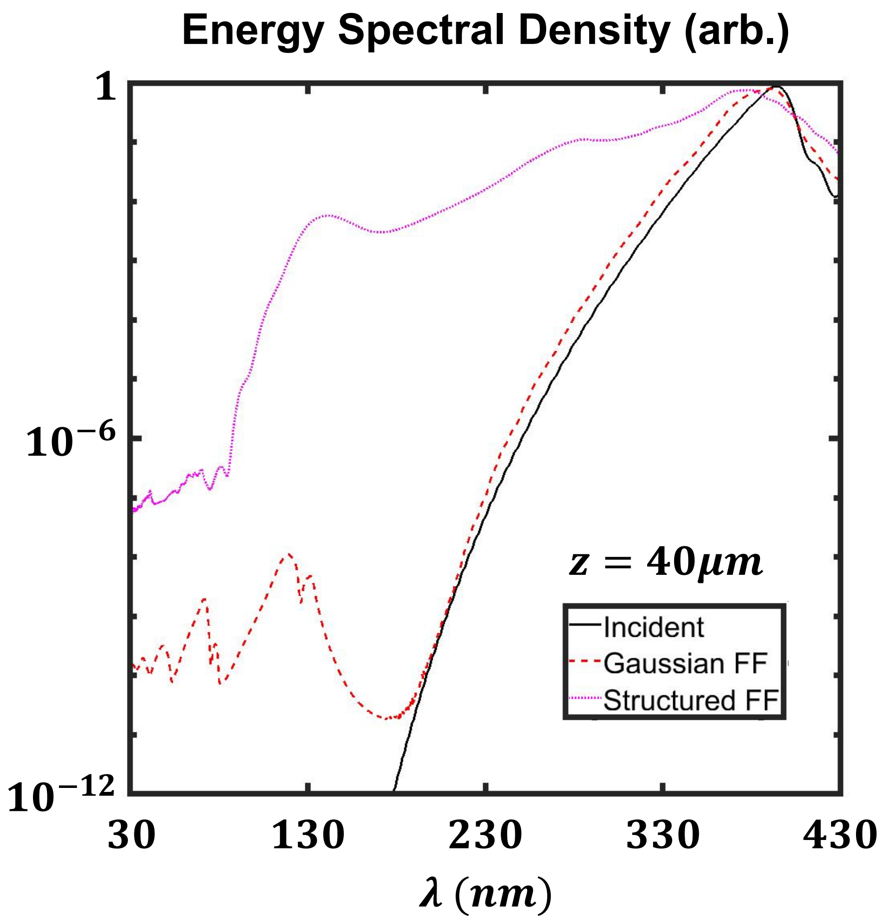


Photon acceleration coherently shifts driver energy from optical to EUV frequencies over short interaction lengths



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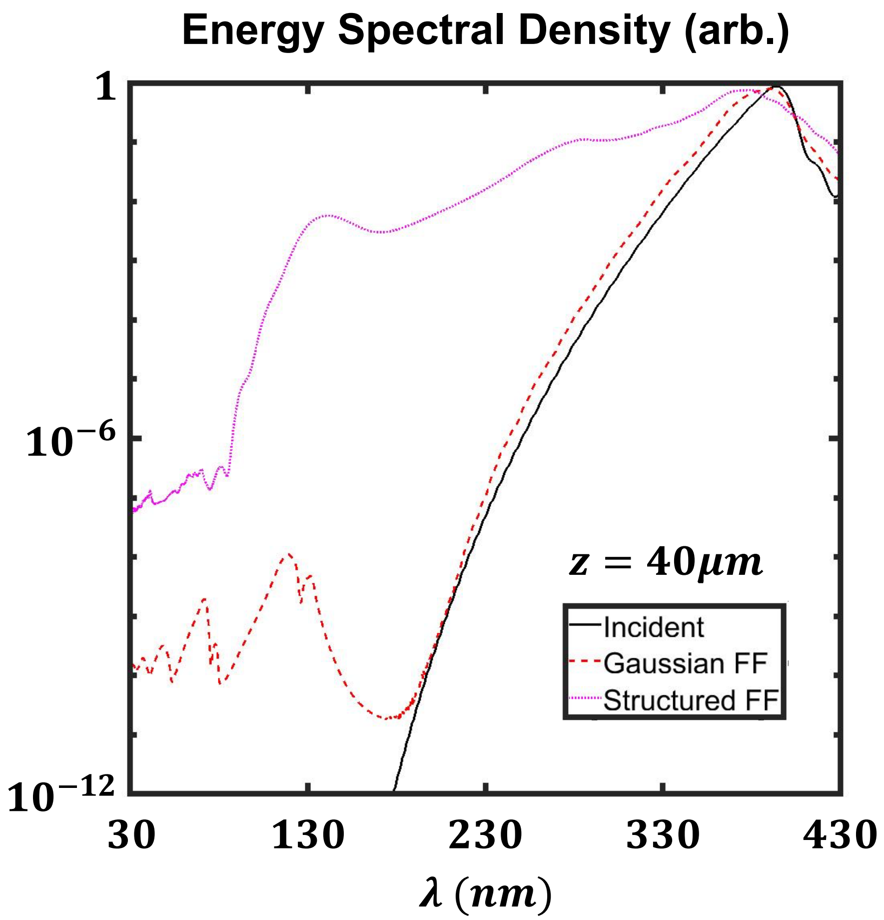
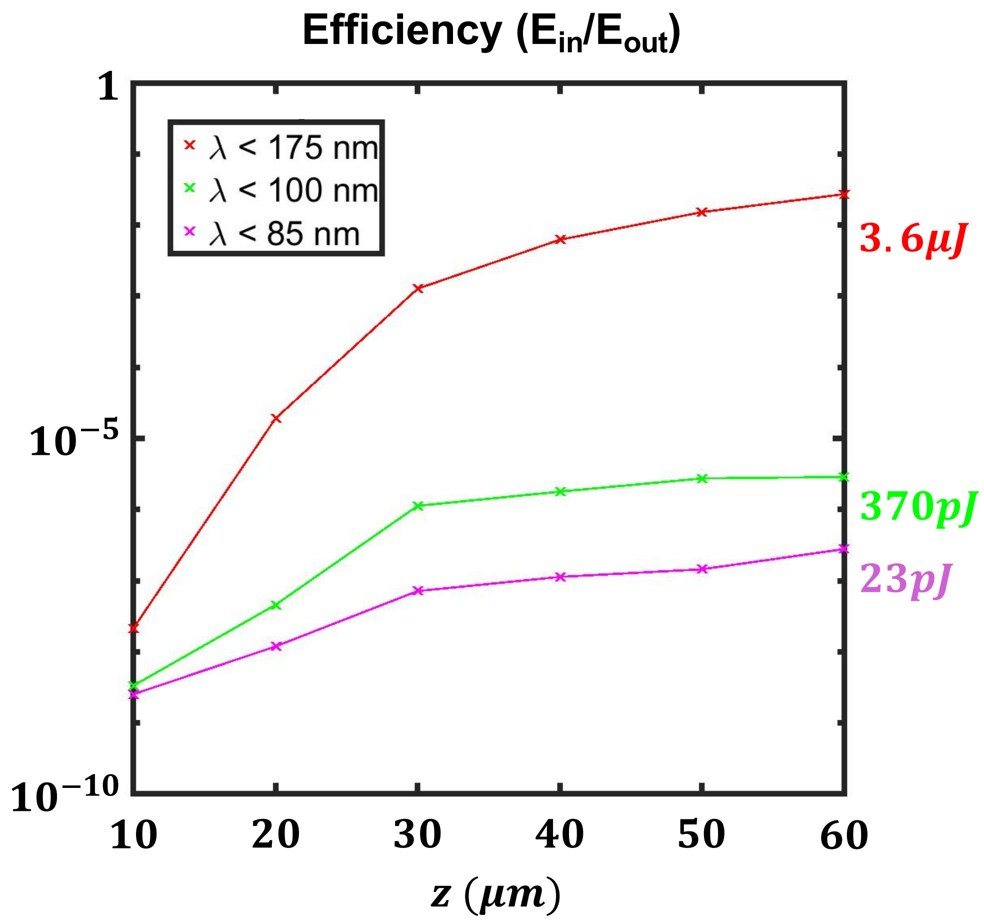
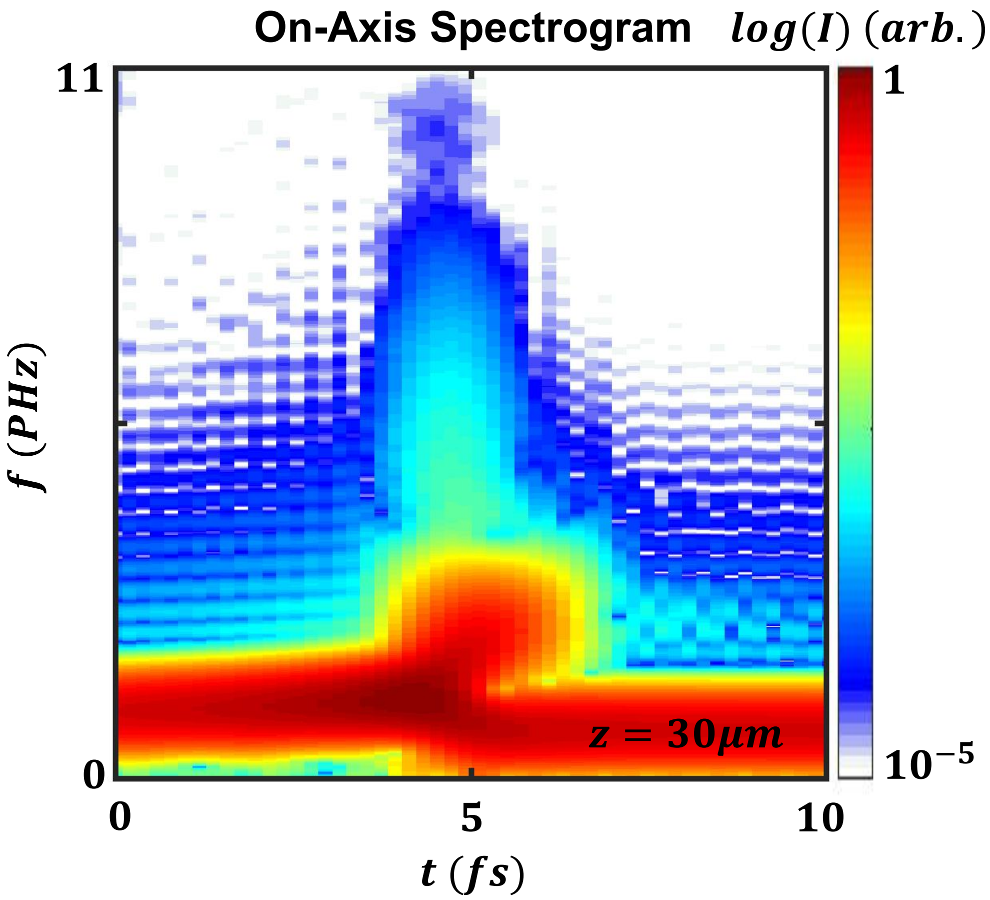




Broad bandwidths in the EUV support sub-femtosecond pulses that can be isolated through spectral filtering



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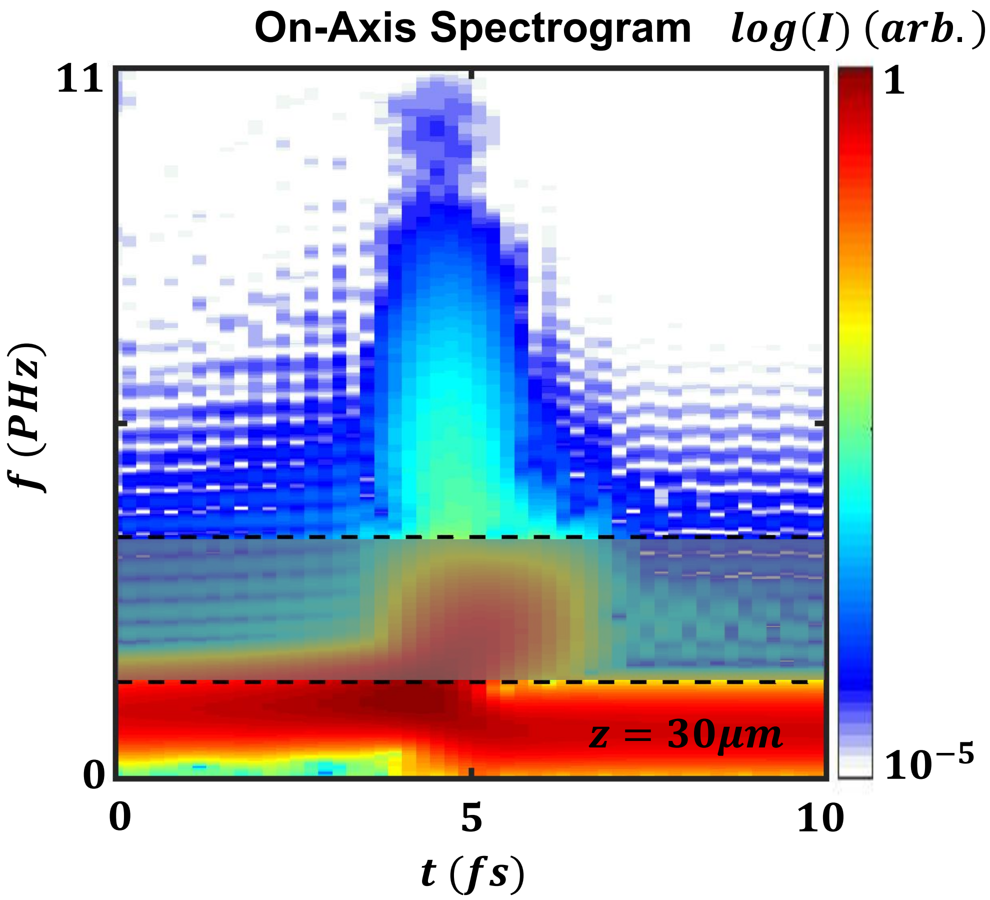

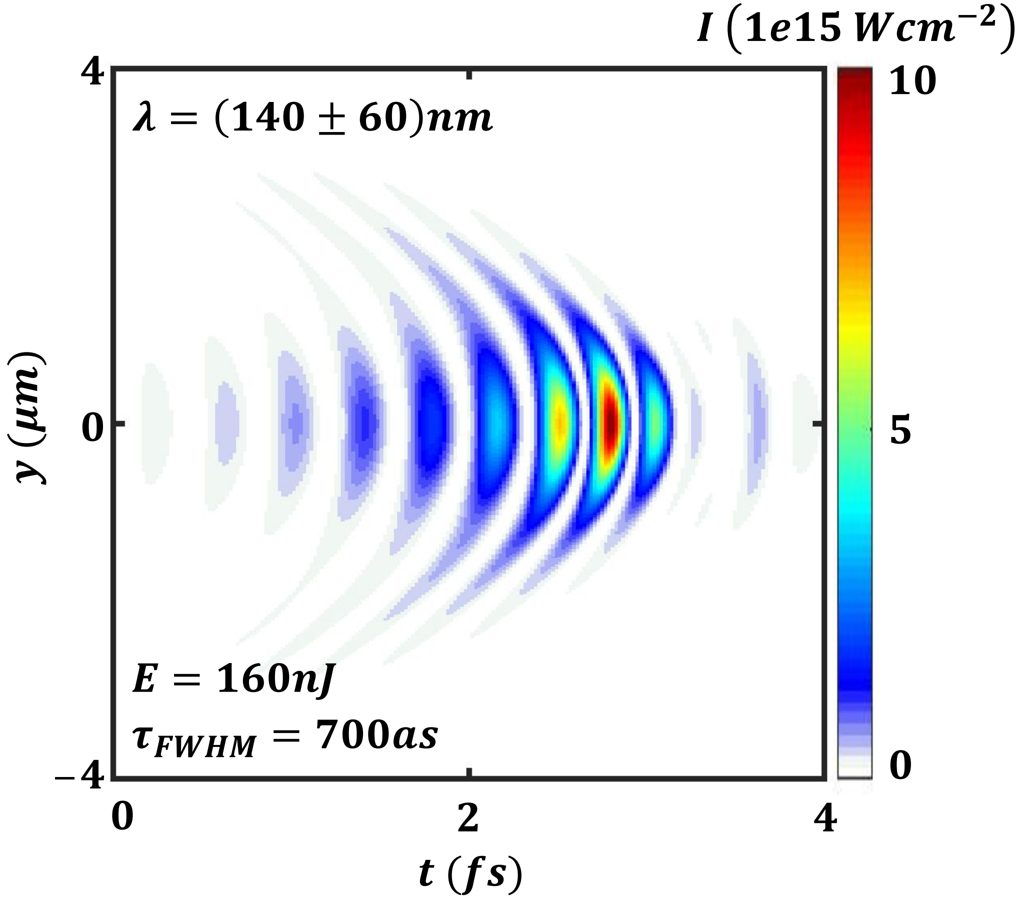

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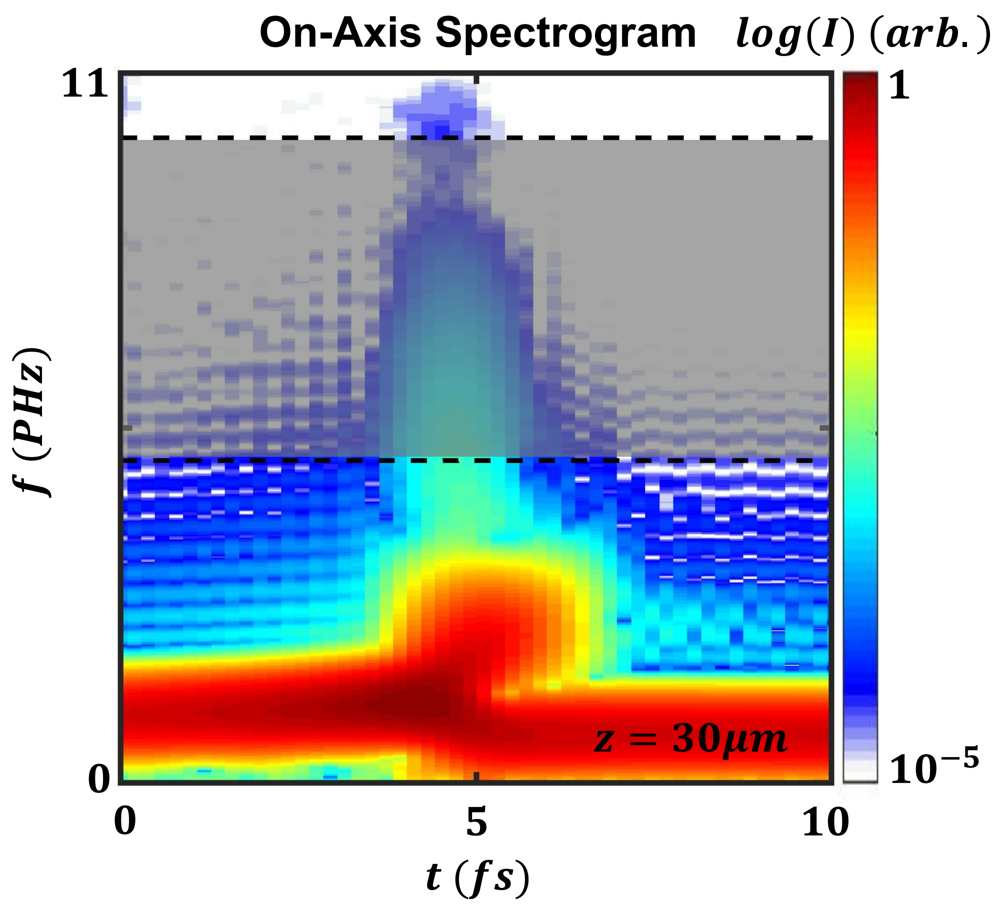

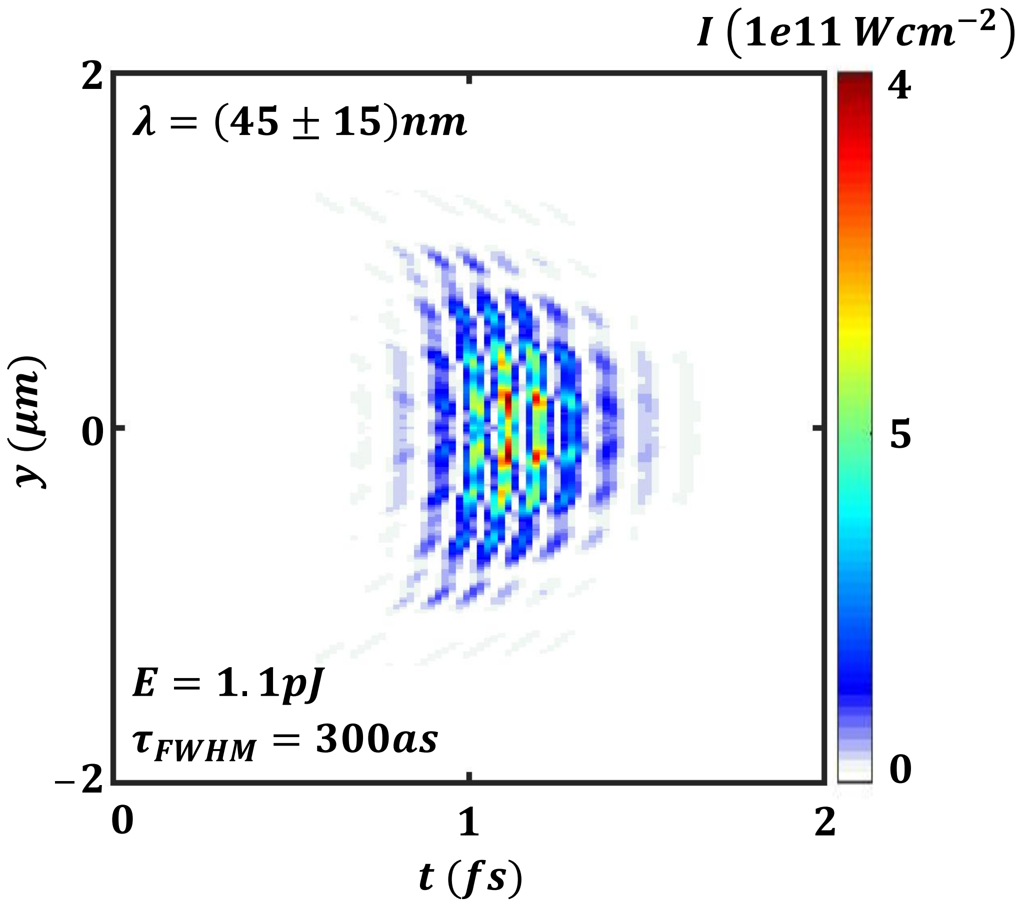

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An optimized photon accelerator could provide an efficient source of coherent EUV radiation and intense, isolated, sub-fs pulses

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