

Aug. 2018

Relativistic, single-cycle tunable-infrared pulses

- 1) Concept
- 2) Experiments

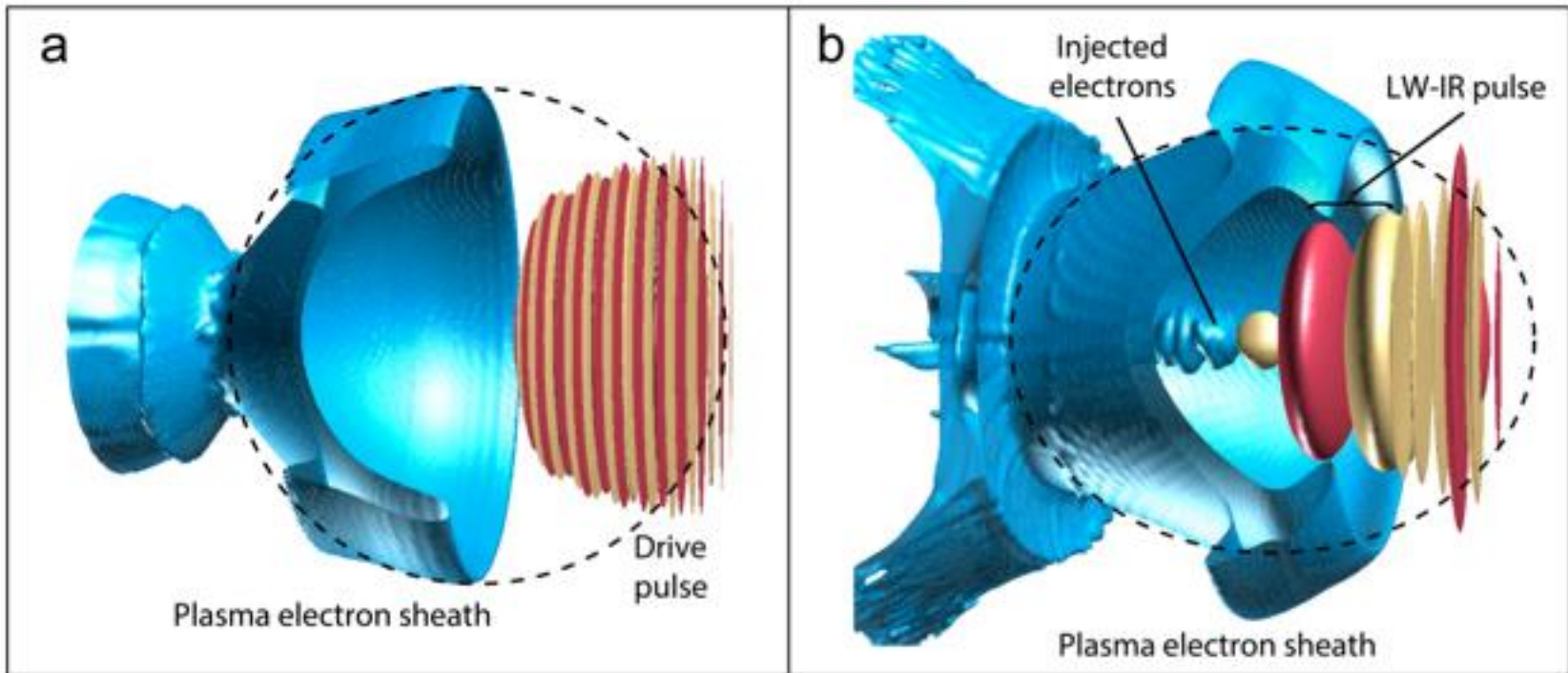


Z. Nie,¹ C.-H. Pai,¹ J. F. Hua,¹ C. J. Zhang,² Y. P. Wu,¹ Y. Wan,¹ F. Li,² J. Zhang,¹ Z. Cheng,¹
 Q. Q. Su,¹ S. Liu,¹ Y. Ma,¹ X. N. Ning,¹ Y. X. He,¹ W. Lu,¹
 H.-H. Chu,³ J. Wang,^{3,4,5}
 W. B. Mori,² and C. Joshi²



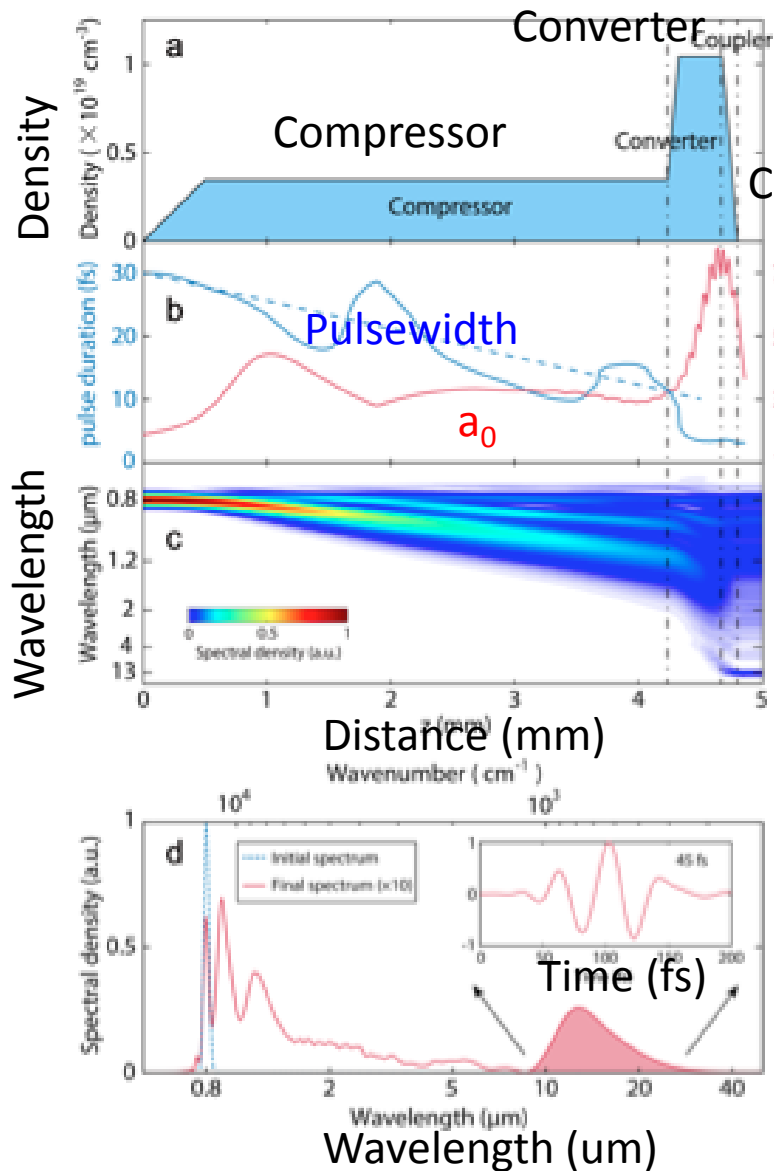
Concept: Asymmetric SPM and GVD using a plasma wake

Need a 10 fs laser pulse with $a_0 > 4$ and $n_p \sim 2 \times 10^{19} \text{ cm}^{-3}$



Continuous frequency downconversion in a density (refractive index) gradient.

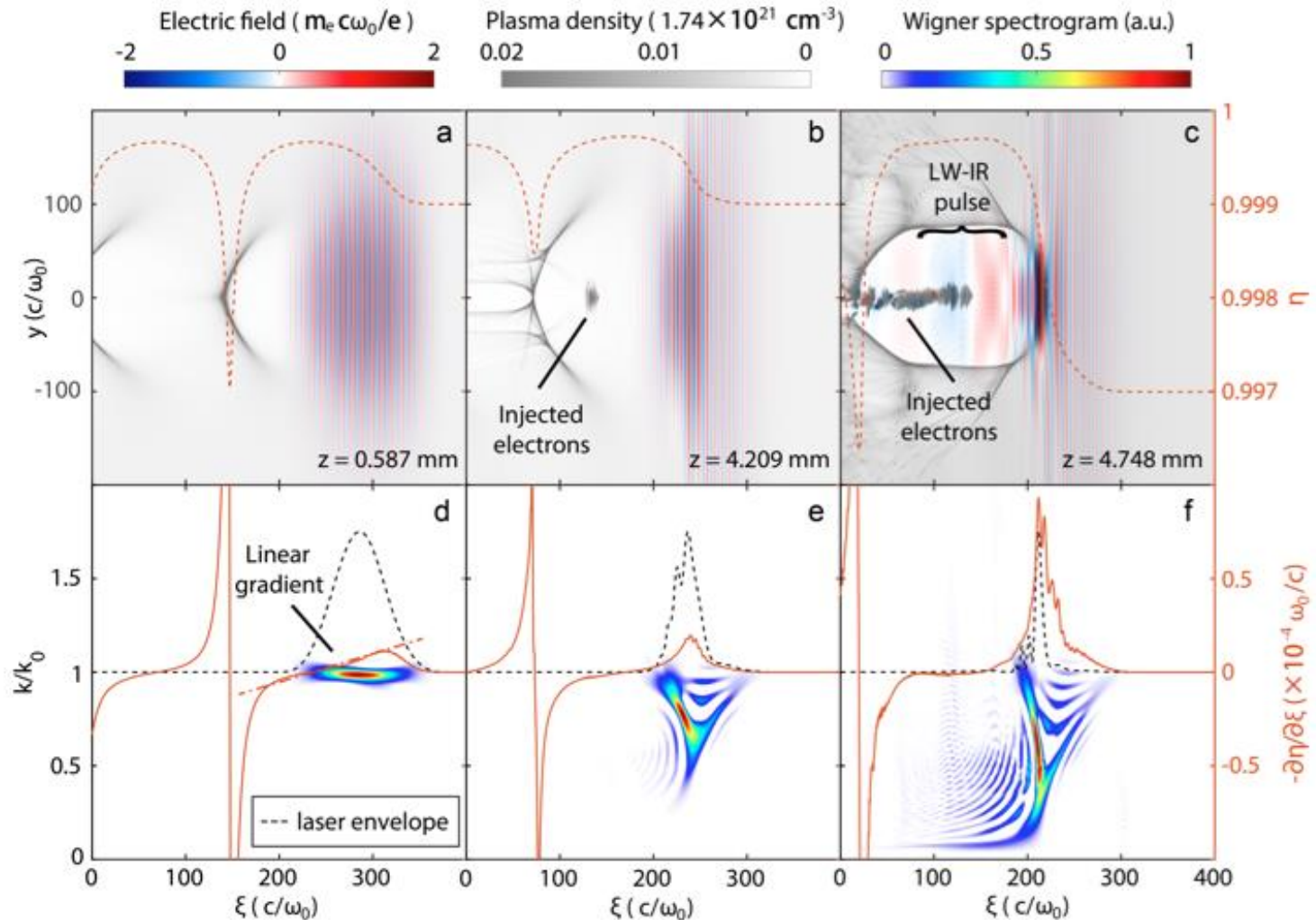
Use a Plasma Density Structure : Density up-ramp.



Different regions of the structure perform different functions

- 1) Compressor compresses the pulse from 30-10 fs by SPM/GVD
- 2) Converter rapidly down converts the pulse while further compressing it. The a_0 of the pulse rapidly increases
- 3) The longest wavelength components slip back by GVD into the cavity where they are phase locked to form a near transform limited pulse
- 4) The pulse width is 1-2 cycles

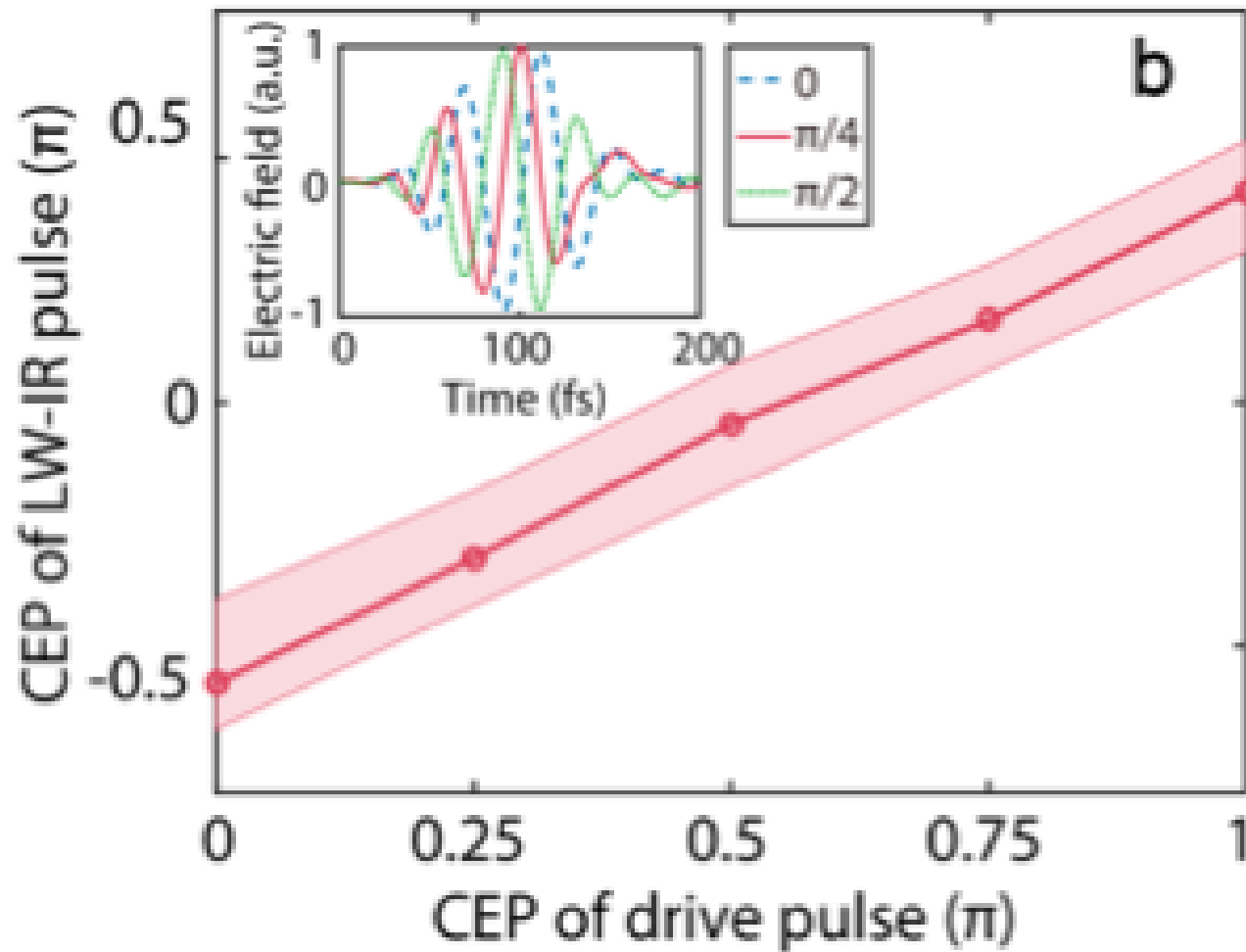
Spectral Evolution of the Pulse Using Wigner Transform



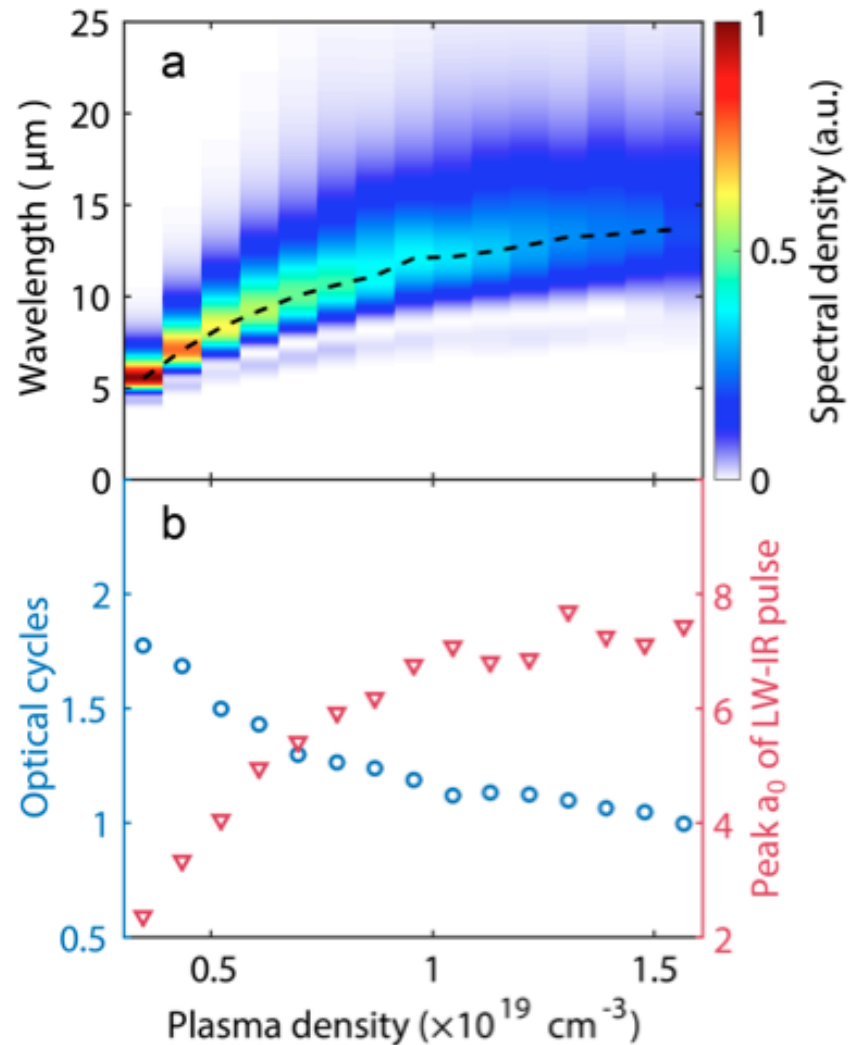
Beginning of Compressor

Beginning and End of Converter

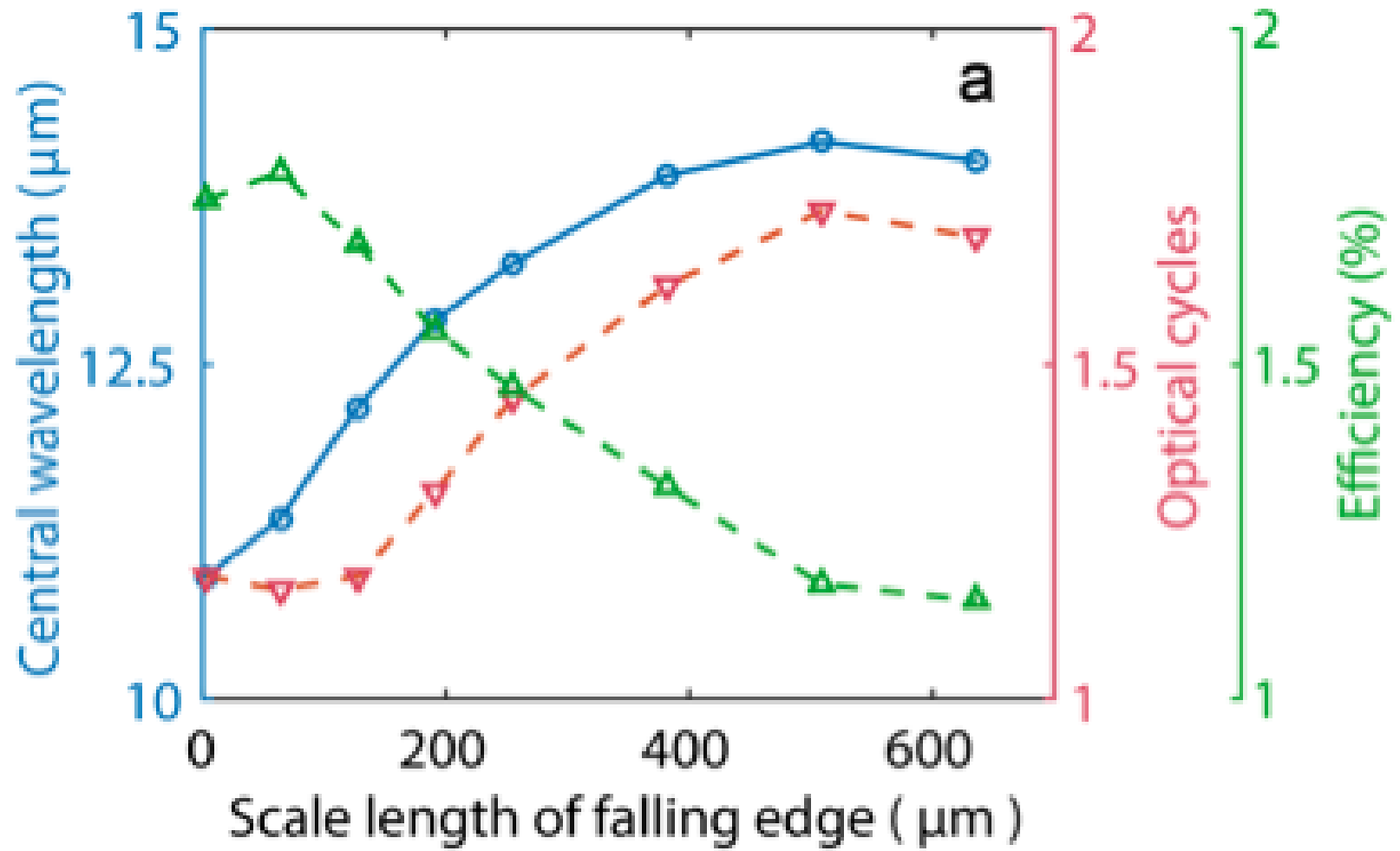
Carrier Envelope Phase Locking



Effect of varying Plasma Density in the Converter Module



Control offered by the Coupler module



Conclusions

- Using a density up-ramp structure, PWFA in the blow-out regime can generate
- Tunable (6-14 μm)
- Relativistic ($\gamma \gg 1$)
- One-two cycle
- CEP locked with pump
- Radiation by optimizing A-SPM and GVD.
- Concept Paper published in Nature Photonics
- Experiment have been done: still being analyzed