

E338: FY23 Status and plans for FY24

FACET-II User Meeting

A. Marinelli on behalf of the E338 Collaboration October 19th, 2023, SLAC

October 19th 2023 / SLAC National Accelerator Laboratory



Outline

- PAX Overview
 - Concept
 - The PAX experiment at FACET-II
- Physics results since FY22
 - Harmonics
 - Coherent Control (polarization switching)
 - Beam shaping
- Installation updates
- Timeline and outlook for upcoming experiments

Collaboration

SLAC

C. Emma, R. Hessami, R. Robles, K. Larsen, J. Morgan, G. White, M. Hogan, A. Marinelli

UCLA – EE

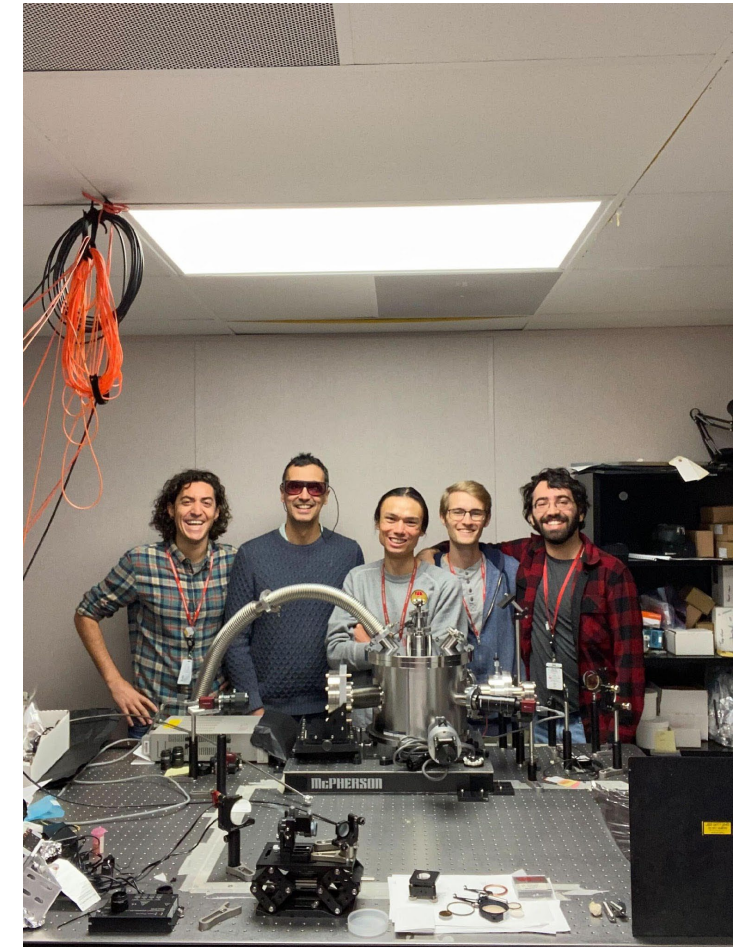
C. Zhang, C. Joshi

UCLA - PAB

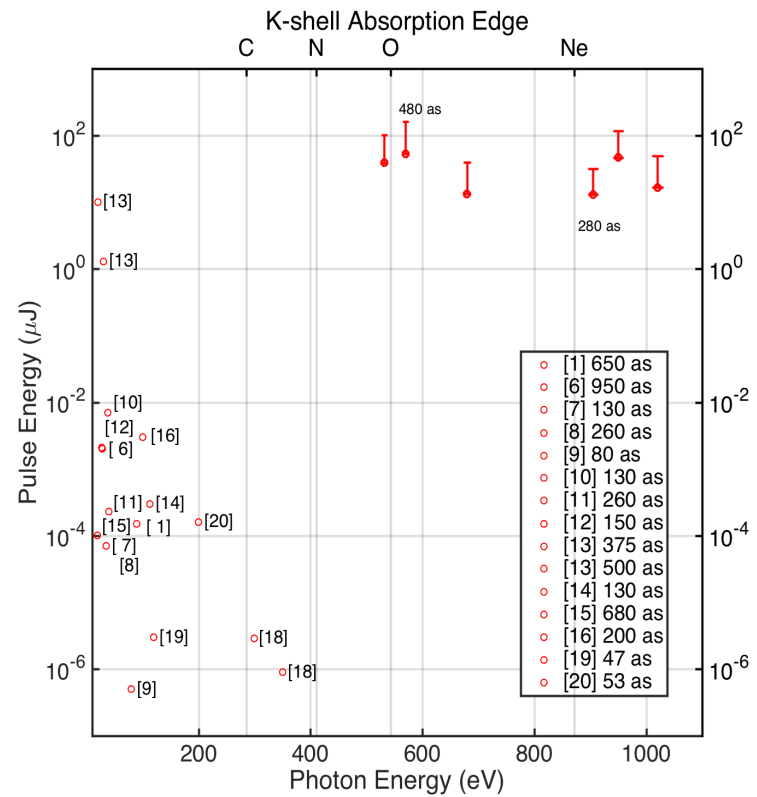
A. Fisher, P. Musumeci

Synergy with E31X Collaboration

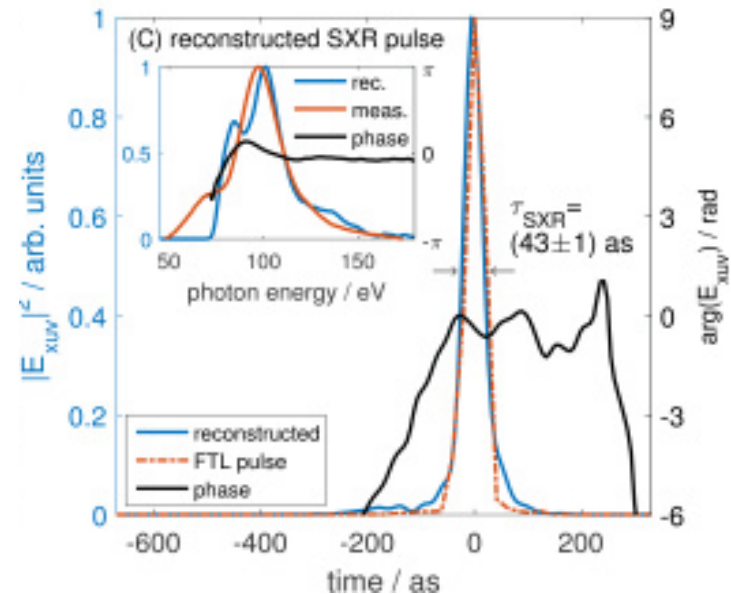
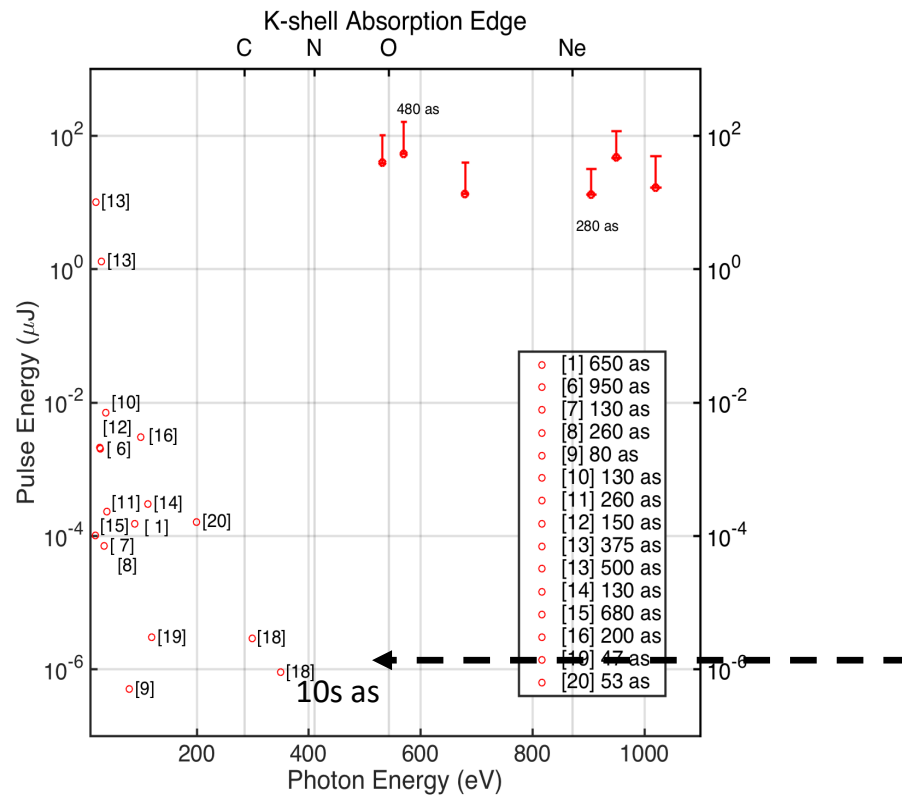
(J. Rosenzweig, B. Hidding and others)



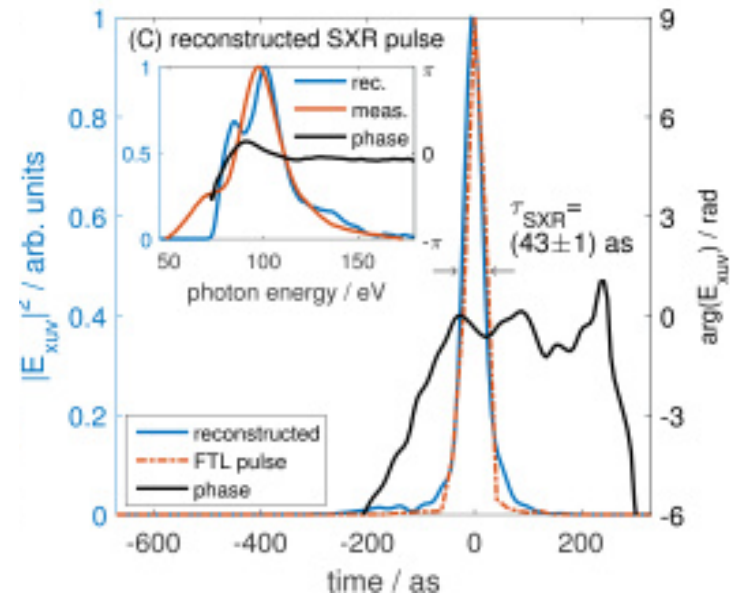
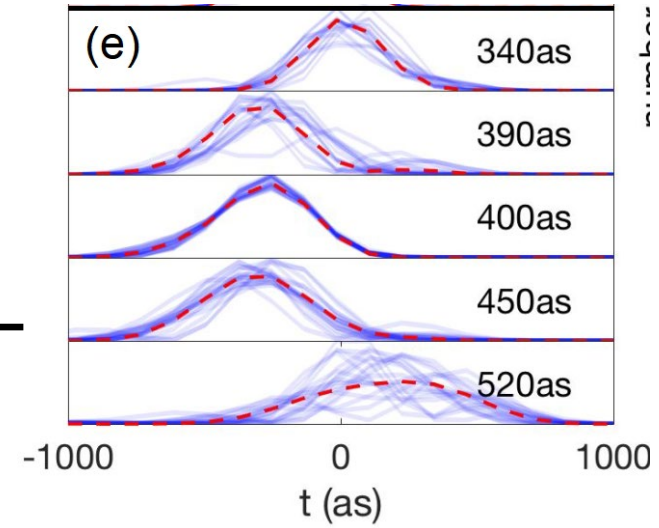
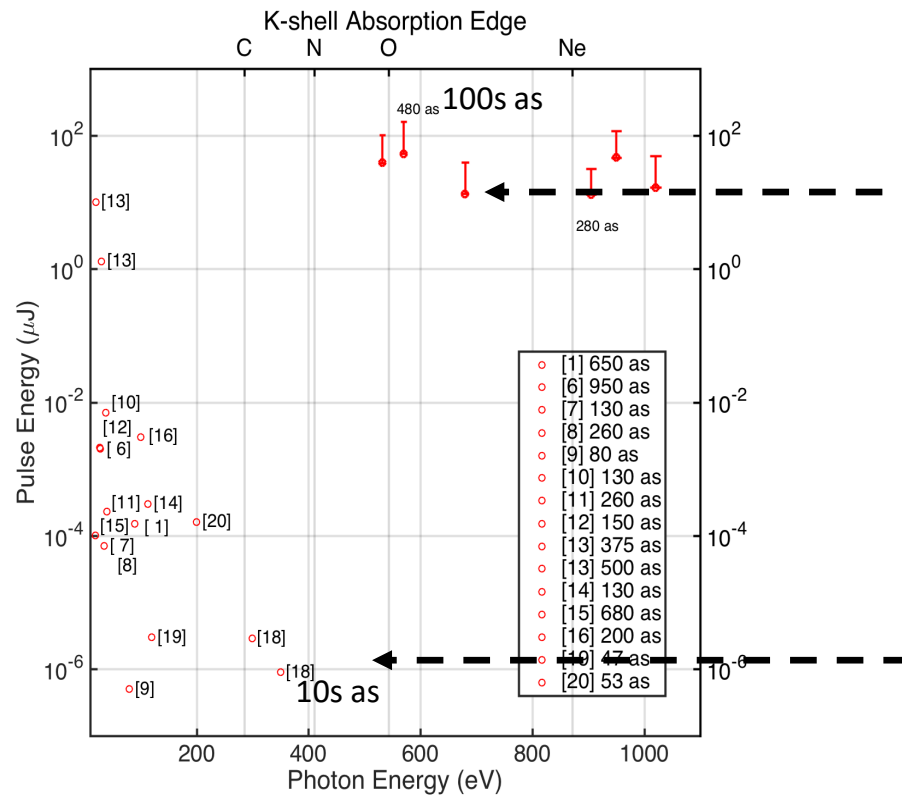
Why Plasma-Based Attosecond Pulses?



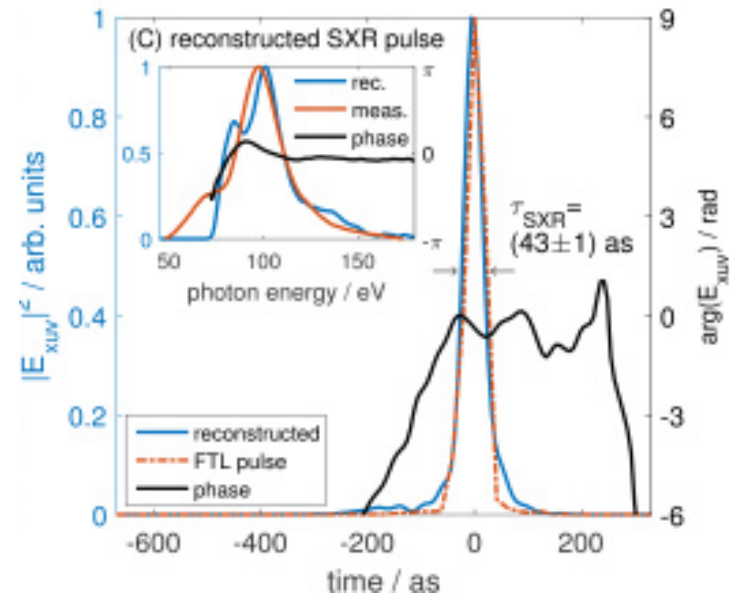
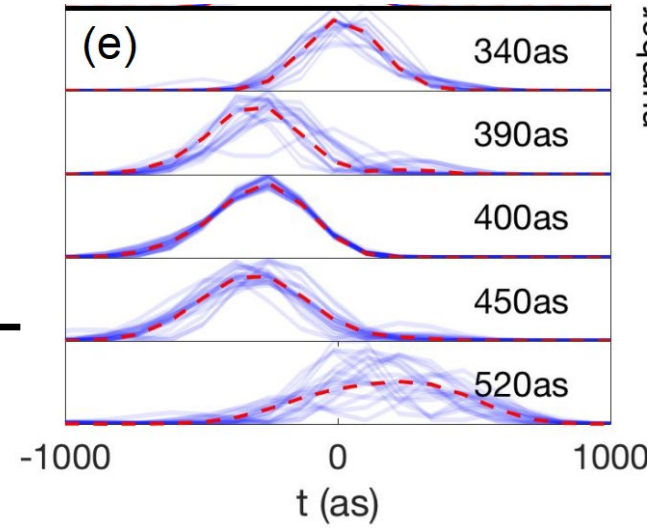
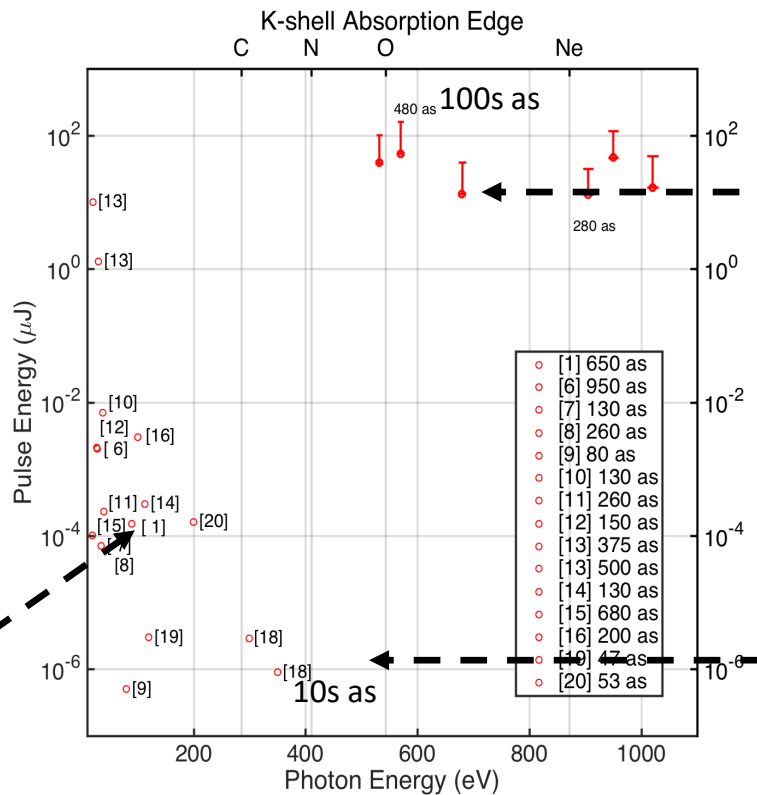
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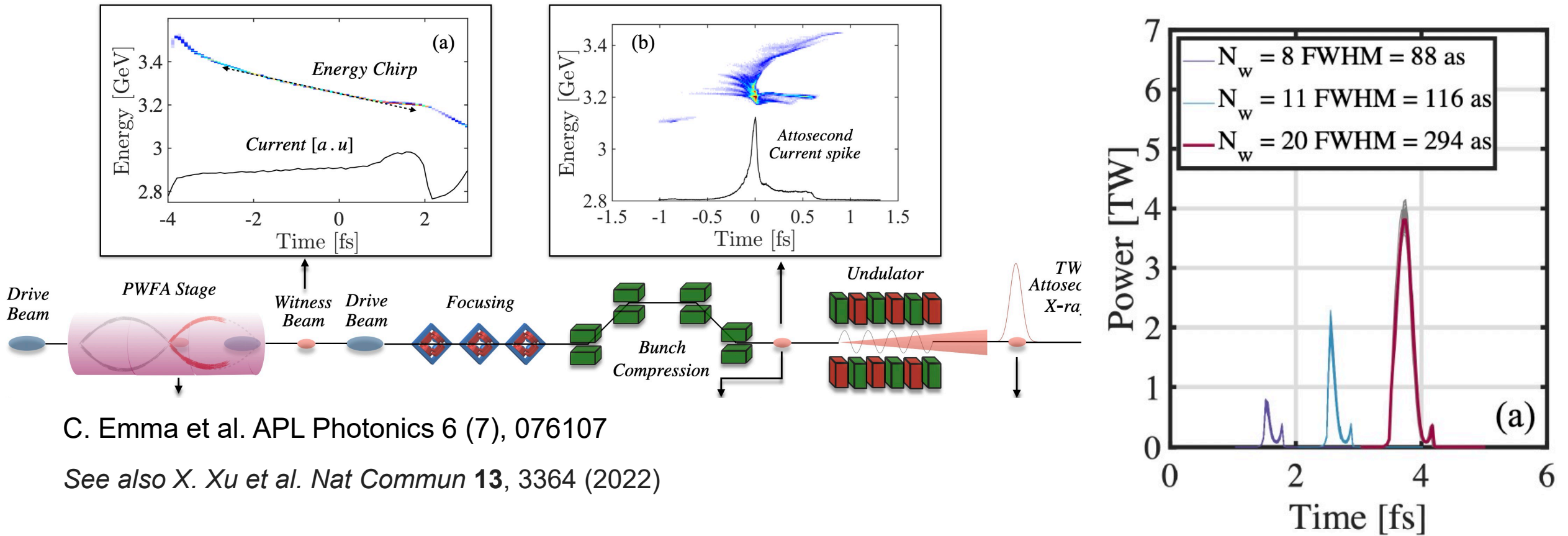
Why Plasma-Based Attosecond Pulses?



Why Plasma-Based Attosecond Pulses?



PAX: Plasma-based Attosecond Pulse Generation



C. Emma et al. APL Photonics 6 (7), 076107

See also X. Xu et al. Nat Commun 13, 3364 (2022)

Phased approach:

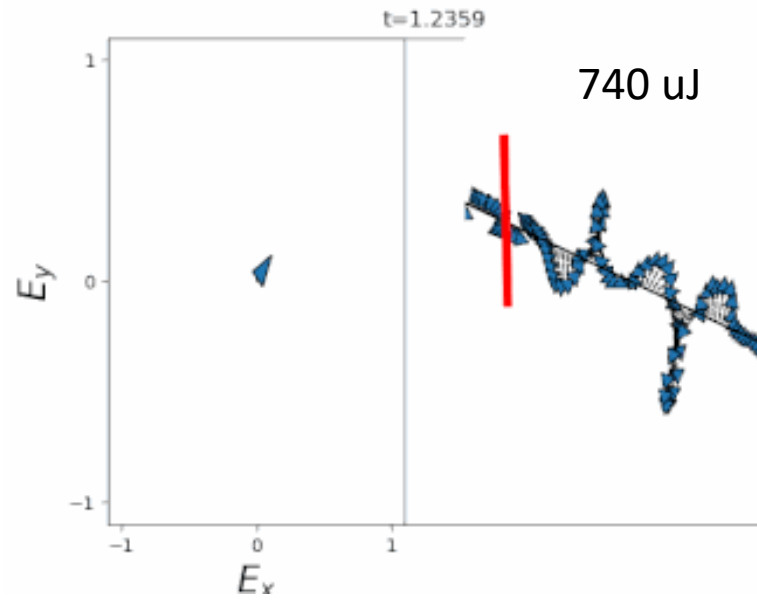
- 1) Plasma compression of the linac beam: observe radiation down to 50 nm with XUV spectrometer
- 2) Compression of high brightness beams from plasma (collaboration with E-300, E-304 and E-31X collaborations)

Recent Research Results: Above the Carbon K-edge

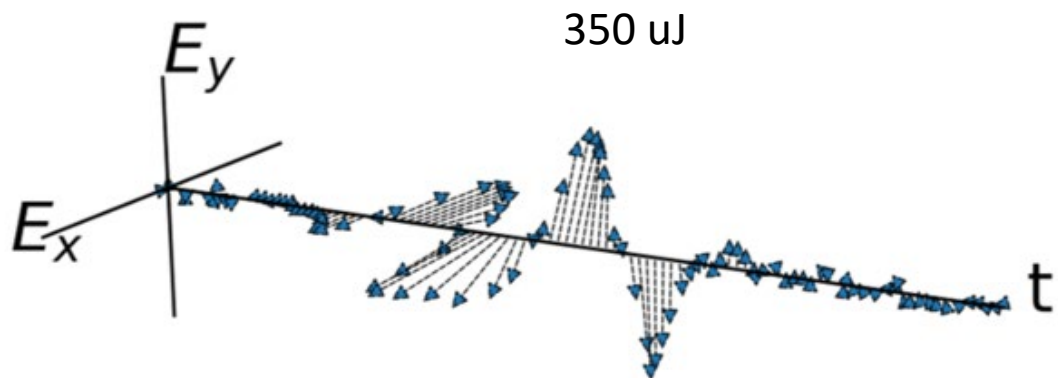
Harmonic up-conversion: sub-100 as pulses from 500 eV to 4 keV
R. Hessami et al. *in preparation*

Recent Research Results: Single-Cycle Control

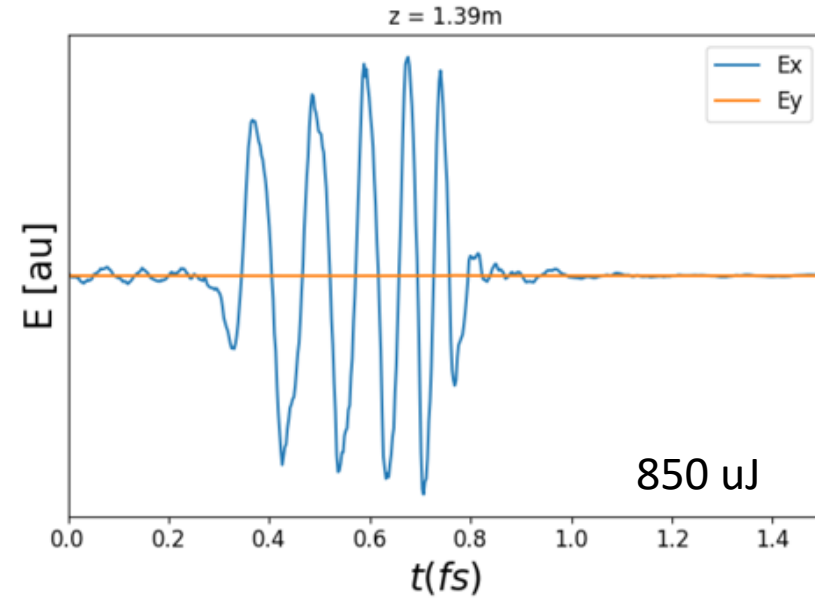
Circular polarization switching



Linear polarization switching

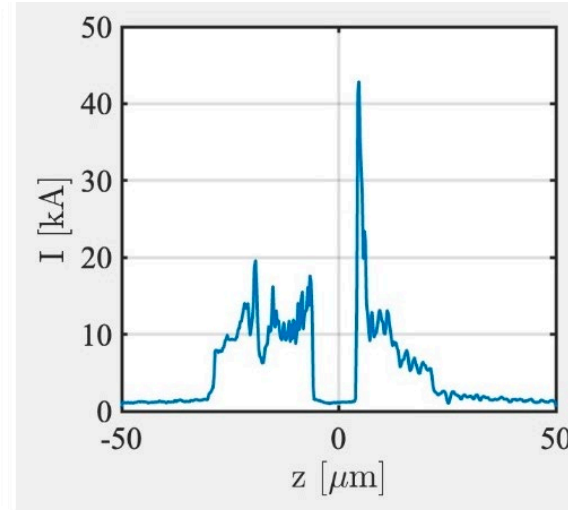
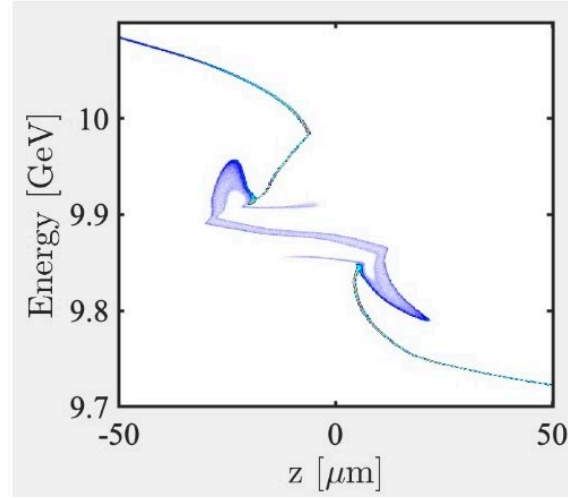
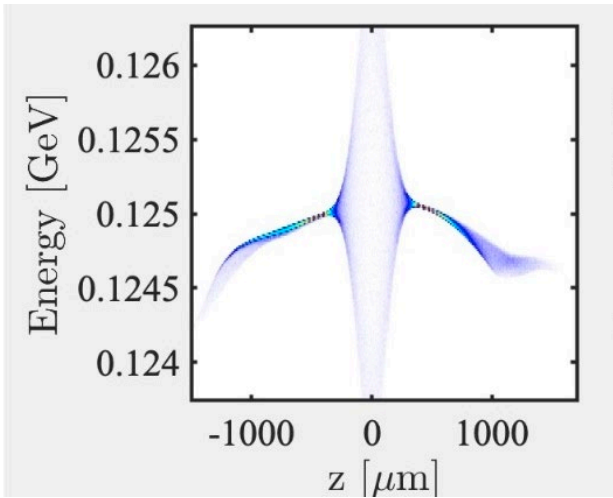


Extreme Chirp



Non-SVEA simulations
Jenny Morgan (SLAC)

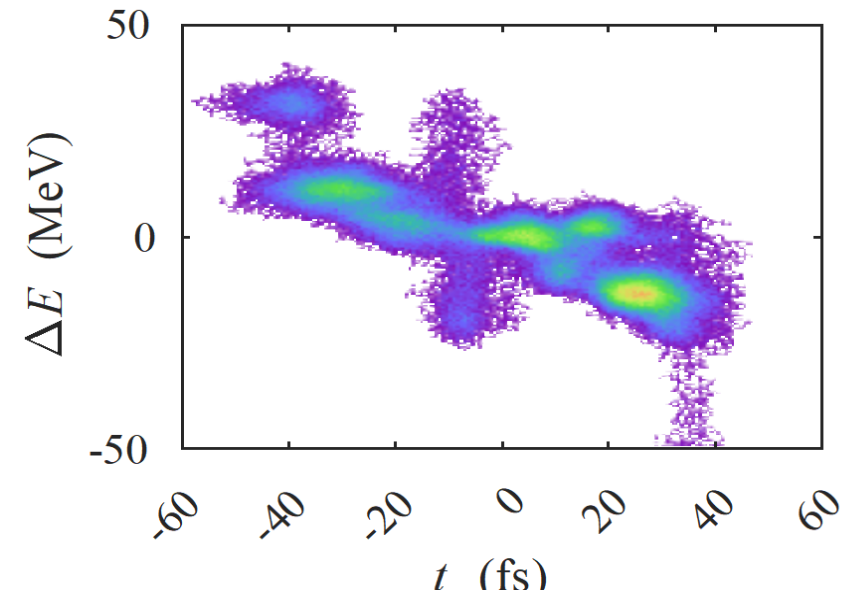
Laser Heater Pulse Shaping



Experimental results at LCLS: S. Li, Z. Zhang et al. (in preparation)

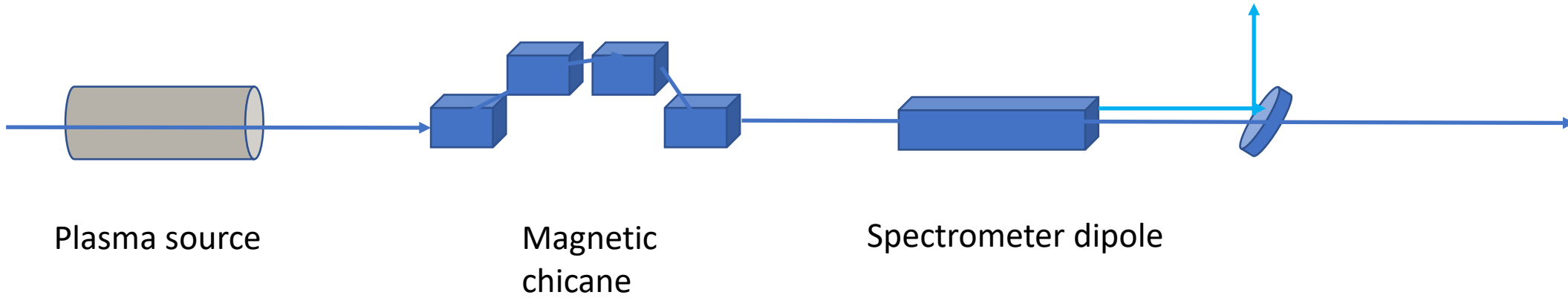
Simulation
C. Emma

- Explore high-current shaping at FACET-II with PAX experimental setup
- Compress pre-shaped e-beam with PAX?
- Applications to other experiments?



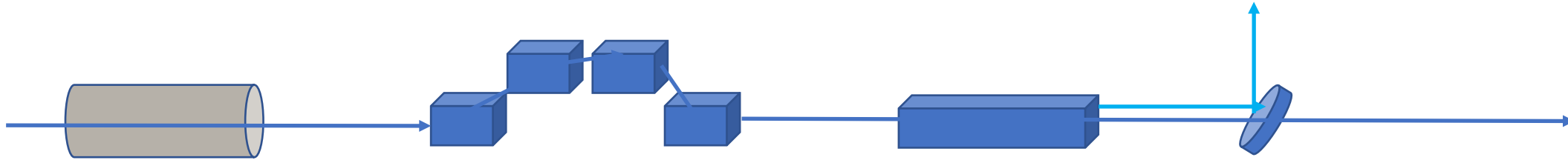
Experimental Layout

SPECTRAL/SPATIAL
DIAGNOSTICS



Experimental Layout

SPECTRAL/SPATIAL
DIAGNOSTICS



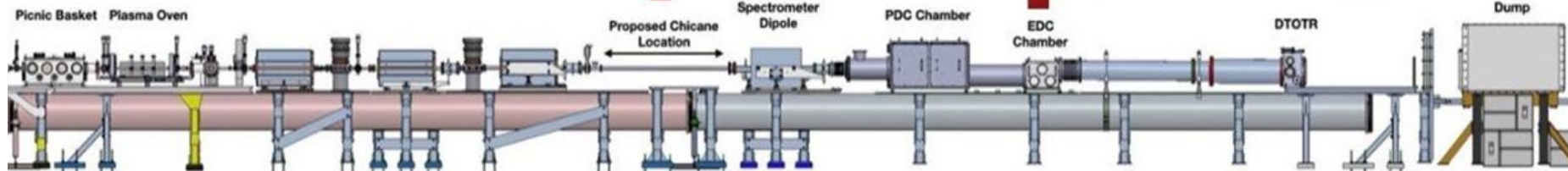
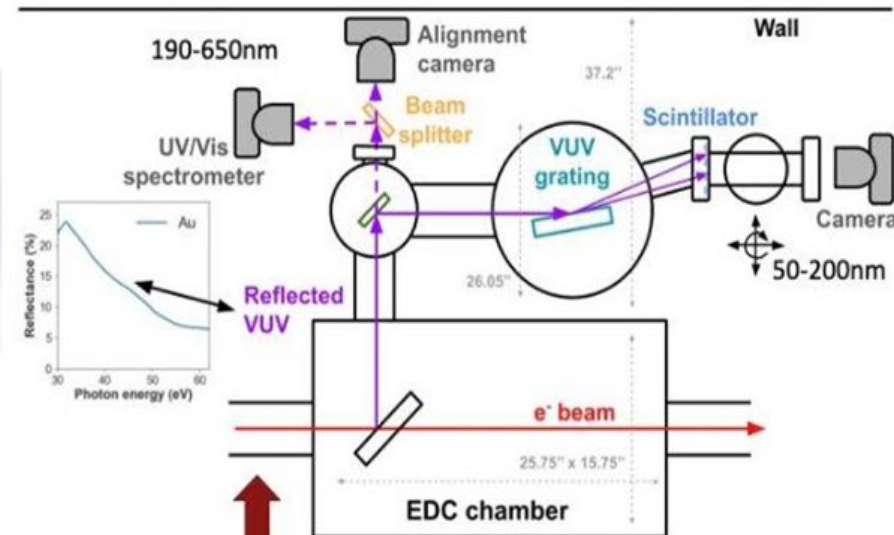
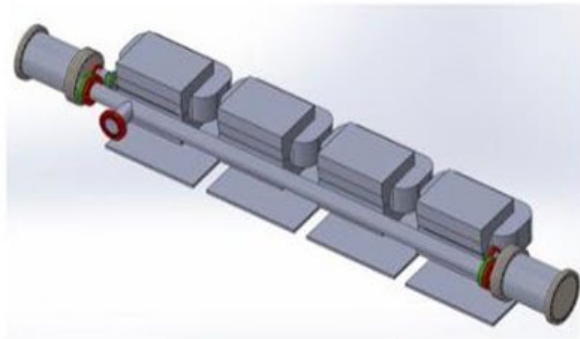
Plasma source

Magnetic
chicane

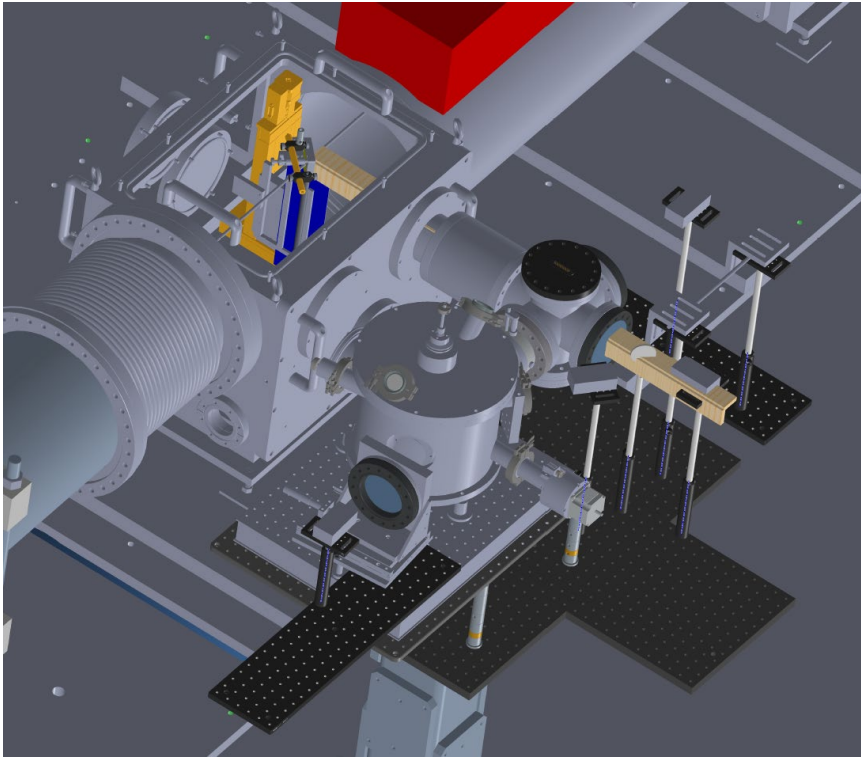
Spectrometer dipole

Sources

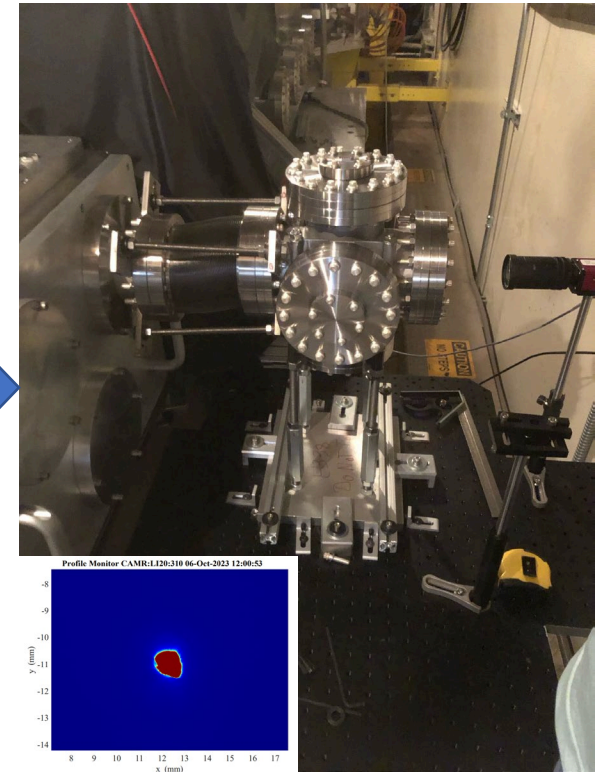
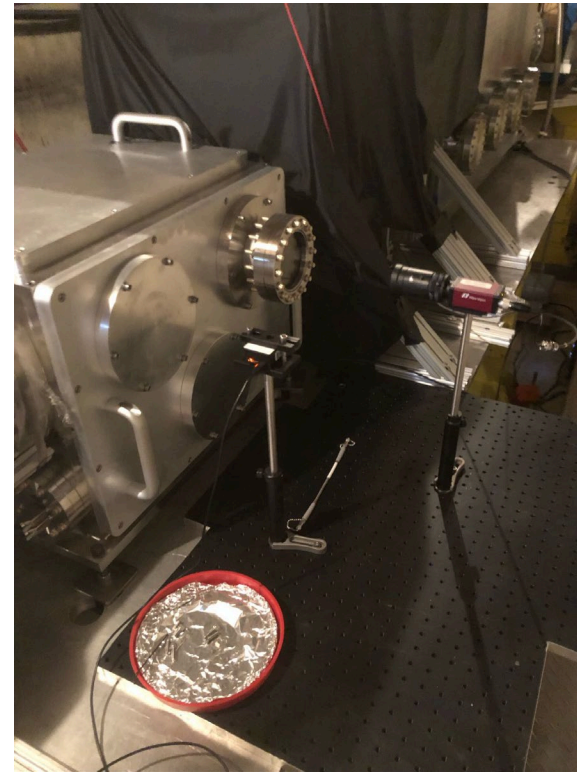
- Gas Jet
 $n_e = 1e18 - 1e20$
 cm^{-3}
- Li Oven
 $n_e = 1e16$ cm^{-3}



Installation Progress



1. EDC Mirror (Complete)
2. UV/Vis spectrometer (Complete)
3. Six-way cross (Complete)
4. XUV spectrometer (Fall 2023)
5. **Magnetic chicane (Summer 2024)**



Install phase 3 complete with photon mode on mirror in inset image

Timeline and outlook for coming experiments

- Before winter 2024 shutdown:

- Commission UV-Vis spectrometer with radiation from plasma/beam light.

- Jan - July 2024:

- Commission XUV spectrometer.
- High-resolution current diagnostic with application to:
 - beam shaping experiments
 - beam-plasma interactions
- Non-destructive measurements of coherent beam radiation with/without heater at multiple BC20 compression settings (correlation with EOS/XTCAV with ML/AI methods, see Claudio's talk).

- Summer 2024:

- Install chicane, commission mover stage, profile monitor

- Fall 24/Winter 25:

- First post-plasma compression experiments.
- Measure spectra of attosecond pulses from plasma-compressed bunches.

Summary

- Plasma-based attosecond X-rays can bridge gap between HHG and FELs
- Opportunities for single-cycle shaping and sub-100 as X-rays
- Installation of diagnostics will be finalized in the next 3 months
- Chicane procurement ongoing, targeting fall '24.

Radiation at 10 nm

