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Leveraging the capabilities of LCLS-II: linking adaptable photoinjector laser shaping to tailored X-ray production

Sunday 10 August 2025 15:00 (3 hours)

SLAC's LCLS-II is pioneering high-repetition-rate attosecond X-ray science, enabling new opportunities to optimize X-ray generation by controlling the electron beam at its source—the photoinjector. LCLS-II employs a 20 ps Gaussian UV laser pulse to drive the photocathode, with an added narrow modulation to induce microbunching for extended modes.*Recent advances in laser pulse shaping and frequency upconversion now allow for more sophisticated tailoring of the electron beam at the injector.*

We present a novel approach using spectral amplitude and phase shaping of the IR laser, followed by dispersion-controlled nonlinear synthesis—relying on phase-modulated noncollinear sum-frequency generation—for UV upconversion.This enables diverse UV temporal profiles, including flattop and double/triple spikes, offering new degrees of freedom for shaping. Preliminary results from LCLS-II beam time show these modulations produce effective downstream perturbations to the electron bunch at the undulators, demonstrating feasibility for programmable bunch formation.

*We are integrating this shaping into a start-to-end simulation framework,*** enabling digital twin modeling of the XFEL chain—from photoinjector laser to X-ray output—laying the groundwork for fully tunable, end-to-end optimized, application-specific X-ray pulses.

Please consider my poster for contributed oral presentation

Yes

Would you like to submit this poster in student poster session on Sunday (August 10th)

Yes

Footnotes

- Zhang, et al. HPLSE 12 (2024), DOI 10.1017/hpl.2024.33. ** Lemons, et al. PRAB 25.1 (2022), DOI 10.1103/PhysRevAccelBeams.25.013401 *** Hirschman, et al. Opt. Express 32.9 (2024), DOI 10.1364/OE.520542.

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

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