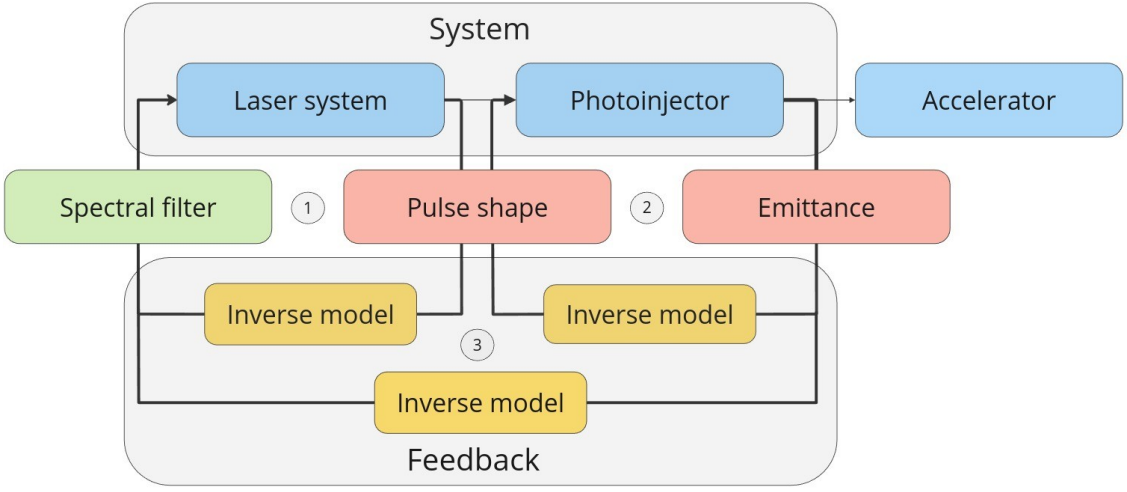
Optimizing EuXFEL Photoinjector Performance via Laser Shaping Approach

OPAL-FEL - Optimized Laser Pulses for Free-Electron-Lasers

A. Klemps[2], M. Cai[1,3], D. Ilia[1,3], Y. Chen[1], H. Tünnermann[1], I. Hartl[1], C. Mahnke[1], F. Brinker[1], W. Decking[1], W. Hillert[3], N. Ay[2]
[1]DESY, [2]TUHH, [3]UHH

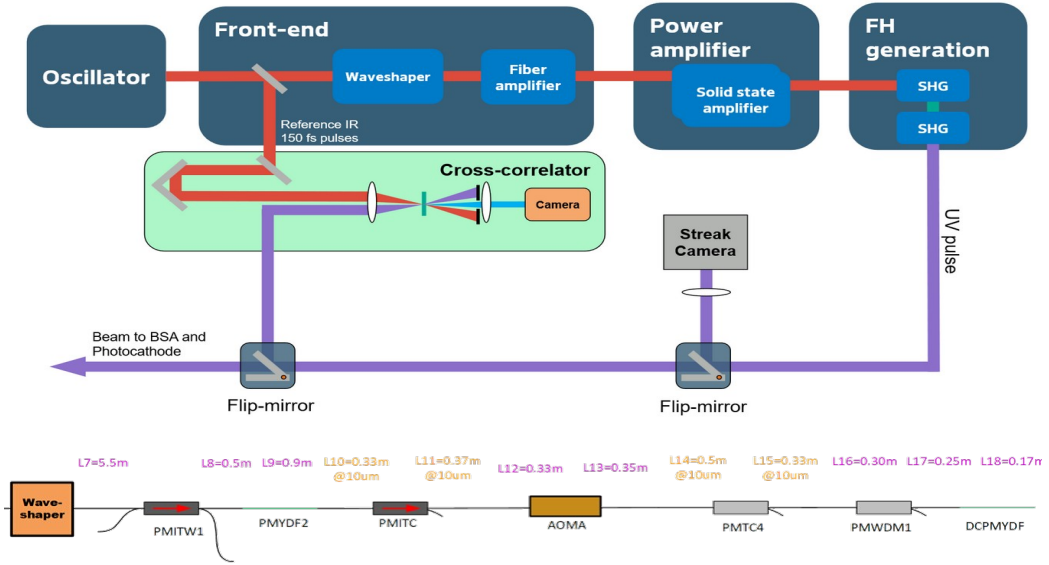
Project goal

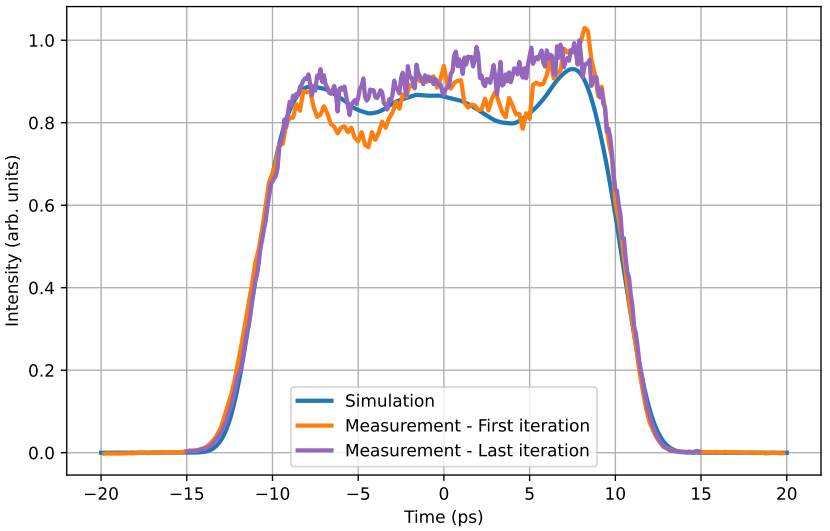
Minimal emittance at higher photon energies (30+ keV) in the EuXFEL injector by temporal laser shaping and ML driven modeling



SPONSORED BY THE
Federal Ministry of Education and Research

Photocathode Laser System Simulations and Experiments*





Results and Achievements

- Development of differentiable simulation software for nonlinear pulse propagation
- Gradient based shape optimization and transfer to the NEPAL laser system
- Successful operation of EuXFEL with flat-top temporal laser shape (1 week)

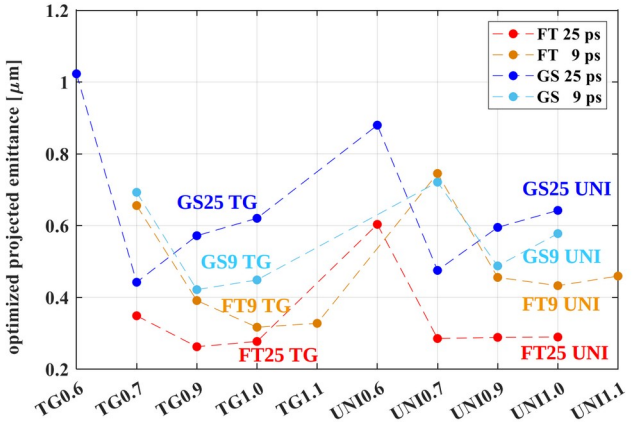
*Main work confined by D. Ilia (FS-LA)

Photoinjector Simulations and Experiments*

Simulation (1)

Simulation results indicating low emittance beam yielded by flat-top bunches of 25ps length

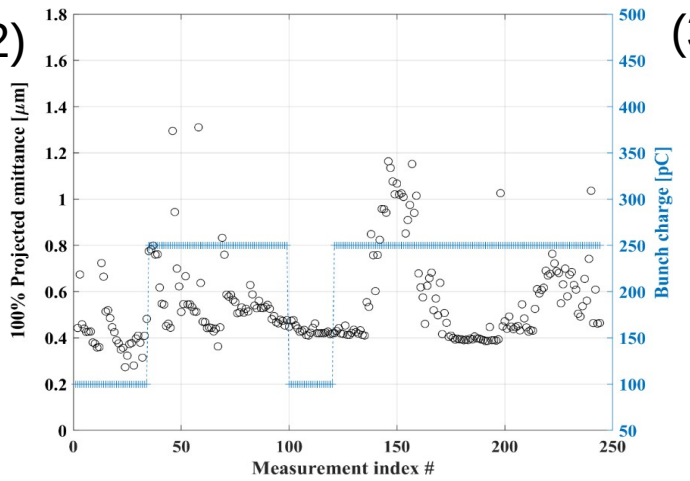
(1)



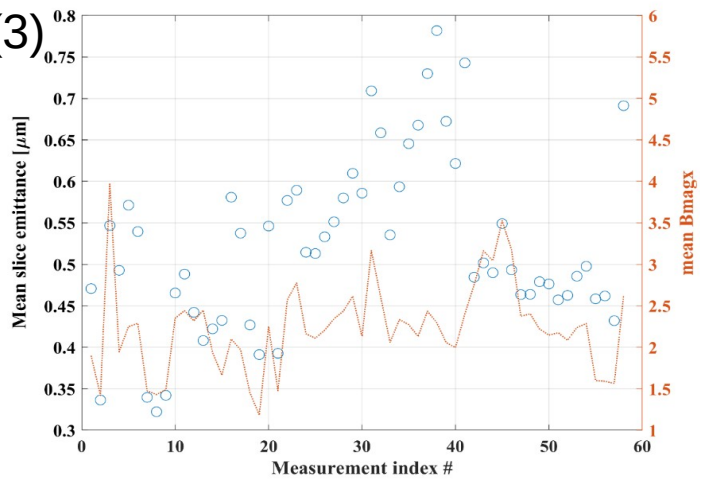
Experiments (2) + (3)

Best ever achieved (slice) emittance results for (250) 100pC at (0.32) 0.27μm

(2)



(3)

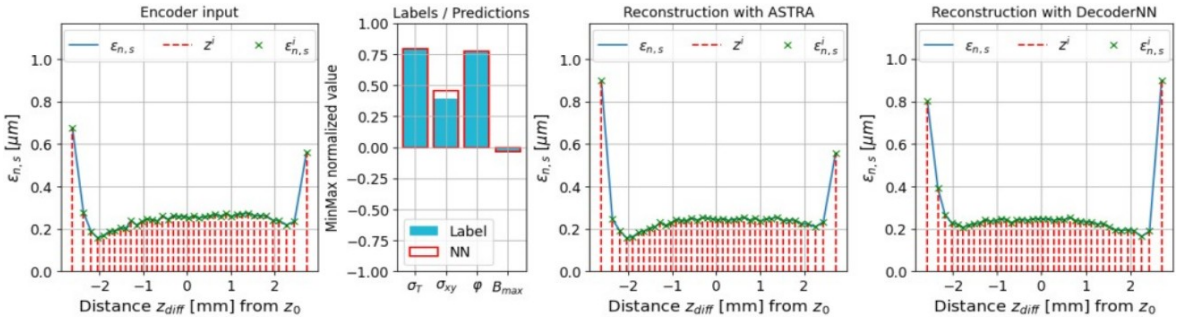


*Main work confined by Ye Chen and Meng Cai (MXL)

Machine Learning and Differentiable Simulations

Inverse modeling for electron gun

Successful prediction of gun parameters from slice emittance and slice mismatch measurements on simulated data



Ongoing and future work

- Development of differentiable gun forward model to be used with Cheetah
- Generative ML modeling for pulse shaping