Ultra-Violet Transverse Beam Shaping for Photocathode Applications

Random Phase Plates : the Road to Photocathode Laser Control

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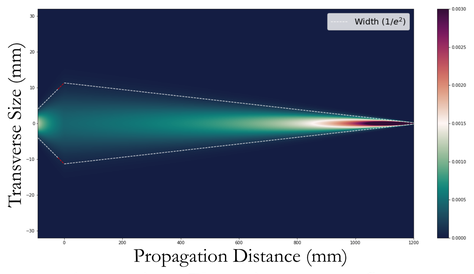
Background

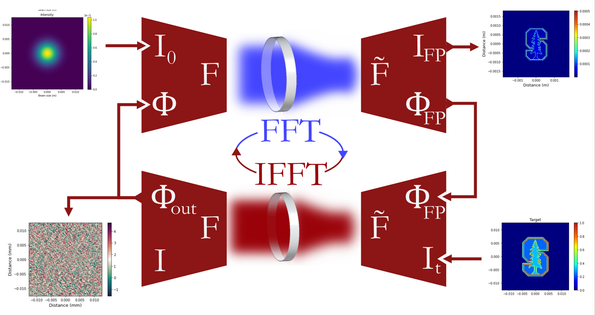
- The photoinjector's electron beam quality is crucial for FEL performance.
- UV laser pulse spatial profile control is essential for optimizing photoinjector emittance and FEL efficiency.
- Traditional beam shaping techniques involve random phase plates and spatial filters

Methods

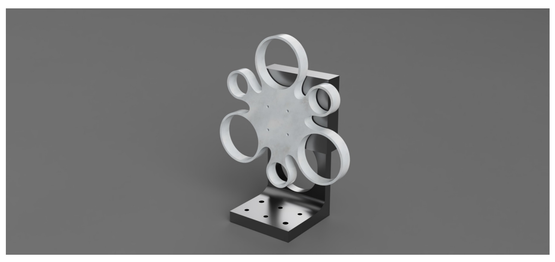
- Gaussian optics based ray tracing was designed for an optimal filling of the phase plate



- An iterative Fourier transform algorithm software was built to design and test phase plate capabilities using Fresnel Optics



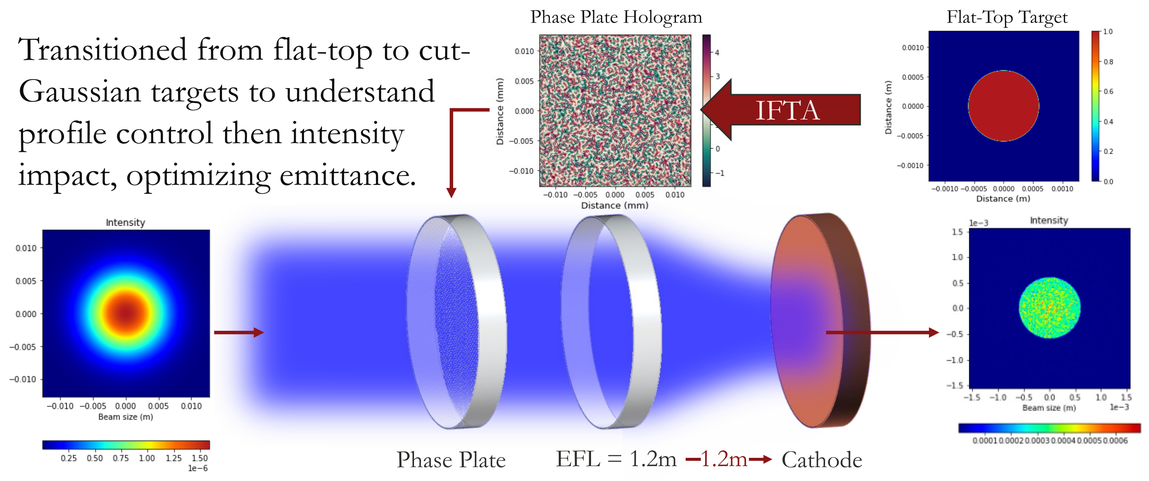
- Designed a non-invasive setup for different shaping requirements

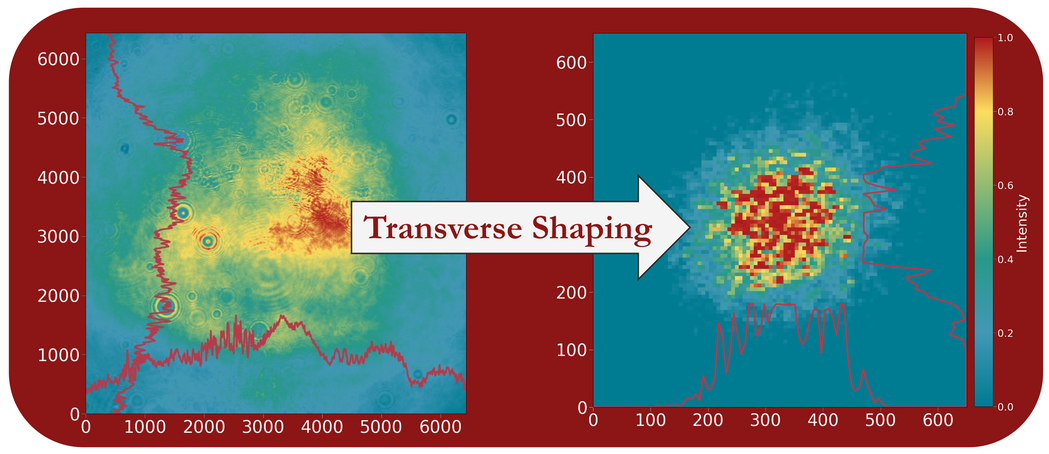


Results

Experimental Schematics

Transitioned from flat-top to cut-Gaussian targets to understand profile control then intensity impact, optimizing emittance.

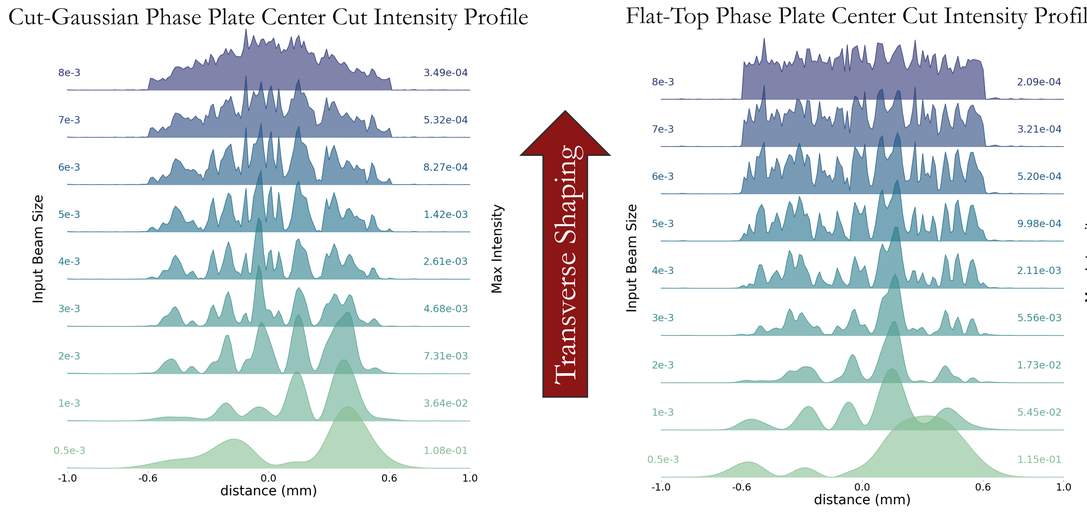




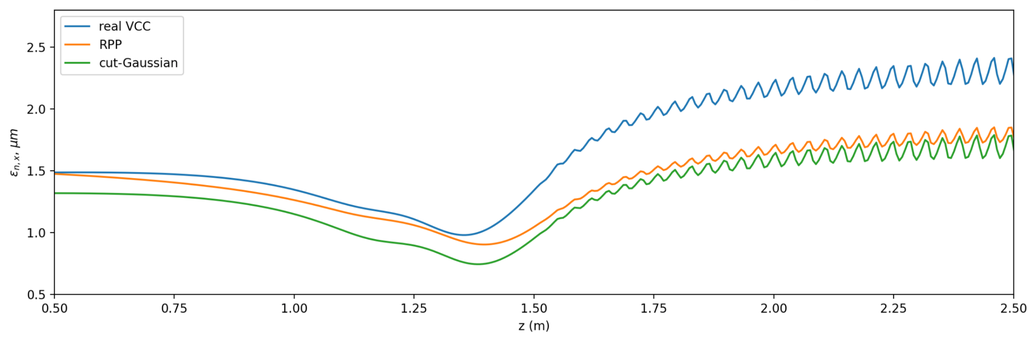
Deep Dive on Performance

Cut-Gaussian Phase Plate Center Cut Intensity Profile

Flat-Top Phase Plate Center Cut Intensity Profile

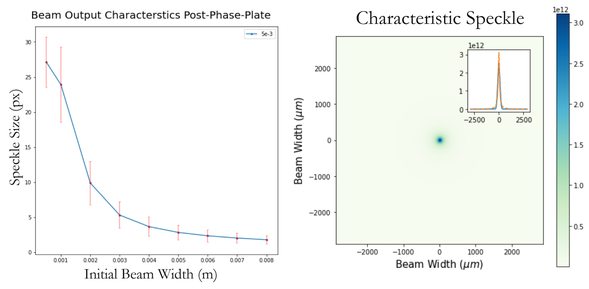


Electron Beam Emittance Performance Upgrade

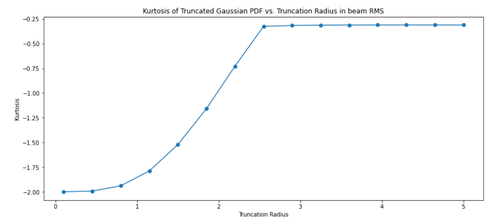


Analysis

- Characteristic speckle size decreases with increased input beam width, as determined through autocorrelation and Lorentzian fit analysis.



- A Kolmogorov-Smirnov determines the goodness of a fit for the Cut-Gaussian or Flat Top beam
- The data's Kurtosis value determines edge steepness



Future Plans

- Exploring options for in house Phase Plate fabrication build the phase plates with less lead time
- Testing a beam reconstruction strategy using a Machine Learning Stabilized 5 axis stage for a glass bi-conical capillary for spatial filtering
- Experimental test of the photoinjector increased performances
- Extracting more valuable insights from our data analysis through repeated measurements and refined techniques.
- Gaining Full Control through a temporal improvement

Scan to **Track our Progress** or click **here**

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