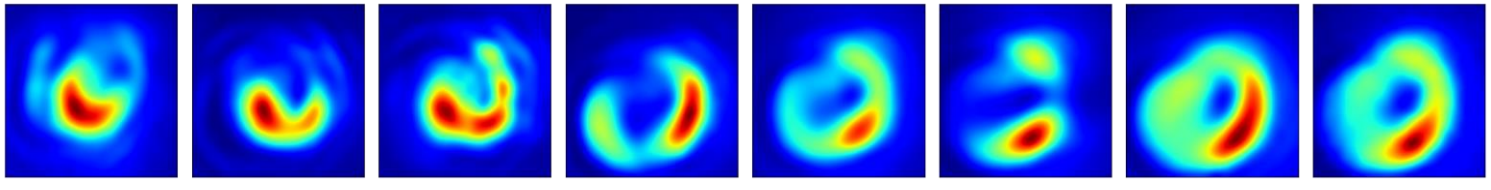
Recent results

Ze Ouyang

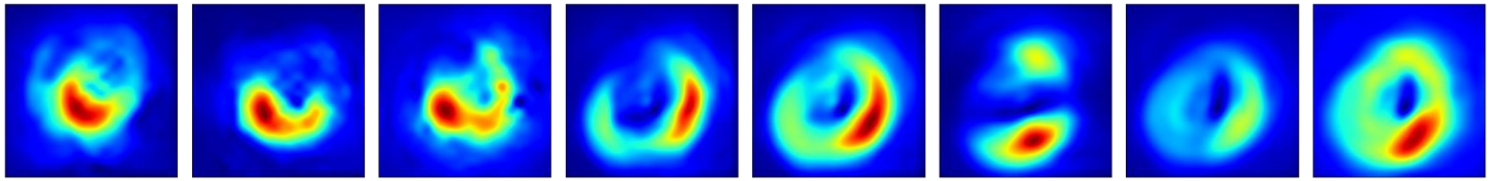
May 6th, 2025

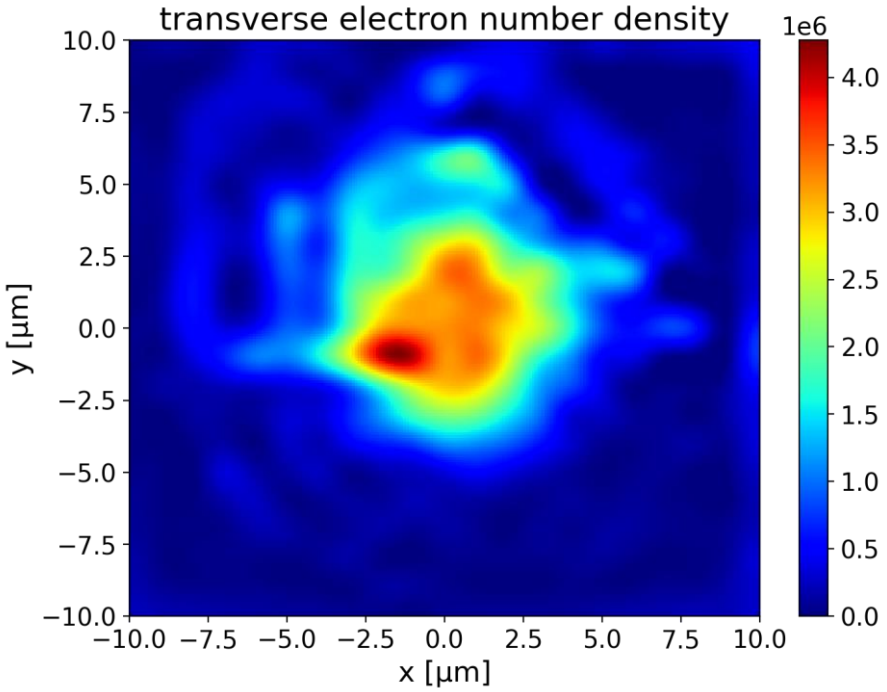
Reconstruction on Shot 228 by Gradient Descent method

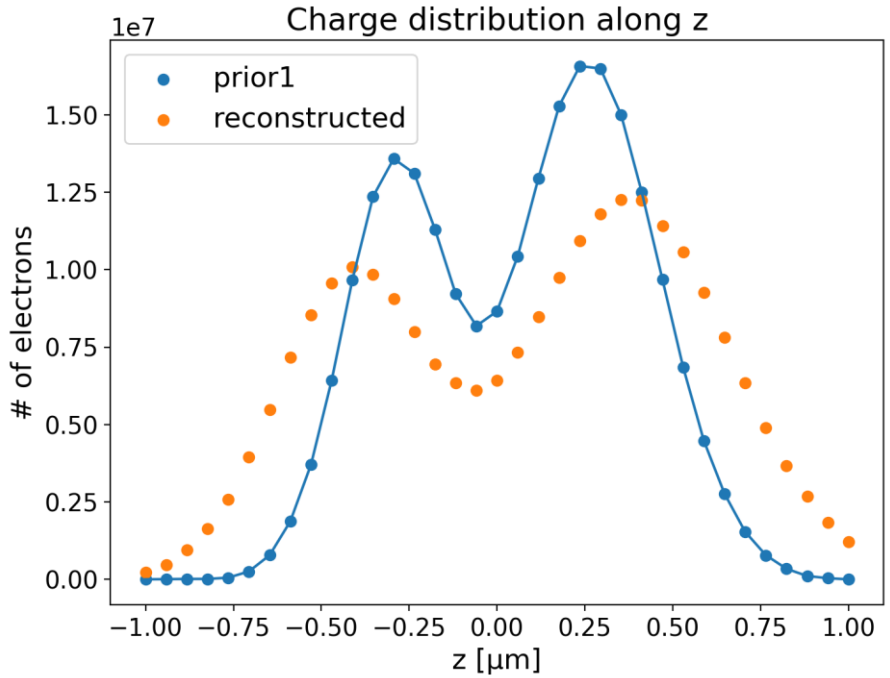
Measured COTR

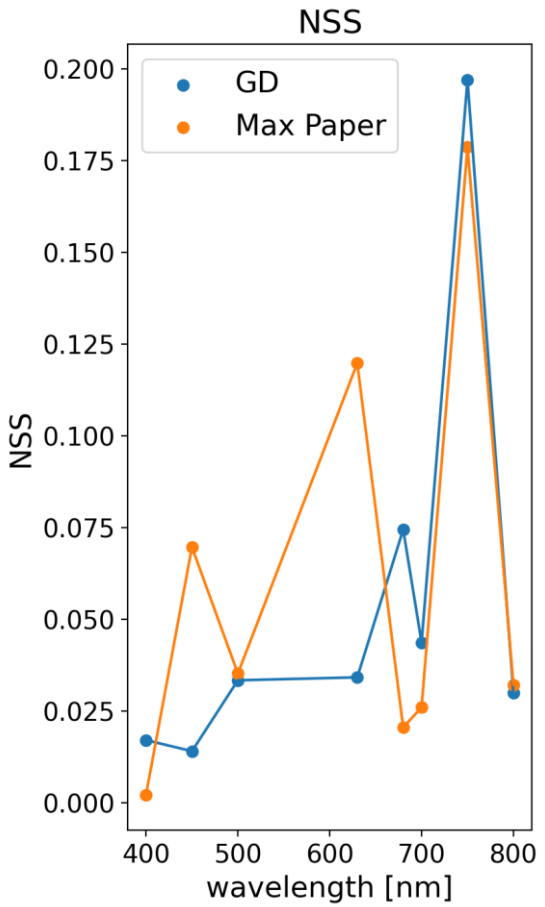


Calculated COTR







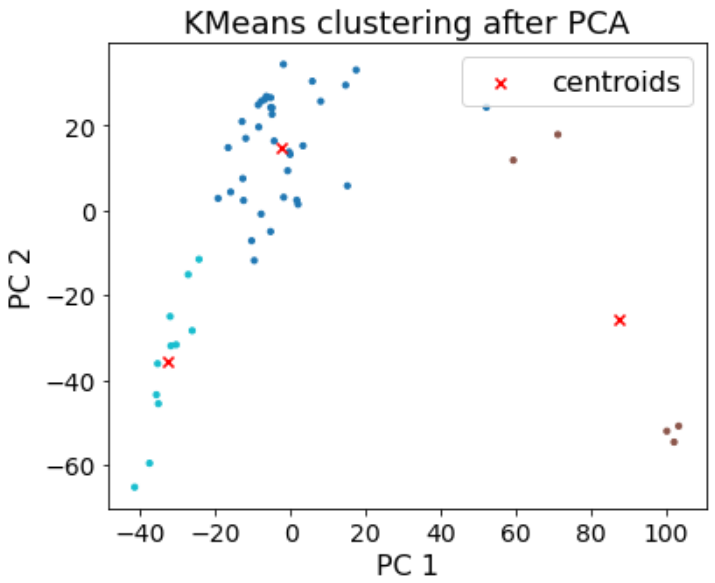


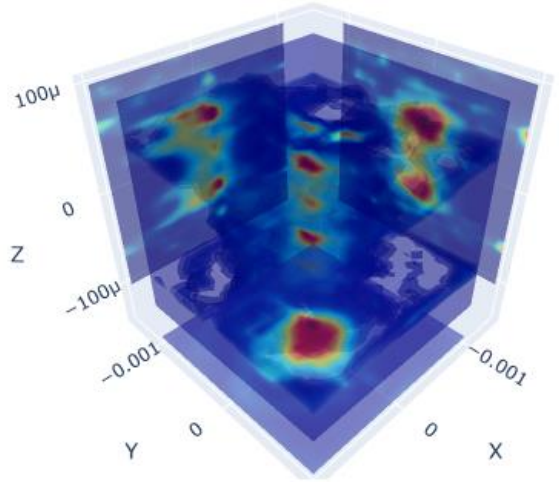
Max's NSS: 0.063

Ze's NSS: 0.056 (can be lower)

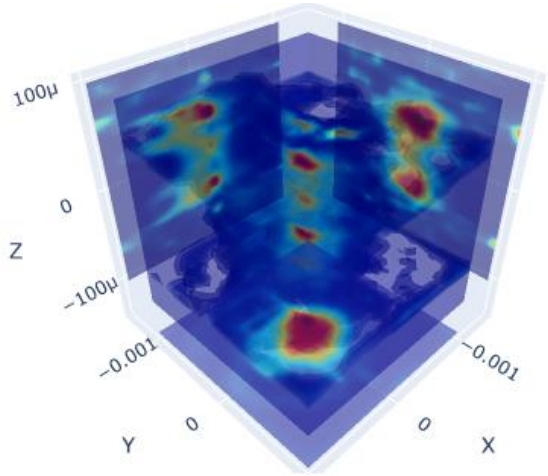
Time used: < 60 seconds

PCA on Shot 228 by Gradient Descent method





<C1>



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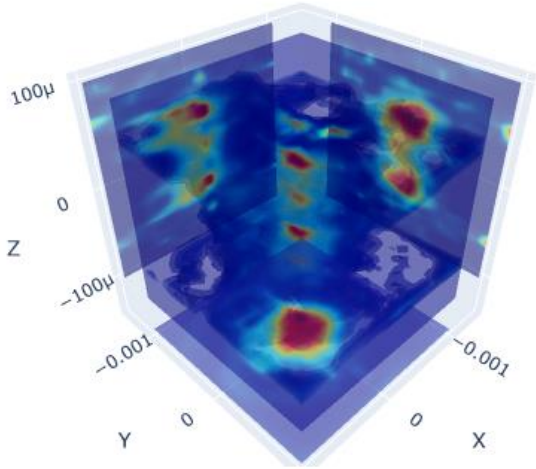

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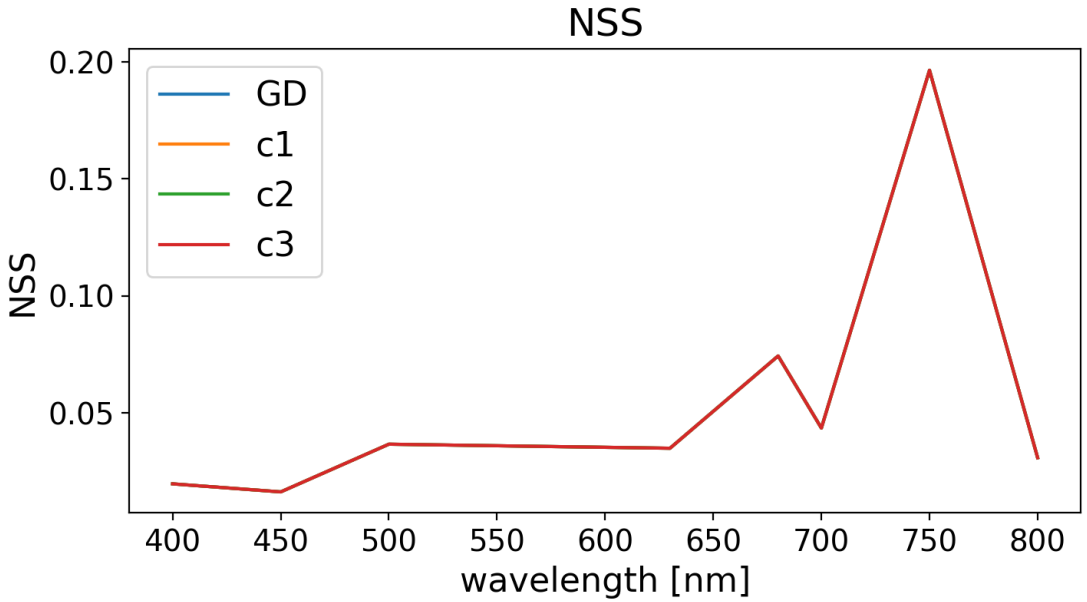


Too good overlap?

- All reconstructions terminate when NSS = 0.056, close to global minimum.
- In Max's paper, NSS = 0.063. There are rooms for some local minimums.

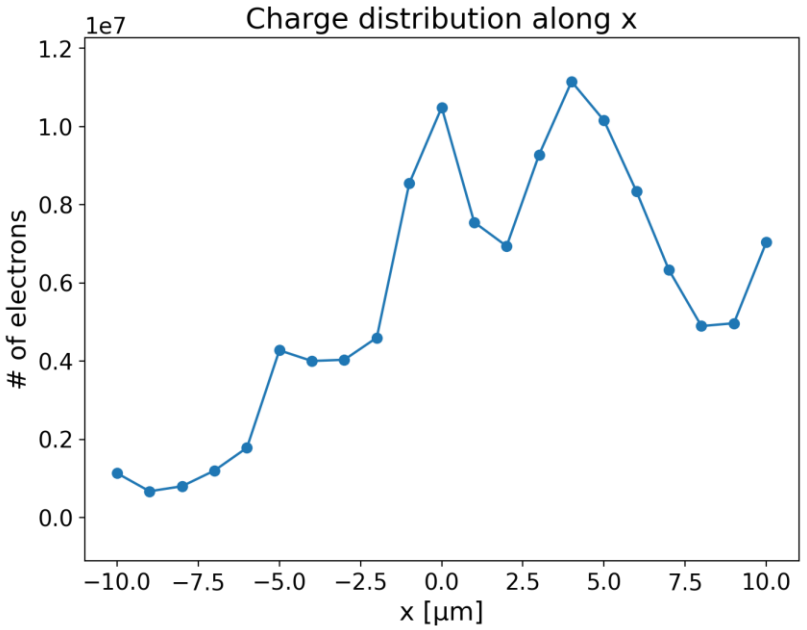
All-optical diagnostics on 3D structure of electron beams

A good reconstruction requires knowledge on

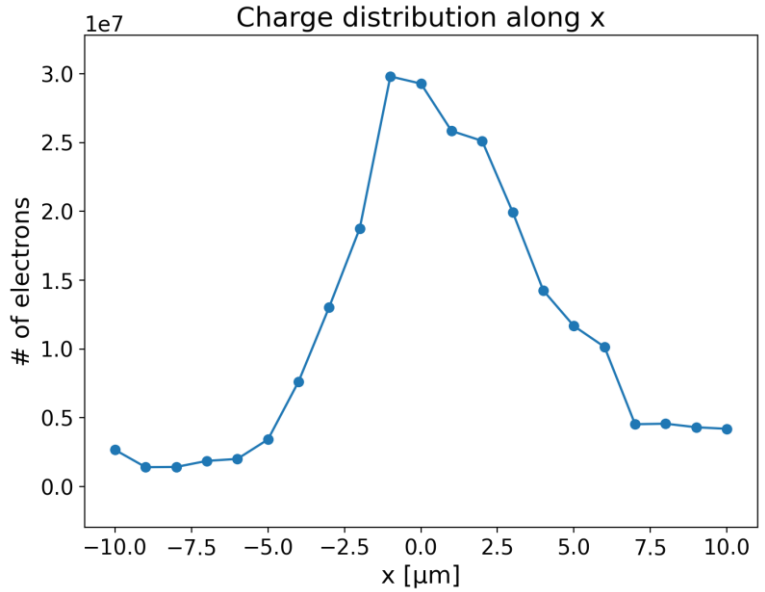
- Longitudinal profile (from CTR spectrum)
- Lorentz factor of electron (from Inverse Compton Scattering)
- **Total charge** (well, this is a brain teaser…)

Total charge can be deduced by

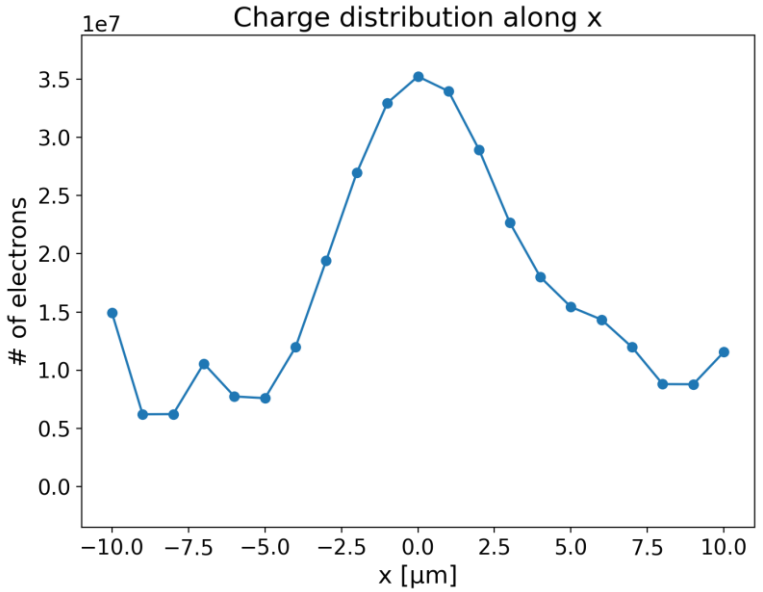
1. Transverse distribution & Boundary charge
2. Time leads to convergence
3. NSS value



Ne = 36*0.5 = 18 pC



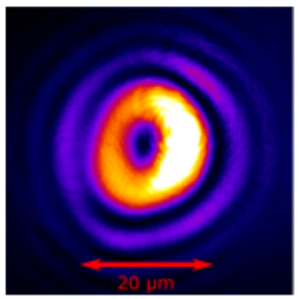
Ne = 36 pC



Ne = 36*1.5 = 54 pC

Conclusion

1. Phase difference, current only a function of θ and ω, but should have φ, ψ, even ρ? $\phi = \frac{2\pi L}{\lambda\beta}(1 - \beta\cos\theta)$
2. With divergence, ρ would also evolve… $\boldsymbol{E_{tot} = E_1 + E_2 = E_1 + E_1 e^{i\phi}}$
3. For electron bunches, the total ***E*** field should be a convolution of 3D position and 2D transverse divergence. (next-2-week goal: 5D reconstruction)
4. Total charge, energy spread, and gamma also determine COTR and COTRI. (All-optical diagnostics for plasma-wakefield-accelerated electron bunches)



Conclusion

1. GD method
2. GD solutions cluster analysis
3. Proposal for all-optical diagnostics for 3D structure
4. **Generative Neural Network** code is under active developing