Submicron emittance and ultra small beam size measurements at ATF.

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Outline/Conclusion

- **0.8 μm** normalized RMS emittance was measured for **0.5 nC / 60 MeV** electron beam

  (full – not slice)

$$\sigma_{RMS} = \sqrt{\varepsilon_{RMS}\,\beta}$$

- Beam waist of the order of **10 μm** was achieved and measured for **0.5 nC / 60 MeV** beam

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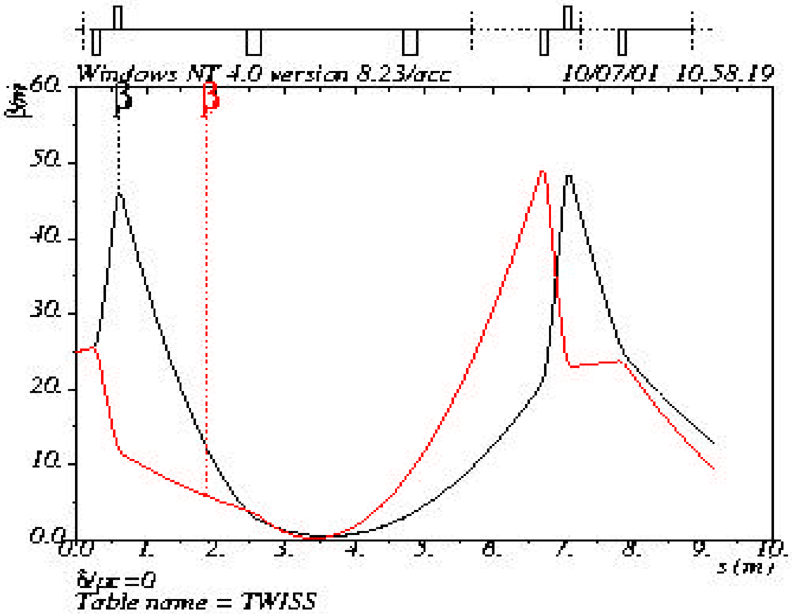
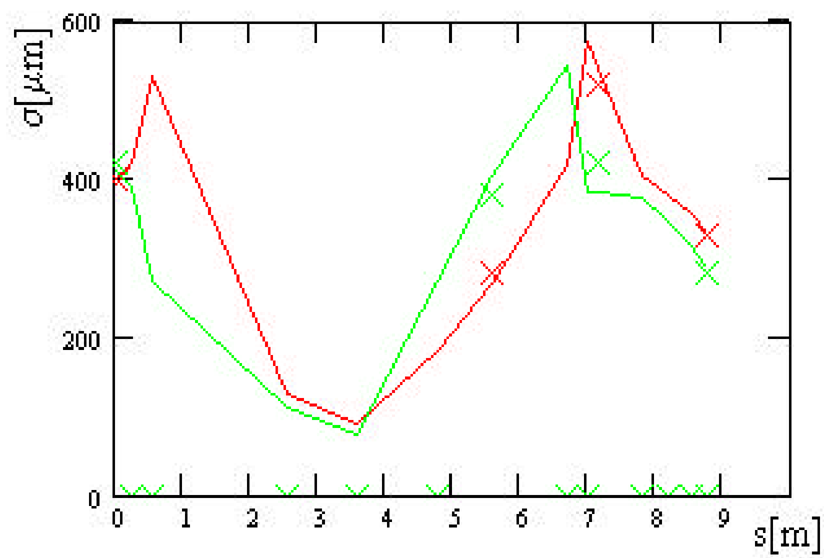
Fitting the beam size using multiple BPMs to resolve emittance

BPMs were used to measure beam sizes >200 μm and quads for smaller sizes





Focusing properties of the transport line were extensively studied for the tomographic phase space rotation.

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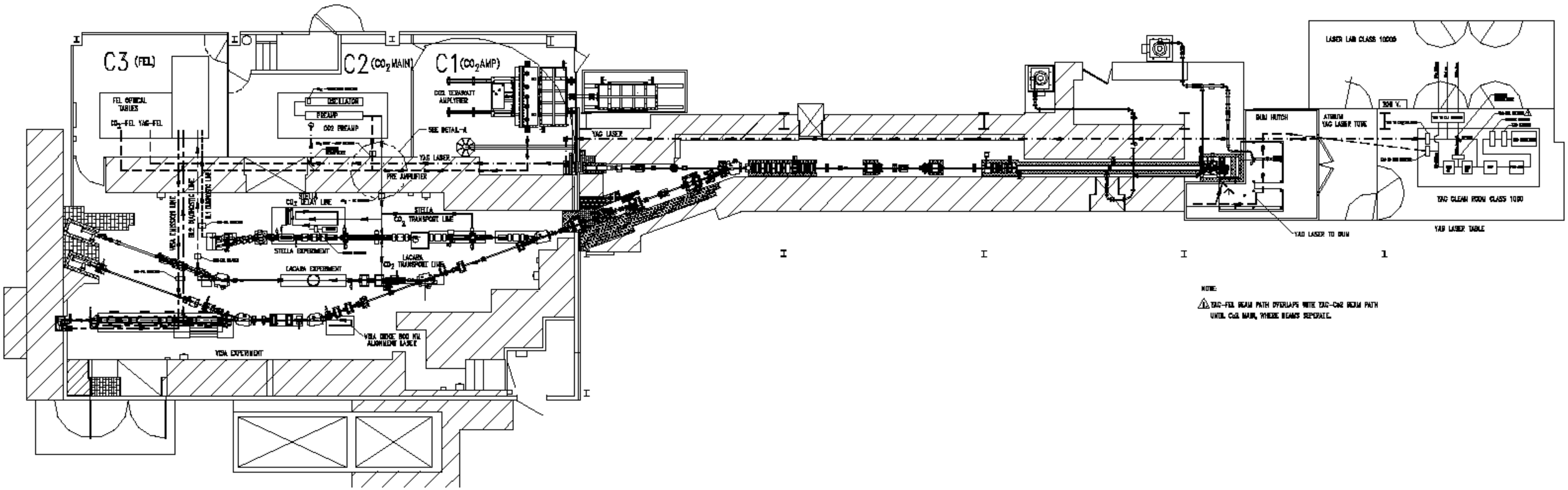
Accelerator Test Facility Layout



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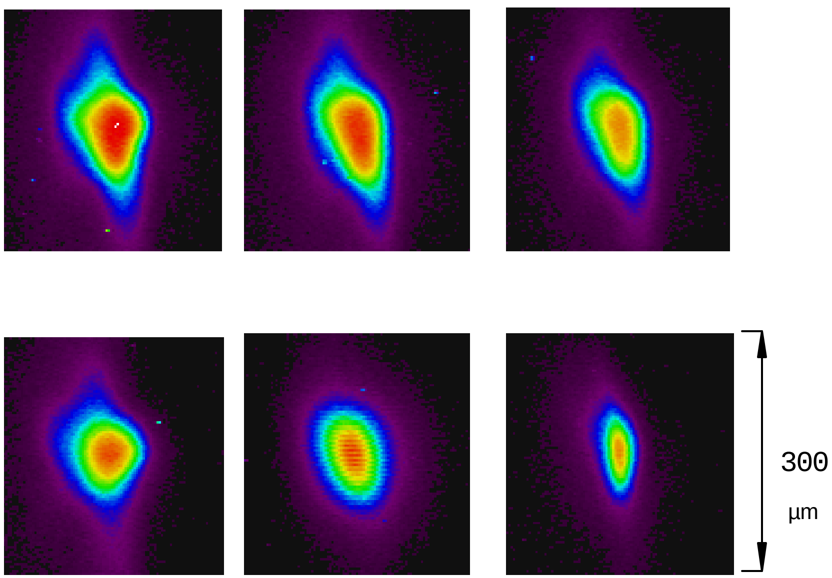
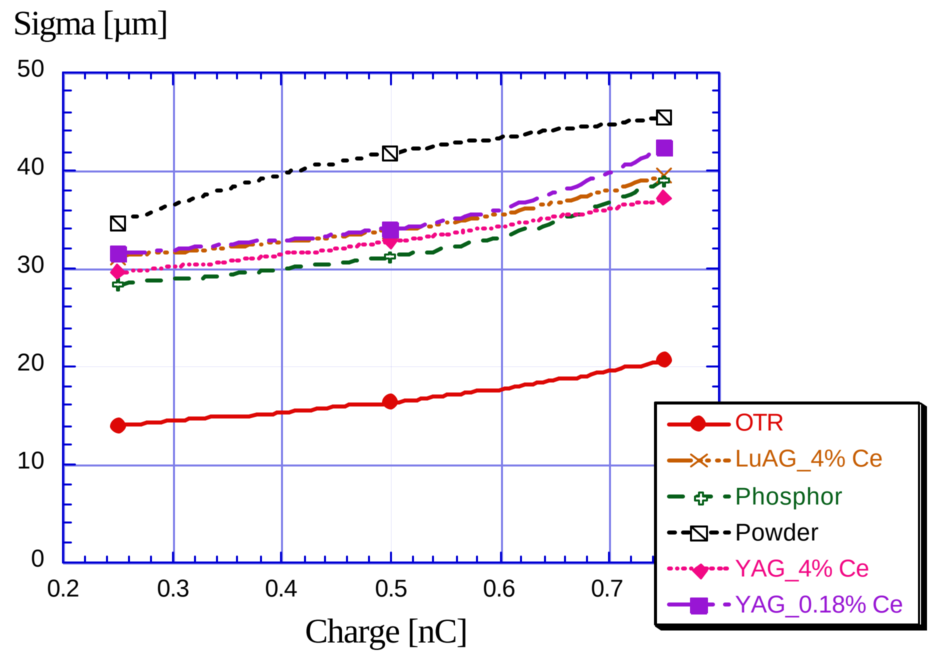
BPM resolution limit



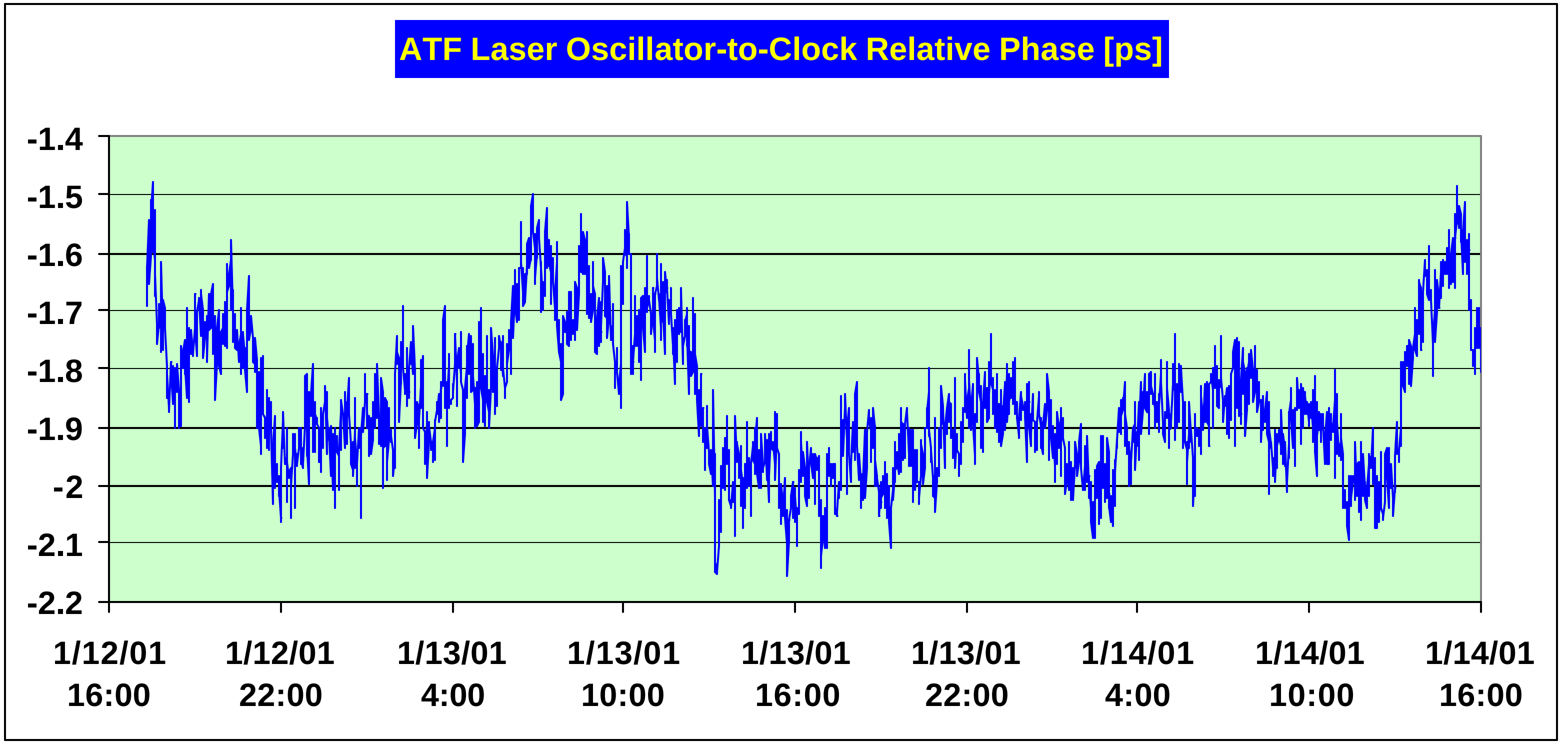


Beam images taken consequently with the six different diagnostics under stable experimental conditions (the charge Q ~ 500 pC).

Electron beam horizontal spot size as a function of charge, measured with the scintillating diagnostics and the OTR.

Step #1 to improve emittance

- ✓ Stability of the driving laser and RF



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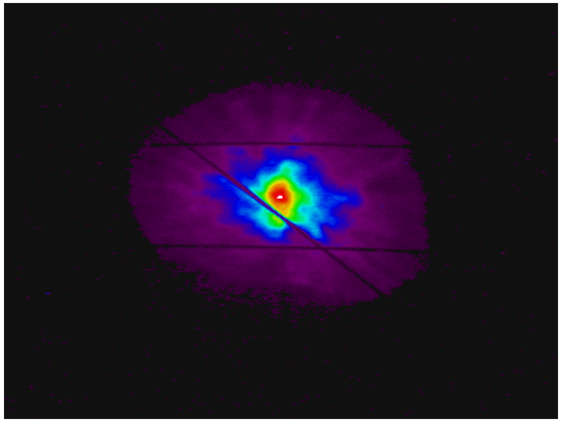
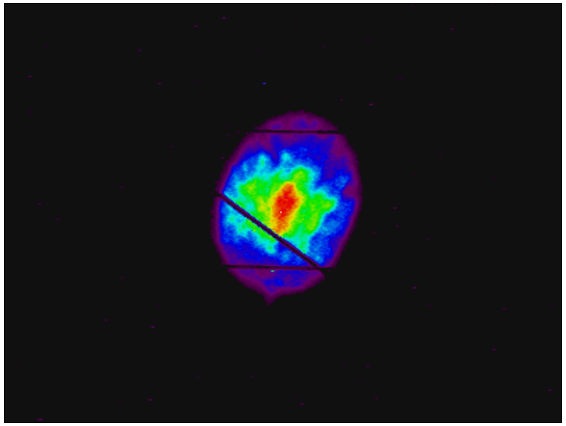
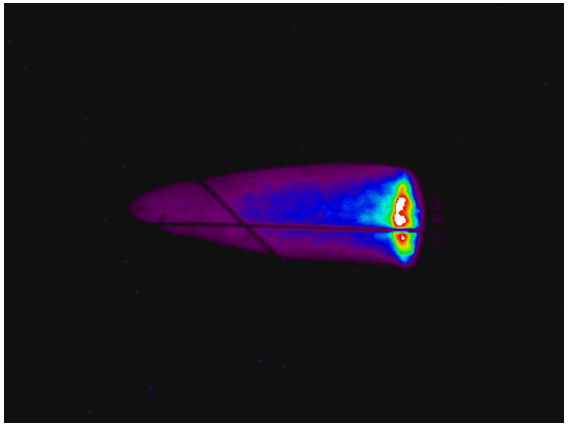
Step #2 to improve emittance

✓ Beam based alignment of the focusing quads to transport beam thought the linac center.

CCD Images of the 0.5 nC /60 MeV beam after linac







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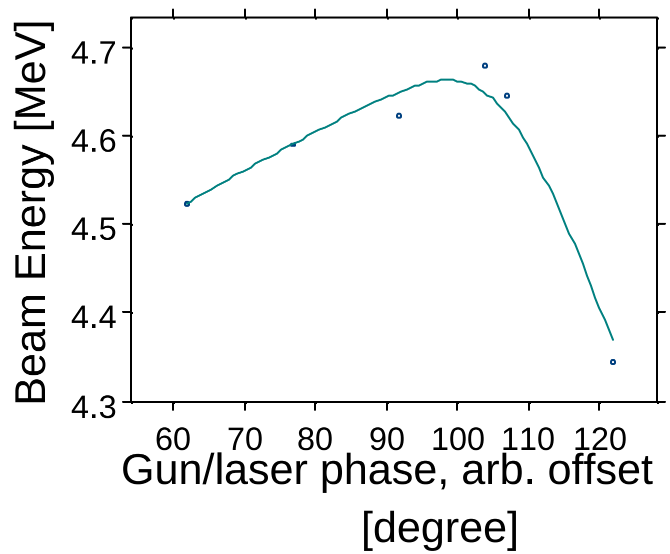
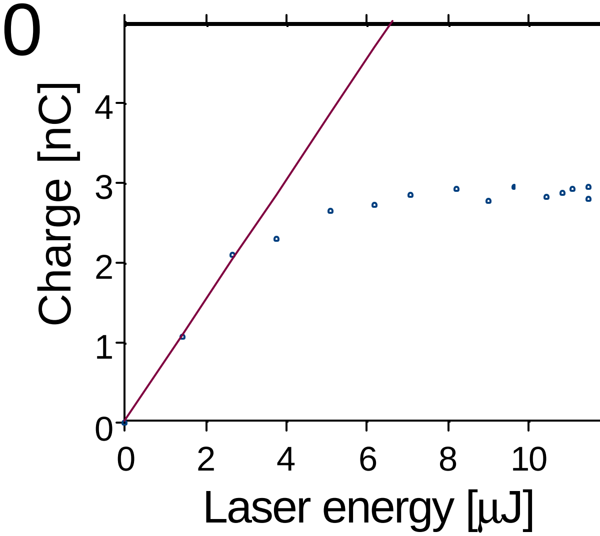
No tricks with black level…

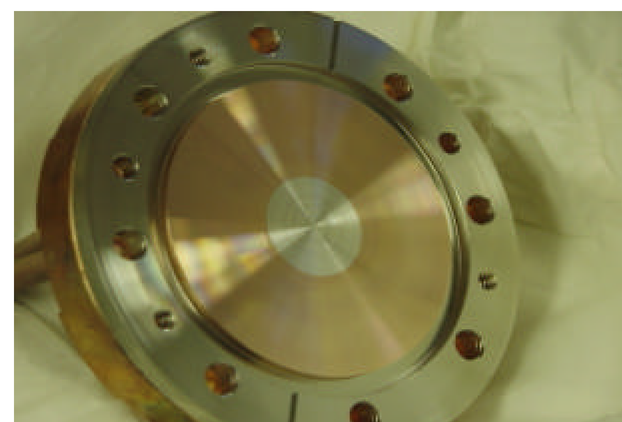
Step #3 to improve emittance

✓ Accelerating gradient in the RF GUN was increased to approximately 110 MV/m





Laser cleaning of cathode produces Mg plug cathode with Qe~0.35%



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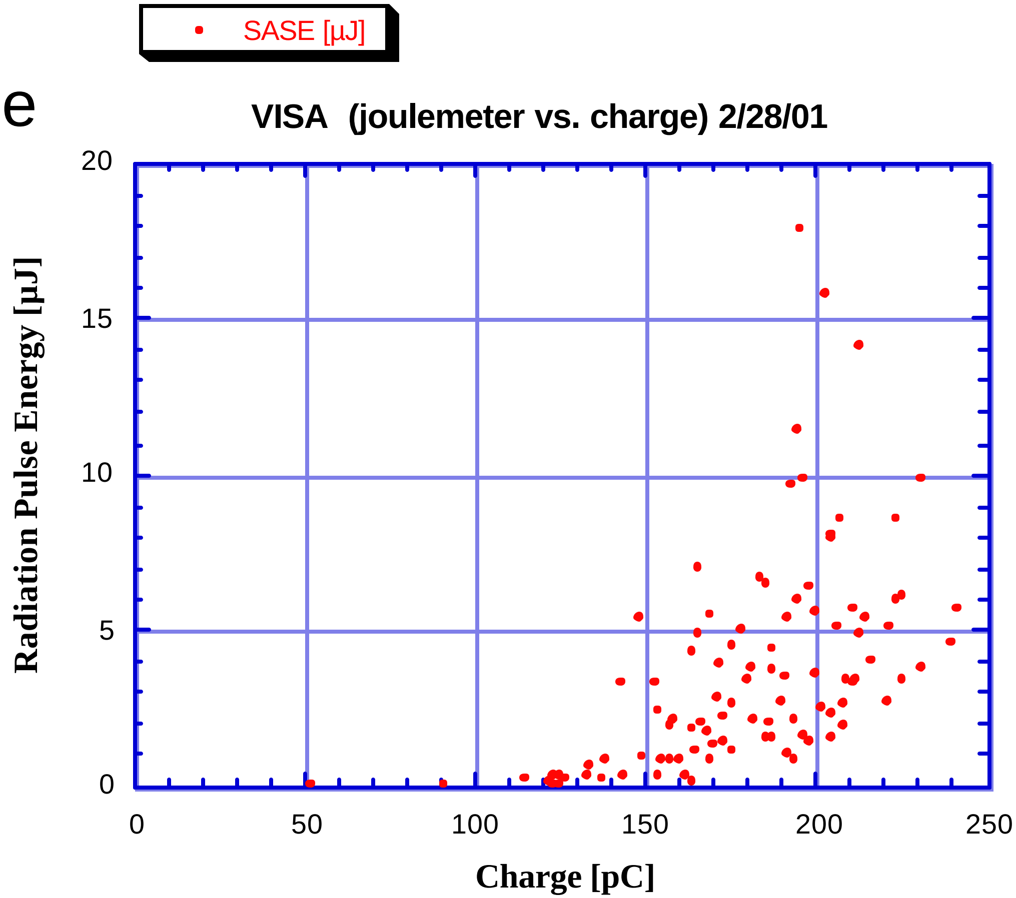
Step #4 to improve emittance

- ✓ Laser spot on the cathode was optimized to generate round electron beam.
- ✓ Damaged optical lens in the driving laser transport was identified and replaced.
- ✓ Beam was tuned to maximize gain in VISA



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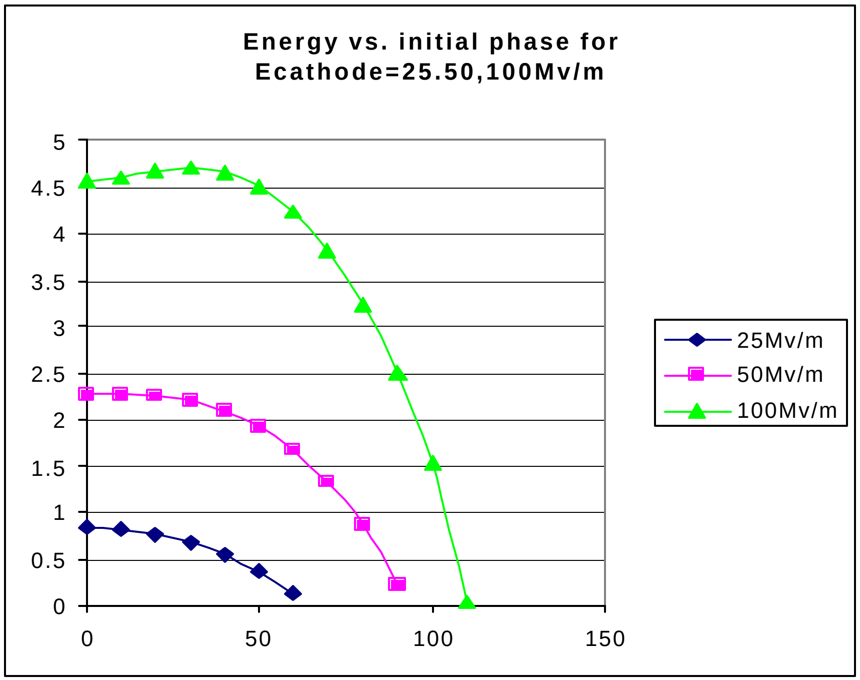
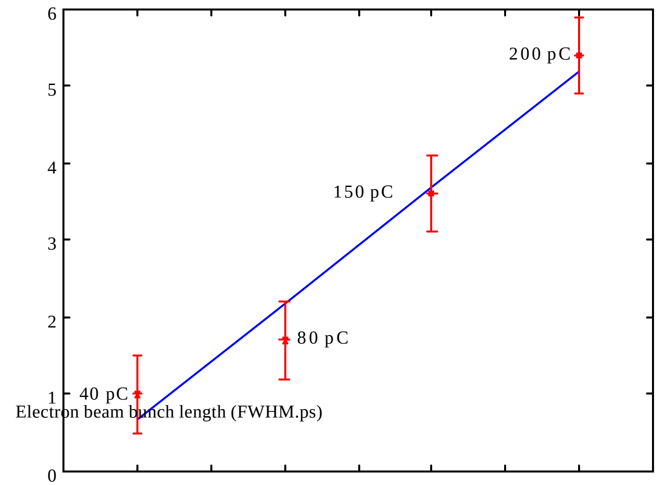
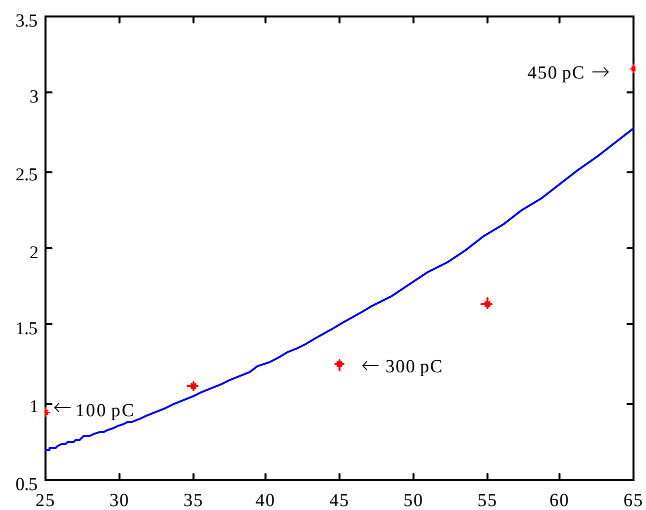
Step #5 to improve emittance

Longitudinal Emittance Compensation







- *Phys. Rev. E. 54, R3121 (1996)*
- *PAC 97*

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Small focus generation and measurements

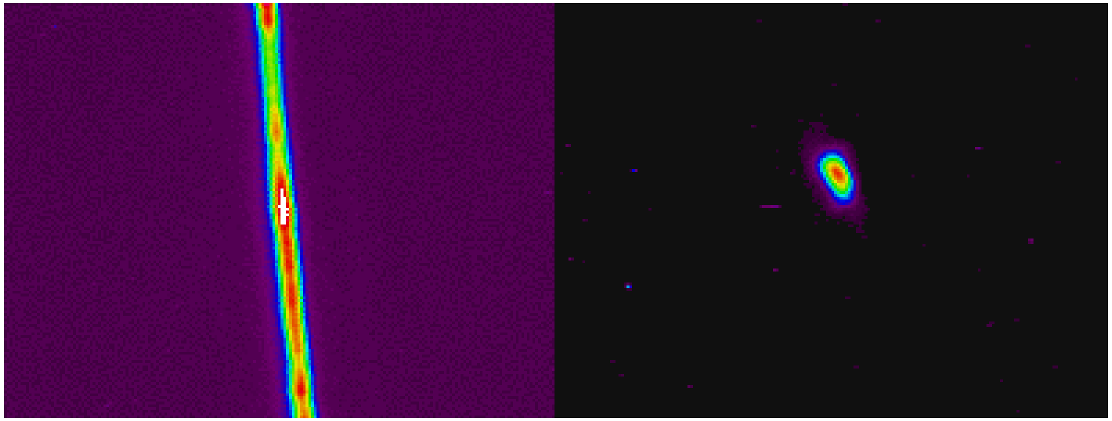
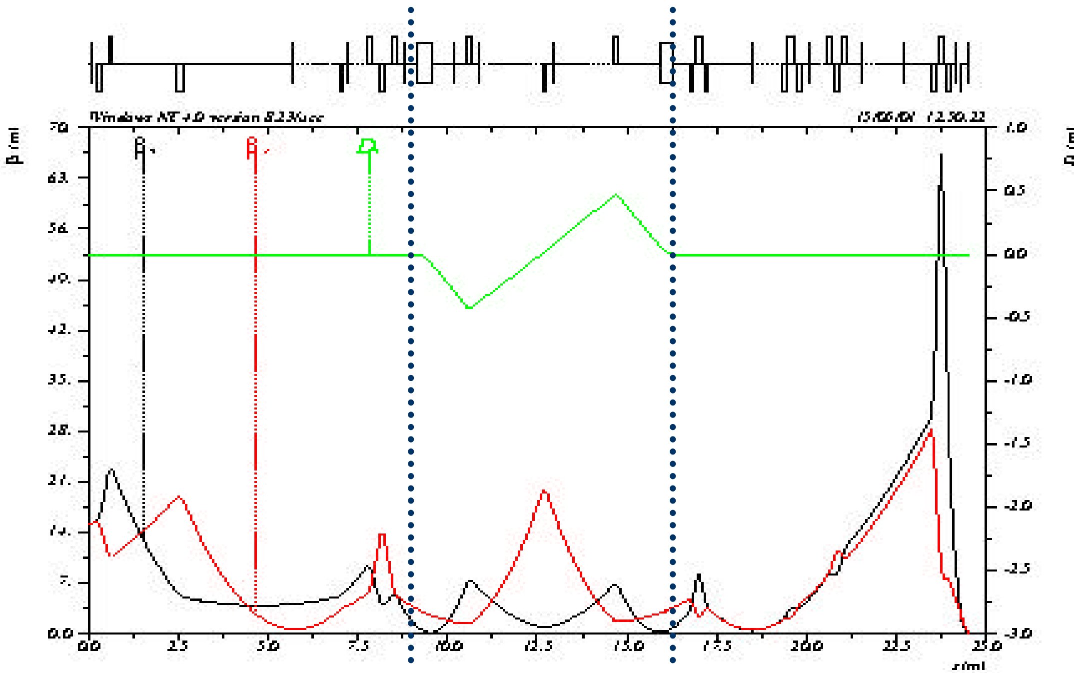


Image of the 30 μm wire taken with same optical magnification as 0.5 nC e-beam on the right

- ✓ In vacuum, permanent magnet quadrupoles were installed approximately 20 cm from focal location to produce 10 μm spot size. (β~1 cm and ε~1 μm).



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- Thank you!