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
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.
Accelerator Test Facility Layout
BPM resolution limit

Beam images taken consequently with the six different diagnostics under stable experimental conditions (the charge \( Q \sim 500 \) 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

[Graph showing ATF Laser Oscillator-to-Clock Relative Phase [ps]]
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

No tricks with black level...
Step #3 to improve emittance

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

Laser cleaning of cathode produces Mg plug cathode with $Q_e \approx 0.35\%$
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.
Step #5 to improve emittance
Longitudinal Emittance Compensation

- PAC 97
In vacuum, permanent magnet quadrupoles were installed approximately 20 cm from focal location to produce 10 μm spot size. ($\beta \sim 1$ cm and $\varepsilon \sim 1$ μm).
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