ASTRA at FNAL (Proton Driver) and PITZ (RF Gun)

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ASTRA at FNAL

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Beam physics of the 8-GeV H^- linac

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Abstract

Fermilab is developing the concept and design of an 8-GeV superconducting H^- linac with the primary mission of increasing the intensity of the Main Injector for the production of neutrino superbeams. The front-end of the linac up to 420 MeV operates at 325 MHz and accelerates the beam from the ion source using a room temperature radio-frequency quadrupole followed by short CH type resonators and superconducting spoke resonators. In the high-energy section, the acceleration is provided by superconducting elliptical 1.3 GHz cavities similar to the ones developed for the International Linear Collider (ILC). The beam physics for the linac is presented in this paper using two beam dynamics codes: TRACK and ASTRA.

ASTRA can do 3D Space Charge

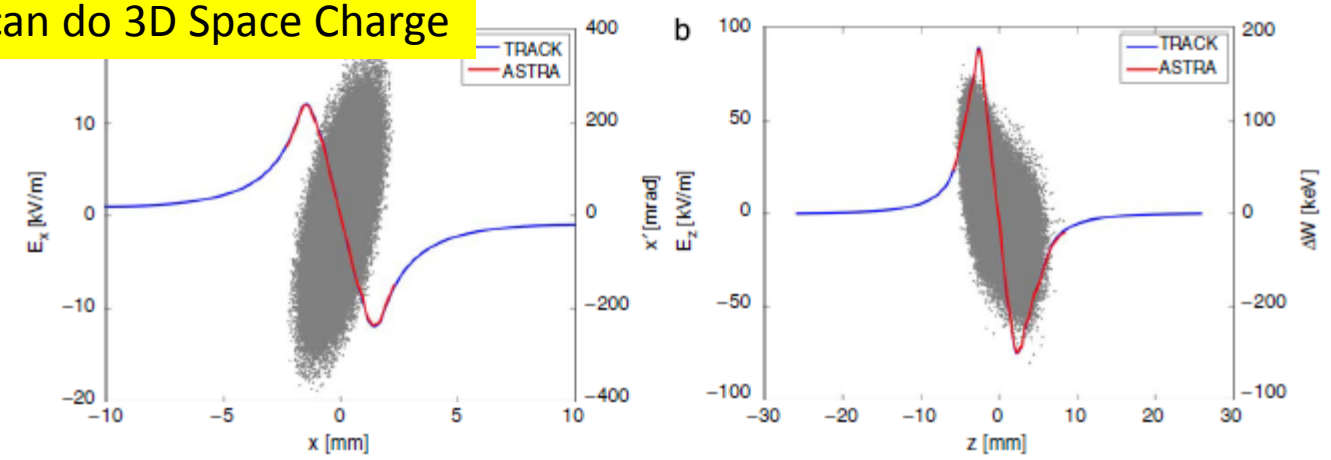


Fig 4. (a) Horizontal and (b) longitudinal phase space of a 43.25 mA beam distribution with corresponding space-charge electric fields on axis from TRACK and ASTRA.

ASTRA can do T&L phase advance per period (with some help from Matlab…)

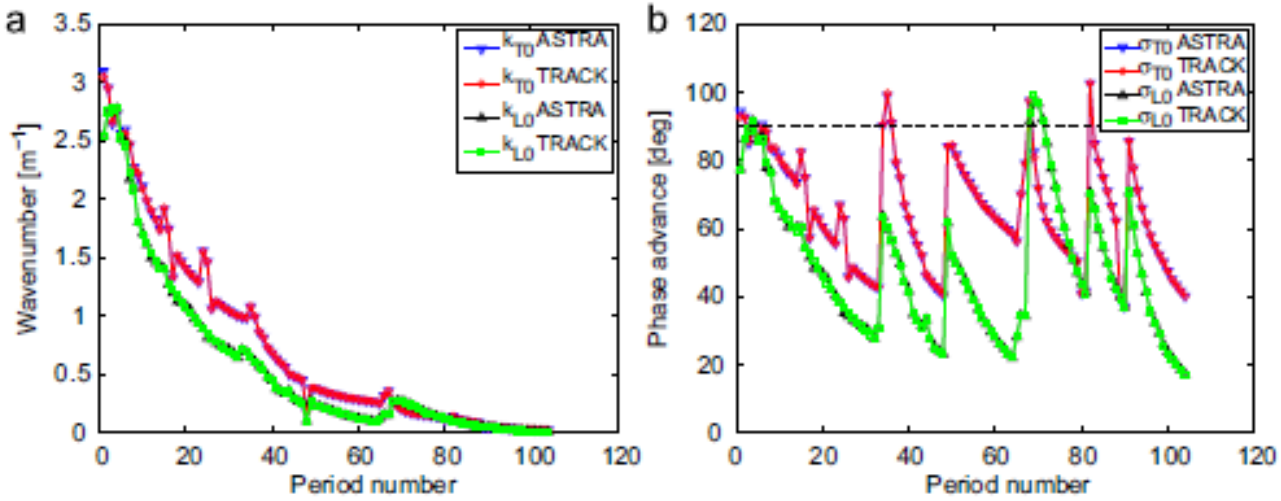


Fig 5. Zero current transverse and longitudinal (a) Phase advance and (b) wavenumber per linac focusing period, from TRACK and ASTRA.

ASTRA can do tune depression

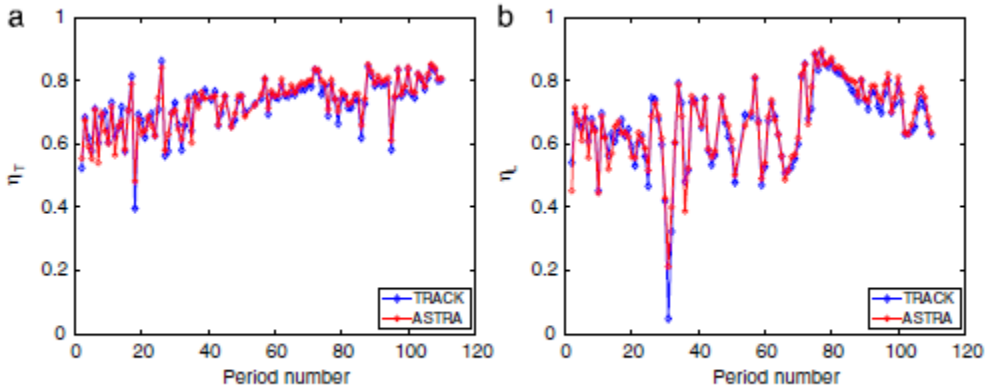
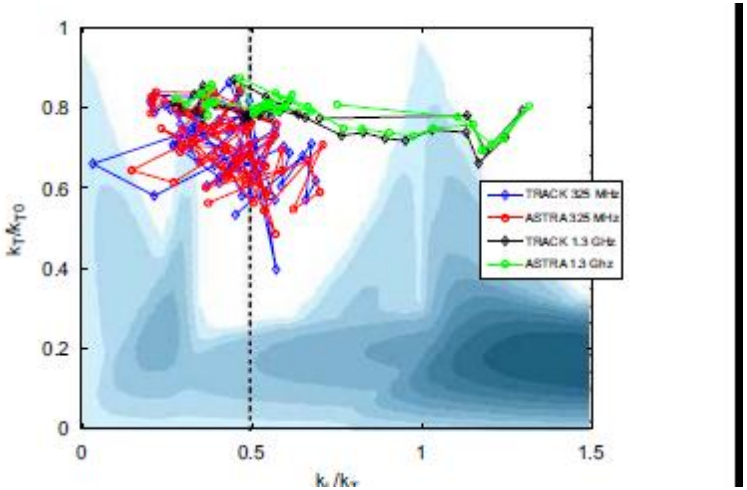
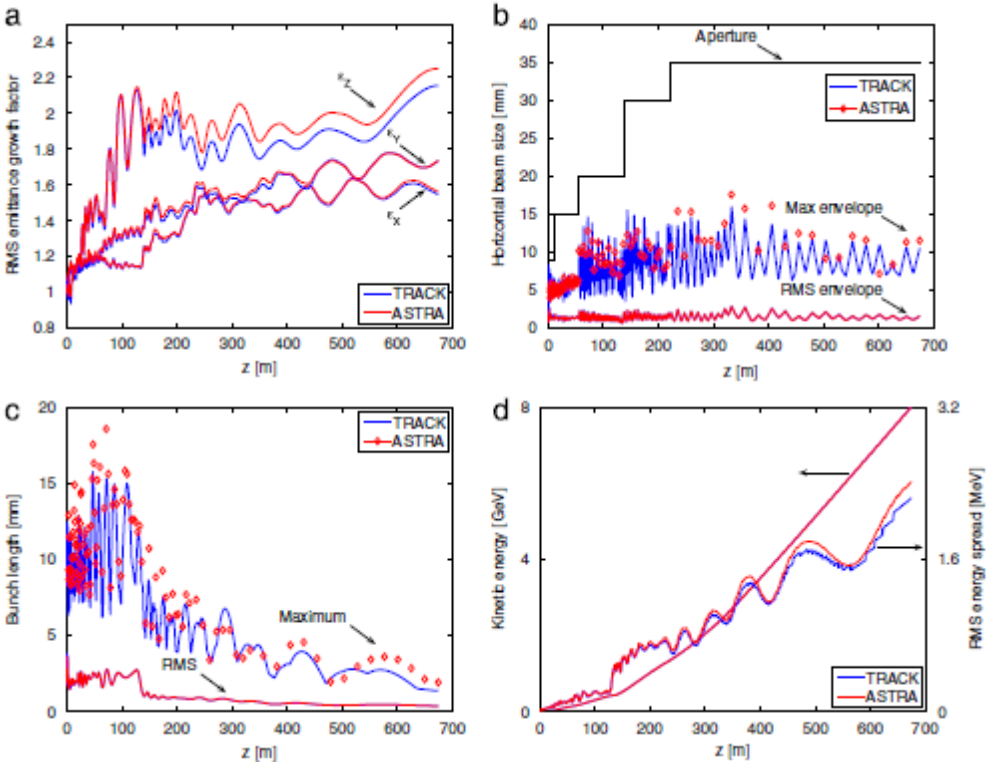


Fig. 7. (a) Transverse and (b) longitudinal tune depression per linac focusing period for a current of 43.25 mA, from TRACK and ASTRA.

ASTRA can even do Hoffmann Charts (with a little help from Hoffmann…)



Off course ASTRA can do RMS emittance, bunch size, etc…along a 700 m proton linac !



FEL 2003

Characterization of the Electron Source at the Photo Injector Test Facility at DESY Zeuthen

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ASTRA can do phase scan (RF Gun)

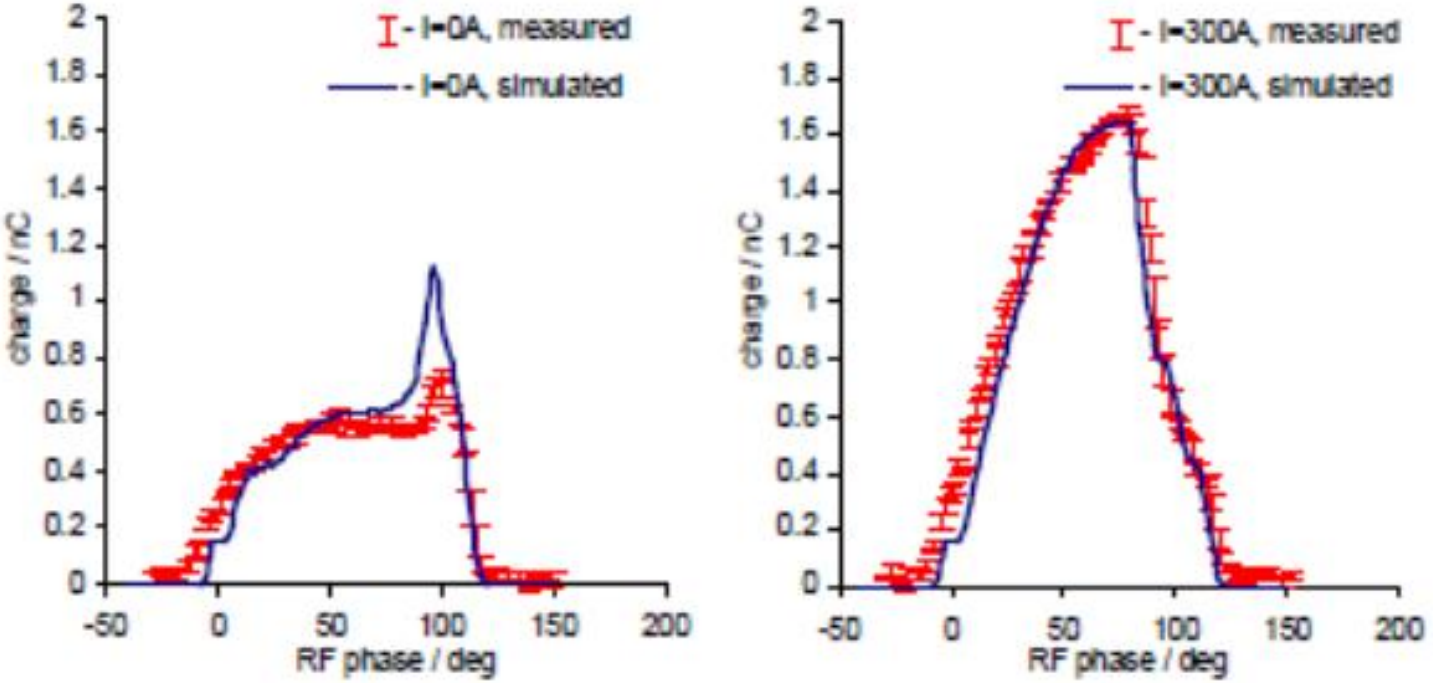

Fig. 3. Phase scans - detected beam charge as a function of RF phase for main solenoid currents of 0 A (left) and 300 A (right), compared with simulations. Gradient at the cathode ~40 MV/m.

ASTRA can do emittance at the exit of the RF gun as a function of Imain

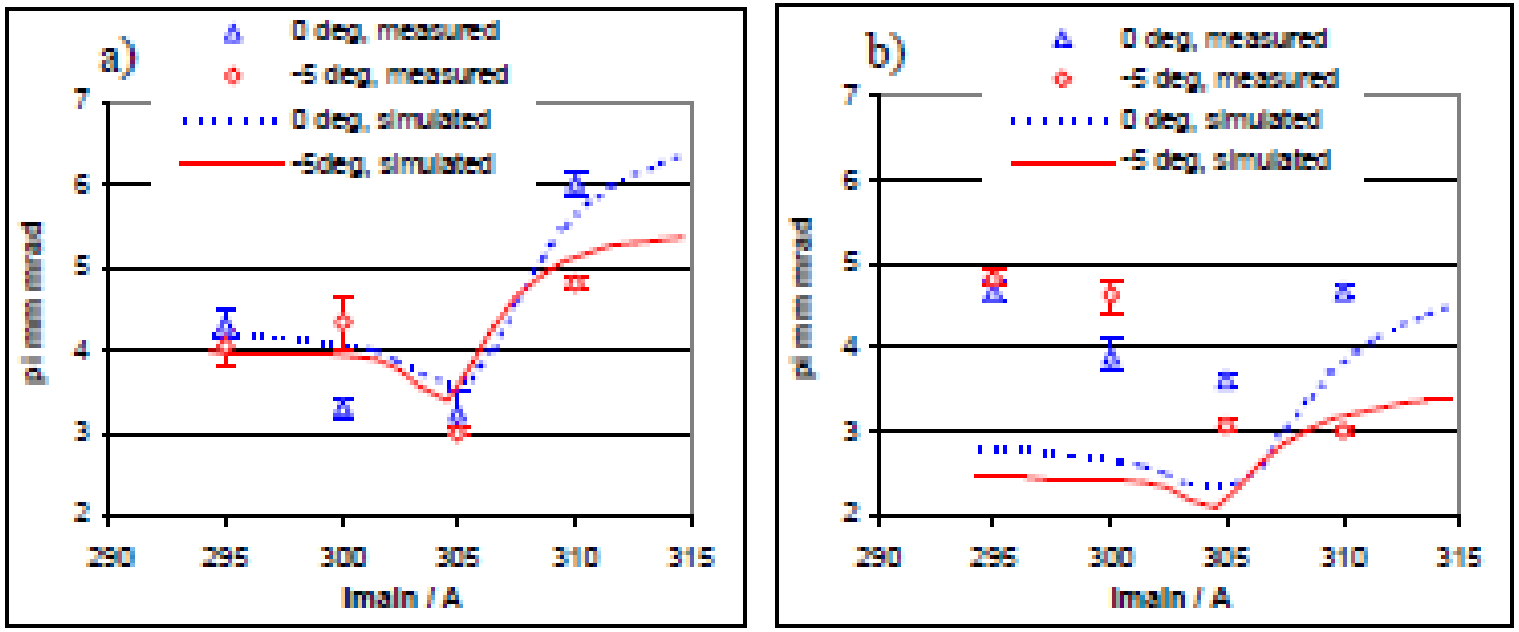

Fig. 7. Simulated horizontal (a) and vertical (b) beam emittance as a function of main solenoid current in comparison with measurements. RF phases are given with respect to Φ_0.

FEL 2004

TRANSVERSE EMITTANCE MEASUREMENTS AT THE PHOTO INJECTOR TEST FACILITY AT DESY ZEUTHEN

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ASTRA can do emittance scaling with the laser spot size

Emittance scaling with the laser spot size

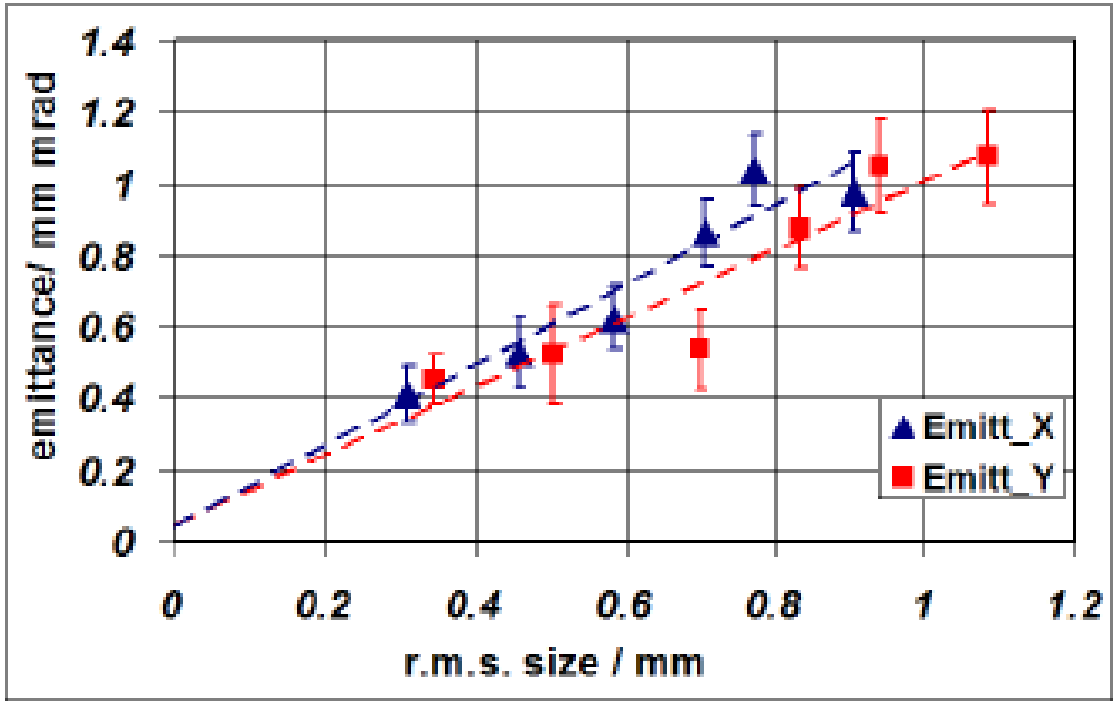

Figure 5: Transverse emittance vs. laser spot r.m.s. size measured with the slit scanning technique at 3 pC.

ASTRA can do emittance at the exit of the RF gun as a function of field on cathode

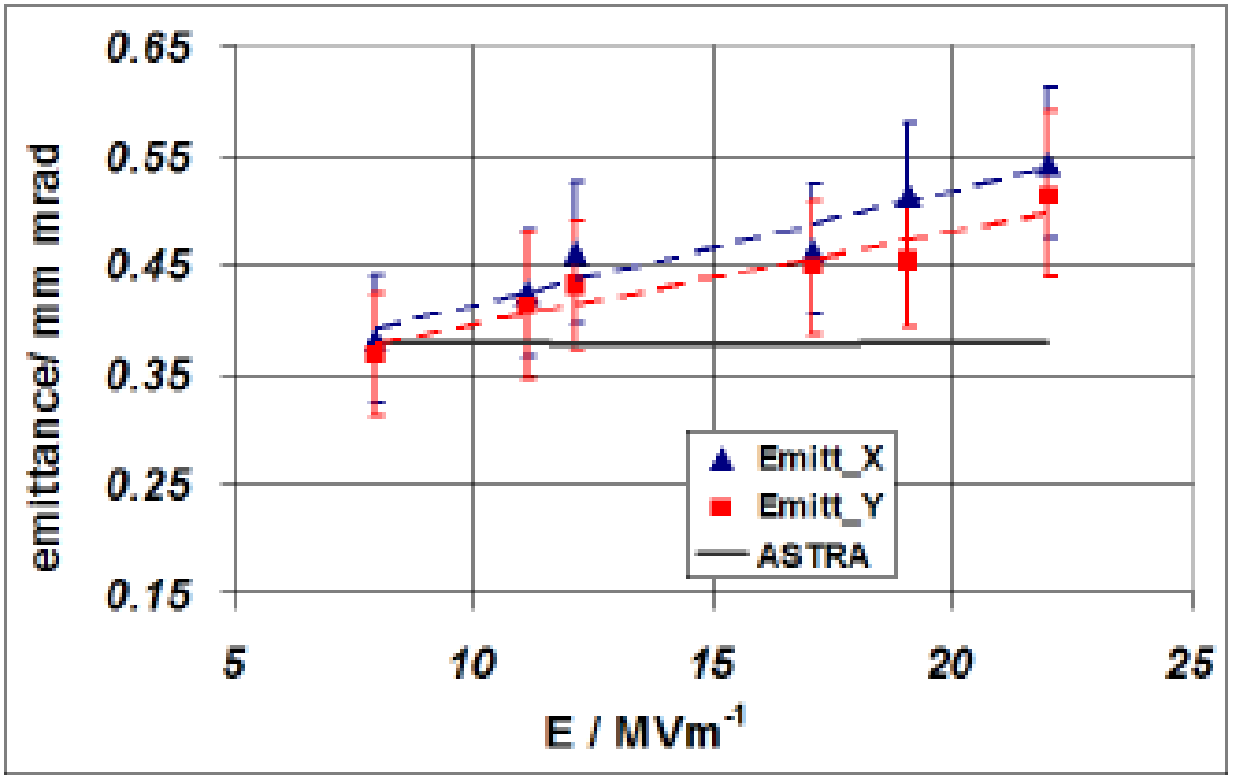

Figure 6: Emittance as a function of the accelerating field on the cathode surface E for a charge of 2 to 3 pC.

Why Velizar did not show ASTRA here ?

RECENT MEASUREMENTS WITH CAVITY PROTOTYPE #1

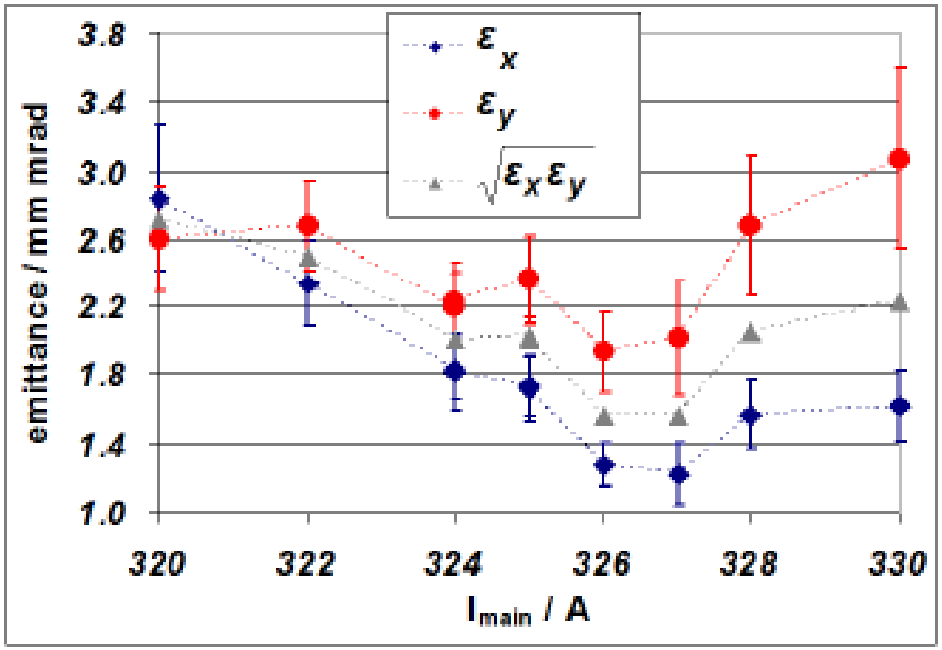

Figure 7: Measurements with cavity prototype #1.

After cavity prototype #2 was fully characterized at PITZ and installed at TTF, cavity prototype #1 was put into operation at PITZ in the beginning of 2004 [2] followed by the rf conditioning [9]. The beam dynamics optimization is