# NML End-to-end Simulations

**Layout:**

- Egun + CC1 + CC2 + 3rd harmonic
- 11/06 Piot Injector (11 quads + 3 skew quads)
  - chicane magnet lengths and drifts slightly modified; bend angle = 21.5°
  - drift at end set to match current NML layout drawings
- 2 TTF cryomodules @ 31 MV/m (accelerating gradient)
  - 1st CM has no quads; 2nd CM has 2 quads (but currently not used)
  - acceleration on crest; d.s. beam energy =555 MeV
- HE beamline has two 25° bends in dogleg configuration

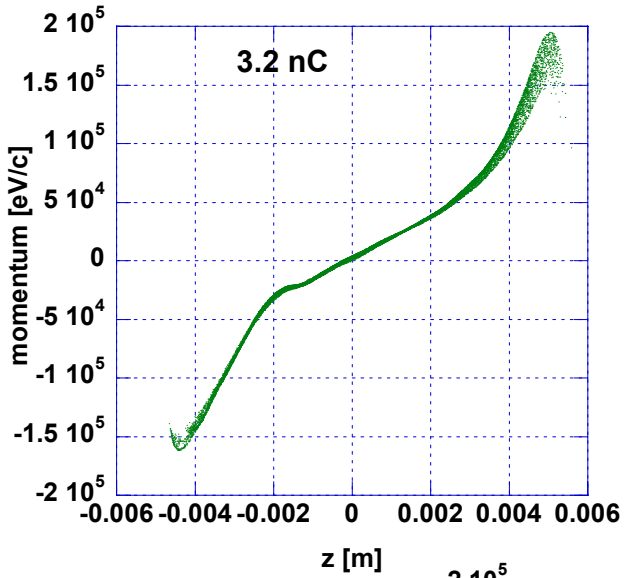
**Lattice constraints** (currently very weak)

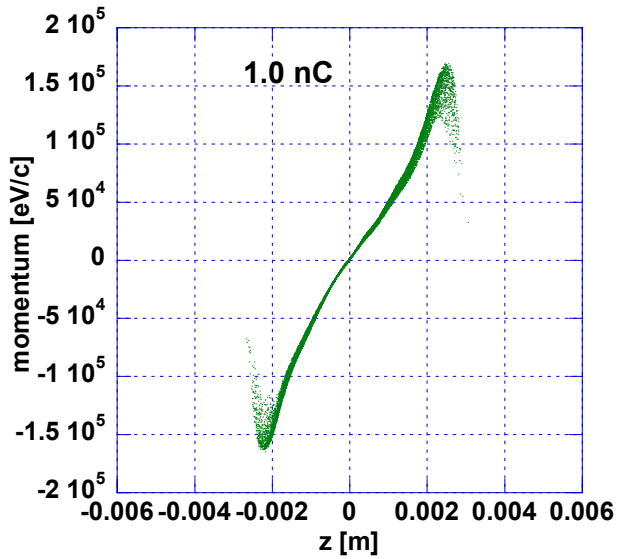
- Initial $\beta$=2.74m, $\alpha$=-.6773
- $\beta$ < 80m in injector; $\beta$ < 200m in CM's; $\beta$ < 200m in u.s. end of HE line
- $R_{56}$ in chicane = 0.22m (dispersion = 0.33m)
- dispersion @ HE IP = 0.64m; dispersion = 0.0m after 2nd HE dogleg dipole
- $\beta_x$ = 20m; $\alpha_x$ = 0.5; $\beta_y$ = 30m; $\alpha_y$ = -3.0 @ d.s. end of 2nd CM (arbitrary but reasonable)
- $\beta_x$ = 2m; $\alpha_x$ = 0.0; $\beta_y$ = 20m; $\alpha_y$ = 0.0 @ HE IP
- $\beta_x$ = 1000m; $\beta_y$ = 4800m at dump (gives rms beamsize between 3.0 and 3.5 mm)

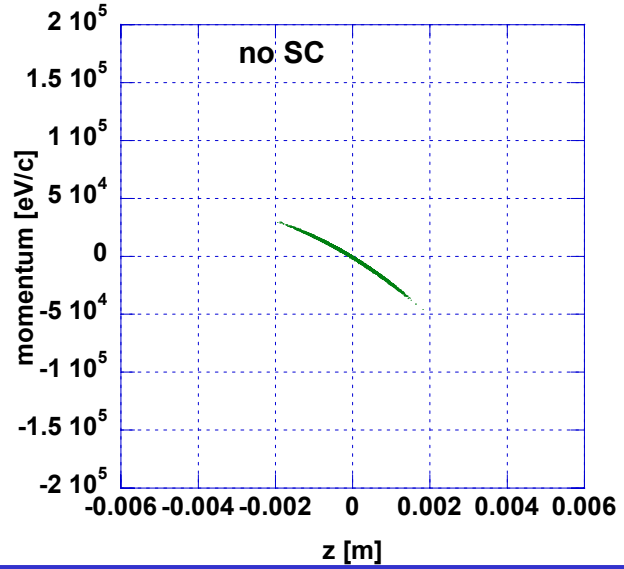
# Beam and ASTRA

- ILC type beam: 3.2nC/bunch; round beam
- laser
  - rms spot size = 1.2mm → flat distribution with full diameter = 4.8mm
  - 4 stacked gaussians 2.3 ps rms each, separated by 1.8 ps
- ASTRA simulation uses 20k macroparticles
- Strategy
  - Set Egun Emax = 40 MV/m; CC1 Emax = 20 MV/m; CC2 Emax = 60 MV/m;
  - Set 3$^{rd}$ Harm Emax = 27 MV/m; phase = 180 deg
  - Set CC1 and CC2 phase to match chicane (-12 deg each)
  - Adjust Egun phase and solenoid field to minimize transverse emittance
- Track particles to 8.3m from photocathode (d.s. of 3$^{rd}$ harm.) with ASTRA; then track with MAD

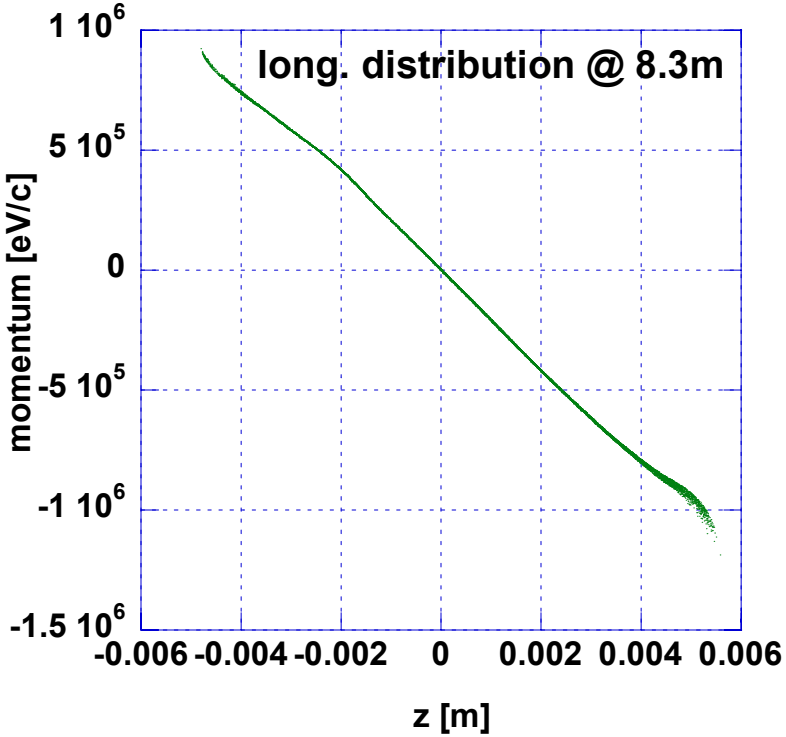
# Longitudinal Distribution out of Egun

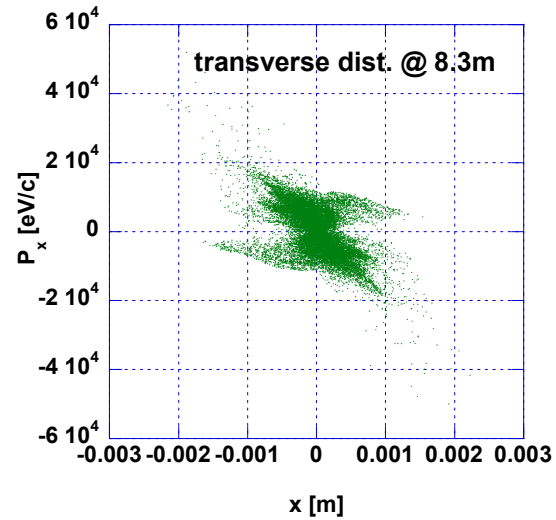


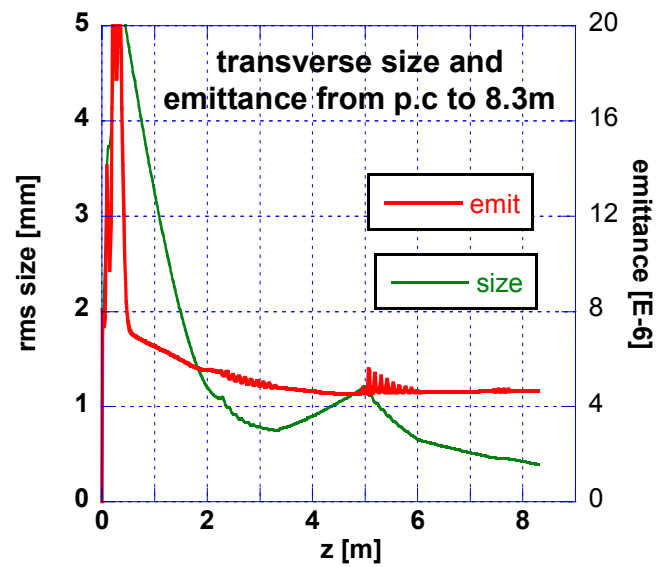



# Distributions d.s. of 3rd Harmonic

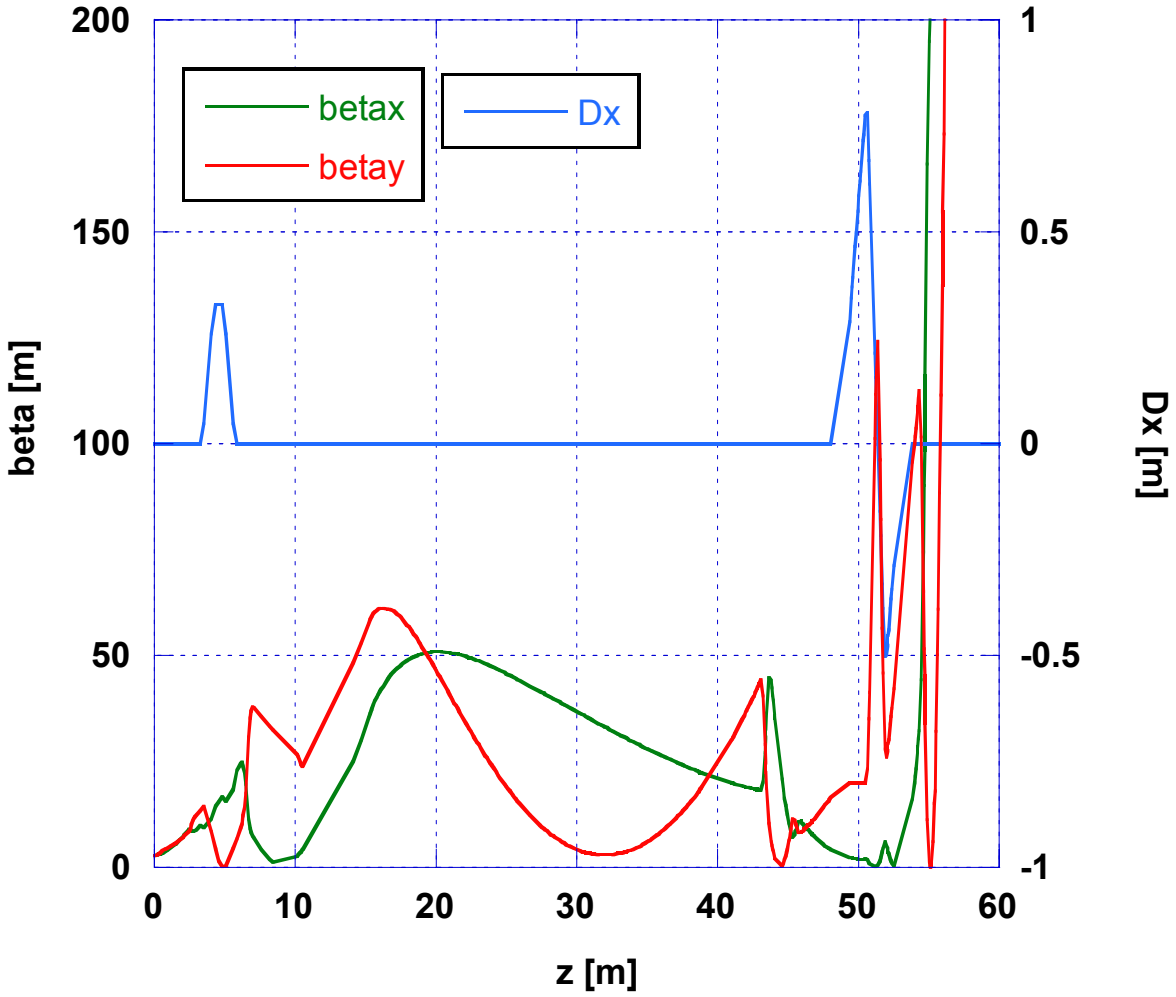


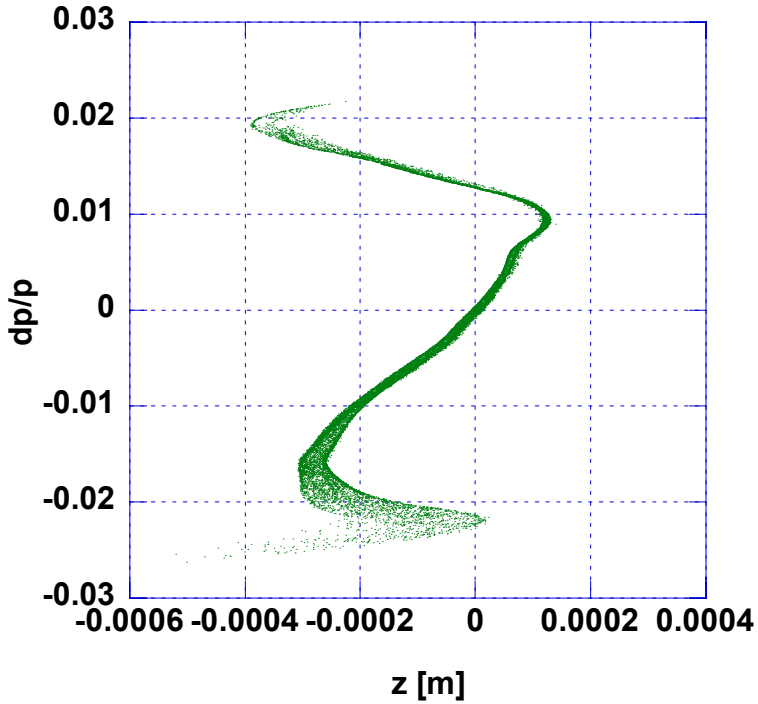



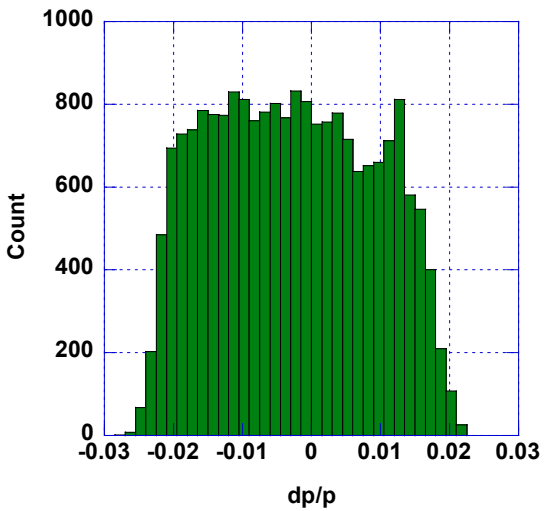

**KE = 41.9 MeV**

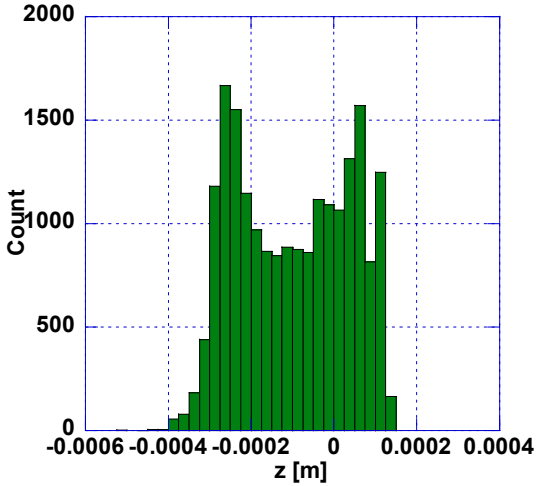
# Lattice Functions from 8.3m to Dump



# Long. Dist. at End of Injector

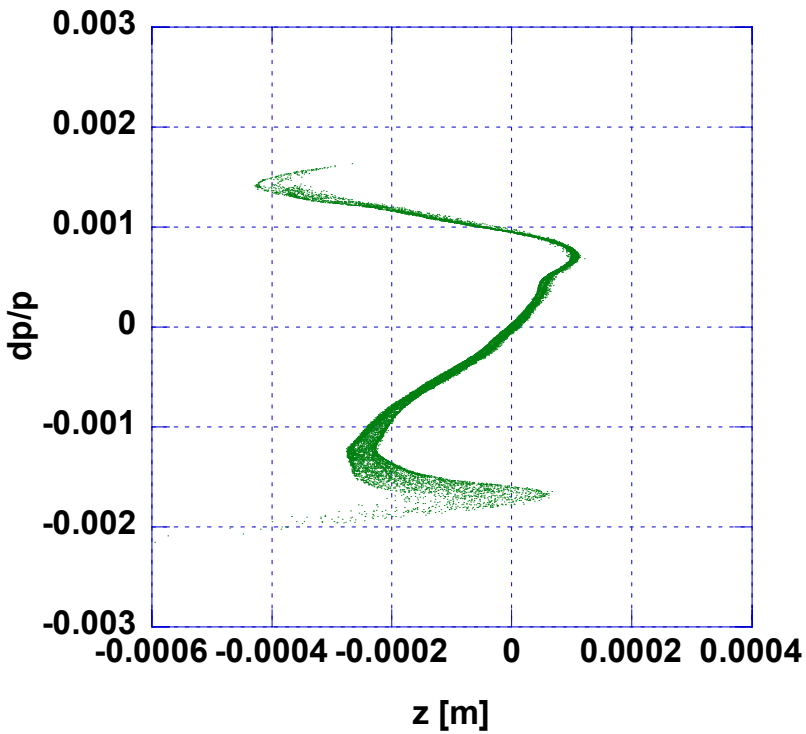


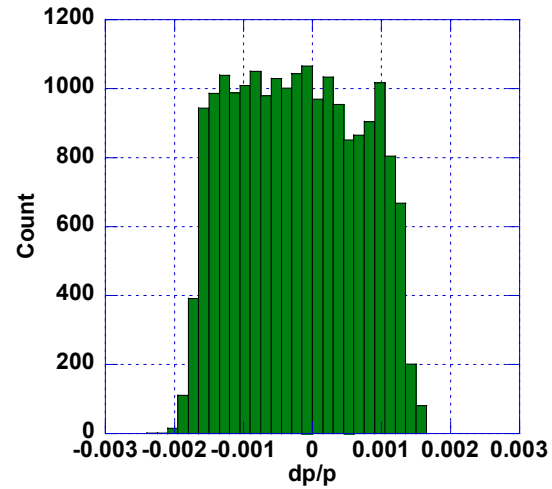



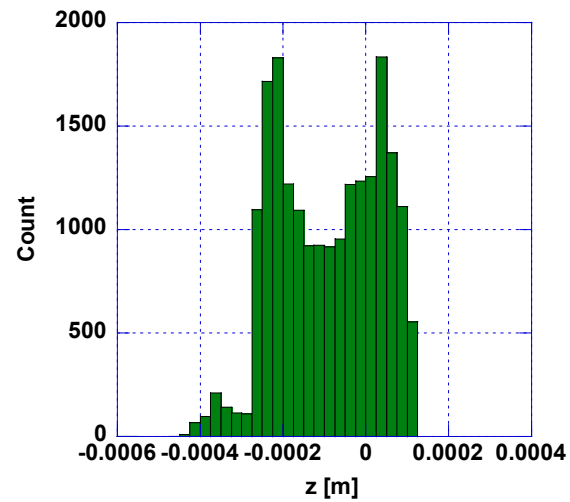




$\sigma_z = 136\mu m$; $\sigma_{dp/p} = 1.16\%$

# Long. Dist. at End of CM 2

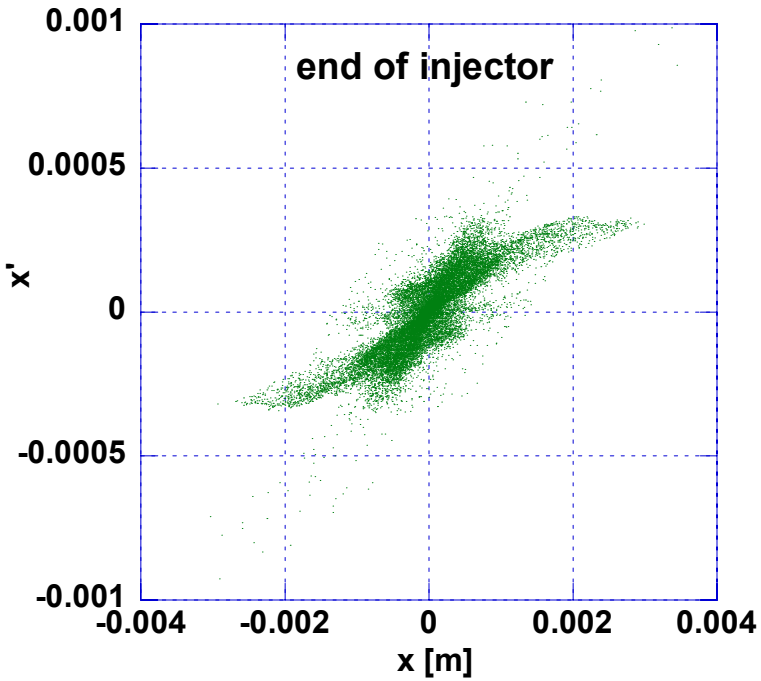


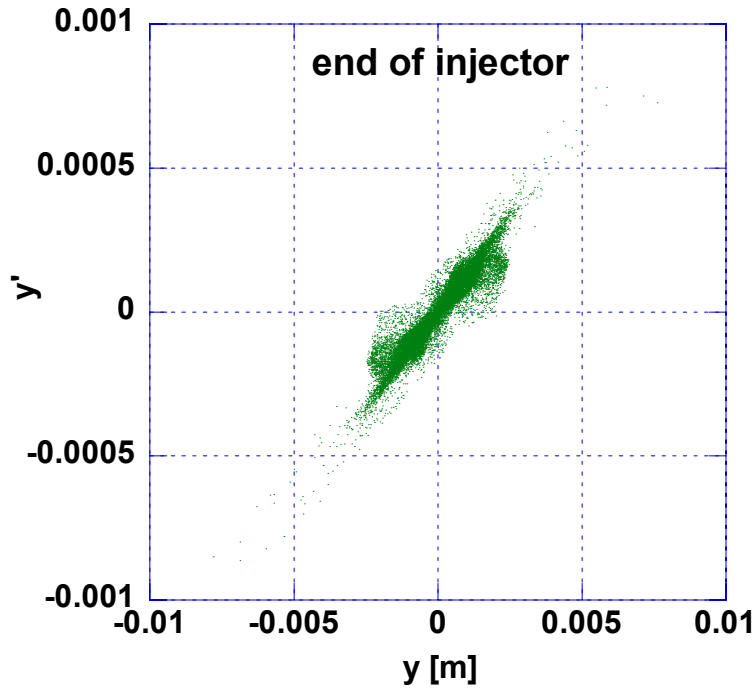



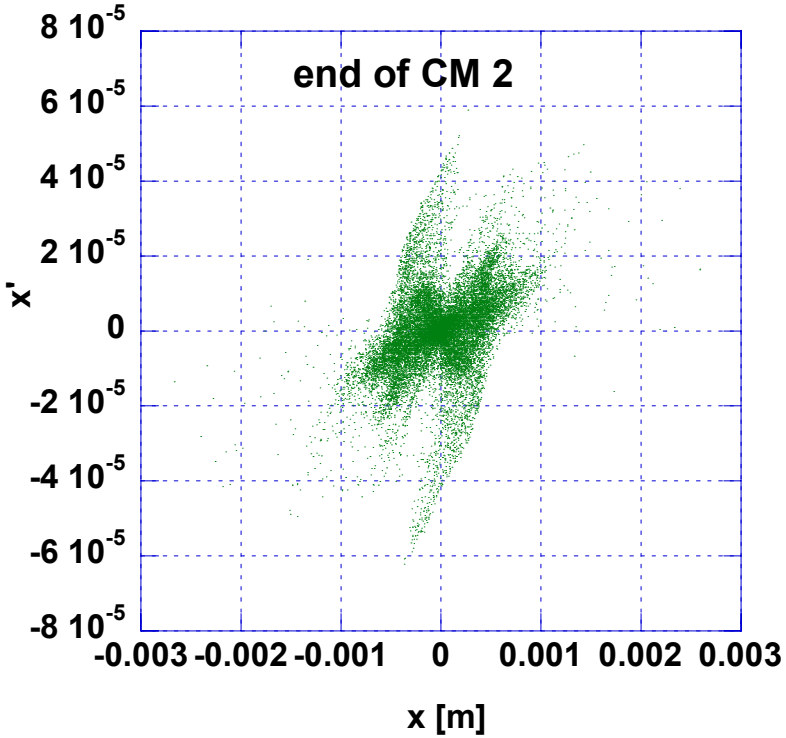

$\sigma_z = 125\mu m$; $\sigma_{dp/p} = 0.088\%$

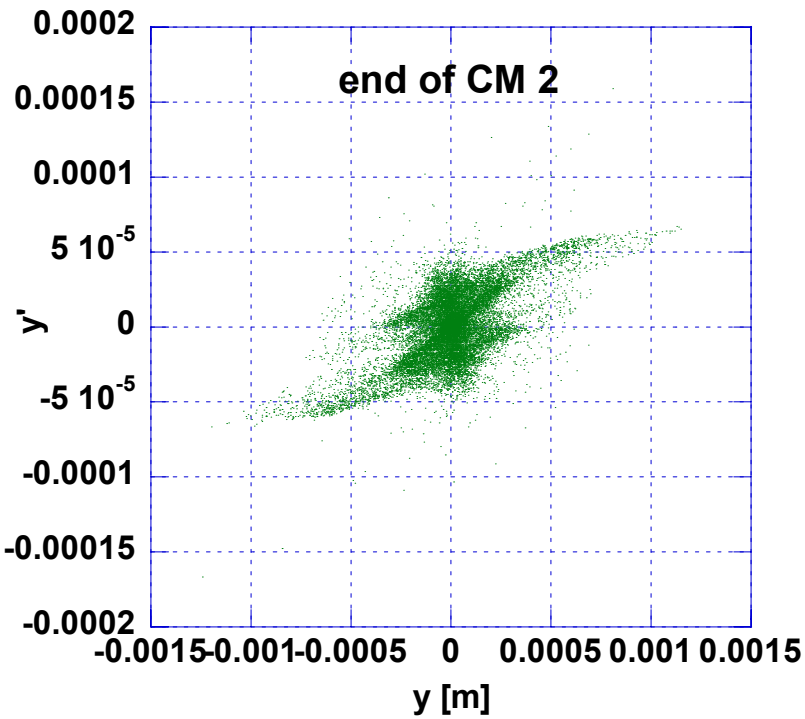
# Transverse Distributions at End of Injector



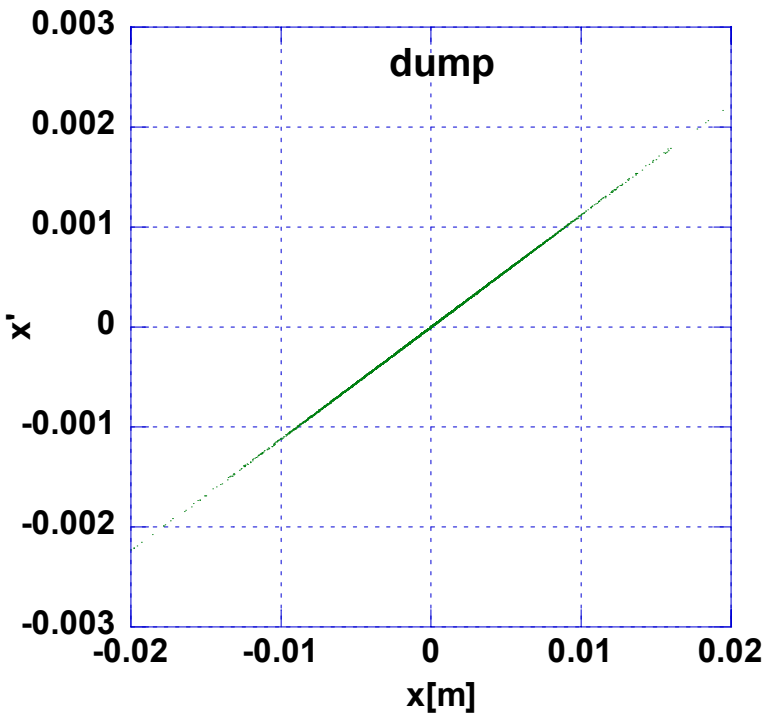



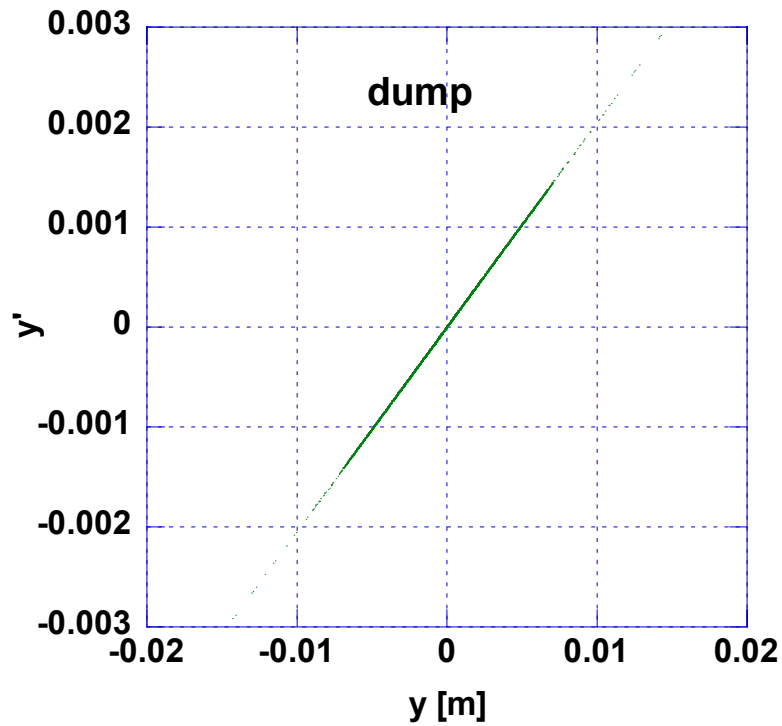
# Transverse Distributions at End of CM 2



# Transverse Distributions at Dump



# Continuing Investigations

- Optimize ASTRA parameters for space charge calculation
- Verify if MAD off-momentum tracking is accurate
- Verify if MAD calculates RF focusing correctly
- Check space charge effects in injector
- Specify lattice and beam constraints
- Determine largest magnitude of injector chicane
- Investigate larger laser spot size (?)