

Initial Beam-Beam studies

January 20, 2014

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- The beam-beam code and the two parameter sets used.
- The beam-beam effects on the phase space of the proton beam.
- Effects of shifting the waist of the beam.
- Effects on the spent beams.
- Effects on the phase space of the spent electron beam.

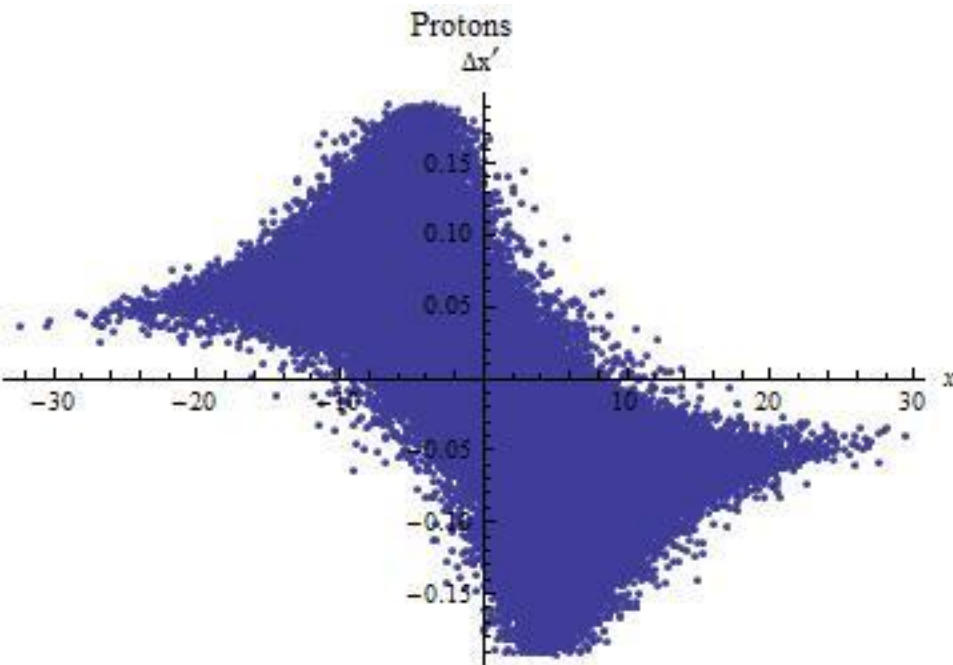
Beam code and Parameters

- The code in use is Guinea pig, two versions are used for the different simulations, the C version, guinea 1.4.4 and the c++ version guinea_pig++

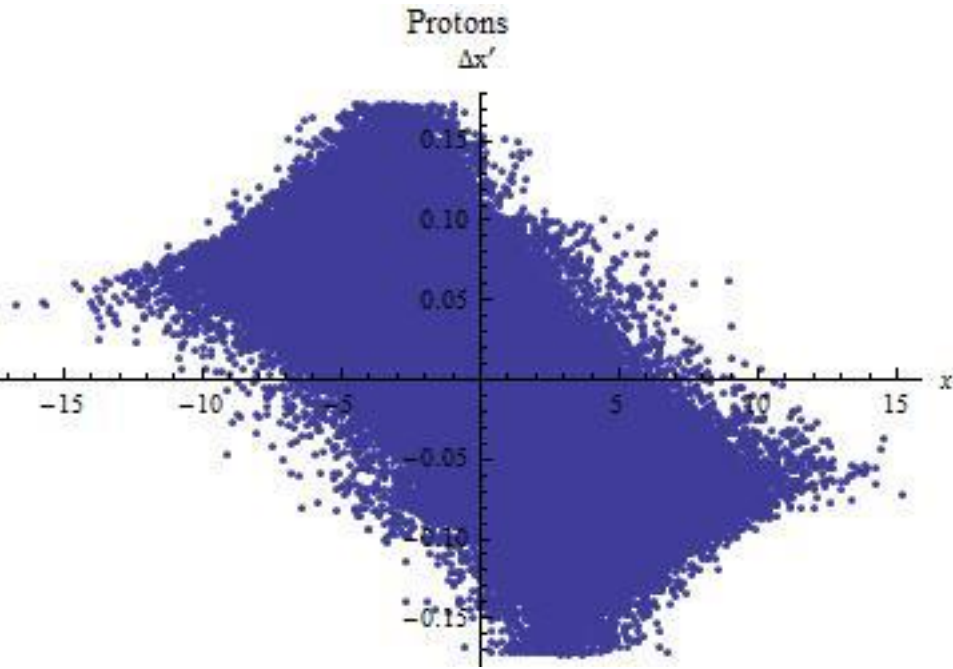
	Value	Nominal Parameters	High Luminosity
Particle number (ion/electron)	10^{10}	17/0.3	22/0.2
β^* ion	mm	100	50
β^* electron	mm	120	32
$\epsilon_{x,y}$ ion	mm mr	3.75	2
$\epsilon_{x,y}$ electron	mm mr	50	50

Transverse Effects

Nominal

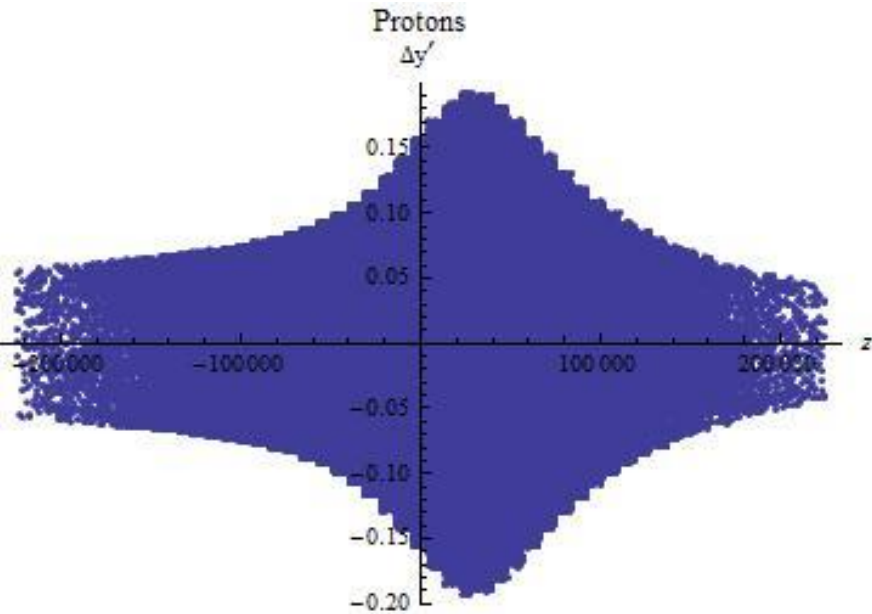


High Luminosity

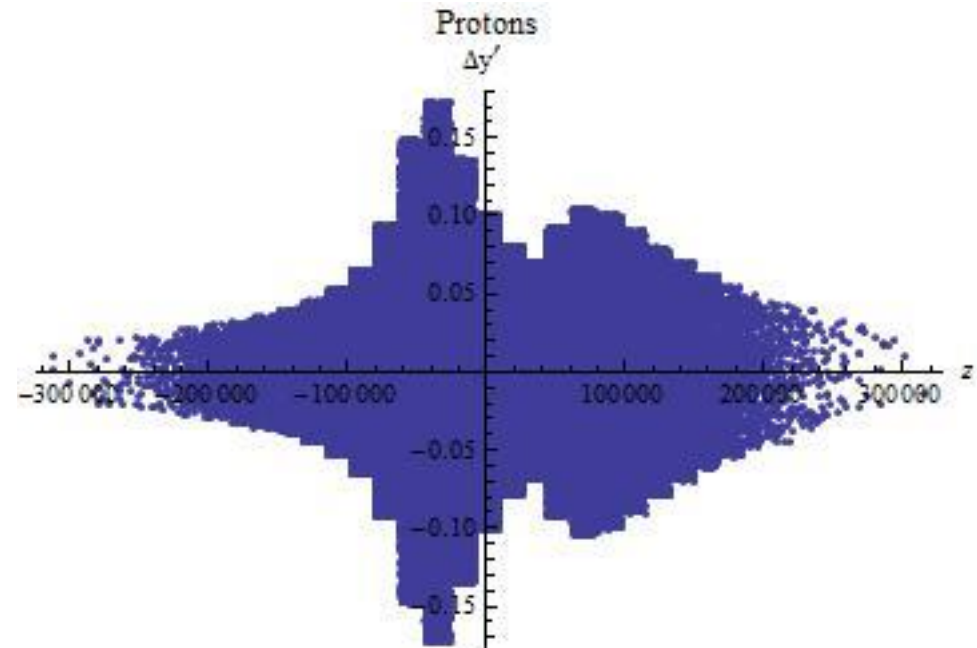


Longitudinal Effects

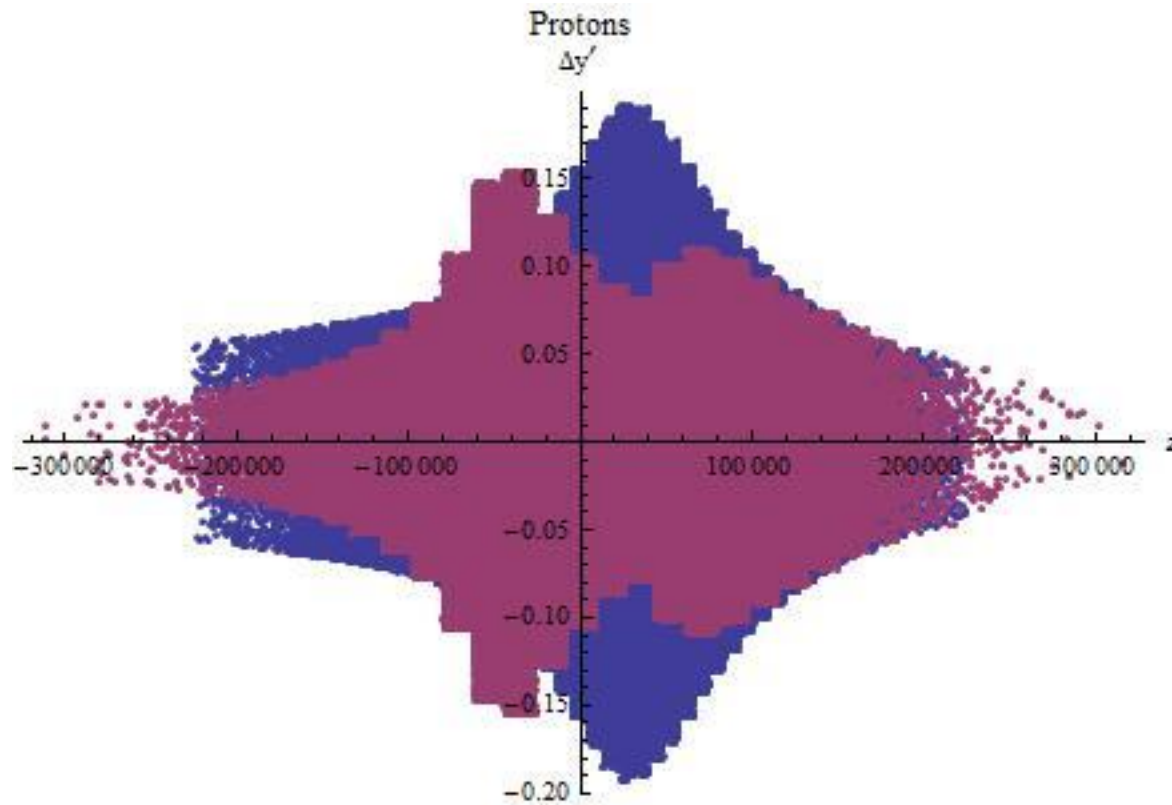
Nominal



High Luminosity

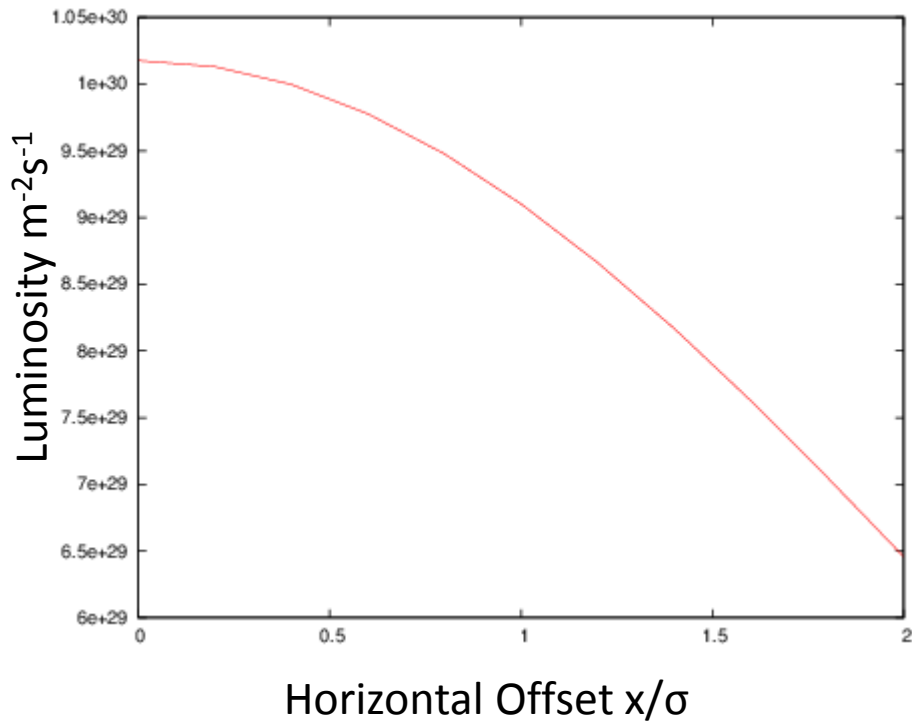


Longitudinal Effects

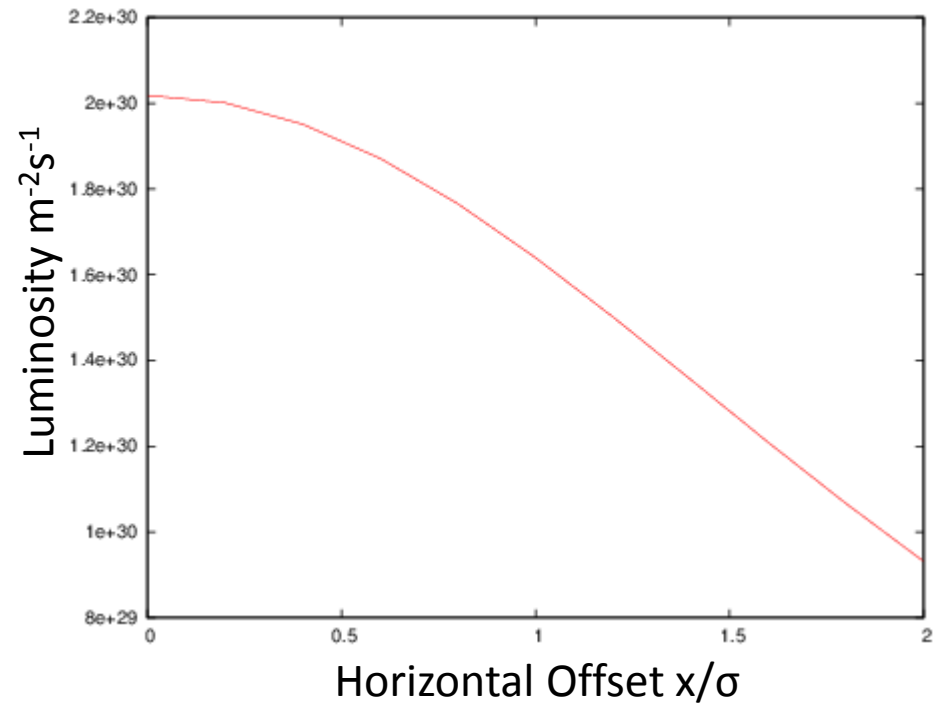


Luminosity Measurements with Offsets

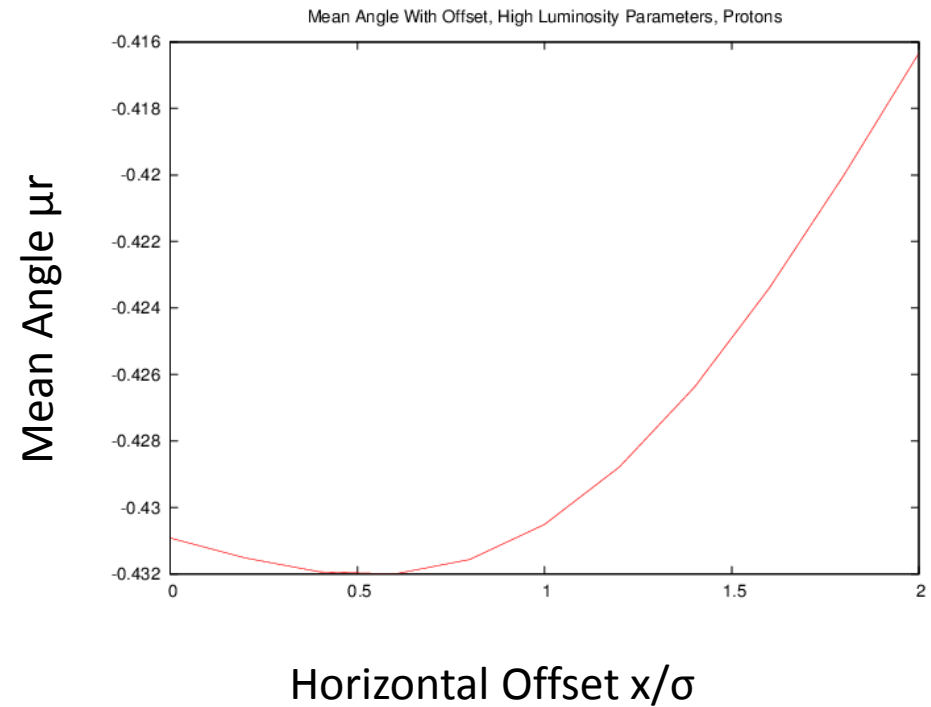
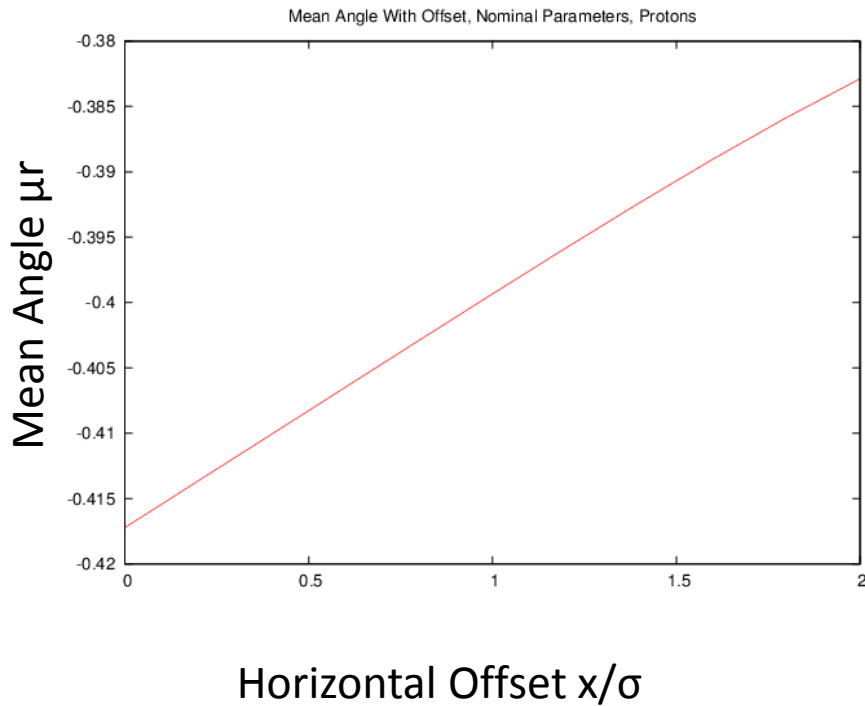
Nominal Parameters



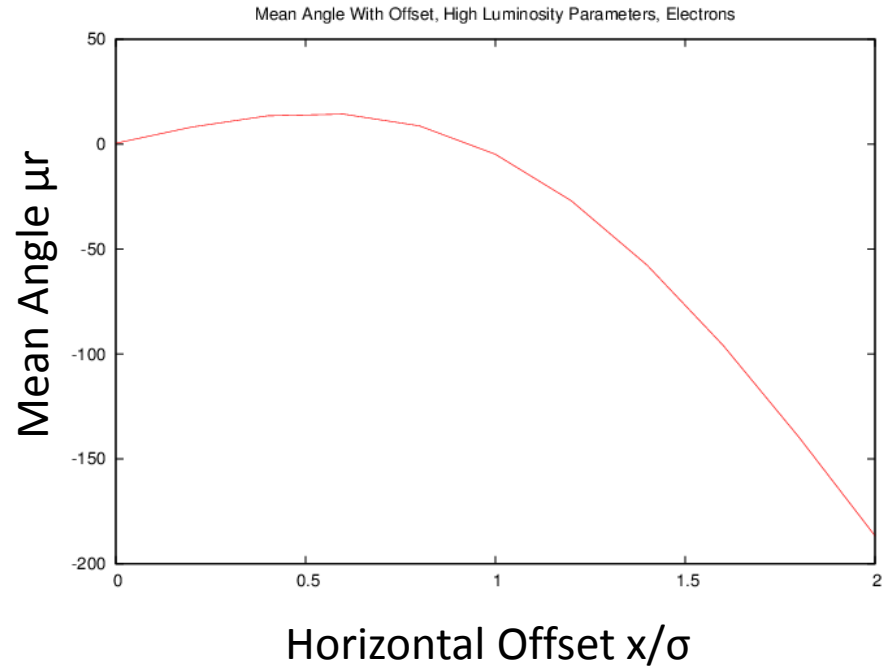
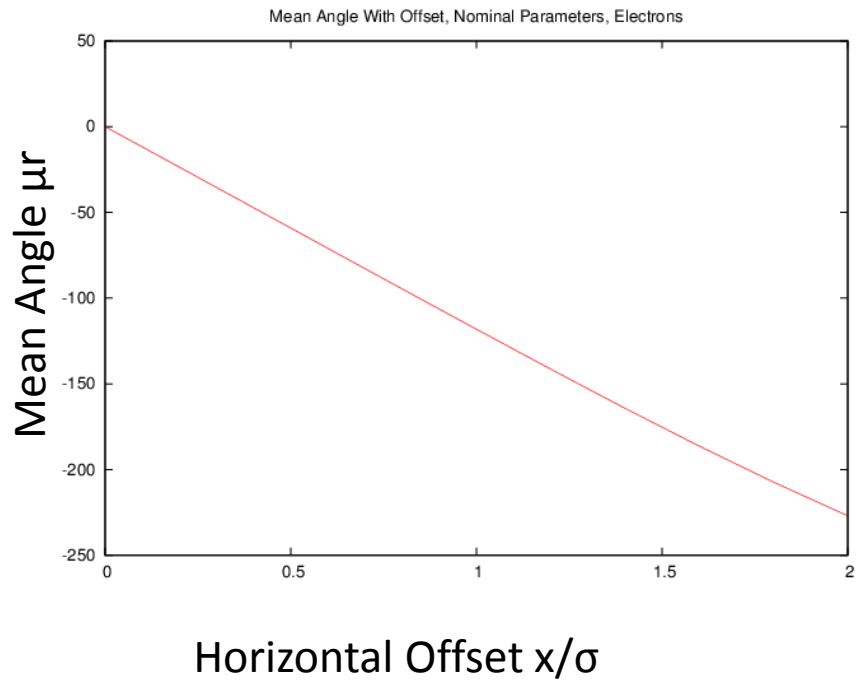
High Luminosity



Angles With Offsets (Protons)



Angles With Offsets (Electrons)



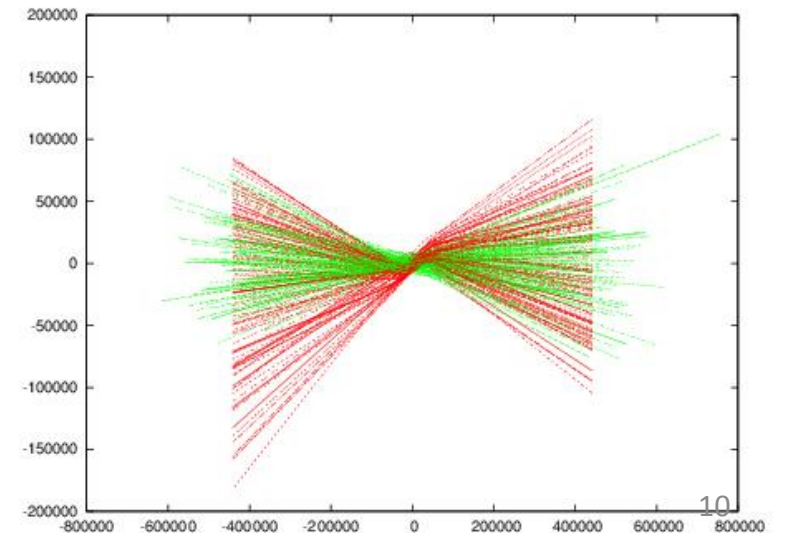
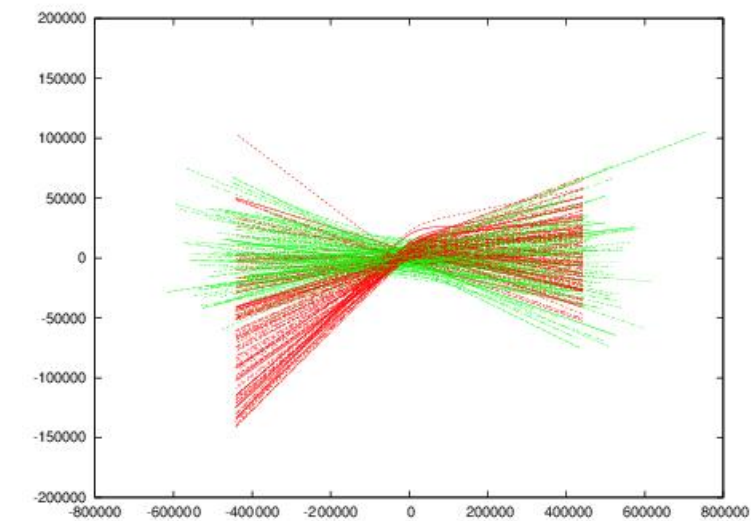
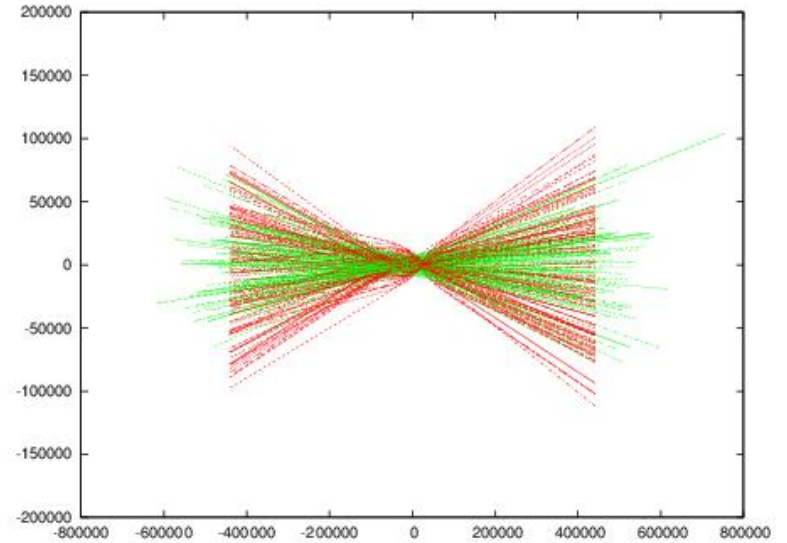
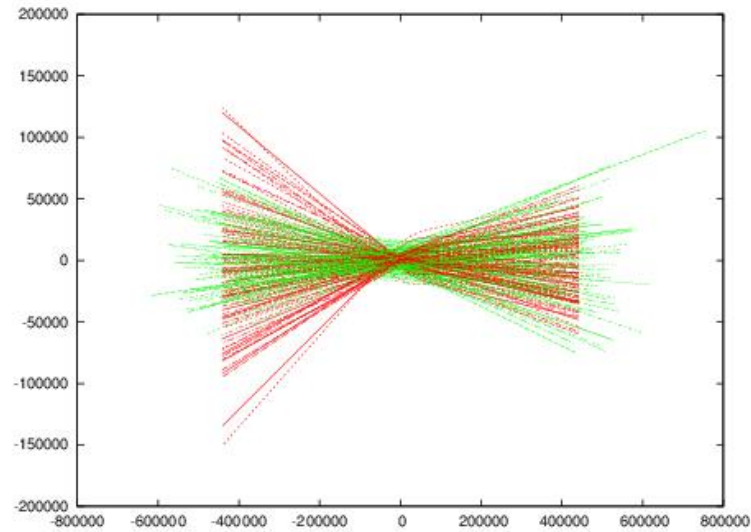
Trajectories with offsets

Nominal Parameters

High Luminosity

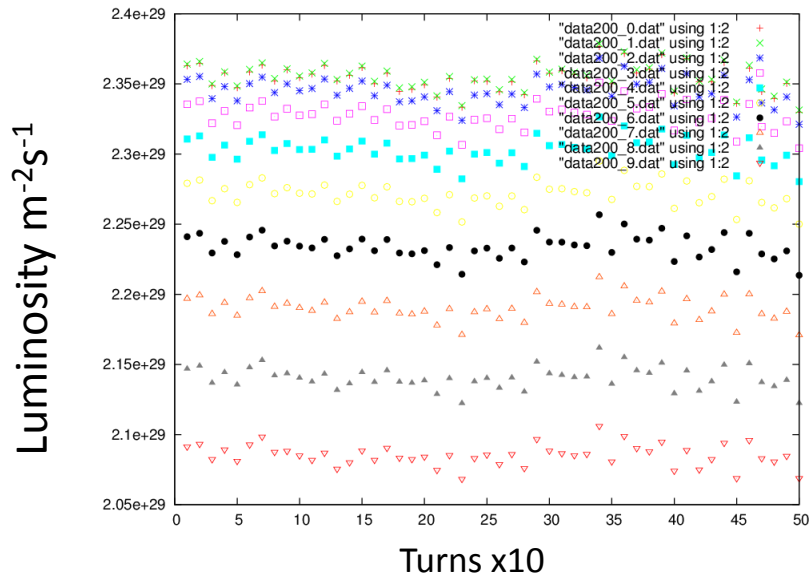
Head-on

1σ offset

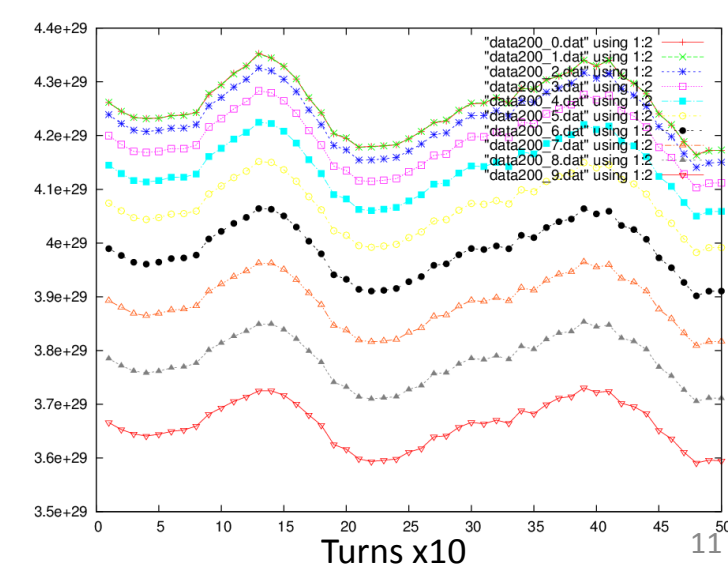
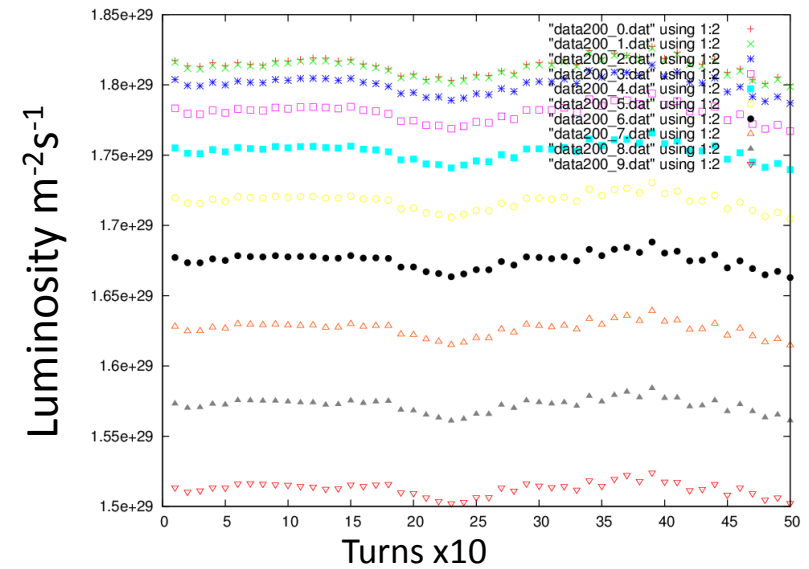
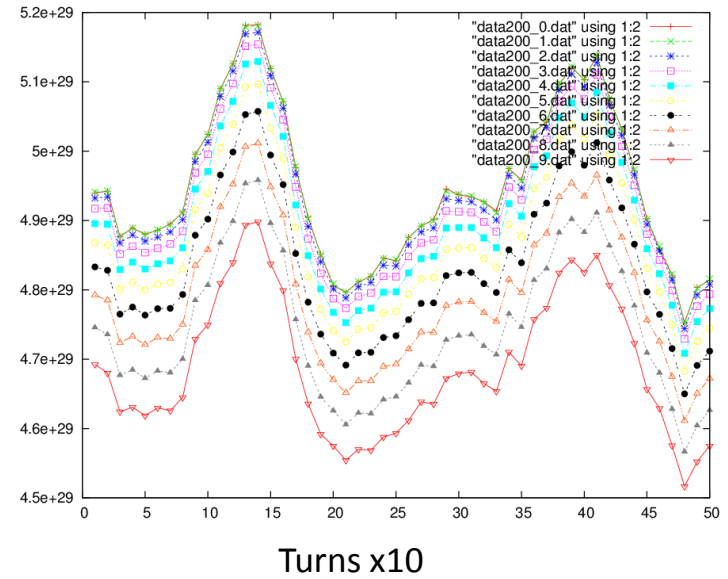


Luminosity Measurements with Tracking

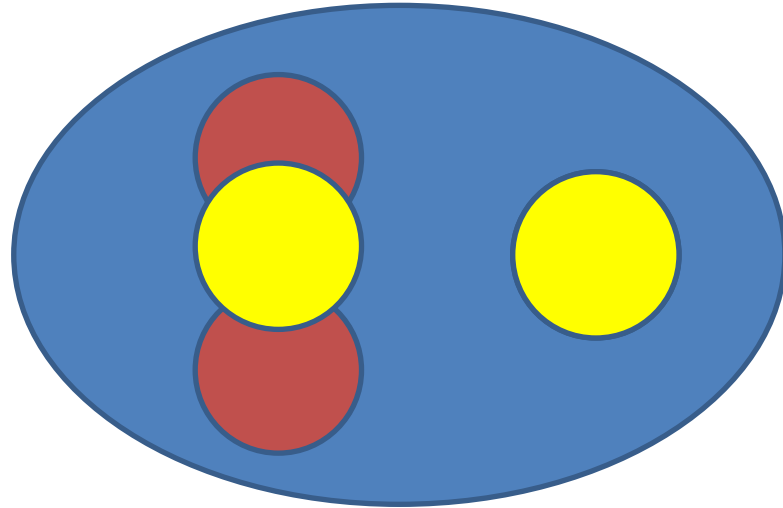
Nominal Parameters



High Luminosity

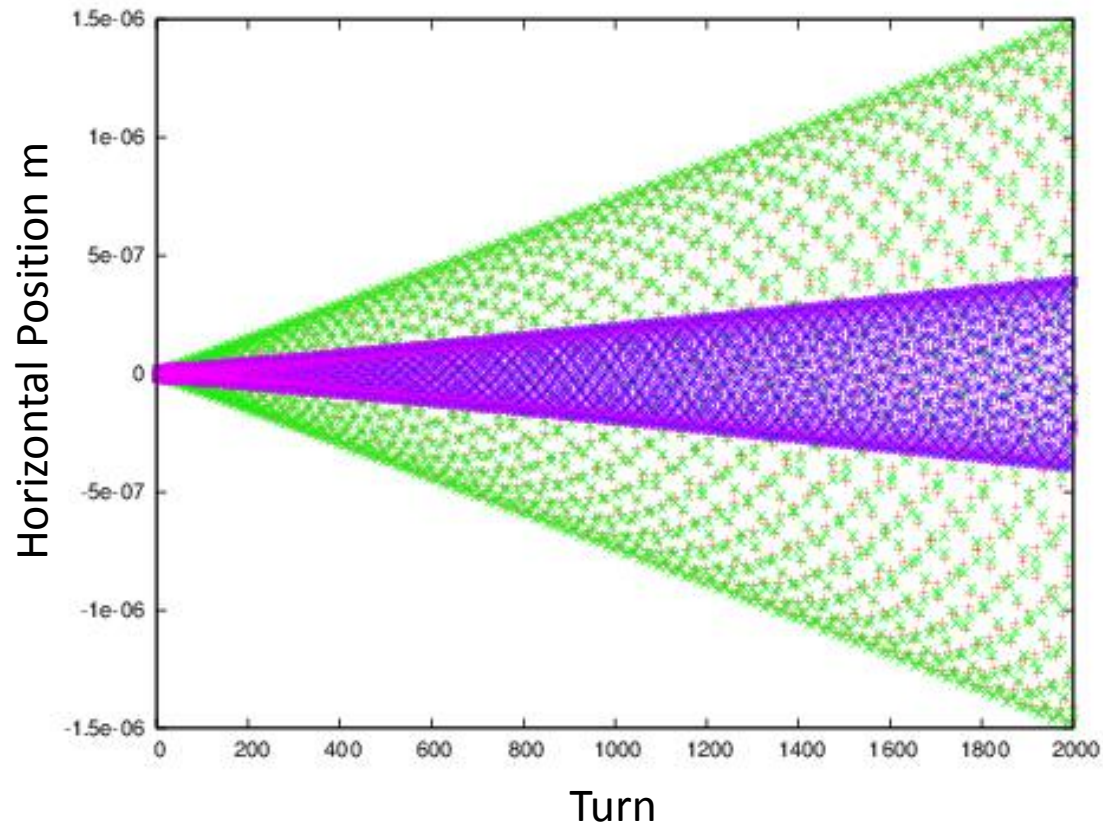


Induce an instability



Attempt to induce instability in recirculating proton beam by matching the electron beam to always hit with a set offset at the same section of the beam, based on the horizontal tune.

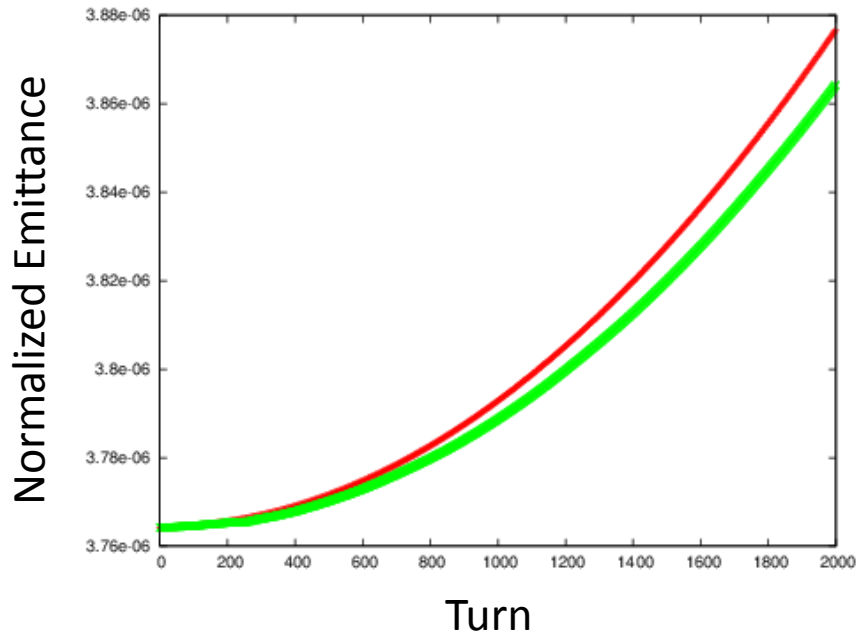
Induced Instability



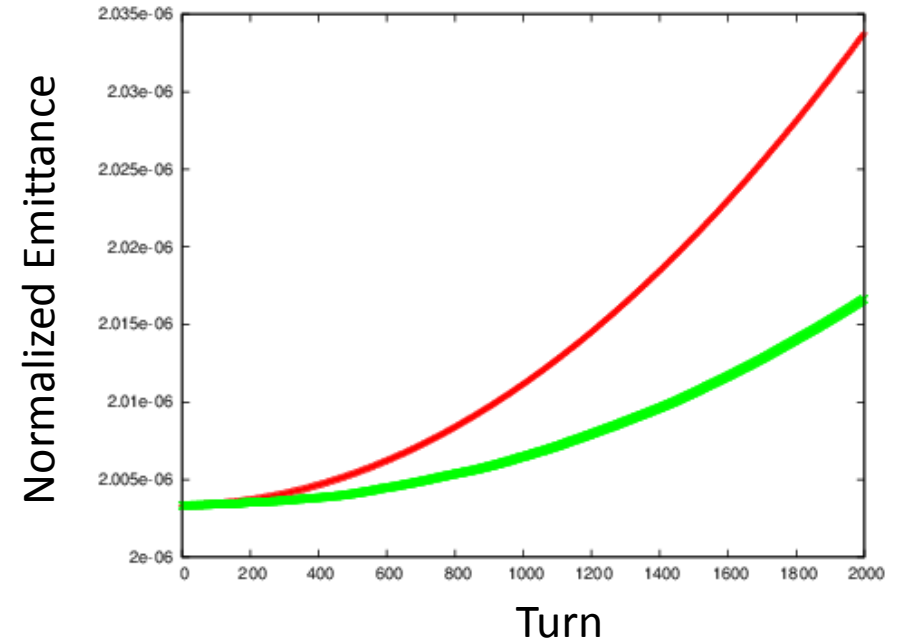
- Red= nominal without longitudinal motion
- Green=nominal with longitudinal motion
- Blue=HL without longitudinal motion
- Purple=HL with longitudinal motion

Induced Instability (cont'd)

Nominal Parameters



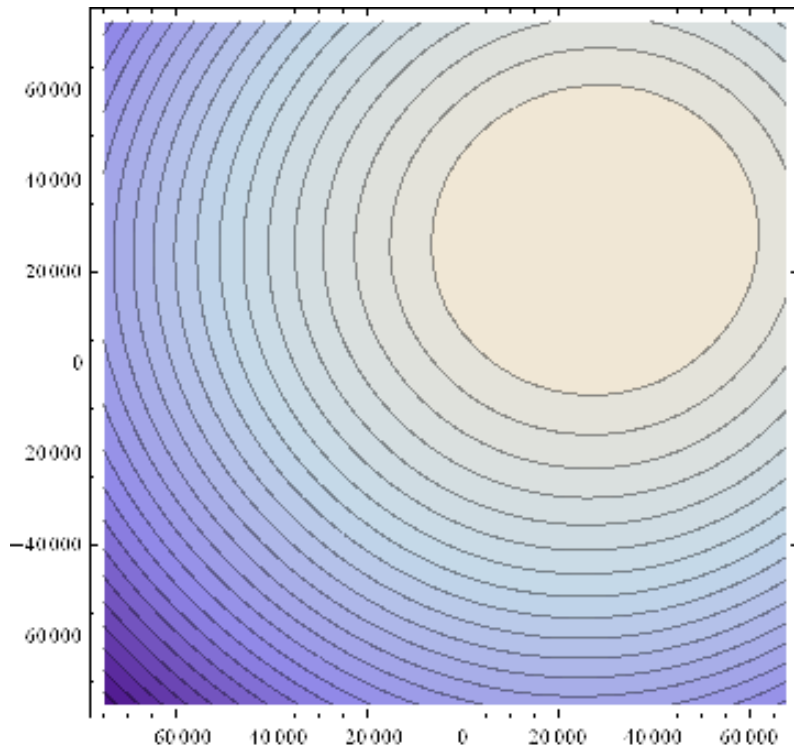
High Luminosity



Red lines indicate no longitudinal motion, green lines indicate longitudinal motion

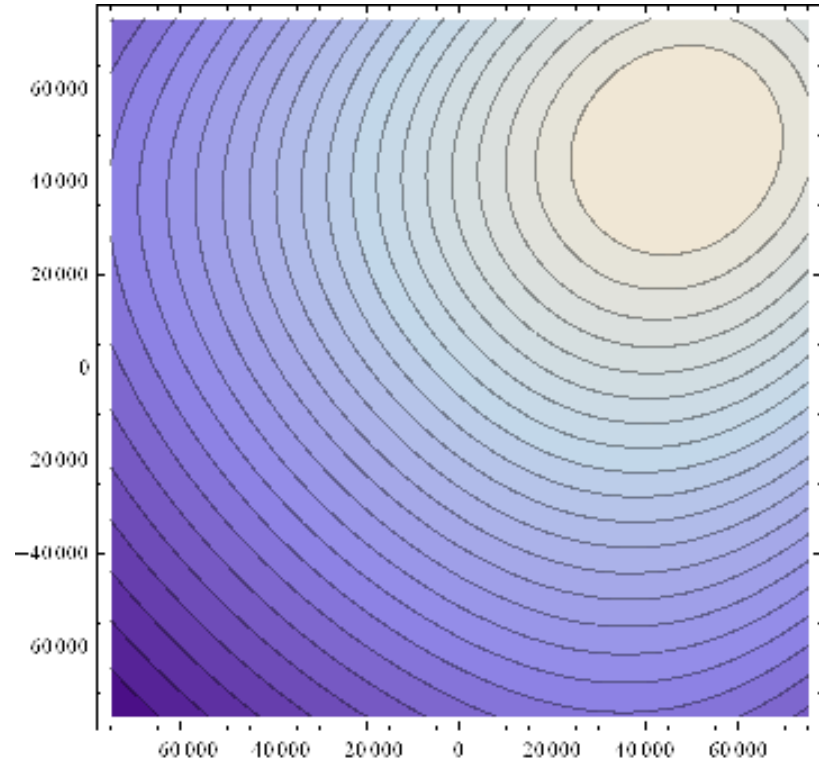
Waist Shifts

Nominal Parameters



1.1% increase

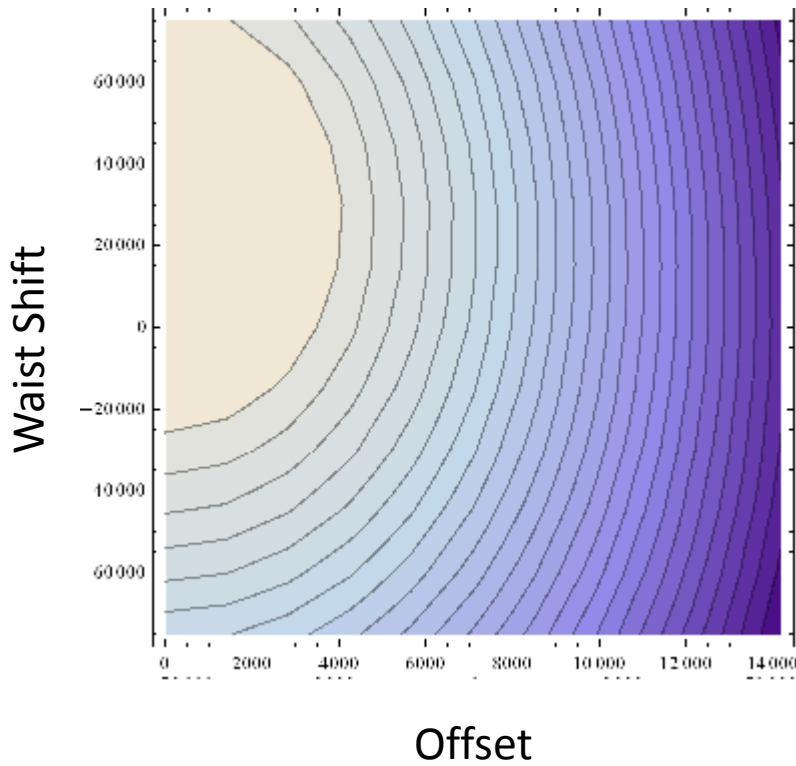
High Luminosity



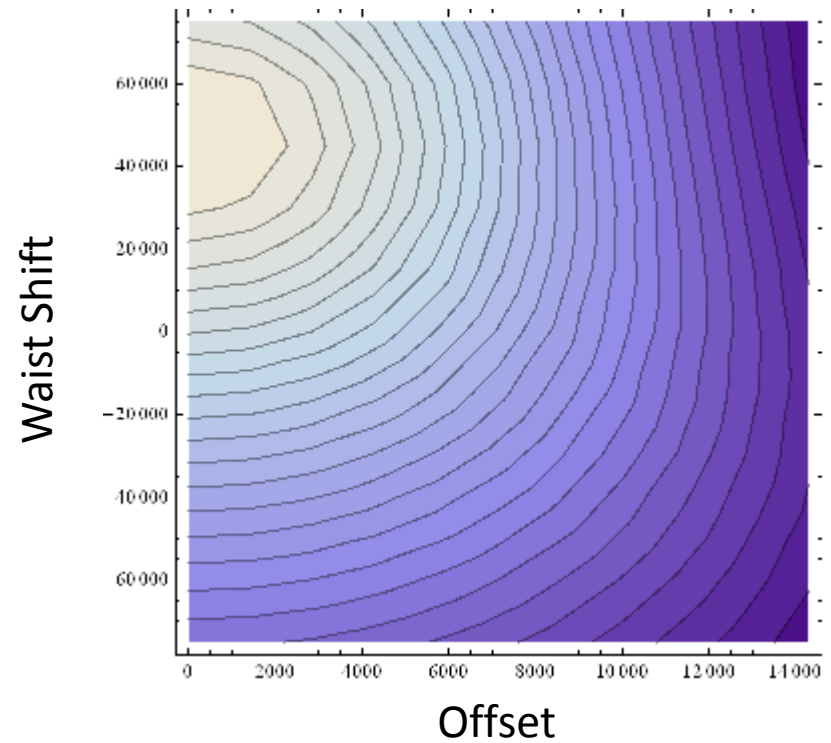
18.7% increase

Waist Shifts Combined with Offsets

Nominal Parameters



High Luminosity

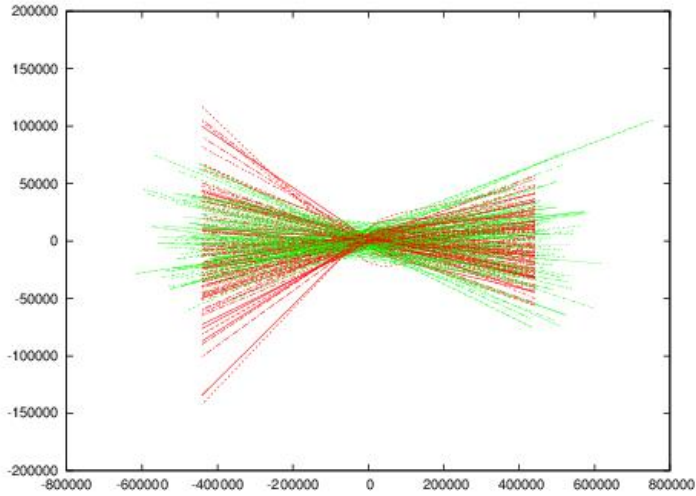


Trajectories with offsets and waist shift

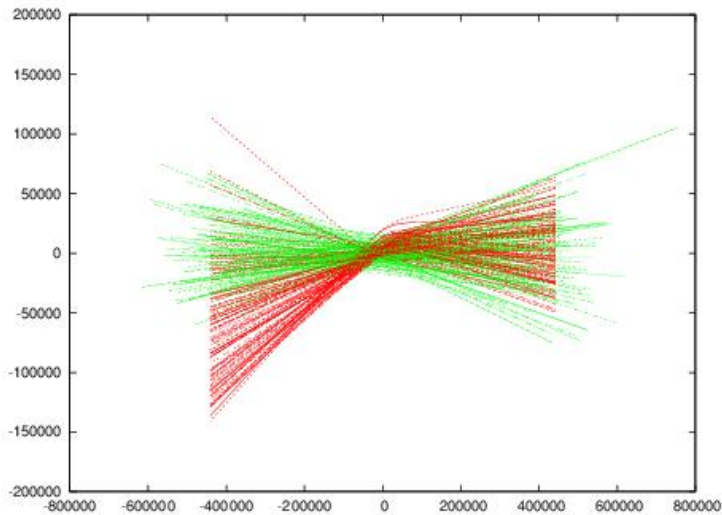
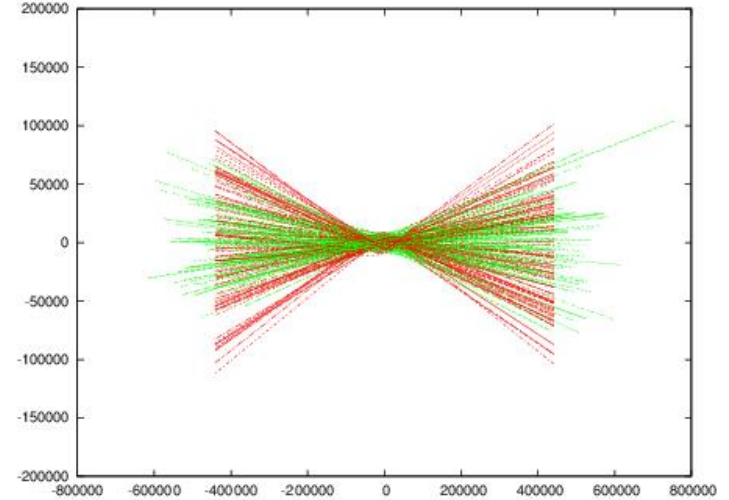
Nominal Parameters

30,000 μm

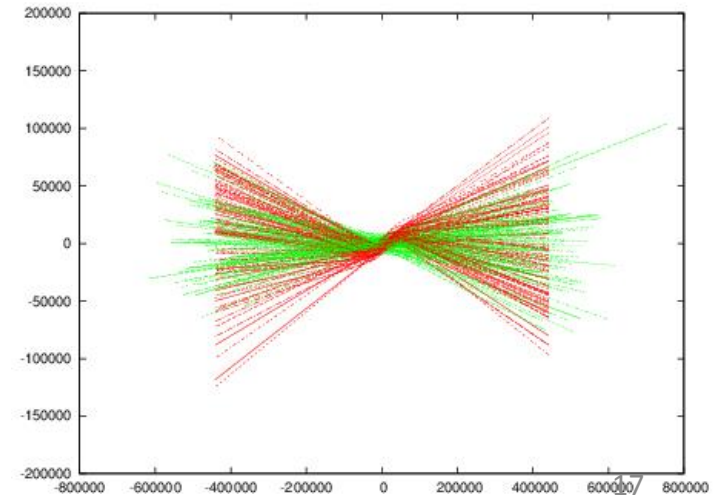
High Luminosity



Head-on

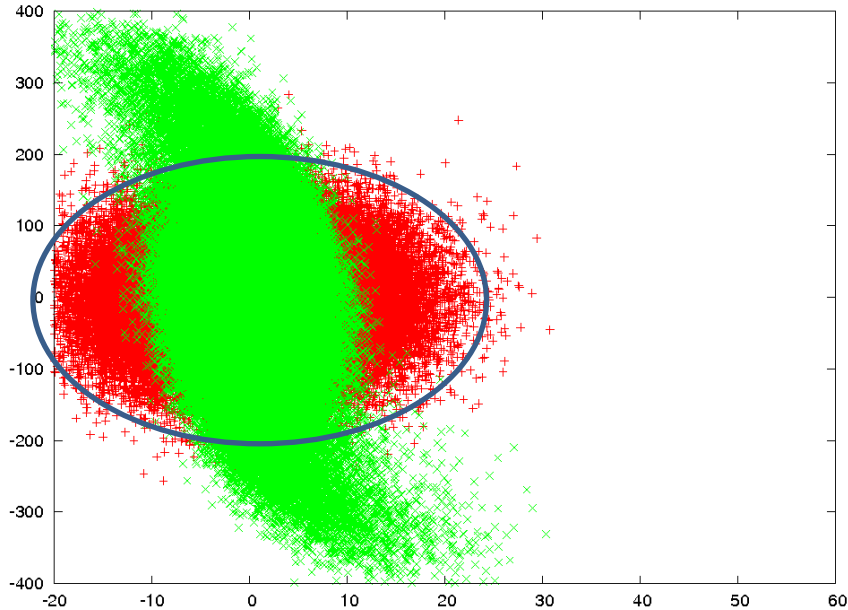


1 σ offset

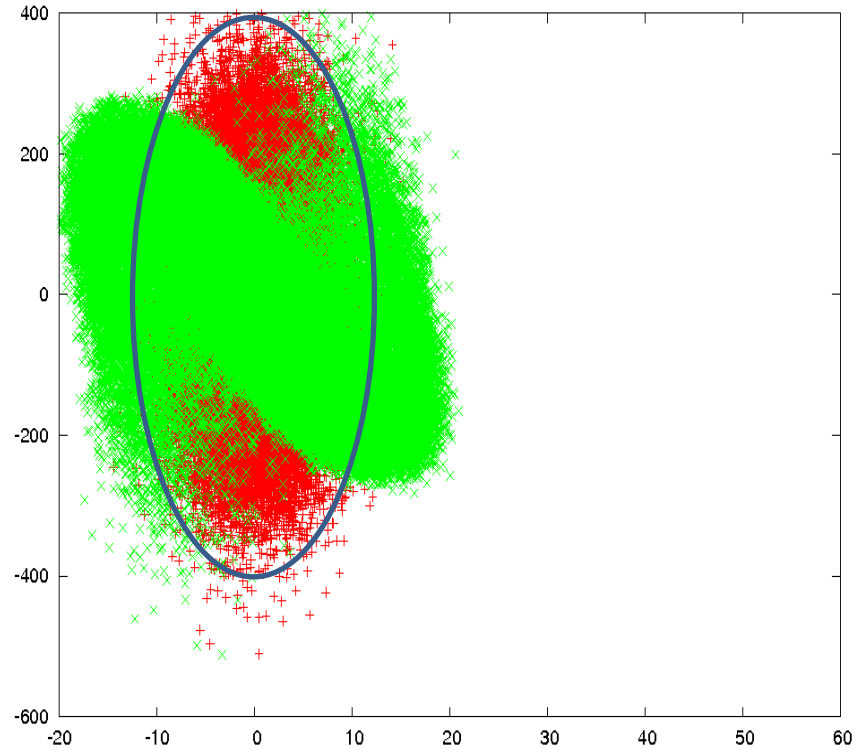


Spent Electron Beam

Nominal Parameters



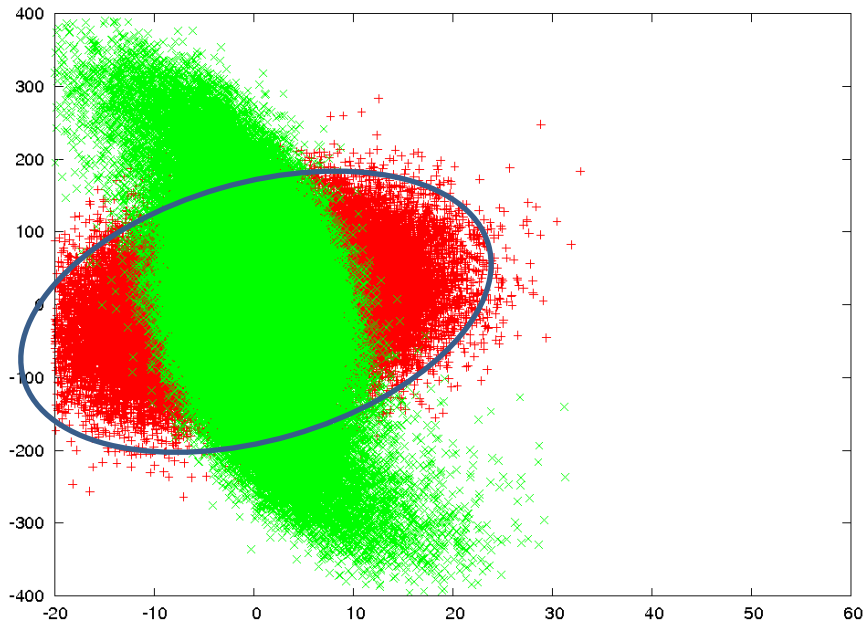
High Luminosity



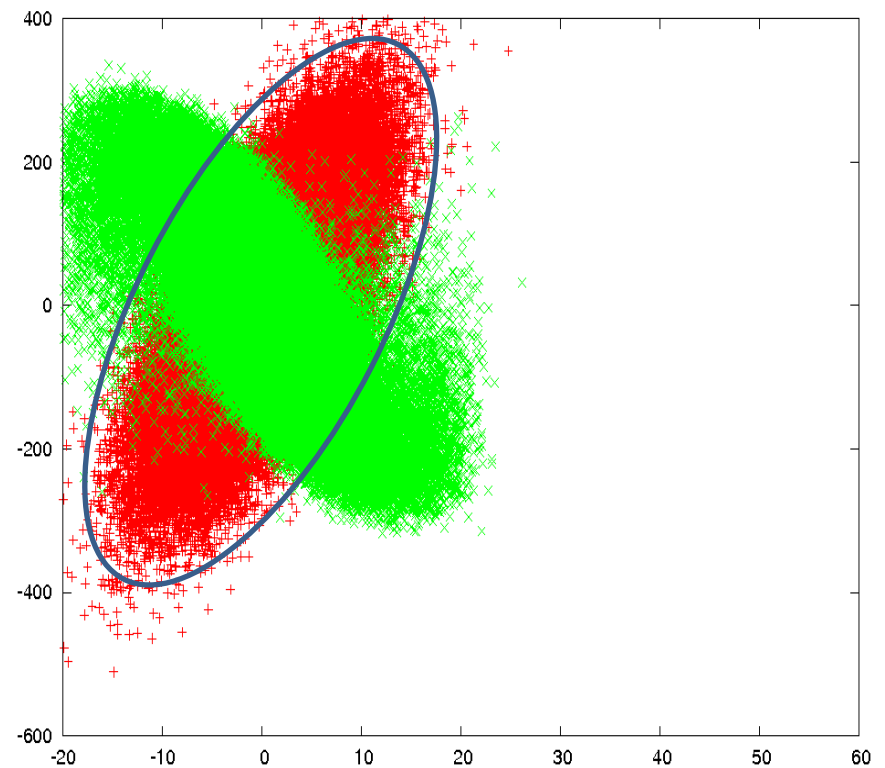
Red particles show the beam without beam-beam effects, green particles show the electron beam with beam-beam effects.

Spent Electron Beam (At Max Luminosity Waist Shift $0.6 \sigma_z$)

Nominal Parameters



High Luminosity

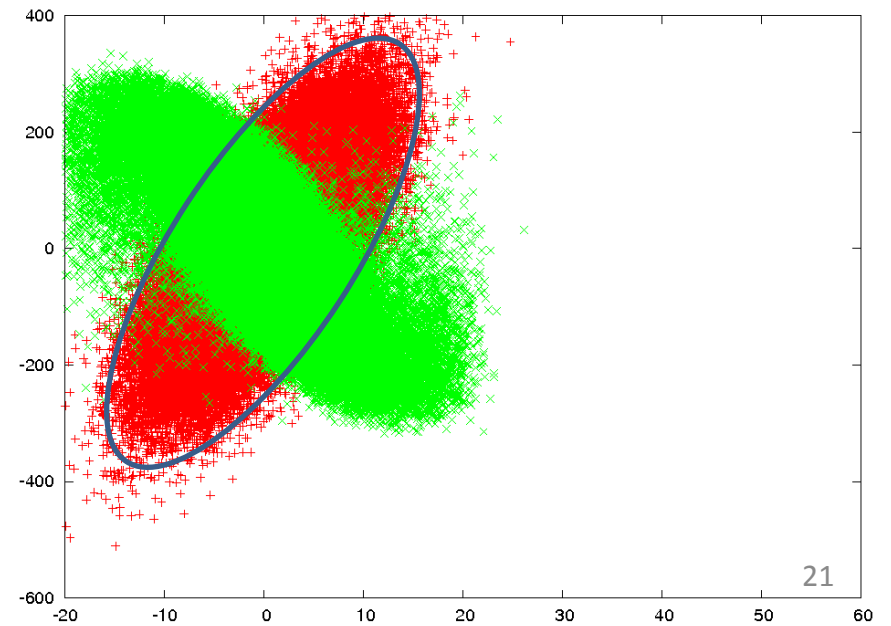
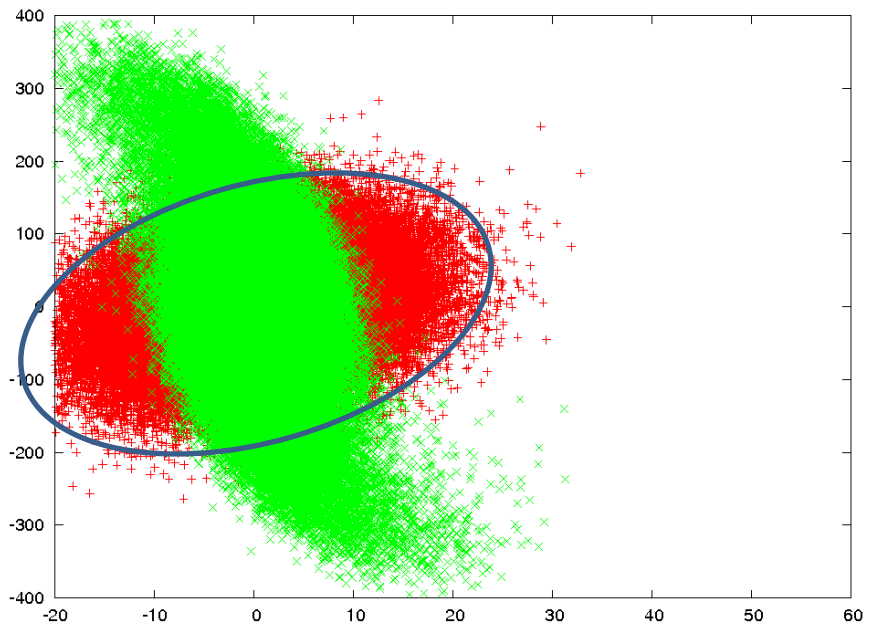
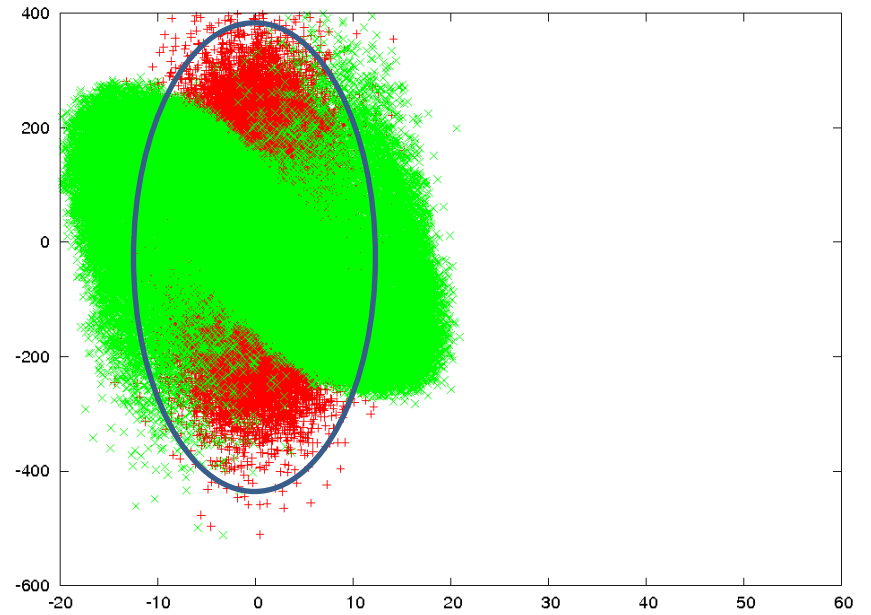
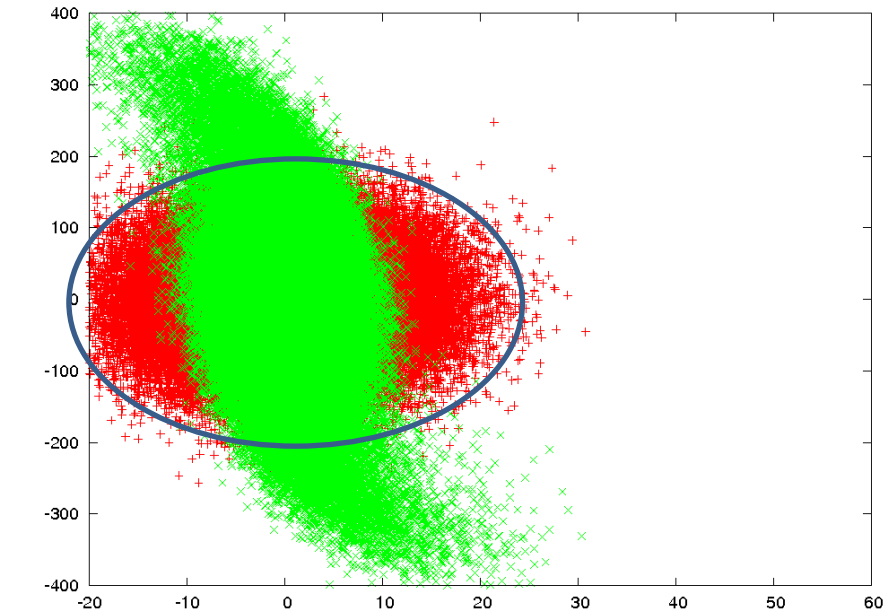


Red particles show the beam without beam-beam effects, green particles show the electron beam with beam-beam effects.

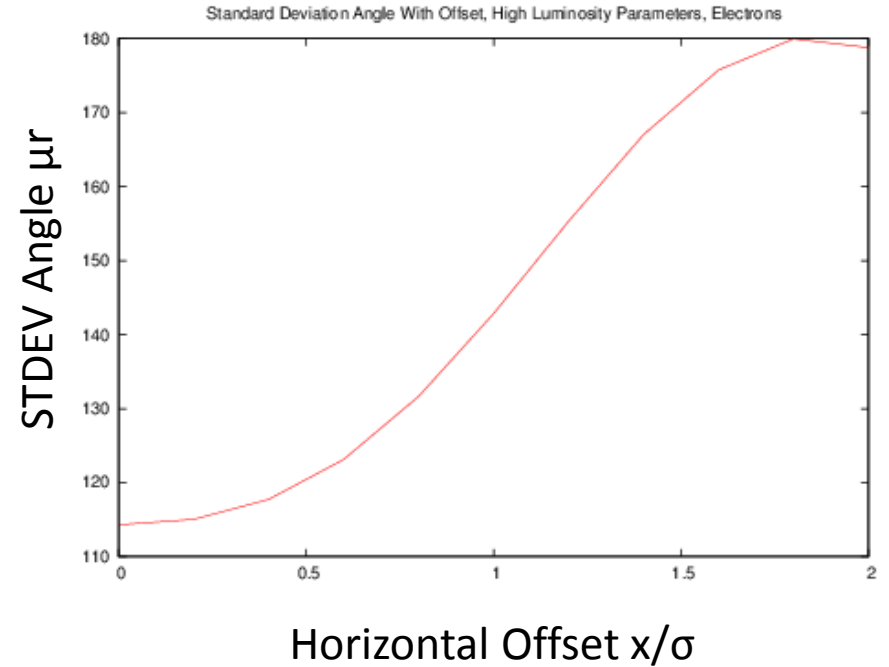
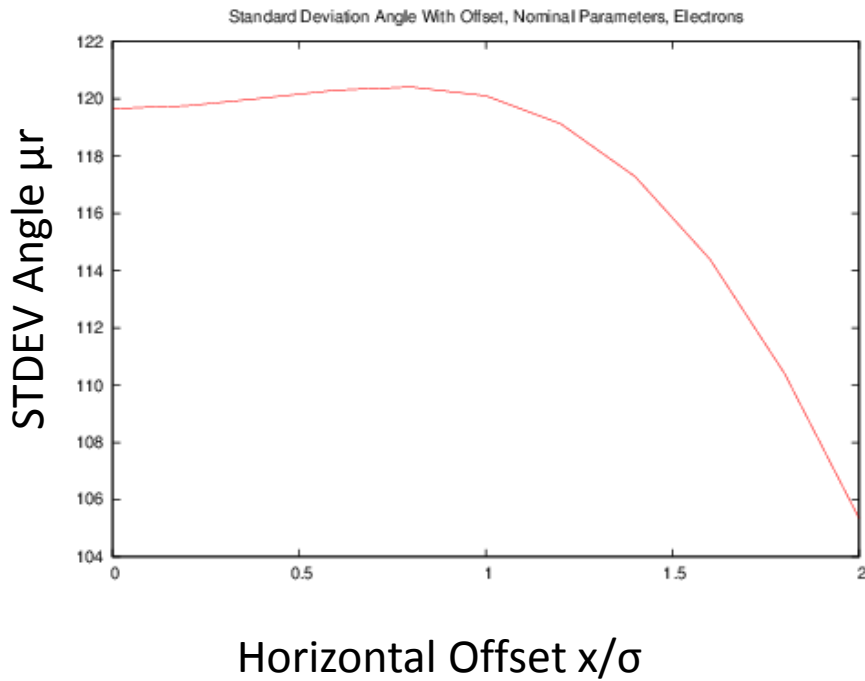
Conclusions

- The beam beam effects on the ion beam are rather small
- The beam beam effects on the electron beam are quite large
- The effects on the spent beam are of particular importance in the high luminosity parameter set
- Could have a nonlinear response to offsets

Backup 1

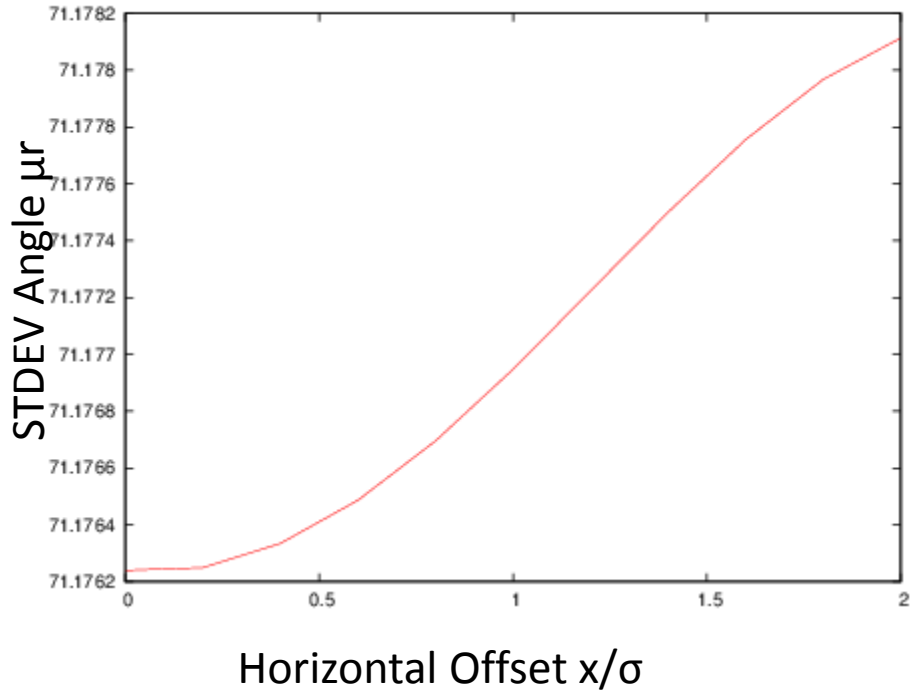


Backup 2



Backup 3

Standard Deviation Angle With Offset, Nominal Parameters, Protons



Standard Deviation Angle With Offset, High Luminosity Parameters, Protons

