eRHIC Orbit Correction Studies Including Chromaticity

Using Oct'14 lattice and dispersion diagnostic

Lattice and Beam

- Oct'14 lattice, FFAG1, beam 1 (1.334GeV)
  - 1982 cells
  - $Q_x = 0.4077$, $Q_y = 0.3299$
  - $C_x = -0.9343$, $C_y = -0.5727$ (1852, 1135 per ring)
- Gaussian beam, 20 mm.mrad RMS normalised emittance in X and Y
  - Only use 50 particles so ends up 22/24 mm.mrad
- Energy spread ±0.1%, uniform distribution

Errors, BPMs and Correctors

- Errors: 100um RMS Gaussian in X and Y quadrupole positions
- BPMs every 2 cells/4 magnets
  - Measure <x> and <y> beam centroids
- Correctors: X and Y dipole with ±0.005T maximum field (~1% of max primary field)
- Tunable in 100 steps of 0.5 Gauss in each direction

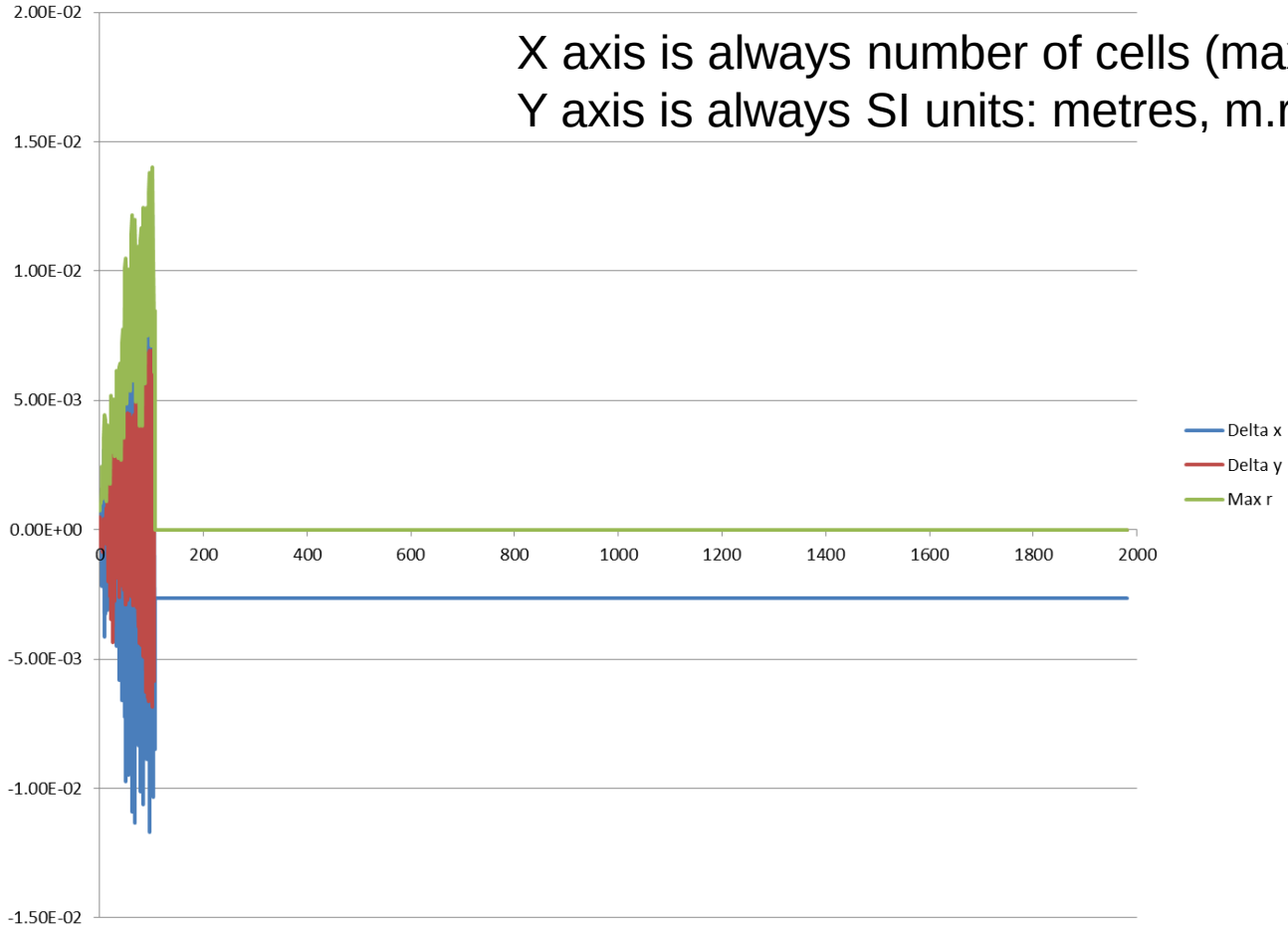
Correction Algorithm

- The 8 correctors before each BPM are tweaked by ±81, ±27, ±9, ±3, ±1 steps
- Changes that decrease the error measure are kept, all BPM sections are swept start-to-end
- The error measure is $\Delta r^2 = \Delta x^2 + \Delta y^2$ summed over the next L correctors
  - $\Delta x = \langle x \rangle - x_{closed}$, similarly for y
  - L is the "look-ahead"

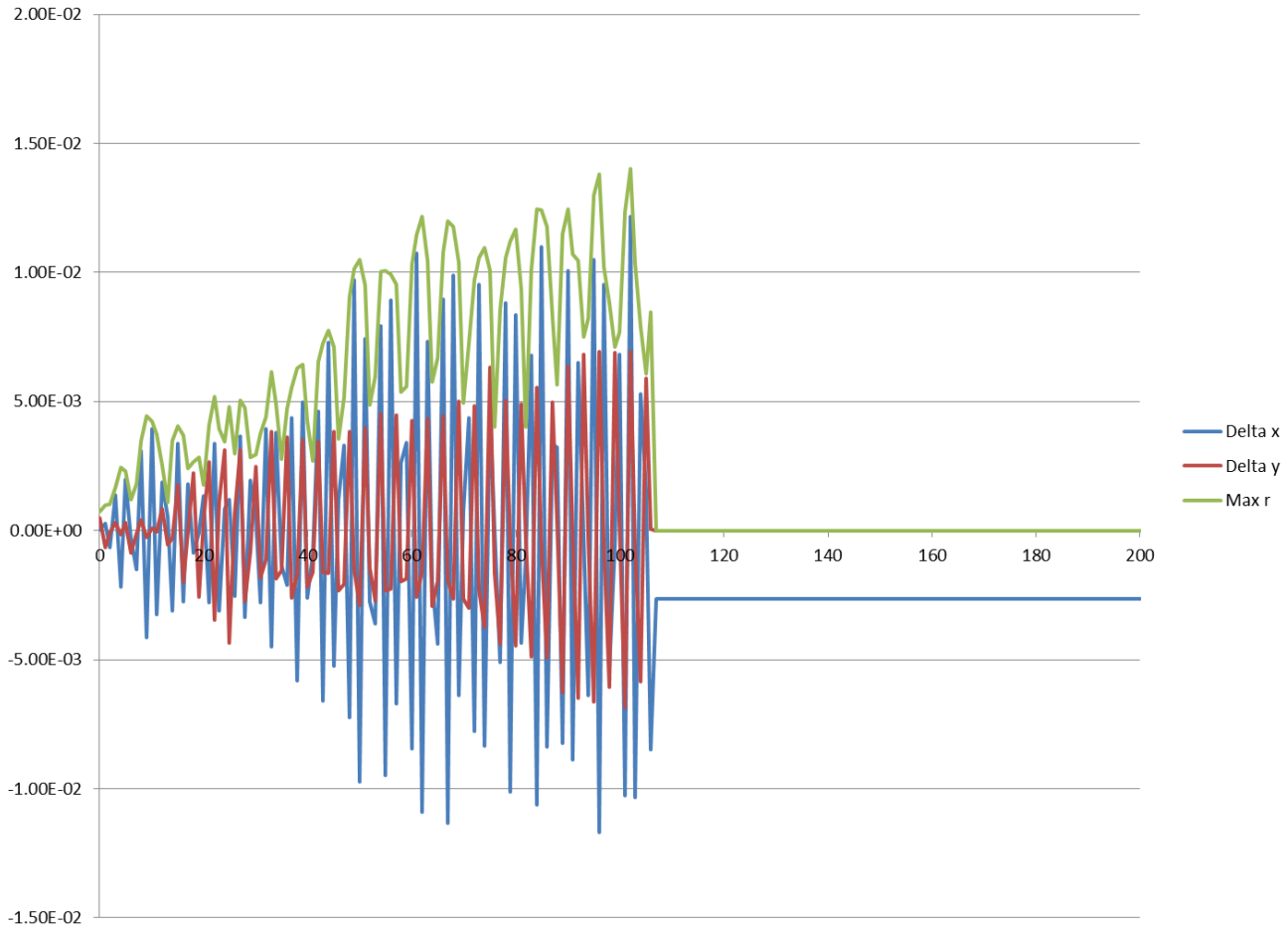
Dispersion Correction Algorithm

- 1344MeV beam "B" is tracked as well as the 1334MeV beam "A" through the same lattice
- The error measure at each BPM is modified to $\Delta r_A^2 + \Delta r_B^2 + D((\Delta x_B - \Delta x_A)^2 + (\Delta y_B - \Delta y_A)^2)$
- Where D is some constant
- Note: $\Delta x_B - \Delta x_A = \langle x \rangle_B - \langle x \rangle_A - (x_{cl.,B} - x_{cl.,A}) = \delta_{B\text{-}A}(D_{x,measured} - D_{x,closed})$

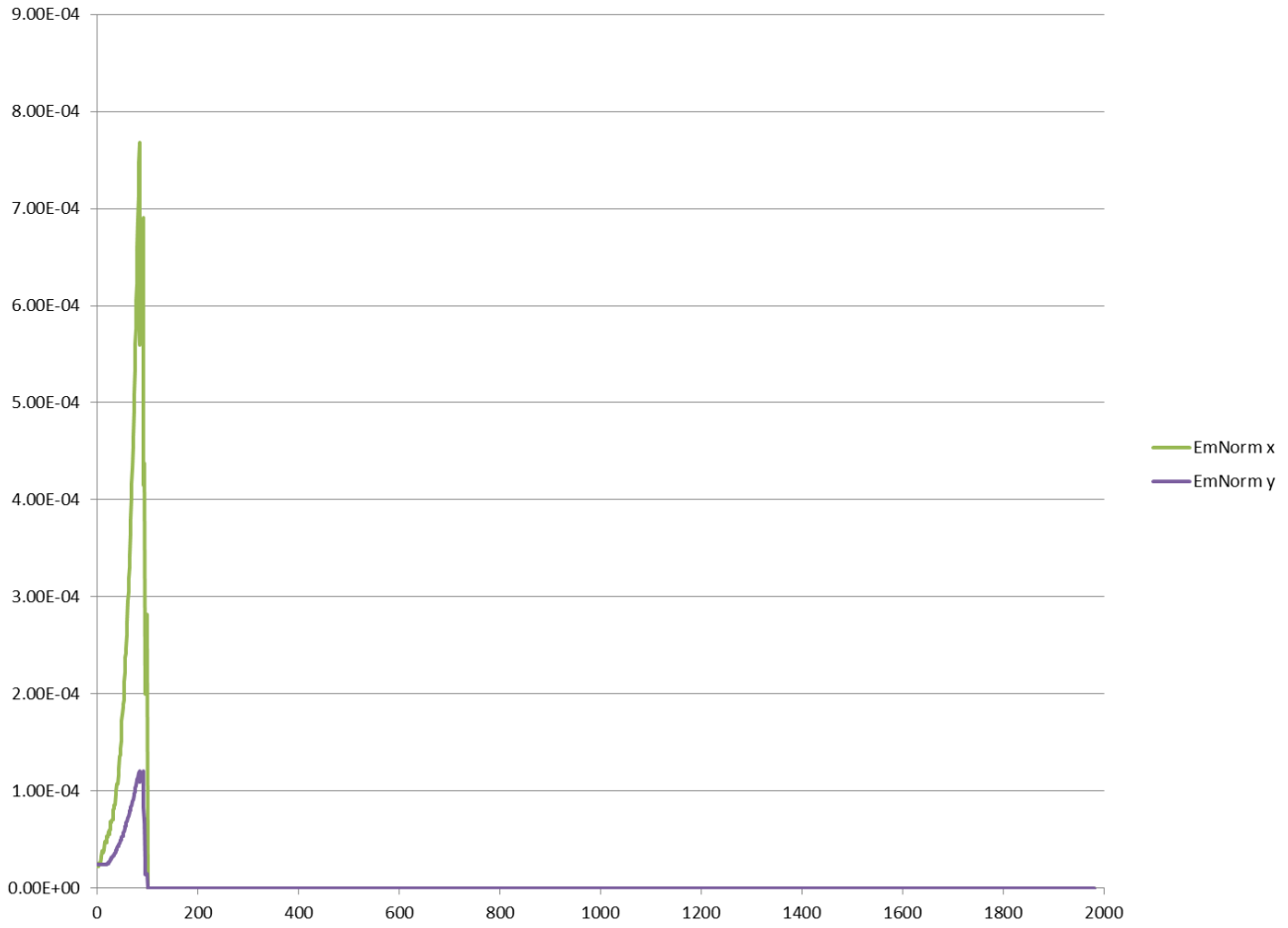
No correction (centroid offsets)



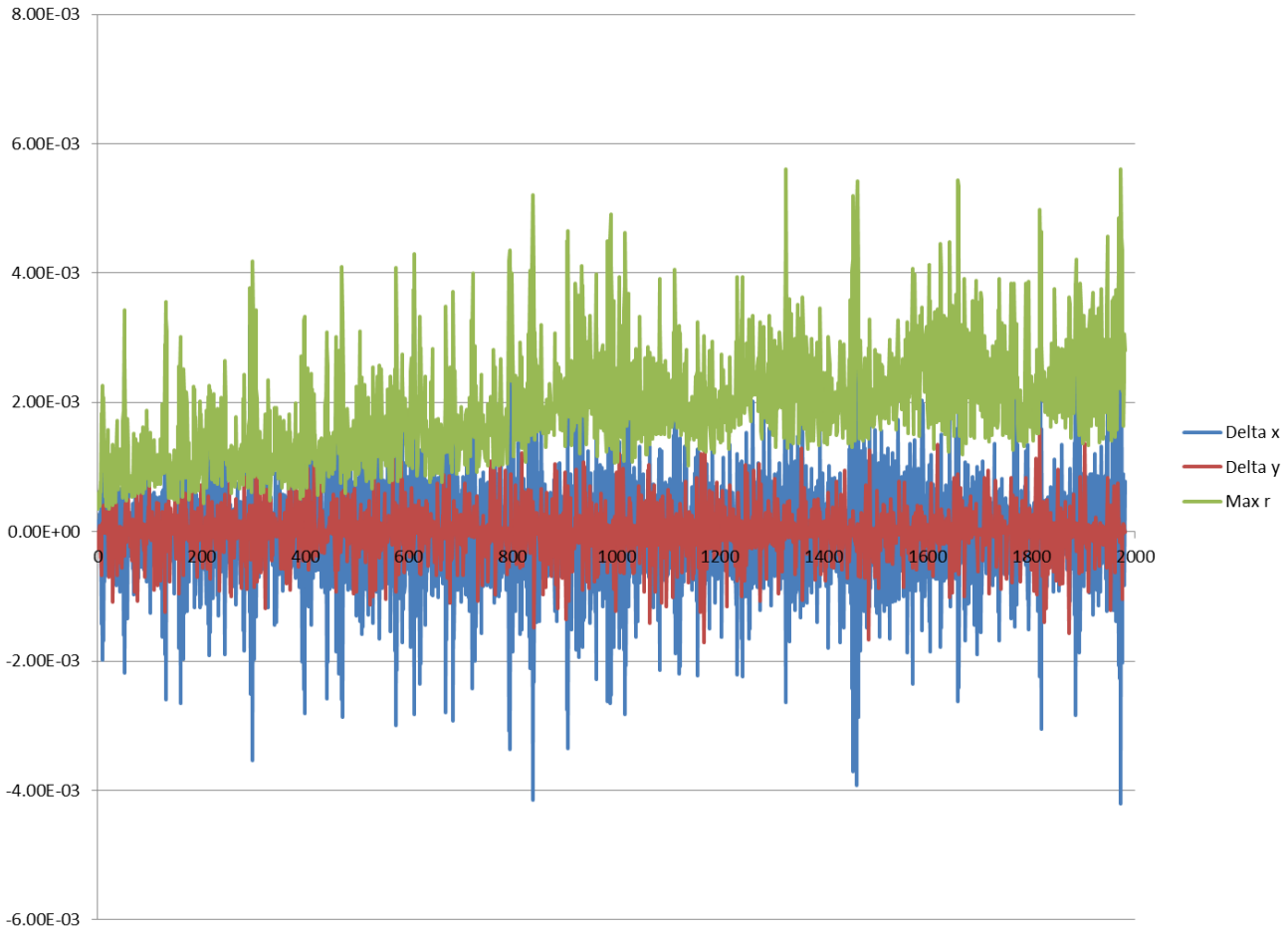
No correction (centroid offsets)



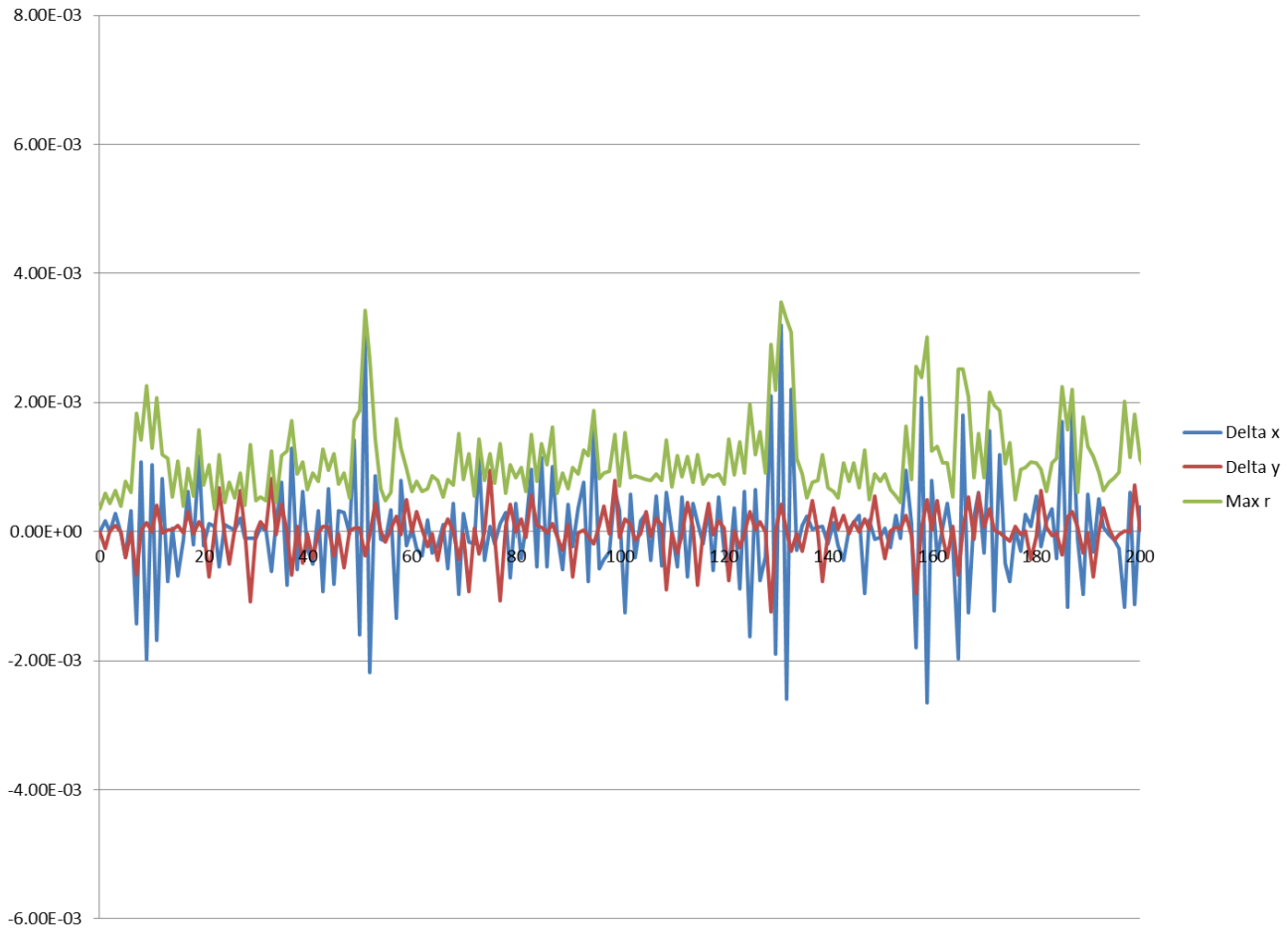
No correction (emittances)



L=1, D=0, Sweep 1 offsets

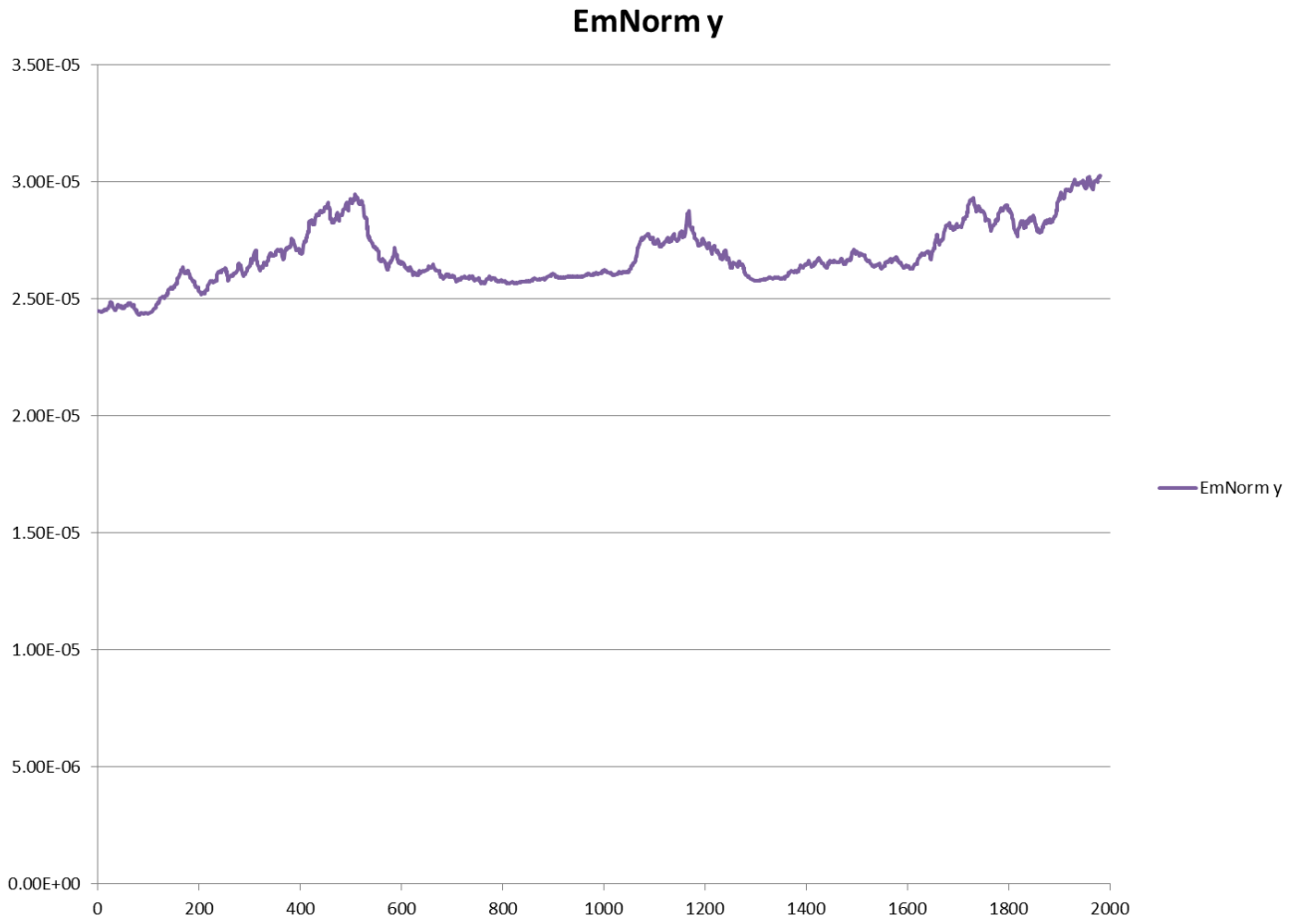


L=1, D=0, Sweep 1 offsets

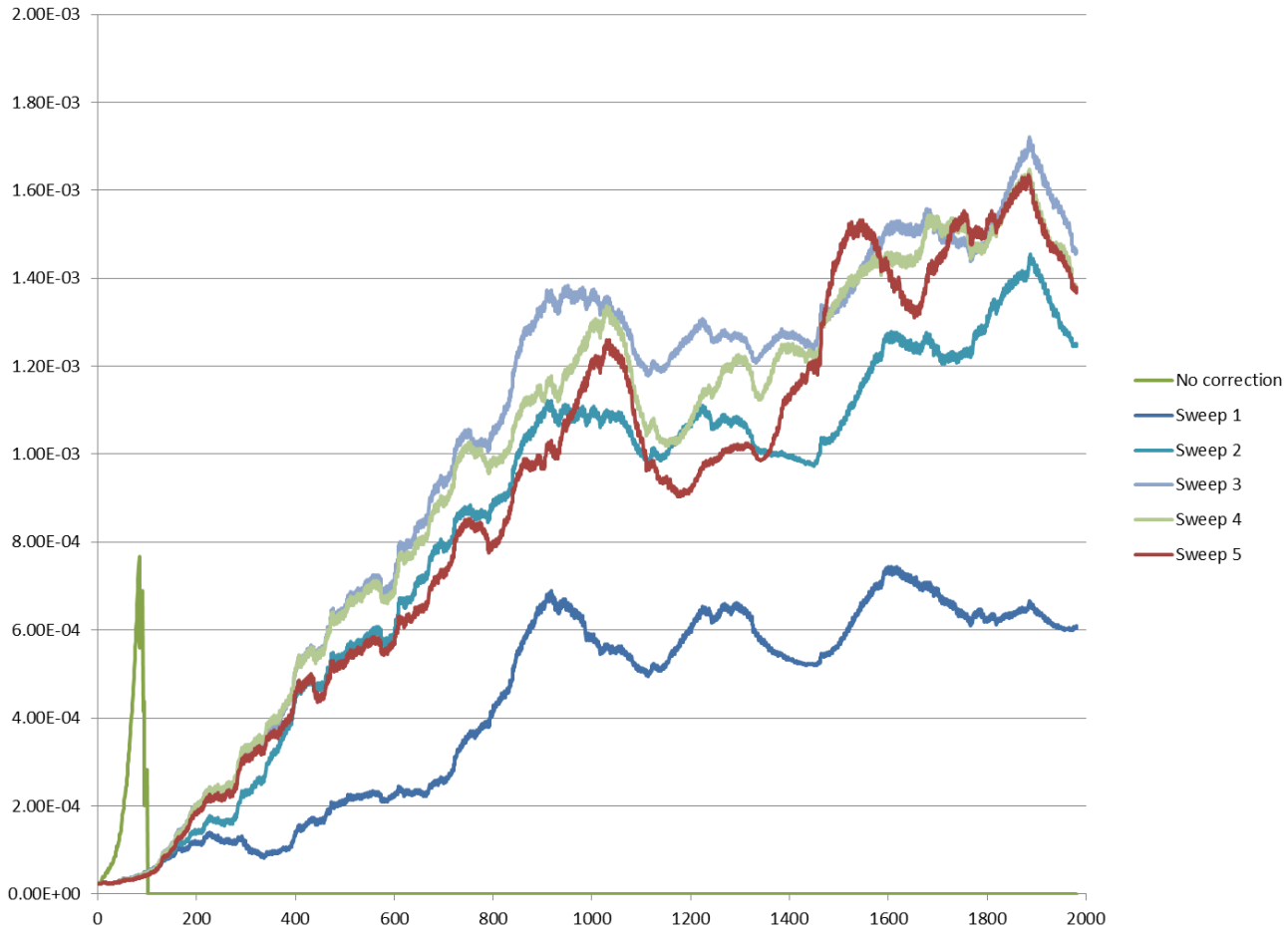


L=1, D=0, Sweep 1 emittances

L=1, D=0, Sweep 1, Y emittance



L=1, D=0, All Sweeps, X emittance



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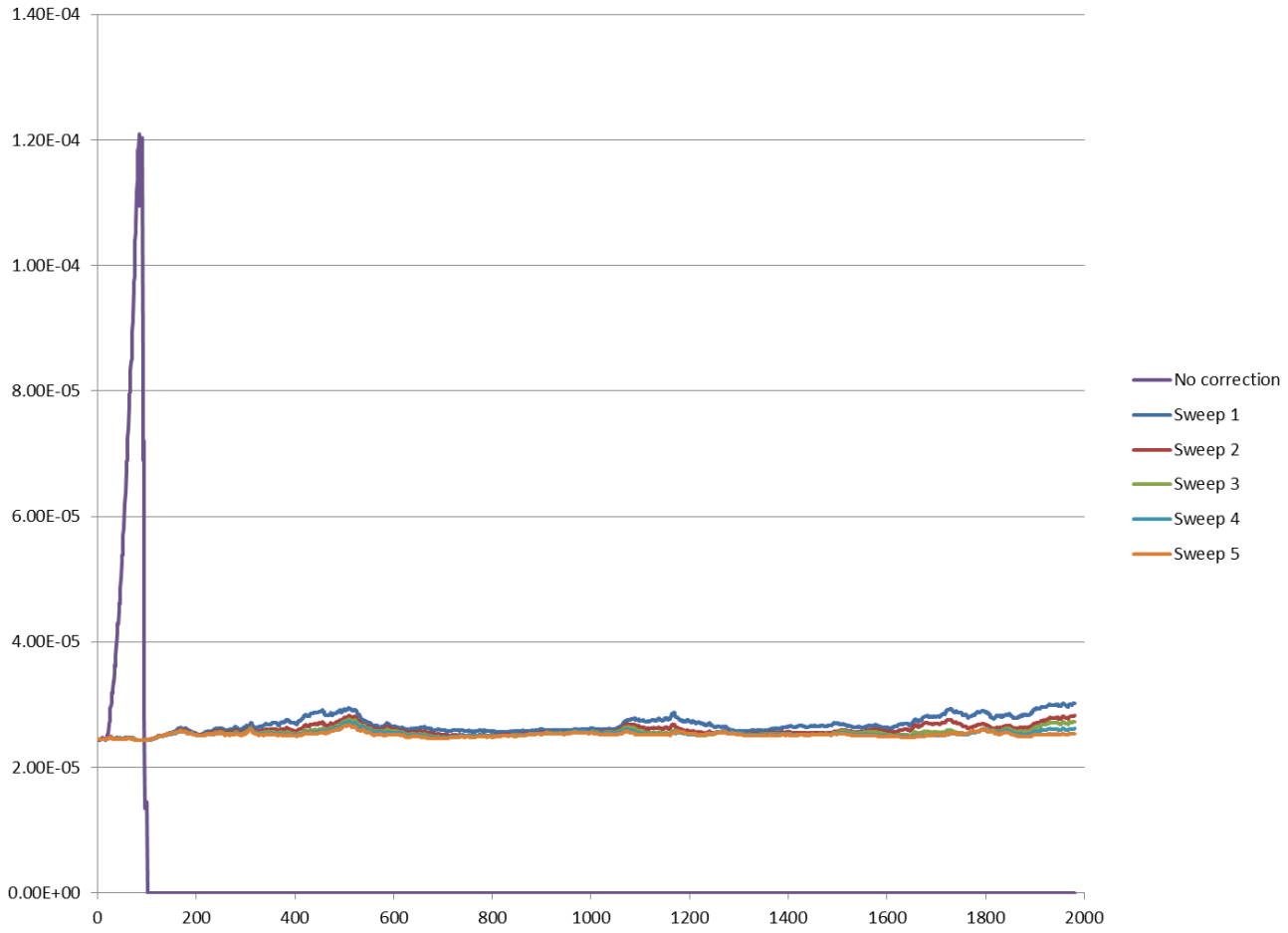
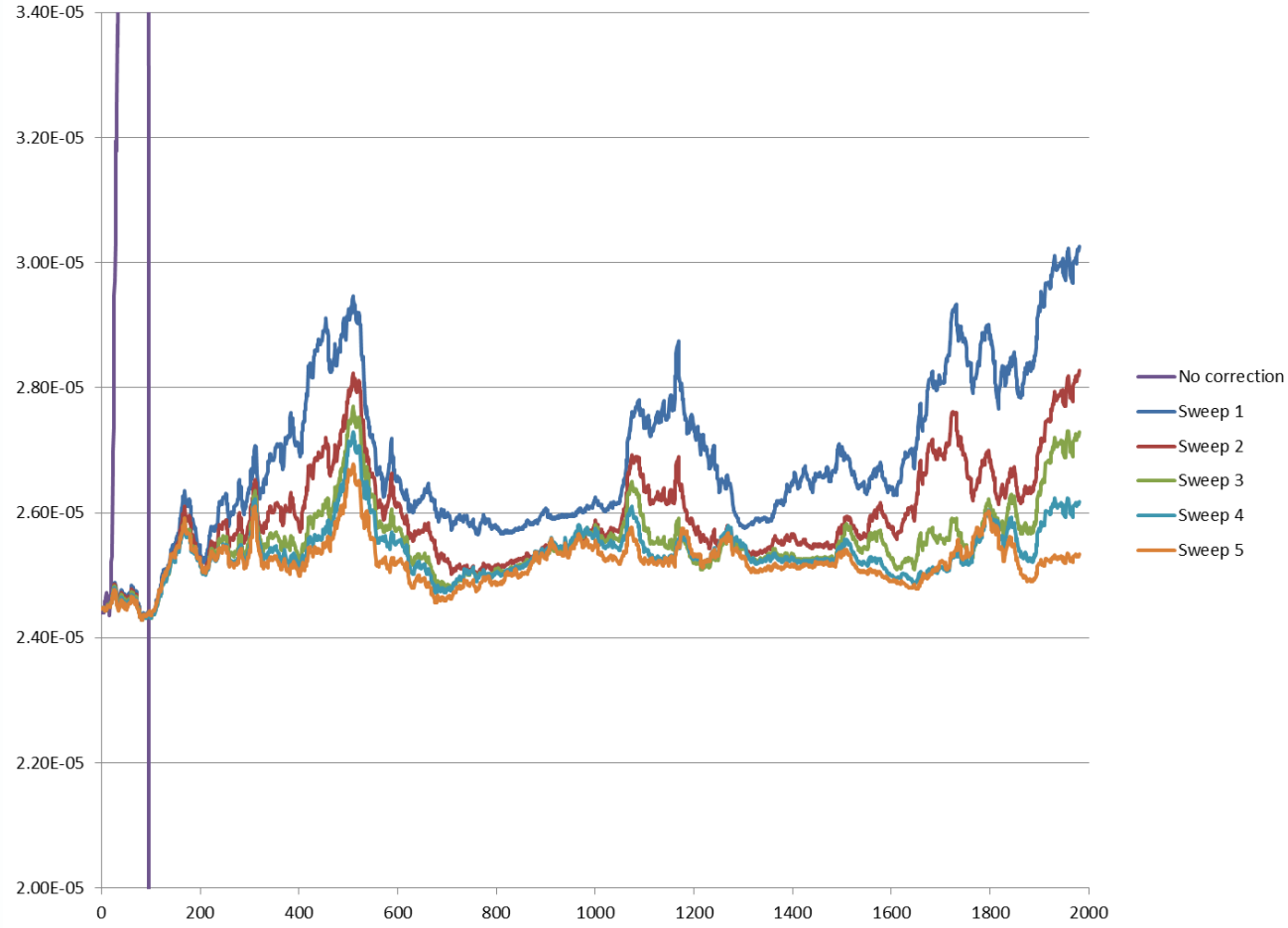


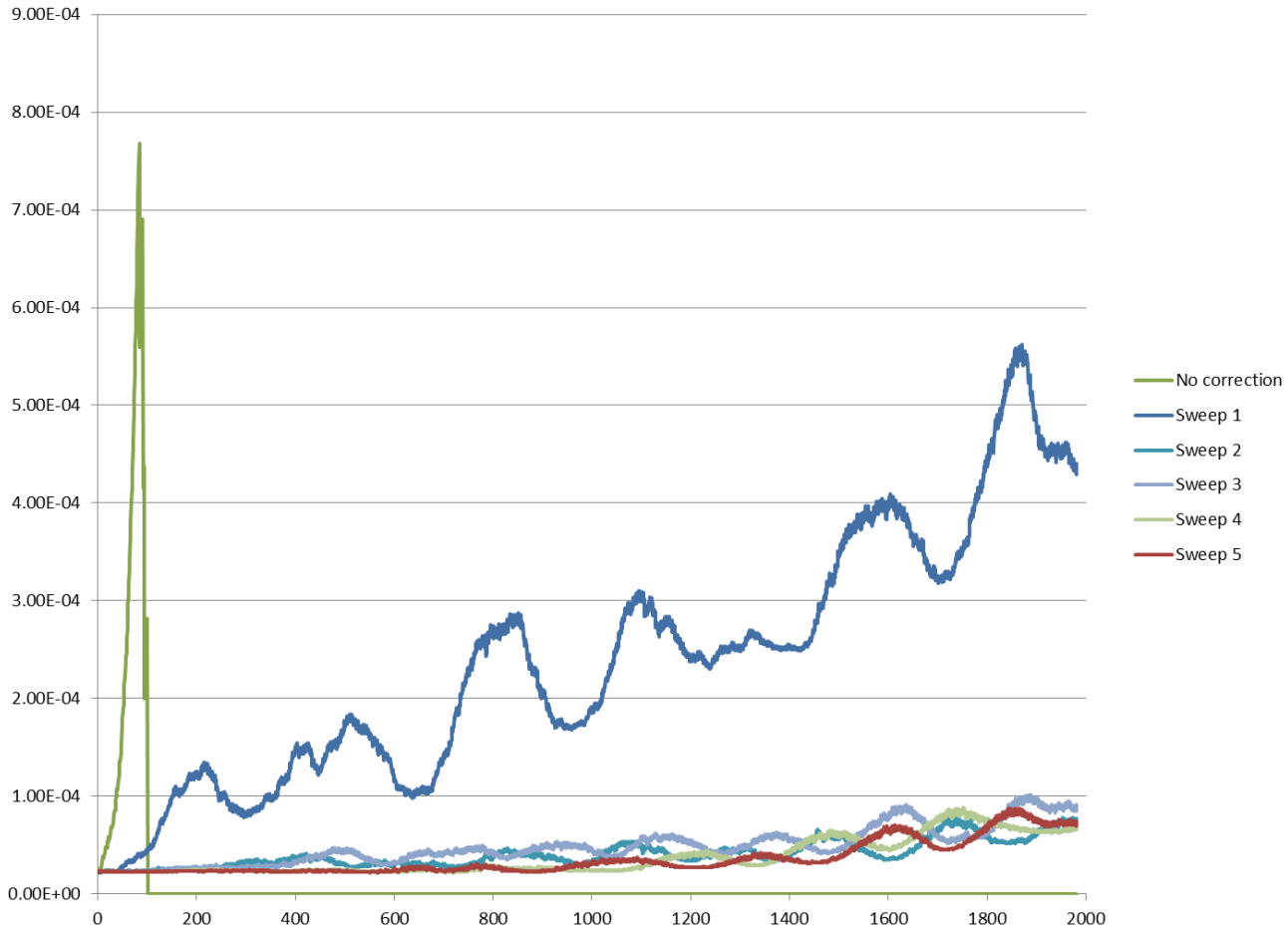
L=1, D=0, All Sweeps, Y emittance



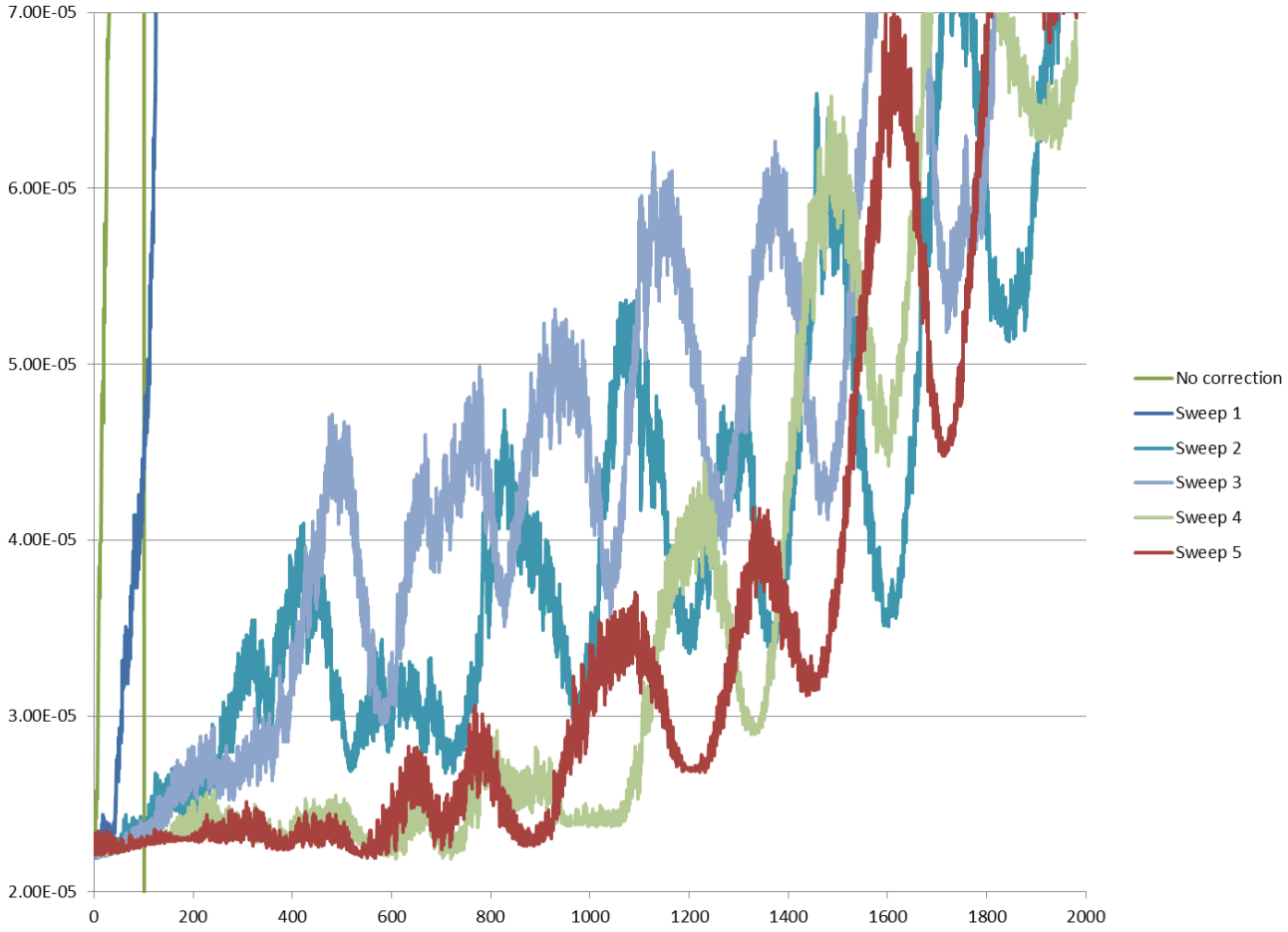
Cumulative Summary

L (BPM look-ahead)	D (dispersion weight)	Initial X emittance mm.mrad	Final X emittance mm.mrad	Growth Ratio
1	0	22.4586	610.609	27.188

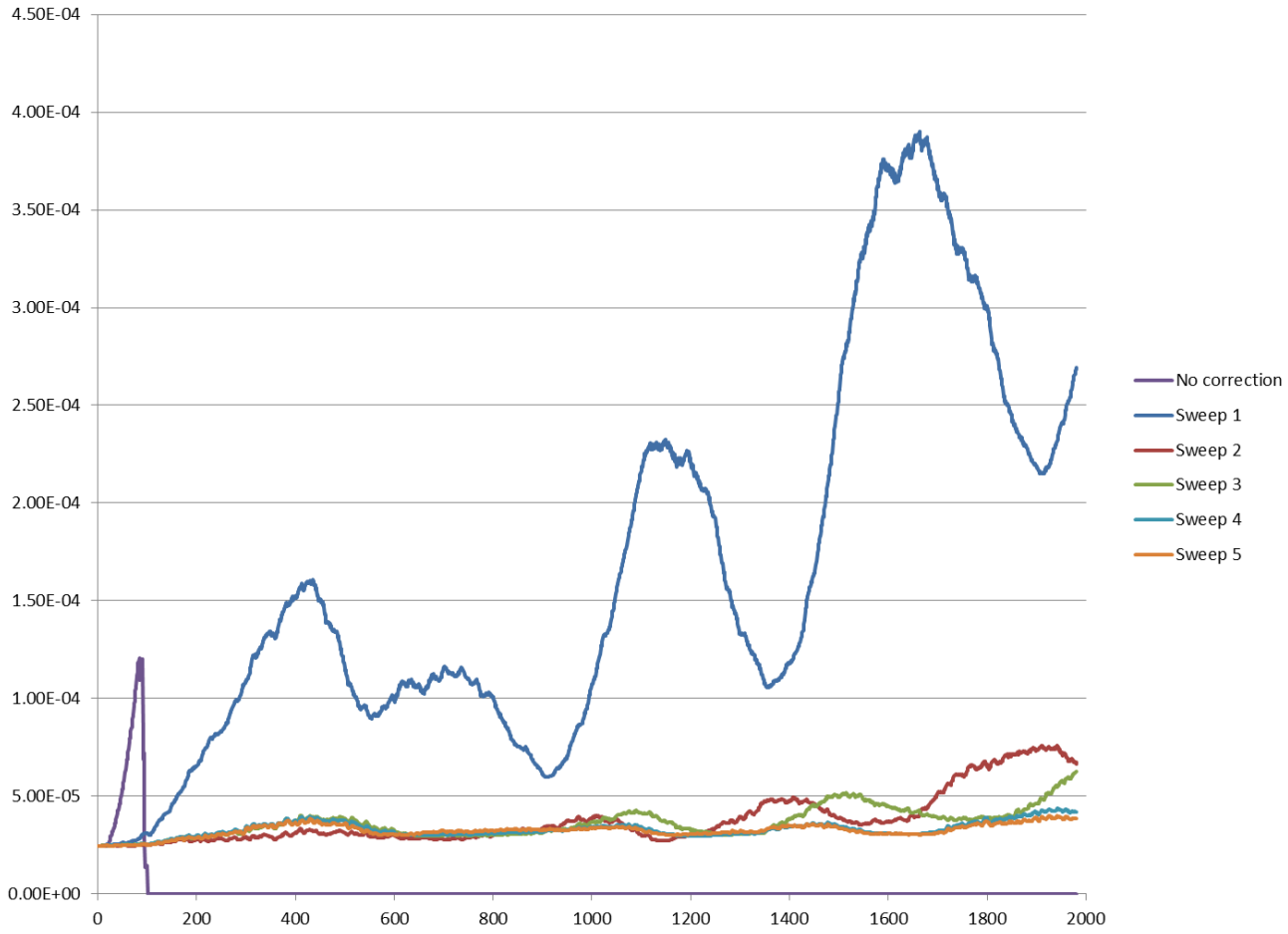
L=5, D=0, All Sweeps, X emittance



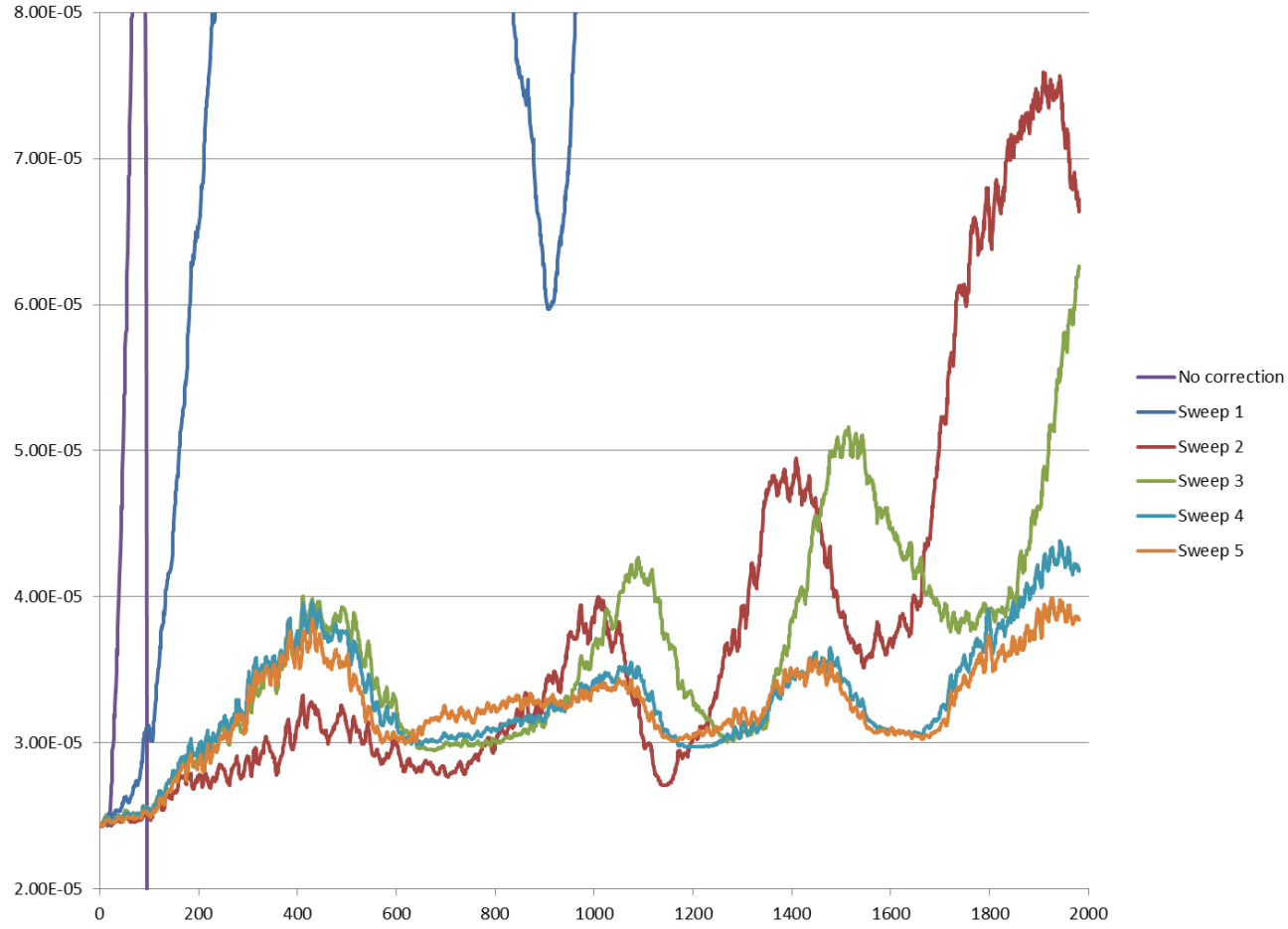
L=5, D=0, All Sweeps, X emittance



L=5, D=0, All Sweeps, Y emittance



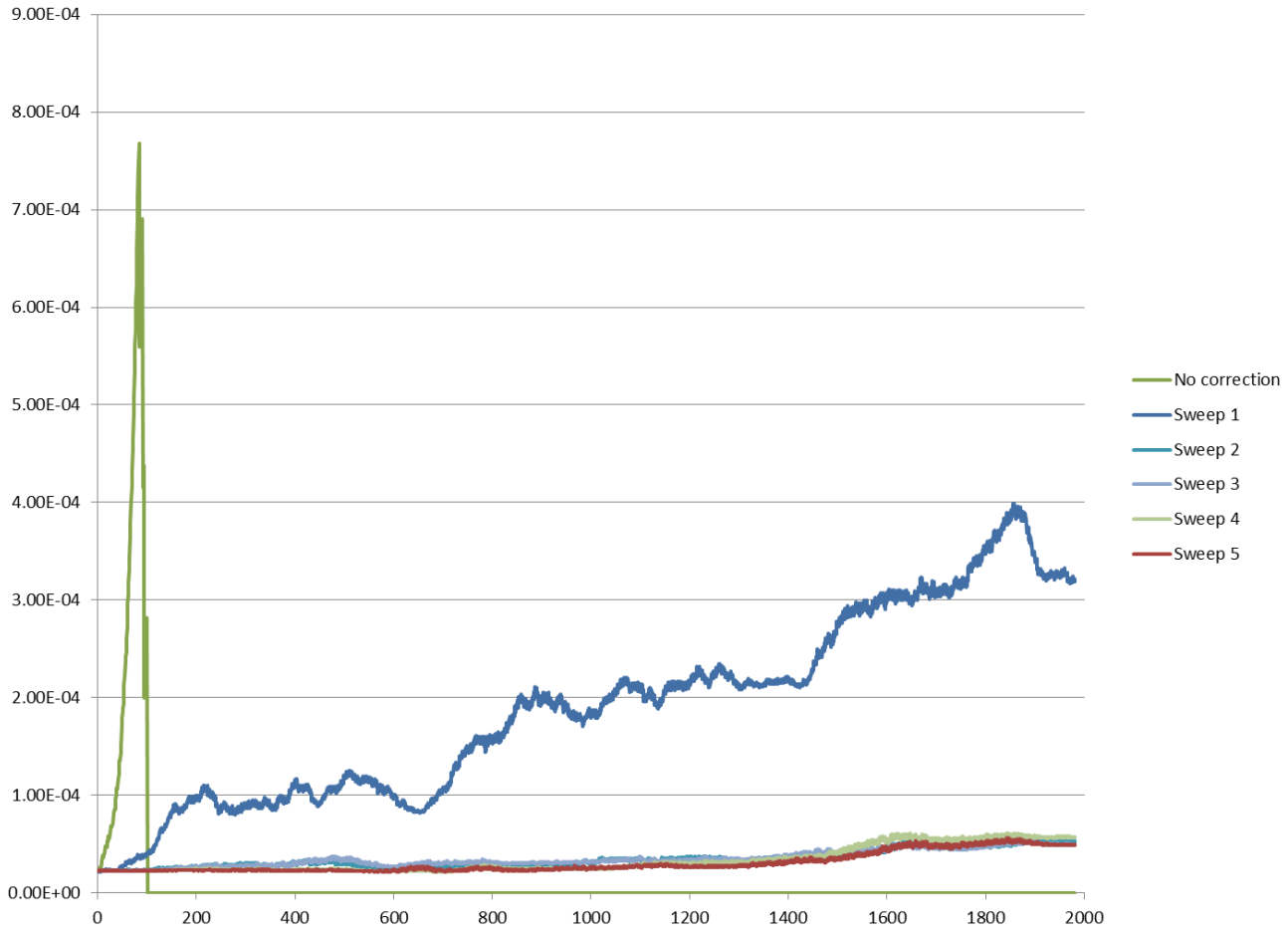
L=5, D=0, All Sweeps, Y emittance



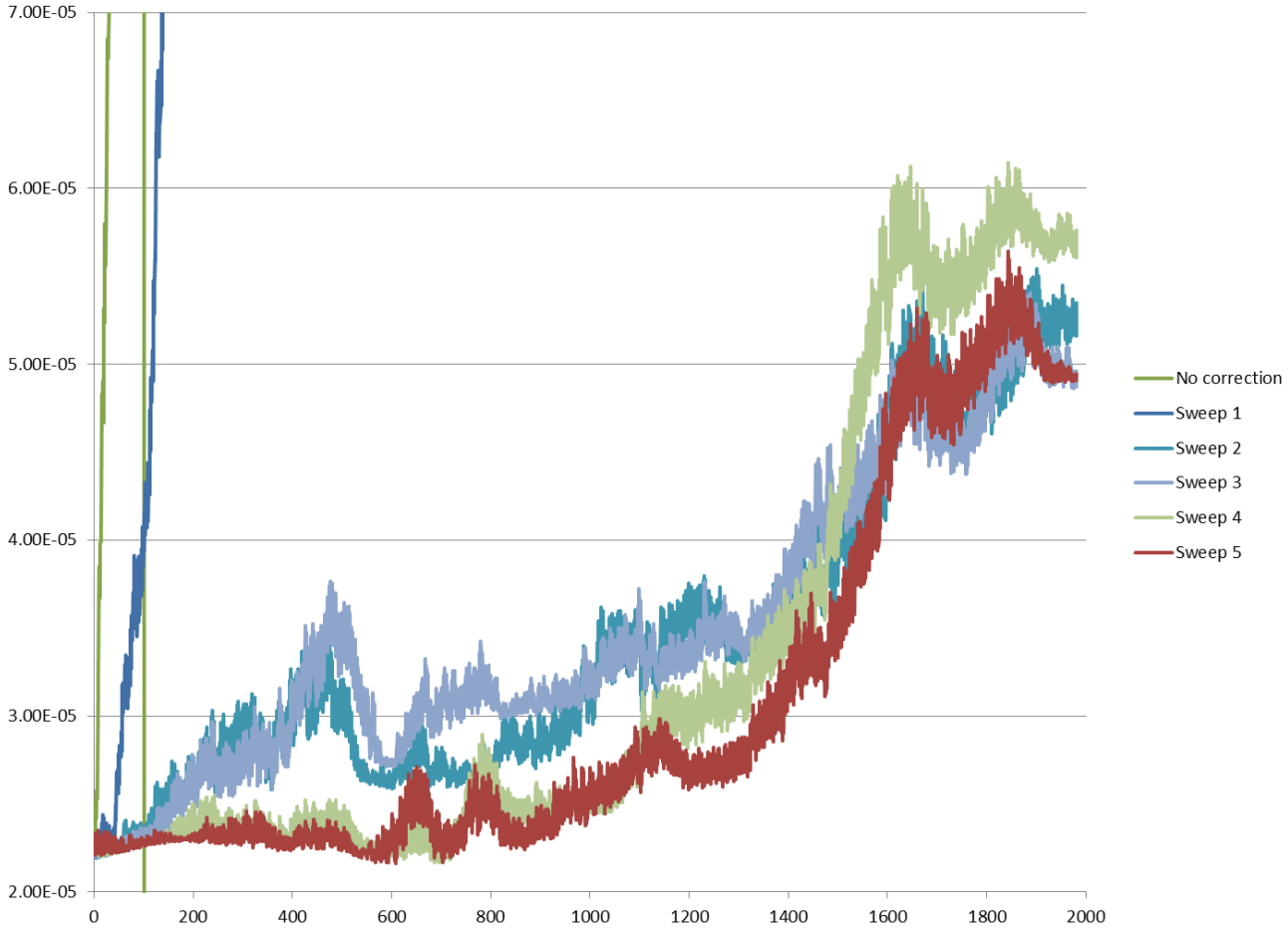
Cumulative Summary

L (BPM look-ahead)	D (dispersion weight)	Initial X emittance mm.mrad	Final X emittance mm.mrad	Growth Ratio
1	0	22.4586	610.609	27.188
5	0	22.4602	67.9431	3.025

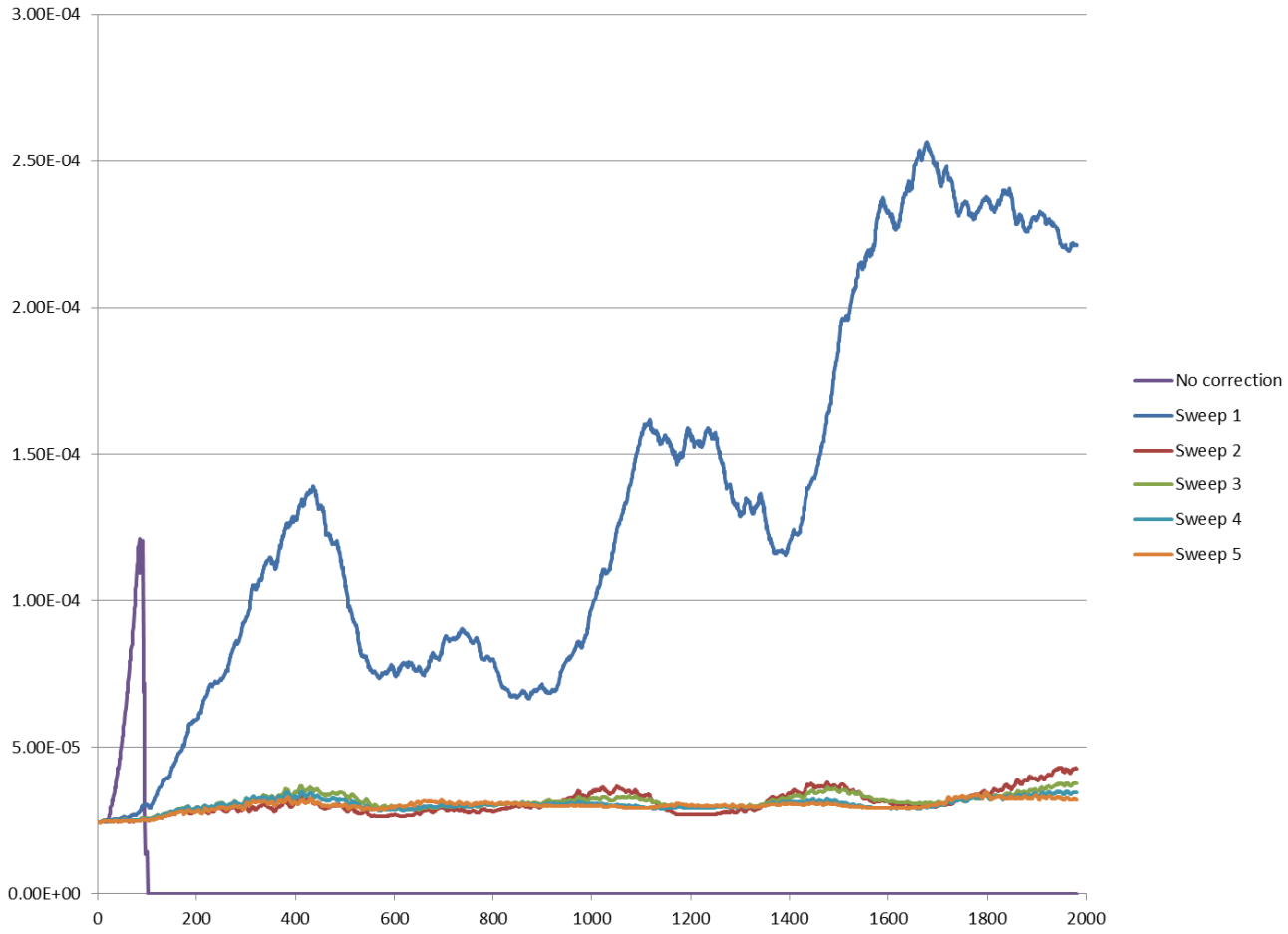
L=5, D=1, All Sweeps, X emittance



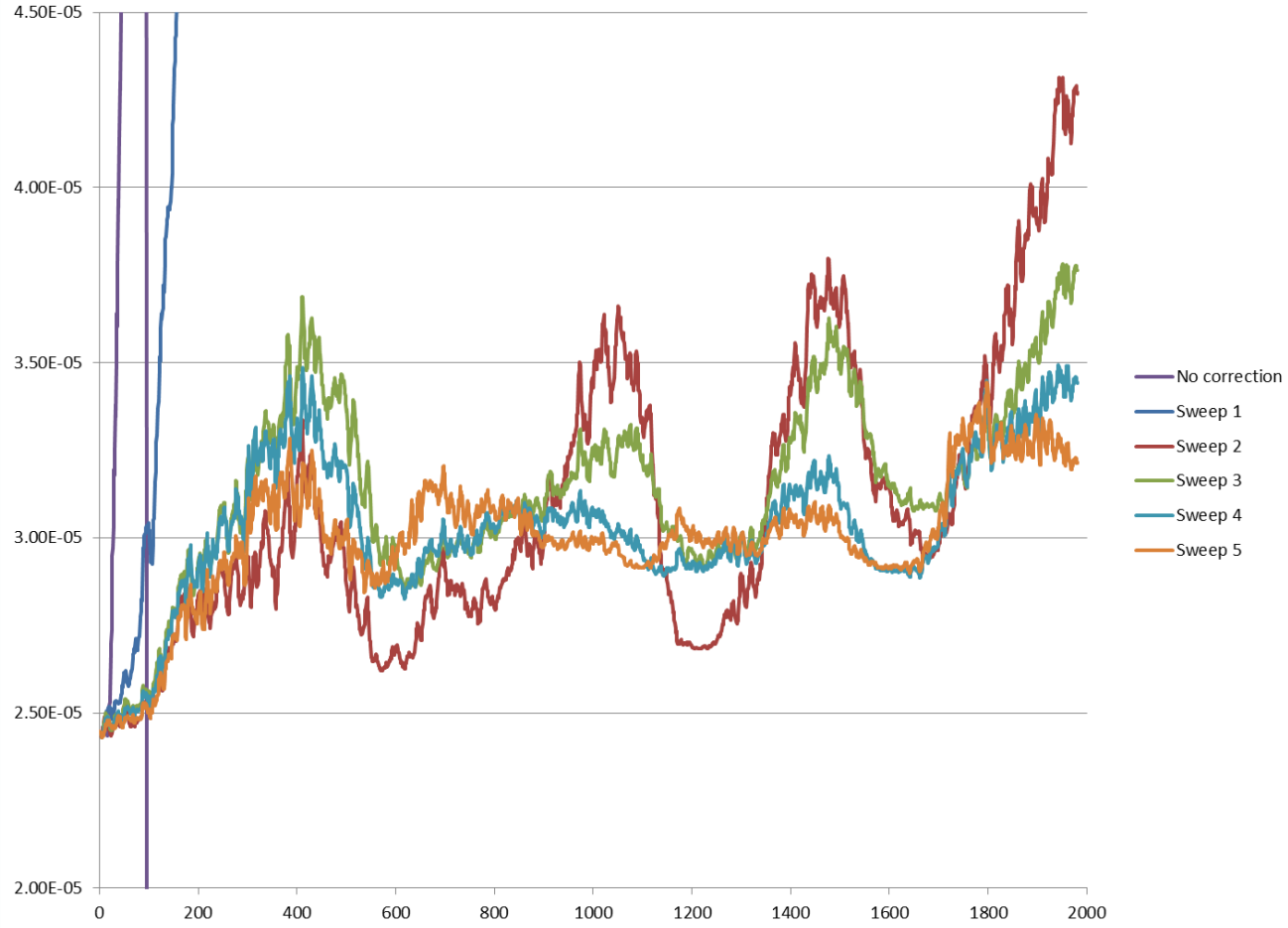
L=5, D=1, All Sweeps, X emittance



L=5, D=1, All Sweeps, Y emittance



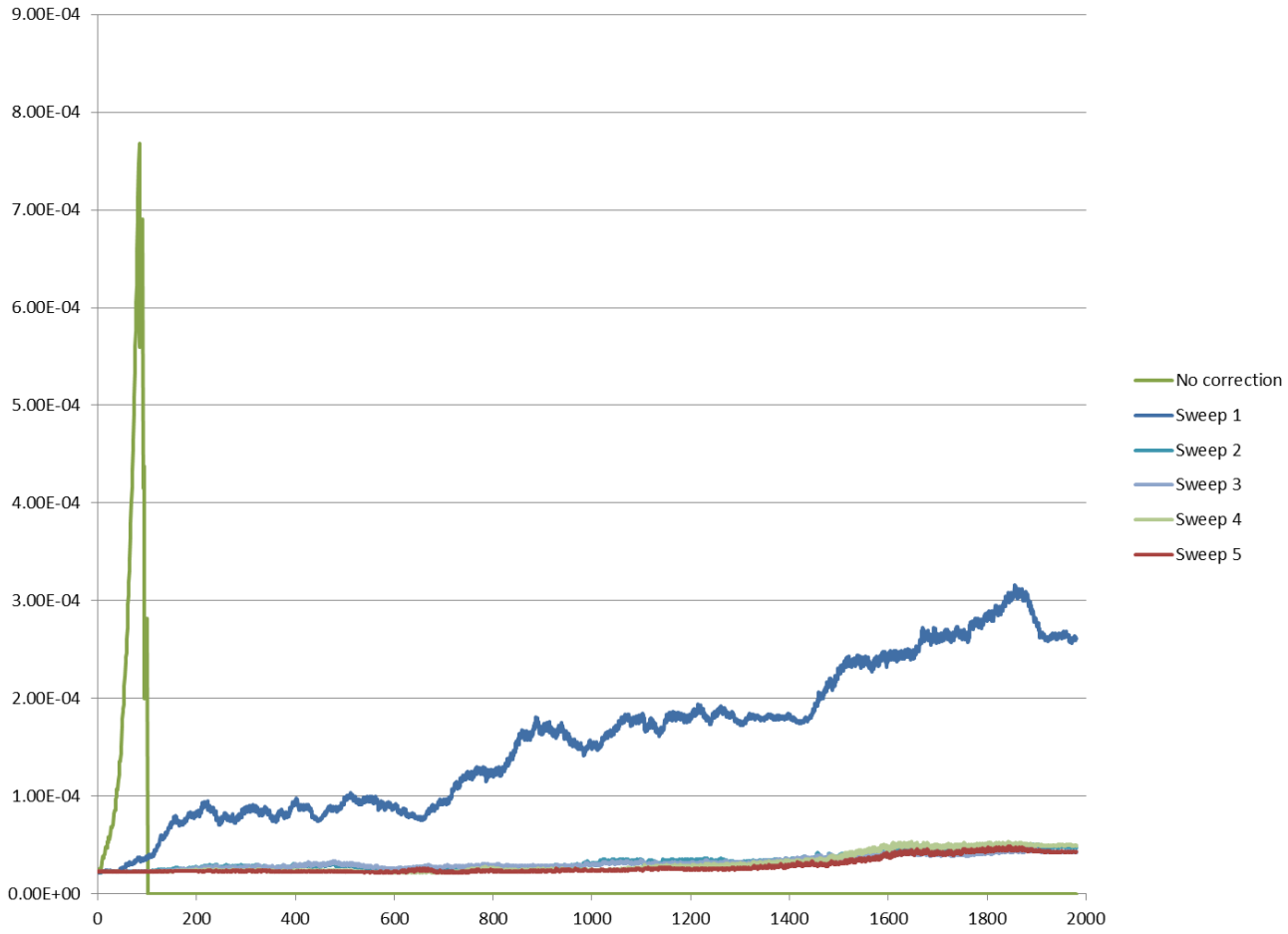
L=5, D=1, All Sweeps, Y emittance



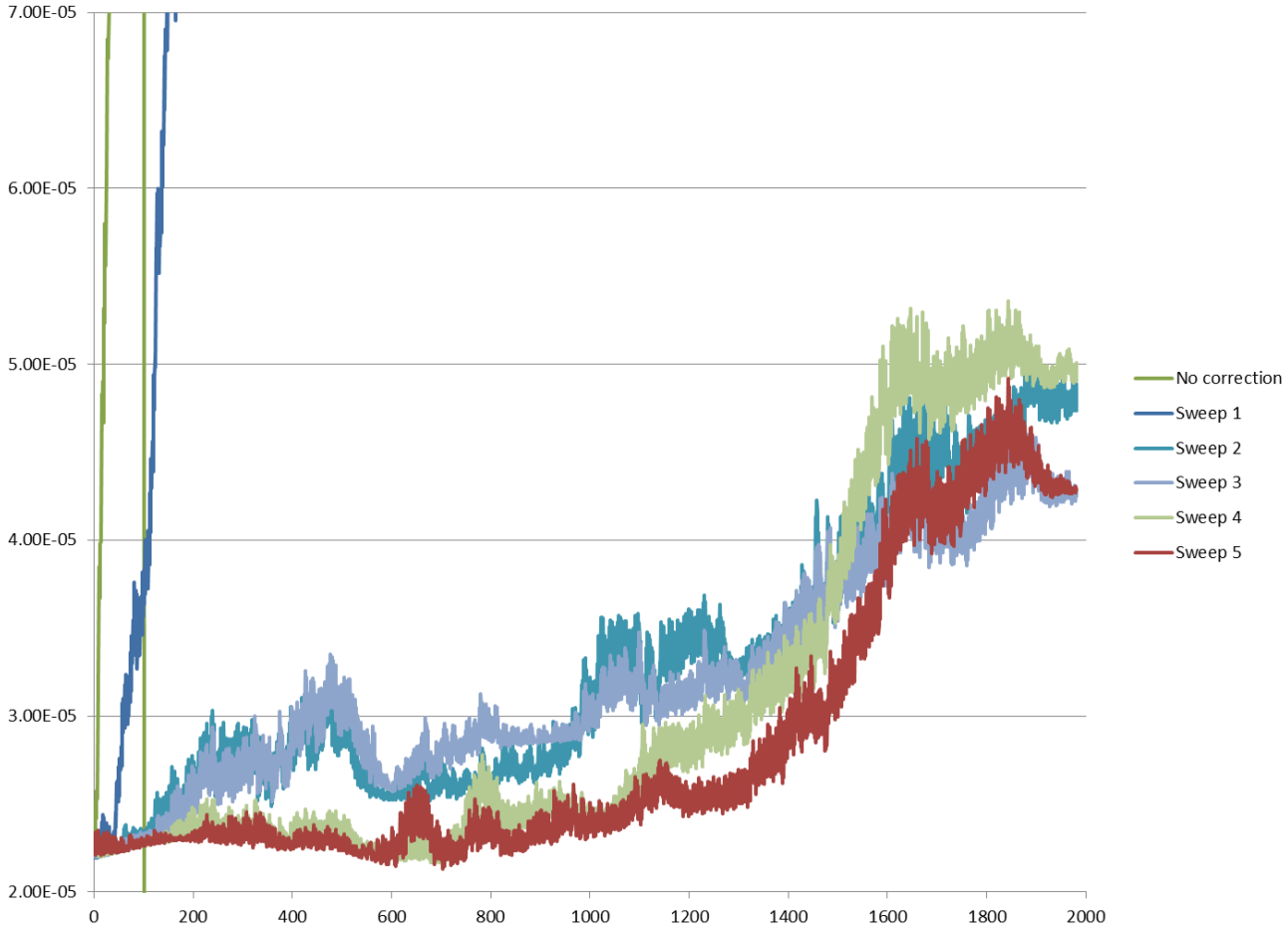
Cumulative Summary

L (BPM look-ahead)	D (dispersion weight)	Initial X emittance mm.mrad	Final X emittance mm.mrad	Growth Ratio
1	0	22.4586	610.609	27.188
5	0	22.4602	67.9431	3.025
5	1	22.4602	48.7195	2.169

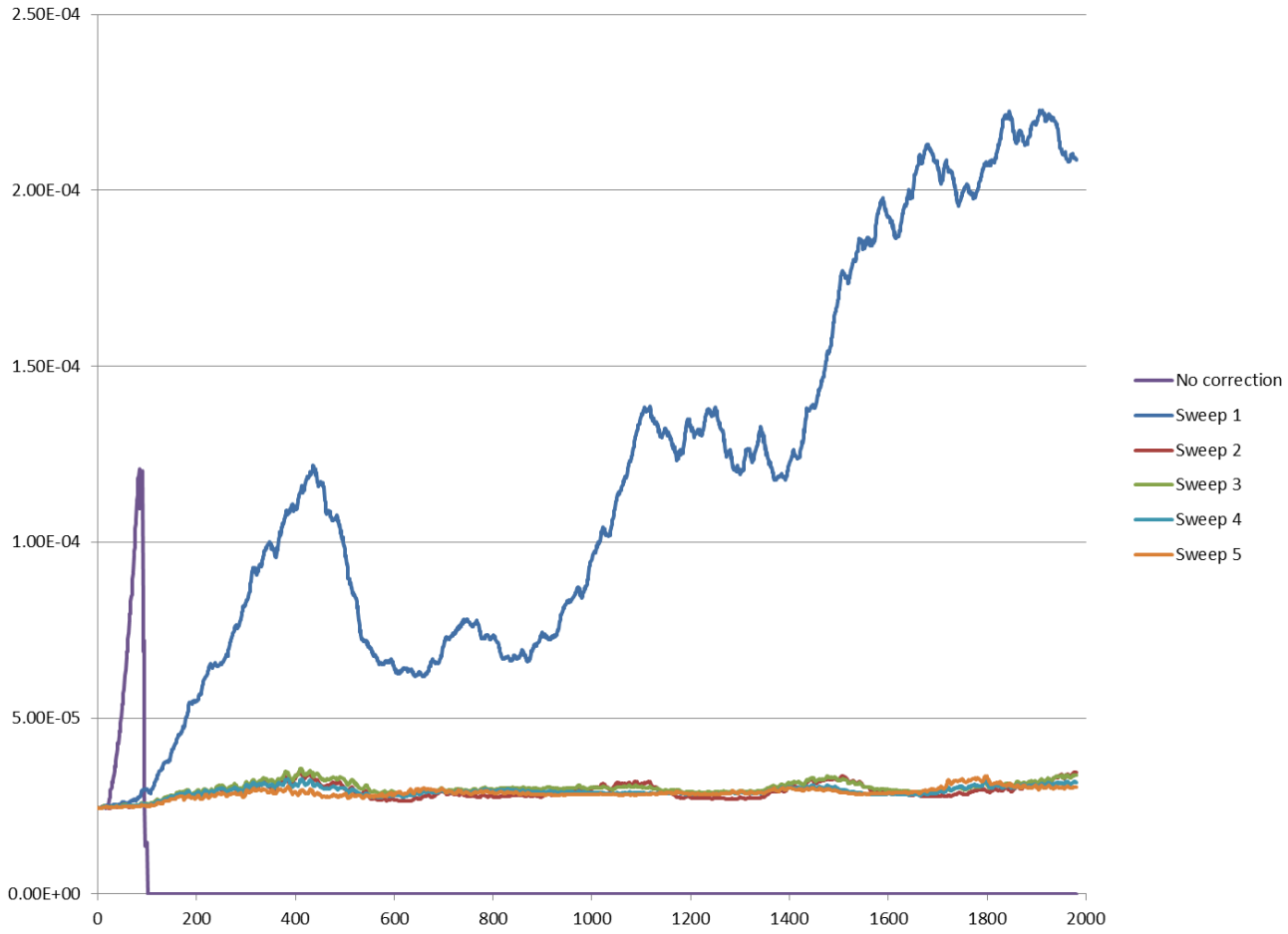
L=5, D=2, All Sweeps, X emittance



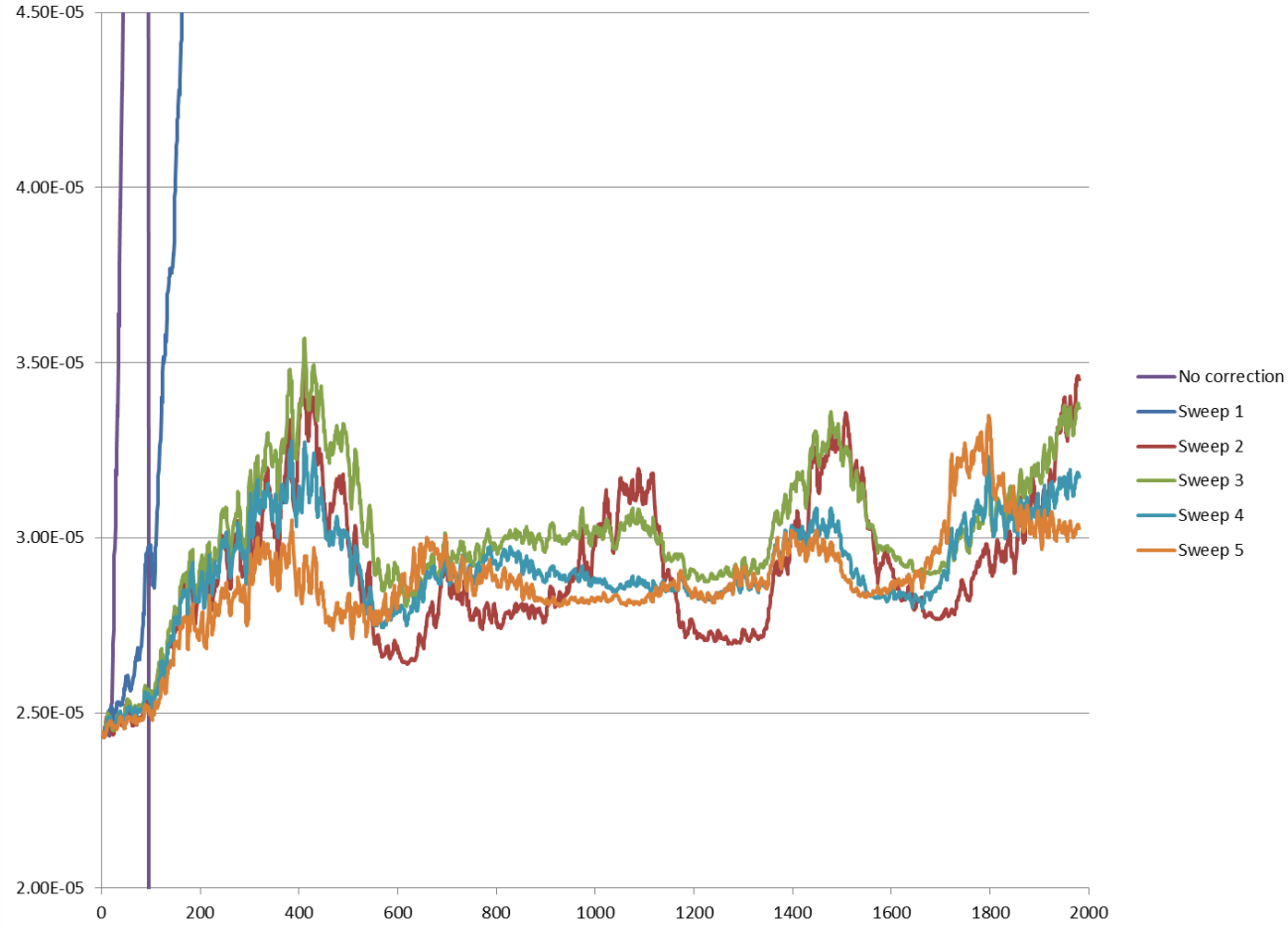
L=5, D=2, All Sweeps, X emittance



L=5, D=2, All Sweeps, Y emittance



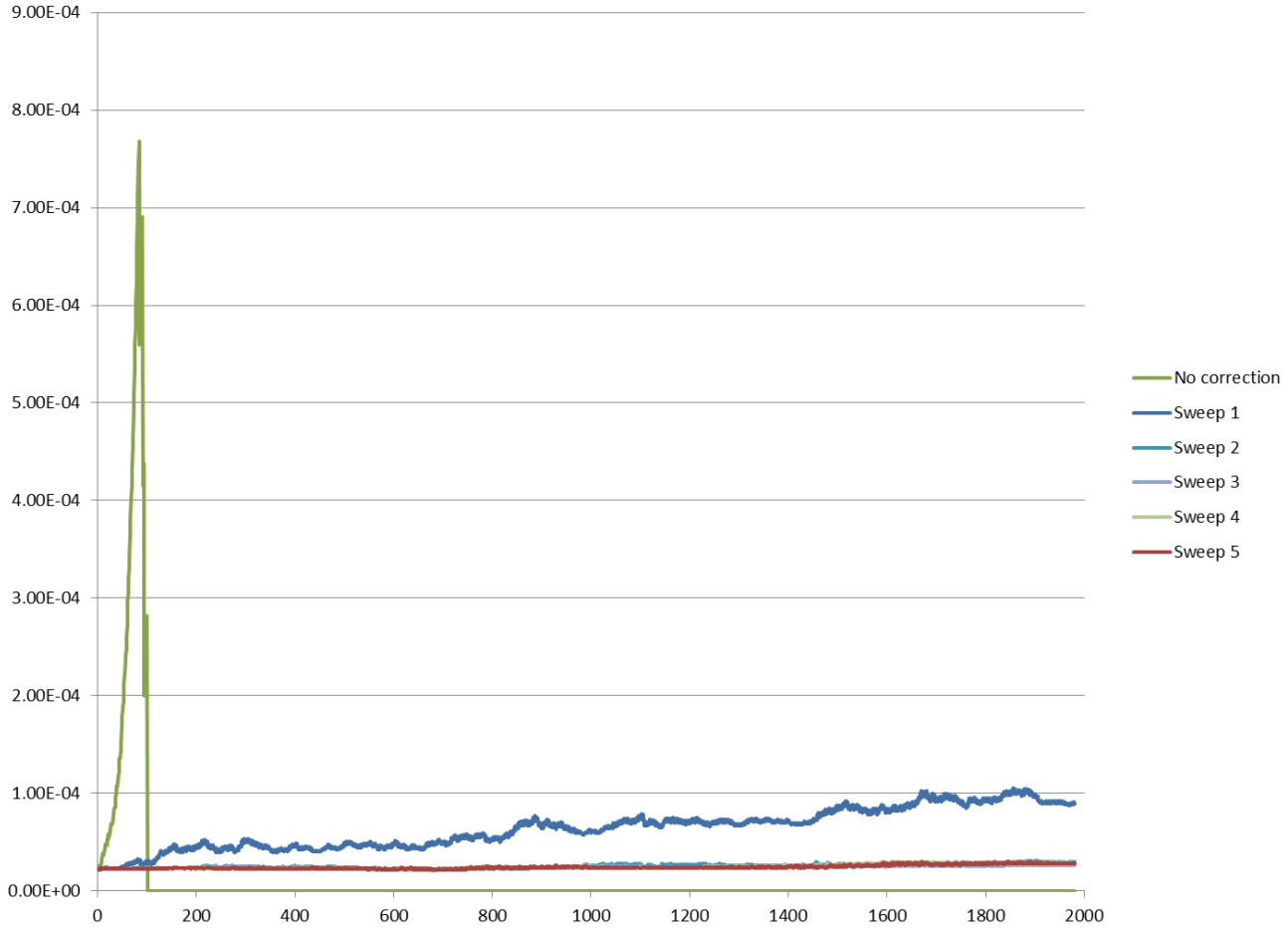
L=5, D=2, All Sweeps, Y emittance



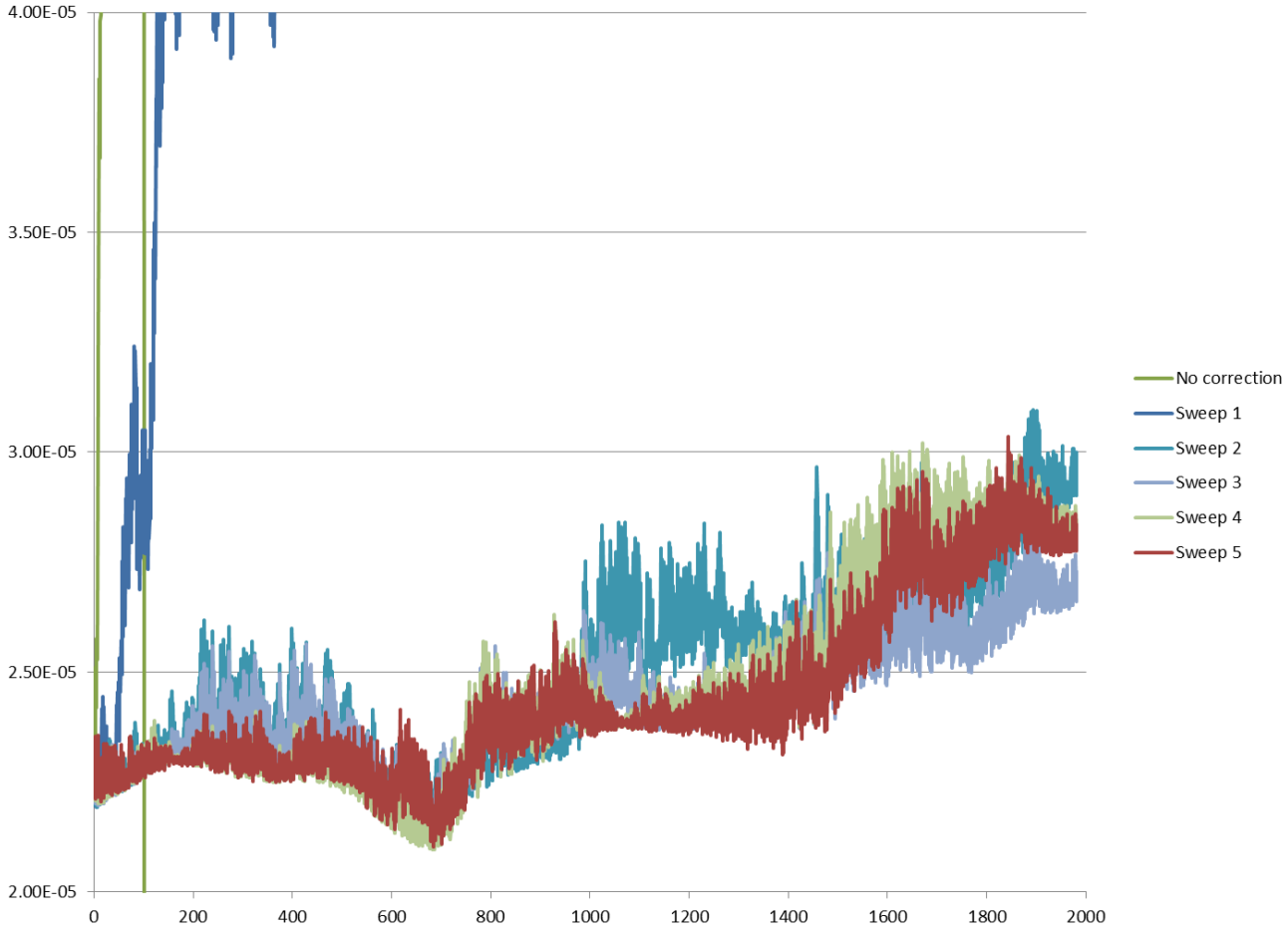
Cumulative Summary

L (BPM look-ahead)	D (dispersion weight)	Initial X emittance mm.mrad	Final X emittance mm.mrad	Growth Ratio
1	0	22.4586	610.609	27.188
5	0	22.4602	67.9431	3.025
5	1	22.4602	48.7195	2.169
5	2	22.4602	42.4646	1.891

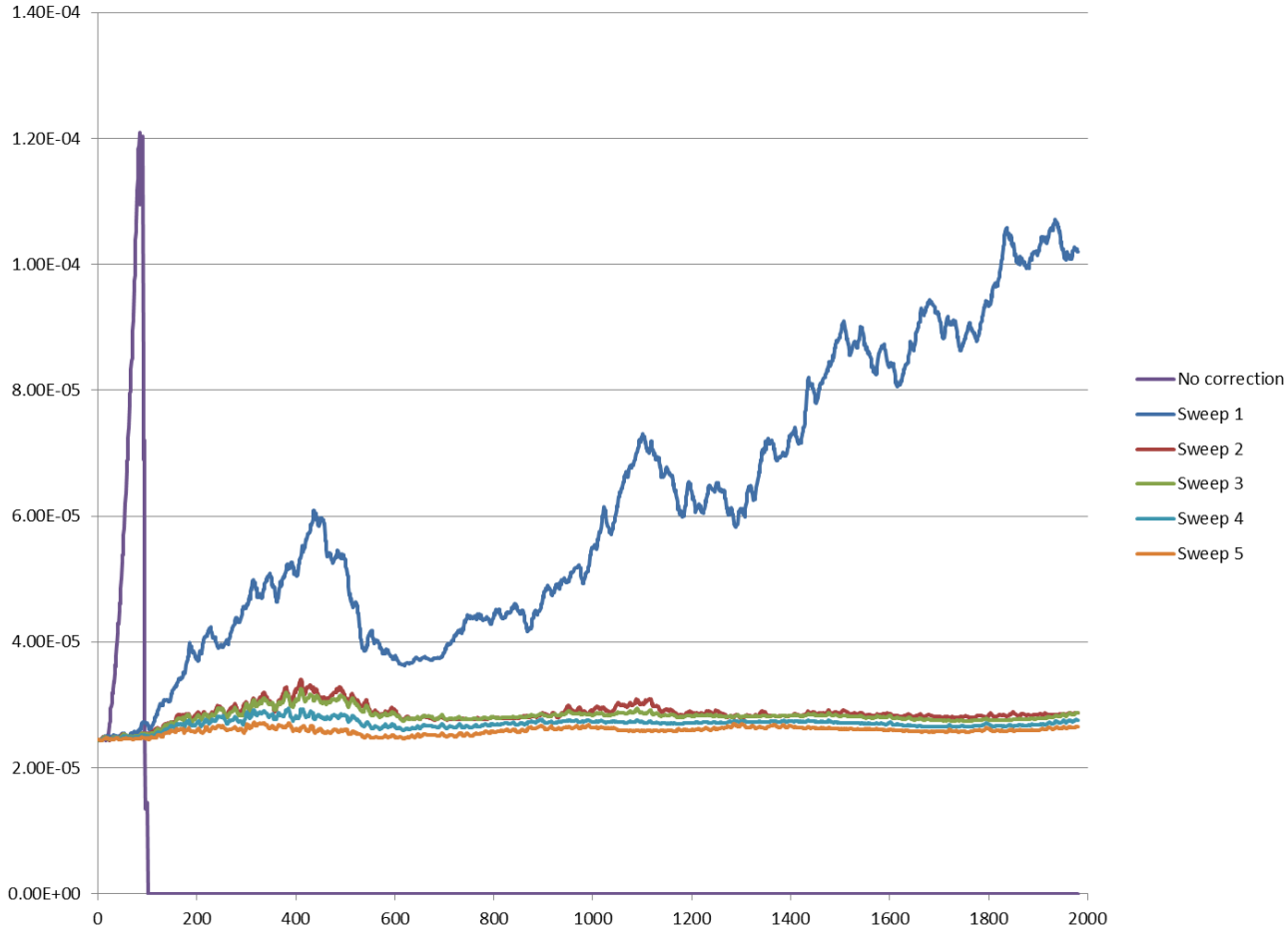
L=5, D=10, All Sweeps, X emittance



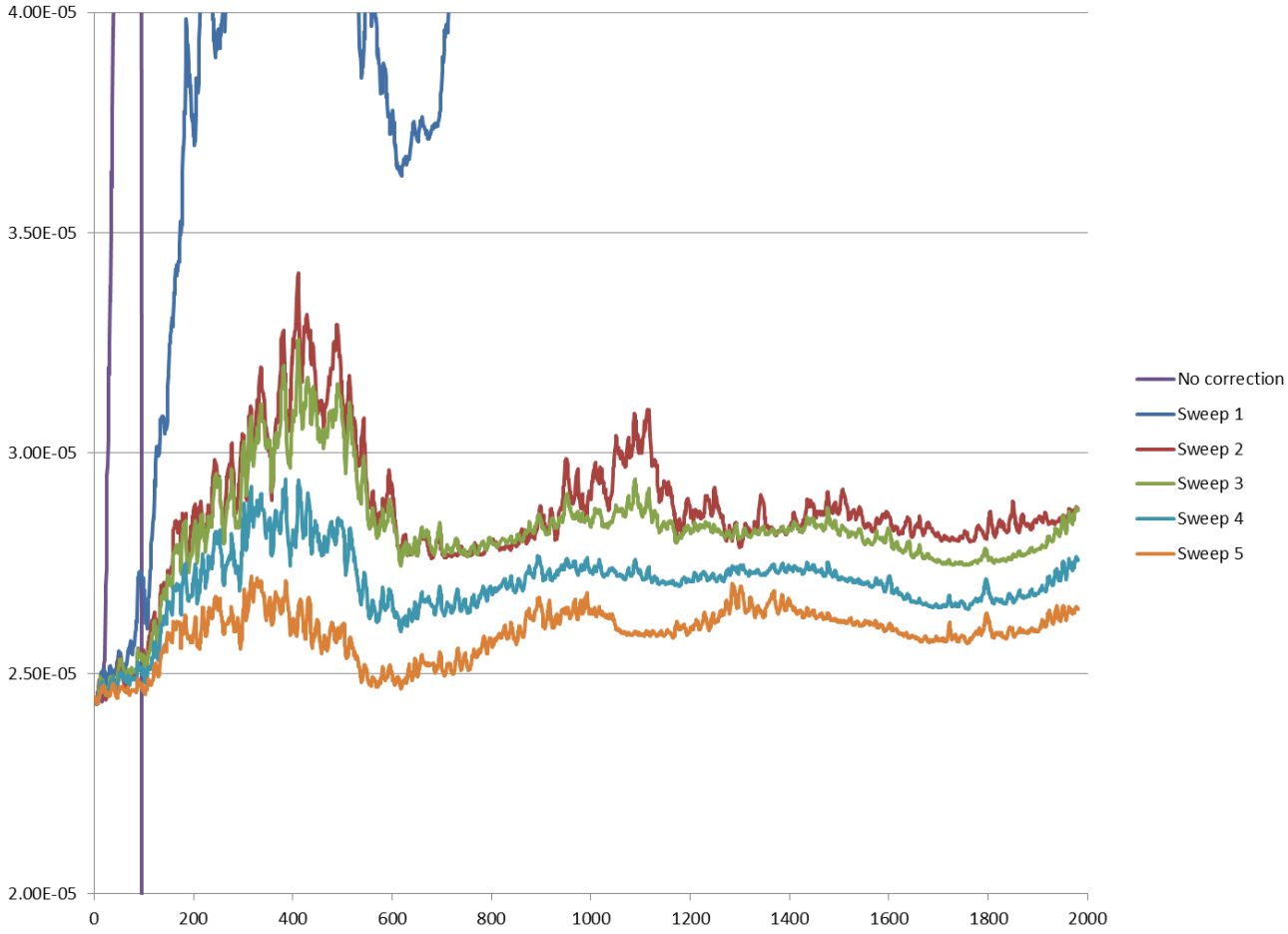
L=5, D=10, All Sweeps, X emittance



L=5, D=10, All Sweeps, Y emittance



L=5, D=10, All Sweeps, Y emittance



Final Summary (for now)

L (BPM look-ahead)	D (dispersion weight)	Initial X emittance mm.mrad	Final X emittance mm.mrad	Growth Ratio
1	0	22.4586	610.609	27.188
5	0	22.4602	67.9431	3.025
5	1	22.4602	48.7195	2.169
5	2	22.4602	42.4646	1.891
5	10	22.4602	27.2930	1.215