Modeling of spin-orbital dynamics in a storage ring

April 13, 2018

Tasks from supervisor

- Study effects of WF tilts (preserves Lorentz force) in FS lattice on S_x, S_y, S_z;
- Same for quadrupole shifts (doesn't preserve LF);
- Study decoherence as a function of the inital beam distribution $(x, y, \delta W)$;
- Study optimal sextupole placement for the suppression of decoherence and chromaticity;
- Modeling of field calibration by effective gamma in the horizontal plane (CW/CCW procedure);

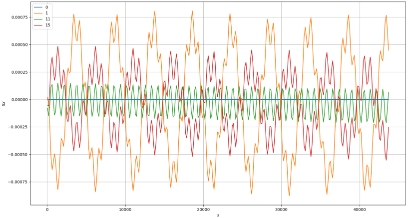
Conventional ODE integrator

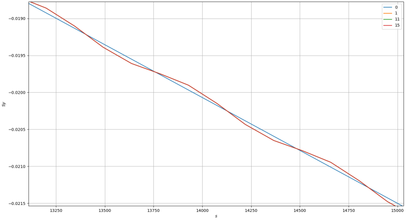
Python prototype

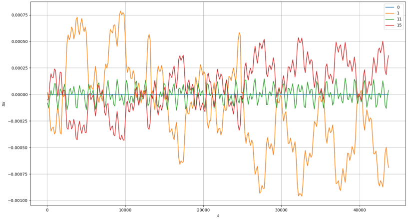
- Wrote that fbecause couldn't get COSY INFINITY to produce results that I could interpret;
- Classes defining most commonly utilized accelerator elements (dipoles, quadrupoles, Wien filters, etc);
- Two versions of element positioning imperfections (tilting):
  - via computing the tilt matrix, and applying it to the computed field at run time (more general but time-consuming, doesn't preserve guiding field strength by default);
  - customized tilting for dipole, WF (less time-consuming, preserves the Lorentz force acting on the particle), and shift for quadrupole;
- Vectorized RHS computation.

Example plots

- $S_x \sim s$ in FS lattice w/o tilt
- $S_x \sim s$ in FS structure w/ all elements tilted about $\hat{s}$
- $S_y \sim s$ in FS structure w/ elements randomly tilted Norm(0, 10^{-4} rad)



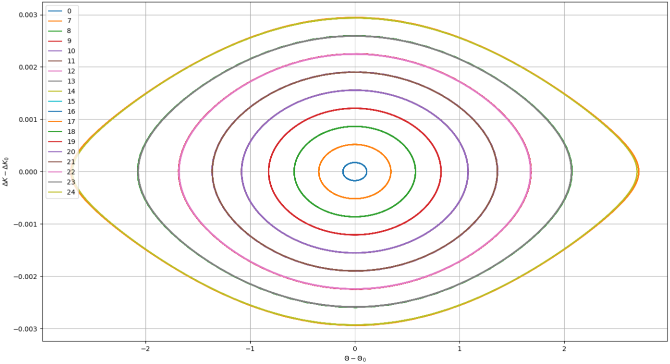




Conventional ODE integrator

C++ extension

- $\omega_i = \omega_0 + G_6 \cdot \Delta\gamma_i^2$, where $\Delta\gamma_i^2$ is the average gamma in phase space, due to synchrotron oscillations.
- $Q_s = \frac{\omega_s}{\omega_{rev}} \ll 1$ (like $1/35$) => require thousands of turns.
- => Reimplemented core functionality in c++



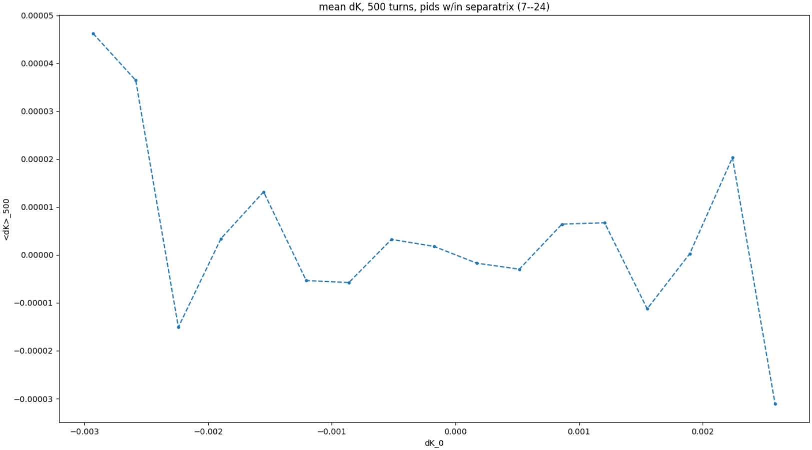


Figure: $\langle \Delta K \rangle$ vs ΔK_0 after 500 turns (14 synchrotron oscillations)

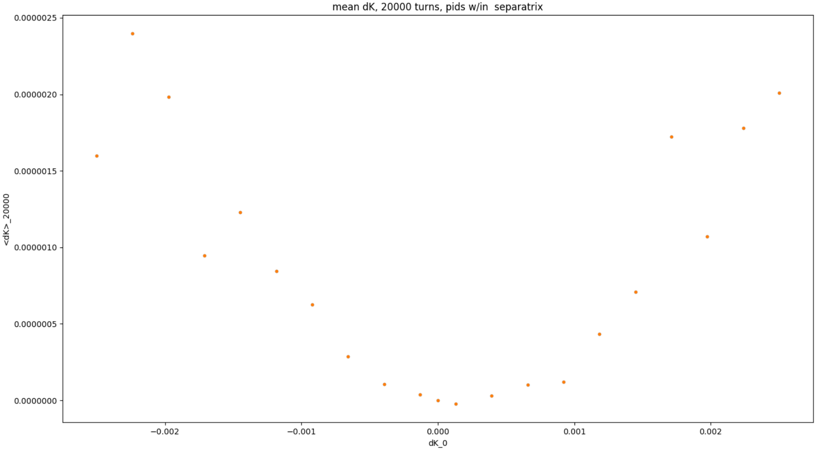


Figure: $\langle \Delta K \rangle$ vs ΔK_0 after 20,000 turns (571 synchrotron oscillations)

Problems

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