Progress of the first-turn commissioning simulation for HEPS*

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We present the simulation algorithm for achieving the first-turn commissioning based on the latest HEPS storage ring lattice. The accelerator toolbox (AT)-based program is updated for automatic optimizing the first-turn commissioning, there is no significant difference compared to the results for previous lattice version. The simulation results and the sensitivities of accumulation rate are also considered, the accumulation rates are higher than 65% if the corrector strength limit higher than 500 μrad and the quadrupole shift lower than 30 μm.

Introduction

- Repeat the whole first-turn commissioning simulation for **the V3.0 lattice**;
- Develop the simulation algorithm for the lattice with error sources;
- Study the sensitivity of the accumulation rate with respect to
  - Physical aperture requirement
  - Corrector strength limit
  - BPM noise/shift
  - Quadrupole shift

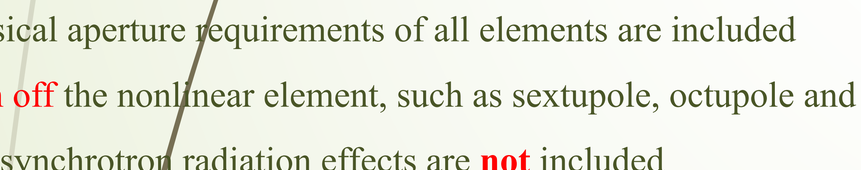
Error Sources

- Nominal error sources:
  - Field and alignment errors and Beam position monitor (BPM) errors
  - All of error sources follows a Gaussian distribution truncated at $\pm 3\sigma$
- Physical aperture requirements of all elements are included
- Turn off the nonlinear element, such as sextupole, octupole and RF cavities
- The synchrotron radiation effects are **not** included

Quadrupole Δx	30μm
Quadrupole Δz	150μm
Quadrupole $\Delta\Phi$	200μrad
Quadrupole $\Delta G/G$	2×10^{-4}
Dipole Δx	200μm
Dipole Δz	150μm
Dipole $\Delta\Phi$	100μrad
Dipole $\Delta G/G$	3×10^{-4}
BPM Noise/Shift	100μm/100μm

Optimization Method

- The similar optimization method compared with the previous one [1];



- Algorithm: Singular Value Decomposition (SVD) and least square method
- Achieve the beam to transfer the first one turn by adjusting the correctors to optimize the orbit section by section;
- Due to the corrector strength limits, we perform another optimization for all BPMs and correctors if there is orbit larger than 1 mm.

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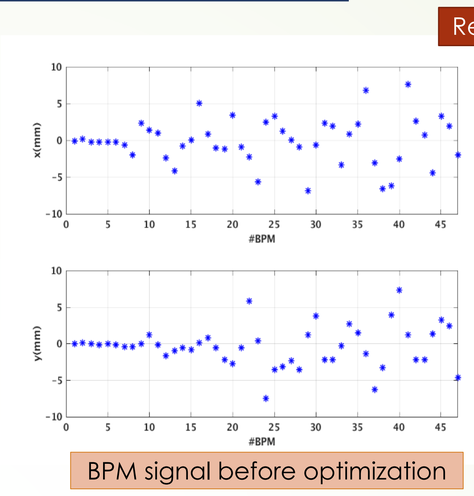
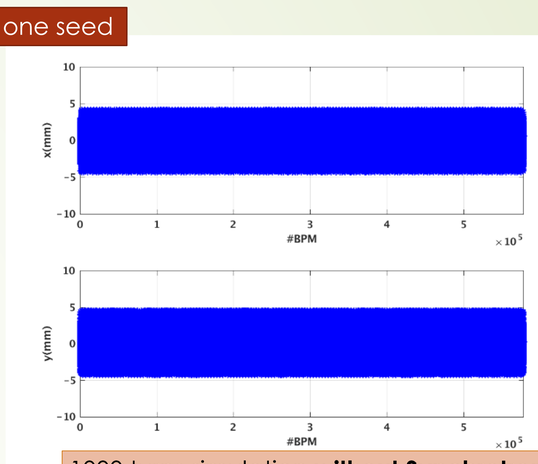
4D Simulation Results

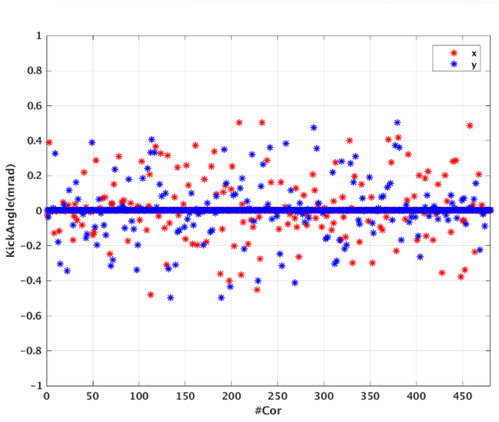
Result of one seed



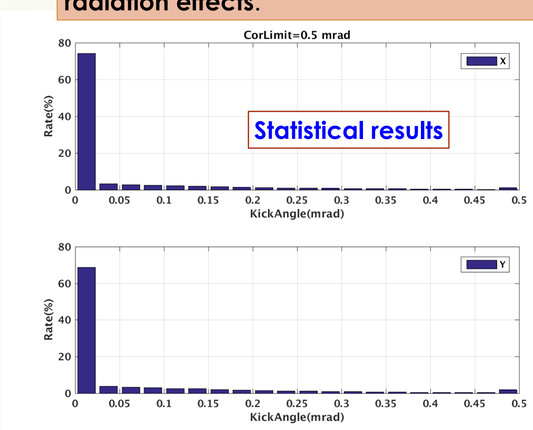
BPM signal before optimization



1000 turns simulation **without Synchrotron radiation effects**.



Corrector strength settings



Distribution of the corrector strength settings

- The beam is successfully accumulated under the current error tolerance;
- No significant difference compared to the results for previous lattice version.

Simulation Sensitivity

- Scan the corrector strength limits from 400 μrad to 900 μrad;
- Scan the BPM noise/shift from 100 μm to 600 μm;
- Scan the Quadrupole shift from 30 μm to 100 μm;
- Use the constant physical aperture requirement (8 mm) [1].

- The accumulation rate decreases due to the smaller physical aperture, while the variation tendency is similar to those of constant physical aperture requirement;
- The accumulation rates are higher than 65% if the corrector strength limit higher than 500 μrad and the quadrupole shift lower than 30 μm.
- Optimization with more practical conditions is ongoing.

[1] Y.L. Zhao *et al*., "First turns around strategy for HEPS", in Proc. IPAC'17, MOPIK082, Copenhagen, Denmark, 2017.5.