MAGNETIC ERROR EFFECTS OF THE STORAGE RING FOR THE SOUTHERN ADVANCED PHOTON SOURCE*

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Introduction

- ✓ One candidate ring lattice of SAPS has been design with the H-MBA concept with the beam energy of 3.5 GeV [1][2]. 7BA lattice has been chosen, featuring a large number of ultra-high gradient quadrupoles and sextupoles.
- ✓ These ultra-high gradient quadrupoles and sextupoles lead to tight tolerance of beam parameters to magnetic errors.
- ✓ For the fourth generation storage ring in the world, the magnetic error effects have been analysed and corrected [3][4][5][6][7].
- ✓ At present, the SAPS magnetic error study covers some common errors in practical accelerator as below:

  Alignment and Rotation Angle Error

  Field Error of Magnet
- ✓ With the above error setting, the distortion of the closed orbit and beam optics of the SAPS lattice were recorded and analyzed, and the resulting Dynamic aperture reduction was been simulated.

Candidate Ring Lattice

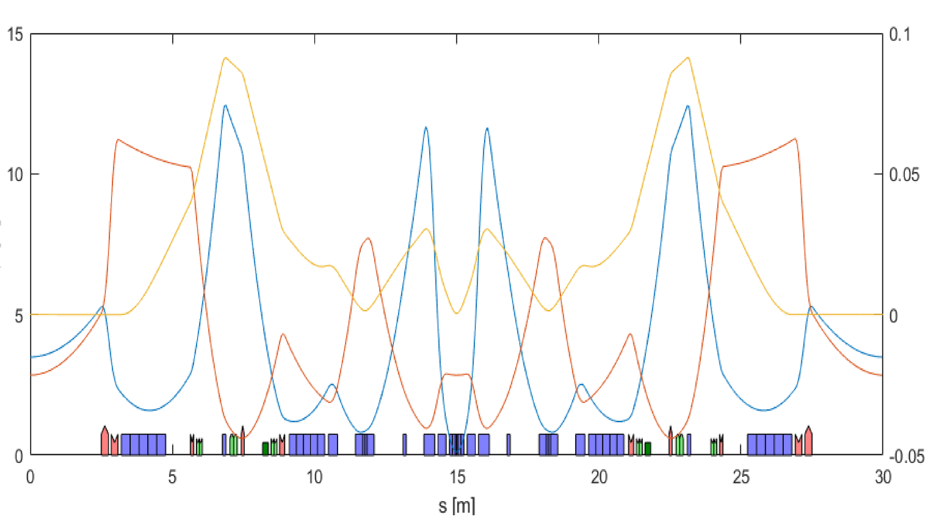

Figure 1:
Layout and optical functions of the candidate lattice designed for the SAPS. The blue, red, green, dark green blocks represent dipoles, quadrupoles, sextupoles and octupoles, respectively.

A hybrid 7BA design for the SAPS has been made, as shown in Figure 1. This design with a 31.7 pm·rad natural emittance, ~4% MA and the dynamic aperture (DA) ~5 mm in x plane and 3.5 mm in y plane, provide a basic for the further studies to be based on.

Error Setting

✓ *Alignment and Rotation Angle Error*

The alignment error will make beam injection difficult and have a big influence on beam performance.

In this study, we assumed 30 μm for misalignment and 100 μrad rotation in r.m.s error for each magnet element.

✓ *Field Error of Magnet*

For each magnet, a random relative error is added to the original field. Considering that the magnet field would have been corrected in future, the scale for different type magnets list as blow:

- Dipoles: 0.03%
- Quadrupoles: 0.02%
- Sextupoles: 0.03%.

With the above error setting, the distortion of the closed orbit and beam optics of the SAPS lattice have been recorded and analysed.

Closed Orbit distortion

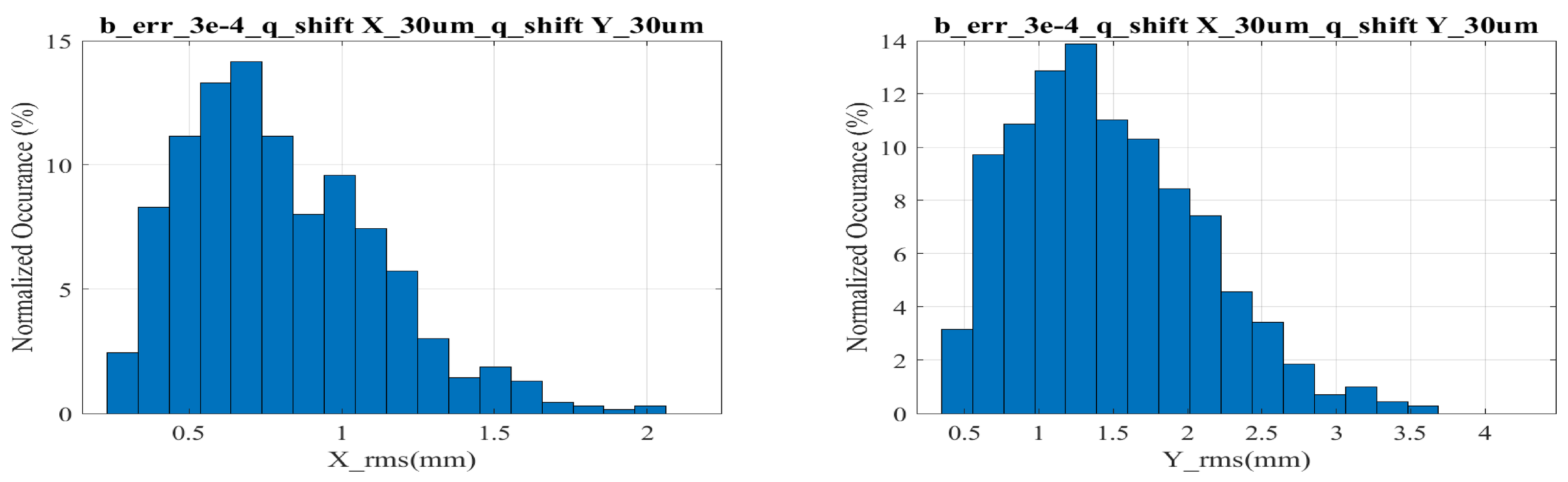

Figure 2: The RMS distribution of the closed orbits with the 30 μm misalignment of quadrupoles and the 0.03% field errors of dipoles (700 seeds).

- ✓ The misalignment of quadrupoles and the field errors of dipoles affect the closed orbit a lot.
- ✓ The maximum RMS closed orbits are ~2 mm and 3.6 mm for x and y, respectively.

Beam optics

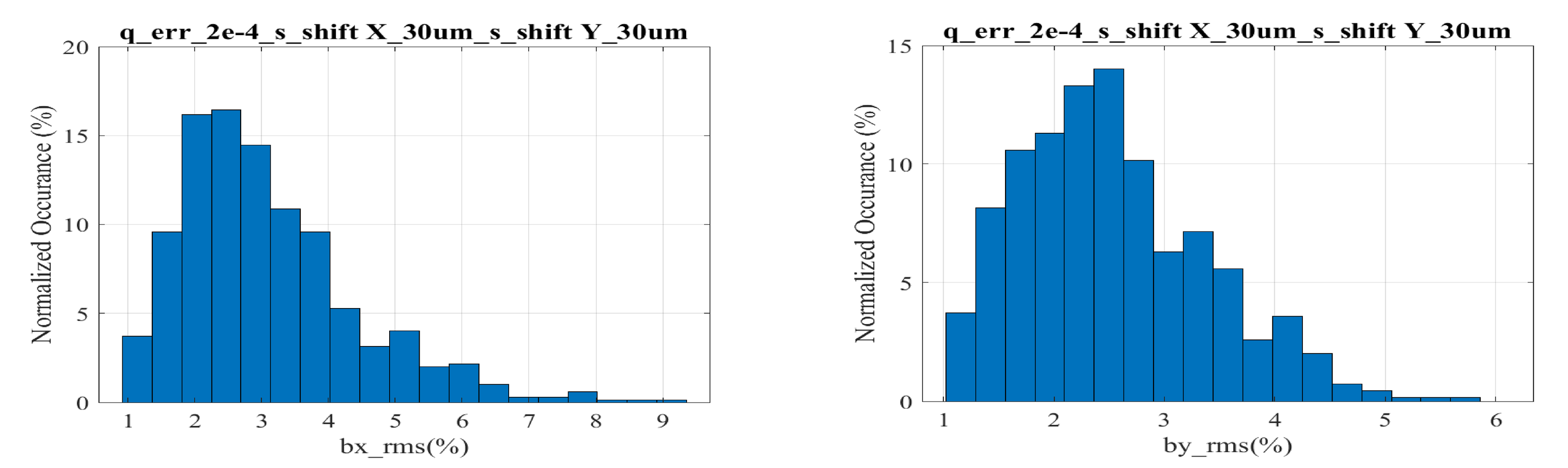

Figure 3: The RMS distribution of the beta-beatings with the 30 μm misalignment of sextupoles and the 0.02% field errors of quadrupoles (700 seeds).

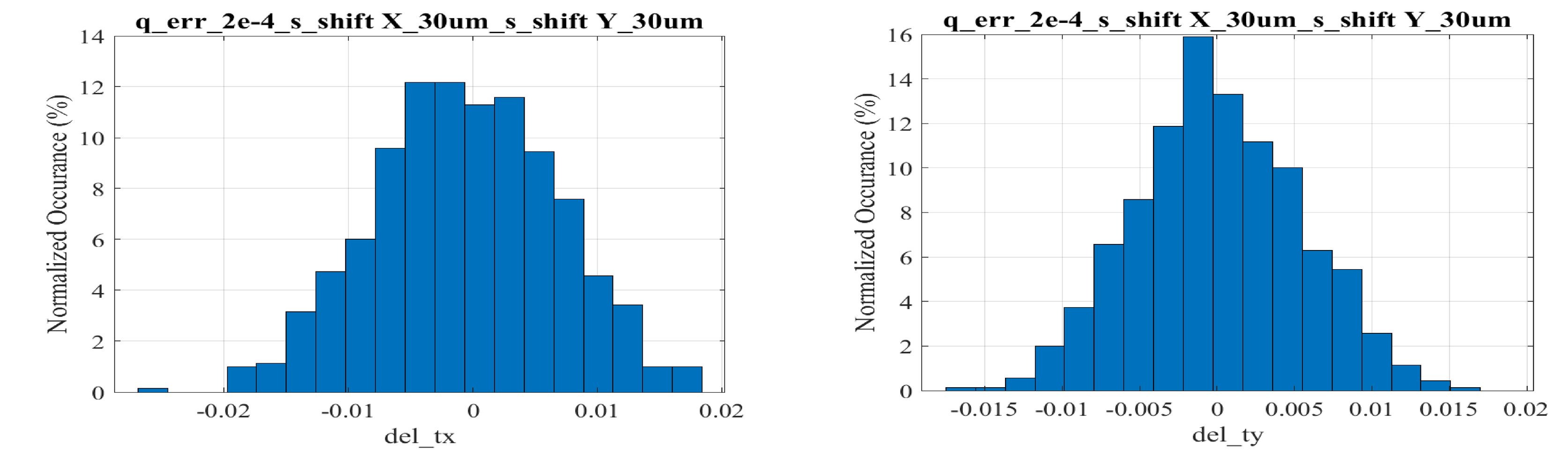

Figure 4: The tune-shifts with the 30 μm misalignment of sextupoles and the 0.02% field errors of quadrupoles (700 seeds).

✓ The misalignment of sextupoles and the field errors of quadrupoles affect mainly the beam optics.

The maximum RMS beta-beatings are ~9.5% and ~6% for β_x and β_y, respectively. Meanwhile, the maximum tune-shifts are $\pm 0.02/\pm 0.015$.

DA reduction

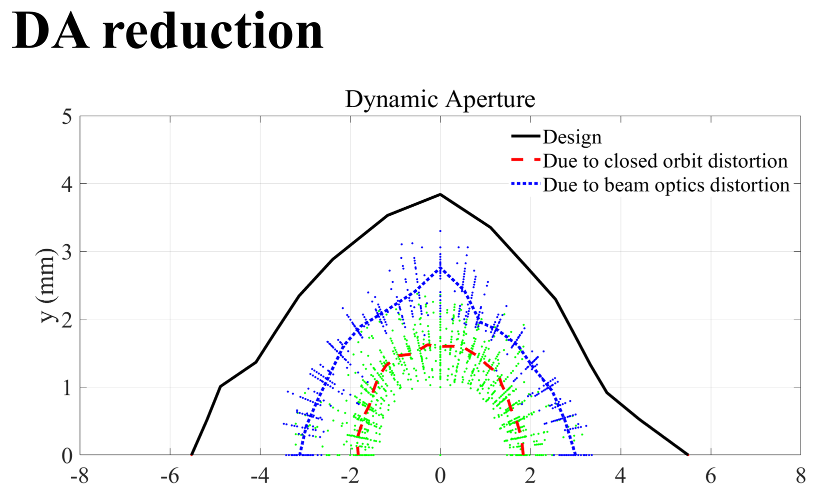

Figure 5: DA tracking result. (Black line): bare lattice DA; (red dot): 50 cases tracking result with closed orbit distortion; (red line): average DA with closed orbit distortion; (blue dot): 50 cases tracking result with beam optics distortion; (blue line): average DA with beam optics distortion.

- ✓ Compared with bare lattice, the DA decreased obviously with error effects.
- ✓ The DA with closed orbit distortion is 1.6/2 mm and the DA with beam optics distortion is 2.8/3 mm.
- ✓ The DA reduction caused by the closed orbit distortion is more serious than that caused by the optics distortion.

Acknowledgment

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References

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