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Enhancing Orbit Correction in Next Generation Lepton Accelerator Storage Rings

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Accelerator storage rings for light sources and colliders are highly sensitive to magnet misalignments and field errors. These imperfections distort the orbit, which negatively impact the brightness or luminosity. Precise orbit correction plays a vital role in optimising the performance of next generation lepton accelerators.

CERN's proposed e^+e^- Future Circular Collider (FCC-ee) is a 91 km high energy dual lepton storage ring aimed at achieving unprecedented luminosities with energies from 45.6 GeV to 182.5 GeV per beam [1]. ANSTO is also researching a fourth generation 3 GeV light source called AS2, proposed to replace the current Australian Synchrotron when it reaches end of life [2]. Both accelerators require strong sextupoles to achieve ultra-low emittance at the pm-rad scale. The orbit offset inside these magnets strongly impacts optics distortion and ultimately accelerator performance. To correct the orbit distortion, numerical simulation toolkits developed by CERN including MAD-X, Xsuite, and Xutil, were used [3].

This presentation explores a systematic approach to linear orbit correction using Singular Value Decomposition (SVD) and how it could benefit current and next-generation storage rings. We demonstrate that the degree of correction is greater through certain magnets and discuss improvements made by considering the Beam Position Monitor (BPM) noise floor to determine a threshold for the number of singular values included in the correction.

References

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- [2] X. Zhang et al. "Preliminary lattice design for Australian Synchrotron 2.0". In: JACoW IPAC2024 (2024), TUPG10.
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