FEL Wiggler Bussbar Field Compensation

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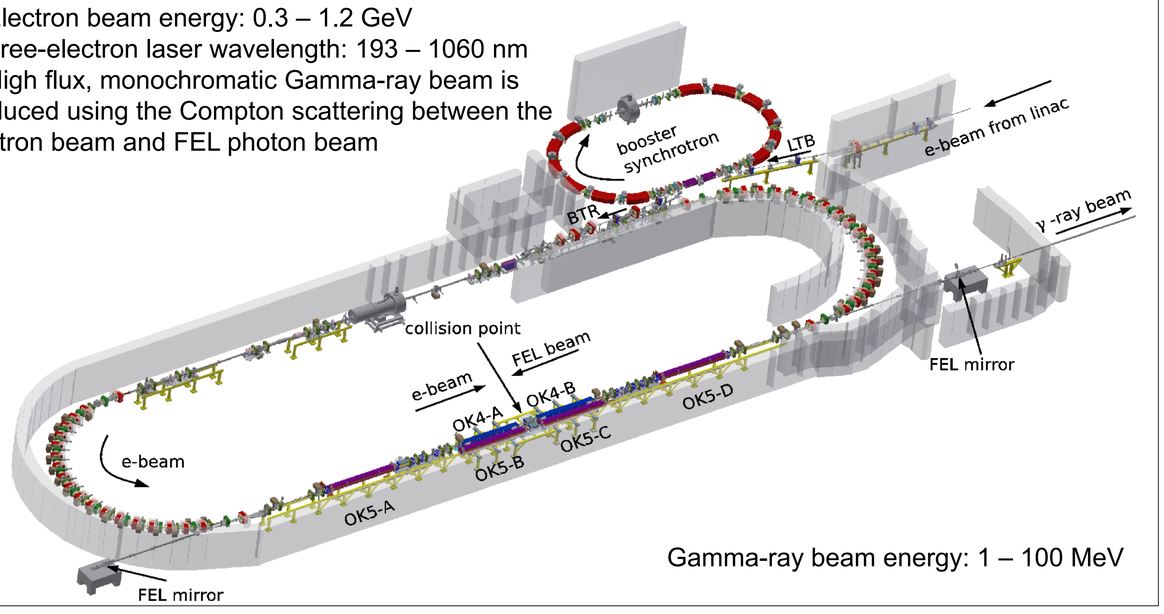
The Duke free electron storage ring is a dedicated driver for the storage ring based free-electron (FEL) lasers and the High Intensity Gamma-ray Source (HIGS). The facility is composed of three accelerators: (1) a 0.16 – 0.27 GeV linac pre-injector; (2) a 0.16 – 1.2 GeV full-energy, top-off booster injector; and (3) a 0.24 – 1.2 GeV electron storage ring. The operation of FEL system is based on six available wigglers (TwoplanarOK-4 wigglers and four helical OK-5 wigglers) with various configurations, located in the south straight section of the Duke storage ring. The bussbar located below the wigglers can impact beam orbit. To have consistent e-beam orbits for a range of FEL wiggler currents, the bussbar field needs to be compensated. As a variety of the wiggler configuration are used, the compensation scheme is complicated. As an example, the compensation to one of the wiggler power supplies which powers two OK-5 wigglers is described in this paper.

High Intensity Gamma-ray Source (HIγ S)

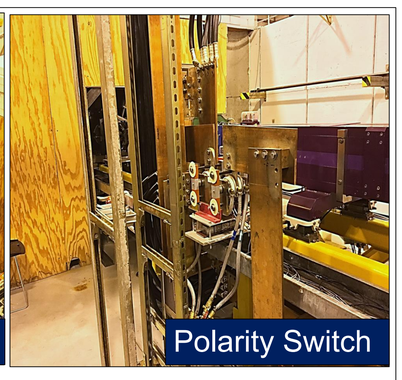
- Electron beam energy: 0.3 – 1.2 GeV
- Free-electron laser wavelength: 193 – 1060 nm
- High flux, monochromatic Gamma-ray beam is produced using the Compton scattering between the electron beam and FEL photon beam

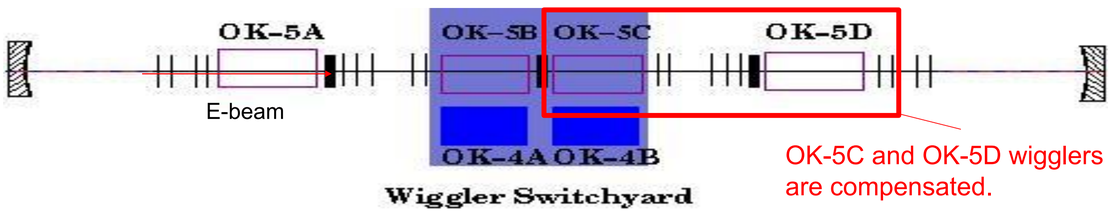


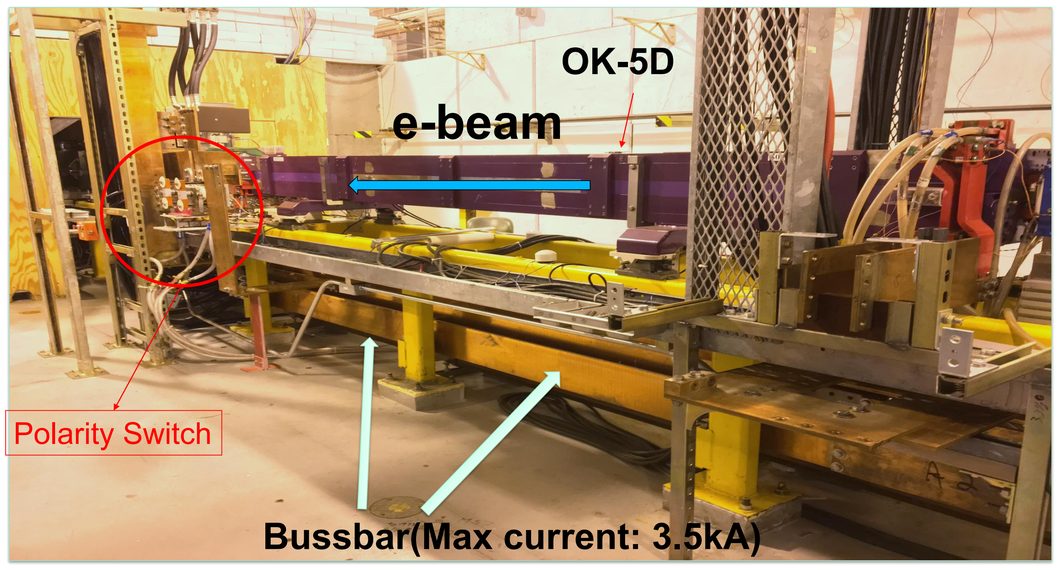
Gamma-ray beam energy: 1 – 100 MeV

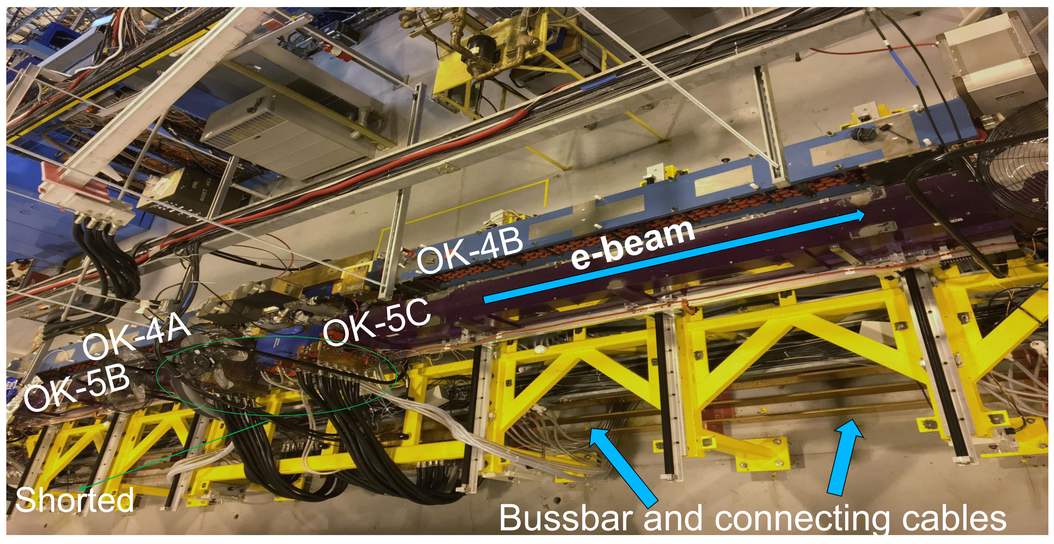
Wiggler Power Supoly


Bussbar from PS to Wiggler

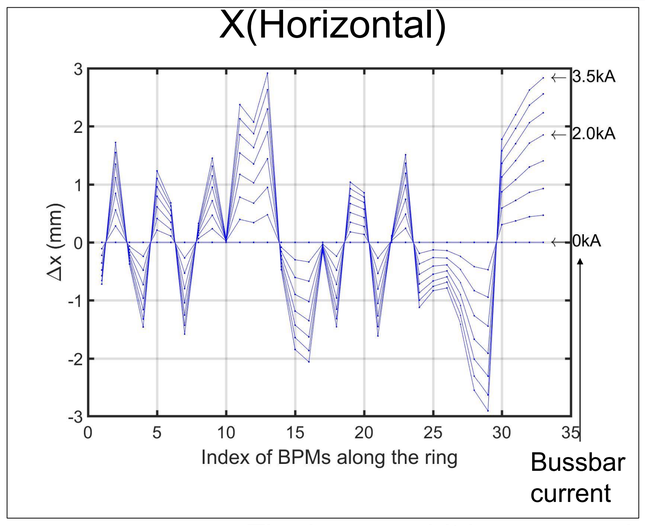

Polarity Switch

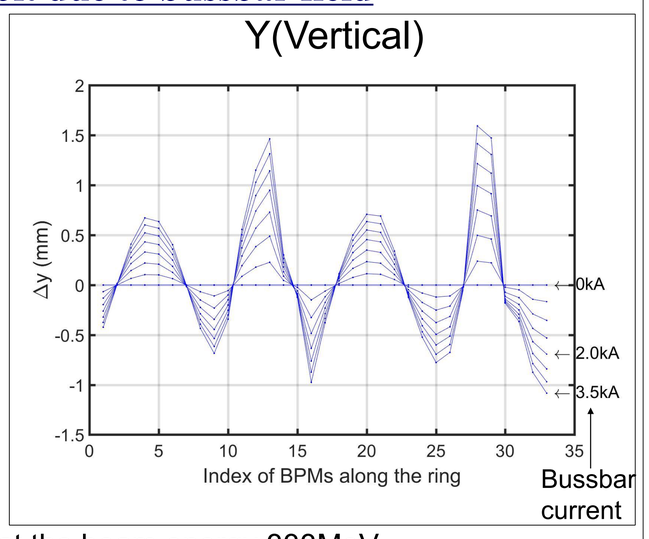




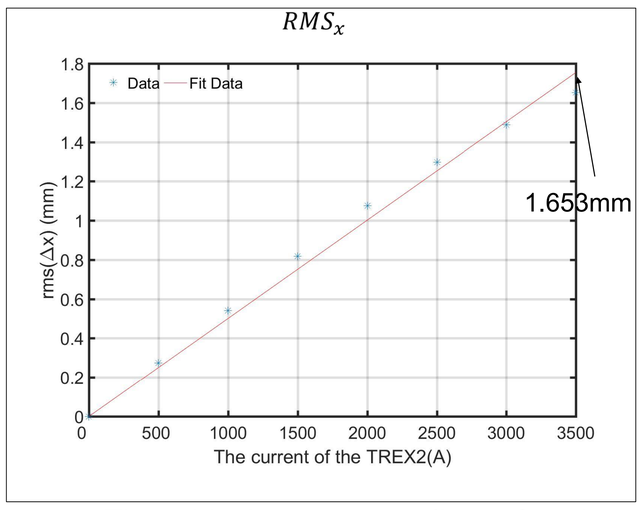


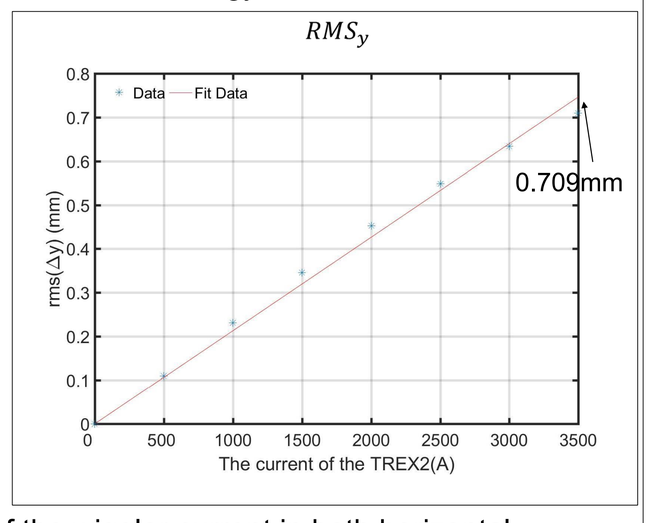
Effect to the beam orbit due to bussbar field





The beam orbit is measured at the beam energy 333MeV.





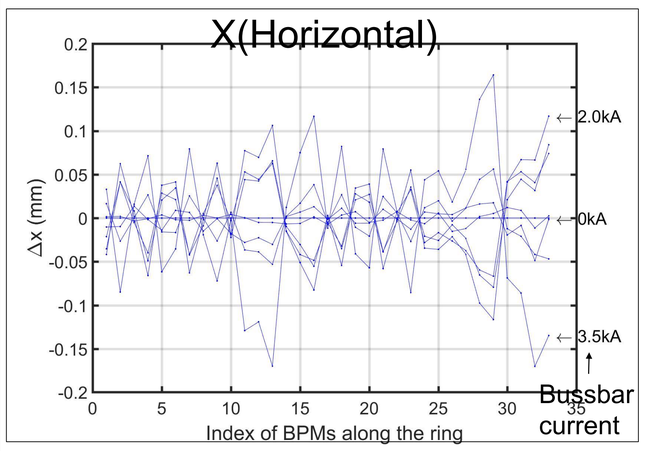
❖ The orbit changes are a linear function of the wiggler current in both horizontal and vertical directions.

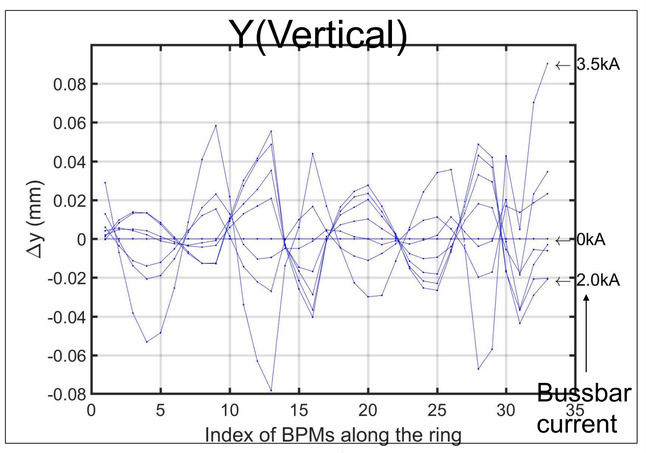
The procedure of the compensation

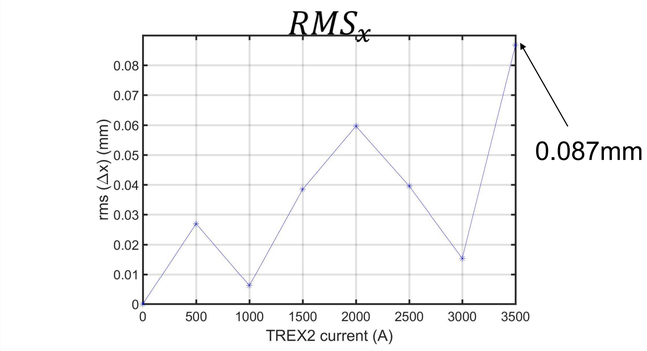
As the distribution of the bussbar field is unknown, this compensation scheme uses beam based method.

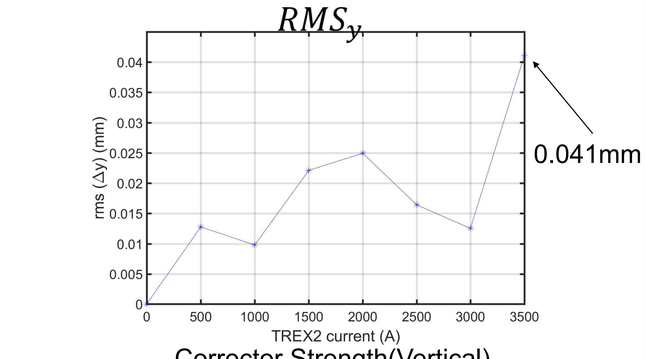
1. The response matrix is measured using beam position monitors (BPMs) and the orbit correctors.
2. The singular value decomposition (SVD) algorithm is used to obtain the corrector's strength for the compensation. 8 horizontal correctors and 7 vertical correctors in the area of the OK-5C and OK-5D wiggler are used. The rms of the beam orbit measured by 15 BPMs in the straight section of the Duke storage ring are minimized.
3. The measured results show that the beam orbit can be efficiently corrected. The rms orbit is improved by a factor of 19 and 17 in horizontal and vertical directions respectively. The maximum residual orbit are 87μm in horizontal direction and 41 μm in vertical direction, which is acceptable for the HIGS operation.

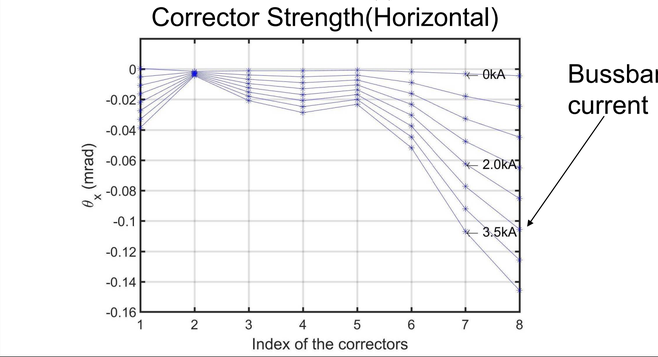
The results after applying compensation

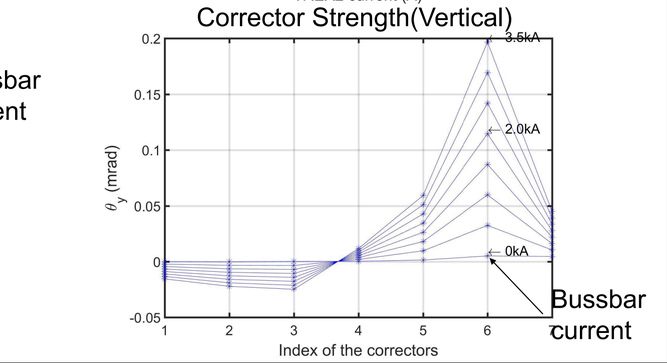












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