STRATEGY FOR NEUTRALIZING THE IMPACT OF INSERTION DEVICES ON THE MAX IV 3 GeV RING

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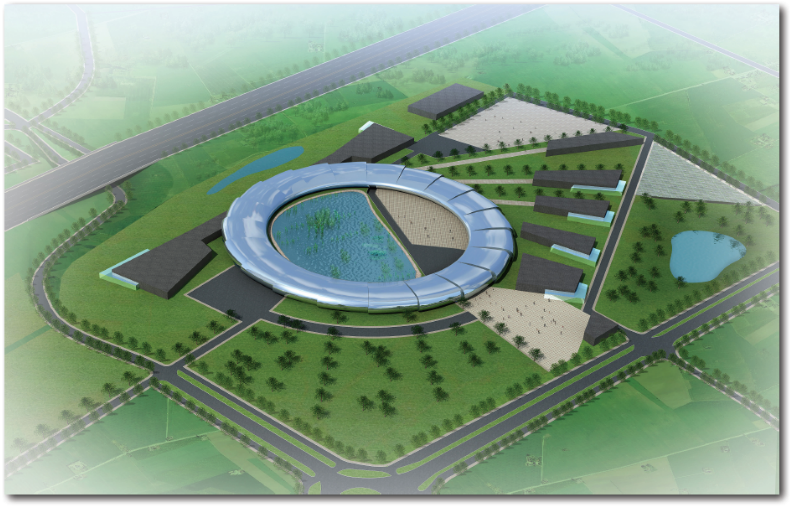
The insertion devices (IDs) might degrade the beam lifetime and injection efficiency and also give beam size and position variations in the MAX IV 3 GeV storage ring [1,2].

Strategy for neutralizing the foreseen effects of the Insertion Devices:

- A local correction of the betatron phase advance by adjusting the strength of the quadrupoles adjacent to the ID.
- A global tune correction in order to avoid drift of the working point of the storage ring during operation.
- Air coils with empirical feed forward tables for the excitation current will compensate for field integral errors.
- The lattice of the MAX IV 3 GeV storage ring appears to be robust and it tolerates the dynamic multipoles created by the expected initial set of IDs provided that the linear optics matching has been carried out.



IDs IN THE MAX IV 3 GeV RING

- The final choice of has not yet been made.
- The first set of IDs will most likely be a combination of the IDs summarized in Table 1.
- The IDs in Table 1 have been modeled Radia [13], which also has been used to calculate the focusing potential and kick maps.
- The EPUs have been modeled in 4 different modes: planar, helical, inclined, and vertical.
- The kick maps cover an aperture of ±2 mm vertically and ±20 mm horizontally, which covers the expected beam stay clear aperture in the straight sections of the MAX IV 3 GeV storage ring.

Table 1: IDs in the MAX IV 3 GeV storage ring.

Name	Type	Length [m]	Period Length [mm]	Gap [mm]
epu48	Ellipt. Pol. Undulator	3.9	48	11
epu53	Ellipt. Pol. Undulator	3.9	53	11
pmuL	In-Vacuum Undulator	3.8	18.5	4.2
pmuS	In-Vacuum Undulator	1.9	18.5	4.2
wig	In-Vacuum Wiggler	1.9	50	5.5

Dynamic and static multipoles

The static field integrals and multipoles will be compensated for by magic fingers, air coils and feed forward tables based on the gap and phase.

The dynamic multipoles gives rise to a focusing/defocusing effect which is nonlinear giving an amplitude-dependent tune shift which can reduce the dynamic aperture.

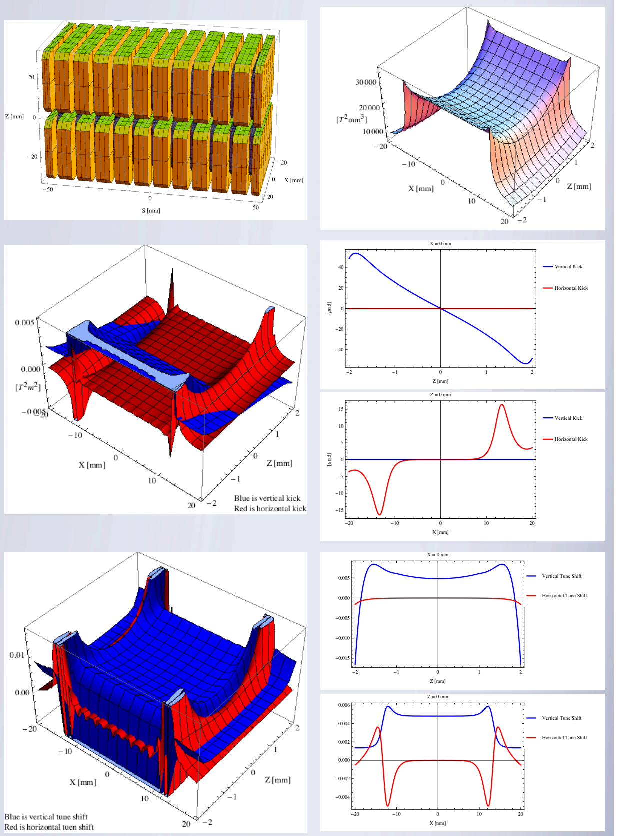
The effect is especially pronounced at low and medium electron energy rings and for IDs with large transverse gradients.

The effect is estimated by using the focusing potential to derive tune shifts and kick maps that can be used for tracking calculations [3].

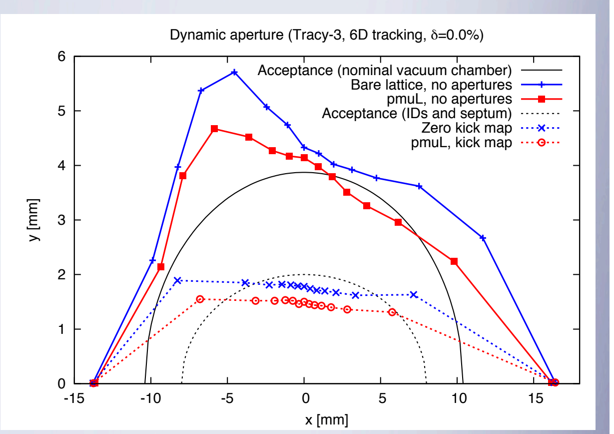
For an EPU in helical mode, the effect can be compensated efficiently with L-shaped iron shims [4, 5] but for the inclined and arbitrary mode active compensation with current strips along the vacuum chamber can be used [6, 7].

Example: pmuL

Hybrid type with Sm_2Co_{17} (B_r = 1.05 T) and iron poles. Magnetic model using Radia [13].



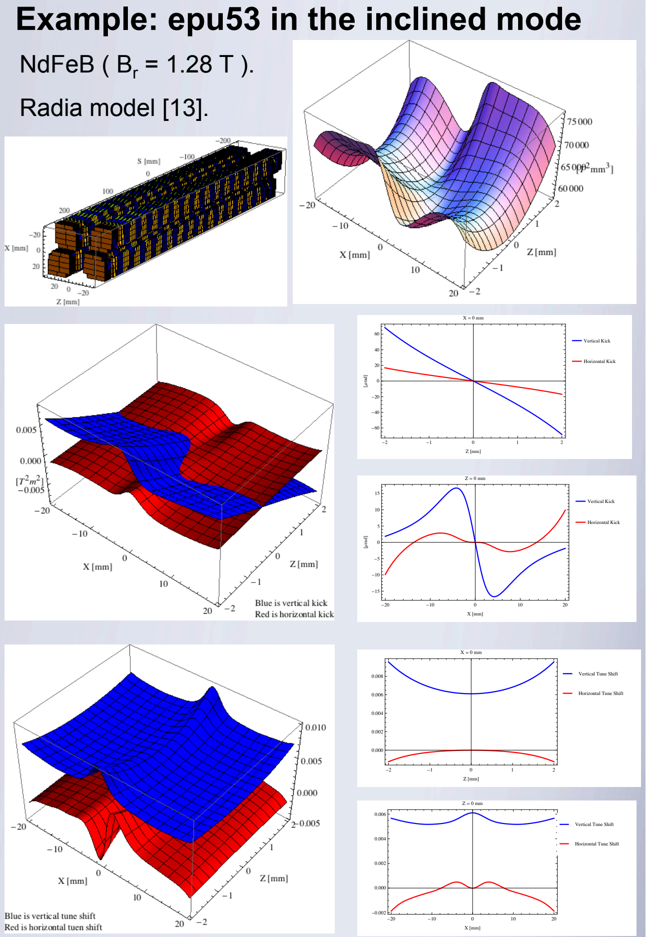
Results from tracking calculations with TRACY [11]



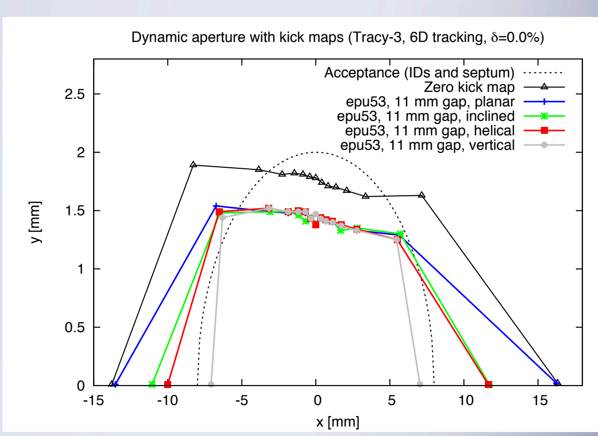
Example: epu53 in the inclined mode

NdFeB (B_r = 1.28 T).

Radia model [13].



Results from tracking calculations with TRACY [11]



Matching of the lattice optics to IDs

The nonlinear optics of the multibend achromat design make use of many sextupoles and octupoles within each achromat make it possible to minimize the resonance driving terms and shape the chromatic and amplitude-dependent tune shifts within each achromat [8, 9, 10]. Therefore, if the linear optics can be matched sufficiently well to an ID, the ID becomes transparent to the nonlinear optics. The linear optics are matched to the ID in a two-stage process:

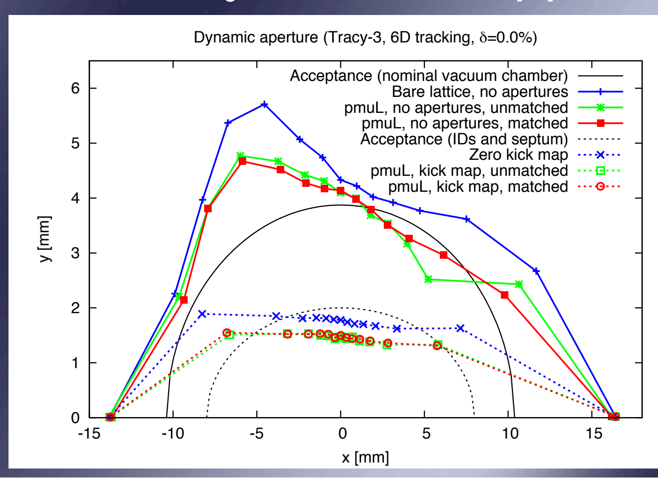
A first local step: the beta functions of the achromats adjacent to the ID are matched to the ID. This is achieved by tuning the final focusing quadrupole doublets in the matching cells adjacent to the ID so that the beam is over-focused in the ID. In this way, ID focusing is compensated without increasing the beam size in the ID [2]. This is a rather fine gradient adjustment (< 1.3%).

A second global step: a global matching is carried out where all other final focusing quadruple doublets around the ring are adjusted to restore the design working point. This gradient adjustment is again rather fine (< 0.07%).

The first matching step can be implemented as a feed-forward table depending on the ID gap and phase setting. The second step can be implemented either as a feed-forward table depending on all gap settings or in a feedback scheme.

Example: uncompensated focusing from pmuL

Results from tracking calculations with TRACY [11]



References

[1] M. Eriksson et al., this conference, TUOBS4.

[2] "MAX IV Detailed Design Report", http://www.maxlab.lu.se/maxlab/max4/DDR public

[3] P. Elleaume, Proceedings of the EPAC 1992, Berlin, Germany, pp 661-663.

[4] J. Chavanne et al., Proceedings of the EPAC 2000, Vienna, Austria, pp 2346-2348.

[5] J. Bahrdt et al., Proceedings of SRI06., Daegu, Korea, 2006.

[6] J.Bahrdtetal.,Proceedingsof EPAC08,Genoa,Italy.

[7] J. Bahrdt et al., Proceedings of PAC09, Vancouver, BC, Canada.

[8] S.C. Leemann et al., Phys. Rev. ST Accel. Beams, 12, 120701 (2009).

[9] S.C. Leemann, A. Streun, Phys. Rev. ST Accel. Beams, 14, 030701 (2011).

[10] S.C. Leemann, (20110117), http://www.maxlab.lu.se/maxlab/max4/max_reports_public

[11] J. Bengtsson,"Tracy-2 User'sManual", unpublished.

[12] OPA, lattice design code, available at http://people web.psi.ch/streun/opa

[13] P. Elleaume O. Chubar and J. Chavanne, Journal of Syn- chrotron Radiation, 5:481, 1998.

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