Storage Ring Development and Implications for Future Insertion Devices

Simon C. Leemann
DanMAX Meeting, April 22, 2015

Storage Rings: Outlook 2020 and Beyond

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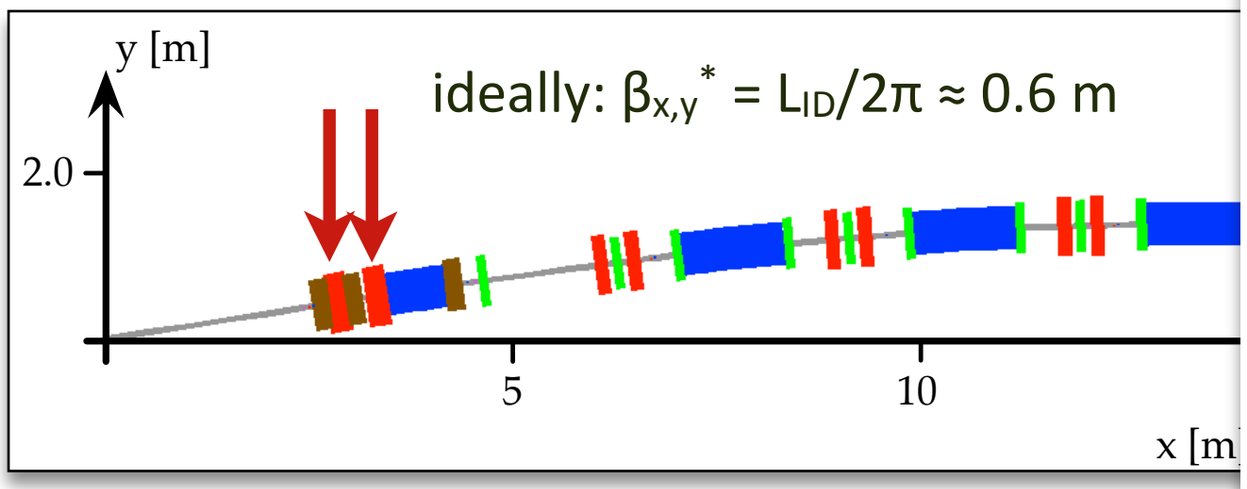
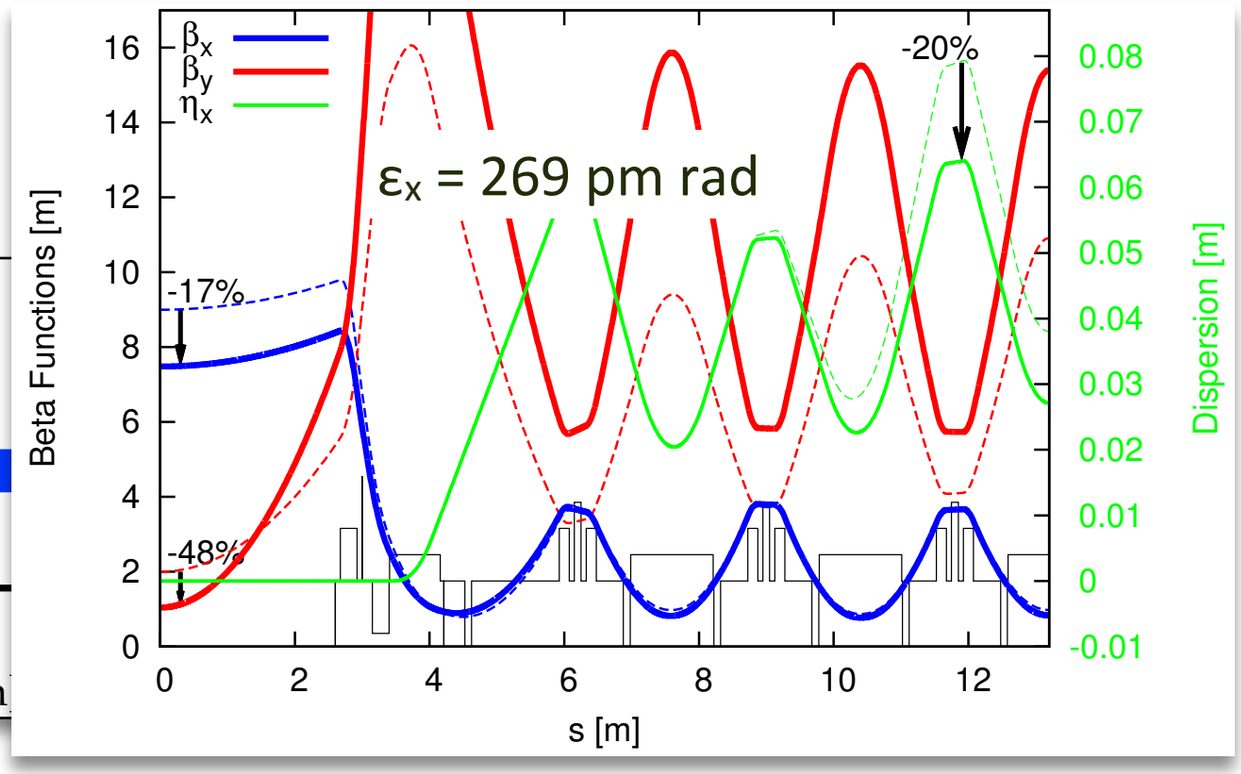
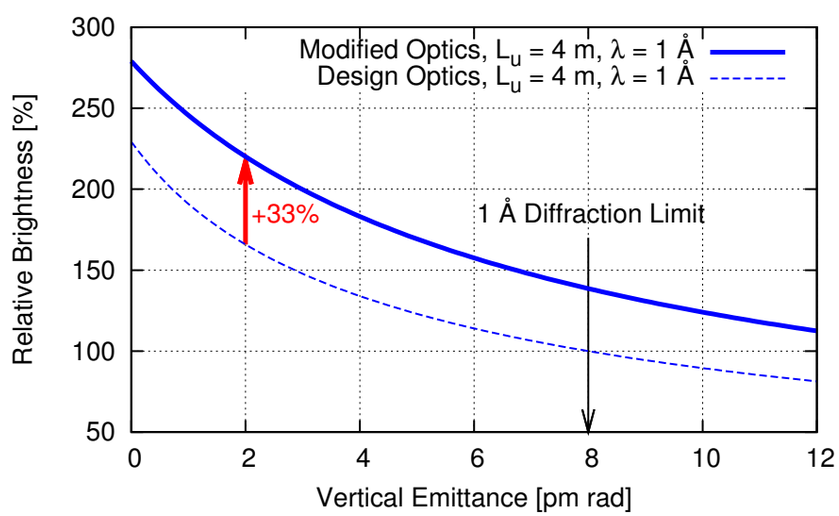




- ε_x = 328 → 269 pm, ε_y = 8 → 2 pm rad, and better $\beta_{x,y}$ match to ID → +120% brightness compared to original design
- As we add IDs → $\varepsilon_x \approx$ 200 pm rad



PAC'**13**, MOPHO05, p.243

IPAC'**14**, TUPRI026, p.1615

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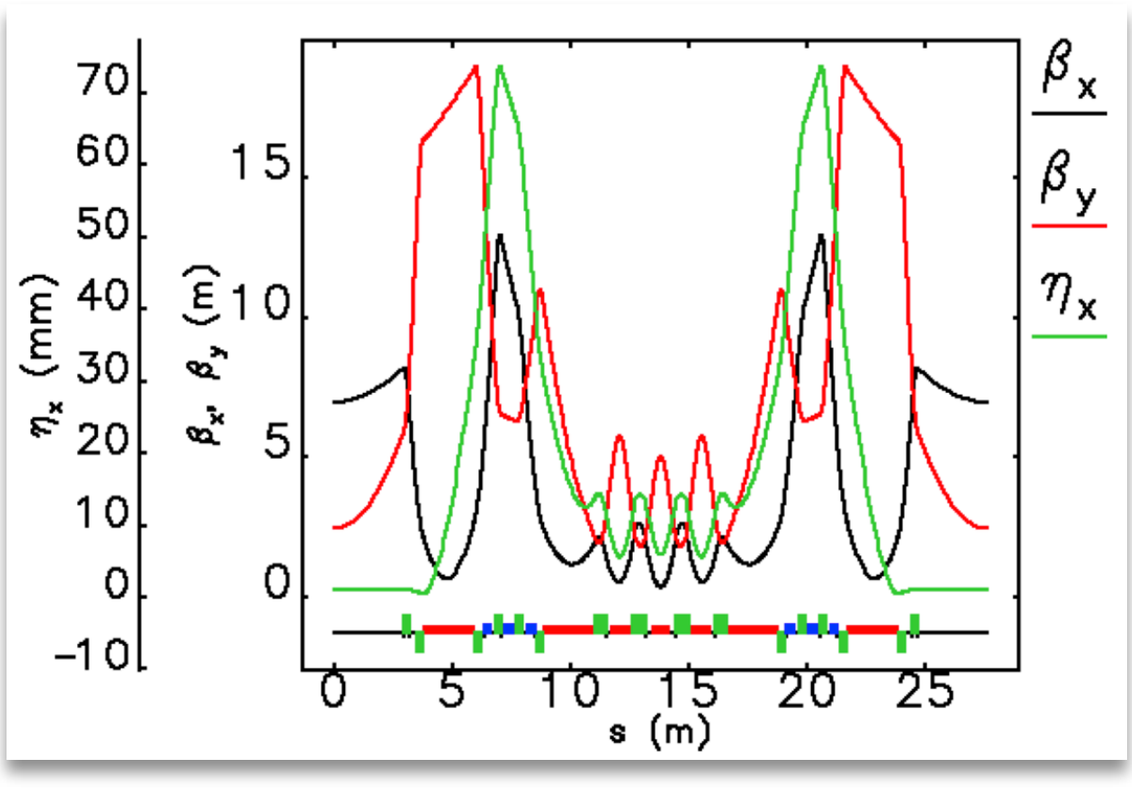
APS-MBA:
ε_x = 67 pm rad @ 6 GeV



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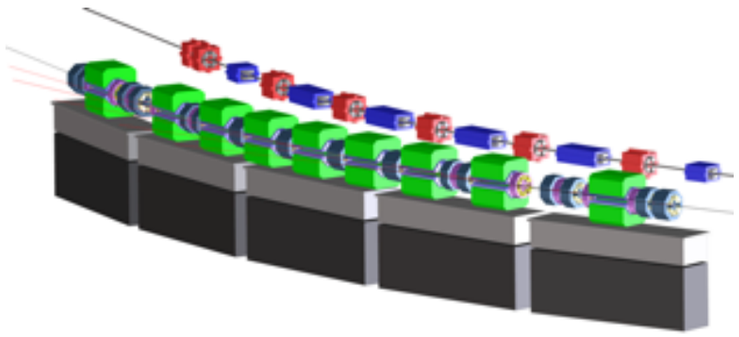
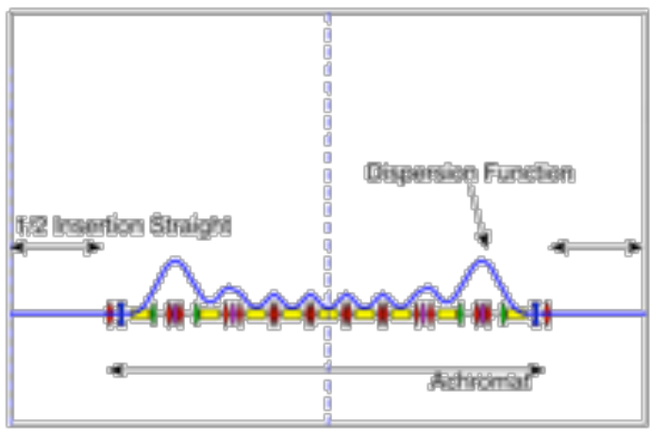
ALS-U:
ε_x = 52 pm rad @ 2 GeV





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- Lattices based on MBAs and designed for high stored current (held constant by top-up)
- Expect also transition to round beams (equal betas, high coupling)
- Reduced DA, (quasi-)on-axis injection

Electron Beam Properties in IDs

- Round beams → matched beta functions ($L/2\pi \lesssim 1$ m) and coupling increase ($\gg$0.1% common today)
- Vertical acceptance unlikely to reduce much farther than ~4 mm (especially for long devices)
- But horizontal acceptance could be shrunk significantly (roll-off unlikely to be very critical considering push towards very small DA)

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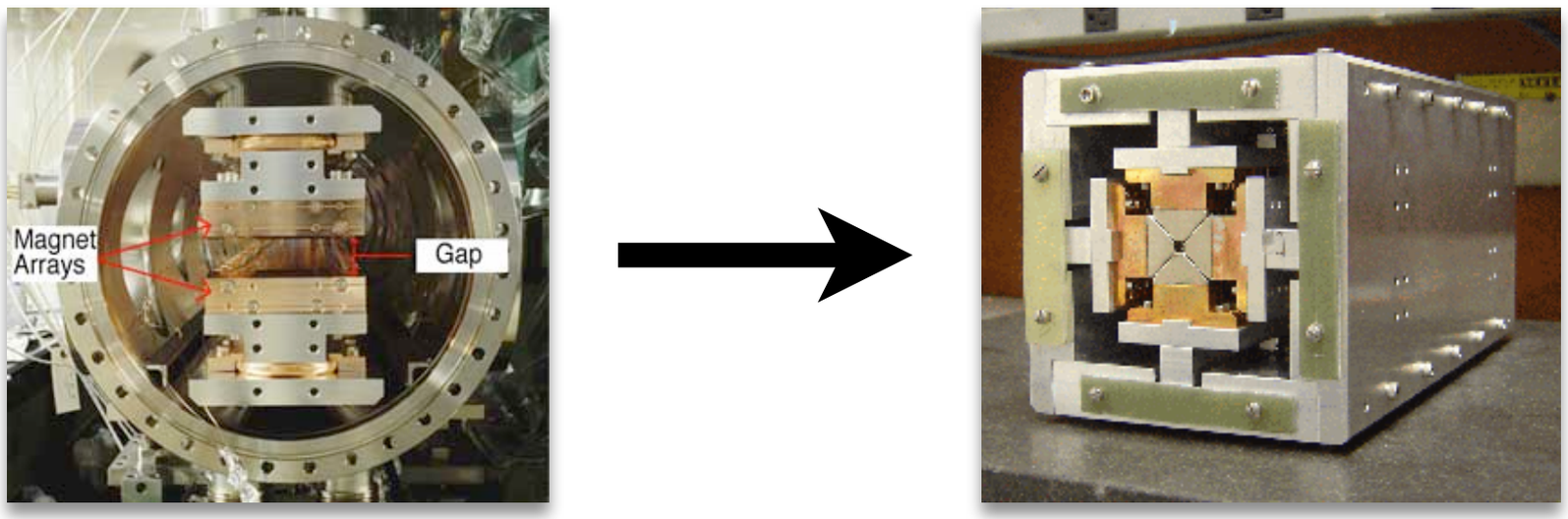
➡Vertically polarizing planar devices or helical devices



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- Considering limited apertures and large coupling, will dedicated collimation of halo particles be required?

Compensation for ID Effects

- DA might be very small, so need to worry about lifetime
- Source size/divergence small ➔ very tight tolerances

➡Good compensation absolute necessity, i.e. not just removing first and second-order field integrals, but also:

  - Local optics matching
    - can be done in lattice (e.g. MAX IV), but might have to be done at ID

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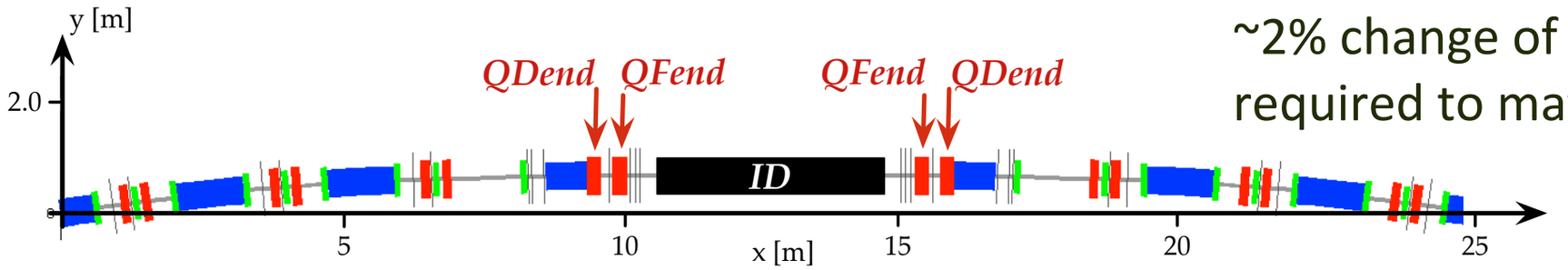

~2% change of quad gradient required to match optics to ID

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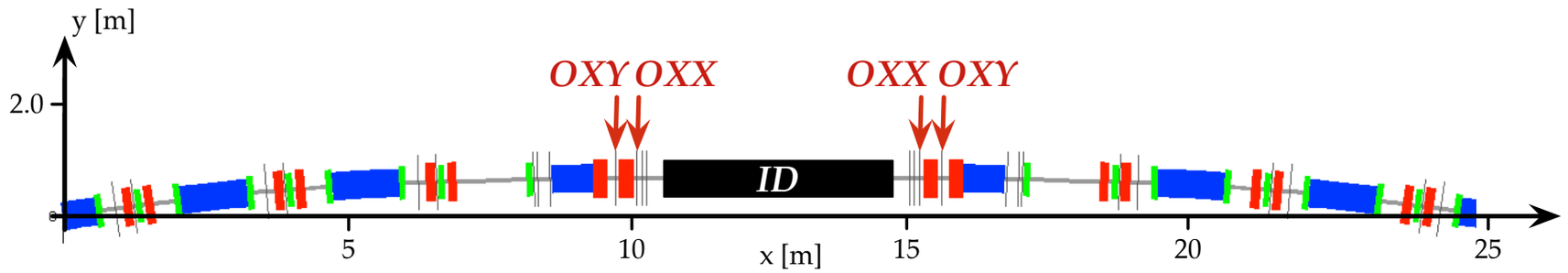

- -0.3 T/m skew quadrupole required to cancel 0.8% coupling
- ~15% change of octupole strength required to correct amplitude detuning (epu53, vertical mode)

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- And most likely local dynamic multipole corrections
  - can be implemented as current strips (~ 100 µm Kapton) on ID chamber (cf. BESSY-II)

Collective Effects

- Chamber dimensions could further reduce leading to even stronger RW contribution ($Z_\perp \sim 1/r^3$)
- Longer bunches to be expected (low RF & HHCs), but only within multibunch fill patterns
- Camshaft bunches or few-bunch mode can still have very high peak currents (low lifetime ➔ high losses)

➡necessitates careful taper design

➡beam dynamics input (collective effects) needs to be gathered early in engineering process, expect iterations between engineering and beam dynamics analysis