Storage Ring Development and Implications for Future Insertion Devices
Storage Rings: Outlook 2020 and Beyond

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Storage Rings: Outlook 2020 and Beyond (cont.)

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  – $\varepsilon_x = 328 \rightarrow 269$ pm, $\varepsilon_y = 8 \rightarrow 2$ pm rad, and better $\beta_{x,y}$ match to ID $\rightarrow +120\%$ brightness compared to original design

  – As we add IDs $\rightarrow \varepsilon_x \approx 200$ pm rad

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PAC'13, MOPHO05, p.243
IPAC'14, TUPRI026, p.1615
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APS-MBA:
\[ \varepsilon_x = 67 \text{ pm rad @ 6 GeV} \]
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ALS-U:
\[ \varepsilon_x = 52 \text{ pm rad @ 2 GeV} \]
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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 $\rightarrow$ matched beta functions ($L/2\pi \approx 1 \text{ m}$) and coupling increase ($\gg 0.1\%$ common today)

• Vertical acceptance unlikely to reduce much farther than $\sim 4 \text{ mm}$ (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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• 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
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$\sim$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