Summary Optics Design, Optics Measurement and correction

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• M. Sjoestroem – Beam Based Calibration of BPM offsets
  - static BBA using quads (individual powered, shunts, extra PS) hysteresis effects important, tune control during measurement
  - K-Modulation harmonic variation of quadrupole fields (LEP, TRISTAN, ALBA (modulate corr))
• At MAXIV quads within sextupoles
  problem of reproduction of quad centers for
different excitation of sextupole
→ solution calibration at zero current
reproducibility within a few micron some outliers
thermal effects are affecting BBA constants
Message: Do not forget iron saturation if you
windings on higher order multipoles!
I. Martin – Optics Measurement Using Fast Orbit Feedback Data

- Streamlined LOCO procedure
- Slow: standard procedure takes ~20 minutes
- Fast: orbit data are extracted from 1kHz data stream (8Hz modulation is well suited depends on various factors: eddy currents, magnets, PS) takes ~1 minute

good agreement for slow and fast measurement
- Python Interface for stable operation!
- NSLS-II algorithm cross check TBT, DC/AC RM measurement + LOCO
  → LOCO more precise (multi freq excitation as well)
  → TBT faster
slow orbit feedback running to keep orbit stable
- ALBA could do Off-Energy RM measurements
- ALBA nonlinear RM measurements modulating sextupoles

- ESRF ID compensation with AC RM measurement
Diamond-II Design GOALs

Design goals for Diamond-II storage ring:

1) Improve quality of photon beams delivered to users:

   • Increase spectral brightness (electron beam emittance, beam energy)
   • Increase transverse coherence (electron beam matched to photons)
   • Reduced source size, line-width (emittance, energy spread)
   • Optimise spectral range (beam energy, ID parameters)

2) Increase number of straight sections:

   • Convert bending magnet beamlines (ID / wiggler / bespoke 3-pole wiggler)
   • Relocate existing IDs (I04.1 and I20-EDE)
   • Space for new beamlines (up to six)
   • Space for ancillary components (RF cavities, diagnostics equipment, ...)

Diamond-II storage ring tuning (H. Ghasem)
Use the ESRF cell (7BA with longitudinal gradient dipoles) – removing the mid dipole to make it a 6BA with a straight at the center.

**Modified-Hybrid 6 Bend Achromat (M-H6BA)**

**Diamond-II Lattice**

**DA after chromaticity correction**

**DA with:**
- multipole errors + simplified errors using Gaussian distr.
Parameter | Value
---|---
Girder misal. / roll [μm /μrad] | 150/150
Dipole misal. / roll within girder [μm /μrad] | 50/100
Quad., Sext., Oct. misal. / roll within girder [μm /μrad] | 25/100
BPM misal. / roll within girder [μm /μrad] | 100/100
BPM misal. / roll within girder at BBA level [μm /μrad] | 5/5
Dipole/Quad./Sext./Oct. fractional strength error | 1E-3

- **252 HV correctors**
  - 192 of HV CORs are as additional winding in the sextupoles.
  - 60 of HV CORs are as 80 mm separate magnets

- **252 BPMs**

- **144 Skew quadrupole as additional windings inside the sextupoles**
  - 96 @ dispersive places and 48 @ non dispersive places

- Commissioning simulation has been done and the results revealed that, the correction algorithm can correct the errors for 94% of the all machine ensembles.
Low and Negative Alpha Commissioning at KARA Storage Ring (A. Mochihashi)
Possibilities for Modified Alpha in KARA

• Negative Alpha
  • Experiments for Collective Phenomena
    • Head-tail instability in negative-\(\alpha\) and negative-chromaticity
    • Potential-well distortion
    • Microbunching instability
    • THz CSR (in low negative \(\alpha\))

• Single Particle Beam Dynamics
  • Expansion of dynamic aperture in negative chromaticity
  • Emittance modification
  • Negative alpha @ various beam energy with ramping-up

• Low Alpha
  • Single Particle Beam Dynamics
    • Top-up injection at low-\(\alpha\)
    • Low-\(\alpha\) @ various beam energy with ramping-up

Etc...
Considering top-up operation, it is not straightforward to achieve enough (tolerable) injection efficiency (injection rate) in low and negative momentum compaction mode.

- **Analysis of Beam Loss Position & Beam Loss Rate for**
  - **Normal Positive Alpha Mode**
    
    Maximum injection rate of 85% could be expected in this simulation at (normal, positive) alpha lattice.

![Graph showing beam loss rate vs. bump amplitude at septum exit.](image)
Maximum injection rate of 30% could be expected in this simulation at (normal, negative) alpha lattice.

How to increase the injection rate?

...Try to adjust exit angle at septum
Normal **Negative** Alpha Mode **with Septum Adjust**

Maximum injection rate of 70% could be expected in this simulation at (normal, negative) alpha with septum adjustment.

Possible Beam Loss Position
- Injection Septum
- SC-ID (CLIC)
Beam Commissioning at KARA in Negative Alpha

- **Strategy**
  - **Basis:** „We can not cross the transition instability by keeping the beam.“

- We have settled normal positive alpha as a starting point.
- By changing the quads, we have gradually change the lattice to low positive alpha by keeping the beam injection.

- After we have arrived at low positive alpha, we tried to go across a=0 by changing both the quads and the RF phase (180deg).
- When we couldn’t have stored beam, we went back again to the low positive alpha and tried again.
- We have also adjusted 3-kickers, septum and beam transport line between the booster and storage ring.

- We have tried to change BM in the storage ring.

![First Stored Beam at Negative Alpha at KARA](image)

- 2019/09/06 beam time
- RF phase: 180deg changed
- Kickers & septum changed
- Sextupoles: positive chromaticity
- Stored current ~several 10 mA
- Characterization of the beam parameters has not yet been done.