Proposal to use electromagnetic correction coils for RT trajectory correction

Proposal to use electromagnetic correction coils for RT trajectory correction

Background (1/2)

- 4000 MB quads,
  need about 80 correctors close to quads for
  beam-based feedback (BBF);
- Pre-choice of 80 locations impossible?
  → equip all 4000 quads with correctors
- Frequency range covered by BBF: sub-Hz to ~1 Hz
- In order to
  - have some feedback gain at f_cl =1 Hz (f_cl = f_s/gain)
  - to average over several BPM readings
  the BBF will run at a sampling frequency f_s=50 Hz;

  i.e. the corrections are applied every pulse:
  requested settling time of corrections is 5 ms
  (in-between 2 beam pulses)

Background (2/2)

- Technical implementation in 2008:
  - additional windings onto quad jokes in order to produce "a sort of dipole correction field"
- Pre-Choice of non-laminated MB quads for stabilization and mechanical engineering (late 2008)
  excludes correction coil (bandwidth problem)

- Present design approach: Extend dynamic range of stabilization actuators by 100 ! and make BBF corrections by displacing the MB quads.
  Fullscale = +- 5 um compared to +- 50nm

Problems with present implementation

- Actuator dynamics, in particular for the (long) heavy magnets
- Absolute position of quad in beam reference frame not know (Hexapod design with sub-nm position readout in each leg)
- BPMs (50 nm required resolution) will move with quad. Needs sophisticated bookkeeping of past displacements. BPM close to “zero” and for longer elongations non-linear (monopole and quadrupole mode signals)
- Machine protection: non-energized position of quad (vertical) is max.down, not middle; might need interlocks.

Implementation

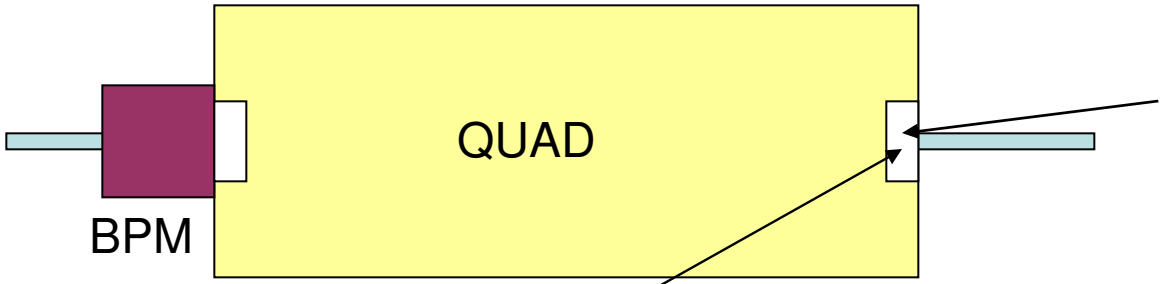
- Required corrector strength (Bdl):
  200 T/m *10 um * 2m (@ 1.5 TeV)

  = 4 mT * m = 0,4 T * 1 cm -→ very week magnet
  assumed strength: scales with length of Q →
  →corrector@ Q1: 0,1 mTm

- 1 cm long 0.1 - 0.4 T magnets
- - end-field problems?
  - interference with quad field?
  - will create synchrotron radiation?
  (200 times higher bending radius)

First sketch

(after discussion with Michele Modena and Alexey Vorozhtsov)



The present space reservation in the module integration includes the space for the coils. Close to the beampipe there is 2-3 cm free space

Small window frame magnet or a variant with magnetic shielding towards the quad can go into that free space.

Alexey will make a first design …

Conclusions

- The presently proposed solution for high excursion piezo actuators for BBF and Stabilization will possibly work, but it has several known (and unknown) complications.
- A simple proposal of small electromagnets for the BBF will decouple BBF and stabilization.
- The stabilization equipment can then be optimized for its original task.
- Having positive answers to the questions of:
  - extra synchrotron light at high energies? (when)
  - a preliminary magnet design (1 month)

  this option should become our CDR baseline.