Fast Luminosity Feedback

Super-B

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Problem

• Beam size at IP is very small
  – About 10 um (x), 0.04 um (y), 200 um (z for crab waist)

• Beams will move
  – Slow (mechanical)
    • Ground motion
    • Diurnal temperature variation
  – Fast
    • Power supply noise at 50, 150, 300, 600 Hz
Dither Coils

- Dither LER at IP in x, y, y’
  - Nominally a few % modulation of lumi
- Frequency: 1-3 kHz
  - Above power supply freqs
  - Below synchrotron and betatron freqs
- 4 coil sets needed (each set has an x and y coil)
  - One near IP on each side
    - Want large $\sqrt{\beta \sin \psi}$
    - About 3.5 m from IP: just outside detector solenoid
  - Another further from IP on each side
    - Want large $\sqrt{\beta \cos \psi}$
    - Between QD2 and SDM2, between B10 and B1
Coil Locations

\[ \frac{\delta E}{p_0c} = 0. \]

Table name = TWISS
### Required Dither Amplitudes

<table>
<thead>
<tr>
<th></th>
<th>Preferred Location</th>
<th>Alternate Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>X (1 um)</td>
<td>(3.5, 3.7)</td>
<td>(-2.3, 10)</td>
</tr>
<tr>
<td>Y (0.004 um)</td>
<td>(0.18, -0.03)</td>
<td>(0.23, -0.08)</td>
</tr>
<tr>
<td>Y' (100 urad)</td>
<td>(-1, -30)</td>
<td>(43, -76)</td>
</tr>
<tr>
<td>Total field (x)</td>
<td>(3.5, 4)</td>
<td>(2.5, 10)</td>
</tr>
<tr>
<td>Total field (y)</td>
<td>(1, 30)</td>
<td>(43, 76)</td>
</tr>
</tbody>
</table>

- Table entries are (Coil1, Coil2) excitations in G-cm
  - 4 GeV beam: 13 G-cm gives 1 urad deflection
  - Table assumes 10% shift of beam position--more than enough
- Alternate location puts coil 2 between B0 (soft bend) and B10
- Note high y sensitivity!
  - Even more sensitive at ends of -I insertion (because beta y large)
  - Has implications for QD, QF, S power supplies here
- Expect coupling between x and y; true excitations will be mixed
Beam Pipe

- Ceramic with ~1-2 um Cu coating
  - Skin Depth ~2 um at 1 GHz
- HOM considerations
  - Want multiple skin depths at ~8 GHz (for ~6 mm bunch)
- Dither frequency considerations
  - 1 um Cu induces ~0.2 degrees phase shift at 1 kHz
- Image current considerations
  - Resistance ~0.1 ohm/m (1 um Cu; 5 cm dia pipe)
  - Dissipates ~0.4 W/m at 2 A beam current
Coils

• Propose coil similar to CRT deflection coils
  – “Saddle” coils with \(\cos(\theta)\) current distribution, ferrite shield
  – Much more efficient than PEP-II Helmholz coils

• Estimated parameters
  – 10 cm long
  – 1 ohm, 2 mH
  – 200 mA for “nominal” excitation, 2A allowed
  – ~$1k per coil set from commercial vendors
System Issues

• Luminosity Monitor
  – Statistical noise depends on lumi signal
  – Feedback system must change with lumi; reduced bandwidth at low lumi

• Corrections
  – LF (< ~1 Hz) through normal dipole correctors
  – HF (> ~1 Hz) through dither coil system
    • Can correct at 10-20% of dither freq at high lumi
References
