Orbit at Q3 from MCSX modulation

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IR nonlinear correctors mounted on outside of Q3 triplets

Can infer horizontal orbit at NL-corrector from modulation of MCSX & feed-down to tune

\[ \Delta Q_{x,y} = \pm \frac{1}{4\pi} K_3 L_{MCSX} \beta_{x,y} \Delta x \]

→ \( \Delta x \) is offset of beam from center of sextupole magnet
Measured IP5 feed-down in 2016 MD
(MCSX polarity check with crossing scheme applied)

- Compare measured & expected tune shifts for applied \( \Delta K_3 = 0.003 \text{ m}^{-3} \)

- Issues with noise lines for \( \Delta Q_x \) measurements
  \( \rightarrow Q_{x,y} \) FD treated independently

- Consider only tune shifts where feed-down pushes tunes apart to limit influence of linear coupling
<table>
<thead>
<tr>
<th>Beam/Side</th>
<th>$\Delta K_3 \text{[m}^{-3}\text{]}$</th>
<th>$\Delta Q_{x,\text{meas}}$</th>
<th>$\Delta Q_{y,\text{meas}}$</th>
<th>$\Delta Q_{x,\text{model}}$</th>
<th>$\Delta Q_{y,\text{model}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHCB1 L</td>
<td>+0.003</td>
<td>−0.0020</td>
<td>+0.0045</td>
<td>−0.0021</td>
<td>+0.0043</td>
</tr>
<tr>
<td>LHCB2 L</td>
<td>+0.003</td>
<td>−0.0043</td>
<td>+0.0025</td>
<td>−0.0059</td>
<td>+0.0030</td>
</tr>
<tr>
<td>LHCB1 R</td>
<td>−0.003</td>
<td>−0.0085</td>
<td>+0.0045</td>
<td>−0.0060</td>
<td>+0.0030</td>
</tr>
<tr>
<td>LHCB2 R</td>
<td>−0.003</td>
<td>−0.0015</td>
<td>+0.0030</td>
<td>−0.0021</td>
<td>+0.0042</td>
</tr>
</tbody>
</table>

- Several measured tune shifts differ significantly from nominal model
  → may indicated orbit deviation, corrector misalignment wrt Q3, optics error, or combination

- More significant on right side of IR
Inferred orbit in MCSX

- Dipole
- Quad
- MCB
- BPM

Model orbit LHCB1
Model orbit LHCB2
Orbit via FD ($Q_x$)
Orbit via FD ($Q_y$)
LHCB1 BPM orbit
LHCB2 BPM orbit

$s \text{ w.r.t IP5} [\text{m}]$

$x [\text{mm}]$
Considering separation of B1/2 in MCSX (can’t come from alignment):

- Smaller separation than nominal model on left side
- Larger separation than nominal model on right side

Need to consider uncertainties in more detail, e.g:

- MCSX feed-down can change the optics (a few percent)
- Effect of coupling modulation from feed-down via separation bump

All this is preliminary