FCCee Injection Meeting #14
Injection Straight Errors and Misalignments

Nov. 29th, 2022 – P. Hunchak
We moved the septum away from the $15\sigma$ limit set by the collimators to protect the septum (Currently using $2\sigma$). This safety gap requires the injected beam to start further out and requires a stronger kick to store it.

With the safety margin added in the kick affects the stored beam more drastically, and because of the 90 degree phase advance from the MKIC to the Septum we risk scraping some of the stored beam on the Septum.
When the kick is set to store the injected beam (top row) the injected beam is spread beyond $17\sigma$ and 2.38% of the 10000 particle stored beam is lost.

Reducing the kick strength so the stored beam avoids the septum (bottom), the injected beam can still be stored but is placed closer to the $15\sigma$ limit set by collimators

- Question of how much the low-field region can be broadened?
- Trade off of moving the septum further out with the greater kick required.
Phase and Beta Function Errors

Errors in injection straight optics to be studied methodically. Drastic examples of errors (Top: $\beta$-beating of 50% at MKI, Bottom: Phase Error of $10^\circ$ between Septum and MKI) show general idea of effects. Both affect the compensation of MKIC/MKI. Injected beam interacts with different regions of MKI field as well and is less reliably stored.

- Tolerances for these errors to be determined
- Numbers on what stored beam disturbance is acceptable?
Kicker Misalignments

- Effect of MKI and MKIC misalignments studied with python implementation of MKI field
- Horizontal offset prevents cancellation of MKI effect on stored beam and results in emittance growth.
- Maximized when kickers have a same sign misalignment.
- When both shift by 200um, emittance increased to 1.75x nominal
Outlook

• Studying misalignments, β-beating, and phase advance errors in the injection straight.
• Working to determine tolerances
• Question of how much the MKI field can be adjusted to broaden the low-field region, trade off of having to store the injected beam further off-axis.
• These tools can be applied to each operation mode and should be applicable for a 4-IP injection straight as well.
Thank you for your attention.
Rotation matrix used to advance beam distributions from MKIC->Septum->MKI

\[ M = \tilde{P}(s_2) R(\Delta \mu) \tilde{P}(s_1)^{-1} = \]

\[ = \begin{pmatrix}
\sqrt{\frac{\beta_2}{\beta_1}} (\cos \Delta \mu + \alpha_1 \sin \Delta \mu) & \sqrt{\beta_1 \beta_2} \sin \Delta \mu \\
\frac{\alpha_1 - \alpha_2}{\sqrt{\beta_1 \beta_2}} \cos \Delta \mu - \frac{1 + \alpha_1 \alpha_2}{\sqrt{\beta_1 \beta_2}} \sin \Delta \mu & \frac{\beta_1}{\beta_2} (\cos \Delta \mu - \alpha_2 \sin \Delta \mu)
\end{pmatrix}. \]