SPS Transverse Impedance Localization

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Intensity Dependent Optics

Based on EPAC04 Paper: G. Arduini, F. Zimmermann, C.Carli

\[ K_{eff} = \frac{eN_b}{2\sqrt{\pi}\sigma_z(E_b/e)} \text{Im}\{Z_{\perp,eff}\} \]

To 1st order, \( \Delta K \) perturbation with intensity causes:

\[ \Delta Q = \frac{1}{4\pi\beta_k} \Delta K \]

\[ \frac{\Delta \beta(s)}{\beta(s)} = \frac{\beta_k \cos (2|\phi(s) - \phi_k| - 2\pi Q)}{2 \sin (2\pi Q)} \Delta K \]

Procedure:

- Measure phase advance between BPM pairs for varying intensities
- Linear fit: \( \phi_I = \phi_0 + (\Delta \phi / \Delta N) N_b \)
- \( \Delta K = R^{-1}\{\Delta \phi / \Delta N_b, Q_x, Q_y\} \), where R is model response matrix
Tune Vs. Intensity (Nov 2, 2007)

QMeter BPM Tunes
(Single Precision BPM)

Form: $-0.017x + 0.2$

SPS BPM Tunes
(Avg, Std from $\approx 100$ BPMs)

Form: $-0.019x + 0.2$
Data Selection

- Histogram of tunes from all BPMs (~100), all files (~410)
- Tune window & ph. adv of the (meas-model) used as selection criteria
Sample Fits (Nov 2 Data)

- Only fit BPMs passing selection criteria (lot of statistics)
- Spread is ph. adv is large (BPM gains ?)
SPS Zero Current Ph. Adv

26 GeV (Fitted Zero Current Ph. Adv)

July 27, 2008 (22 Point Fit)

Nov 2, 2008 (50-400 Point Fit)
Fitted Slope $\Delta \phi / \Delta N$

Similar slopes for 2 exps: Nov 2 (400 data sets) & July 27 (22 data sets)

Relative error appears similar, not too much gain from statistics
- Error in phase adv $< 1\text{deg}$ (a bit high)
- Error in slope is 1 order of magnitude smaller than slope
Matched Model to Slope $\Delta \phi / \Delta N$

Constraint: $\Delta K < 0$  SVD (6 Iter) $\rightarrow$ Simplex (18 Quads) $\rightarrow$ SVD (6 Iter)
Sources near 2.5 km & 5.5 km ?
(Also seen by FZ/GA in 2004)

Most sources similar for July 27 & Nov 2, some missing near 3-5 km
Estimated Impedance Distribution

- Main difference (±) constraints: 4-5 km, else remarkably similar
- No constraint yield big spike at 1.8 km & similar behavior with constraints