Dispersion Calculation Using MP02 Data

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1. Field-Free Region (circulating beam):

- Lackey/Brown's MP02 data:

$$q = B'L/B\rho = k_1 L = 0.008 \text{ m}^{-1} \qquad \text{(V)}$$

- The maximum dispersion wave at Short 2:

$$\Delta D(y)/D(y) = -q \times \{\beta_1(y) \times \beta_2(y)\}^{1/2}$$

$$\beta_1(y) = 20 \text{ m}, \beta_2(y) = 5 \text{ m}$$
$$\rightarrow \quad \Delta D(y)/D(y) = 8\%$$

- This is a rather small effect and can be neglected. (Recall that the design value of D(y) is zero.) Ray's measurement of the vertical dispersion in the Booster during septum firing supports this conclusion.

2. Field Region (extracted beam):

- Δf *vs.* $\Delta p/p$: (scaling of the dispersion measurement)

$$\eta = -(\Delta f/f) / (\Delta p/p)$$

@ 8 GeV:

$$\eta = 0.0227$$
$$f = 52.81 \text{ MHz}$$
$$\Delta f = +1 \text{ kHz} \rightarrow \Delta p/p = -0.08\%$$

- Lackey/Brown's MP02 data:
  - Old septum:

$$q = B'L/B\rho = k_1 L = -0.00909 \text{ m}^{-1} \quad \text{(V)}$$

➢ New septum:

$q = B'L/B\rho = k_1 L = 0.00654\ m^{-1}$ (V)

➢ Difference:

$\Delta q = 0.01563\ m^{-1}$

- Maximum dispersion change downstream in the MI-8 line:

  $\beta_1(y) = 20$ m, $\beta_2(y) = 50$ m

  $\rightarrow$ $\Delta D(y)/D(y) = 50\%$

- The vertical dispersion at MP02 is small ($D(y) < 50$ mrad $\times$ 60 inch = 3 inch). So the maximum dispersion change is also small ($\Delta D(y) < 1.5$ inch ≈ 4 cm).

3. Comments and Questions:

- It is unlikely that MP02 is responsible for the vertical dispersion increase in the MI-8 line. Is there anything else in the MI-8 line that has been changed during the shutdown? (e.g., the setting of the 8 quadrupole knobs Q802-Q809 and of the two big B3 vertical bends)

- Why is the vertical dispersion at MP02 positive with the new septum? (It was negative, as it should be, before the shutdown.)