

Systematic Multipoles in the Quadrupoles and Their Effect on Dynamic Aperture and Δ -Spread

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and
Their Effect on Dynamic Aperture and A ν -spread

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Introduction — Systematic b_5

The ~~quadrupoles~~ systematic b_5 in the quadrupoles can also produce an appreciable ν spread in the beam.

The two systematic multipoles, b_5 and b_4 appear to be responsible for most of the ν spread. It may then be desirable to control these two multipoles to be below a certain tolerance level. A tolerance (or guideline) for b_5 is given below.

The effect of b_5 on the dynamic aperture is not large, and this effect appears to be less important than the ν -spread

V spread effect , b_5

Tolerances (guidelines)

at $\gamma = 30$, $\epsilon_t = 1.92$, $\Delta P/P = \pm 0.005$, b'_5 to
give $\Delta V_{\text{spread}} = 3 \times 10^{-3}$ with $\beta^* = 6$

$$b'_5 = 2.2$$

$$\text{for } G/B = 21.4$$

b'_5 is given relative to B_0 .

To get b'_5 ~~relative~~ to the Gradient, multiply by 2.

Note, random $b'_5 = 1.7$... rms

at $\gamma = 100$, $\epsilon_t = 1.16$, $\Delta P/P = \pm 0.002$, $\beta^* = 2$

$$b'_5 = 2.6$$

For $\gamma = 100$, about 50% of ΔV due to Q1 Q2 Q3.

$$\Delta V \text{ due to Q1 Q2 Q3} \simeq 1/\beta^{*3} \quad \text{for } b_5$$

Thus, systematic b_5 in Q1 Q2 Q3 may limit the lowest possible value of β^* .

ΔV spread, b_q

Tolerances (guidelines)

$$\frac{\gamma = 30}{\beta^* = 6}, \quad b_q' \text{ to give } \Delta V_{\text{spread}} = 3 \times 10^{-3}$$

$$b_q' = 10.4 \quad \text{for } G/B = 21.4$$

$$\frac{\gamma = 100}{\beta^* = 2}$$

$$b_q' \text{ to give } \Delta V_{\text{spread}} = 3 \times 10^{-3}$$

$$b_q' = 6.0$$

Note, random $b_q' = .3$

For $\gamma = 100$, about 70% of ΔV is due to $Q1, Q2, Q3$

$$\Delta V \text{ due to } Q1, Q2, Q3 \approx 1/\beta^{*5} \quad \text{for } b_q$$

Systematic b_q may become important for low values of β^* .

Dynamic Aperture Effect

$$\text{For } \beta^* = 6, \quad \Delta p/p = 0$$

$$A_{SL} = 14.5 \text{ mm},$$

$$b_5 = b_9 = 0$$

$$A_{SL} = 14.5 \text{ mm}$$

$$b'_5 = -3, \quad b'_9 = 1$$

$$\beta^* = 2, \quad \Delta p/p = 0$$

$$A_{SL} = 7.5 \text{ mm}$$

$$b_5 = b_9 = 0$$

$$A_{SL} = 6.5 \text{ mm}$$

$$b'_5 = 5, \quad b'_9 = 1$$

$$A_{SL} = 6.5 \text{ mm}$$

$$b'_5 = 12, \quad b'_9 = 1$$