

BNL-101707-2014-TECH RHIC/AP/51;BNL-101707-2013-IR

Effects of Random Quadrupole Field Errors and Their Correction

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September 1987

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U.S. Department of Energy

USDOE Office of Science (SC)

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September 8, 1987

Effects of Random Quadrupole Errors

Small magnet aperture generates large Vandom a, b, which cause the following effects: Randomb, causes Vandom DBx/Bx DBx/By and random DXp, horizontal dispersion Random Q, causes coupling and random Dyp. These effects can cause loss of aperture and can worsen the beam-beam interaction. They may also reduce the dy namic operture, since the reach further out in the magnets.

Linear Effects of Random Q, b, 9,=16.8×10-5/cm, b,=8,4×10-5/cm (rms) projected by J.Hebrera Linear effects can be found from analytical results or by trading. The agreement is good. $\left(\Delta B \right) \sim 15.7$ P_max____ 15Xp (QE) max = , 34m, 207. of Xp ∆Yp (4p) max = ,48 m 309, of Xp At Crossing Point BXP, max = 1 m, 20% change in beamsize 1/2 Integer Stop band, OV = .023 half-width Coupling Stopband BUmm =,033 half-width The two stop-bands also give a measure of the size of the N-shifts.

Previous History

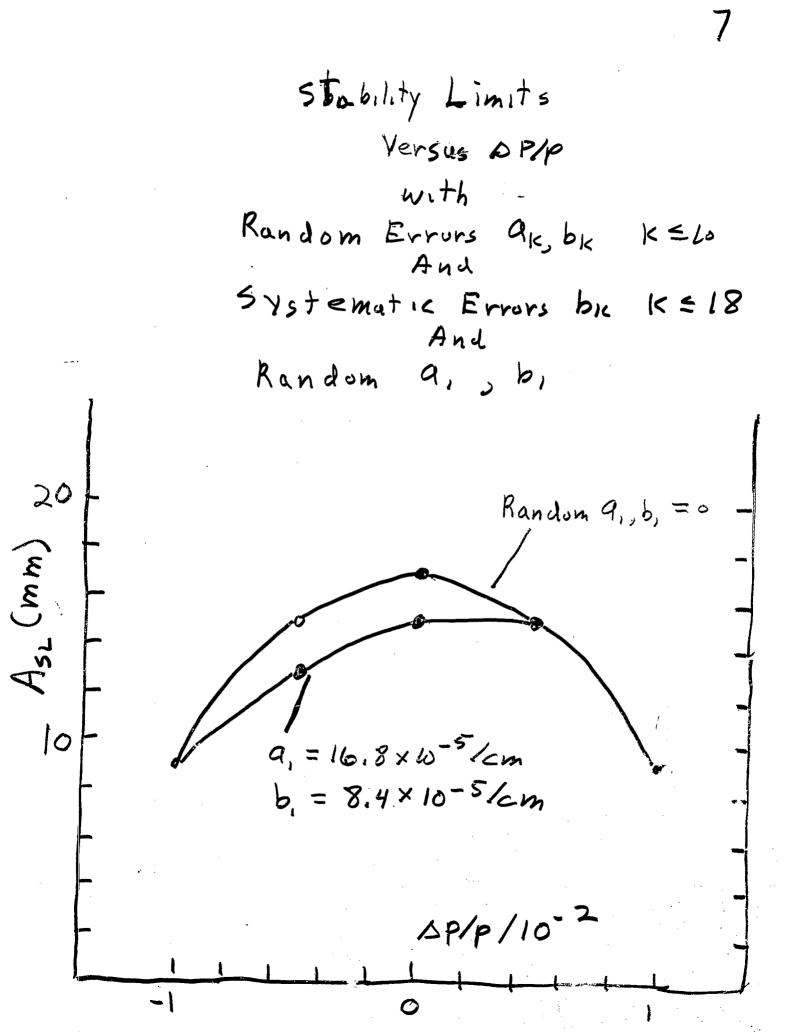
at one time, magnet shuffling was not considered feasibile, and tracking studies were not yet being done for RHIC. Because of the large linear effects, and fears of possible losses in aperture, a correction 54stem for the random a, bi was proposed the having 36 in dependent b, and q, power Sapplies

At some later time shuffling the magnets to reduce the linear effects of the random 91, b, was being taken more seriously. Also tracking studies seemed to inducate # little loss in aperture. The suggestion was made that we commit ouvselves to magnet shaffling and drop the proposed 9, b, Correction system.

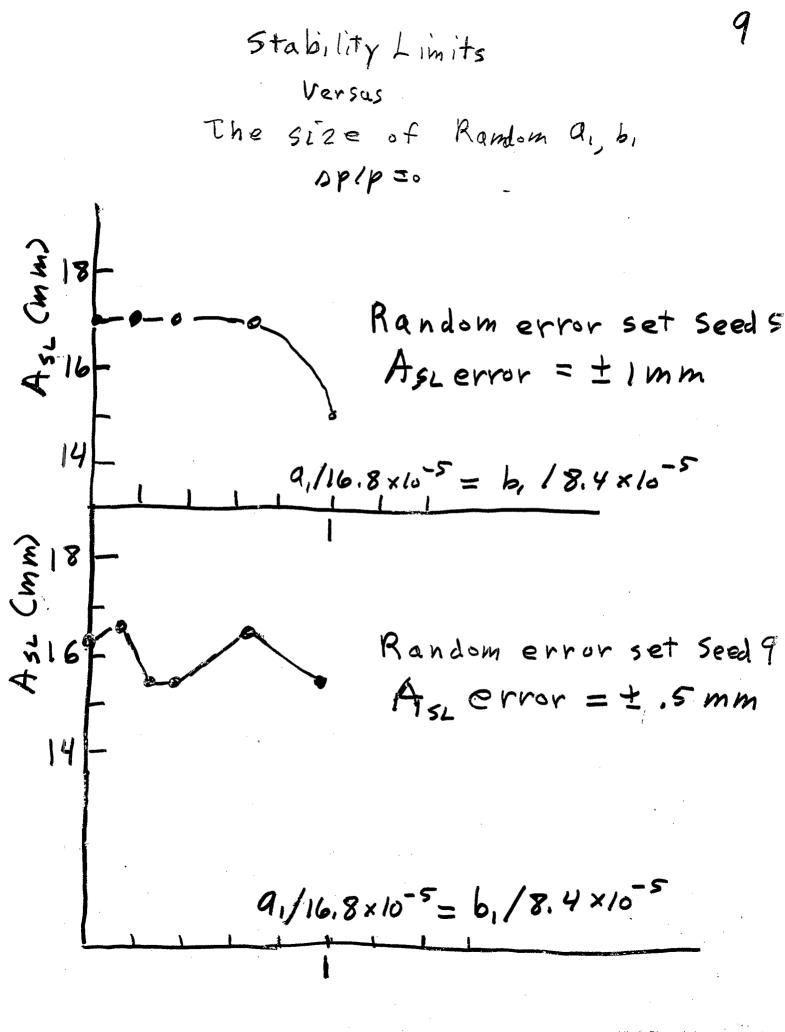
How ever, later tracking Studies that in cluder the higher systematic field errors like bio biz, biy bib bis ... in the dipoles, indicated a large loss in aperture, $A_{s} = 17 \text{mm} \rightarrow A_{sc} = 11 \text{mm}.$ - Also the tracking studies were not quite correct as the linear coupling was not corrected. The tracking studies have now been repeated including Correction of the linear Coupling, and a more recent estimate of the Systematic multipoles.

Results of Tracking Studies The Higher Systematic br, The The lower bk are made close to zero. The higher br, e.g. blo, b12, b14, b16, can be much larger than the corresponding random bx. The linear effects due to the random 9, 6, cause the particles to reach further out from the center of the magnet where the presence of the higher systematic bk thay cause a loss in dy namic aperture. Requirements for the Tracking study () The linear coupling introduced by the random a, has to be removed by exciting a skew quadrupole correction system. This also removes the splitting in the N- Values associated with linear Caupling.

2 The shift in the V-values Caused by the random b, has to be removed by exciting the quadrupoles of the V-value Correction system (3) The field multipoles have to include not only the random field errors but also the expected systematic field multipoles, particularly the higher systematic bu like bio, biz, biy, etc in the dipoles. the expected systematic Multipoles in the dipoles were provided by P. Thompson (RHIC-MD-56)



Effect of Shuffling the Magnets The linear effects of the random 9, 6, may be reduced by about a factor of 4 (Srohnuma, Tech. Note, RHIC-15) The effect of Shuffling on the dynamic aperture by simply reducing the size of the random a, b, there here shown on the next stide?)



Random Proposed, Q., b, Correction System Shuffling of the magnets $\widehat{\mathbf{D}}$ to reduce the linear effects by about a factor of 4 2 families of Skew guadrupoles into control the linear Coupling. These are located near Q2 Q3 3) Correctors for Controlling the beam-beam interaction at the crossing point. The insertion guadrupole trims can correct SBx/Bx, SBy/By and Xp at the crossing point. Provision for 9, Correctors at Xp to locations for controlling the vertical dispersion at the Crossing Points, These may not be available on the first day.