

BNL-101697-2014-TECH RHIC/AP/41;BNL-101697-2013-IR

The ?-dependence on Momentum and Betaton Amplitude in RHIC Due to Random Error Field Multipoles

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February 1986

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U.S. Department of Energy

USDOE Office of Science (SC)

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AD/RHIC-AP-41

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December 9, 1986

Introduction:

Studies of the dependence of the v-values on particle momentum $\Delta p/p$, and in the betatron amplitude, A show that the random error field multipoles can produce large changes in the v-values at the larger values of A and $\Delta p/p$, that may cause the particle to cross resonances of lower order than the tenth. According to the experience at the SPS, the crossing of such resonances may cause beam losses.

In the basic operating region for RHIC, $A \leq 18 \text{ mm} \cong \Delta p/p \leq .005$, some particles have v-shifts which move the particle out of the basic operating square, and the particle crosses resonances of lower order than the tenth. This appears to happen only for some particles with large betatron amplitudes, A, and the effect does not seem likely to affect the performance by much. The v-shifts in the operating region for colliding beams is primarily due to betatron amplitude, A.

At large $\Delta p/p$, $\Delta p/p \approx .01$, large v-shifts are observed, which are primarily due to $\Delta p/p$. This was observed by F. Dell. This occurs at larger $\Delta p/p$ which are outside the basic operating region for colliding beams. Also this effect is probably correctable with b₂, b₃, b₄ correction coils. v-shifts due to A are more difficult to correct, as this shift depends on the size of the horizontal and vertical betatron amplitudes, and is different in different directions in betatron amplitude space.

The studies reported on in this note were done for particles with equal initial horizontal and vertical emittances, ε_x and ε_y . More studies are needed for the case when $\varepsilon_x \neq \varepsilon_y$.

े अप (1) कि हैंद्र Allowed V-limits V=28,826, 28,821 in box, boundaries are 14 .80 . 333 (4/5 and 5/6 resomances) 6 Vx 18 1833 1. Generalized V-Values Fourier analyze Xend y Motion; find frequencies in each motion $\gamma \rightarrow \gamma$, γ_2 , γ_3 , γ_4 , γ_4 , γ_5 , γ_4 , γ_5 , γ_4 , γ_5 , γ_4 , γ_5 , γ_5 , γ_6 , $y \rightarrow \overline{V}, \overline{V}_2, \overline{V}_3, \overline{V}_{y}, \ldots$ Notions are coupled and r and y motions four same V, V2 V3,... Largest X component is V, largest Y component is V2. Vi, V2 are primary V- volue V3, Vy De are Secondary V- values.

Comments In operating Regim, AB = 17mm DPIP == 1005, primary V-values ene all in square. Secondary V-volues go our of square. Worst case (2 V(A, p) = 1852 DV(A, p)=,026 and is entirely due to amplitude A. in the granting region, V(A) dominates and V(p) is small. $V(4) \leq 0.24$)(p) < arlange prip, prip = t, of V(p) dominates. Worst cose is - V-CA, P) = 862 - DV(P) < 028 V(A) 2 01 (Smaller A allowed at large DP/P) -Primany V-volues go out of square primarly due to SVCp). linear Note, the y-volues for pP/p=0 are Vx=28.826, (f)1/2 = 28.821 and only the fractional part of 2 15 usually listed.

Comments (continued) In the conjuter runs done to find V(A, P) Ex=Ey for the inition conditione, and amplitude up to A = 17 mm was included in the study. I the required A, when Ex=Ey, is only 13 mm, then the DV due to betation completude will be much raduced in this study. The derections in the instead Ex, Ey have not keen studied very much. When Ex = Ey, the V dependence on A is quite different from that to found in the Ex=Ex case.

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))-dependence on A and DPIP due to Random error Field multipoles

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	6	6	6	3
\$P/P	0	-,005	±.01	0
Prinskary V	all Stay in Square	All Stay in Square		all Stay in Square
·····	V(A,p) 2.820	V(A,P) 5,830	V(A,P) 2,862	6V(A, P) 5. 832
5. 	13V(A, P)≤.017	$\Delta V(A, R) \leq 0.19$	$AV(A, p) \leq .03L$	DUCA, EZ . 01-
	$\Delta V(4) \leq .017$	∆ V(A) ≤, 026	BV(A) = ,011	$\beta V(A) \leq 01$
	$\Delta V(p) = 0$	BUCD 2,007	6 V(p) 2, 628	$\delta V(p) = 0$
		i		
Secondary	Y(A, 0 2, 852	V(A, D 4. 847	Secondary V	$\mathcal{V}(A,p) \leq .837$
	BV(A, D = .026	AVCA, PZ. 021	than primary	$\Delta V(4,p) \leq .01$
	<u>A)(A) 2.026</u>	BV(A)=.018		$DV(A) \leq 101$
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Lincar OFIF = 0	28.826 28.821			28.827,28.82/
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V Dependence on PP/P Sextupoles only (no random field errors) $\beta^{*} = 6, \quad \delta p = \pm, 0.05, \quad \Delta V = .0025$ BPIP = 1,0025 , BU = ,0025 β* = **3** The chromatic variations in the V-values for the accelerator with random tipole errors is not large in the region of planned operation.