

Intrabeam Scattering In RHIC

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RHIC-PG-18

INTRABEAM SCATTERING IN RHIC

G. PARZEN

(BNL, December 8, 1983)

RHIC-AG-18

Intra beam Scattering in RHIC

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BNL, December 8, 1983

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Table of Contents

1) Tentative Scenario

2) $\delta = 100$ operation

3) $\delta = 12$ operation

a) minutes lifetime

b) hours lifetime

4) Confidence in Theory and Results

a) Computer code accuracy

b) Theory accuracy

$$N_b = 6.2 \times 10^8 / \text{bunch}$$

$$B = 57 \text{ bunches}$$

$$\sigma_e = 10 \text{ cm}$$

$$BF = 189$$

$$I_{\text{peak}} = 120 \text{ mA}$$

$$I_{\text{av}} = .45 \text{ mA}$$

$$\beta_y^* = 2$$

$$\beta_x^* = 40$$

$$\alpha = 4 \times 10^{-3}$$

$$\sigma_y = .115 \text{ mm}$$

$$\sigma_H = .51 \text{ mm}$$

$$\Delta V_{\text{beam-beam}} = .003$$

$$L = 2.2 \times 10^{26}$$

$$\beta_x^* \rightarrow 2, L \rightarrow 6 \times 10^{26}$$

$$L = \frac{N_b^2 B f_{\text{rev}}}{4\pi \sigma_y \left(\sigma_H^2 + \left(\alpha \sigma_e / 2 \right)^2 \right)^{1/2}}$$

$\gamma = 2$
 $\delta = 100$

$\gamma = 100$

$I_{peak} = 120 \text{ mA}$

$EPXN = EPYN = 4\pi \times 10^{-6}$ (95% emittance)

$\nu = 22.16$, $\beta_x = R/\nu = 26.5$, $X_p = R/\nu^2 = 1.2$

Vary δ , emittance constant

$\delta/10^{-3}$.4	.8	1.2	1.6	2.0	
GH/hr	15.7	8.89	6.41	4.66	3.76	} Const, β_x, X_p x1.3
GS	12.9	1.83	.56	.24	.12	
GV	-.41	-.23	-.16	-.12	-.098	
GH			9.2			} Lattice (CBA)
GS			.41			
GV			-.0017			

Vary $EPXN$, $EPZN = 4\pi \times 10^{-6}$, $\delta = 1.2 \times 10^{-3}$

$EPXN/10^{-6}$	4	8	16	40	
GH/hr	7.97	2.98	1.07	.26	} Const, β_x, X_p
GS	.72	.55	.40	.25	
GV	-.21	-.083	-.01	-.046	
GH/hr	11.5	4.2	1.5	.37	} Lattice (CBA)
GS	.42	.35	.27	.18	
GV	.015	.087	.11	.10	

Vary $EPXN = EPZN$, $\delta = 1.2 \times 10^{-3}$

$EPXN/10^{-6}$	4	8	12	16	
GH	7.97	1.6	.71	.39	} Const β_x, X_p
GS	.72	.29	.19	.15	
GV	-.21	-.041	-.018	-.01	
GH			.94	.51	} Lattice (CBA)
GS			.29	.22	
GV			-.014	-.009	

$\delta = 100$

(3)

Time integration, $S_0 = 1.2 \times 10^{-3}$, $EPX_0 = EPZ_0 = 4 \times 10^{-6}$

T (hrs)	0	.031	.0876	.191	.386	.765	1.53	2.53	Lum
* EPXY/ 10^{-6}	2.67		6.0		13.5		30.4	39.7	
* EPZY	2.67		2.6		2.5		2.7	2.97	
$S/10^{-3}$	1.2		1.27		1.41		1.7	1.85	
GH/hr	7.97		4.44		11.28		1.15		
GS	.72		.58		.33		.083		
GV	-.21		-.13		-.011		.040		
Lum	1		.76		.48		.34	.21	.21
σ_H^* (mm)	.51		.77		.62		.47		
EM			.0225		.027		.027		.17
* 90% emittance									$L_{av} \approx 1 \times 10^{26}$ over 2 hrs

Time integration, $S_0 = .4 \times 10^{-3}$, $EPX_0 = EPZ_0 = 4 \times 10^{-6}$

T (hrs)	0	.029	.133	.514	1.51	2.51
EPXY/ 10^{-6}	2.67	5.33	8.3	21.3	35.7	44.1
EPZY	2.67	2.59	2.51	2.51	2.7	2.94
$S/10^{-3}$.4	.56	1.1	1.1	1.46	1.63
GH/hr	16.9	4.81		13.4	.117	
GS	13.9	4.02		1.29	.101	
GV	-.444	-.14		1.043	1.04	

2.13

(4)

 $\gamma = 12$ $\gamma = 12$, minutes operationGrowth $\approx 10\%$ /min goal $I_{peak} = 12 \text{ ma}$, $\sigma_e = 100 \text{ cm}$, $BF = 20$ $EPXN = EPZN = 4\pi \times 10^{-6}$ (95% emittance)

$\delta/10^{-3}$.2	.4	.8	1.2	1.6	2.0	
GH/hr	-3.4	-1.2	.34	.67	.69	.65	} B_x, X_p constant
GS	121	10	-.75	-.65	-.38	-.22	
GV	-8	-2.8	.79	1.54	1.6	1.5	
GH	.12	2.8	4.6	4.9	4.8	4.6	} Lattice (CBA)
GS	120	13	.075	-.40	-.32	-.22	
GV	-8.3	-1.6	3.1	4.3	4.5	4.4	

 $\gamma = 12$, hours operationGrowth $\approx 1/2$ hrs goal, $EPXN = EPZN = 8\pi \times 10^{-6}$ $I_{peak} = 4 \text{ ma}$, $\sigma_e = 300 \text{ cm}$, $BF = 7$

$\delta/10^{-3}$.4	.8	1.2	2.0	4.0	
GH/hr	-.19	-.023	.033	.054	.040	} B_x, X_p constant
GS	3.0	.094	-.059	-.035	-.0066	
GV	-.402	-.0498	.071	.118	.088	
GH/hr	.235	.38	.41	.39	.30	} Lattice (CBA)
GS	2.2	.012	-.067	-.035	-.0079	
GV	-.13	.261	.36	.37	.29	

 $\sigma_y = 3 \times 1.5 \text{ mm}$, $\sigma_H = 3 \times .51 \text{ mm}$, $2\sigma_e/2 = 6 \text{ mm}$

$$L = \frac{2.2 \times 10^{26}}{3 \times 12} = .6 \times 10^{25}$$

Computer Code Accuracy

- 1) Old Piwinski Theory (G. Parzen) - Constant β, X_p
- 2) Bjorken-Mtingwa Theory (G. Parzen) - Variable β, X_p
- 3) New Piwinski Theory (Ruggiero-CERN) - Variable β, X_p

① and ② agree within 10%

①, ② and ③ disagree, factor 1.3 in $1/T_E$
factor 2.6 in $1/T_H$

Theory Accuracy

error of factor 2 or 3 not unlikely?

Assumptions:

- 1) Gaussian distributions
- 3) particle force interaction,
and method of solution