RHIC-PG-18

INTRABEAM SCATTERING IN RHIC

G. PARZEN

(BNL, December 8, 1983)

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$\gamma = 100$ (1)

Scenario

$N_b = 6.2 \times 10^8$ / bunch

$B = 57$ bunches

$\sigma_z = 10$ cm

$BF = 189$

$I_{peak} = 120$ ma

$I_{av} = .45$ ma

$\beta_y^* = 2$

$\beta_x^* = 40$

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

$\sigma_y = .115$ mm

$\sigma_H = .51$ mm

$\Delta\nu_{beam-beam} = .003$

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

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

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

$\gamma = 100$ (2)

$\gamma = 100$

$I_{peak} = 120$ ma

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

$\nu = 22.6$, $\beta_x = R/\nu = 26.5$, $X_p = R/\nu^2 = 1.2$

Vary δ, emittance Constant

$\delta/10^{-3}$	.4	.8	1.2	1.6	2.0	
GH/hr	15.7	8.89	6.11	4.66	3.76	Const, β_x, X_p
GS	12.9	1.83	.56	.24	.12	
GV	-.41	-.23	-.16	-.12	-.098	
GH			9.2			Lattice (CBA)
GS			.41			
GV			-.007			

$\times 1.3$

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	.111	.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	

$\gamma = 100$

(3)

Time integration, $\delta_0 = 1.2 \times 10^{-3}$, $EPXN_0 = EPZN_0 = 4 \times 10^{-6}$

T (hrs)	0	.031	.0876	.191	.386	.765	1.53	2.53
* EPXN/10^{-6}	2.67		6.0		13.5		30.4	39.7
* EPZN	2.67		2.6		2.5		2.7	2.97
$\delta/10^{-3}$	1.2		1.27		1.41		1.7	1.85
GH/hr	7.97		4.44		1.28		.15	
GS	.72		.53		.33		.083	
GV	-.21		-.13		-.011		.040	
Lum	1		.76		.48		.31	
σ_H* (mm)	.51		.77		1.2		1.7	

* 90% emittance $L_{av} \simeq 1 \times 10^{26}$ over 2 hrs

Time integration, $\delta_0 = .4 \times 10^{-3}$, $EPXN_0 = EPZN_0 = 4 \times 10^{-6}$

T (hrs)	0	.029	.133	.514	1.51	2.51
EPXN/10^{-6}	2.67	5.33		21.3	35.7	41.
EPZN	2.67	2.59		2.51	2.7	2.94
$\delta/10^{-3}$	.4	.56		1.1	1.46	1.63
GH/hr	16.9	4.81		.134	.117	
GS	13.9	4.02		.29	.101	
GV	-.444	-.14		.043	.04	

$\gamma = 12$

$\gamma = 12$, minutes operation

Growth $\simeq$ 10%/min goal

$I_{peak} = 12$ ma, $\sigma_z = 100$ 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	β_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 operation

Growth $\simeq$ 1-2 hrs goal, $EPXN = EPZN = 8\pi \times 10^{-6}$

$I_{peak} = 4$ ma, $\sigma_z = 300$ cm BF = 7

$\delta/10^{-3}$	.4	.8	1.2	2.0	4.0	
GH/hr	-.19	-.023	.033	.054	.040	β_x, X_p constant
GS	3.0	.094	-.054	-.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	

$\sigma_y = 3 \times .115$ mm, $\sigma_H = 3 \times .51$ mm, $2\sigma_z/2 = 6$ mm

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

Confidence in Results

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 $1/\tau_E$
factor 2.6 in $1/\tau_H$

Theory Accuracy

error of factor 2 or 3 not unlikely ?

Assumptions:

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