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Intrabeam Scattering In RHIC

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DISCLAIMER

RHIC-PG-18

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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

$\sigma_\ell = 10$ cms

$BF = 189$

$I_{peak} = 120$ ma

$I_{av} = .45$ ma

$\beta_y^* = 2$

$\beta_x^* = 40$

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

$\sigma_y = .115$ mm

$\sigma_H = .51$ mm

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

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

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

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

$\nu = 2$
$\gamma = 100$

$\gamma = 100$

$I_{peak} = 120$ 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 ×1.3
GS	12.9	1.83	.56	.24	.12	
GV	-.41	-.23	-.16	-.12	-.098	
GH			9.2			} Lattice (CBA)
GS			.41			
GV			-.007			

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	

$\gamma = 100$

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Time integration, $\delta_0 = 1.2 \times 10^{-3}$, $EPXN0 = EPZN0 = 4 \times 10^{-6}$

T (hrs)	0	.031	.0876	.191	.386	.765	1.53	2.53	Lum[illegible]
* $EPXN/10^{-6}$	2.67		6.0		13.5	[illegible]	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	[illegible]	
GS	.72		.58		.33		.083	[illegible]	
GV	-.21		-.13		-.011		.040	[illegible]	
Lum	1.		.76		.48		.34	[illegible]	.21
σ_H^* (mm)	.51		.77		1.2		1.7		
F[illegible]			[illegible]		[illegible]		[illegible]	[illegible]	
								1.7	

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

Time integration, $\delta_0 = .4 \times 10^{-3}$, $EPXN0 = EPZN0 = 4 \times 10^{-6}$

T (hrs)	0	.029	.133	.514	1.51	2.51
$EPXN/10^{-6}$	2.67	5.33	[illegible]	21.3	35.7	44.
EPZN	2.67	2.59	[illegible]	2.51	2.7	2.94
$\delta/10^{-3}$	.4	.56	[illegible]	1.1	1.46	1.63
GH/hr	16.9	4.81	[illegible]	.134	.117	
GS	13.9	4.02	[illegible]	.129	.101	
GV	-.444	-.14	[illegible]	.043	.04	

$\gamma = 12$

$\gamma = 12$, minutes operation

Growth $\simeq$ 10%/min goal

Ipeak = 12 ma, σ_ℓ = 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 = $8\pi \times 10^{-6}$

Ipeak = 4 ma, σ_ℓ = 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	-,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	

$\sigma_y = 3 \times .115$ mm, $\sigma_H = 3 \times .51$ mm, $2\sigma_\ell/2$ = 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–Mitingwa 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