

Intrabeam Scattering In RHIC

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INTRABEAM SCATTERING IN RHIC

E COURANT

(BNL, December 9, 1983)

RHIC-AG-20

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IBS:

$$\frac{1}{L} = \frac{3}{4} L \frac{(Z^2 r_p / A)^2 m c^2 N}{\gamma E_x E_y S} H(\gamma) \quad (\text{Bjorken})$$

$$E_x = \gamma \sigma_x^2 / \beta \quad \left(\frac{1}{6} \text{ of conventional definition} \right)$$

$$S = \text{long. phase space per mass unit (eV}^{-2}\text{)} \\ = 6\pi \sigma_s \sigma_p / A$$

$$L = \ln \frac{\beta_{\max}}{\beta_{\min}} \approx \ln \frac{10^{-1} \text{ mm}}{A^{2/3} \times 1.5 \times 10^{-12} \text{ mm}} \approx 20$$

H is a complicated integral.

At high energies, "smooth" machine ($v_x = v_y = \gamma_t$; $E_x = E_y$):

$$H \approx \pi \left(\frac{\gamma^2}{\gamma_t^2} + \frac{E_x \gamma \gamma_t}{R(\delta p/p)^2} \right)^{1/2} \quad \text{provided this} \gg 1.$$

Strategy: Make E and S as large as possible.

Transition energy:

$$\text{Max } \frac{\Delta p}{p} \sim \frac{h^{1/3}}{\gamma_t^{1/3}} \left(\frac{eV \omega_s^2 \rho_s}{m \rho_s} \right)^{1/6} \left(\frac{S}{R} \right)^{1/2}$$

$$\text{Max allowable } \frac{\Delta p}{p} \sim \gamma_t^2 a/R \quad a = \text{maximum aperture}$$

Therefore: Large γ_t permits larger S

Hence better EBS lifetime!

Transition space charge effect turns out to
be OK (Sørensen - see CERN Spring Study,
1972)

COLD; $\gamma = 100$

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I_e	2.14 mA	3.39 mA	1.55
N	1.74×10^{11}	2.87×10^{11}	1.24×10^{11}
\bar{E}	10×10^{-6}	10×10^{-6}	1.67×10^{-6}
No. of links	3	57	57
χ_{tr}	35	35	25
S/M (eV)	50	263	5
V (eV)	250	250	250
Lum	10^{27}	10^{27}	5×10^{26}
E_{LBS}	1.78 h	0.78	0.26

H I 12/9/83

e=79
M=197
I/e=2.18E-3
GAM=100.00
EX=10.00
EY=10.00
BX=30.00
BY=2.00
Z=2.00E-3
R=610.00
GTR=35.00
H=3
Nb=3
N=1.74E11
P/b=5.00E10
A/M=50.00
V=250.00

SIGX=1.73E-3
SIGY=4.47E-4
NU-S=1.91E-5
SIGZ=13.92
dP/P=6.09E-4
AT TRS
dP/P=3.69E-3
SIGZ=7.59

LUM=1.00E27
DOX=1.71E-4
DOY=1.88E-3
L/b=4.26E21
IBS 1.78 HRS

e=79
M=197
I/e=3.59E-3
GAM=100.00
EX=10.00
EY=10.00
BX=30.00
BY=2.00
Z=2.00E-3
R=610.00
GTR=35.00
H=205
Nb=57
N=2.07E11
P/b=5.04E9
A/M=2.63
V=250.00

SIGX=1.73E-3
SIGY=4.47E-4
NU-S=1.06E-4
SIGZ=1.02
dP/P=4.36E-4
AT TRS
dP/P=3.86E-3
SIGZ=0.38

LUM=1.00E27
DOX=3.75E-4
DOY=9.86E-4
L/b=2.24E20
IBS 0.78 HRS

I/e=1.55E-3
GAM=100.00
EX=1.67
EY=1.67
BX=30.00
BY=2.00
Z=2.00E-3
R=610.00
GTR=25.00
H=205
Nb=57
N=1.24E11
P/b=2.18E9
A/M=5.00
V=250.00

SIGX=7.07E-4
SIGY=1.83E-4
NU-S=2.70E-4
SIGZ=1.70
dP/P=5.00E-4
AT TRS
dP/P=5.95E-3
SIGZ=6.58E-1

LUM=5.00E26
DOX=1.05E-4
DOY=1.06E-3
L/b=1.12E20
IBS 0.26 HRS