

Intrabeam Scattering In RHIC

E. Courant

December 1983

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No. DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

INTRABEAM SCATTERING IN RHIC

E. COURANT

(BNL, December 9, 1983)

RHIC-AG-20

Intrabeam Scattering in RHIC

E. Courant

BNL, December 9, 1983

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 = long. phase space per mass unit (eV-se)

$$= 6\pi \sigma_z \sigma_p / A$$

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

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:

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

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

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)

GOLD; $\gamma = 100$

3

I_e	2.14 mA	3.39 mA	1.55
N	1.74×10^{11}	2.87×10^{11}	1.24×10^{11}
G	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
L_{um}	10^{27}	10^{27}	5×10^{26}
E_{LBS}	1.78 A	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