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RF Parameters And Beam Dimensions At Transition

A. G. Ruggiero

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Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy
USDOE Office of Science (SC)

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RHIC-PG-34

RF PARAMETERS AND BEAM DIMENSIONS AT TRANSITION

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Luminosity Head-on Initial

$$L_0 = \frac{N^2 B f_{rev}}{4\pi \sigma_H^* \sigma_V^*}$$

initial values

$N = 1.1 \times 10^9$

$B = 57$ bunches

$f_{rev} = 78.2$ kHz

$\beta_H^* = 17.7$ m

$\beta_V^* = 3.0$ m

$\gamma = 108.4$

$\varepsilon_N = 10\pi$ mm·mrad

$\sigma_L = 40$ cm

$\sigma_E/E = 0.4 \times 10^{-3}$

$\sigma_{Int.} = 20$ cm

$L_0 = 0.4 \times 10^{27}$ cm^{-2} s^{-1}

Crossing at angle α

α	2 mrad	10 mrad
L/L_0	0.79	0.25
σ_I	15. cm	7 cm

Beam-Beam Tune Shift (head-on, initial)

$$\Delta\nu_0 = \frac{3 N r_0 Z^2}{\pi \varepsilon_N A} \frac{1}{1 + \frac{\sigma_{V,H}}{\sigma_{H,V}}} = \begin{cases} 0.0036 & (H) \\ 0.0015 & (V) \end{cases}$$

Harmonic No., h	6 × 57 = 342		12 × 57 = 684	
RF Frequency ($\beta=1$)	26.743 MHz		53.486 MHz	
RF Voltage, MV	1.42	2.85	1.42	2.85
Bucket Area, eV/A-s	13.38	18.92	4.73	6.69
Height, ΔE_B	280. MeV/A	400. MeV/A	200. MeV/A	280. MeV/A
$\Delta E_B/E$	0.283 %	0.40 %	0.20 %	0.283 %
σ_E/E } aspect	0.1 %	0.1 %	0.1 %	0.1 %
σ_L } ratio	128 cm	90 cm	90 cm	64 cm
S, eV/A-sec (95%)	7.96	5.66	5.66	3.98
σ_E/E max	0.116 %	0.163 %	0.082 %	0.116 %
σ_L max	148 cm	148 cm	74 cm	74 cm
S max	10.71	15.04	3.80	5.36
Voltage/cavity	200 KV	200 KV	200 KV	200 KV
Length of Cavity	2.5 m	2.5 m	1.3 m	1.3 m
no. of Cavities	7	14	7	14
Total Length	17.5 m	35. m	9.1 m	18.2 m
R_{sh}/cavity	0.84 MΩ	0.84 MΩ	1.19 MΩ	1.29 MΩ
Power/cavity	24 KW	24 KW	16 KW	16 KW
Power Cost	4.5 $/W		4.5 $/W	
Total Cost/Ring (w/ 50% trans. eff.)	1.5 M$	3.0 M$	1.0 M$	2.0 M$

Harmonic No., h	6 × 57 = 342		12 × 57 = 684	
Voltage, MV	1.42	2.85	1.42	2.85
Stationary Bucket Injection:				
Area, eV/A-s	2.36	3.34	0.84	1.18
$\Delta E_B/E$	± 0.43 %	± 0.60 %	± 0.30 %	± 0.43 %
Acceleration Period	30 sec			
No. of Revolutions	2.346×10^6			
Total Energy Gain	89.3 GeV/A			
Energy Gain/Turn	38 KeV/A			
$V_{sin\phi_s}$	95 KV			
$\sin\phi_s$	0.0669	0.03345	0.0669	0.03345
ϕ_s	3.836°	1.917°	3.836°	1.917°
X	0.86	0.92	0.86	0.92
Y	1.34	1.30	1.34	1.30
Transition Energy Crossing γ_T S = 1. eV/A-s				
T ± msec	21.2	16.8	16.8	13.3
$\Delta p/p$ ± %	1.15	1.45	1.45	1.83
L ± nsec	1.30	1.03	1.03	0.82

Beam Dimensions @ Transition

Phase Advance / Cell	98°	120°
γ_T	26.42	30.64
β_{max}	51.6 m	62.6 m
η_{max}	1.4 m	1.1 m
ε @ $\gamma = \gamma_T$	0.3785 π mm-mrad	0.3264 π mm-mrad
σ_V (max, rms)	1.8042 mm	1.8453 mm
δ (rms)		
1 MV h = 12×57 (6×51) 1 eV/A-sec	0.53 % (0.42)	0.50 %
σ_H (max, rms)	7.64 mm (6.15)	5.80 mm
$\sqrt{6}\,\sigma_H$ (95%)	18.7 (15.1)	14.2 mm
For h = 12×57 Voltage requirement at top energy	1.4 MV	1.0 MV