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RF Parameters And Beam Dimensions At Transition

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RF PARAMETERS
AND
BEAM DIMENSIONS AT TRANSITION

A. G. Ruggiero

(BNL, February 24, 1984)

Luminosity Head-on Initial

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

initial values

$$N = 1.1 \times 10^9$$

$$\beta_H^* = 17.7 \text{ m}$$

$$E_N = 10 \pi \text{ mm mrad}$$

$$B = 57 \text{ bunches}$$

$$\beta_V^* = 3.0 \text{ m}$$

$$\sigma_L = 40 \text{ cm}$$

$$f_{rev} = 78.2 \text{ kHz}$$

$$\gamma = 108.4$$

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

$$\sigma_{Int.} = 20 \text{ cm}$$

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

Crossing at angle α

$$\alpha \quad 2 \text{ mrad} \quad 10 \text{ mrad}$$

$$L/L_0 \quad 0.79 \quad 0.25$$

$$\sigma_I \quad 15. \text{ cm} \quad 7 \text{ cm}$$

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

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

Harmonic No., h	$6 \times 57 = 342$		$12 \times 57 = 684$	
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 σ_L } ratio	0.1 %	0.1 %	0.1 %	0.1 %
	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 } σ_L max } S min }	0.116 %	0.163 %	0.082 %	0.116 %
	148 cm	148 cm	74 cm	74 cm
	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_{ca} /cavity	0.84 M Ω	0.84 M Ω	1.29 M Ω	1.29 M Ω
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	$6 \times 57 = 342$		$12 \times 57 = 684$	
Voltage, MV	1.42	2.85	1.42	2.85
Stationary Bucket Injection: Area, eV/A-s $\Delta E_B/E$	2.36 $\pm 0.43\%$	3.34 $\pm 0.60\%$	0.84 $\pm 0.30\%$	1.18 $\pm 0.43\%$
Acceleration Period No. of Revolutions Total Energy Gain Energy Gain/Turn $\sqrt{s} \sin \phi_s$			30 sec 2.346×10^6 89.3 GeV/A 38 KeV/A 95 KJ	
$\sin \phi_s$ ϕ_s v Y	0.0064 3.836° 0.86 1.34	0.03345 1.917° 0.92 1.38	0.0669 3.836° 0.86 1.34	0.03345 1.917° 0.92 1.38
Transition Energy Crossing $S = 1. \text{eV/A-s}$				
T \pm msec $\Delta p/p$ \pm % L \pm nsec	21.2 1.15 1.30	16.8 1.45 1.03	16.8 1.45 1.03	13.3 1.83 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)		
$\frac{1 \text{ MV}}{h = 12 \times 57 \text{ (6} \times 57\text{)}} \\ \frac{1 \text{ eV/A-sec}}$	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 $h = 12 \times 57$ Voltage requirement at top energy	1.4 MV	1.0 MV