

RF Parameters And Beam Dimensions At Transition

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RF PARAMETERS
AND
BEAM DIMENSIONS AT TRANSITION

A. G. Ruggiero

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Luminosity

Head-on

Initial

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

initial values

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

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

$$\epsilon_N = 10 \pi \text{ mm} \cdot \text{mrad}$$

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

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

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

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

$$\gamma = 108.4$$

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

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

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

Crossing at angle α

$$\alpha$$

$$2 \text{ mrad}$$

$$10 \text{ mrad}$$

$$L/L_0$$

$$0.79$$

$$0.25$$

$$\sigma_I$$

$$15. \text{ cm}$$

$$7 \text{ cm}$$

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

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

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	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 %	0.116 %	0.163 %	0.082 %	0.116 %
σ_L max } 148 cm	148 cm	148 cm	74 cm	74 cm
S min } 10.71	10.71	15.04	3.80	5.36

Voltage / cavity	100 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 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	2.36	3.34	0.84	1.18
$\Delta E_B / E$	$\pm 0.43 \%$	$\pm 0.60 \%$	$\pm 0.30 \%$	$\pm 0.43 \%$
Acceleration Period No. of Revolutions Total Energy Gain Energy Gain / Turn $V \sin \phi_s$	30 sec 2.346×10^6 89.3 GeV/A 38 KeV/A 95 K/V			
$\sin \phi_s$	0.0669	0.03345	0.0669	0.03345
ϕ_s	3.836°	1.917°	3.836°	1.917°
v	0.86	0.92	0.86	0.92
Y	1.34	1.38	1.34	1.38
Transition Energy Crossing $S = 1. \text{ eV/A-s}$				
T $\pm \text{ msec}$	21.2	16.8	16.8	13.3
$\Delta p/p \pm \%$	1.15	1.45	1.45	1.83
L $\pm \text{ nsec}$	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)		
$\frac{1 \text{ MV}}{h = 12 \times 57 \text{ (6} \times 57\text{)}} \\ 1 \text{ eV/A-sec}$	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