

# Muon Collider Beam And Wall Plug Power Estimates

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## *Abstract*

We estimate beam power and wall plug power for different schemes of muon collider: 1.5 TeV cme and 3.0 TeV cme; for low-emittance option and for high-emittance options.

## Facts:

- 1) 500 GeV ILC linac power consumption is 230MW (93MW RF + 137 MW Conv [ILC Design report])
- 2) Tevatron collider ring wall plug power with cryogenics 12MW [J.Morgan PAC1991]
- 3) 8 GeV PD Linac wall plug power 3MW standby +1MW/Hz for the range of beam powers 0.5MW (5.5 MW from wall plug ) to 2.0 MW (12.5MW from wall plug) [G.W.Foster et al, Proton Driver CD-0 documents]
- 4) 1 GeV 1.4 MW SNS linac wall plug power (incl. water cryo and RF) :  
21 MW 200MeV NC linac + 37MW for 800MeV SC linac [SNS CDR]
- 5) Previous estimate for 3TeV cme MC wall plug power was 204 MW – see table below [Phys. Rev. ST Accel. Beams 2, 081001 (1999)]

TABLE I. Baseline parameters for high energy and low energy muon colliders. Higgs/yr assumes a cross section  $\sigma = 5 \times 10^4$  fb; a Higgs width  $\Gamma = 2.7$  MeV, 1 yr =  $10^7$  s.

COM energy (TeV)	3	0.4		0.1	
$p$ energy (GeV)	16	16		16	
$p$ 's/bunch	$2.5 \times 10^{13}$	$2.5 \times 10^{13}$		$5 \times 10^{13}$	
Bunches/fill	4	4		2	
Rep. rate (Hz)	15	15		15	
$p$ power (MW)	4	4		4	
$\mu$ /bunch	$2 \times 10^{12}$	$2 \times 10^{12}$		$4 \times 10^{12}$	
$\mu$ power (MW)	28	4		1	
Wall power (MW)	204	120		81	
Collider circum. (m)	6000	1000		350	
Ave bending field (T)	5.2	4.7		3	
rms $\Delta p/p$ (%)	0.16	0.14	0.12	0.01	0.003
$\delta D \epsilon_{6,N} (\pi m)^3$	$1.7 \times 10^{-10}$	$1.7 \times 10^{-10}$	$1.7 \times 10^{-10}$	$1.7 \times 10^{-10}$	$1.7 \times 10^{-10}$
rms $\epsilon_n$ ( $\pi$ mmmrad)	50	50	85	195	290
$\beta^*$ (cm)	0.3	2.6	4.1	9.4	14.1
$\sigma_z$ (cm)	0.3	2.6	4.1	9.4	14.1
$\sigma_r$ spot ( $\mu$ m)	3.2	26	86	196	294
$\sigma_\theta$ IP (mrad)	1.1	1.0	2.1	2.1	2.1
Tune shift	0.044	0.044	0.051	0.022	0.015
$n_{\text{tunes}}$ (effective)	785	700	450	450	450
Luminosity ( $\text{cm}^{-2} \text{s}^{-1}$ )	$7 \times 10^{34}$	$10^{33}$	$1.2 \times 10^{32}$	$2.2 \times 10^{31}$	$10^{31}$
Higgs/yr			$1.9 \times 10^3$	$4 \times 10^3$	$3.9 \times 10^3$

- 6) Solyak and Yakovlev made detail estimates for 1.5-3TeV MC ILC-type RLA – see [mctf.fnal.gov](http://mctf.fnal.gov) meeting 03/13/2008.

Discussion 02/15/2008:

- 1) Continue

Working table:

	MC1999	HE2008	HE2008	LE2008	LE2008
Collider cm Energy (TeV)	3	1.5	3	1.5	3
Luminosity (1e34)	7	1	3	3	3.5
Emittance (pi mm mrad)	50	25	25	2.1	2.1
Rep rate (Hz)	15	13	8	65	32
Muons/beam (1e12)	8	2	2	1	1
PD beam power (MW)	4	4	2	3.6	8
Muon beam power (MW)	57.6	6.24	7.68	15.6	15.36
TOTAL wall plug power (MW):	204	60	83	166	158
PD (MW)		16	11	68	35
Bunching Ring(s) (MW)		4	4	4	4
Target station (MW)		1	1	1	1
Collection system (MW)		4	4	4	4
Cooling system (MW)		4	12	2	2
Acceleration (MW)	130	25	32	81	93
Beamlines		2	4	2	4