



# LINEAR COLLIDER COLLABORATION

Designing the world's next great particle accelerator

Updates to the Power Estimate (ILC-CR-0018)

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TCMB Meeting

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**Table 11.6**

Estimated DKS power loads (MW) at 500 GeV centre-of-mass operation. 'Conventional' refers to power used for the utilities themselves. This includes water pumps and heating, ventilation and air conditioning, (HVAC). 'Emergency' power feeds utilities that must remain operational when main power is lost.

Accelerator section	RF Power	Racks	NC magnets	Cryo	Conventional		Total
					Normal	Emergency	
e <sup>-</sup> sources	1.28	0.09	0.73	0.80	1.47	0.50	4.87
e <sup>+</sup> sources	1.39	0.09	4.94	0.59	1.83	0.48	9.32
DR	8.67		2.97	1.45	1.93	0.70	15.72
RTML	4.76	0.32	1.26		1.19	0.87	8.40
Main Linac	52.13	4.66	0.91	32.00	12.10	4.30	106.10
BDS			10.43	0.41	1.34	0.20	12.38
Dumps					0.00	1.21	1.21
IR			1.16	2.65	0.90	0.96	5.67
<b>TOTALS</b>	<b>68.2</b>	<b>5.2</b>	<b>22.4</b>	<b>37.9</b>	<b>20.8</b>	<b>9.2</b>	<b>164</b>

**Table 11.17**

Summary of power loads (MW) by Accelerator section. 'Conventional' refers to power used for the utilities themselves. This includes water pumps and heating, ventilation and air conditioning, (HVAC). 'Emergency' power feeds utilities that must remain operational when main power is lost.

Accelerator section	RF Power	RF Racks	NC magnets & Power supplies	Cryo	Conventional		Total
					Normal load	Emergency load	
e <sup>-</sup> source	1.28	0.09	0.73	0.80	1.02	0.16	4.08
e <sup>+</sup> source	1.39	0.09	4.94	0.59	2.19	0.35	9.56
Damping Ring	8.67		2.97	1.45	1.84	0.14	15.08
RTML	4.76	0.32	1.26	part of ML cryo	0.12	0.14	6.59
Main Linac	58.1	4.9	0.914	32	8.10	5.18	109.16
BDS			10.43	0.41	0.24	0.28	11.36
Dumps					1		1.00
IR			1.16	2.65	0.09	0.17	4.07
<b>Total</b>	<b>74.2</b>	<b>5.4</b>	<b>22.4</b>	<b>37.9</b>	<b>14.6</b>	<b>6.4</b>	<b>161</b>



Note: This is for 2625 bunches!

TABLE 4.3-1

Estimated nominal power loads (MW) for 500 GeV centre-of-mass operation.

Area System	RF Power	Conventional Power				Emer Power	Total (by area)
		Conv	NC Magnets	Water Systems	Cryo		
Sources e <sup>-</sup>	1.05	1.19	0.73	1.27	0.46	0.06	4.76
Sources e <sup>+</sup>	4.11	7.32	8.90	1.27	0.46	0.21	22.27
DR	14.0	1.71	7.92	0.66	1.76	0.23	26.29
RTML	7.14	3.78	4.74	1.34	0.0	0.15	17.14
Main Linac	75.72	13.54	0.78	9.86	33.0	0.4	134.21
BDS	0.0	1.11	2.57	3.51	0.33	0.20	7.72
Dumps	0.0	3.83	0.0	0.0	0.0	0.12	3.95
Totals (by system)	102.0	32.5	25.6	17.9	36.9	1.4	216.3



- Japanese (DKS) and American (KCS) designs have different numbers for power of conventional facilities
- For Damping Rings, the difference is 0.07MW for „normal“ CFS power and 0.56MW for „emergency“ power
- Resulting overall power numbers for different configurations

	KCS	DKS
2 Rings, 10Hz (TDR), 1312b	15.1MW	15.7MW
2 Rings, 5 Hz, 1312b	13.6	14.2
2 Rings, 5 Hz, 2625b	21.5	22.2
3 Rings, 10Hz, 2625b	30.3	31.0



- TDR has 8.40MW for DKS and 6.59MW for KCS
- On top: 2MW from cryogenics (reassigned from Main Linac)
- Included: 4.76MW RF power
  - Surprise: Bunch compressor total voltage is  $0.465 \times 11 = 11.465$ GV per arm  
=> corresponds to 0.5MW total RF to beam => 2.5MW RF power  
=> TDR number almost certainly an overestimate
- Calculation by N.W. spreadsheet nevertheless scales RF power up (+60% for 2625 bunches, +100% for 10Hz)  
**-> consistent with RDR numbers!**
- Reduction for smaller length of transport line <1MW, not considered

Power RTML	KCS	DKS
5+5Hz, (TDR), 1312b	8.6 MW	10.4 MW
5 Hz, 1312b		10.4
5 Hz, 2625b		13.3
10Hz, 2625b		16.1



- Sources: include 1.3/1.4 MW RF power
- This seems to be already the number for full power (2625 bunches) operation:
- With  $I_{\text{beam}}=1.5*5.8\text{mA}$  and  $\langle g \rangle=24.1\text{MV/m}$  for 176 cavities in SC booster, one gets 0.15MW RF to beam in 5GeV booster  
-> approx 0.7MW RF power
- Calculation by N.W. spreadsheet nevertheless scales RF power up (+60% for 2625 bunches, +100% for 10Hz)

Power e-/e+ source	KCS	DKS
5+5Hz, (TDR), 1312b	4.09 / 9.56 MW	4.87 / 9.32 MW
5 Hz, 1312b		4.9 / 9.3
5 Hz, 2625b		5.6 / 10.2
10Hz, 2625b		6.4 / 11.0



	500 TDR	250-A	250-A' w/R&D	250-A Lx2	500@250	500 Lx2
Rep-Rate / Hz	5	5	5	5	10	5
Bunches / Pulse	1312	1312	1312	2625	2625	2625
Lumi / 10 <sup>34</sup>	1.8	1.35	1.35	2.7	5.4	3.6
Gradient / MV/m	31.5	31.5	35	31.5	14.7	31.5
Q <sub>0</sub> /1E10	1.0	1.0	1.6	1.0	1.0	1.0
ML E-gain / GeV	470	220	220	220	220	470
ML Power / MW	107.1	50.1	49.3	53.5	104.3	135.7
e- Src / MW	4.9	4.9	4.9	5.6	6.4	5.6
e+ Src / MW	9.3	9.3	9.3	10.2	11.0	10.2
DR / MW	14.2	14.2	14.2	22.2	31.0	22.2
RTML / MW	10.4	10.4	10.4	13.3	16.1	13.3
BDS / MW	12.4	9.3	9.3	9.3	9.3	12.4
Dumps / MW	1.2	1.2	1.2	1.2	1.2	1.2
IR / MW	5.8	5.8	5.8	5.8	5.8	5.8
Campus / MW	2.7	2.7	2.7	2.7	2.7	2.7
Gen. Margin/MW	5.1	3.3	3.2	4.0	5.6	6.3
<b>Total</b>	<b>173</b>	<b>111</b>	<b>110</b>	<b>138</b>	<b>191</b>	<b>215</b>



- Further checks have confirmed the numbers presented last time and checked by the CRP
- I propose to approve the Change Request