Electrical Power Load

AD & I

20 June, 2012

Marc Ross – for Emil Huedem (Fermilab)

KCS Load Tables – 13.06.2012

Thermal Load

TDR baseline- low power (KCS) 10Hz					
load to LCW technical only	load to Air	*Conventional* [e]	Cryo (Water Load)	**Total**	
1.40 [j]	0.70 [j]	0.80	0.80 [k]	**3.70**	e-
5.82	0.64	1.51	0.59 [l]	**8.56**	e+
10.92	0.73	1.79	1.45 [m]	**14.89**	DR
4.16 [p]	0.76 [p]	0.68	0 [f]	**5.59**	RTML
43.3 [h]	8.7 [h]	5.32	40.5 [g]	**97.8**	Linac
9.2	1.23	3.23	0.41	**14.07**	BDS
14	0	0.05	0	**14.05**	Dump
0.4 [q]	0.76 [q]	0.1	2.65 [r]	**3.91**	IR
89.2	*13.5*	*13.5*	*46.4*	**163**	Total

Electrical Load

TDR baseline - Low Power (KCS) 10Hz						
RF Power	RF Racks	NC Magnets & Power Supplies	Cryo	Conventional [e]		Total
				Normal Load	Emerg Load	
1.28 [j]	0.09	0.73 [b]	0.80 [k]	1.02	0.16	4.08
1.39	0.09	4.94	0.59 [l]	2.19	0.35	9.6
8.67		2.97	1.45 [m]	1.84	0.14	15.1
4.76 [p]	0.32	1.26	0 [f]	0.12	0.14	6.6
58.1 [h]	4.9	0.914	40.5 [g]	8.10	5.18 [n]	118
0		10.43	0.41	0.24	0.28	11.4
0		0	0	1 [d]	0	1
0		1.16 [q]	2.65 [r]	0.09	0.17	4.1
74.2	*5.4*	*22.4*	*46.4*	*14.6*	*6.4*	**169**

‘Peak Operating Load’ per system

System – by – System ‘worst case’ to be used to estimate equipment ratings

AC Power and Heat Loads (KCS)

Low Power

For **both main linacs**:

Average **rf power**: 413 klystrons × 10 MW × 1.652 ms × 5Hz = 34.11 MW
Average **beam power**: 2 × 5.785 mA × 235 GV × 726.6 μs × 5Hz = 9.878 MW (28.96%)

wall plug–modulator pulse efficiency: ~90.3%
modulator pulse–HPRF efficiency: ~65% ➔ wall plug – HPRF: ~58.7%
34.11 MW / 0.587 = 58.11 MW AC
58.11 MW(AC) – 9.878 MW(beam) = 48.23 MW cooling

17.0% efficient

Efficiencies:

.587	wall plug to rf	0.5038 → 49.62% lost *above ground*:	**~28.8 MW**
.85826	klystron to shaft		
.80075	shaft to cavity	0.3522 → 32.64% lost *below ground*:	**~19.0 MW**
.4398	cavity to beam		
.1774		17.0% into *beam* (dump):	~9.88 MW
4.4% over?		~0.74% missing?	~0.43 MW

1.06% extra rf units (3/282)
1.45% extra generated
→ 2.53% extra

Chris Nantista

500 GeV E_cm (5 Hz nominal)

Thermal Load

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4.16 [p]	0.76 [p]	0.68	0 [f]	**5.59**
43.3 [h]	8.7 [h]	5.32	40.5 [g]	**97.8**
9.2	1.2			
14	0			
0.4 [q]	0.7			
89.2	*13.*			

e-
e+
DR
RTML
Linac

Electrical Load

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58.1 [h]	4.9	0.914	40.5 [g]	8.10	5.18 [n]	118
					.28	11.4
					0	1
					.17	4.1
					.4	**169**

Reduce 'Peak Operating Load' per system →
5 Hz e- operation, longer damping cycle for e+
Approximate:

e- RF reduced half; cryo less:	0.8
RTML RF reduced ¼; cryo less	1.2
DR RF reduced ½; cryo 0.5MW	4.5
TOTAL reduction: 6.5 MW	

162.5

DR 5Hz/ 10Hz cryo

- RDR numbers use 40W dynamic heat load per cavity - this has both beam and non-beam scaling contributions. They give 2.52 MW cryo plant capacity.
- For the 5 Hz Low Power - beam currents are nominally the same as RDR and the DYNAMIC RF contribution to the cryo heat load should scale as number of cavities. This leads to an estimate (8 cavities per ring) of ~1.66 MW cryo plant capacity.
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- For 10Hz Low power (WHICH IS WHAT CFS WANTS, there's no simple scaling) - Number of cavities is 12 for the positron ring and 10 for the electron ring. However, the positron ring will only have
- half the beam current, hence an adjusted power load which has not been calculated. For the moment, Vic has penciled in 2.1 MW as a placeholder.

- 10 cavities, 54 wiggler magnets, on the e- side.
- 12 cavities, 60 magnets, on the e+ side.
- Same unit static and dynamic heat loads as in the RDR.
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- One cryogenic plant provides all the damping ring cooling at 4.5 K and 70 K.
- Same uncertainty and overcapacity factors as in RDR and same plant efficiency as in RDR.
- **Total installed plant size for all damping ring cryogenics (one cryogenic plant) is 1.45 MW.**
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- Comparison with RDR (just for reference).
- My conclusion for the RDR was two cryogenic plants at 1.13 MW each, for a total of 2.26 MW. (See RDR Table 3.8-3, which is consistent with the numbers in my spreadsheets.) So this present damping ring configuration requires 64% of the RDR damping ring power.