Heat Loads of cryomodule

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From data of Tom Peterson

ILC-9-8-9

Temperature Level	2K		2K	
RF load		4.95		7.46
Supports	0.60		0.60	-
Input coupler	0.24	0.48	0.17	0.53
HOM coupler (cables)	0.01	0.27	0.01	0.18
HOM absorber	0.14	0.02	0.14	0.01
Beam tube bellows		0.24		0.36
Current leads	0.04		0.28	0.28
HOM to structure		1.68		1.20
Coax cable (4)	0.05		0.05	
Instrumentation taps	0.07		0.07	
Scales as Gfac		**5.19**		**7.83**
Scales as Pfac		**0.48**		**0.53**
Independent of G,Tf	**1.15**	**1.97**	**1.32**	**1.68**
Static, dynamic sum	**1.15**	**7.64**	**1.32**	**10.04**
2K Sum [W]	**8.8**		**11.4**	

	5K		5K	
Radiation	1.95		1.41	
Supports	2.40		2.40	
Input coupler	2.40	3.60	1.73	4.00
HOM coupler (cables)	0.40	2.66	0.29	1.82
HOM absorber	3.13	0.77	3.13	0.76
Current leads			0.47	0.47
Diagnostic cable	1.39	-	1.39	-
Scales as Pfac		**3.60**		**4.00**
Independent of G,Tf	**11.67**	**3.43**	**10.82**	**3.04**
Static, dynamic sum	**11.67**	**7.03**	**10.82**	**7.05**
5K Sum [W]	**18.7**		**17.9**	

	40K		40K	
Radiation	44.99		32.49	
Supports	6.00		18.00	
Input coupler	22.80	49.20	16.47	54.73
HOM coupler (cables)	2.55	13.22	1.84	9.04
HOM absorber	(3.27)	15.27	(3.27)	15.04
Current leads	13.00	5.00	4.13	4.13
Diagnostic cable	5.38		5.38	
Scales as Pfac		**49.20**		**54.73**
Independent of G,Tf	**91.45**	**33.49**	**75.04**	**28.22**
Static, dynamic sum	**91.45**	**82.69**	**75.04**	**82.95**
40K Sum [W]	**174.1**		**158.0**	

In the S1-G cryomodule, static loss and dynamic loss at 2K are measured by the LHe evaporation.
These losses at 5K and 80K are measured by the temperature change of the thermal shields.
Heat loads of components are calculated from the measured temperature profile.

Power going through HOM coupler of ILC Cavity

From the note by Kiyoshi Kubo

Field		Result
Accelerating mode	Depend on Q of HOM coupler	Eq. (2)
Short range longitudinal wake	From parameters in TESLA-TDR	~ 400 W/cavity
Long range longitudinal wake	Depend on parameters of modes	Eq. (7)
Dipole and higher mode	Depend on beam - cavity offset	Negligible

< 10 W /cavity

$$P_{acc}[W] \sim \frac{1\times 10^{12}}{Q_{ext}} \qquad (2)$$

$Q_{ext} > 1\times10^{11}$ ⇨ $P_{acc} < 10$ W

$$P_{lhw} = \frac{V_b^2}{(R/Q)Q_L} \approx \frac{(R/Q)Q_L I_b^2}{1+8Q_L^2(1-\cos(\omega t_b))/(\omega t_b)^2} \qquad (7)$$

For estimating heat loads at RF cables, the heat loads by accelerating mode and short range longitudinal wake are considered.

The total power going through HOM couplers is 410W/cavity.
Duty of ILC is about 1 %, and then 1 % of the power, 4.1 W/cavity, is considered.

KEK RF cables

- RF cable: SUCOFLEX 103
  - Cross section area of Cu in the cable = $0.06 cm^2$
- The cable design
  - Total Length = 4.5 m
    - $L_{300\ K-52K}$ = 1m, L_{52K} = 0.5m, L_{52K-5K} = 1.5 m, L_{5K} = 0.5 m, L_{5K-2K} = 1m
  - Static heat loss
    - $Q_{S@52K}$ = 0.664 W, $Q_{S@5K}$ = 0.205 W, $Q_{S@2K}$ = 0.0072 W for 1 cable
    - $Q_{S@52K}$ = 11.5 W, $Q_{S@5K}$ = 3.55 W, $Q_{S@2K}$ = 0.125 W for 1 module
    - $Q_{S@40K}$ = 1.84 W, $Q_{S@5K}$ = 0.29 W, $Q_{S@2K}$ = 0.01 W for 1 module (From data of Tom)
  - Dynamic heat loss at the cable
    - Loss factor at the RF cable=5%/m
    - $Q_{D@52K}$ = 0.15 W, $Q_{D@5K}$ = 0.2 W, $Q_{D@2K}$ = 0.1 W for 1 cable
    - $Q_{D@52K}$ = 2.6 W, $Q_{D@5K}$ = 3.5 W, $Q_{D@2K}$ = 1.7 W for 1 module
    - $Q_{D@40K}$ = 9.04 W, $Q_{D@5K}$ = 1.82 W, $Q_{D@2K}$ = 1.38 W for 1 module (From data of Tom)

- Proposal to Cavity Integration Group
  - The RF cable specification can be defined from the operation of ILC by Cavity Integration Group.