

ILC Cryomodule Heat Load

Heat Load Table in RDR (starting point)

TABLE 3.7-1

Heat loads for one RF unit of 3 cryomodules with 26 cavities. All values are in watts.

	2 K		5-8 K		40-80 K	
	Static	Dynamic	Static	Dynamic	Static	Dynamic
RF Load		22.4	4.2		97.5	
Supports	1.8	0.0	7.2		18.0	
Input coupler	1.6	0.5	4.4	4.0	46.5	198.2
HOM coupler (cables)	0.0	0.6	0.9	5.5	5.5	27.1
HOM absorber	0.4	0.0	9.4	1.6	9.8	32.6
Beam tube bellows		1.1				
Current leads	0.9	0.9	1.4	1.4	12.4	12.4
HOM to structure		3.6				
Coax cable (4)	0.2					
Instrumentation taps	0.2					
Diagnostic cable			4.2		7.4	
Sum	5.1	29.0	31.7	12.5	177.6	270.3

Cryomodule cooling scheme in RDR

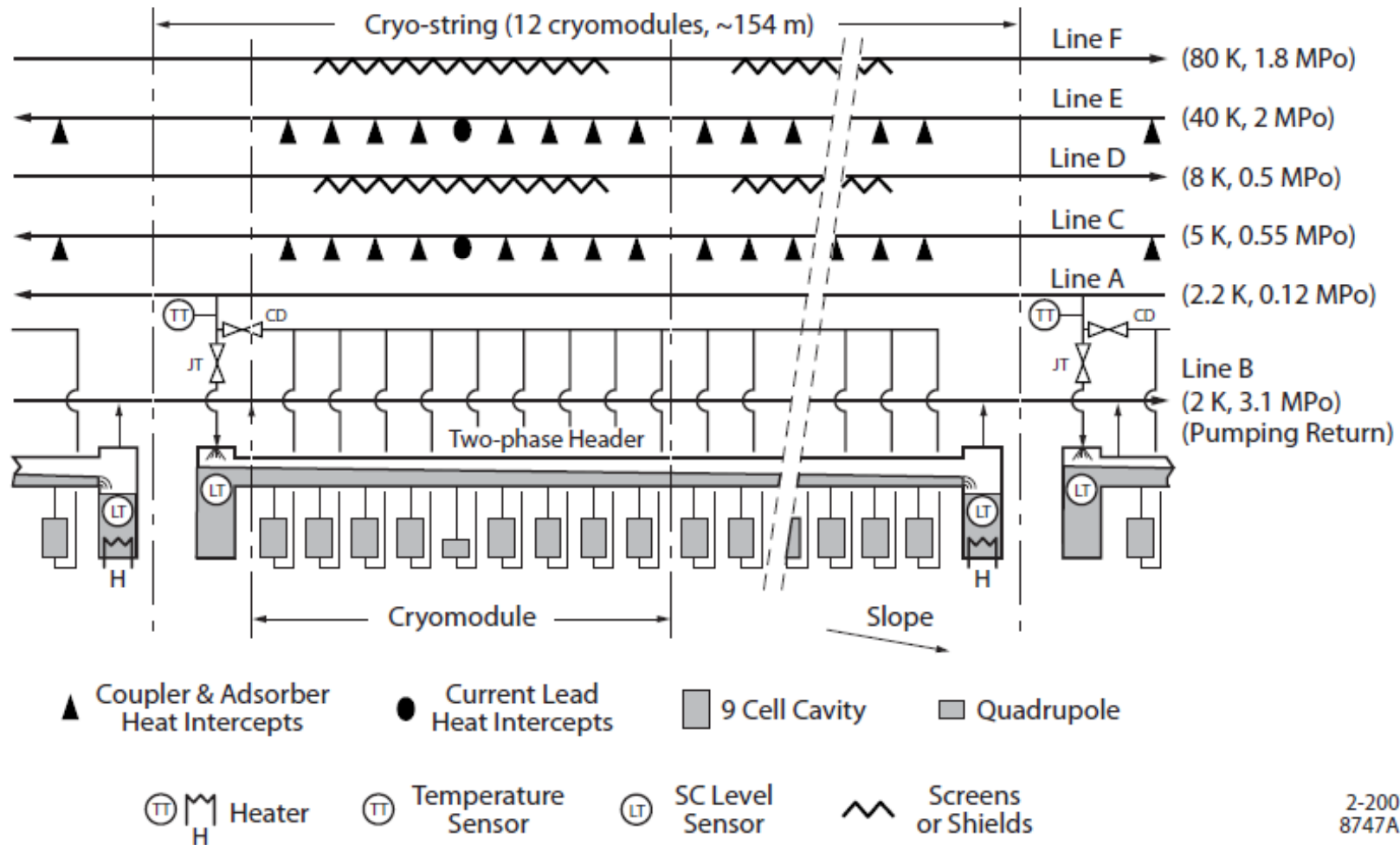
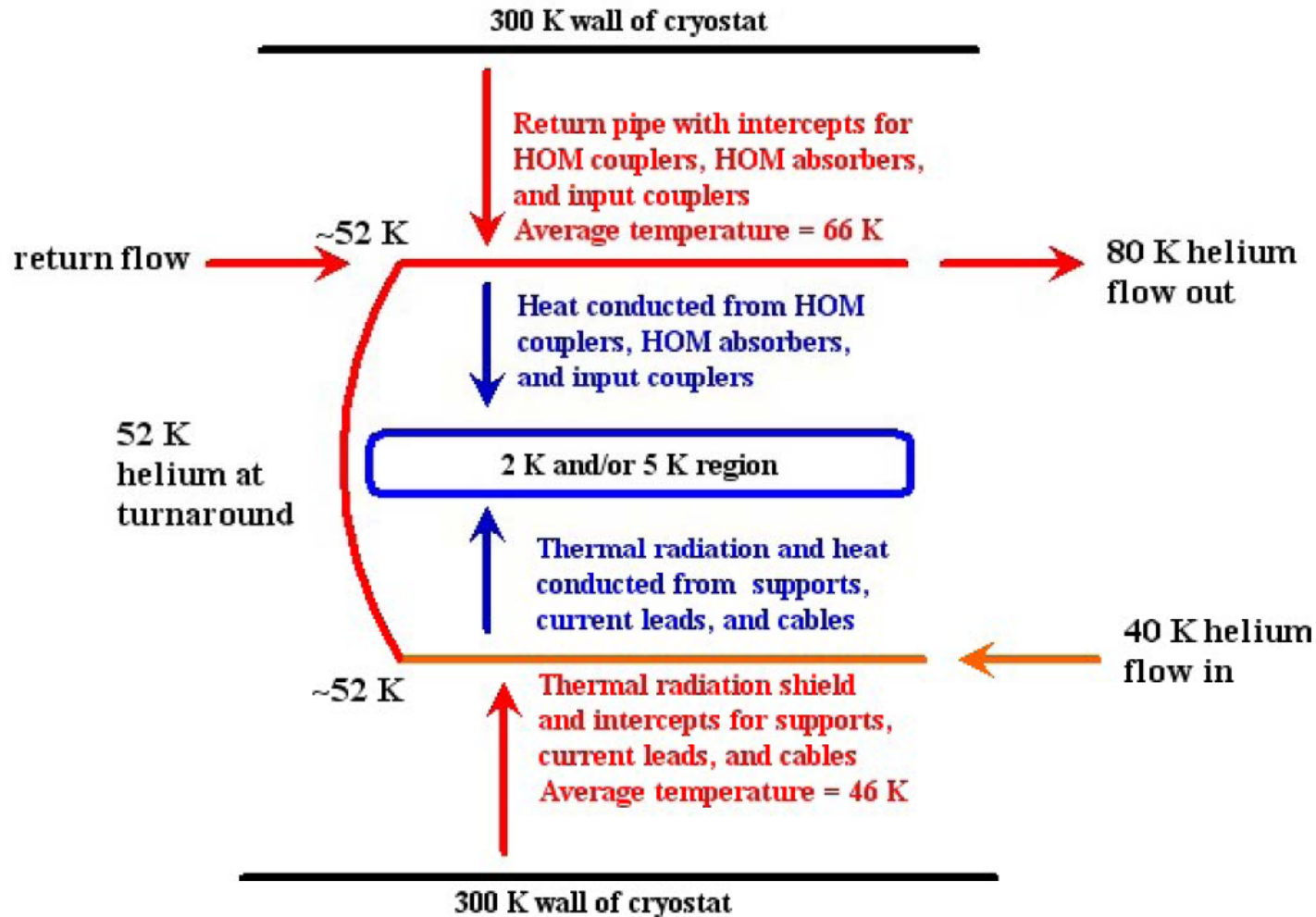


FIGURE 3.8-2. Cooling scheme of a cryo-string.

Cooling scheme by Tom

Allocation of thermal loads to 40 K - 80 K circuit



Modified heat load table for one cryomodule

Heat Load at 2 K				
	With Full 5K shield		Without lower part of 5 K shield	
	Static	Dynamic	Static	Dynamic
Cavity RF loss	0	7.46	0	7.46
Thermal radiation	0.001	0	0.1	0
Supports	0.324	0	0.225	0
Input couplers	0.26	0.16	0.26	0.16
HOM couplers (cables)	0.03	0.18	0.03	0.18
HOM absorber	0.14	0.01	0.14	0.01
Beam tube bellows	0	0.36	0	0.36
Current leads	0.28	0.28	0.28	0.28
HOM to structures	0	1.2	0	1.2
Coaxial cables (4)	0.05	0	0.05	0
Instrument cables	0.07	0	0.07	0
Sum	1.155	9.65	1.155	9.65
Total	10.805		10.805	

Thermal radiation: GRP, 2K LHe supply pipe, cavity jackets have Super Insulation. Emissivity is assumed to be 0.03.

Supports: heat loads are calculated by ANSYS with 3D model.

Input coupler: the heat loads are referred to the paper "TESLA RF Power Coupler Thermal Calculations".

HOM coupler (cables): Cable specifications are referred to the document of the K_03252_D-06.

Heat Load at 5 K				
	With Full 5K shield		Without lower part of 5 K shield	
	Static	Dynamic	Static	Dynamic
Thermal radiation	1.14	0	0.18	0
Supports	2.055	0	1.059	0
Input couplers	1.287	1.32	1.602	1.32
HOM couplers (cables)	2.387	1.82	3.046	1.82
HOM absorber	3.13	0.76	3.13	0.76
Current leads	0.47	0.47	0.47	0.47
Instrument cables	1.39	0	1.39	0
Sum	11.859	4.37	10.877	4.37
Total	16.229		15.247	

Heat Load at 40 K				
	With Full 5K shield		Without lower part of 5 K shield	
	Static	Dynamic	Static	Dynamic
Thermal radiation	54.38	0	54.55	0
Supports	16.62	0	19.03	0
Input couplers	17.63	66.08	16.75	66.08
HOM couplers (cables)	3.619	9.04	2.82	9.04
HOM absorber	-3.27	15.04	-3.27	15.04
Current leads	4.13	4.13	4.13	4.13
Instrument cables	2.48	0	2.48	0
Sum	95.589	94.29	96.49	94.29
Total	189.879		190.78	

Required cooling power

Efficiency in Watts @ 300 K/ Watt

	2K	5K – 8K	40K – 80K
Watts @300K / Watt	702.98	197.94	16.45

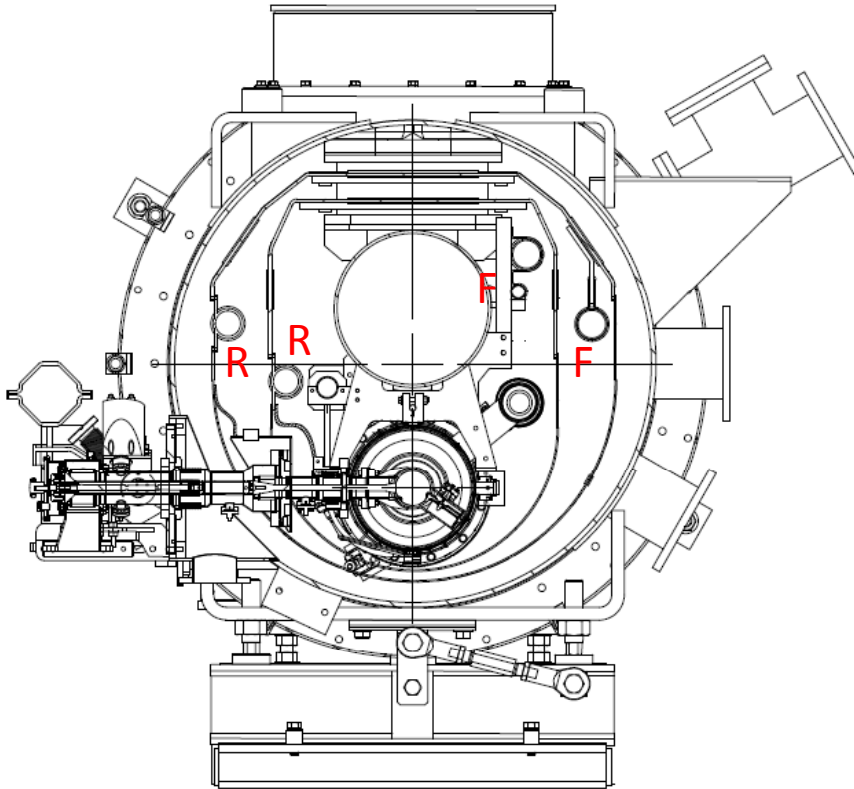
Full 5K shield and present cooling scheme:

$$Q = 10.805 \times 702.98 + 16.229 \times 197.94 + 189.879 \times 16.45 = 1.393 \times 10^4 \text{ W at 300 K}$$

Removing lower part of 5K shield and **the cooling scheme by Tom:**

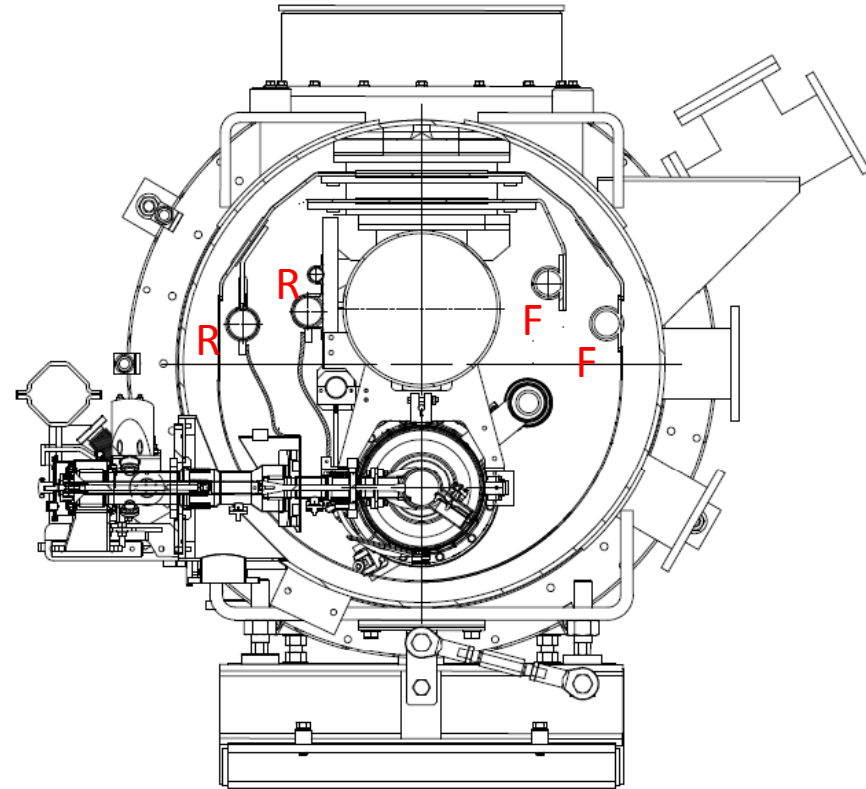
$$Q = 10.805 \times 702.98 + 15.247 \times 197.94 + 190.78 \times 16.45 = 1.375 \times 10^4 \text{ W at 300 K}$$

Present cryomodule cross section



- The design of the thermal intercepts are not matched cooling scheme in RDR.
- The thermal intercepts of HOM are connected to 2K LHe supply pipe.

Cooling scheme by Tom



- Thermal intercepts for HOM coupler and input coupler are connected to the 5K cooling pipe.
- Locations of cooling pipes should be re-arranged.