# S1-G Cryomodule Thermal Performance

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# 1. S1-G cryomodule



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# 2. Cryomodule Thermal Tests and Schedule

#### • Heat load measurements

- Heat loads of the modules are mainly measured by the mass flow rate of evaporated 2K LHe.
- Static heat load of Module A and C
- Dynamic heat load of DESY, FNAL and KEK cavities at the average gradient of 31.5 MV/m
- Heat loads at 4K are measured during the cool-down of modules (back-up measurement).

#### • Temperature profile

- The temperature profiles of the components are automatically measured during all test period.
  - Cool-down and warm-up stages (two times)
  - Operating conditions of cavities.
- Temperature measurement by Cernox, PtCo and CC.

# Thermal Test Schedule

Mon	Tue	Wed	Thu	Fri	Sat	Sun
28	29	30	1	2	3	4
5	3. Lc	ow Powe	er RF Te FNAL	۹ st	10	11
12	Heat Meas	Load . at 2K	<sup>ı₅</sup> Calib. 2K by	Meas. a Heater		18
Holiday	4. Lc	ow Powe (or INFN	er RF Te N/FNAL)	st	Warm	25 up

#### November

Mon	Tue	Wed	Thu	Fri	Sat	Sun	
1	Lorentz	Holiday) Detunin	g Comp	ensatior	6 1	7	
	A-1/C-1	A-2/0-2	A-3/C-3	A-4/C-4			
٤	Dynar	ic Loss	Meas.	12	13	14	
	A-1	A-2	A-3	A-4		/-	
15	5 <sup>16</sup> 4	Cavity	Dynam	c Loss	20	<	
	C	ontrol	A 4 cav	C 4 cav	v.		
22	(Holiday	24 Cavity	Dynan	c Loss	27	28	
		Control	8 cav.	8 cav.		,	

#### October



#### December Tue Wed Fri Sat Mon Thu Sun LLRF Heat Load at 2K Calibration by Heater **DRFS** Preparation 13 DRFS(1) 24 20 25 26 Holida **DRFS** (2) Warm up

Scheduled by Eiji Kako

# 3. Cool-down of S1-G cryomodule

The second cool-down of 8 cavities was started from September 6.



# 4. Heat Load Measurements

#### Calculated Static Heat Load to Cavities, W

	Module-A	Module-C	
Four cavities (wires of temp. sensors)	0.18	0.18	
Four cavities (WPM wires)	0.90	0.0	
Four cavities (Pin diode wires)	0.82	0.82	
WPM connection pipe to the end flange	0.17	~0.0	
Four tuner driving shafts	0.48	0.0	
HOM RF cables	1.24	0.02	
Piezo cables, etc.	0.84	0.03	
Four input couplers	0.17	0.25	
Thermal radiation	+α	~0.0	
Total of each module	4.8 + α	1.3	
Total	6.1 + α		

Volume Flow Meter at room temperature and 1 bar

#### Static heat load measurements

- 1. Measurement of evaporated He gas flow rate with keeping the LHe level in the 2K LHe supply pipe.
- 2. Measurement of evaporated He gas flow rate with keeping 2K LHe only in the 8 cavity-jackets.
- 3. The helium was kept at pressure of 3.1 kPa (T=1.96K).



### Thermal conditions at heat load measurement



## Static heat load measurements at 2 K

	July 12	July 13	July 14	July 15	July 16
Cooling 80K shield by LN2	Cooling stopped at 10 pm	Cooling continued from 8 am <del>&lt;</del>	Cooling all day long	Cooling continued till 17 pm	Cooling started from 8 am
Cooling 5Kshield and cavities by LHe	Cooling stopped 6:30 pm	Cooling stopped at 7:30 pm	Cooling continued from 8 am	Cooling stopped at 5 pm	Cooling started from 3 pm
Heat load at 2.5K	13.1 W	12.2 W	11.8 W		
Heat load at 2.0K including 2K cold box		12.8 W	12.4 W	<b>11.6 W</b> 11.8 W (Once refilling LHe)	12.5 W
Heat load of S1-G cryomodule at 2.0K				7.5 W	
Calibration by heater at 2.0 K			Heat input:10.1 W Measured:10.7 W		

#### Heat load measurements at 5K and 80 K levels

- Heat loads at the 5 K and 80 K temperature levels were calculated with the temperature rises of 5 K and 80 K shields after stopping cooling.
- Temperature data on 30 September were used for the analyses.



#### Temperature sensors

- Module-A
- 80K shield: 12 CC thermocouple sensors
- 5K shield: 14 PtCo resistance thermometers
- Module-C
- 80K shield: 12 CC thermocouple sensors
- 5K shield: 13 PtCo resistance thermometers

### Heat loads on 80 K thermal shields



Heat load= 48.7 W

Heat load= 34.4 W

### Heat loads on 5 K thermal shields



### 5. Temperature profiles of components Temperature profile of FNAL Cavity (July 15)



2010/10/20

#### Temperature profile of DESY Cavity (July 15)



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#### Temperature profile of KEK Cavity (July 15)



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#### Temperature profile of Module-C support posts (July 15)



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2010/7/168

2010/7/16 8

#### Temperature profile of Module-A support posts (July 15)



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# Temperature profiles of 5K and 80K thermal shields of Module C (July 14-15)





# Temperature profiles of 5K and 80K thermal shields of Module A (July 14-15)





# Summary

- 1. The S1-G cryomodule was cooled down to 2 K in the 2<sup>nd</sup> test term, and now the cold tests are being continued. The thermal test including dynamic loss measurements will start from the next week.
- 2. In the 1<sup>st</sup> test term, the static heat loads were measured by evaporation of 2 K LHe and temperature rise of thermal shields.

2 K	5	K	80 K		
A+C	А	С	А	С	
7.5 W	7.3 W	5.3 W	49 W	34 W	

3. The temperature profiles of the components were measured. Thermal analyses by these temperature profiles will be performed from now.