



Crab Cavity Cryomodules: Thermal Budget and Heat Loads

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Engineering Department

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with inputs from O. Capatina, K. Brodzinski, T. Jones, R. Leuxe, Z. Li, H. Park, N. Templeton, S. Verdú Andrés, C. Zanoni, and many others

Crab Cavity Meeting

CERN, Geneva, Switzerland – 31.10.2016



Back to 2013 CC Workshop

HL per cryomodule		HL @2K [W]	HL @80K [W]	Comments
Static	Radiation (Cavity + Phase Sep. Cold surface + Thermal shield)	0.2	6.8	Rescaling from LHC: 0.1W/m ² @cold mass 1.7W/m ² @thermal shield
	CWT	3.0	12.6	1 heat interceptor not optimized
	Supporting system	0.2	3.3	HL@2K estimated from SPL
	RF couplers	2 x 2 = 4.0	2 x 50 = 100	For a tube thickness t = 3mm
	Cables & Instrumentation	1.0	0	Tentative
	Tuner	0.2	0	Not thermalized
	Other order modes	4x0.2 + 2x2 ~ 5.0	100	Max losses found in ODU cryostat: 4 small HOMs (4x0.2W @2K estimated from SPL) + 2 "chimneys" HOM (2x2W @2K for a thickness of 3 mm and a length outside He bath of 340 mm); @80K: 4x? + 2x45W
Total Static		13.6	222.7	
Dynamic	Deflecting mode	6.0	0	Tentative
	Beam current	0.5	0	Tentative
	RF couplers	2 x 2 = 4.0	2 x 5 = 10	For a tube thickness t = 3mm ; P _{avg} = 100 kW
	Other order modes	0.6	10	for a P _{avg} = 100 kW; f = 1000 MHz; @2K chimneys: 2x0.1 + small HOM (estimated from SPL): 4x0.1@2K; @80K: 4x?+2x4
Total Dynamic		11.1	20	
Total losses		24.7	242.7	

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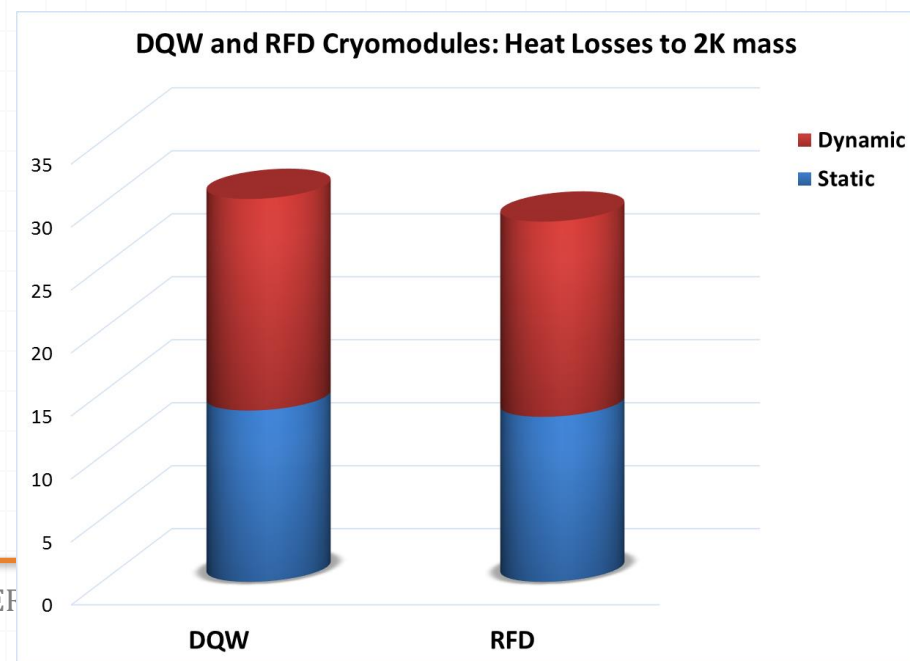


Thermal Budget: October 2016

	DQW		RFD	
	2K	80K	2K	80K
Static				
Radiation	2.5	30	2.5	30
CWT	0.7	0	0.7	0
Supports	2	40	2	40
FPC	4	100	4	100
Instrumentation	1	0	1	0
HOM/Pickup	3.1	40	2.6	30
Tuner	0.3	10	0.3	10
Total static	13.6	220	13.1	210
Dynamic				
Cavity	6	0	6	0
FPC	5.6	10	5.4	10
HOM/Pickup	4.7	10	3.6	10
Beam	0.5	0	0.5	0
Total Dynamic	16.8	20	15.5	20
TOTAL	30.4	240	28.6	230

Some considerations and changes wrt 2013:

- In **italic**: changes with respect to 2013
- From active to **passive cooling**. He gas temperature >50K, 80K considered in the analyses. Heat interceptions via **Cu bands**, design under completion.
- **Supports**: 0.25W from biphase supports + 0.5Wx4 sup +0.2Wx2 FPC reinforcements
- Larger contribution by **radiation losses**: holes in the thermal screen to allow online instrumentation alignment
- **Coaxial lines** necessary for the HOM (standard cables too resistive for the RF @1kW, 1GHz). Same concept for pickups
- **Radiation**: no baffle noir (80K in particular would be ~10W...)



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