DESIGN OF THE LIQUID HELIUM SUPPLY OF THE SOLEIL SUPRACONDUCTING RF SYSTEM

Soleil's poster links:
THP36
THP45

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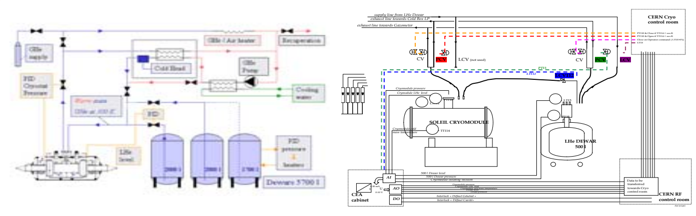
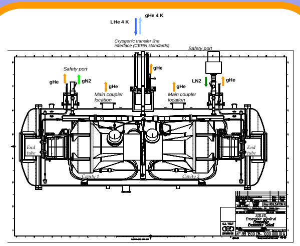
The cryo module:

In the Storage Ring (SR) of the SOLEIL Synchrotron light source, two cryomodules will provide the maximum power of 600 kW required at the nominal energy of 2.75 GeV with the full beam current of 500 mA.
CNRS, CEA and CERN concluded a collaboration agreement for the design, fabrication and test of a cryomodule prototype. After a refurbishment, the prototype will become the cryo module n°1 of SOLEIL.



E.S.R.F. TESTING CONFIGURATION C.E.R.N. SM18



CRYOMODULE (CM1) 2D DRAWING

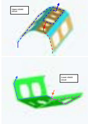
FLUID INTERFACE

Testing

The first cryomodule was installed on the ESRF SR in order to validate the performance with high intensity beam. Four test periods were carried out; each of them allowed 17 hours of stable operation at 4K with LHe from Dewar.

The results were quite satisfying, but these tests pointed out two cryogenic weak points that could be improved:
- Relatively poor cooling on the T-type HOM couplers, it resulted, above 3 MV, in overheating that produced quench-like events with pressure bursts inside the He tank,
- Total static losses evaluated around 120 W instead of 80 W estimated, which is 50% larger than predicted.

COPPER THERMAL SHIELD



LN2 CIRCULATION

	Characteristics	Without LN_2TS	With LN_2TS	Comments
Cold mass	**4 K**			
Radiation				0.15 W/m2 from 80 K
End tubes	Æ 260 SS/Copper	69	14	Cooled with 0.15 g/s/tube
Main couplers	Æ 100 SS/Copper	2	2	Cooled with 0.08 g/s/tube
Conduction				
Transfer line bayonet	Standard CERN (e=0.5mm)	3	3	
Suspension tie rods	Ti alloy	1,5	0,5	
Main couplers		1	1	Cooled with 0.08 g/s/tube
End tubes		2	2	Cooled with 0.15 g/s/tube
HOM antennas		9,5	7,5	
Safety lines		2	2	
Instrumentation		8	2	
Others		2	2	
Convection		0,5	0,5	Vacuum << 10-4 mbars
Static Sub-total at 4 K		**100,5**	**36,5**	**W @ 4K**
LN_2 Thermal shield	**80 K**			
Radiation	MLI (2 x 15 layers)			Average value 5 W/m2
Cylindrical part	13		65	5
Extremity plates	1,9		9,5	
Chimney shield	0,55		3	
Conduction				
HOM antennas	0,2 mm SS		7,5	
HOM antennas	10 mm Cu RRR=100		2	
Suspension tie rods			1	
Instrumentation wires			6	
Convection			1	Vacuum << 10-3 mbars
Sub-total at 80 K			**95**	**W @ 80K**
Dynamic losses	**4K**			
Cavities	25 W /cell	50		qq MV/m
HOM antennas mono	4 W / antenna	8		
HOM antennas dipo	1 W / antenna	2		
Dynamic Sub-total at 4 K		**60**		
Global				
Refrigeration part	per cryomodule	86,5	96,5	W @ 4K
Transfer line	LN2 cooled	4	4	W @ 4K
Inlet Phase separator	4 K outlet heated to 300 K	6	6	l/h
Liquefaction rate	per cryomodule	37	14	l/h

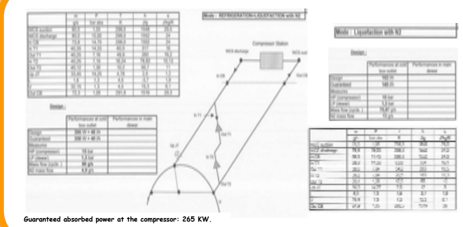
Upgrading of the Cryomodule

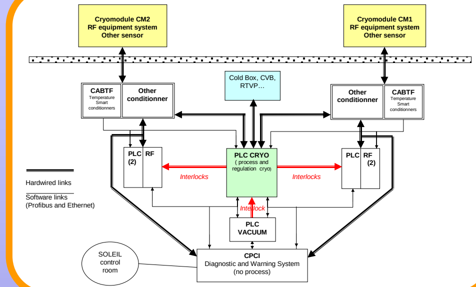
For the T-type HOM couplers, in order to improve the cooling efficiency, the LHe feeding connection was moved towards the cryomodule bottom.
For reducing the high static losses, a copper thermal shield, cooled by liquid nitrogen, has been inserted. Thermalisation straps anchored on the shield were introduced to draw heat out of the HOM couplers, the bulky tuning system, the coaxial lines, etc… The He circuitry was modified to accommodate the shield.
The instrumentation, temperature sensors (carbon type) with wider operating range (CERNOX) were mounted for proper survey of the cool-down from 300K down to 4K; each of them is mounted on a sensor holder.

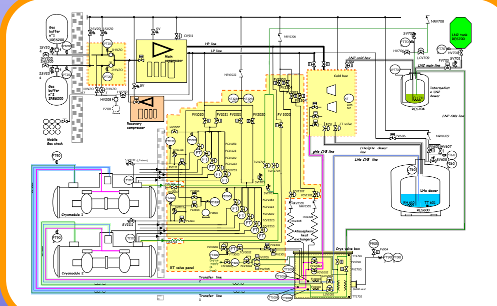
Under construction

Installation of all modules is done, piping and cabling is currently being done.

Conditioning and first tests will occur October in order to assume cool down the cryo module at end of November.







CONTROL SYSTEM GENERAL ARCHITECTURE

CHARACTERISTICS OF SOLEIL'S AIR LIQUIDE HELIAL 2000

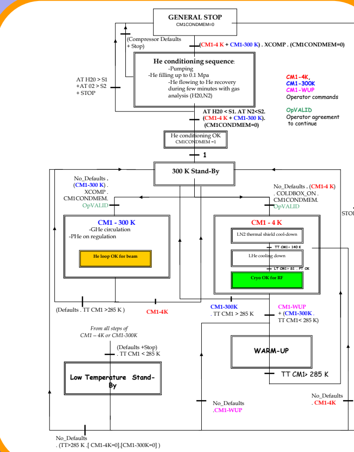
PRELIMINARY LEVEL I GRAFCET

CRYOPLANT GENERAL PID

CRYOPLANT SITUATION

WHAT LED US TO LIQUID NITROGEN FACILITY?

CRYOGENIC TRANSFER LINES HANGING



Liquid nitrogen precooling allows increasing of global efficiency:

- Smaller liquefactor and lower cost
- Lower electric consumption

Liquid nitrogen facility cost is balanced with the global gain on efficiency and flexibility.

Liquid nitrogen thermal shield cooling for cryomodule:

- Important decrease of static losses,
- Possibility of cold stand alone without liquefactor,
- Stability at low temperature reached faster.

Liquid nitrogen thermal shield cooling for cryo transfer lines LHe:

- Important decrease of static losses,
- Participate in increasing of global efficiency of liquefactor