QRL Sector Tests– Cryogenics

What are the tests for?

The tests are done in order to verify the conformity of the QRL with the specifications stipulated in the technical specification LHC-QRL-CI-0001.

OK => deliver Certificate of Provisional Acceptance

Problems => Repair & restart

What are the QRL tests not intended for?

The QRL tests are not aimed at validating other LHC systems

 \Rightarrow As long as schedule is not compromised OK

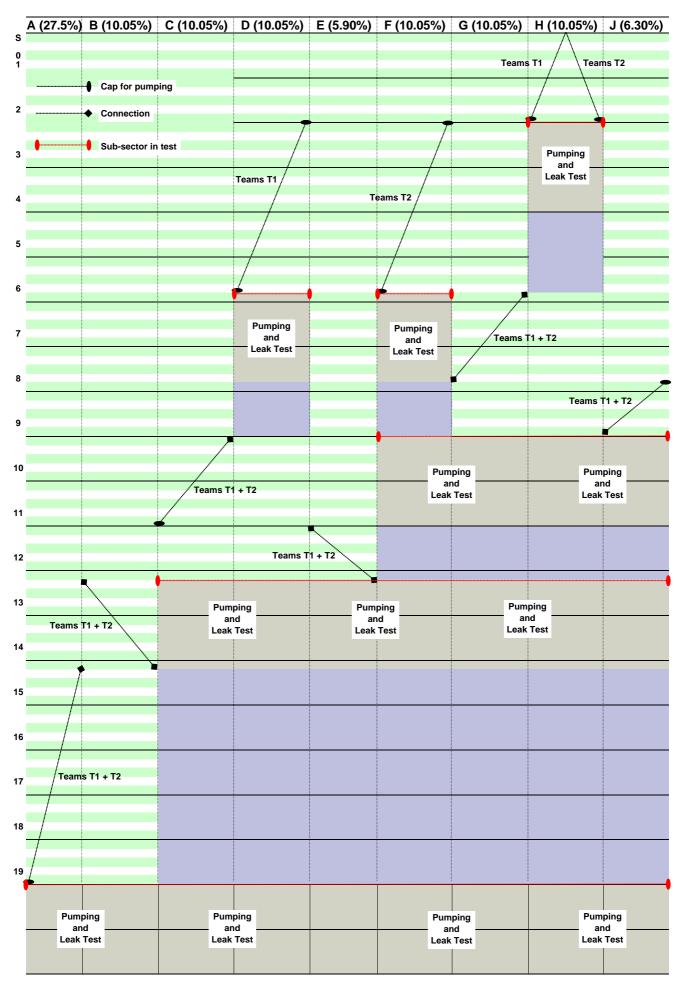
Schedule

- The tests run from late 2003 until early 2006.
- No parallel tests of QRL sectors are foreseen
- Electrical crates need to be removed before magnet installation
- QRL is on the LHC critical path

Roger GIRARDOT		LHC CRYO : QRL Installation-Schedule	CAUTION: CERN CALENDAR WITH 2 WERKS CLOSED BND OF EACH YEAR				
Révision du 20.02.02 Estision du Wed 27-03-02		MARS 2002					
ID Task Name	2003	2004 1213/415 517/1819	2005				
1	17-11	15.07 15.11	15:01				
² CRITICAL PERIODS							
⁸ Contract ¹³ End Install 7 - 8	End Install. 7 - 8						
 End Install. 7 - 8 End Install. Last sector 			End Install. Last sector				
¹⁵ 8 Sectors (2*21 / 6*19 Weeks)							
	Supports: 8 Wks Pumping: 3 Wks Pumping: 3 Wks	Cold Teste Discon: 19 Wite					
²¹ Sector 8 - 7	1000 (01-12	0 12:00					
22 Sector 8 - 7	07-11 01-12						
 Vacuum + PressLeak Test + Instrum. Supports: Measure + Install. 	1606		· ····································				
25 Cold Tests	01-12	0500					
26 Disconnecting QUI 27 Sector available	ector available 😦 '30-05	0600 1200					
³⁰ Timing 2 - 3	Supports: 8 Wks Installation	n: 21 Wis Cold TeshDiscon: 9Wis					
³⁵ Sector 2 - 3 (3 Weeks superposed)	16.09	x ³¹⁹⁶⁵ C 0907					
³⁶ Sector 2 - 3	10-11	16-04					
 Vacuum + PressLeak Test + Instrum. Supports: Measure + Install. 	16.09	1604 10:05					
38 Supports: Measure + Install. 39 Cold Tests		10.06					
40 Disconnecting QUI	Sector available 12.09	05-07 🔽 09-07					
41 Sector available	Jeutra avandure	Supports: 8 Wks Installation: 19 Wks Cold Test+Discon: 9Wks					
 ⁴⁴ Timing 8 - 1 ⁴⁹ Sector 8 - 1 (5 Weeks superposed) 	+	09-02					
50 Sector 8 - 1 (5 Weeks superposed)	╊╴╍┥╴┙┥┥┙┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥	05.04					
51 Vacuum + PressLeak Test + Instrum.		13.0806.09					
52 Supports: Measure + Install. 53 Cold Tests		06/02 05/04					
54 Disconnecting QUI		01-11 06-11					
55 Sector available	Sector available 01-08 Tunnet Floor Available 14-11	Supports: 8 Wes Installation: 19 Wes Cold Tests	Oiscon: 9M/s				
58 Timing 6 - 7		oupports	Jacon: ywys				
63 Sector 6 - 7 (10 Weeks superposed) 64 Sector 6 - 7		28-06					
65 Vacuum + PressLeak Test + Instrum.	╊╴╍┥╴┙┥┥┙┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥┥	0511" 2911					
66 Supports: Measure + Install.		23-06					
67 Cold Tests 68 Disconnecting QUI			04/2				
69 Sector available		Sector available 💼 18-06					
72 Timing 2 - 1		Supports: 8 Wks Installation: 19 Wks	Cold Test-Diacon: SWis				
⁷⁷ Sector 2 - 1 (10 Weeks superposed)		240"12 00] 646					
 78 Sector 2 - 1 79 Vacuum + PressLeak Test + Instrum. 		2009	1142				
80 Supports: Measure + Install.		23-07 20.09					
81 Cold Tests			2004				
B2 Disconnecting QUI Sector available	Sector available 31-10		ucu 🛛 060				
16 Timing 8 - 7 21 Sector 8 - 7 22 Sector 8 - 7 23 Vacuum + PressLeak Test + Instrum. 24 Supports: Measure + Install. 25 Disconnecting QUI 27 Sector available 30 Timing 2 - 3 35 Sector 2 - 3 36 Sector 2 - 3 37 Vacuum + PressLeak Test + Instrum. 38 Supports: Measure + Install. 39 Cold Tests 40 Disconnecting QUI 41 Sector available 44 Timing 8 - 1 45 Sector 8 - 1 46 Sector 8 - 1 57 Vacuum + PressLeak Test + Instrum. 58 Sector 6 - 7 59 Sector 6 - 7 50 Sector 6 - 7 51 Vacuum + PressLeak Test + Instrum. 56 Sector 2 - 1 50 Sector 2 - 7 51 Vacuum + PressLeak Test + Instrum. 52 Supports: Measure + Install. <td></td> <td>Supports: 8 Wks</td> <td>Installation: 19 Wks Cold Test-Discon." 9Wks</td>		Supports: 8 Wks	Installation: 19 Wks Cold Test-Discon." 9Wks				
⁹¹ Sector 6 - 5 (10 Weeks superposed)			12 13 11% p3000 0 29 07				
92 Sector 6 - 5		13/2	0605				
93 Vacuum + PressLeak Test + Instrum. 94 Supports: Measure + Install.							
95 Cold Tests			3005 22/07				
		Sector svalisble 📑 13:06 📷 17.09 Tunnel Floor Available	2507 5 2907				
 97 Sector available 100 Timing 4 - 5 		Sector available 13:08 17.09 Tunnel Floor Available	Supports: 8 Wks Installation: 19 Wks Cold TetanDiscon: 9Wks				
	╊╶╍╍╺╌╍╌╌╌╌╌╌╌╌╌╌╌╌╌╌╌╌╌╴		2401 200 21:40				
¹⁰⁵ Sector 4 - 5 (10 Weeks superposed) ¹⁰⁶ Sector 4 - 5	╊╶╍╍╺╌╍╌╌╌╌╌╌╌╌╌╌╌╌╌╌╌╌╌╴		2103 2807				
107 Vacuum + PressLeak Test + Instrum.			2907 2208				
108 Supports: Measure + Install. 109 Cold Tests			2401 22206 1410				
110 Disconnecting QUI			17-10 21-10				
111 Sector available		Sector available 26.03					
ining i o			Supports: 8 Wer Installation: 19 Wer Cold Test/Decort: 9 We				
¹¹⁹ Sector 4 - 3 (10 Weeks superposed)							
120 Sector 4 - 3 121 Vacuum + PressLeak Test + Instrum. 122 Supports: Measure + Install.			21:10				
			1804				
123 Cold Tests			14-11 20				

	GRAROT da: 2020.02 da: Wal 7:765 02	LHC CRYO: QRL Installation-Schedule MARS 2002					CAUTION: CERN CALENDAR WITH 2 WEEKS CLOSED END OF EACH YEAR		
-		2003			2004			2005	
ID 124	Task Name Disconnecting QUI						1 2 3 4 5 6 7 8 9		1 2 3 4 5
124 125 128	Sector available		Sector available	2 1 6-01	Tunnel Floor Available			T.S. 26:08	
	Technical Specification: 28 August								

Scenario:19 weeks installation with 2 teams (2 x 8h00)



Reception Tests

After installation of each QRL sector reception tests will be done to:

- Verify correct operation of components (sensors, actuators)
- Verify mechanical characteristics
- Asses overall behavior at cryogenic conditions
- Measure the thermal performance

QRL Sector Tests– Cryogenics

Test Procedure

- After assembly of the QRL (sub) sector, the insulation is pumped out and both leak & pressure tests are performed.
- "Magnets" are replaced by "test Boxes" housing interconnecting pipes.
- Test 1: Circulation of cold helium only in the main headers (pipes)
- Test 2: Circulation along headers & interconnection pipes in "test Boxes".

Process Characteristics

- Cryogenic equipment is extremely slow
- Measurement of thermal properties is even slower, static conditions are required.
 <u>accuracy</u> of instrumentation is the issue
- No disturbances due to circulating particles beam, eddy currents,.....
 => No very complex dynamics => Control shall be much simpler than for the LHC
- => Programming shall be straightforward

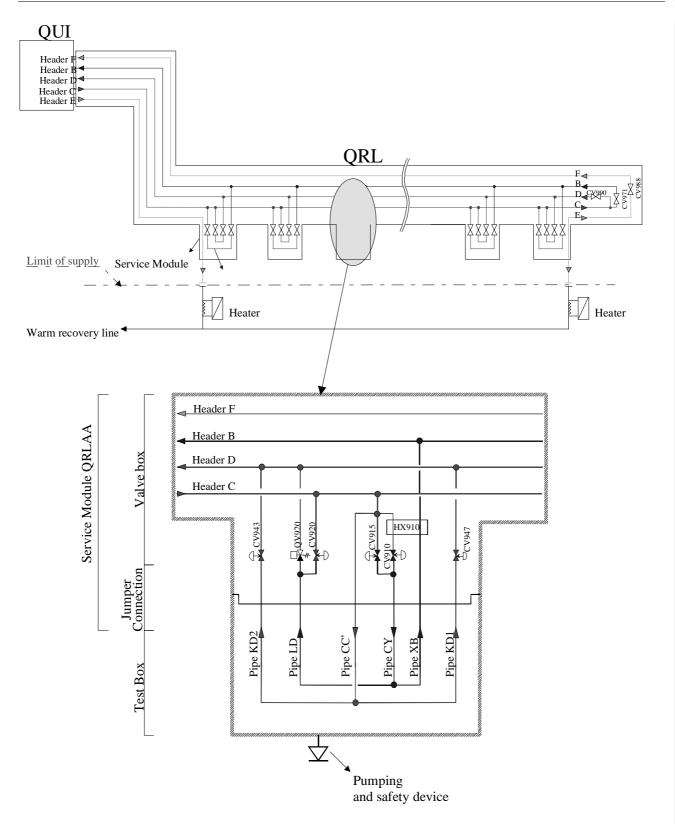


Figure 12-1: Typical base frame flow-scheme of a QRL Sector

QRL Sector Tests– Cryogenics

Requirements for tests

- Access to tunnel already 8 weeks before installation
- Utilities: electrical power, compressed "air", ...
- Adjacent cryogenic refrigeration
- Control Infrastructure: Ethernet network, "piquet" calls
- Vacuum in full operational status
- Cables
 - WorldFIP (digital)
 - alcove ⇔ QRL Service Module (SM)
 - QRL SM ⇔ Local electronics
- Cryogenic (industrial) control equipment in operational status
- World FIP equipment for signal readout
- Wireless communications for safety & mobile SCADA

Open Issues

- Position of controllers (Alcoves or local control room) room) reliability vs equipment reliability
- Valve positioner not yet chosen, it can be of either "smart" or "analog pneumatic" type
- LHC type electronic cards will not be on ready until mid-2004
 => Use (fabricate) prototypes for missing parts
 - => Shuffle IO crates to QRL sector under test
 <= Evacuation of electronics imposed by</p>

installation of cryo-magnets

Conclusions

Schedule is tight and all "LHC solutions" will not be ready for the first QRL reception test, but fallback solutions are (already) available.

"Field Network" for tunnel cryogenics

For Cryogenics the control system is highly distributed:

- WorldFIP and analogue wires are used to exchange information with the field (tunnel),
- Ethernet is used for exchanging information with "WorldFIP interfaces",
 - "Schneider remote IO" and "Schneider controllers".

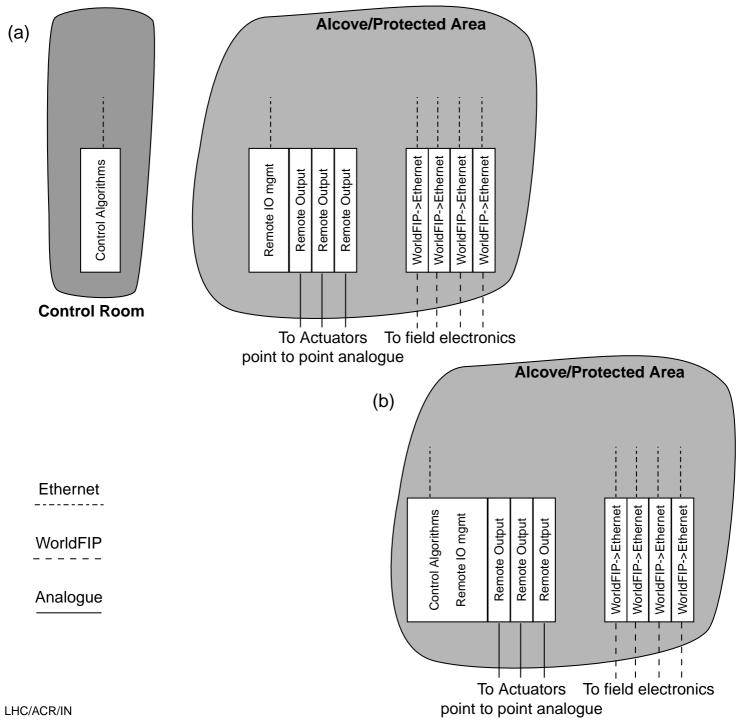
The closed control loop algorithms are calculated in the controllers.

Case (a): Ethernet must be available during all phases concerning installation, commissioning & operation of cryogenic equipment.

Case (b): Ethernet availability is required only locally. Wide area Ethernet still required for SCADA or data server applications.

Note that it is not completely ruled out that one day WorldFIP interfaces may be integrated directly onto the PLC backplane.

How are the network connections routed?



LHC Cryogenic crate for tunnel

