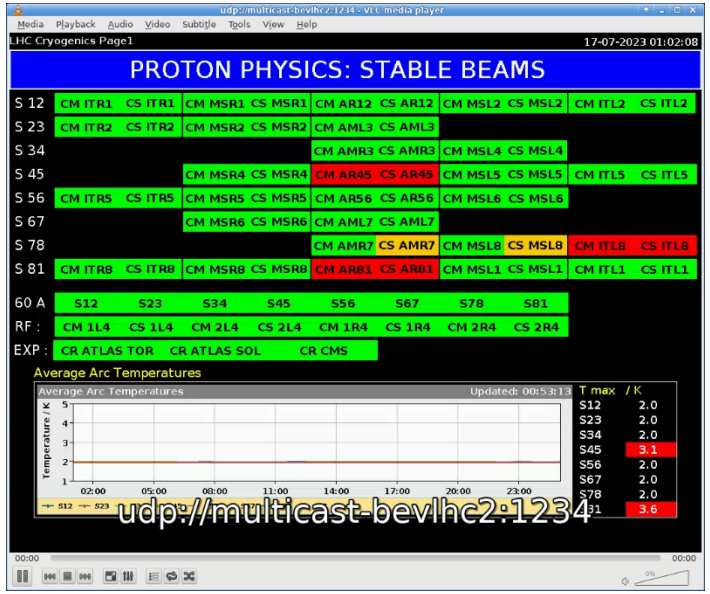
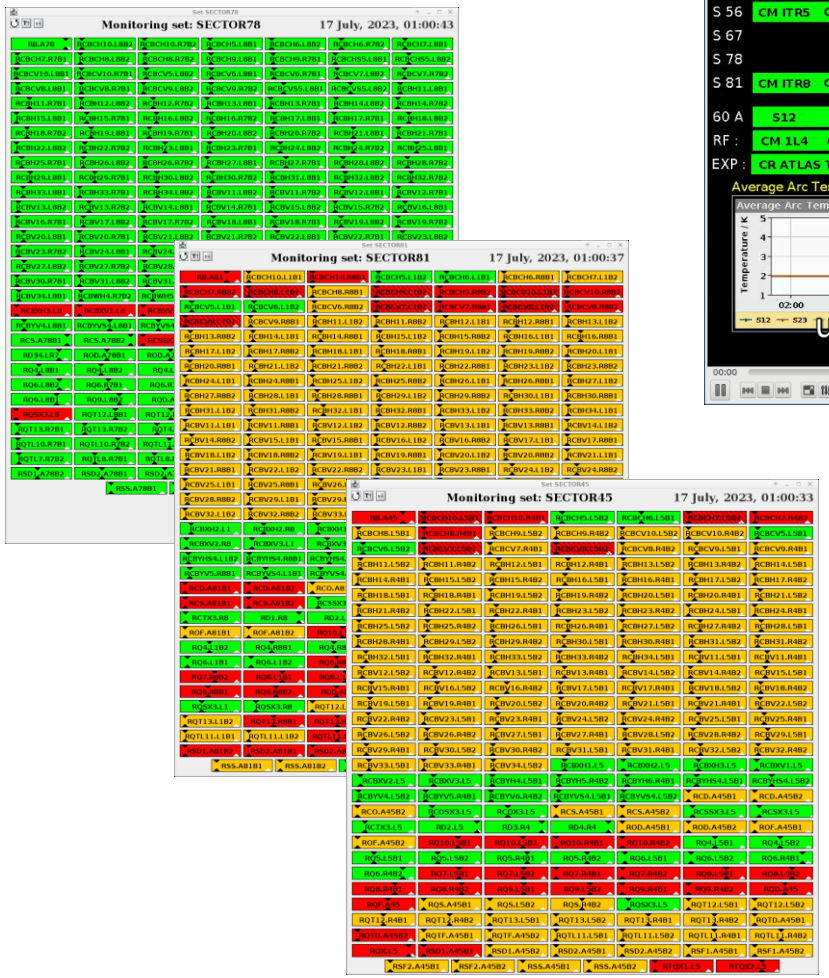
IT.L8 event on 17/7/23 at 1 AM

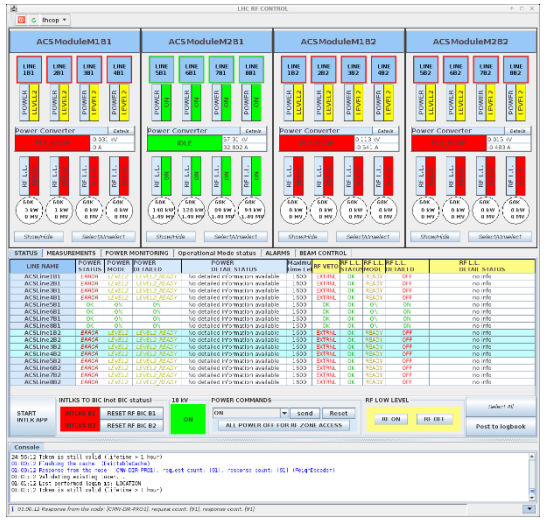
(some material quickly copy-pasted from 3 meetings in the CCC)

Observation in CCC

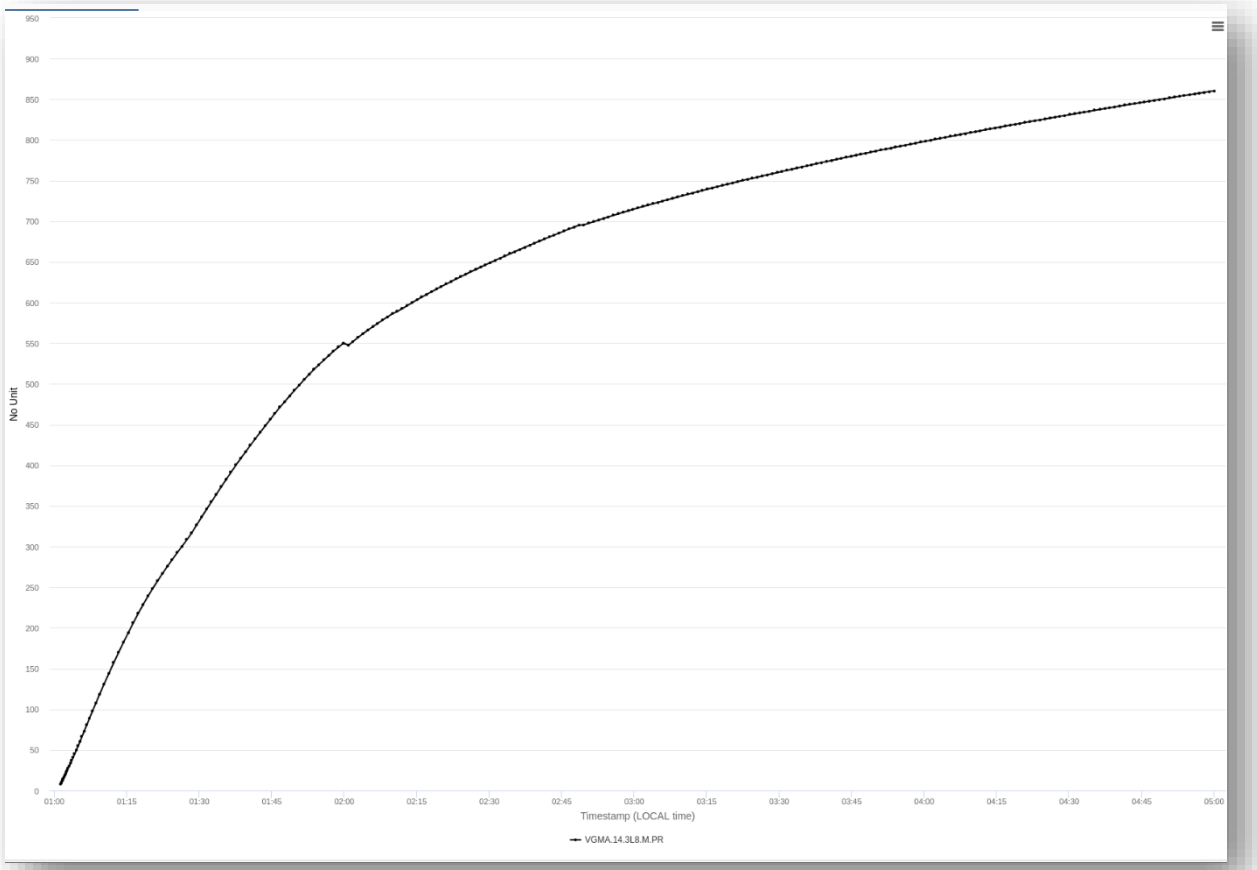
- Beams dumped at 01:00:17 by **RF trip**
- Few hundreds of milliseconds later **several magnets quenched**:
  - RQ7/9/10.R4
  - RQ10.R8
  - RQX.L8
- The heat wave generated by RQX.L8 quench made **IP8 cold compressor trip**







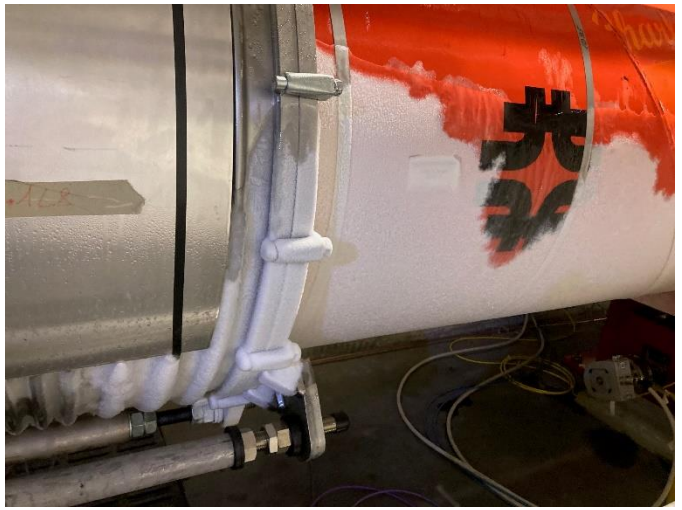
Observation in CCC



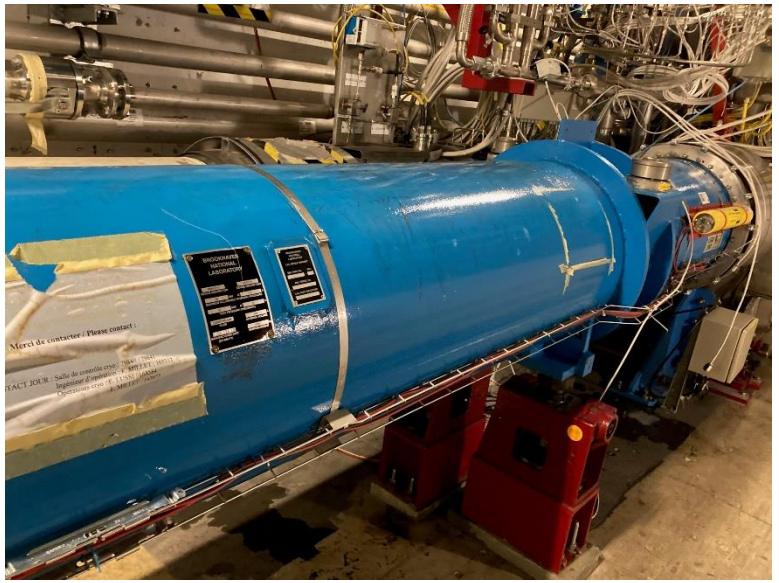
- Following the quench, the insulation vacuum **pressure increases**
- Indication of a **possible leak** in the vacuum vessel


P7
DFBMH
Q6
DFBAN
DFSM
Q7
Q9
Q11
Q13
CRYO. :
ELEC. :
Magnet VAC. :
06R7
VACSEC.A6R7.M
CRYO-CELL 7_9 R7
CRYO-CELL 11_13 R7
07R7
08R7
09R7
10R7
11R7
12R7
13R7
14R7
15R7
VACSEC.A7R7.M
VACSEC.A11R7.M
Q15
Q17
Q19
Q21
Q23
Q25
CRYO-CELL 15_17 R7
CRYO-CELL 19_21 R7
CRYO-CELL 23_25 R7
16R7
17R7
18R7
19R7
20R7
21R7
22R7
23R7
24R7
25R7
26R7
27R7
VACSEC.A15R7.M
VACSEC.A19R7.M
VACSEC.A23R7.M
Q27
Q29
Q31
Q33R
Q33L
CRYO-CELL 27_29 R7
CRYO-CELL 31 R7_33 L8
28R7
29R7
30R7
31R7
32R7
33R7
34R7
34L8
33L8
32L8
VACSEC.A27R7.M
VACSEC.A31R7.M
VACSEC.A31L8.M
Q31
Q29
Q27
Q25
Q23
Q21
CRYO-CELL 31_29 L8
CRYO-CELL 27_25 L8
CRYO-CELL 23_21 L8
31L8
30L8
29L8
28L8
27L8
26L8
25L8
24L8
23L8
22L8
21L8
20L8
VACSEC.A27L8.M
VACSEC.A23L8.M
VACSEC.A19L8.M
Q19
Q17
Q15
Q13
CRYO-CELL 19_17 L8
CRYO-CELL 15_13 L8
19L8
18L8
17L8
16L8
15L8
14L8
13L8
12L8
VACSEC.A15L8.M
VACSEC.A11L8.M
P8
LHCb
Q11
Q9
Q7
DFSM
DFBAO
Q6
DFBMC
Q5
DFBMA
Q4
D2
D1
DFBXG
Q3
Q2
Q1
CRYO-CELL 11_9 + Q7 L8
11L8
10L8
09L8
08L8
07L8
06L8
05L8
04L8
03L8
02L8
01L8
VACSEC.A7L8.M
VACSEC.A6L8.M
VACSEC.A5L8.M
VACSEC.A4L8.M
VACSEC.A1L8.M
Sector 7-8

Tunnel visit



- Condensation clearly visible on **Q1/2/3**
- Some (less) on **D1 and DFBX**

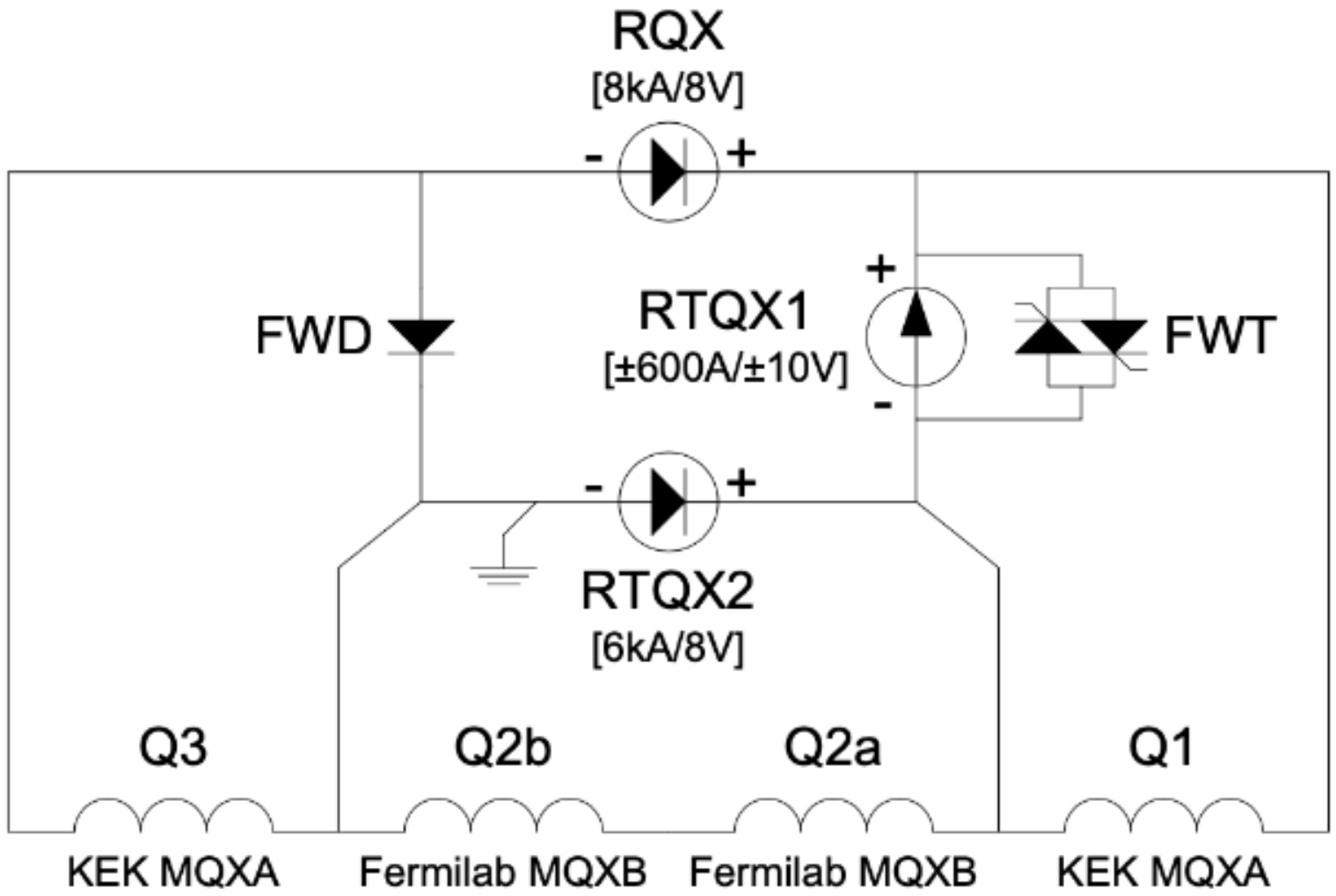


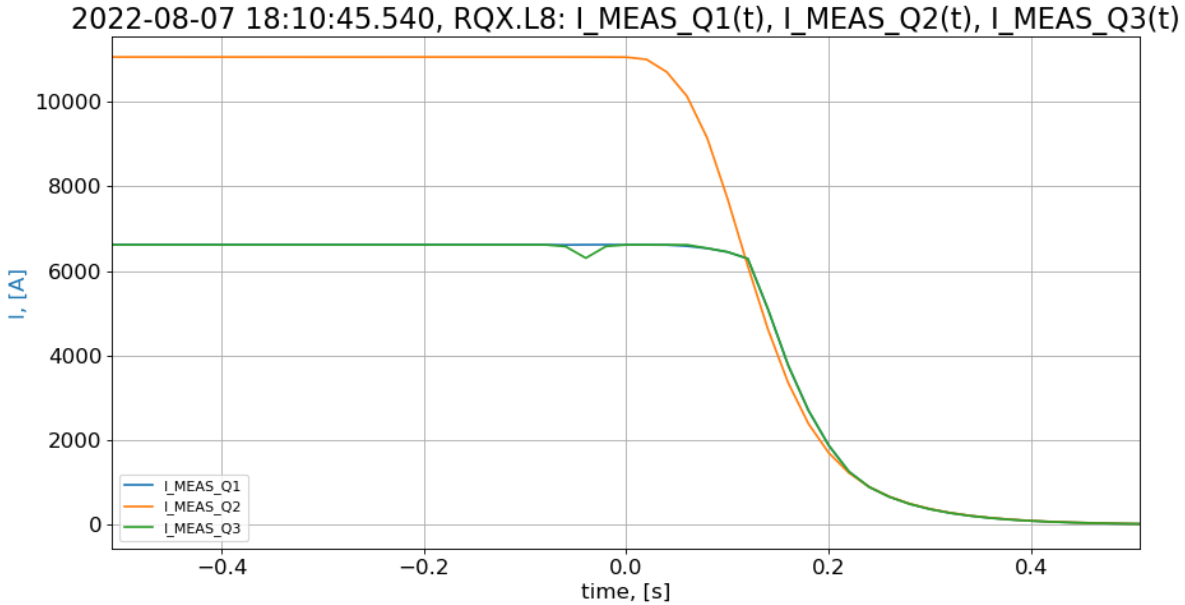
DFBX & D1 Monday at ~11h

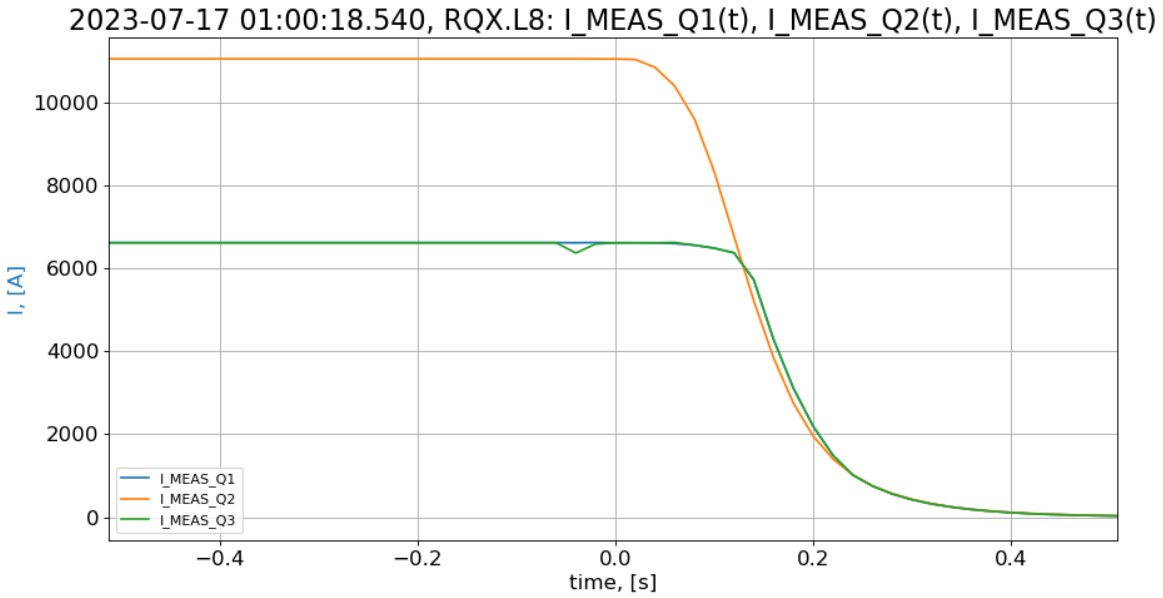
➔ Condensation on DFBX + D1, but no ice
(was probably iced before, wet on the ground)

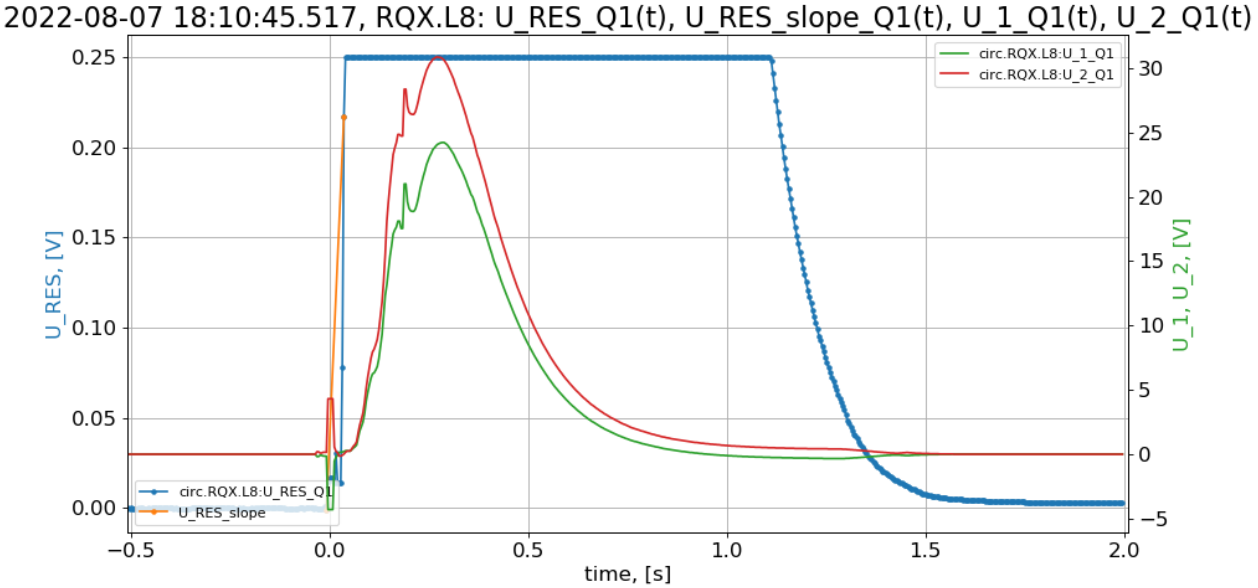
Circuit IT.L8

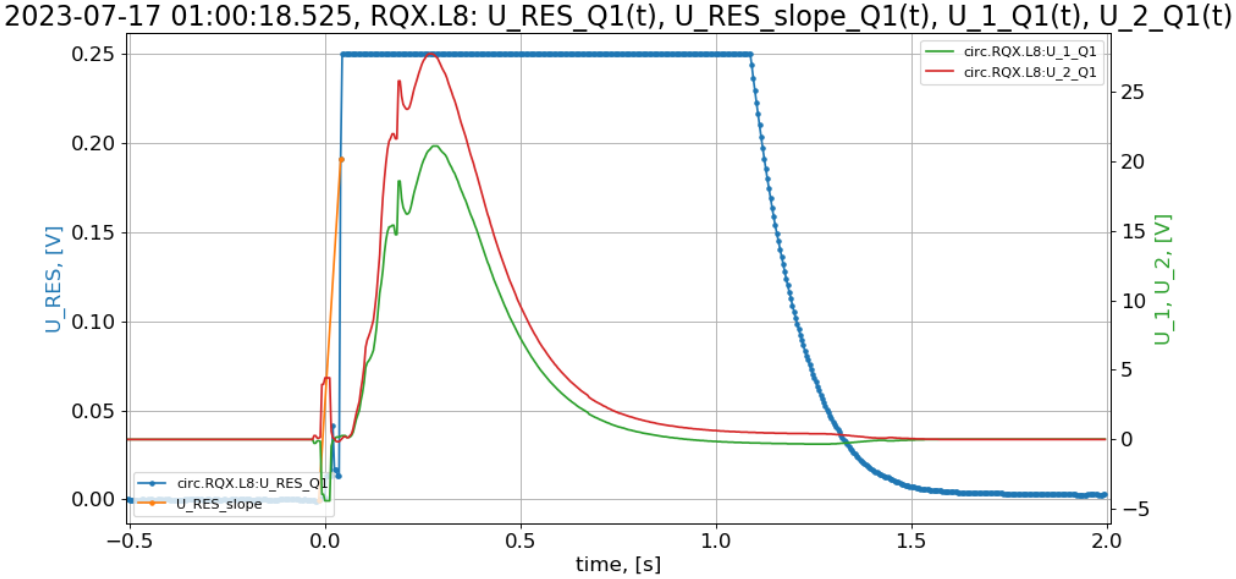
Nominal values	
I_RQX	6617 A
I_RTQX1	- 5 A
I_RTQX2	4428 A
I_Q1=I_RQX+I_RTQX1	6612
I_Q2=I_RQX+I_RTQX2	11044
I_Q3=I_RQX	6617



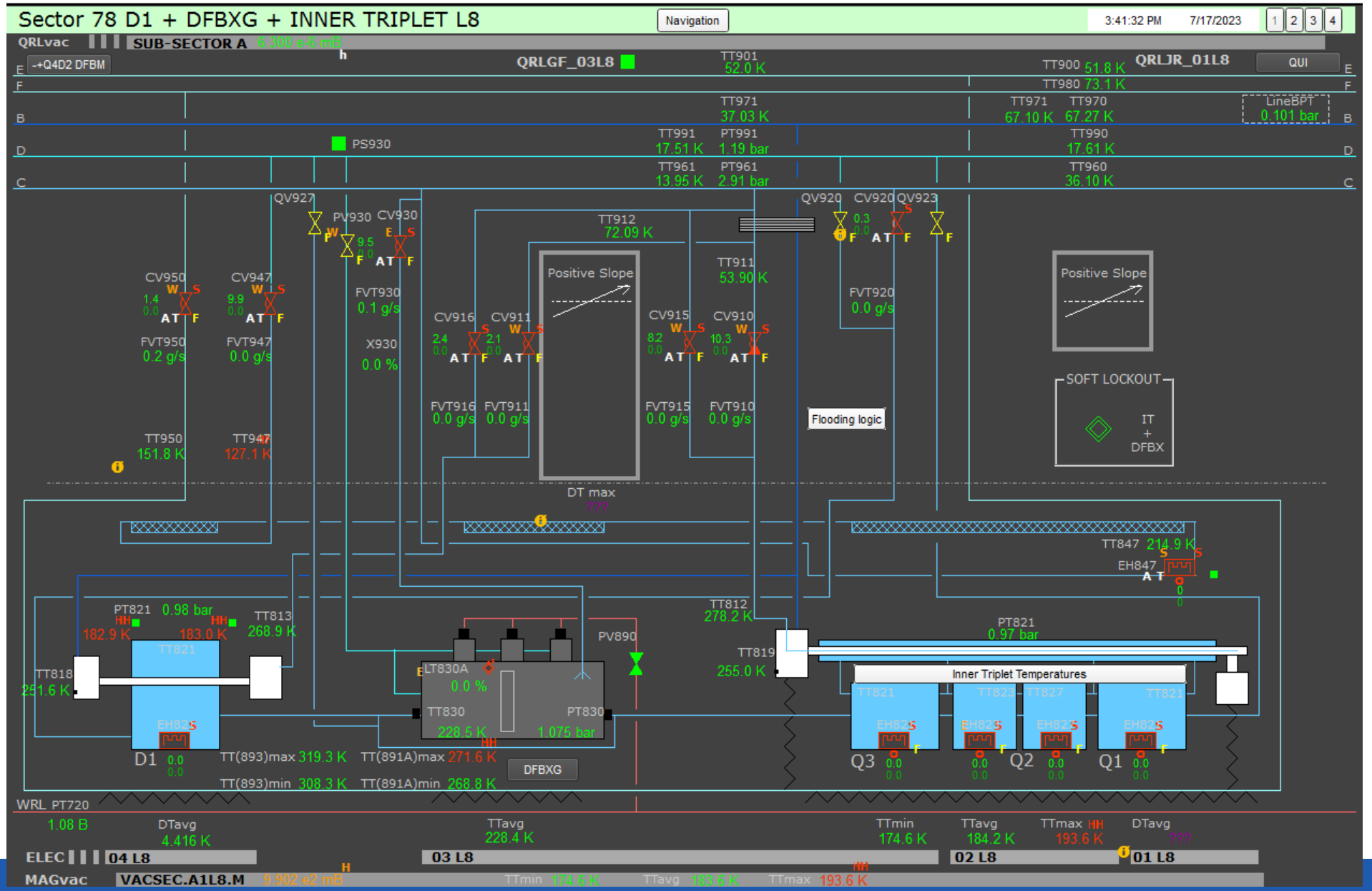

2022-08-07 18:10:45.540, RQX.L8: I_MEAS_Q1(t), I_MEAS_Q2(t), I_MEAS_Q3(t)
I, [A]
time, [s]
I_MEAS_Q1
I_MEAS_Q2
I_MEAS_Q3


2023-07-17 01:00:18.540, RQX.L8: I_MEAS_Q1(t), I_MEAS_Q2(t), I_MEAS_Q3(t)
I, [A]
time, [s]
I_MEAS_Q1
I_MEAS_Q2
I_MEAS_Q3


2022-08-07 18:10:45.517, RQX.L8: U_RES_Q1(t), U_RES_slope_Q1(t), U_1_Q1(t), U_2_Q1(t)
U_RES, [V]
U_1, U_2, [V]
time, [s]
circ.RQX.L8:U_1_Q1
circ.RQX.L8:U_2_Q1
circ.RQX.L8:U_RES_Q1
U_RES_slope

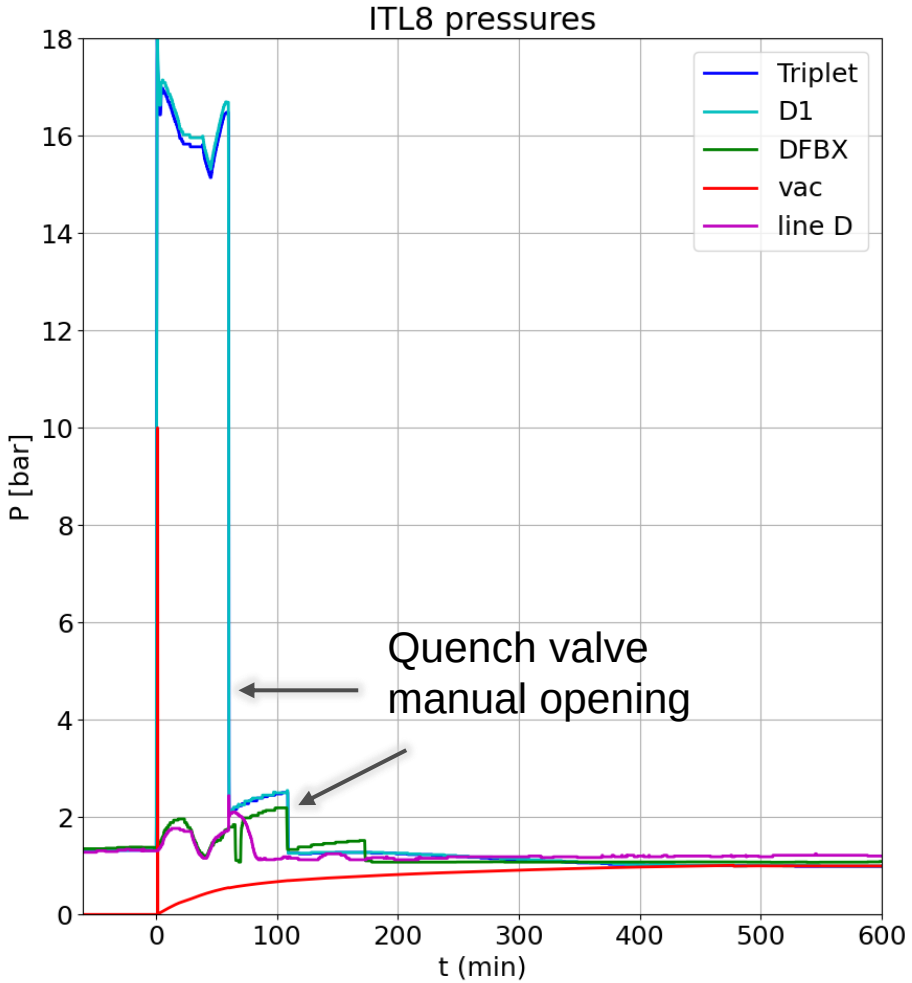

2023-07-17 01:00:18.525, RQX.L8: U_RES_Q1(t), U_RES_slope_Q1(t), U_1_Q1(t), U_2_Q1(t)
U_RES, [V]
U_1, U_2, [V]
time, [s]
circ.RQX.L8:U_1_Q1
circ.RQX.L8:U_2_Q1
circ.RQX.L8:U_RES_Q1
U_RES_slope

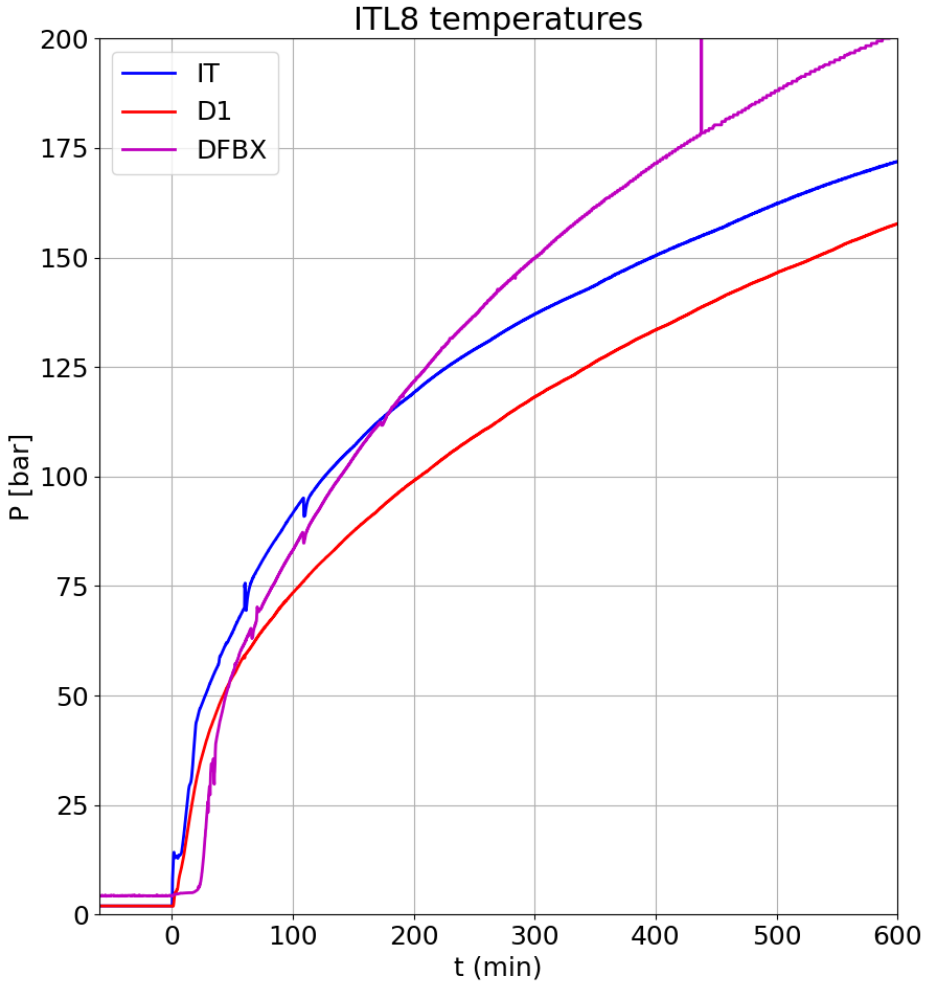
- IT & D1 & DFBX are thermally coupled and share the same insulation vacuum
- IT & D1 share the same superfluid helium bath

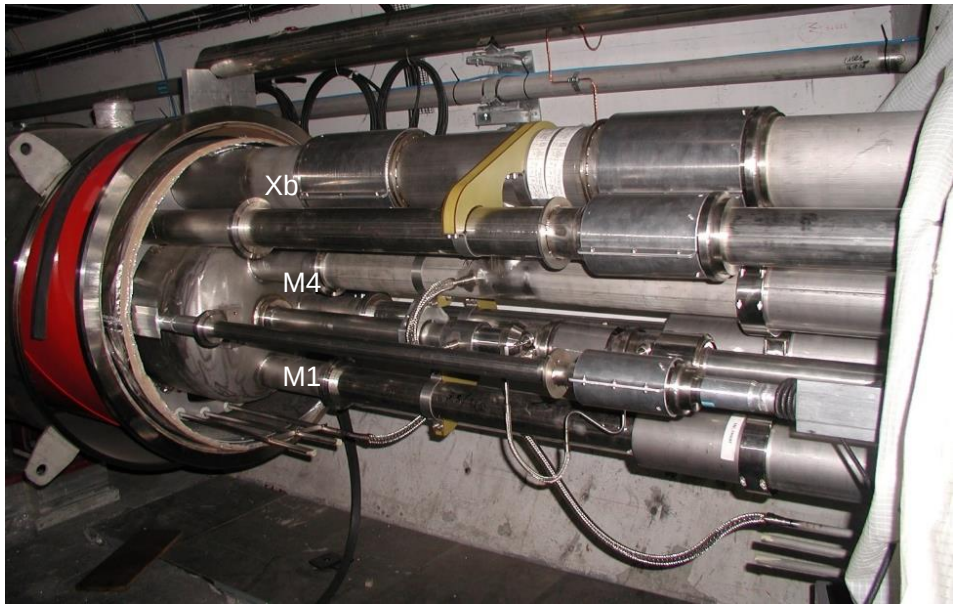


IT-D1-DFBX L8: general cryo trends

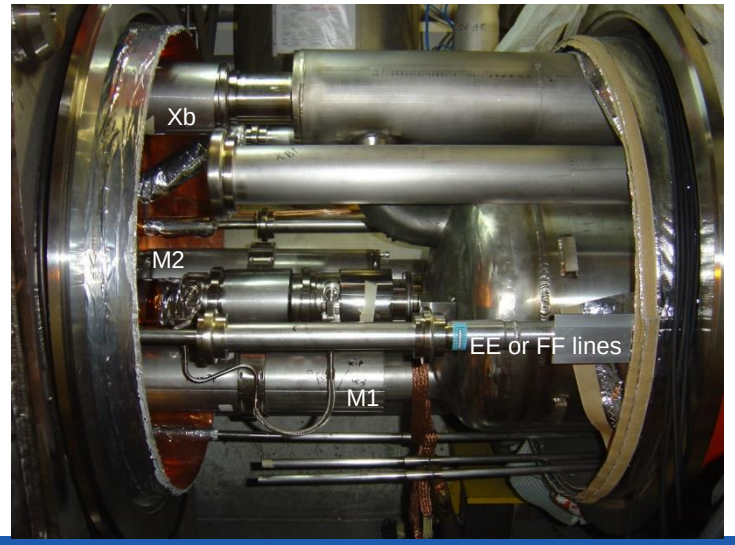
- IT & D1 & DFBX are thermally coupled and share the same insulation vacuum
- IT & D1 share the same superfluid helium bath



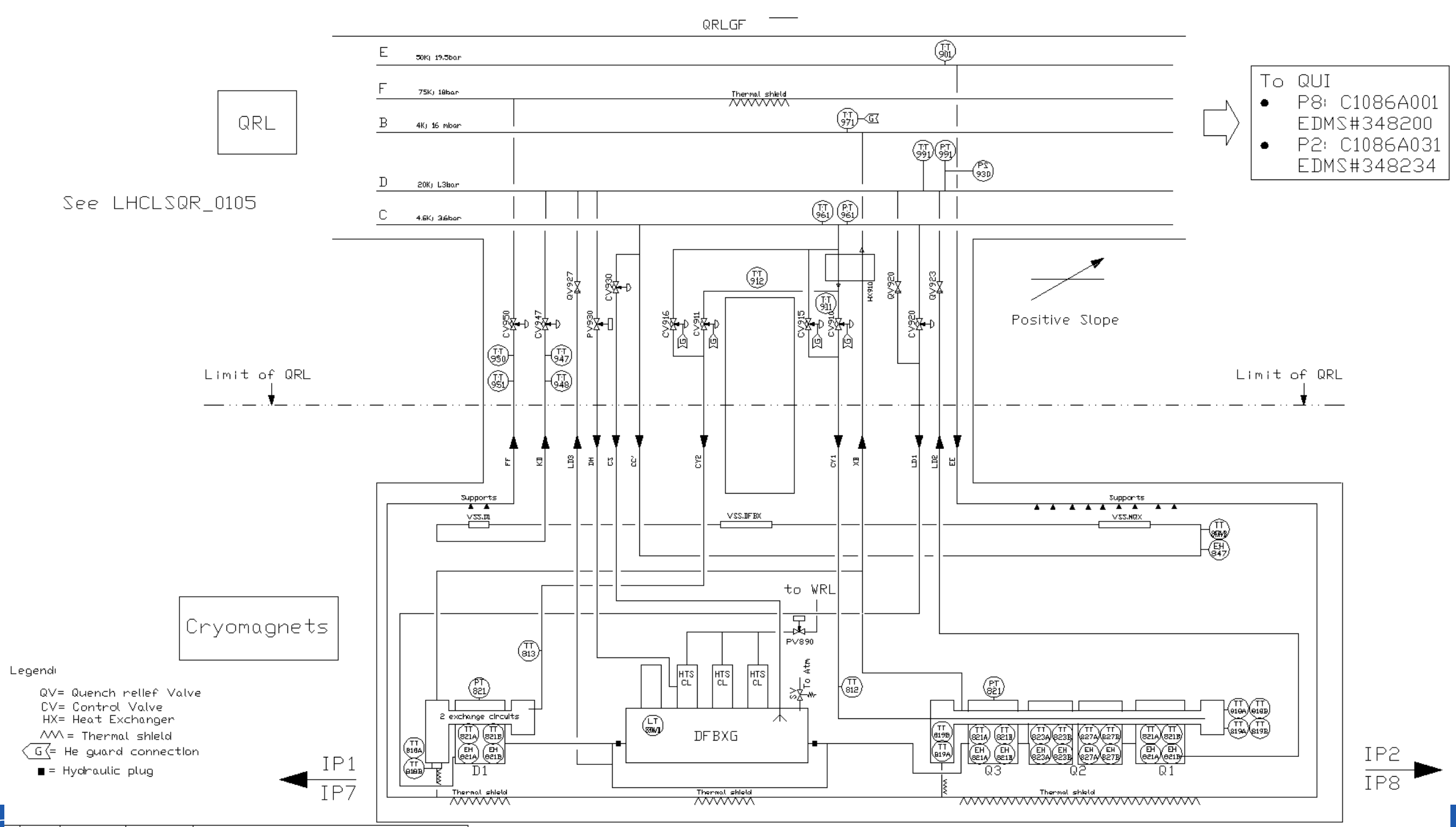




Q1-Q2 and Q2-Q3 interconnections

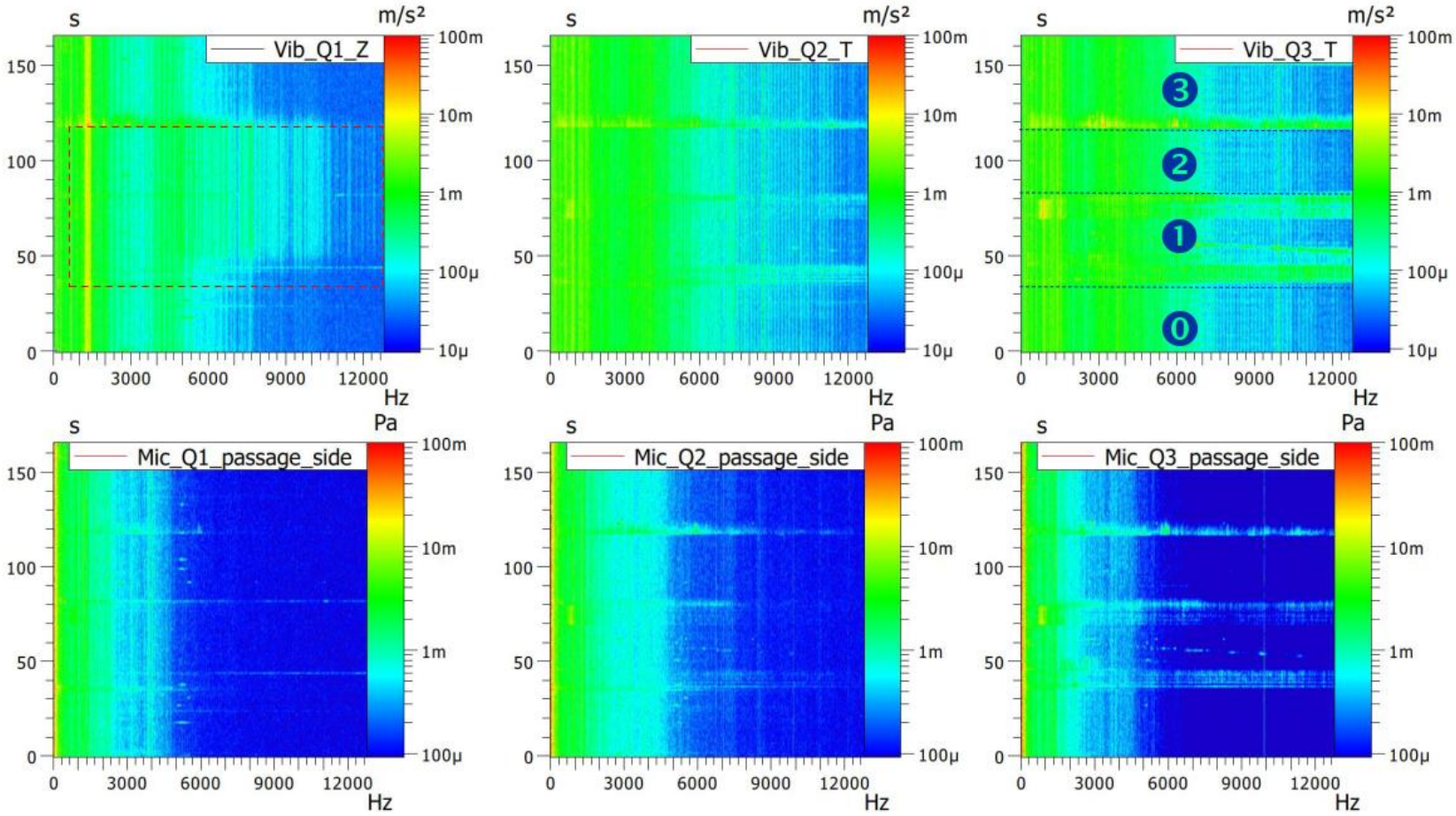


DFBX-Q3 interconnection


QRLGF
QRL
See LHCLSQR_0105
E 50K; 19.5bar
F 75K; 18bar
B 4K; 16 mbar
D 20K; 1.3bar
C 4.6K; 3.6bar
Thermal shield
To QUI
P8: C1086A001 EDMS#348200
P2: C1086A031 EDMS#348234
Positive Slope
Limit of QRL
Limit of QRL
Supports
Supports
VSS.DFBX
to WRL
PV890
Cryomagnets
Legend:
QV= Quench relief Valve
CV= Control Valve
HX= Heat Exchanger
= Thermal shield
G = He guard connection
= Hydraulic plug
2 exchange circuits
DFBXG
HTS CL
HTS CL
HTS CL
To Atm
D1
Q3
Q2
Q1
Thermal shield
Thermal shield
Thermal shield
IP1
IP7
IP2
IP8

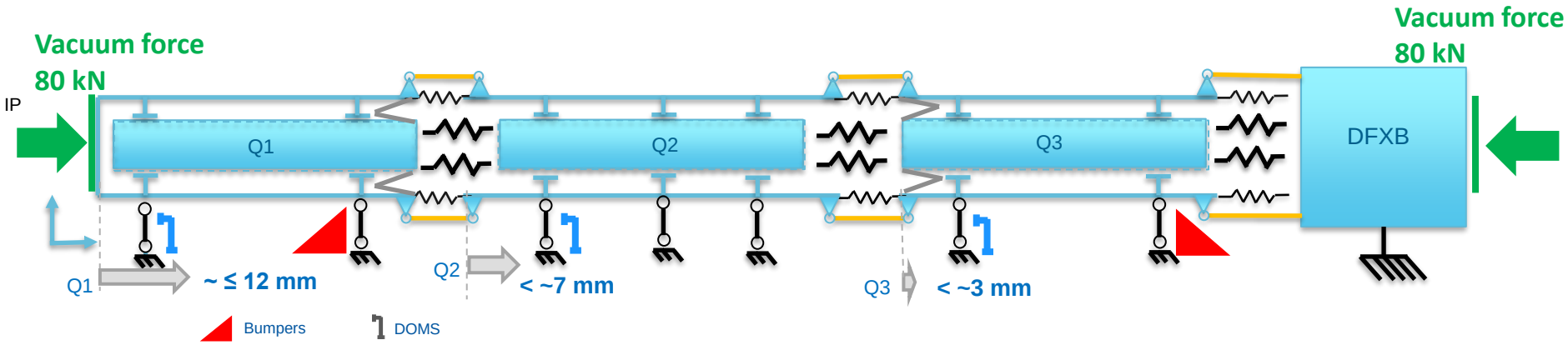
Pressure tests (2) : acoustic / vibration tests

Fast Fourier analysis



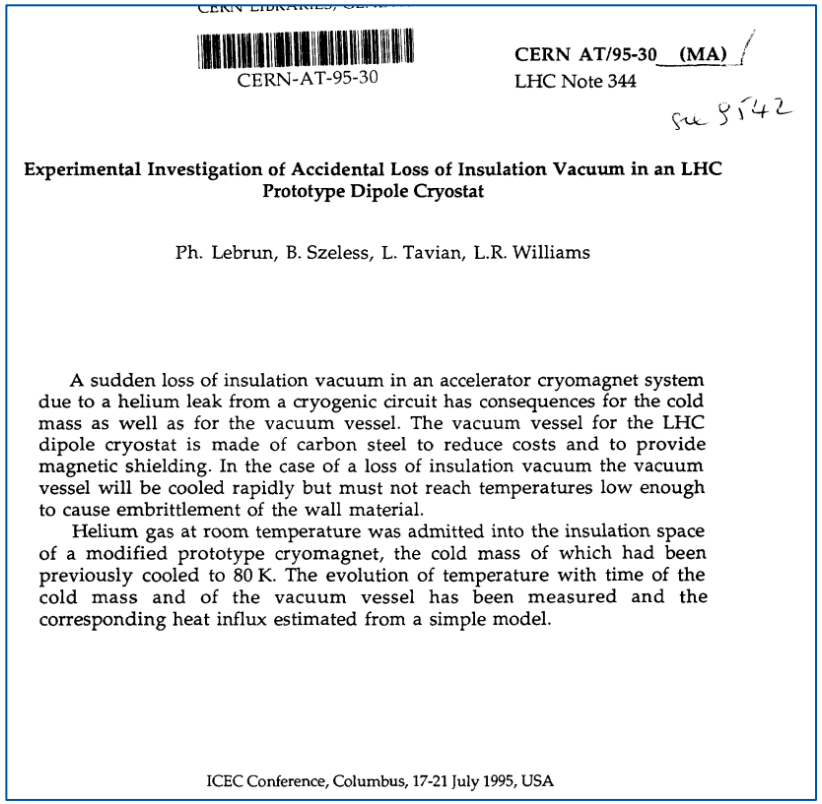
Courtesy of M. Guinchard

Large movements, due to insulation vacuum forces



- ✓ Under vacuum, ~80 kN longitudinal compressive force between Q1 and DFBX, restrained through compression of tie-rods
- ✓ Longitudinal movements of triplets towards DFBX (fixed point to ground):
- ✓ At ~12 mm, Q1 jack in contact → friction interfering with vertical adjustment of motorized jacks → unpredictable vertical alignment

1995 vacuum degradation test



CERN-AT-95-30

CERN AT/95-30 (MA)
LHC Note 344

Experimental Investigation of Accidental Loss of Insulation Vacuum in an LHC Prototype Dipole Cryostat

Ph. Lebrun, B. Szeless, L. Tavian, L.R. Williams

A sudden loss of insulation vacuum in an accelerator cryomagnet system due to a helium leak from a cryogenic circuit has consequences for the cold mass as well as for the vacuum vessel. The vacuum vessel for the LHC dipole cryostat is made of carbon steel to reduce costs and to provide magnetic shielding. In the case of a loss of insulation vacuum the vacuum vessel will be cooled rapidly but must not reach temperatures low enough to cause embrittlement of the wall material.

Helium gas at room temperature was admitted into the insulation space of a modified prototype cryomagnet, the cold mass of which had been previously cooled to 80 K. The evolution of temperature with time of the cold mass and of the vacuum vessel has been measured and the corresponding heat influx estimated from a simple model.

ICEC Conference, Columbus, 17-21 July 1995, USA

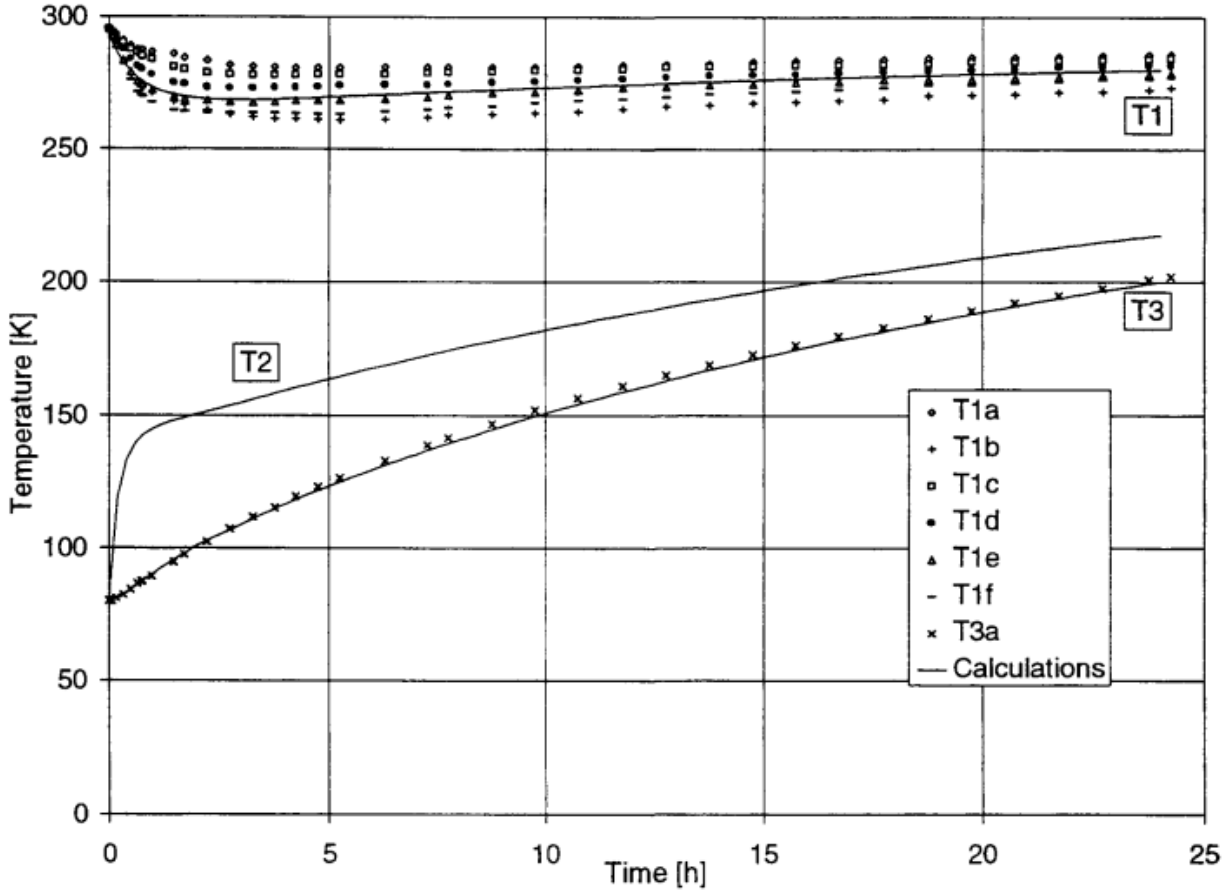
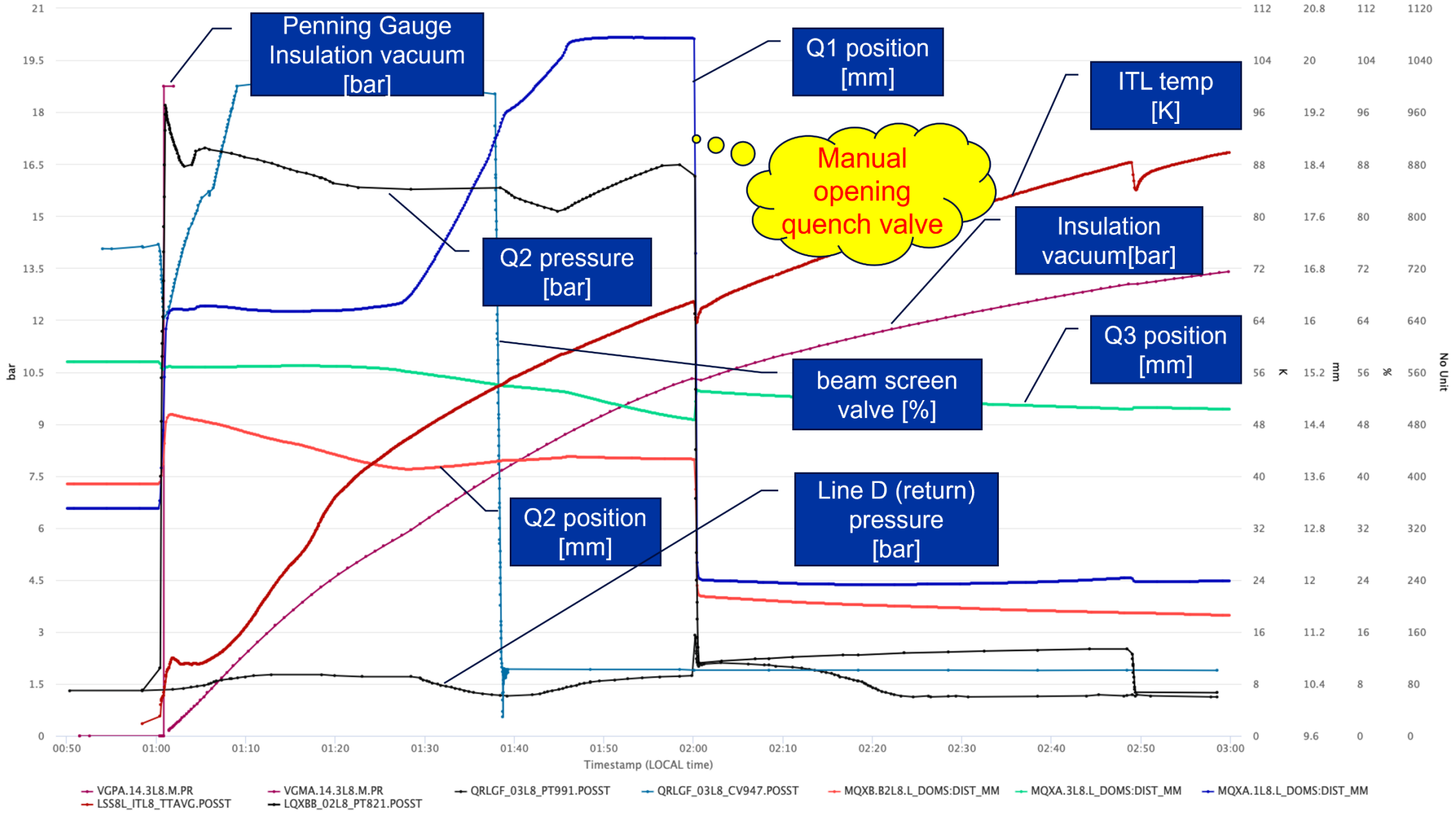


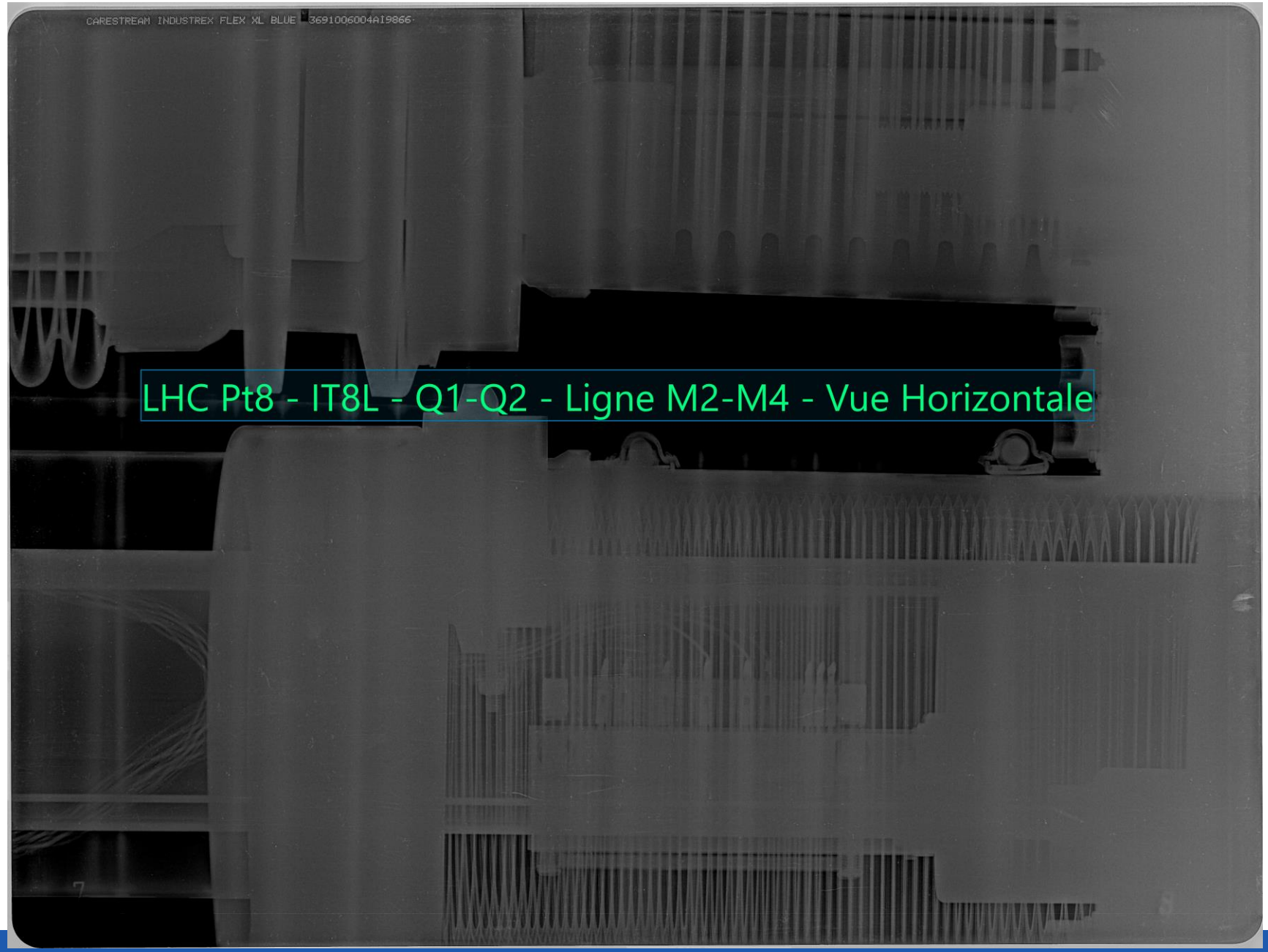
Figure 4: Calculated and measured temperature evolution.

The TAP cryomagnet test show:

- Vacuum vessel wall is at minimum temperature after only ~2 hrs - vacuum vessel longitudinal contraction
- Significant vacuum vessel wall temp difference top to bottom – banana effect, with potential lifting of cryostat mid-point


Penning Gauge Insulation vacuum [bar]
Q1 position [mm]
ITL temp [K]
Manual opening quench valve
Insulation vacuum[bar]
Q2 pressure [bar]
Q3 position [mm]
beam screen valve [%]
Q2 position [mm]
Line D (return) pressure [bar]
bar
K
mm
%
No Unit
Timestamp (LOCAL time)
VGPA.14.3L8.M.PR
VGMA.14.3L8.M.PR
QRLGF_03L8_PT991.POSST
QRLGF_03L8_CV947.POSST
MQXB.B2L8.L_DOMS:DIST_MM
MQXA.3L8.L_DOMS:DIST_MM
MQXA.1L8.L_DOMS:DIST_MM
LSS8L_ITL8_TTAVG.POSST
LQXBB_02L8_PT821.POSST

X-rays


CARESTREAM INDUSTREX FLEX XL BLUE 3691006004A19866
LHC Pt8 - IT8L - Q1-Q2 - Ligne M2-M4 - Vue Horizontale

Planning:

Ongoing: emptying S78 (i.e. warming up from 1.9 to >4.5 K)
Today: ELQA and possibly more X-Rays
Tomorrow: preparation for “W-opening”
Monday: Depressurization QRL and W-opening and leak detection

Main issues:

- Temperature difference between QRL and magnet -> could cause damage to “jumpers”
- Temperature difference between magnet and beam tube/screen/shield -> could damage the “PIMs” (buckling of RF fingers)

If leak can be repaired without opening/cutting a line, then beam could be back in a couple of weeks.
If leak repair requires opening/cutting a line, then probably S78 has to be warmed up first (4-5 weeks). In this case beam could be back earliest in about 3 months.