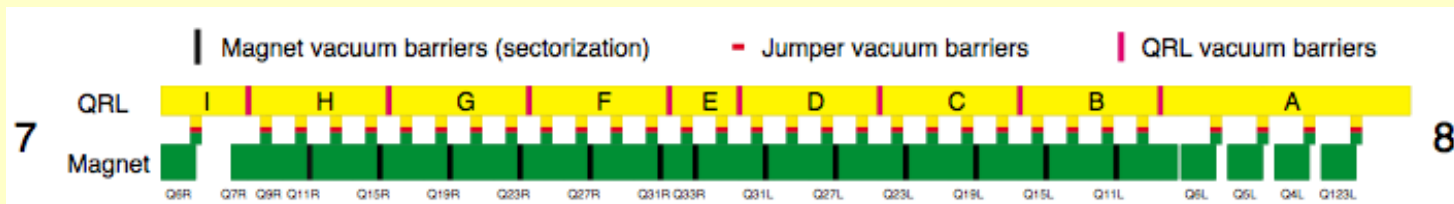




- **LHC Insulation vacuum system**
- **Periodic maintenance plan**
- **Christmas break 2011-2012**
- **Insulation Vacuum behaviour & Leak tests**
- **Conclusion**



Insulation vacuum system



➤ **Magnet insulation vacuum ~22 km (Arc+LSS)**

- 162 volumes
- 214m each (arc)
- ~80m³ each (arc)

➤ **QRL insulation vacuum ~26 km**

- 72 volumes
- 428m each
- ~80m³ each

➤ **Pumping groups**

- ~ 180 Turbo pumps
- ~ 180 Primary pumps

➤ **Gauges**

- ~970 (membranes, piranis, penning)



Preventive maintenance plan on the fix pumping group

	Quantity	Oil change	Oil pad	Bearings	Internal seals	Mist filter	Visual check
Turbo pump Alcatel ATH 300	98			17000h			
Turbo pump Pfeiffer Hipace 300	30		2 years	34000h			
Turbo pump TPH 260	2		1 year	17000h			
Turbo pump TPH 060	50		1 year	17000h			
Primary pump Edwards RV12	150	1 year			17000h	2 years	Each TS
Primary pump Sogevac SV16	30	1 year				1 years	Each TS

17000 h : 2 years continuous operation
34000 h : 4 years continuous operation

➤ Maintenance plan

- Follow preventive maintenance recommendation of equipment supplier
- Minimise corrective intervention

➤ Cost ~140 000€ a year (Parts + Manpower) - Does not include mobile equipment -

- Turbo Alcatel ATH300 ~62.000€ (~45%)
- Turbo Pfeiffer TPH ~13.000€ (~9%)
- Turbo Pfeiffer Hipace ~5.000€ (~4%)
- Primary pump ~60.000€ (~42%)

- ❖ Preventive maintenance activities are made in each technical stop & Christmas break to smooth the work load
- ❖ Activities mainly done by 40-30 with procedure established by EIV section

Christmas break 2011-2012

- **Periodic maintenance** -100% of all foreseen activities completed-
 - **Primary pumps fully revised**
✓ ~70 in TS4 & Christmas break (40% of total)
 - **Primary pumps oil change**
✓ ~110
 - **Oil pad replacement on the LSS Pfeiffer turbo pump**
✓ 50
 - **Bearings replacement on the DSL3 turbo pump Pfeiffer**
✓ 1

- **Leak tests** (See later)



Christmas break 2011-2012

➤ Miscellaneous

• Corrective maintenance

- ~ 10 primary pumps replaced (leak, bad limit vacuum, blocked)
- 4 turbo power supply replaced
- 1 LSS Turbo pump replaced (bearings failure)
- APG 101 for membrane gauge replaced (ICM.Gael)
- Turbo pump cabling problem (bad contact) on DSL3 (ICM.Henrik)

• Corrective actions

- 4 Hipace 300 turbo pump had to be restarted locally after power cut
- Pressure reading crossed between a volume and pumping group gauges on 12R3.Q (ICM.Francois)
- 500 mbar alarm not generated by the PLC on 4L6.Q (ICM.Sebastien)

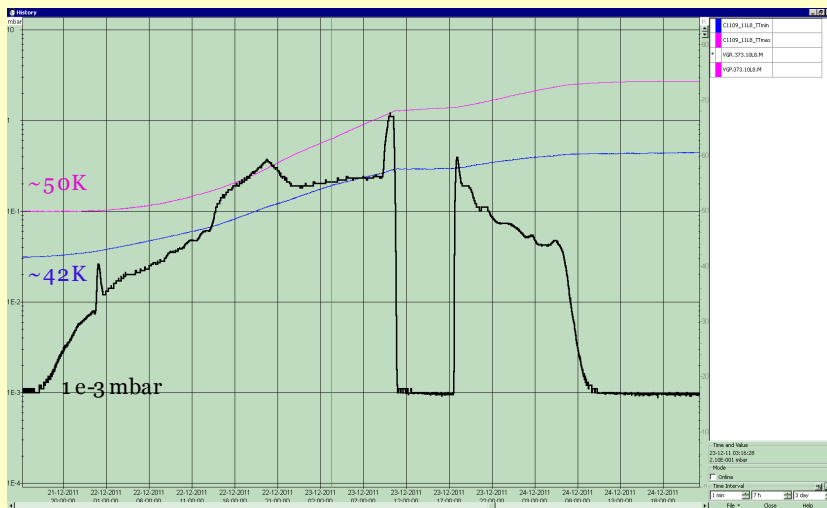
➤ Add/remove Additional mobile pumping groups on 11 subsectors (desorption)

Insulation Vacuum behaviour & Leak tests

- **Insulation vacuum was 100% available for LHC operation in 2011**
- **There are some internal helium leaks which are pumped by turbo pump**
 - (to be repaired in LS1)
- **There are some external air leaks which are continuously pumped by the cold magnets but start to desorb when system temperature is above 25K.**
- **During Christmas break the cryo is OFF, helium liquid removed and the cold system warm naturally to 25-50K**



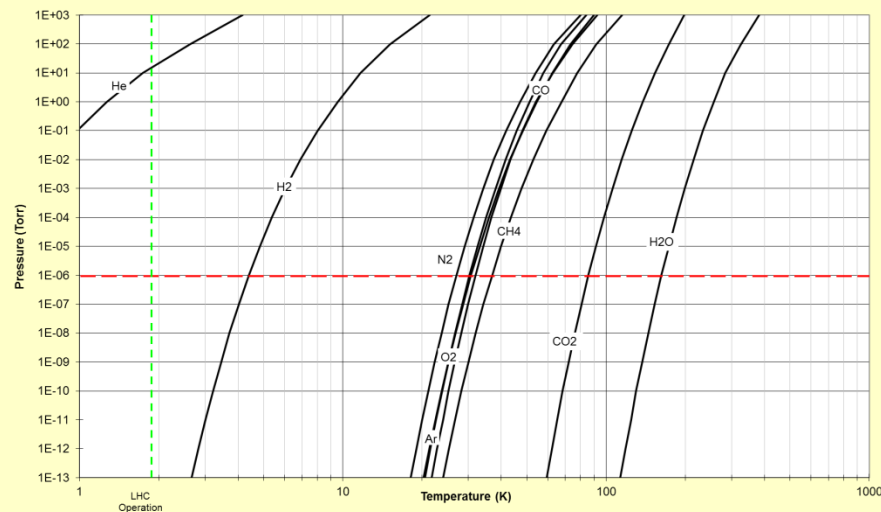
Insulation Vacuum behaviour & Leak tests



Pressure rised on A6-A7L8.M

- In 2010 pressure rose up to 1 mbar or more on several volumes (ex: QRL 4-5, magnet A6L8, QRL 7-8)
- 14 subsectors identified as penalising (for VAC and cryo)
 - 3 volumes rose above 1 mbar
 - 11 volumes rose ~ 0,1 mbar

Vapour Pressures of common gases in the LHC insulation vacuum



- External leaks Diagnosed due to 2010 behaviour
- Leak detection was planned for Christmas break 2011-2012

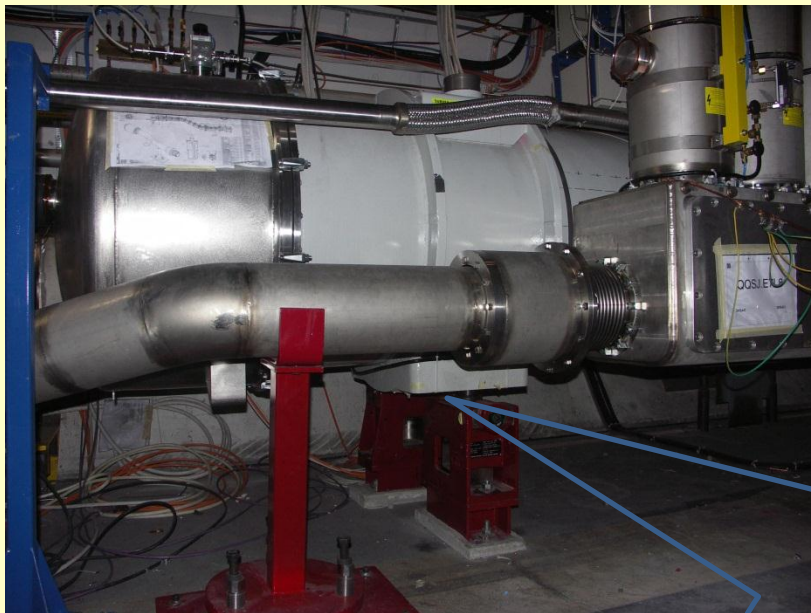
Insulation Vacuum behaviour & Leak tests



- QRL 7-8 subsector A, leak on a weld ($3 \cdot 10^{-2}$ mbar.l/s)
 - Temporarily fixed with mastic until LS1



Insulation Vacuum behaviour & Leak tests



- Magnet A6L8 leak on the foot ($4 \cdot 10^{-3}$ mbar.l/s)
 - Temporarily fixed with mastic until LS1

Insulation Vacuum behaviour & Leak tests



A19R3 Jumper. Leak on the weld 4.10^{-4} mbar.l/s
Temporarily fixed with mastic until LS1



A15L4.M Leak on seal $3.3.10^{-4}$ mbar.l/s
(risk to repair leak : No action until LS1)



Insulation Vacuum behaviour & Leak tests

- 7 air leaks were found, 5 temporarily fixed
- The largest air leaks on magnet A6L8.M & QRL 7-8 subsector A are temporarily fixed until LS1
- No desorption this year (rose up to 10 mbar on 2010) & no leak found on QRL 4-5 subsector B
 - No external leak on this volume
- 2 other (communicating) volumes on sector 5-6 rose the 20/1/2012 until 1 mbar
 - No air leak was found

Conclusion

- **Continue major maintenance campaign of primary pump in 2012 & turbo exchange** (4 Technical stop)
 - 110 primary pump (60%)

- **Repair external leak found in Christmas break 2011-2012**
 - (LS1)

- **Second leak test at 300K on volume where leaks was not found**
 - (LS1)

- **LS1 activities preparation** (Splice, leak repairs, Safety valves, pims, preventive maintenance, new turbos..)

Thanks to participants

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Thank you for your attention

Questions?