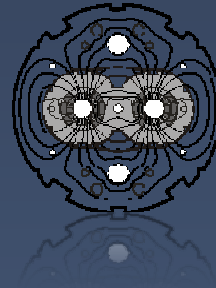


# POWERING TESTS AND SAFETY

LHC project

23<sup>th</sup>, July 09

Cryogenic Safety



On behalf of the planning & coordination, this presentation is a summary of several discussions between safety and cryogenic teams.

J.Coupard  
7/23/2009

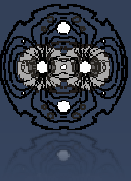
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# Content

- 1) Cryogenic risks
- 2) Cryogenic phases from RT/floating to nominal and additional safety rules
  - A. Sectors warmed-up to RT or considered floating
  - B. Cooling between 300K and 4.5K
  - C. Cooling between 4.5K and 1.9K
- 3) Issues and decisions
- 4) Reminder on existing cryogenic safety rules
  - > Compulsory individual safety equipment
  - > Cryogenic “consignation”

# Cryogenic safety rules during Hardware Commissioning



## I) The cryogenic risks

The dangers for personnel are:

ODH, cold burns, oxygen enriched air



They can be caused by:

- > Workers
- > Transport / handling
- > Cryogenic system (helium jam / multi-helium jam)

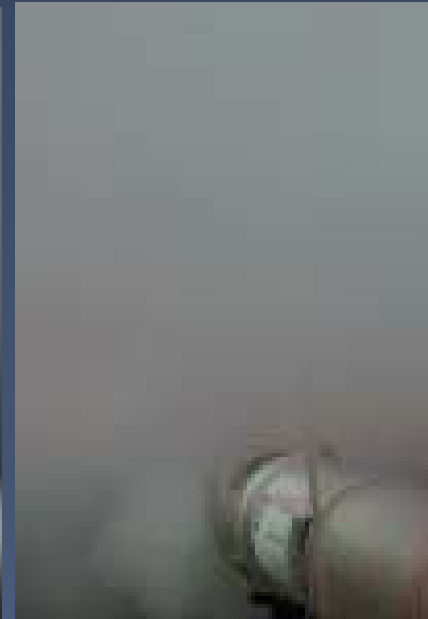
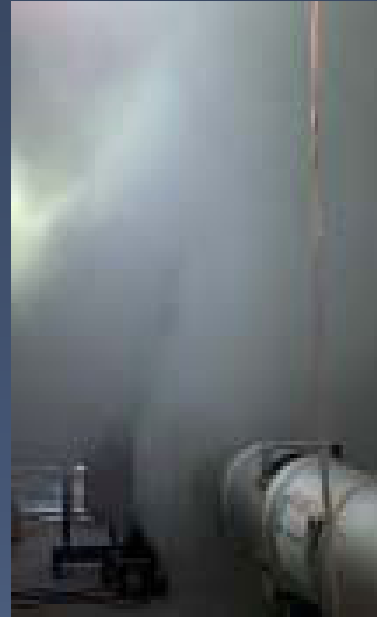
The hazards are defined according to:

- > The type of intervention
- > The cryogenic conditions
- > The level of consolidation of the area (relief valves)
- > The location in the tunnel (emergency exit)

# Helium jam



L.Tavian's LMC warning



**Conclusion: During cool-down, cold stand-by or in Phase I of powering, multiple He jams have to be avoided to improve the personnel safety !**

Video from safety training level 4 – cryogenic safety – can be found to the url:  
<http://cern.ch/websafetytraining/lhc/cryo/video/helium2.swf>

# Cryogenic safety rules during Hardware Commissioning



## I) The cryogenic risks

Safety protections foreseen to be installed on/around the relief valves:

- > Springs [TE-VSC]
- > Deflectors [TE-CRG]
- > Mechanical protections

Other relief valves concerns:

- > QRL = analysis ongoing
- > DSLC in LSS3 = analysis ongoing
- > Cryogenic safety valves on DFBAs = collectors to put in place



# Cryogenic safety rules during Hardware Commissioning

## 2) The cryogenic phases:

### A. at room temperature/floating

- > No liquid helium in the lines
- > Main lines are depressurized  
(except recovery lines such as the Helium Ring Line-HRL)
- > No major temperature variation

### ⦿ Rules defined

- > All works / transports are allowed
- > All handling (with mechanical protection for HRL if needed) are allowed

# Cryogenic safety rules during Hardware Commissioning

(A)



EDMS document  
in work

		first floor (UJ, RR, ...)	on/around cryogenic lines (cryo magnets, QRL, DFB, SA)	on/around warm elements of the machine	other works in the passage side (inspections, services,...)	transports			handling		safety protection of the relief valves
						all transports	standard transports	light transports (PEFRA/bicycle + remork)	with compensatory measures	without compensatory measures	
Service areas			X						X	X	
zone tunnel	zone without exit (IT)		X	X	X	X	X	X	X	X	
	LSS	X	X	X	X	X	X	X	X	X	
	consolidated DFBA's (s.12, 34, 45, 56, 67)		X		X	X	X	X	X	X	
	non-consolidated DFBA's (s.23, 78, 81)		X		X	X	X	X	X	X	
	DS + Arcs	X	X		X	X	X	X	X	X	

# Cryogenic safety rules during Hardware Commissioning



## 2) The cryogenic phases:

### B. during the cooling between 300K and 4.5K

- > No liquid helium in the lines
- > Main lines **are pressurized**
- > **Mechanical movement** over 80K (no access in sector when it is considered as a first cooling – i.e. Sector 34)

### ⦿ Rules defined

- > Some works are forbidden, others need conditions
- > Only standard transports are allowed
- > Only handling with compensatory measures are allowed



# Cryogenic safety rules during Hardware Commissioning

(B)



EDMS document  
in work

safety protection of the relief valves

	first floor (UJ, RR, ...)	on/around cryogenic lines (cryo magnets, QRL, DFB, SA)	on/around warm elements of the machine	other works in the passage side (inspections, services,...)	transports			handling		
					all transports	standard transports	light transports (PEFRA/bicycle + remark)	with compensatory measures	without compensatory measures	
zone tunnel	Service areas							X		
	zone without exit (IT)		X	X				X		The IT must be equipped with springs (DN65, DN200) + deflectors (DN200)
	LSS	X	cryo	X		X	X	X		
	consolidated DFBA's (s.12, 34, 45, 56, 67)		cryo	X		X	X	X		
	non-consolidated DFBA's (s.23, 78, 81)			X		X	X	X		The DFBA must be equipped with a deflector for the DN90 valves and collectors must be installed on the cryogenic safety valves.
	DS + Arcs	X	springs	X		X	X	X		The SSS must be equipped with springs (DN100, DN100BPM) + mechanical protections for the DN100BPM valves The consolidated dipoles must be equipped with springs (DN200)

# Cryogenic safety rules during Hardware Commissioning



## 2) The cryogenic phases:

### C. during the cooling between 4.5K and 1.9K

- > **Liquid helium** in the lines
- > Main lines **are pressurized**

### ⊙ Rules defined

- > Few works are allowed under conditions
- > Only light transports are allowed
- > Only handling with compensatory measures are allowed in the LSS (w/o IT areas)

# Cryogenic safety rules during Hardware Commissioning

(C)



**EDMS document  
in work**

	first floor (UJ, RR, ...)	on/around cryogenic lines (cryo magnets, QRL, DFB, SA)	on/around warm elements of the machine	other works in the passage side (inspections, services,...)	transports			handling		safety protection of the relief valves
					all transports	standard transports	light transports (PEFRA/bicycle + remork)	with compensatory measures	without compensatory measures	
<b>Service areas</b>								X		
zone without exit (IT)			X	X						The IT must be equipped with springs (DN65, DN200) + deflectors (DN200)
LSS			X	X			X	X		The deflectors must be installed on the DFBM (DN90), link (DN200), DFBL (DN200) Concerning the LSS3: DSLC has to be equipped with deflectors and springs (DN160, DN200)
consolidated DFBAs (s.12, 34, 45, 56, 67)				X			X	X		The DFBA must be equipped with a deflector for the DN230 valves and collectors must be installed on the cryogenic safety valves.
non-consolidated DFBAs (s23, 78, 81)				X			X	X		The DFBA must be equipped with a deflector for the DN90 valves and collectors must be installed on the cryogenic safety valves.
DS + Arcs				X			X			The SSS must be equipped with springs (DN100, DN100BPM) + mechanical protections for the DN100BPM valves The consolidated dipoles must be equipped with springs (DN200)

# Cryogenic safety rules during Hardware Commissioning

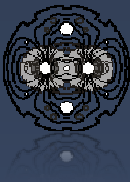


## 3) Issues and decisions:

### When will all the safety conditions be in place?

- > Mechanical protections: already done for link of DFB
- > Springs installation:
  - In the arcs = 78-81 still to complete in DS, 12 ongoing, then 56-67-45-34-23  
complete week 35 (28.08)
  - On the ITs = start this week
  - In the LSS = the clamps are removed and installation will start week 34 (no risk of helium jam)

# Cryogenic safety rules during Hardware Commissioning



## 3) Issues and decisions:

### > Deflectors installation:

A.Perin

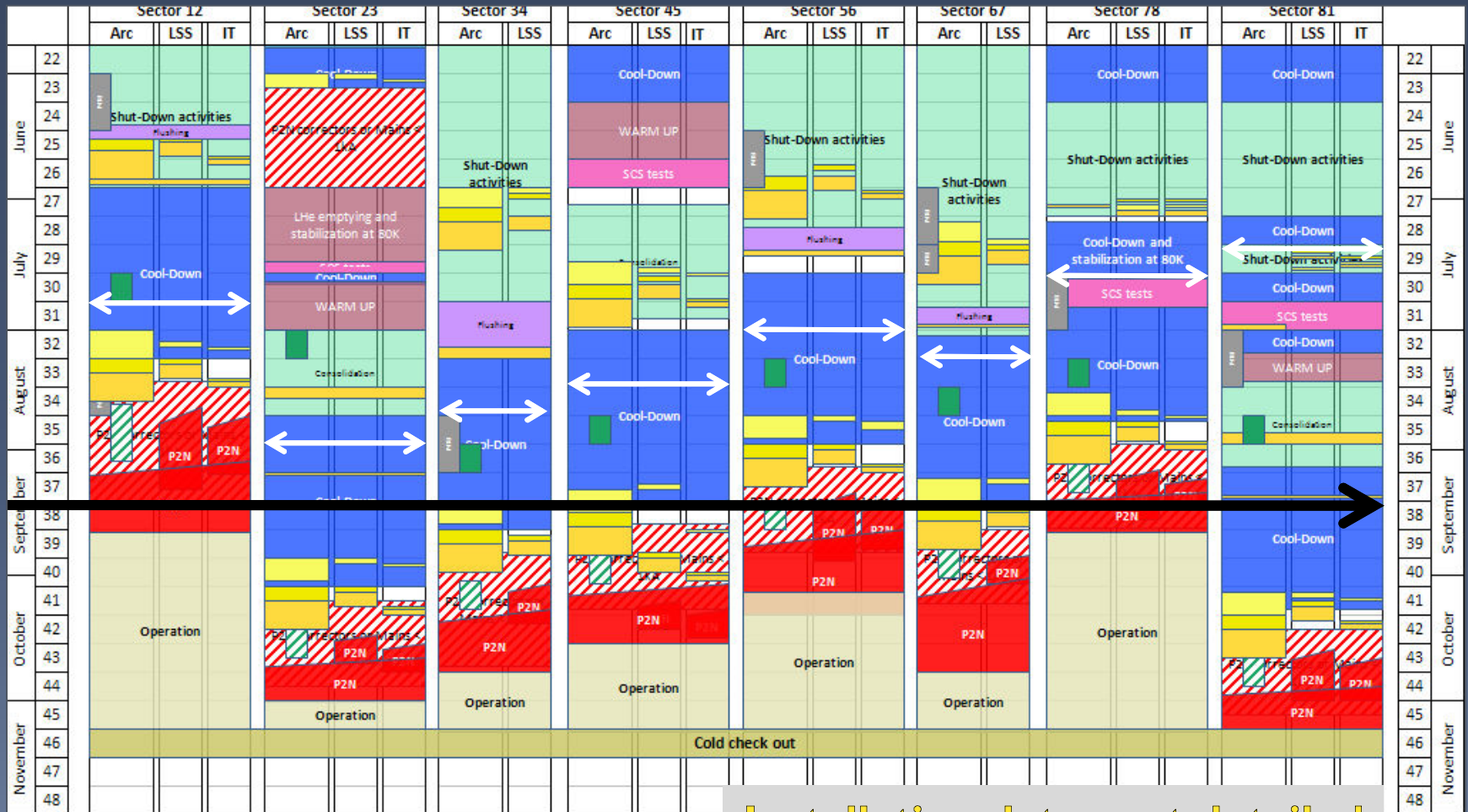
Equipment	Port	Deflectors	Total	Tentative schedule for Installation* (all dates in 2009)
SSS	DN100 / DN90	NO	-	-
DIPOLE	DN200	NO	-	-
DFBA HCM	DN230	YES	10	15/09 - 15/10
DFBA LCM	DN200 / DN100	YES	12	09/09 - 15/10
DFBM chim.	DN100	YES	23	15/09– 30/10
DFBM link	DN200	YES	27	01/09? – 31/12
SAM	DN160	NO	-	-
IT	DN200	YES	8	01/10 - 30/10
DFBL	DN200 / DN65	YES	5	15/09 – 15/10

*\* The installation dates are based on tentative availability of equipment and do not take into account (yet) the constraints of hardware commissioning and tunnel access*

# Cryogenic safety rules during Hardware Commissioning



↔ Springs  
→ Deflectors



Installation dates not detailed

# Cryogenic safety rules during Hardware Commissioning



## 3) Issues and decisions:

What about the interventions that have to be done in non-allowed conditions ?

- > Activities known to date:
  - ELQA at cold: they need to access behind DFBAs at nominal
  - Re-connection of the DFBs cables
  - ... what else ? → inform the HC coordination team

During the weekly coordination meeting, safety and cryogenic teams define the conditions

# Cryogenic safety rules during Hardware Commissioning



## 4) Reminder on existing cryogenic safety rules

- > Compulsory individual safety equipment
- > Level 4: Underground risks + test
- > Formation masque auto-sauveteur :



1. Risque "manque d'oxygène"
  2. Contraintes réglementaires
  3. Les masques auto-sauveteurs
  4. Conduite à tenir en cas d'alarme
  5. Mise en place du masque
- Pratique :



*simulation des conditions réelles dans le tunnel : port des EPI obligatoires, obscurité, bruit de fuite et fumées inoffensives, alarme ODH*



# Cryogenic safety rules during Hardware Commissioning



## 4) Reminder on existing cryogenic safety rules

### > Cryogenic “consignation”

Although a reminder is included in the ADI (ref. Matteo’s presentation), you must obtain a written “consignation” for any intervention on a cryogenic element.

**Consignations**

1. Consignation \*: Cryogénie ? Chargé de consignation \*:  ?

Commentaires \*: 

Electricité  
Eau  
Gaz  
**Cryogénie**  
Air comprimé  
Alarme niveau 3

+ Ajouter



# Conclusions

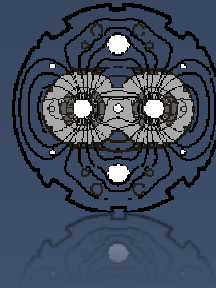
- Complete activities remaining in each sector before the final cooling
- The scheduling, coordination and safety take into account these rules in addition of the others
- ELQA at cold + re-connection of the cables behind DFBA's are issues
- EDMS document in work for approval defining all these additional cryogenic safety rules

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23<sup>th</sup>, July 09

Cryogenic Safety



Thank you for your attention