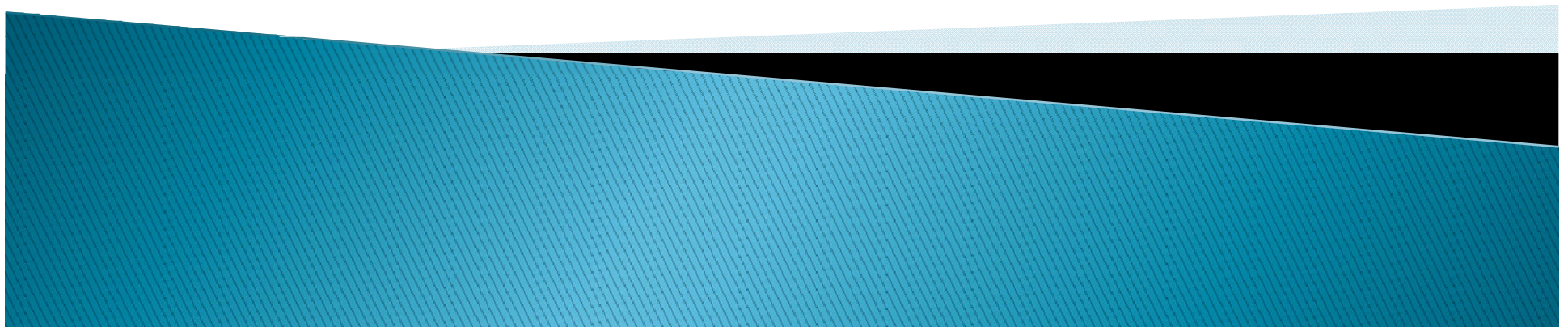


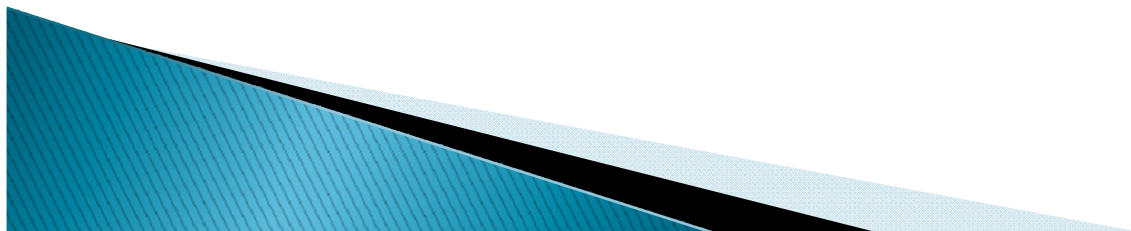
# Magnets repairs for 3-4 sector

P. Fessia, M. Modena and L. Rossi  
Technology Dept.– MSC group



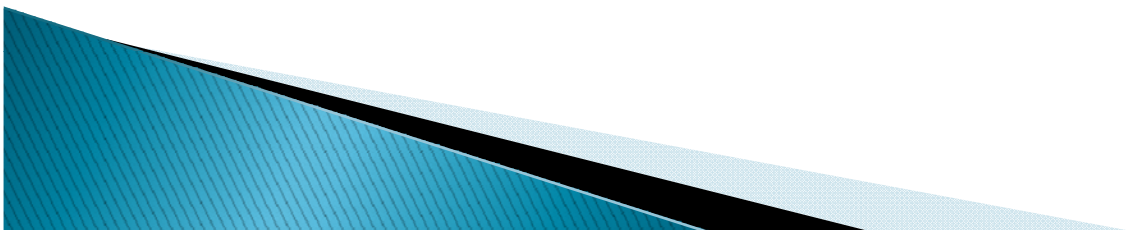
# Content

- ▶ Situation of spares before the incident
- ▶ Magnets affected and damaged
- ▶ Criteria for magnet replacements
- ▶ Logistics, workflow and plan for 3–4 re–filling
- ▶ Magnets Factories snapshot
- ▶ Plan for reserve stock re–constitution



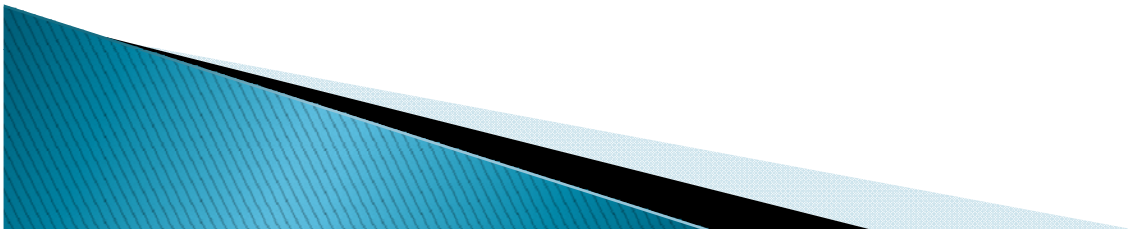
# Spares: actions in 2005

- ▶ 6 dipoles and 2 quads (1 full cell) was considered kind of very bad incident during HWC, and also for eventual damaged by beam during first year(s);
- ▶ Initially the idea was either to have either 30 dipoles or a dozen dipoles and the MAR (MAGnet Rescue facility).
- ▶ However in view of the very long lead time to repair a magnet, and also the time needed to set up the MAR, and to minimize the impact on accelerator operation it was decided:
- ▶ To purchase
  - 30 additional dipoles (16 were already additional in the series contract)
  - 6 additional SSS and 2 bare MQ magnets (8 were already in the contract)
- ▶ **Decision to set up a Magnet Rescue Facility;**
- ▶ Facility for Quadrupole, because of the number of variants, was always thought as priority
- ▶ **For budget and manpower reason in 2006 the MAR was delayed to after the LHC commissioning**



# Status main dipoles at 19Sept08

- ▶ DIPOLES : 46 ordered in addition to the 1232 for tunnel
- ▶ However 6 were (are) not available:
  - 1 lost during production (MB1005, bad cable)
  - 1 under repair (MB-2001) because pole or inter-layer splice not conform. This is the first action as MAR (started in Ansaldo, since winding is not yet ready)
  - 3 out-of-service following the string-2 incident: need work to investigate and put in conformity.
  - 1 suspected short circuit (in the tunnel, after late review of test in SM18), MB1055
- ▶ OF the 40 MBs actually available
  - one needed more examination: MB2252 incident ROCLA; re-tested and used of OSQAR but waiting Performance Assent
  - 3 were waiting Performance Assent





## SPARES (and other) C.M. and CRYOMAGNETS GENERAL STATUS

STEPS	DIPOLE			
	TYPE A		TYPE B	
	QTY	ID	QTY	ID
COLD MASS (not cryostated, not tested)	11	2739 / 2868 / 2435 / 2436 / 2437 / 2438 / 2443 / 2444 / 2445 / 2446 / 2524	13	2399 / 2418 / 2421 / 2422 / 2428 / 2429 / 2431 / 2432 / 2433 / 2434 / 2440 / 2441 / 2442
CRYOSTATING DONE	3	2690 / 2439 / 1055 (sick magnet)	2	3383 / 2420
COLD TEST DONE * waiting for PA	4	2551* / 2598 / 2624* / 2790	3	2252* / 2427* / 2419*
STRIPPING DONE	0		0	
FIDUCIALISATION DONE	1	1011	1	2430
BEAM SCREEN INTEGRATED	2	2342 / 3413	1	1219
READY FOR TUNNEL	0		0	
<b>TOTAL</b>	<b>21</b>		<b>20</b>	

**Legend**

blue: diode L

red: diode R

black: no diode

3-4 sector

L- diodes

L-Beam screen

STEPS	SSS					
	ARC		DS		MS	
	QTY	ID	QTY	ID	QTY	ID
COLD MASS (not cryostated, not tested)	12	005 / 055 / 072 / 243 / 277 / 279 / 344 / 364 / 367 / 369 / 372 / 080(leak under invest.)				
CRYOSTATING DONE	1	006 (under test in test-cryostat)	1	603		
COLD TEST DONE * waiting for PA	1	064*				
STRIPPING DONE						
FIDUCIALISATION DONE						
BEAM SCREEN & BPM INTEGRATED			1	523 (used for warm-up test)		
READY FOR TUNNEL						
<b>TOTAL</b>	<b>14</b>		<b>2</b>			

UPDATED

01-10-08

BY

N.Bourcey AT/MCS/CI

### NEW Spares Situation (MB and SSS (MQ)) few days after the event:

– 5 MB “practically ready” for the Tunnel; other 7 becoming ready in short time; other 4 in a longer time (need to be tested at SM18). Tot: 16 MB

– NO SSS ready for the tunnel

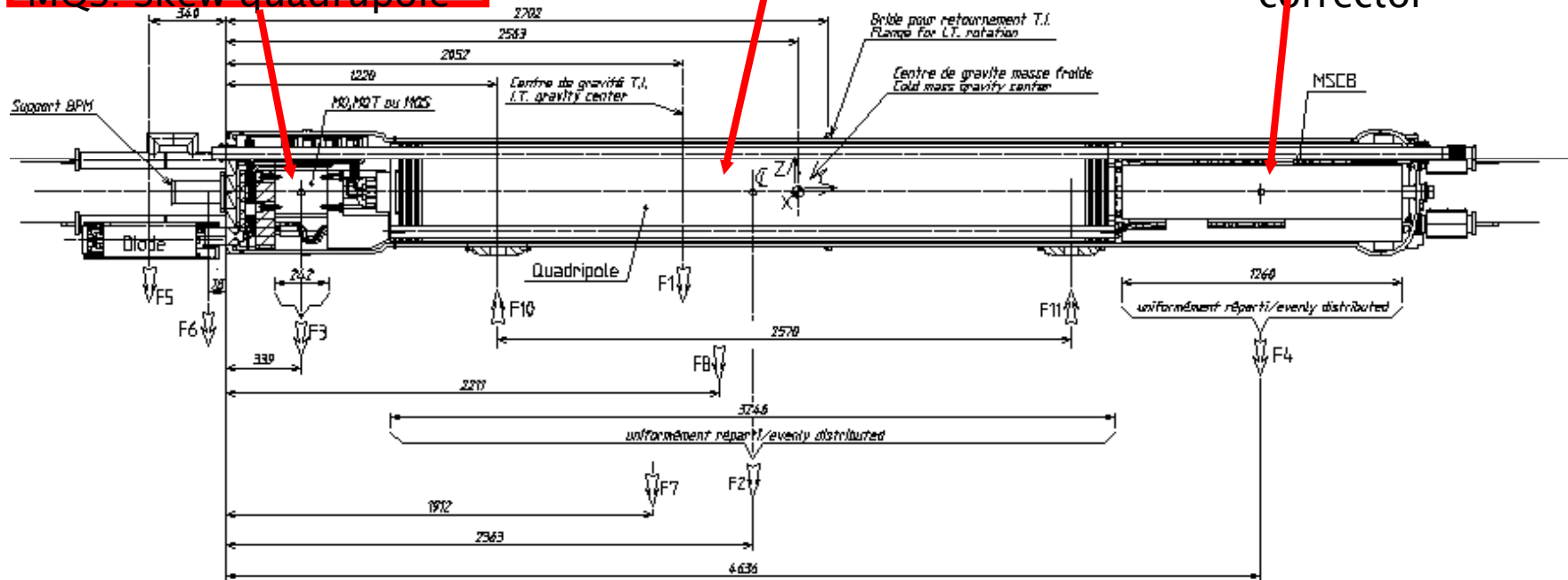
MO: Octupole

MQT: Tuning  
quadrupole

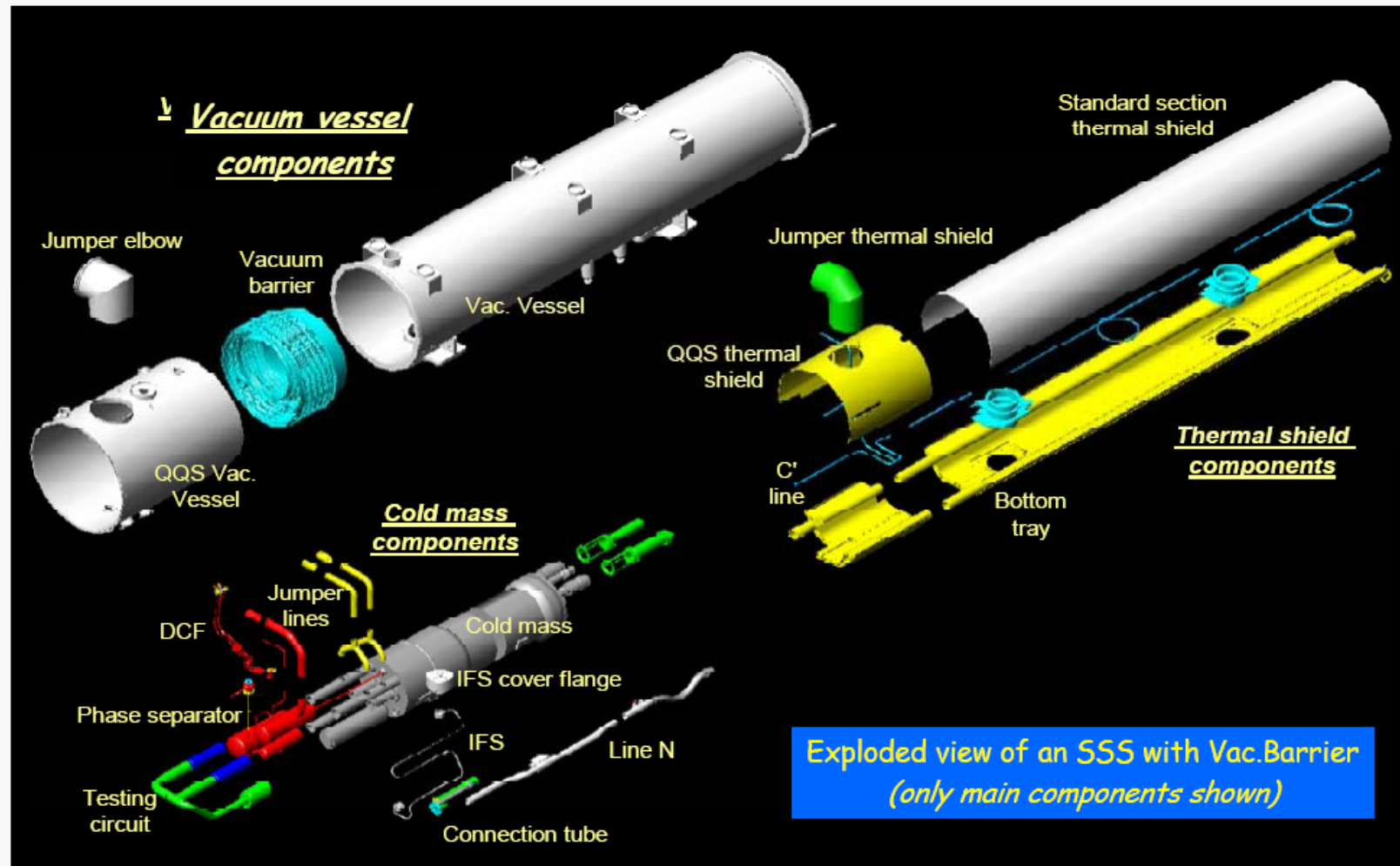
MQS: Skew quadrupole

MQ (F,D): Main  
quadrupole

MSCB (A,B,C,D):  
Sextupole-dipole  
corrector



For example: The missing c.m. type (**LQMSA/LQMSB**) is composed by MQS + MQ + MSCBB + D/F busbars

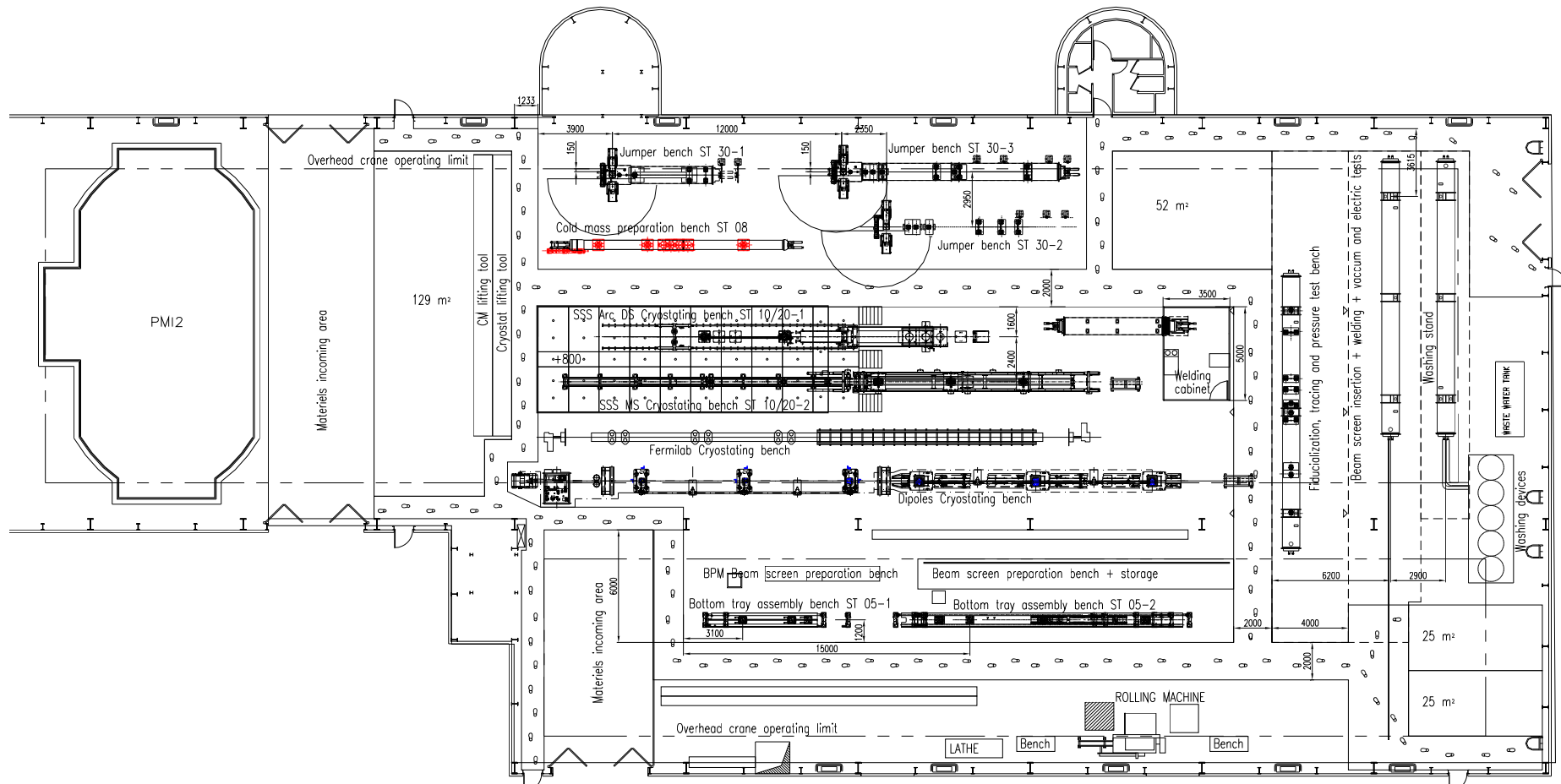


"Status of LHC main magnet spare cold masses and cryostats", MARIC 19 Dec 2007 9/16

## Spare SSS Status “as delivered”

SSS or c.m. IDENTITY	c.m.TYPE, population in LHC	MQ ext./int.	Sextupole/ dipole corr.	Correct or magnet	Diode type	SSS TYPE	Cryostat Items or STATUS
SSS064	LQMOF,27	D/F	MSCBB	MO	B	LQOAH	SSS cryostated. In test configuration.
c.m. 005	LQMOG,3	D/F	MSCBD	MO	A	LQOAJ	- Standard inertia tube - Studs (x4) - Line X short
c.m. 006	LQMOU,9	F/D	MSCBC	MO	B	LQOBF, LQOBD	To be confirmed after cold test.
c.m. 055	LQMTF,30	D/F	MSCBB	MQT	B	LQATI	- Standard inertia tube - No studs - Line X short
c.m. 072	LQMTF,30	D/F	MSCBB	MQT	B	LQATI	- Standard inertia tube - No studs - Line X short
c.m. 243	LQMTE,30	D/F	MSCBB	MQT	A	LQATH	- VB inertia tube - No studs - Line X long
c.m. 277	LQMOR,9	F/D	MSCBA	MO	B	LQOBB	- Standard inertia tube - No studs - Line X short
c.m. 279	LQMSD,12	F/D	MSCBA	MQS	B	LQASE, LQASF	- VB inertia tube - PLUGS - NO Xline
c.m. 344	LQMOU,9	F/D	MSCBC	MO	B	LQOBF, LQOBD	- Standard inertia tube - Studs (x2) - Line X short
c.m. 364	LQMOF, 27	D/F	MSCBB	MO	B	LQOAH	- VB inertia tube - Studs (x4) - Line X long
c.m. 367	LQMTE,30	D/F	MSCBB	MQT	A	LQATH	- VB inertia tube - Studs (x4) - Line X long
c.m. 369	LQMTH,18	F/D	MSCBA	MQT	B	LQATK, LQATM, LQATU	- VB inertia tube - Studs (x4) - Line X short
c.m. 372	LQMOA,2	D/F	MSCBB	MO	A	LQOAB	- VB inertia tube - Studs (x4) - Line X short
<i>c.m. 080</i>	LQMTG,18	F/D	MSCBA	MQT	A	LQATJ, LQATL, LQATV	<i>Under investigation for Leak</i>
<i>SSS523</i>	LMQTC,6	F/D	MSCBA	MQTL	A	LQTCC	<i>Under investigation for potential short circuit inter-turn</i>

**SMI2 Team is now able to change any configuration at cryostat/VB/plugs level;  
ONLY modifications not yet possible : CHANGE the BB and Correctors layout inside the c.m.**



## SMI2 LOGISTIC:

- SMI2 covers what was done for the serie production in: SMA18, 904, SMI2 and Bld 185 (cryostating and final preparation for MB and SSS).
- In SMI2 we have mainly ONE cryostating line for MB and TWO for SSS (covering all the different types and sizes of SSS).
- Several other benches and stands are present and necessary for dedicated operations and parallel activities.

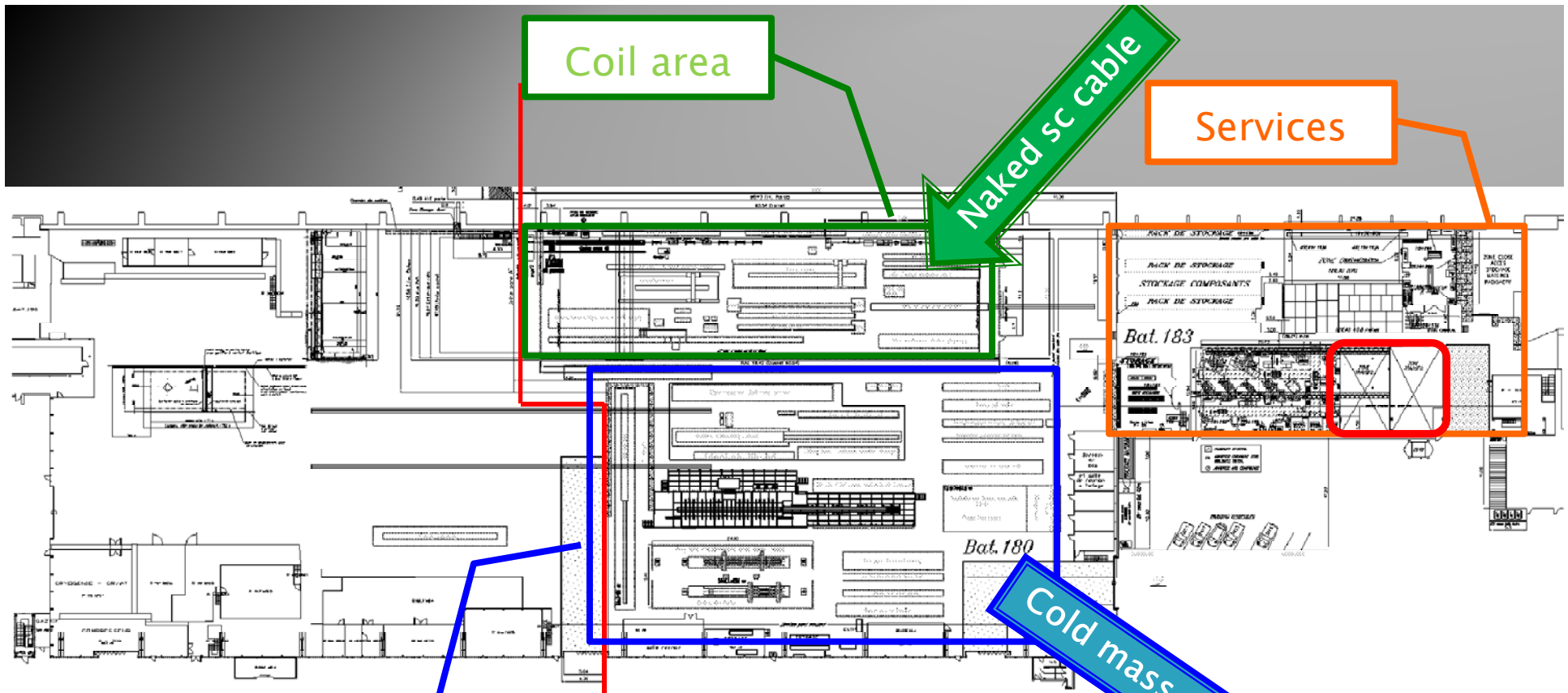




## B-SMI2 today

Arrangements to satisfy radiation protection rules are still to be implemented





Cold mass area

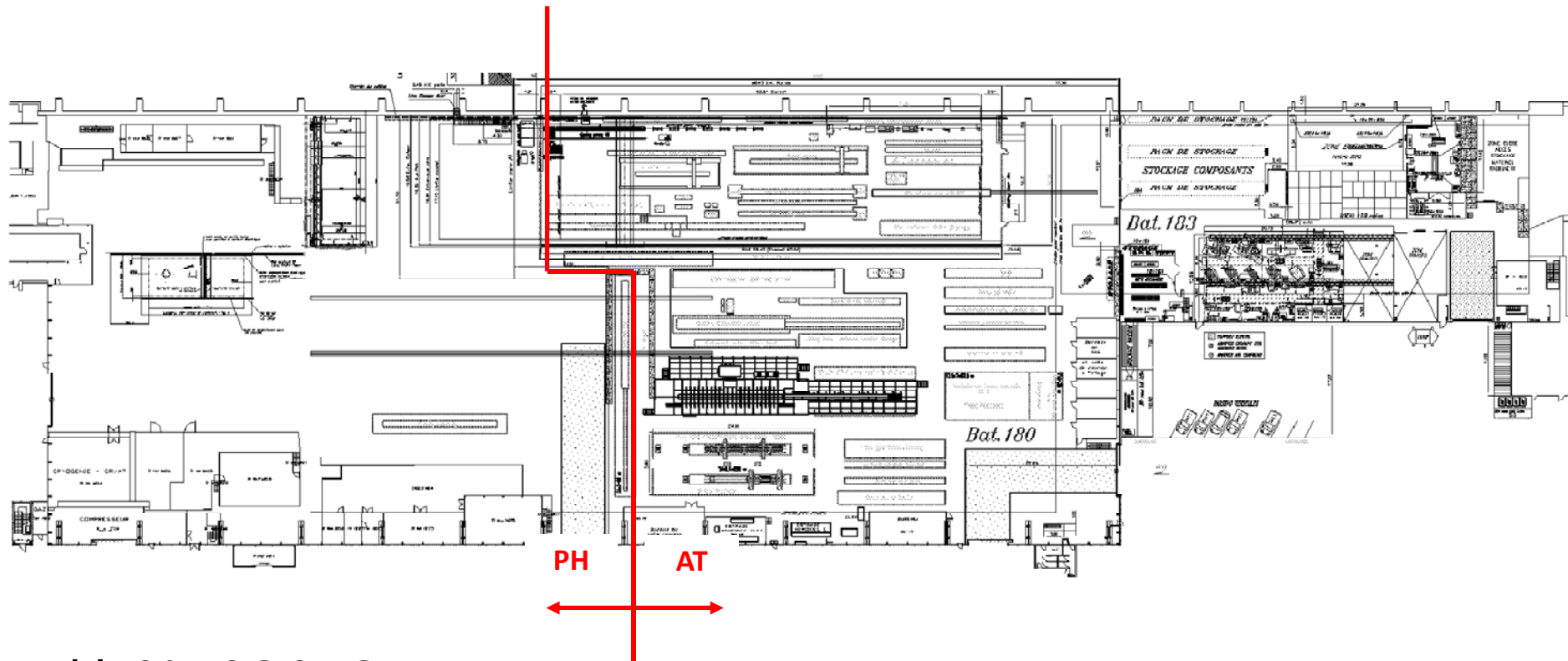
PH AT



Cold mass to B-SMI2

B-180/B-183 >>>

B-180 will be shared with PH-ATLAS  
 B-183 will be shared with AB/PO  
 We will cover about 5'000 m<sup>2</sup> in B-180 and about 1'450 m<sup>2</sup> in B-183



### Bld180 LOGISTIC:

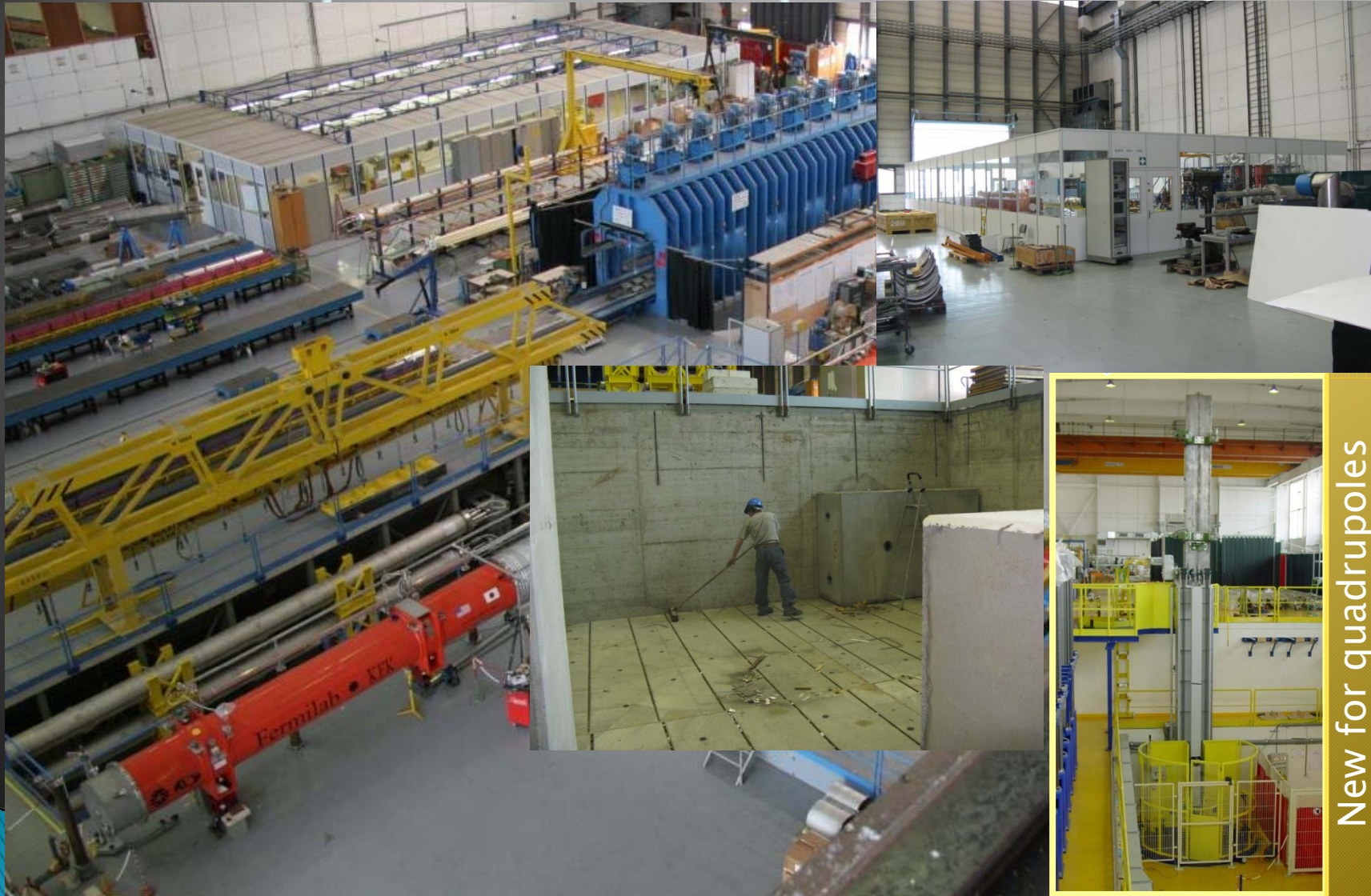
- The cryostating/de-cryostating MECHANICAL bench developed by CEA was installed and is now operating to decryostat ALL MB seriously damaged coming from the Tunnel
- The Bld. is actually hosting the majority of the MB Cryodipoles and MB c.m extracted from the Tunnel.
- OUTSIDE the Bld.180 the facility for sandblasting and cleaning of Cryostat and bottom trays is now operational.

### OTHER LOGISTIC:

- Bld.904: for storage, investigation and partial decryostating of SSS
- SMA18: for preparation of the 9 MB + 8 SSS coming from the tunnel, and STRIPPING of Cryomagnets after cold tests. Also operational the tent with cleaning of cold mass by spray water



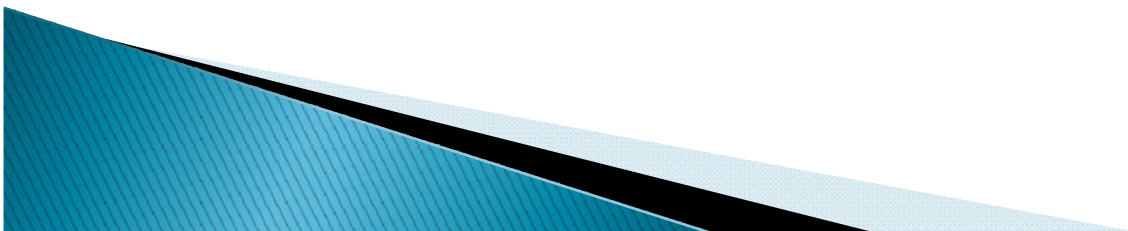
# Keep tooling for sc magnets and complete with others for a more



New for quadrupoles

# Content

- ▶ Situation of spares before the incident
- ▶ Magnets affected and magnets damaged
- ▶ Criteria for magnet replacements
- ▶ Logistics, workflow and plan for 3–4 re-filling
- ▶ Magnets Factories snapshot
- ▶ Plan for reserve stock re-constitution



### Sector 3-4 Event Findings and Observations Summary

← Point 3

(Based on investigation and measurements by AT-MCS, AT-MEI, AT-VAC, TS-MME and TS-SU)

Point 4 →

	J,VB,Plugs																J
	A18	B18	C18	Q18	A19	B19	C19	Q19	A20	B20	C20	Q20	A21	B21	C21	Q21	
Δ Cryostat	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	
Δ CM Longit.	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
MLI&Cleannes Status																	
Beam Screen Status *					soot	soot	soot	soot	soot	soot	soot	soot	soot	soot	X	X	
PIM UP-stream*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CM Status																	

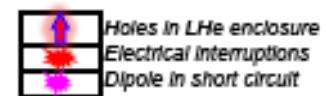
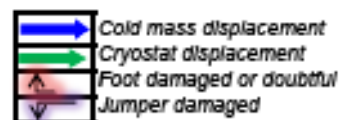
	J,VB,Plugs																J
	A18	B18	C18	Q18	A19	B19	C19	Q19	A20	B20	C20	Q20	A21	B21	C21	Q21	
Δ Cryostat ( → +)	<2	<2	<2	-7	<2	<2	<2	-187	<2	<2	<2	<2	<2	<2	<2	<2	
Δ CM Longit. ( → +)	<5	<2	<2	-20	-87	-102	-144	<5	-190	-130	-80	<5	<2	<2	<2	<5	
MLI&Cleannes Status																	
Beam Screen Status *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PIM UP-stream*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CM Status																	

	J,VB,Plugs																J
	A18	B18	C18	Q18	A19	B19	C19	Q19	A20	B20	C20	Q20	A21	B21	C21	Q21	
Δ Cryostat	<2	<2	<2	<2	<2	<2	<2	474	-4	<2	<2	11	<2	<2	<2	<2	
Δ CM Longit.	<2	<2	<2	<5	57	114	150	-45	230	189	144	85	50	35	<5	<5	
MLI&Cleannes Status																	
Beam Screen Status *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PIM UP-stream*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CM Status																	

	J,VB,Plugs																J,VB	A34
	A18	B18	C18	Q18	A19	B19	C19	Q19	A20	B20	C20	Q20	A21	B21	C21	Q21		
Δ Cryostat	<2	<2	<2	<2	<2	<2	<2	188	<2	<2	<2	5	<2	<2	<2	<2		
Δ CM Longit.	<5	<5	<5	<5	19	77	148	<5	140	105	62	18	<5	<5	<5	<2		
MLI&Cleannes Status																		
Beam Screen Status *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PIM UP-stream*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CM Status																		

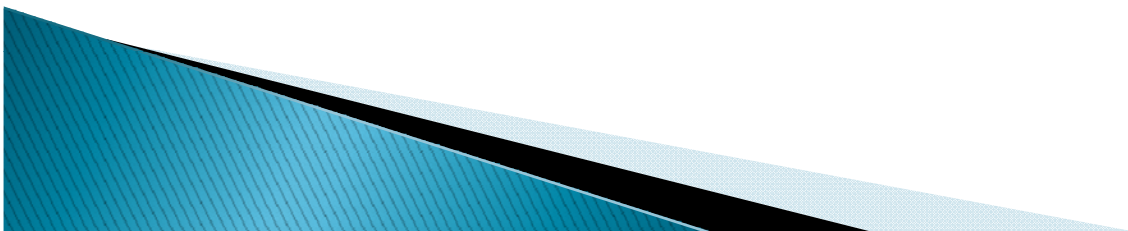


(\* Note: some PIMs and some random minor CBT pollution also OUTSIDE zone Q19-Q33 (up to Q7.R3 and Q7.L4))



# Content

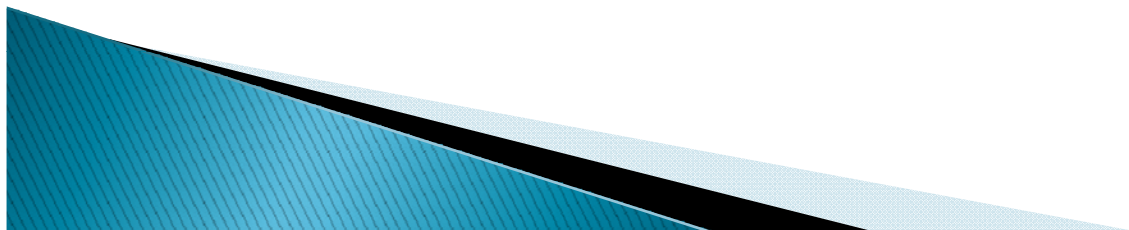
- ▶ Situation of spares before the incident
- ▶ Magnets affected and magnets damaged
- ▶ **Criteria for magnet replacements**
- ▶ Logistics, workflow and plan for 3–4 re-filling
- ▶ Magnets Factories snapshot
- ▶ Plan for reserve stock re-constitution

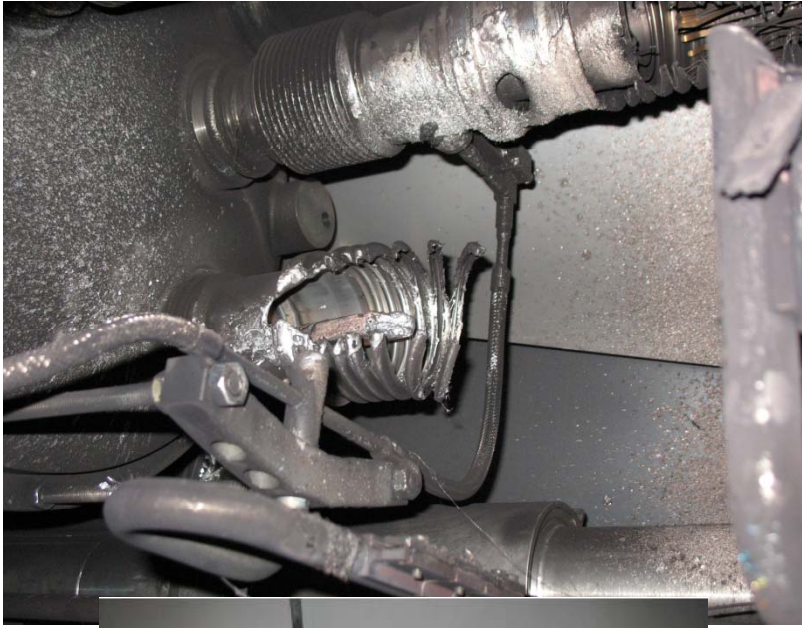




# Assessing magnet damage

- ▶ Cold mass removed and substituted when:
  - Electrically damaged
  - Mechanically damaged,
  - Bus-bar system damaged due to displacements
  - Dirtiness
- ▶ Cold mass removed and re-used:
  - No electric damage or soot in the cold mass;
  - No movements at rest: we estimate from models that at max the displacement for such CM was  $< 50$  mm well within the max elongation of the lyra (180 mm). For Q22 the displacement at rest is about 20 mm. We believe that it is safe.
  - No visual damage from endoscopy (except minor scratch on bus bar that are similar to other seen in installed magnet).
  - Qualification after cold test







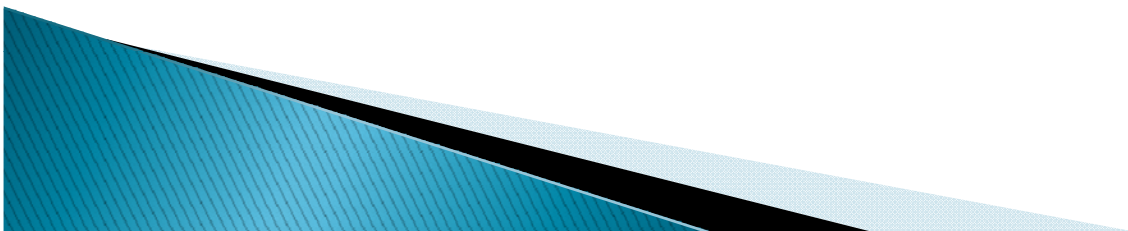
## Inspection of Q32.R3 (M 1-2 lines)



Serious contamination by soot. TS-MME analysis show a mix of copper and SS (not austenitic). Magnetic and elec. conducting; around-globular shapes; micrometric dimension for some amount.

# Assessing magnet damage

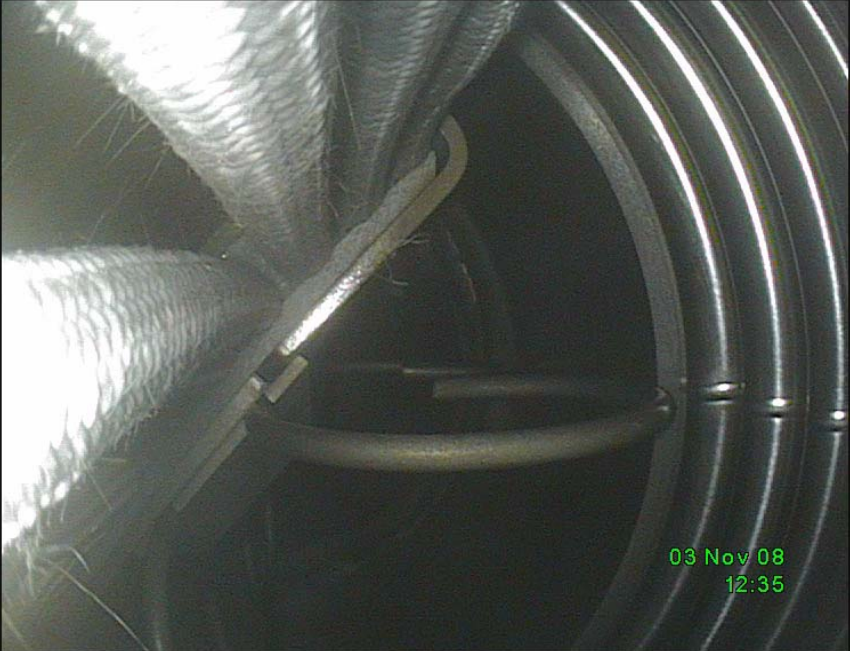
- ▶ Cold mass removed and substituted when:
  - Electrically damaged
  - Mechanically damaged,
  - Bus-bar system damaged due to displacements
  - Dirtiness
- ▶ Cold mass removed and re-used:
  - No electric damage or soot in the cold mass;
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  - No visual damage from endoscopy (except minor scratch on bus bar that are similar to other seen in installed magnet).
  - Qualification after cold test



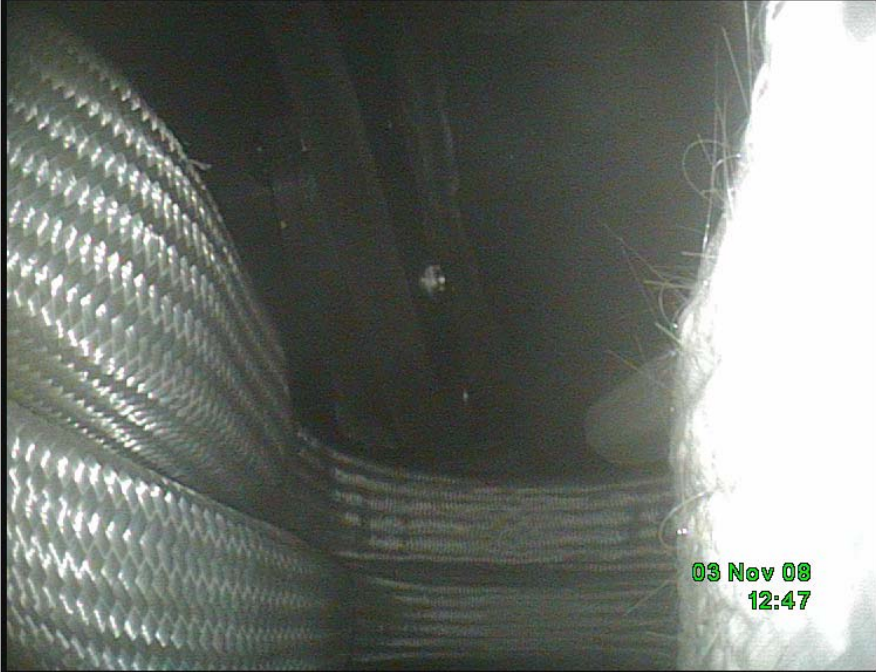


# Inspection of Cell 21.R3 via endoscopy

B21.R3-NCS/M1



C21.R3-NCS/M2



C21.R3-NCS/M2

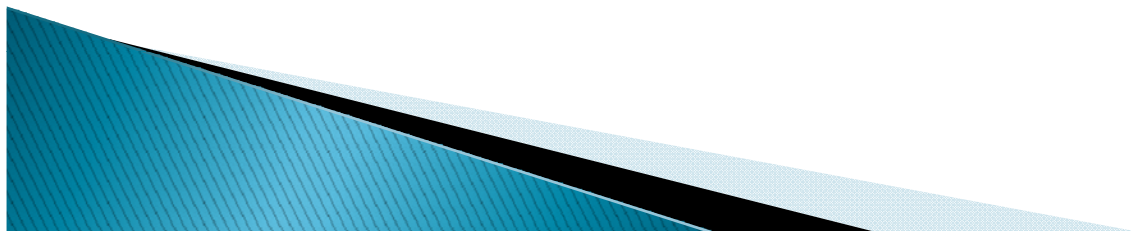


C21.R3-NCS/M1

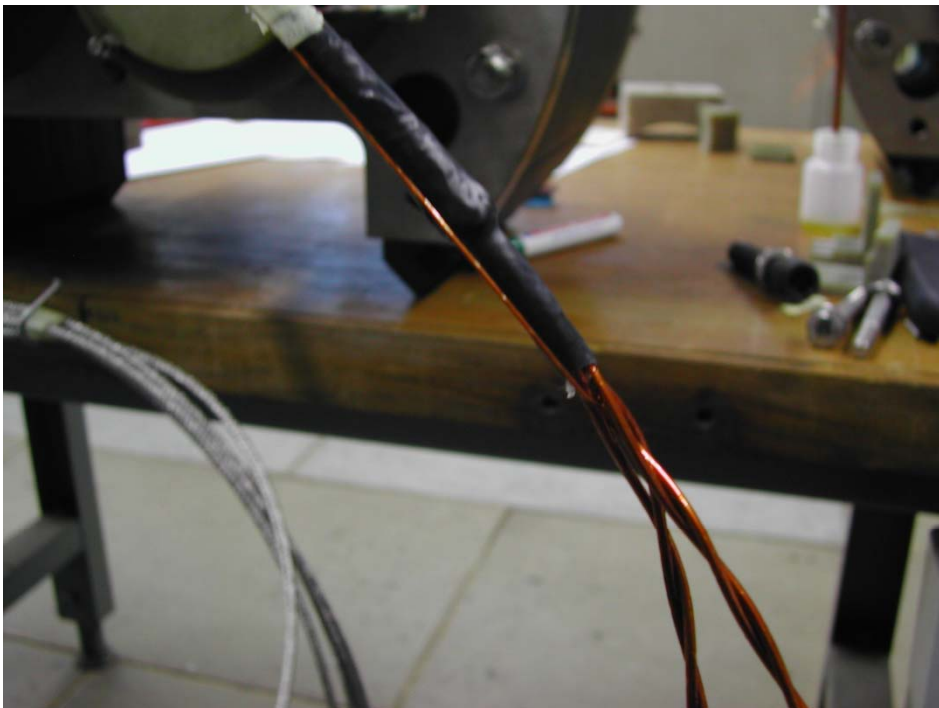


# Qualification of magnets inside tunnel

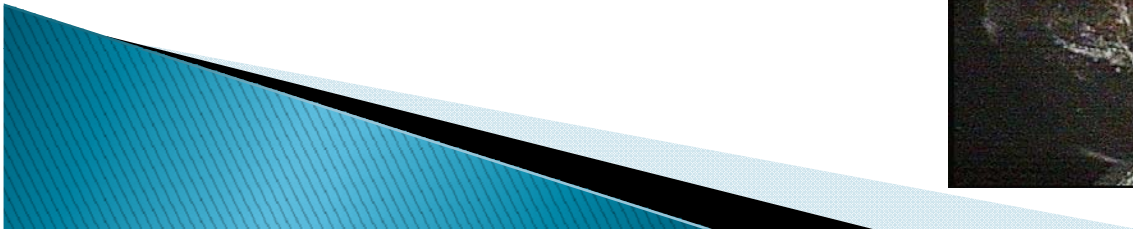
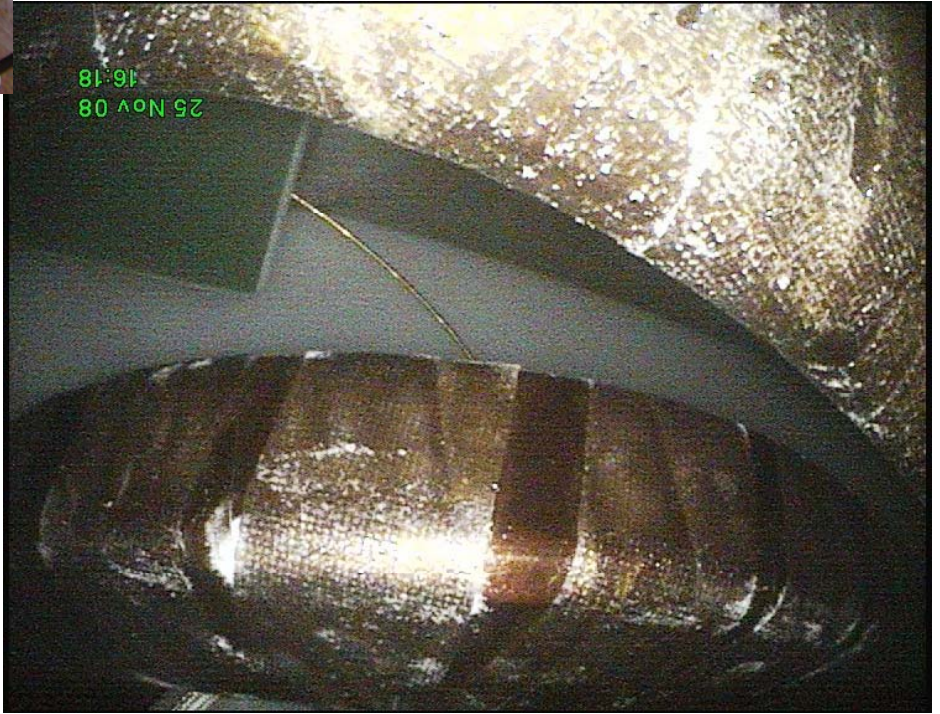
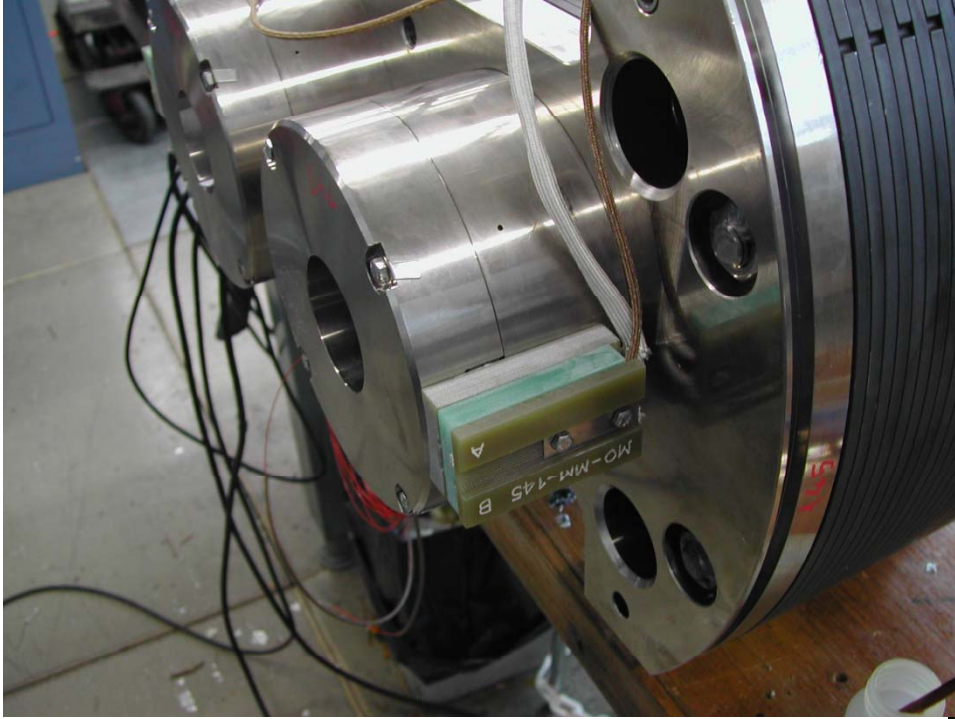
- ▶ The magnets re-used qualify, if they are found good, the magnet “behind”.
- ▶ Mystery of floating wire in SSS that has made the decision to remove one semi-cell more.
- ▶ The 4 magnets in the affected-zone that we don't remove and the rest of the magnets in the sector are then qualified by this procedure.











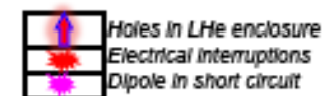
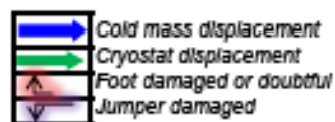
### Sector 3-4 Event Findings and Observations Summary

← Point 3

(Based on investigation and measurements by AT-MCS, AT-ME1, AT-VAC, TS-MME and TS-SU)

Point 4 →

	J, VB, Plugs																J
	A18	B18	C18	Q18	A19	B19	C19	Q19	A20	B20	C20	Q20	Q21	B21	Q21	Q22	
Δ Cryostat	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	
Δ CM Longit.	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
MLI&Cleannes Status																	
Beam Screen Status*					soot	soot	soot	soot	soot	soot	soot	soot	soot	soot	X	X	
PIM UP-stream*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CM Status																	
↓																	
	J, VB, Plugs																J
	Q19	B20	C20	Q20	A20	B20	C20	Q20	A20	B20	C20	Q20	Q21	B21	Q21	Q22	
Δ Cryostat ( → +)	<2	<2	<2	-7	<2	<2	<2	-187	<2	<2	<2	<2	<2	<2	<2	<2	
Δ CM Longit. ( → +)	<5	<2	<2	-20	-67	-102	-144	<5	-190	-130	-80	<5	<2	<2	<2	<5	
MLI&Cleannes Status																	
Beam Screen Status*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PIM UP-stream*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CM Status																	
↓																	
	J, VB, Plugs																J
	A20	B20	C20	Q20	A20	B20	C20	Q20	A20	B20	C20	Q20	Q21	B21	Q21	Q22	
Δ Cryostat	<2	<2	<2	<2	<2	<2	<2	474	-4	<2	<2	11	<2	<2	<2	<2	
Δ CM Longit.	<2	<2	<2	<5	57	114	150	-45	230	189	144	85	50	35	<5	<5	
MLI&Cleannes Status																	
Beam Screen Status*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PIM UP-stream*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CM Status																	
↓																	
	J, VB, Plugs																J, VB
	Q20	B20	C20	Q20	A20	B20	C20	Q20	A20	B20	C20	Q20	Q21	B21	Q21	Q22	A34
Δ Cryostat	<2	<2	<2	<2	<2	<2	<2	188	<2	<2	<2	5	<2	<2	<2	<2	<2
Δ CM Longit.	<5	<5	<5	<5	19	77	148	<5	140	105	62	18	<5	<5	<5	<2	<2
MLI&Cleannes Status																	
Beam Screen Status*	X				X	?											
PIM UP-stream*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CM Status																	



(\* Note: some PIMs and some random minor CBT pollution also OUTSIDE zone Q19-Q33 (up to Q7.R3 and Q7.L4))

# Inventory of magnets in D-zone

## ▶ 15 SSS (MQ)

- 1 not removed (Q19)
- 14 removed
  - 8 cold mass revamped (old CM, partial de-cryostating for cleaning and careful inspection of supports and other components)
  - 6 new CMs
  - In this breakdown there is consideration about timing (SSS cryostating takes long time; variants problems).

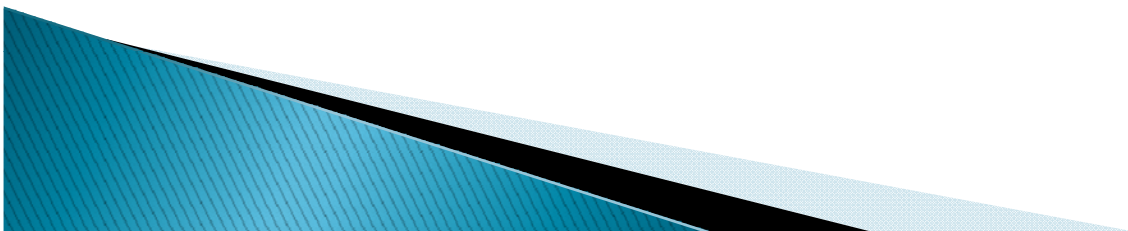
## ▶ 42 Dipoles (MBs)

- 3 not removed (A209,B20,C20)
- 39 removed
  - 9 Re-used (old CM, no decryostating -except one?)
  - 30 new CMs
  - New cold masses are much faster to prepare than rescuing doubtful dipoles)

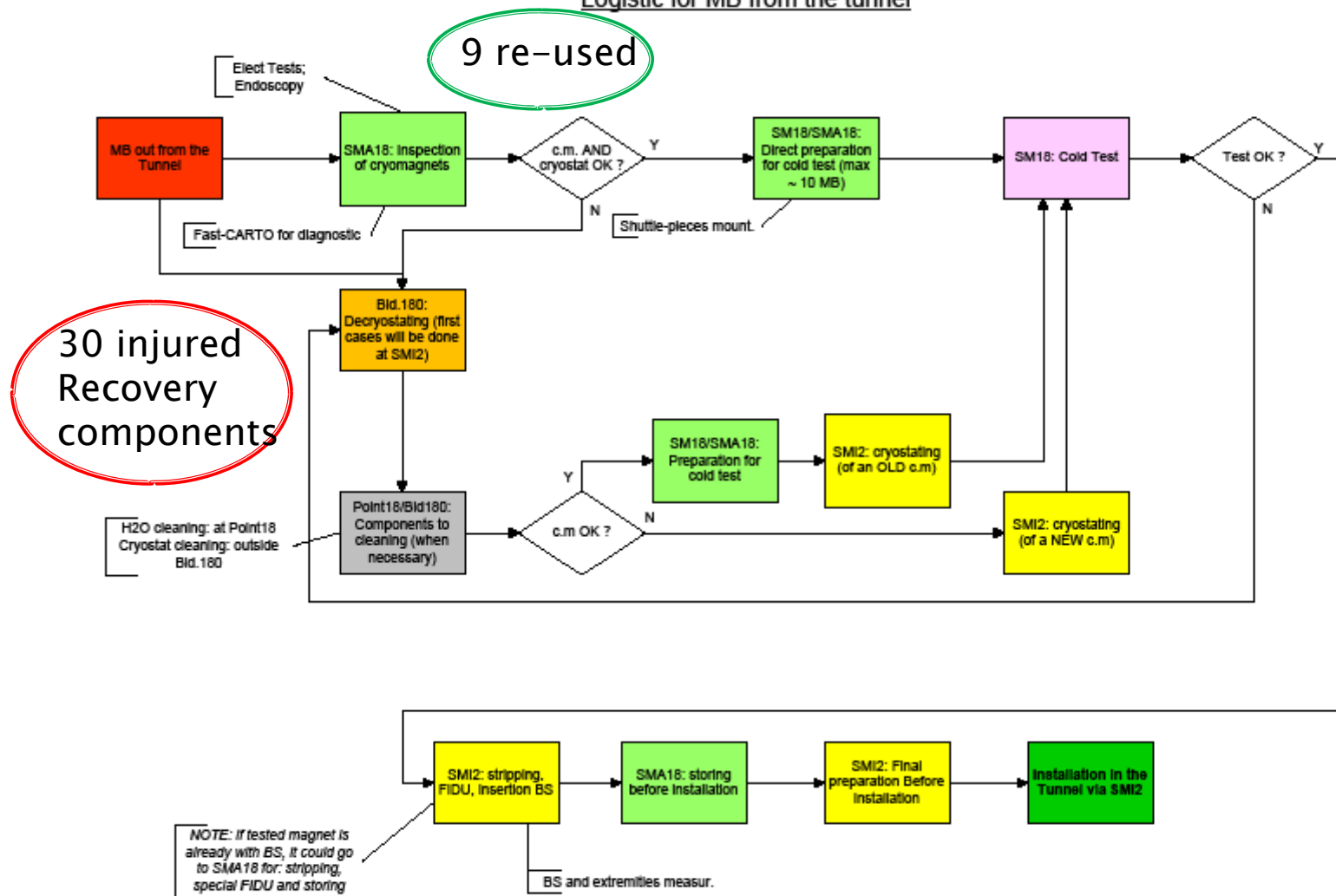


# Content

- ▶ Situation of spares before the incident
- ▶ Magnets affected and magnets damaged
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- ▶ **Logistics, workflow and plan for 3-4 re-filling**
- ▶ Magnets Factories snapshot
- ▶ Plan for reserve stock re-constitution



Logistic for MB from the tunnel





# Group A: Dipoles to be retested and sent back to sector 3-4 (9 units)

GROUP A			
No decryostating / reconfigured for cold testing			
DIPOLE		ARRIVAL	STATUS
A21	2035	12/12/2008	On going
B21	1092	12/9/2008	On going
C21	1099	12/5/2008	On going
A22	1085	11/17/2008	At cold tests <b>Good!</b>
B22	3118	11/15/2008	<i>Ready for cold tests</i>
C22	1071	11/14/2008	<i>Ready for cold tests</i>
A33	2103	12/16/2008	On going
B33	2192	12/19/2008	On going
C33	2108	12/17/2008	On going

First equipped with pressure relief port

**Good!**

SPARES DIPOLES STATUS					
STEPS		DIPOLE			
		TYPE A		TYPE B	
		QTY	ID	QTY	ID
COLD MASS	NOT TESTED	4	2437 / 2438 / 2445 / 2524	2	2431 / 2442
	NOT TESTED & Allocated for 3-4	0		2	2433 / 2441 (for sect 6-7)
	TESTED	0		0	
CRYOSTATING	IN WORK	1	2443	0	
	DONE	0		0	
COLD TEST	IN WORK	6	1055 (sick magnet) / 2868 / 2435 / 2444 / 2446	6	2429 / 2421 / 2427(NC) / 2418 / 2440 / 2428
	DONE * waiting for PA	1	2690 (NC)	2	2252 / 2420 (NC)
STRIPPING	IN WORK	1	2739	0	
	DONE	0		0	
FIDUCIALISATION	IN WORK	0		1	2432 (for sect 1-2)
	DONE	1	1011 (spare for sector 7-8)	0	
BEAM SCREEN	IN WORK	0		0	
	DONE	0		1	2399
TUNNEL PREPARATION	IN WORK	2	2436 / 2342	3	3383 / 2422 / 2434
	DONE	6	2790 / 3413 / 2598 / 2551 / 2439 / 2624	3	2430 / 1219 / 2419
TOTAL		22		20	
UPDATED		1/29/2009		BY N.Bourcey AT/MCS/CI	

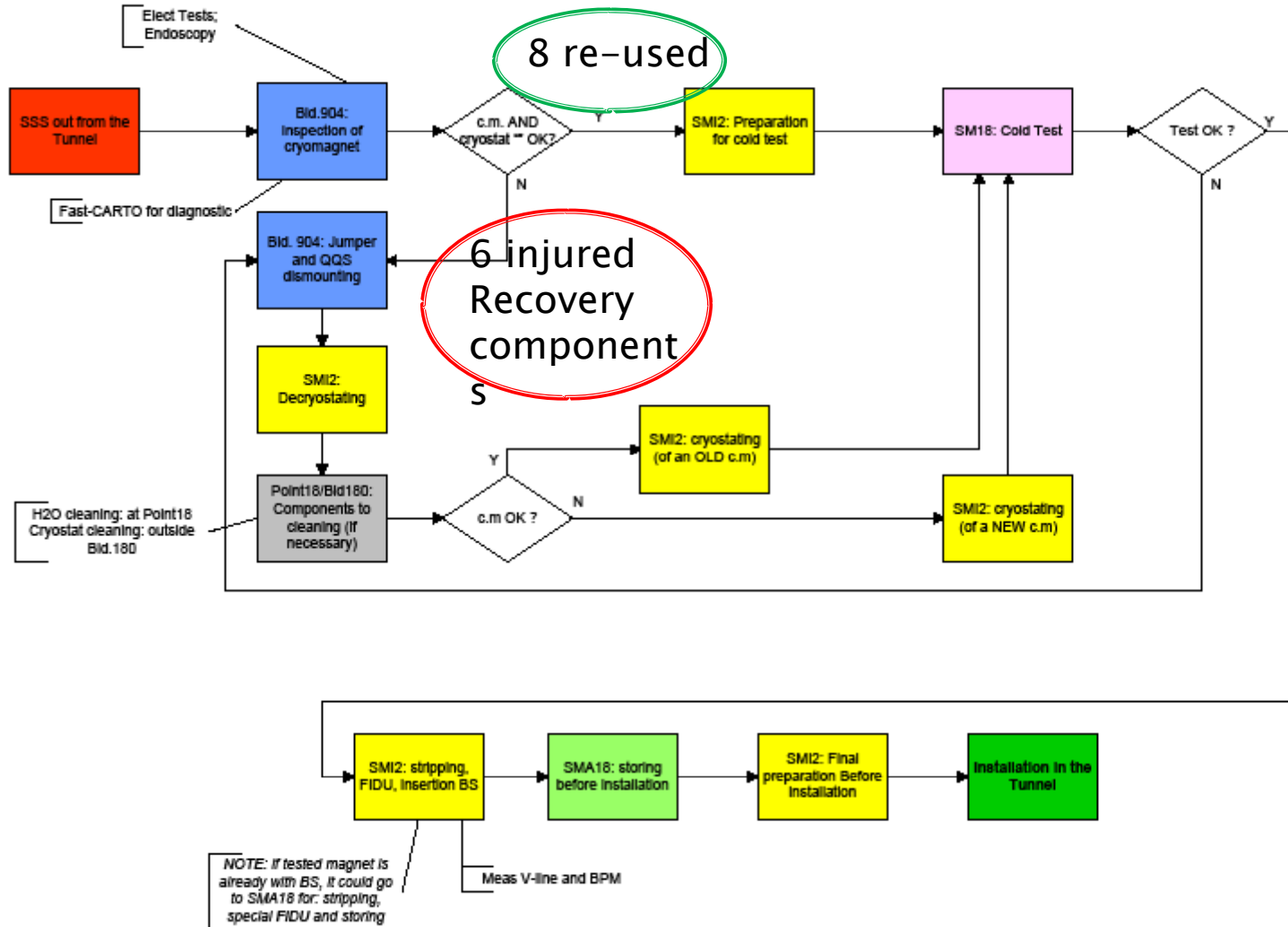
Legend  
blue: type L  
red: type R  
black: no diode

***MB Spares Situation at 29 January 2009***

- 9 MB installed or ready
- 23 MB in the pipe-line

***NOTE: Needed 32 NEW spares (30 for S.3-4 + 1 for S.1-2 + 1 for sector 6-7) and other 9 MB are recovered from tunnel 3-4 sector***

Logistic for SSS from the tunnel





## STATUS SSS FROM SECTOR 3-4

SSS		ARRIVAL	STATUS
Q19	228	N.A.	Stay in the tunnel
Q20	195	12/18/2008	Ready for cold tests W05
Q21	225	12/15/2008	Ready for cold tests W07
Q22	203	11/28/2008	Ready for cold tests W05
Q23	233	11/27/2008	Replace by SSS-243
Q24	199	1/7/2009	Replace by SSS-277
Q25	219	12/9/2008	Ready for cold tests W07
Q26	208	12/1/2008	Ready for cold tests W06
Q27	230	12/4/2008	Replace by SSS-055
Q28	198	12/5/2008	Replace by SSS-369
Q29	221	11/25/2008	Ready for cold tests W05
Q30	204	11/26/2008	Replace by SSS-006, W04
Q31	192	11/7/2008	Ready for cold tests W06
Q32	200	11/6/2008	Replace by SSS-279, W07
Q33	227	12/15/2008	Ready for cold tests W06

SPARES SSS STATUS							
STEPS		SSS					
		ARC		DS		MS	
		QTY	ID	QTY	ID	QTY	ID
COLD MASS	NOT TESTED	7	005 / 072 / 279 / 344 / 367 / 372 / 080 (leak under investigation)				
	TESTED						
CRYOSTATING	IN WORK						
	DONE						
COLD TEST	IN WORK	2	369 / 6	1	603		
	DONE	2	64* / 364				
STRIPPING	IN WORK						
	DONE						
FIDUCIALISATION	IN WORK	1	243				
	DONE						
BEAM SCREEN & BPM	IN WORK	1	55				
	DONE			1	523 (used for warm-up test)		
PREPARATION FOR TUNNEL	IN WORK						
	DONE	1	277				
<b>TOTAL</b>		<b>14</b>		<b>2</b>			
UPDATED		1/29/2009		BY		N.Bourcey AT/MCS/CI	

***SSS Spares Situation at 29 January 2009***

- 1 SSS installed
- 5 SSS in the pipe-line

***NOTE: Needed 6 new spares for S.3-4 and other 8 SSS are recovered from the Tunnel***

## Sector 3-4: Status and SSS spares allocation (at 19/12/08)

NAME	FUNCTION	JUMPER	VB & PLUG	PT821	MAGNET ID.	MQ needed	MSCB needed	MO/MQT, MQS needed	Diode polarity	CM Status	New proposed pre-allocation	New Propose CM TYPE	New Propose SSS (and Slot) TYPE	SLOT Configuration
LQASB.23R3	Q23R3	X	X		233	D/F	MSCBB	MQS	B		SSS243	LQMTD	LQATD	NOT OK
LQOBA.24R3	Q24R3				199	F/D	MSCBA	MO	A		SSS277	LQMOQ	LQOBA	OK
LQASB.27R3	Q27R3	X	X		230	D/F	MSCBB	MQS	B		SSS055	LQMTD	LQATD	NOT OK
LQOBA.28R3	Q28R3				198	F/D	MSCBA	MO	A		SSS369	LQMTK	LQATS	NOT OK
LQOBK.30R3	Q30R3				204	F/D	MSCBC	MO	A		SSS006	LQMOW	LQOBK	OK
LQOBA.32R3	Q32R3				200	F/D	MSCBA	MO	A		SSS279	LQMSE*	LQASH*	NOT OK

\* = new type

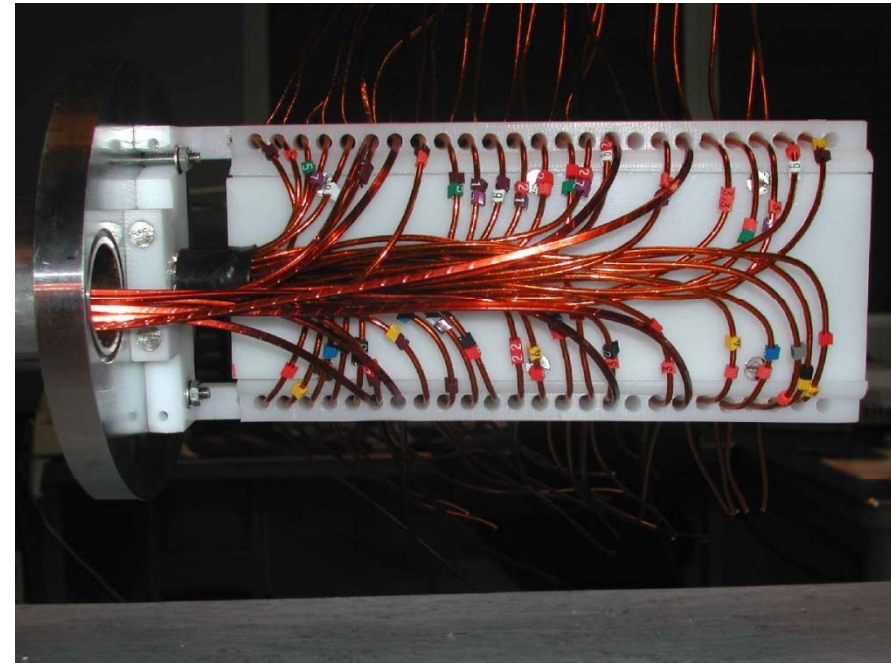
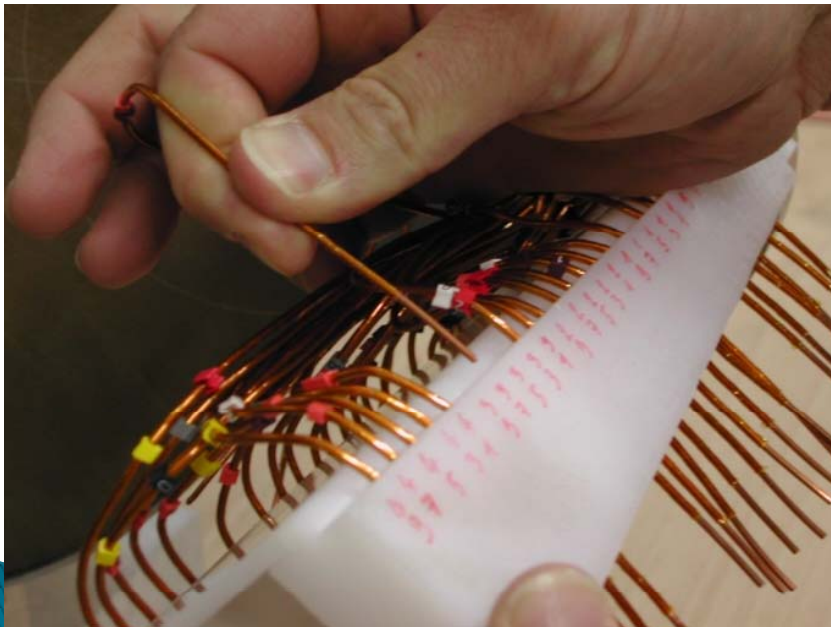
Impossibility to have an exact substitution for the SSS. We will loose correctors, because :

- We don't have in stock all type and needed number of SSS spares as necessary
- BE-ABP priorities are:
  1. Try to preserve the MSCB (orbit corrector and sextupole magnet) and MQT/MQS/MO layout
  2. If both not possible: priority is for MSCB preservation
  3. If more then one choice: sort MQ to minimize the effect on the beta-beating

It is foreseen to loose 2 MQS/beam (out of 4 in sector 3-4) and 2 MO out of 13 in sector 3-4.



Not Standard modification will be necessary at the level of the “line-N” connection boxes to insulate the corrector BB not utilized and to bridge the corrector circuits connection to guarantee the continuity of them



All these modification are part of an ECR under preparation by MSC/Cryomagnet coordination with all concerned teams in the various departments.

TE-MPE in charge of the cabling map and ELQA new procedure.

**Cryomagnet coordination will update the baseline document of arc SSS**







SECTOR	SLOT	POSITION	NEW MAGNET ID	OLD MAGNET ID	END DECRYOSTATING	END CRYOSTATING	END PREPA FOR COLD TESTS	END COLD TESTS	END STRIPPING & POLARITY TEST	END FIDUCIALISATION	END BS INTEGRATION	END PREPA FOR TUNNEL	READY FOR INSTALLATION
	LBBLD.31R3	C31	2429	1231	N.A.	W 6 2009 W	N.A.	W 11 2009 W	W 12 2009 W	W 12 2009 W	W 14 2009 W	W 15 2009 W	W 15 2009 W
	LQOAC.31R3	Q31R3	192	192	W --- W done	W 5 2009 W	N.A.	W 8 2009 W	W 9 2009 W	W 9 2009 W	W 10 2009 W	W 11 2009 W	W 11 2009 W
	LBALA.32R3	A32	2624	2102	N.A.	W --- W done	N.A.	W --- W 47 2008	W --- W 49 2008	W --- W 49 2008	W --- W 2 2009	W 4 2009 W	W 4 2009 W
	LBBLA.32R3	B32	2252	2194	N.A.	W --- W done	N.A.	W 3 2009 W	W 4 2009 W	W 4 2009 W	W 5 2009 W	W 6 2009 W	W 6 2009 W
	LBALB.32R3	C32	2443	2171	N.A.	W 5 2009 W	N.A.	W 9 2009 W	W 10 2009 W	W 10 2009 W	W 11 2009 W	W 12 2009 W	W 12 2009 W
	LQOBA.32R3	Q32R3	279	200	N.A.	W 7 2009 W	N.A.	W 11 2009 W	W 12 2009 W	W 12 2009 W	W 13 2009 W	W 14 2009 W	W 14 2009 W
	LBBLA.33R3	A33	2103	2103	N.A.	N.A.	W 5 2009 W	W 10 2009 W	W 12 2009 W	W 12 2009 W	W 13 2009 W	W 14 2009 W	W 14 2009 W
	LBALA.33R3	B33	2192	2192	N.A.	N.A.	W 7 2009 W	W 11 2009 W	W 13 2009 W	W 13 2009 W	W 14 2009 W	W 15 2009 W	W 15 2009 W
	LBBLD.33R3	C33	2108	2108	N.A.	N.A.	W 7 2009 W	W 11 2009 W	W 12 2009 W	W 12 2009 W	W 13 2009 W	W 14 2009 W	W 14 2009 W
	LQOAK.33R3	Q33R3	227	227	N.A.	N.A.	W 5 2009 W	W 8 2009 W	W 9 2009 W	W 9 2009 W	W 10 2009 W	W 11 2009 W	W 11 2009 W
<b>1-2</b>	LBBRA.16R1	B16	2432	2334	N.A.	W --- W 50 2008	N.A.	W 4 2009 W 4 2009	W 5 2009 W	W 5 2009 W	W 6 2009 W	W 7 2009 W	W 7 2009 W
<b>6-7</b>	LBBRA.32R6	B32	2441	2303	W W	2009 W	W W	2009 W	W W	2009 W	W W	2009 W	W W

Today estimation is to have all magnets transported in the Tunnel for WEEK 15 (ending with Friday 10 April– Easter Friday ).

This planning is success oriented (i.e. no contingency built-in). The most risky aspects are the uncertainties that could come from magnets coming from the tunnel (the 8 SSS but and the 9 MB) and the uncertainties coming from the NEW test on splices resistance recently added at SM18. MB2420 substitution CM already launched

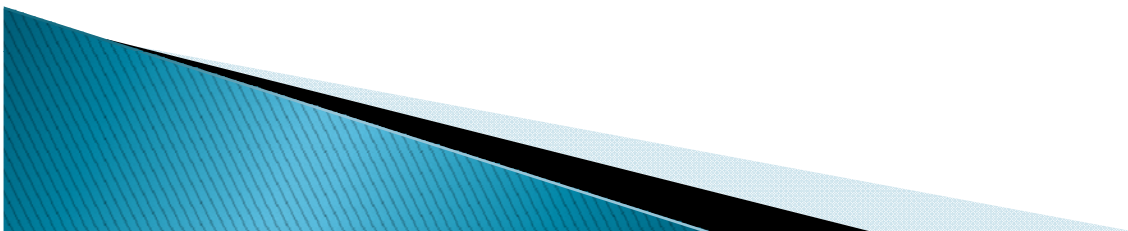
Especially the consequence of an SSS from the tunnel not passing the cold test could have huge time consequences (7–8 weeks).

MB 2427, MB2690, MB3383 are blocked , waiting investigation on splice I (opening of MB2420). DECISION of last week: Cryostating all dipoles

(For following activities. See planning for Tunnel activities (F.Bertinelli).

# Content

- ▶ Situation of spares before the incident
- ▶ Magnets affected and magnets damaged
- ▶ Criteria for magnet replacements
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- ▶ **Magnets Factories snapshot**
- ▶ Plan for reserve stock re-constitution



# New cryo-dipole assembly



Cryo-dipole ready for testing

Next dipole to cryostat

Preparation for recovery of Sect.3-

4

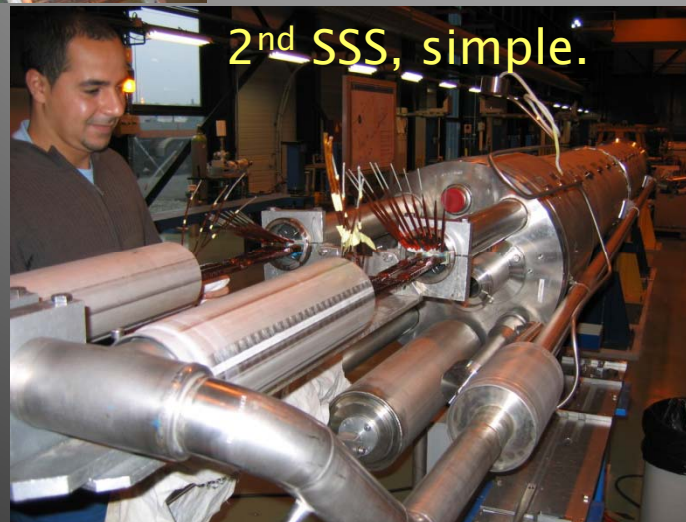


# 180 (West Hall) and SMA18





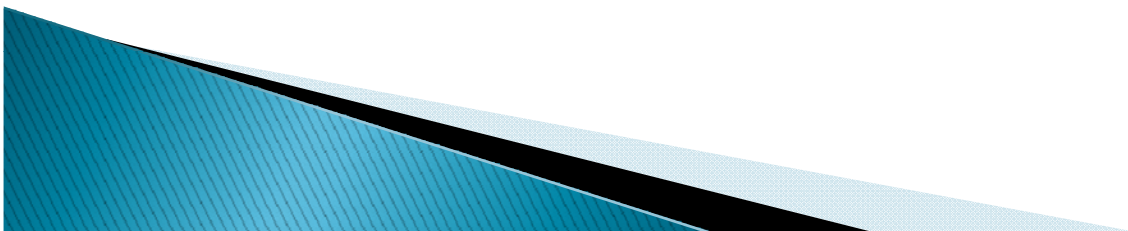
# SSS with new CMs in progress



Preparation for recovery of Sect.3-

# Content

- ▶ Situation of spares before the incident
- ▶ Magnets affected and magnets damaged
- ▶ Criteria for magnet replacements
- ▶ Logistics, workflow and plan for 3–4 refilling
- ▶ Magnets Factories snapshot
- ▶ **Plan for reserve stock re-constitution**

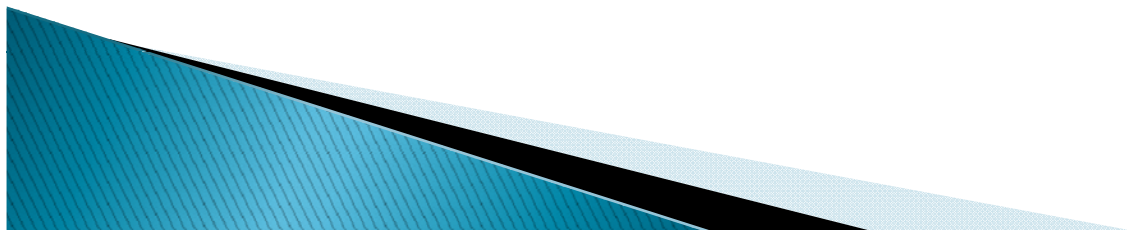


# Group B: magnets without direct electrical damage, no measured displacement (9 units)

Decryostating without displacement			
DIPOLE		ARRIVAL	STATUS
A26	1242	11/28/2008	Decryostated
B26	2111	11/24/2008	Decryostated
C26	2100	11/27/2008	Decryostated
A30	1154	12/17/2008	Decryostated
B30	3409	12/15/2008	Decryostated
C30	1083	12/2/2008	Decryostated
C29	2040	12/12/2008	Decryostated
B25	1084	12/5/2008	Decryostated
C25	3096	11/25/2008	Decryostated

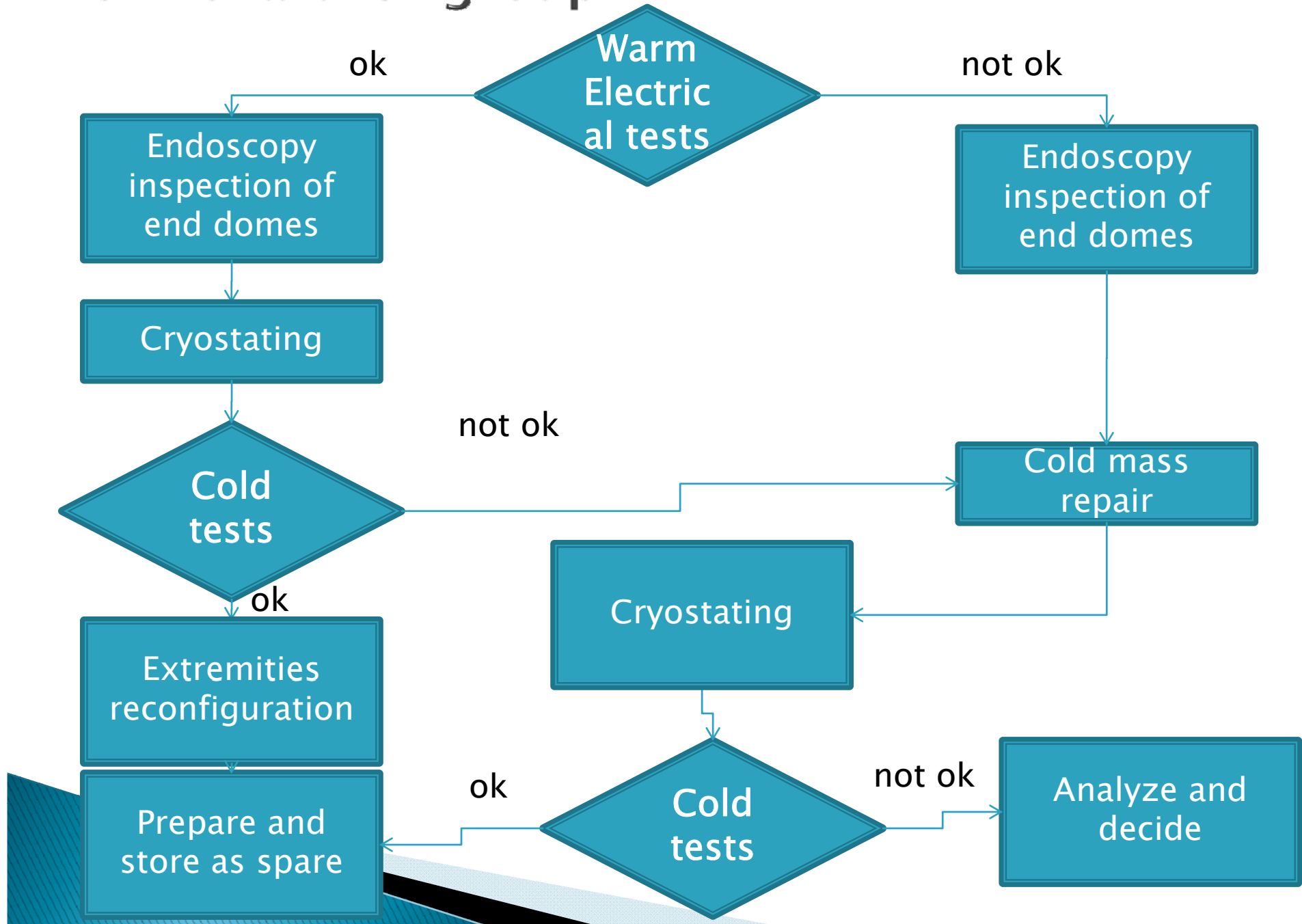
All de-cryostated to re-use components for cryostating new CMs.

Order of intervention:  
from farther from an electrical problem to nearer





# Flow-chart for group B

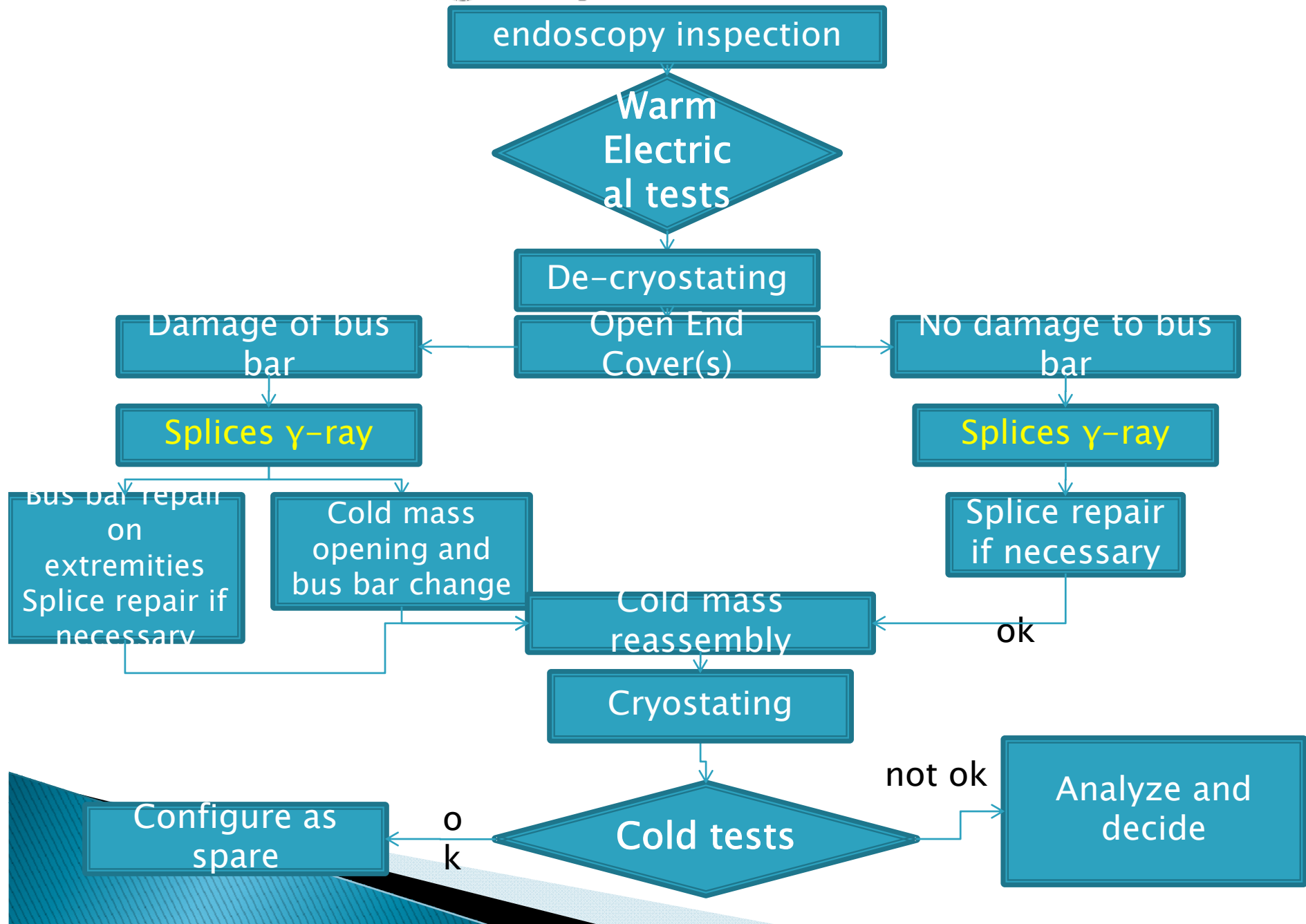


# Group C: Dipoles without electrical damage, but displaced ( 11 units)

GROUP C			
Decryostating with displacement / cold mass apparently not damage			
DIPOLE		ARRIVAL	STATUS
A23	1236	11/19/2008	
A29	1112	12/3/2008	
B29	1061	12/16/2008	On going
A31	3636	12/18/2008	Decryostated
A27	2043	12/19/2008	
B31	1072	12/8/2008	
B23	2193	11/20/2008	
B27	1089	11/28/2008	
A32	2102	12/10/2008	
C31	1232	12/3/2008	
C28	3103	12/10/2008	

Order of intervention:  
from less displaced to  
more displaced,  
taking into account  
that a compression  
on lyras is less  
dangerous then a  
similar actions on  
CS side

# Flow-chart for group C



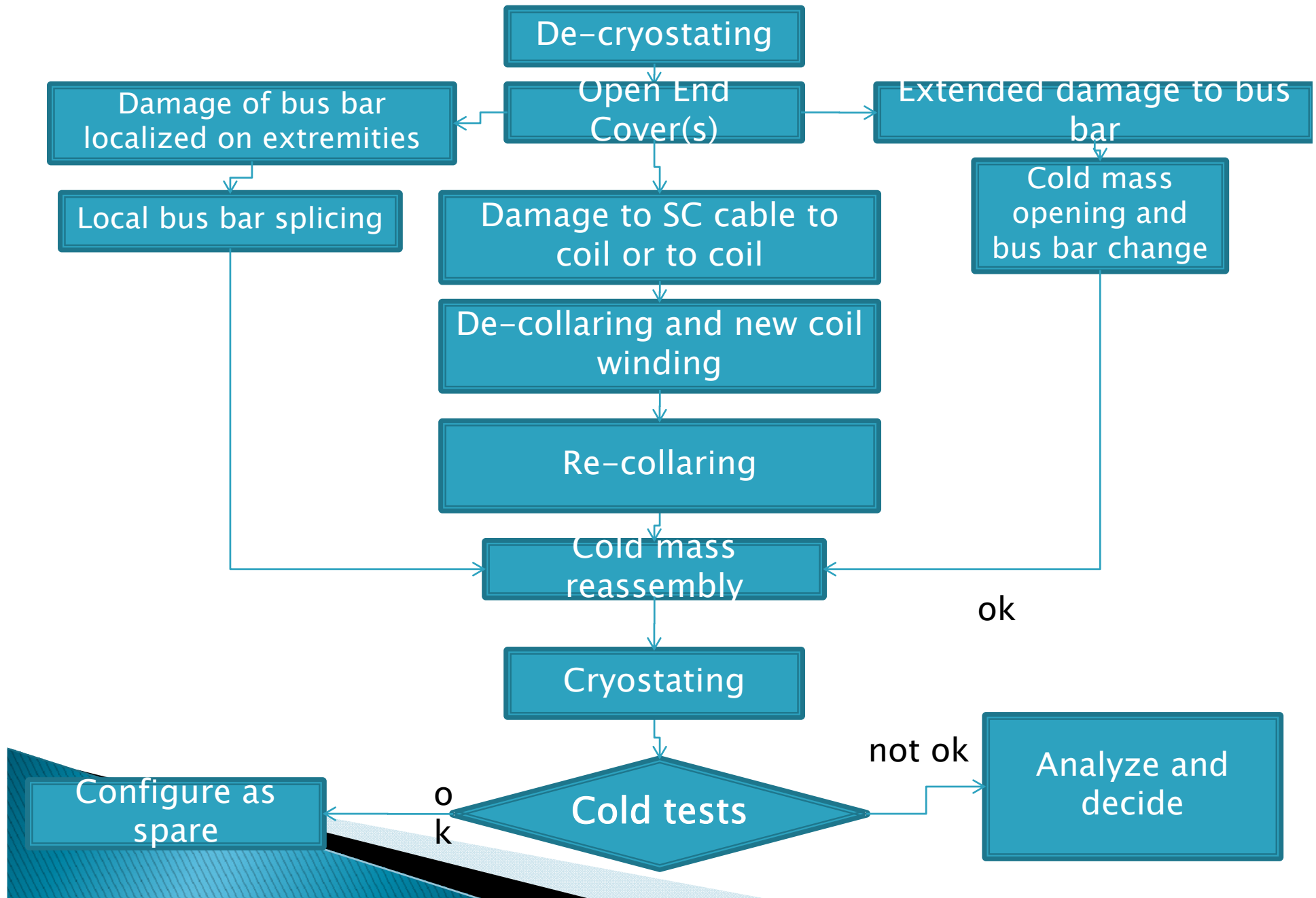
# Group D: magnets with direct electrical damage (10 units)

GROUP D			
Decryostating with displacement / cold mass apparently damage			
DIPOLE		ARRIVAL	STATUS
C32	2171	1/6/2009	
B28	3128	1/7/2009	
A25	1132	12/4/2008	Decryostated
B24	2055	1/6/2009	
B32	2194	1/8/2009	
C27	1235	12/2/2008	
C24	3110	1/8/2009	
C23	1109	11/21/2008	
A28	1088	12/11/2008	
A24	1241	12/11/2008	

Order of intervention from probably less damaged to more damaged.



# Flow-chart for group C



# Plan for MB repair

Starting date	End date	Units/week	Magnet Group	Cumulative of repaired spare
Oct 2008	April 2009	2	New CM prepar.	(30)
May 2009	July 2009	Magnet facilities and tooling	==	==
		Reparation external splice		? (2 minimum)
September 2009	End November 2010	1	Group B	9
December 2009	Mid June 2010	0.5	Group C	20
June 2010	End of August 2010	0.5	Gr. D easy	23
<b>September 2010</b>	<b>December 2010</b>	<b>1 /month</b>	<b>Gr. D medium</b>	<b>27</b>
January 2011	End 2011		Gr. D – Rebuilt	30

# Plan for SSS

The tower for vertical assembly and disassembly is being installed at CERN. End of March.

We need to practice with this technology that was never used at CERN before and due to the lack of spares components we need to recover the pieces during disassembly.

It will be longer and more complex than for dipoles

Bus bars availability (need workshop)

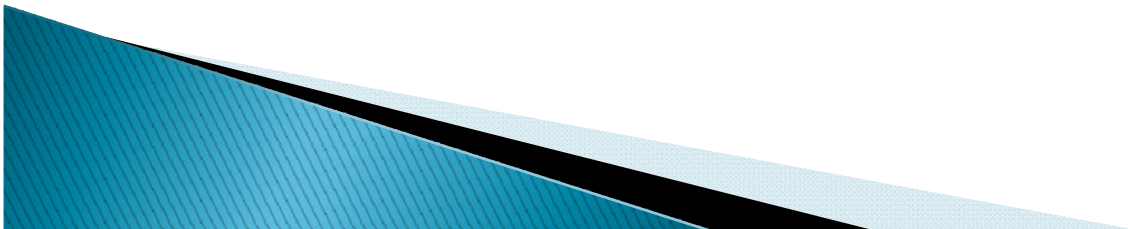


Thanks for the attention



# Spare slides for discussions

- ▶ Inventory of corrector lost due to SSS substitution
- ▶ Results on test of rupture strength of bus bar fix point of dipoles
- ▶ Slides on spare strategy in AT department



## Circuit RQS.R3B1: **lost at 100%**

RQS.R3B1 : Skew quad. (Q23R3, Q27R3) Beam 1 [Link to MTF](#)

ID : 254507, CIRCUIT VERSION : STUDY, LAYOUT VERSION : STUDY

Power Converters in the Circuit	PC Location	Rack Name/Slot	
RPMBA.UJ33.RQS.R3B1 (MTF)	UJ33	RYMCA08=UJ33	1.2
Magnets in the Circuit	Number		
MQS	2		

(NOTE that Circuit RQS.L4B1: is **OK (Not concerned)**)

RQS.L4B1 : Skew quad. (Q27L4, Q23L4) Beam 1 [Link to MTF](#)

ID : 254502, CIRCUIT VERSION : STUDY, LAYOUT VERSION : STUDY

Power Converters in the Circuit	PC Location	Rack Name/Slot	
RPMBB.UA43.RQS.L4B1 (MTF)	UA43	RYMCB02=UA43	1.1
Magnets in the Circuit	Number		
MQS	2		

## Circuit RQS.A34B2: **lost at 50%**

RQS.A34B2 : Skew quad. (Q23R3, Q27R3, Q27L4, Q23L4) Beam 2 [Link to MTF](#)

ID : 254498, CIRCUIT VERSION : STUDY, LAYOUT VERSION : STUDY

Power Converters in the Circuit	PC Location	Rack Name/Slot	
RPMBA.UJ33.RQS.A34B2 (MTF)	UJ33	RYMCA08=UJ33	1.1
Magnets in the Circuit	Number		
MQS	4		

## Circuit ROD.A34B1 **lost 2/13**

**ROD.A34B1** : D. Octupole in series per sector (Q22R3, Q24R3, Q26R3, **Q28R3**, Q30R3, **Q32R3**, Q34R3, Q32L4, Q30L4, Q28L4, Q26L4, Q24L4, Q22L4) Beam 1 [Link to MTF](#)

ID : 254365, CIRCUIT VERSION : STUDY, LAYOUT VERSION : STUDY

Power Converters in the Circuit	PC Location	Rack Name/Slot	
RPMBB.UJ33.ROD.A34B1 (MTF)	UJ33	RYMCB06=UJ33	1.2
Magnets in the Circuit	Number		
<b>MO</b>	<b>13</b>		

## Circuit ROF.A34B2 **lost at 1/13**

**ROF.A34B2** : .F. Octupole in series per sector (Q22R3, Q24R3, Q26R3, **Q28R3**, Q30R3, Q32L4, Q34R3, Q32L4, Q30L4, Q28L4, Q26L4, Q24L4, Q22L4) Beam 2 [Link to MTF](#)

ID : 254404, CIRCUIT VERSION : STUDY, LAYOUT VERSION : STUDY

Power Converters in the Circuit	PC Location	Rack Name/Slot	
RPMBB.UJ33.ROF.A34B2 (MTF)	UJ33	RYMCB07=UJ33	1.1
Magnets in the Circuit	Number		
MO	13		
Current Leads in the Circuit			
DFLBS.UJ33.19			
DFLBS.UJ33.20			
Magnets per Power Converter			
RPMBB.UJ33.ROF.A34B2			
<b>MO</b>	<b>13</b>		

# Test Report

CERN - TS/MME/MM Metallurgy and Metrology section

*Point fixe busbar quadrupole 15 mm-1-2-3*

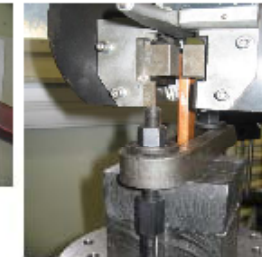
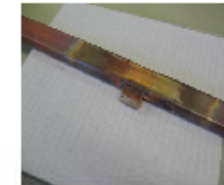


Material: Busbar  
 Operator: AG  
 Speed Step1: 200.00 mm/min  
 Customer: P. Fessia AT/MCS  
 Testdate: 10/11/2008  
 Type of test: Cisaillement

Exemple	Fm [kN]	Agf [mm]
Point fixe busbar quadrupole 15 mm -1	20.81	18.20
Point fixe busbar quadrupole 15 mm -2	28.64	20.90
Point fixe busbar quadrupole 15 mm -3	21.24	7.03

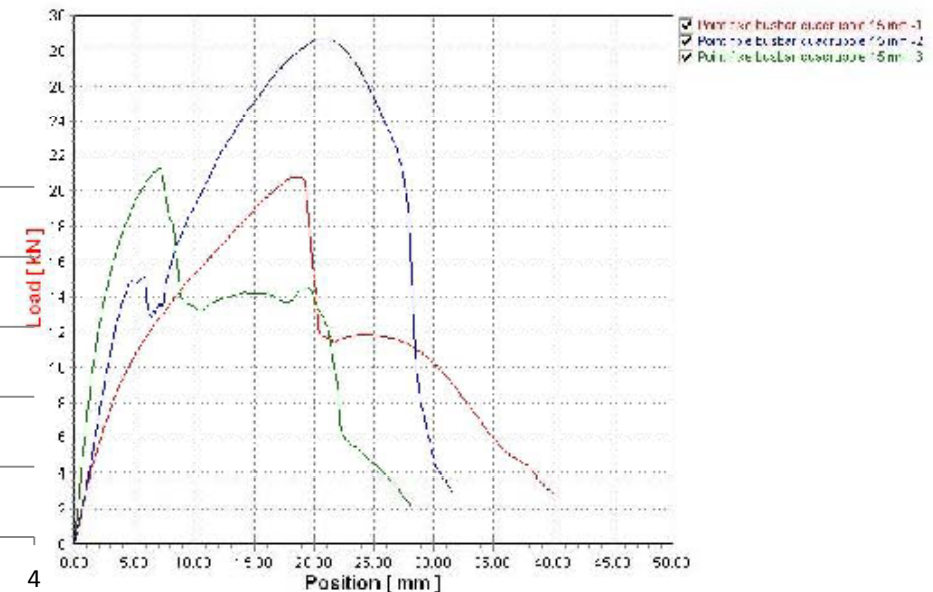
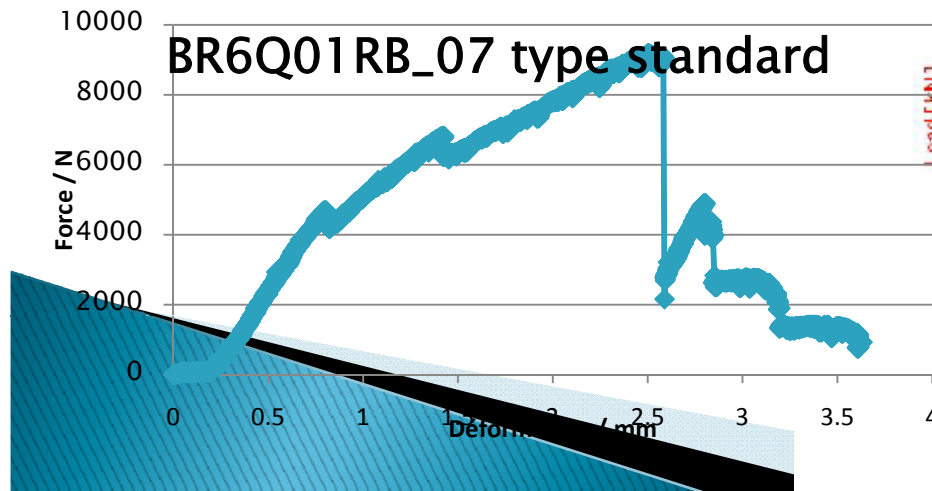
Echantillon avant test

Montage dans la machine



Echantillon 1: rupture point fixe -sans cable supra-  
 Echantillon 2: rupture point fixe -avec cales vetronite et isolant-  
 Echantillon 3: rupture point fixe -avec isolant-

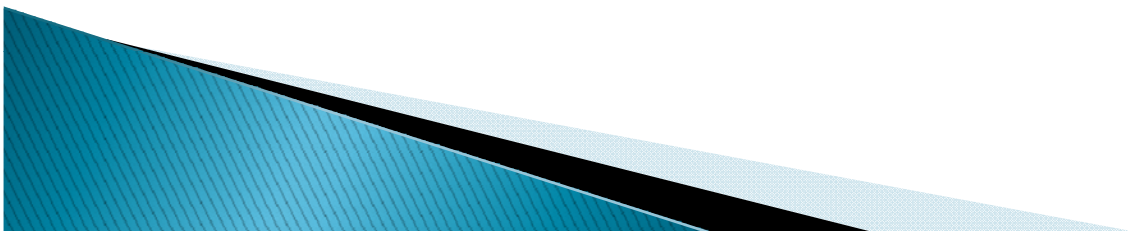
Of the 4 types of bus bar fixed points  
 The weakest is the quand in the SSS.  
 Tested: 20 kN tensile strength  
 Bus Bar interconnection rupture strength is  
 At max 13-14 kN.





# Magnet and Component Spares

- ▶ As early as 2003 discussion on spare in AT
  - Triggered by deadline on option deadlines in series contract for components (SC cables and others)
  - Amount of reserve in contract was small (due to budget limitation and trimmed down in 2002).
- ▶ Decision to constitutes an adequate reserve for SC cables (very long lead time component).
  - 50 dipole equivalent of Sc in addition to the already 40–50 dipole equivalent present in the series contract to face scarps and problem in magnet fabrication.



# Main Magnet spare: status 2004

- ▶ In 2004 became clear that the small reserve we had in the contract to cope with loss during production was only moderately eaten up for main magnets cold masses.
- ▶ Reserve in the series:
  - 16 dipoles (1248 ordered vs. 1232 needed for tunnel)
  - 8 quadrupoles (400 MQ ordered vs. 360+32 needed)
- ▶ Reserve in the original components almost all used:
  - Needed in more quantity than foreseen (for example iron for lamination : fine blanking more demanding)
  - Scrapped to repair NCs of part containing the components: scrapping a coils for short circuits many components are scrapped: cable , insulation, etc.; By re-collaring, many components need to be changed.
- ▶ Almost all options in contracts for purchasing extra component were activated

