

Where are we with the current shutdown?

LHC Performance Workshop 2009

Session 5

Shutdown schedule 2008/9 and Future shutdowns

Shutdown 08-09

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Key Drivers

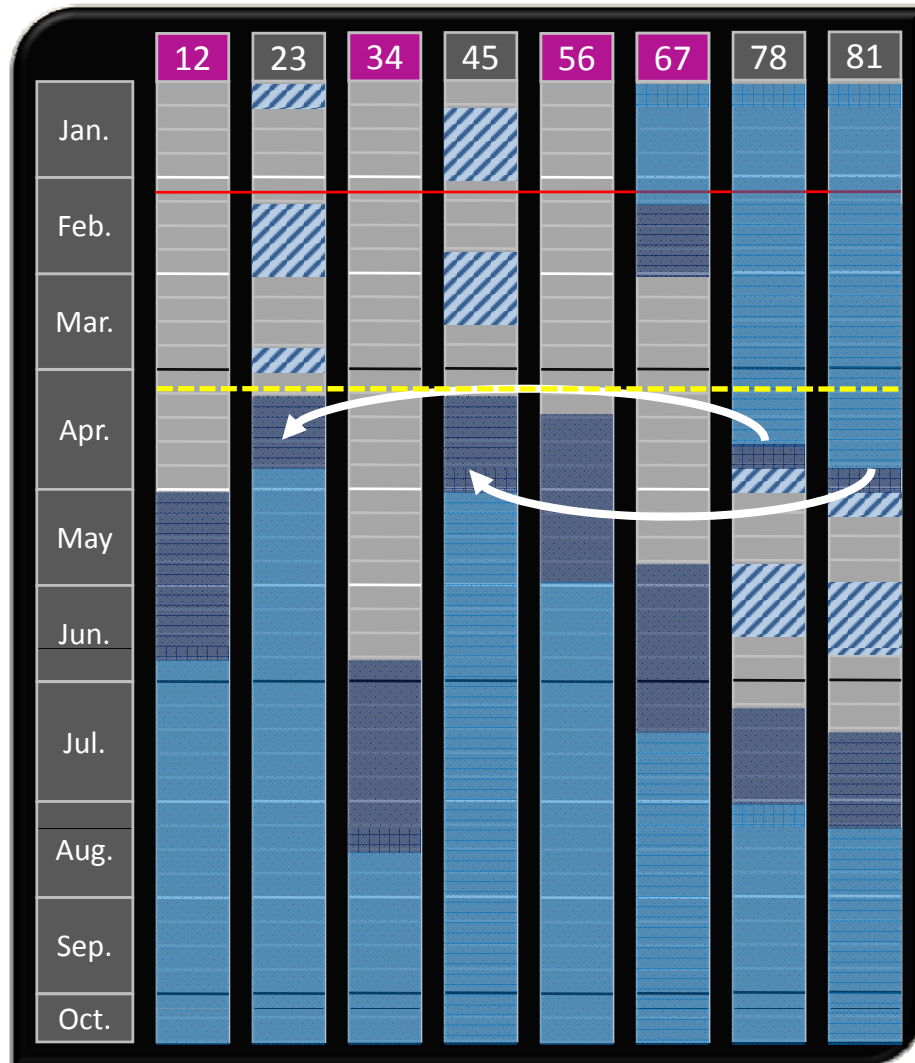
Maintenances

Priorities

Activities – service areas, LSS, Arcs

Schedule

Critical Points



Sectors warm to R.T = 4

- ⊗ Sectors 12, 34, 56
- ⊗ Sector 67 in February

Current status = 5 sectors empty

Helium Storage = max. 6 sectors

Cool-down of sectors 12, 23, 34, 56 and 67 cannot be done as long as there are transports of dipoles for sectors 34 and 67

Last dipole = week 15

For sectors not warmed to R.T.

Maintain the T. under 100K for the PIMs = 2 weeks of intermediate cool-down / 4 weeks

Warm-up of the stand-alone and QRL = + 1 week

It's a 6 weeks cycle: only 3 weeks of works !

Machine cold in August

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Key Drivers

Maintenances

Priorities

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Schedule

Critical Points

☼ Maintenance which have a direct impact on the cryogenic conditions

- ☼ Cryogenic maintenance ~ 4 weeks

Preventive maintenance of LHC cryogenic plants (surface-underground) each year

- ☼ Cooling maintenance ~ 3 weeks

Fluids: cooling-towers, pumping station

☼ Electricity maintenance

- ☼ 400kV maintenance in partnership with EDF ~ 2 weeks

- ☼ AUG tests ~ 1 day / point

- ☼ ...

☼ Other maintenances

- ☼ Instruments inspection

- ☼ Mechanical inspection

- ☼ Check of the electronic systems

- ☼ Access systems

- ☼ Security alarms

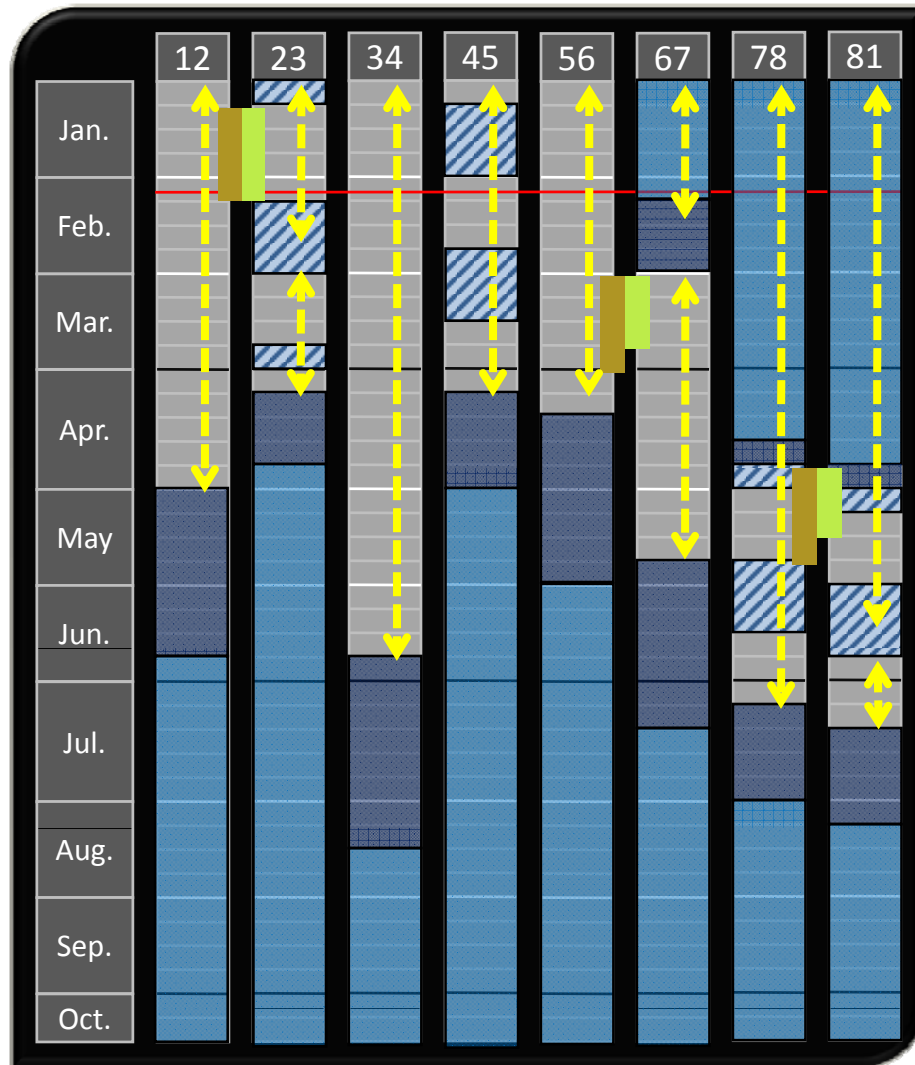
- ☼ Ventilation

- ☼ Handling systems

- ☼ ...

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Key Drivers **Maintenances** Priorities Activities – service areas, LSS, Arcs Schedule Critical Points



The two main maintenance operations need the sectors to be empty

⚙️ Cryogenic maintenance

- Pt 1.8 / Pt 4 complete
- Pt 2 ongoing
- Pt 6 / Pt 8 to perform

⚙️ Cooling and Ventilation maintenance

- Pt 4 complete
- Pt 2 ongoing
- Pt 6 / Pt 8 to perform

⚙️ Check, inspection, calibration,...

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Key Drivers

Maintenances

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Schedule

Critical Points

☼ 3 Priorities are defined according to :

- ☼ Operation at 5TeV beam energy
- ☼ Safety
- ☼ ALARA principle (As Low As Reasonably Achievable)

Priority 1 :

All priorities 1 must be performed during this *first shutdown*

Priority 2 :

All priorities 2 not performed during this current shutdown must be taken into account for the *second shutdown*

Priority 3 :

All priorities 3 not performed during this current shutdown will be done during *next shutdowns*

- Departments reviewed the priorities of activities proposed by groups

The target is to complete all priorities 1 and carry out a maximum of priorities 2 and 3, especially for warm sectors

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Key Drivers

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Critical Points

As an example results of « AT » activities of priority 1

Not included: repairs of sector 3-4, hardware commissioning/coldcheck out activities, secondary support activities (leak check, EIQA, Bake-out...), activities scheduled by other departments

Action	AT Group	Nature	Priority	Comment	Num	Location	Conditions cryo	Affected pipewo
Repair BB in connection cryostats	MCS	Repair	1	Risk of short between bus-bars	3	A56	Sub-sector warm-up	W, CM
Copper strip in inner triplets	MCS/CRG	Repair	1	Longer cool-down. Luminosity limited.	2	XR5, XL1	Sub-sector warm-up	All
Installation of metallic markers on the magnet electrical terminals	MCS	Consolidation	1	Simplify future interventions	155	LSS	None	None
Installation of purge fittings	MCS	Consolidation	1	Simplify future interventions	58	LSS	None	None
Replacement of protection cover screws	MCS	Consolidation	1	Reduce intervention time	48	LSS	None	None
Re-location of the DFB manifold in point 3	MCS/CRG	Repair	1	Integration problem	1	LSS3	None	None
Replacement of filter cartridges	MCS/TS-CV	Consolidation	1	New version	71	LSS	None	None
Relocation of electrical boxes below resistive magnets	MCS/TS-EL	Repair	1	Integration problem	155	LSS	None	None
Installation of rails under MSD magnets	MCS	Consolidation	1	Reduce intervention time	15	LSS	None	None
Installation of flowmeters	MCS/TS-CV	Consolidation	1	Simplify interventions in the tunnel	84	LSS	None	None
Add thermostiches in current leads	MEI	Consolidation	1	Equipment safety	1100	DFB	None	None
New protection system for symmetric quenches and bus-bars	MEI	Consolidation	1	Equipment safety	1233	All	None	None
Alignment of vacuum pipes	VAC/TS-SU	Consolidation	1			LSS	None	None
Installation of mobile pumping groups in cold vacuum	VAC	Maintenance	1	Required prior to cool-down		All	None	B1,B2
Transfer of actuators UX85 to UL84	CRG	Consolidation	1	Frequent single events	1	A78, A81	Intermediate warm-up	
Remote reset safety PLC TU AL (P2&P8) & QURC Linde (P8&P4)	CRG	Consolidation	1	Equipment safety	4	P2,P4,P8	None	None
Access securisation, Equipment protection CB Surface/QUI underground	CRG	Consolidation	1	Personnel and equipment safety	30	DFB	He emptying	None
DFB mechanical protections	CRG	Consolidation	1	Personnel and equipment safety		DFB	He emptying	None
Securisation discharge of DFBs safety valves	CRG	Consolidation	1	Personnel and equipment safety		DFB	He emptying	None
Interconnection DSLC/DFB S34 (both sides)	CRG/MCS	Repair	1	Hot points affecting corrector circuits	1	A34	Intermediate warm-up	DSL vaccum ins
Helium guards inner triplets & DFBX	CRG/MCS	Repair	1	Leaks		LSS	He emptying	WRL
Documentation DFBX		Consolidation	1	Integration problem				
Automatic and remote reset of QPS controllers	MEI	Consolidation	1	Avoid frequent tunnel interventions	<30	All	None	None
Voltage taps on Q10L6	MCS/MEI	Repair	1	Disconnected at the IFS level. Regular checks	1	A56	Sub-sector warm-up	W
Layout drawings as installed	VAC/TS-IC	Consolidation	1			LSS	None	None
DFBX intergation			1					

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Key Drivers

Maintenances

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Schedule

Critical Points

☀ Services areas

- ☀ Consolidation & installation

☀ Installation, Consolidations & repairs in the LSS

- ☀ Warm part
- ☀ Cold part

☀ Consolidations & repairs in the arcs

- ☀ “repetitive” activities
- ☀ Sector 12
- ☀ Sector 34
- ☀ Sector 56
- ☀ Sector 67

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⚙️ AUG tests – Priority 1

They are performed once a year during shut-downs. Moreover during this shutdown, it allows us to identify the equipments which were not on UPS as specified, and showed some loss of communications.

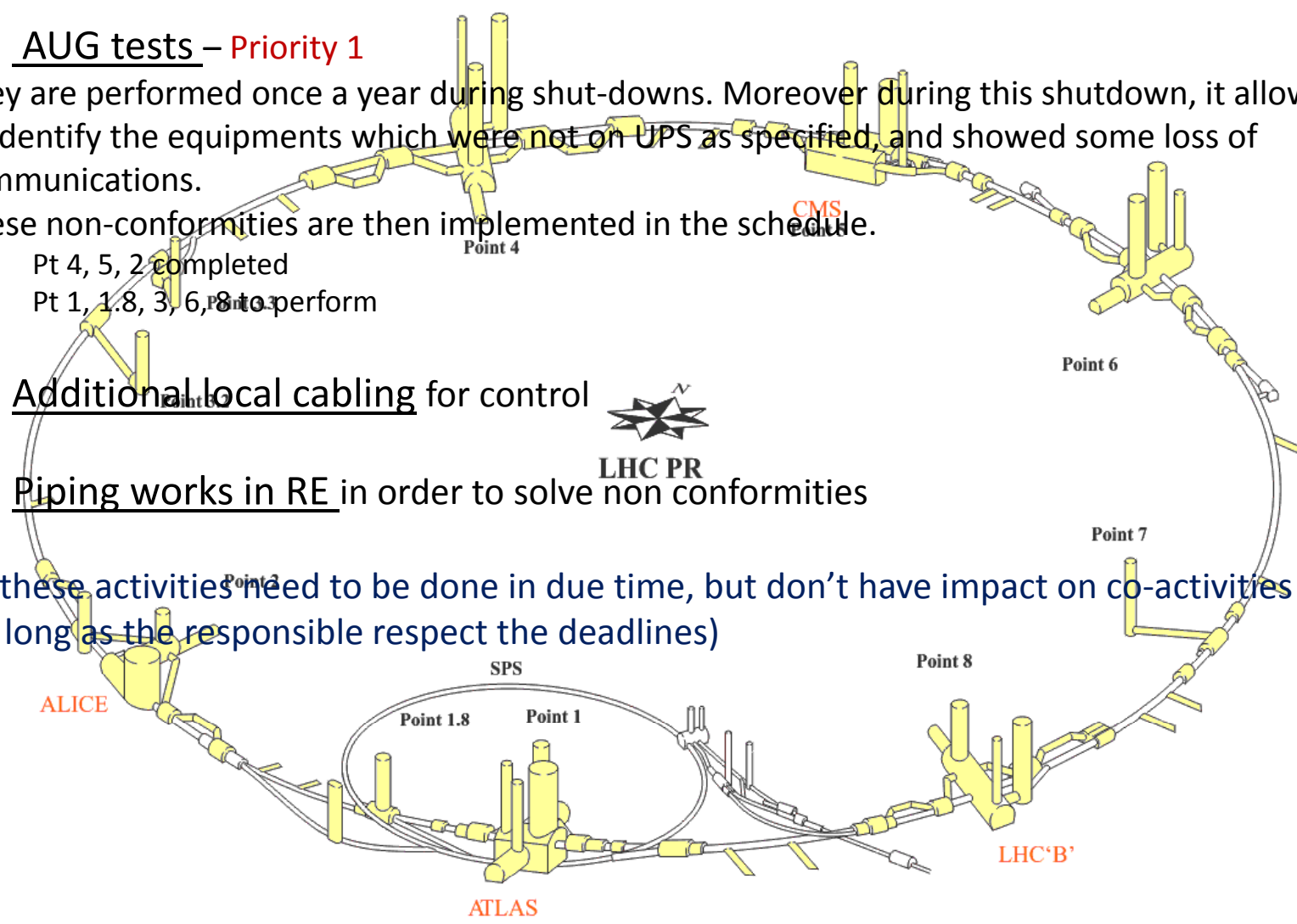
These non-conformities are then implemented in the schedule.

- Pt 4, 5, 2 completed
- Pt 1, 1.8, 3, 6, 8 to perform

⚙️ Additional local cabling for control

⚙️ Piping works in RE in order to solve non conformities

All these activities need to be done in due time, but don't have impact on co-activities (as long as the responsible respect the deadlines)



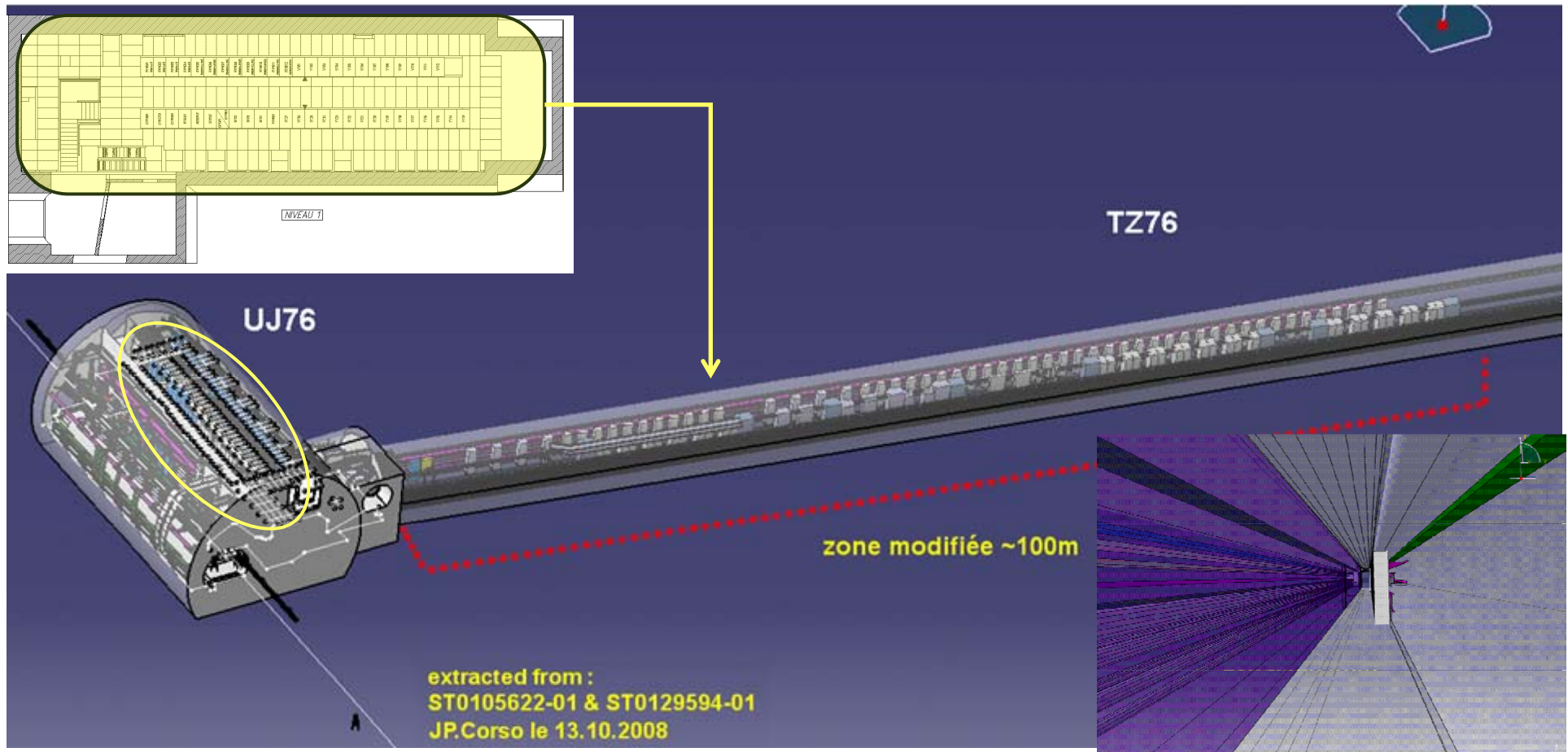
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Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points

☀ Modification of the underground integration of Point 7 (TZ76 and UJ76) – **Priority 1**

Objective: relocation of UPS and electronics from UJ76 to the TZ76 ~ until end of June 09

Reason for these modifications: radiation levels - rf. M.Brugger's talk



☀ Completion of machine installation

☀ **20 Collimators** ; 2 in LSS1, 3 in LSS2, 2 in LSS5, 10 in LSS7, 3 in LSS8

All these collimators are ready to be installed

☀ Priority 1 : 6/10 are installed

☀ Priority 2 : 5/10 are installed

☀ **4 Kickers** in LSS6 (Dump line)

All these MKB are ready to be installed

☀ Priority 1 : no kicker is still installed

☀ **4 Roman Pots** in LSS1 (ALFA)

☀ Priority 1 : available end of May

☀ **12 detectors** in LSS5 (TOTEM)

☀ Priority 1 : 2/12 are installed

☀ **4 Beam monitors** (BPMWF) ; 2 in LSS1 and 2 in LSS5

☀ Priority 1 : available mid of March

☀ **2 pick-up** BPAWT in LSS4

☀ Priority 2 : current instruments are still under RF approbation

☀ Consolidation/Repairs

☀ **2 TDI** ; 1 in LSS2, 1 in LSS8

Objective : repair an important leak detected

From removal to re-installation ~ 2 months/TDI (on going)

☀ **22 Collimators** ; 1 in LSS2, 8 in LSS2, 2 in LSS6, 11 in LSS7

Objective : increase expected lifetime for early series production

From removal to re-installation ~ 3 weeks/3 collimators (on going)

☀ **Priority 1** : 4/12 are re-installed

☀ **Priority 3** : 1/10 is re-installed

☀ **3 Kickers** in LSS6 (Dump line)

Objective : replacement

☀ **Priority 1** : no kicker is still re-installed

☀ **1 Shottky monitor** (BQSV) in LSS4

Objective : change cables that release Argon inside the monitor

From removal to re-installation ~ 1 month (on going)

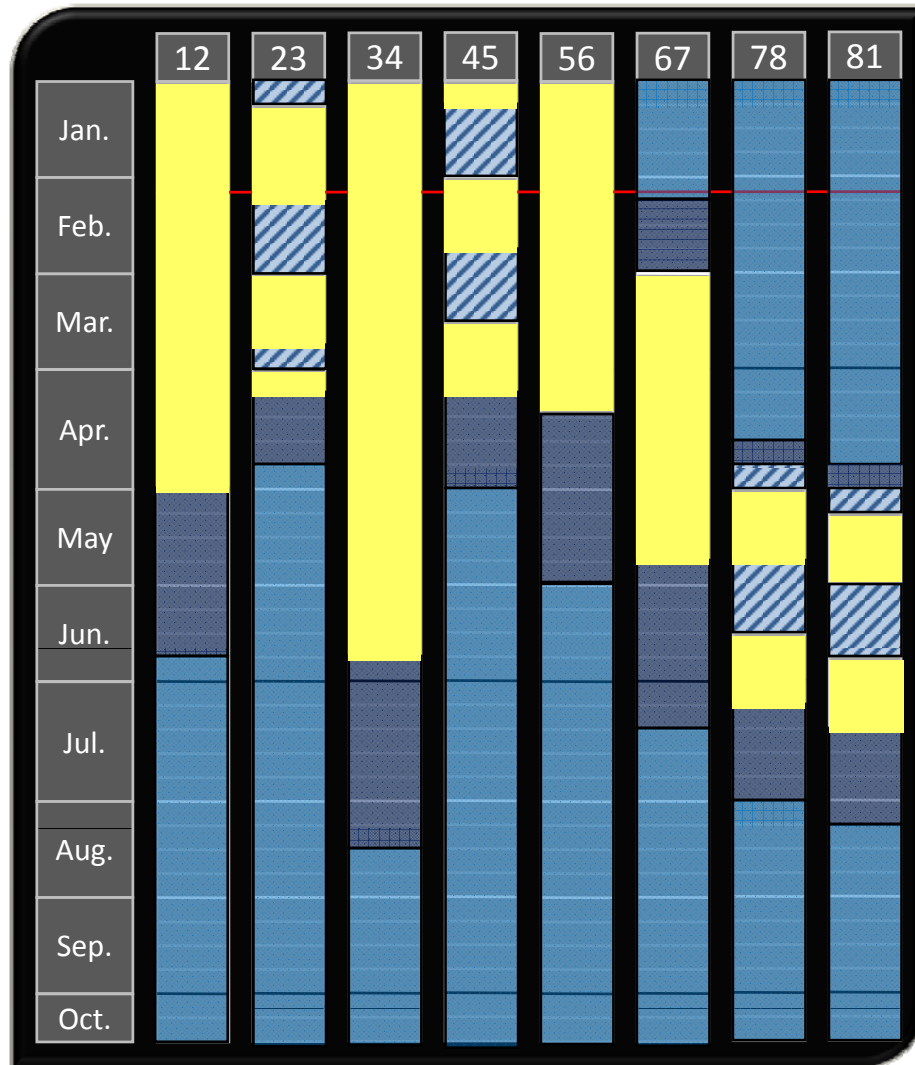
☀ **Priority 1** : repairs ongoing

☀ Upgrade synchrotron light monitor installation (BSRT) in LSS4 if possible

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Warm part Cold part

Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points



If there is Liquid Helium or Pressure in the cryogenic lines, all activities around them or which could damage them are forbidden

(i.e cabling, transports, installation of heavy instruments such as collimators, kickers,...)

If works cannot be done in the yellow periods :

- ⚙ Interventions must be more precisely studied
- ⚙ Protection have to be installed to ensure the personal safety
- ⚙ Cool-down is delayed = critical points

Concerning LSS3 and LSS7, there is no QRL, but the Helium Ring Line which is always under pressure.

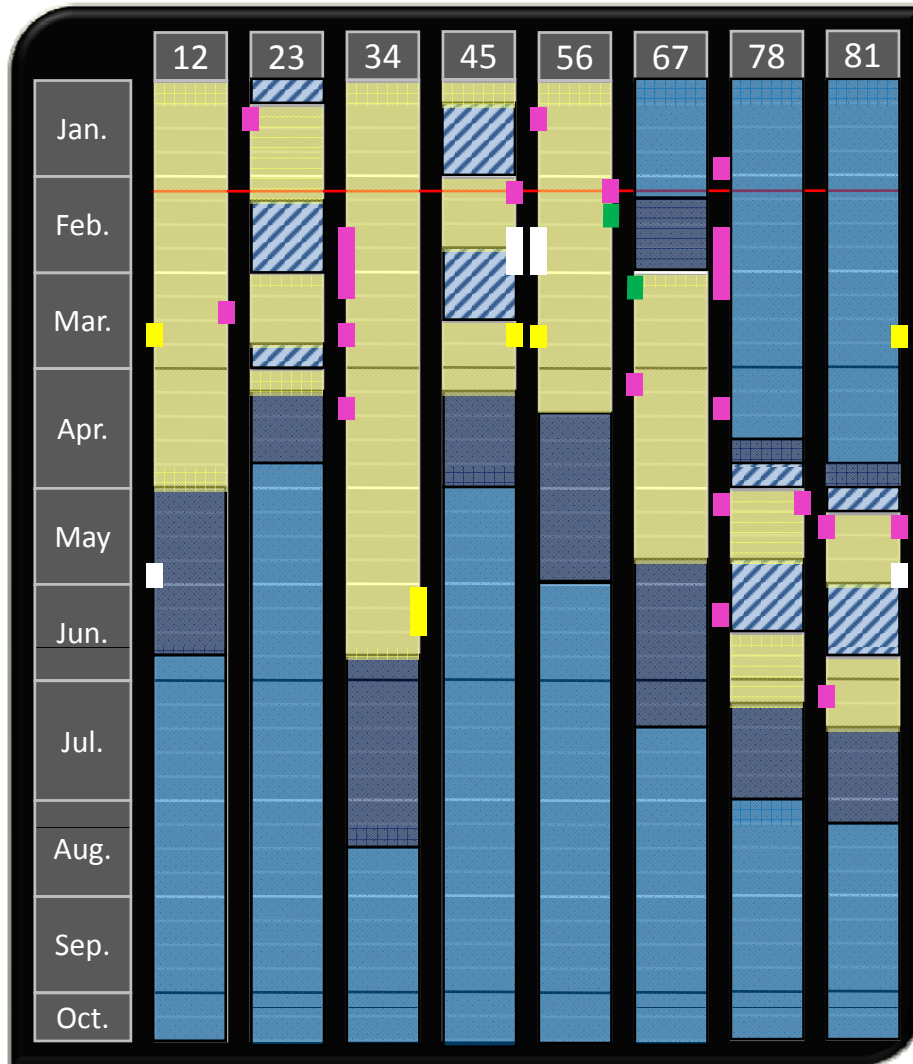
➤ Design of protection is on going.

Impact on the schedule : installation of the collimators are delayed, and so vacuum activities too.

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Warm part Cold part

Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points



The major constraint for installations is the cryogenic conditions

No heavy installation if there is LHe or pressure in closed cryogenic pipes (bellow of QRL, DSL, HRL)

Installation forecasts

⚙️ TDI/Collimators

⚙️ Kickers

⚙️ ALFA Roman Pots / TOTEM Detectors

⚙️ Beam Instrumentations

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Warm part Cold part

Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points

☼ 40 vacuum sub-sectors to bake-out again

- ☼ Mechanical works (closure, pumping, mechanical preparation for bake-out)
 - ☼ Installation of the bake-out equipment
 - ☼ NEG activation
 - ☼ Dismounting of the bake-out equipment
- = between 3 and 5 weeks of works / sector, according to the complexity of the sector

- ☼ Installations/Repairs Priority 1 = 5/30 are complete and 3/30 are on going
- ☼ Installations/Repairs Priority 2 = 1/5 is on going
- ☼ Installations/Repairs Priority 3 = 1/5 is complete



[No work during the bake-out](#)

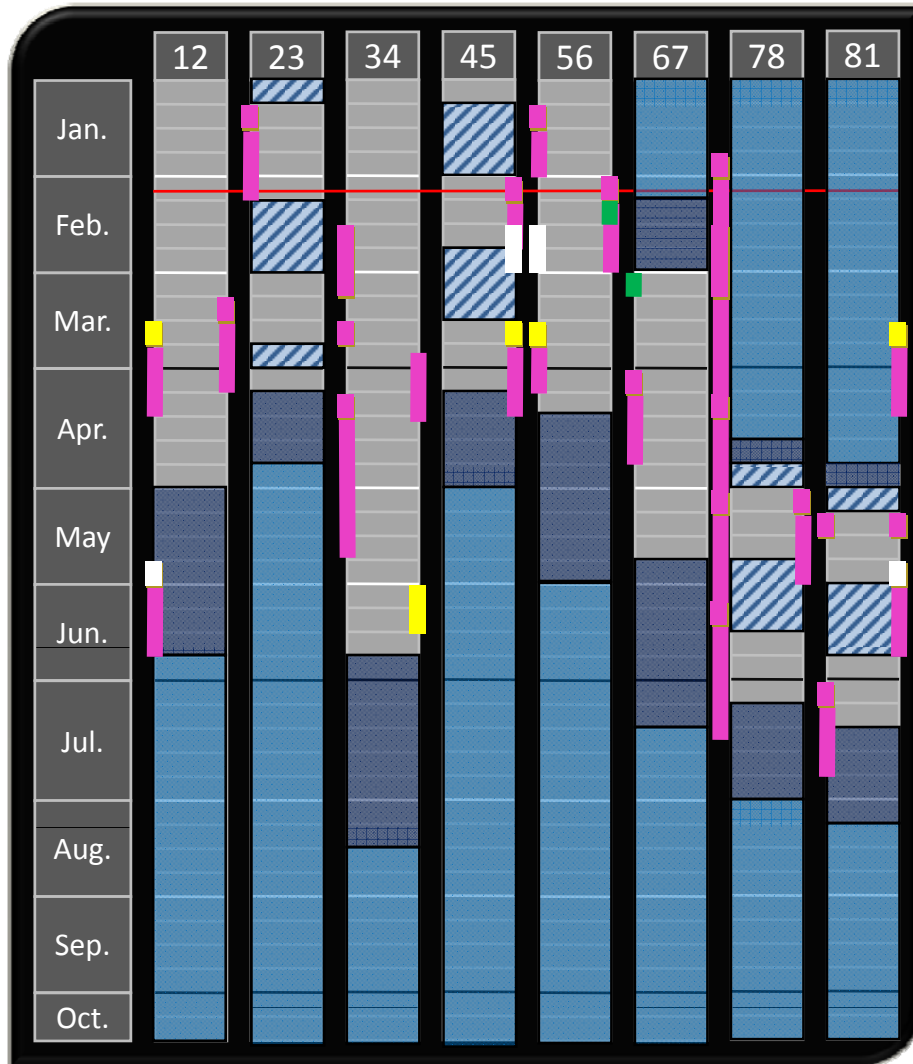


[Materiel in the passage side](#)

Shutdown 08-09

Warm part Cold part

Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points



The major constraint is the transport of dipoles for the sectors 34 & 67

No bake-out in LSS3 as long as there are transports week 15

Co-activities taken into account :

- ⚙ Cabling
- ⚙ Consolidations of stand-alone

End of bake-out end of July

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Warm part Cold part

Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points

☀ Measure/Alignment

- ☀ Radial smoothing of main elements ~ 2 weeks/LSS
 - ☀ **Priority 1 - ongoing**
- ☀ Measure of the vacuum chambers position (Q7L to Q7R)
 - ☀ **Priority 2 - ongoing**



☀ Completion of service installation

☀ **Shielding**

LSS7 in RR73 and RR77, and in LSS6

- ☀ **Priority 1 – ongoing**

☀ **6 hoists** (RR13, RR17, RR53, UJ56, RR57, UJ76)

- ☀ **Priority 1 - ongoing**

☀ **Remote handling system** over TAN in LSS1 and LSS5

~ 3 weeks/installation

- ☀ **Priority 1 - The first installation starts on week 7**



Shutdown 08-09

Warm part

Cold part

Key Drivers

Maintenances

Priorities

Activities – service areas, LSS, Arcs

Schedule

Critical Points

☼ Consolidations on Stand-alone

- ☼ 28 S.A. concerned / ~20 will be done this year
 - ☼ Priority : MQY
- ☼ Work started
 - ☼ Priority : 2 (increase stand-alone availability)



☼ Additional cabling:

- ☼ BLM cabling : More HV cables are put in place in the tunnel to limit cross talk between detectors ionization chambers and SEMs, but also between ionization chambers itself for fast losses
- ☼ Cryogenic cabling
- ☼ DC cables for warm magnets at point 3
- ☼ Started

☼ Water Cooled Cables repairs:

- ☼ **Not started - problem of delay.**
- ☼ Should we choose to repair 4L instead of 6L (less time constraints) ?
 - ☼ But will have an impact on RF tests (4R)

Shutdown 08-09

Warm part Cold part

Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points

- ⚙ DFB consolidations: mechanical (protection , Velan valves..) & instrumentations, Transfer actuors UX85-UL84
 - ⚙ Started
 - ⚙ **Priorities 1 & 2**

- ⚙ Thermo switch: Add thermal switches on top of leads in order to mitigate the risk associated with « software interlocks ».
 - ⚙ Components availability : end of March
 - ⚙ **Priority 1**

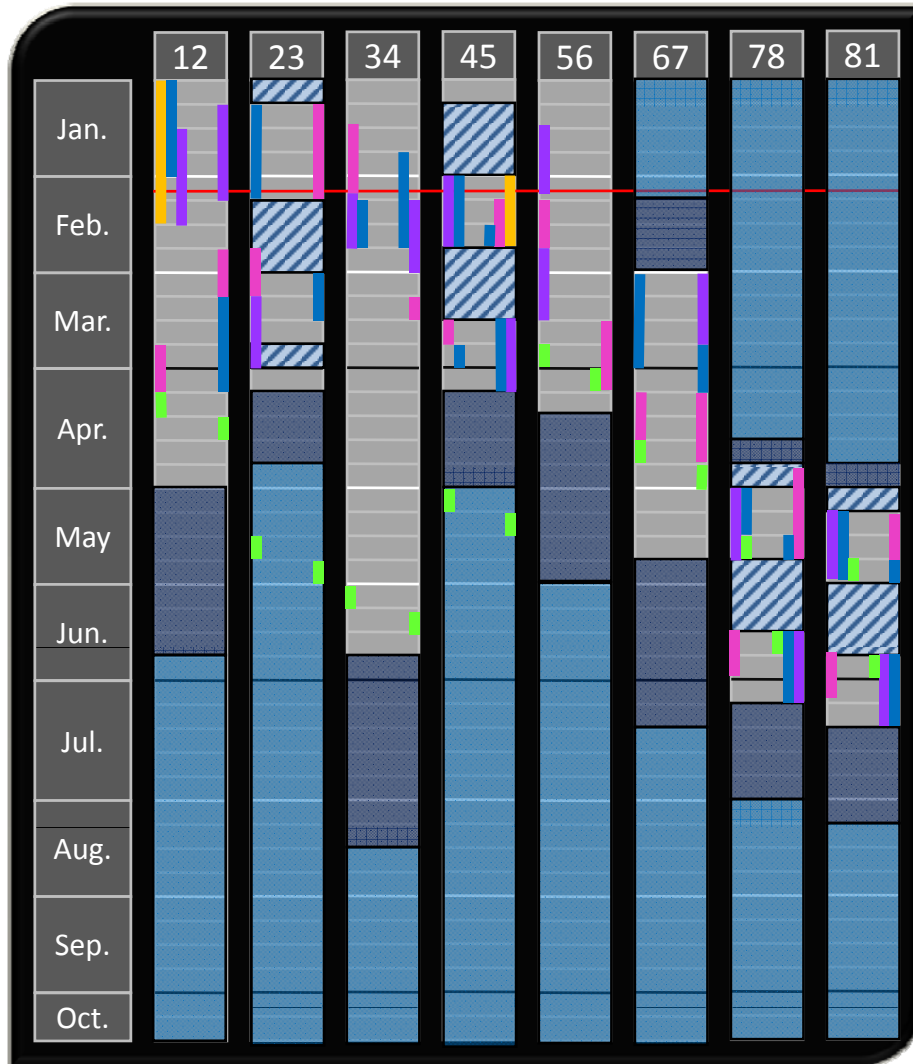
- ⚙ Inner Triplet copper strip: Thermal strip & Additional thermal sensors in IT1R & 5L
 - ⚙ Started
 - ⚙ **Priority 1**



Shutdown 08-09

Warm part Cold part

Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points



⚙ The major constraint is the cryogenic condition

⚙ Consolidation forecasts:

⚙ Cabling

⚙ Stand alone consolidation

⚙ Inner triplet repairs

⚙ DFB consolidation

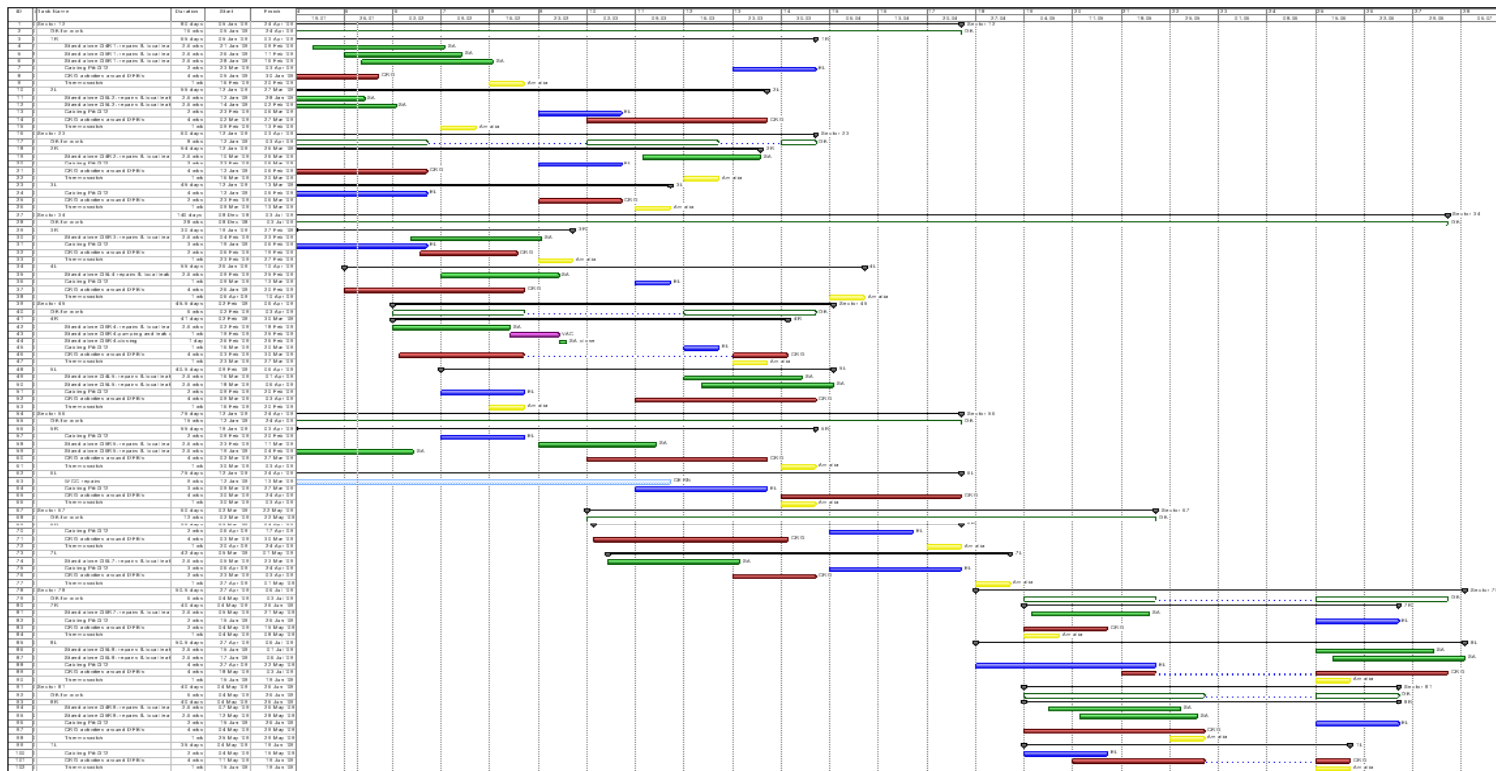
⚙ Additional thermoswitch

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Warm part Cold part

Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points

- ☀ The schedule below shows only the cold part installation in the LSS.
- ☀ Each change or delay force us to review all the schedule, as we are very tight in term of resources and time !!!



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Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points

- ⚙ Magnet smoothing at cold
 - ⚙ Measures
 - ⚙ Smoothing

- ⚙ Installation of the new Quench detection system * rf. R. Denz talk
 - ⚙ Including Cabling (started) & racks installation and tests (1st av.: End of April)
 - ⚙ Cabling without LHe or pressure in cryo-lines
 - ⚙ **Priority 1**

- ⚙ Dipoles and SSS relief valves * rf. V. Parma's talk
 - ⚙ Dipole relief valves (DN200) to be added in warm sectors
 - **BLM removal & installation still need to be studied in detail**
 - ⚙ SSS relief valves = Springs to be added in all sectors
 - ⚙ Removal of clamp: as late as possible & without LHe
 - ⚙ **Priority : 1**

- ⚙ Jacks reinforcements * rf. O. Capatina's talk
 - ⚙ In first approach drillings without Lhe, Installation possible with LHe
 - ⚙ **Priority : 1 (for sectors not warm to R.T.)**

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Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points

☼ Sector 12

- ☼ Magnet exchange
- ☼ PIMs check & repairs

☼ Sector 34

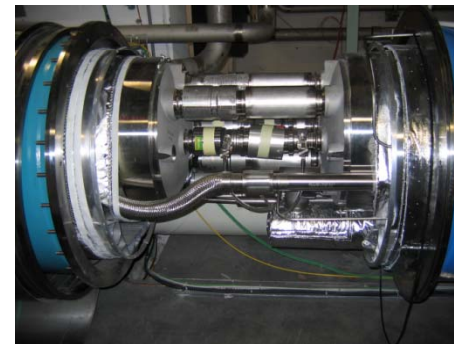
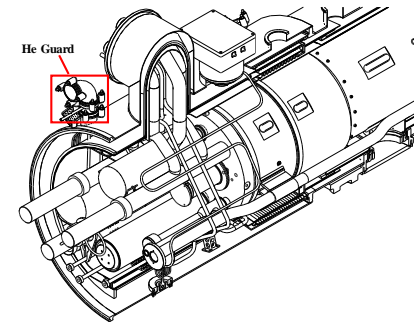
- ☼ rf. Session 03 - Repair of 34

☼ Sector 56

- ☼ Repair BB in connection cryostat : Risk of short between bus-bars
- ☼ QRL helium guards : Potential HE leak to insulation vacuum
- ☼ PIMs check & repairs
- ☼ **Priorities : 1 & 2**

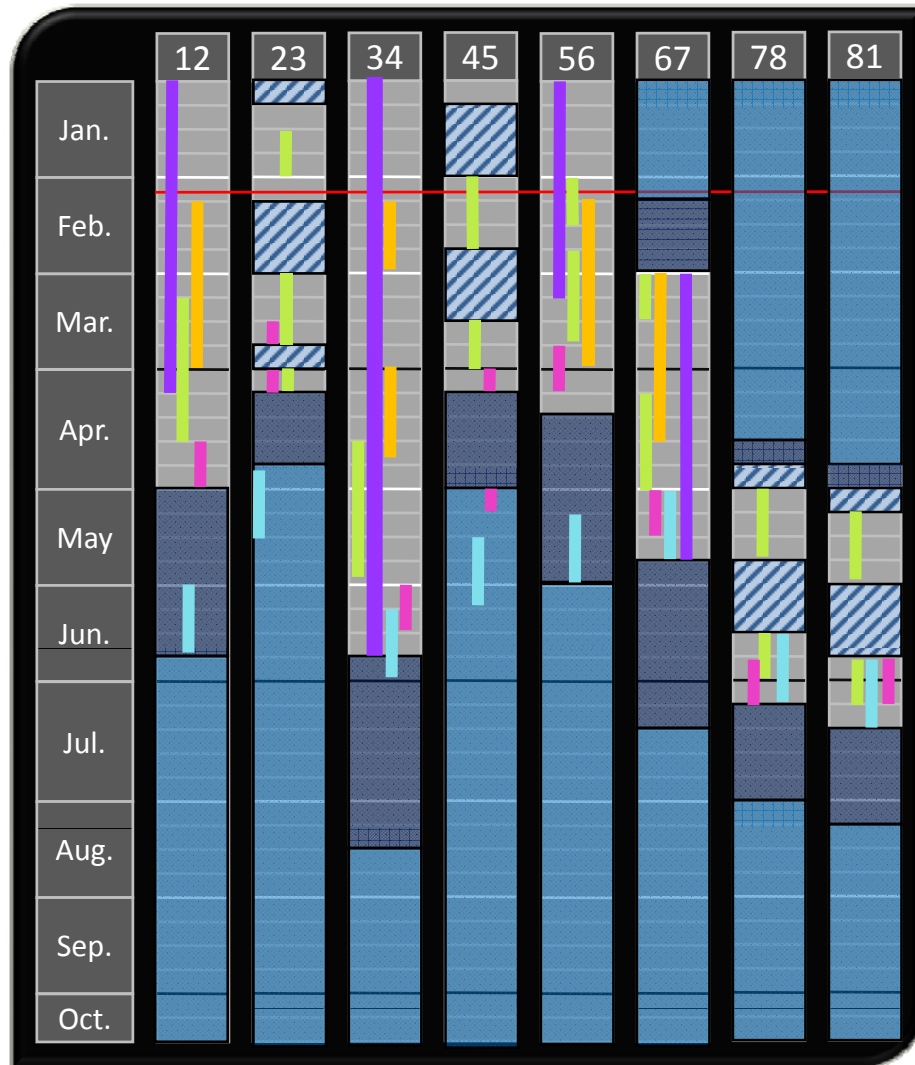
☼ Sector 67

- ☼ Magnet exchange
- ☼ PIMs check & repairs



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Key Drivers Maintenances Priorities **Activities** – service areas, LSS, Arcs Schedule Critical Points



Arcs schedule

- ⚙ Sectors 12-34-56-67 : MSC & VAC
- ⚙ PIM's & Magnets exchange and IC
- ⚙ nQDS cabling
- ⚙ Dipoles relief valves (warm sectors only)
- ⚙ SSS relief valves
- ⚙ nQDS- racks installation & tests

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Key Drivers

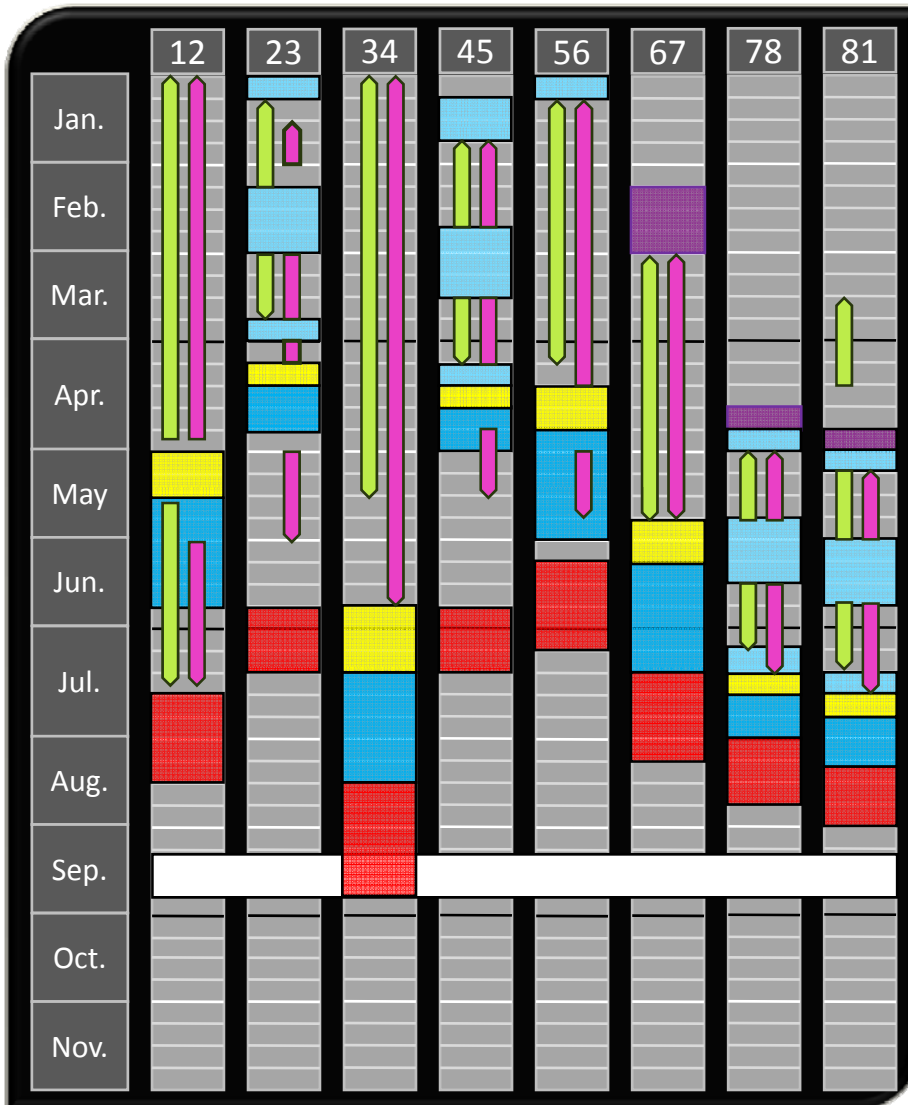
Maintenances

Priorities

Activities – service areas, LSS, Arcs

Schedule

Critical Points



☼ Intermediate cool-down & QRL warm-up (Stand Alone)

☼ Activities

☼ Arc

☼ LSS

☼ Flushing & ELQA at warm

☼ Cool-down

☼ Powering tests

☼ Cold check-out

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Key Drivers

Maintenances

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Critical Points

☼ “Critical path”

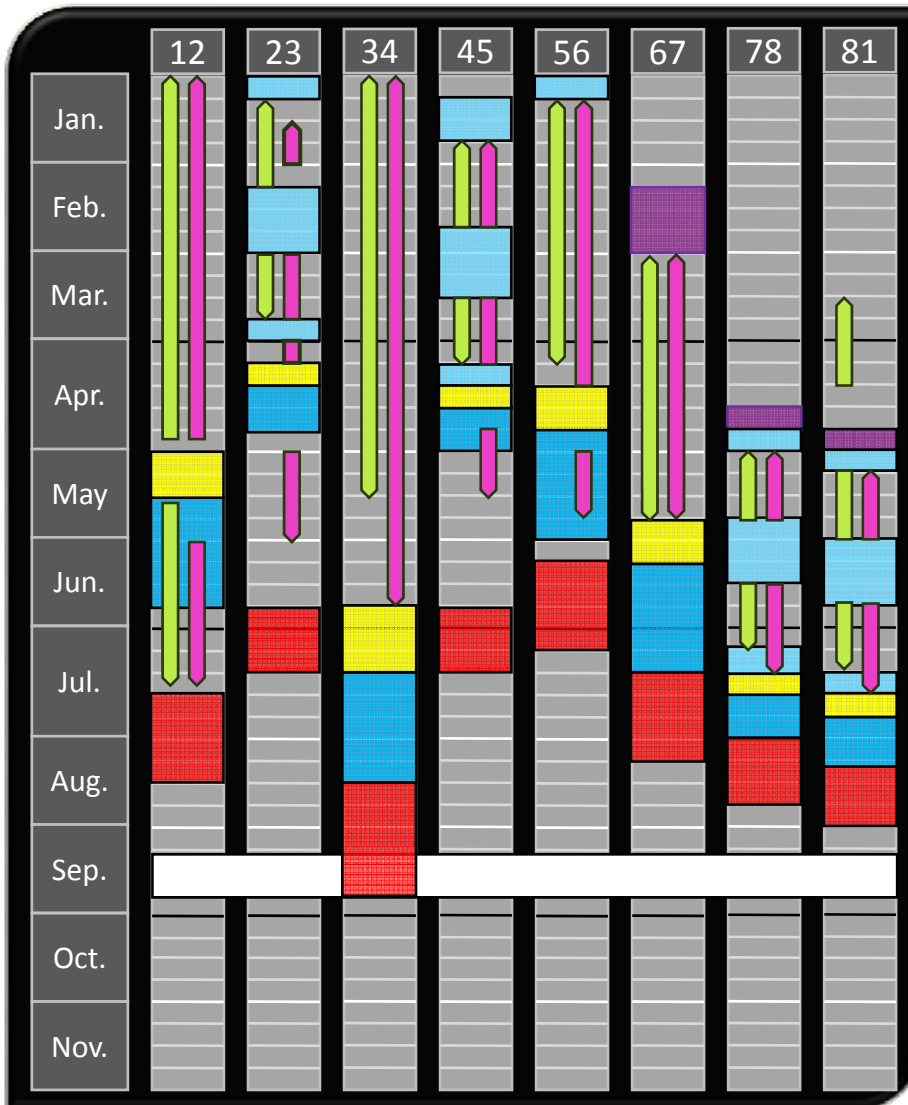
- ☼ Sector 34 : Preparation of magnets on surface – Interconnections
- ☼ Last dipole within 34 & 67
- ☼ Sectors 23-45 allowing to empty the LHe of sectors 78 & 81 – These sectors have 3 weeks margin compare to sector 34

☼ What has not been started / material not @ CERN are critical

- ☼ DN200
- ☼ SSS relief valves (springs will arrive end of March)
- ☼ Racks for nQDS (available end of April)
- ☼ Jacks reinforcements

☼ LSS schedule is very tight: lot's of activities not compatible one with another !!

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☀ Intermediate cool-down & QRL warm-up (Stand Alone)

☀ Activities

☀ Arc

☀ LSS

☀ Flushing & ELQA at warm

☀ Cool-down

☀ Powering tests

☀ Cold check-out