

# Magnet activities during LS1

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**With contributions from M. Dumas, D. Bodart, A. Newborough and D. Tommasini**

- *Baseline strategy*
- *Maintenance and consolidation in IEF*
- *LIU activities*
- *Resources*
- *Summary*

→ **Memorandum** addressed in October 2011:

*TE/MS/MNC activities in IEF during LS1 (EDMS 1169429)*

## → We intend to complete:

- Full inspection of the magnets
- Corrective maintenance
- Preventive maintenance and necessary consolidations
- Necessary actions in highly radioactive areas 
- LIU activities to be done during LS1

Most of it could not be done during short shutdowns of the last 3 years

## → To reserve resources for LHC splice consolidation, we will put on hold:

- Less urgent consolidations (SMIT quadrupoles in L2, L3 and PSB; SPS pole shims, PS busbars and PFW's, NEA interlock cabling, etc.)
- Many desirable but less urgent maintenance activities

## In all machines

### → Detailed inspection of magnets

- Removal of the magnet covers
- Electrical tests
- Audio-visual inspection in pulsed mode
- Thermal inspections

### → Machine conditions

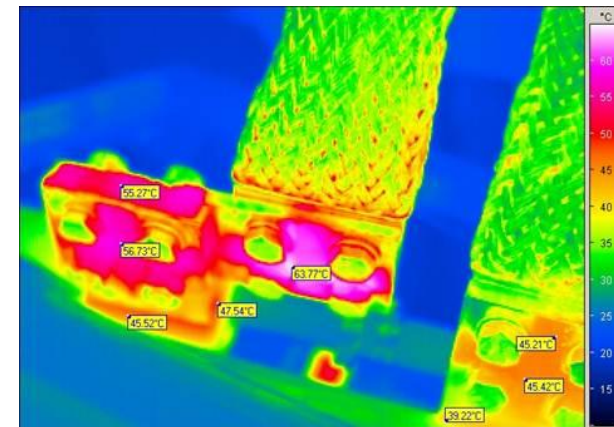
- Machine closed to non-MNC personnel during power tests
- Power, cooling, interlocks, access operational

### → Support from other groups

- BE/OP to power the magnets and lock the accesses
- TE/EPC support for power converters operation

### → *To be done in the beginning of LS1*

(except  zones!)



Loose electrical connection

## In all machines

### → Corrective / preventive maintenance

- Repair / replacement of faulty magnets
- Shimming in-situ or replacement of magnets with critical coil movement
- Refurbishment of defective magnets in workshops
- Cleaning of all magnet filters

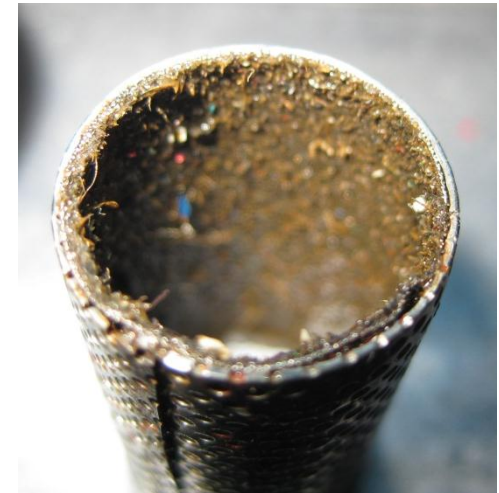
### → Machine conditions

- Free access for handling and transport in the tunnel (coactivity)

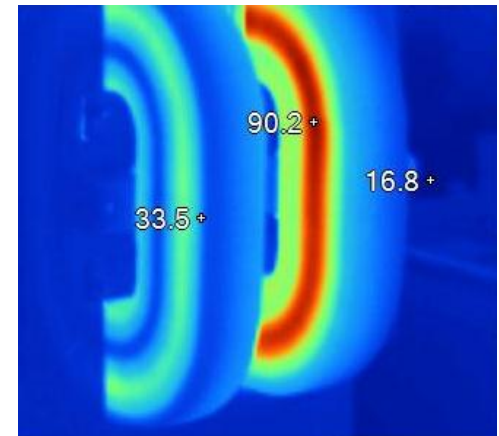
### → Support from other groups

- EN/HE, TE/VSC, BE/ABP for magnet replacements

### → *Activity spread over the whole LS1 duration, ending with the most radioactive zones*



Clogged filter



Clogged coil

## PS Booster

### ➔ Revise most critical auxiliary magnet cooling circuits

- Missed preventive maintenance
- Replacement of internal flexible hoses
- Check hoses crimping system

### ➔ Activity spread over the whole LS1 duration



ONO/XNO/QSK-Type IA



OSK/XSK/DVT/DHZ  
(Type B)

## AD transfer lines

### ➔ Removal of unused magnet in beam lines 7000 and 8000

- Required for the ELENA project

### ➔ Machine conditions

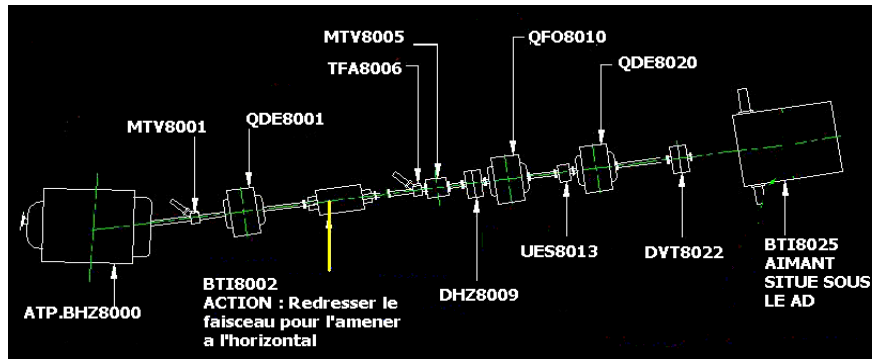
- Opening the concrete roof of AD

### ➔ Support from other groups

- EN/HE, TE/VSC



BHZ 8000 – 30 T



Layout of transfer line 8000



BTI 8002 – 7.5 T

## ISOLDE

### → Refurbishment *in-situ* of separator magnets GPS and HRS



- Missed preventive maintenance

### → Support from other groups

- None if work in-situ
- EN/HE, TE/VSC, BE/ABP, if major refurbishment in workshop is needed

### → *After radiation cool-down period*



HRS 90 deg. magnet



HRS 60 deg. magnet



GPS 70 deg. magnet



## PS ring

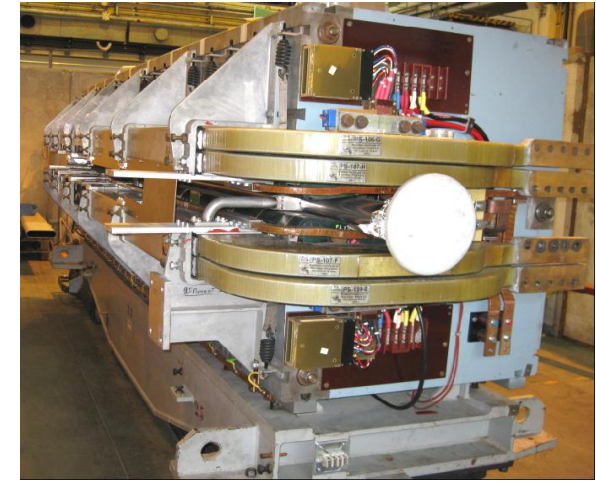
### → Replacement of PFW sets on main units #55 and #75

- Corrective maintenance
- Crimped contact resistance increase monitored recently

### → Support from other groups

- EN/HE, TE/VSC, BE/ABP

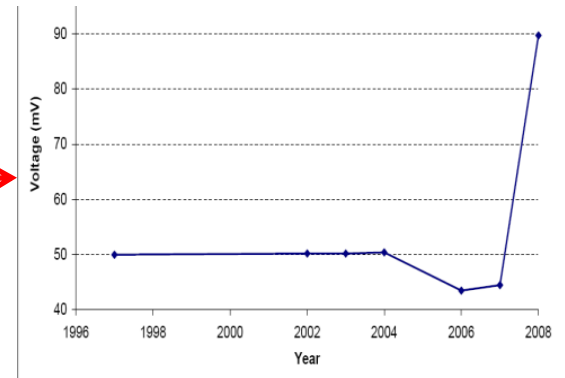
### → *After radiation cool-down period*



PS main unit



PFW internal assembly



Typical increase of contact resistance

## TT2 transfer line

### → Refurbishment of most critical quadrupole cooling circuits

- Corroded brazed hydraulic connections on several magnets
- Degraded internal soft hoses to be replaced

### → Support from other groups

- EN/HE, TE/VSC, BE/ABP for replacement of some of the magnets



TT2 quadrupoles



Degraded hydraulic connection brazed joints

## East Area

### → Refurbishment of defective magnets

- F61N.DVT01 out of service due to water leak, replacement requires to dismount part of the concrete block shielding around
- F61N.DHZ01 in degraded state, no spare
- Magnets to be refurbished in workshop

### → Support from other groups

- EN/HE, TE/VSC, BE/ABP



F61N.DVT01



F61N.DHZ01

## East Area

### → Replacement of the SMH.01 splitter by a “standard” dipole

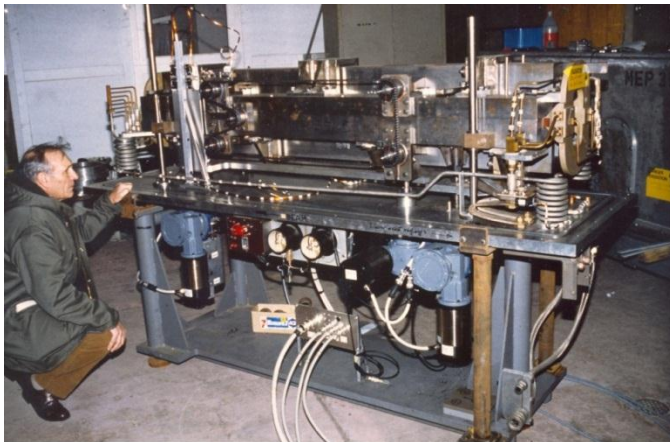


- Control system of mechanical movement is “orphan” equipment
- Split functionality not needed anymore with modification of beam distribution mode (replacement of MNP23 septum by MCB)

### → Support from other groups

- EN/HE, TE/VSC, BE/ABP

### → Start after radiation cool-down period



MEP35 splitter



MCB dipole

## SPS

### → Special inspections and tests of main magnet circuits

- Inspection of the busbars → removing of all BB covers
- Completion of capacitive discharge tests campaign (3/3): 250 dipole coils



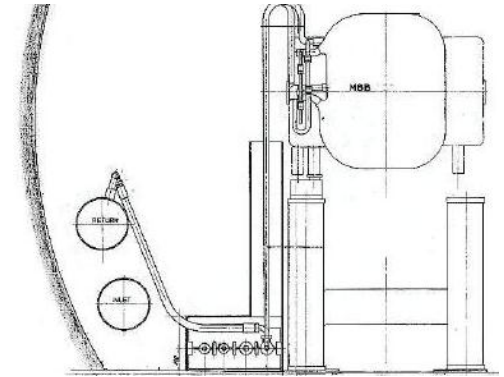
### → Machine conditions

- Sectors 1-2 and 2-3 not accessible during a few days (capacitive discharge)

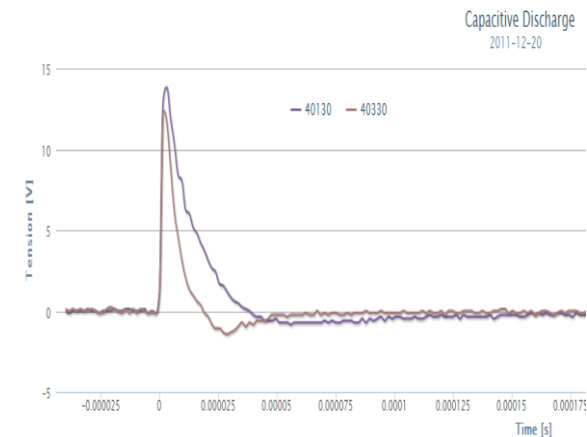
### → Support from other groups

- TE/EPC to separate the SMD's from the load in sector 6-1 and 1-2

### → After cool-down time for works in half-sextants 1+ and 2-



SPS cross-section at MBB



Inter-turn short-circuit on MBB  
40330 during capacitive discharge  
campaign 2/3 in 2011

## SPS and transfer lines

### → Replacement of all cooling supply flexible hoses

- Consolidation approved, all 2000 hoses already purchased in 2010
- Equipment stored since then, could not be installed during previous short shutdowns

### → Support from other groups

- EN/CV to empty demineralized water circuits in all sextants

### → *When all inspections requiring cooling water will be completed*



Delaminated cooling hose



Burst cooling hose

## SPS

### → Expected exchange of 10 to 15 main magnets, following audio-visual inspection results

- Standard preventive and corrective maintenance (few spares)

### → Machine conditions

- Need access to material lift

### → Support from other groups

- EN/HE, TE/VSC, BE/ABP



Main dipole exchange in the SPS

## SPS

### → Refurbishment of the 10 most critical MBA magnets with corroded manifold brazed joints

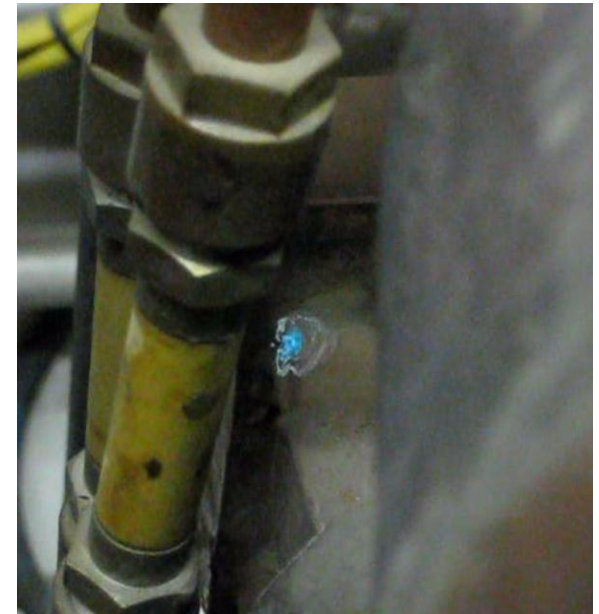
- Brazed joints corrosion → sign of future water leaks
- Problem identified on 70 dipoles, mostly MBA

### → Machine conditions

- Possibility to do it in ECX5 to avoid logistics in surface? TBC
- Otherwise, need access to material lift

### → Support from other groups

- EN/HE, TE/VSC, BE/ABP



Corroded brazed joint



## North Experimental Area – TCC2

### → **Suppression of weak electrical contacts of water pressure and water temperature interlocks**



- False triggering of interlock system → important part of piquet interventions
- Decision to be taken about technical solution

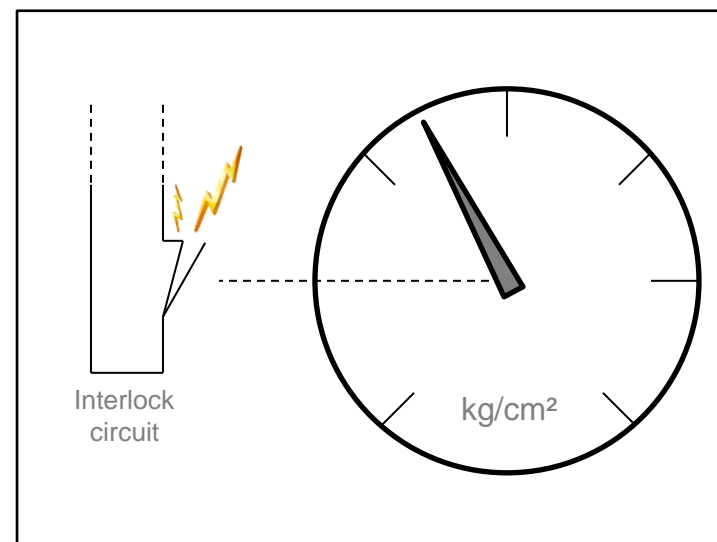
### → Support from other groups

- Possibly TE/MPE, depending on technical solution

### → *After cool-down period*



Manometer with gold tip contacts corroding due to water pressure oscillations



## North Experimental Area – TCC2

### → Improvements to magnet supply circuits

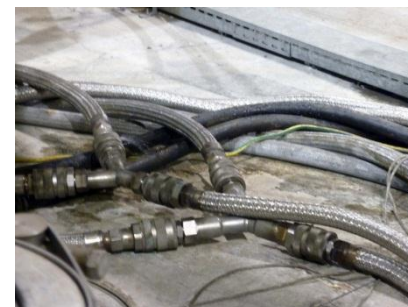


- Reduction of hoses interconnections in radiation exposed areas
- Replacement of obsolete electro-valves by manual valves
- Proper sleeving of power cables connections on the ground

### → *After radiation cool-down period*



Improper electrical connections to be sealed with appropriate sleeves



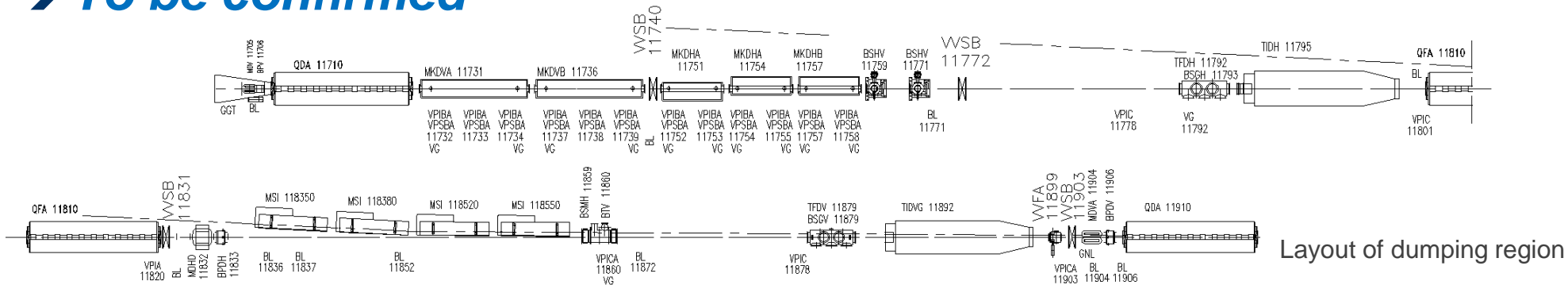
Quick connector gaskets degraded by irradiation

## Requests from other groups

➔ **EN/EL** - Removal of magnets in SPS – LSS1+ 

- To allow access to cable trays for irradiated cable replacement campaign

➔ **To be confirmed**



Layout of dumping region

## Requests to other groups

- ➔ **DGS/RP** – Support needed in all interventions described above
- ➔ **TE/EPC** – Consignation of power converters
- ➔ **EN/CV** – Maintain flow in demineralized water circuits

## LIU-PSB

### → Upgrade of cooling circuits of the main bending and quadrupole magnets

- Necessary to allow 2 GeV operation of main magnets
- Cannot fit with other modifications in LS2 planning
- Removal of flow-switches and installation of additional temperature interlocks
- Upgrade of hydraulic connections

### → *Activity spread over the whole LS1 duration, ending with the most radioactive zones*



PSB main bending magnet



PSB main Quadrupole magnet

## LIU-PSB

### → Installation of the PSB injections magnets

- To reduce congestion during the connection of LINAC 4
- BI.BVT10 – required for LINAC 4 (160 MeV) operation
- BI.QNO 50 & 60 – Consolidation action (profit of vacuum opening)

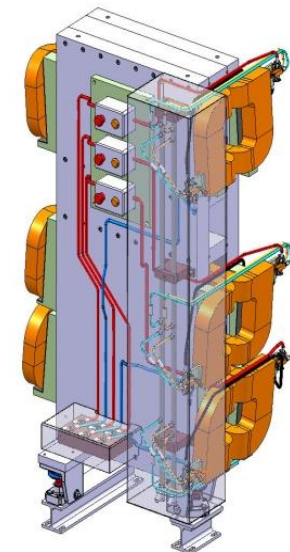
### → Support from other groups

- EN/HE, TE/VSC, BE/ABP

### → *To be confirmed based on magnet availability and planning agreement*



Magnets BI.BVT10 (red) and BI.QNO 50 & 60 (green)



Design of new BI.BVT 10

## LIU-SPS (e-cloud mitigation)

### → Coating of 16 dipoles and 4 quadrupoles in 2 adjacent cells of sextant 5

- Validation of both magnetron sputtering and hollow cathode coating of VC with a-C during 2014 MD's
- Dipoles removed from machine to be coated in workshop (50% to be rebuilt)
- Installation of pre-coated VC in quadrupoles

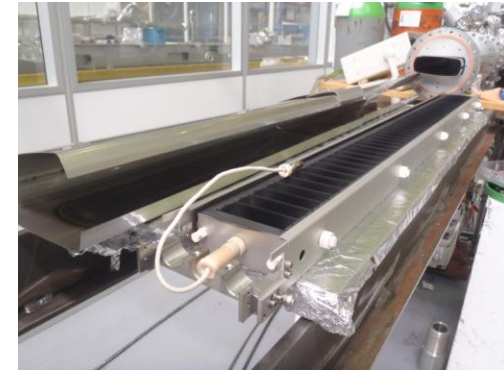
### → Machine conditions

- Access needed to material lift

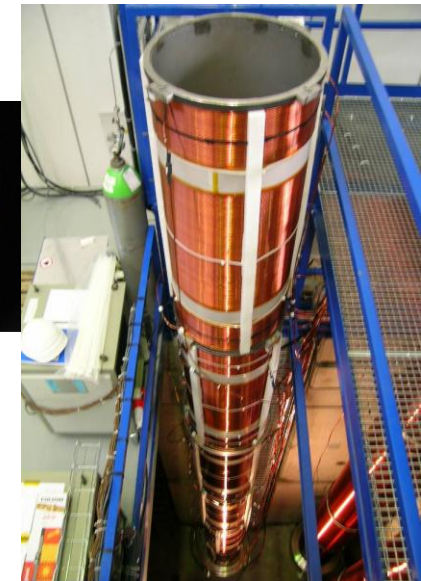
### → Support from other groups

- EN/HE, TE/VSC, BE/ABP

### → *All magnet should be removed from SPS at the beginning of LS1, and put back in place at the end in a single batch*



Hollow cathode coating \*



Magnetron sputtering \*

\* Pictures: courtesy of P.Costa Pinto – TE/VSC

## LIU-SPS (Q20)

### ➔ Modification of the MDHD 11832 for injection dogleg compensation

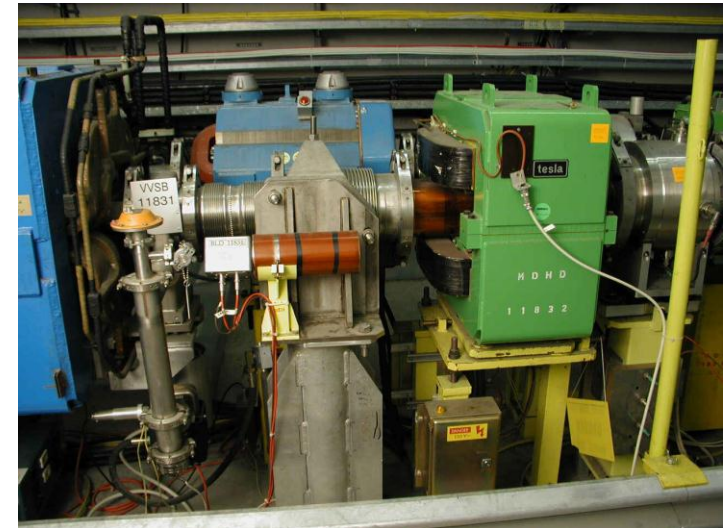
- Modification of the coils powering scheme from series to parallel to increase strength
- Required to be done in workshop

### ➔ Machine conditions

- Access needed to material lift

### ➔ Support from other groups

- EN/HE, TE/VSC, BE/ABP

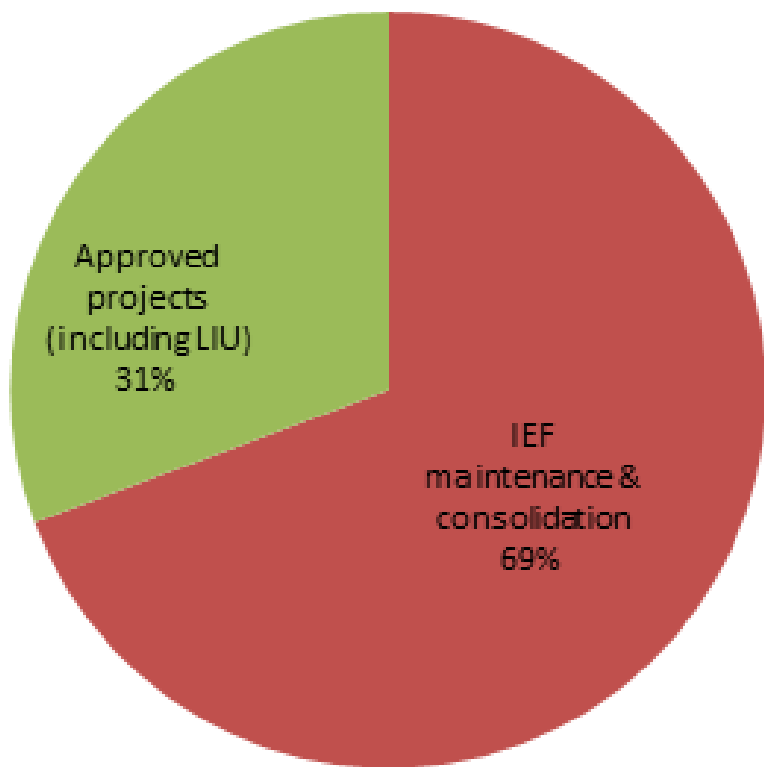


MDHD11832 (green)

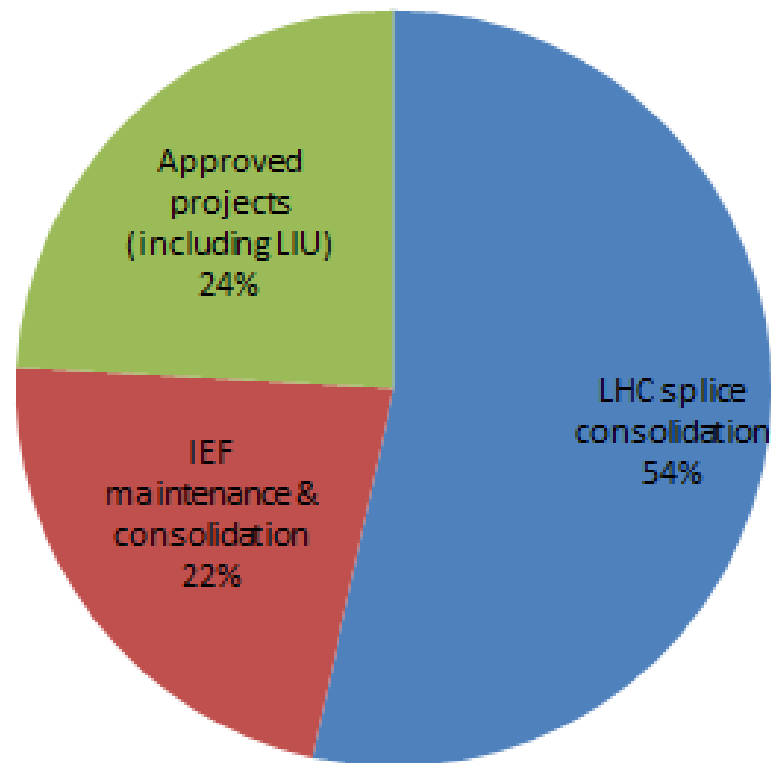


Layout of half-cell 118

## MNC staff and FSU resources



MNC resources distribution per activity in 2011



MNC resources distribution per activity during LS1



- ➔ Baseline strategy described in EDMS 1169429
  - More than half of the staff and FSU personnel of MNC will be involved in the LHC splice consolidation
  - We will perform all the necessary actions to ensure a reliable operation of the magnets in the CERN accelerator complex, including the ones only possible during a long shutdown
  - We will perform all the necessary actions required by the LIU and the other approved projects
  - We must postpone less urgent consolidation and maintenance
- ➔ We acknowledge in advance our colleagues for:
  - Their support to our activity
  - Ensuring the availability of the technical services during the inspections
  - To avoid interrupting the water flow in magnets for long periods