Alignment activities during LS2 period
Agenda

• Towards LS2
  • EYETS 2016-2017
  • Preparation of LS2
  • Contributions to other groups

• The LS2
  • Alignment activities
  • Contributions to other groups
Towards LS2 : EYETS

- Activities triggered by SU
  - LHC
    - Vertical survey of 2 sectors S78 and Horizontal of 1 sector (S81)
    - Survey of LSS1 (D1 magnets), LSS5 (D1 magnets and -2 mm vertical re-alignment (?) asked by CMS) and LSS6 (TD68 side)
Towards LS2 : EYETS

- SPS complex
  - SPS: quads levelling, monitoring TT10
  - TI2 : Measurements and realignment of all elements (done in 2013, anticipation of LS2)
- TT20 : Measurements and realignment (last time done in 2003, many unique jacks have sunk by 2mm)
- PS Complex
  - AD : vertical measurements and realignment
  - LEIR, Linac3 and transfer lines
Towards LS$_2$: EYETS

- Inner triplets monitoring system
  - Maintenance, validation, calibration in situ

- Contributions
- For accelerators
  - AWAKE, ELENA ok
  - all validated in PLAN
- Experiments
  - Networks redetermination around each detectors
  - Alignment of new detectors
Towards LS2 : Preparation

• Accelerators
  • LHC
    • Fiducialisations of
      • Cryo-magnets for exchange
      • collimators (50)

• Detectors
  • Surface assembly works : ATLAS NSW, LHCb trackers, etc
  • CENF : EHN1 ext., WA104, WA105, ProtoDUNE
Towards LS2: Preparation

- Inner triplets monitoring system
  - Consolidation of the system in PT2 and 8
    - exchange of fiducials
    - Sensors (dating from LEP)
    - New sensors on C Fiducials of Q2
Towards LS2

- Manpower Resources
  - Globally ok
  - Due to heavy load of HL-LHC, one missing staff

- Budget
  - Not completely finalised for EYETS
  - No allocated budget for the inner triplets consolidation (300K)
**LS2**

- Activities triggered by SU
- LHC
  - Vertical and Horizontal survey of all sectors
  - Vertical and Horizontal Survey of all LSSs
  - Link to the Experiments Network

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### Smoothing the Arcs

**Vertical**
- DNA03, Cholevsky, Outward and Return
- Calculation fixed on the deep references, smoothing with PLANEX

- **34% magnets realigned**
- Very small degradation of the r.m.s except Arc81
- No big difference between quads and dipoles

### Smoothing the Arcs

**Radial**
- Offsets wrt a stretched wire, between Q8R to Q8L+
- Calculation fixed on Q8s, radial constraint, smoothing with PLANEX
- Quite important degradation of the r.m.s, especially in Arc 34 and 81

- **36% magnets realigned, 36 magnets by more than 1mm**
- Twice more quads than dipoles

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**Deviation wrt the smooth curve (mm) & Realigned magnets**

<table>
<thead>
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<th>Arc</th>
<th>Deviation</th>
<th>Realigned</th>
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<tbody>
<tr>
<td></td>
<td>RMS</td>
<td>Min</td>
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<td>0.16</td>
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<td>34</td>
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<td>45</td>
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<tr>
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<td>-0.55</td>
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<tr>
<td>67</td>
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<tr>
<td>78</td>
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<td>-0.76</td>
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<tr>
<td>81</td>
<td>0.21</td>
<td>-0.86</td>
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<tr>
<td>all</td>
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LS\textsubscript{2}Activities triggered by SU

- SPS complex
  - SPS: quads levelling
  - TI\textsubscript{18}: Measurements and realignment of all elements (done in early 2014)
  - TT\textsubscript{10}: Measurements and realignment of all elements

- PS Complex
  - Smoothing of LT, LTB, BI for connection with PS Booster
  - L\textsubscript{4}: Smoothing of main linac and L\textsubscript{4}T
LS2

- Inner triplets monitoring system
  - Corrective and preventive Maintenance in PT1, 2, 5 and 8
  - Consolidation: exchange of fiducials and of old sensors in Pt2 and 8
  - In situ calibration in Pt1 and 5
LS2

• Contribution
  • ATLAS
    • Full opening and closing (ECT/EBA/EBC/ECA/ECC/EB/Big Wheels, Muon Barrel ends), TAS
    • Installation of JD and New Small Wheels (A+C-side), change of Muon BIS7/8
  • CMS
    • Full Opening of all CMS Endcaps and Barrel Wheels, MABs survey, Muon GE1/1, partly beam pipe replacement, MilliCan, DT, Full Closing of CMS Endcaps and Barrel Wheels, HF, Beam pipes parts Z+/Z-adjustments, TAS control and re-alignment
LS2

- ALICE
  - Full opening of L3 zone with TPC and entirely new ITS, Work zones in surface and cavern.

- LHCb
  - Checking of Beam Pipe in different conditions, UT surface assembly and installation, alignment of RICH 1+2 Mirrors, VELO, replacement of M1 and IT/OT by SciFi
  - Isolde: measurement and realignment of the entire ‘Hall Isolde’ lines (agreed two weeks ago?)
  - survey, fiducialisation, alignment
LS2

• LHC : alignment of new components (collimators, 11T dipoles, CC, ...)
• SPS : aC coating, new beam dump, crab cavity
• PS complex
  • PS ring : Renovation of 45 MU
  • TT2 : Renovation of 40 quads
• East area : network from the current position of magnets, link to PS, marking, alignment of 4 new lines
• Transfer lines from ELENA to AD experiments (2019)
**LS2**

- HL-LHC:
  - Surface network (should be done before LS2)
  - Orientation of the 2 new galleries
  - Link to LHC tunnel
  - Monitoring the LHC components due to the boring of UPR areas
  - Scans
  - Fiducialisation of magnets for the SM18 string

- Preparation of LS3 has to be continued during LS2
LS2

- Contributions
  - Huge demand for the PS complex (1 FTE in 2019)
  - Validated in PLAN except:
    - Isolde lines (budget ?)
    - East area (no manpower in 2019)
    - Transfer lines from ELENA to AD (no manpower in 2019)
LS2

- Issues during LS1
  - Smoothing of the LSSs done at warm with other activities
    - A lot of time lost during LS1
  - Smoothing of the LHC has to be done below 100k and therefore coactivity with ELQA
  - Work in shift?
LS2

• Manpower
  • Almost the same number as for the LS1
    • But with 40% of field staff and a new contractor (12) not having participated to LS1 in the accelerator unit
  • For the Monitoring of triplets
    • 1 fellow and 1 mechanical technician needed
  • For experiments
    • ATLAS ok with JINR (to be confirmed for 2020)
    • ALICE, CMS and LHCb still to be discussed
      • help from collaborations needed
      • 2 PJAS needed : participation of EN and EP requested
      • 2 industrial support persons needed

• 2LD arriving at the end of their contract in 2020 !!
Conclusions

• For SU, the workload in LS2 will be as huge as for LS1
  • Preventive maintenance
    • Same activity for LHC
    • For the SPS complex, it starts during the EYETS
    • A bit lighter for PS complex
  • Requested contributions will be much higher for SPS and PS
Conclusions

- **Manpower**
  - Pb with East area and AD experiments Transfer lines
  - Pb for HL-LHC as the work has to continue during LS2
  - For experiments still to be solved
- **Budget issues to be clarified for**
  - consolidation
  - Experiments
Thank you for your attention!