New VAX area

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18 October 2018

8th HL-LHC Collaboration Meeting, CERN, 15-18 October 2018
Outline

- From LHC to HL-LHC
  - LHC approach
  - VAX relocation
- HL-LHC VAX design
  - VAX area
  - Q1-TAXS connection
- LS2 activities linked to VAX relocation
- Summary
From LHC to HL-LHC
LHC approach

- **VAX**: Vacuum assembly for experimental area. Module including necessary vacuum instrumentation for operation on the experimental side.
- **VAX area** refers to the full vacuum connection between Q1 and the experimental chambers.
  - 2x2 sector valves located at Q1 cold warm transition
  - VAX module (vacuum gauges, ion pumps and interface to pumping and venting lines)
  - Pumping and Ne venting lines
  - Vacuum bellows to compensate relative movements

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From LHC to HL-LHC
Access to VAX in LHC

ATLAS access pathway
ATLAS pumping and venting lines

CMS access pathway
CMS pumping and venting lines
From LHC to HL-LHC
Working and access constraints in existing VAX

- VAX area in a confined space with high radiation level ⇒ routine operations difficult and costly in terms of radiation dose
- Access to VAX difficult and into a dead end ⇒
  - Access constraints at cryo. temperature for safety reasons

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Due to beam operational aspects, triplet relative movement and ALARA principle for maintenance activities ⇒ displacement of VAX area to experimental side + remote handling of vacuum components under the coordination of WP8.
HL-LHC VAX design
VAX area: ATLAS

- Same conceptual design for CMS and ATLAS
- Some slight differences in:
  - Cabling and piping: similar needs but different routing constraints
  - Access conditions
  - Mechanical interfaces to supports and experimental chambers
**HL-LHC VAX design**

**CMS: service lines**

- Pumping/venting lines cross TAXS and ‘free maintenance area’ ⇒ **REDUNDANCY**
- Existing system will be prolonged until new VAX
- Cabling routing similar to existing one

Q1-TAXS area lateral access at CMS open state
HL-LHC VAX design

ATLAS: service lines

- Pumping/venting lines are routed externally with good access for repair/maintenance ⇒ NO REDUNDANCY NEEDED
- Existing lines will be dismantled during LS3
HL-LHC VAX design

VAX area cross section

Cold vacuum
(until end of D1)

Vacuum @RT

Apertures to absorb relative re-positioning/movement without further re-alignment

Bellows to compensate +/- 10 mm transversal

TAS to be replaced by TAXS to increase aperture of the beam (ID34mm to 60mm)

ID aperture transitions

Smooth ID aperture transitions: same solution for ATLAS and CMS

New radiation hard ID 80 mm sector valve under development

- aC coating
- NEG coating (until TAXS)
Support concept is the same both in ATLAS and CMS
- Common vacuum layout: 2 valve modules + 1 VAX (vacuum instrumentation module) prepared for remote handling
- 1st valve module attached to support #1 on TAXS ⇒ moves with TAXS
- VAX module + 2nd valve module attached to support #2, which will be part of structural support of 1st experimental chamber (cone, in ATLAS; FIN support, in CMS) ⇒ relative alignment remains stable
  - To be adapted and/or designed for LS3
HL-LHC VAX design
Module assembly principle

- Vertical installation and accessibility for remote operation
- Use of quick radiation hard connectors for cabling and compressed air
- Use of quick CF vacuum connections

Valve module #1 prototype

VAX module prototype

Handling tests on real mock-up (CMS type) with final module supports and dummy loads (vacuum instrumentation) ongoing under the coordination of WP8

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HL-LHC VAX design
Valve modules design

- Sector valve
- Cold cathode gauge
- DN100 quick vacuum connection
- Local patch pannels
- Quick connectors
- Guiding pockets
- Mobile axial valve frame
- Fix frame
- Isostatic support through 3 ‘V-shape’ seats
HL-LHC VAX design
VAX module design

- Ion pump
- Service line valves
- NEG cartridge
- Hot cathode gauge
- Quick connectors
- DN40 quick vacuum connection (service line)
- Bellows compression mechanism
- Isostatic support through 3 ‘V-shape’ seats
- Guiding pockets
HL-LHC VAX design Prototyping

- Extensive prototyping campaign ongoing
- Component tests (mechanisms and quick connectors) to be finished by Q1 2020
  - Remote operation analysis and tests to be started in 2019 at component level (within ITHACA WG) [ITHACA: InTerventions in Highly ACTivated Areas]
- Integration and remote operation tests at assembly level to be started in 2020 (within ITHACA with coordination of WP8)
- Tests of edge welded bellows for new sector valve actuator concept are ongoing (by external company). To be finished by Q1 2019

DN40 and DN100 quick vacuum connections tested and analysed. Tightening procedure already fixed.

Bellows retraction mechanism test bench

Valve actuator active test bench for radiation (R2M project) and operation tests
HL-LHC VAX design
Q1-TAXS connection

- Pumping and bellows to decouple room temperature TAXS from cryogenic temperature triplet
- Unbaked a-C coated TAXS vacuum chamber
- Considered as a free maintenance area
- Installation in LS3 during TAS exchange
- Risk analysis, remote handling capabilities (through ITHACA WG) and alignment process to drive the final connection design

Longitudinal end stop (blockage) for TAXS and vacuum chamber at machine side extremity

TAXS ±10 mm

±2.5 mm Remote alignment

New cold-warm transition and end cover concepts

Pumping redundancy

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LS2 activities linked to VAX relocation
Summary and CMS modifications

- 3 ECRs released and/or approved
  - 2 involving ATLAS: modifications on shieldings (JTT and JFC2) due to new VAX envelope, and modification of the VT chamber support system following the shielding modification
  - 1 involving CMS: modifications on beampipe support on FIN (Fixed Iron Nose)

New beam pipe support on FIN (CMS): designed to accommodate the future new HL-LHC VAX

Already approved
LS2 activities linked to VAX relocation
ATLAS modifications

- New JFC2 “nose” shielding
- JTT movement at opening status
- New JTT plug 1 shielding to accommodate VAX envelope at opening status
- Additional extender mechanism in plug 1
- New length of the VT support rails
- ATLAS modifications

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The LHC vacuum instruments station (VAX) of ATLAS and CMS experiments needs to be relocated for the HL-LHC era

- Personnel exposed to less radiation dose
- Easier maintenance/repair interventions are foreseen
- Relocated VAX is compatible with experiment shielding and opening procedures. Still, a number of minor modifications of shielding structures are required. Some modifications advanced to LS2
  - Modifications of ATLAS shielding (ECR released; WP8)
  - Modifications of CMS beam pipe supporting system (ECR released, WP8)
  - Modification of the VT support system following the shielding modification (ECR approved, WP12)

The HL-LHC VAX assembly comprises 3 modules:

- To be remotely installed/removed
- Design based on proven solutions to increase reliability
- Prototyping phase is started: compatibility with robotic handling to be tested (ITHACA)

The Q1-TAXS is still being studied following the last modifications on the area coming from the new remote alignment capability and a new cold-warm transition

- Remote handling analysis to be started (ITHACA)

Detailed studies performed under the coordination of WP8:

- Integration dedicated to ATLAS and CMS specificities
- Optimised vacuum chamber cross section for aperture & impedance
- Detailed definition of alignment capabilities, interventions and recovery scenarios is ongoing
Thanks for your attention

... and thanks to all contributors to the presentation: C. Adorisio, V. Baglin, A. Gaddi, L. Krzempek, G. Pigny, M. Raymond, F. Sánchez Galán, J. Sestak, and many others