Outline

- ALICE LS2 upgrade scope
- Work between now and LS2 (including YETS/EYETS)
- Work during LS2
ALICE LS2 upgrade scope

**Motivation:** Focus on high-precision measurements of rare probes at low $p_T$
- Cannot be selected by hardware trigger
- Need to record large sample of events

**Goal:** Pb-Pb recorded luminosity $\geq 10 \text{ nb}^{-1}$ (plus pp and p-Pb data)
- $8 \times 10^{10}$ events to gain a factor 100 in statistics over the Run1+Run2 programme

**Strategy:**
- Read out all Pb-Pb interactions at a maximum rate of 50kHz (i.e. $L = 6 \times 10^{27} \text{ cm}^{-1} \text{s}^{-1}$) upon a minimum bias trigger
- Perform online data reduction based on reconstruction of clusters and tracks
- Improve vertexing and tracking at low $p_T$
  ➔ New Inner Tracking System (ITS)
New Inner Tracking System (ITS)
- improved pointing precision
- less material → thinnest tracker at the LHC

Time Projection Chamber (TPC)
- new GEM technology for readout chambers
- continuous readout
- faster readout electronics

New Online/Offline computing farm (O2)
- new architecture
- on line tracking & data compression
- 50kHz PbPb event rate

Muon Forward Tracker (MFT)
- new Si tracker
- Improved MUON pointing precision

MUON Arm
- continuous readout electronics

New Trigger Detectors (FIT)
- Faster readout

(c) by St. Rossegger
ALICE TDRs

LS2 upgrade is detailed in 5 Technical Design Reports:

- Inner Tracking System (ITS)
- Readout and Trigger System
- Time Projection Chamber (TPC)
- Muon Forward Tracker (MFT)
- Online Offline Computing System (O²)
Post LS2 radiation load

- Vacuum pressure in LSS around ALICE of $2.3 \times 10^{-8}$ mbar during Run1 pp resulted in excessive radiation load on the detector through beam-gas collisions.

- In order to ensure that the radiation load due to beam gas collisions does not exceed the radiation load from genuine IP collisions during Run3+Run4, the vacuum pressure in the LSS must be $<10^{-9}$mbar\(^1\).

- The following machine modifications are foreseen (LS2) in order to reduce the background in ALICE:
  - LSS vacuum consolidation to minimize vacuum pressure (TE-VSC)
  - New TDI to limit high vacuum pressure from outgassing (EN-STI)
  - Modified layout RB24 beampipe (TE-VSC)

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New collimator in IR2 region

- Bound Free Pair Production (BFPP) losses would limit the PbPb max luminosity for ALICE
- **Solution:** put a new collimator and short 11T dipoles or a collimator in the cryostat connection region. The implementation of this collimator is scheduled for LS2
- Decision after the quench test with Ions at the end of this year's PbPb run
Upgrade preparation already started…

What is foreseen between now and LS2

… and what is foreseen during LS2
Items between now and LS2 with direct involvement of Technical Sector

- Design and procurement new central beampipe
- New Online/Offline computing farm (O\(^2\))
- New cleanroom
- New ALICE visitor centre at P2
- New dry air plant for present ITS (upcoming YETS)
- New ITS, MFT water cooling plants (construction only)
New central beampipe (TE-VSC)

Design & procurement schedule:
- New beampipe approved at LMC in September 2014
- Central beampipe section: OD38mm, ID36.4mm i.e. 0.8mm wall
- Engineering design completed
- Order placement: Q3 2015
- Delivery to ALICE: Q2 2017

<table>
<thead>
<tr>
<th></th>
<th>Present beampipe</th>
<th>LS2 beampipe</th>
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</thead>
<tbody>
<tr>
<td>Outer diameter</td>
<td>60mm</td>
<td>38mm (only central part)</td>
</tr>
<tr>
<td>Wall thickness</td>
<td>800um</td>
<td>800um</td>
</tr>
<tr>
<td>Length</td>
<td>482cm</td>
<td>550cm</td>
</tr>
<tr>
<td>Beryllium length</td>
<td>395cm</td>
<td>88.8cm</td>
</tr>
<tr>
<td>Bellows/flanges</td>
<td>SS</td>
<td>Al</td>
</tr>
<tr>
<td>Nb. of supports</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

June ALICE week
New Online/Offline computing farm (O²)

- O² is a new computing farm of 1750 nodes (2.4 MW)

- **Cooling**: different options being evaluated:
  - Custom building & mixed or primary water cooled racks
  - Built-in container & outside air cooling ("Fresh Air Cooling")

- The infrastructure costs are included in the O² project. Collaboration with EL, CV and GS

- Plan: decision by end 2016, infrastructure installation before end 2018
Cleanrooms

- **ITS cleanroom (b.167):** new 200m² cleanroom for the assembly of the ITS components

- **TPC cleanroom (SXL2, P2):** will be used for TPC upgrade. A refurbishment of the ventilation system is needed, such to improve the air quality (and possibly reach an ISO7)

- **Resources:** CV, (EL, GS)

- **Schedule:**
  - ITS cleanroom in 2016
  - TPC cleanroom in 2017-18 (design end 2015)
New ALICE visitor centre

- ALICE will be part of CERN official tours

- **Redo entirely existing exhibition at P2**

- Resources: GS, EL and CV

- Plan: design complete Dec 2015, implementation in 2016
Work during LS2

- Three sequential phases:
  1. 2 months: opening Experiment + TPC/ITS/beampipe de-installation
  2. 10 months: TPC upgrade + services modifications
  3. 8 months: reinstall TPC/ITS/MFT/FIT/beampipe + close Experiment

- This plan foresees 5 months contingency over the LS2 duration

- We greatly rely on the availability of the CERN support groups, and in particular:
  - Transport coordination (many operations in two shifts)
  - Survey (mostly during re-installation)
  - CV & EL, VSC, …
  - Safety coordination
Opening Experiment + TPC/ITS/beampipe de-installation

**Phase I**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
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</thead>
<tbody>
<tr>
<td>Open cavern, L3 doors, comp.magnet/miniframe</td>
<td>3.5</td>
</tr>
<tr>
<td>Remove ITS &amp; beampipe</td>
<td>4.5</td>
</tr>
<tr>
<td>Bring TPC to cleanroom</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>9 weeks</strong></td>
</tr>
</tbody>
</table>

Transport organized in 2 shifts
2 TPC upgrade

Replace all wire chambers with 4-GEM
New FE electronics
Work executed in P2 cleanroom – **40 weeks**

<table>
<thead>
<tr>
<th>Phase II</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove electronics</td>
<td>4</td>
</tr>
<tr>
<td>Swap chambers</td>
<td>10</td>
</tr>
<tr>
<td>Survey and align chambers and end plates</td>
<td>2</td>
</tr>
<tr>
<td>Sealing and He leak test</td>
<td>4</td>
</tr>
<tr>
<td>Reinstall electronics</td>
<td>8</td>
</tr>
<tr>
<td>Readout test</td>
<td>7</td>
</tr>
<tr>
<td>Contingency</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total: 40 weeks</strong></td>
<td></td>
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</table>
Reinstall TPC/ITS/MFT/FIT/beampipe + close Experiment

<table>
<thead>
<tr>
<th>Phase III</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinstall TPC/miniframe/MCTS</td>
<td>4</td>
</tr>
<tr>
<td>Install ITS cage and new beampipe (incl. bakeout)</td>
<td>5</td>
</tr>
<tr>
<td>Install &amp; commissioning MFT/FIT/ITS</td>
<td>26</td>
</tr>
<tr>
<td>Close L3 doors and cavern</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total: 36.5 weeks</strong></td>
<td></td>
</tr>
</tbody>
</table>

Survey & transport deeply involved in all these operations
Services: cabling & fibers

- **Copper cabling campaigns:**
  - LV & signal cables for ITS/MFT/FIT (EN-MEF)
  - Remove all cables from C-side (absorber area) (ALICE + FSU/PJAS)
  - Miniframe modification (patch panels, cables,…)(ALICE + FSU/PJAS)

- **Optical fibers for Detector to O² data transfer – 10’000 links (EL-CF):**
  - Two types of fibers being evaluated: blowing (+splicing) or pre-connectorized. It seems the pre-connectorized option is more advantageous as one do not need to do the splicing in the pit
  - Choice by end of this year
  - Possible synergies with LHCb
Services: cooling & ventilation

• New ITS cooling plant
  • Most probably water based

• New MFT cooling plant
  • Very similar or identical to ITS cooling plant, but separate machine

• ITS/MFT dry air plant
  • Whether needed has yet to be decided

All these plants will require control (EN-ICE) and power (EN-EL)

Production before LS2, installation at the beginning of LS2, commissioning jointly with ALICE during LS2

Cooling pipes to detectors installed by ALICE
Conclusion

• ALICE will be upgraded in LS2 to read all PbPb events at 50kHz \((L=6\times10^{27}\text{cm}^{-1}\text{s}^{-1})\) into the online system. Increase data sample of MB physics by a factor 100!

• In order to reduce the radiation load in ALICE after LS2 due to beam-gas, the vacuum in the LSS around P2 must be consolidated. New collimator is foreseen in the IR2 region to limit the BFPP losses.

• Several activities scheduled from now until LS2, service groups are already at work!

• ALICE has a very dense planning for the upgrade implementation, partially organized in shifts.

• Availability of transport, survey personnel and safety coordination is very important.

• Services: ALICE will supervise its own FSUs/PJAS to carry some of the cabling activities, however we greatly rely on the EL and MEF cabling contracts and on the CF section for the fibers installation.
THANK YOU