

ALICE



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The ALICE TPC: Upgrade and Physics Perspective

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The large Time Projection Chamber (TPC) is the main tracking and particle identification (PID) device of the ALICE detector. It is currently being upgraded with a new readout system, including new GEM based Readout Chambers and new front-end electronics. This will enable to operate the TPC in continuous mode, recording the full minimum bias interaction rate of 50 kHz in Pb-Pb collisions, as anticipated at the LHC in Run3 and beyond. In this presentation, we discuss the physics potential of the upgraded TPC¹ and show the status of the upgrade activities during the ongoing LHC Long Shutdown 2, for which the TPC was lifted into a large clean room at ground level. Status of the upgrade activities is presented.

Physics objectives.

Improved understanding of QGP in heavy-ion collisions include detailed measurements of heavy quark production at low p_T , low p_T quarkonia production, low mass dielectron production, correlation in high multiplicity events and production of nuclei and exotic hadronic states. To obtain this, excellent particle tracking and particle identification is required down to the lowest possible p_T and up to the full minimum bias rate of 50 kHz in Pb-Pb collisions at the LHC.

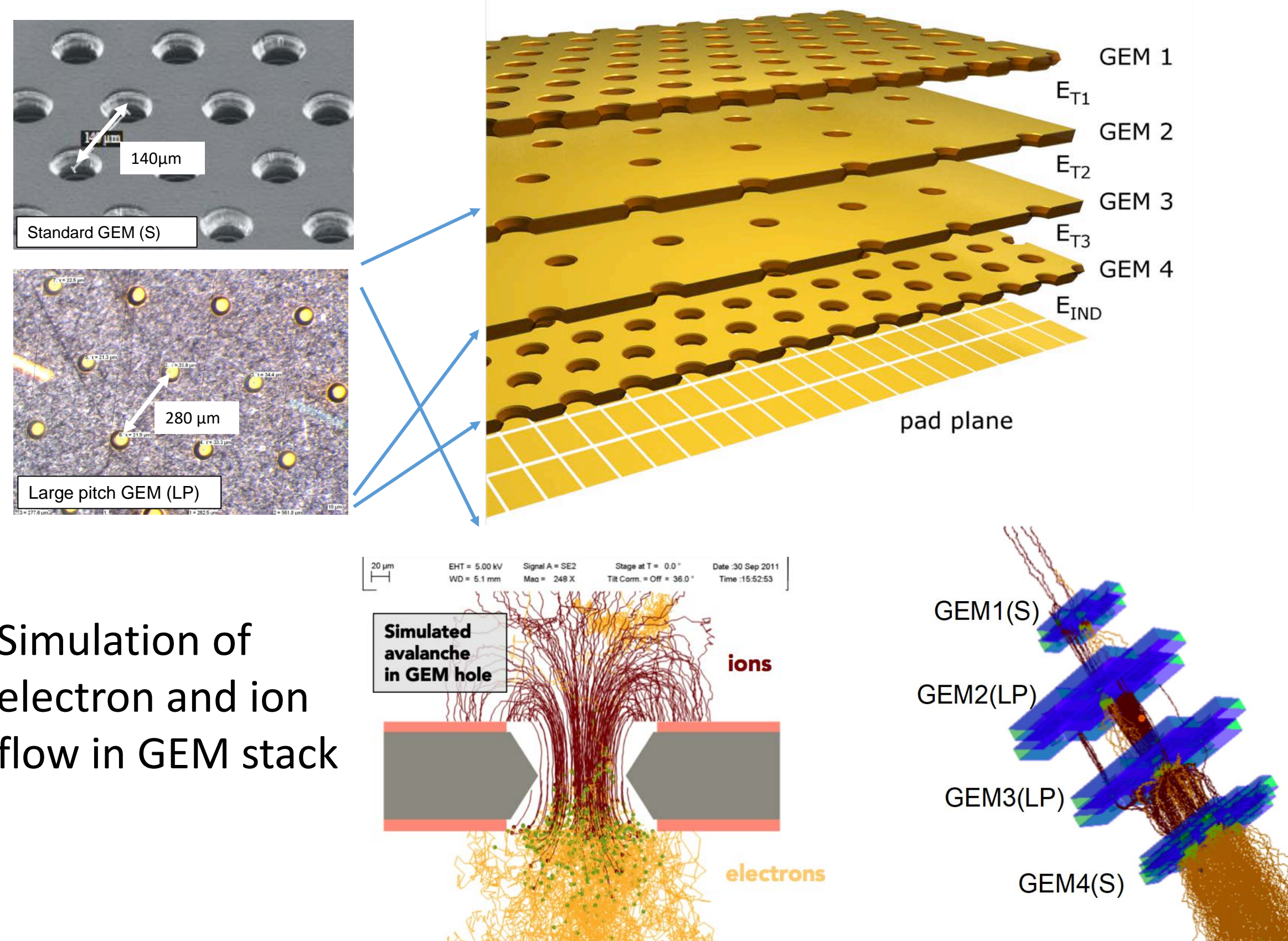
The upgrade.

The objective is to be able to operate the ALICE Time Projection Chamber in a continuous read-out mode, i.e. without trigger or gating. To do this, the upgrade include:

1. Replacement of all MWPC's with GEM based read-out chambers.
2. Electronics capable of continuous read-out up to 5 MHz sampling rate.

Read-out chambers.

Stack of 4 layers of micro-pattern GEM detectors supply sufficient gain while maintaining low ion feedback (< 1%) at gain of 2000 in Ne-CO₂-N₂ (90-10-5).



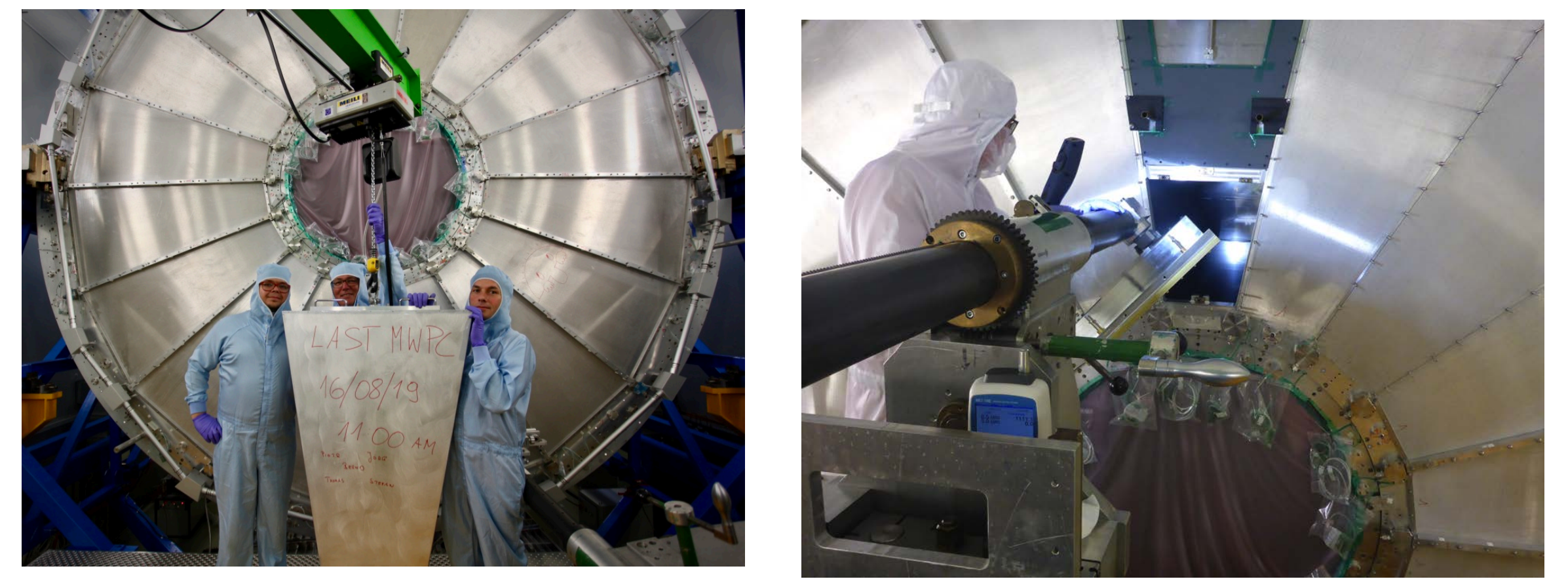
Simulation of electron and ion flow in GEM stack

Upgrade ongoing.

The TPC was extracted from the ALICE experiment and transported to the surface in March 2019.



The MWPC's were extracted and replaced by GEM chambers in summer 2019.



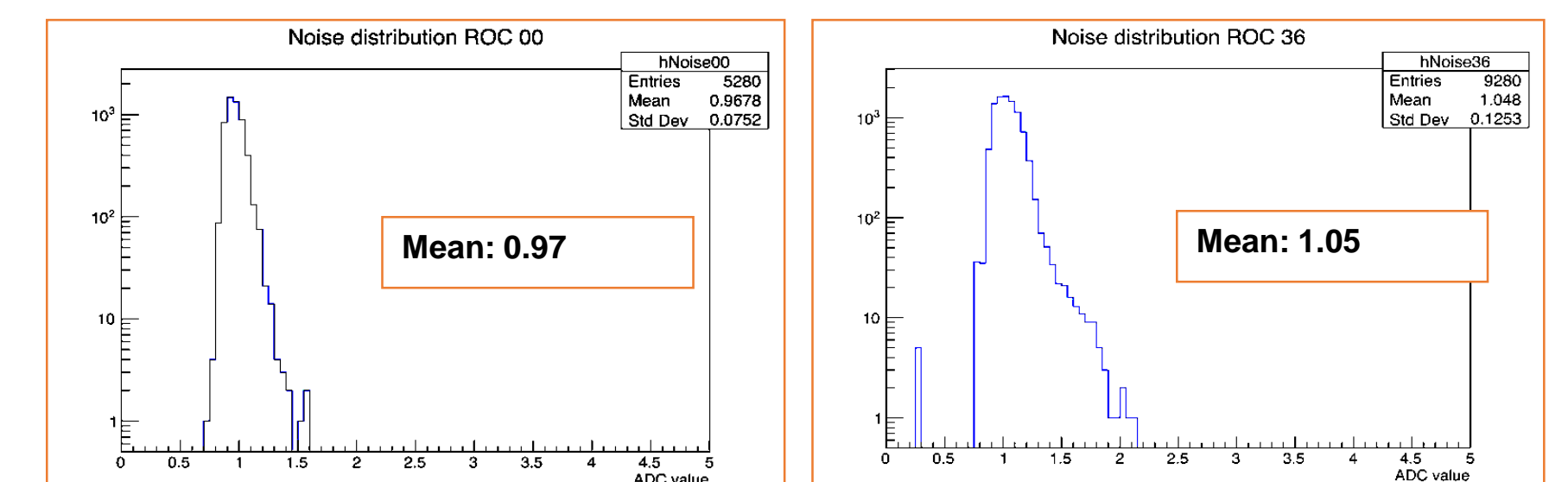
Front-end electronics has been produced and tested.

Current status.

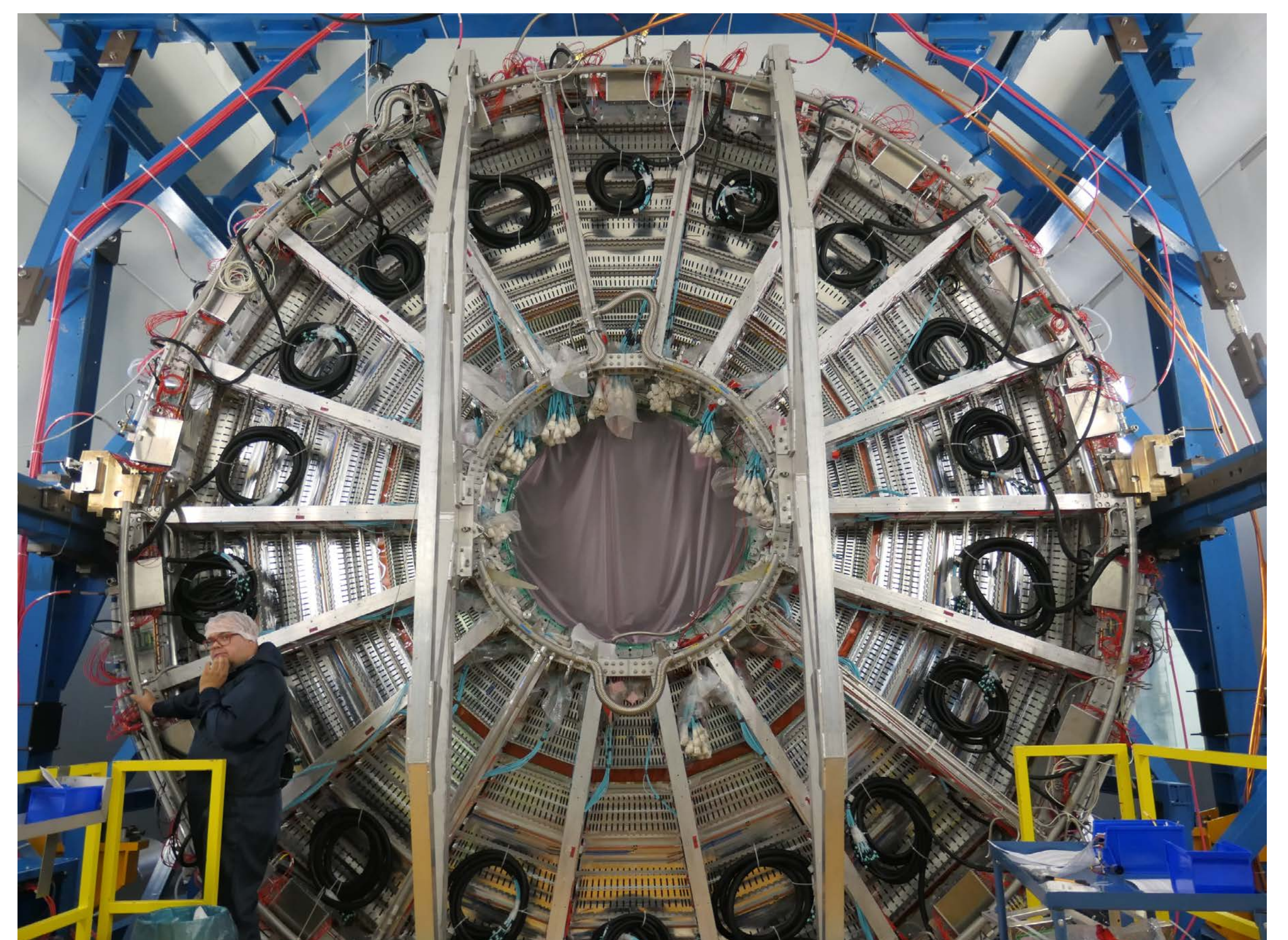
All chambers installed, sealed and connections tested: one being replaced.

Front-end electronics installed.

Measured noise in installed electronics for typical inner and outer chamber:



November-January: pre-commissioning with cosmics, laser, pulser and X-ray.
February: transport back to ALICE cavern
Remainder of 2020: commissioning with ALICE.

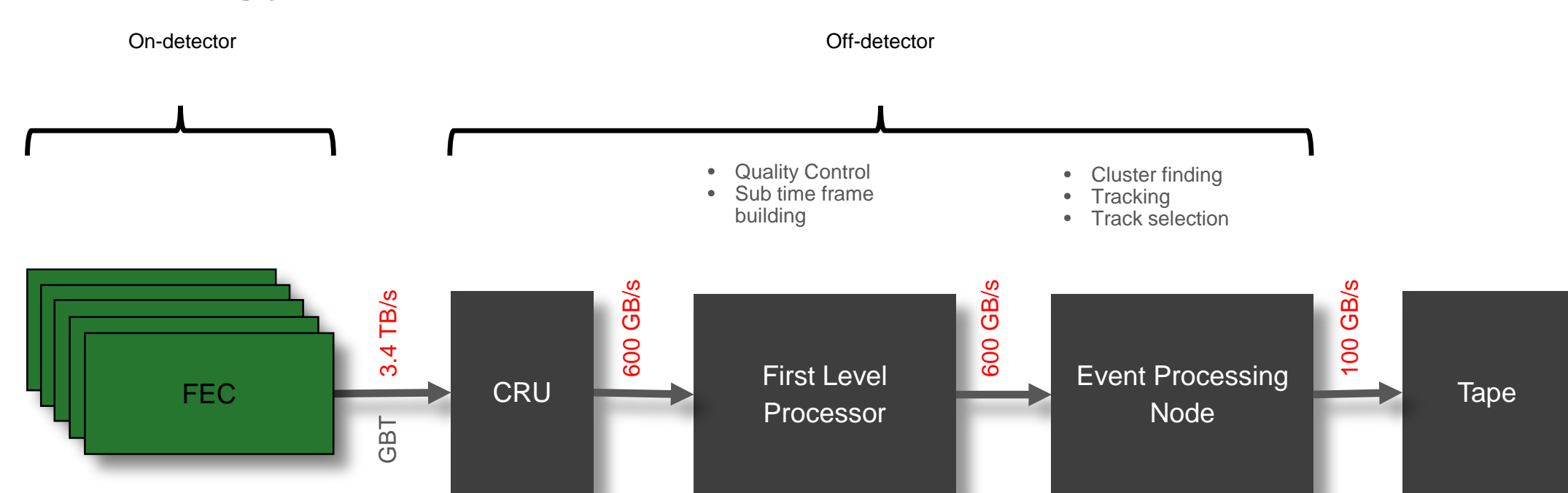


Electronics.

Front-end accepts negative polarity signals at low noise (670 e ENC) and a dynamic range of 30 MIP. The continuous read-out (0.5 M channels @ 5 MHz) is backed up by an online off-detector data compression factor of ~20 in 50 kHz Pb-Pb collisions.

Front-end based on SAMPA chip (130 nm TSMC CMOS).

Read-out strategy:



1. Upgrade of the ALICE Time Projection Chamber, B. Abelev et al (ALICE Collaboration), CERN-LHCC-2013-020, ALICE-TDR-016 (2013)