



Status of the ATLAS RPC commissioning and cosmic test results

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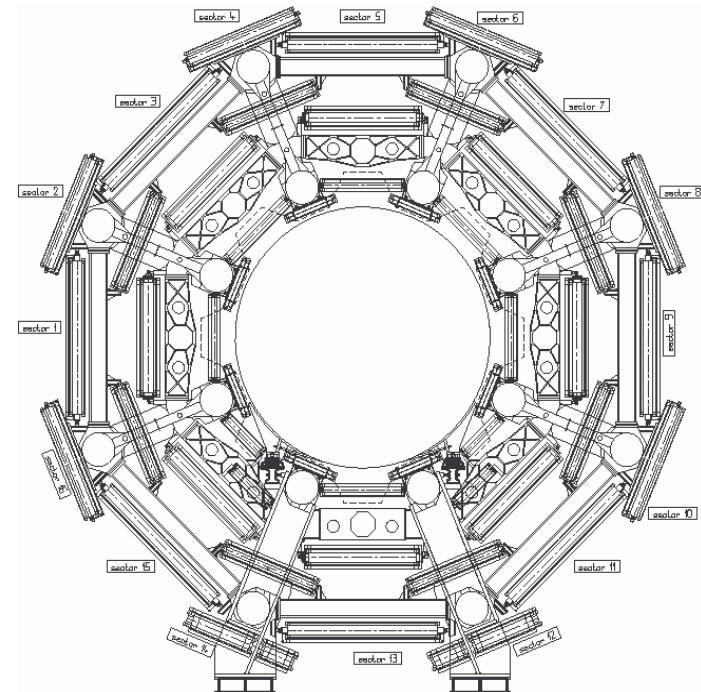
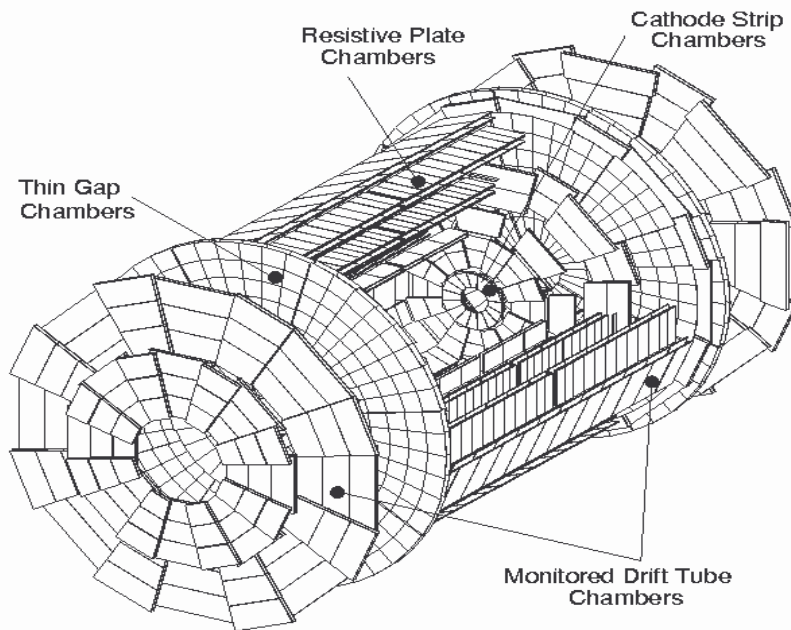
*INFN Lecce & Physics Department, Salento University
on behalf the ATLAS RPC and LVL1 Group*

Outline

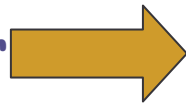
- ✓ The ATLAS muon trigger in the barrel region
- ✓ RPC hardware commissioning
- ✓ Online & offline software commissioning
- ✓ Results with cosmics
- ✓ Conclusions

The ATLAS Muon Spectrometer

Resistive Plate Chambers (RPC) will be used as **Muon Trigger Detector** in the barrel region ($-1 < \eta < 1$)



Muon Spectrometer



16 Sectors (8 Large and 8 Small)
64 Trigger Sector Logic
416 Trigger Towers

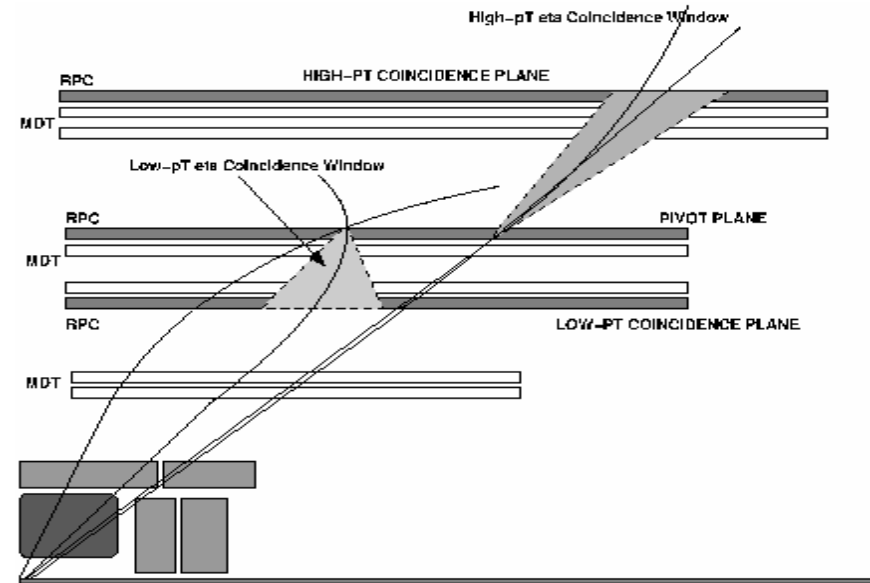
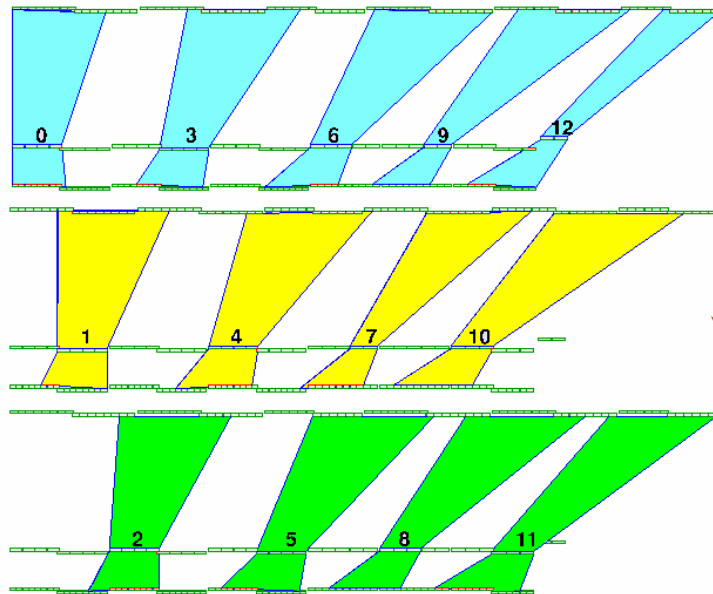
- ✓ More than 1100 RPC units
- ✓ 368.416 Read-out channels
- ✓ 26 different chamber types
- ✓ Total surface $\sim 4000 \text{ m}^2$

Muon trigger strategy

Muon selection mechanism is based on allowed fast geometrical coincidence windows (*Trigger roads*)

Two threshold regimes:

- Low- p_T : muon trigger ($6 < p_T < 20$ GeV)
majority 3/4
- High- p_T : muon trigger (> 20 GeV)
majority 1/2 + Low- p_T



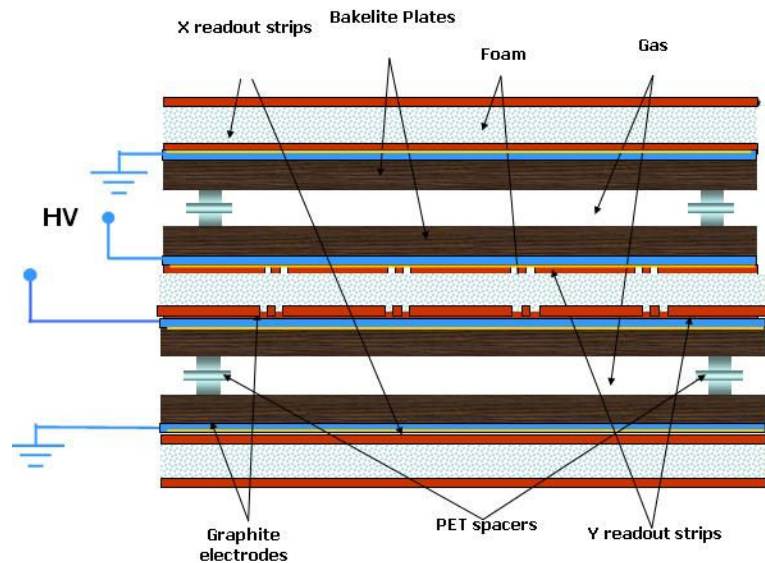
Trigger tower for muon selection in a typical ATLAS Sector Logic.

The ATLAS Resistive Plate Chambers

Gaseous detector operated at atmospheric pressure

ATLAS RPC works in saturated avalanche regime

Gas mixture: $C_2H_2F_4$ 94.7% - C_4H_{10} 5% - SF_6 0.3%



Each unit contains 2 layers of gas volume.

2mm gas gap, bakelite resistivity $\sim 1-4 \times 10^{10} \Omega\text{cm}$

η and ϕ read-out copper strip panels, pitch ranging from 26.4 to 37 mm

Main ATLAS RPC tasks:

- Good time resolution for bunch-crossing identification (~ 1 ns).
- High rate capability to sustain the high background level.
- 2nd-coordinate measurement with a 10mm resolution

Hardware commissioning status

Gas System Status

Gas manifolds ~ 256

Inlet gas connection ~ 1200

Outlet gas connection ~ 1200

Pressure drop capillaries ~ 2050

T and Y shaped plastic junctions 2360

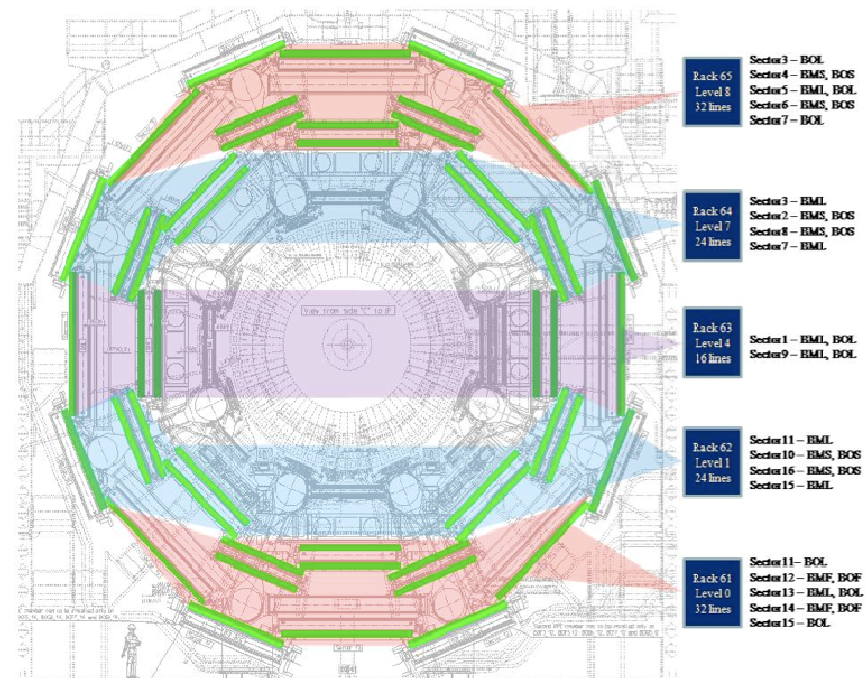
{ ~ 4.5 km of 6 mm plastic pipe

{ ~ 2.2 km of 1 mm inner radius plastic pipe

Leak Test

Complete gas leak checks of the detector performed twice and continuously monitored.

Check performed sealing the gas gap and measuring the flow needed to keep it at constant pressure.



Gas System Re-circulation Status

- Since the April 14th to May 24th we flushed 2 racks
 - ✓ Flushing 2 (out of 5) racks with 4-5 sectors simultaneously active
 - ✓ Re-circulating 2200 l/h
 - ✓ 7% fresh flow
 - ✓ Total gas leak 40 l/h
 - ✓ Stable Gap currents

- Since 24th of May a new test is on-going.
 - ✓ Flushing 3 out of 5 racks with ~ 9 sectors simultaneously active
 - ✓ Re-circulating ~3000 l/h
 - ✓ 7% fresh flow
 - ✓ Total gas waste ~50 l/h
 - ✓ Stable Gap currents

Cabling Status

- ❑ Cable testing and connection to chambers. The test procedure is managed via DCS. Can be done only after the connection on rack side.
- ❑ This allows to check the correct identification of the cable itself:

Chamber \longleftrightarrow Rack \longleftrightarrow DCS id

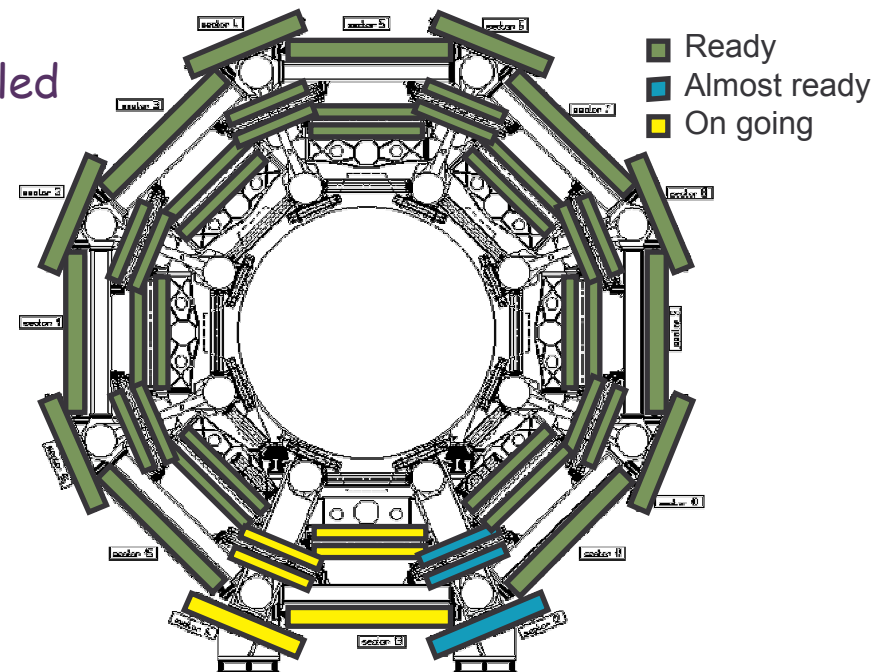
- ❑ HV cables are power-up to 10 kV to check "electrical isolation".

- ❑ Sectors from **1 to 11, 15, 16** already cabled

- Sectors **12** almost done
- Sectors **13, 14** cables in test
- Time for completion: ~ 4 weeks

- ❑ Racks cabling almost finished.

All cabling works on racks and chambers will be finished at the cavern closure.



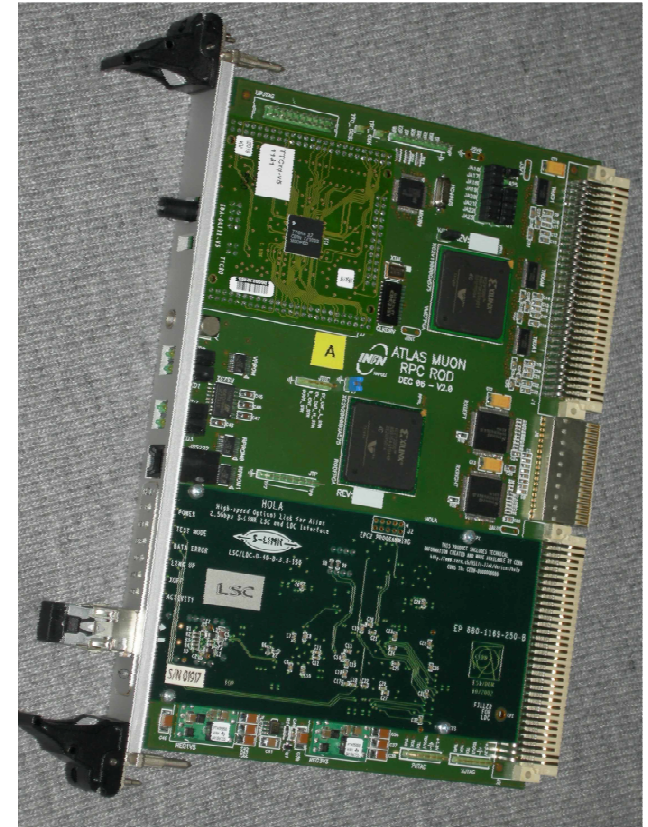
ReadOut Driver (ROD) Status

■ ROD Hardware:

- All RODs and ROD Buses are installed and are working in stable way so far.

■ ROD Firmware and DAQ software:

- Worked without any problems at low rate (~ 100 Hz) with cosmics and at an higher rate (40 kHz) with external random trigger.
- ROD ran smoothly, but the running condition are easier than in the final ATLAS configuration. Final configuration (busy logic, high trigger rate, all sector at the same time) is still to be tested.
- Full commissioning requires intensive run in critical condition. At the present higher priority is given to the sectors commissioning, and only a small fraction of data taking time can be devoted to this tests.



Software commissioning status

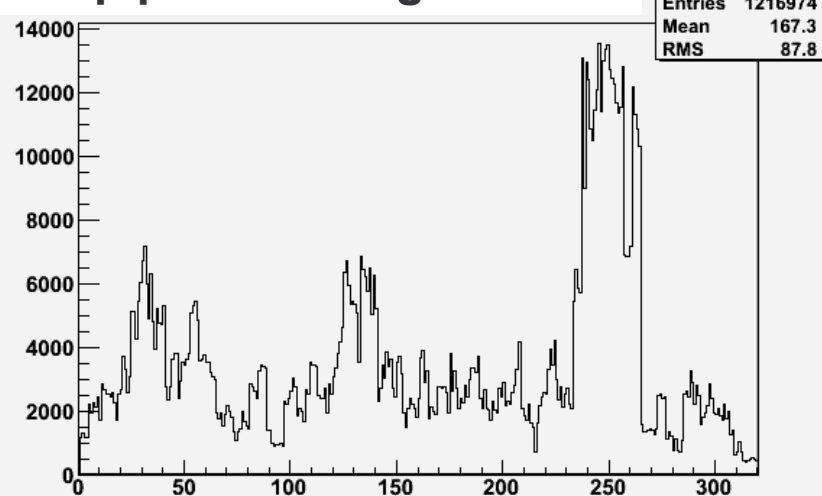
DCS Operation Status

- Mapping of the whole RPC detector (16 sectors, HV/LV etc.) completed. (Final tuning and ENV sensors mapping ongoing).
 - All functionality (mostly expert tools and manager scripts) extended to run on the whole detector or all systems and moved to CVS.
 - Full FSM tree for the whole detector generated (via automatic scripts).
 - Procedures for definition, setting and masking of Warnings, Alarms etc done via scripts.
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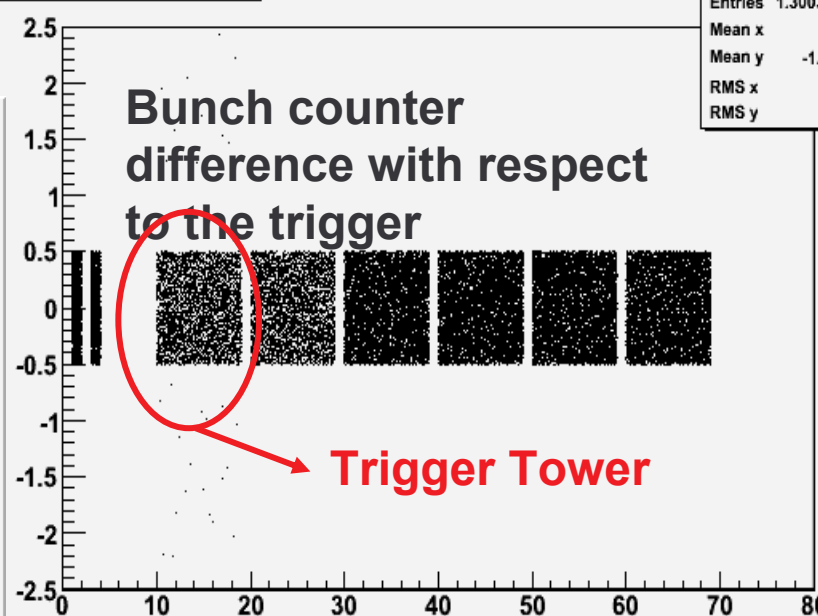
Online Monitoring Status

- Event sampled on different point of the data flow.
- Data integrity checks performed to verify the data quality from different points of views:
 - Consistency of each subfragment
 - Time alignment between each subfragment and with respect to the trigger
 - Detector functionality

Strip profile along a sector



BCID Misalignment



BCID Alig RX0	
Entries	1.300387e+07
Mean x	39.65
Mean y	-1.309e-05
RMS x	19
RMS y	0.01614

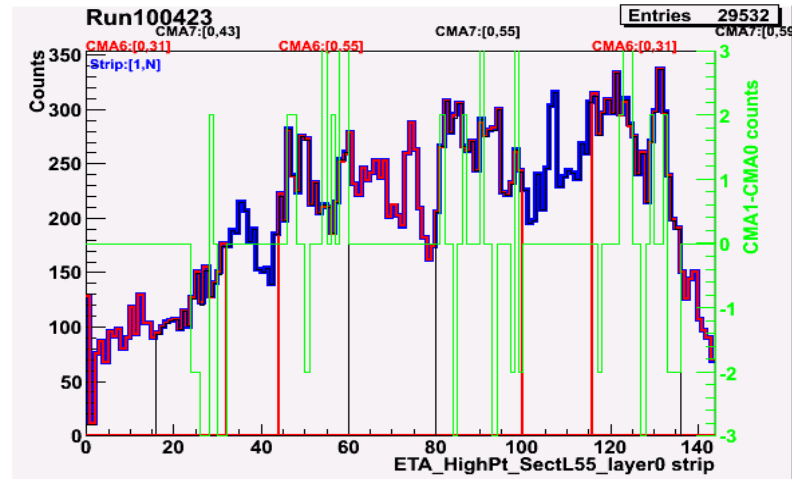
Read Out Sub-element

ATLAS RPC offline

1. Developed and successfully tested the offline software used for the detector commissioning with cosmic rays.
 - ✓ Cabling check and dead channels identification
 - ✓ Efficiency measurements with RPC in stand-alone mode
 - ✓ RPC studies with MDT
 - ✓ Current and noise measurements

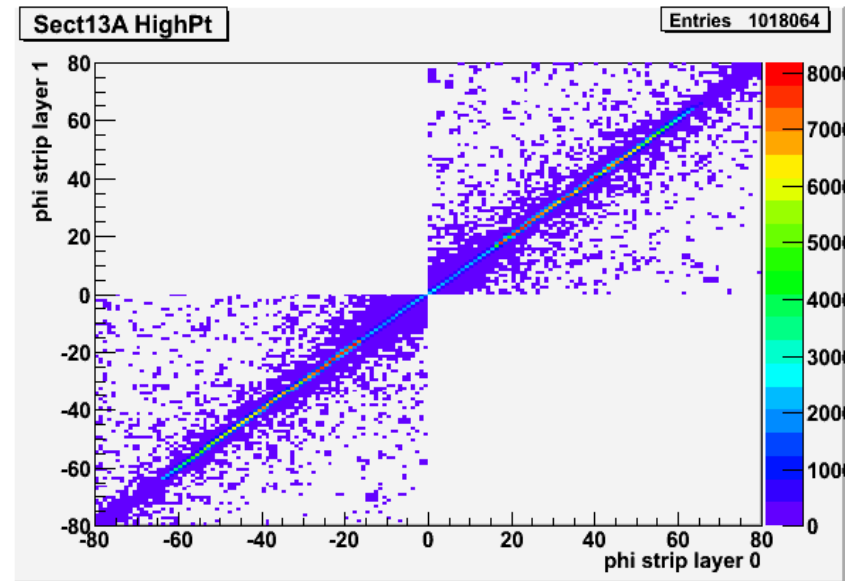
2. RPC offline monitoring and Data Quality in ATHENA (ATLAS software framework)
 - ✓ Detector Monitoring
 - ✓ Trigger Monitoring

Results with cosmic: debugging

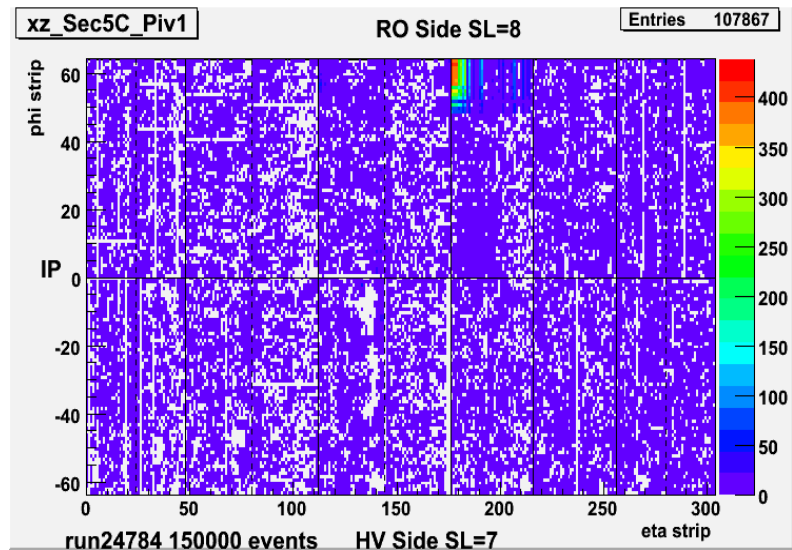


← RPC strips profiles

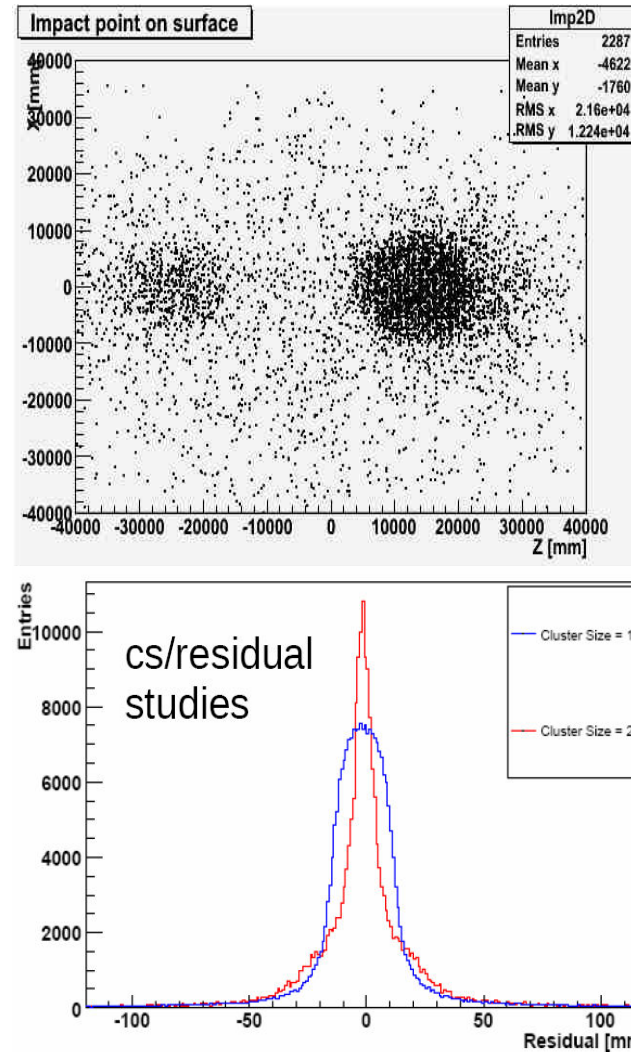
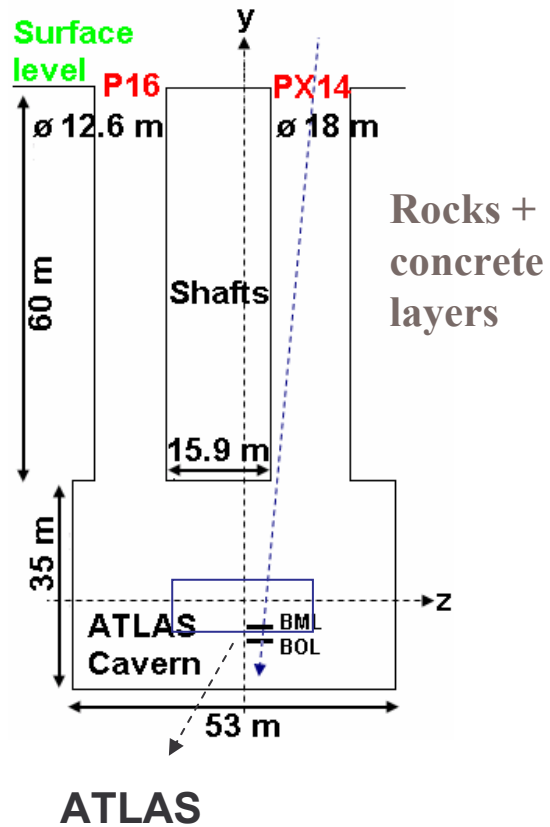
RPC strips correlation



← 2D strips correlation



Results with cosmic: tracking in standalone mode and with MDT



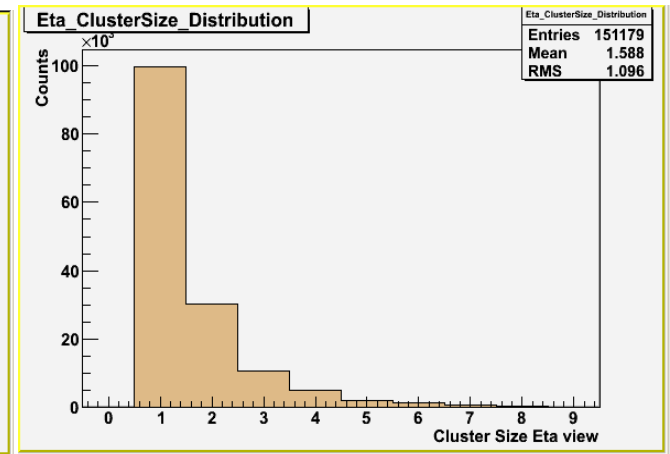
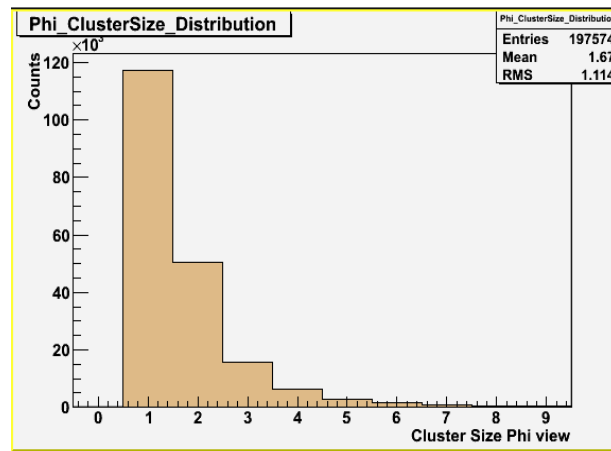
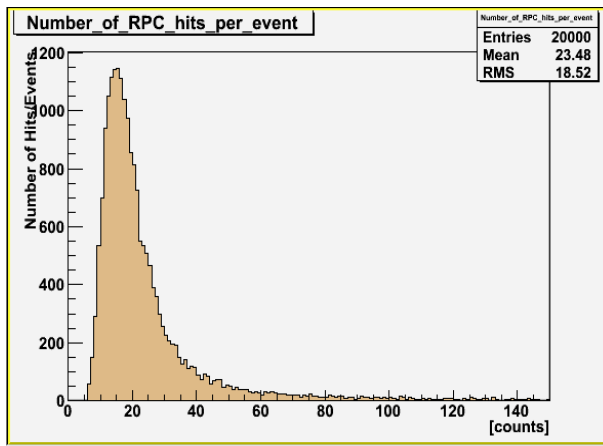
Track impact parameters distribution at surface level realized with standalone tracking.

Residuals distribution obtained with cluster with size one and two.

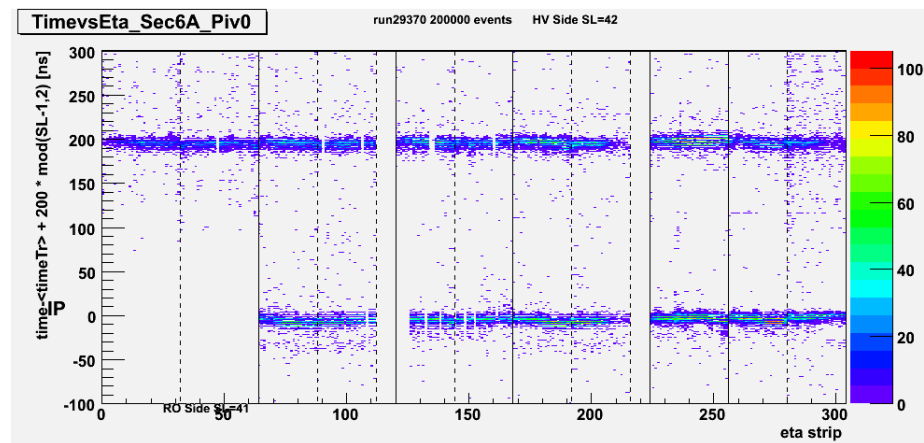
RPC and LVL1 monitoring with cosmics

N° of hits per events

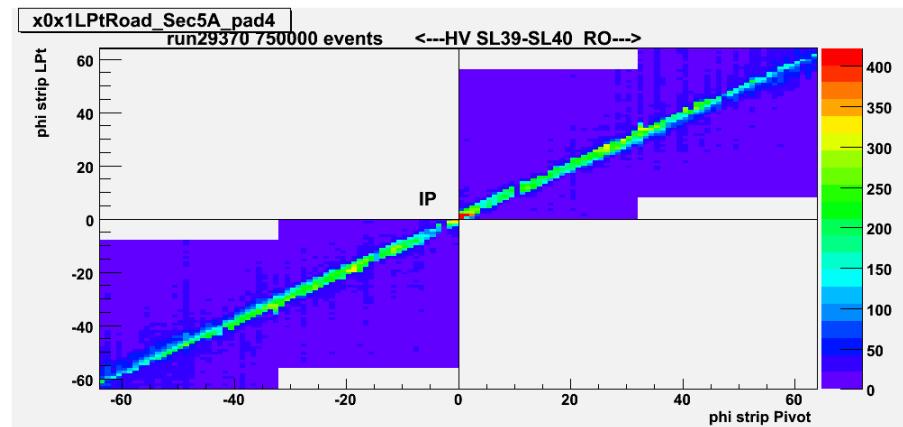
Cluster Size distribution per phi and eta panels



Time-Trigger Time strip along sector



Trigger Road in Phi view



Conclusions

- ✓ *Gas re-circulation system is working fine since the end of April, three (out of 5) gas racks are working now in re-circulation mode.*
- ✓ *Racks and chambers cabling almost done, all work will be finished before cavern closure.*
- ✓ *Online monitoring integrated in the latest TDAQ release.*
- ✓ *Offline RPC monitoring integrated in ATHENA.*
- ✓ *10 ATLAS RPC Sector commissioned so far with cosmic rays.*