ATLAS RPC off-line monitoring and data quality

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The muon spectrometer of the ATLAS experiment at the Large Hadron Collider (LHC) is built around three large super-conducting air-core toroids. In the barrel region, where the magnetic field is provided by eight radial coils, muon triggering is accomplished by 596 Resistive Plate Chambers [2] arranged radially at about 6.5 m, 7.5 m, and 10 m from the beam line [3].

The RPC planes are made of one or two mechanically independent RPC units (for a total of 1116). Each unit consists of 2 layers of active gas volume, each one instrumented with two orthogonal readout strip panels (measuring the bending and non-bending views with a pitch of about 3 cm) with built-in fast GaAs front-end electronics.

The area covered by the RPC detector is 3650 m^2 and the front-end electronics consists of approximately 355,000 readout channels. The group is responsible of off-line monitoring and data quality for Resistive Plate Chamber within the ATLAS experiment.

The off-line monitoring and data quality assessment of such a large sub-system are crucial to maximize the physics reach of the experiment. This can be accomplished by a detailed knowledge of the detector performance during runs and ensuring a uniform detector behavior between runs in order to reduce systematic errors.

We developed within the ATLAS software framework a software package to debug, monitor, and asses data quality for the RPC detector. Being a part of the muon spectrometer off-line monitoring package, the code runs automatically at the CERN computing facility, where data are processed just after being available on the central data storage. Run by run, all relevant quantities characterizing the RPC detector are measured (such as efficiency, adjacent strip molteplicity, noise, ...) and stored in a dedicate database. These quantities are used for MonteCarlo simulations and off-line reconstruction by physics analysis groups.

The software tools are capable to produce a fast feedback on RPC detector data quality, without relay on the full ATLAS event reconstruction and combined quantities.

A RPC standalone tracking is implemented in off-line monitoring [4]. The tracking is based on RPC space points, which are defined by orthogonal RPC adjacent hits (clusters) of the same detection layer. The pattern recognition is seeded by a straight line, which is defined by two RPC space points belonging to different RPC chambers. RPC space points not part of any previous tracks and inside a predefined distance from the straight line are associated to the pattern. Resulting patterns with points in at least 3 out of 4 detection layers are retained and a linear interpolation is performed in two orthogonal views.

From cosmic data about 95 % percent of events have at least one RPC track. This is due the strong correlation between the pattern recognition and the trigger algorithm. Applying a quality cut of chi2/dof < 1 about 70 % of events have at least a good tracks and 10 % with more than one.

In Figure 1 the spatial distribution on surface of cosmic rays triggered and reconstructed by the RPC detector is shown. The cosmic rays came mainly from the two shafts used to lift-off material (positioned along the z axis) and the two elevators to transport people down (positioned along the x axis).

In order to measure the detection efficiency the RPC tracking is repeated 6 times, each time removing the layer under test from the pattern recognition and track fitting. This results in an unbiased efficiency measurements because of the 3 out of 4 RPC majority trigger logic.

In Figure 2 the distribution of RPC hits per event with RPC trigger and with random trigger are shown. The average value of these distributions correspond to the average RPC detector occupancy due to cosmics and uncorrelated noise. The cosmic ray and random trigger data show a low level of uncorrelated noise in RPC detector, which corresponds to fraction of Hz/cm^2.

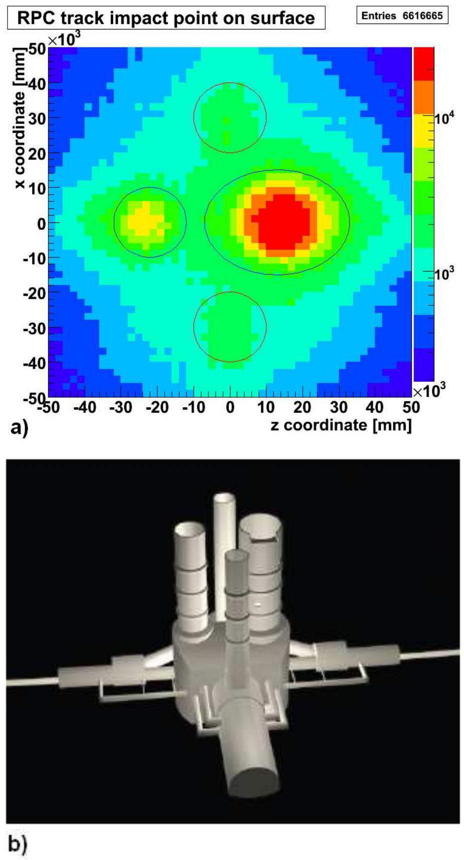

Figure 1. a) Cosmics muon map reconstructed by off-line RPC monitoring projected on surface (y=81m). b) Pictorial view of ATLAS underground location showing the 4 conduits where most cosmics came from and correspondig to the circles drawn on a).

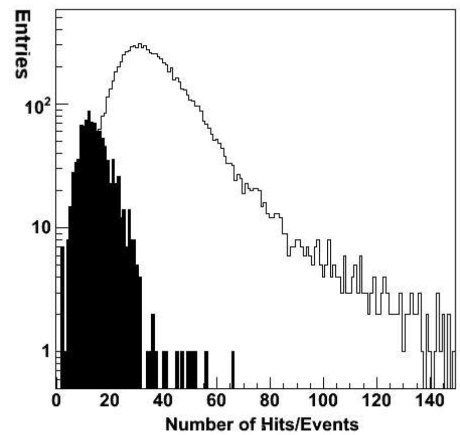

Figure 2. Hits multiplicity in the event considering cosmic rays triggered by RPC (non filled plot) and random trigger (filled plot).

During beam collisions, at nominal luminosity, uncorrelated and correlated noise is going to be dominated by cavern background and low energy tracks.

The RPC tracking standalone is extended to the forthcoming LHC p-p beam collisions. Cosmic rays arrive randomly in time and not uniformly on detector surface. This makes detector studies with cosmics not very accurate and predictable. Tracks produced by beam collisions are synchronous with beam clock, pointing, and uniform in azimuthal angle and pseudo-rapidity. The difficultly with beam is due to the presence of the magnetic field and operation at high luminosity. The above described pattern recognition and the track quality cut correspond, in magnetic field, to a cut in transverse momentum. At high luminosity a large uncorrelated and correlated background could increase the number of fake tracks significantly. In order to mitigate such a problem we tune the pattern recognition and the track quality cut and reject low momentum tracks.

Data quality on trigger selection and detector performance is also established by more hardware related quantities such as layer patterns and geometrical coincidences in trigger, single channel overlaps, time alignemnts, data corruptions, and channels mapping. In particularly, the RPC mapping is a not trivial task because the same electronics implements the trigger logic and the readout. In fact, to avoid trigger inefficiency a large fraction of RPC strips are readout by two adjacent trigger towers (named ‘cabling overlaps’). The pointing geometry requires cabling overlaps which are position dependent along the beam and when chamber boundaries are crossed in the bending view, a full non-bending view overlap is required between chambers (named ‘logical-or’).

The monitoring of these distributions guarantees good data on tape and promptly spot eventually occurring problems.

REFERENCES

1. ATLAS Collaboration is made of about 2500 Physicists coming from 167 Institutions of the following countries: Argentina, Armenia, Australia, Austria, Azerbaijan, Belarus, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, France, Georgia, Germany, Greece, Israel, Italy, Japan, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan,

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