Performance of the ATLAS RPC Detector and Trigger at 13 TeV

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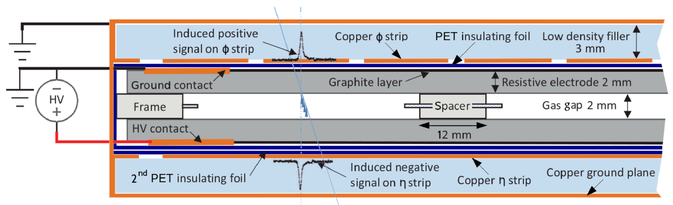
JINST 16(2021) P07029

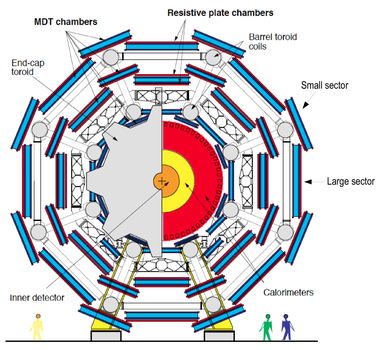
Introduction

The ATLAS experiment utilizes the Resistive Plate Chambers detector (RPC) for the first level muon trigger system in the barrel region of the detector. This poster presents measurements of RPC detector and trigger performance using proton-proton collisions at a center-of-mass energy of 13 TeV collected in 2018, showing the results in terms of the detector and trigger timing and efficiency

RPC Detector @ ATLAS

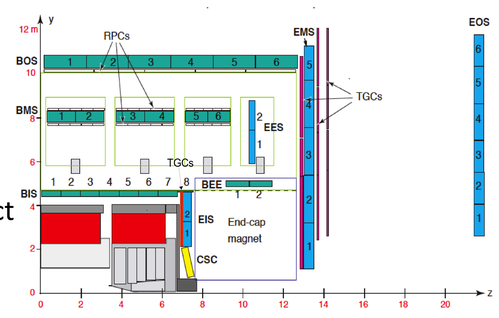
The RPC technology was chosen by the ATLAS experiment for fast response, good time and position resolution, and relatively low cost.





ATLAS muon trigger in the barrel region

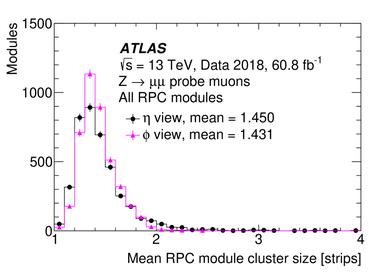
- 3 concentric RPC layers
- 16 physical sectors, ~3700 gas volumes each physical sector is segmented in 4 trigger sectors
- 64 trigger sectors in side A and side C each trigger sect is segmented along η in towers [1] [3]

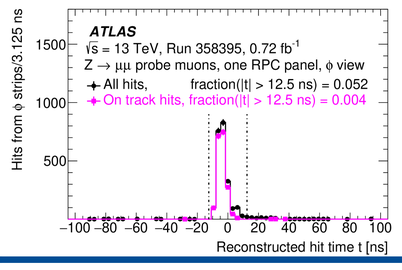


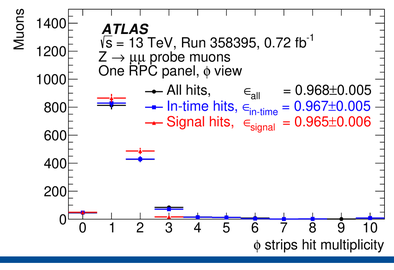
RPC Detector Performance

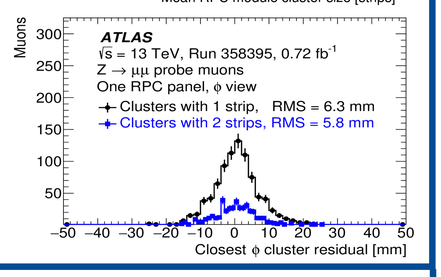
RPC detector hit position response

- Hit time compared to the triggered bunch crossing
- Hit multiplicity of single RPC
- Hit residual to the center of RPC Cluster
- Average size of RPC Cluster ~1.5 strips



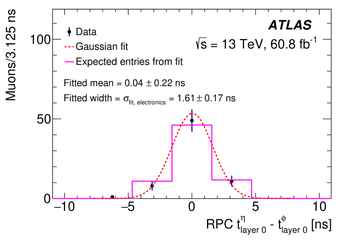


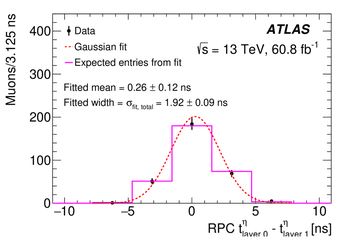


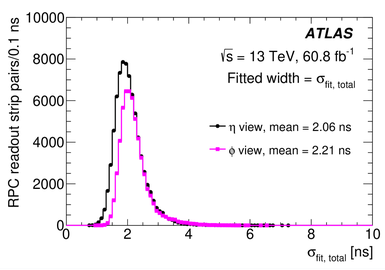


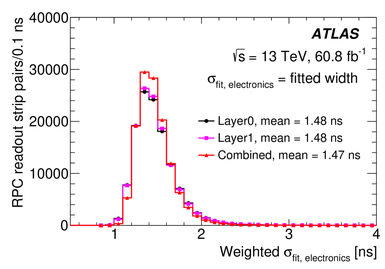
RPC time resolution

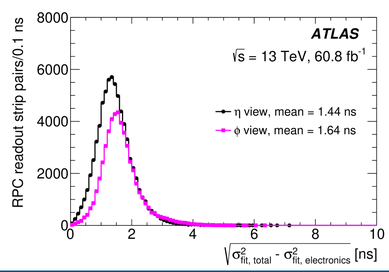
- **Intrinsic resolution**
  - Depends on fluctuations in the location of the 1st ionization event
- **Electronics resolution**
  - Depends on time resolution of the readout system
  - Evaluation : width of gaussian fit for $t^{\eta}_{layer\ i} - t^{\phi}_{layer\ i}$
- **Total time resolution**
  - Calculation : $\sigma^2_{total} = \sigma^2_{Electronics} + \sigma^2_{Intrinsic}$
  - Evaluation : width of gaussian fit for $t^{\eta(or\ \phi)}_{layer\ i} - t^{\eta(or\ \phi)}_{layer\ j}$





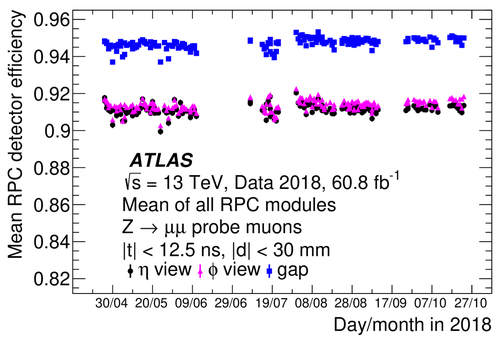


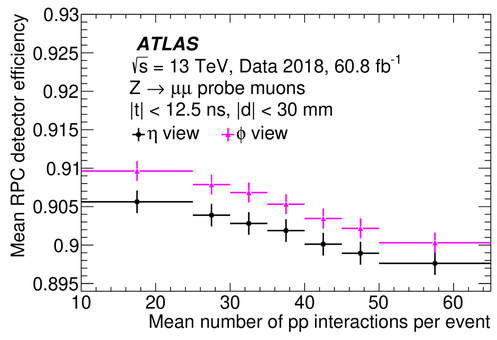




RPC module efficiency evaluation:

- Panel $\eta(or\ \phi)$: ≥ 1 hit in related strips
- Gap (module) : ≥ 1 hit in related $\eta\ or\ \phi$ strips

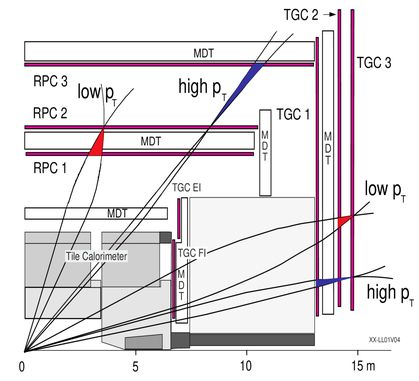




Level-1 Muon Barrel Trigger

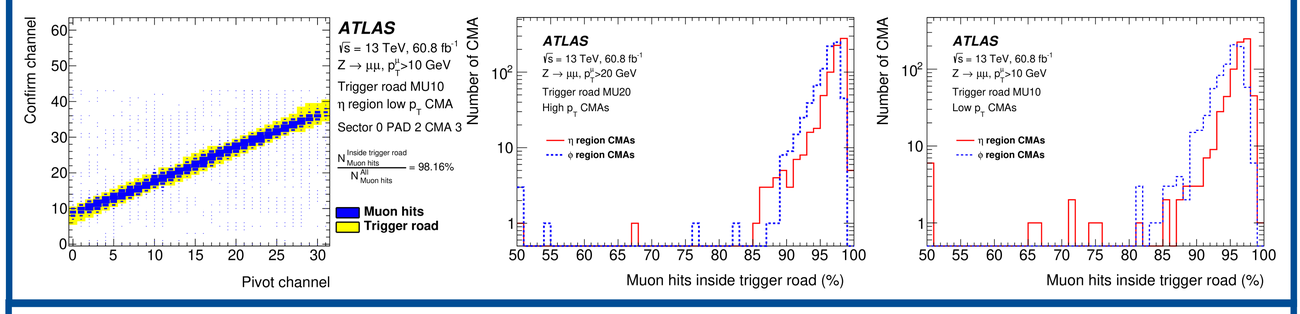
The Level-1 (L1) trigger algorithm [3]

- Based on hit coincidence of 3 concentric RPC stations
- Low p_T trigger : coincidence between RPC1 & RPC2
- High p_T trigger: additional confirmation on RPC3



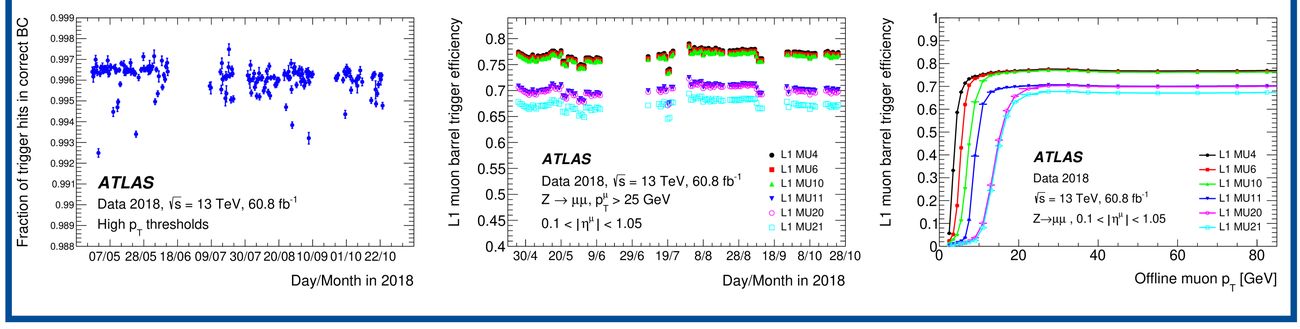
Trigger tower logic

- Processing in RPC FE electronics processor box (PAD)
- Each PAD contains four coincidence matrices ASIC(CMA)
- **The CMA trigger logic**
  - Check the time coincidence of RPC hits.
  - Applies the geometrical matching criteria of pT thresholds.
  - **Trigger road** : geometrical correlation between pivot and confirm layer



The L1 trigger performance

- Measurement : using unbiased muons from $Z \rightarrow \mu\mu$ candidates.
- **Trigger timing performance**
  - ~ 99.7% of muon trigger candidates associated to the correct bunch crossing (BC)
- **Trigger efficiency of different muon *p*T thresholds**
  - muon candidates with $pT > 20$ GeV is ~ 76.5% for low pT thresholds and ~ 70% for high pT thresholds with good stability during the data taking.



RPC Currents and Counting Rate

RPC currents

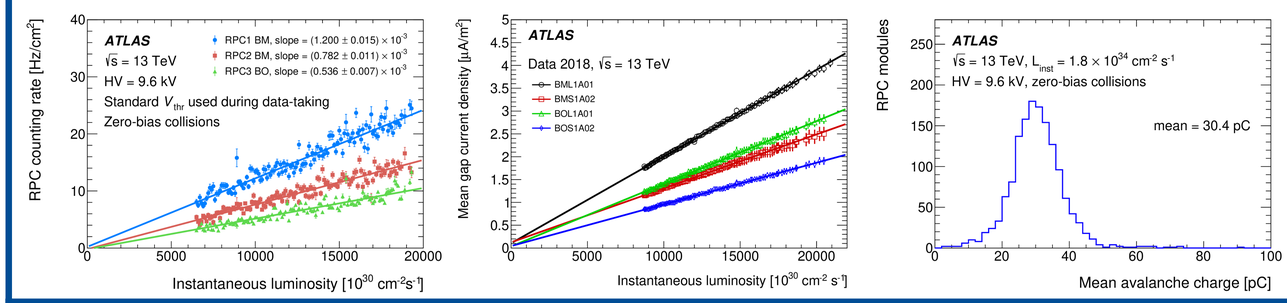
- Mechanism: generated from ionization current in RPC gas gap
- Measurement : currents were recorded during periods of pp collisions with stable LHC and detector conditions.

RPC counting rate

- Measurements : using zero-bias collisions, dominated by background events from neutron and photon interactions with the RPCs.

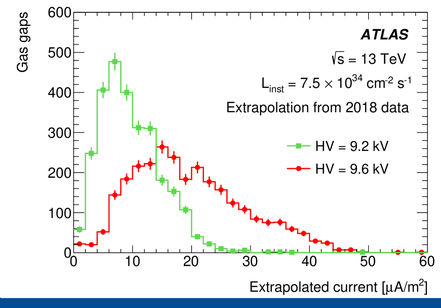
RPC avalanche charge measurements

- Avalanche charge $Q = \frac{Current\ density}{Counting\ rate}$, works well with mean value 30.4pC



Prospect for Hi-Lumi LHC

- **Hi-Lumi** : $7.5\times10^{34} cm^{-2} s^{-1}$(instantaneous)
- Extrapolate RPC counting rate and RPC current density to Hi-Lumi using linear functions
- Reasonable HV working point : 9.2kV



Reference
[1] M. Corradi, Performance of ATLAS RPC Level-1 muon trigger during the 2015 data taking, 6032 Journal of Instrumentation 11 (2016) C09003
[2] ATLAS Collaboration, ATL-COM-MUON-2018-065 [3] C. Luci, The Level-1 Trigger Muon Barrel System of the ATLAS experiment at CERN, 2009 JINST 4 P04010 [4] ATLAS Collaboration, ATL-COM-DAQ-2018-181

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