LHCC Poster Session - CERN, 27 February 2019

Performance of the ATLAS RPC detector and trigger at 13 TeV

Introduction

The ATLAS experiment utilises 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 centre-of-mass energy of 13 TeV collected in 2018, showing results in terms of the detector and trigger timing and efficiency.

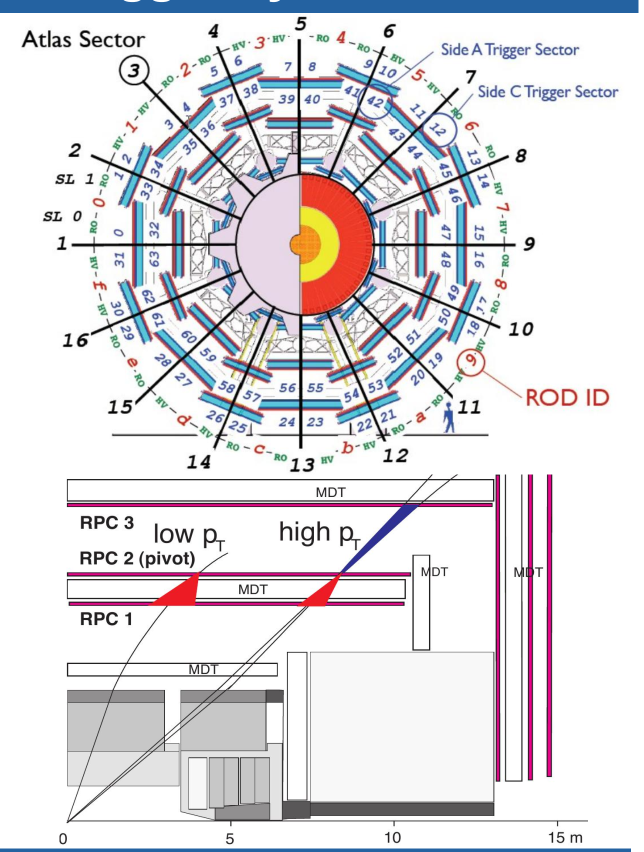
The ATLAS RPC Detector and Trigger System

The present ATLAS muon trigger in the barrel region based on

- 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 sector is segmented along η in towers [1] [3]

The Level-1 (L1) trigger algorithm is based on hit coincidence of 3 concentric RPC stations [3]

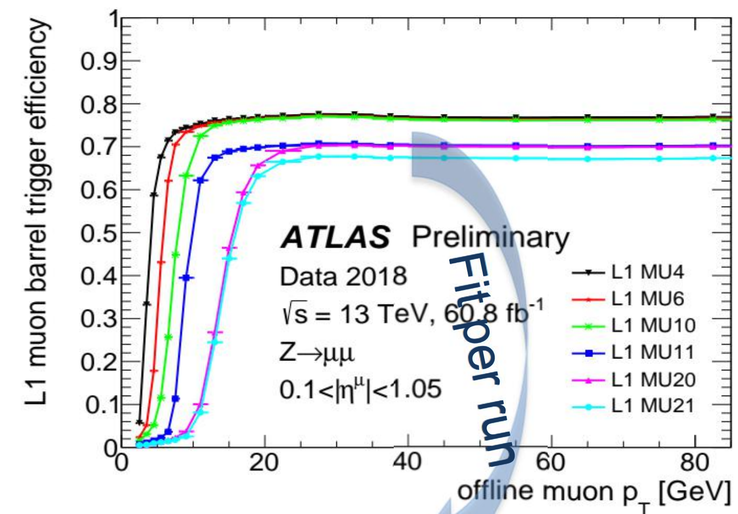
- low p_T trigger: coincidence between the innermost two RPC stations
- ligh p_T trigger: additional confirmation on the third external station



Trigger efficiency vs. offline muon p_T

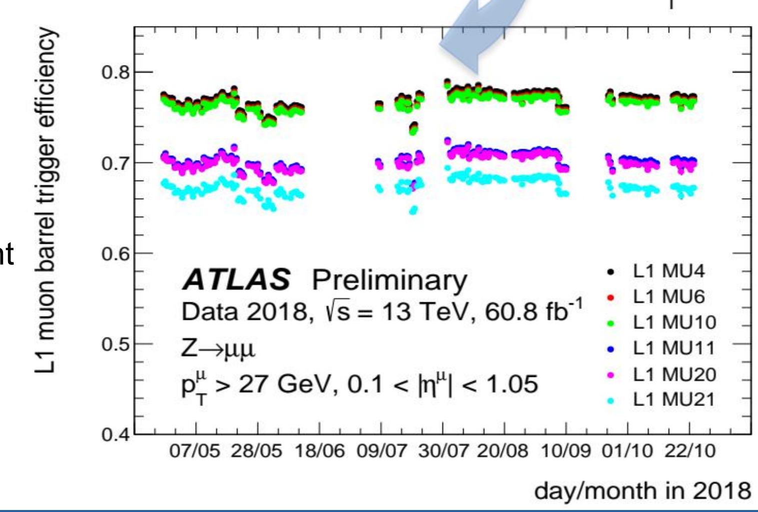
L1 muon barrel trigger efficiency for offline muons as a function of their transverse momentum [4].

- efficiencies are measured using a tag-and-probe method with candidates
- efficiencies for the low p_T trigger thresholds (MU4, MU6, MU10) reach a plateau of about 78%
- efficiencies for high p_T trigger thresholds (MU11, MU20, MU21) rise to around 68% [1]

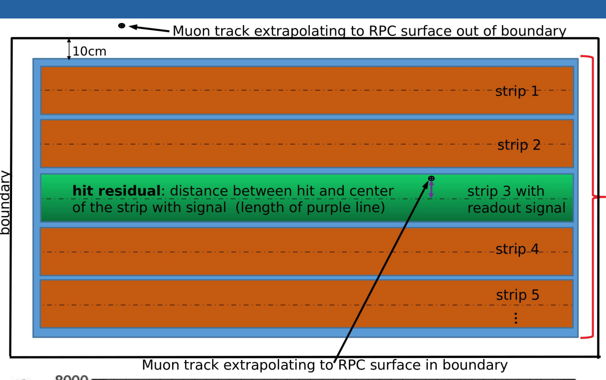


Plateau value of the L1 muon barrel trigger efficiency for offline muons as a function of time [4].

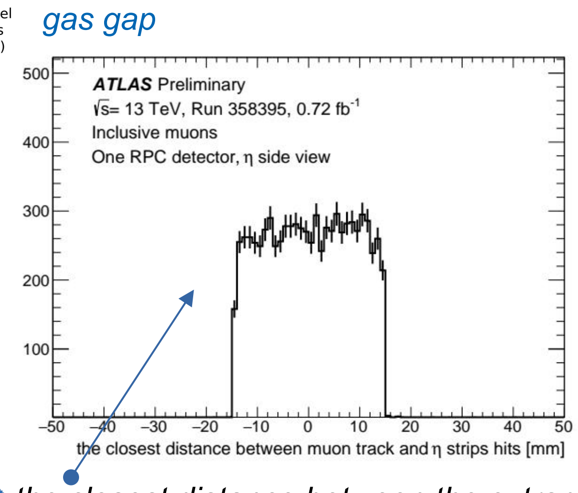
- each point corresponds to a different ATLAS run recorded in 2018
- only runs with integrated luminosity greater than 50 pb^{-1} are used



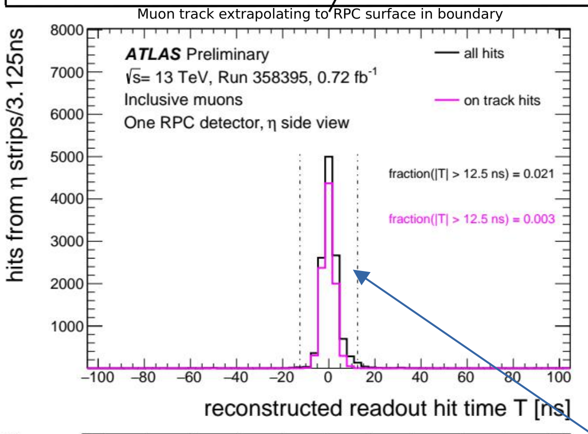
Performance in one detector gas gap

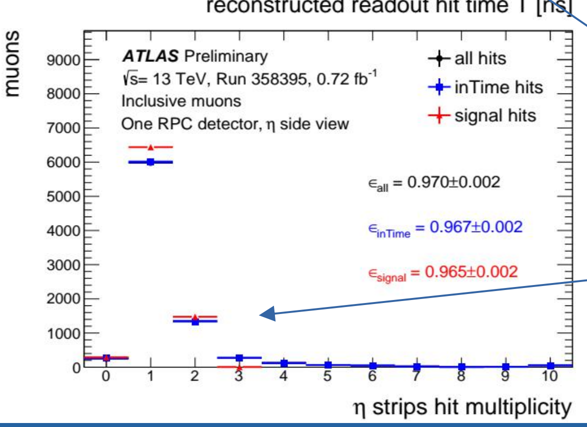


- *all muon tracks are extrapolated to the RPC surface from MDT detector*
- *only muons with tracks extrapolated inside the boundary are used for the study of this gas gap*



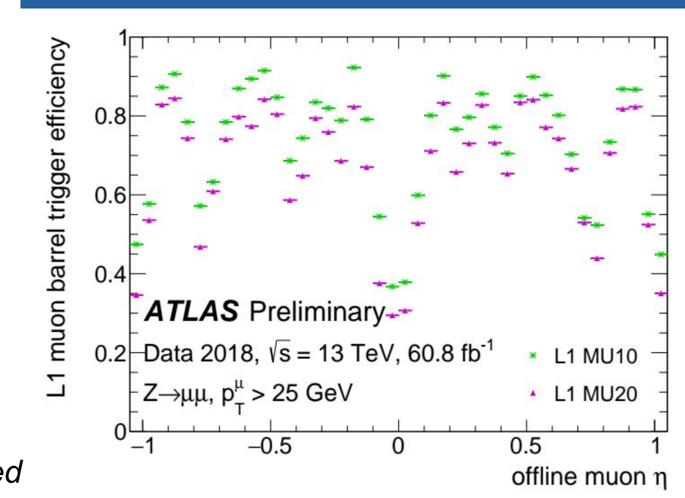
- *the closest distance between the extrapolated muon track position and hits (d) from η strips*

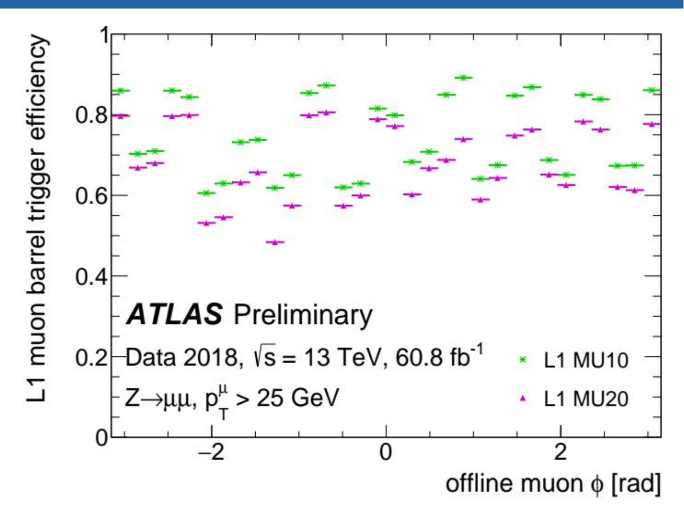




- *reconstructed readout hit time (T) for η strips*
  - the time is calibrated by the triggered bunch crossing but without offline calibration
  - on track hits: hits with |d| < 30 mm
- *hit multiplicity for three selections of hits*
  - all hits: all recorded RPC readout hits
  - inTime hits: all hits with |T| < 12.5 ns
  - signal hits: inTime hits with |d| < 30 mm

Trigger efficiency vs. offline muon η and φ

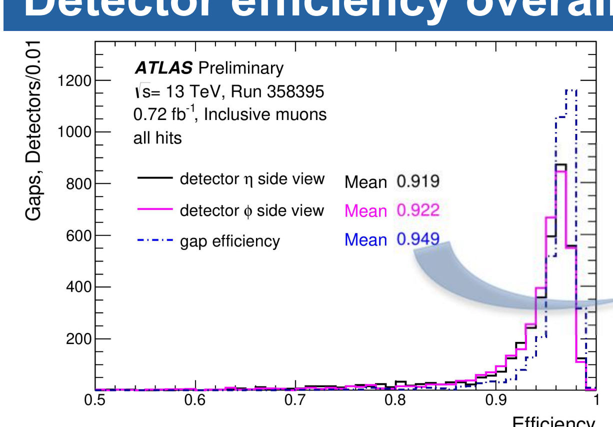




Level 1 muon barrel trigger efficiency for offline muons with p_T > 25 GeV as a function of η (left) and φ (right) coordinates [4].

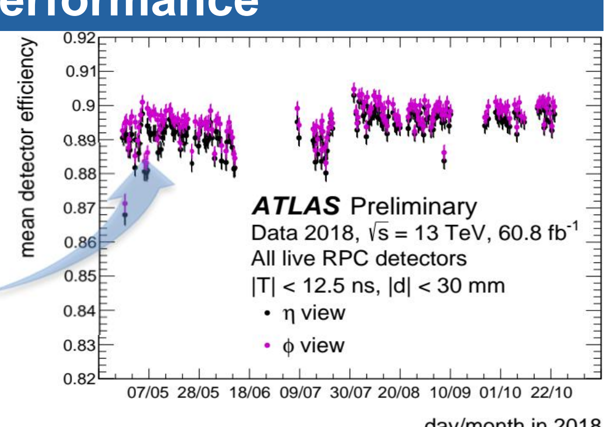
- efficiencies for trigger threshold MU10 (low p_T) and trigger threshold MU20 (high p_T)
- the left plot shows a lower trigger efficiency in regions where the detector coverage is lower due to the barrel toroid mechanical structures
- the regions with lower efficiency around ϕ = -2 and ϕ = -1 in right plot correspond to the "feet" structures that support the ATLAS calorimeters, in which the muon chamber coverage is reduced

Detector efficiency overall performance



Distribution of the RPC "gap efficiency" of each gas volume and the "detector efficiency" for each strip panel in η and φ view.

- "gap efficiency": the presence of hits on at least one of the two strip panels
- "detector efficiency": the presence of hits in the related strip panel



Mean detector efficiency as a function of time in η view and φ view of all live RPC panels.

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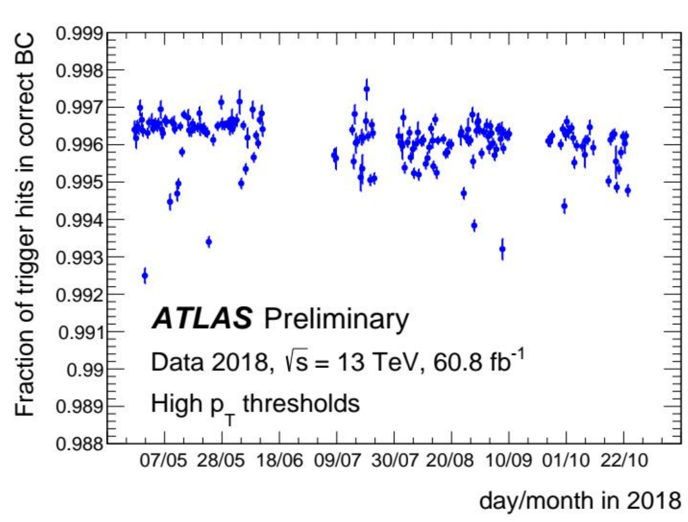
Trigger timing performance



Fraction of RPC high-pT trigger hits associated correctly to the collision Bunch Crossing(BC) for the whole RPC trigger system as a function of time [4].

- each point corresponds to a different ATLAS run recorded in 2018
- only runs with integrated luminosity greater than 50 pb^{-1} are used
- the fraction of high p_T muons associated to the correct BC is 99.6% [1]

[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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