RPC Performance and Calibration Plans for 2017 Commissioning

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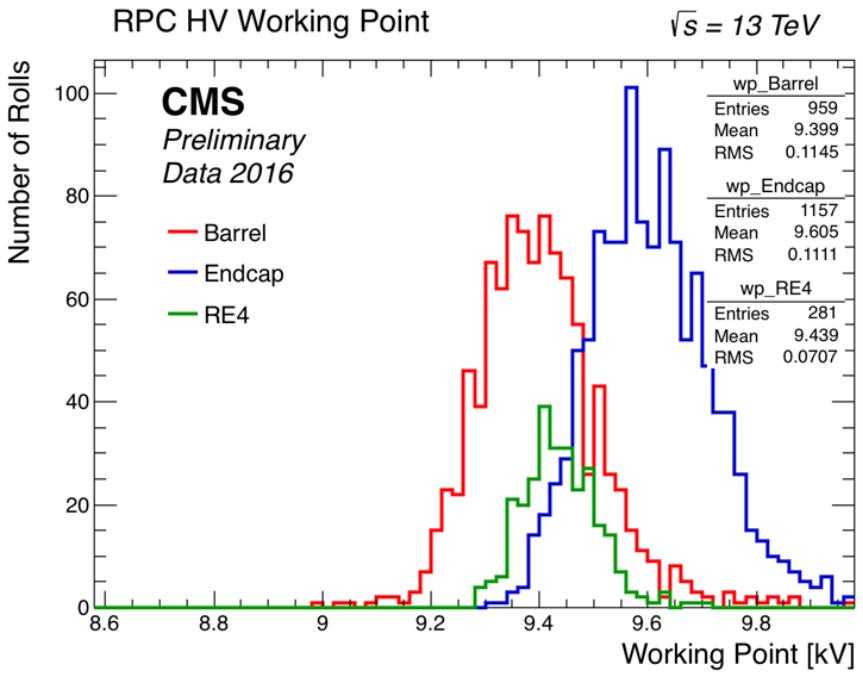
On behalf of the RPC DPG

CMS Run & DPG Commissioning Workshop

24-26 January 2017 – Torino, Cavallerizza Reale

Table of contents:

RPC Detector Performance during 2016 – HV Scan
Evaluation of the New Working Points



Newly evaluated HV WP for RPC during 2016:

Excluded from the analysis:
missing extrapolations from other muon detectors and hardware problems like chambers OFF or rolls with higher number of inactive strips.

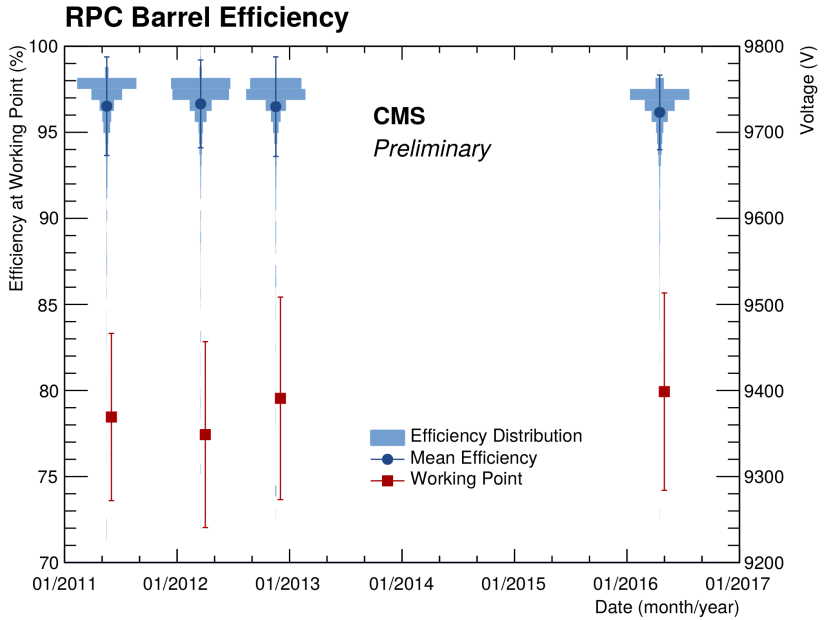
Clean sample, containing approx. 90% of the rolls - is quite representative.

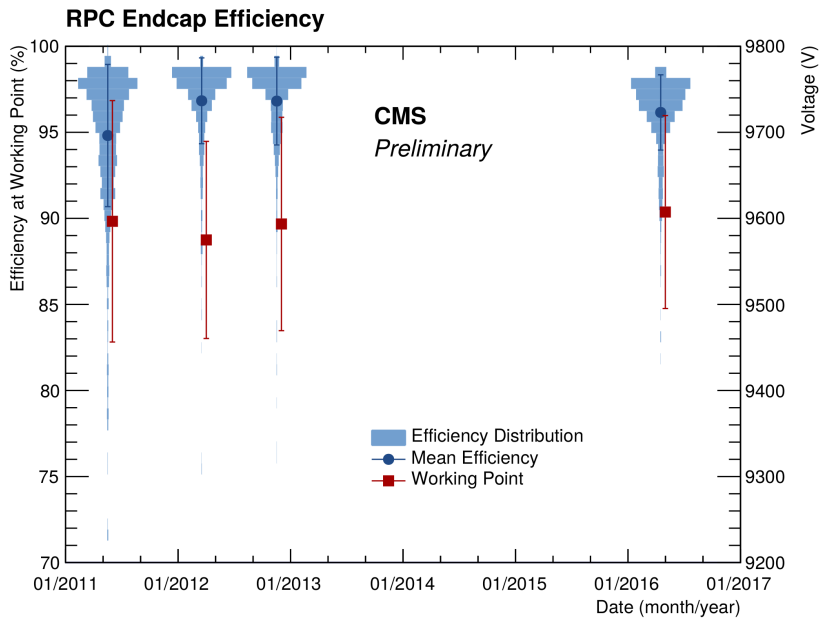
HV Scan – Details:
Run 272818
RPCMonitor stream
Inst. Luminosity ~ 0.82 x 10^{33} $cm^{-2}s^{-1}$

The red sample represents the working point distribution of 959 Barrel rolls.
The blue sample represents the working points of 1157 rolls of the old Endcap RE1, RE2 and RE3 stations.
The green sample represents the working point distribution of 281 rolls in the lately installed forth muon station RE4.

RPC Detector Performance during 2016 – HV Scan Detector Stability

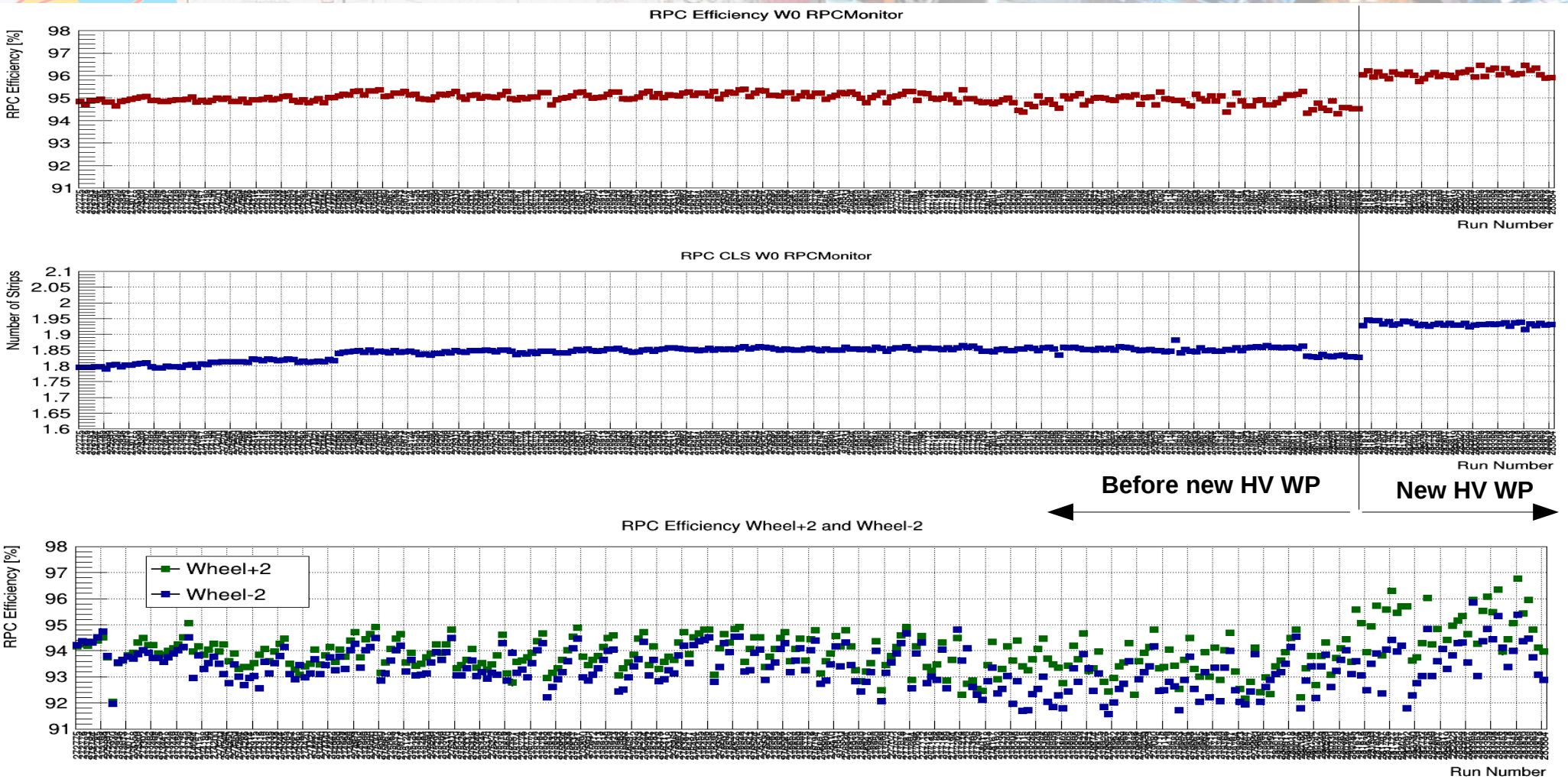
HV Scans history - RPC system is stable within the years





Efficiency at working point, evaluated from different HV Scans in the years for Barrel (left) and Endcap (right)
With a blue, full circle is presented the mean efficiency at WP for each of the HV scans.
With symmetric bars is presented the efficiency working points distribution rotated to +/-90 degrees.
The whiskers (thin, dashed lines) represent the outliers, the tail of the efficiency working points distribution greater than 25% of the central distribution.
By red, full squares is represented the mean of the working point distribution for each HV scan with their RMS.

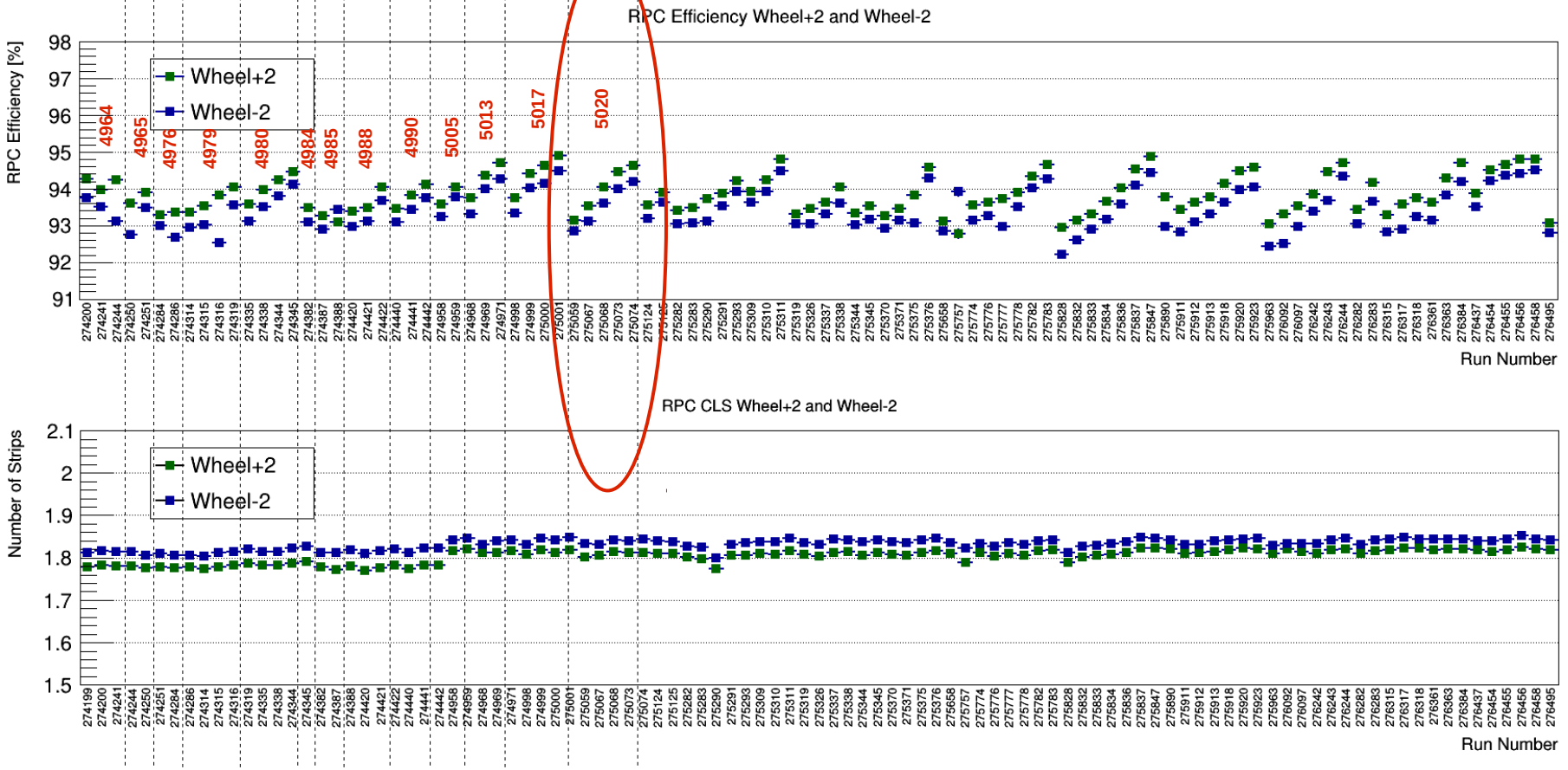
RPC Barrel Efficiency and Cluster Size History



Plots – Efficiency history for Wheel 0 (upper plots); Cluster Size history for Wheel 0 (plot in the middle); Efficiency history for Wheels +-2

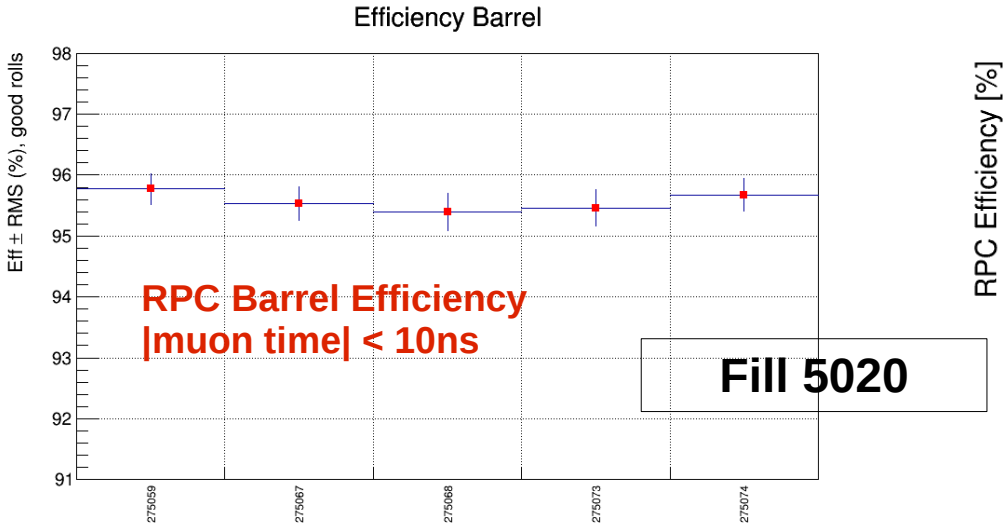
- Deployment of the new HV WP - efficiency increases with 1% in average; Cluster size in also increases slightly
- Observed **efficiency variations – Z dependence**, i.e. larger effect is observed at higher Z;

Efficiency Variations within the Fill

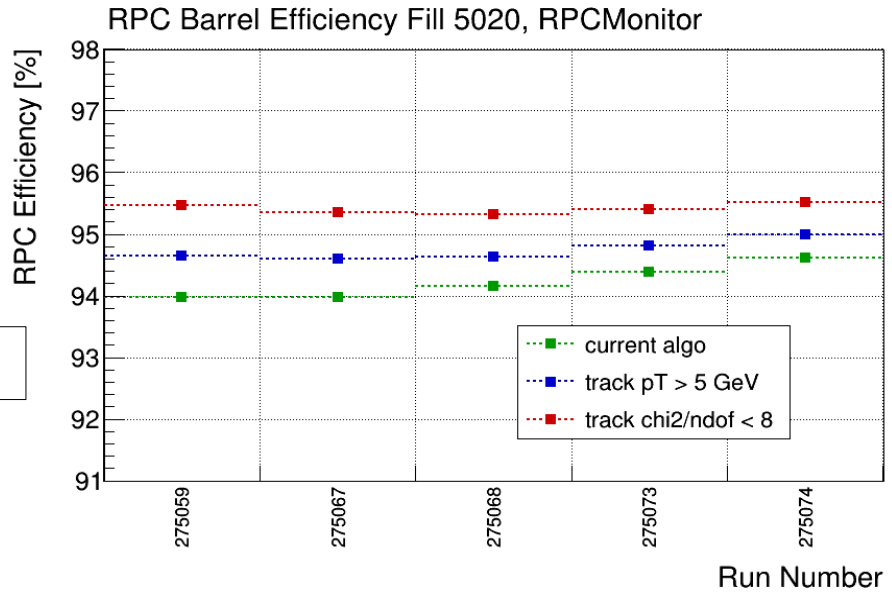


- Efficiency variations – efficiency increases in the end of the fill;
- Considered example: fill 5020, L = [5.3, 8.7] x 10^{33} $cm^{-2}s^{-1}$ – moderate instantaneous luminosity;
- The efficiency variations are within 1-2% per fill and seems to be algorithm related;
- Work in progress – new analysis strategy – reject the “fake” standalone tracks, using timing and/or quality selection;
- Work in progress – investigation of the possible dependence on the ambient temperature.

Efficiency with muon time and muon track selection
Work in Progress



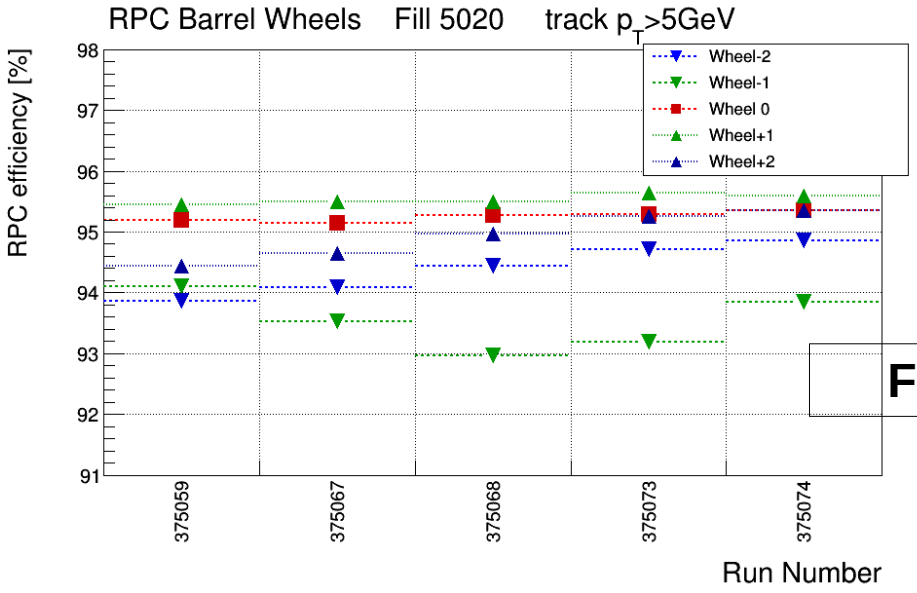
RPC timing is currently stored in reco::Muons as an average of "times" measured by all RPC hits assigned to a muon track.
More details in the presentation from Camilo Carrillo here:
https://indico.cern.ch/event/598602/contributions/2430256/attachments/1394048/2124511/camilo_rpc_timing_110117.pdf



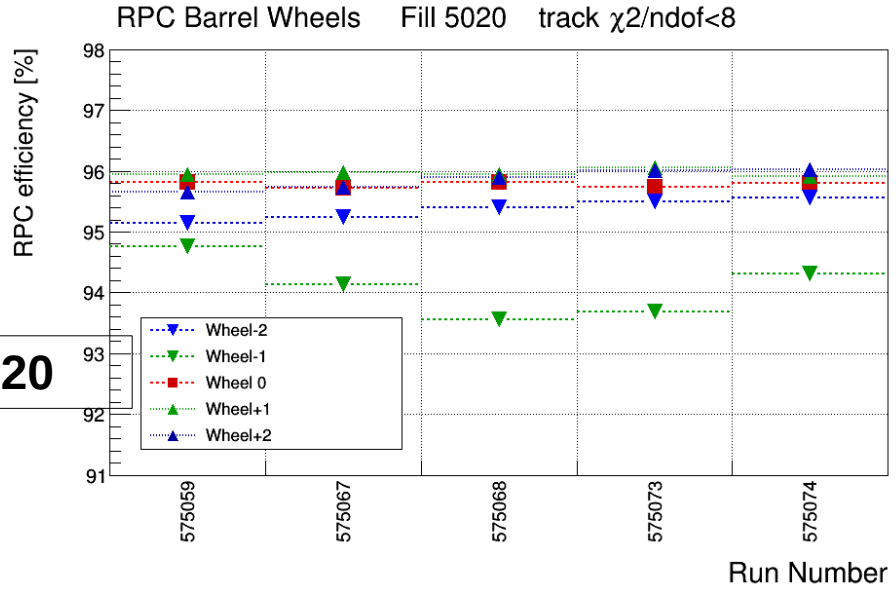
RPC Barrel efficiency using different standalone track selections

- **Using the timing cut the dependence on the inst. luminosity disappear or decrease significantly. Also the evaluated efficiency increases with more than 1 %;**
- **The cut of pT>5GeV for the muon tracks reduces the same dependence negligible, but as a whole the estimated efficiency increases with 1-2%**
- **Selection of the standalone tracks with normalized chi2/ndof improve the efficiency, for the barrel the dependence on the luminosity is disappearing, for the endcap – a clear decrease of the effect is observed; The efficiency increases with ~ 1%**

Efficiency with muon time and muon track selection
Work in Progress - Z dependence



Fill 5020



Selection of the standalone tracks with p_T>5GeV:

- Higher efficiency values;
- Moderate decrease of the Z – dependence;

Selection of the standalone tracks with chi2/ndof < 8:

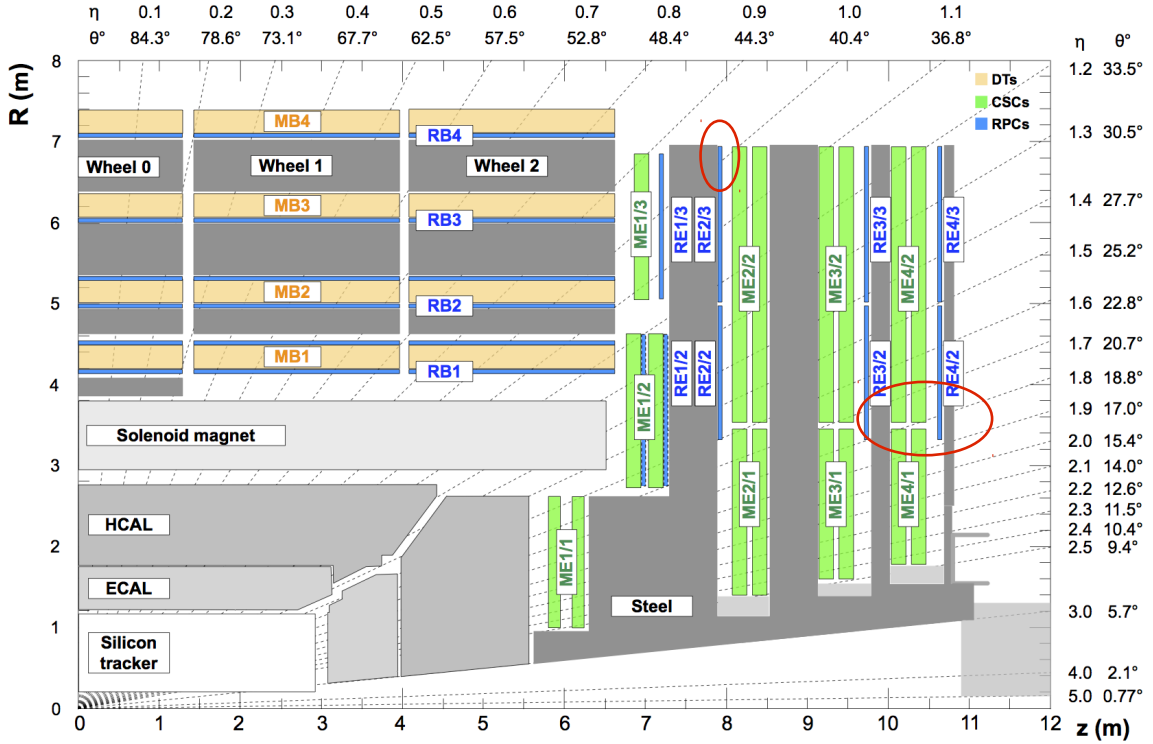
- Significantly reduced efficiency variation within the fill;
- Higher efficiency values;
- Clear decrease of the Z – dependence;

Timing selection for Z dependence – work ongoing

Work in Progress – Evaluate the best selection criteria and reevaluate the RPC Efficiency history for the entire 2016 statistics.

RPC Detector Performance during 2016
Efficiency Algorithms

1.) Segment Extrapolation Method - Extrapolating segments from the near muon detector (DT or CSC);
2.) With Tracker Muon and T&P - Extrapolating segments from the inner tracker; T&P – selection of the muon sample.

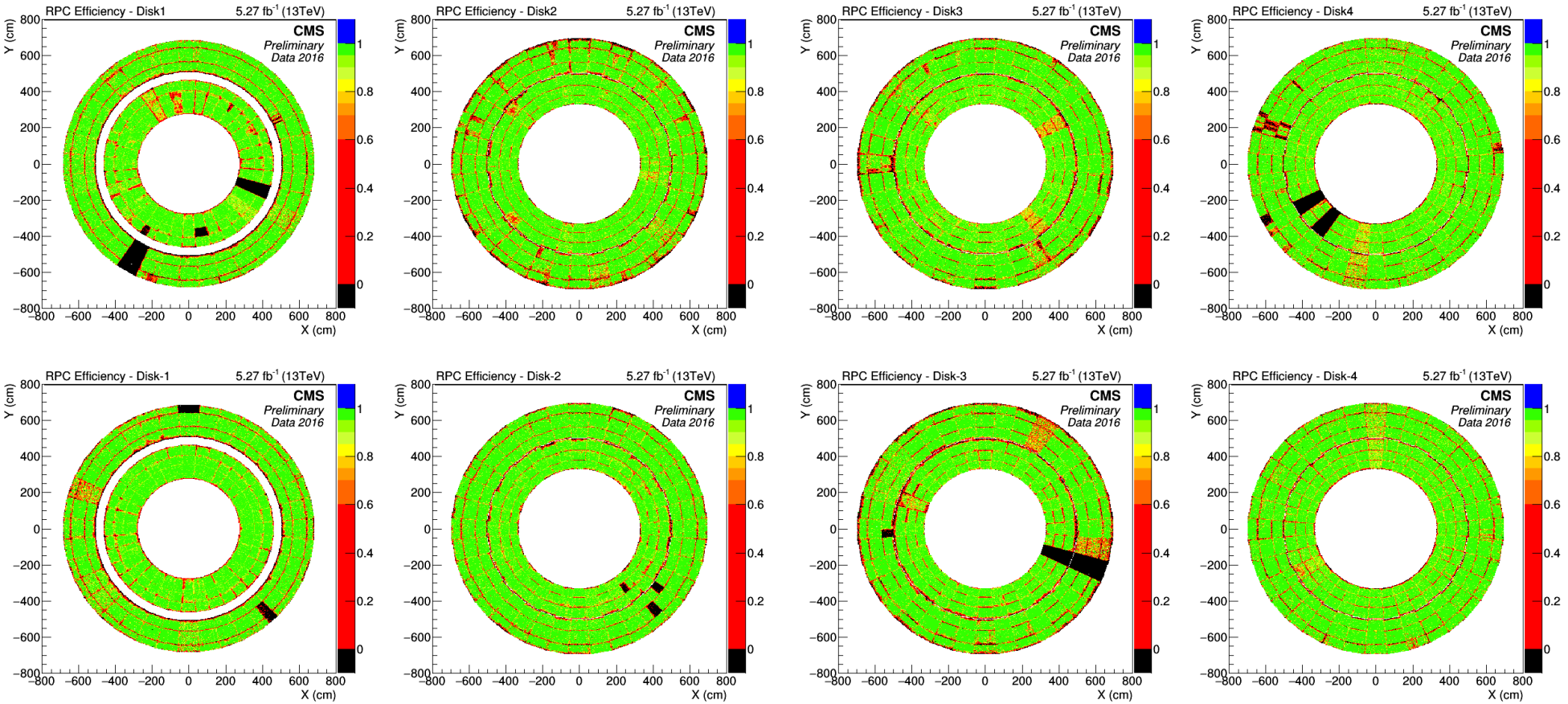


Main motivations for developing the new method:

- Some RPC chambers have less chance to have segment extrapolated points
- From the Run-II, the RPCMuon [1] reconstruction algorithm is included in the standard reconstruction, where the algorithm starts from the inner track and finds matched RPC hits(RPCRecHits) along its trajectory.

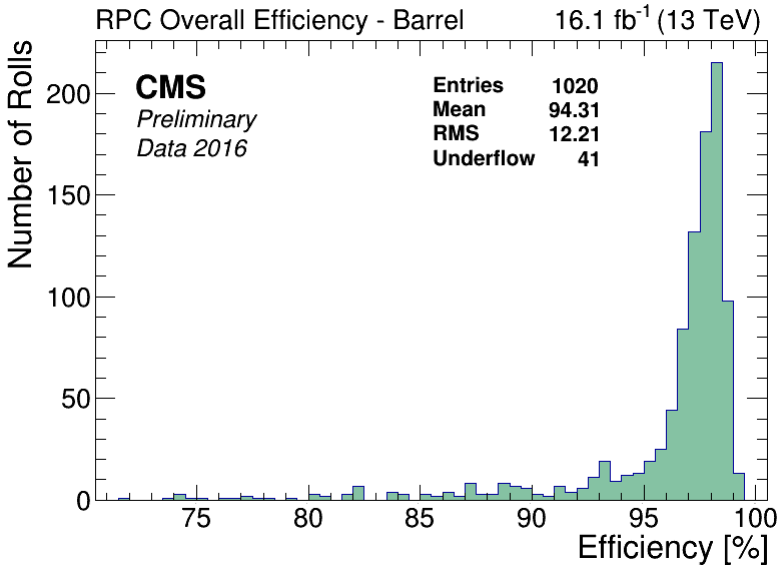
RPC Detector Performance during 2016
New Efficiency Algorithm

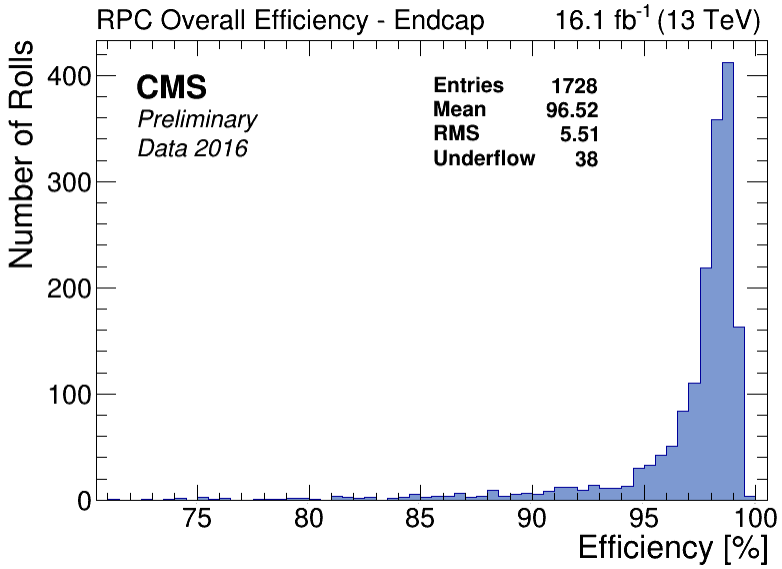
Due to the geometrical reasons (mainly in |η| > 1.6), some RPC rolls have less chance to have segment extrapolated points;
This problem is resolved with T&P method.



T&P Efficiency in Endcap: White: no extrapolation, Black: no RPC hit (LV problems)

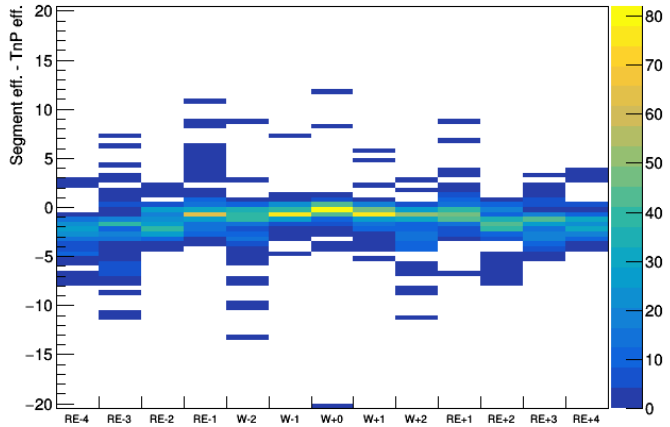
RPC Detector Performance during 2016
Overall Efficiency





RPC Overall efficiency with Tracker muons for Barrel (left) and Endcap (right)

- **two independent methods - 1% level of agreement;**
- **higher efficiency with TnP;**
- **z-dependency of efficiency difference;**
- **T&P method is convenient for larges statistics; Segment extrapolation – convenient for run per run analysis.**



Preparation for 2017 Data Taking
Status and Ongoing work

Main DPG Efforts – Software for unpacking the RPC digis from the muon supper primitives:

New Condition format – following the new hardware architecture
The format is originally developed for unpacking the RPC digis from TwinMux data.
With some minor modifications the format is also compatible for OMTF and CPPF – work in progress;

PR 16106 (for 8_1_X), automatically ported to PR 16638 (for 9_0_X)
On 22 Nov 2016: This pull request is fully signed and it will be integrated in one of the next CMSSW_9_0_X IBs (tests are also fine).
This pull request requires discussion in the ORP meeting before it's merged.

It is crucial to have the new Data Format in CMSSW in order to proceed with the further steps:

- Unpacking RPC digis from TwinMux – the code is ready and currently is ran “by hand”;
- Validation package RPC digis (legacy trigger) vs RPC digis(unpacked from TwinMux) – the code is ready – currently is ran “by hand”;
- Developing the unpackers for OMTF and CPPF – work in progress;
- Validate the available DQM histograms with the new input collection (unpacked RPC digis).

Preparation for 2017 Data Taking
Data Tiers and Streams

MWGR and Cosmics – Express Stream (FEVT), having RPCMonitor (RAW) will be nice, but not necessary

Collision data taking - RPCMonitor (RAW)
Event size:
<= 30 kB/event - Average Uncompressed Size
<= 3kB/event Average Compressed Size
Reduced to the minimal necessary information for the RPC detector analysis: hltMuonCSCDigis, hltMuonDTDigis, hltMuonRPCDigis, hltCscSegments, hltDt4DSegments, hltRpcRecHits, TriggerResults, TriggerEvent.

Efficiency estimation with T&P method - SingleMuon(AOD)

Summary

- **During the 2016 data taking period the RPC system performed well;**

- **Deployment of higher HV WP led to higher efficiency with about of 1% mainly in the barrel and slightly increase of the cluster size;**

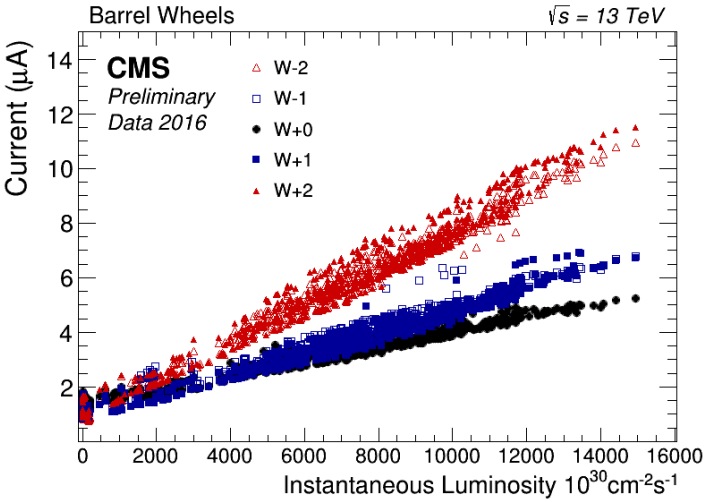
- **Detector performance and analysis:**
  - The observed efficiency variations show clear Z dependence and are rather algorithm related;
  - Applying different selection criteria we can reduce the observed variations and also to improve the efficiency evaluation with few %;

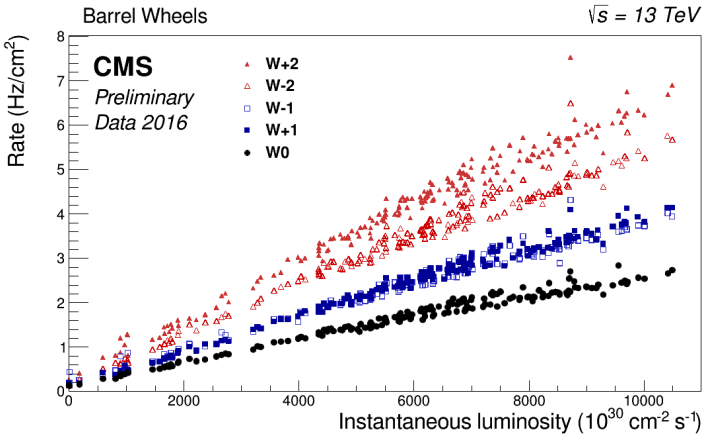
- **The new RPC efficiency algorithm have been developed;**
  - The new algorithm shows that the regions, problematic for efficiency evaluation with the segment extrapolation method, are efficient and well performing;

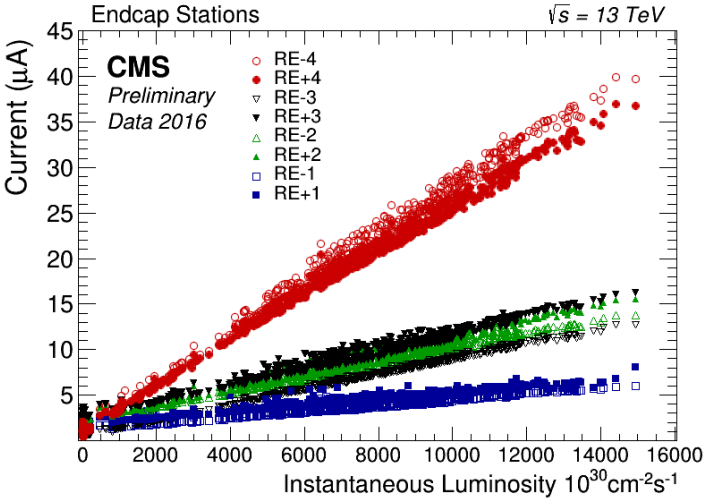
- **Preparations for 2017 data taking:**
  - We need the new Condition format to be included in the official CMSSW.

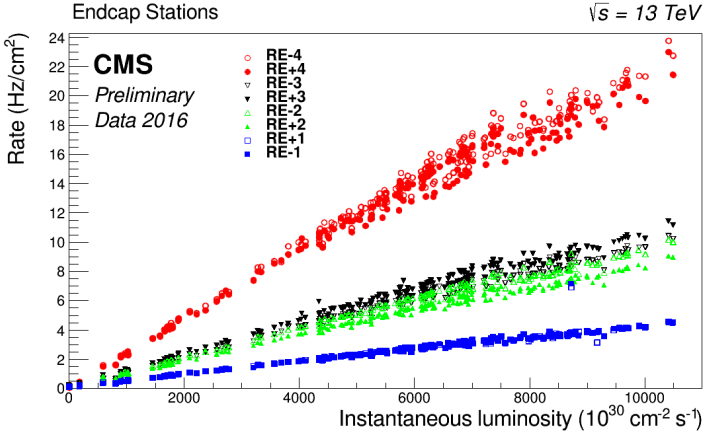
Backup Slides

Rates and Currents vs Inst. Luminosity



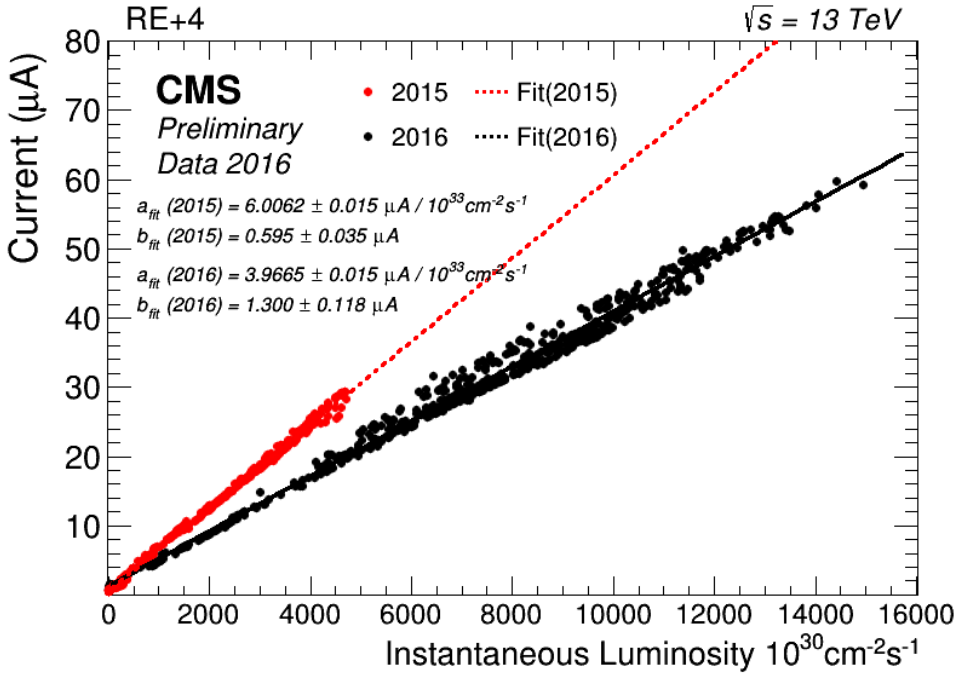


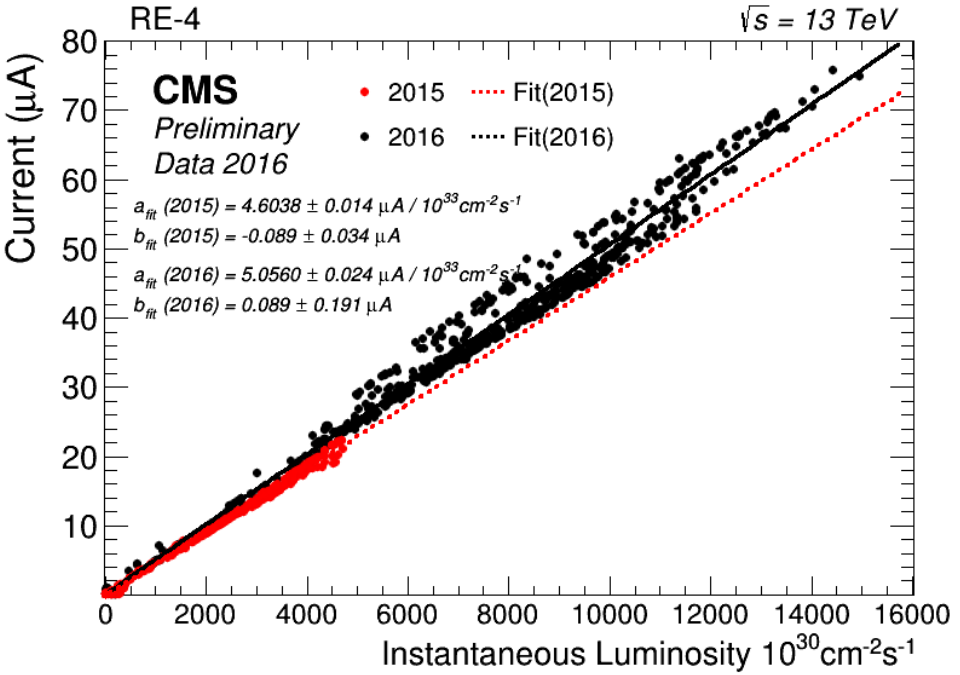




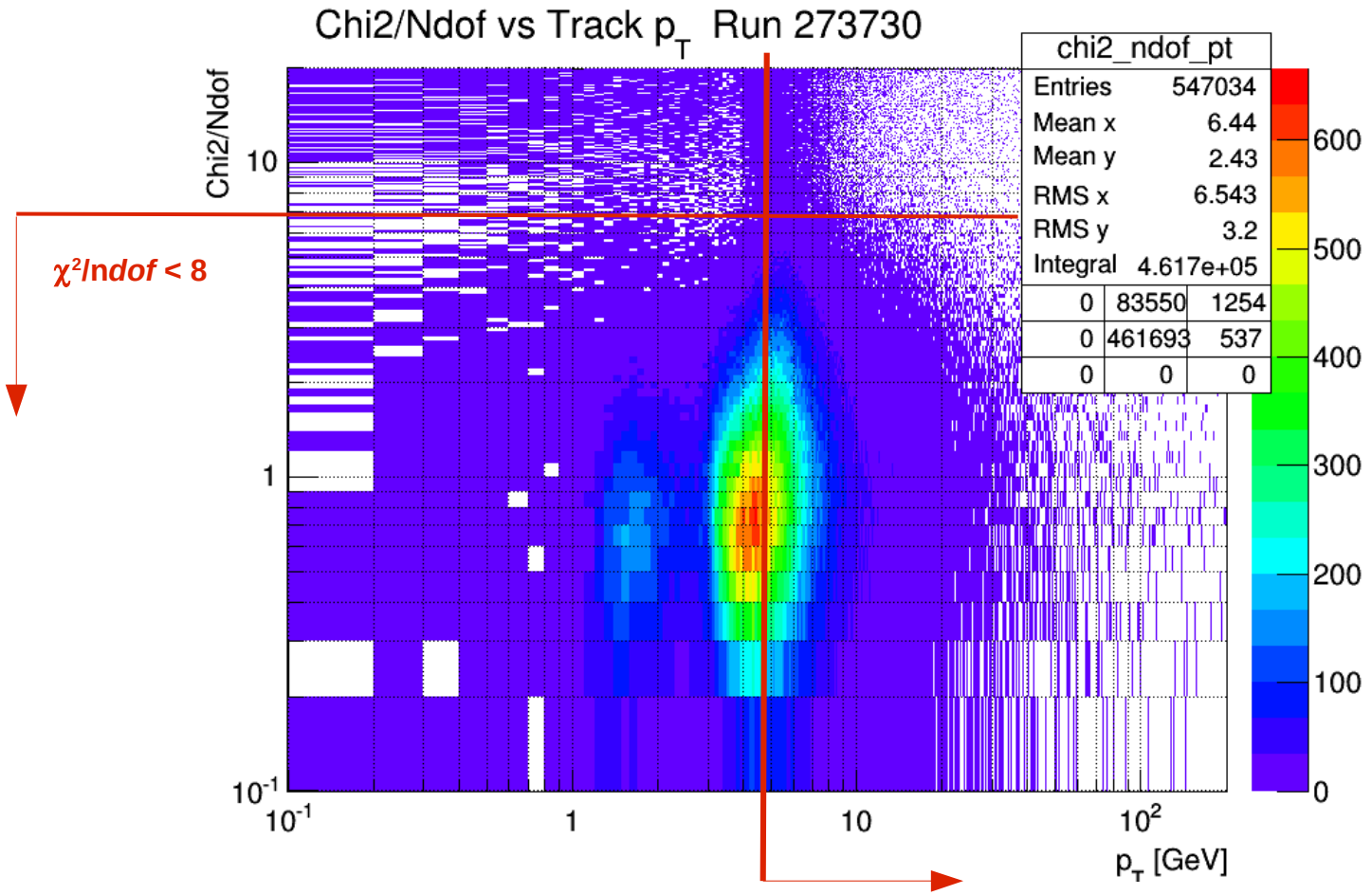
2016 RPC Barrel currents and background hit rate dependence on LHC instataneous luminosity: The plots represent the dependence of the monitored current (on the left) and the measured hit rate (on the right) on the LHC luminosity for all 5 barrel wheels. The currents and rates have been measured during 2016 pp collision data taking. Both parameters are averaged for a Barrel wheel which is an object along Z. The current and rate values are lowest in the central Barrel wheel (W0) and are increasing progressively away from the interaction point. The installation of the new shielding on the positive Rotating Shielding (RS) and HF platform on both ends in March 2016 changed the background distribution in the UXC cavern inducing a small asymmetry between the positive and negative end. Despite the positive effect of the RS shielding, the currents and rates in the outer wheels, caused by the higher cavern background, are still higher than the central part of the CMS detector.

Rates and Currents vs Inst. Luminosity
Effect of the new Shielding

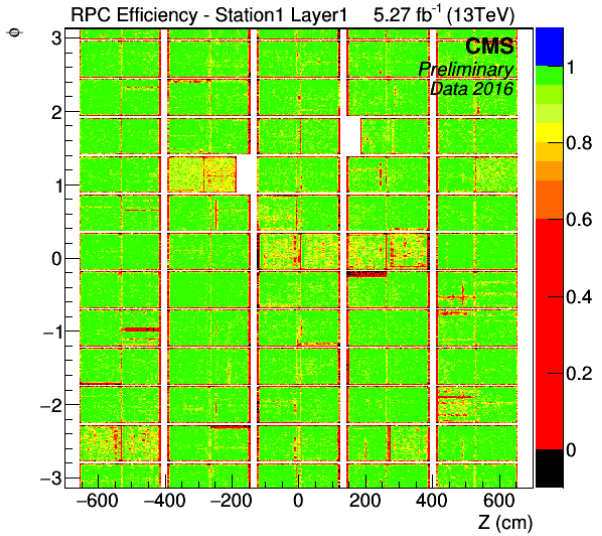


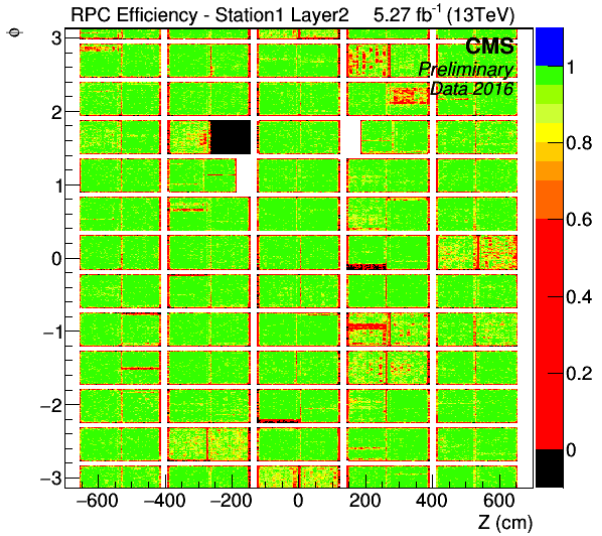


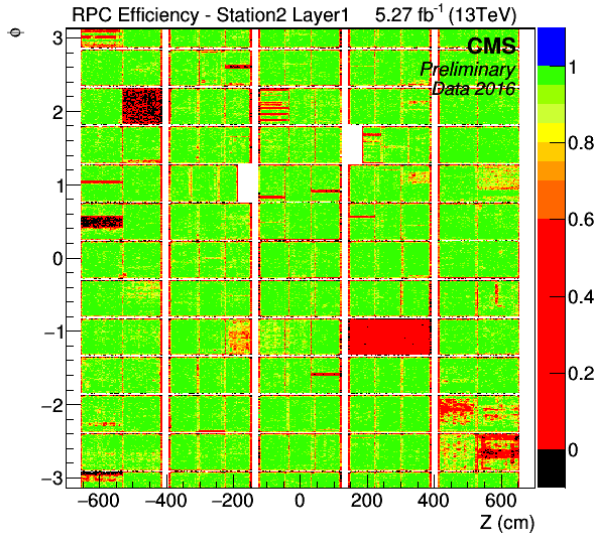
Have a look on the input data
RPCMonitor stream – RAW
Segments are requested to belong to standalone track, no further selection

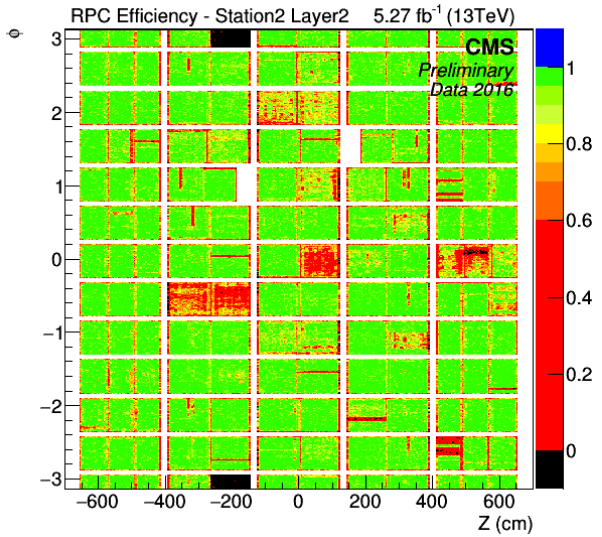


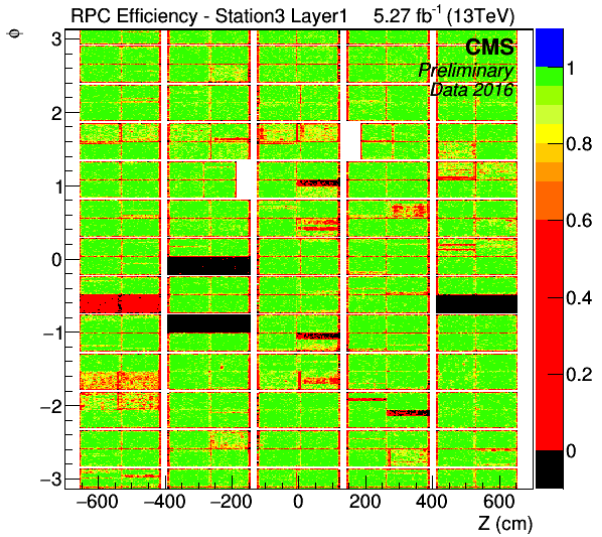
Mainly soft muons, probably coming from Upsilon and small fraction, coming from J/psi.
Standalone muon tracks with p_T > 5 GeV: ~61.5 % of all standalone muon tracks
Standalone muon tracks with χ2/ndof < 8 GeV: ~69 % of all standalone muon tracks

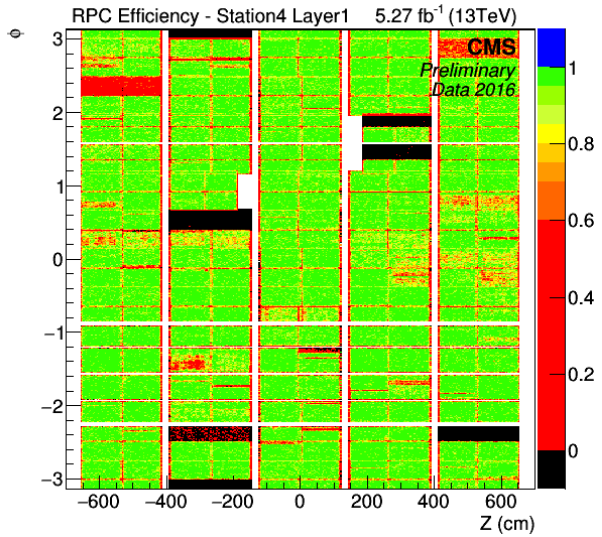

RPC Efficiency - Station1 Layer1 5.27 fb-1 (13TeV)
CMS
Preliminary
Data 2016
Z (cm)


RPC Efficiency - Station1 Layer2 5.27 fb-1 (13TeV)
CMS
Preliminary
Data 2016
Z (cm)


RPC Efficiency - Station2 Layer1 5.27 fb-1 (13TeV)
CMS
Preliminary
Data 2016
Z (cm)


RPC Efficiency - Station2 Layer2 5.27 fb-1 (13TeV)
CMS
Preliminary
Data 2016
Z (cm)


RPC Efficiency - Station3 Layer1 5.27 fb-1 (13TeV)
CMS
Preliminary
Data 2016
Z (cm)


RPC Efficiency - Station4 Layer1 5.27 fb-1 (13TeV)
CMS
Preliminary
Data 2016
Z (cm)