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CMS DP -2012/001

The Compact Muon Solenoid Experiment

CMS Performance Note

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17 February 2012

Performance of the CMS Resistive Plate Chambers (RPC) in 2011

CMS Collaboration

Abstract

RPC performance plots first shown at the RPC2012 conference.

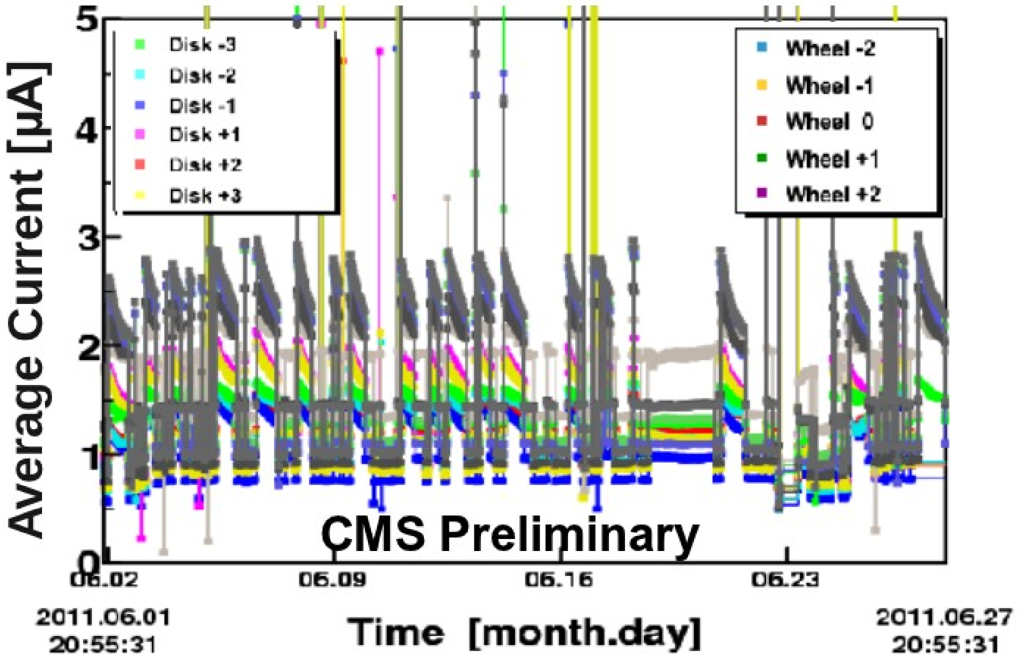
RPC Performance Plots

CMS collaboration

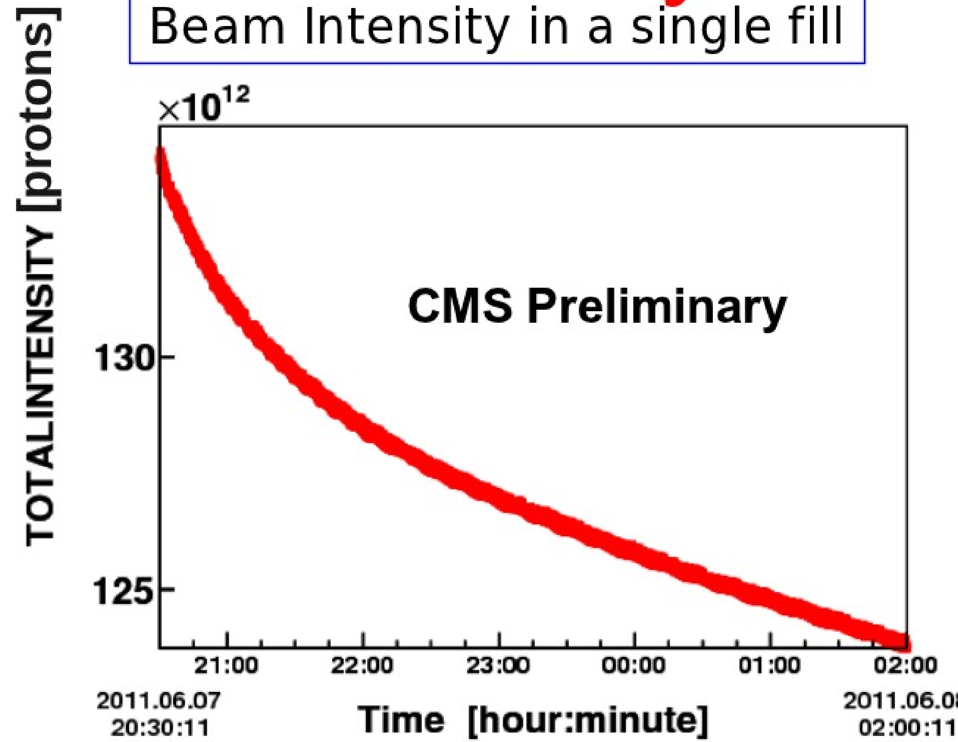
January 30th 2012

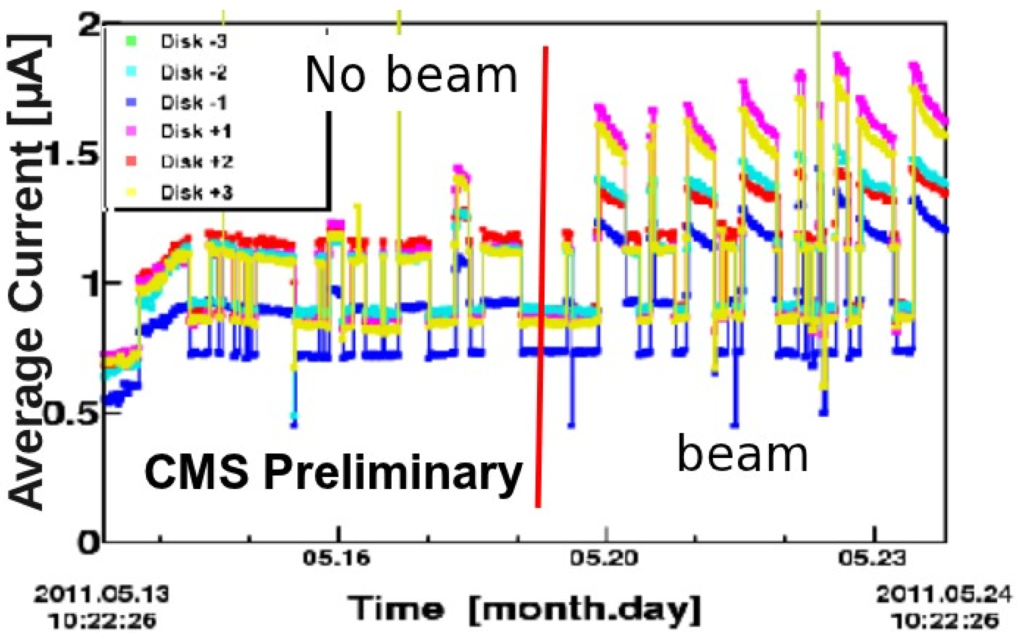
Dark Current Vs Luminosity

Average Current trend .vs. time



Beam Intensity in a single fill





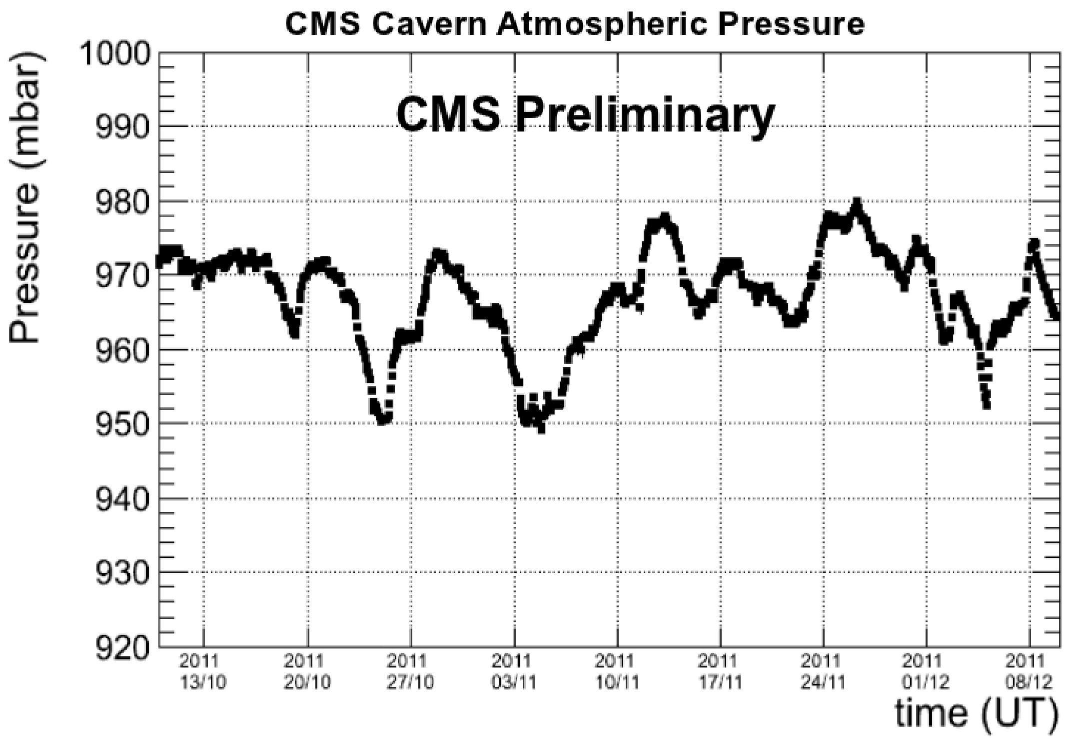
- A clear correlation is observed between the current and the beam intensity, this effect was clear for the high luminosity beam during 2011.

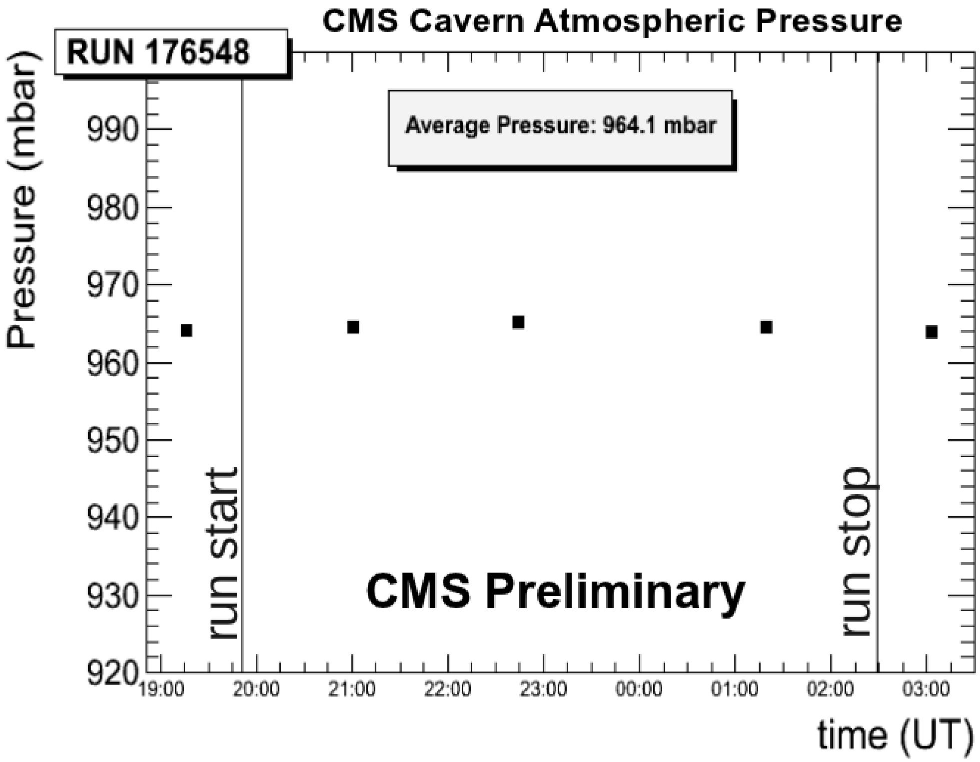
- The dark current, measured without beam is stable in time.

Contact:Pierluigi.Paolucci@cern.ch

HV Working Point Pressure Corrected

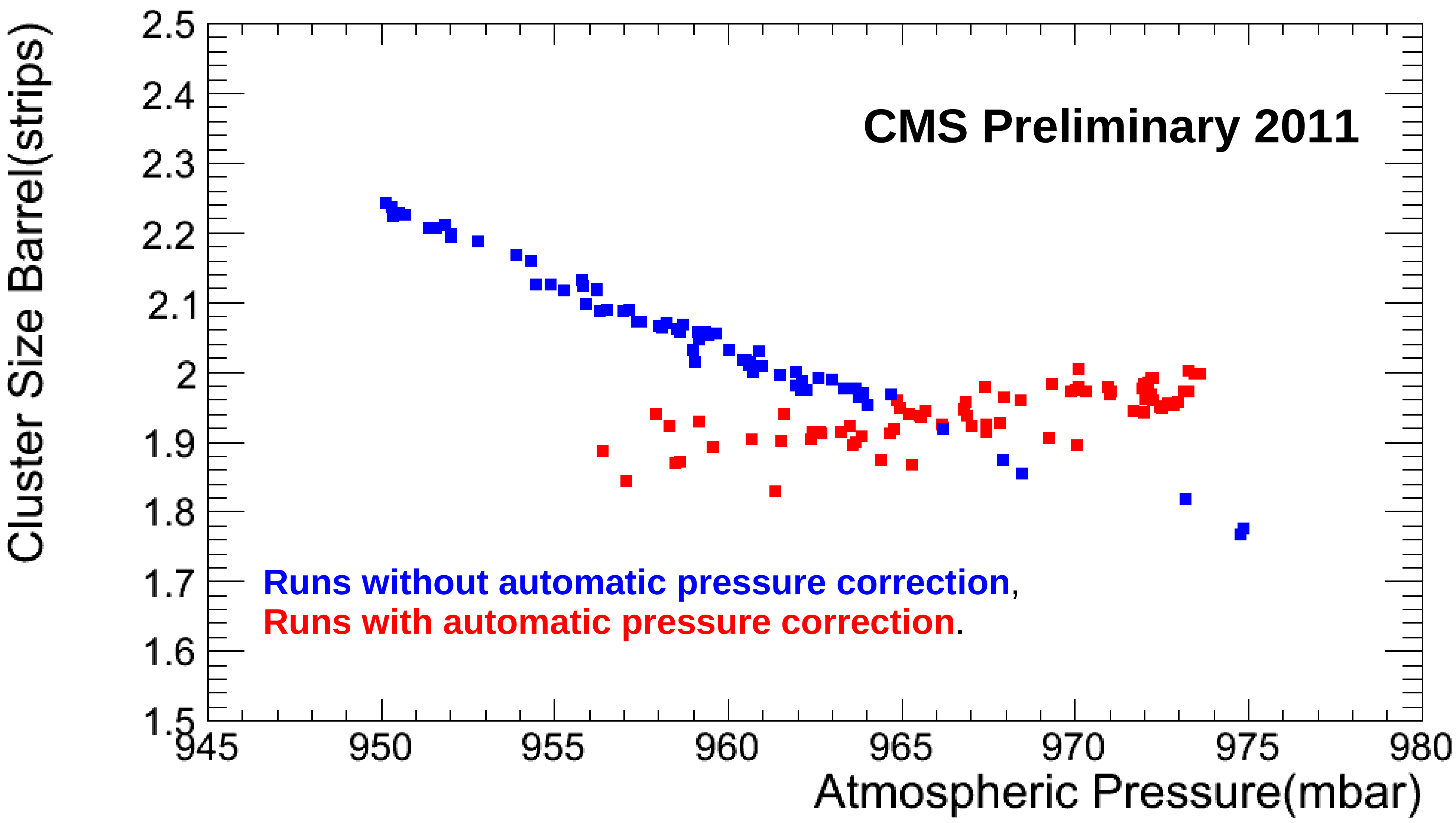
HV working point is calculated taking into account the pressure variations
HV_effective = HV · Po/P · T/To
Po = 965 mbar, To = 293 K
~1% P variation = ~ 100 V difference





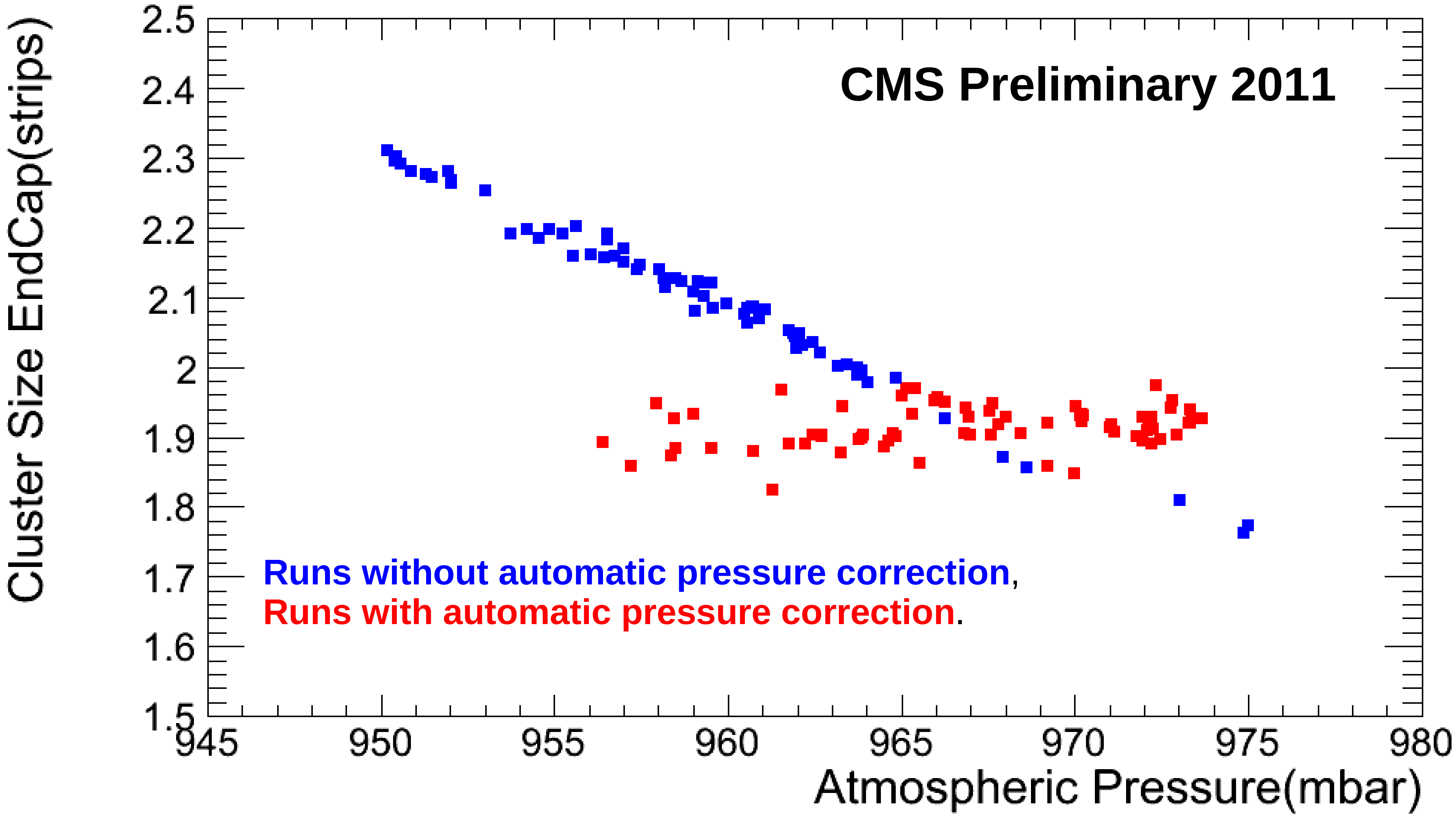
Contact:Umberto.Berzano@cern.ch

Cluster Size and Pressure Correlation Plot RPC Barrel



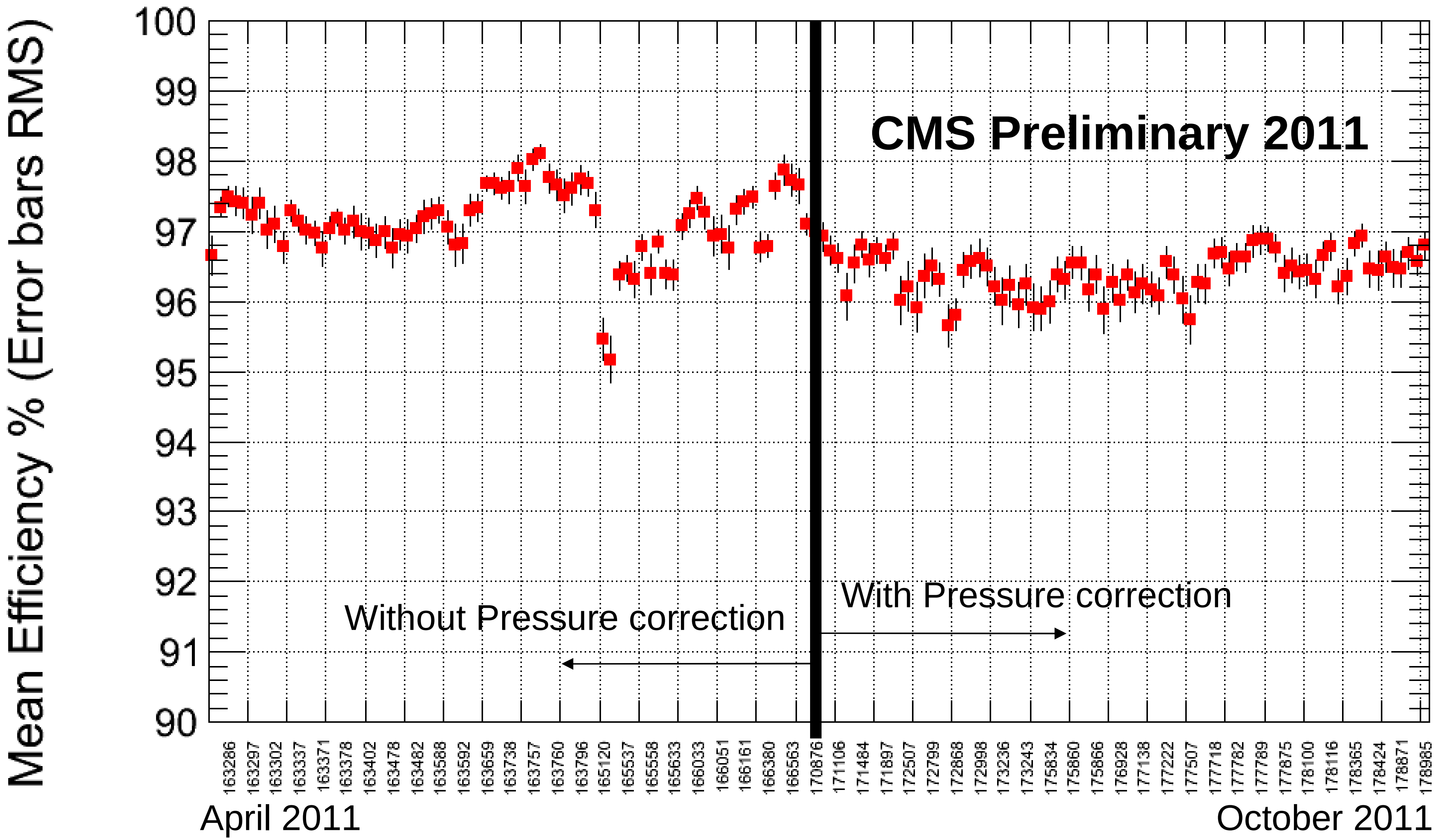
Contact:Camilo.Carrillo@cern.ch

Cluster Size and Pressure Correlation Plot RPC EndCap



Contact:Camilo.Carrillo@cern.ch

Barrel Efficiency History Plot



The plot has been produced with a new method still under validation (a small systematic effect could affect the overall value)

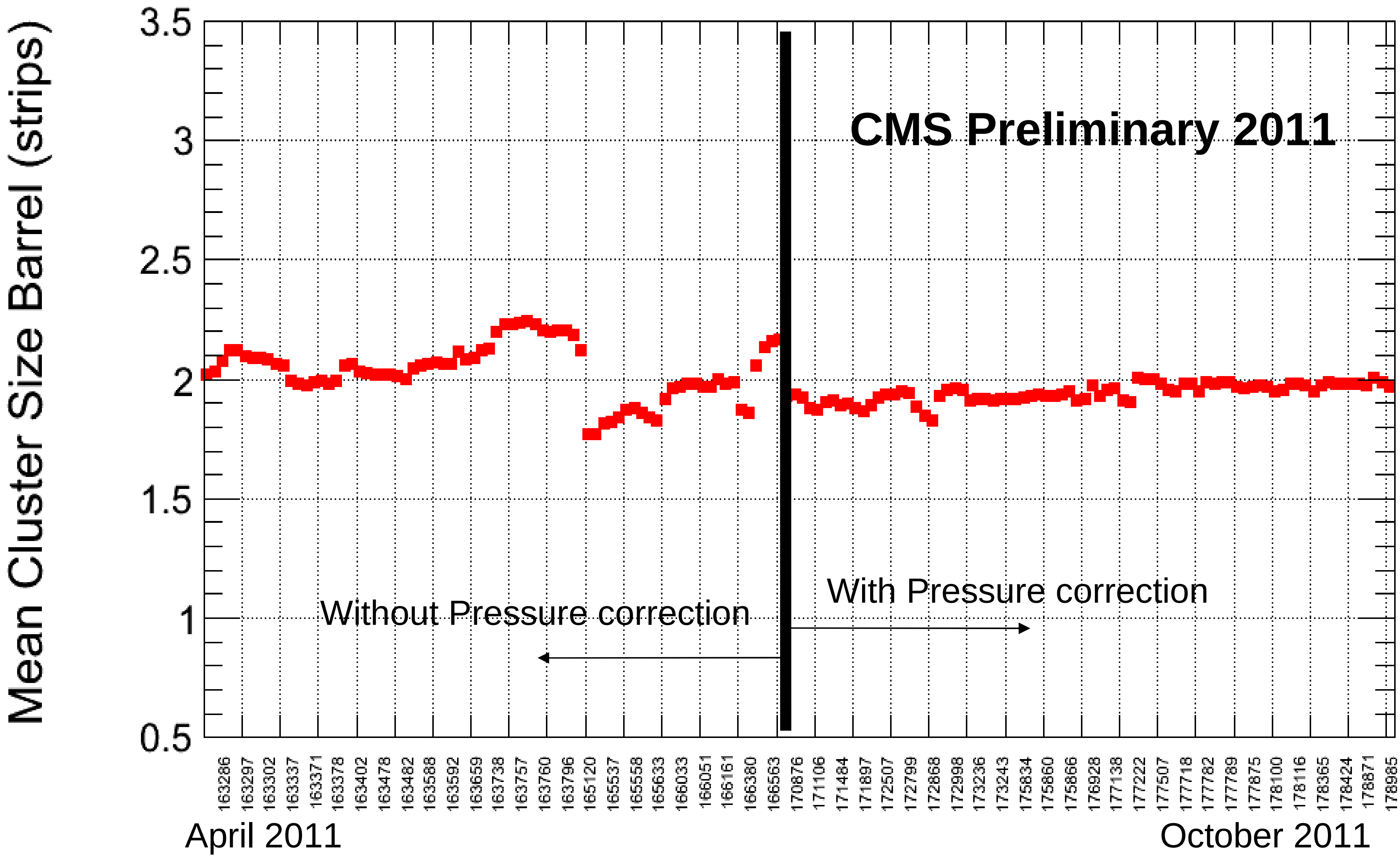
Stability with pressure correction is clear.

Average Efficiency increased with respect to values previously shown, this new efficiency tool is under validation.

Chambers with know Hardware Problems are removed from this plot.

Contact:Camilo.Carrillo@cern.ch, djp@cern.ch

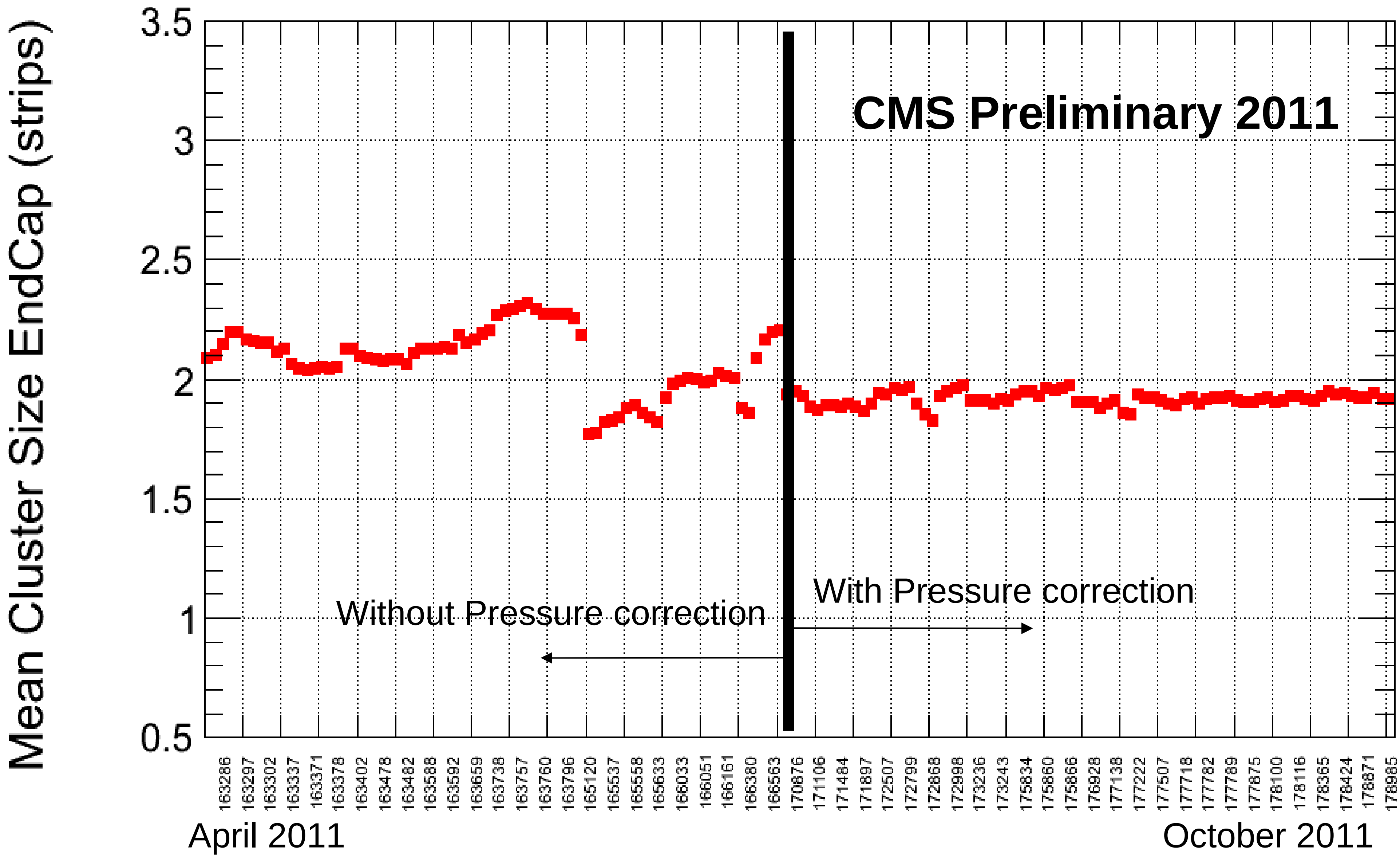
Barrel Cluster Size History Plot



Cluster Size for the Barrel during 2011. The system is more stable after the automatic pressure correction

Contact:Camilo.Carrillo@cern.ch, djp@cern.ch

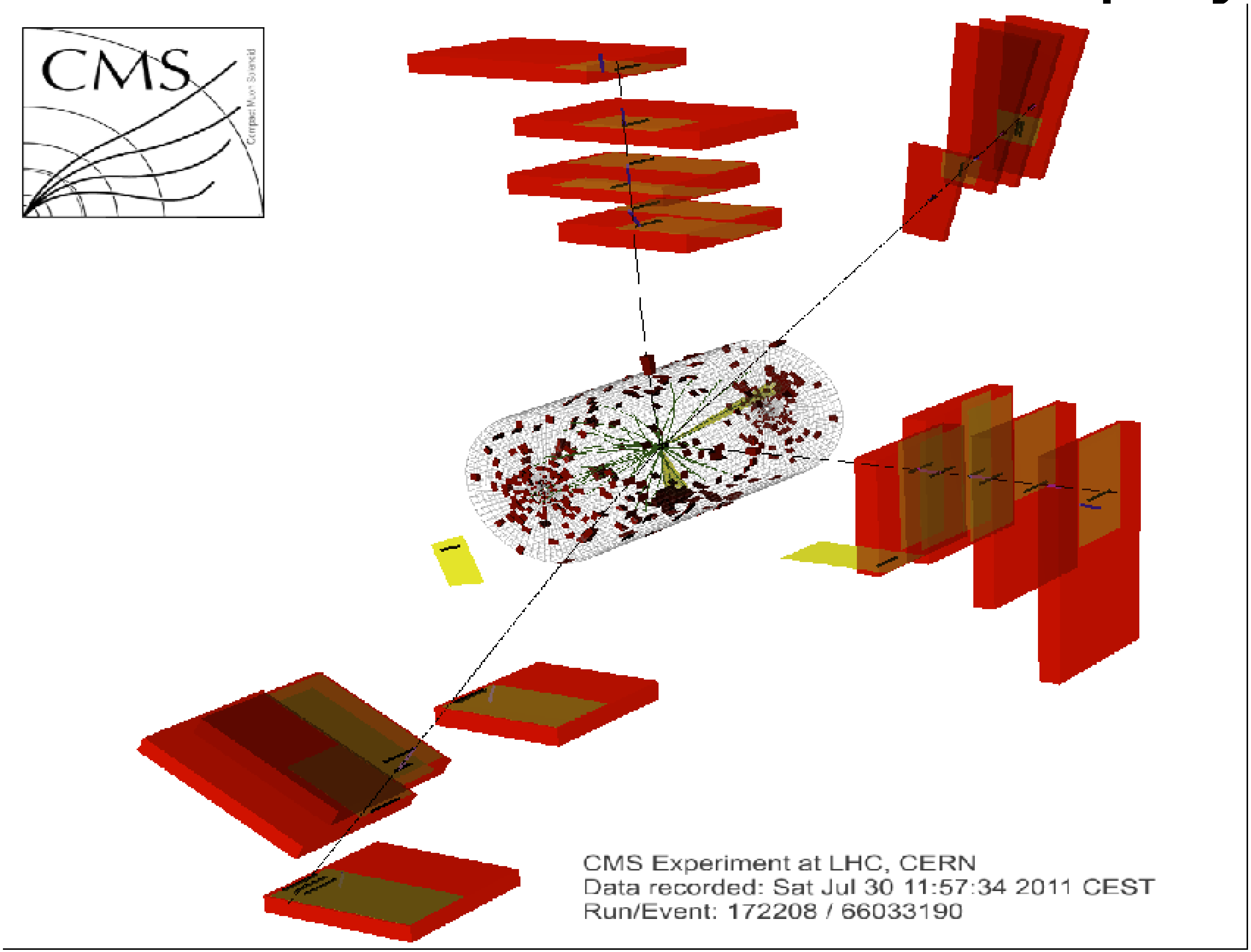
Endcap Cluster Size History Plot



Cluster Size for the EndCap during 2011. The system is more stable after the automatic pressure correction

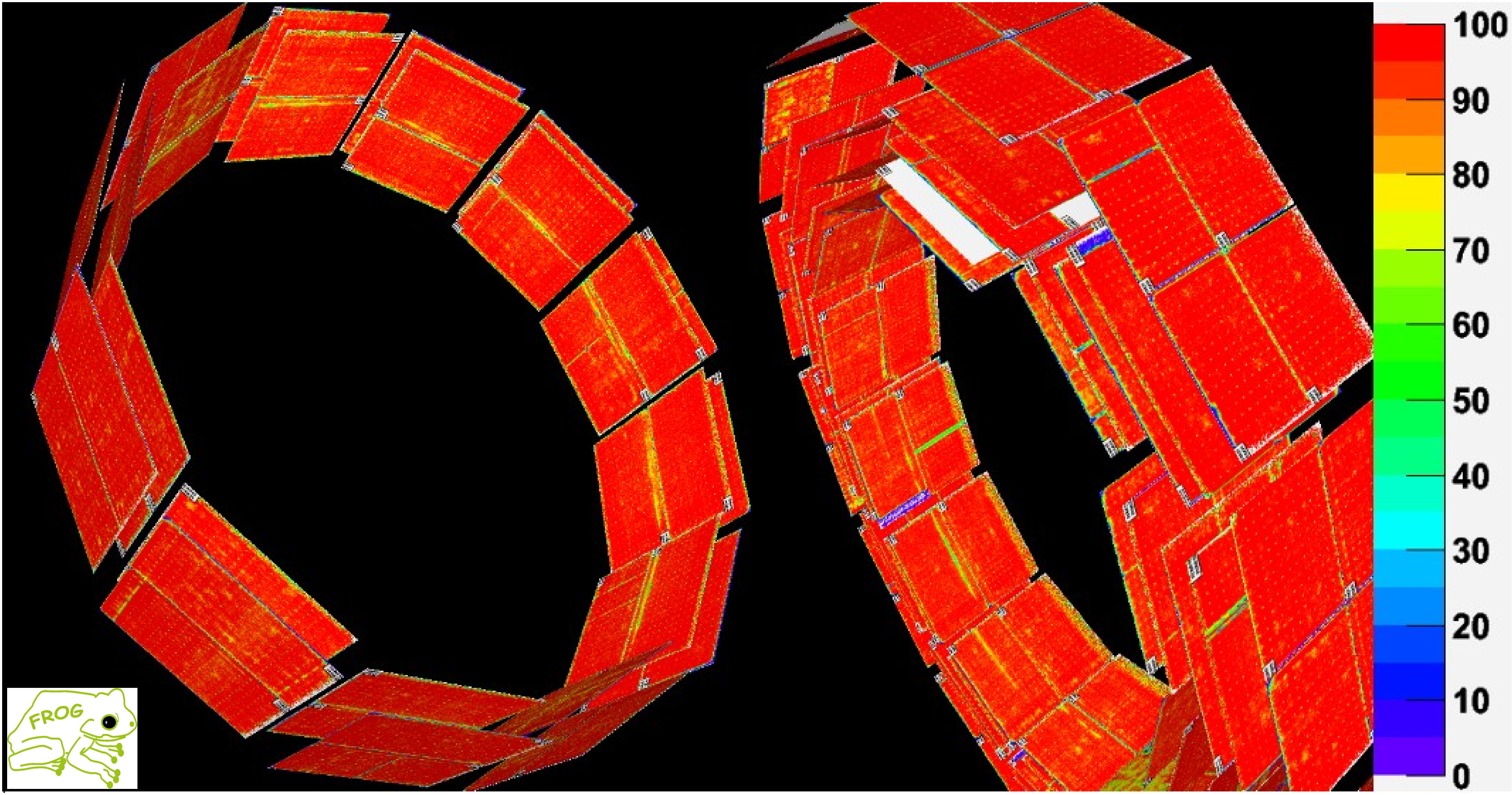
Contact:Camilo.Carrillo@cern.ch, djp@cern.ch

4 Muons and RPC hits event display



Event display with 4 muons, the RPC hits (in black) are shown explicitly.
Not all the event content is shown (CSC hits are supressed)
Contact:Camilo.Carrillo@cern.ch

2D Efficiency maps, following CMSSW Geometry (Frog)



CMS Preliminary 2011

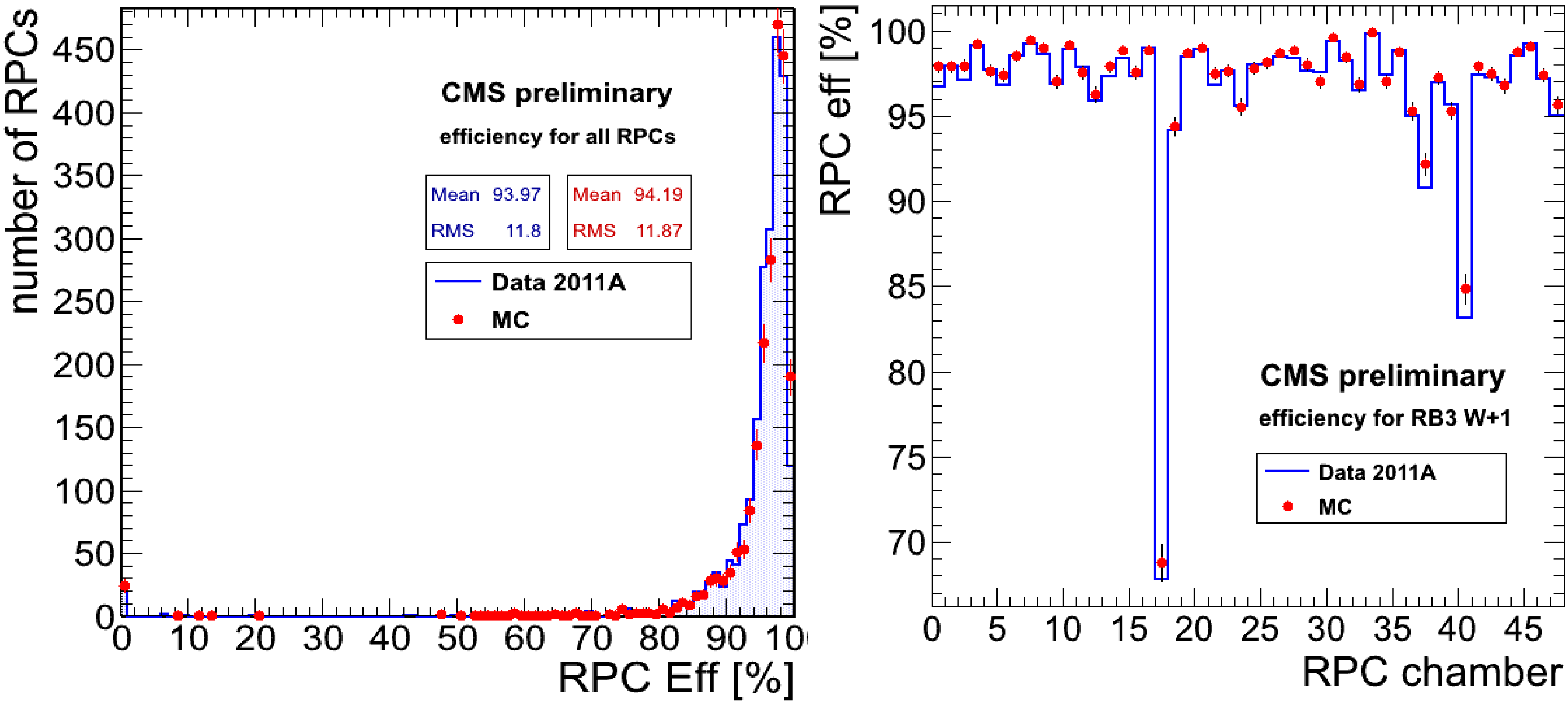
Chambers off are represented in white.
Blue and yellow lines are lower efficiency regions due to masked/dead strips.
The joints in between double gaps can be seen in yellow as well.
Little squares in the corners are just ROOT legends, not an inefficient region.

Contact:Camilo.Carrillo@cern.ch Loic.Quentermont@cern.ch

RPC efficiency simulation

Data collected in the first part of 2011 have been used to simulate the efficiency in MC.

Left plot: Efficiency distribution for all the RPCs (data in blue, MC in red)
Right plot: example of the efficiency for all the RB3 chambers of the Barrel Wheel+1

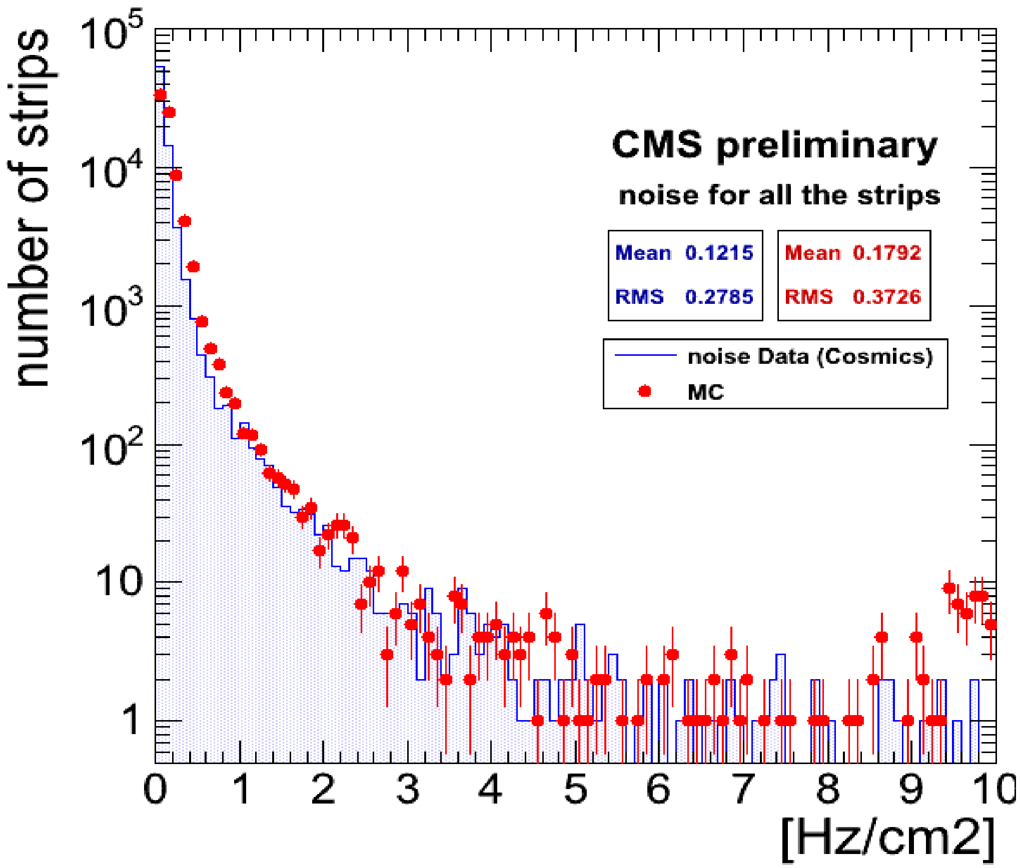


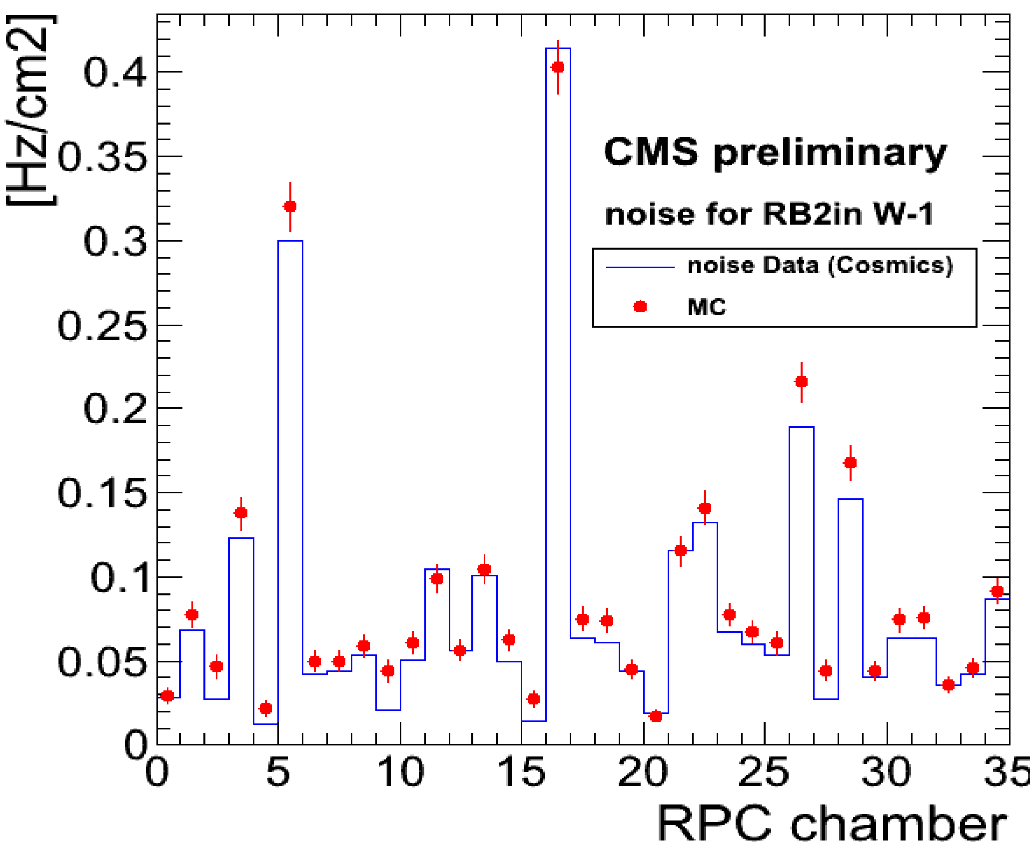
Contact Roumyana.Mileva.Hadjiiska@cern.ch

RPC noise simulation

Intrinsic RPC noise is measured during cosmic runs and used to model the MC response.
To each single strip of the system the measured noise is assigned in MC

Left plot: Intrinsic noise distribution for all the RPCs strips (data in blue, MC in red)
Right plot: example of correlation between simulated and measured noise for all the RB2in chambers of the Barrel Wheel-1





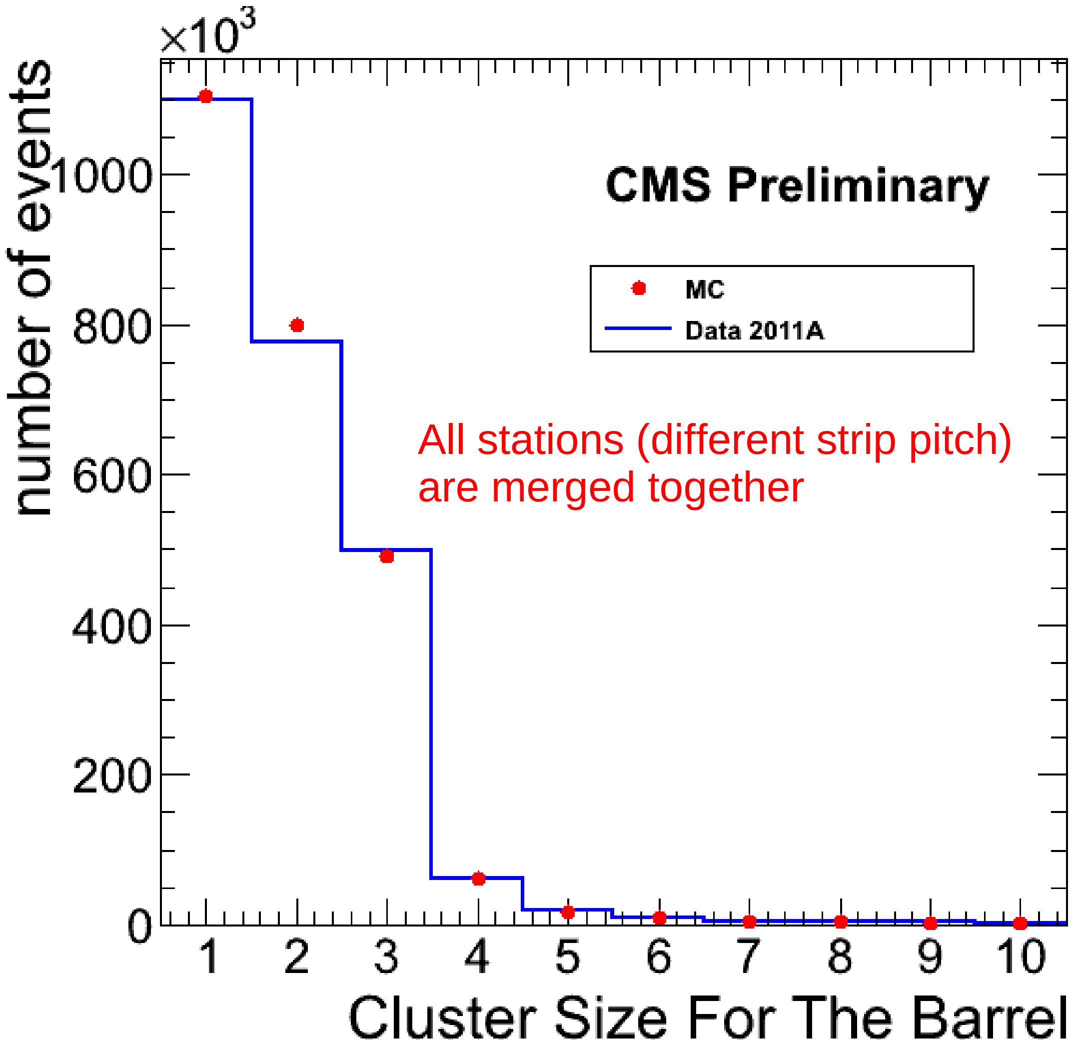
Contact Roumyana.Mileva.Hadjiiska@cern.ch

RPC cluster size simulation

Cluster Size of RPC hits is simulated according to the data collected with cosmic rays and used to parametrize the MC.

plot: Overall Barrel cluster size for muons crossing RPCs

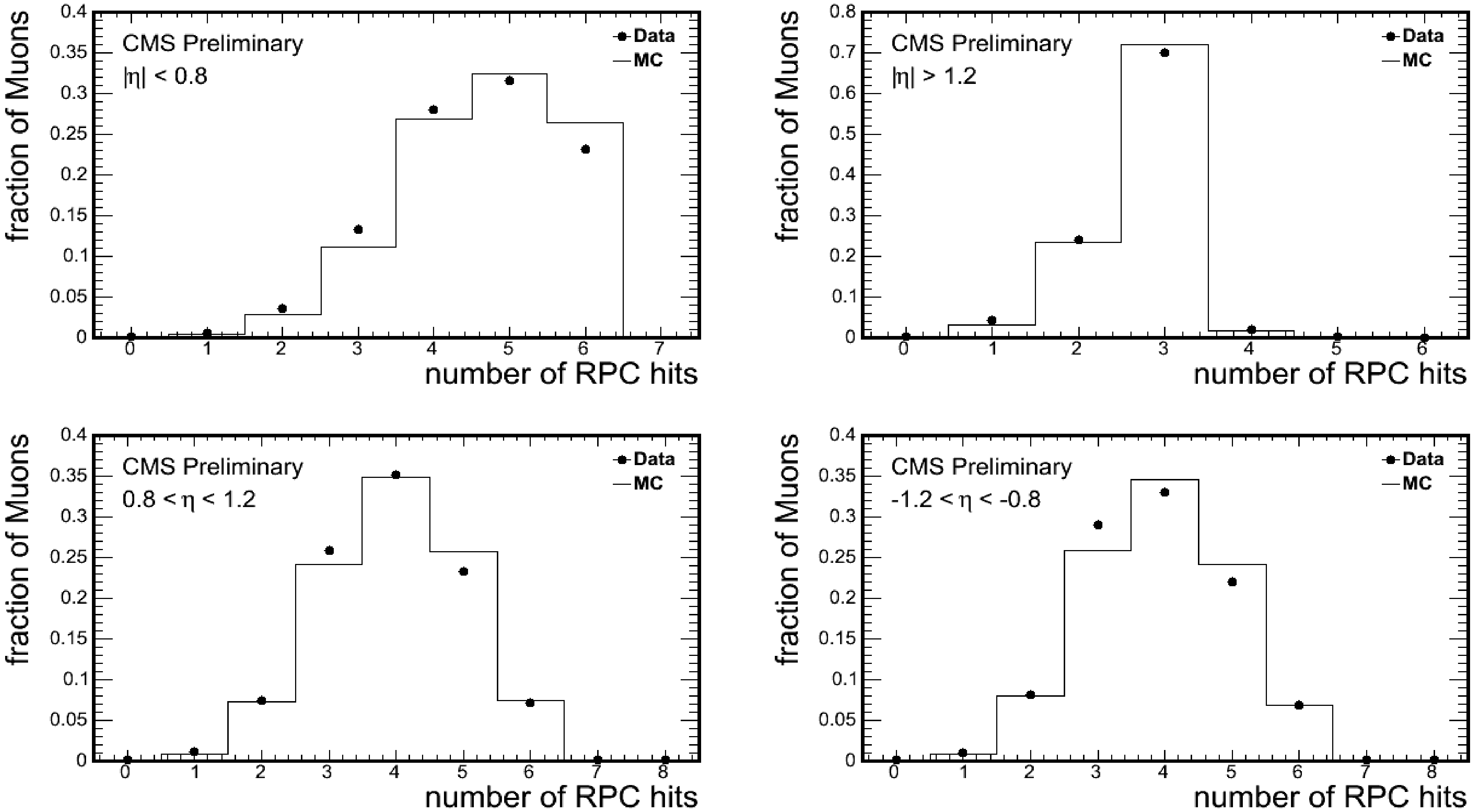
Cluster Size definition:
Number of consecutive strips fired on a Chamber for a given muon crossing



Contact Roumyana.Mileva.Hadjiiska@cern.ch

Average number of RPC hits For muons coming from Z decay

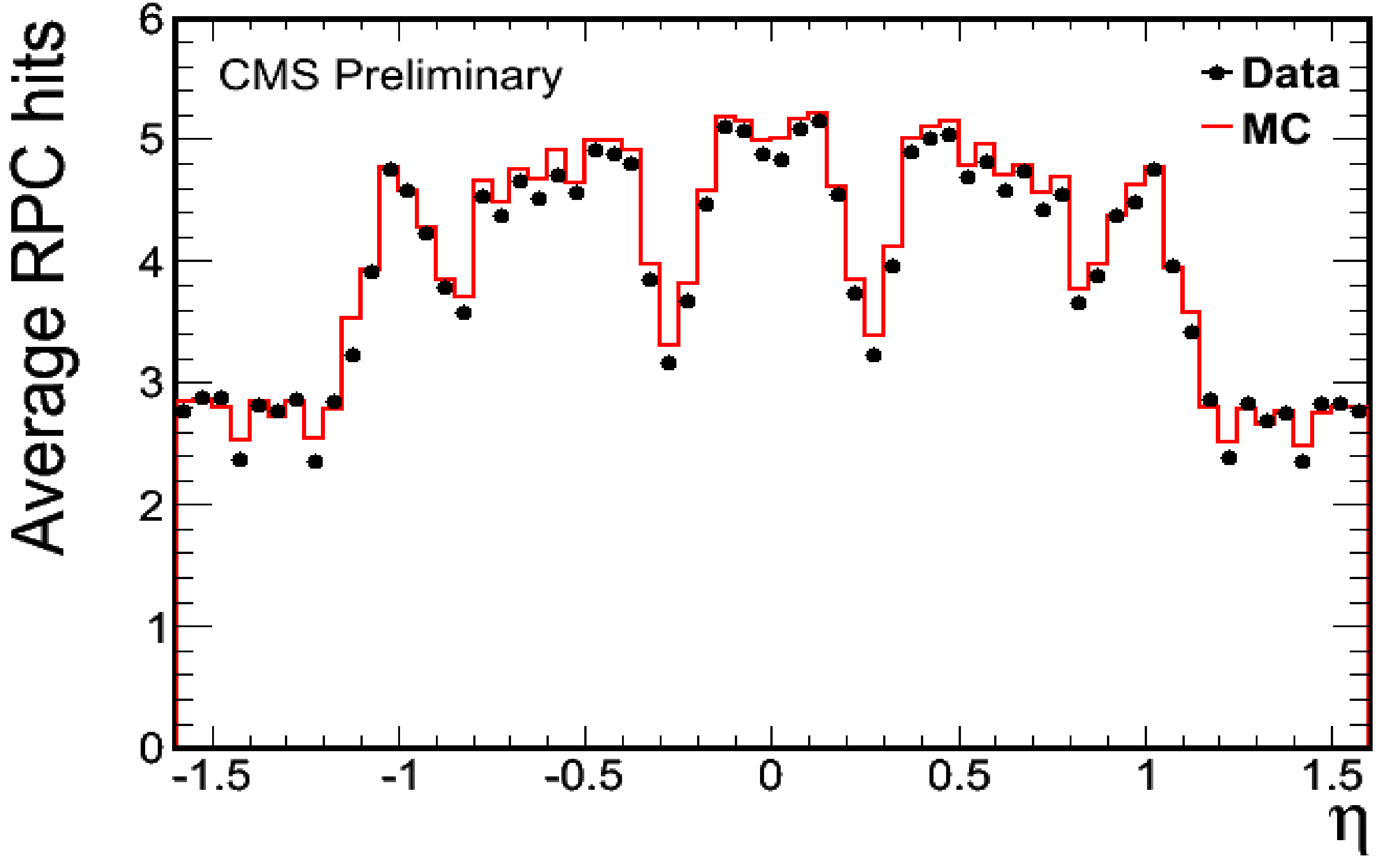
Average number of RPC hits associated to the Global Muons with Pt>20 GeV/c coming from Z decay (small bias due to the selection of the events: requested at least one muon triggered)



Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

Average number of RPC hits For muons coming from Z decay

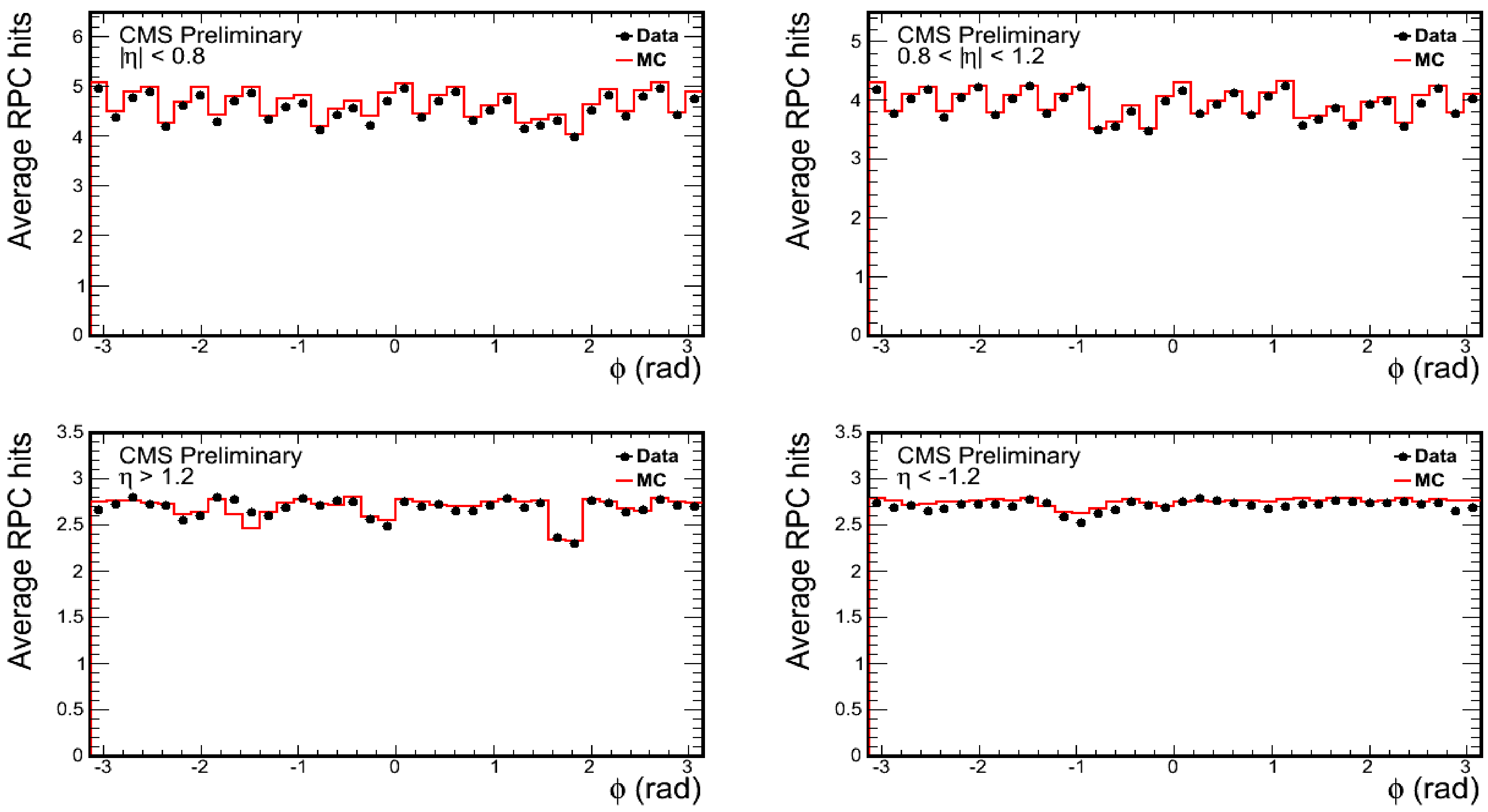
Average number of RPC hits as function of eta for Global Muons with Pt>20 GeV/c coming from Z decay



Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

Average number of RPC hits For muons coming from Z decay

Average number of hits as function of phi in different CMS regions for Global Muons with Pt>20 GeV/c coming from Z decay. Oscillations in the efficiency vs phi of the barrel distribution are due to the cracks between adjacent sectors.

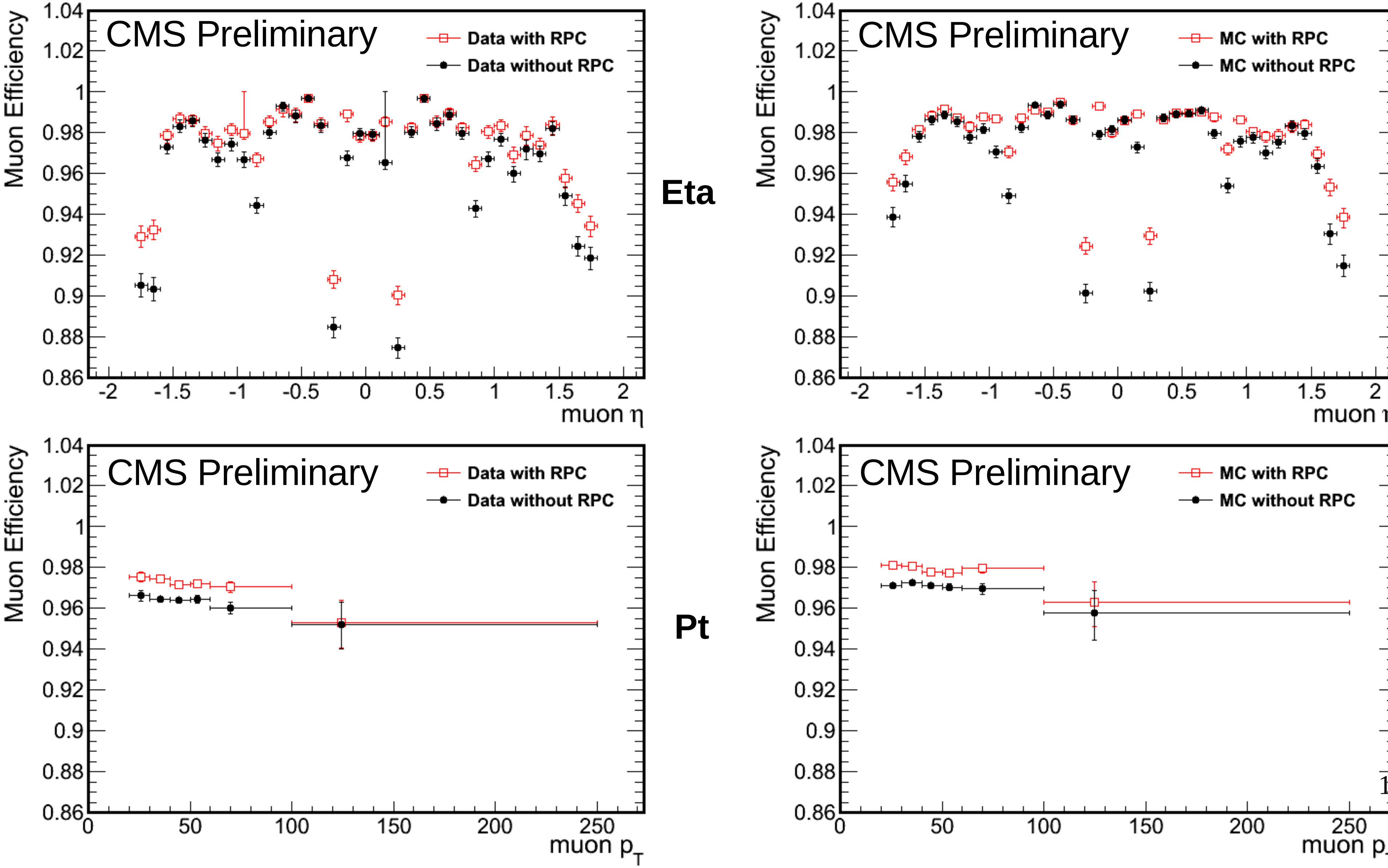


Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

Efficiency for muon identification with and without rpc

when the RPC hits are used (red square) or removed (dots), respectively

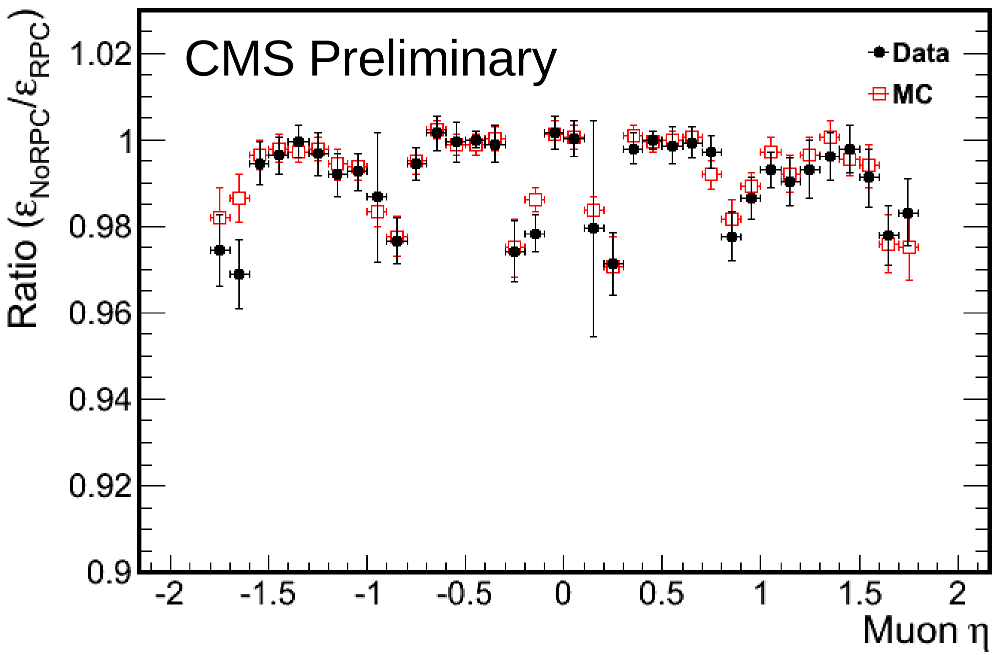
Data MC



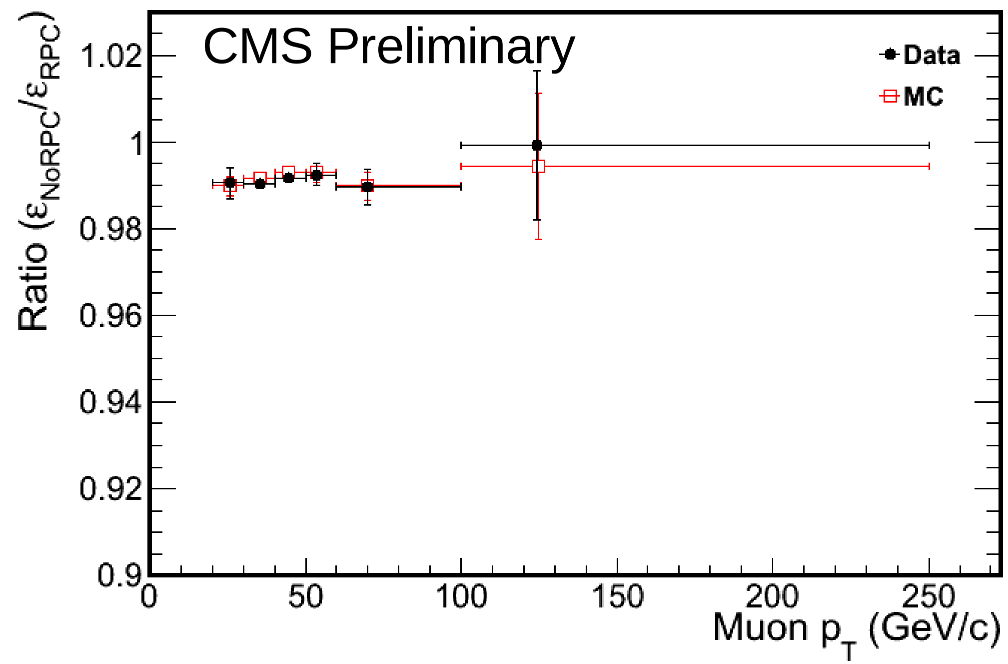
Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

Relative Efficiency for muon identification with and without rpc

Ratio vs. Eta



Ratio vs. pT



- $R = \dfrac{\varepsilon(\text{globalMuonNoRPC})}{\varepsilon(\text{globalMuonRPC})}$

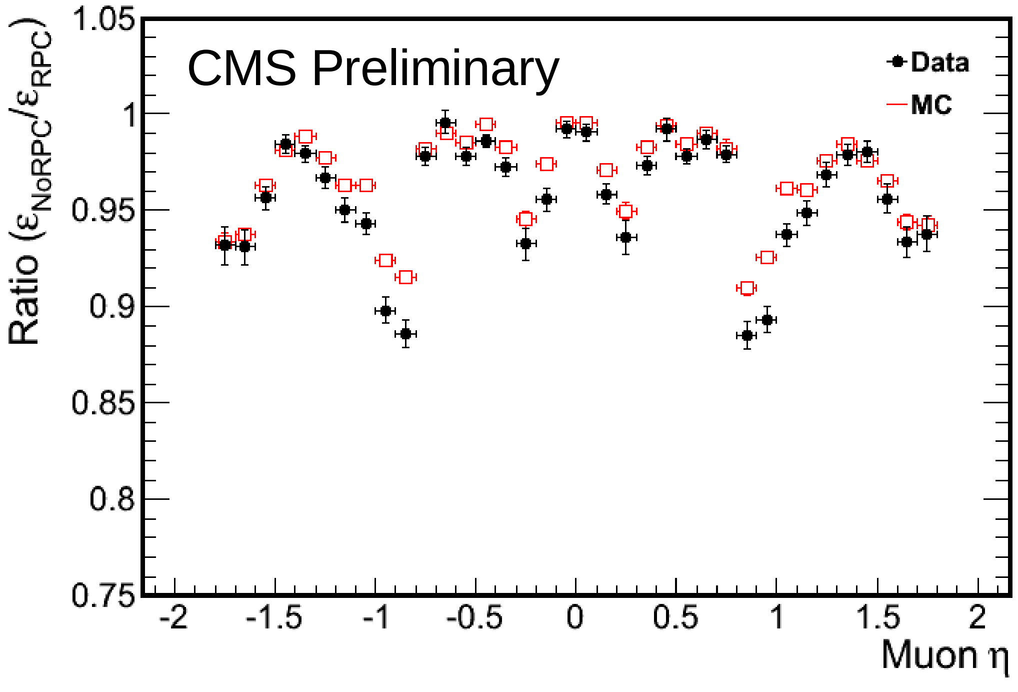
Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

If we also require a number of Valid hits greater than 0 in the global muon fit the impact of RPC is more evident

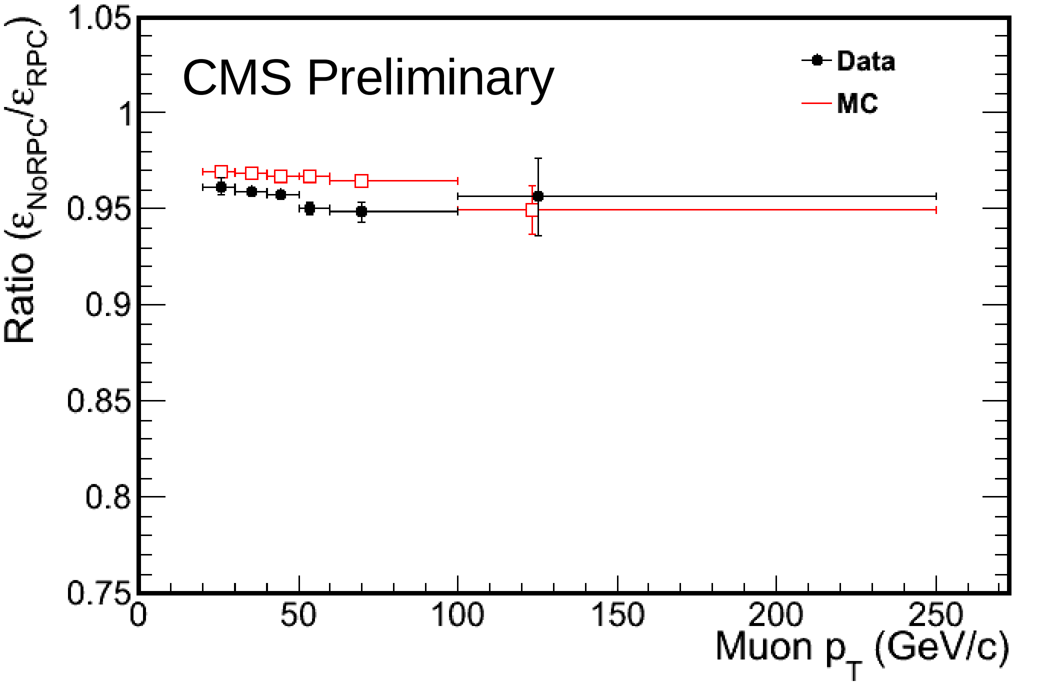
Additional requirements with respect to table 2:

- NumberOfMuonValidHits>0
- at Least 2 DT/CSC stations matched

Eff vs Eta



Eff vs Pt



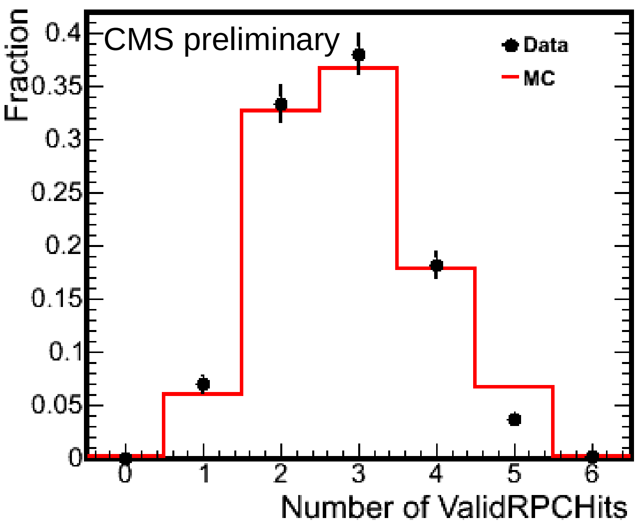
Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

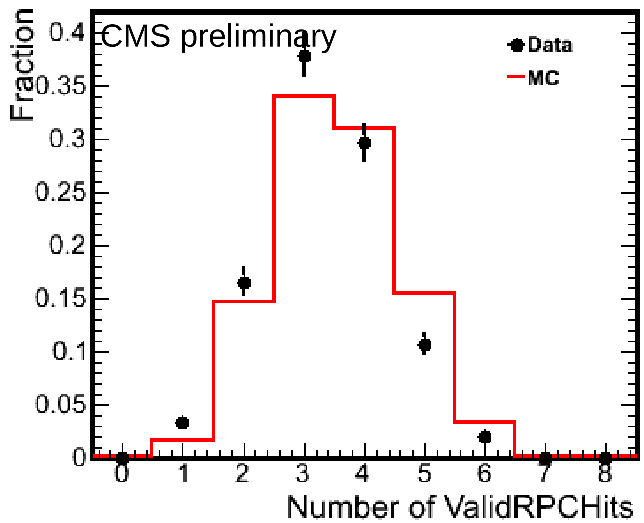
RPC hits distribution

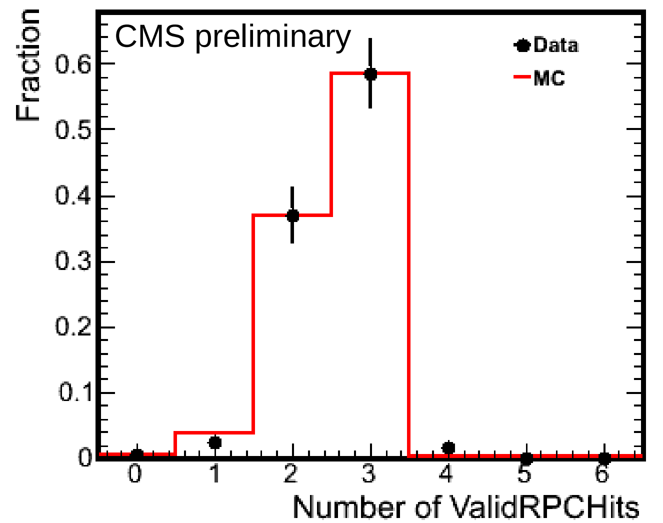
(in case the muon reconstruction fails when the RPC hits are removed)

Barrel Region Overlap Region Endcap Region

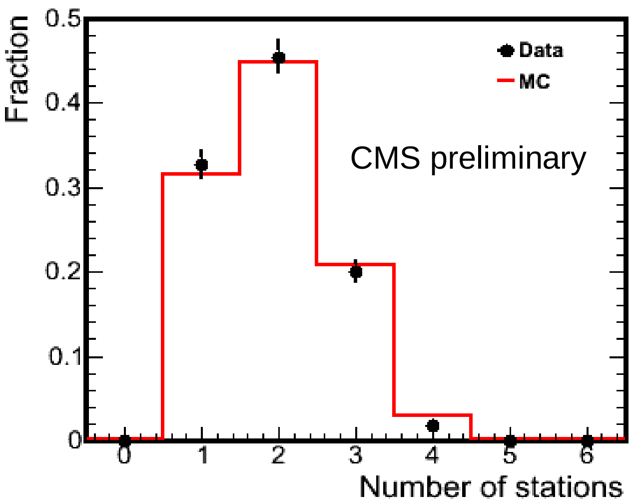
- Number of layers

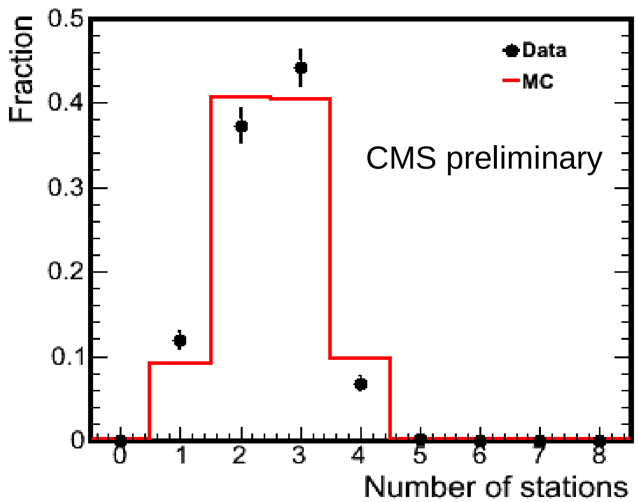


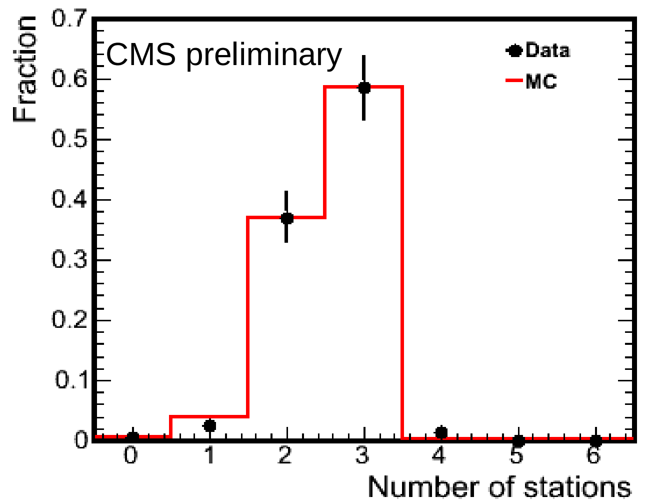




- Number of stations



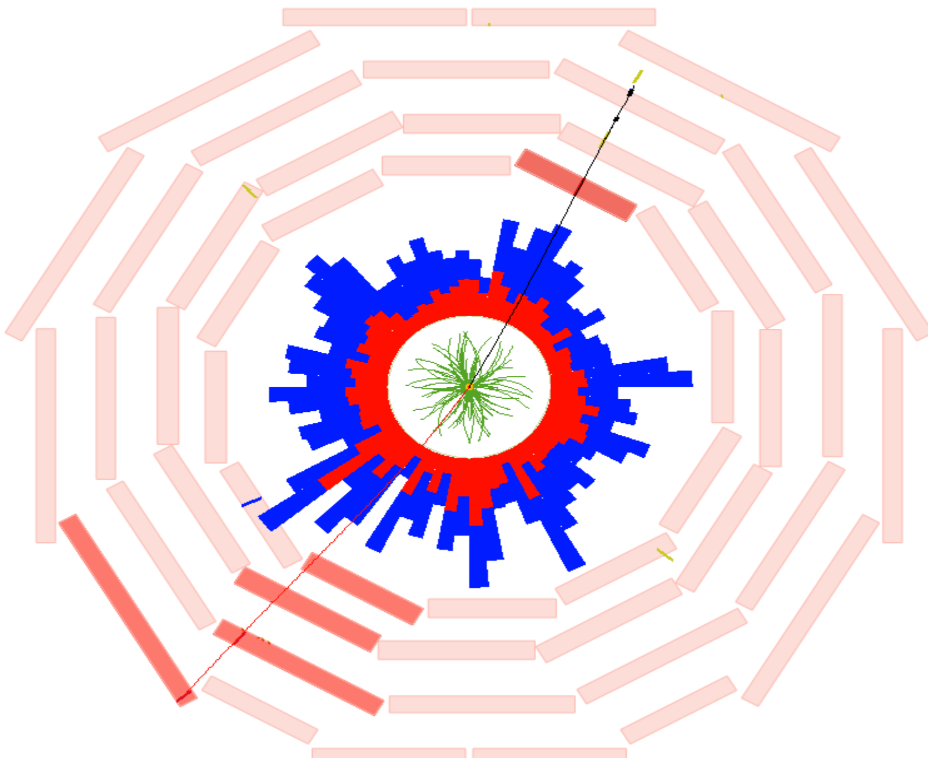


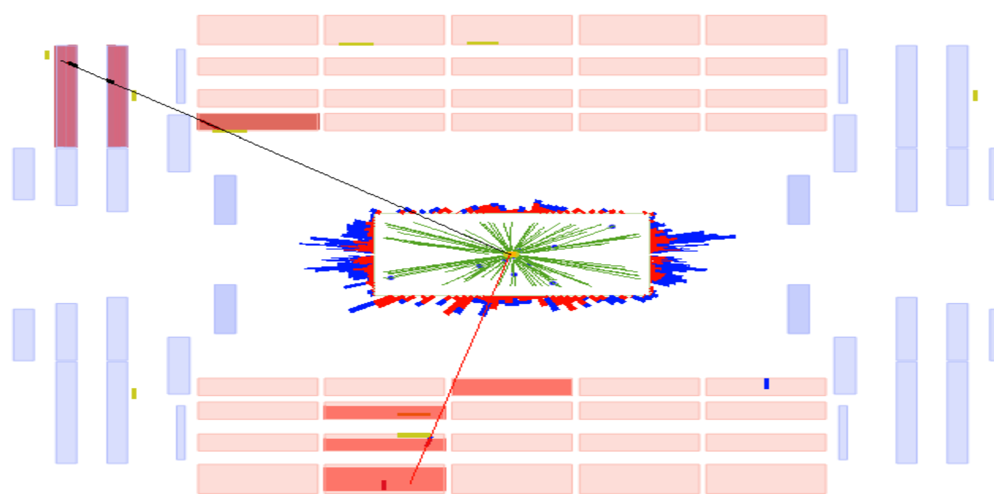


Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

Example of muon recovered by RPCs

Run 173406, Event 85902752, m=89.241GeV





The red track will fail in reconstruction when the RPC hits are removed in the track fitting

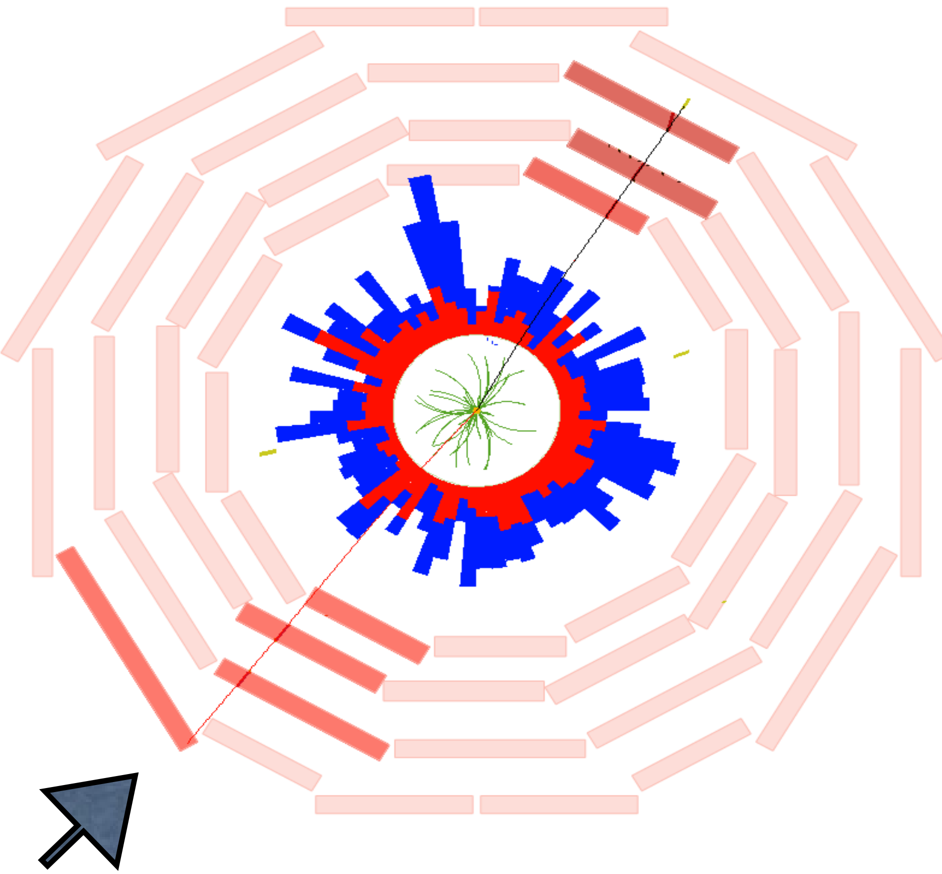
2 segments, but

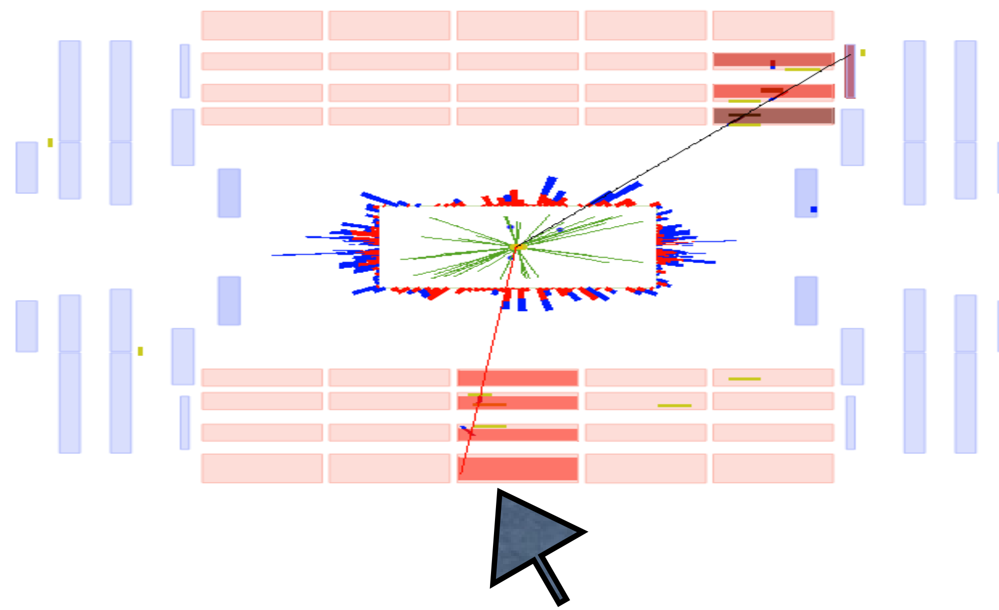
z-coordinate not measured in MB4

Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

Example of muon recovered by RPCs

Run 173430, Event 123740040, m = 97.121GeV





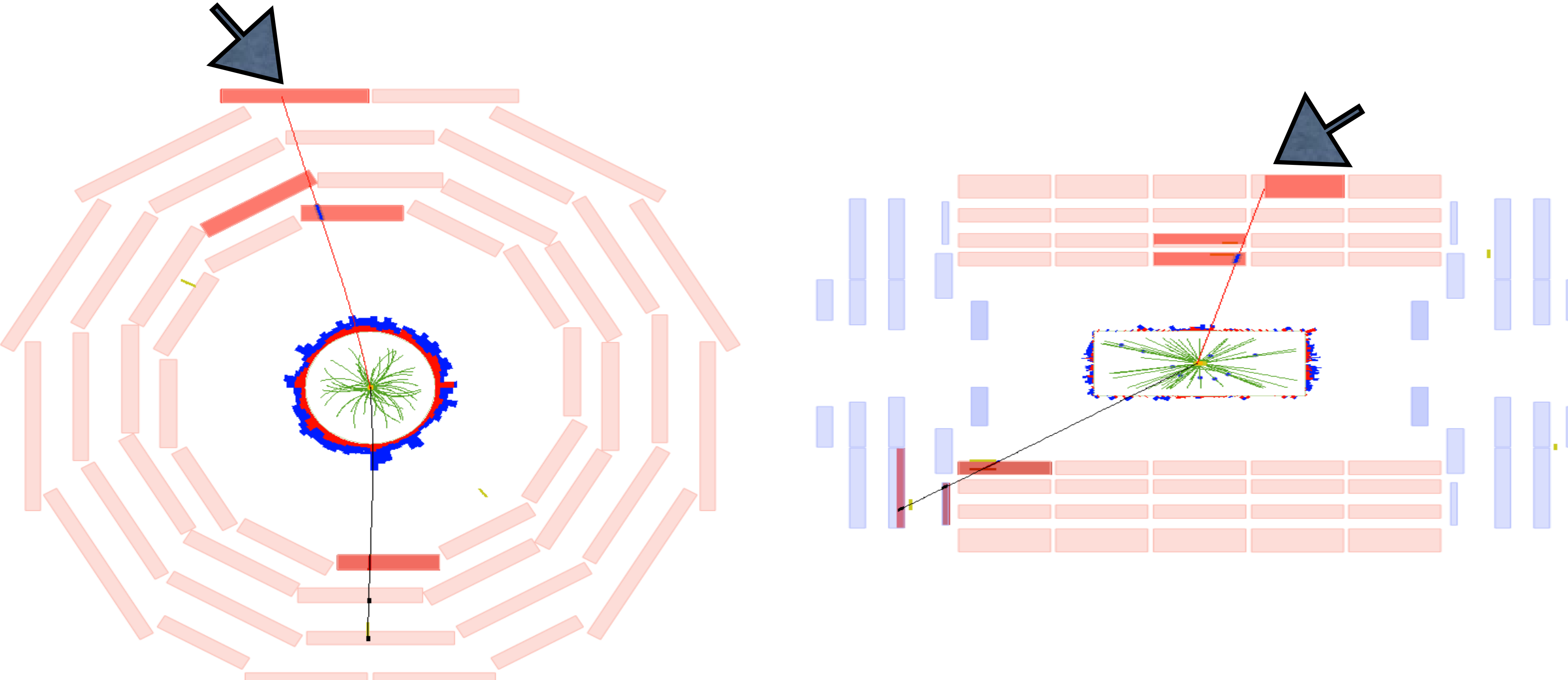
match problem

The red track will fail in reconstruction when
the RPC hits are removed in the track fitting

Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

Example of muon recovered by RPCs

Run 173406, Event 57918504, m = 90.900GeV

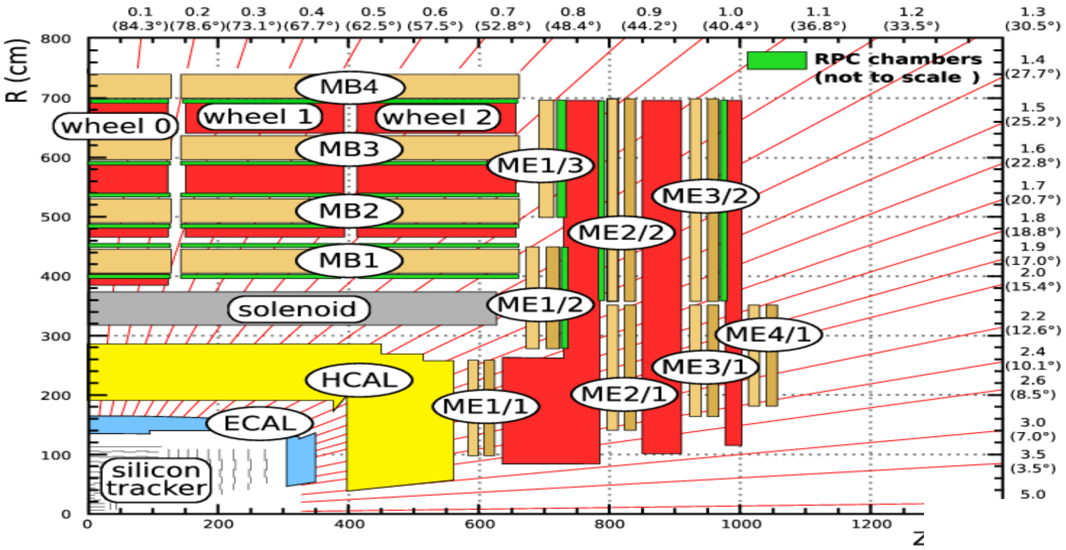


The red track will fail in reconstruction when the RPC hits are removed in the track fitting

1 DT segment + 2 RPC hits

Contacts Min.Suk.Kim@cern.ch, Hyunkwan.Seo@cern.ch

Muon system geometry and simulated radiation background

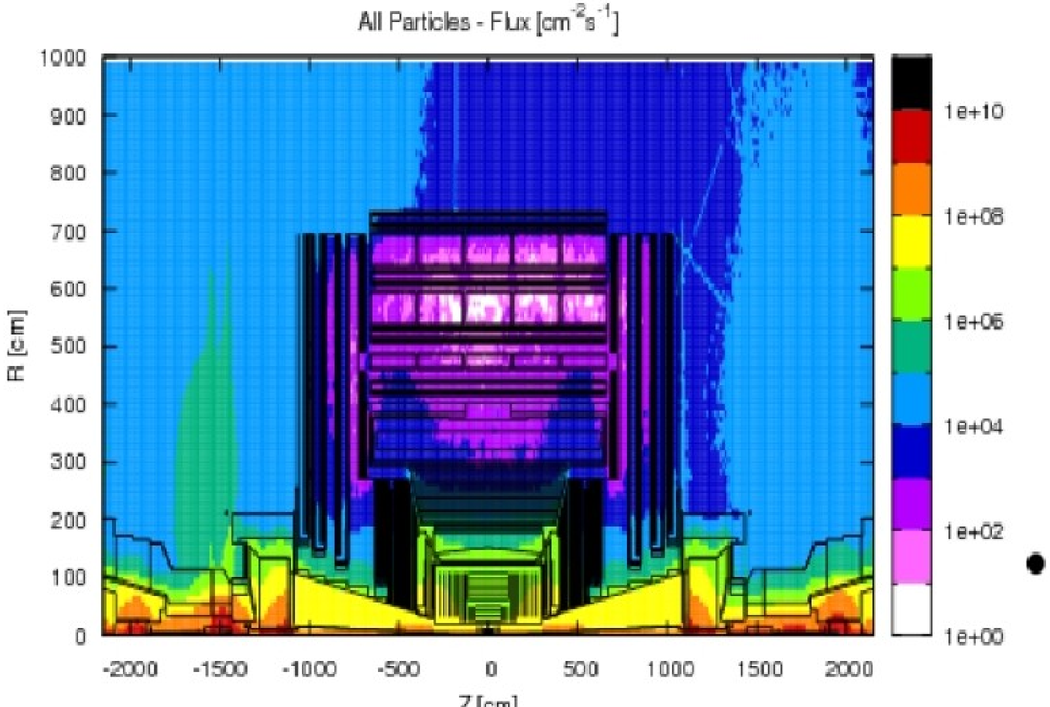


Muon system geometry . The position of the RPC chambers is shown

Fluka simulation of the radiation background in the CMS cavern. Castor is located close to the beam pipe, in the z < 0 region.

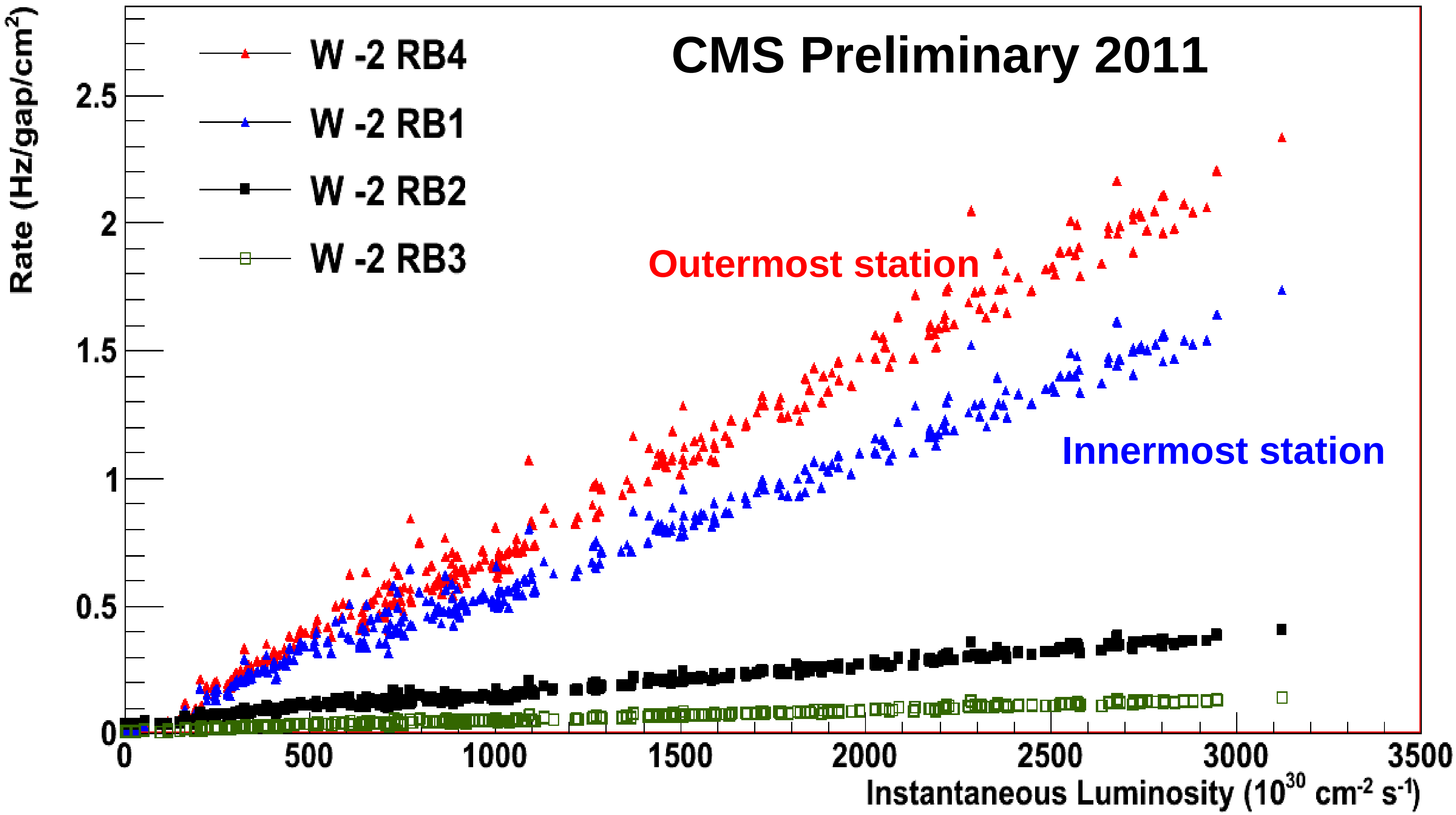
a) – flux through the gap between the barrel and the endcap of the calorimeters, affecting mostly RB1

b) – flux of back-scattered neutrons from Castor, affecting RB4



Contact:Mircho.Rodozov@cern.ch , Silvia.Costantini@cern.ch

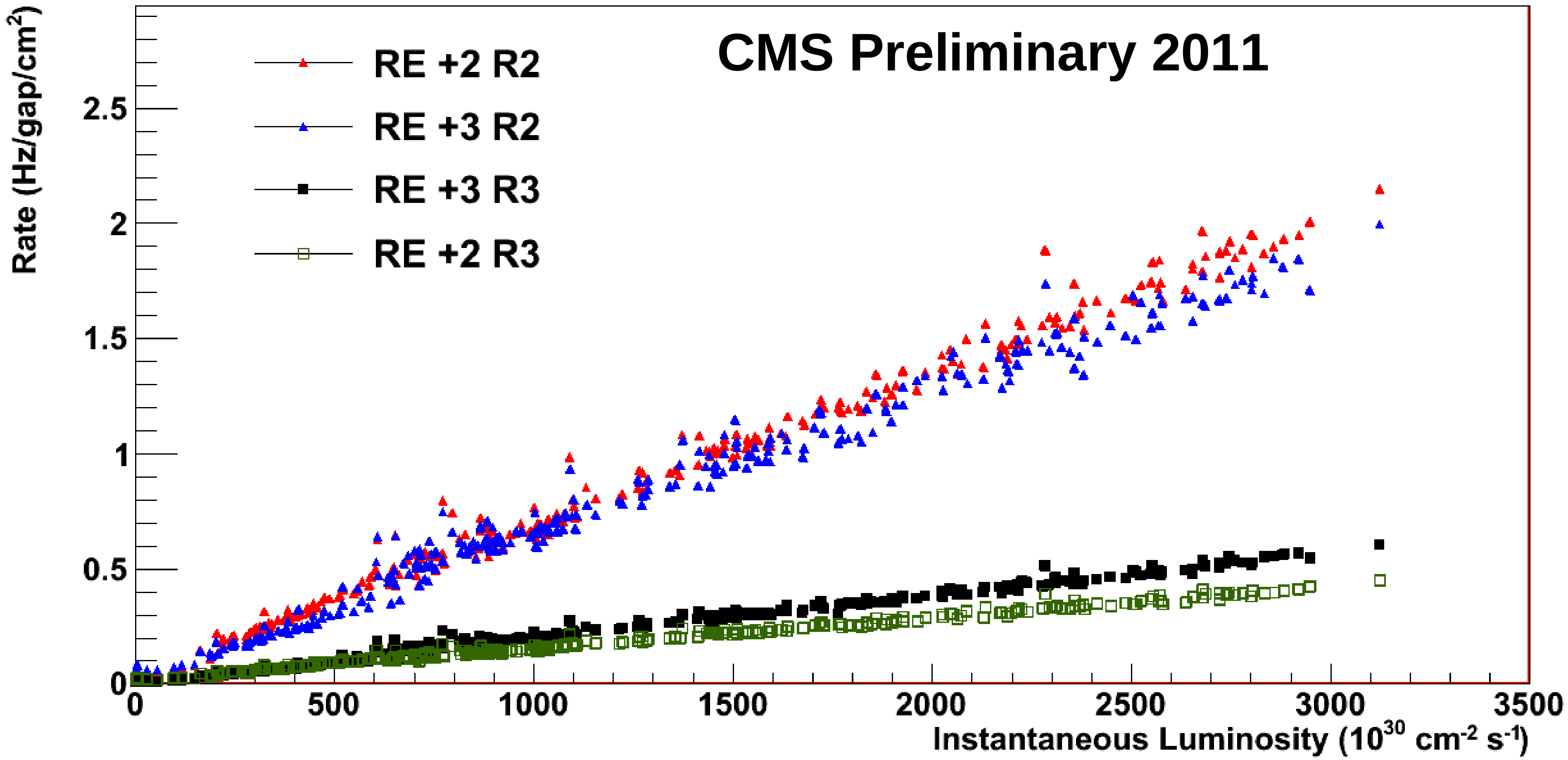
Radial distribution of the rate Barrel



RPC Background rate as a function of the instantaneous luminosity, for four radial stations of Barrel wheel W-2. Outermost station affected mainly by neutron background, innermost mainly affected by particles coming from the vertex.

Contact:Mircho.Rodozov@cern.ch , Silvia.Costantini@cern.ch

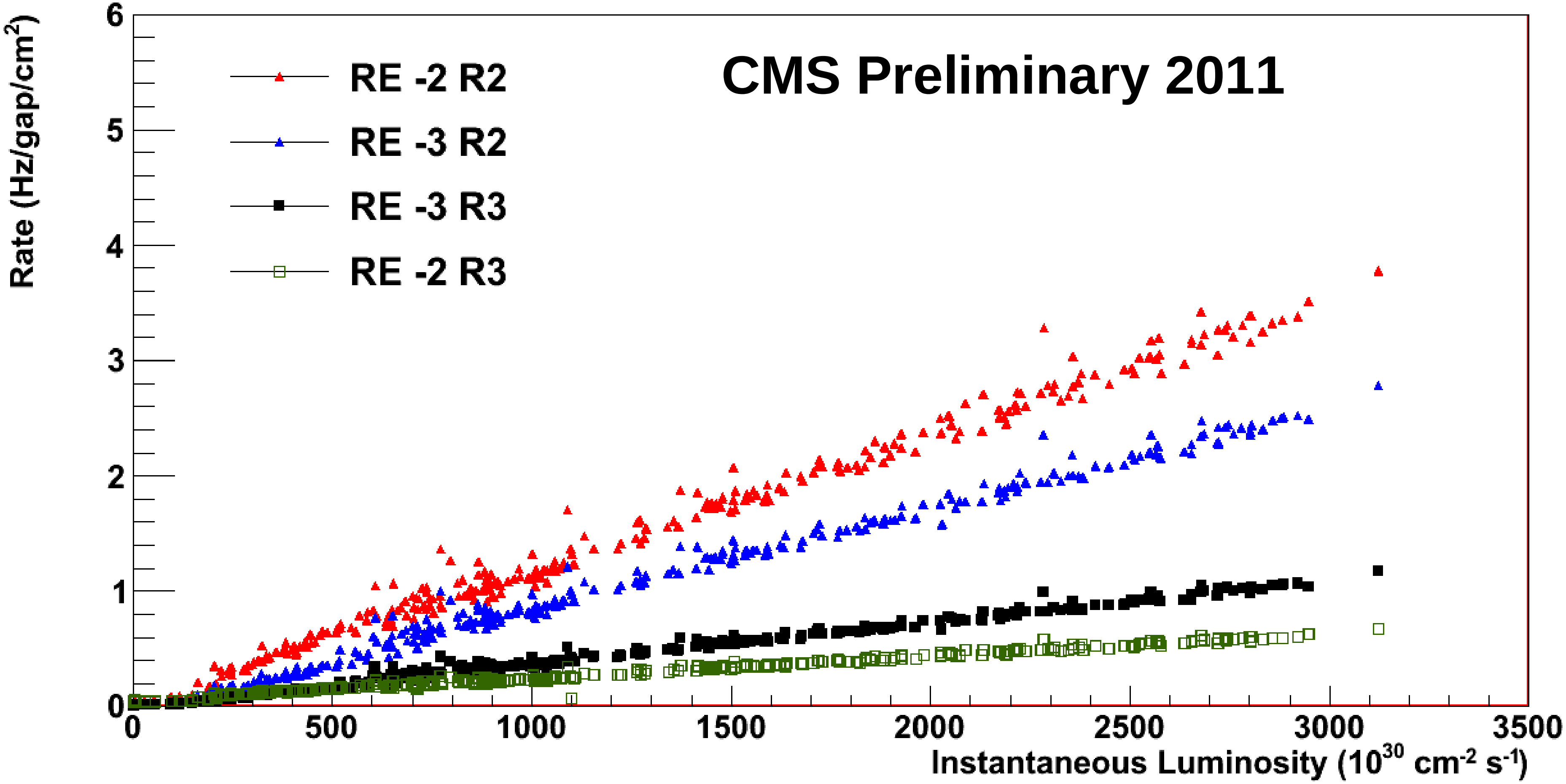
Radial distribution of the rate EndCap+



RPC Background rate as a function of the instantaneous luminosity. Innermost rings are the most affected.

Contact:Mircho.Rodozov@cern.ch , Silvia.Costantini@cern.ch

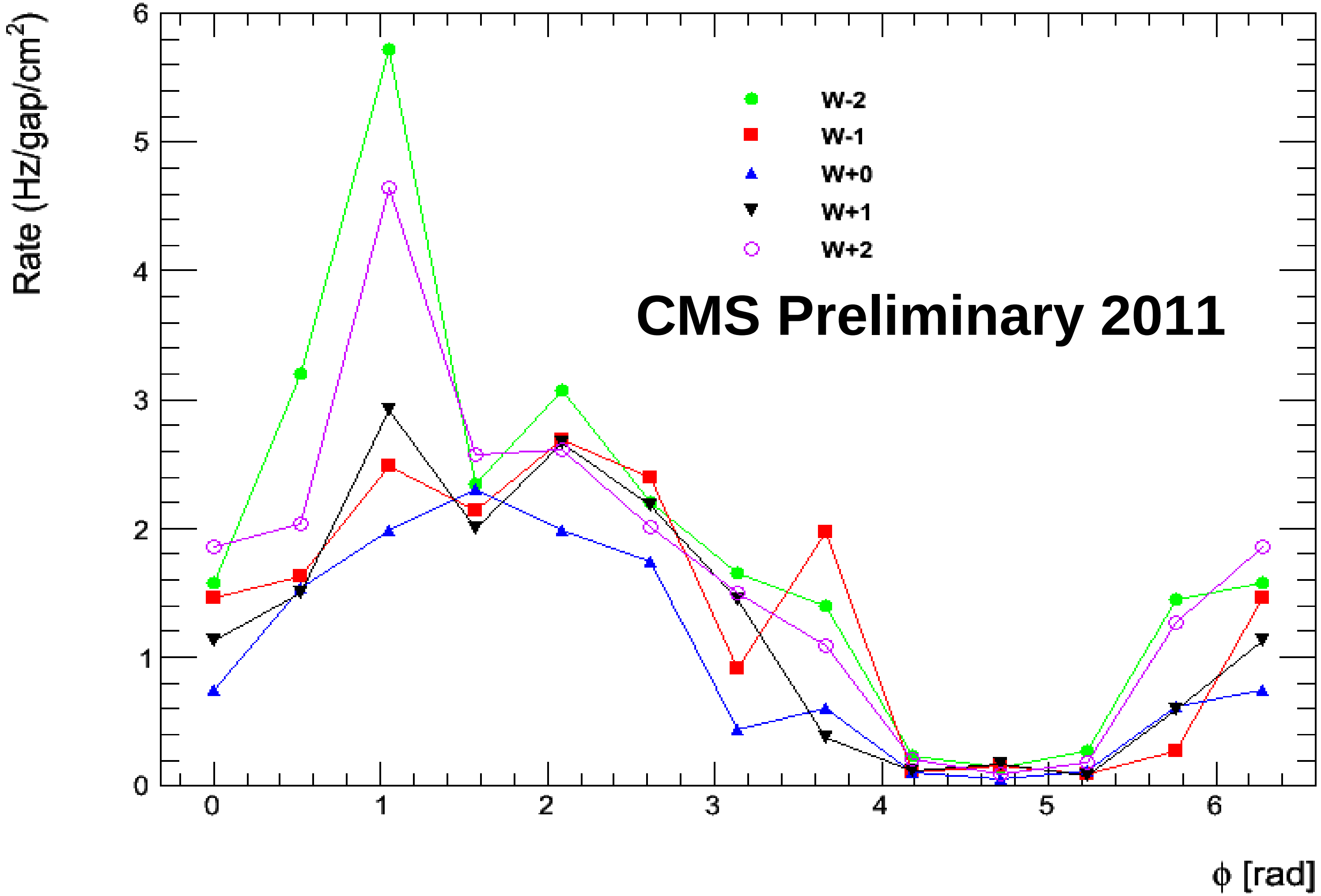
Radial distribution of the rate EndCap-



Negative disks show higher rate with respect to the positive, due to the presence of CASTOR on the negative side of CMS.

Contact:Mircho.Rodozov@cern.ch , Silvia.Costantini@cern.ch

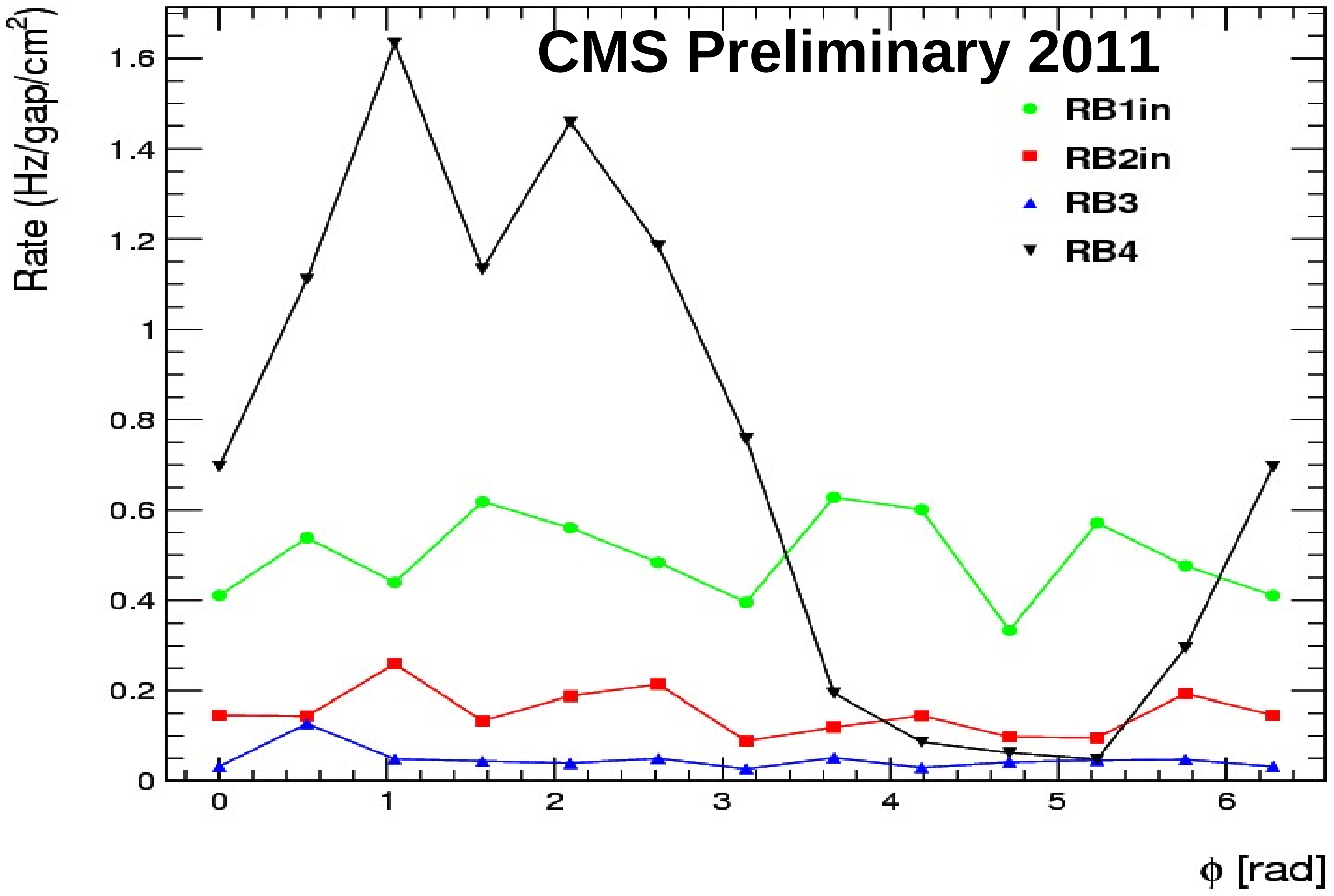
Rate vs Phi Angular distribution Barrel



Background rate on the outermost Barrel RPC station (RB4) for different wheels. The bottom sectors are less affected by neutron background due to the shielding of the cavern floor

Contact:michele.gabusi@cern.ch , silvia.costantini@cern.ch

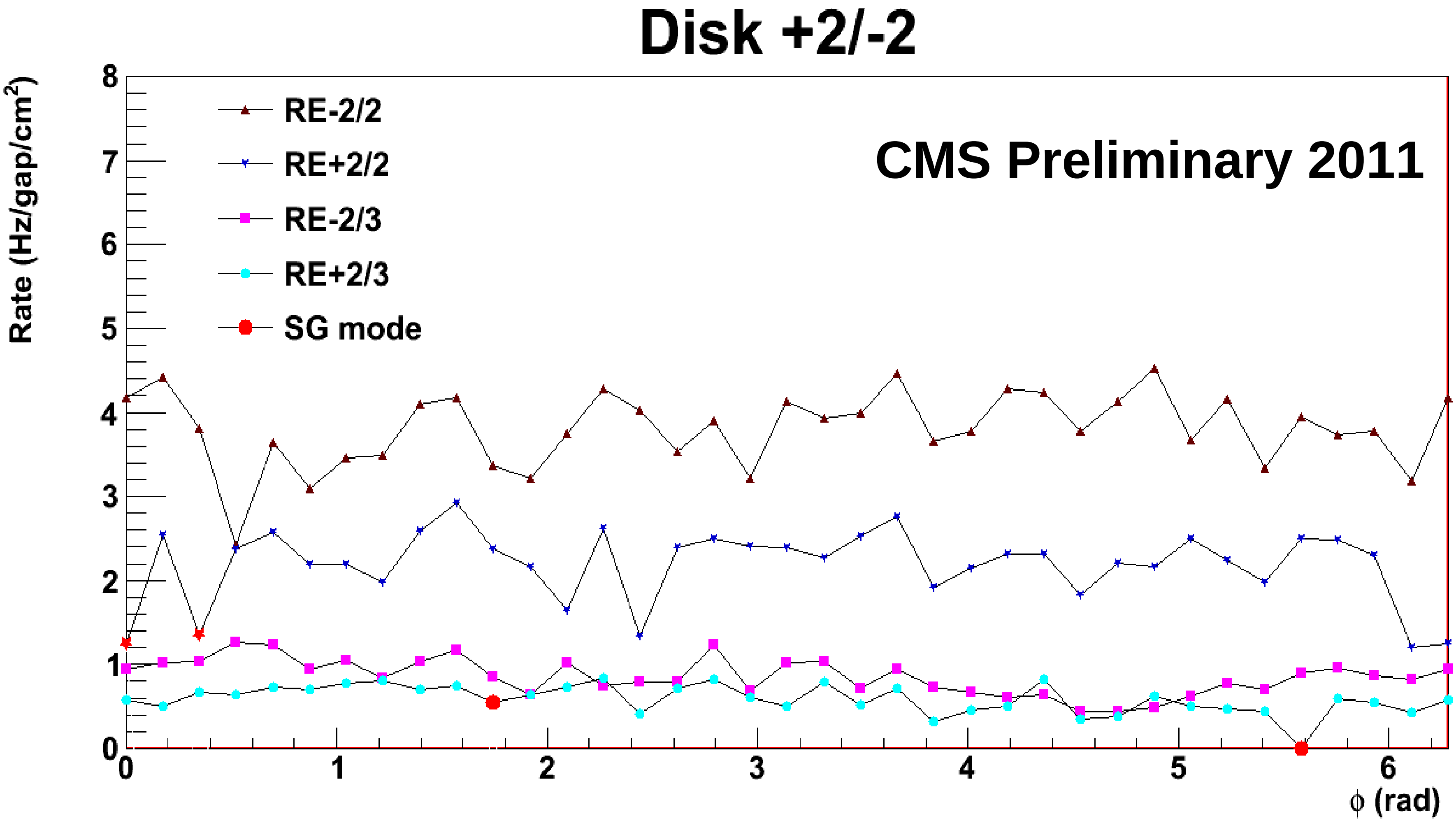
Rate vs Phi Angular distribution Barrel



Background rate vs azimuthal angle for different barrel stations of Wheel +1. The asymmetry between top and bottom sectors is evident in the outermost Station RB4.

Contact:michele.gabusi@cern.ch , Silvia.Costantini@cern.ch

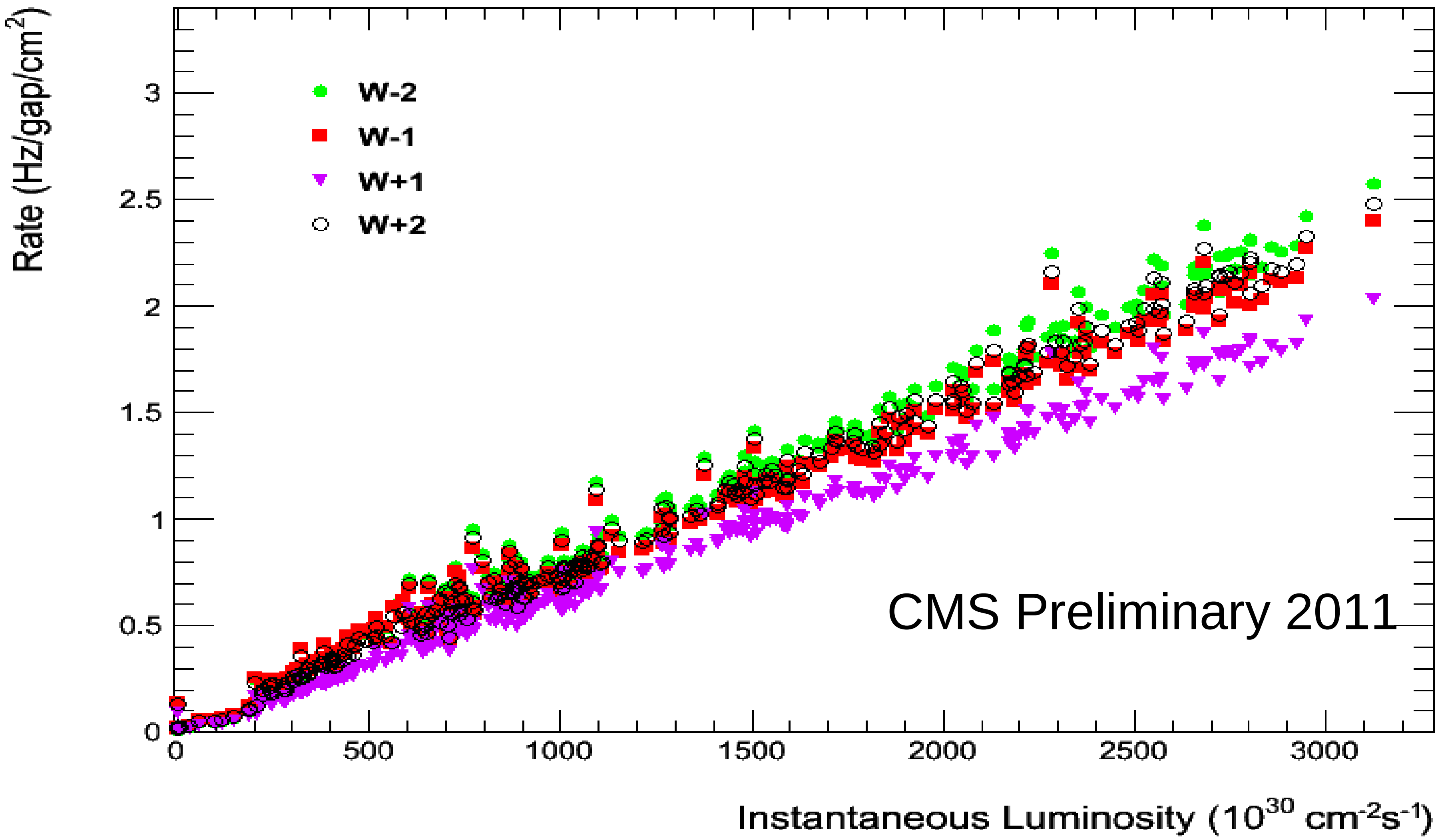
Rate vs Phi Angular distribution EndCap



Background rate vs azimuthal angle for different endcap stations.
No evidence of phi asymmetry in the endcaps.
The z-/z+ asymmetry (particularly evident for station 2 of the negative and positive side) is also shown.
2 Chambers working in Single Gap mode (SG) are highlighted with a circular red dot.

Contact:mircho.rodozov@cern.ch , Silvia.Costantini@cern.ch

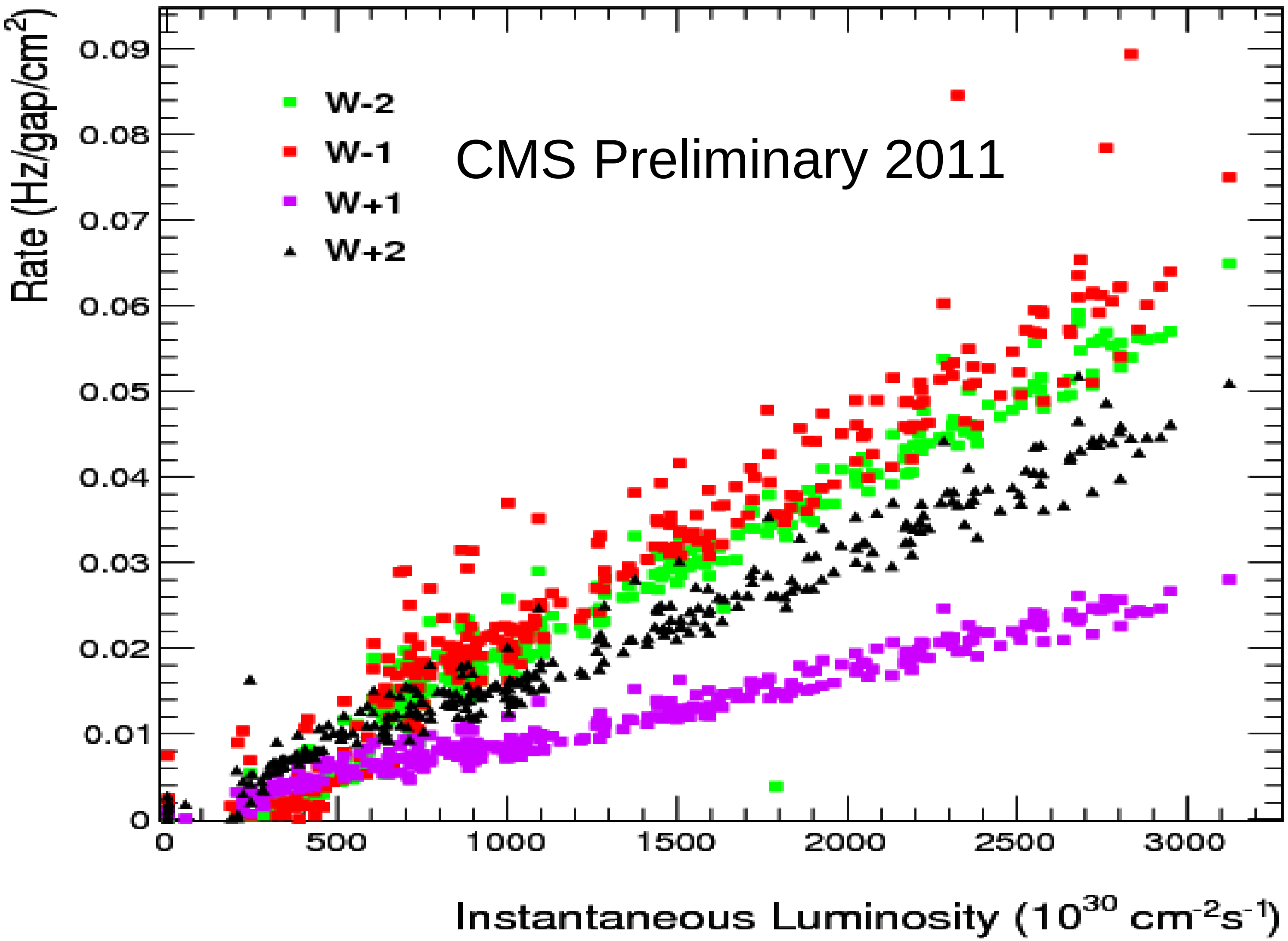
Rate vs Z Longitudinal distribution of the rate Barrel



Overall rate (for all sectors) in wheels +- 1, +-2, station RB4.
No significant Z asymmetry in the barrel.

Contact:Michele.Gabusi@cern.ch , Silvia.Costantini@cern.ch

Rate vs Z Longitudinal distribution of the rate Barrel

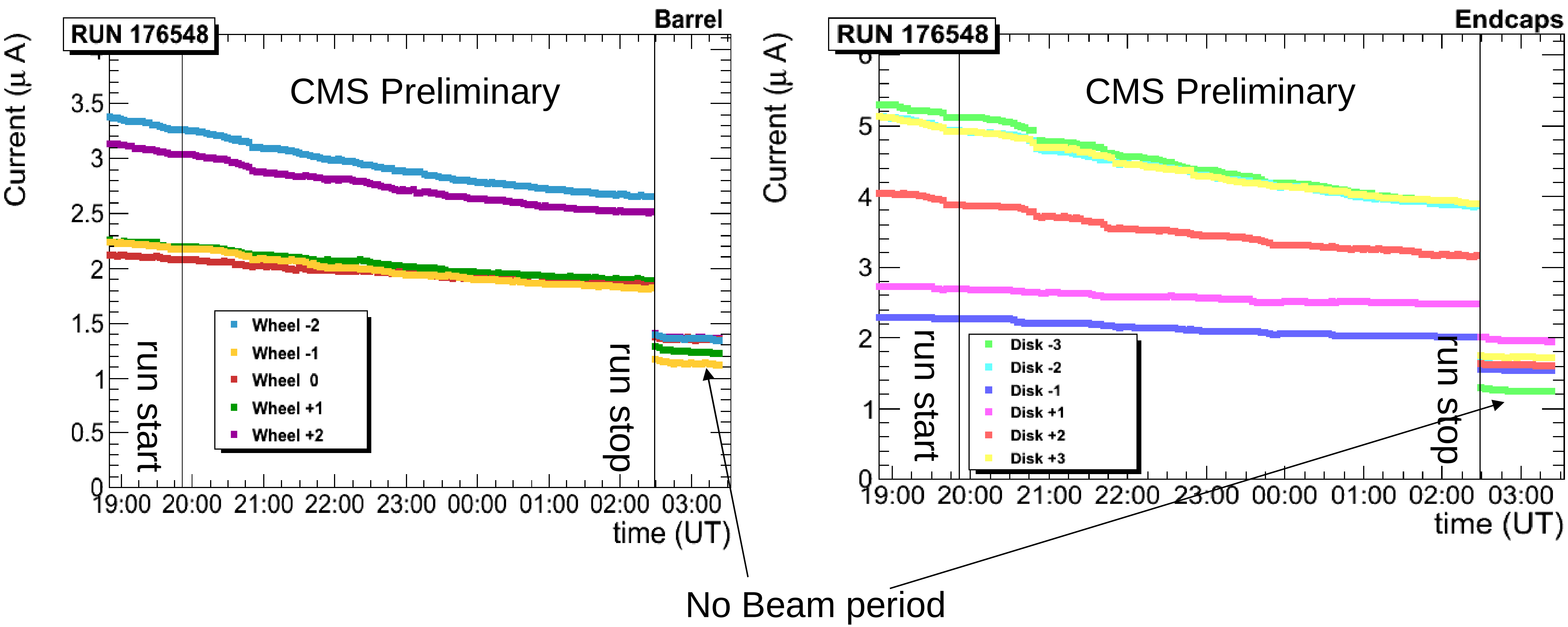


Z distribution of the rate for wheels +-1, +-2, station RB4, for the bottom sector 10 only

(less occupied barrel sector for RB4)

Contact:Michele.Gabusi@cern.ch , Silvia.Costantini@cern.ch

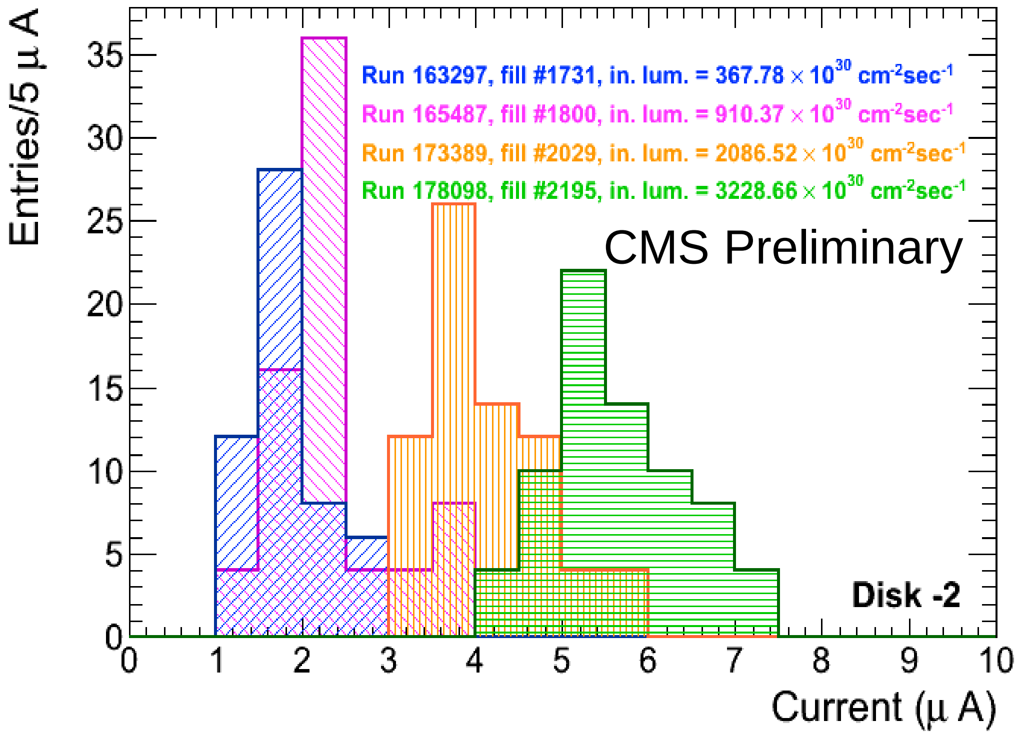
Current history plot

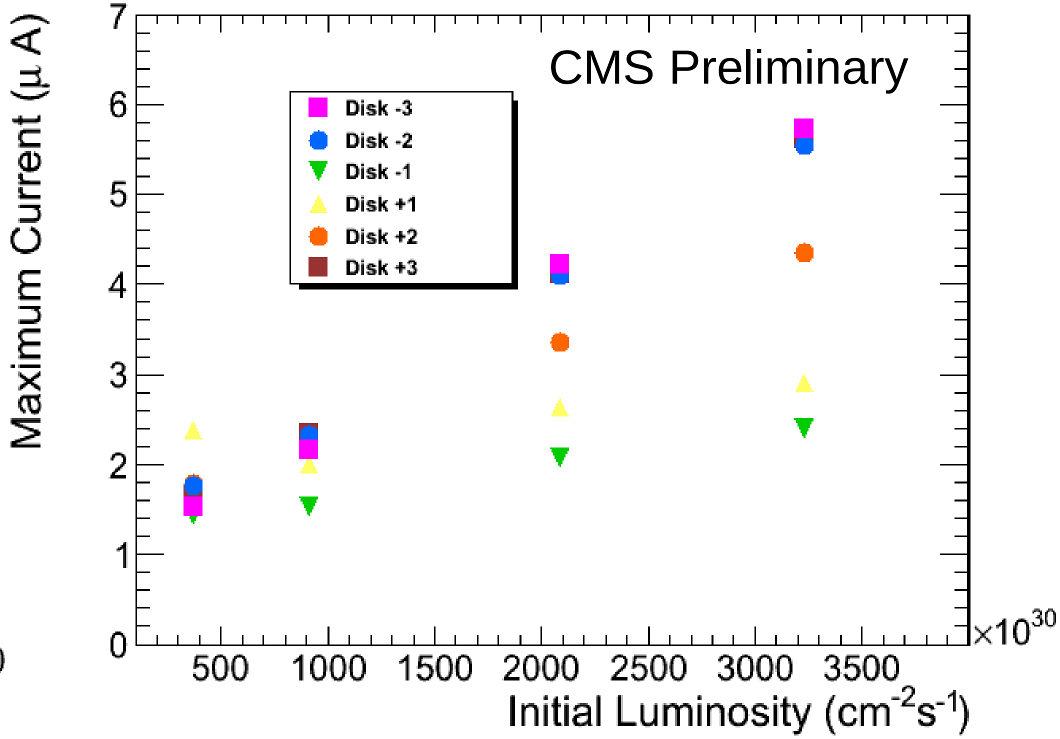


History plot for mean current in a wheel for a given run, the current is correlated to the beam intensity that decreases in time.

Contact: Umberto.Berzano@cern.ch

Maximum current distribution

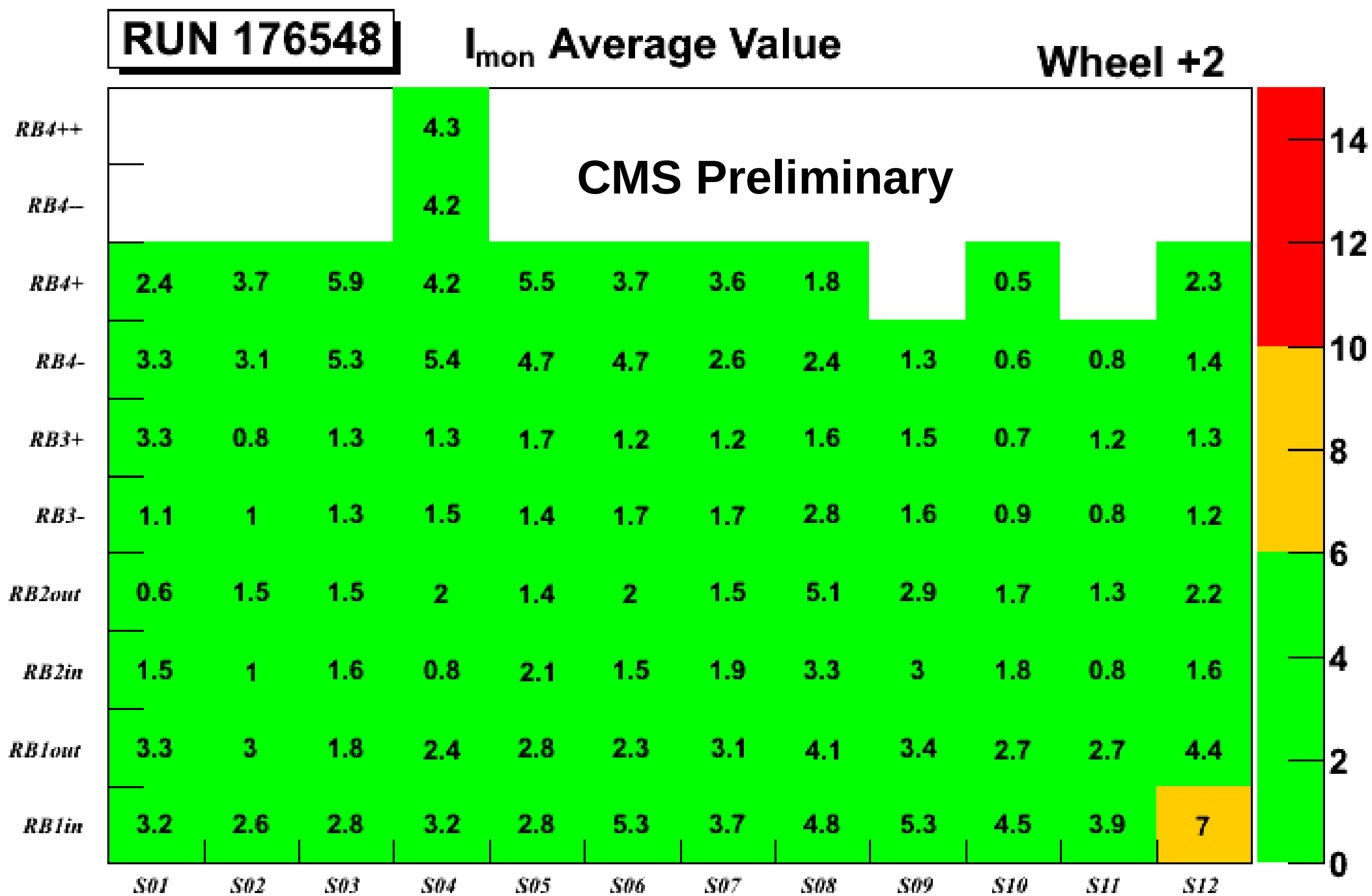




4 runs with increasing initial luminosity are compared.

Contact: Umberto.Berzano@cern.ch

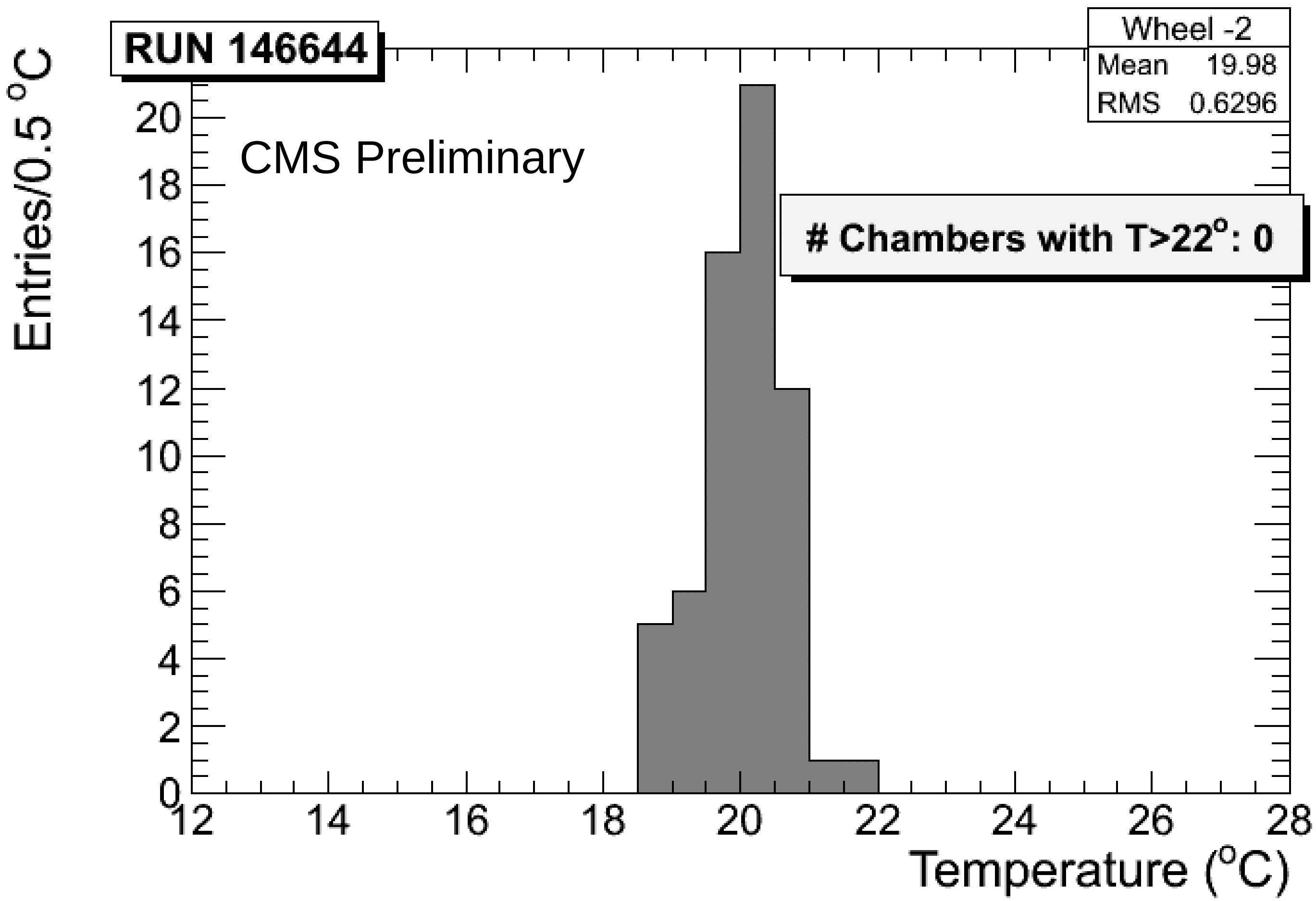
Mean current, color map



Mean current color map by chamber per run.

Contact: Umberto.Berzano@cern.ch

Chamber temperature



Chamber temperature distribution in Wheel -2 for a given run.
Maximum temperature is always below 22°C.

Contact: Umberto.Berzano@cern.ch