

CSC-RPC Associated Trigger Common Object

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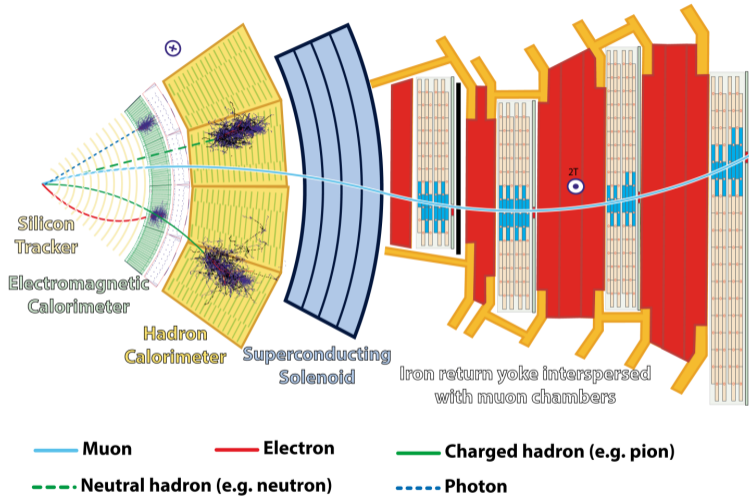
Advisor: Roumyana Hadjiiska

CERN Summer Students 2021

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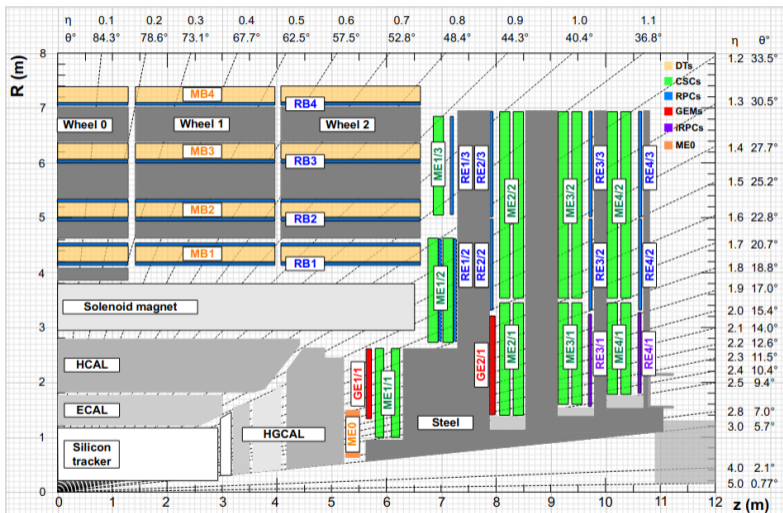
- 1 Introduction
- 2 The CMS detector
- 3 The Muon System
- 4 The L1-Trigger Level
- 5 The RPC-CSC common L1 trigger object
- 6 Methodology and Results
- 7 Conclusions and perspectives
- 8 Backup slides

The CMS detector



Source: CERN Document Server.

The Muon System



Source: CERN Document Server.

The L1-Trigger Level

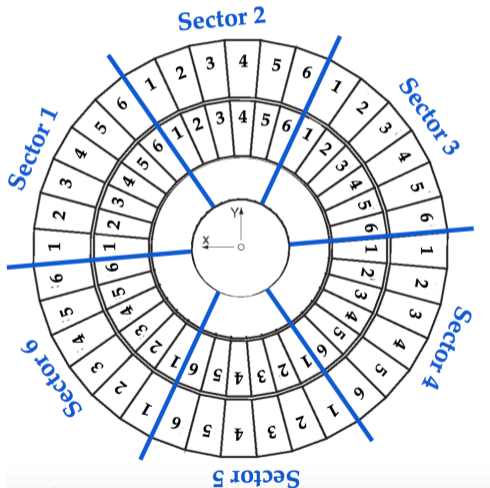


Source: CMS Collaboration.

- CAL Trigger + Muon Trigger → Global Trigger
 - CAL Trigger: Layer 1 receives Trigger Primitives from HCAL and ECAL and Layer 2 finds particle candidates and computes the global energy sums.
 - Muon Trigger: Three Muon Track Finders to reconstruct muons in the different regions which receives TPs from the muon detectors processed by different intermediate layers.

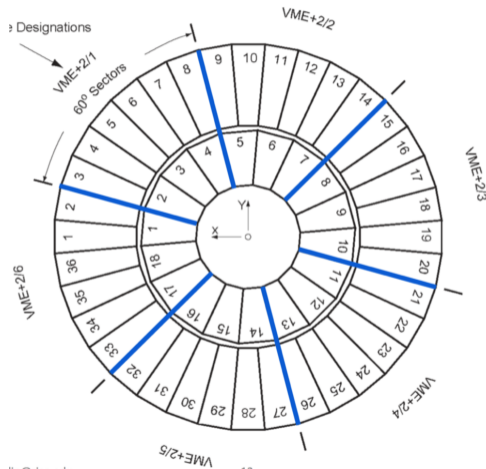
RPC and CSC endcap stations in x-y plane

RPC endcap stations



Source: CMS Collaboration.

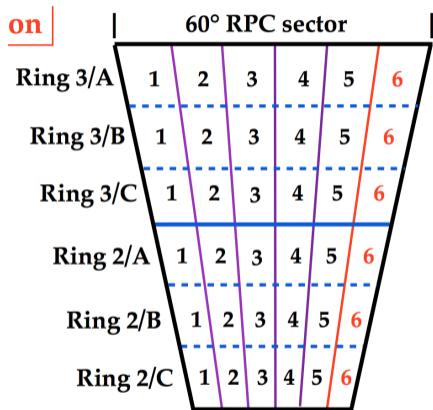
CSC endcap stations 2-4



Source: CMS Collaboration.

RPC and CSC endcap stations in x-y plane

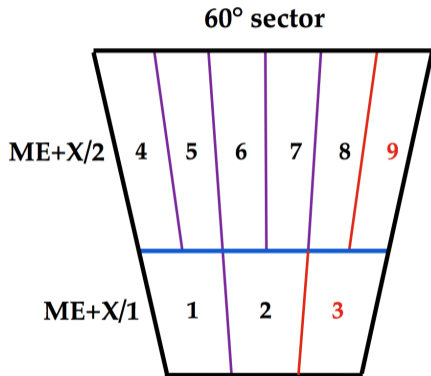
RPC endcap sector



All stations, $+\eta$ ($-\eta$ mirrored),
with neighbor subsectors

Source: CMS Collaboration.

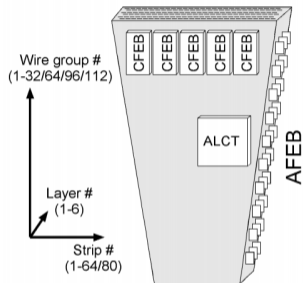
CSC endcap sector (2-4 stations)



Stations 2 - 4, $+\eta$ ($-\eta$ mirrored),
with neighbor chambers

Source: CMS Collaboration.

CSC chamber and objectives



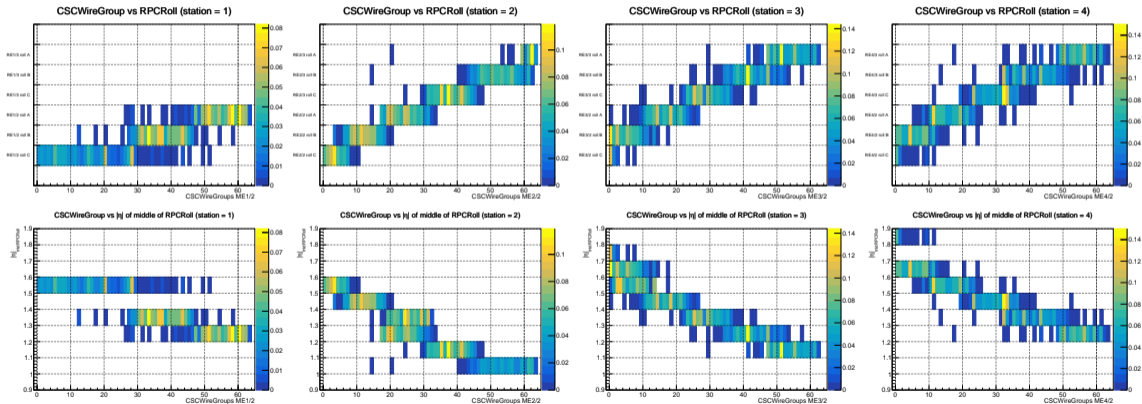
Source: CMS Collaboration.

- Check the feasibility of correlating each roll (η partition) of RPC to an CSC wire group range.
- Get the η value on global coordinates of CMS of the middle of the RPC roll to correlate to a CSC wire group range.
- Also check if it is possible to correlate the strip number of RPC to the CFEBs of CSC.
- The main objective of this work is to check the feasibility of building a superprimitive of RPC-CSC in L1 Trigger.
- It may help in low- p_T muon reconstruction for long-lived analysis, B-physics, veto fake muons, etc.
- MC data sample: 500,000 generated events of a muon pair of $p_T = 100$ GeV, $|\eta| < 1.9$, Run II geometry and no PU.

CSC wiregroups and RPC rolls

Preliminary matching criteria:

coincidence between region, station, chamber and bunch crossing.



The table of CSC wiregroups and RPC info

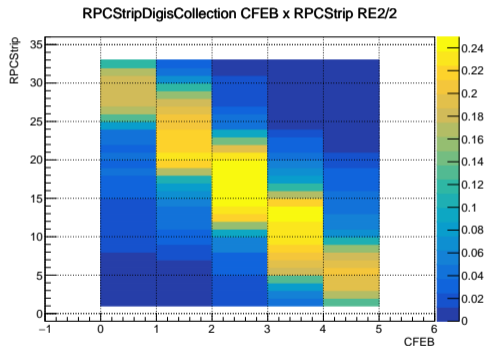
Station 2		
RPC roll name	CSC wire group	$ \eta $
RE2/2 roll C	01 - 08	1.53
RE2/2 roll B	09 - 18	1.41
RE2/2 roll A	19 - 31	1.29
RE2/3 roll C	32 - 45	1.18
RE2/3 roll B	46 - 58	1.08
RE2/3 roll A	59 - 64	1.01

Station 3		
RPC roll name	CSC wire group	$ \eta $
RE3/2 roll C	01 - 02	1.73
RE3/2 roll B	03 - 11	1.60
RE3/2 roll A	12 - 23	1.47
RE3/3 roll C	24 - 37	1.36
RE3/3 roll B	38 - 47	1.25
RE3/3 roll A	48 - 64	1.16

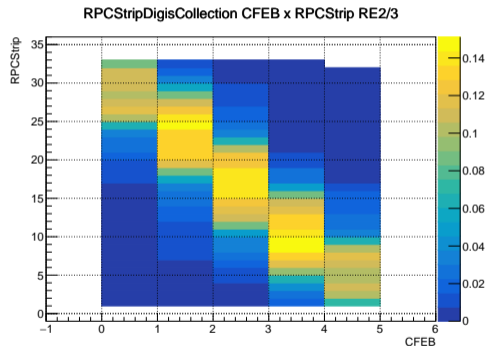
CSC CFEBs and RPC strip numbers

Preliminary matching criteria:

coincidence between region, station, chamber and bunch crossing.



Source: The Author



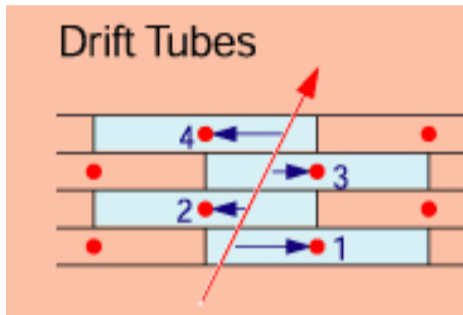
Source: The Author

Conclusions and perspectives

- It is possible to note a correlation between both CSC wire groups and RPC rolls and CSC CFEBs and RPC strips.
- The outliers dots and the overlap regions on the plots are due to the noises and the smearing effects.
 - In η direction, the smearing is due to the perfect matching just occurs when the muon trajectory is parallel to the beam axis, which is never true.
 - In ϕ direction, the smearing is due to the bending angle of the muons due to the magnetic field.
- This correlations leads to the possibility to map RPC FEBs and the CSC electronics to build a common object of RPC-CSC.
- Currently, to CSC build a correlated Local Charged Track, it is required at least four fired layers (two ALCT and two CLCT). It is possible to loose this criteria to 3 fired layer, which may be the case of low- p_T muons, but require a RPC digi, building the common object.

BACKUP SLIDES

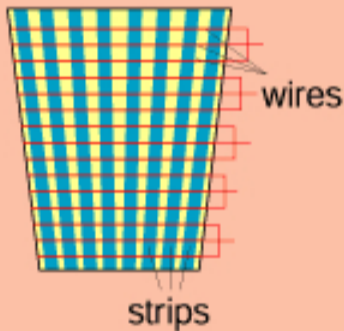
The Muon System: Drift Tubes



Source: Muon Drift Tubes.

- DTs are segmented into drift cells.
- Most used for precise space and time measurement.
- The position of the muon is determined by measuring the drift time to an anode wire of a cell with a shaped electric field.
- Barrel region: $0.9 < |\eta| < 2.4$.

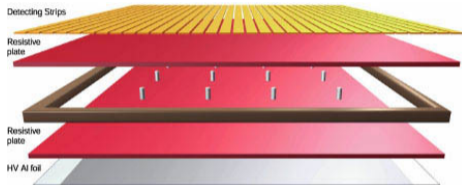
Cathode Strip Chamber



Source: Cathode Strip Chambers.

- CSCs operate as a standard multi-wire proportional counters, but add a finely segmented cathode strip readout, giving a precise measurement of the position.
- Each CSC module contains six layers making it able to accurately identify muons and match their tracks to those in the tracker.
- Endcap region: $0.9 < |\eta| < 2.4$

The Muon System: Resistive-plate chambers



Source: Resistive Plate Chambers.

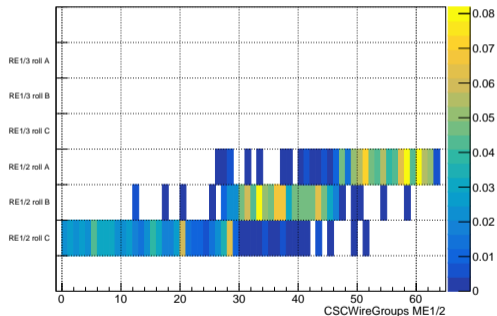
- The RPCs are double-gap chambers operated in avalanche mode.
- Provides an independent measurement for triggering purposes with a coarser space resolution but a fast time response for unambiguous bunch crossing assignment.
- Both Barrel and Endcap region:
 $|\eta| < 1.61$.

CSC wiregroups and RPC rolls

Preliminary matching criteria:

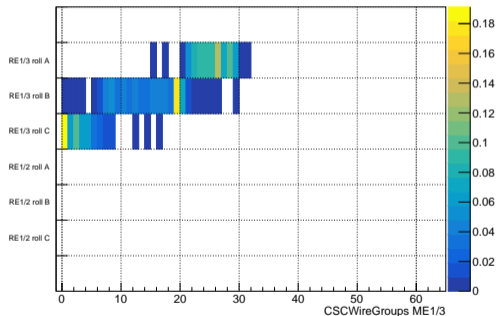
coincidence between region, station, chamber and bunch crossing.

CSCWireGroup vs RPCRoll (station = 1)



Source: The Author

CSCWireGroup vs RPCRoll (station = 1)



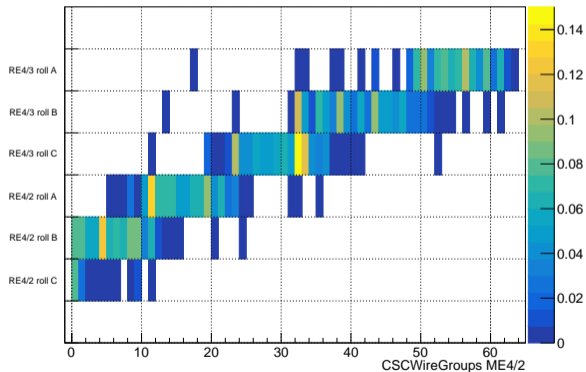
Source: The Author

CSC wiregroups and RPC rolls

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CSCWireGroup vs RPCRoll (station = 4)

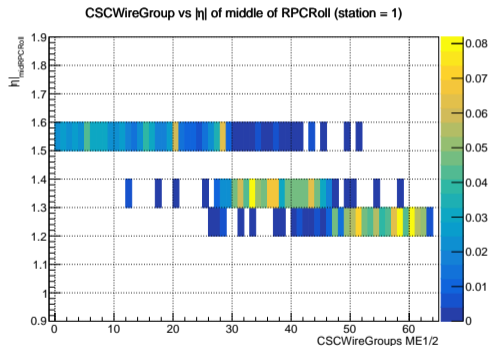


Source: The Author

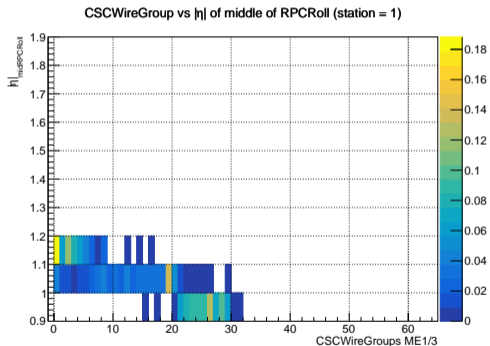
CSC wiregroups and η of the middle of RPC rolls

Preliminary matching criteria:

coincidence between region, station, chamber and bunch crossing.



Source: The Author

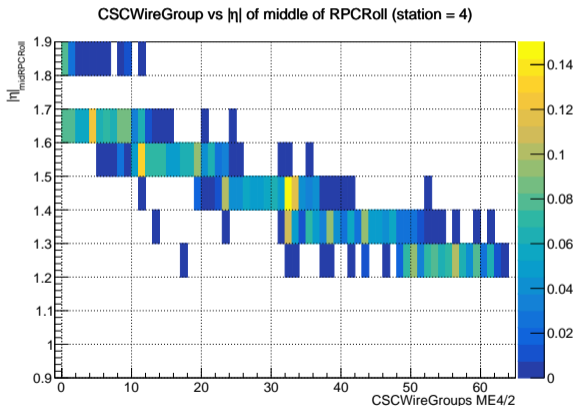


Source: The Author

CSC wiregroups and η of the middle of RPC rolls

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Source: The Author

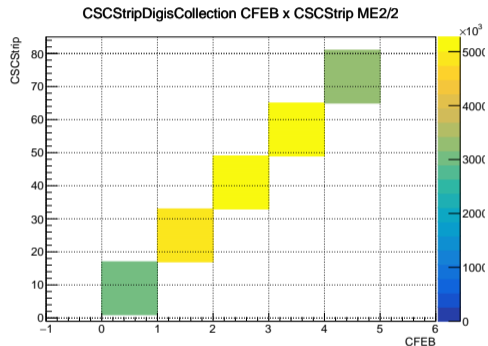
The table of CSC wiregroups and RPC info

Station 1		
RPC roll name	CSC wire group	$ \eta $
RE1/2 roll C	01 - 29	1.52
RE1/2 roll B	30 - 47	1.40
RE1/2 roll A	48 - 64	1.24
RE1/3 roll C	01 - 07	1.10
RE1/3 roll B	08 - 21	1.01
RE1/3 roll A	22 - 32	0.94

Station 4		
RPC roll name	CSC wire group	$ \eta $
RE4/2 roll C	01 - 02	1.81
RE4/2 roll B	03 - 11	1.68
RE4/2 roll A	12 - 23	1.55
RE4/3 roll C	24 - 36	1.44
RE4/3 roll B	37 - 48	1.33
RE4/3 roll A	49 - 64	1.24

CSC strips and CSC CFEBs

- There is a straight correlation between CSC strips and CSC CFEBs.
- If it is possible to require a correlation between CSC CFEBs and RPC strips, it is possible to correlate the strips of CSC and RPC.

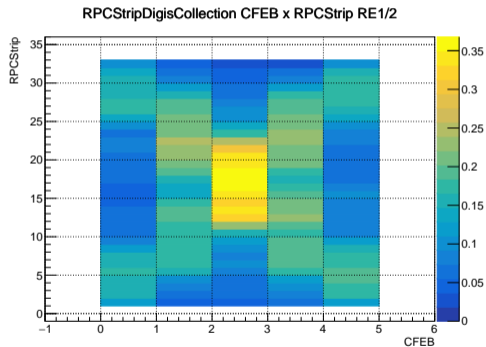


Source: The Author

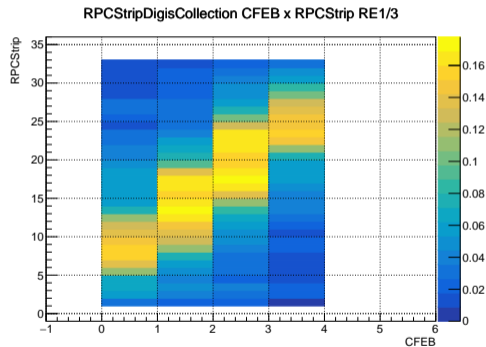
CSC CFEBs and RPC strip numbers

Preliminary matching criteria:

coincidence between region, station, chamber and bunch crossing.



Source: The Author

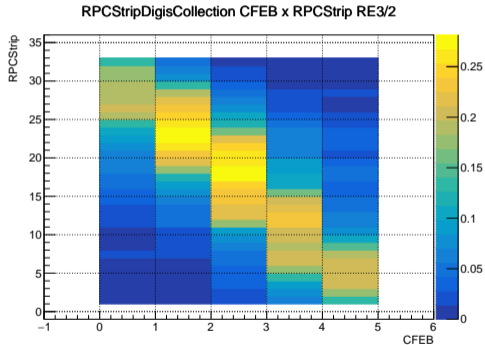


Source: The Author

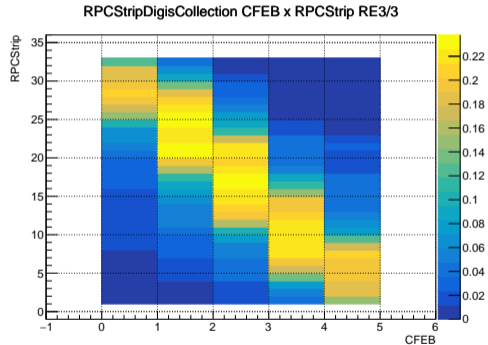
CSC CFEBs and RPC strip numbers

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Source: The Author

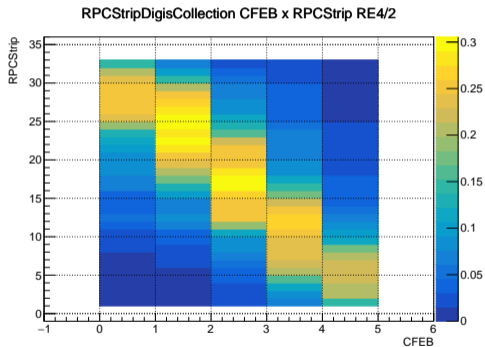


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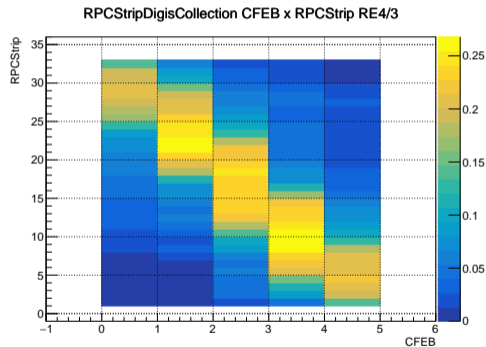
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Source: The Author



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