CMS RPC Longevity Studies

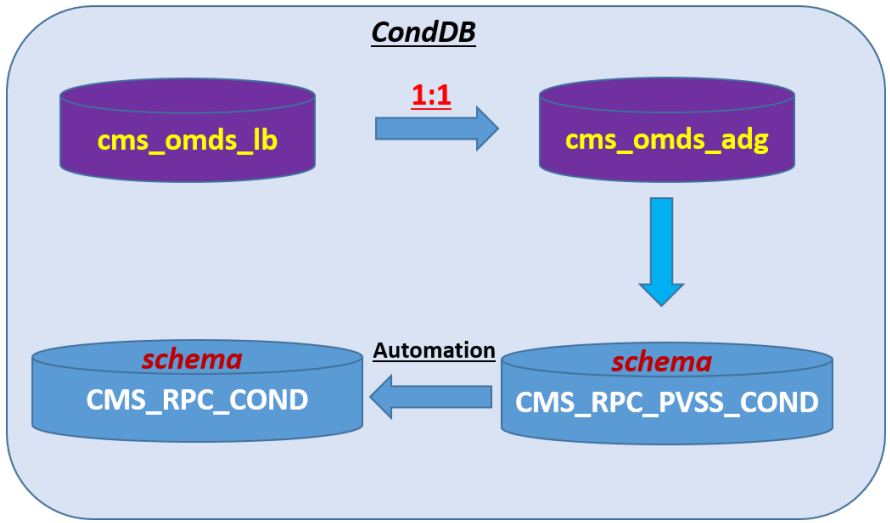
Osvaldo Miguel Colín

Universidad Iberoamericana

July 9, 2020

DCS

CMS stores its conditioning data in the CMS ORACLE Database; the RPC group has two schemas in this database. The CMS RPC PVSS COND schema is locked and dedicated only for the Detector Control System (DCS) so it can write raw condition data coming from the RPC detector, such as: currents, gas flow rates and environmental parameters.



The second, CMS RPC COND schema, is designed to store analyzed RPC conditioning data.

RPC Automation

The RPC Automation is designed to retrieve raw asynchronous data from the CMS RPC PVSS COND schema, analyze, inject important information from external non-RPC schemas, synchronize, re-order and store it in the CMS RPC COND schema.

Asynchronous Data → Synchronous Data

VMON	IMON	STATUS	CHANGE DATE
8800			02.12.2016 22 hrs
	1.6		02.12.2016 23 hrs
		0	03.12.2016 0hrs
7700			03.12.2016 1hrs
…		1	
9000			03.12.2016 22 hrs
	16		03.12.2016 23hrs
9000			03.12.2016 22 hrs
8800			03.12.2016 23 hrs

VMON	IMON	STATUS	FLAG	TDELTA	CHANGE DATE
8800	1.6	0	24	3600	03.12.2016 0hrs
7700	1.0	0	12	…	03.12.2016 1hrs
…					
9000	16.0	1	24	3600	03.12.2016 22 hrs
8800	1.0	1	24	3600	03.12.2016 23hrs
9000	16.0	1	24	3600	04.12.2016 0 hrs
8800	1.0	1	24	…	04.12.2016 1 hrs
…					

Synchronously means that whenever any of the RPC parameters changes outside of its archiving dead band, the rest of the parameters should be copied under the same time-stamp, e.g. the monitored current (imon), the rest of the recorded parameters like monitored voltage (vmon) and actual status (actual status), should be copied in to the new record.

Automation Schema

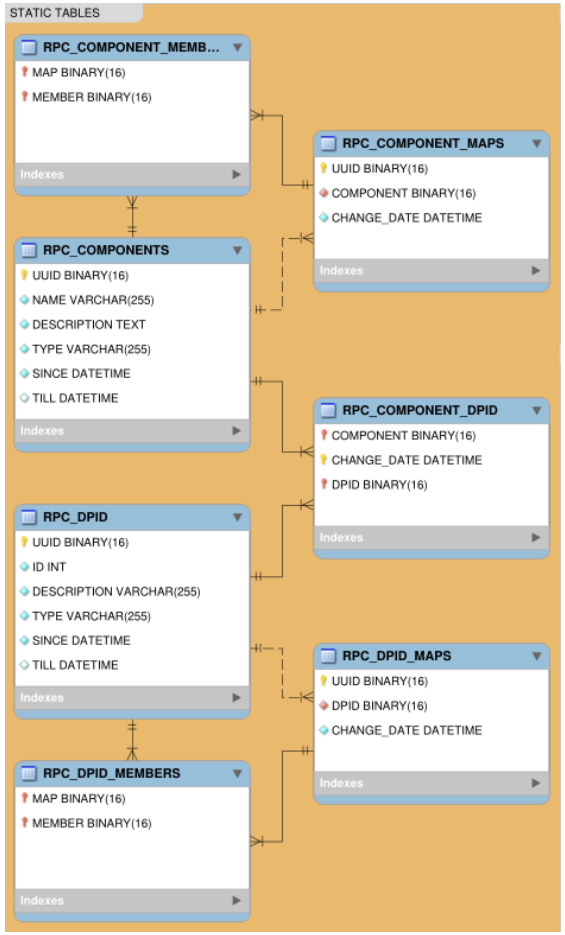
The RPC Automation data is stored in 35 tables in the CMS RPC COND schema in the cms omds lb database. These 35 tables are organized in the following groups:

- Static Tables
- Automat Tables
- Auxilary Tables
- Work Tables
- RPC Static Tables

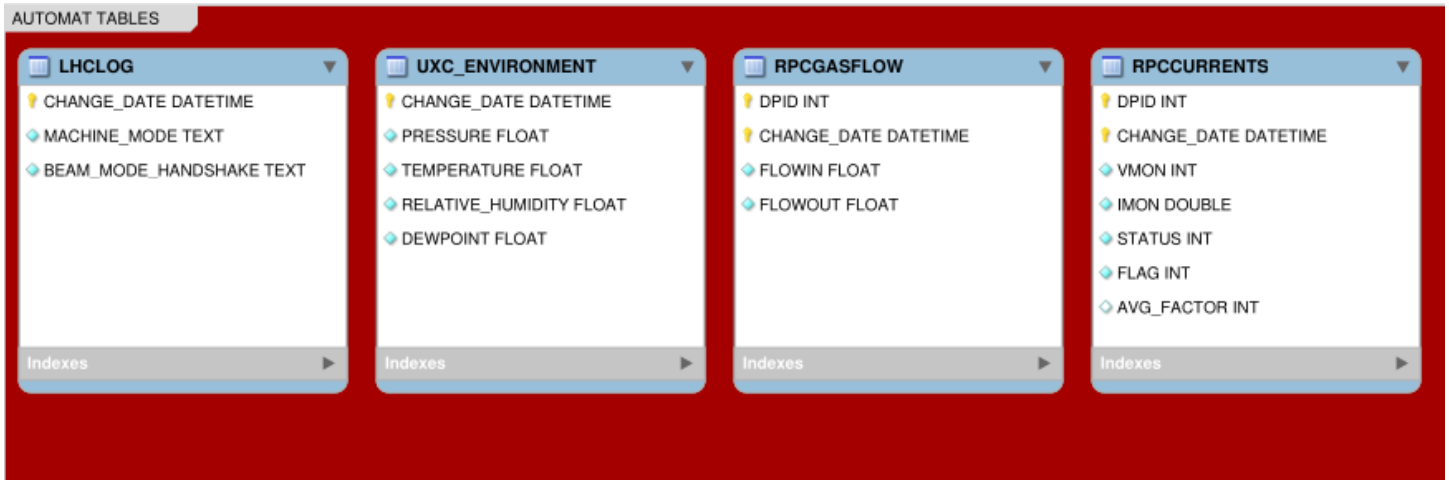
Static Tables

These tables are designed to store the geometry and assigned sensors of each detector. Inside the automation, detectors are known as components.

Virtual components are those that physically don't exist, however they represent an average behavior of various detectors.

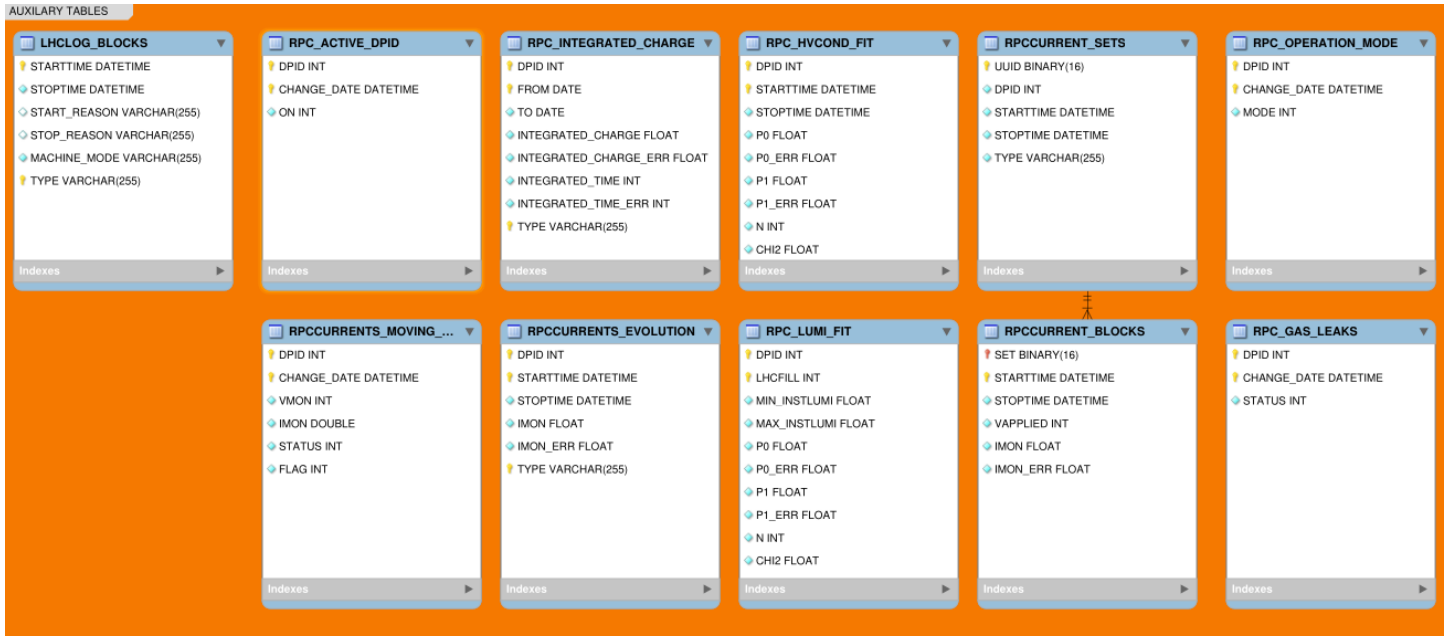


Automat Tables



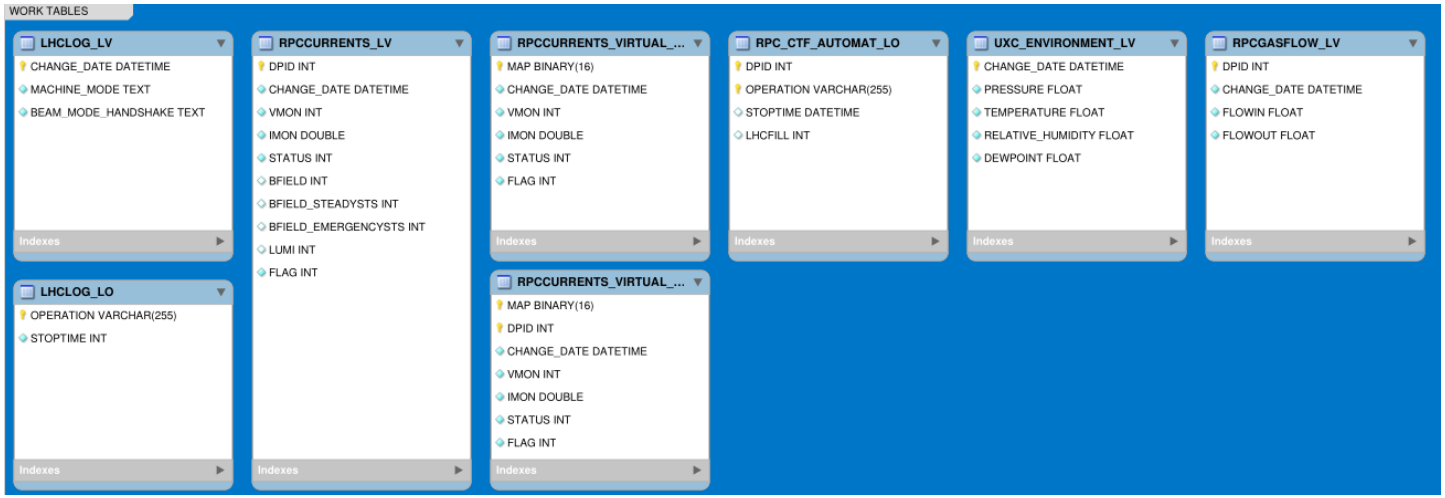
As the system synchronizes the raw data from the CMS RPC Conditioning data, all relevant data is stored in these tables for later studies.

Auxiliary Tables



Once the system has finished synchronizing the data, it goes to the auxiliary tables and updates the studies.

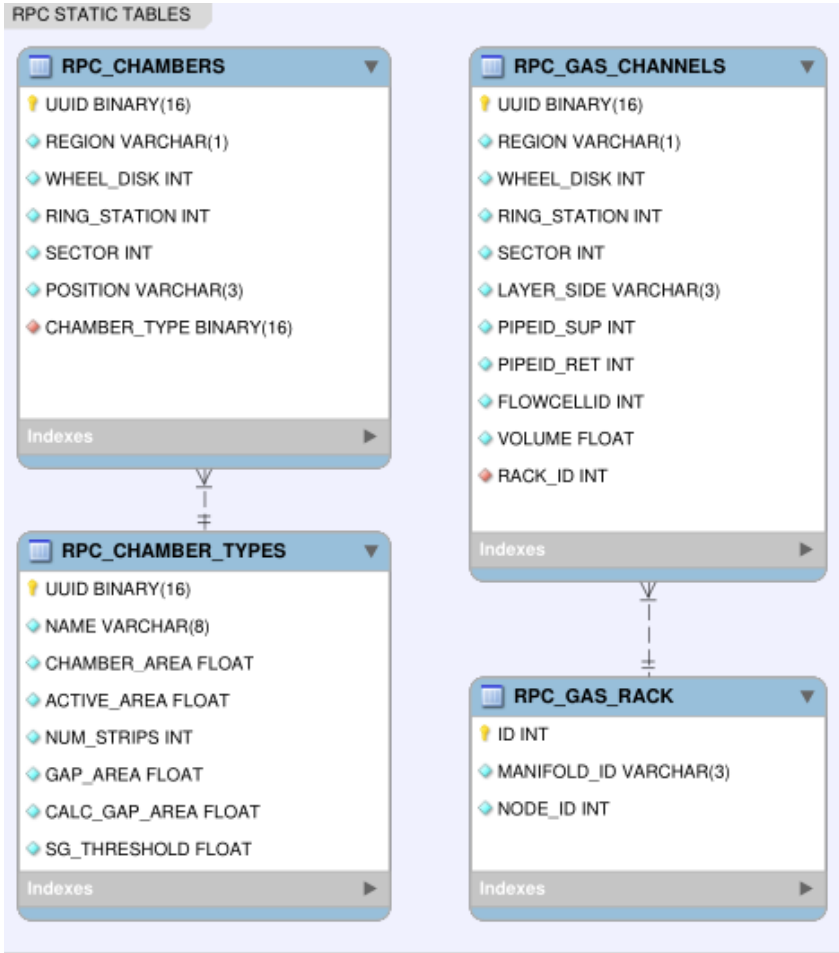
Work Tables



As the automation goes on, the system stores its current state in the work tables. These can be thought of as snapshots of the system.

RPC Static Tables

This is where the RPC group describes their detectors. These descriptions contain information such as: gap area, strip length, etc..



Data Tagging

The main automate of the RPC automation is the RPCCURRENTS automate, which is in charge of flagging all the currents recorded in the FWCAENCHANNEL table in CMS RPC PVSS COND.

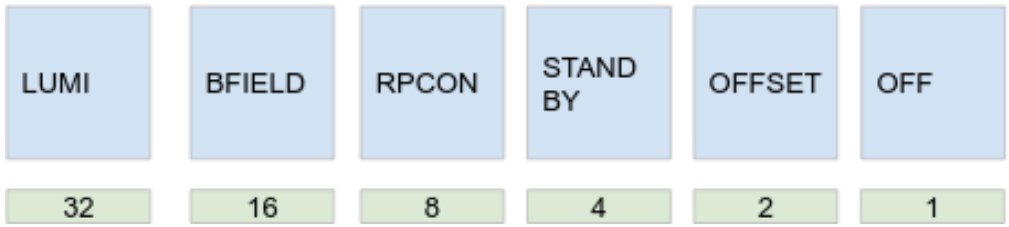
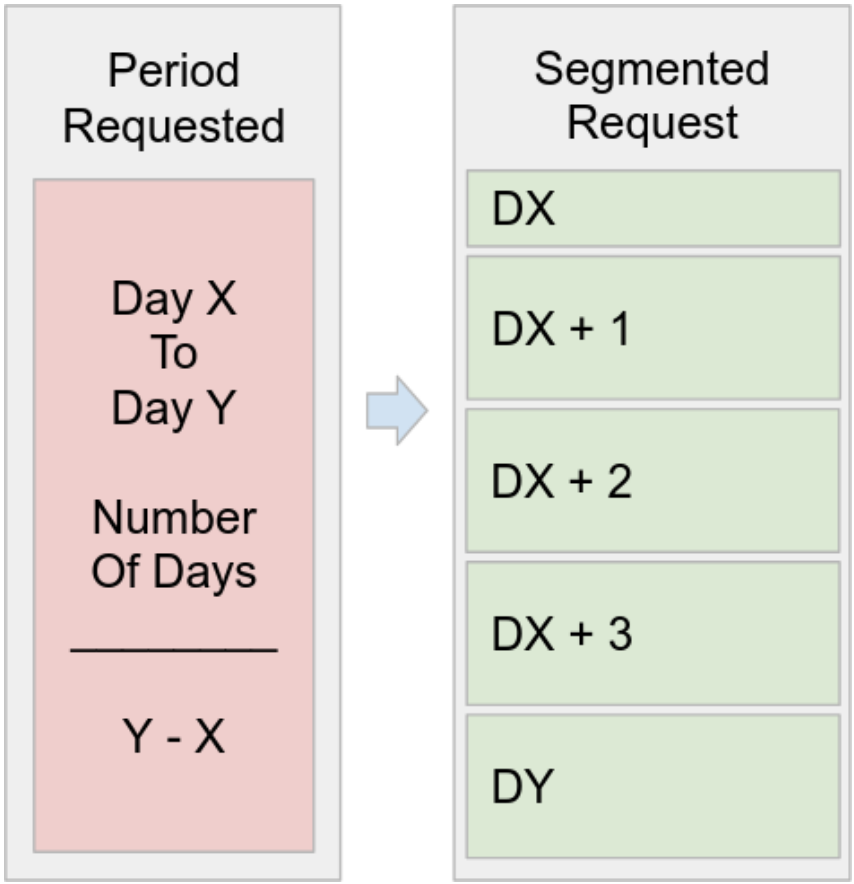
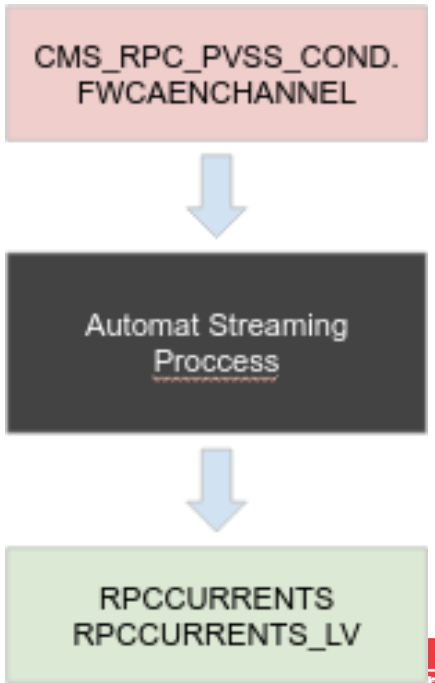


Figure: Binary Flag

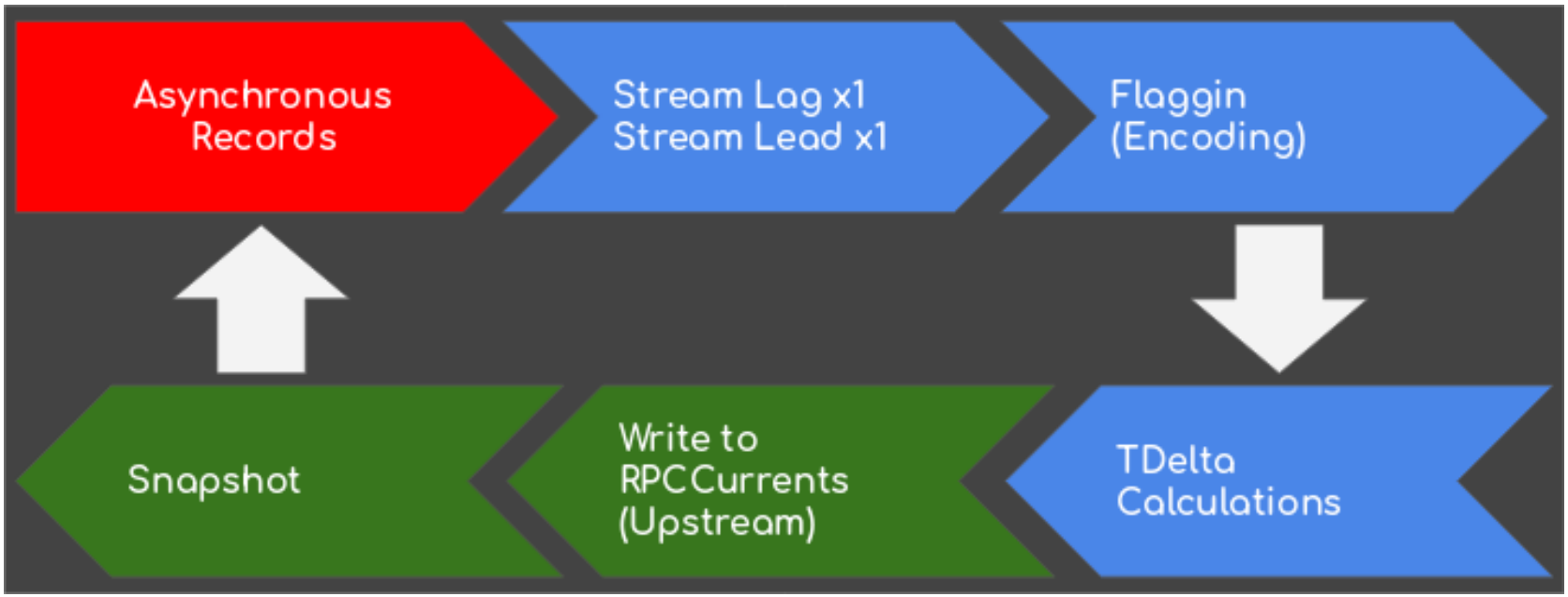
Divide and Conquer



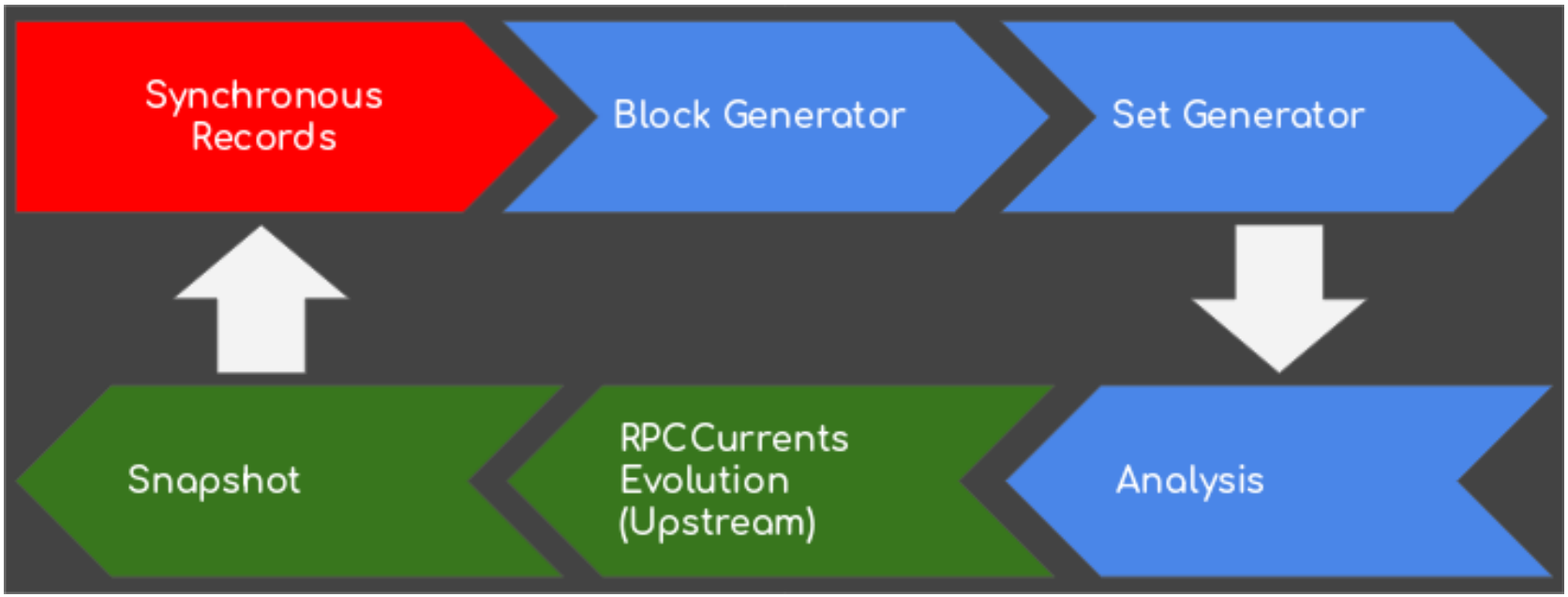
Due to the huge amount of records read, multi-threading techniques are used to divide the load into smaller chunks (days). The retrieved data is then sent to a "black box".



RPCCURRENTS AUTOMAT

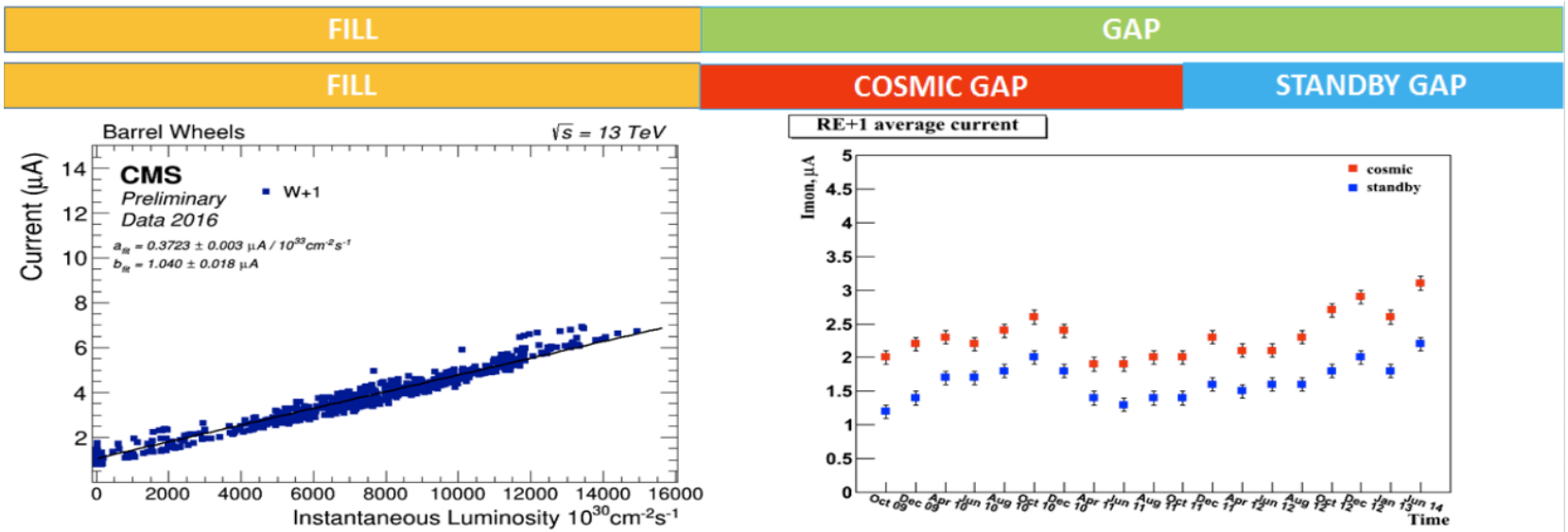


RPCCURRENT PROBES



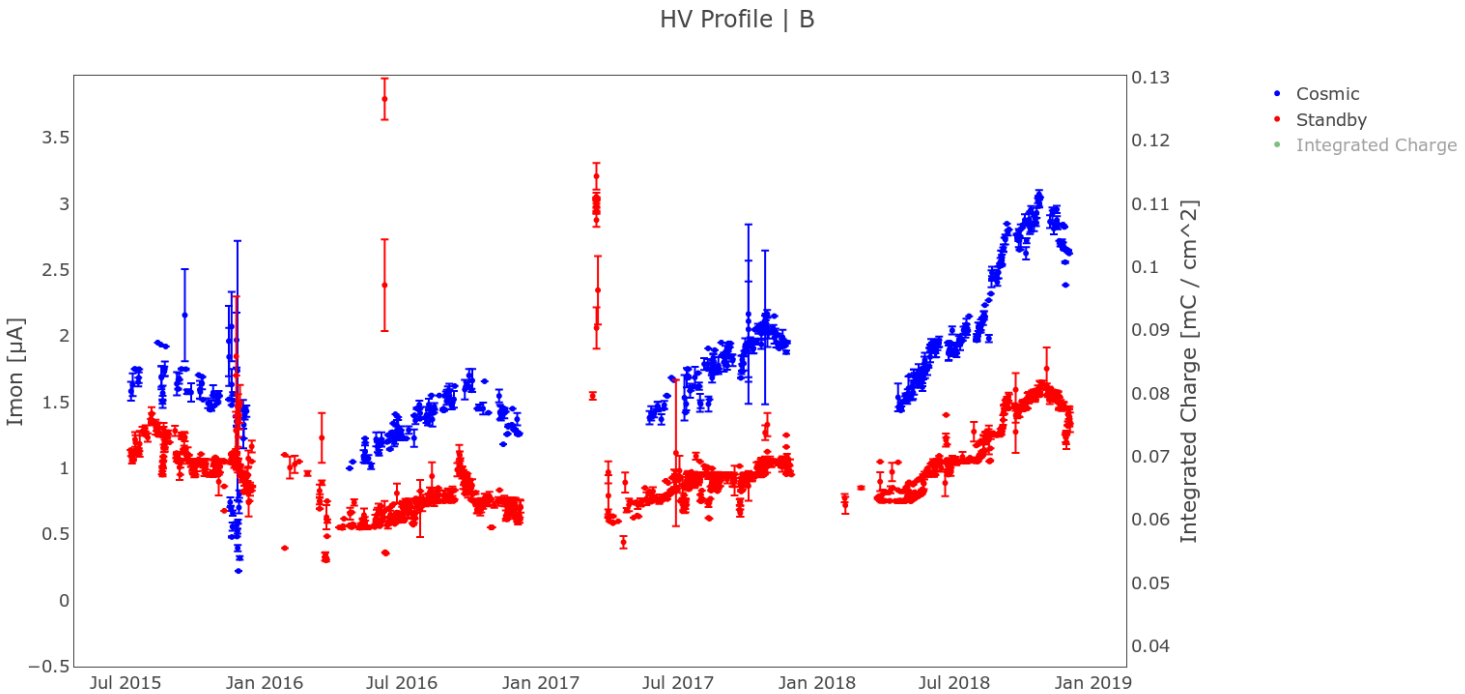
Current Evolution

The currents evolve in time and have different behaviors depending on the LHC MACHINE MODE. We will only discuss 3 of these: fill, cosmics and standby.



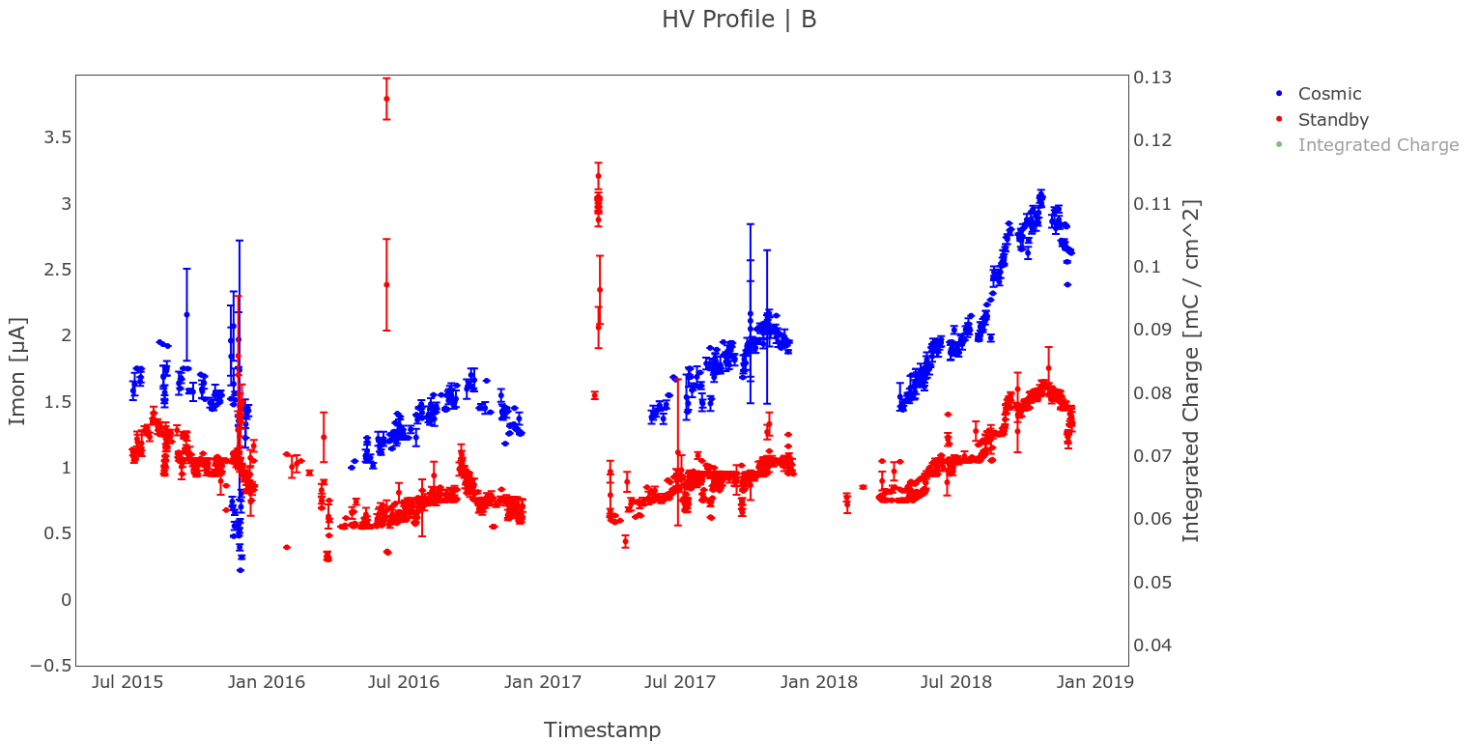
Standby Currents

These are currents produced by the RPC when set to 7000. They should be stable in time, because they represent the detector's normal operation current; at this point there isn't any gas gain.

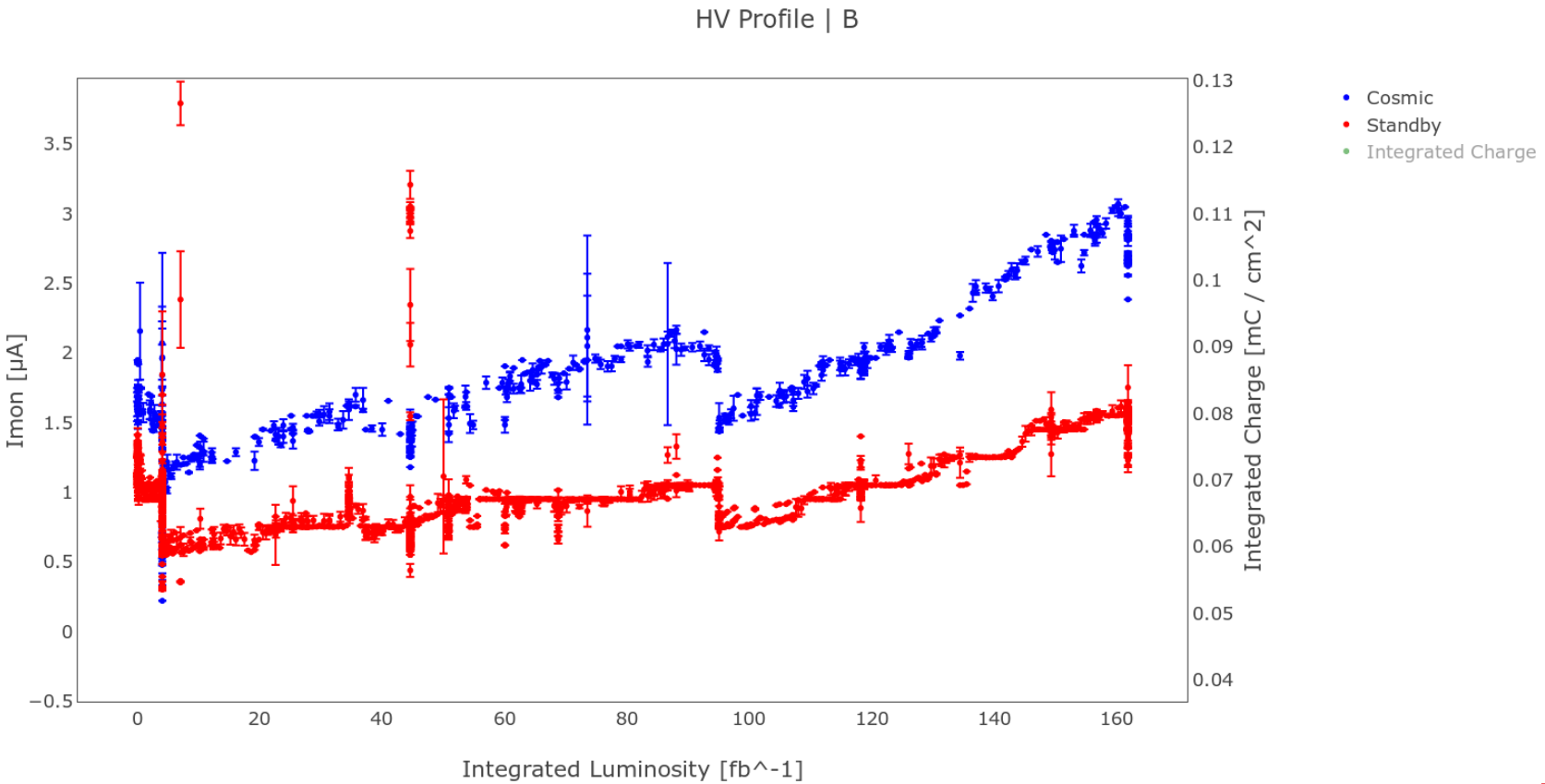


Cosmic Currents

Currents produced by the RPC when set to Working Point HV, hence we see gas gain; currents due to background emerge.



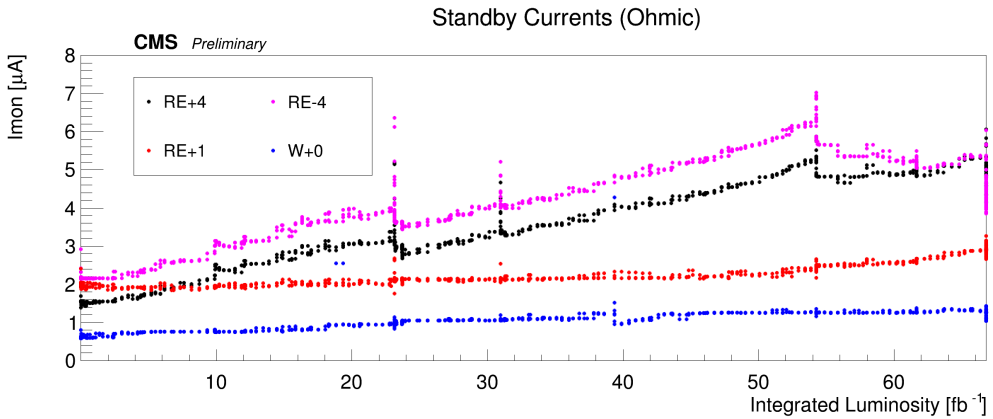
Current Profile vs luminosity

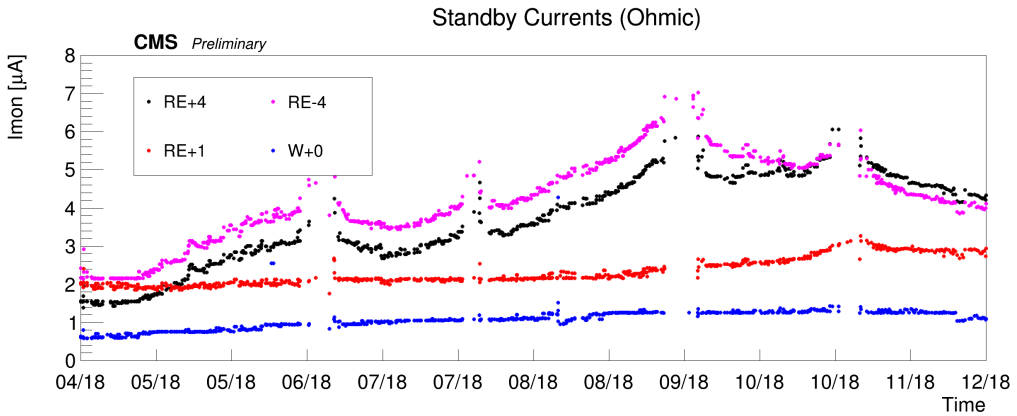


Aging and Recovery

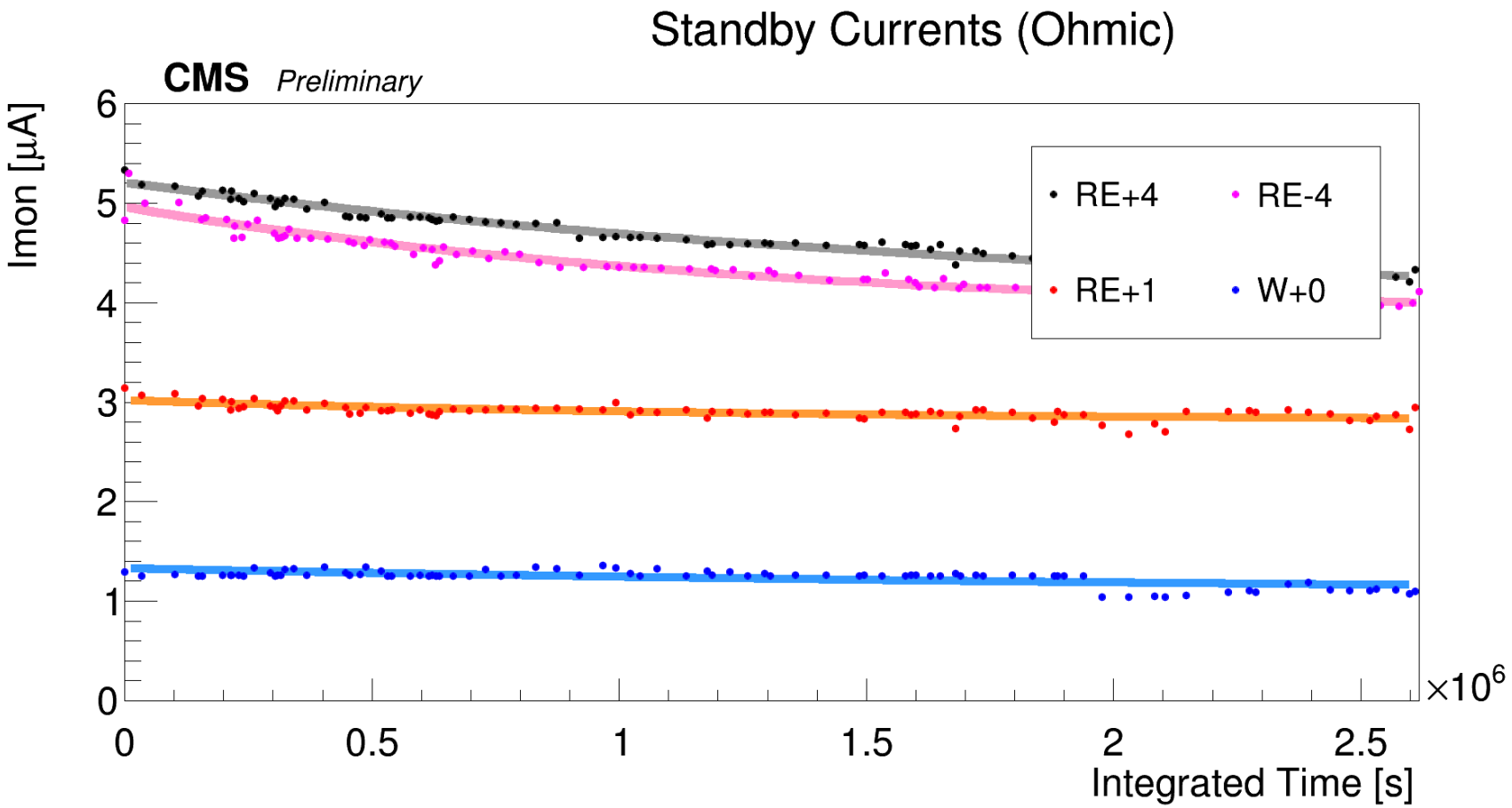
The increase in the ohmic currents (standby) were observed during proton-proton collision periods. However at the end of Run2, LHC ran in heavy ion collisions during 1 whole month. This was an important event for those of us studying aging effects, because this allowed us to observe how the detectors reacted when at working point HV and gasflow. The result was the mysterious decay in the currents we observed during technical stops.

Aging


Standby Currents (Ohmic)
CMS Preliminary
Imon [μA]
RE+4
RE-4
RE+1
W+0
Integrated Luminosity [fb⁻¹]


Standby Currents (Ohmic)
CMS Preliminary
Imon [μA]
RE+4
RE-4
RE+1
W+0
04/18
05/18
05/18
06/18
07/18
07/18
08/18
08/18
09/18
10/18
10/18
11/18
12/18
Time

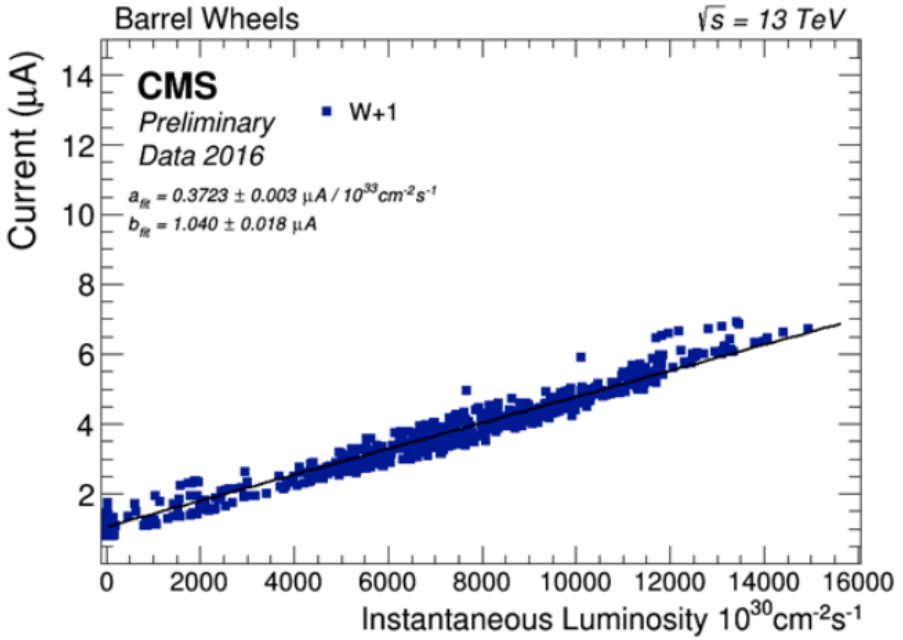
Recovery


Standby Currents (Ohmic)
CMS Preliminary
Imon [μA]
RE+4
RE-4
RE+1
W+0
×10^6
Integrated Time [s]
0
0.5
1
1.5
2
2.5
0
1
2
3
4
5
6

Luminosity Fits

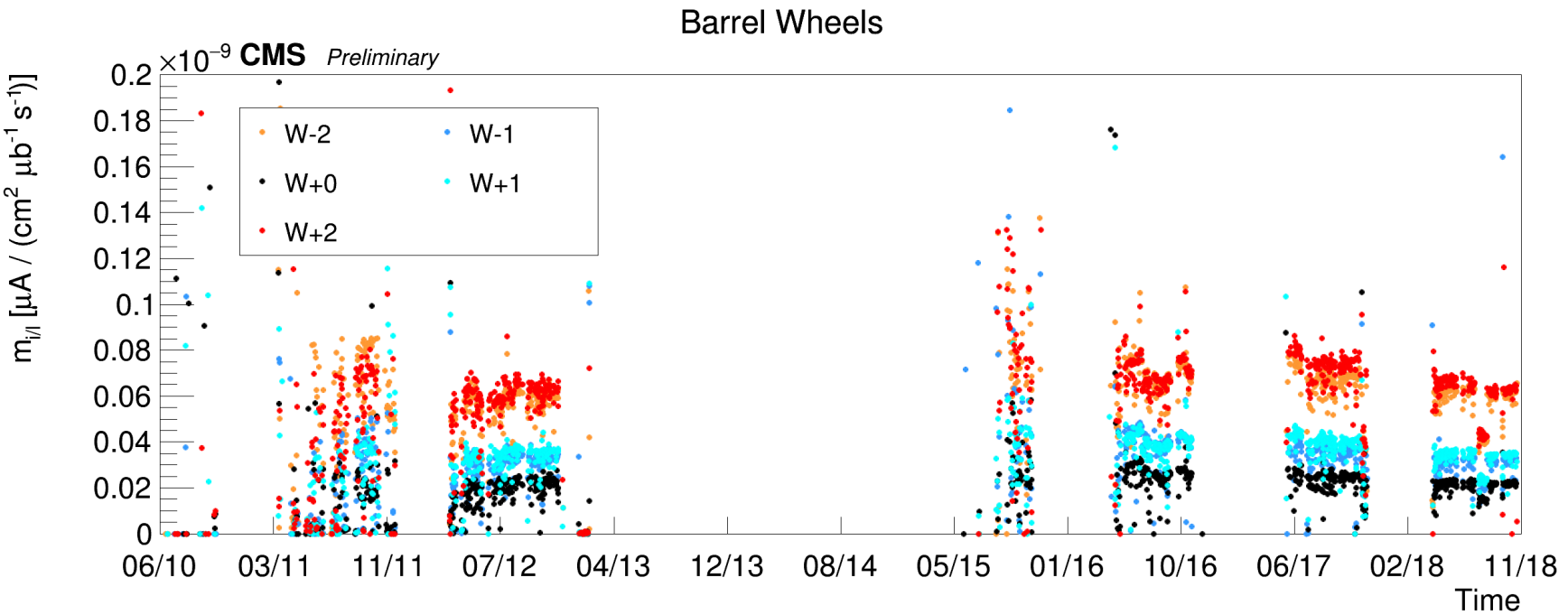
The RPC Automation system includes an automate that fits the currents vs inst. luminosity in each LHC Fill. The relation between these 2 parameters is completely linear, following the function:

$$I_{mon} = m * L_{inst} + I_{offset}$$



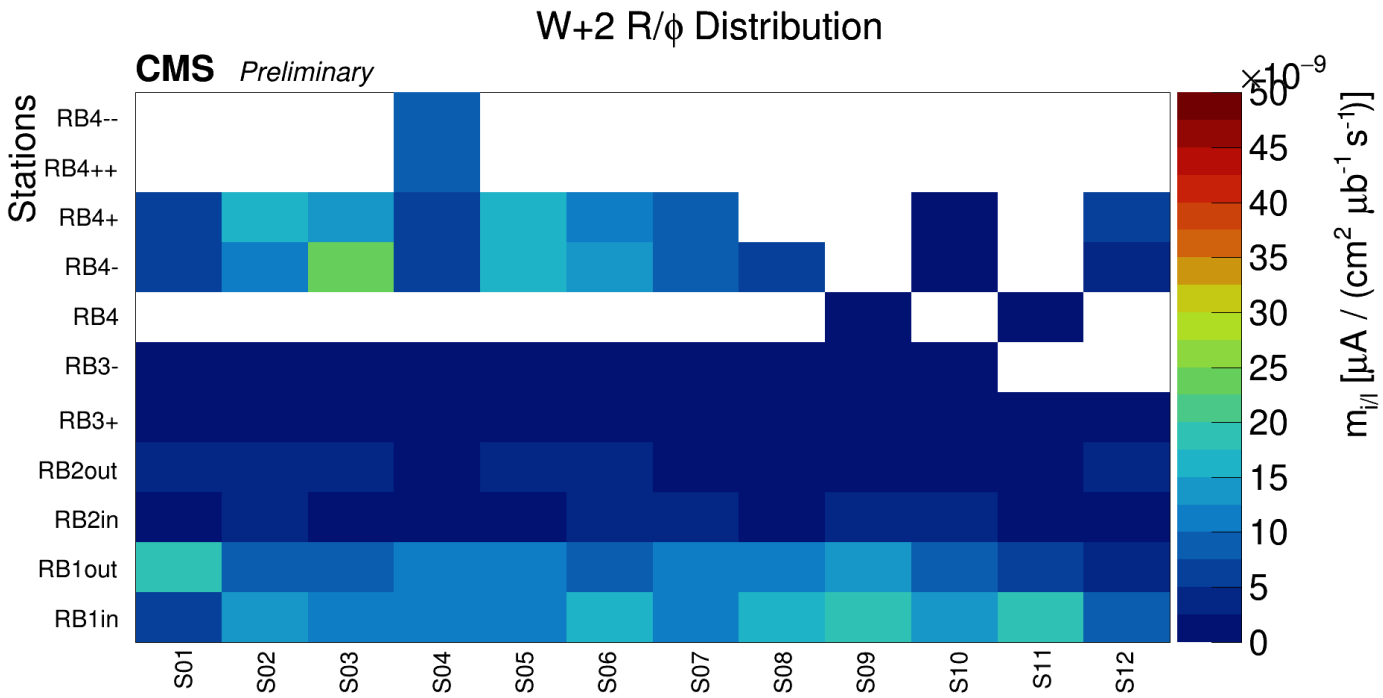
Slope in Time

The slope should be a stable, because it's the physical response of the detector to the luminosity.

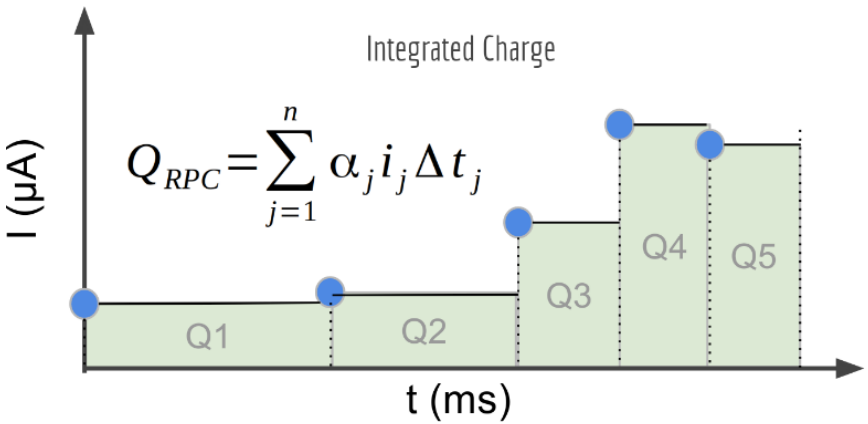


Slope R/ϕ 2D distribution - Snapshot LS2

Given that the slope is the real response of the detector to the inst. luminosity we can assume that this should follow the same behavior as the noise distributions of the CMS RPC Detector.



Integrated Charge



Operationally this is a simple task, it consists in taking each current and multiplying it by its duration, i.e. $Q = I * \Delta t$.

The current measured from the RPC is of the order of μA, hence its integration in time gives μC.

Currently we calculate 3 variations of the integrated charge:

- RPC_ON
- COLLISION
- COLLISION_NO_COSMIC

Integrated Charge Comparisons

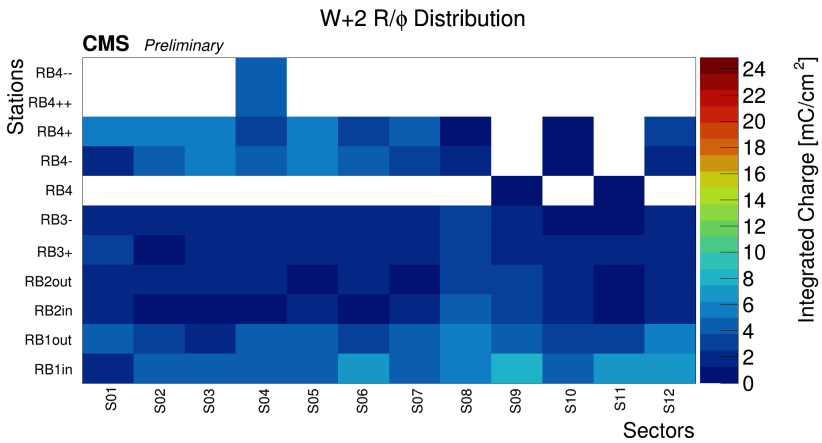


Figure: RPC ON

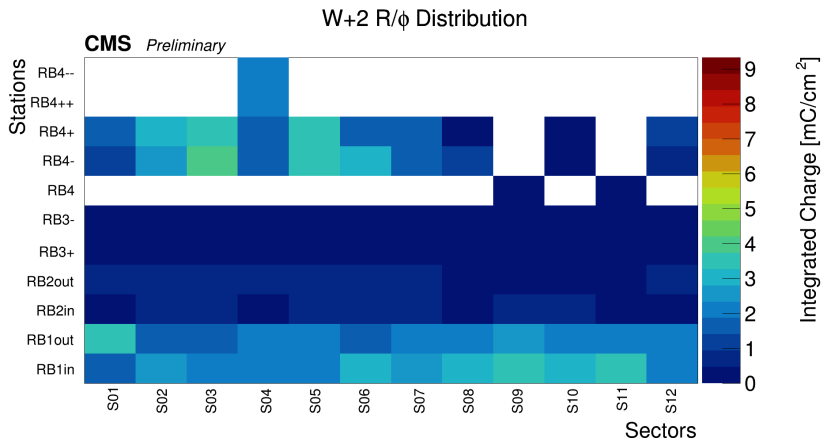


Figure: Collision no cosmics

The most important distinction between these two plots is the magnitud of the values. Note how in the left plot the highest values are around 12mC whilst in the right plot these values are around 5mC.

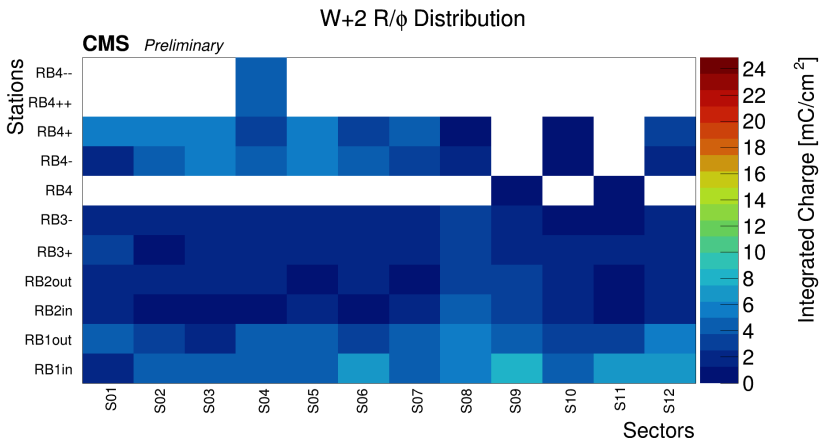


Figure: RPC ON

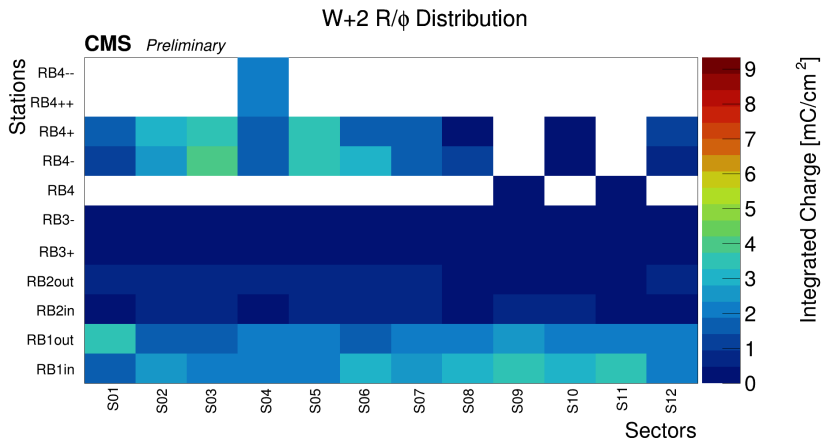
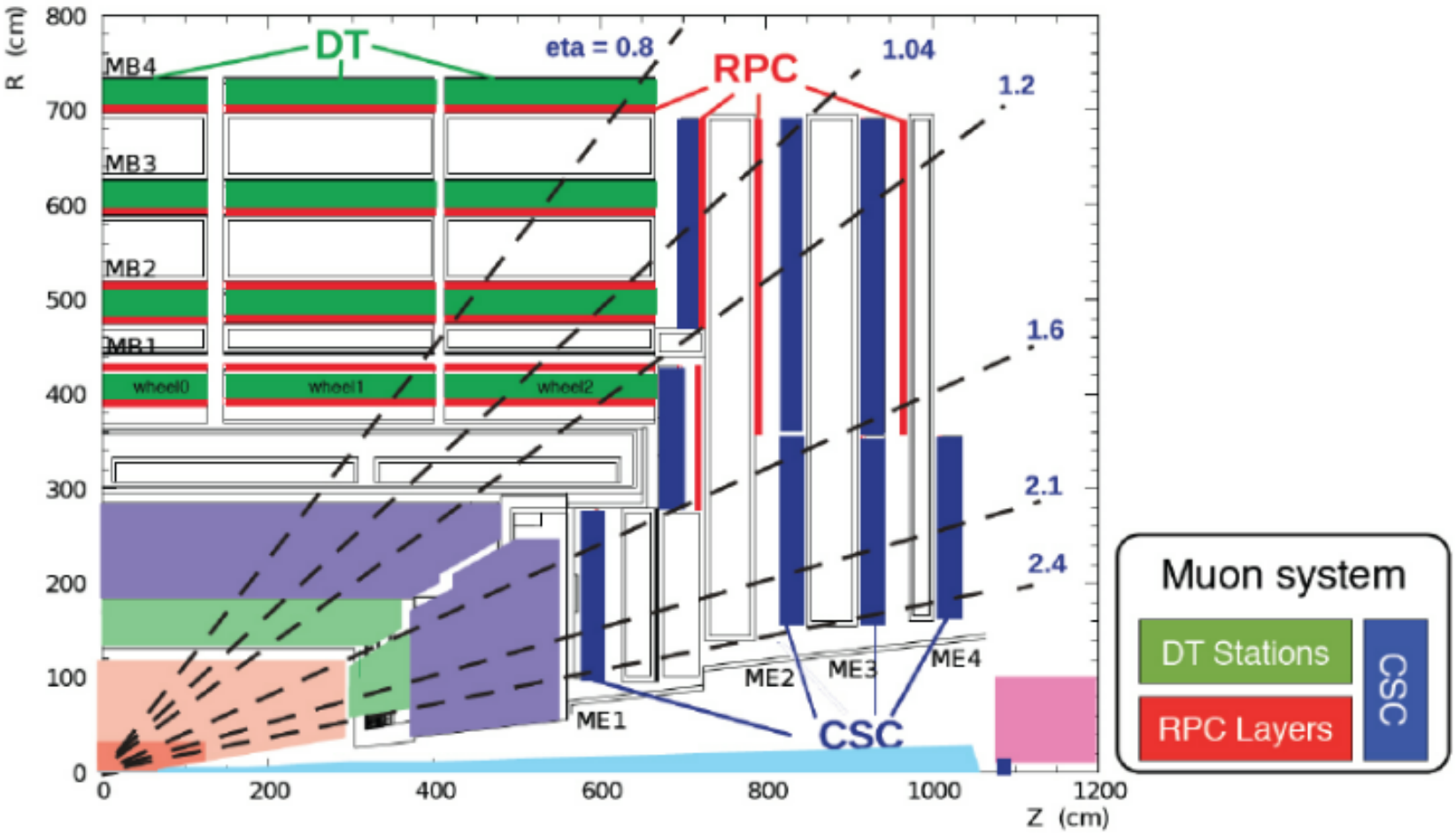


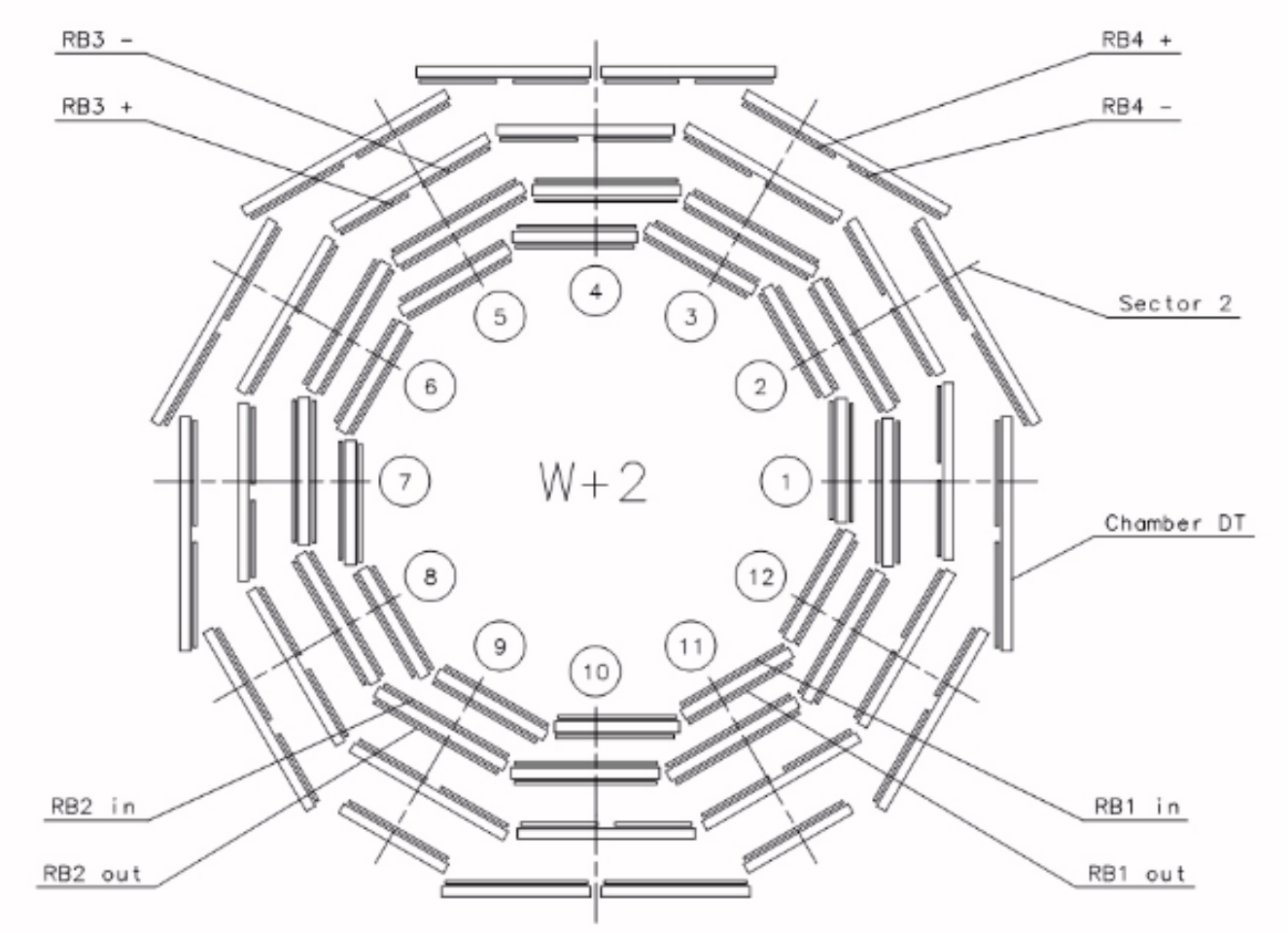
Figure: Collision no cosmics

The second most important feature are the hot zones. Observe the plot on the left, you can see that there are random hot spots in zones where it should be cold (low radiation), whilst the plot on the right shows a uniform behavior.

The End

Thank you for your attention!


R (cm)
Z (cm)
DT
RPC
CSC
eta = 0.8
1.04
1.2
1.6
2.1
2.4
MB4
MB3
MB2
MB1
wheel0
wheel1
wheel2
ME1
ME2
ME3
ME4
Muon system
DT Stations
RPC Layers
CSC


RB3 -
RB3 +
RB4 +
RB4 -
Sector 2
Chamber DT
RB2 in
RB2 out
RB1 in
RB1 out
W+2
1
2
3
4
5
6
7
8
9
10
11
12