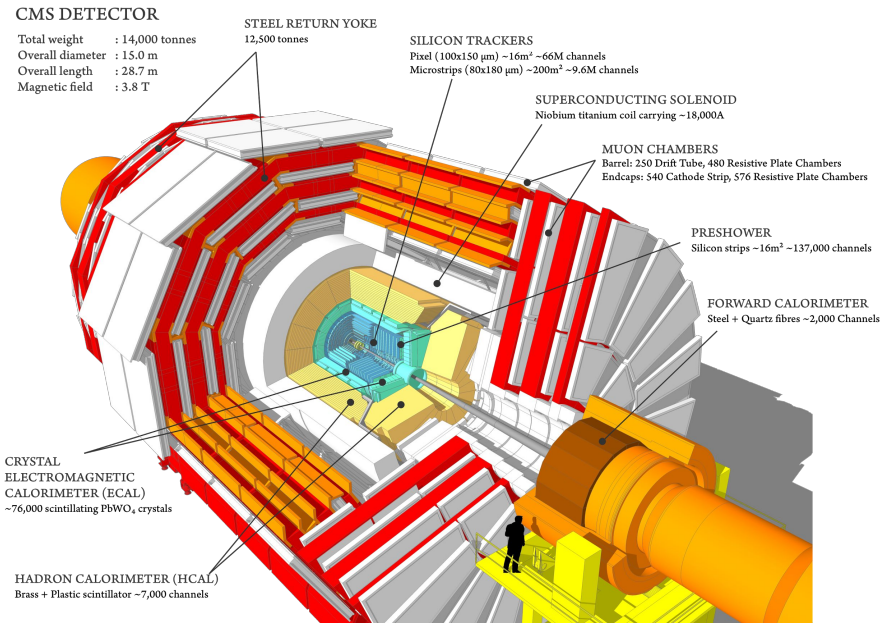
Longevity studies of the CMS RPC detector

Integrated Charge

Osvaldo M. Colin

CMS detector



https://twiki.cern.ch/twiki/bin/view/CMSPublic/SketchUpCMS

CMS Muon System

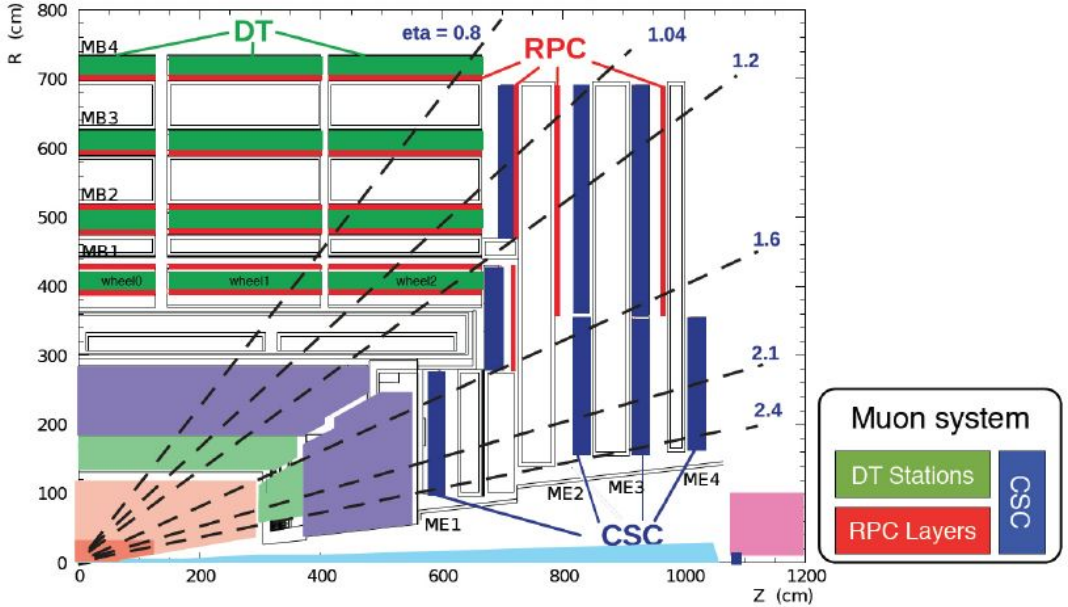


Figure 1: Longitudinal layout of one quadrant of the CMS detector. The four DT stations in the barrel (MB1–MB4, green), the four CSC stations in the endcap (ME1–ME4, blue), and the RPC stations (red) are shown. [5]

CMS RPC Barrel Wheel Layout

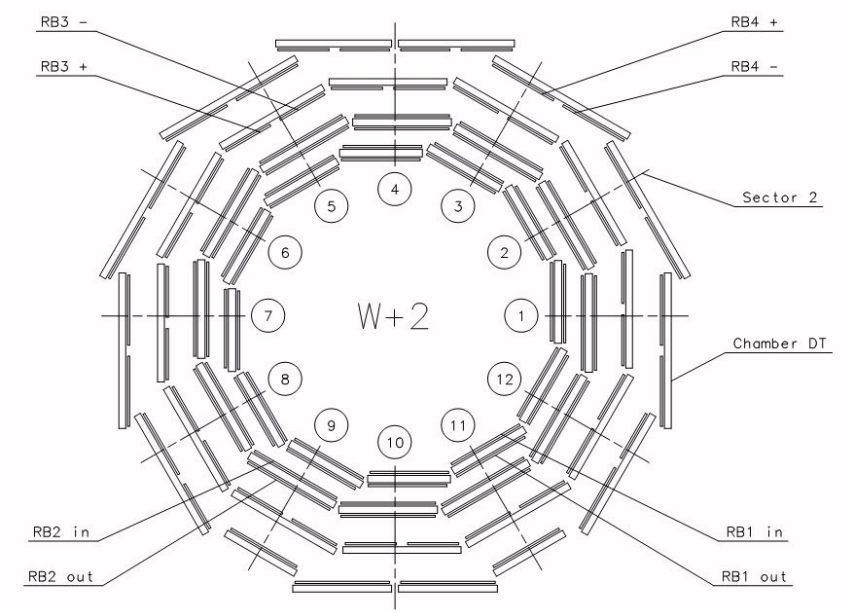


Figure 2: Schematic layout of one of the 5 barrel wheels, which are labeled –2, –1, 0, +1, and +2, respectively. Each wheel is divided into 12 sectors that are numbered as shown. [4]

CMS RPC Endcap Disk Layout

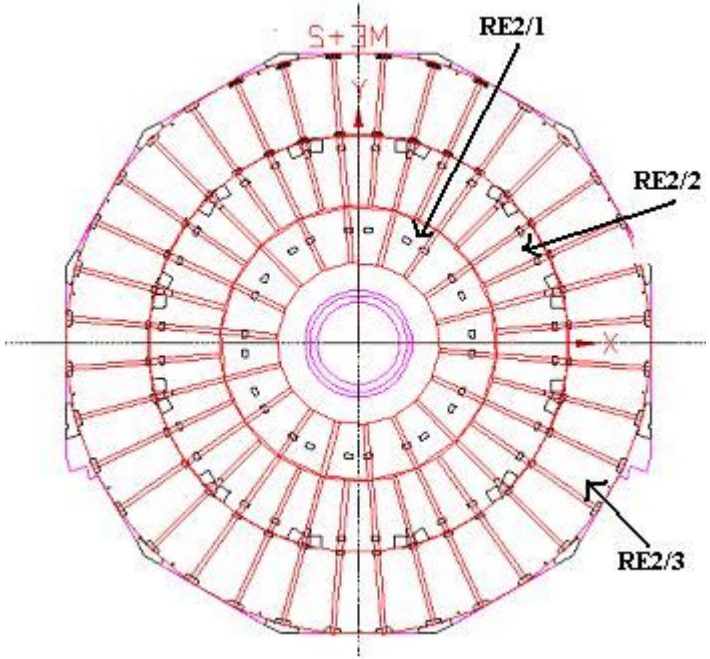


Figure 3: Schematic r-φ layout of RPC station RE2 on the back side of the first endcap yoke. [4]

CMS RPC

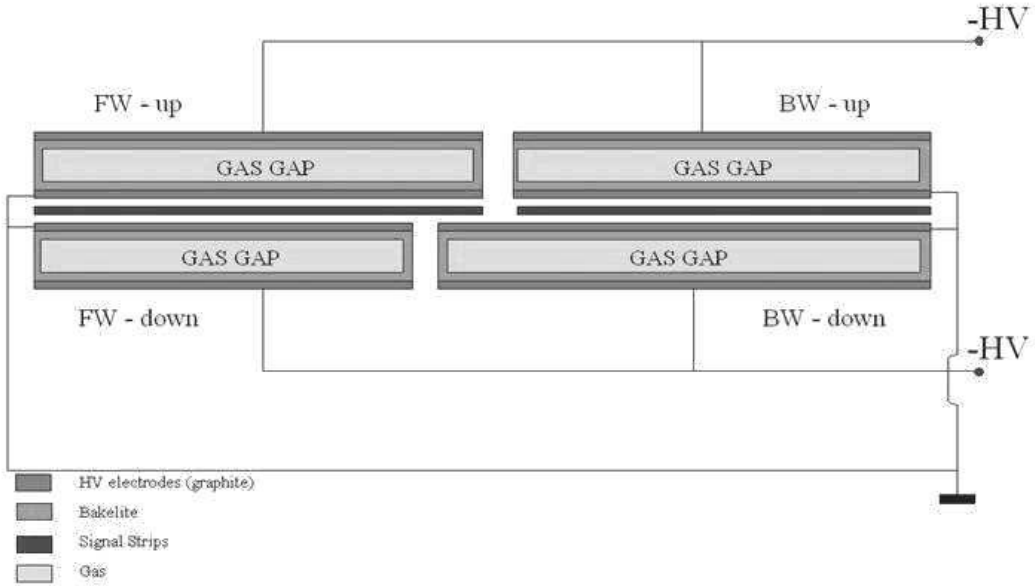
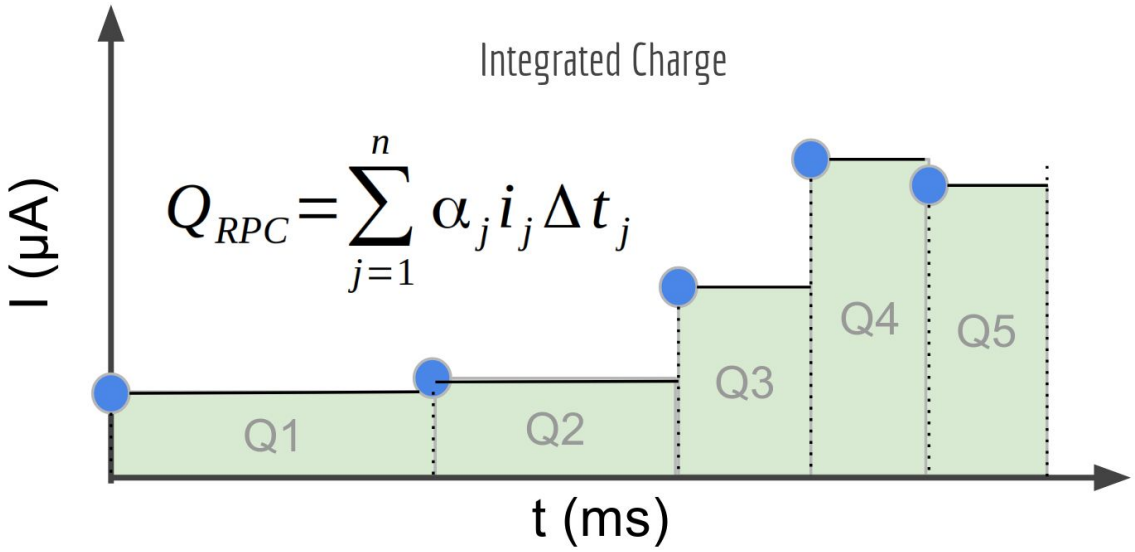


Figure 4: A barrel RPC chamber made by two double-gaps and with a strip plane in the middle. [3]

Integrated Charge



α: 1 when RPC ON, 0 otherwise

i: Current measured by the CAEN module

Δt: Duration of the current

The RPC currents have 2 currents that must be subtracted on integration: Ohmic and Offset

Figure 5: Representation of the currents integrated in time.

Filtering and Integrating

Detector Control System (DCS) → FWCAENCHANNEL [CHANGE LOG]

The DCS reads the HV Channels and records their changes into the FWCAENCHANNEL.

Not all of the currents contribute to the integrated charge.

How do we know which currents to integrate ?

We only consider the currents that satisfy the following:

1. The voltage must be above 8790V
2. The status must be 1

Filtering and Integrating

The DCS records thousands of records per second

The aging effects should only be studied while the detectors are being irradiated.

In other words, only when LHC reports luminosity and stable beams, and the CMS Magnet is on.

Some of the currents that comply with the requirements mentioned, may also be accidents or tests… meaning that we don't want to include them in the estimation.

In previous estimations the integrated charge could only be estimated through an indirect method.

Using modern programing techniques such as data streaming in combination with multithreading algorithms.

It is now possible to obtain a more realistic estimation of the integrated charge.

The integrated charge has been normalized to the RPC gap area in order to obtain the density of the integrated charge in [C/cm^2].

- In the endcap regions of CMS, the muon rates and background levels are high [3]
- The hottest regions of the barrel are located in the furthermost (RB4) and innermost (RB1) stations to the interaction point. (See Fig. 2)

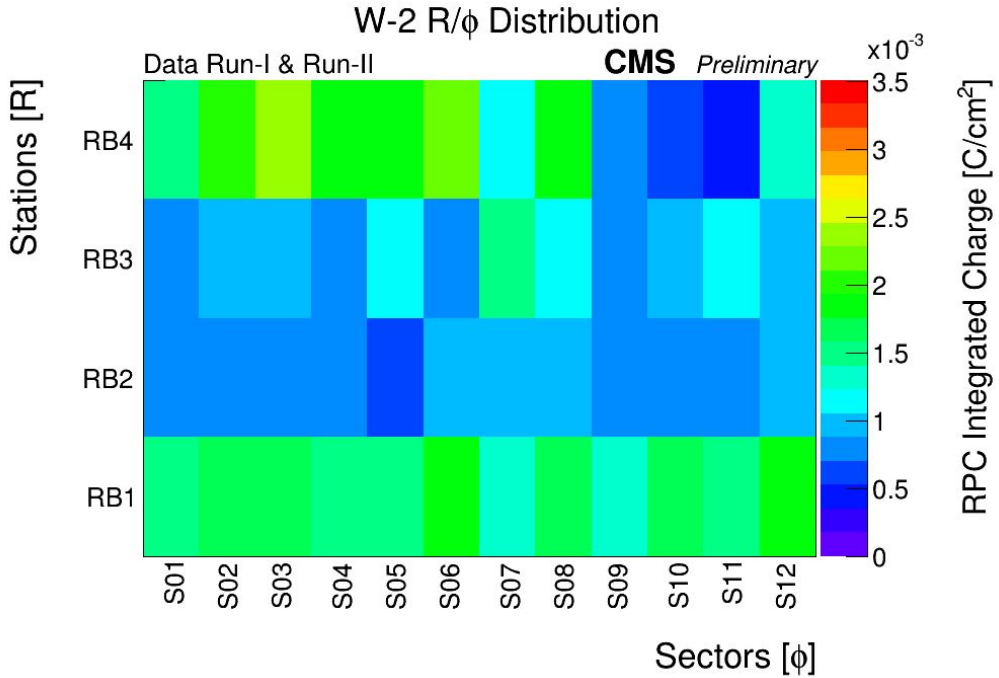
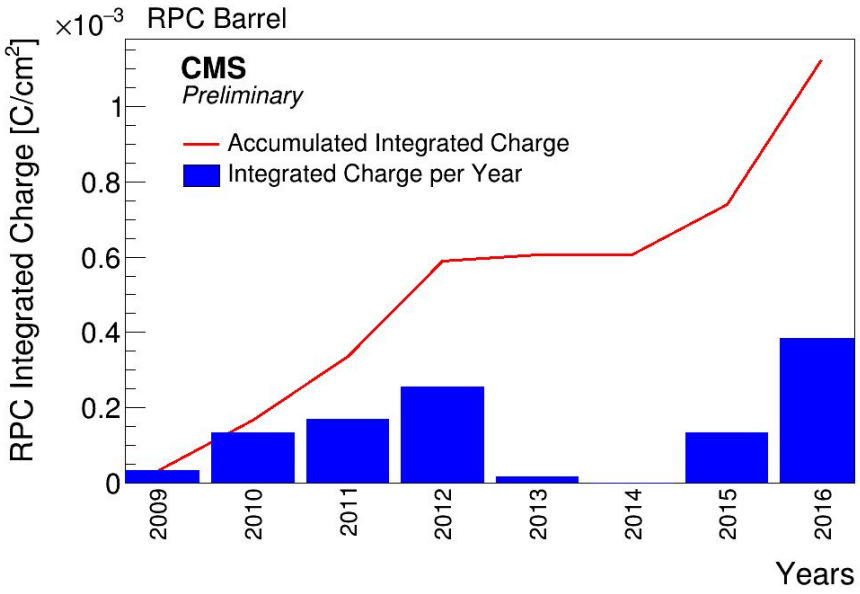


Figure 6: RPC Barrel Integrated Charge Density: R/Φ Distribution for wheel W-2, Run-I and Run-II period.

CMS RPC Barrel IC



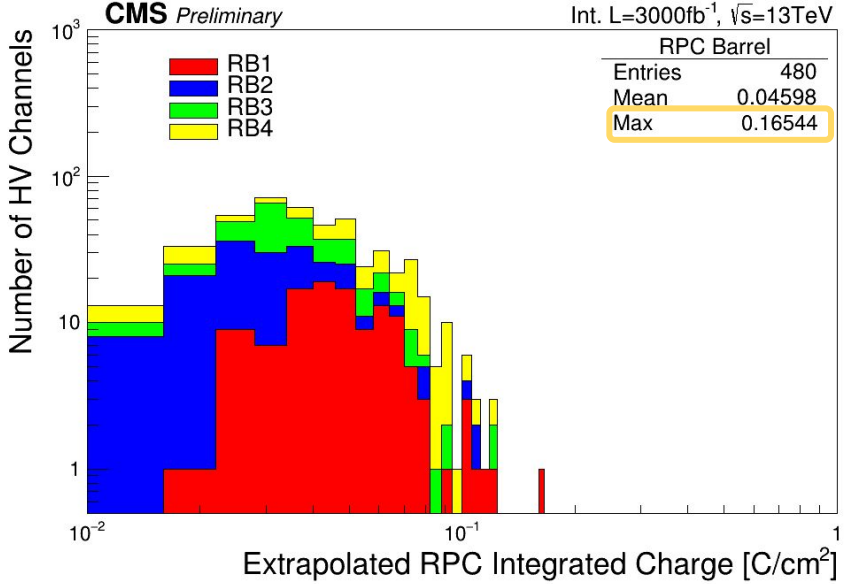
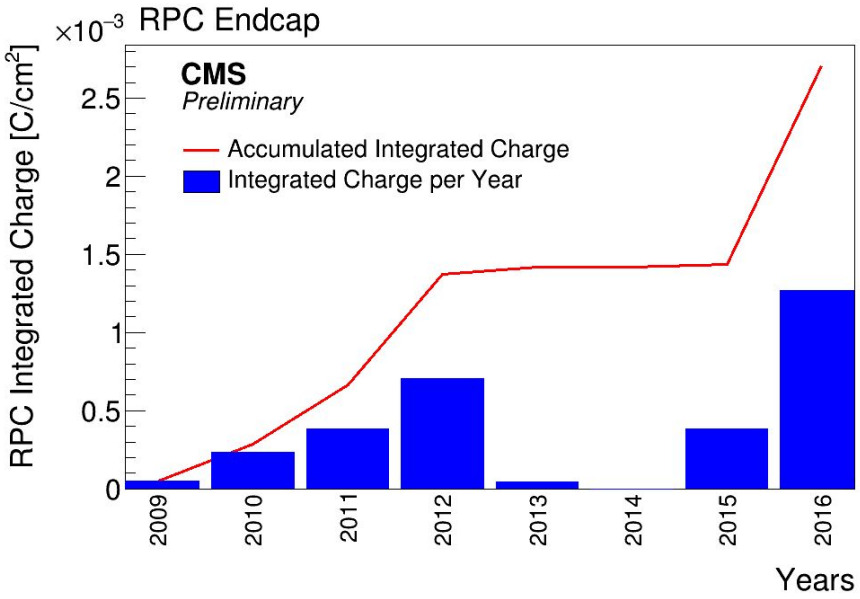


Figure 7: Left: RPC Barrel Integrated Charge in Time, Right: RPC Barrel Extrapolated Integrated Charge Distribution

CMS RPC Endcap IC



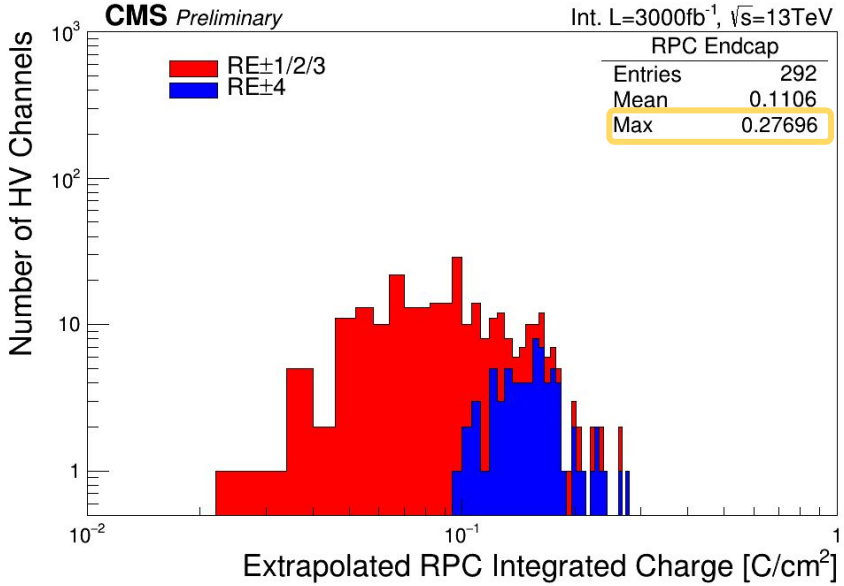


Figure 8: Left: RPC Endcap Integrated Charge in Time, Right: RPC Endcap Extrapolated Integrated Charge Distribution

Forthcoming Research

Currently the integrated charge study is still in its first stage.

The next stages include:

1. Subtraction of the offset contribution
2. Subtraction of the ohmic currents
3. Studying the RPC resistivity vs integrated charge dependence.

As a result of having to map the currents in order to reach the above milestones. We open the possibility to new studies regarding the RPC currents, such as the effects of the environmental parameters on the cosmic and ohmic currents, and more.

Questions

Reference

[1] CMS Collaboration, CMS, the Compact Muon Solenoid. Muon technical design report, CERN-LHCC-97-32
[2] CMS Muon group, Aging studies for the CMS RPC system, Poster EPS-HEP2017
[3] G Polese et al 2010 J. Phys.: Conf. Ser. 219 022019
[4] CMS Collaboration et al 2008 JINST 3 S08004
[5] Paolucci, Pierluigi & Hadjiiska, R & Litov, Leandar & Pavlov, B & Petkov, Peicho & Dimitrov, Aleksandar & Beernaert, Kelly & Cimmino, Anna & Costantini, Silvia & Guillaume, G & Lellouch, Jeremie & Marinov, Andrey & Ocampo, A & Strobbe, Nadja & Thyssen, Filip & Tytgat, Michael & Verwilligen, Piet & Yazgan, Efe & Zaganidis, Nikolaos & Choi, Young-Il. (2013). CMS Resistive Plate Chamber overview, from the present system to the upgrade phase I. Journal of Instrumentation. 8. P04005. 10.1088/1748-0221/8/04/P04005.

Backup

This system uses bash for managing the executions and python for processing data

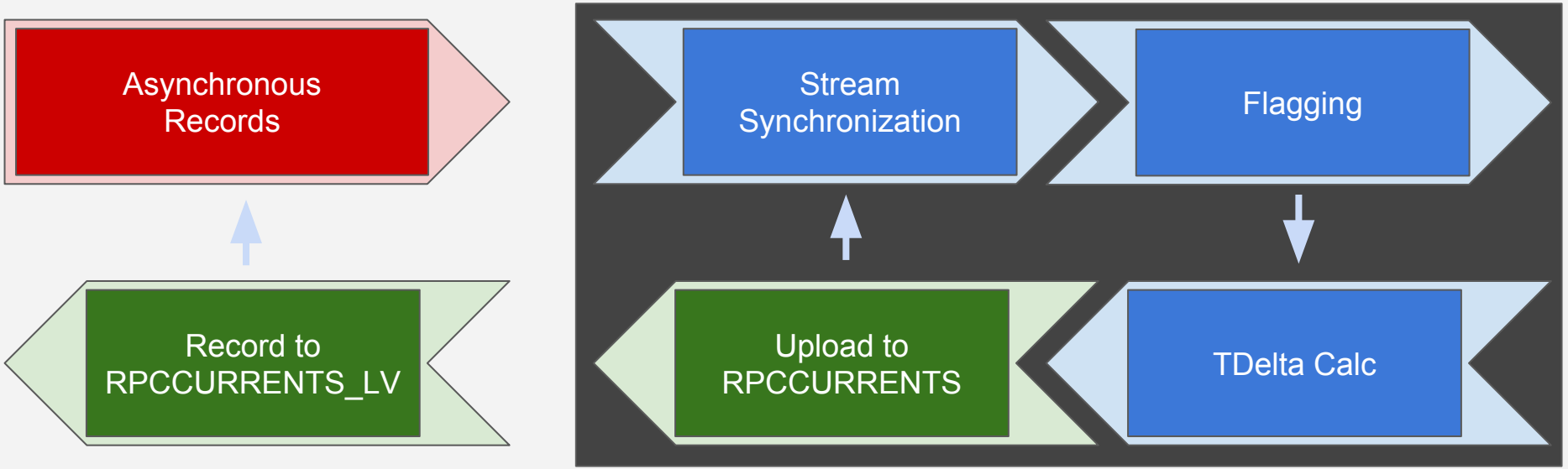
Streaming process for synchronizing 1 day of data or less

Color Scheme

Red: cx_Oracle, SQL, Python

Blue: Python, Multithreading, Streaming Libraries

Green: cx_Oracle, DML, Python



Current Bakery

This block will repeat itself for every record returned by the query and can be run simultaneously by a maximum of 10 threads. The Flagging and TDelta Calculation stages in the data flow are highly important given that they will reduce the stress on the database later on in the production phase (WBM, offline analysis, web applications).

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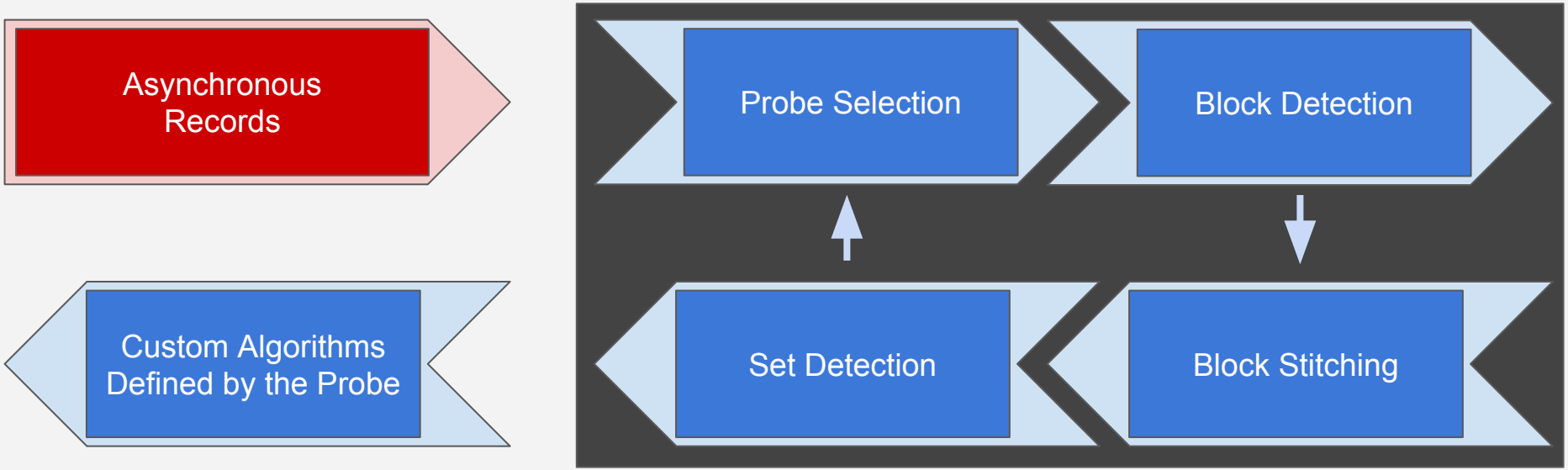

RPCCURRENTS PROBE

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