Status of CPPF firmware and data analysis result

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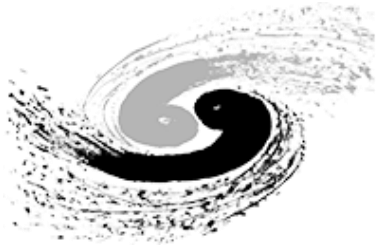

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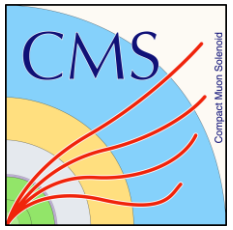
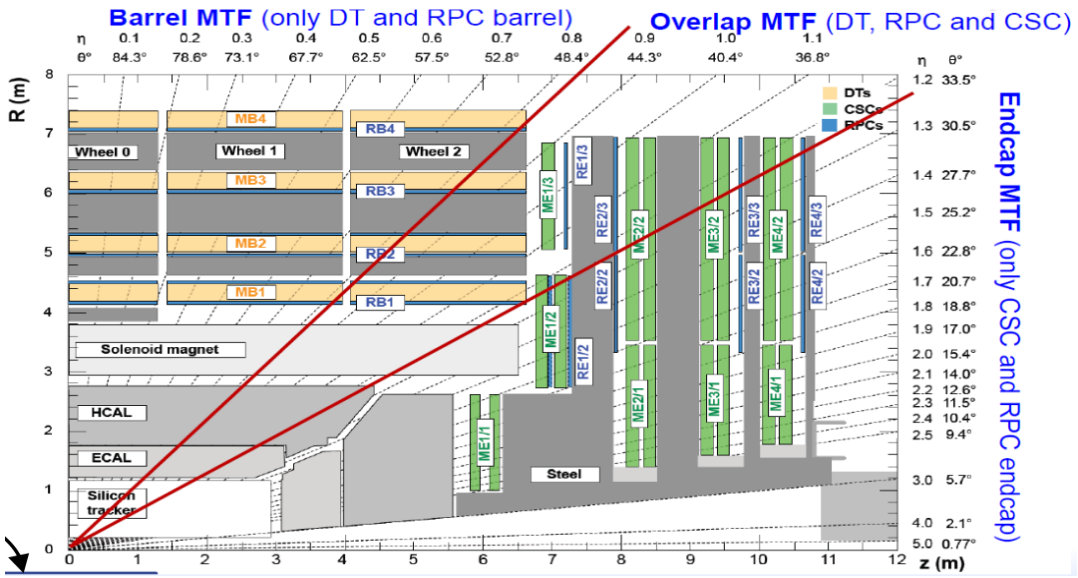


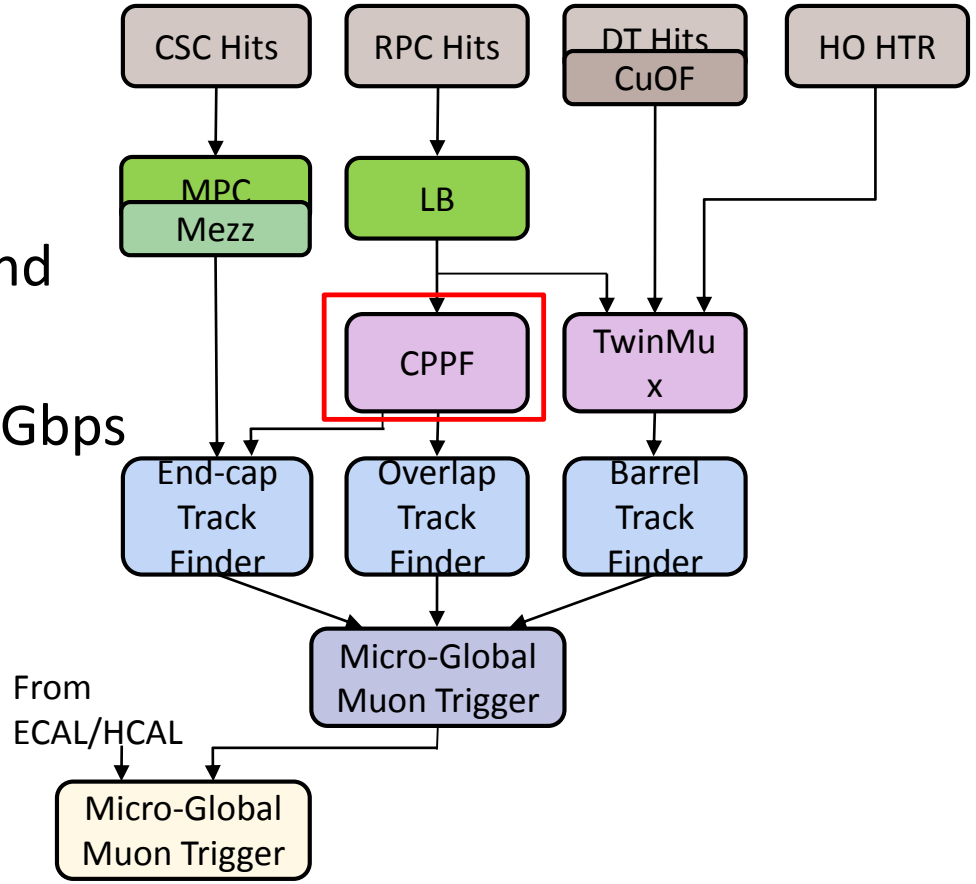
Outline

- introduction
- CPPF Hardware
- Firmware development
- SWATCH implementation
- Offline Software
- CPPD Data Analysis Result
- Summary

CPPF introduction

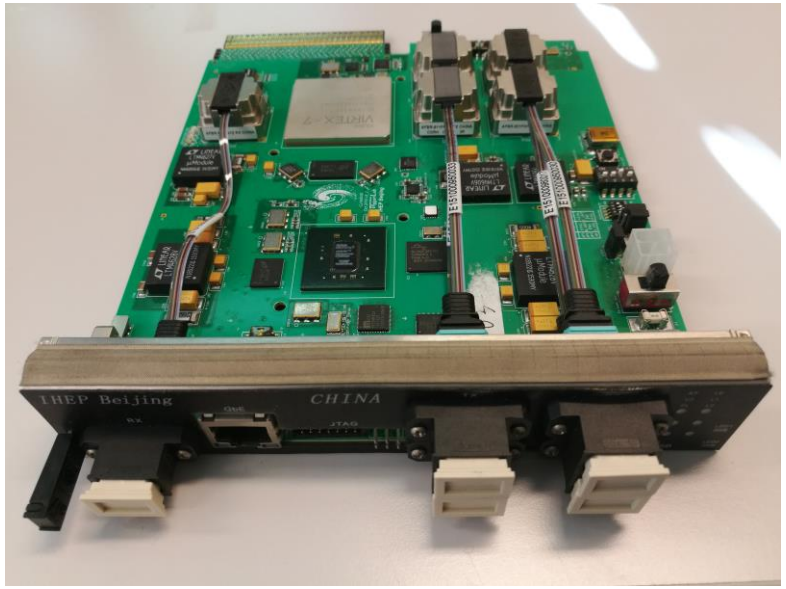
- CPPF: Concentration PreProcessing and Fanout
  - Overlap region RPC data transmission
  - Receiving RPC data @1.6Gbps
  - Preprocessing received data with clusterization and angle conversion algorithm
  - Fan the preprocessed data to EMTF(/OMTF) @10Gbps

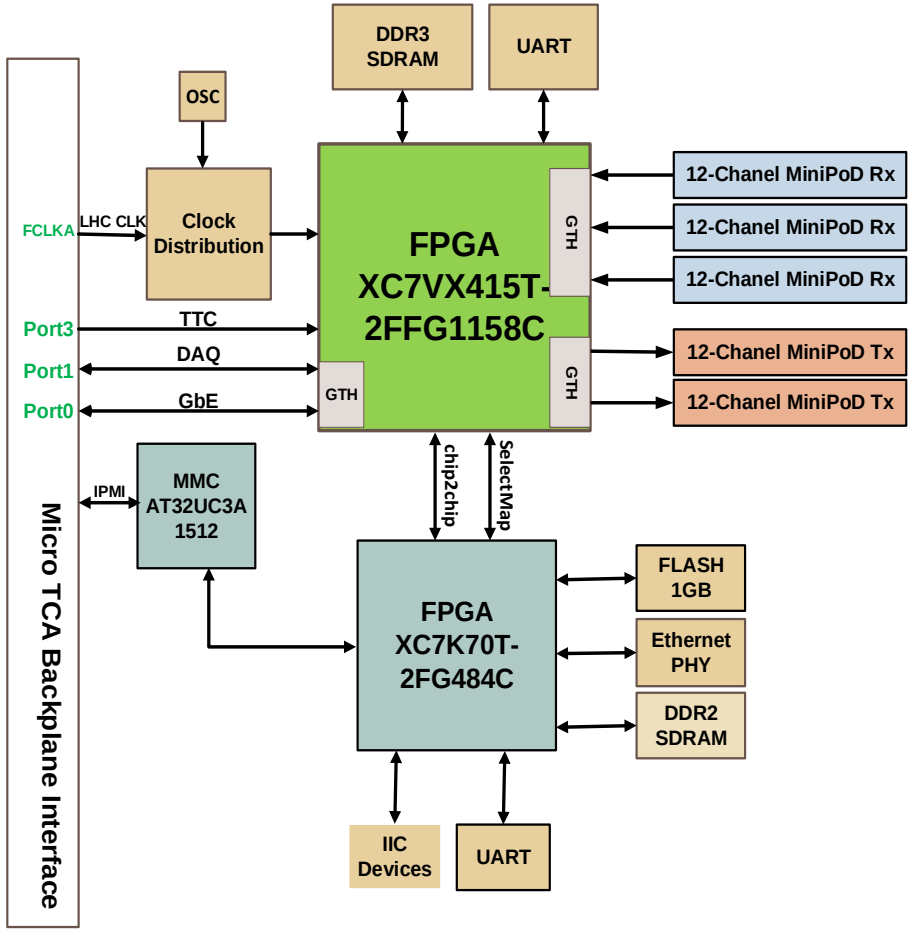




CPPF Hardware

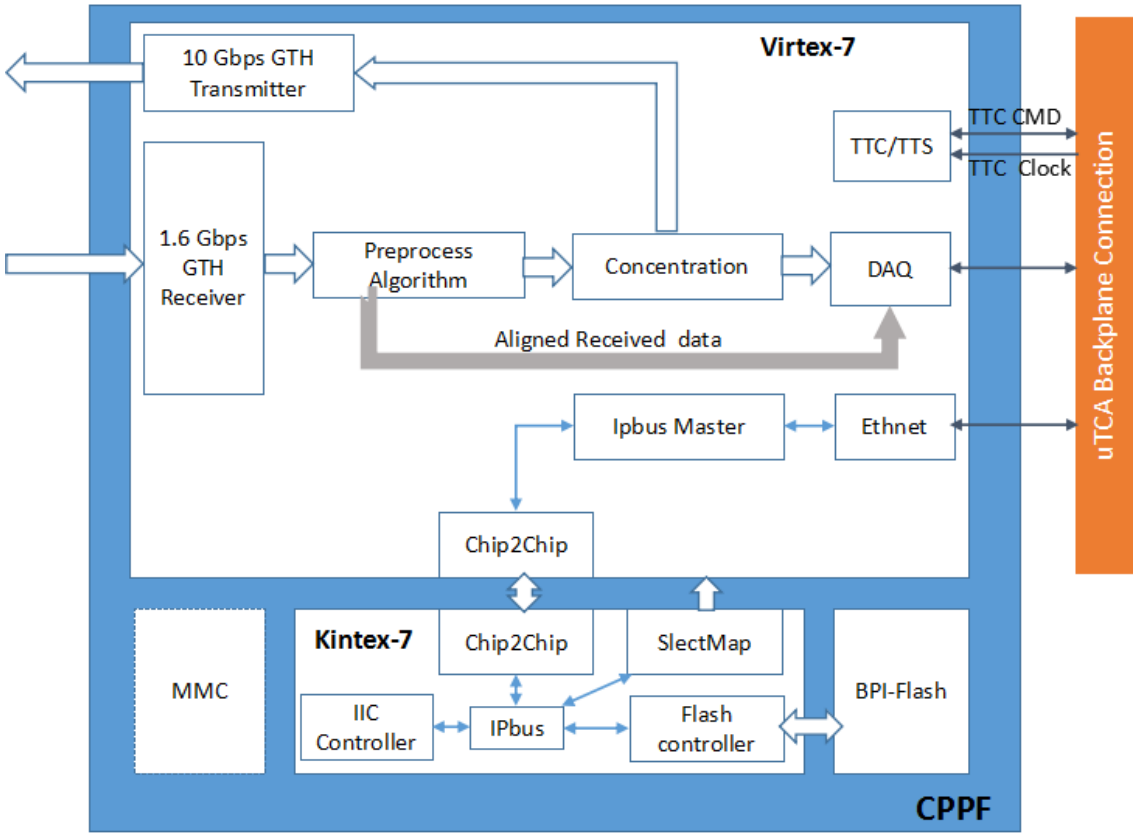
- Based on MicroTCA protocal
- Including two Xilinx FPGA chips for board controlling and functionalities implement
- 36 optical links for receiver and 24 optical links for transmitter, each link support 10 Gbps data transmission





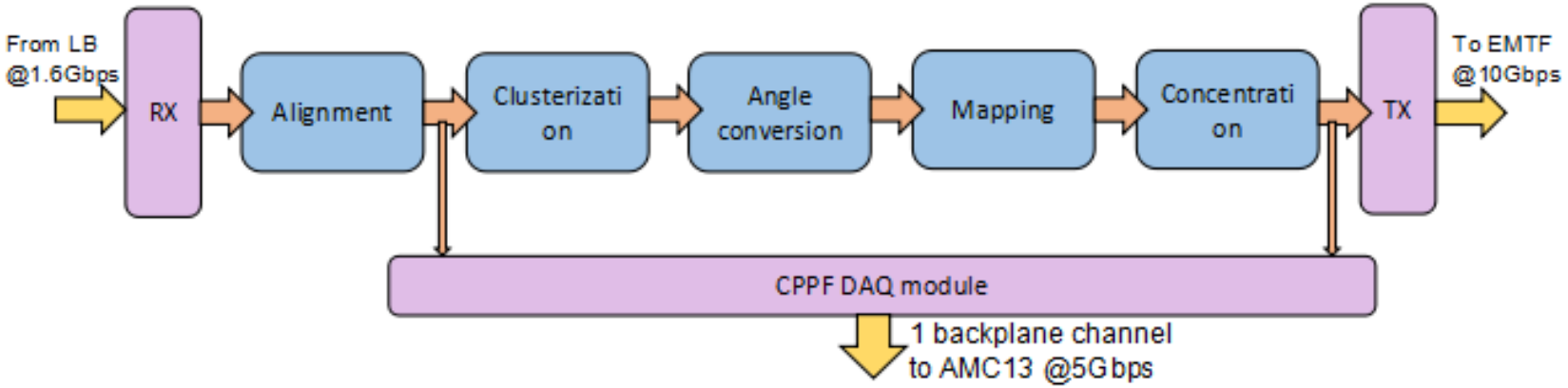
Firmware development

- There are two Xilinx FPGA chips
  - Virtex-7 as core chip, Implemented with main functions of CPPF subsystem, for example, GTH Transceiver, preprocess algorithm, TTC/TTS, UDP/IP(IPBus) ethnet transmission, etc.
  - Kintex-7 as control chip, including other units controlling in the board, for example, BPI-flash, DDR memory, etc.



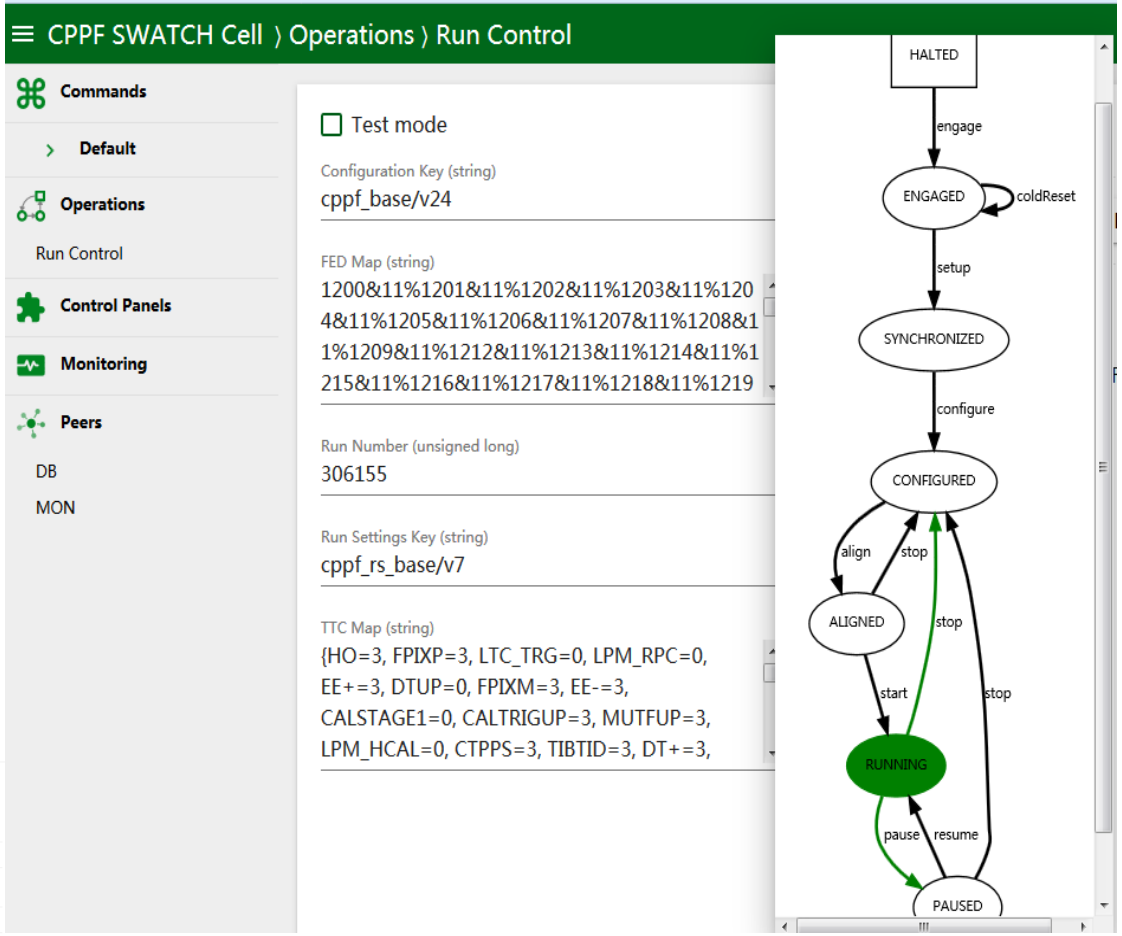
CPPF firmware development

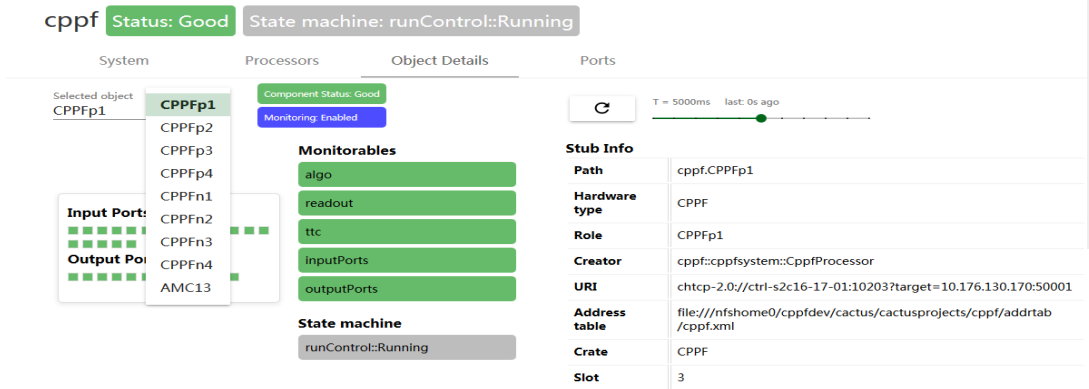
- There are two dataflows in CPPF firmware
  - RPC data transmission
    - Receiving Link Board RPC data@1.6Gbps
    - Preprocessing received data, including clusterization and angle conversion
    - Transmitting preprocessed data to EMTF@10Gbps
  - DAQ data recording
    - Recording received data after alignment and preprocessed data before transmitting
    - Packed them and send to AMC13 by the CPPF DAQ module @5Gbps



CPPF SWATCH implementation

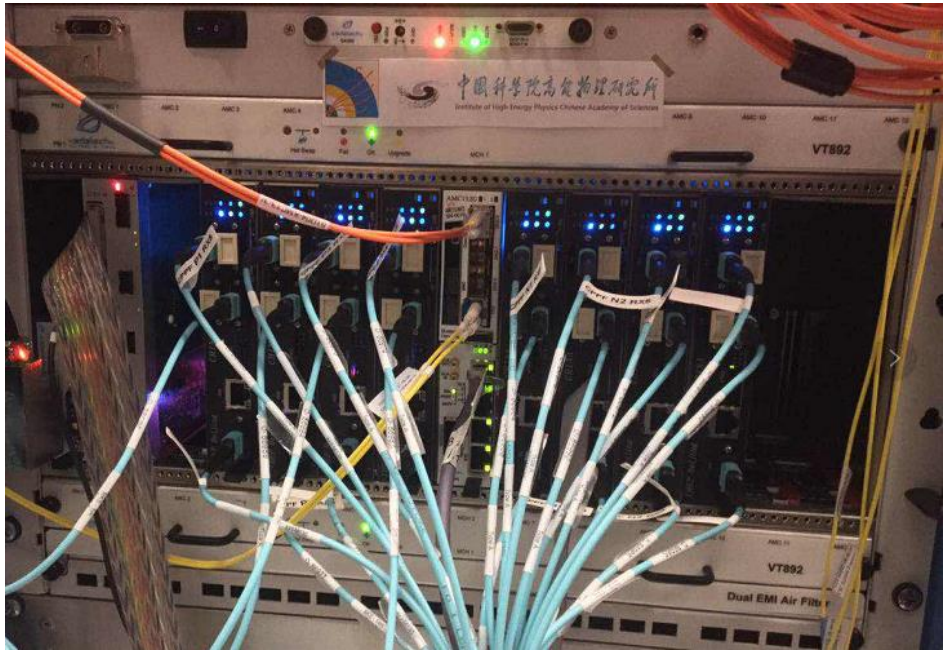
- SWATCH: SoftWar for Automating conTrol of Common Hardware
  - Developped for controlling and monitoring CMS Level-1 trigger upgrade hardware
  - CPPF is one of the customized user
- Including two parts:
  - Controlling: standard FSM configuration
  - Monitoring: Five monitoring objects

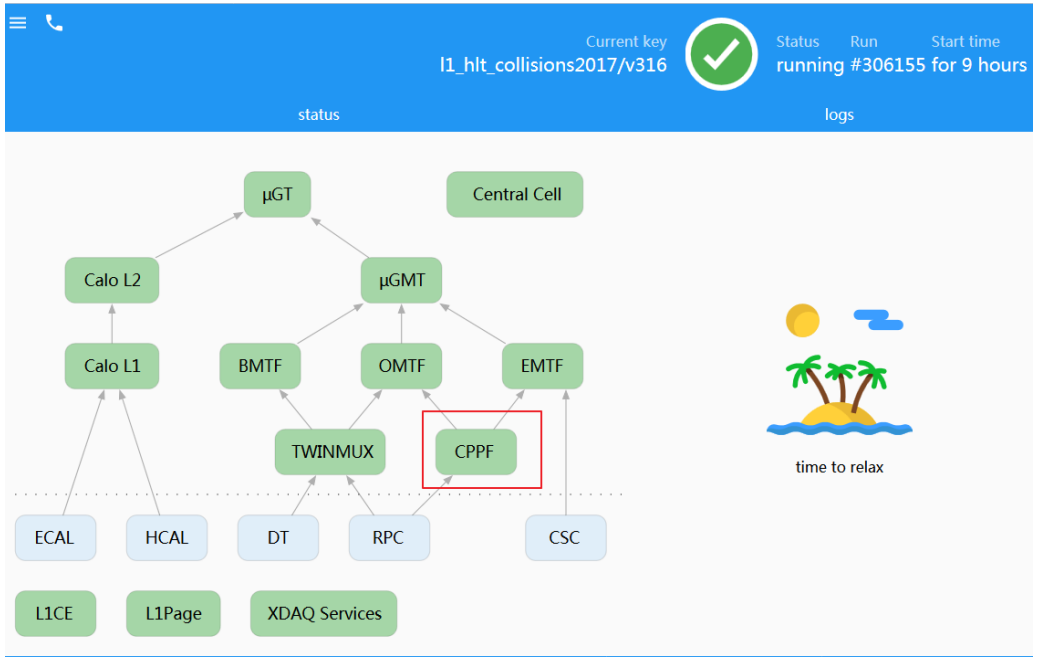




CPPF system integration

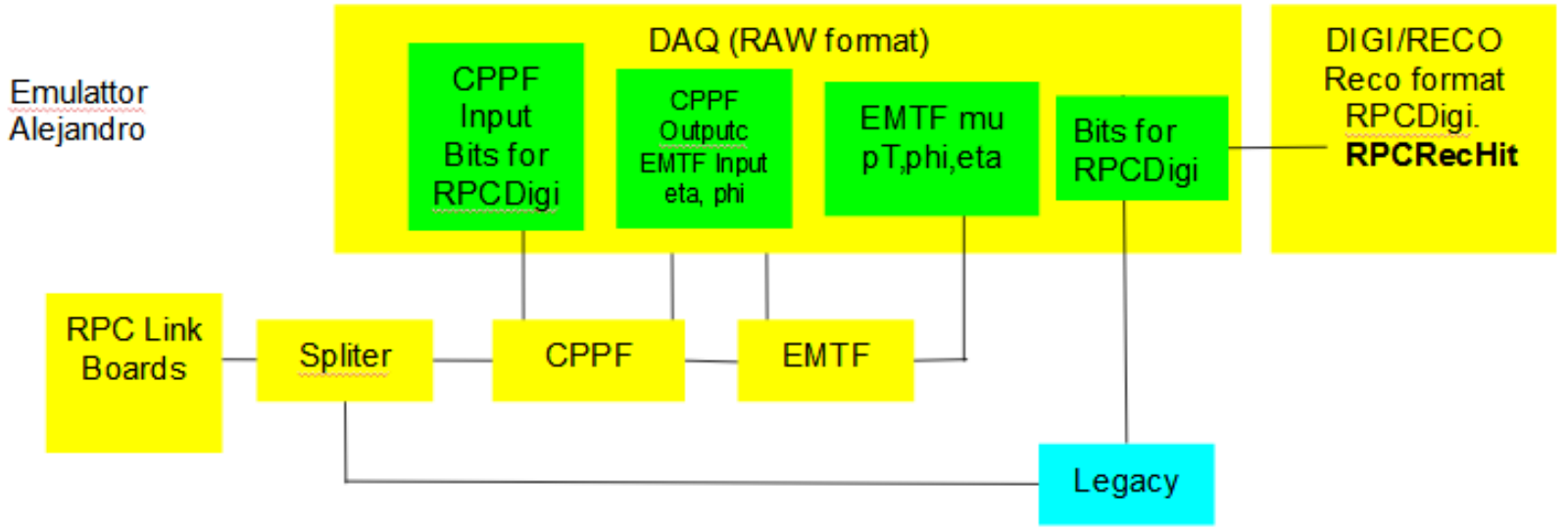
- The whole CPPF system includes 8 CPPF boards, and are installed in 1 microTCA crate
  - The system was deployed since May of 2017
  - Picture in the left shows the CPPF boards installation in CMS USC55
  - Picture in the right shows the integrated CPPF SWATCH in CMS central SWATCH





CPPF offline software

- In CMSSW framework, the CPPF offline software includes two parts:
  - Unpacker
    - Unpacking CPPF recorded raw DAQ data
    - Including: input data unpacker and output data unpacker
  - Emulator
    - Simulating the function of CPPF clusterization and angle conversion



RPCDigi:
For CPPF input data.

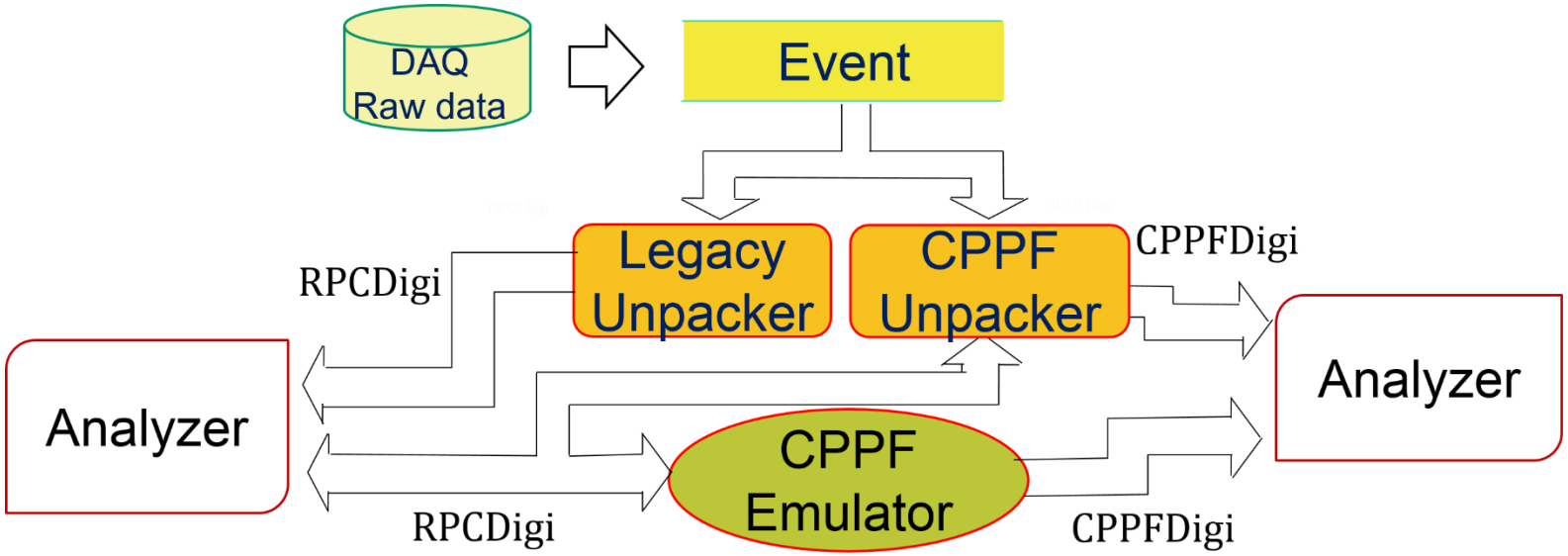
CPPFDigi:
For CPPF output data.

- Legacy system(The Muon part of old trigger system)

CPPF Data analysis method

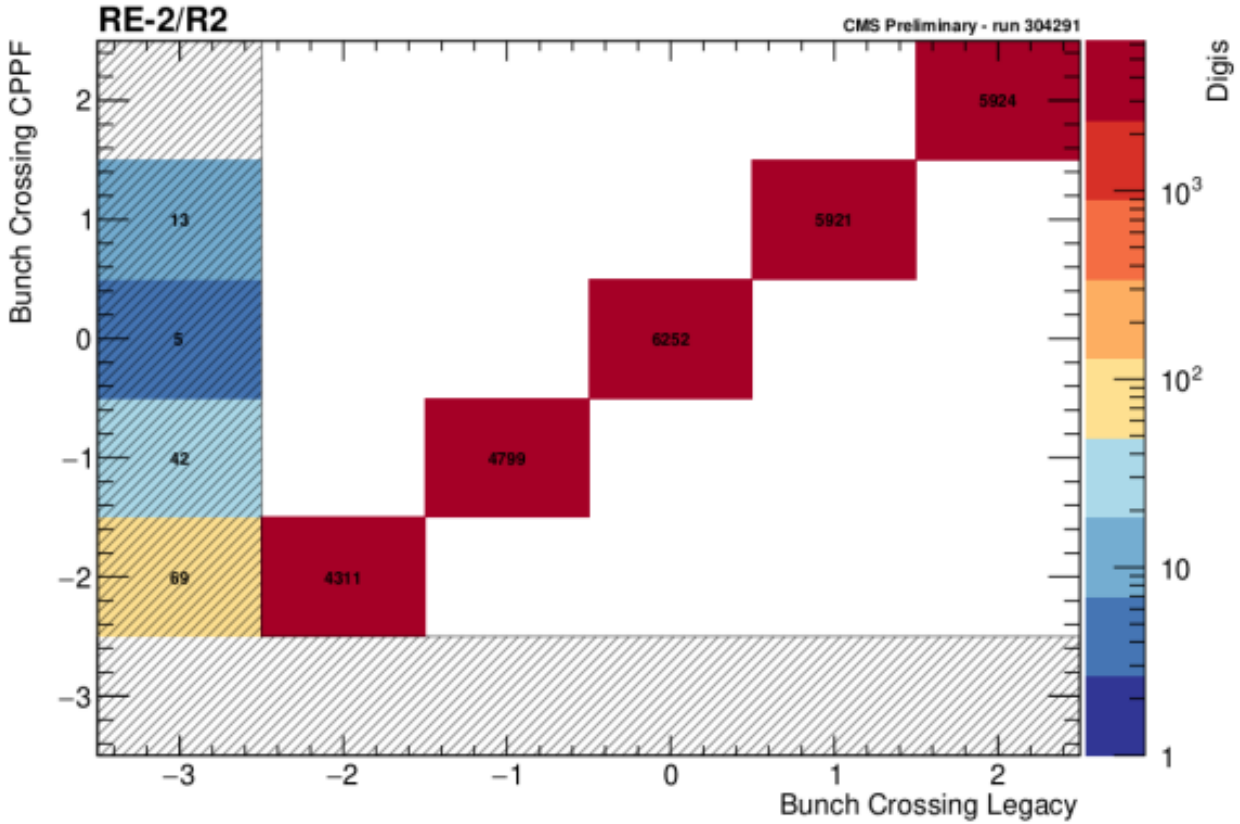
- Two analyses for CPPF verification have been done:

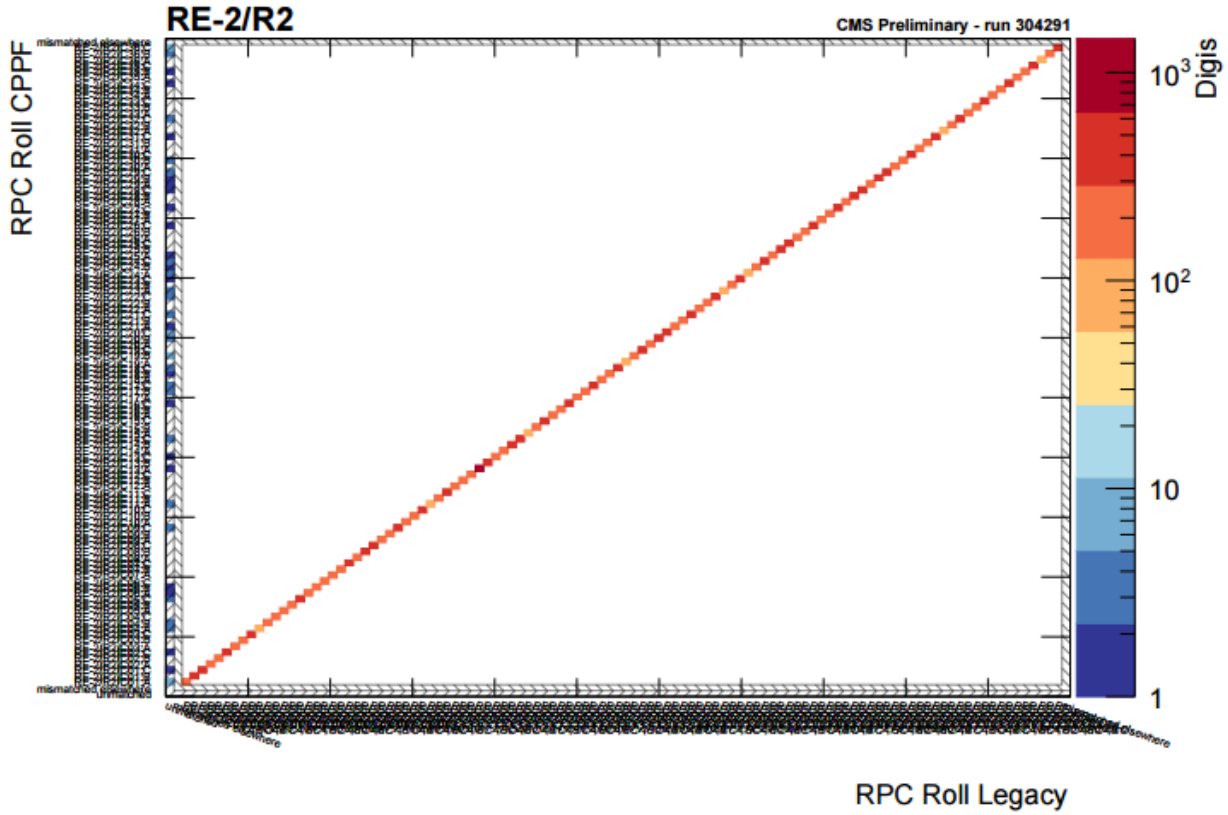
1. Comparison of CPPF recorded RPC data(input data) with CMS parallel running Legacy recorded RPC data in corresponding region.
2. Comparison of CPPF recorded output data (cluster) with CPPF Emulator Digi output.



CPPF Data analysis result

- Comparison of CPPF recorded RPC data(input data) with CMS parallel running Legacy recorded RPC data in corresponding region.
- A total agreement > 99%.





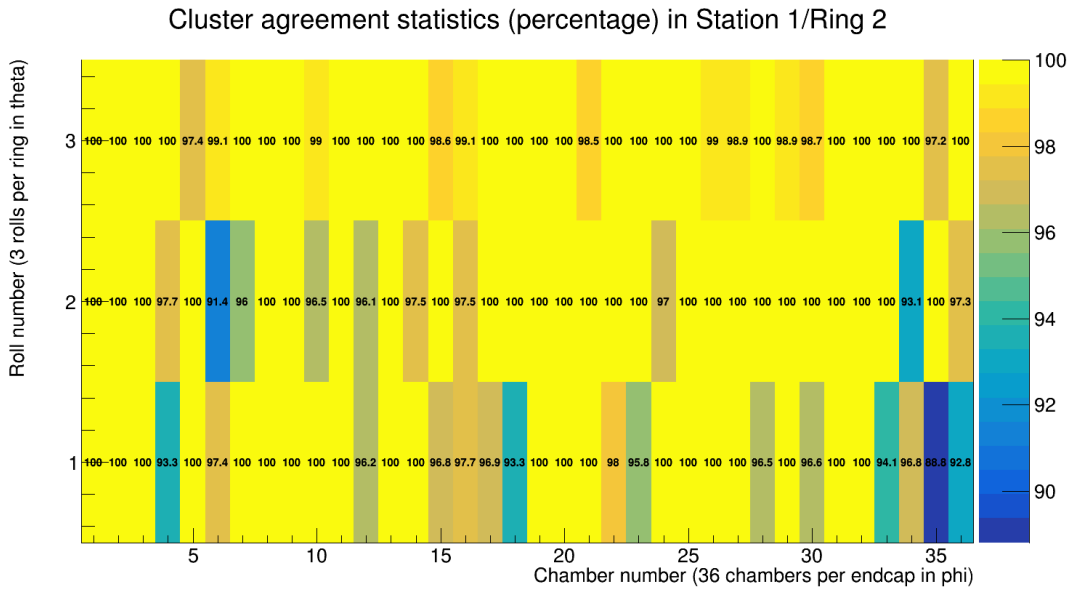
Hits timing agreement between CPPF and Legacy in Station 2/ Ring 2, in run 304291

CPPF Data analysis result

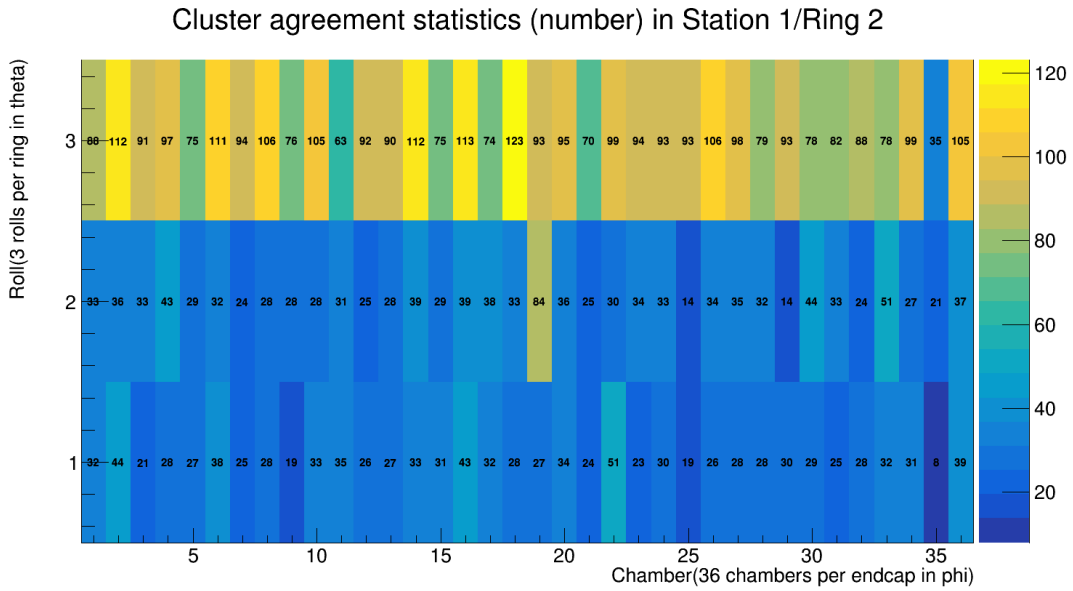
- Comparision between CPPF unpacked input data with Legacy recorded RPC data
  - The <1% mismatch including:
    - Legacy only recorded data < 0.5%
      - In the reason of problematic links, GTH reset problem or spliter leading to weak connection
      - Still in investigating
    - CPPF only recorded data ~ 0.5%
      - Legacy with a problem in recording multiple hits when happened multiple BXs
      - Reasonable

CPPF Data analysis result

- Comparison of CPPF recorded output data (cluster) with CPPF Emulator Digi output.
- The total agreement is about ~ 99.5% (by Alejandro).



(b) Cluster agreement in percentage in Station 1/Ring 2



(c) Cluster agreement in number in Station 1/Ring 2

Summary

- CPPF functionalities
  - Firmware and SWATCH were well implemented
  - The system deployed since April of 2017
- Offline software
  - Unpacker and Emulator are well developped
  - Data analysis: Both analysis results are as good as expected, which demonstrate a satisfaction with the CPPF system.