Clas12Mon: The CLAS12 monitoring GUI

Stefan Diehl[1], Raffaella De Vita[2], Latifa Elouadrhiri[3]

[1]University of Connecticut, sdiehl@jlab.org
[2]INFN Genova, devita@jlab.org
[3]Jefferson Lab, latifa@jlab.org

Content

1. Introduction

The Clas12Mon application is designed to provide shift takers with basic information based on CLAS12 raw data, such as occupancies, ADC and TDC spectra, to check the detectors functionality. It is divided into a summary section with 1 – 2 overview plots per detector and a detailed section for each detector. In addition beam properties and trigger information will be displayed in a specific tab. Figure 1 shows the Basic GUI interface and the summary page for the detectors of the forward detector system.

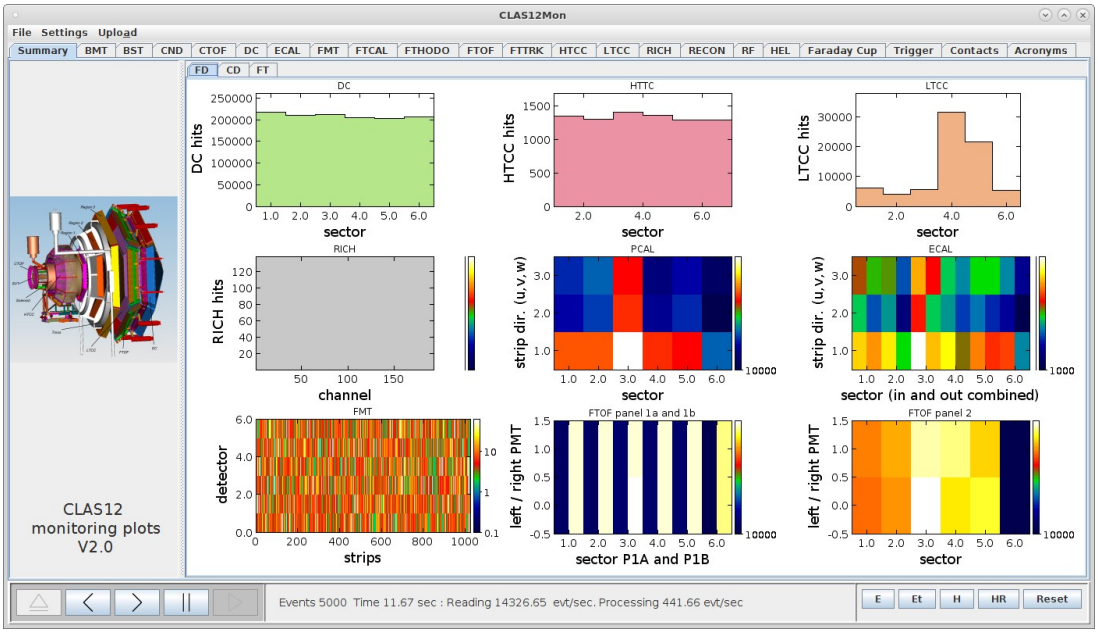


Figure 1: Front page of the MON12 GUI

The Clas12Mon application is based on java and can be downloaded from:
https://github.com/JeffersonLab/clas12mon

2. The GUI interface

2.1 Clas12Mon input sources

The input source / file of Clas12Mon can be selected in the lower right edge of the GUI.

Input data for the MON12 GUI can be:

- EVIO (**E**) raw data from file or DAQ ET ring (**Et**),
- HIPO (**H**) data from file or HIPO ring (**HR**); these are obtained from the EVIO raw data running the CLAS12 common tool decoder.

The input data source can be selected clicking on the **E**, **Et, H** or **HR** buttons at the bottom right of the GUI. E and H will open a file browser to select the input file, while Et and HR will ask for connection information to the Et or HIPO ring (IP address and file are needed).

The primary source of data for MON12 during data taking is the DAQ ET ring.

2.2 Launching MON12

a) Usage on a local machine with EVIO or HIPO files

Run the downloaded program with netbeans or eclipse. To read HIPO files, the correct path of COATJAVA has to be set. After the GUI is opened, click on E or H to load a file.

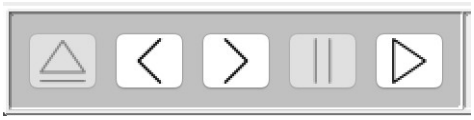
b) Usage for monitoring run data

To start the GUI, connect to clondaq4 as clasrun and, in a terminal, type

```
mon12
```

Once the GUI is opened, click on the **Et** button and click on **Connect**. Clas12Mon will establish a connection with the ET ring.

Once the connection file is loaded (a) or the connection to the ET-Ring is established (b), the buttons in the bottom left part of the GUI will turn black as in the following figure.



Click on the rightmost button to start accumulating events. At any time this process can be stopped with the pause button. Left and right arrows allow also moving backward and forward, one event at a time.

Once the accumulation process is in progress, plots both in the front panel and in the detector tabs will be updated every 2 sec. The update time can be modified from the dropdown menu at the top left of the GUI under **Settings → Set GUI update interval.** Here a time in ms has to be entered.

2.3 Change log/lin scale for the z-axis if 2 dimensional plots

For 2 dimensional plots the z-axis can be set globally to a logarithmic (log) or linear (lin) scale. This change can be done via the dropdown menu at the top left of the GUI under **Settings → Set global z-axis log scale.**

2.4 Resetting the histograms

At any time, histograms can be cleared clicking on the **Reset** button at the bottom right of the GUI. An automatic reset is available for all detector, beam and trigger tabs. It is set to a default value of 10.000.000 events after which the histograms for these detectors are automatically reset. The user can turn this off by clicking on **Disable Histogram Reset** in the **Reset** dropdown menu. By clicking on **Default for all** in the **Reset** dropdown menu it can be turned on again. The number of events after which the rest takes place can be adjusted for each detector individually by clicking on **Reset XXX histograms** in the **Reset** dropdown menu. It will ask if a reset should be done for this detector and after how many events it should be done.

2.5 Saving and printing the plots

a) Save histograms to a HIPO file

All the plots in the GUI can be **saved to HIPO file** by clicking on **Save histograms to file** in the **File** dropdown menu at the top left of the GUI.

→ A file chooser window will open to allow the user to choose the filename and destination folder. By default the GUI will use date and time to define the filename.

b) Displaying histograms from file

Histograms that were previously saved to file can be displayed in the Clas12Mon GUI by clicking on the **Open histogram file** item in the **File** dropdown menu at the top left of the GUI.

→ A file chooser window will open to allow the user choosing the histogram file to be opened.

c) Save Screenshots of all canvases

All the canvases in the GUI can be **saved to image files (.png)** by clicking on the **Print histograms to file** item in the **File** dropdown menu at the top left of the GUI.

→ Clas12Mon will create a folder and save snapshots of all the canvases in PNG format. The folder name will be automatically defined based on the date and time.

d) Save all canvases as one PDF

All canvases can be saved in a PDF file via **File → Create histogram PDF**
This feature is not operational in the current version.

e) Upload Canvas to the electronic Logbook

A direct upload of a canvas can be done via **Upload → Upload to Logbook**
This feature is not operational in the current version.

3. Summary and detector specific plots

Clas12Mon is divided into a summary section with 1 – 2 overview plots per detector and a detailed section for each detector.

3.1 The Summary section

The summary section represents an overview of the functionality of all detector sub-systems. For each sub detector one or two occupancy plots are shown. For the central detector and the forward tagger each channel is represented in the occupancy plots. In contrast to this, in the forward detector channels are combined due to the large amount of channels. More detailed occupancy plots can be found in the specific detector tabs. The following pictures show the appearance of the three summary tabs for the forward detector (FD), the central detector (CD) and the forward tagger (FT).

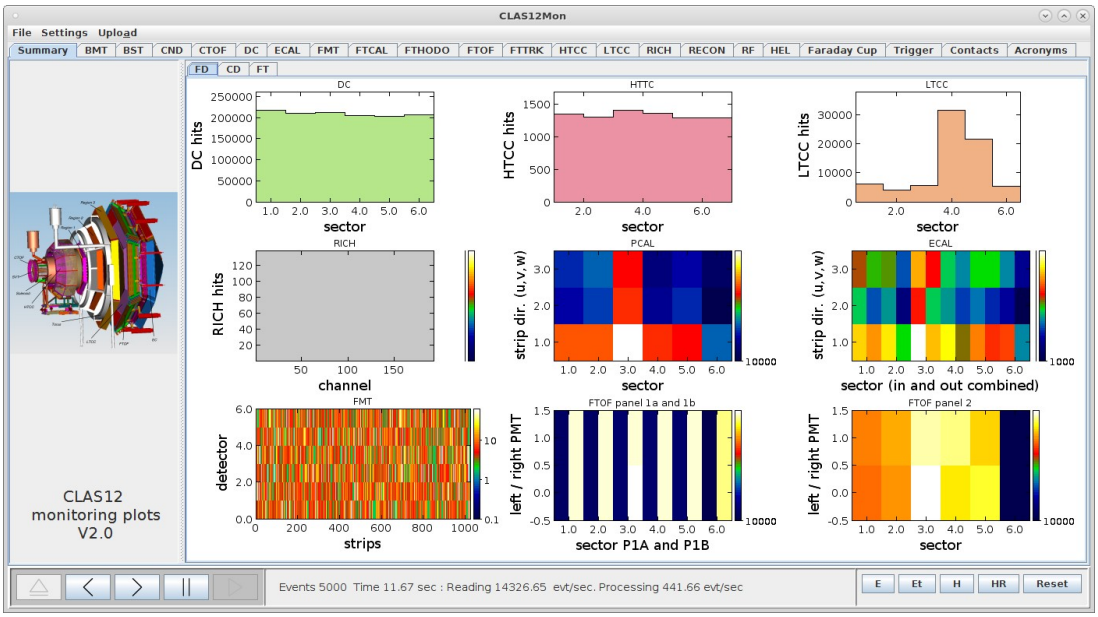


Figure 2: Summary tab of the FD

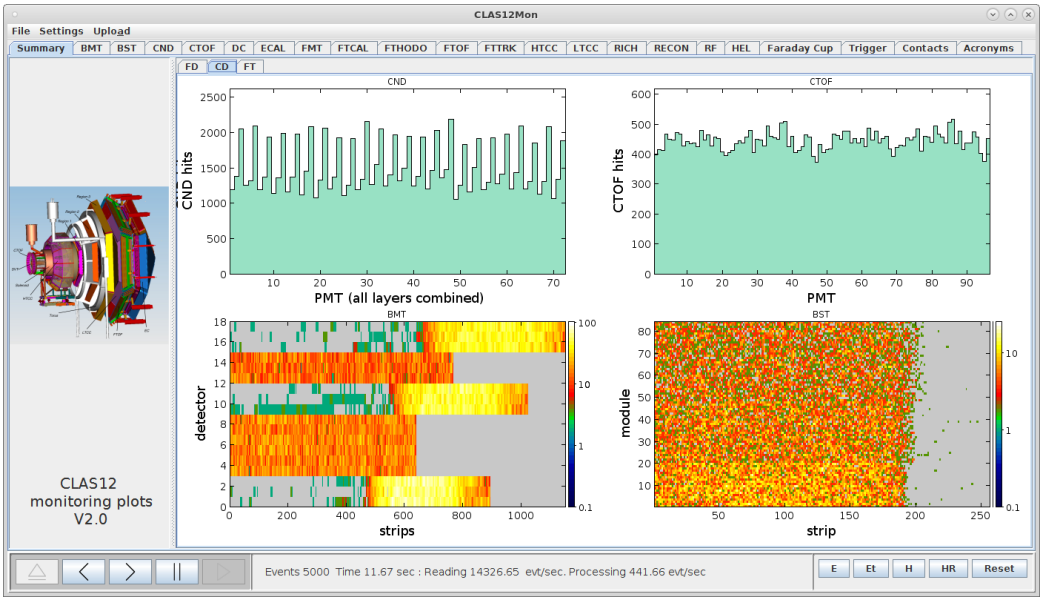


Figure 3: Summary tab of the CD

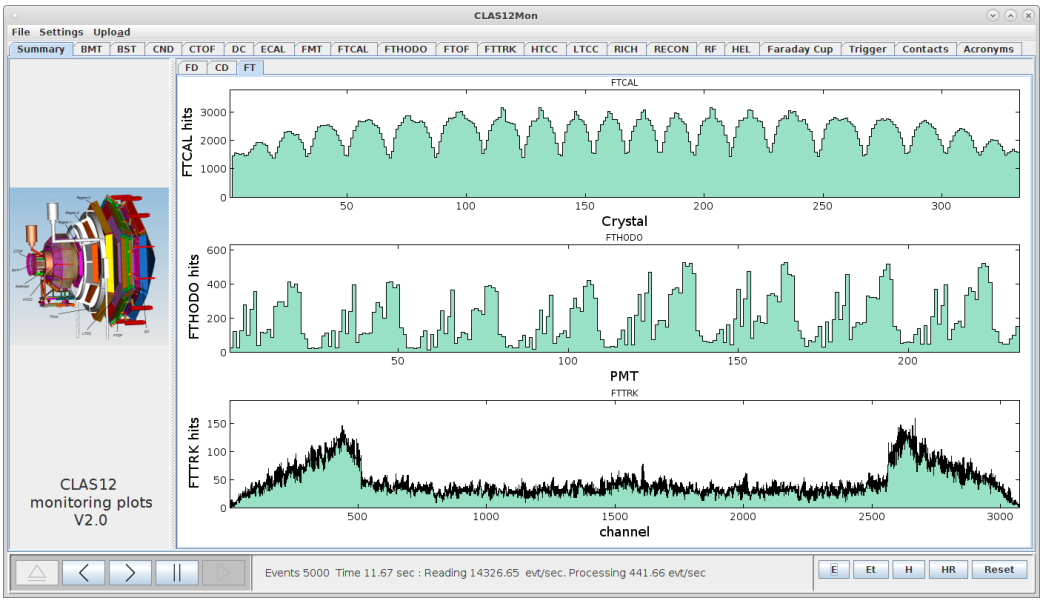


Figure 4: Summary tab of the FT

The shift taker should use this plots to monitor on a regular basis, if all channels / sectors are occupied. This can be done by observing, if a channel is filled (differs from 0) after a Reset if the histogram. If channels are not filled any more at a certain point, a problem with the specific detector is indicated and has to be investigated more closely via the detector monitoring tabs. Examples for such detector problems are shown in figure 5 for the BMT and the CTOF. I the example for the BMT, all strips in one part of the detector are not functional, which causes very low amount of events for detector 16, which manifests as a blue line in contrast to the yellow lines for the other detectors. For the CTOF the example clearly shows, that two PMTs are not functional.

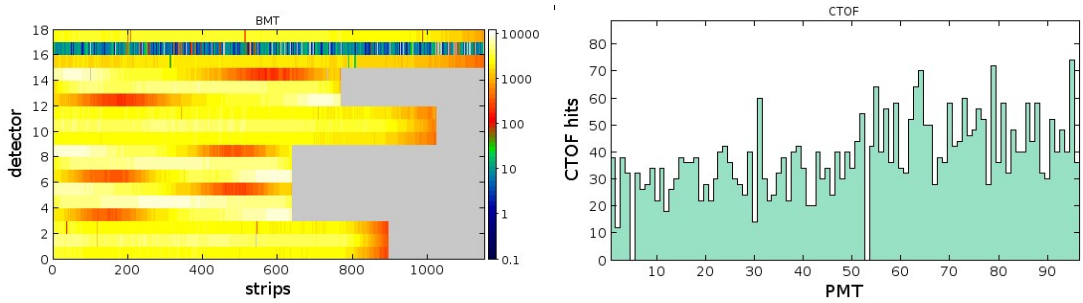
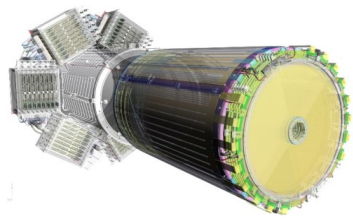


Figure 4: Example for the malfunction of single channels / sections for the BMT and the CTOF

3.2 The detector monitors

The detector monitors contain more detailed information on each sub-detector system. They especially contain the full occupancy plots for all channels of the detector for the ADC and the TDC if applicable. In addition, depending on the detector, overview plots for the ADC and TDC pulse high distribution for all channels, multiplicity plots, plots for timing and other detector specific variables are available.
Each detector monitor consists of several sub tabs. The first tab (from the right side) in most cases contains detailed occupancies for the ADC and can be seen as the main tab for the monitoring of the detector functionality. Some detectors also show the pulse height distributions for the ADC and TD on this first tab.

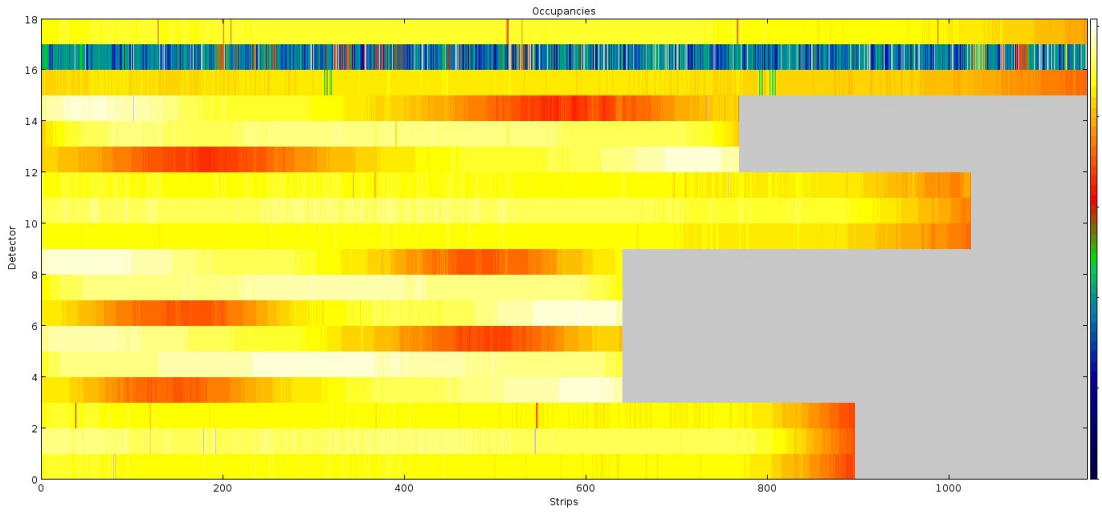
3.2.1 BMT (Barrel Micromegas Tracker)



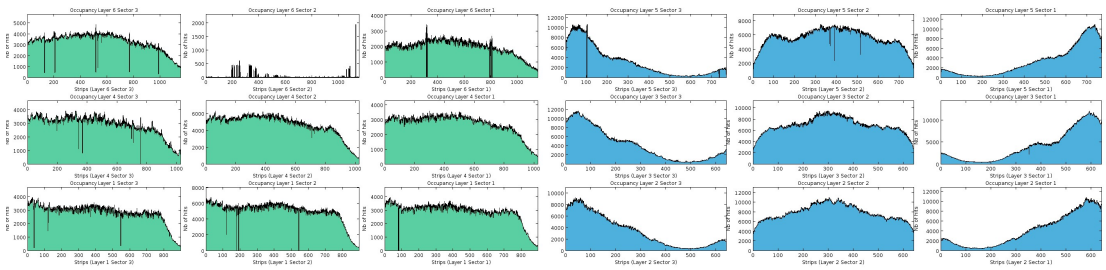
The BMT is located in the Central Detector of CLAS 12 within the 5T solenoid magnet. It is a Barrel tracker made of 18 cylindrical detectors arranged in 6 layers. In combination with the SVT it covers the region from 35 to 125° and greatly enhances the polar angle resolution.

The monitoring plots are as follows:

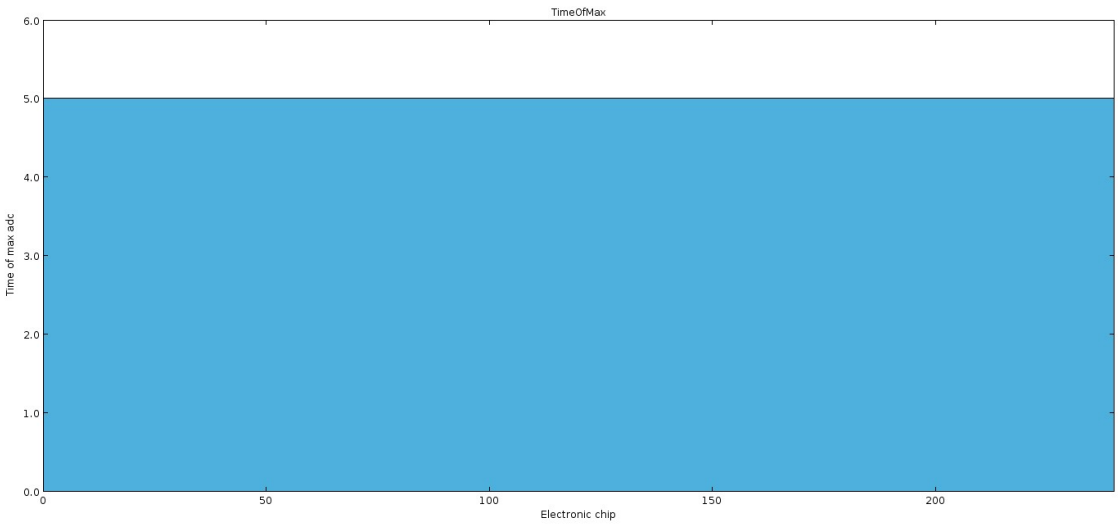
a) Occupancy of the 18 detectors versus their strips



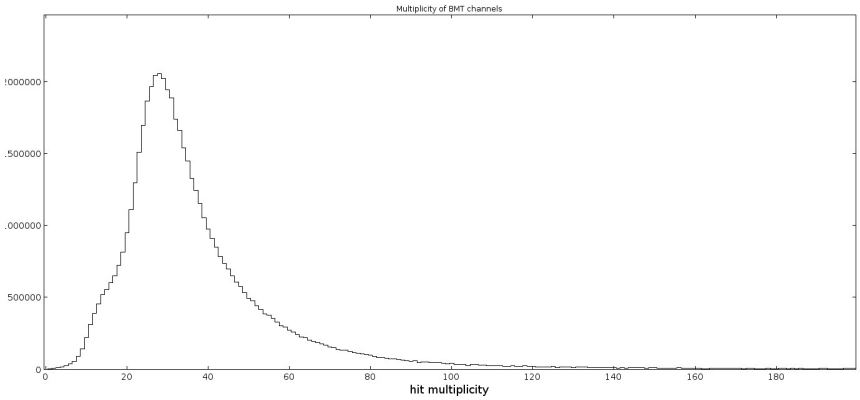
b) 2 dimensional Occupancy plots for the 18 detectors (2 tabs with 9 detectors each)



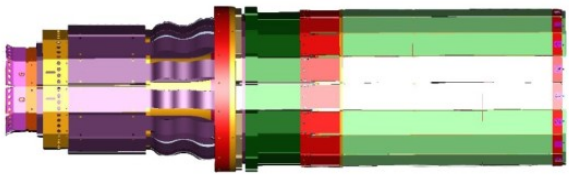
c) Time of the maximum versus electronic chip (a flat distribution is expected)



d) Multiplicity (can be used to identify abnormal noise behavior)



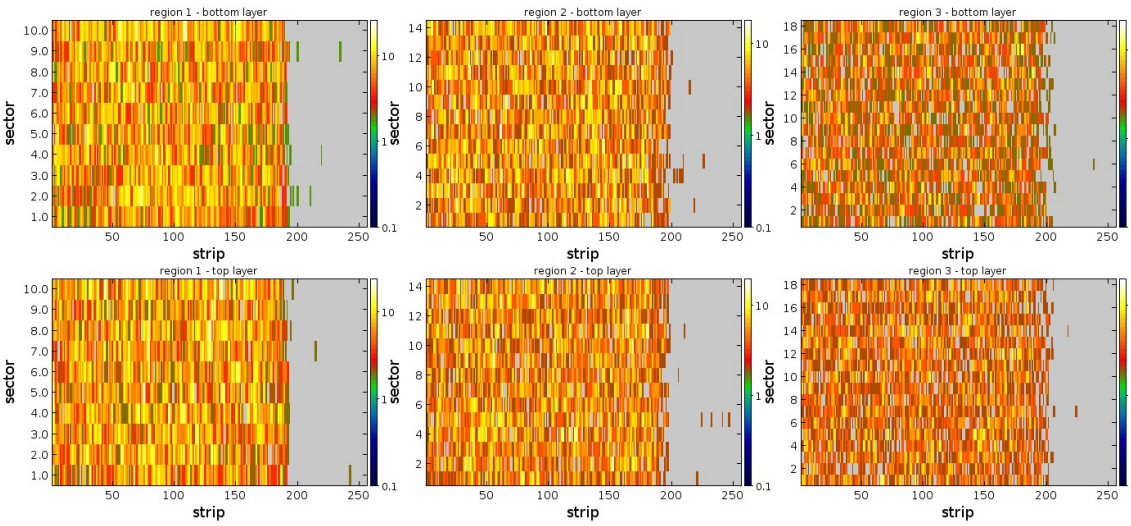
3.2.2 BST (Barrel Silicon Tracker)



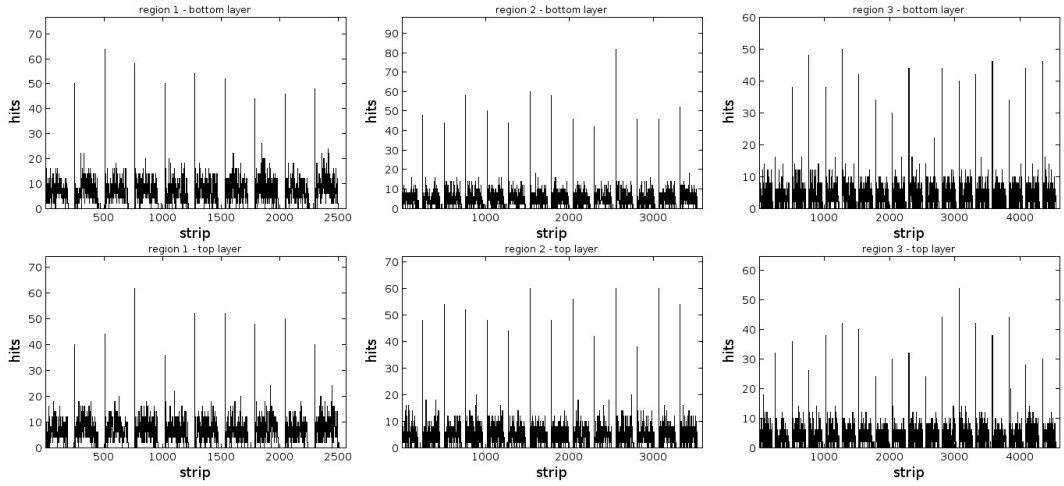
The **CLAS12 BST** system is a part of the Central Detector and will be used to measure the momentum and determine the vertex of charged particles emerging from the target. The BST system includes 3 regions with 10, 14 and 18 sectors of double-sided modules (silicon sensors on both sides of the backing structure) instrumented with digital readout ASICs.

The monitoring plots are as follows:

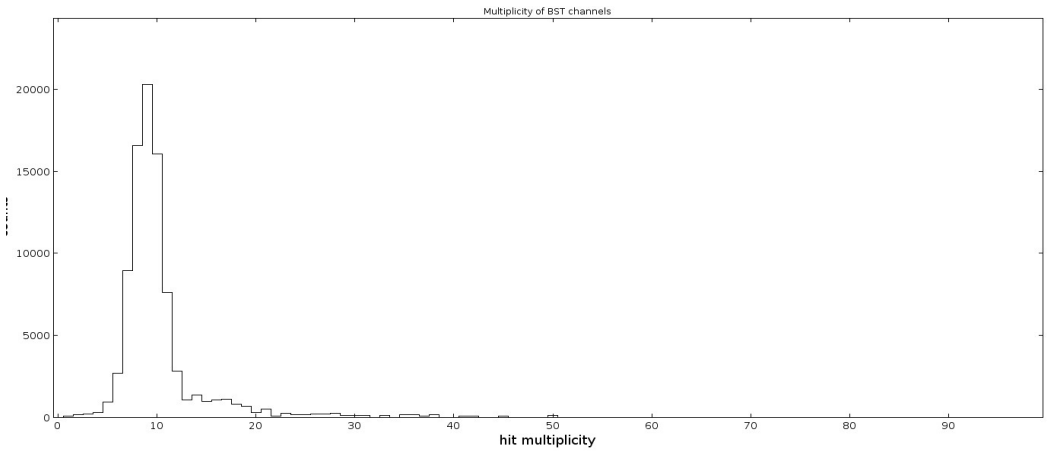
a) Occupancies for the 3 regions (upper row: bottom layer, lower row: top layer)



b) 1 D Plot of the number of hits versus the strip number for the 3 regions (upper row: bottom layer, lower row: top layer)

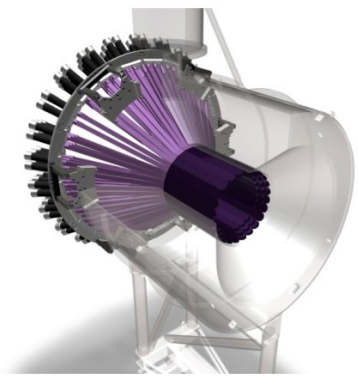


d) Multiplicity (can be used to identify abnormal noise behavior)



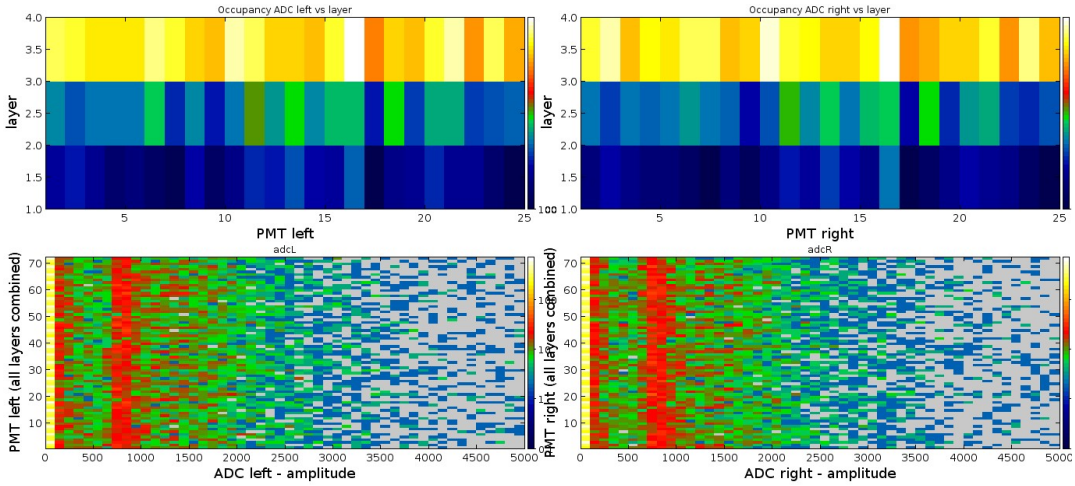
3.2.3 CND (Central Neutron Detector)

The Central Neutron Detector (CND) is made of three layers of scintillator paddles (48 paddles per layer), coupled two-by-two at the front with semicircular light guides and read at the back by photomul1pliers placed outside of the high magne1cfield region and connected to the bars via 1.5-m-long bent light guides.

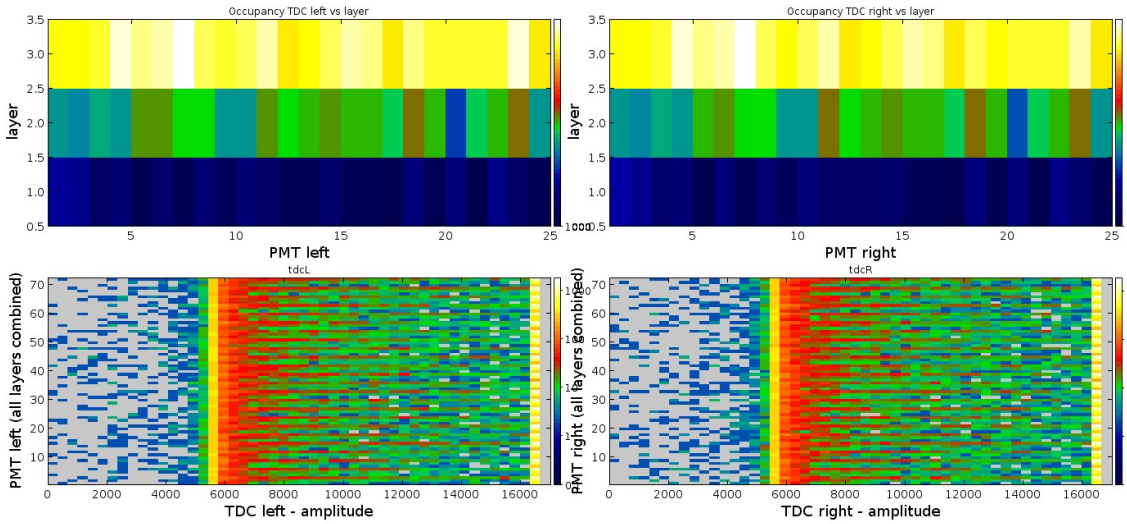


The monitoring plots are as follows:

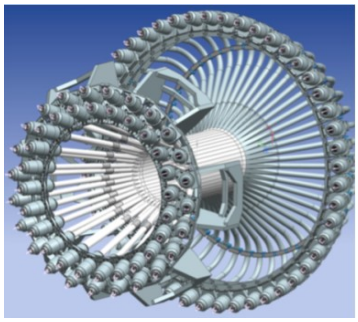
a) ADC Occupancy and pulse height spectra for the left and right PMTs separately



a) TDC Occupancy and pulse height spectra for the left and right PMTs separately



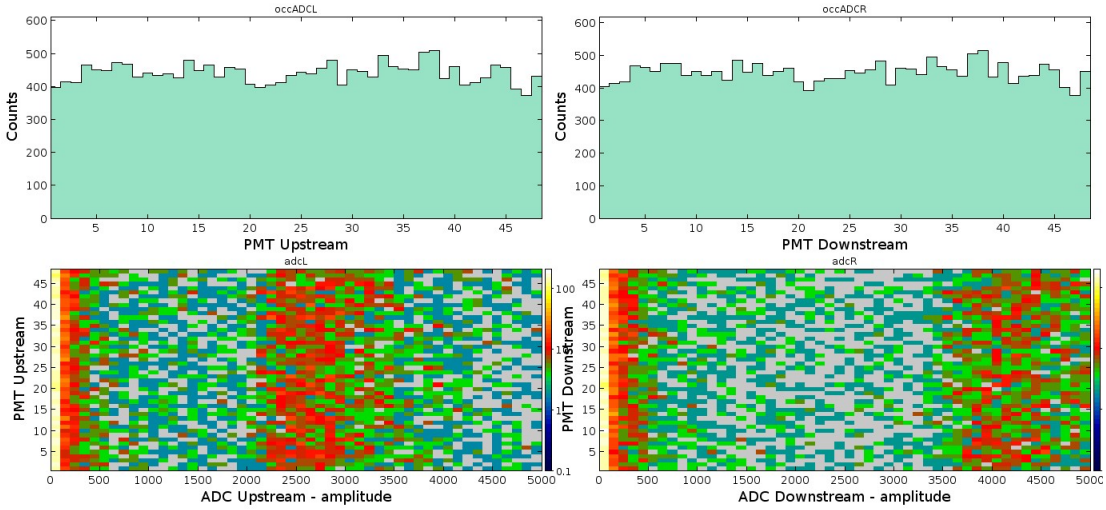
3.2.4 CTOF (Central Time of Flight Detector)



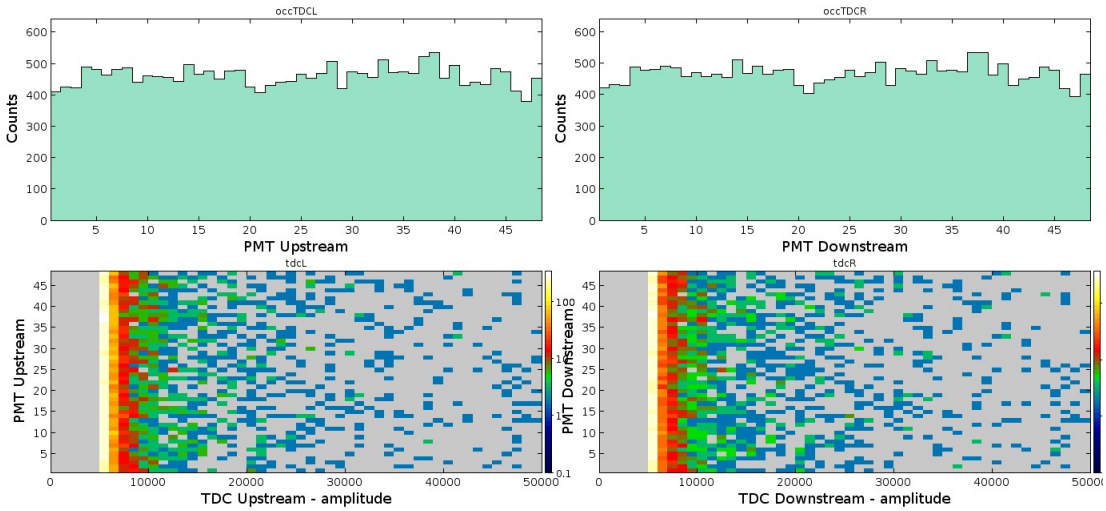
The CTOF system includes 48 plastic scintillators with double sided photomultiplier (PMT) readout via 1 m-long upstream and 1.6 m-long downstream focusing light guides, respectively. The array of 48 counters forms a hermetic barrel around the target. The barrel is aligned with the beam axis inside the 5T solenoid.

The monitoring plots are as follows:

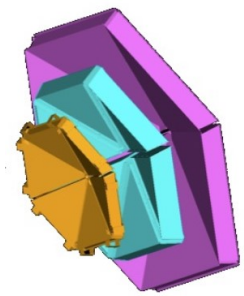
a) ADC Occupancy and pulse height spectra for the upstream and downstream PMTs separately



b) TDC Occupancy and pulse height spectra for the upstream and downstream PMTs separately



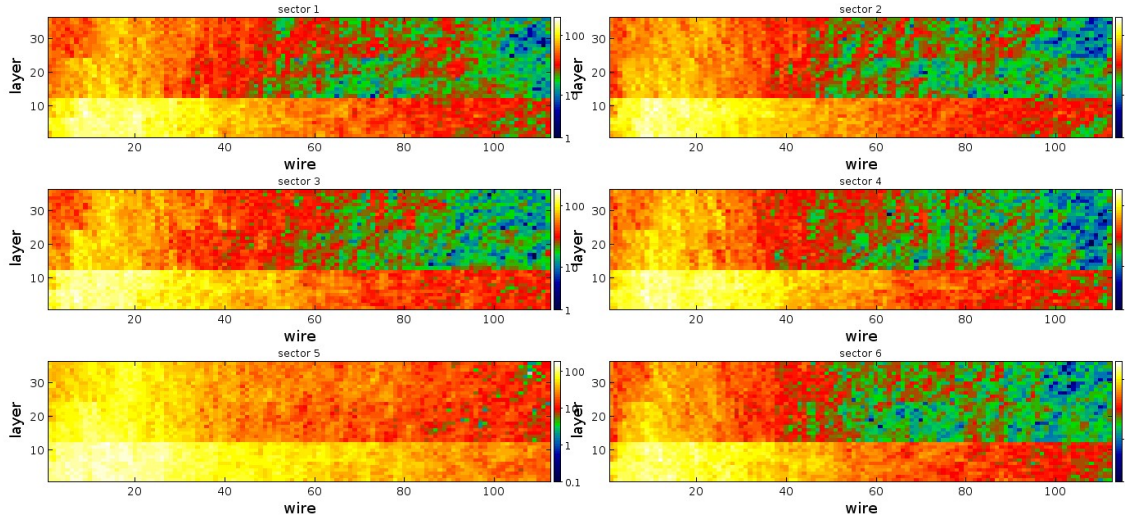
3.2.5 DC (Drift Chambers)



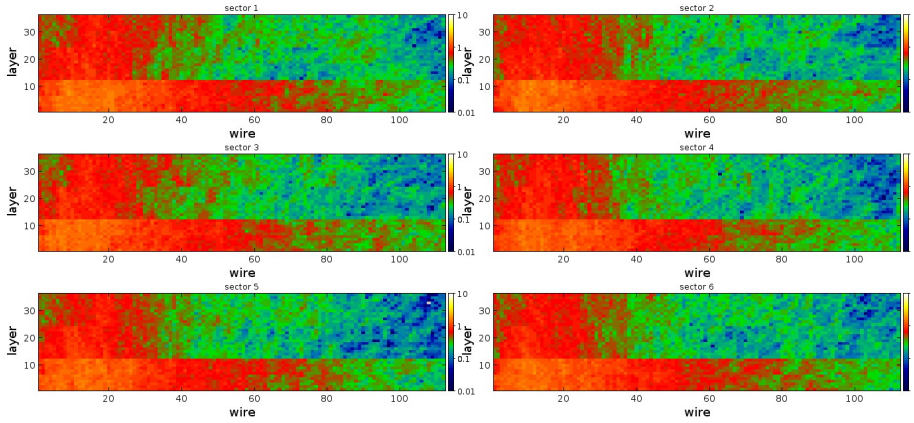
The **CLAS12 DC** system will measure the **momentum of charged particles** emerging from the target. The DC system includes 18 wire chambers, each with 2 super layers of 6 layers by 112 wires. It contains a total of 24,192 sense wires.

The monitoring plots are as follows:

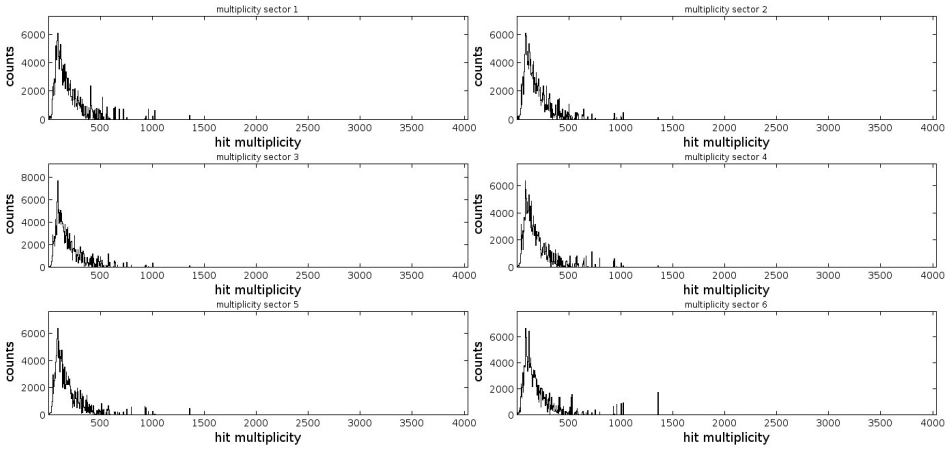
a) Occupancy of the 36 layers in longitudinal direction versus their wires for the 6 sectors



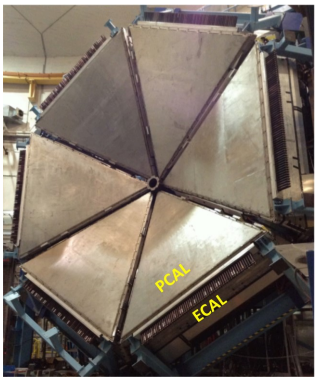
b) Normalized ocupancy of the 36 layers in longitudinal direction versus their wires for the 6 sectors



b) Multiplicity of the 6 sectors (all layers combined)



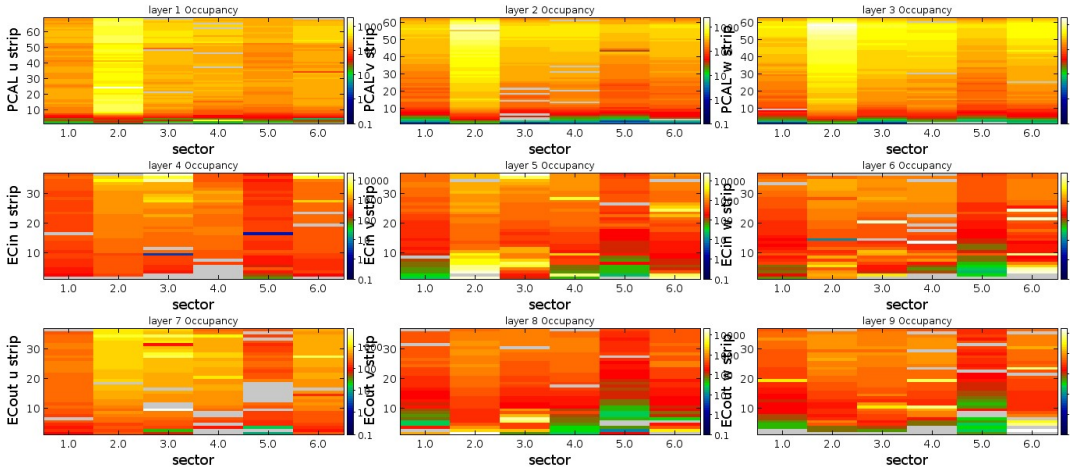
3.2.6 ECAL (Electromagnetic Calorimeter including Preshower Calorimeter)



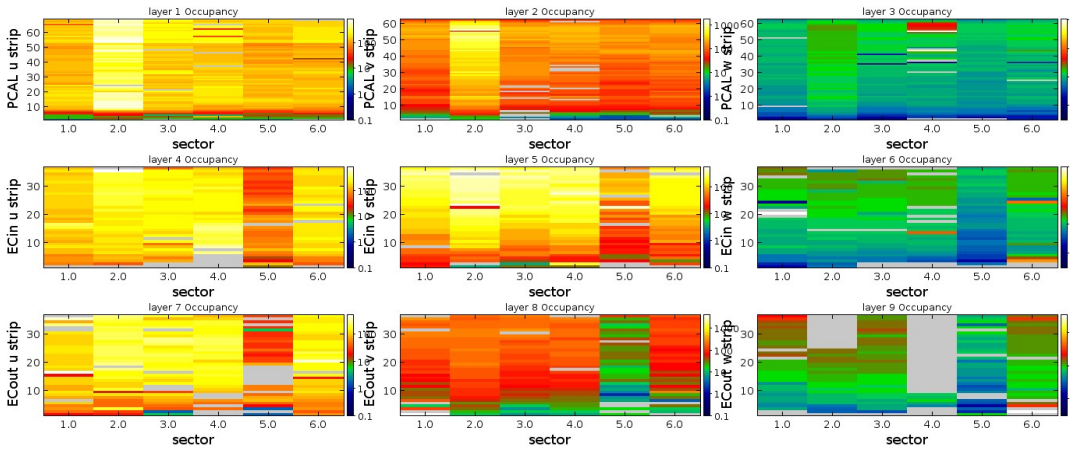
The PCAL and ECAL are sampling calorimeters consisting of six modules. Each module has a triangular shape with 54 (15/15/24, PCAL/ECAL-inner/ECAL-outer) layers of 1-cm thick scintillators segmented into 4.5/10-cm (PCAL/ECAL) wide strips and sandwiched between 2.2-mm thick lead sheets. The total thickness is about 20.5 radiation lengths. Scin8llator layers are grouped into three readout views with 5/5/8, PCAL/ECAL-inner/ECAL-outer, layers per-view providing several cm resolu8on of energy clusters. Light from each scin8llator readout group is routed to PMTs via flexible optical fibers.

The monitoring plots are as follows:

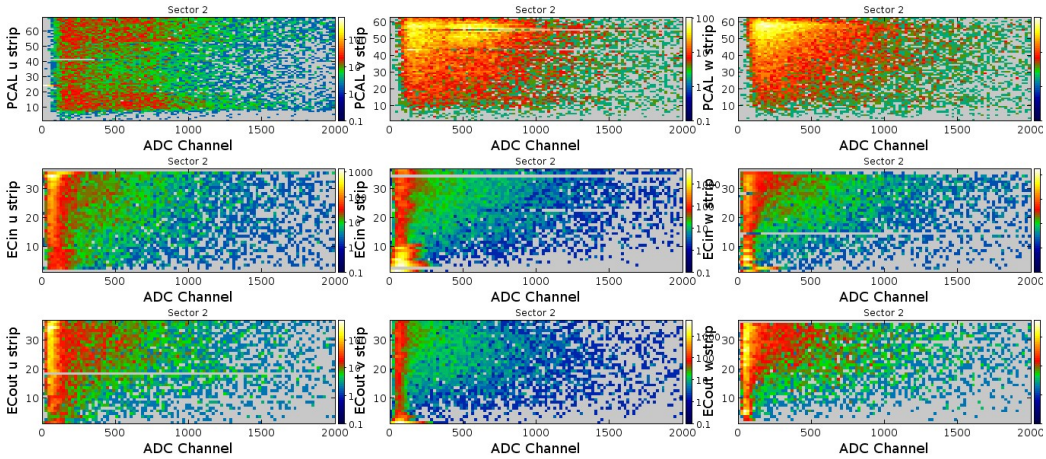
a) ADC Occupancy for the 9 layers of PCAL and ECAL (the sector can be selected via the radio buttons on the lower side of the canvas)



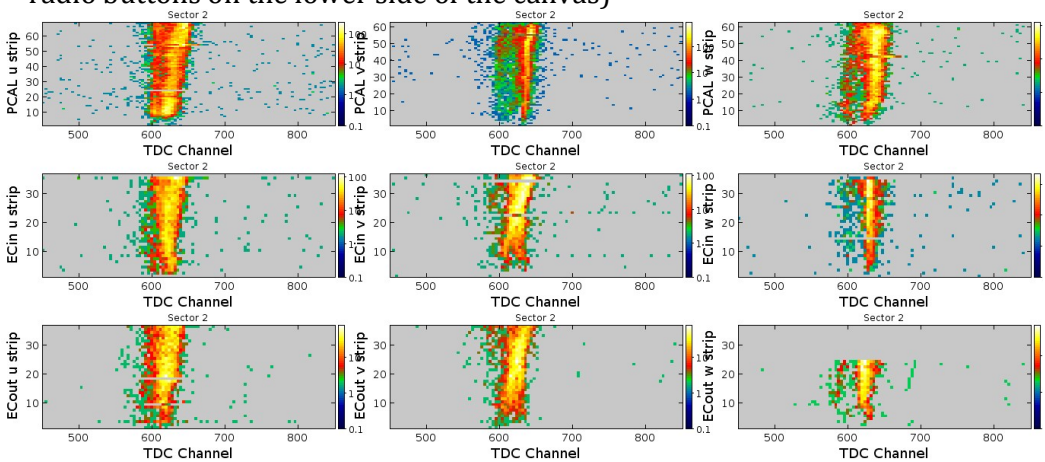
b) TDC Occupancy for the 9 layers of PCAL and ECAL (the sector can be selected via the radio buttons on the lower side of the canvas)



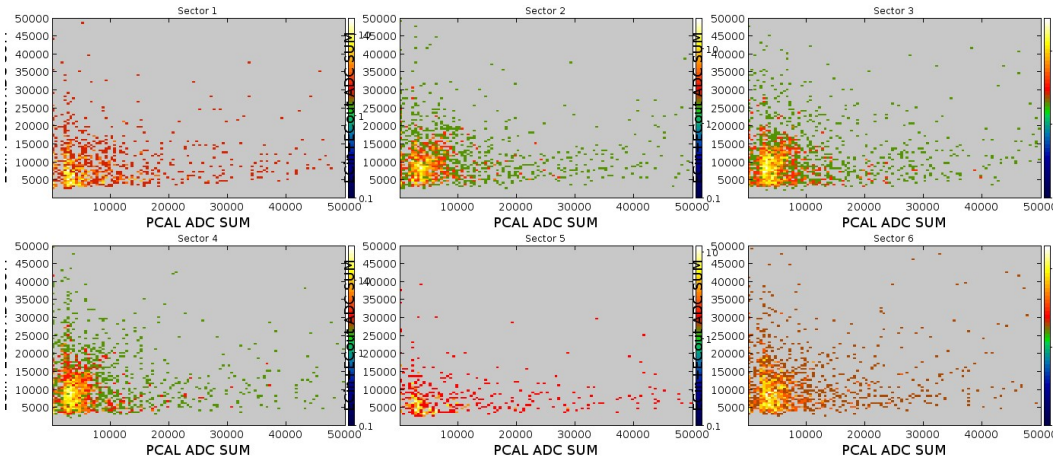
c) ADC histograms for the 9 layers of PCAL and ECAL (the sector can be selected via the radio buttons on the lower side of the canvas)



d) TDC histograms for the 9 layers of PCAL and ECAL (the sector can be selected via the radio buttons on the lower side of the canvas)



e) ECAL ADC sum versus PCAL ADC sum (the sector can be selected via the radio buttons on the lower side of the canvas)

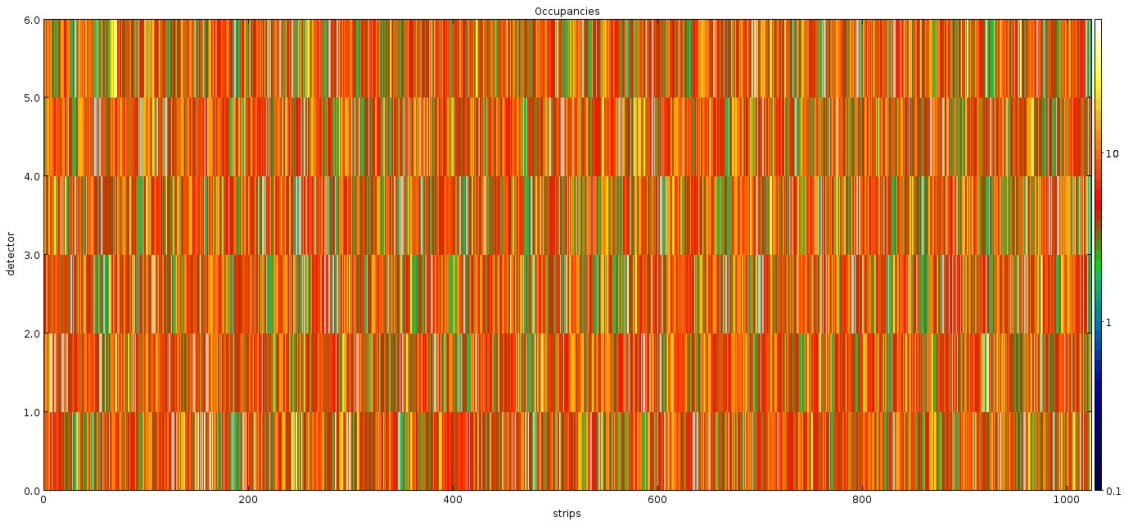


3.2.7 FMT (Forward Micromegas)

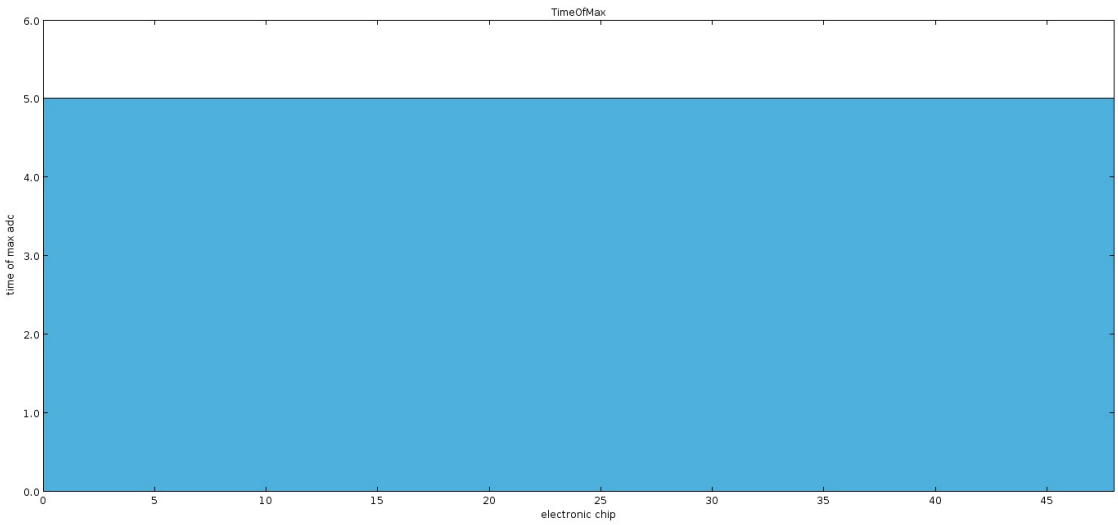
The FMT is the forward part of the BMT. It is a Forward tracker made of 6 circular, flat detectors from 6 to 29°. It improves the vertex resolutions by a factor 3 to 10 compared to the Drift Chambers.

The monitoring plots are as follows:

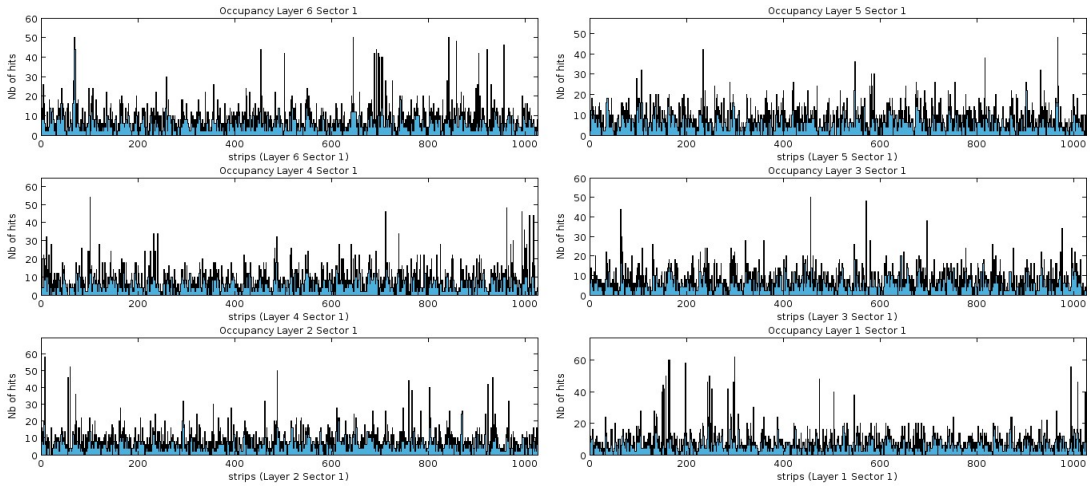
a) Occupancy of the 6 detectors versus their strips



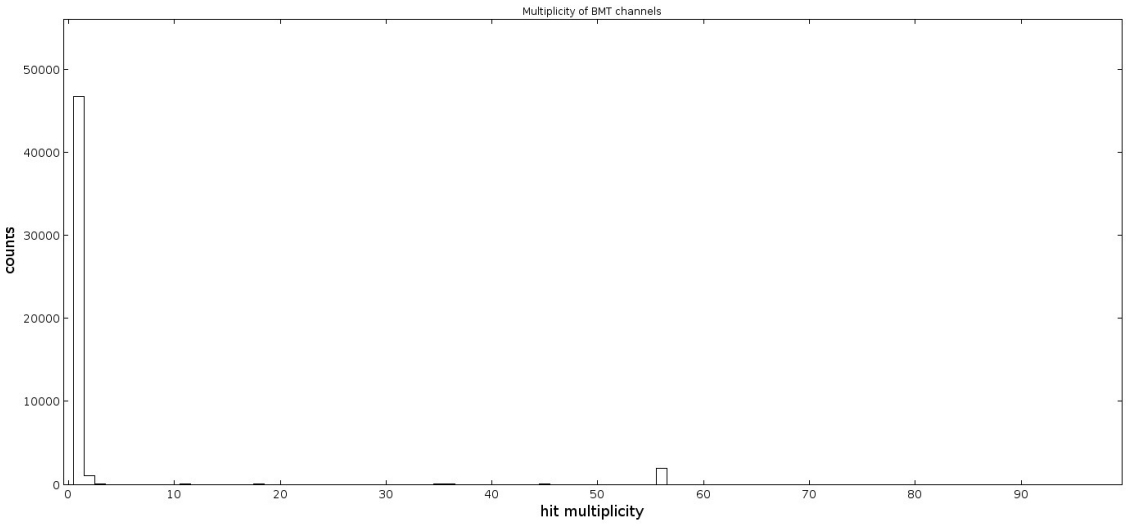
b) Time of max versus chip number (a flat distribution is expected for normal operation)



c) 1 D Plot of the number of hits versus the strip number for the 6 detectors



a) Combined multiplicity of the FMT (can be used to monitor abnormal noise contributions)

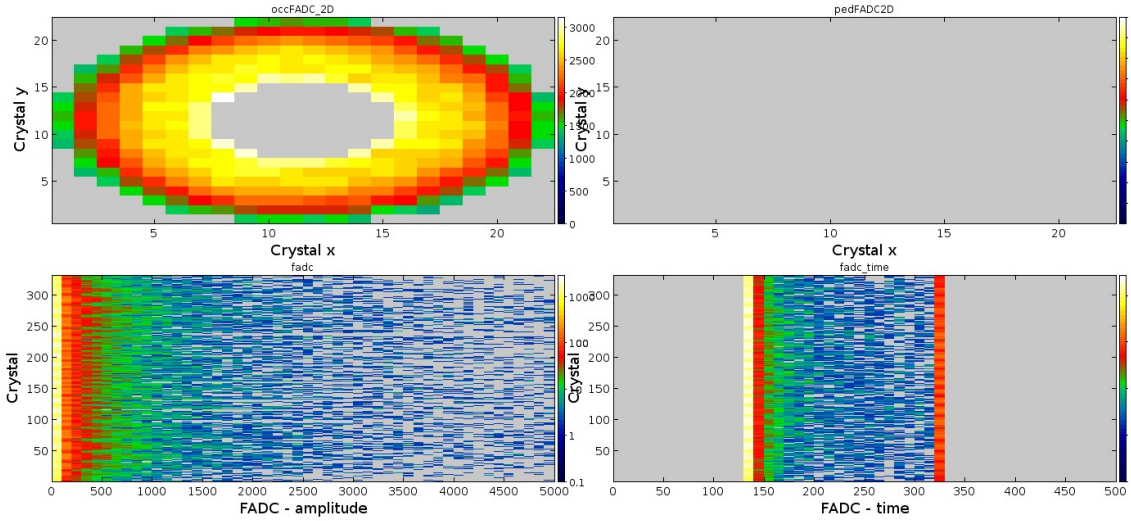


3.2.8 FTCAL (Forward Tagger Calorimeter)

The FTCAL is the electromagnetic calorimeter of the Forward Tagger, consisting of 392 lead tungsten crystals read out by a single APD per crystal.

The monitoring plots are as follows:

a) Occupancy, Pedestal and ADC and TDC pulse height distributions

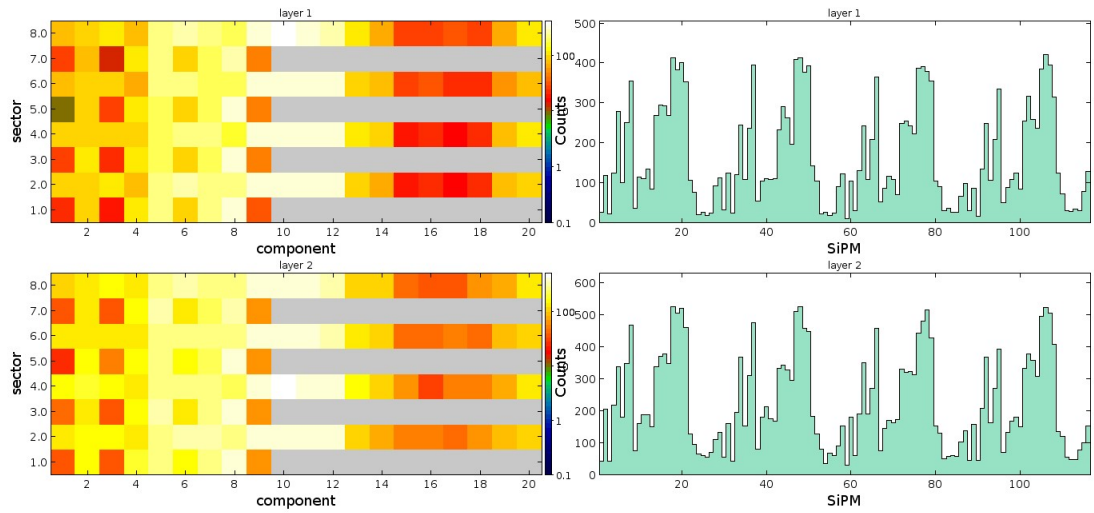


3.2.9 FTHODO (Forward Tagger Hodoscope)

The FTHODO consists of two layers of altogether 116 plastic scintillator tiles with SiPM readout. It is placed in front of the FTCAL in the Forward Tagger.

The monitoring plots are as follows:

a) 2 and 1 dimensional Occupancy of the Tiles / SiPMs



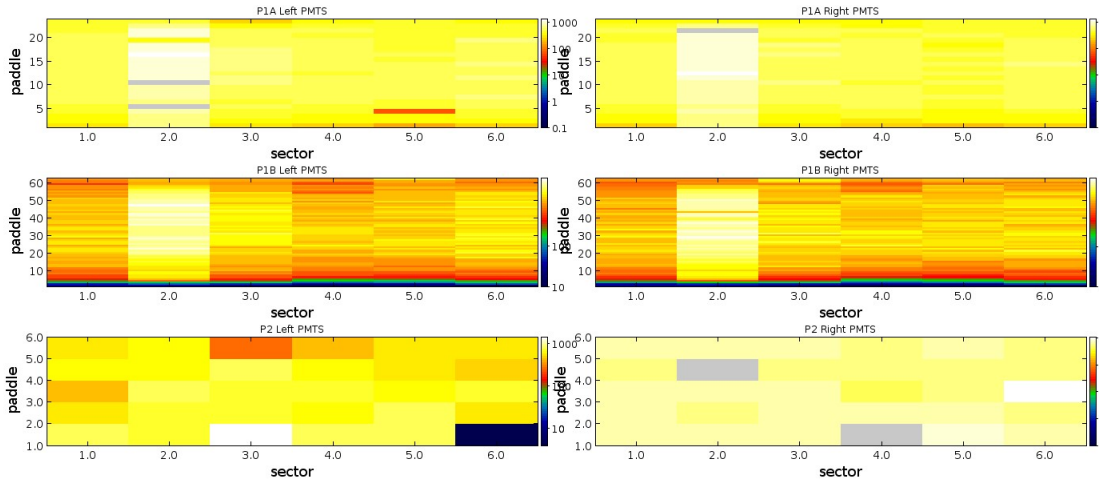
3.2.10 FTOF (Forward Time of Flight Detector)

The CLAS12 FTOF system will be part of the forward detector used to measure the time-of-flight of charged particles emerging from the target. The FTOF system includes 6 sectors of plastic scintillators with double sided PMT readout. Each sector consists of three arrays of counters:

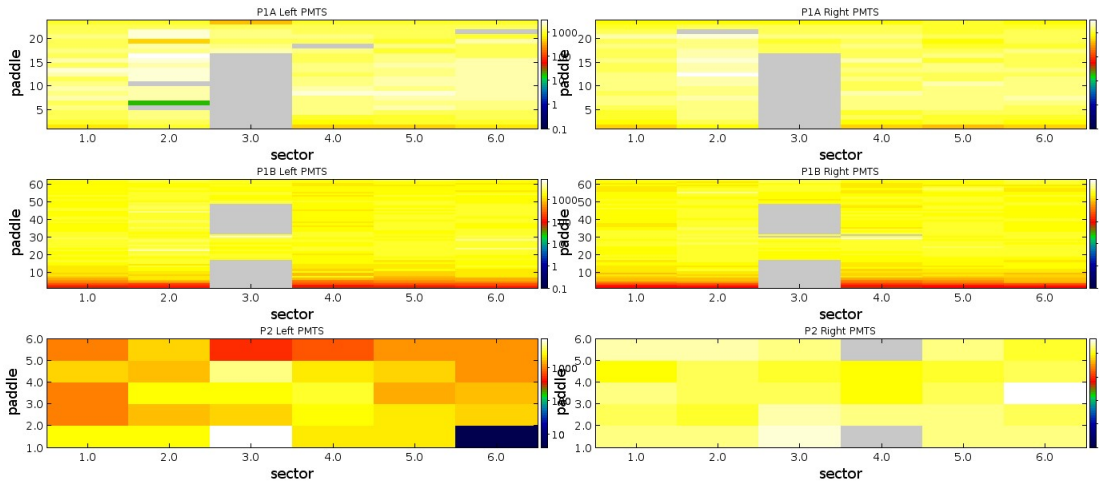
- Panel-1a – 23 counters
- Panel-1b – 62 counters
- Panel-2 – 5 counters

The monitoring plots are as follows:

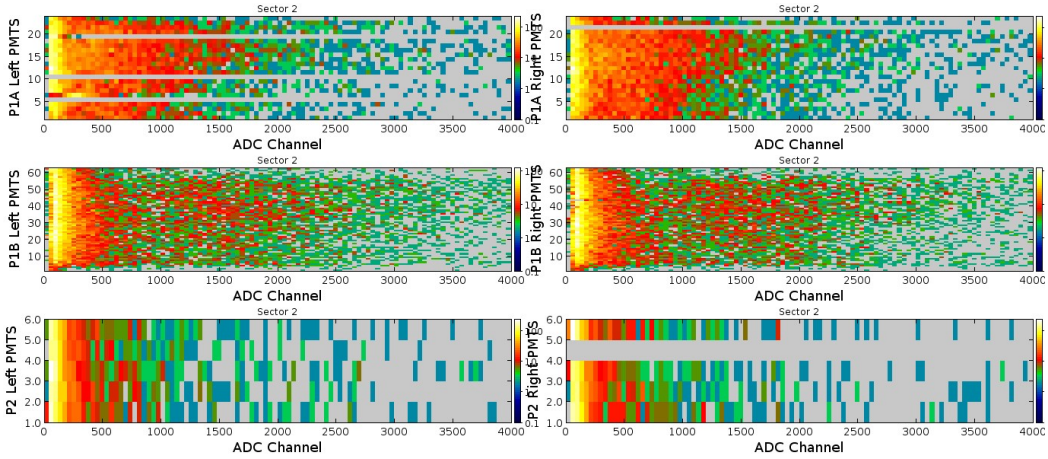
a) ADC occupancy of the different panels (the sector can be selected via the radio buttons on the lower side of the canvas)



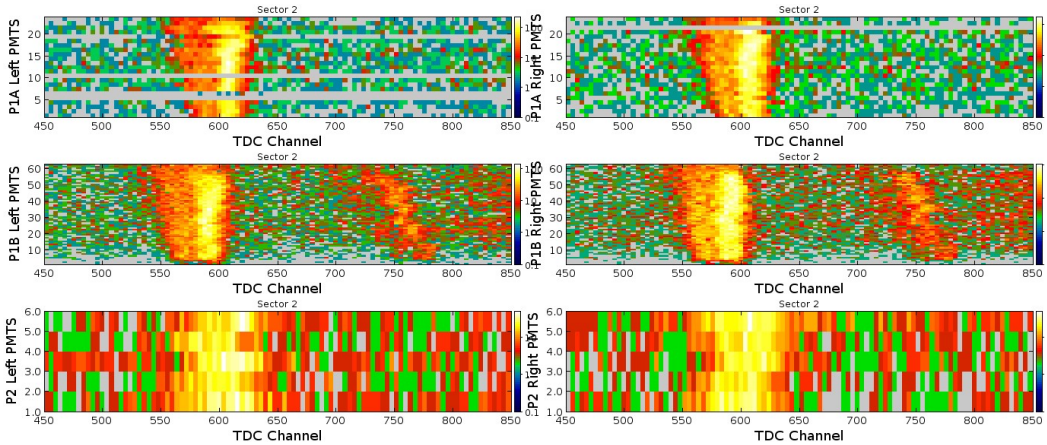
b) TDC occupancy of the different panels (the sector can be selected via the radio buttons on the lower side of the canvas)



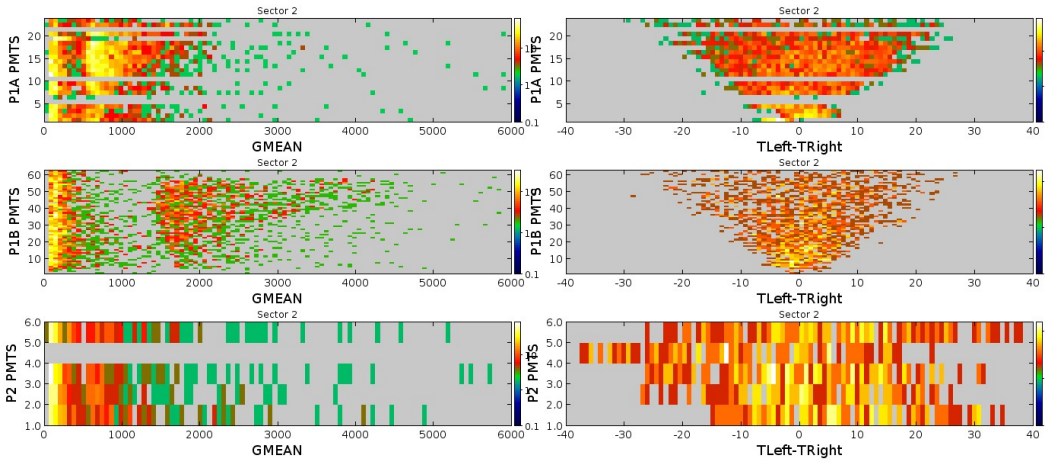
c) ADC pulse height distributions of the different panels (the sector can be selected via the radio buttons on the lower side of the canvas)



d) TDC pulse height distributions of the different panels (the sector can be selected via the radio buttons on the lower side of the canvas)



e) GMEAN distributions of the different panels (the sector can be selected via the radio buttons on the lower side of the canvas)

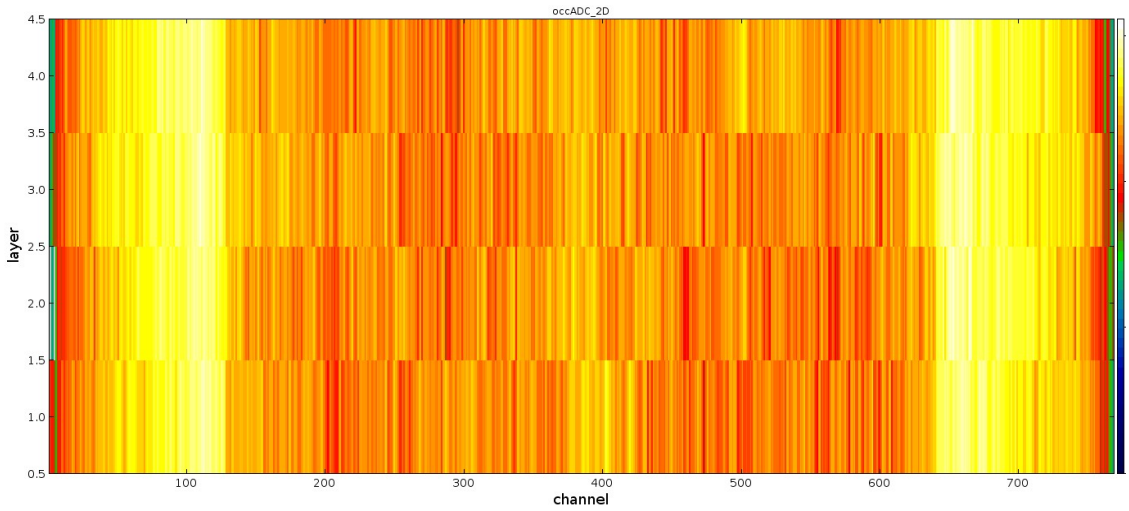


3.2.11 FTTRK (Forward Tracking Detector)

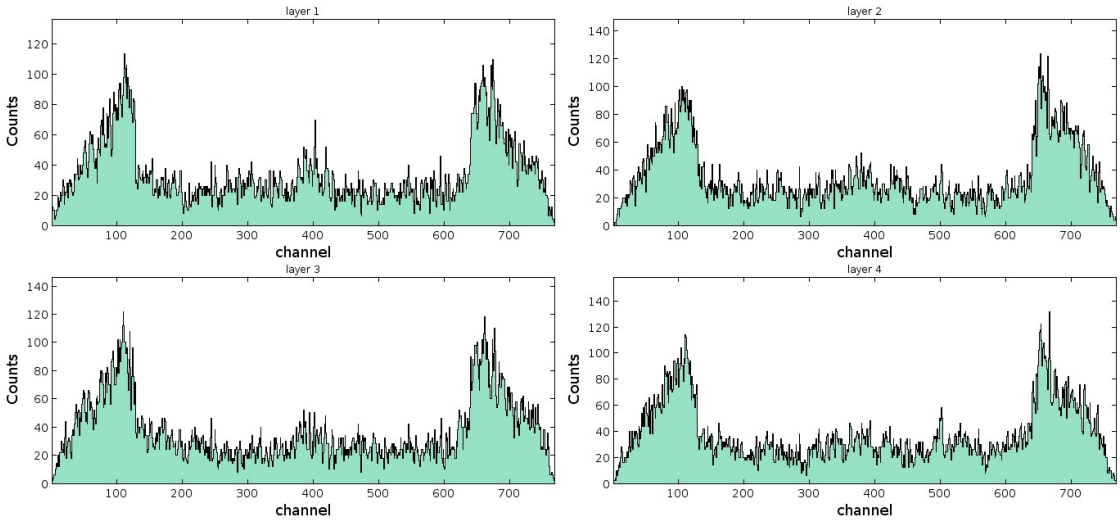
The FTTRK is the tracking detector of the Forward Tagger. It consists of two double layers of silicon strip detectors with altogether 3392 channels.

The monitoring plots are as follows:

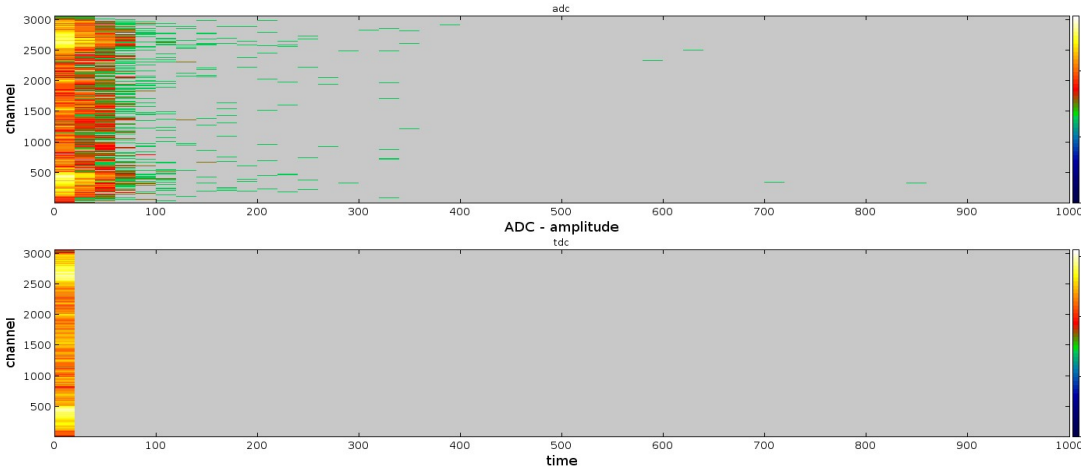
a) Occupancy of the 4 layers in longitudinal direction versus their readout channels



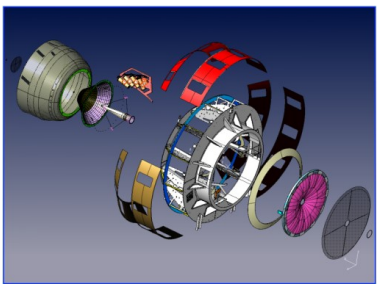
b) One dimensional occupancy for the 4 layers



c) ADC and TDC pulse height spectra



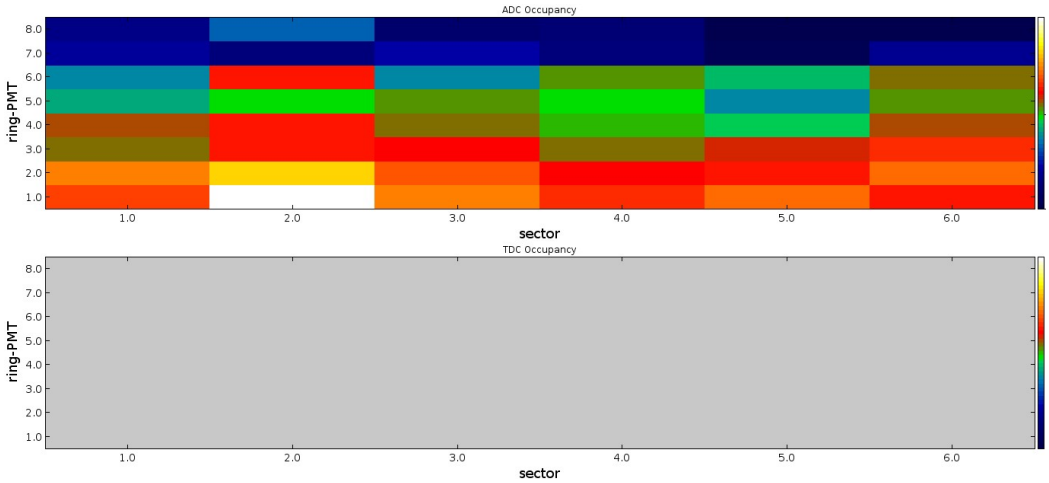
3.2.12 HTTC (High Threshold Cherenkov Detector)



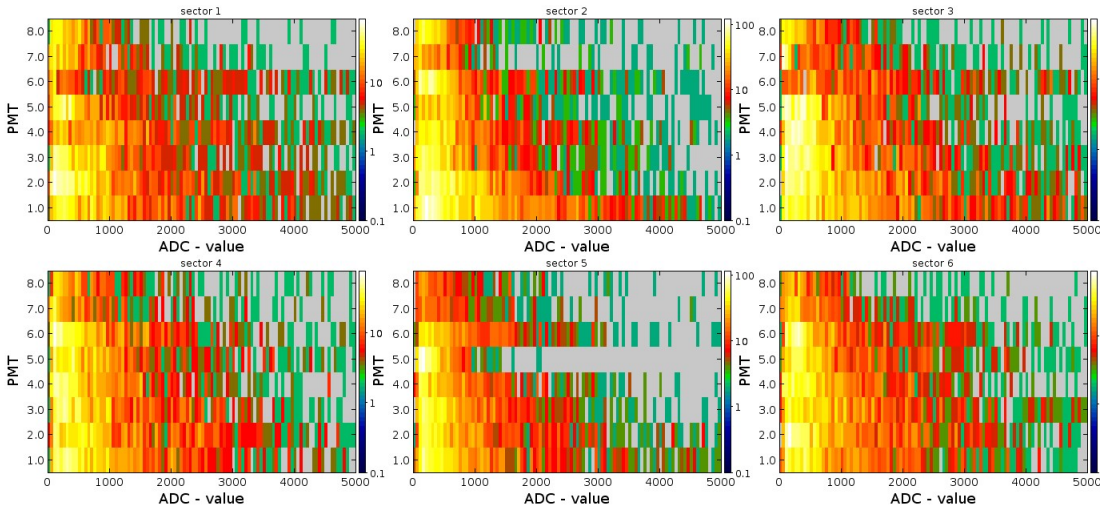
The HTCC will be one of the detector systems of the CLAS12 spectrometer and used to generate fast trigger signal in experiments with electron beam. The HTCC will be installed in front of the R1 Drift Chambers and will introduce a minimal amount of materials. The HTCC is one unit, and the core component of it is a multifocal mirror consisting of 60 lightweight composite ellipsoidal mirrors. Each sector of the CLAS12 is covered with 2 identical half-sector mirrors that are focusing Cerenkov light on eight 5-inch phototubes (total of 48 channels for entire detector).

The monitoring plots are as follows:

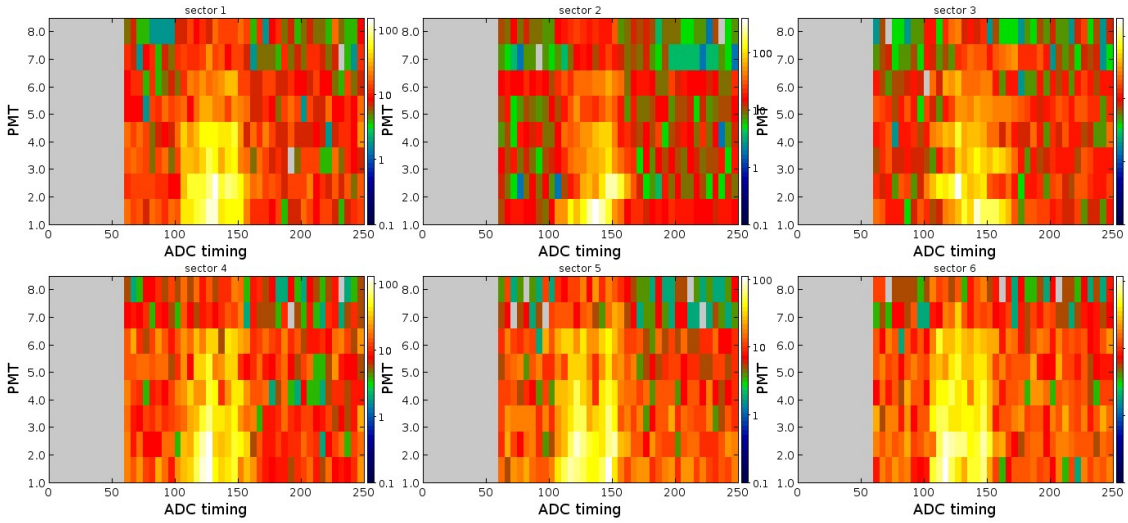
a) ADC and TDC occupancies for the 8 ring PMTs per sector versus the sector



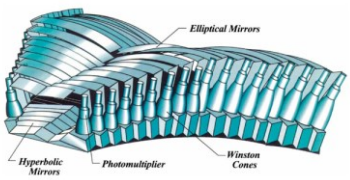
b) ADC pulse height spectra for the 6 sectors



c) ADC timing spectra for the 6 sectors



3.2.13 LTTC (Low Threshold Cherenkov Detector)

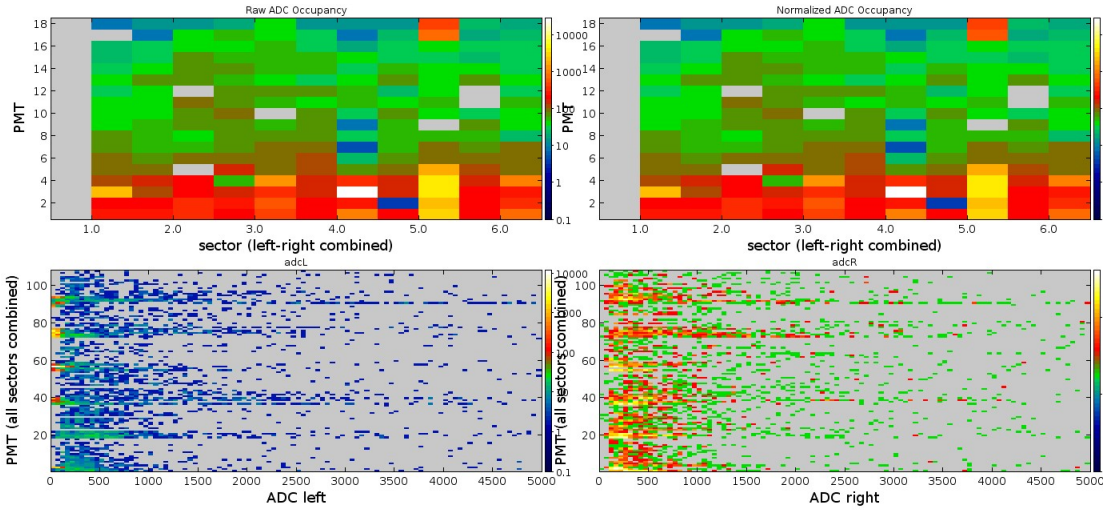


The LTCC system is part of the forward CLAS12 detector and will be used for pion/kaon discrimination. The LTCC consists of 6 sectors of lightweight mirrors, light collecting cones, 5” PMTs, and magnetic shields. The sectors are filled with C4F10 gas, providing pion/kaon discrimination from 3.5 to 9 GeV/c. Each sector contains:

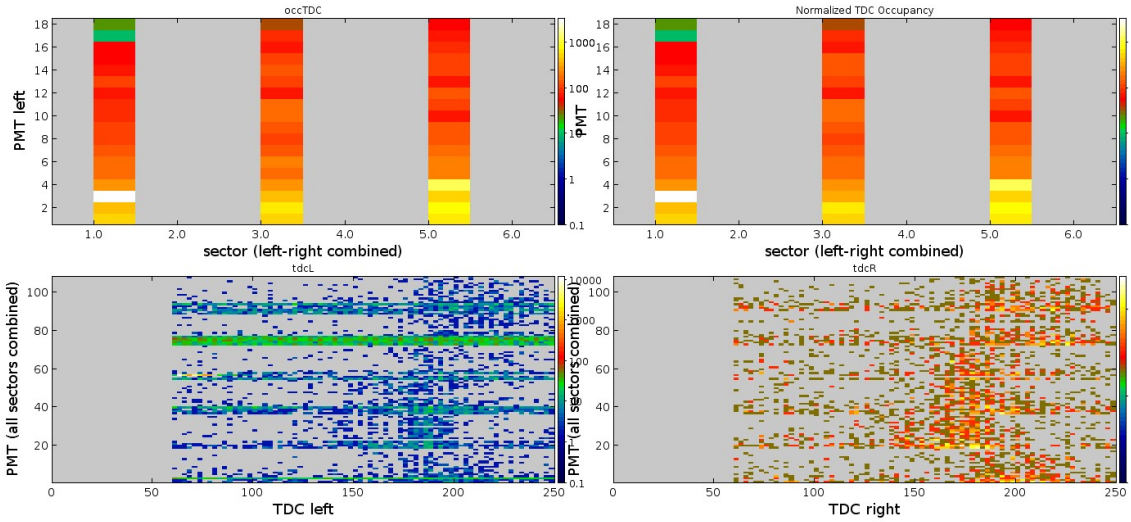
- 108 lightweight mirrors
- 36 Winston Cones
- 36 5’’ PMT with magnetic shields

The monitoring plots are as follows:

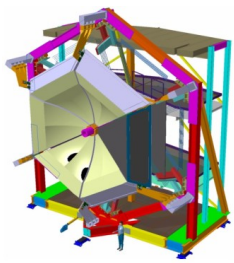
a) ADC occupancy and pulse height spectra (left and right PMTs of each sector are combined as half sectors on the x-axis of the plots in the upper row)



a) TDC occupancy and pulse height spectra (left and right PMTs of each sector are combined as half sectors on the x-axis of the plots in the upper row)



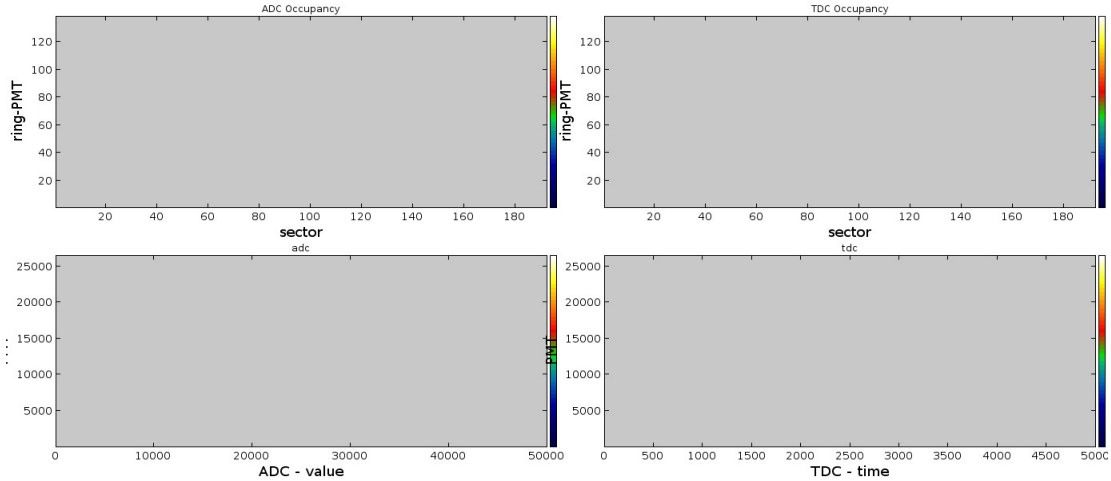
3.2.14 RICH (Ring Imaging Cherenkov Detector)



The Ring Imaging Cherenkov detector (RICH) is designed to improve CLAS12 particle identification in the momentum range 3-8 GeV/c and will replace one sector of the existing LTCC detector. It consists of 23 tiles with 2 MCPMTs and 113 tiles with 3 MCPMTs. Altogether 391 PMTs. Each MCPMT provides 64 readout channels.

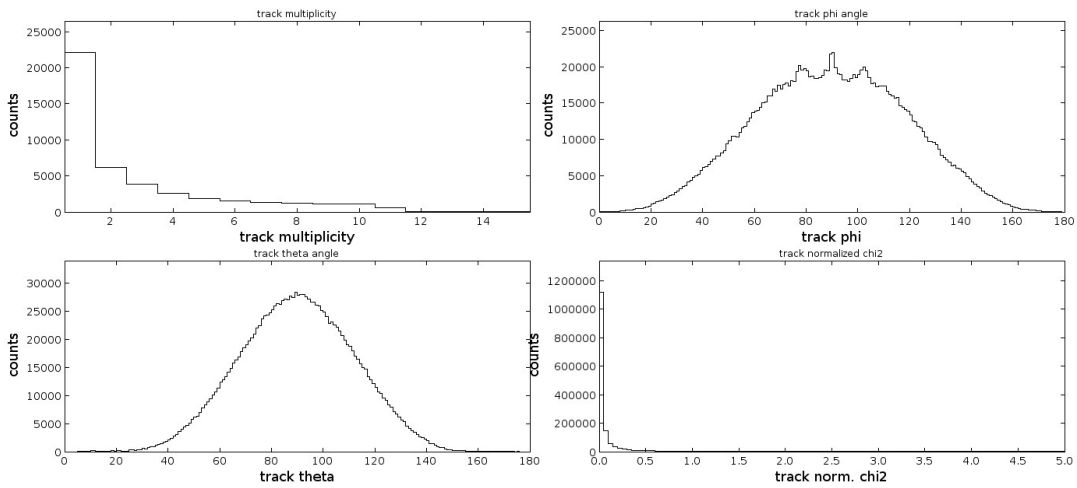
The monitoring plots are as follows:

a) 2 D plot of the occupancy and the pulse height spectra for ADC and TDC



3.3 The RECON monitor

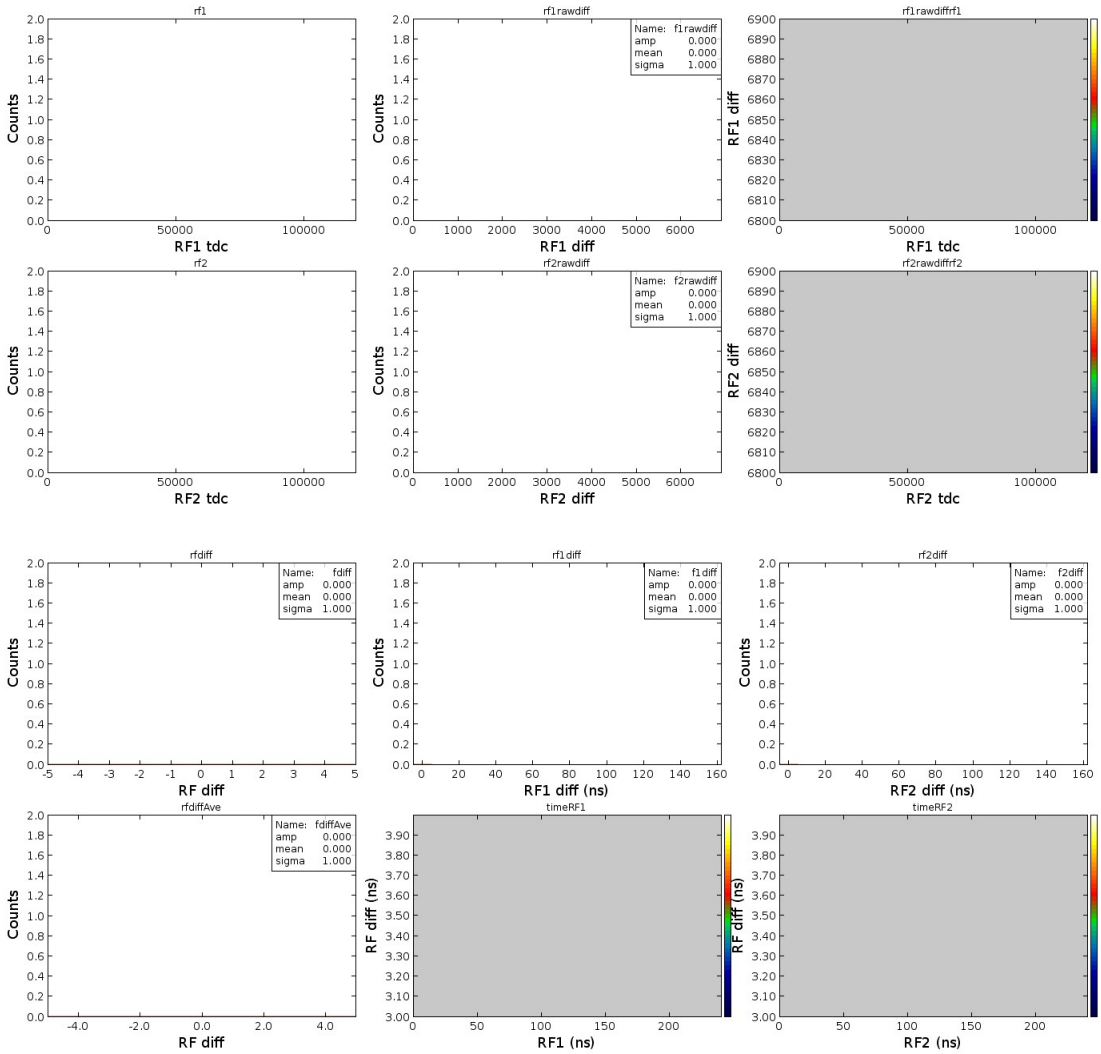
While the detector monitors visualize the raw information of the single sub-detectors, the RECON monitor tab displays selected properties of the reconstructed data. It is only functional if a **reconstructed HIPO file** is read in or if CLAS12Mon is connected to the online reconstruction via the **HIPO ring**. Up to now tracking plots are included for the Vertex tracking of the central detector (CVT) and for the Driftchambers (DC). The figure shows an example of basic information obtained by the central vertex tracking, which combines the BMT and the BST.



3.4 Beam and Trigger Monitors

3.4.1 The RF tab

The RF tab displays the beam information contained in the data stream.



3.4.2 The HEL tab

In the HEL tab a histogram with the helicity distribution of the beam can be found.

3.4.3 The Faraday Cup tab

The Faraday Cup tab contains the information provided by the Fraday cup.

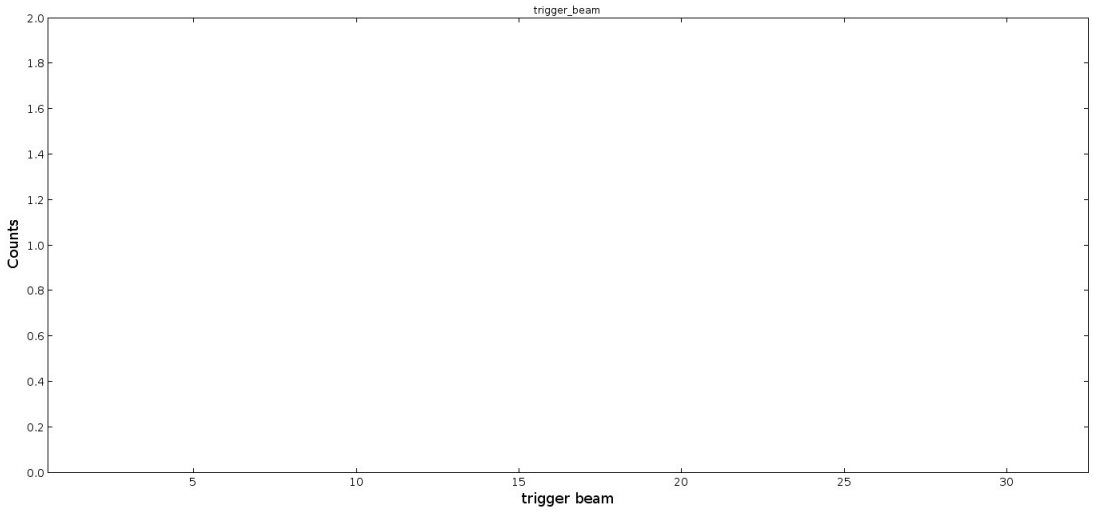
3.4.4 The Trigger Tab

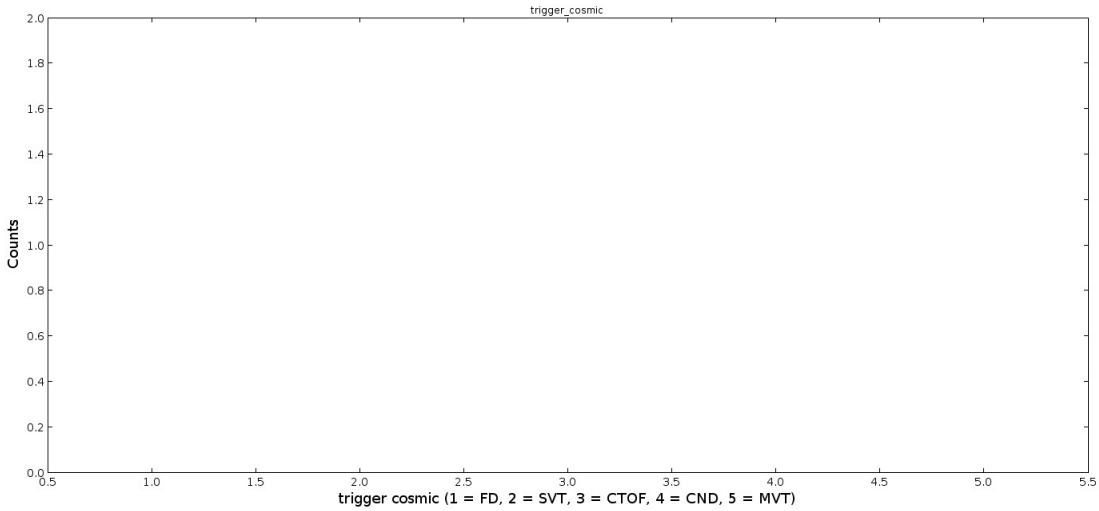
The trigger tab shows the rate distributions of the different triggers. There is one sub tab for the beam triggers and one for the cosmic triggers. The plots are done for all sectors combined. Therefore the radio buttons for the sectors on the bottom of the GUI have no effect on these distribution plots.

For the cosmic triggers, five possible triggers are available. The assignment is as follows:

1: FD 2: SVT 3: CTOF 4: CND 5: MVT

For the in beam triggers, 32 triggers will be available. The exact assignment will be added as soon as it is available.





In addition to these rate distributions more detailed information for the detectors which initiated the trigger are shown in additional sub tabs. In detail this are the energy, time and coordinate for the EC peak and the EC cluster trigger as well as the cluster mask information for the HTTC and FTOF cluster trigger. The different histograms can be plotted for the individual sectors by selecting the current sector via the radio buttons on the bottom of the GUI.

3.5 Contacts and Acronyms

The **Contact** panel contains the Names, mail addresses and phone numbers of the people responsible for the expert monitoring of the single detector systems. If a malfunction or problem with a specific detector system is discovered by the shift takers and can not be solved by them, the responsible person should be contacted for a closer investigation.

The **Acronyms** section gives an overview over the Acronyms used within the GUI.

4. Contact information

For information or issues with CLAS12Mon, contact: Stefan Diehl, sdiehl@jlab.org

The following list contains the contact information of the people responsible for the expert monitoring of the single detector systems:

system	name	email	phone
CND	Daniel Carman	carman@jlab.org	757-344-7204
CTOF	Daniel Carman	carman@jlab.org	757-344-7204
DC	Mac Mesteyer	mestayer@jlab.org	757-584-5509
ECAL	Cole Smith	lcsmith@jlab.org	757-810-1489
FTOF	Daniel Carman	carman@jlab.org	757-344-7204
FTTRK	xx xx	xx@jlab.org	757-xxx-xxx
FTHODO	xx xx	xx@jlab.org	757-xxx-xxx
FTCAL	Raffaella De Vita	devita@jlab.org	757-xxx-xxx
HTTC	Youri Sharabian	youris@jlab.org	757-344-7174
LTTC	Maurizio Ungaro	ungaro@jlab.org	757-329-4846
BMT + FMT	Guillaume Christiaens, Maxim Defurne	guillaume.christiaens@cea.fr , mdefurne@jlab.org	757-xxx-xxx
SVT	Yuri Gotra	gotra@jlab.org	757-541-7539
DAQ	Sergey Boiarinov	boiarino@jlab.org	757-869-2188
Slow Control	Nathan Baltzell	baltzell@jlab.org	757-748-6922
Beamline	Rafayel Paremuzyan	xx@jlab.org	757-303-3996

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References

Pictures and detector descriptions have been taken from the detector spec sheets provided on https://www.jlab.org/Hall-B/clas12-web/