

MON12: the CLAS12 monitoring GUI

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1. Introduction

The Clas12Mon application is designed to provide shift takers with basic information on CLAS12 raw data, such as occupancies, ADC and TDC spectra, to check the detectors functionality. It is divided into a summary section with few overview plots per detector and a specific section for each detector. In addition, beam-related observables and trigger information are displayed in specific tabs. Figure 1 shows the mon12 GUI and the summary page on RF, helicity, trigger and time jitter that is visible upon launching the application.

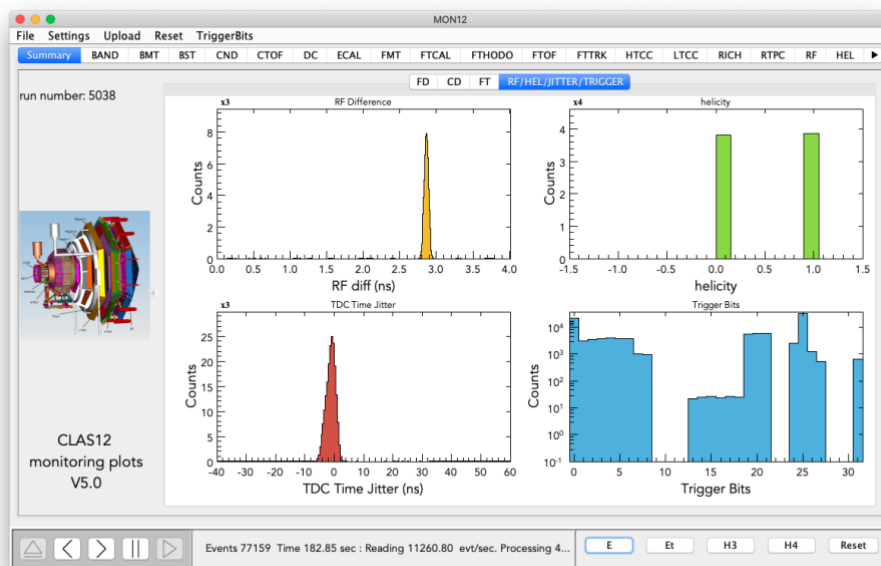


Figure 1: Front page of the mon12 GUI, showing the RF, beam helicity, TDC time jitter and trigger bits plots.

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

2. Shift takers instructions

2.1 Launching mon12

Open a terminal on a clonpc as user clasrun and type mon12. This will launch the application and open the GUI.

2.2 mon12 input sources

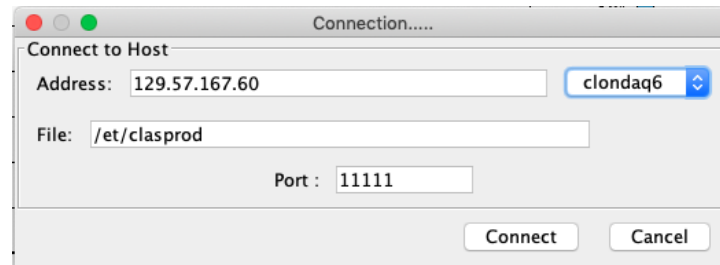
The input source can be selected using the buttons in the lower right corner of the GUI.



Available choices are:

- EVIO (**E**) raw data from file or DAQ ET ring (**ET**),
- HIPO (**H**) raw data from files in HIPO3 or HIPO4 format.

The primary data source for mon12 during data taking is the DAQ ET ring. To establish the connection, click on the ET button, select the correct IP address for the machine hosting the ET ring in the window below and click connect. A list of hosts is accessible via the drop-down menu.



2.3 Start, pause and reset

Once the input file is opened or the connection to the ET-Ring is established, 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. After pausing the app, data accumulation can continue one event at a time by clicking on the forward button or be resumed in continuous mode with the start button.

Once the accumulation process is in progress, plots both in the summary tab 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.

At any time, histograms can be cleared clicking on the **Reset** button at the bottom right of the GUI. A reset will be triggered automatically when a new run starts, and the run number changes. Alternatively, a periodic reset can be set from the Reset drop-down menu on the top left, inserting the number of events after which the reset command will be issued. Reset of histograms for a specific detector can be issued, selecting the corresponding option in the Reset drop-down menu.

2.4 Plotting options

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. Other plotting options are available via the same menu.

2.5 Selecting trigger bits

Events accumulated in the histograms can be selected according to specific triggers, by selecting the relevant trigger bit in the Trigger drop-down menu. Note that the displayed list does not update automatically when the trigger configuration changes and may not match the trigger bits in usage if the app has not been updated recently. To return to accumulate events for all triggers, uncheck the selected trigger bit.

2.6 Saving and printing the histograms

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. Histograms that were previously saved to file can be displayed in the mon12 GUI by clicking on the **Open histogram file** item in the **File** dropdown menu at the top left of the GUI.

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. Mon12 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.

Upload all histograms to the electronic Logbook

A direct upload of the histograms to the logbook can be done via **Upload → Upload all histos to the logbook**. The app will first create PNGs for each tab, saving them in a new folder in the /home/clasrun/CLAS12MON/output area named according to run number, date and time. Then it will create a logbook entry in the HBLOG. See for example <https://logbooks.jlab.org/entry/3773565>. Once the entry is created, plots can be compared to a selected reference or to previous entry via the web site accessible at the link **Comparison between mon12 plots**, listed in the **Useful links** tab on the run page.

2.7 Usage tips

At any time, mon12 logging information can be checked in the terminal from which the application was started. In case of misbehaviors, check the printouts for errors and log relevant information about the problem and the errors in the electronic logbook, notifying devita@jlab.org. Then kill the application and restart it.

When the DAQ is restarted from Configure-Download, the ET ring is terminated and mon12 may not reconnect automatically at the DAQ restart. If so, close the GUI and restart the application from the terminal.

For any problem or comment, contact devita@jlab.org.

3. Expert instructions

Instructions for experts and developers are provided on the GitHub repository wiki at <https://github.com/JeffersonLab/clas12mon/wiki>.

4. Summary and detector specific plots

(To be updated)

4.1 The summary tab

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).

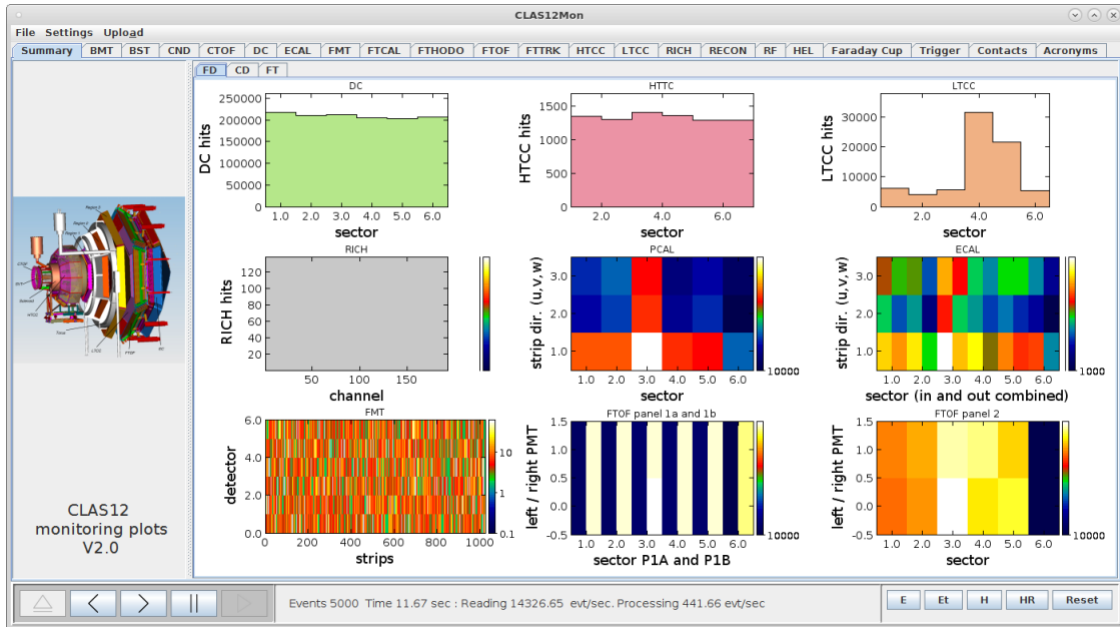


Figure 2: Summary tab of the FD

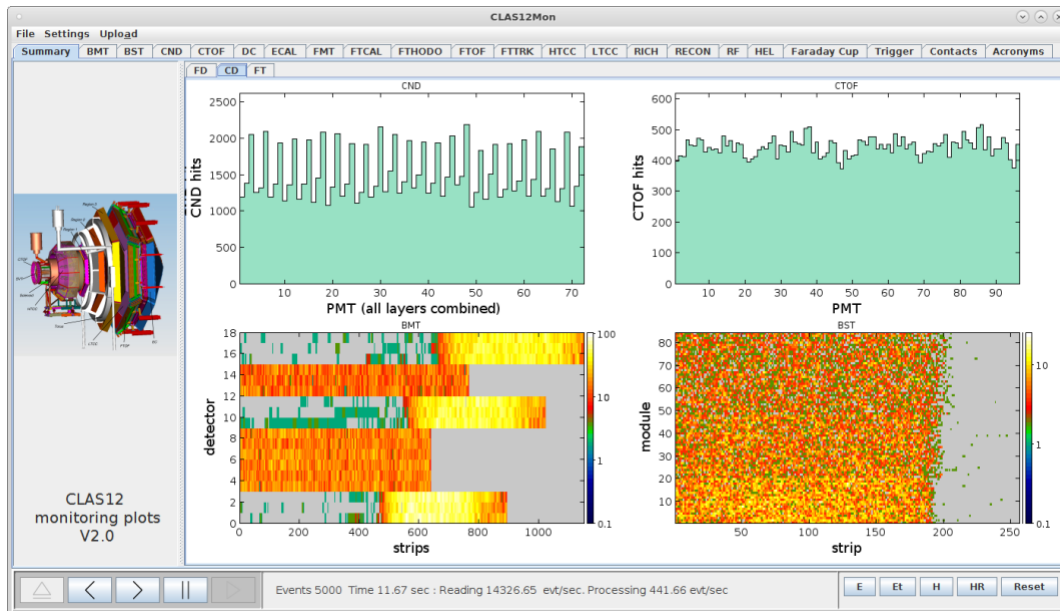


Figure 3: Summary tab of the CD

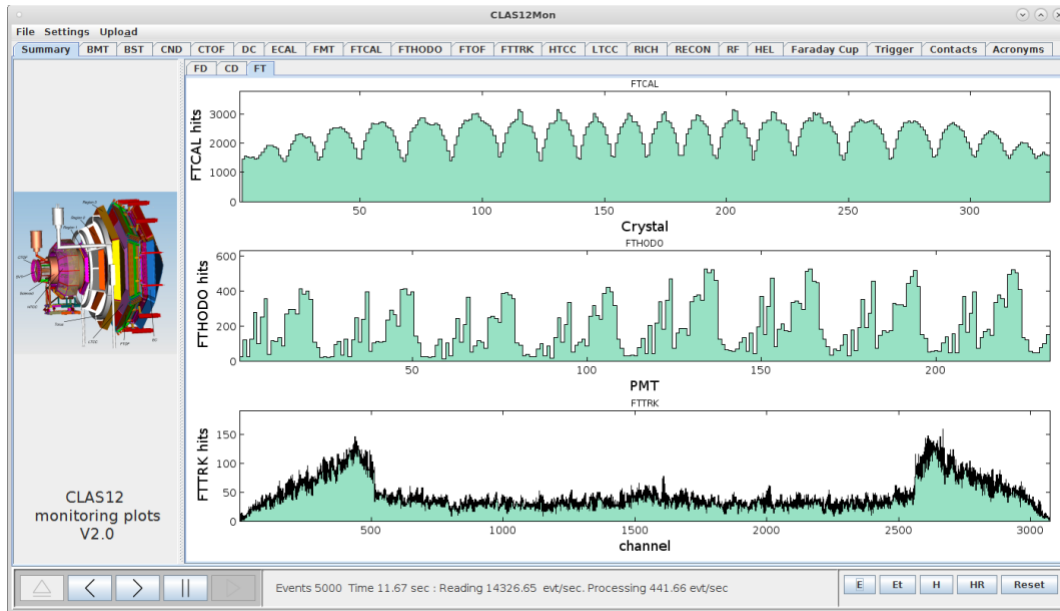


Figure 4: Summary tab of the FT

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. In 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.

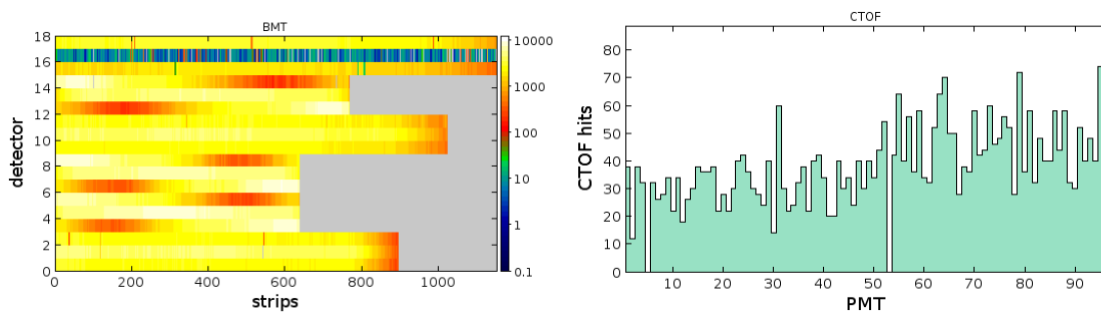


Figure 4: Example for the malfunction of single channels / sections for the BMT and the CTOF

4.2 The detector tabs

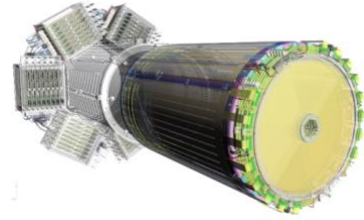
The detector monitors contain more detailed information on each sub-detector system. They especially contain the full occupancy plots for all channels of the detector for the ADC and the TDC if applicable. In addition, depending on the detector, overview plots for the

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.

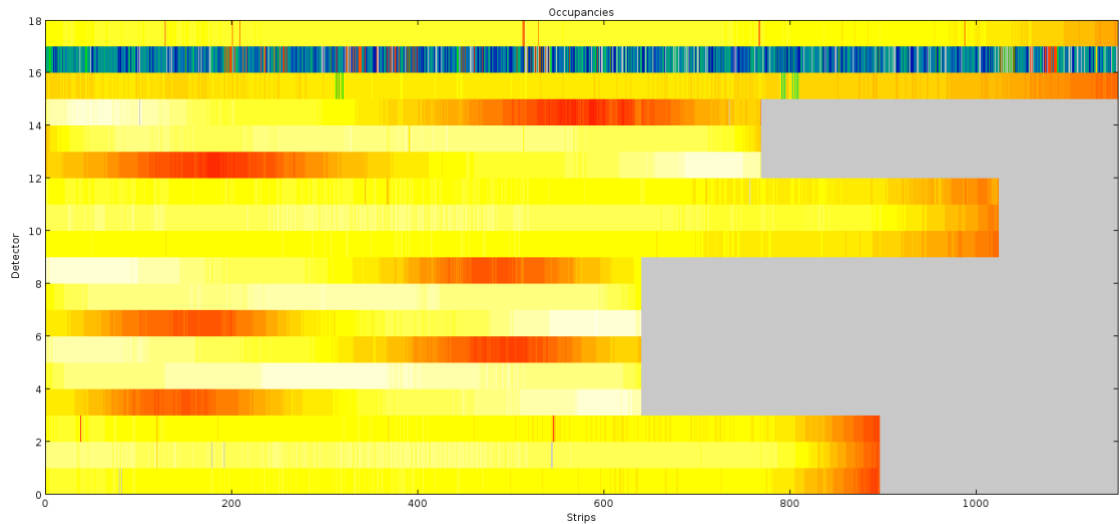
BMT (Barrel Micromegas Tracker)

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.

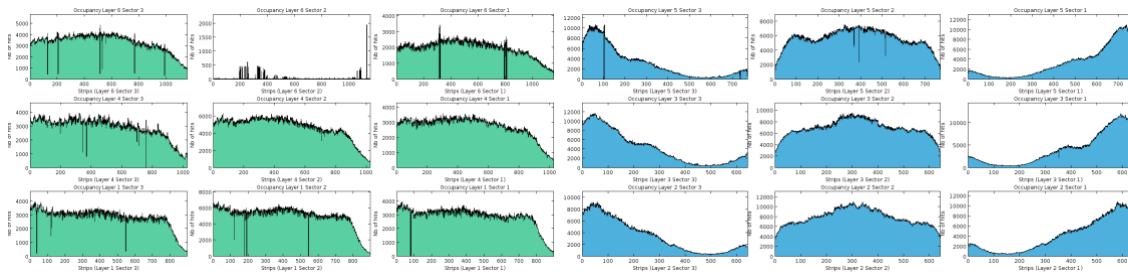


The monitoring plots are as follows:

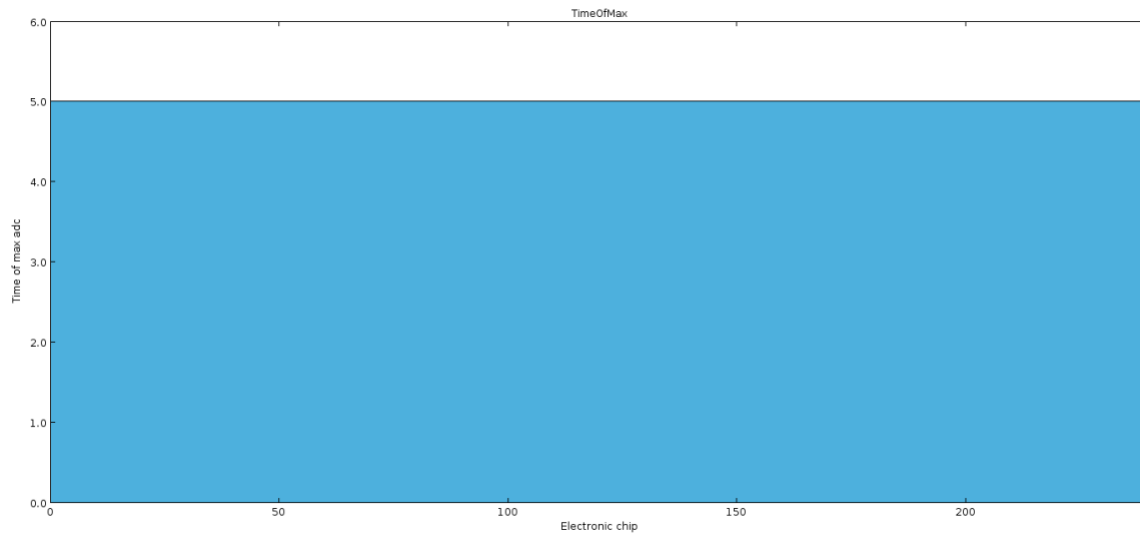
a) Occupancy of the 18 detectors versus their strips



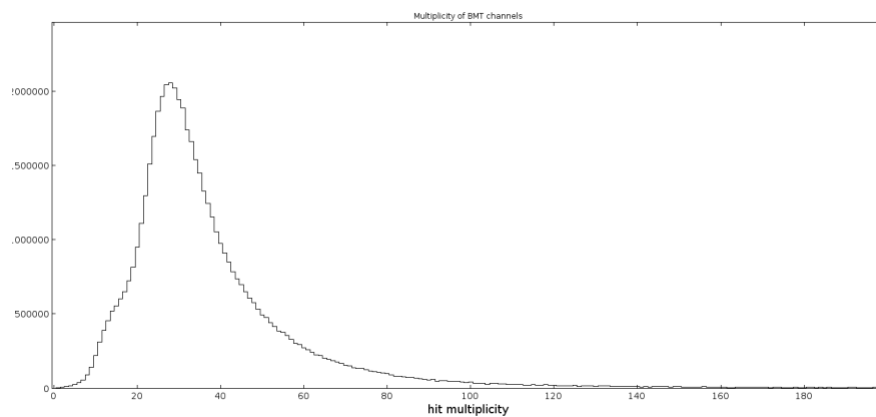
b) 2 dimensional Occupancy plots for the 18 detectors (2 tabs with 9 detectors each)



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

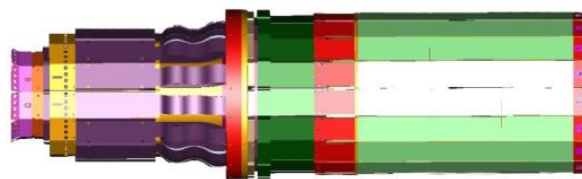


d) Multiplicity (can be used to identify abnormal noise behavior)



BST (Barrel Silicon Tracker)

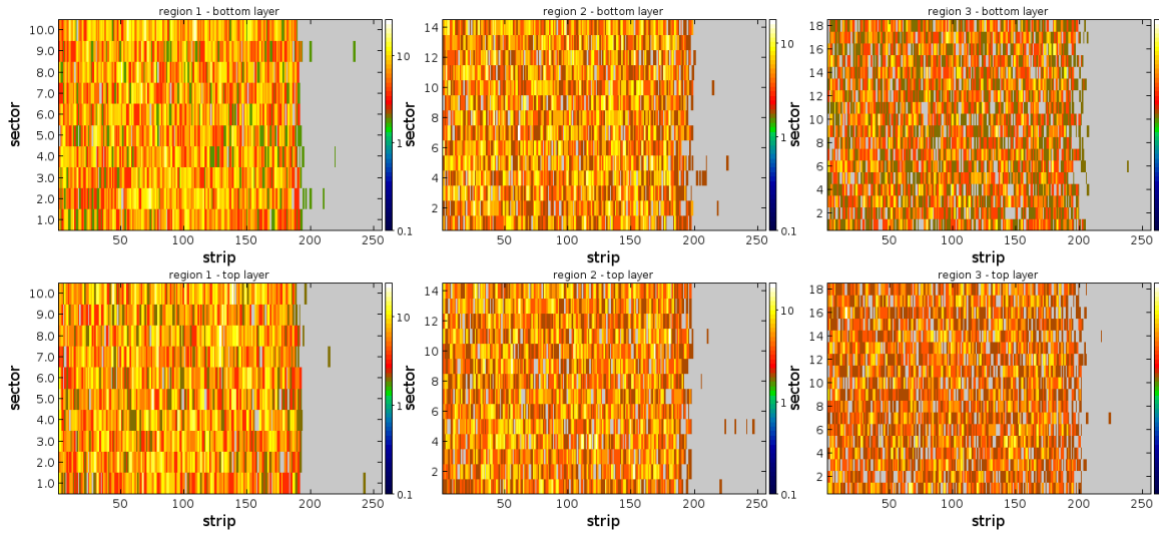
The **CLAS12 BST** system is a part of the Central Detector and will be used to measure the momentum and determine the vertex of charged particles emerging from the target. The BST system



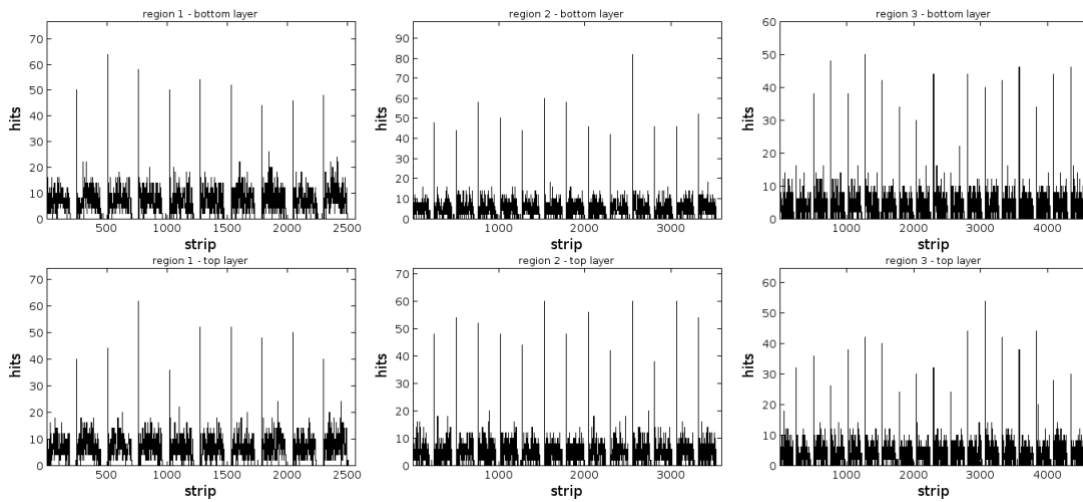
includes 3 regions with 10, 14 and 18 sectors of double-sided modules (silicon sensors on both sides of the backing structure) instrumented with digital readout ASICs.

The monitoring plots are as follows:

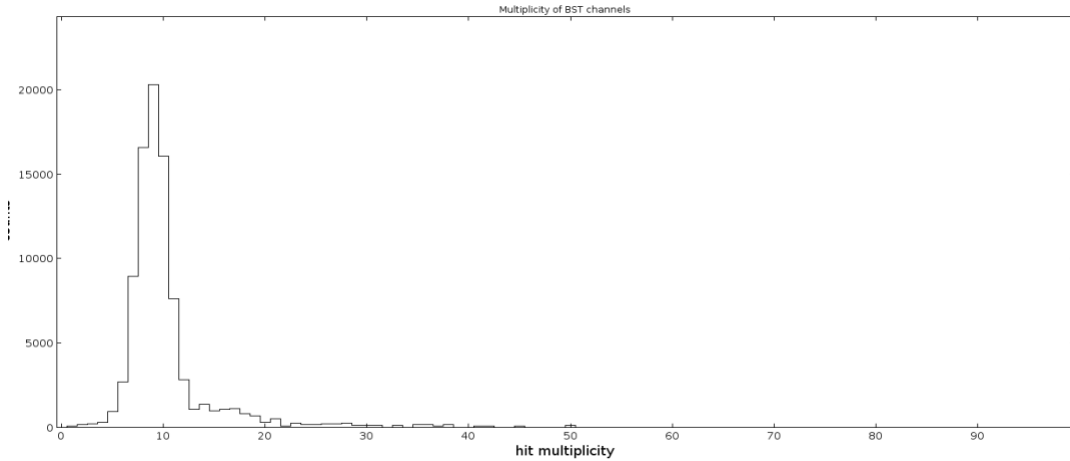
a) Occupancies for the 3 regions (upper row: bottom layer, lower row: top layer)



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)

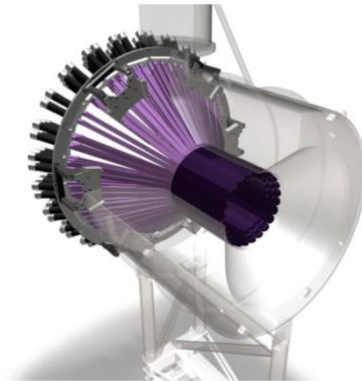


d) Multiplicity (can be used to identify abnormal noise behavior)



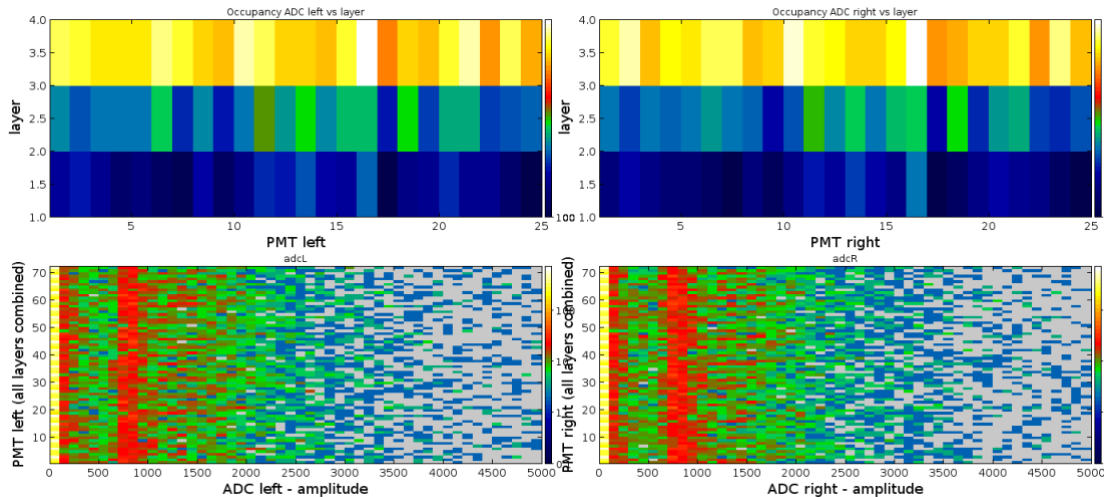
CND (Central Neutron Detector)

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 photomultipliers placed outside of the high magnetic field region and connected to the bars via 1.5-m-long bent light guides.

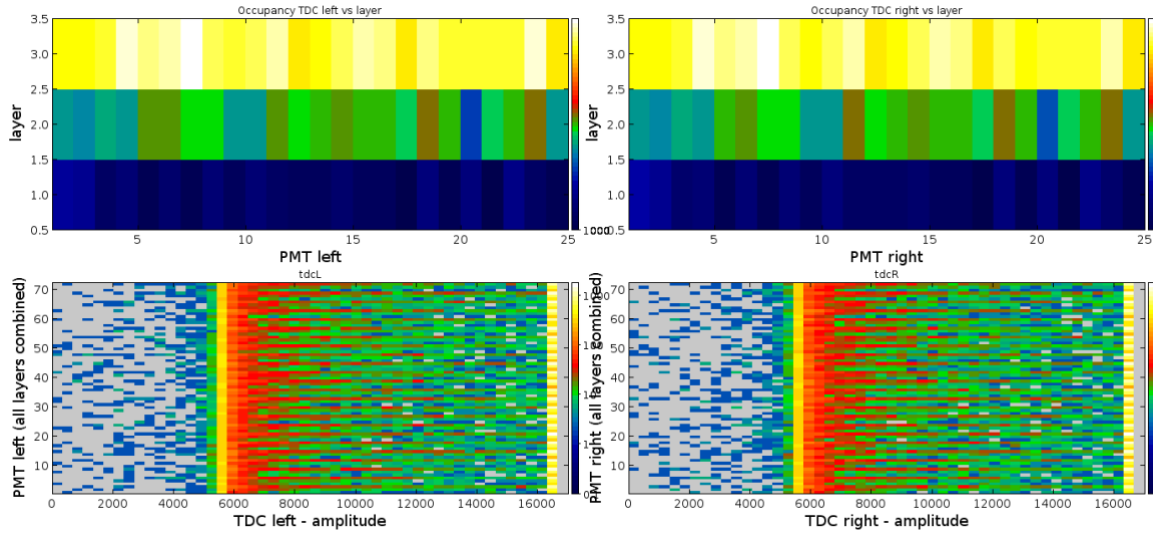


The monitoring plots are as follows:

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

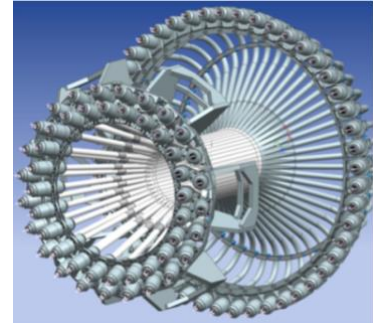


a) TDC Occupancy and pulse height spectra for the left and right PMTs separately



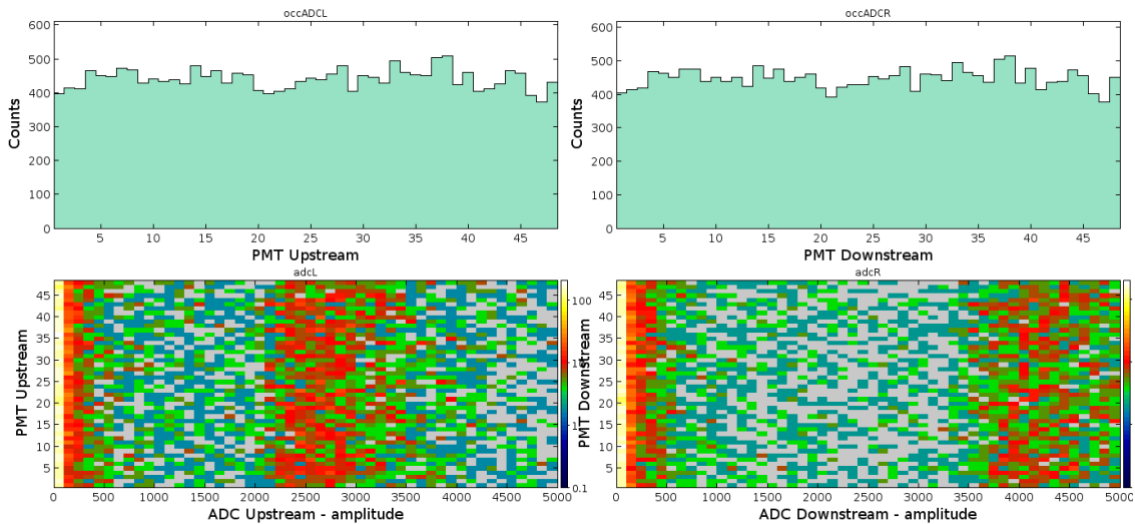
CTOF (Central Time of Flight Detector)

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.

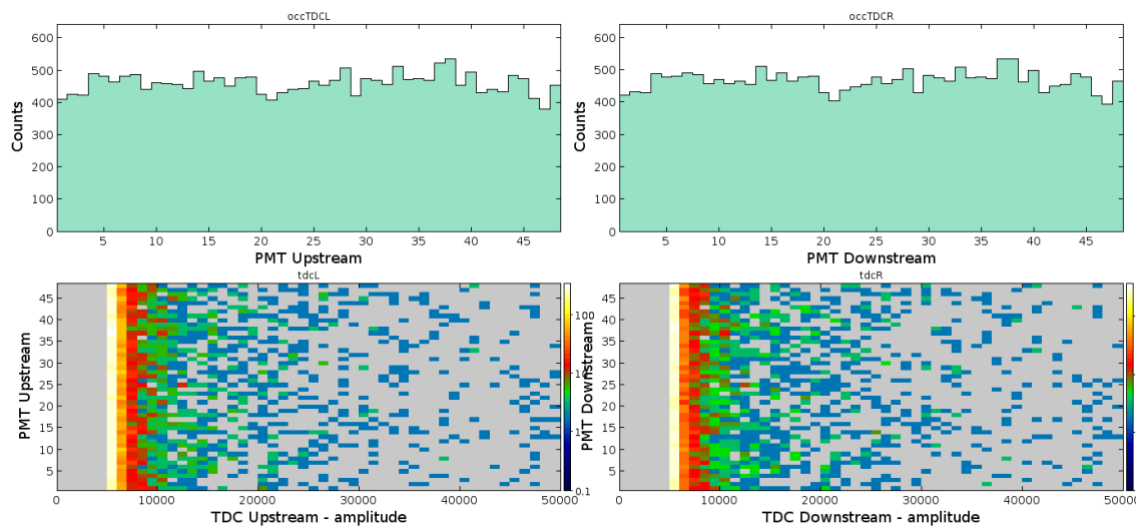


The monitoring plots are as follows:

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

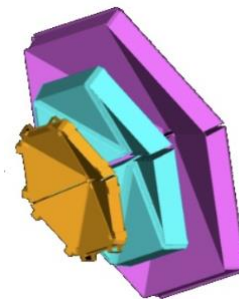


b) TDC Occupancy and pulse height spectra for the upstream and downstream PMTs separately



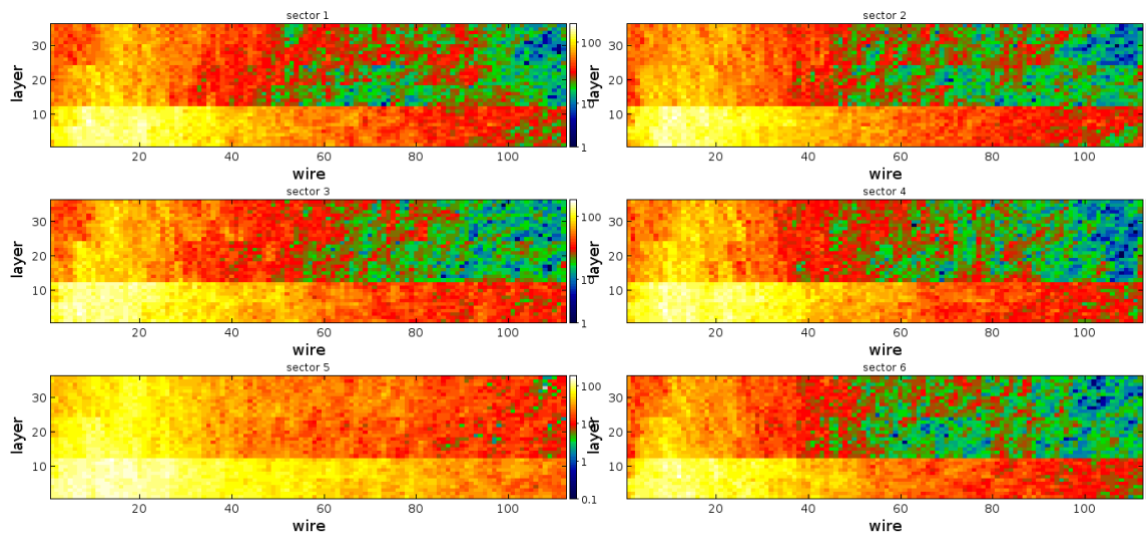
DC (Drift Chambers)

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.

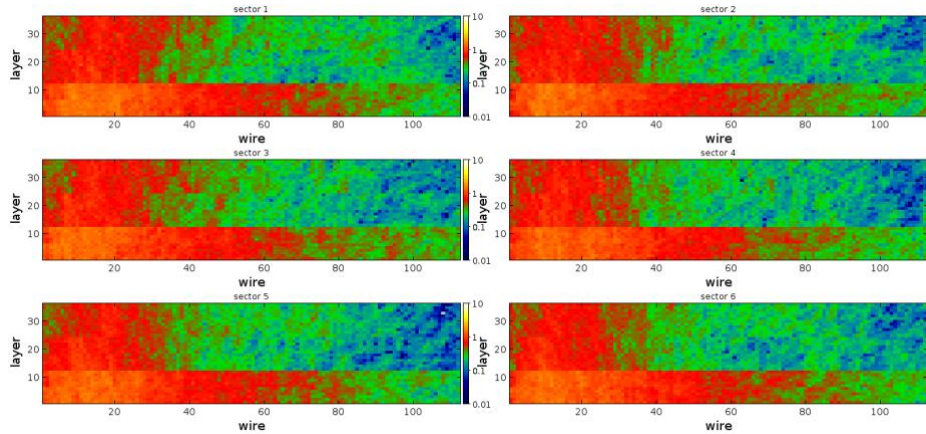


The monitoring plots are as follows:

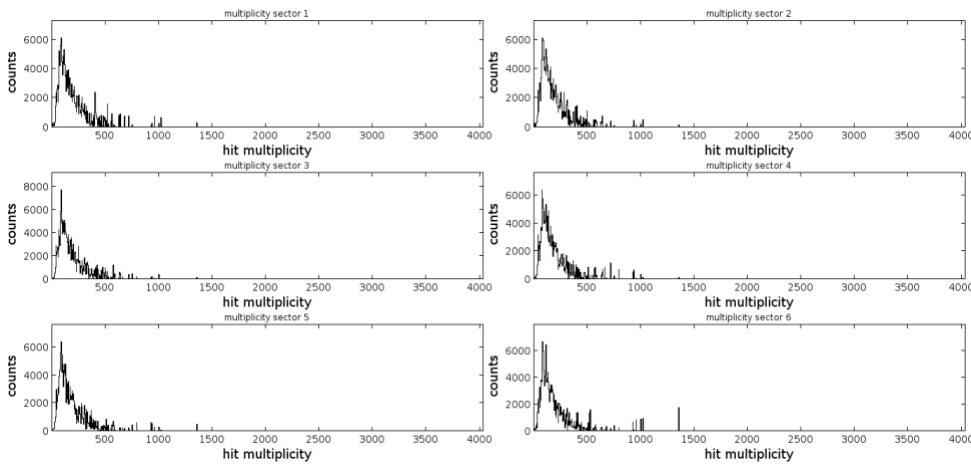
a) Occupancy of the 36 layers in longitudinal direction versus their wires for the 6 sectors



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

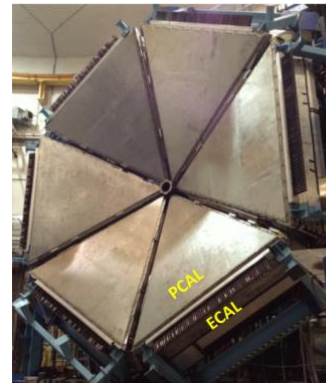


b) Multiplicity of the 6 sectors (all layers combined)



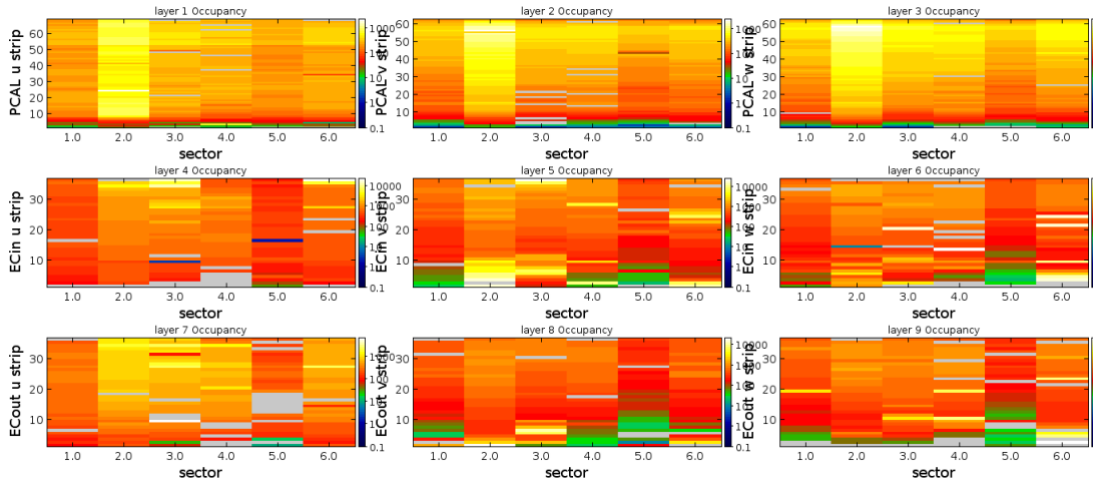
ECAL (Electromagnetic Calorimeter including Preshower Calorimeter)

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. Scintillator layers are grouped into three readout views with 5/5/8, PCAL/ECAL-inner/ECAL-outer, layers per-view providing several cm resolution of energy clusters. Light from each scintillator readout group is routed to PMTs via flexible optical fibers.

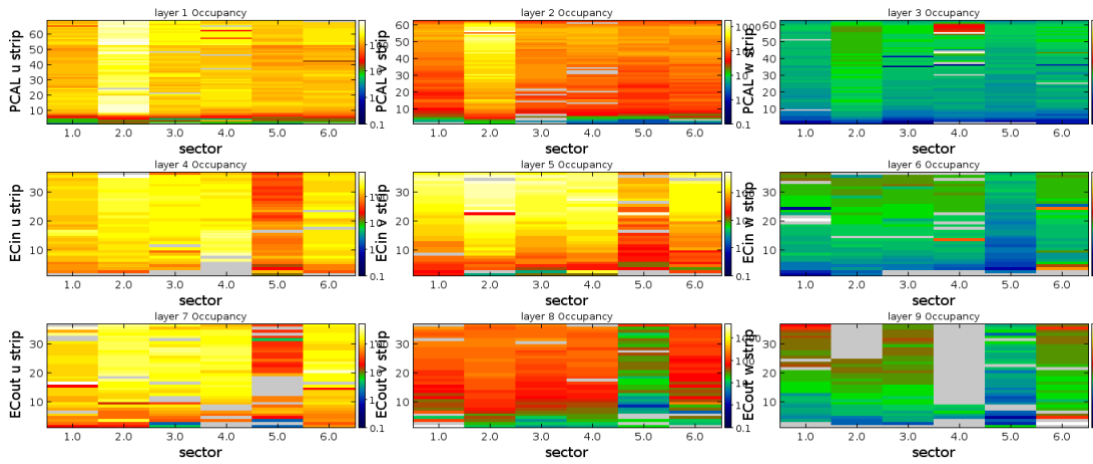


The monitoring plots are as follows:

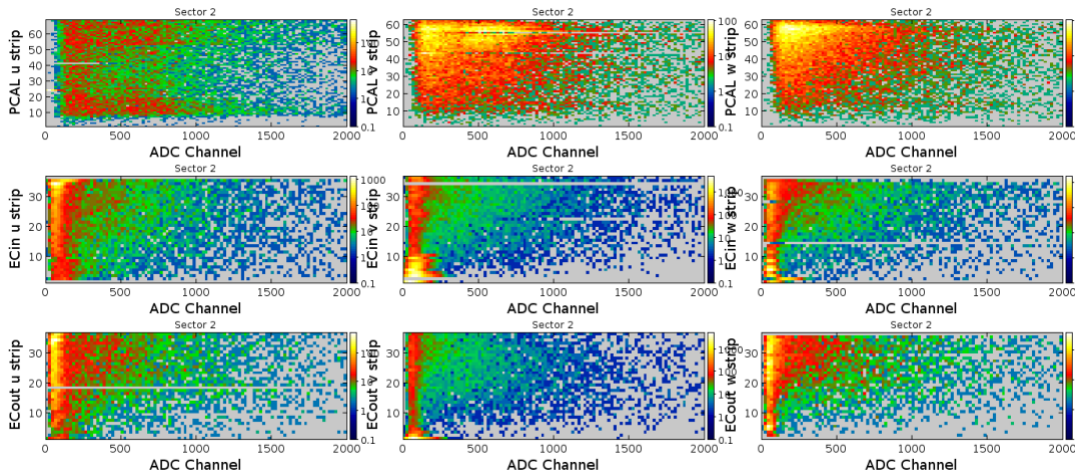
- ADC Occupancy for the 9 layers of PCAL and ECAL (the sector can be selected via the radio buttons on the lower side of the canvas)



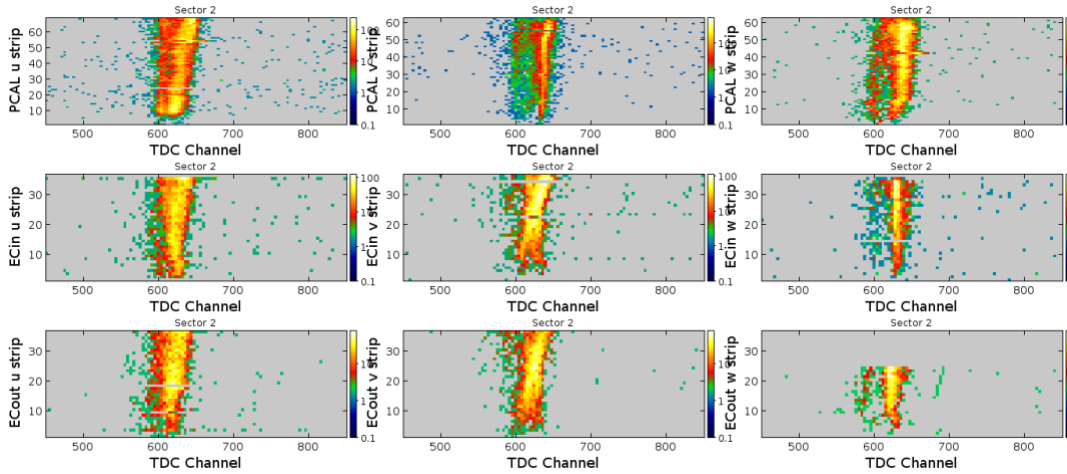
b) TDC Occupancy for the 9 layers of PCAL and ECAL (the sector can be selected via the radio buttons on the lower side of the canvas)



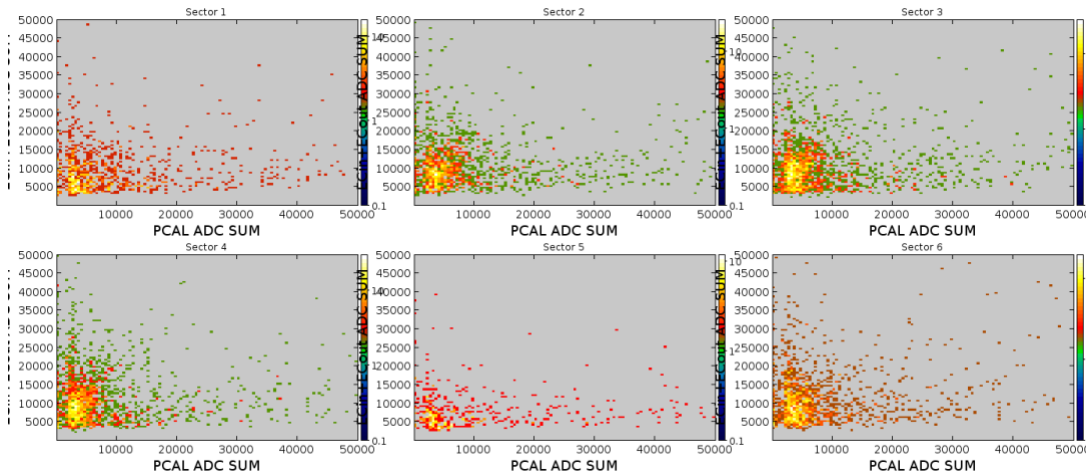
c) ADC histograms for the 9 layers of PCAL and ECAL (the sector can be selected via the radio buttons on the lower side of the canvas)



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)

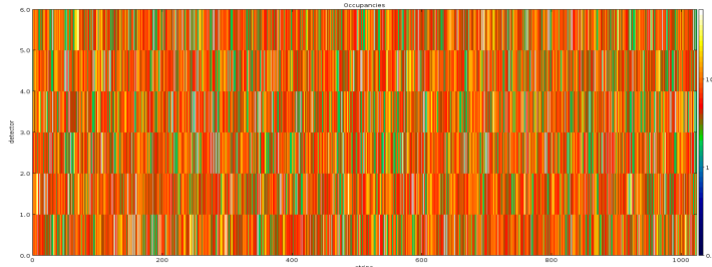


FMT (Forward Micromegas)

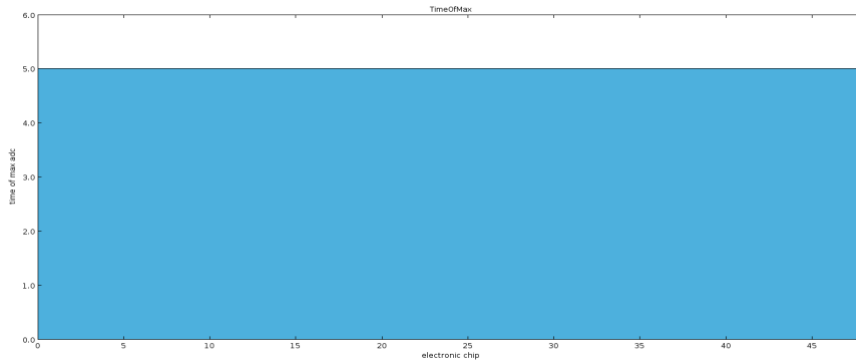
The FMT is the forward part of the BMT. It is a Forward tracker made of 6 circular, flat detectors from 6 to 29°. It improves the vertex resolutions by a factor 3 to 10 compared to the Drift Chambers.

The monitoring plots are as follows:

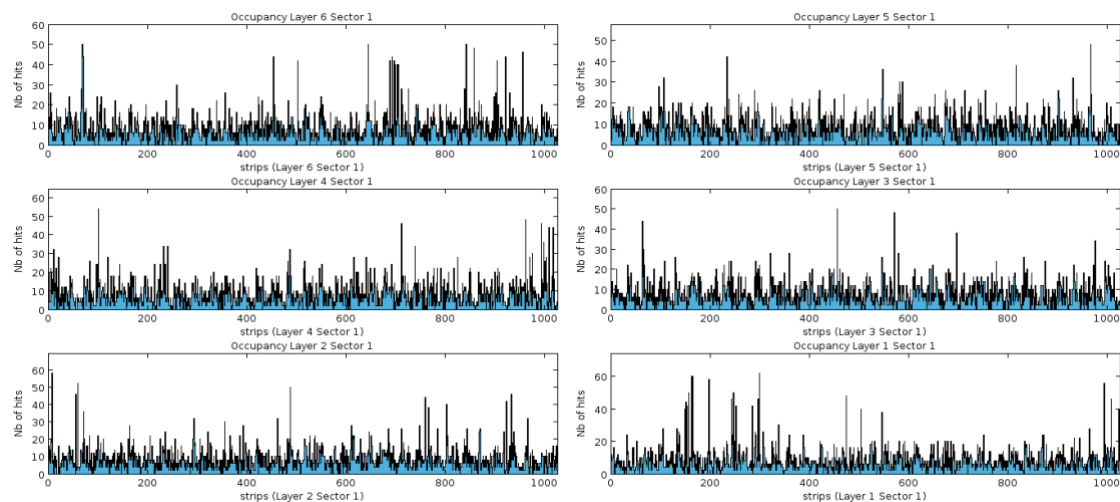
a) Occupancy of the 6 detectors versus their strips



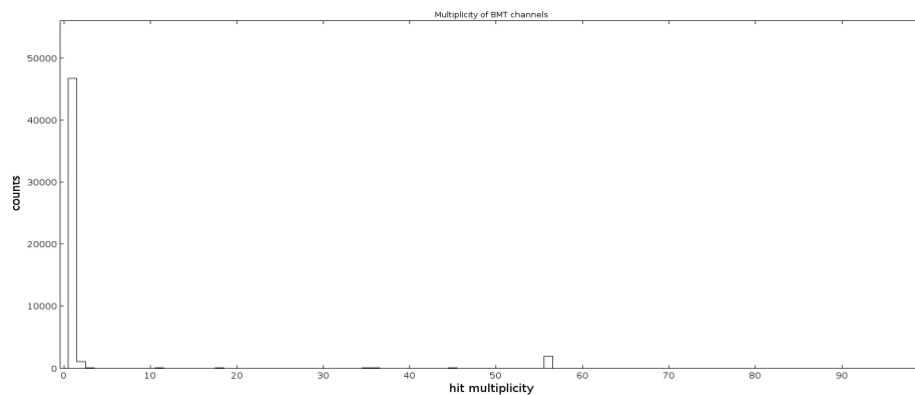
b) Time of max versus chip number (a flat distribution is expected for normal operation)



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)

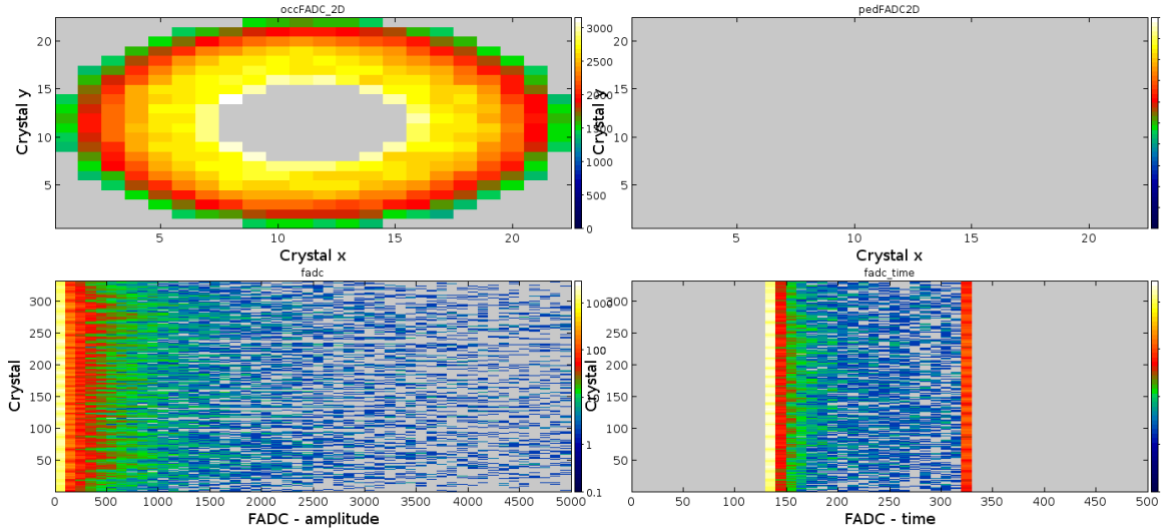


FTCAL (Forward Tagger Calorimeter)

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

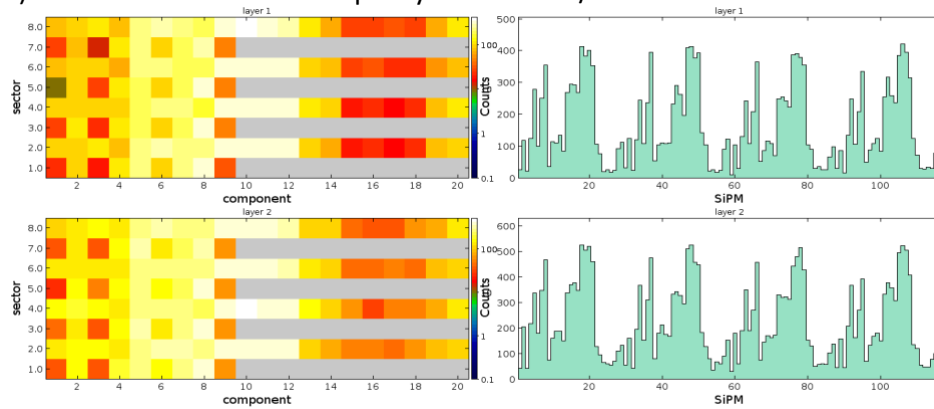


FTHODO (Forward Tagger Hodoscope)

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



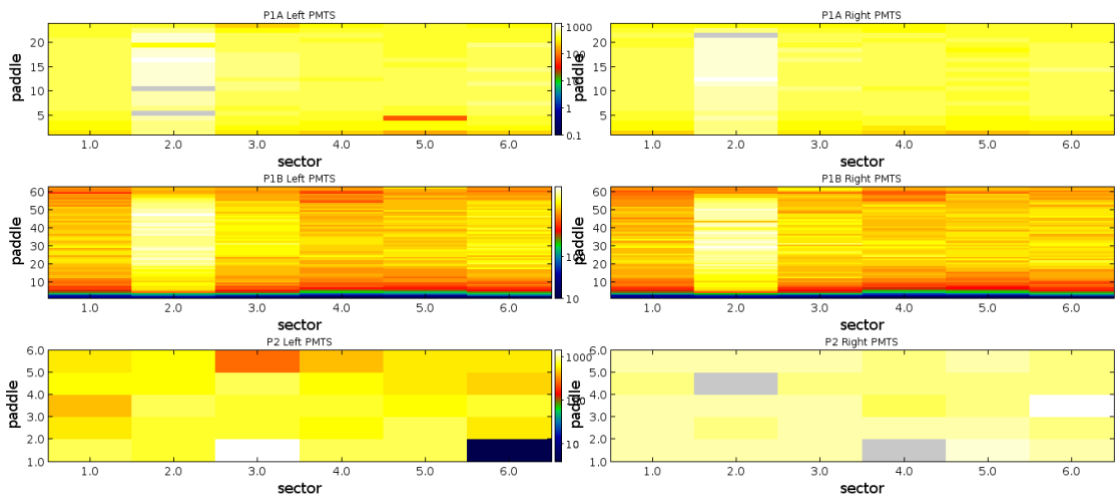
FTOF (Forward Time of Flight Detector)

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:

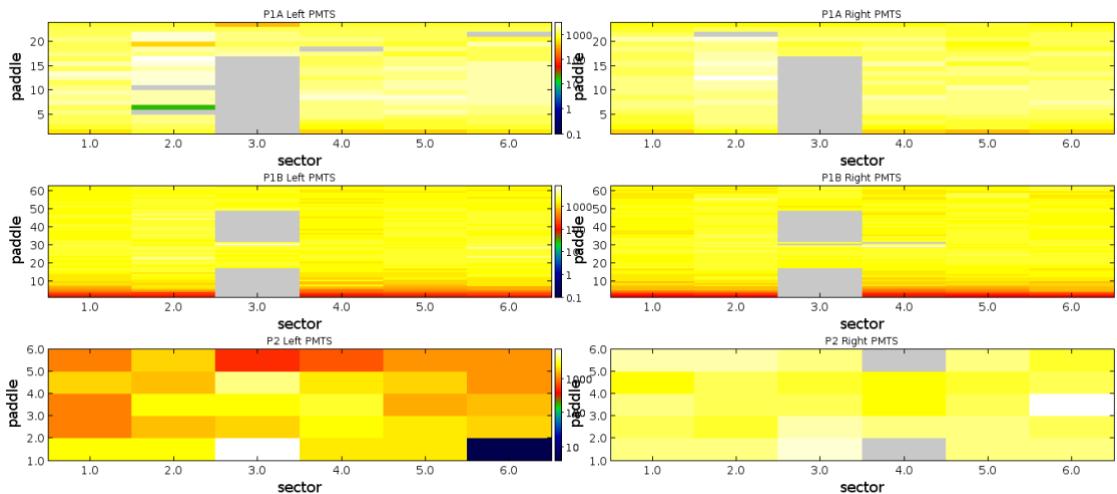
- Panel-1a – 23 counters
- Panel-1b – 62 counters
- Panel-2 – 5 counters

The monitoring plots are as follows:

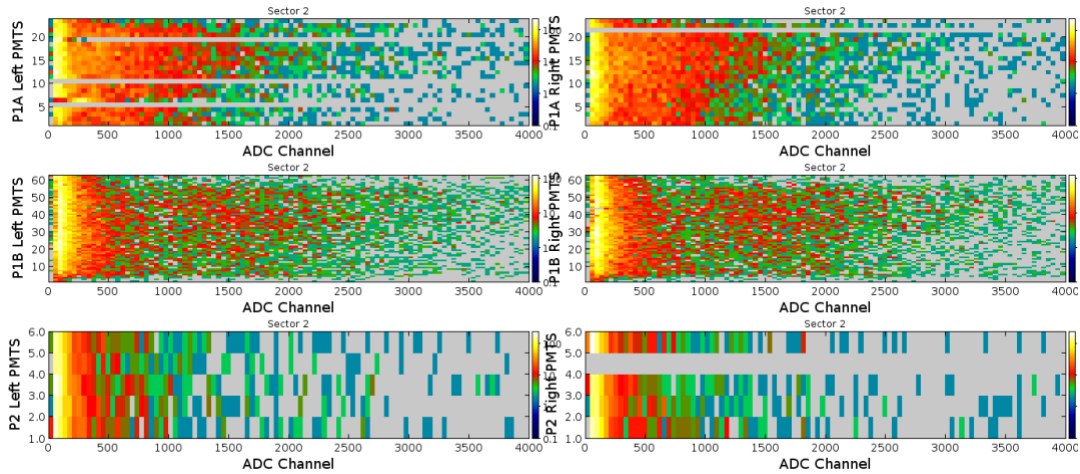
a) ADC occupancy of the different panels (the sector can be selected via the radio buttons on the lower side of the canvas)



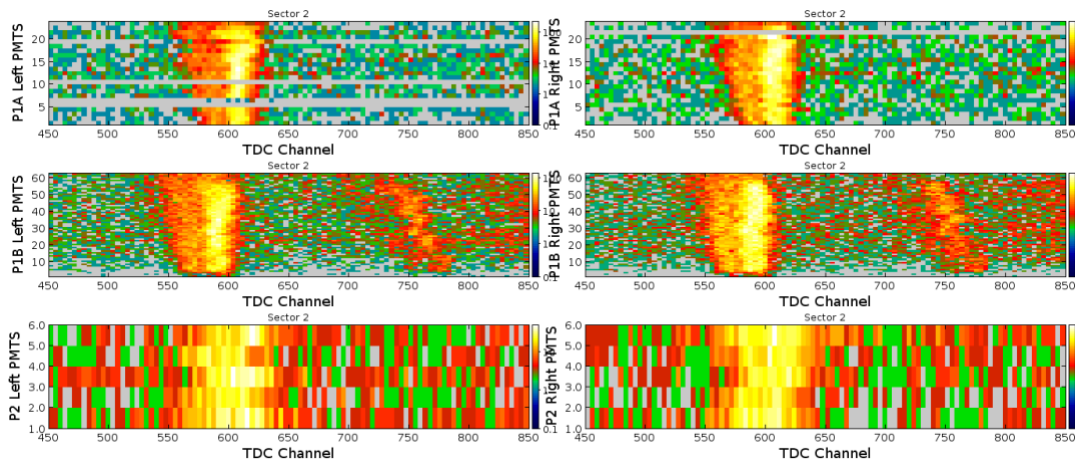
b) TDC occupancy of the different panels (the sector can be selected via the radio buttons on the lower side of the canvas)



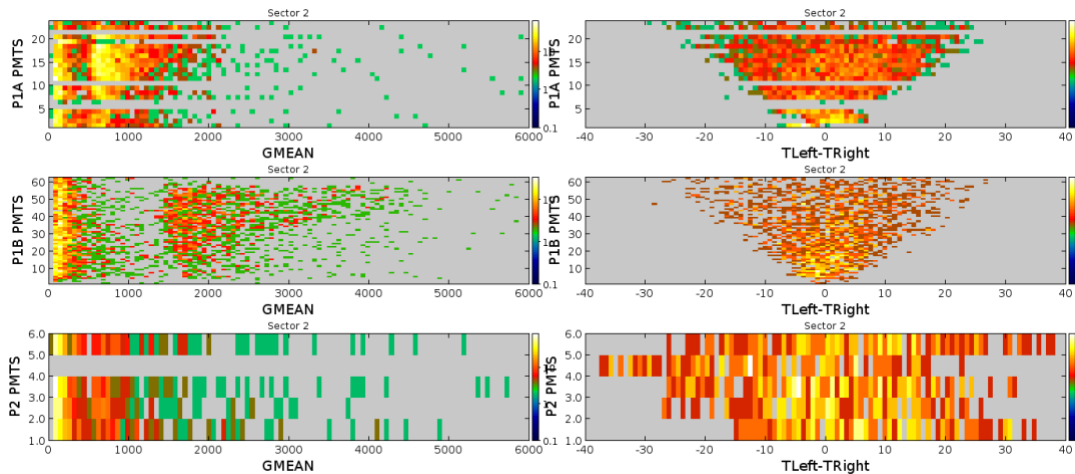
c) ADC pulse height distributions of the different panels (the sector can be selected via the radio buttons on the lower side of the canvas)



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)

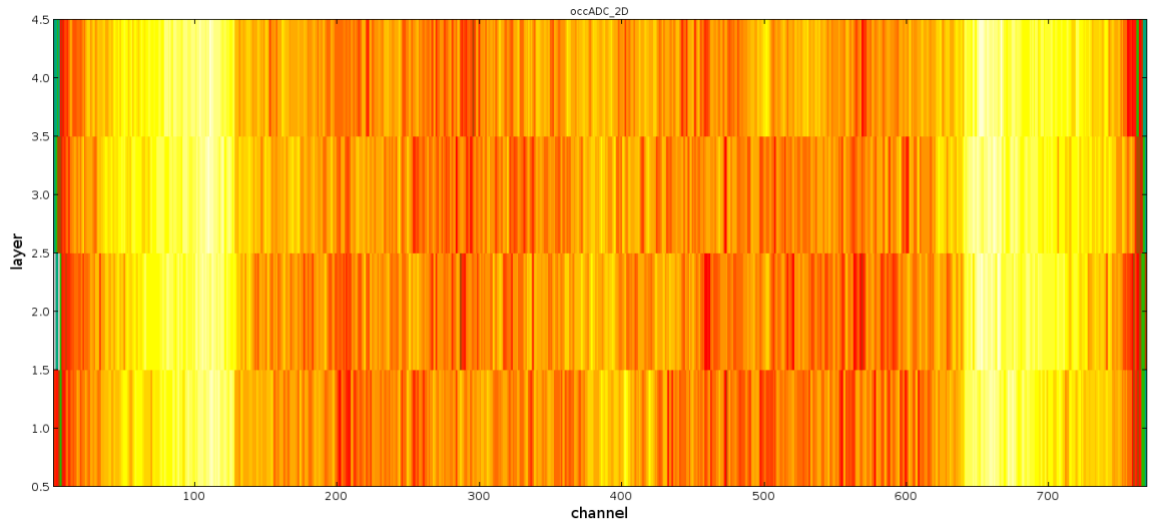


FTTRK (Forward Tracking Detector)

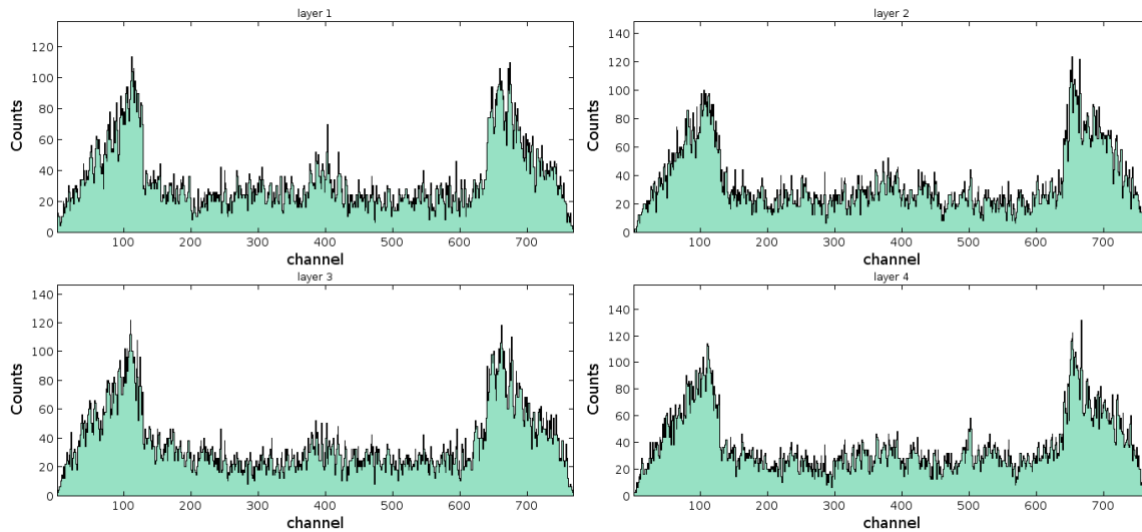
The FTTRK is the tracking detector of the Forward Tagger. It consists of two double layers of silicon strip detectors with altogether 3392 channels.

The monitoring plots are as follows:

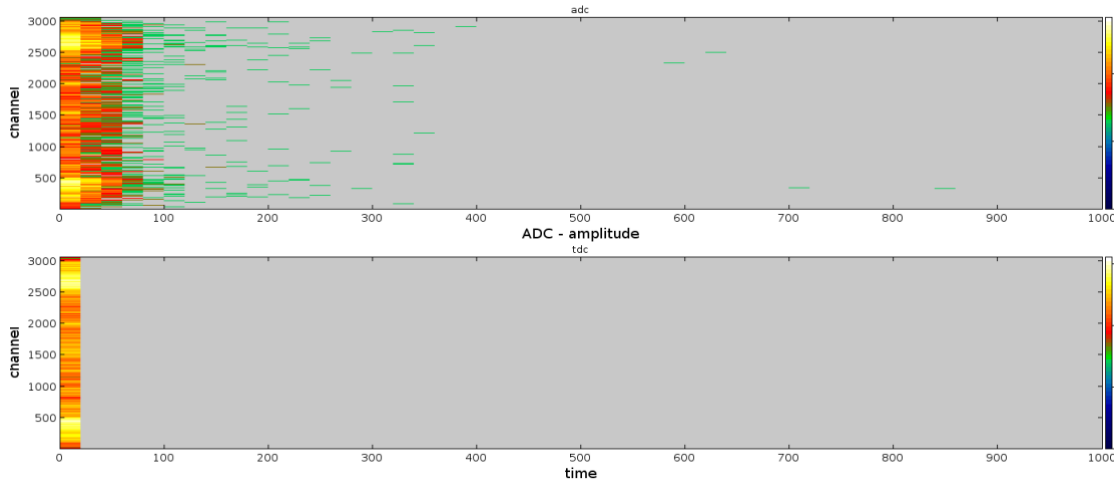
a) Occupancy of the 4 layers in longitudinal direction versus their readout channels



b) One dimensional occupancy for the 4 layers

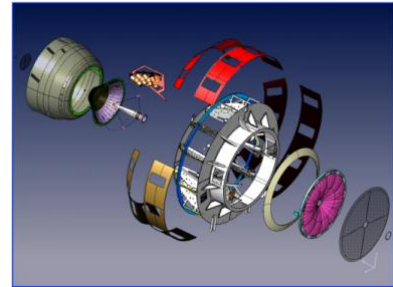


c) ADC and TDC pulse height spectra



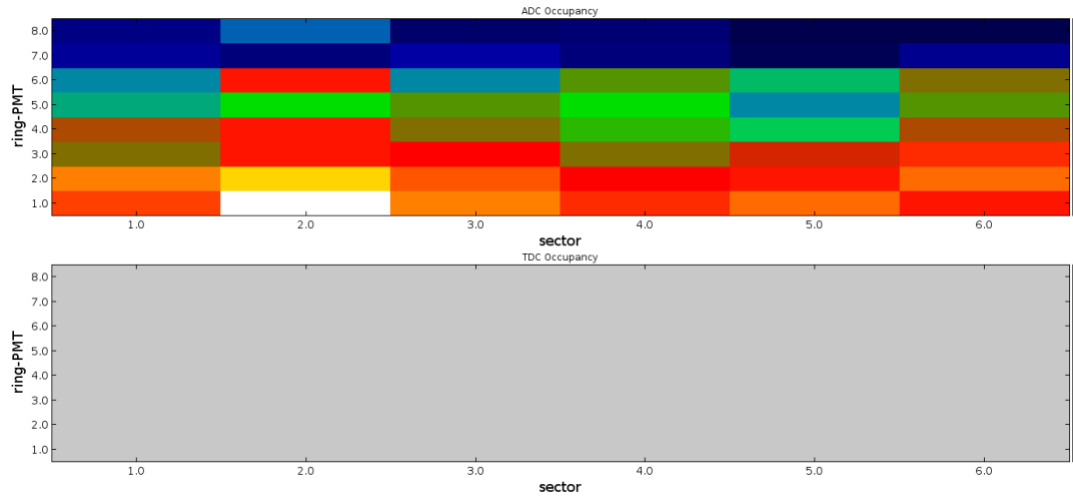
HTTC (High Threshold Cherenkov Detector)

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).

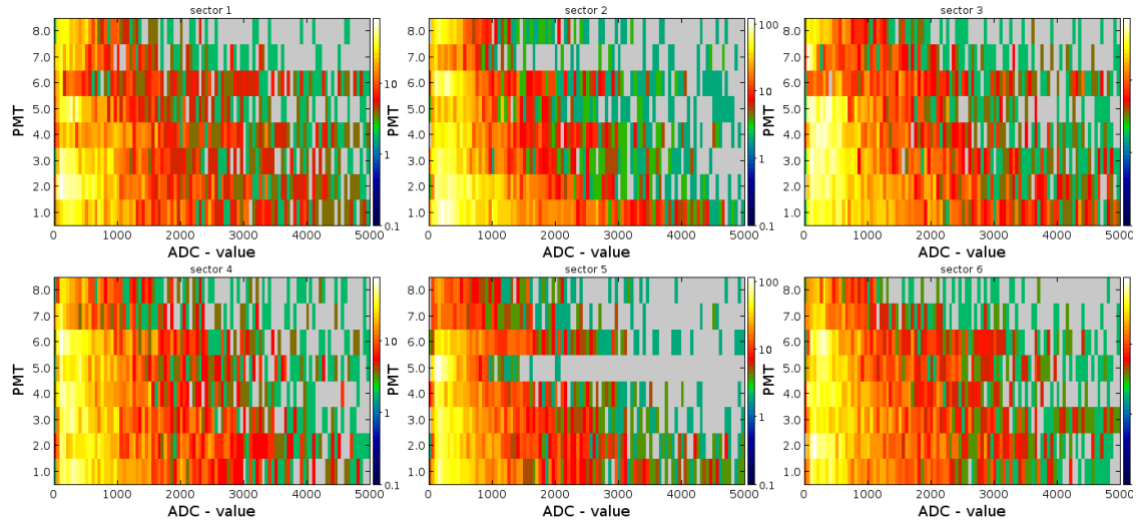


The monitoring plots are as follows:

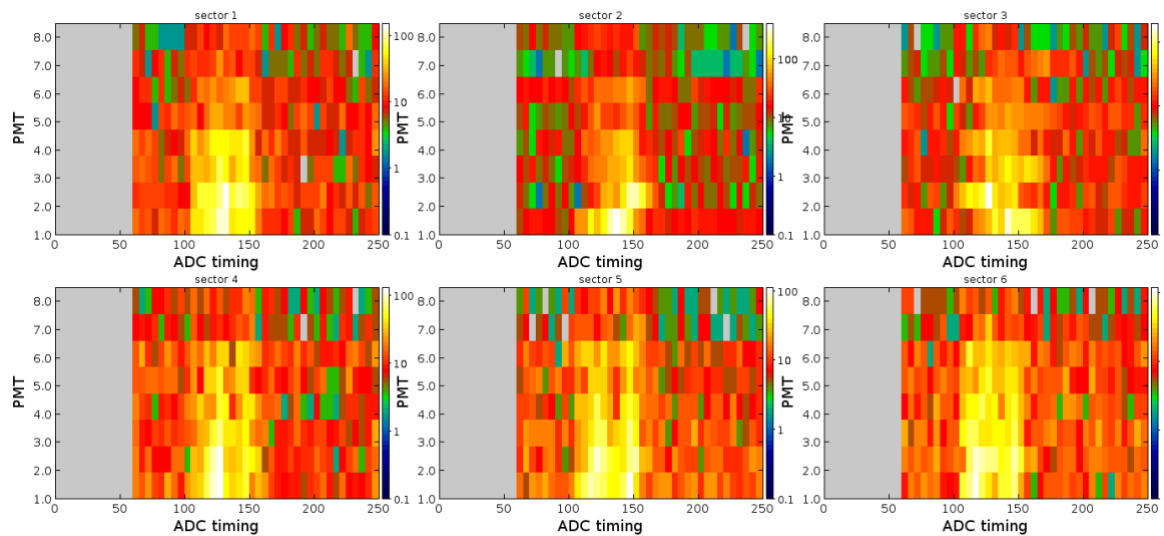
a) ADC and TDC occupancies for the 8 ring PMTs per sector versus the sector



b) ADC pulse height spectra for the 6 sectors



c) ADC timing spectra for the 6 sectors

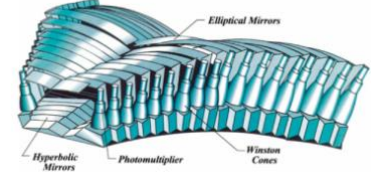


LTTC (Low Threshold Cherenkov Detector)

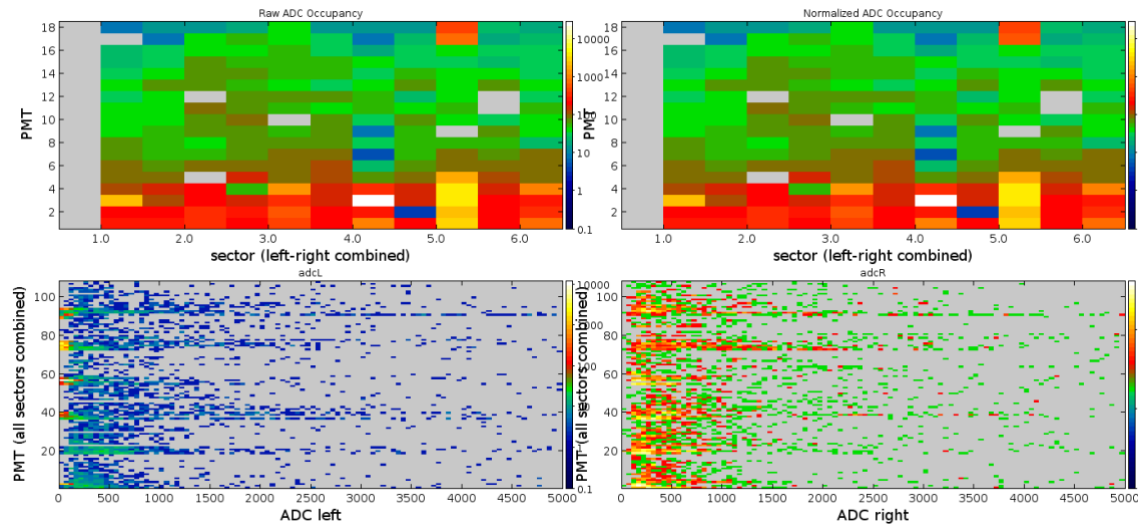
The LTCC system is part of the forward CLAS12 detector and will be used for pion/kaon discrimination. The LTCC consists of 6 sectors of lightweight mirrors, light collecting cones, 5'' PMTs, and magnetic shields. The sectors are filled with C4F10 gas, providing pion/kaon discrimination from 3.5 to 9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

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

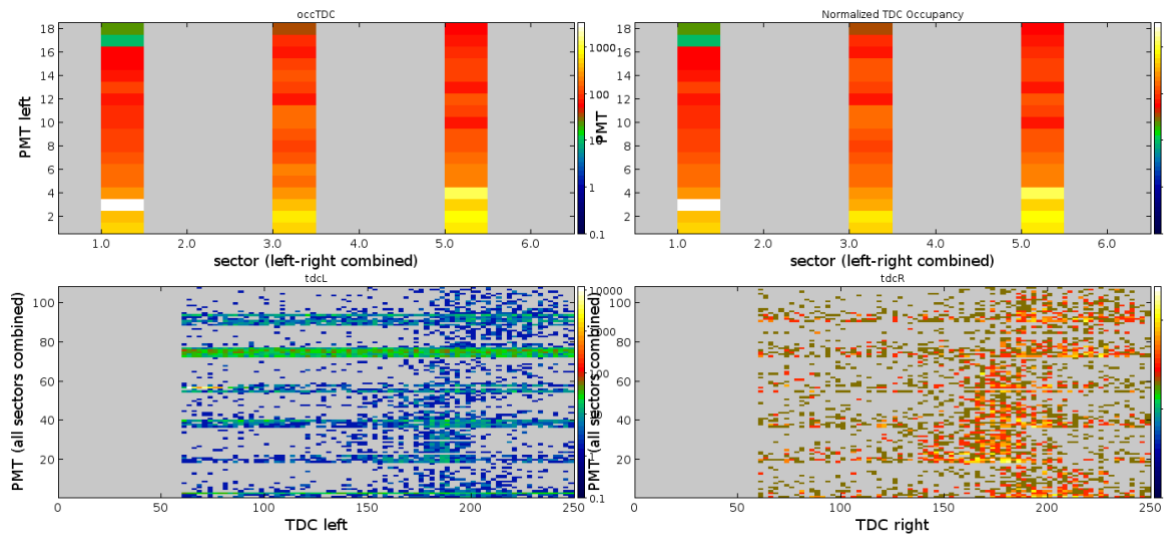
The monitoring plots are as follows:



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)

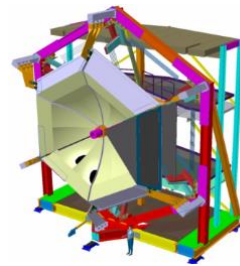


a) TDC occupancy and pulse height spectra (left and right PMTs of each sector are combined as half sectors on the x-axis of the plots in the upper row)



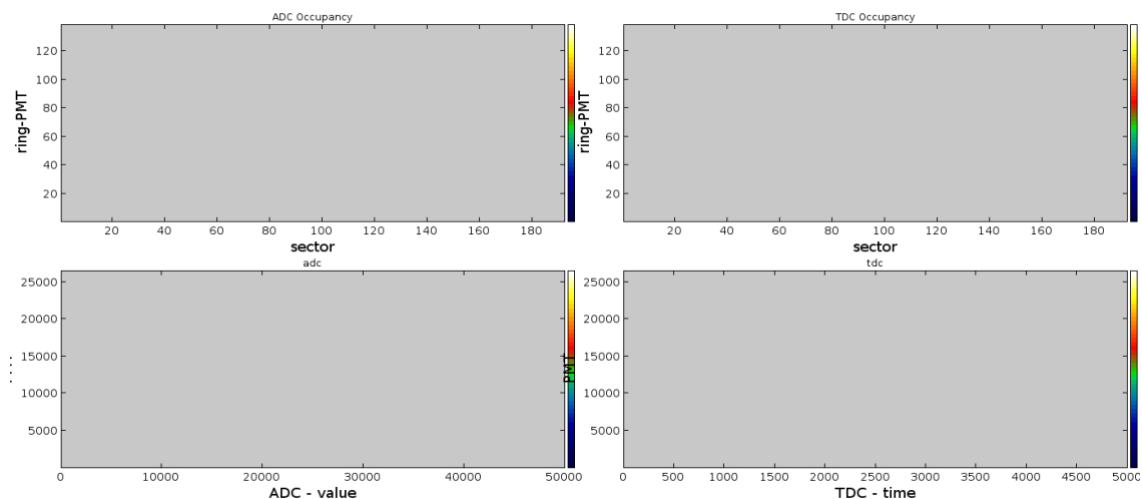
RICH (Ring Imaging Cherenkov Detector)

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



The RF tab

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

The HEL tab

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

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.

Acronyms

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