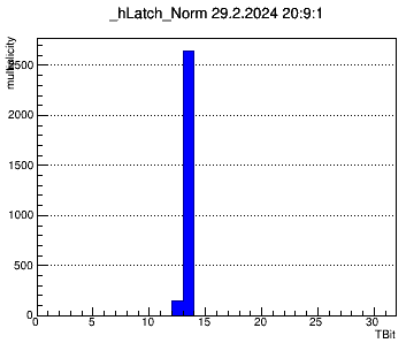
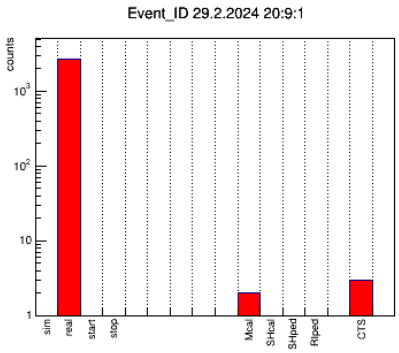
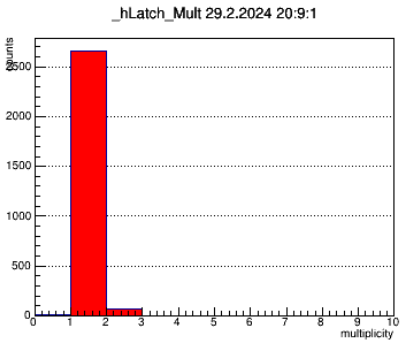
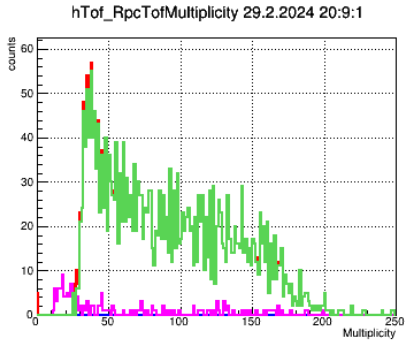
QA Documentation
March 2024

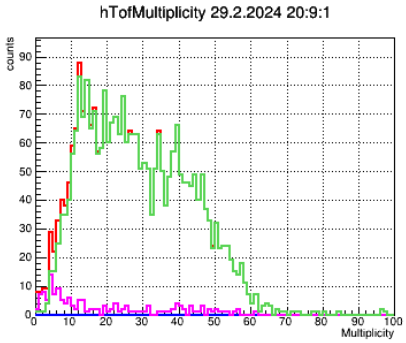
Main - MainTrigger







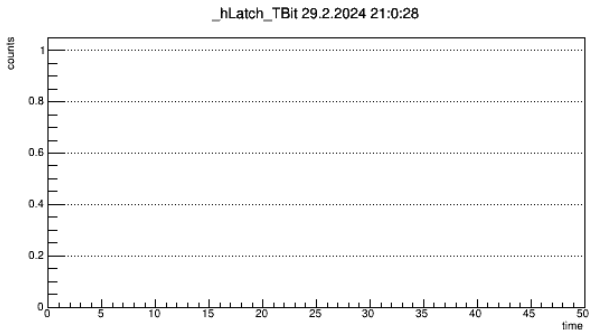


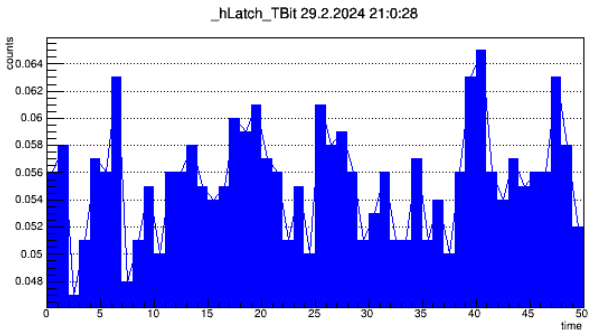


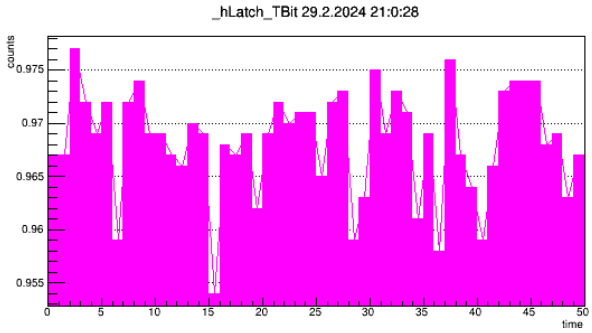
All triggers PT1 PT2 PT3

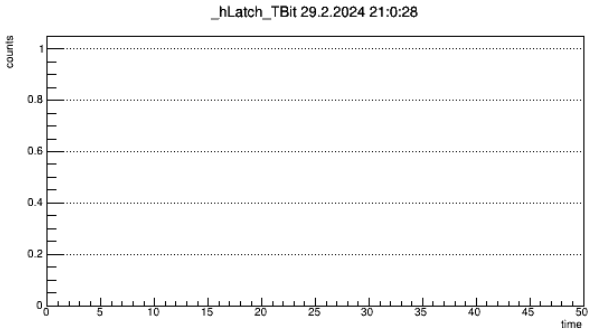
- Top left
  - Set trigger bits. This should match the trigger setting
  - Compare to CTS monitor: Bits are the last column, from top to bottom. Bit 12 corresponds to PT2 trigger
- Top middle
  - Statistics for each trigger type. 'real' are normal events, (CTS and MDC must show up as well in equal parts (once per second))
- Top right: Just a multiplicity, should look like on this plot
- Bottom
  - Average multiplicity per event for Tof, Rpc and combined (f.l.t.r)
  - Shown for PT1, PT2, PT3. Average should match the corresponding trigger setting (M2, M5 and M20)

Main - MainTriggerTrend



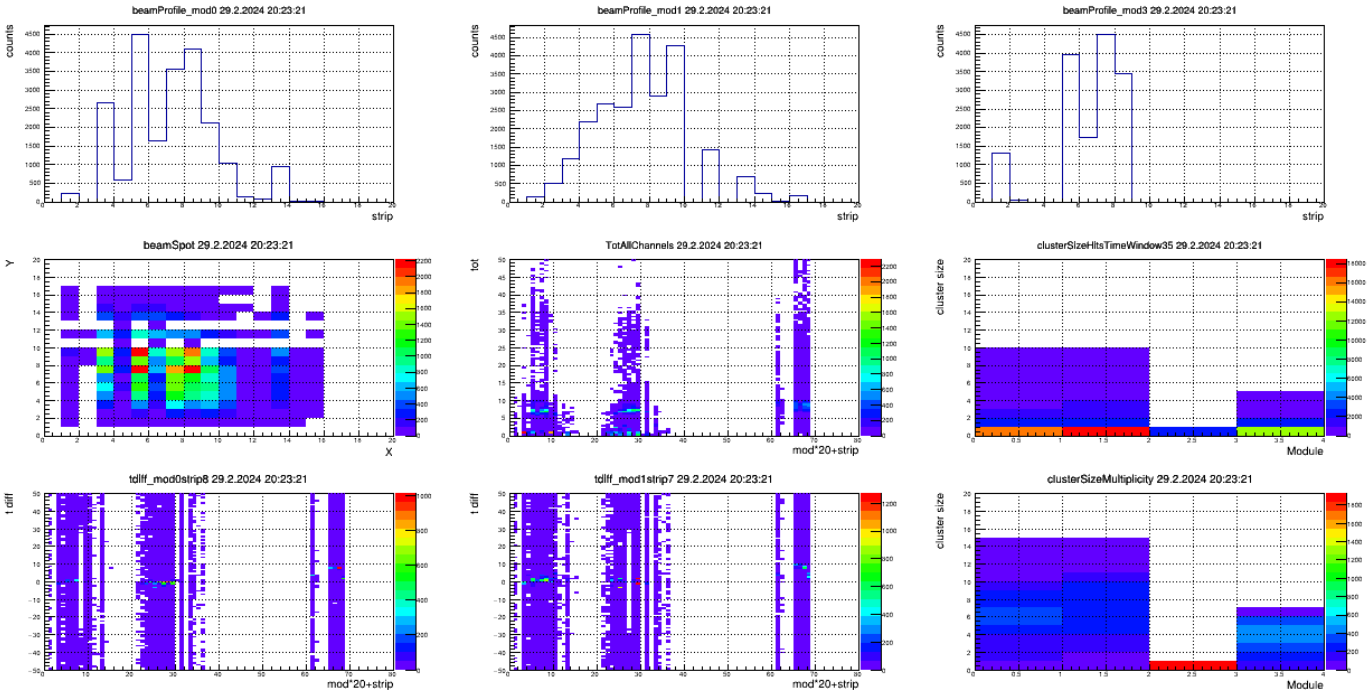






- Just trends, should be stable around these values...

Start – Main 2024

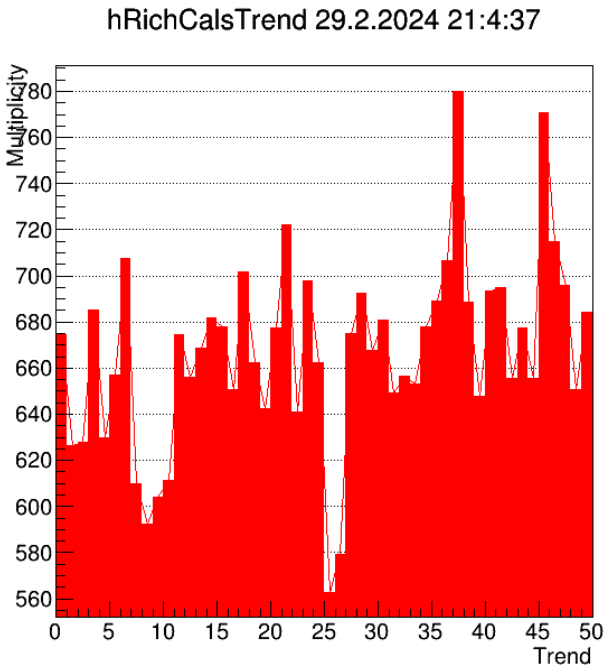


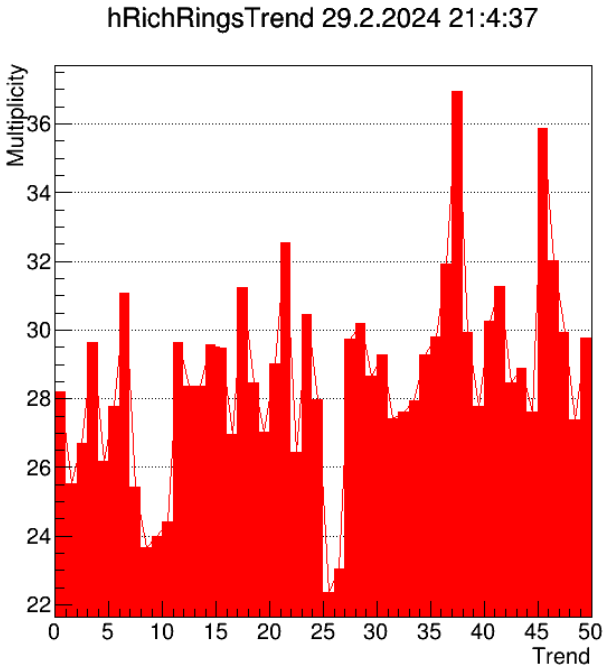
- Top row: Distribution of hist on the strips of start detector
  - A beam profile should be visible (gaps may be there)

- Middle left: beam spot (with blank lines from above)
- Middle middle: time over treshold for channels, should be ~7 for the first 2 modules and ~9 for the 4th.
- Middle right:
  Amount of hits time coincidences,
  proportional to the average multi below
- Bottom right:
  Multiplicity of fired strips per event,
  Same amount in each bin

- Bottom: time difference for modules 1 and 2 with respect to the central one
  - Should be around 0 for all channels in the range of +-10, but may have shifted time between module 1 and 2

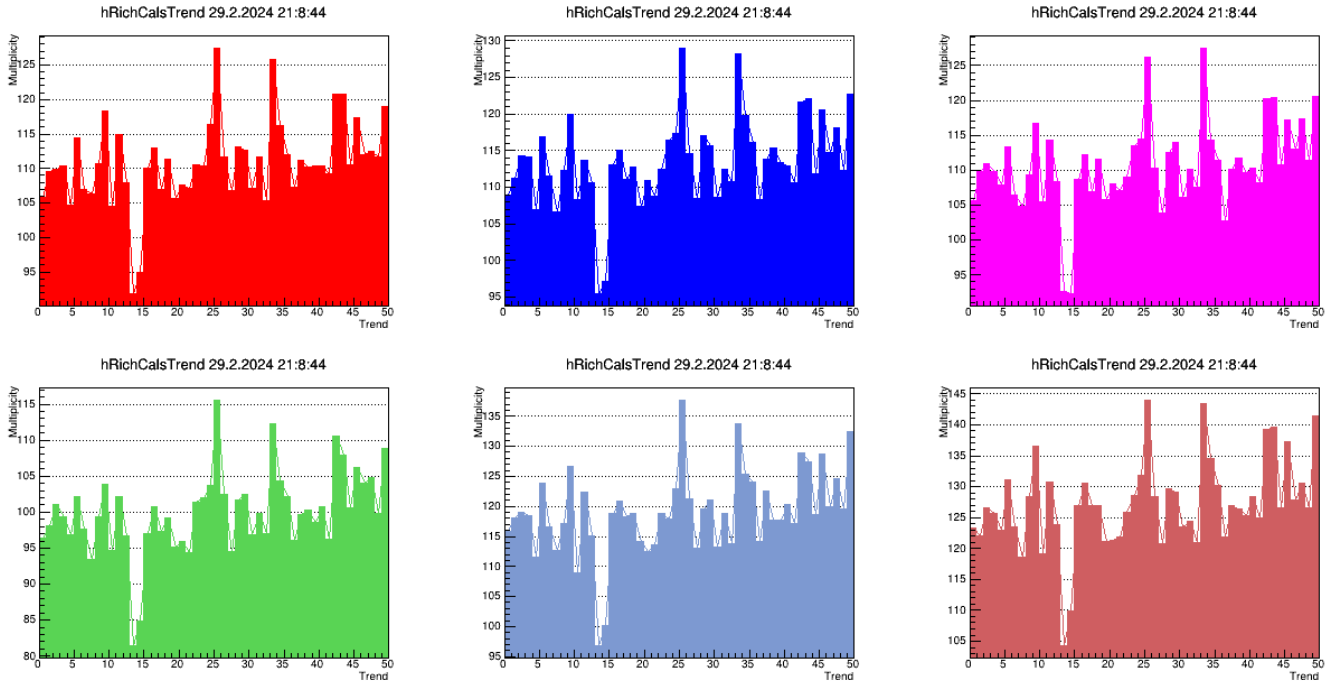
Rich - TotalMult





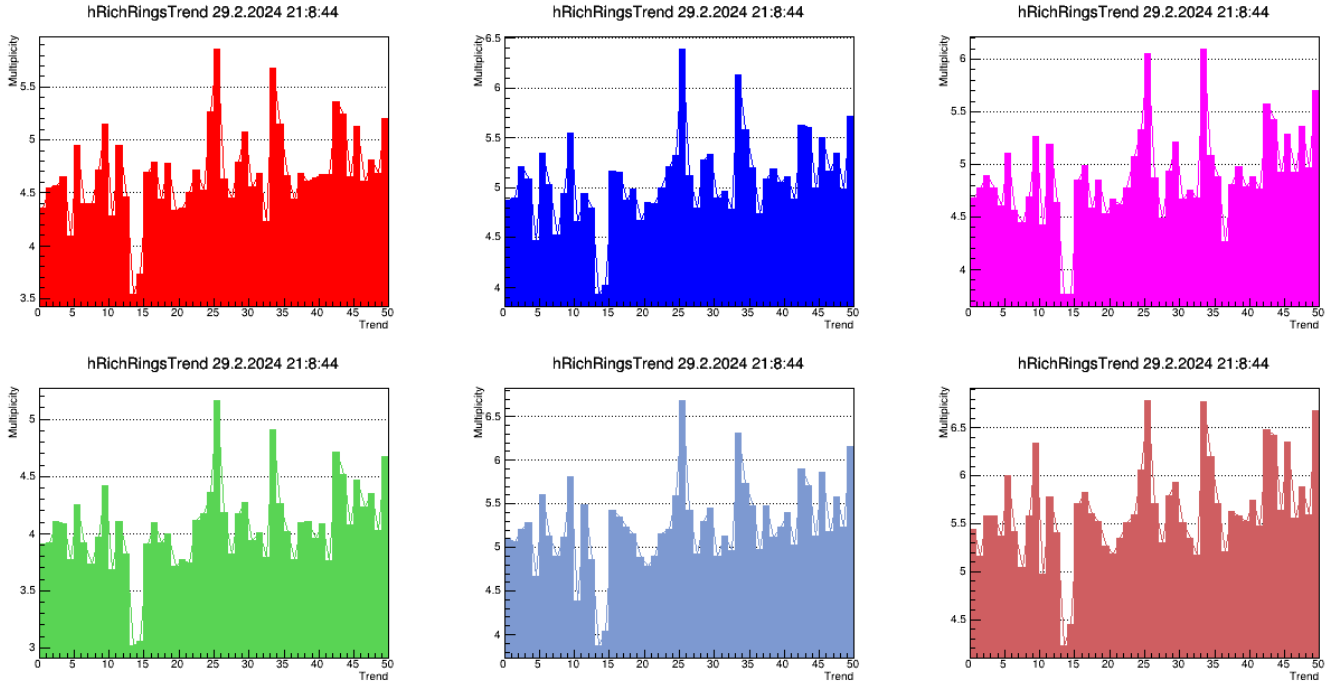
- Trend plots in RICH
  - Left: Number of RICH cals (detected photons) in full RICH per event
  - Right: Number of reconstructed rings in full RICH per event

Rich - SecMultCals



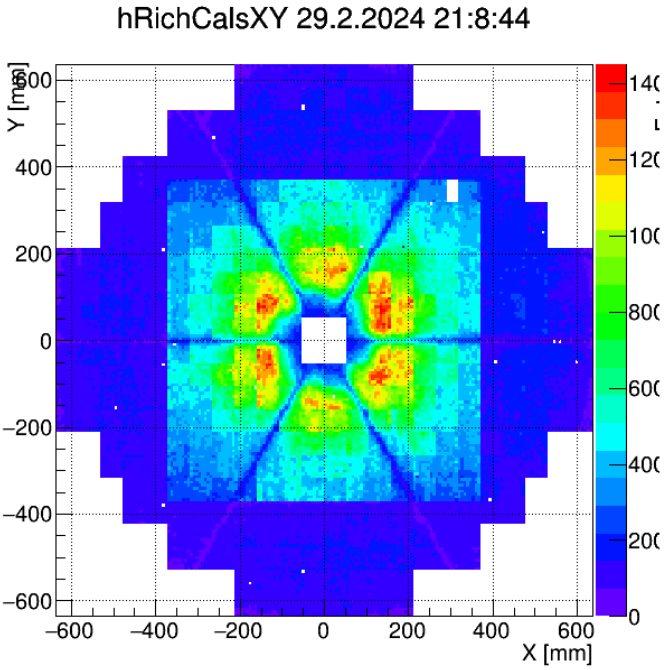
- Trend plots in RICH
  - Number of detected photons (RICH cals) per event. One plot for each of the six HADES sectors

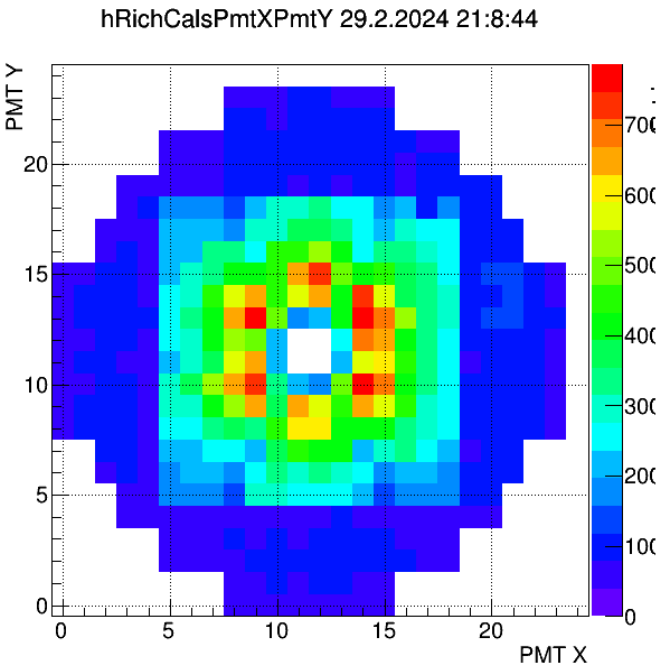
Rich – SecMultRings



- Trend plots in RICH
  - Number of detected rings per event. One plot for each of the six HADES sectors

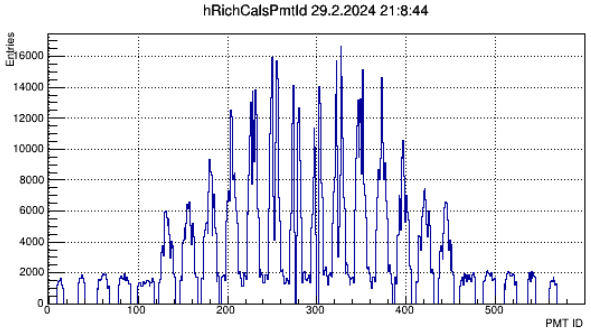
Rich – CalsXY

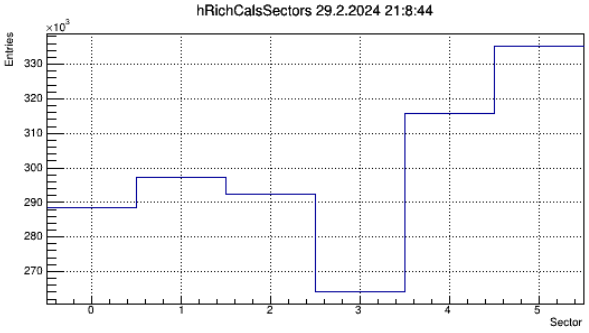


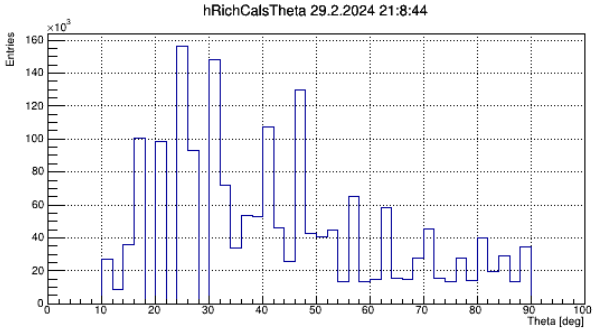


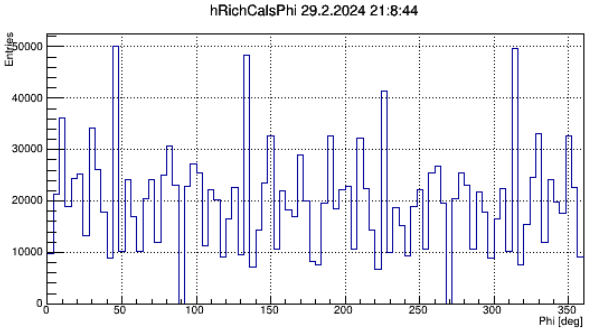
- Left: Number of detected photons (RICH cals) in the X-Y-plane
  - Units are millimeters
- Right: Number of detected photons (RICH cals) in X-Y-plane, grouped by PMT
  - Units are PMT coordinates (0..23)
  - A hole in this plot usually points to missing HV in this PMT
  - A PMT with much lower rate points to wrong HV or wrong theshold setting

Rich – Cals



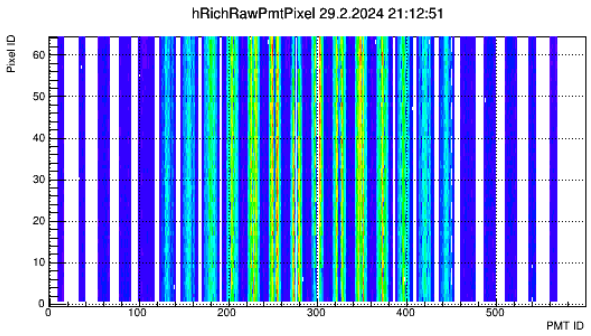


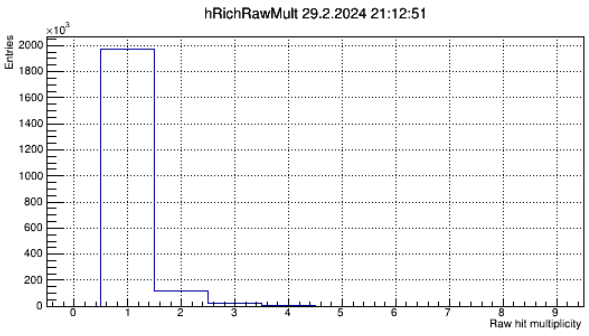


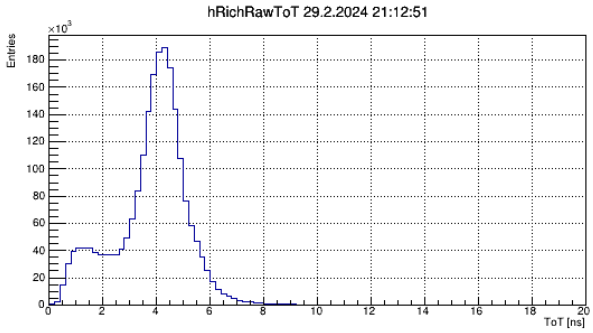


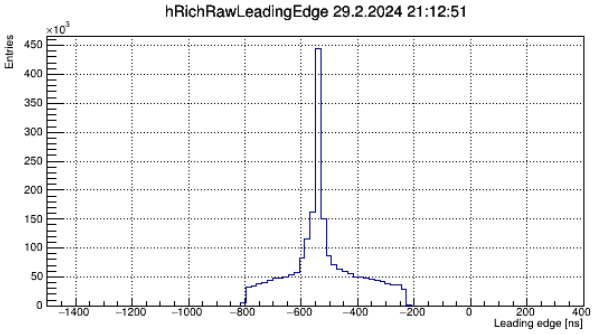
- Top Left: Number of detected photons for each PMT ID
  - Not all PMT IDs do exist, so there are some holes.
- Top Right: Number of detected photons for each sector
- Bottom Left: Number of detected photons versus polar angle (Theta)
- Bottom Right: Number of detected photons versus azimuthal angle (Phi)

Rich – RawHits



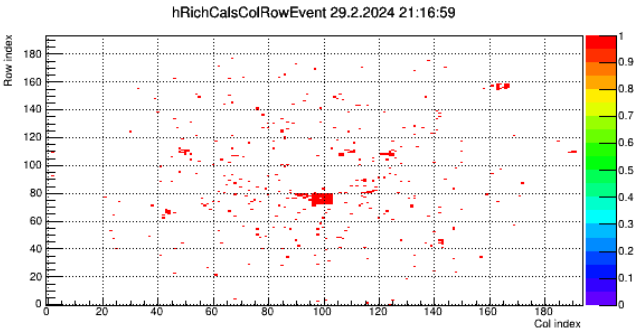


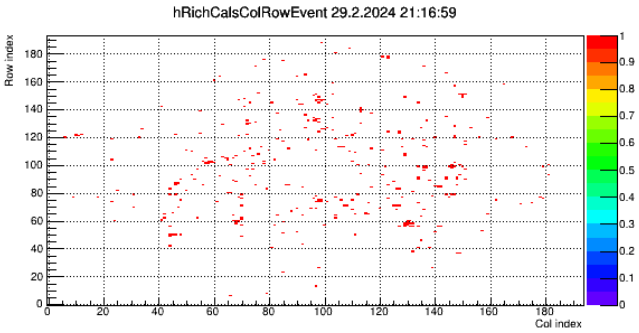


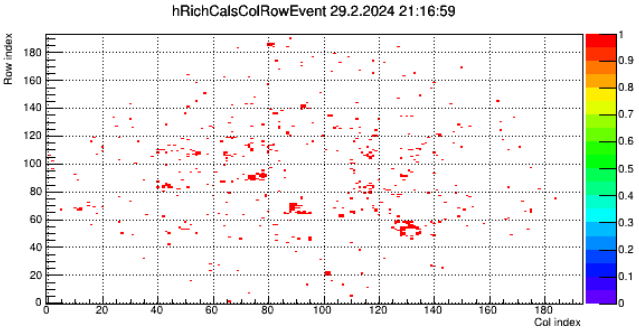


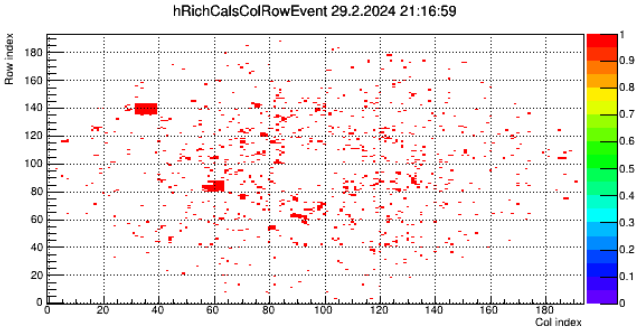
- Top Left: Number of raw hits of each PMT pixel
  - Vertical stripes are due to PMT IDs that don’t exist
  - The ID of each PMT is between 0 and 575, each PMT has 64 pixels
- Top Right: Raw hit multiplicity for the full RICH
- Bottom Left: Time-over-Threshold distribution
  - The main photon peak is expected around 5 ns
  - The much lower peak around 2 ns are noise effects
- Bottom Right: Distribution of leading edge times
  - All photons from the primary reaction are expected around -550 ns, before and after there should be close to no hits.

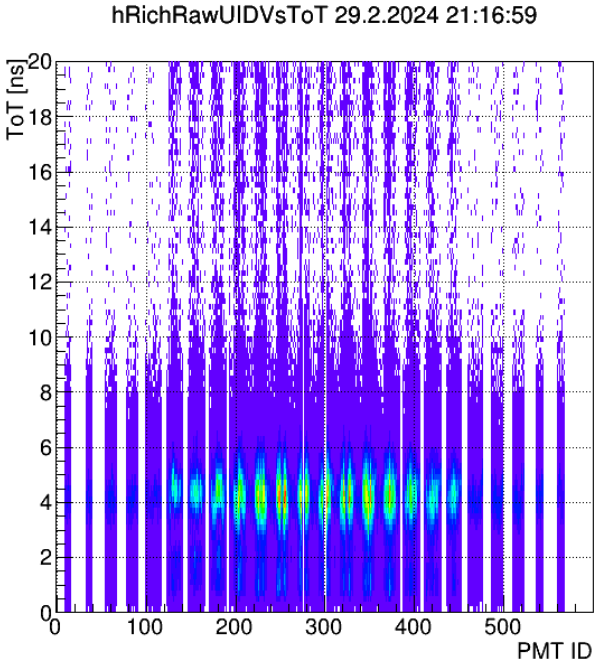
Rich – Single event && UID 2D

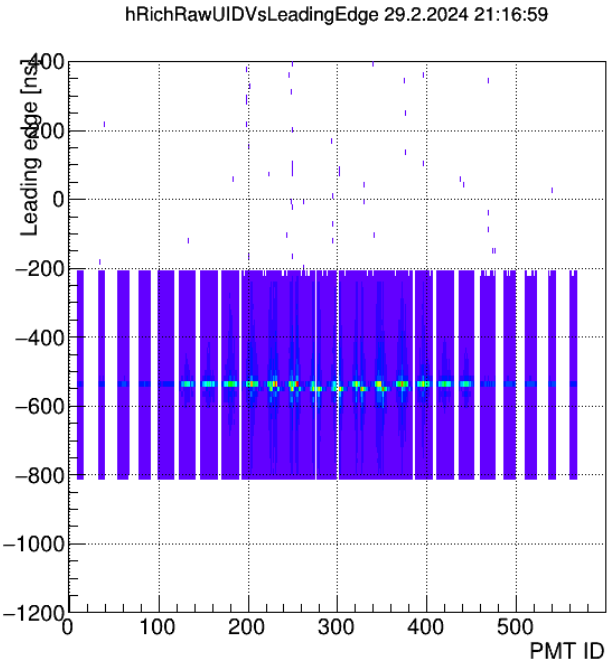




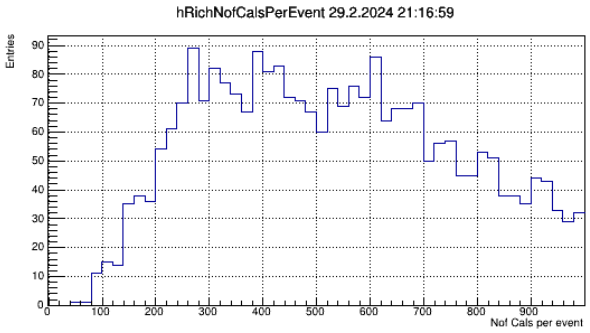


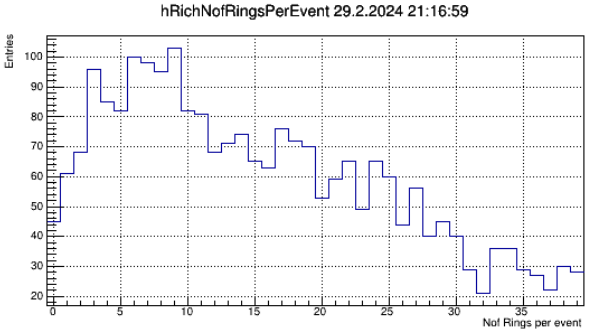


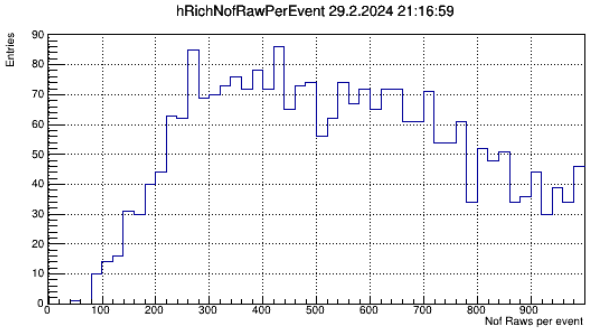


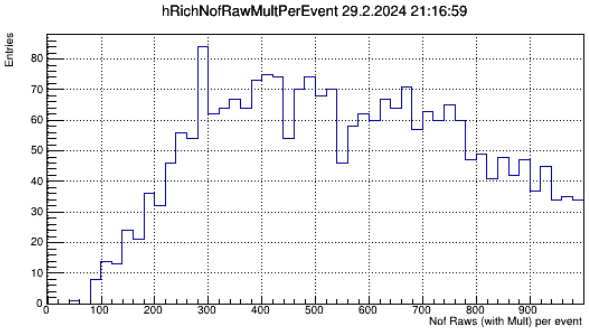


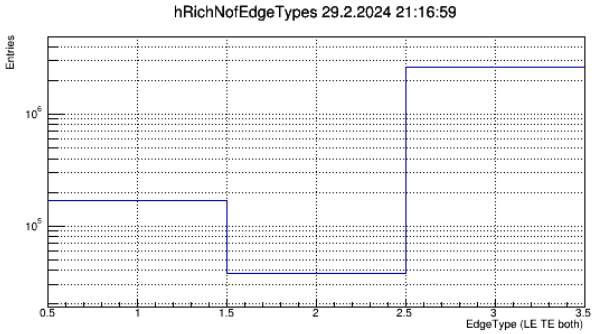
Rich – Nof per event && Edge info

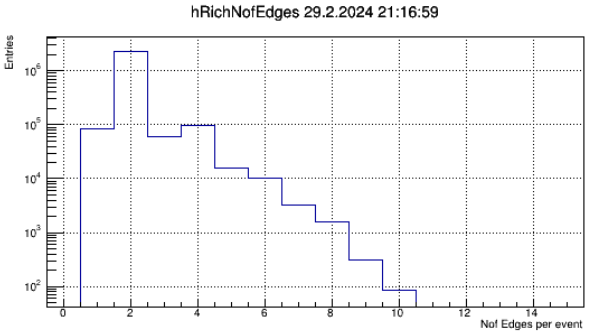


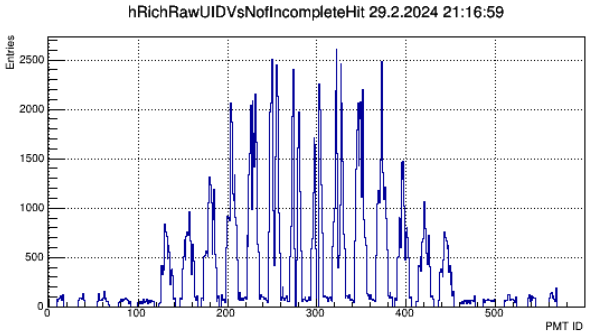




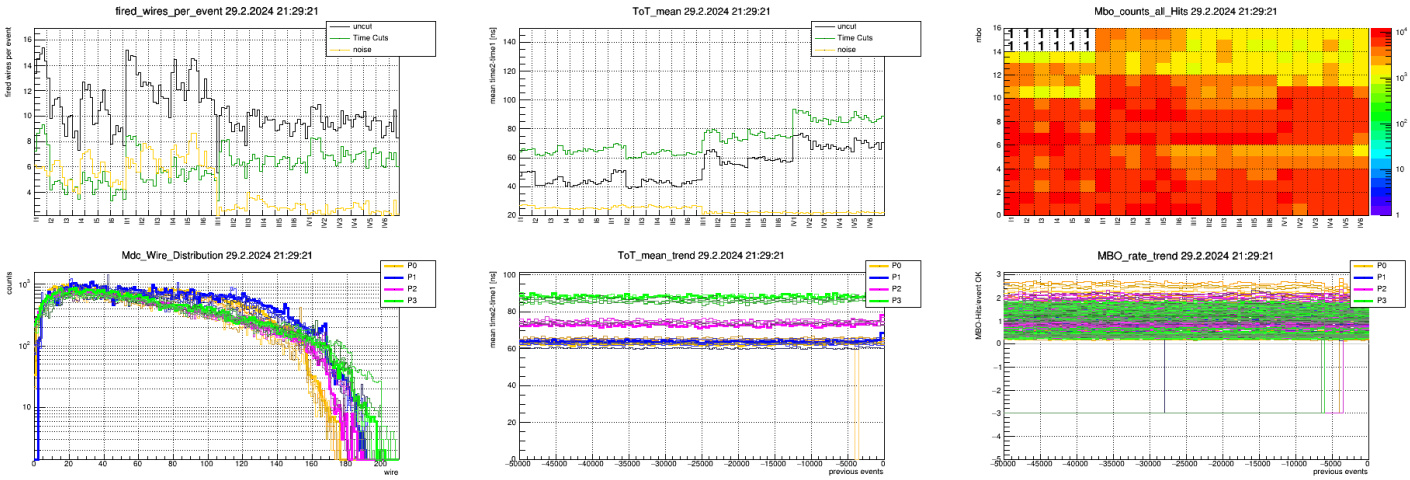








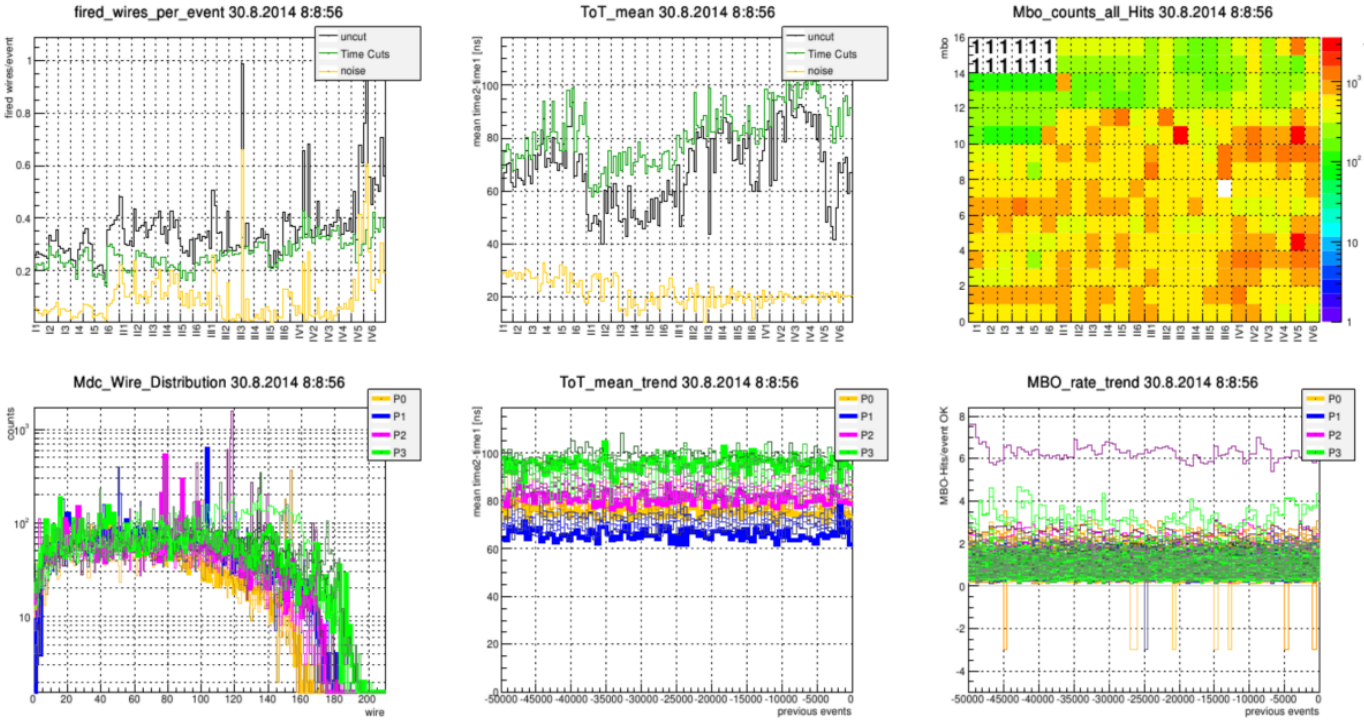
Mdc-Main 2024



- Top left: Fired wires per event for each chamber and wire plane
  - Black: all signals, green: after time cuts, yellow: noise
  - Gaps point to missing high voltage on some planes / chambers
- Top middle: Mean time-over-threshold for each chamber and wire plane
  - Noise (yellow) should show low values, well separated from real signals (green)
- Top right: Number of data words for each motherboard (MBO)
  - Cells marked '1' are not existing
  - White spaces should not exist (means MBO failure) (despite one switched off board Aug14: III6 MBO7)
- Bottom left: wire distribution, integral for each chamber
  - should be a smooth distribution over all wires
  - reduced counts/gaps fore single wires point to missing readout DBO/MBO
  - lower distribution of one chamber (line) over all wires (compared to other chambers) point to reduced HV in some layer(s)
- Bottom middle: time-over-threshold for each chamber and wire plane
  - Smooth distribution over time
  - Equal within one MDC plane
- Bottom right: Trend of mean count rate per motherboard (normalized to mean value of the full plane)
  - All lines should be around 1 (0...3) if all motherboards are ok
  - Values at **-3** point to count rates that are lower than normal
    - Short drops are expected, especially in planes 0 & 1
    - Longer drops point to non-working motherboards → try to recover this one
  - Values >+**3** (means 3 times normal count rate) point to noisy motherboards

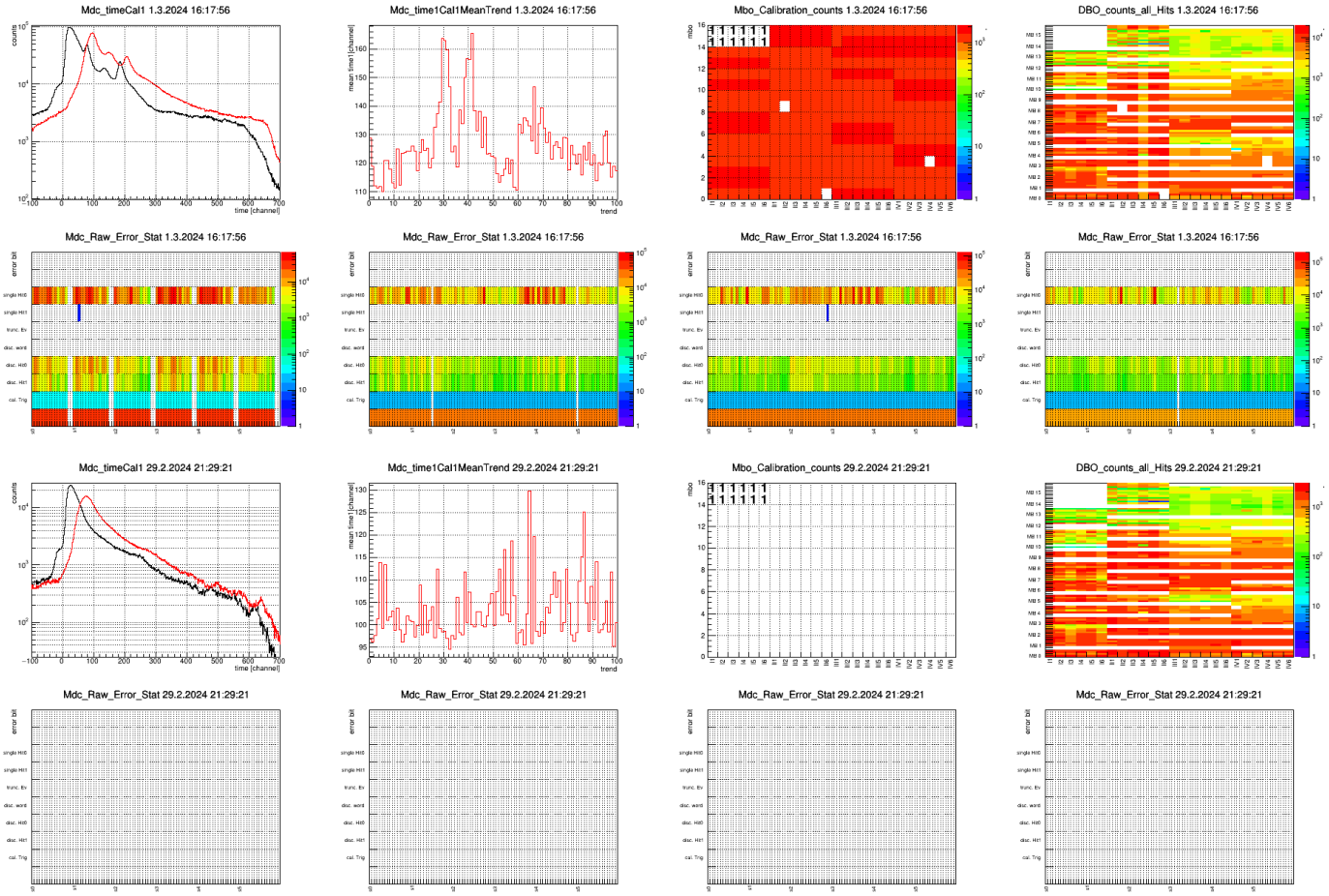
Mdc-Main – possible Errors

(how it should not be)



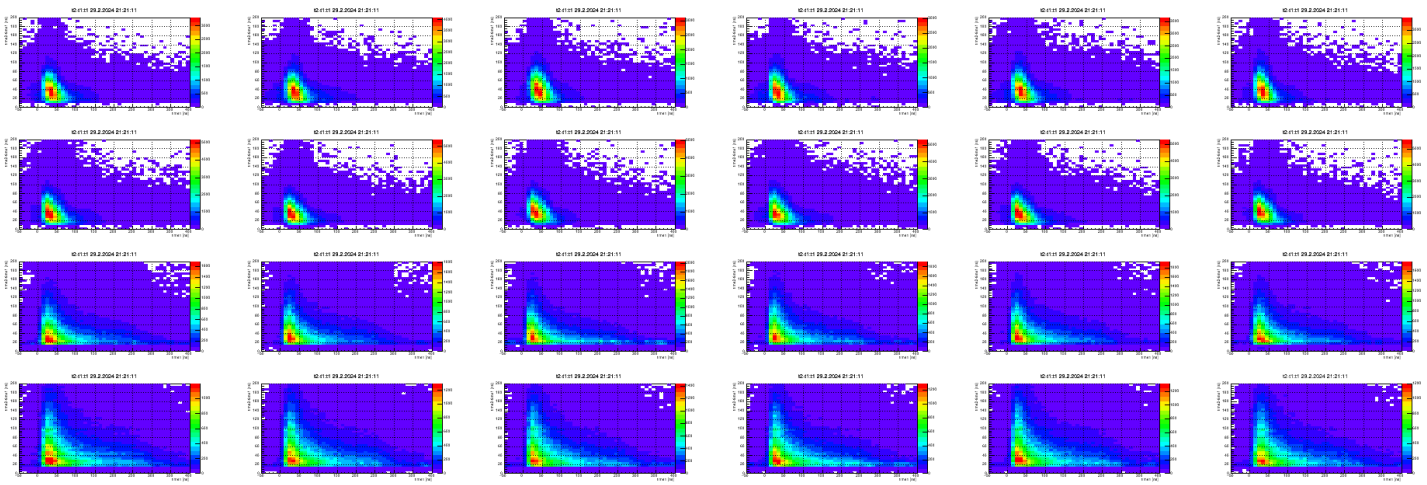
- Top left: Fired wires per event for each chamber and wire plane
  - spike in III3 points to noisy channels (see Top,Bottom right plots)
- Top middle: Mean time-over-threshold for each chamber and wire plane
  -
- Top right: Number of data words for each motherboard (MBO)
  - noisy motherboard: III3 MBO10
- Bottom left: wire distribution, integral for each chamber
  -
- Bottom middle: time-over-threshold for each chamber and wire plane
- Bottom right: Trend of mean count rate per motherboard (normalized to mean value of the full plane)
  - One line **around 6** (means 6 times normal count rate) shows noisy motherboard: III3 MBO10 (also visible as deep red bin in Top right plot)

Mdc – Error 2024



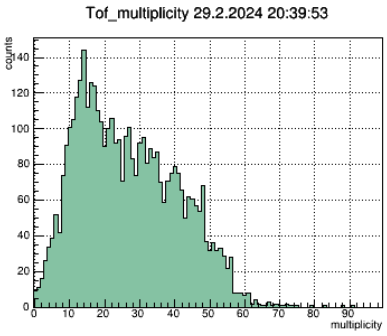
- Top left: Leading and trailing edge time distribution.
  - Both should be similar, but shifted. Time2 (red) must be after time1
  - Both should have a clear peak between 0 and 200
- Top 2nd: Mean calibrated time from all channels
  - Should stay constant, short drops might be due to beam breaks
- Top 3rd: Number of calibration data words
  - Uniform distribution required. White spots point to non-working motherboards (those marked '1' do not exist)
  - (despite one switched off board Aug14: III6 MBO7)
- Top right: Number of hits for each daughterboard
  - “horizontal” (same within one plane) white spots are non-existing channels → OK
  - “vertical” (not equal within a full plane) white spots are non-working daughter-/mother-boards → try to recover the corresponding MBO
  - Red spots correspond to noisy groups of channels
- Bottom: Error and Warning flags
  - None bin points to real errors – expert information only. Refer to MDC QA manual

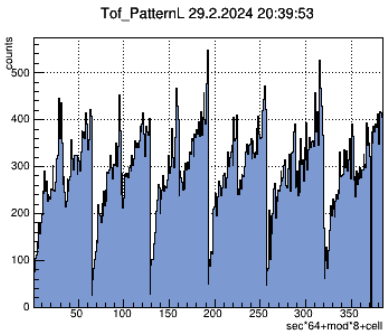
Mdc – Potato 2024

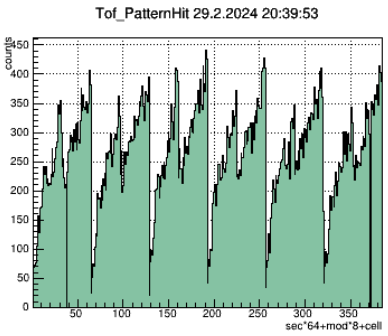


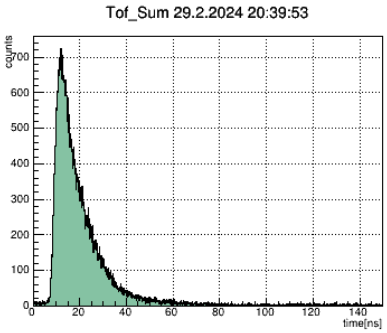
- MDC 'potato' plots (calibrated times)
  - One plot for each chamber (time1 versus time-over-threshold)
  - A blob should be visible in all chambers
    - Must be completely inside the histogram, not cut on the edges
    - Should start around time1 = 0, with correct delays/calibration
  - Should be separated from the floor of noise measurements
  - Ghost peaks separated by 200 ns from the main one are due to spill structure from the accelerator
  - Should be similar for each chamber within one plane

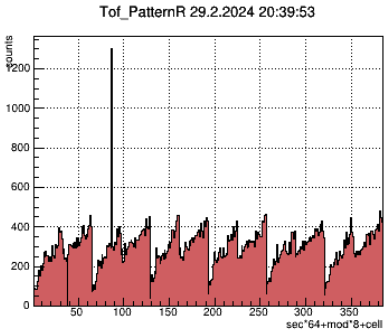
Tof - Main

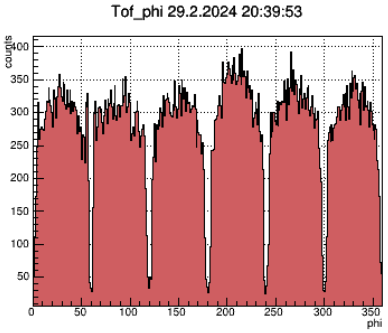






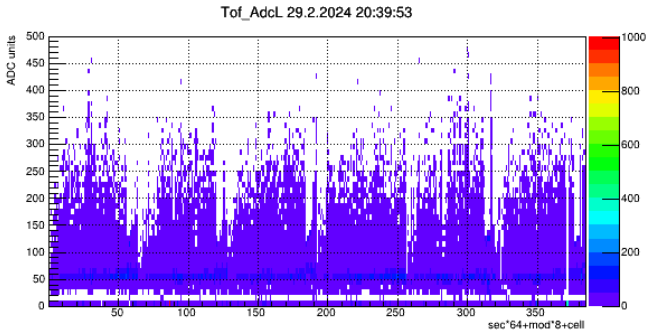


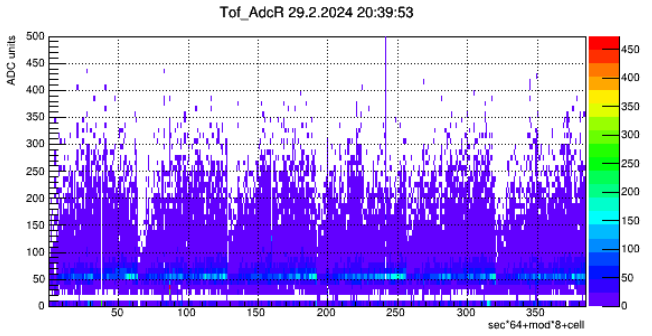


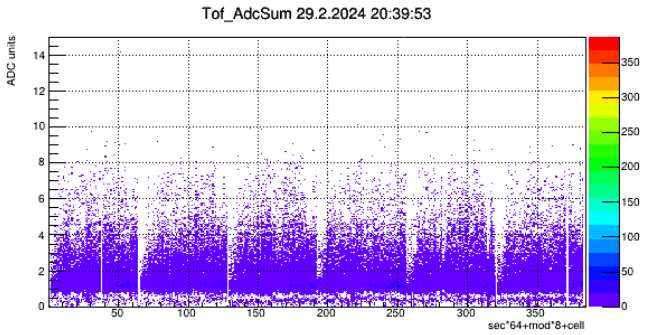


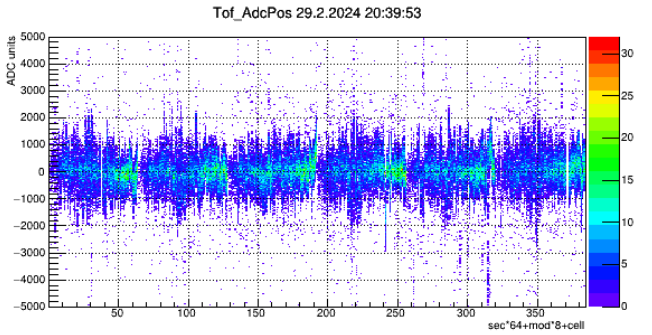
- Top left: Multiplicity per event in TOF
- Middle top & bottom: Hit distribution over channels of TOF
  - From left and right side of each bar
- Top right: Hit distribution over channels of TOF
- Bottom left: Time distribution of TOF hits
  - Shows a peak at 10 ns and a 30ns tail
- Bottom right: Phi distribution of hits in TOF
  - shows all six sectors. Should be equal in all sectors, but an unequal distribution is observed mostly

Tof - Adc



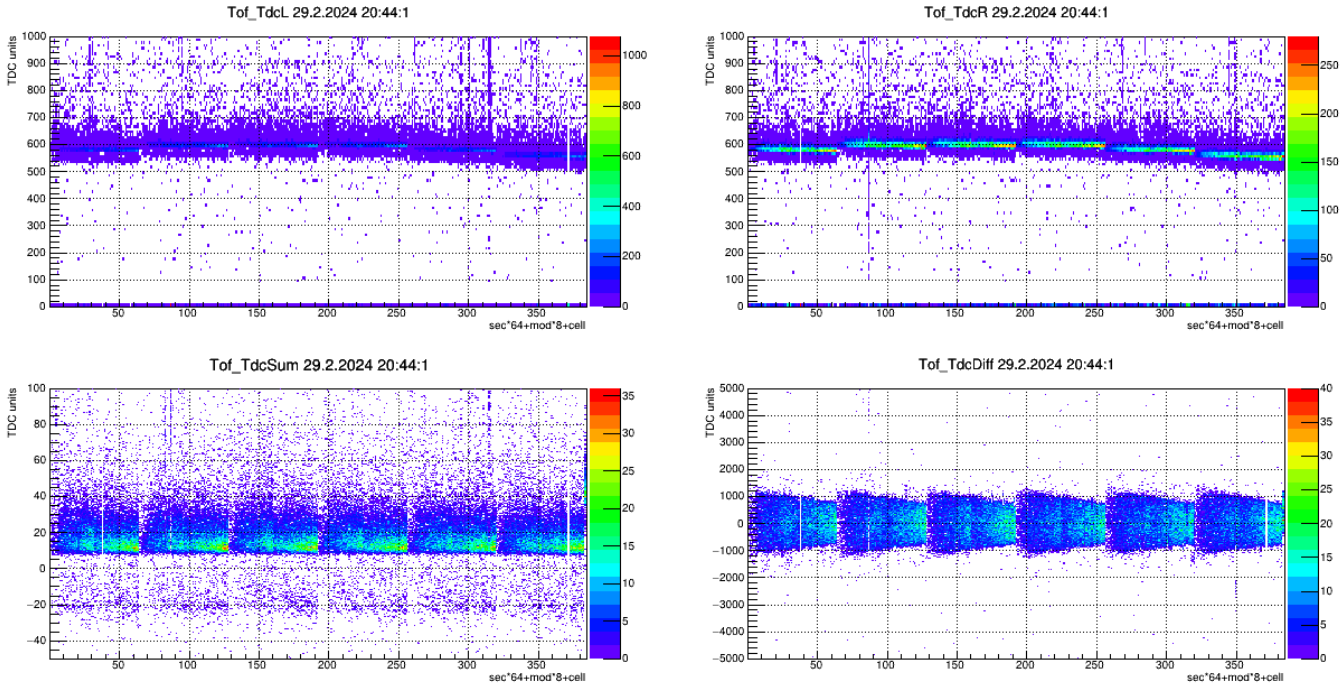






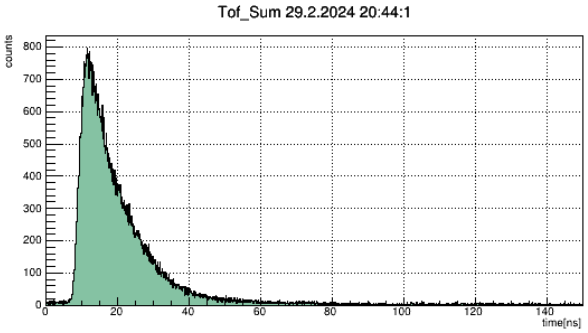
- Time-over-threshold measurements from TOF
- Top: left and right read-out of each bar
  - A distribution peaked at 50 is expected
  - Entries at low values correspond to noise in the detector
- Bottom left: Calibrated sum of left and right amplitude for each bar
  - A broad distribution with a maximum around 1 is expected
- Bottom right: Estimated position within a rod calculated from known attenuation and both ADC values
  - x: rod number, y: position

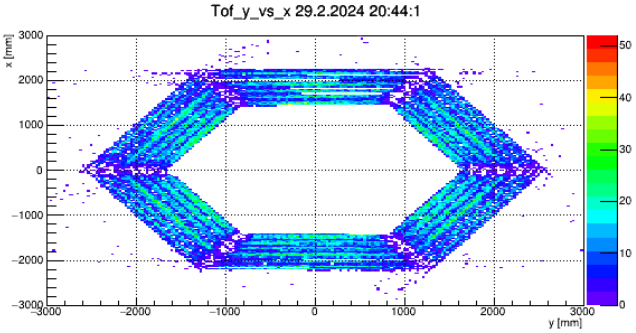
Tof - TDC

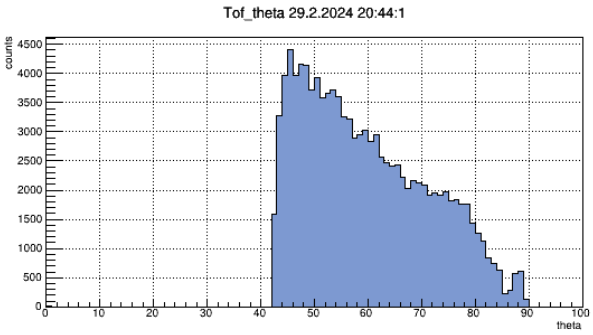


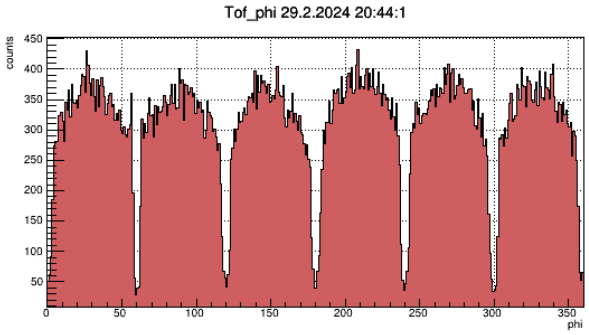
- Top: TDC measurements in TOF from left and right side.
  - For each side a clear line should be visible
  - Offsets between sectors are due to different cable lengths
  - Outliers correspond to noise
- Bottom left: Sum of TDC measurements from both sides of a bar, after offset correction. Should show a clear band around 10 ns for all channels
- Bottom rigth: Difference of time measurement from both sides a bar. A broad band centered at 0 and a width of +- 1000 is expected (due to length of the bar, changing within one sector)

Tof - Hit



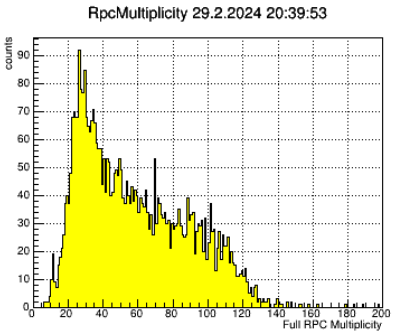


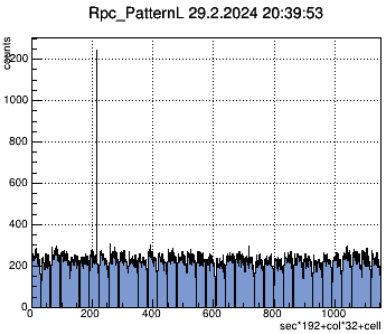


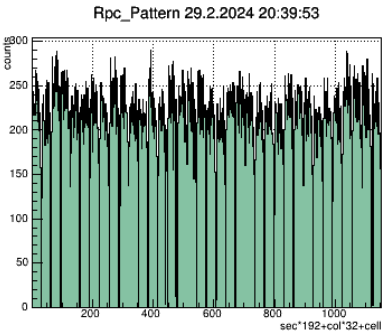


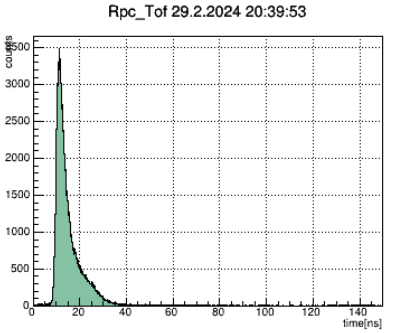
- Top left: Measured times in the TOF
  - Should show a clear peak around 10 ns (time-of-flight of fast particles)
- Top right: 2D hit distribution in TOF
- Bottom: Theta and Phi distribution of hits in TOF
  - Phi distribution shows all six sectors. Should be equal in all sectors, but an unequal distribution is observed mostly

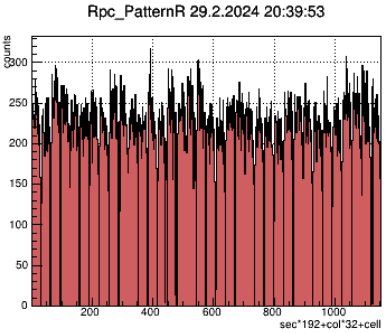
Rpc - Main

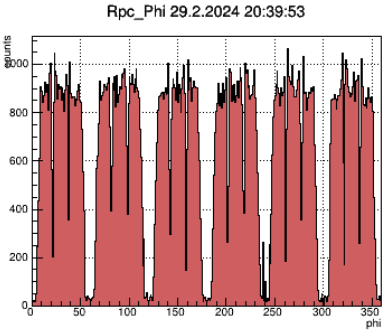






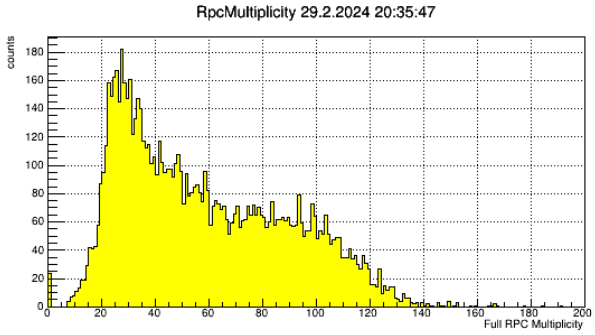


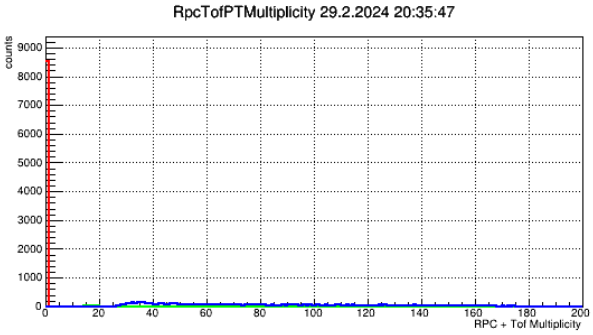


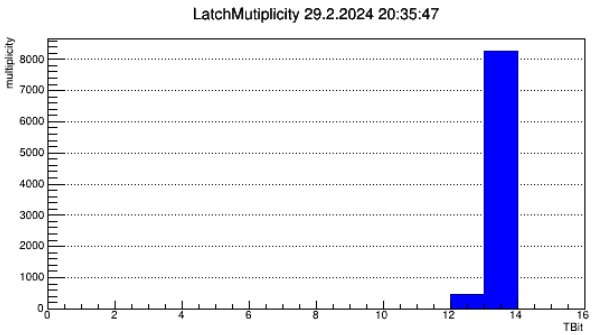


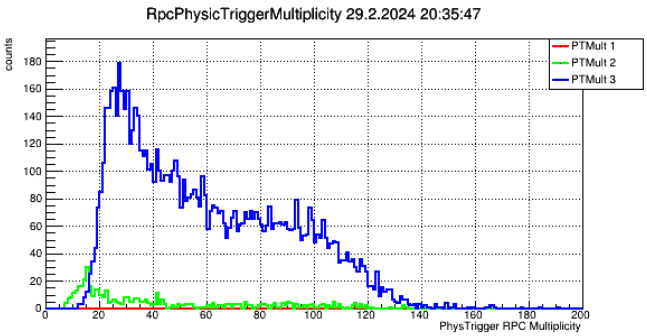
- Top left: Raw RPC hit multiplicity per event
- Bottom left: Times measured in Rpc and Tof
  - Should show a clear peak around 11 ns (time-of-flight of fast particles)
- Middle column: Hit distribution on left and right sides for all cells of RPC
  - Six sectors are shown side by side (→ six peak structure expected)
  - Should be similar in all sectors
- Top right: Hit distribution of RPC, see middle column
- Bottom right: Phi distribution of hits in RPC
  - Six sectors shown side by side
- All distributions should be equal in all sectors

Rpc - RawRpcMult



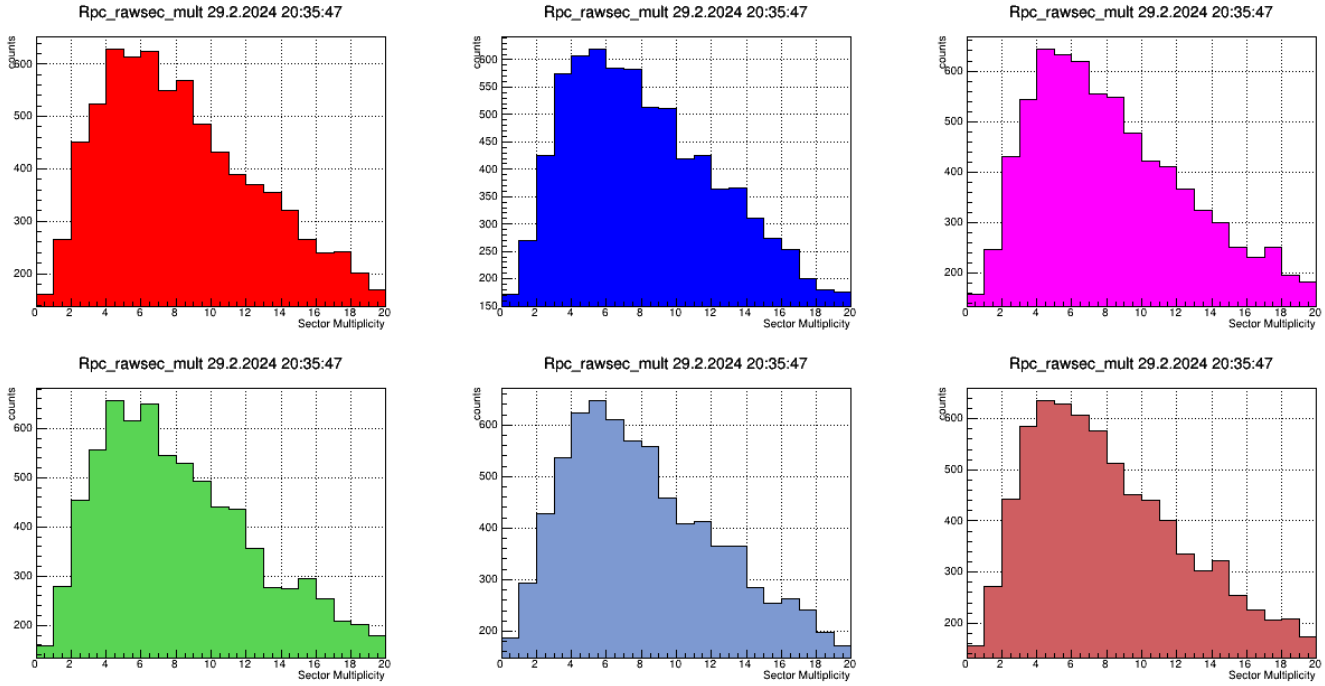






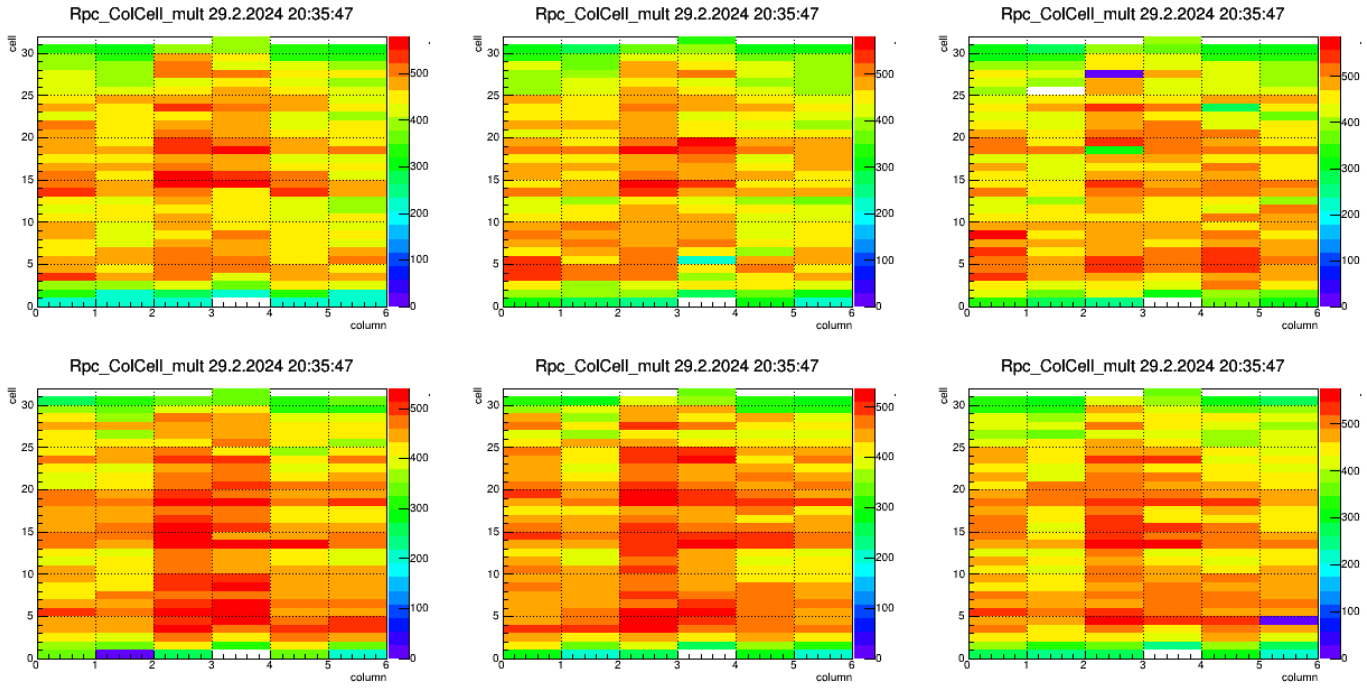
- Top left: Raw multiplicity in RPC for each event
- Top right: Combined multiplicity in Tof and Rpc for each event
  - Colors correspond to different trigger inputs.
  - Mean multiplicities should match the ones set in the trigger module
- Bottom left: Number of events of a given trigger source
  - Bit 11 corresponds to PT1 used for Pions
- Bottom right: same as top right, but for Rpc only

Rpc - RawSecMult



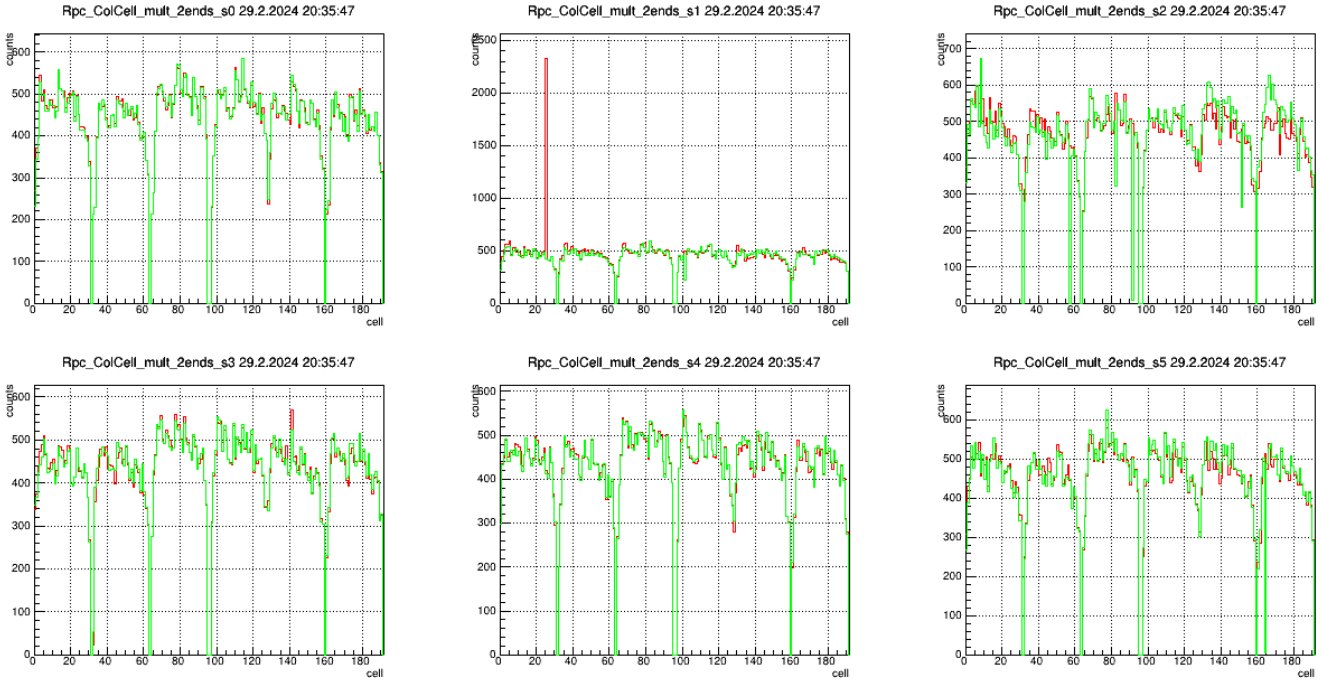
- Raw multiplicity in RPC for each event for each sector
  - Should be equal in all sectors

Rpc - RawCollCellMult



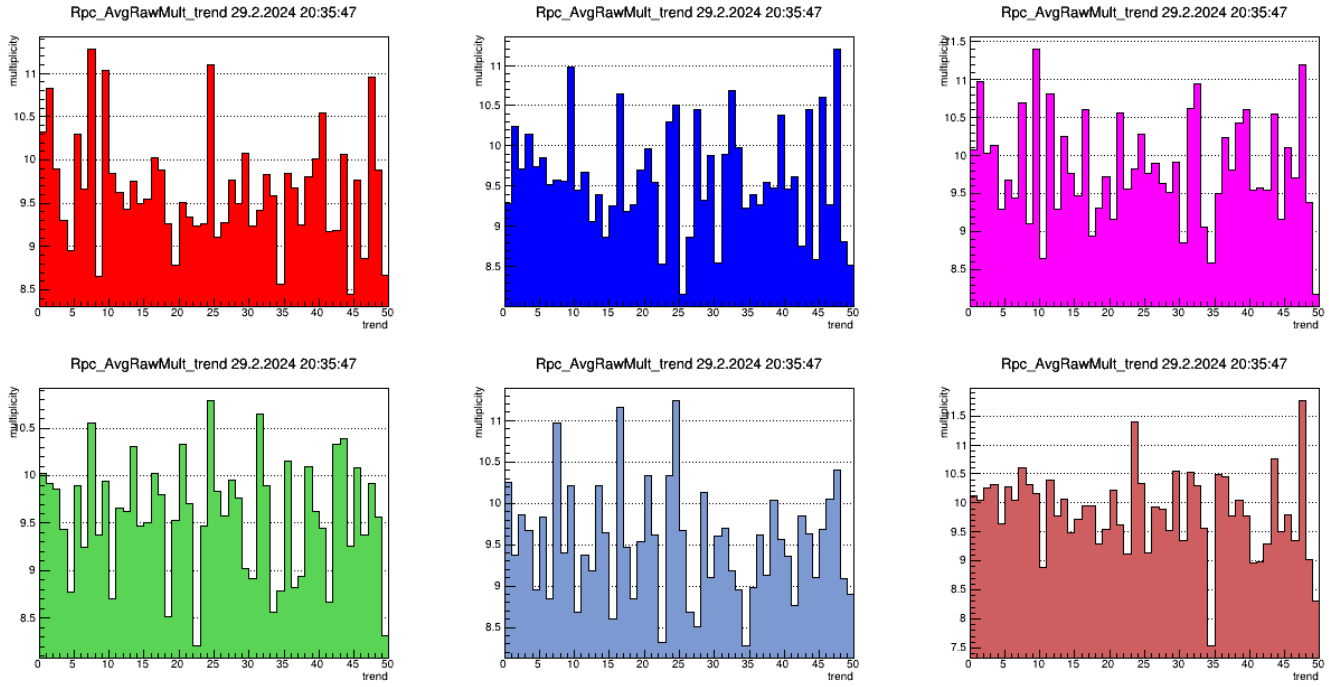
- Number of hits per RPC cell
  - One plot for each sector
  - Left (1-2) /right (4-5) should show similar values
  - Distribution should be similar in all sectors
  - White entries are dead channels (cell 31 exist only in column 3, cell 1 column 3 is also not existing)
  - Two cells (1/2 in sector 4 and 5/6 in sector 6 are known dead channels)

Rpc - RawCollCellMult2



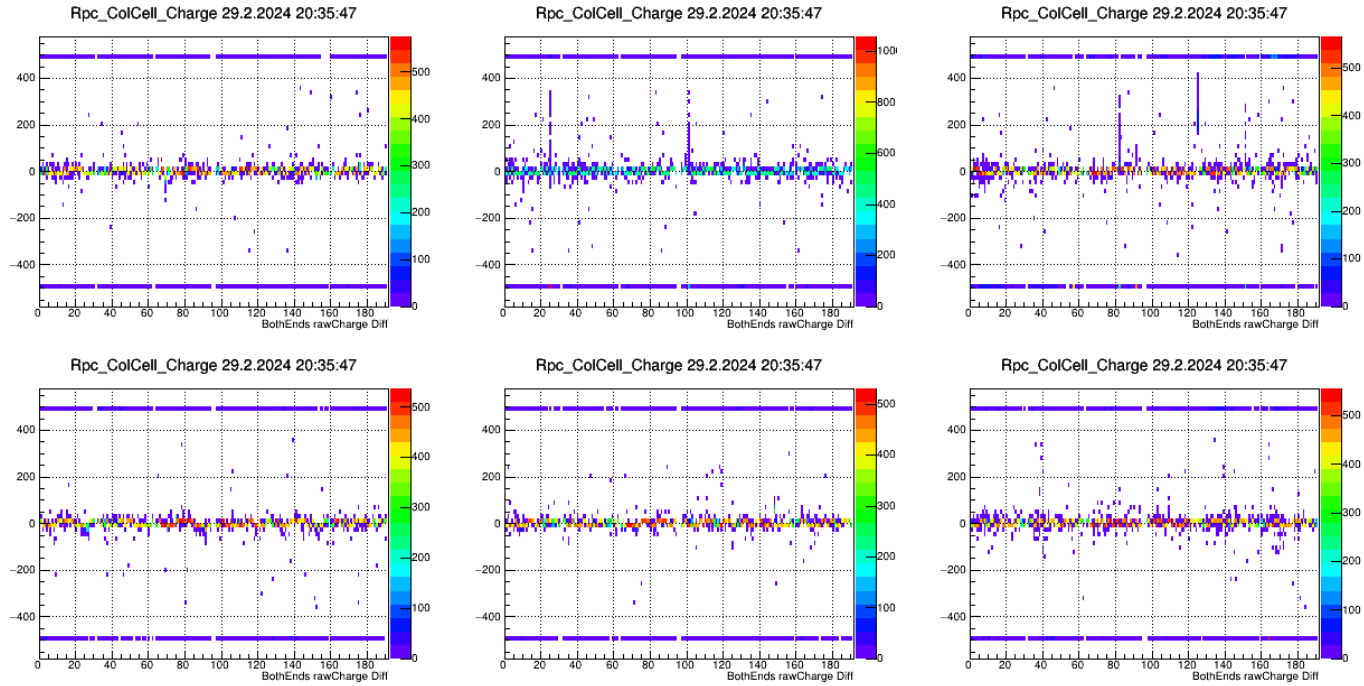
- Total number of hits per RPC cell
  - Colors correspond to left / right readout of cell
  - Distribution should be similar in all sectors
  - Peaks correspond to noisy channels
  - Both sides of each cell should show similar values

Rpc - RawHitsTrend



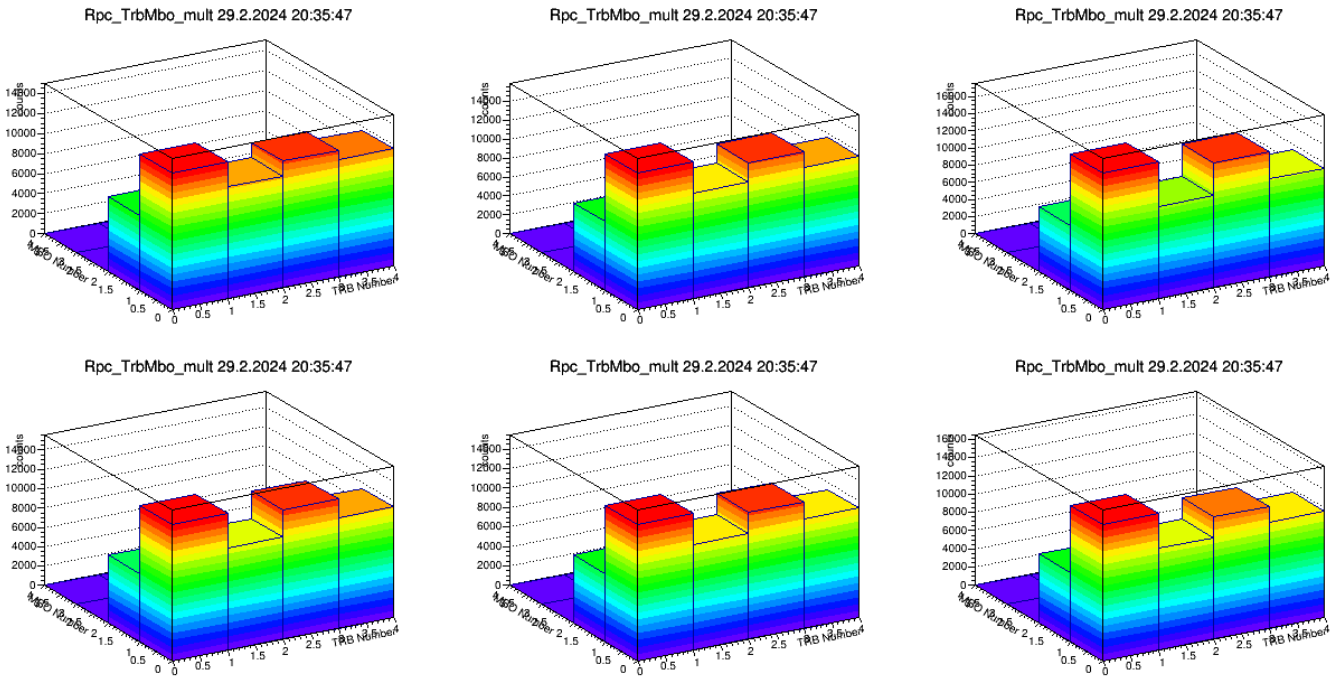
- Trend plot of the average signal multiplicity per event in RPC
  - One plot per sector
  - Should be equal on all sectors
  - Should not change over time

Rpc - RawChargeDiff



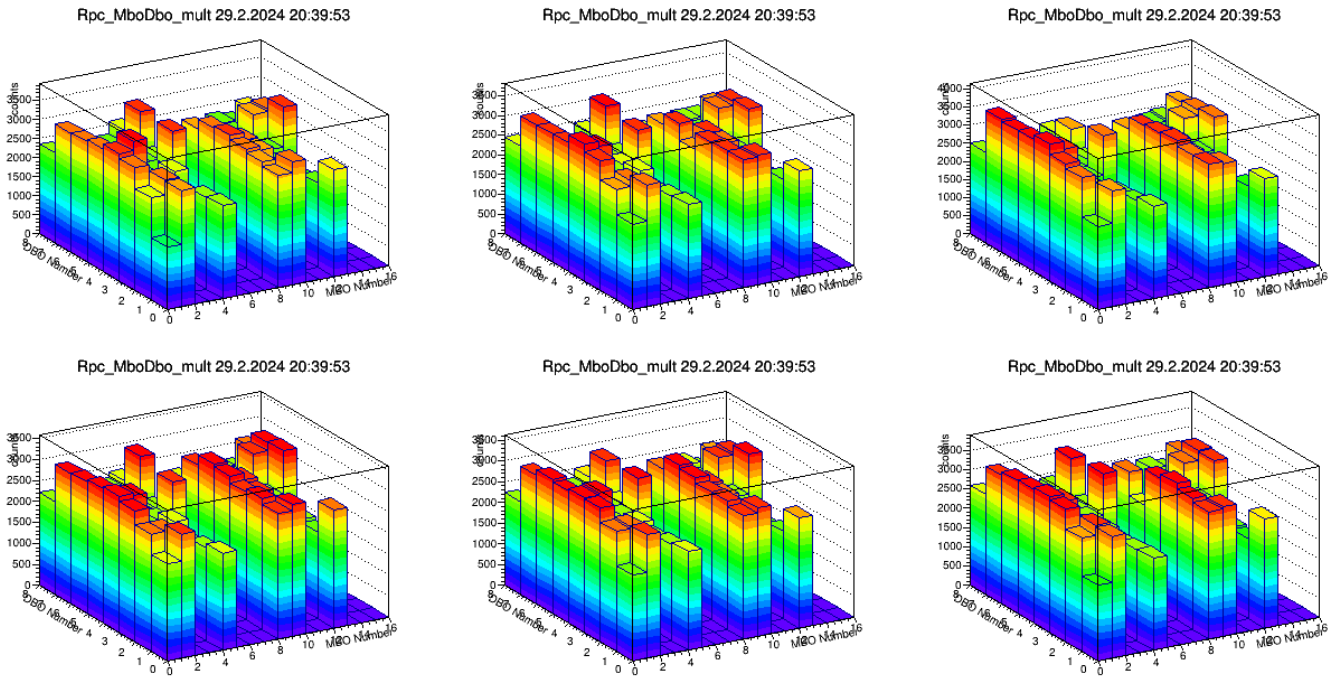
- Difference between measured charges from both sides of a RPC cell
  - One plot per sector
  - Should show a (wiggly) (due to calibration & efficiency) line around 0
  - Entries at +- 500 correspond to hits measured on one side only, i.e. one of the hits has not been measured. The amount should stay low

Rpc - FeeTrbMb



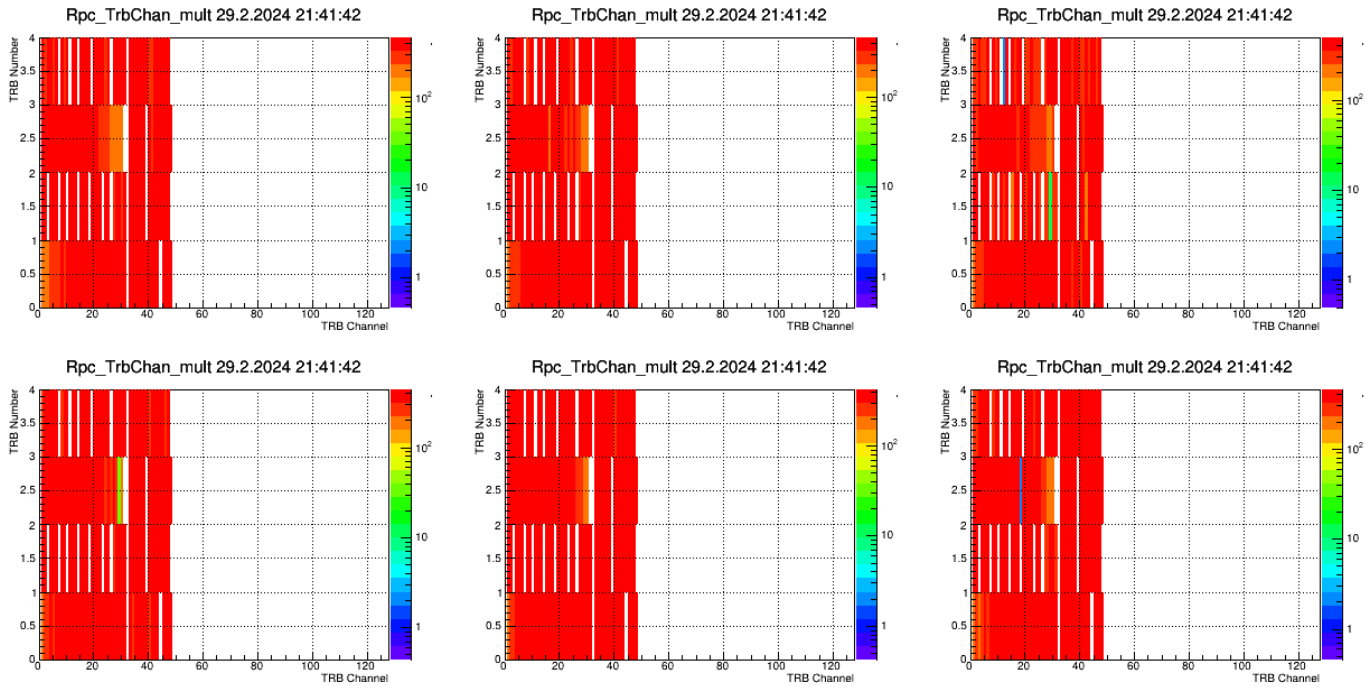
- Hit distribution in RPC ordered by front-end modules and read-out boards (MBO, TRB)
  - One plot for each sector
  - Distribution should be similar in all sectors

Rpc - FeeDbMb



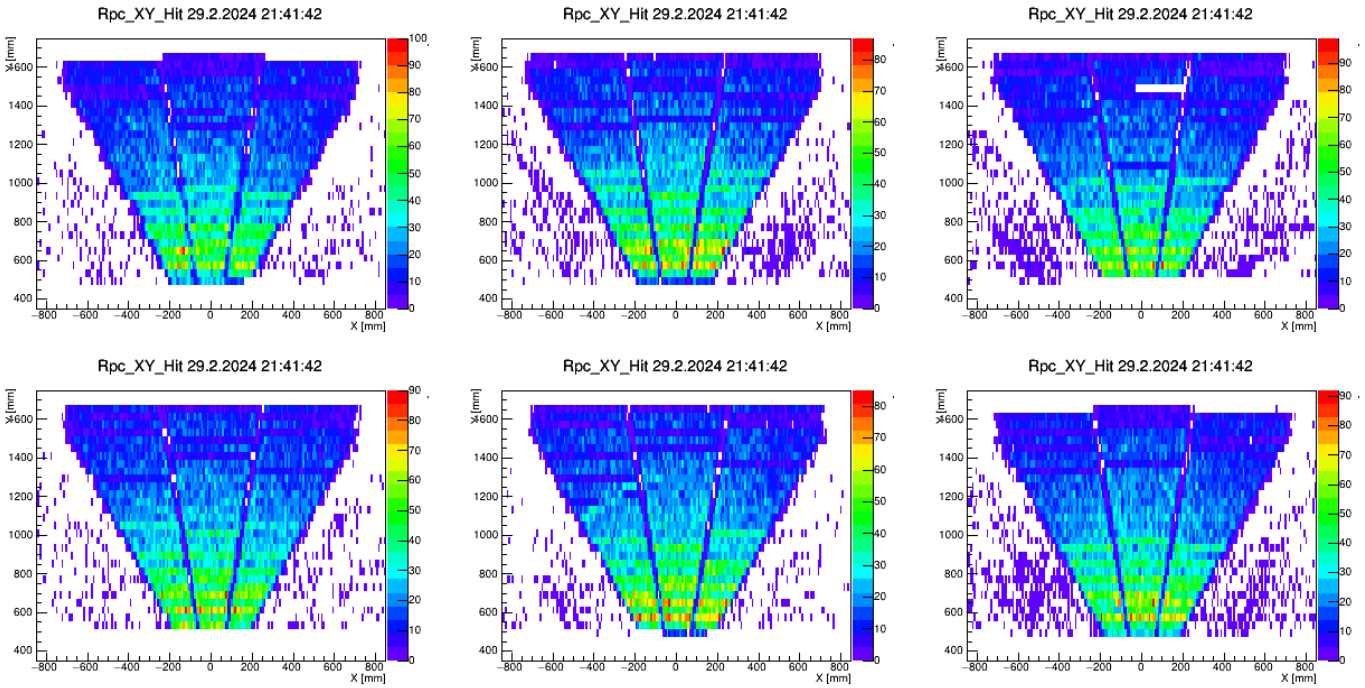
- Hit distribution in RPC ordered by front-end modules (MBO, DBO)
  - One plot for each sector
  - Distribution should be similar in all sectors

Rpc – FeeTrbChannel Feb24



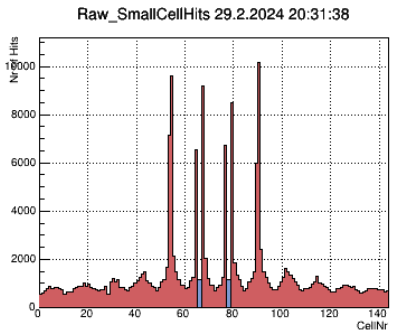
- Hits in the RPC, ordered by channel on the readout boards.
  - One plot per sector
  - Each sector has four read-out boards, one is used only partly (→ white parts in the plots)
  - Red lines are due to reference time which is contained in the data (four parallel lines in each plot)

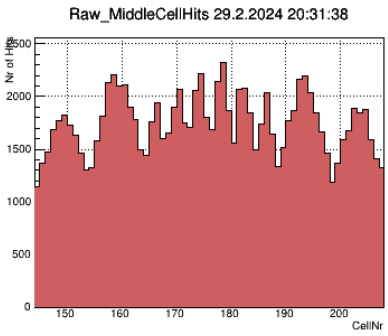
Rpc - RpcHit

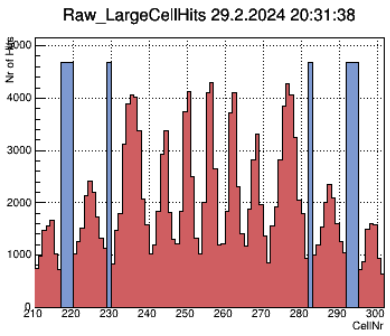


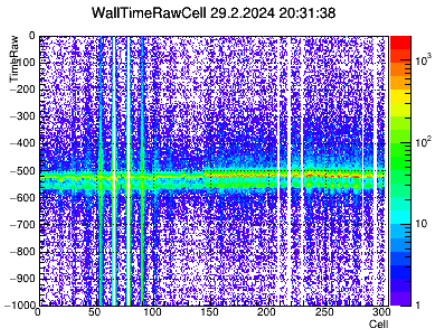
- Hit distribution in the six sectors of RPC
  - Higher occupancy in the inner part of the detector
  - Peaks point to noise in the detector

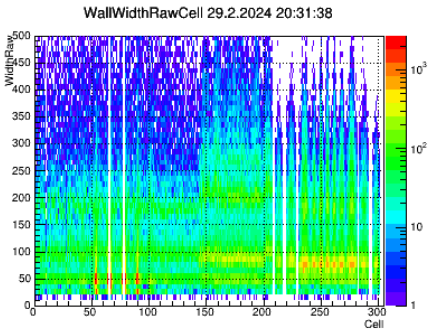
Wall - Main











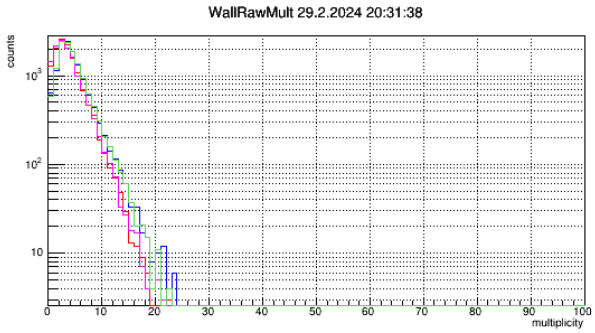
Number of hits in all cells of forward wall

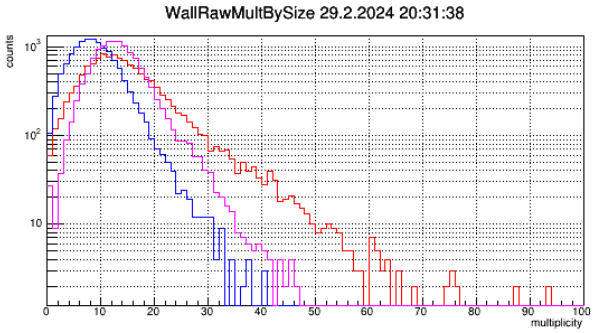
- Three plots corresponding to small, middle and large cells
- Blue columns are non-existing cells (due to geometry)

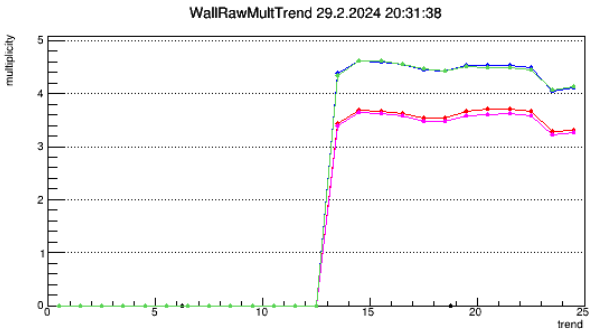
Time Raw vs cell - time should be around -500 ns

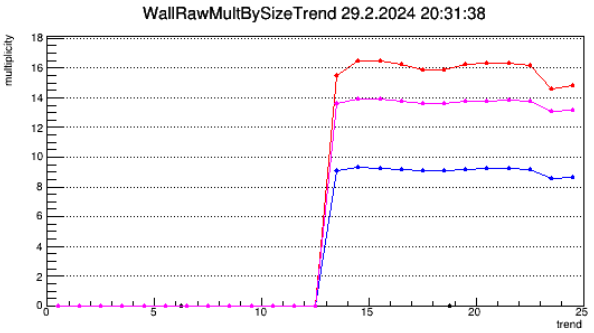
Width Raw vs cell - width (ToT) should be around 100 ns

Wall - Trend









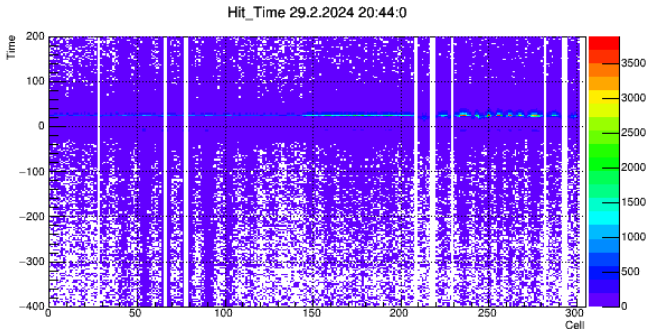
- Left column displays data from only small cells. Cells are divided in 4 quarters, and each line corresponds to each quarter.
  - Top left displays multiplicity counts per quarter
  - Bottom left displays trends of mean multiplicities for each quarter
- Right column displays FW cell data divided into three groups, corresponding to the size of the cells: small, medium, large
  - Top right corresponds to multiplicities for each size (red – small)
  - Bottom right displays the multiplicity trend
  -

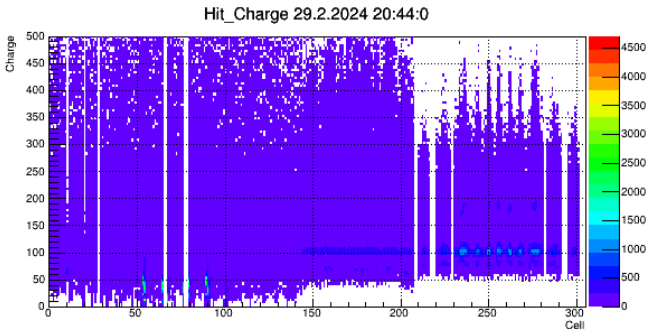
Color sequence: Red, Blue, Magenta, Green, Orange, Cyan

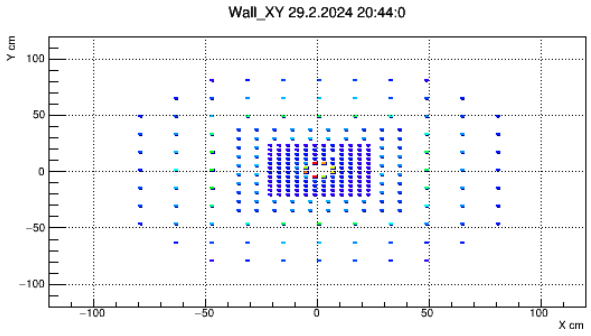
Quarters: I – 1-6;61-66; II – 7-12;67-72; III – 73-78;133-138, IV – 79-84; 139-144;

Sizes: Small: 1 – 144; Medium: 144 – 208; Large:208-305

Wall - Hit

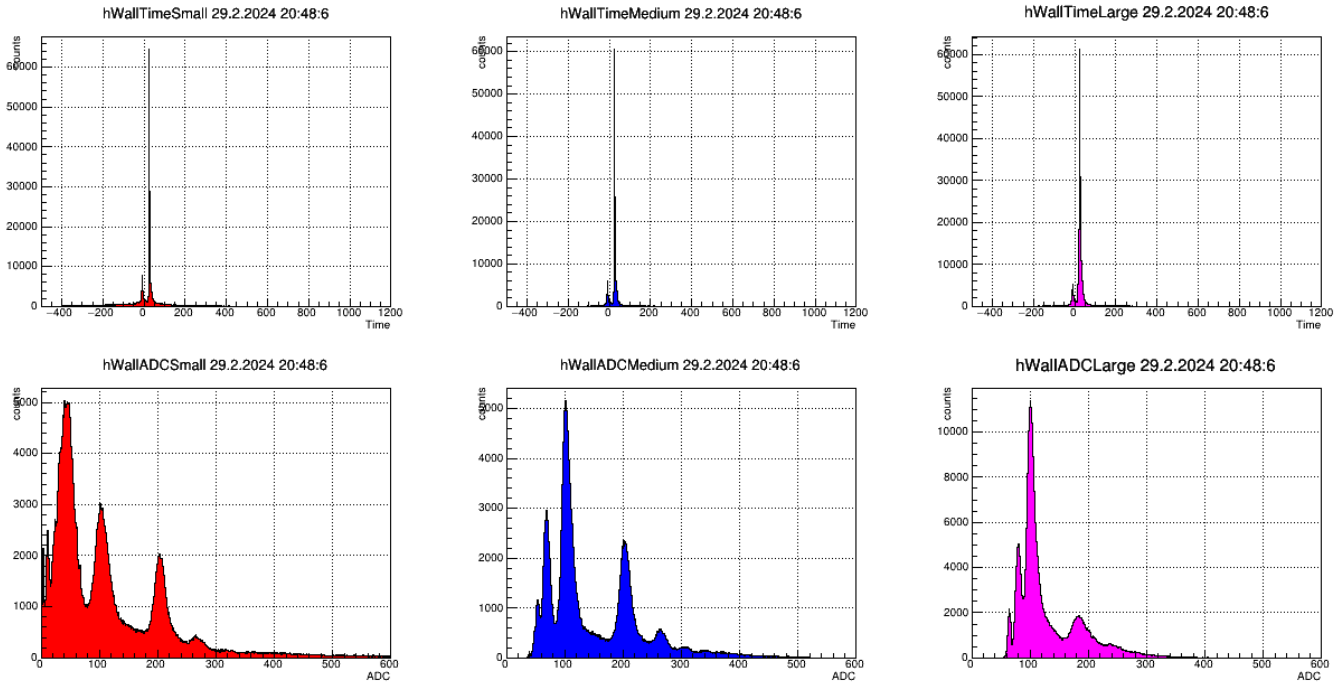






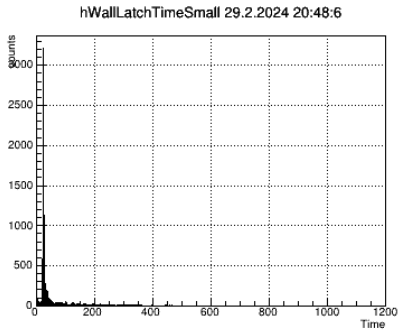
- Upper left: Calibrated time of hits
  - Compact distribution, similar for all cells, centered around 24 ns
- Upper right: Calibrated amplitude spectra of all cells
  - Should show a clear maximum
- Lower left: Distribution of hits in forward wall
  - Any asymmetry in the center region can point to possible misaligned beam

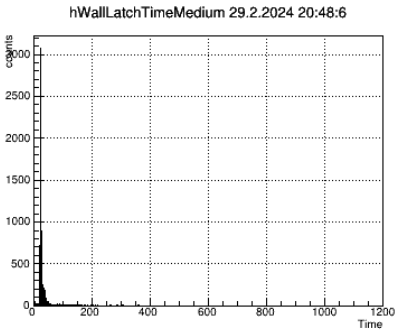
Wall - Control

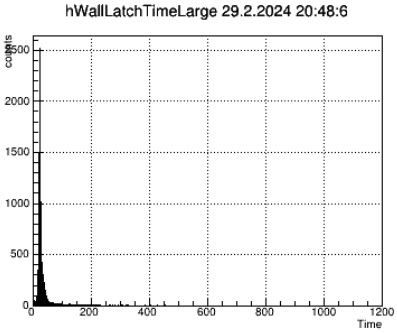


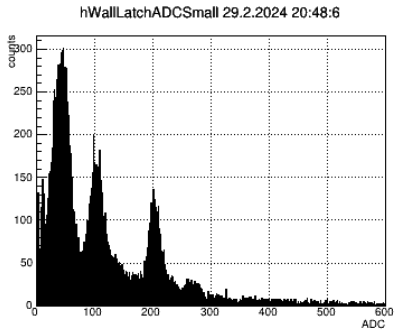
- Upper row: Calibrated time in small, middle and large cells
  - A clear peak should be visible.
  - Additional peaks spaced 200 ns are due to beam structure
- Lower row: Charge of hits for each cell size
  - Peaks at 100 units correspond to proton signal

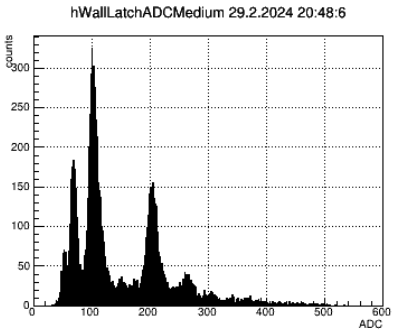
Wall - ControlLatch

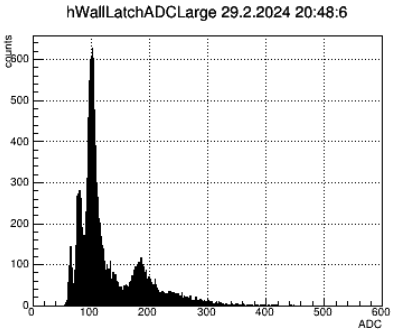




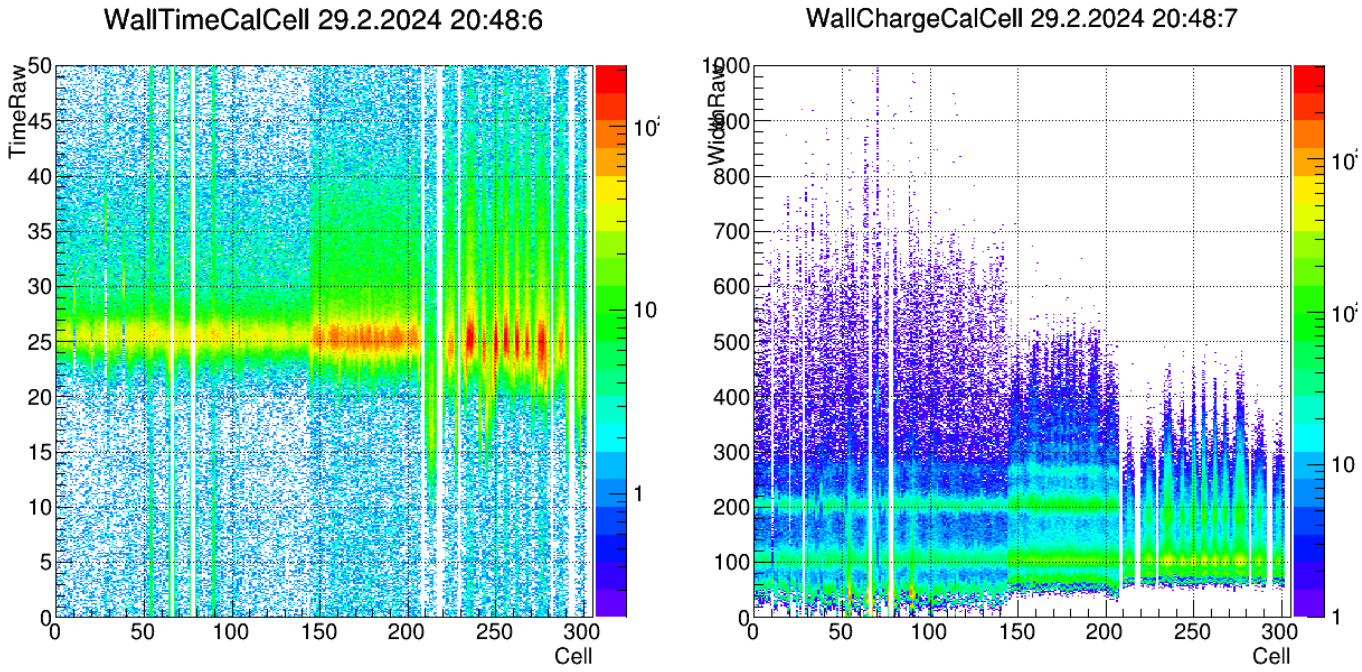






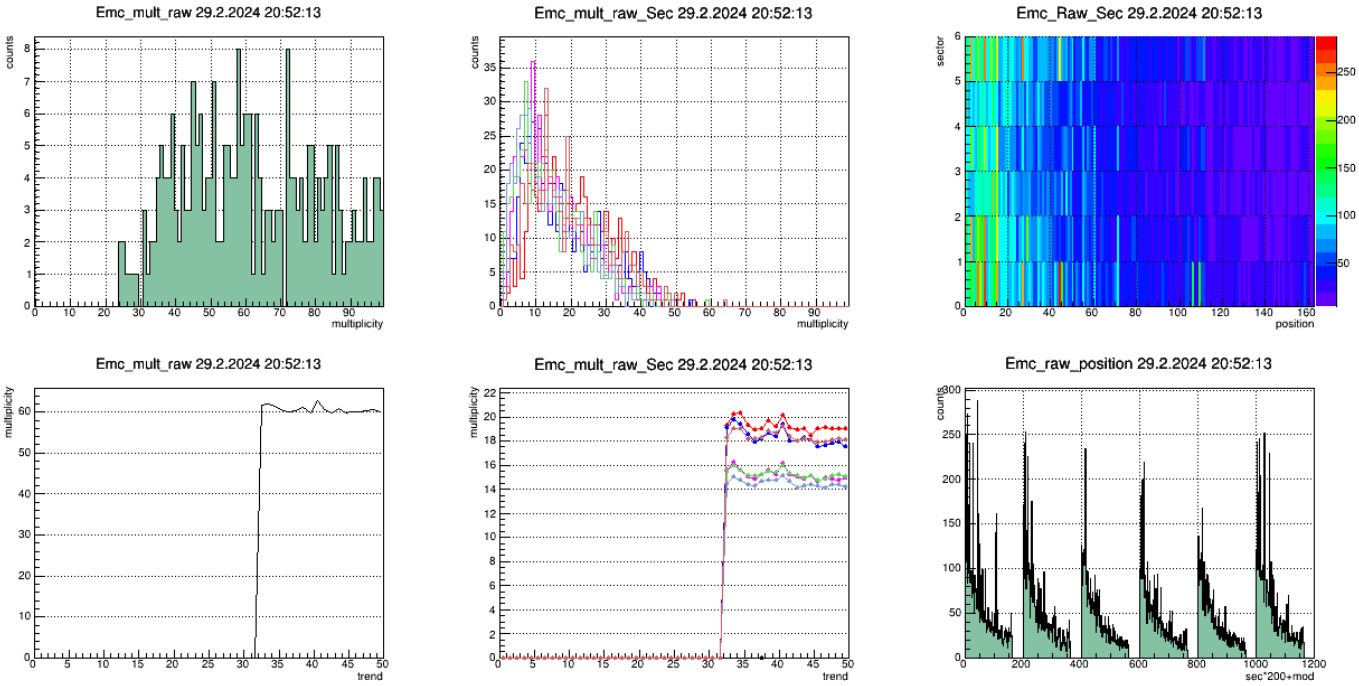


Wall - Cal(ibrated)



- Left: Calibrated time
  - A clear peak should be visible at ~25.
- Lower row: Charge of hits for each cell size
  - Peaks at 100 units correspond to proton signal

ECAL - Main



- Upper row:

  - Emc multiplicity raw (left), Emc multiplicity raw for different sectors (middle) - drop in the multiplicity can indicate the problem with threshold settings

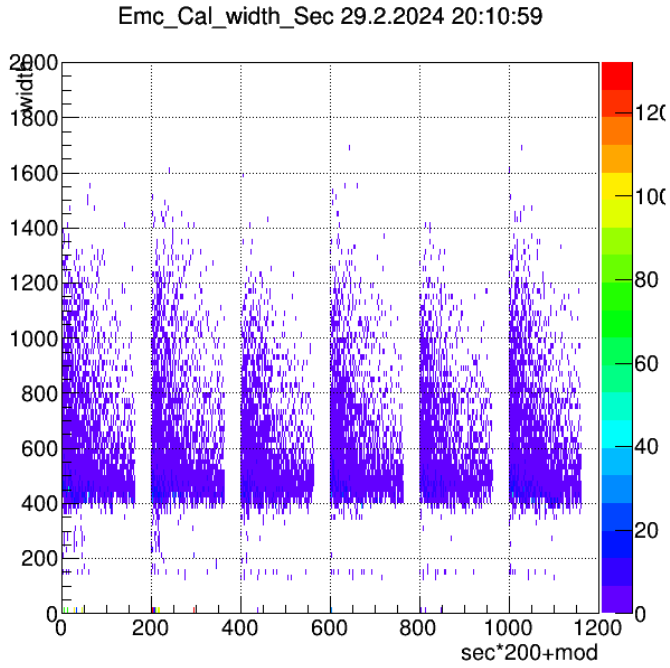
  - sector vs position (right) – there should be no empty holes (missing cells)

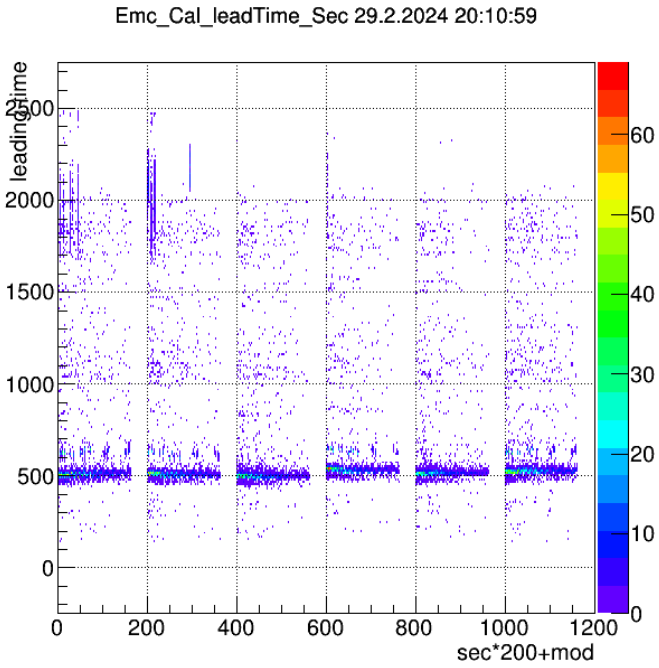
- Lower row:

  – trend of multiplicity in time, similar like in the upper row (left and middle).

  - Counts vs sec*200+module (right panel)

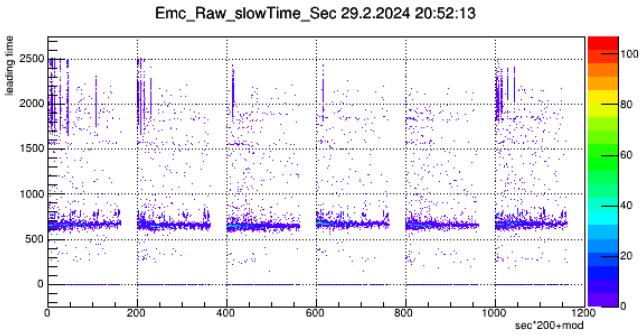
ECAL - Cal

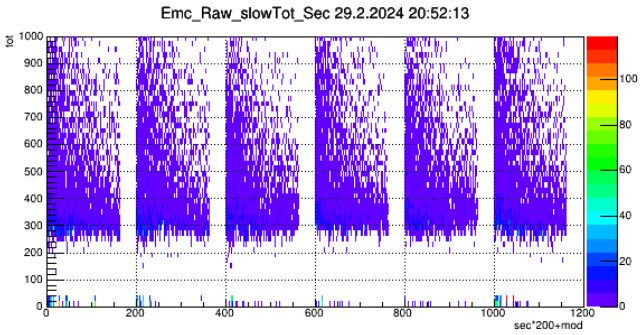


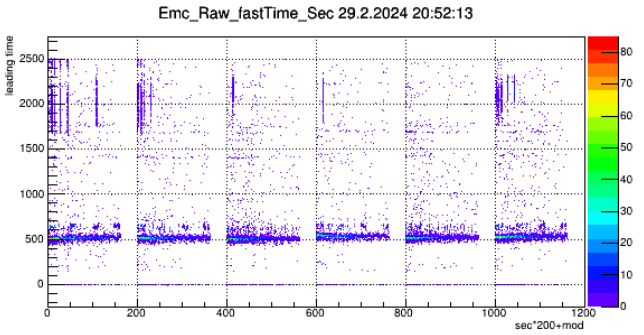


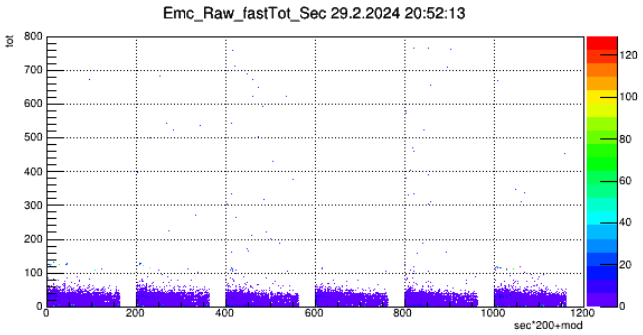
- Left plot: Emc Width vs sec*200+module – Width is defined as Emc Width = rawTimeTrailingSlow – rawTimeLeadingFast and should be around 500 ns. If very small Tot occur check thresholds.
- Right plot: Emc Fast Leading Time vs sec*200+module (left) - leading fast time should be around 500 ns

ECAL - Raw expert





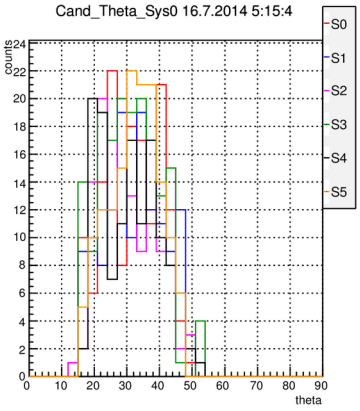


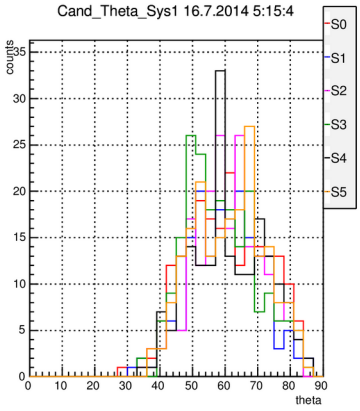


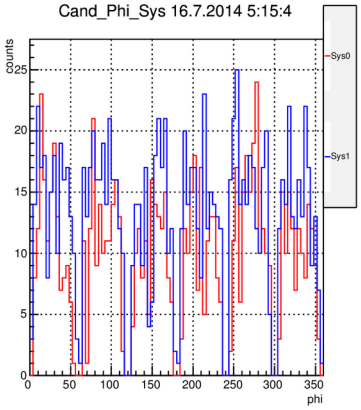
- Upper row:
  - Emc Slow Time vs sec*200+module (left) - leading slow time should be around 650 ns
  - Emc Slow ToT vs sec*200+module (right) – ToT (Width) should be around 300 ns

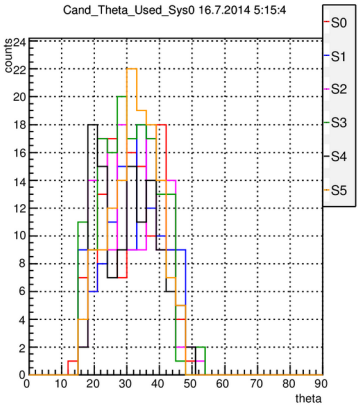
- Lower row:
  - Emc Fast Time vs sec*200+module (left) - leading fast time should be around 500 ns
  - Emc Fast ToT vs sec*200+module (right) – ToT (Width) should be close to 0

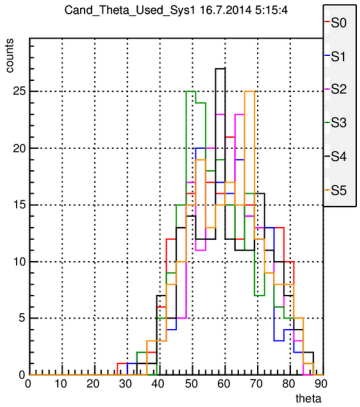
Phys - MultCand

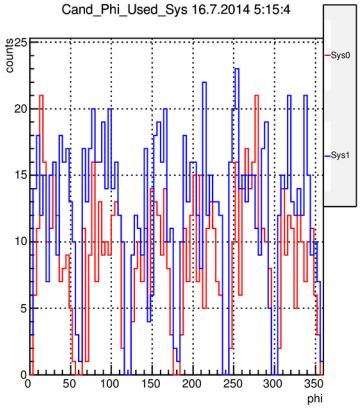




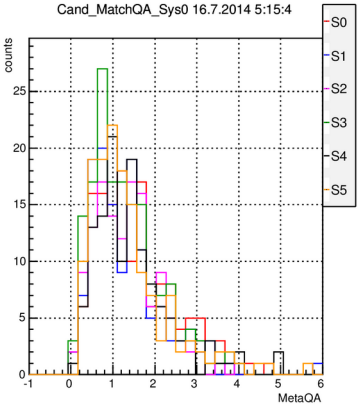


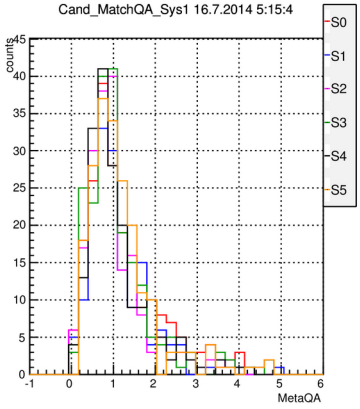


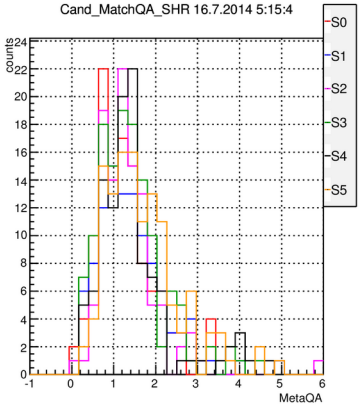


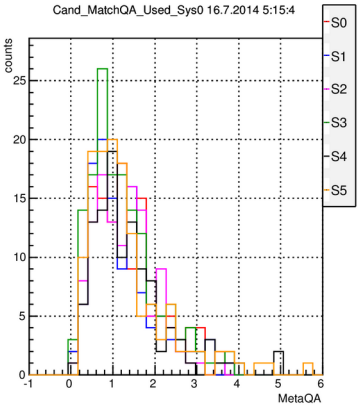


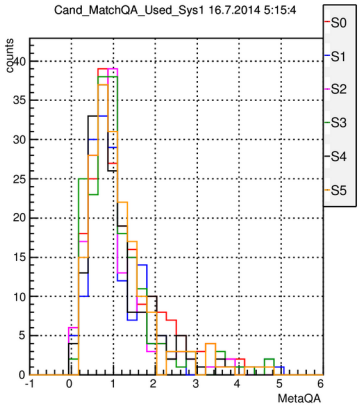
Phys - Match

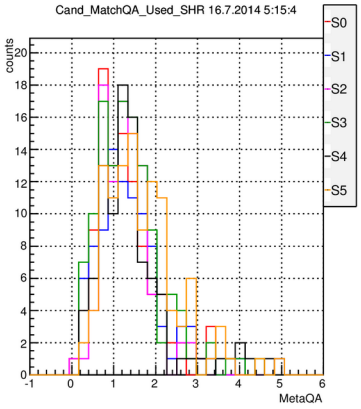

Cand_MatchQA_Sys0 16.7.2014 5:15:4
counts
MetaQA
S0
S1
S2
S3
S4
S5


Cand_MatchQA_Sys1 16.7.2014 5:15:4
counts
MetaQA
S0
S1
S2
S3
S4
S5

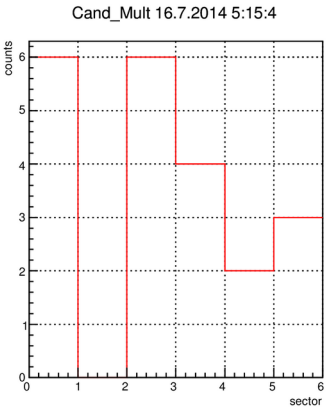

Cand_MatchQA_SHR 16.7.2014 5:15:4
counts
MetaQA
S0
S1
S2
S3
S4
S5

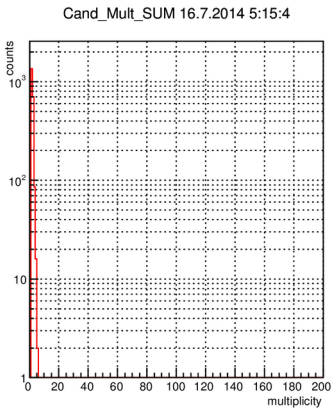

Cand_MatchQA_Used_Sys0 16.7.2014 5:15:4
counts
MetaQA
S0
S1
S2
S3
S4
S5

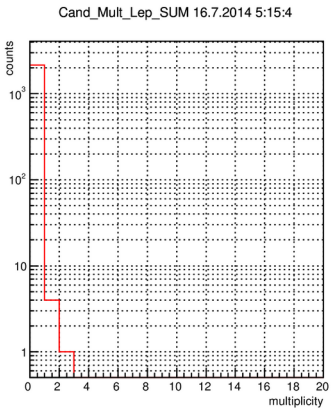

Cand_MatchQA_Used_Sys1 16.7.2014 5:15:4
counts
MetaQA
S0
S1
S2
S3
S4
S5

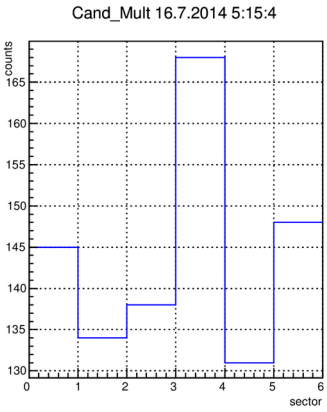

Cand_MatchQA_Used_SHR 16.7.2014 5:15:4
counts
MetaQA
S0
S1
S2
S3
S4
S5

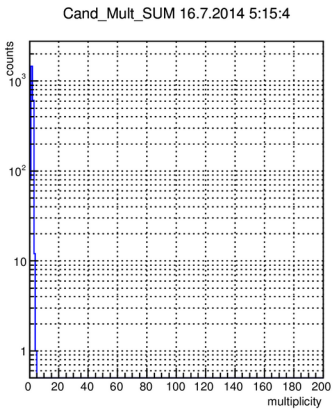
Phys - MultDist

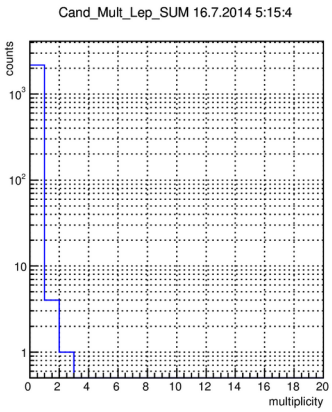




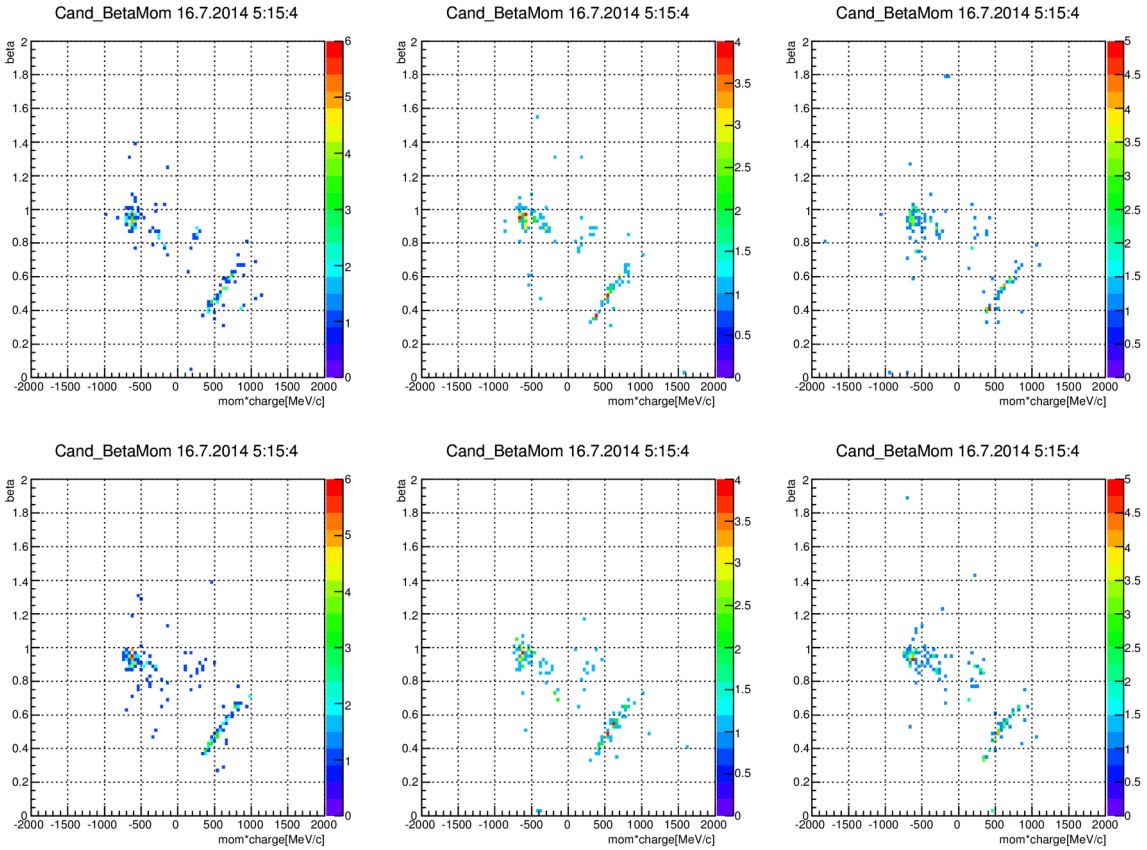






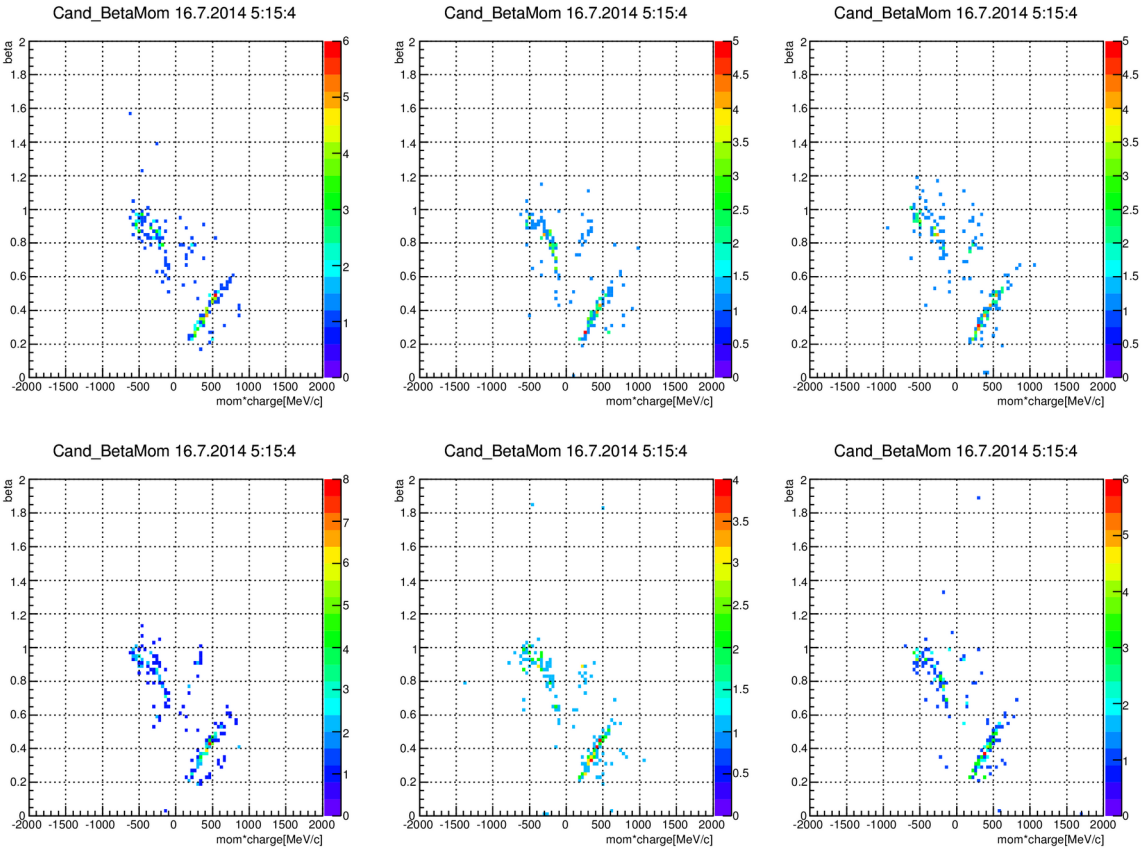


Phys - BetaMomSys0



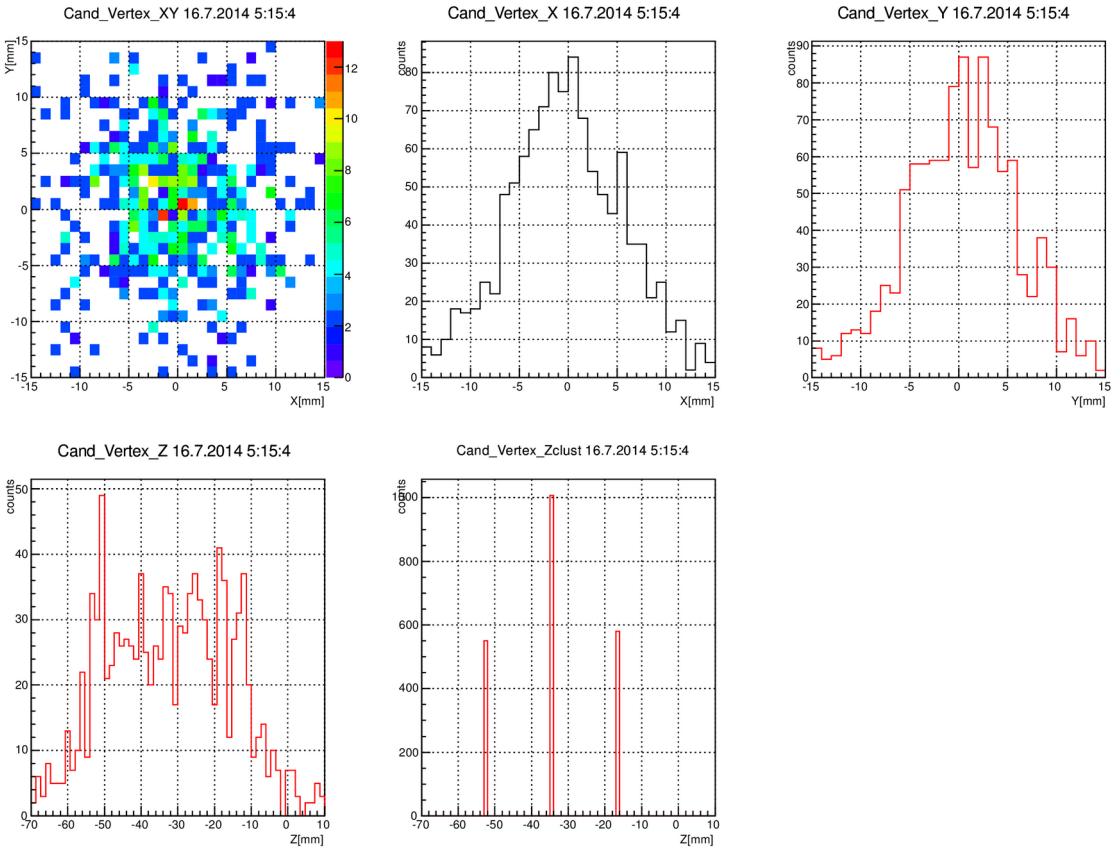
- Beta-vs-momentum plots for each sector
  - Only tracks in RPC region (Theta 18° - 45°)

Phys - BetaMomSys1



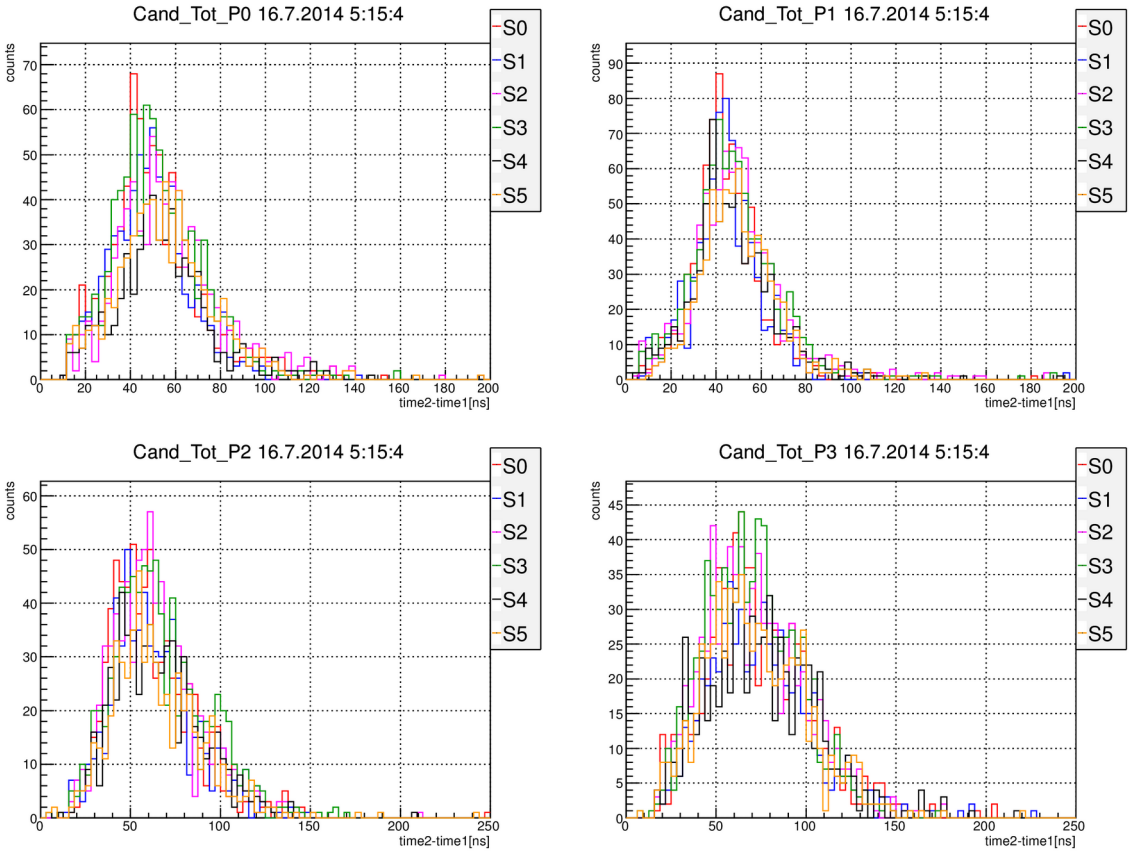
- Beta-vs-momentum plots for each sector
  - Only tracks in TOF region (Theta 45° - 81°)

Phys - Vertex



- Top left: Reconstructed vertex in X-Y from track candidates
- Bottom left & top middle, right: Projection of reconstructed vertex to different axes.
  - X/Y is expected to reach from -5 to 5 mm
  - Z is stretched over 50 mm
- Bottom right: UNKNOWN

Phys - TotMips



- Energy loss of track candidates in MDC chambers
  - One plot for each MDC plane
  - Colors correspond to sectors
  - Plotted is Time-over-threshold which is correlated with energy loss of the particle
- Curves should be similar in all sectors of one plane