University of New Hampshire

Validation and determination of CLAS12 trigger efficiencies

Rafayel Paremuzyan

CLAS collaboration meeting: March 6 - 9, 2018

The objective of the program

Main goal: Validate the trigger, and determine the trigger efficiency

Phase1: Validation of stage 1 triggers

1) Using GEMC generated mode1 data for each trigger component (HTCC, PCal, EC etc)
2) Run stage1 trigger simulator on this data and check whether trigger found the hit/cluster/mask, and if yes, how close it to the expected

Phase2: Validation of stage 2 and stage 3 triggers

Bypassed for now

When stage1 is cleared, based on trigger banks from stage 1, simulate stage 2 and stage 3 triggers, and compare with hardware output.

Phase3: Trigger efficiency

Use data taken with random trigger, select a “good” trigger candidate event, and check whether the corresponding trigger bit is lit.

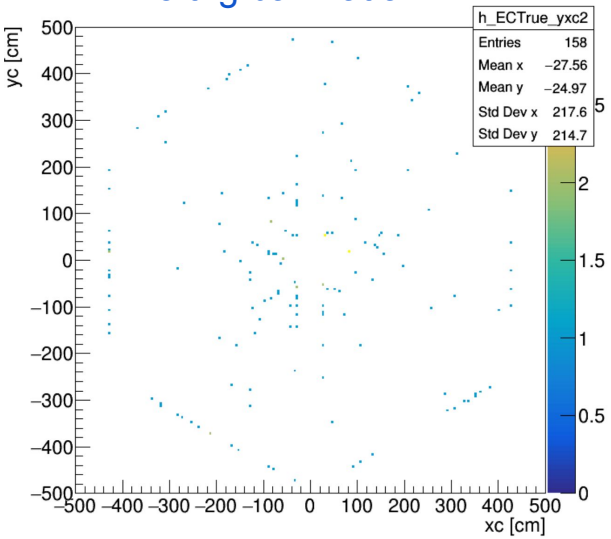
Stage 1 distributions

Validation of PCal/EC

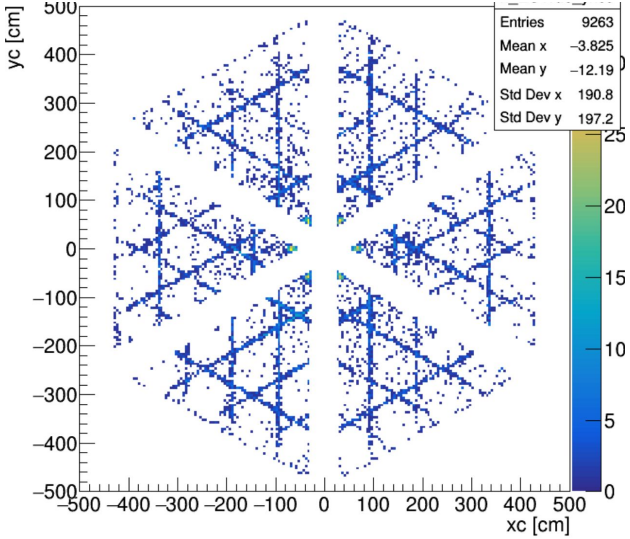
In GEMC, throw e- on PCal/EC with uniform phase space cos(theta), phi, momentum, if e- entered the detector volume, then check:

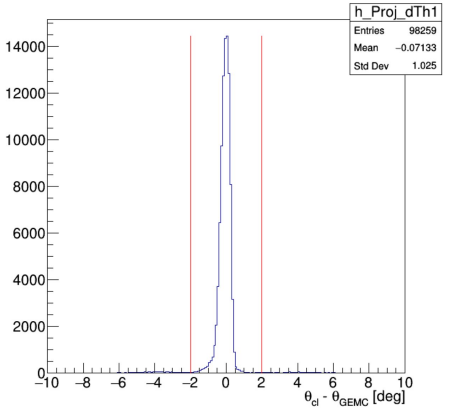
1) Is there a trigger bank in the event
2) If yes, is the trigger bank has the same sector as GEMC hit?
3) If yes, is there a cluster in the trigger bank?
4) If yes how close is the position of the cluster to the GEMC entrance position?

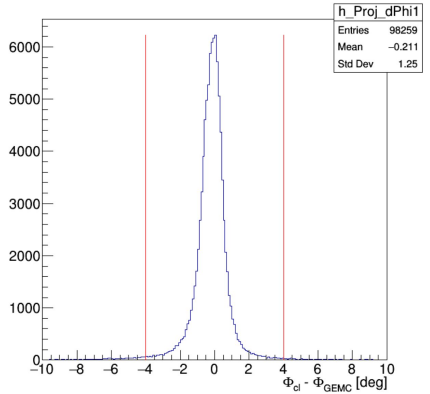
No trig bank at all



There are peaks, but no clusters







Stage 1 distributions

Validation of PCal/EC

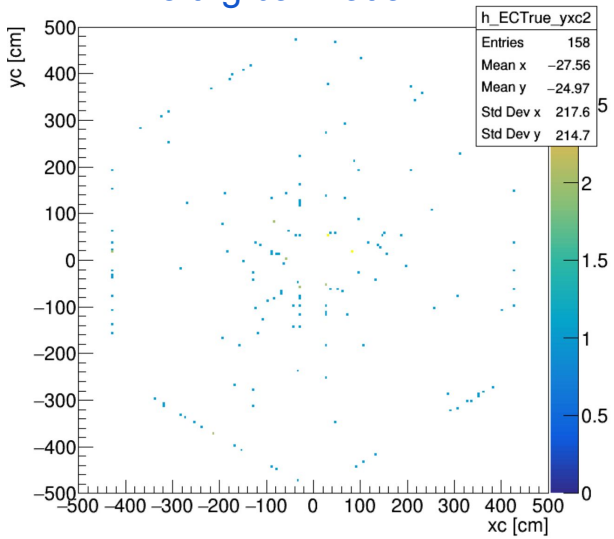
In GEMC, thr… …if e- entered the detector volu…

1) Is there…
2) If yes, i…
3) If yes, i…
4) If yes how close is the position of the cluster to the GEMC entrance position?

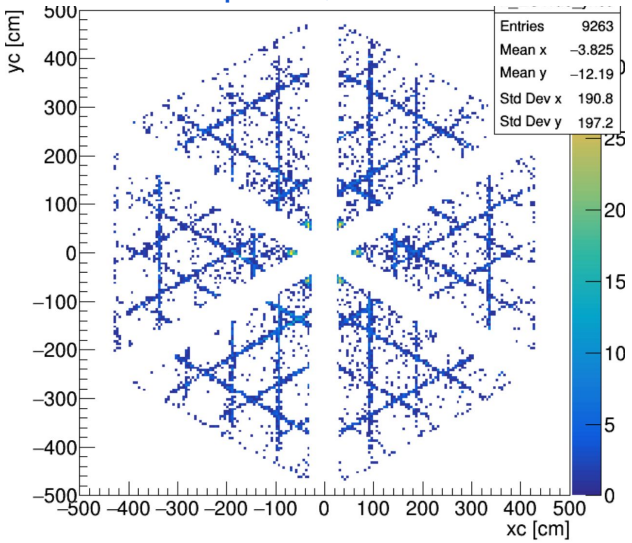
EC: Periodic inefficiency over on U, V and W strips

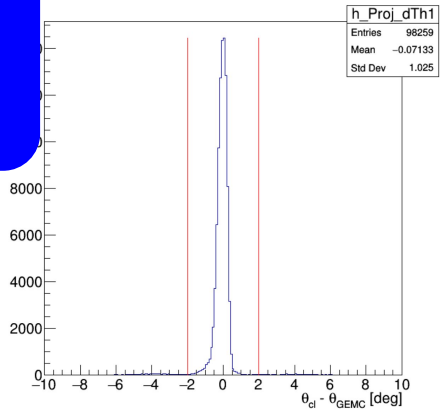
PCal: No such inefficiencies. It only had less than 1% inefficient regions just on the very edges of the detectors

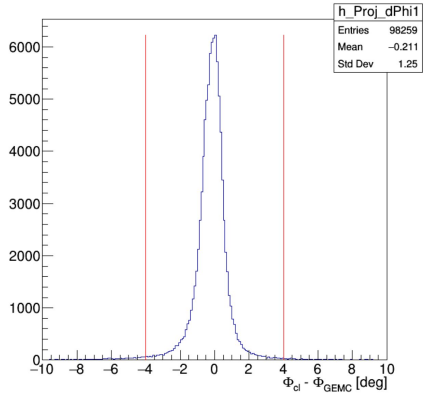
No trig bank at all



There are peaks, but no clusters







Stage 1 distributions

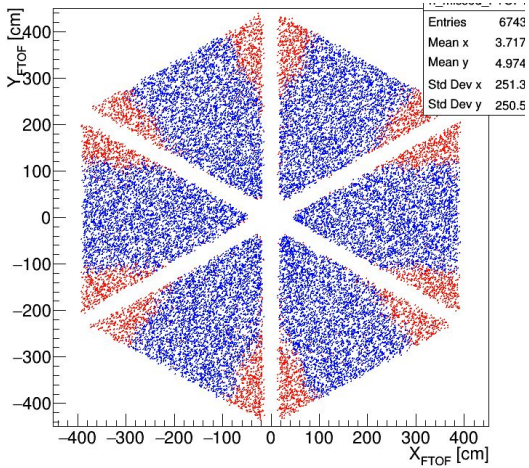
Validation of FTOF/CTOF

FTOF trg. is 62 bit word. Coincidence between left and right PMTs

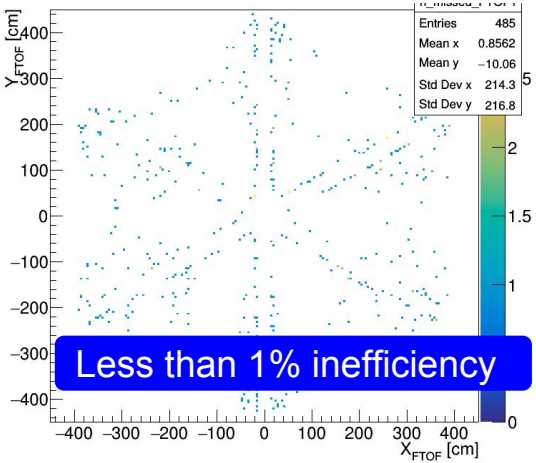
Trg. found

Trg. not found

Persistency = 4

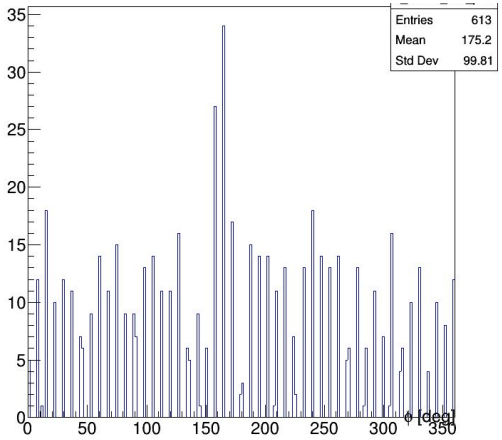


Persistency = 8



Less than 1% inefficiency

CTOF trg. is 48 bit word. Coincidence between left and right PMTs



Less than 1% inefficiency inefficiency is at borders of adjacent counters

Similarly other trigger components: before deploying trigger into FPGA, the trigger is checked/validated with GEMC

Electron trigger efficiency using recon data

To estimate the electron trigger efficiency, special random runs were taken.
The trigger is coming from the 10 KHz random generator.

The strategy is from the reconstructed data select “Good” electrons, and check whether the electron trigger bit is lit in the trigger word.

Note: in the selection of “Good” electrons, cuts are not optimized to keep as much as possible electrons, or increase the acceptance, but instead to be highly confident that the particle is electron

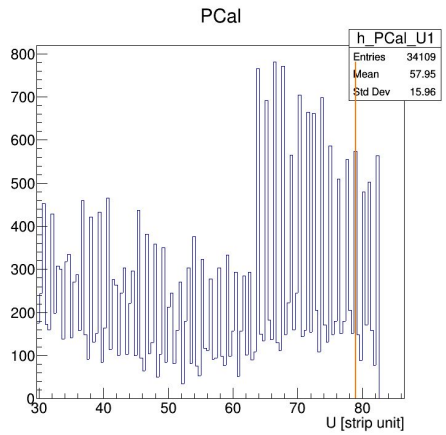
Several random trigger runs were taken since Dec, with different beam energies, Solenoid and Torus polarizations.

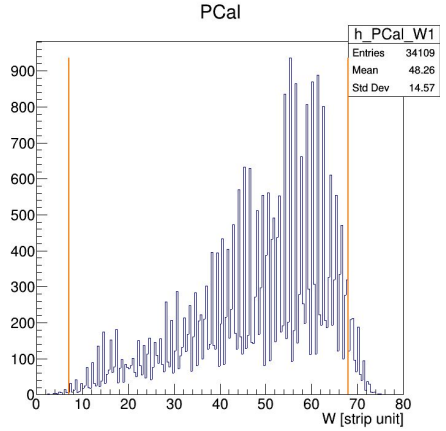
Each of taken data helped to better understand, find bugs, and improve the electron trigger

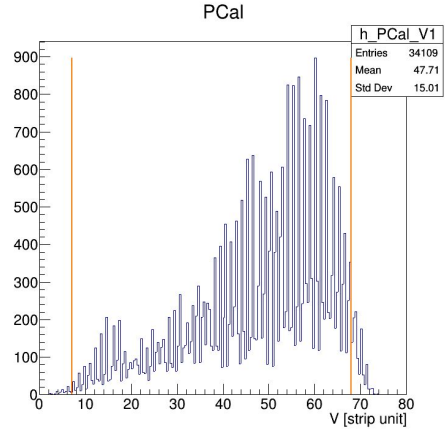
A lot of thanks to FX, for cooking as quickly as possible these data!

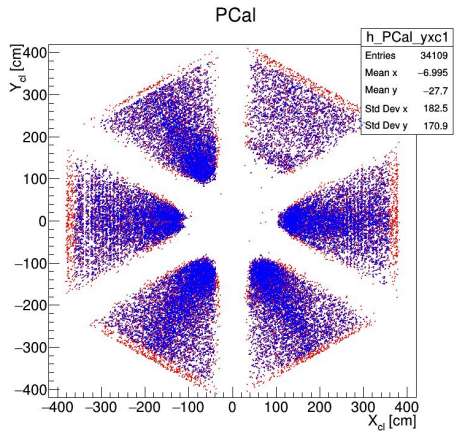
Fid. cuts

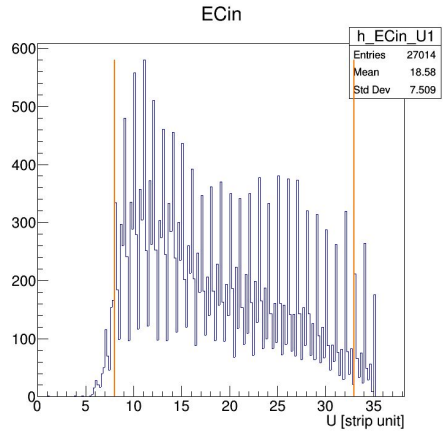
Making sure electron hit the PCal/EC not too close to edges

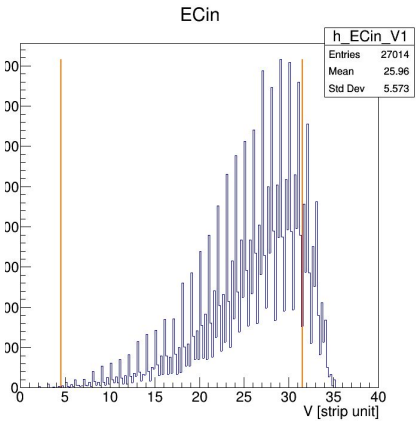


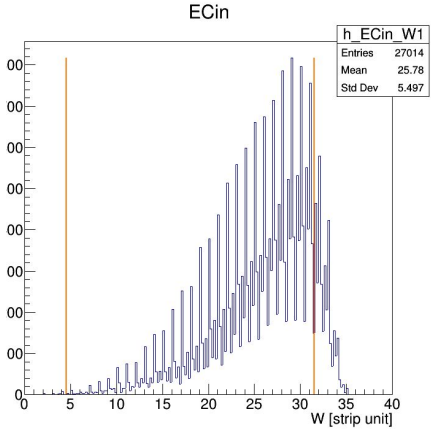


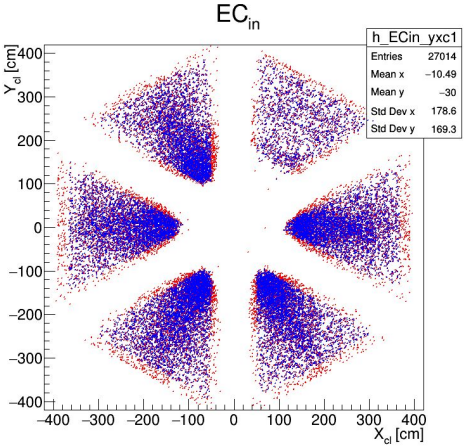








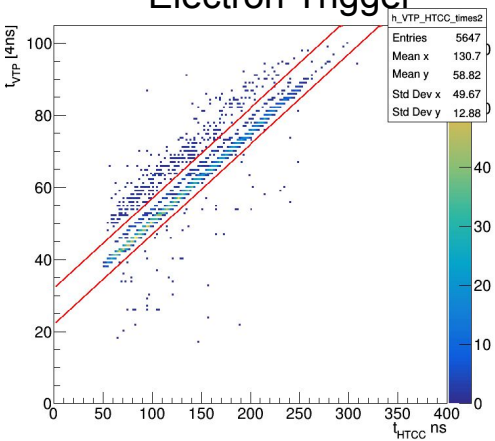




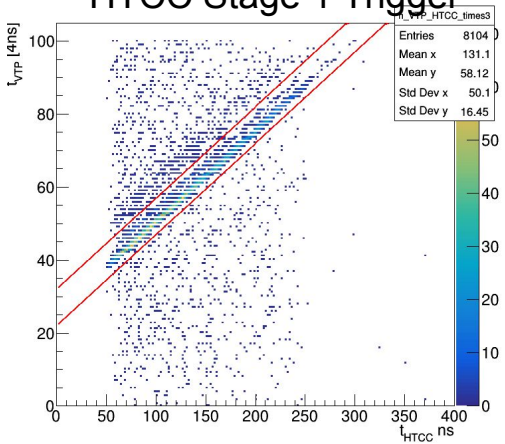
In the readout we have VTP triggers with a 4ns precision for a 400 ns time interval

Dec. runs

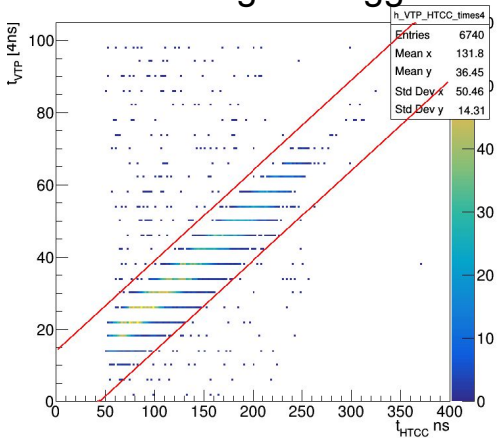
Electron Trigger



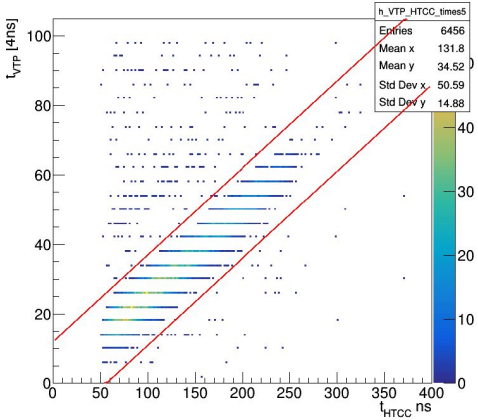
HTCC Stage 1 Trigger



PCal Stage 1 Trigger



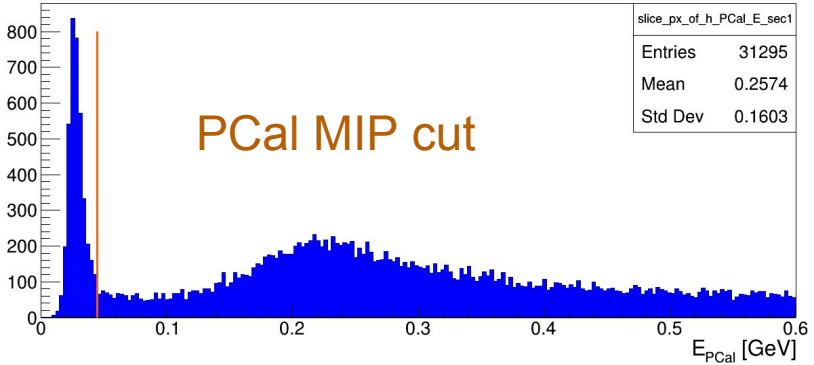
EC Stage 1 Trigger



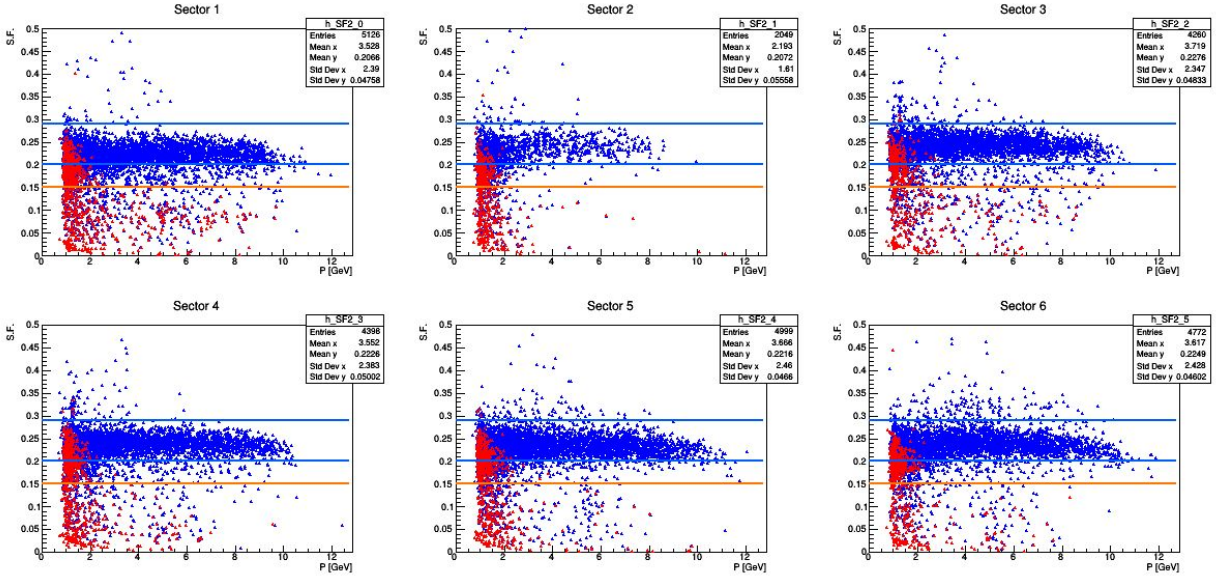
Red lines indicate correlation boundaries, i.e. if VTP trigger time is out of that region, it is counted as no trigger bit present.

For each “Good” electron, check if there is an electron trigger bit exist, Whether it’s time is in correlation with HTCC time.

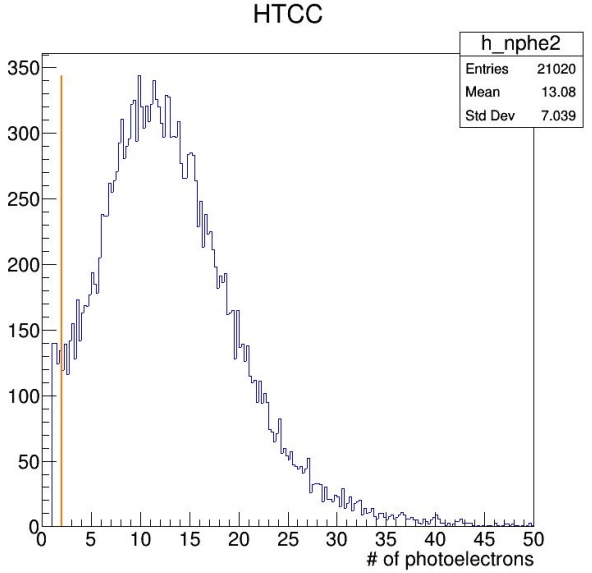
Electron identification cuts



Particle has clusters in PCal and ECin
Particle has only cluster PCal



SF > 0.2 and EPcal > 45 MeV



Dec. runs

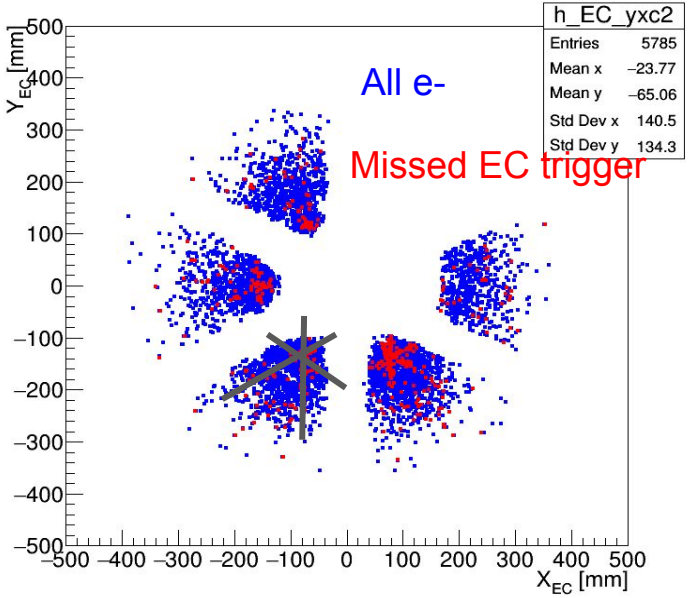
Efficiency in Dec runs

An example: Dec run showed inefficiency pattern similar to what was observed with GEMC

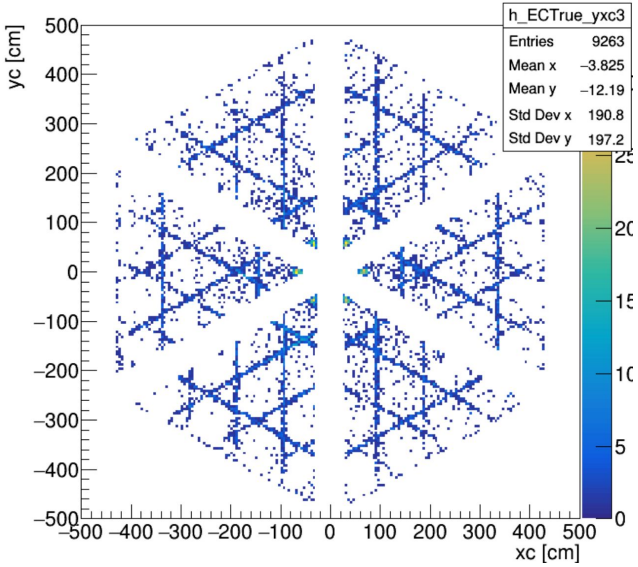
Statistics is not great in the data, but it shows similar pattern as was observed before studying trigger efficiency through GEMC

GEMC showed close to 100% for HTCC and PCal similar to data

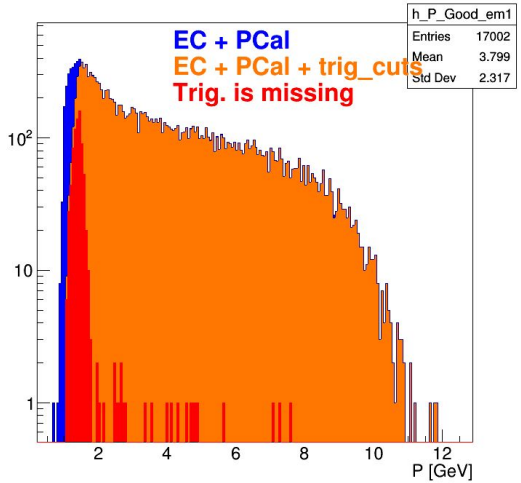
A bug was found and fixed, before starting January runs in the clustering code

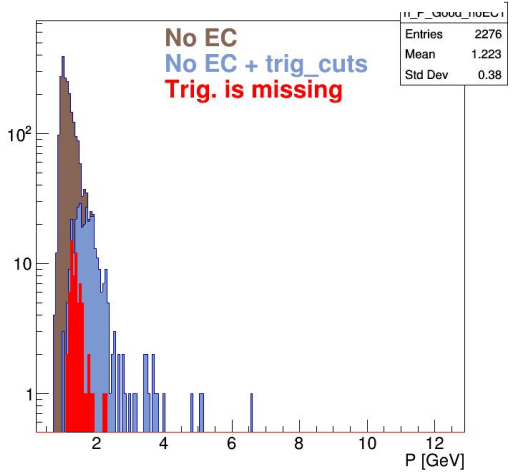


Inefficiency from GEMC

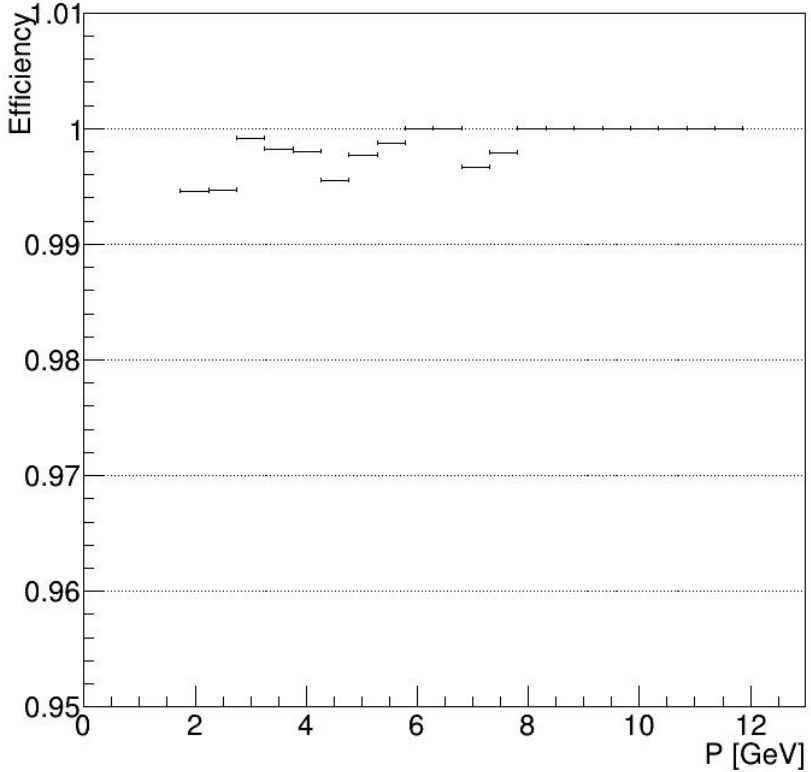


Electron trigger efficiency





This is not the most recent e- trigger, No DC segment in this



Summary and outlook

We have a tool, to validate stage1 triggers

Before deploying to FPGA, stage1 triggers are checked/validated

A procedure is developed to validate electron trigger

Electron trigger efficiency is more than 99%

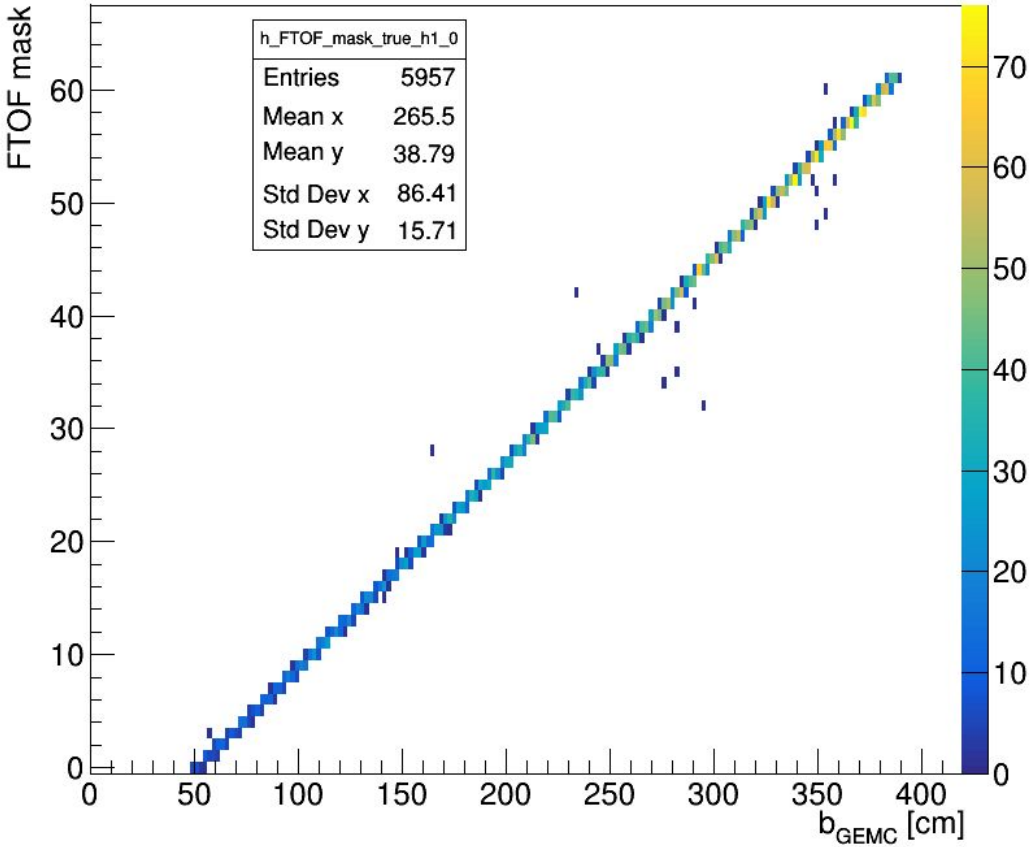
Estimate Hadron trigger efficiency: Andrea started to work on it

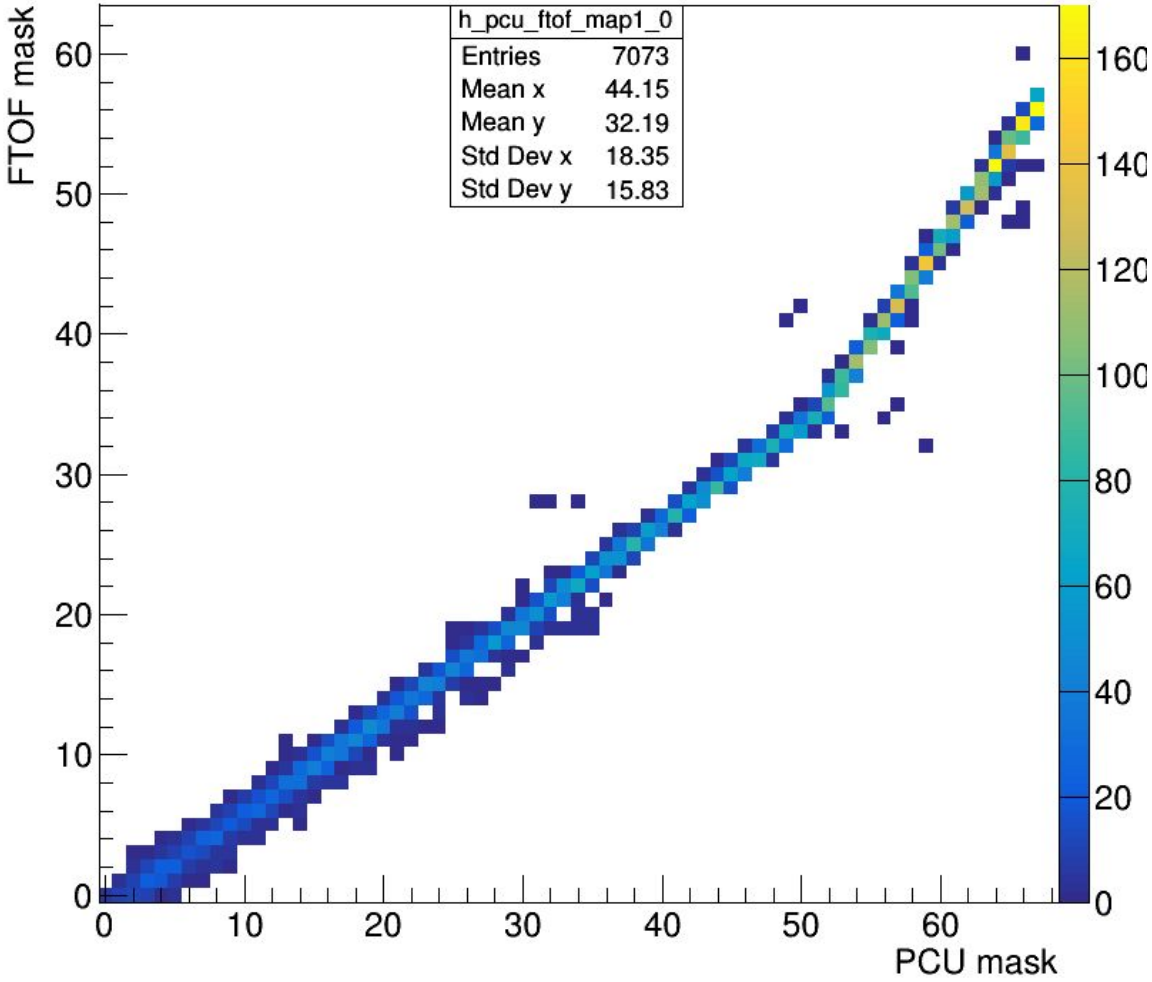
We need one more random trigger run to validate most recent change in electron trigger.

Simulate stage 2 triggers.

Develop an online monitoring framework for trigger related parameters, e.g. time difference between detectors, etc.

Backup slides


h_FTOF_mask_true_h1_0
Entries 5957
Mean x 265.5
Mean y 38.79
Std Dev x 86.41
Std Dev y 15.71
FTOF mask
0
10
20
30
40
50
60
0
50
100
150
200
250
300
350
400
b_{GEMC} [cm]
0
10
20
30
40
50
60
70


h_pcu_ftof_map1_0
Entries 7073
Mean x 44.15
Mean y 32.19
Std Dev x 18.35
Std Dev y 15.83
FTOF mask
PCU mask
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160