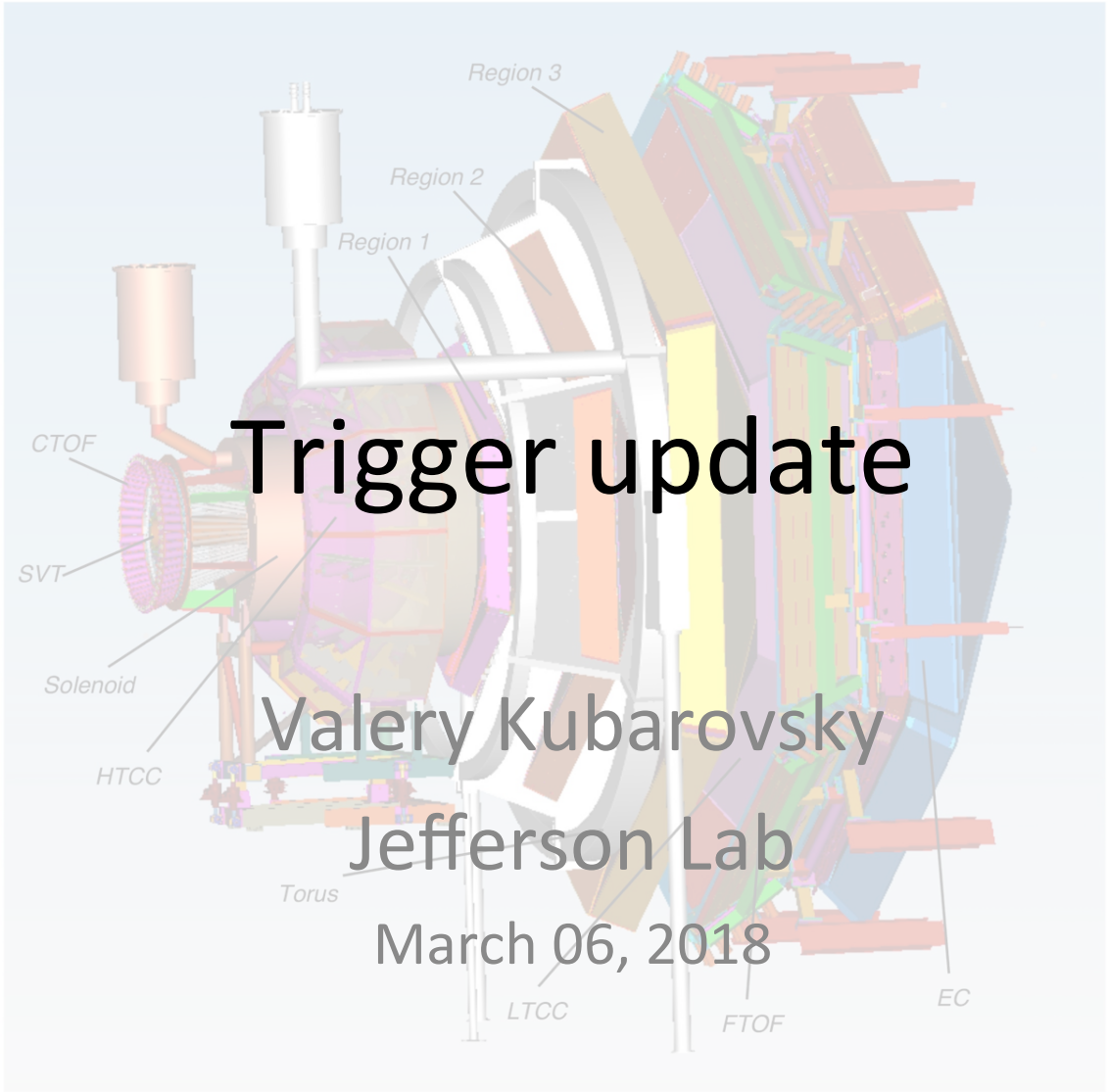

Trigger update

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Jefferson Lab

March 06, 2018

Run Group A trigger

- ***Inclusive electron scattering trigger***

Scattered electron detected in the Forward Detectors (FD): High Threshold Cherenkov Counter (HTCC), Drift Chambers (DC), Preshower Calorimeter (PCAL) and electromagnetic calorimeter (EC).

- ***Photoproduction trigger (FT trigger)***

Scattered electron detected in Forward Tagger (FT) in coincidence with charge particles in the Forward and Central Detectors.

- ***"Muon" trigger***

Select events with two muons detected in the Forward Detectors ONLY. This trigger does not require to detect scattered electron at all.

- ***Technical riggers (prescaled)***
  - Electron trigger without DC segments
  - PCALxECAL trigger with low threshold
  - Forward tagger trigger with low threshold

Electron Trigger

- **Trigger detectors**
  - High Threshold Cherenkov Counter (HTCC)
  - Preshower calorimeter (PCAL)
  - EC calorimeter (ECAL)
  - DC track segments
- **Trigger parameters**
  - HTCC – minimum number of photoelectrons >2
  - PCAL – minimum cluster energy > 60 MeV
  - ECAL – minimum cluster energy > 10 MeV
  - PCAL+ECAL – sum of the energy deposition > 350 MeV
  - DC – number of reconstructed segments in the sector in R2 and R3 >3

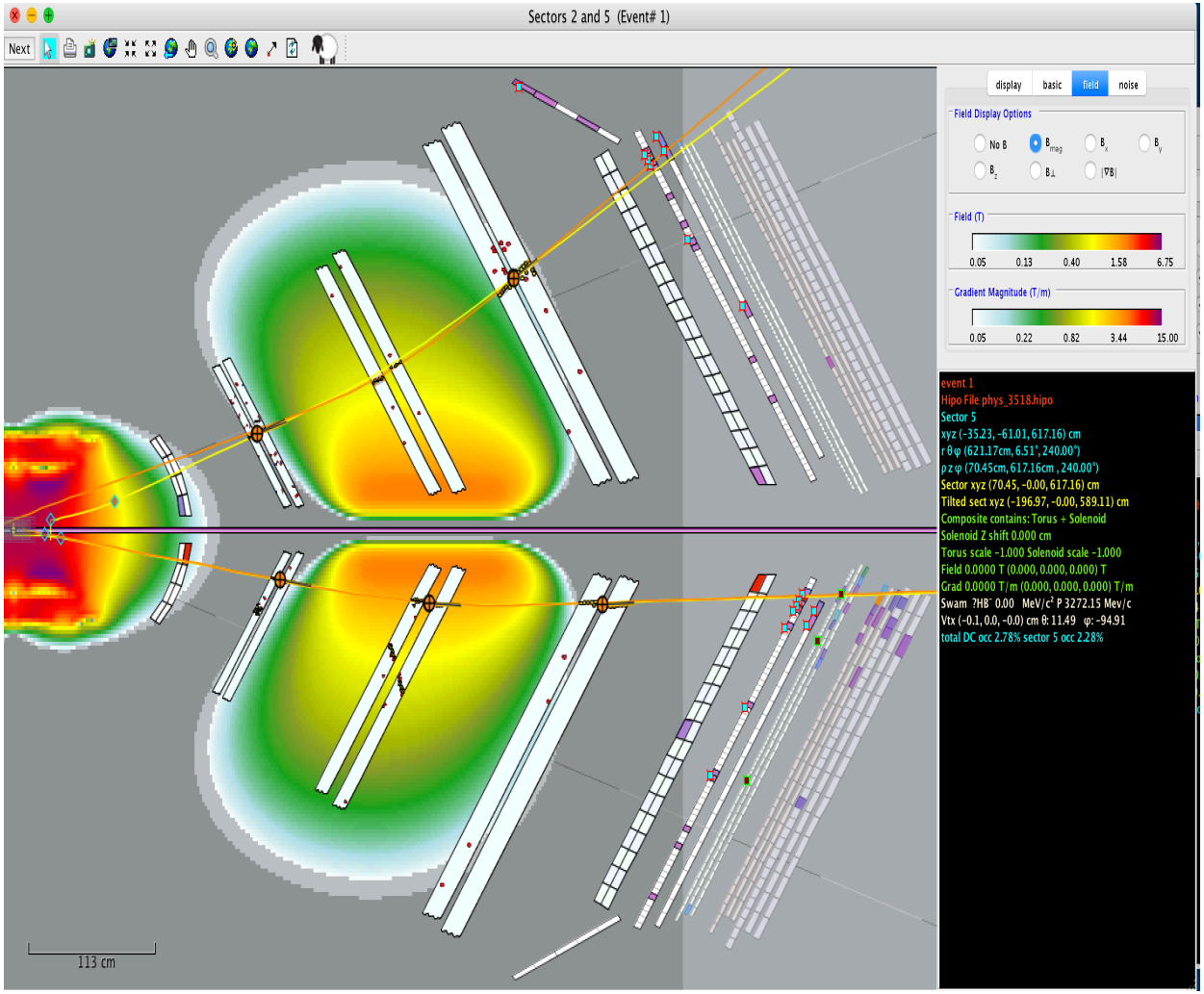
Forward Tagger Triggers

- **Trigger detectors**
  - Forward tagger calorimeter (FTCal)
  - Forward tagger hodoscope (FTHodo)
  - Forward time of flight (FTOF)
  - Preshower calorimeter (PCAL)
  - EC calorimeter (ECAL)
  - Central time of flight (CTOF)
  - DC track segments
- **Trigger parameters**
  - Cluster energy in forward calorimeter [0.3-4.0] GeV
  - Hits in two layers of FTHodo matching the FTCal cluster position
  - PCAL cluster energy > 15 MeV
  - Hits in FTOF matching PCAL U-strips
  - Hits in CTOF detector
- **Trigger configurations**
  - FTCalxFTHodo coincidence with FTOFxPCALxUstrips in two CLAS sectors
  - FTCal(0.3-8.5] GeV xFThodo coincidence with FTOFxPCALxUstrips and CTOF (prescaled)

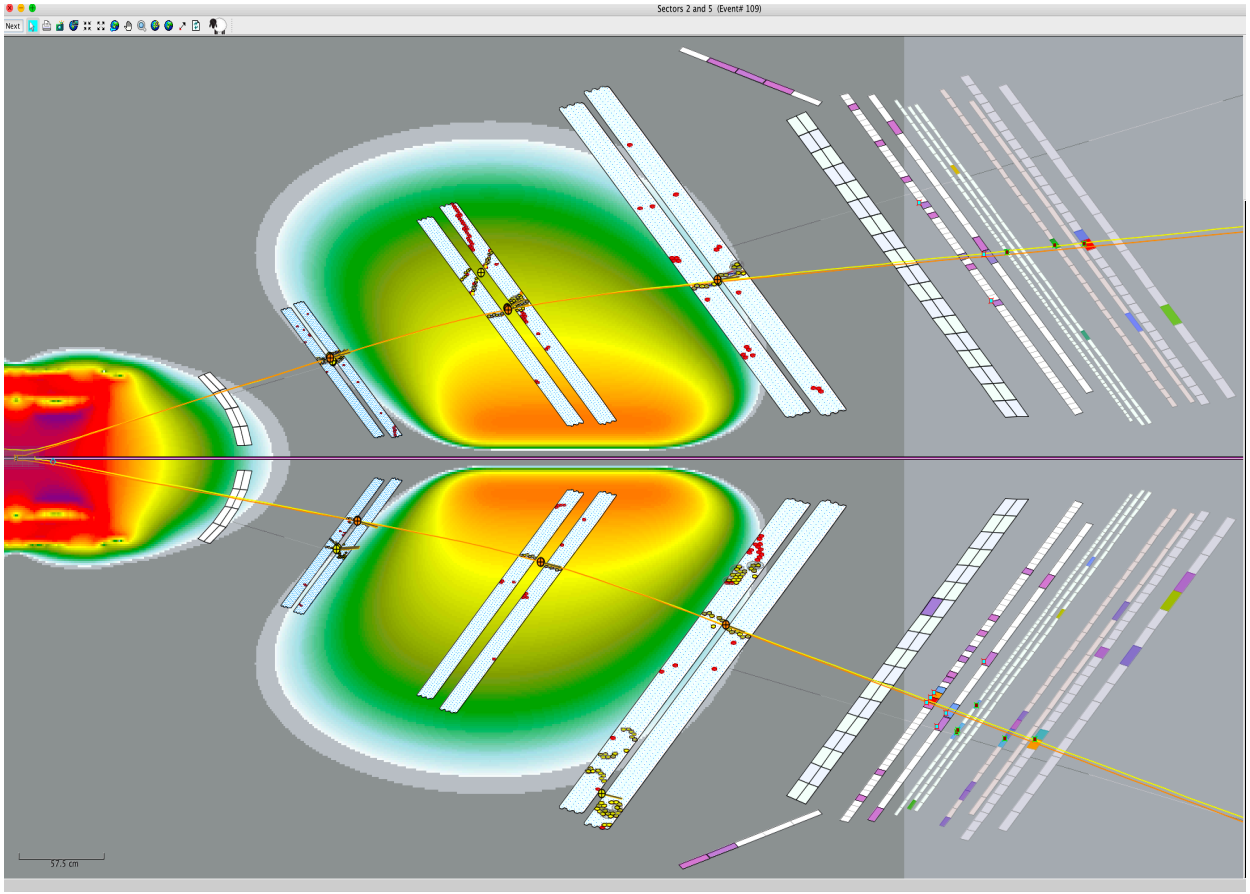
“Muon” Trigger
$J/\psi \rightarrow \mu^+\mu^-$ decay

- **Trigger detectors**
  - Preshower calorimeter (PCAL)
  - EC calorimeter (ECAL)
  - DC track segments
- **Trigger parameters**
  - PCAL cluster energy [15-60] MeV
  - ECAL cluster energy [40-120] MeV
  - Hits in FTOF matching PCAL U-strips
  - DC segments in R2 and R3
- **Trigger configuration**
  - FTOFxPCALxUstrips in two CLAS opposite sectors

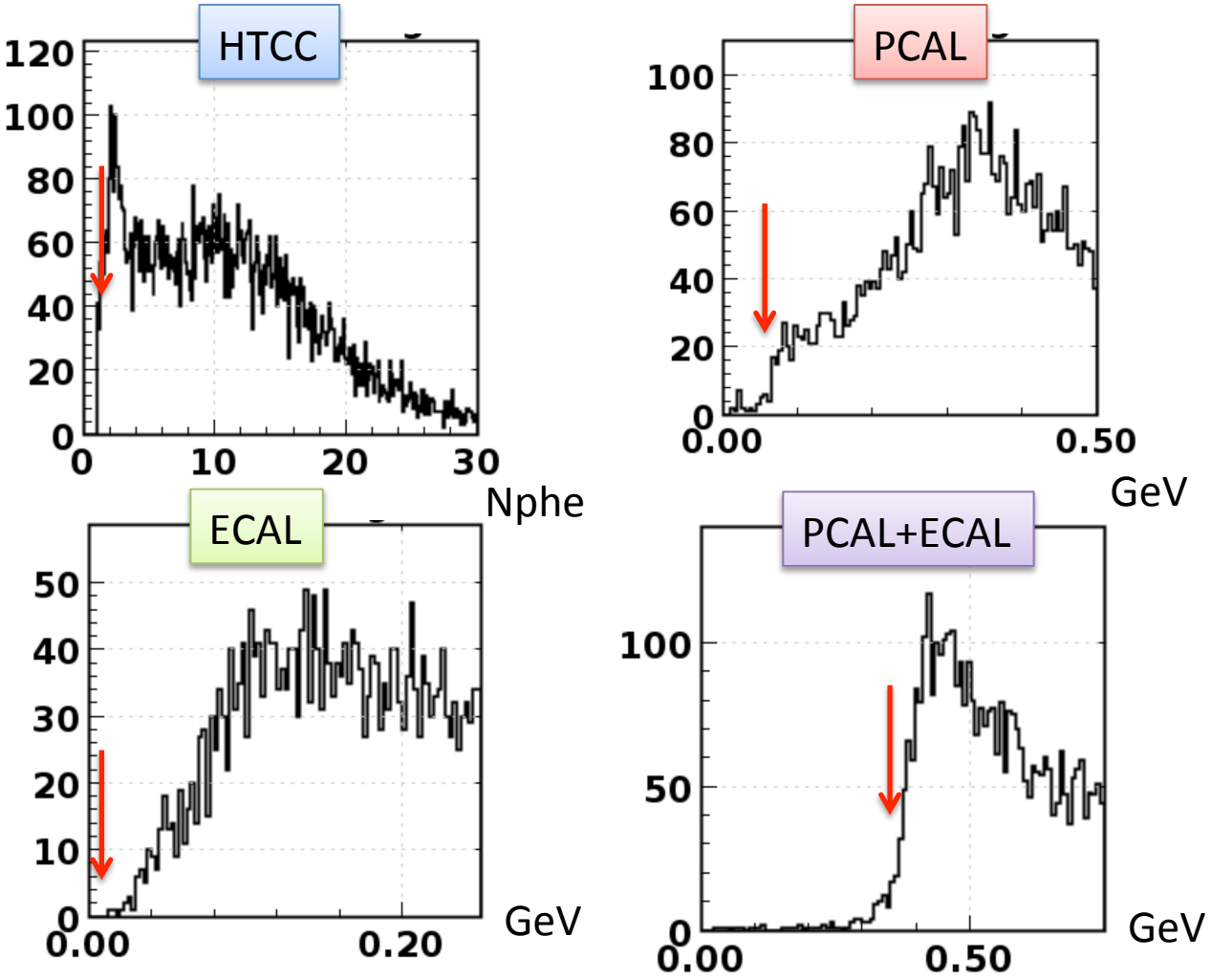
Electron inbending



“Muon” Trigger
two tracks in opposite sectors



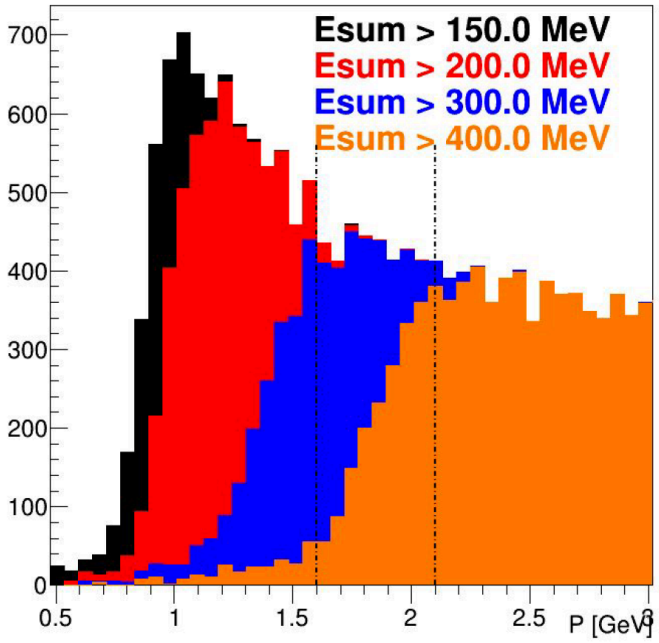
Electron Trigger

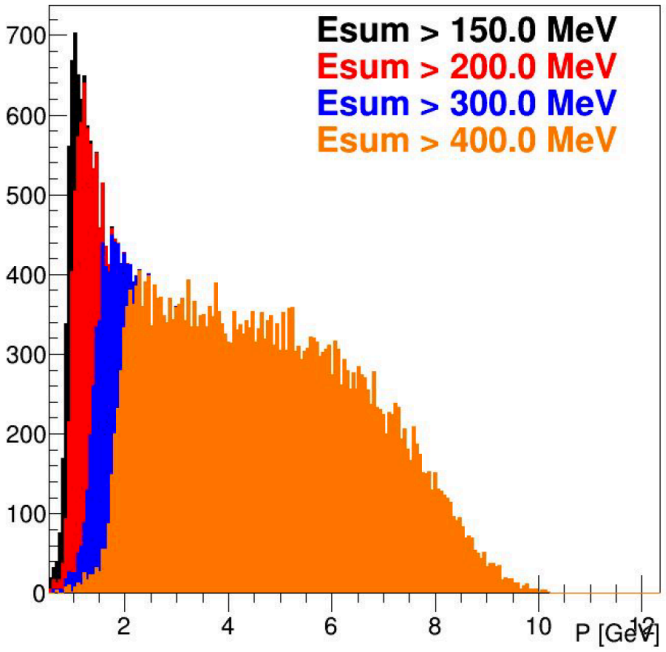


Electron Momentum with different ESUM=PCAL+ECAL cuts

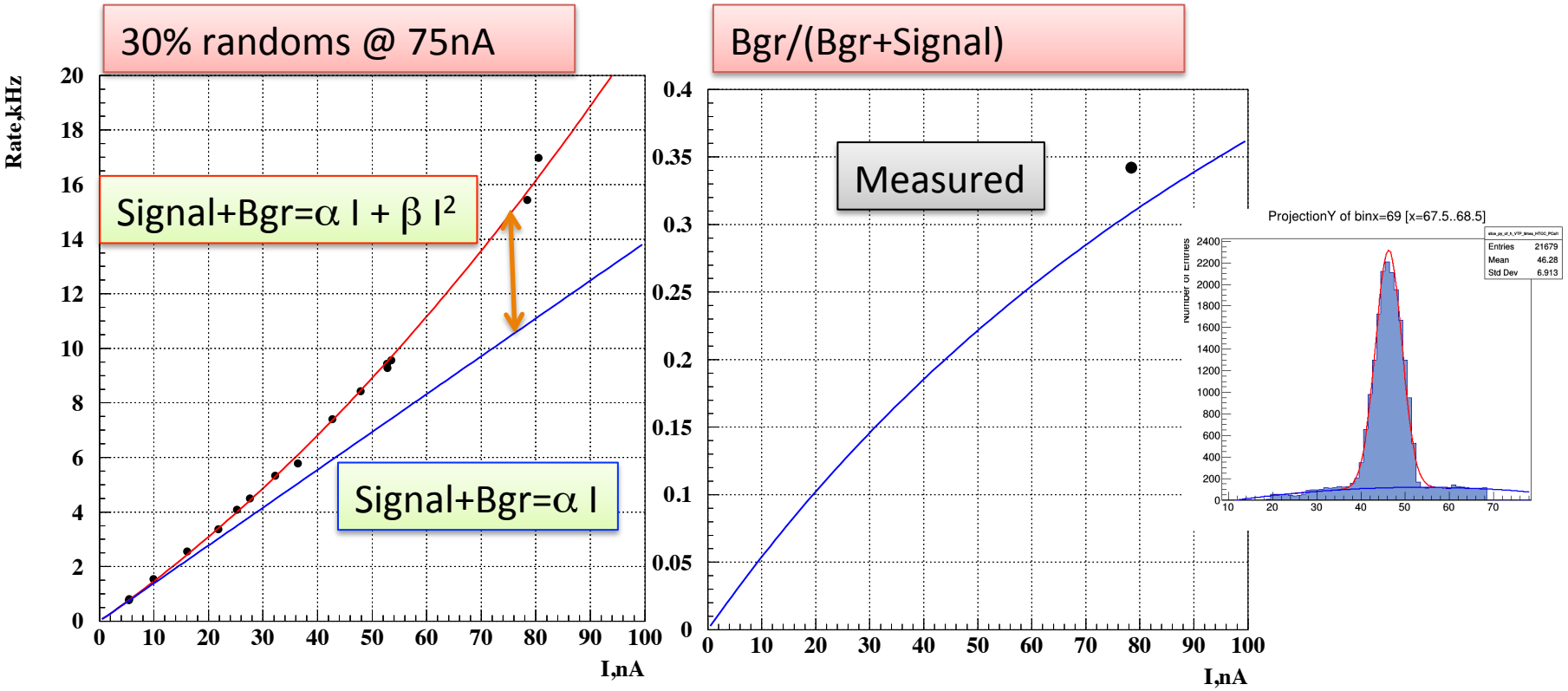
Run 2667: Esum > 150 MeV, E_EC > 10 MeV, E_PCal > 60 MeV || E_PCal > 150 MeV
Select “Good” electron, then apply different trigger condition cuts on clusters form trigger banks

NOTE: in this particular run sec4 (PCal) and sec5 (EC) VTP banks are corrupt, so this data represents only sectors 1, 2, 3, and 6



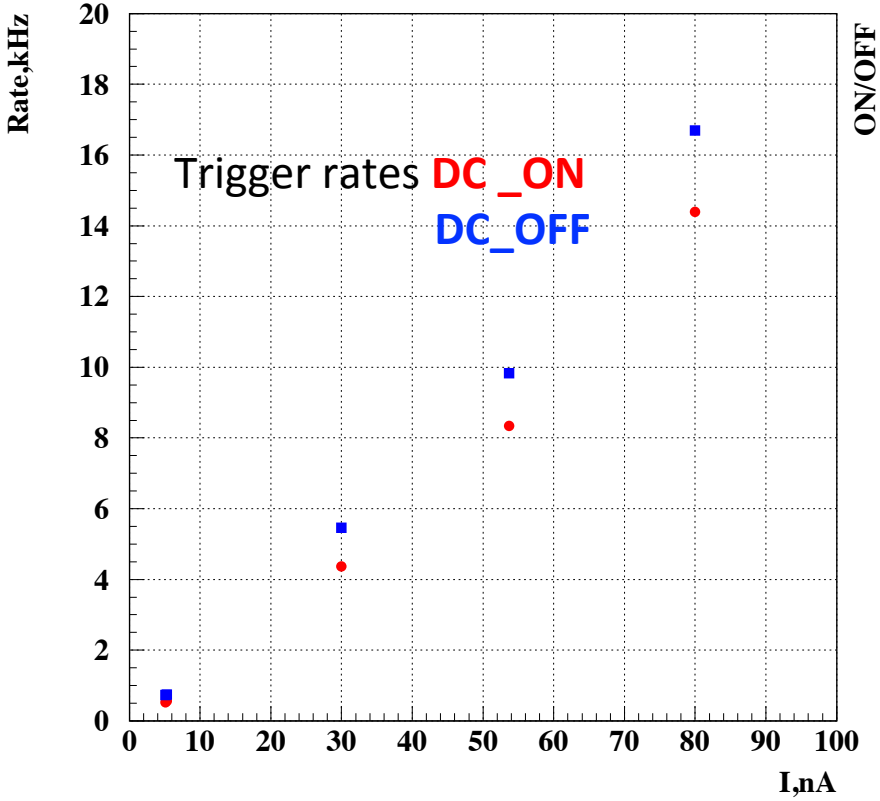


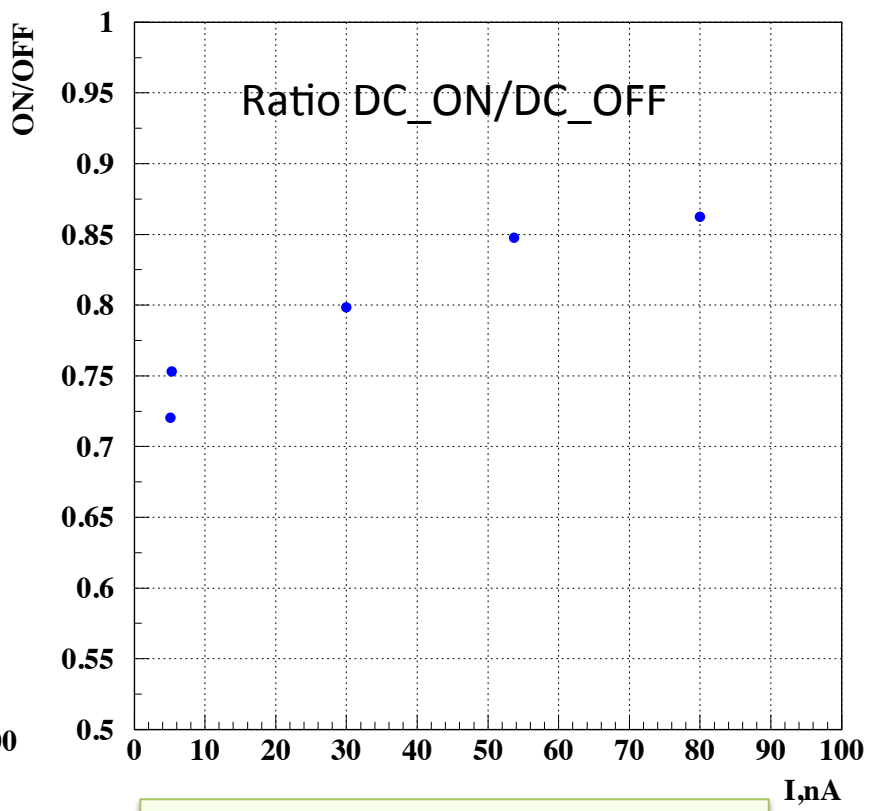
Electron Trigger Rate vs Beam Current



- Trigger rate @75nA is 15 kHz
- 30% random coincidence @75 nA
- 15% random coincidence @30 nA

Trigger rates vs Current





DC trigger gives

- 1% improvement @ 75 nA
- 20% improvement @30 nA
- DC trigger is 100% efficient

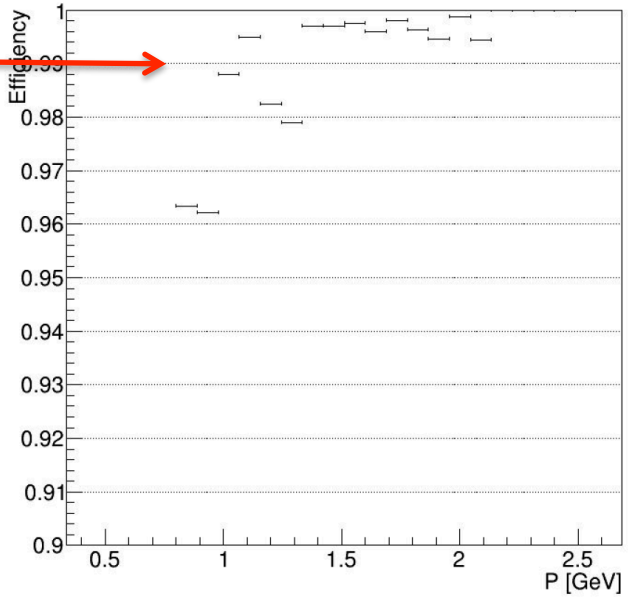
Electron Trigger Validation

Runs from Jan 25

Efficiency

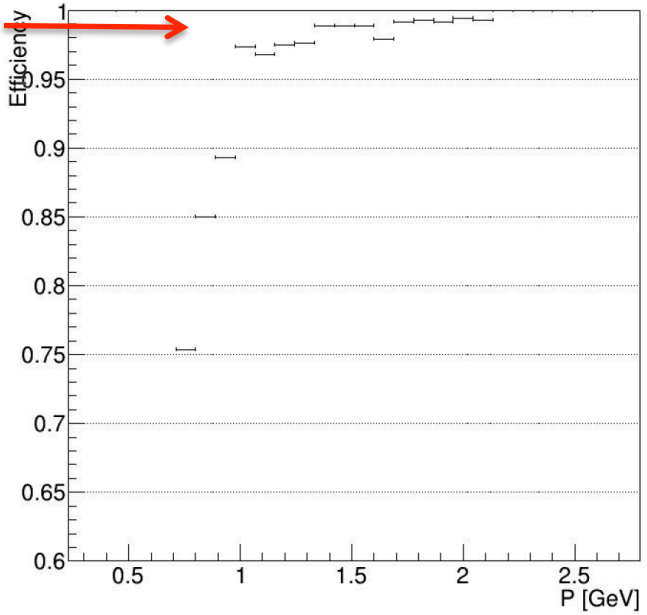
EC has cluster

99%



Combined (both categories)

99%



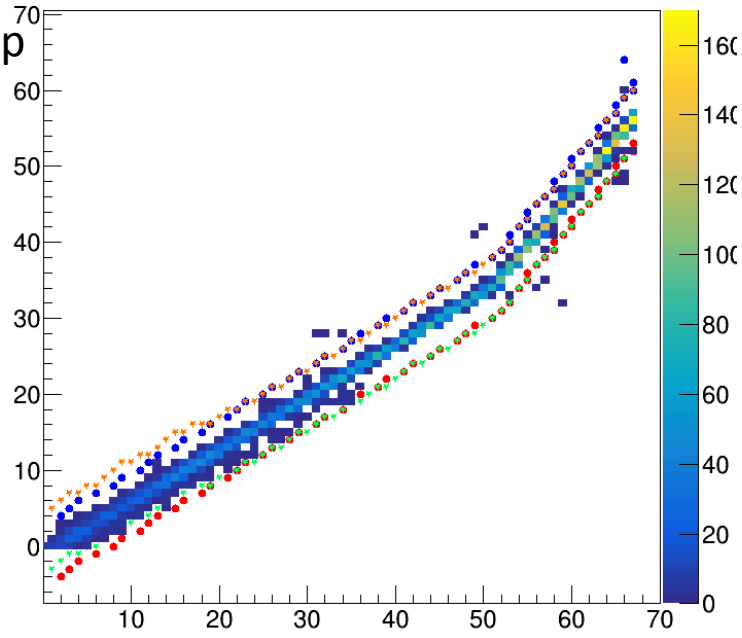
See Rafo's presentation for more details

FTOF-PCAL Ustrips matching

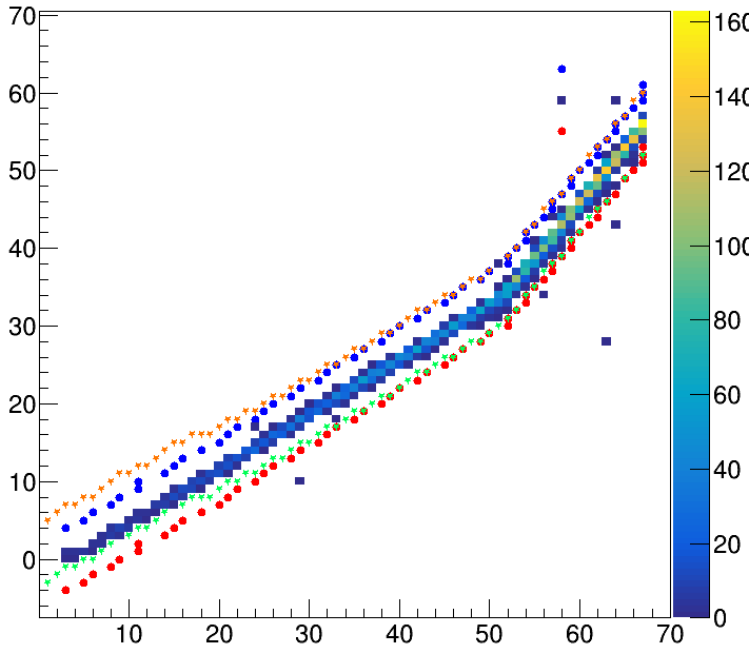
negative particles

positive particles

FTOF strip

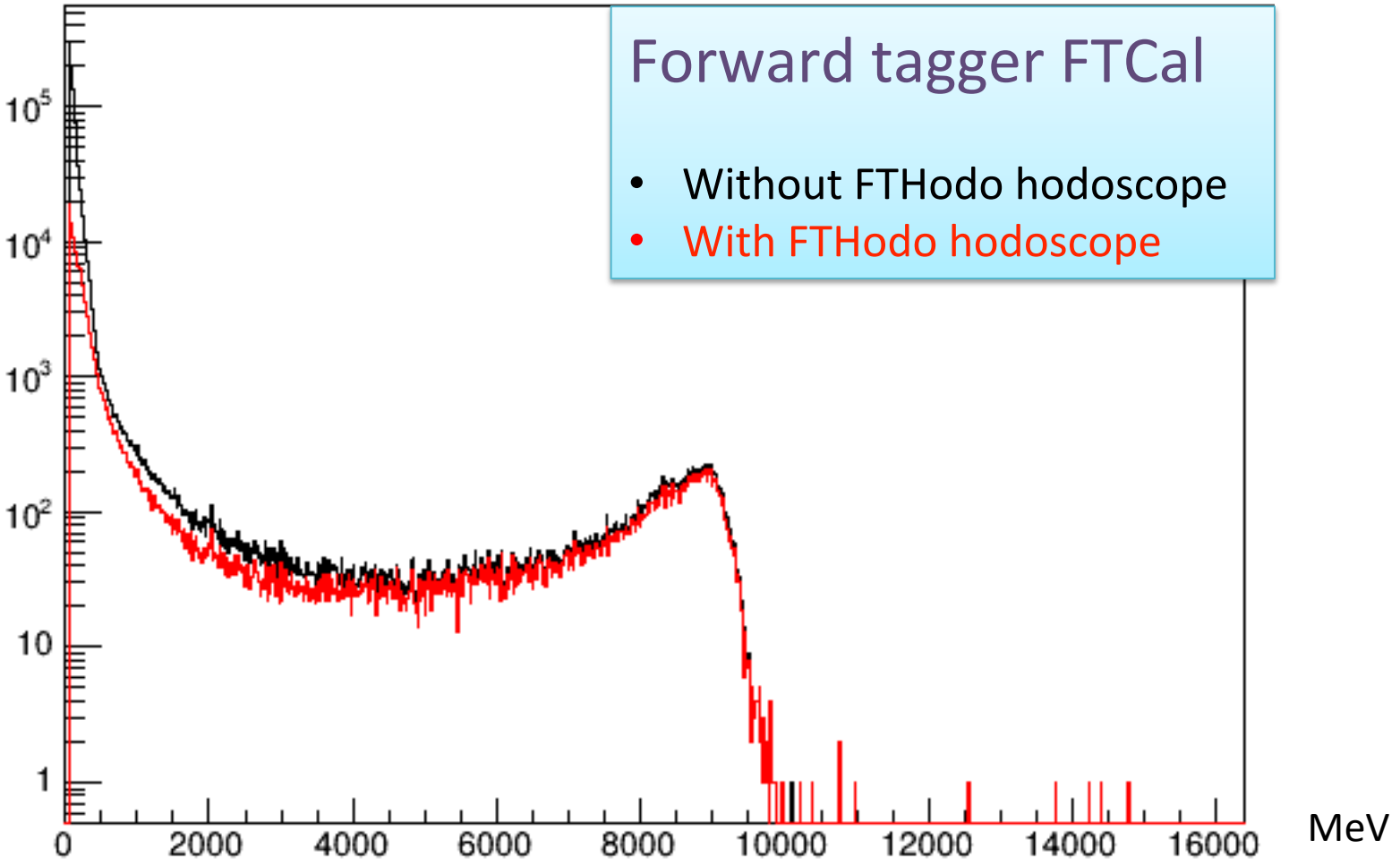


PCAL U strip

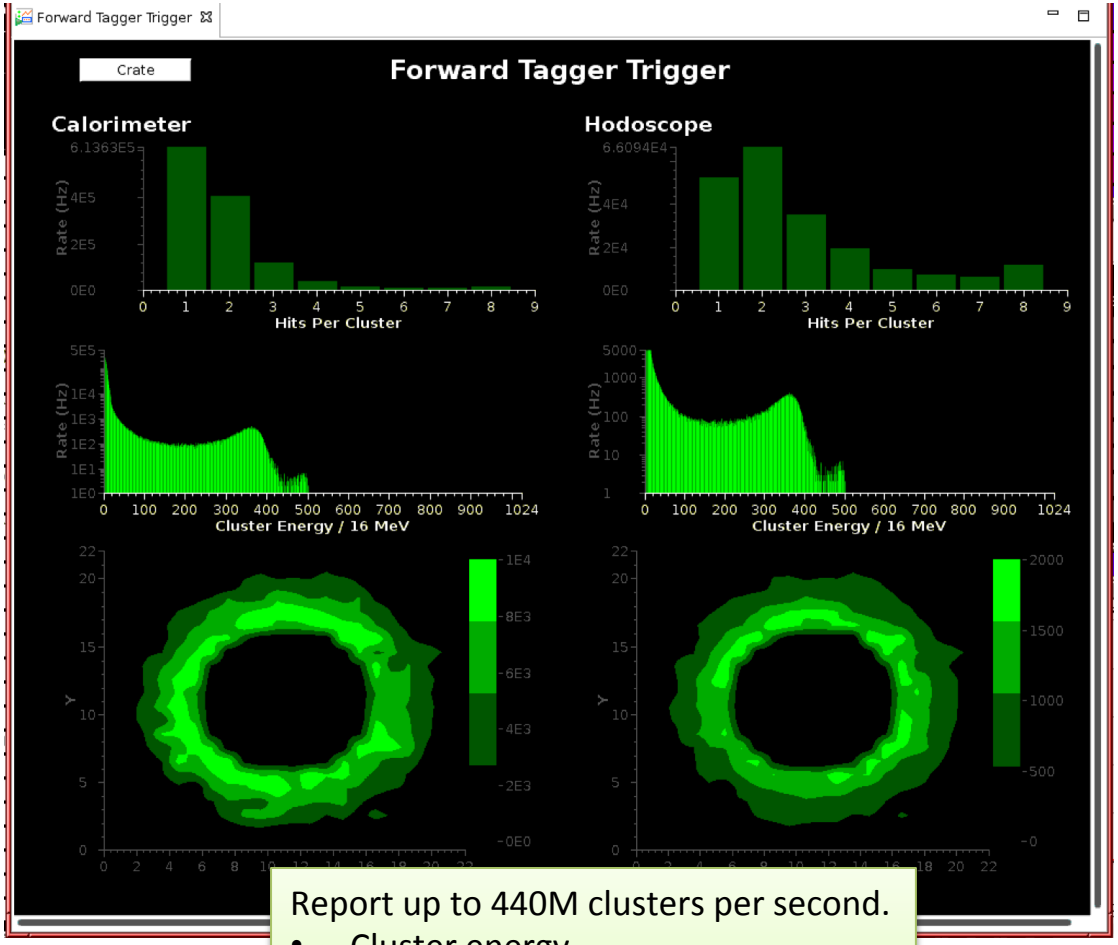


PCAL U strip

FTCal Cluster Energy Distribution



Forward Tagger Trigger Scalers



Report up to 440M clusters per second.

- Cluster energy
- Cluster coordinates
- Cluster time

Trigger Rates and Live Time

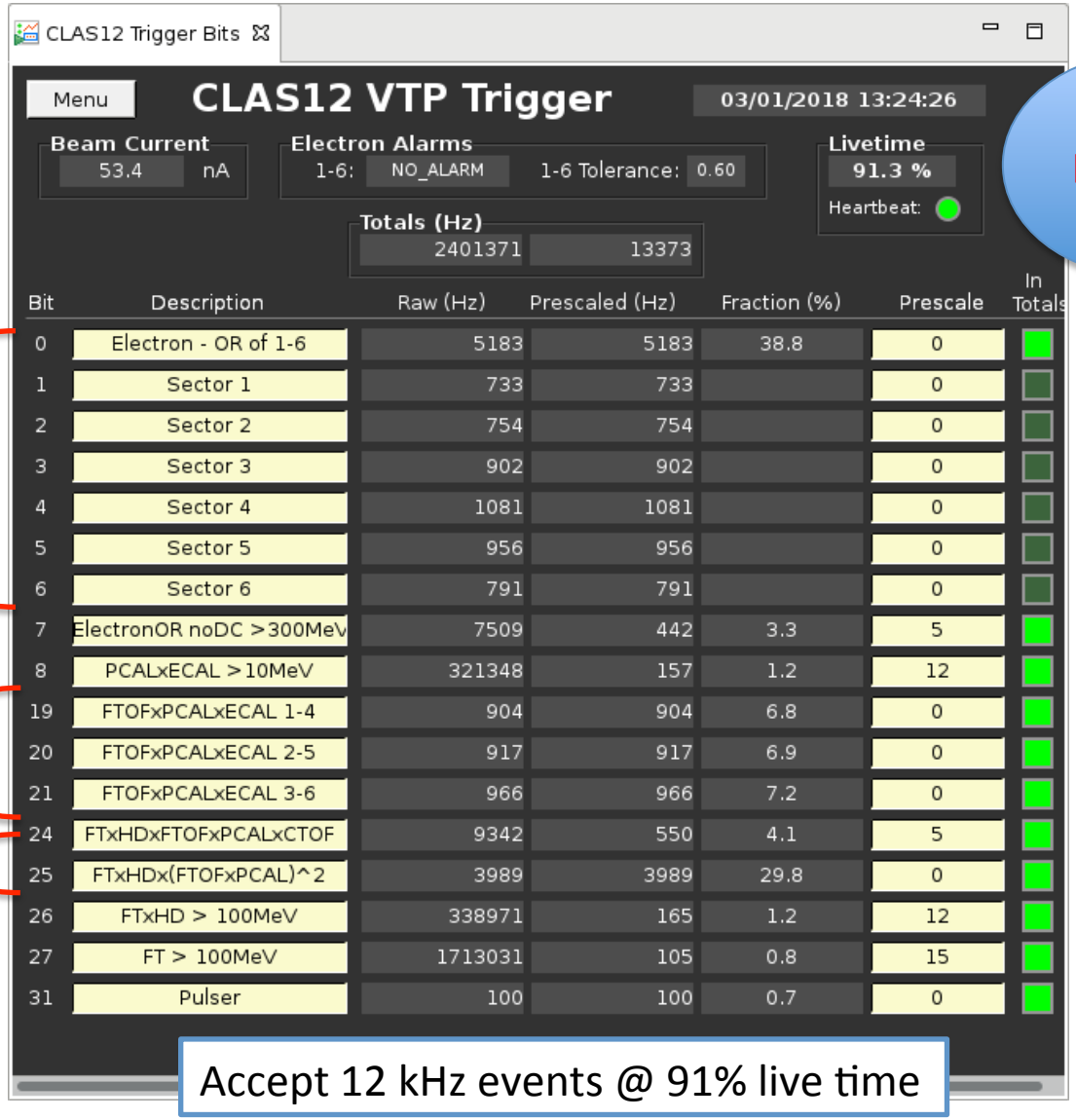
I= 50 nA

LT=91%

Electron trigger
5 kHz

Muon trigger
2.7 kHz

FT trigger
4.5 kHz



Accept 12 kHz events @ 91% live time

Conclusion

- The CLAS12 trigger system is fully operational.
- CLAS12 ***is taking data*** with three physical trigger:
  - Electron trigger
  - Forward tagger trigger
  - Muon trigger
- Electron trigger is operating since December 2017.
- 2018 upgraded trigger firmware includes
  - Geometrical matching between FTOF and PCAL U-strips
  - DC track segments in region 1 and 2
  - Maximum energy deposition in PCAL and ECAL (used in the muon trigger)
  - Central detectors CTOF and CND were added to the forward tagger trigger logic
- The electron trigger was validated and found to be at least 99% efficient
- DC trigger tested and found to be 100% efficient. Gives 15-25% improvement in the trigger rates depending on the beam current. Used in all Run Group A triggers.