Clustering algorithms and eγ Runs of the TB 2016 data

FCAL S&A meeting
14/06/17
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Outline

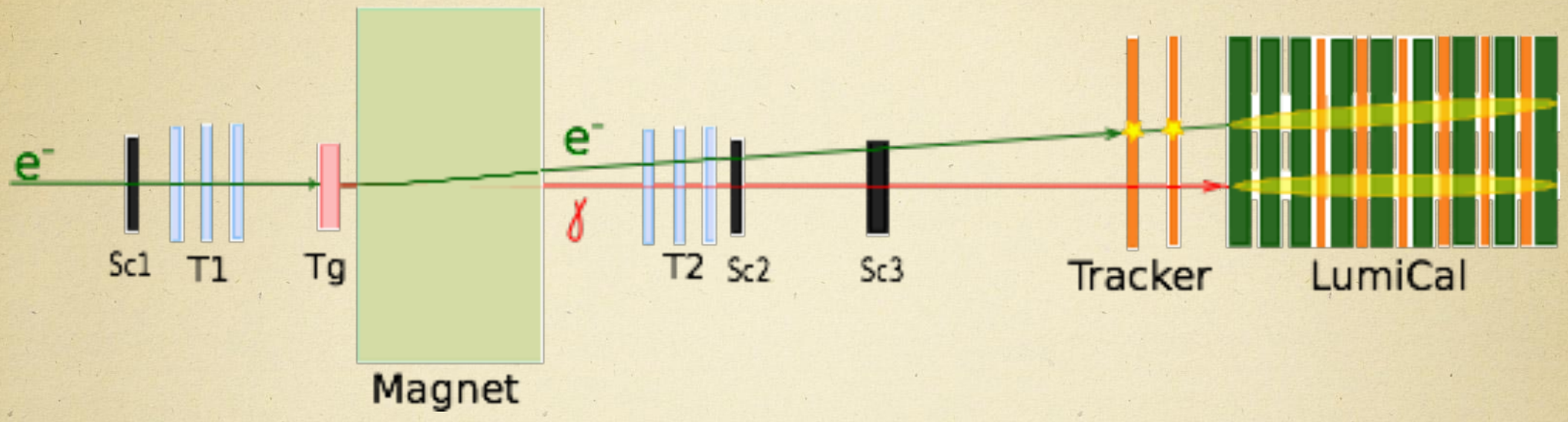
★**Occupancy** for physics runs:

- 767-786 @ 5 GeV w/ charge Divider, Low Eγ trigger

★**Different clustering algorithms:**

- **Modified k-means Clustering algorithm**
- **E clustering algorithm**
- **Linking neighboring pads for physics run:**
  - 741 @ 5 GeV w/ charge Divider
  - 771 @ 5 GeV w/ charge Divider, Low Eγ trigger

Experiment layout



Performed 3 types of studies:

- electron beam with 5 GeV, no target, no magnetic field
- electron beam with 5 GeV, Cu target, trigger Sc1&Sc2&Sc3 =>Low Eγ Trigger
- electron beam with 5 GeV, Cu target, trigger Sc1&Sc2&veto Sc3 =>High Eγ Veto

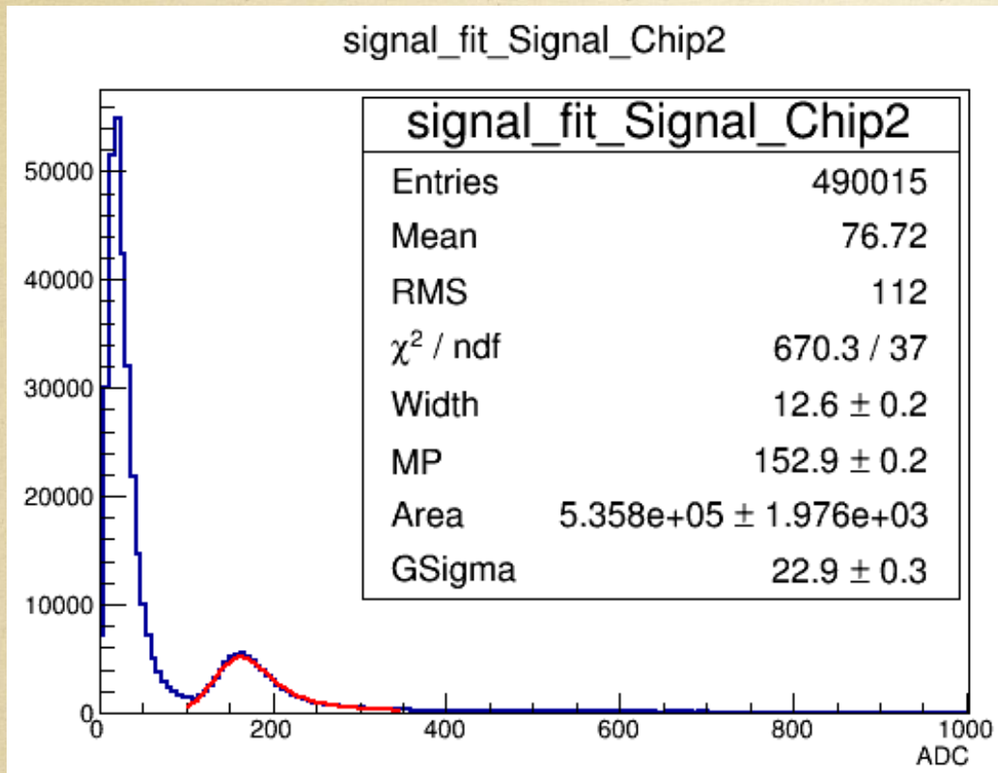
Everything was done with and without charge divider

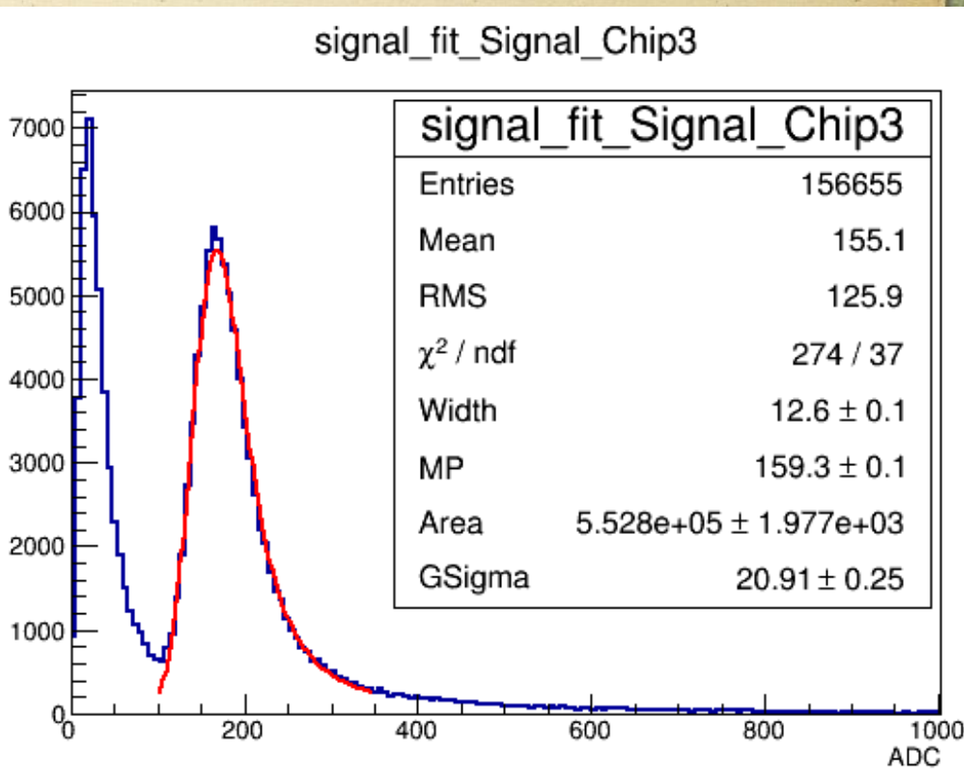
Runs 767-786 E= 5GeV

- Calorimeter w/divider
- Cu target (1.5mm) before magnet
- Low Eγ Trigger
- Cut on NN_output > 0.95

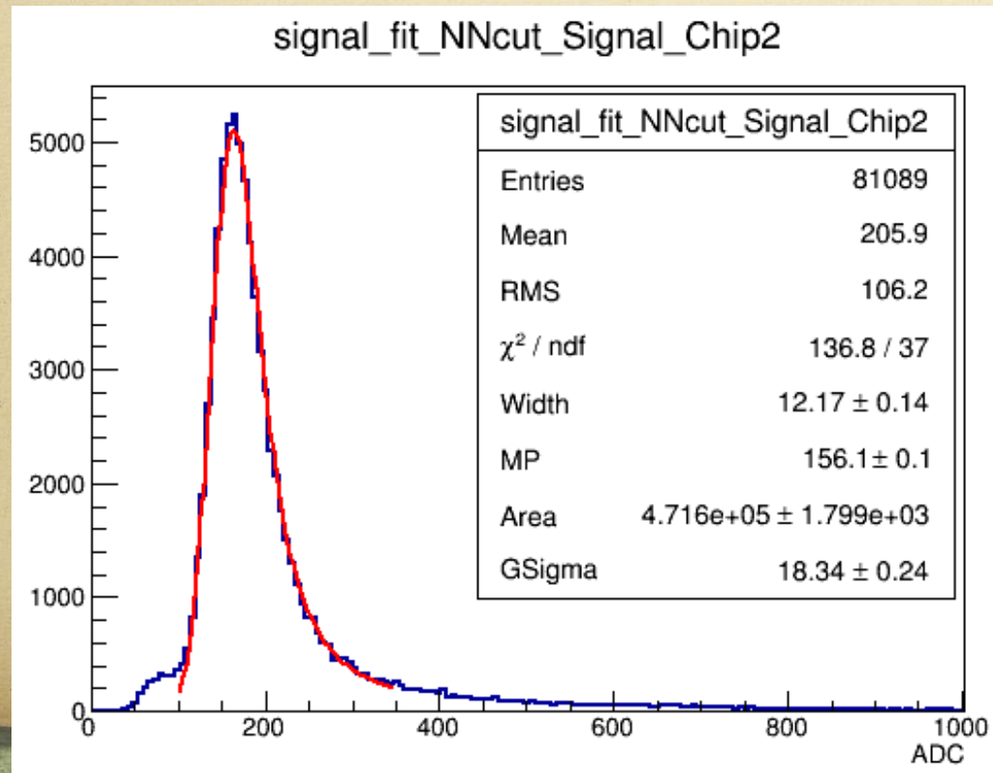
Signal in Second Tracker Plane (APVs: 2, 3). 5 GeV e^-

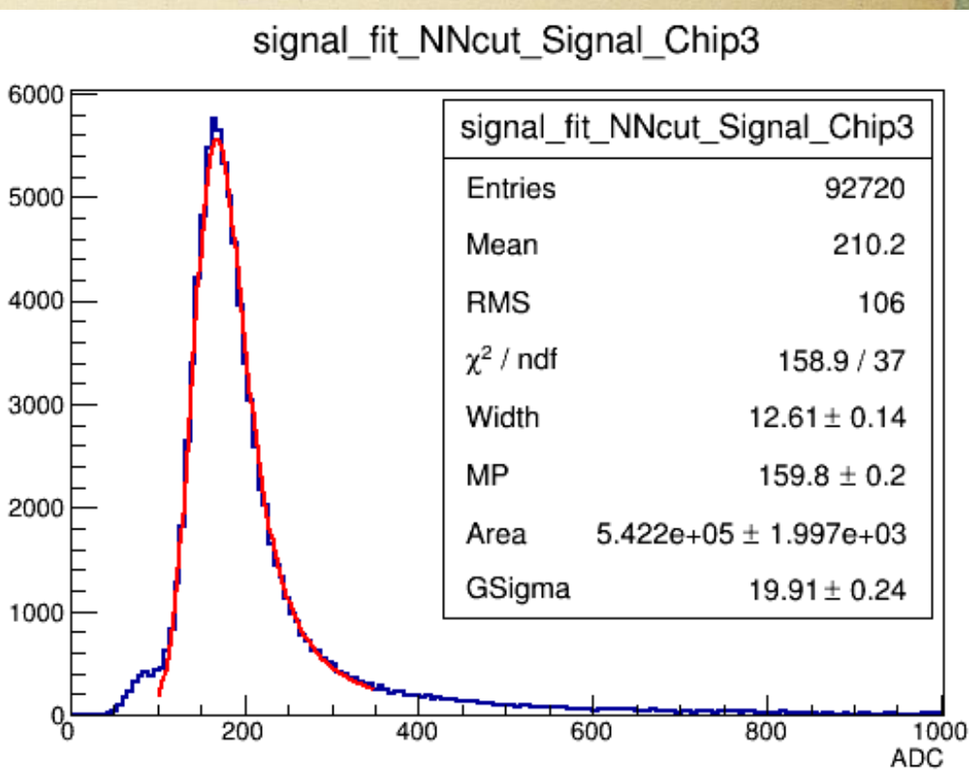
No cut





Cut on NN output: NN>0.95

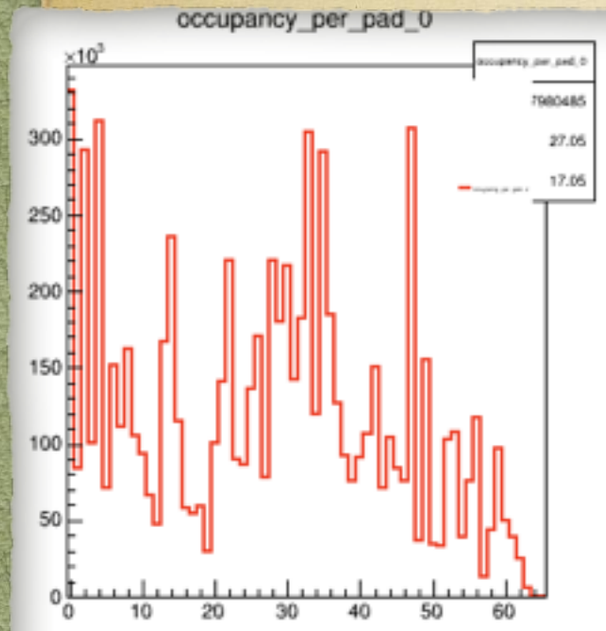


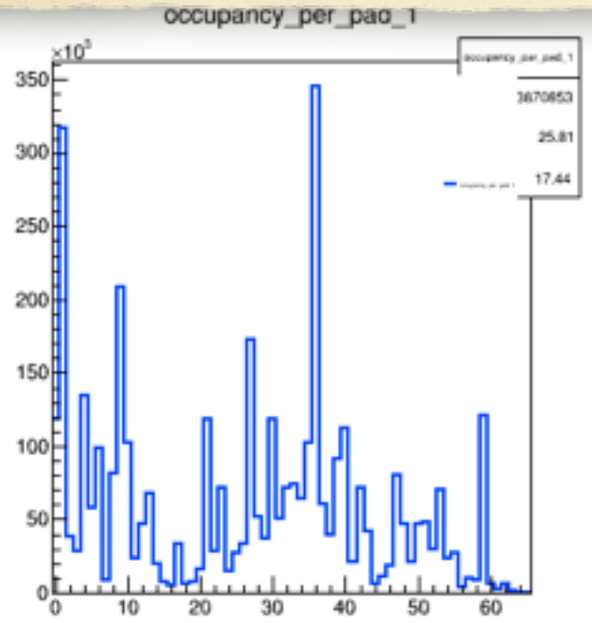


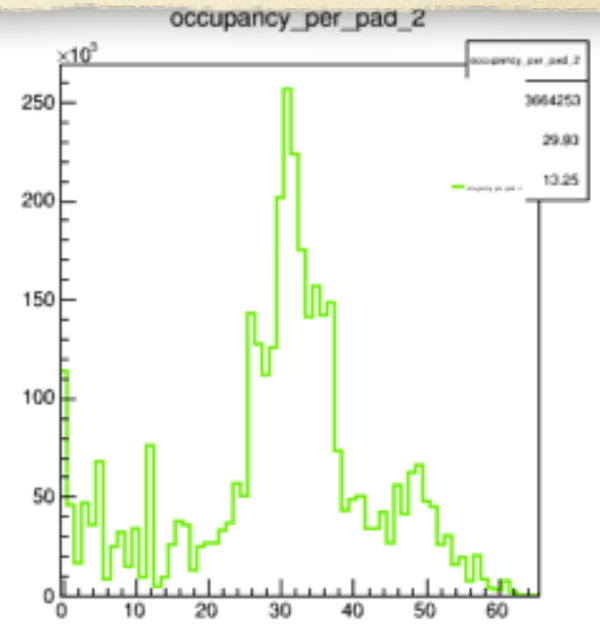
Occupancy, ~ 555k Events, E= 5GeV, Low Eγ Trigger

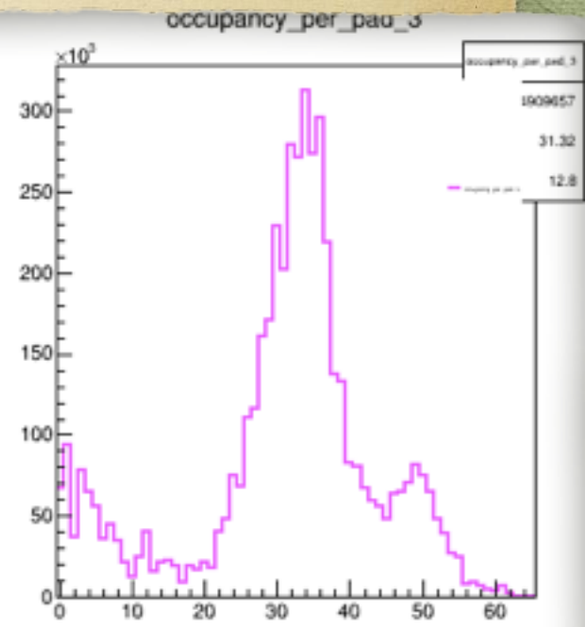
Calibration 1MIP = 160.0 ADC

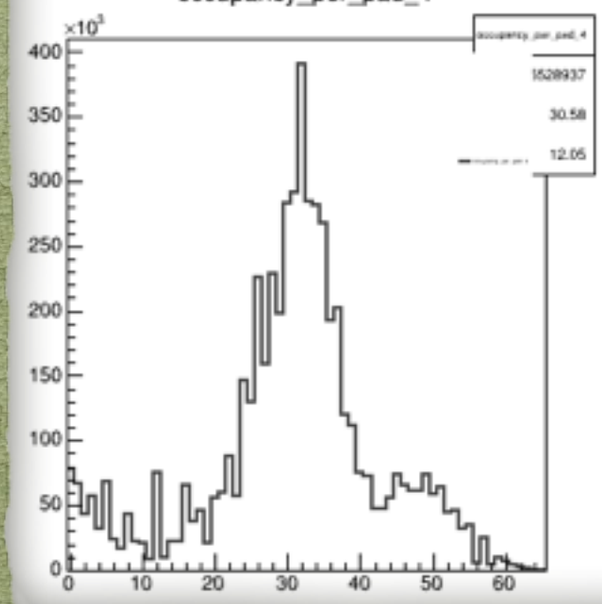
NO cuts

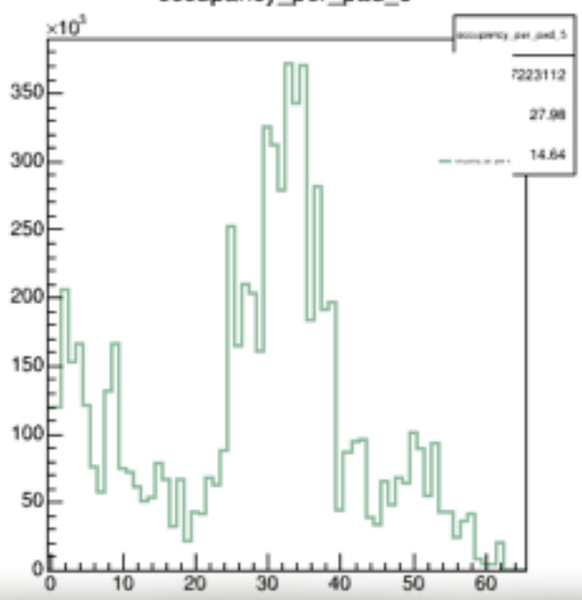


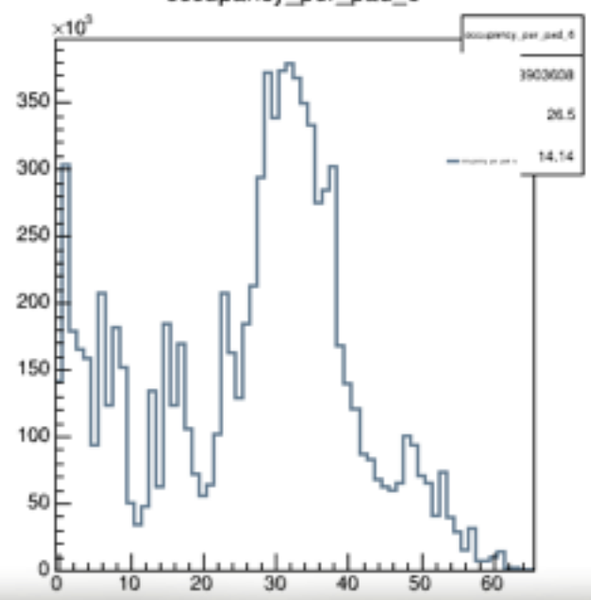


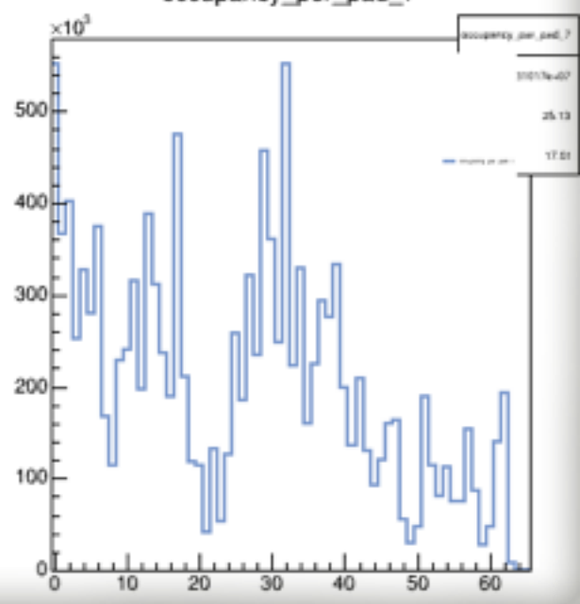






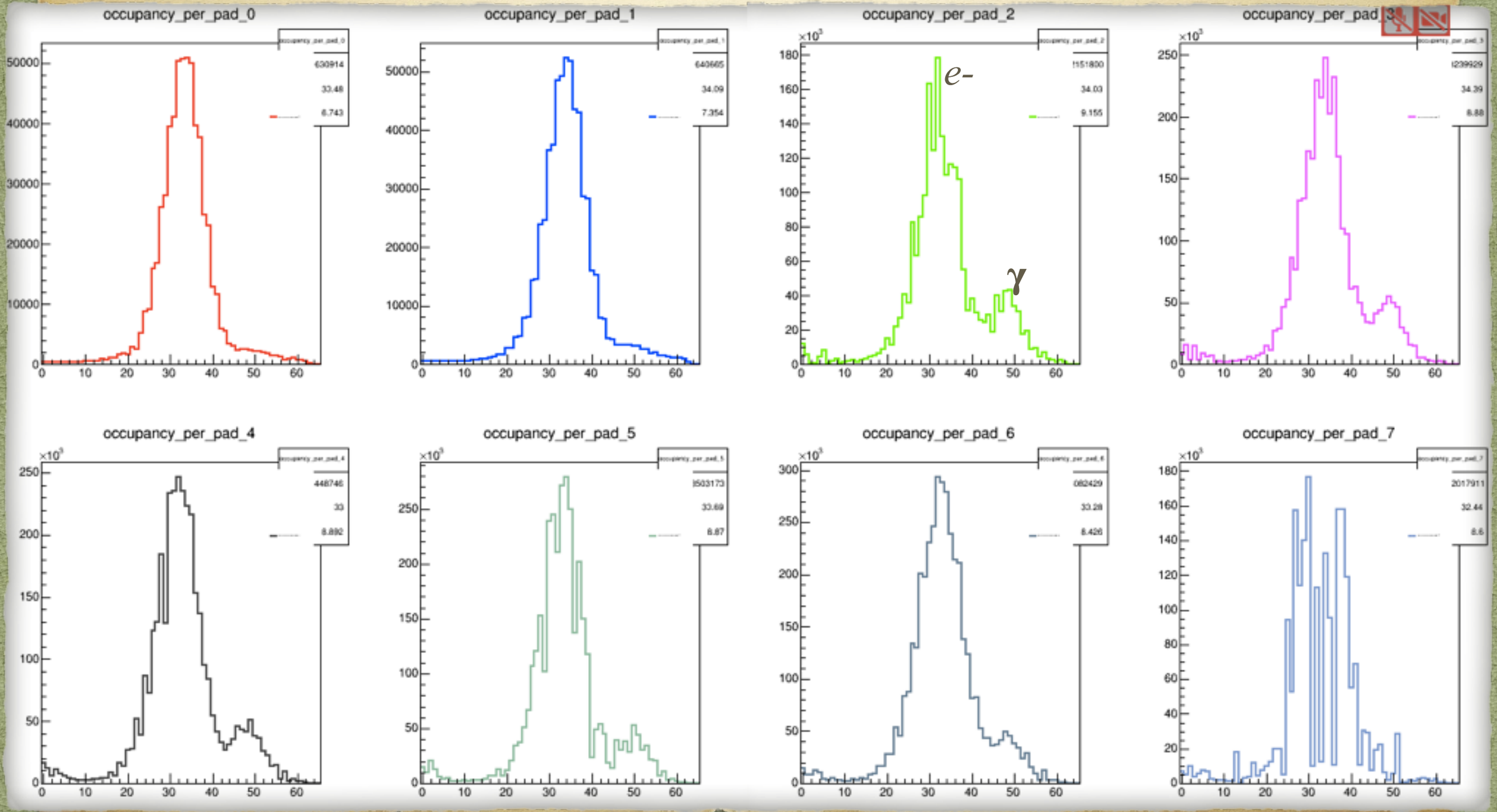






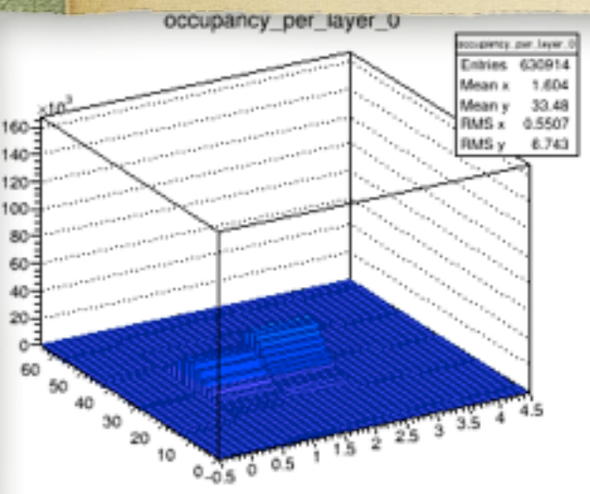
Occupancy, ~ 555k Events, E= 5GeV, Low Eγ Trigger

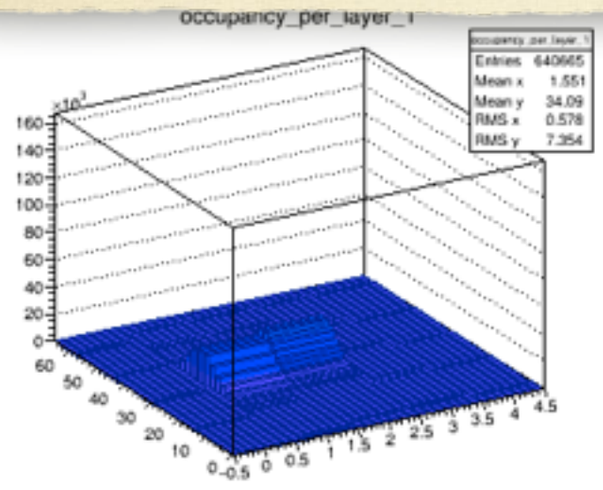
Calibration1MIP = 160.0 ADC
Cut on NN_output > 0.95

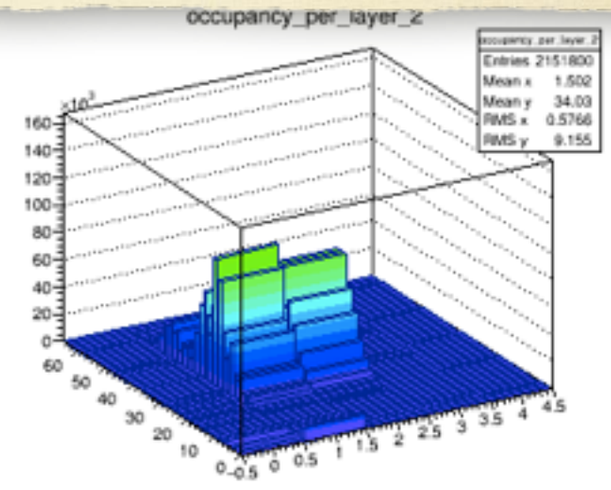


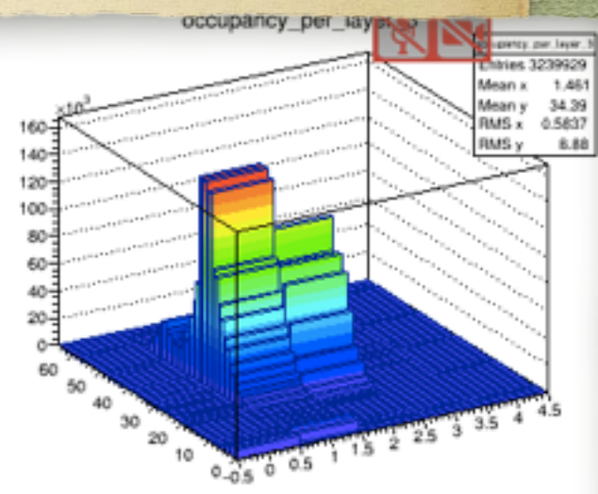
Occupancy vs pads vs sectors,
~ 555k Events, E= 5GeV, Low Eγ Trigger

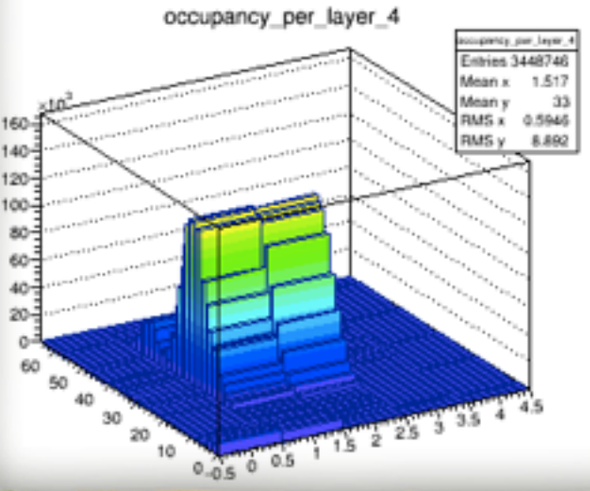
Calibration1MIP = 160.0 ADC
Cut on NN_output > 0.95

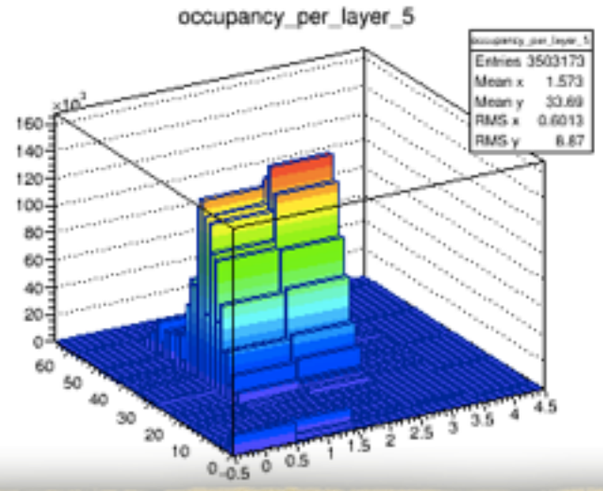


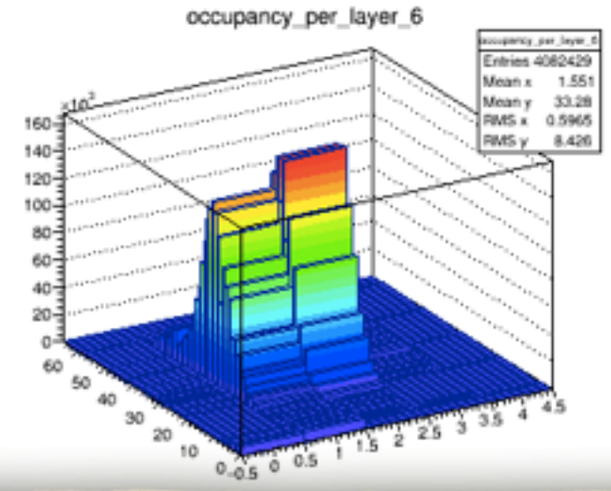


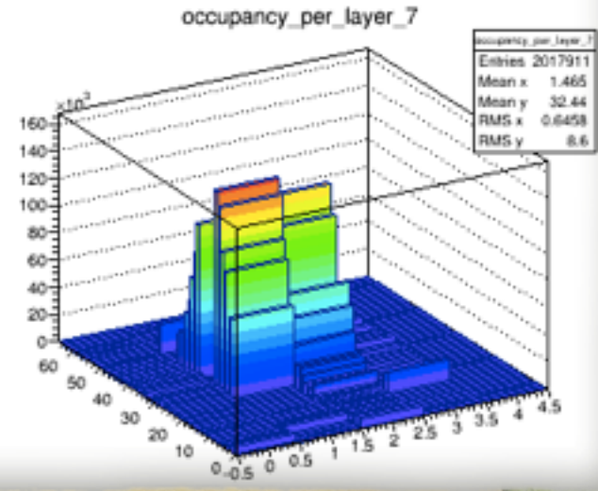








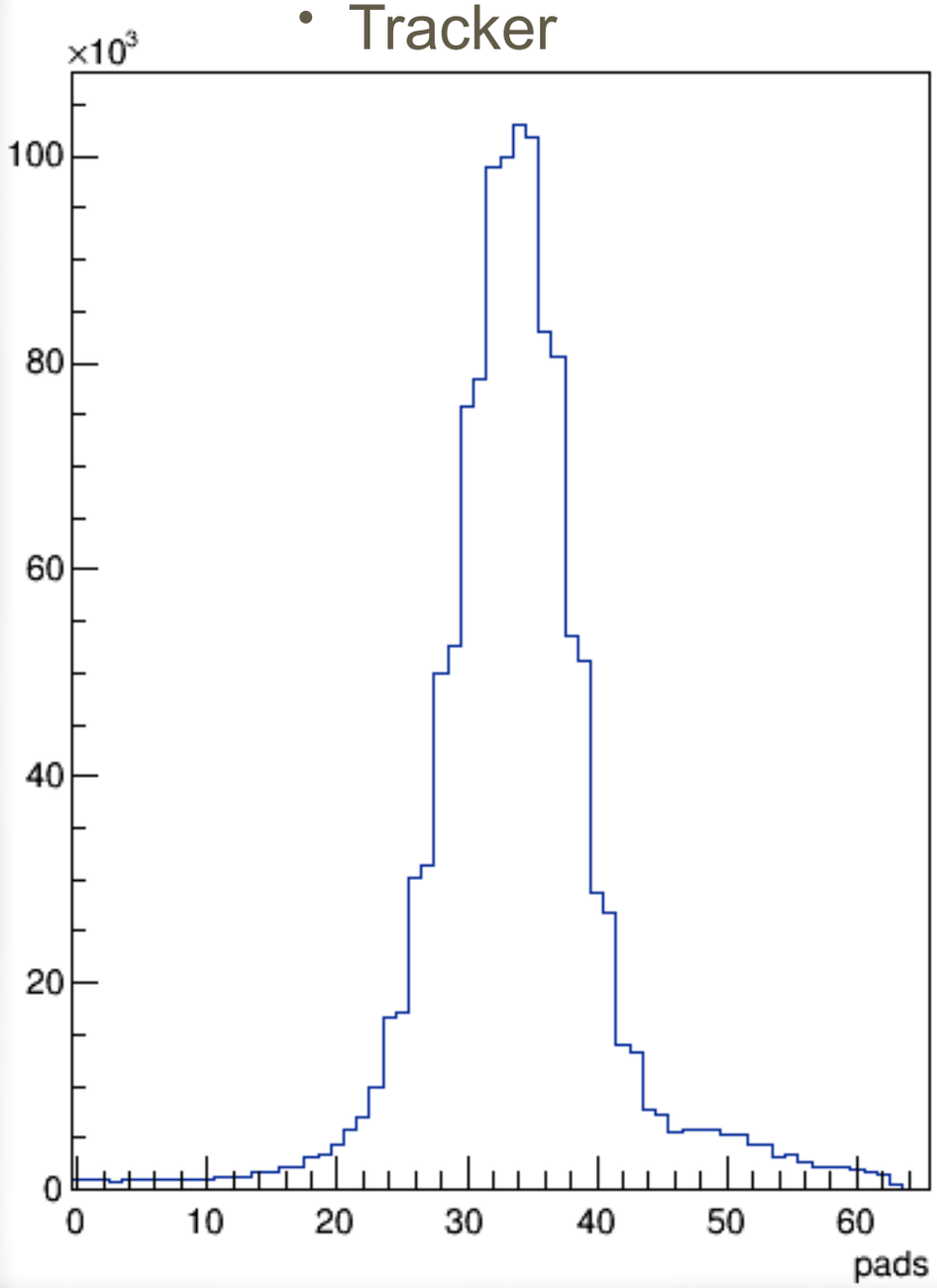




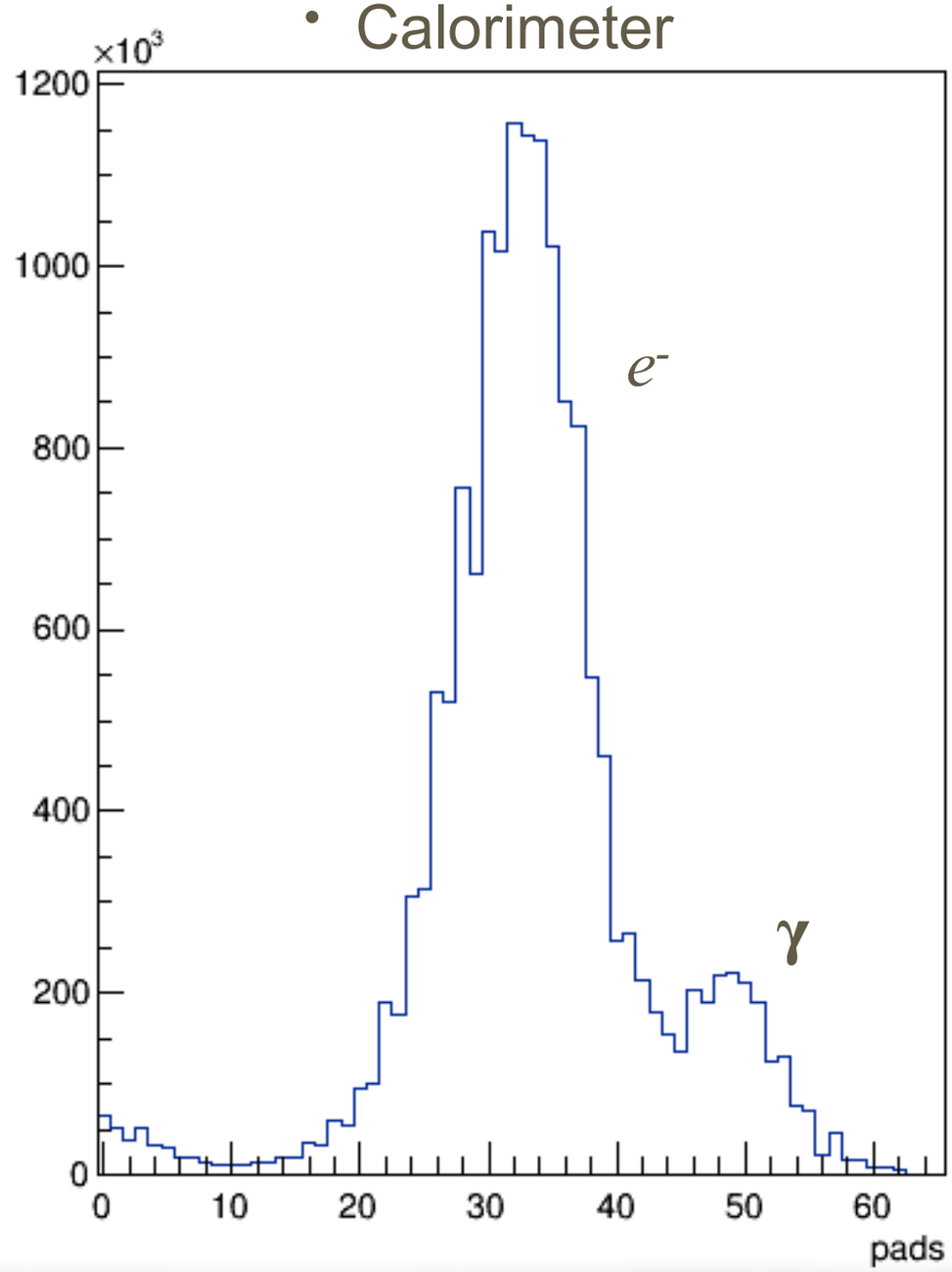
Occupancy, ~ 555k Events, E= 5GeV, Low Eγ Trigger

Calibration1MIP = 160.0 ADC
Cut on NN_output > 0.95

- Tracker



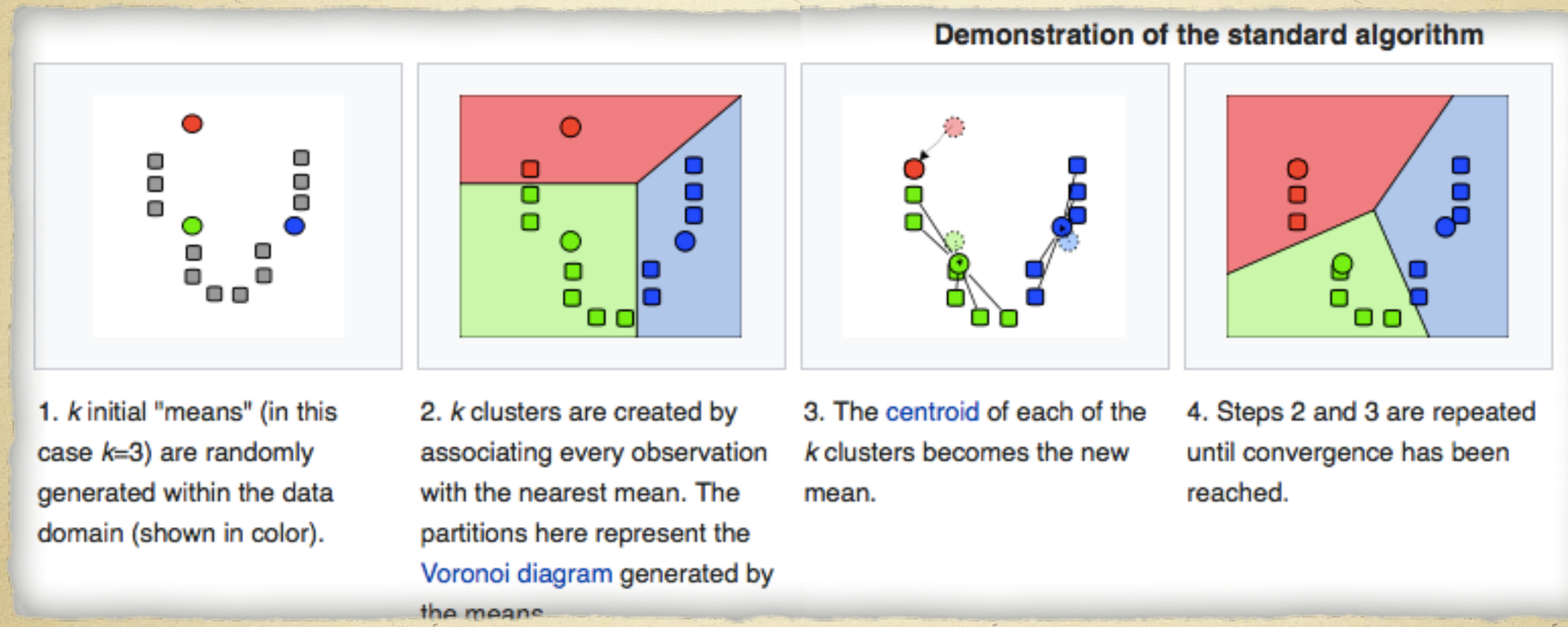
- Calorimeter



Clustering algorithms

- Modified k-means Clustering algorithm
- E clustering algorithm
- Linking neighboring pads

K-means clustering algorithm



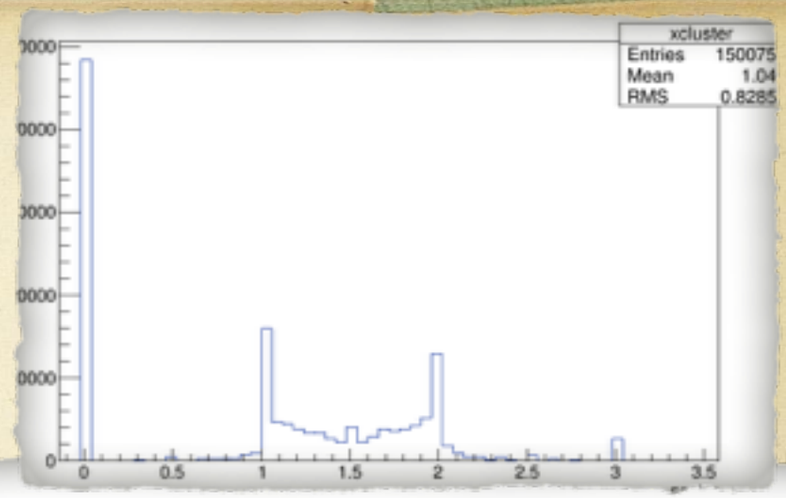
- We require 2 clusters
- k-means was modified to enhance the weight of hits with high energy. lnE factor was introduced to modify distance calculations

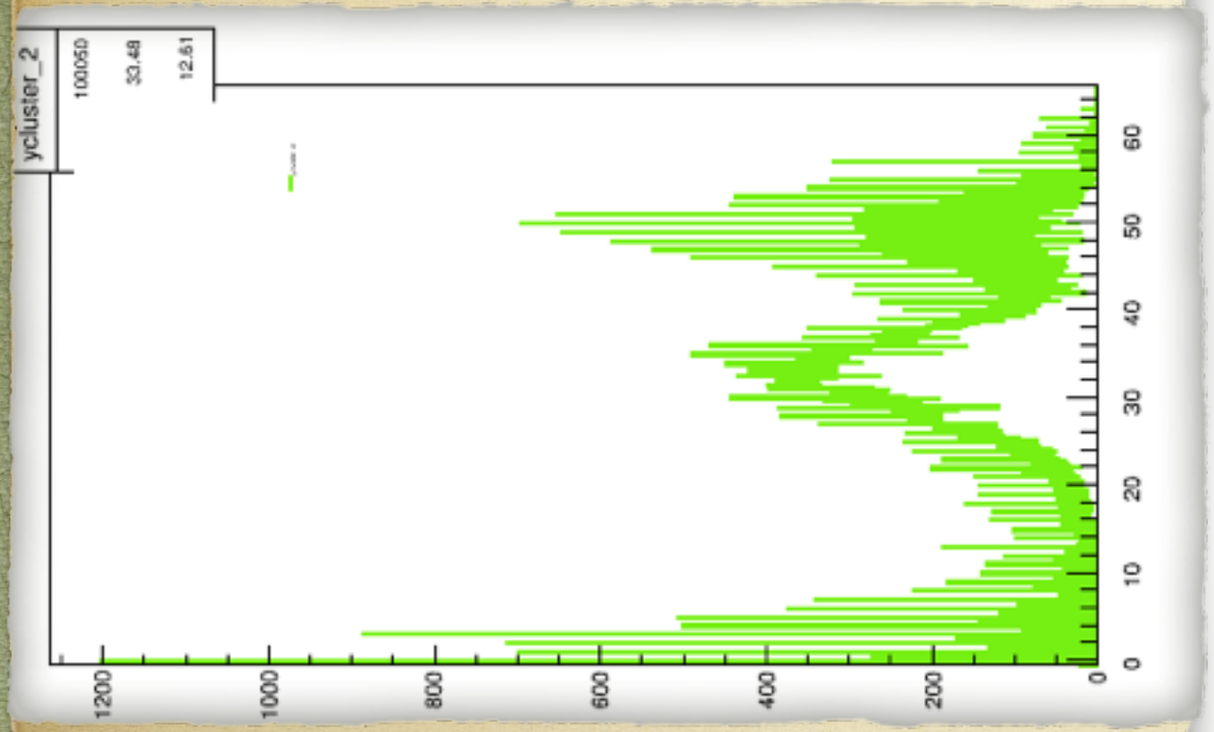
K-means Clustering Event-by-Event

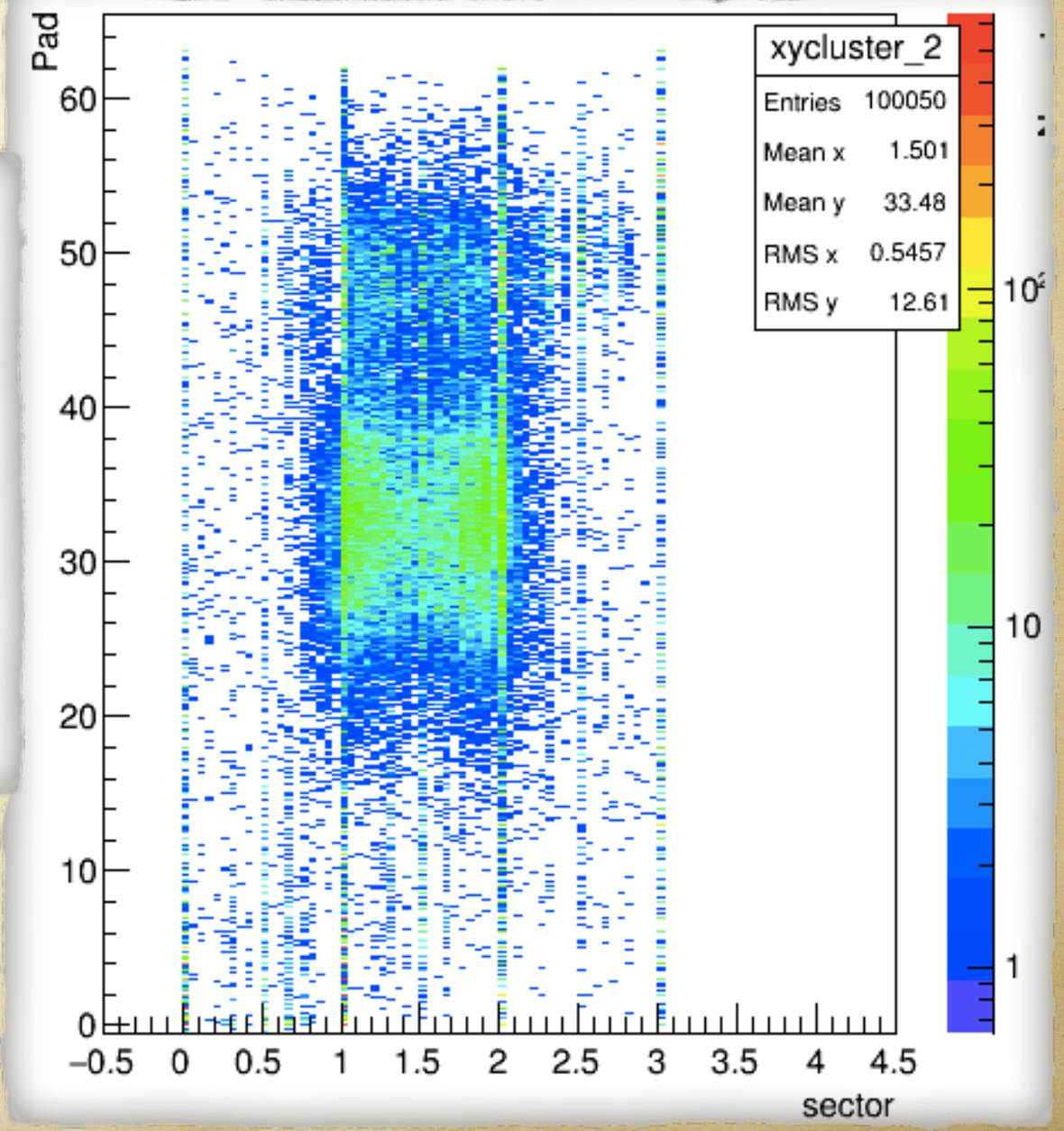
Low Eγ Trigger, ~55K events

w/ divider

(Run 771)

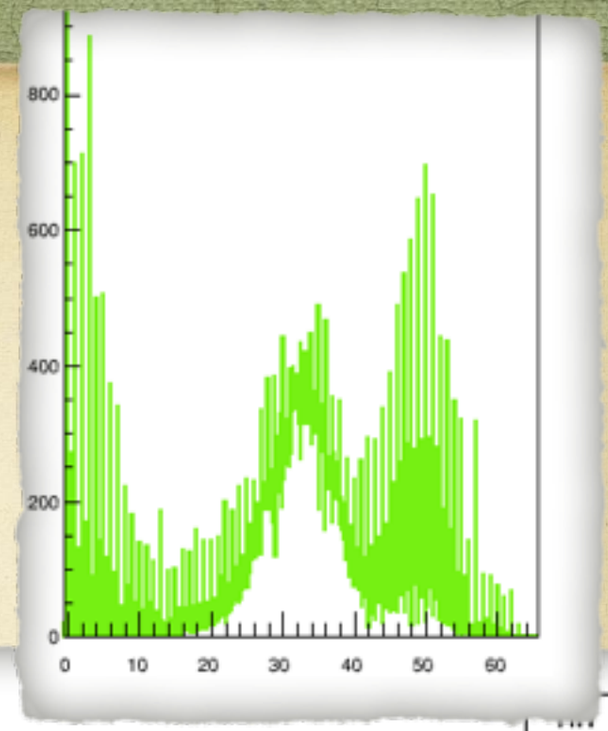




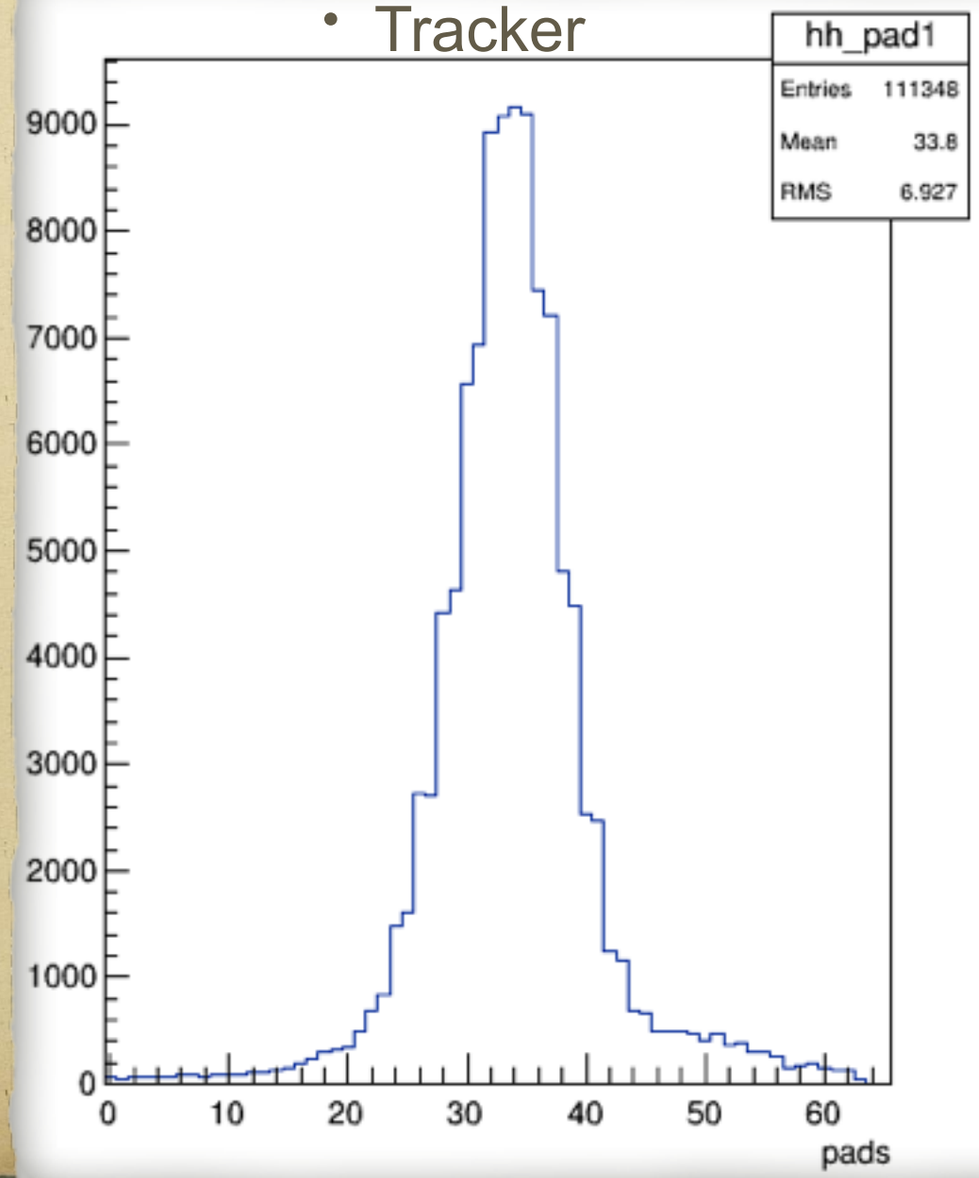


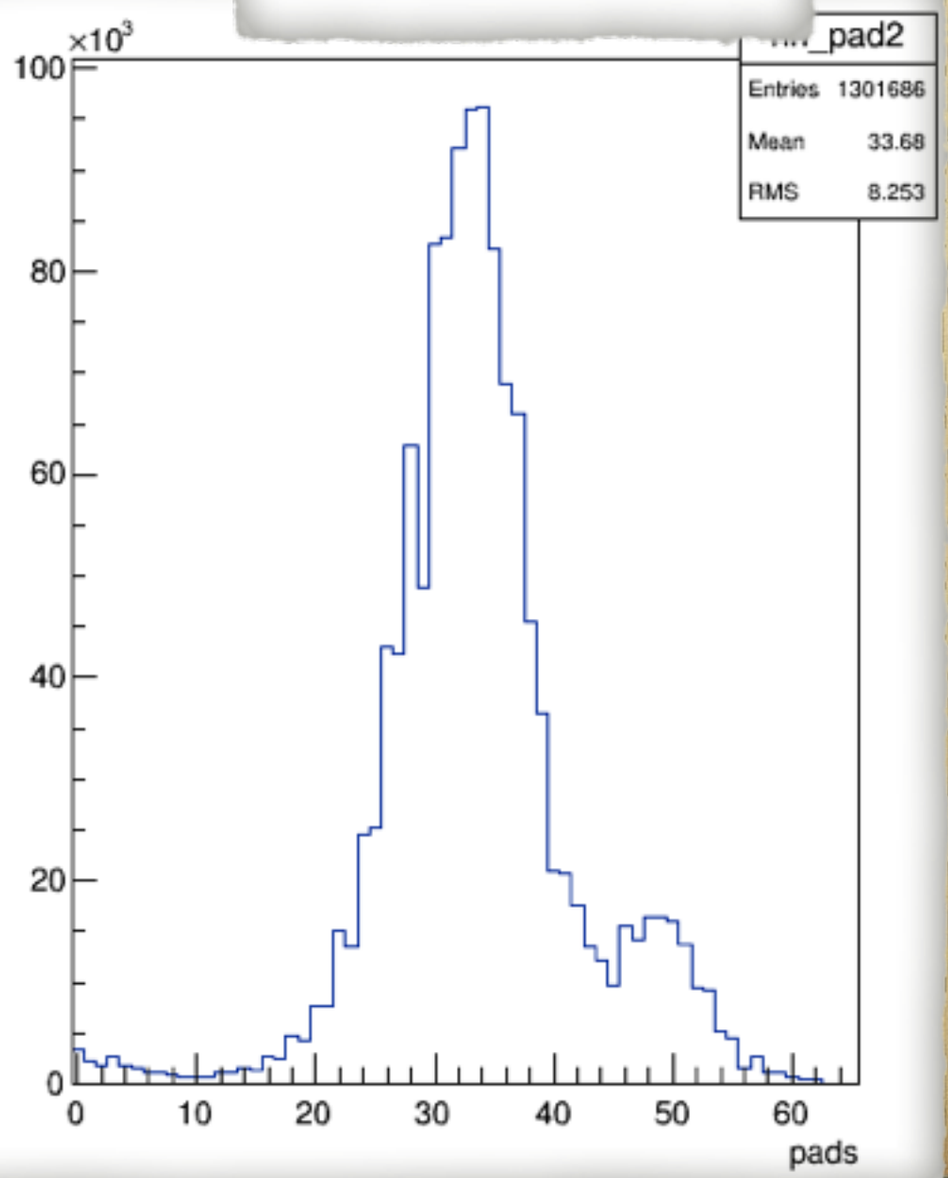
K-means Clustering vs occupancy

Low Eγ Trigger, ~55K events (Run 771)



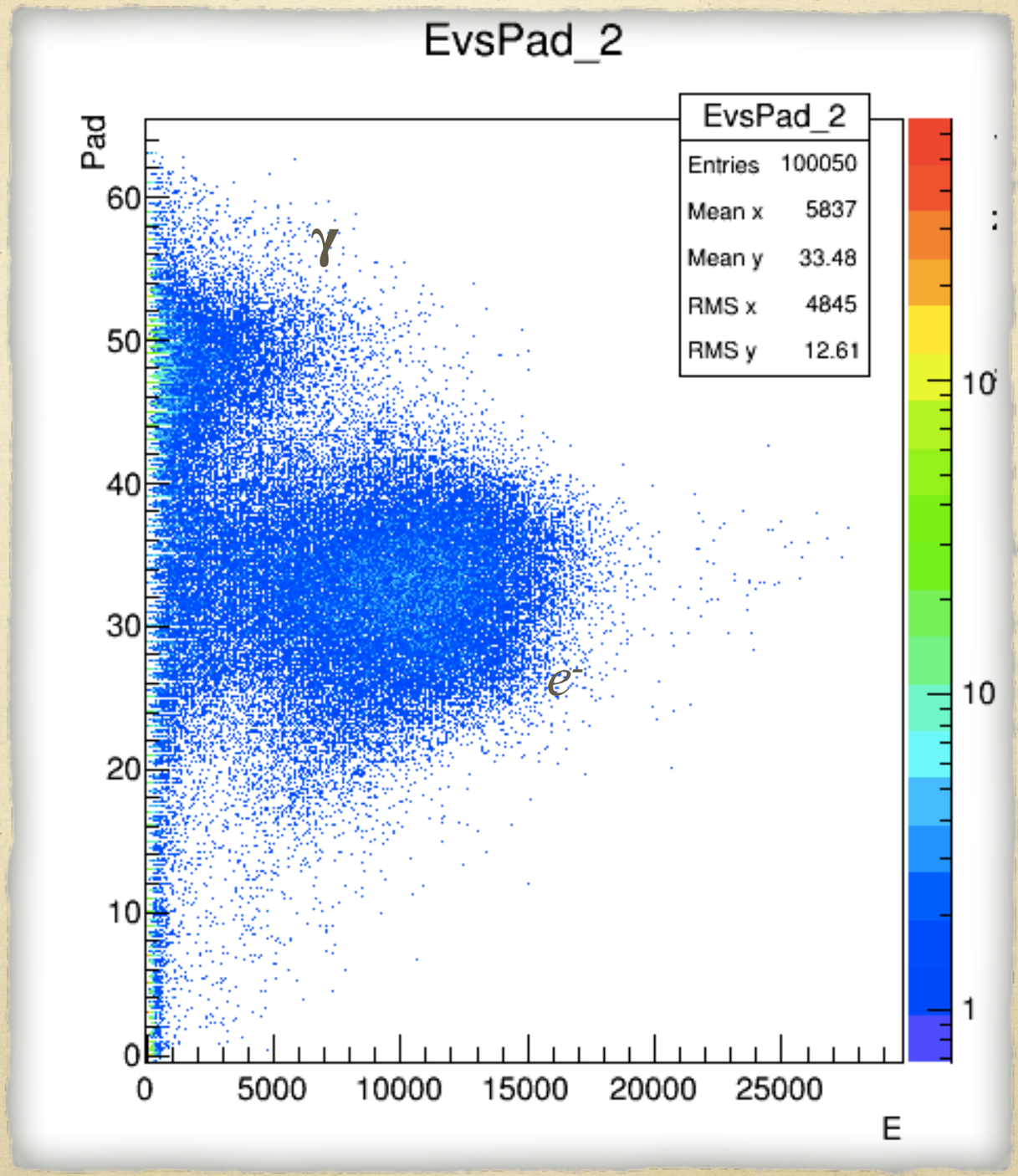
- Tracker





Energy vs Pad, k-means clustering

Low Eγ Trigger,
~55K events
w/ divider
(Run 771)



E-clustering algorithm:

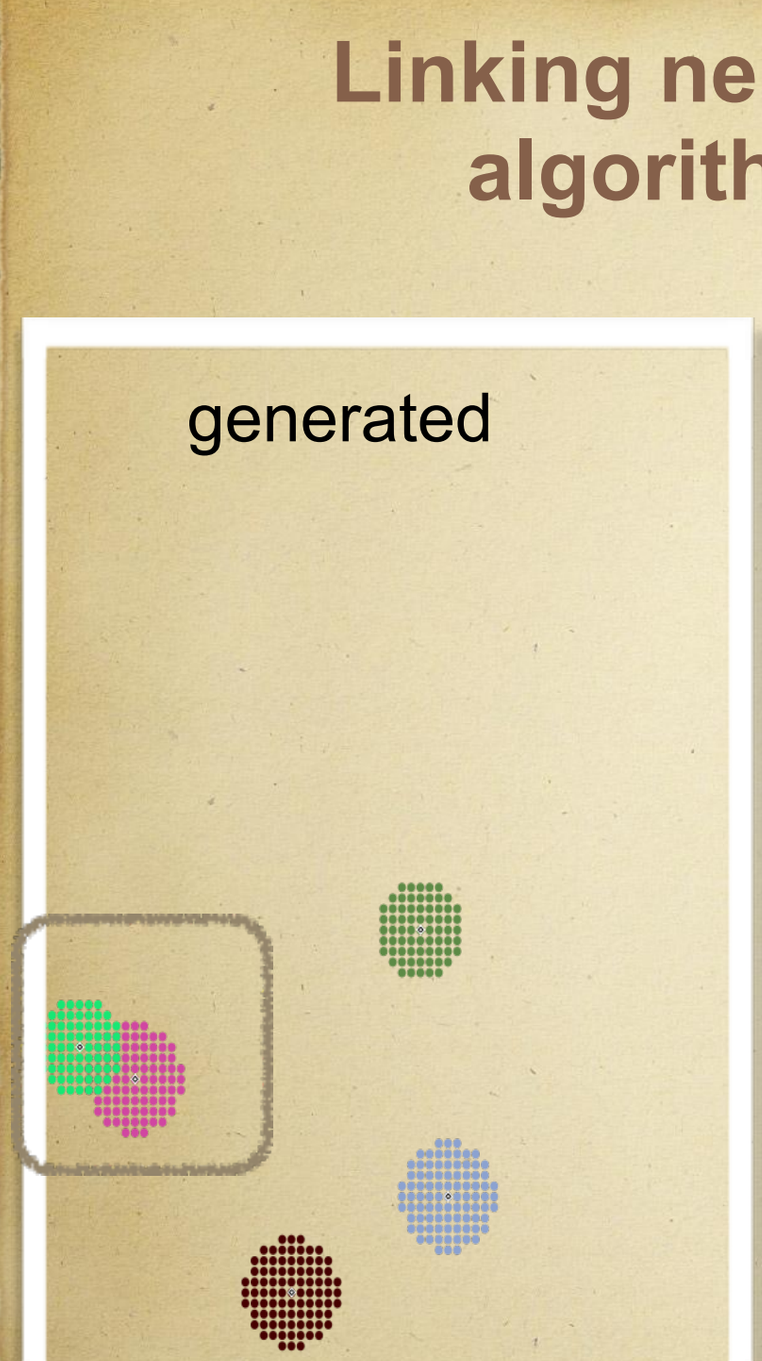
- Looking for hit with maximum energy and then assign it as center of the cluster. Used in Zeus. Pads with local maximum in deposited energy become the seeds of the clusters. All neighboring pads with descending energy are assigned to the seed.

Linking neighboring pads:

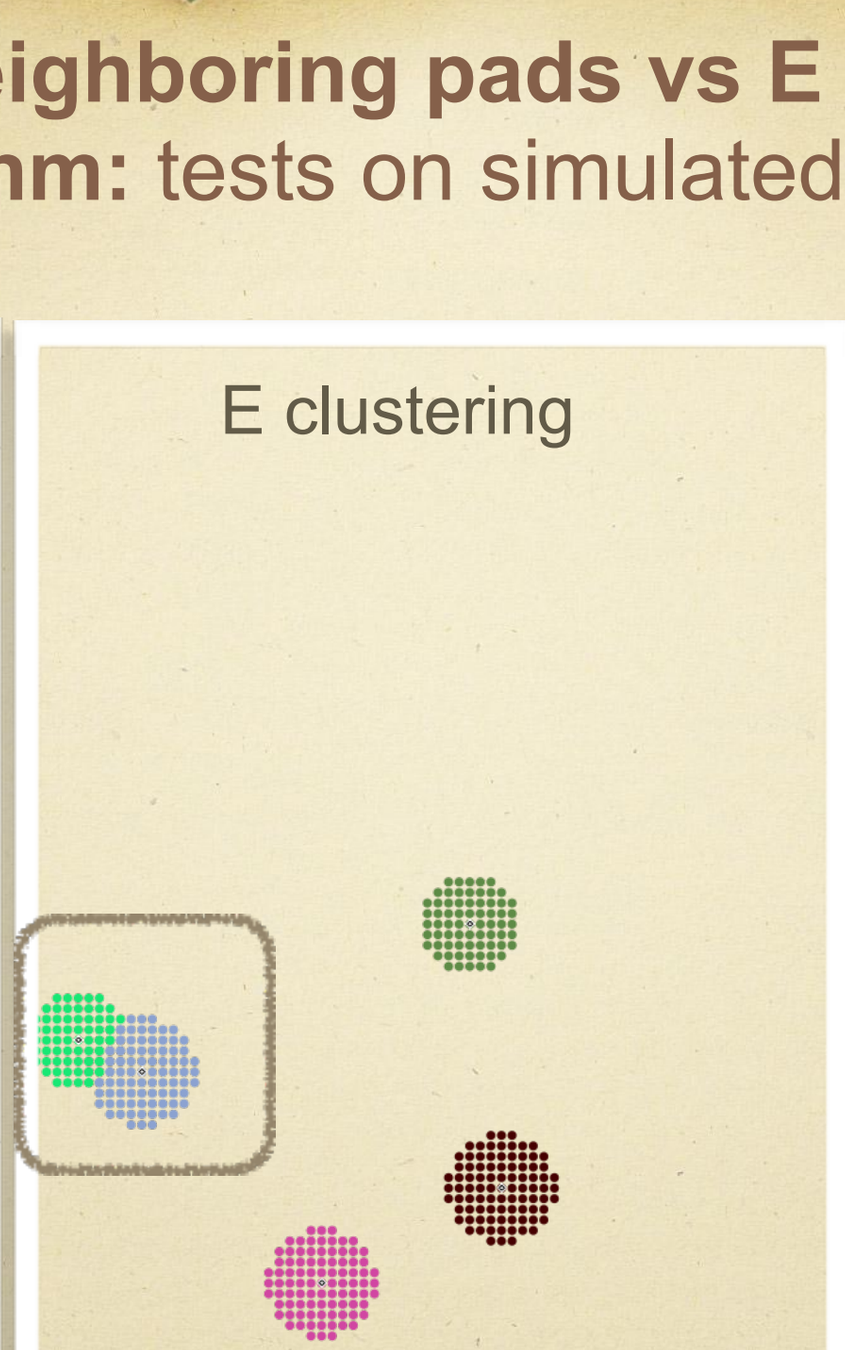
- Looking for the closest neighbors (with distance no more then 1 pad in any direction) and then assigning it to the cluster

Linking neighboring pads vs E clustering algorithm: tests on simulated events

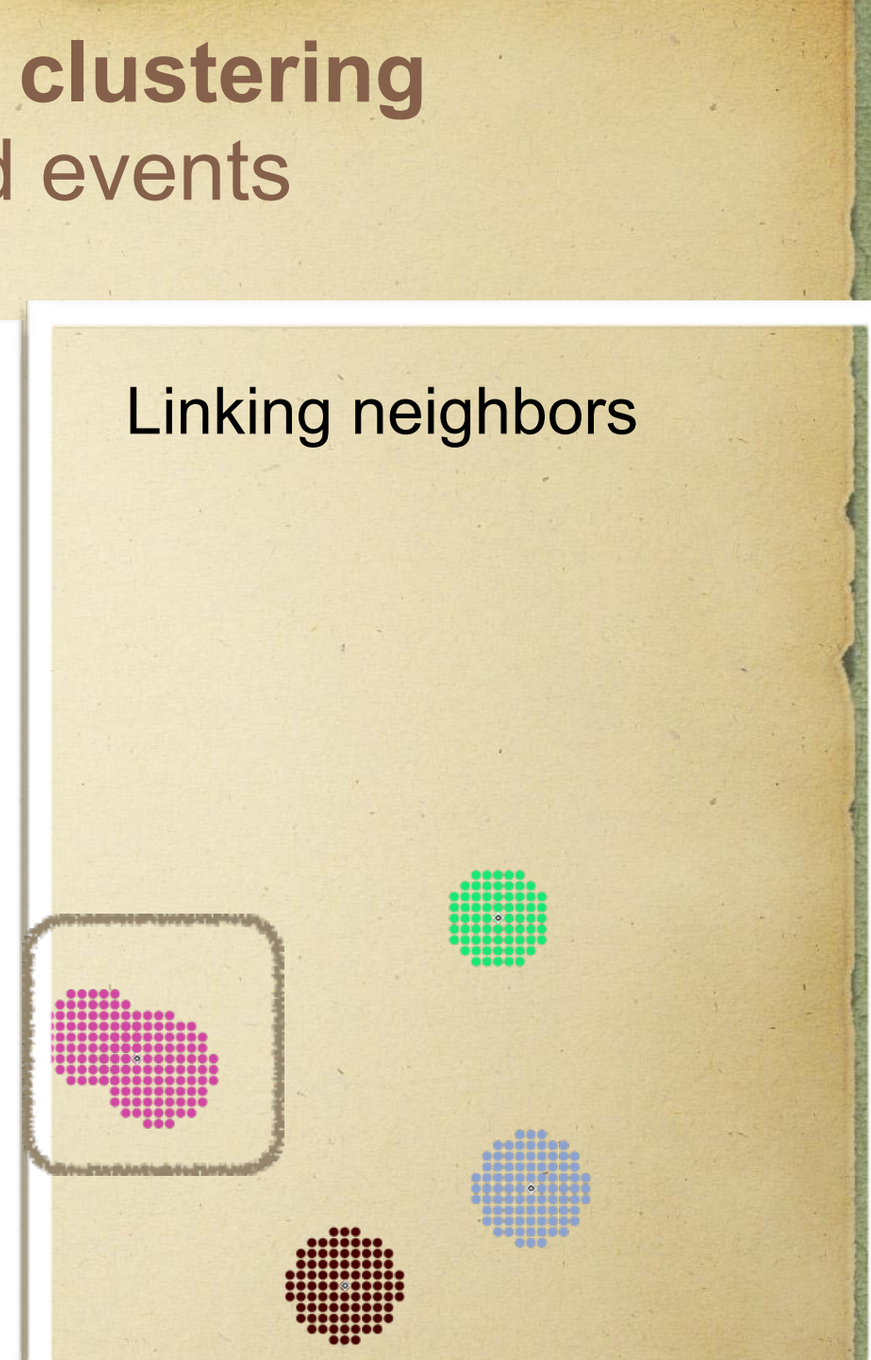
generated



E clustering

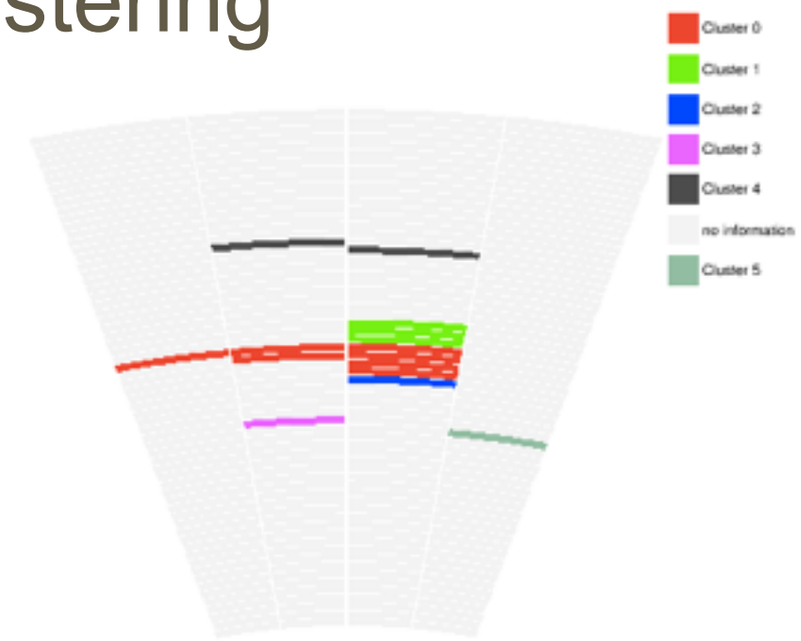


Linking neighbors

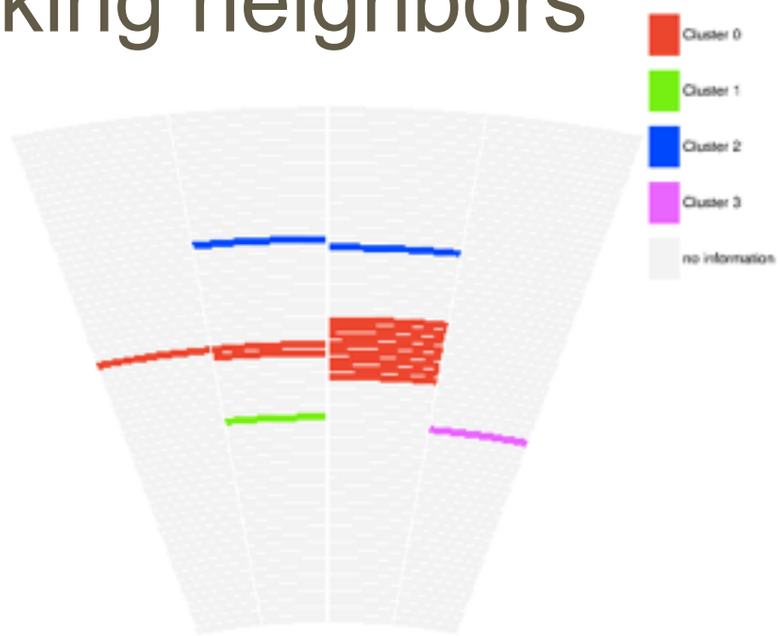


Event 10, Run 771 @ 5 GeV w/ charge Divider, Low γ trigger

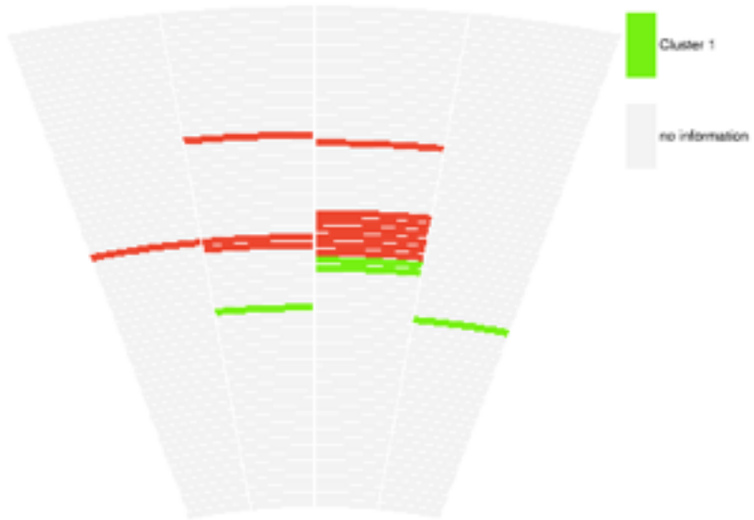
E clustering



Linking neighbors



k-means clustering



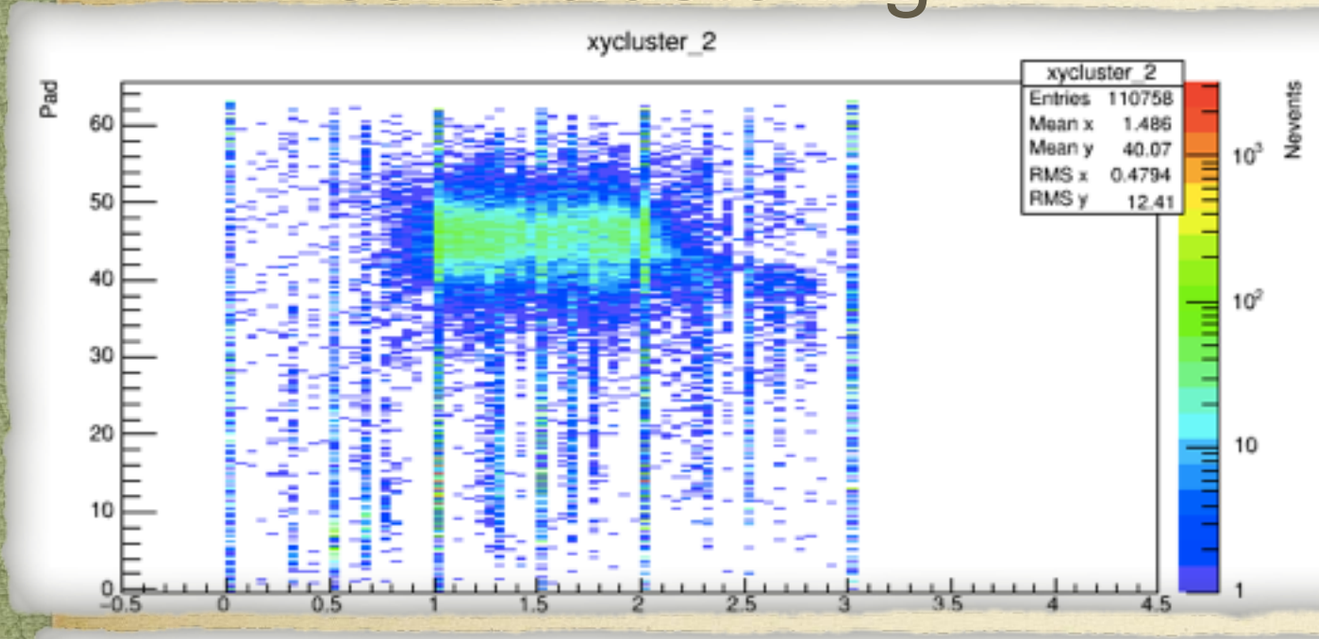
Run 741 E= 5GeV

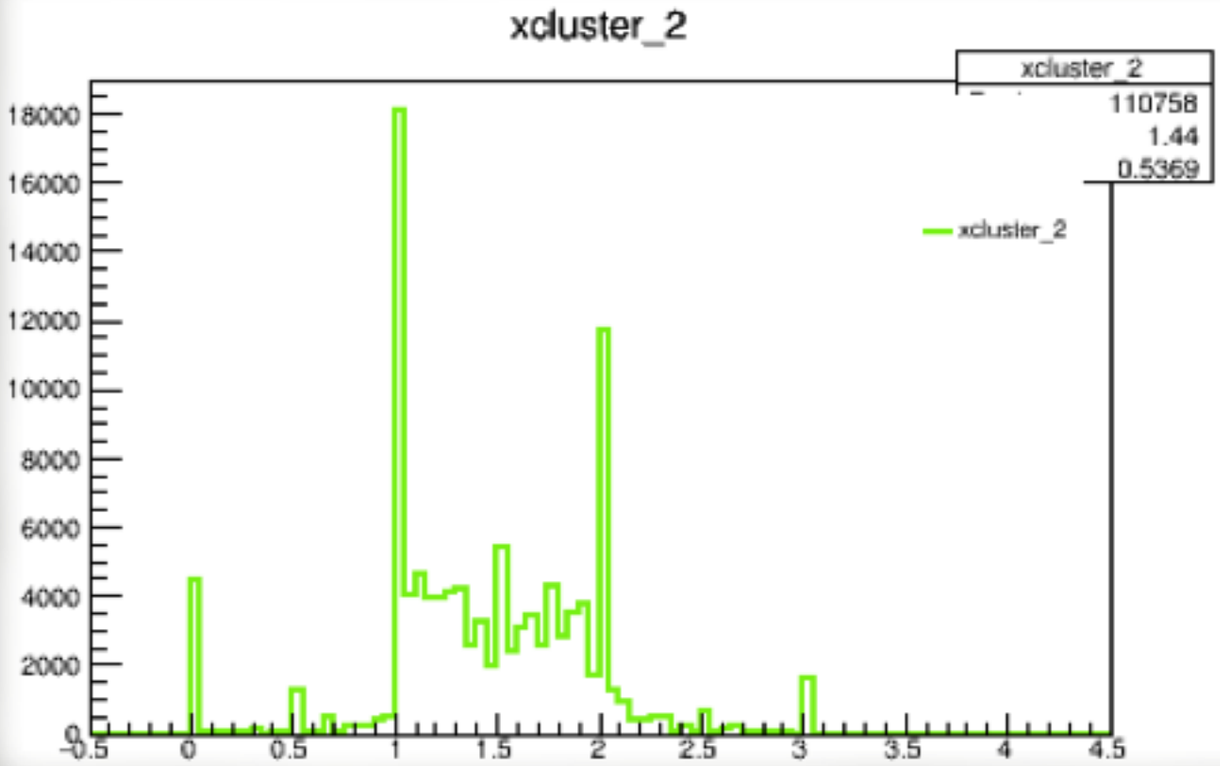
- ~55K events
- electron beam with 5 GeV
- no target, no magnetic field
- Calorimeter: with charge divider

K-means vs E Clustering

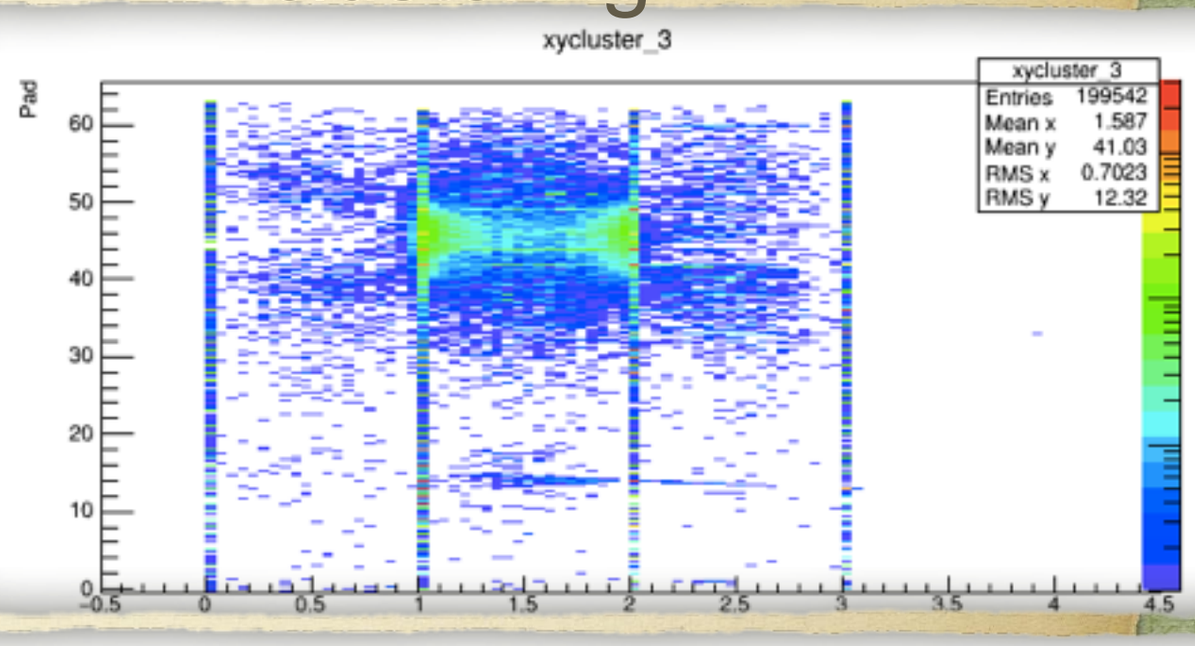
- electron beam with 5 GeV, no target, no magnetic field (Run 741)

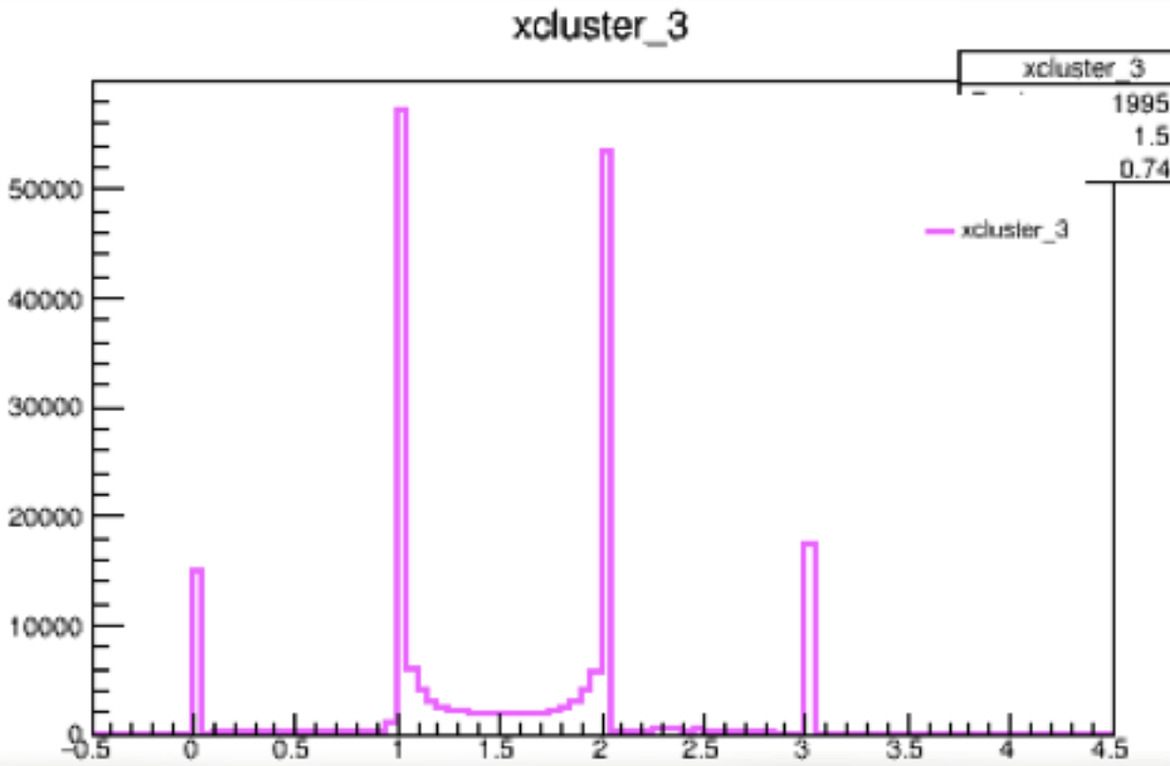
k-means clustering





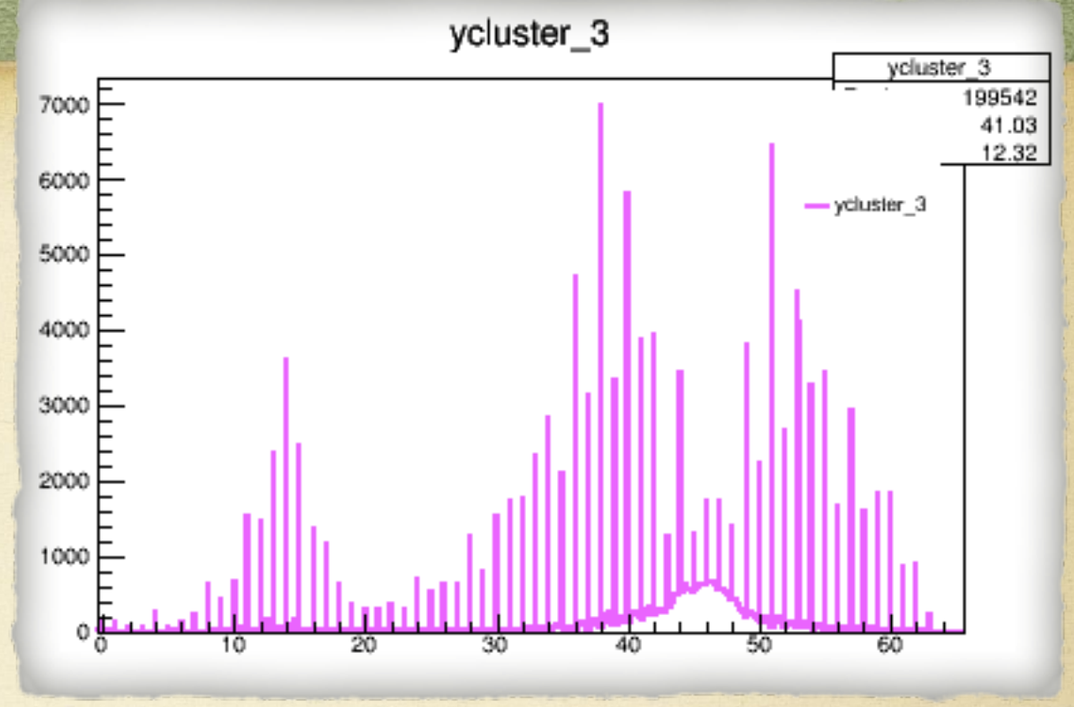
E clustering



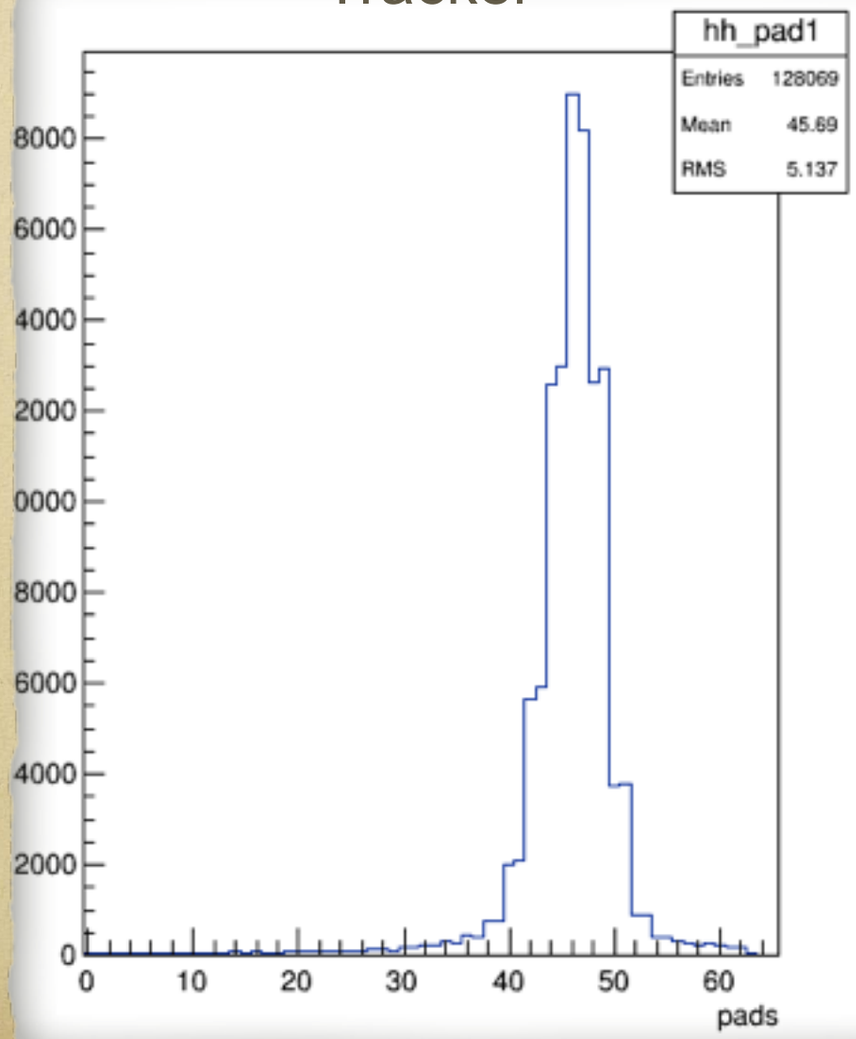


E Clustering vs hits

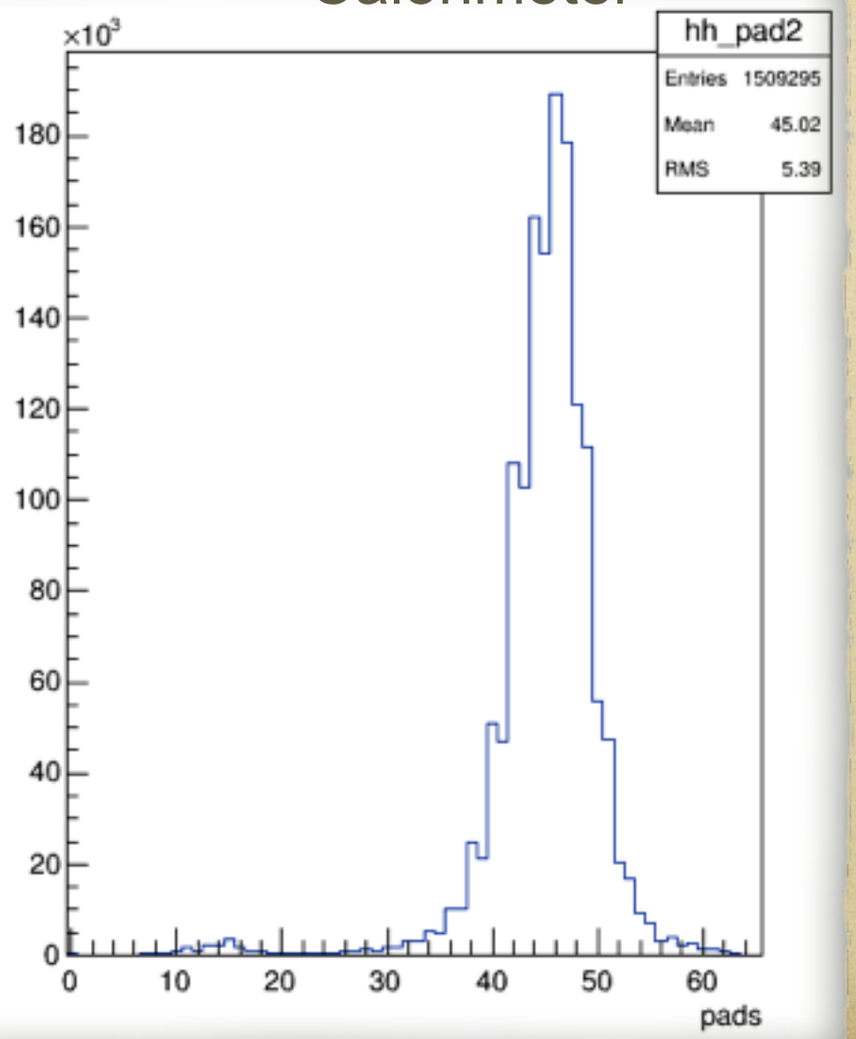
- electron beam with 5 GeV, no target, no magnetic field (Run 741)



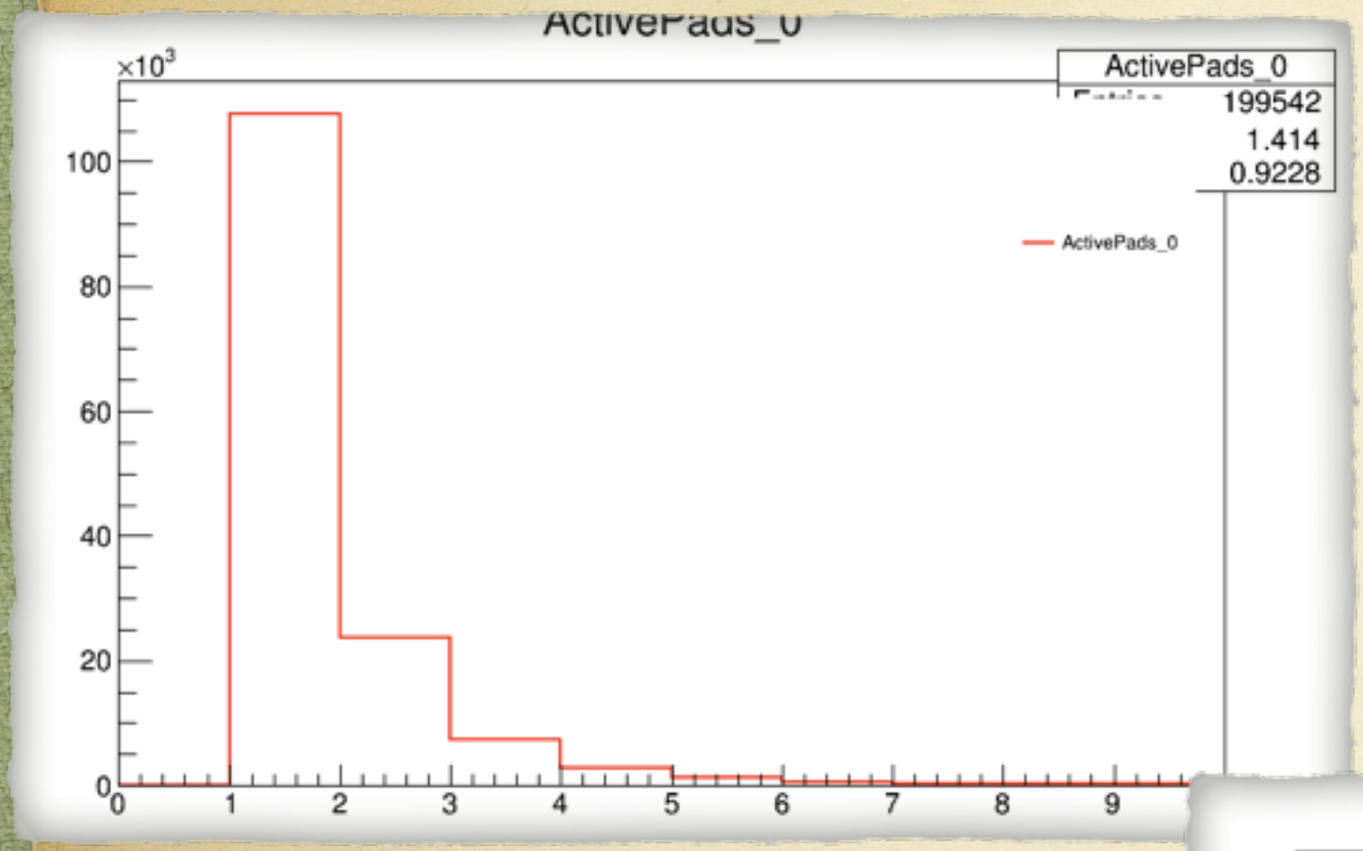
- Tracker



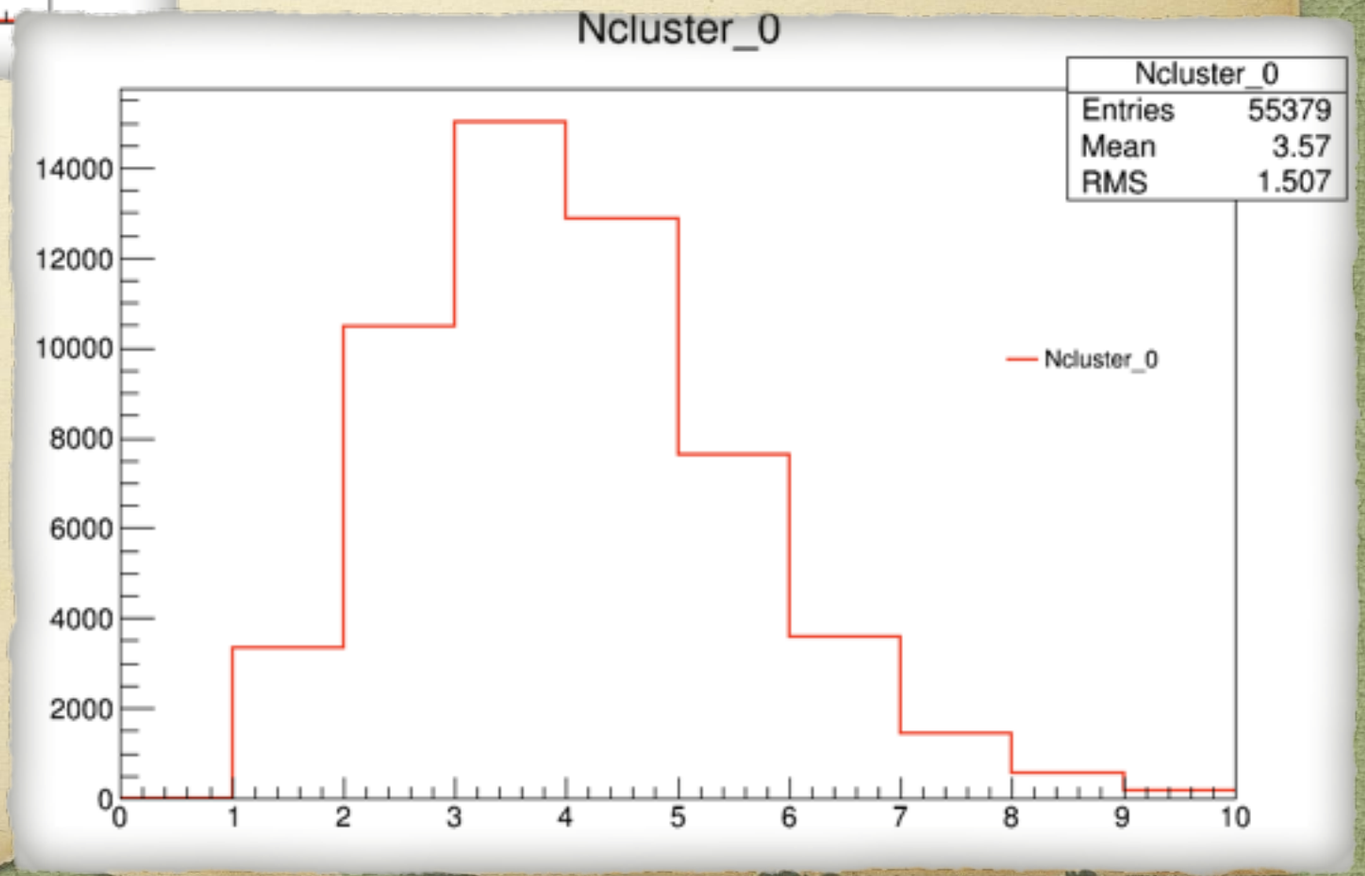
- Calorimeter



Linking neighbors CA Run 741

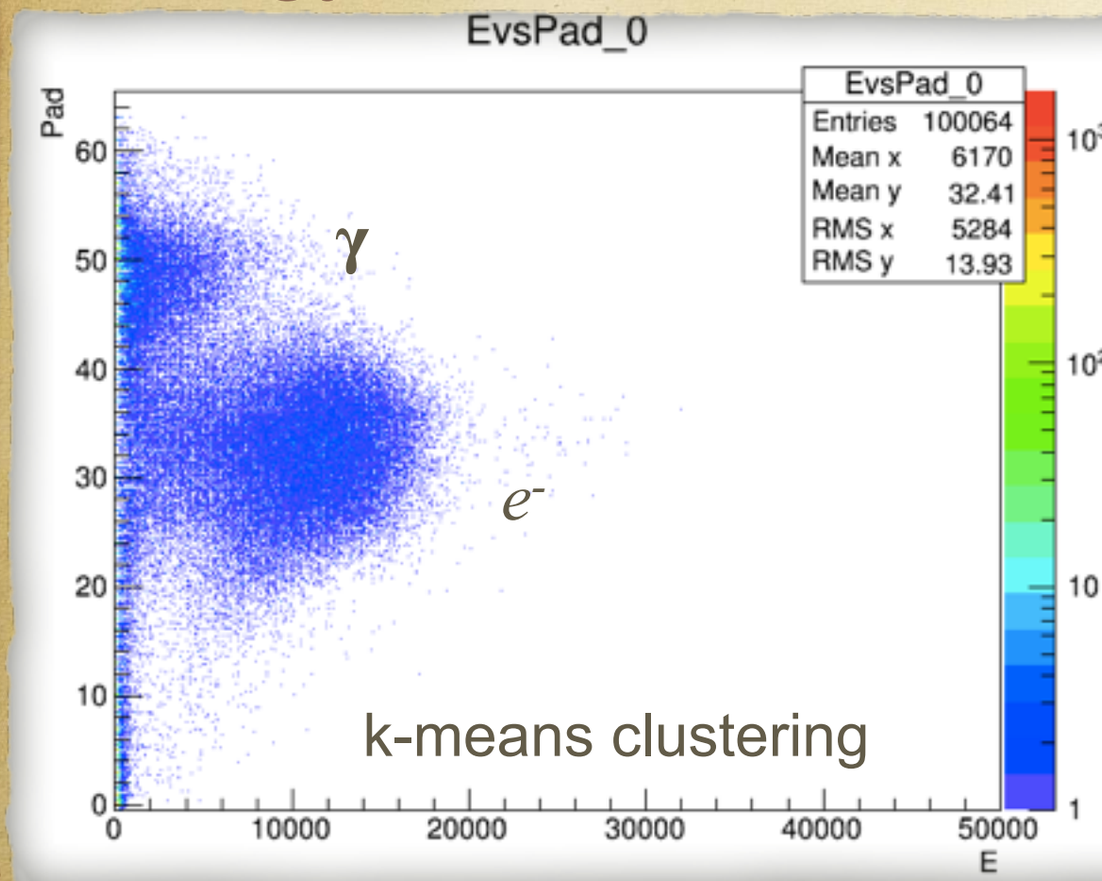


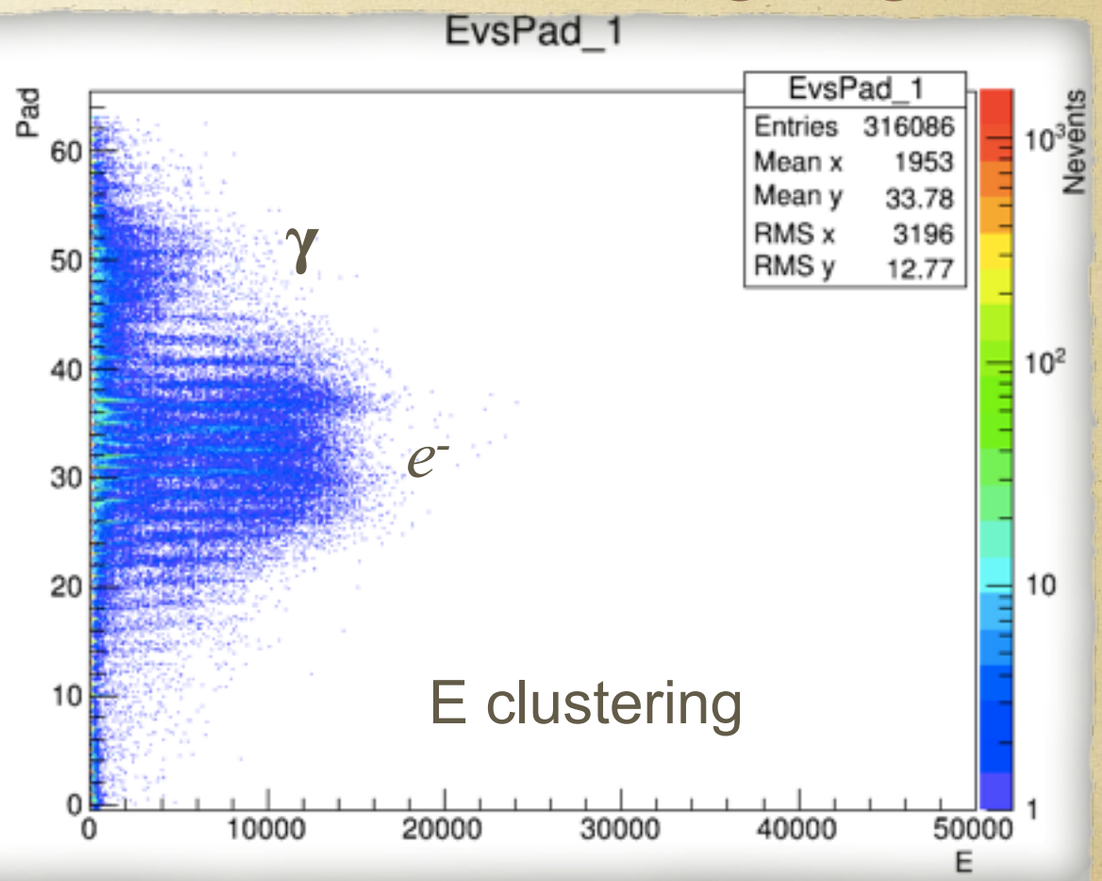
Number of the pads in the cluster



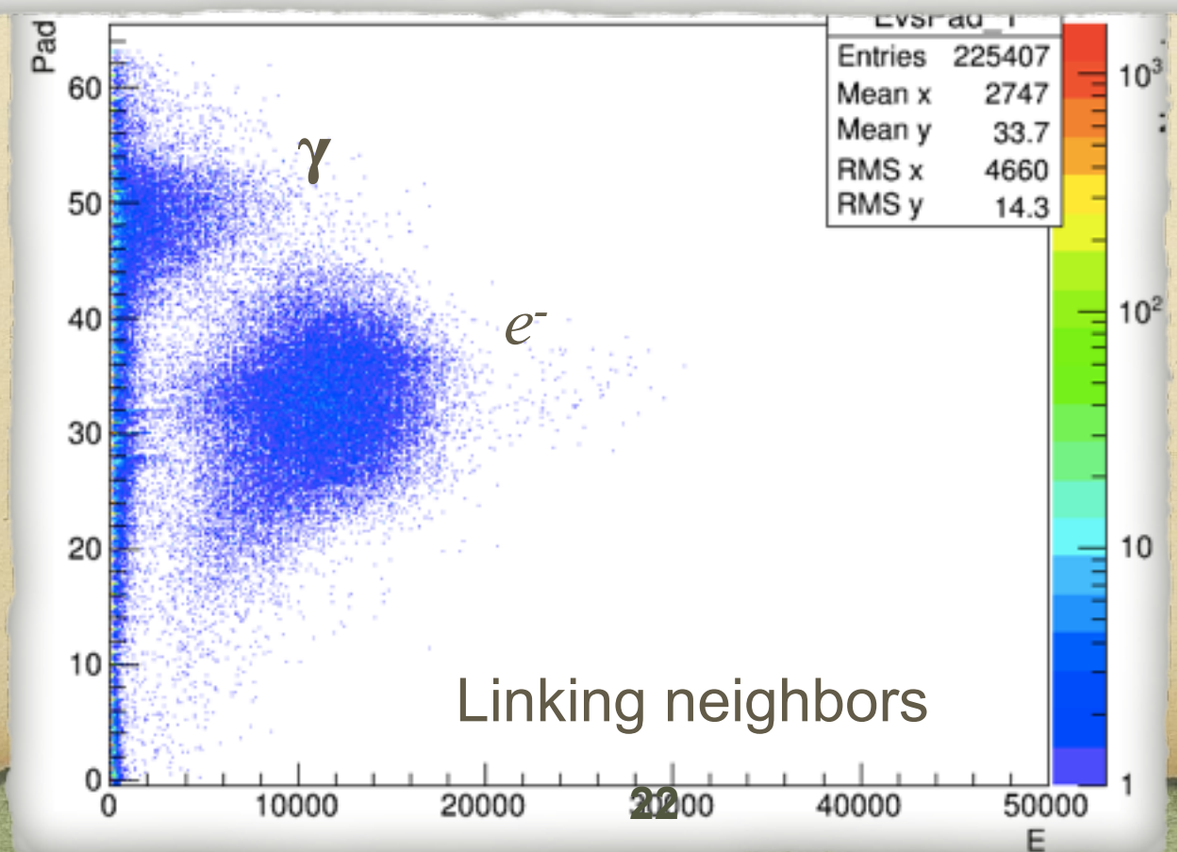
Number of the clusters in event

Energy vs Pad, Run 771, Different clustering algorithms

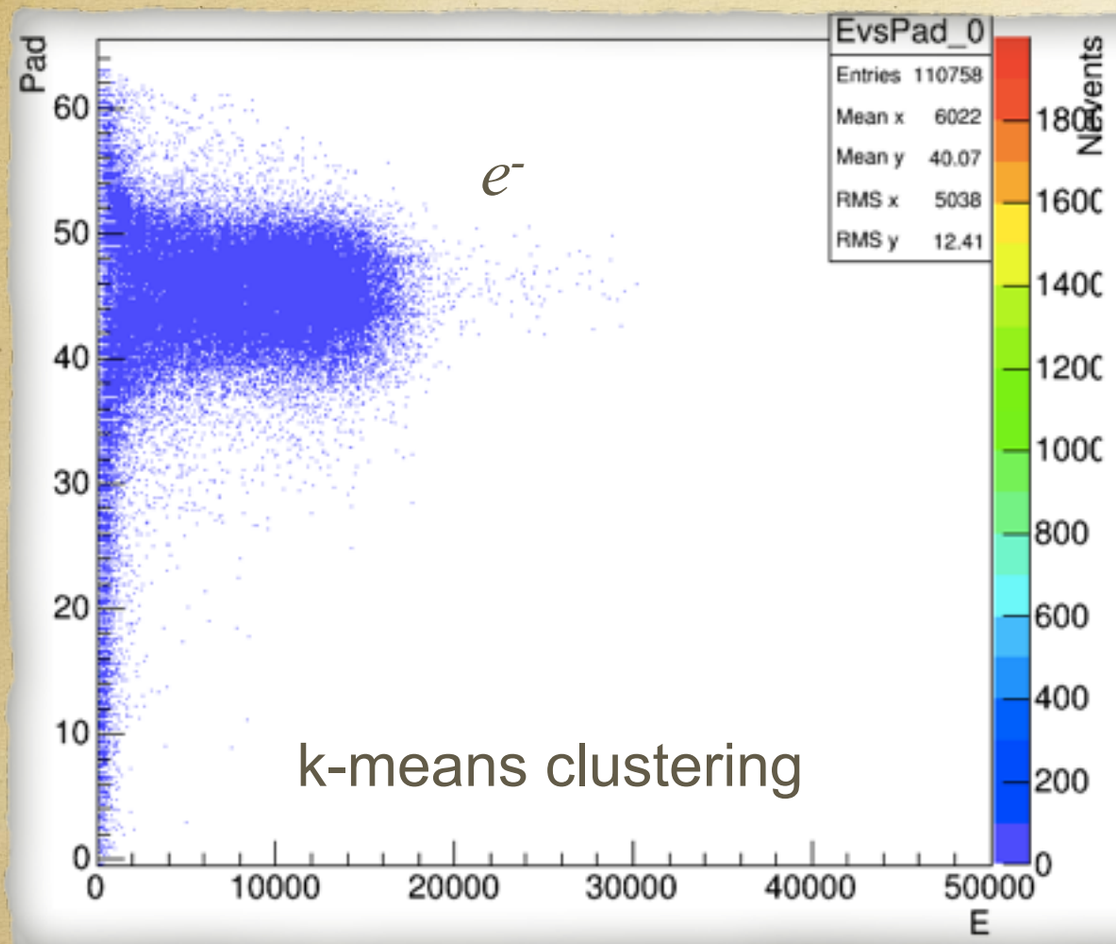


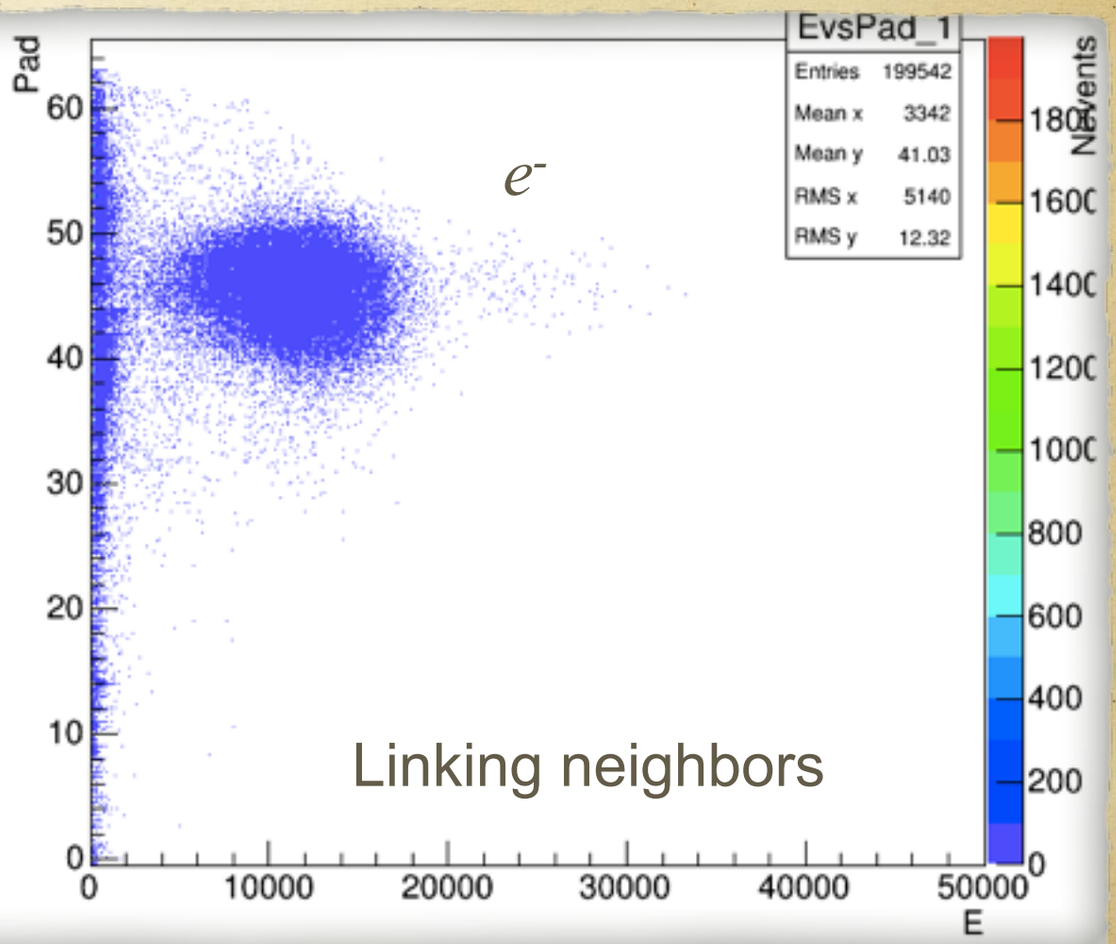


Low Eγ Trigger,
~55K events
w/ divider
(Run 771)

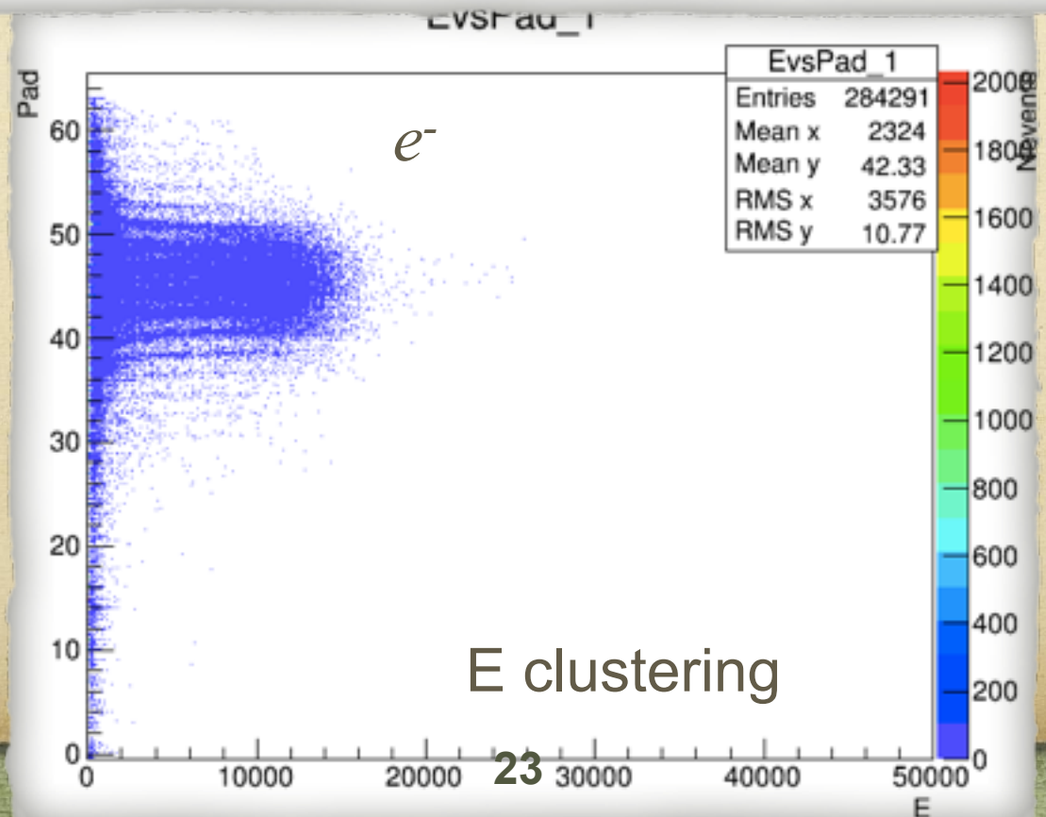


Energy vs Pad, Run 741, Different clustering algorithms





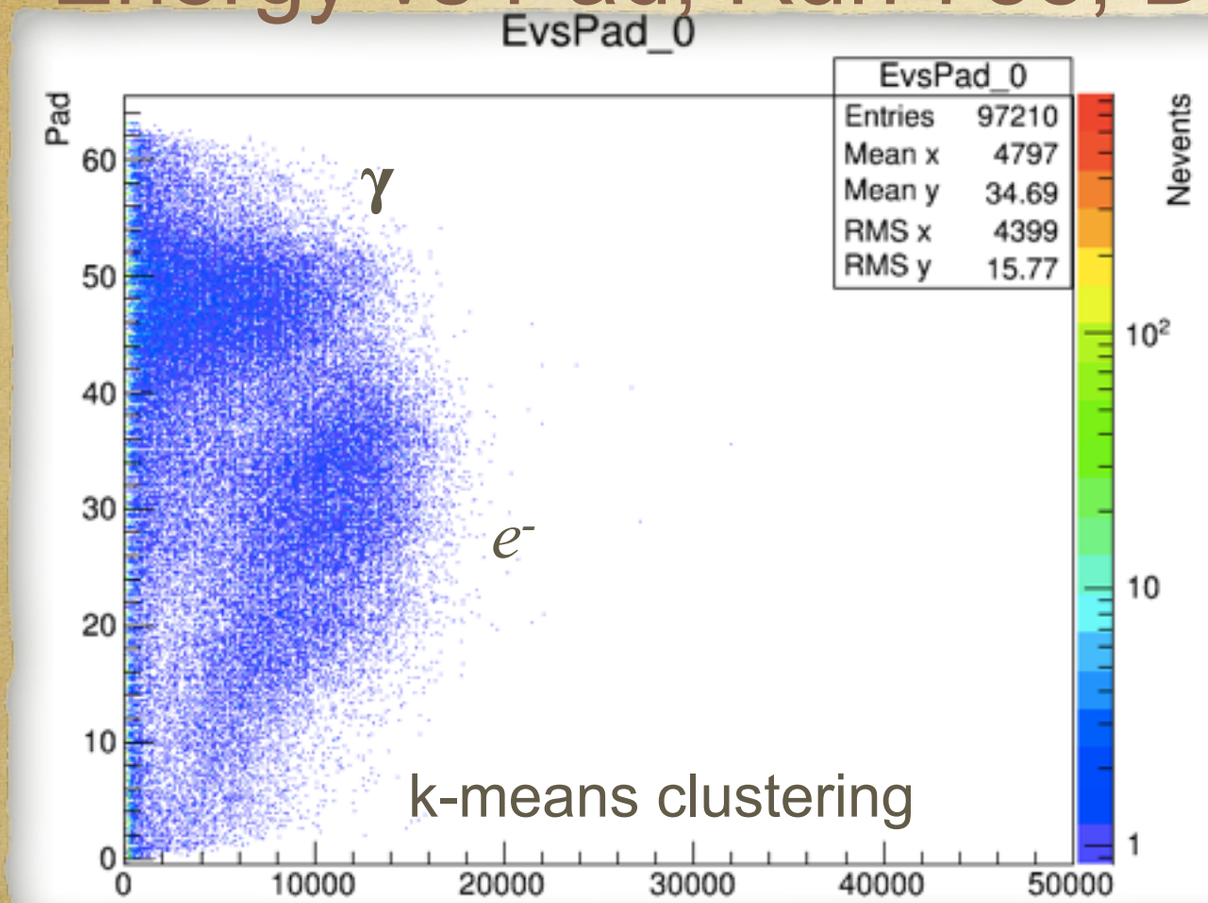
- electron beam with 5 GeV, no target, no magnetic field w/ divider (Run 741)

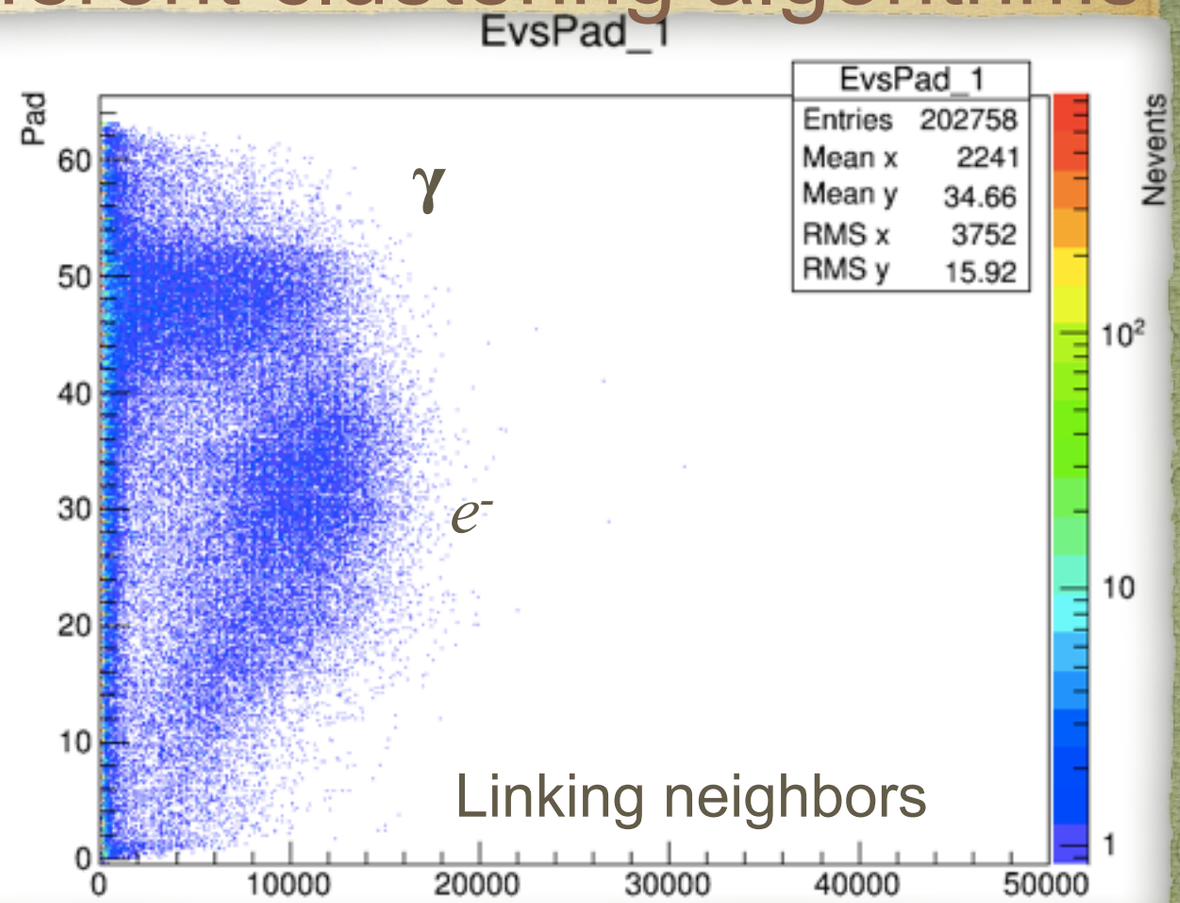


Runs 788 E= 5GeV

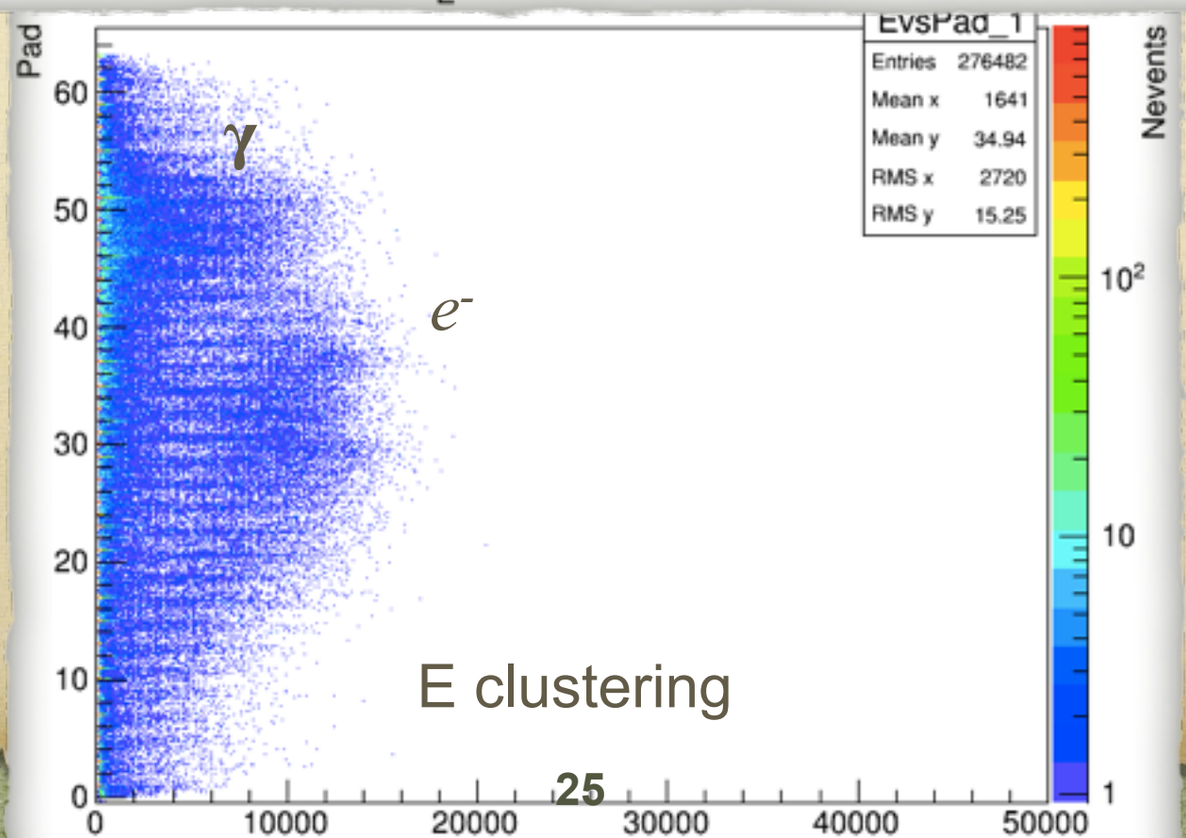
- Calorimeter w/divider
- Cu target (1.5mm) before magnet
- Ee High Energy Veto
- Cut on NN_output > 0.95

Energy vs Pad, Run 788, Different clustering algorithms

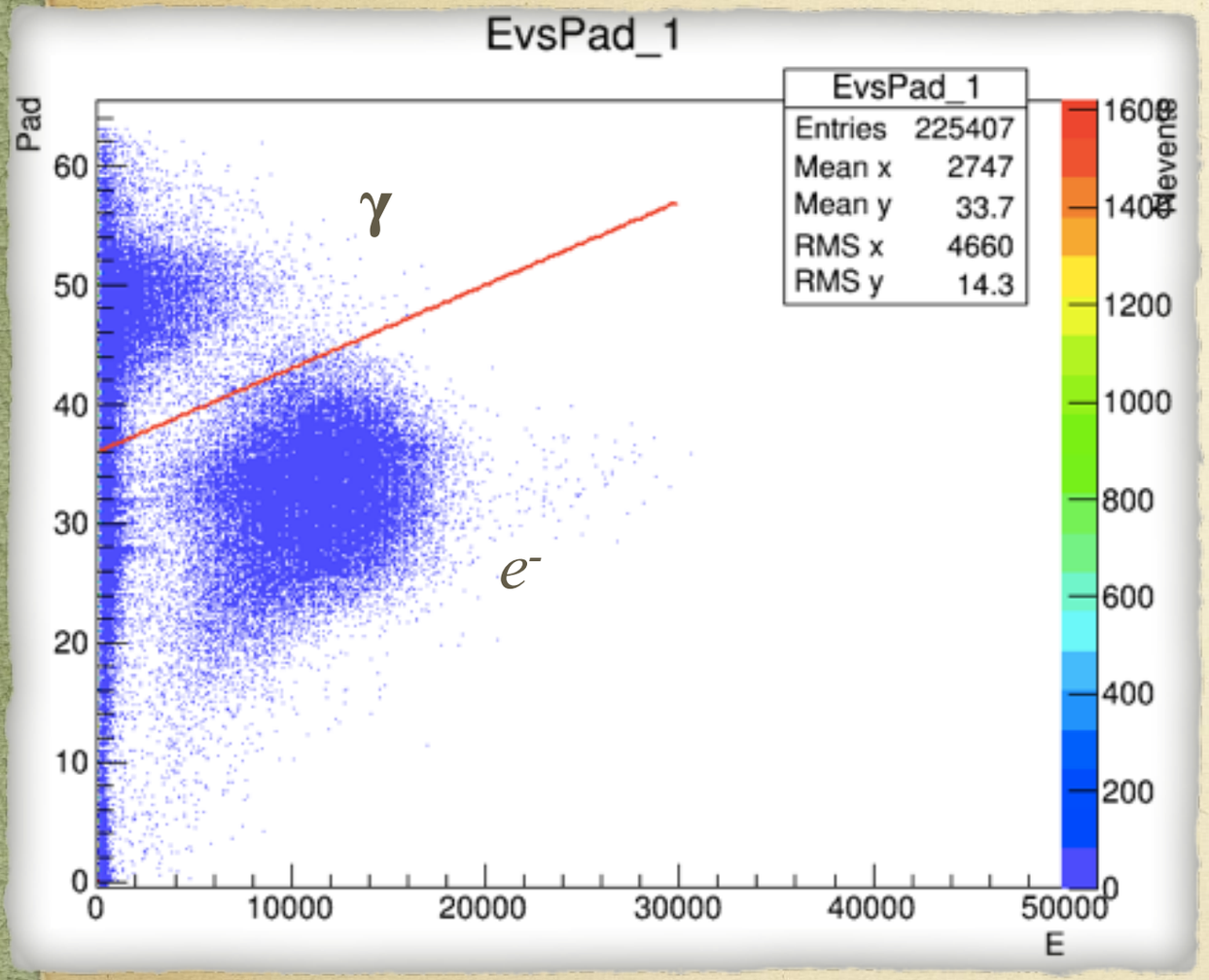




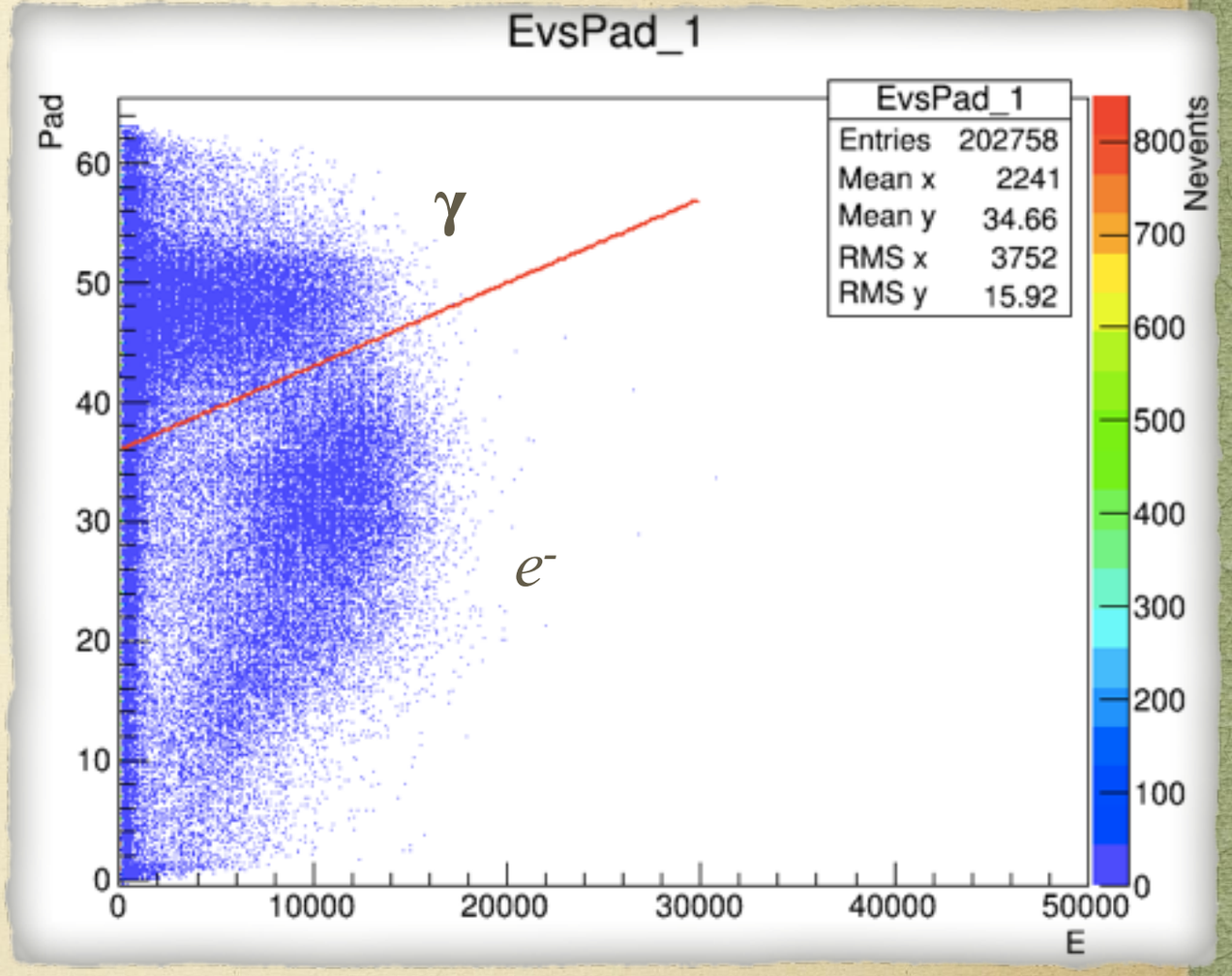
High Ee Veto,
~55K events
w/ divider
(Run 788)



2D cut

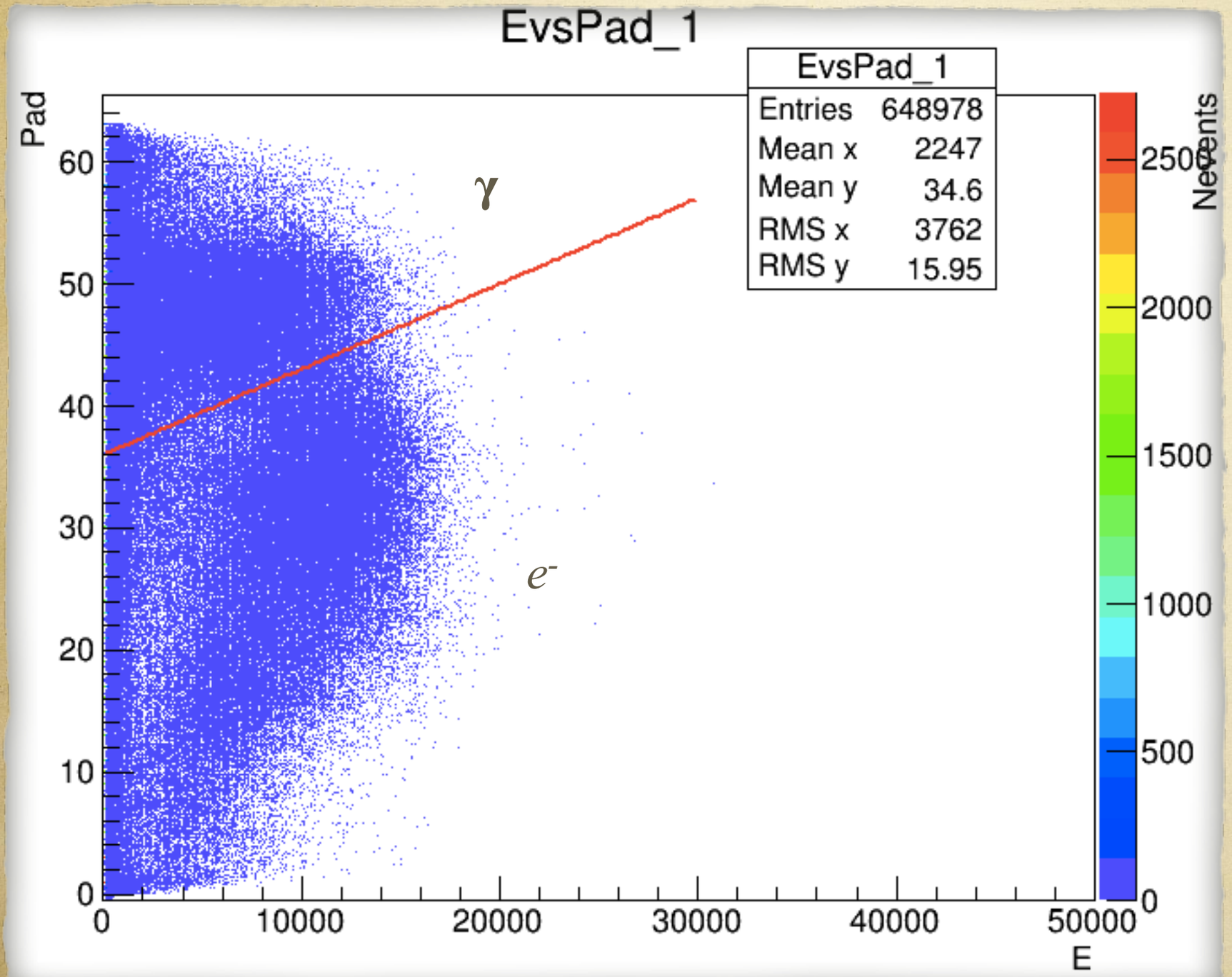


Low Eγ Trigger,
~55K events
w/ divider
(Run 771)



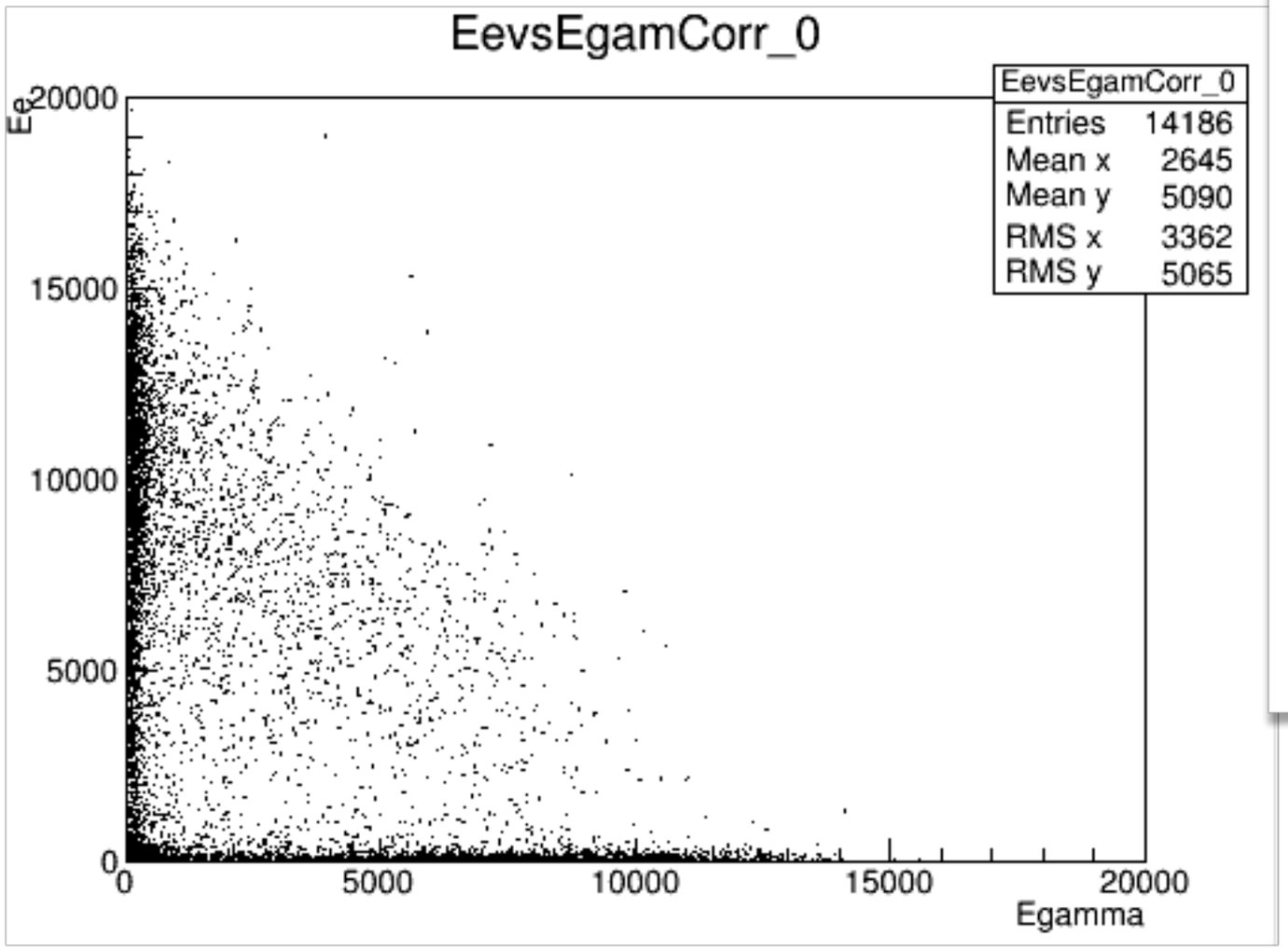
High Ee Veto,
~55K events
w/ divider
(Run 788)

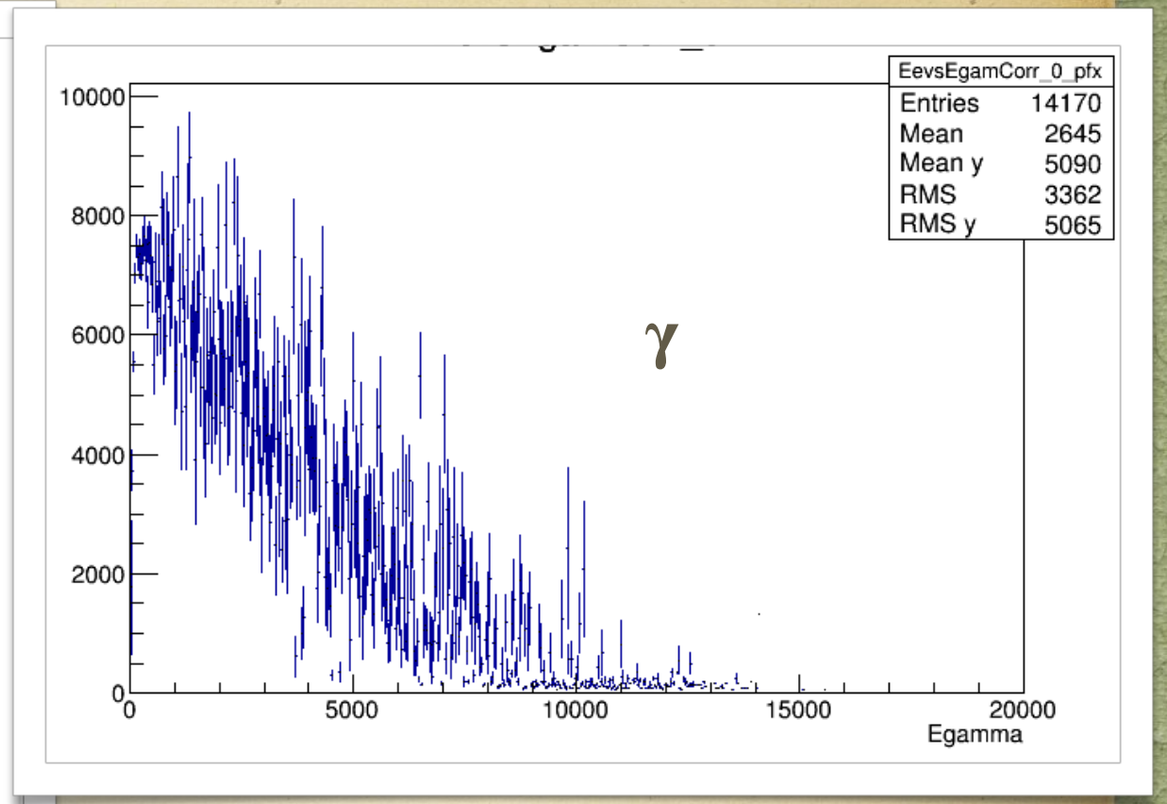
2D cut, Runs 788-801, HE veto



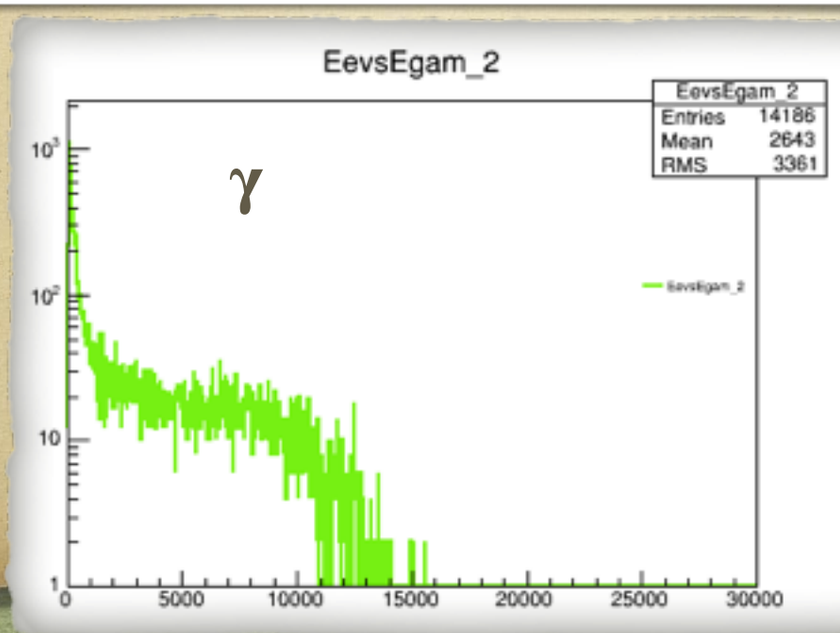
- Calorimeter w/ divider
- Cu target (1.5mm) before magnet
- Ee High Energy Veto
- Cut on NN_output > 0.95
- ~200K events
- (Run 788-801)

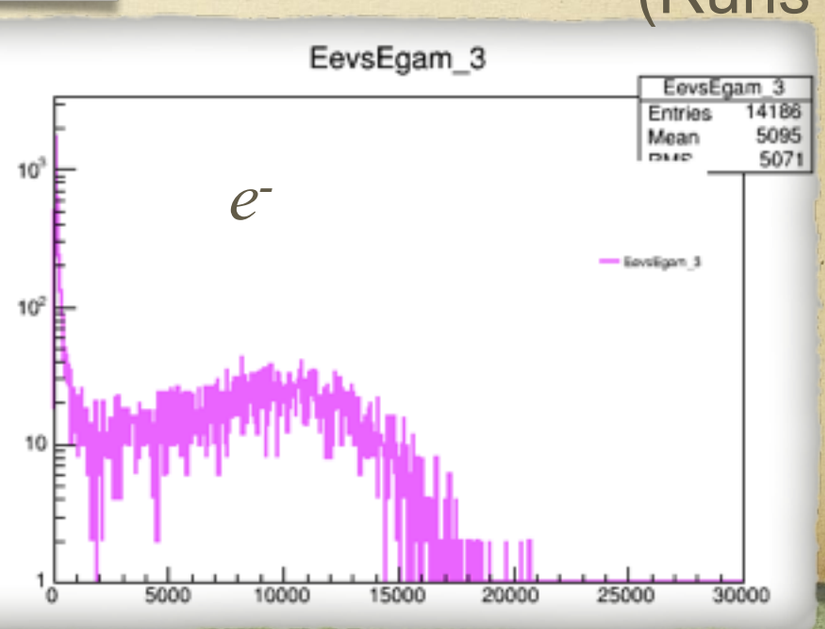
Ee vs Egamma, Ee High Energy Veto



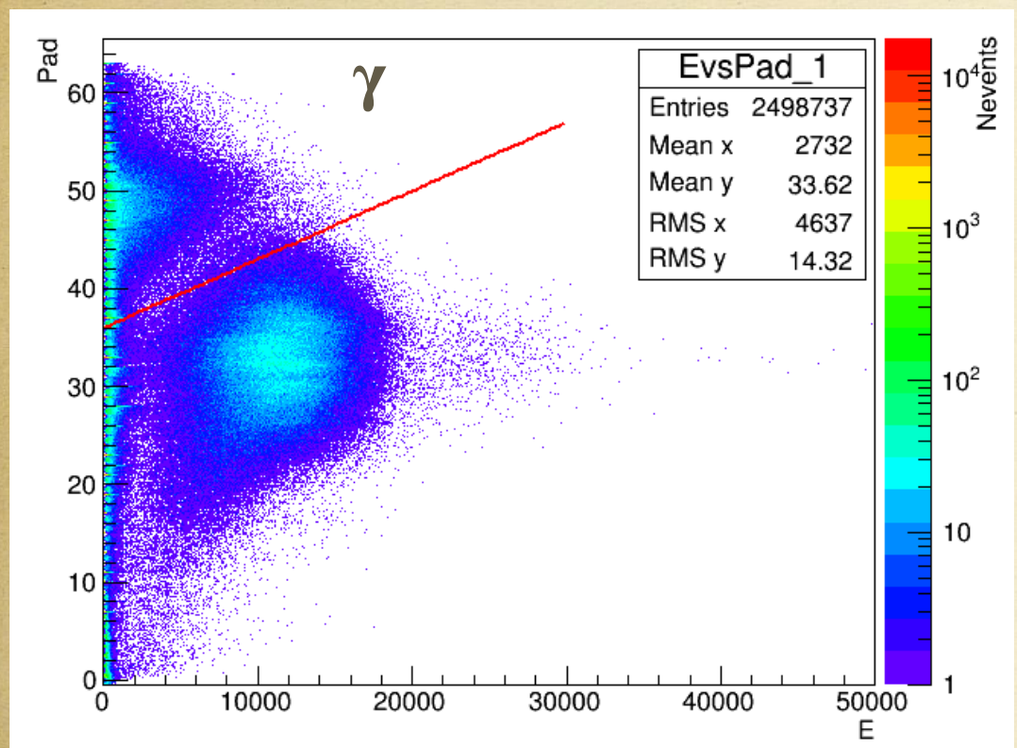


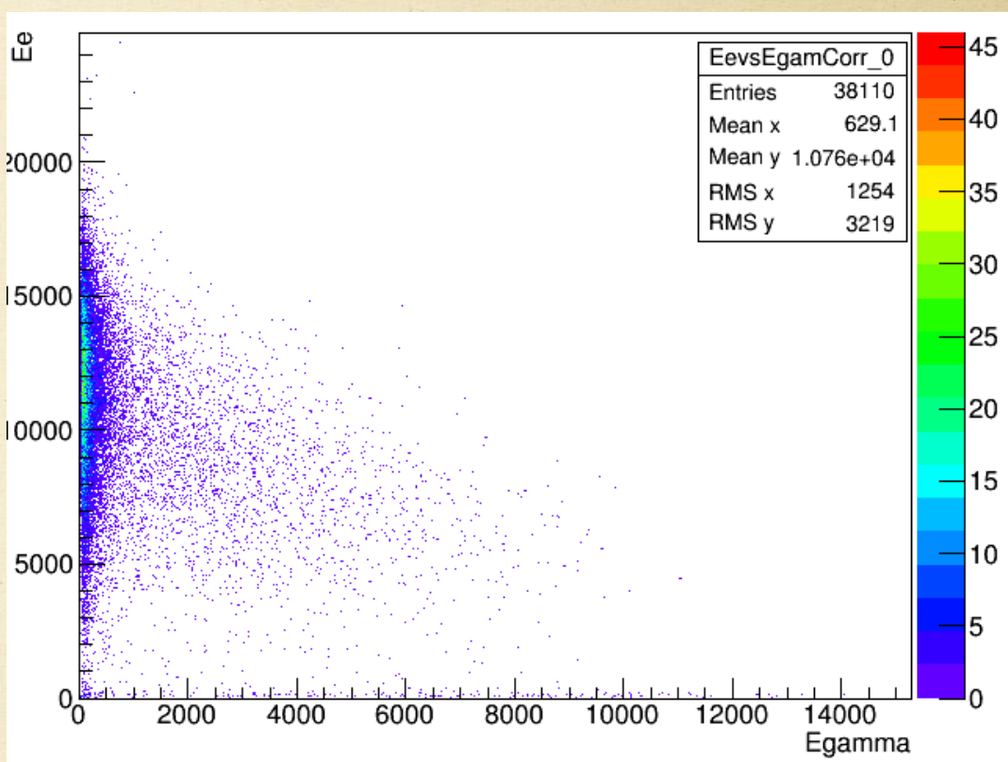
High Ee Veto,
~200K events
w/ divider
(Runs 788-801)



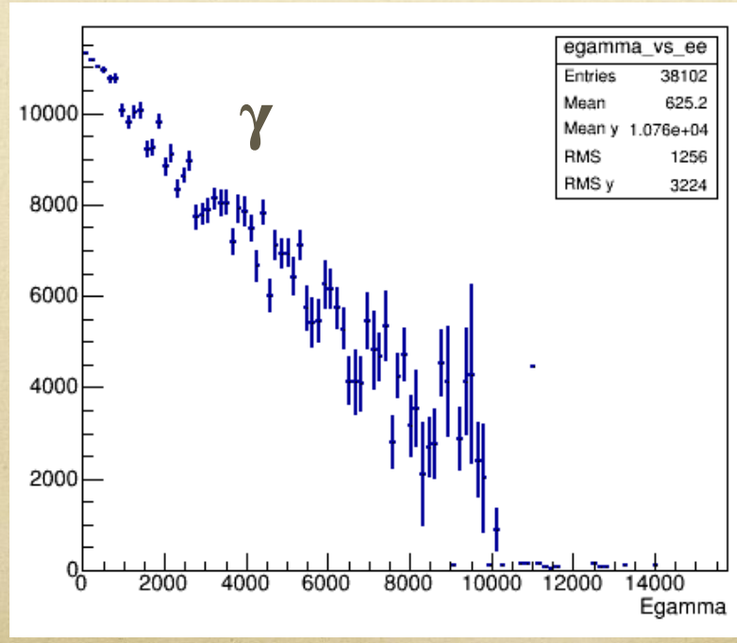


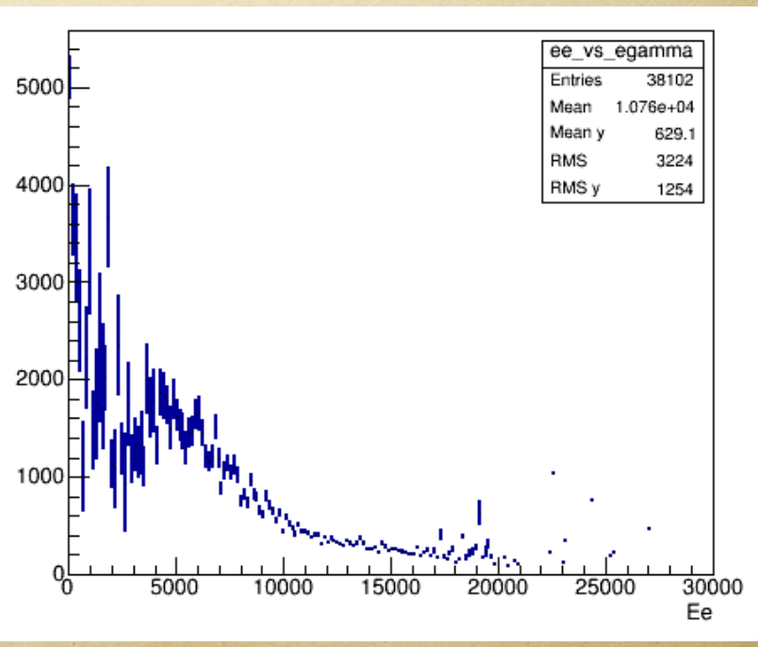
Ee vs Egamma, Low Eγ Trigger





Low Eγ Trigger, ~555K events w/ divider (Run 767-777)





Outlook

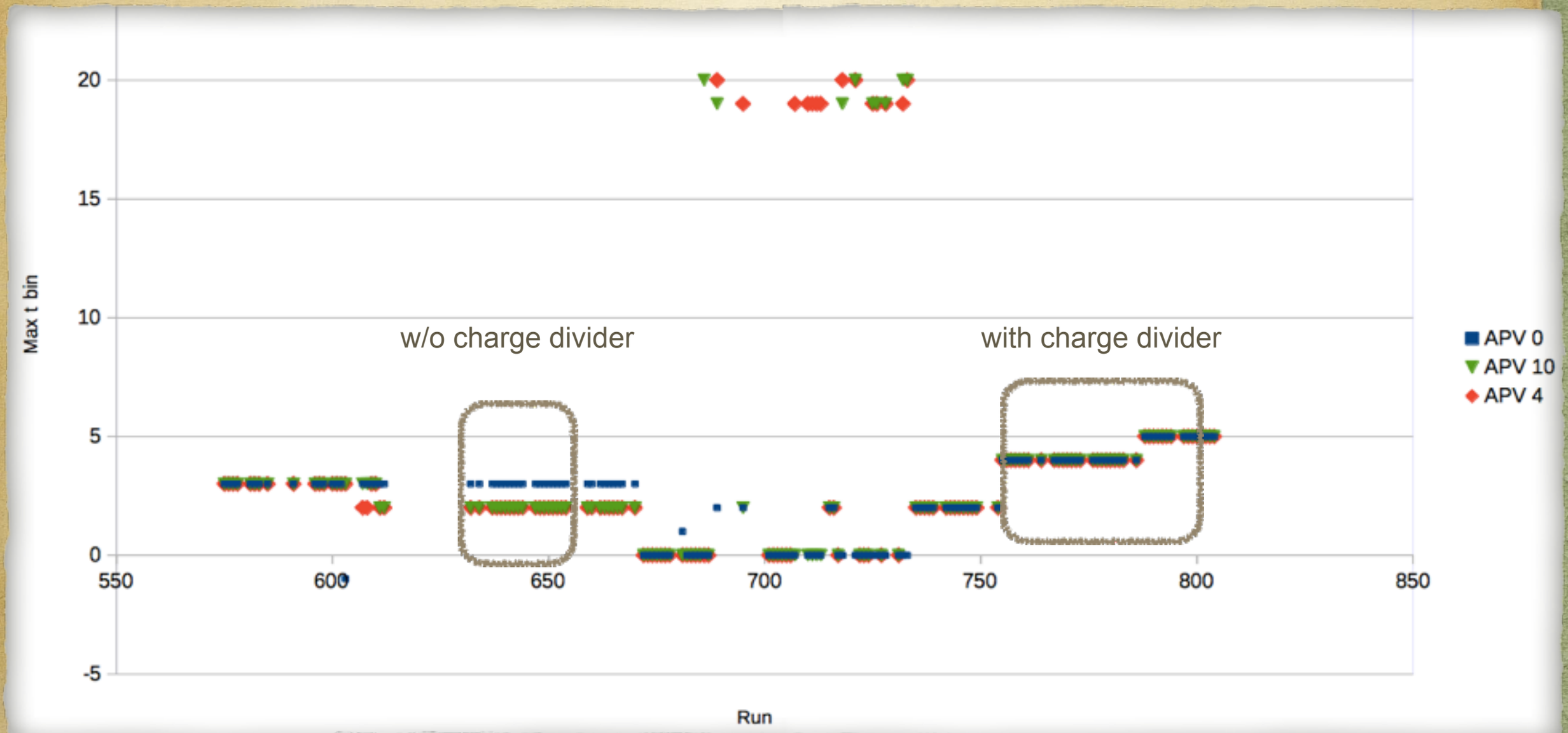
- Occupancy and signal distributions in Tracker look good after NN cut application

- Testing different clustering algorithms for 2016 test beam data. Checked them for different experimental conditions

- Linking neighbors algorithm gives reasonable results while E clustering and k-means need to be improved in order to be used
- Clustering allows to do a good separation between electrons and photons

Back up

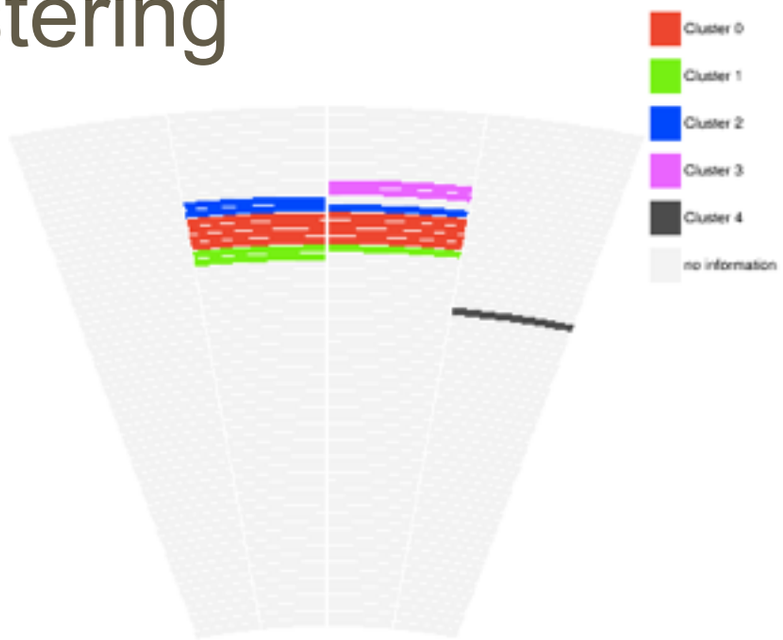
Max bins across all Runs, APV 0, 4,10



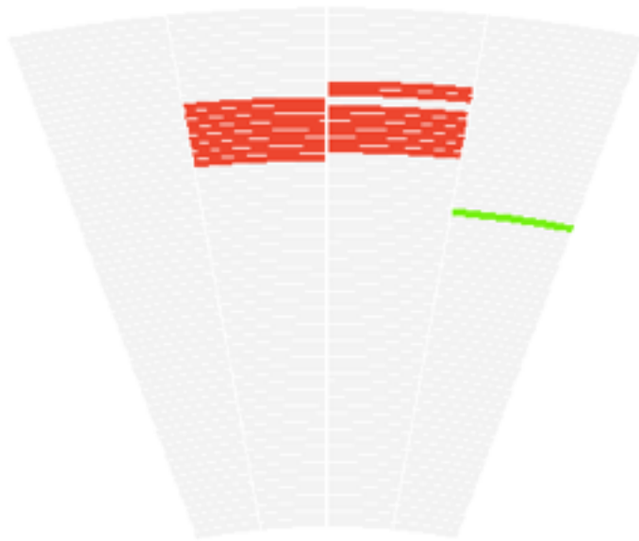
Runs	Tracker	Calorimeter,4	Calorimeter,10
575-610	3	3	3
611-670	3	2	2
672-733	0	0	0
715-716	2	2	2
735-754	2	2	2
755-786	4	4	4
788-804	5	5	5

Event 10, Run 741 @ 5 GeV w/ charge Divider

E clustering



Linking neighbors



k-means clustering