VTX at CNAO2024

Chris, Luana, Marco
Thanks to: Giacomo U., Yun, Riccardo

Threshold

CNAO2024:

- 9/11: Default
- 17/11 : 6 sigma
  - except run: 6964,6965: Default
- 18-11: logbook-threshold
- 19-11: logbook-threshold

Quantity of interest

- **Tracking efficiency**

$$\frac{\text{\#evt with a matched VTX}}{\text{\#evt with 1 BM track in the VTX acceptance}}$$

Quantity of interest

- **Tracking efficiency:**

$$\frac{\text{\#evt with a matched VTX}}{\text{\#evt with 1 BM track in the VTX acceptance}}$$

- **Cluster size**
  - Select events with only 1 track in VTX
  - Fill a histogram with cluster sizes from clusters forming tracks
    - mean
    - std_dev

Quantity of interest

- **Tracking efficiency:**

$$\frac{\text{\#evt with a matched VTX}}{\text{\#evt with 1 BM track in the VTX acceptance}}$$

- **Cluster size**
  - Select events with only 1 track in VTX
  - Fill a histogram with cluster sizes from clusters forming tracks
    - mean
    - std_dev

- **Sensors efficiency**
  - Intersection of BM track with the sensors
  - search for a cluster near the intersection point

    - $\frac{\text{\#evt with a clust near the intersection point (distance} \leq \text{2mm)}}{\text{\#evt with 1 BM track in the VTX acceptance}}$

Quantity of interest

- **Tracking efficiency:**

$$\frac{\text{\#evt with a matched VTX}}{\text{\#evt with 1 BM track in the VTX acceptance}}$$

- **Cluster size**
  - Select events with only 1 track in VTX
  - Fill a histogram with cluster sizes from clusters forming tracks
    - mean
    - std_dev

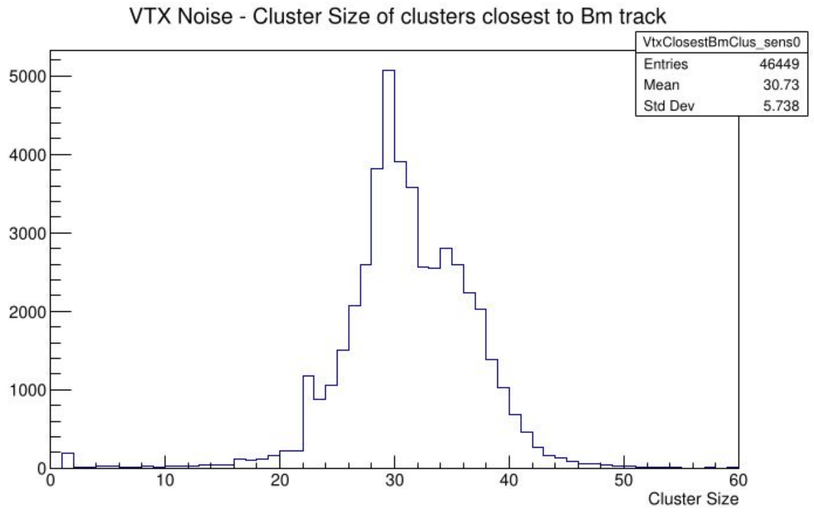
- **Sensors efficiency**
  - Intersection of BM track with the sensors
  - search for a cluster near the intersection point

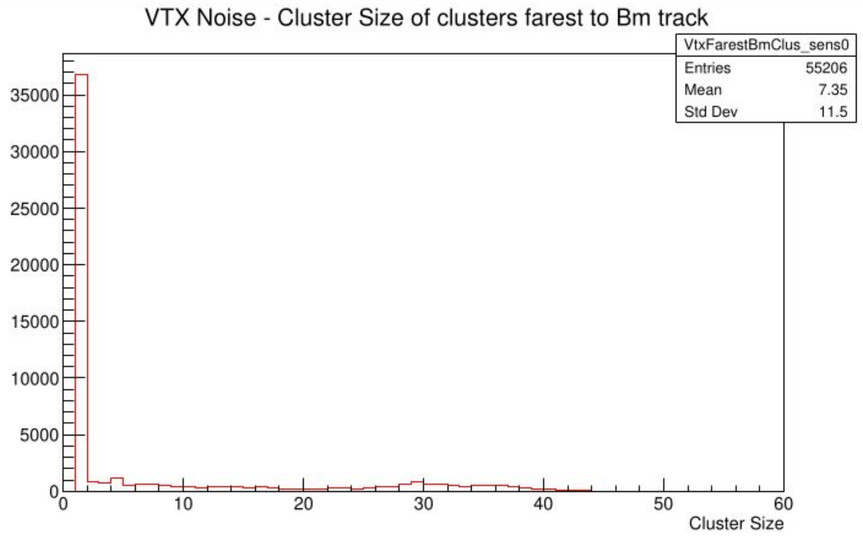
$$\frac{\text{\#evt with a clust near the intersection point(distance}\leq 2\text{mm)}}{\text{\#evt with 1 BM track in the VTX acceptance}}$$

Dependence on:

- VTX interalignment
- VTX-BM alignement

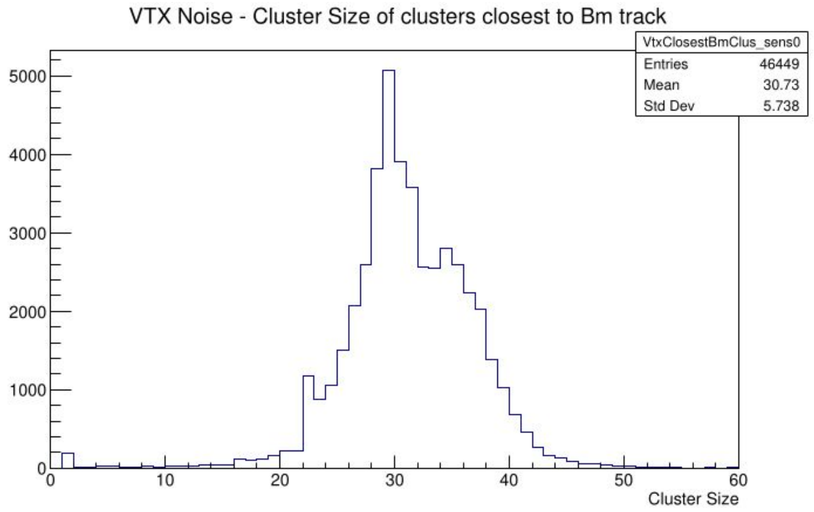
Sensors efficiency -> Cluster size

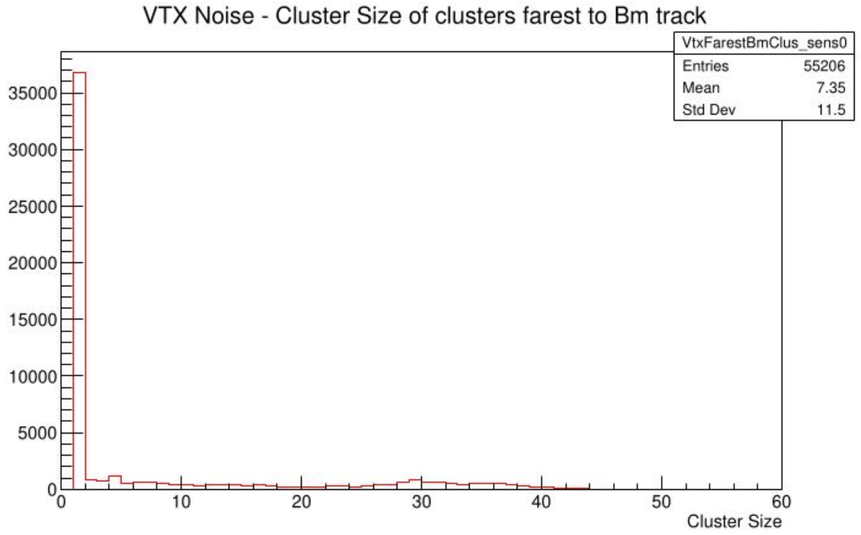




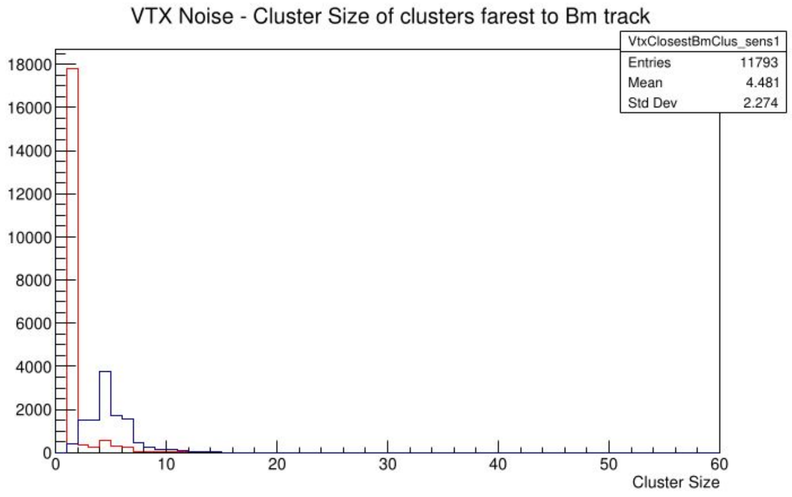
17/11/2024
C 200MeV/u run: 6923

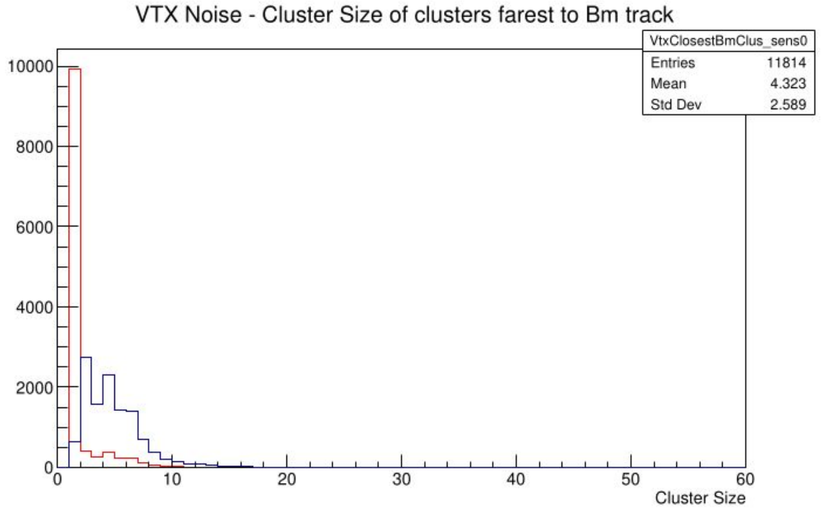
Sensors efficiency -> Cluster size





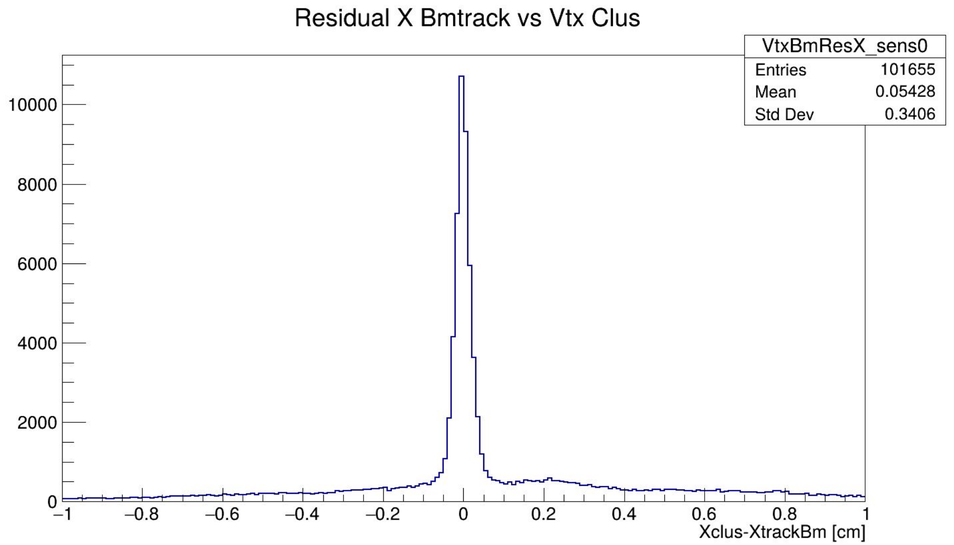
17/11/2024
C 200MeV/u, run: 6923

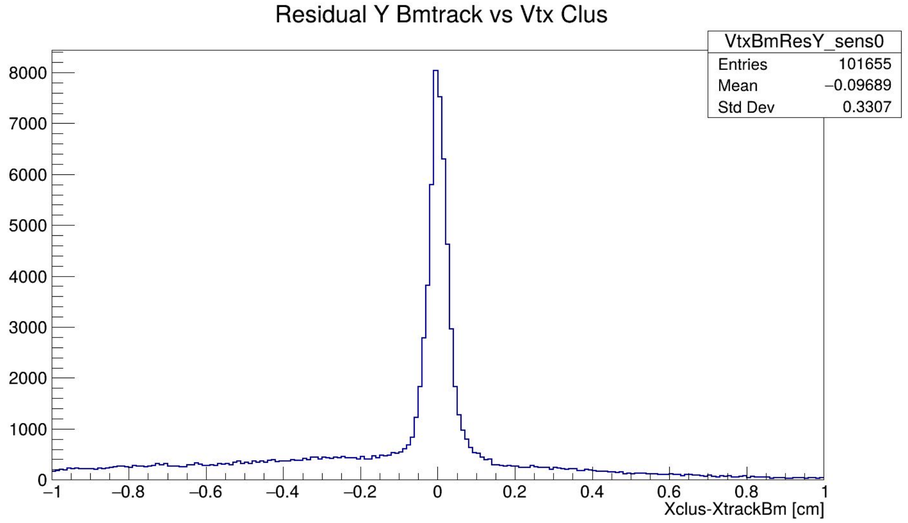




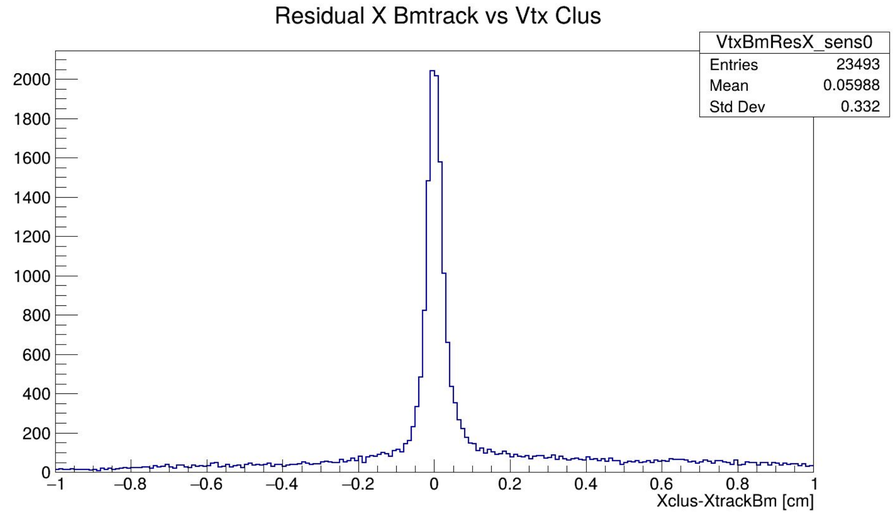
17/11/2024
p 230MeV run: 6929

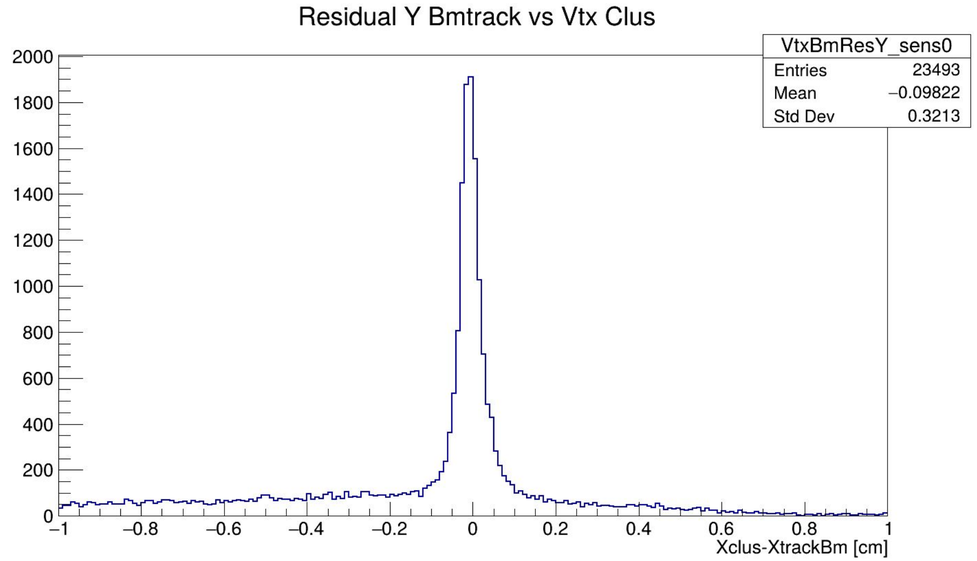
Sensors efficiency -> Residual





17/11/2024
C 200MeV/u run: 6923



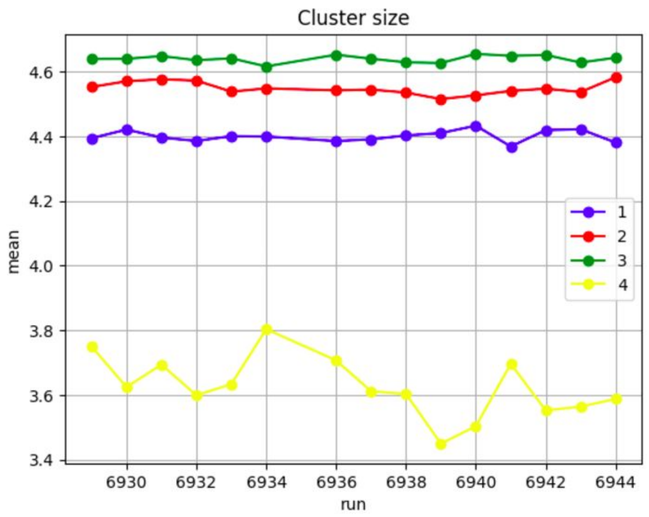


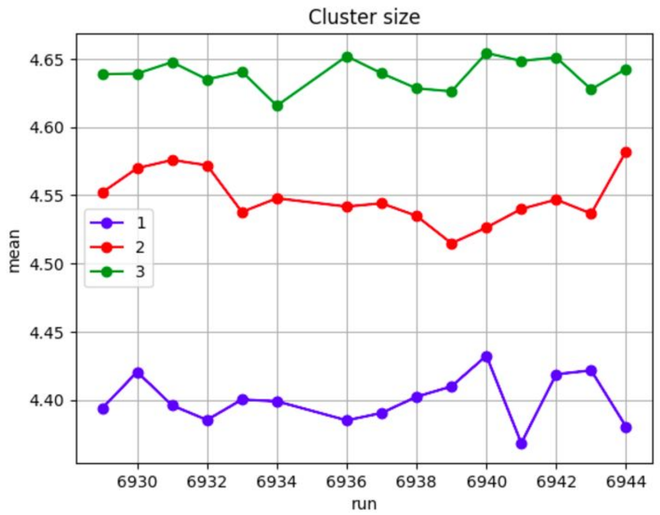
17/11/2024
p 230MeV run: 6929

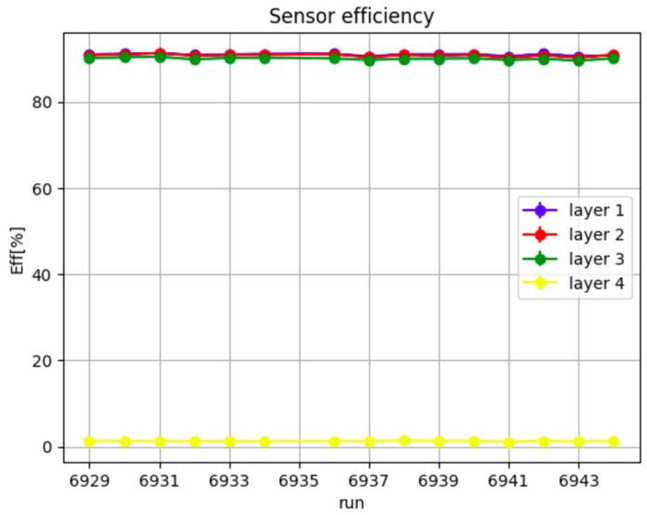
17/11/2024 Threshold

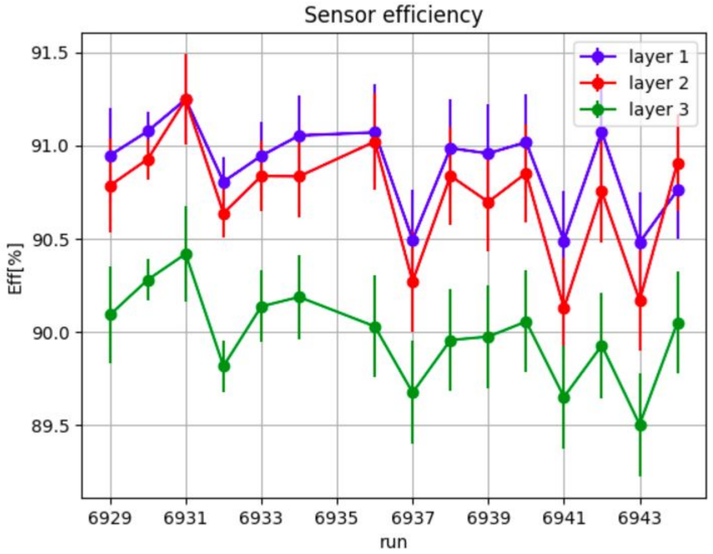
Protons 230MeV

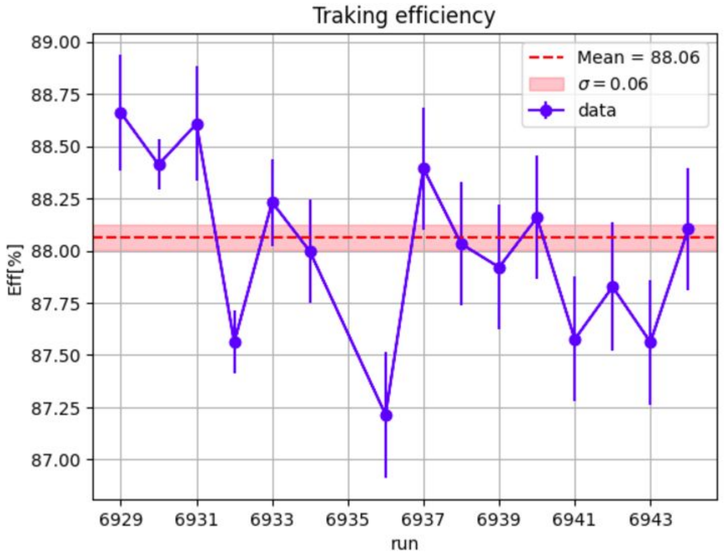
17/11/2024
run: 6929-6934, 6936-6944











Protons 230MeV

Threshold of the 17/11

-	17/11	17/11 (6964)	18/11 (6σ->7011)
Tracking efficiency	88.06 ± 0.06	28.22± 0.32	98.23 ± 0.11
Sensor 1 efficiency	90.93 ± 0.05	36.48± 0.35	91.34 ± 0.22
Sensor 2 efficiency	90.77 ± 0.05	72.18 ± 0.32	91.12 ± 0.22
Sensor 3 efficiency	90.03 ± 0.05	72.42 ± 0.32	90.48 ± 0.23
Sensor 4 efficiency	1.23 ± 0.02	0.037± 0.014	86.29 ± 0.27
Cluster size 1	4.402 ± 0.004	1.61 ± 0.01	4.39 ± 0.01
Cluster size 2	4.555 ± 0.004	1.63 ± 0.01	4.49 ± 0.01
Cluster size 3	4.638 ± 0.004	1.62 ± 0.01	4.54 ± 0.01
Cluster size 4	3.62 ± 0.02	1.62 ± 0.21	2.49 ± 0.01

- run of 17/11 are compatible with run at 6σ of the 18/11
  - difference on sensor 4 ➡ 18/11:: some noisy columns of the 4th sensor are masked, and a new power supply is used

- the last runs of the 17/11 (6964, 6965) are not compatible with previous ones
  - run 6964 and 6965, taken after a power cicle of VTX ➡ Default configuration of threshold

Protons 230MeV

Threshold of the 17/11

-	17/11	17/11 (6964)	18/11 (6σ->7011)
Tracking efficiency	88.06 ± 0.06	28.22± 0.32	87.33 ± 0.25
Sensor 1 efficiency	90.93 ± 0.05	36.48± 0.35	91.34 ± 0.22
Sensor 2 efficiency	90.77 ± 0.05	72.18 ± 0.32	91.12 ± 0.22
Sensor 3 efficiency			
Sensor 4 efficiency			
Cluster size 1			
Cluster size 2			
Cluster size 3			
Cluster size 4			

Consistency between runs ;)

-> all run (except 6964 and 6965) of the 17/11 at 6σ

- run of 17/11 are compatible with run at 6σ of the 18/11
  - difference on sensor 4 ➡ 18/11:: some noisy columns of the 4th sensor are masked, and a new power supply is used

- the last runs of the 17/11 (6964, 6965) are not compatible with previous ones
  - run 6964 and 6965, taken after a power cicle of VTX ➡ Default configuration of threshold

Protons

Default

-	17/11 (6964: 230 MeV)	9/11 (6749: 230 MeV)	9/11 (6766: 200MeV)	CNAO2023 (6113: 200MeV)
Tracking efficiency	28.22± 0.32	30.17± 0.43	37.42± 0.41	41.40± 4.35
Cluster size 1	1.61 ± 0.01	1.69 ± 0.01	1.69 ± 0.01	1.70± 0.09
Cluster size 2	1.63 ± 0.01	1.62 ± 0.01	1.70 ± 0.01	–
Cluster size 3	1.62 ± 0.01	1.66± 0.01	1.67 ± 0.01	1.63± 0.08
Cluster size 4	1.62 ± 0.21	1.54 ± 0.08	3.21 ± 1.01	2.31± 0.13

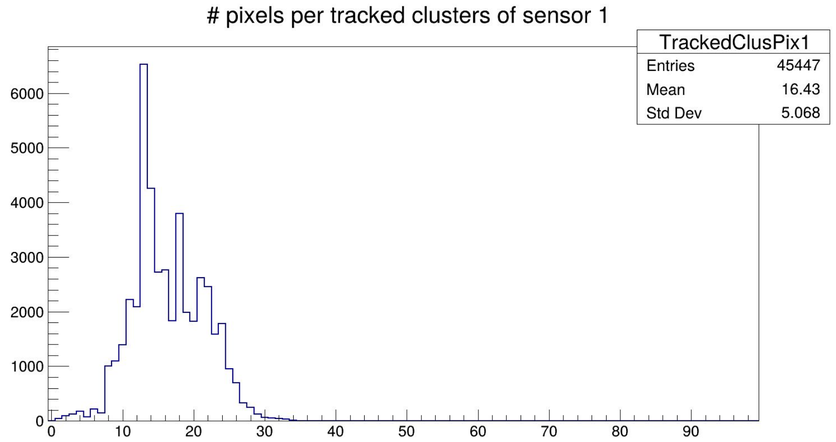
- consistency between 6964 & 6749 ➡ run of the 9/11 and 6964, 6965 of 17/11 have the config: Default
- consistency between 6766 of CNAO2024 and 6113 of CNAO2023 ➡ also CNAO2023 is at Default ?

-	9/11 (6749: 230 MeV)	17/11 (6964: 230 MeV)	18/11 (7013: 230MeV)
Threshold	Default	Default	Max
Sensor efficiency 1	37.57± 0.46	36.48± 0.35	77.02± 0.33
Cluster size 1	1.69 ± 0.01	1.61 ± 0.01	1.66 ± 0.01

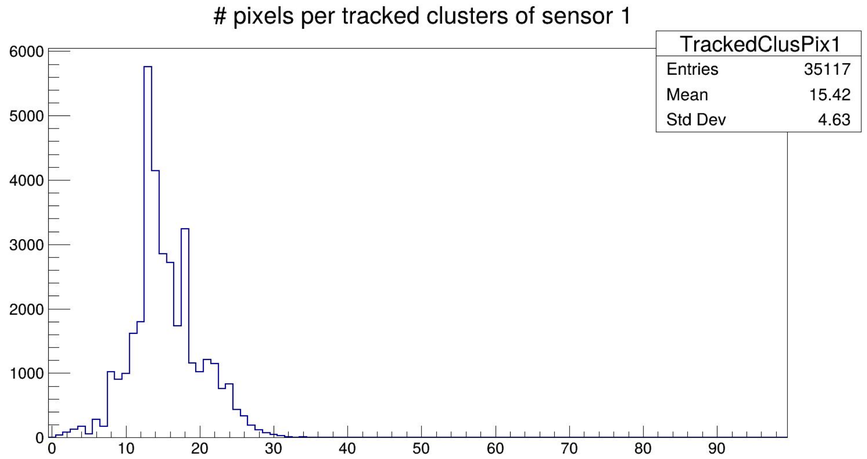
Default seems to be different from Max (255)!!

Cluster size in different campaigns (ch3 HW is the same)

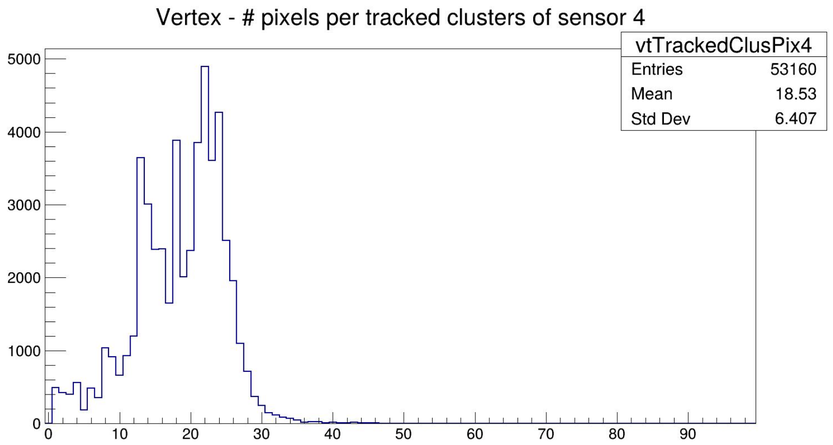
- CNAO2024: 200MeV/u C (6747)
  - Default



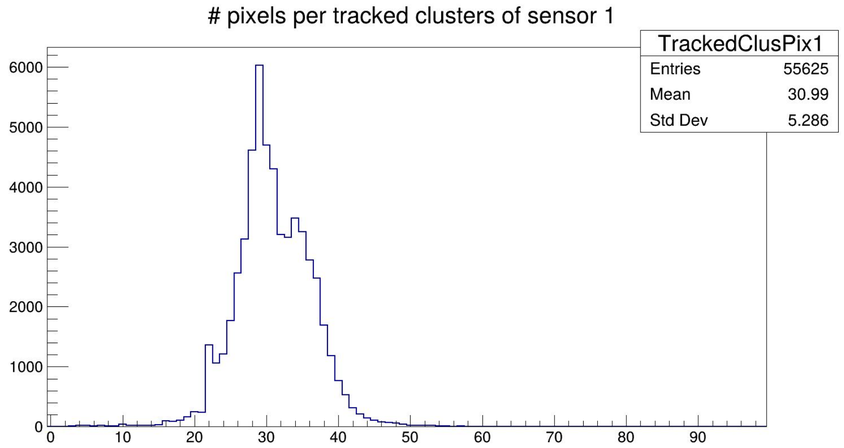
- CNAO2023: 200MeV/u C (6307)



- CNAO2022: 200MeV/u C (5460)



- CNAO2024: 200MeV/u C (6923)
  - 6σ



CNAO2022 and CNAO2023 have the same cluster size of CNAO2024 with Default configuration, and is different from the cluster size at 6σ.

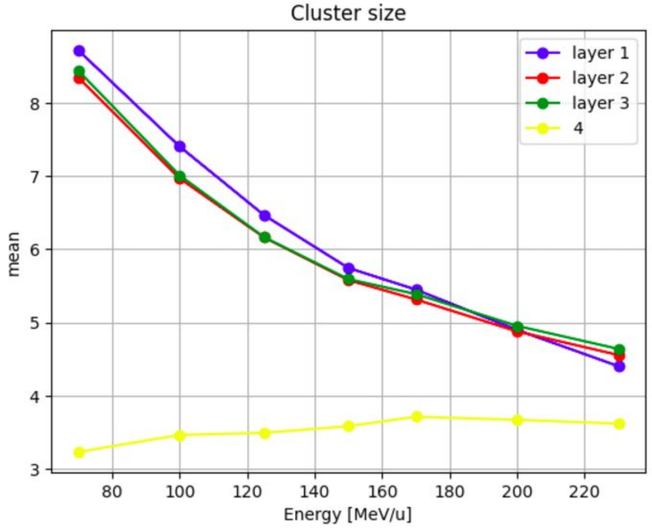
Is possible that also in this 2 campaigns the VTX is at Default?

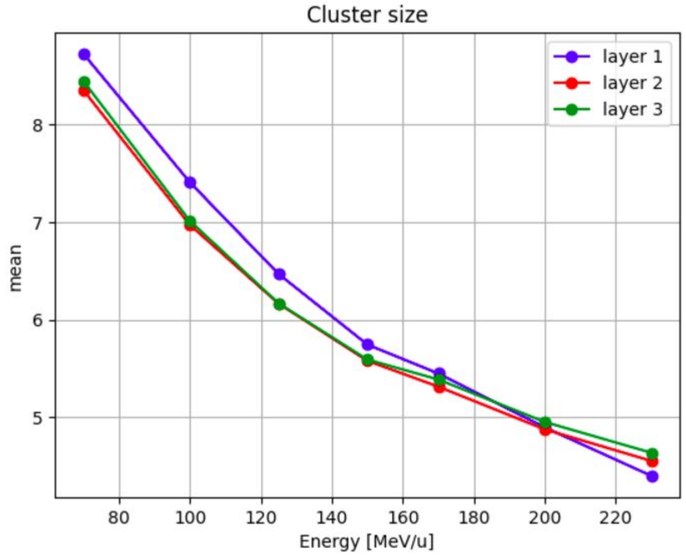
17/11/2024 Energy scan

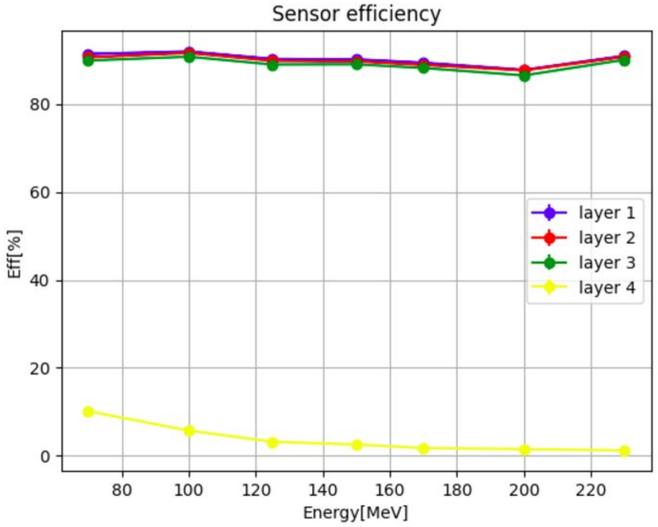
(Threshold = 6σ)

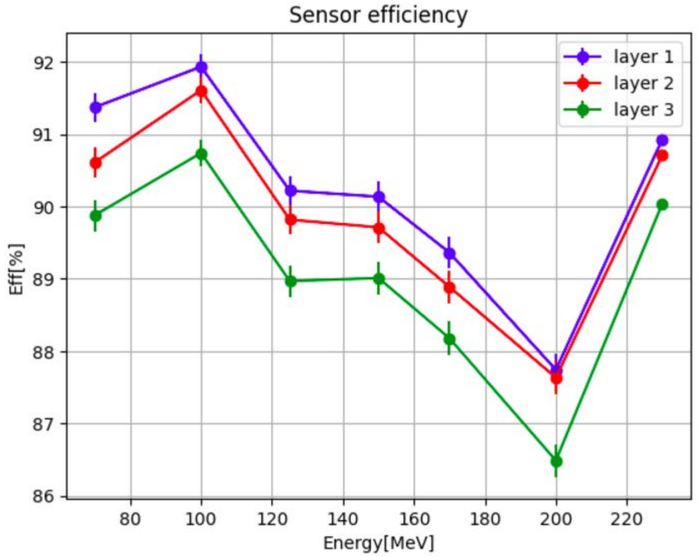
Protons: Energy scan

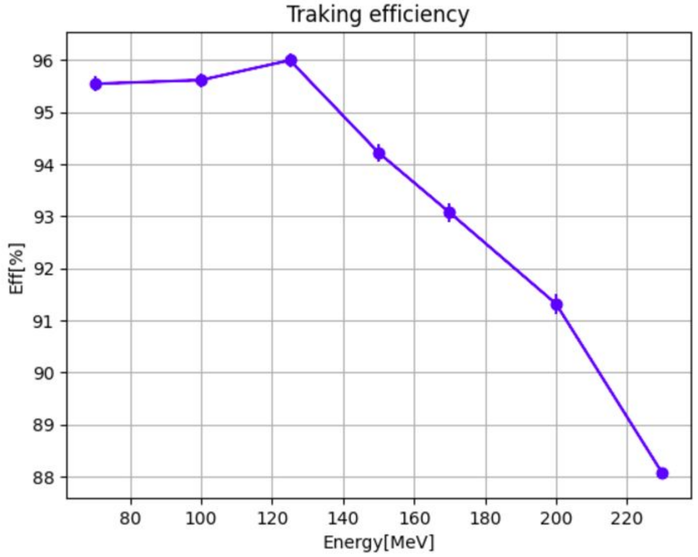
17/11/2024
run: 6946-6951





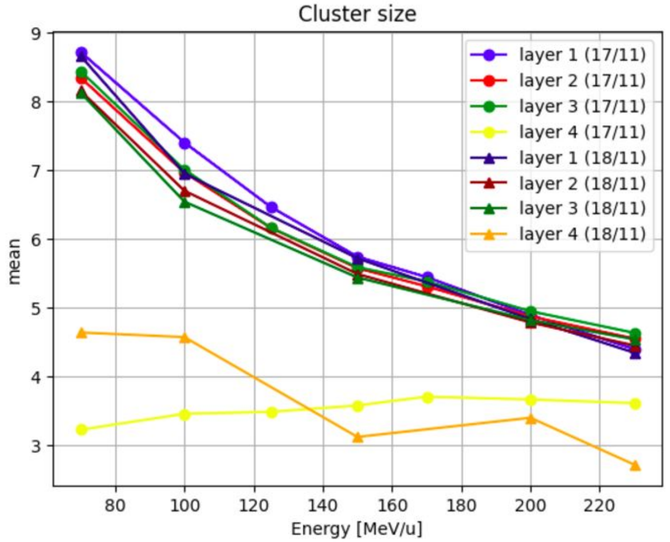


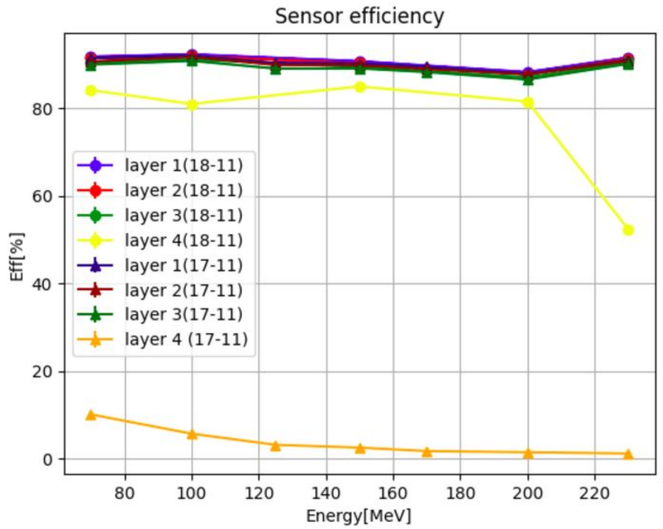


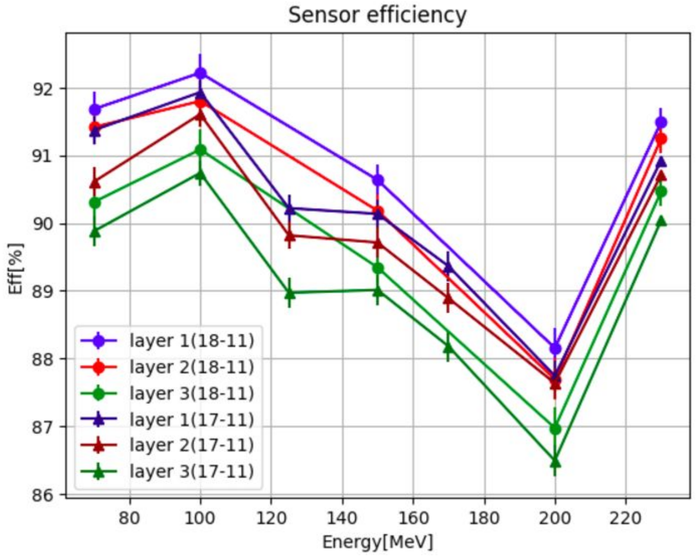


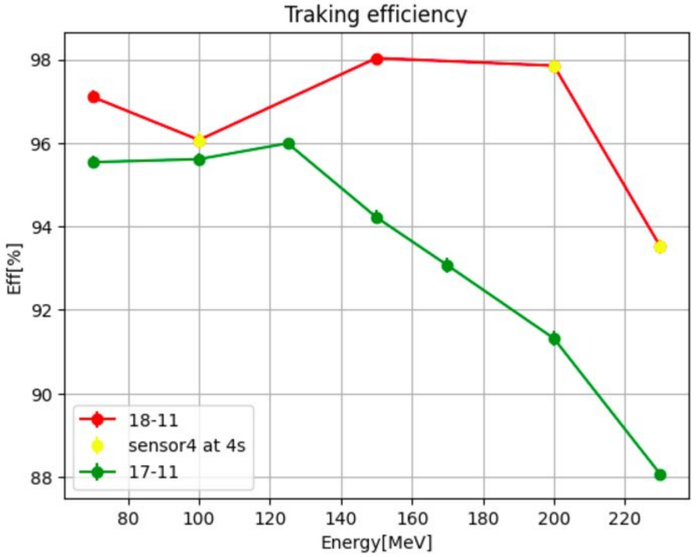
Energy scan 17/11 vs 18/11

17/11/2024
run: 6946-6951





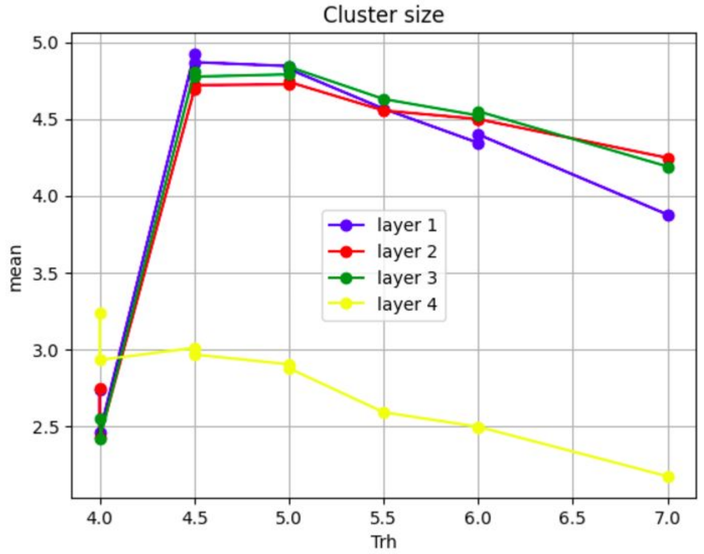


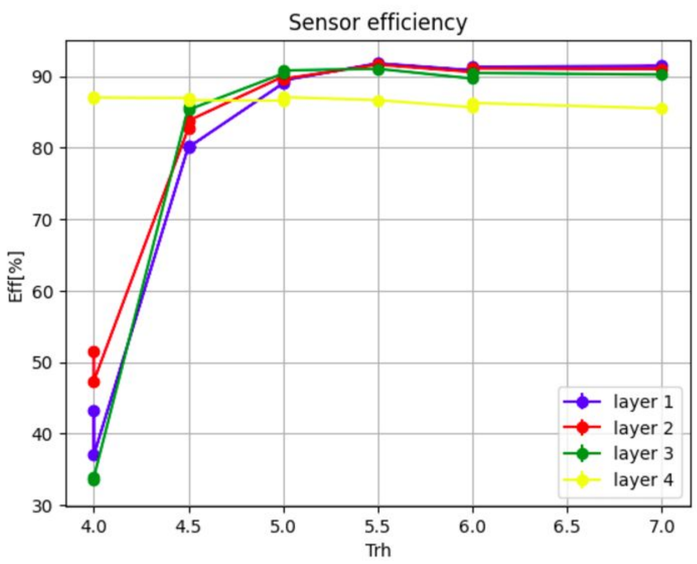


18/11/2024 Threshold scan

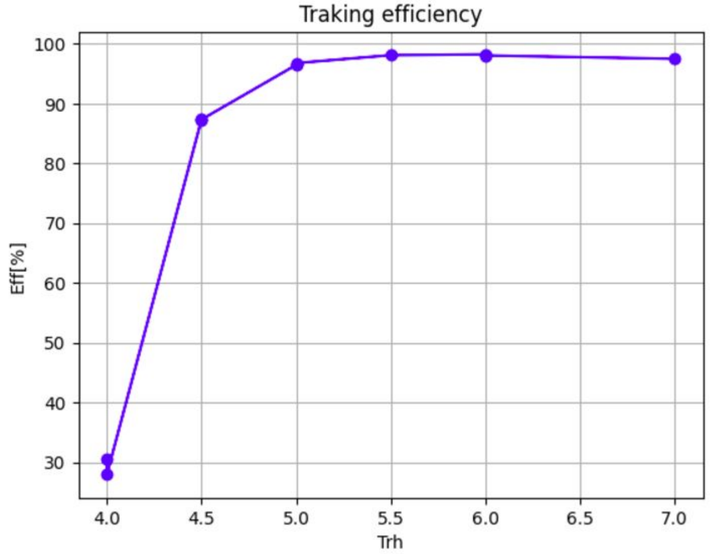
230MeV Protons

Threshold scan



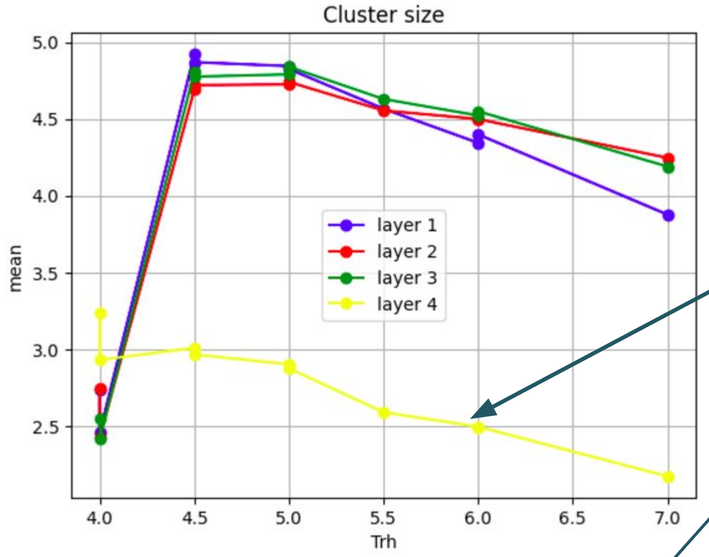


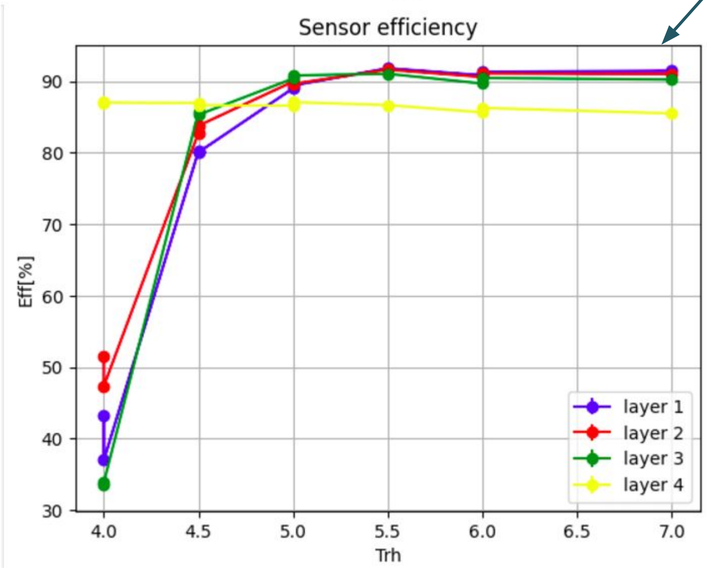
18/11/2024
run: 7005, 7007-7015, 7017, 7018



230MeV Protons

Threshold scan

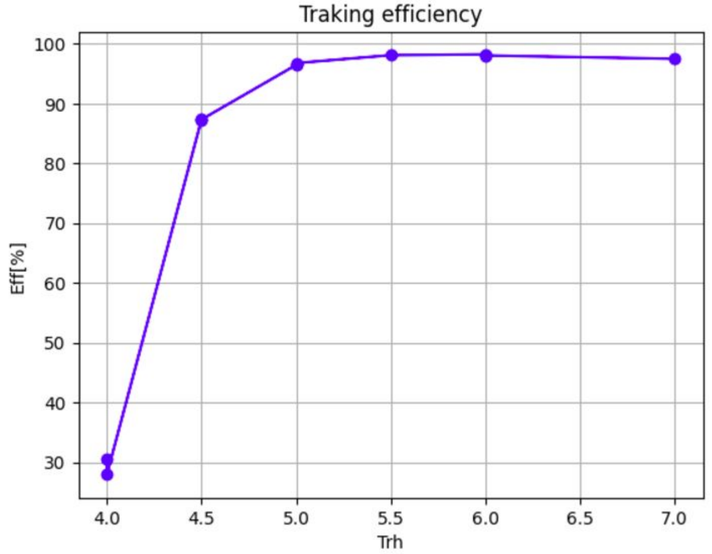




- Cluster size of sensor 4, on 17/11, at 6σ was at : 3.61+/- 0.54
- Sensor 4 efficiency is improved

The only difference respect to the 17/11 are that some noisy columns of the 4th sensor are masked and the power supply is changed.

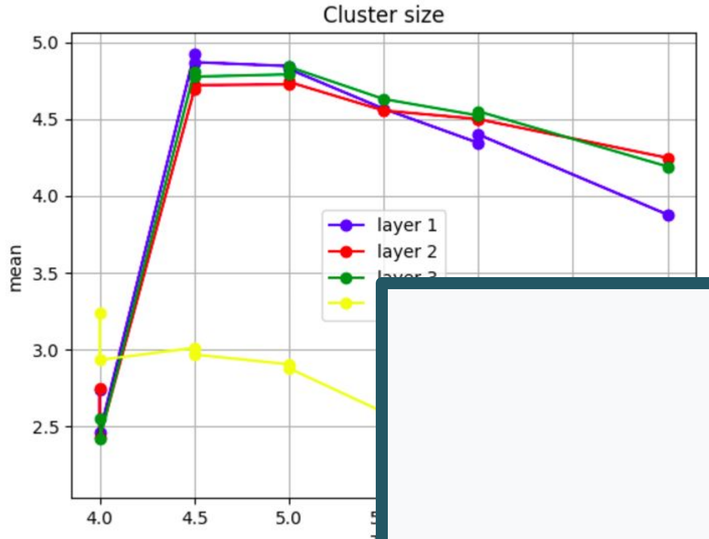
18/11/2024
run: 7005, 7007-7015, 7017, 7018



230MeV Protons

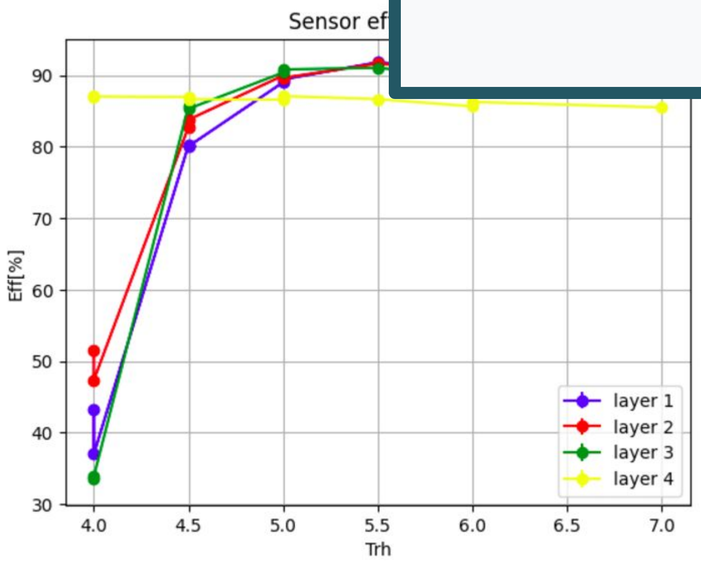
Threshold scan

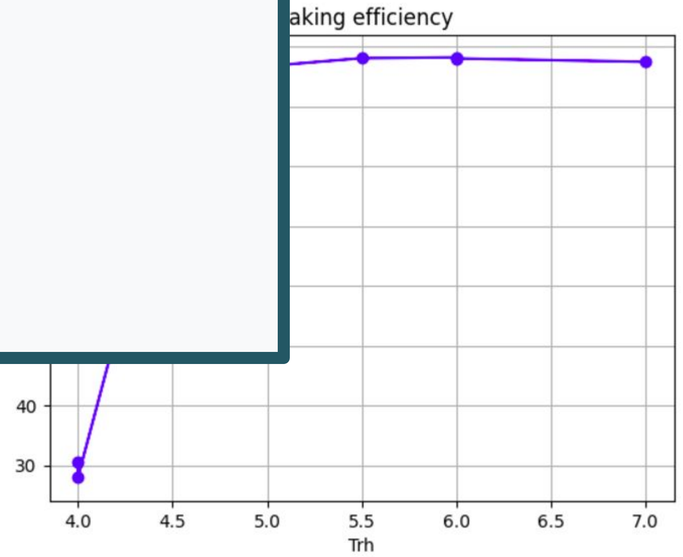
18/11/2024
run: 7005, 7007-7015, 7017, 7018



- Cluster size of sensor 4, on 17/11,

What happened to 4σ?





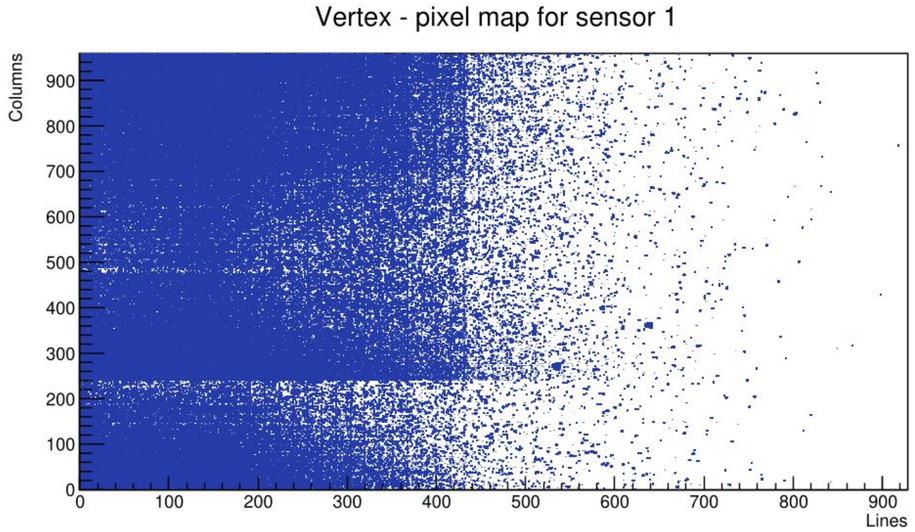
The only difference respect to the 17/11 are that some noisy columns of the 4th sensor are masked and the power supply is changed.

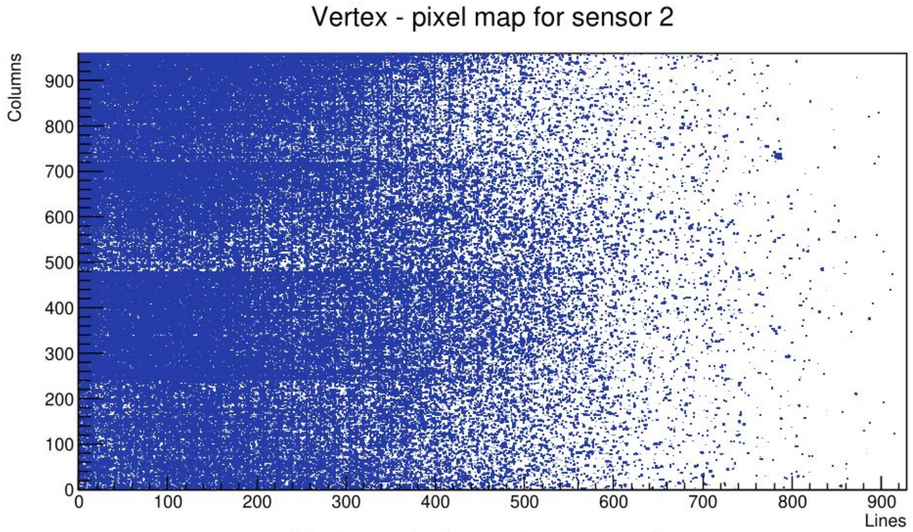
230MeV Protons

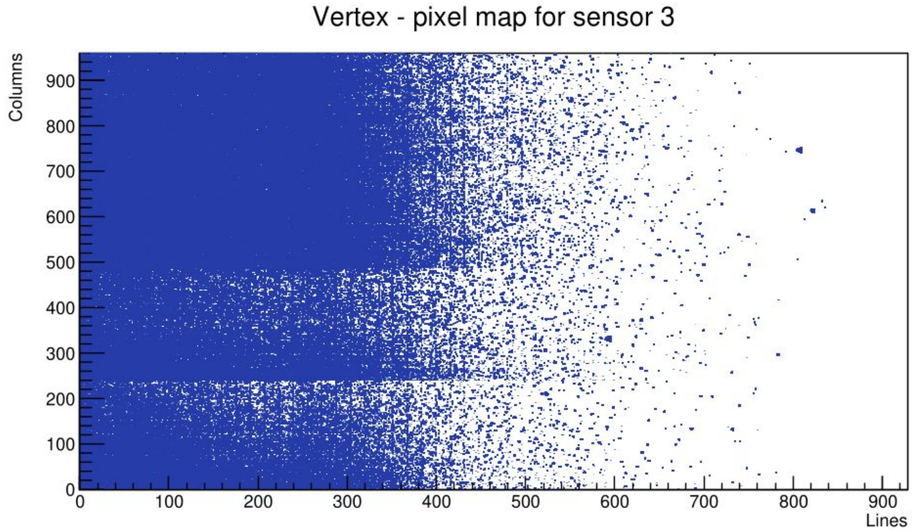
Threshold study: 4σ

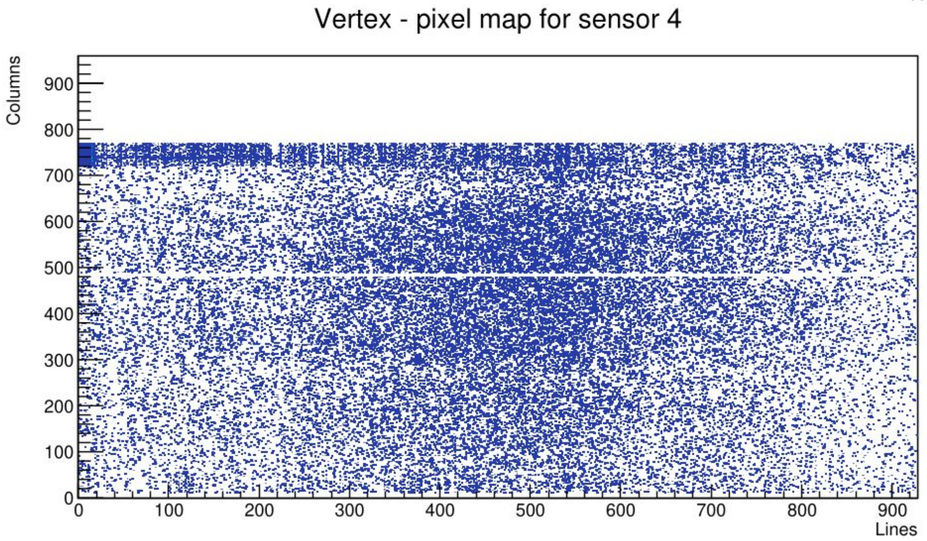
18/11/2024

run 7014 -> all layer at 4σ





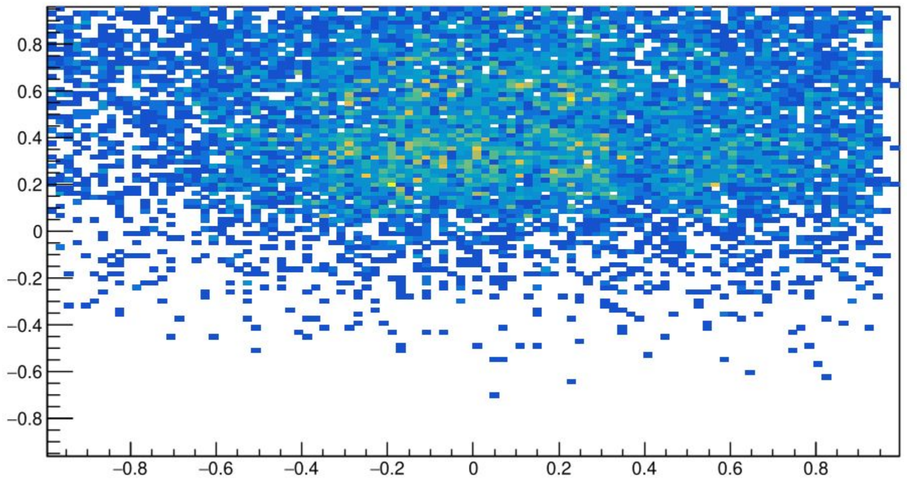


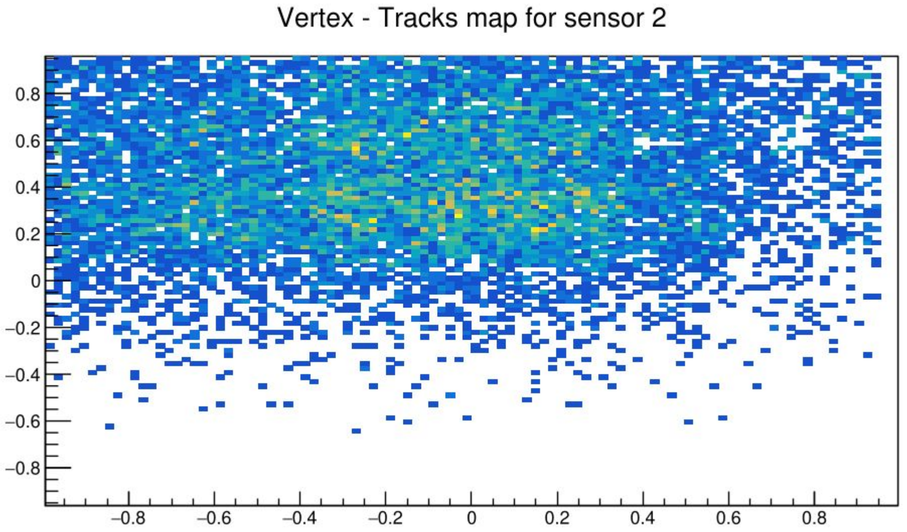


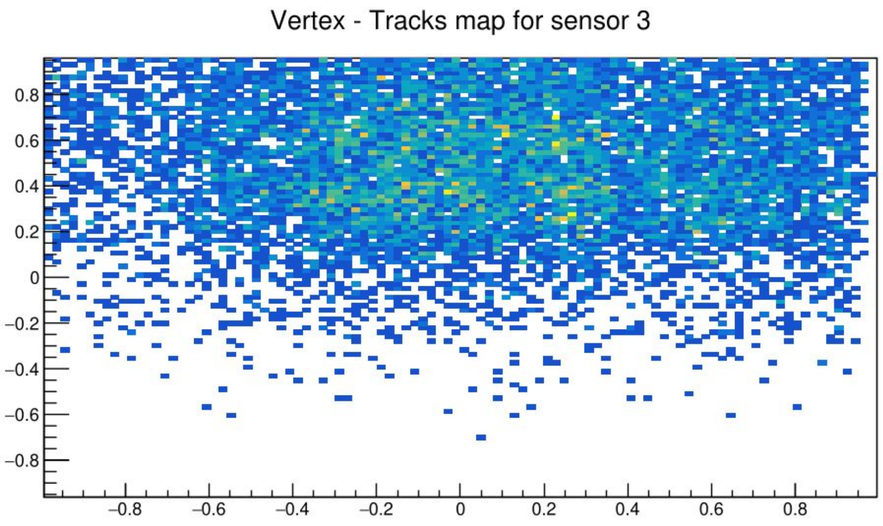
Only the sensor 4 can operate at 4σ !!!

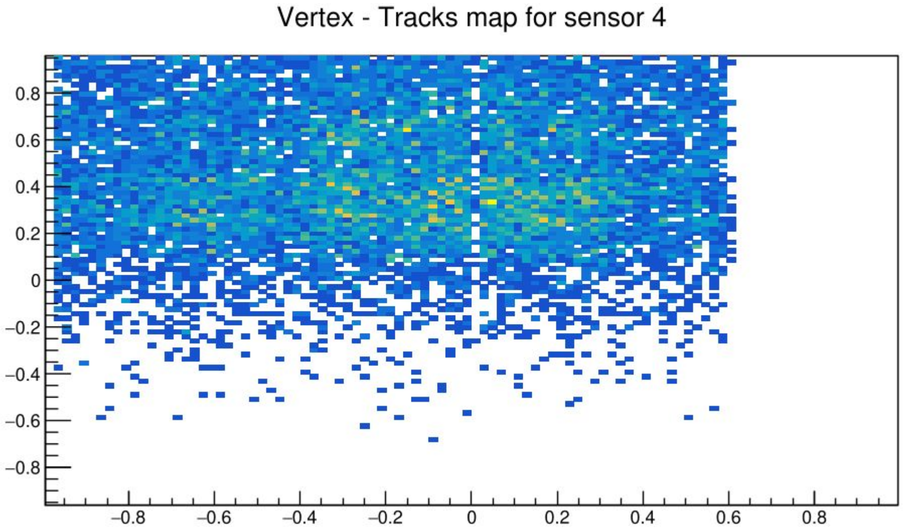
230MeV Protons

Threshold study: 4σ









run 7014 -> all layer at 4σ

The track maps reveal the beam shape

↓

tracks can be reconstructed despite the noise.

This threshold is not viable as half of the detector is non-functional.

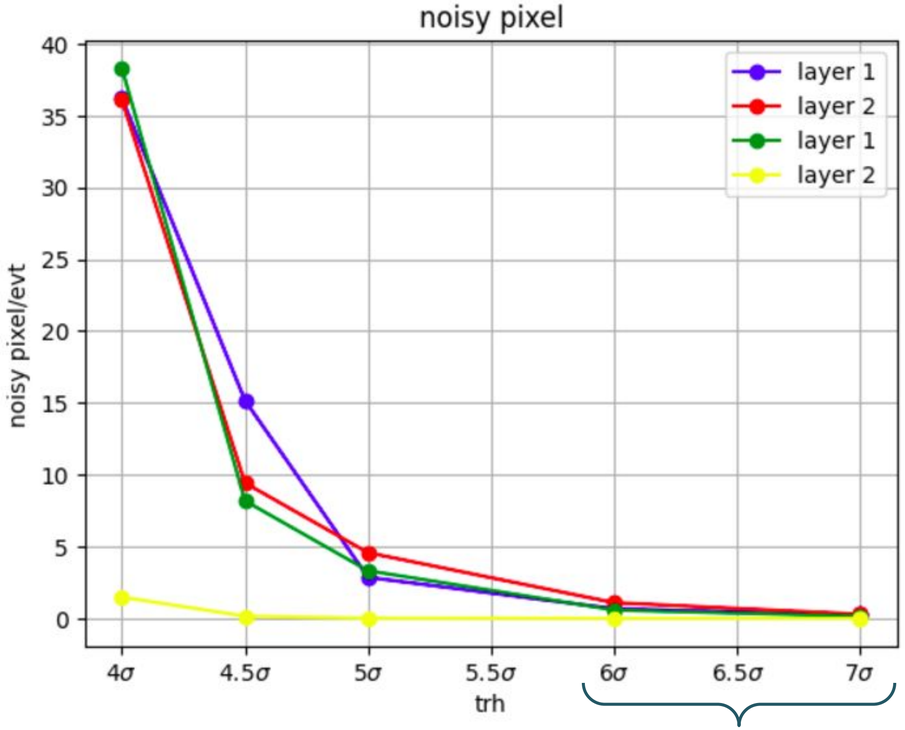
(some features also at 4.5σ and 5σ)

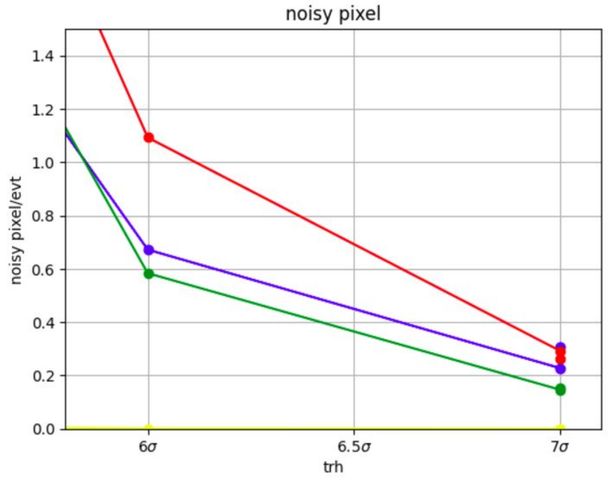
Pedestal run to study the noise

run: 6993-6997, 7000

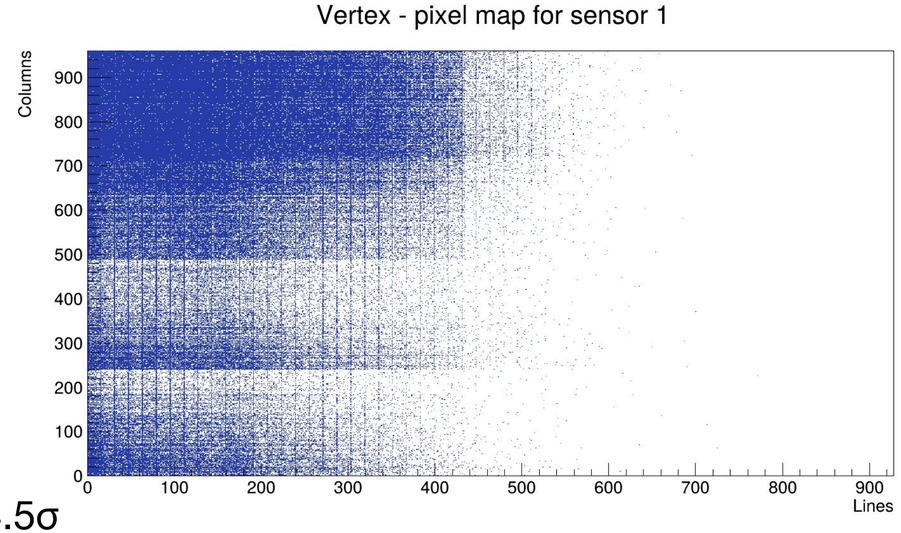
❖ **Noisy pixel:**

$$\frac{\#\text{active pixel}}{\#\text{events}}$$

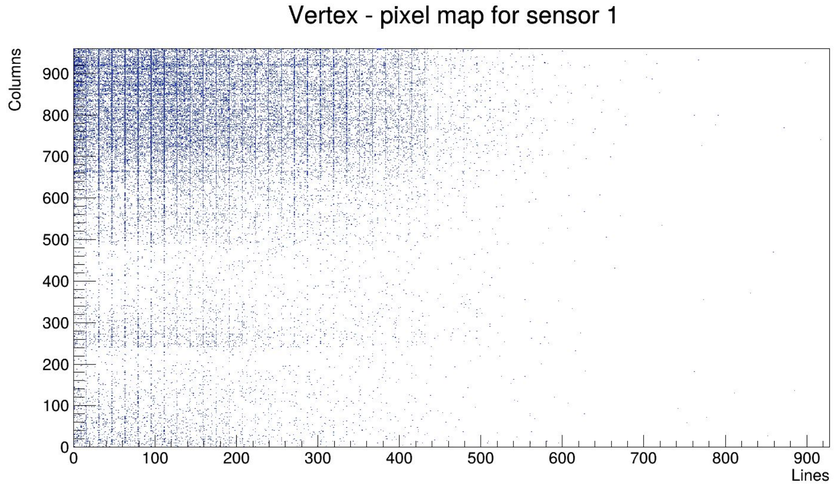




- 4σ

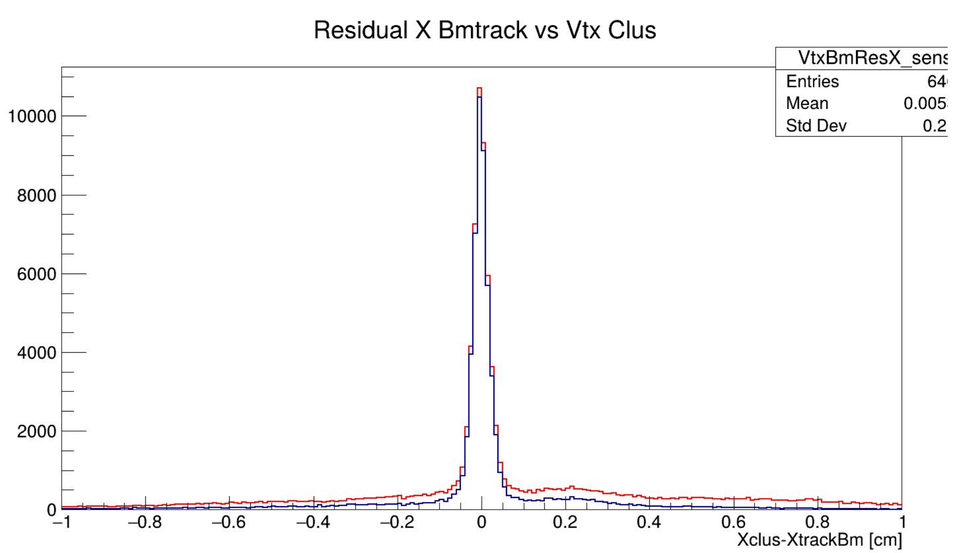


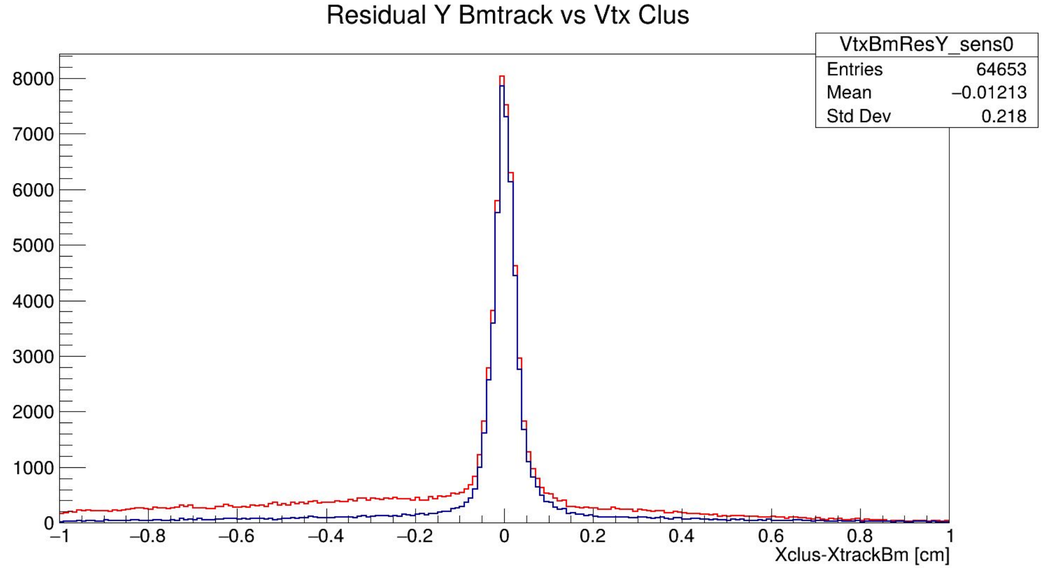
- 4.5σ




come fai..SBAI

Sensors efficiency -> Residual





17/11/2024
C run: 6923

- Cluster size>=1
- Cluster size>=2

Asymmetry of residual:

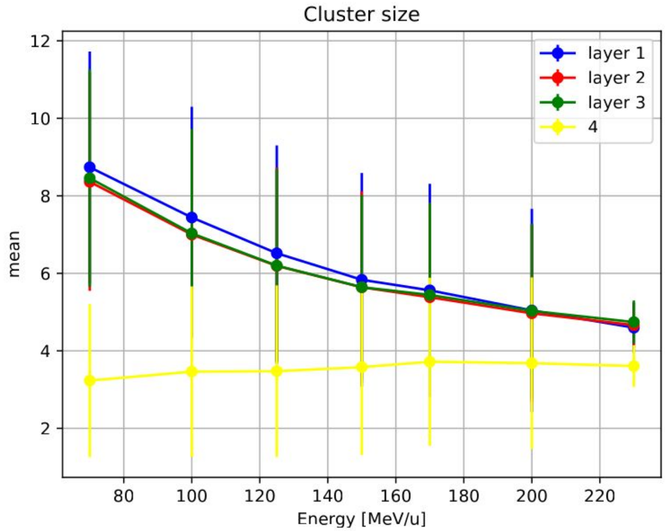
- present in all sensors
- present when eliminating noise at cluster size 1

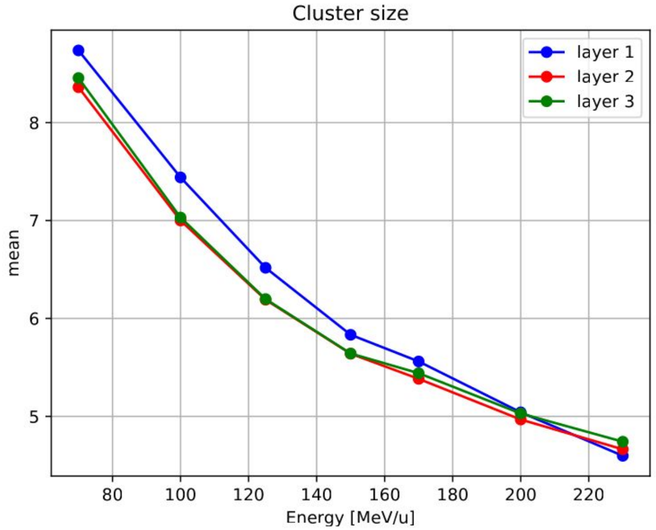
→ Do to the PileUp -> for a more precise analysis it is necessary to observe the (asymmetric) beam size for pileup events

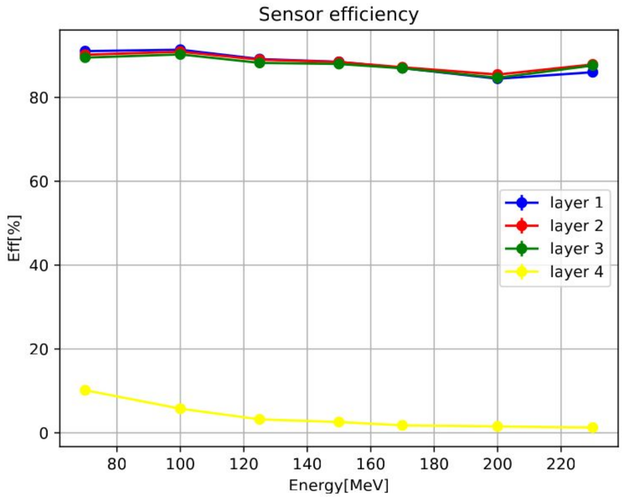
config1: min 2 pixel per cluster

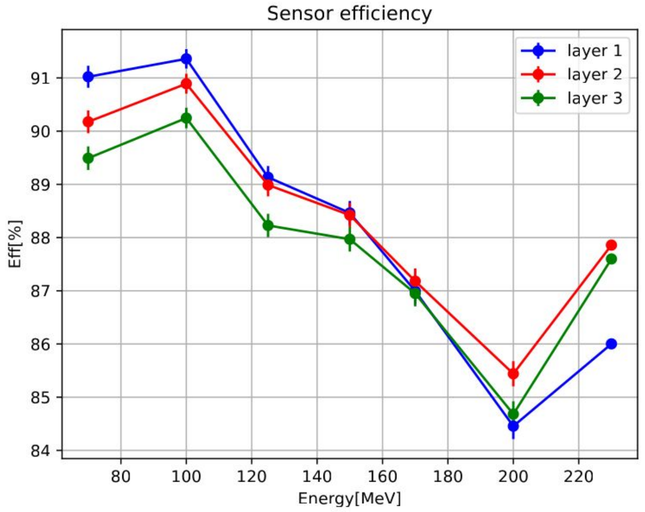
Protons: Energy scan

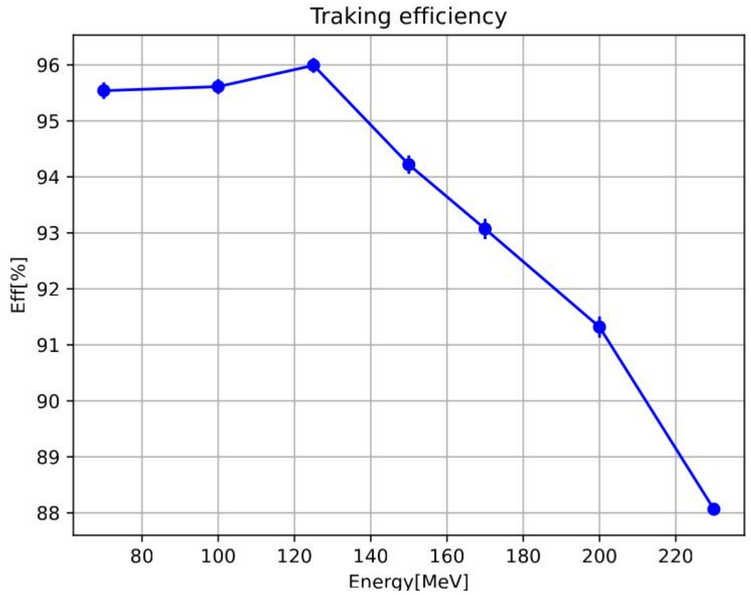
17/11/2024
run: 6946-6951









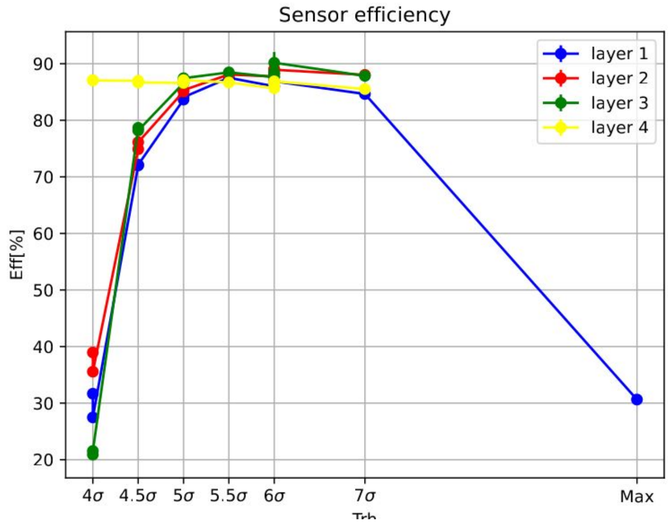


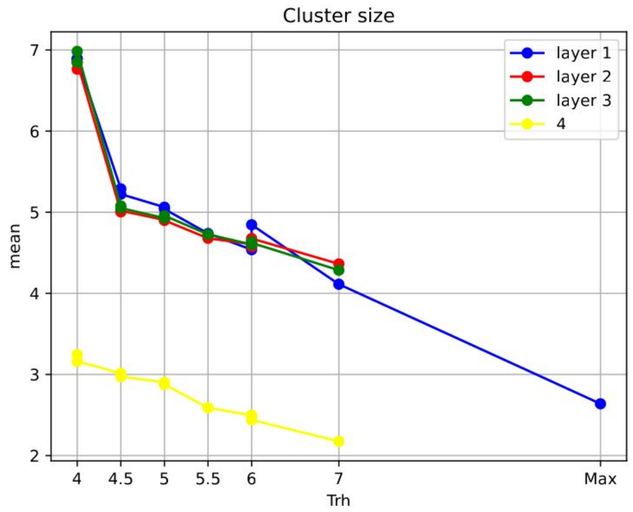
230MeV Protons

Threshold scan

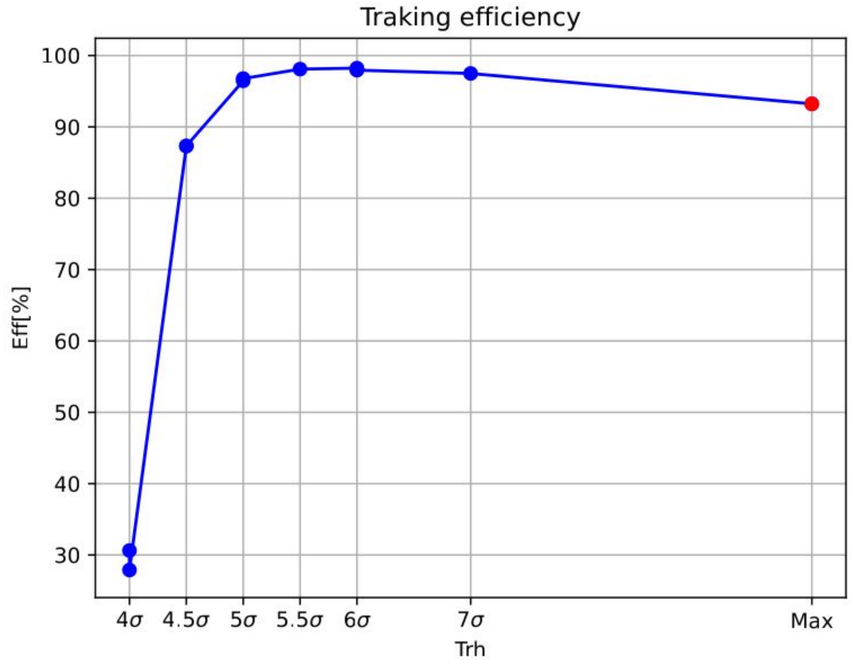
config1

18/11/2024
run: 7005, 7007-7015, 7017, 7018





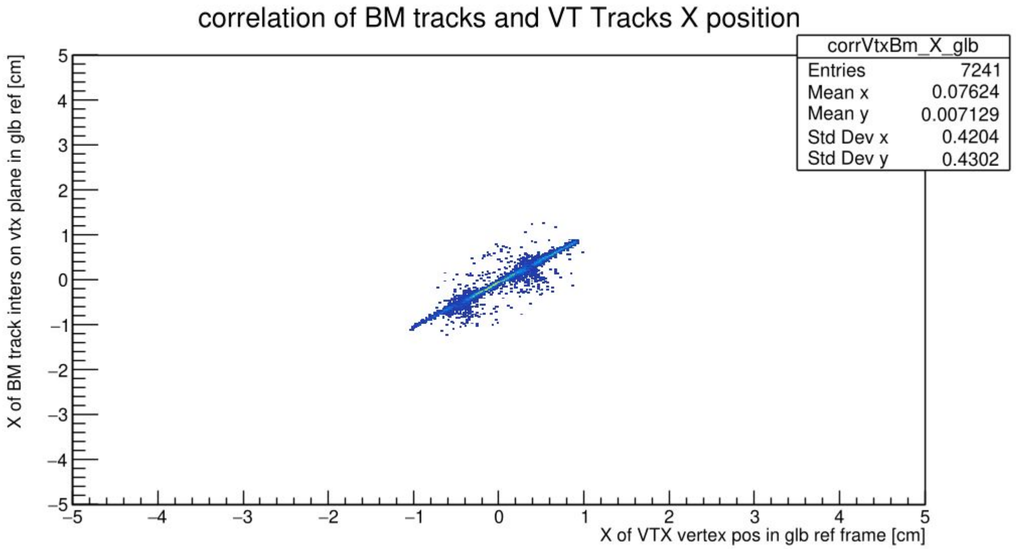
Efficiency and cluster size of the 4th sensor improved compared to the previous day.
The only change is that the 18/11 some noisy columns of the 4th sensor are masked

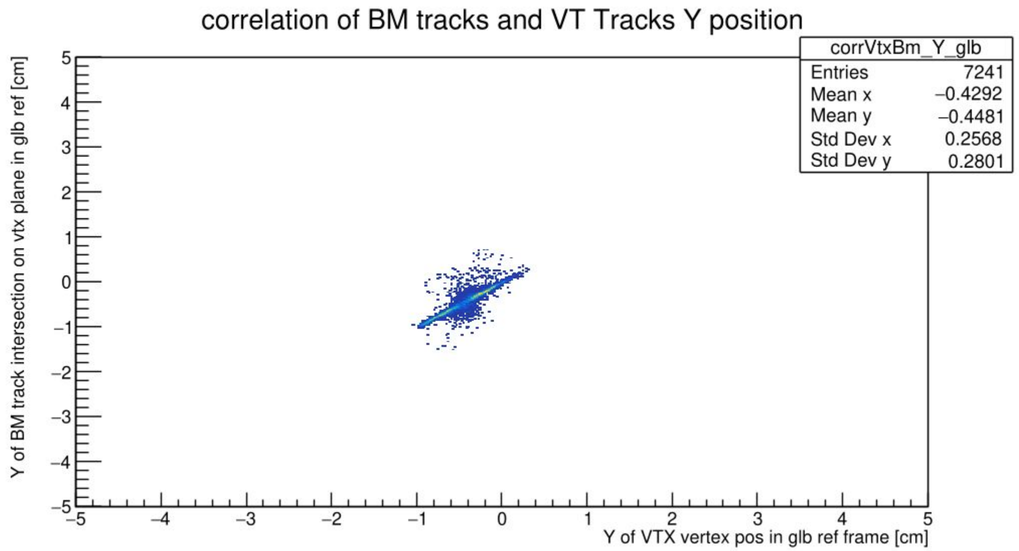


230MeV Protons

Threshold study: 4σ

run 7014 -> all layer at 4σ

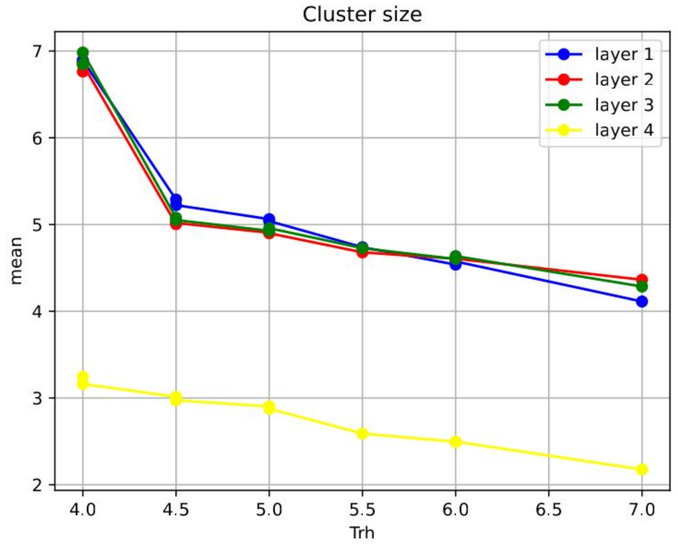


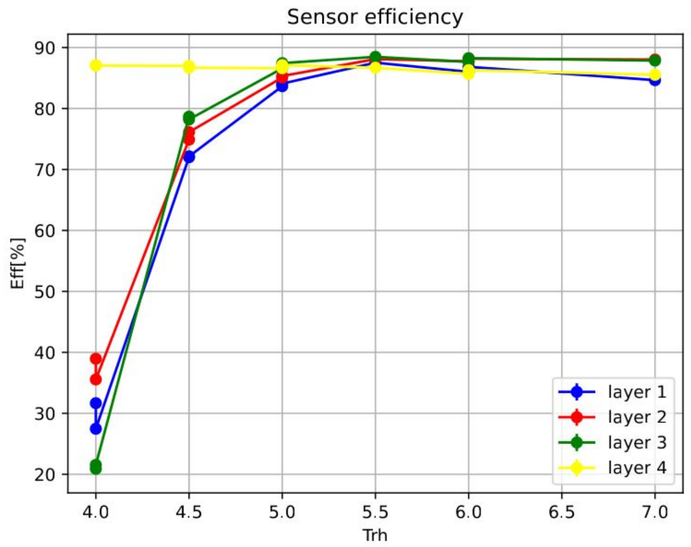


230MeV Protons

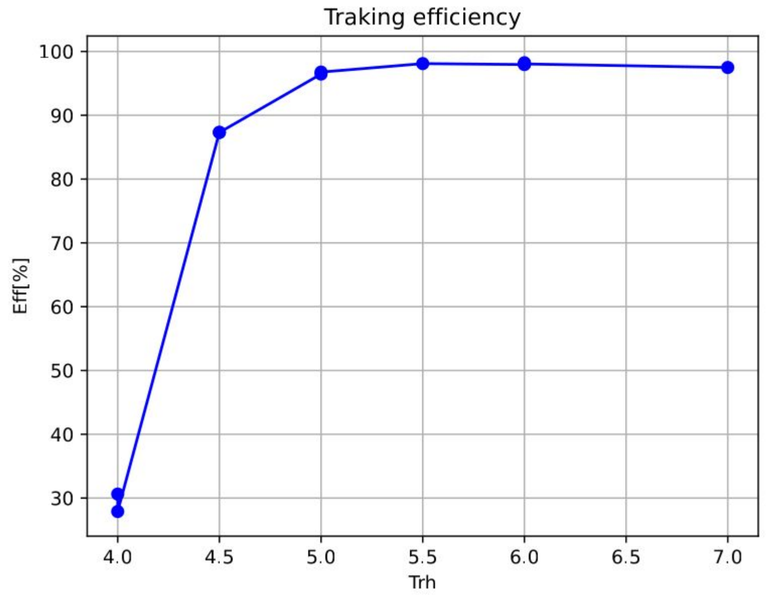
config 1

Threshold scan



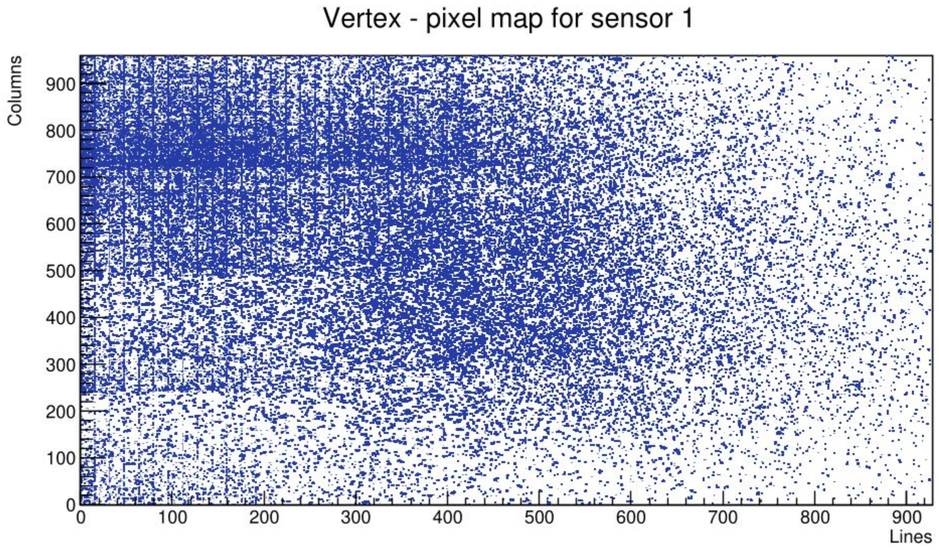


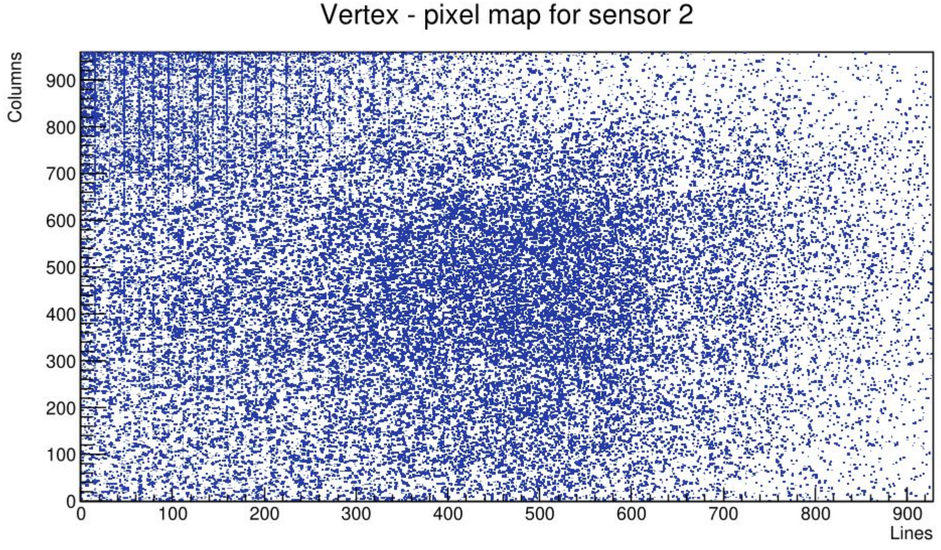
18/11/2024
run: 7005, 7007-7015, 7017, 7018



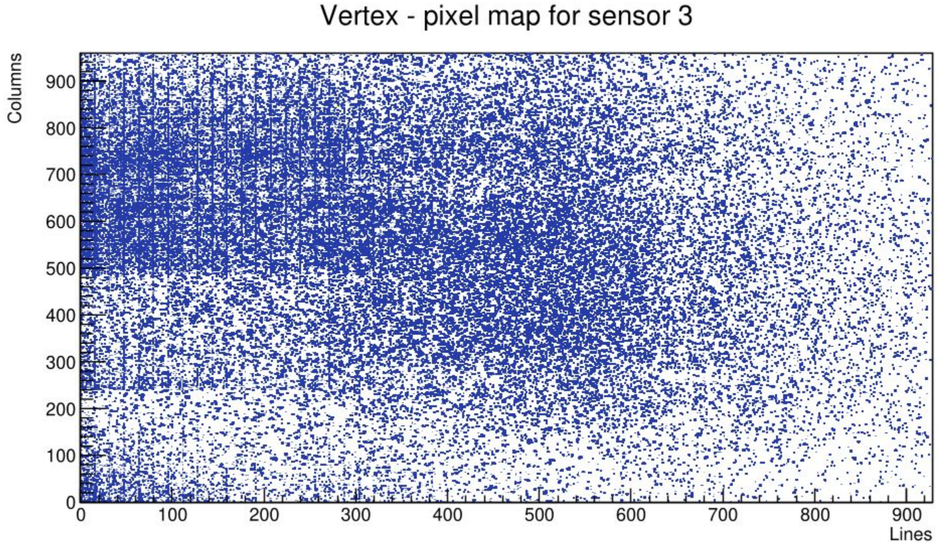
230MeV Protons

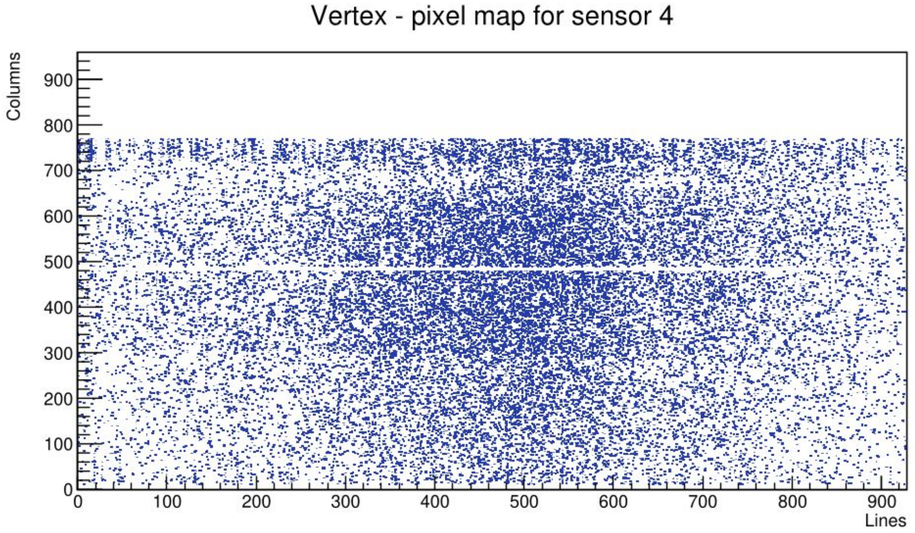
Threshold study: 4.5σ





run 7017 -> all layer at 4.5σ





Even at 4.5 σ the first 3 sensors have some small features !!