V0 Analysis First Looks: Pass0 & 2019 New Detector
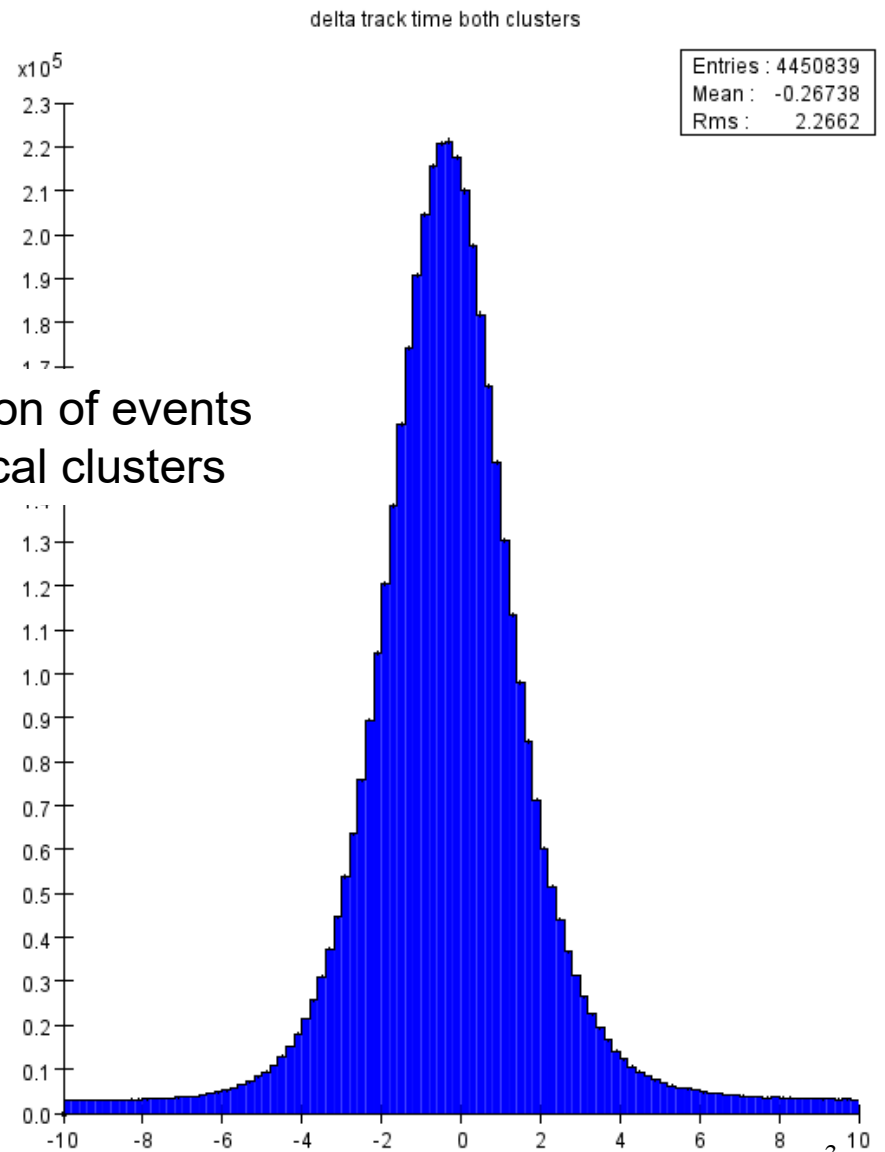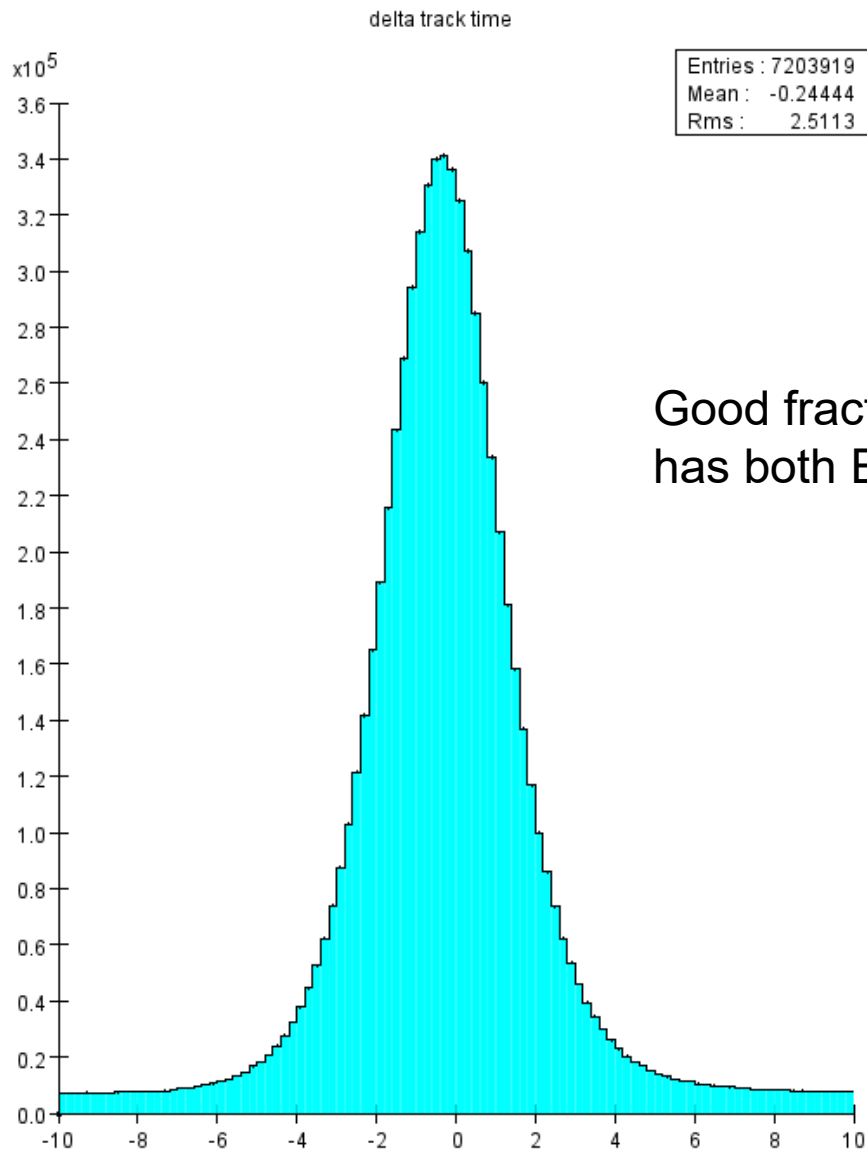
Norman Graf (SLAC)
HPS Analysis Workshop
April 12, 2023

V0 Analysis with Pass0 Data

- Analyze UnconstrainedV0Candidates_KF
    - 0.1 < electron momentum < 6.8
    - positron momentum > 0.1
    - electron track >= 10 nHits
    - positron track >= 10 nHits
    - electron chisq/dof < 30.
    - positron chisq/dof < 30.

Track Delta Time 2019

delta track time

Entries :	7203919
Mean :	-0.24444
Rms :	2.5113

delta track time both clusters

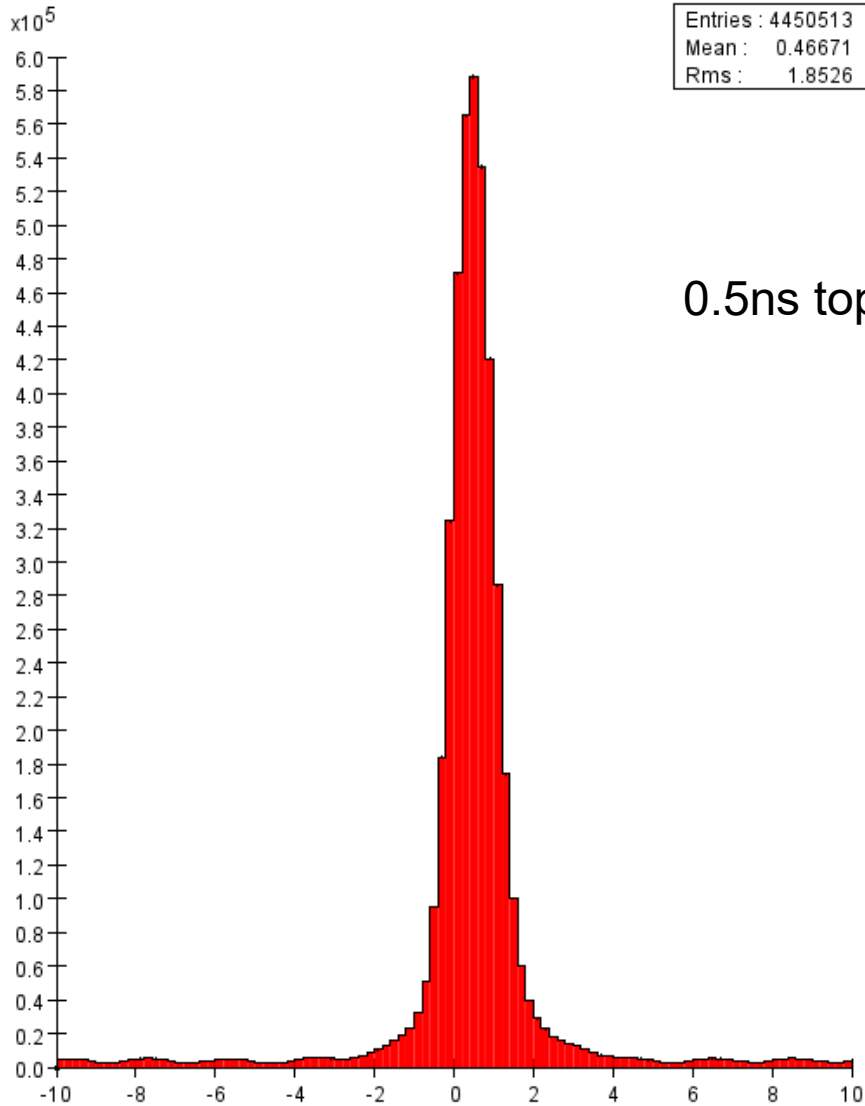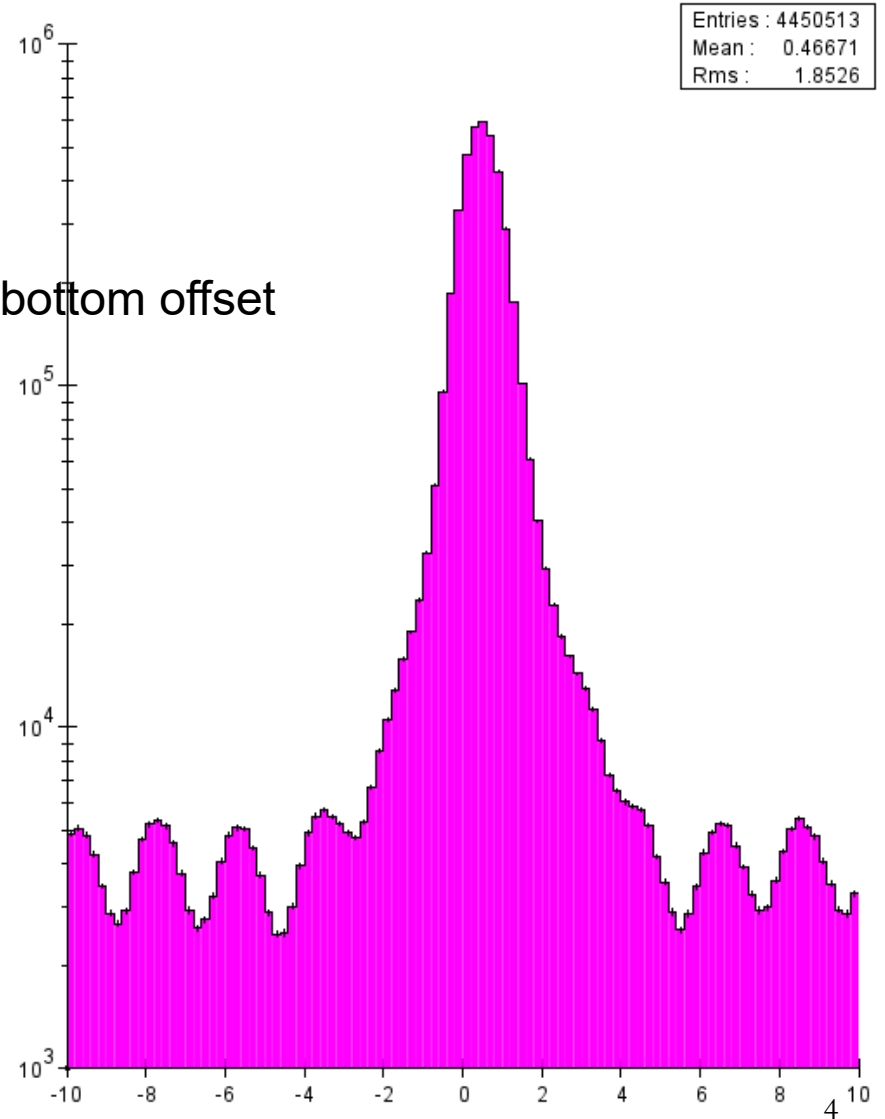| Entries :	4450839
Mean :	-0.26738
Rms :	2.2662

Good fraction of events has both Ecal clusters

Cluster Delta Time 2019

top cluster time - bottom cluster time both clusters

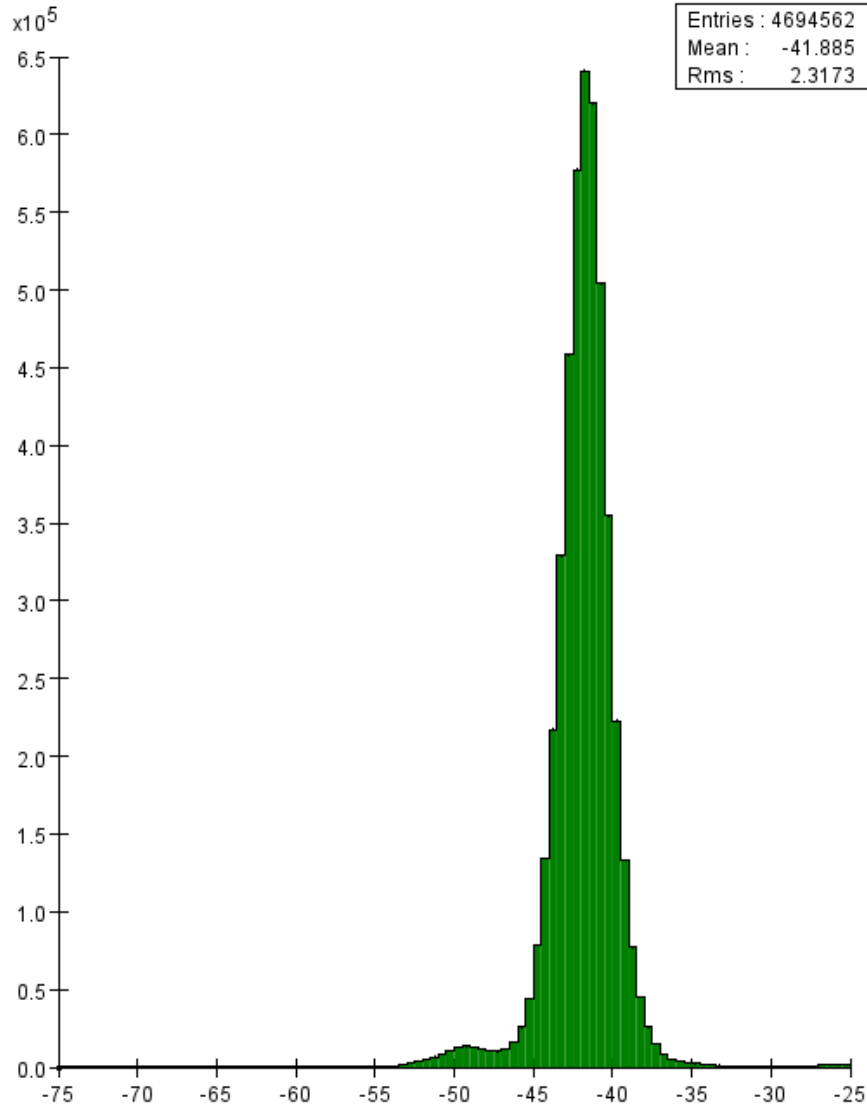| Entries :	4450513
Mean :	0.46671
Rms :	1.8526

0.5ns top/bottom offset

top cluster time - bottom cluster time both clusters

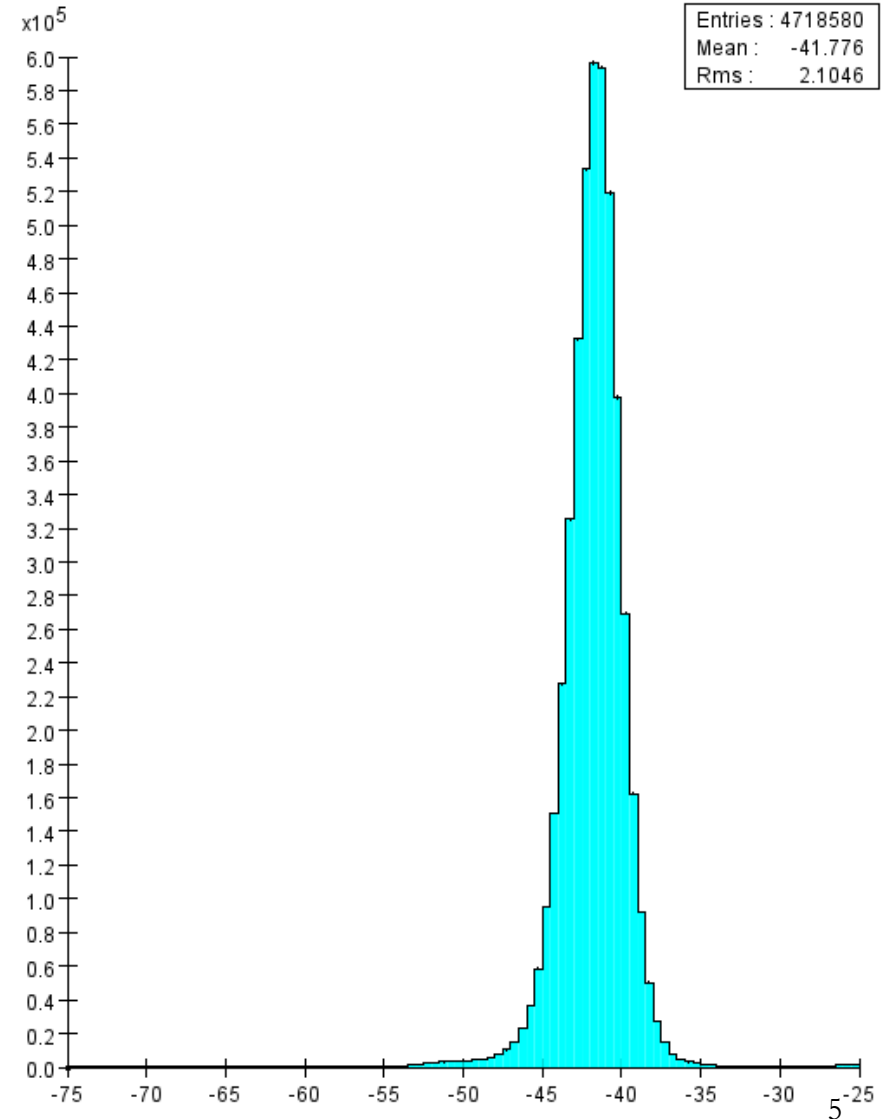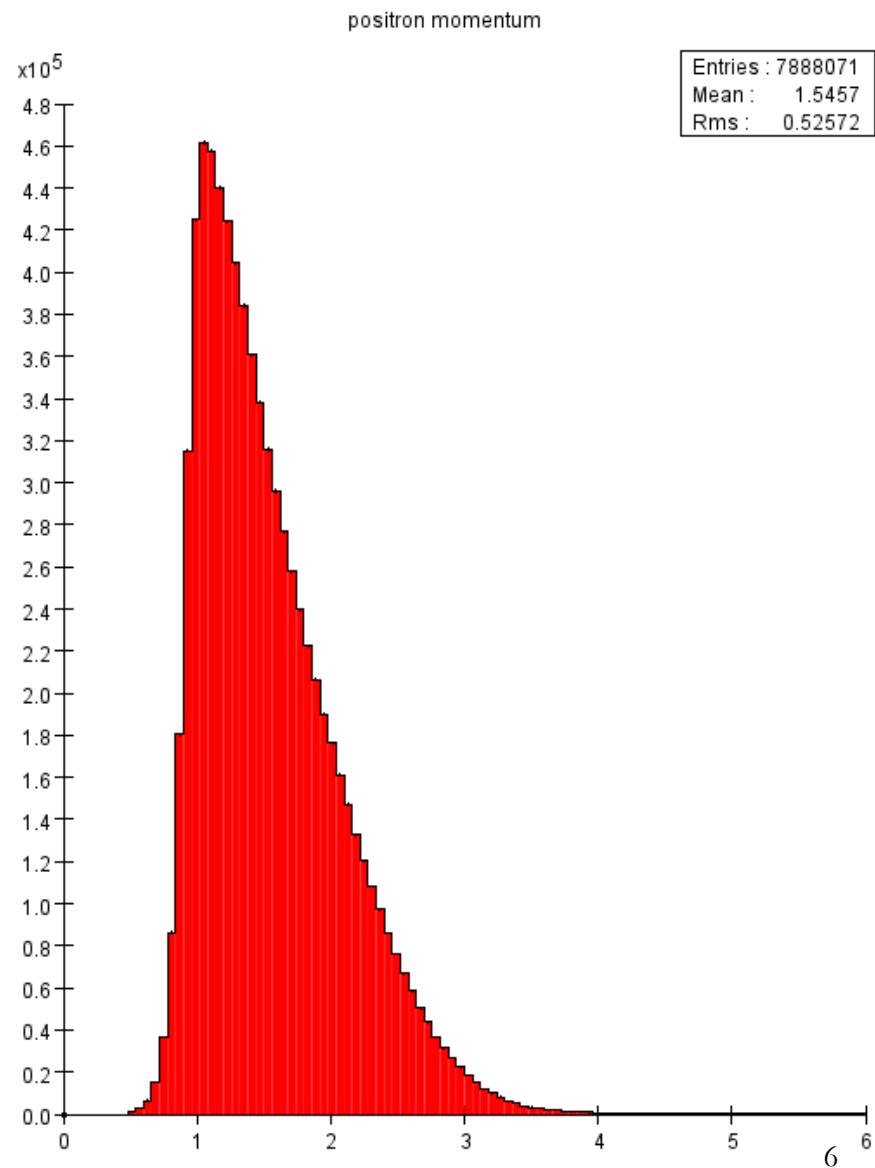| Entries :	4450513
Mean :	0.46671
Rms :	1.8526

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Track – Cluster Time (both clusters)

electron track time - cluster time both clusters

Entries : 4694562
Mean :   -41.885
Rms :   2.3173

positron track time - cluster time both clusters

Entries : 4718580
Mean :   -41.776
Rms :   2.1046

Track Momentum 2019

electron momentum

Entries : 7884042
Mean : 1.8283
Rms : 0.96336

Clear FEE contamination

positron momentum

Entries : 7888071
Mean : 1.5457
Rms : 0.52572

Electron vs Positron Momentum 2019

electron vs positron momentum

Psum 2019
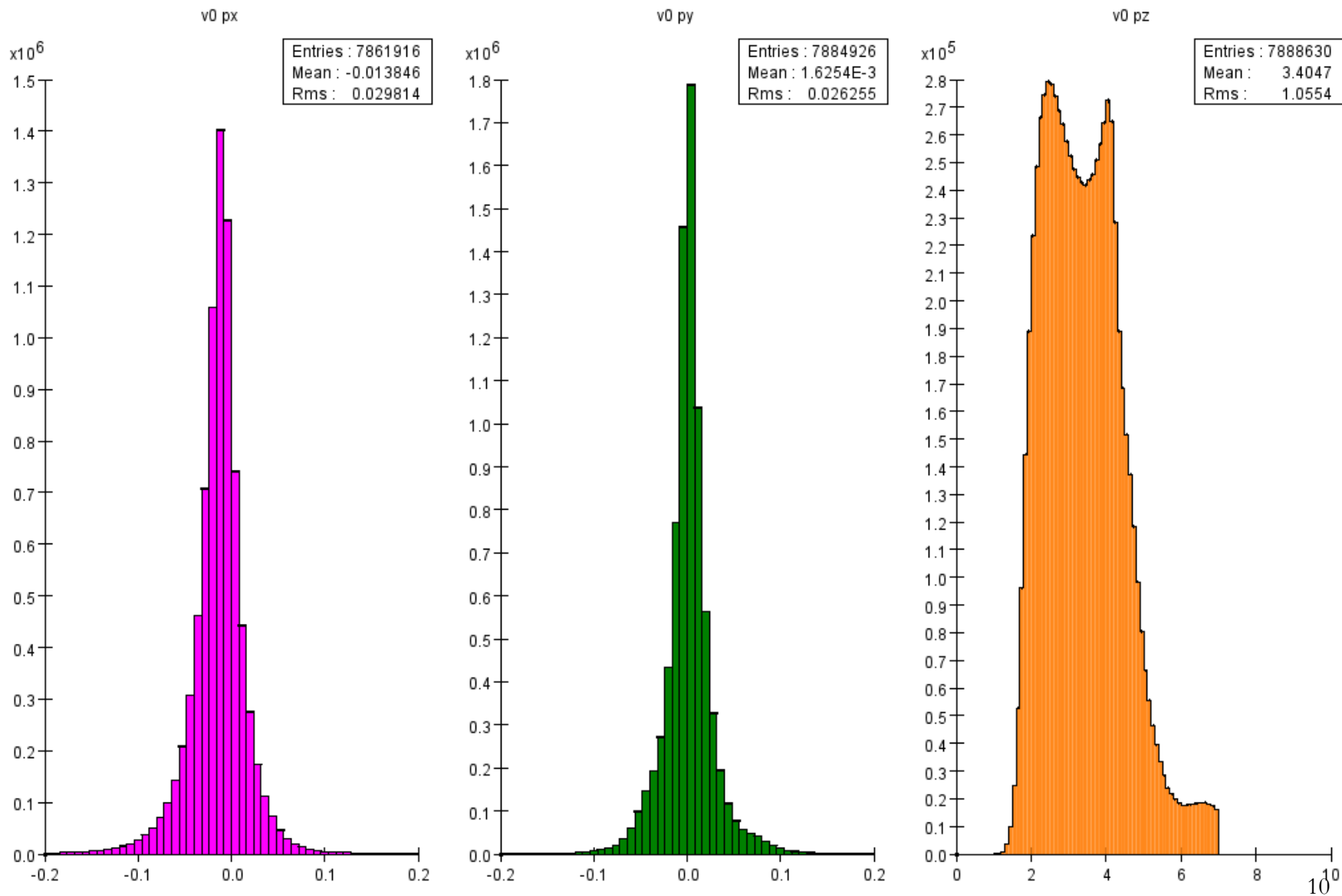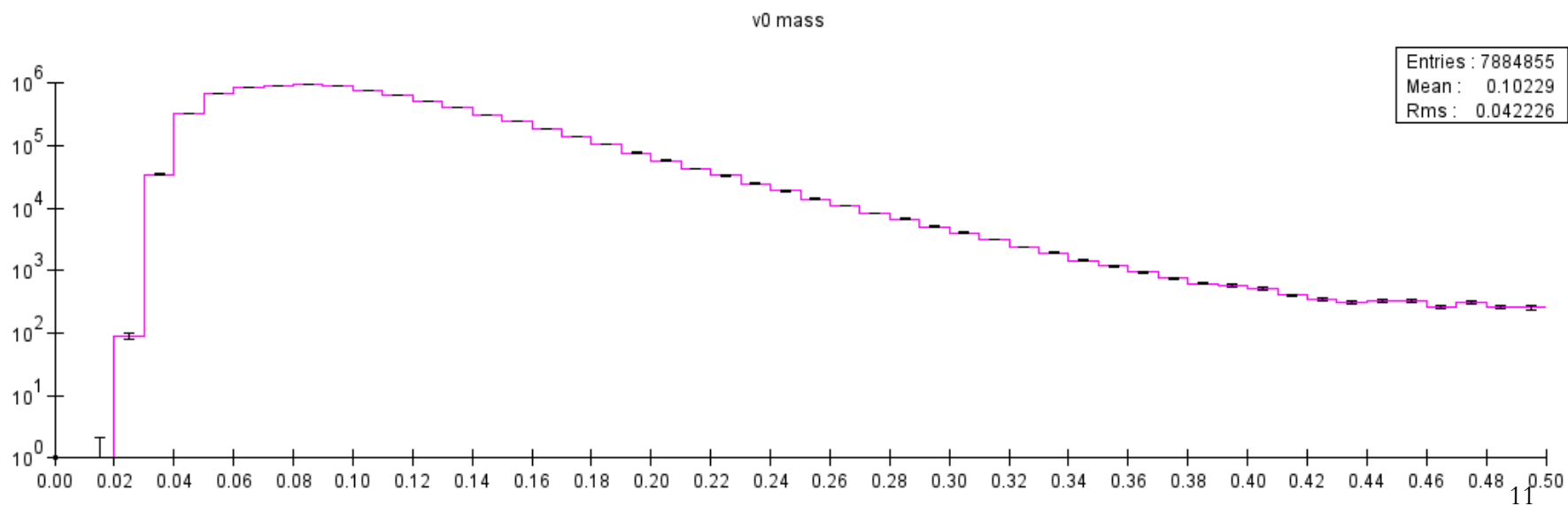

psum

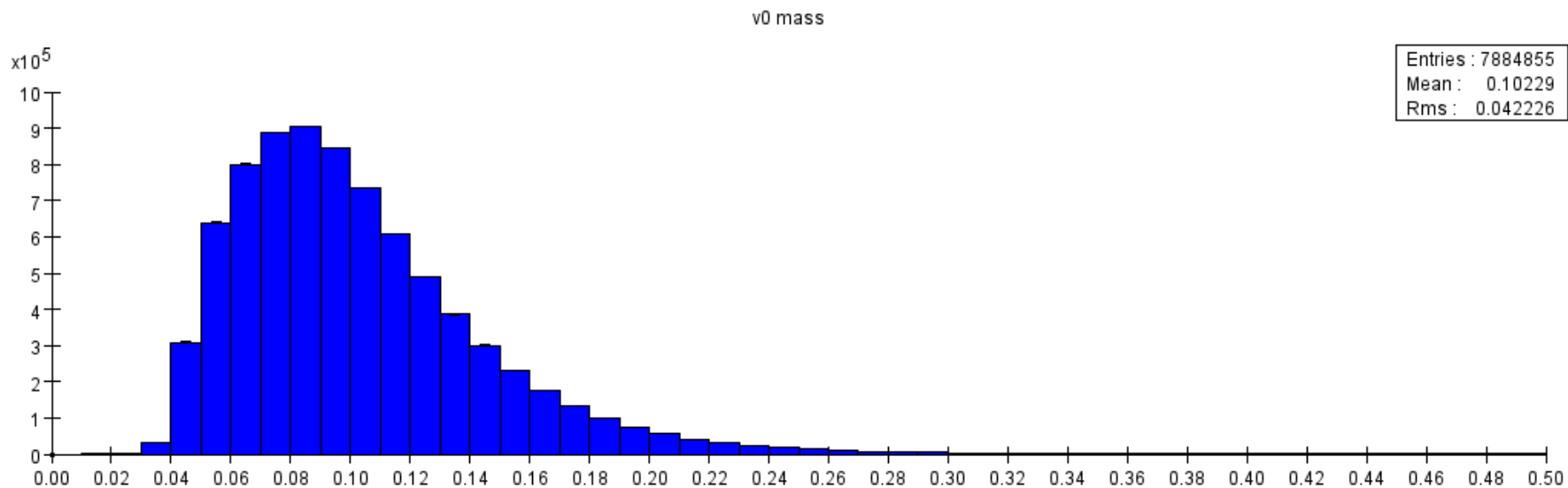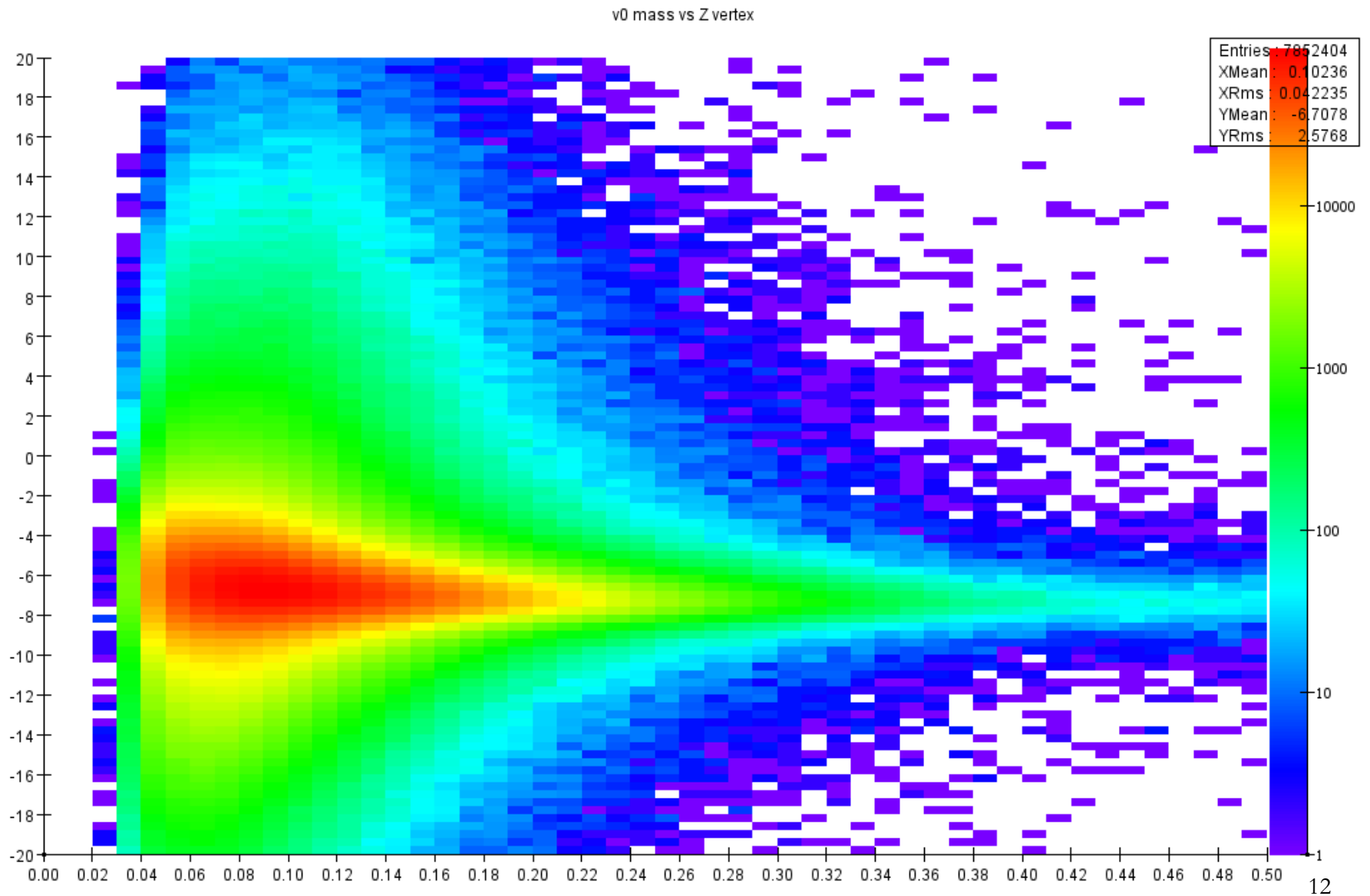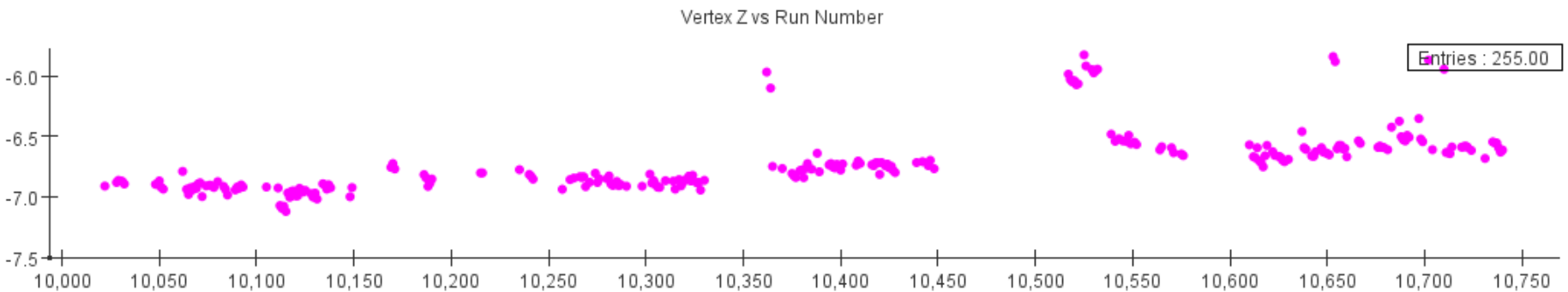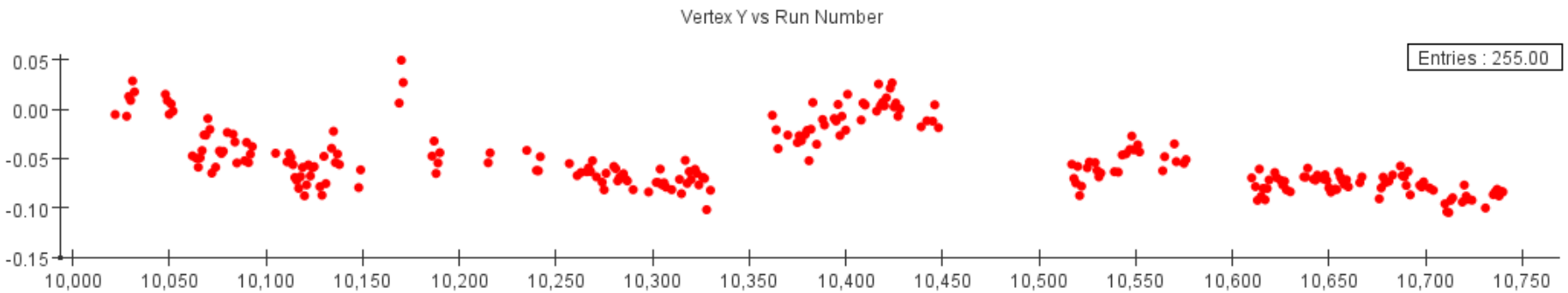| Entries : 7740989 |
| Mean : 3.3182 |
| Rms : 0.95491 |
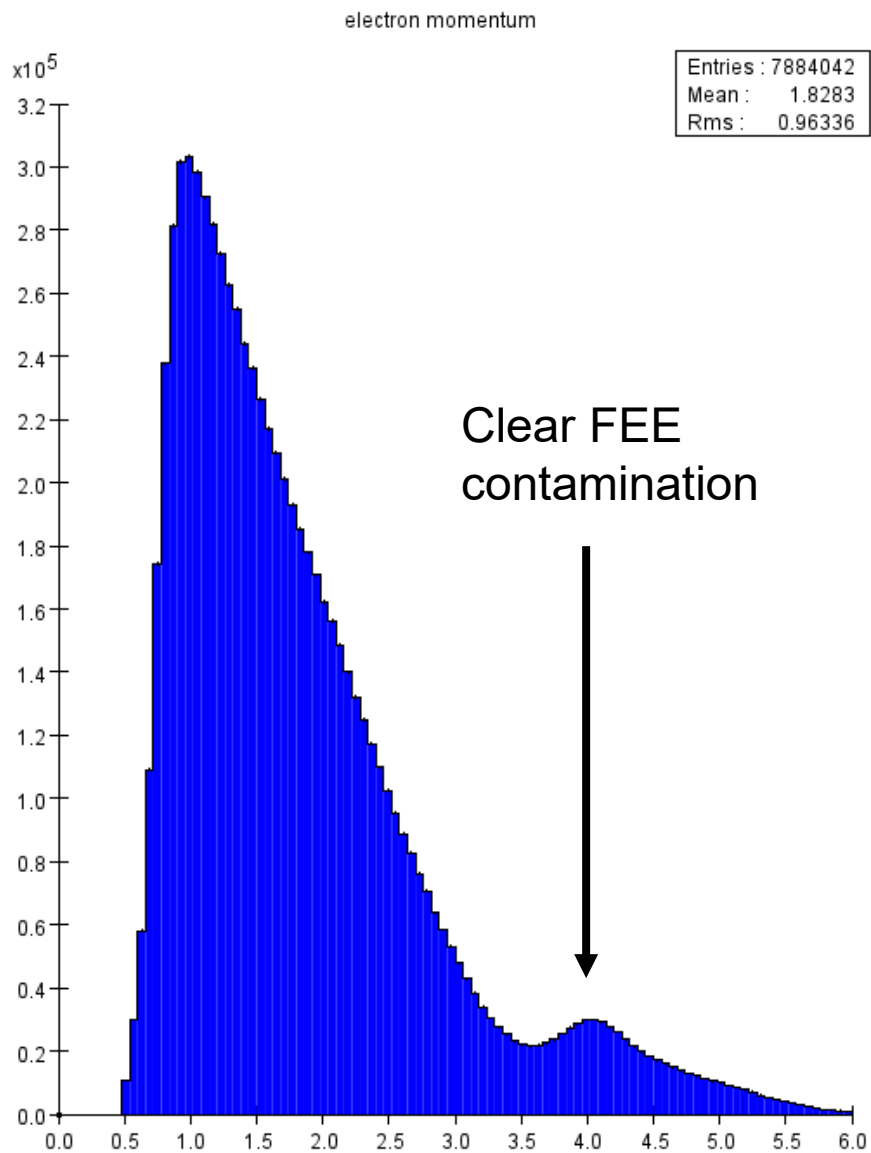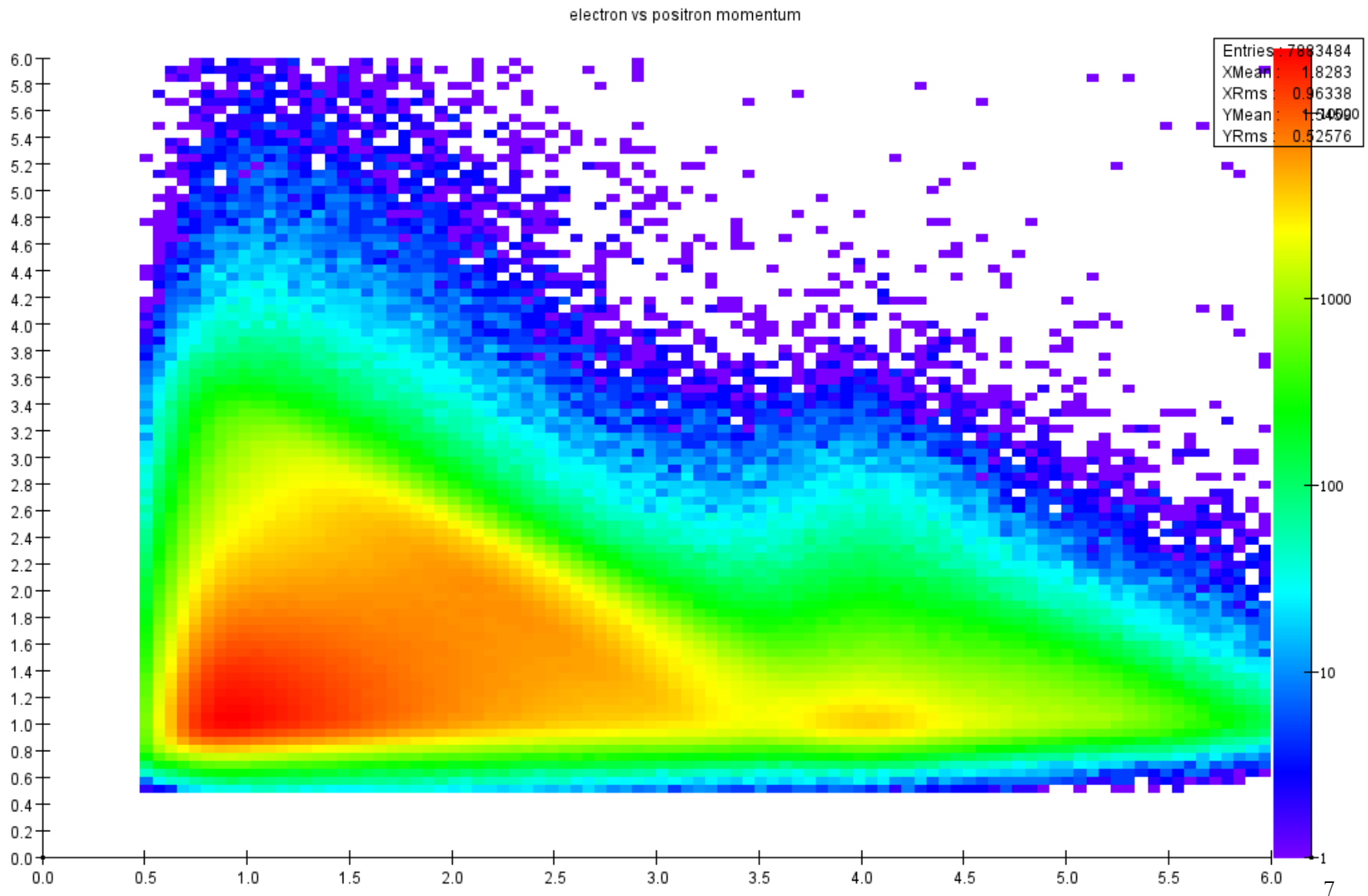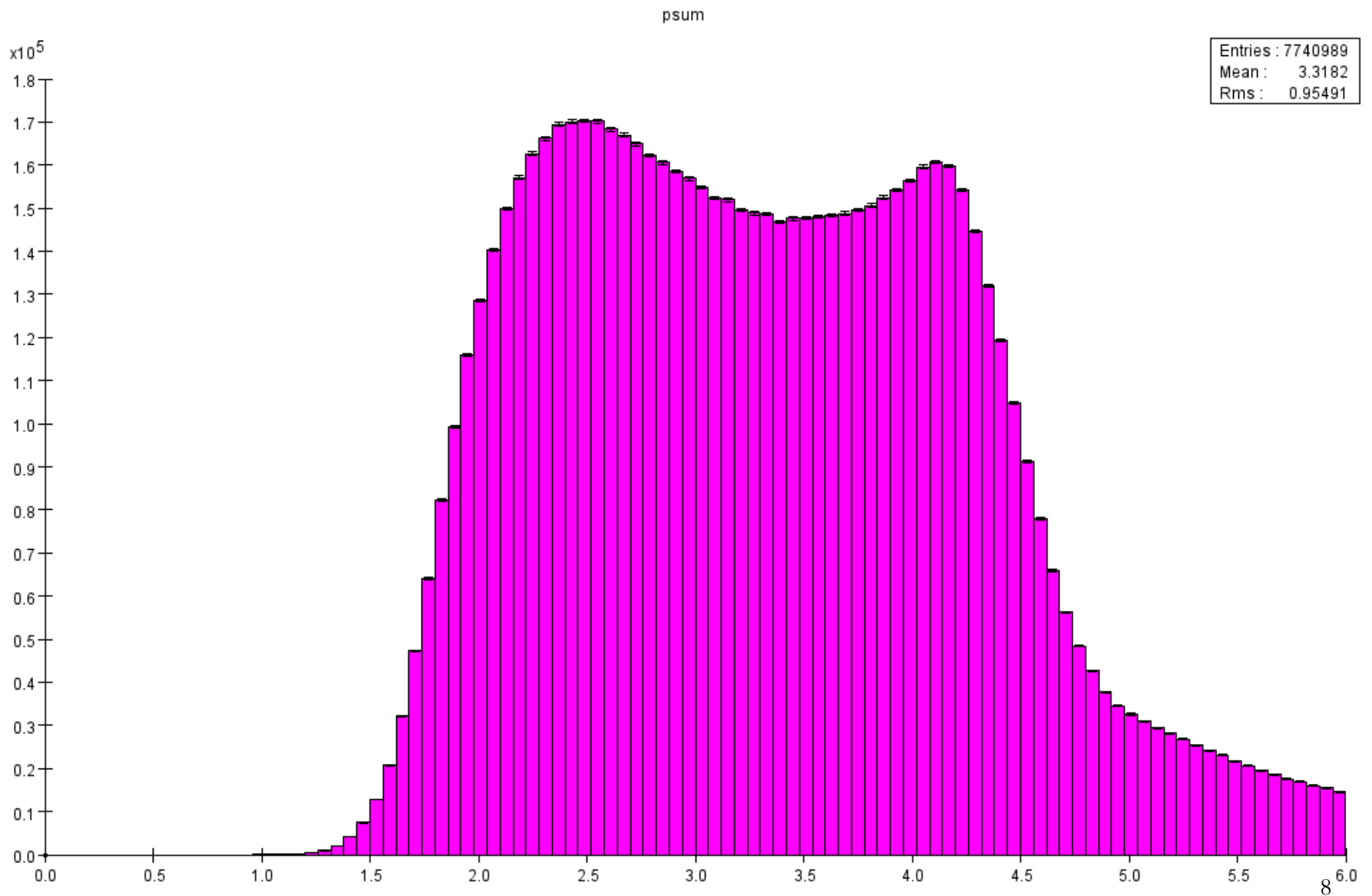
V0 Vertex Positions 2019
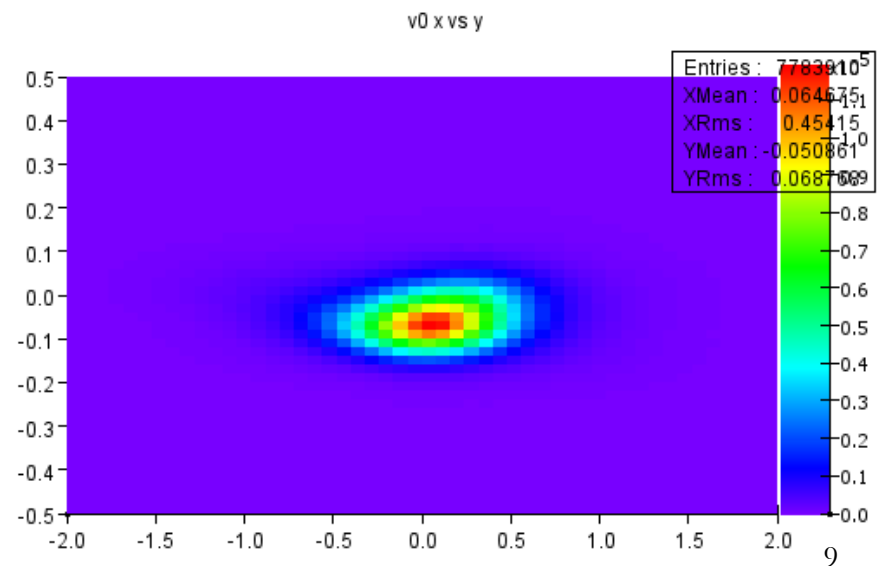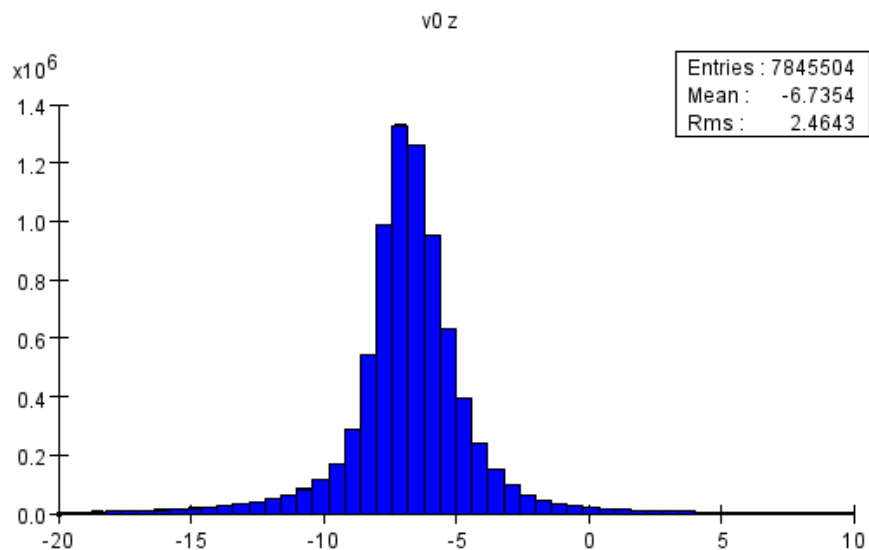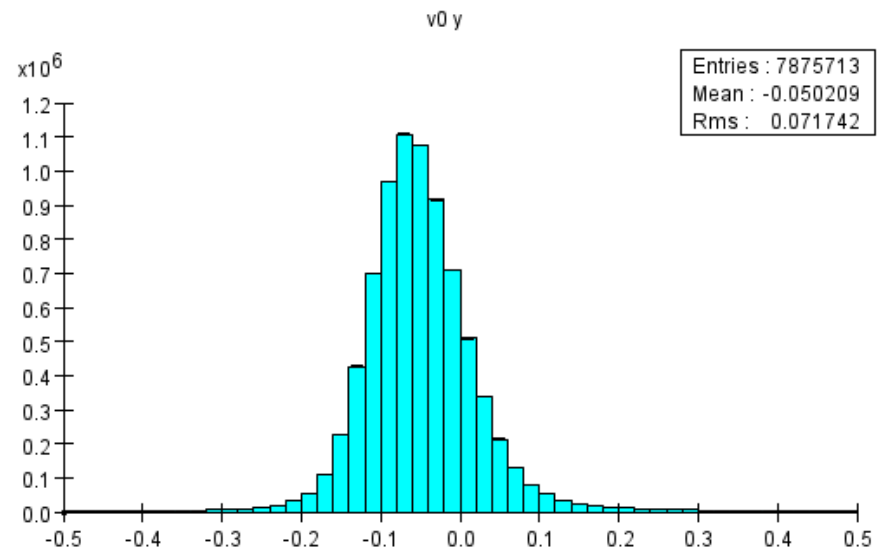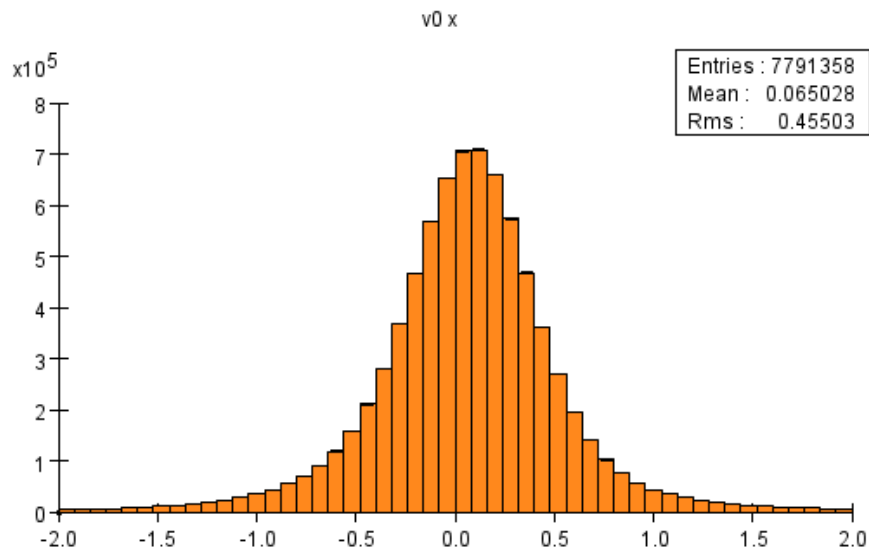
V0 Vertex Momenta 2019

V0 Mass 2019
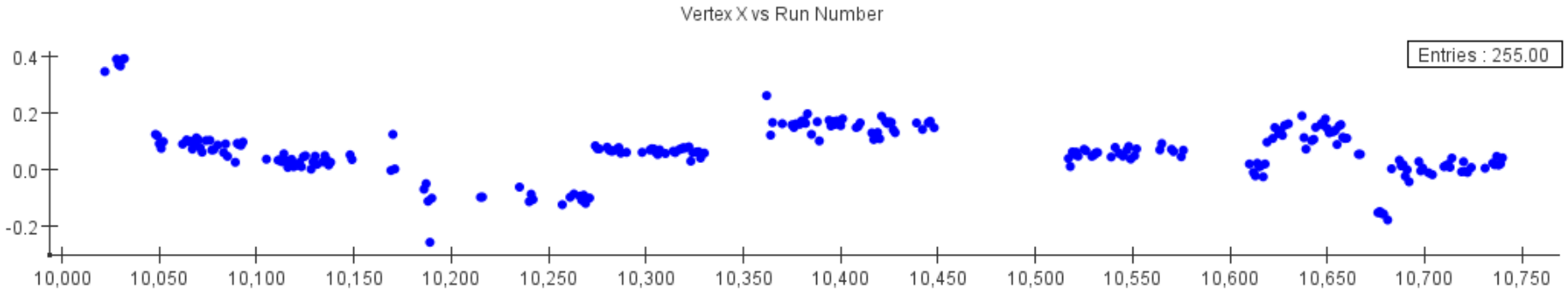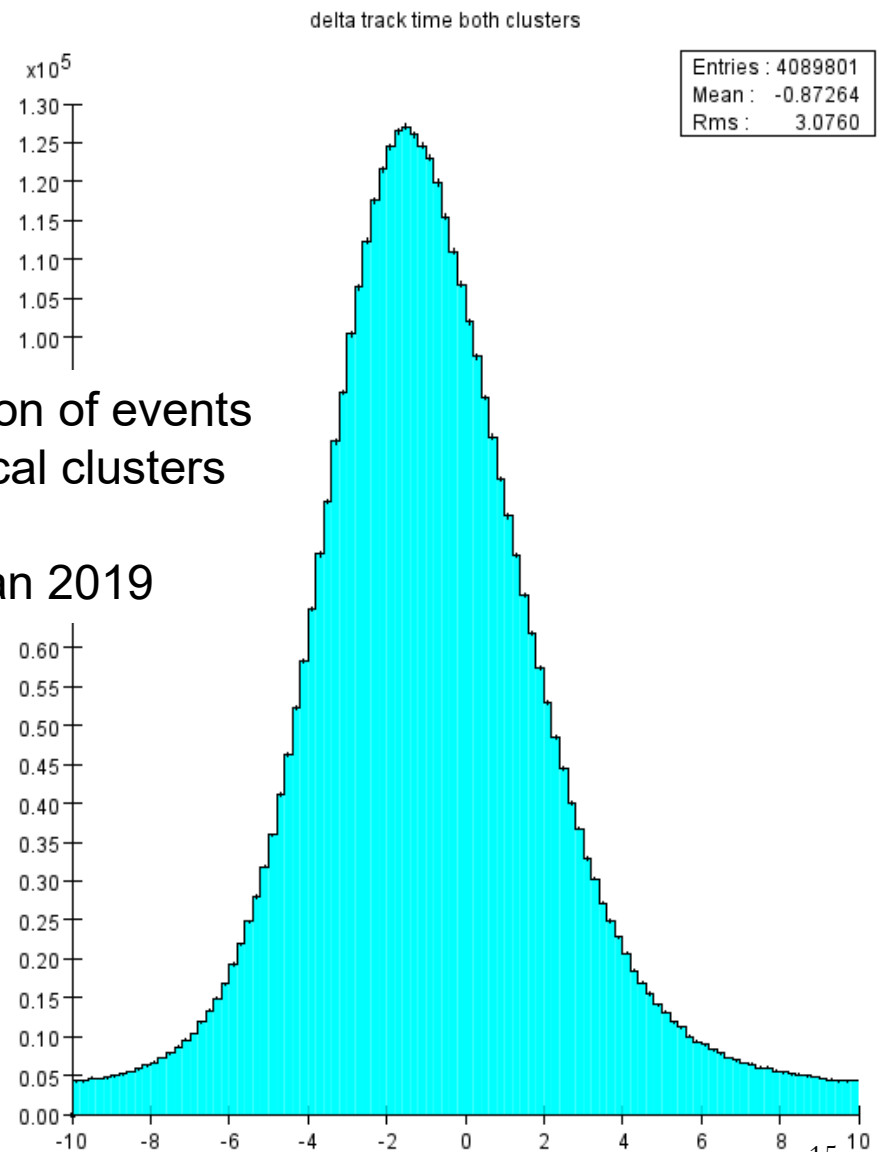
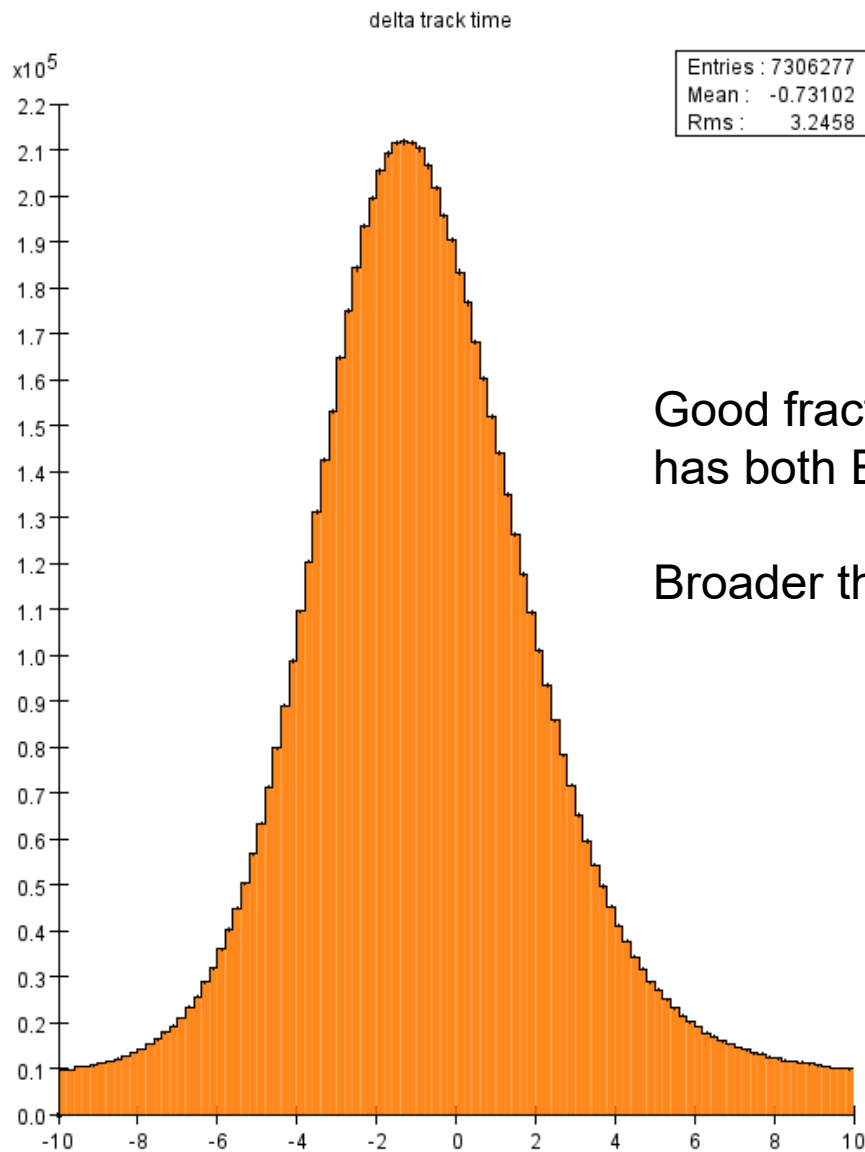# V0 Vertex Mass vs Vertex Z 2019

v0 mass vs Z vertex

Vertex Positions vs Run Number 2019
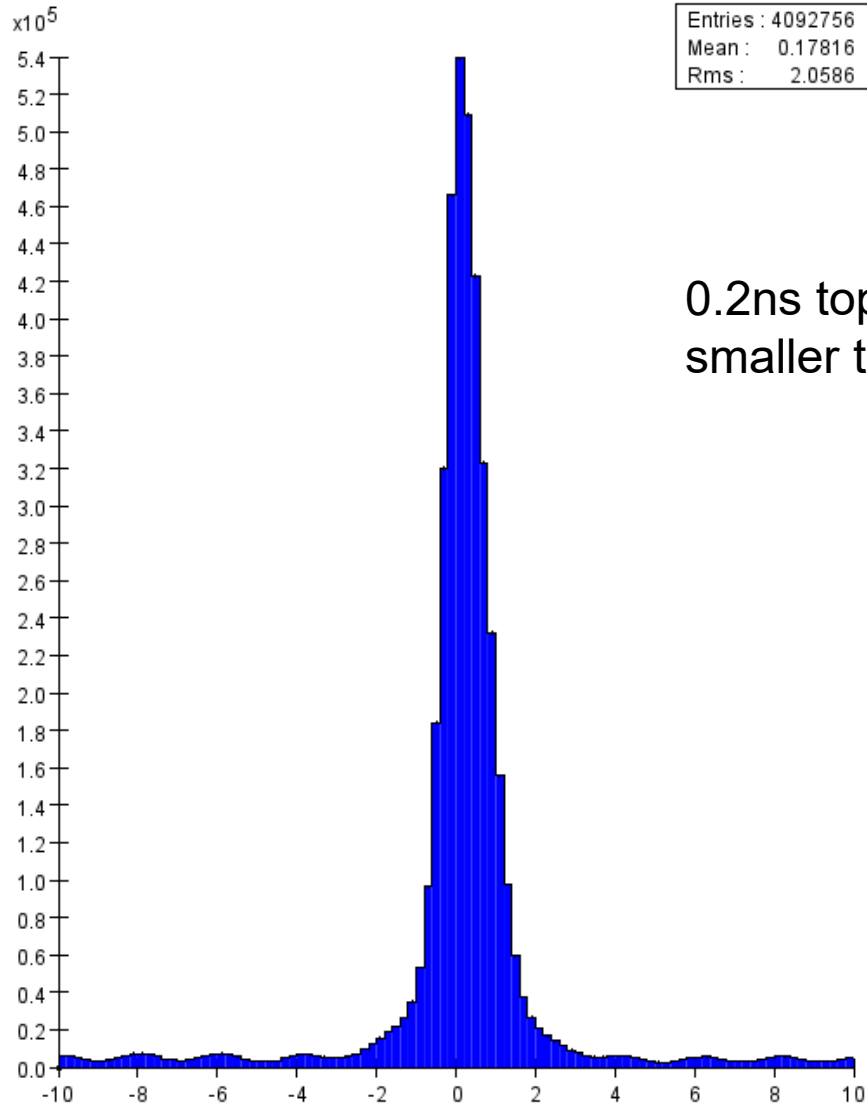
2021

Track Delta Time 2021

Good fraction of events has both Ecal clusters

Broader than 2019

Cluster Delta Time 2021

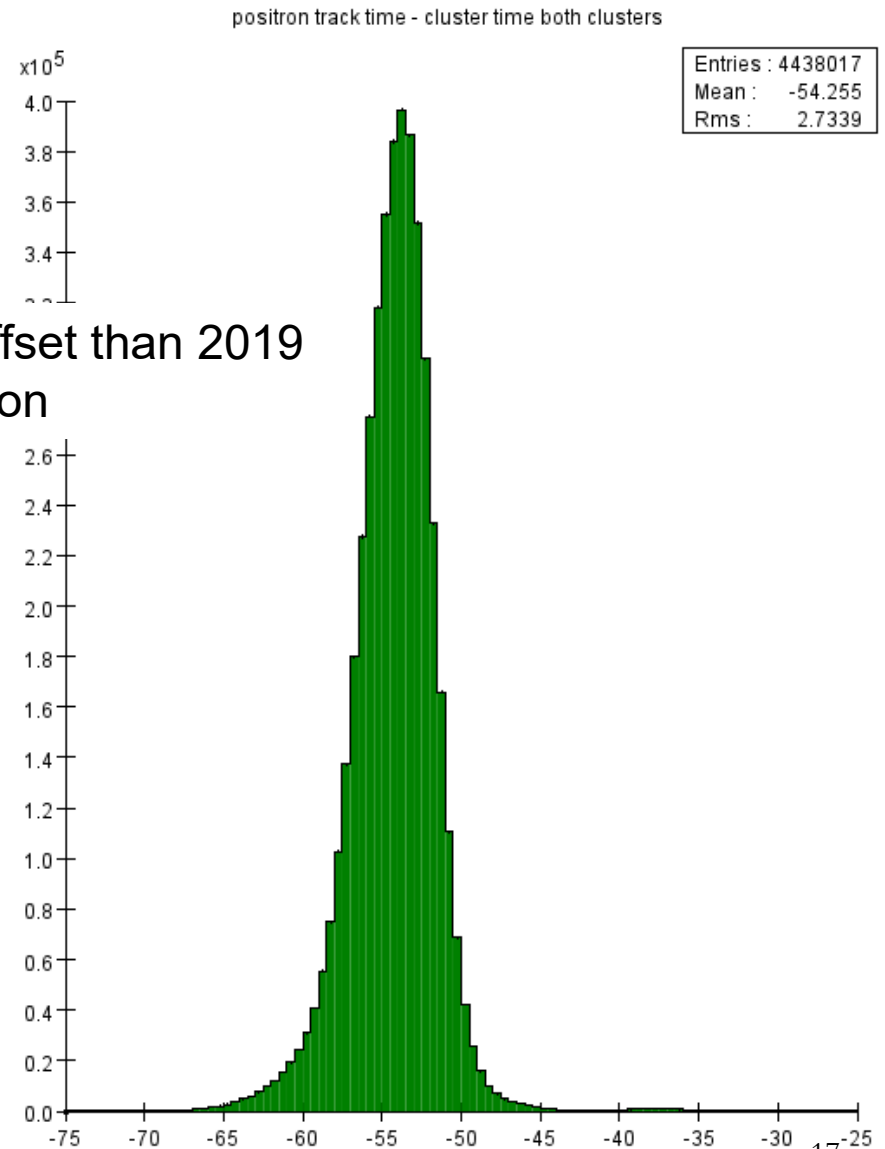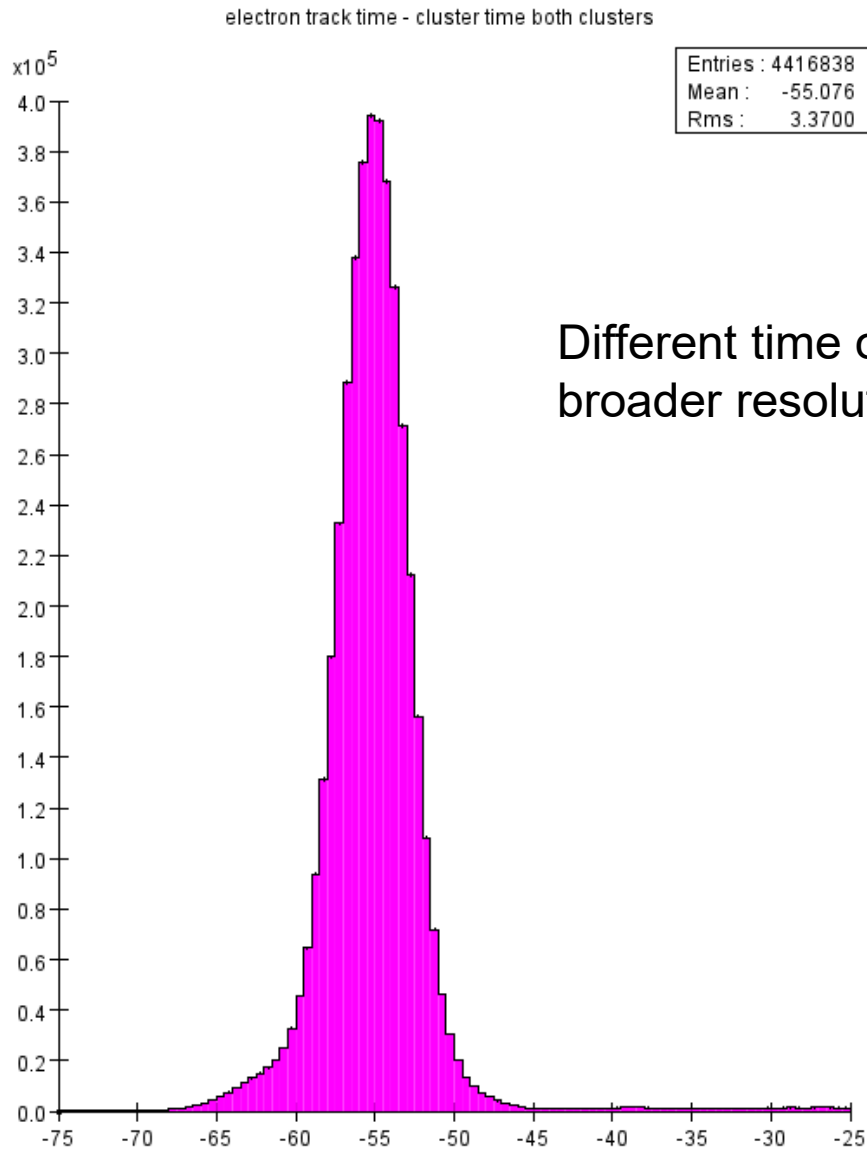top cluster time - bottom cluster time both clusters

Entries : 4092756
Mean : 0.17816
Rms : 2.0586
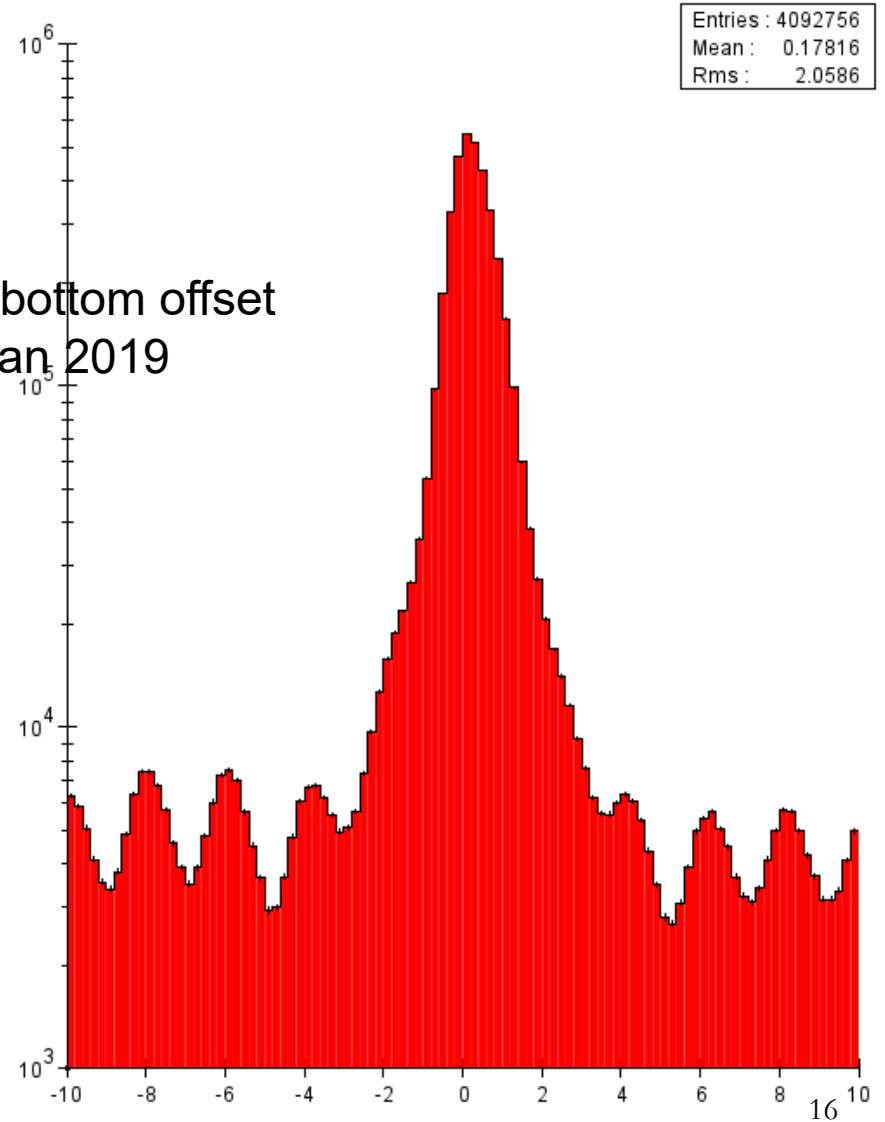
0.2ns top/bottom offset smaller than 2019

top cluster time - bottom cluster time both clusters

Entries : 4092756
Mean : 0.17816
Rms : 2.0586

Track – Cluster Time (both clusters)

electron track time - cluster time both clusters

Entries :	4416838
Mean :	-55.076
Rms :	3.3700

positron track time - cluster time both clusters

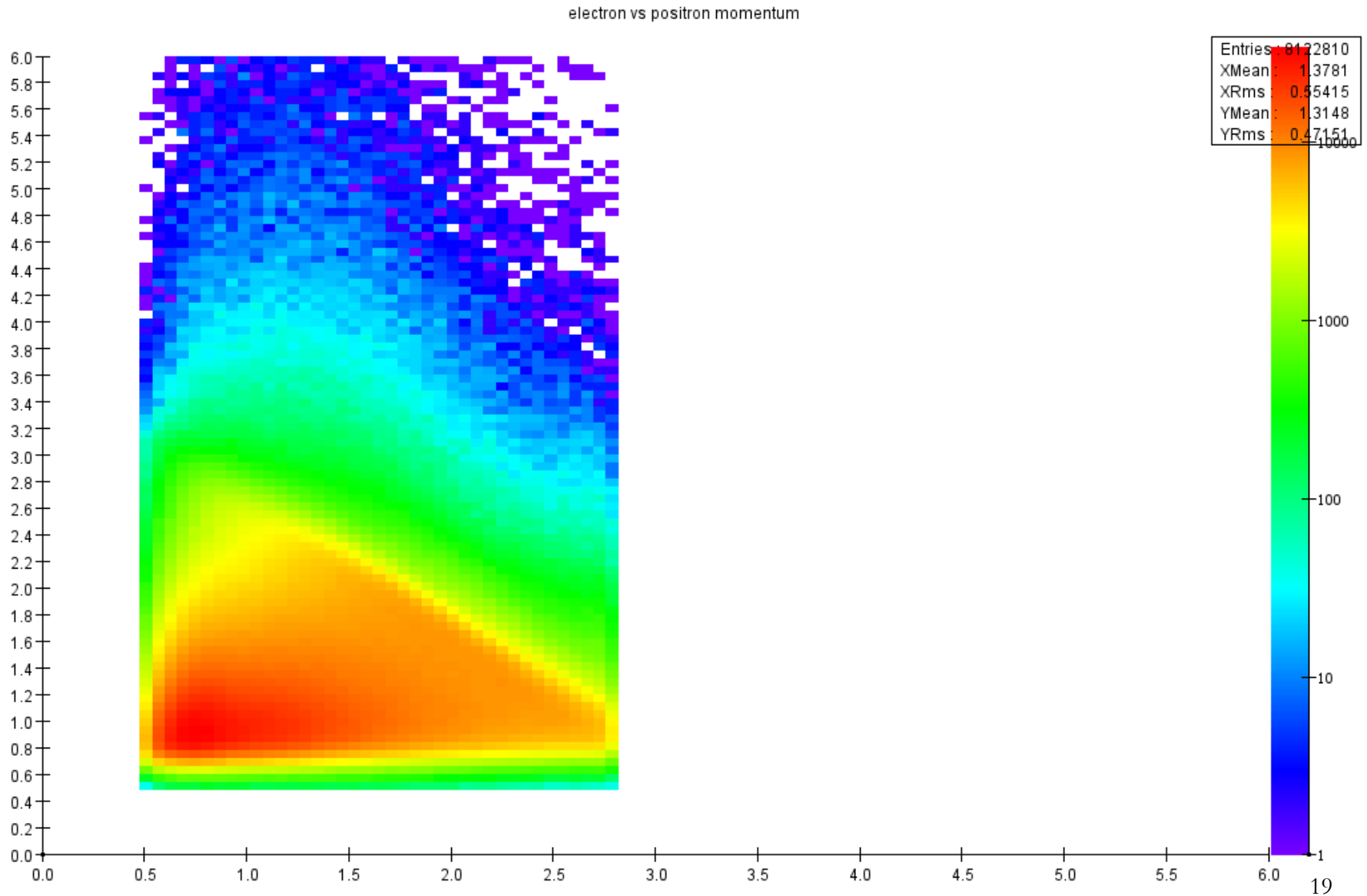|	
Entries :	4438017
Mean :	-54.255
Rms :	2.7339

Different time offset than 2019
broader resolution

Track Momentum 2021

electron momentum

Entries :	8124002
Mean :	1.3781
Rms :	0.55412

Cut at 2.8GeV

positron momentum

Entries :	8122810
Mean :	1.3148
Rms :	0.47150

Electron vs Positron Momentum 2021

electron vs positron momentum

Psum 2021

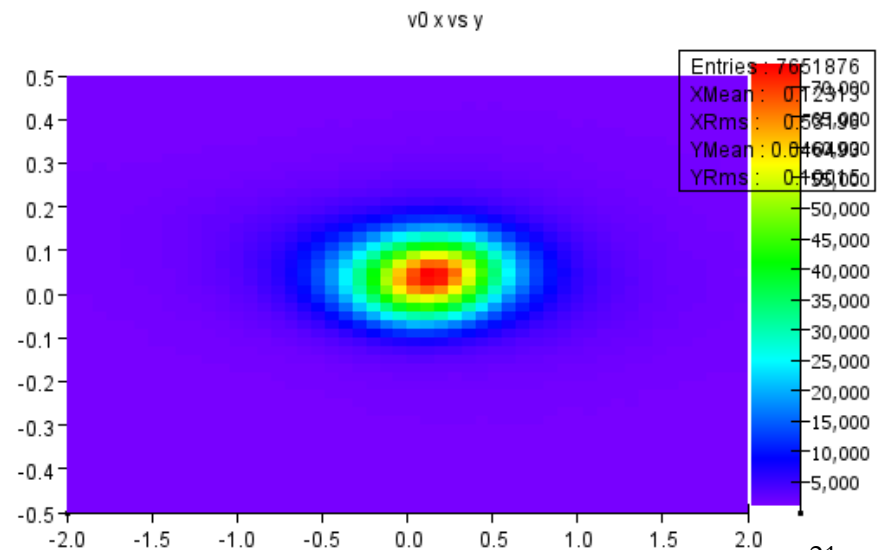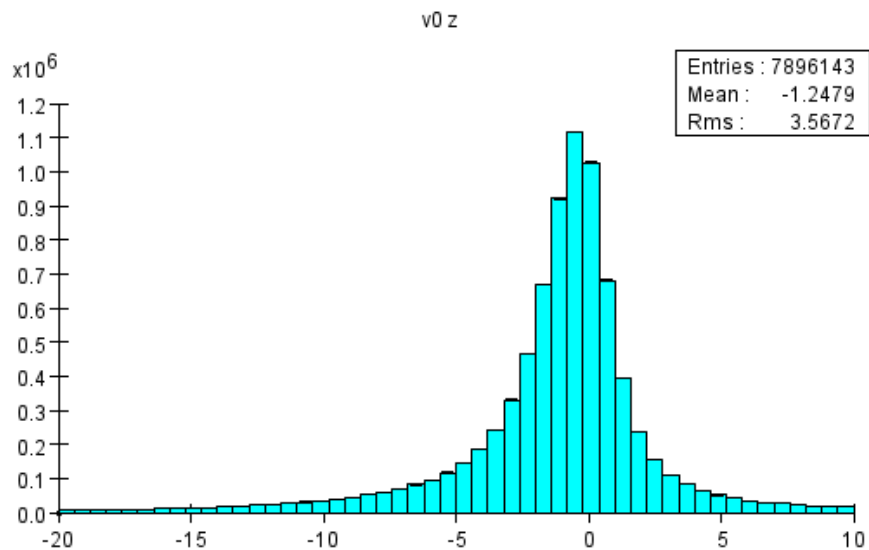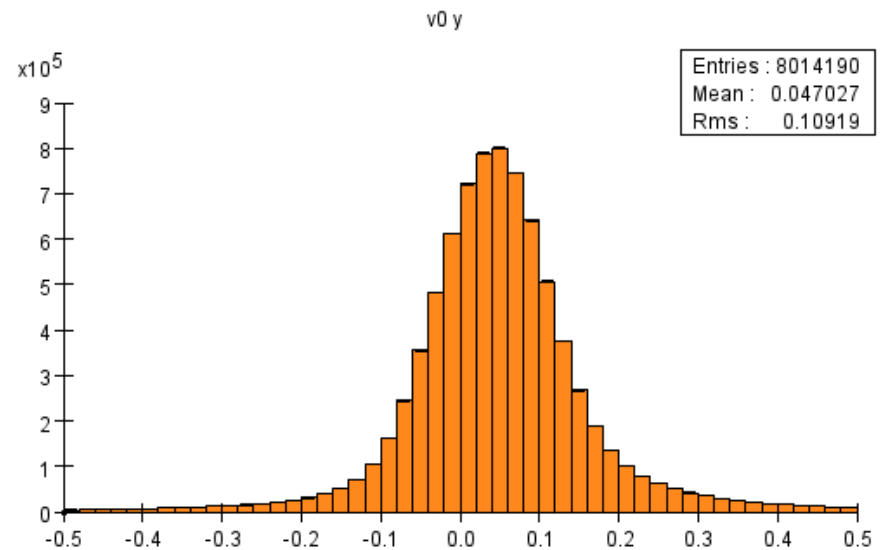psum

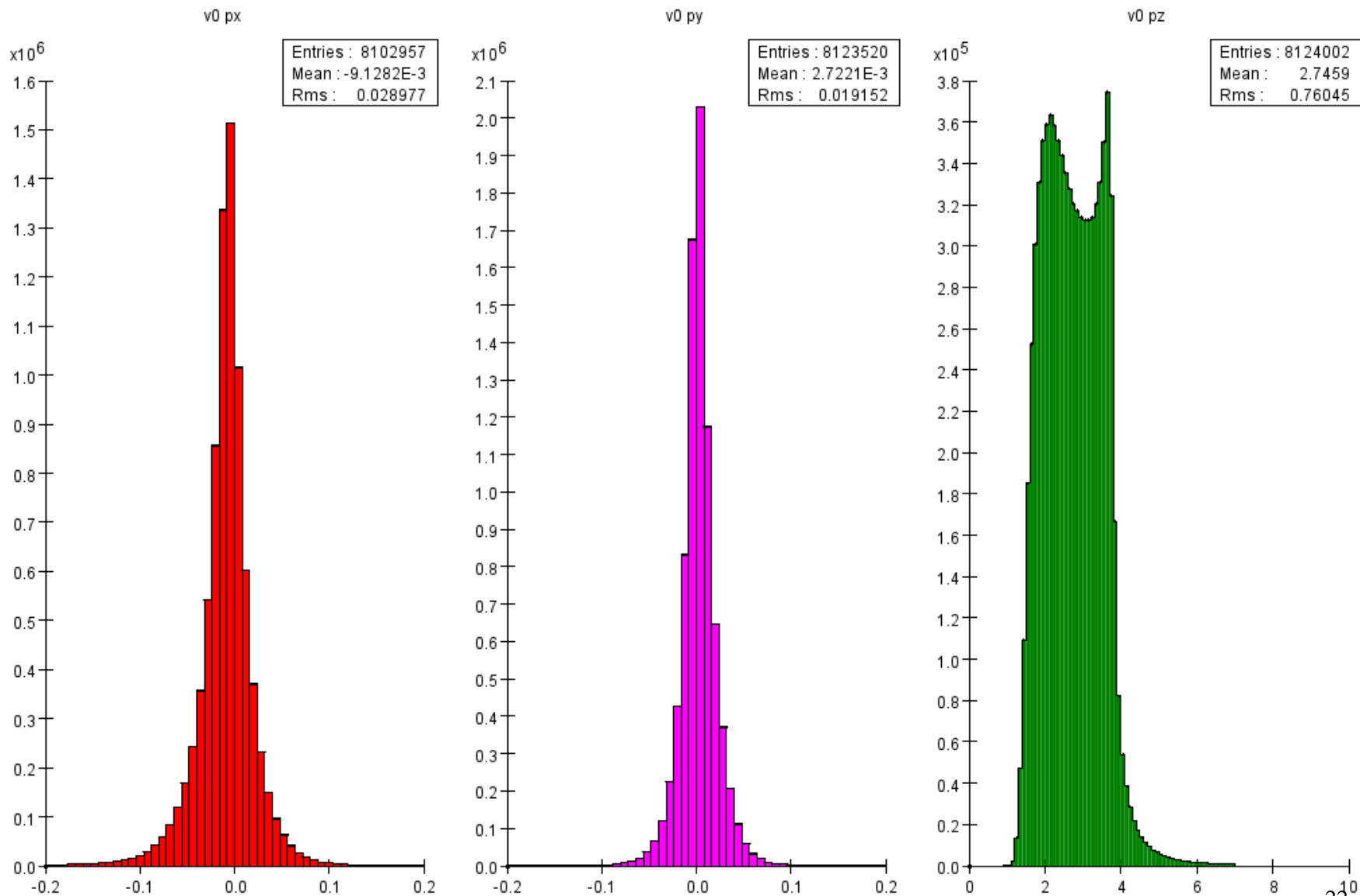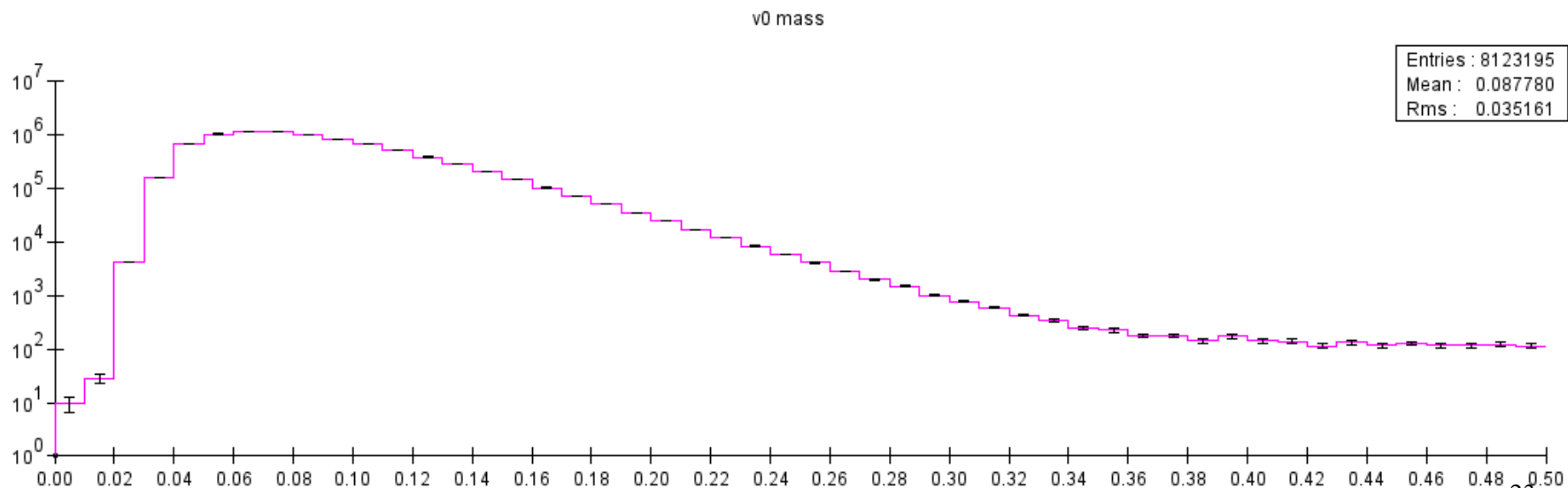| Entries :	8119419
Mean :	2.6913
Rms :	0.72234
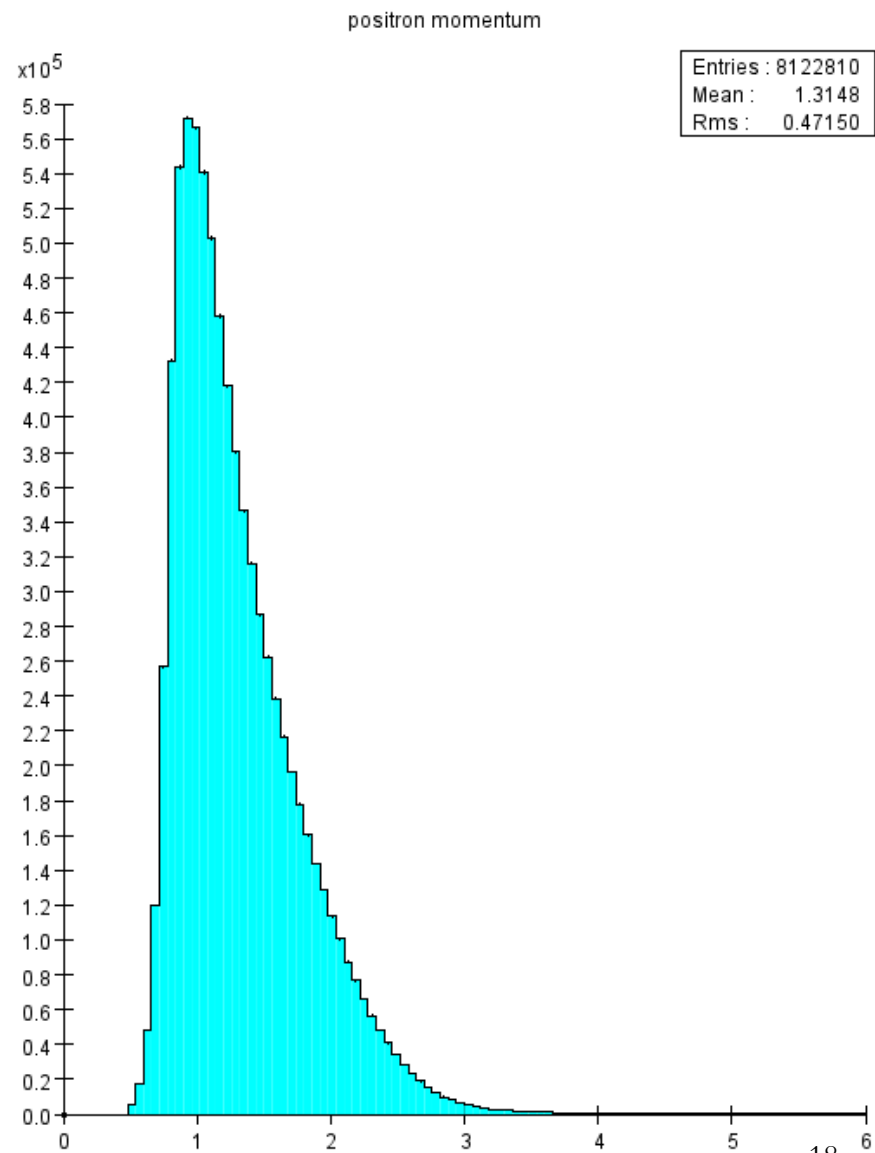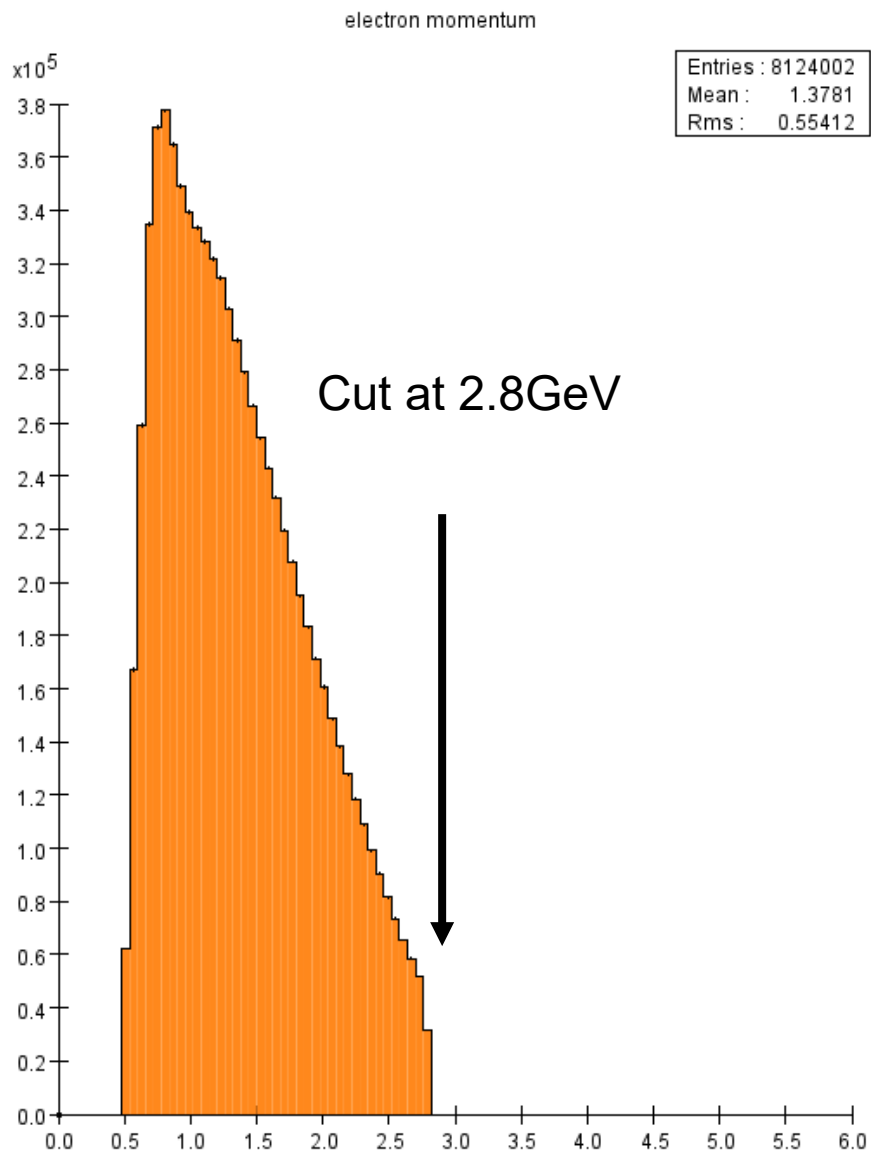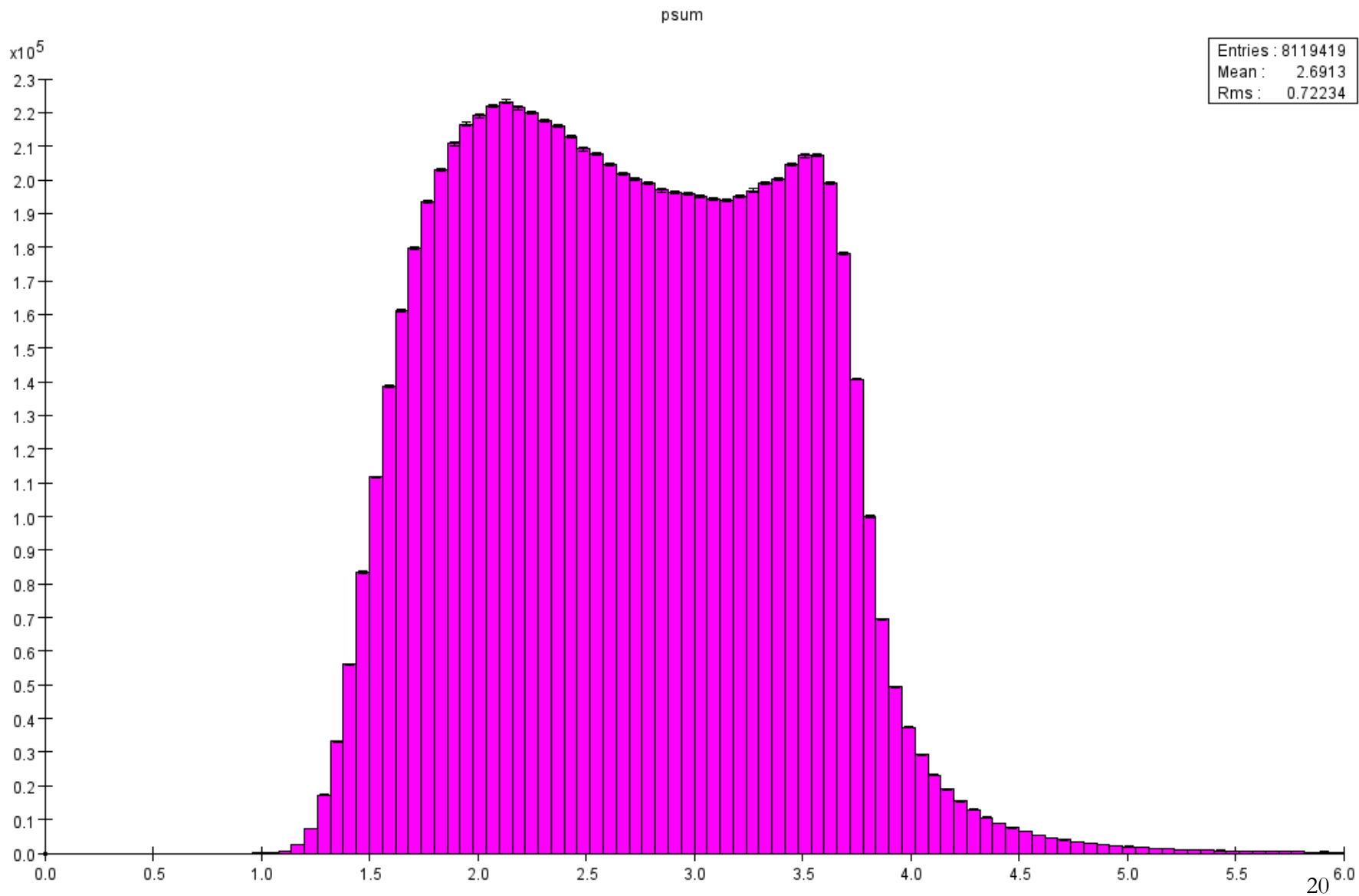
V0 Vertex Positions 2021
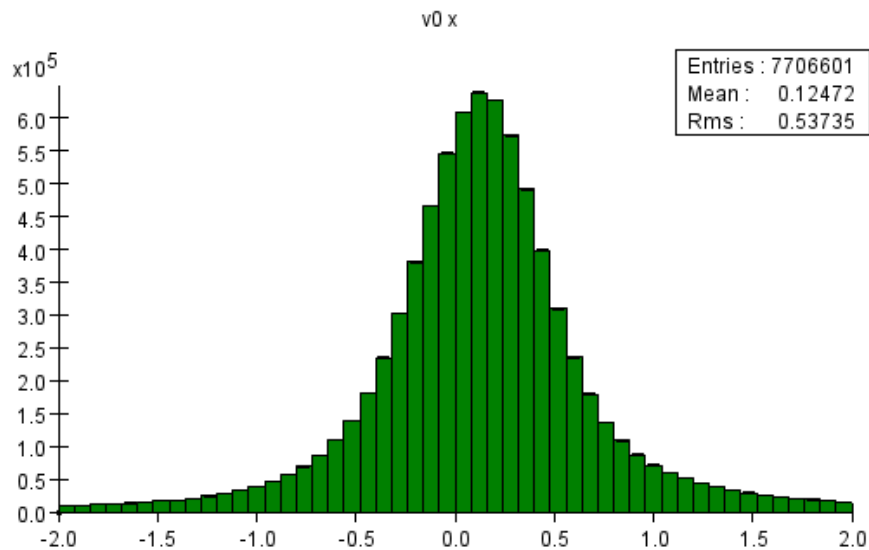
V0 Vertex Momenta 2021

V0 Mass 2021

v0 mass

| Entries : 8123195 |
| Mean : 0.087780 |
| Rms : 0.035161 |

v0 mass

| Entries : 8123195 |
| Mean : 0.087780 |
| Rms : 0.035161 |
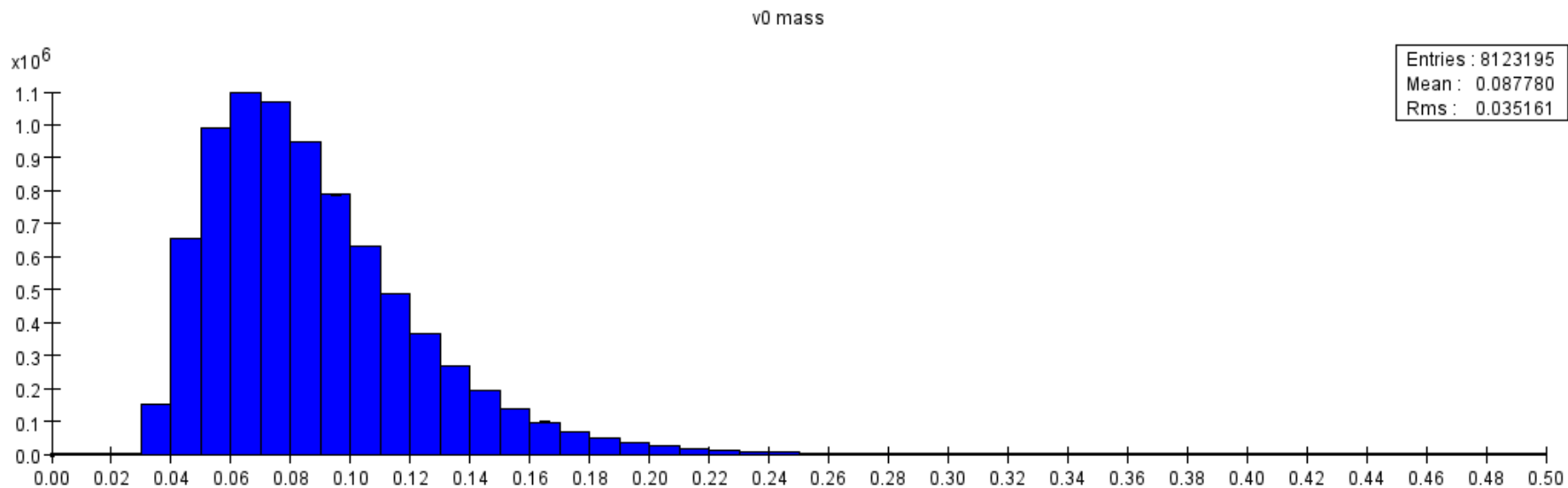
V0 Vertex Mass vs Vertex Z 2021

v0 mass vs Z vertex
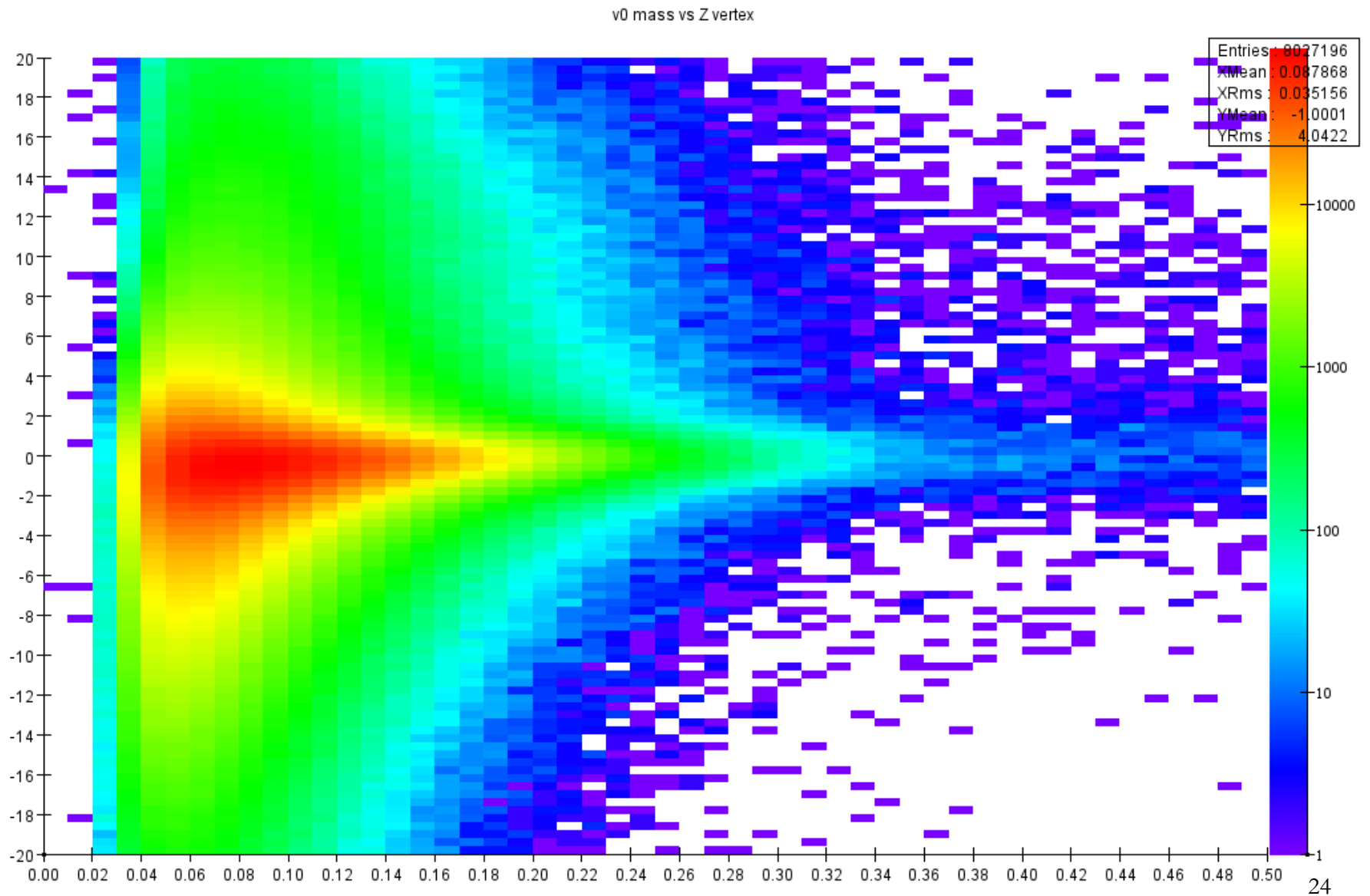
HPS_TimDesign_iter6

- Latest version of the 2019 detector introduced by PF yesterday.

- Process a single physics run with this detector

- Analyze V0s, compare to 2019 Pass0

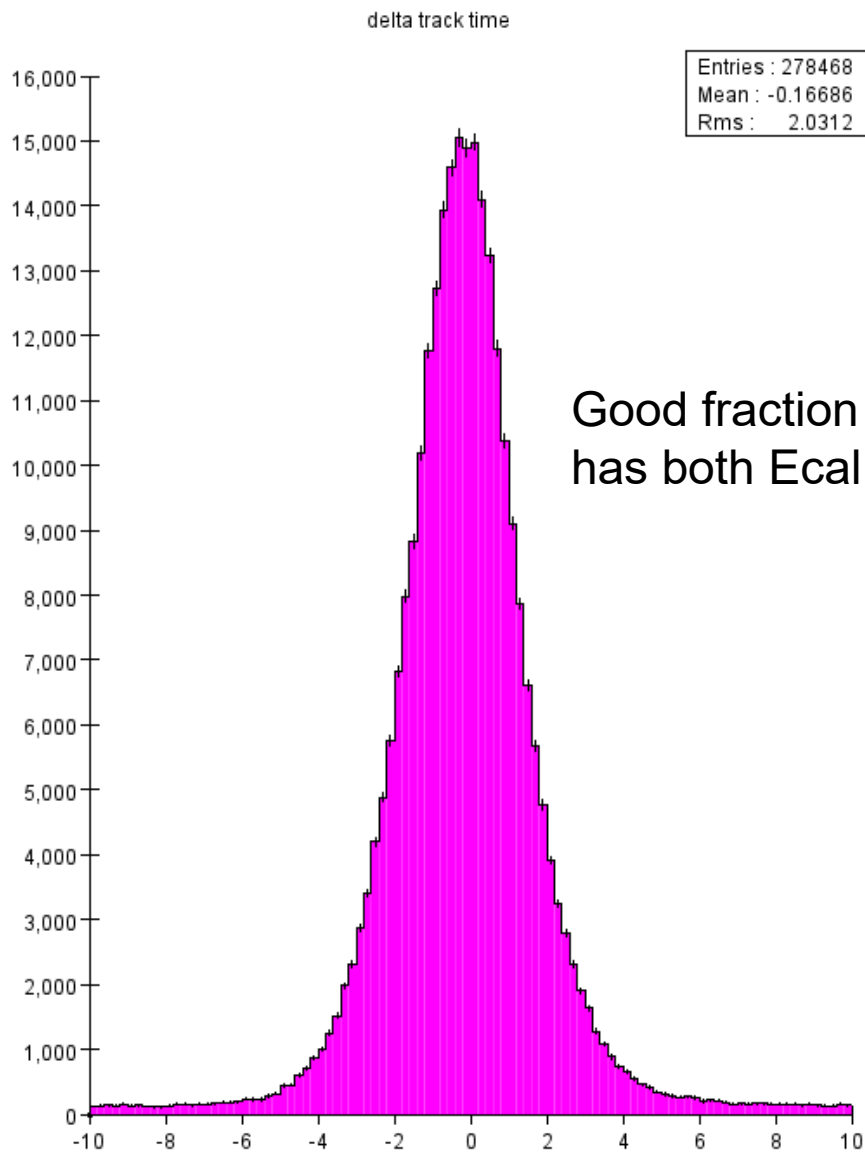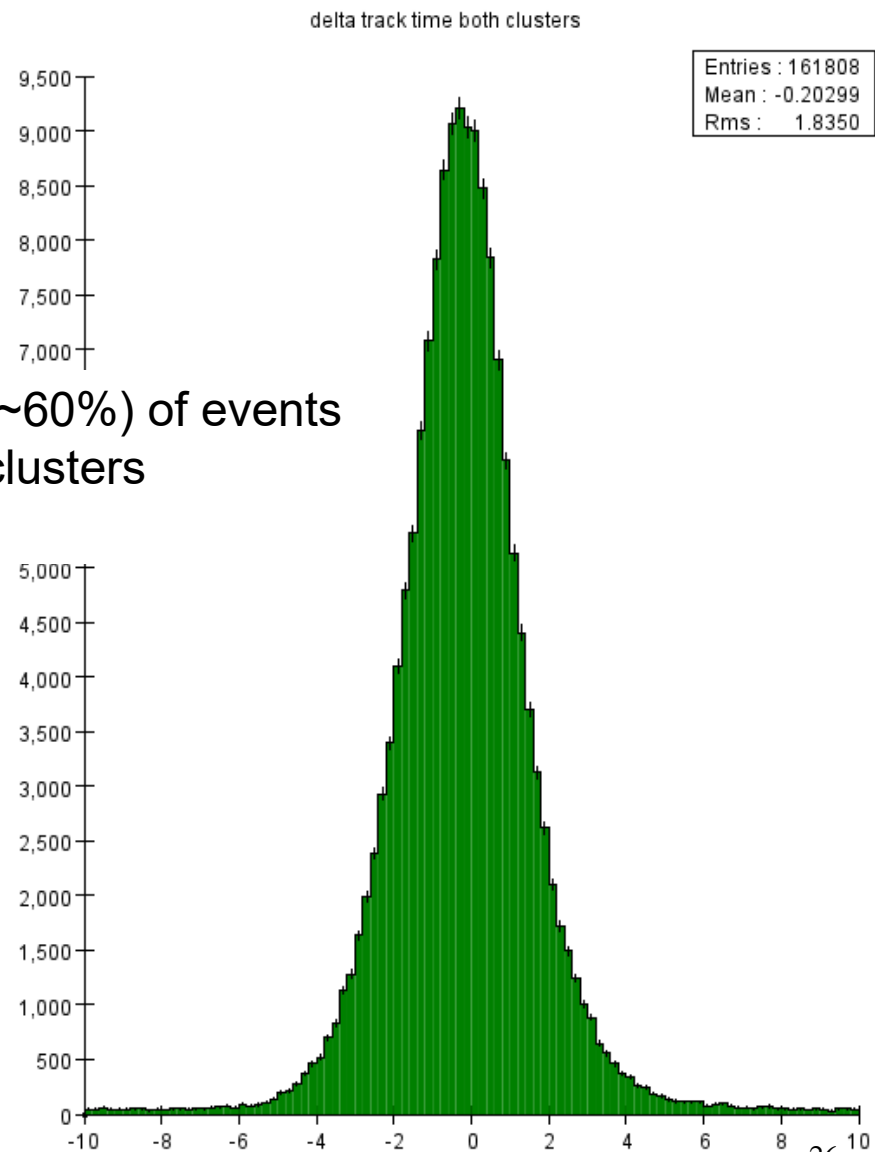# Track Delta Time 10022

delta track time

Entries : 278468
Mean : -0.16686
Rms :   2.0312

Good fraction (~60%) of events
has both Ecal clusters

delta track time both clusters

Entries : 161808
Mean : -0.20299
Rms :   1.8350

Cluster Delta Time 10022

top cluster time - bottom cluster time both clusters

Entries : 161592
Mean : 0.71947
Rms : 1.3104

top cluster time - bottom cluster time both clusters

Entries : 161592
Mean : 0.71947
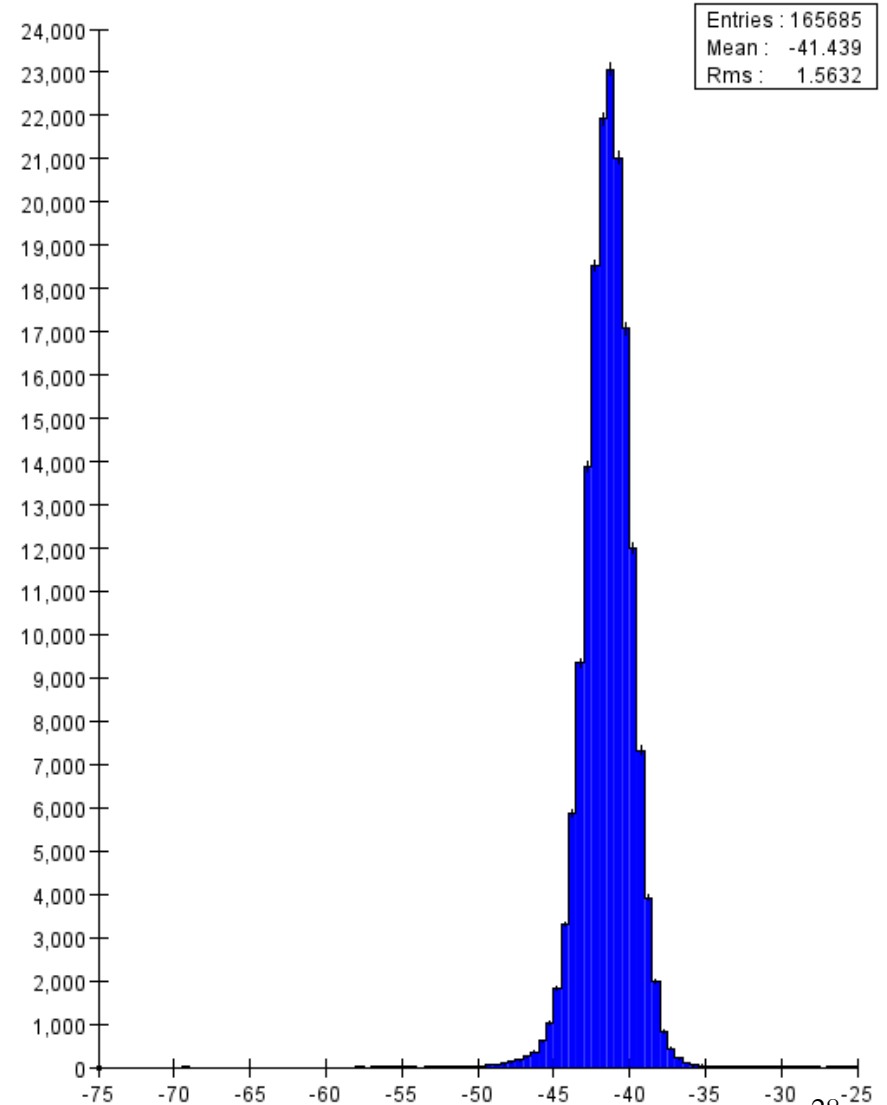Rms : 1.3104
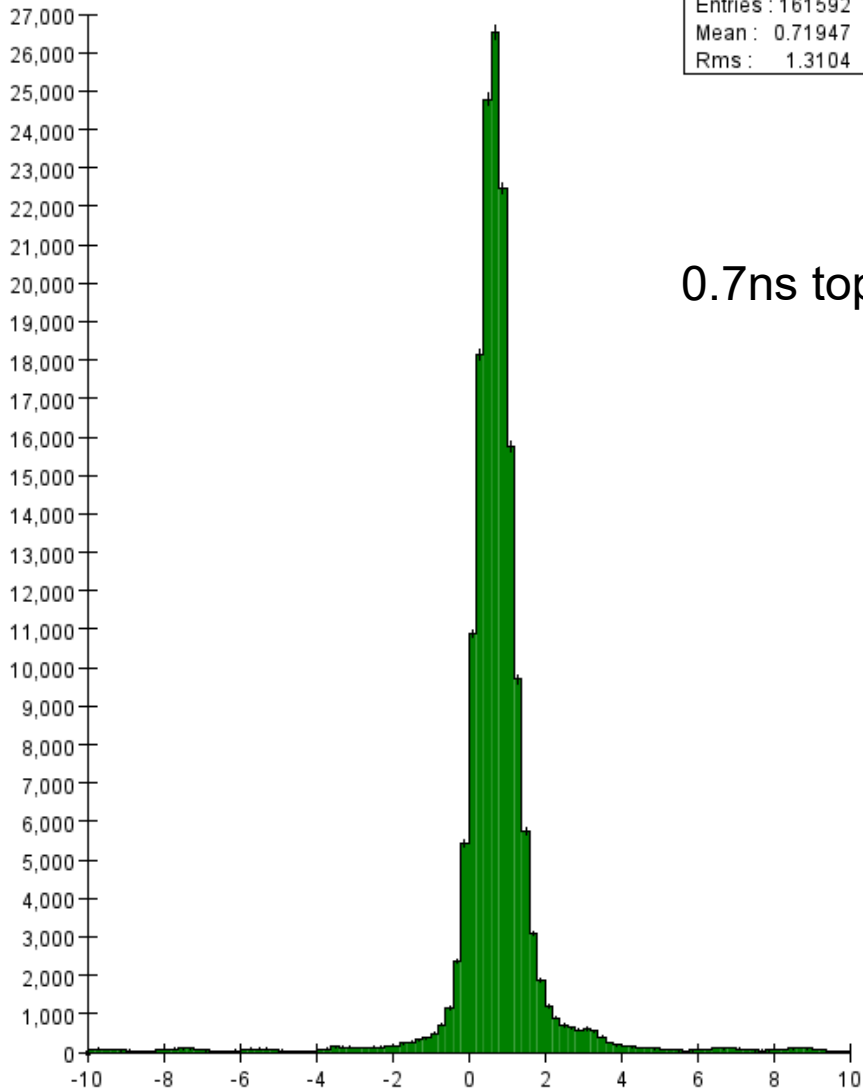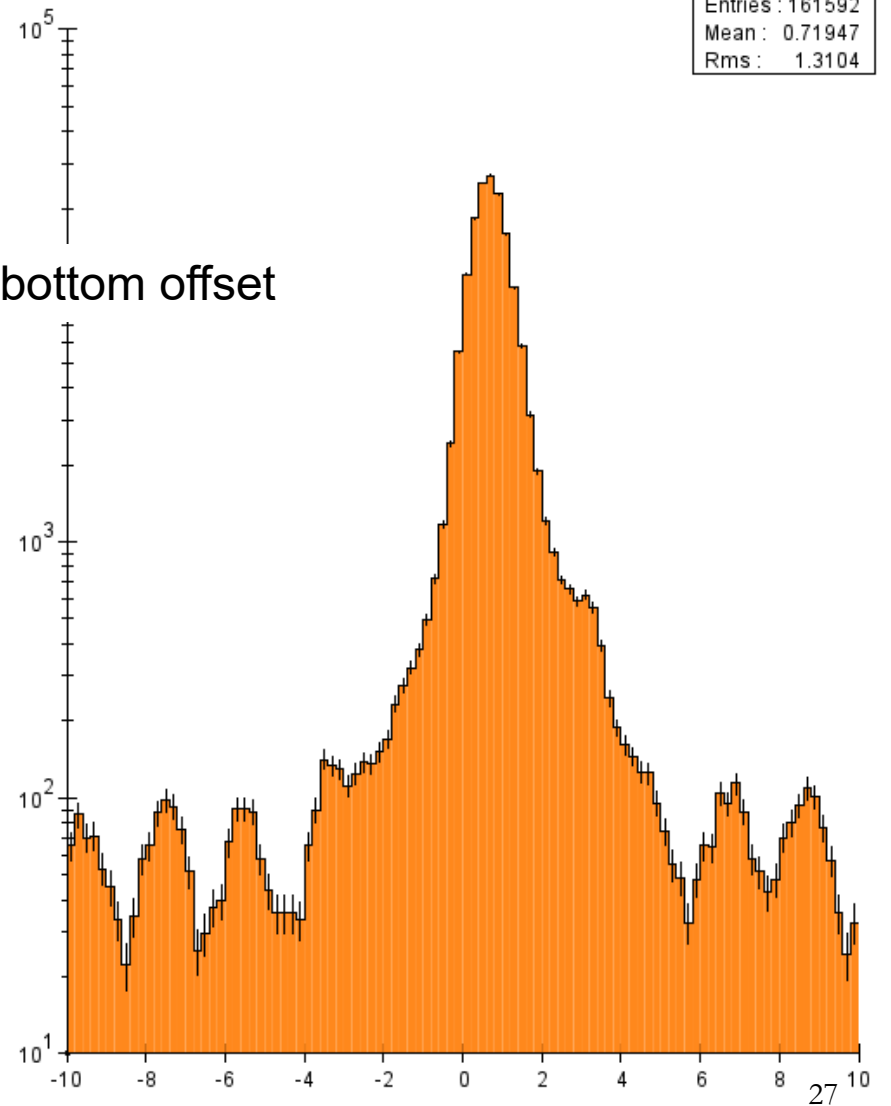
0.7ns top/bottom offset

Track – Cluster Time (both clusters)

electron track time - cluster time both clusters

Entries : 165280
Mean : -41.182
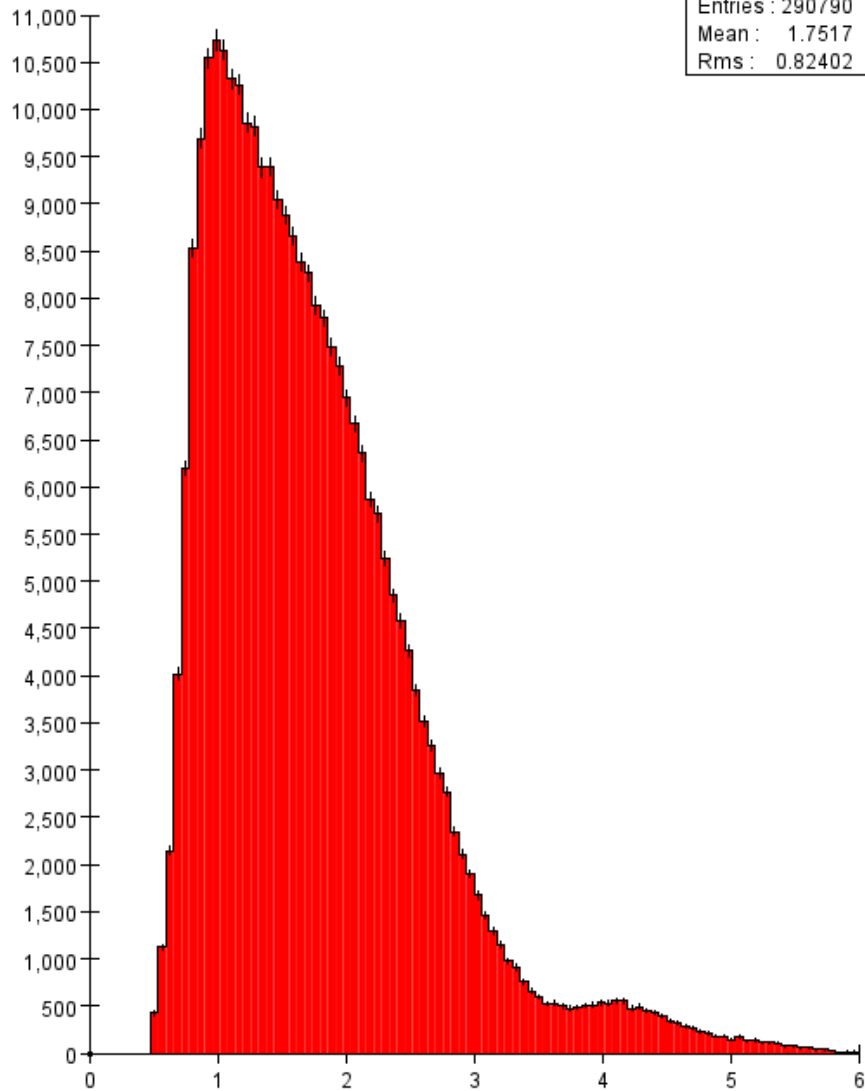Rms : 1.5747

positron track time - cluster time both clusters

Entries : 165685
Mean : -41.439
Rms : 1.5632
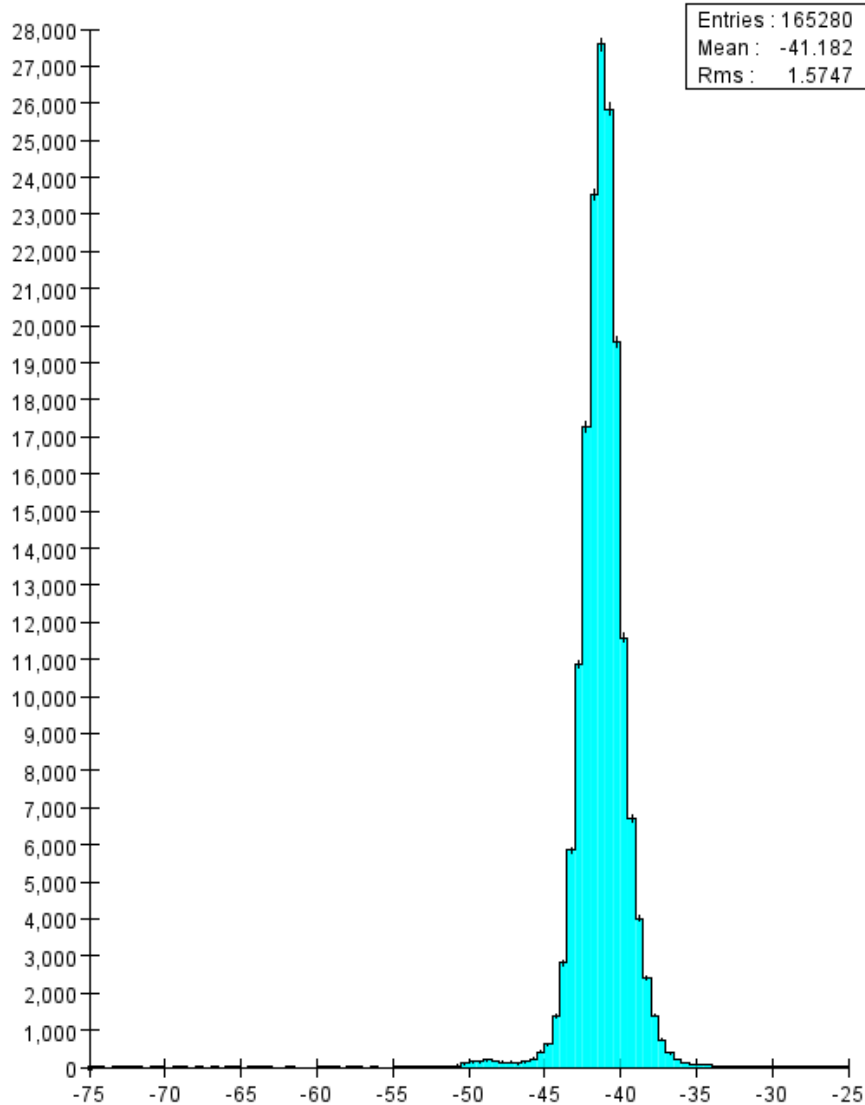
Track Momentum 10022

electron momentum

Entries : 290790
Mean : 1.7517
Rms : 0.82402

positron momentum

Entries : 290908
Mean : 1.5848
Rms : 0.50387

Electron vs Positron Momentum 10022

electron vs positron momentum

Psum 10022

psum

Entries : 287906
Mean : 3.3059
Rms : 0.87593

31
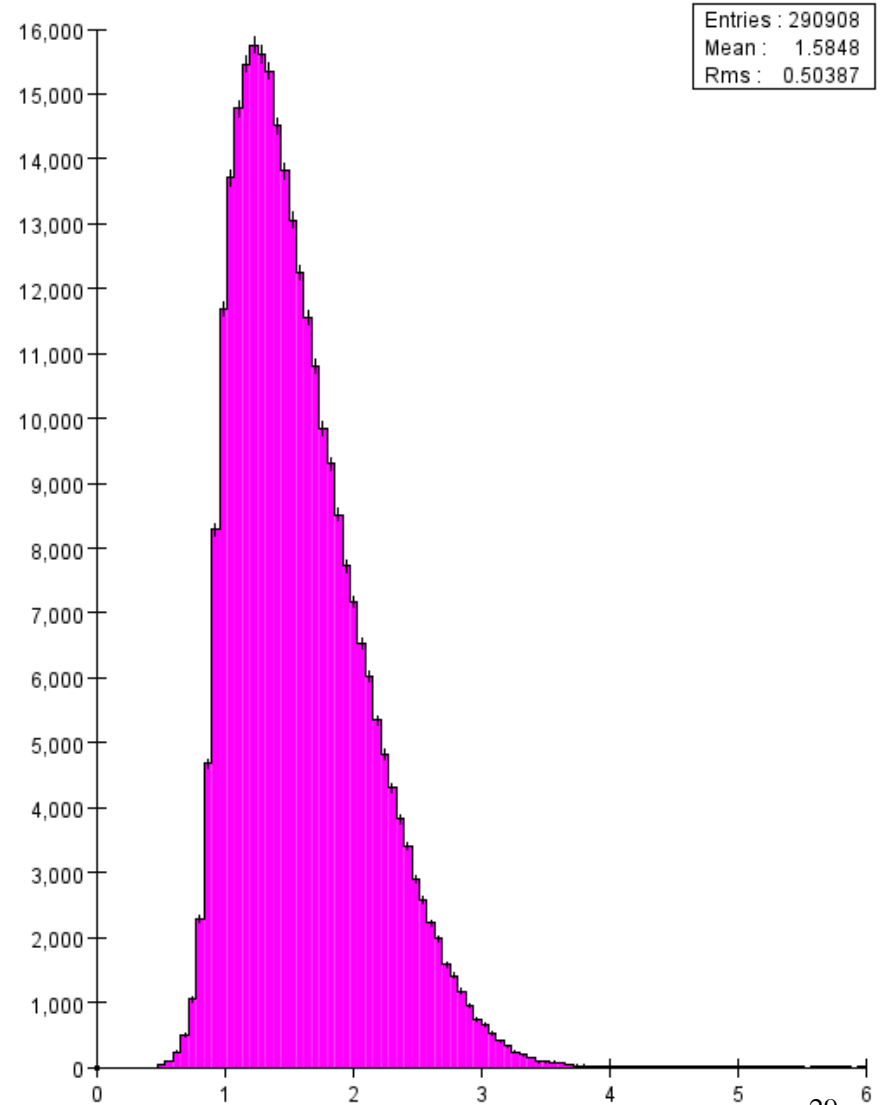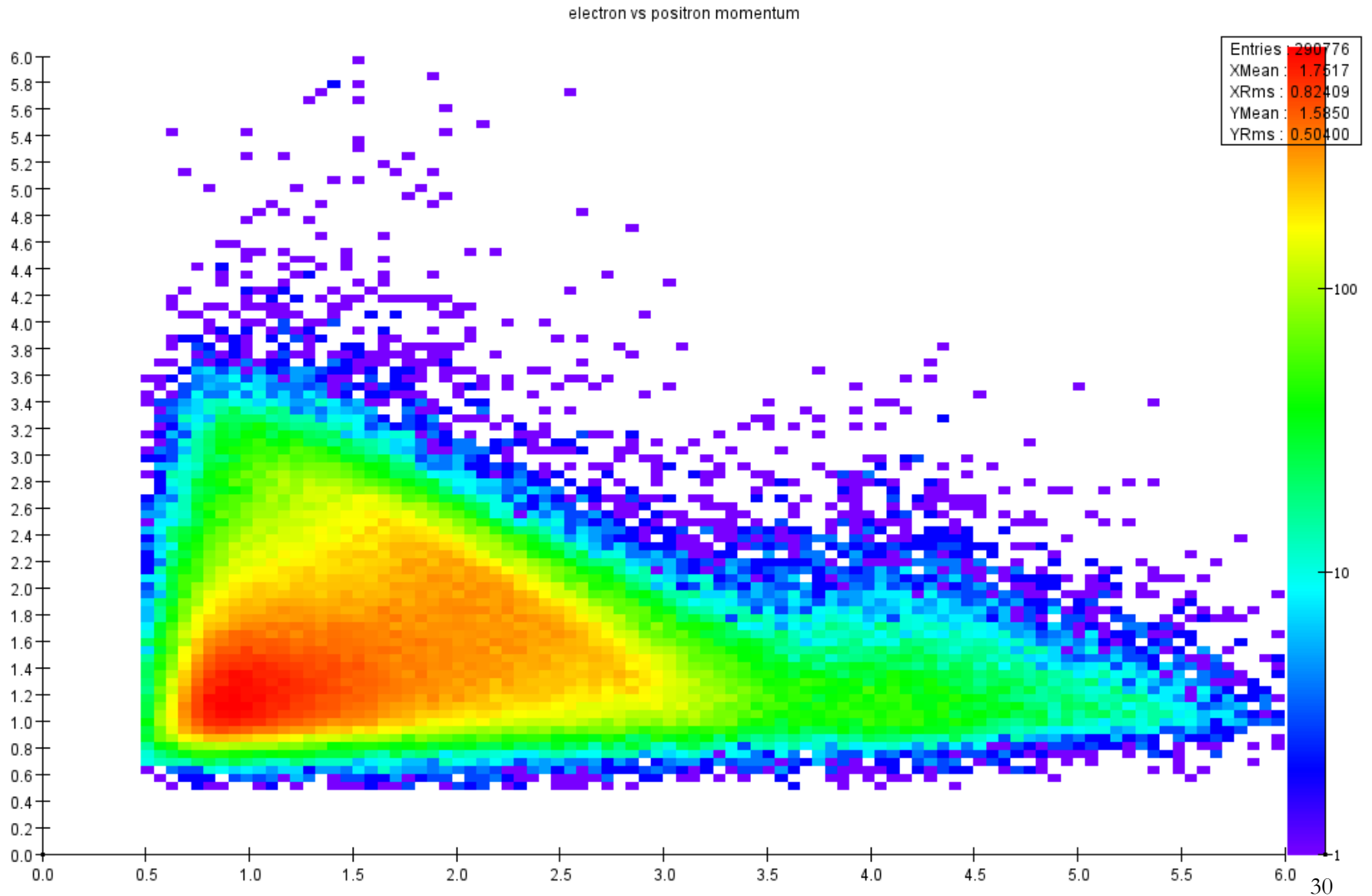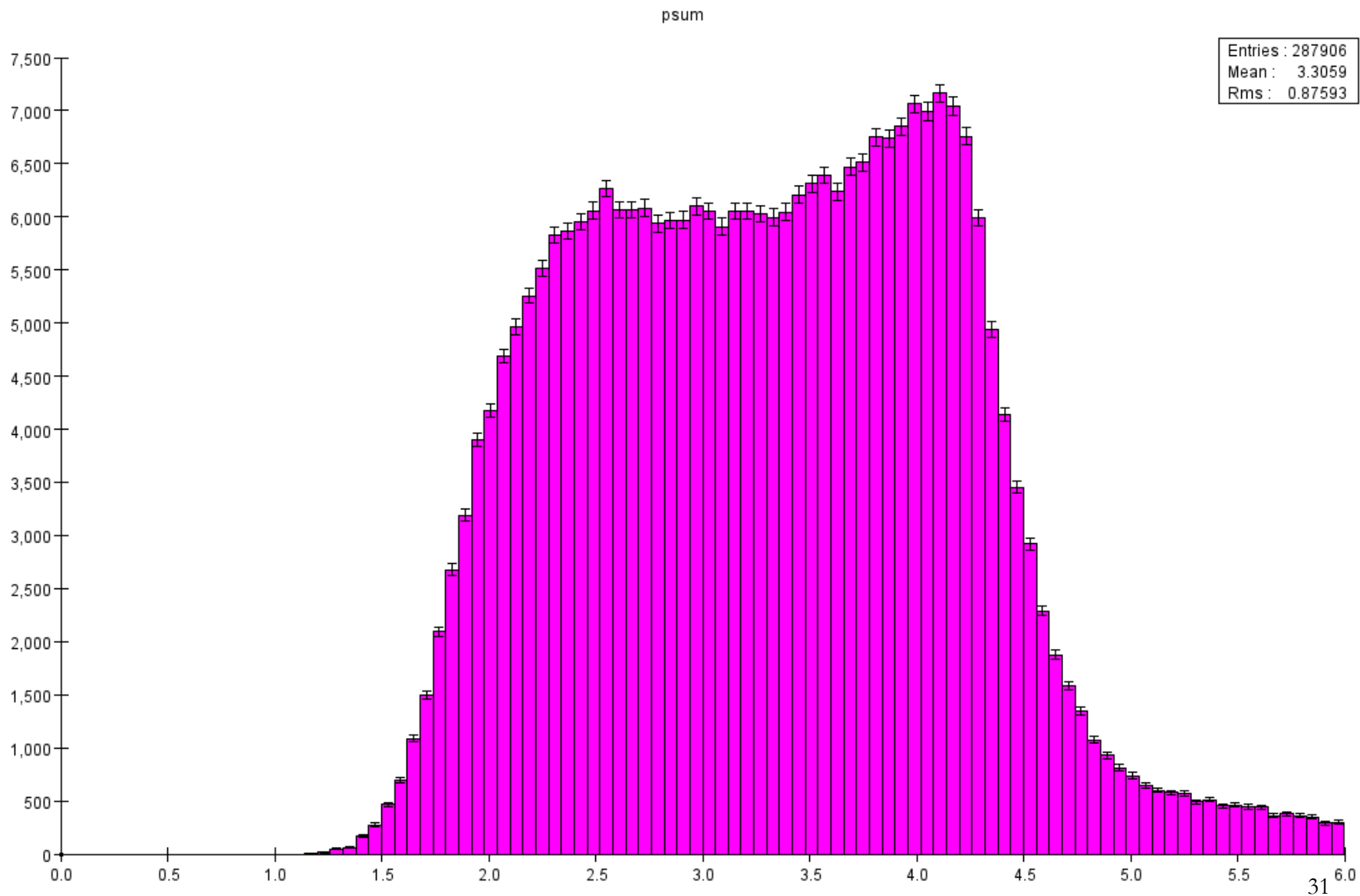
V0 Vertex Positions 10022
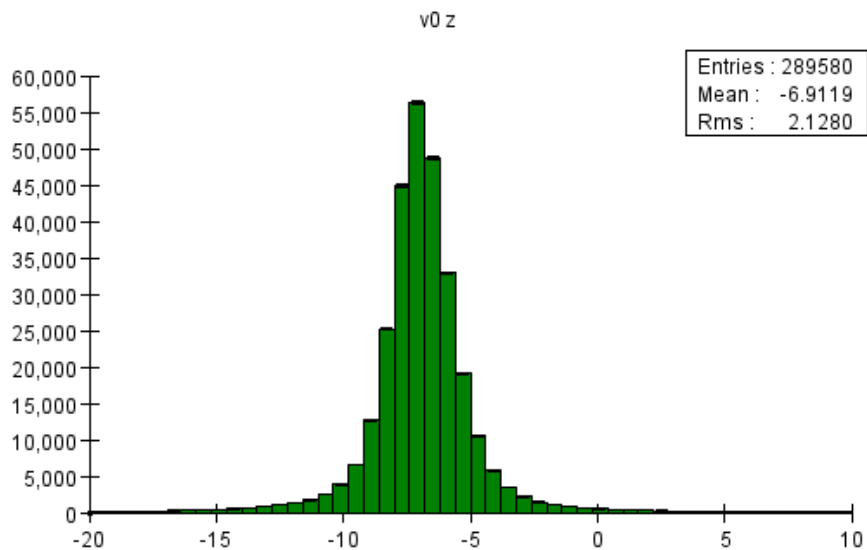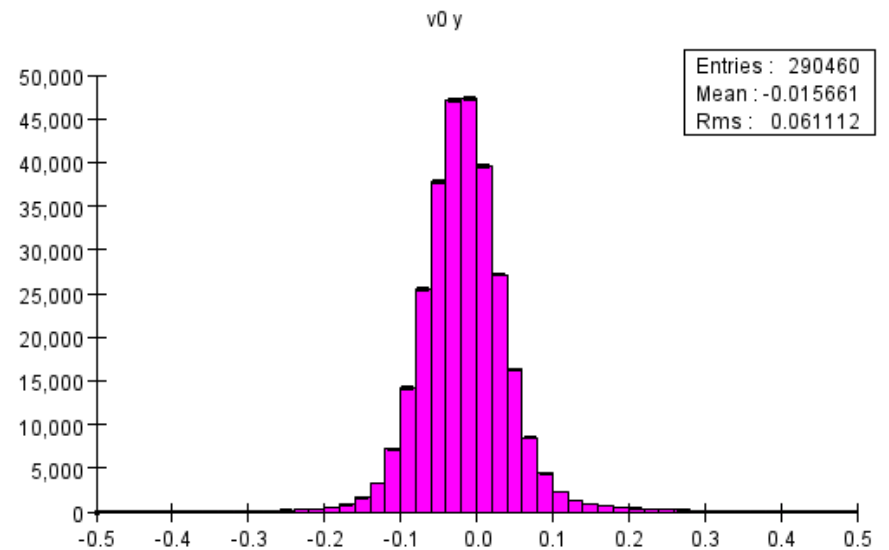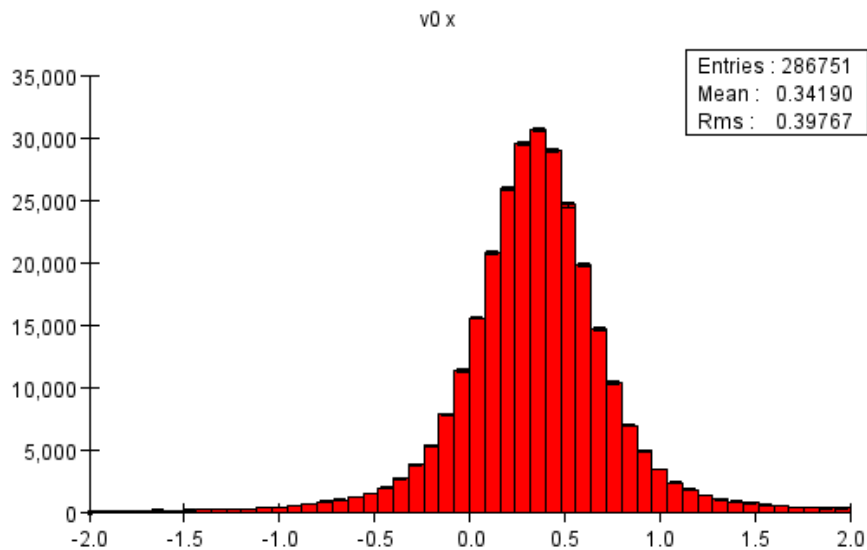
V0 Vertex Momenta 10022

v0 px

Entries : 290104
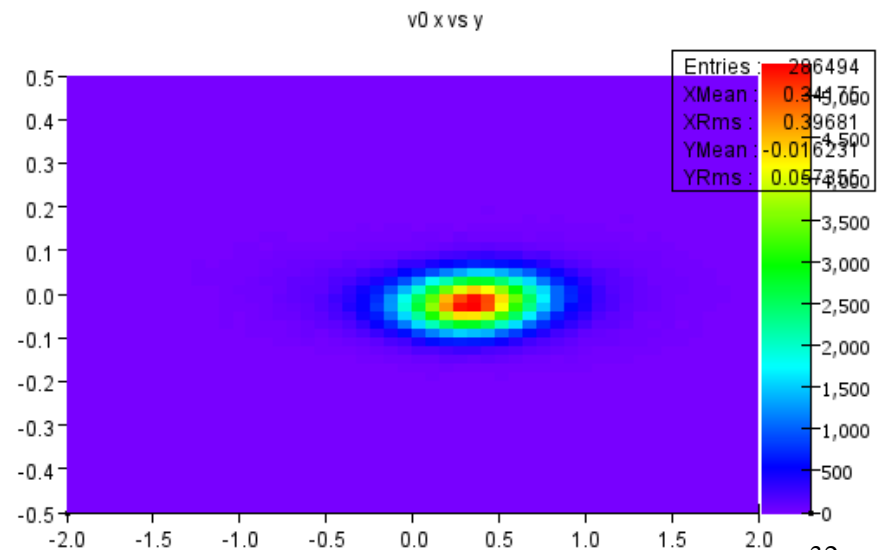Mean : -0.013900
Rms : 0.026614

v0 py

Entries : 290857
Mean : -2.7189E-4
Rms : 0.021490

v0 pz

Entries : 290922
Mean : 3.3492
Rms : 0.93743

V0 Mass 10022

v0 mass

Entries : 290536
Mean : 0.10132
Rms : 0.042311

v0 mass

Entries : 290536
Mean : 0.10132
Rms : 0.042311

V0 Vertex Mass vs Vertex Z 10022
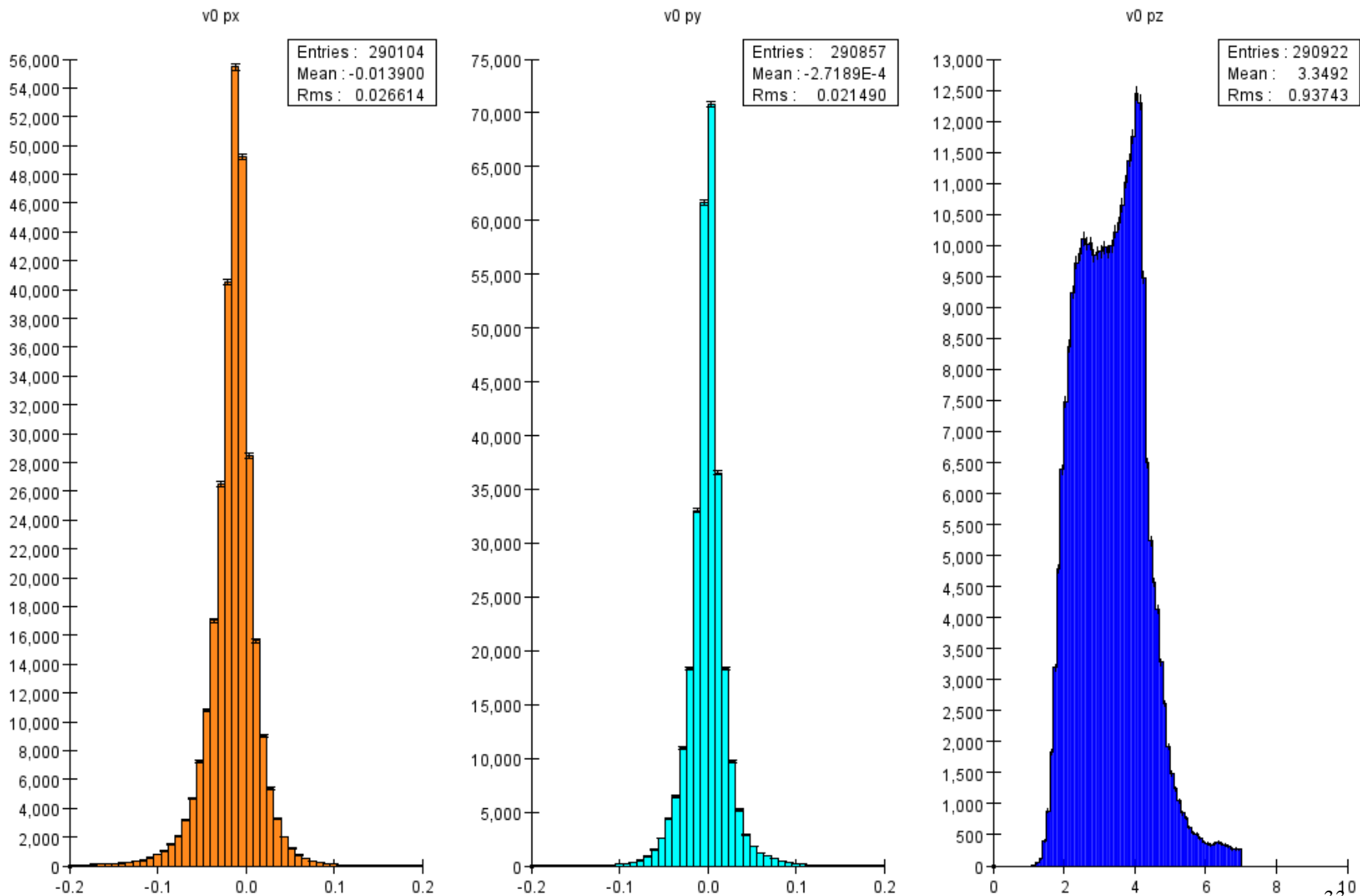

v0 mass vs Z vertex

Entries	289588
XMean	0.10135
XRms	0.042336
YMean	-6.8834
YRms	2.2630
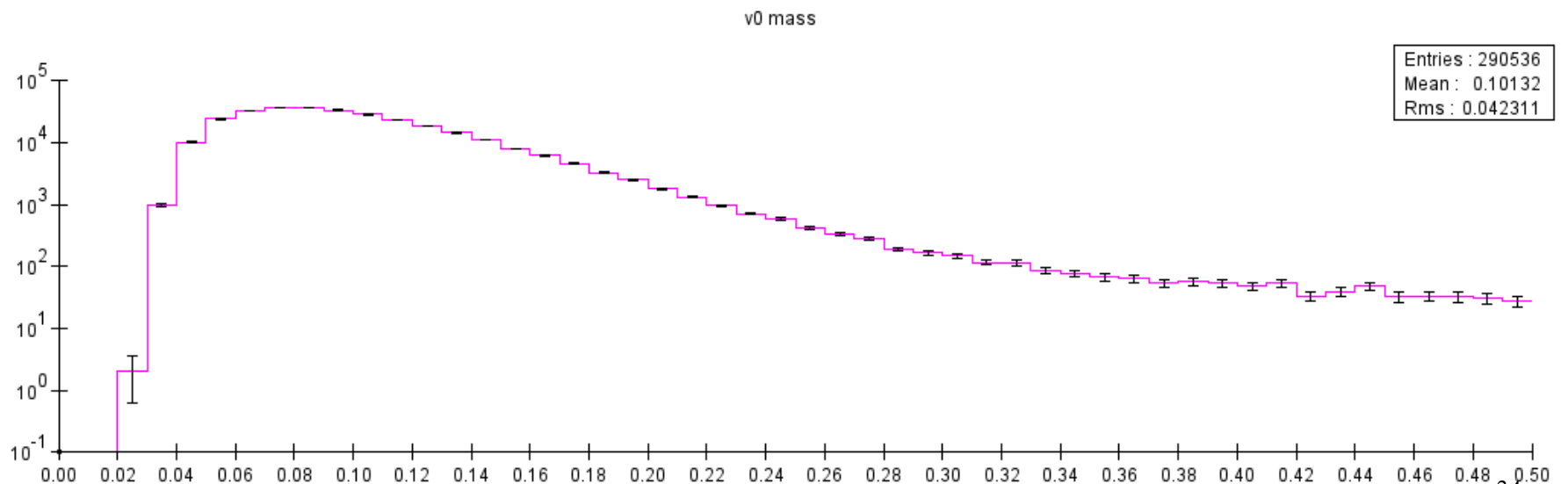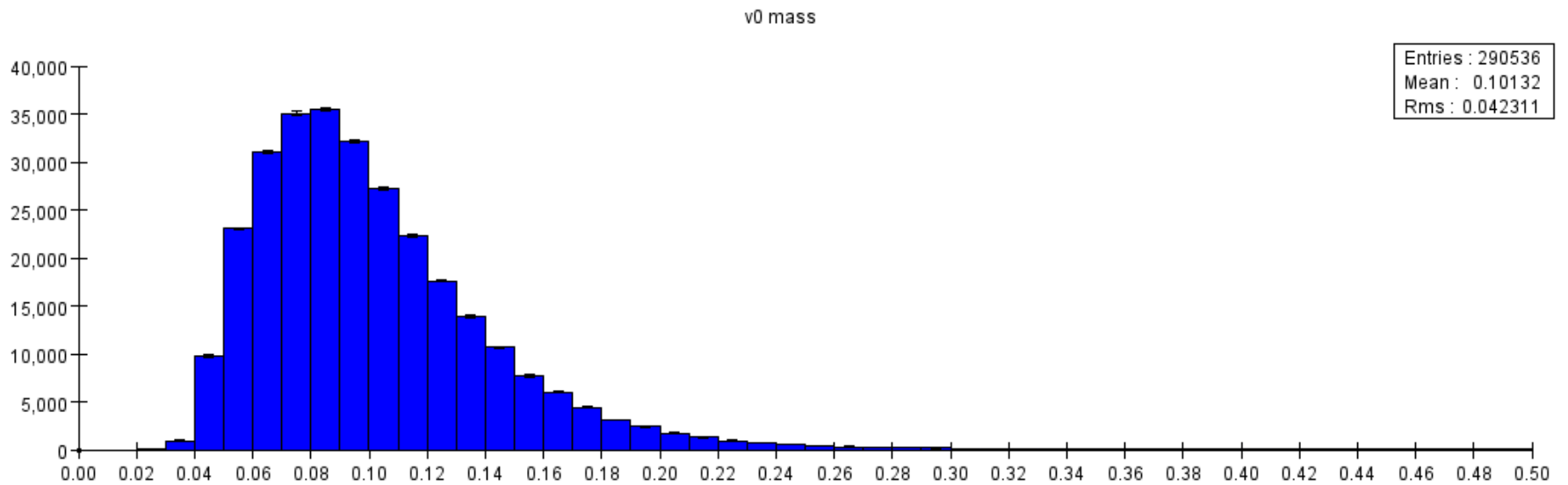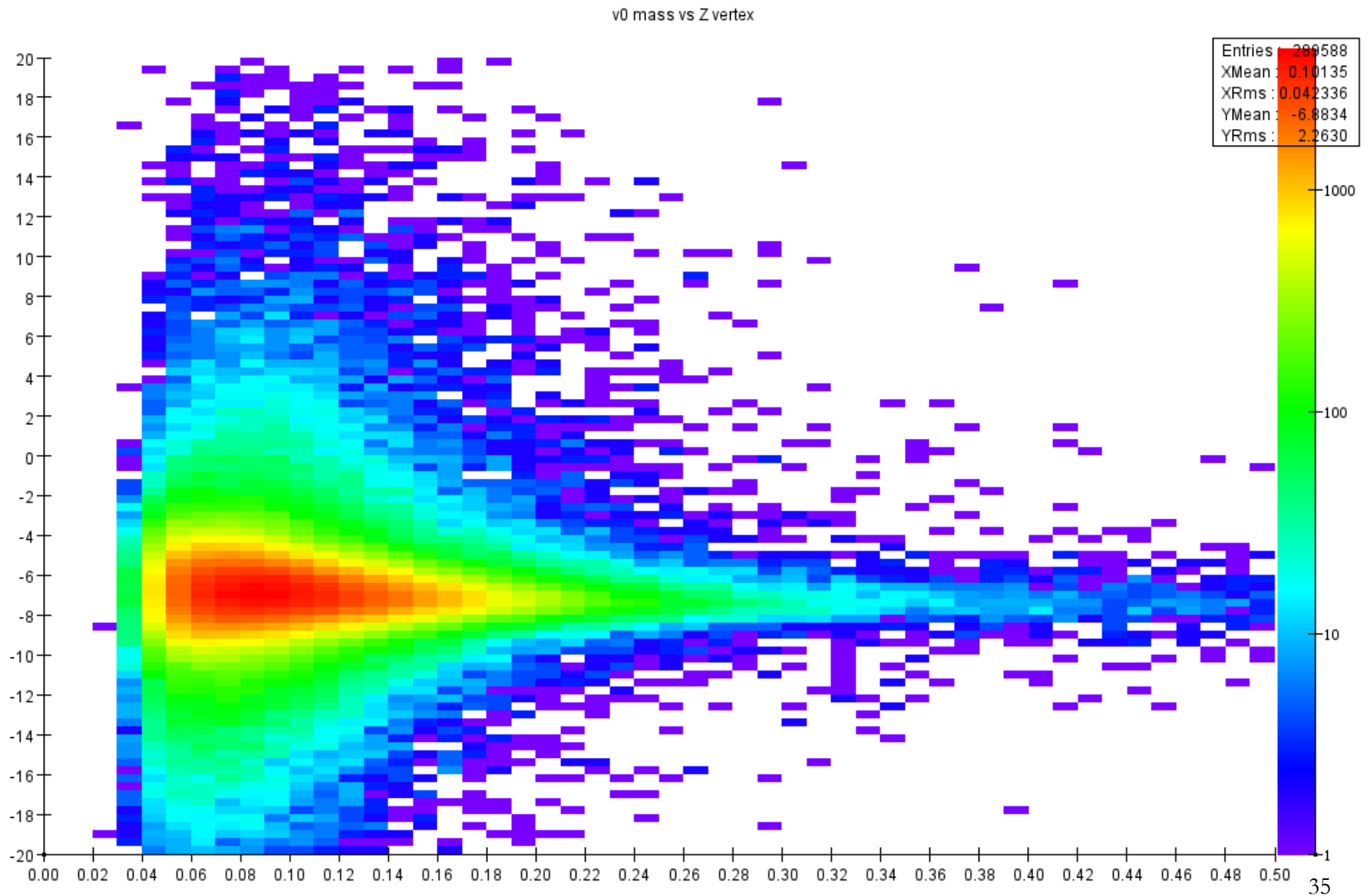
Pass0 vs Run 10022

- Care should be taken when comparing these plots
- Pass0 is averaged over the run conditions and trigger versions
- Run 10022 is a single run
- Nevertheless, interesting to compare
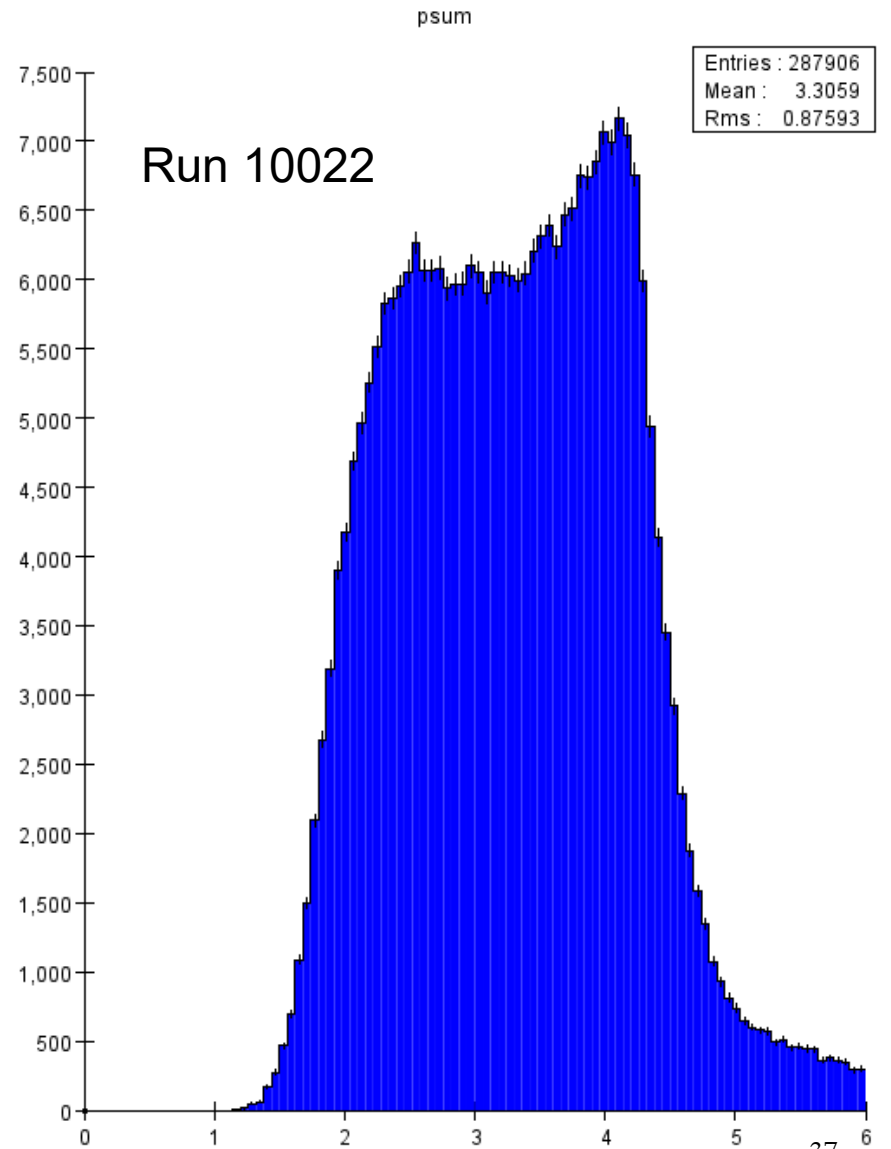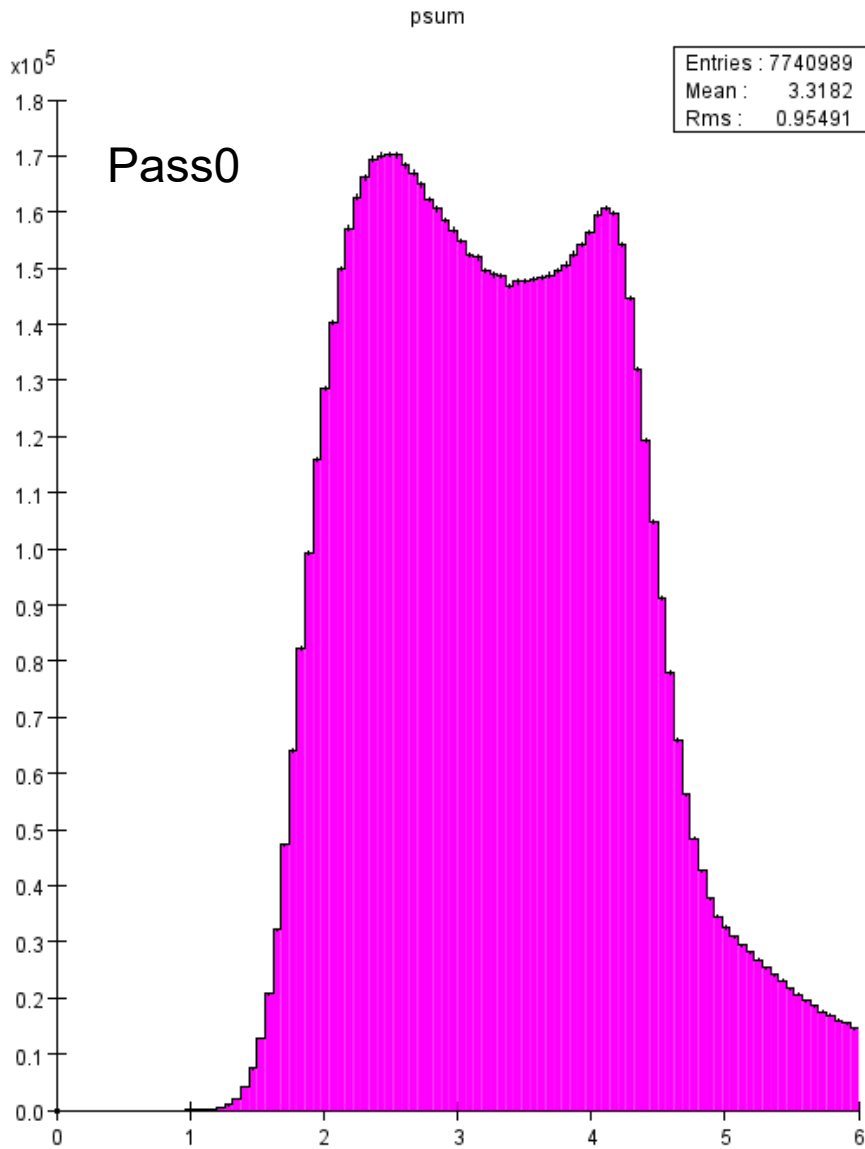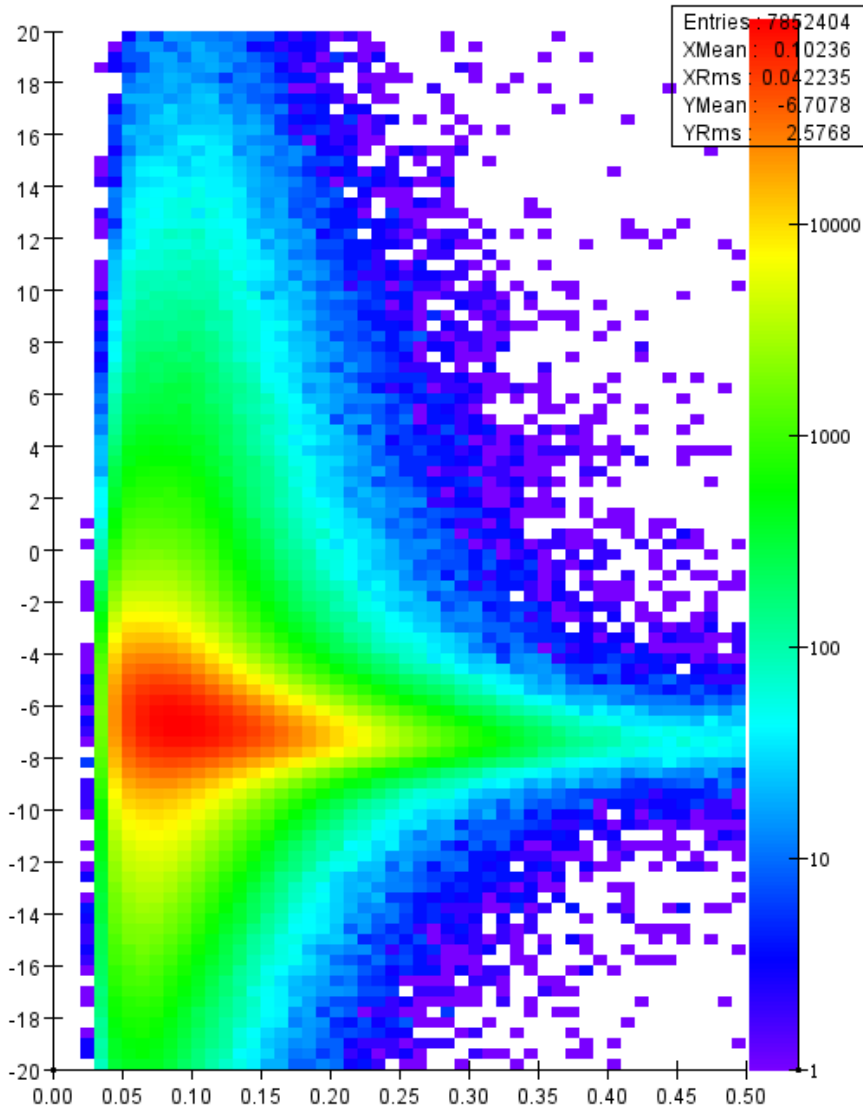
Psum

V0 Mass vs Vertex Z

Pass0 — v0 mass vs Z vertex

Entries: 7852404
XMean: 0.10236
XRms: 0.042235
YMean: -6.7078
YRms: 2.5768

Run 10022 — v0 mass vs Z vertex

Entries: 289588
XMean: 0.10135
XRms: 0.042336
YMean: -6.8834
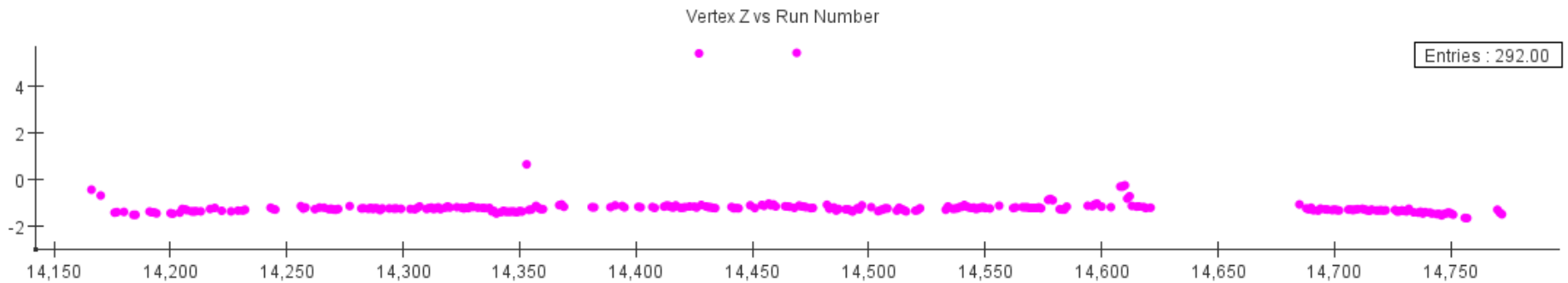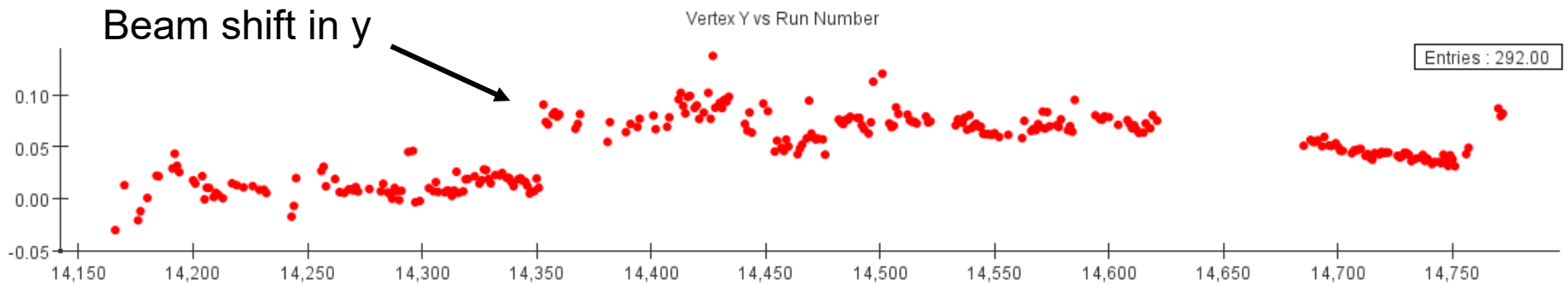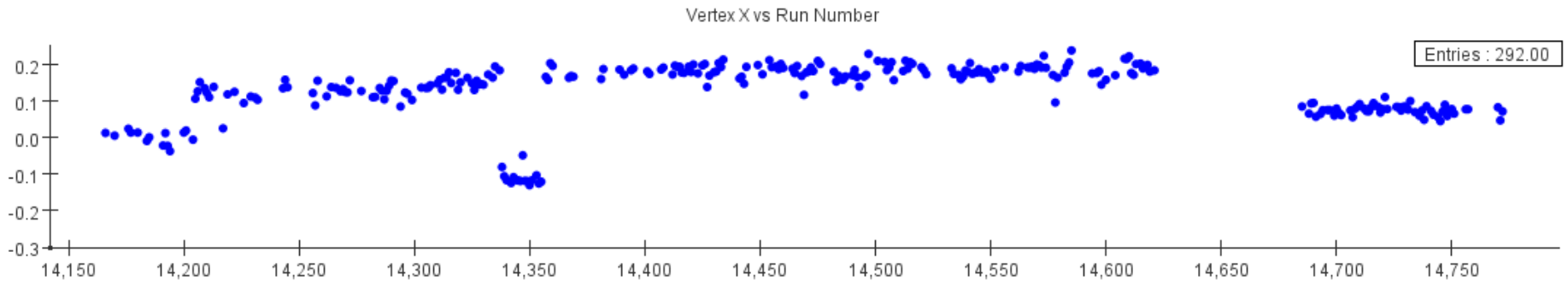YRms: 2.2630
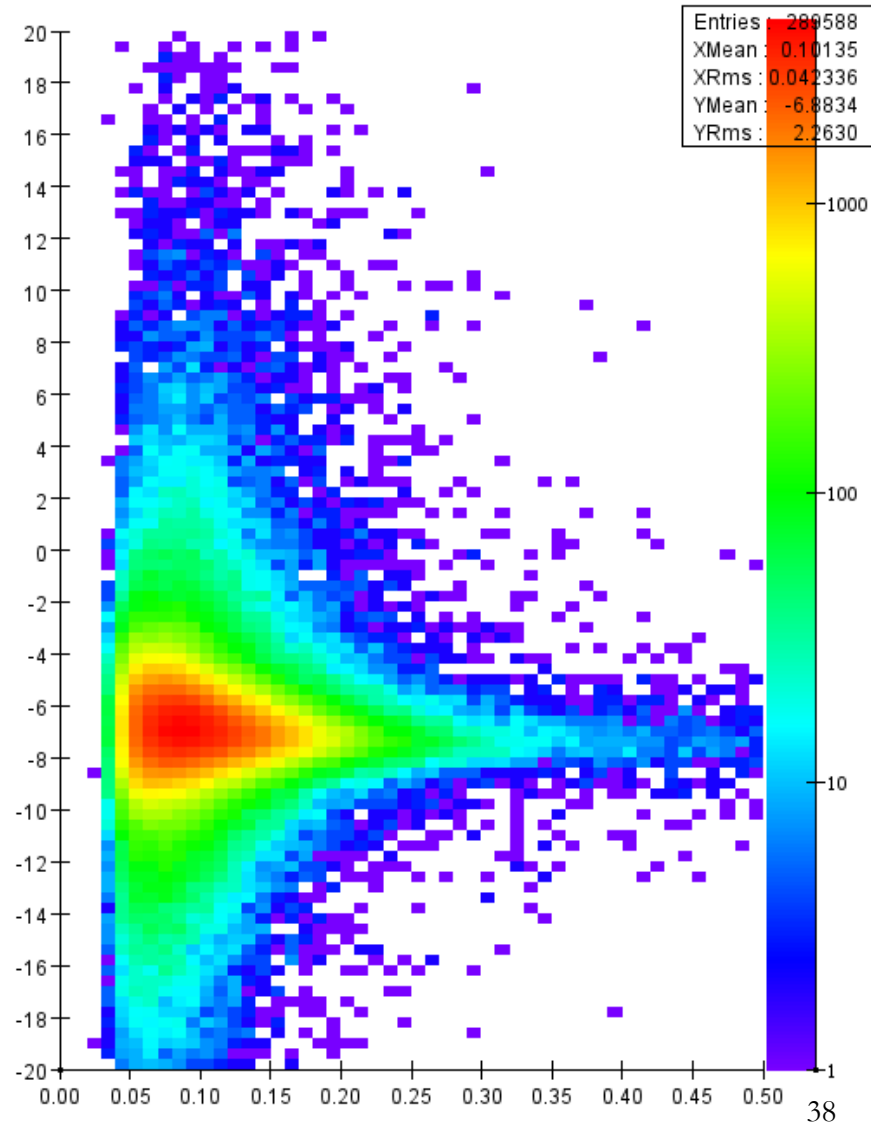
Dude! Where's my target?

- For first time, getting consistent estimates for the z position of the IP: -6.96, -7.12, -7.13

Vertex Positions vs Run Number 2021

Vertex X vs Run Number

Beam shift in y
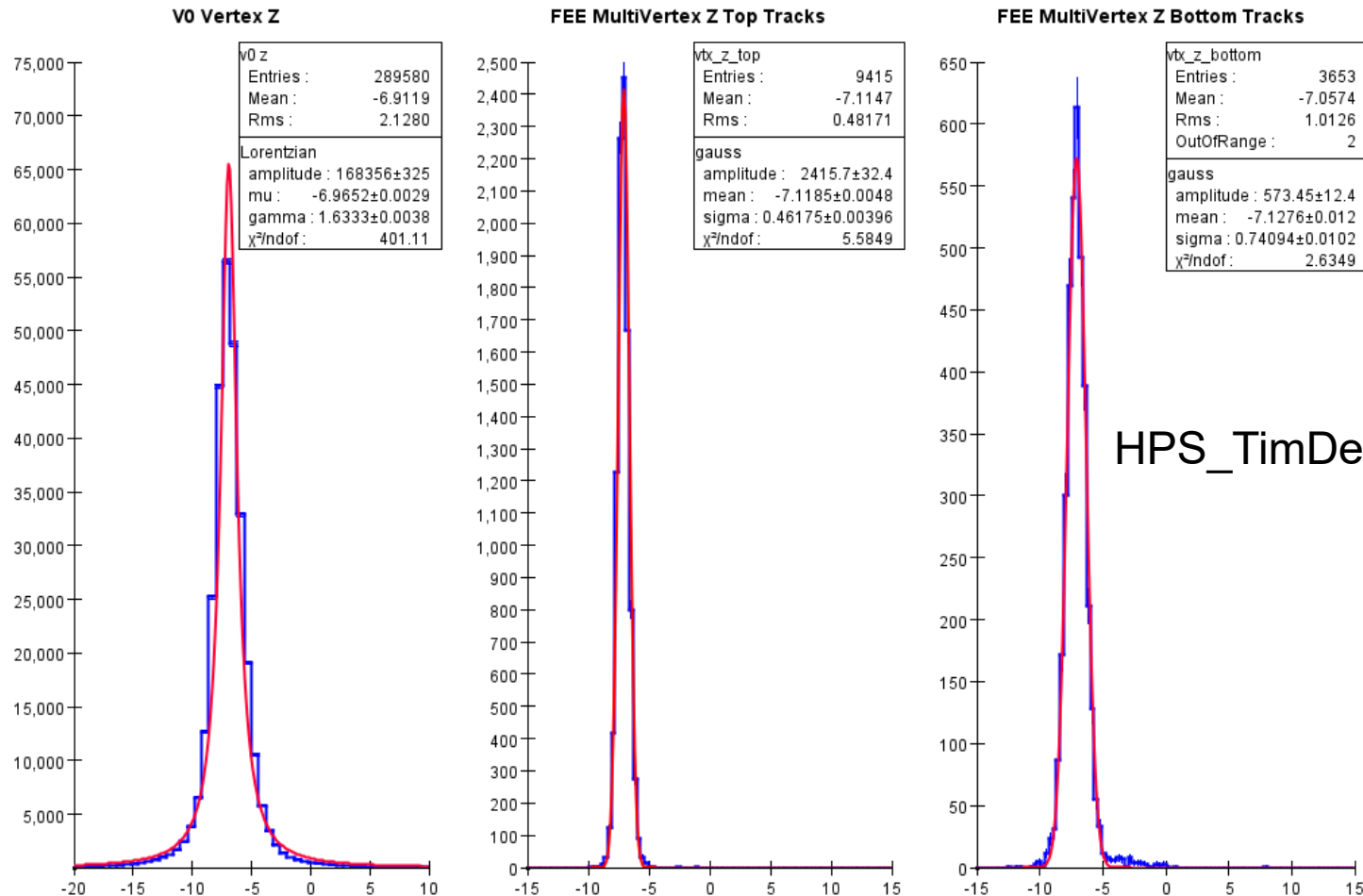
Vertex Y vs Run Number
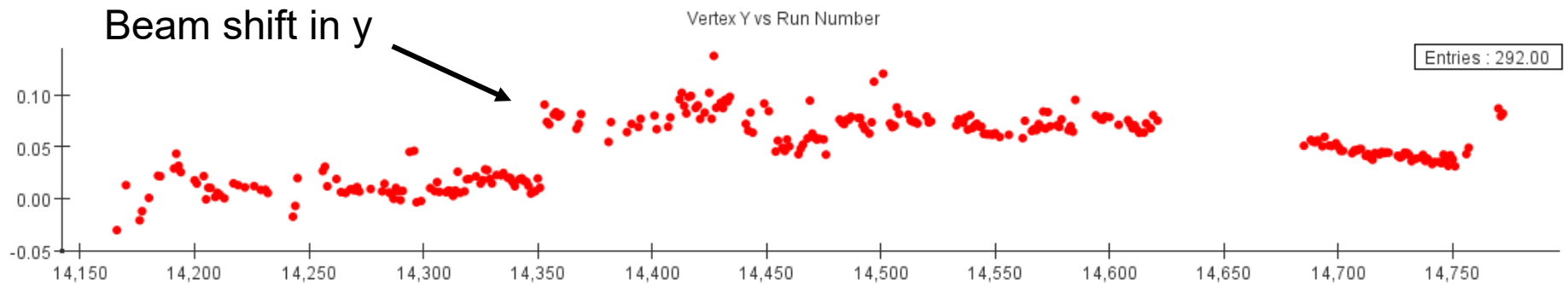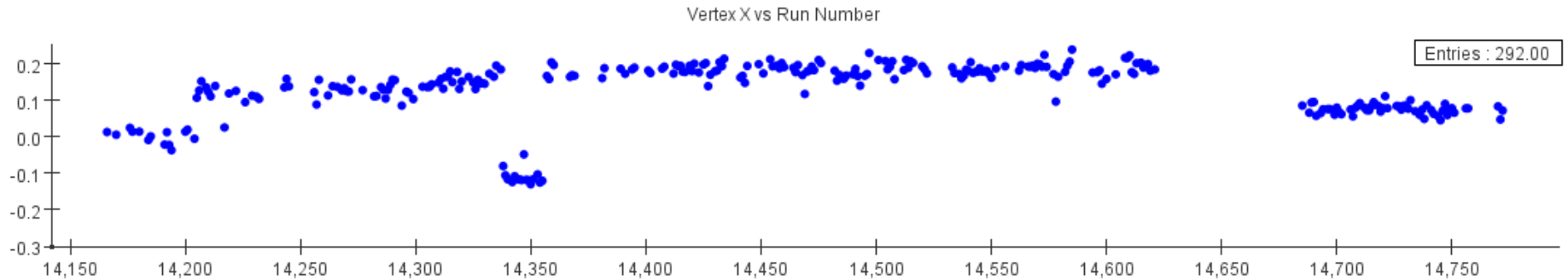
Vertex Z vs Run Number

Vertex Positions vs Run Number 2021
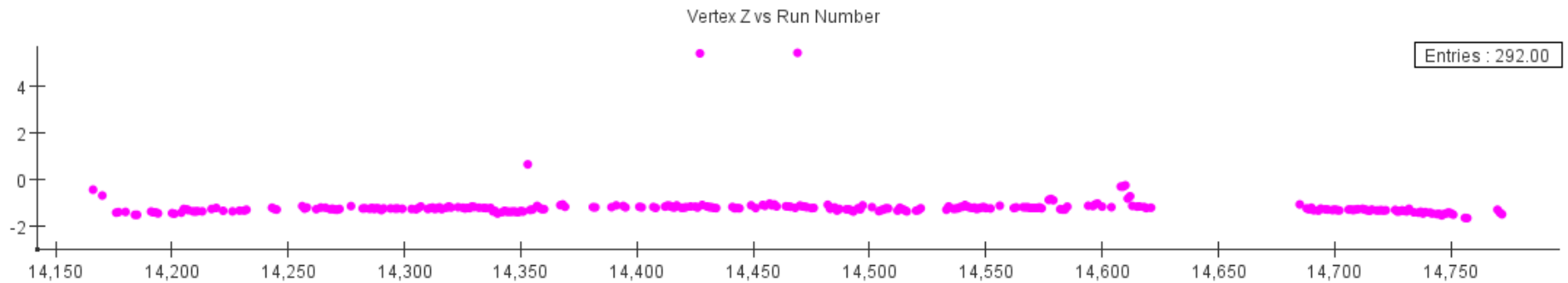
V0 Yield 2019

- Largest surprise (to me) was the yield!
- Number of V0 candidates / total in pass0 run

'D://work/hps/analysis/pass0/V0Analysis/2019_V0SkimSummaries.txt' using 1:4

Some variation may be due to trigger changes
Yield is low and falling as the run progresses
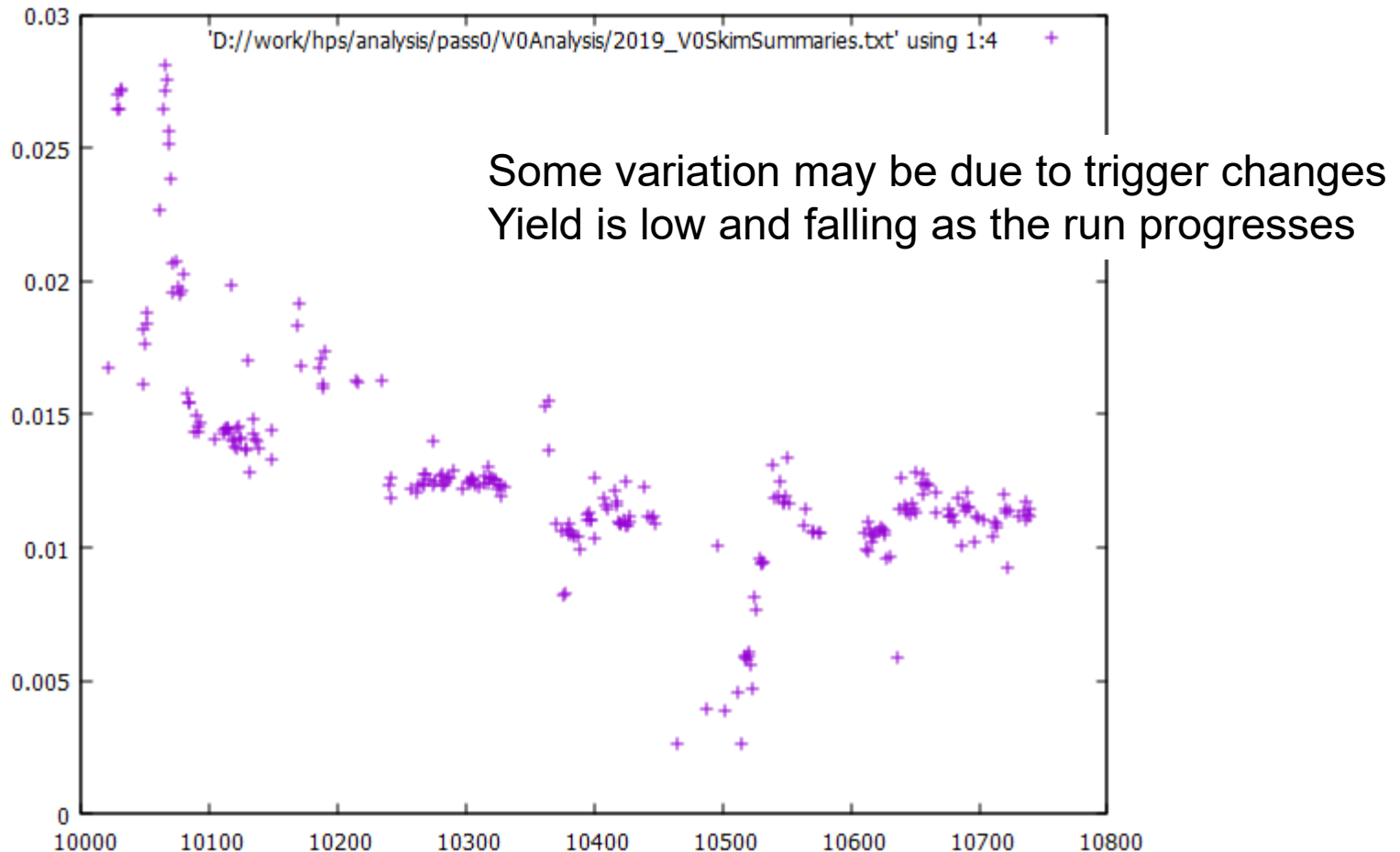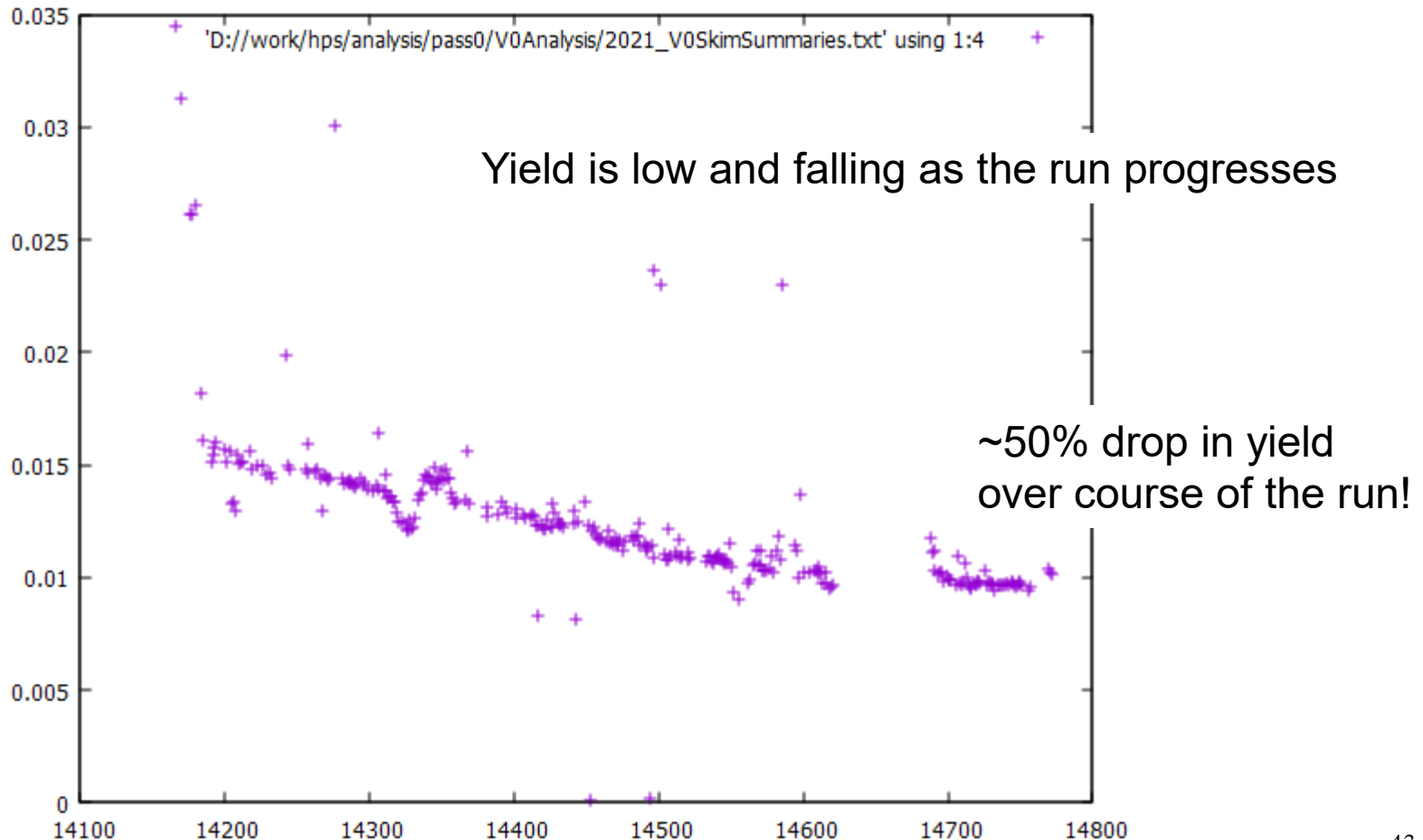
V0 Yield 2021

- Largest surprise (to me) was the yield!
- Number of V0 candidates / total in pass0 run

Yield is low and falling as the run progresses

~50% drop in yield over course of the run!

Summary

- Still have a long way to go to finalize detector calibration, but first look at V0s in Pass0 is not discouraging
- Latest 2019 detector shows definite improvements
  - promising leads (e.g. module bowing) being pursued
- Will need to understand systematics as a function of run and populate database with run-specific IP positions, tracking efficiency, geometry(?), etc.
- Need to systematically study selection criteria and cuts
  - to eliminate backgrounds
    - current selection criteria are intentionally loose
  - to increase yield?