

Preliminary analysis of the acquired data at GSI (April 2019)

roberto spighi, 5/6/2019

Performed Analysis:

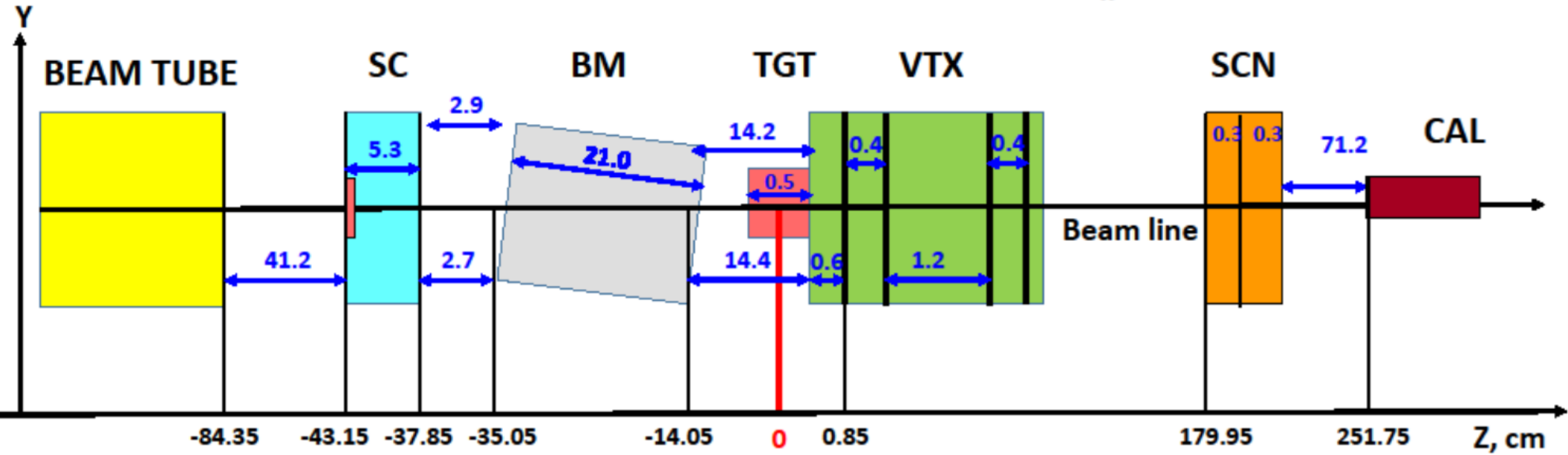
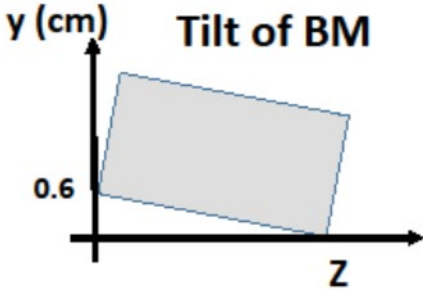
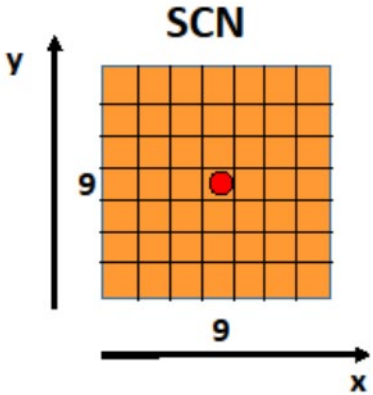
- ❑ Single detectors
 - ❑ SC, BM, VTX, SCN
- ❑ Correlation between sub-detectors:
 - ❑ BM-VTX
 - ❑ BM-SCN (for NO Target Runs)
 - ❑ VTX-SCN

Acquired data

	Run	Statistics	Target	Characteristic	date	Duration (s)
Without Target	2210	20463	NO	DAQ Test	7/4, 18h,41'	126
	2211	62782	NO	“ “	7/4, 18h,44'	350
	2212	116349	NO	“ “	7/4, 18h,51'	626
With Target	2239	20821	YES	BM HV=1800 V	8/4, 19h,16'	161
	2240	20004	YES	BM HV=1850 V	8/4, 19h,20'	157
	2241	20041	YES	BM HV=1900 V	8/4, 19h,23'	153
	2242	202729	NO	SCN CALibration	8/4, 19h,37'	1425
	2251	6863	YES	Physics	9/4, 08h,33'	74

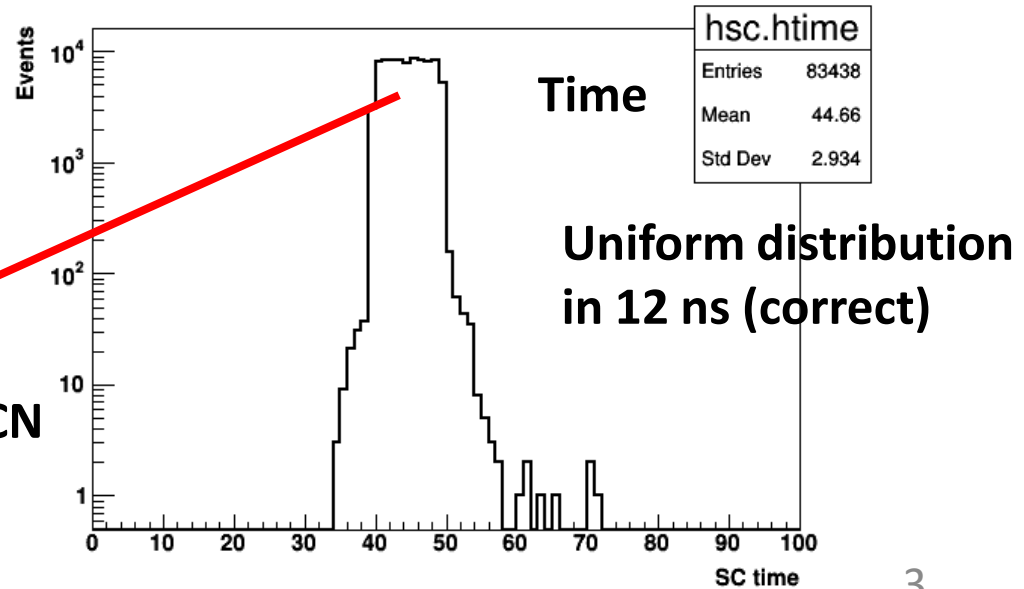
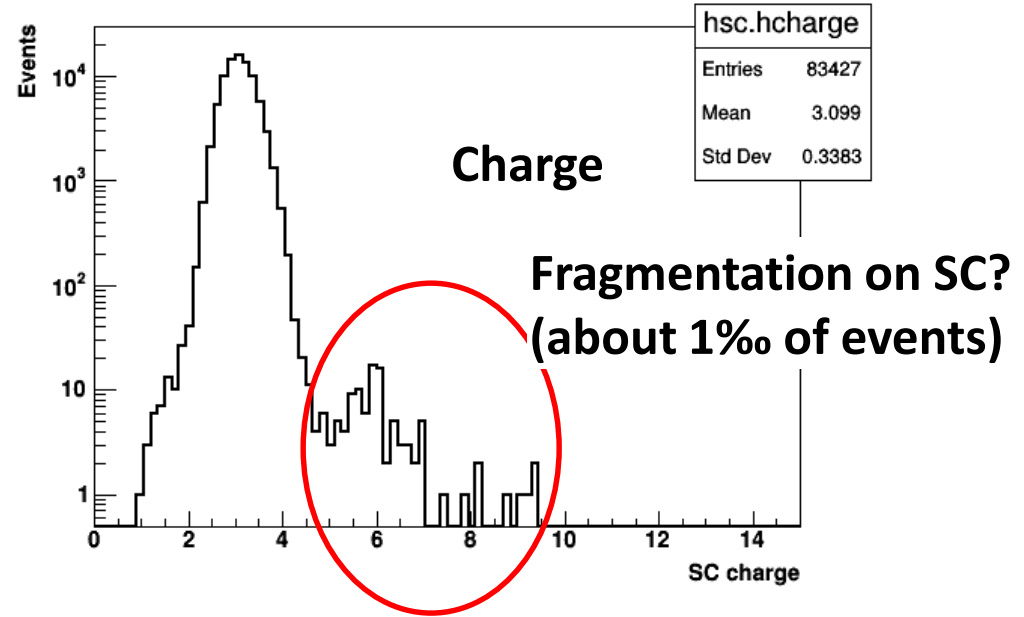
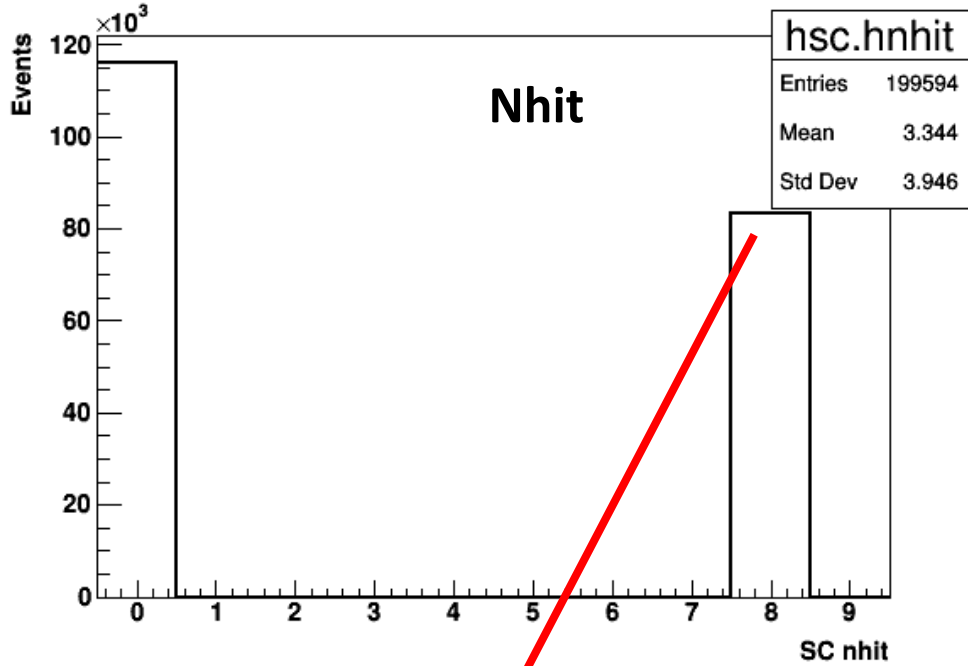
Detectors geometry

- ❑ SC: scintillator of 250 μm
- ❑ BM: tilted after the first day of data taking
- ❑ TGT: 5 mm depth, C material ($=\rho 1.83\text{g}/\text{cm}^3$)
- ❑ VTX: 4 Si layers of 50 μm depth
- ❑ SCN: 2 layers of 3 mm each (length 44 cm, active 40 cm)



Start Counter, SC (Run 2210-11-12)

How to define SC efficiency?



Efficiency = 40% (?)

Run 2239-51 Eff = 80%

" 2242 Eff = 100%

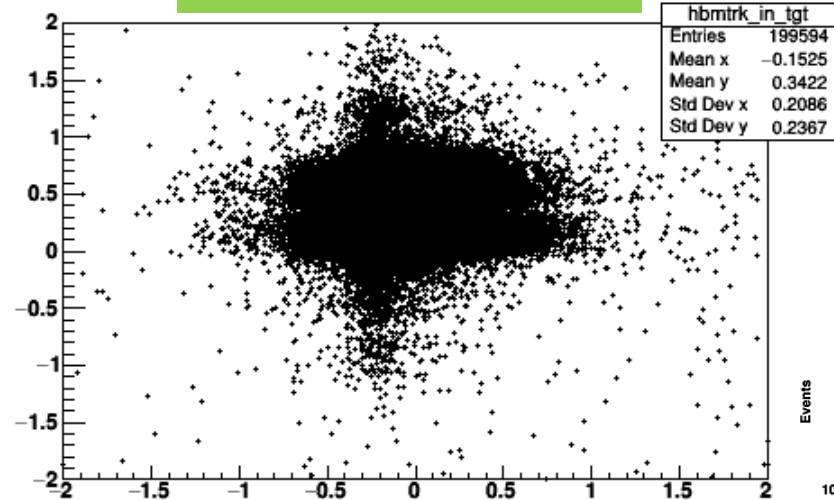
Probably different trigger definition

same distribution as SCN

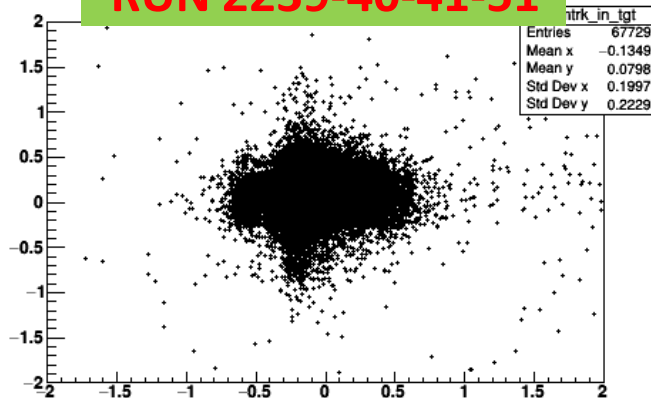
Beam Monitor, BM

Projection in TGT

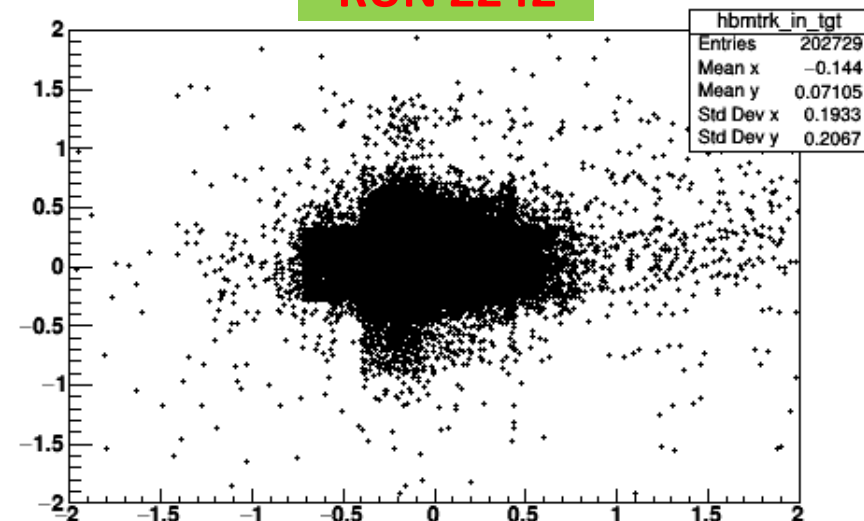
RUN 2210-11-12



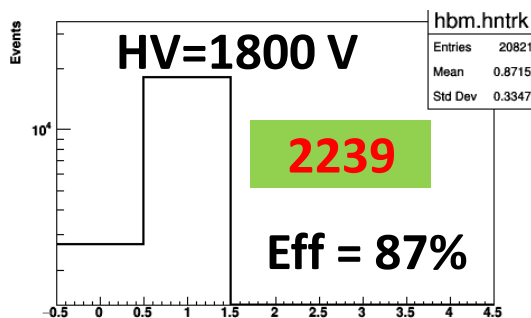
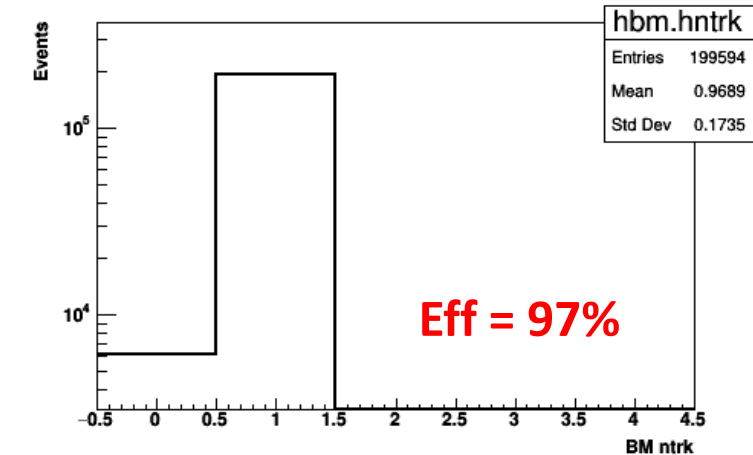
RUN 2239-40-41-51



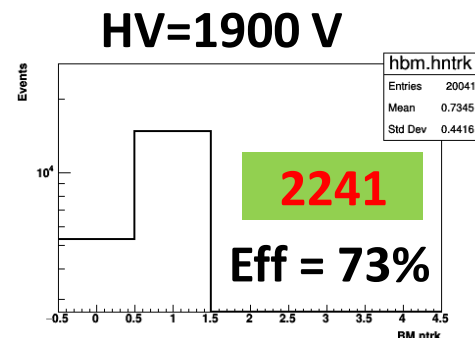
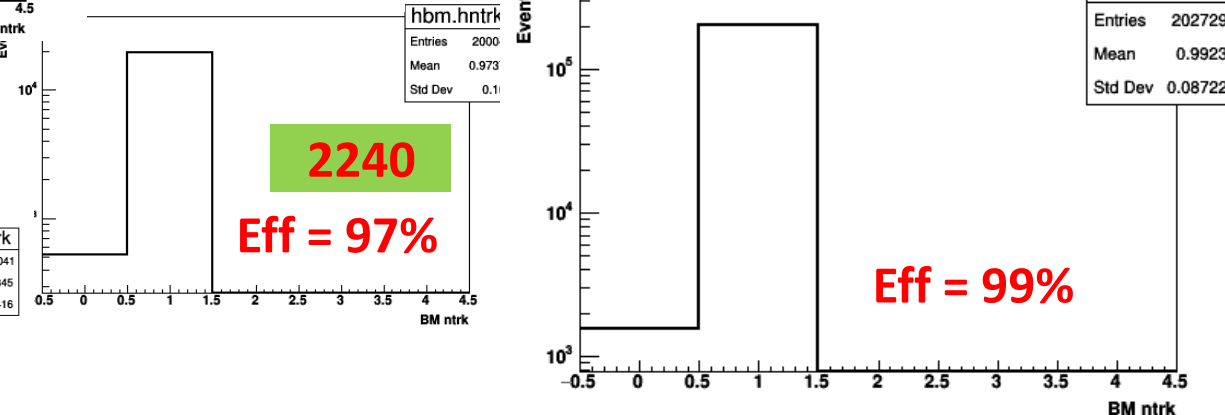
RUN 2242



Efficiency



HV=1850 V

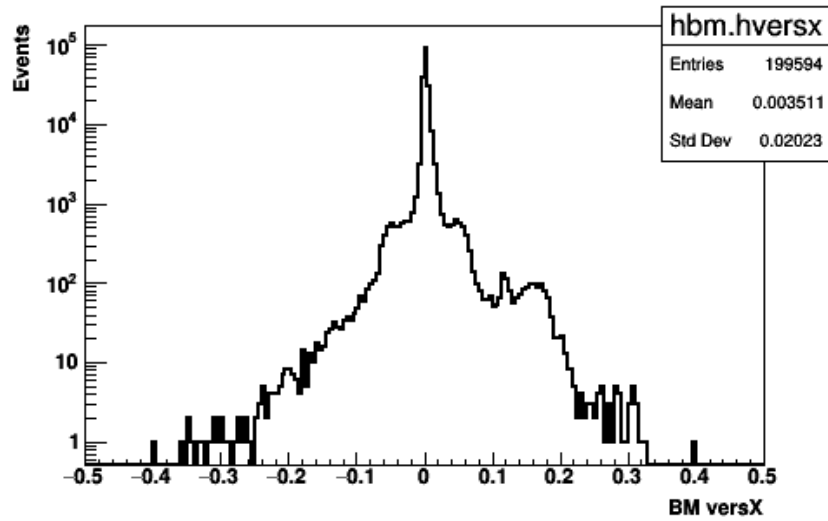


Eff = 99%

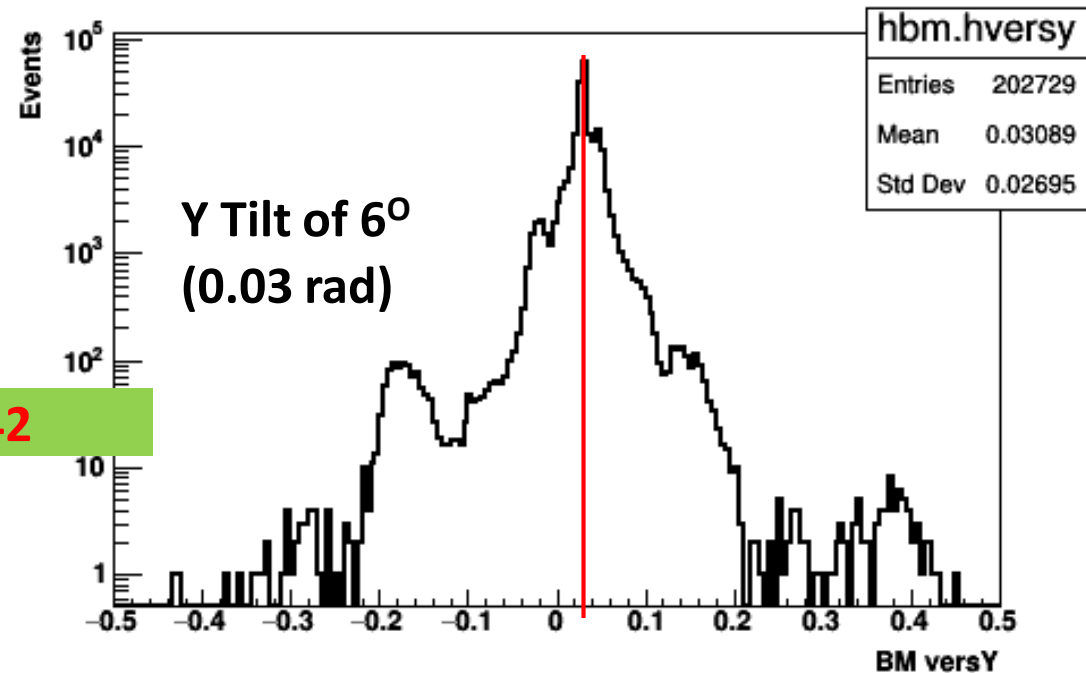
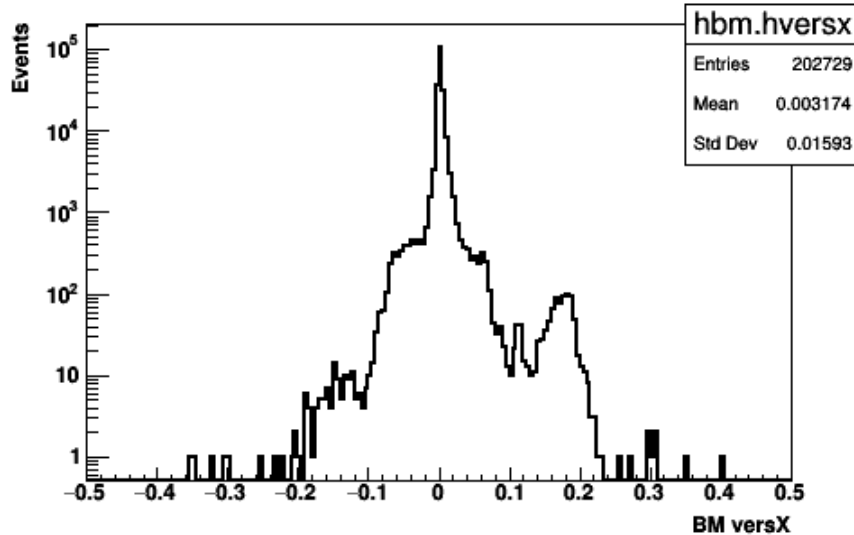
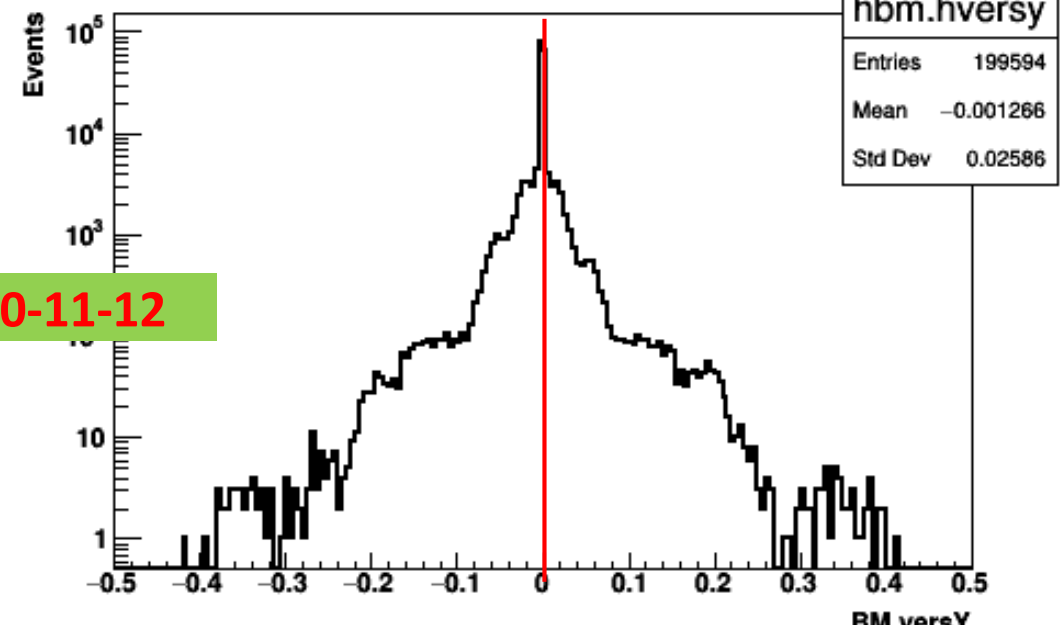
BM Efficiency close to 100%

BM: track direction

Direction in X coordinate

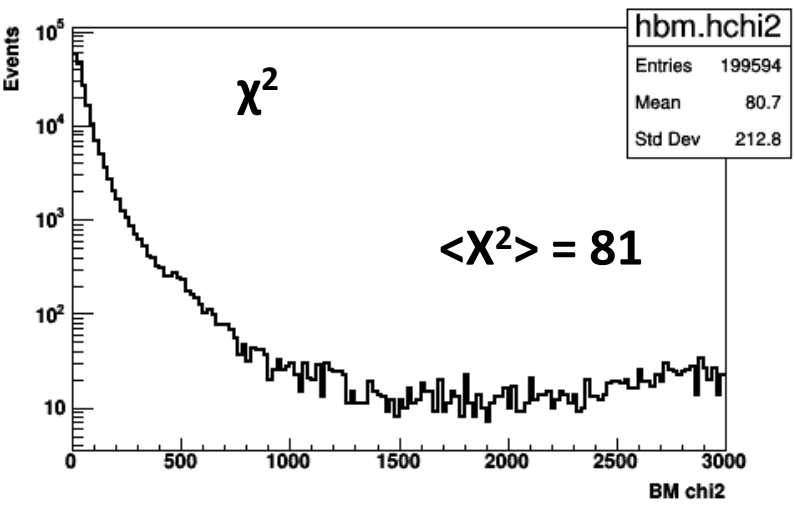


Direction in Y coordinate

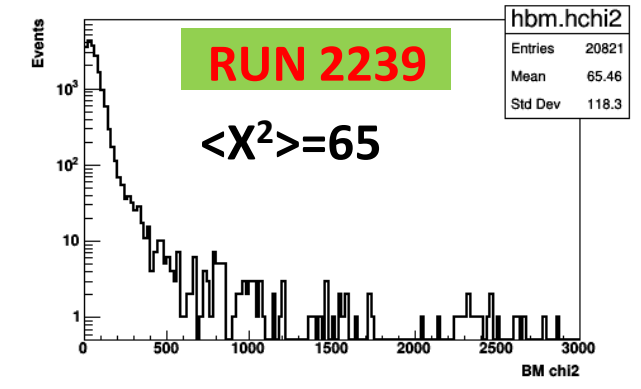


Beam Monitor χ^2

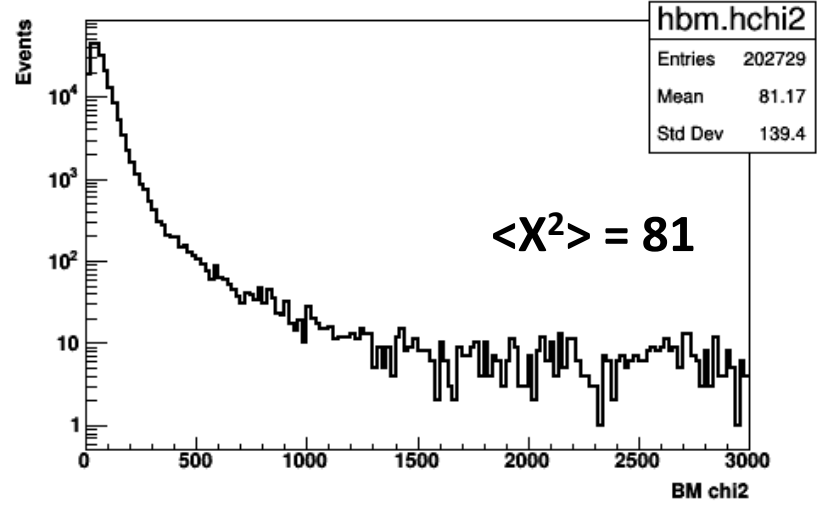
RUN 2210-11-12



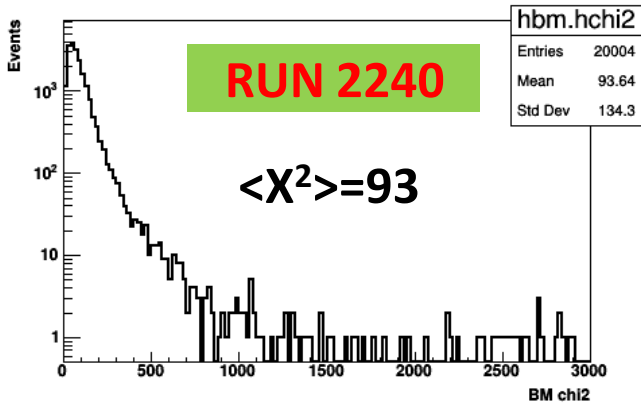
RUN 2239



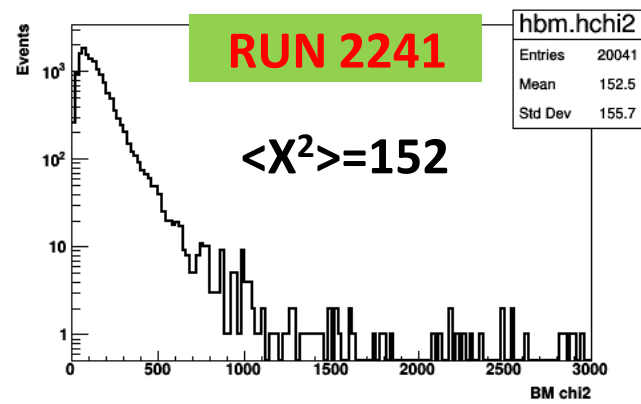
RUN 2242



RUN 2240



RUN 2241

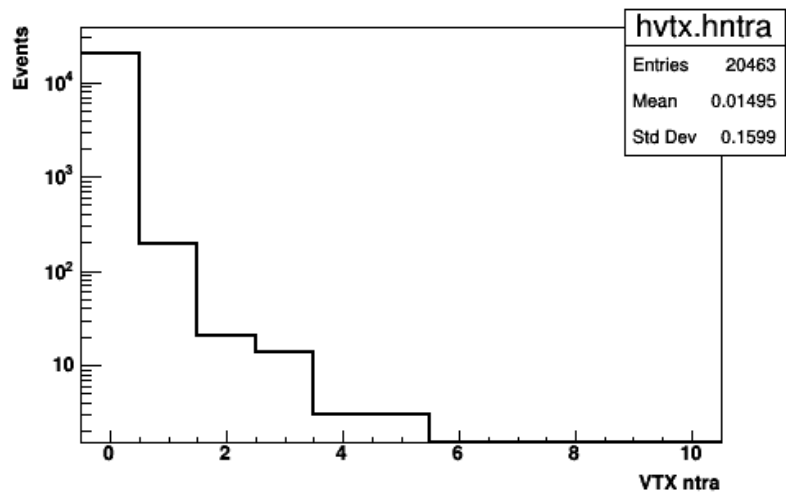


Vertex, VTX

RUNS WITHOUT TARGET: expected 1 track/ev

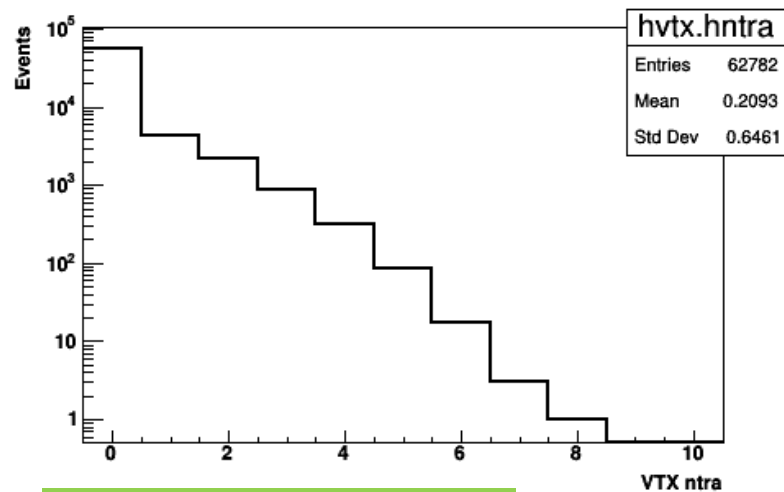
RUN 2210

236 ev with 1tracks (20K ev)



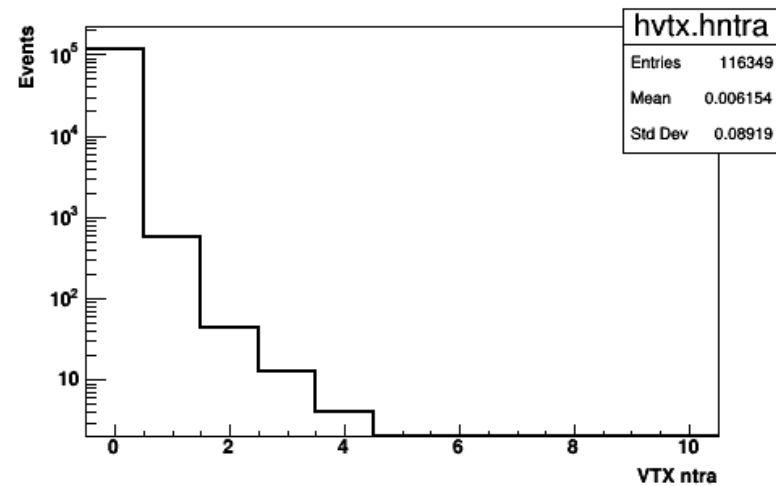
RUN 2211

7810 ev with 1tracks (63K ev)

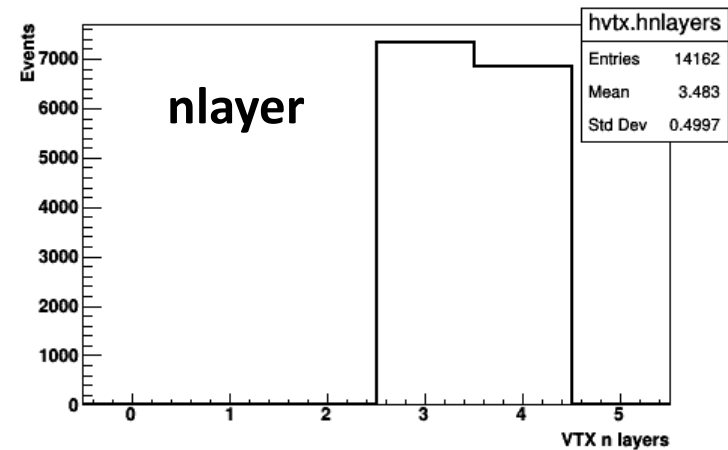
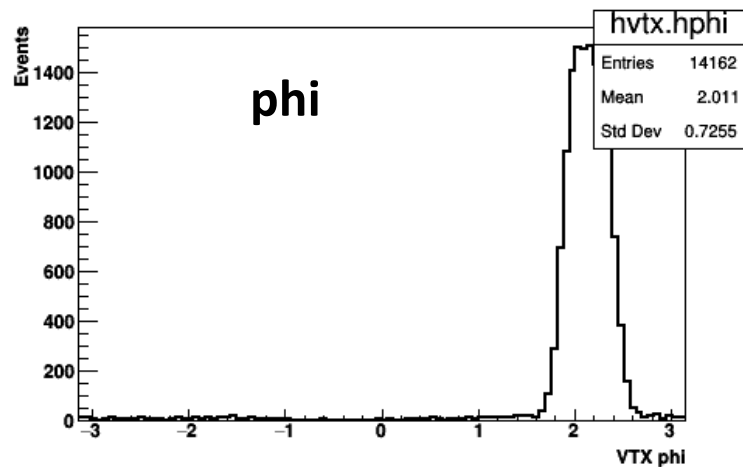
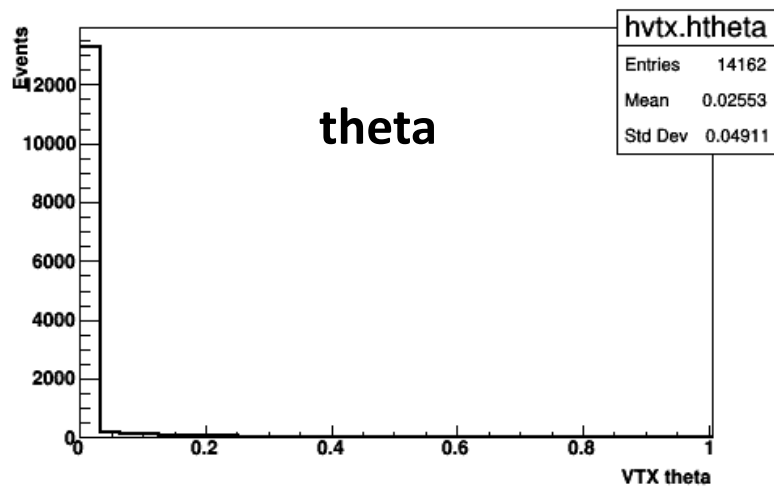


RUN 2212

634 ev with 1tracks (116K ev)

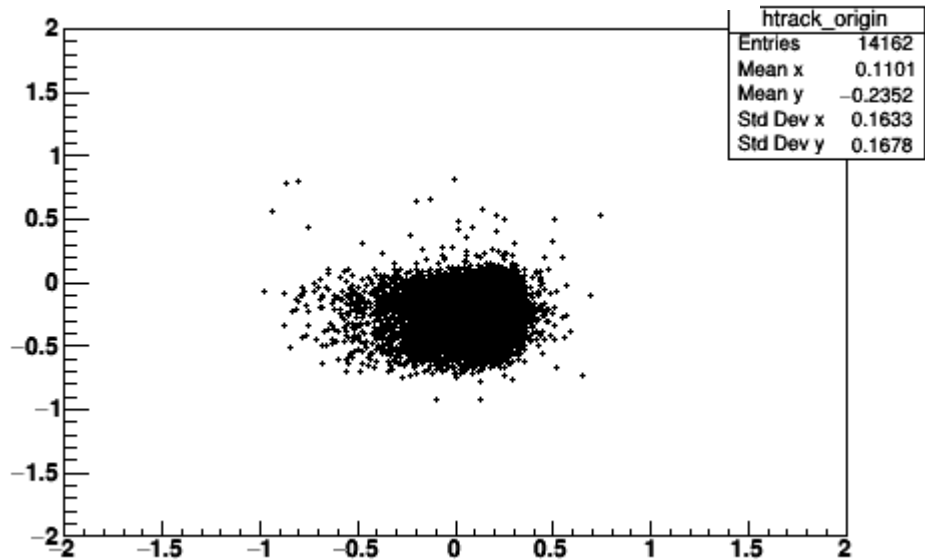


RUN 2210 - 11 - 12



VTX – BM: xy on target

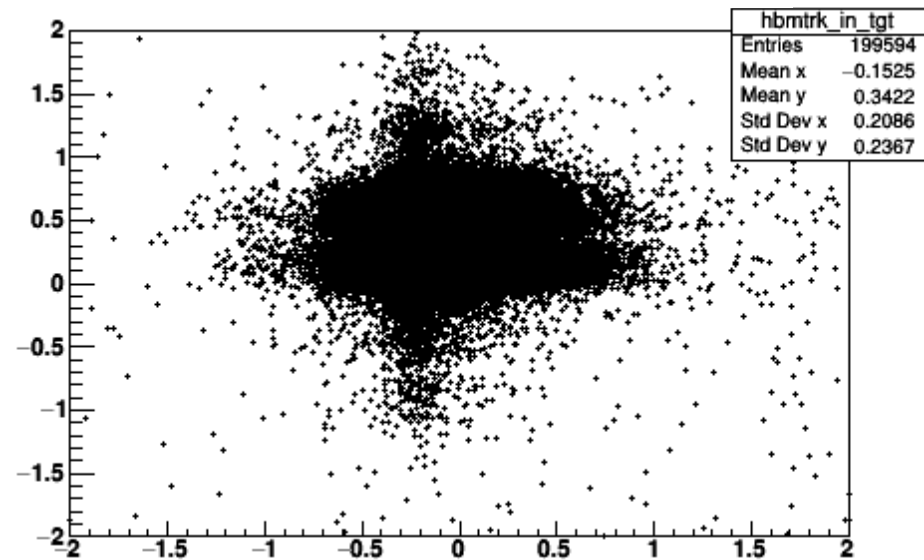
XY at the z-TGT from VTX



RUN 2210 – 11 - 12

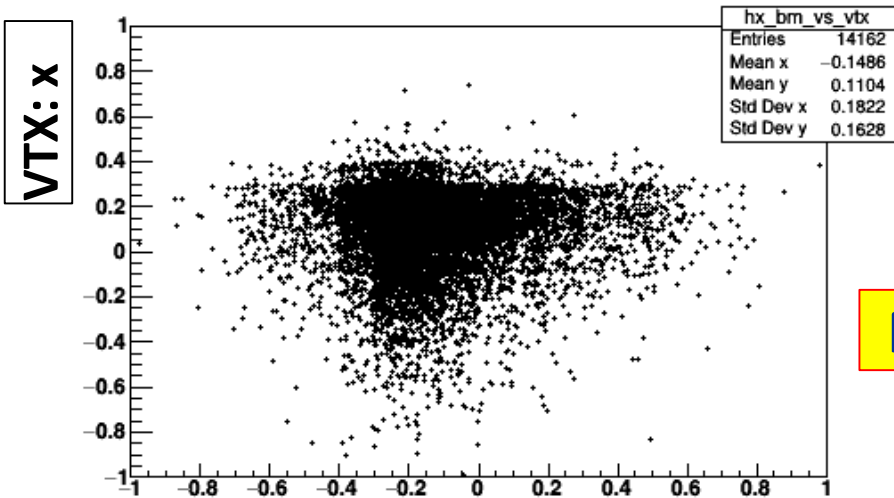
RUNS WITHOUT TARGET

XY at the z-TGT from BM



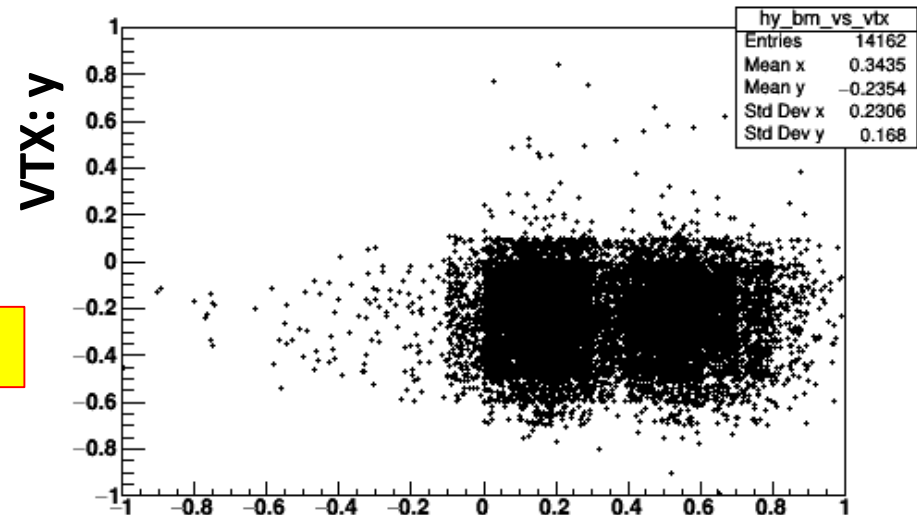
X: correlation BM-VTX

X BM vs VTX in 0



NO correlation BM-VTX

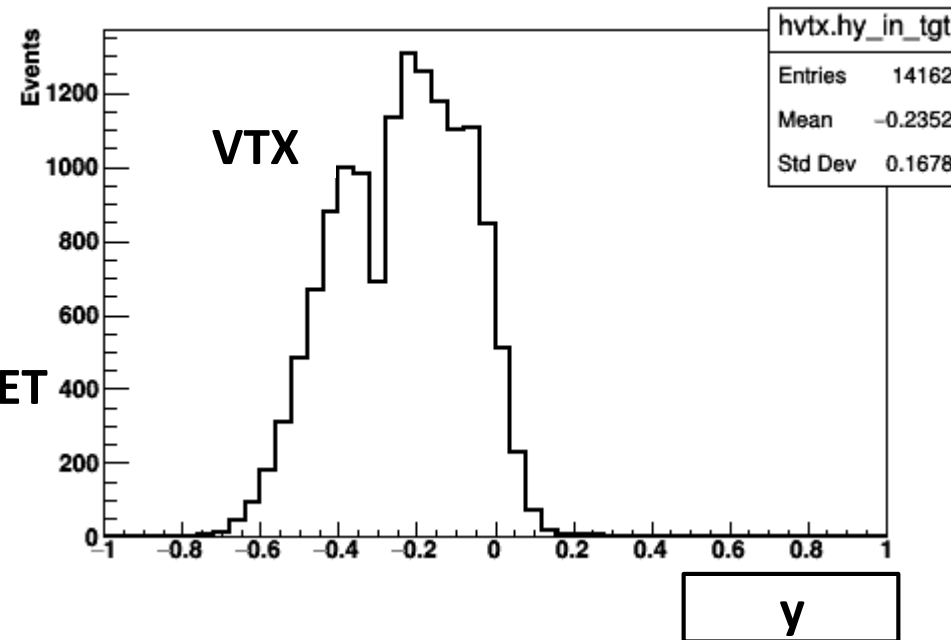
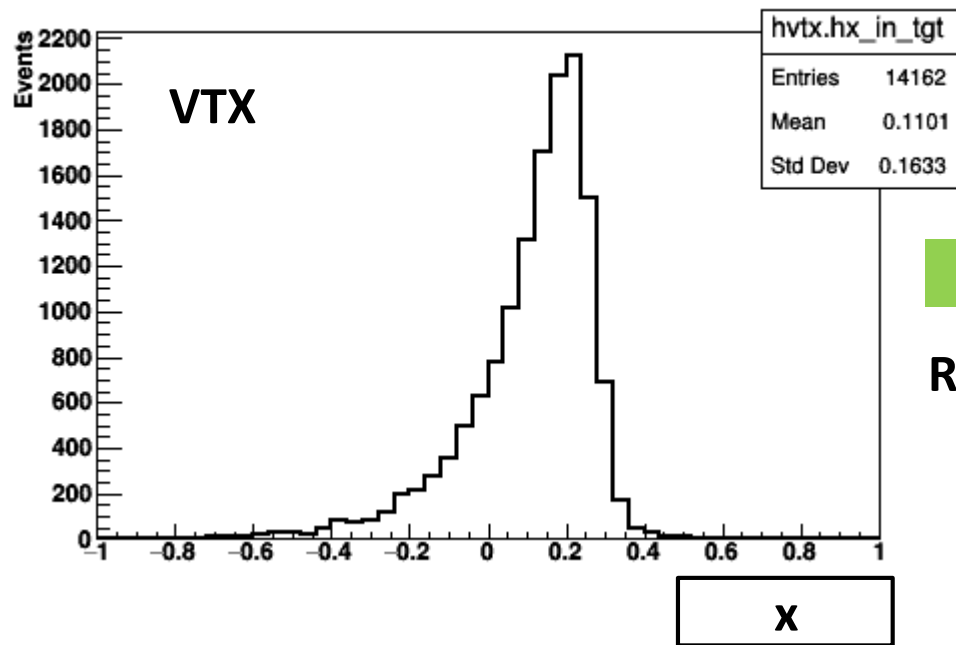
Y BM vs VTX in 0



BM: x

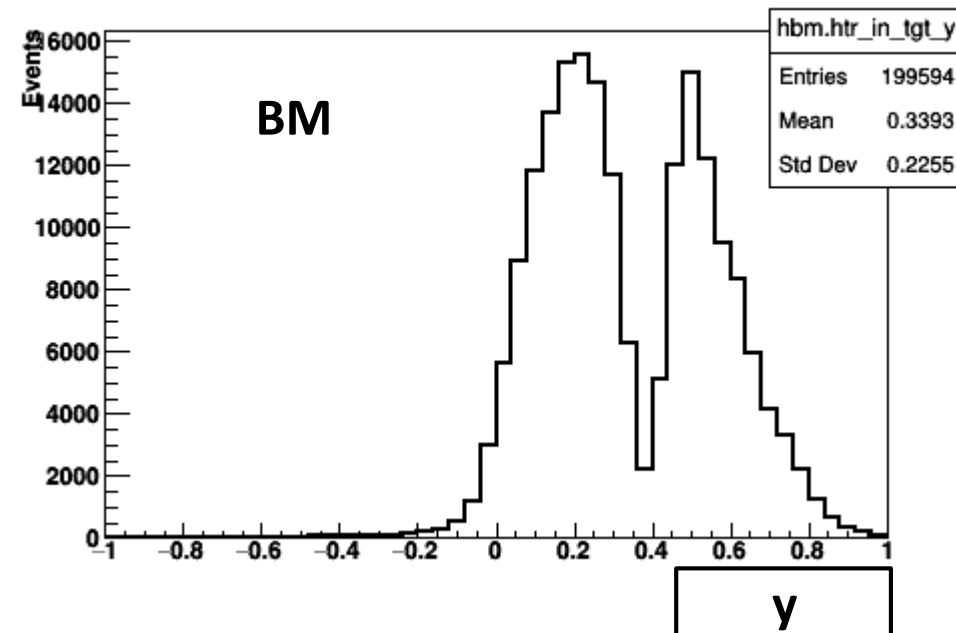
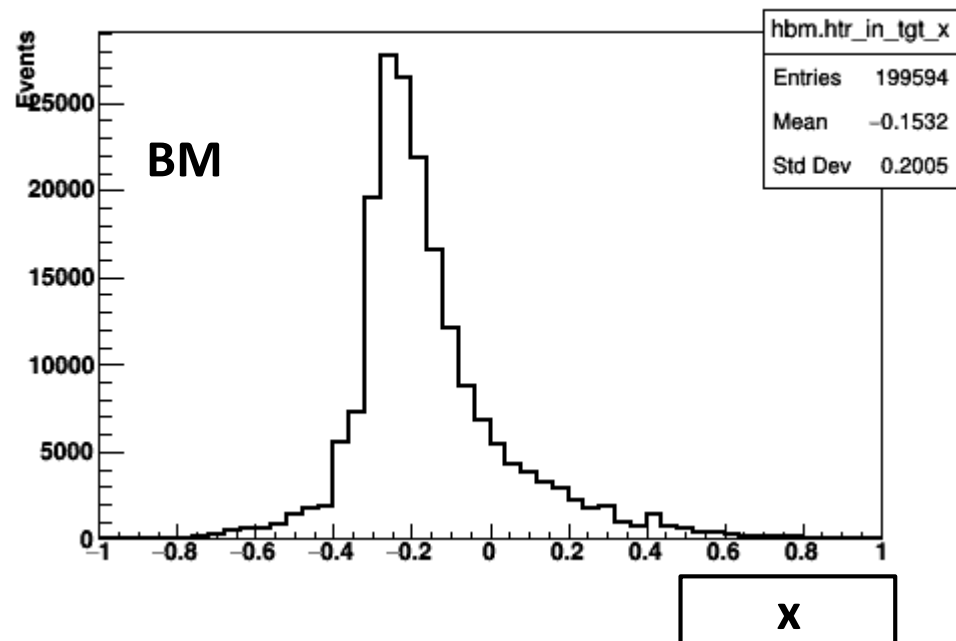
BM: y

VTX – BM: x and y on target

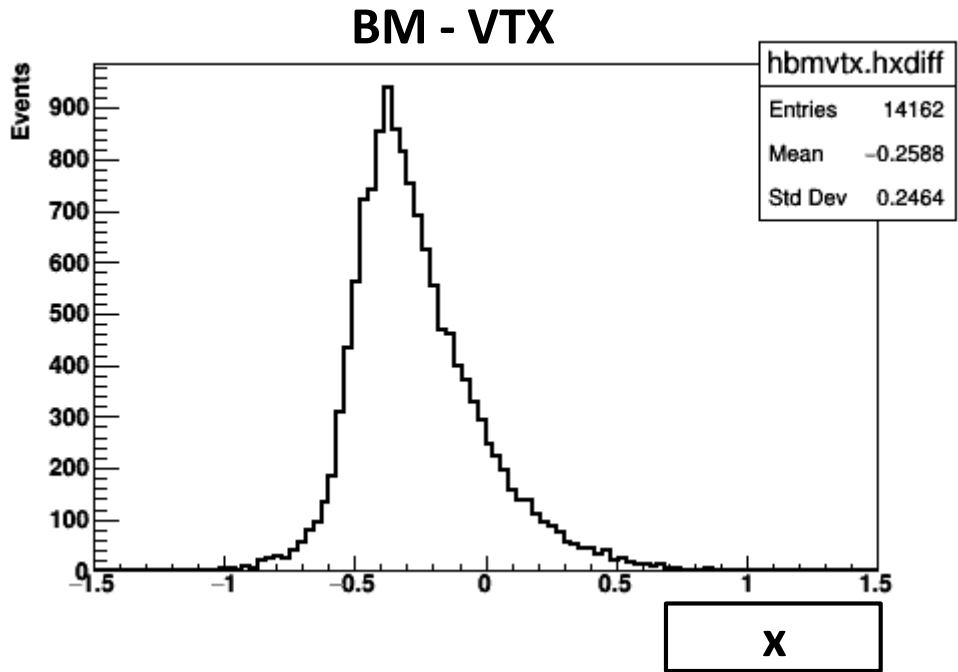


RUN 2210 – 11 - 12

RUNS WITHOUT TARGET

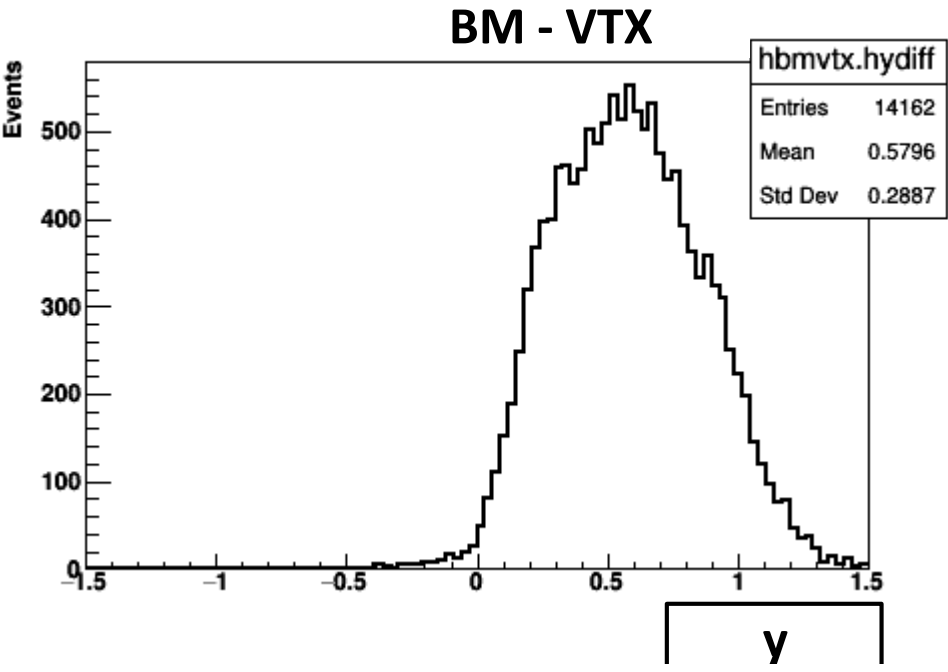


VTX – BM: x and y difference at the Z of the Target



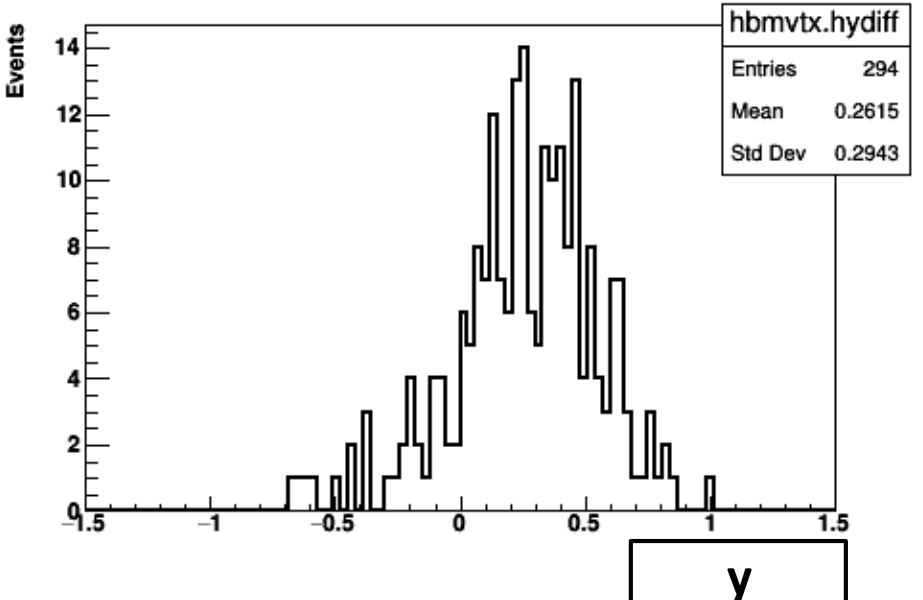
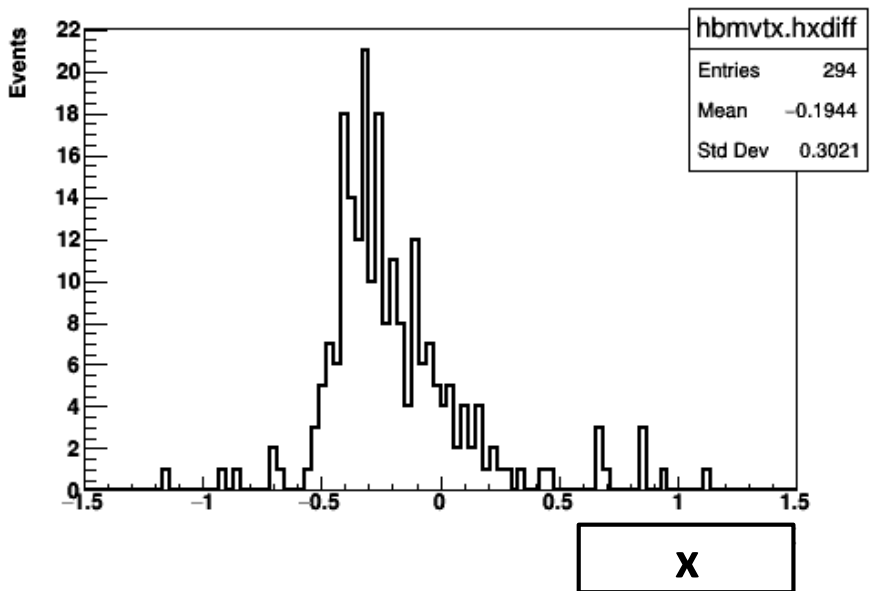
RUN 2210 – 11 - 12

RUNS WITHOUT TARGET



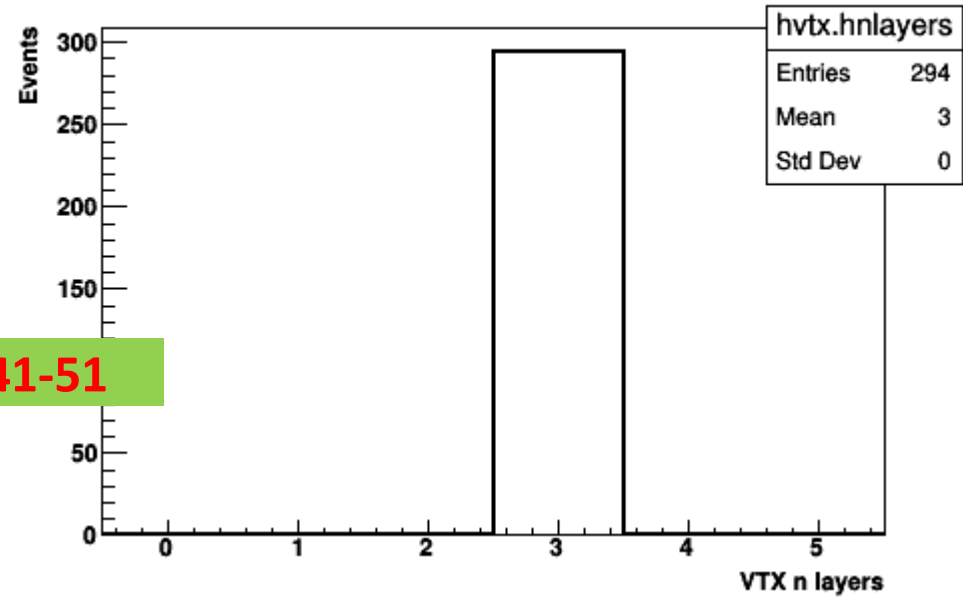
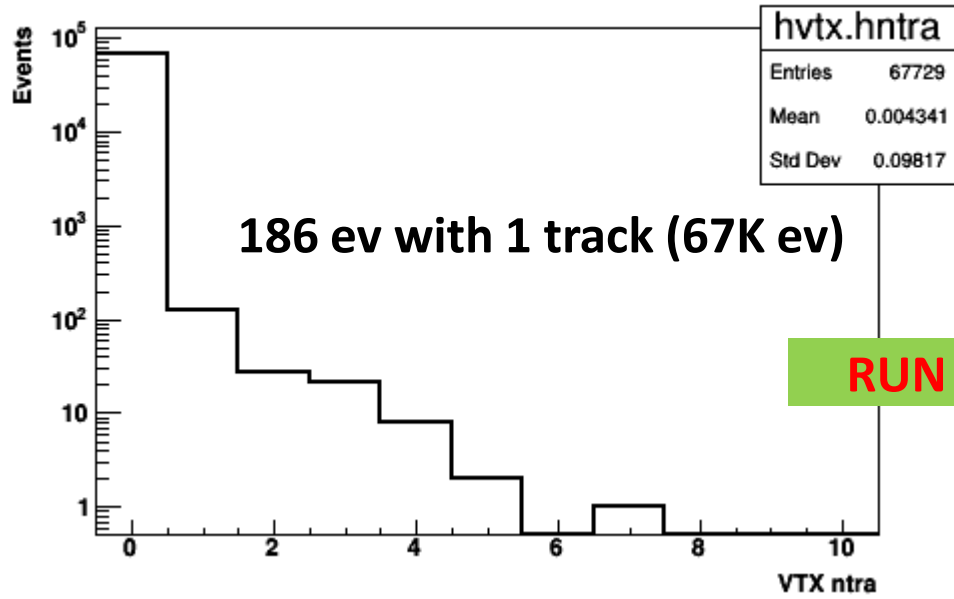
RUN 2239-40-41-51

RUNS WITH TARGET

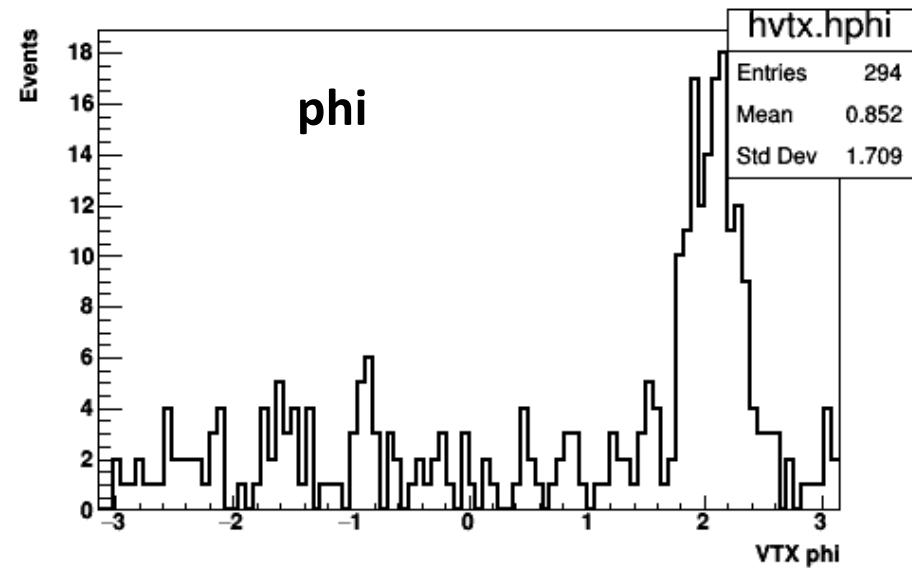
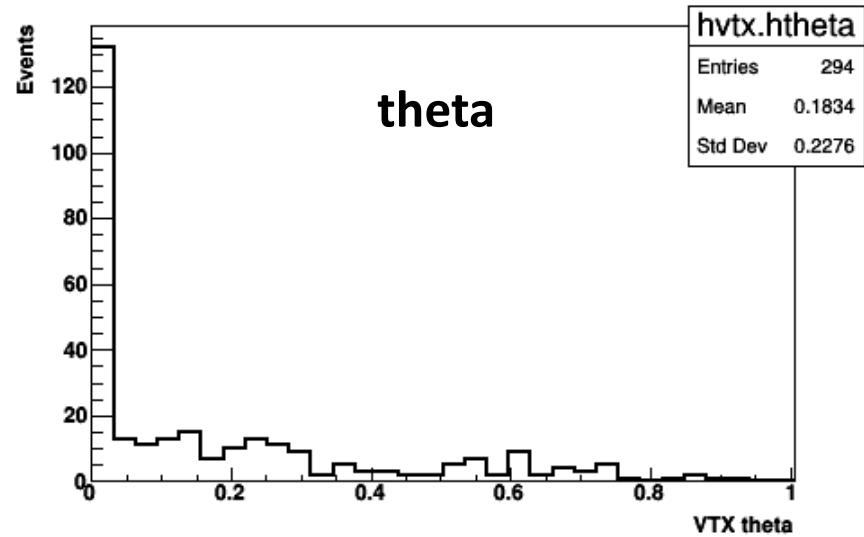


Vertex, VTX

RUNS WITH TARGET

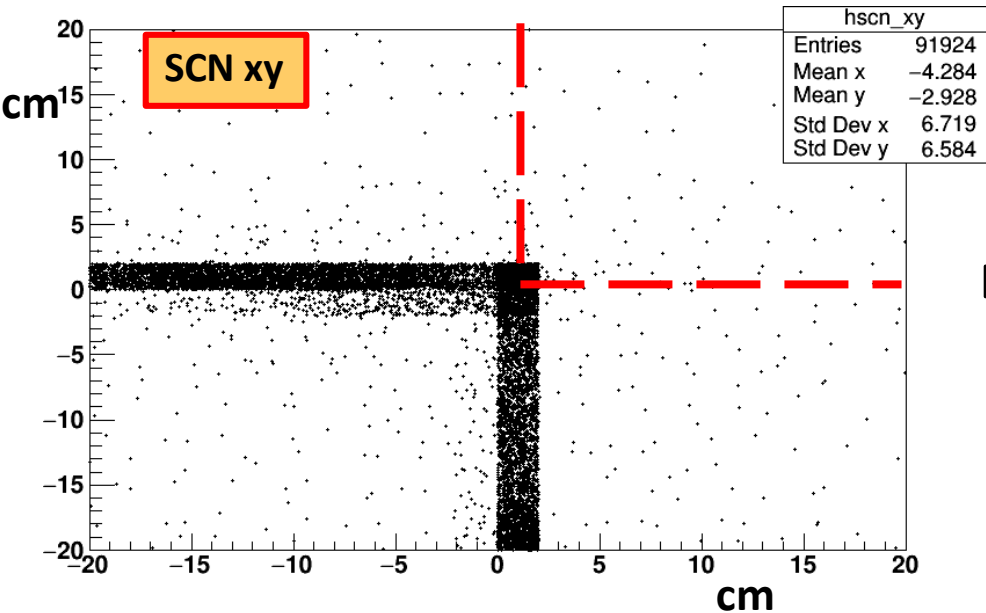


RUN 2239-40-41-51

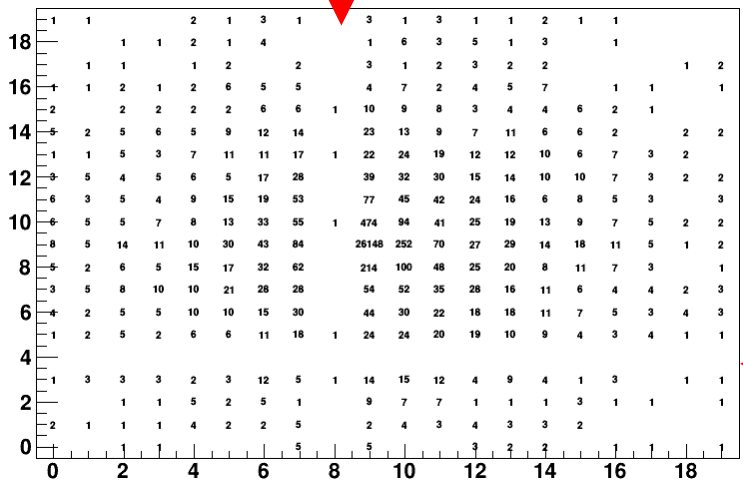


SCN: equalization (Run 2242)

Problem: acquired only 1/3 of data

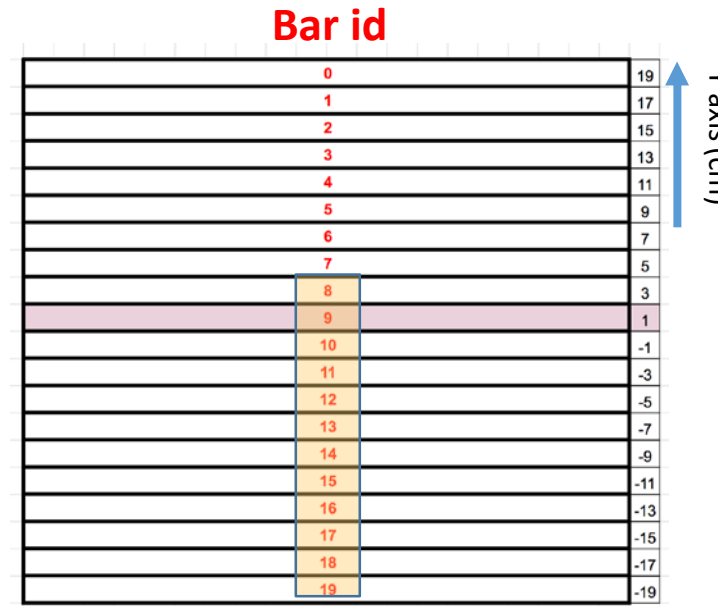


Equalized half slabs

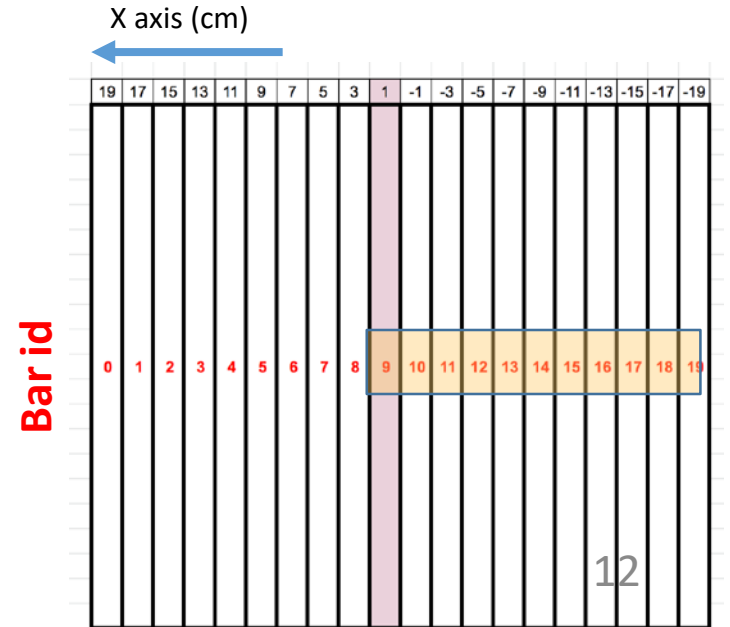


8-vertical and 4-horizontal do not give signal

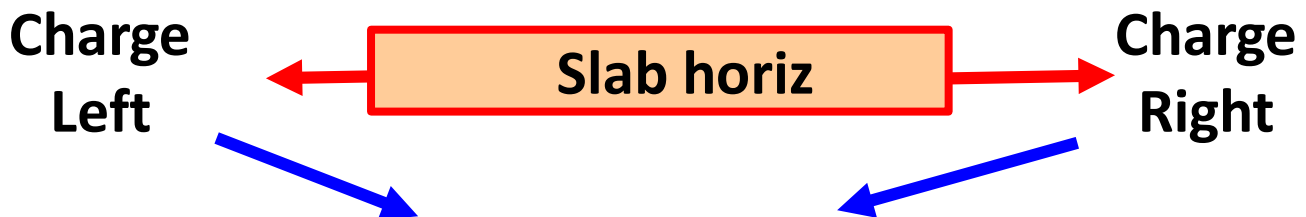
TW Front layer (layer 1 in shoe)



TW Rear layer (layer 0 in shoe)



SCN charge definition



$$Q_{horiz} = \sqrt{Q_{Left} * Q_{right}}$$

Charge product independent on hit position

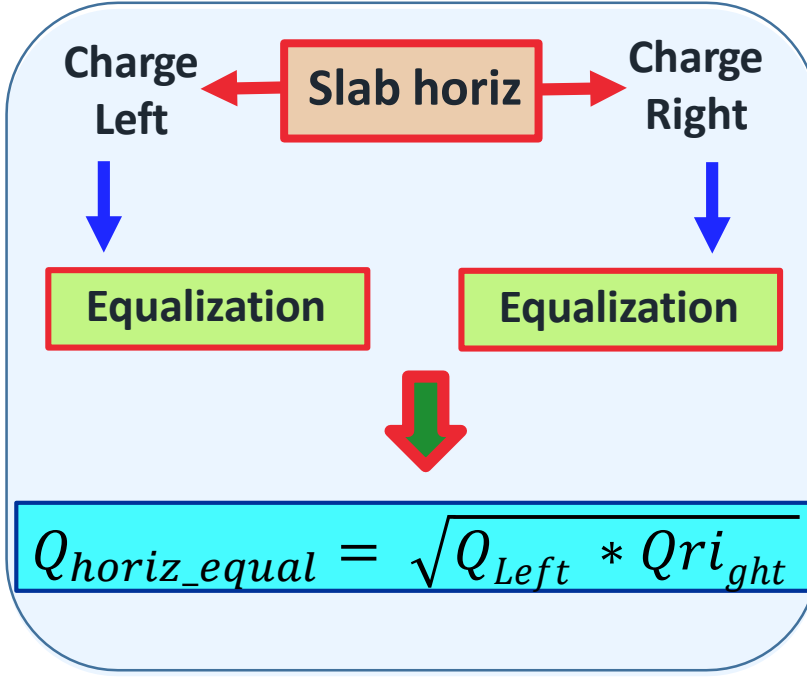
Equalization

$$Q_{horiz_equal}$$

Same for Vertical Slab

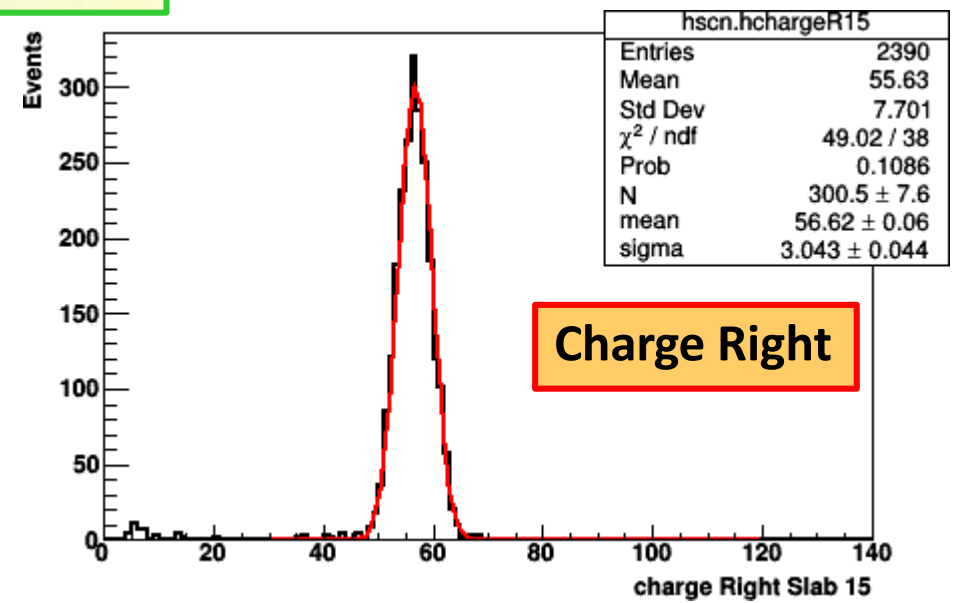
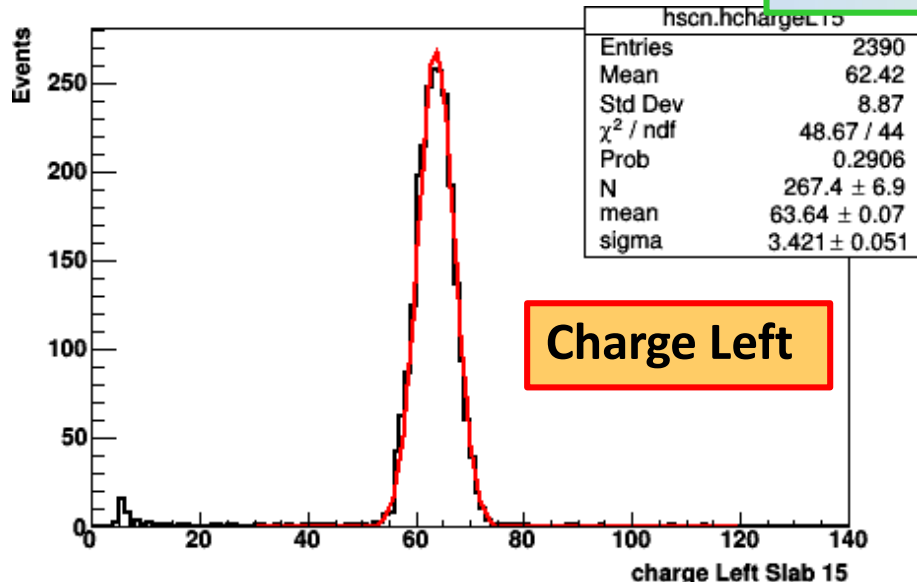
$$Q_{fragm} = Q_{horiz_equal} + Q_{vert_equal}$$

Tested also this possibility: SAME RESULTS

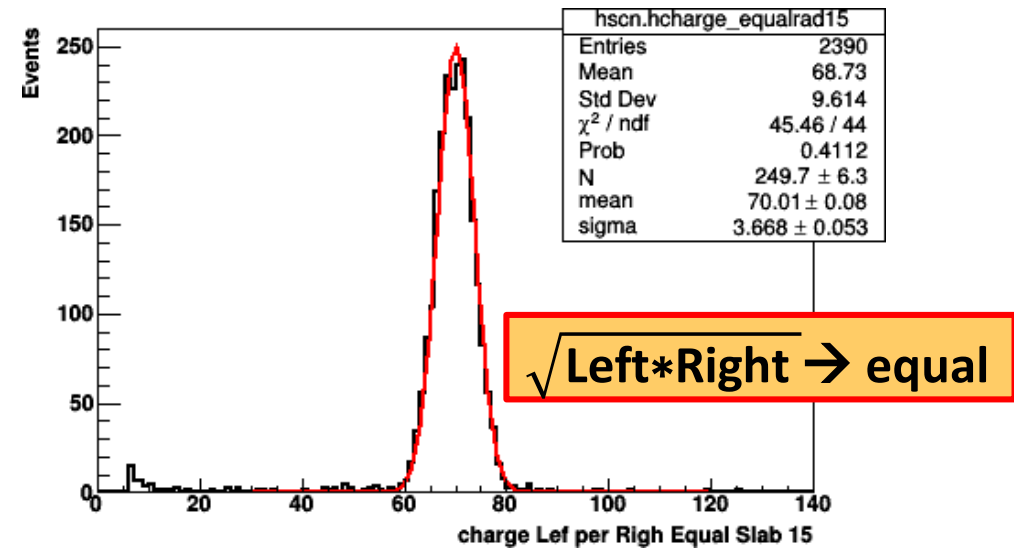
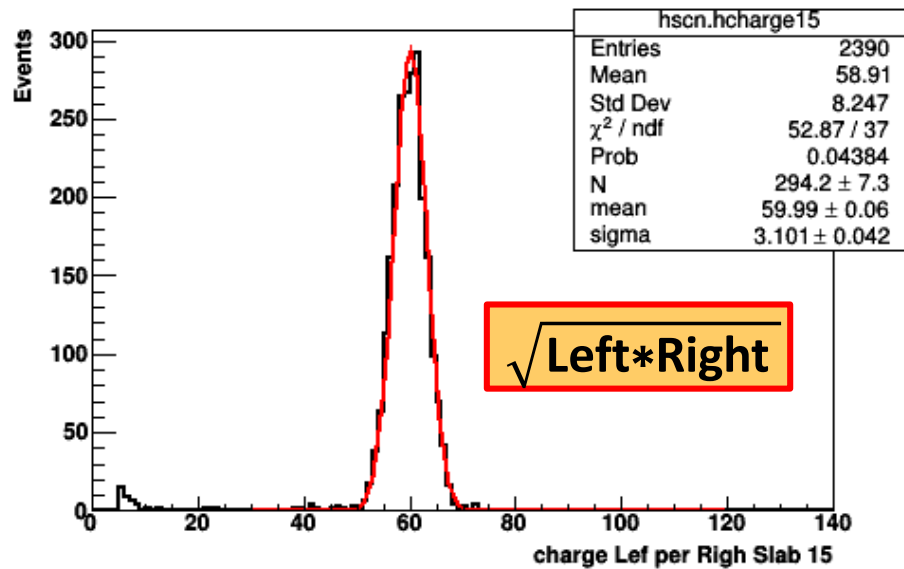


NO difference between the 2 methods

Signal Equalization (Run 2242)



Slab 14, oriz



Each Signal of each slab positioned at 70 !! (arbitrary value)

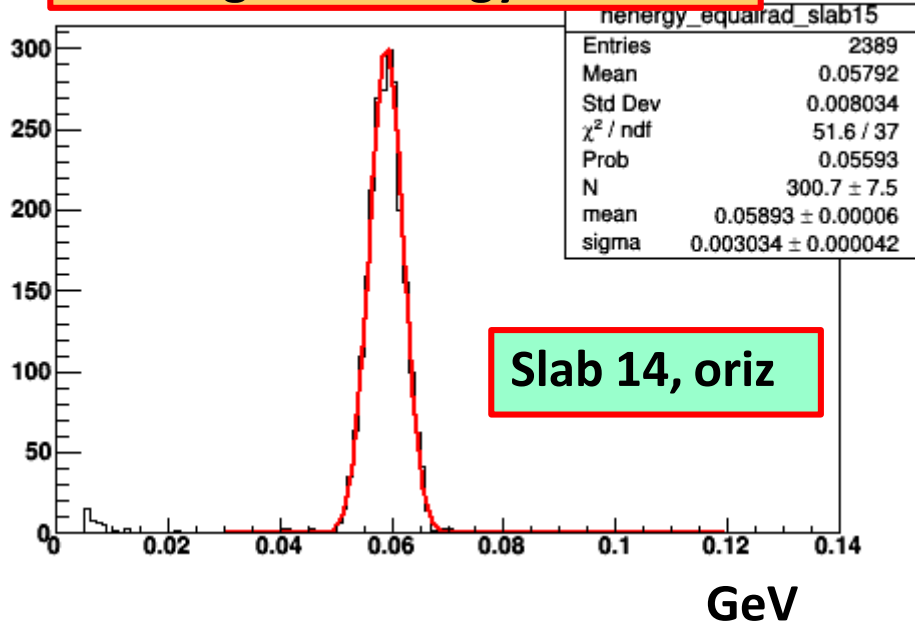
Signal "calibration" (Run 2242)

Simulation: ^{16}O (400 MeV/u) \rightarrow dE/dx on SCN

Wide dynamic range: [2 – 120] MeV (H to O)

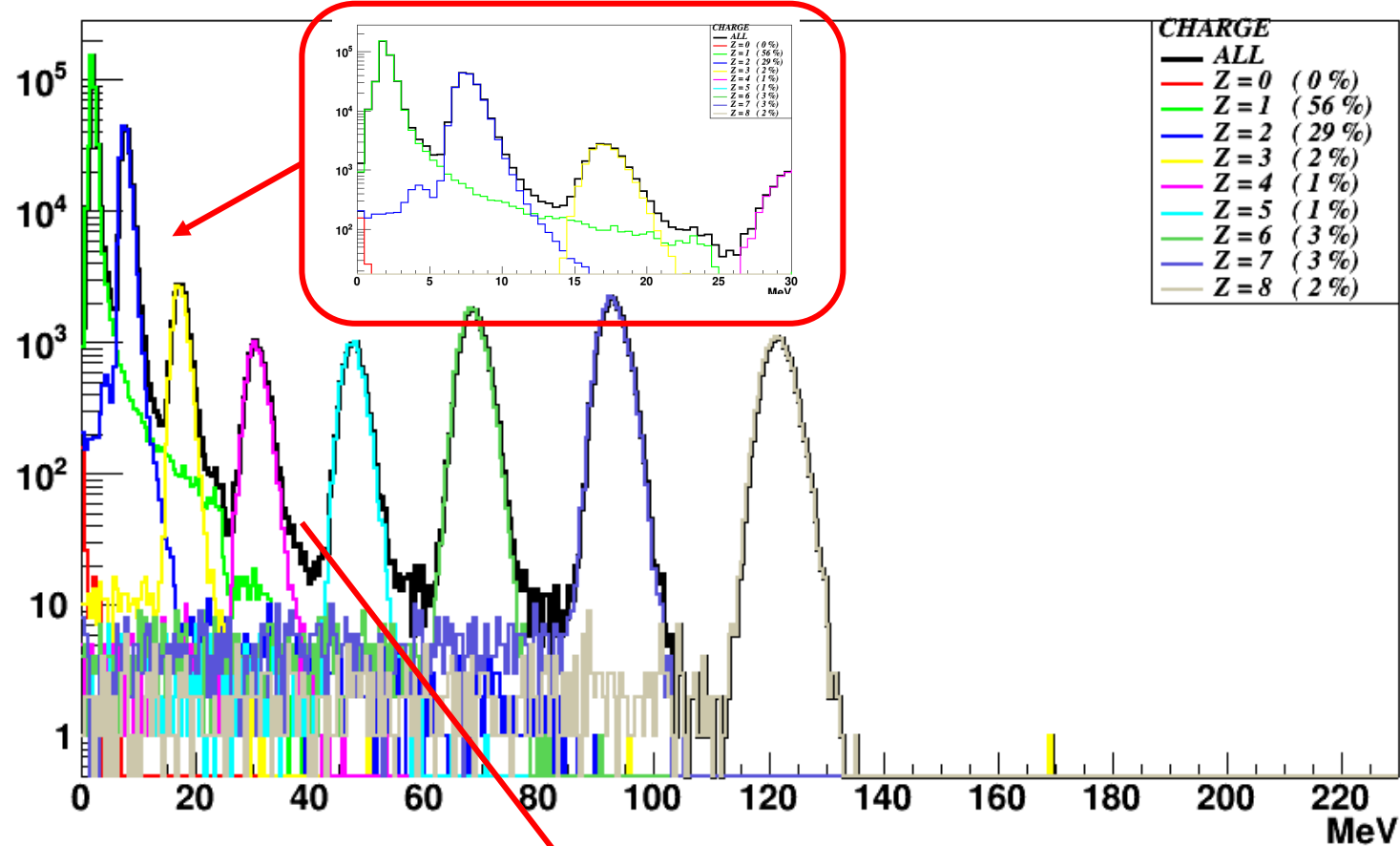
On average ^{16}O (400 MeV/u) \rightarrow 59 MeV per slab

Left*Right \rightarrow energy calibrated



Slab 14, oriz

Events

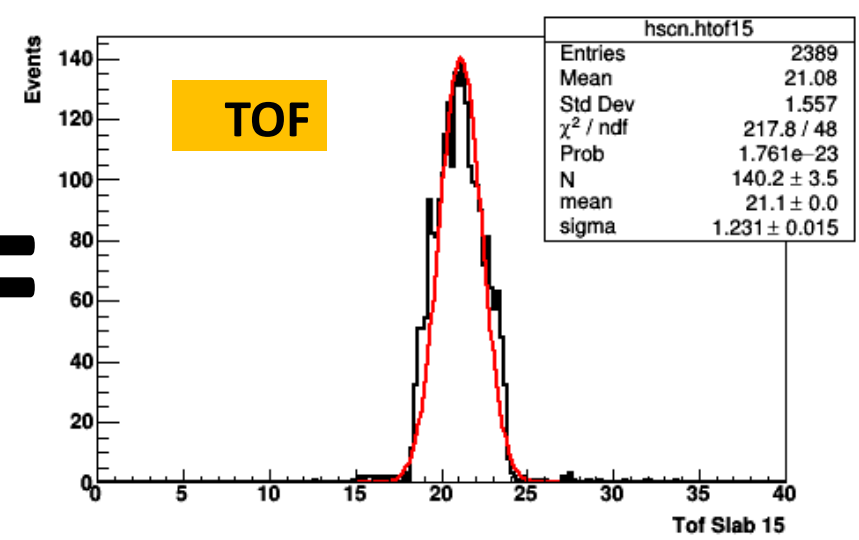
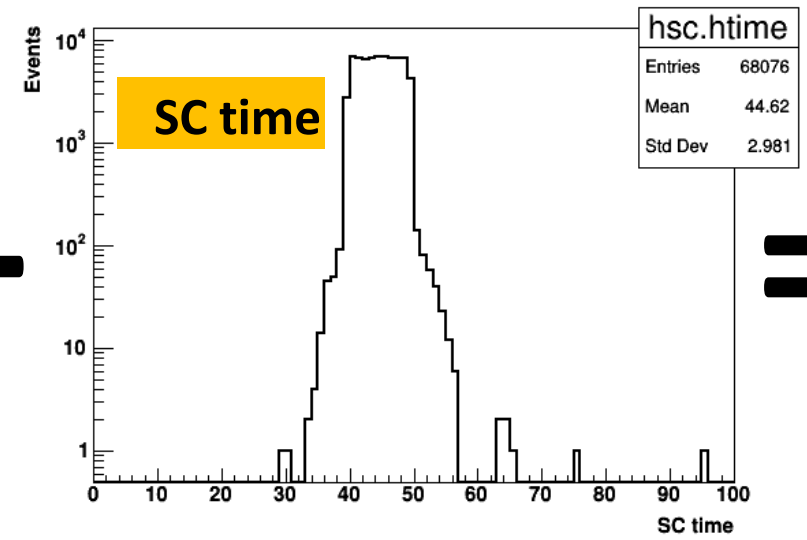
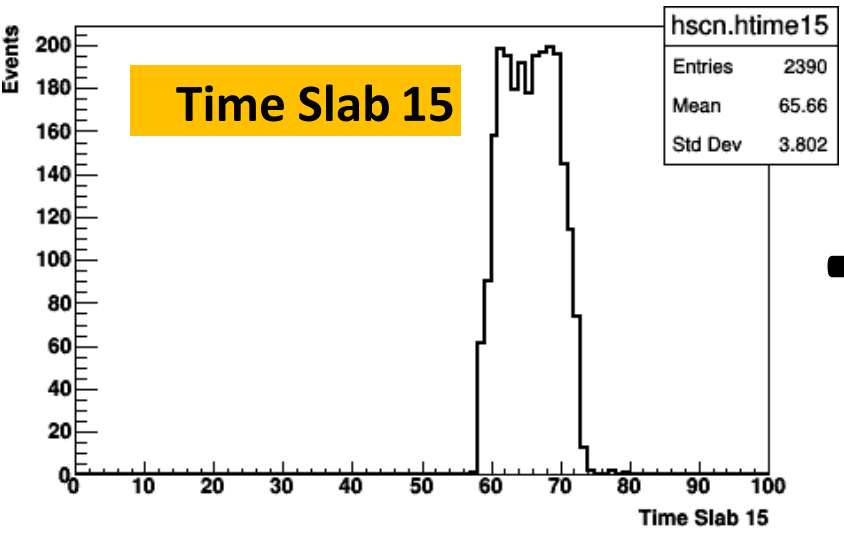


Obviously there is also the contribution from β

To calibrate with only 1 energy is not a correct procedure

Each Signal of each slab positioned at 0.059 GeV !!

TOF: example of slab 15: Run 2242



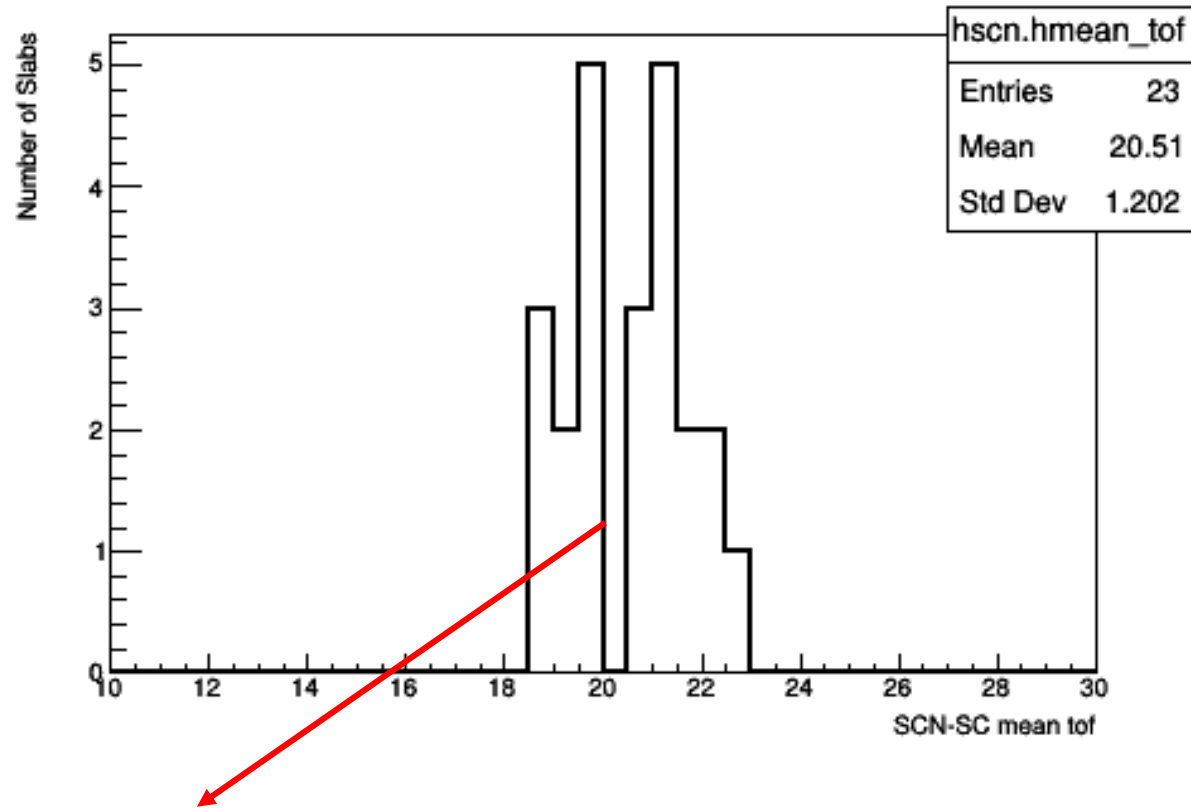
NO Target → Tof for ¹⁶O beam (400 MeV/u) = 10.5 ns → offset of ~10 ns



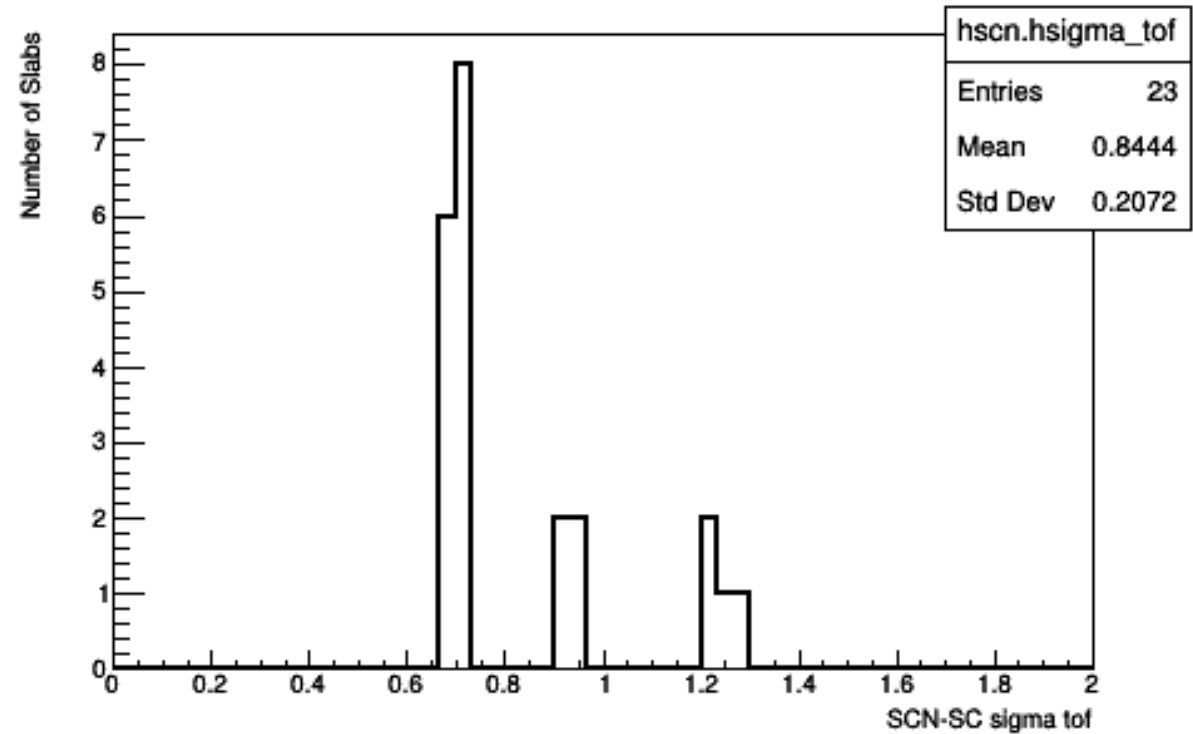
Evaluated the offset for each slab

SCN: Tof for each slab

Fitting the Tof of each slab with a Gaussian (only equalized slabs)



Determine the offset for each slab



Till now the Tof precision is low: [0.7 – 1.2] ns

Need more precise fit implementation

At the moment considered only the charge and not the E and β information

SCN: Signal combination

EQUALIZATION:

ALL slab equalized to a arbitrary value

MAKE ALL COMBINATIONS:

ALL horizontal slab combined with ALL vertical slab

HYPOTHESIS:

fragment deposit is similar in horizontal and vertical slab

Tof is similar in horizontal and vertical slab

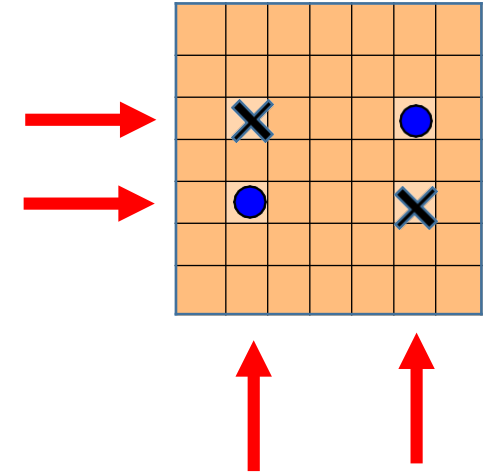
GOOD COMBINATION:

if horizontal and vertical hit:

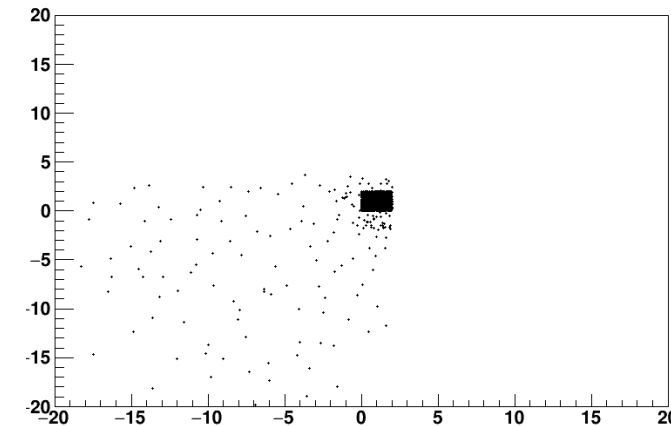
$$\text{Diff Charge} < 0.1 * \text{Average Charge}$$

$$\text{Diff Tof} < 0.2 * \text{Average Tof}$$

$$\text{fabs}(\text{Charge}_{\text{horiz}} - \text{Charge}_{\text{vert}}) < 0.1 * (\text{Charge}_{\text{horiz}} + \text{Charge}_{\text{vert}}) / 2 \quad \&\& \text{ same for Tof}$$

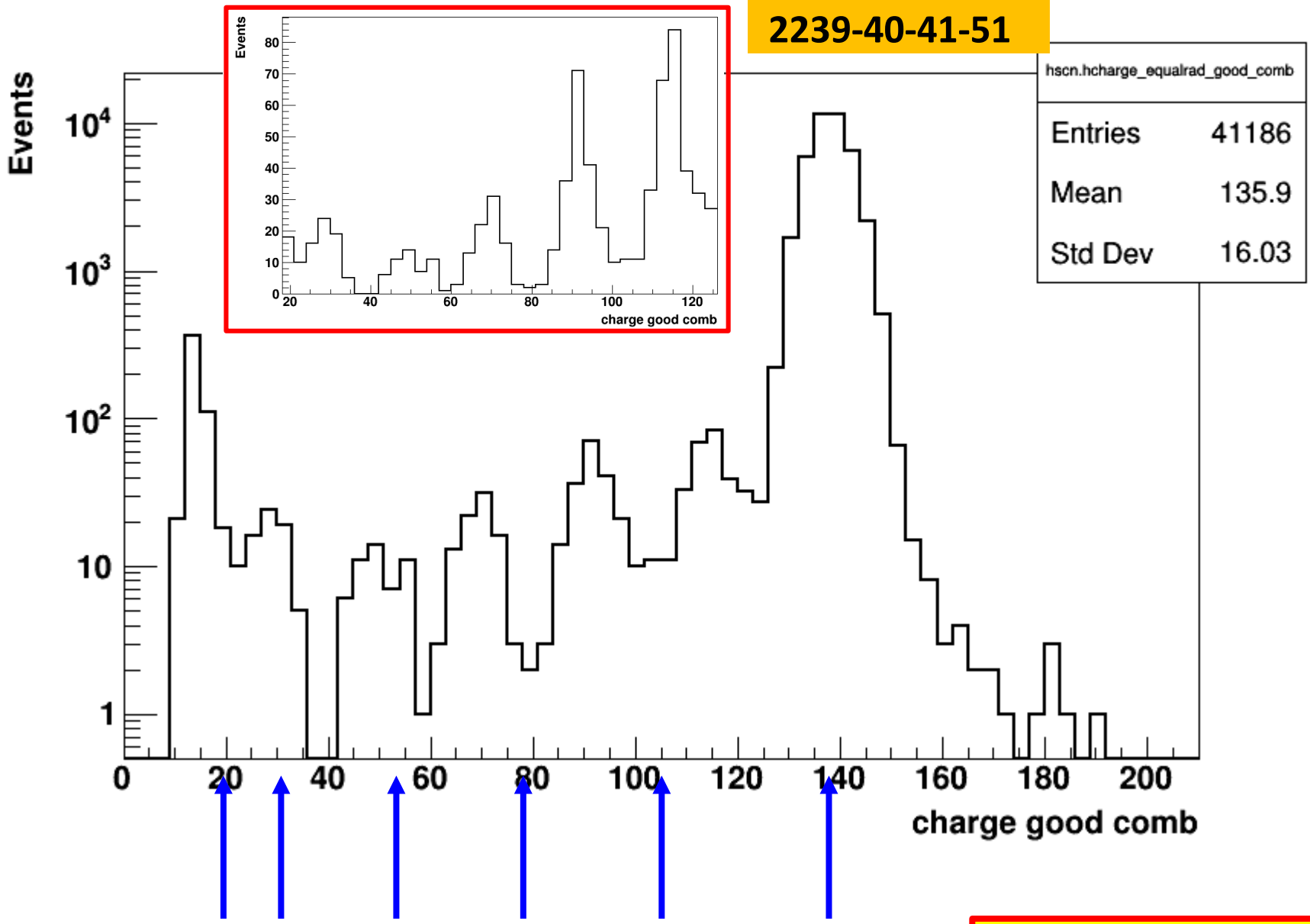


scn xy good comb



Applied to RUNS 2239-40-41-51 where the Target is present

SCN: Good combination



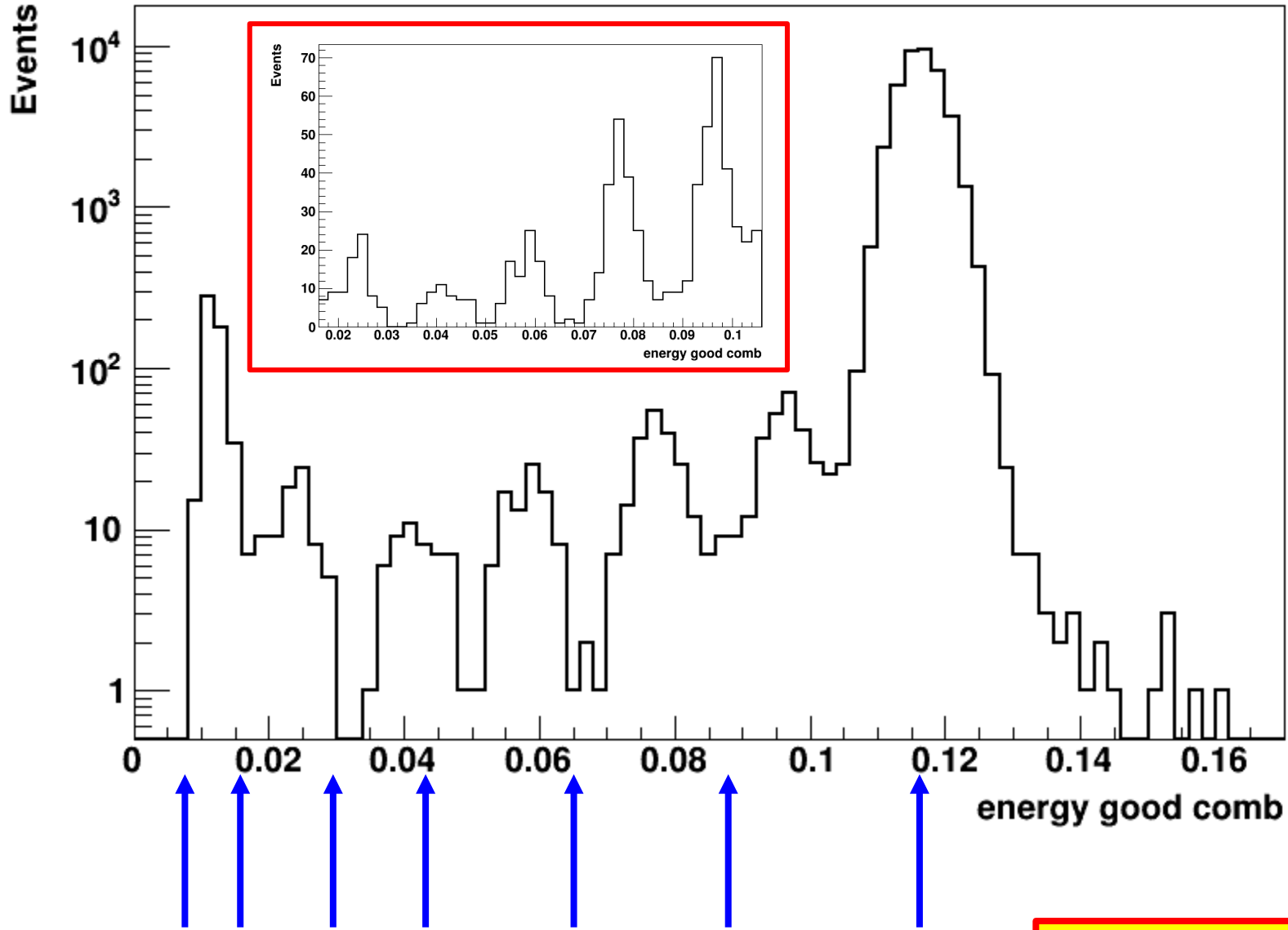
Z	Energy	# Fragments
8	1	1
7	0.76	1.5
6	0.56	1.5
5	0.39	0.5
4	0.25	0.5
3	0.14	1
2	0.06	15
1	0.015	30

Depend on dE and β

SCN standalone shows peaks

SCN: Good combination

2239-40-41-51



Z	Energy	# Fragments
8	1	1
7	0.76	1.5
6	0.56	1.5
5	0.39	0.5
4	0.25	0.5
3	0.14	1
2	0.06	15
1	0.015	30

Depend on dE and β

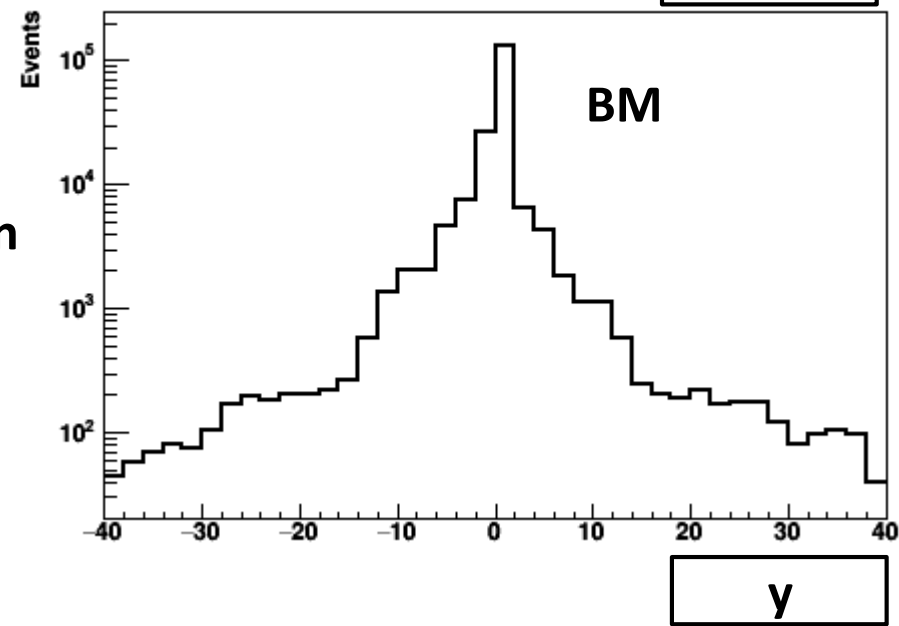
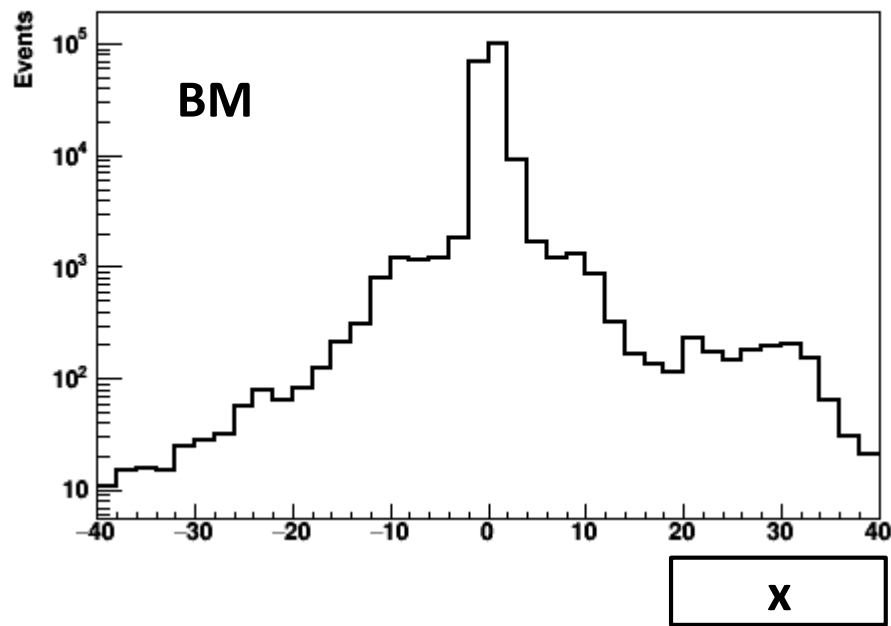
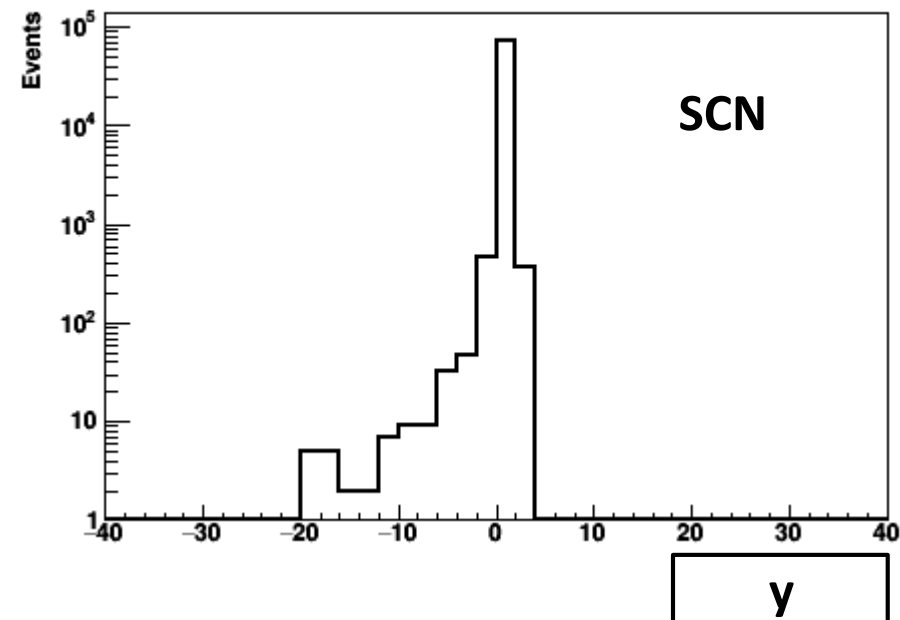
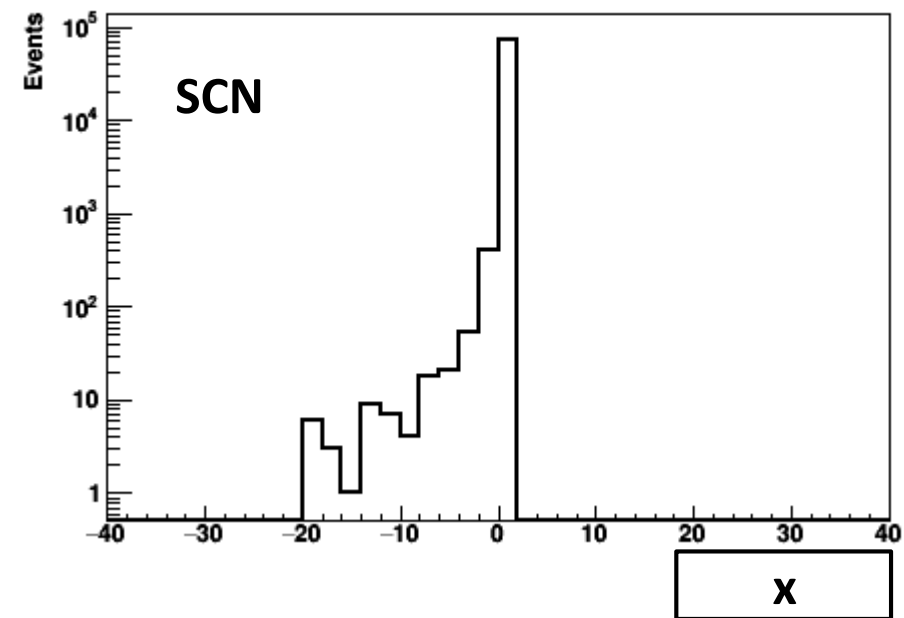
SCN standalone shows peaks

BM – SCN: x and y on SCN

Track extrapolation on SCN

2210-11-12
NO Target

Presence of the peak at zero
SCN ctive only in negative region

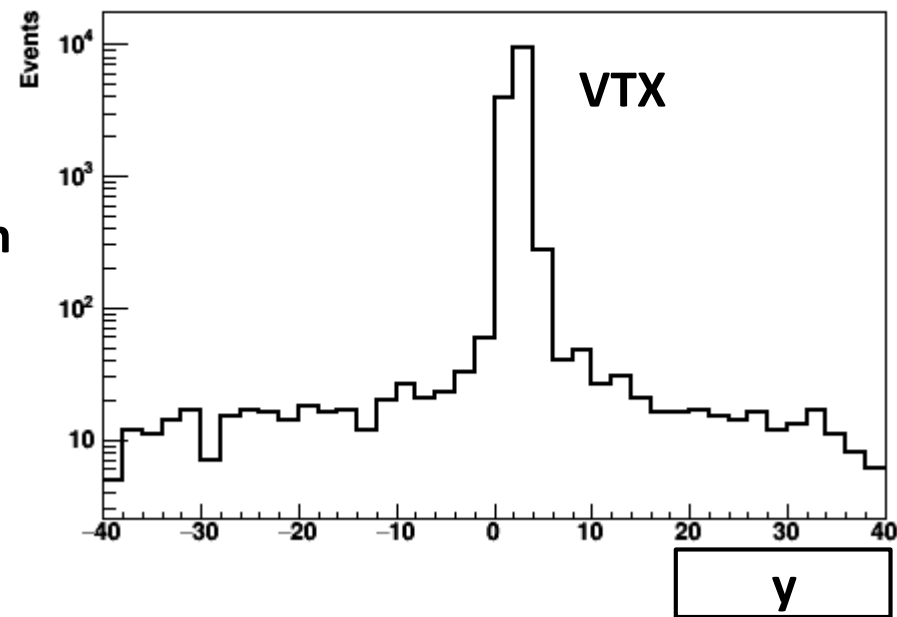
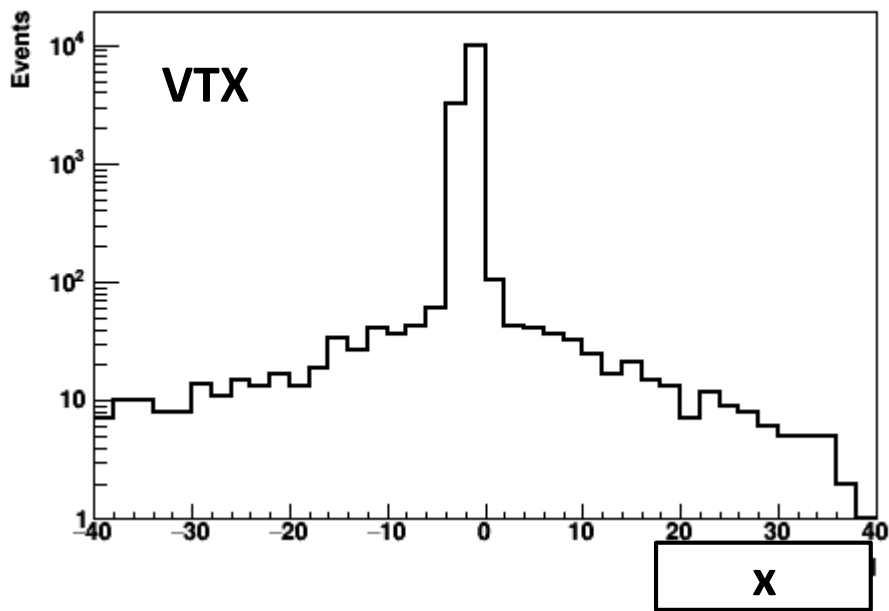
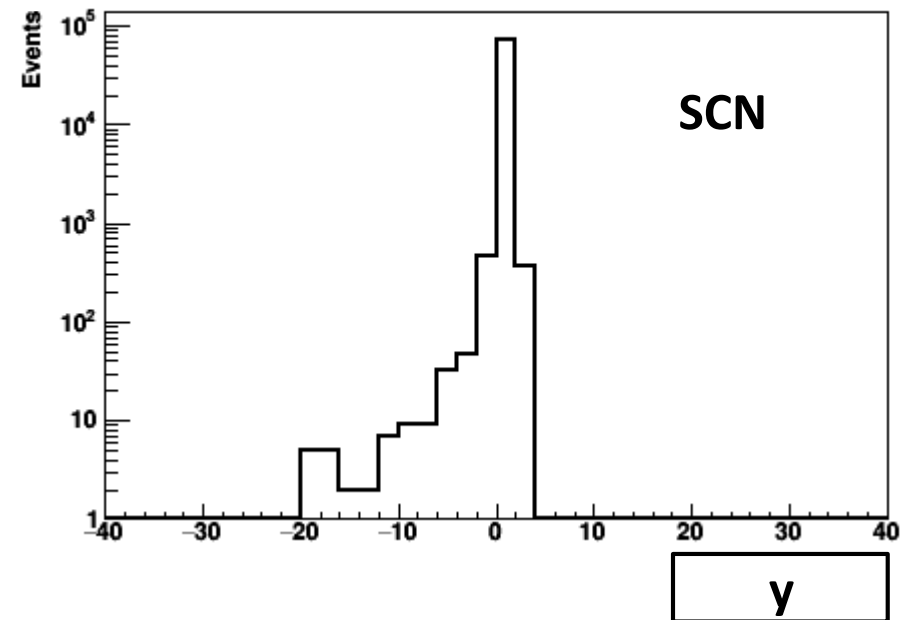
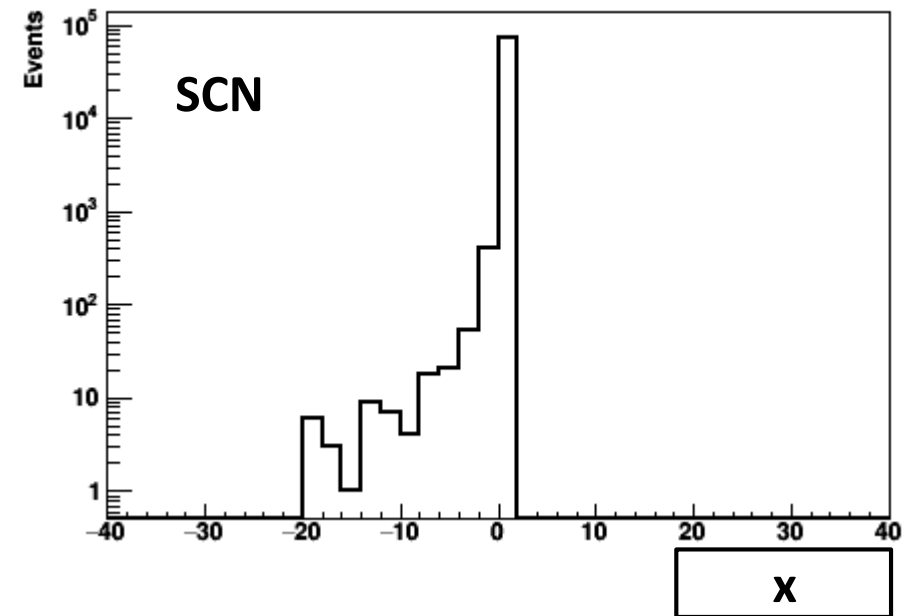


VTX – SCN: x and y on SCN

Track extrapolation on SCN

2210-11-12
NO Target

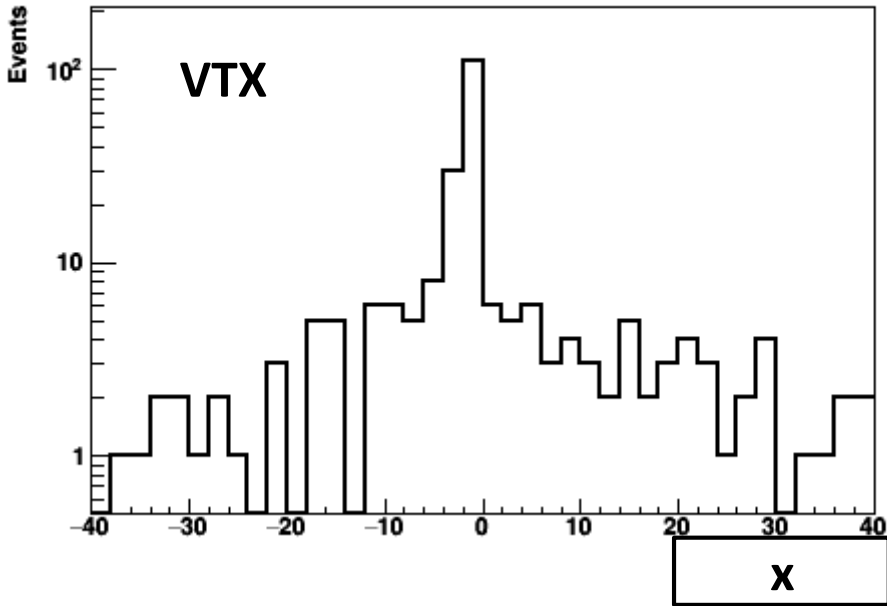
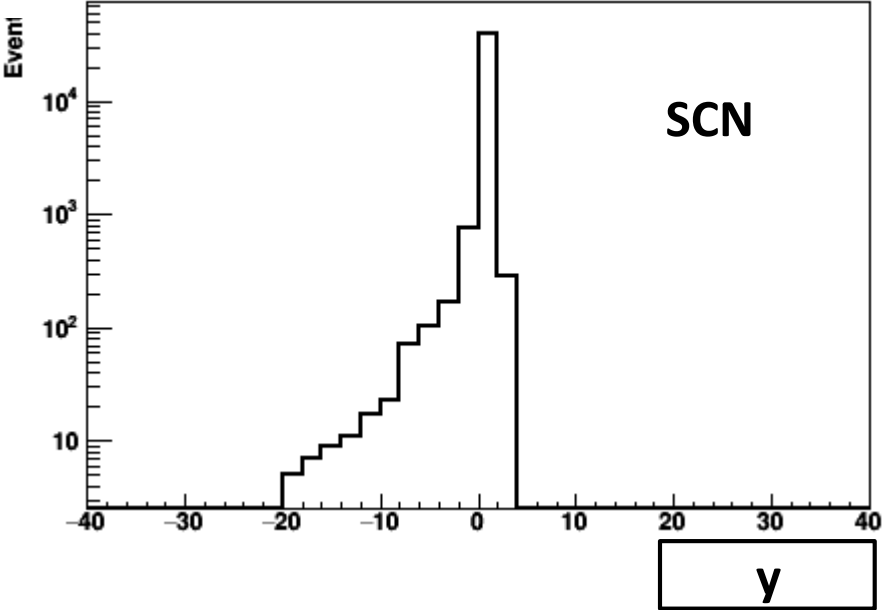
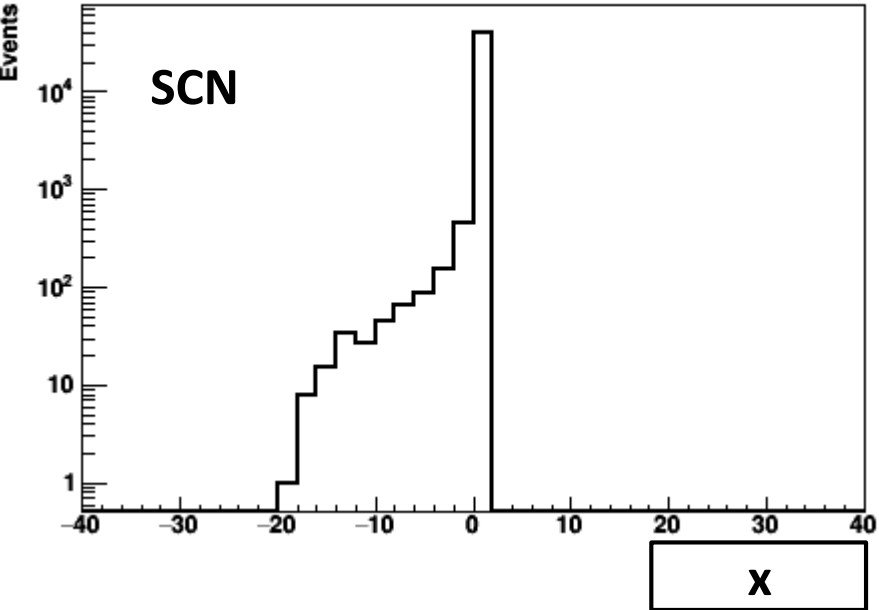
Presence of the peak at zero
SCN ctive only in negative region



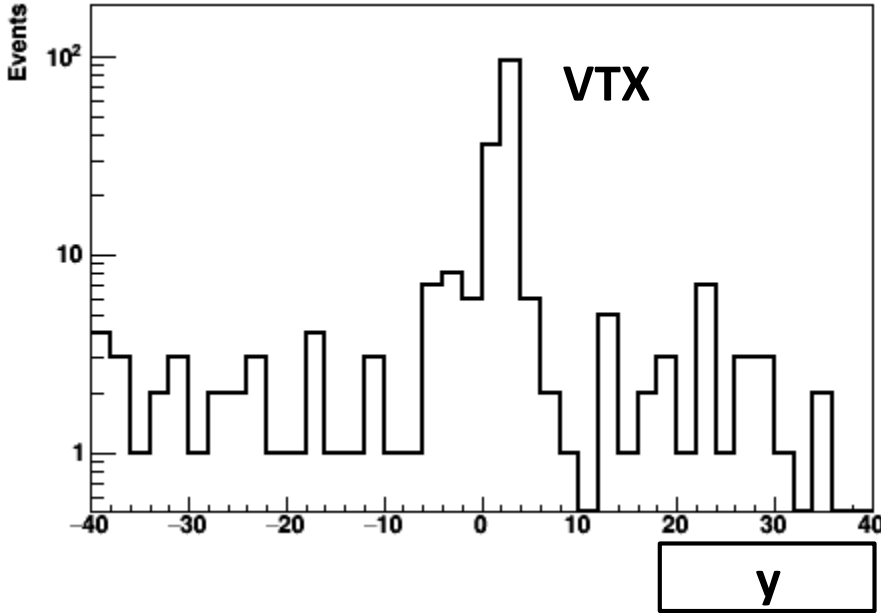
VTX – SCN: x and y on SCN

Track estrapolation on SCN

**2239-40-41-51
Target**



Presence of the peak at zero
SCN ctive only in negative region



CONCLUSIONS

Analysis of the GSI data taking:

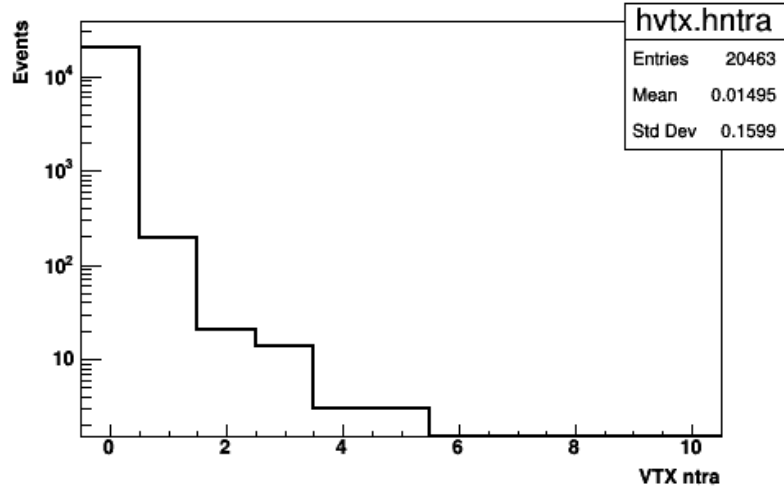
- ❑ **First data taking with SC, BM, VTX, SCN**
 - ❑ **SC: good efficiency, to adjust the TOF precision**
 - ❑ **BM: good efficiency, probably the χ^2 is too high**
 - ❑ **VTX: low efficiency, problems on track reconstruction**
 - ❑ **SCN: calibration of half channels, 2 slabs don't give signals, good charge distributions for fragmentation candidates**
 - ❑ **Correlation between sub-detectors:**
 - ❑ **BM-VTX-SCN: central peak visible**
- ❑ **Todo list:**
 - ❑ **DAQ-VTX-SCN setup in Bologna to fix problems**
 - ❑ **Hopefully: repeat the GSI data taking at CNAO before the end of 2019**

Vertex, VTX

RUNS WITHOUT TARGET: expected 1 track/ev

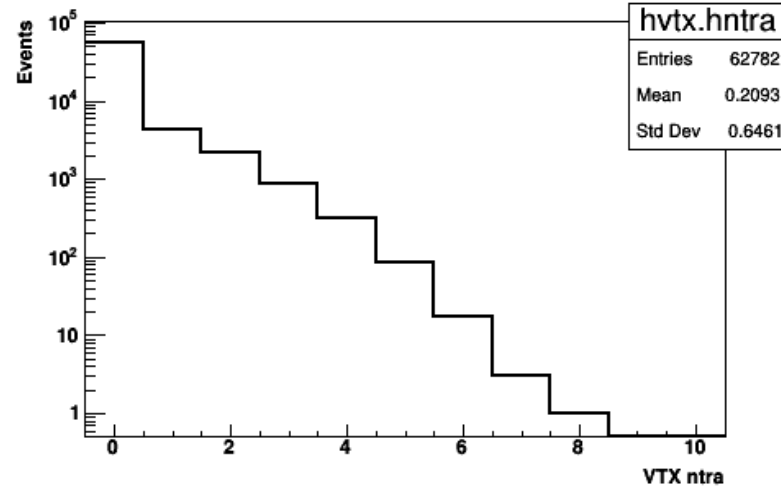
RUN 2210

236 ev with 1 track (20K ev)



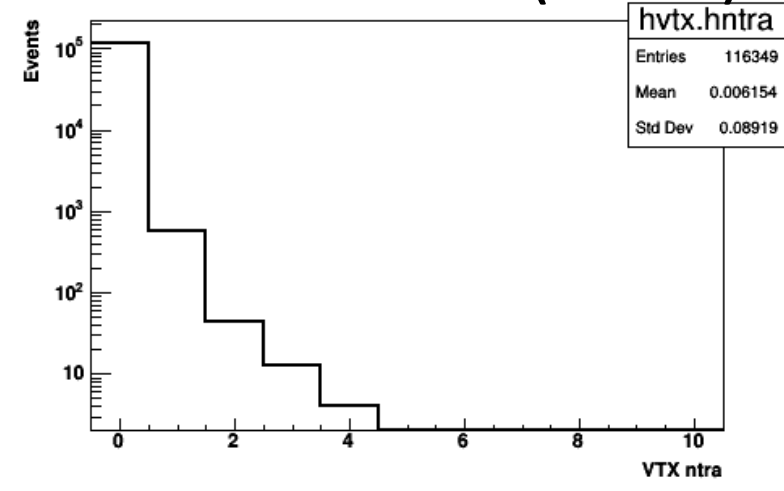
RUN 2211

7810ev with 1 track (63K ev)

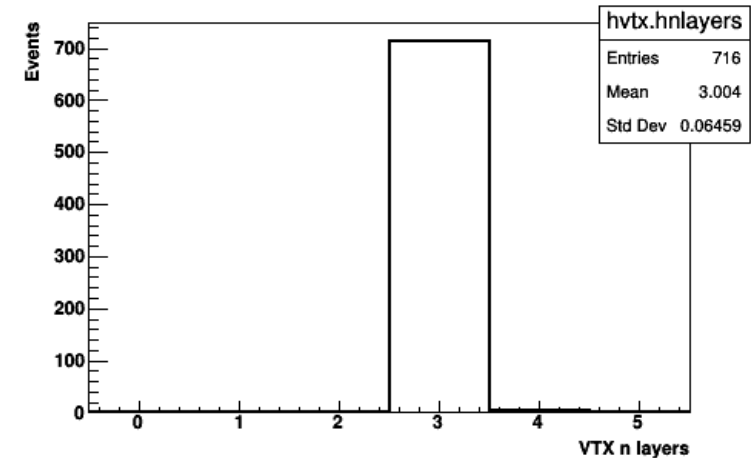
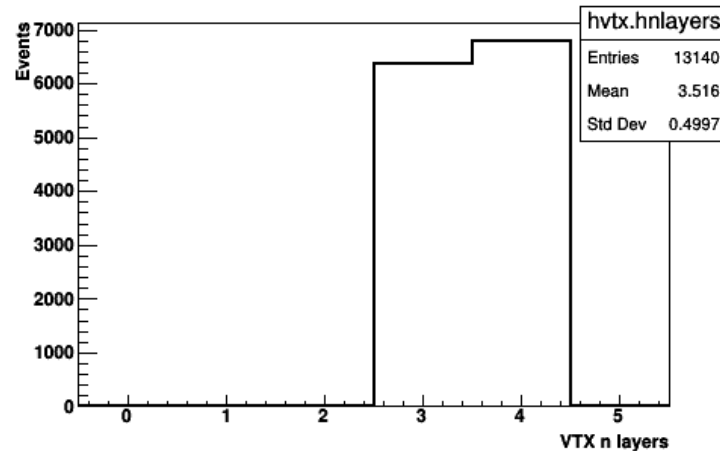
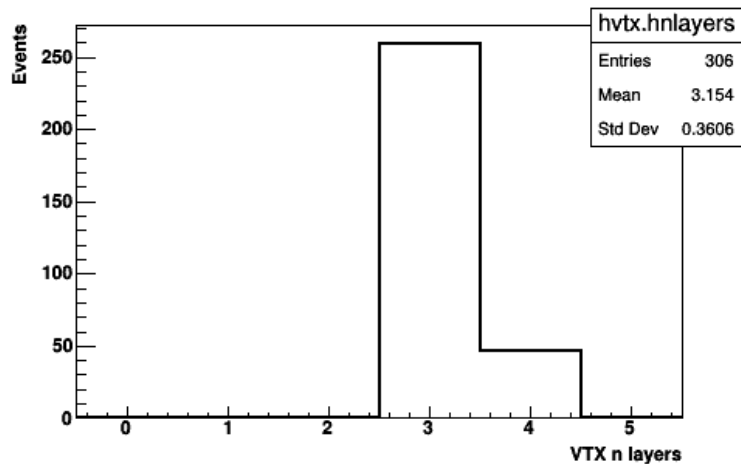


RUN 2212

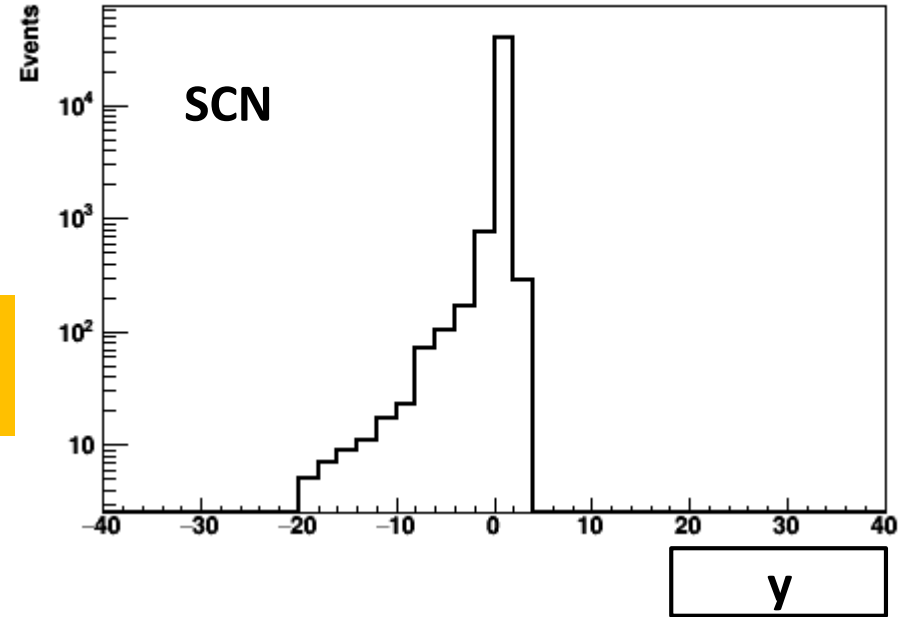
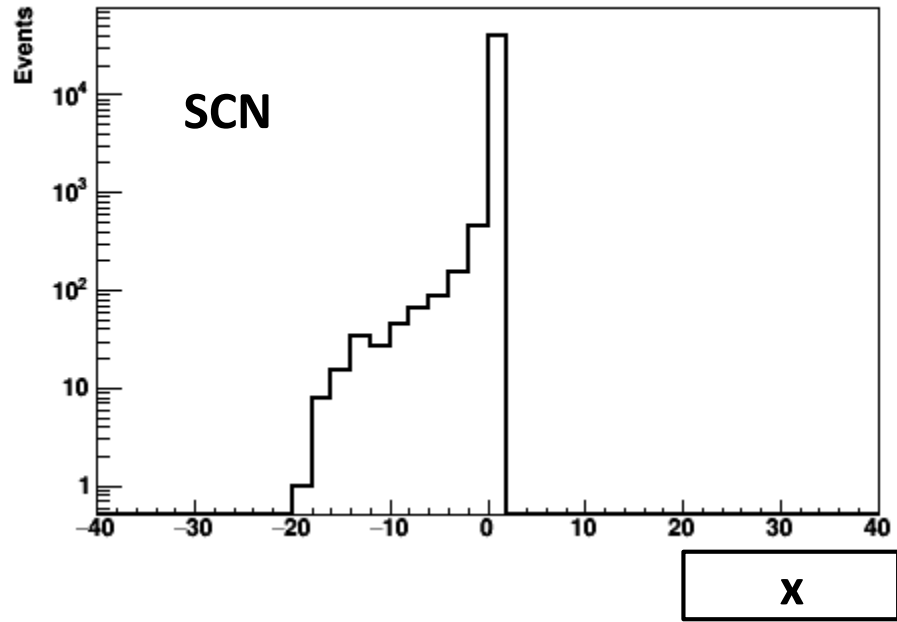
634 ev with 1 track (116K ev)



Number of hit layers



BM – SCN: x and y on SCN



2239-40-41-51
Target runs

