
Proton beam gas background

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Beam parameters and collision rate

- We use the Pythia8 fixed target events including beam effects (cross angle, crab cavity, beam energy spread, angular beam divergence, bunch length) for our simulation;
- $-5.5\text{m} < s < 5\text{m}$ beam gas is considered;

Species Energy (GeV)	Proton 275	Proton 100	Proton 41
RMS Emittance h/v (nm)	18/1.6	20/2.7	44/10
β^* h/v (cm)	80/7.1	63/5.7	90/7.1
RMS $\Delta\theta$ h/v (μrad)	150/150	220/220	220/380
RMS Bunch length (cm)	6	7	7.5
RMS Δ/p (10^{-4})	6.8	9.7	10.3

PM = dRT;

R = 0.0821 atm/mol;

P = $2.63032\text{e-}09$ mbar = $2.63032\text{e-}09 * 0.000986923\text{atm} = 2.5959\text{e-}12\text{atm}$

T = 293k;

M = 1.00794g/mol (molar mass)

Density = $1.0877\text{e-}13\text{g/L} = 6.4991\text{e}7$ molecules/cm³

Background collision rate = $L_{bg} * \sigma_{pH^2}$;

Luminosity of background = (beam current) * (average gas density) * (length);

Current = $(1.0\text{C/s}) * (\text{protons}/1.6\text{e-}19\text{C}) = 6.3\text{e}18$ protons/s;

Length = 10.5m;

σ_{pH^2} = 39.27mb *2 (Pythia8);

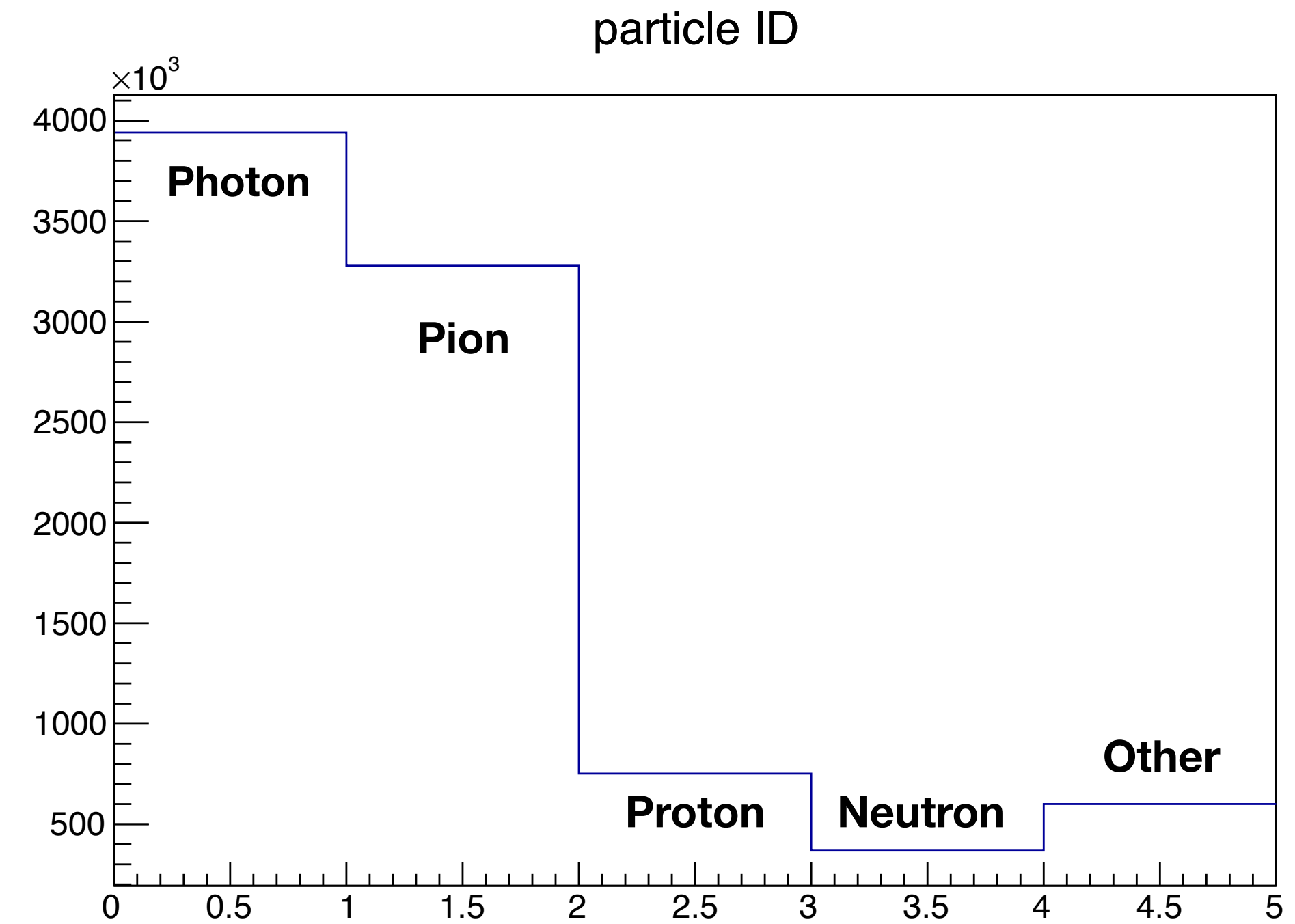
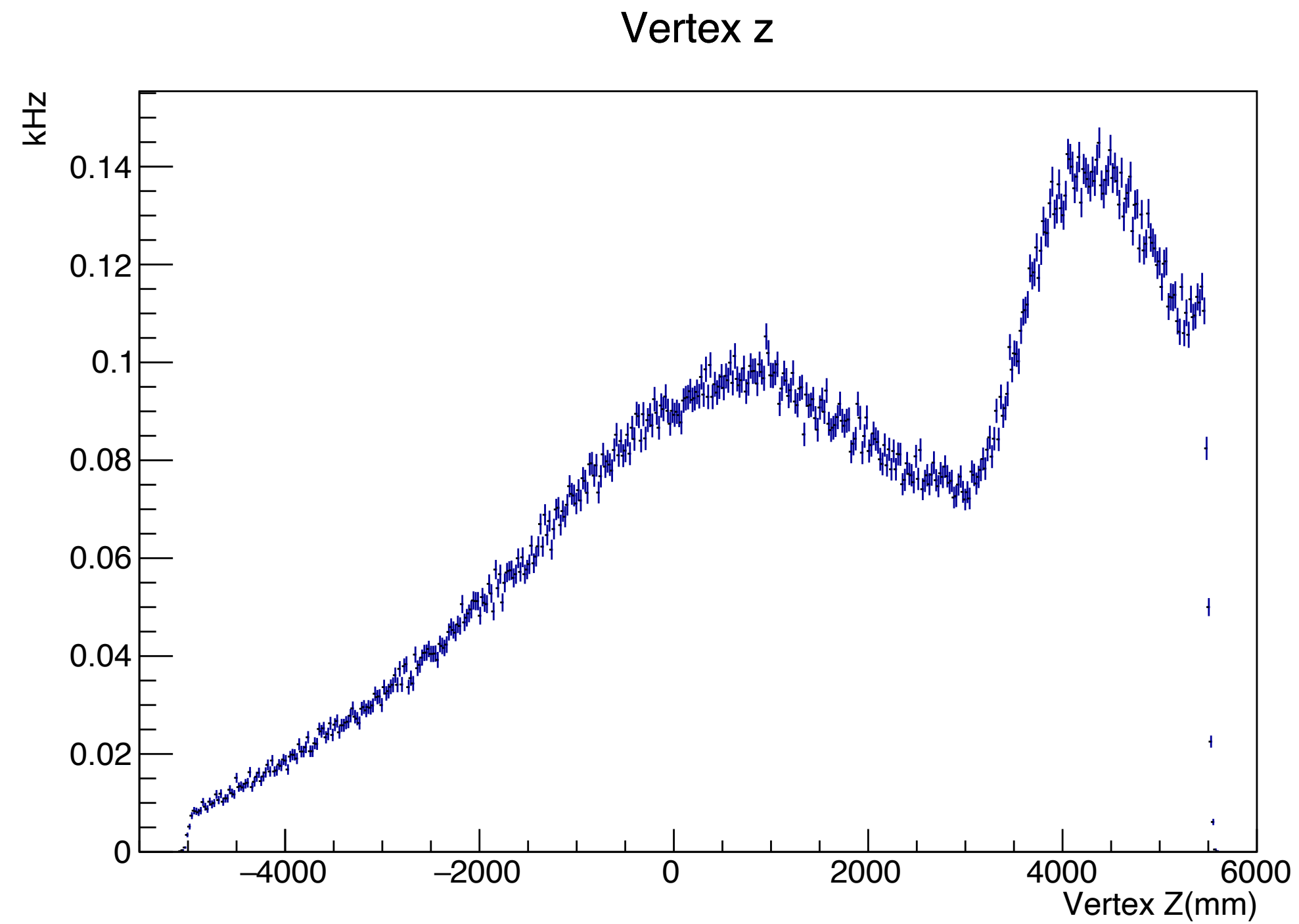
Background collision rate =

$6.33\text{e}18(\text{s-}1) * 6.4991\text{e}7(\text{cm-}3) * 1050(\text{cm}) * 39.27 * (1.0\text{e-}27\text{cm}^2) * 2 = \underline{\underline{33.93\text{kHz}}}$; //275GeV

33.16kHz; // 100GeV

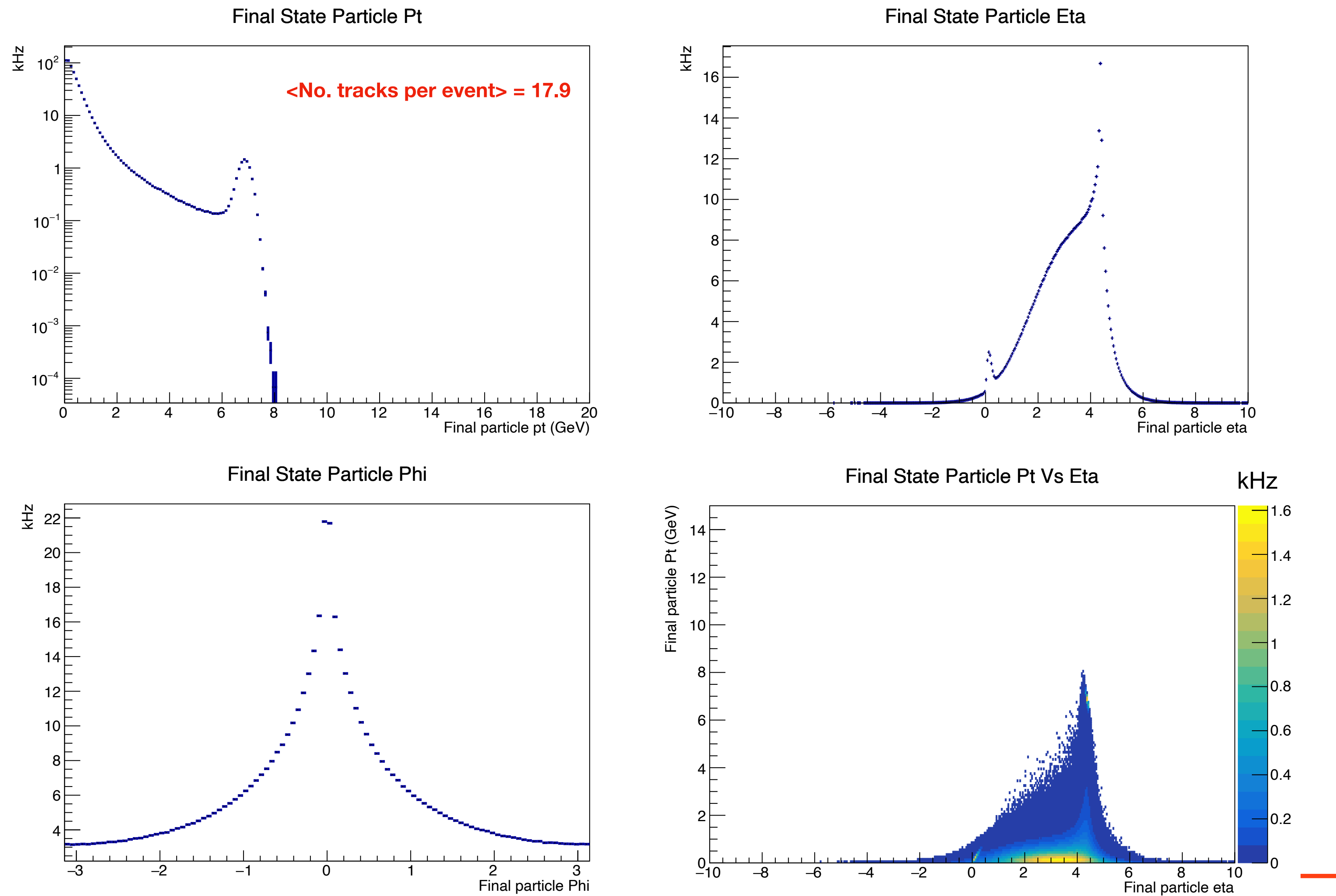
33.40kHz; // 41GeV

Events QA plots



- Total collision rate = 33.93kHz in $-5.5\text{m} < s < 5\text{m}$;

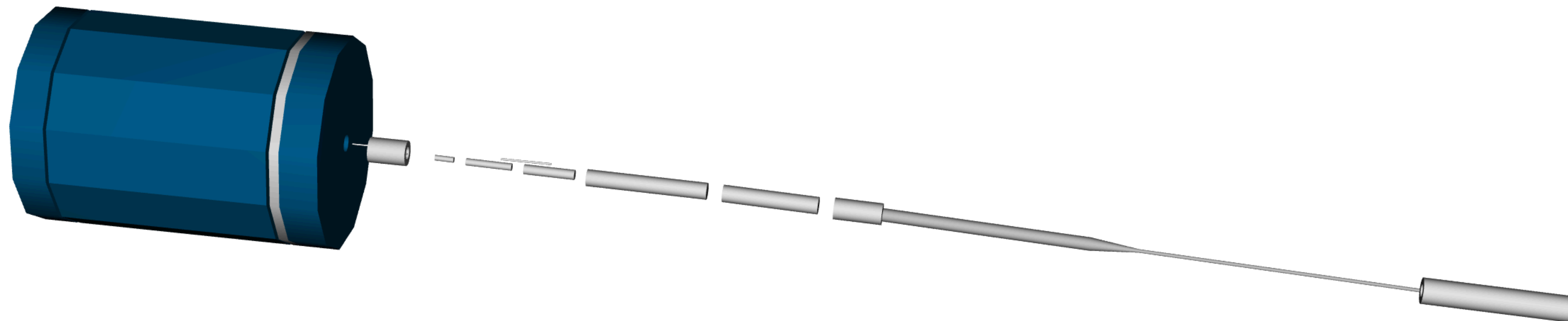
QA plots per event



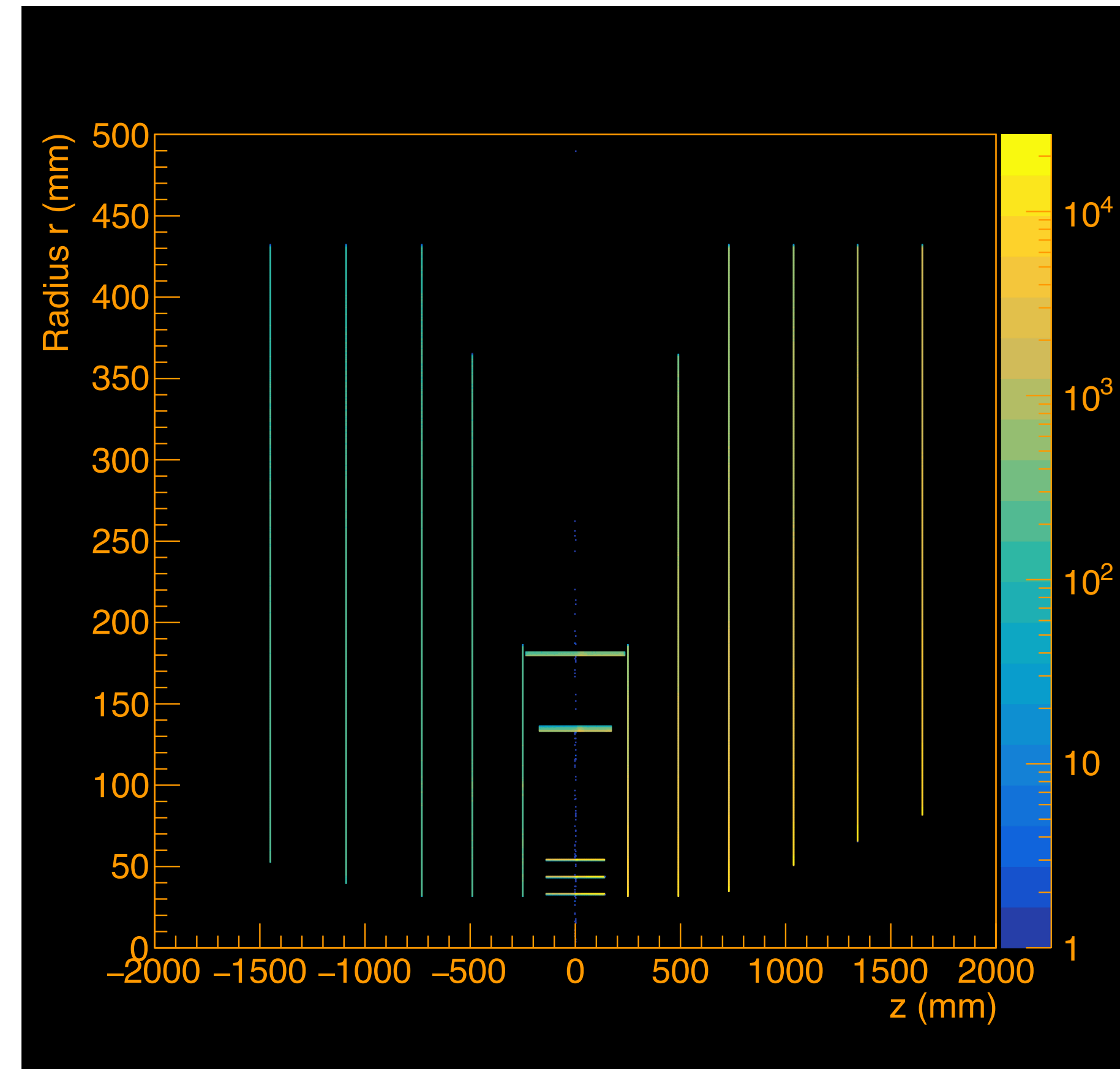
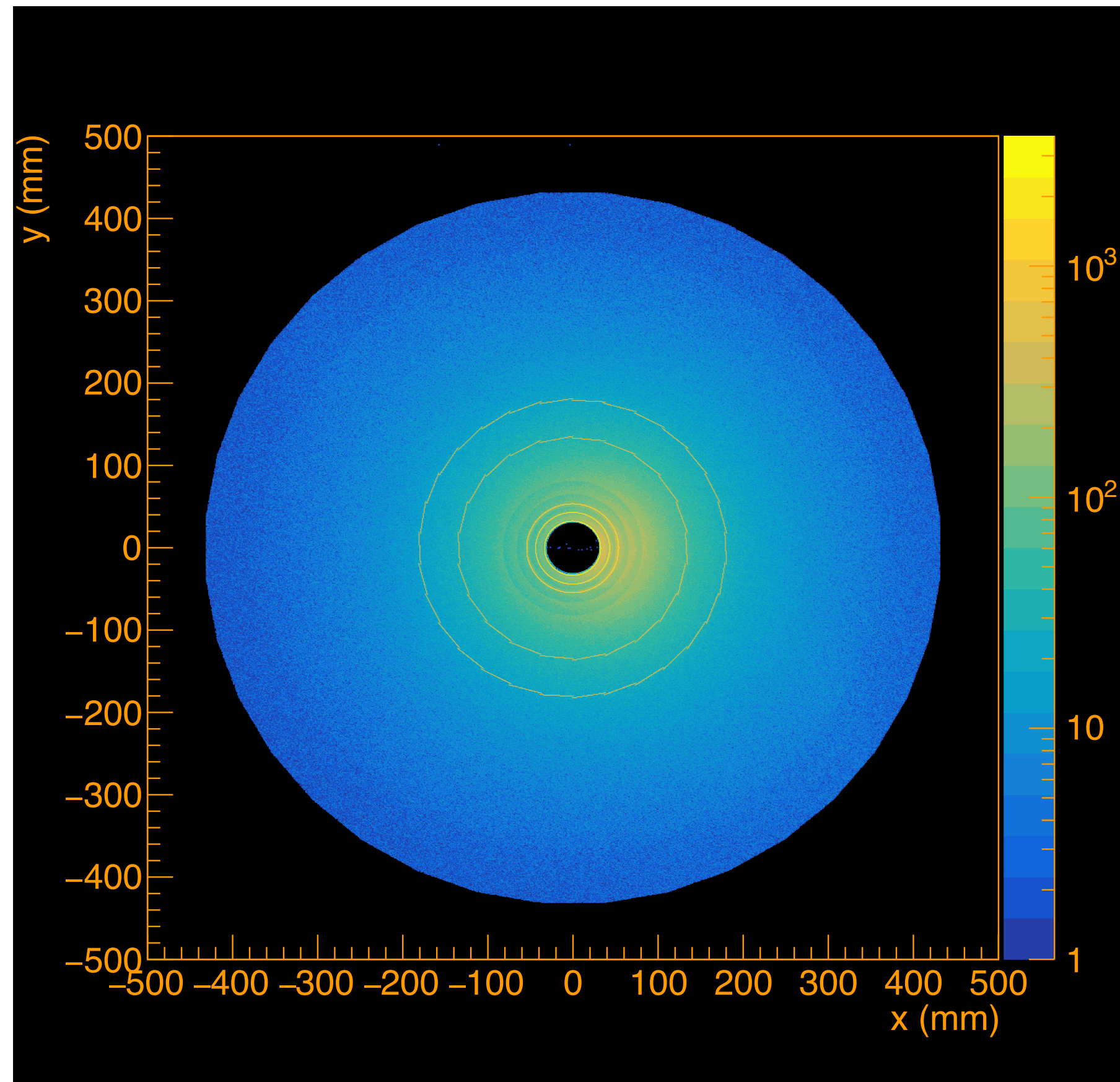
- Total produced tracks rate = 606.8 kHz in $-5.5m < s < 5m$;

Athena Full Simulation

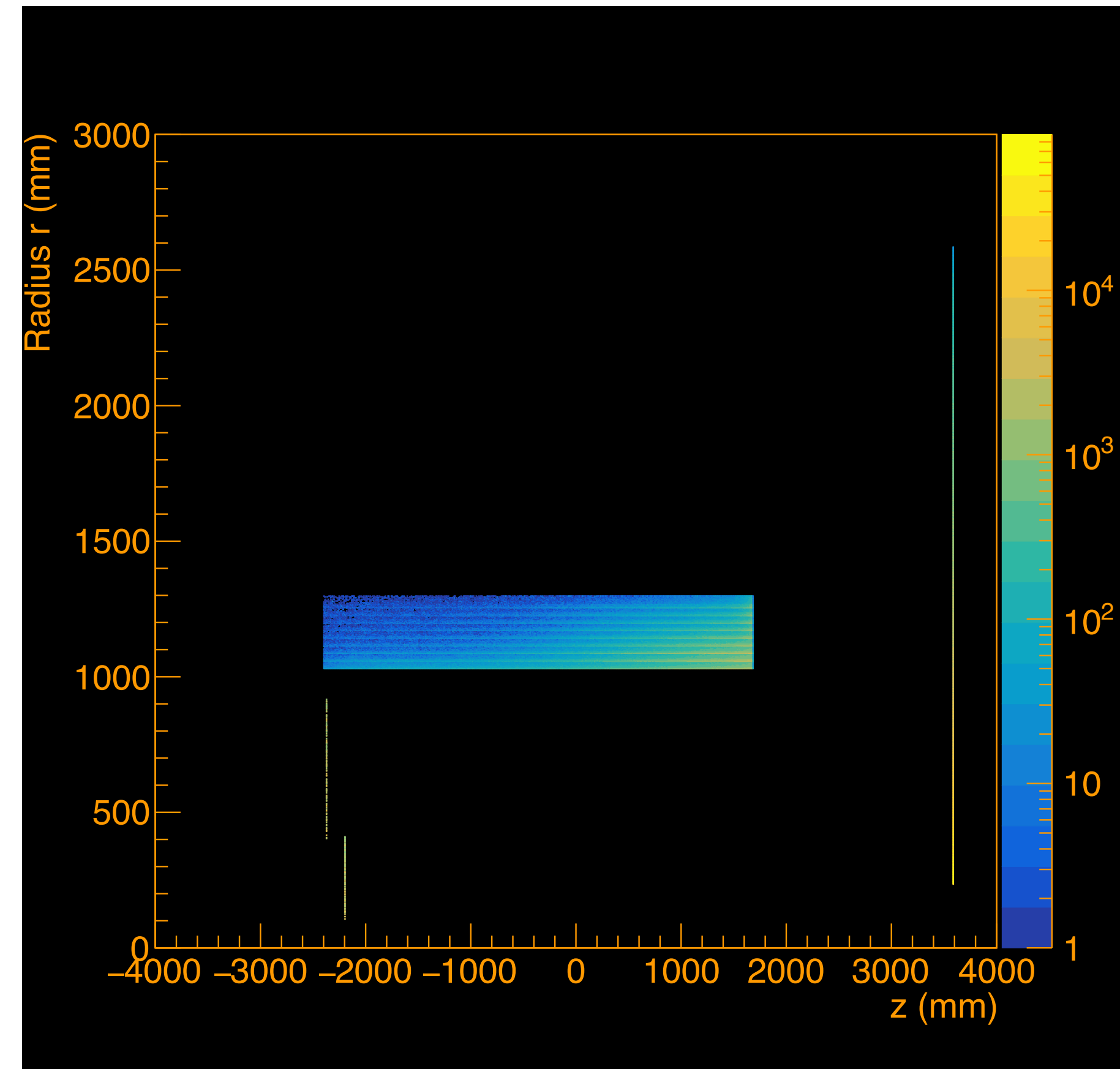
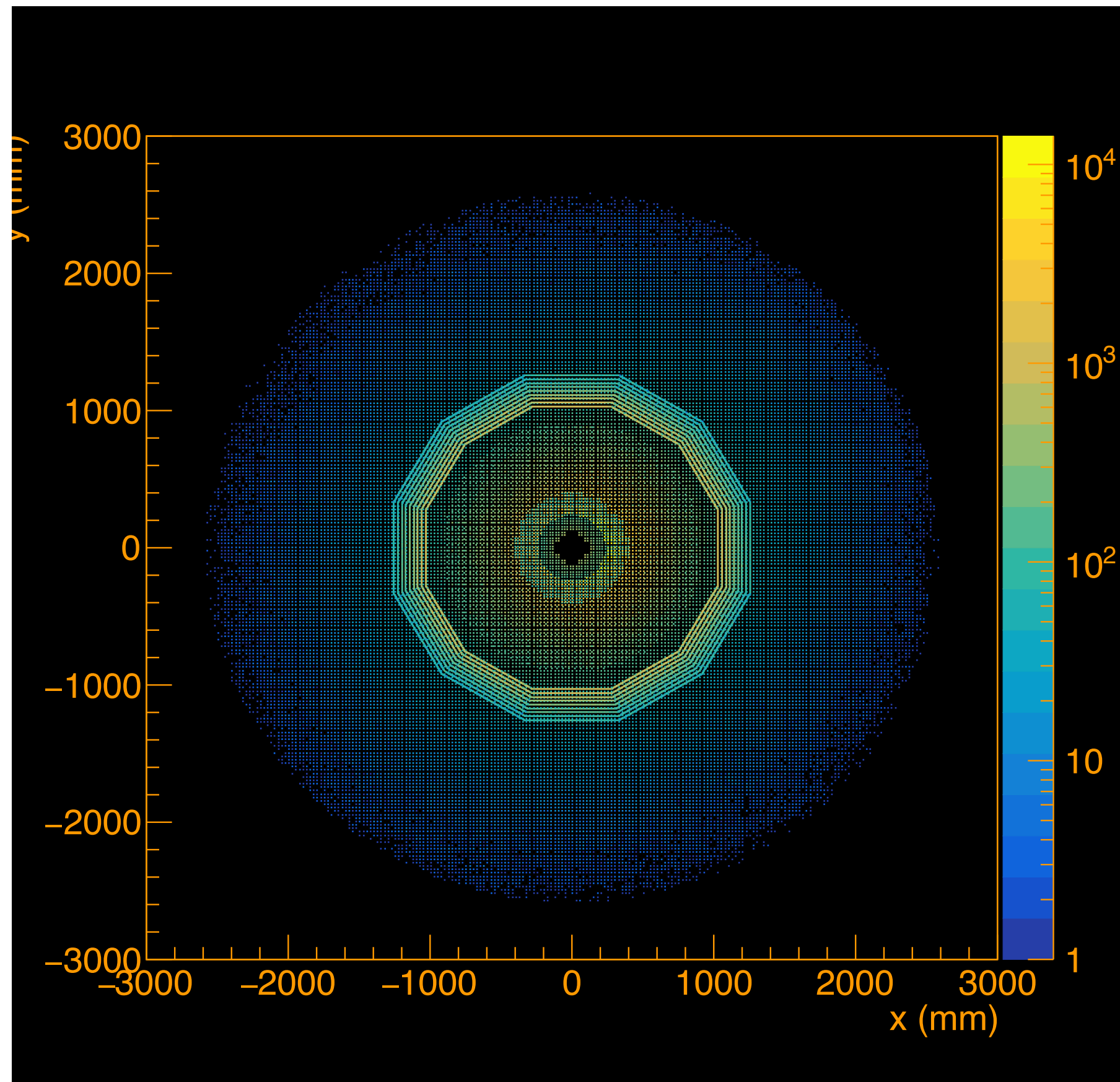
- `source /opt/detector/setup.sh`
- `npsim --inputFiles /gpfs/mnt/gpfs02/eic/zhangzq/pythia8/beameffect/BeamGas/test.hepmc --compactFile athena.xml --random.seed 123456 --physics.list FTFP_BERT --numberOfEvents 1000 --outputFile protonBeamGasBG.root`
- We can get the hits information in all sub detectors;



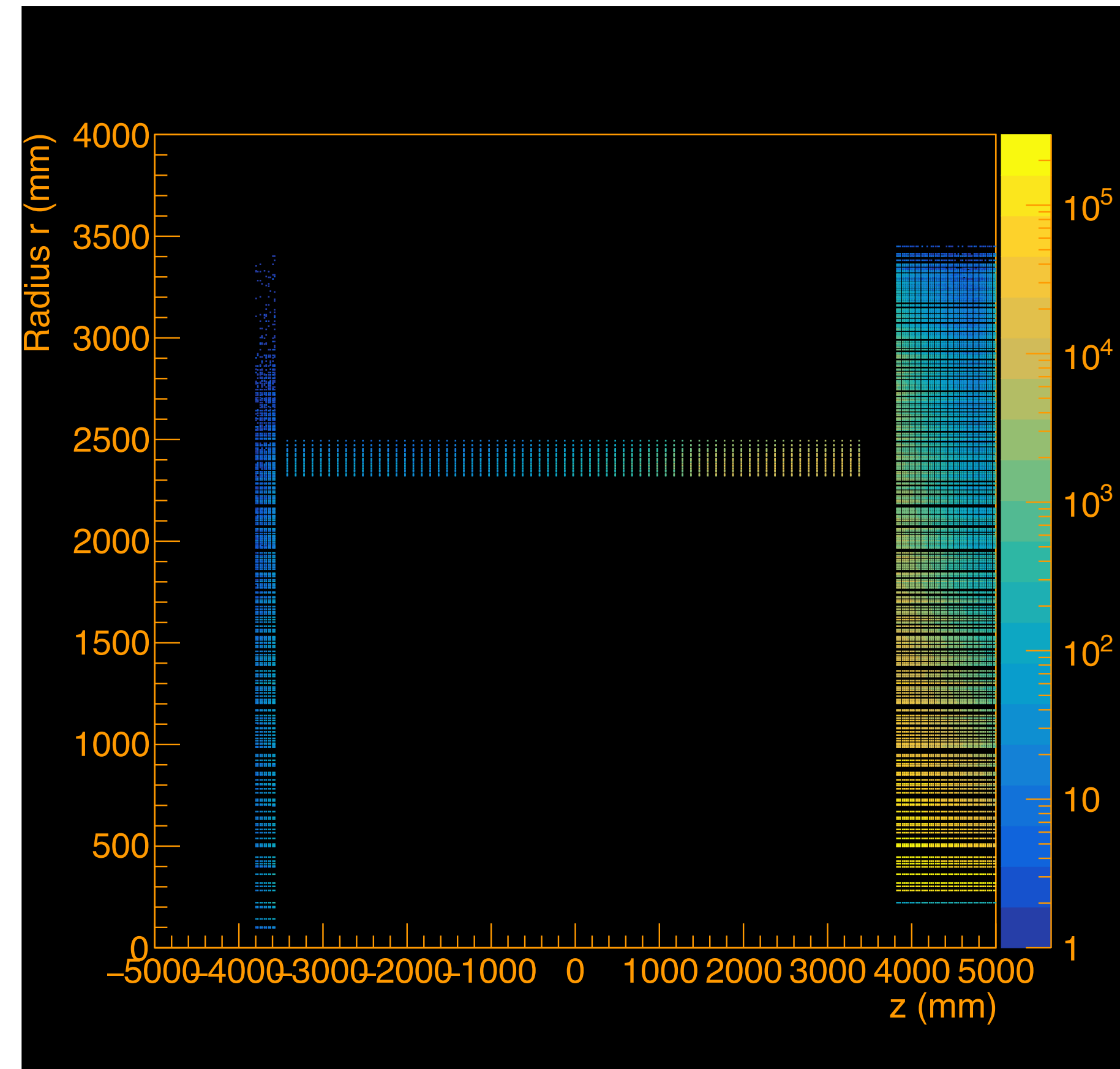
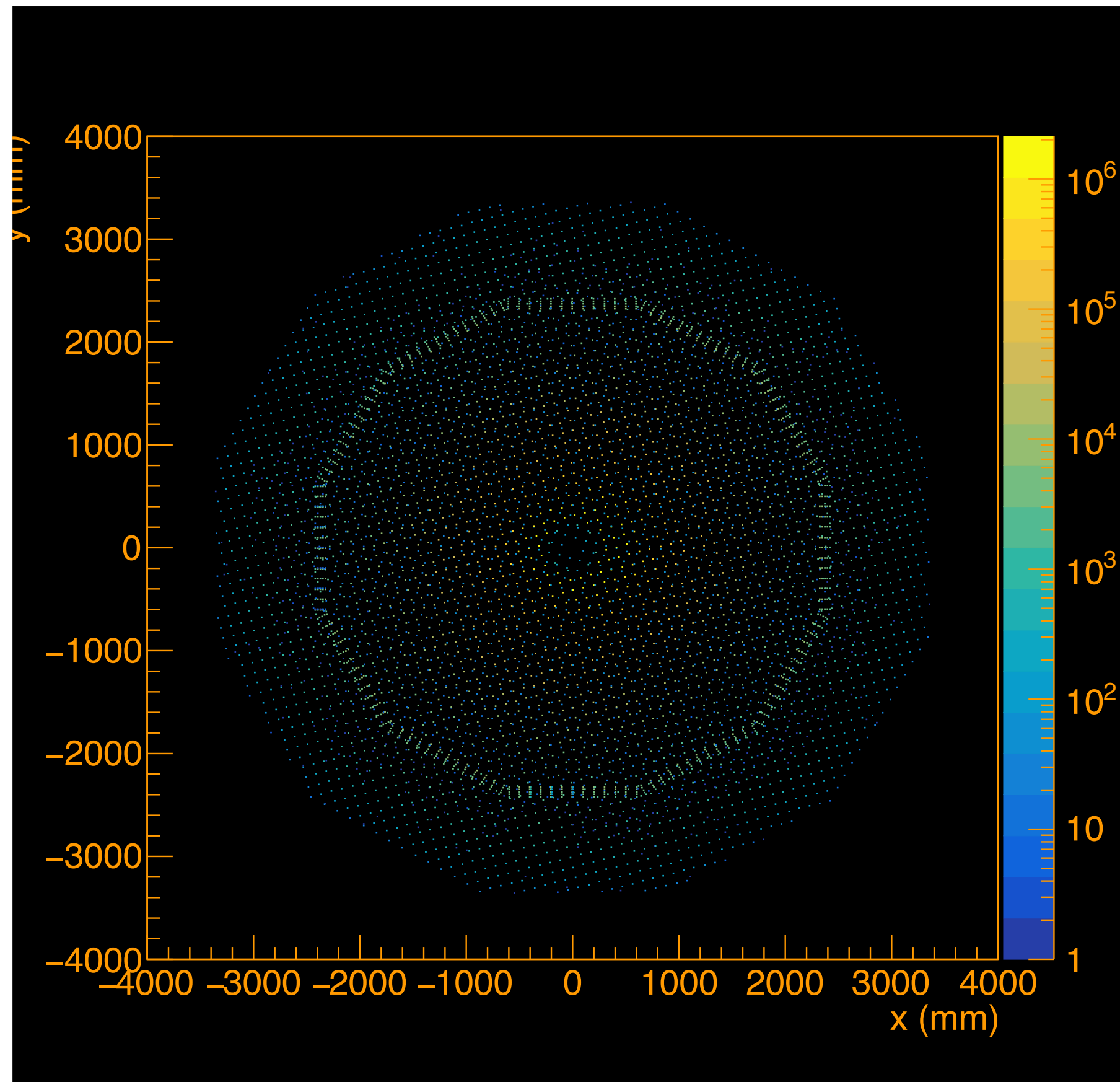
Tracking detectors, VertexBarrel + TrackerBarrel + TrackerEndcap



Electromagnetic calorimeters, EcalEndcapP + EcalEndcapN + EcalBarrel



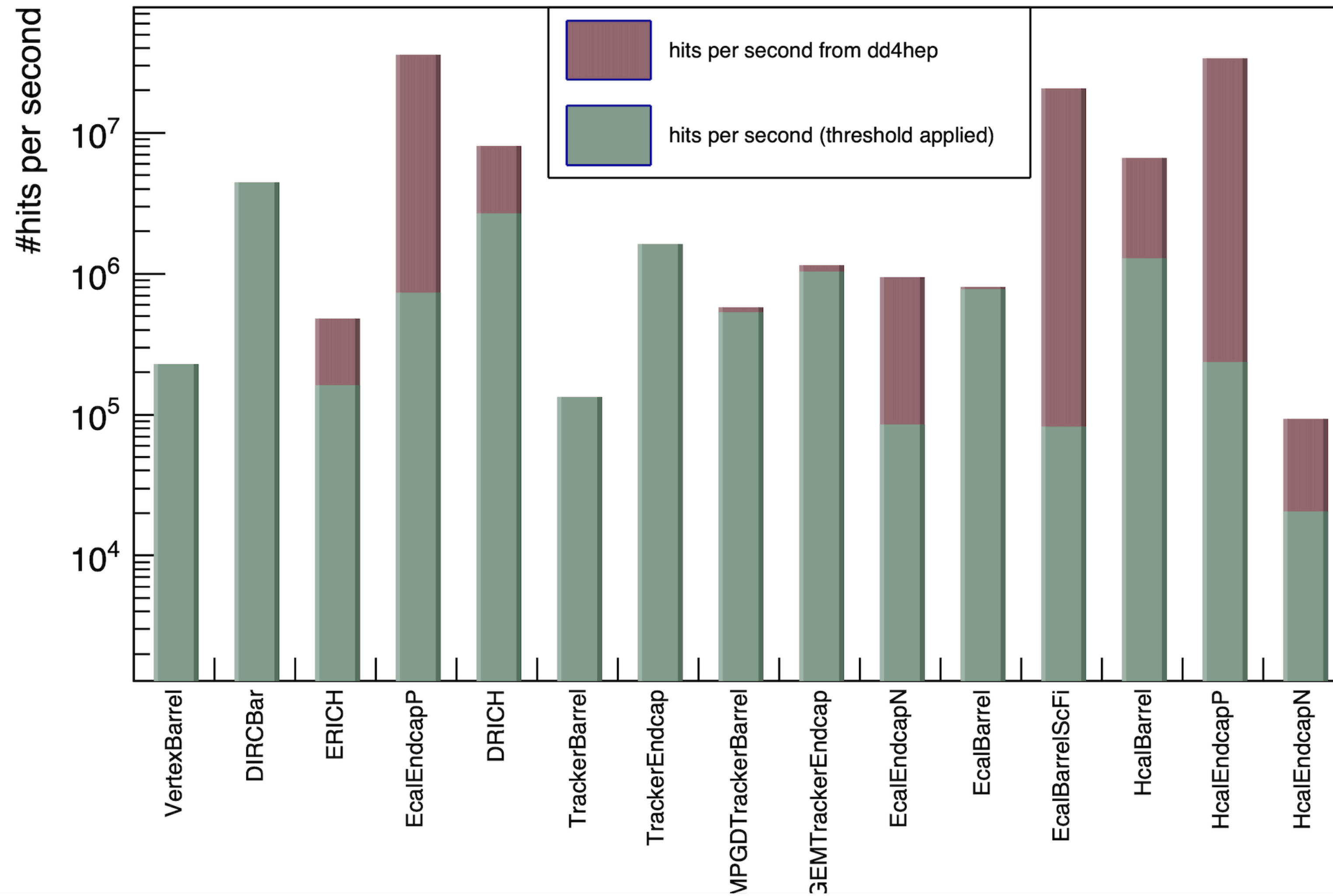
Hadron calorimeters, HcalBarrel + HcalEndcapN + HcalEndcapP



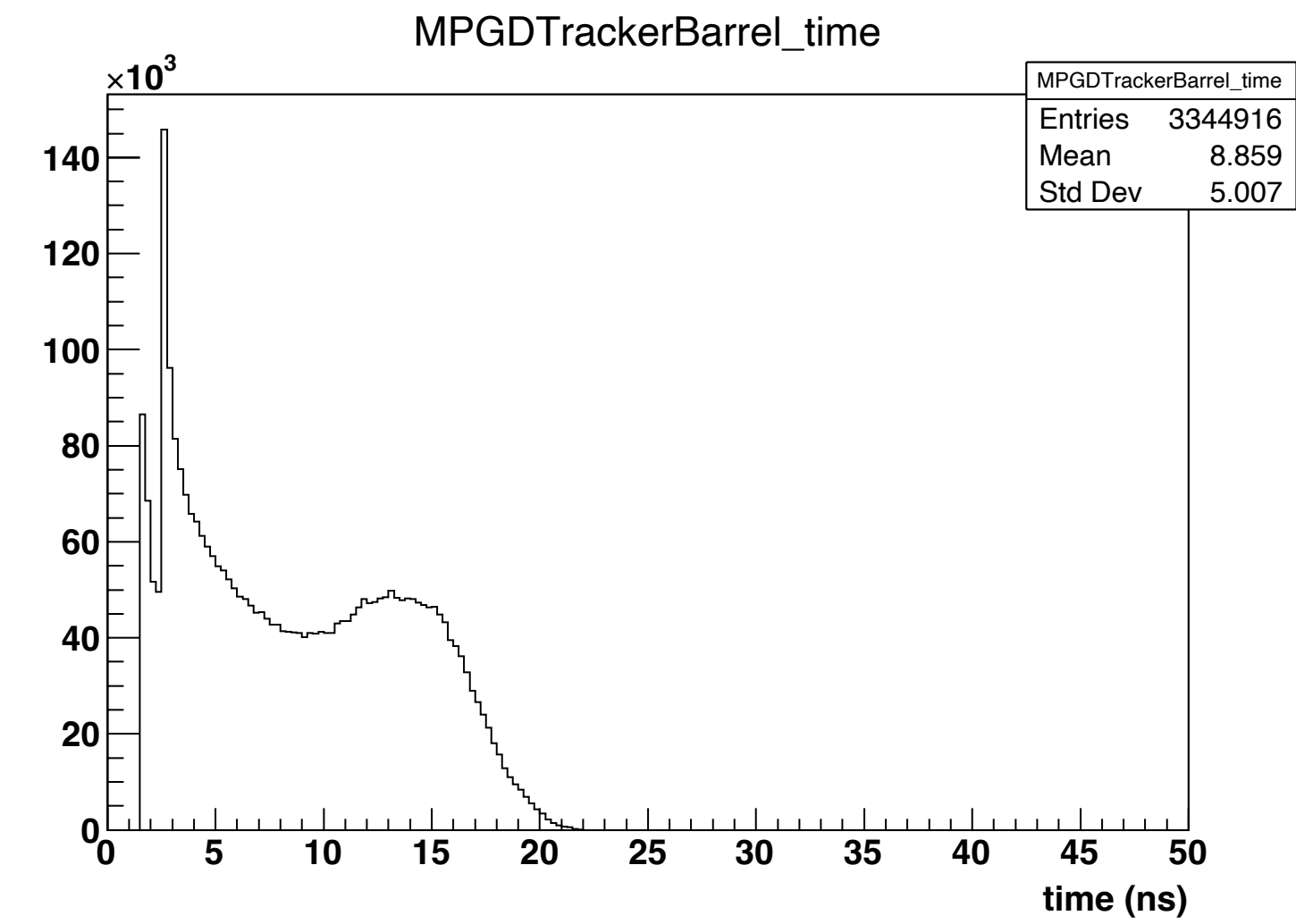
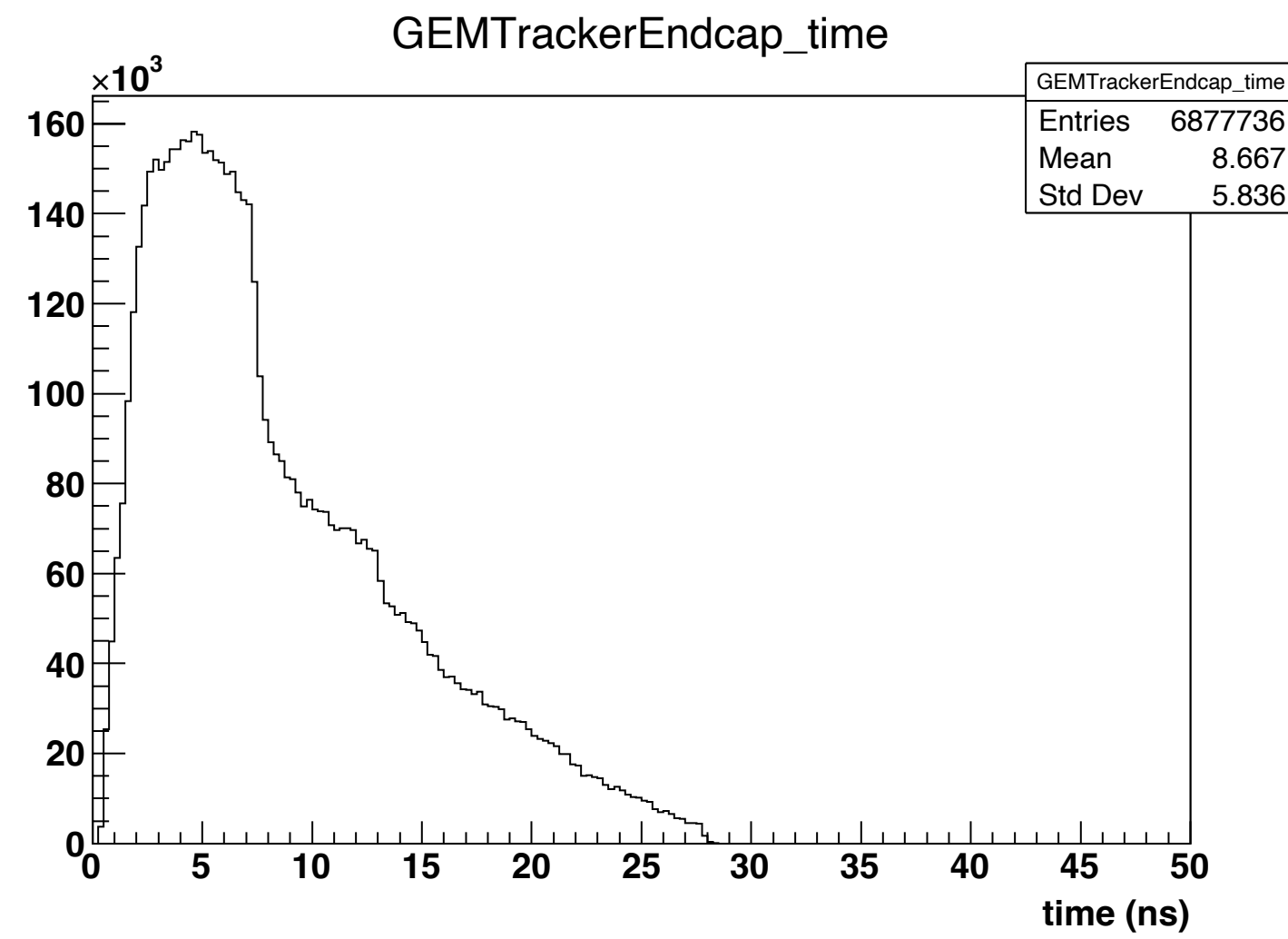
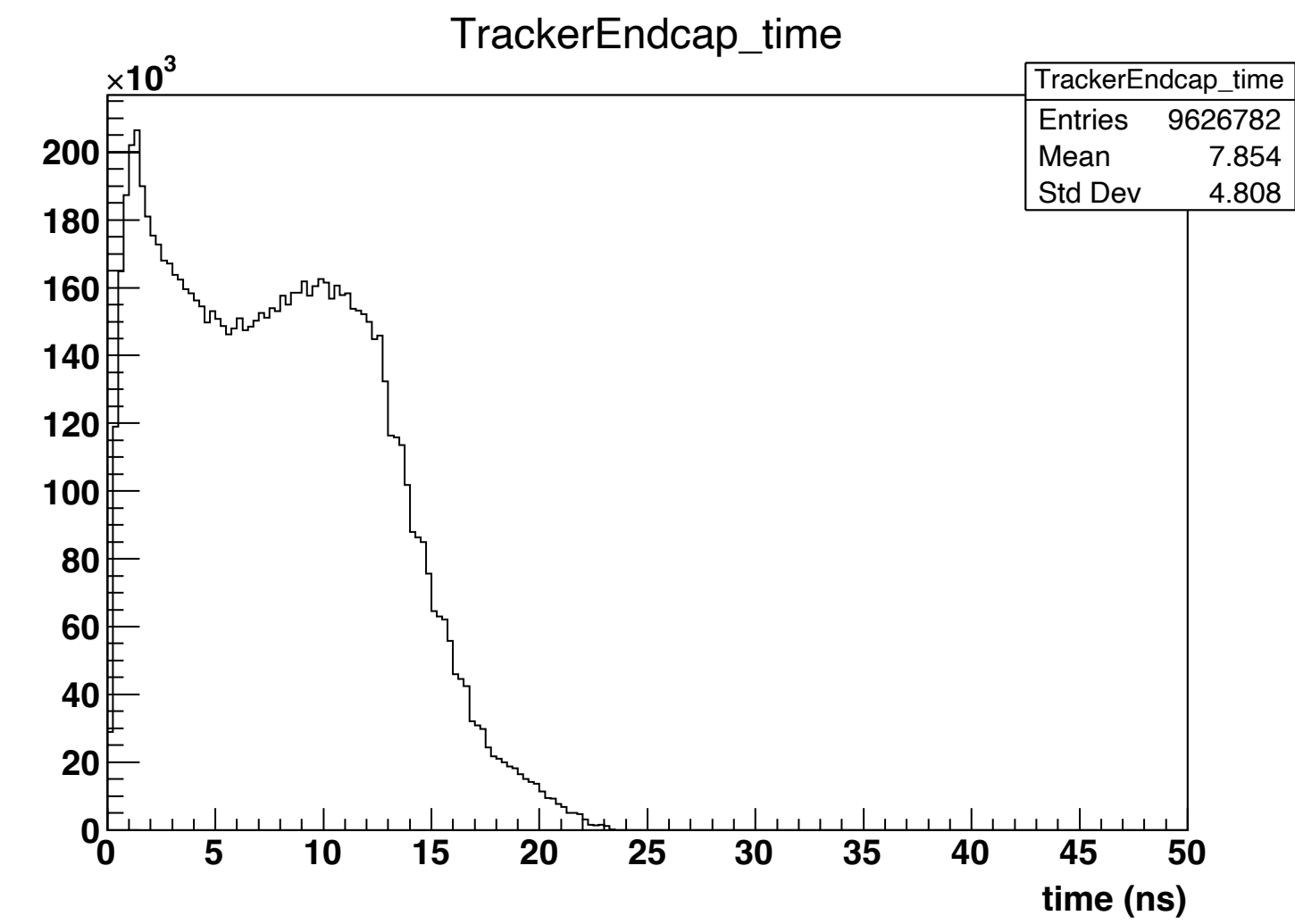
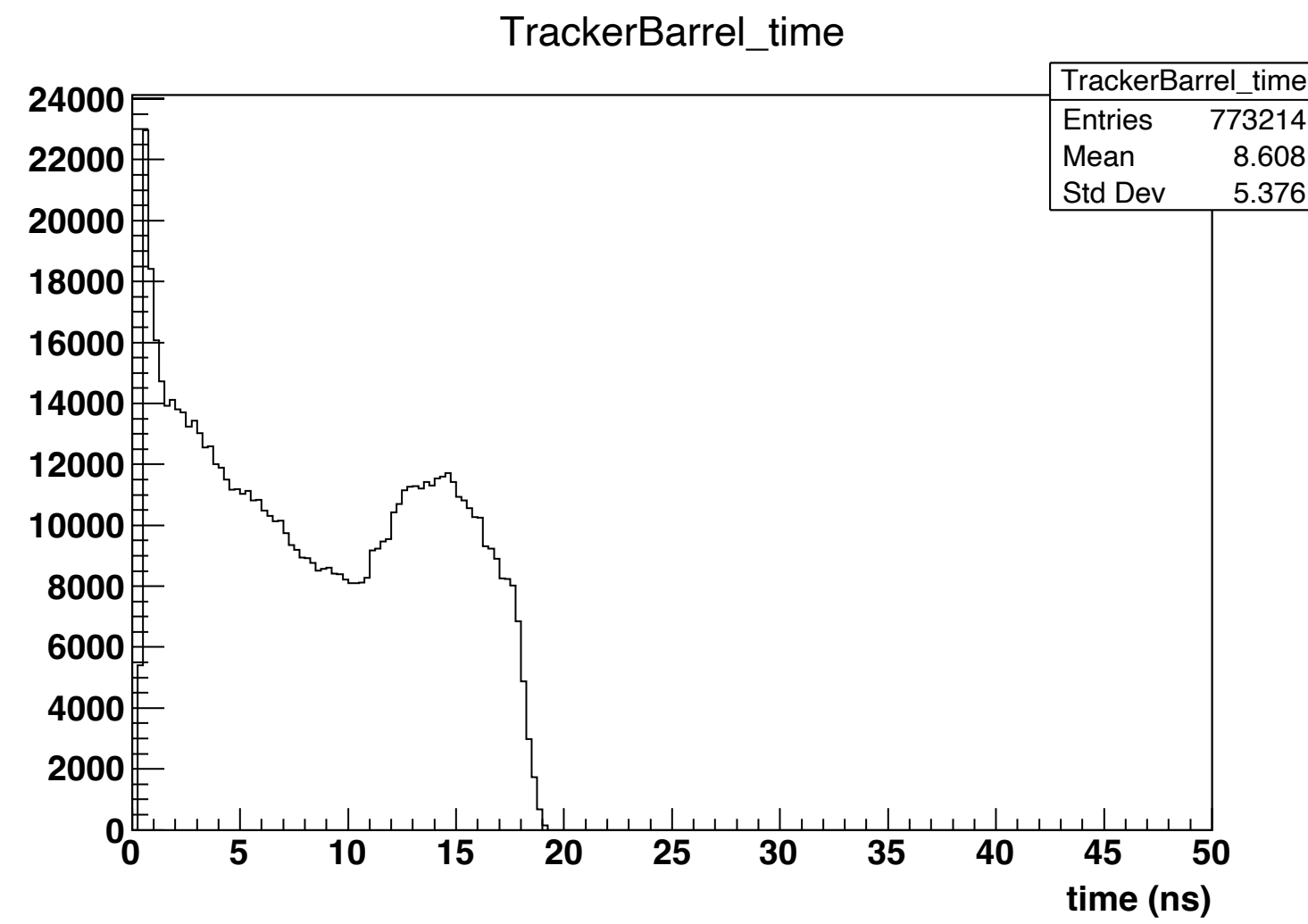
Hits Rate and Threshold

	readout unit(grid_size_x*grid_size_y)	no. hits per second	Threshold	after threshold
VertexBarrel	0.010mm*0.010mm	2.27E+05	0.4keV	2.27E+05
DIRCBar	3.0mm*3.0mm	4.40E+06		4.4E+06
ERICH	3.2mm*3.2mm	4.81E+05	divided by 3	1.60E+05
EcalEndcapP	1 fiber (20.5mm*20.5mm)	3.58E+07	5 MeV	7.34E+05
DRICH	3.2mm*3.2mm	8.05E+06	divided by 3	2.68E+06
TrackerBarrel	0.010mm*0.010mm	1.33E+05	0.4 keV	1.33E+05
TrackerEndcap	0.010mm*0.010mm	1.61E+06	0.4 keV	1.61E+06
MPGDTrackerBarrel	0.52mm*0.52mm	5.75E+05	0.2 keV	5.31E+05
GEMTrackerEndcap	0.17mm*0.87mm	1.14E+06	0.2 keV	1.03E+06
EcalEndcapN	1 fiber (20.5mm*20.5mm)	9.43E+05	2.5 MeV	8.47E+04
EcalBarrel	0.5mm*0.5mm	8.02E+05	0.4 keV	7.71E+05
B0Preshower		4.13E+04		4.13E+04
EcalBarrelScFi	1 fiber	2.06E+07	2.5 MeV	8.19E+04
HcalBarrel	100.0mm*100.0mm	6.63E+06	0.1 MeV	1.29E+06
HcalEndcapP	100.0mm*100.0mm	3.36E+07	300 MeV	2.36E+05
HcalEndcapN	100.0mm*100.0mm	9.34E+04	0.1 MeV	2.04E+04
B0Tracker		1.86E+05		1.86E+05
ForwardOffMTracker		2.11E+03		2.11E+03
ffiZDCSi		4.36E+03		4.36E+03
ffiZDCWSciFi		2.03E+05		2.03E+05
ffiZDCSiPb		1.91E+05		1.91E+05
ForwardRomanPot		1.35E+05		1.35E+05
ffiZDCScint		5.03E+03		5.03E+03

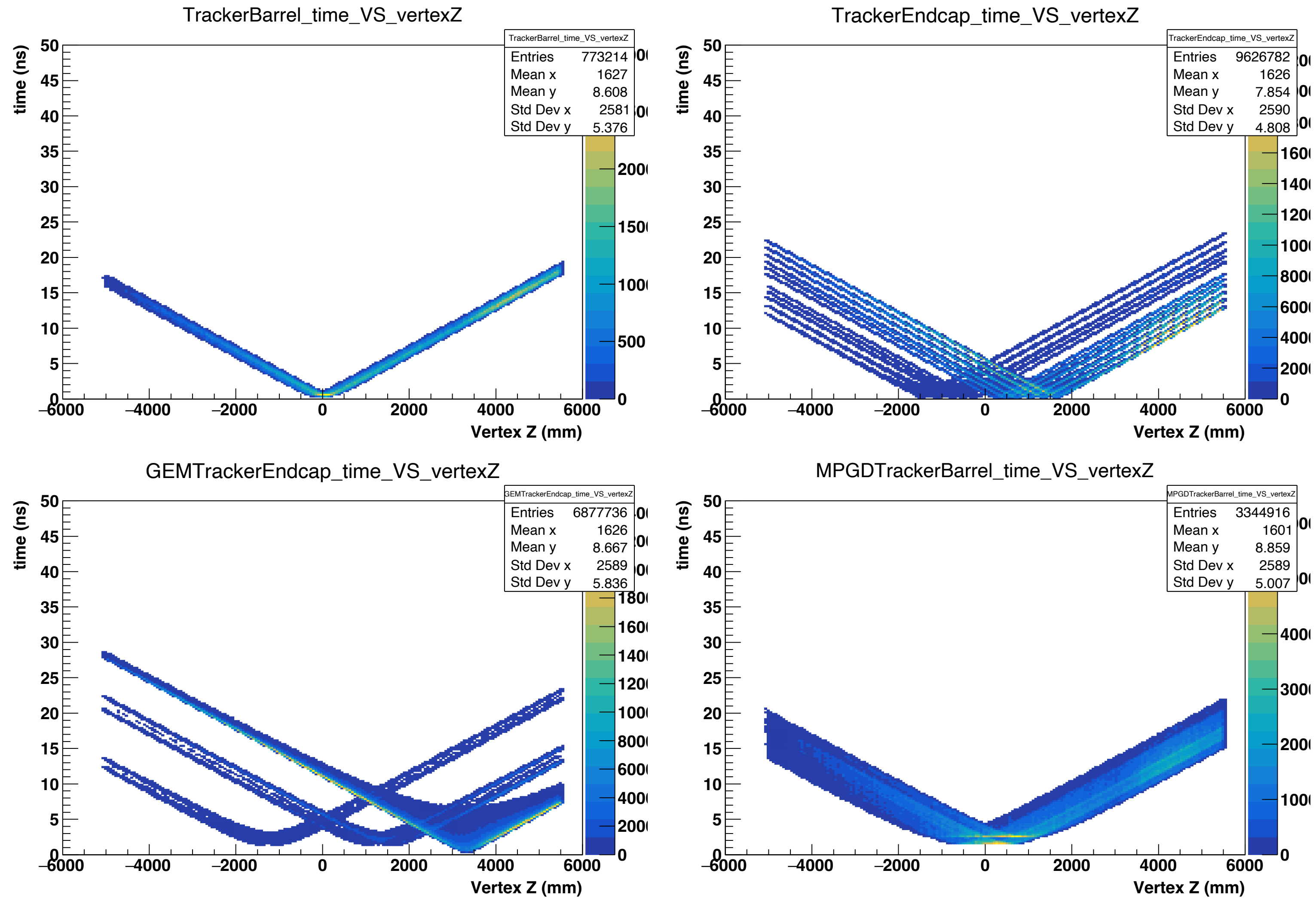
Hits Rate in Sub Detectors



Hits Time in Tracking Detectors



Hits Time VS vertex Z in Tracking Detectors



THANK YOU!

Threshold in details

EcalEndcapPHits

5 MeV

hit per homogenous block, hit energy from geant to be scaled by 0.028 and then apply 5 MeV threshold

EcalBarrelScFiHits

SciFi in Pb

2.5 MeV

hit per scifi fiber, SiPM for fibers, 300 of fibers per one SiPM, energy sum of each 300 groups of fibers is greater than the threshold

correct procedure takes segment of 2.5 cm times 2.5 cm and 300 fibers falls into a given segment

HcalBarrelHits

Steel and scintillator layers

0.1 MeV

threshold 0.1 MeV is for each single layer

count the first 5 layers

hit from dd4hep per layer

instruction by Sylvester on layer number

HcalEndcapNHits

Steel and scintillator layers

0.1 MeV

threshold 0.1 MeV is for each single layer

count the first 10 layers

hit from dd4hep per layer

instruction by Sylvester on layer number

HcalEndcapPHits

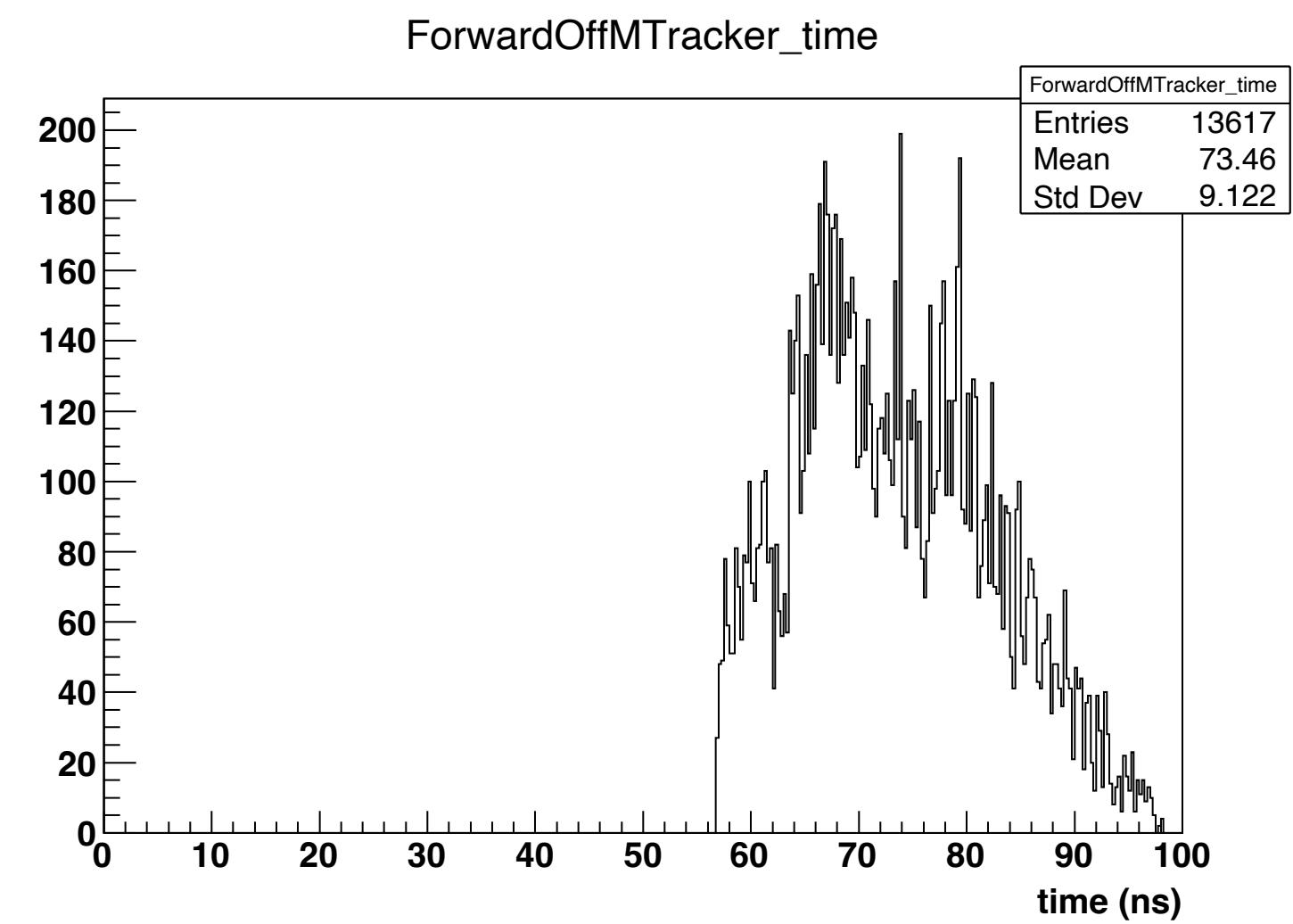
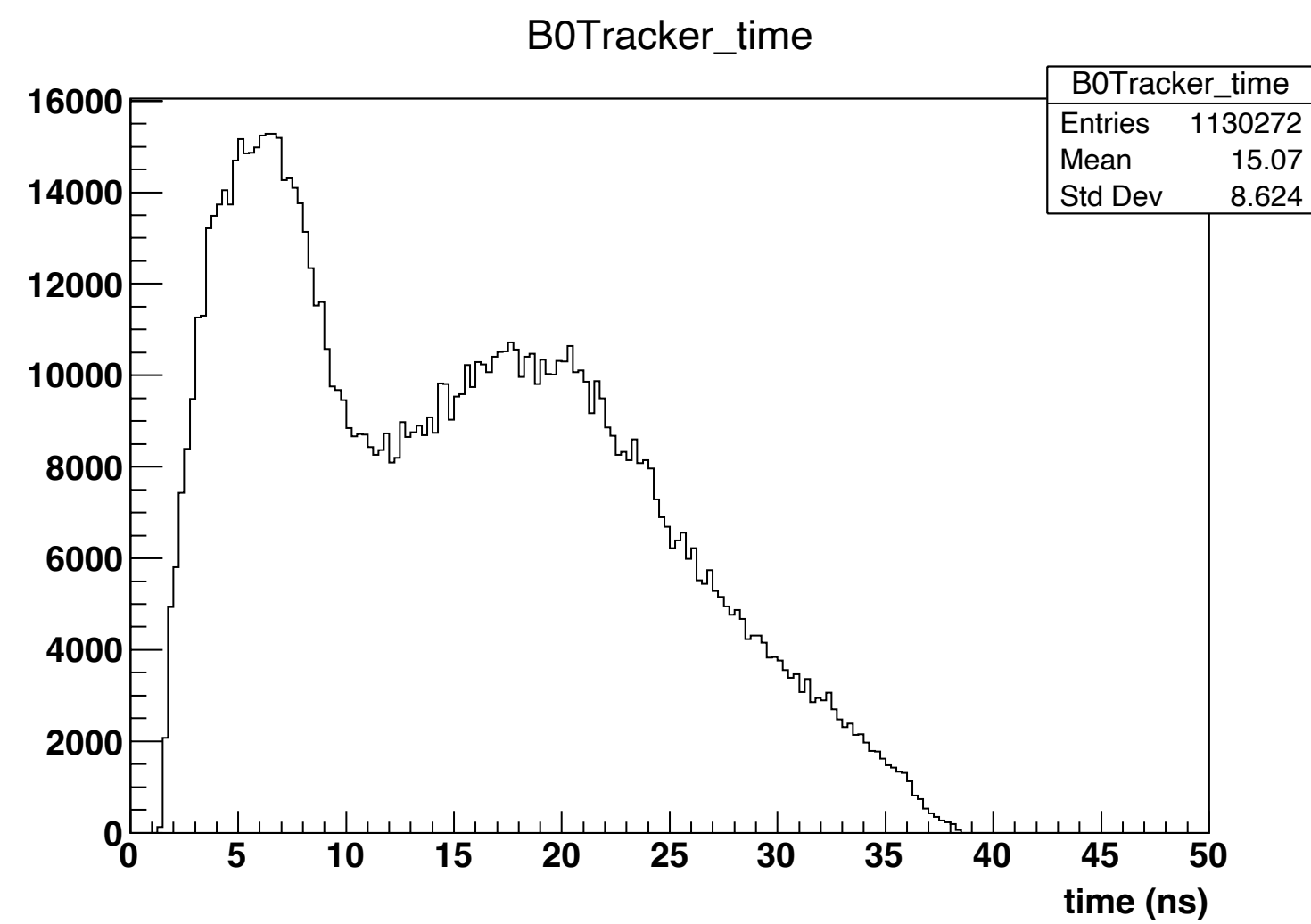
Fe/Scint

300 MeV

number of hits to be divided by the number of layers, threshold of 300 MeV applies to the sum of the layers

51 layers in total

Hits Time in Tracking Detectors



Hits Time VS vertex Z in Tracking Detectors

