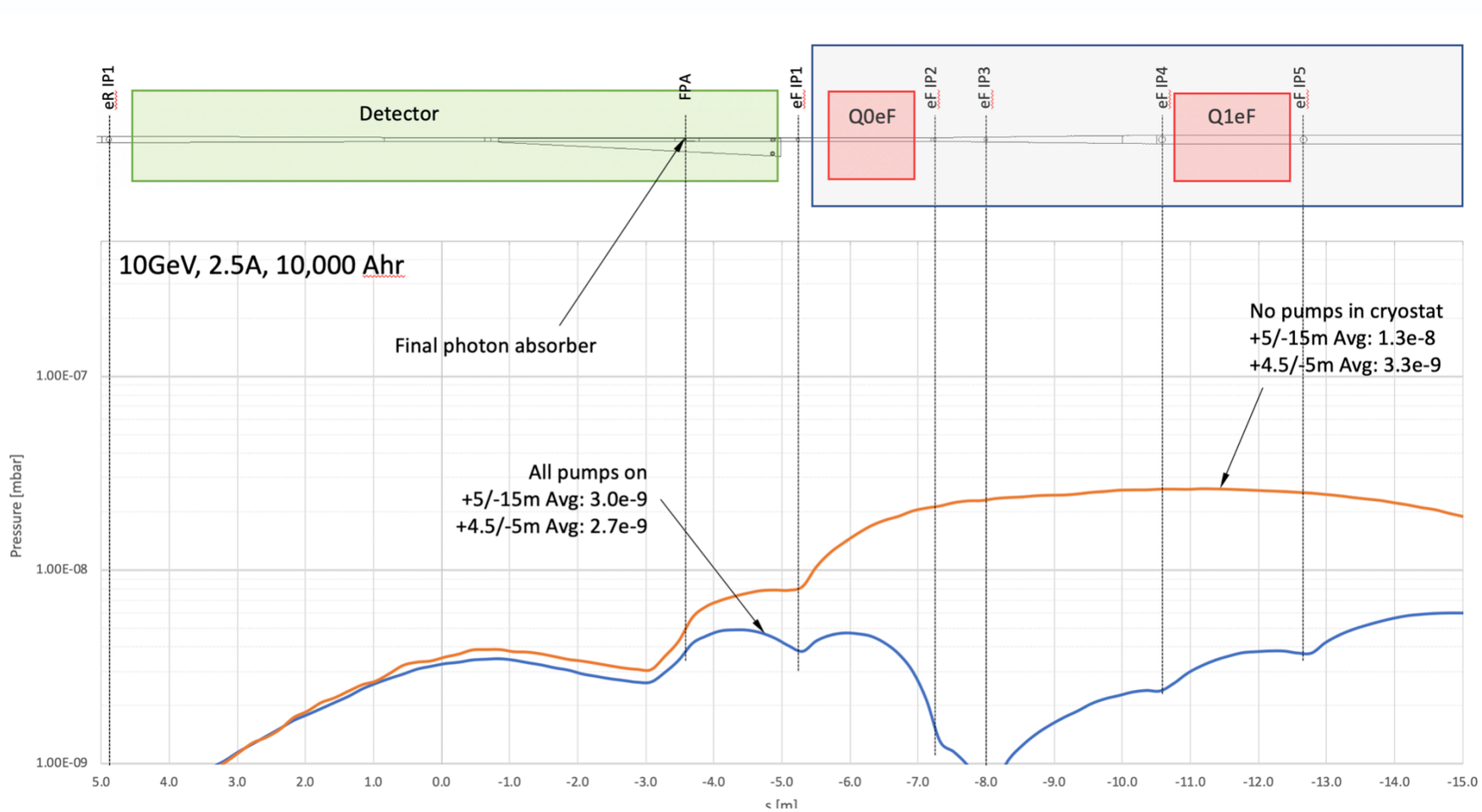
Proton beam gas background

Zhengqiao Zhang
BNL

Introduction

- We use Charles Hetzel's vacuum simulation after 10000Ahr (All pumps on);
- 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;



Beam parameters and collision rate

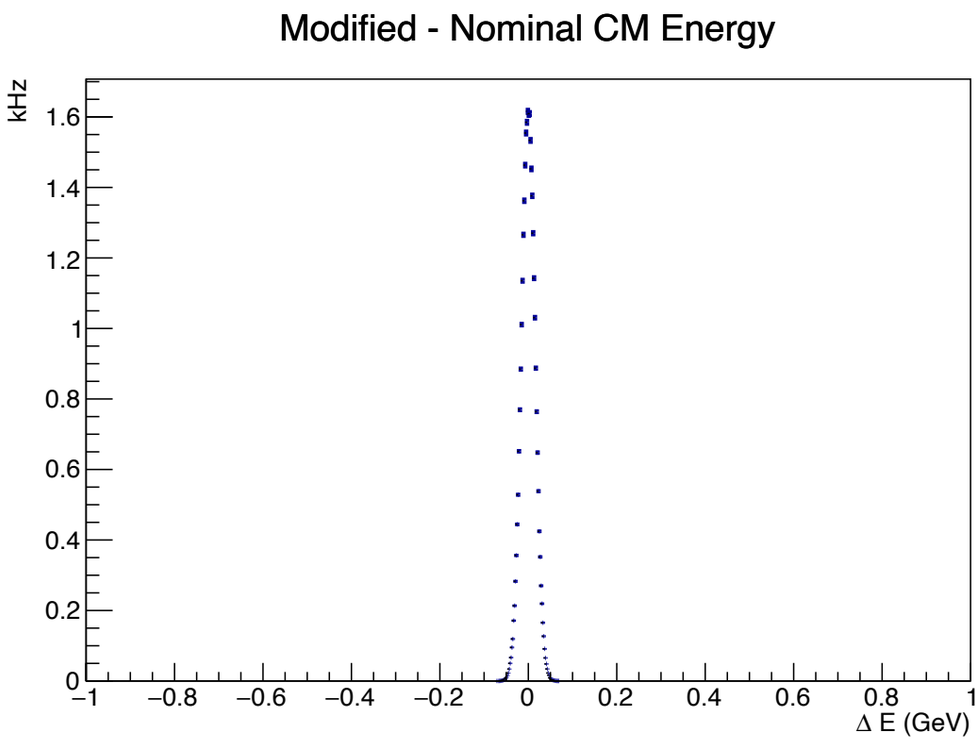
Species Energy (GeV)	Proton 275	Proton 100	Proton 41
RMS Emittance h/v (nm)	18/1.6	20/2.7	44/10
β* h/v (cm)	80/7.1	63/5.7	90/7.1
RMS Δθ h/v (μrad)	150/150	220/220	220/380
RMS Bunch length (cm)	6	7	7.5
RMS Δ/p (10^{-4})	6.8	9.7	10.3

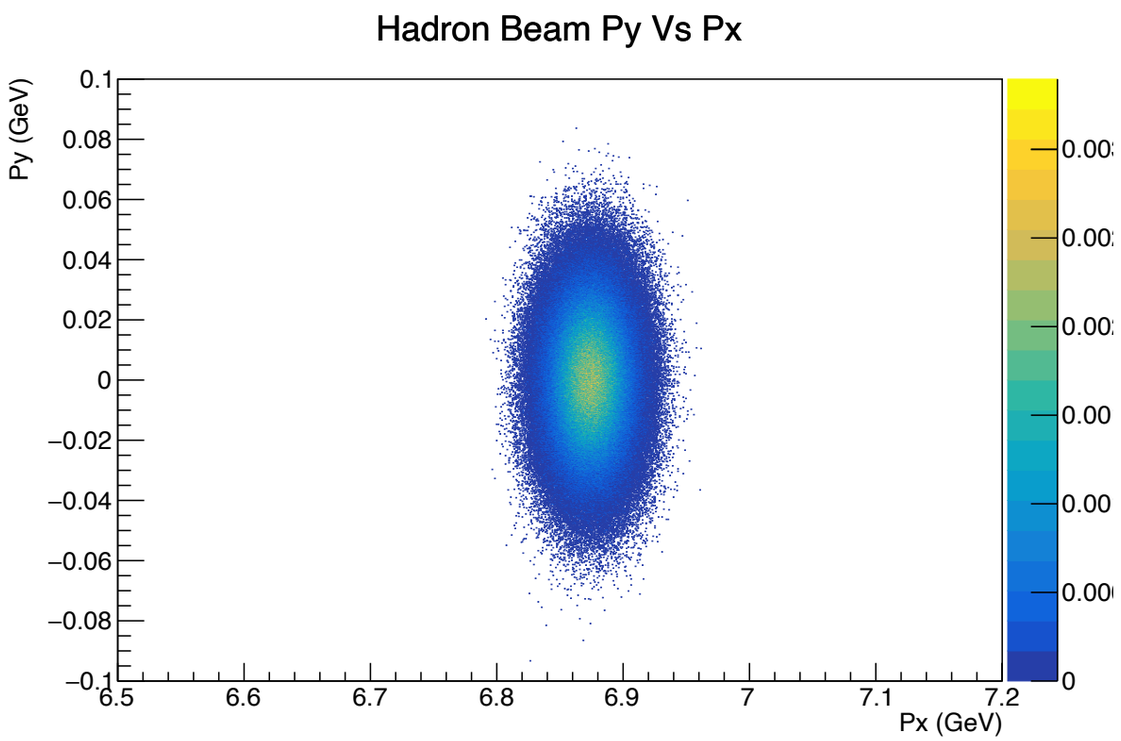
PM = dRT;
R =0.0821 atm/mol;
P = 2.560254e-09 mbar = 2.560254e-09*0.000986923atm = 2.5267736e-12atm
T = 293k;
M = 1.00794g/mol (molar mass)
Density = 1.0587422e-13g/L = 6.326e7 molecules/cm3

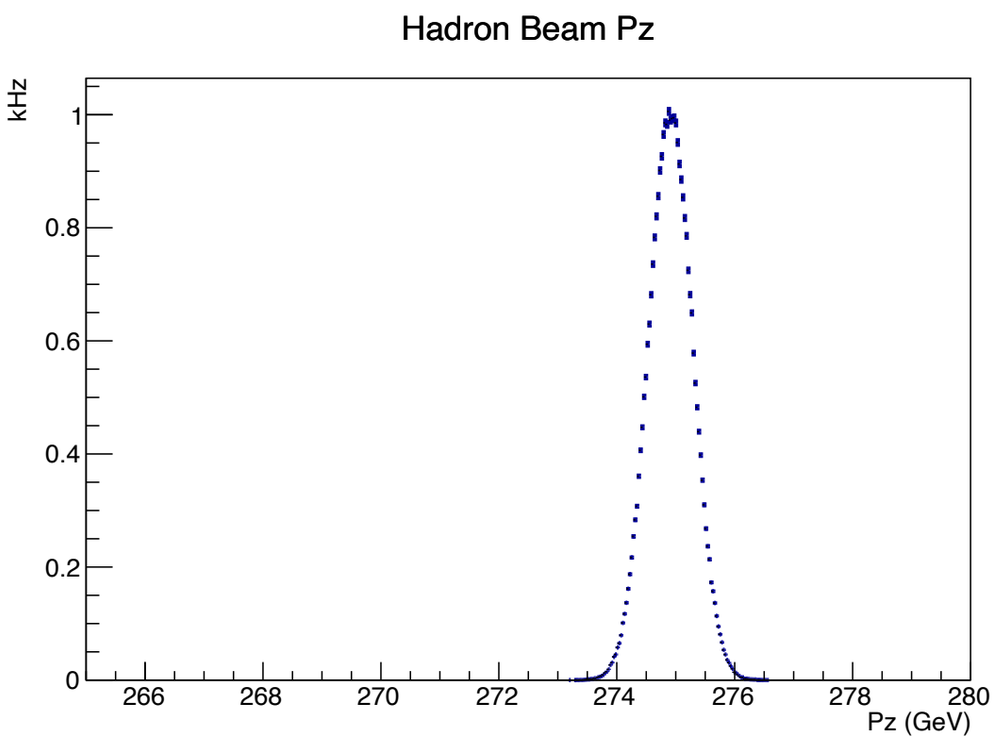
Background collision rate = $L_{bg}*\sigma_{pH}^2$;
Luminosity of background = (beam current) * (average gas density) * (length);
Current = (1.0C/s)*(protons/1.6e-19C) = 6.3e18 protons/s;
Length = 10m;
σ_{pH2} = 39.27mb *2 (Pythia8);

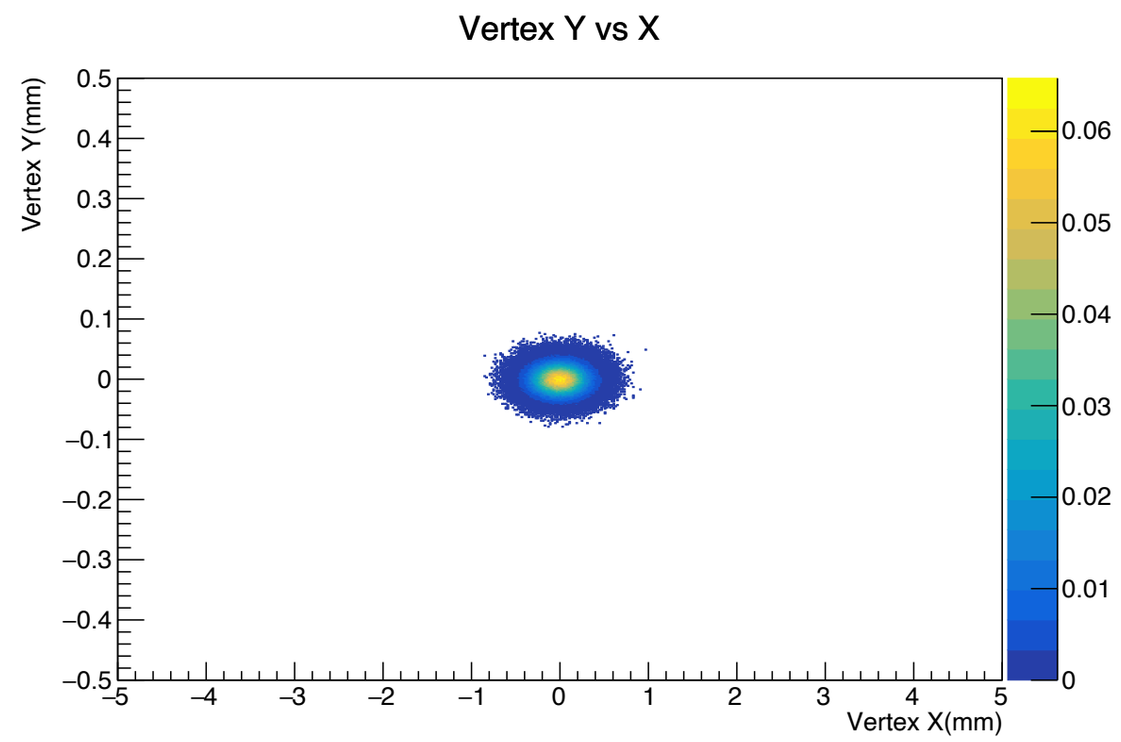
Background collision rate =
6.33e18(s-1)*6.326e7(cm-3)*1000(cm)*39.27*(1.0e-27cm2) *2 = **31.45kHz**; //275GeV
30.74kHz; // 100GeV
30.96kHz; // 41GeV

Events QA plots



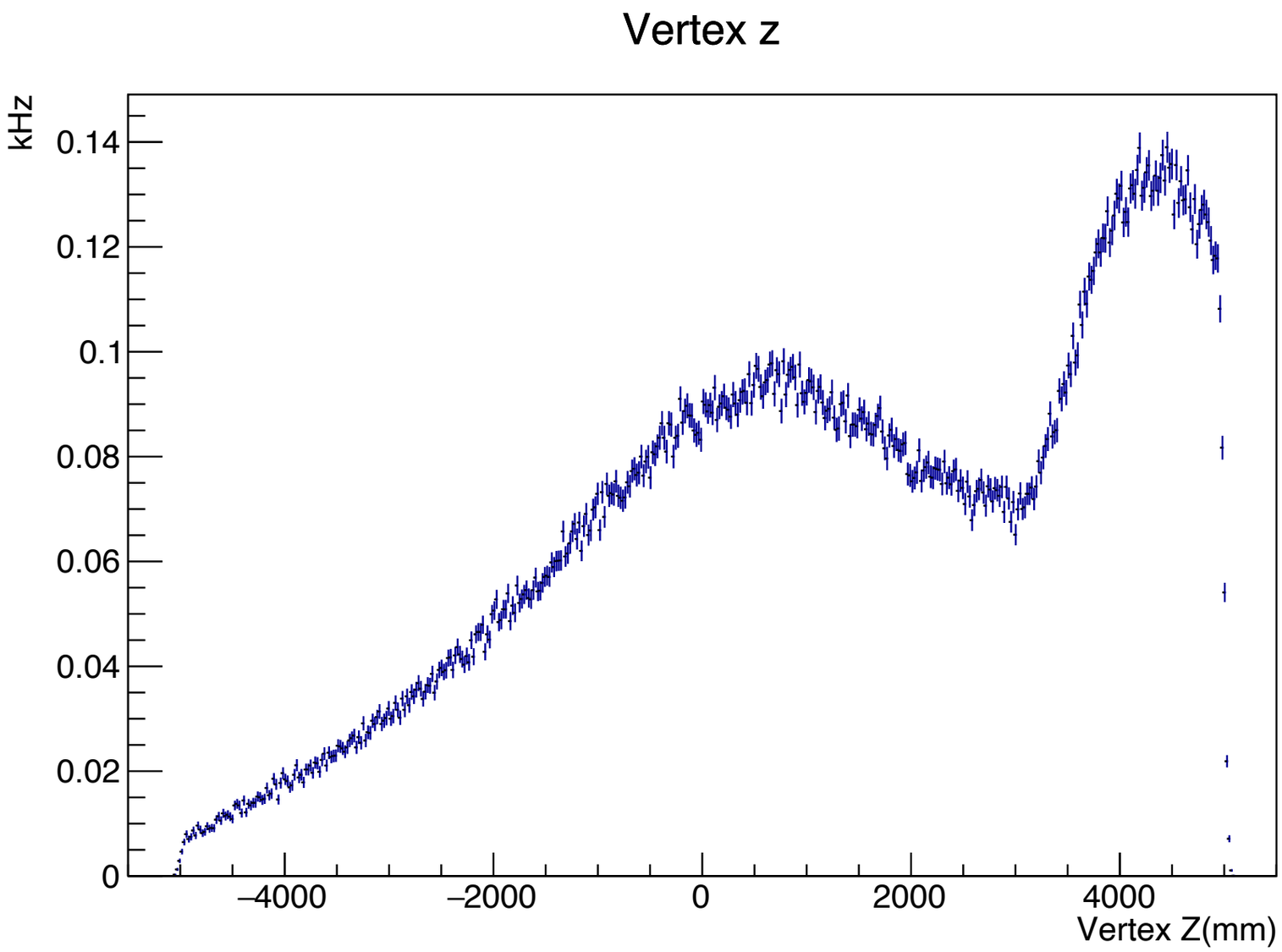






- Total collision rate = 31.45kHz in -5m < s <5m;

Events QA plots



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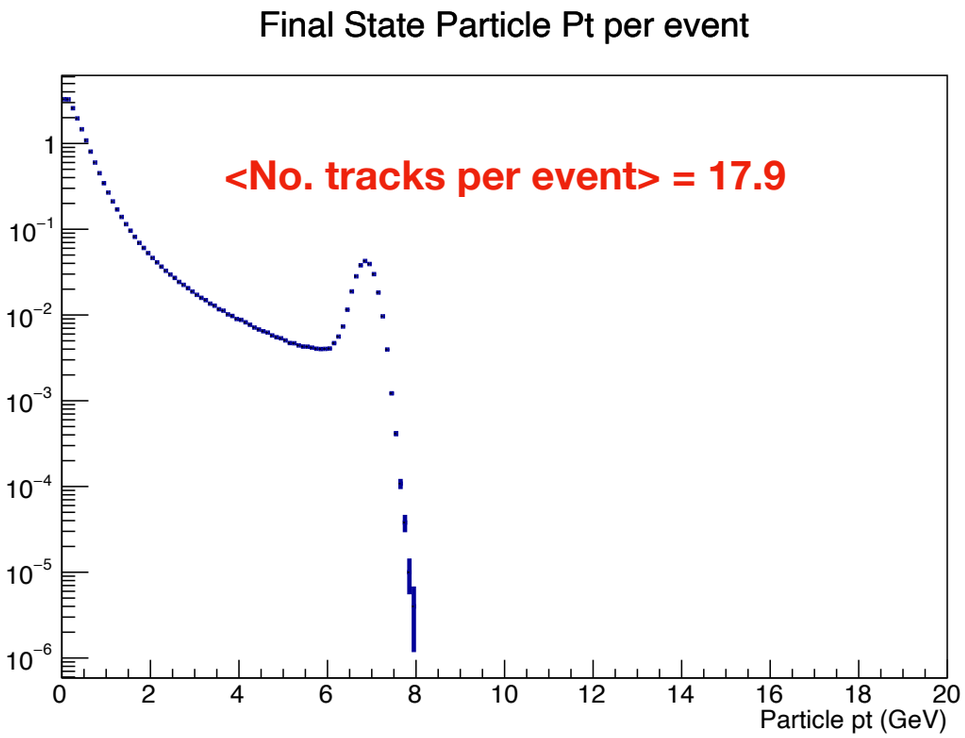
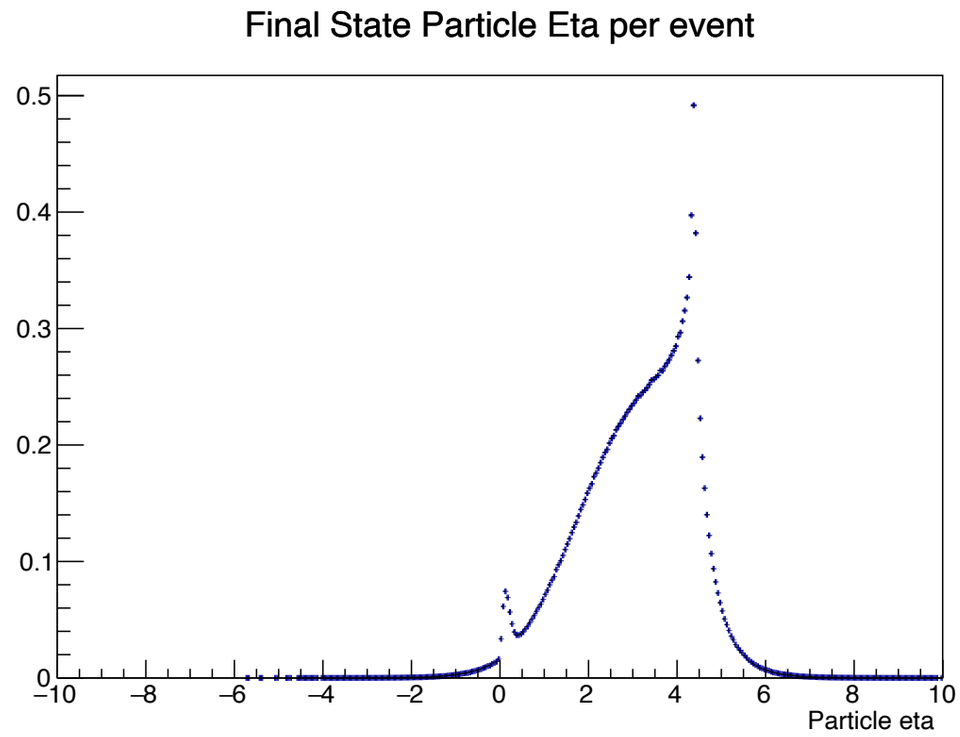
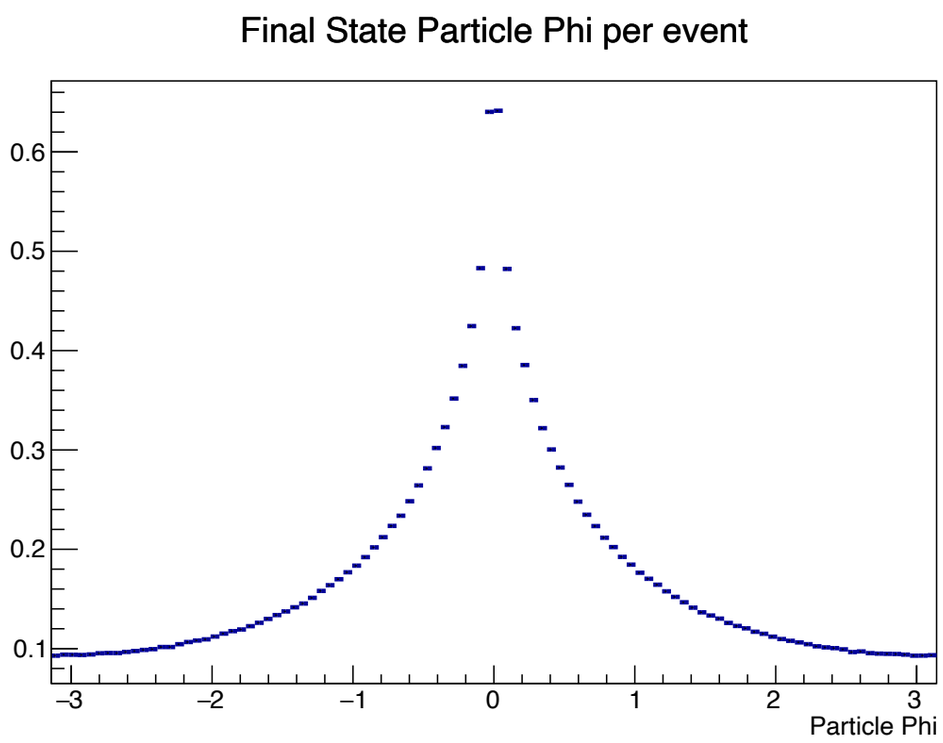
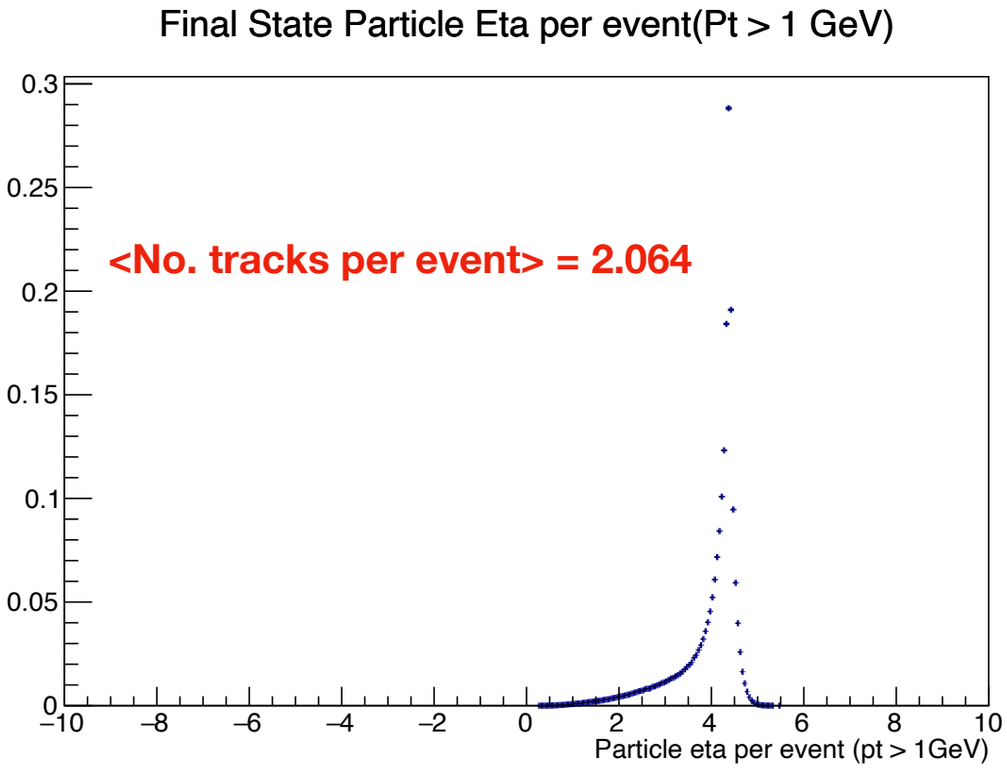
QA plots per event

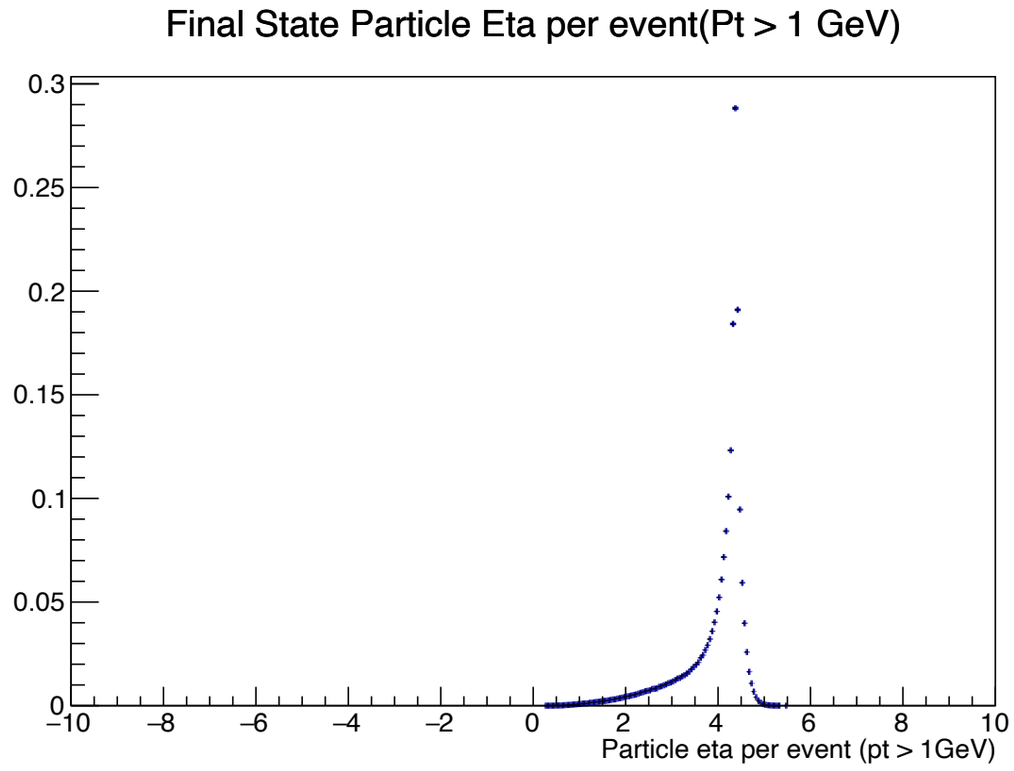




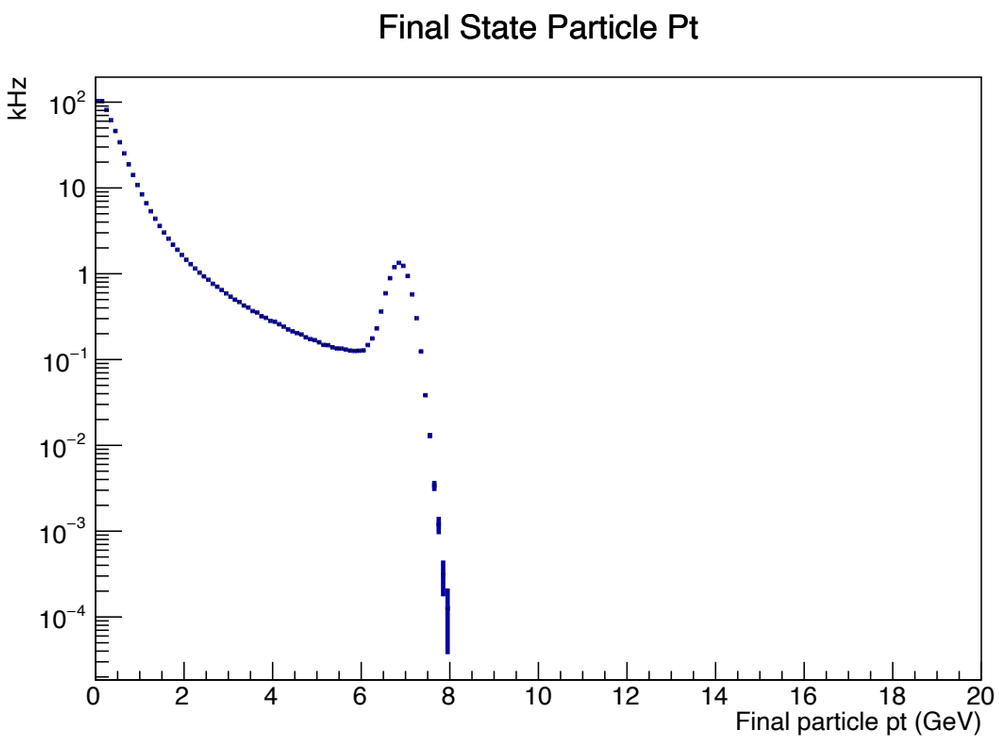


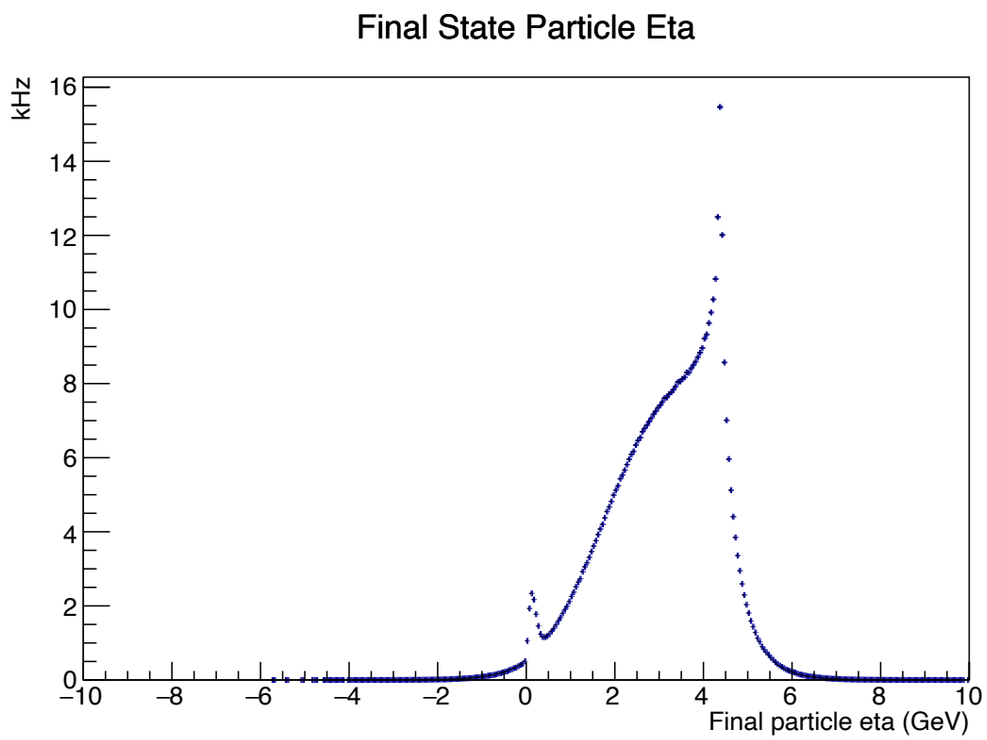
QA plots per event (pt > 1GeV)

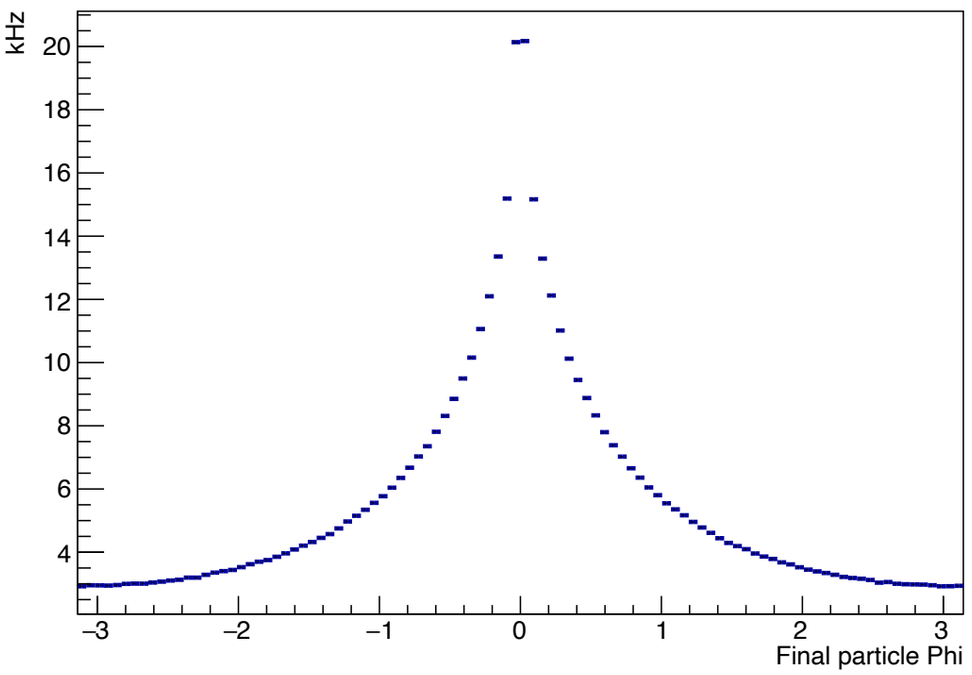


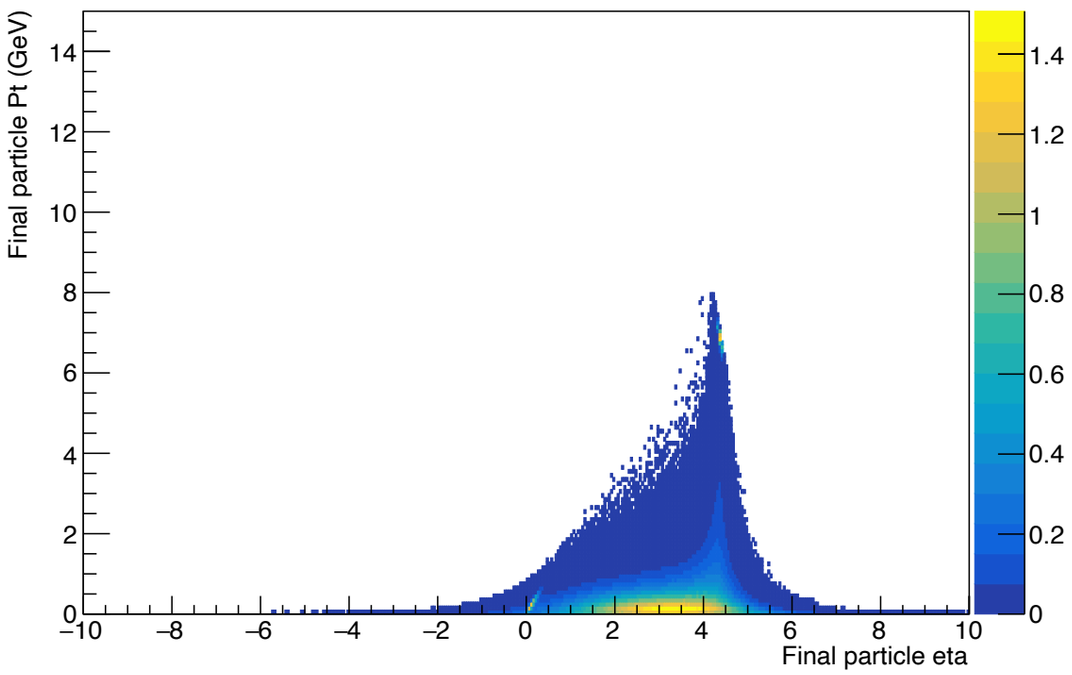


Events QA plots



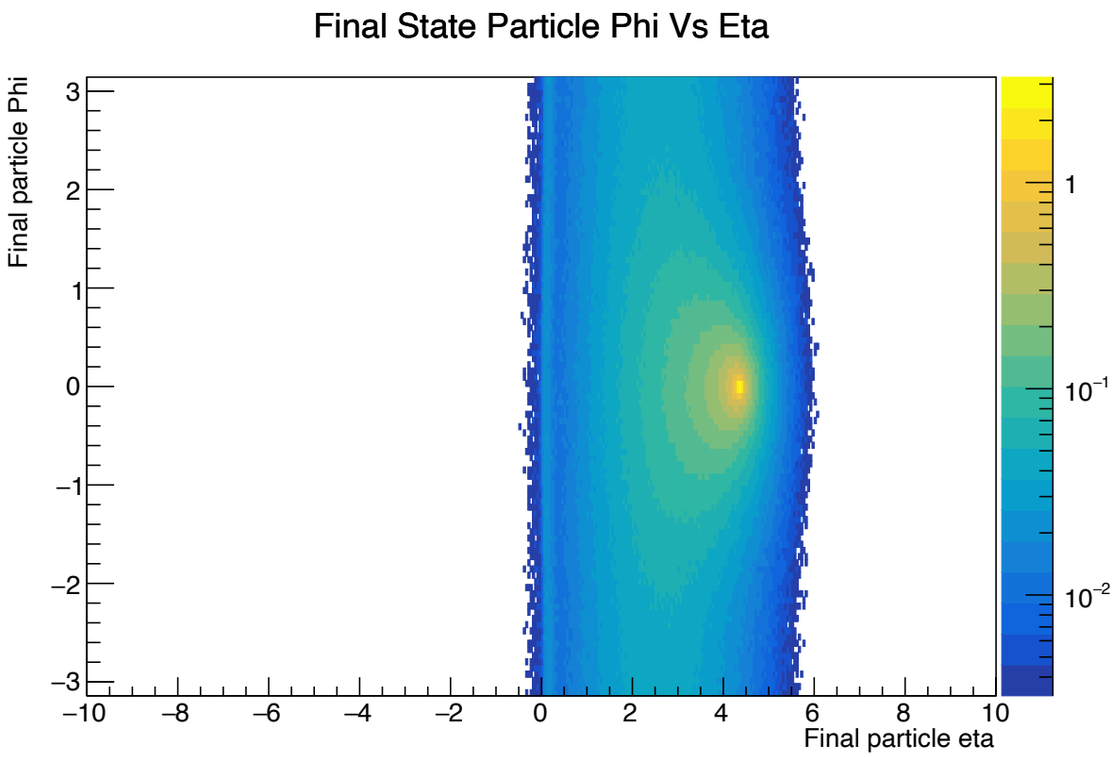


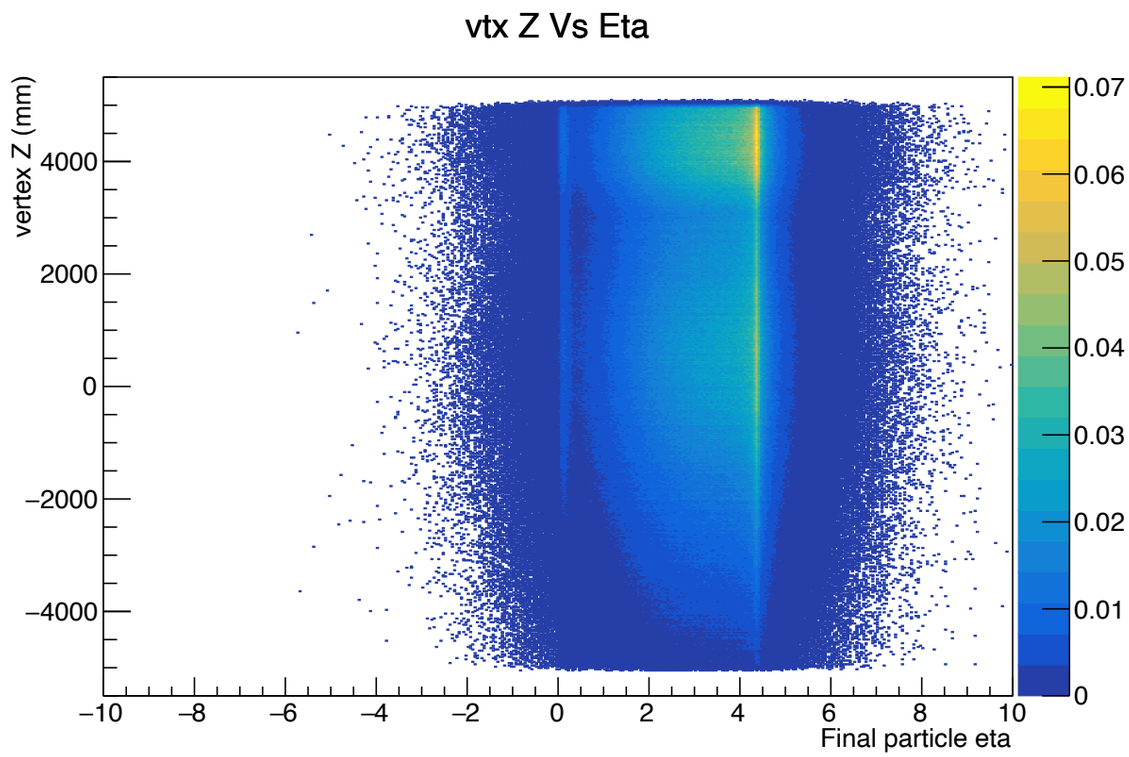




- Total produced tracks rate = 562.9 kHz in -5m < s <5m;

Events QA plots





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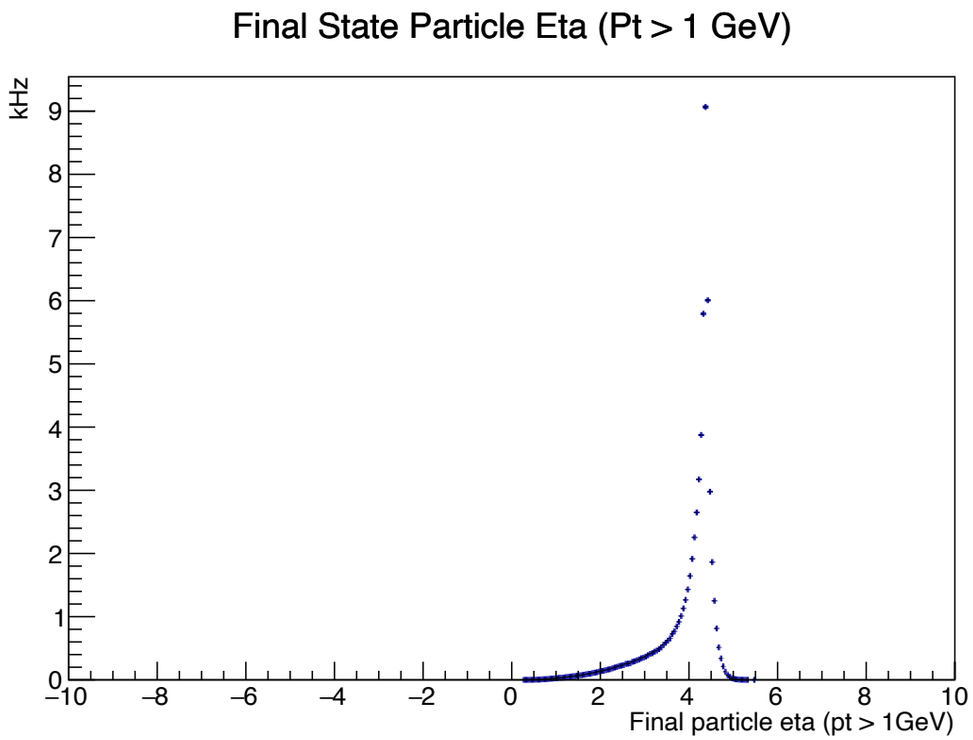
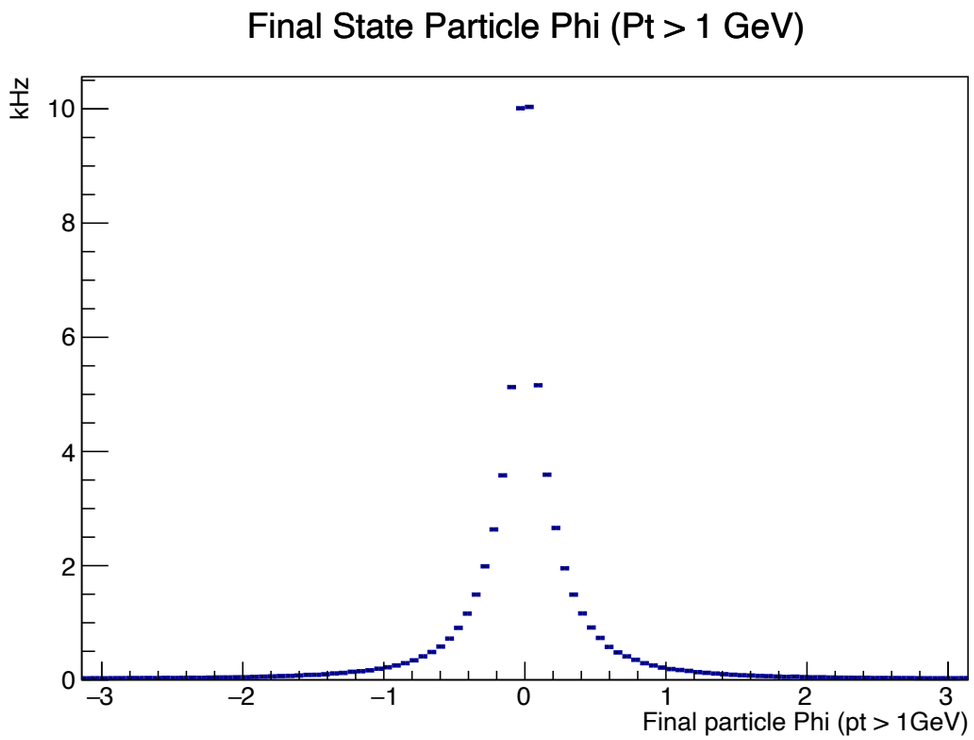
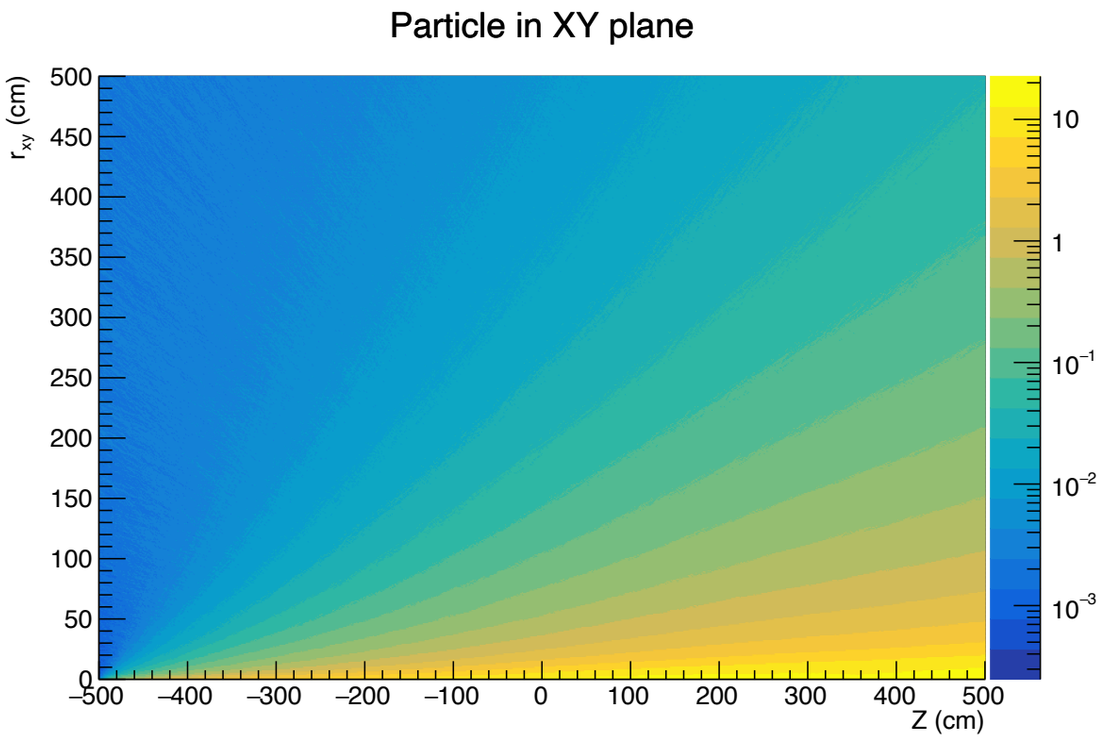
Events QA plots

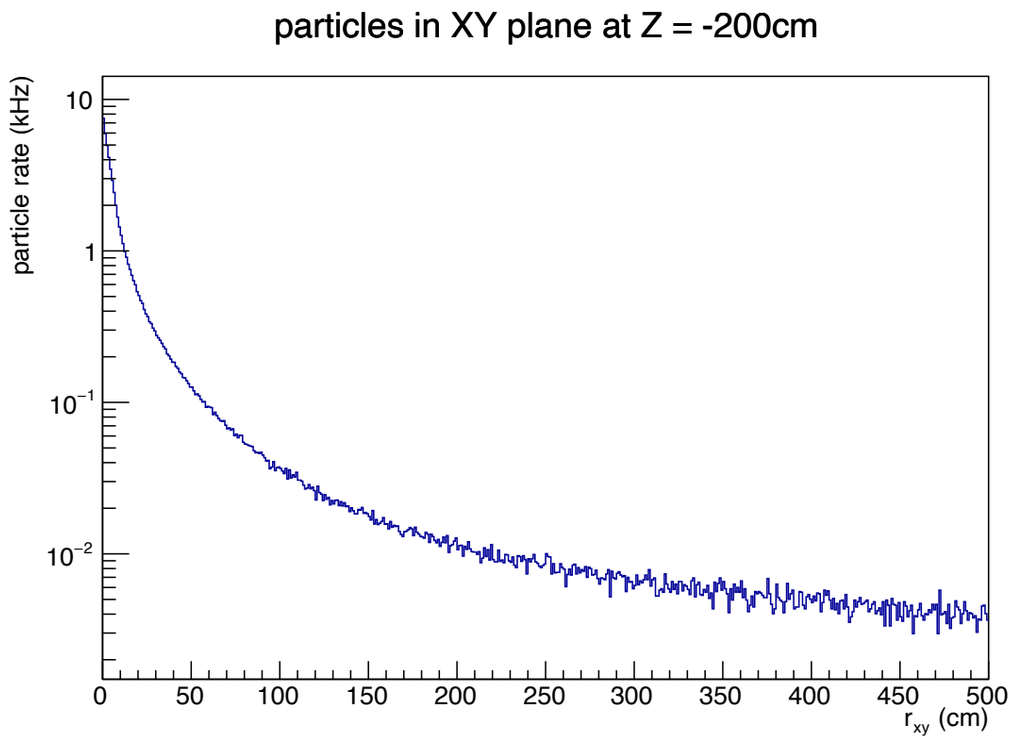


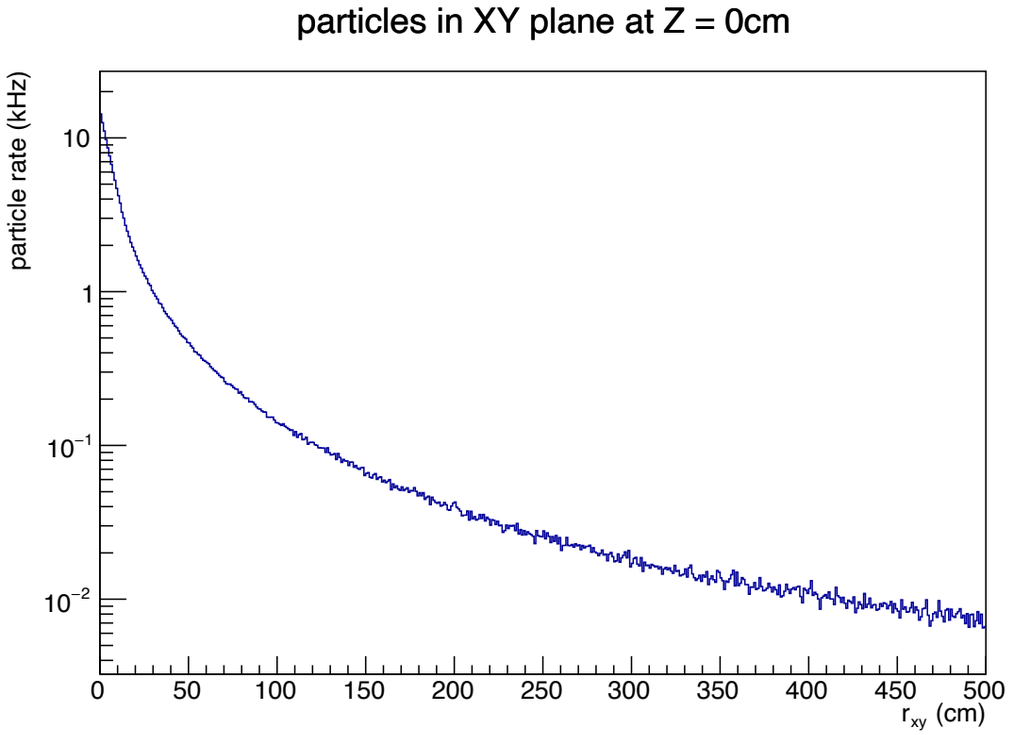


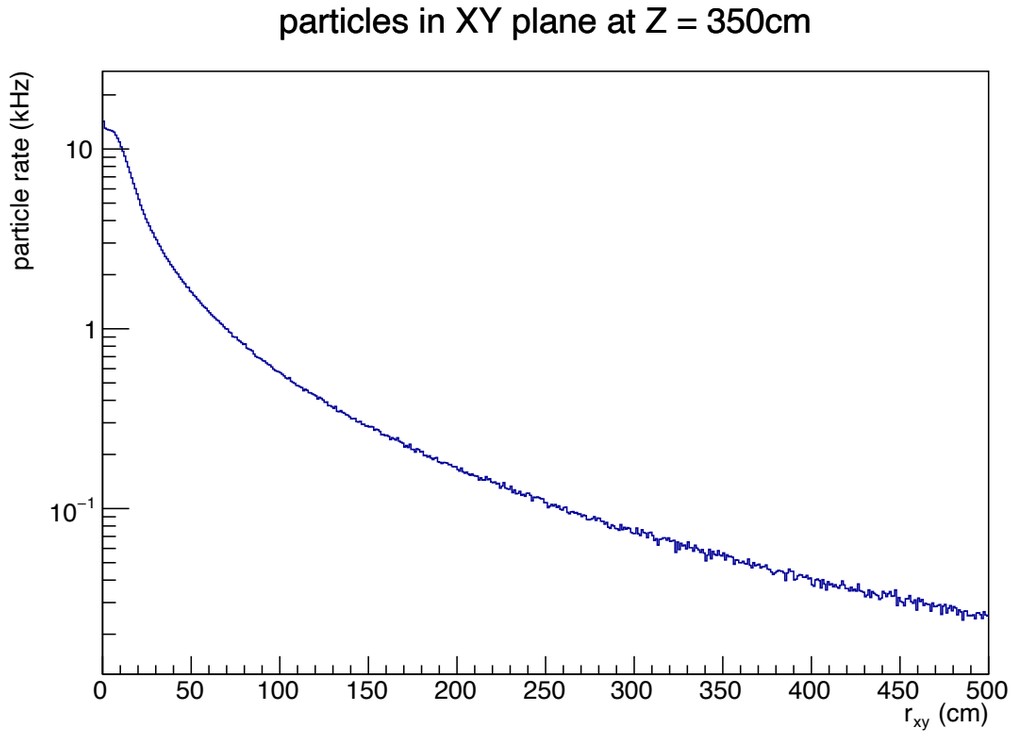
- Total produced high pt tracks rate = 64.9 kHz in -5m < s <5m;

Particle projection onto XY plane

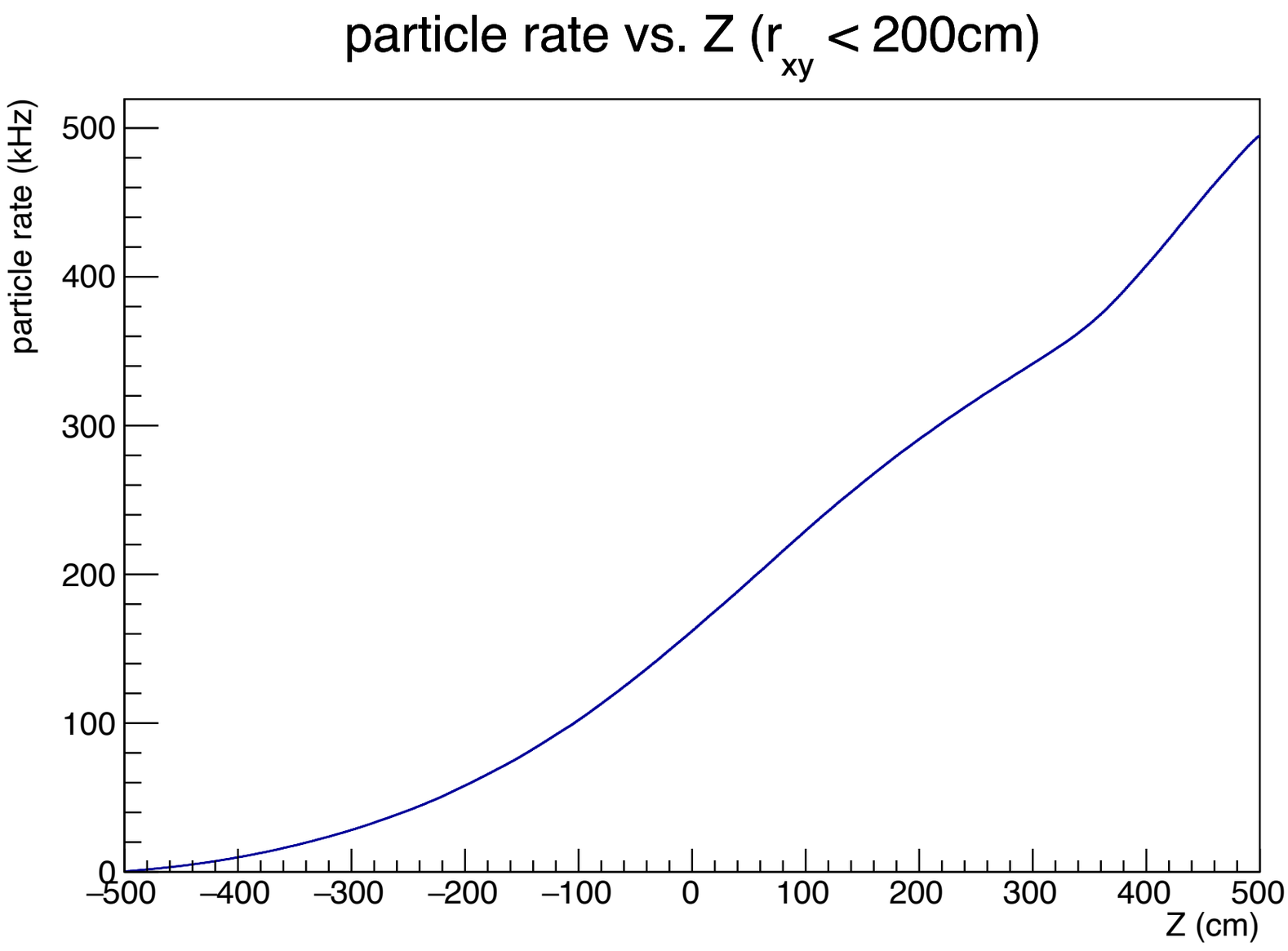








Particle rate vs. Z



Summary

- The background collision rate for different proton beam energy is estimated based on Pythia8 model;
- All proton beam effects (cross angle, crab cavity, beam energy spread, angular beam divergence, bunch length) are added in our simulation;
- Beam gas events are stored in HepMC3

  ➡ /gpfs/mnt/gpfs02/eic/zhangzq/pythia8/beameffect/BeamGas/BeamGasEvents