

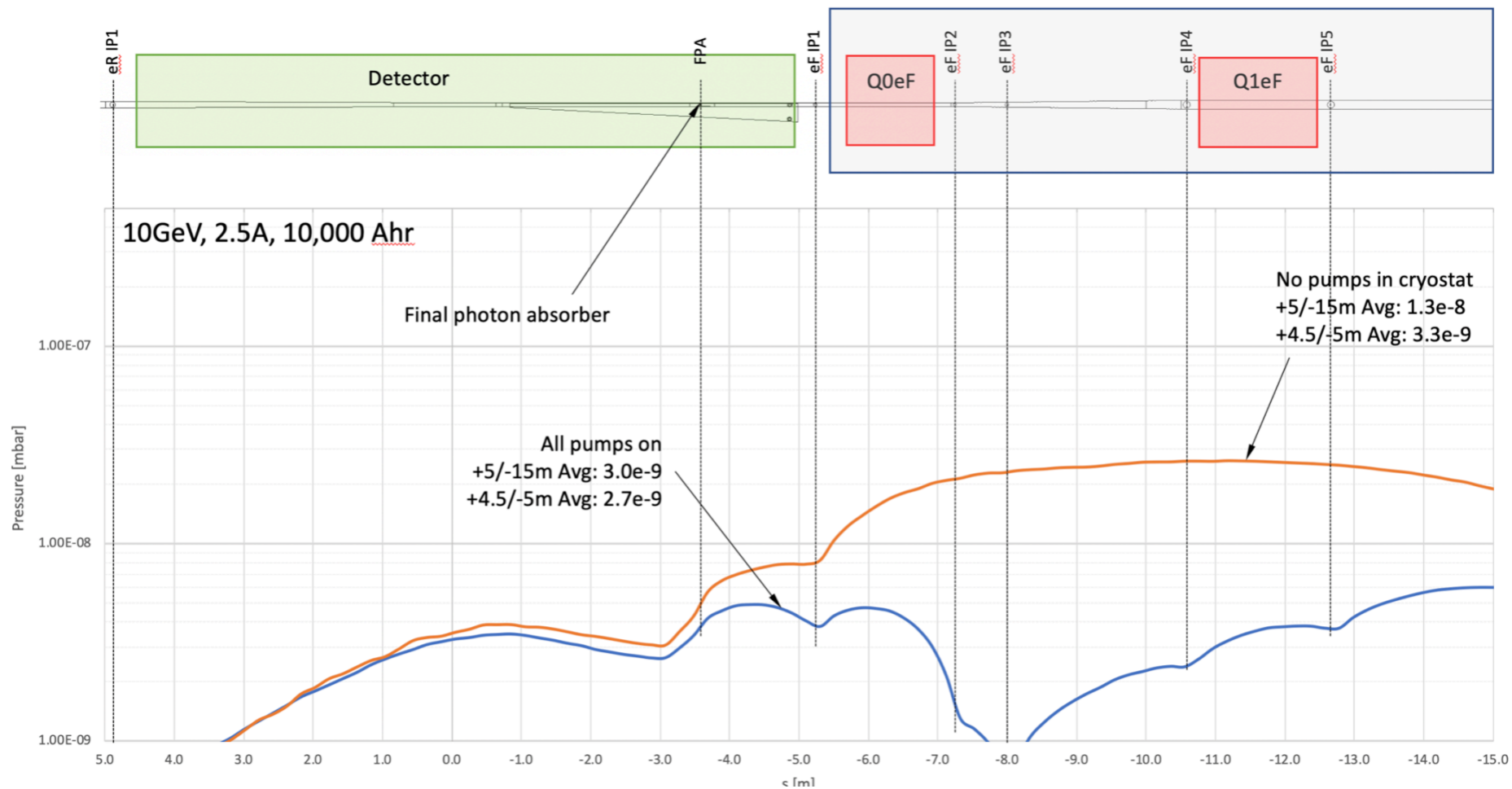
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# Proton beam gas background

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**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
$\beta^*$ h/v (cm)	80/7.1	63/5.7	90/7.1
RMS $\Delta\theta$ h/v ( $\mu$ rad)	150/150	220/220	220/380
RMS Bunch length (cm)	6	7	7.5
RMS $\Delta/p$ ( $10^{-4}$ )	6.8	9.7	10.3

**PM = dRT;**

R = 0.0821 atm/mol;

P = 2.560254e-09 mbar = 2.560254e-09 \* 0.000986923 atm = 2.5267736e-12 atm

T = 293k;

M = 1.00794g/mol (molar mass)

**Density** = 1.0587422e-13g/L = 6.326e7 molecules/cm<sup>3</sup>

**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;

$\sigma_{pH^2}$  = 39.27mb \* 2 (Pythia8);

**Background collision rate** =

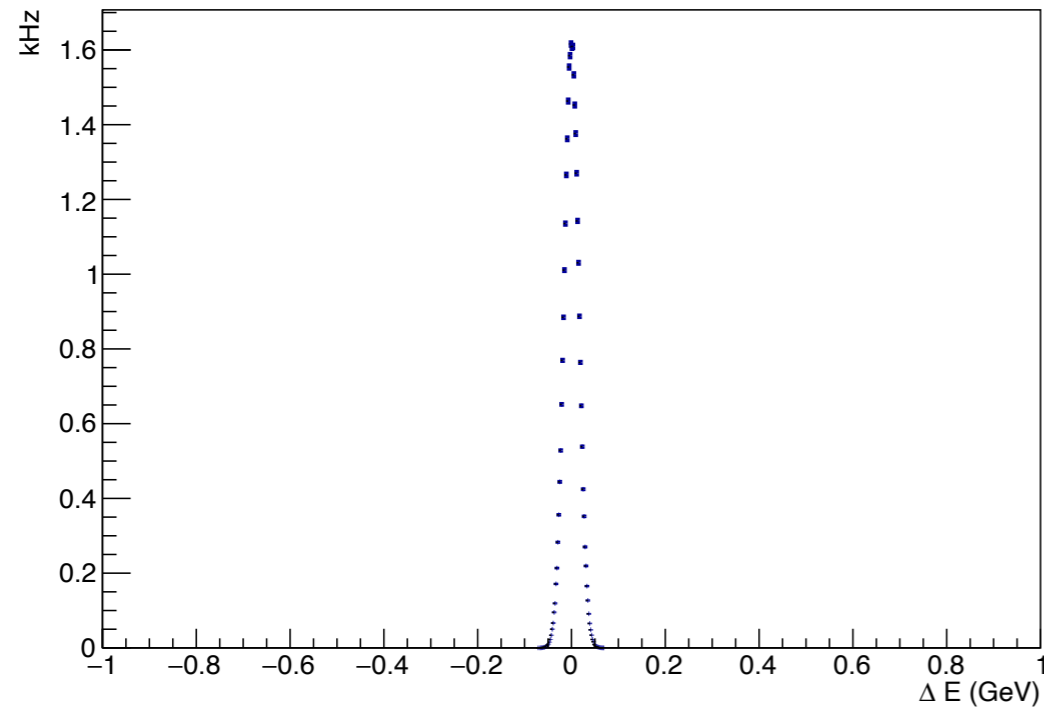
6.33e18(s-1) \* 6.326e7(cm-3) \* 1000(cm) \* 39.27 \* (1.0e-27cm<sup>2</sup>) \* 2 = **31.45kHz**; //275GeV

30.74kHz; // 100GeV

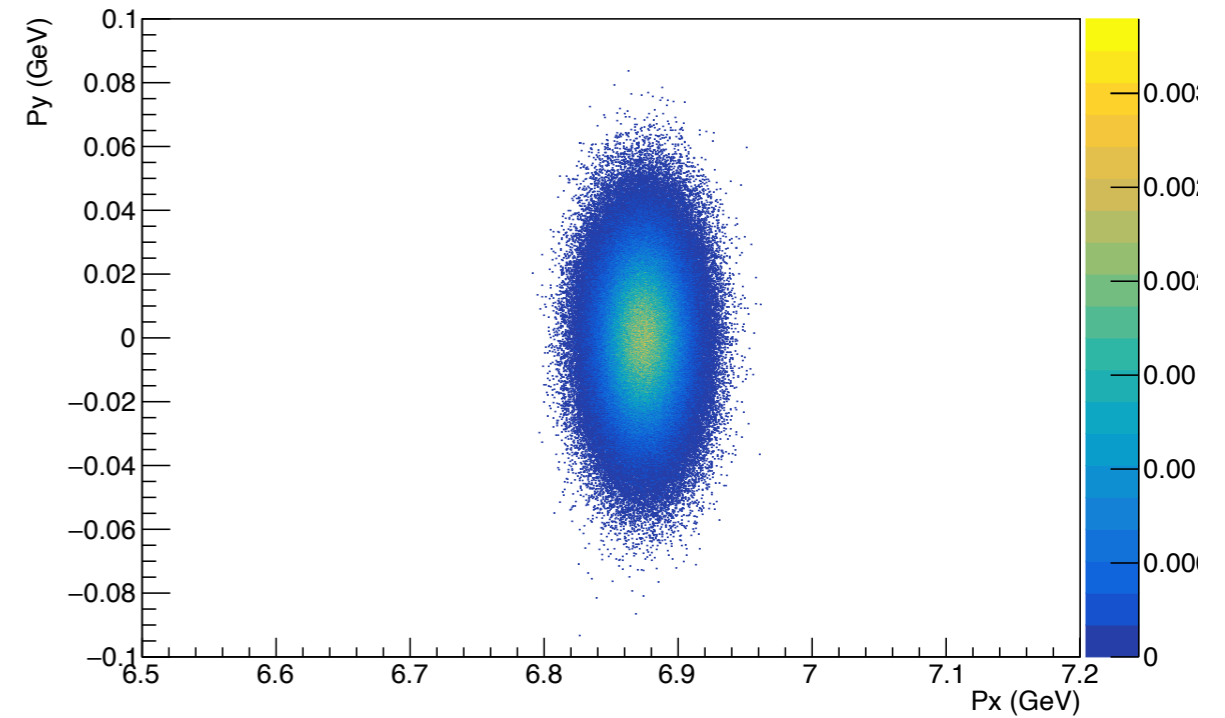
30.96kHz; // 41GeV

# Events QA plots

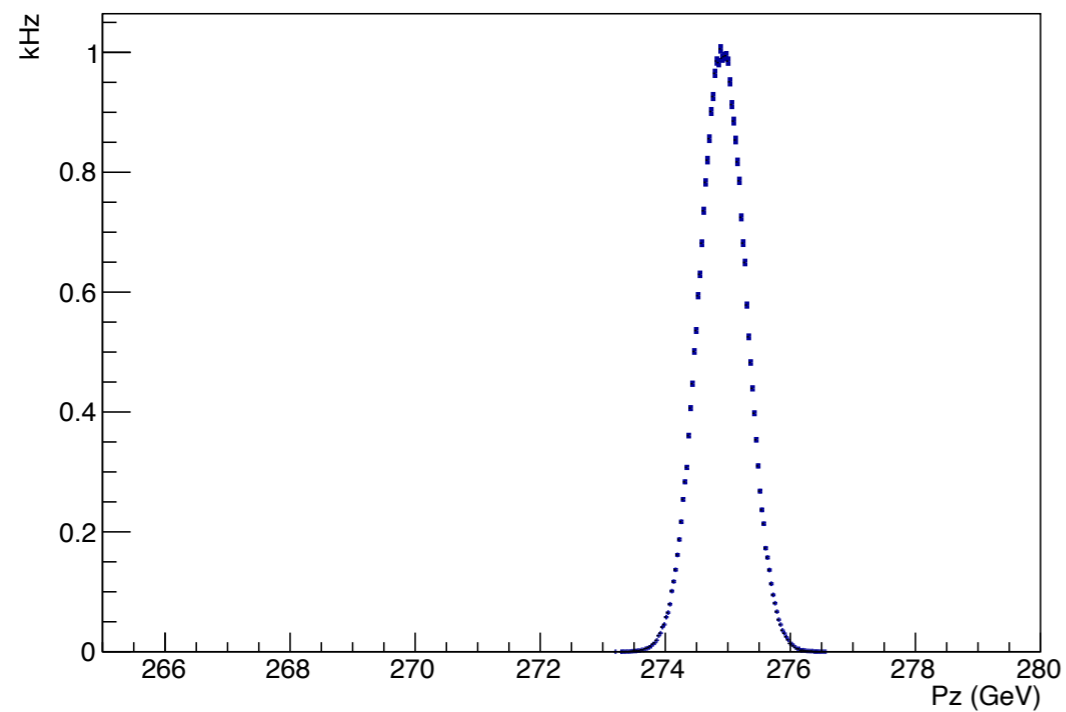
Modified - Nominal CM Energy



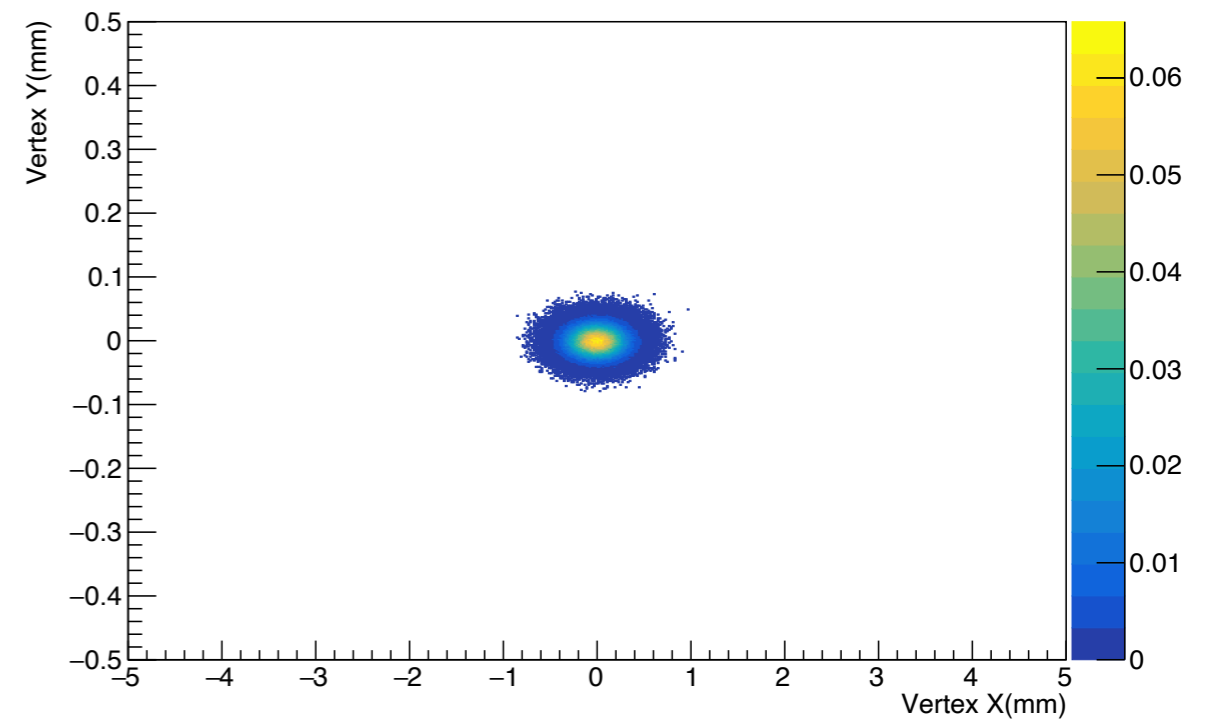
Hadron Beam Py Vs Px



Hadron Beam Pz

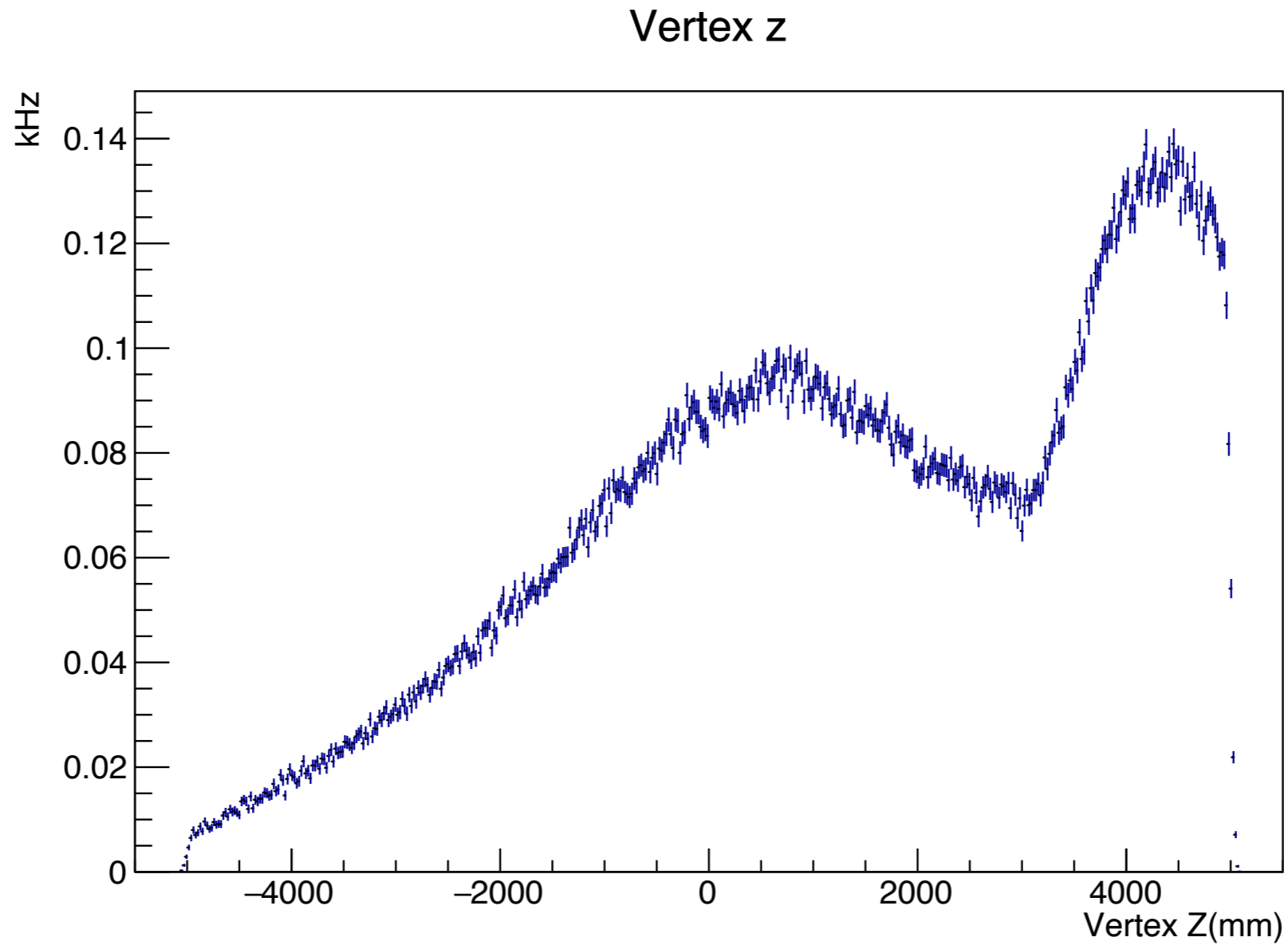


Vertex Y vs X



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

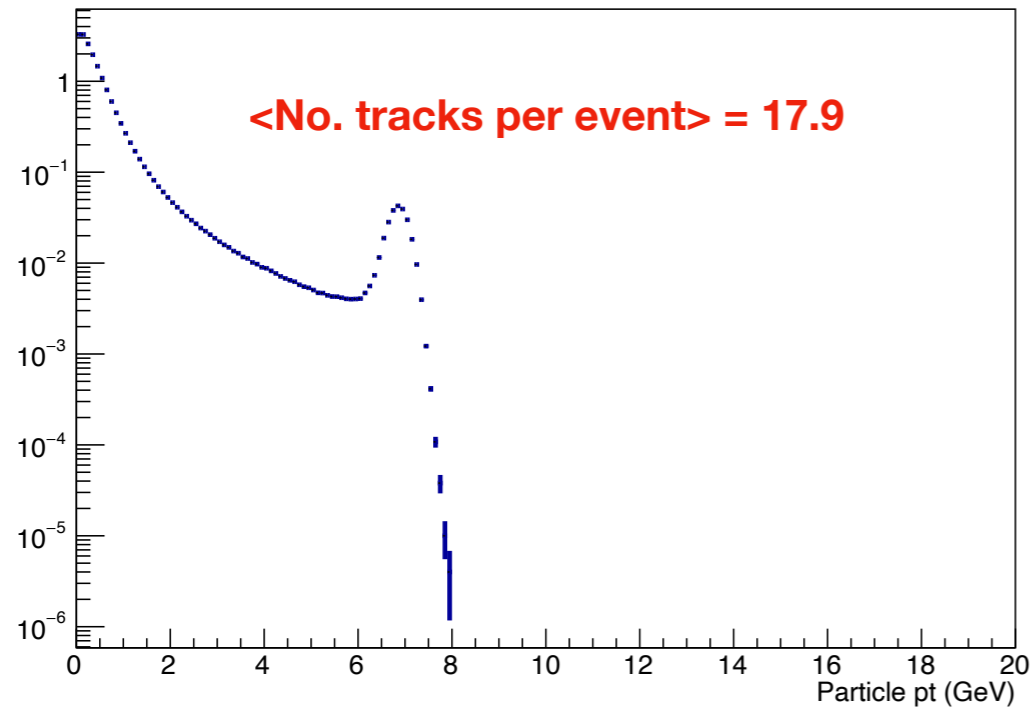
# Events QA plots



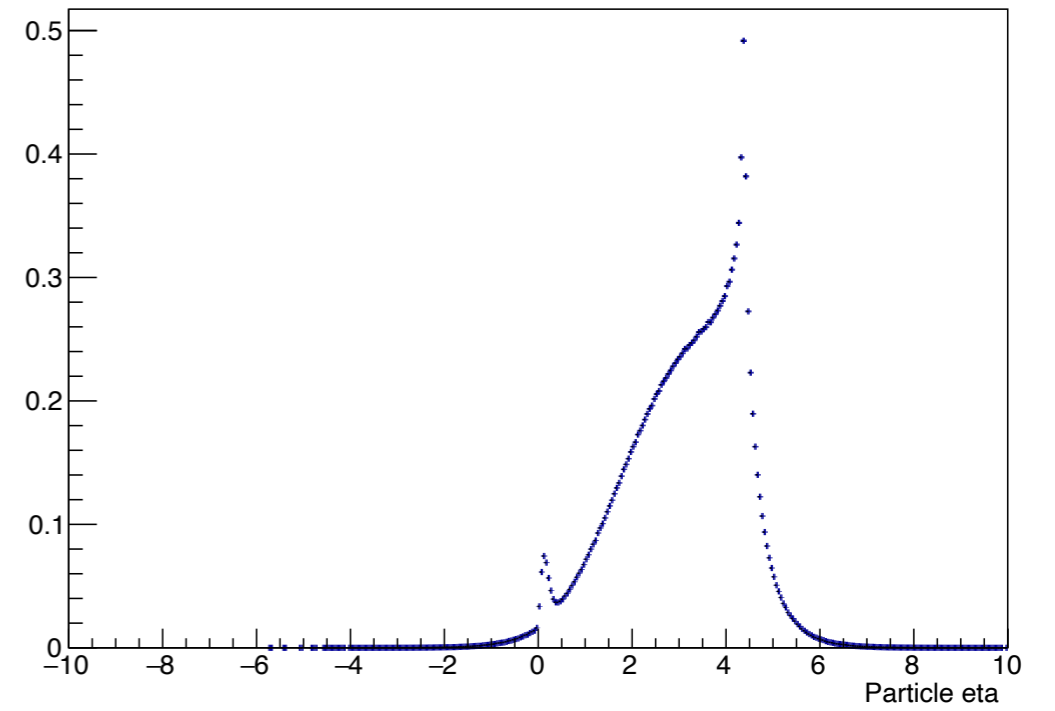
- Total collision rate = 31.45kHz in  $-5\text{m} < s < 5\text{m}$ ;

# QA plots per event

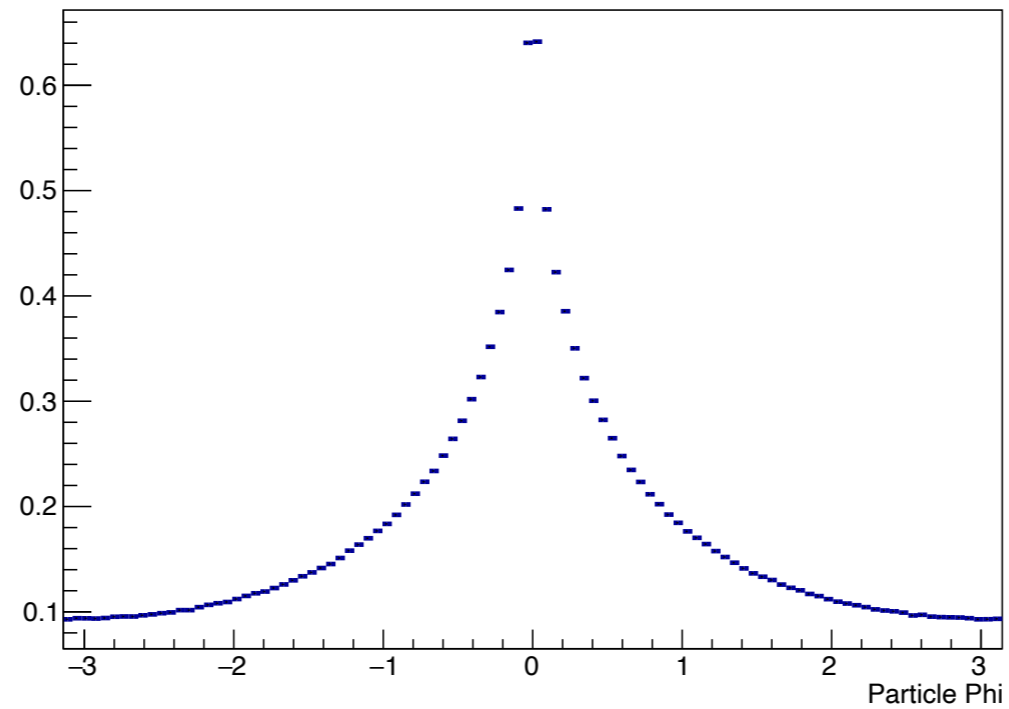
Final State Particle Pt per event



Final State Particle Eta per event

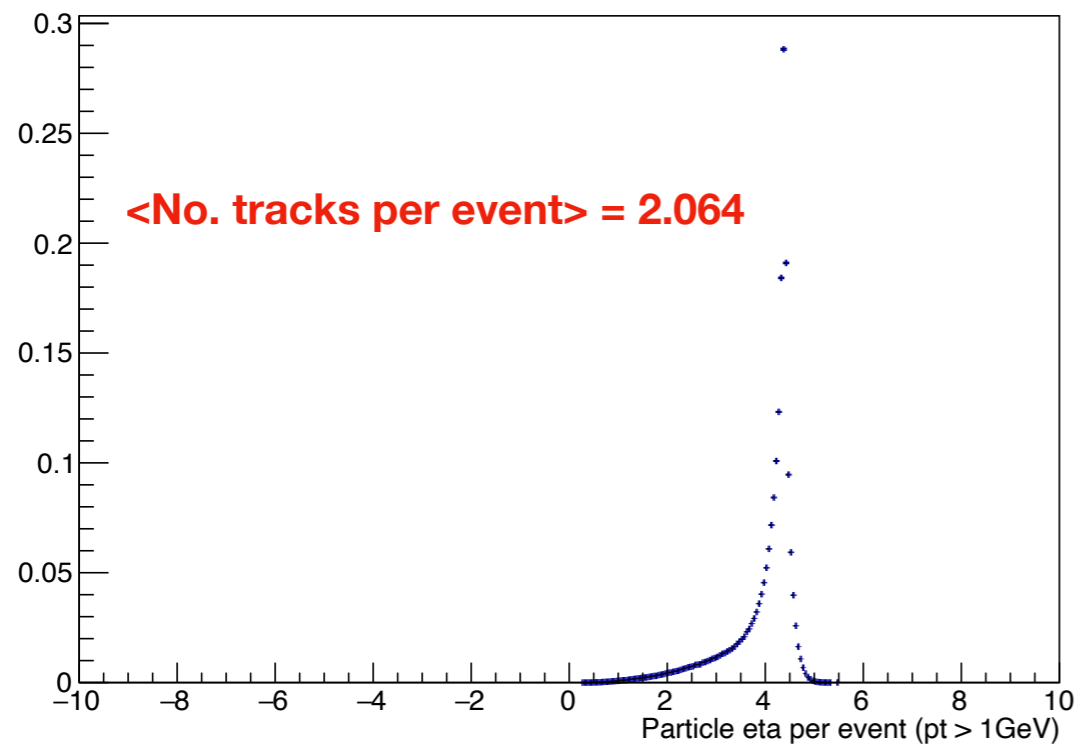


Final State Particle Phi per event

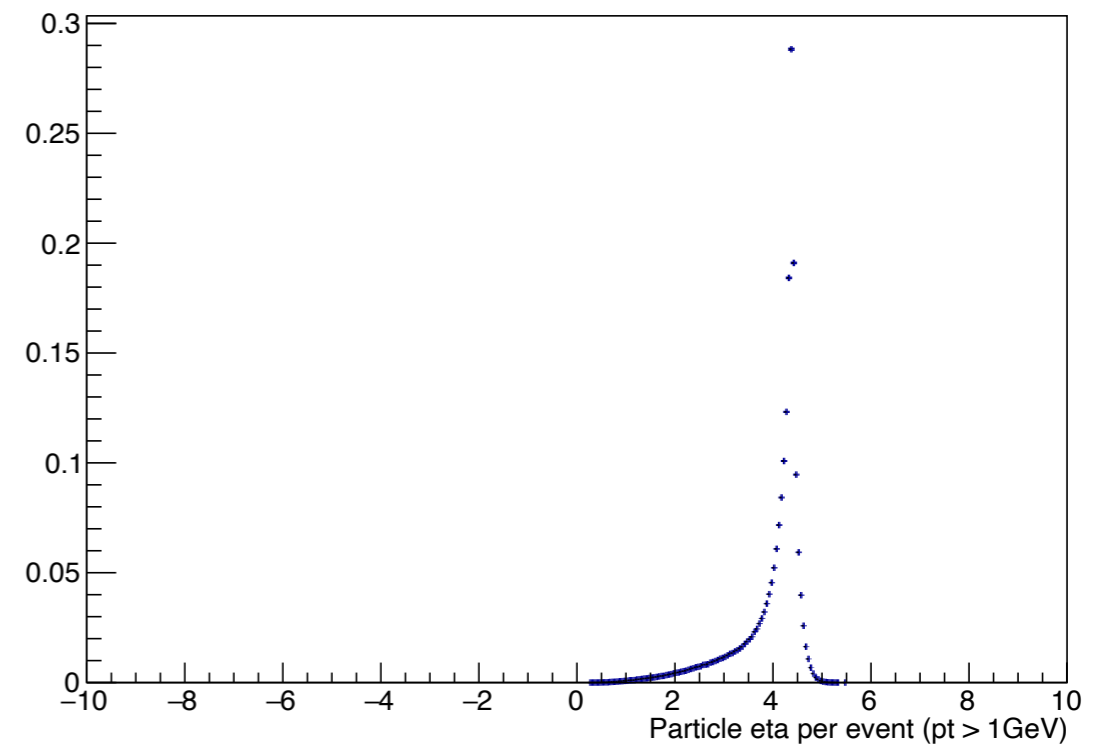


# QA plots per event (pt > 1GeV)

Final State Particle Eta per event(Pt > 1 GeV)

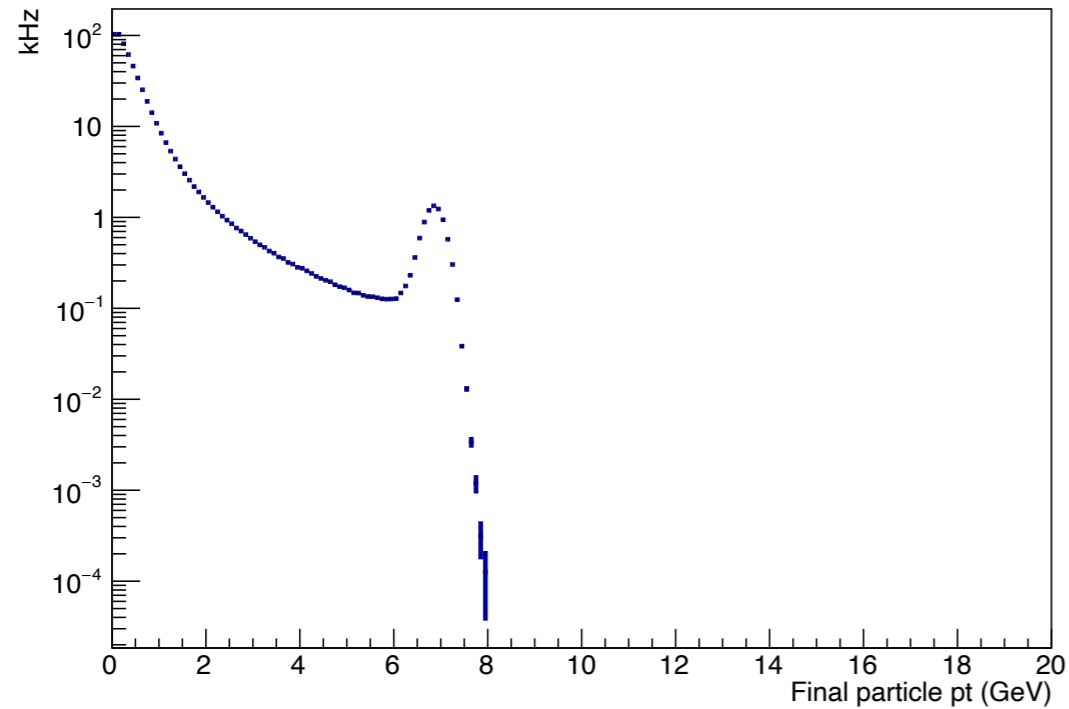


Final State Particle Eta per event(Pt > 1 GeV)

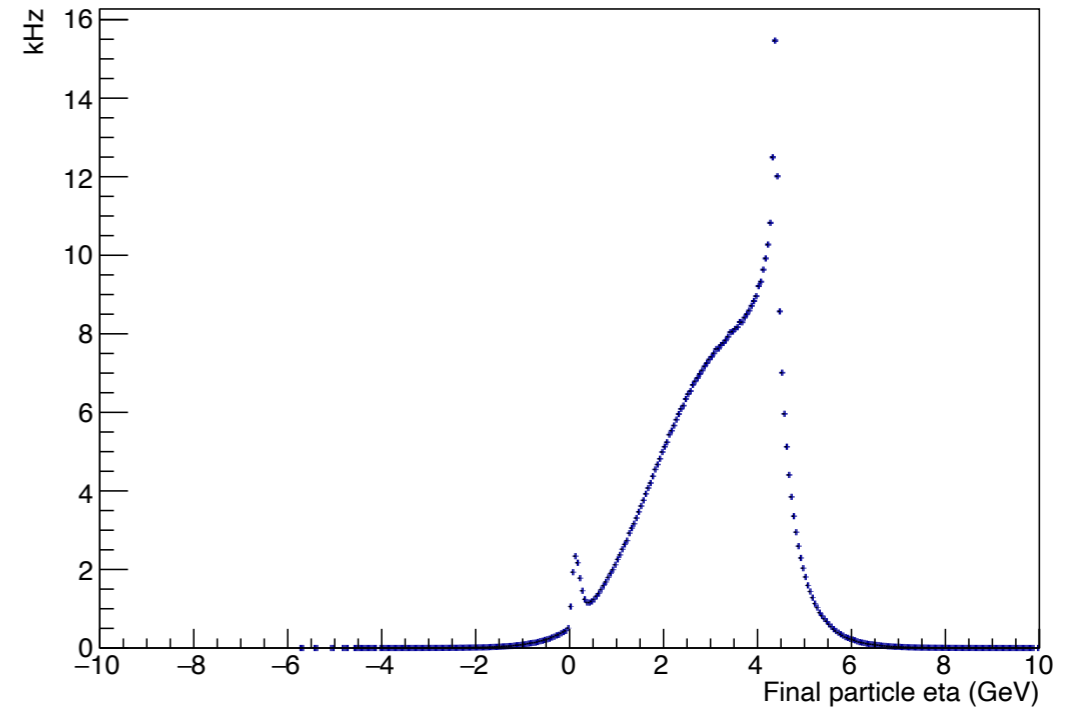


# Events QA plots

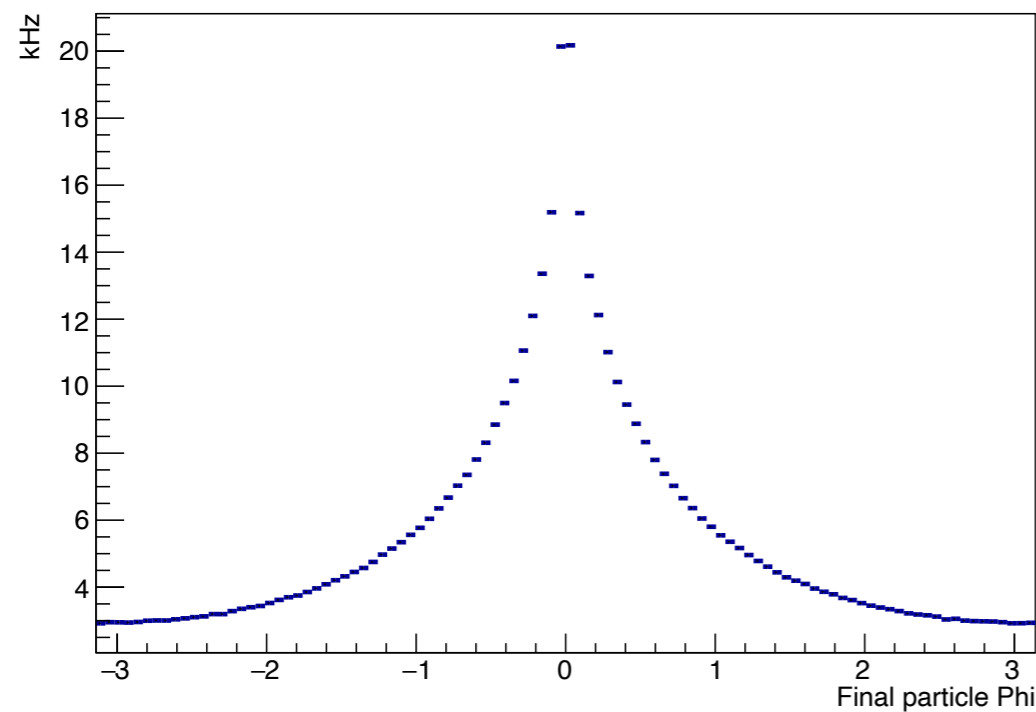
Final State Particle Pt



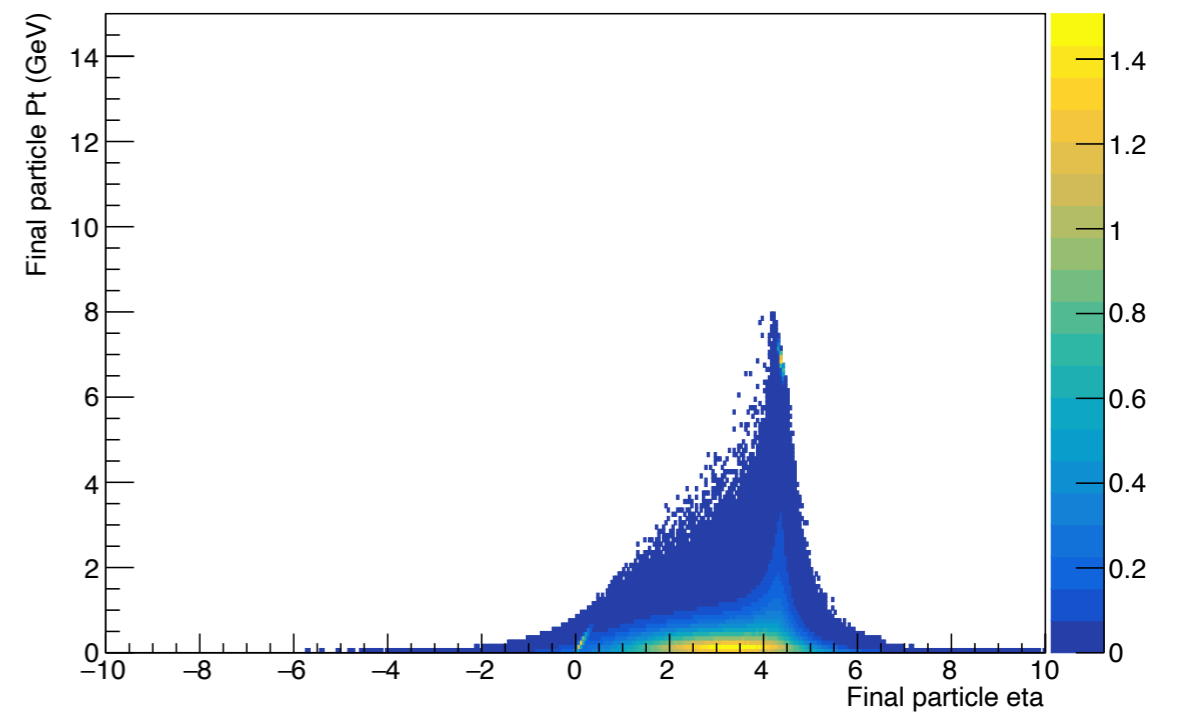
Final State Particle Eta



Final State Particle Phi



Final State Particle Pt Vs Eta

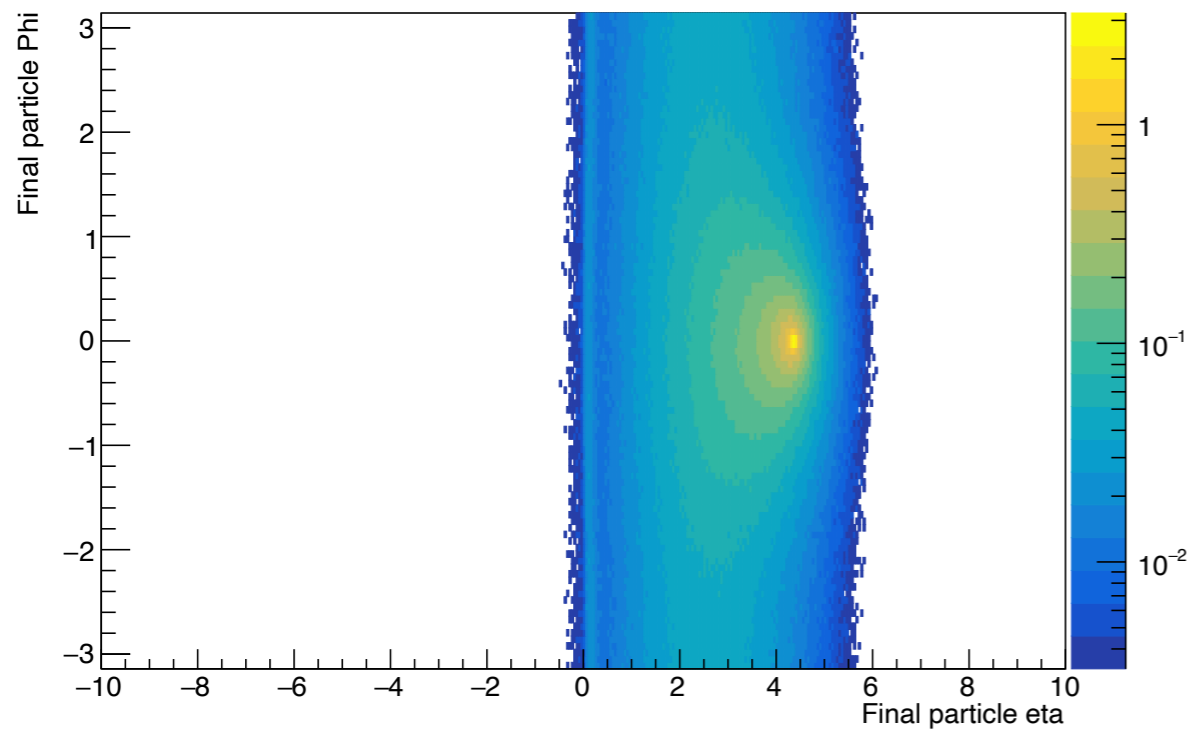


- Total produced tracks rate = 562.9 kHz in  $-5m < s < 5m$ ;

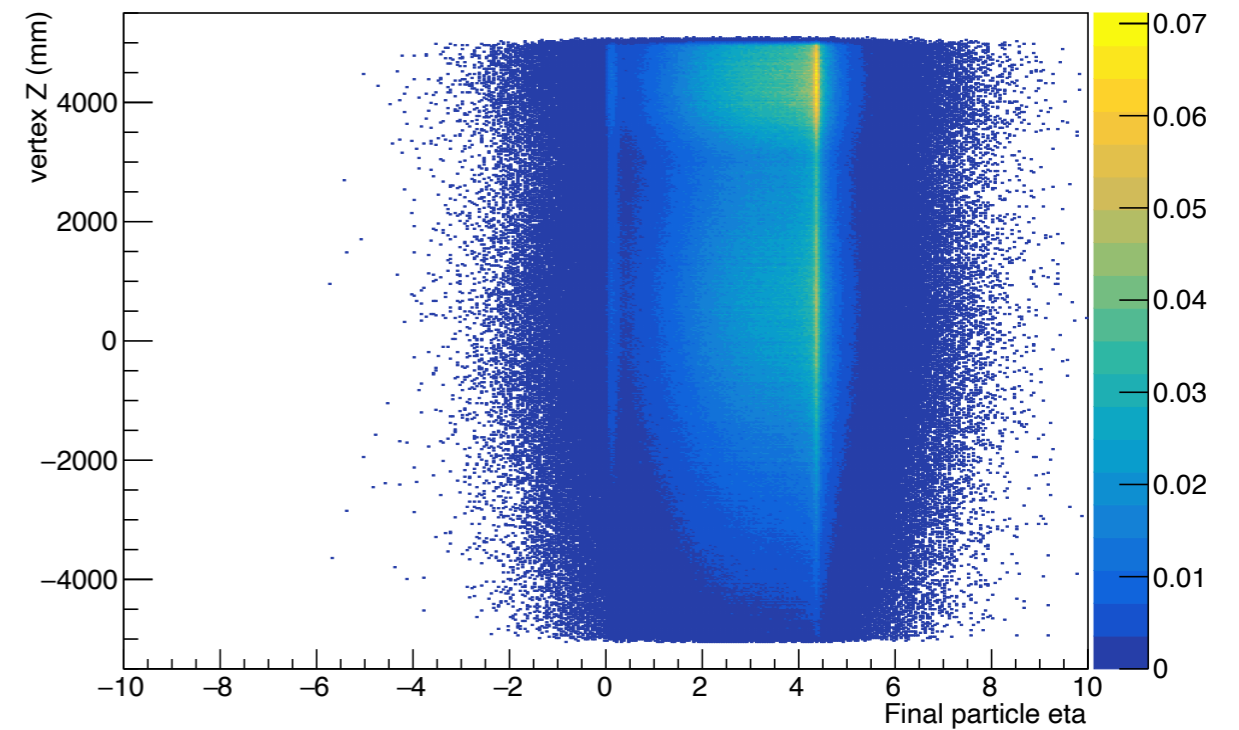


# Events QA plots

Final State Particle Phi Vs Eta



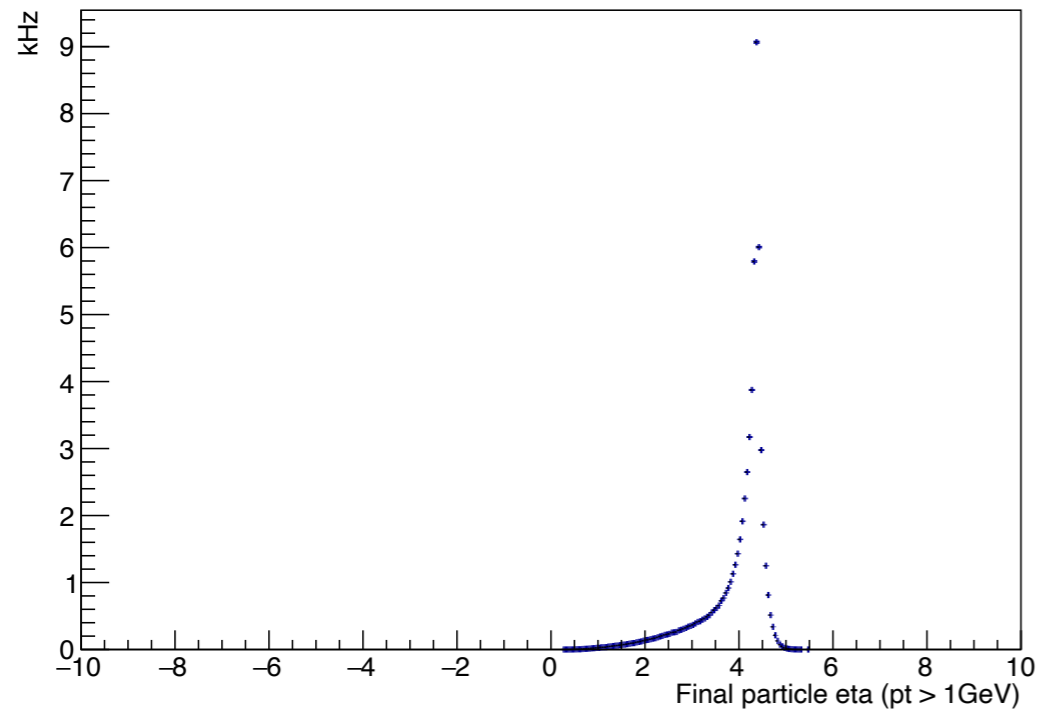
vtx Z Vs Eta



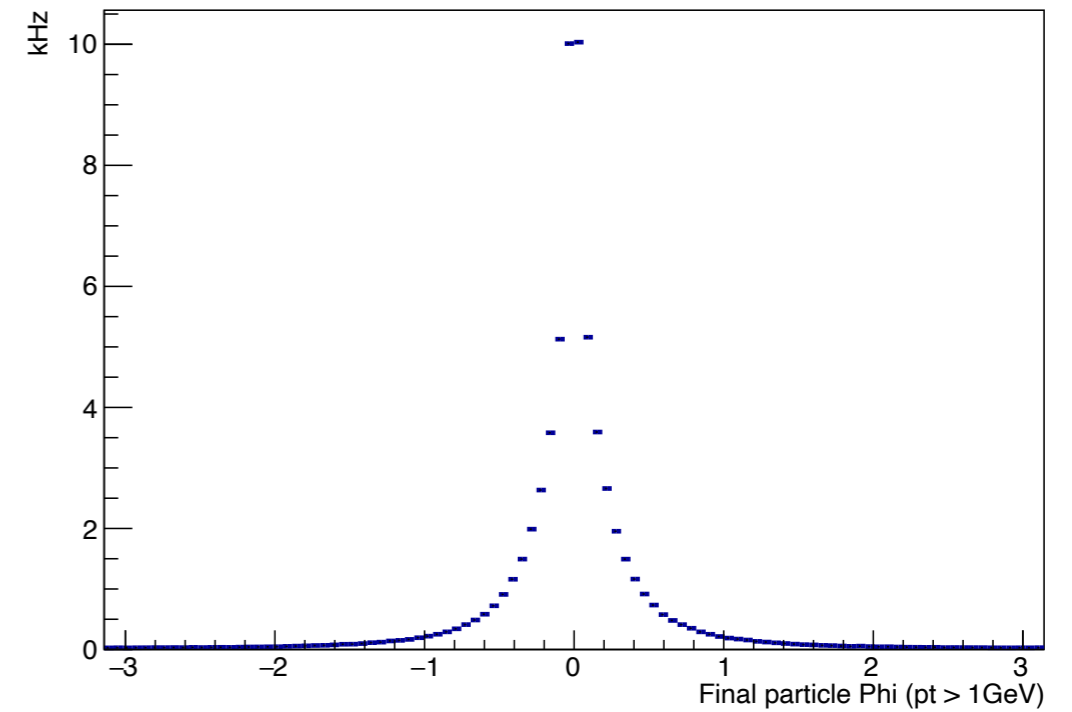
- Total produced tracks rate = 562.9 kHz in  $-5m < s < 5m$ ;

# Events QA plots

Final State Particle Eta (Pt > 1 GeV)



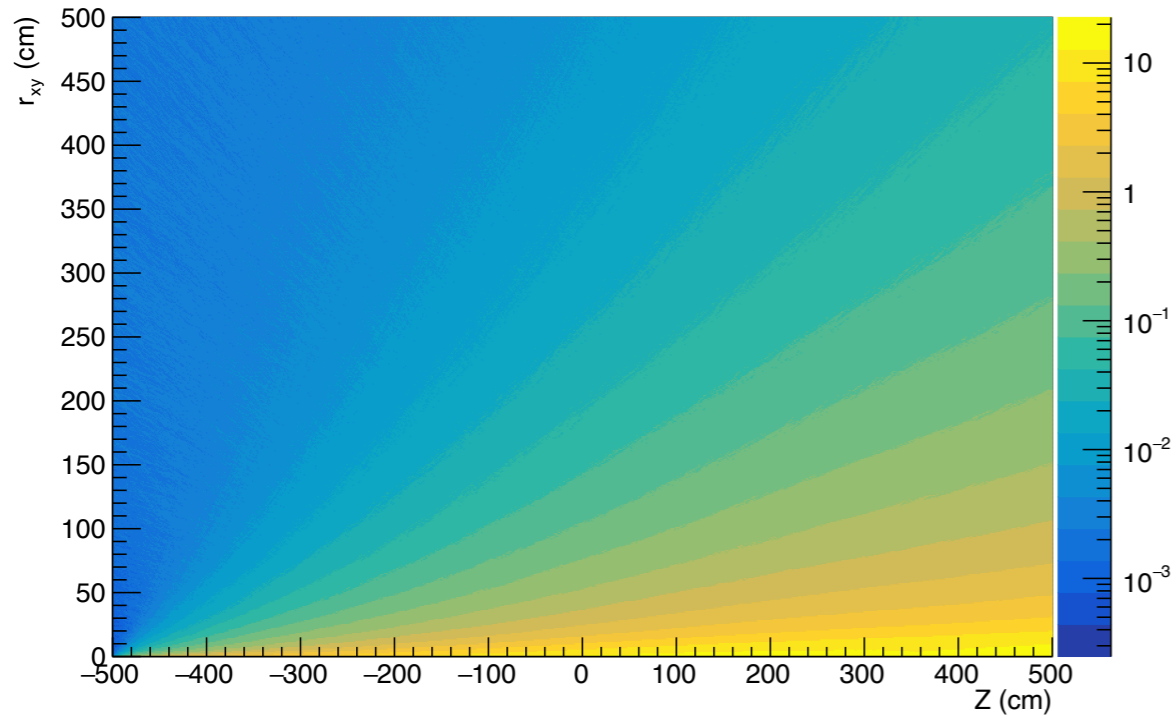
Final State Particle Phi (Pt > 1 GeV)



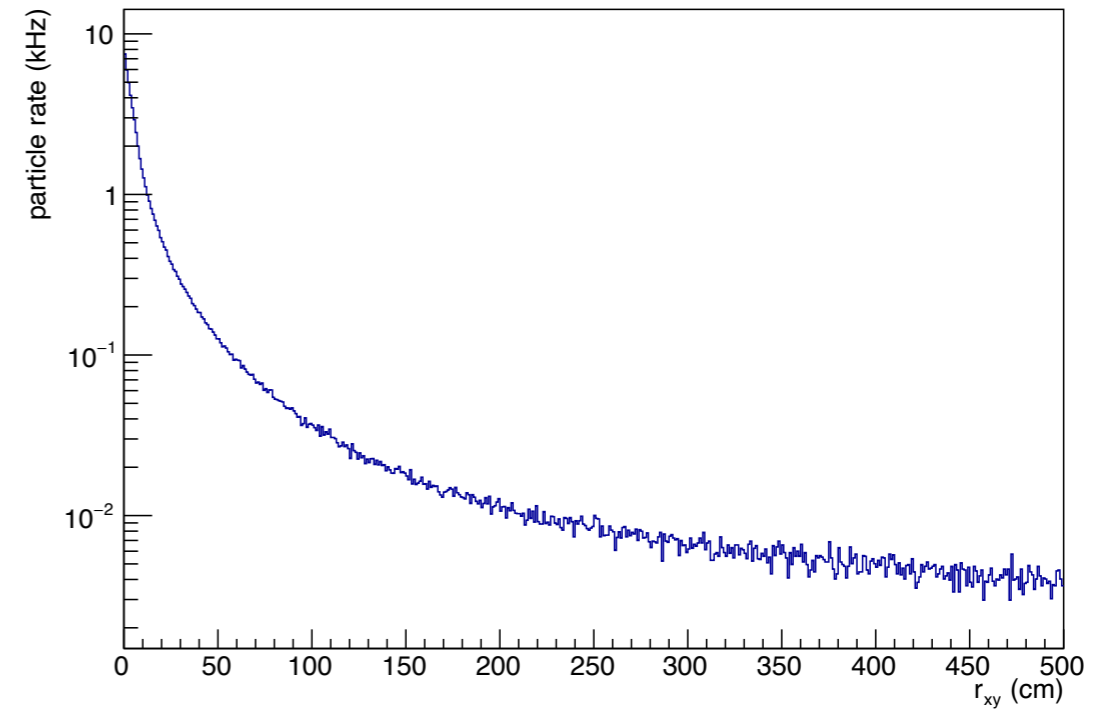
- Total produced high pt tracks rate = 64.9 kHz in  $-5m < s < 5m$ ;

# Particle projection onto XY plane

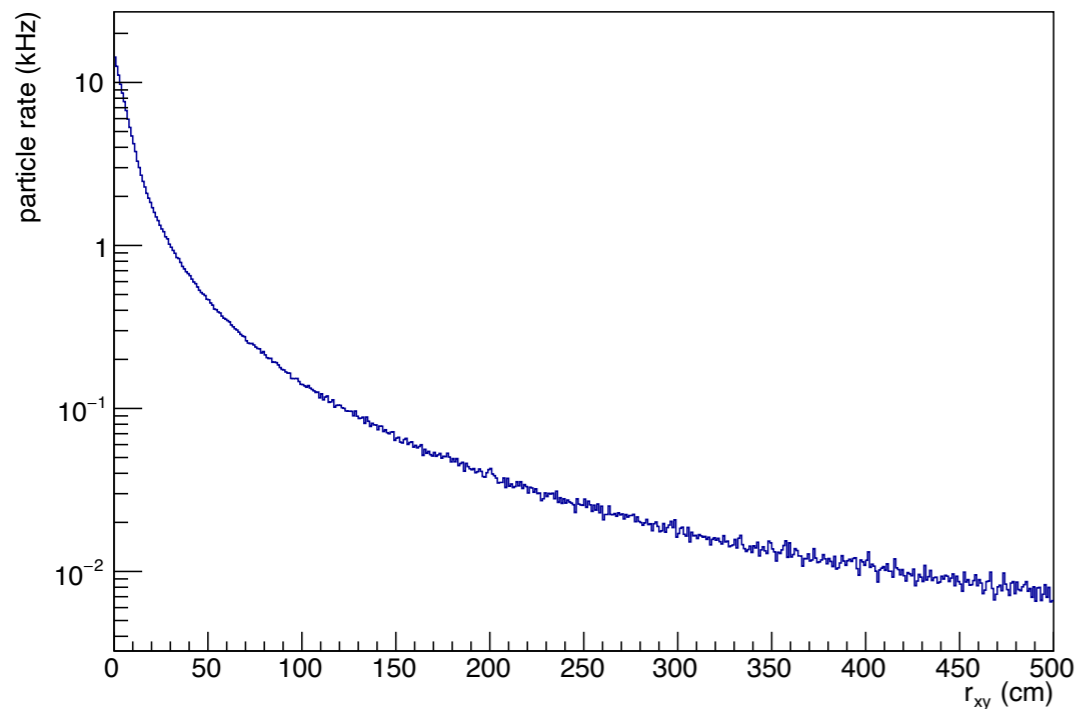
Particle in XY plane



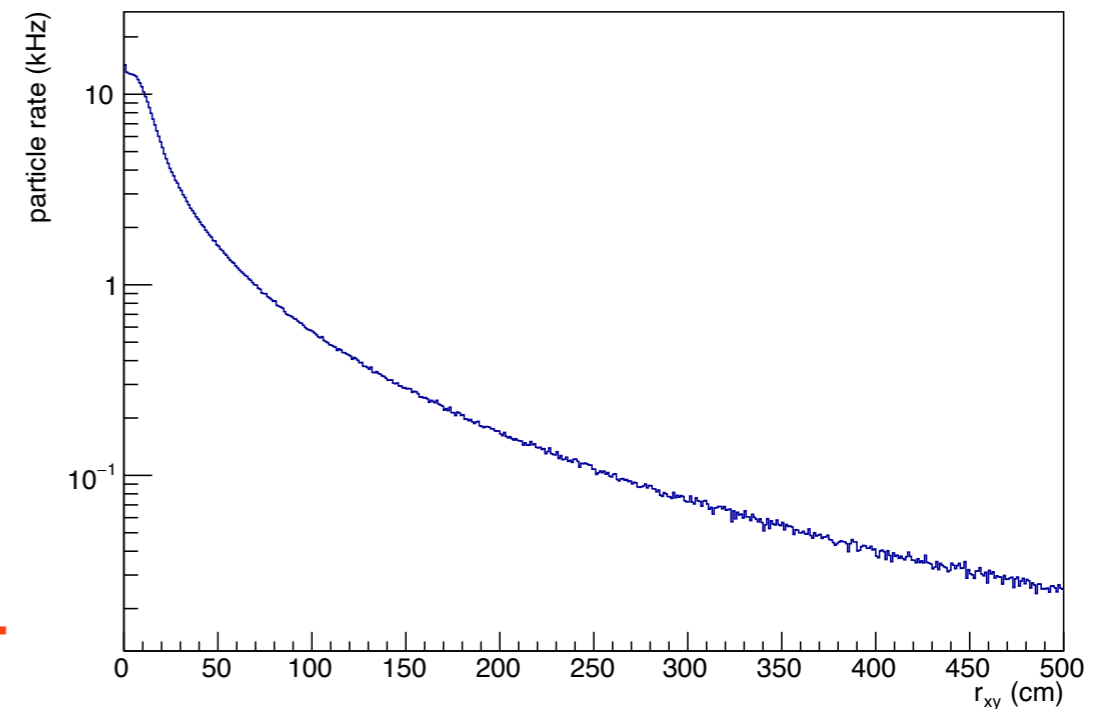
particles in XY plane at  $Z = -200\text{cm}$



particles in XY plane at  $Z = 0\text{cm}$



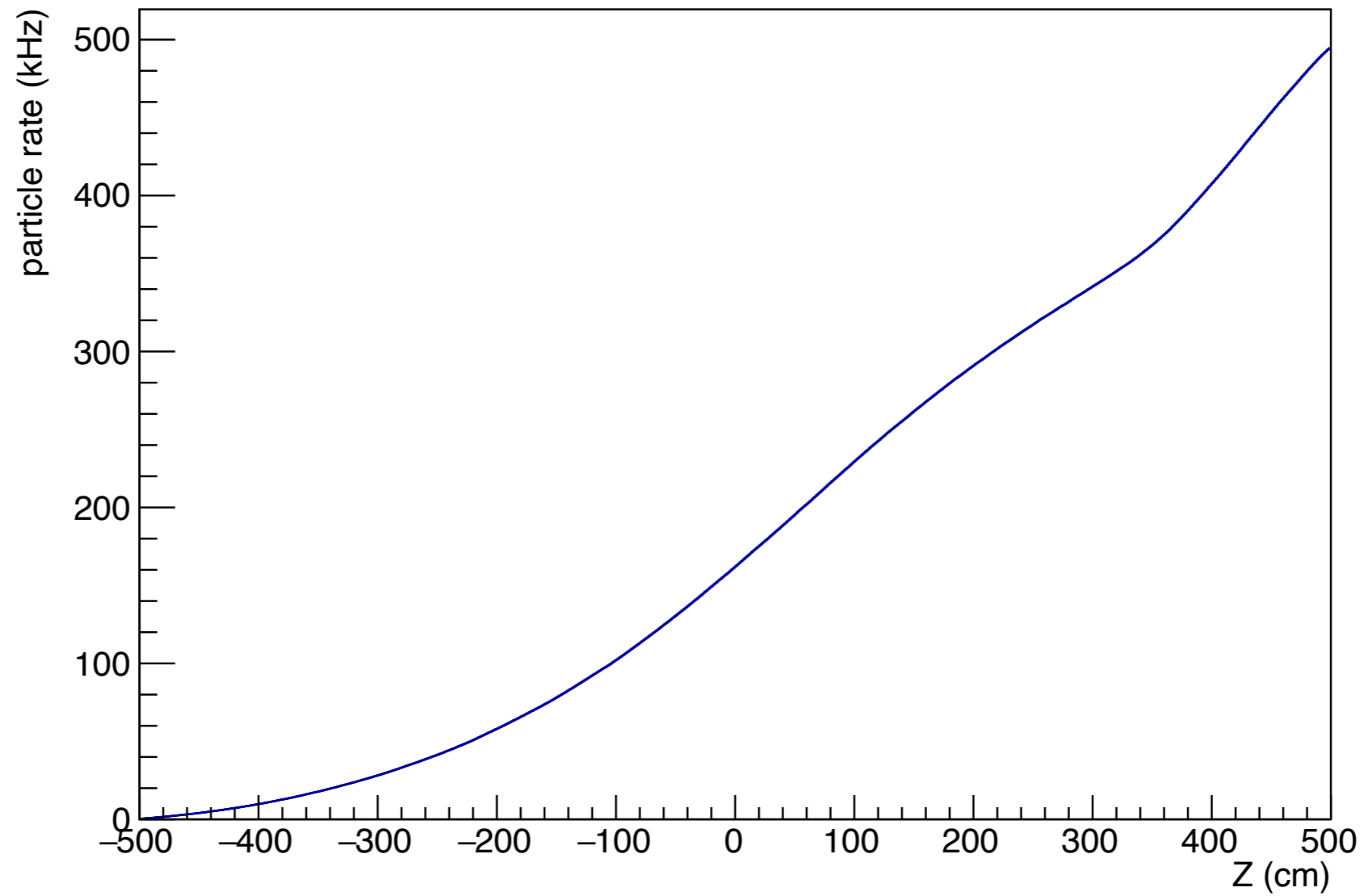
particles in XY plane at  $Z = 350\text{cm}$



# Particle rate vs. Z

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particle rate vs. Z ( $r_{xy} < 200\text{cm}$ )



# Summary

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- 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`