Scintillation Screen IP Background Analysis

John Hallford

University College London

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LUXE

DESY.

‘Exotic’* Particles in Geant4 Background Simulation

Analysis of ~0.1 BX of e-LASER background G4 simulation with QGSP_BERT_HP physics list. All Integrals scaled to per 1 Bunch Crossing.

The following table is all recorded particles which intercept the screen, regardless of if they deposit energy / induce signal.

*If we take exotic to mean anything other than e^-, e^+, γ …

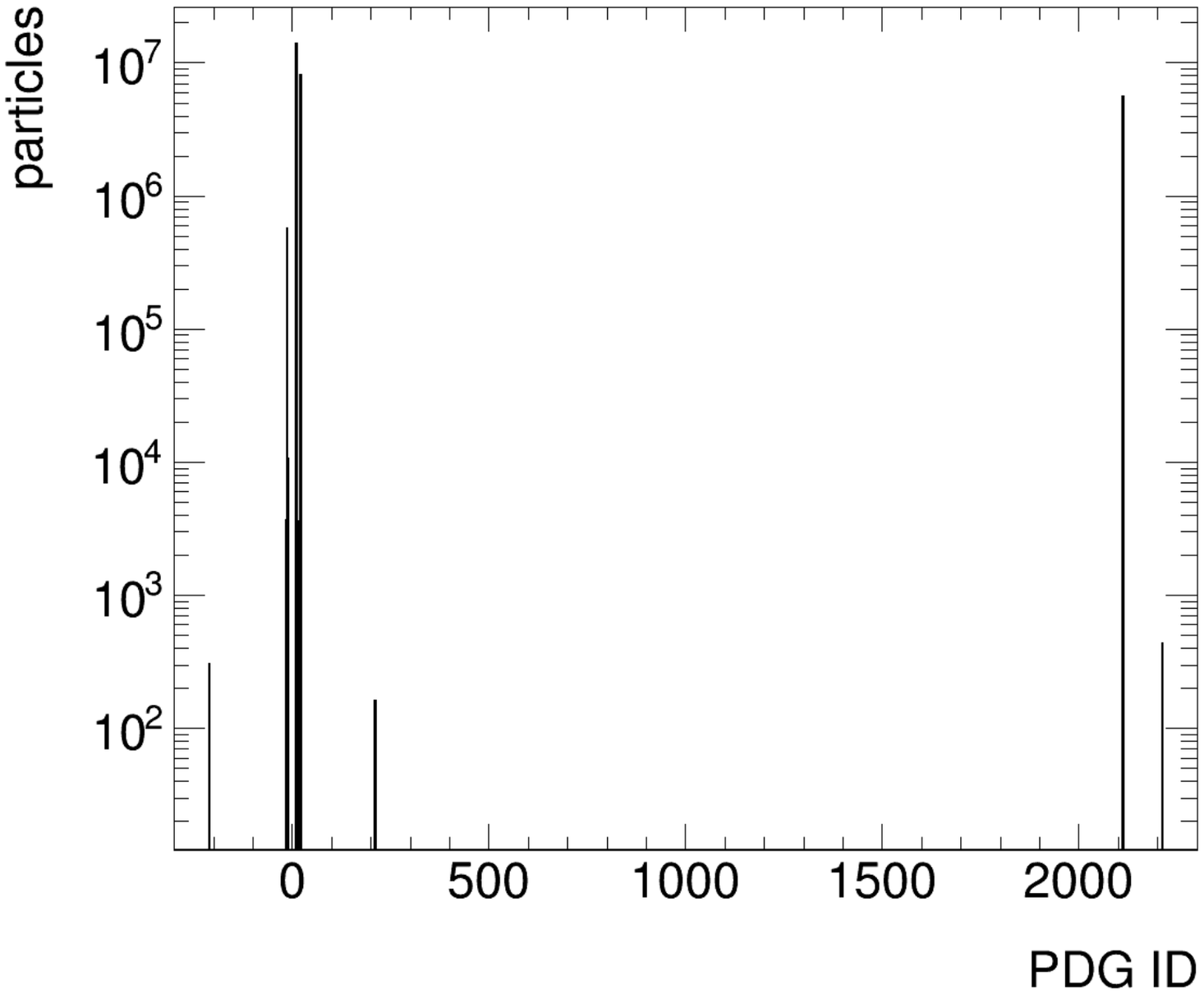
‘Exotic’ Particles in Geant4 Background Simulation

PDG ID	Integral/BX	Particle	Note
-211	307	π^-	~1.15 signal compared to e^- (1 GeV)
-14	3654	$\bar{\nu}_\mu$	Neutrino, no effect
-13	24	μ^+	Signal similar to e- at 1 GeV
-12	5.73×10^5	$\bar{\nu}_e$	Neutrino, no effect
-11	10631	e^+	Signal similar to e- at 1 GeV
11	1.386×10^7	e^-	
12	4.79×10^5	ν_e	Neutrino, no effect
13	24	μ^-	Signal similar to e- at 1 GeV
14	3544	ν_μ	Neutrino, no effect
22	8.077×10^6	γ	~1/30 signal compared to e^- at 1 GeV
211	159	π^+	~1.15 signal compared to e^- (1 GeV)
2112	5.541×10^6	n	~1/6 signal compared to e^- (1 GeV)
2212	441	p	~1.18 signal compared to e^- (1 GeV)

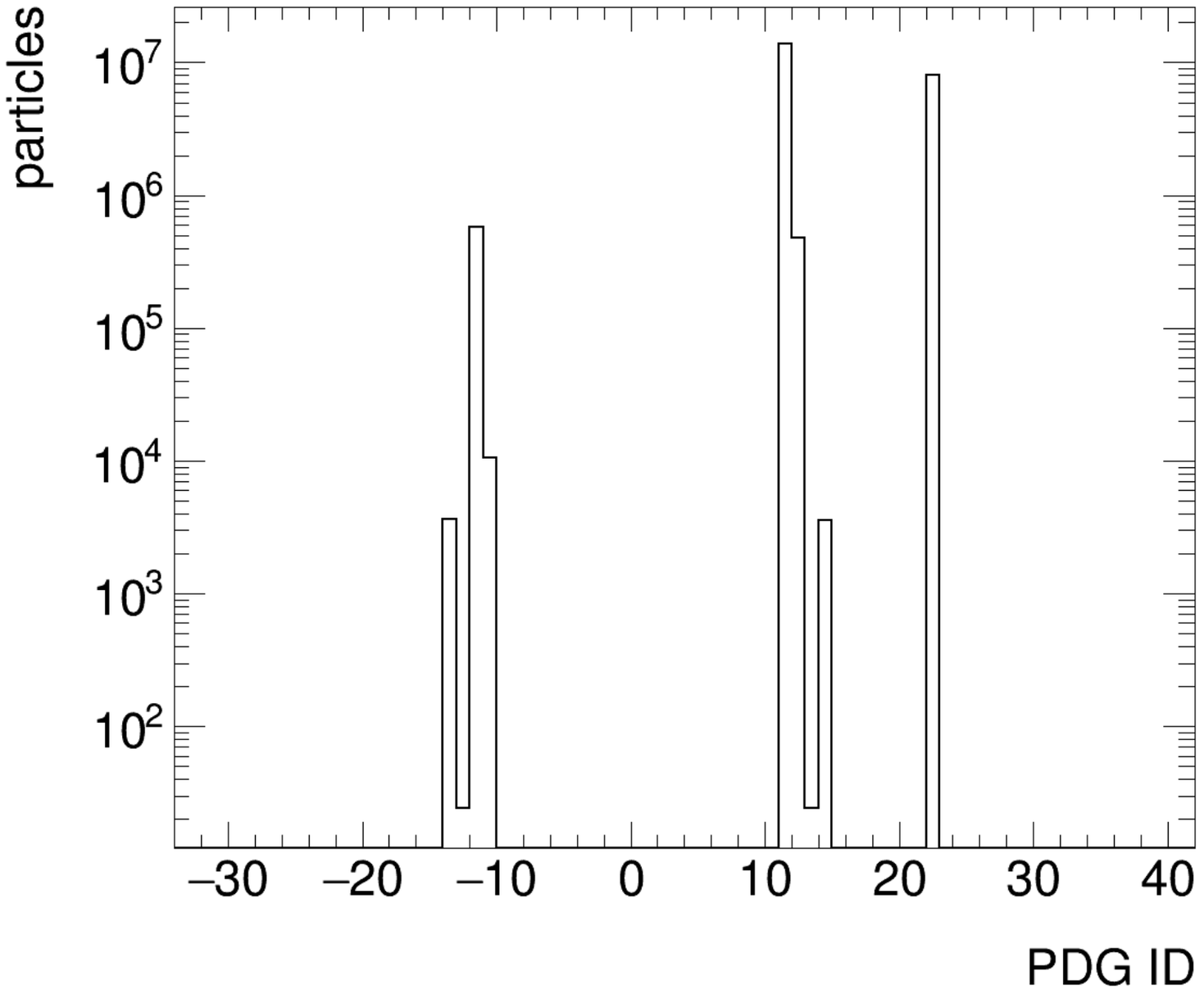
‘Exotic’ Particles in Geant4 Background Simulation

PDG ID	Integral/BX	Particle	Note
100001002	61.3	H nucleus	
100002004	61.3	He Nucleus	
100008016	12.26	O Nucleus	Low energy (5.77 keV)

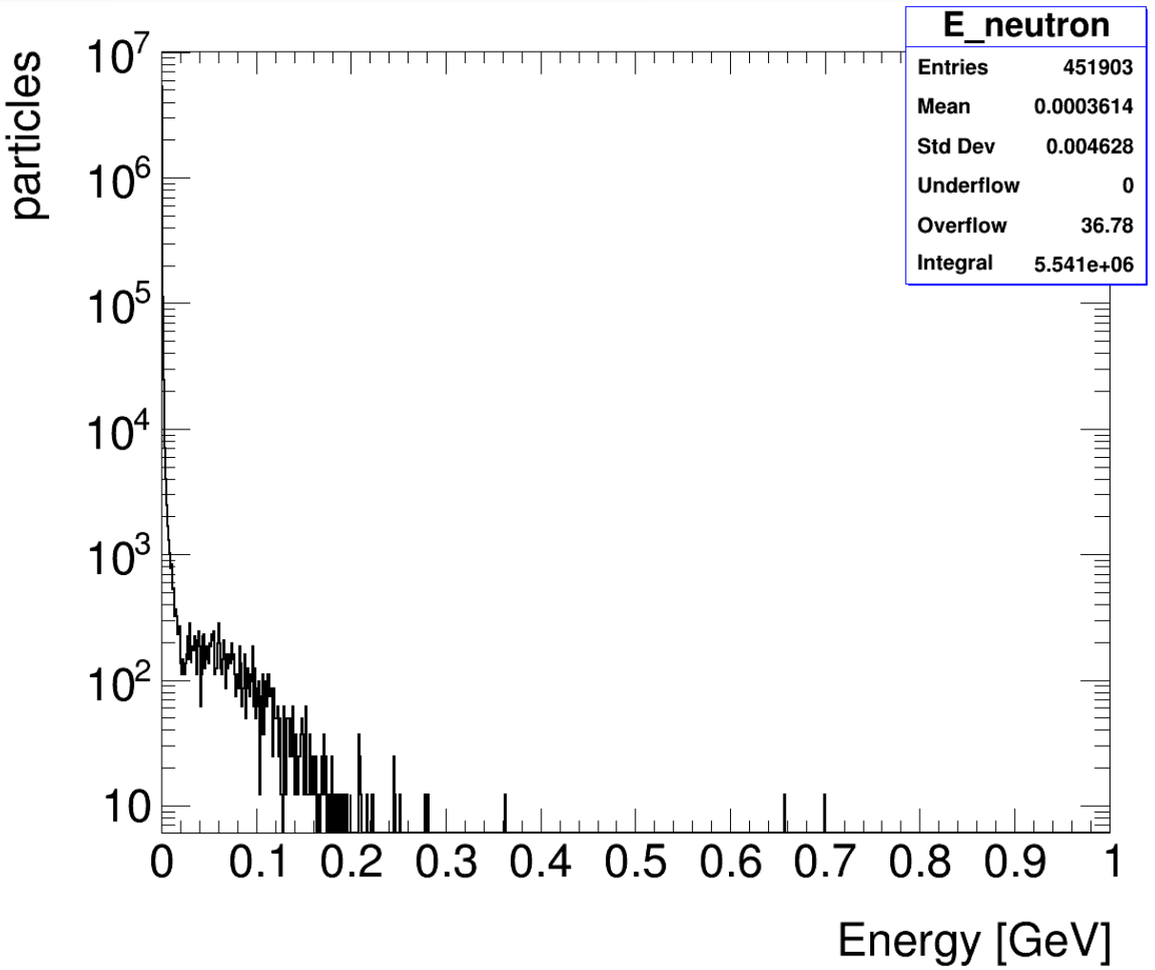
‘Exotic’ Particles in Geant4 Background Simulation

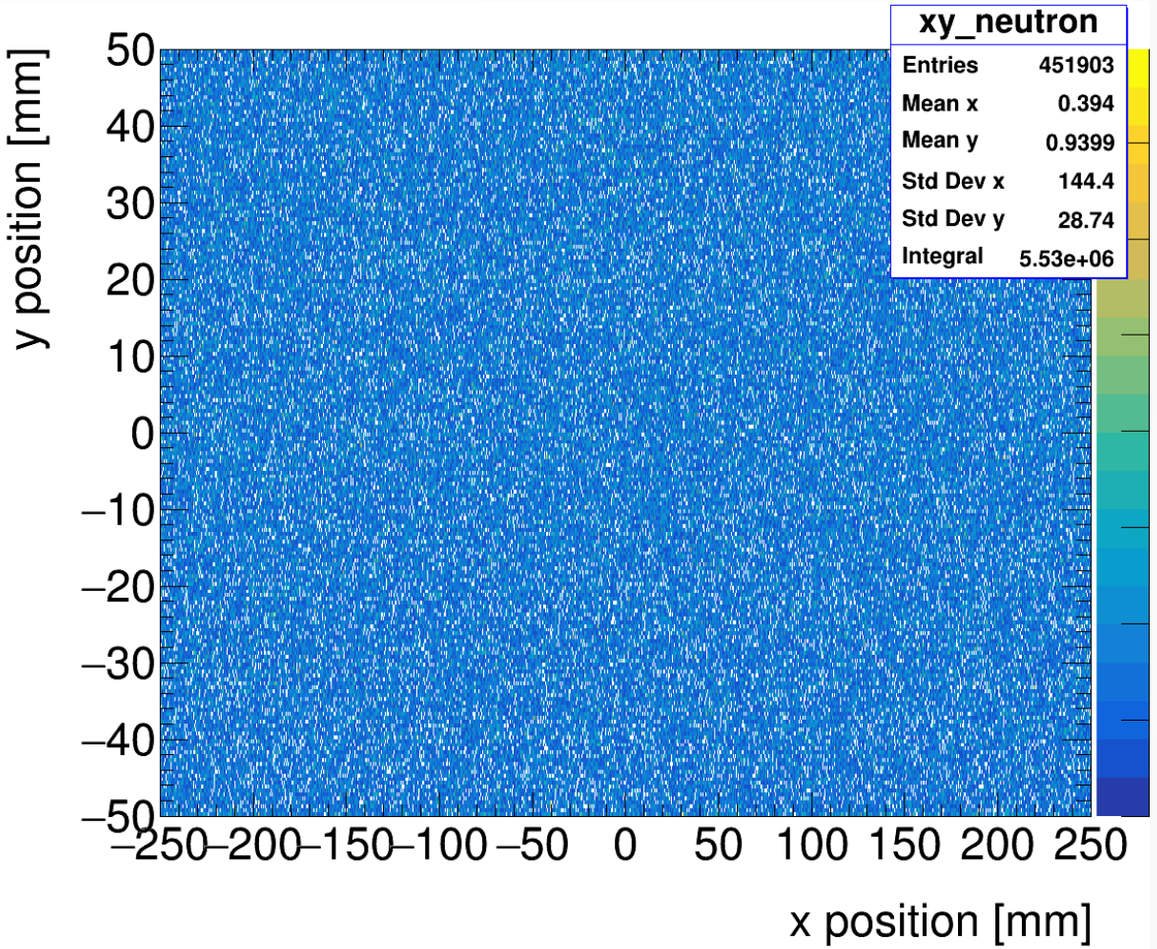


‘Exotic’ Particles in Geant4 Background Simulation



Neutrons Intercepting the Screen

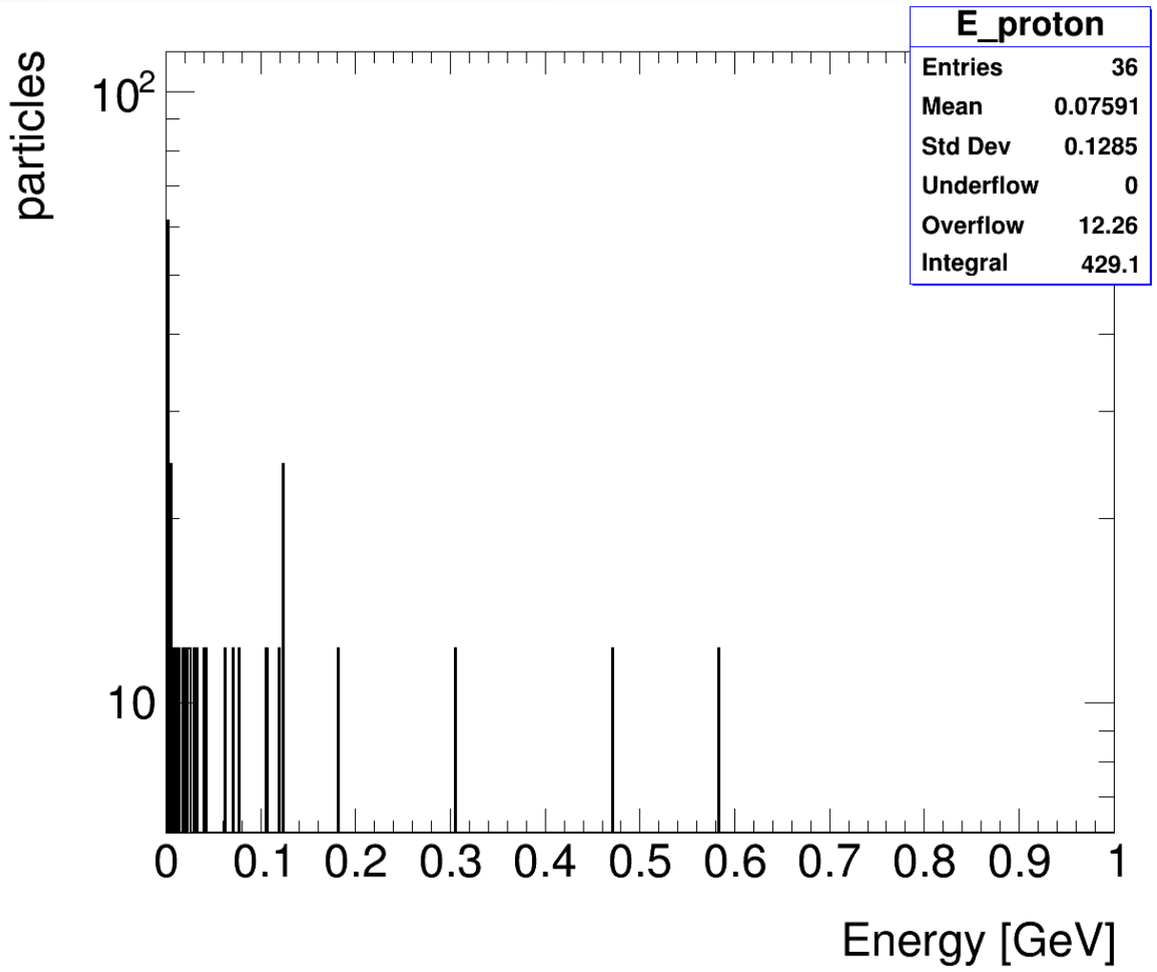


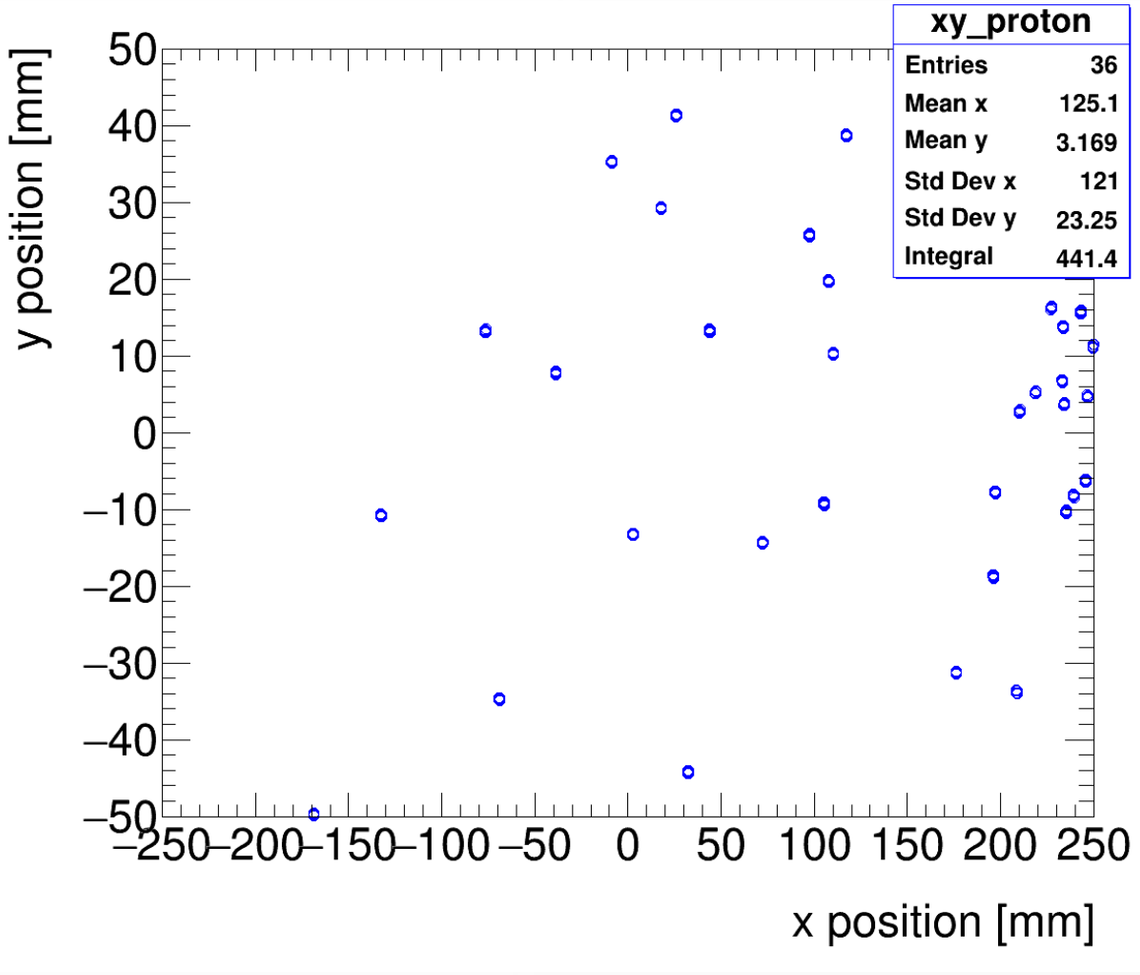


Using mean energy E = 360 keV, neutrons have on average 1/1000 scintillation response of 1 GeV e^- Most will pass through depositing no energy.

A very flat xy response (mean x,y close to zero) as the neutrons mostly come from the beam-dump. XY position is relative to centre of screen.

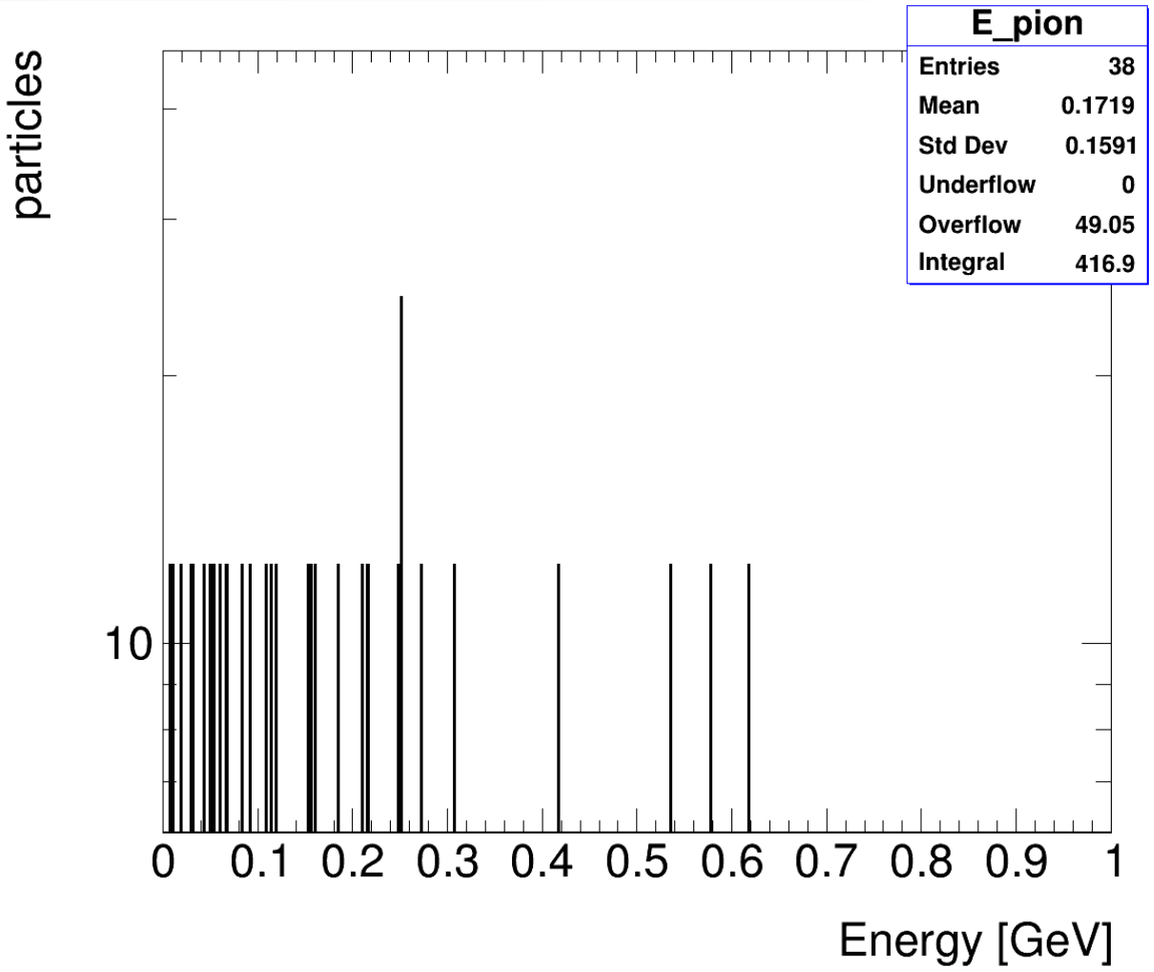
Protons Intercepting the Screen

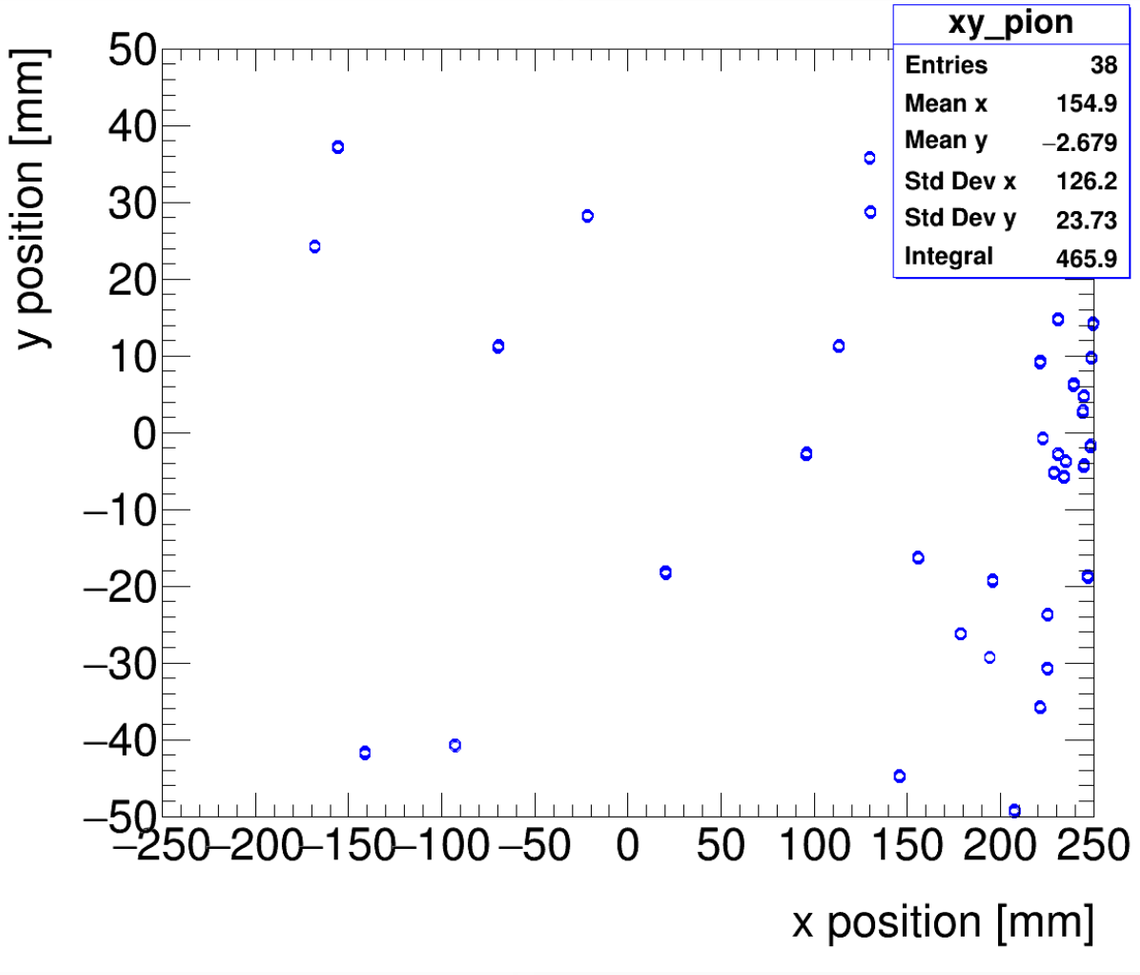




A beam-line-centred distribution (mean x close to far right). XY position is again relative to centre of screen.

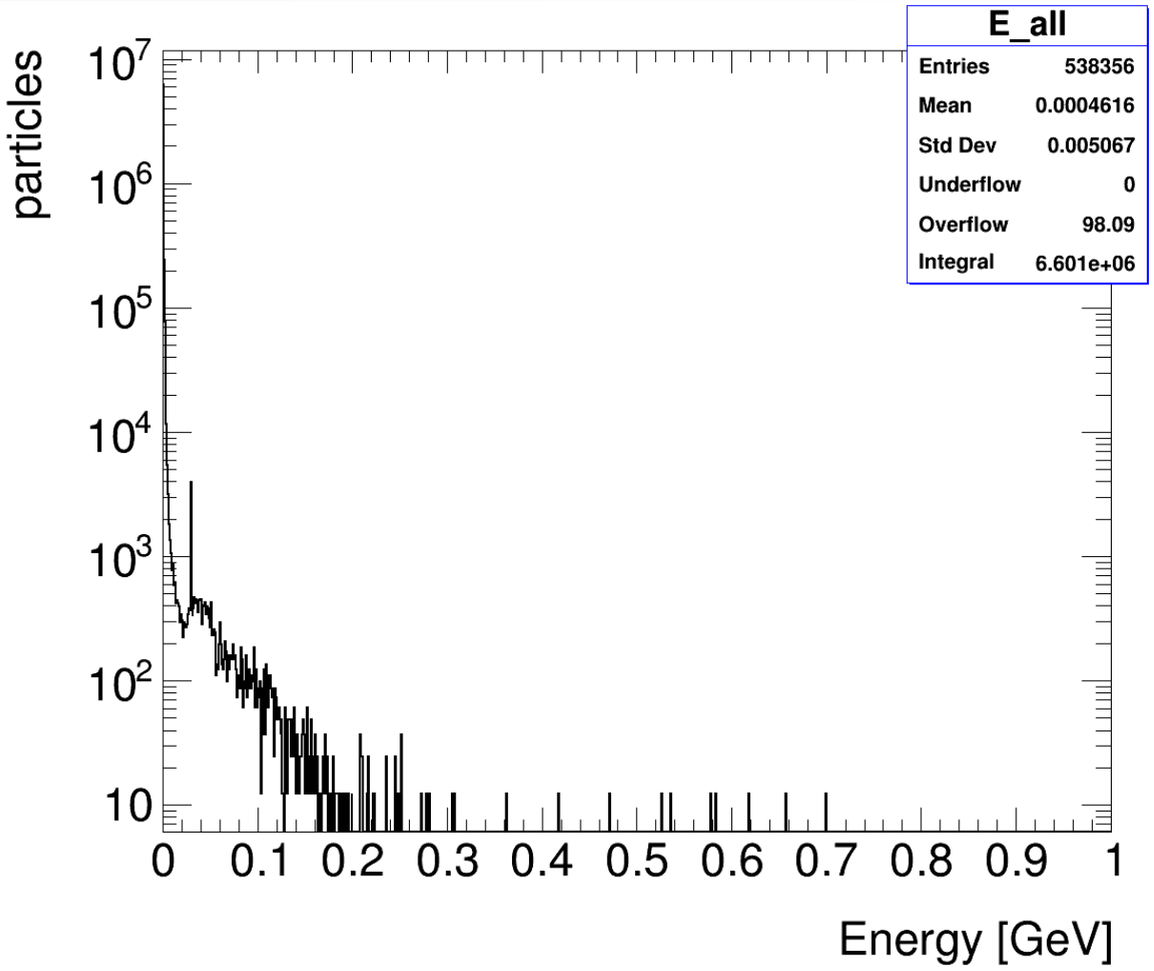
Pions Intercepting the Screen

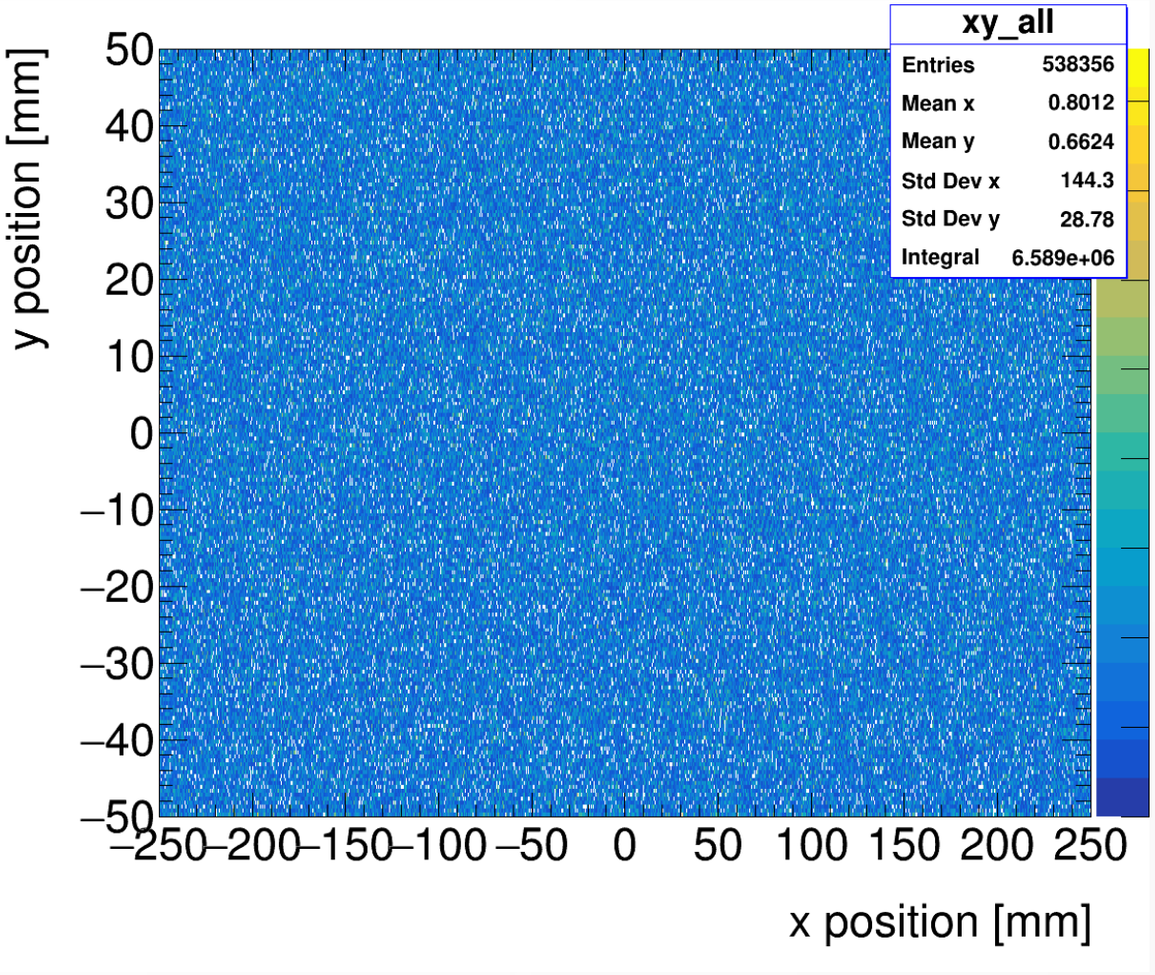




Similar to protons. Small number, centred on e^- beamline.

All Particles in Geant4 Background Simulation Excluding e^+, e^-, γ

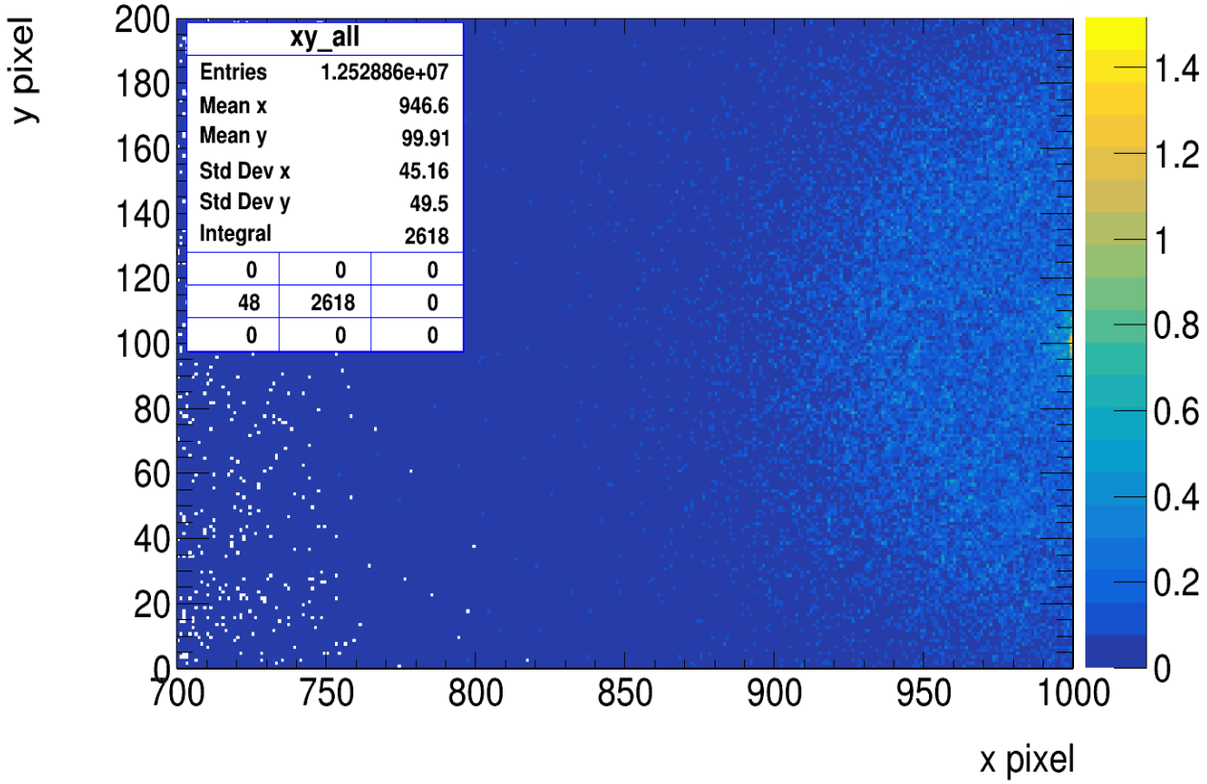


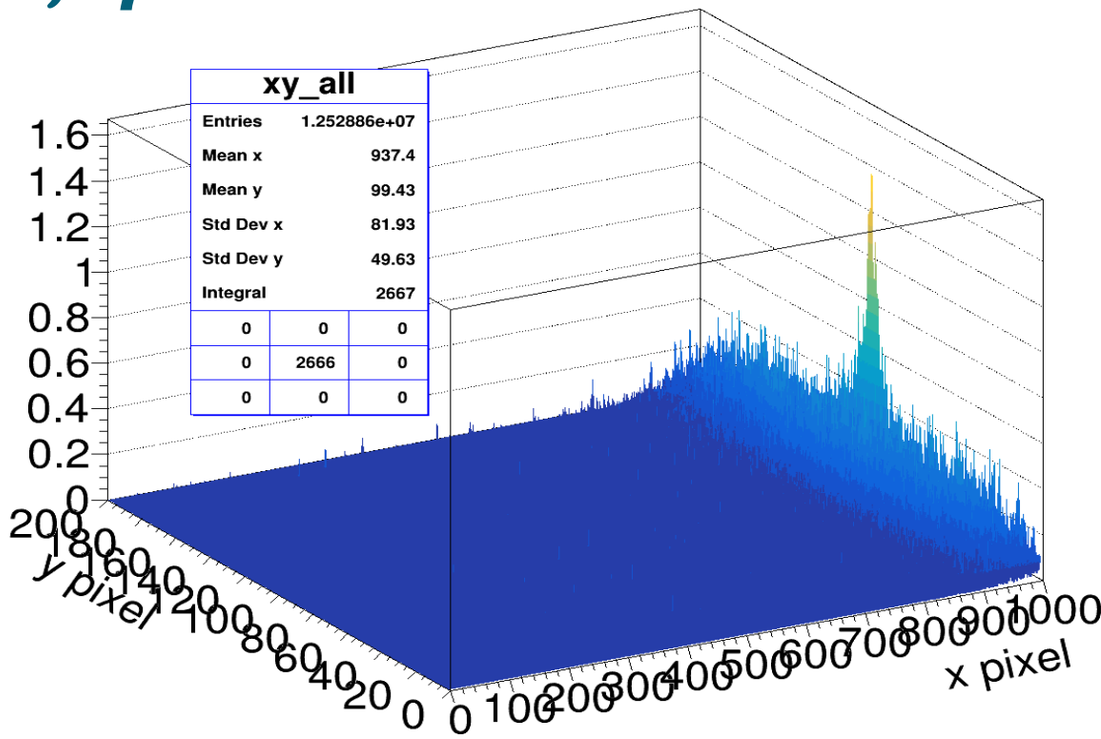


Neutrons and neutrinos dominate number of particles. But this does not correspond to energy deposition.

EM Particle Energy Deposition in Geant4 Background Simulation

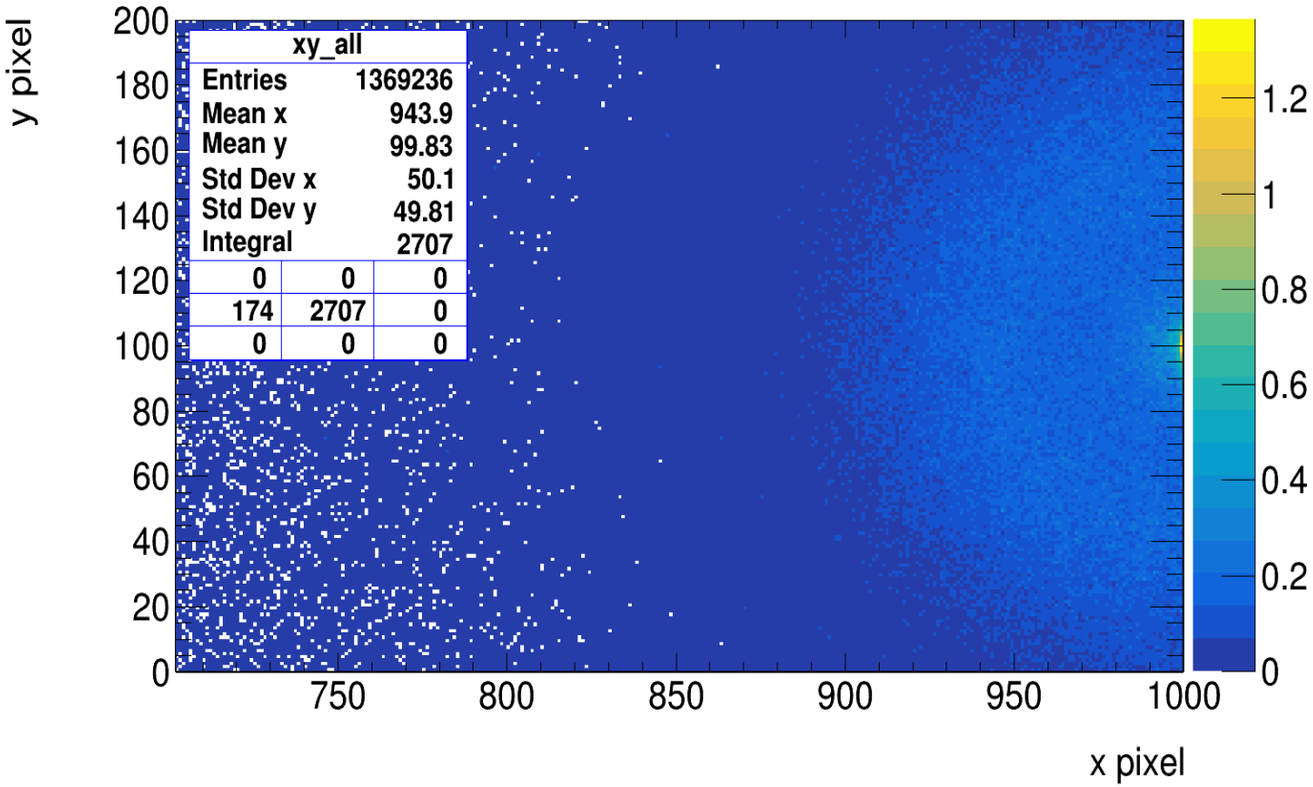
Only e^+, e^-, γ

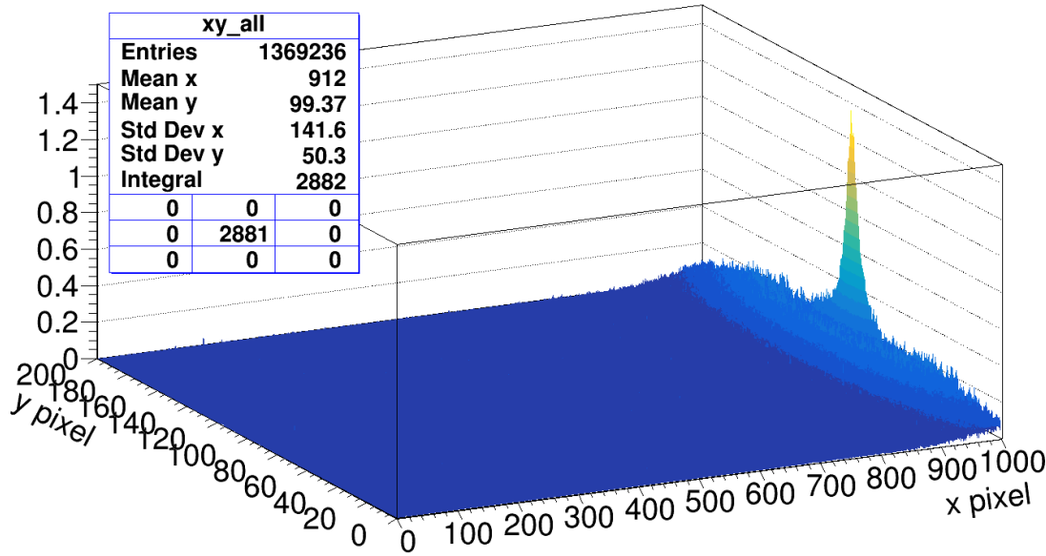




From a previous bkg (E=16.5 GeV) simulation not including 'exotic' particles.
Deposition in energy of IP Scintillation Screen [Z dimension in GeV]

‘Exotic’ Particle Energy Deposition in Geant4 Background Simulation Including e^+, e^-, γ

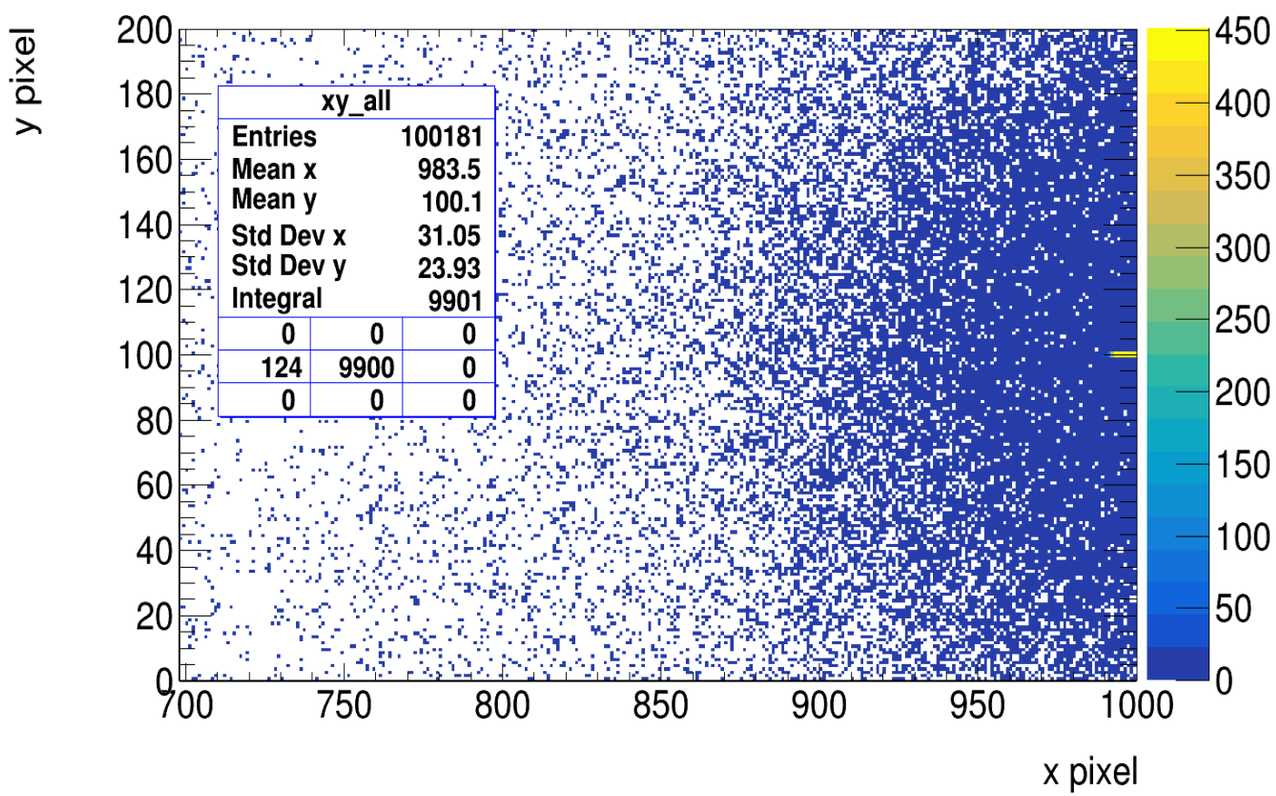


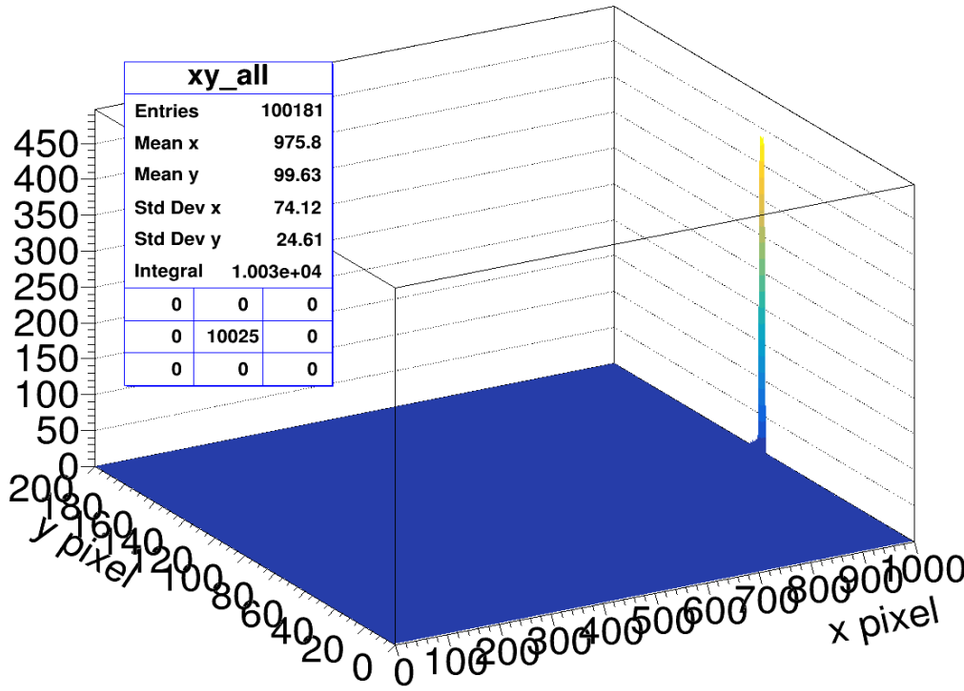


Back to QGSP_BERT. Deposition in energy of IP Scintillation Screen [Z dimension in GeV]. Including these particles means a modest shift in the integral of energy deposited in the entire screen [GeV] from 2667 → 2882.

Our idea of the shape of the bkg (flat component + radially symmetric component centred around e-beamline) is unchanged. Suitable for measurements and subtraction.

Energy Deposition in Geant4 Signal Simulation Only e^+, e^-, γ



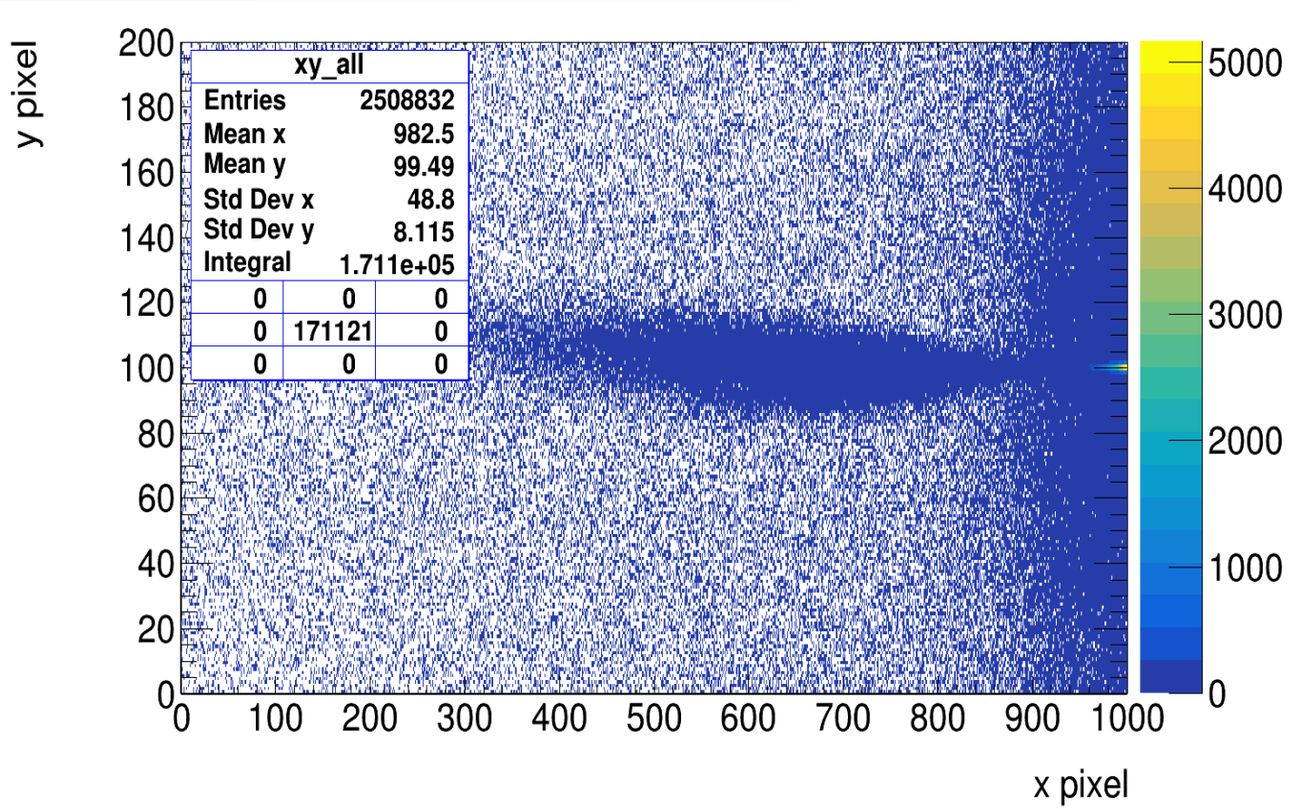


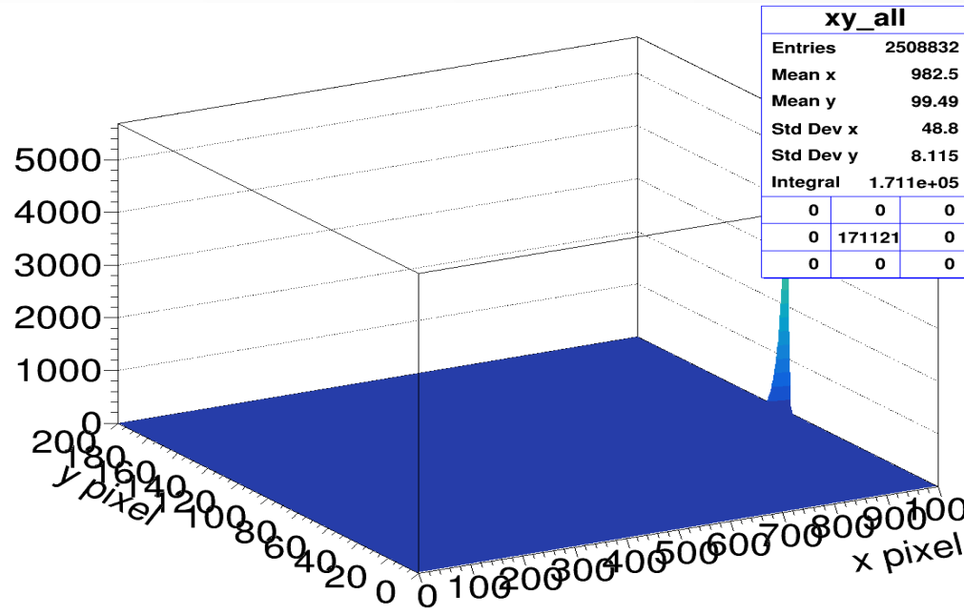
IP Scintillation Screen [Z dimension in GeV]

The S/B in the region of interest is then ~400/1.4 or a few hundred. Negligible difference after the inclusion of QGSP_BERT physics.

W_0 = 50 μm, phase-0 LASER

Energy Deposition in Signal Simulation
Only e^+, e^-, γ





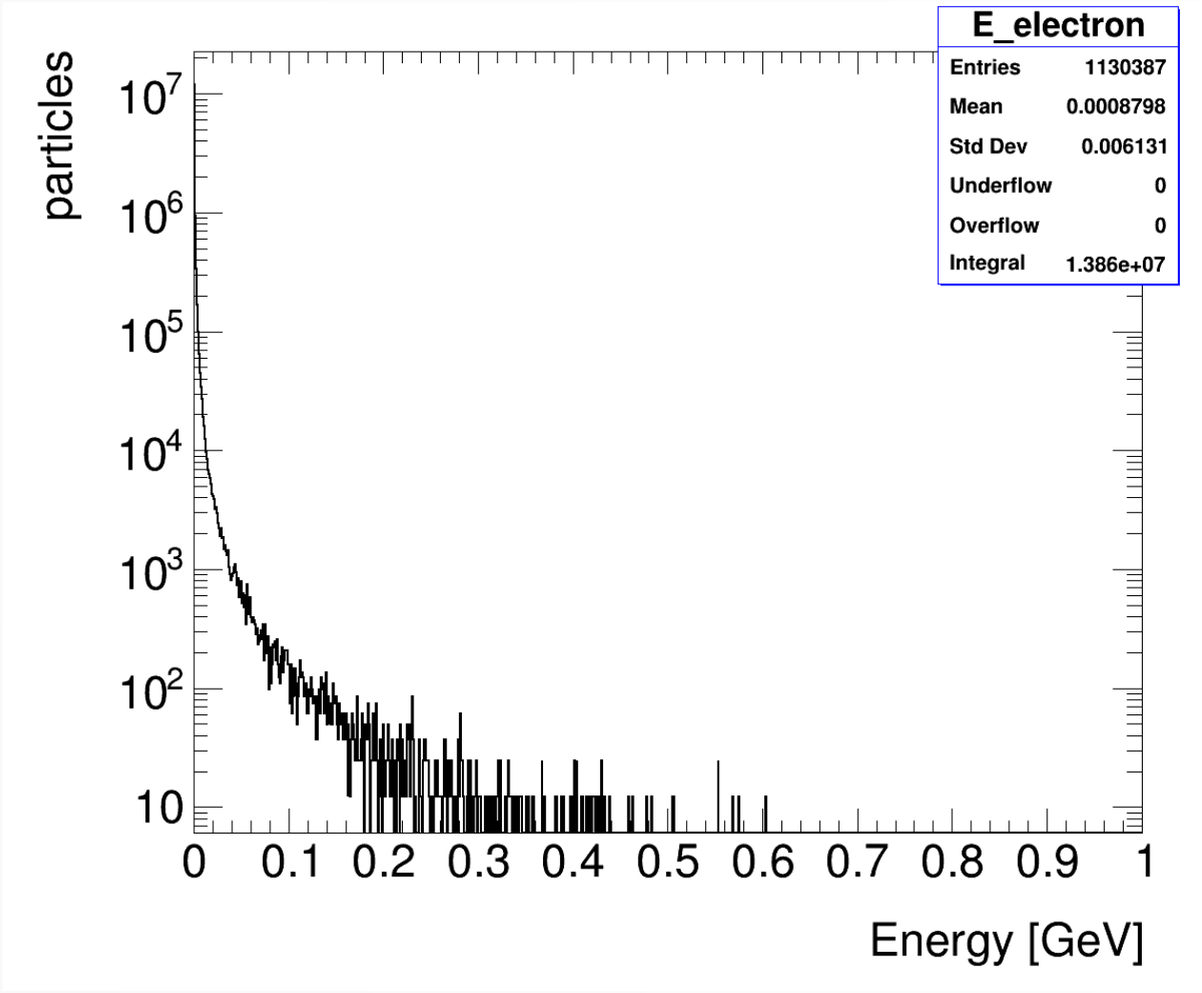
IP Scintillation Screen [Z dimension in GeV]

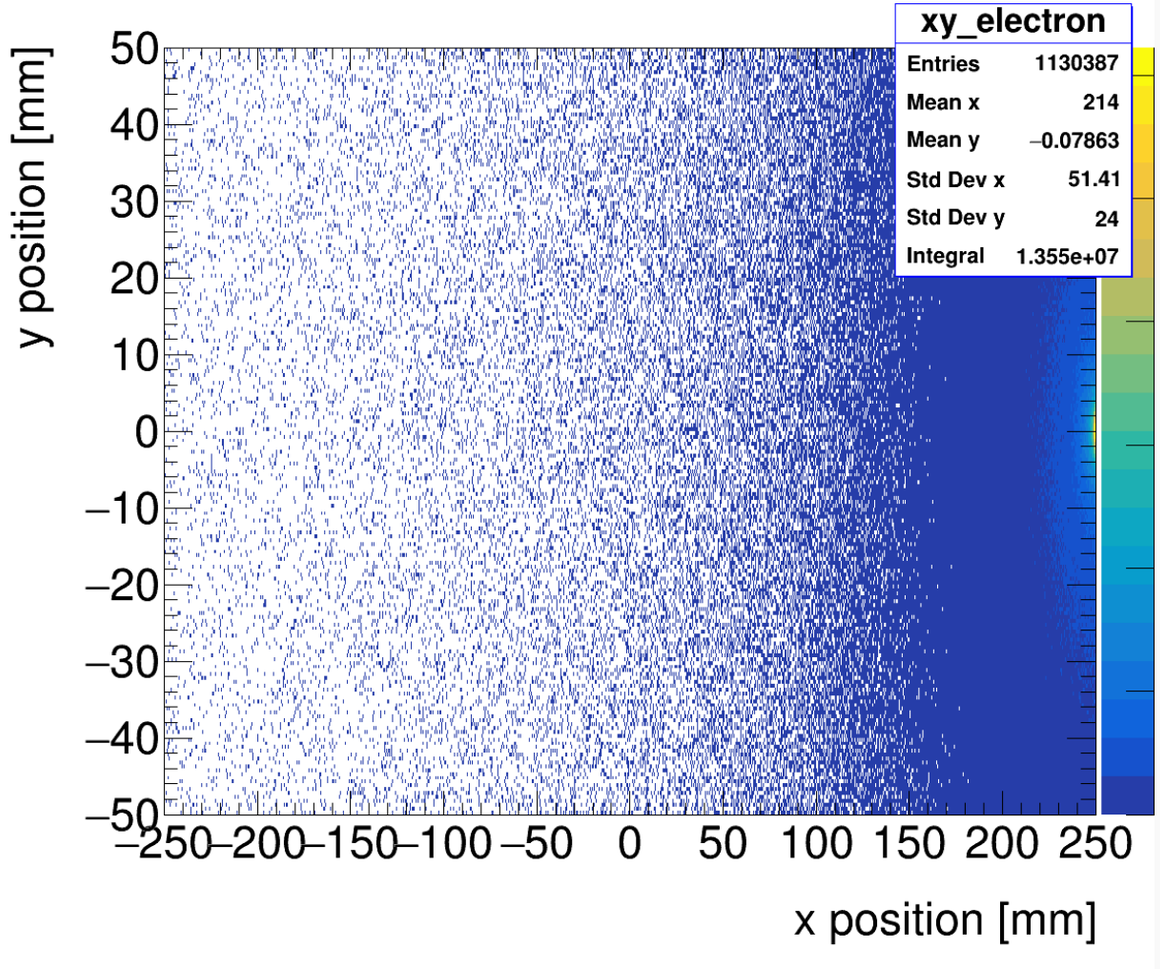
Here the general S/B in the highest flux region is a few thousand.

W_0 = 8 μm, phase-I LASER

Backup

‘Exotic’ Particles in Geant4 Background Simulation





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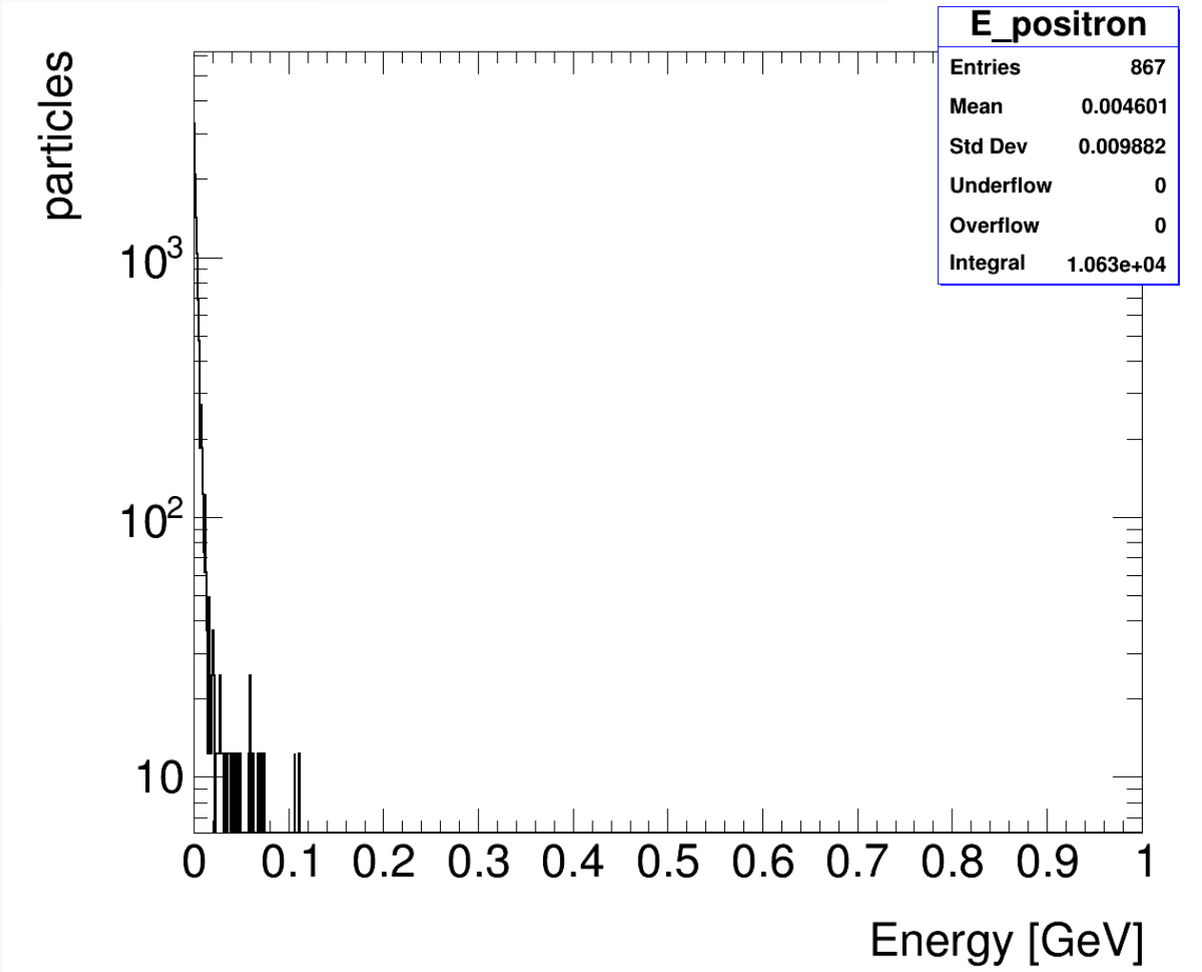

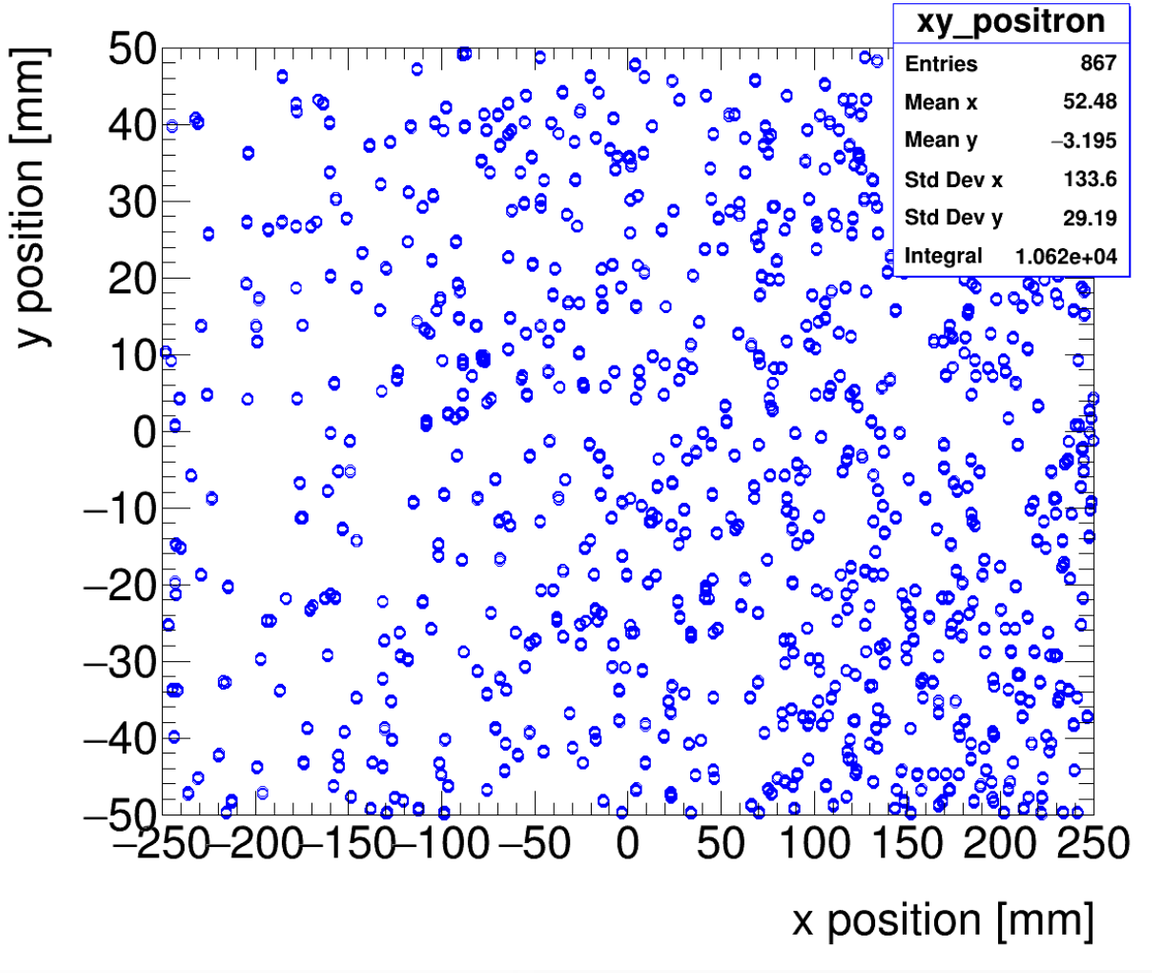

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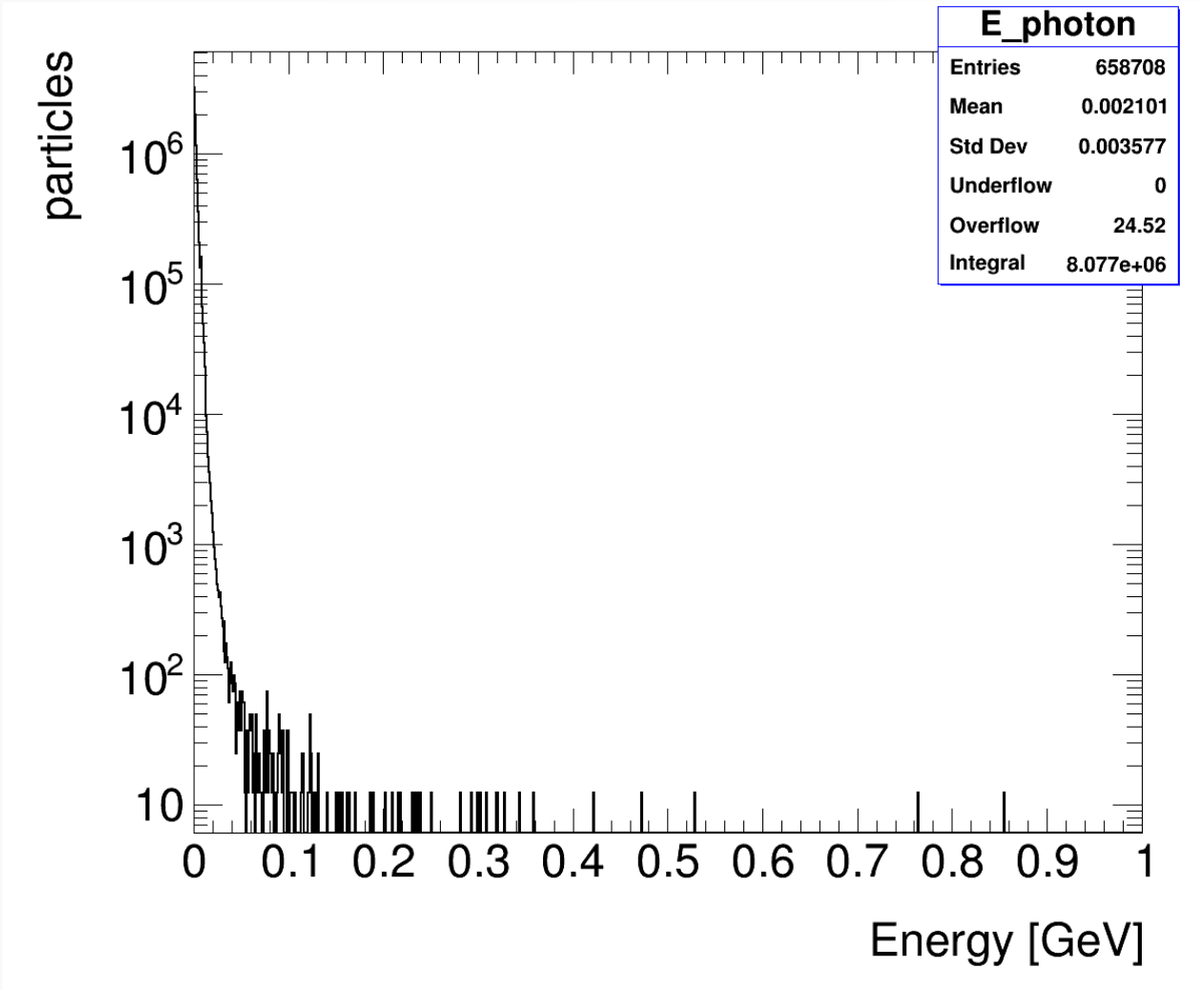

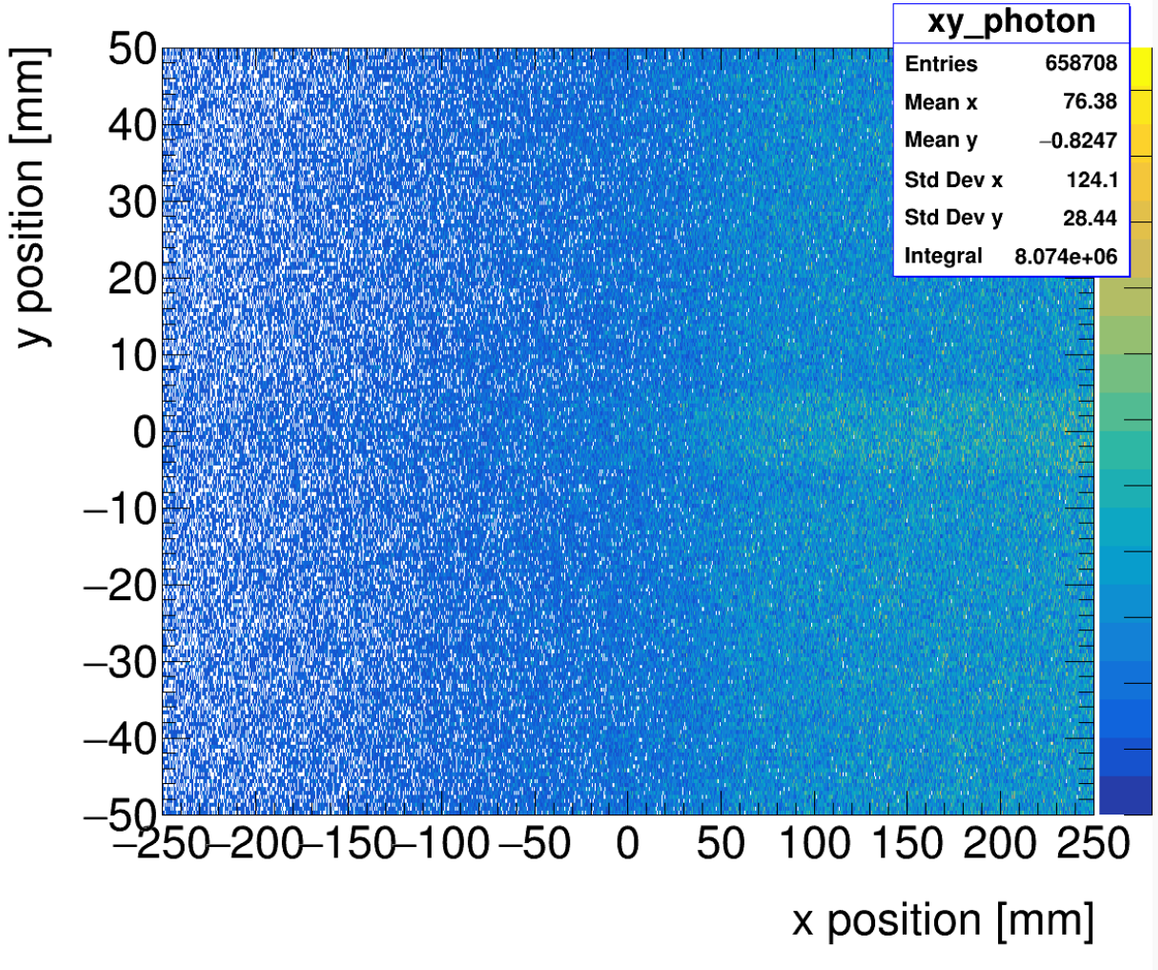

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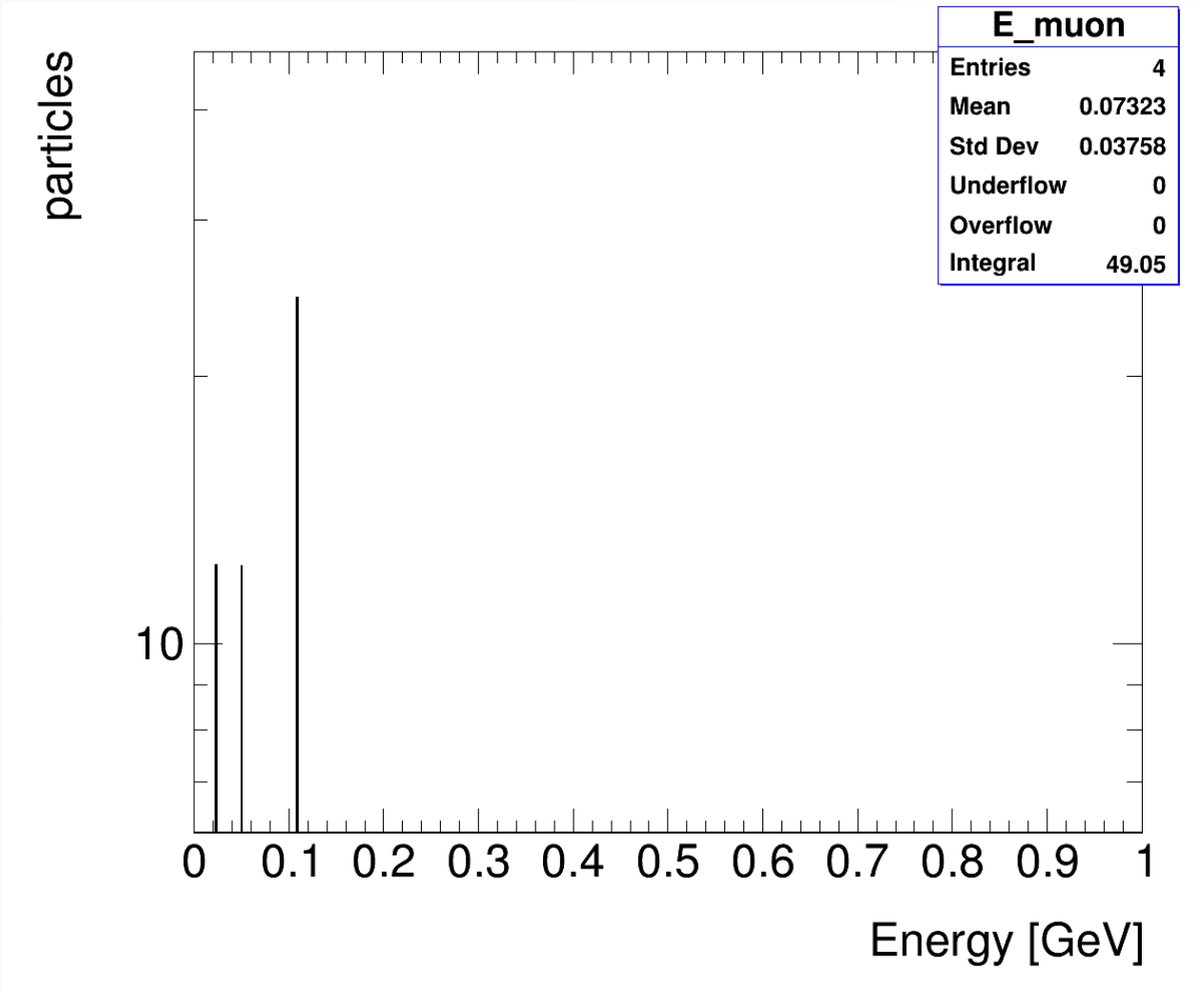

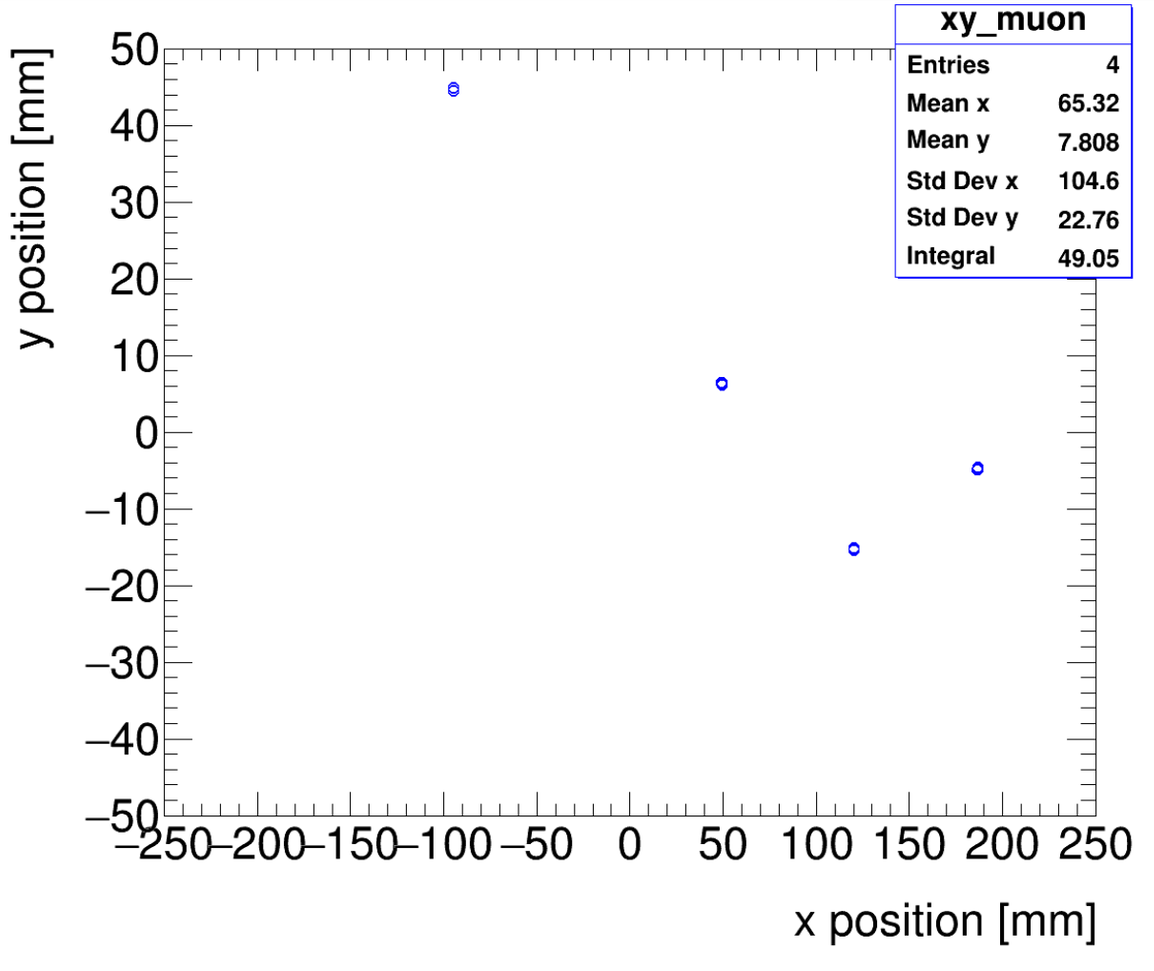

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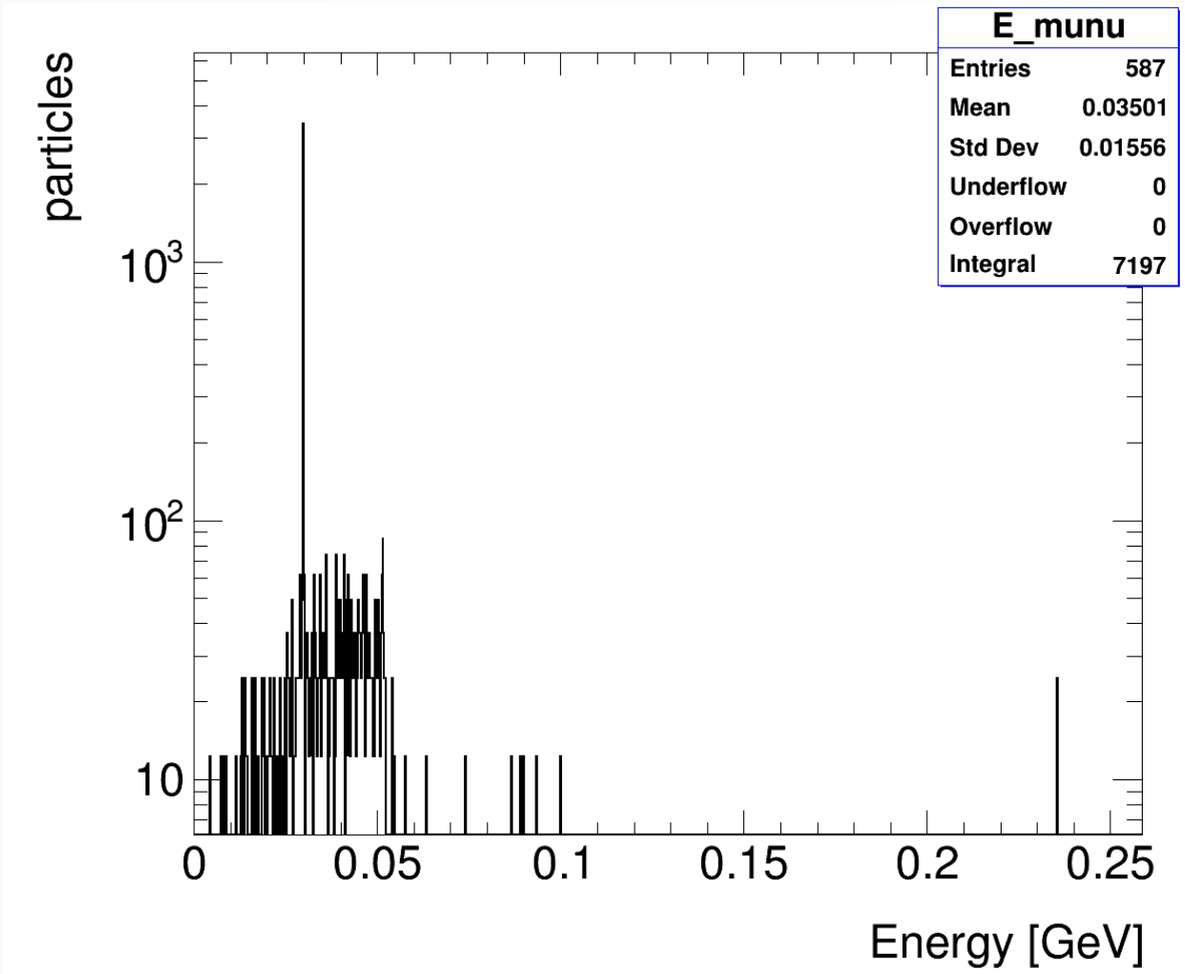

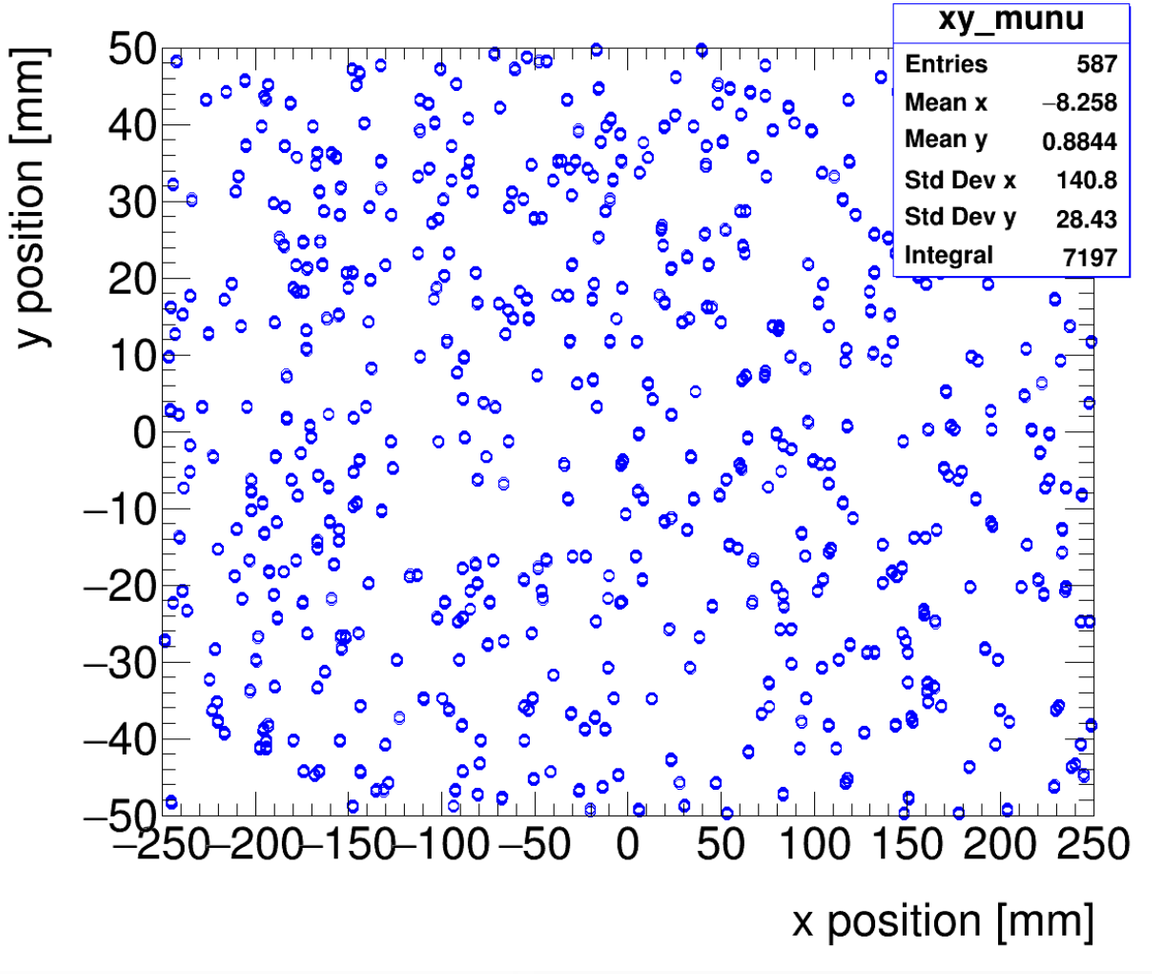

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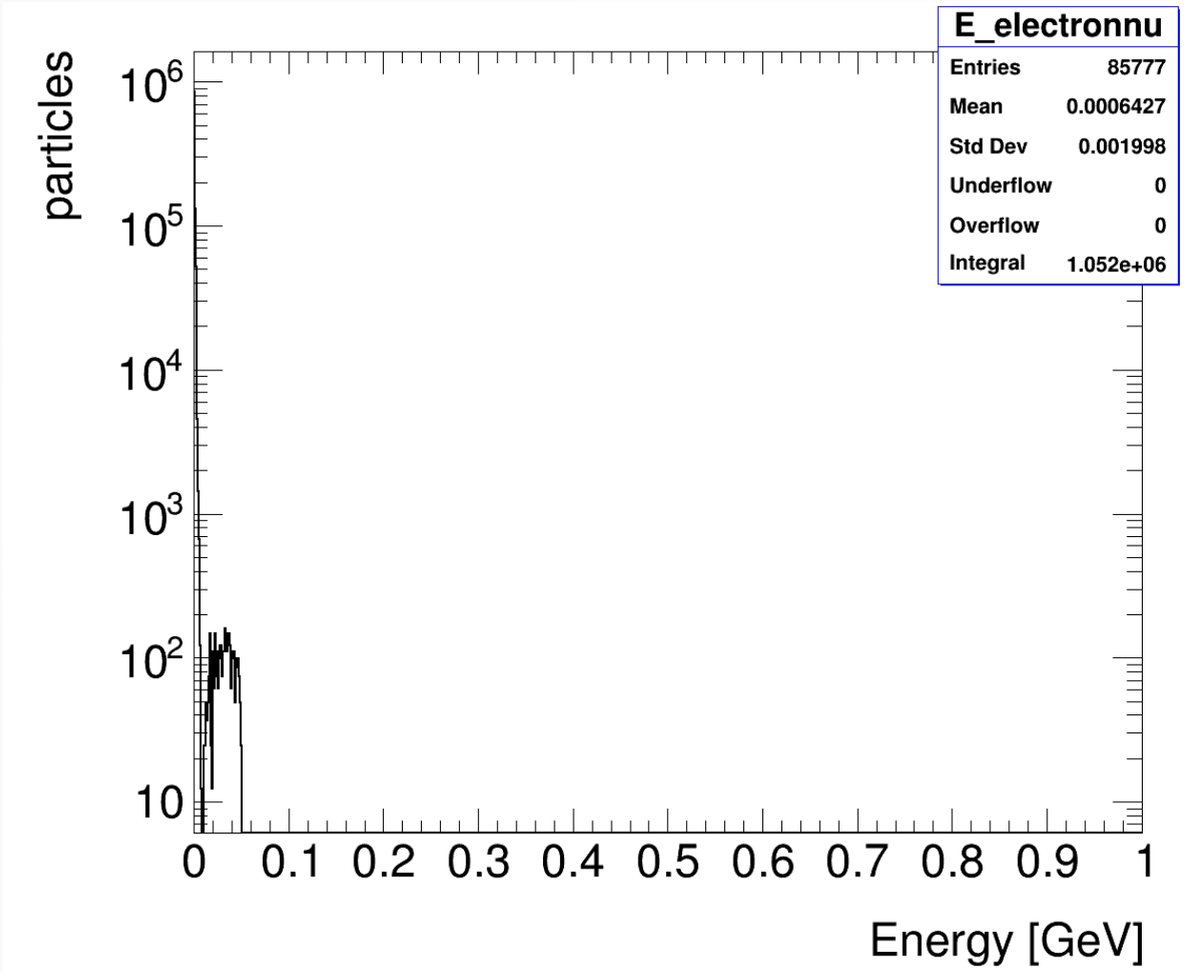
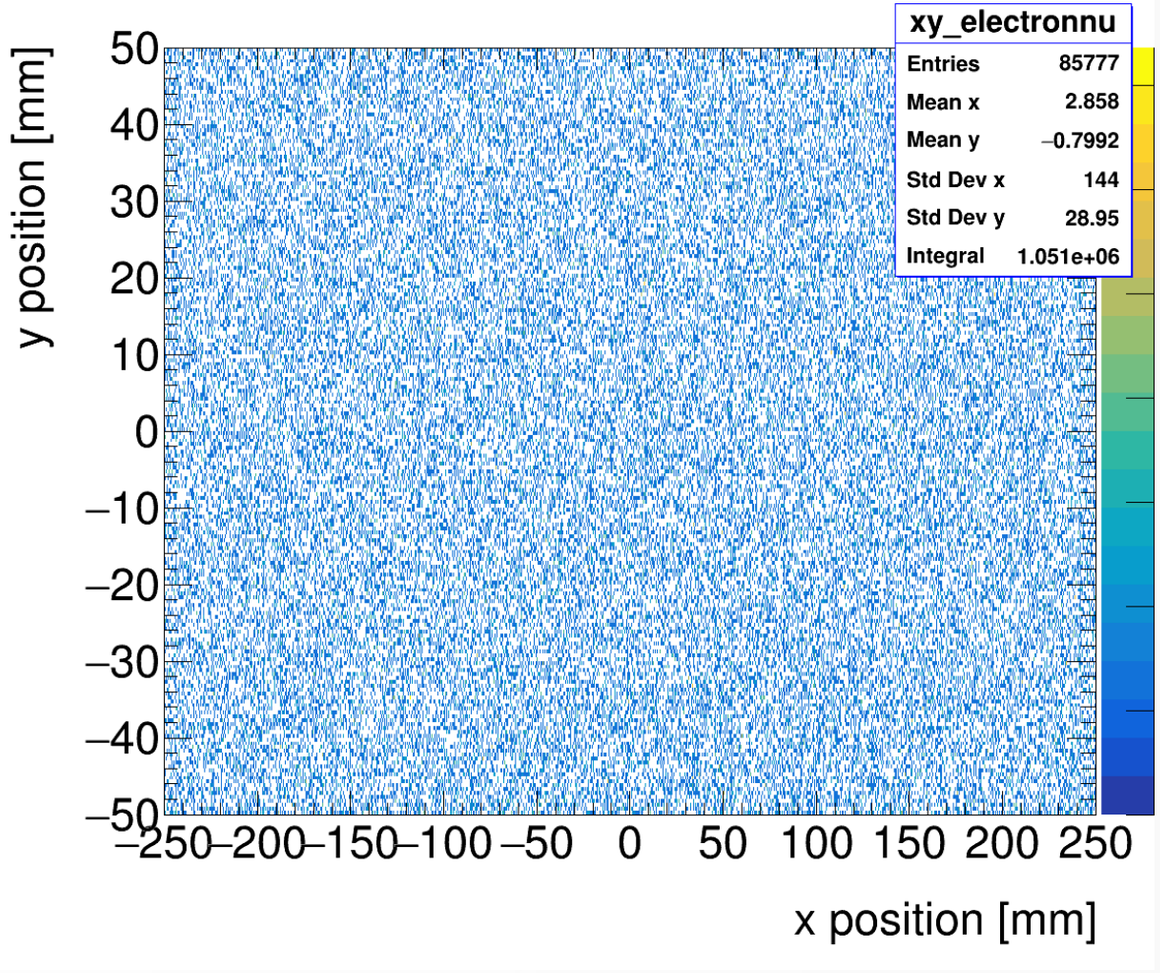




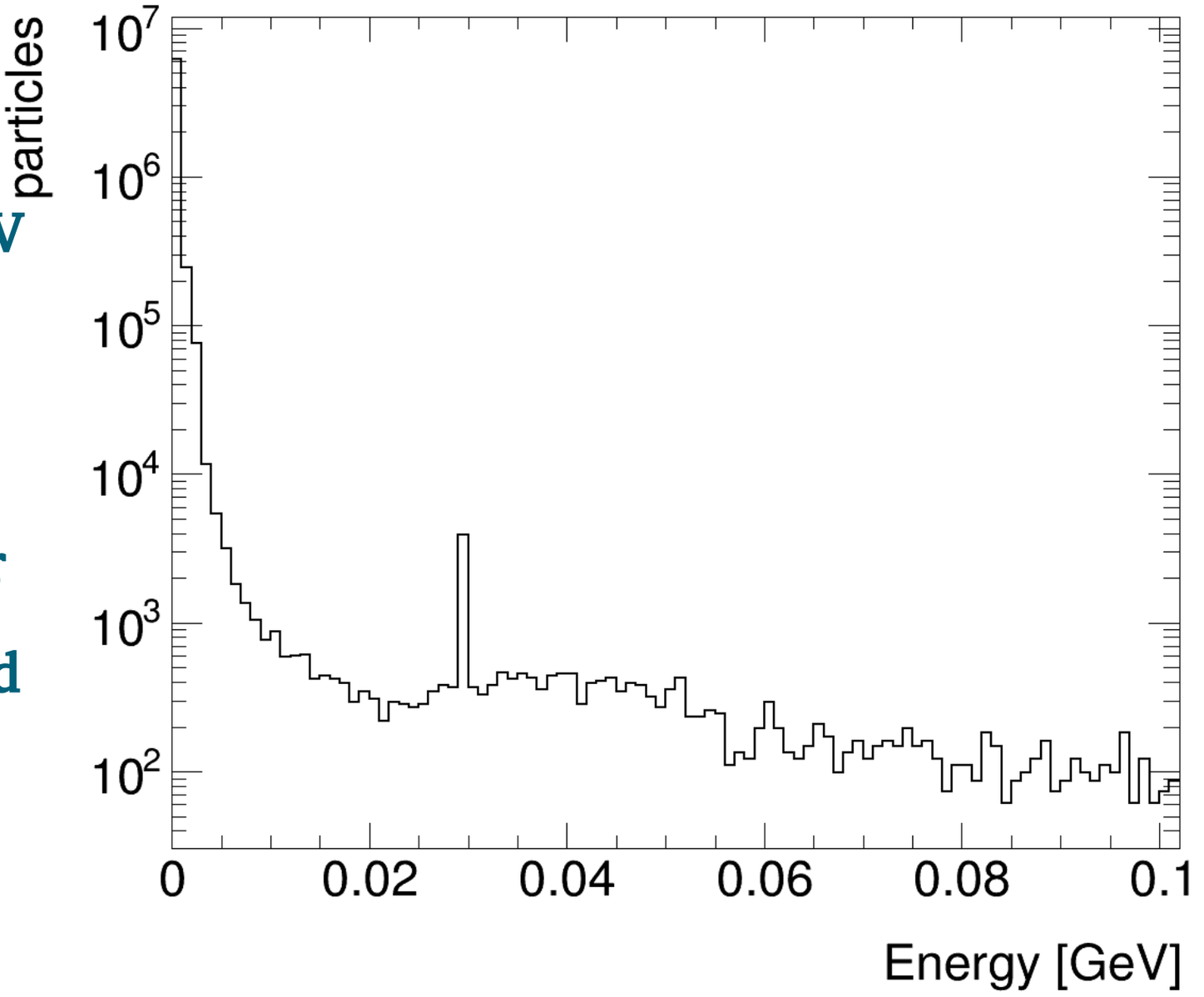
‘Exotic’ Particles in Geant4 Background Simulation

- peak at 29-30 MeV

- Muon Neutrinos

- Any ideas?

- Not important for LUXE, as they are neutrinos, just weird



QED Particles in Geant4 Signal Simulation