Update on LUXE GEANT4 Simulation

Oleksandr Borysov

LUXE S&A Meeting
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Electron laser background with QGSP_BERT_HP

Simulation	# particles	Processed (BX)	Location	Notes
Electron background for electron-laser setup, fast simulation updated ECal geometry	2.0764e11 2.1207e11 2.485e10	138.42 141.38 16.56	/nfs/dust/luxe/user/oborysov/hics_list/list_root_hics_background_fast_9f6b6590_0_16.txt /nfs/dust/luxe/user/oborysov/hics_list /list_root_hics_background_fast_9f6b6590_17_33.txt /nfs/dust/luxe/user/oborysov/hics_list /list_root_hics_background_fast_9f6b6590_34_35.txt	Setup corresponds to commit 9f6b6590 of hics_fast branch, ECal has stainless casing and additional lead shielding between the beam pipe and detectors (tracker, ECal). Particle tracking is stopped when it crosses any of beam dump or shielding volumes. IP magnet: 1 T.
Background for gamma-laser setup, fast simulation updated ECal geometry	6.051e10	40.34	/nfs/dust/luxe/user/oborysov/hics_list/list_root_bppp_background_fast_0508546b_0_5.txt	ECal has stainless casing. Particle tracking is stopped when it crosses Shielding, BeamDumpAssembly, GammaBeamDumpAssembly
Background for gamma-laser setup, fast simulation, updated geometry to reduce background	1.1917e11 7.463e10 2.5266e11	79.45 49.75 168.44	/nfs/dust/luxe/user/oborysov/bppp_list /list_root_bppp_background_fast_850fd10d_0_11.txt /nfs/dust/luxe/user/oborysov/bppp_list /list_root_bppp_background_fast_850fd10d_12_16.txt /nfs/dust/luxe/user/oborysov/bppp_list /list_root_bppp_background_fast_850fd10d_17_33.txt	ECal has stainless casing. The beam pipe section which joins interaction chamber with vacuum chamber changed to rectangular with bigger cross section. Particle tracking is stopped when it crosses Shielding, BeamDumpAssembly, GammaBeamDumpAssembly. IP magnet: 1.6 T.
Electron background for electron-laser setup, simulation with QGSP_BERT_HP physics list	2.7829e8	0.1855	/nfs/dust/luxe/user/oborysov/hics_list /list_root_hics_background_qgsp_9a61db54_0_13.txt	Simulation with QGSP_BERT_HP physics list. Geometry corresponds to commit 9a61db54 of hics branch. Sapphire planes of Beam Profiler were implemented compared to previous fast simulation (9f6b6590).

G4 with beam profiler and QGSP_BERT_HP physics list

IPstrong_V1.1.00
JETI40
e_laser 16.5 GeV

MC	# MC out (BX)	Processed (BX)	Location	Notes
w0_5000nm	986	978	/nfs/dust/luxe/user/oborysov/hics_list /list_root_hics_w0_5000nm_qgsp_bert_hp_9a61db54.txt	Geometry with sapphire planes for beam profiler (hics 9a61db54) and QGSP_BERT_HP physics list
w0_8000nm	986	982	/nfs/dust/luxe/user/oborysov/hics_list /list_root_hics_w0_8000nm_qgsp_bert_hp_9a61db54.txt	Geometry with sapphire planes for beam profiler (hics 9a61db54) and QGSP_BERT_HP physics list

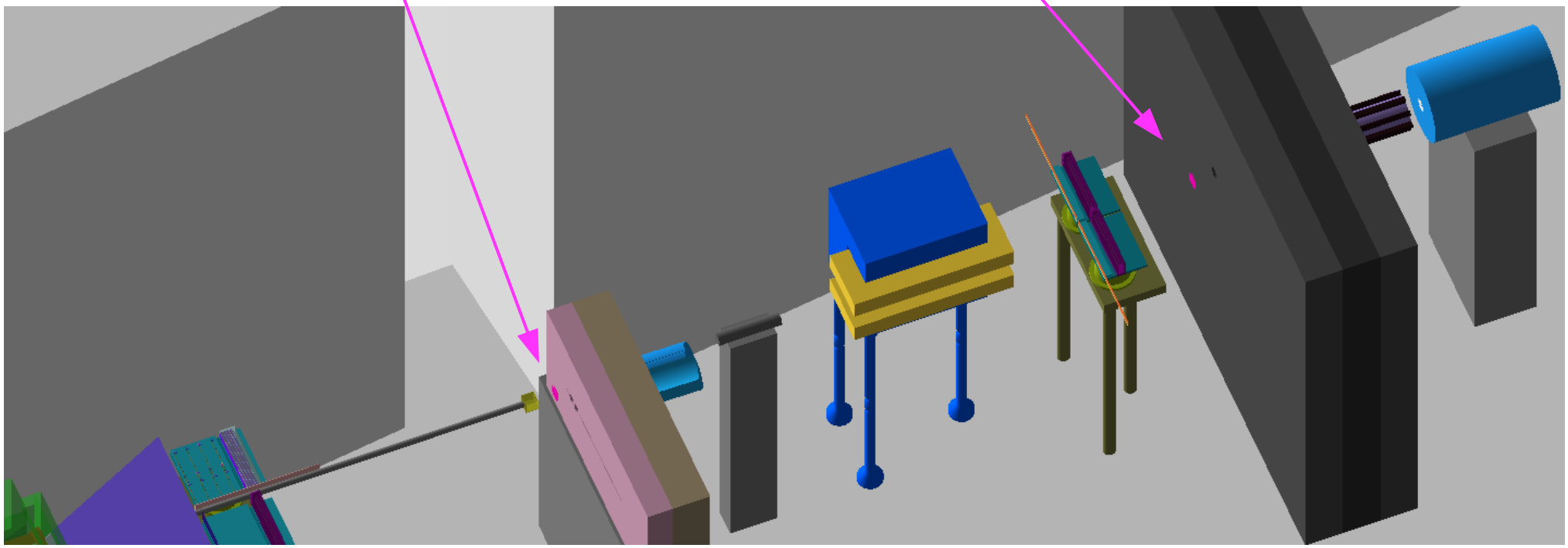
There is 1BX of MC ptarmigan for ξ=2

`/nfs/dust/luxe/user/oborysov/hics_list/list_root_hics_xi2_ptarmigan_qgsp_bert_hp_9a61db54.txt`

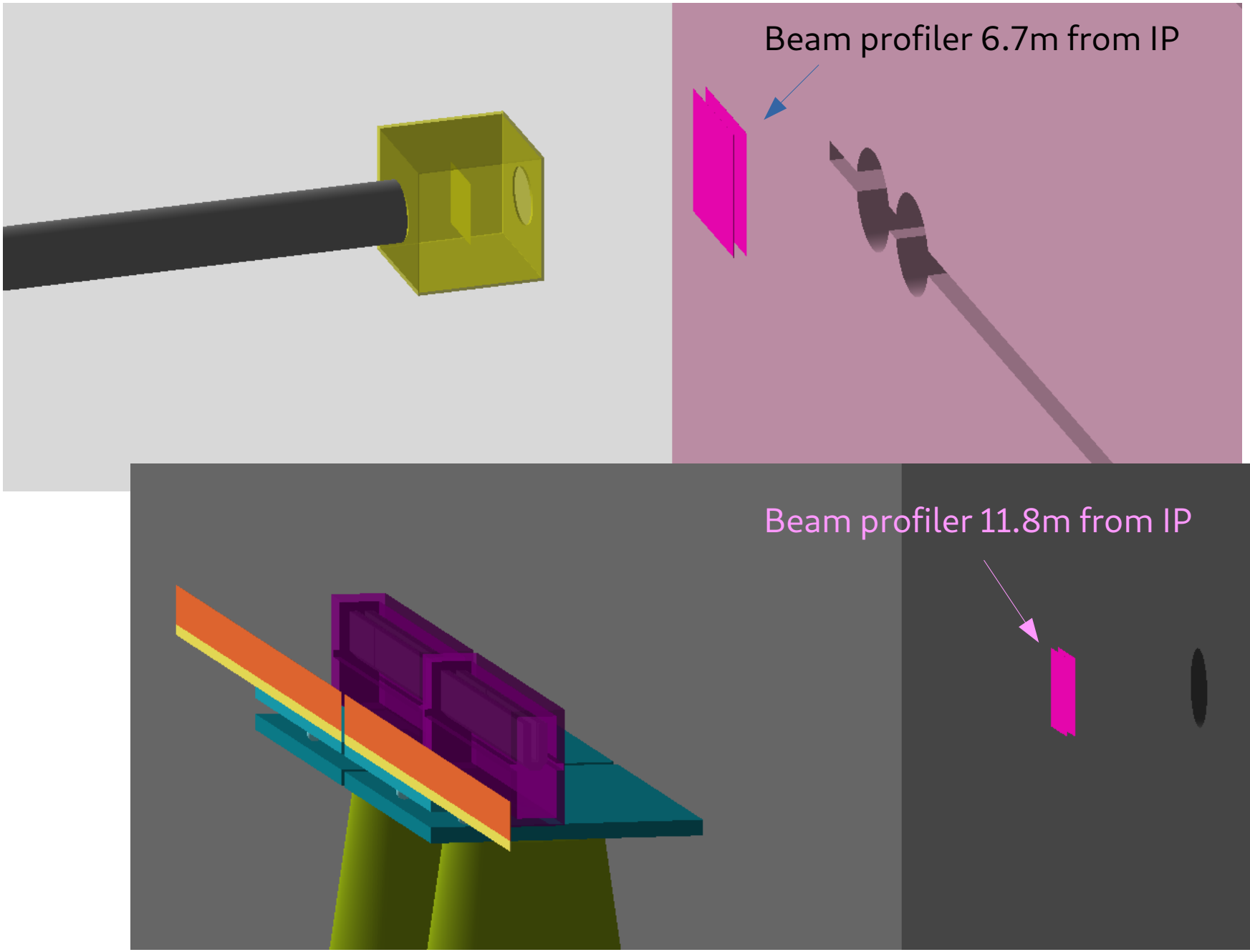
Sapphire planes of beam profiler

Beam profiler 11.8m from IP

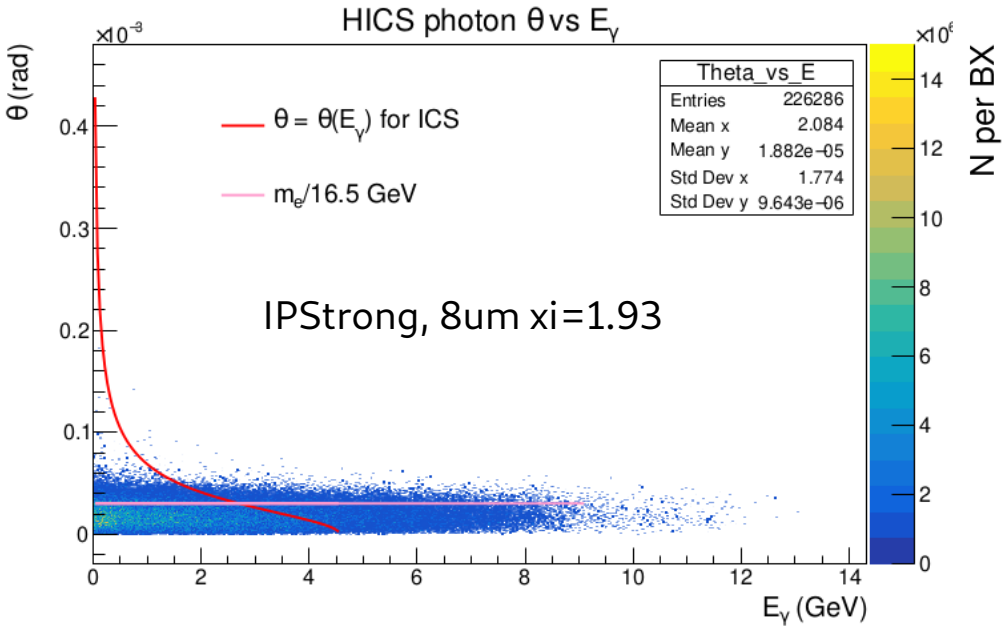
Beam profiler 6.7m from IP

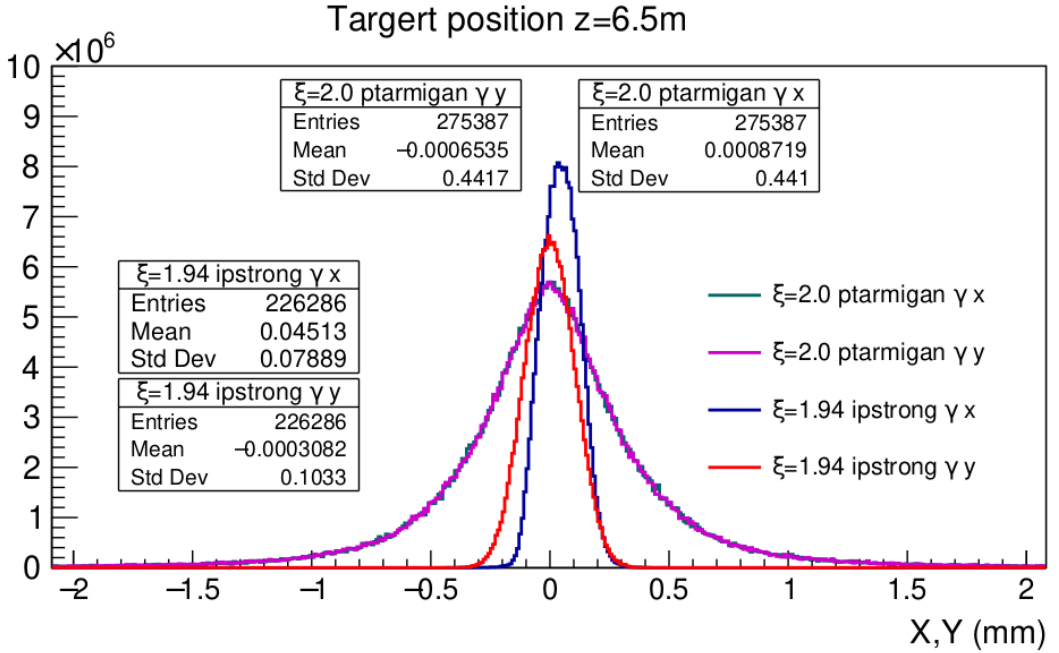


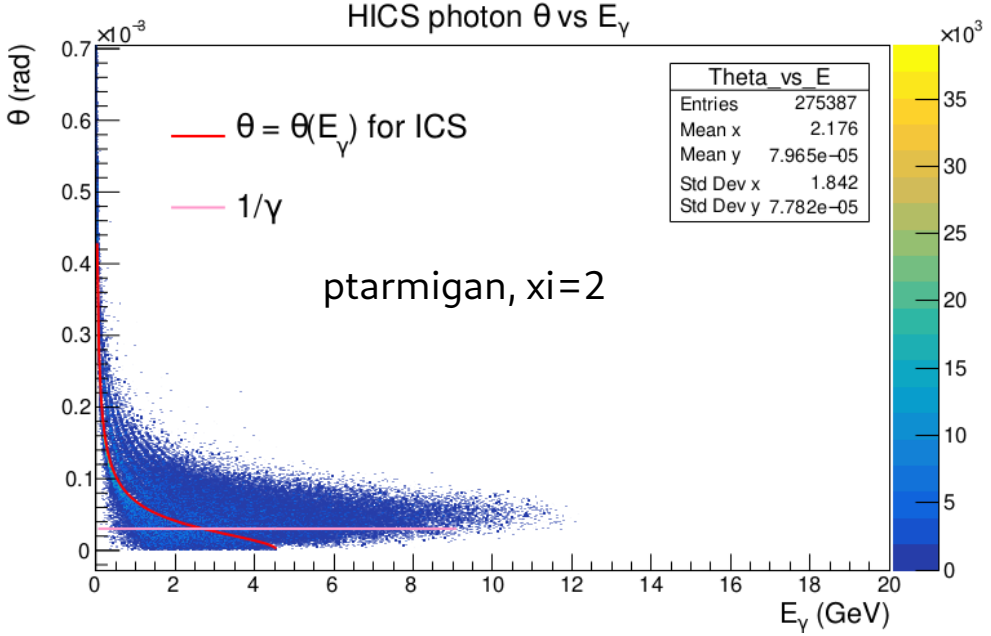
Sapphire planes of beam profiler

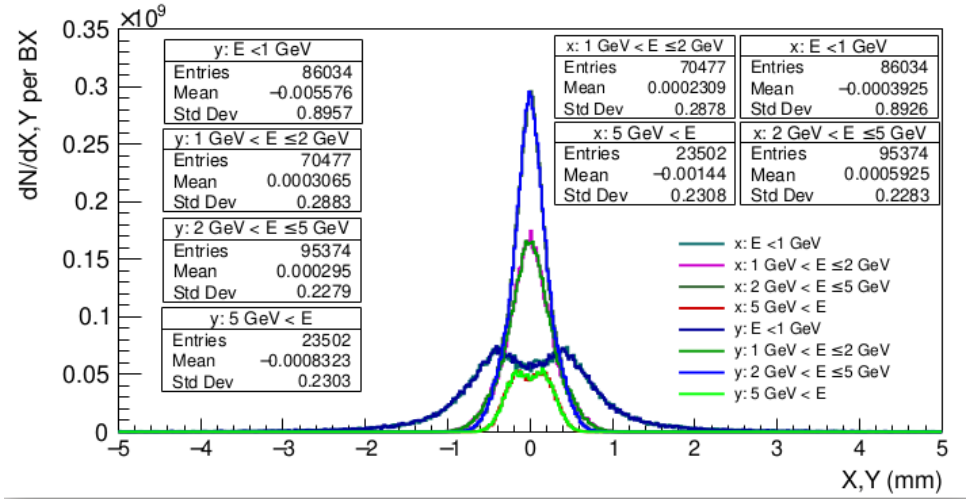


Compton photons IPStrong and Ptarmigan

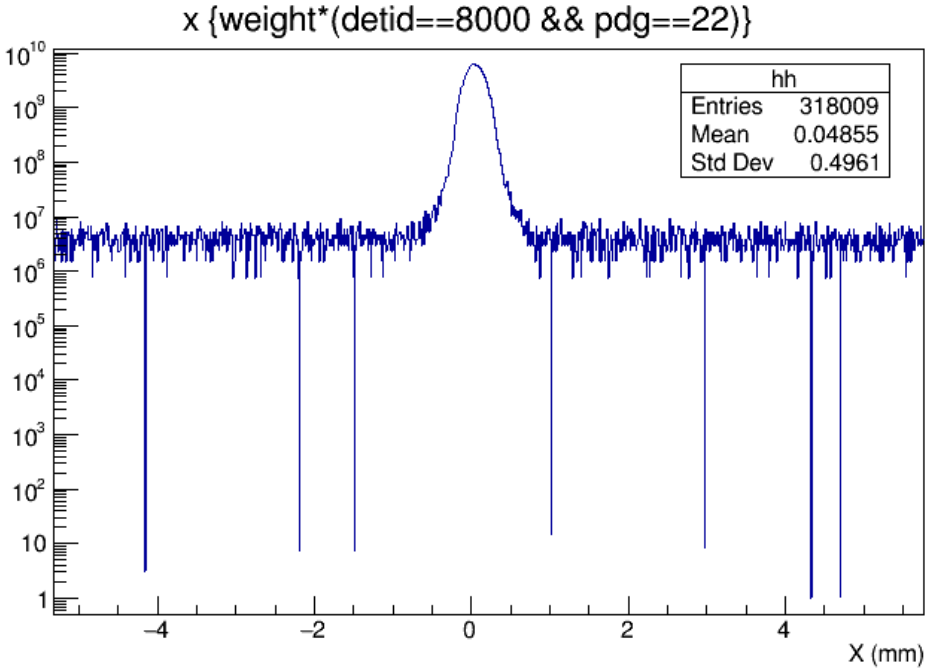


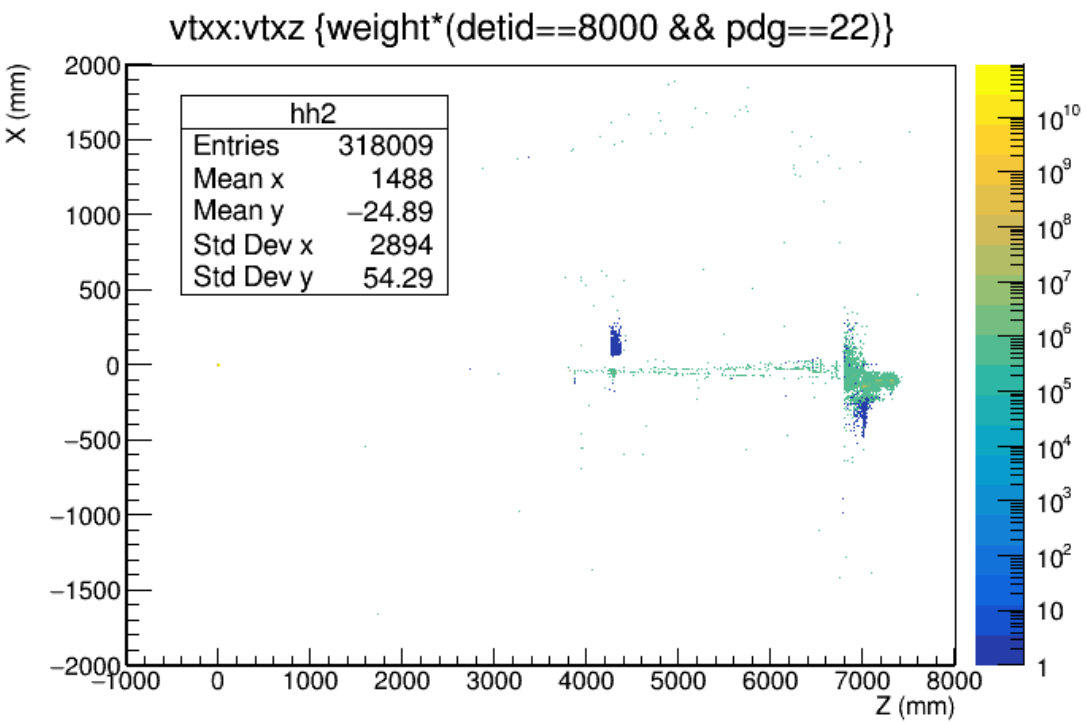


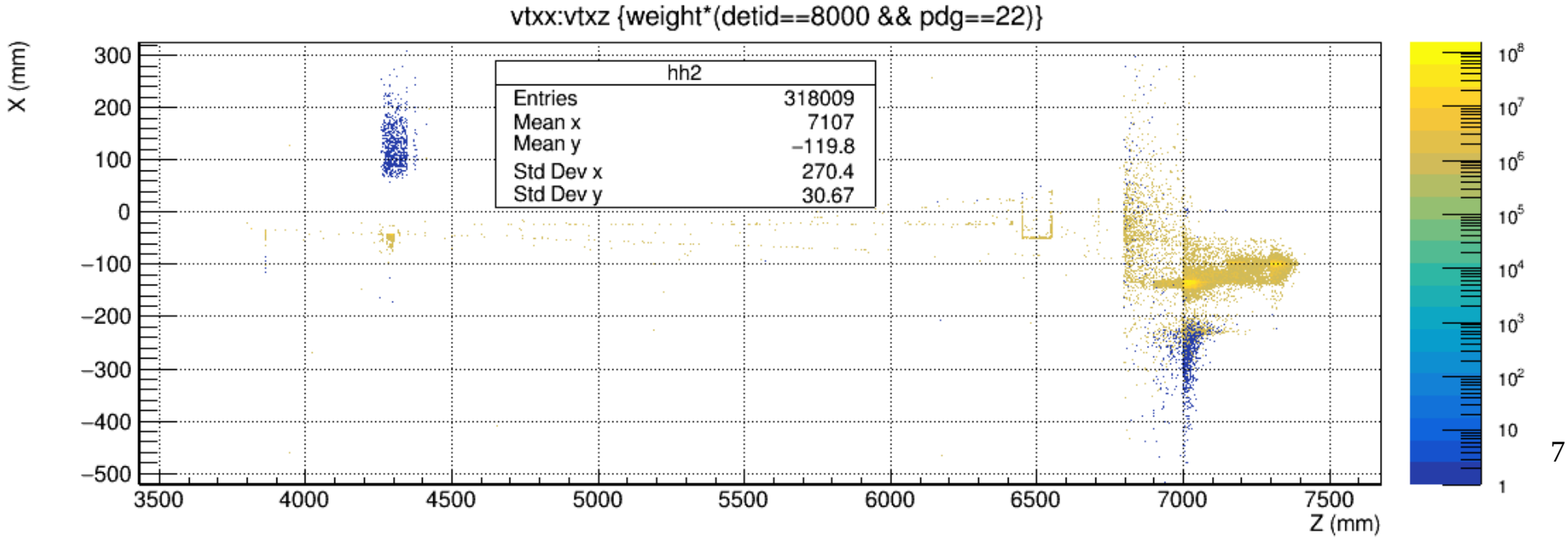




Vertex X,Z distribution of photons crossing first profiler plane



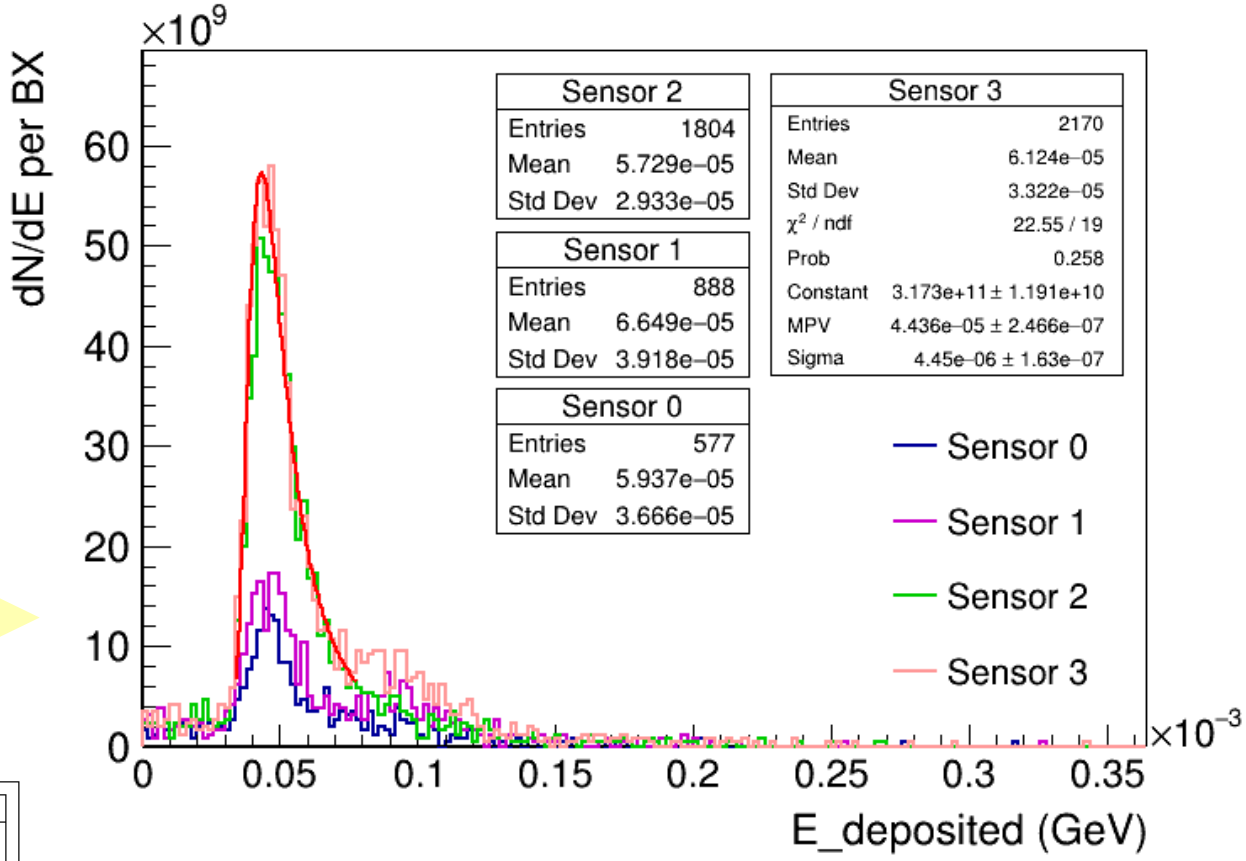




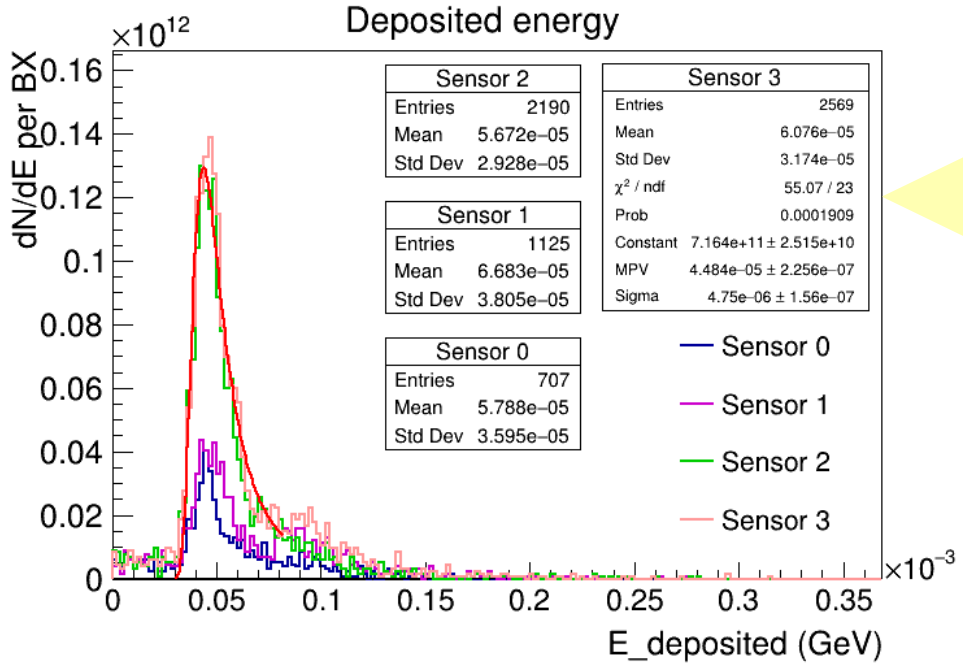
Deposited energy

- Sensor limited to 2 cm by 2 cm;
- Segmented with strips of 100 µm;
- Deposited energy in strips for primary photon is used;
- Strips with zero deposition are ignored

IPStrong, 8um, ξ = 1.9



ptarmigan, ξ = 2.0



Simple standalone test:

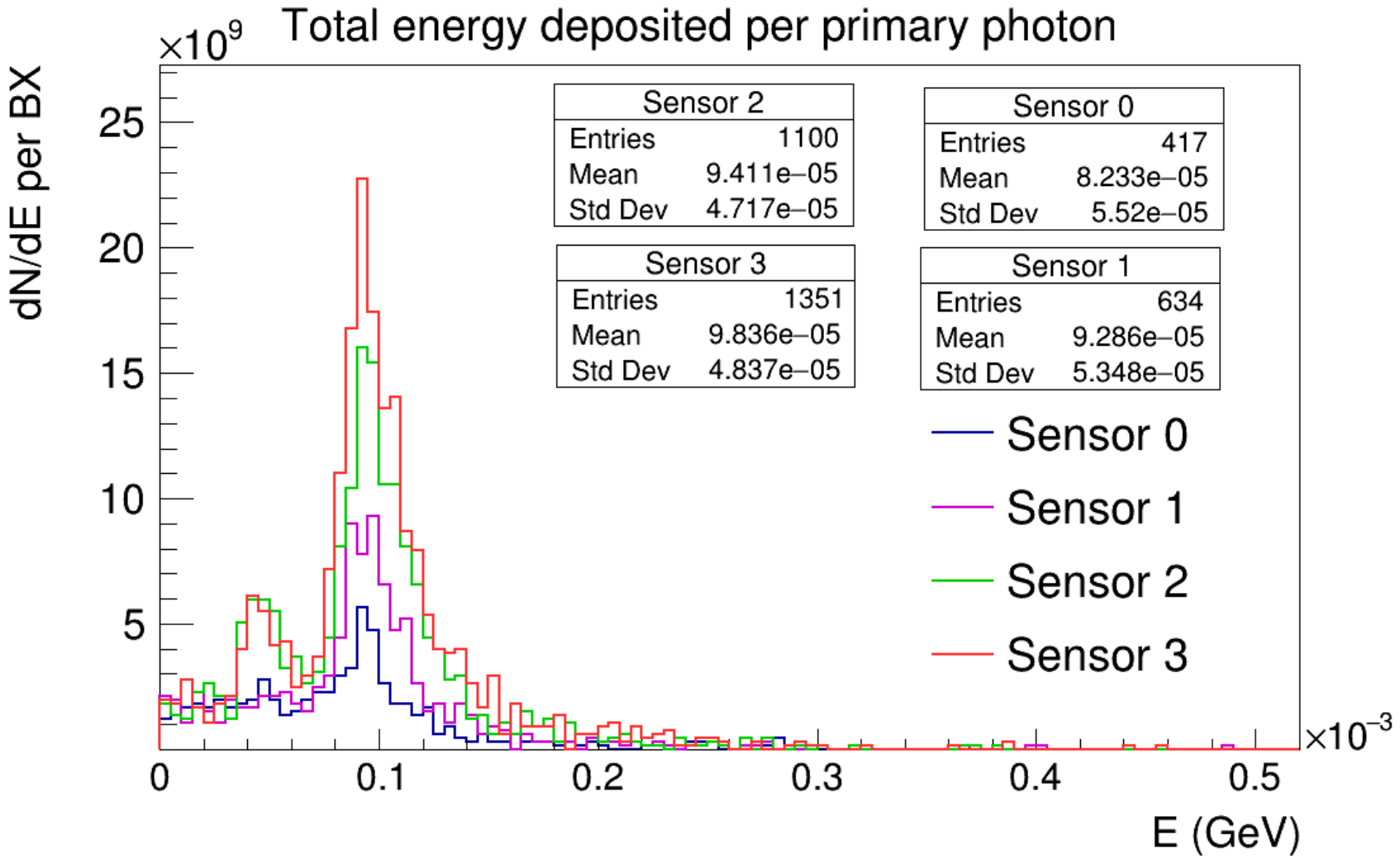
The run was 100000 e- of 10 GeV through 100 um of G4_ALUMINUM_OXIDE (density: 3.97 g/cm3)

Total energy deposit in absorber per event = **56.44 keV** +- 87.46 eV

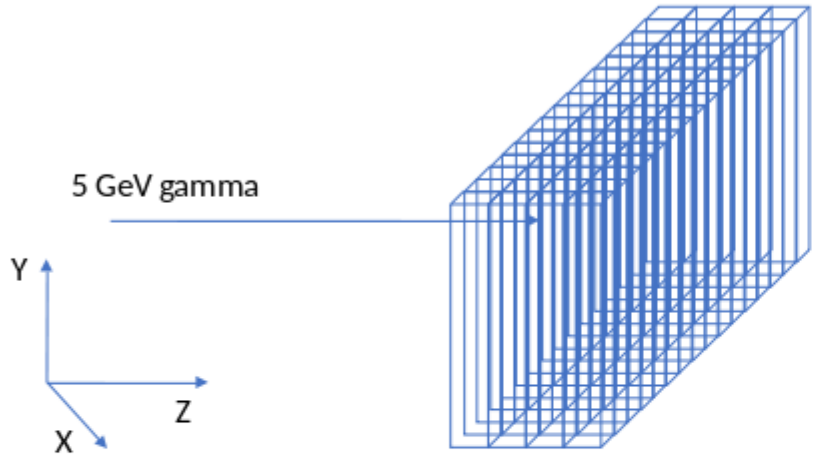
Deposited energy in sensor

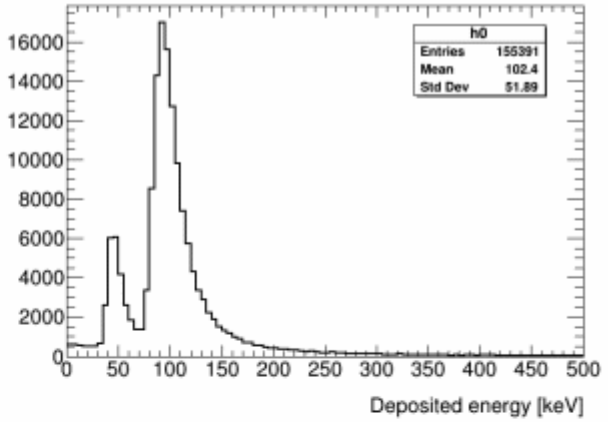
- Sensor limited to 2 cm by 2 cm;
- Events with zero deposition are ignored

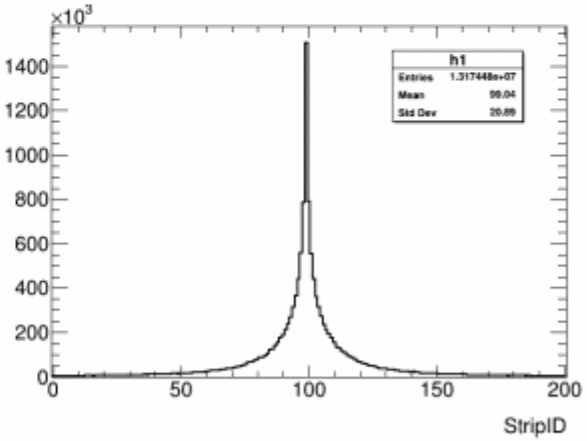
IPStrong, 8um, ξ = 1.9



MC Standalone

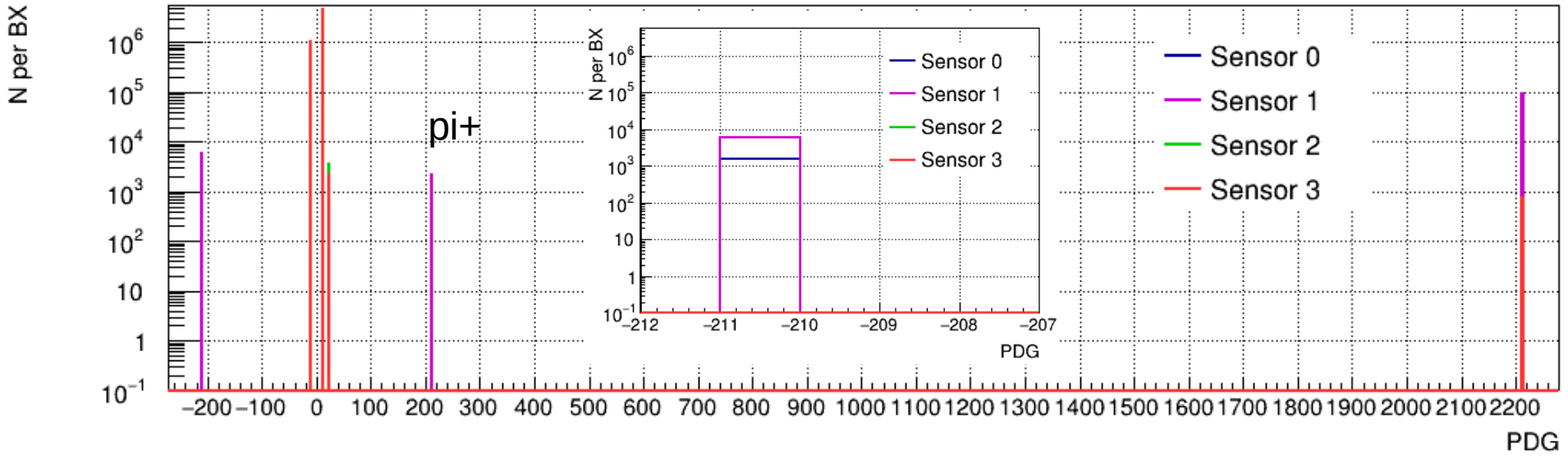






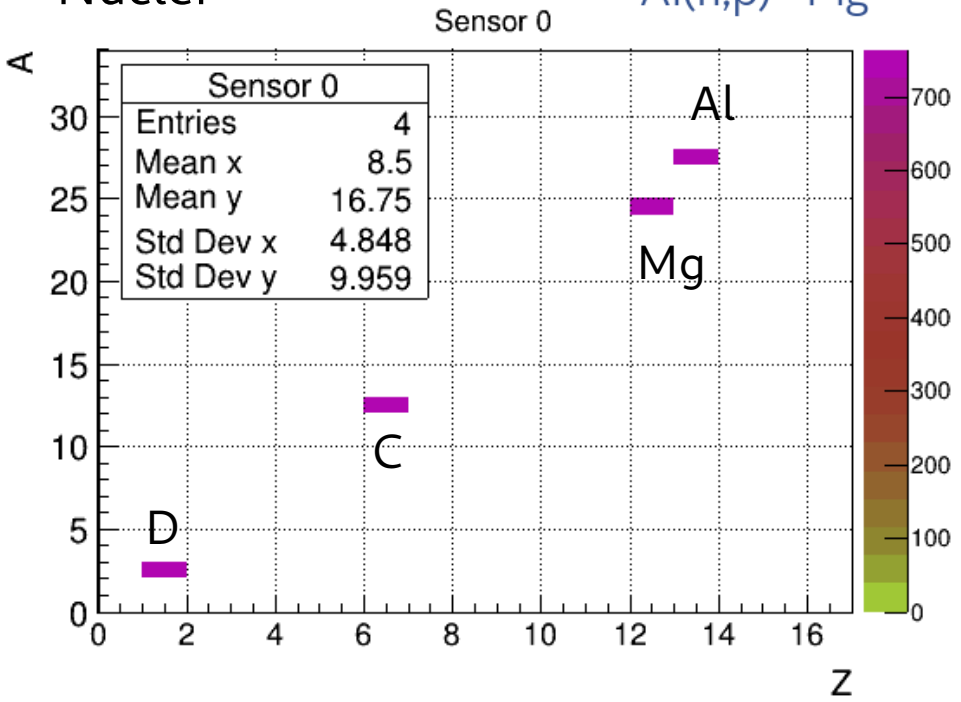
- A standalone Geant4 MC simulation of the detector is being developed to study systematic effects
- First tests performed with a pencil beam of 5 GeV and 6m of air show a non negligible beam width spread

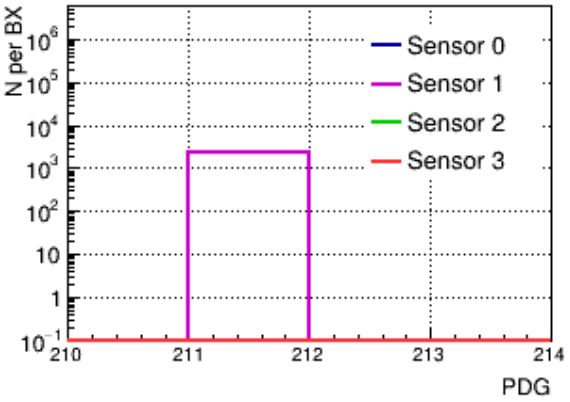
Particles deposited energy in profiler

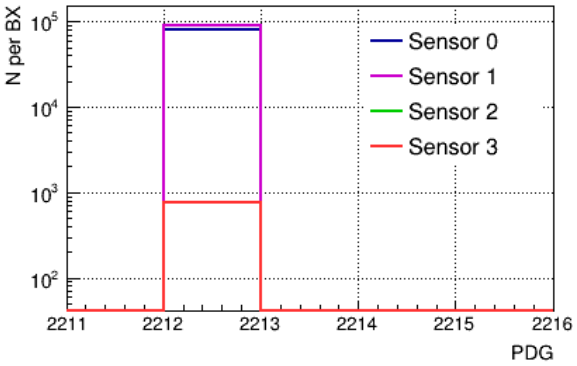


Nuclei

$^{27}Al(n,p)^{27}Mg$



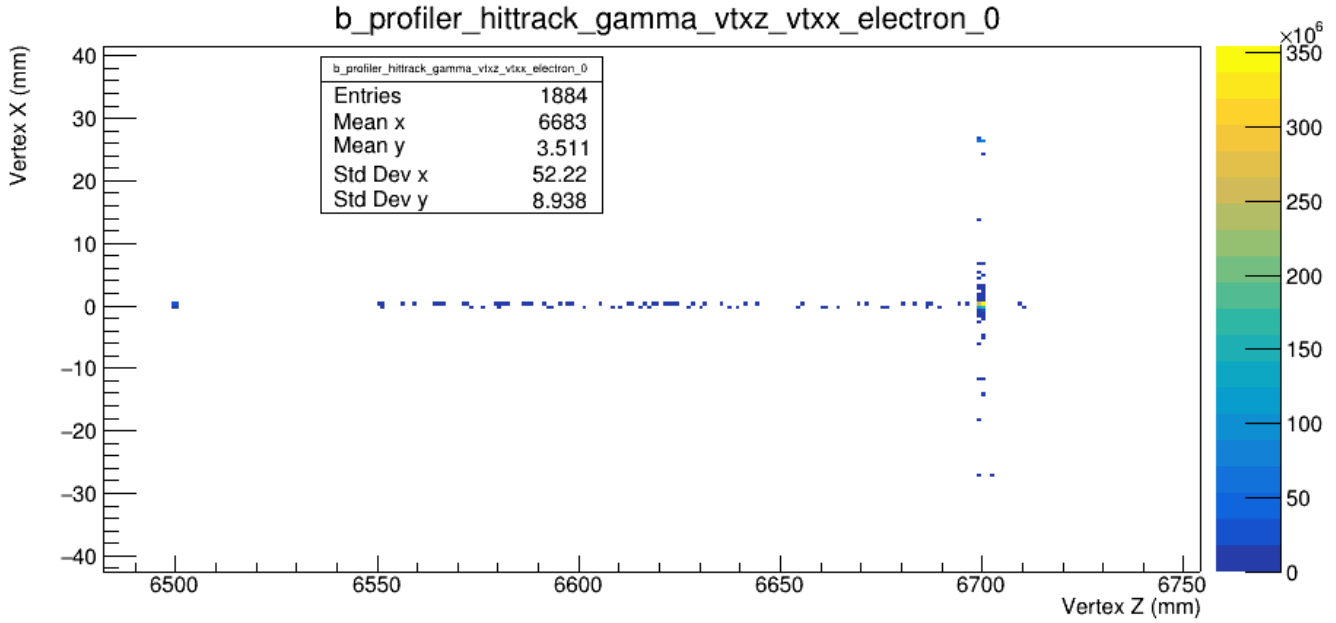


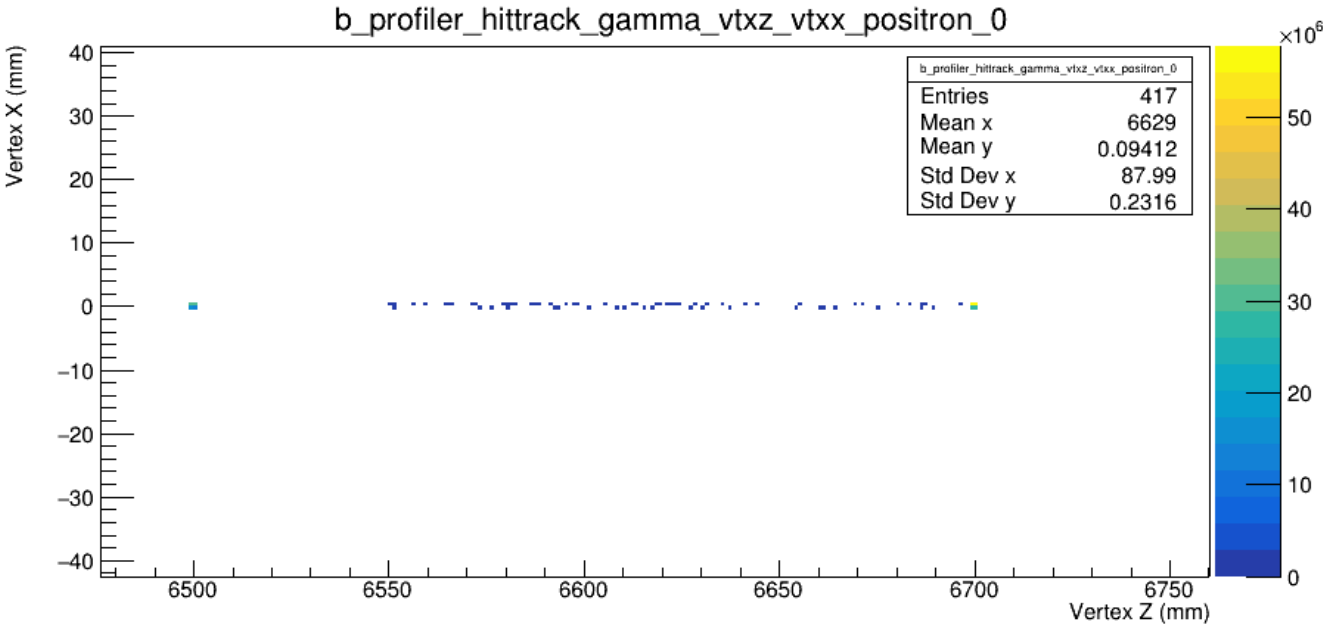


Production vertices

Plane 0

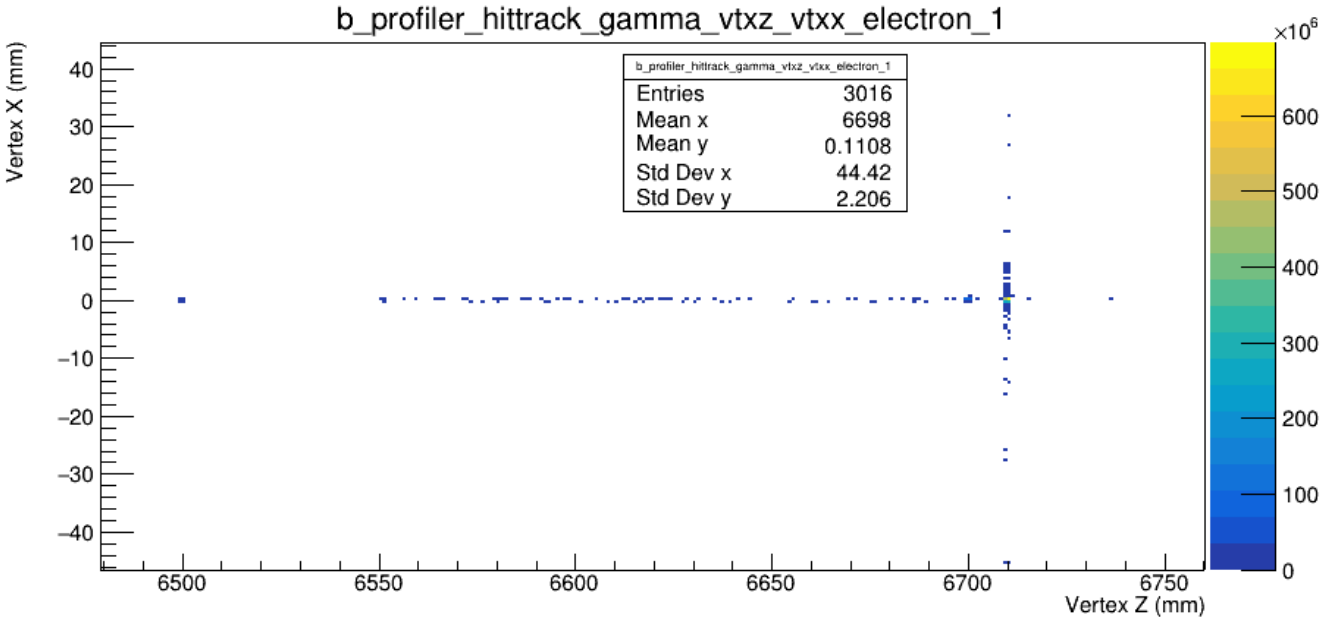
Production vertices: electrons and positrons which deposited energy in profiler planes for events with primary (signal) photons

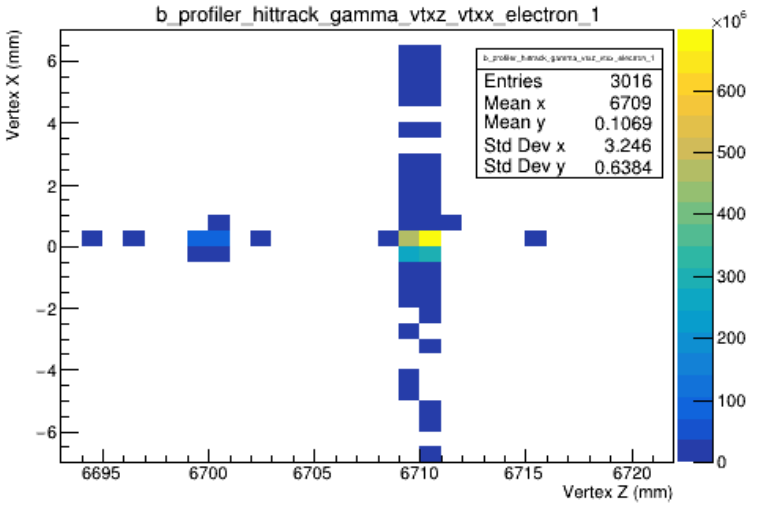


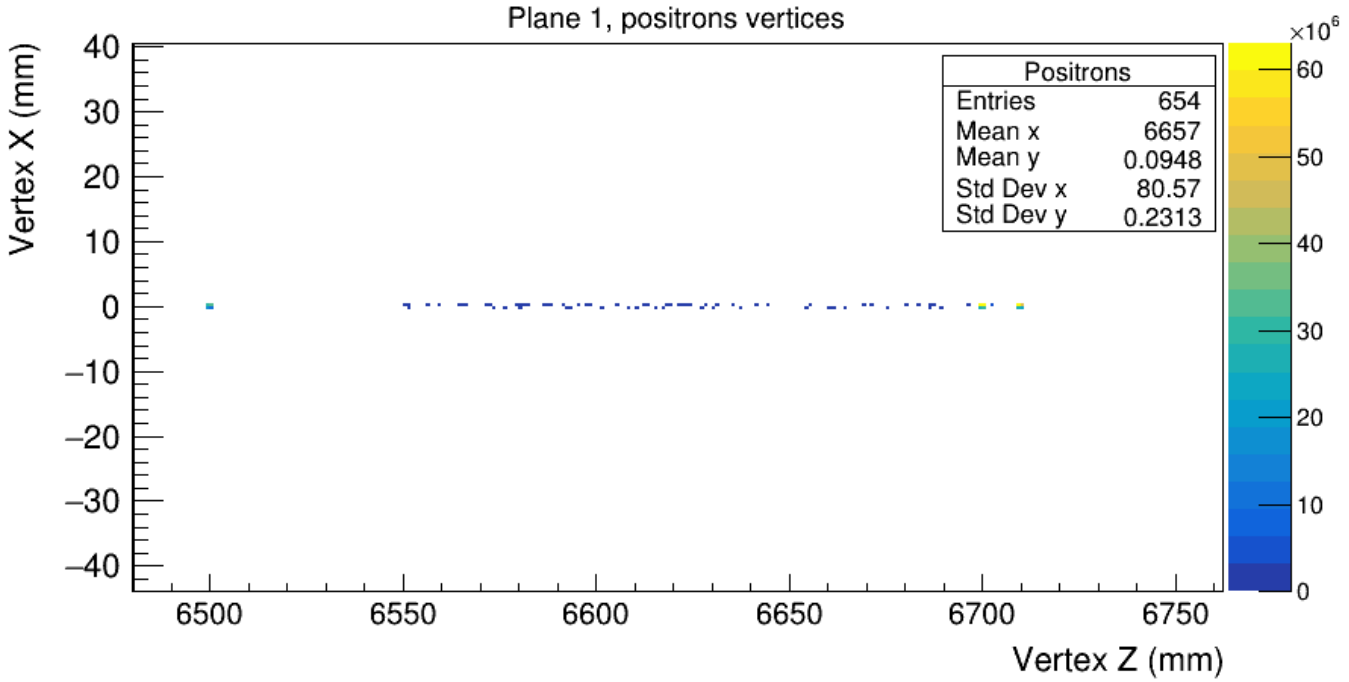


Production vertices

Plane 1





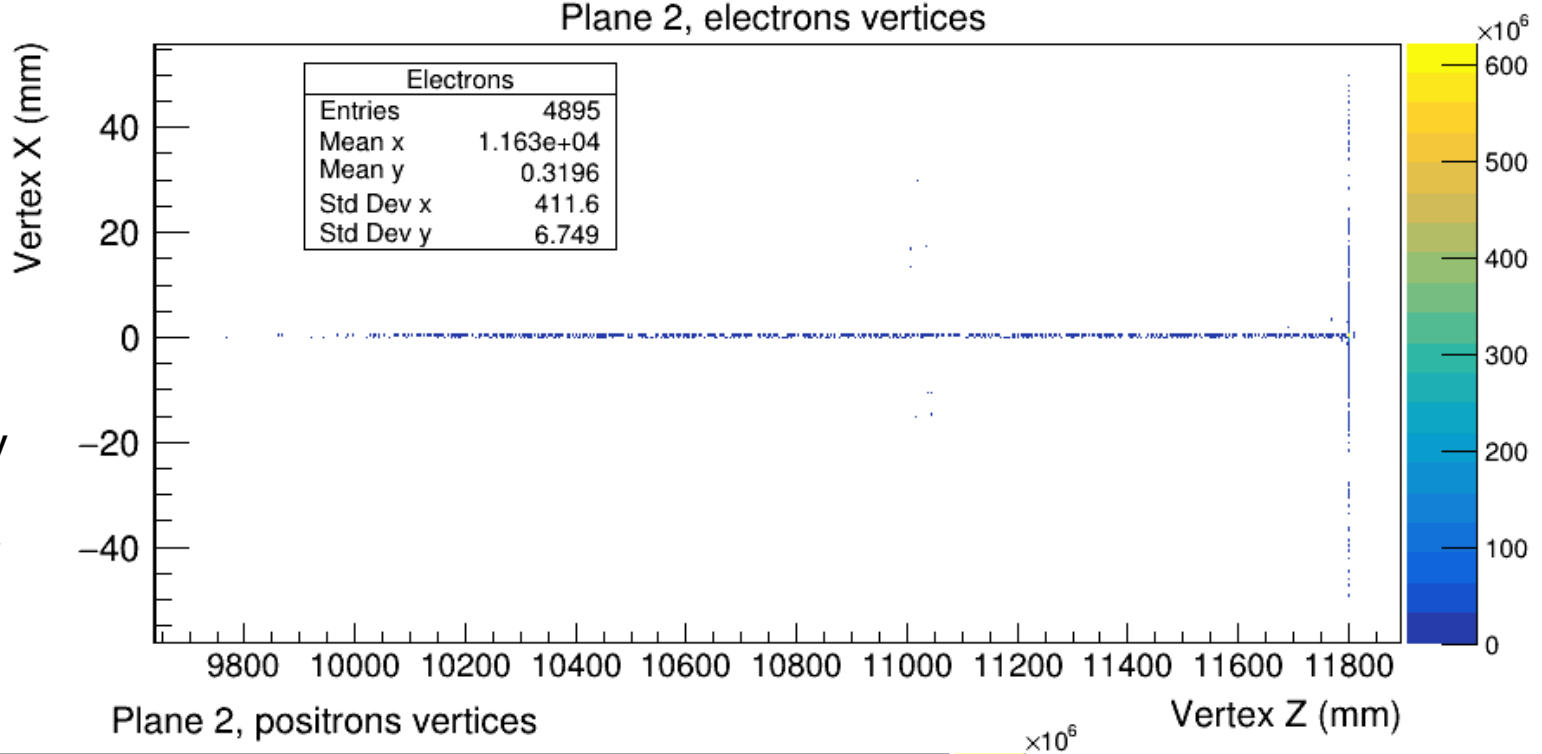


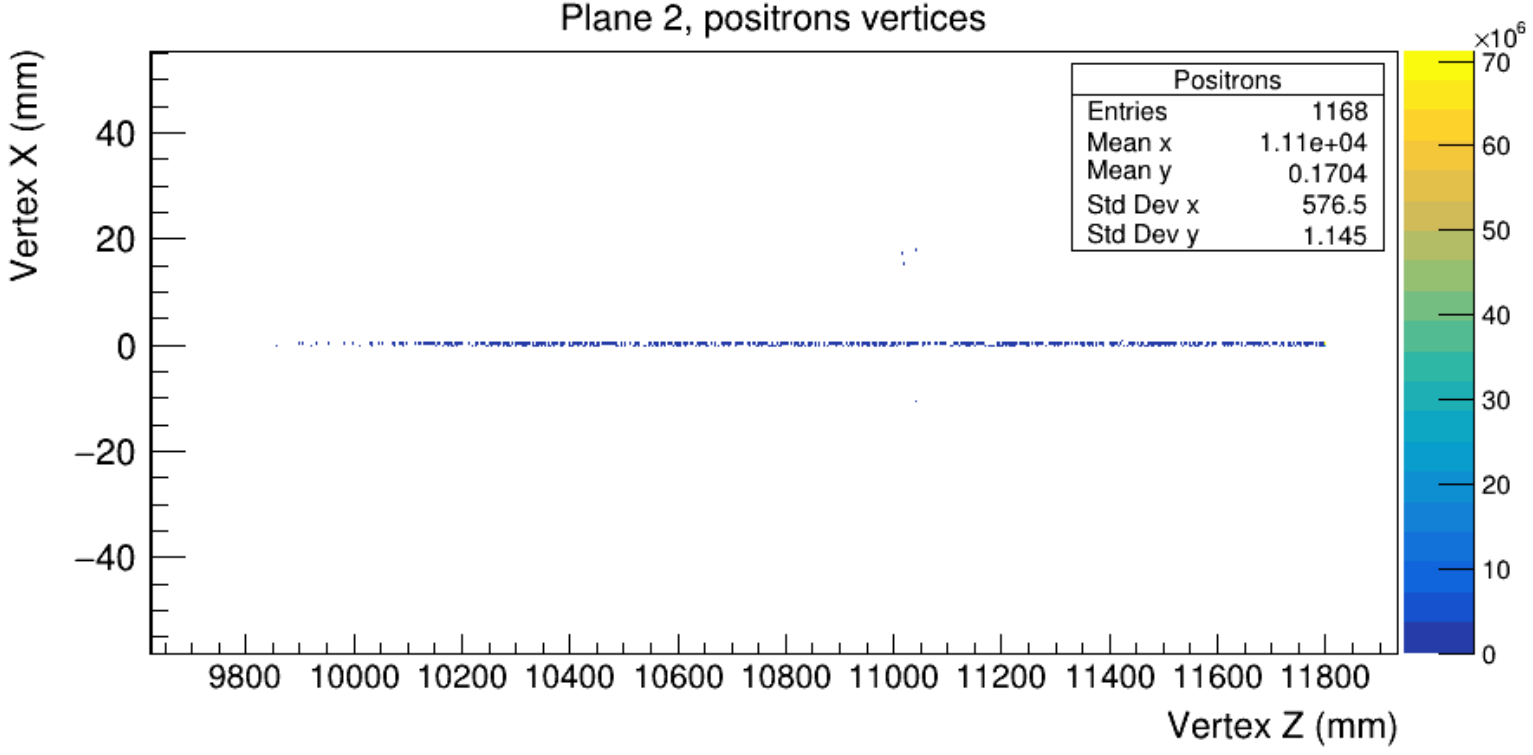
Production vertices: electrons and positrons which deposited energy in profiler planes for events with primary (signal) photons

Production vertices

Plane 2

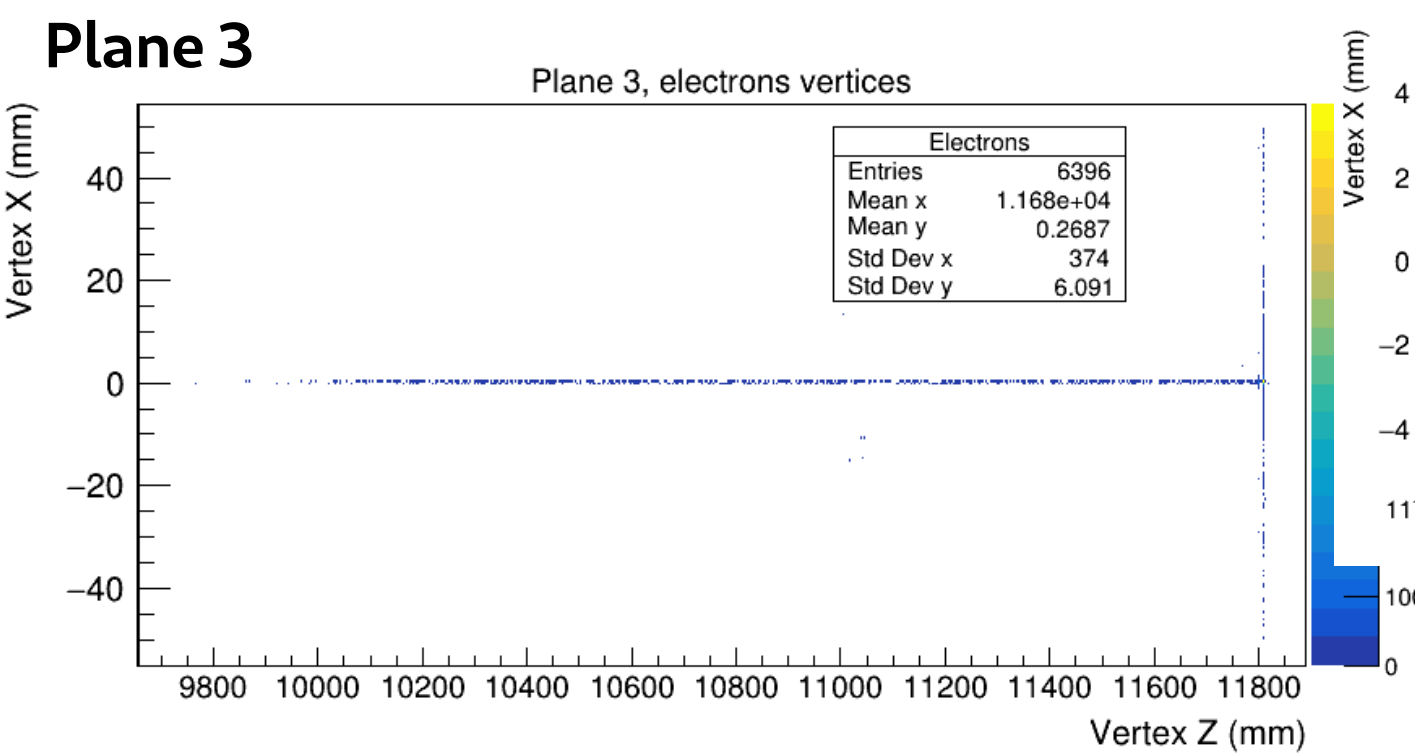
Production vertices: electrons and positrons which deposited energy in profiler planes for events with primary (signal) photons

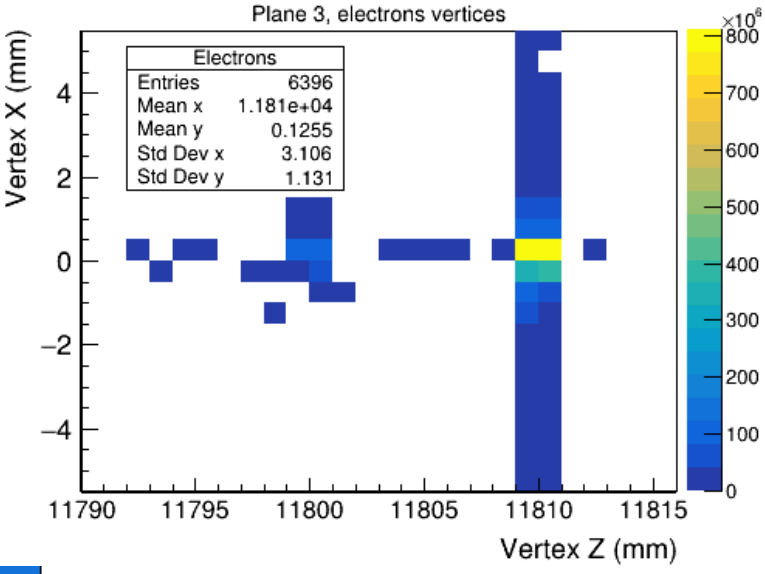


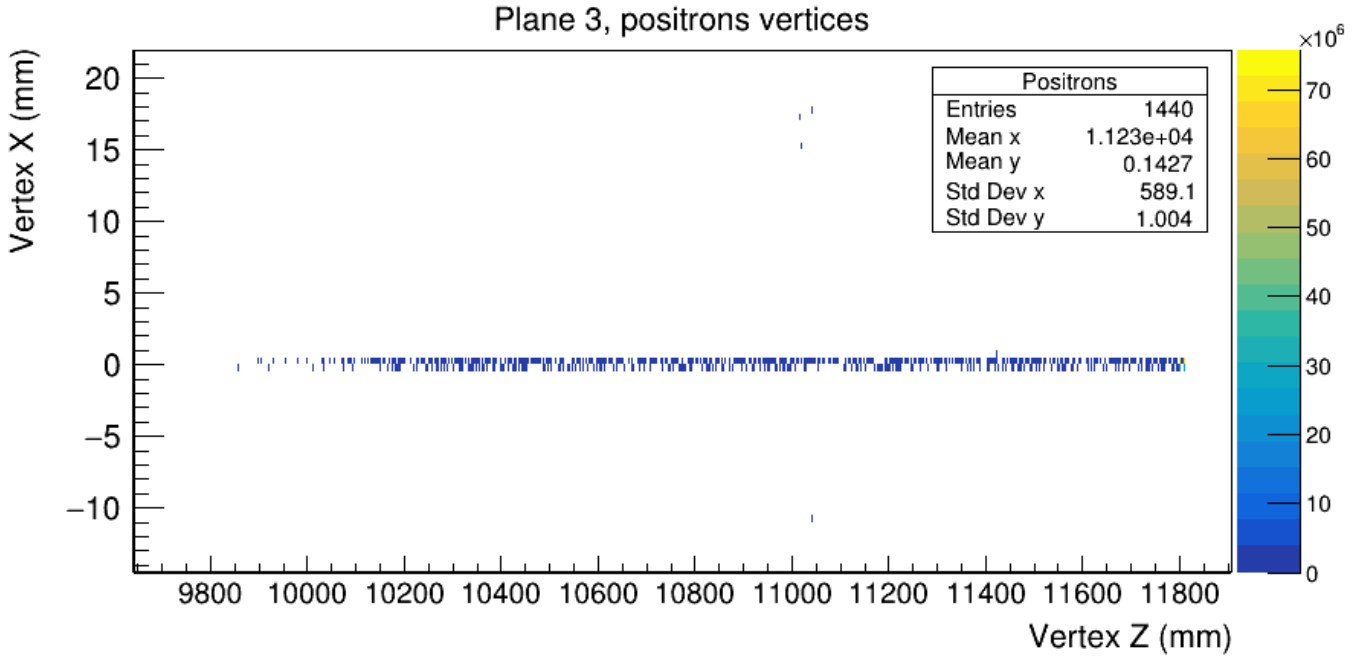


Production vertices

Plane 3





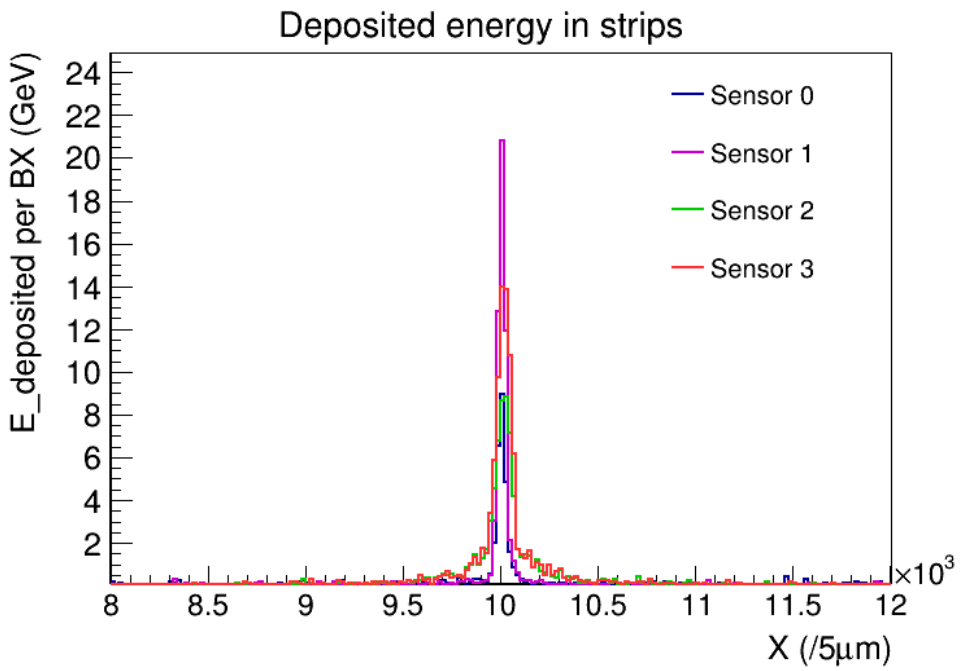


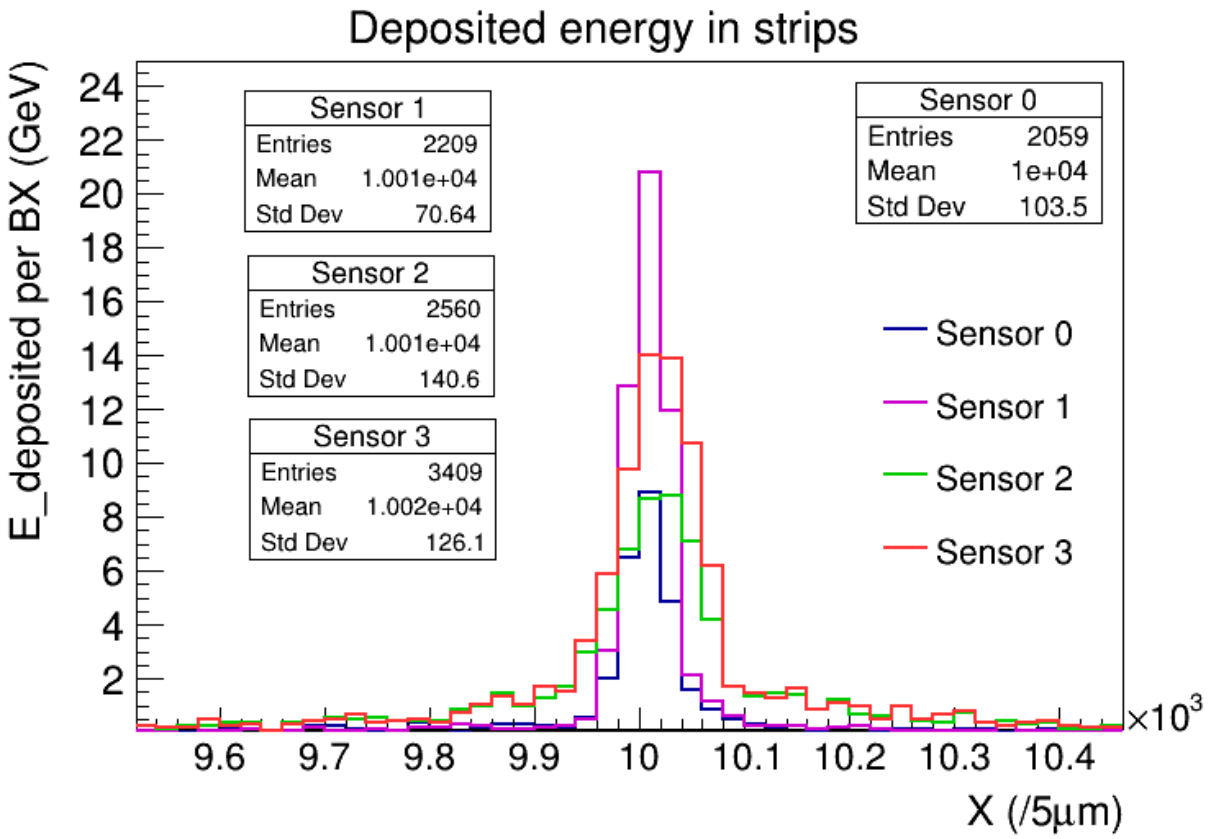
Production vertices:
electrons and positrons
which deposited energy
in profiler planes
for events with primary
(signal) photons

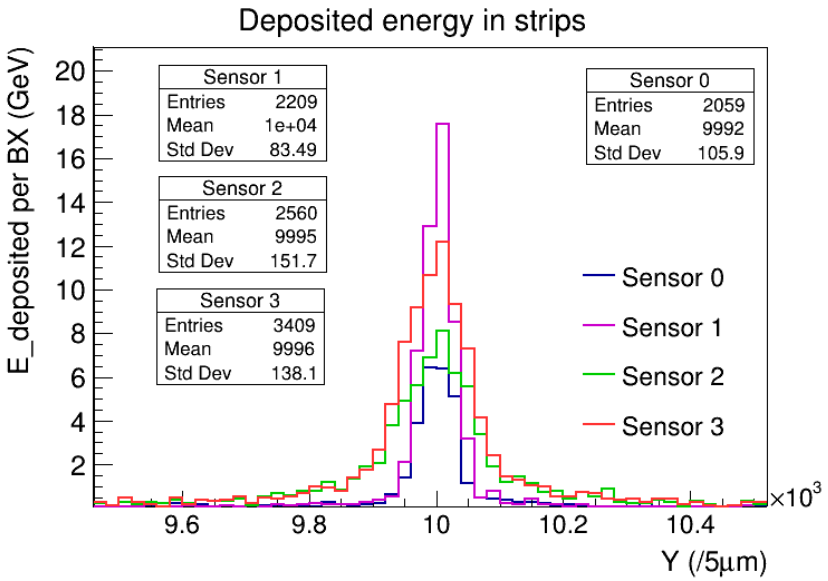
Energy deposited in strips 100µm

IPStrong, 8um, ξ = 1.9

Selected area 2cm by 2cm



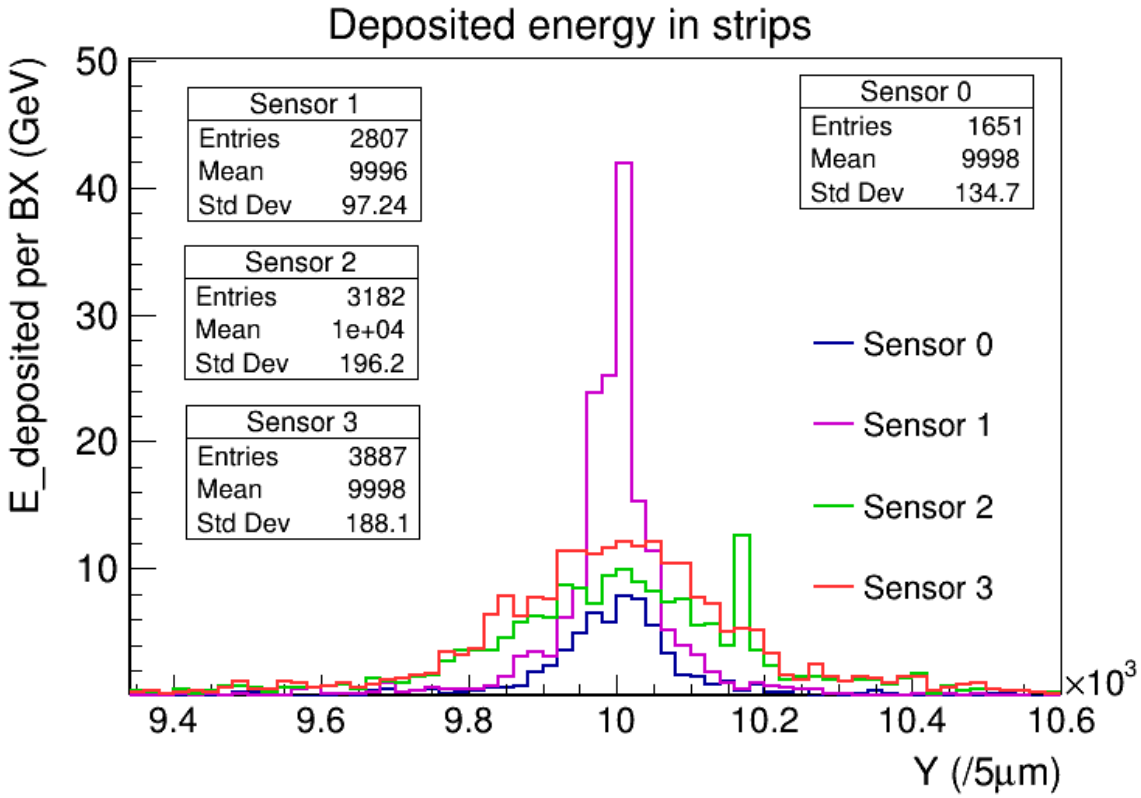


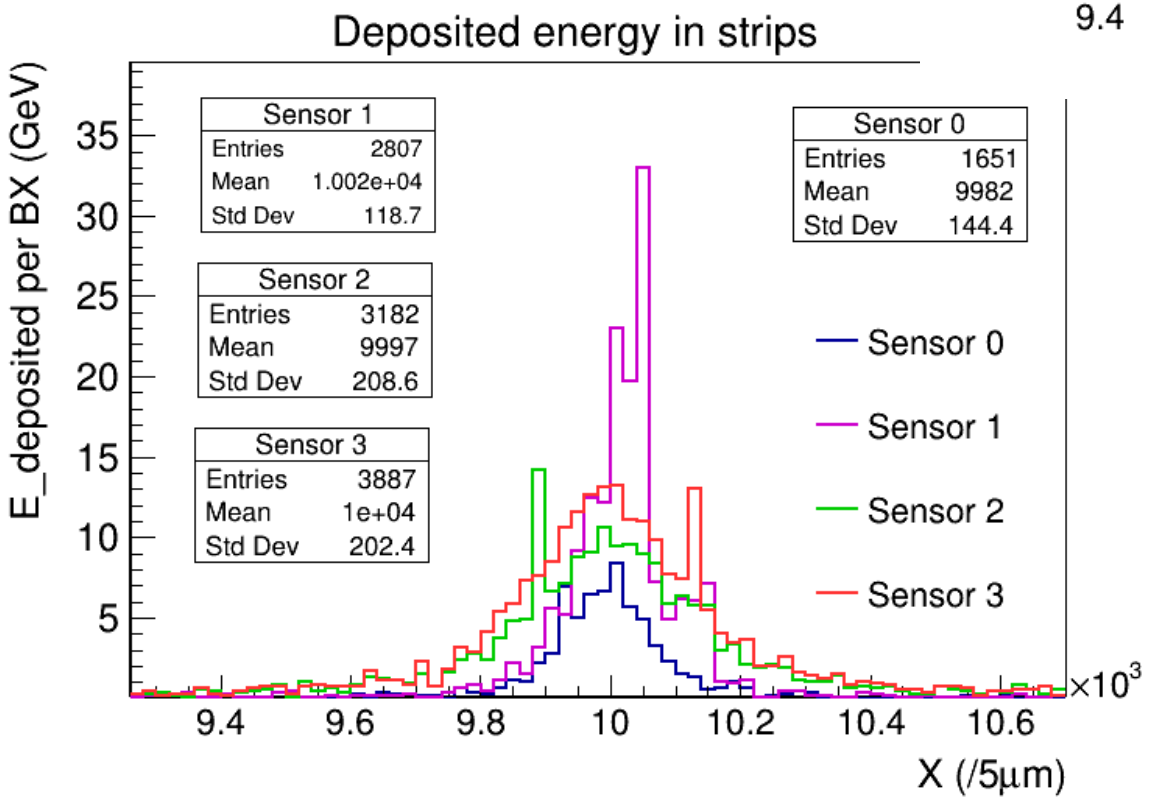


Energy deposited in strips 100µm

ptarmigan, ξ = 2.0

Selected area 2cm by 2cm

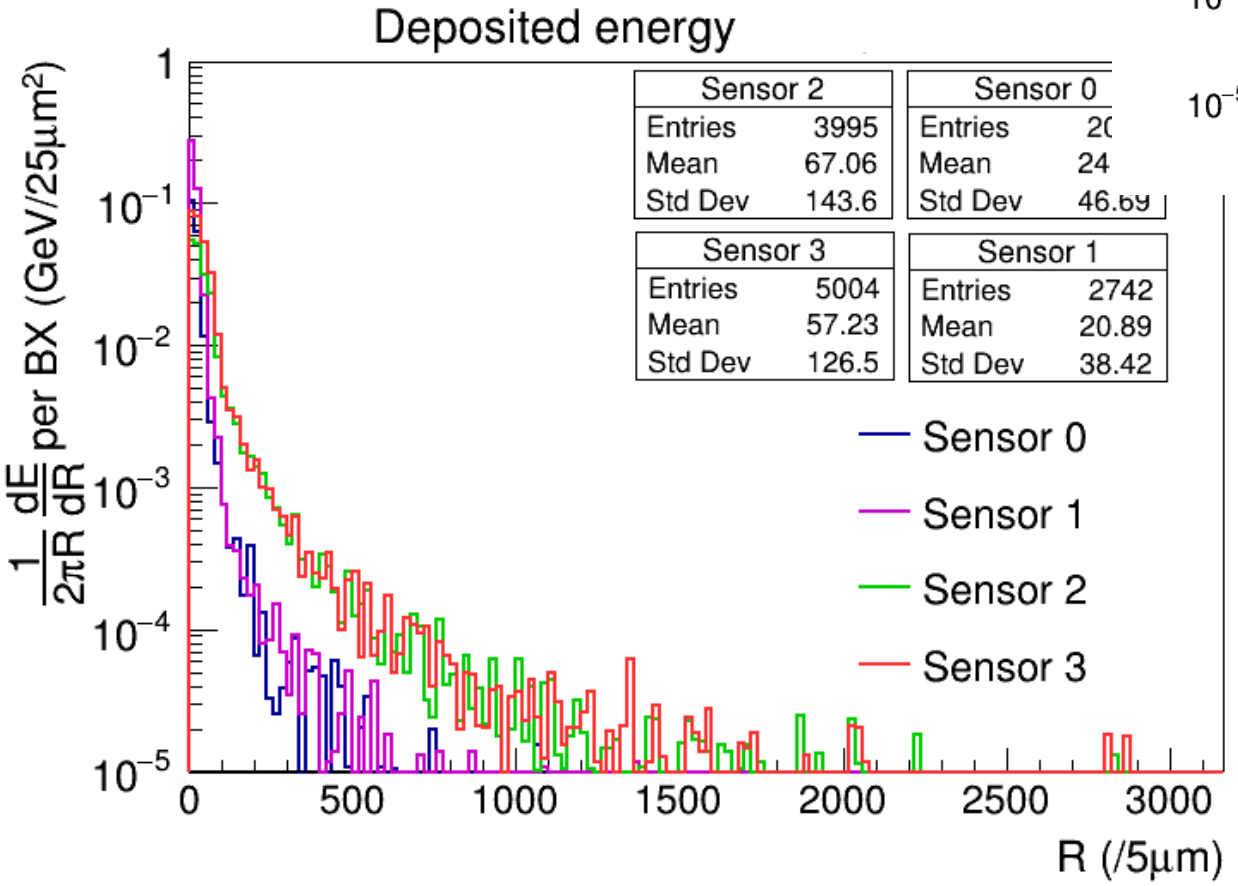


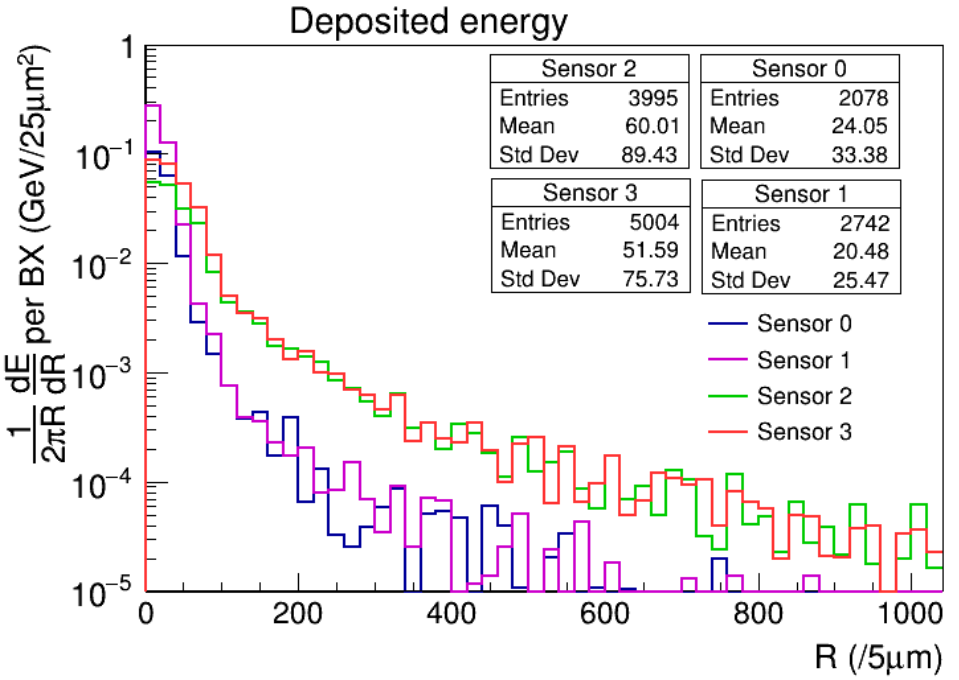


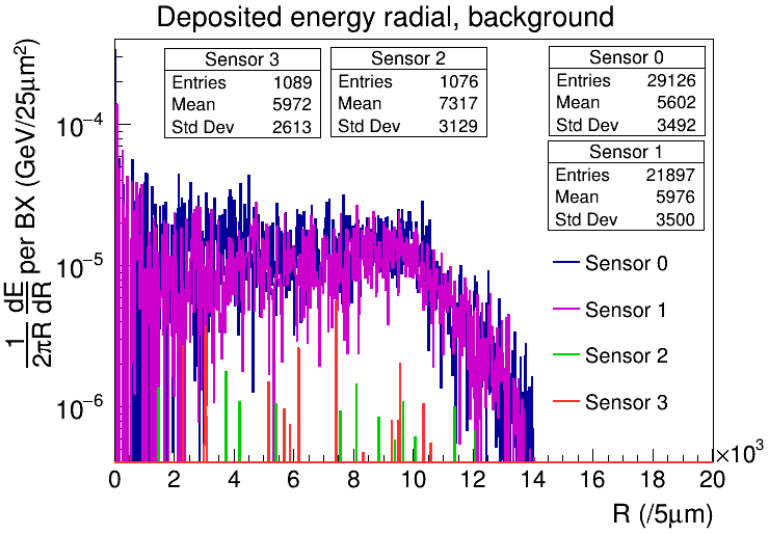
Radial distribution of deposited energy

IPStrong, 8um, ξ = 1.9

Signal events



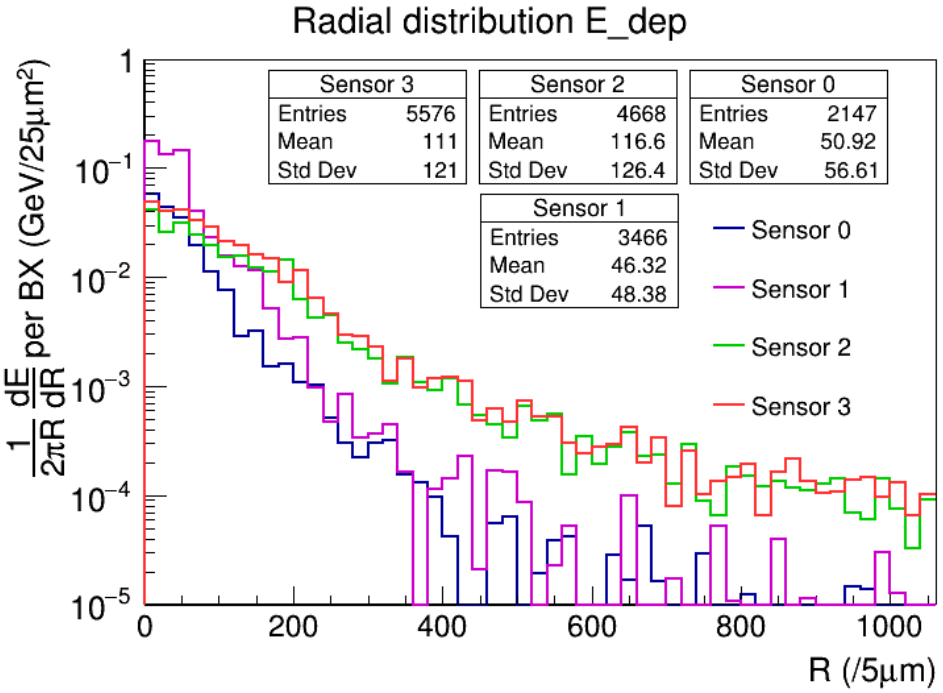


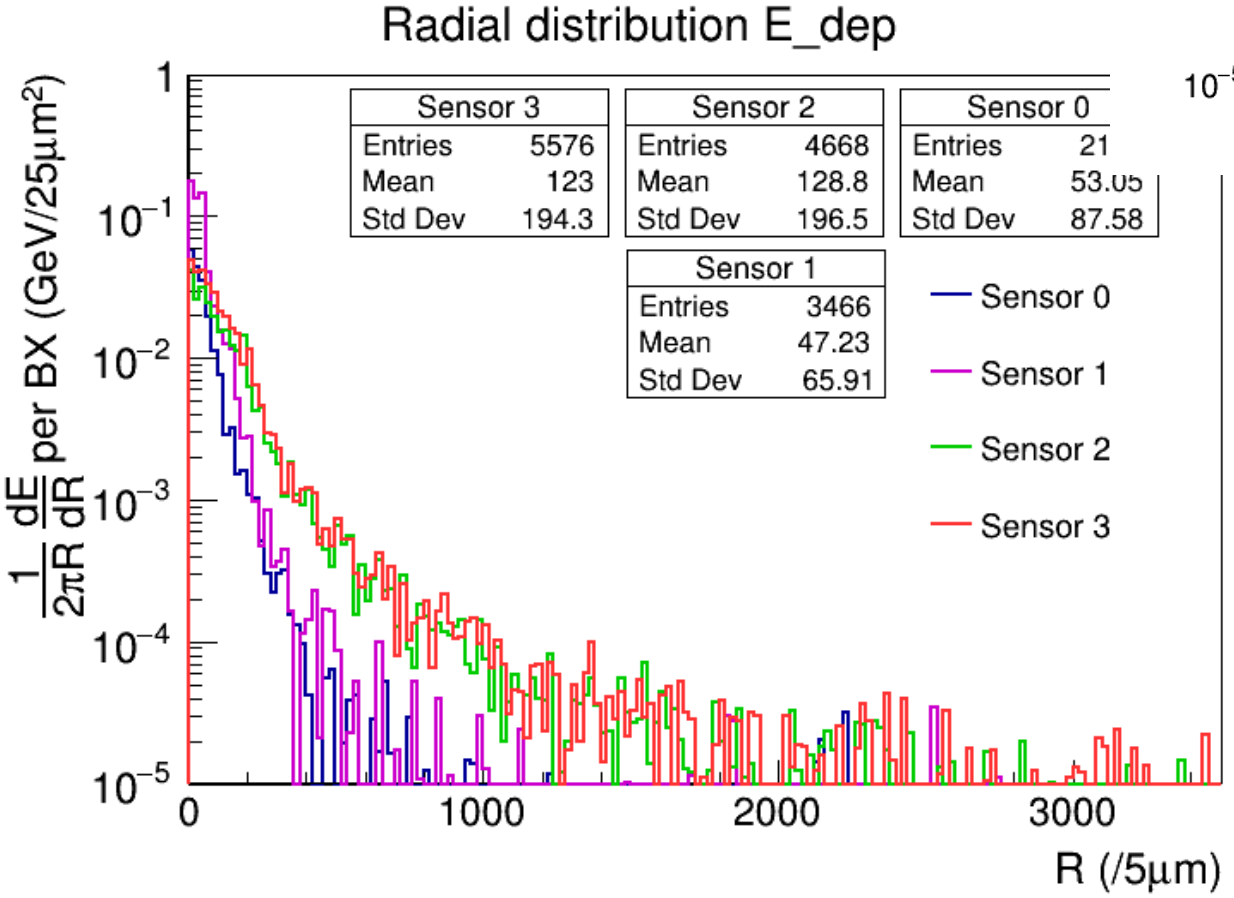


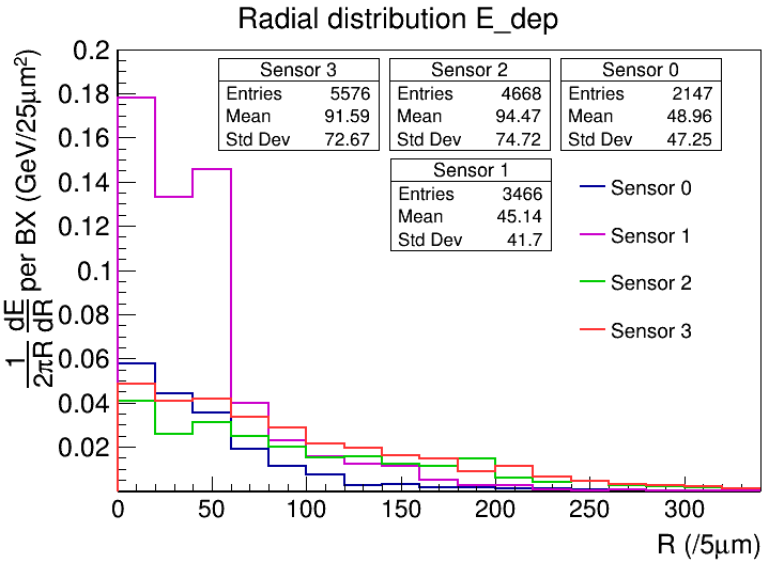
Radial distribution of deposited energy

ptarmigan, ξ = 2.0

Signal events







Summary

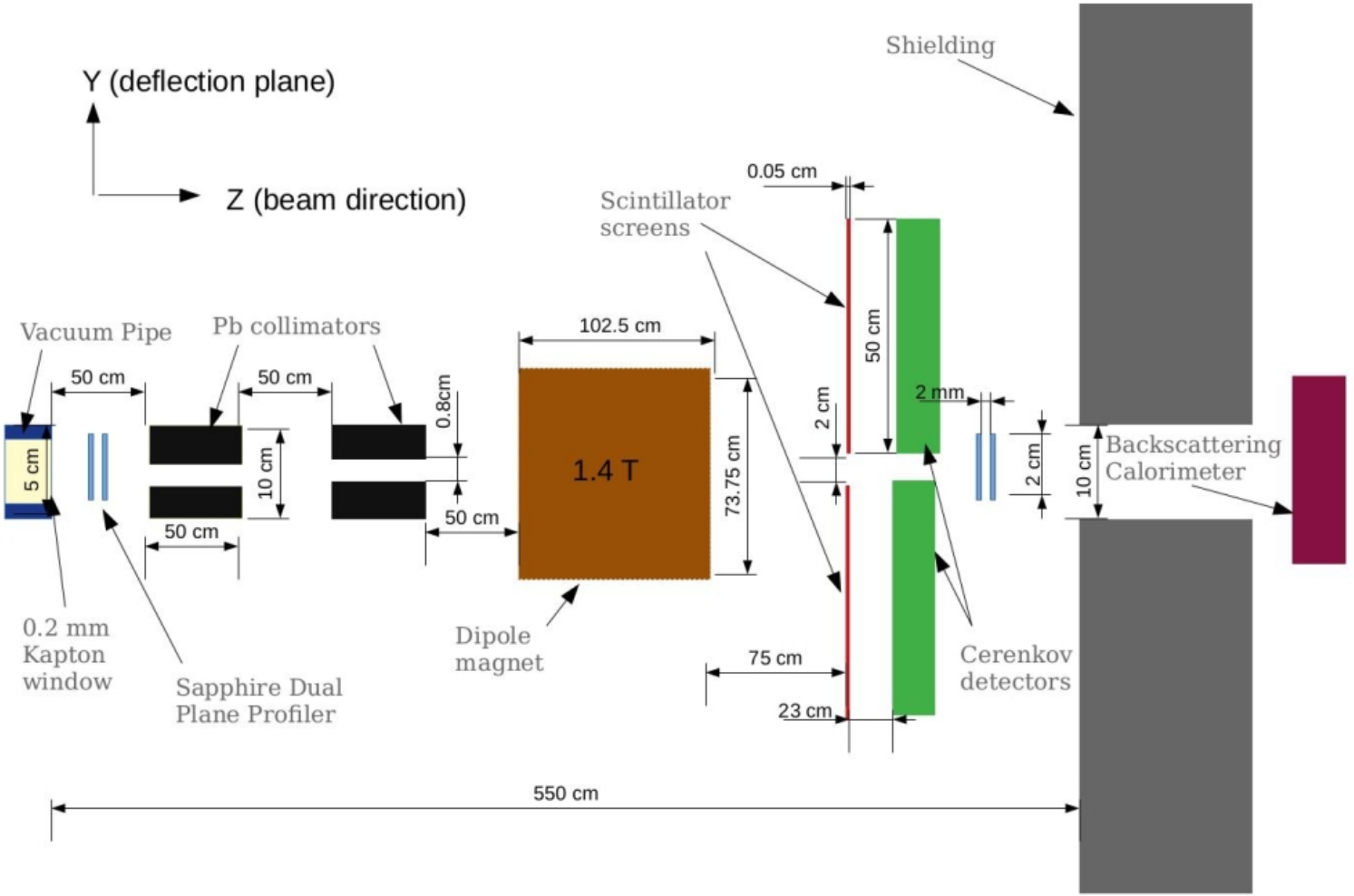
- Geant4 simulation with beamp profiler implemented with sapphire planes is available for analysis.
- Two HICS MC were processed IPStrong and ptarmigan for comparable ξ (1.9 and 2).
- Energy deposition in profiler planes are mostly produced by e+e- pairs created in the air and in sapphire volume.
- There is substantial background observed in the first station 6.7m for IP because of proximity of the beam dump.
- Second sapphire plane of each station has higher deposition than first one.

Backup

Gamma Ray Profiler Simulation Status

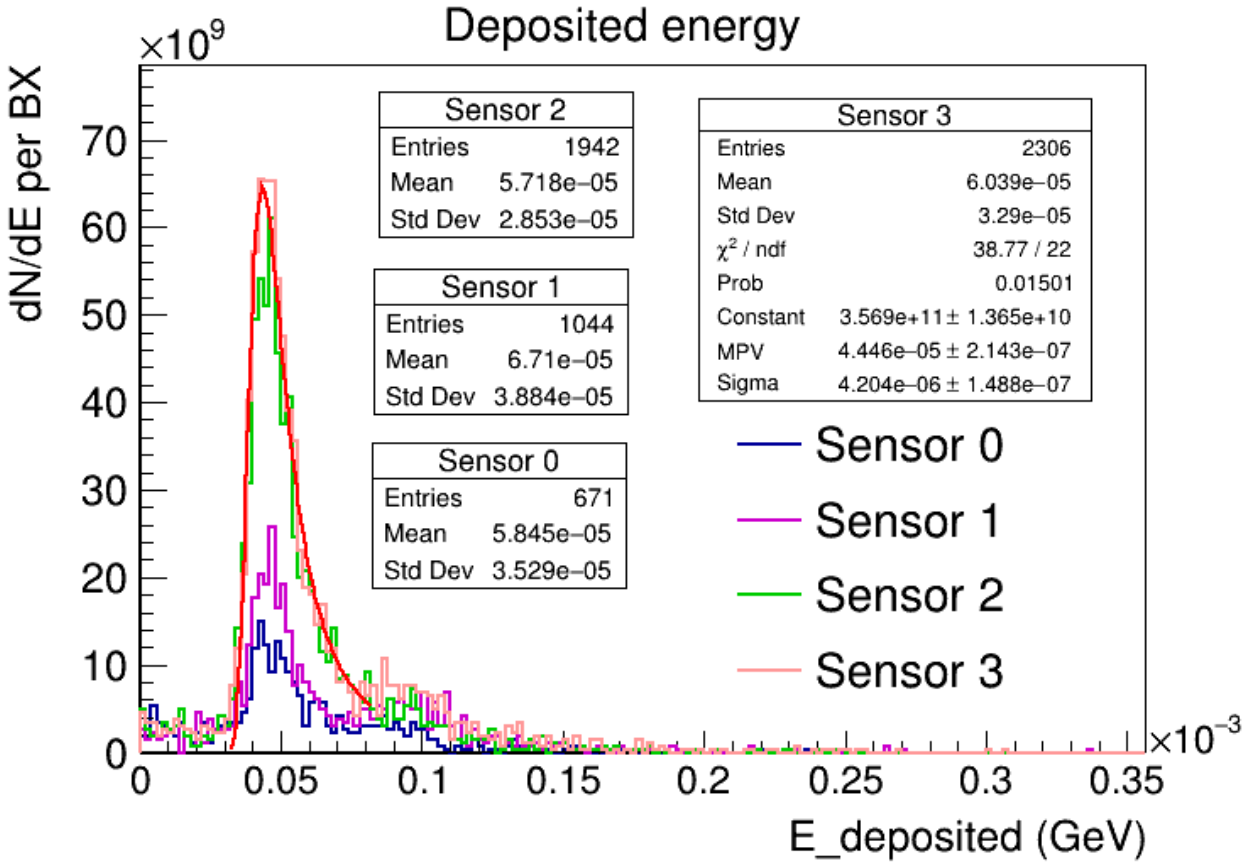
Dr. Gianluca Sarri, Kyle Fleck and Niall Cavanagh

Geometry Diagram



Deposited energy

IPStrong, 5um, ξ = 3.1

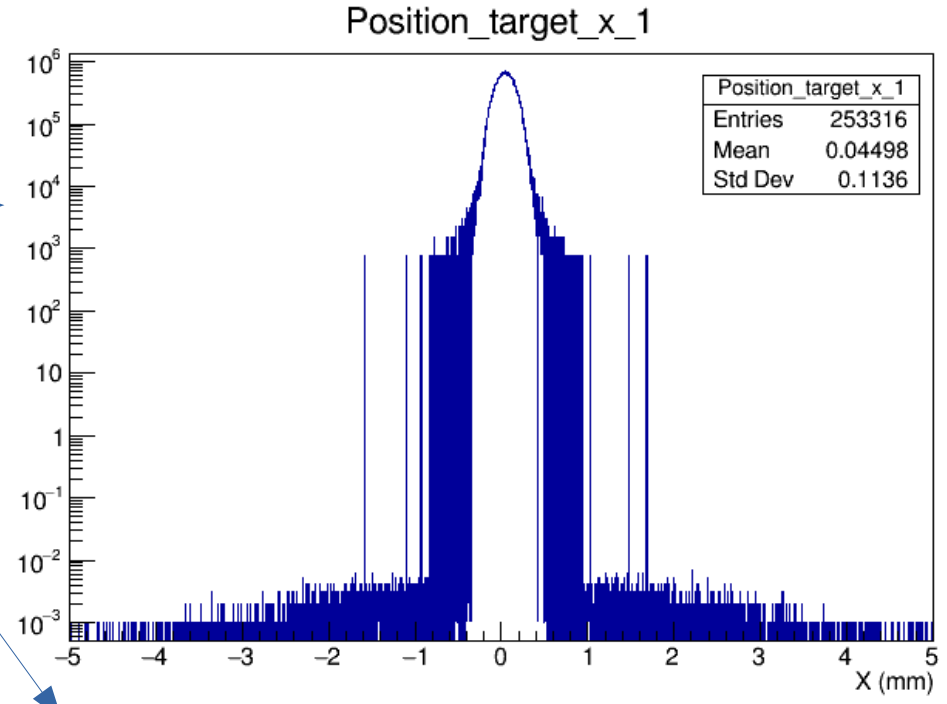


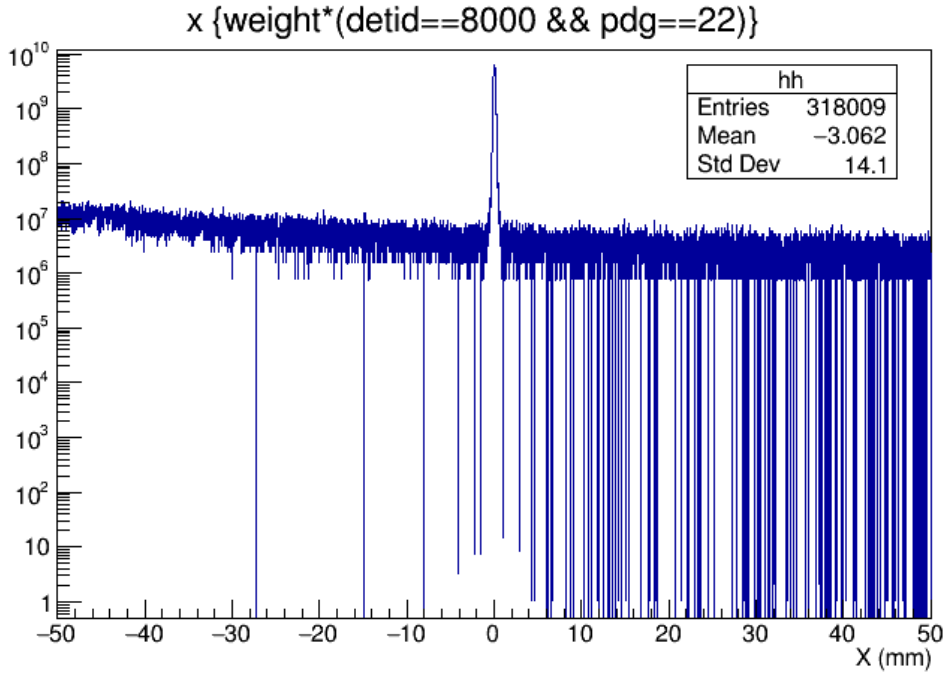
Primary MC photons

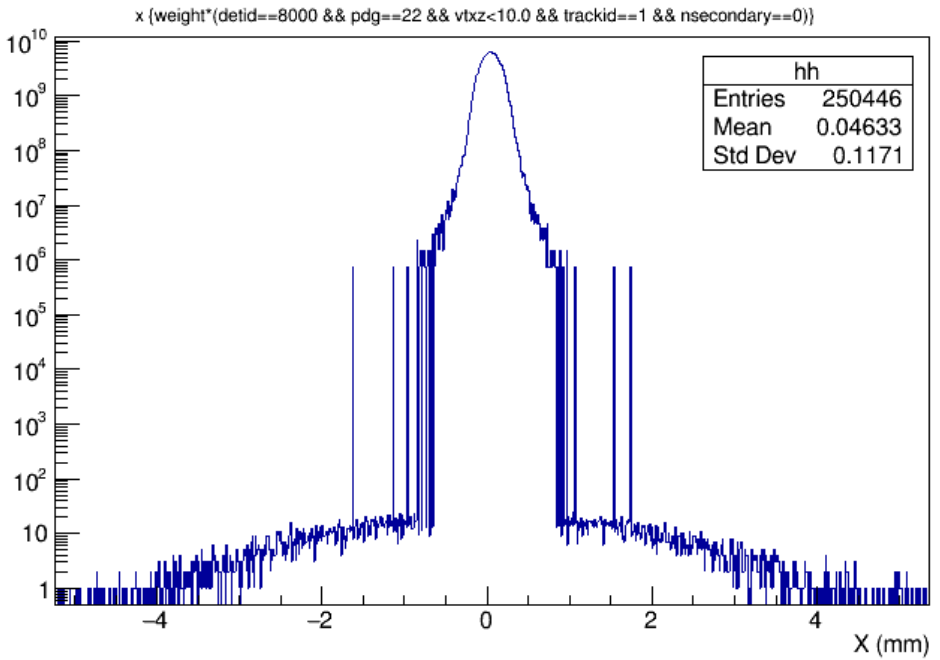
MC: X = X0 + px/pz * (Z-Z0)

Primary photons as they cross the firs profiler plane

All photons crossing the first profiler plane







All particles crossing the surface of the first profiler plane

Zoom on X