

Notes on GEANT4 simulation of ECAL

Oleksandr Borysov

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Positron simulation in ECAL

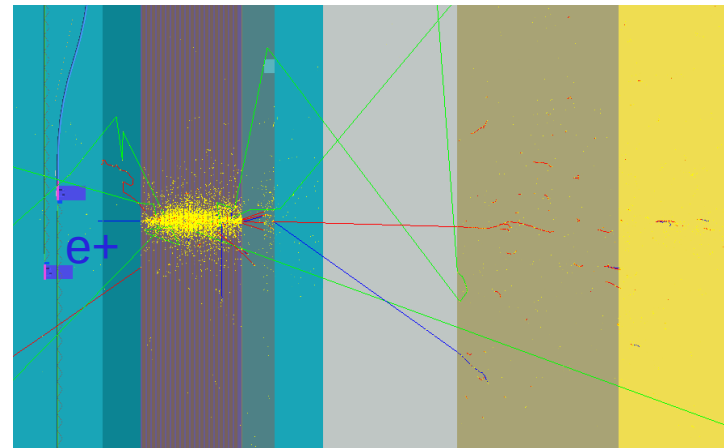
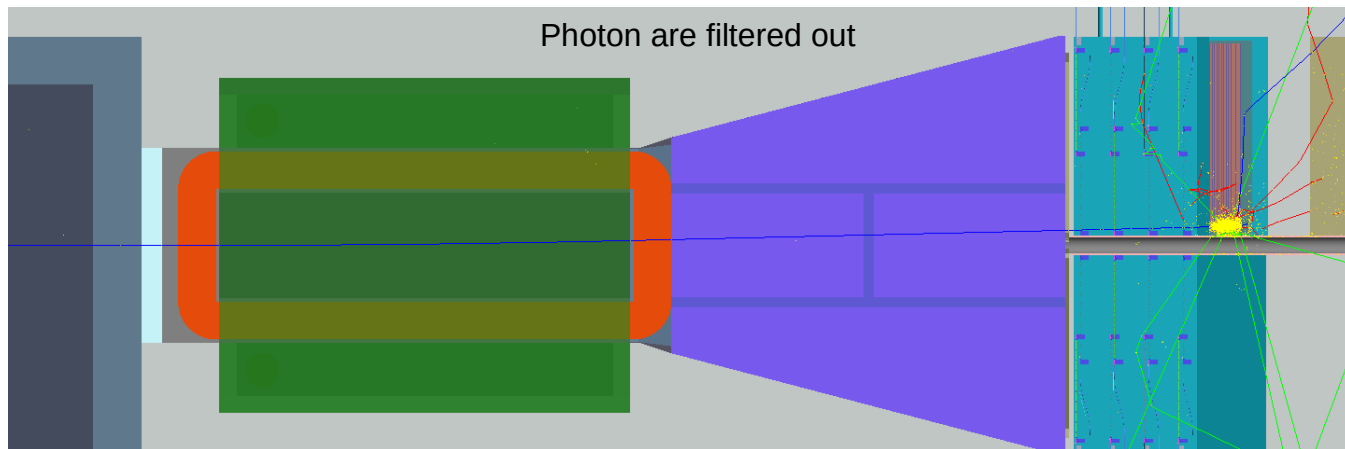
Positrons of different energies with idea to calibrate calorimeter and study the shower development in details for optimizing the reconstruction algorithm.

- Positrons starts far from ECAL and travels through the magnet;
- referred as **v 0002**.
- Positrons starts right in front of ECAL with $x = 314.13$ mm, between pads 54 and 55.
- referred as **v 0003**.

/nfs/dust/luxe/group/MCProduction/SinglePositron/elaser_positron

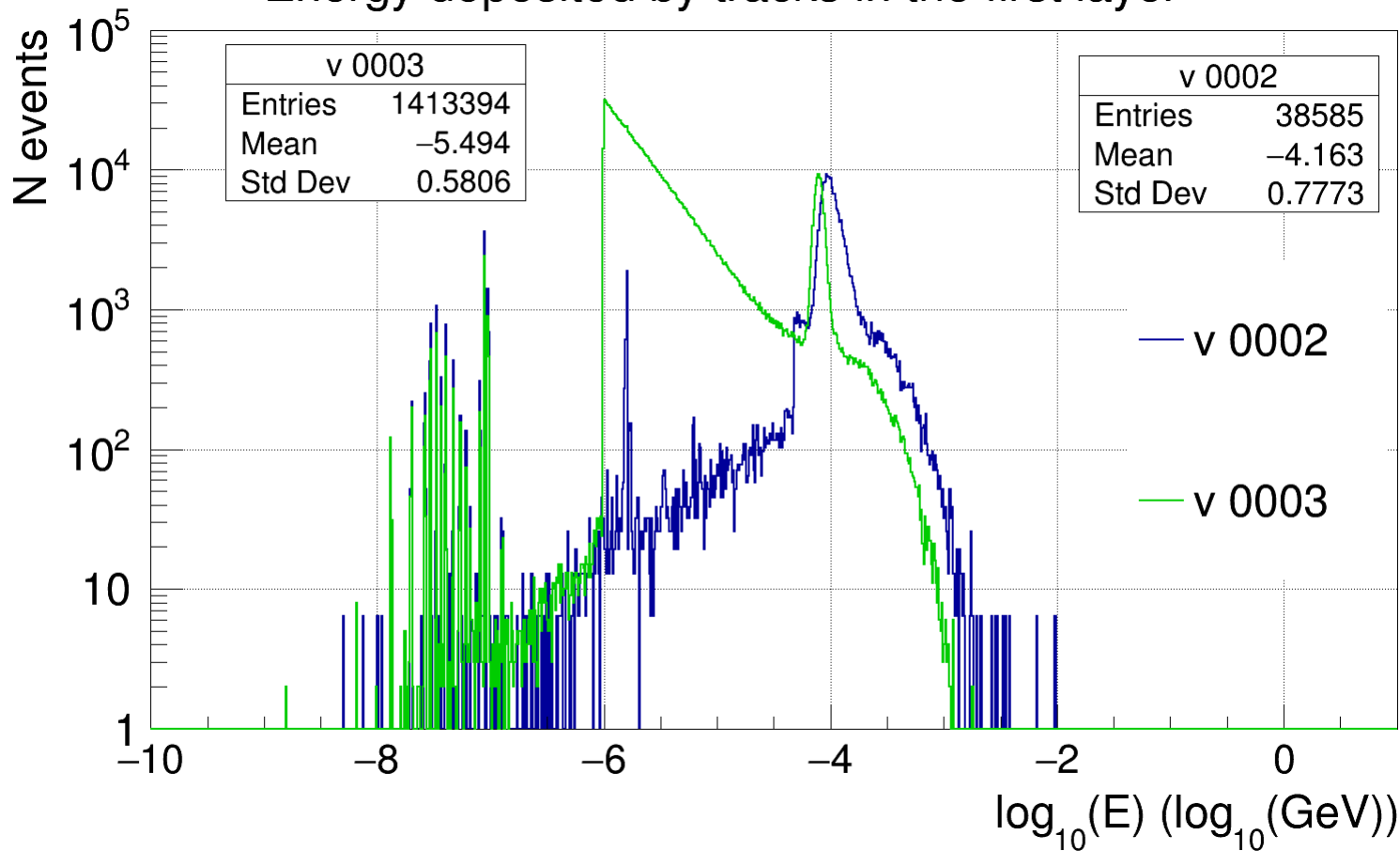
mc21.singlePositron_150GeV.G4gun.SIM.se0002.root

mc21.singlePositron_150GeV_ECALP_run2.G4gun.SIM.se0003.root



Energy deposited by individual particles in the first sensitive layer of ECAL

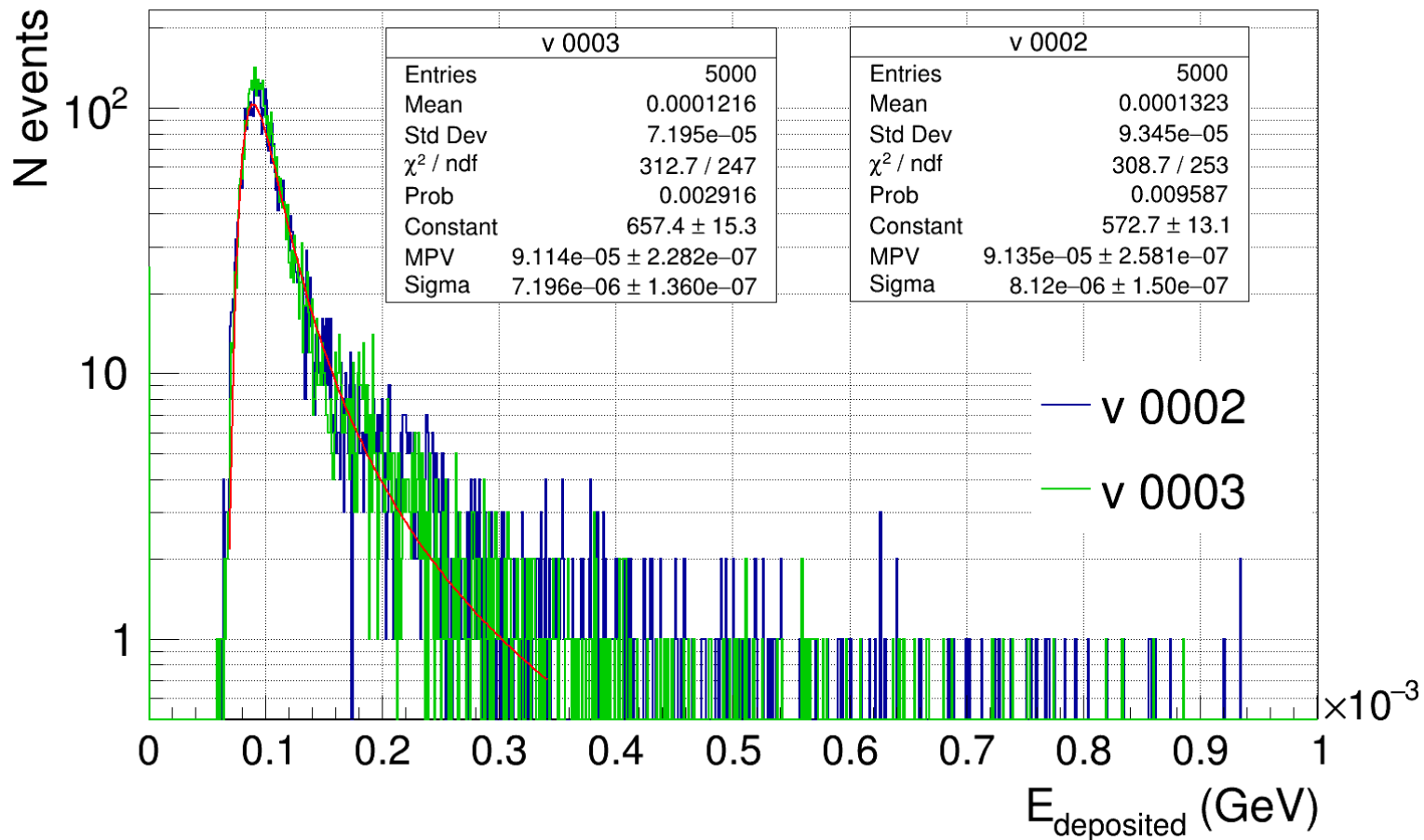
Energy deposited by tracks in the first layer



Normalized to peak height at ~100 keV

Energy deposited
in ECAL layer 0
by primary
positron and its
direct
descendants

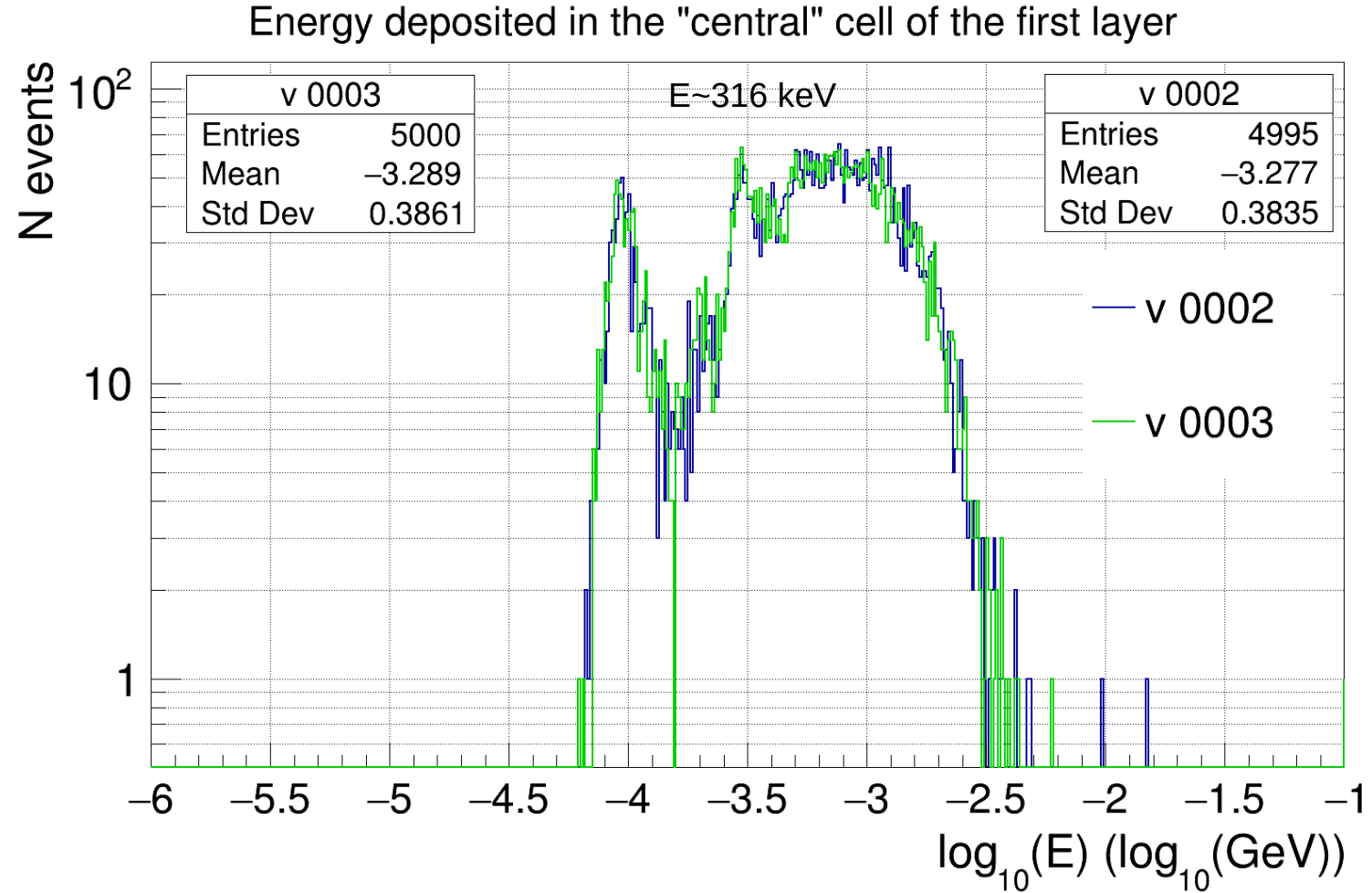
Deposited energy by primary positron and its descendant



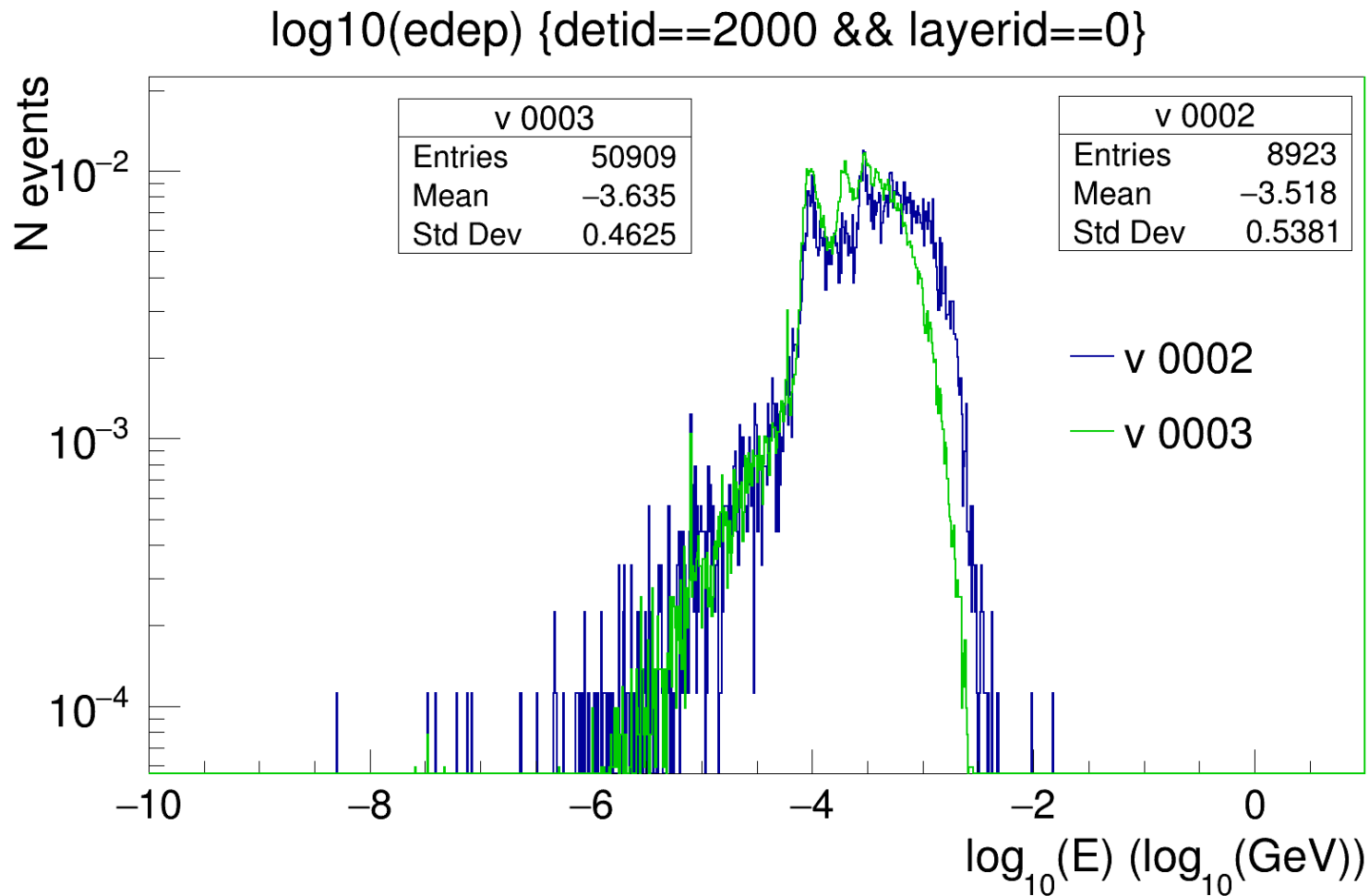
Energy deposited in ECAL cell closest to the position of primary positron in layer 0

In v0002 cellx==2

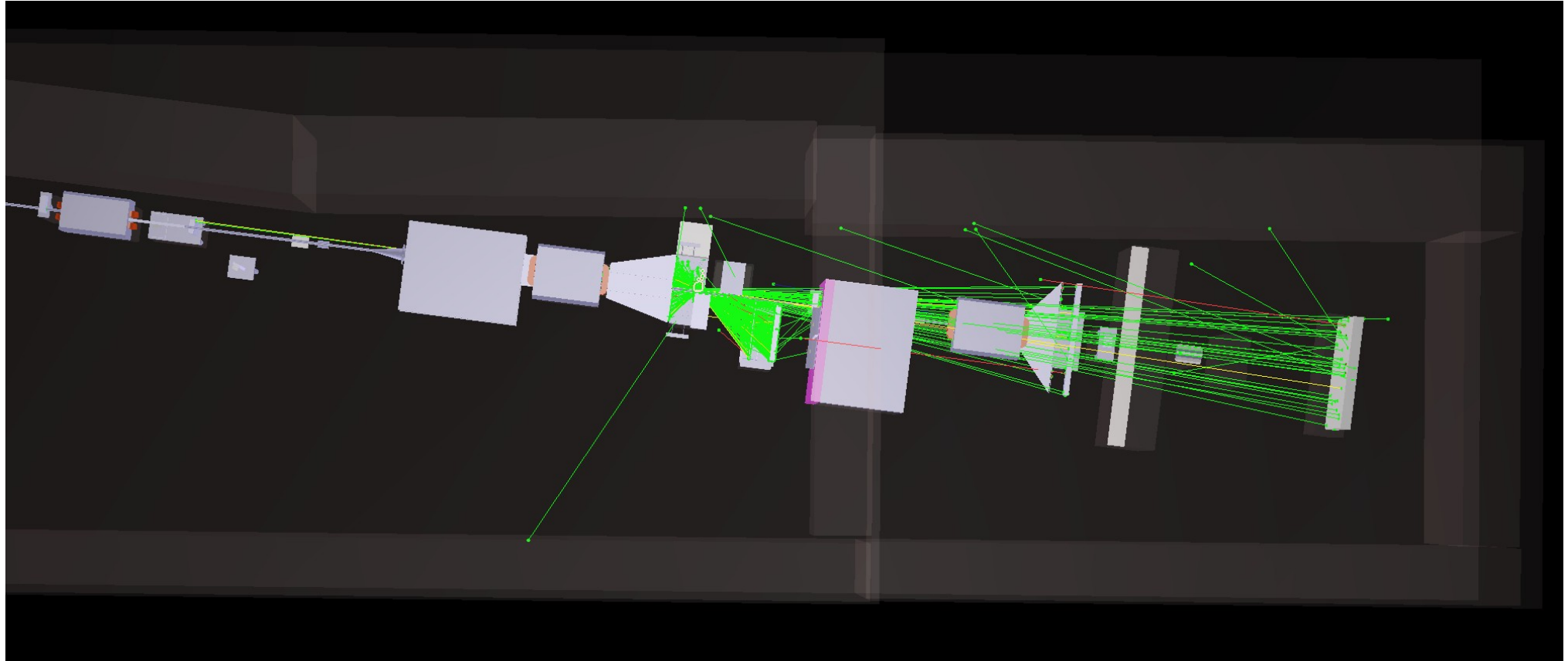
- In v0003 the primary positron is between 54 and 55.
- The histogram filled with sum of energy deposited in the two cells 54 and 55.



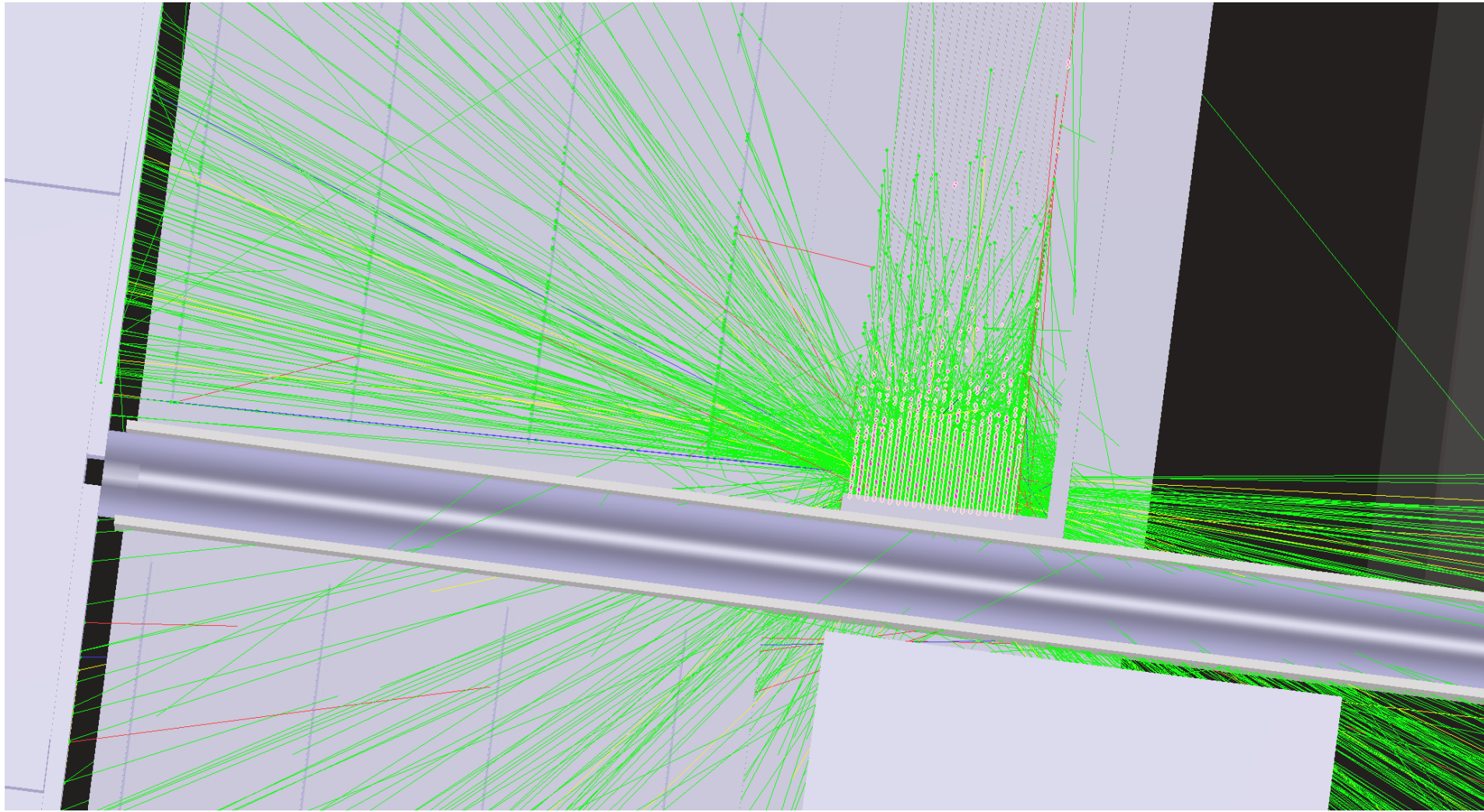
Energy deposited in ECAL layer 0



100 positron events v_0002

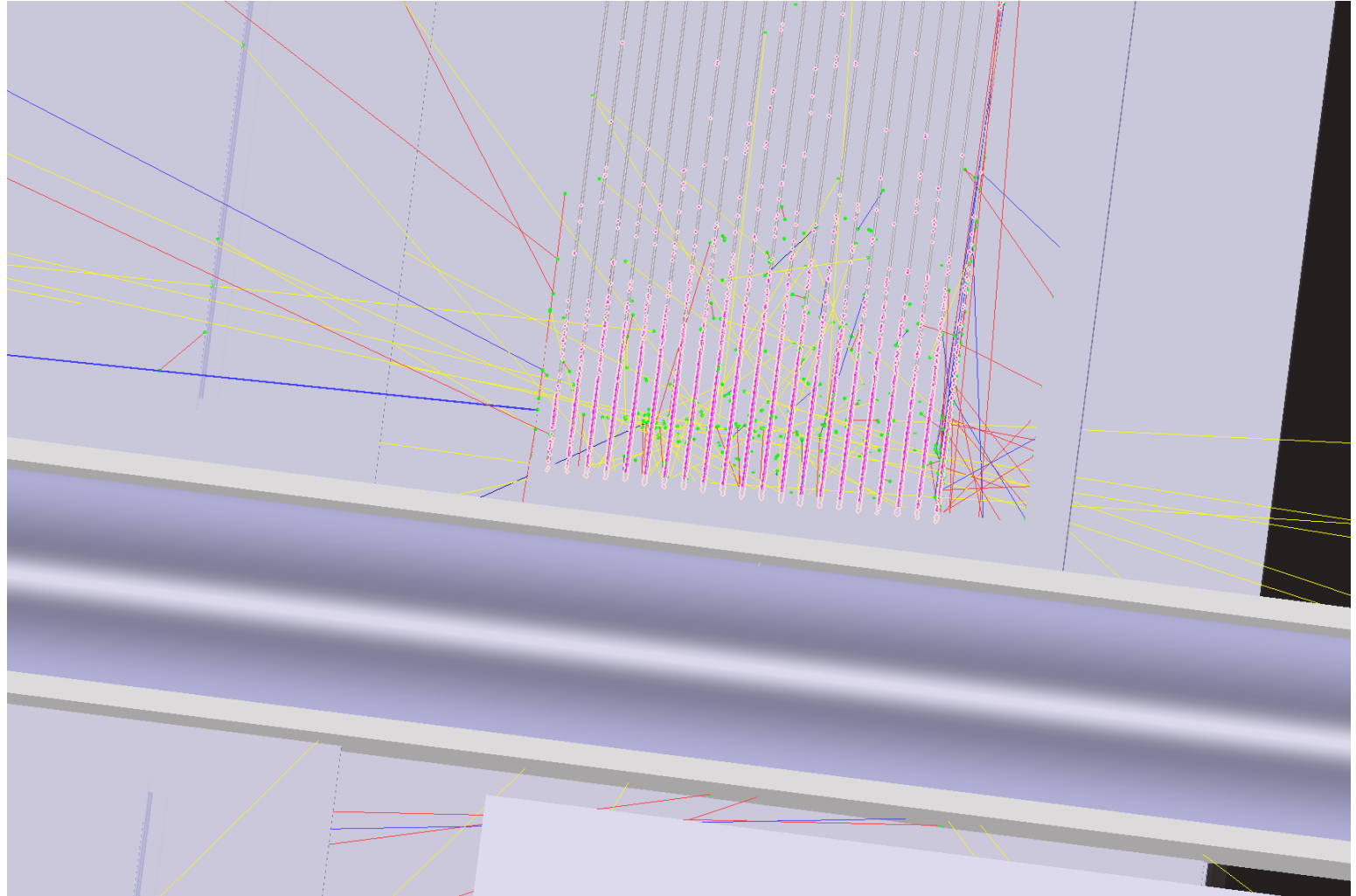


100 positron events v_0002

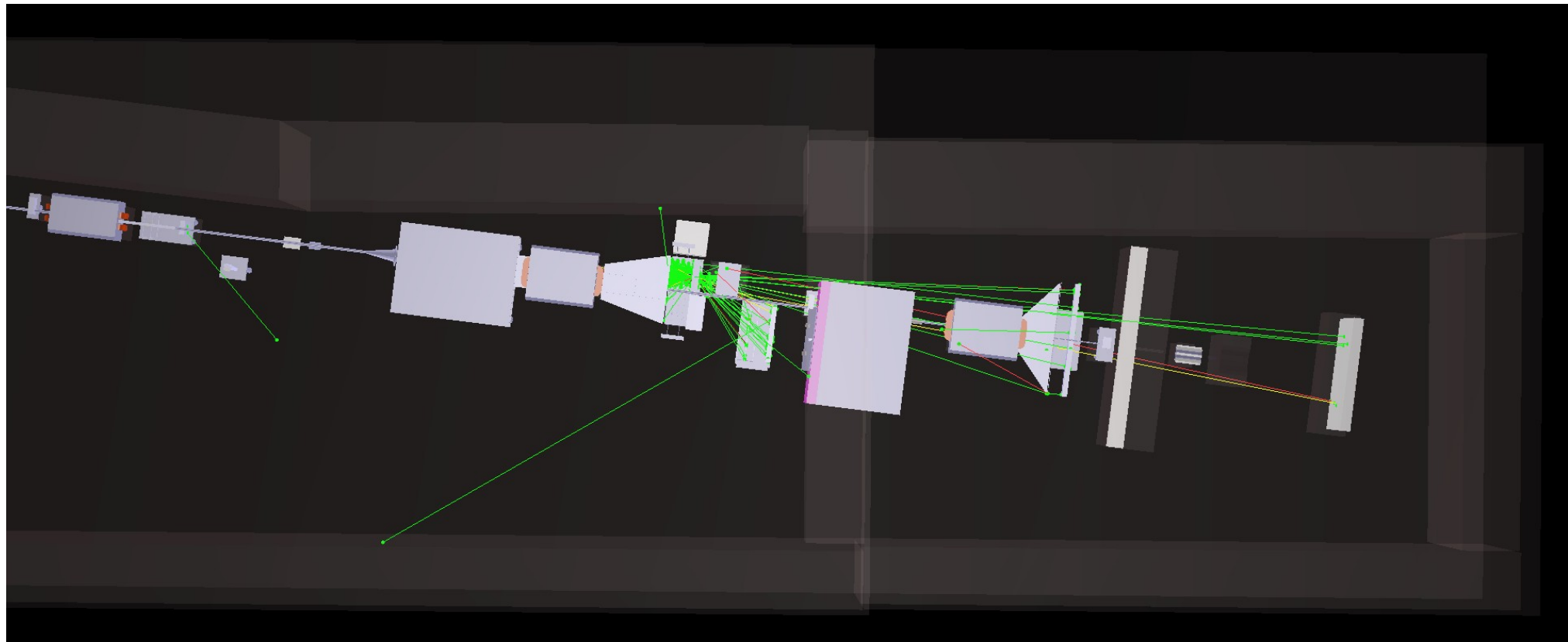


100 positron events v_0002

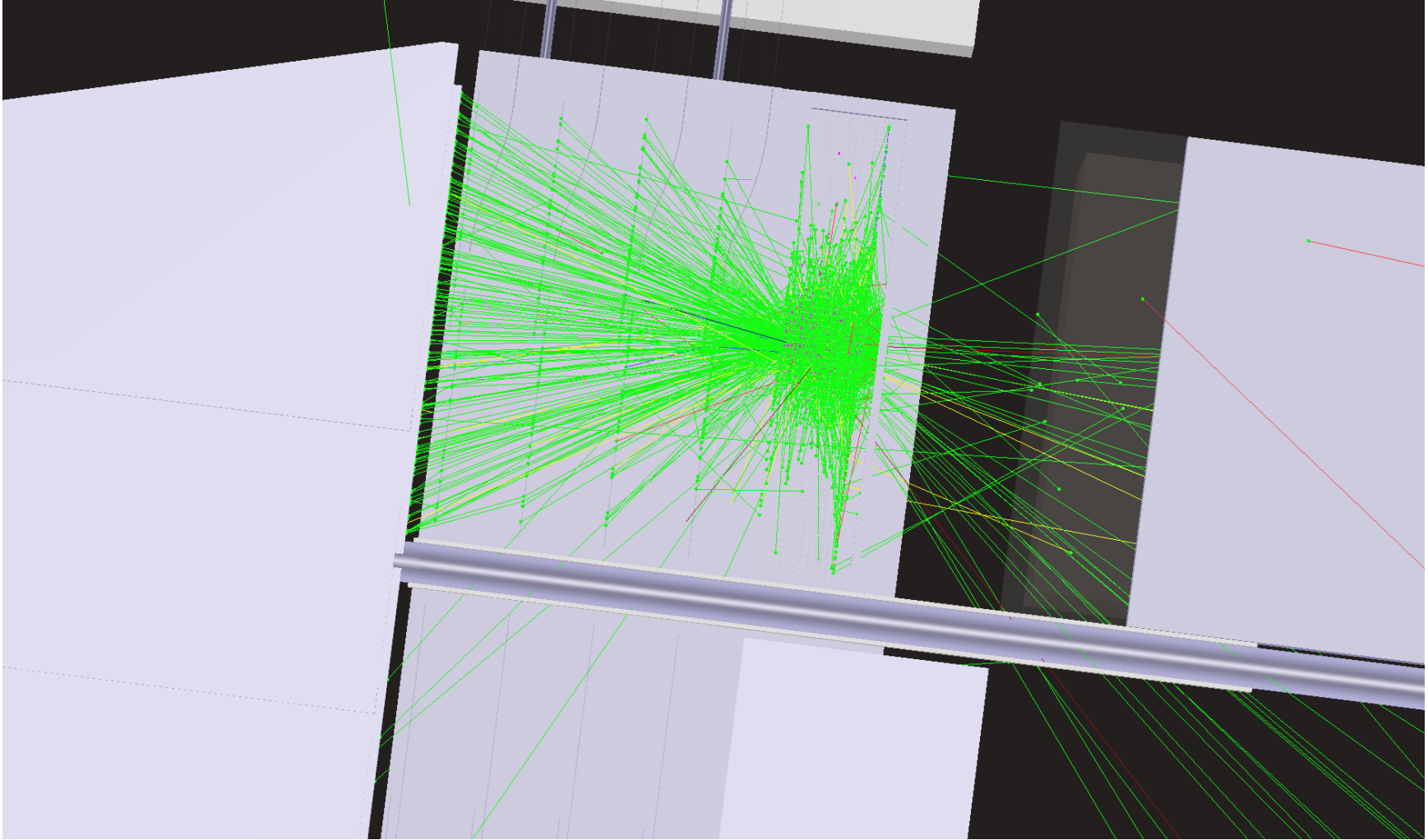
- ☒ nu e bar 0 100 ■
- ☒ e+ 0 100 ■
- ☒ e- 0 100 ■
- ☒ nu e 0 100 ■
- ☐ gamma 0 100 ■
- ☒ neutron 0 100 ■



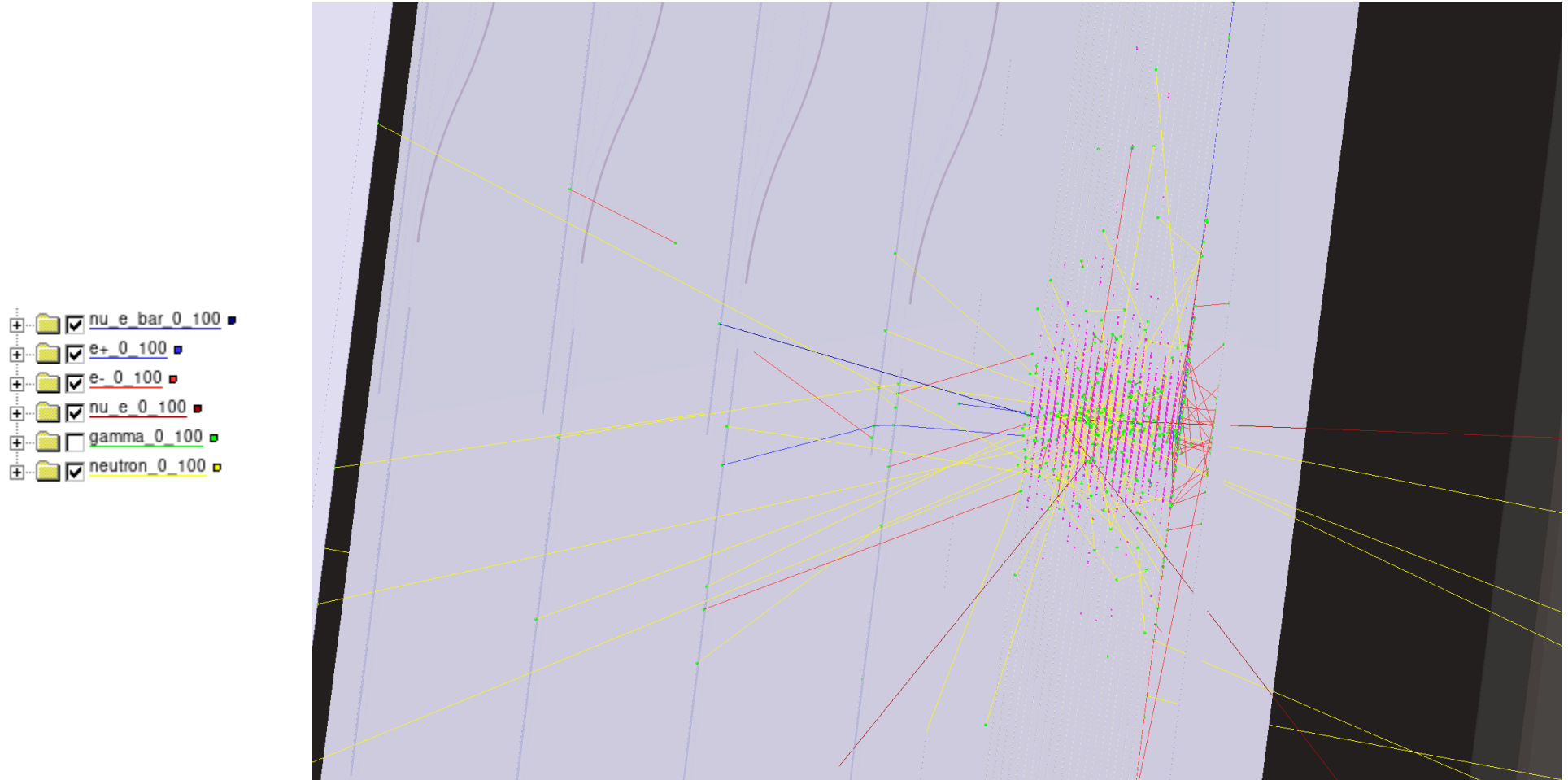
100 positron events v_00003



100 positron events v_0003

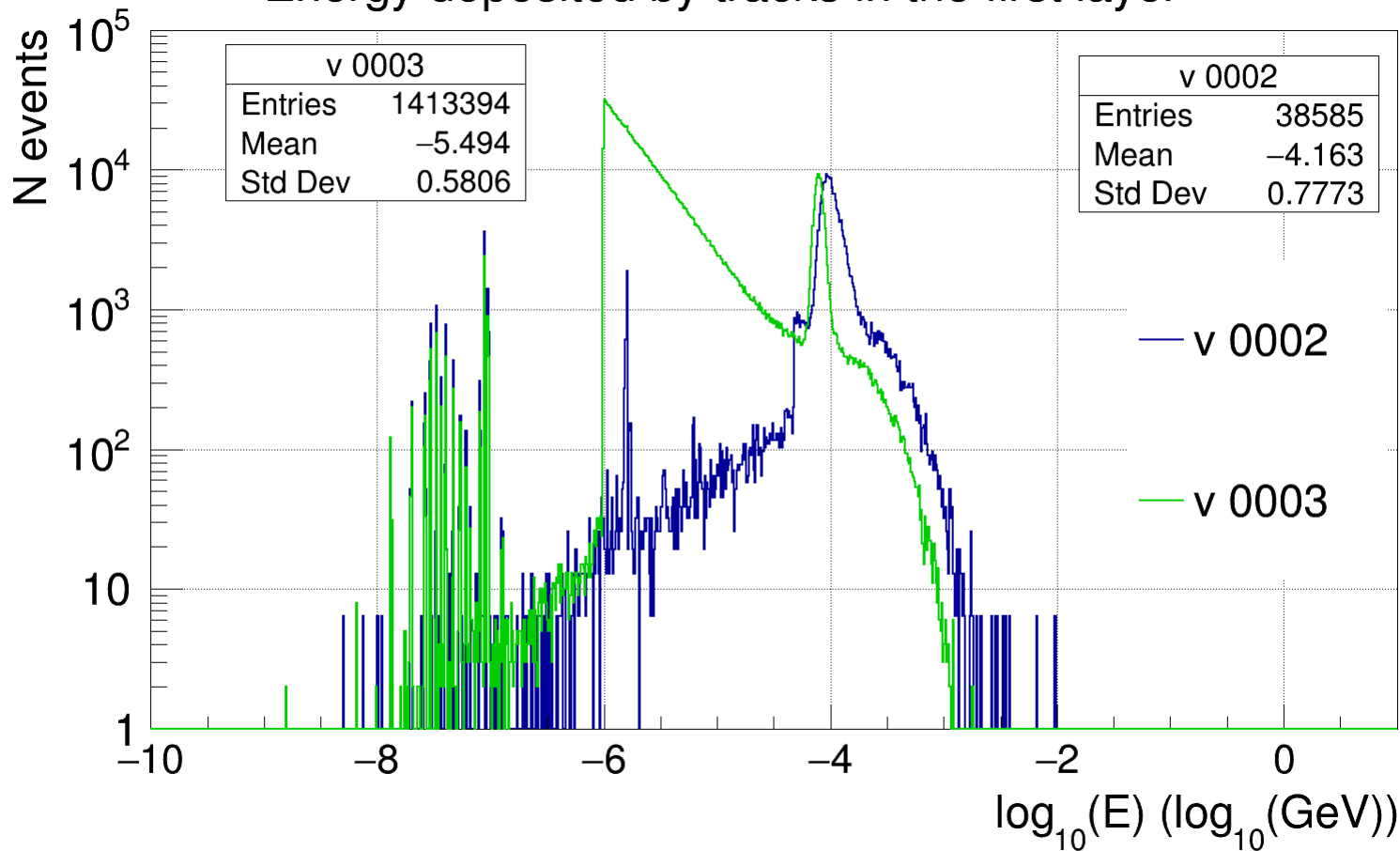


100 positron events v_0003



Energy deposited by individual particles in the first sensitive layer of ECAL

Energy deposited by tracks in the first layer



Normalized to peak height at ~100 keV

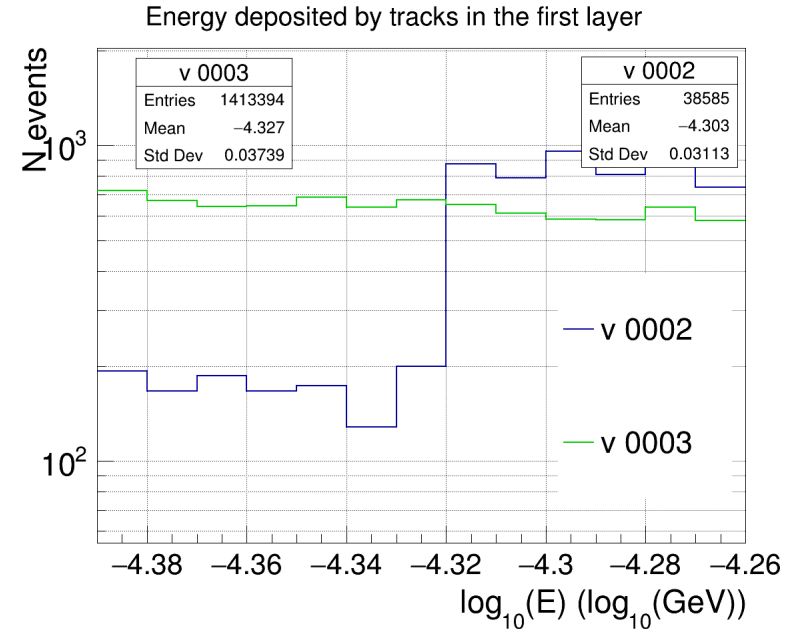
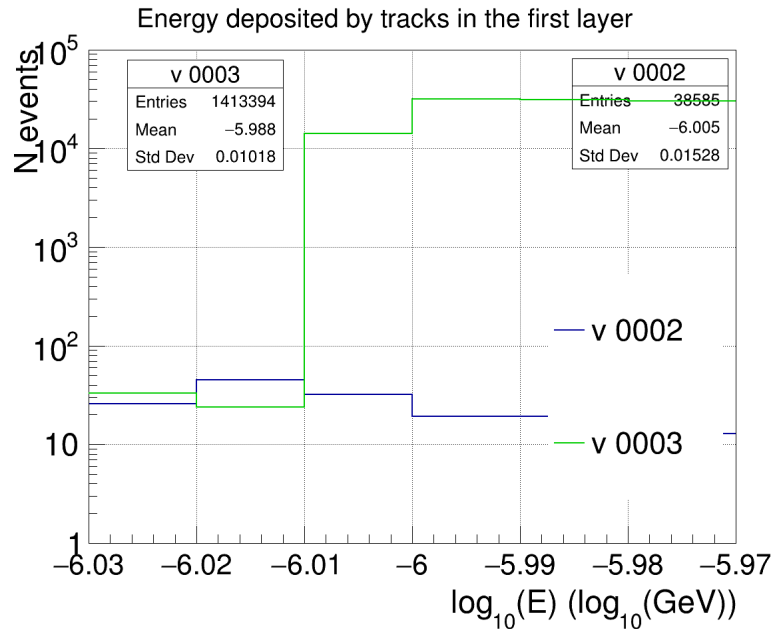
Production threshold

Material : G4_Si
 Range cuts : gamma 1 um e- 1 um e+ 1 um proton 0 fm
 Energy thresholds : gamma 990 eV e- 990 eV e+ 990 eV proton 0 eV

Material : G4_Si
 Range cuts : gamma 20 um e- 20 um e+ 20 um proton 0 fm
 Energy thresholds : gamma 1.08038 keV e- 47.8191 keV e+ 46.8647 keV proton 0 eV

$$10^{-6.005} = 9.89 \times 10^{-7} = 989 \text{ eV}$$

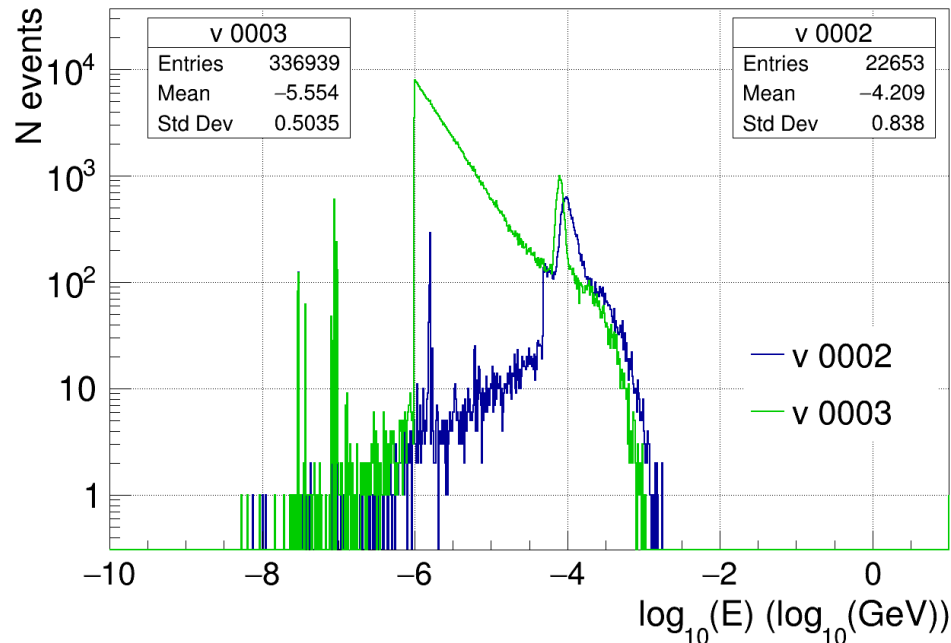
$$10^{-4.32} = 4.79 \times 10^{-5} = 47.9 \text{ keV}$$



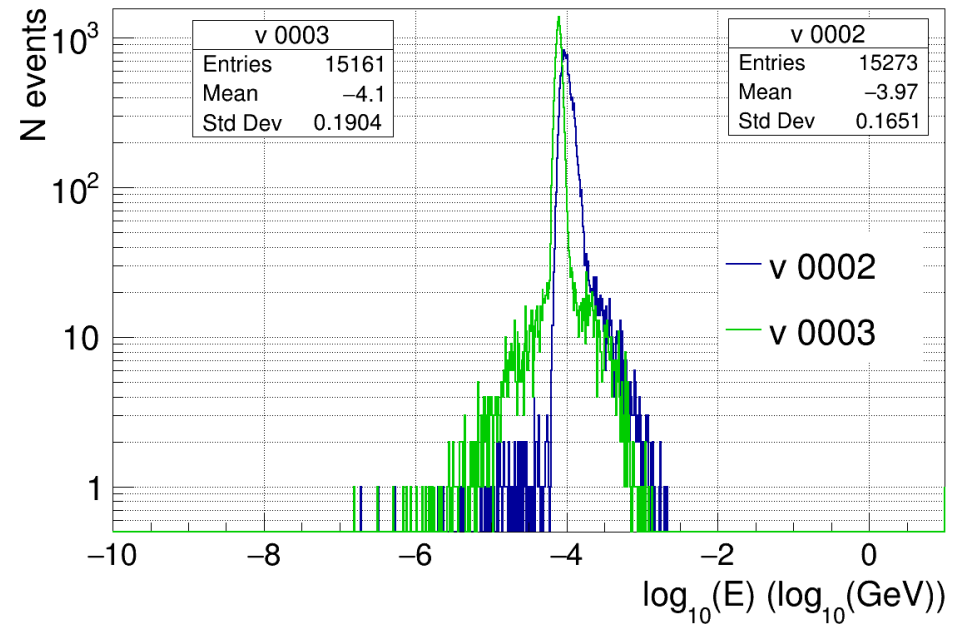
Energy deposited by individual e-, e+ (tracks) in the first layer of ECAL

Not normalized, just same number of primary positrons 5k

Energy deposited by electrons in the first layer

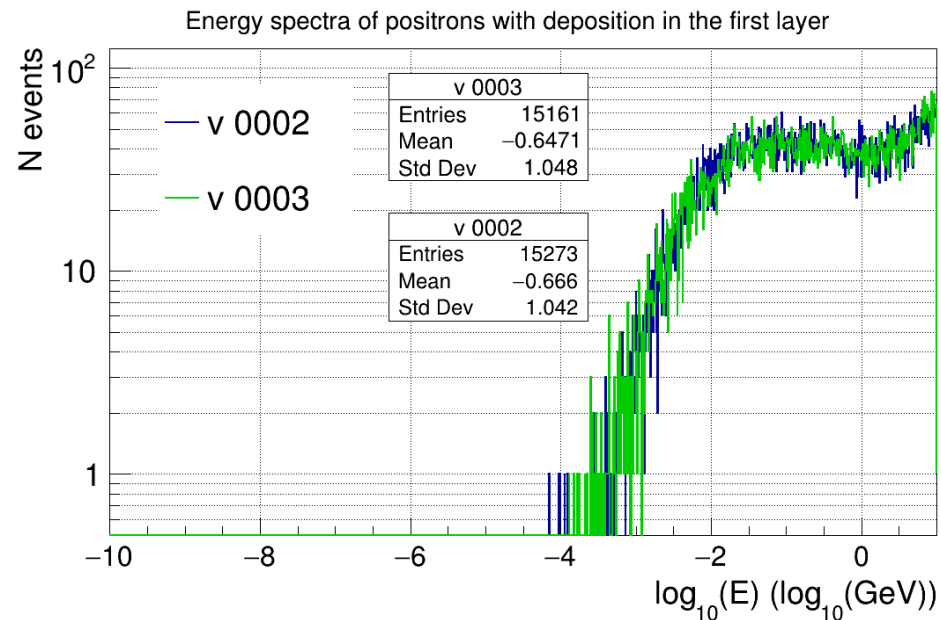
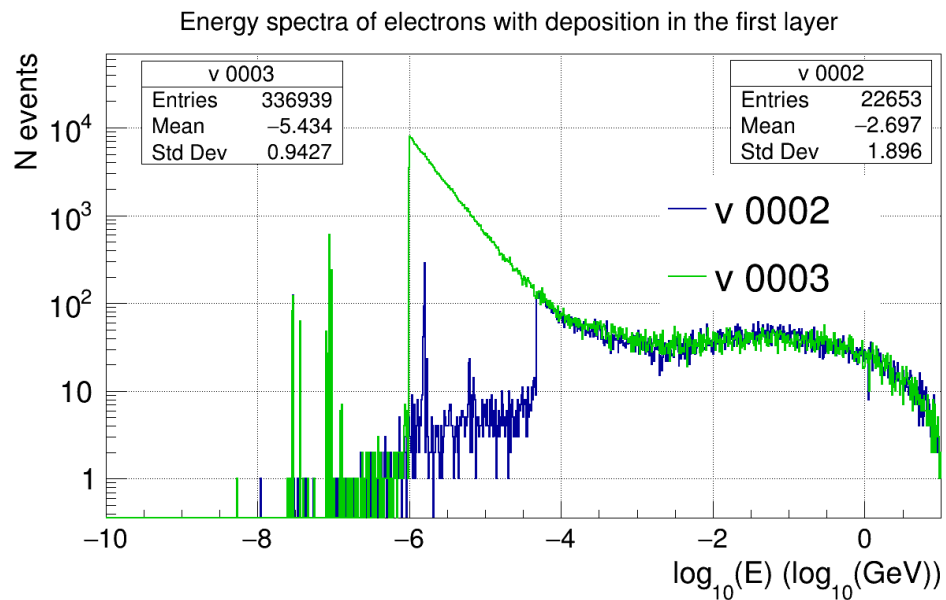


Energy deposited by positrons in the first layer



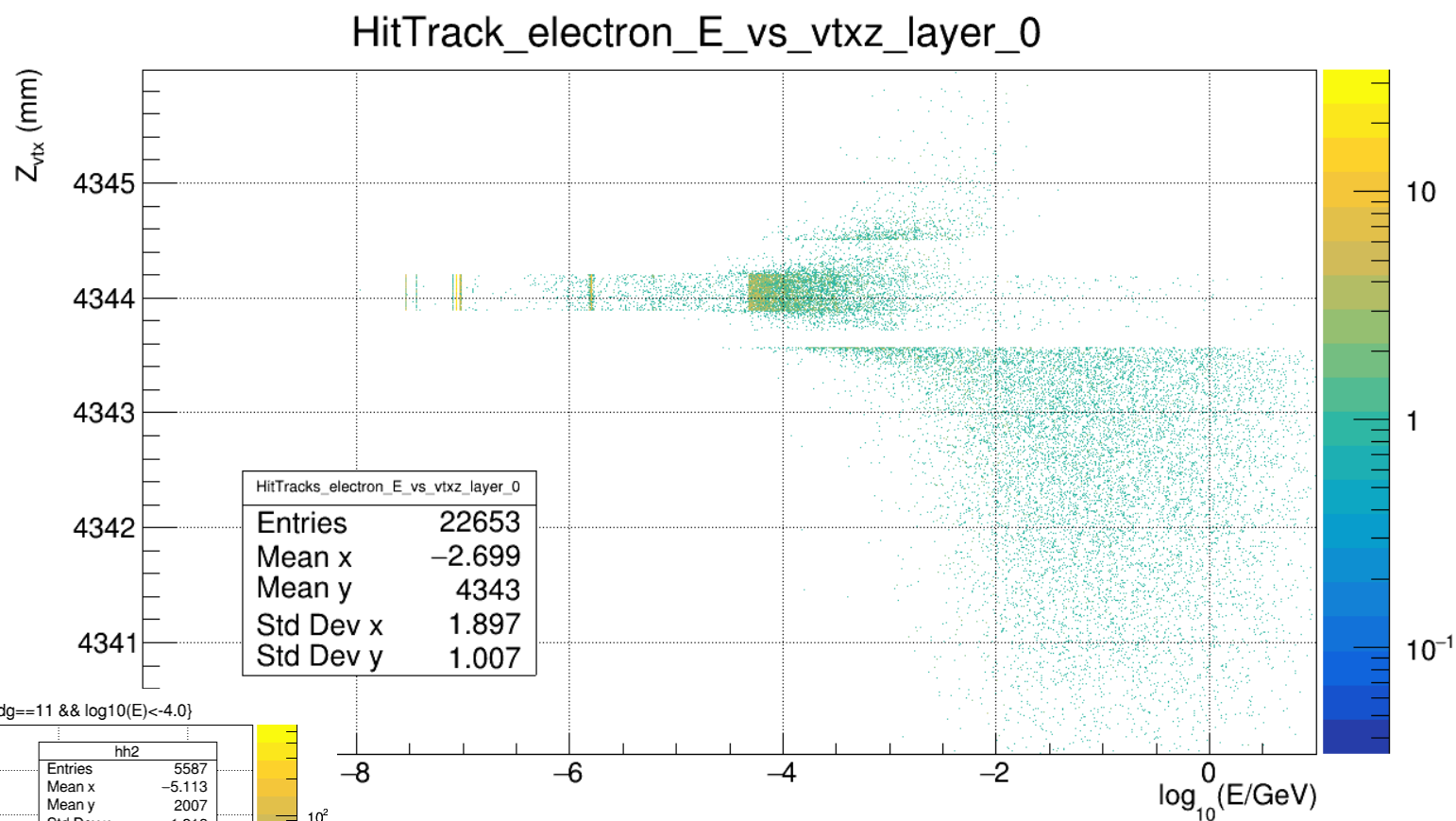
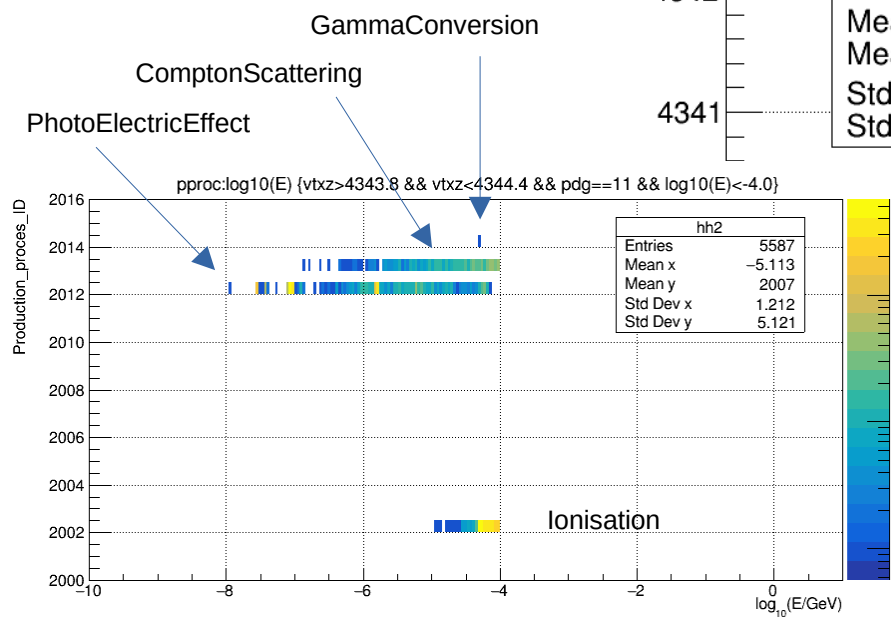
Spectra of the particles which deposited energy in the first layer of ECAL

Not normalized, just same number of primary positrons 5k



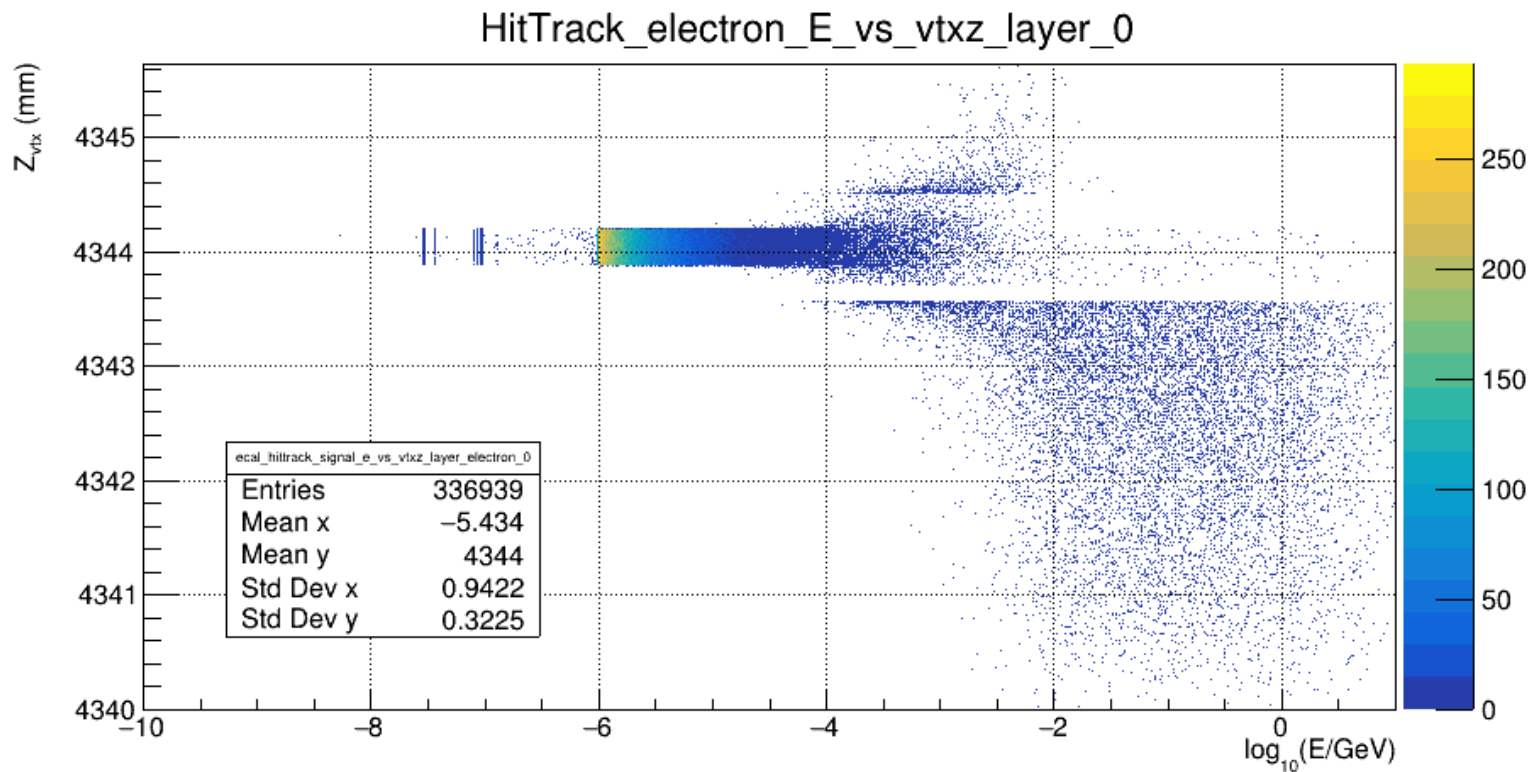
Energy and vertex Z position of the electrons which deposited energy in the first layer of ECAL

Version (0002) with the range cut: 20 μm



Energy and vertex Z position of the electrons which deposited energy in the first layer of ECAL

Version (0003) with
the range cut: 1 um

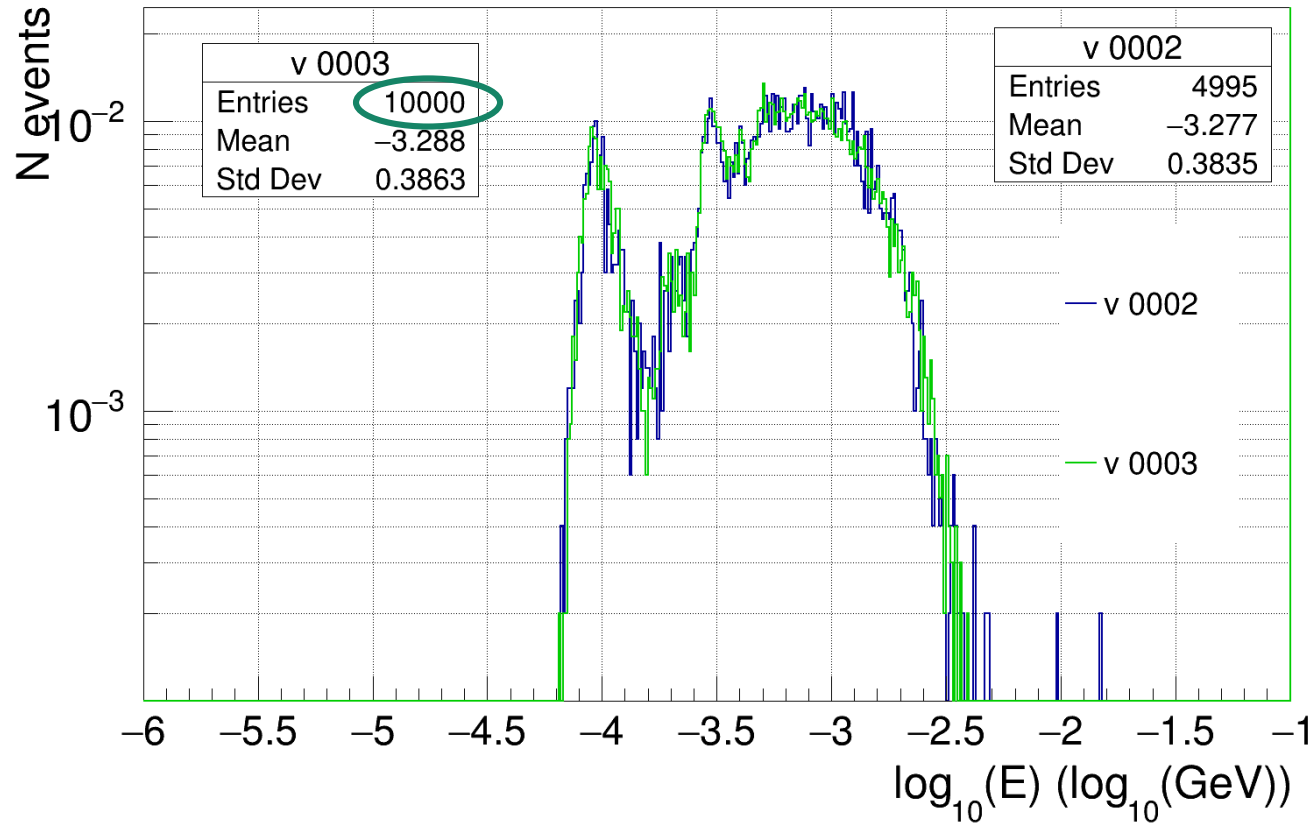


Summary and plans

- Two versions of positron simulations in ECAL (and in the rest of LUXE geometry) are consistent and observables agree well.
- Lower production cut naturally generates more secondary particles.
- Finish updating geometry for the BSM study.

Backup

Energy deposited in the "central" cell of the first layer



Energy deposited in ECAL cell closest to the position of primary positron in layer 0.
More stats.

Same, but linear scale

Energy deposited in the "central" cell of the first layer

