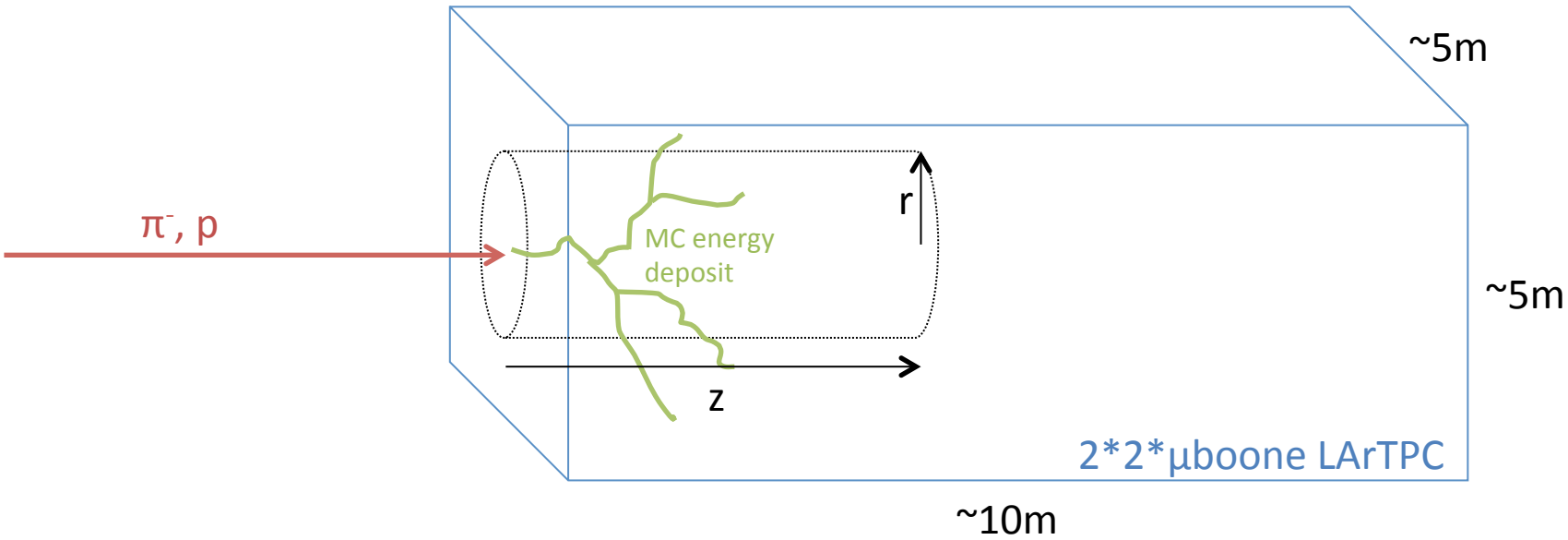
MC hadron containment in a test beam simulation

Pawel Guzowski
University of Manchester

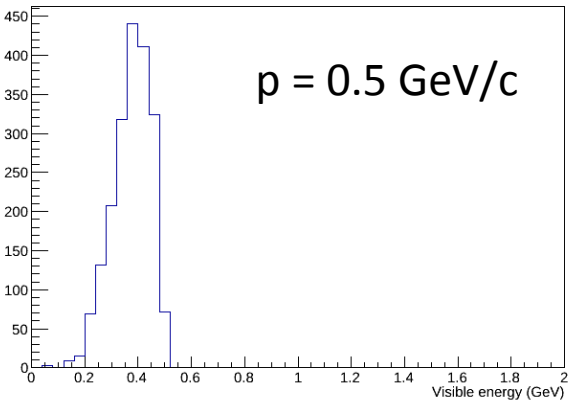
Quantifying containment

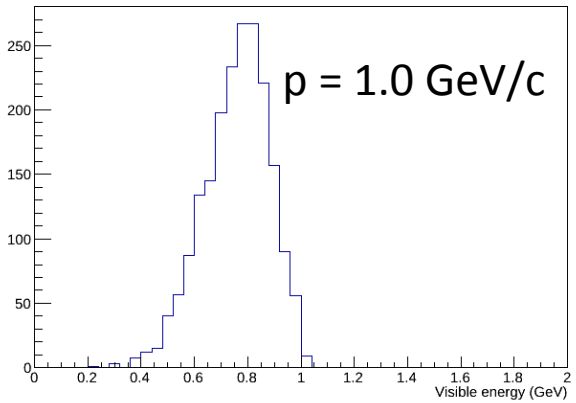
- Fire hadrons at an expanded microboone detector simulation (double width & double height)
- Determine what fraction of total visible energy deposit is contained inside cylinder (r,z) around particle axis

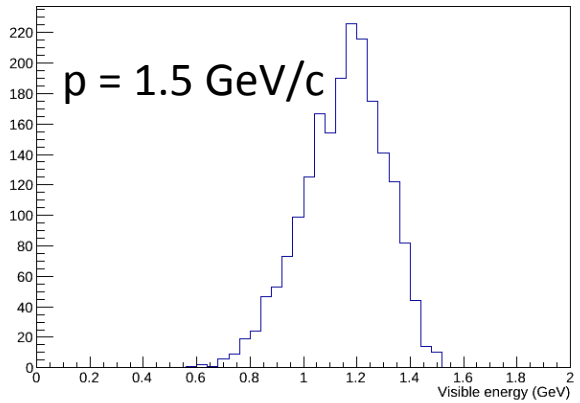


Pions, visible energy

Summing up all the (MC truth) deposited energy in the whole LArTPC for each particle

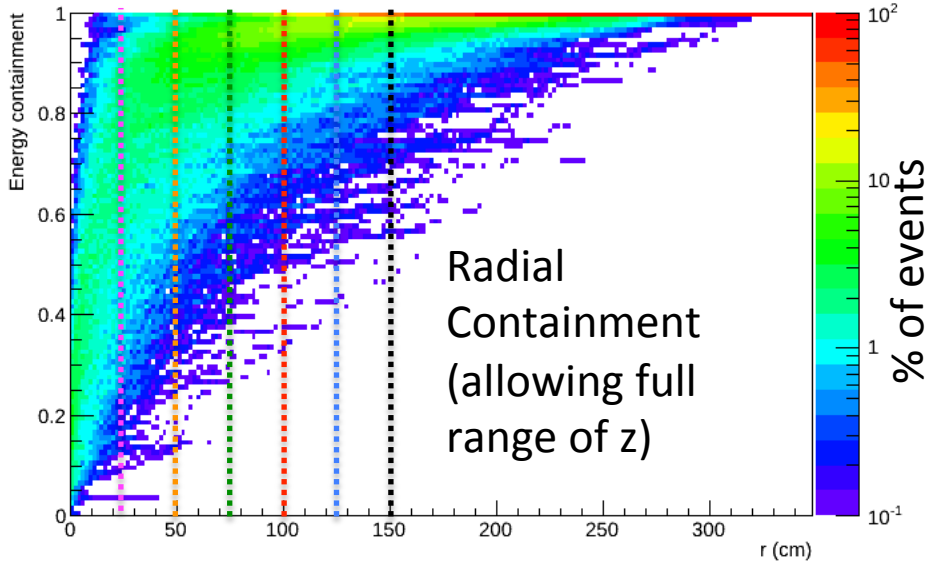


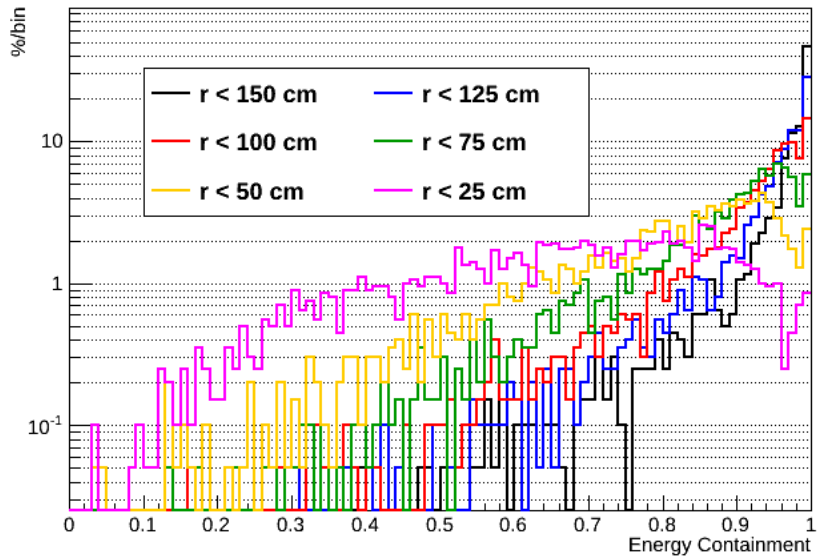




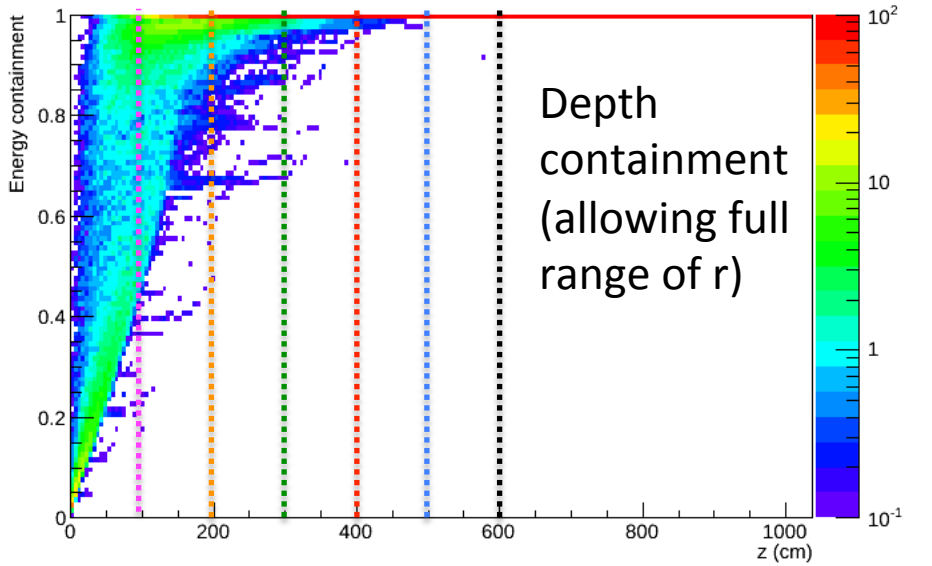
(1 entry = 1 particle)

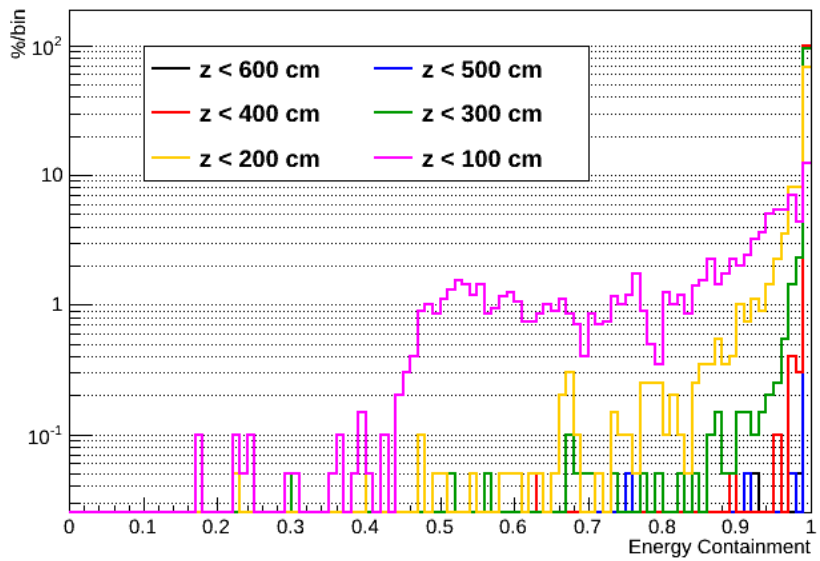
0.5 GeV pions



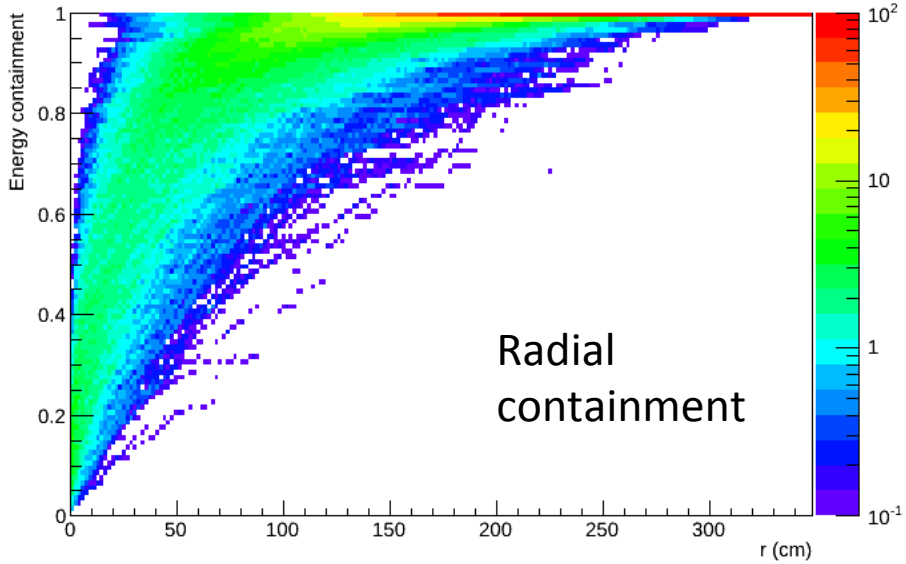


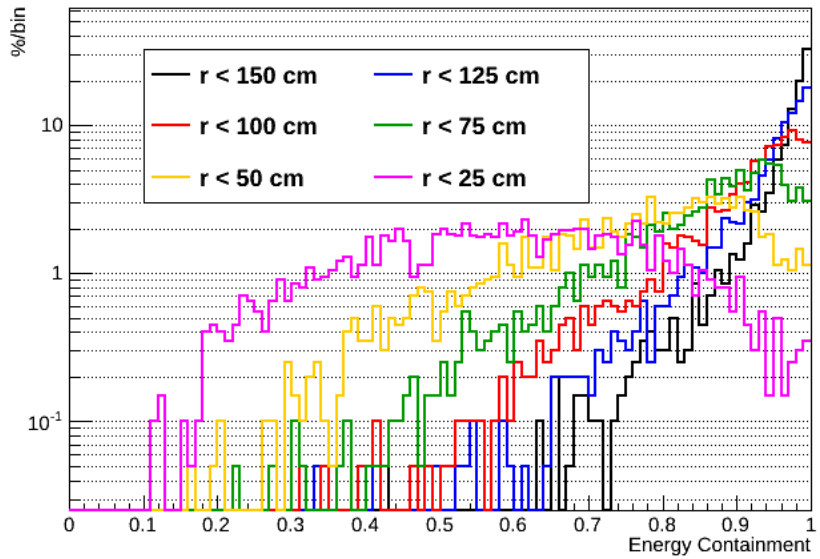
(1 = fully contained - all energy deposits within that cylinder, 0 = no containment)

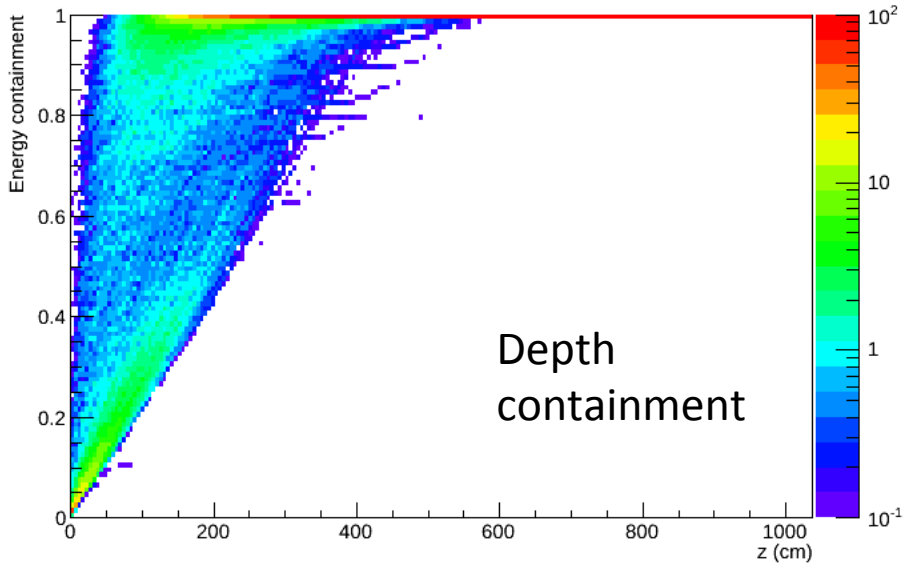


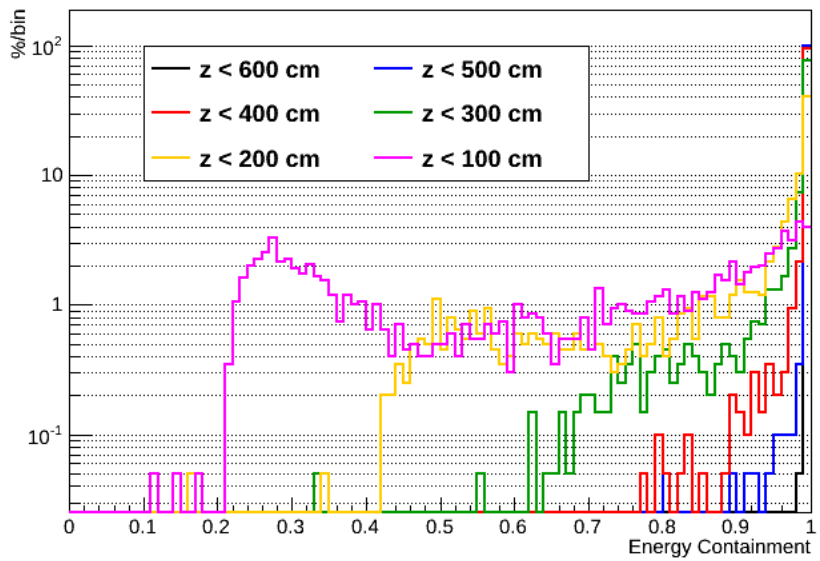


1.0 GeV pions

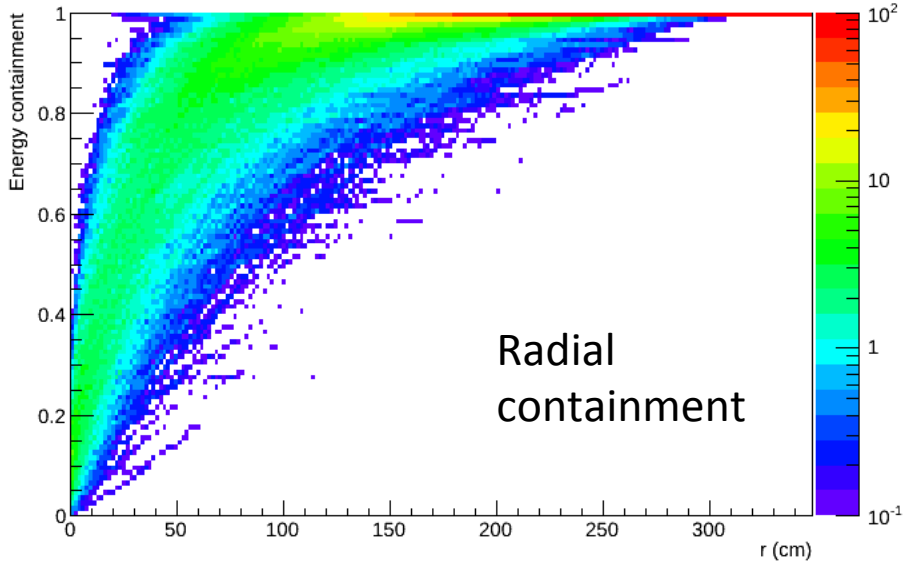

Energy containment
r (cm)
Radial
containment

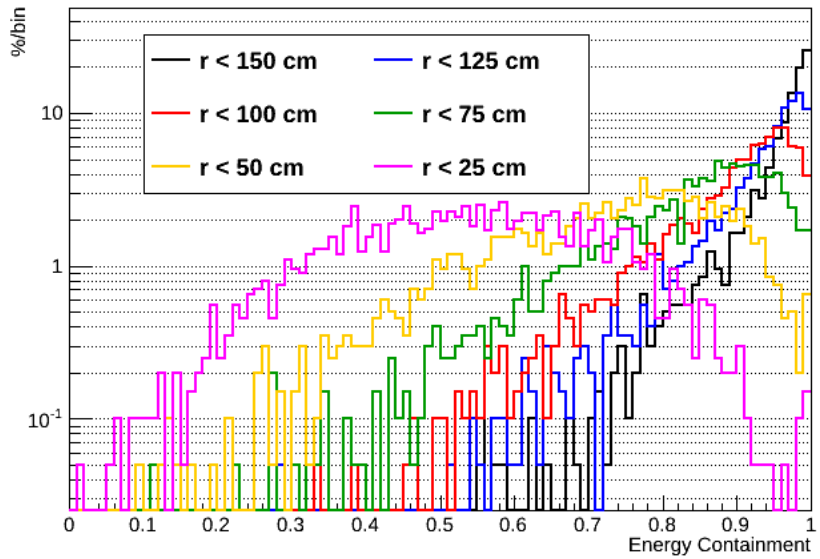

%/bin
Energy Containment
r < 150 cm
r < 125 cm
r < 100 cm
r < 75 cm
r < 50 cm
r < 25 cm

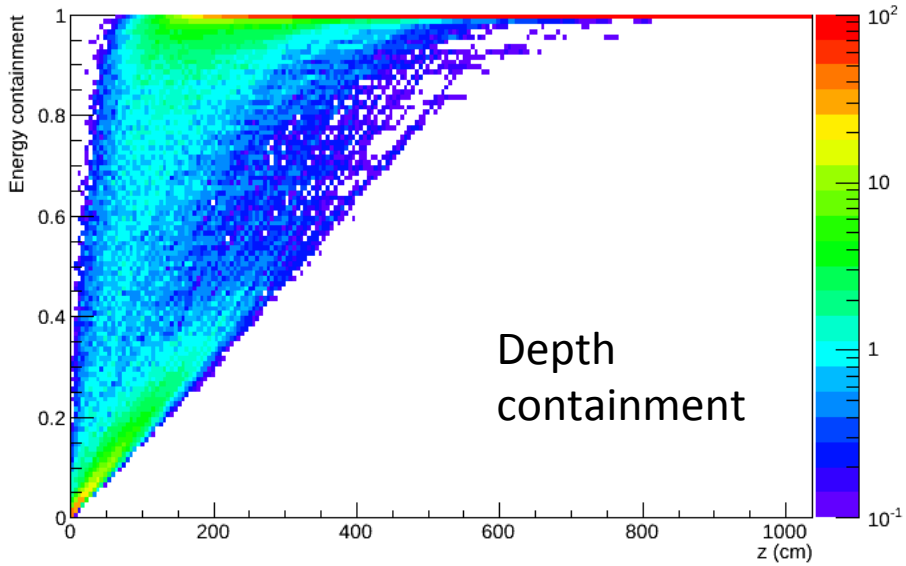

Energy containment
z (cm)
Depth
containment

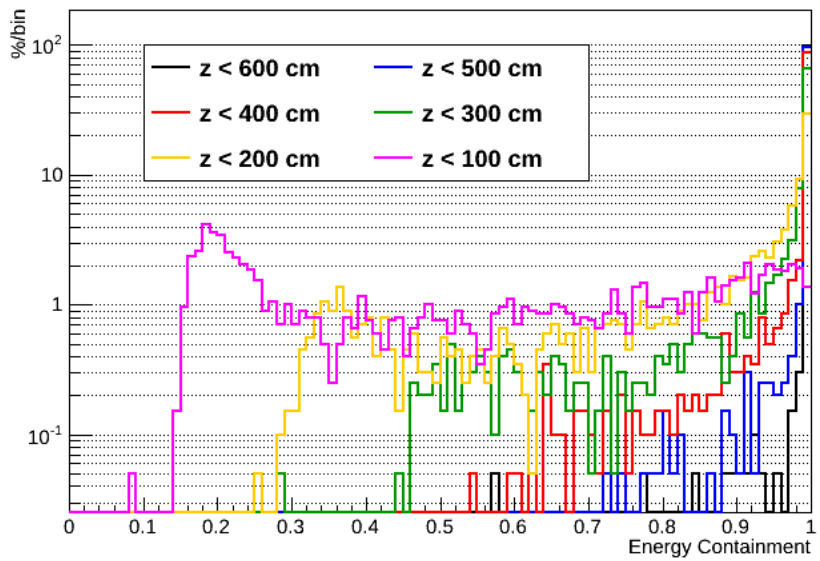

%/bin
Energy Containment
z < 600 cm
z < 500 cm
z < 400 cm
z < 300 cm
z < 200 cm
z < 100 cm

1.5 GeV pions

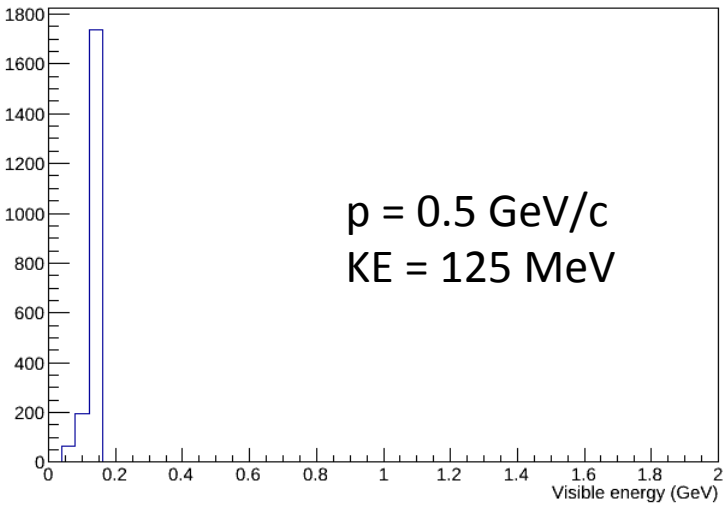

Energy containment
r (cm)
Radial
containment

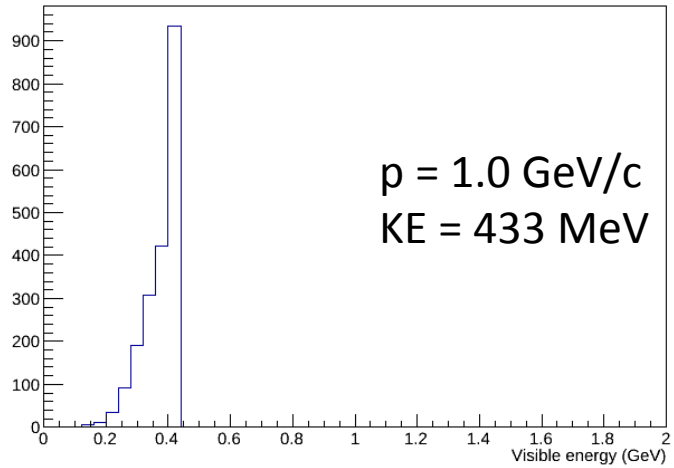

%/bin
Energy Containment
r < 150 cm
r < 125 cm
r < 100 cm
r < 75 cm
r < 50 cm
r < 25 cm

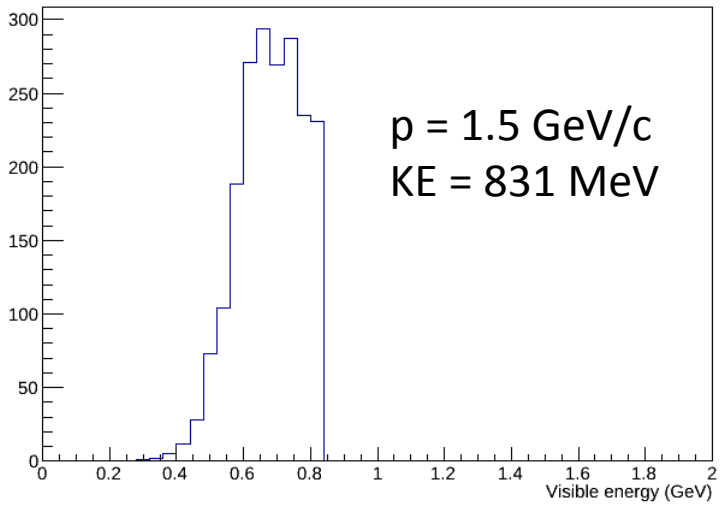

Energy containment
z (cm)
Depth
containment


%/bin
Energy Containment
z < 600 cm
z < 500 cm
z < 400 cm
z < 300 cm
z < 200 cm
z < 100 cm

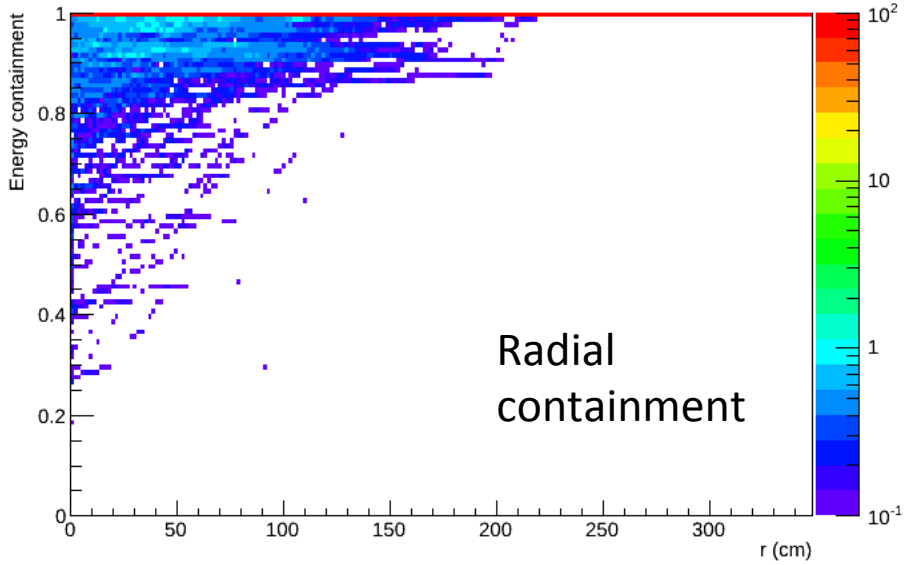
Protons, visible energy

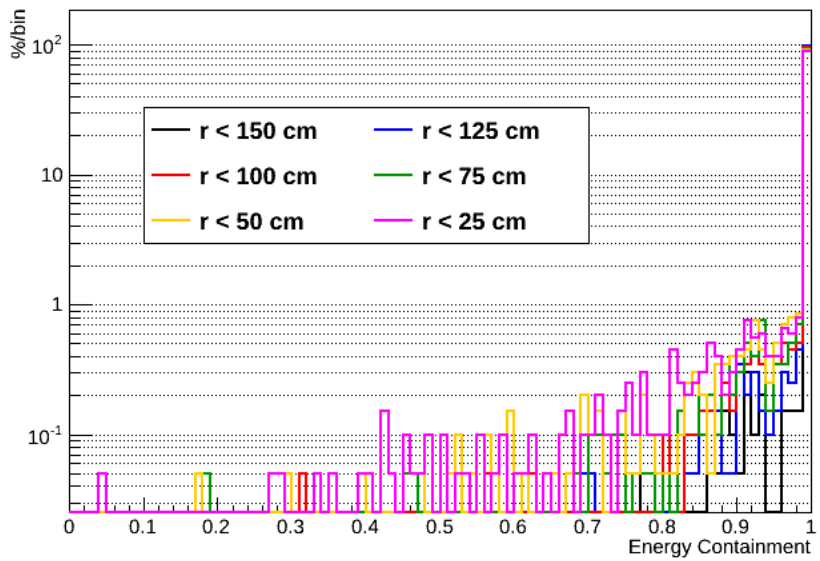


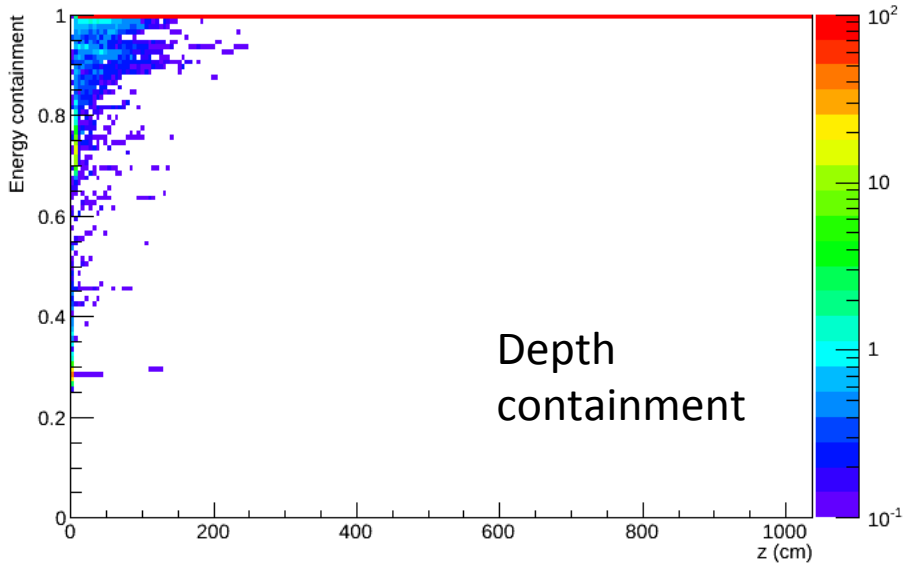


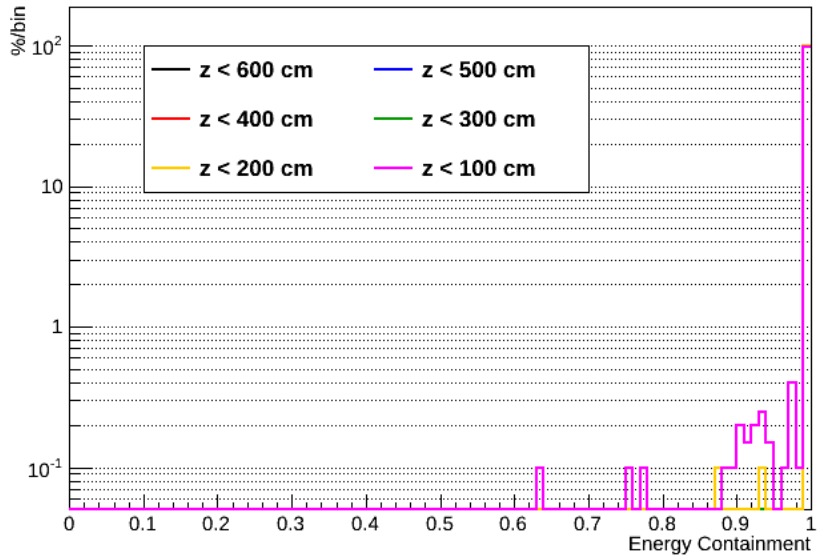


0.5 GeV protons

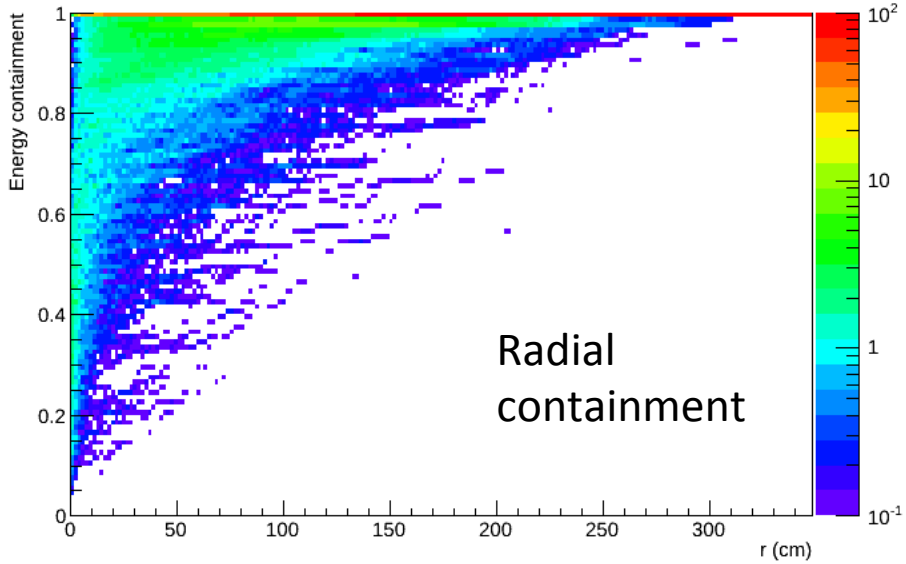


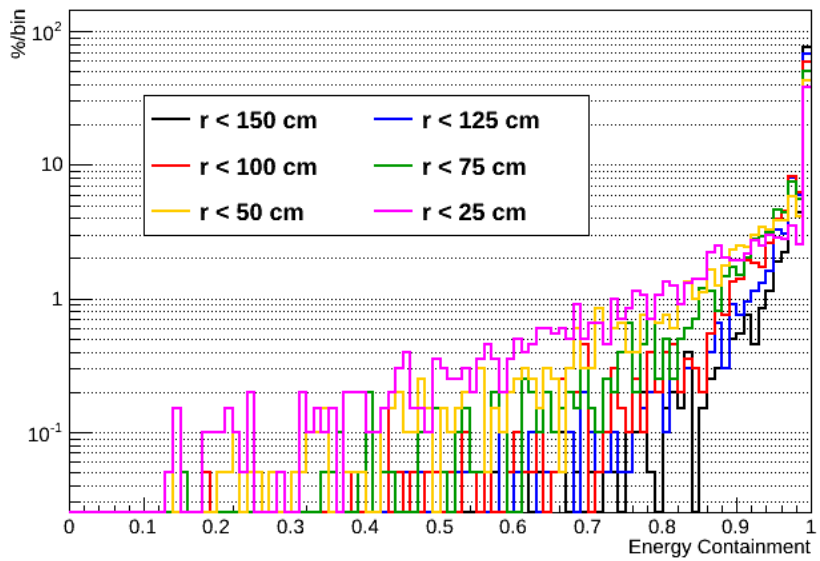


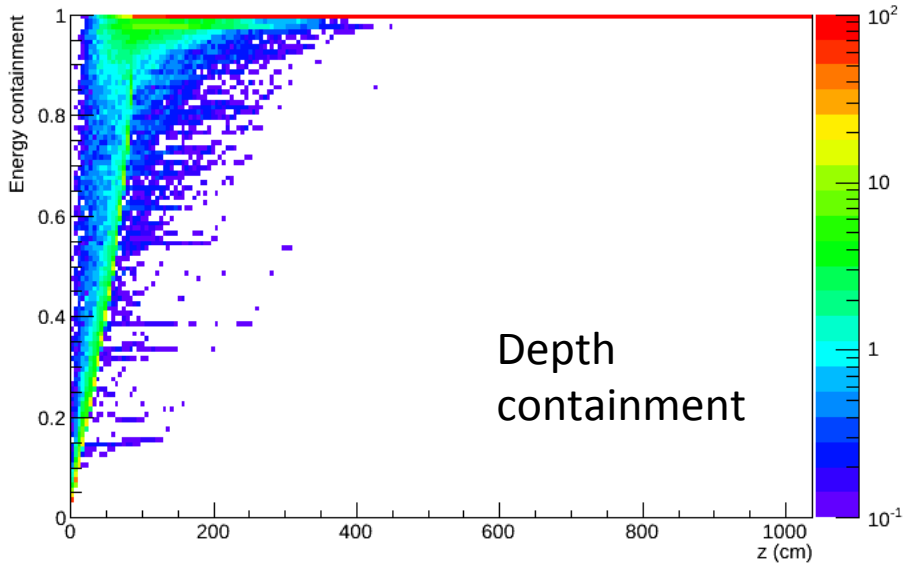


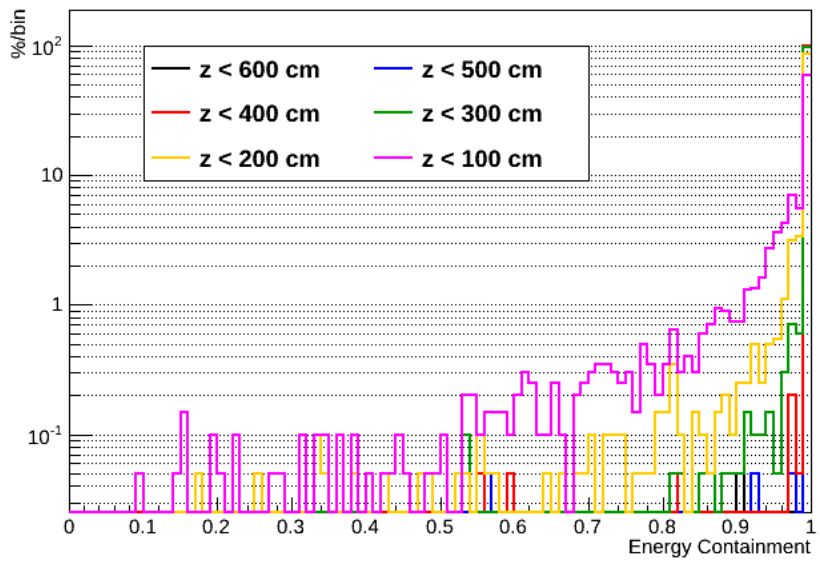


1.0 GeV protons

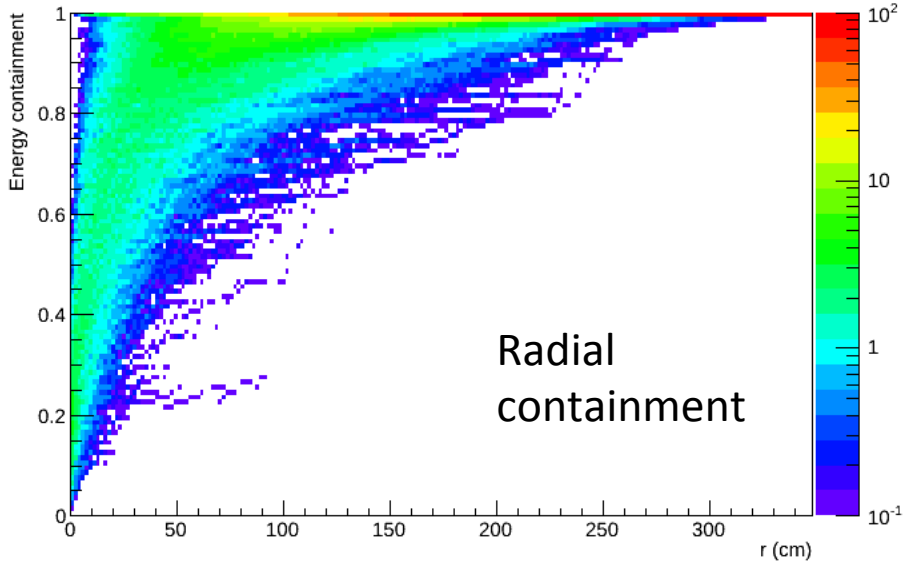


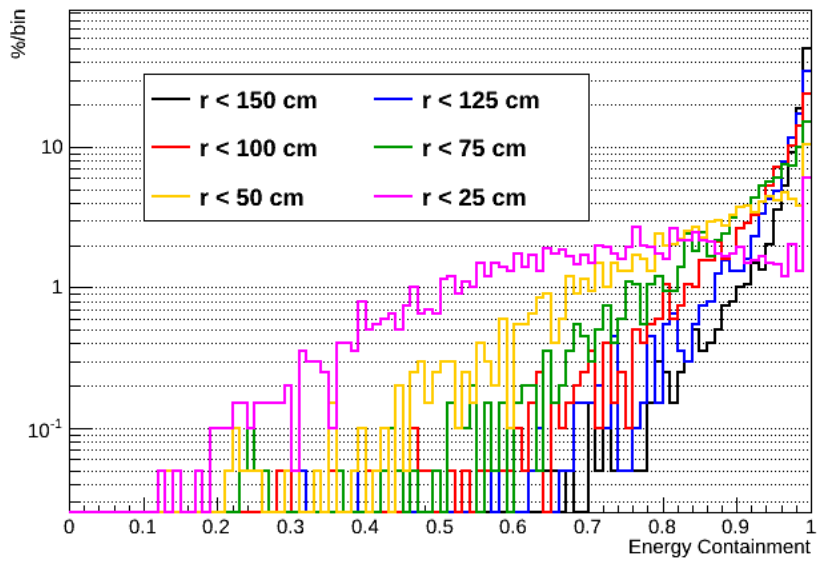


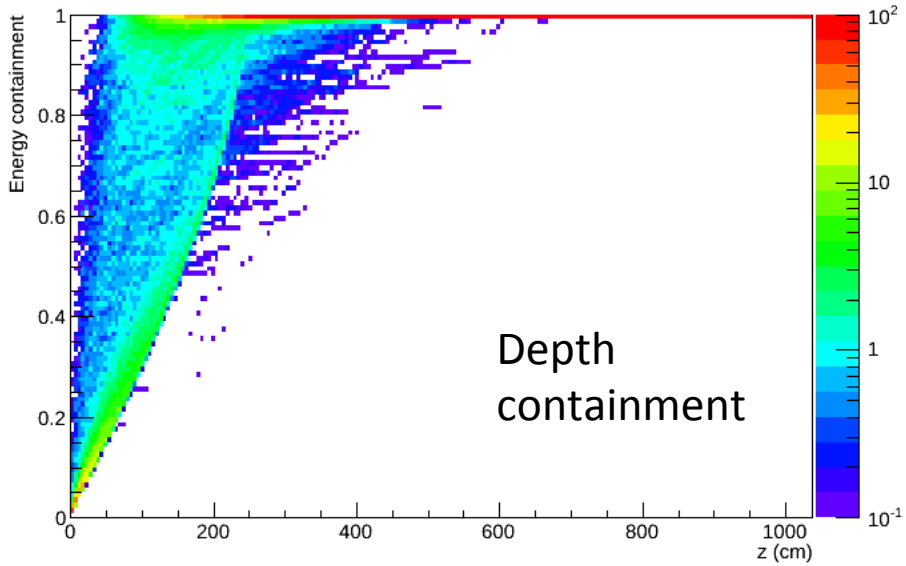


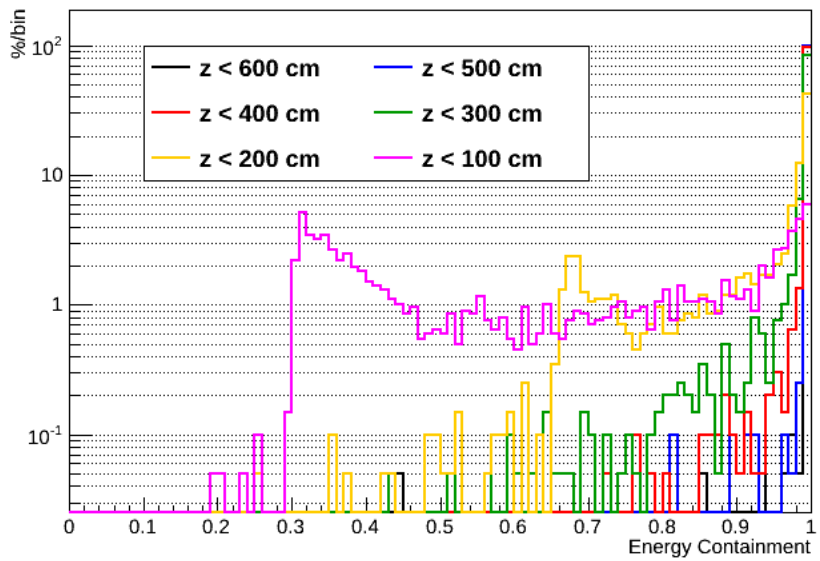


1.5 GeV protons



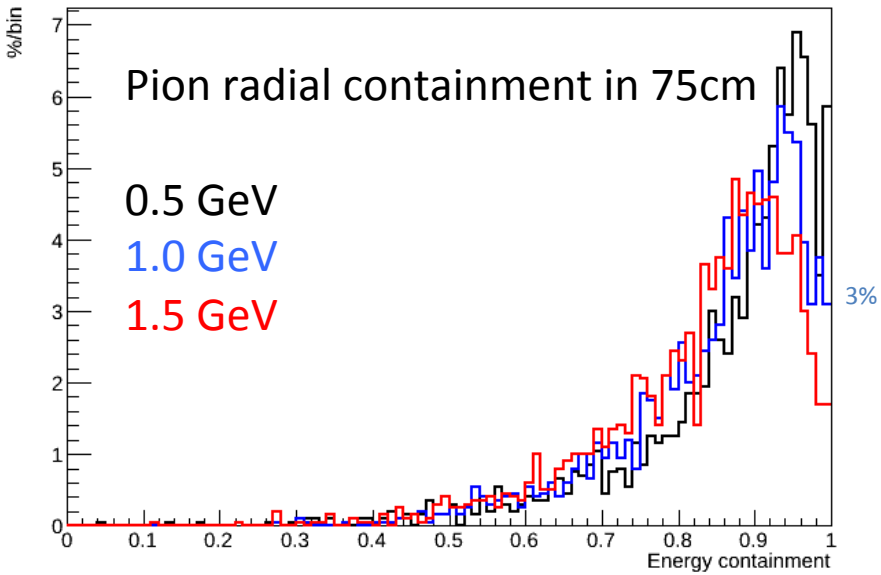


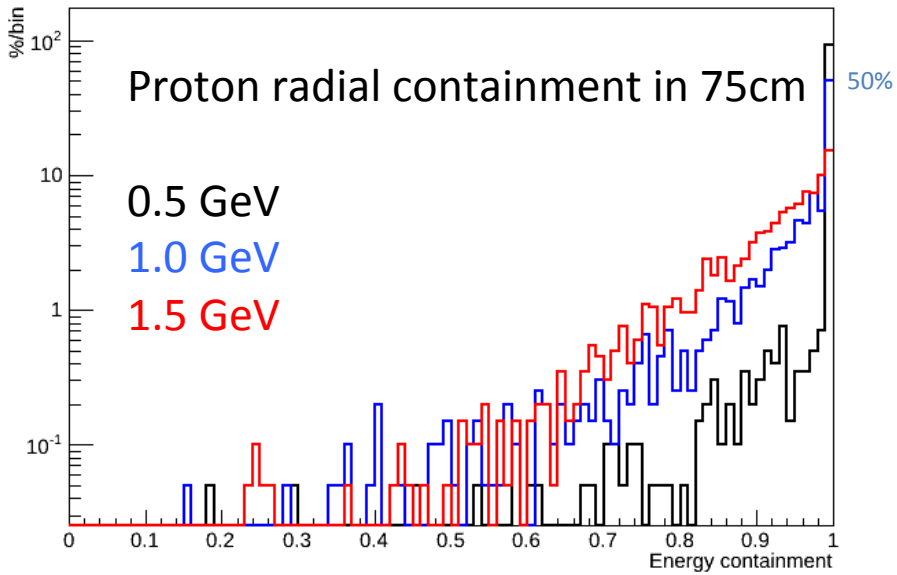




Hadron containment conclusion

- Assuming a test beam TPC of dimensions 1.5 x 1.5 x 4 m^3
- Depth containment OK, with vast majority of particles fully contained in 4m
- Radial containment (<75cm) significantly worse for pions
  - Only ~3% of 1GeV pions fully contained in 75cm

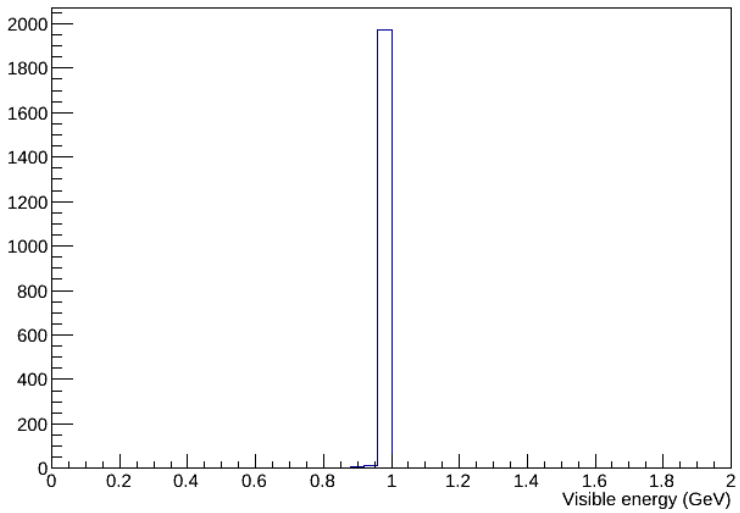




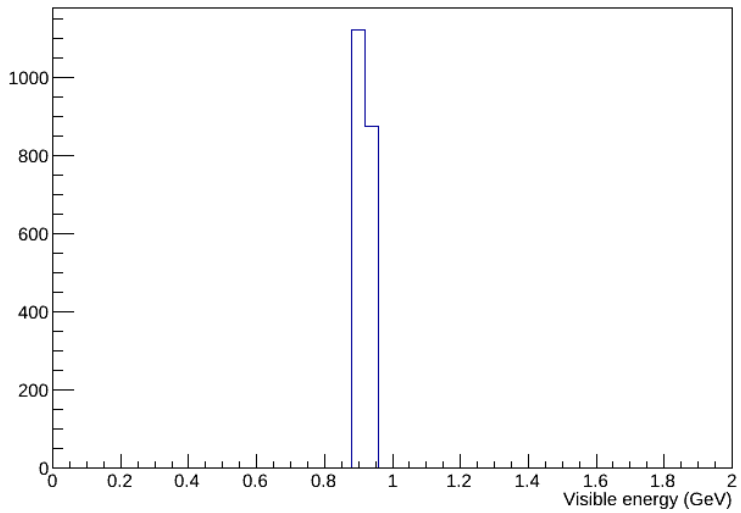
Leptons

As a crosscheck, also looked briefly at 1GeV leptons to check my methods are consistent with known properties

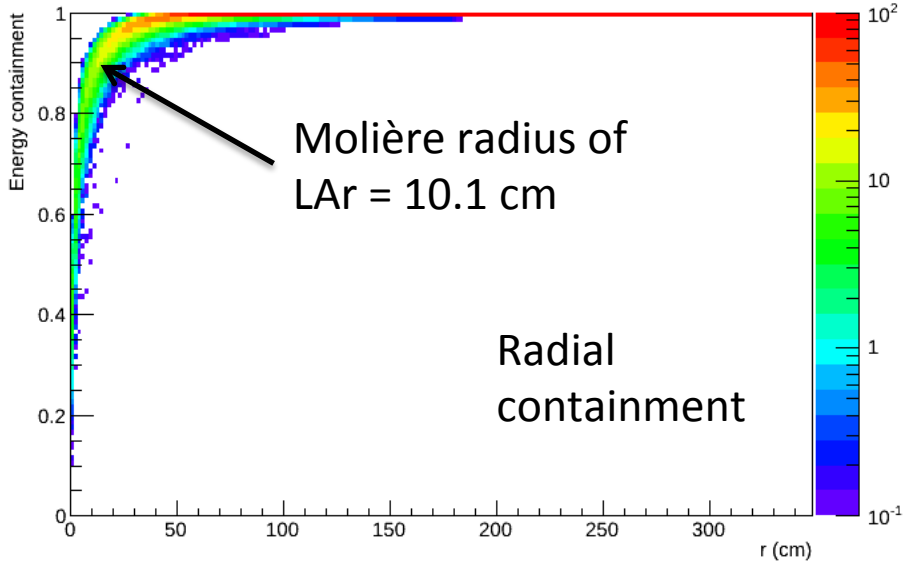
1 GeV electrons
Visible energy

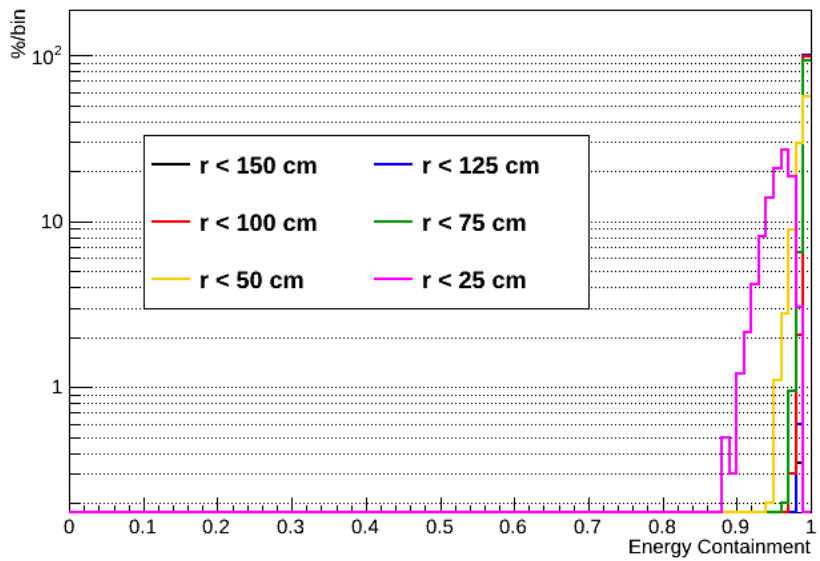


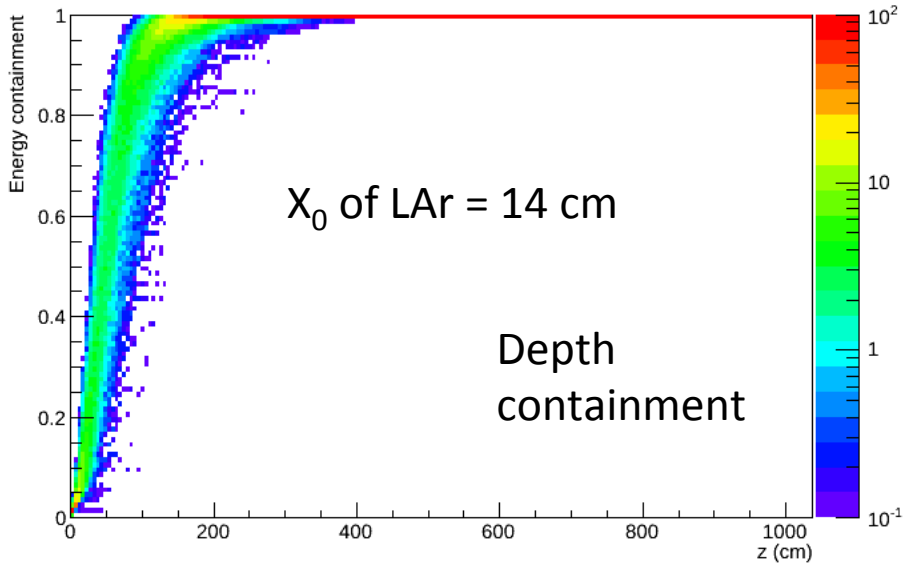
1 GeV muons
Visible energy

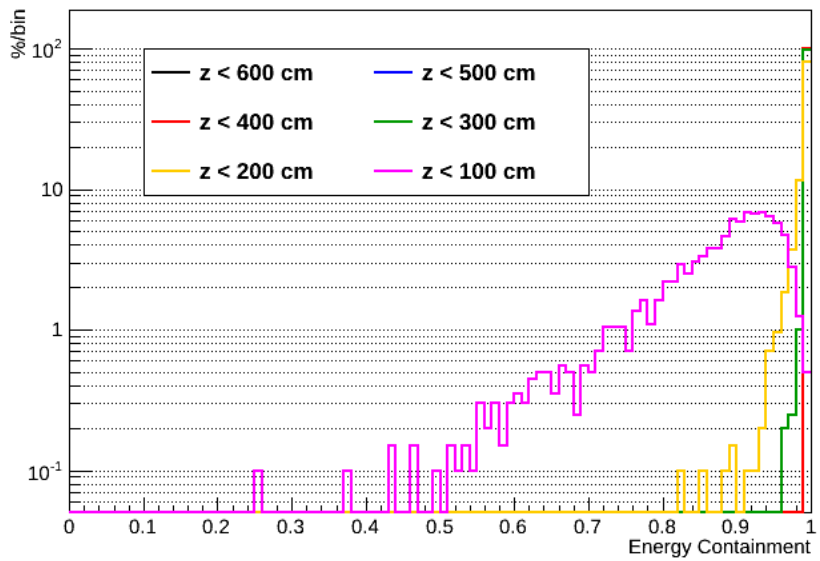


1.0 GeV electrons

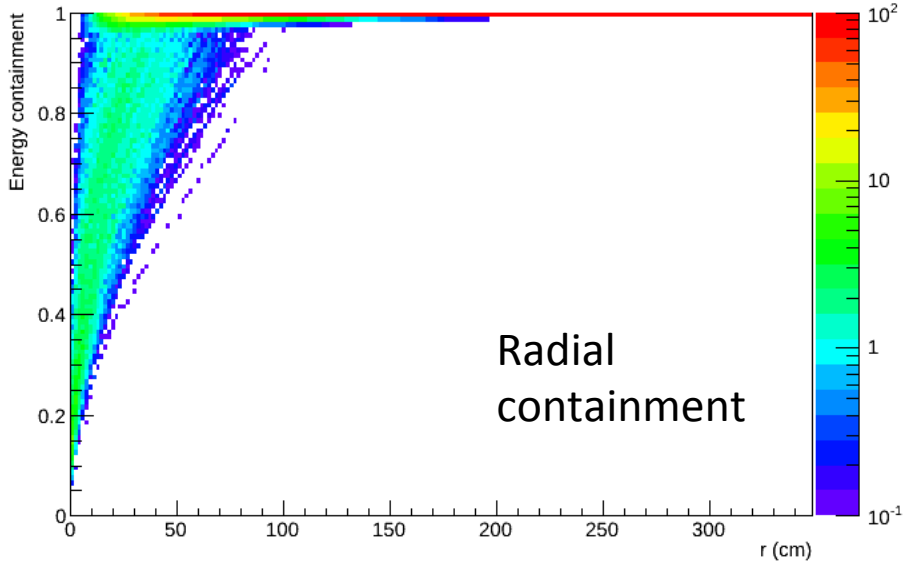


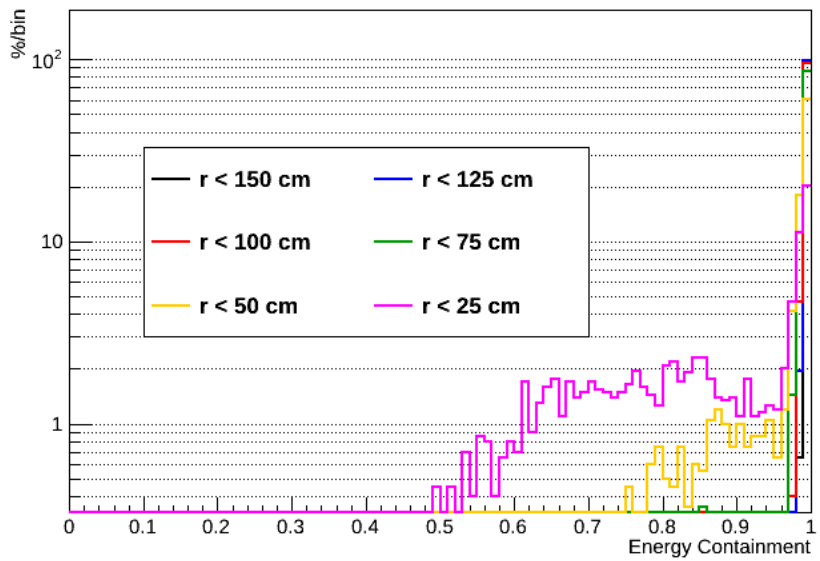


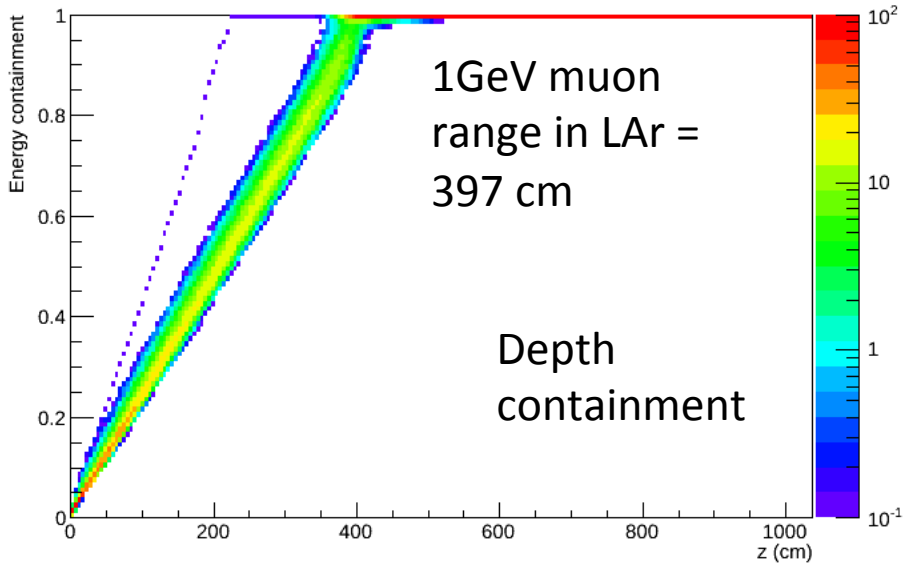


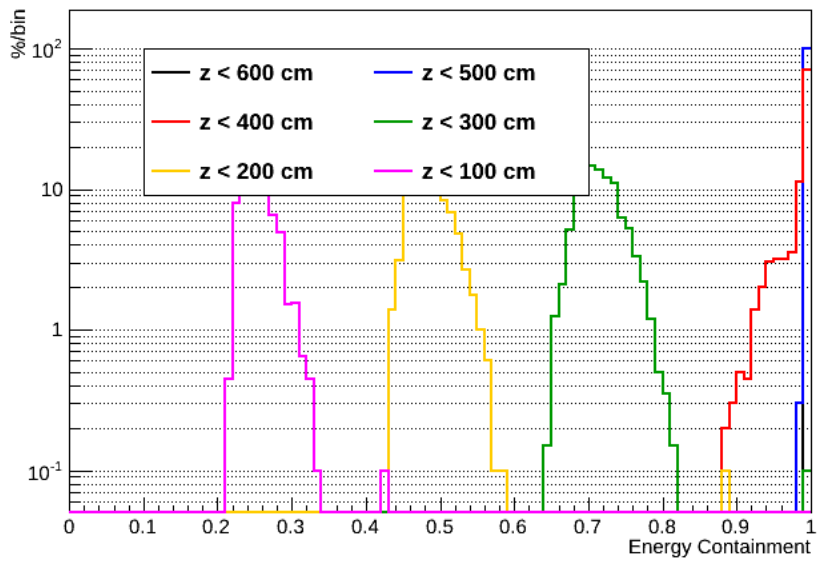


1.0 GeV muons


Energy containment
r (cm)
Radial
containment


%/bin
Energy Containment
r < 150 cm
r < 125 cm
r < 100 cm
r < 75 cm
r < 50 cm
r < 25 cm


Energy containment
z (cm)
1GeV muon
range in LAr =
397 cm
Depth
containment


%/bin
Energy Containment
z < 600 cm
z < 500 cm
z < 400 cm
z < 300 cm
z < 200 cm
z < 100 cm

Next steps

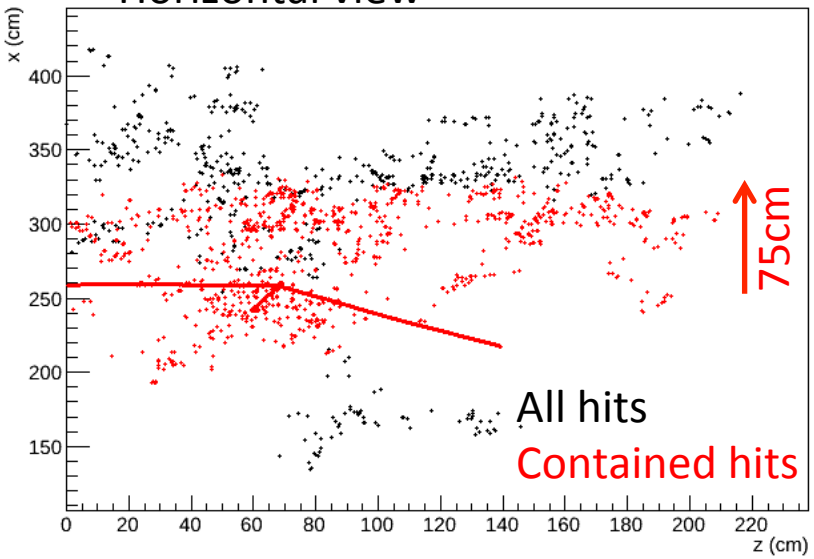
- Simulate fuller range of momenta, 0-2 GeV
- Could produce distributions of the fraction of particles that are at least 90%, 95%, 99% etc. contained in r<75cm, as a function of momentum
- Looking at how the reconstruction performs

Update

- Event display pictures
- Escaping particles

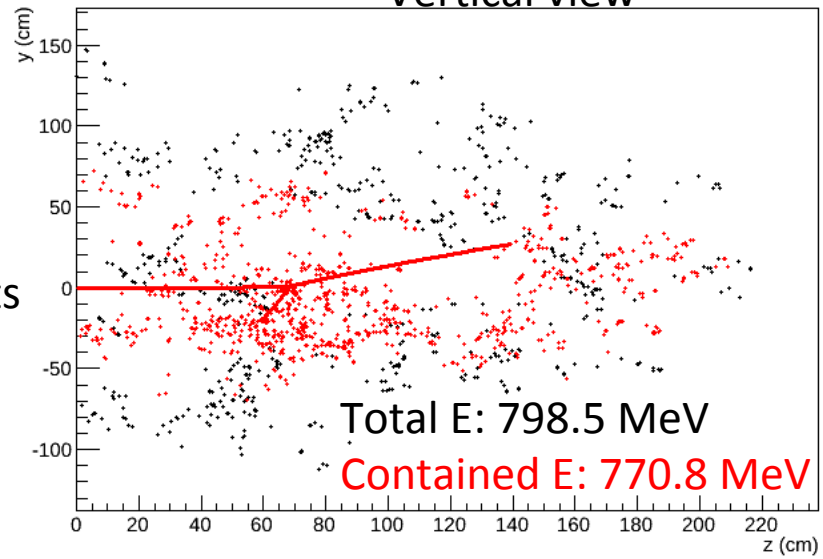
1.0 GeV pions

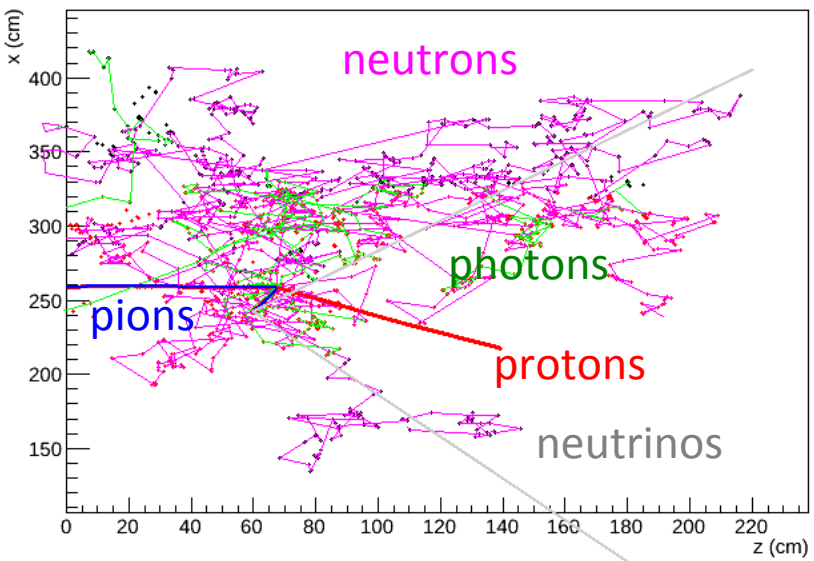
Horizontal view



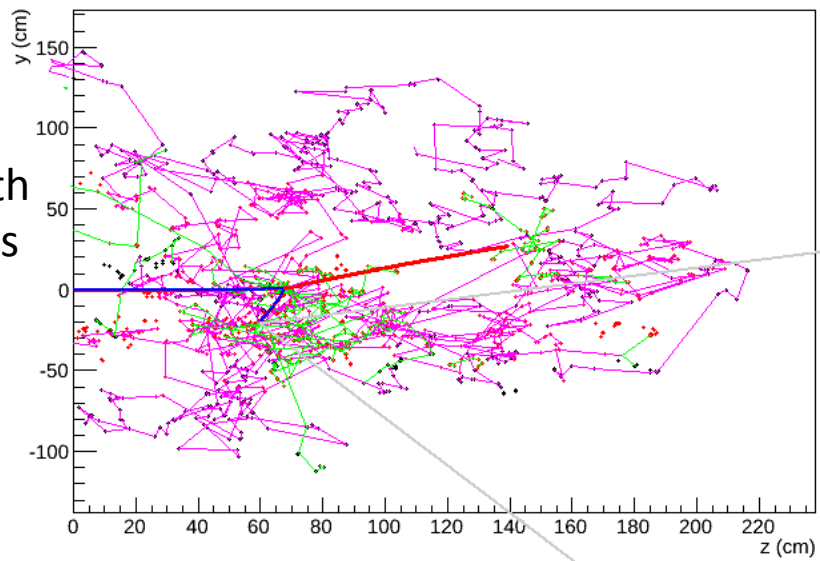
MC energy deposits

Vertical view





MC truth particles

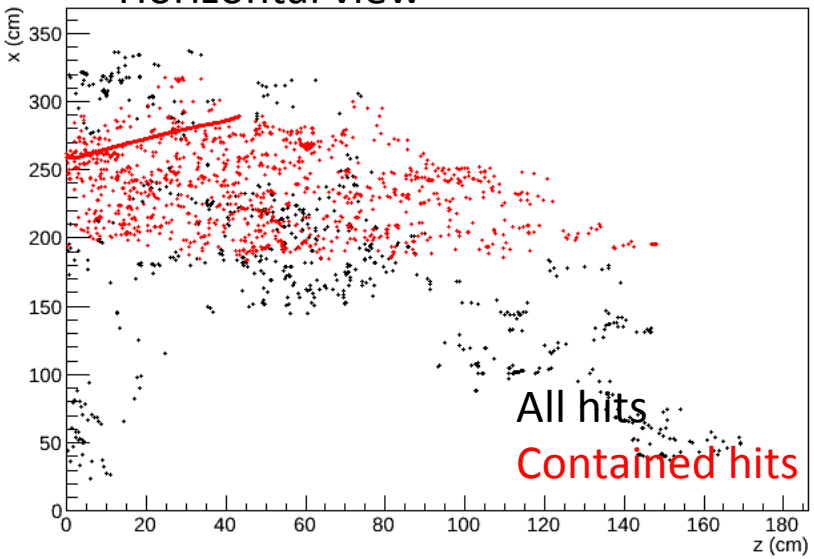


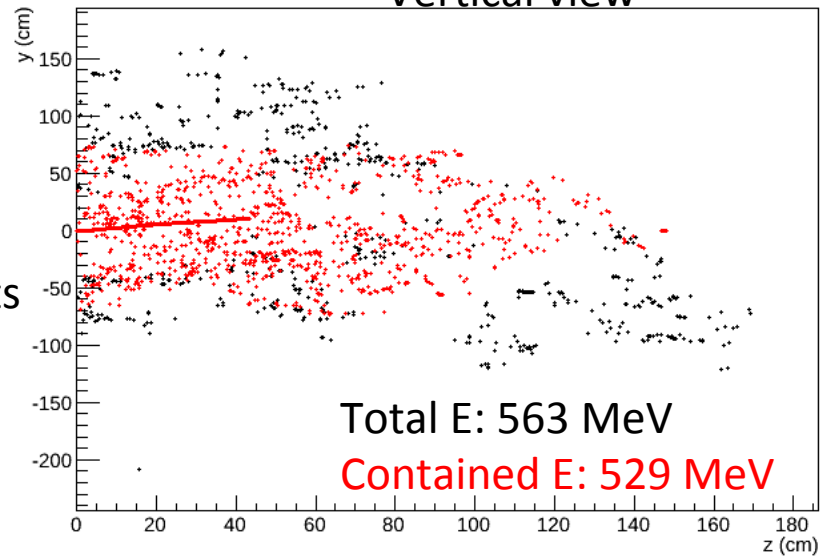
1.0 GeV pions

Horizontal view

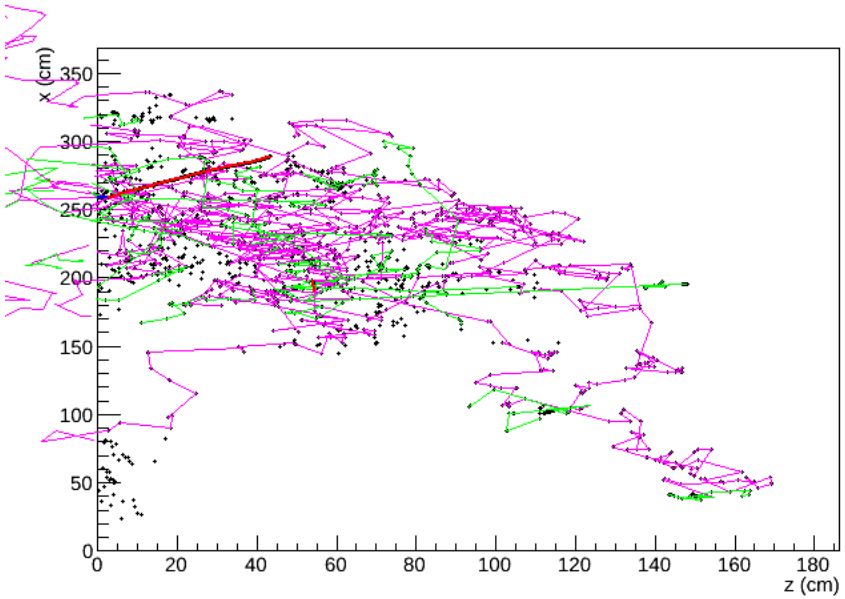
Vertical view

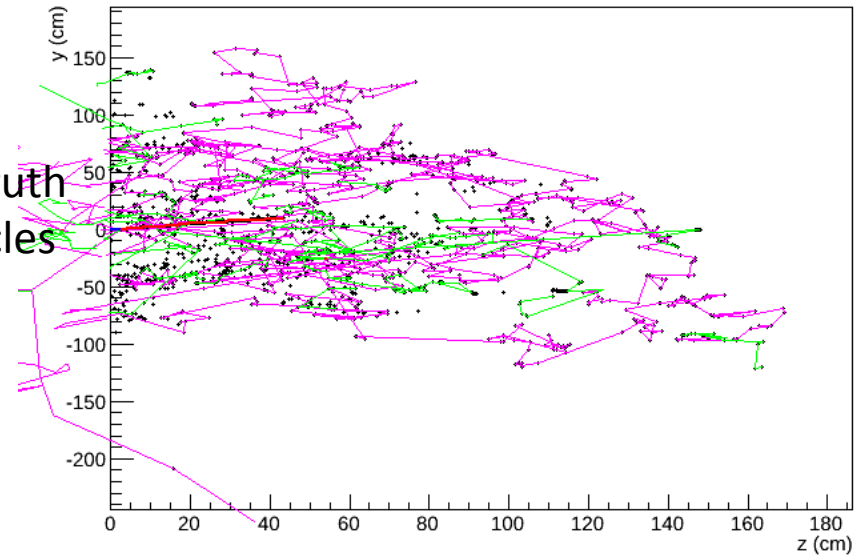
MC energy deposits





MC truth particles



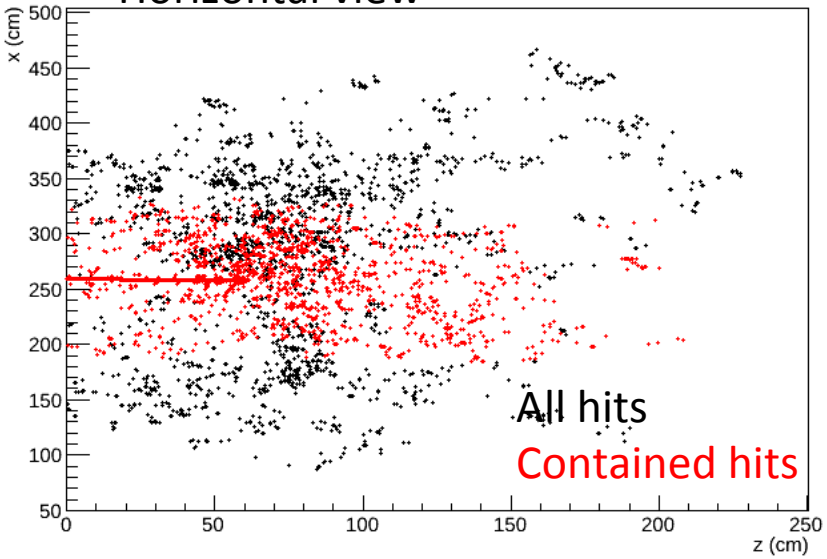


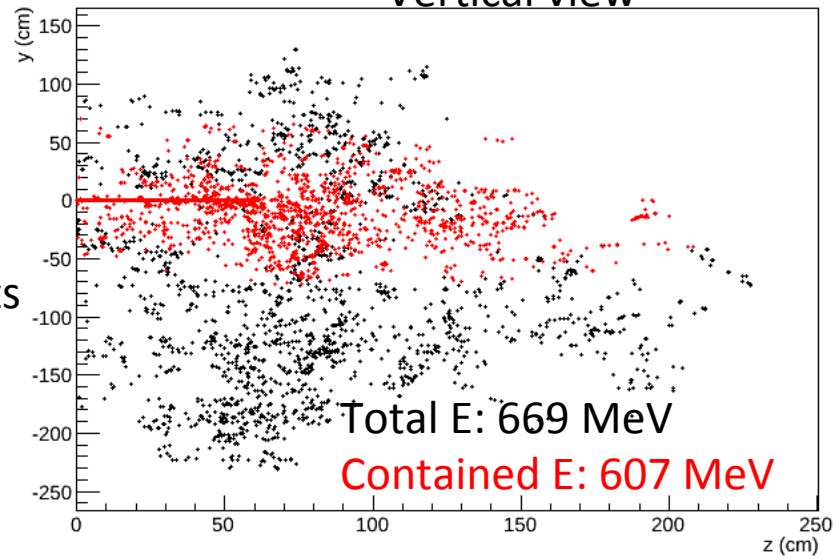
1.0 GeV pions

Horizontal view

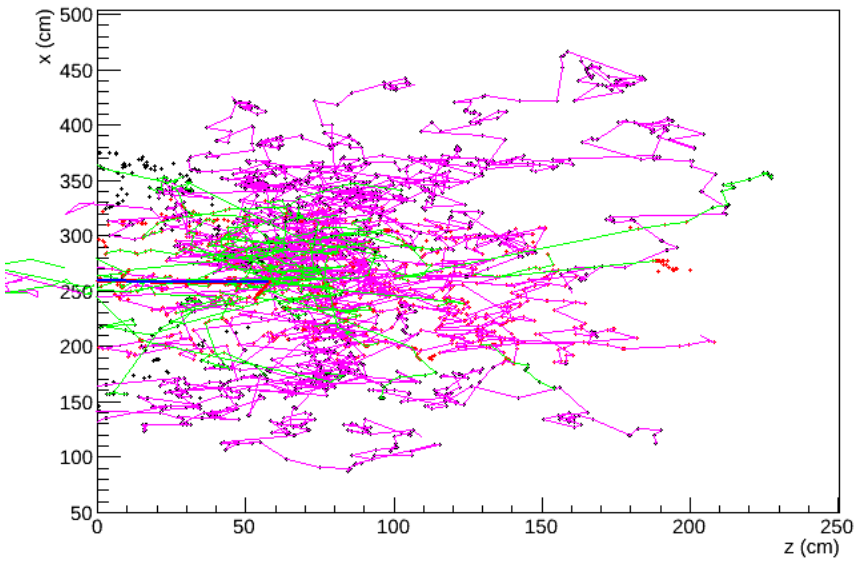
Vertical view

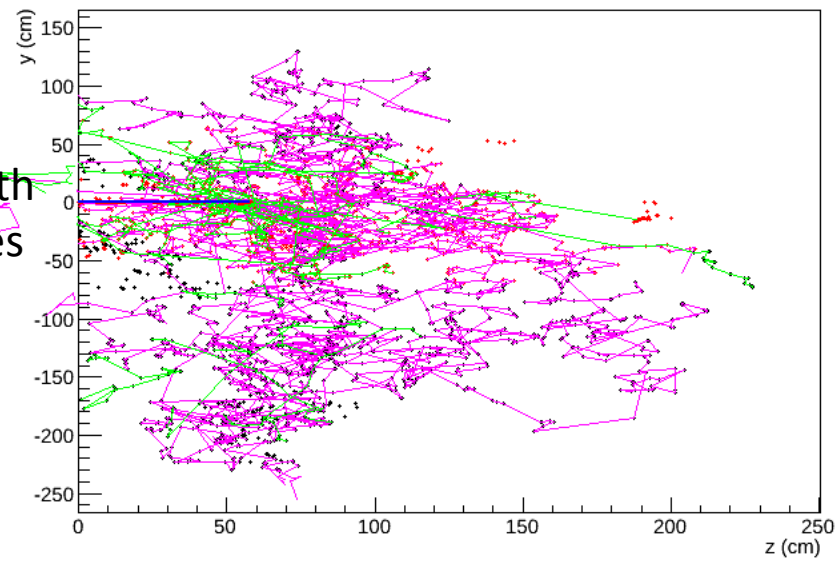
MC energy deposits





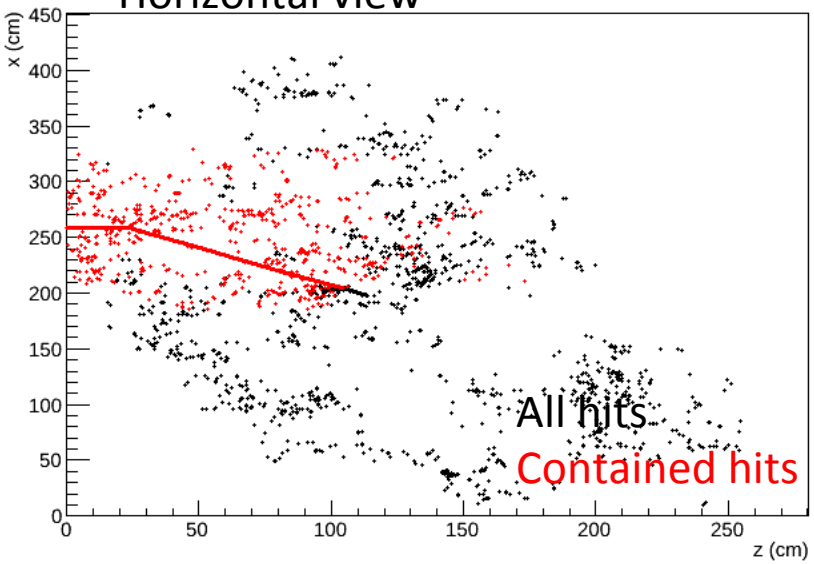
MC truth particles





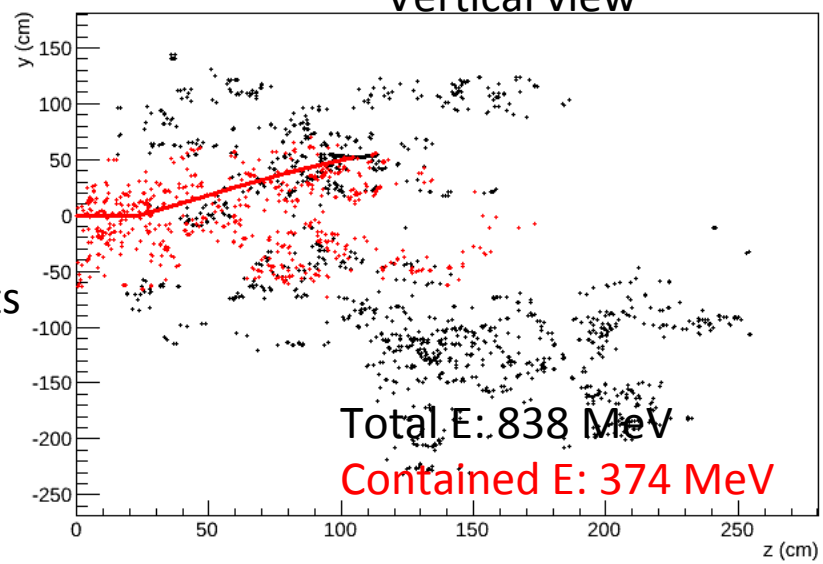
1.0 GeV pions

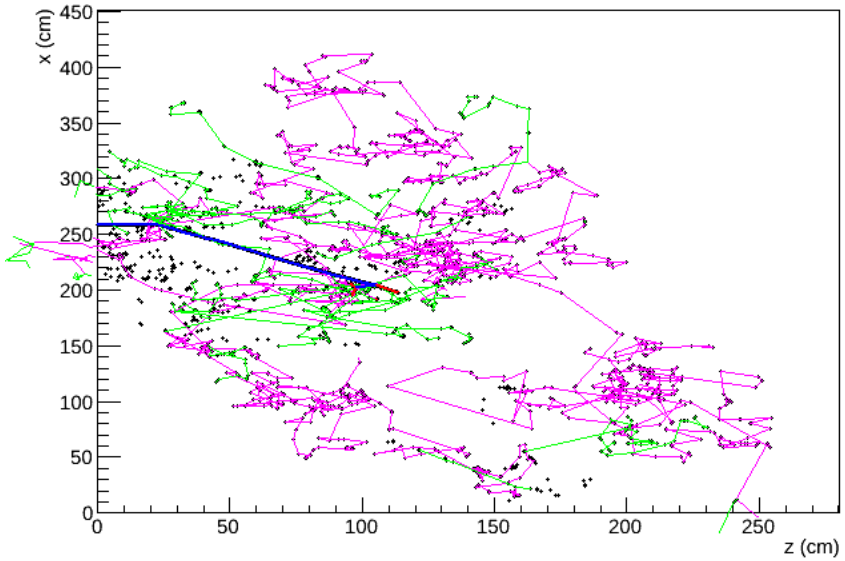
Horizontal view



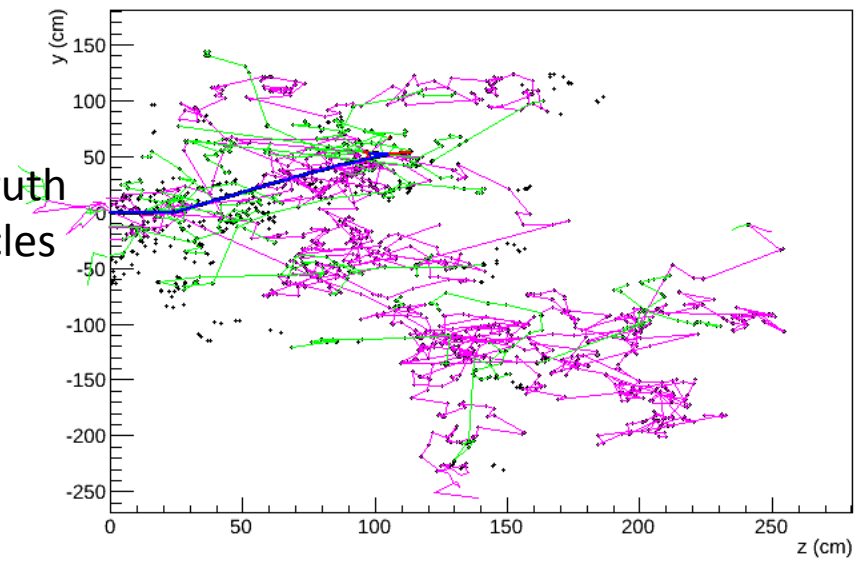
MC energy deposits

Vertical view



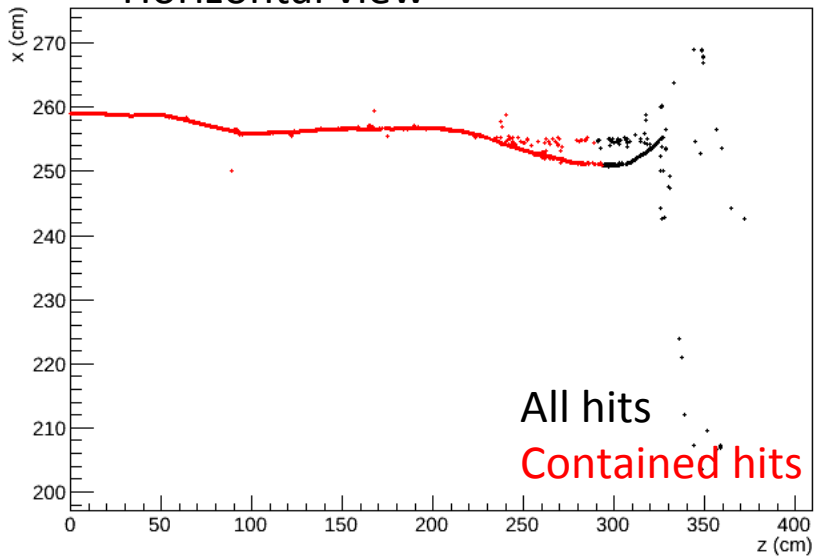


MC truth particles



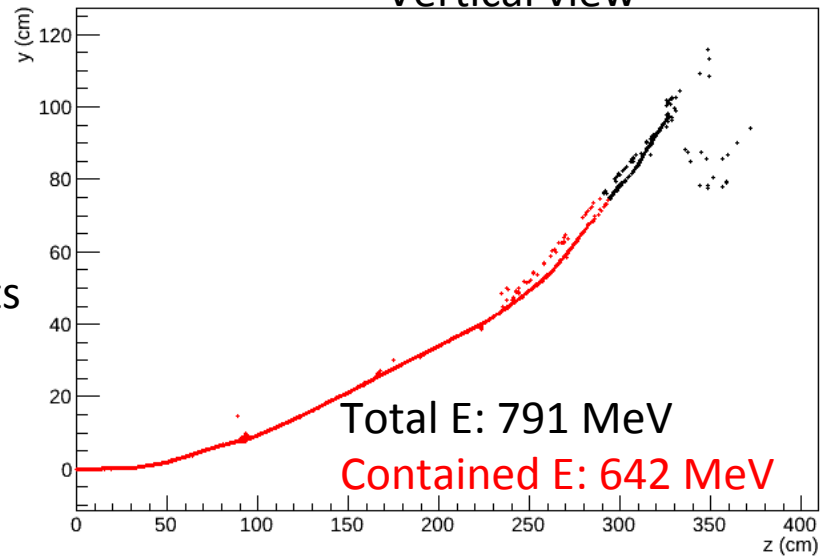
1.0 GeV pions

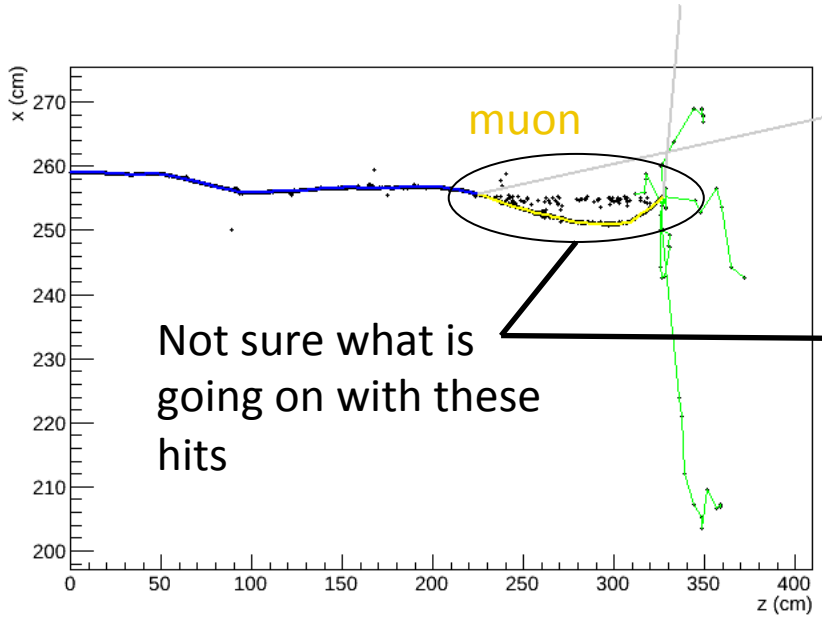
Horizontal view



MC energy deposits

Vertical view

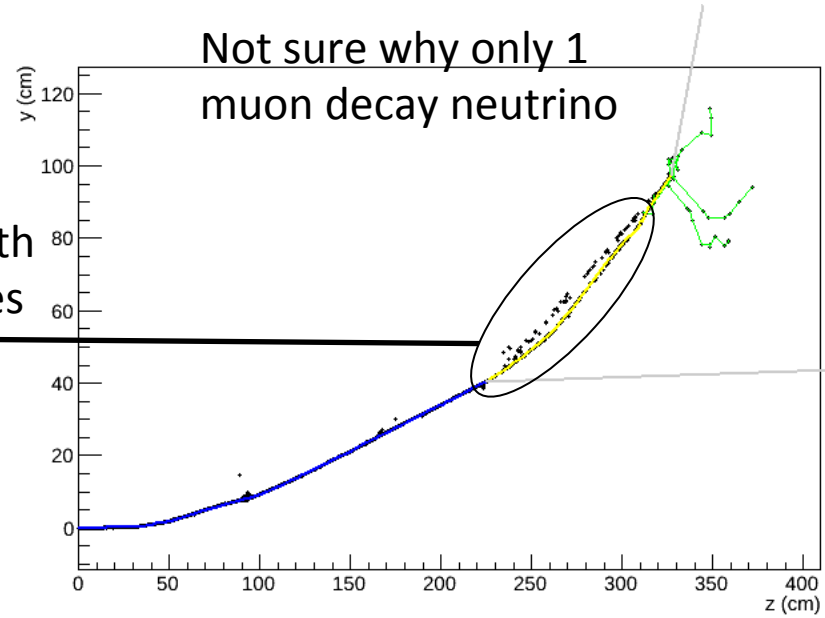




Not sure what is going on with these hits

MC truth particles

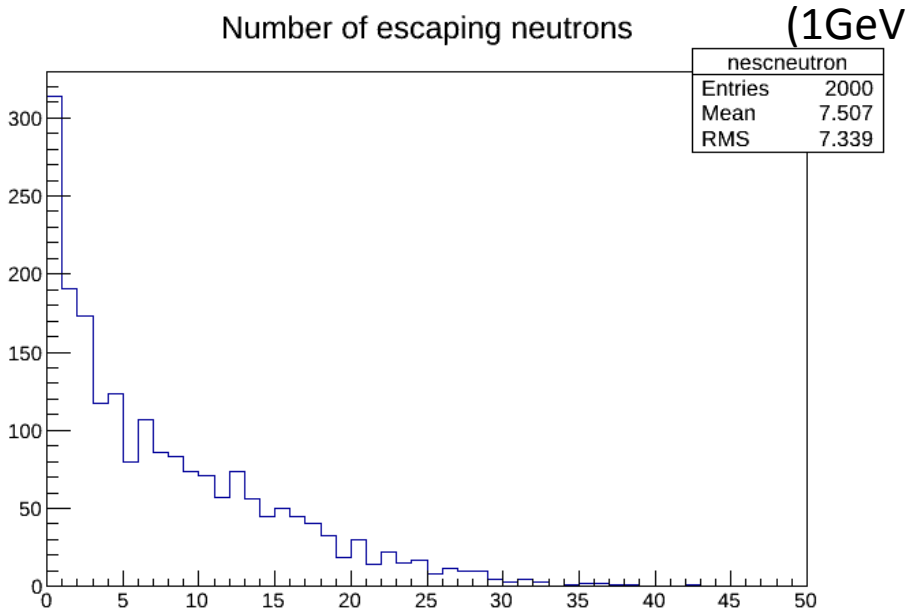
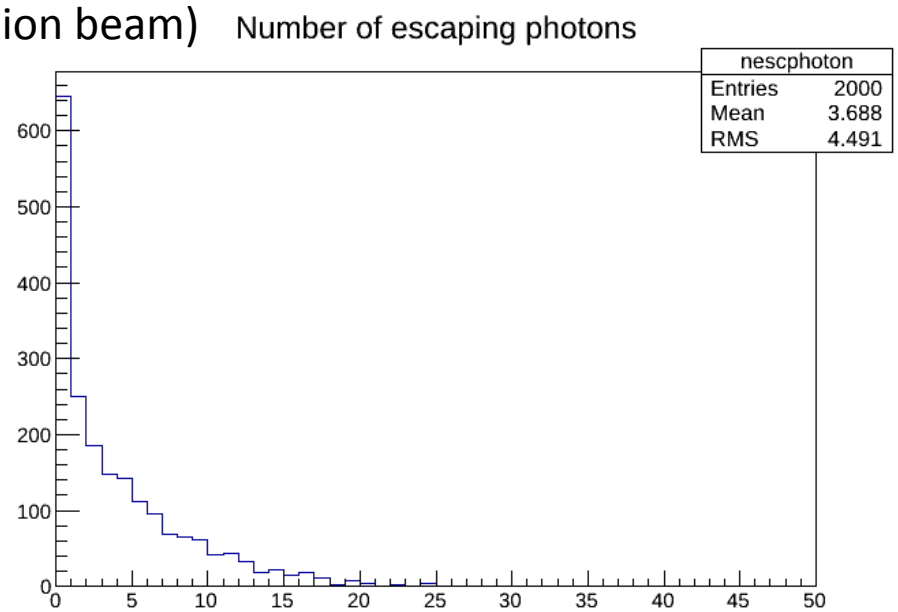
Not sure why only 1 muon decay neutrino



Remarks

- Pions are poorly contained because they produce neutrons which scatter all over the detector
  - Will have to check size of these energy deposits, might not even be over the threshold for producing a signal
  - Probably applies to protons as well, but haven't looked at those event displays yet

Escaping energy

- There does seem to be a certain amount of escaping neutrons, photons that leave the whole detector (whole 5x5x10 m^3)

(1GeV pion beam)