ECAL: Barrel vs. endcap studies

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Introduction

Here I am looking at energy in the endcaps and the barrel

These plots help answer a question that Alan asked, i.e., what if there is no endcap ECAL, and instead we just have a long barrel - In this older geometry, the barrel ECAL is ~ 7.2 m long

Eldwan is making files with the latest geometry

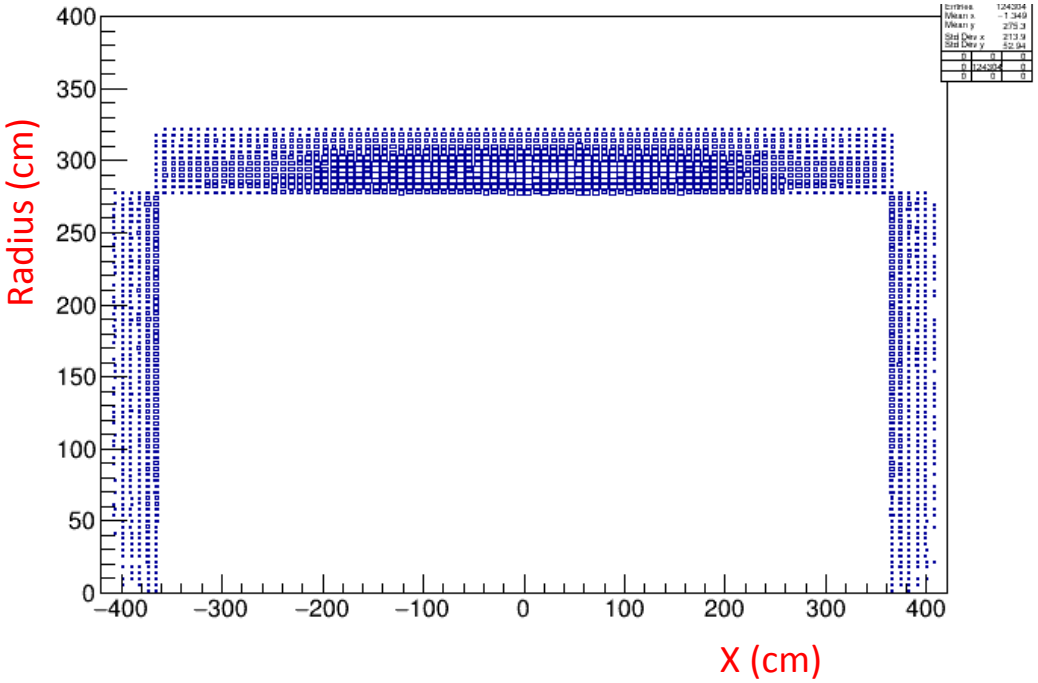
Old geometry

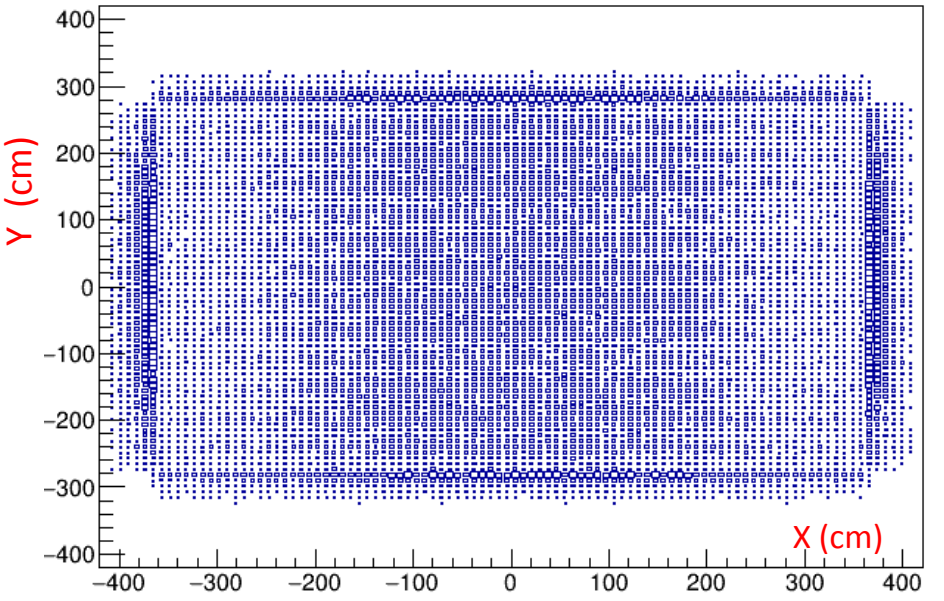
TPCFidRadius = 222.5;
TPCFidLength = 215.;

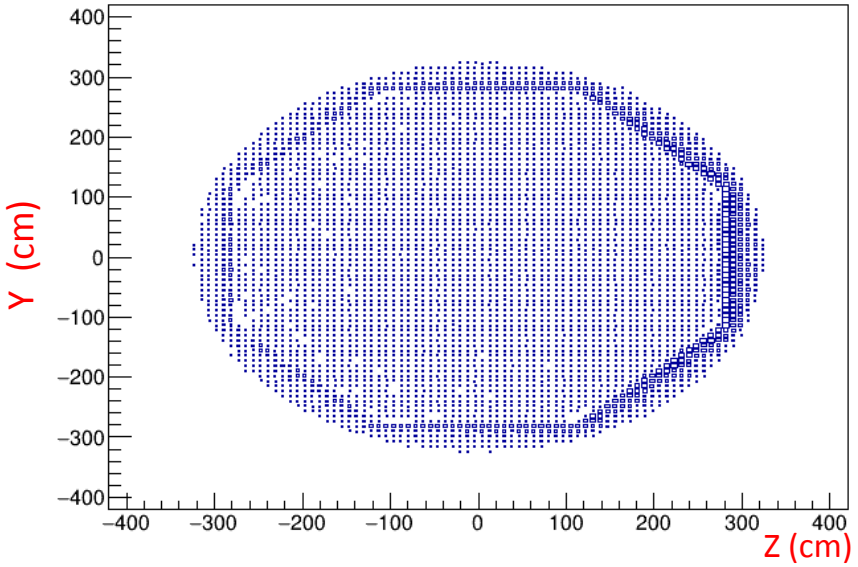
TPCRadius = 273.;
TPCLength = 259.;

ECALInnerRadius = 278.;
ECALOuterRadius = 321.;

ECALStartX = 364.;
ECALEndX = 406.;







Positions of particles that STOP in the ECAL

Neutrino interaction is constrained to be in the TPC fiducial volume

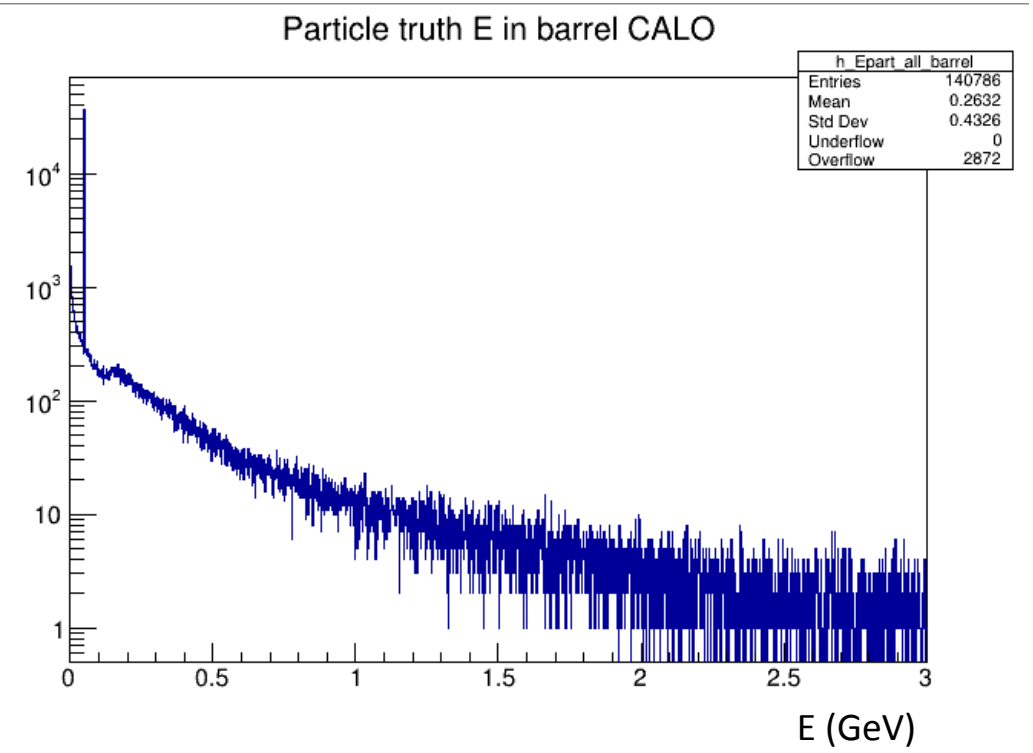
Aggregated over all modes, neutrino flavors (FHC)

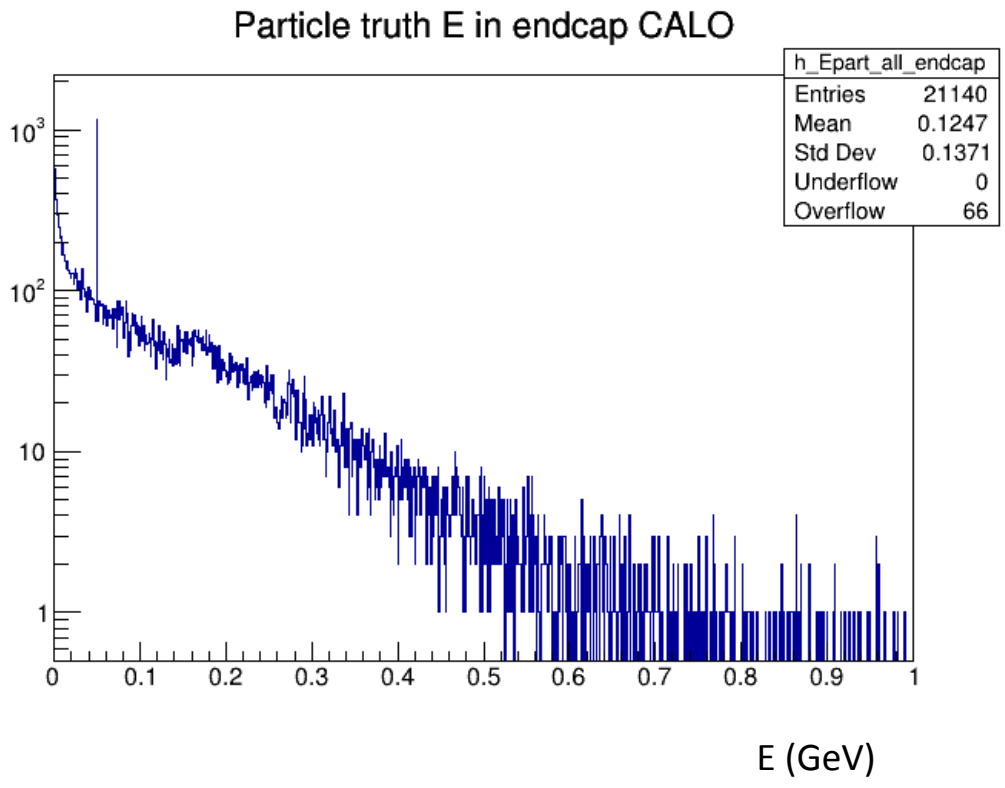
Neutrino event vertex is within the TPC Fiducial volume

One entry per particle – only use primary particles from neutrino event (instead of primary π^0, use their daughter photons)

Energy of particles that stop in or go through the CALO (the spike at 49 MeV is due to through-going charged particles)

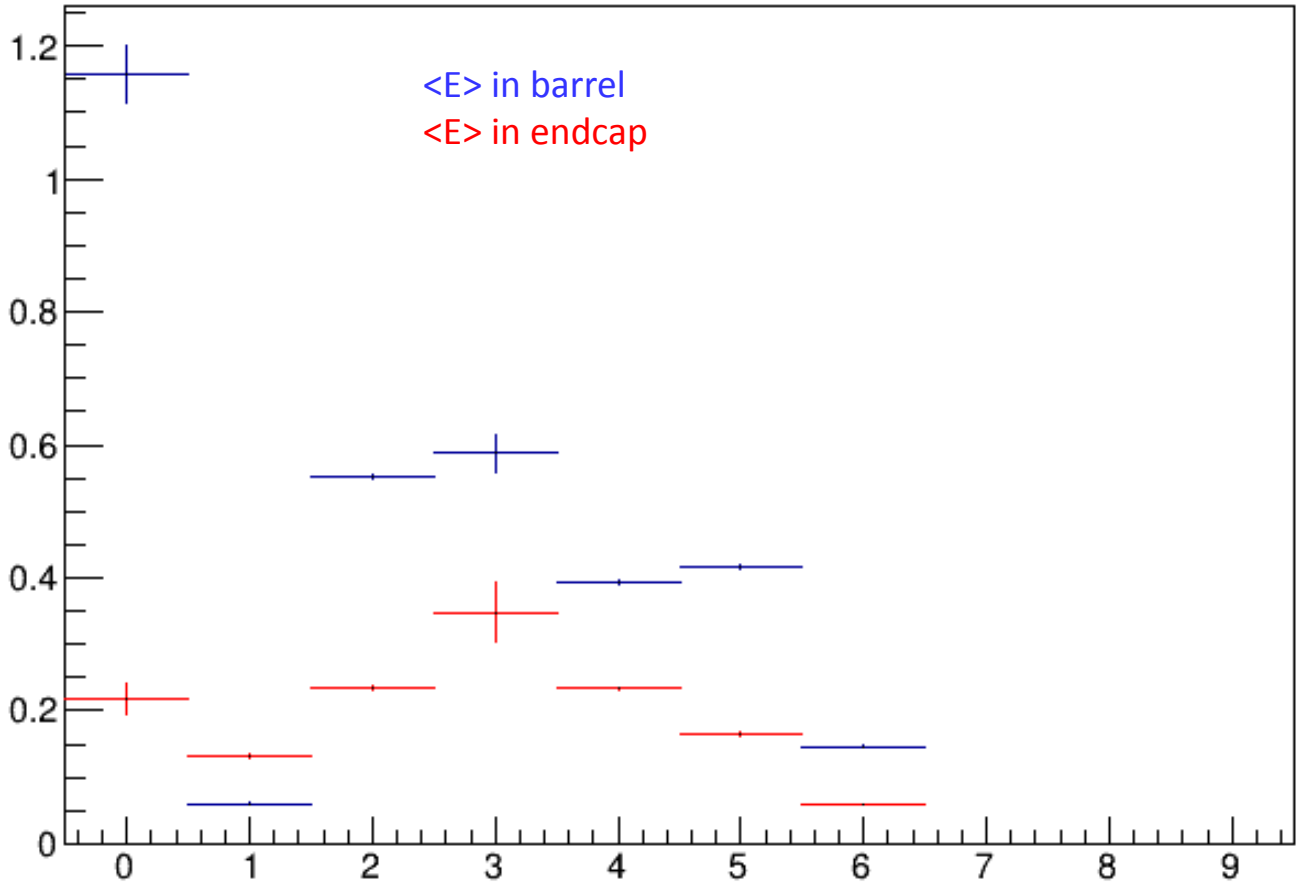
Using truth information in all plots





Currently, E means KE for all particles – will be fixed in the new files.

Profile plots



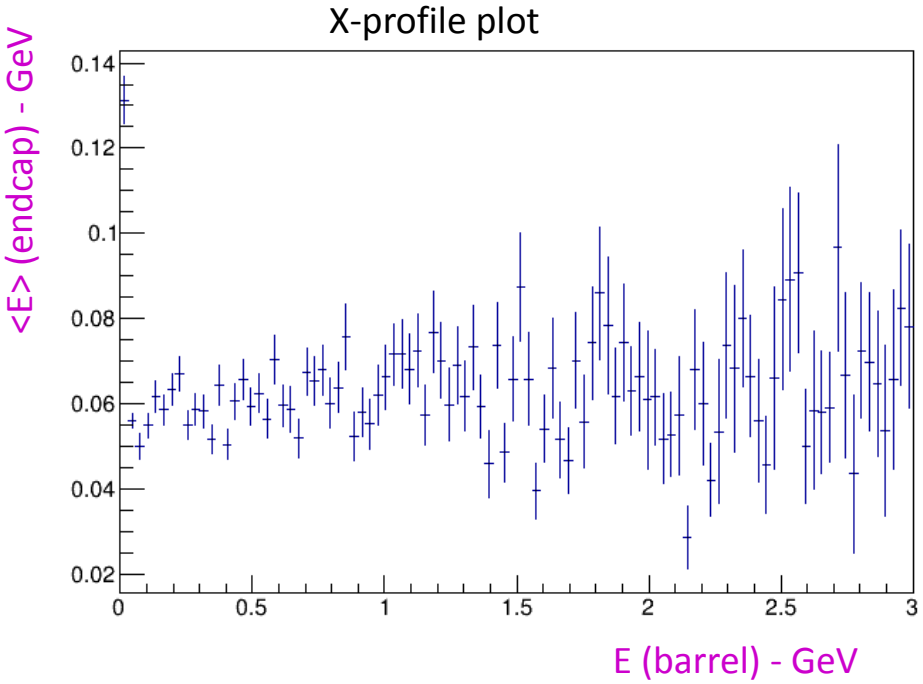
In general, less energy is deposited in the endcaps compared to barrel

<E> for muons is higher in the endcaps – I think that's because more of them actually stop in the endcap CALO, and deposit all their energy rather than go through and deposit only 49 MeV

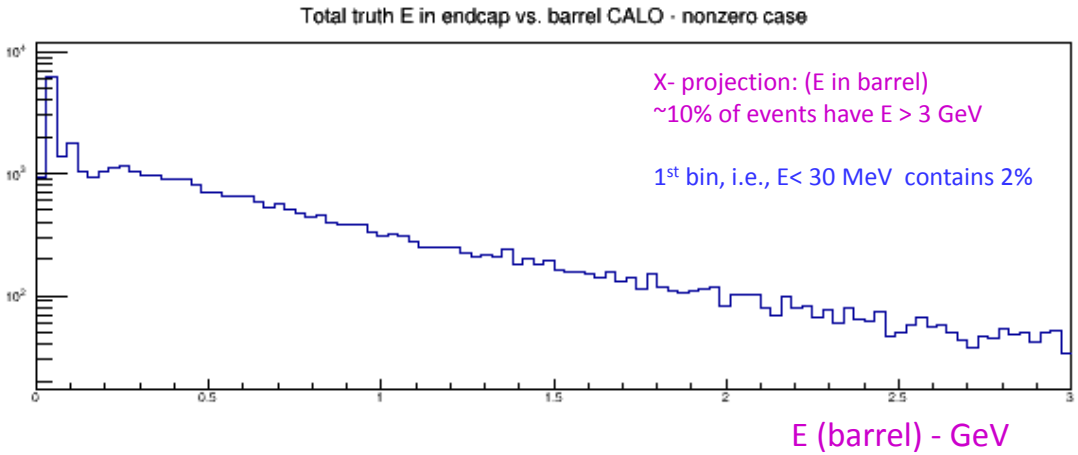
0 – electron, 1 – muon, 2 – charged pion, 3 – charged kaon, 4 – proton, 5 – photon, 6 – neutron

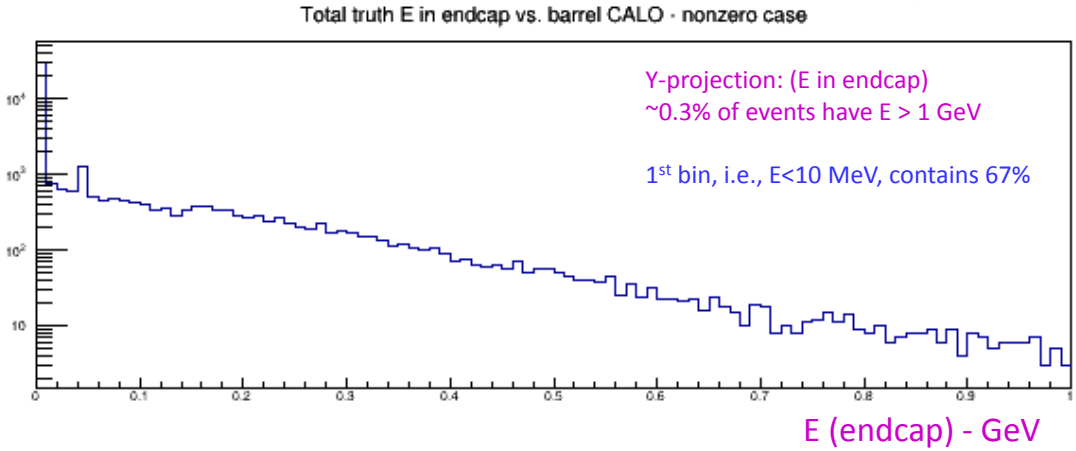
Event level plots – one entry/event - filled when *Total Energy* in either barrel or endcap > 0 – (97% of the events satisfy this)

X-profile plot



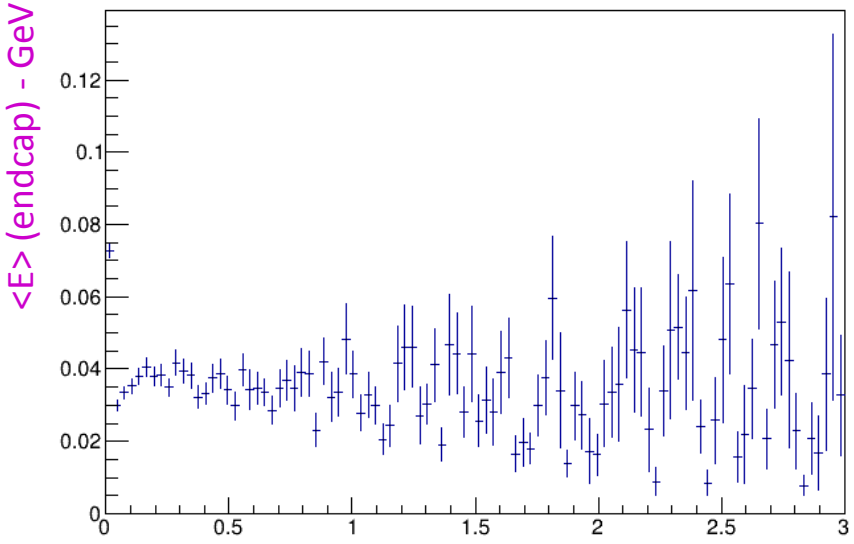
The first X-bin has <E> in endcap ~ 0.13 GeV, everywhere else ~ 60 MeV



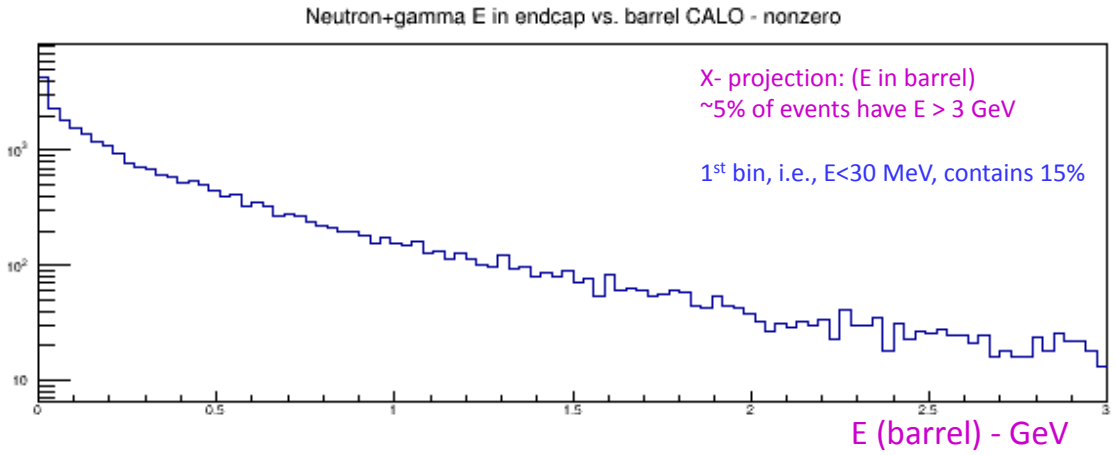


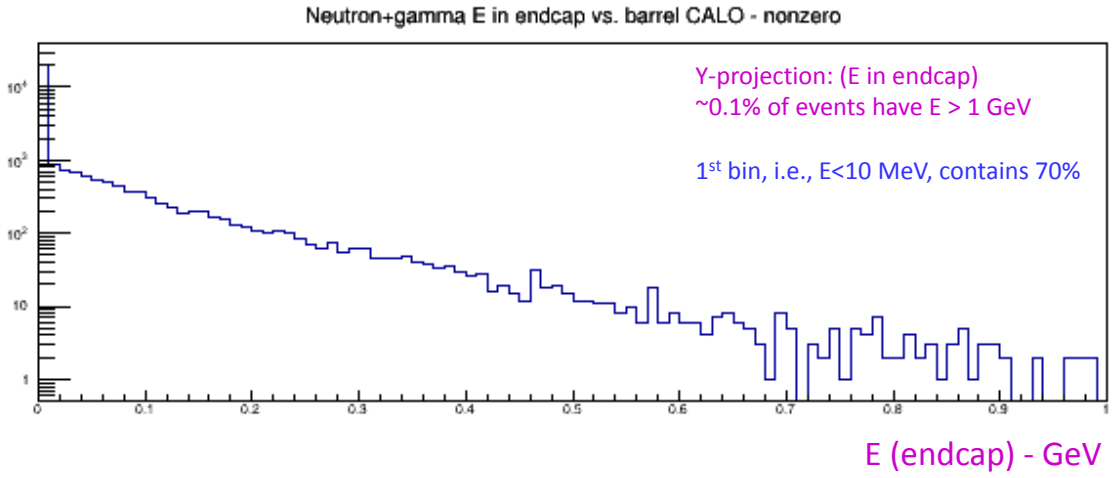
Event level plots – one entry/event – filled when *Neutral Energy** in either barrel or endcap > 0 – (67% of the events satisfy this)

X-profile plot



The first X-bin has <E> in endcap ~ 75 MeV, everywhere else ~ 40 MeV

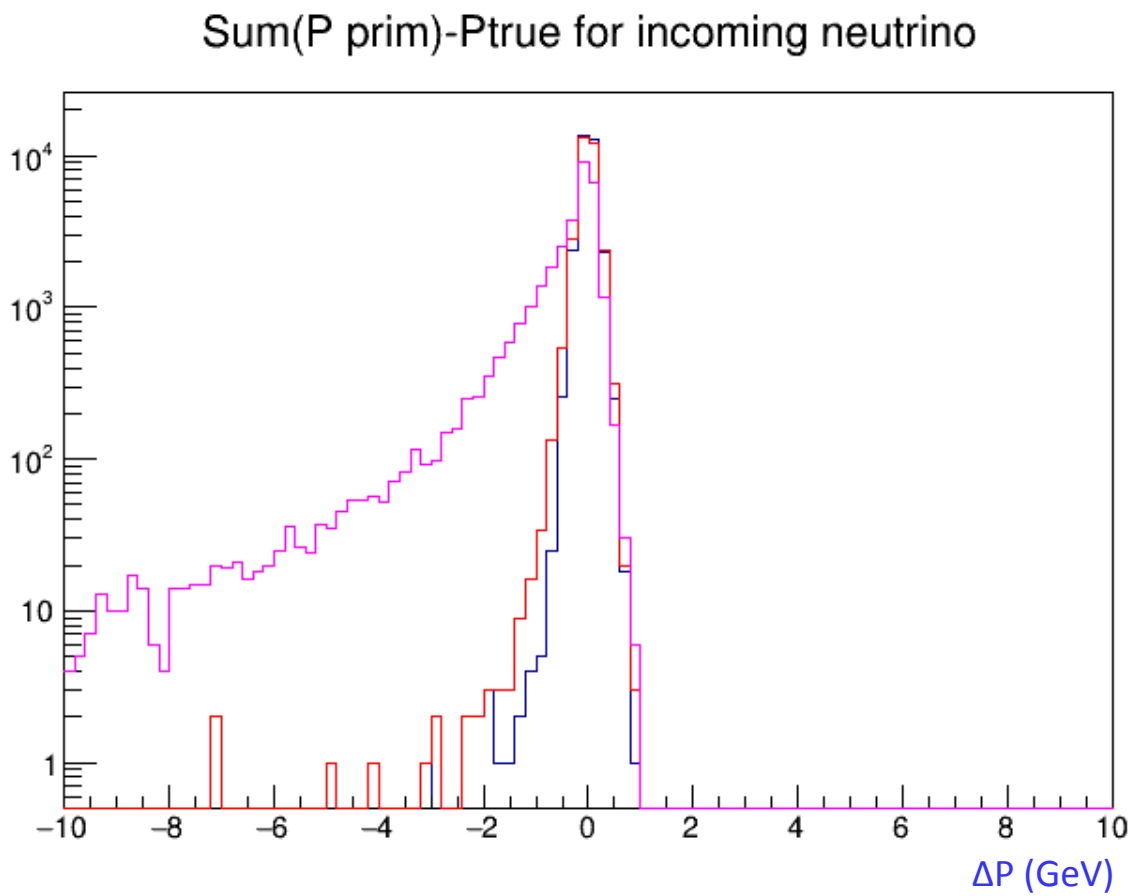




**Neutral Energy means photons + neutrons*

Benchmark studies – use ΔP as a metric – CC ν_μ events

ΔP = |Vector sum of P of outgoing primaries| – $|p_{Inc.neutrino}|$



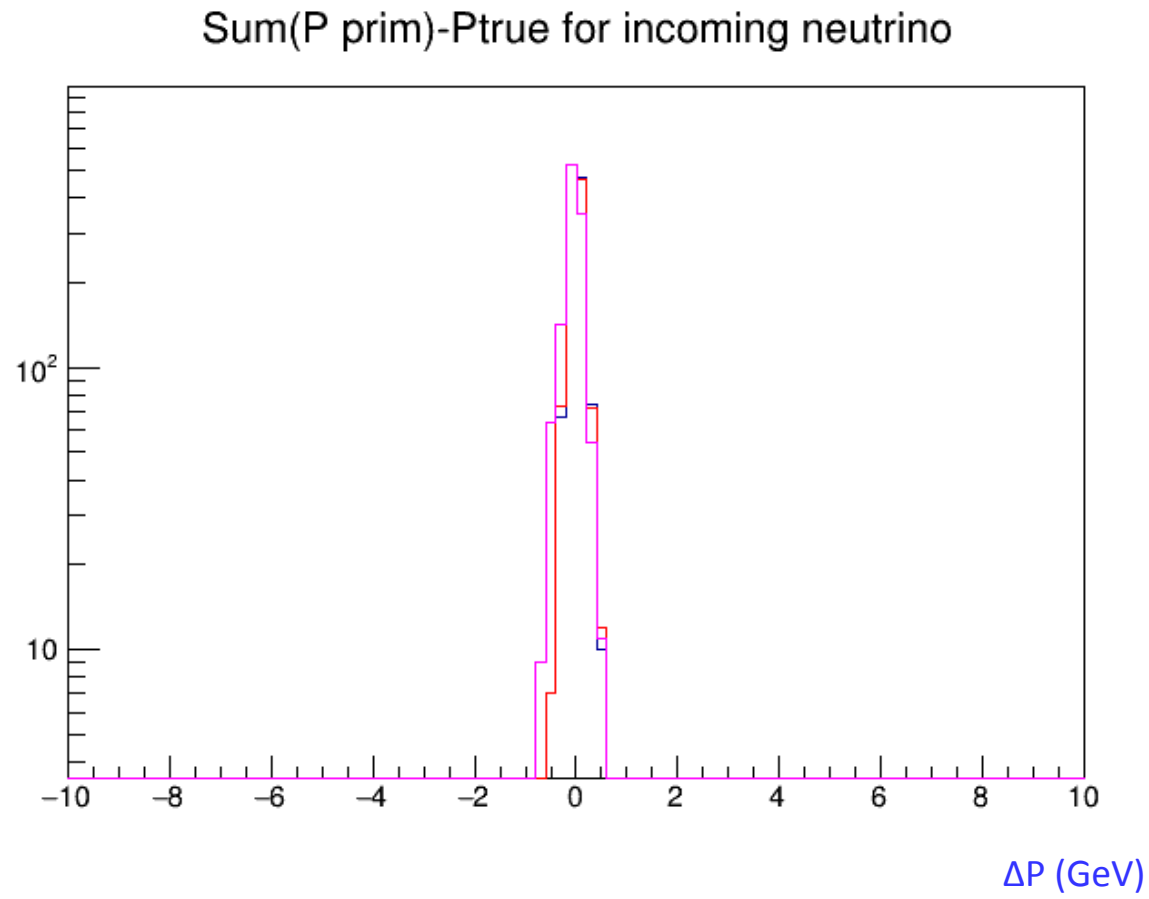
Using all primaries

Using all primaries excluding neutrons & photons that stop in Endcap ECAL

Using all primaries excluding neutrons & photons that stop in Barrel ECAL

Benchmark studies – use ΔP as a metric – CC ν_μ events ($E_\nu < 1$ GeV – 4%)

ΔP = |Vector sum of P of outgoing primaries| – $|p_{Inc.neutrino}|$



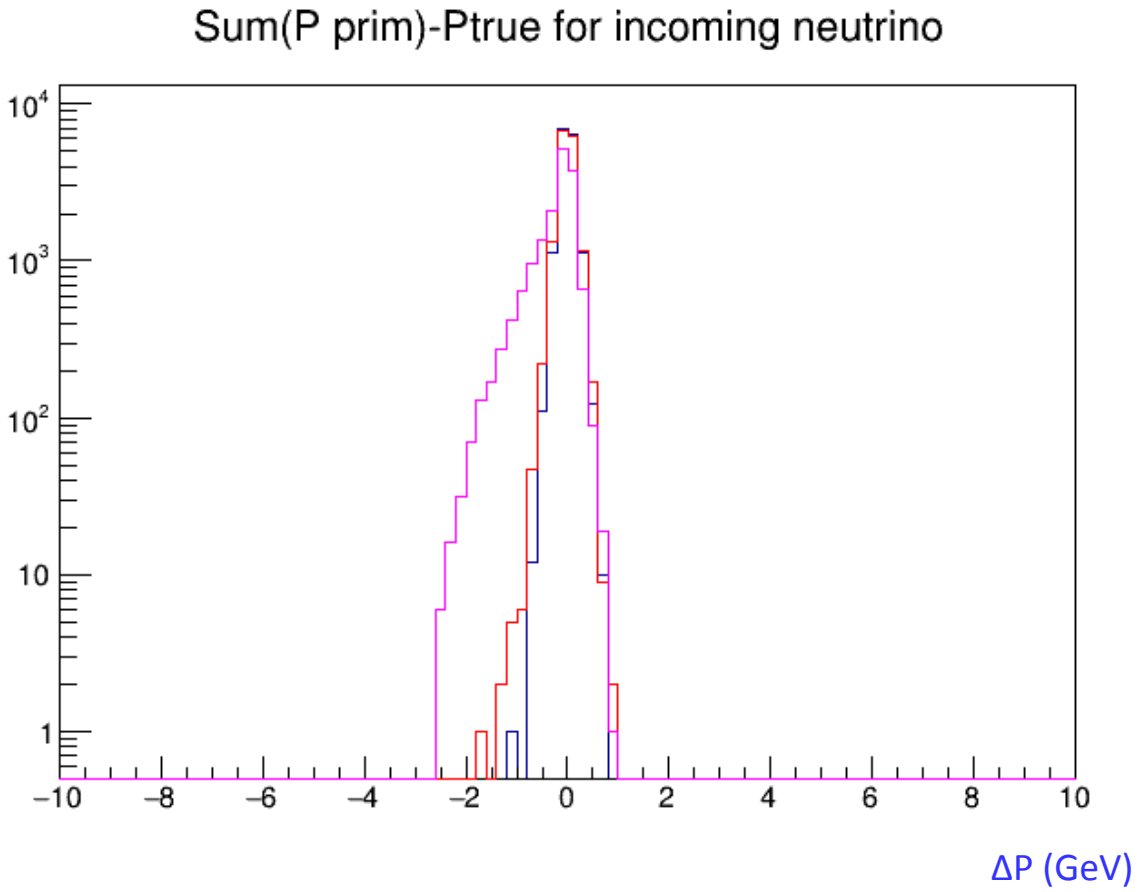
Using all primaries

Using all primaries excluding neutrons & photons that stop in Endcap ECAL

Using all primaries excluding neutrons & photons that stop in Barrel ECAL

Benchmark studies – use ΔP as a metric – CC ν_μ events (E_ν : 1-3 GeV – 50%)

ΔP = |Vector sum of P of outgoing primaries| – $|p_{Inc.neutrino}|$



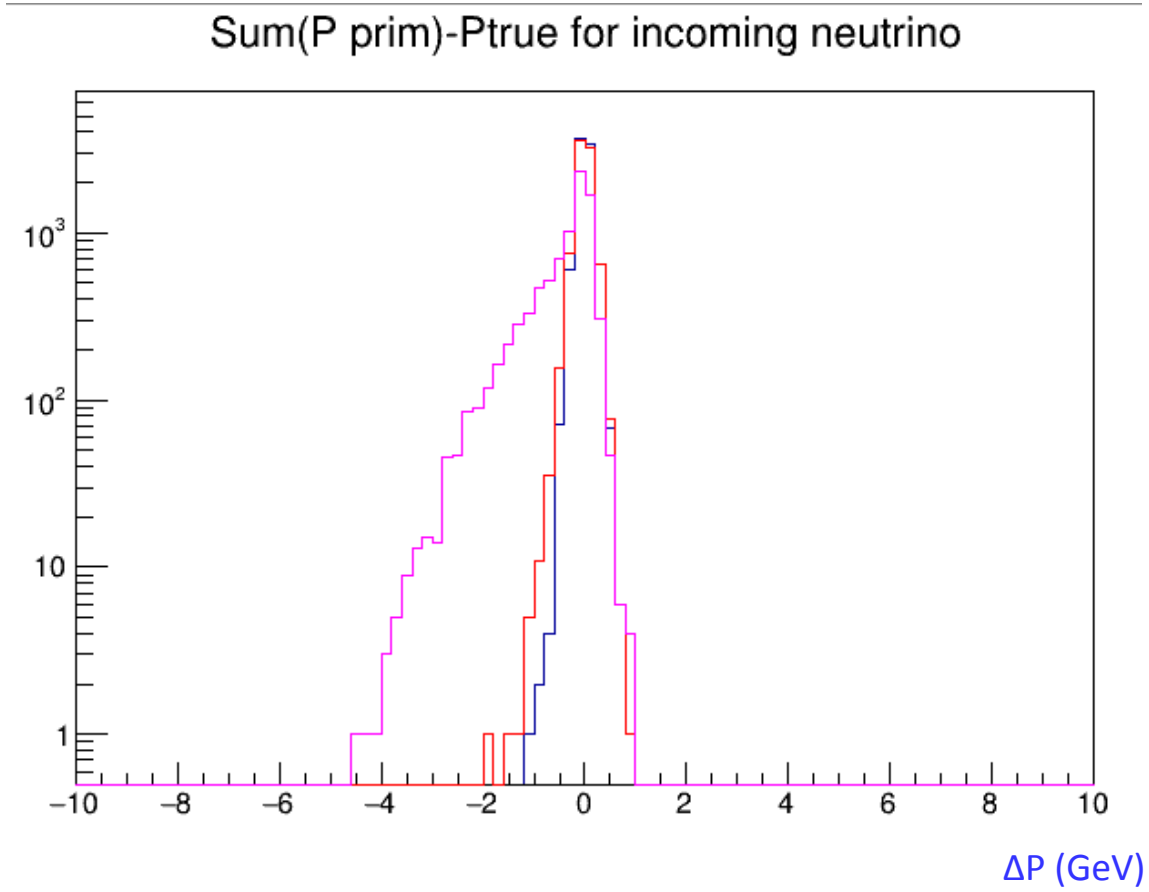
Using all primaries

Using all primaries excluding neutrons & photons that stop in Endcap ECAL

Using all primaries excluding neutrons & photons that stop in Barrel ECAL

Benchmark studies – use ΔP as a metric – CC ν_μ events (E_ν : 3-5 GeV – 27%)

ΔP = |Vector sum of P of outgoing primaries| – $|p_{Inc.neutrino}|$



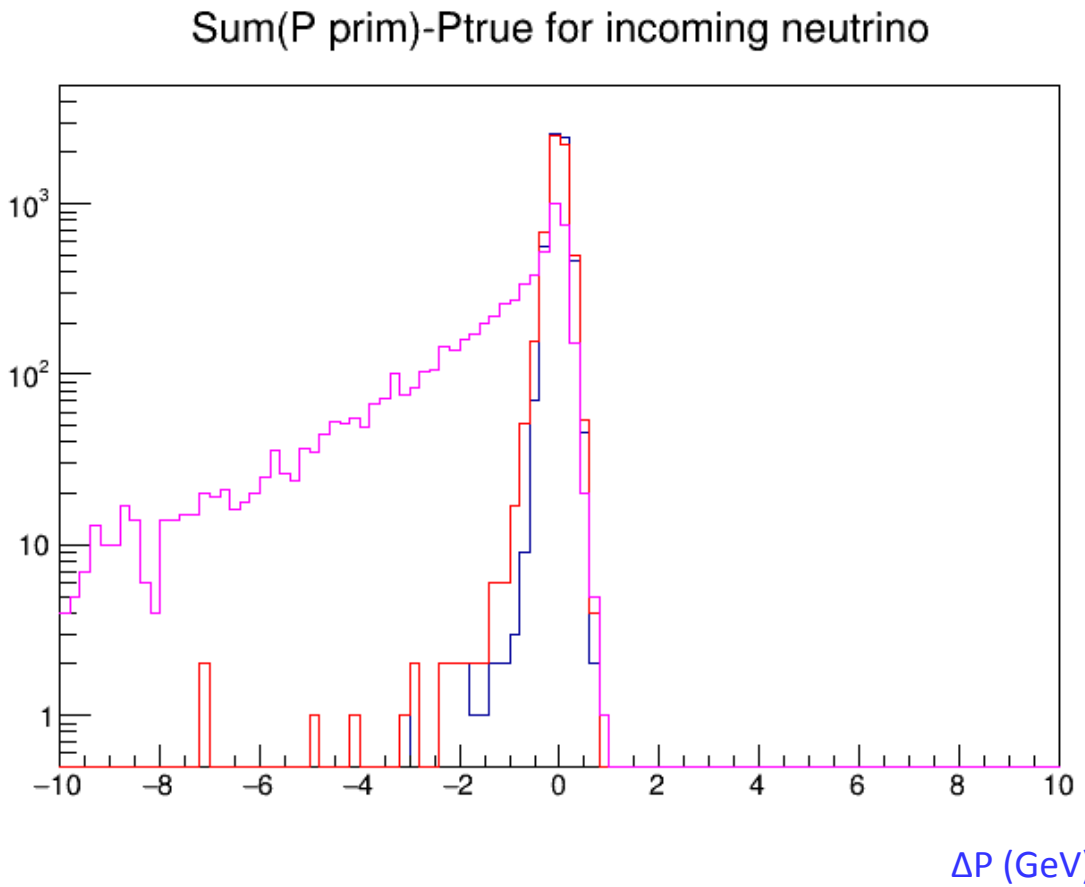
Using all primaries

Using all primaries excluding neutrons & photons that stop in Endcap ECAL

Using all primaries excluding neutrons & photons that stop in Barrel ECAL

Benchmark studies – use ΔP as a metric – CC ν_μ events (E_ν : >5 GeV – 20%)

ΔP = |Vector sum of P of outgoing primaries| – $|p_{Inc.neutrino}|$



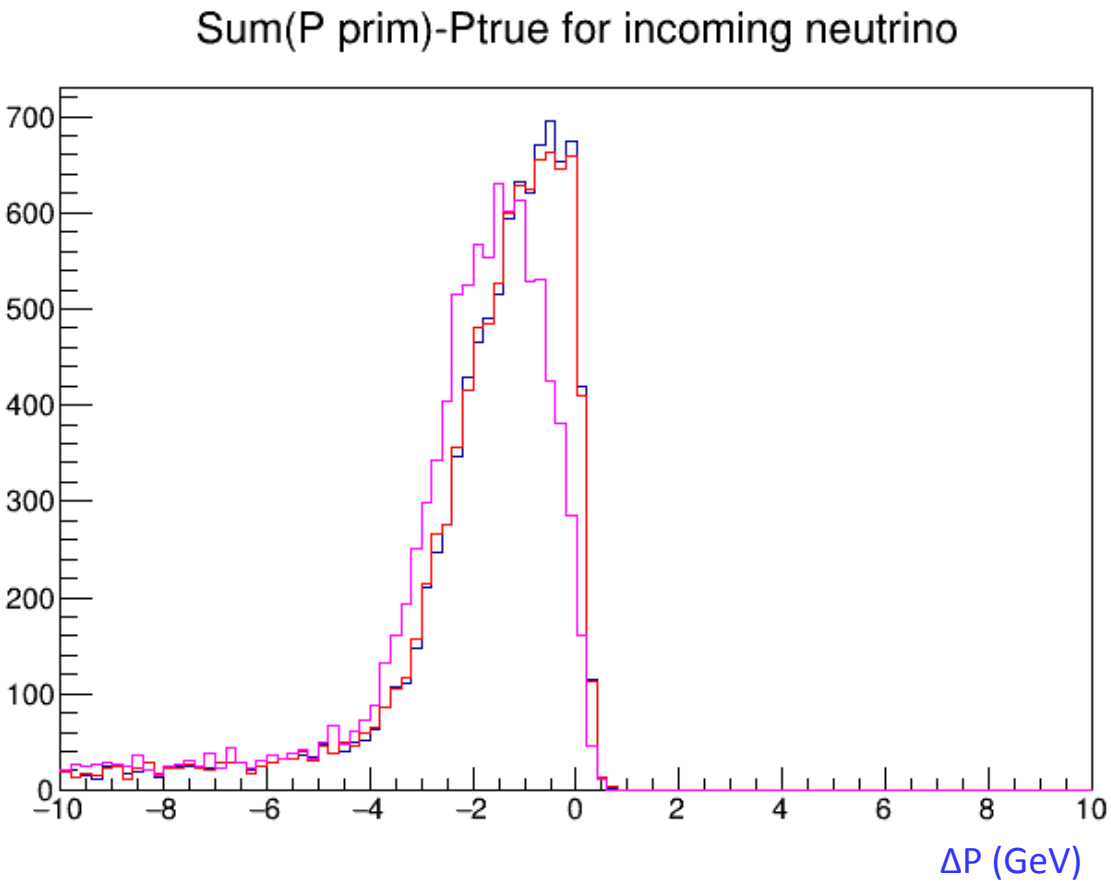
Using all primaries

Using all primaries excluding neutrons & photons that stop in Endcap ECAL

Using all primaries excluding neutrons & photons that stop in Barrel ECAL

Benchmark studies – use ΔP as a metric – NC ν_μ events

ΔP = |Vector sum of P of outgoing primaries (excl. neutrino)| – $|p_{Inc.neutrino}|$



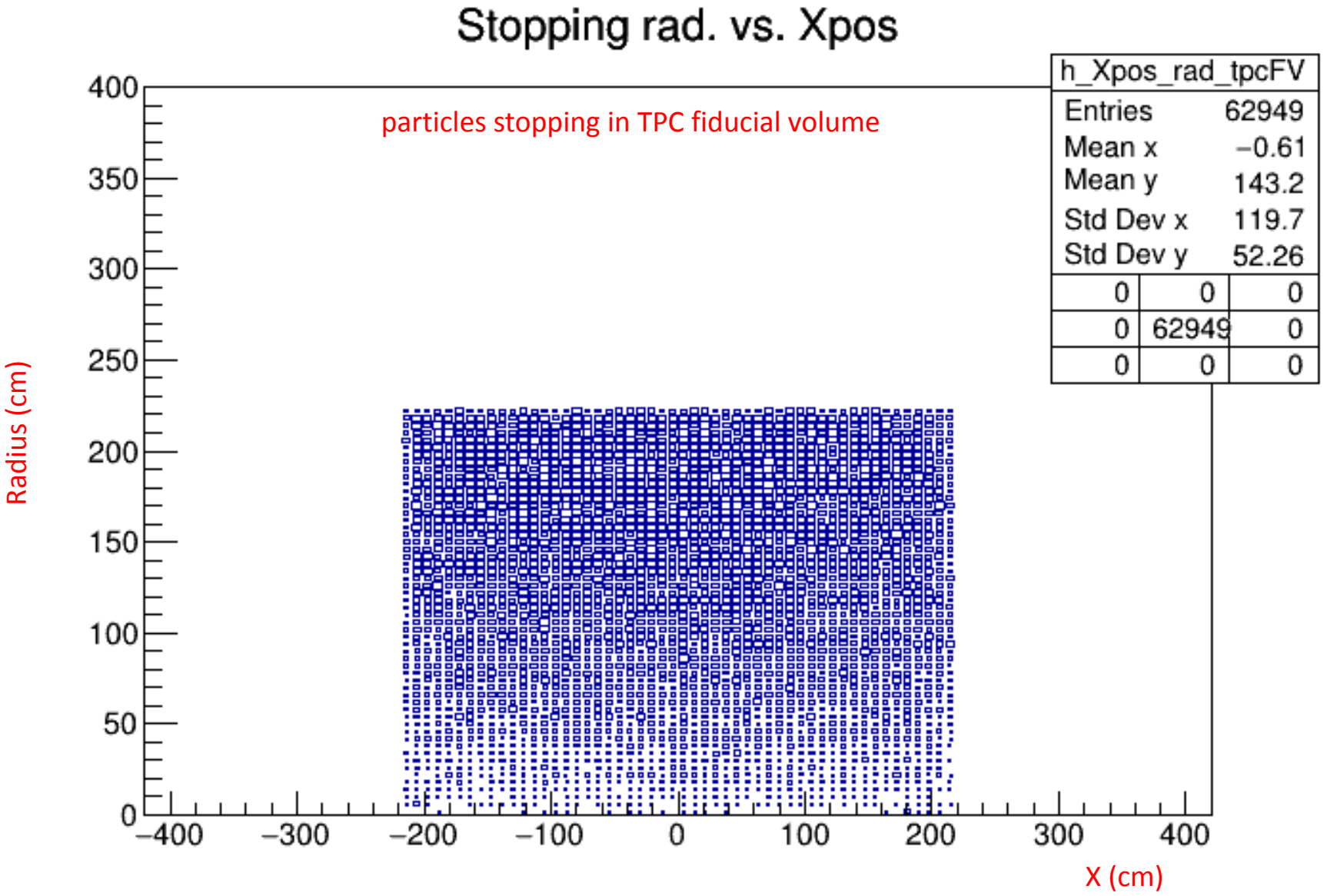
Using all primaries – except the outgoing neutrino

Using all primaries excluding neutrons & photons that stop in Endcap ECAL

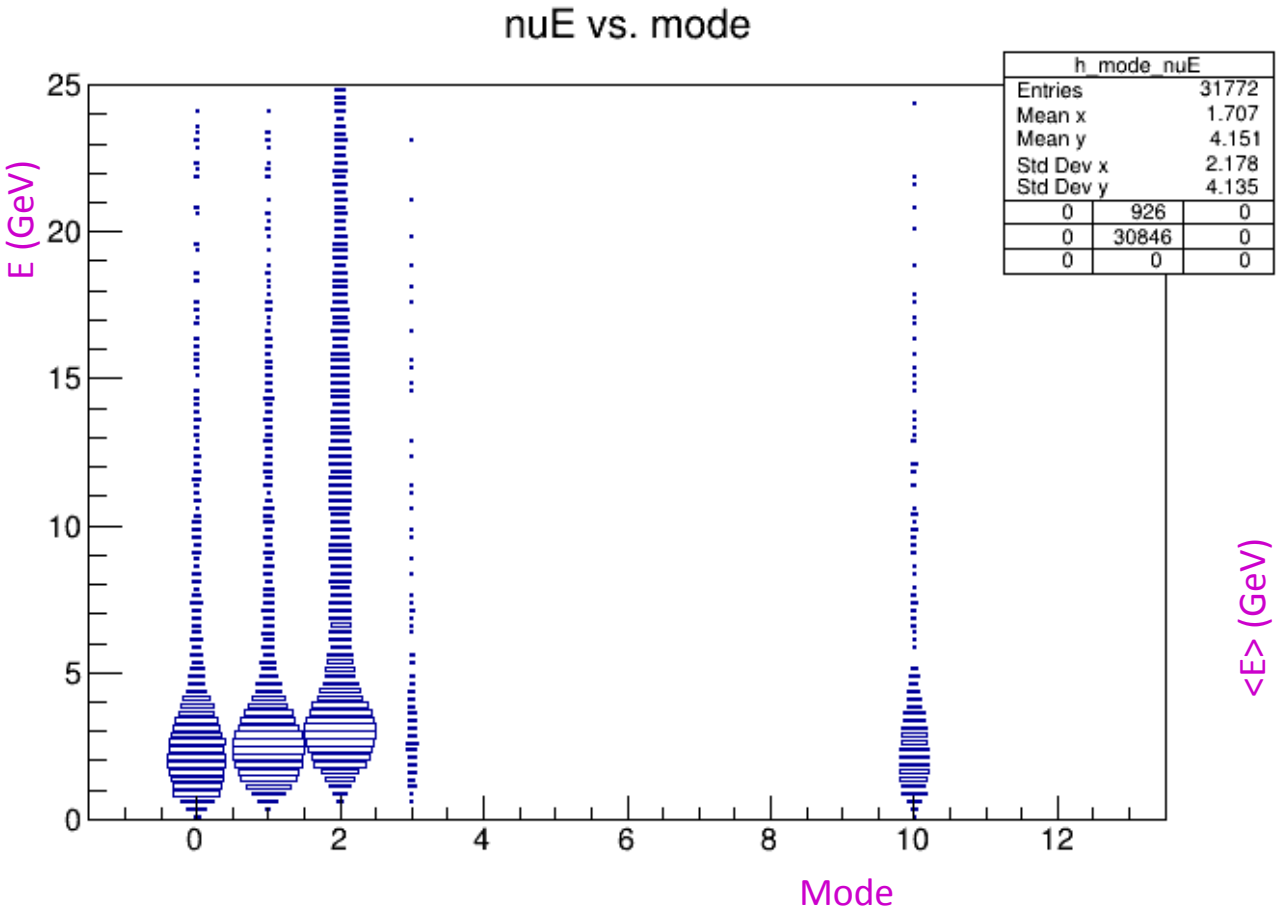
Using all primaries excluding neutrons & photons that stop in Barrel ECAL

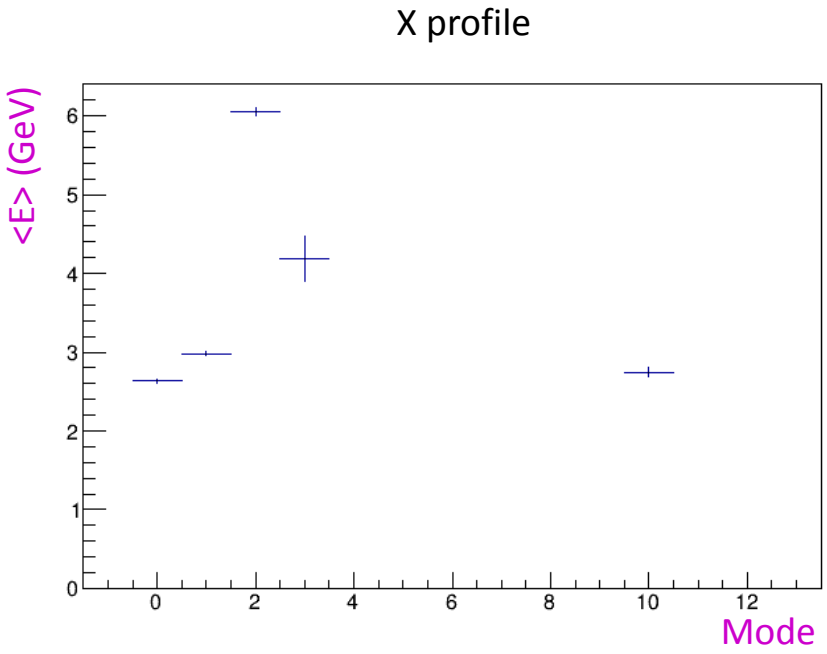
(Interesting that the "noBarrel" distribution is different Between CC and NC events – not sure why)

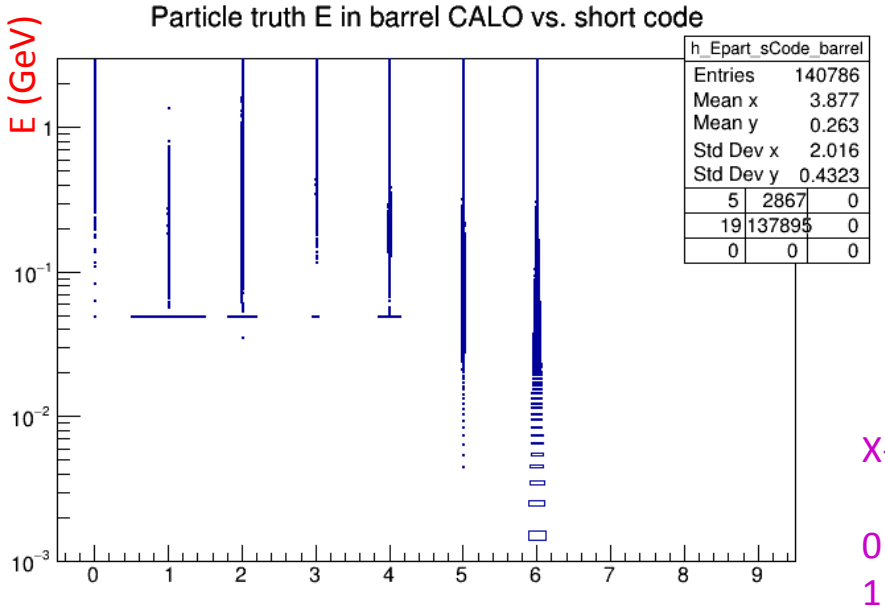
Extra slides

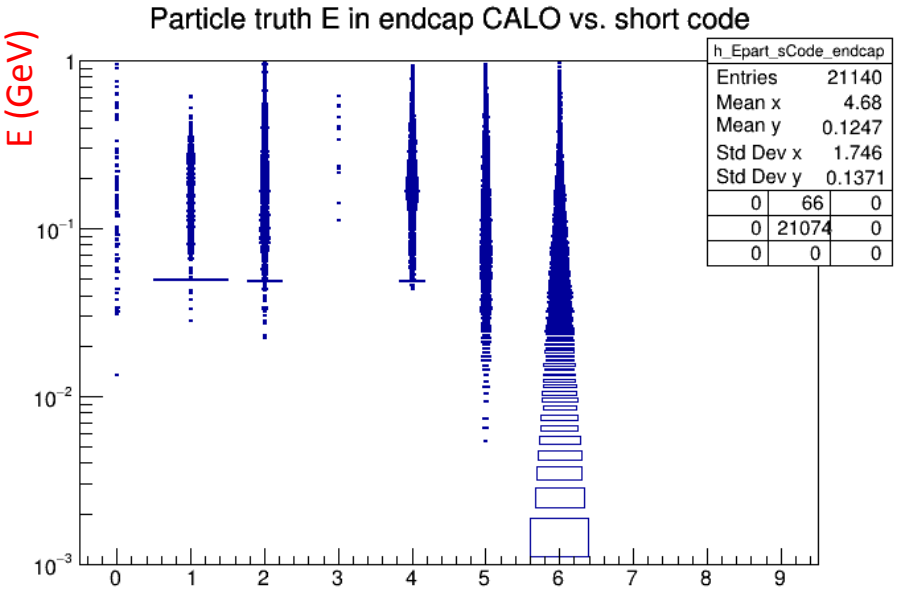

Stopping rad. vs. Xpos
particles stopping in TPC fiducial volume
h_Xpos_rad_tpcFV
Entries 62949
Mean x −0.61
Mean y 143.2
Std Dev x 119.7
Std Dev y 52.26
0 0 0
0 62949 0
0 0 0
Radius (cm)
X (cm)
400
350
300
250
200
150
100
50
0
−400
−300
−200
−100
0
100
200
300
400

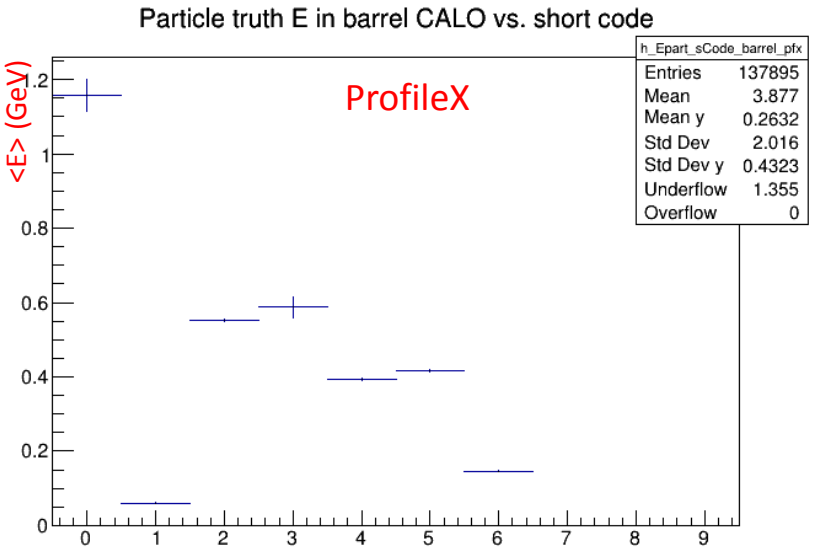
CC ν_μ events

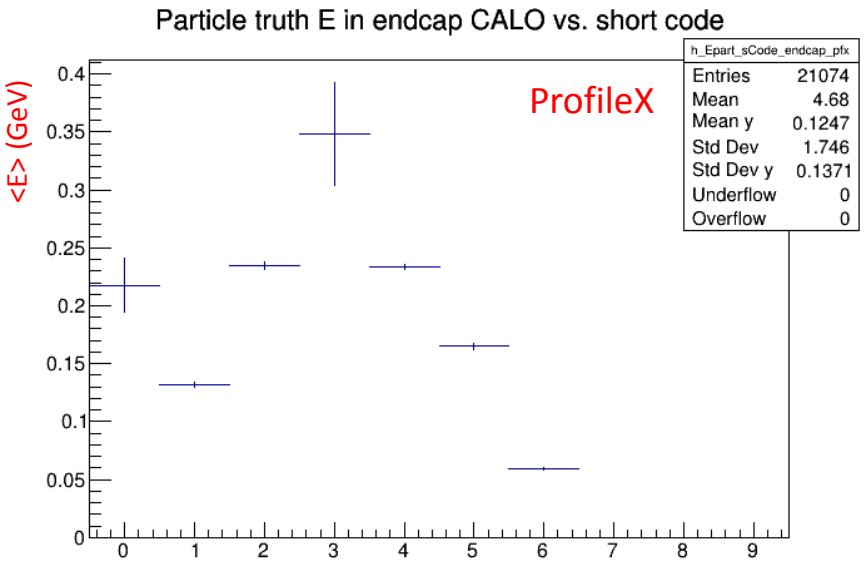








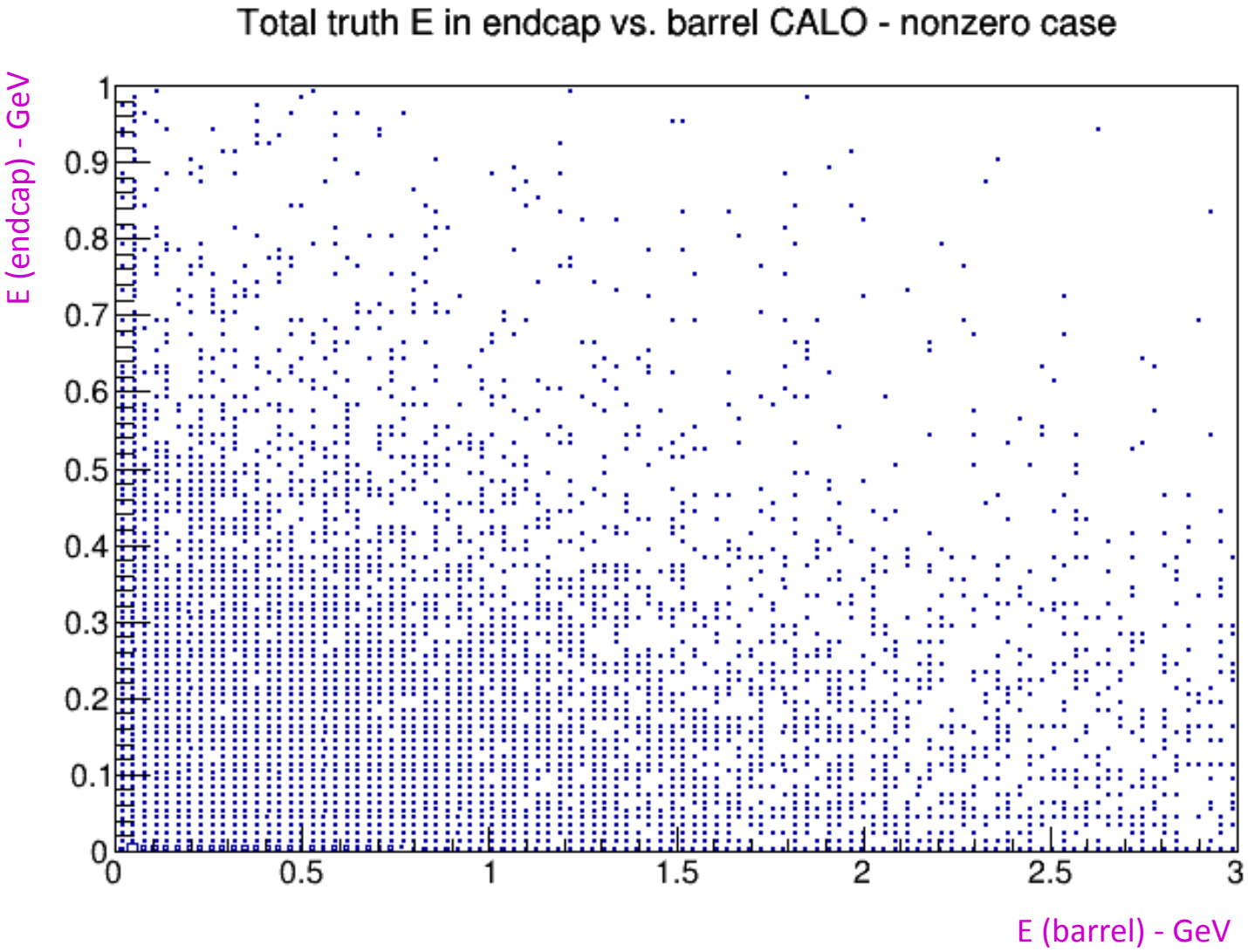




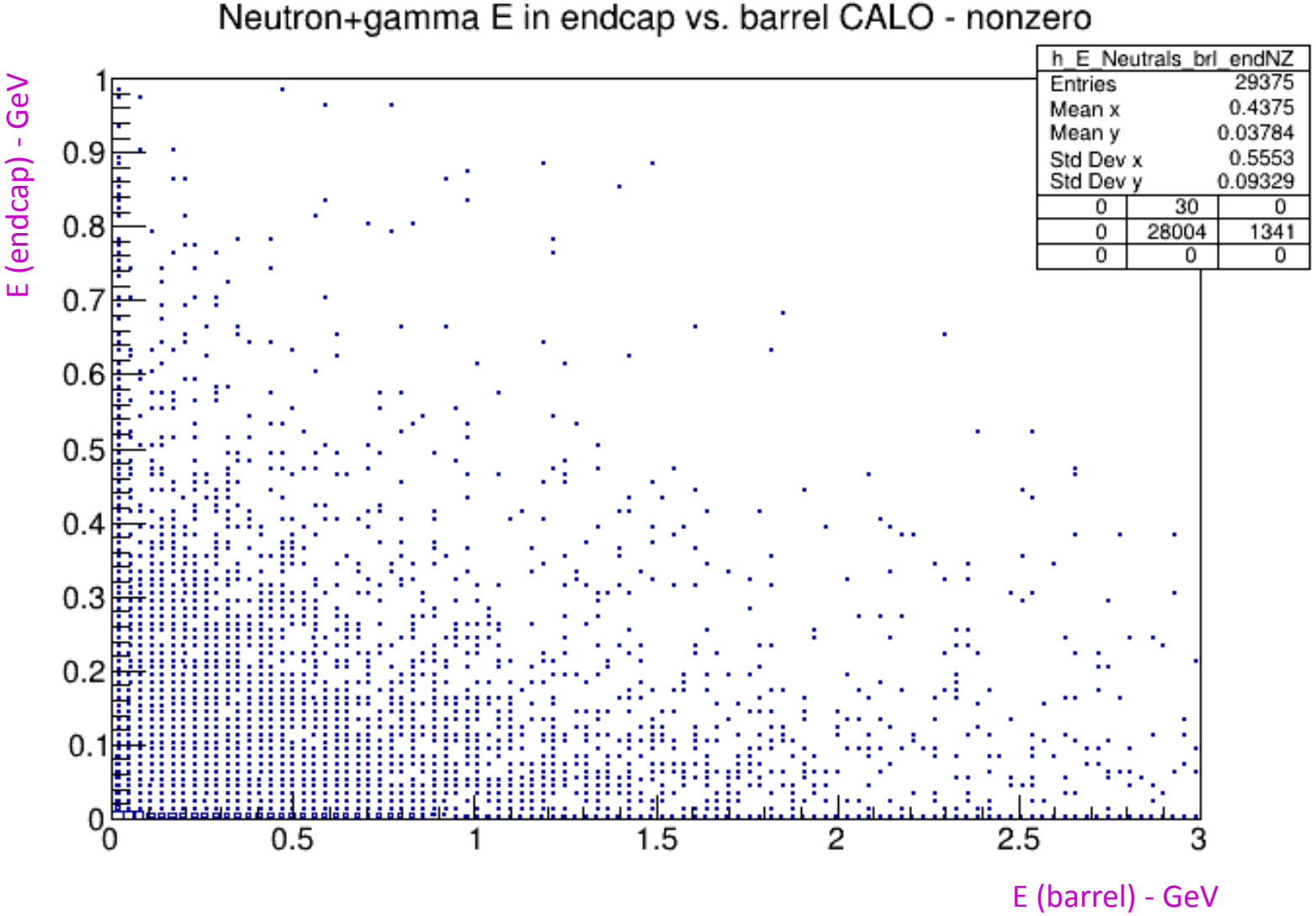
X-axis of these plots:

0 – electron
1 – muon
2 – charged pion
3 – charged kaon
4 – proton
5 – photon
6 – neutron

Event level plots – one entry/event - filled when *Total Energy* in either barrel or endcap > 0 – (97% of the events satisfy this)



Event level plots – one entry/event – filled when *Neutral Energy* in either barrel or endcap > 0 – (67% of the events satisfy this)



CC ν_μ events (31772 evts)

Mode	QE	RES	DIS	COH	MEC
# events	6901	9487	13348	196	1750
Fraction of events with neutral E in barrel	0.3	0.7	0.82	0	0.64
Fraction of events with neutral E in endcap	0.13	0.27	0.26	0	0.33

CC anti-ν_μ events (1340)

Mode	QE	RES	DIS	COH	MEC
# events	230	341	675	14	80
Fraction of events with neutral E in barrel	0.64	0.8	0.81	0	0.91
Fraction of events with neutral E in endcap	0.3	0.33	0.27	0	0.5

NC ν_μ events (9923 events)

Mode	QE	RES	DIS	COH	MEC
# events	2176	3277	4385	85	0
Fraction of events with neutral E in barrel	0.51	0.81	0.81	0.84	0
Fraction of events with neutral E in endcap	0.19	0.33	0.27	0.04	0

NC anti-ν_μ events (526 events)

Mode	QE	RES	DIS	COH	MEC
# events	108	143	265	10	0
Fraction of events with neutral E in barrel	0.49	0.83	0.83	0.9	0
Fraction of events with neutral E in endcap	0.22	0.32	0.27	0	0