Remoll SoLID Simulation Update

EM Calorimeter Update – 1

Simulation Summary

- Used newly developed remoll simulation
  - First SoLID analysis using remoll simulation
- Baffles : Lead babar_more1
- Wiser DIS and pions inputs
- Full EM calorimeter included

Calorimeter Geometry

- Hexagonal ecal blocks
  - Radius is 3.6 cm
- Each block has,
  - 0.05 cm Pb
  - 0.15 cm scintillator Material
  - 0.024 cm air gap
- There are 194 layers of these blocks along the z-directions
- In x-y plane, R_in = 118 cm R_out = 261 cm
- Energy deposited on scint. material and photons generated from the deposited energy are recorded for each block

Analysis Summary

- Only looked at events with primary tracks crossed the last GEM
  - Plotted momentum distribution of primary tracks and background electron and photon tracks at the last GEM
  - Looked at photons produced by the ecal block scintillators for these events
- Analysis done for DIS e, pions (±) with lead baffles

Analysis Summary

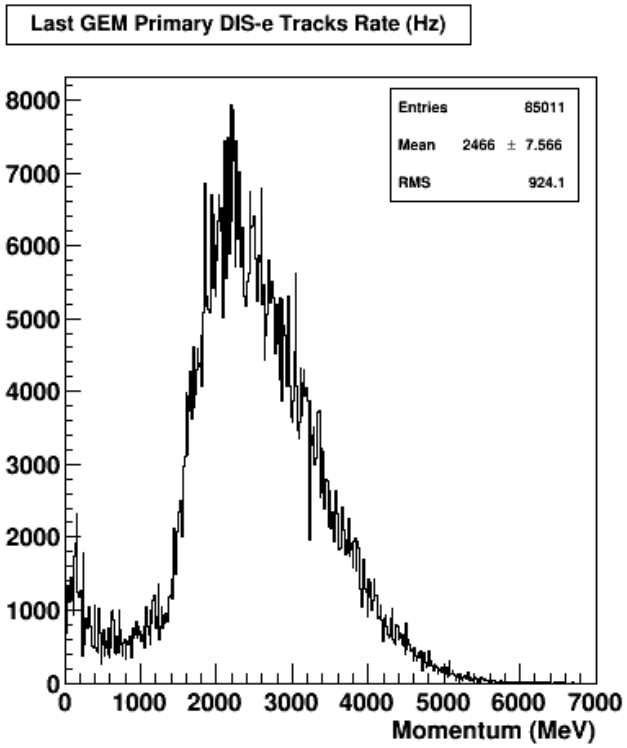
- Sample event

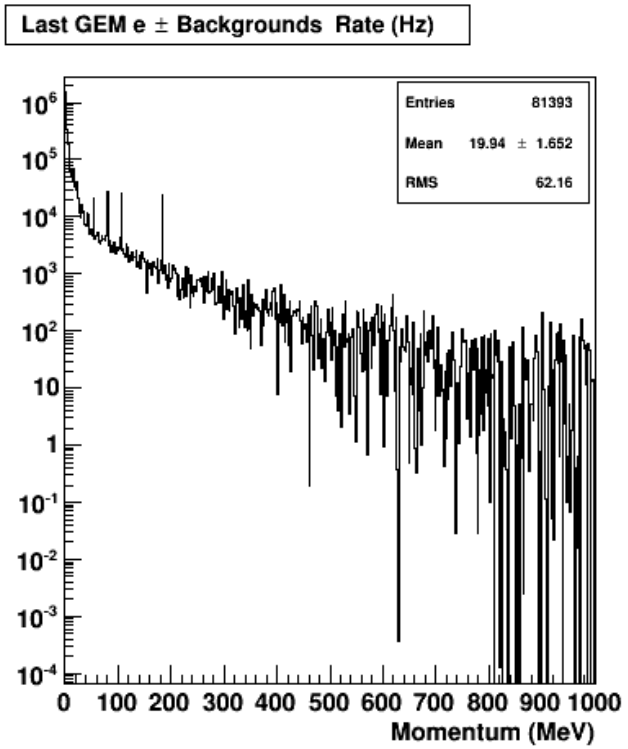
T->Scan("ev.evnum:hit.trid:hit.pid:(hit.det-40005)","(hit.p>0 && ((hit.det-40005)%100==0) && hit.det>40000 && hit.det<50000)","")

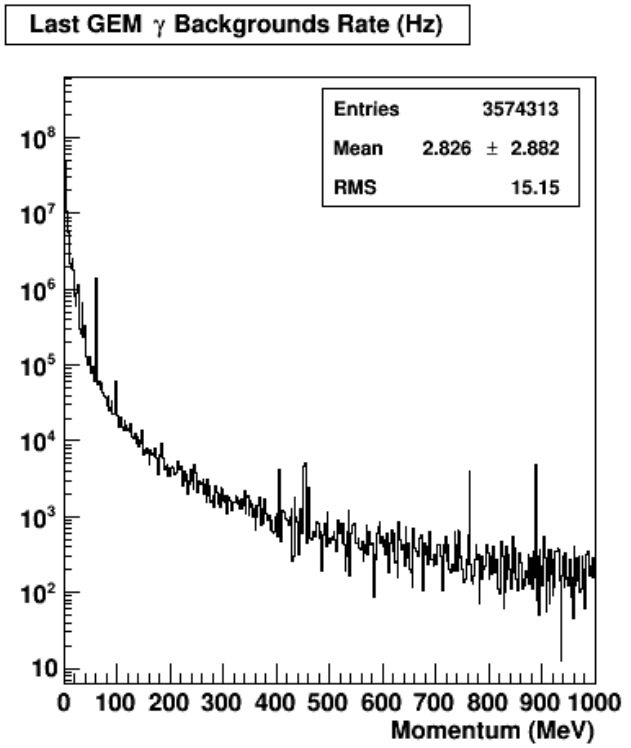
Row	Ins	evnum	hit.trid	hit.pid	hit.det
2	28	3	617	22	2000
2	32	3	1	11	2200
2	33	3	107	22	2200
2	34	3	1018	22	2200
2	35	3	2040	22	2200

Note: trid=1 is primary track and trid>1 are secondaries

DIS-e Momentum distributions at last GEM with lead baffles (From all the events)



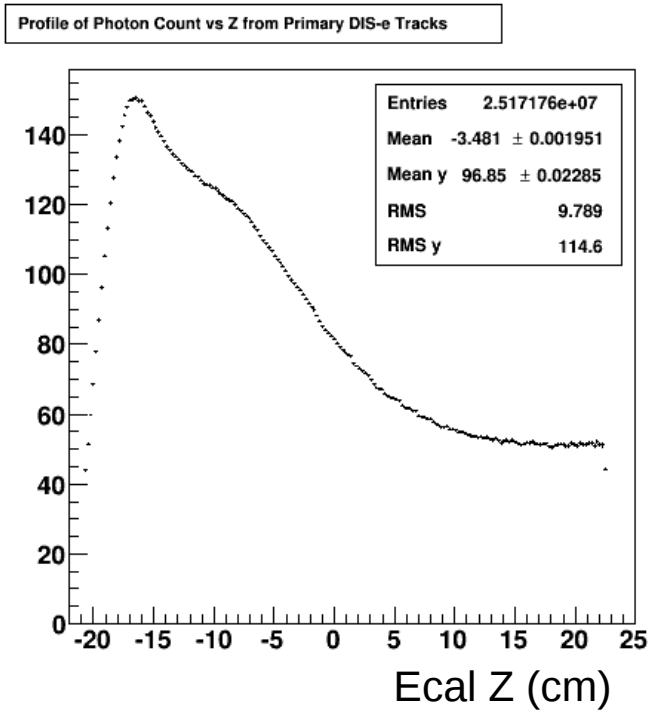


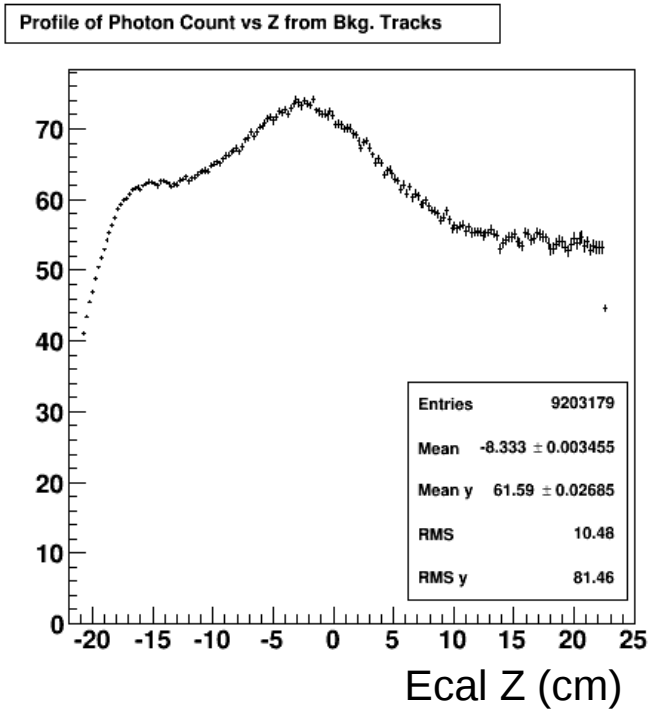


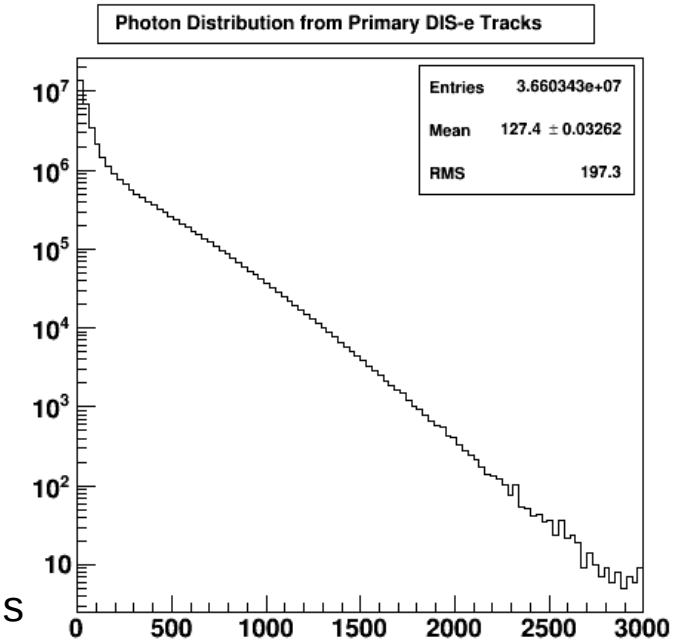
Primary Electron Rate = 0.44 MHz
Bkg. Electron Rate = 1.84 MHz
Bkg. Photon Rate = 223.35 MHz

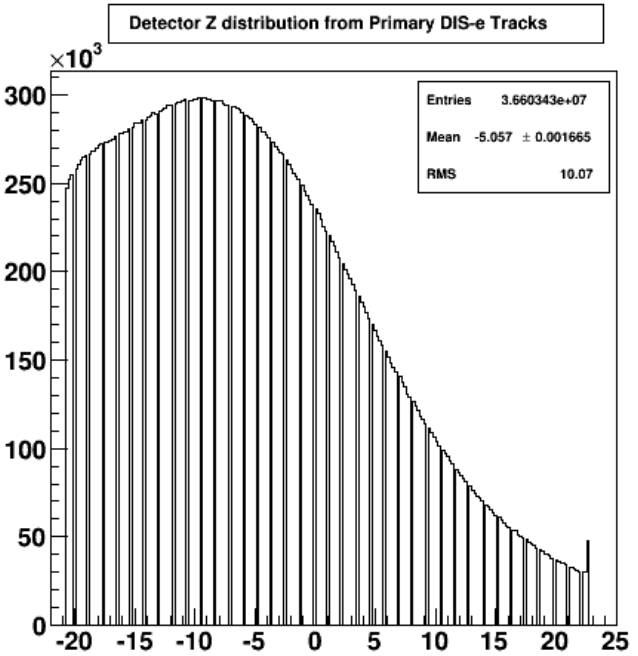
Photon production at scint. for events with primary DIS-e tracks with lead baffles (From all the events)

Avg. Photons



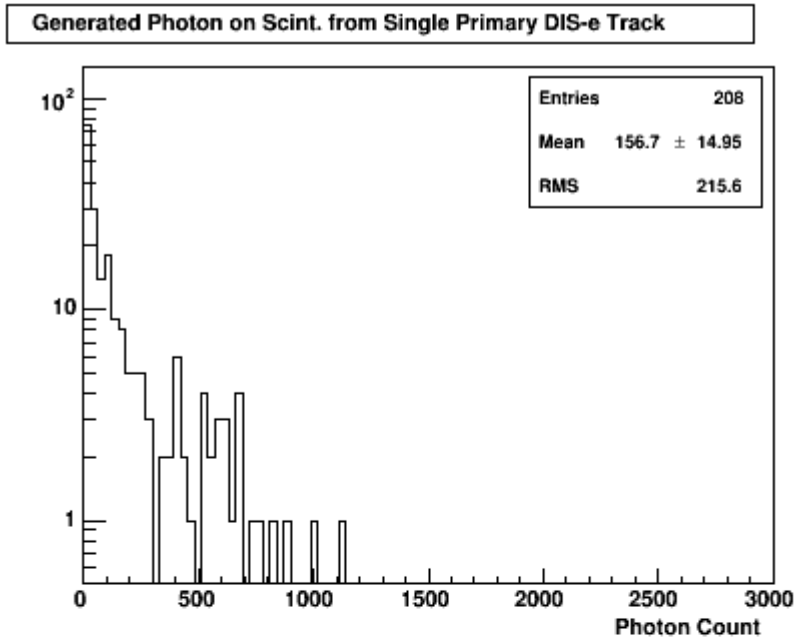


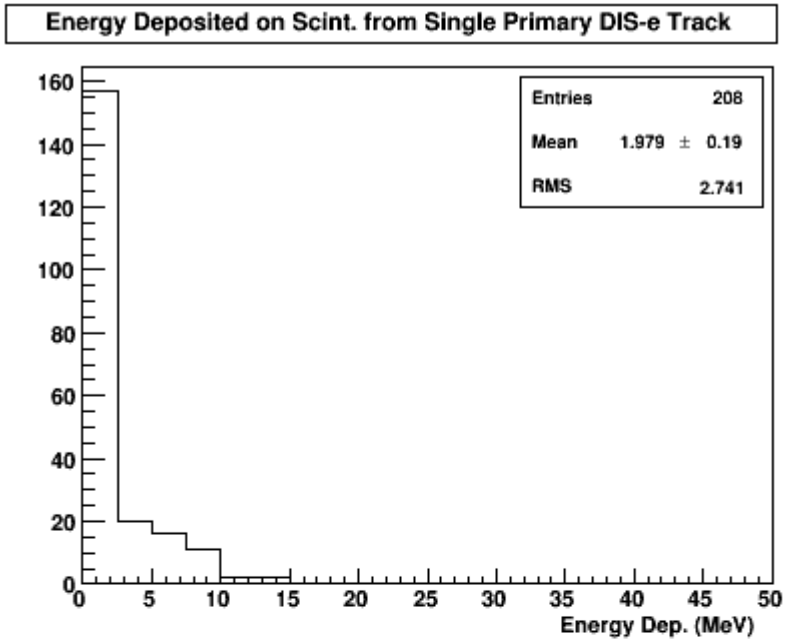


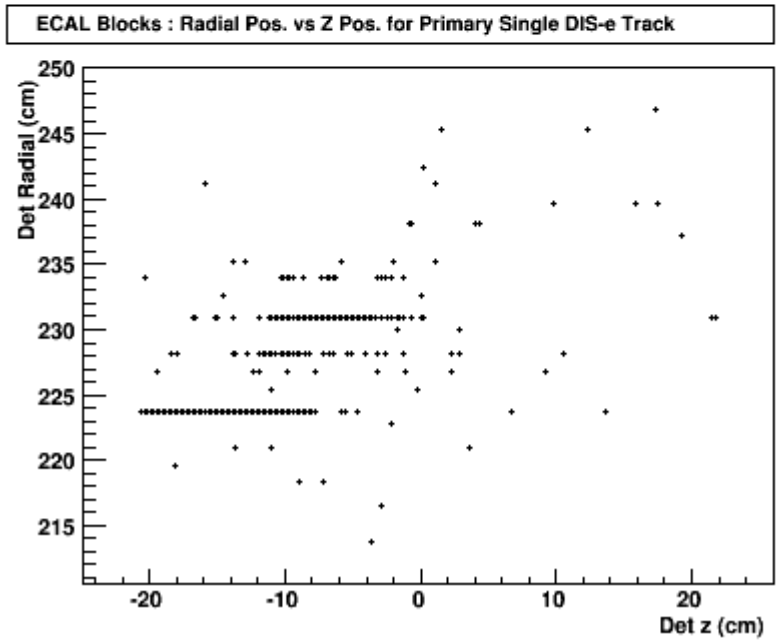


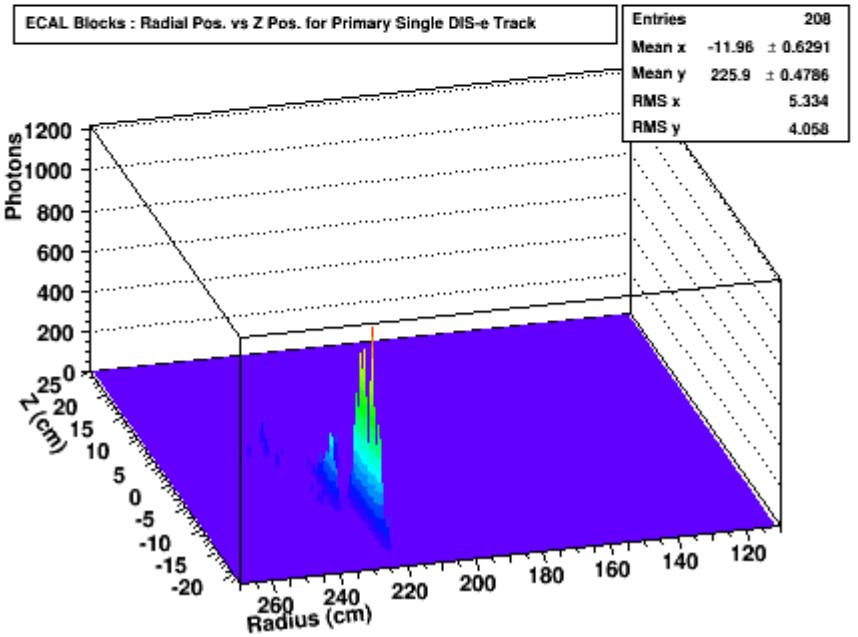
DIS-e Single Event

Energy deposition for a single event with Pb baffles









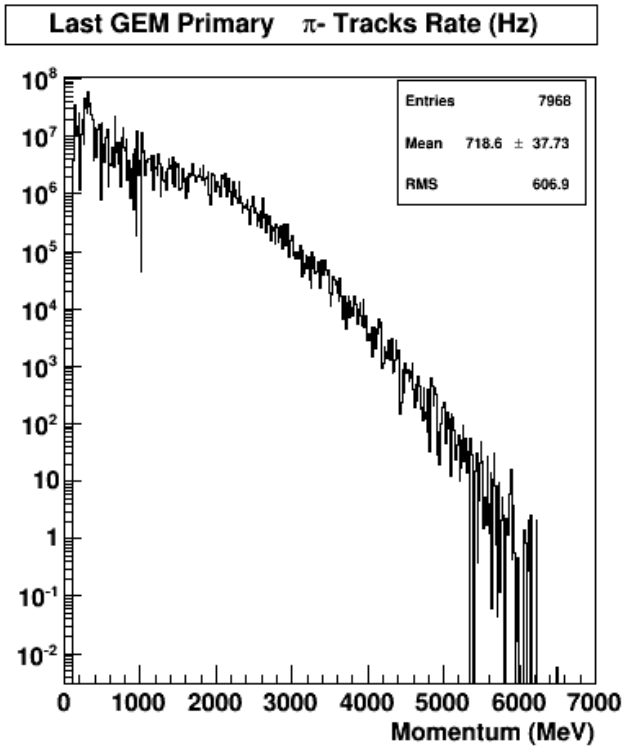
DIS-e Single Event

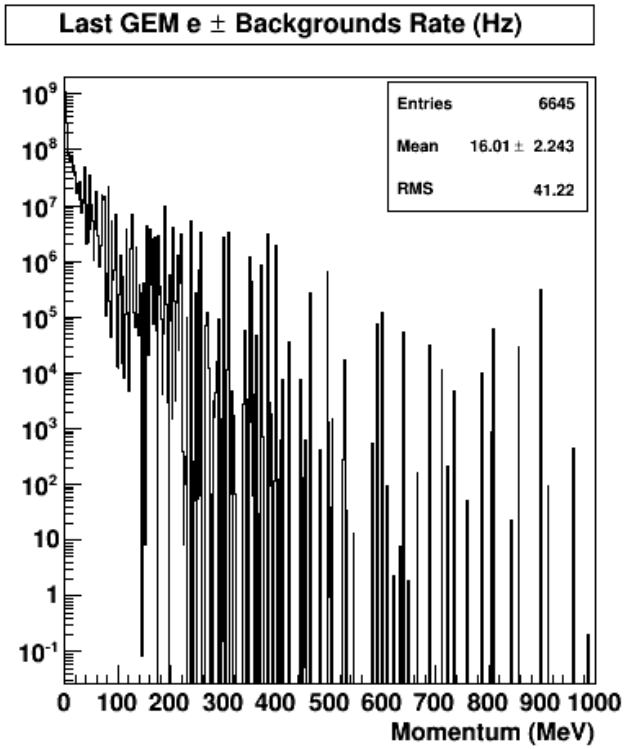
Kinematics of the hit at last GEM:
Momentum = 1166.2 MeV Location[x,y] = [-22.7,209.9] cm and Radius = 211.1 cm

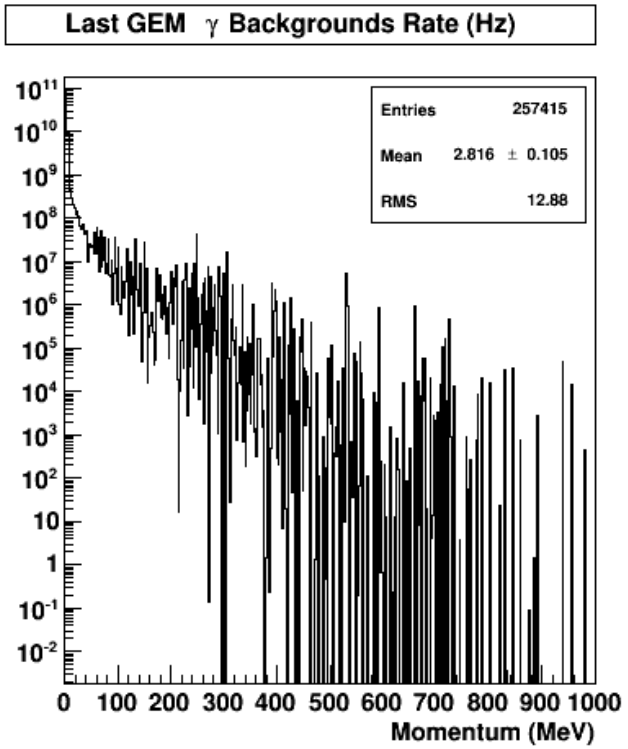
Row	Instance	hit.p*100	rate/1e3	hit.pid	hit.trid	hit.mtrid
1199	1	0.0931565	0.0036913	22	1435	1432
1199	4	0.2300952	0.0036913	22	179	162
1199	5	0.5109989	0.0036913	22	1445	193
1199	53	1166.2434	0.0036913	11	1	0
1199	54	0.4092676	0.0036913	22	147	145
1199	55	2.6843197	0.0036913	22	183	162
1199	56	1.2480258	0.0036913	22	197	192
1199	57	0.8112135	0.0036913	22	179	162
1199	58	15.345471	0.0036913	22	177	162
1199	59	0.8928279	0.0036913	22	252	245
1199	60	0.6857611	0.0036913	22	390	388
1199	61	983.08967	0.0036913	22	18	1
1199	62	4.2139657	0.0036913	22	934	885
1199	63	0.1776755	0.0036913	22	972	969
1199	64	0.5057344	0.0036913	22	1189	491
1199	65	0.3652997	0.0036913	22	1160	612
1199	66	0.2616179	0.0036913	22	1433	201
1199	68	1.4035044	0.0036913	22	469	449
1199	69	2.4625398	0.0036913	11	474	469

π- Summary

π- Momentum distributions at last GEM with lead baffles (From all the events)



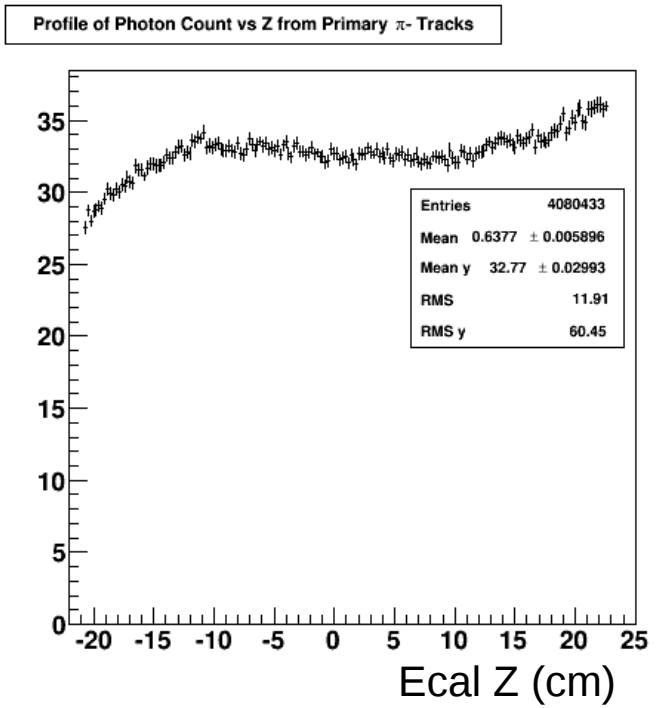


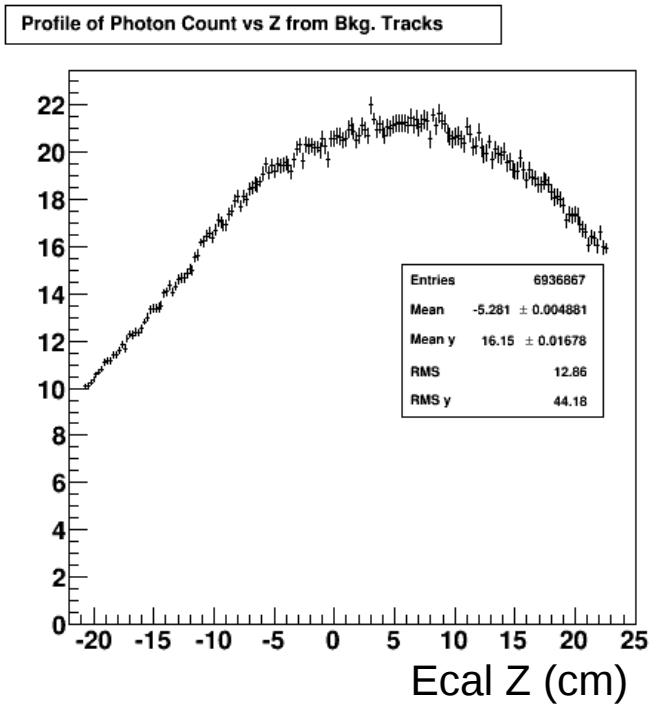


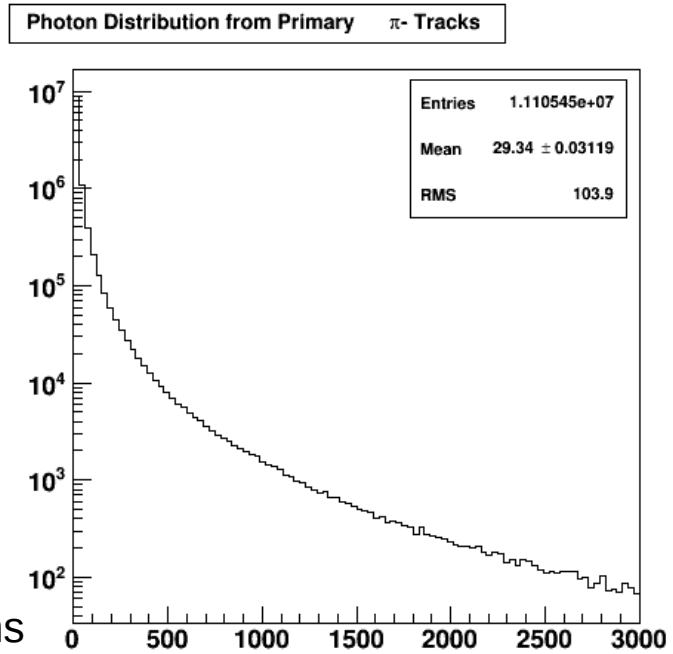
Primary π- Rate = 473.60 MHz
Bkg. Electron Rate = 1456.73 MHz
Bkg. Photon Rate = 73765.53 MHz

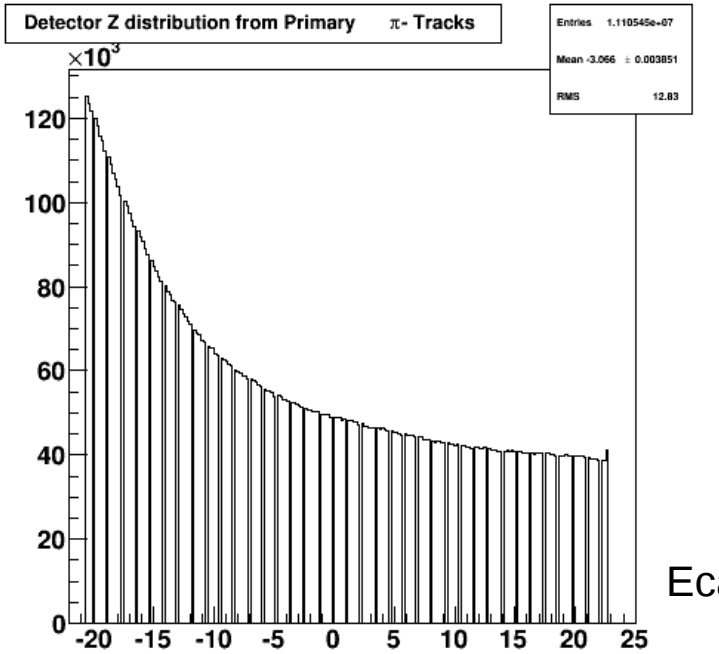
π- Photon production at scint. for events with primary tracks with lead baffles (From all the events)

Avg. Photons



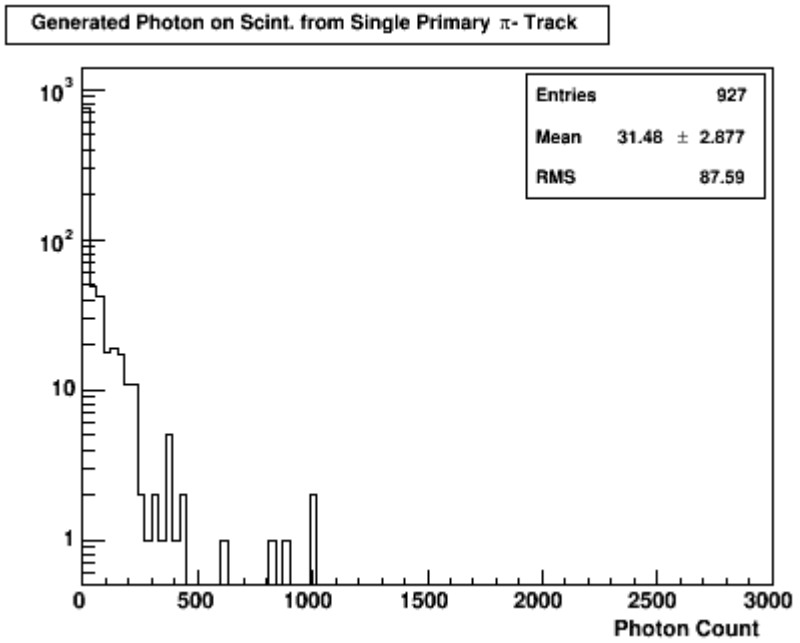


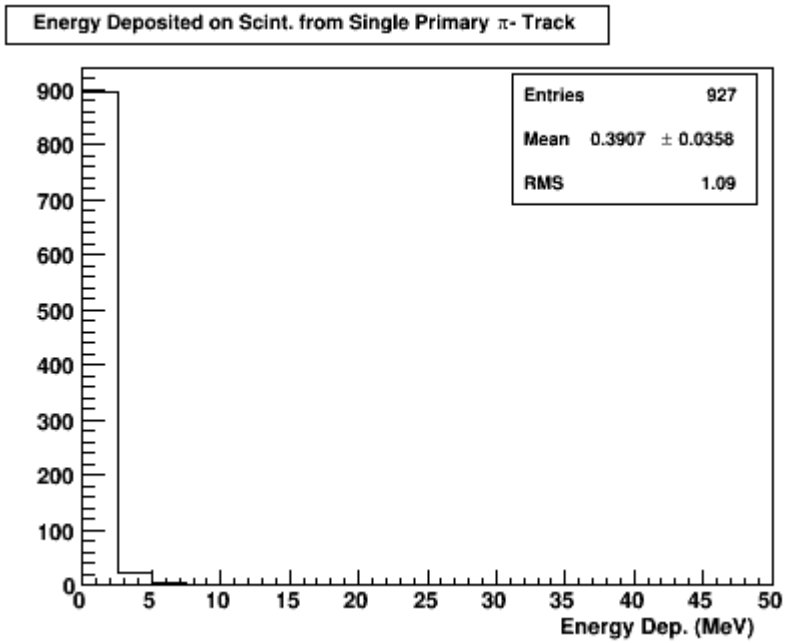


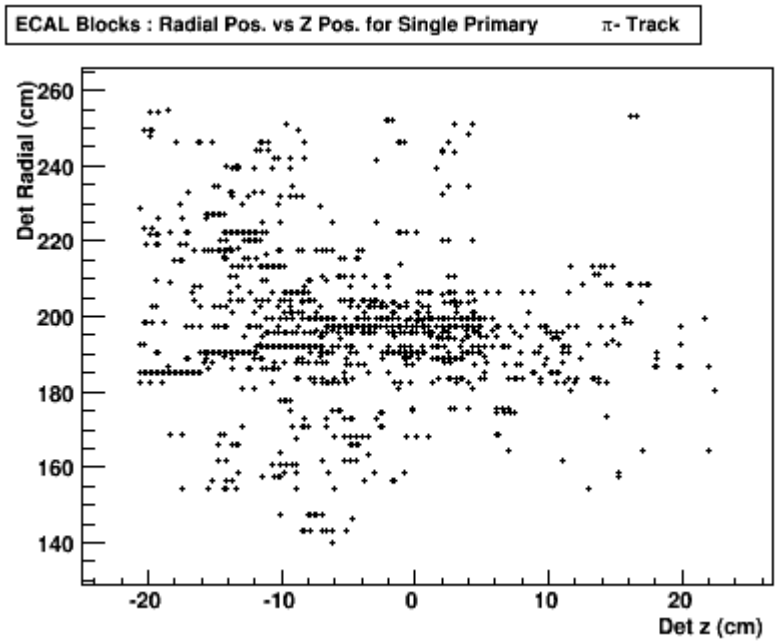


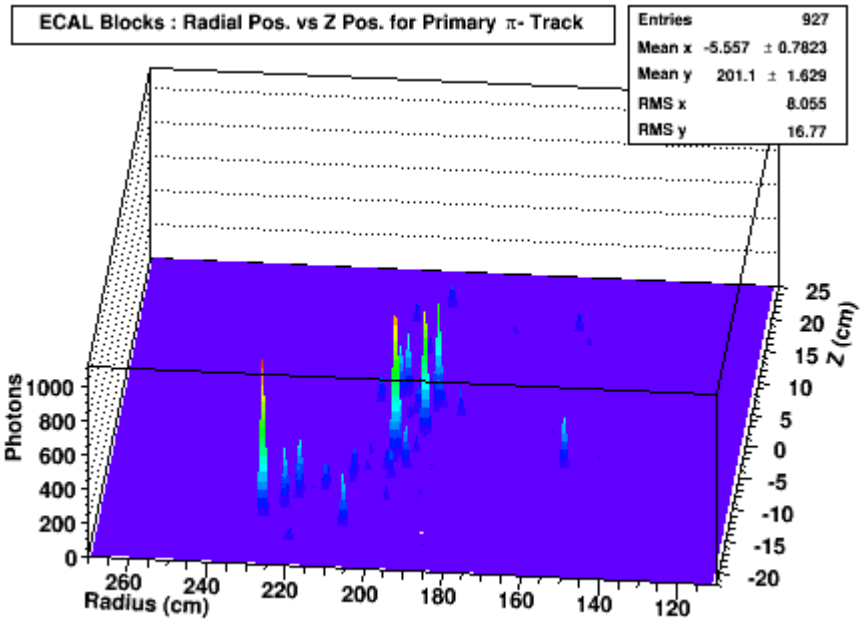
π- Single Event

Energy deposition for a single event with Pb baffles









π- Single Event

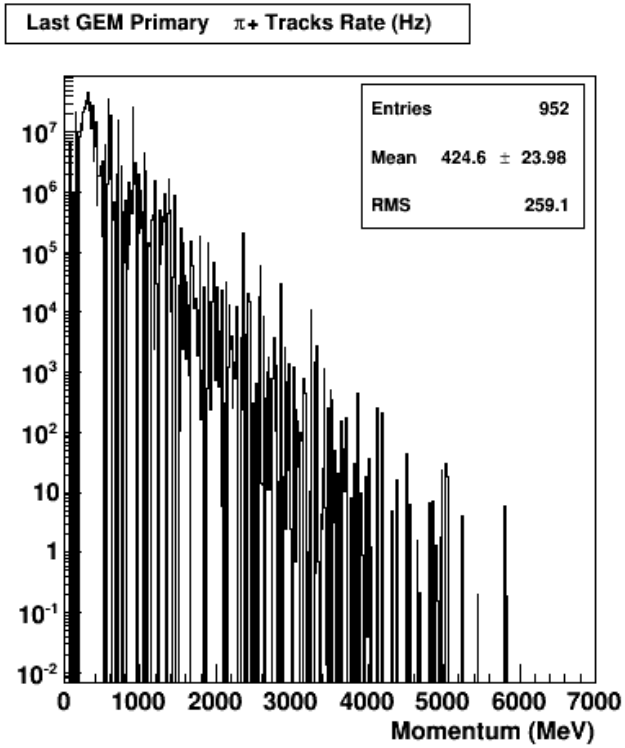
Kinematics of the hit at last GEM:
Momentum = 1671.16 MeV Location[x,y] = [-122.5,128.3] cm and Radius = 177.4 cm

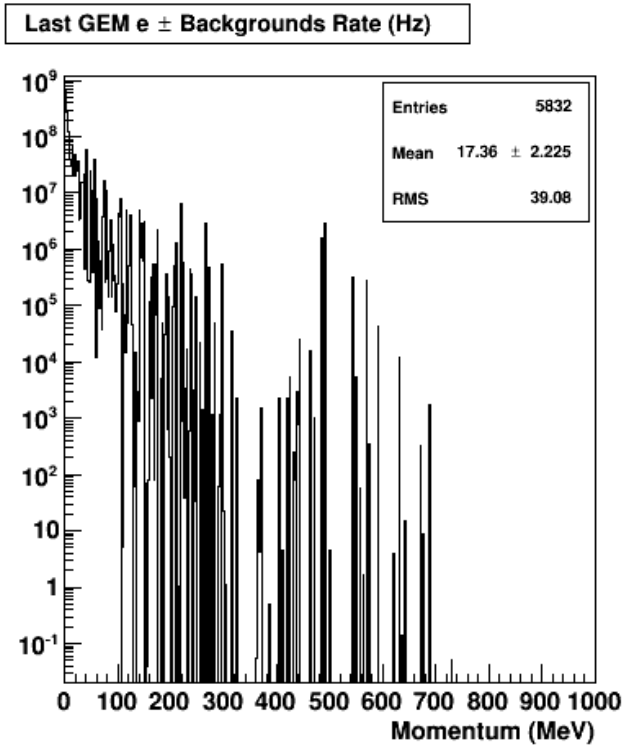
Row	Instance	hit.p*100	rate/1e3	hit.pid	hit.trid	hit.mtrid
3470	3	54.211811	69.025533	2112	383	39
3470	79	47.611416	69.025533	2112	123	35
3470	80	4.7384499	69.025533	2112	400	38
3470	81	0.2602467	69.025533	22	362	349
3470	82	4.5435387	69.025533	22	361	349
3470	85	3.6619440	69.025533	2112	384	39
3470	86	3.1248666	69.025533	2112	384	39
3470	87	3.4564719	69.025533	22	362	349
3470	88	0.5757682	69.025533	22	142	122
3470	89	0.2888957	69.025533	2112	446	439
3470	129	1671.1585	69.025533	-211	1	0
3470	130	3.5772249	69.025533	2112	333	49
3470	131	369.40177	69.025533	2112	39	1
3470	132	1.6104594	69.025533	22	282	62
3470	133	0.4137283	69.025533	22	258	67
3470	134	6.1467075	69.025533	22	199	196
3470	138	96.120609	69.025533	2112	78	36
3470	139	11.111381	69.025533	2112	384	39
3470	140	3.8969821	69.025533	2112	384	39
3470	163	2.6133422	69.025533	2112	333	49

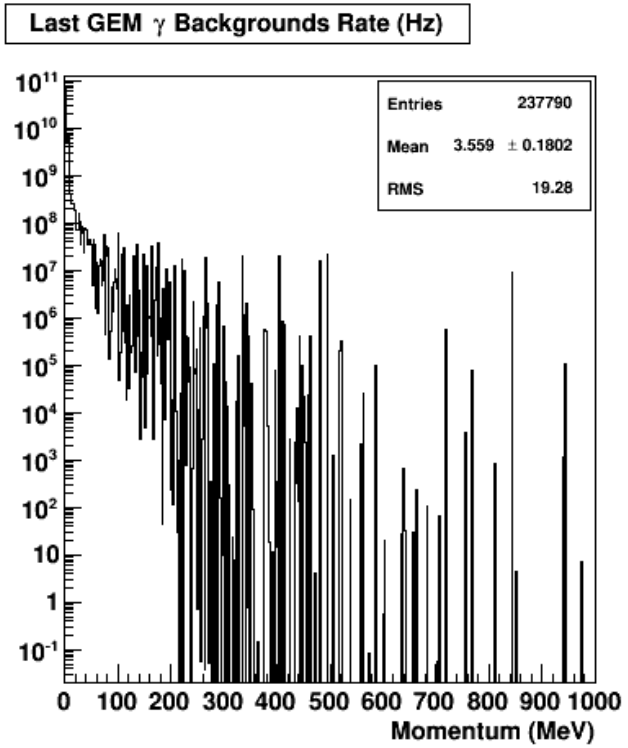
*PID 2112 is a neutron

π+ Summary

π+ Momentum distributions at last GEM with lead baffles (From all the events)



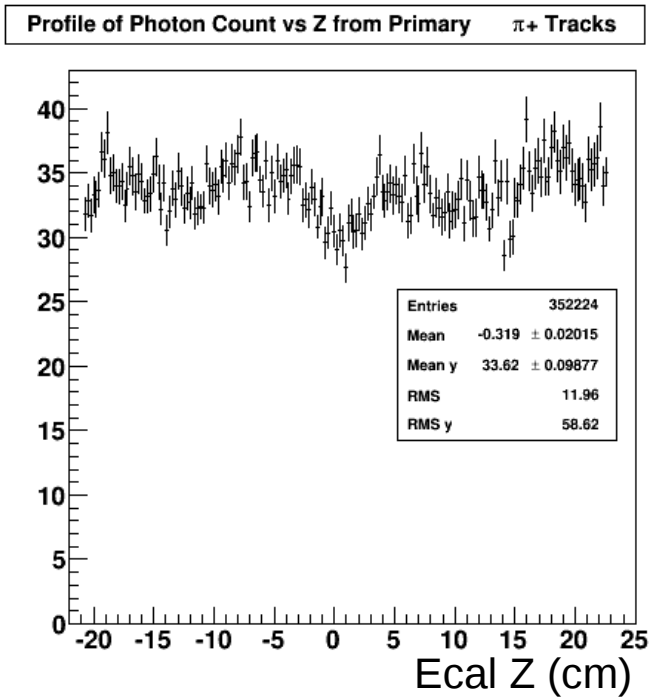


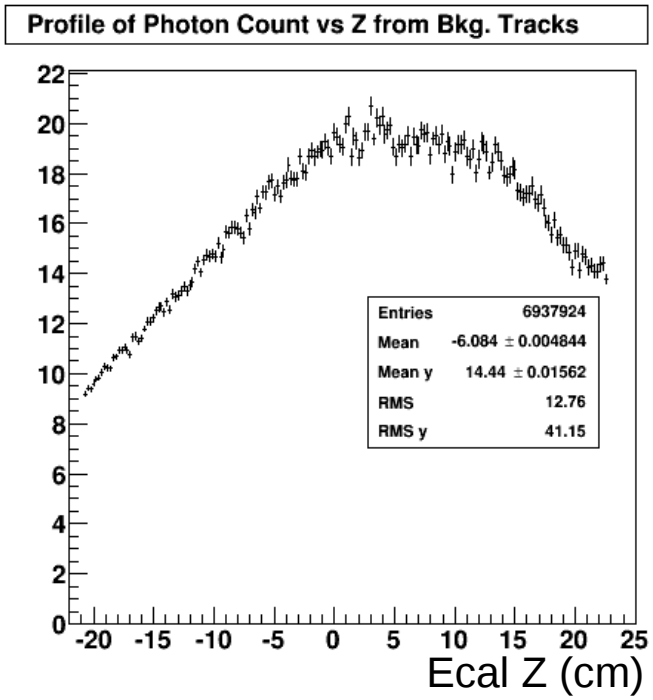


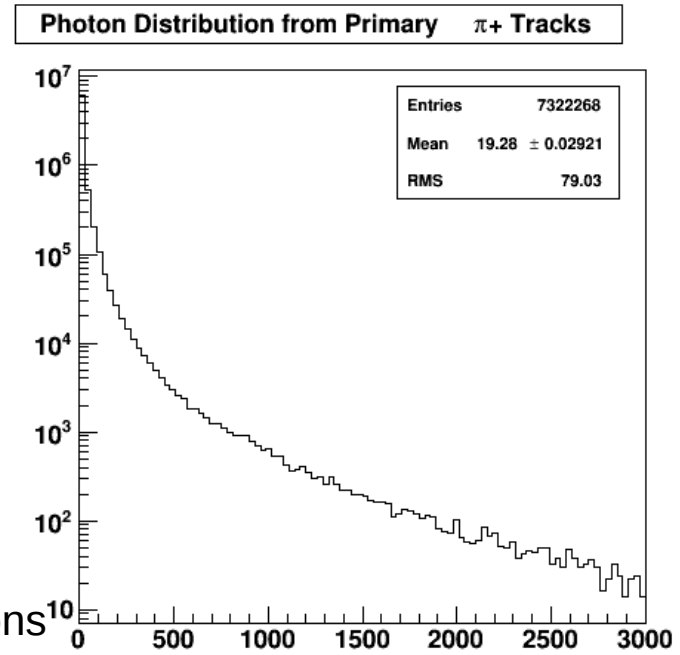
Primary π+ Rate = 263.38 MHz
Bkg. Electron Rate = 1011.50 MHz
Bkg. Photon Rate = 50122.59 MHz

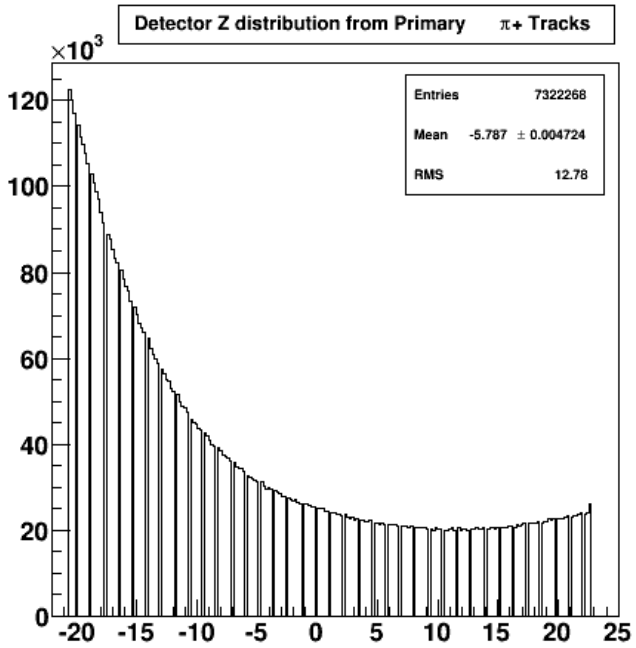
π+ Photon production at scint. for events with primary tracks with lead baffles (From all the events)

Avg. Photons



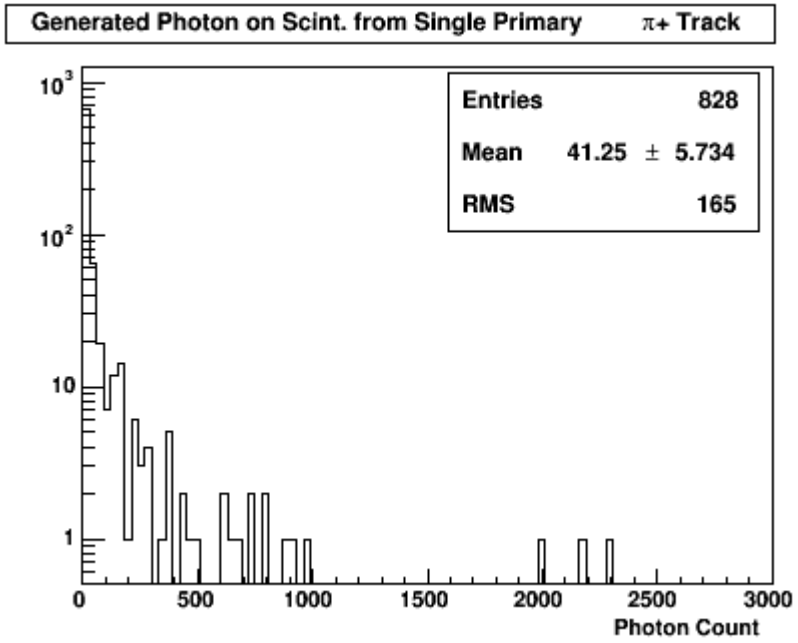


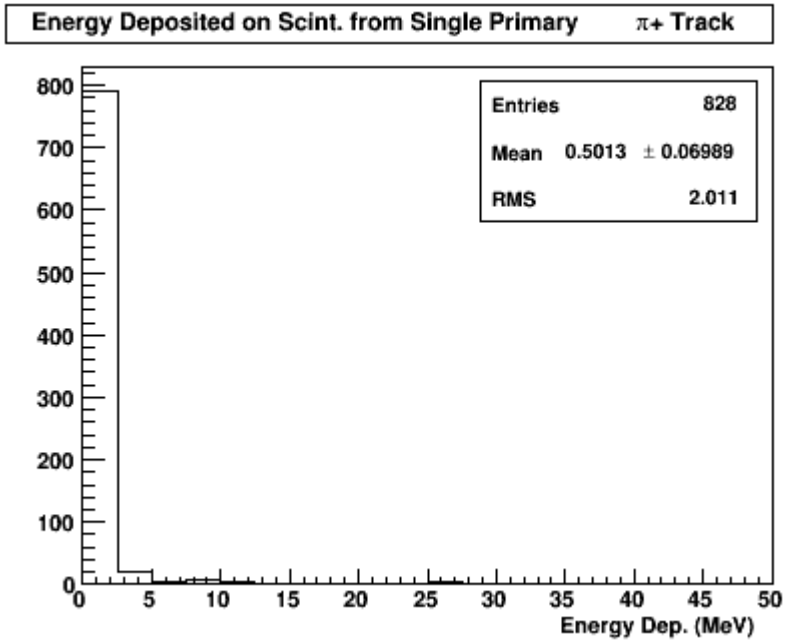


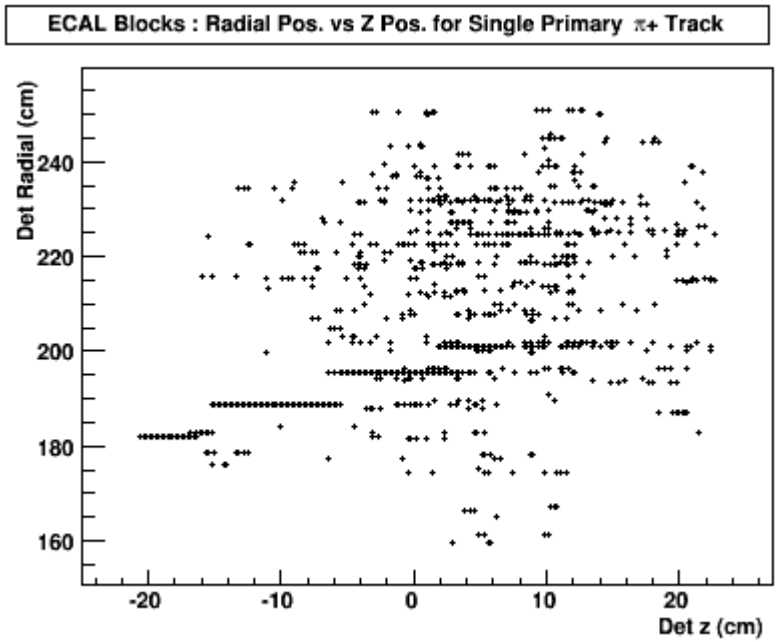


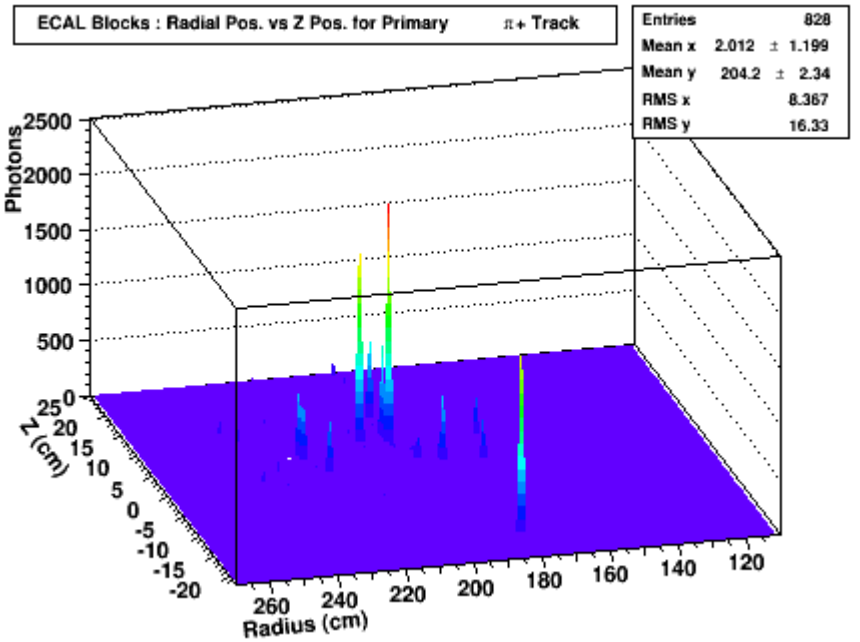
π+ Single Event

Energy deposition for a single event with Pb baffles









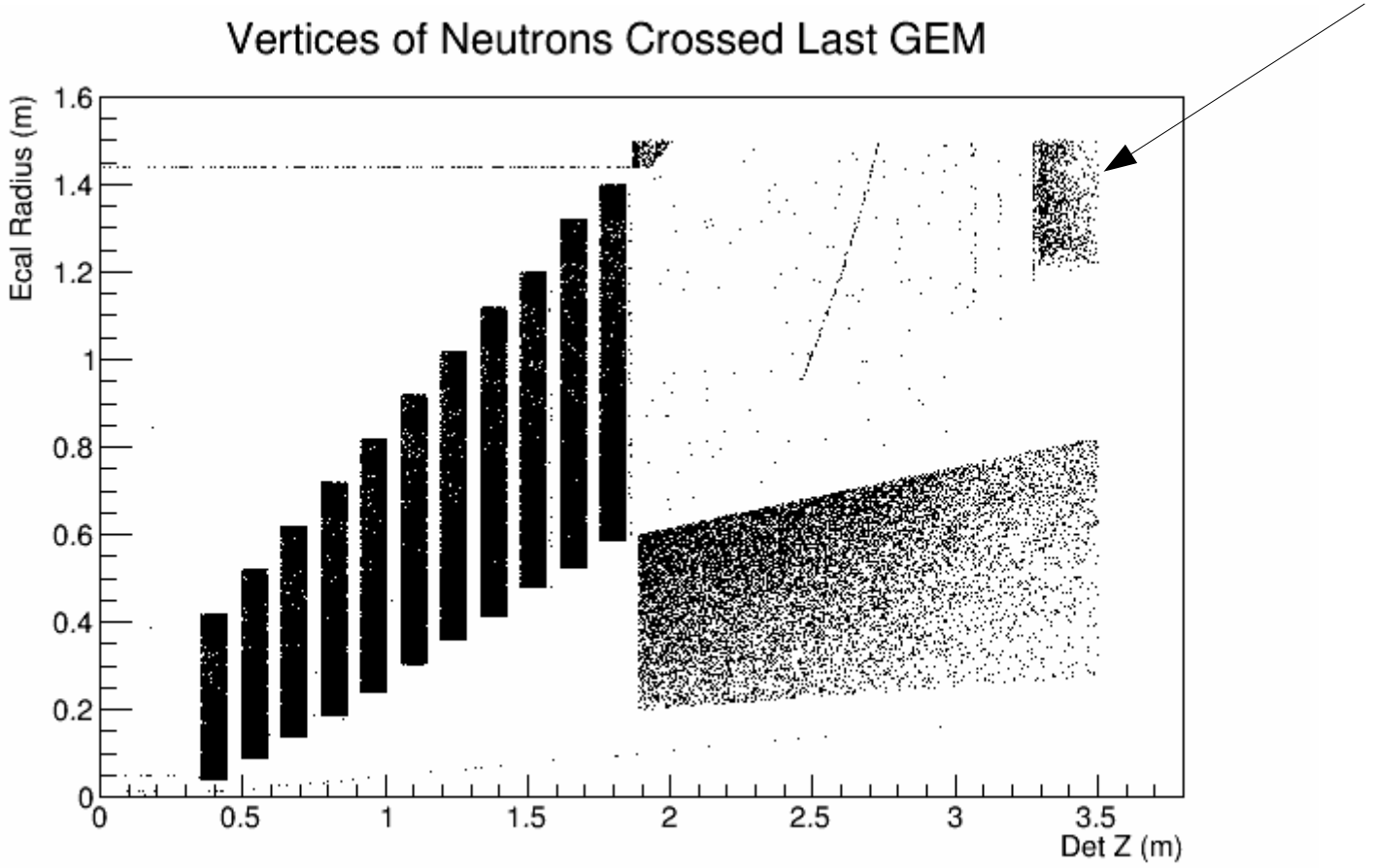
π+ Single Event

Kinematics of the hit at last GEM:
Momentum = 1436.79 MeV Location[x,y] = [104.4,137.6] cm and Radius =172.8 cm

Row	Instance	hit.p*100	rate/1e3	hit.pid	hit.trid	hit.mtrid
28129	10	1436.7898	10.432679	211	1	0

Neutron Production in SoLID

- This is initial look at events where neutrons crosses the last GEM
  - 72% of damaging neutrons, (E>10 MeV) crossing the last GEM are from baffles
  - Some neutrons crossed the last GEM are from ECAL



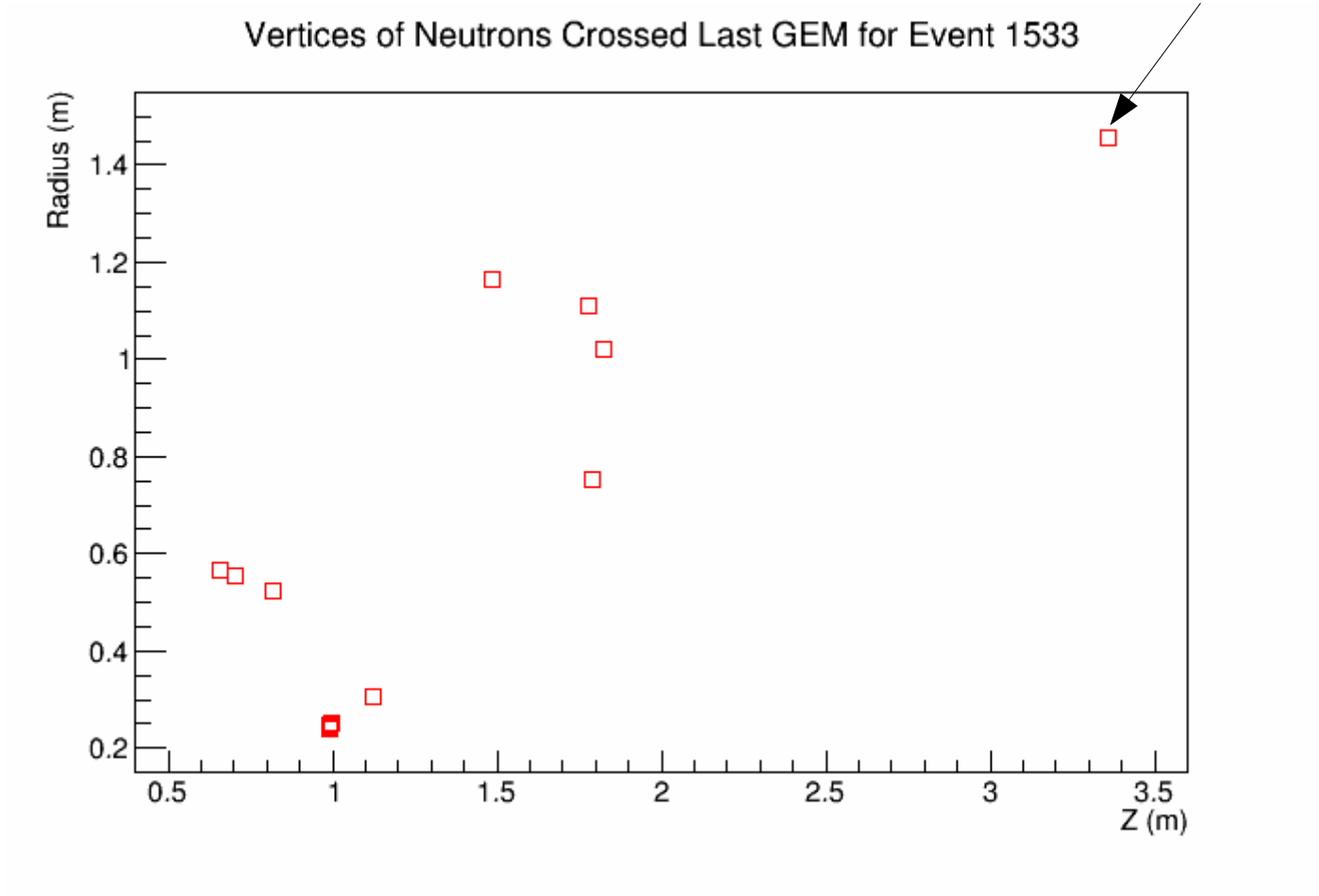
A Single Event with Neutrons

- A pion of energy 4184.3 MeV produce a neutron of 1039.0 MeV (rate is 39.6 kHz).
  - The primary pion traverses till about 2nd GEM and then interacted with the baffle (probably) to generate the neutron(s).
  - Neutrons that crossed the last GEM is shown here →

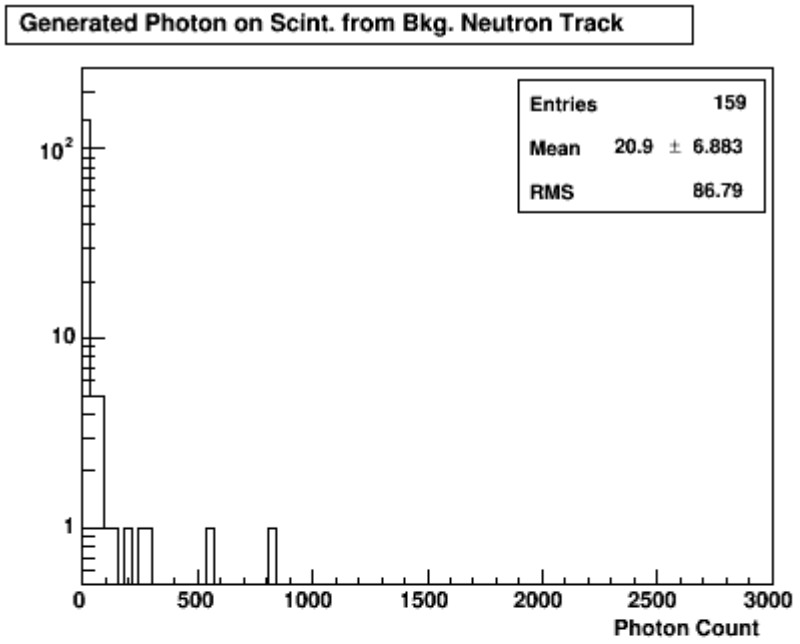
Row	Instance	hit.p*100	rate/1e3	hit.pid	hit.trid
1532	4	11.081446	39.575648	2112	1997
1532	8	2.7663177	39.575648	22	2806
1532	9	0.3143340	39.575648	22	2805
1532	10	0.2107929	39.575648	22	3550
1532	20	0.6748753	39.575648	2112	2866
1532	30	0.5109989	39.575648	22	2489
1532	31	5.8455219	39.575648	2112	2866
1532	32	27.382014	39.575648	2112	2877
1532	61	115.26298	39.575648	2112	3463
1532	62	108.48643	39.575648	2112	3564
1532	63	3.0402322	39.575648	22	3485
1532	66	18.668791	39.575648	2112	791
1532	67	12.276061	39.575648	2112	791
1532	232	22.539024	39.575648	2112	3637
1532	233	5.8177829	39.575648	2112	3636
1532	236	271.63421	39.575648	2112	49
1532	237	0.6256686	39.575648	2112	3451
1532	279	0.4032997	39.575648	22	611
1532	280	1.6596935	39.575648	22	3658
1532	285	25.673838	39.575648	2112	3636
1532	286	21.901756	39.575648	2112	3636
1532	287	0.4499683	39.575648	22	3471
1532	290	24.283833	39.575648	2112	3438
1532	356	28.221068	39.575648	2112	2675
1532	357	1039.0075	39.575648	2112	35
1532	359	5.0291749	39.575648	2112	791
1532	403	94.691192	39.575648	2112	3508
1532	404	113.25222	39.575648	2112	3629
1532	437	0.5207742	39.575648	2112	3654

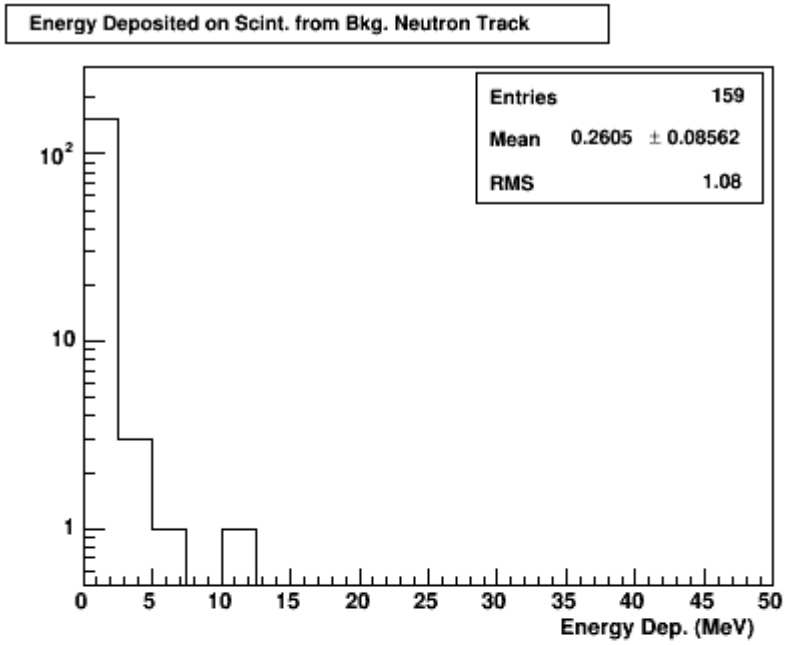
A Single Event with Neutrons

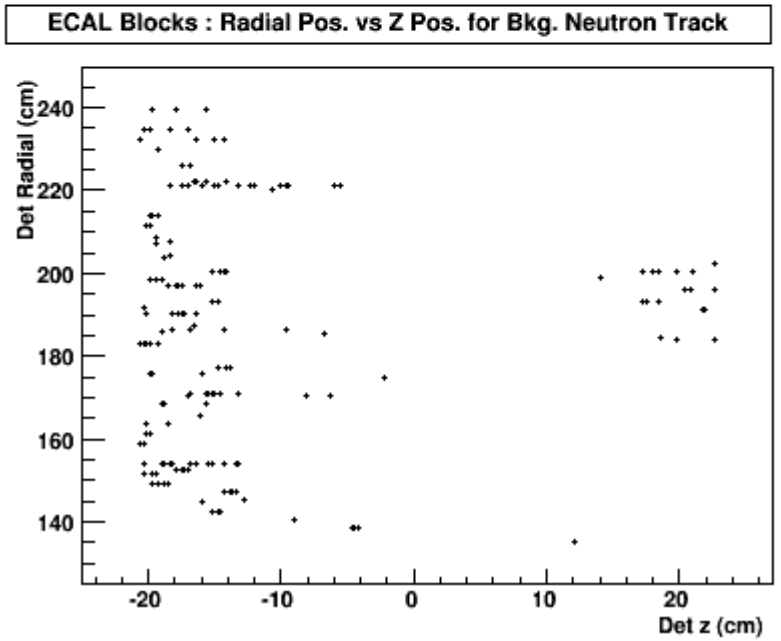
Created in the Ecal and crossed the last GEM

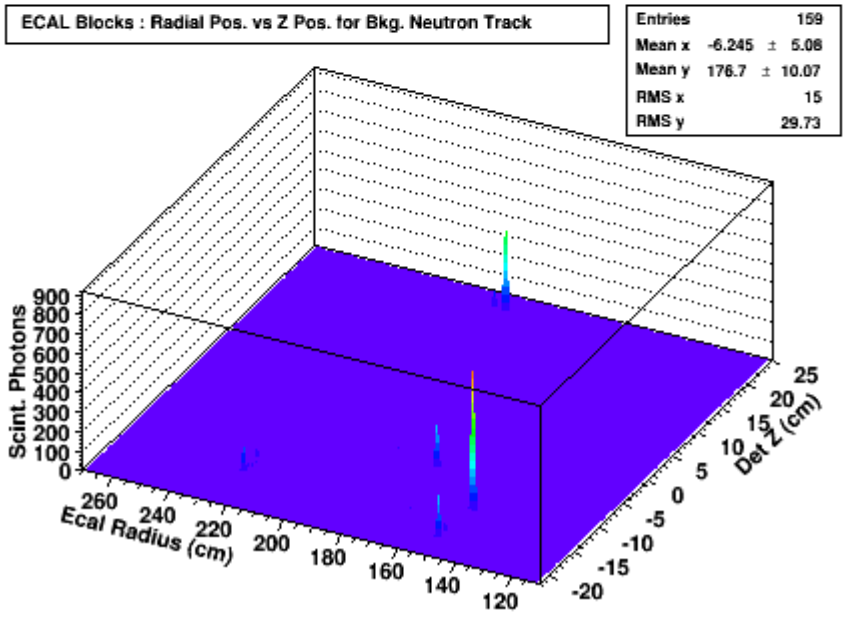


A Single Event with Neutrons







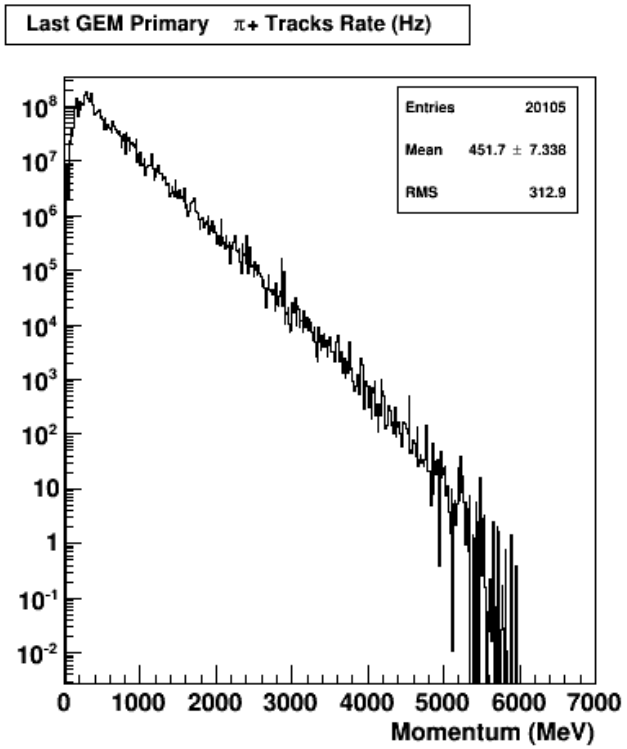


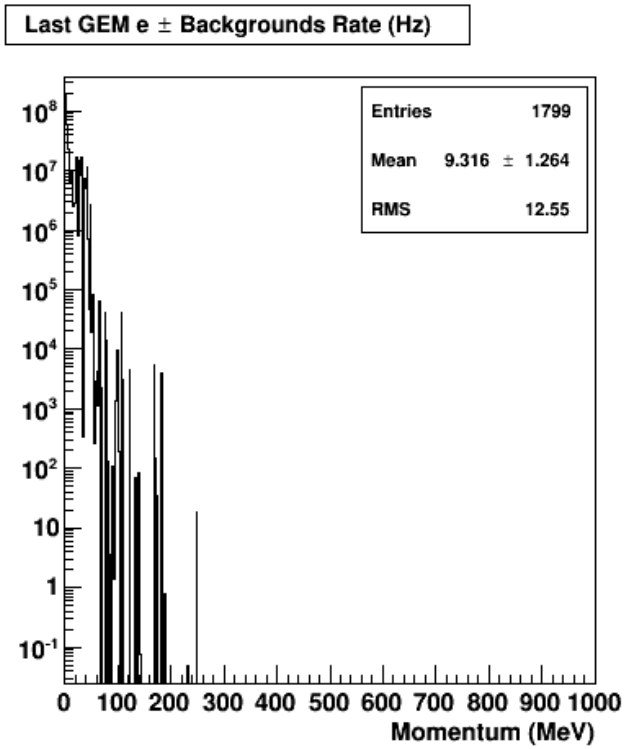
Physics Process Control

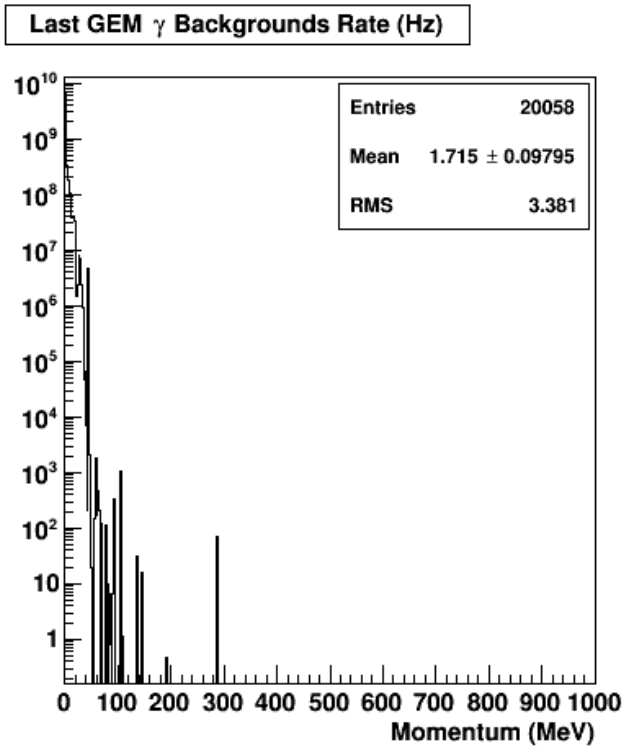
- In remoll simulation, we can switch ON/OFF physics processes
  - For example simulate with EM only or Hadronic only or switch of certain EM processes, etc.
- In the following slides, I looked at pion simulation with EM physics only (No Hadronic physics)

π+ Summary (EM Only)

π+ Momentum distributions at last GEM with lead baffles (From all the events)

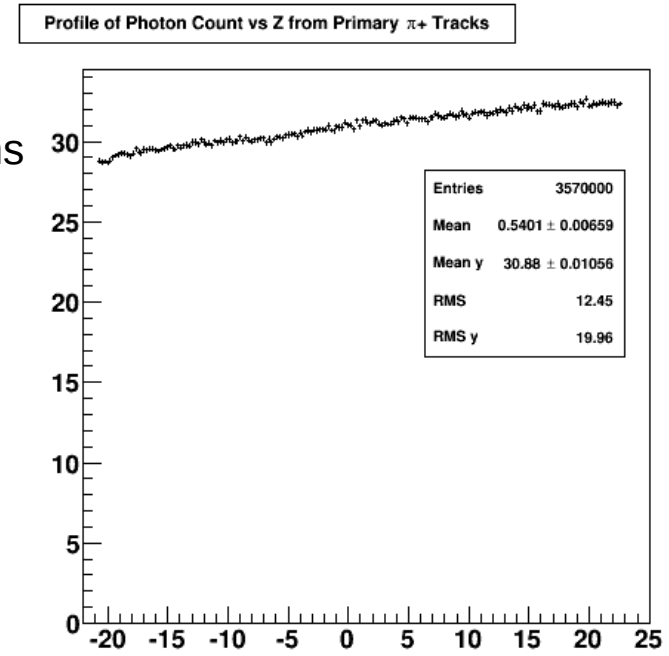




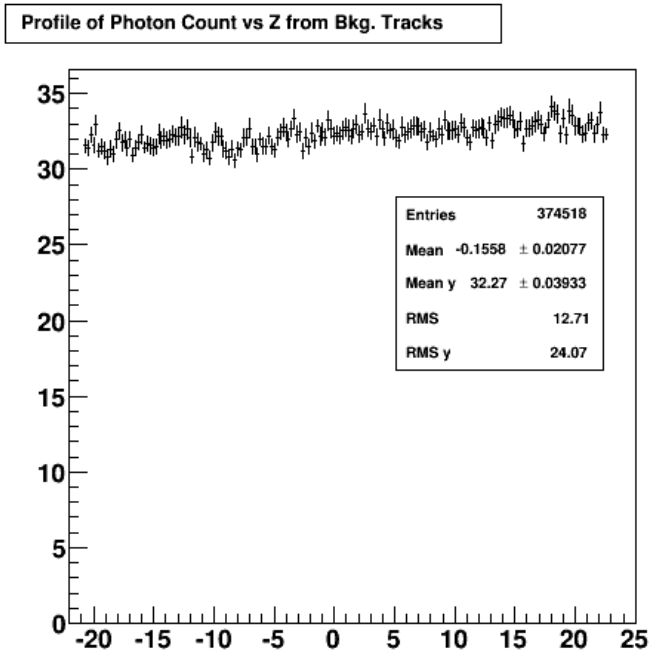


Primary π+ Rate = 2202.56 MHz
Bkg. Electron Rate = 239.79 MHz
Bkg. Photon Rate = 4361.32 MHz

π+ Photon production at scint. for events with primary tracks with lead baffles (From all the events)

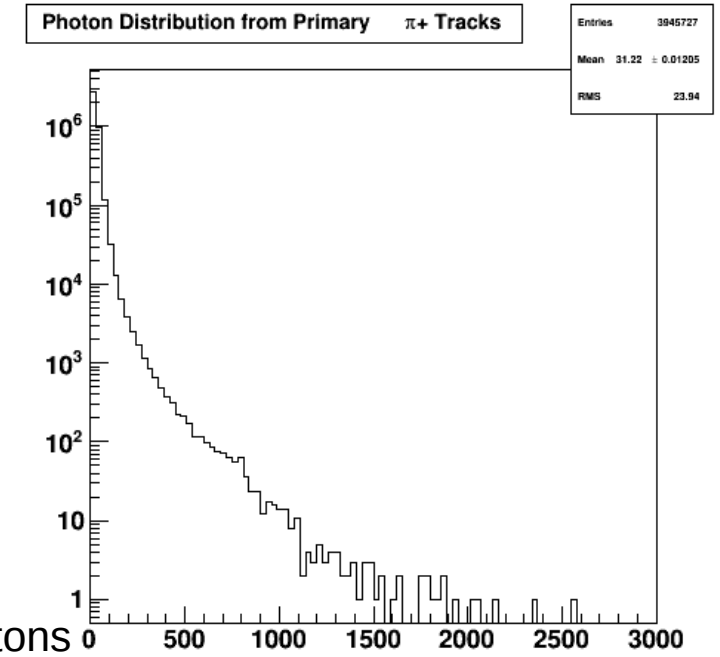


Avg. Photons

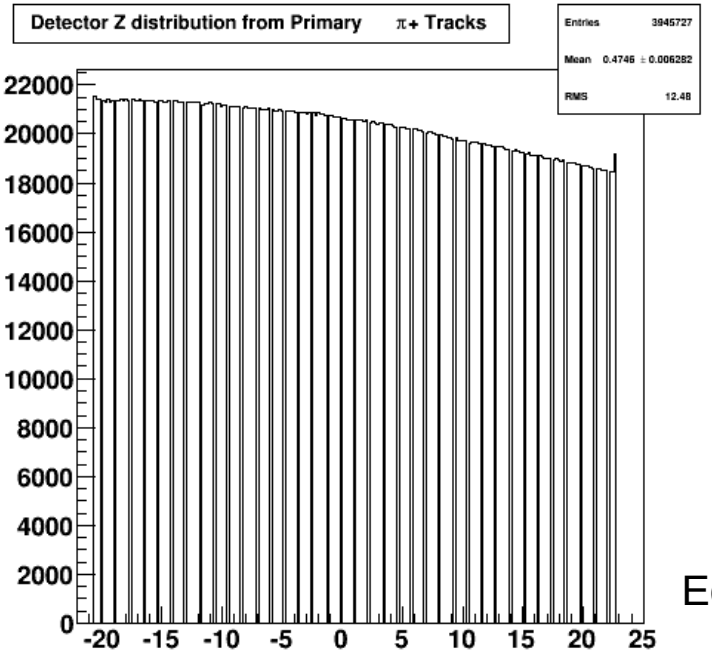


Ecal Z (cm)

Ecal Z (cm)



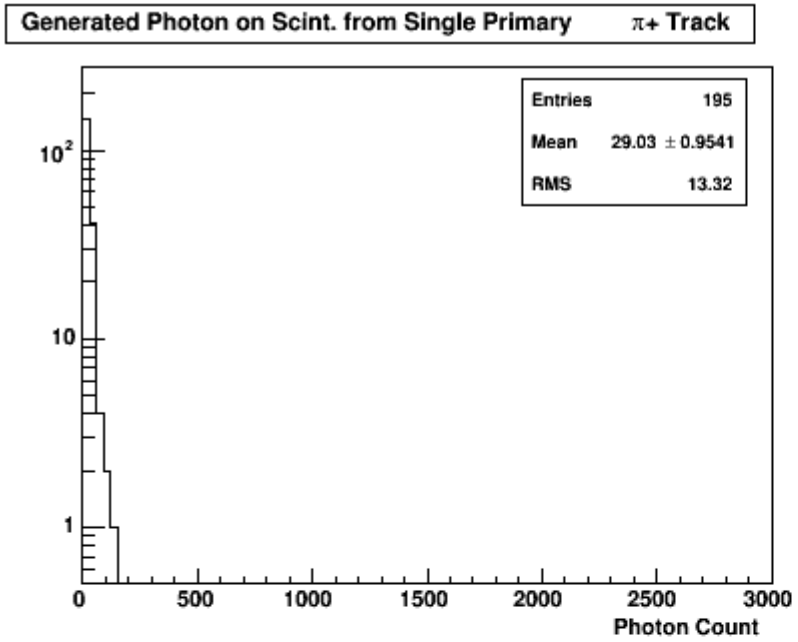
Photons

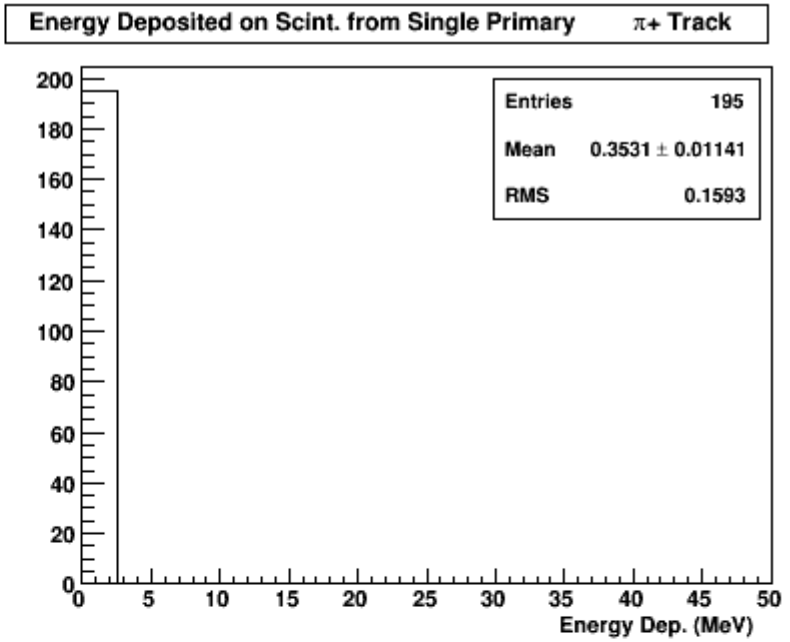


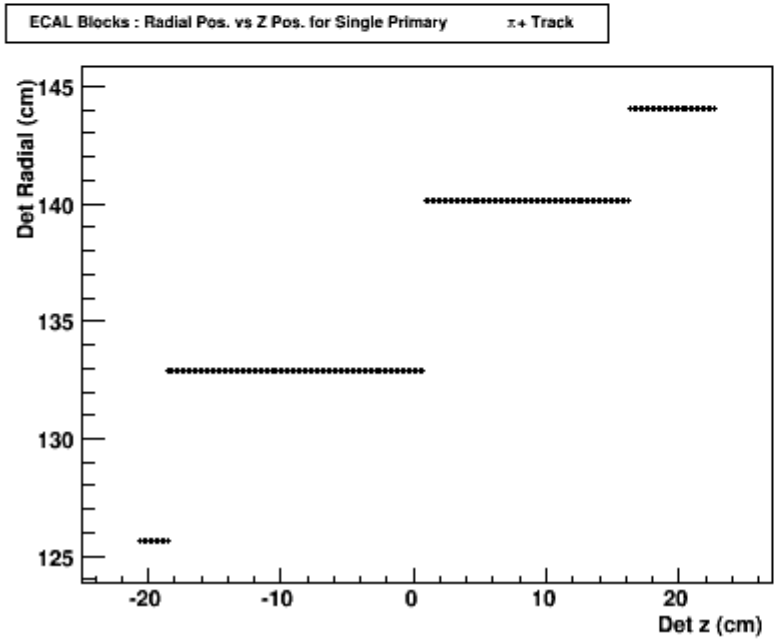
Ecal Z (cm)

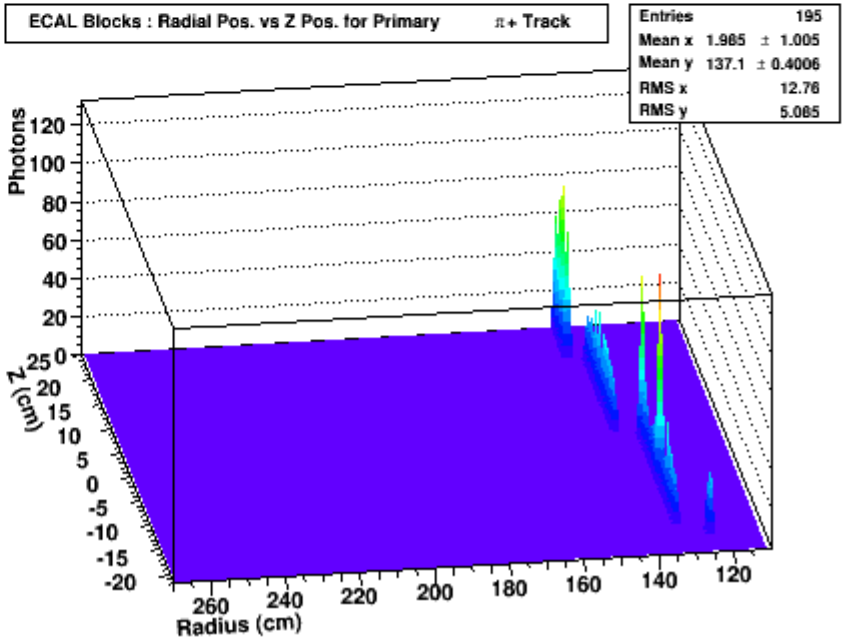
π+ Single Event (EM Only)

Energy deposition for a single event with Pb baffles









π+ Single Event

Kinematics of the hit at last GEM:
Momentum = 3553.51 MeV Location[x,y] = [-108.6,-58.2] cm and Radius = 123.2 cm

Row	Instance	hit.p*100	rate/1e3	hit.pid	hit.trid	hit.mtrid
559	2	3553.5122	0.0579609	211	1	0

Summary

- Only looked at primary tracks and so far very simple analysis
- Can look at background only events to see ECAL background only signal
- ECAL signals are summed over all the hits within an event
  - Currently it is not possible to separate background signal from primary signal within an event or do a rate weighting
- For each ECAL block sum, the time of first hit for each event is saved with the block sum
- For each GEM hit, the time of hit is saved
- Goal is to help understand PVDIS triggering with full ECAL
  - Can develop full trigger simulation based on these information
  - Work in progress

Supplementary