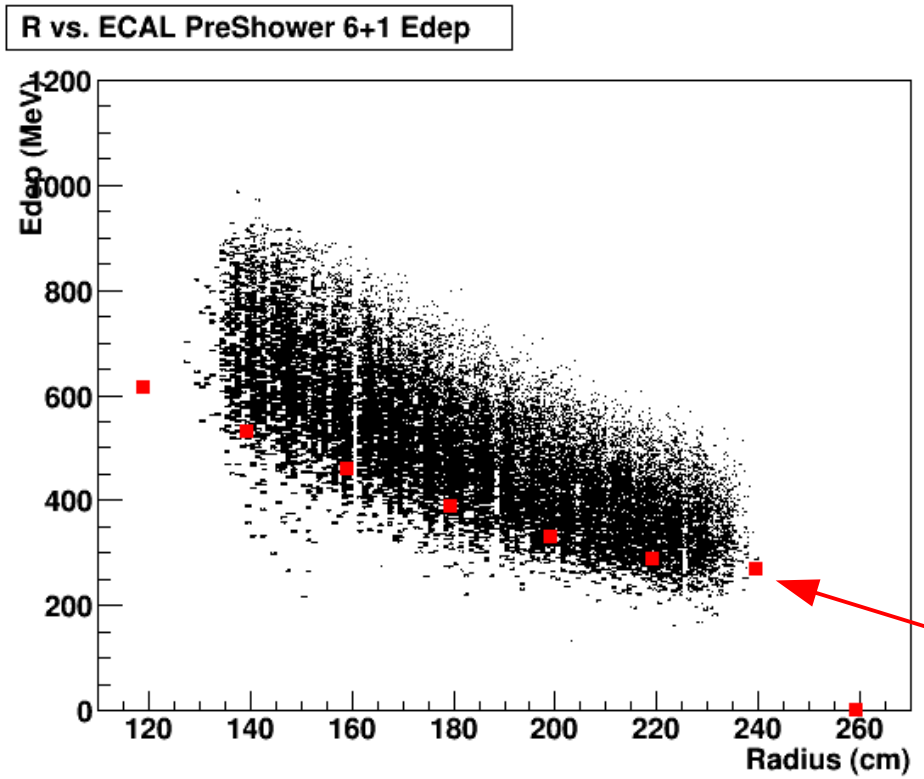
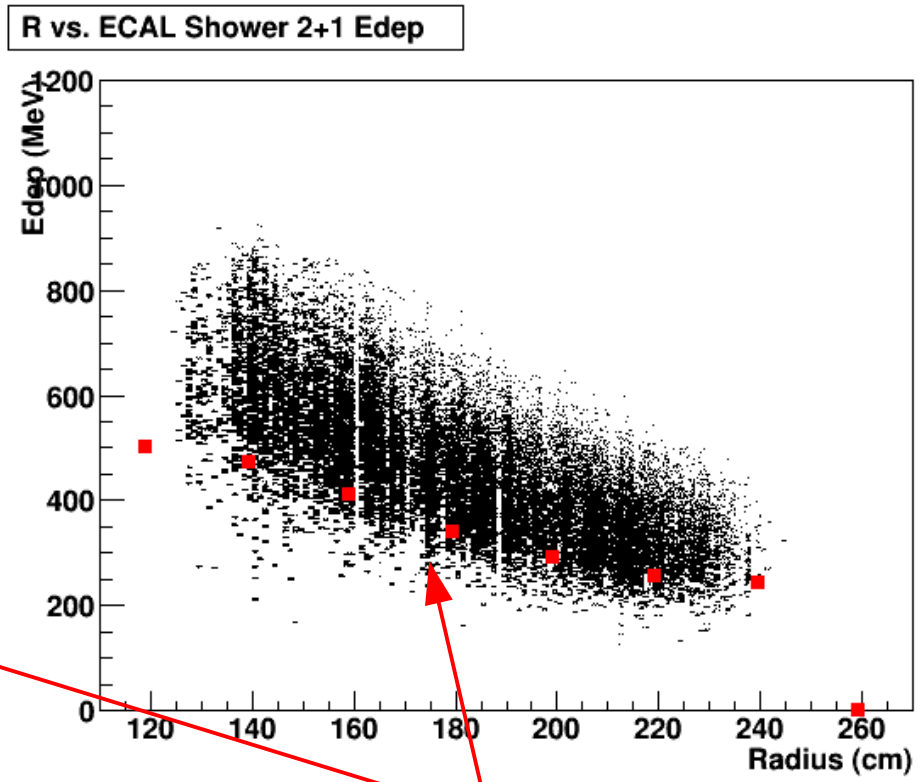
ECAL Pion Background in Trigger

Trigger Thresholds from DIS Gen.

Cluster thresholds generated from electron signals (DIS weighted generator)

To preserve x > 0.35 in angle range of 22 to 35 deg





1σ lower limit in Shower cluster

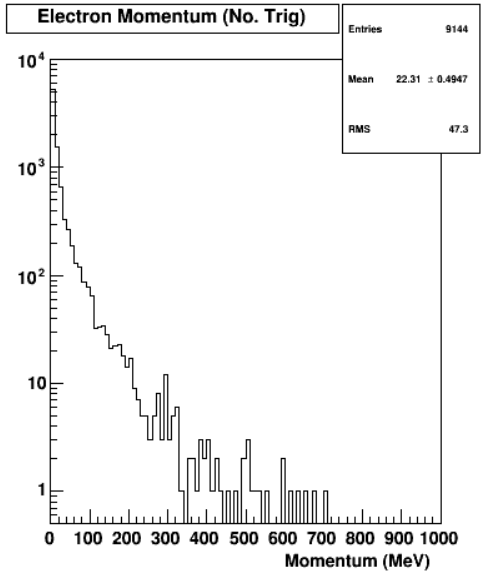
Trigger Thresholds from DIS Gen.

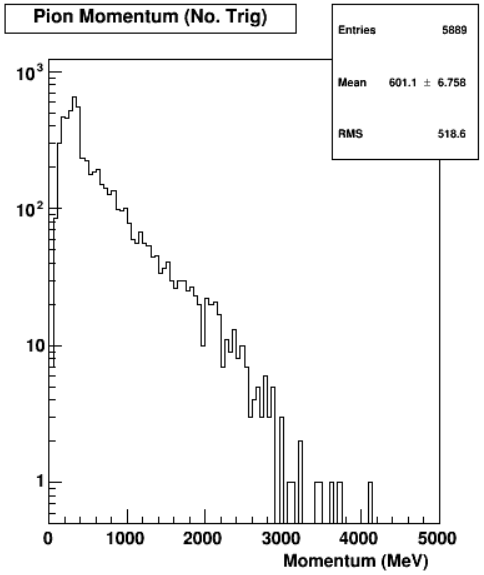
- Cluster thresholds generated from electron signals (DIS weighted generator)
- The trigger threshold is the DIS threshold in the shower.
  - Radius bins: {110 -130 ,130 - 150 ,150 – 170, 170 – 190, 190 - 210 ,210 – 230, 230 - 250 ,250 - 270}
  - Shower 6+1 Thresholds : {617.9 ,531.0 ,460.0 ,389.8 , 331.0 ,287.6 ,271.9 ,0.0} MeV
  - Shower 2+1 Thresholds : {501.5 ,471.9 ,412.8 ,340.5 , 291.9 ,255.3 ,243.7 ,0.0} MeV
- No threshold is applied to Pre-Shower clusters

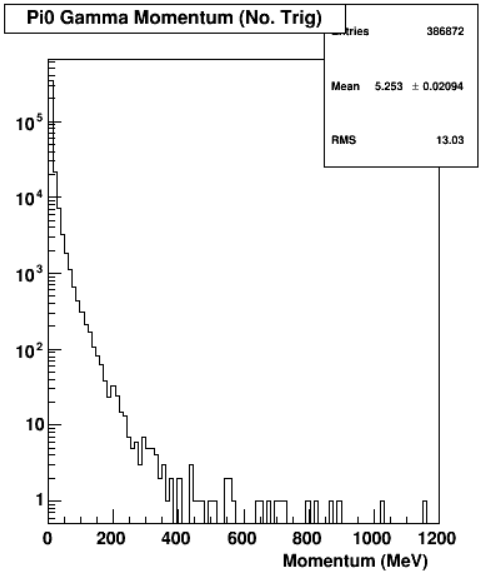
Multi-PID Triggering

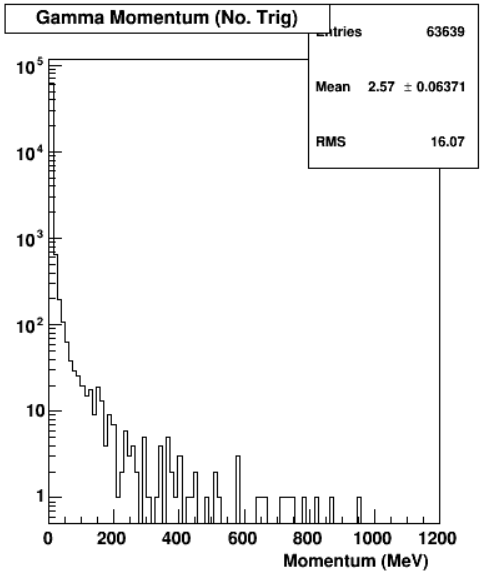
- Combined Pions (Uniform wiser generator) : π^- , π^+, π^0
- Simulation includes the photon blocker
- Generated events are separated in time based on total rate of generated events
- Used 30 ns trigger windows : total windows available 233
- Select 6+1 max energy cluster for each window in each sector
- If above the threshold, trigger the sector
- Trigger condition applied based on cluster thresholds generated from electron signals (DIS generator)
  - Radial dependence cluster threshold

Background Incident on ECAL





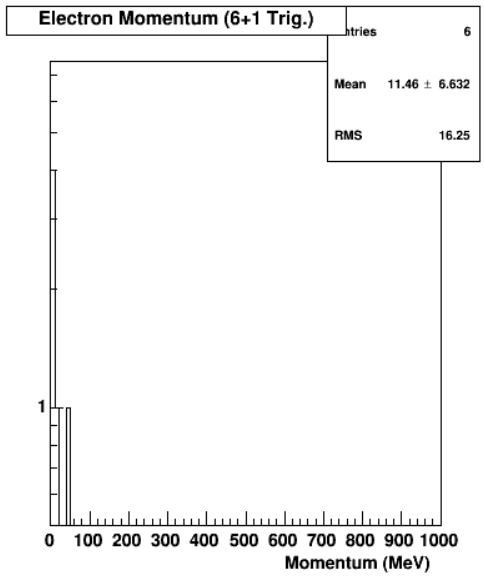


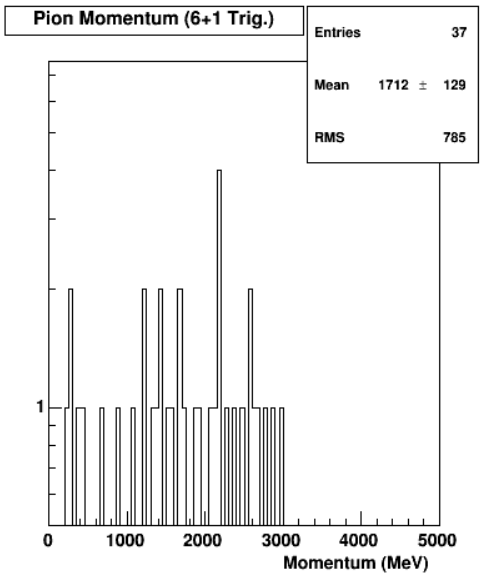


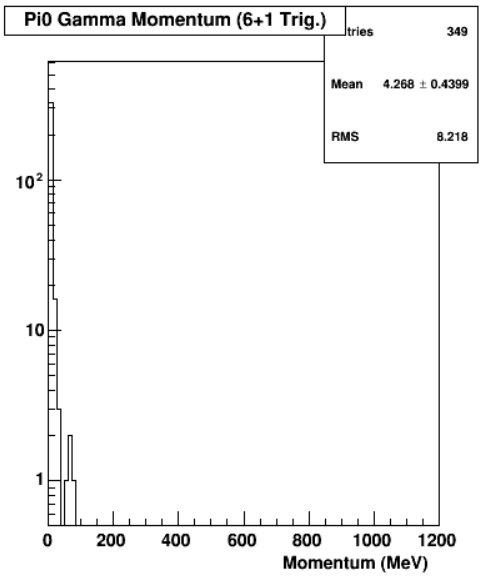
Total no.of tracks incident on the ECAL are categorized in to,

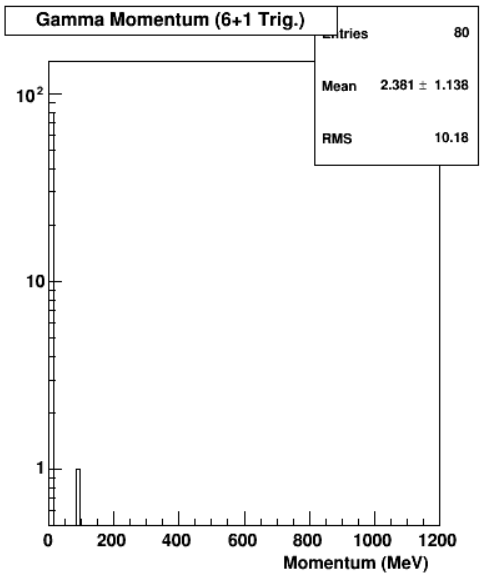
- Secondary electrons
- Pions (+/-)
- Photons from Pi0 simulation
- All other secondary photons

Background on ECAL After 6+1 Trigger





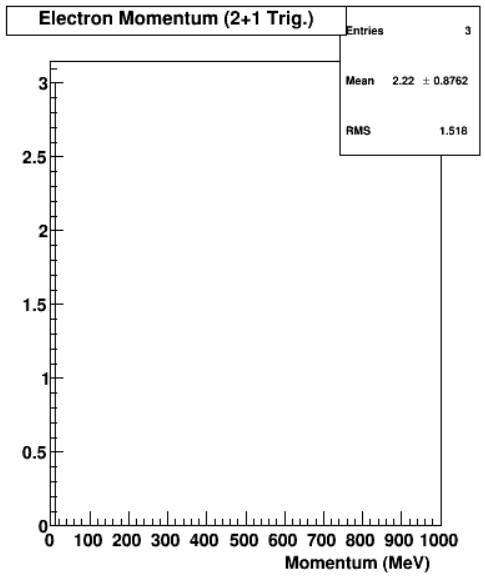


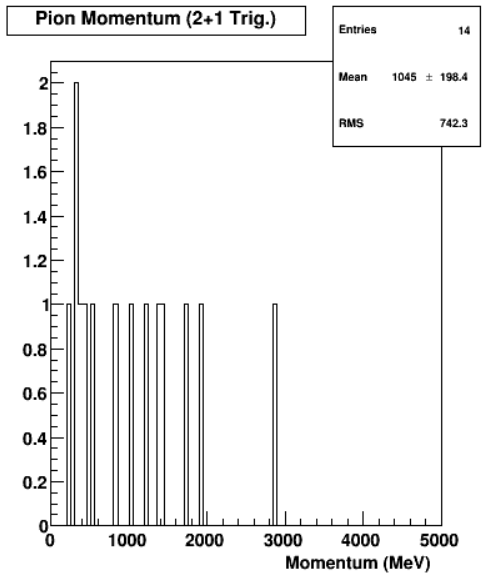


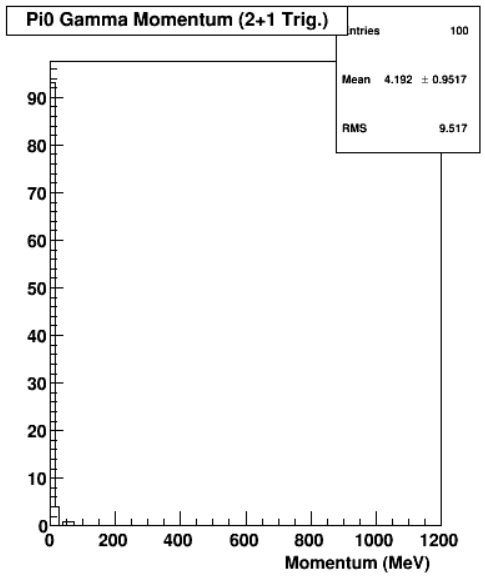
Total no.of tracks incident on the ECAL are categorized in to,

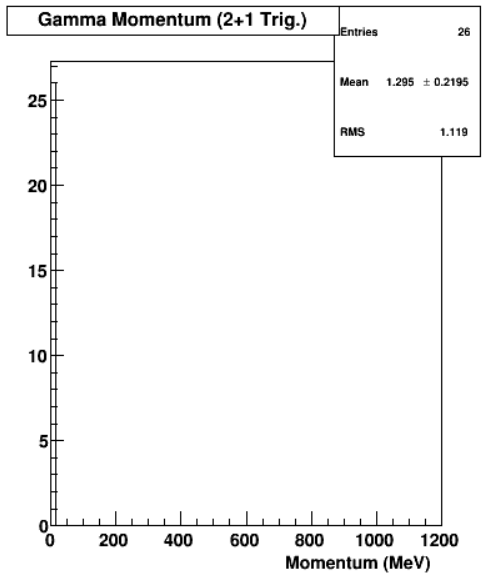
- Secondary electrons
- Pions (+/-)
- Photons from Pi0 simulation
- All other secondary photons

Background on ECAL After 2+1 Trigger





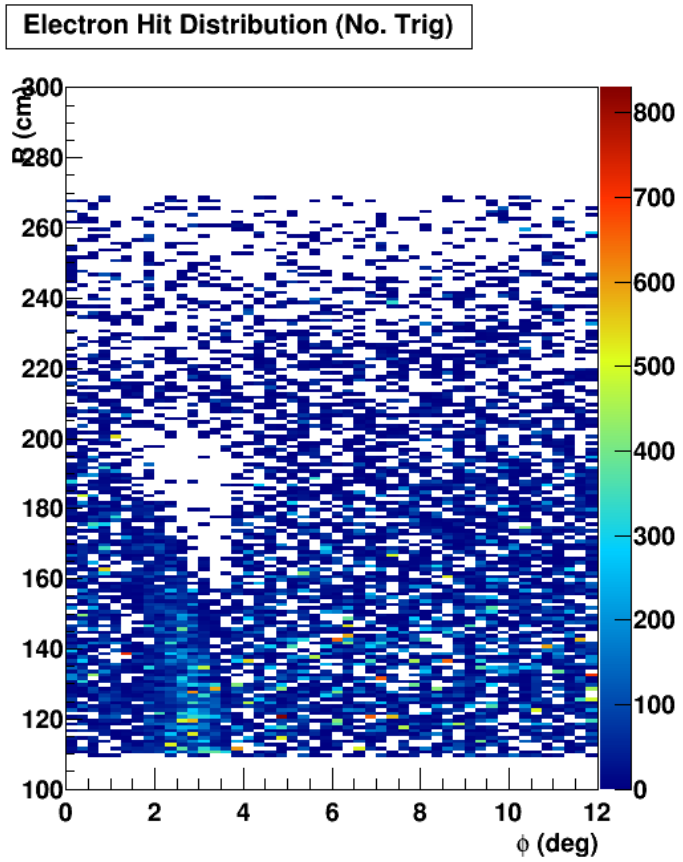


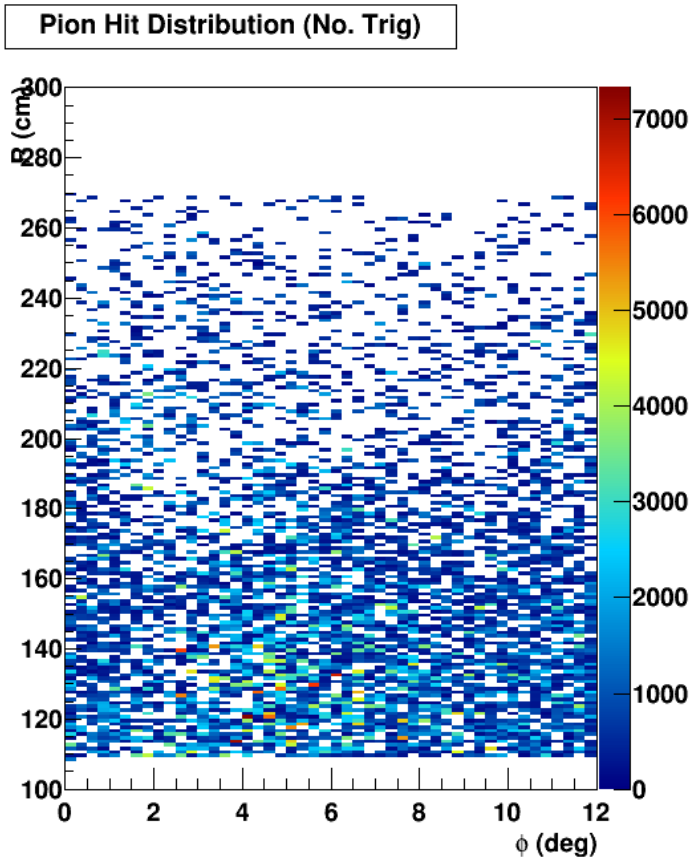


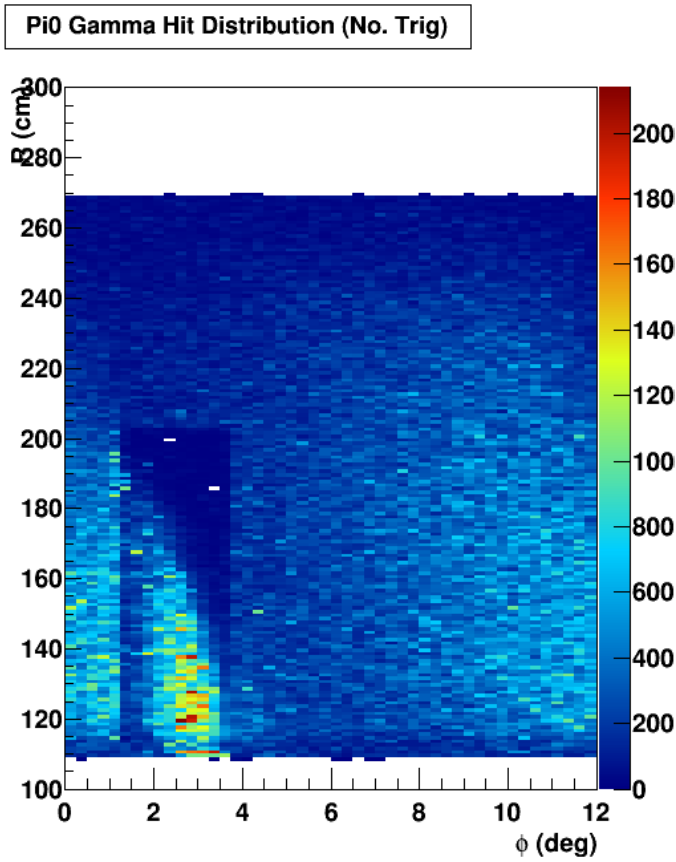
Total no.of tracks incident on the ECAL are categorized in to,

- Secondary electrons
- Pions (+/-)
- Photons from Pi0 simulation
- All other secondary photons

Background Incident on a ECAL Sector

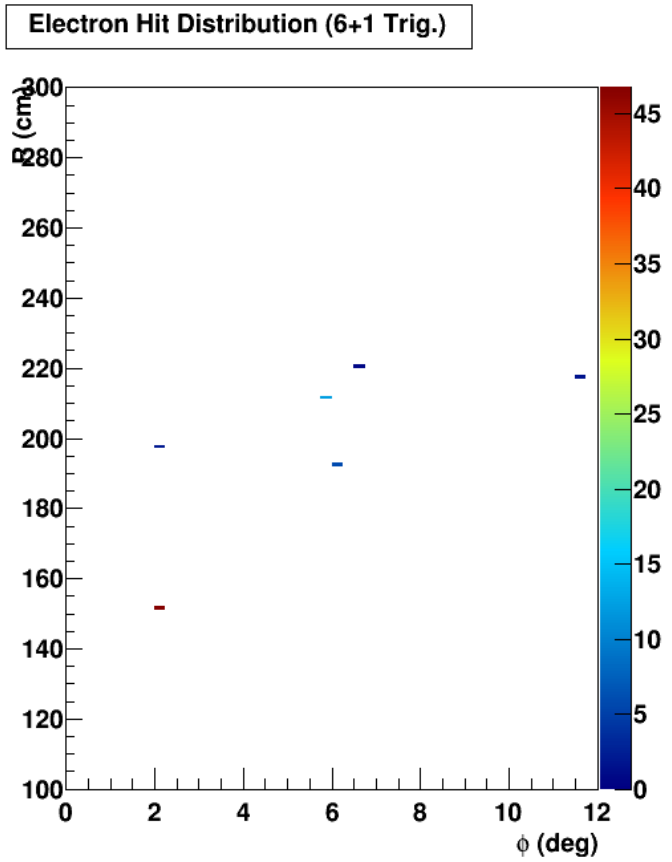


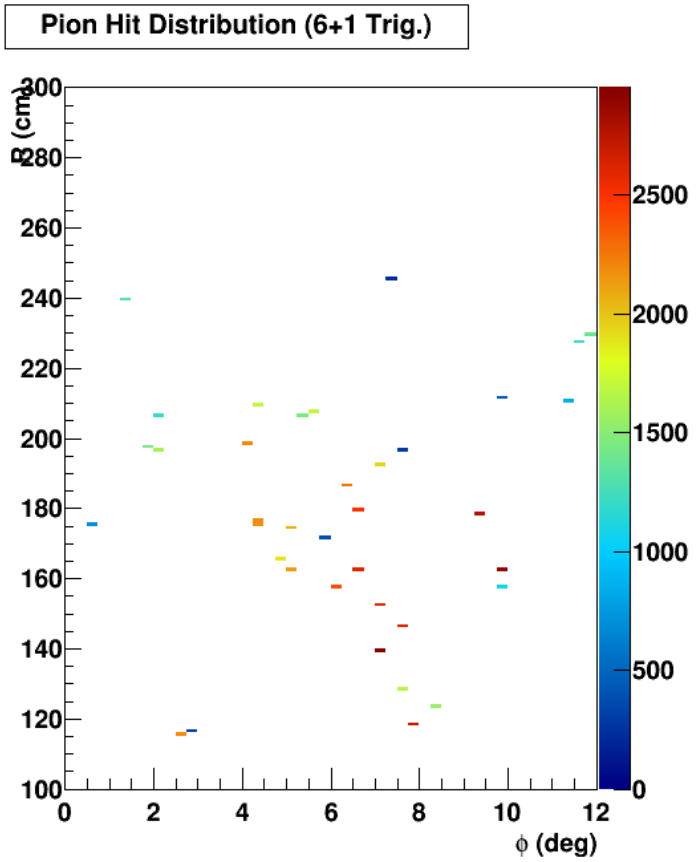


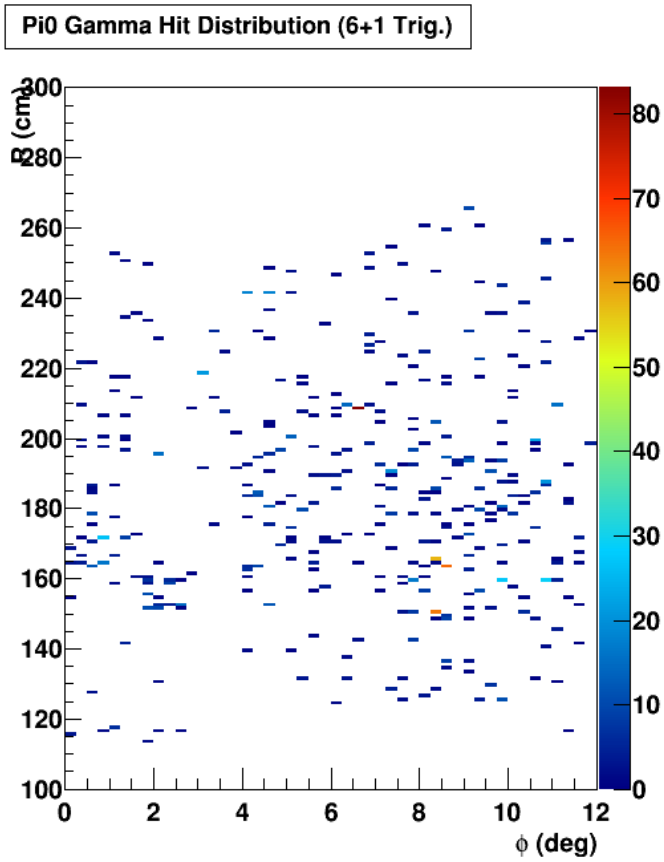


Total no.of tracks incident on the ECAL weighted by incident energy

Background on a ECAL Sector After 6+1 Trigger

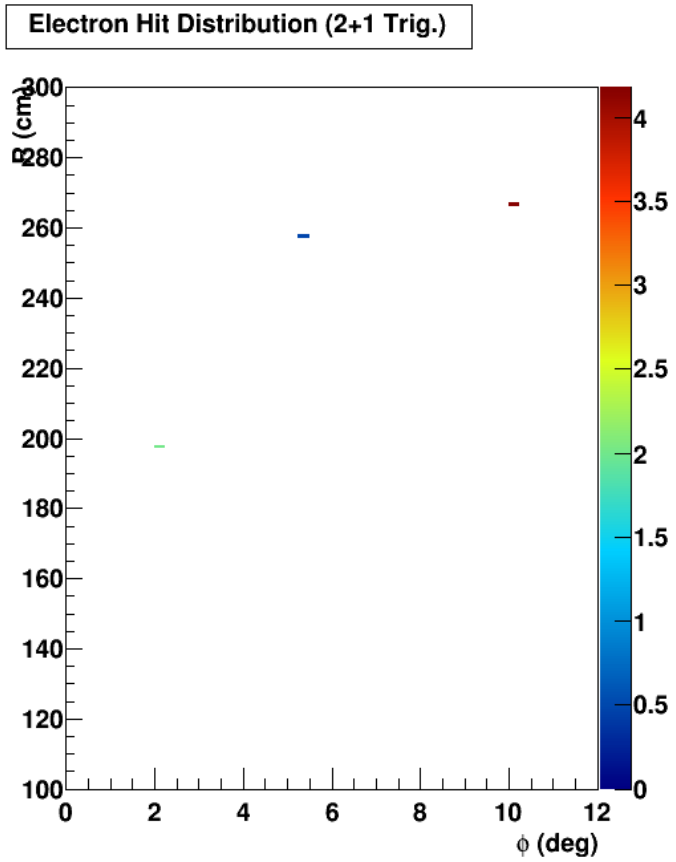


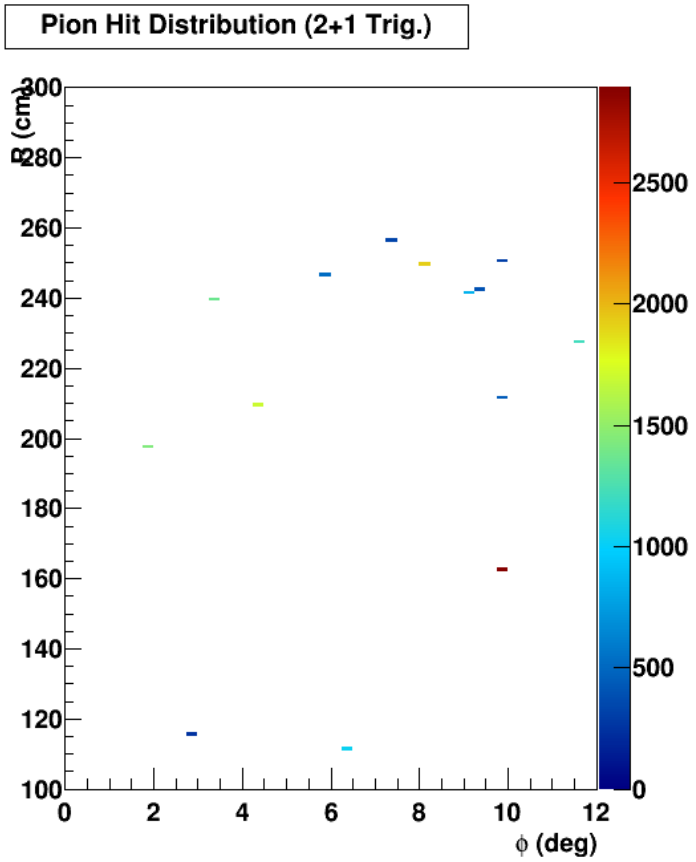


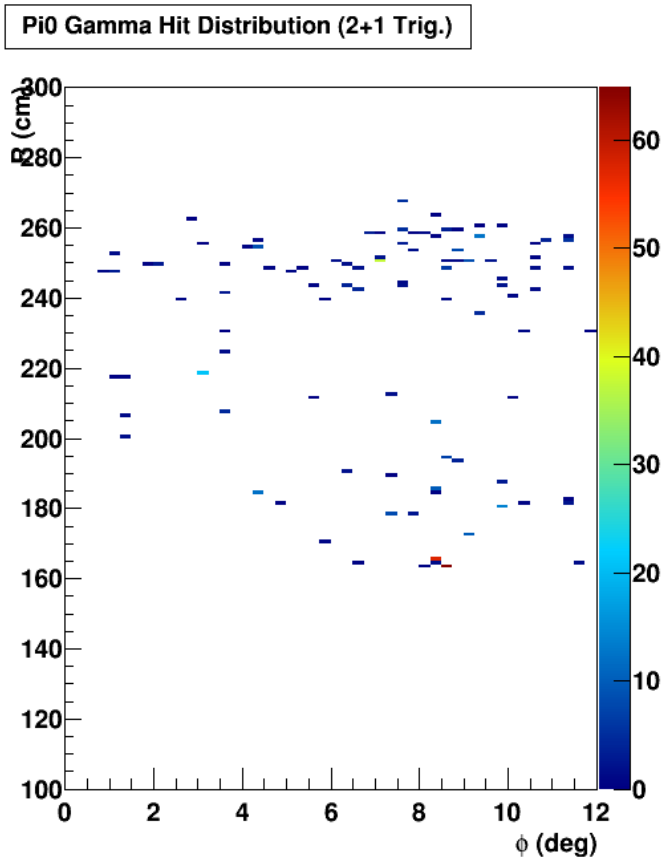


Total no.of tracks incident on the ECAL

Background on a ECAL Sector After 2+1 Trigger







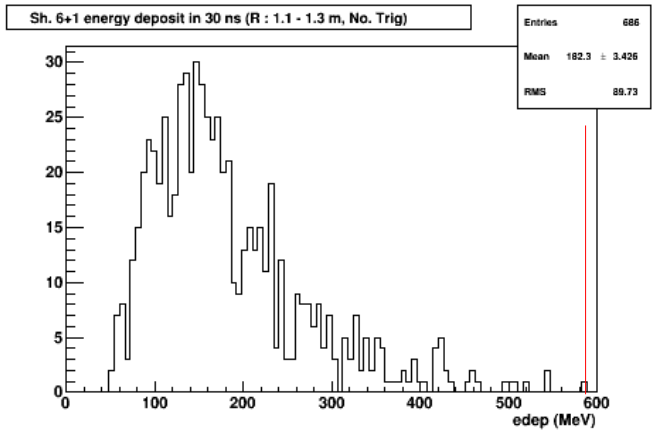
Total no.of tracks incident on the ECAL

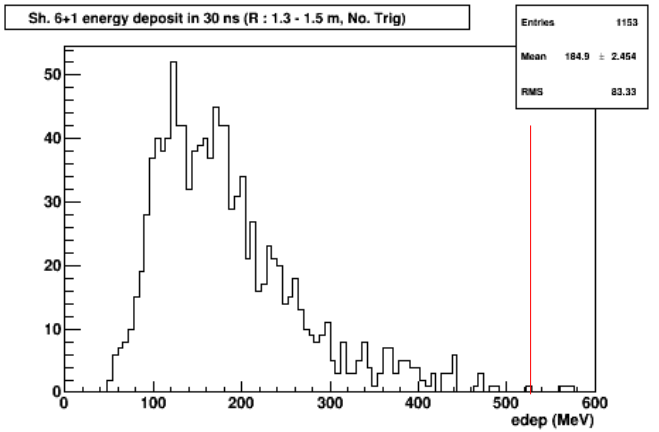
ECAL Energy Deposit per Trigger Window

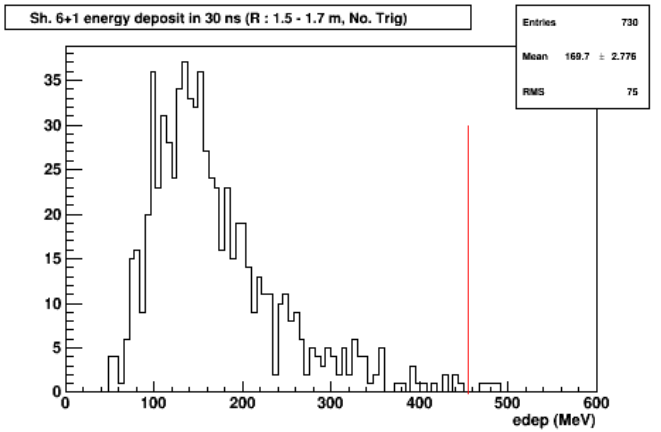
- Backgrounds are generated using uniform generators
- Tracks can be separated in time according to the background rates
- Tracks incident on the ECAL can then be separated to time windows (trigger window is 30 ns)
- Each sector (12 deg) of ECAL is treated independently
- Total time in simulation is 6990 ns or 233 trigger windows

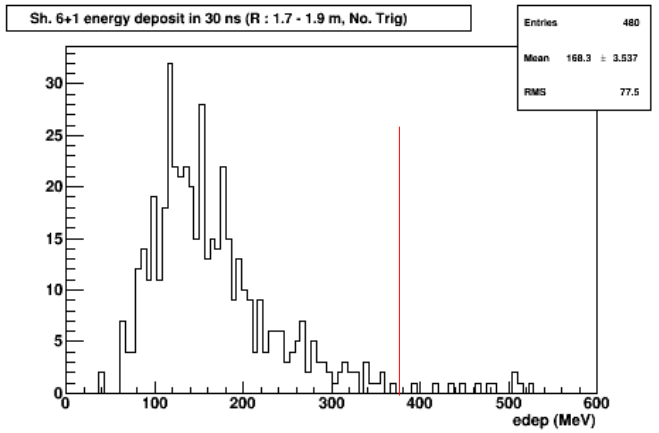
ECAL Shower Energy Deposit

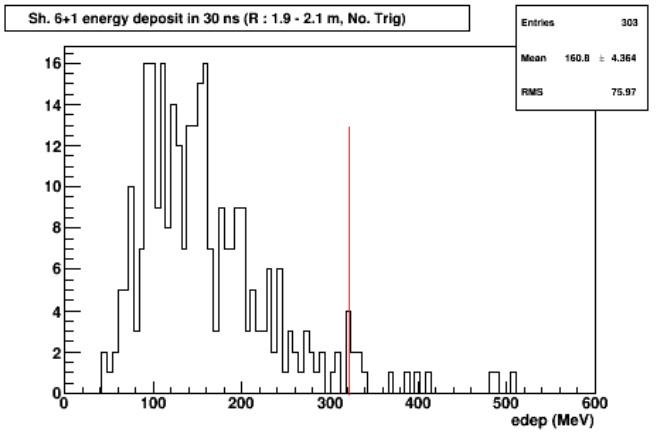
Trigger threshold

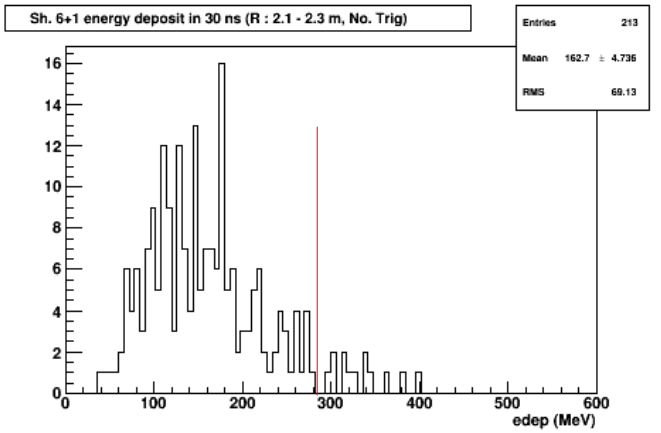


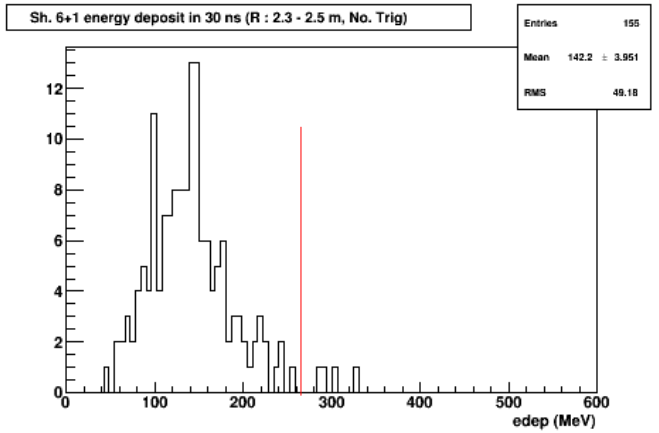


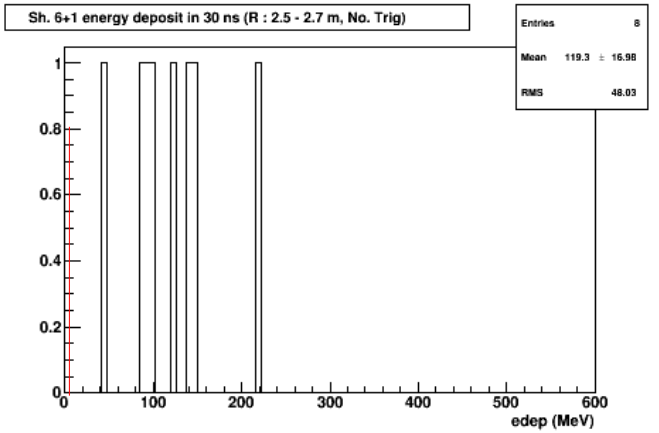


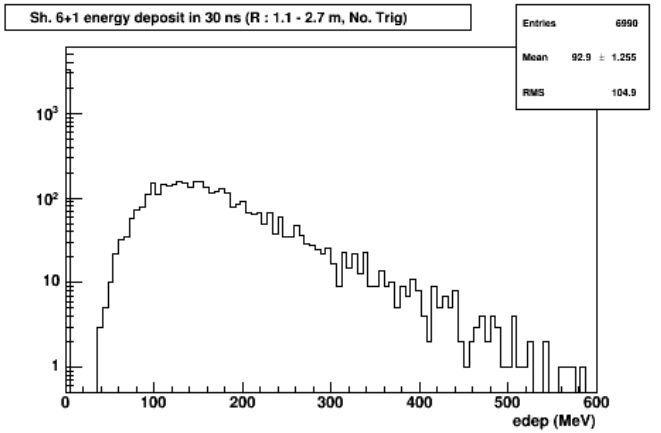






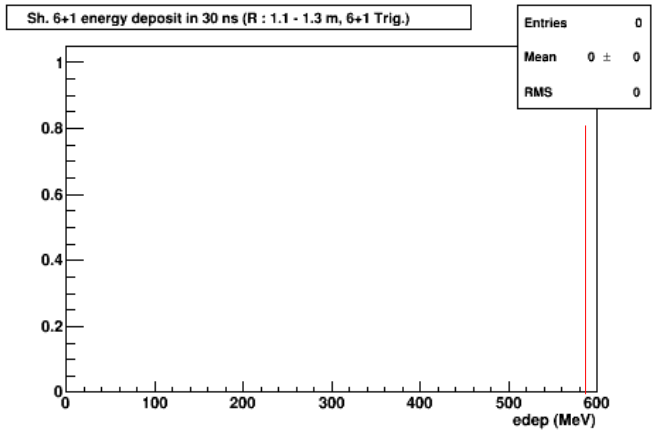


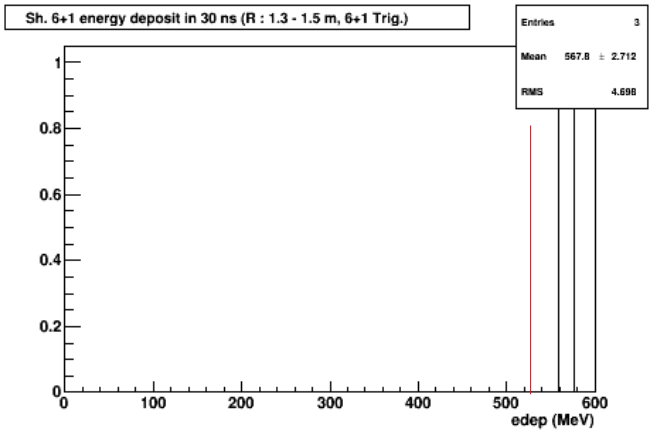


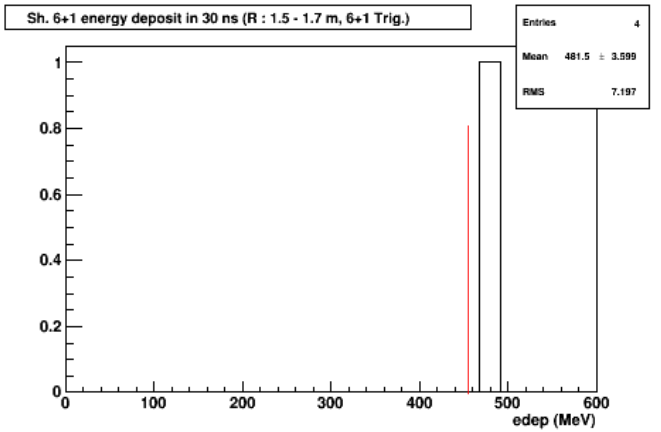


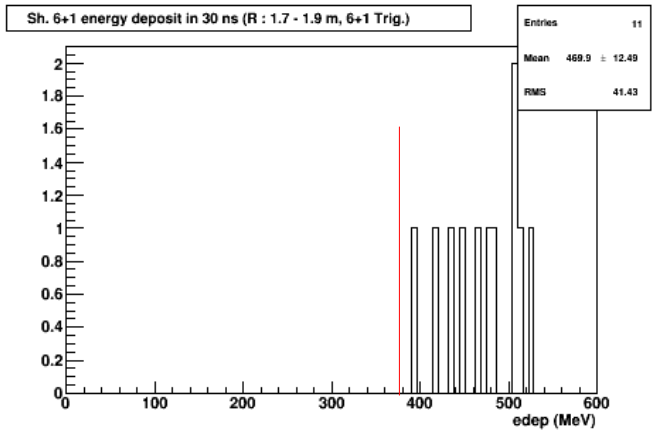
ECAL Shower Energy Deposit after Trigger

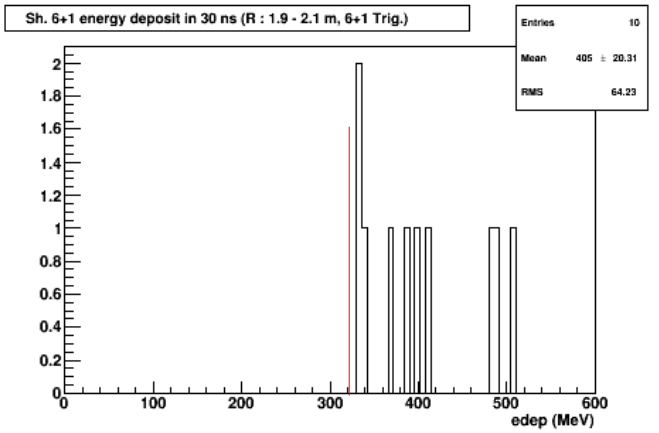
Trigger threshold

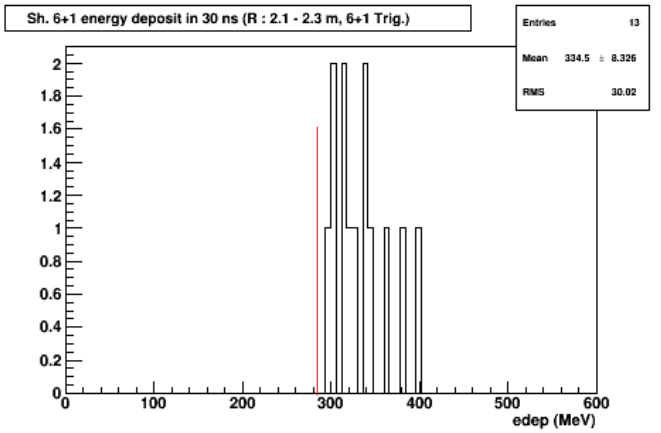


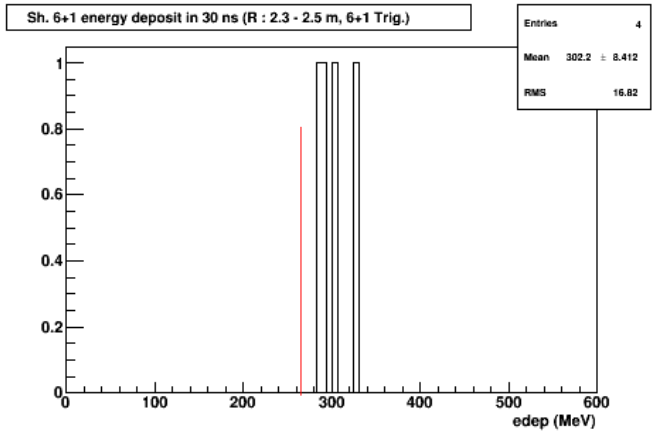


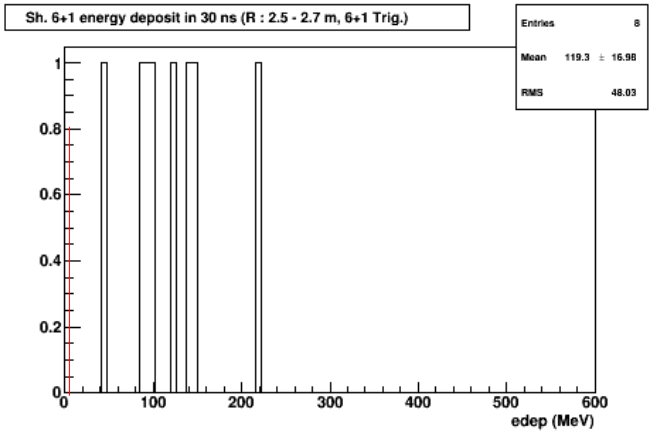


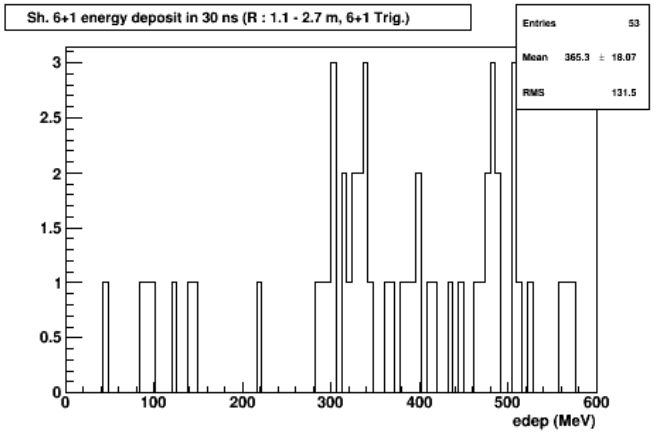




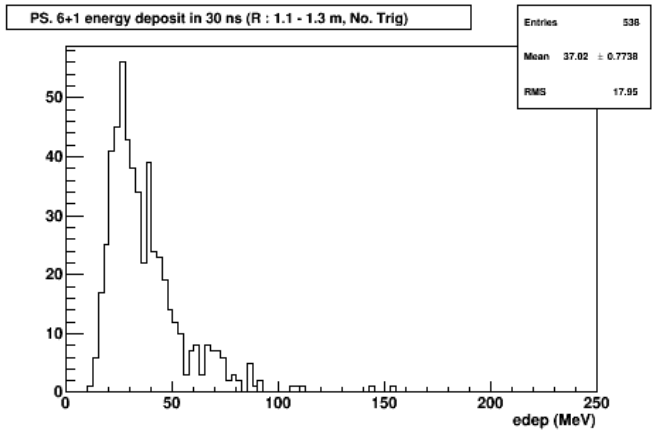


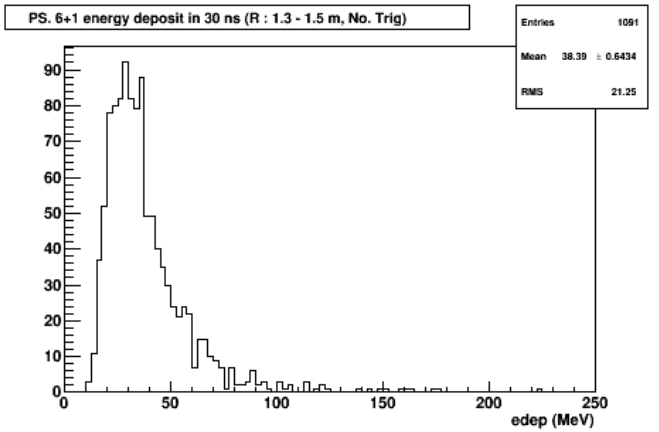


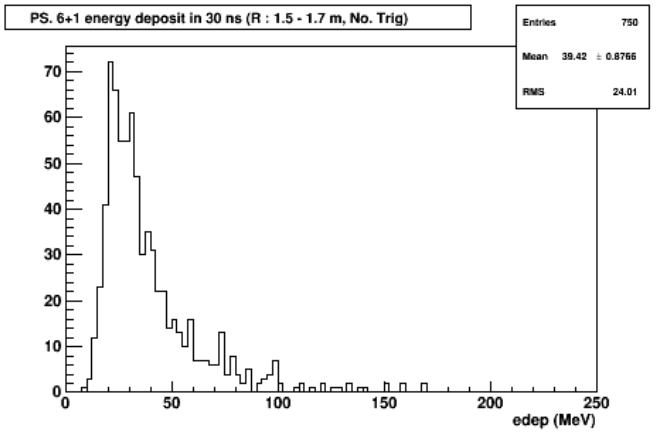


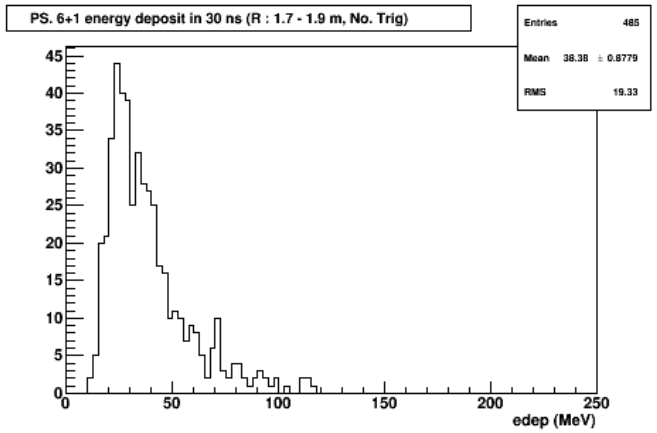


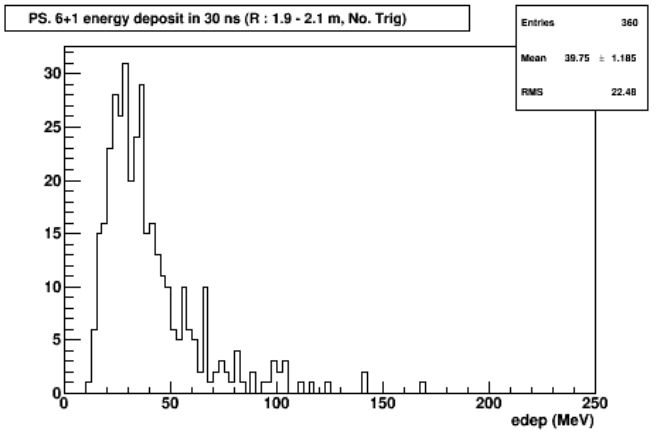
ECAL Pre-Shower Energy Deposit

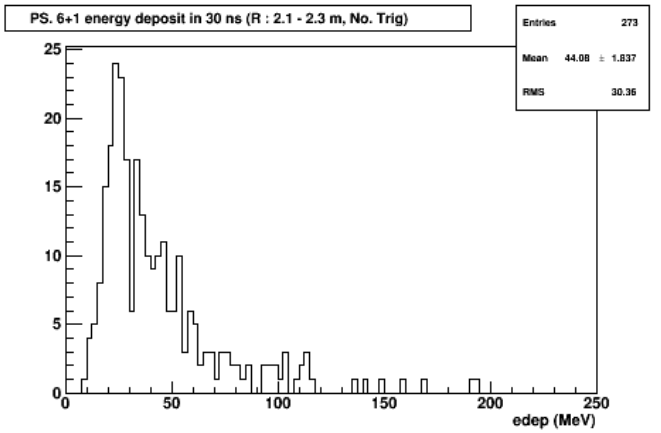


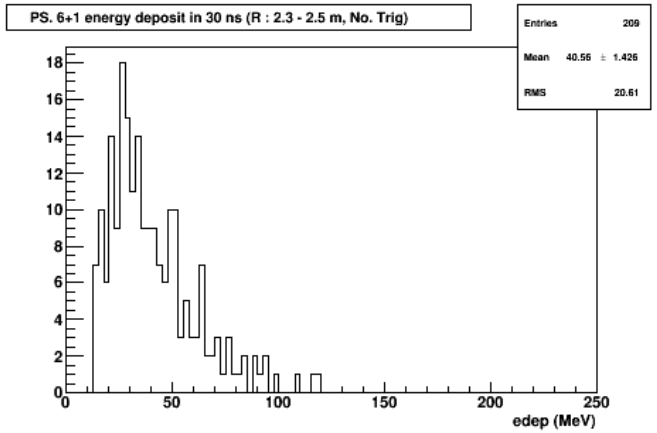


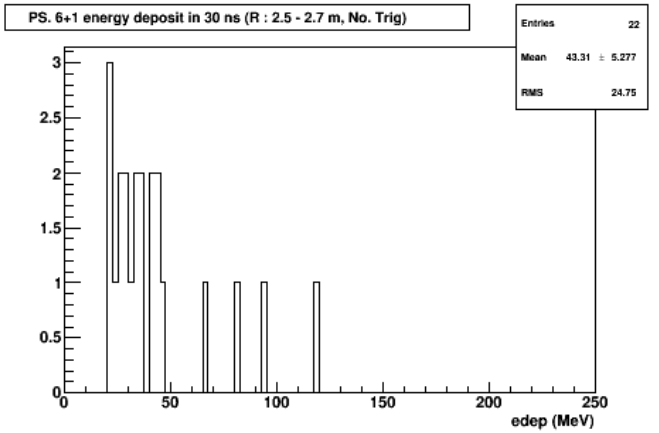


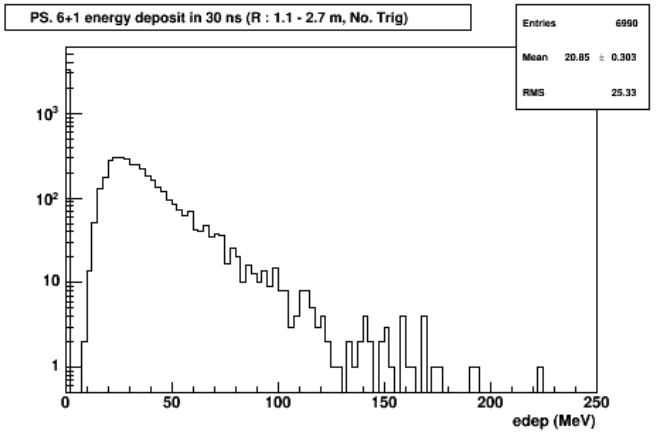




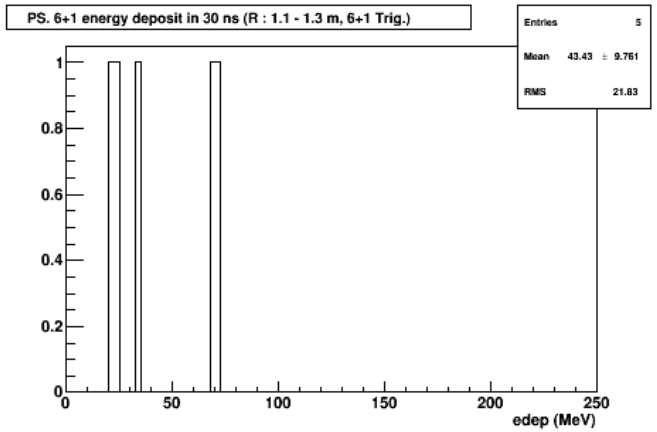


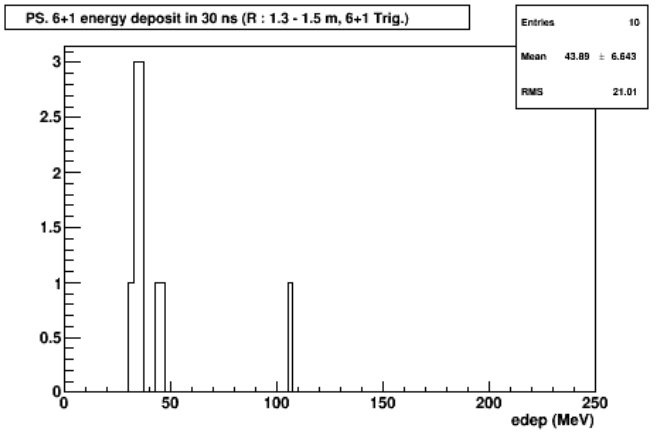


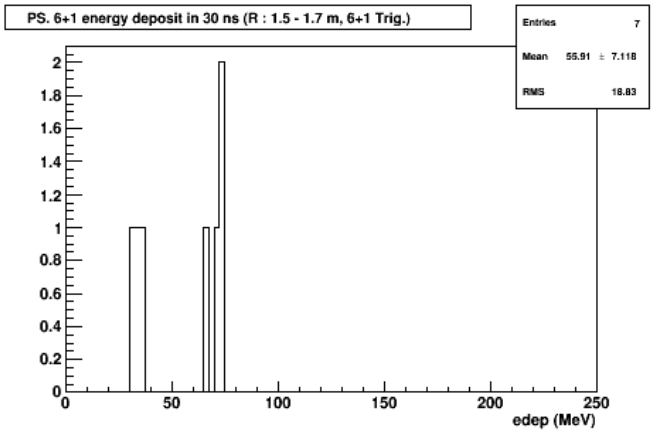


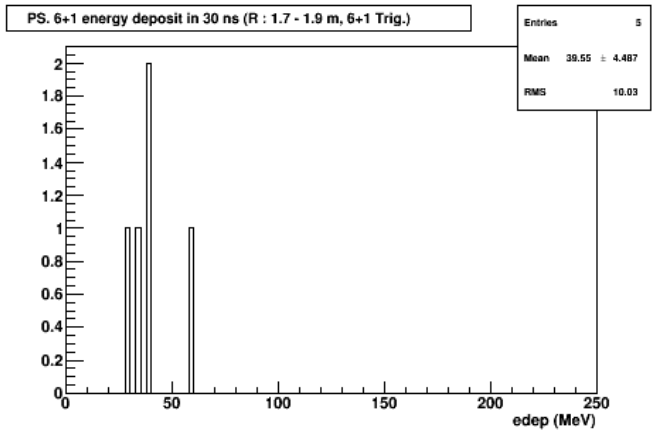


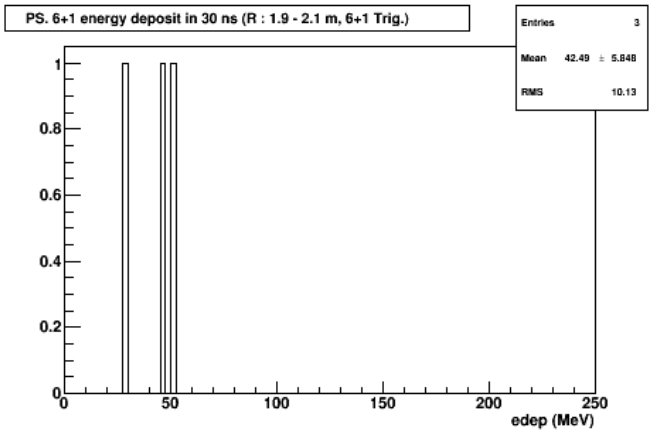
ECAL Pre-Shower Energy Deposit after Trigger

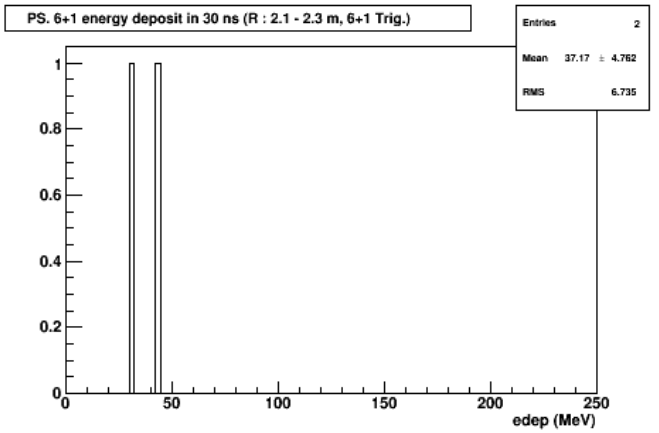


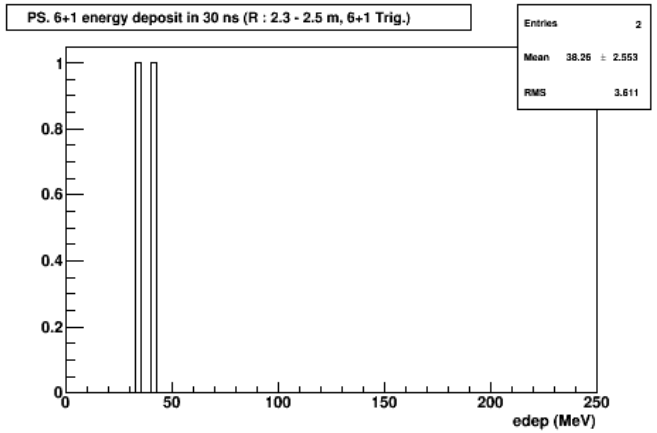


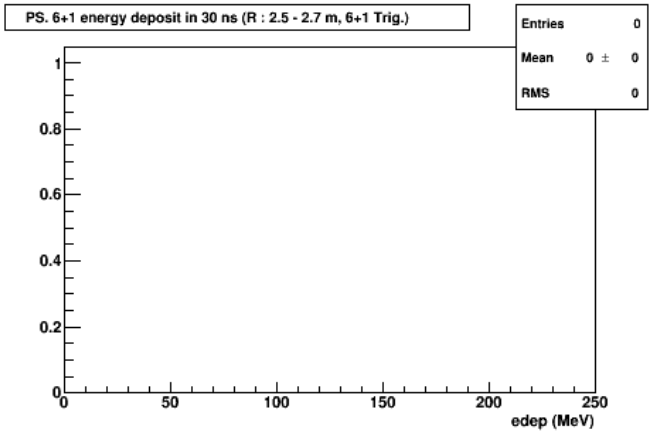


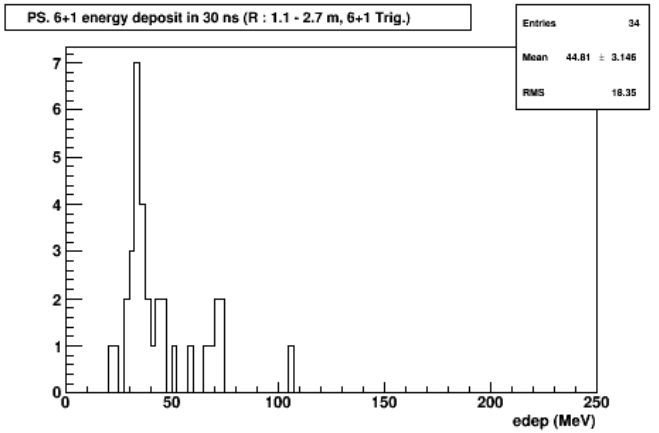












Total Rate Summary

- With the photon blocker
- Photons are separated into two groups
  - From Pi0 and all other secondary photons
  - No high energy gammas after photon blocker
  - Photon rate is mostly dominated by very low energy tracks

All Mom.		Before Trigger	After 6+1 Trigger	After 2+1 Trigger
		(MHz)	(MHz)	(MHz)
	Bkg. e±	1308.2	0.9	0.4
	π±	842.5	5.3	2.0
	γ(π0)	55346.5	49.9	14.3
	all other γ	9104.3	11.4	3.7
P > 1 GeV				
	Bkg. e±	0.0	0.0	0.0
	π±	140.1	4.3	1.0
	γ(π0)	0.3	0.0	0.0
	all other γ	0.0	0.0	0.0
P < 1 GeV				
	Bkg. e±	1308.2	0.9	0.4
	π±	702.4	1.0	1.0
	γ(π0)	55346.2	49.9	14.3
	all other γ	9104.3	11.4	3.7

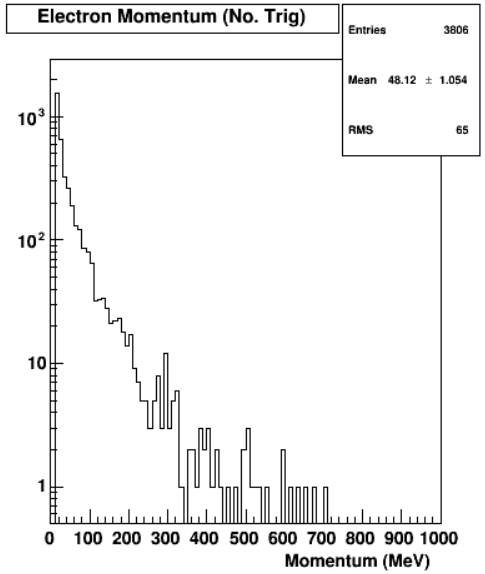
Total Rate Summary

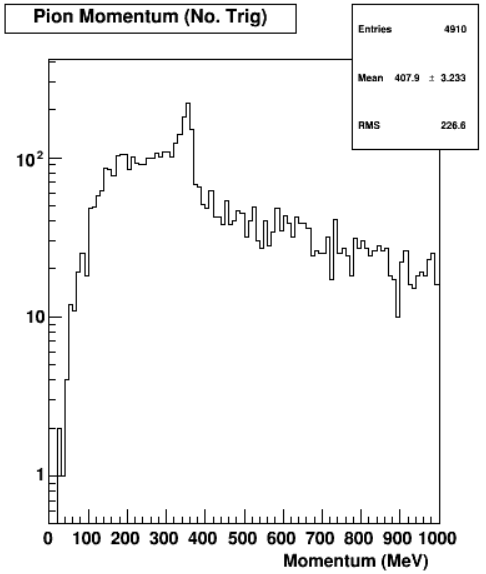
- With the photon blocker
- Photons are separated into two groups
  - From Pi0 and all other secondary photons
  - No high energy gammas after photon blocker
  - Photon rate is mostly dominated by very low energy tracks

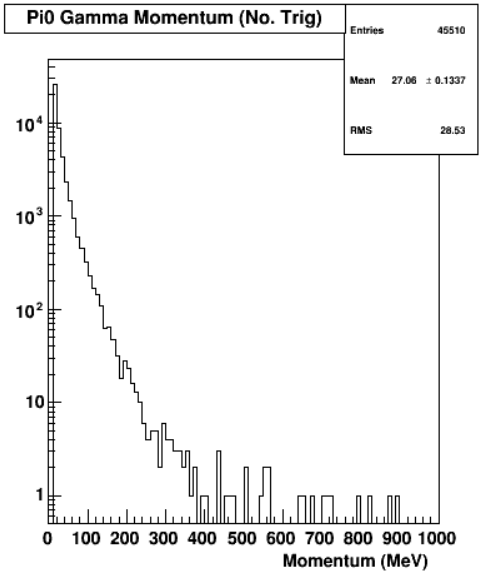
P < 1 GeV		Before Trigger	After 6+1 Trigger	After 2+1 Trigger
		(MHz)	(MHz)	(MHz)
	Bkg. e±	1308.2	0.9	0.4
	π±	702.4	1.0	1.0
	γ(π0)	55346.2	49.9	14.3
	all other γ	9104.3	11.4	3.7
0.01 < P < 1 GeV				
	Bkg. e±	544.5	0.3	0.0
	π±	702.4	1.0	1.0
	γ(π0)	6510.7	5.2	1.3
	all other γ	222.5	0.3	0.0
P < 0.01 GeV				
	Bkg. e±	763.7	0.6	0.4
	π±	0.0	0.0	0.0
	γ(π0)	48835.5	44.8	13.0
	all other γ	8881.8	11.2	3.7

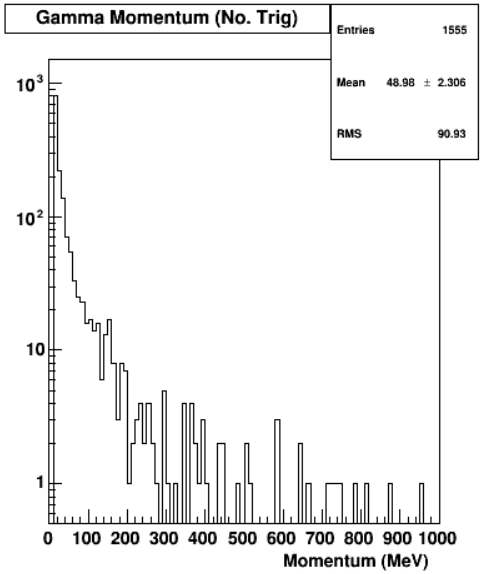
Before Trigger

0.01 < P < 1 GeV momentum range

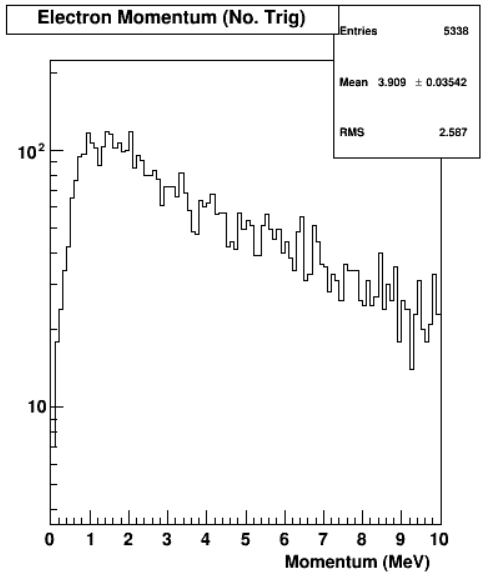


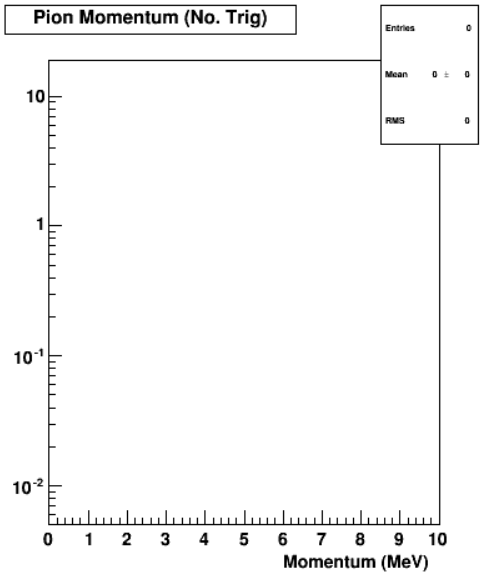


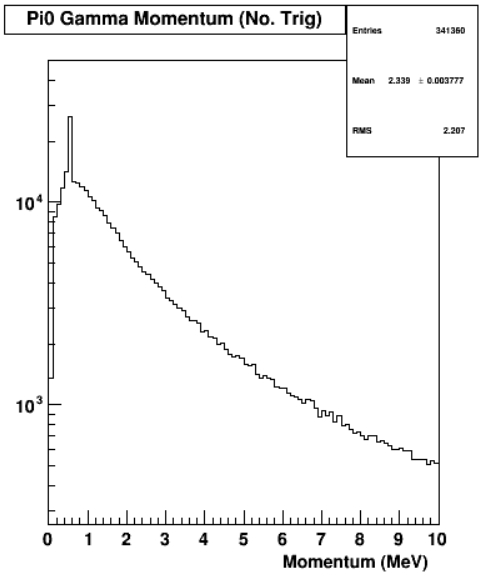


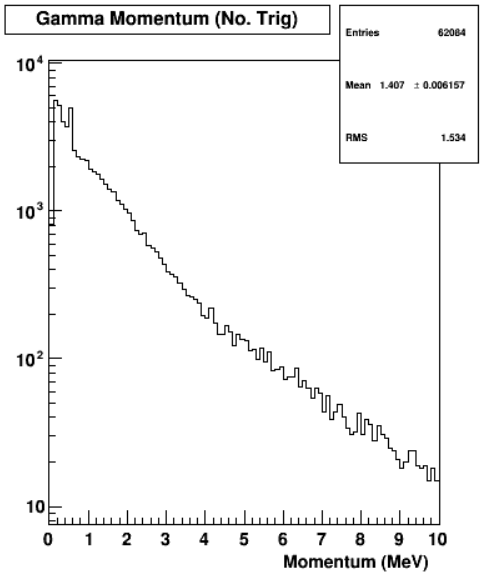


P < 0.01 GeV momentum range



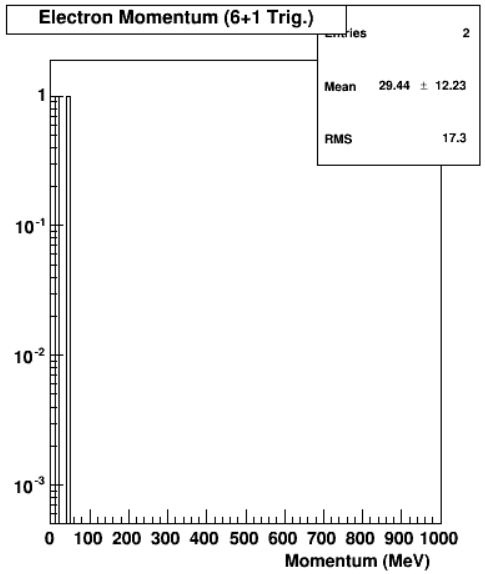


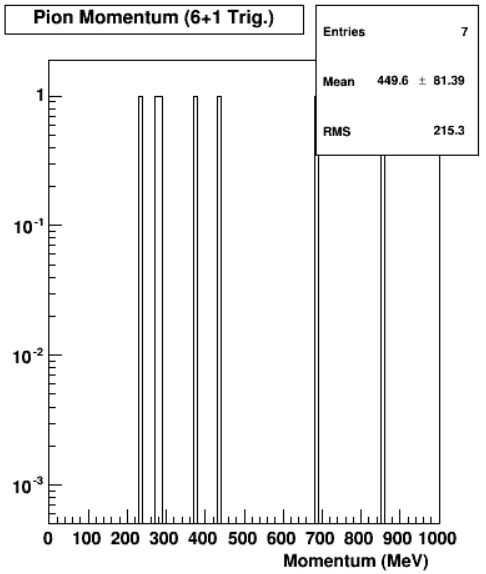


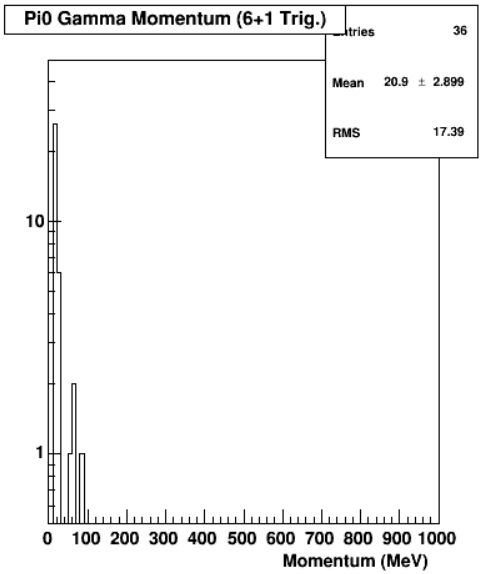


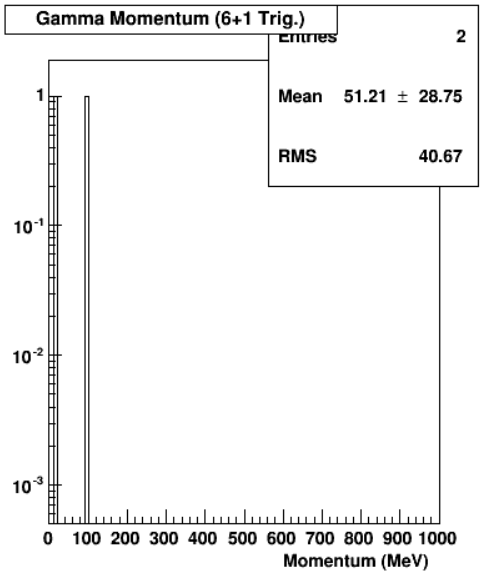
After Trigger

0.01 < P < 1 GeV momentum range

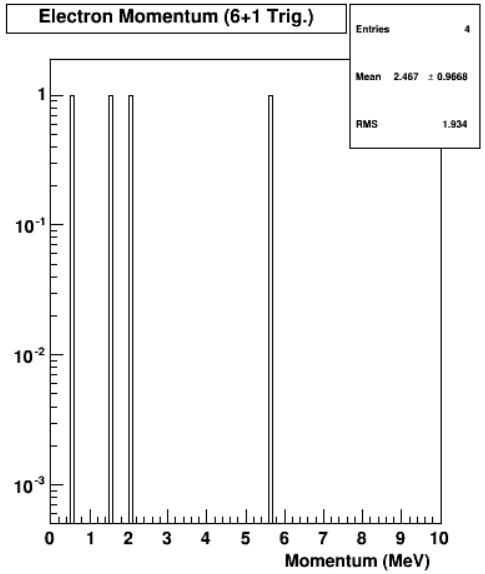


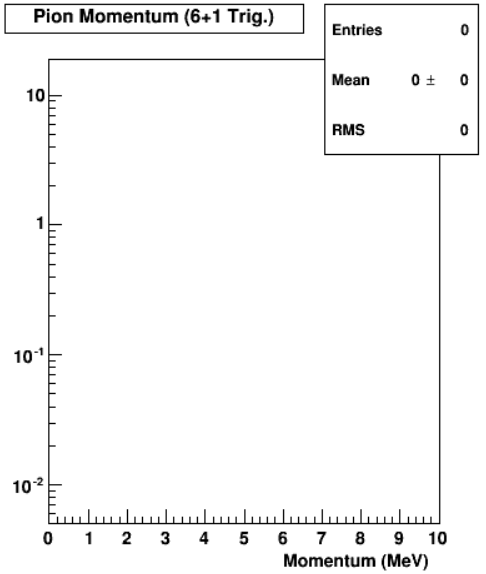


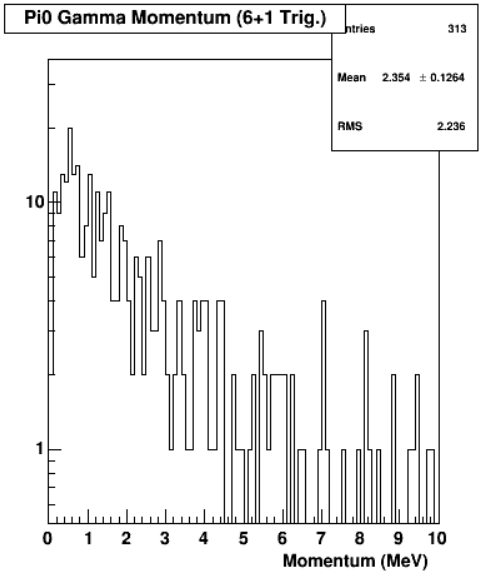


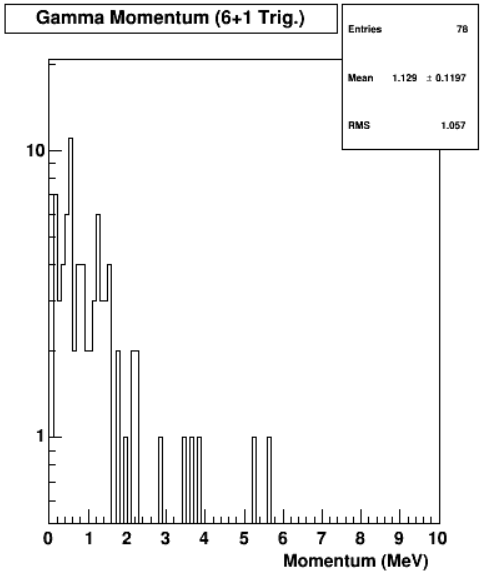


P < 0.01 GeV momentum range









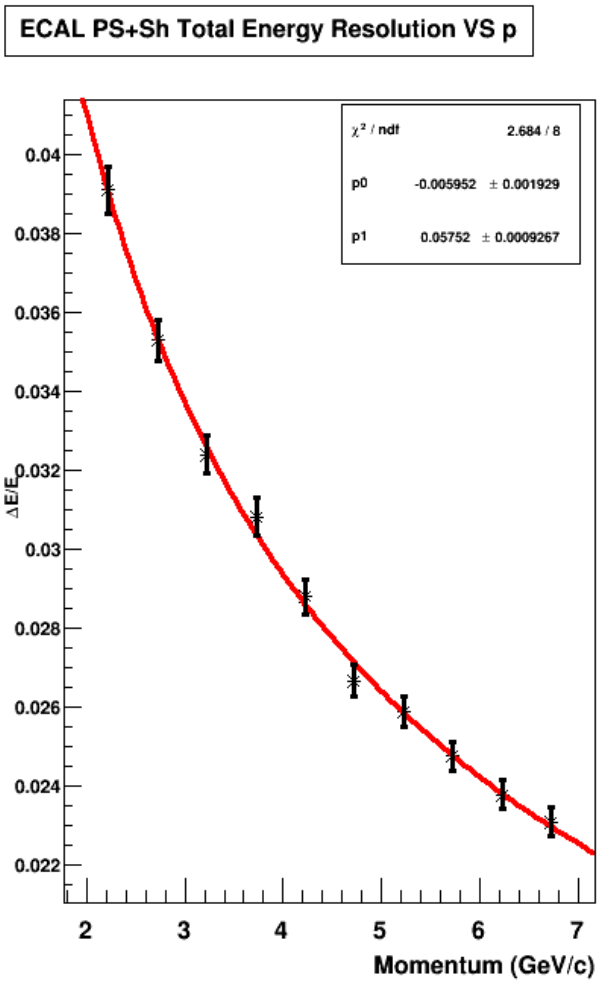
Summary

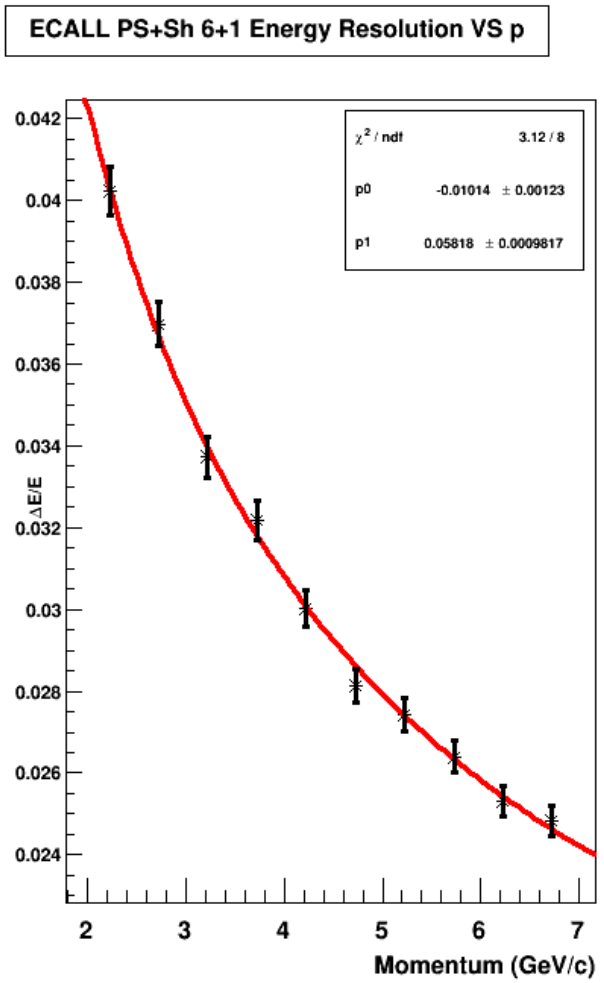
- Trigger rates closely match with Jin's trigger estimates for P > 1 GeV
  - Based on trigger efficiencies from standalone ECAL simulation applied on total background incident on the face of the ECAL
- This study is based on wiser pions incident on the full ECAL :
  - Better estimate than Jin's?
- For P < 1 GeV photons less that 10 MeV contributes a lot to trigger rate
  - Looking in to ways this low energy photon signal could be removed in the trigger level (level 1) itself
  - Using hit timing information for level 1 trigger will be helpful
- **Pre-Shower is still available for triggering**

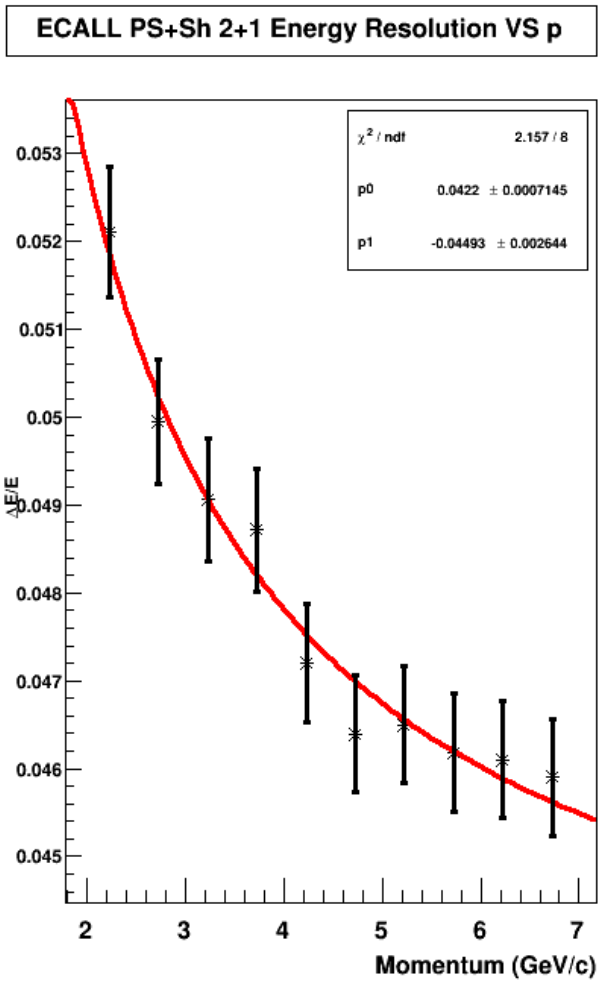
Summary

- 2+1 cluster triggering can further reduce the background by a factor of 4 for P > 1 GeV and A factor of 3 for P < 1 GeV
  - Two fold reduction from
    - Trigger threshold : less energy deposit per 2+1 cluster
    - Area of the cluster : less area in 2+1 cluster → fewer backgrounds tracks
- But going to 2+1 clusters, we will loose in energy resolution
- Could only use 2+1 for triggering but save 6+1 cluster for offline analysis?

Shower Energy Resolution with No Backgrounds







Shower Energy Resolution with No Backgrounds

From Total Energy on ECAL		
Pf (GeV)	Res (%)	Error (%)
2.23	0.039	0.00058
2.73	0.035	0.00053
3.23	0.032	0.00048
3.73	0.031	0.00046
4.23	0.029	0.00043
4.73	0.027	0.00040
5.23	0.026	0.00039
5.73	0.025	0.00038
6.23	0.024	0.00036
6.73	0.023	0.00035

From 6+1 Clusters		
Pf (GeV)	Res (%)	Error (%)
2.23	0.040	0.00059
2.73	0.037	0.00054
3.23	0.034	0.00049
3.73	0.032	0.00047
4.23	0.030	0.00044
4.73	0.028	0.00041
5.23	0.027	0.00040
5.73	0.026	0.00039
6.23	0.025	0.00037
6.73	0.025	0.00037

From 2+1 Clusters		
Pf (GeV)	Res (%)	Error (%)
2.23	0.052	0.00074
2.73	0.050	0.00071
3.23	0.049	0.00070
3.73	0.049	0.00070
4.23	0.047	0.00067
4.73	0.046	0.00066
5.23	0.047	0.00066
5.73	0.046	0.00067
6.23	0.046	0.00066
6.73	0.046	0.00066

Total Rate Summary

- **With no photon blocker**
- Photons are separated into two groups
  - From Pi0 and all other secondary photons
  - No high energy gammas after photon blocker
  - Photon rate is mostly dominated by very low energy tracks

All Mom.		Before Trigger	After 6+1 Trigger	After 2+1 Trigger
		(MHz)	(MHz)	(MHz)
	Bkg. e±	1754.4	6.7	1.2
	π±	971.5	12.8	2.3
	γ(π0)	77458.4	237.4	51.1
	all other γ	10627.3	26.0	7.2
P > 1 GeV				
	Bkg. e±	0.8	0.0	0.0
	π±	163.4	8.4	1.6
	γ(π0)	36.0	3.0	0.9
	all other γ	0.3	0.0	0.0
P < 1 GeV				
	Bkg. e±	1753.6	6.7	1.2
	π±	808.1	4.4	0.8
	γ(π0)	77422.4	234.4	50.2
	all other γ	10626.9	26.0	7.2

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  - From Pi0 and all other secondary photons
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  - Photon rate is mostly dominated by very low energy tracks

P < 1 GeV		Before Trigger	After 6+1 Trigger	After 2+1 Trigger
		(MHz)	(MHz)	(MHz)
	Bkg. e±	1753.6	6.7	1.2
	π±	808.1	4.4	0.8
	γ(π0)	77422.4	234.4	50.2
	all other γ	10626.9	26.0	7.2
0.01 < P < 1 GeV				
	Bkg. e±	760.6	3.6	0.8
	π±	808.1	4.4	0.8
	γ(π0)	11614.2	44.7	12.2
	all other γ	248.6	0.6	0.2
P < 0.01 GeV				
	Bkg. e±	993.0	3.1	0.5
	π±	0.0	0.0	0.0
	γ(π0)	65808.3	189.7	38.0
	all other γ	10378.3	25.4	7.0