Status of Reconstruction in sidloi3

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5/20/10

Outline

- What is sidloi3
- PFA changes
- Comparisons to sid02

sidloi3

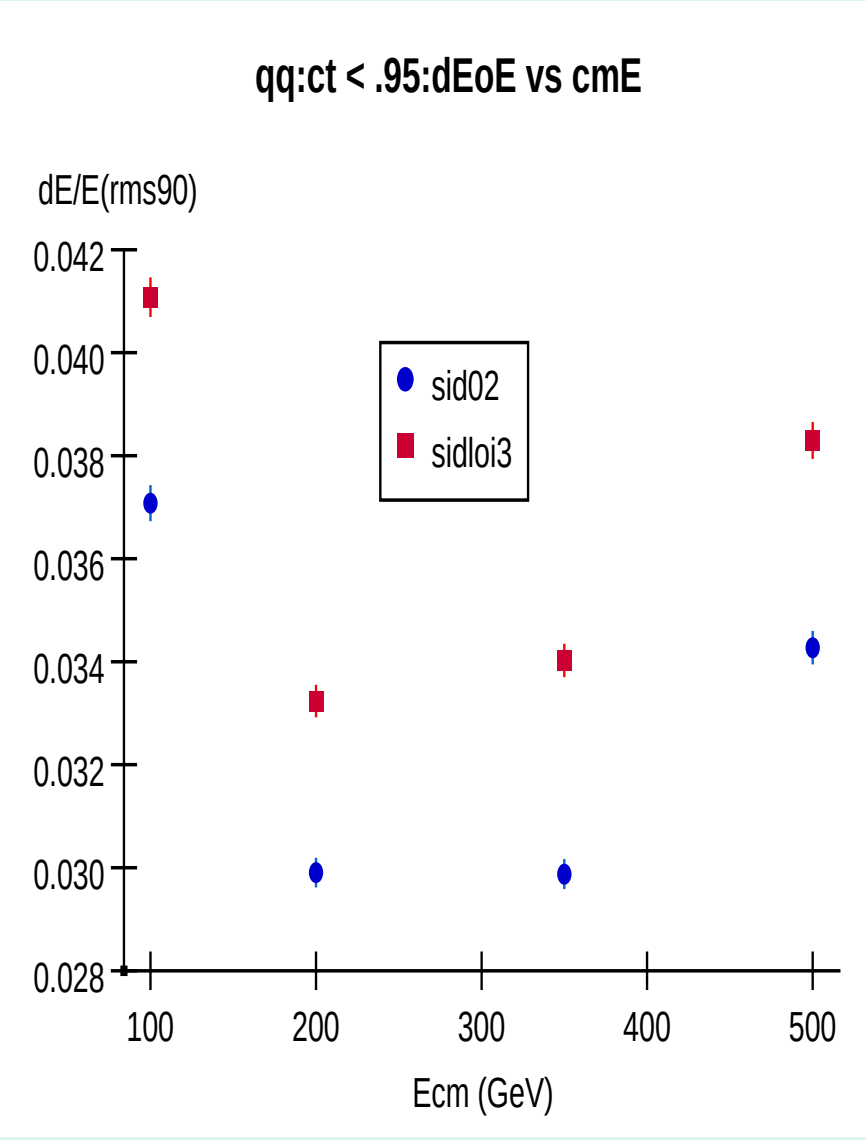
- EcalBarrel - 12 overlapping staves, some tiny dead areas at borders.
- EcalEndcap – 12 sided polyhedron, no module borders.
- Ecal – 31 layers, extra 250 micron air gap per layer, 44mm gap between B and EC.
- HcalBarrel – 12 modules, 40 layers, some empty areas at module borders.
- HcalEndcap – 12 sided polyhedron, no module borders, 45 layers.
- MuonBarrel – 8 modules, some empty areas at module borders.
- MuonEndcap – 8 sided polyhedron, no module borders.
- Hadronic interaction model in G4 changed from sid02 runs.
- Detector modified to make gaps as in loi drawings, although still empty (air). I have not looked at this data yet, so all plots in this presentation are from detector as described.

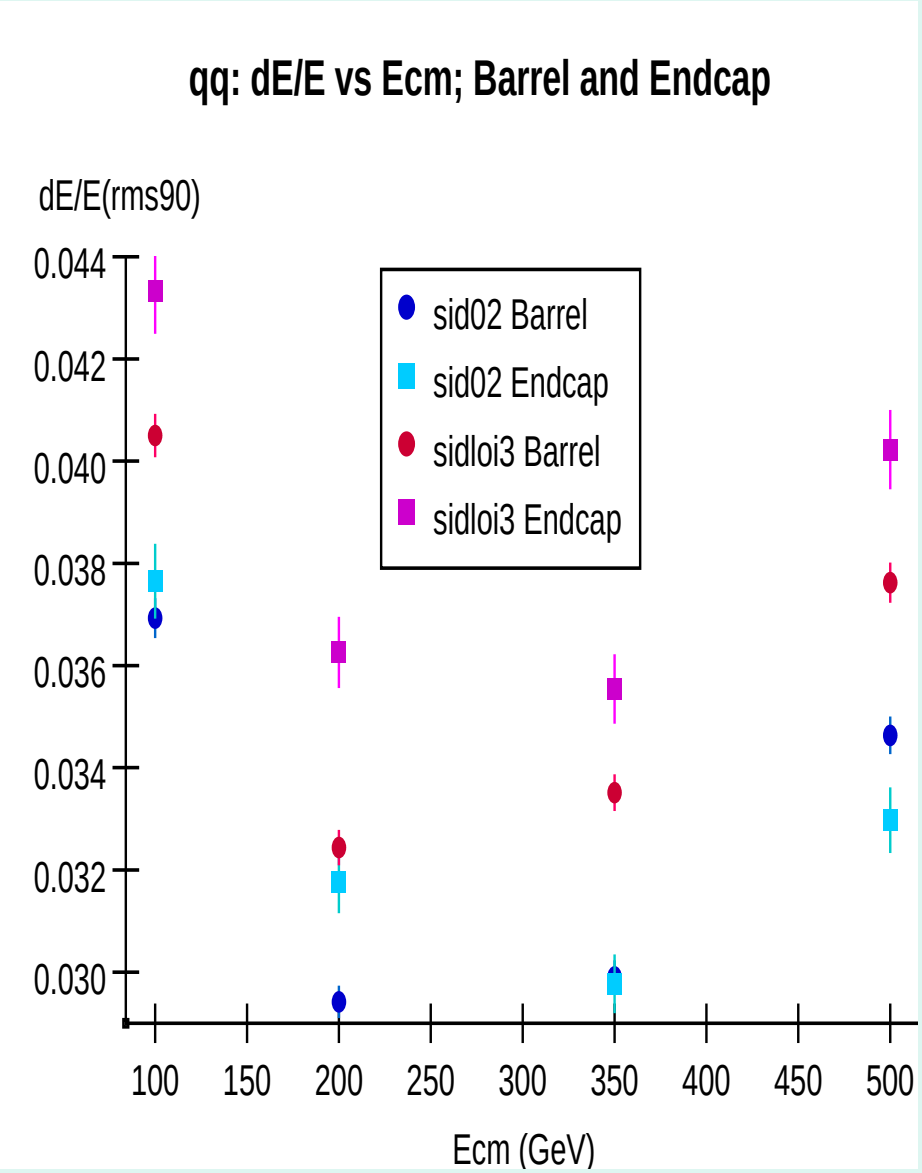
Code changes

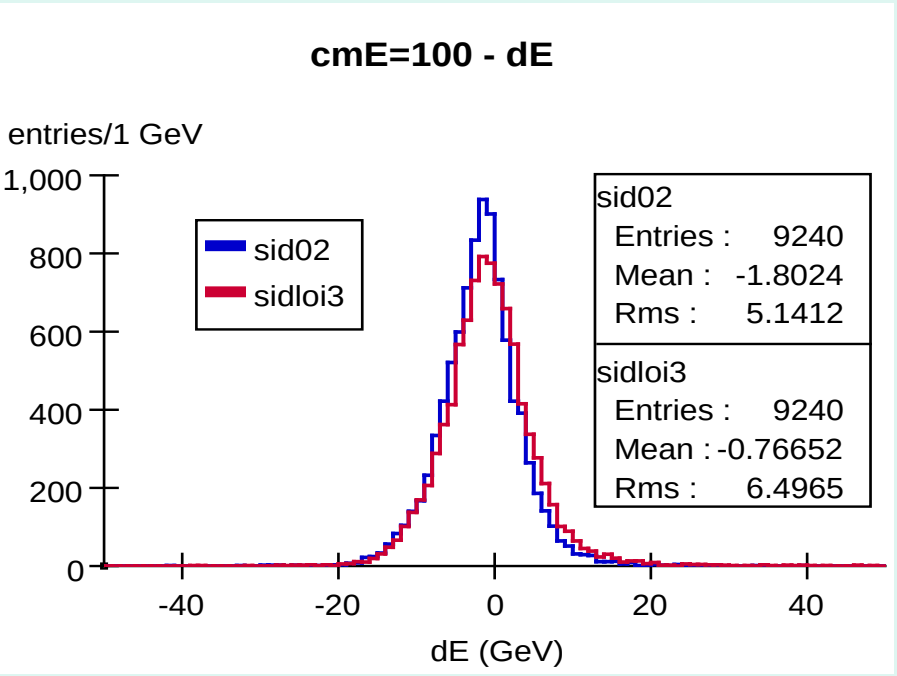
- Neighboring capability of hit implemented for the new calorimeters.
- Access to calorimeter information implemented. (collection names, geometry, detector ID, etc.)
- Dual use of “layer” addressed: when intent is depth in calorimeter, use Vlayer instead.
- Track extrapolation.
- Attempted to make all changes backward compatible: no degradation in sid02 reconstruction.

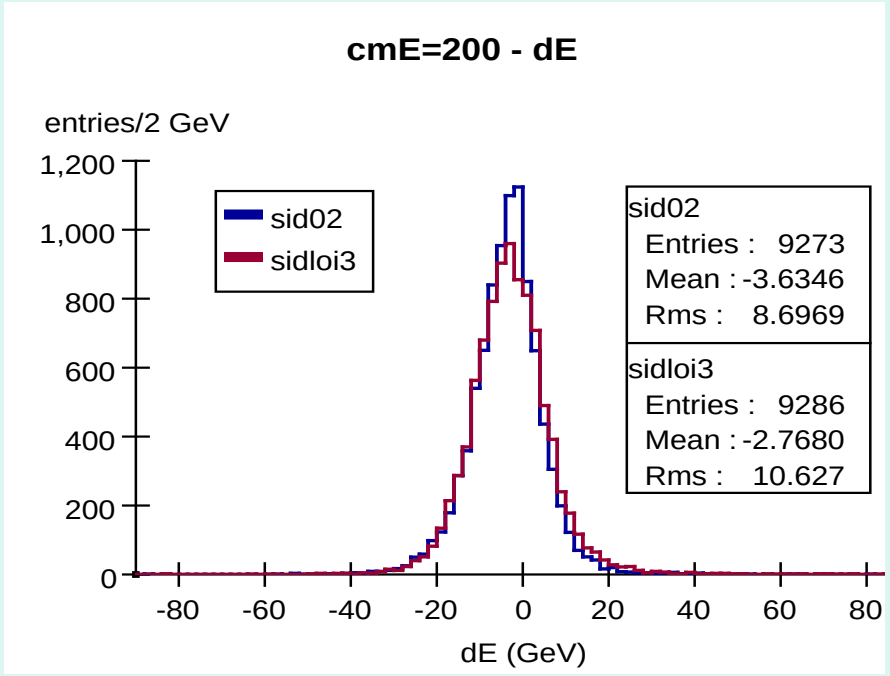
Comparisons to sid02

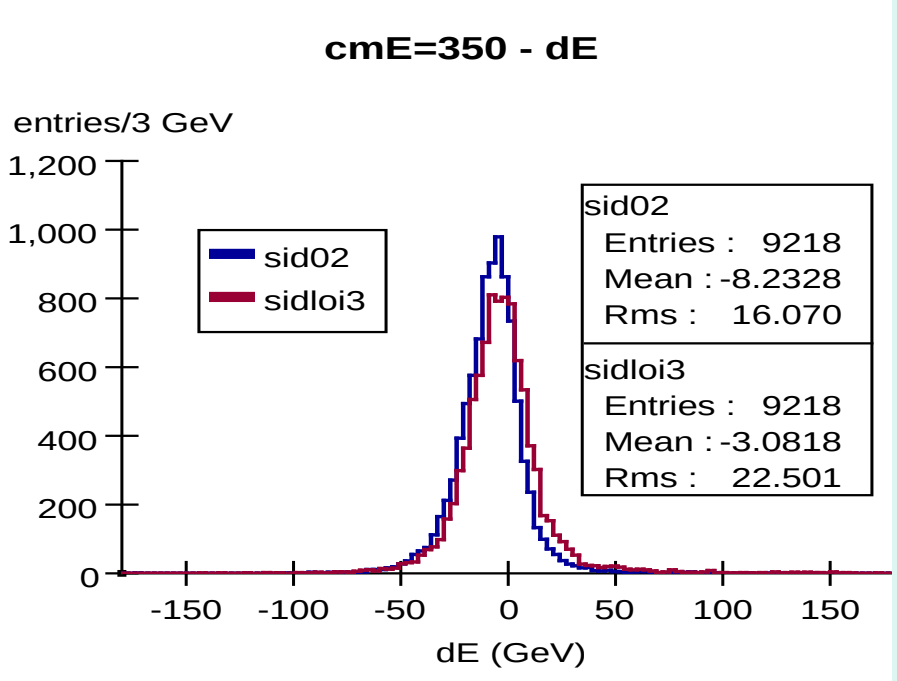
- Event energy resolution in qqbar events at fixed energy.
- Mass resolution in Z(qq)Z(nunu) events.
- Calorimeter only resolutions.
- Single particles.

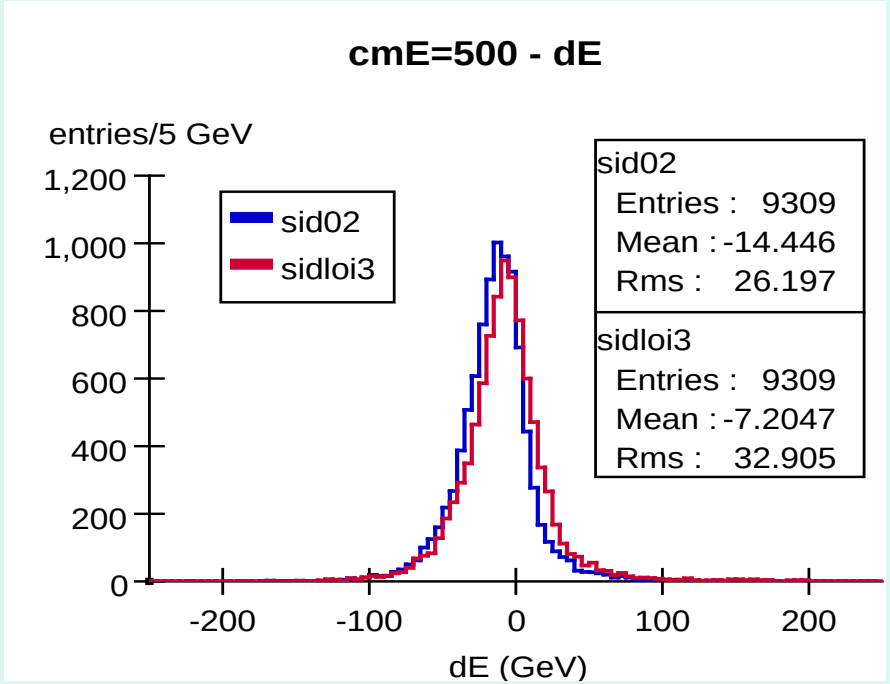

qq:ct < .95:dEoE vs cmE
dE/E(rms90)
0.042
0.040
0.038
0.036
0.034
0.032
0.030
0.028
sid02
sidloi3
100
200
300
400
500
Ecm (GeV)


qq: dE/E vs Ecm; Barrel and Endcap
dE/E(rms90)
0.044
0.042
0.040
0.038
0.036
0.034
0.032
0.030
sid02 Barrel
sid02 Endcap
sidloi3 Barrel
sidloi3 Endcap
100
150
200
250
300
350
400
450
500
Ecm (GeV)


cmE=100 - dE
entries/1 GeV
sid02
sidloi3
sid02
Entries : 9240
Mean : -1.8024
Rms : 5.1412
sidloi3
Entries : 9240
Mean : -0.76652
Rms : 6.4965
dE (GeV)


cmE=200 - dE
entries/2 GeV
sid02
sidloi3
sid02
Entries : 9273
Mean : -3.6346
Rms : 8.6969
sidloi3
Entries : 9286
Mean : -2.7680
Rms : 10.627
dE (GeV)

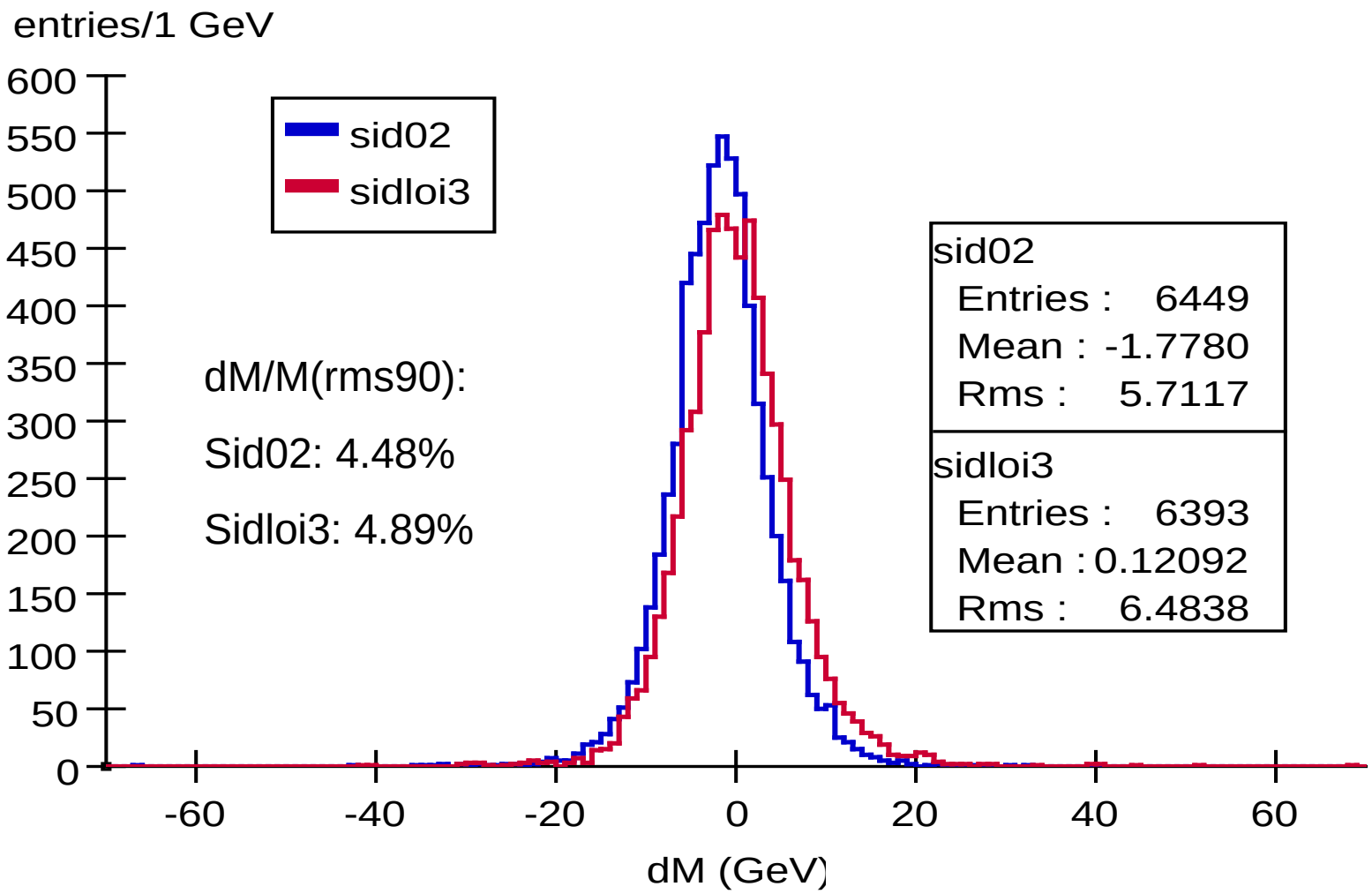

cmE=350 - dE
entries/3 GeV
sid02
sidloi3
sid02
Entries : 9218
Mean : -8.2328
Rms : 16.070
sidloi3
Entries : 9218
Mean : -3.0818
Rms : 22.501
dE (GeV)

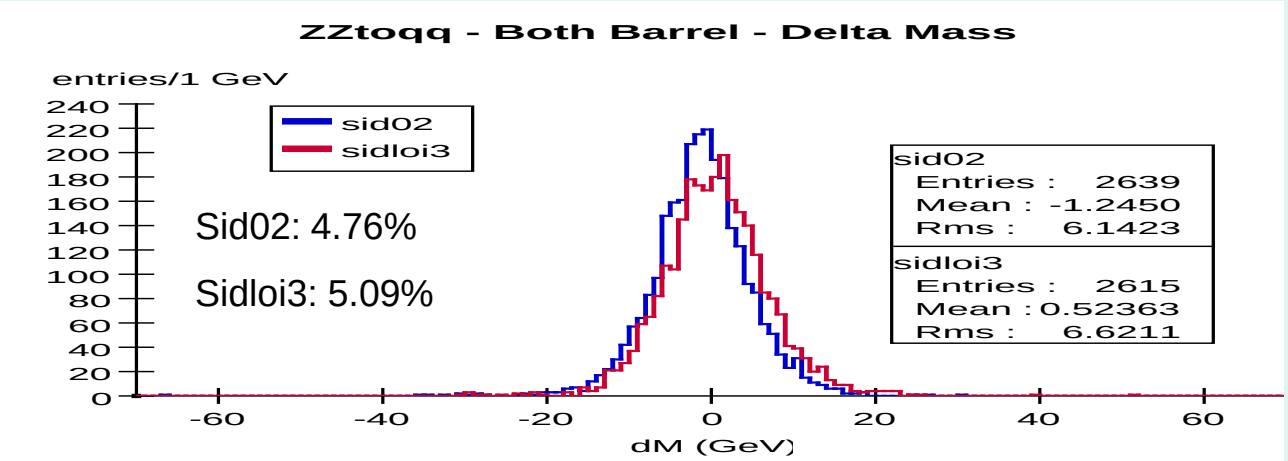

cmE=500 - dE
entries/5 GeV
sid02
sidloi3
sid02
Entries : 9309
Mean : -14.446
Rms : 26.197
sidloi3
Entries : 9309
Mean : -7.2047
Rms : 32.905
dE (GeV)

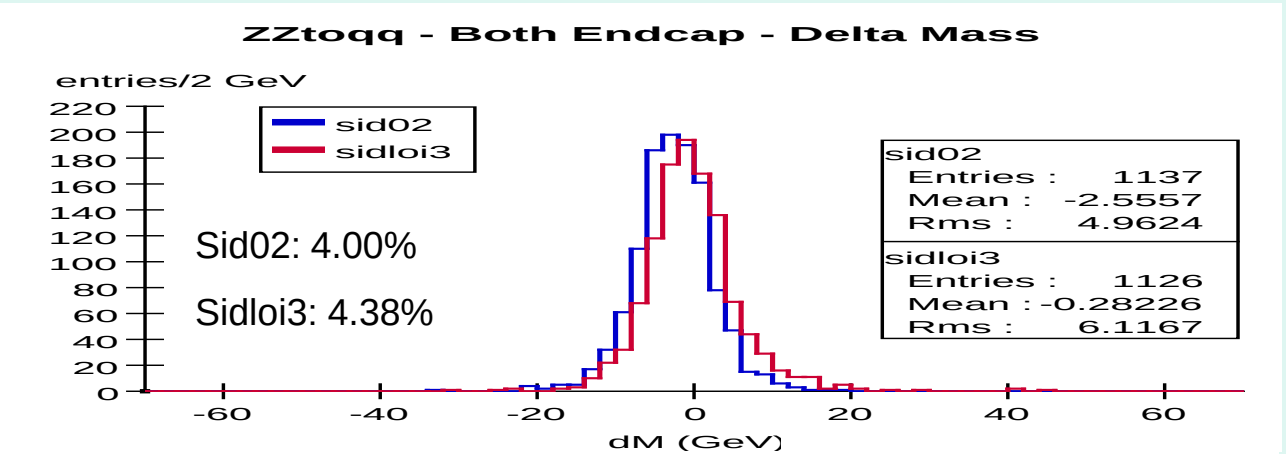
Event energy resolution

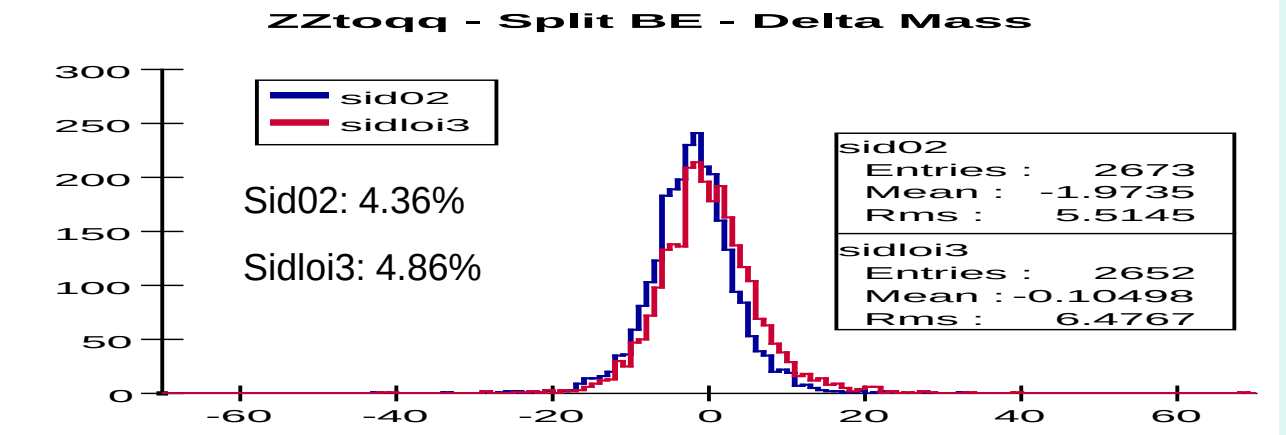
- From qq events at fixed energies, overall degradation of ~ 10%, larger in EC than Barrel.
- Appears to be spreading on high end.
- Some events up to 2-3 times the actual event energy.

ZZtoqq - Events ct < 0.95 - Delta Mass




ZZtoqq - Both Barrel - Delta Mass
entries/1 GeV
sid02
sidloi3
Sid02: 4.76%
Sidloi3: 5.09%
sid02
Entries : 2639
Mean : -1.2450
Rms : 6.1423
sidloi3
Entries : 2615
Mean : 0.52363
Rms : 6.6211
dM (GeV)

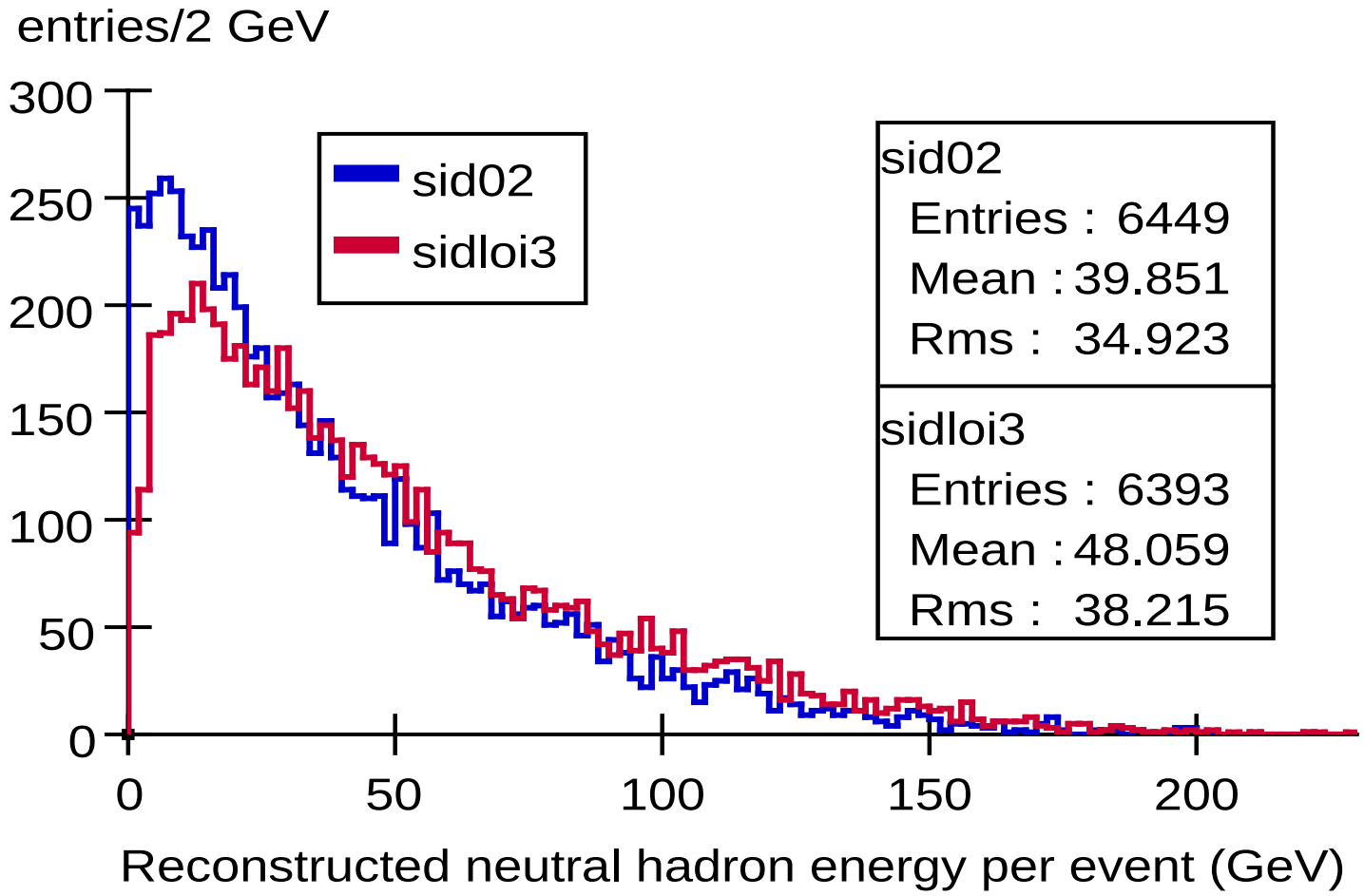

ZZtoqq - Both Endcap - Delta Mass
entries/2 GeV
sid02
sidloi3
Sid02: 4.00%
Sidloi3: 4.38%
sid02
Entries : 1137
Mean : -2.5557
Rms : 4.9624
sidloi3
Entries : 1126
Mean : -0.28226
Rms : 6.1167
dM (GeV)


ZZtoqq - Split BE - Delta Mass
sid02
sidloi3
Sid02: 4.36%
Sidloi3: 4.86%
sid02
Entries : 2673
Mean : -1.9735
Rms : 5.5145
sidloi3
Entries : 2652
Mean : -0.10498
Rms : 6.4767

Mass resolution

- 9% worse overall.
- As with Eres, seems to come from high side.
- Big hint from neutral hadron energy per event.

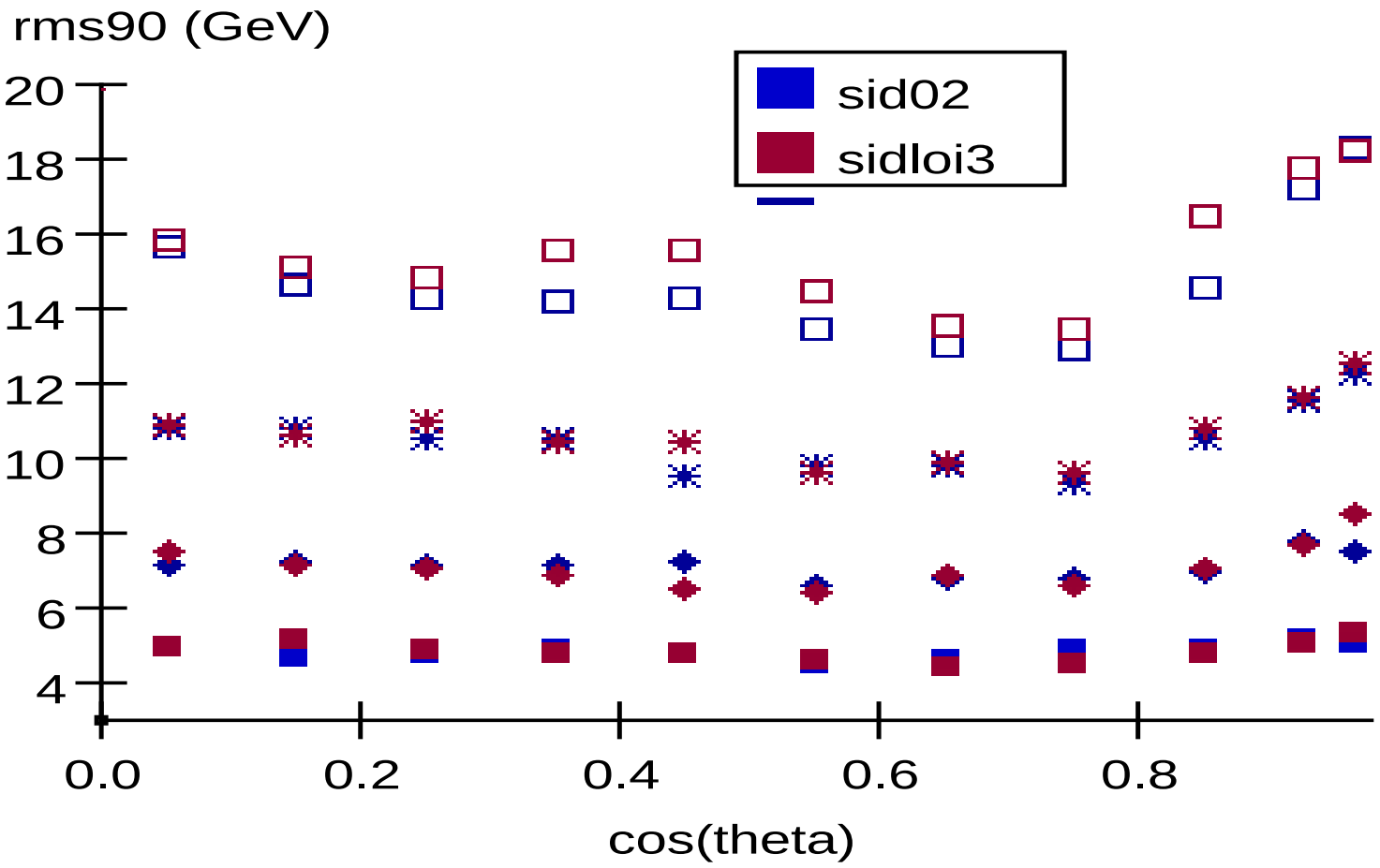
ZZtoqqnunu - Events ct < 0.95 - Recon nhadron E per event



Why? And how do we check?

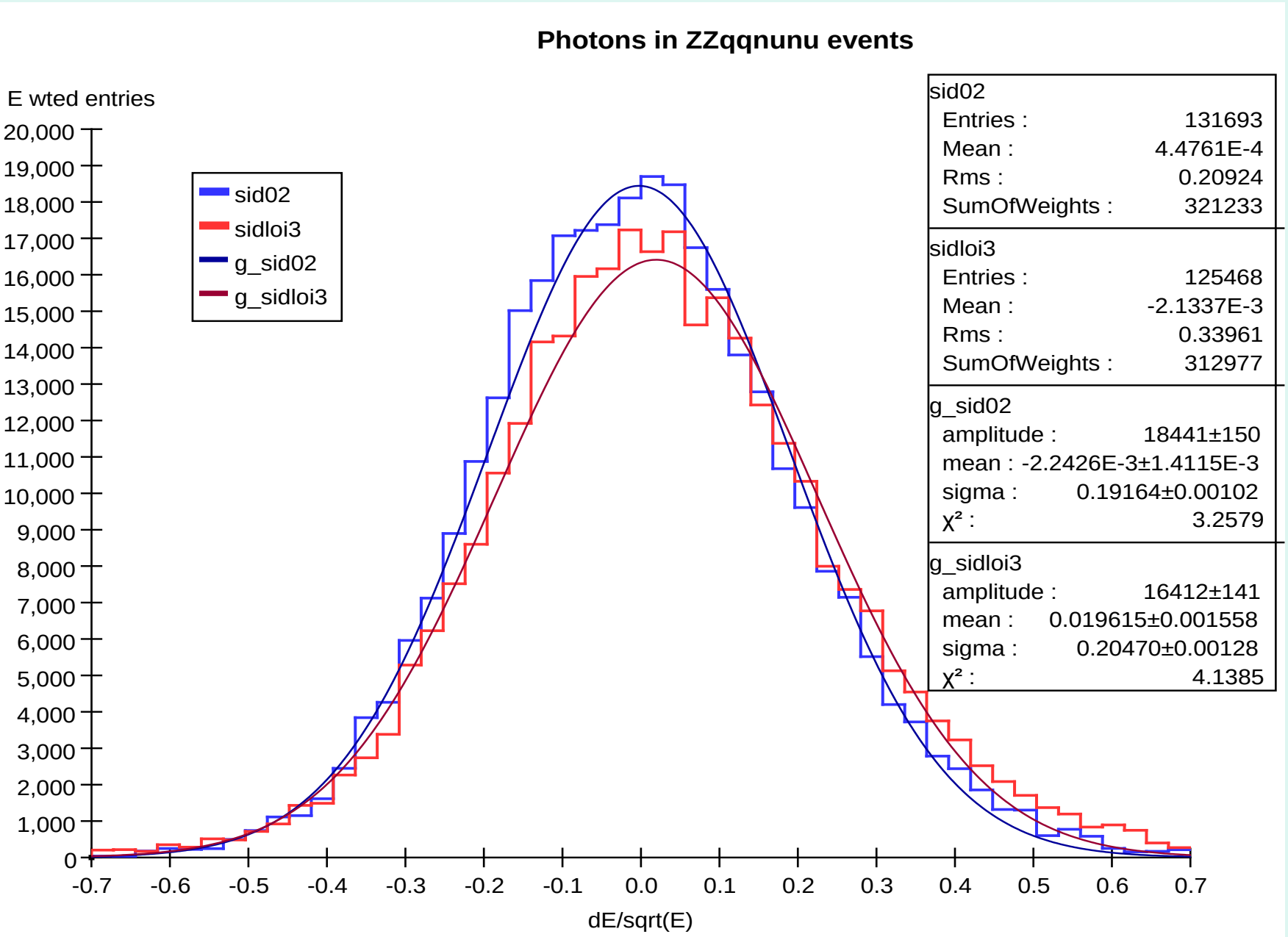
- Detector intrinsic resolution: detector and hadronic model have changed. Look at “CalorimetryOnly” resolution, and at single particle resolution.
- Reconstruct single particles, see if we can get an idea where it is breaking down.
- Generate likelihood.bin file for this detector (instead of using same as sid02) and see if there is any effect. (Not yet done)

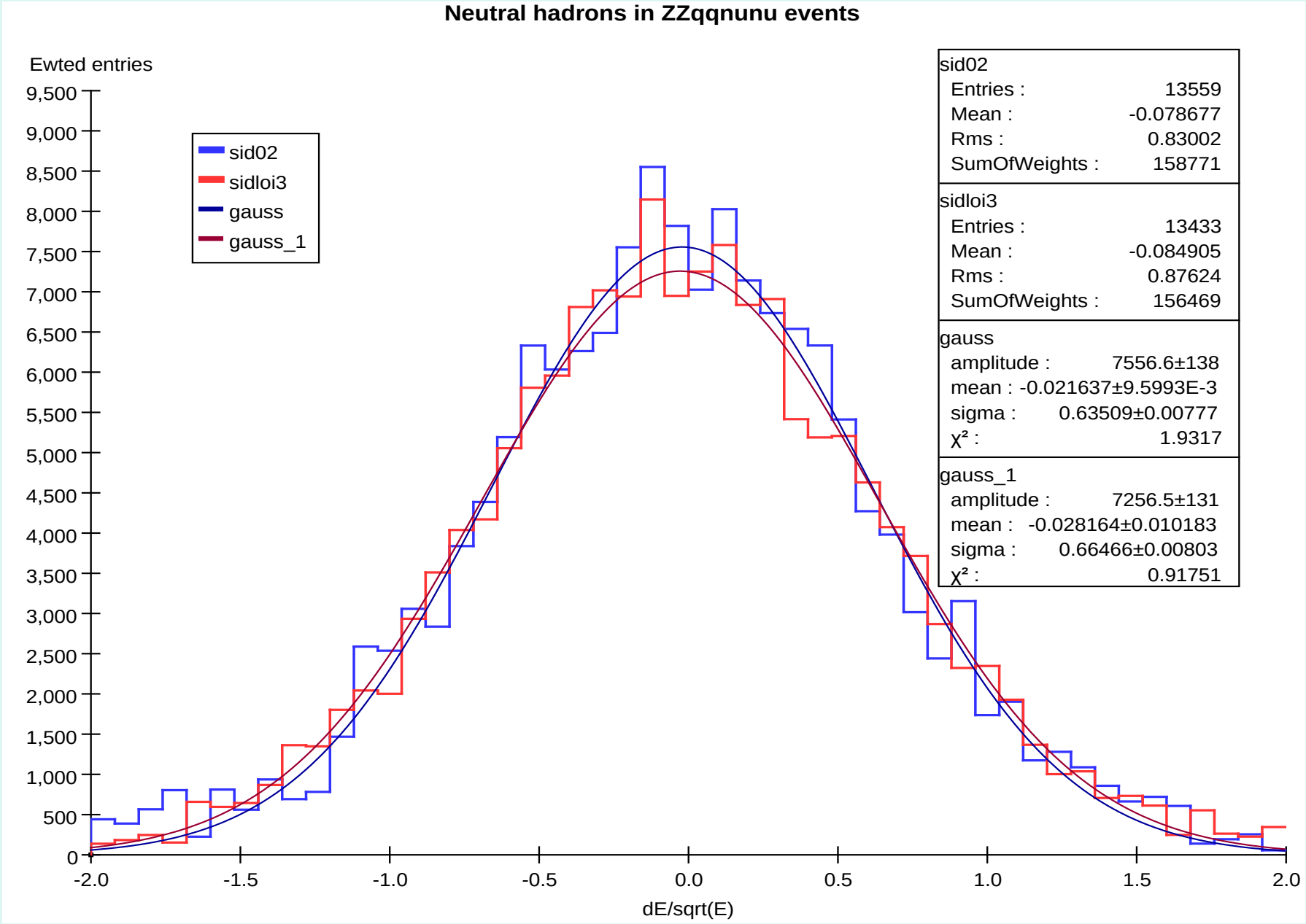
qq100,200,350,500: Calorimetry only



Detector resolution

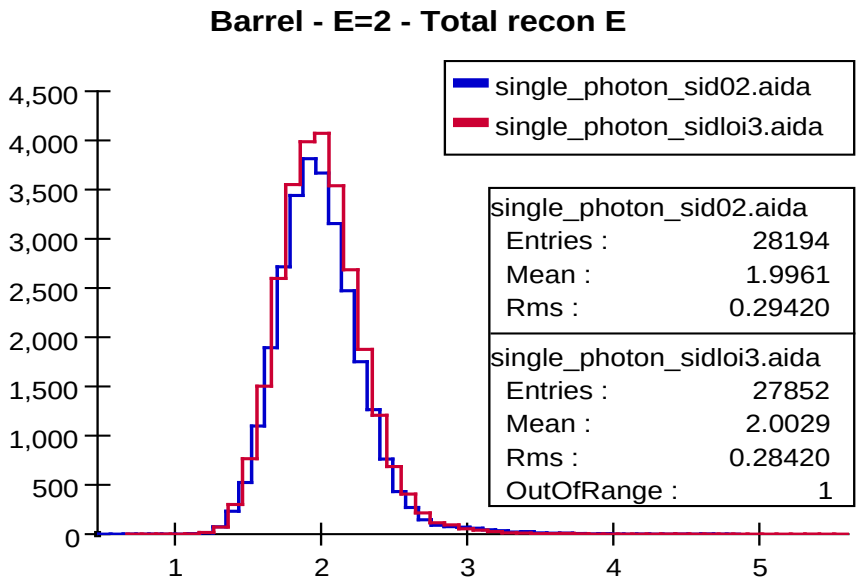
- Similar energy resolution for sid02 and sidloi3 using only the calorimeters up to 350 GeV event energy. A few per cent degradation at 500 GeV.
- Pick out photons and nh's from ZZ events, and look at an "effective" resolution plot. Plot dE/sqrt(E) and weight by energy.

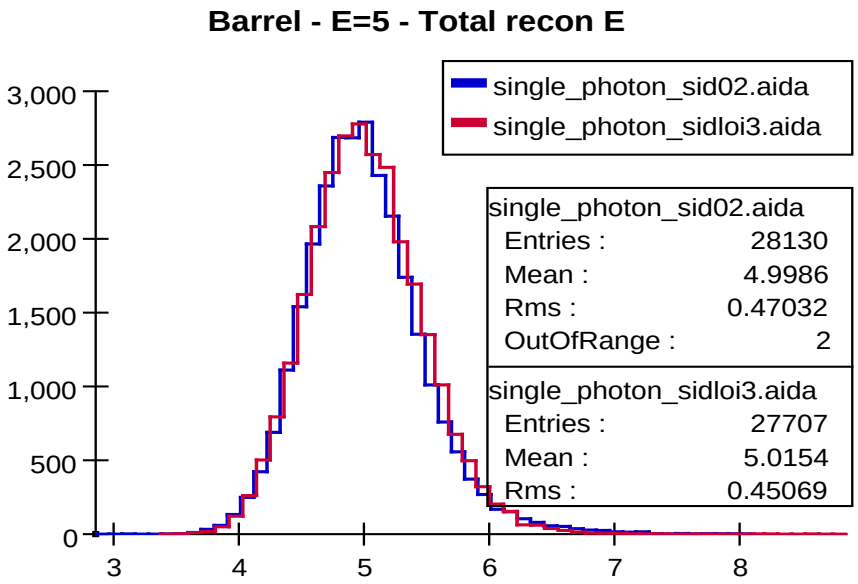

Photons in ZZqqnunu events
E wted entries
20,000
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
dE/sqrt(E)
sid02
sidloi3
g_sid02
g_sidloi3
sid02
Entries : 131693
Mean : 4.4761E-4
Rms : 0.20924
SumOfWeights : 321233
sidloi3
Entries : 125468
Mean : -2.1337E-3
Rms : 0.33961
SumOfWeights : 312977
g_sid02
amplitude : 18441±150
mean : -2.2426E-3±1.4115E-3
sigma : 0.19164±0.00102
χ² : 3.2579
g_sidloi3
amplitude : 16412±141
mean : 0.019615±0.001558
sigma : 0.20470±0.00128
χ² : 4.1385

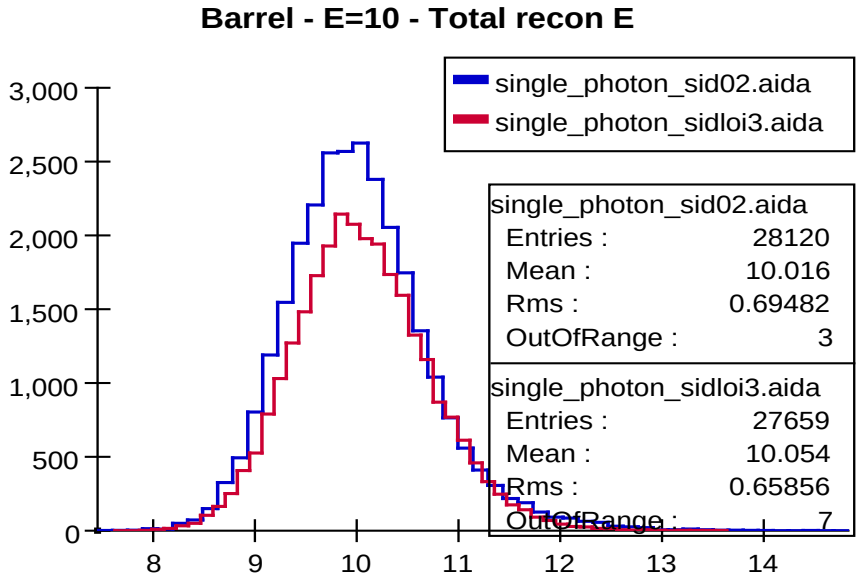

Neutral hadrons in ZZqqnunu events
Ewted entries
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
sid02
sidloi3
gauss
gauss_1
sid02
Entries : 13559
Mean : -0.078677
Rms : 0.83002
SumOfWeights : 158771
sidloi3
Entries : 13433
Mean : -0.084905
Rms : 0.87624
SumOfWeights : 156469
gauss
amplitude : 7556.6±138
mean : -0.021637±9.5993E-3
sigma : 0.63509±0.00777
χ² : 1.9317
gauss_1
amplitude : 7256.5±131
mean : -0.028164±0.010183
sigma : 0.66466±0.00803
χ² : 0.91751
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
dE/sqrt(E)

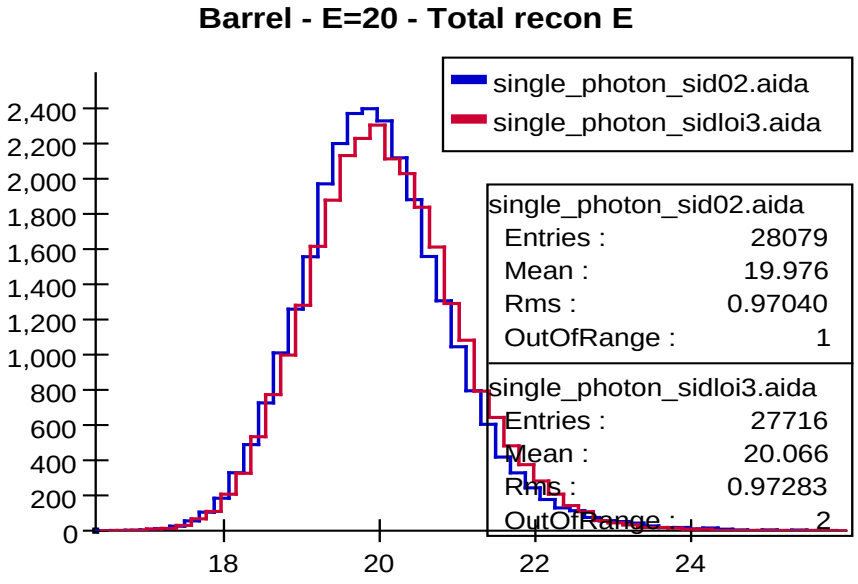
Neutral resolution

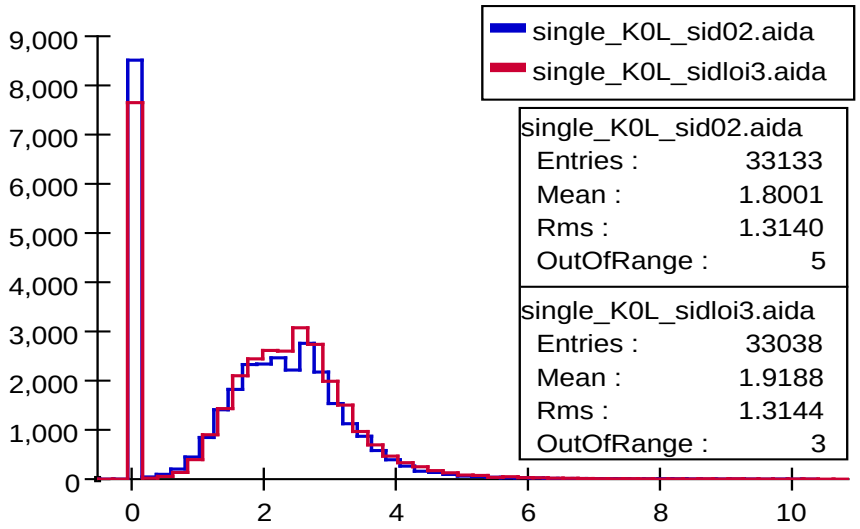
- A few % degradation in effective resolution.
- Look at single particle files.
- First photons: E={1,2,5,10,20,50,100} GeV. Theta = {90,100,110,120,130,140,150,155,160,170} degrees

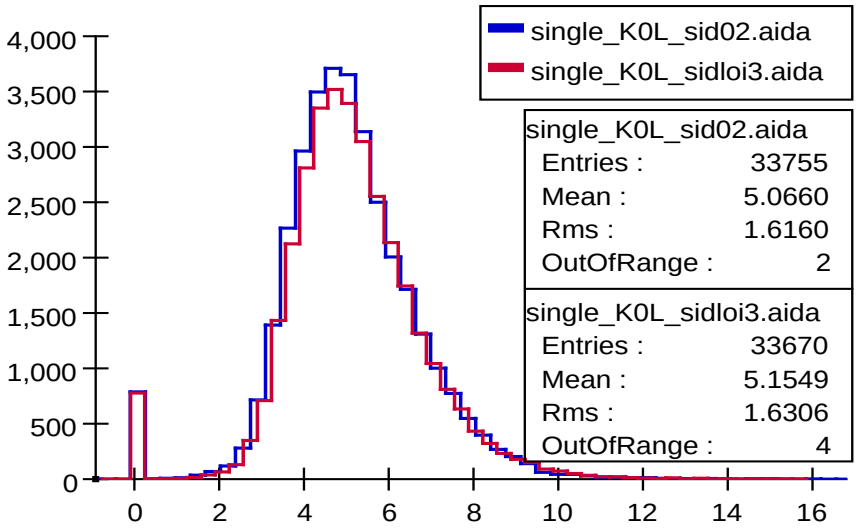

Barrel - E=2 - Total recon E
single_photon_sid02.aida
single_photon_sidloi3.aida
single_photon_sid02.aida
Entries : 28194
Mean : 1.9961
Rms : 0.29420
single_photon_sidloi3.aida
Entries : 27852
Mean : 2.0029
Rms : 0.28420
OutOfRange : 1

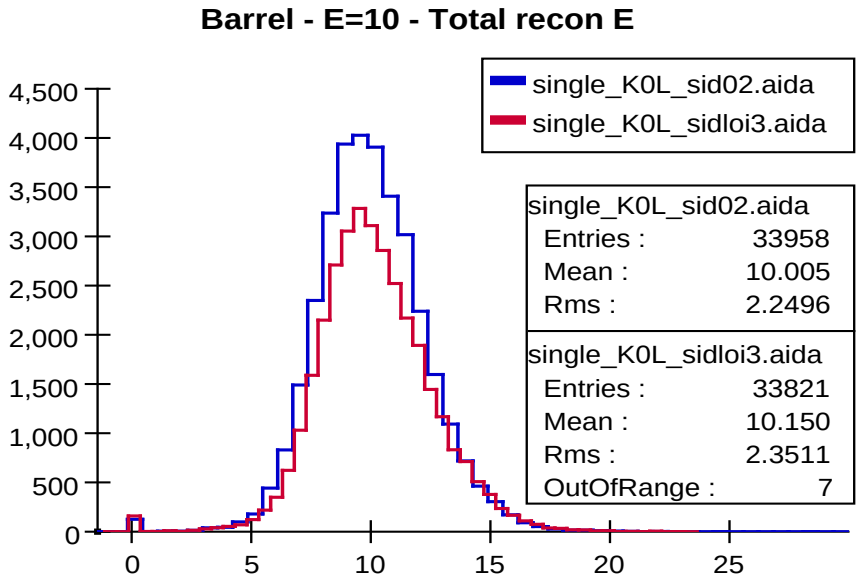

Barrel - E=5 - Total recon E
single_photon_sid02.aida
single_photon_sidloi3.aida
single_photon_sid02.aida
Entries : 28130
Mean : 4.9986
Rms : 0.47032
OutOfRange : 2
single_photon_sidloi3.aida
Entries : 27707
Mean : 5.0154
Rms : 0.45069

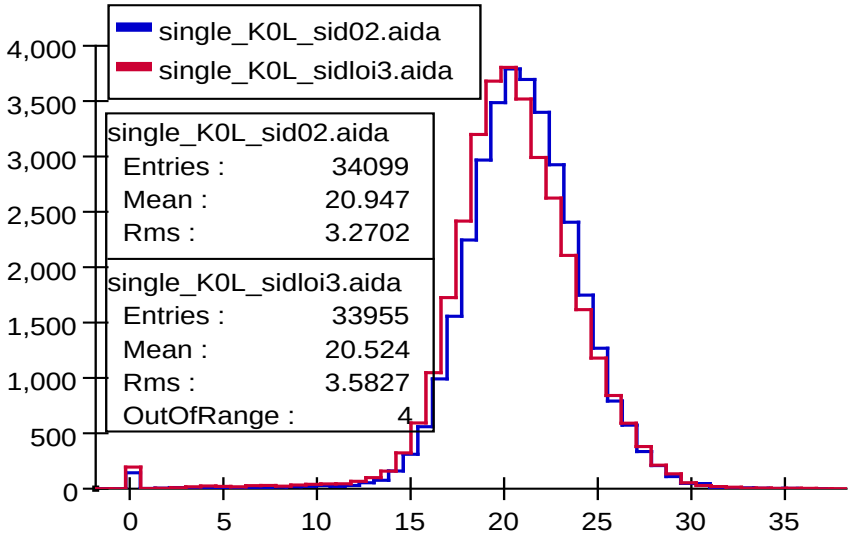

Barrel - E=10 - Total recon E
single_photon_sid02.aida
single_photon_sidloi3.aida
single_photon_sid02.aida
Entries : 28120
Mean : 10.016
Rms : 0.69482
OutOfRange : 3
single_photon_sidloi3.aida
Entries : 27659
Mean : 10.054
Rms : 0.65856
OutOfRange : 7


Barrel - E=20 - Total recon E
single_photon_sid02.aida
single_photon_sidloi3.aida
single_photon_sid02.aida
Entries : 28079
Mean : 19.976
Rms : 0.97040
OutOfRange : 1
single_photon_sidloi3.aida
Entries : 27716
Mean : 20.066
Rms : 0.97283
OutOfRange : 2


Barrel - E=2 - Total recon E
single_K0L_sid02.aida
single_K0L_sidloi3.aida
single_K0L_sid02.aida
Entries : 33133
Mean : 1.8001
Rms : 1.3140
OutOfRange : 5
single_K0L_sidloi3.aida
Entries : 33038
Mean : 1.9188
Rms : 1.3144
OutOfRange : 3

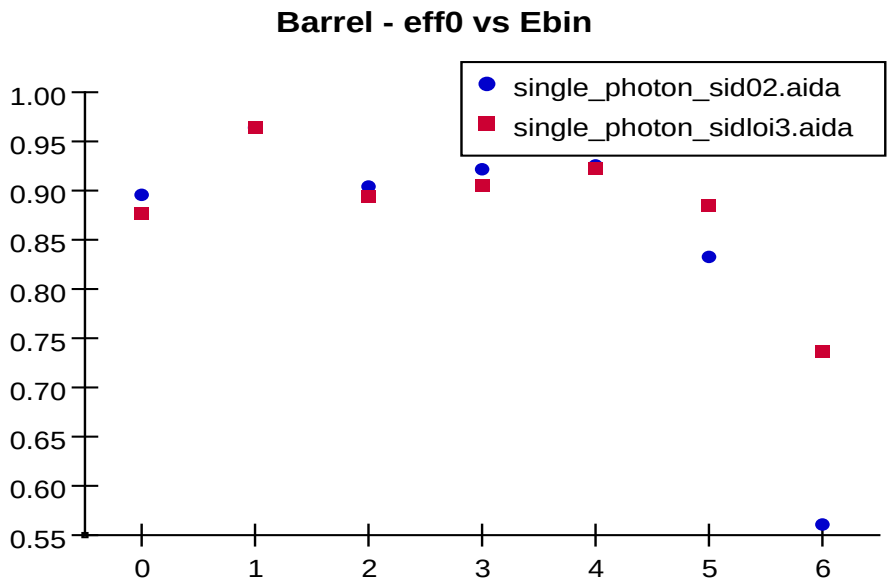

Barrel - E=5 - Total recon E
single_K0L_sid02.aida
single_K0L_sidloi3.aida
single_K0L_sid02.aida
Entries : 33755
Mean : 5.0660
Rms : 1.6160
OutOfRange : 2
single_K0L_sidloi3.aida
Entries : 33670
Mean : 5.1549
Rms : 1.6306
OutOfRange : 4

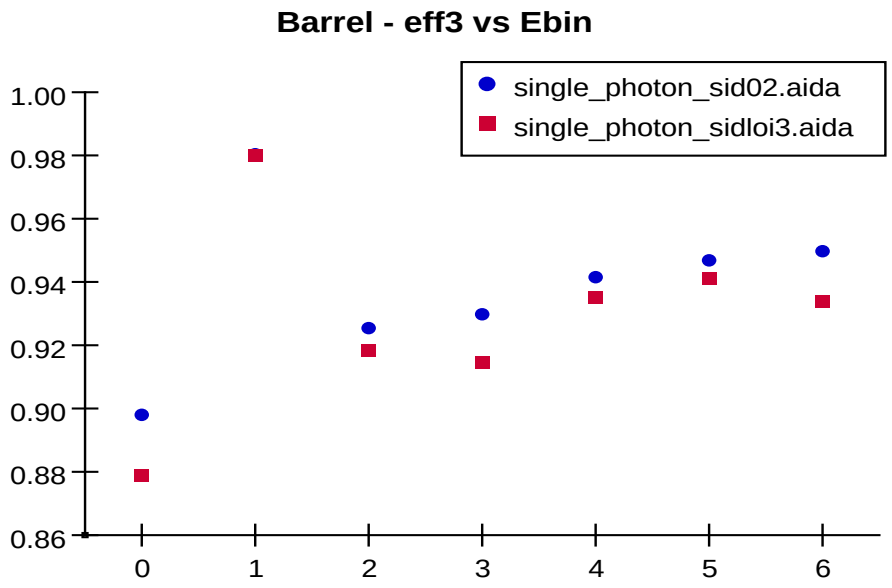

Barrel - E=10 - Total recon E
single_K0L_sid02.aida
single_K0L_sidloi3.aida
single_K0L_sid02.aida
Entries : 33958
Mean : 10.005
Rms : 2.2496
single_K0L_sidloi3.aida
Entries : 33821
Mean : 10.150
Rms : 2.3511
OutOfRange : 7

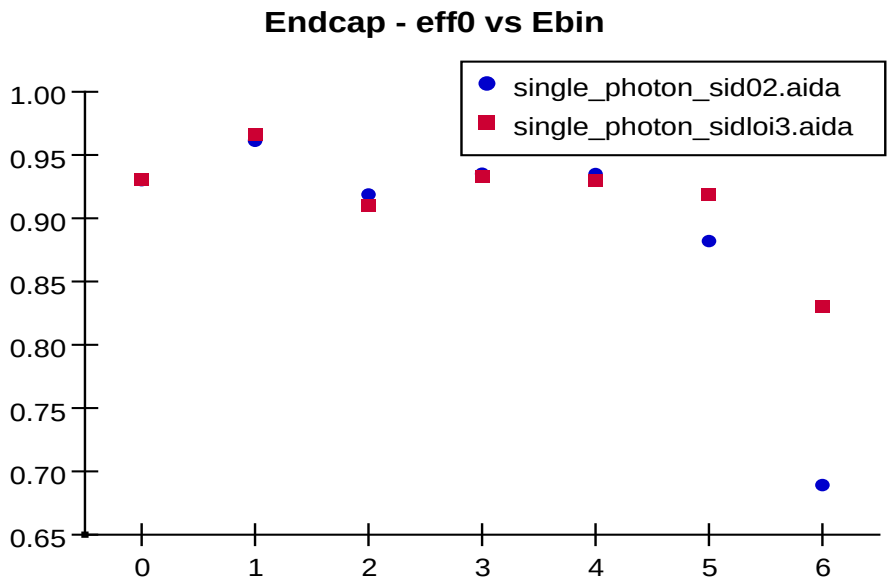

Barrel - E=20 - Total recon E
single_K0L_sid02.aida
single_K0L_sidloi3.aida
single_K0L_sid02.aida
Entries : 34099
Mean : 20.947
Rms : 3.2702
single_K0L_sidloi3.aida
Entries : 33955
Mean : 20.524
Rms : 3.5827
OutOfRange : 4

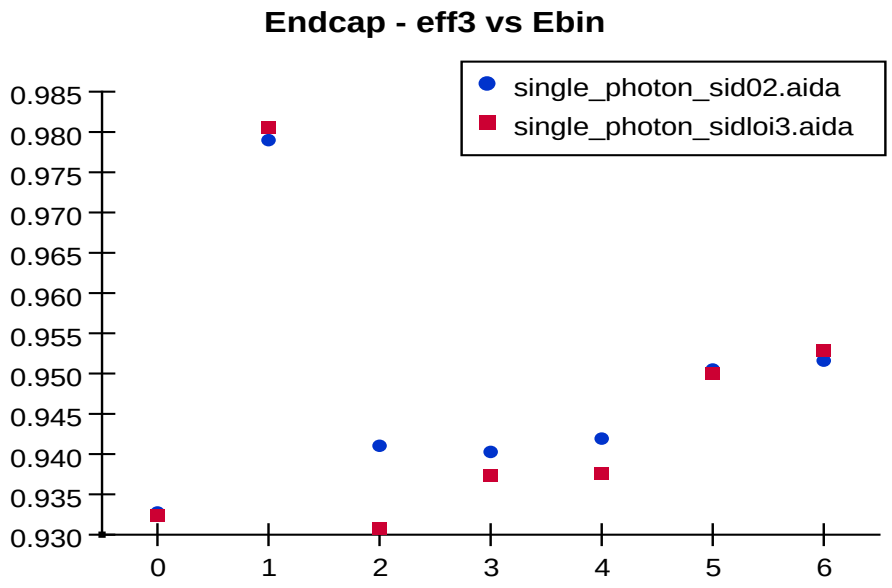
Detector resolution

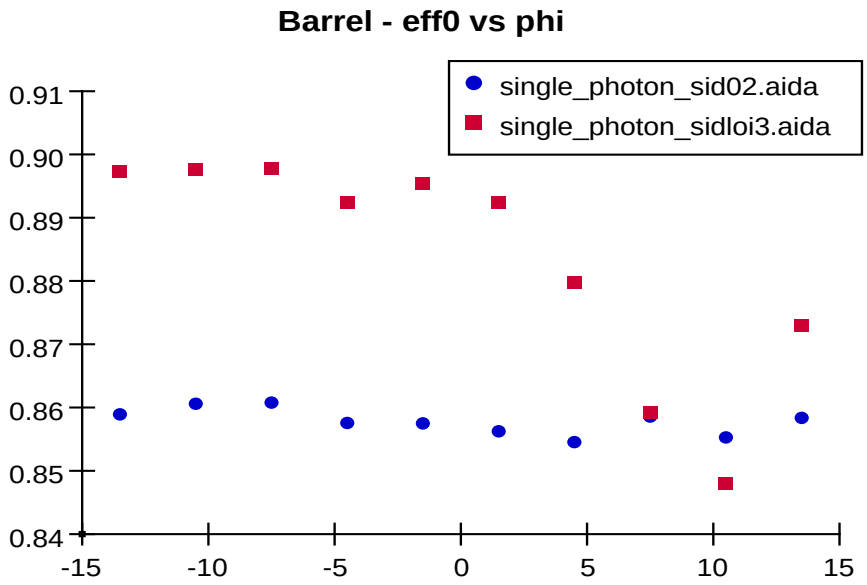
- While all checks look somewhat worse than sid02, nothing stands out that should degrade PFA resolution by 10%.
- Left with algorithm.
- Reconstruct single particles and see if we can spot problems.

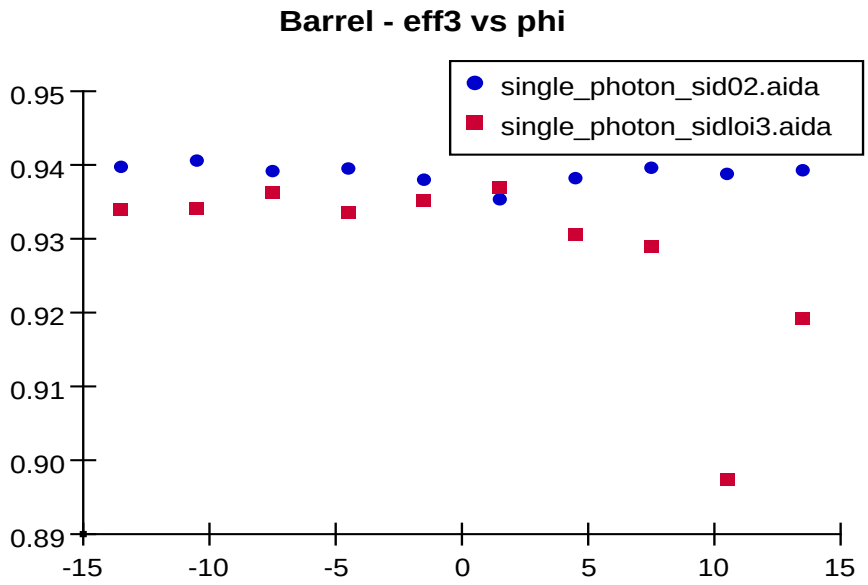

Barrel - eff0 vs Ebin
single_photon_sid02.aida
single_photon_sidloi3.aida
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0 1 2 3 4 5 6

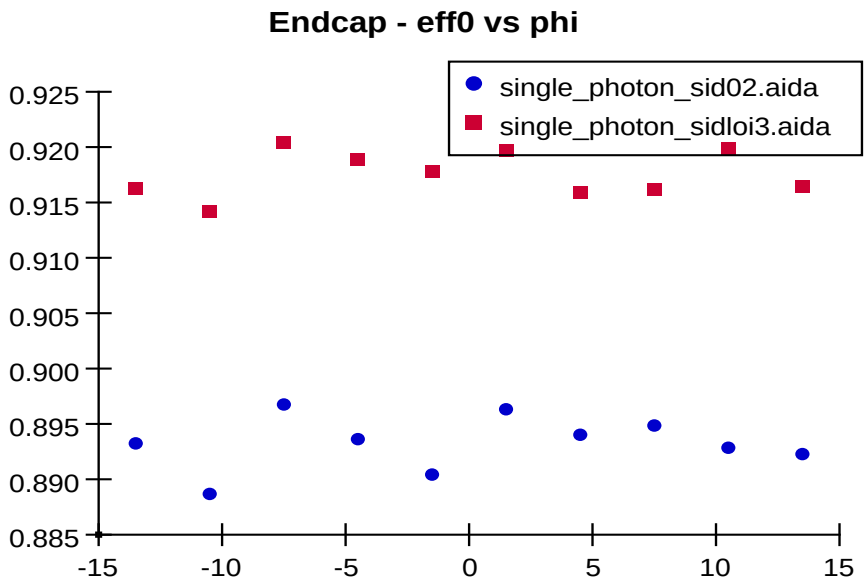

Barrel - eff3 vs Ebin
single_photon_sid02.aida
single_photon_sidloi3.aida
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0 1 2 3 4 5 6

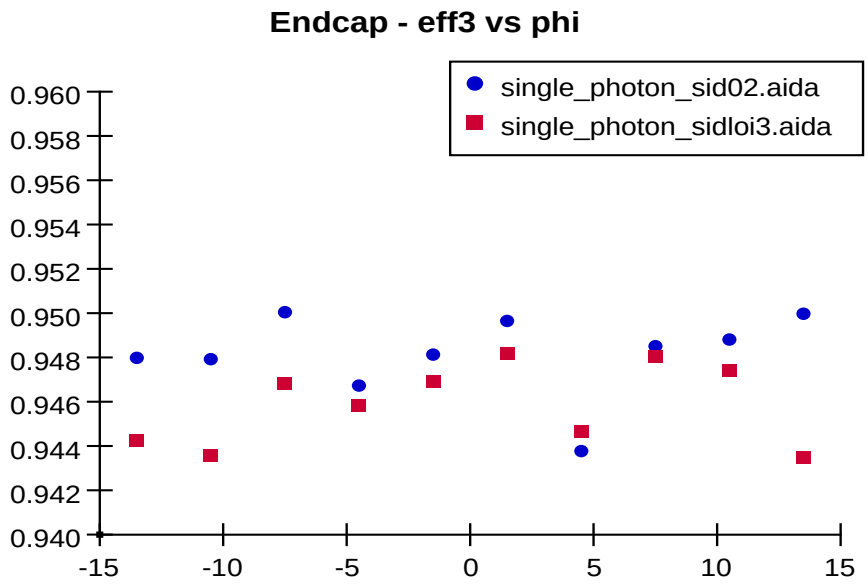

Endcap - eff0 vs Ebin
single_photon_sid02.aida
single_photon_sidloi3.aida
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0 1 2 3 4 5 6

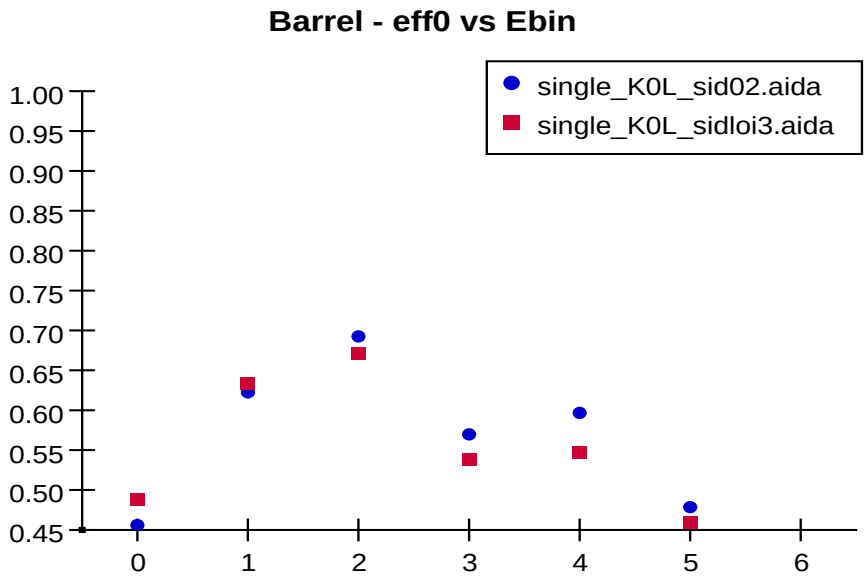

Endcap - eff3 vs Ebin
single_photon_sid02.aida
single_photon_sidloi3.aida
0.985
0.980
0.975
0.970
0.965
0.960
0.955
0.950
0.945
0.940
0.935
0.930
0 1 2 3 4 5 6

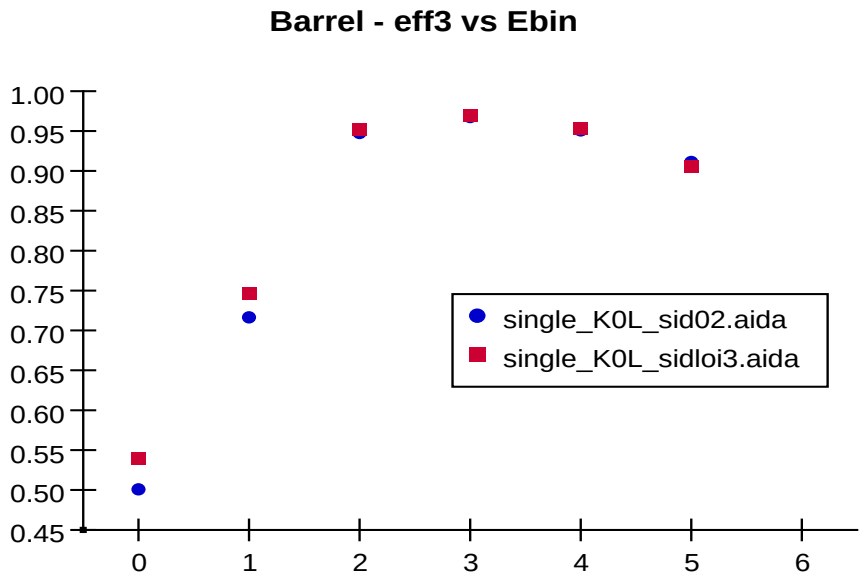

Barrel - eff0 vs phi
single_photon_sid02.aida
single_photon_sidloi3.aida
0.91
0.90
0.89
0.88
0.87
0.86
0.85
0.84
-15
-10
-5
0
5
10
15

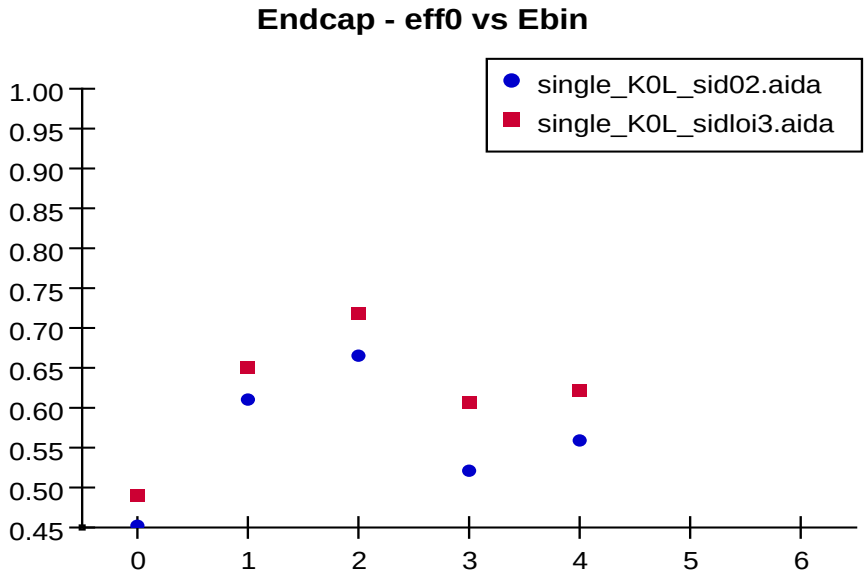

Barrel - eff3 vs phi
single_photon_sid02.aida
single_photon_sidloi3.aida
0.95
0.94
0.93
0.92
0.91
0.90
0.89
-15
-10
-5
0
5
10
15

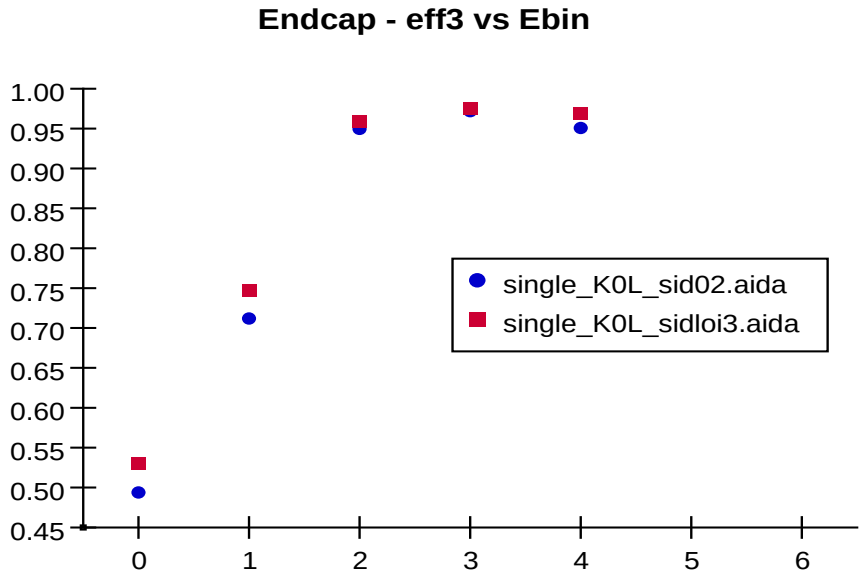

Endcap - eff0 vs phi
single_photon_sid02.aida
single_photon_sidloi3.aida
0.925
0.920
0.915
0.910
0.905
0.900
0.895
0.890
0.885
-15
-10
-5
0
5
10
15


Endcap - eff3 vs phi
single_photon_sid02.aida
single_photon_sidloi3.aida
0.960
0.958
0.956
0.954
0.952
0.950
0.948
0.946
0.944
0.942
0.940
-15
-10
-5
0
5
10
15


Barrel - eff0 vs Ebin
single_K0L_sid02.aida
single_K0L_sidloi3.aida
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0
1
2
3
4
5
6

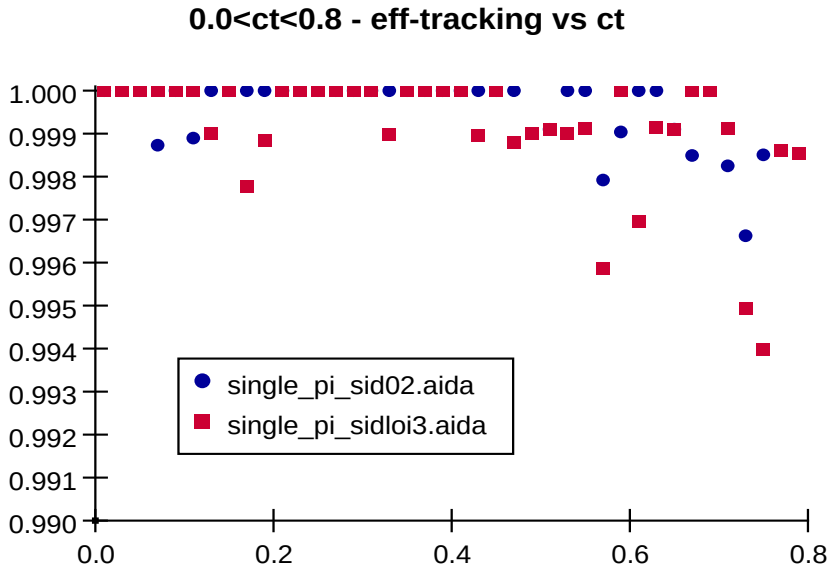

Barrel - eff3 vs Ebin
single_K0L_sid02.aida
single_K0L_sidloi3.aida
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0
1
2
3
4
5
6

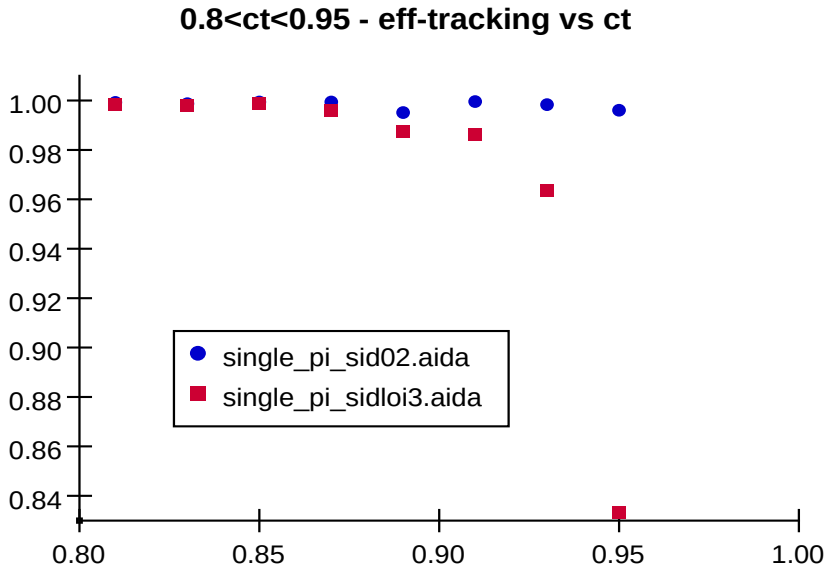

Endcap - eff0 vs Ebin
single_K0L_sid02.aida
single_K0L_sidloi3.aida
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0
1
2
3
4
5
6

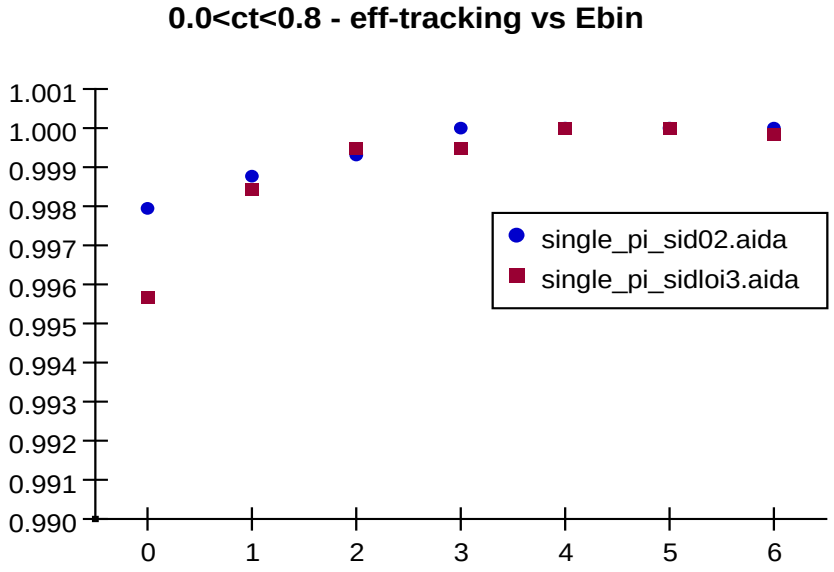

Endcap - eff3 vs Ebin
single_K0L_sid02.aida
single_K0L_sidloi3.aida
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0
1
2
3
4
5
6

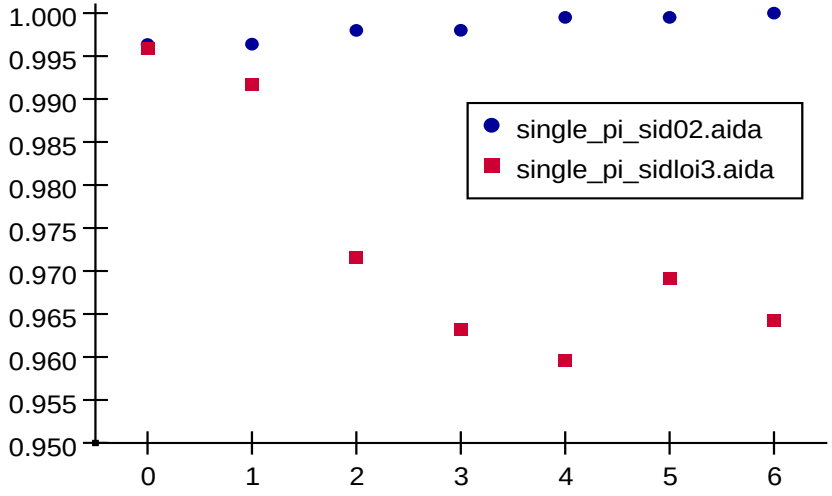
Single pions

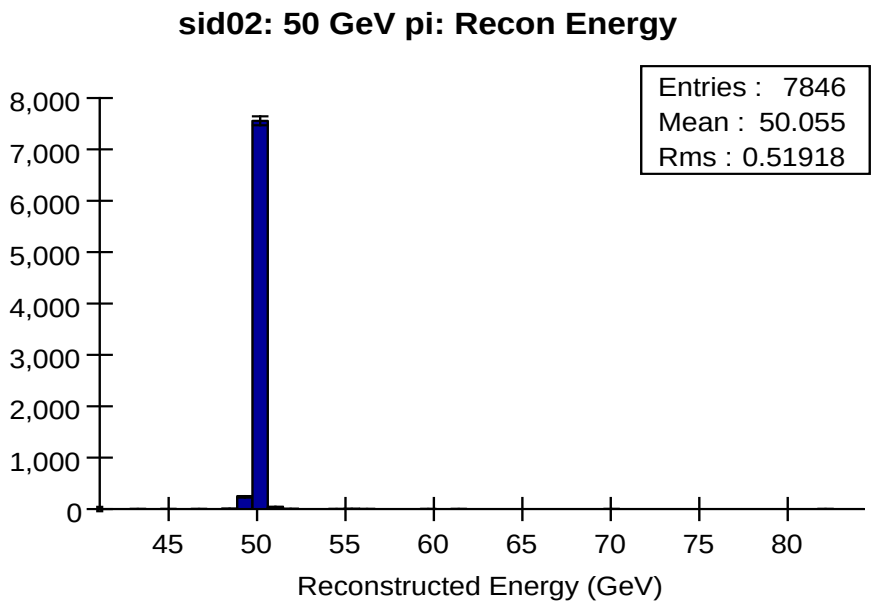
- Reconstruct single pions and look for differences from sid02.
- First tracking:

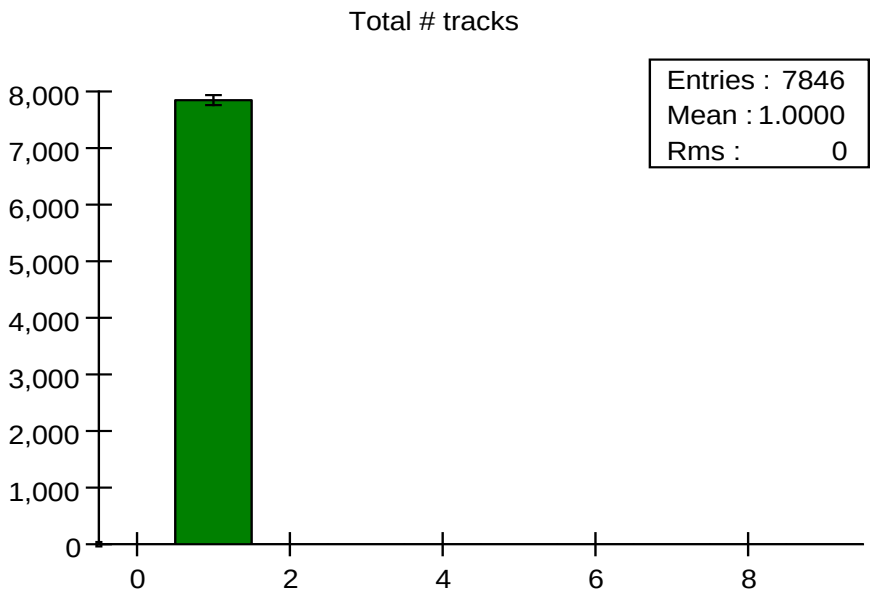

0.0<ct<0.8 - eff-tracking vs ct
1.000
0.999
0.998
0.997
0.996
0.995
0.994
0.993
0.992
0.991
0.990
0.0
0.2
0.4
0.6
0.8
single_pi_sid02.aida
single_pi_sidloi3.aida

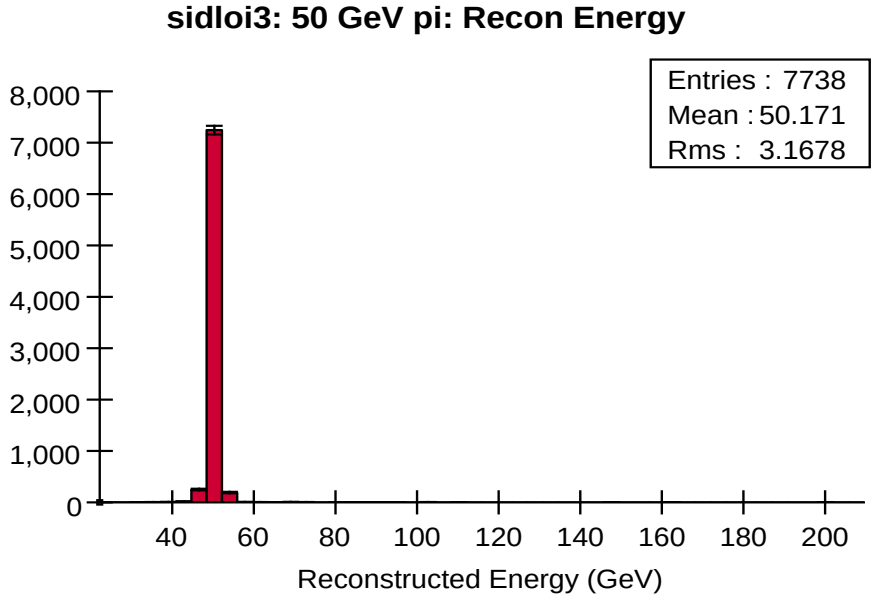

0.8<ct<0.95 - eff-tracking vs ct
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.80
0.85
0.90
0.95
1.00
single_pi_sid02.aida
single_pi_sidloi3.aida

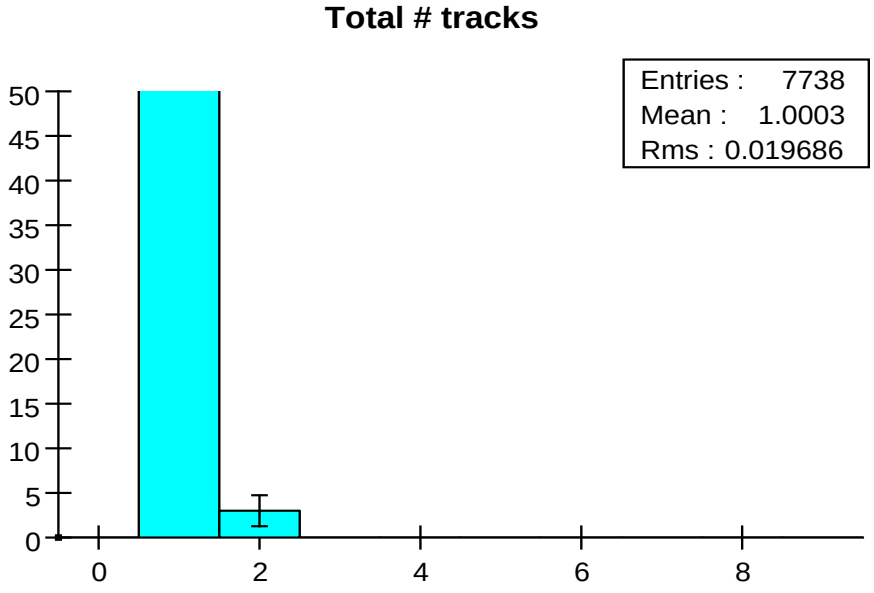

0.0<ct<0.8 - eff-tracking vs Ebin
1.001
1.000
0.999
0.998
0.997
0.996
0.995
0.994
0.993
0.992
0.991
0.990
0
1
2
3
4
5
6
single_pi_sid02.aida
single_pi_sidloi3.aida

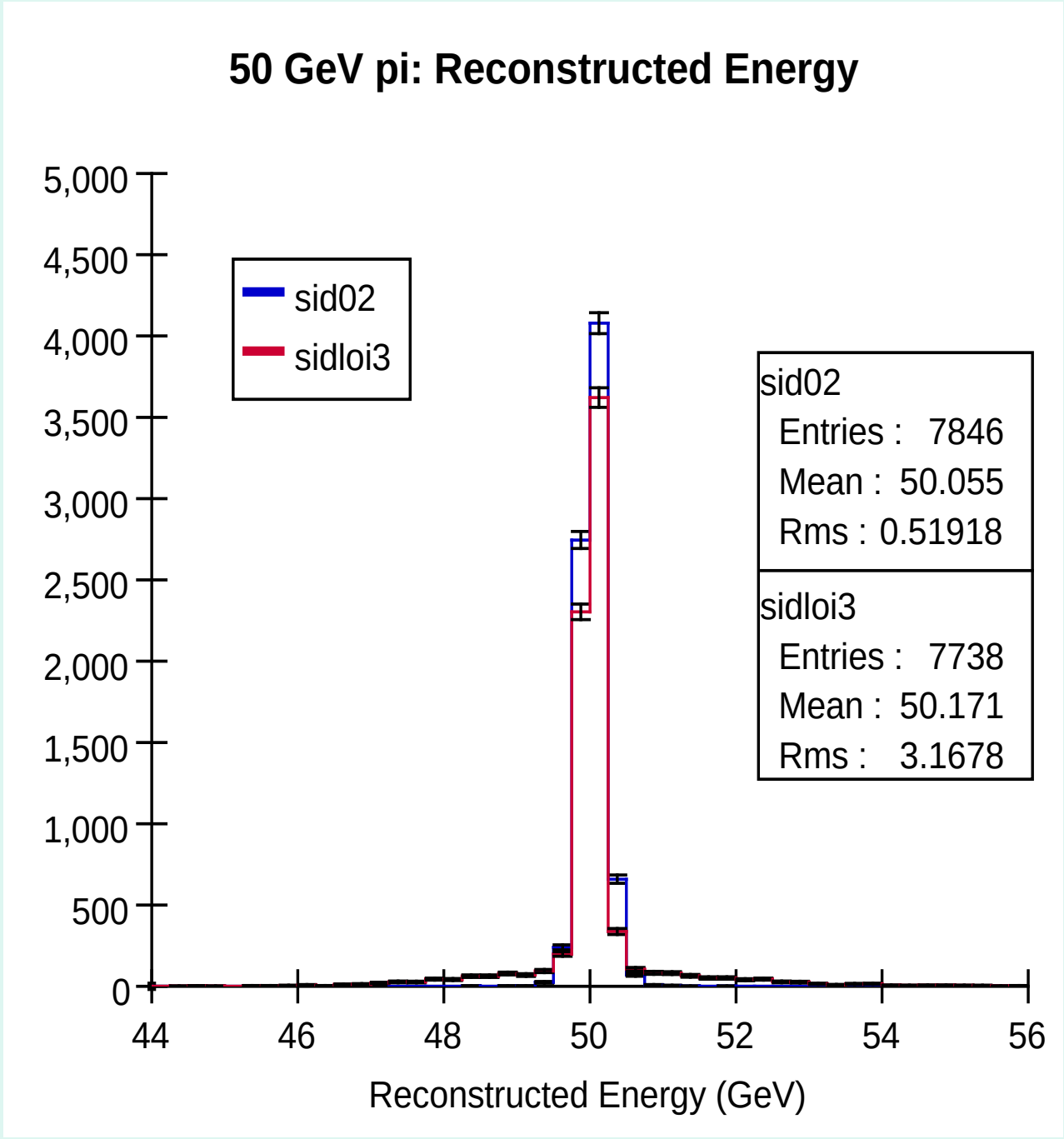

0.8<ct<0.95 - eff-tracking vs Ebin
1.000
0.995
0.990
0.985
0.980
0.975
0.970
0.965
0.960
0.955
0.950
0
1
2
3
4
5
6
single_pi_sid02.aida
single_pi_sidloi3.aida


sid02: 50 GeV pi: Recon Energy
Entries : 7846
Mean : 50.055
Rms : 0.51918
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
45
50
55
60
65
70
75
80
Reconstructed Energy (GeV)


Total # tracks
Entries : 7846
Mean : 1.0000
Rms : 0
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0
2
4
6
8


sidloi3: 50 GeV pi: Recon Energy
Entries : 7738
Mean : 50.171
Rms : 3.1678
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
40
60
80
100
120
140
160
180
200
Reconstructed Energy (GeV)


Total # tracks
Entries : 7738
Mean : 1.0003
Rms : 0.019686
50
45
40
35
30
25
20
15
10
5
0
0
2
4
6
8

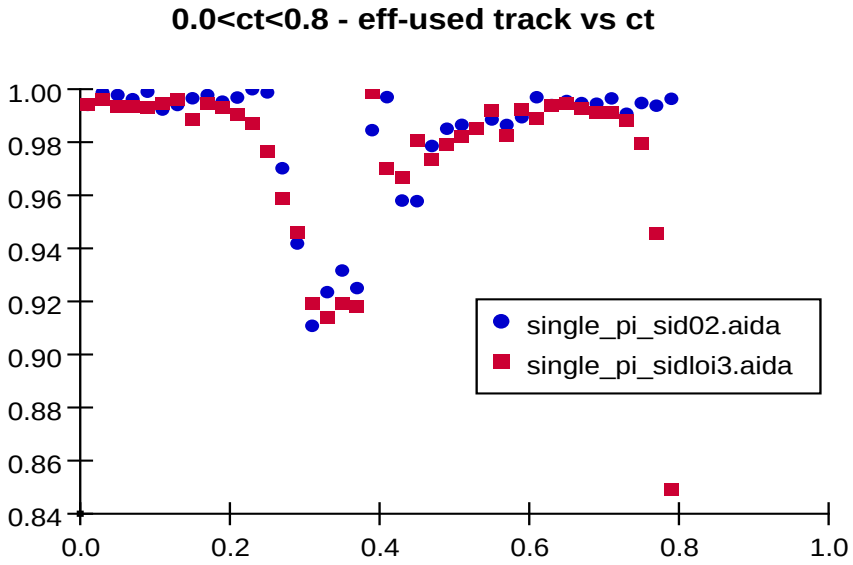

50 GeV pi: Reconstructed Energy
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
44
46
48
50
52
54
56
Reconstructed Energy (GeV)
sid02
sidloi3
sid02
Entries : 7846
Mean : 50.055
Rms : 0.51918
sidloi3
Entries : 7738
Mean : 50.171
Rms : 3.1678

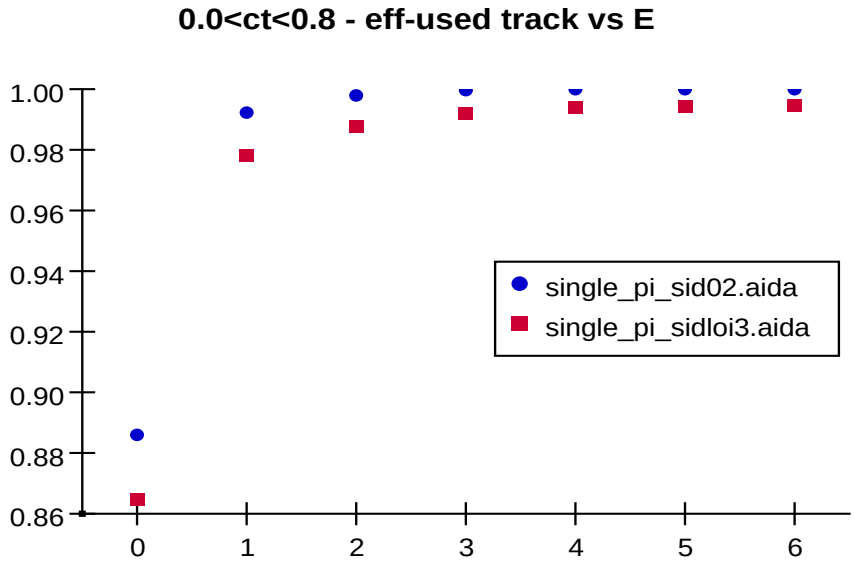
Tracking

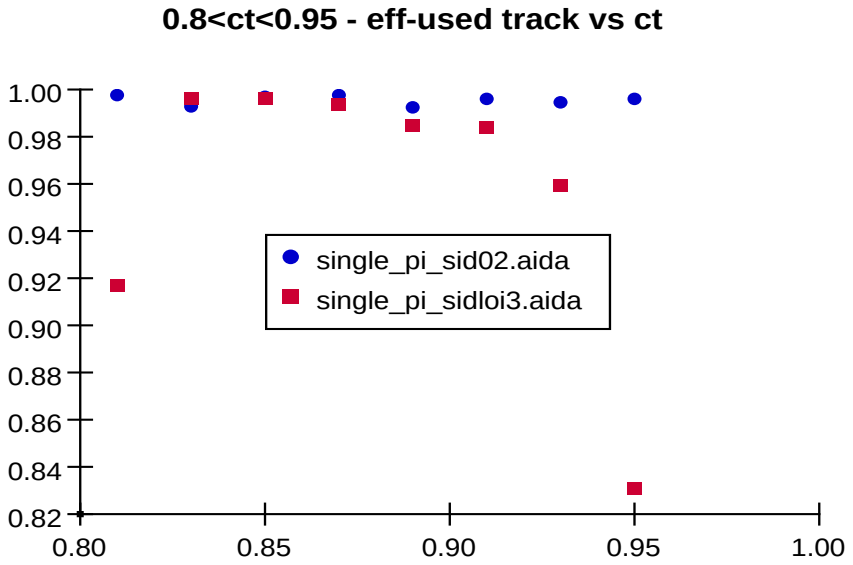
- Loss of efficiency could be important in Endcap.
- Curious large tails in measurement.

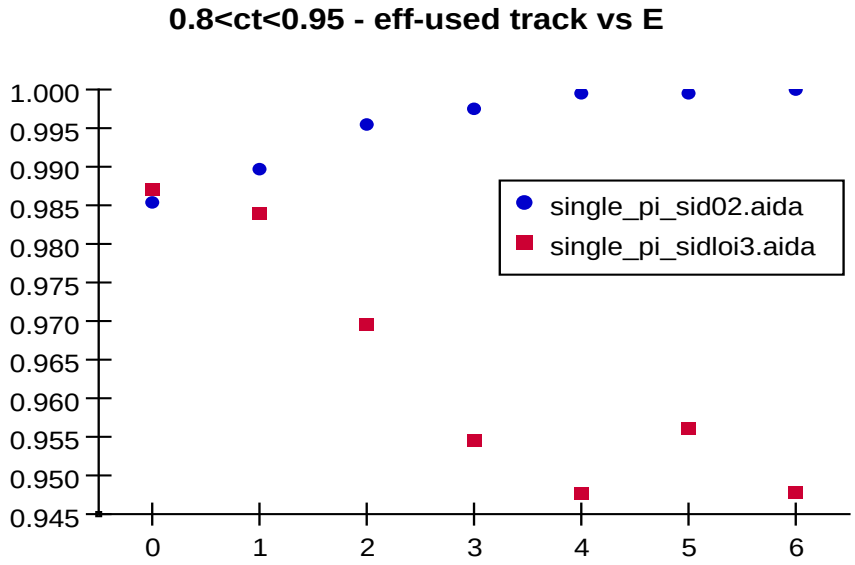
Track reconstruction

- Not all Tracks are used. (Initial association, E/P)
- Look at efficiency for finding the track AND making it into a ReconstructedParticle.


0.0<ct<0.8 - eff-used track vs ct
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.0
0.2
0.4
0.6
0.8
1.0
single_pi_sid02.aida
single_pi_sidloi3.aida

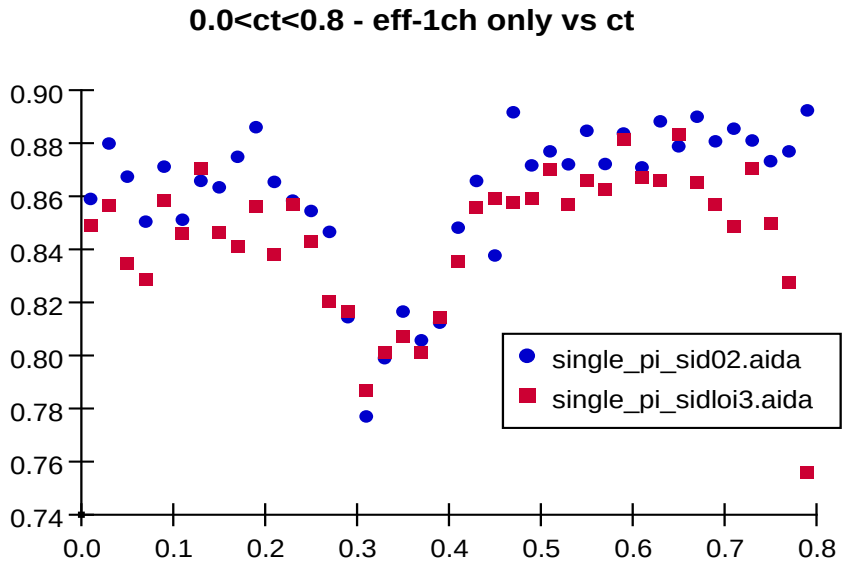

0.0<ct<0.8 - eff-used track vs E
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0
1
2
3
4
5
6
single_pi_sid02.aida
single_pi_sidloi3.aida

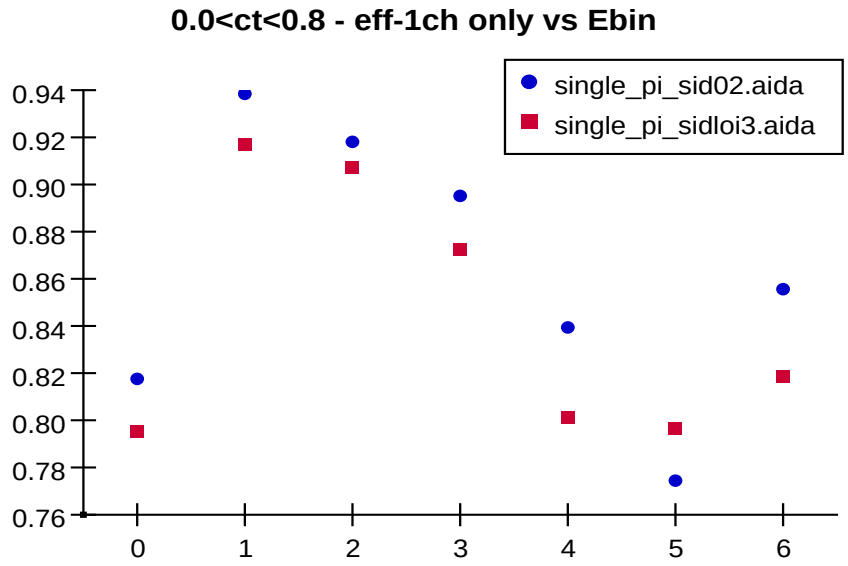

0.8<ct<0.95 - eff-used track vs ct
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.85
0.90
0.95
1.00
single_pi_sid02.aida
single_pi_sidloi3.aida

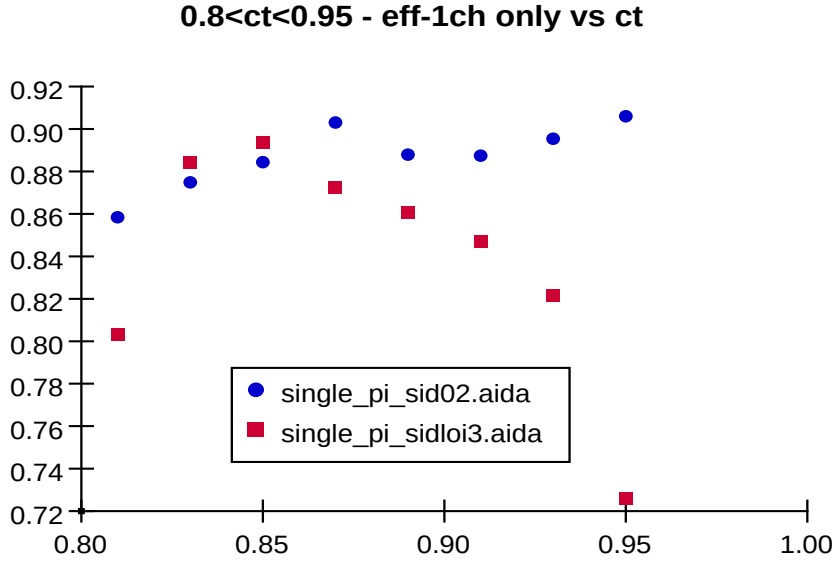

0.8<ct<0.95 - eff-used track vs E
1.000
0.995
0.990
0.985
0.980
0.975
0.970
0.965
0.960
0.955
0.950
0.945
0
1
2
3
4
5
6
single_pi_sid02.aida
single_pi_sidloi3.aida

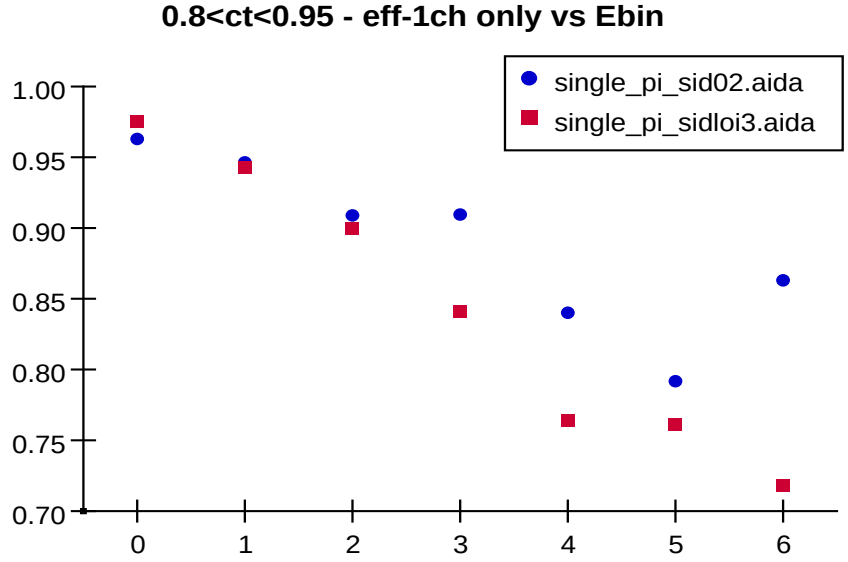
Single pi reconstruction

- Also look at how often we reconstruct a single pi and nothing else.


0.0<ct<0.8 - eff-1ch only vs ct
single_pi_sid02.aida
single_pi_sidloi3.aida


0.0<ct<0.8 - eff-1ch only vs Ebin
single_pi_sid02.aida
single_pi_sidloi3.aida


0.8<ct<0.95 - eff-1ch only vs ct
single_pi_sid02.aida
single_pi_sidloi3.aida


0.8<ct<0.95 - eff-1ch only vs Ebin
single_pi_sid02.aida
single_pi_sidloi3.aida

Generalities

- Neutral energy resolution slightly worse than sid02.
- Reconstruction of single neutrals looks as good as sid02.
- Single pion reconstruction has problems: need to separate tracking, extrapolation, and association problems.
- Still not clear why jet energy resolution and mass resolution worse.

In progress

- Change sidloi3 to be closer to loi drawing. (Main change reducing excessive gap between B and EC Ecal) Check resolutions.
- Make likelihood file, rerun, check.
- Isolate events with small neutral hadron contribution in sid02 and step through algorithm on same events with sidloi3.