z-dependence of the BCAL π^0 energy calibration (Update)

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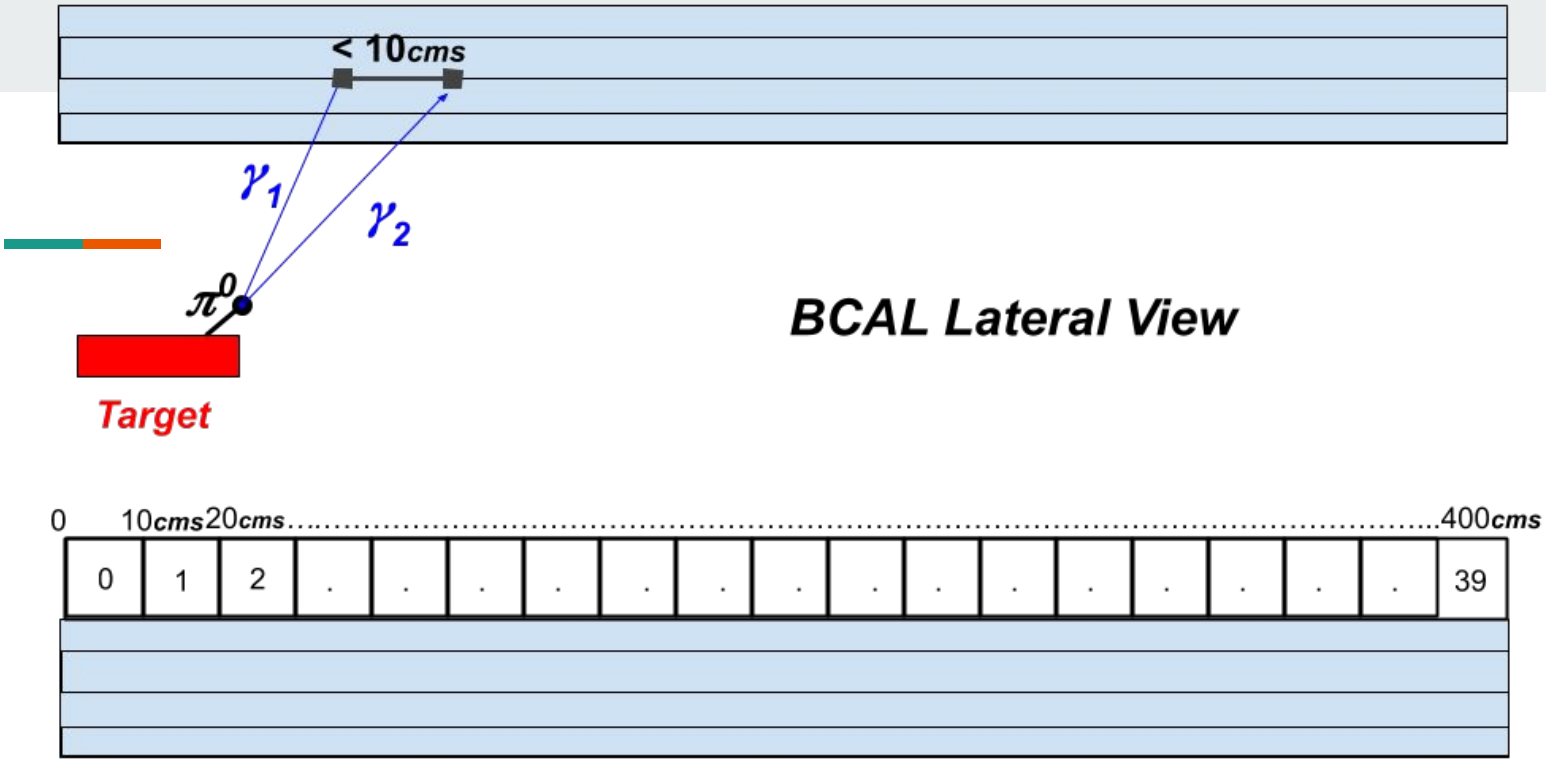
3rd Feb 2020

The main Idea

- Look into the Energy of the reconstructed photon as a function of ‘z’ in the BCAL
- Carry out energy and Position based corrections simultaneously.
- Use Pi0 skims look into the reconstructed mass of pi0 and Make bins o f energy (photon 500 MeV each) and then look into the Reconstructed energy as a function of z and implement corrections for each bins of energy.
- MC (by Mark Dalton) has studied this using photon gun.

- Binning into energy was not feasible since lack of data. Look into following slides. Therefore we made just 1 Bin of energy and corrected for dependance on energy and z independently

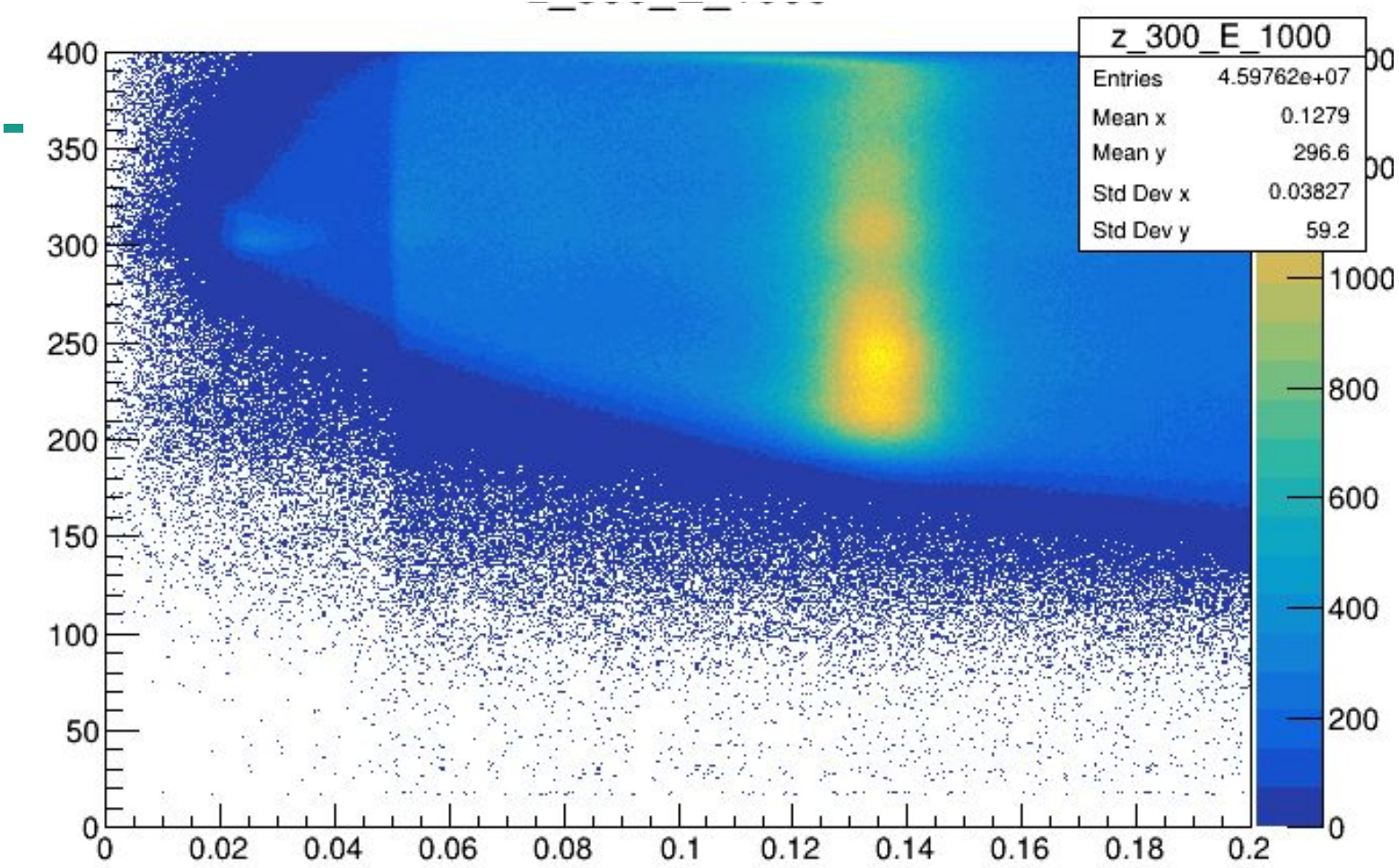


Procedure

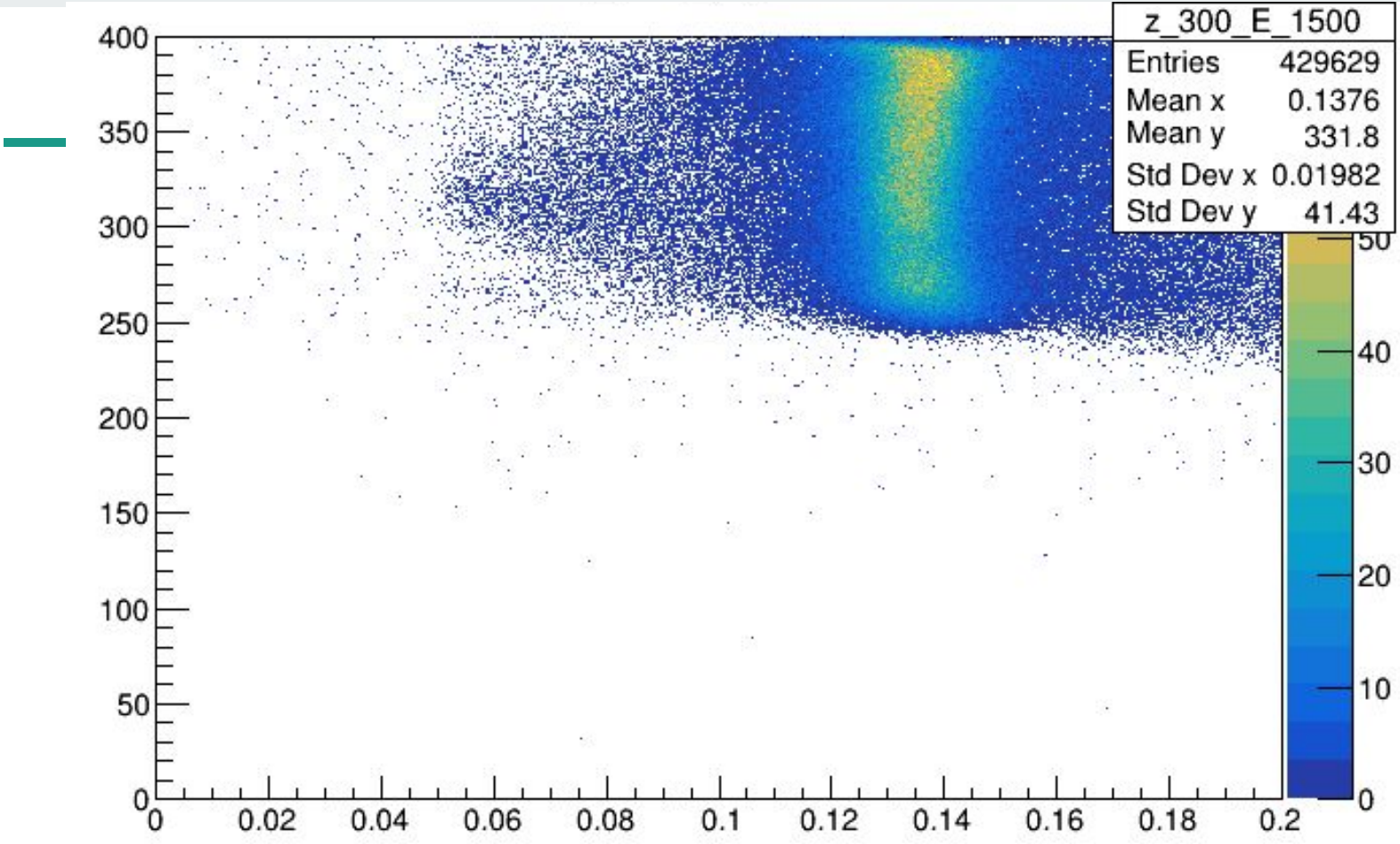
- Used Pi0 skims to do a similar study like the nonlinearity in Energy due to sipm saturation.
- Used the Fall 2018 data (entire data set) for this study
- Tried to compare with MC.

Invariant mass of Pi0 as a function of z in various bins of photon energy bins (500 MeV)

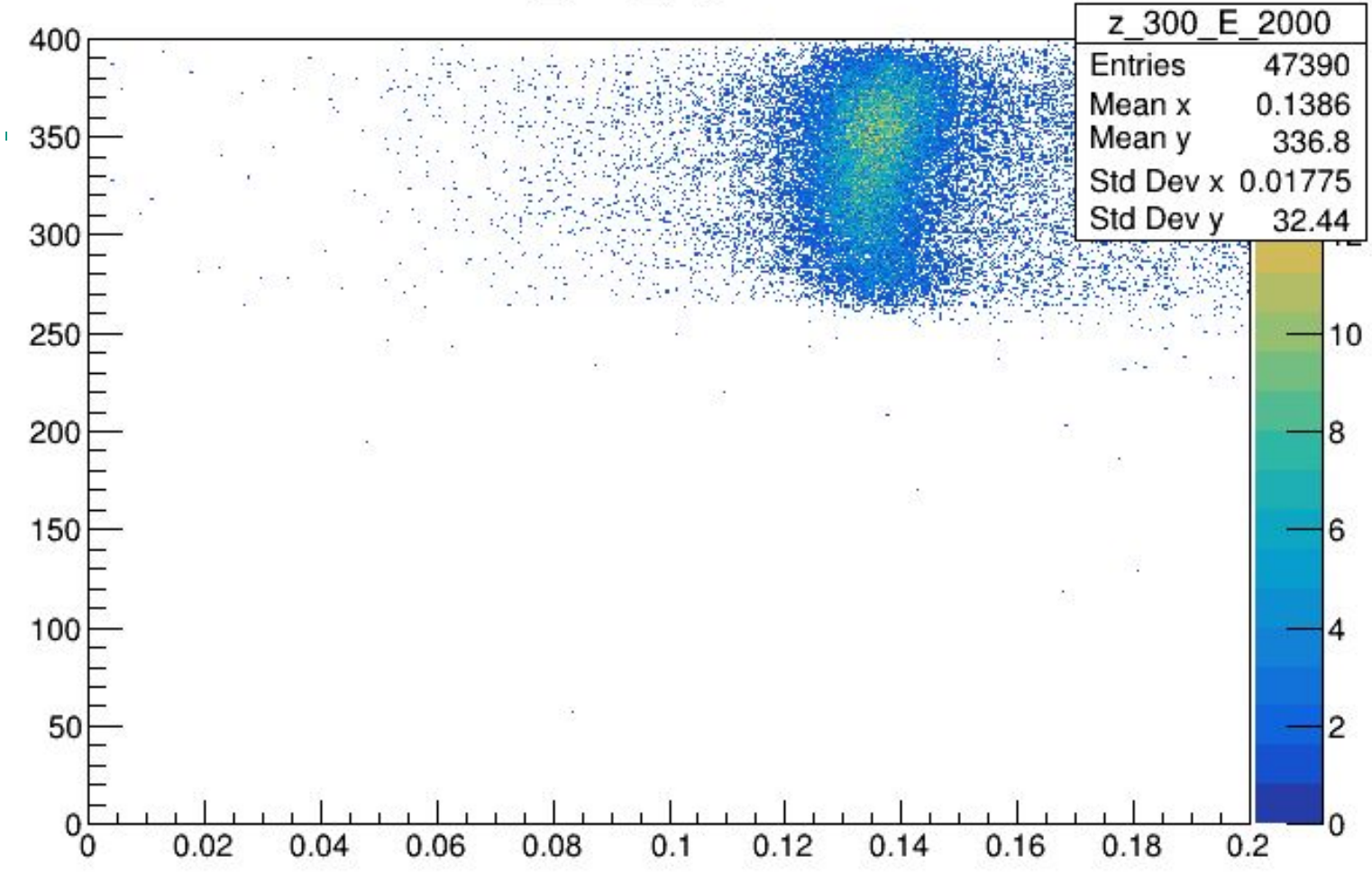
Invariant mass of Pi0 as a function of z with Photons (1 - 1.5 GeV)



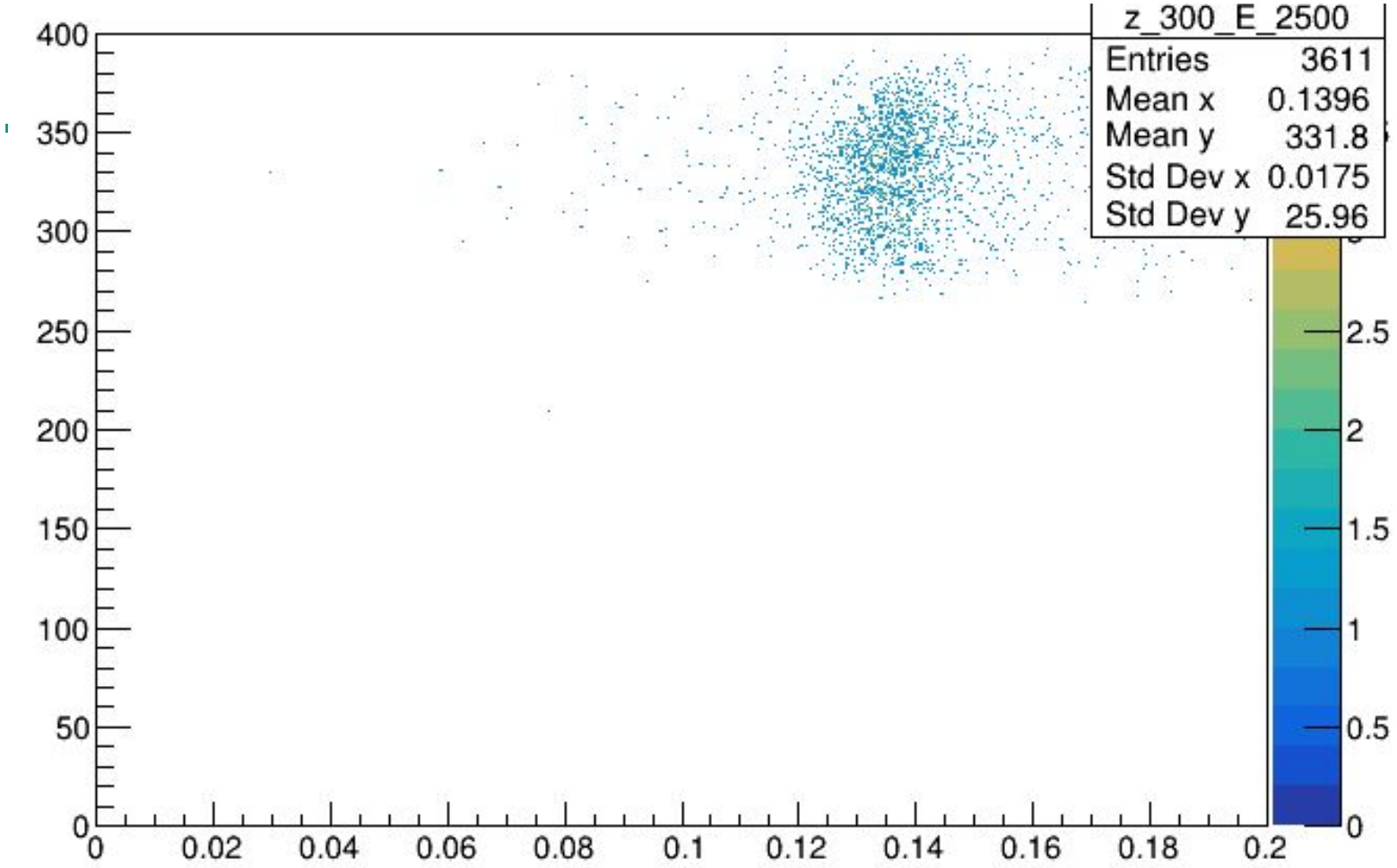
Invariant mass of Pi0 as a function of z with Photons (1.5 - 2.5 GeV)



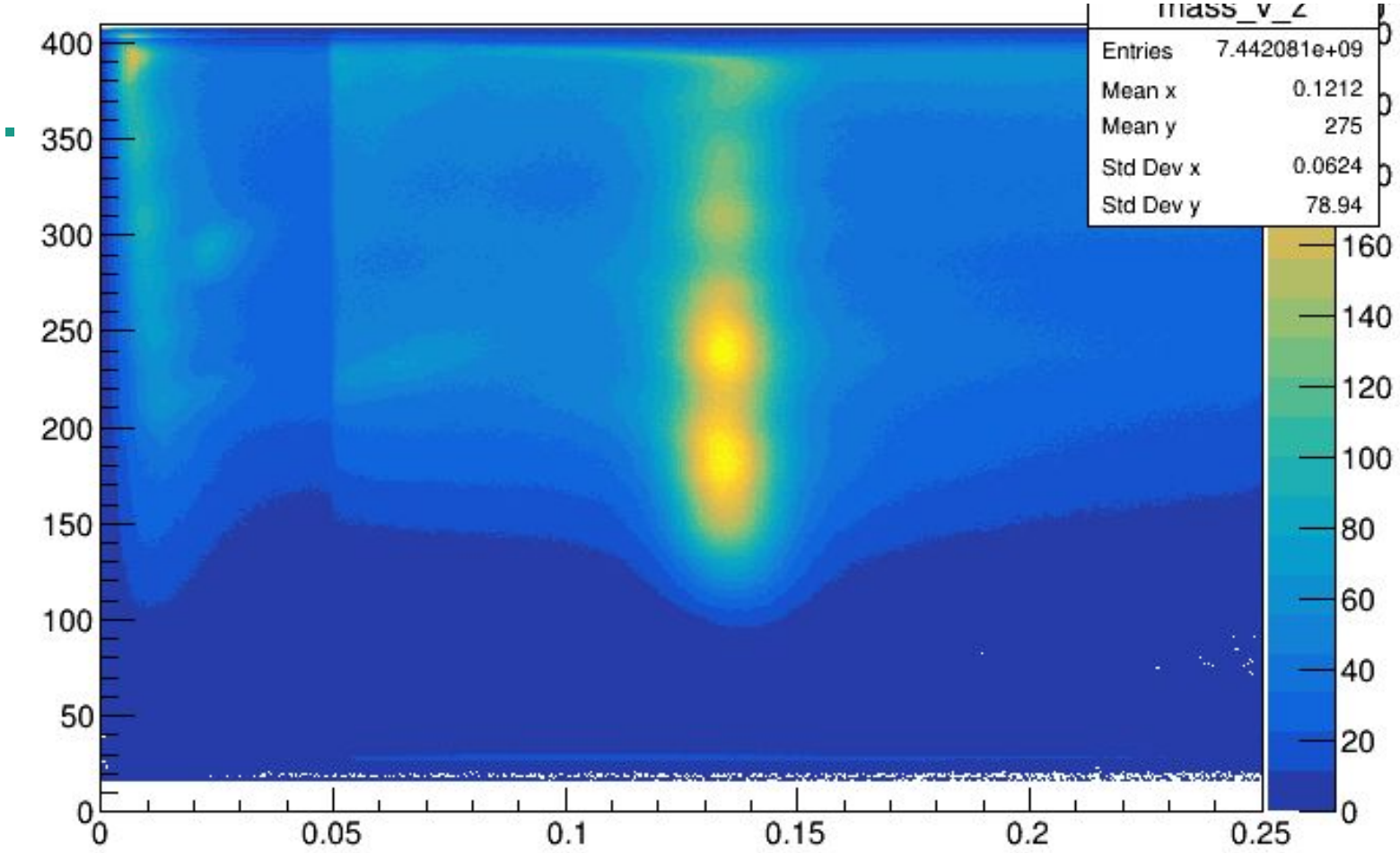
Invariant mass of Pi0 as a function of z with Photons (2- 2.5 GeV)



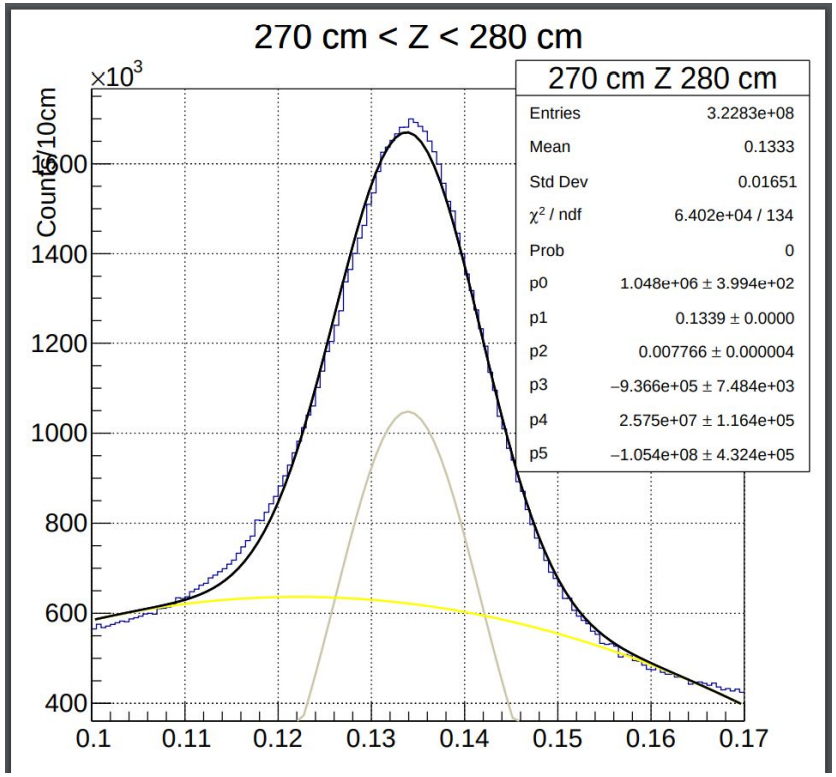
Invariant mass of Pi0 as a function of z with Photons (2.5- 3 GeV)

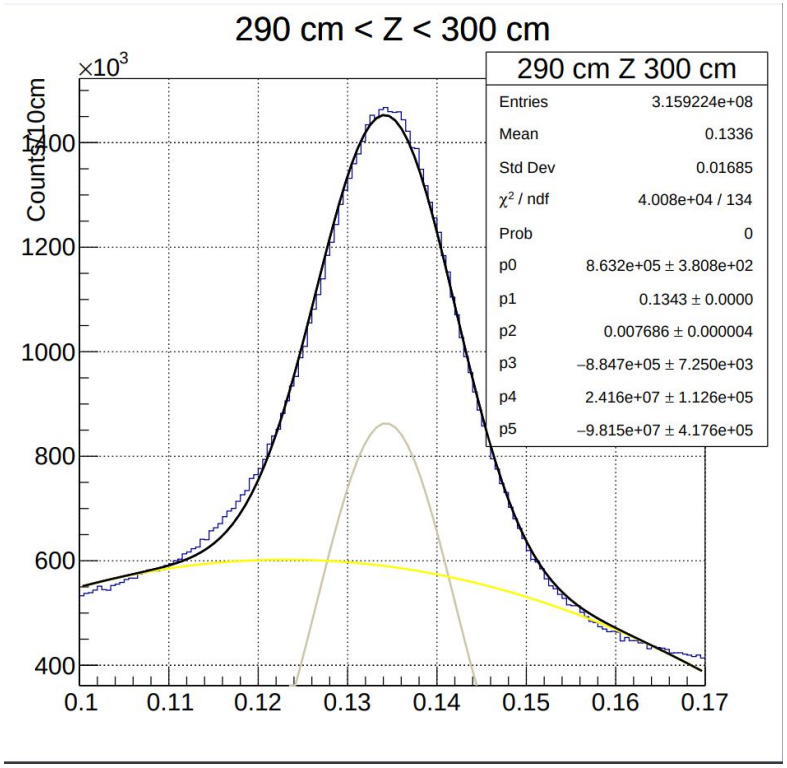


Made just 1 Bin (aggregate all the events in to 1 bin)



Sliced them into 10cm bins and fit Pi0 mass distribution



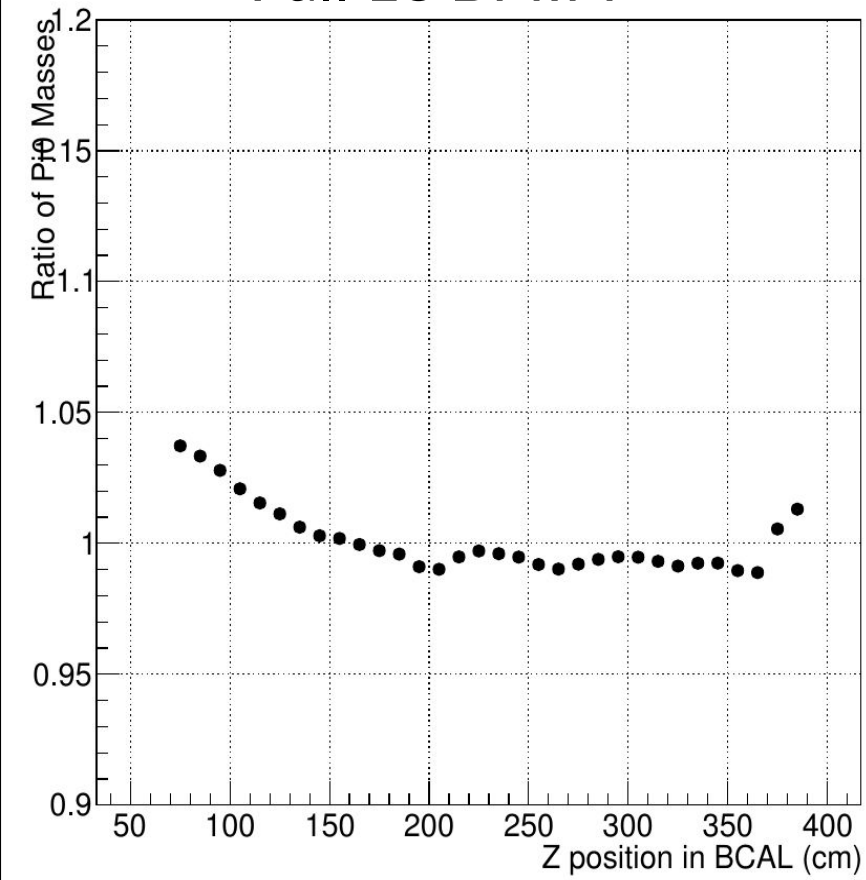


Refer

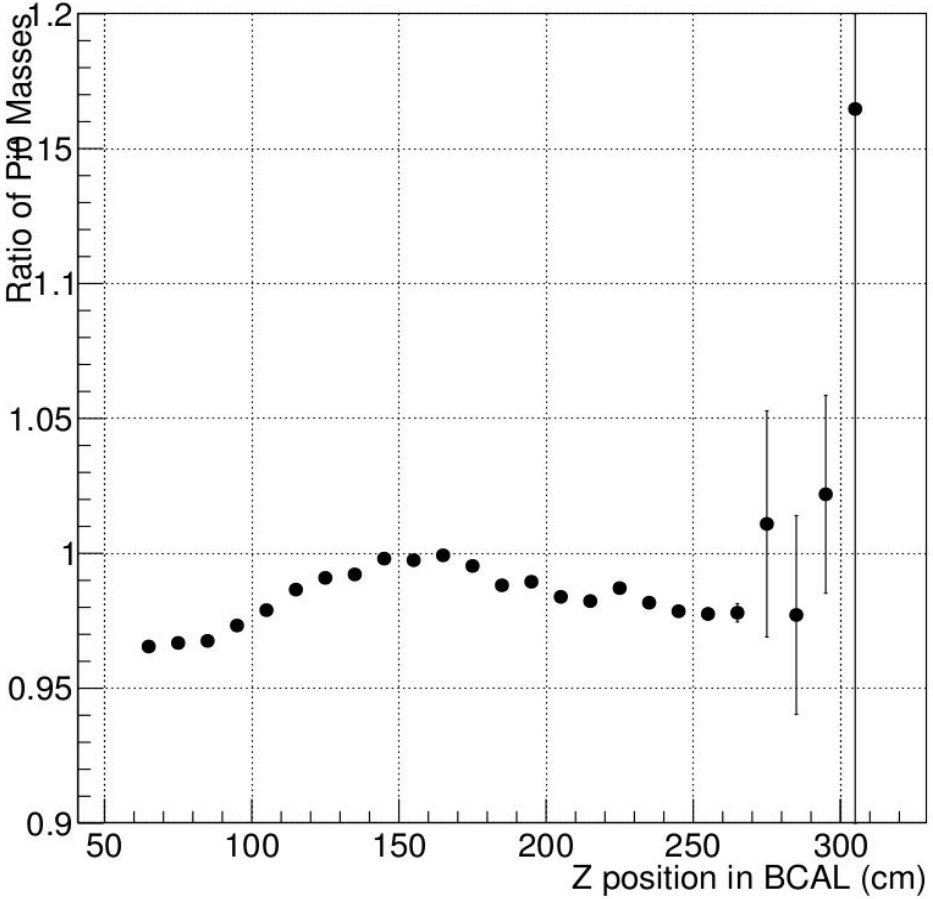
1. https://halldweb.jlab.org/DocDB/0040/004003/003/z_sym_0.pdf
2. https://halldweb.jlab.org/DocDB/0040/004003/002/z_sym_0.pdf

Ratio of pi0 mass as a function of z position in bcal

Fall 18 DATA



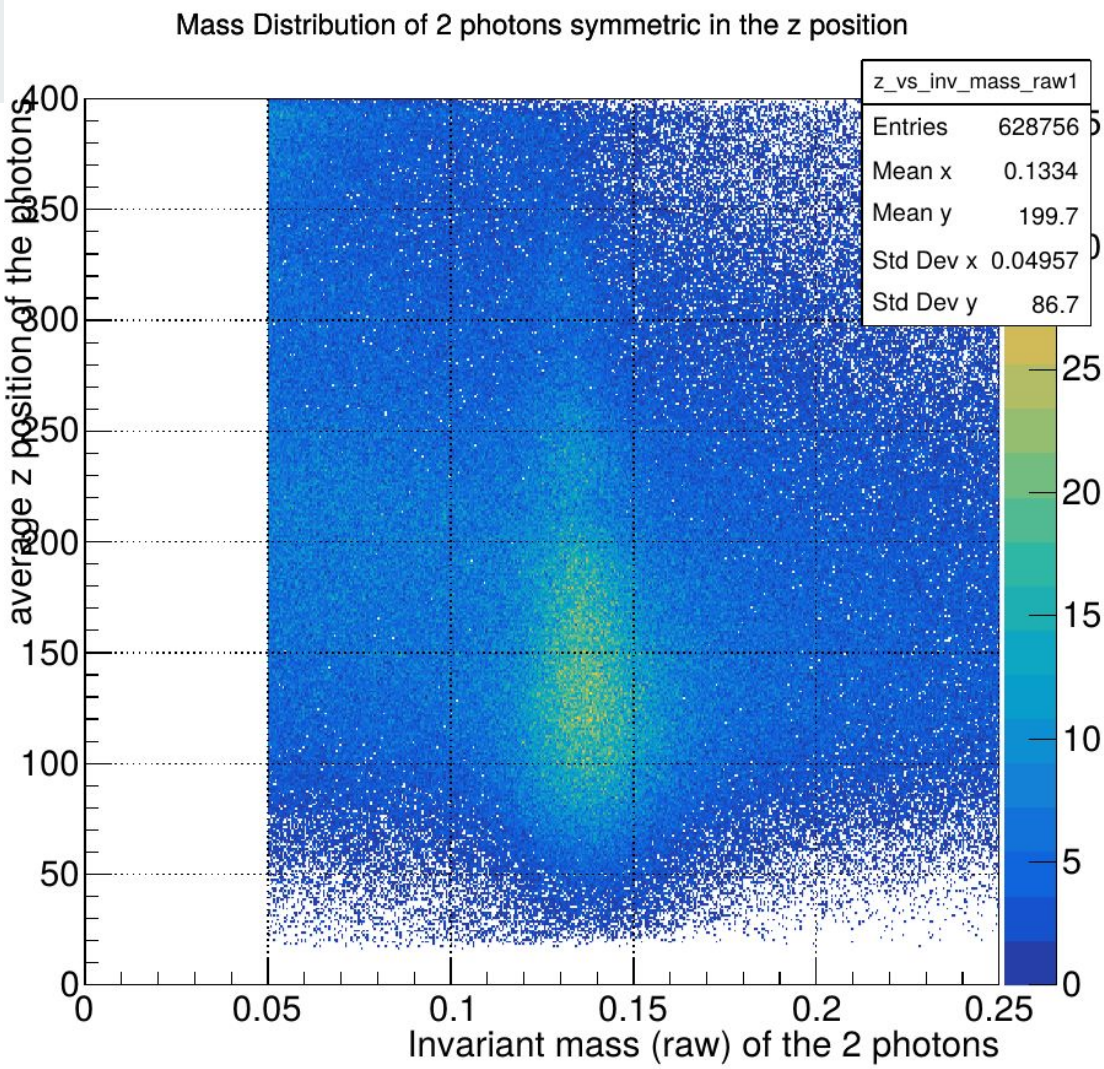
Pi0 MC

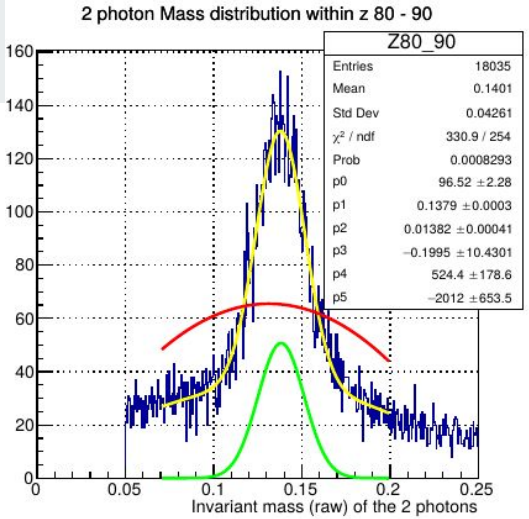


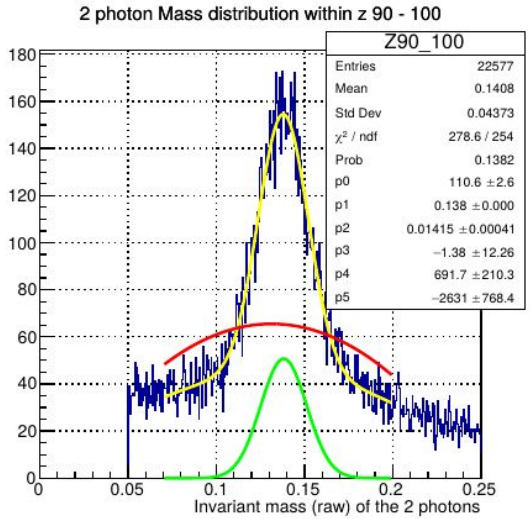
Repeating the same with bggen

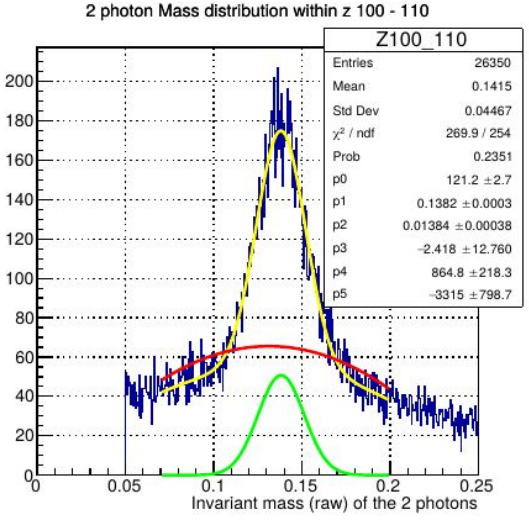
- Potential issue could be the fitting curve and pi0 gun is too pure of a sample to compare with data. Therefore, look into the bggen
- Started off with a bggen sample with run number 30965 (**recon-2017_01-ver03_10.xml**) with 5 Million events with no random noise embedded (had showers peaking at 220 cms).
- Then repeated the same procedure on the bggen sample

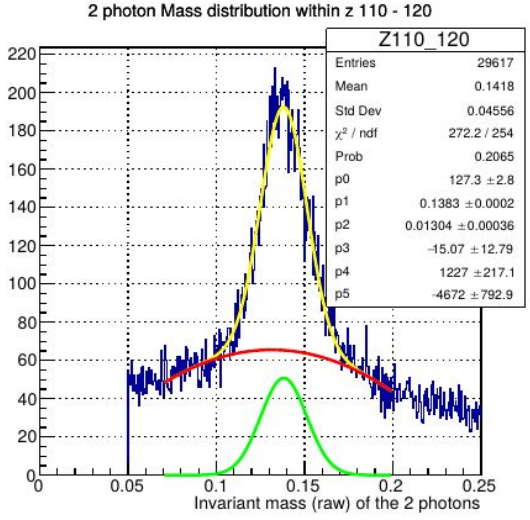
- Not enough statistics
- No Of points in shower > 1
- 0.05 < Invariant mass < 0.25
- Increase statistics ?

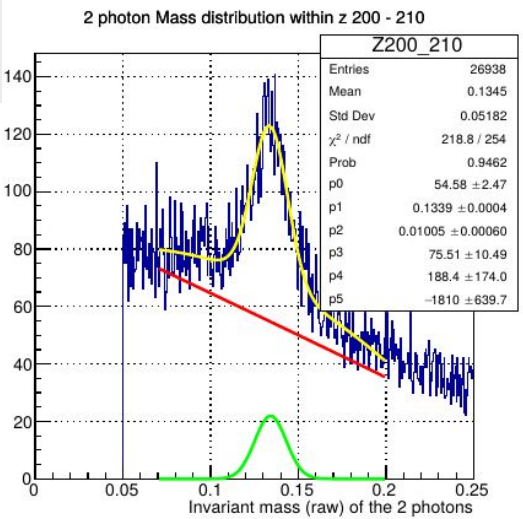


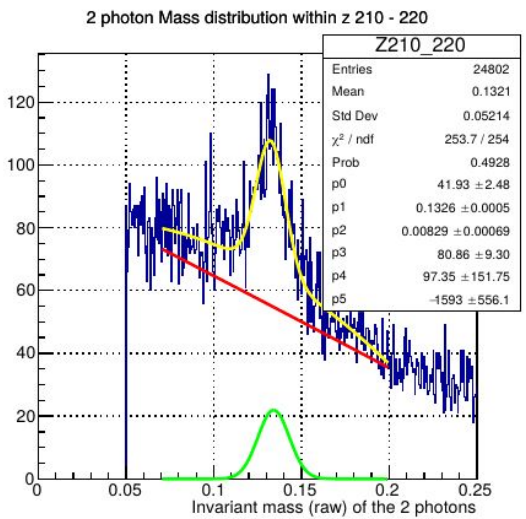

2 photon Mass distribution within z 80 - 90
Z80_90
Entries 18035
Mean 0.1401
Std Dev 0.04261
χ² / ndf 330.9 / 254
Prob 0.0008293
p0 96.52 ±2.28
p1 0.1379 ±0.0003
p2 0.01382 ±0.00041
p3 −0.1995 ±10.4301
p4 524.4 ±178.6
p5 −2012 ±653.5
Invariant mass (raw) of the 2 photons

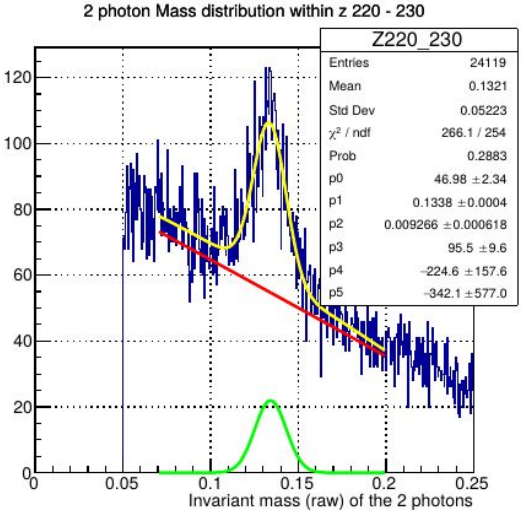

2 photon Mass distribution within z 90 - 100
Z90_100
Entries 22577
Mean 0.1408
Std Dev 0.04373
χ² / ndf 278.6 / 254
Prob 0.1382
p0 110.6 ±2.6
p1 0.138 ±0.000
p2 0.01415 ±0.00041
p3 −1.38 ±12.26
p4 691.7 ±210.3
p5 −2631 ±768.4
Invariant mass (raw) of the 2 photons

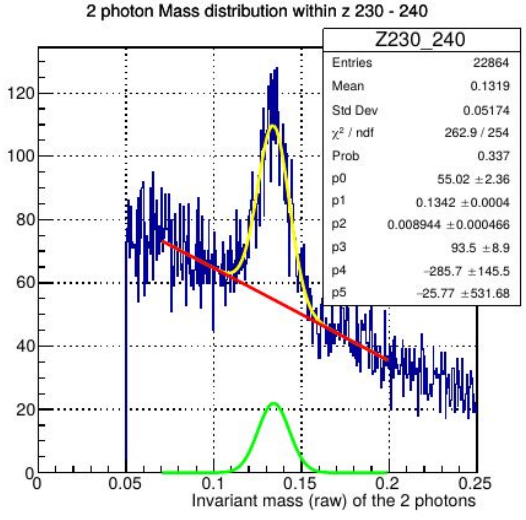

2 photon Mass distribution within z 100 - 110
Z100_110
Entries 26350
Mean 0.1415
Std Dev 0.04467
χ² / ndf 269.9 / 254
Prob 0.2351
p0 121.2 ±2.7
p1 0.1382 ±0.0003
p2 0.01384 ±0.00038
p3 −2.418 ±12.760
p4 864.8 ±218.3
p5 −3315 ±798.7
Invariant mass (raw) of the 2 photons

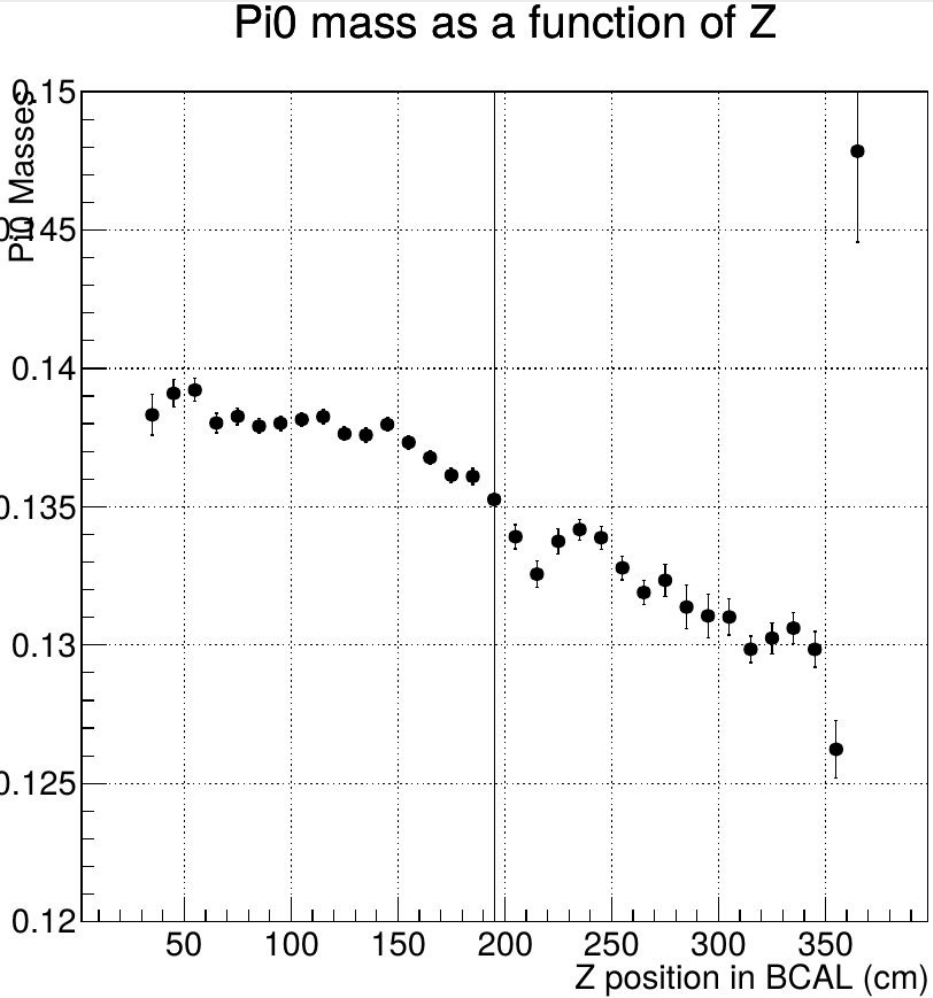

2 photon Mass distribution within z 110 - 120
Z110_120
Entries 29617
Mean 0.1418
Std Dev 0.04556
χ² / ndf 272.2 / 254
Prob 0.2065
p0 127.3 ±2.8
p1 0.1383 ±0.0002
p2 0.01304 ±0.00036
p3 −15.07 ±12.79
p4 1227 ±217.1
p5 −4672 ±792.9
Invariant mass (raw) of the 2 photons

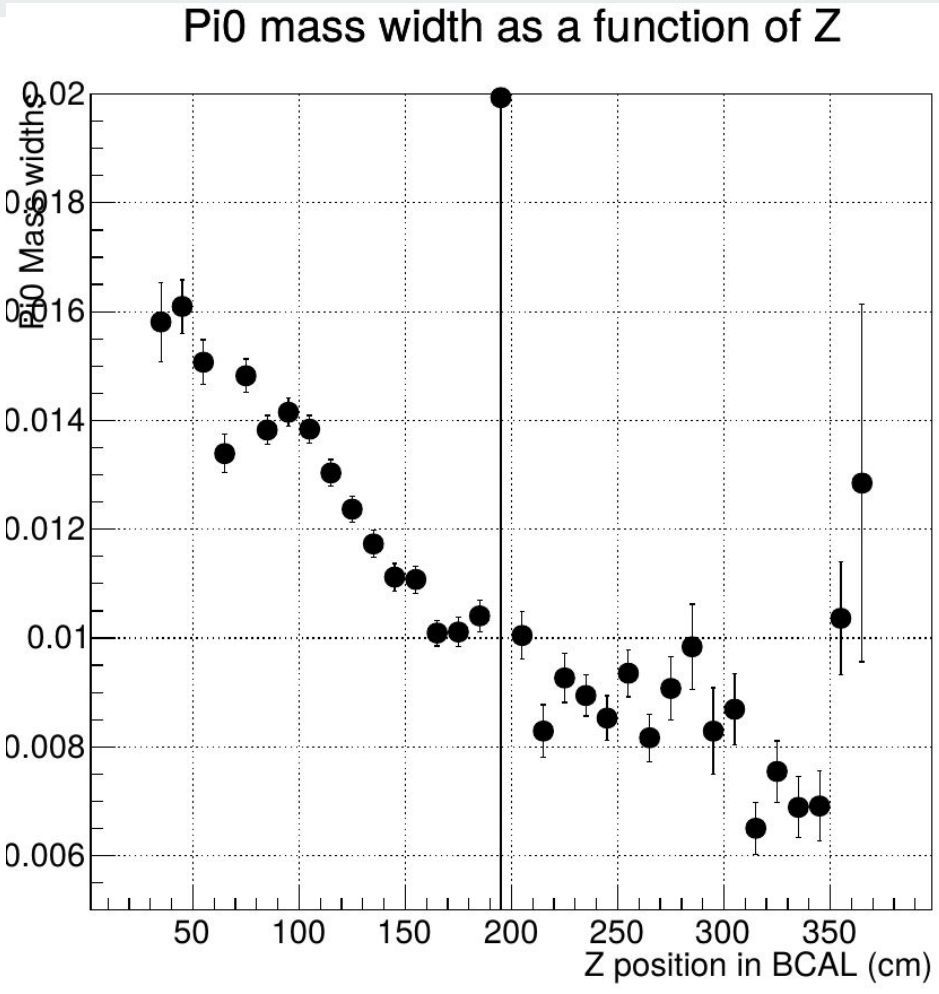

2 photon Mass distribution within z 200 - 210
Z200_210
Entries 26938
Mean 0.1345
Std Dev 0.05182
χ² / ndf 218.8 / 254
Prob 0.9462
p0 54.58 ±2.47
p1 0.1339 ±0.0004
p2 0.01005 ±0.00060
p3 75.51 ±10.49
p4 188.4 ±174.0
p5 −1810 ±639.7
Invariant mass (raw) of the 2 photons


2 photon Mass distribution within z 210 - 220
Z210_220
Entries 24802
Mean 0.1321
Std Dev 0.05214
χ² / ndf 253.7 / 254
Prob 0.4928
p0 41.93 ±2.48
p1 0.1326 ±0.0005
p2 0.00829 ±0.00069
p3 80.86 ±9.30
p4 97.35 ±151.75
p5 −1593 ±556.1
Invariant mass (raw) of the 2 photons


2 photon Mass distribution within z 220 - 230
Z220_230
Entries 24119
Mean 0.1321
Std Dev 0.05223
χ² / ndf 266.1 / 254
Prob 0.2883
p0 46.98 ±2.34
p1 0.1338 ±0.0004
p2 0.009266 ±0.000618
p3 95.5 ±9.6
p4 −224.6 ±157.6
p5 −342.1 ±577.0
Invariant mass (raw) of the 2 photons


2 photon Mass distribution within z 230 - 240
Z230_240
Entries 22864
Mean 0.1319
Std Dev 0.05174
χ² / ndf 262.9 / 254
Prob 0.337
p0 55.02 ±2.36
p1 0.1342 ±0.0004
p2 0.008944 ±0.000466
p3 93.5 ±8.9
p4 −285.7 ±145.5
p5 −25.77 ±531.68
Invariant mass (raw) of the 2 photons


Pi0 mass as a function of Z
Pi0 Masses
0.15
0.145
0.14
0.135
0.13
0.125
0.12
50
100
150
200
250
300
350
Z position in BCAL (cm)

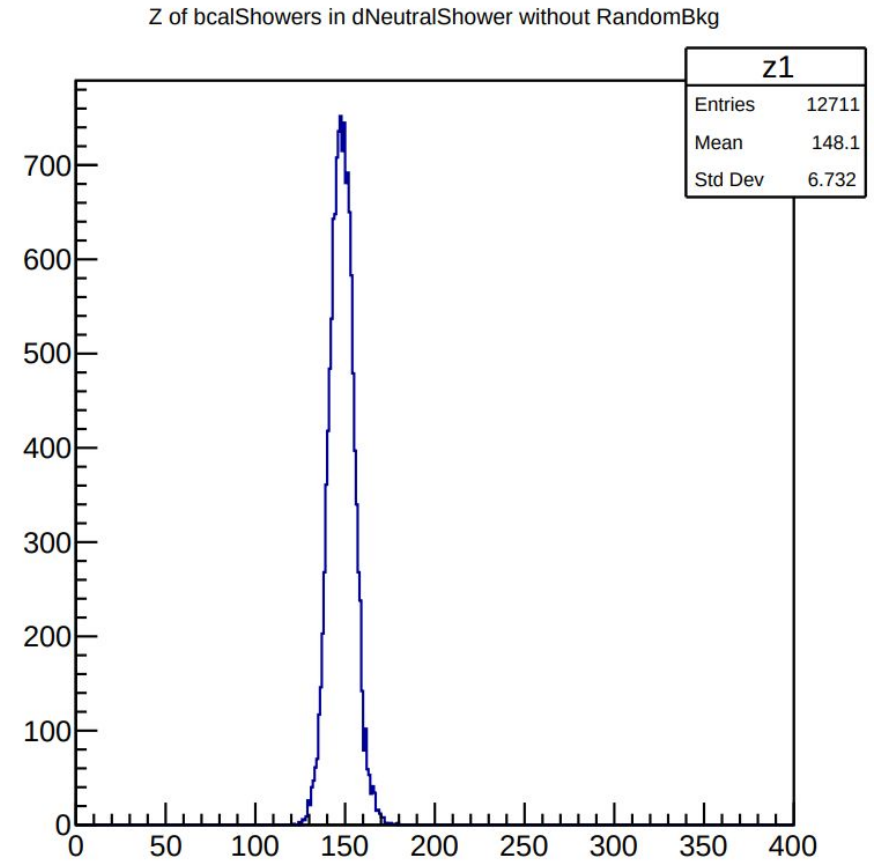

Pi0 mass width as a function of Z
Pi0 Mass widths
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
50
100
150
200
250
300
350
Z position in BCAL (cm)

Next steps

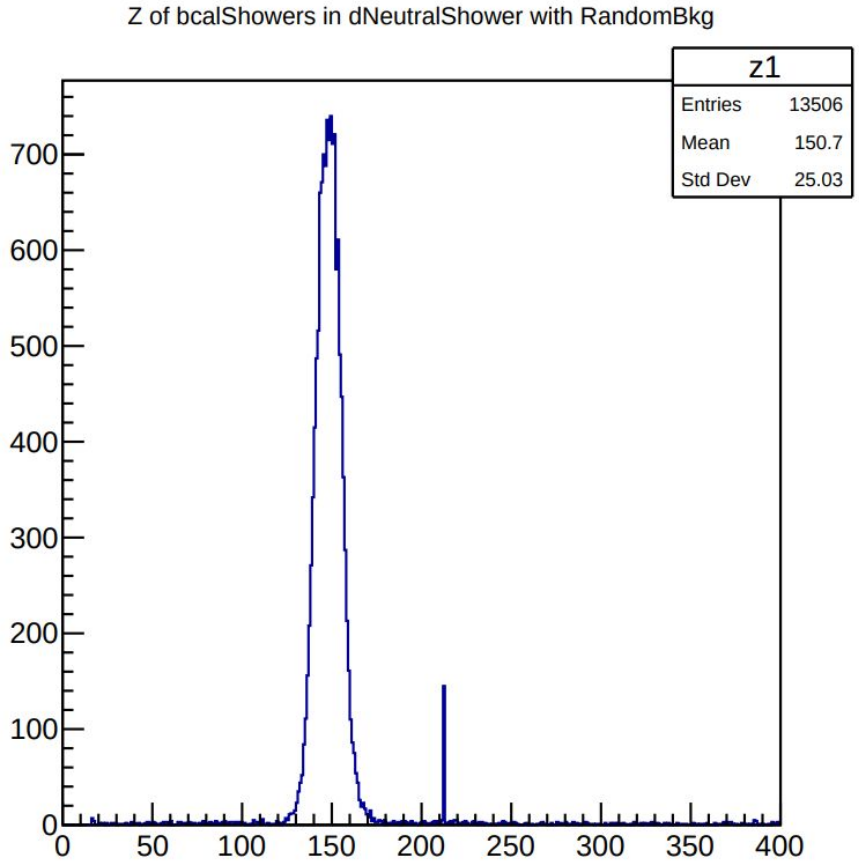
- Increased the statistics by another 10M now. Compiling the new results
- Understand the background for fitting once enough statistics is produced

backups

Embedding noise (pi0 gun , thrown z = 150 cms)

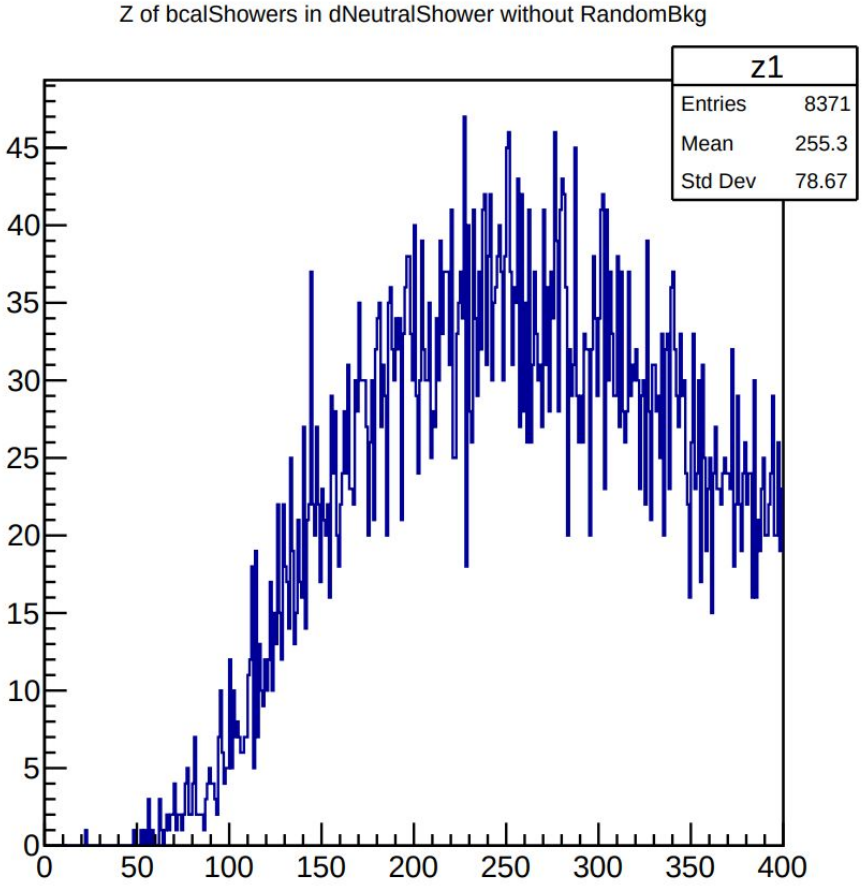


Run 50904 pi0 gun sample has BKG=None

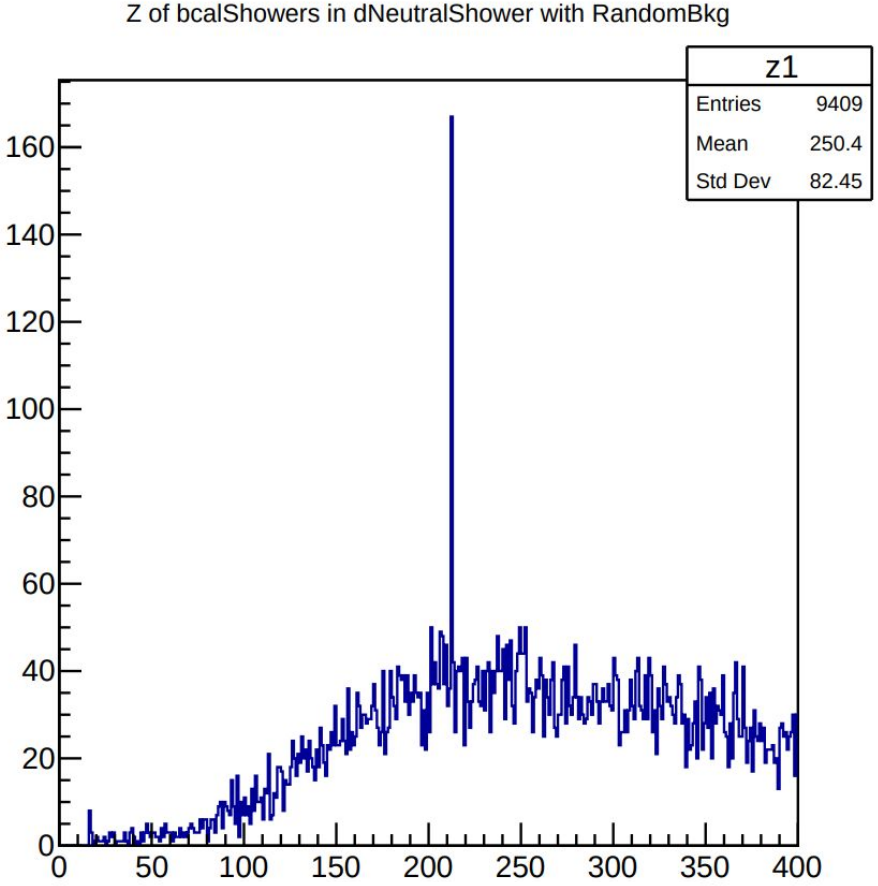


Run 50904 pi0 gun sample has BKG=Random:recon-2018_08-ver02

Embedding noise (bggen , thrown z = 150 cms)



Run 50904 bggen sample has BKG=None



Run 50904 bggen sample has BKG=Random:recon-2018_08-ver02