



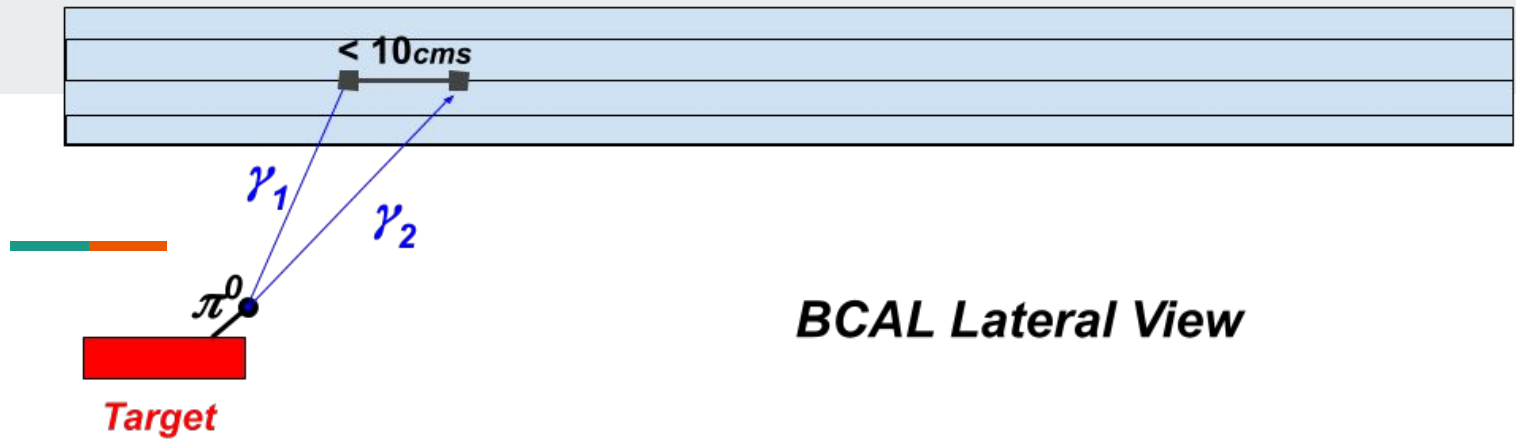
# **z-dependence of the BCAL $\pi^0$ energy calibration (Update)**

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3rd Feb 2020

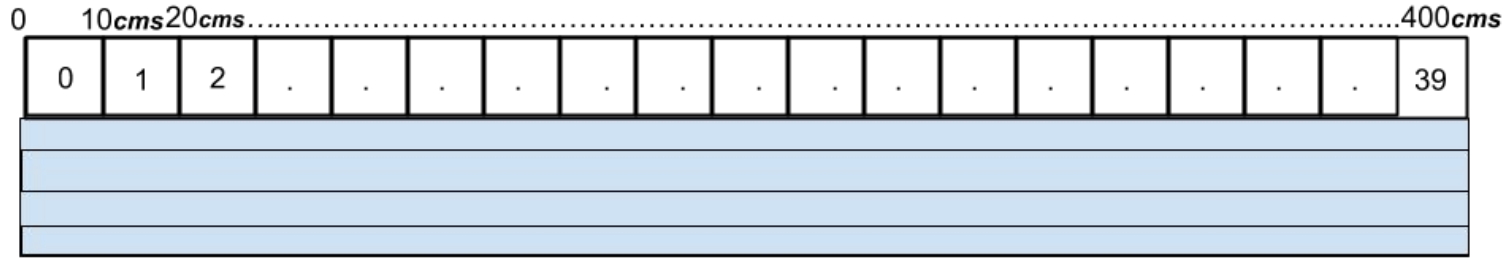
# The main Idea



- 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 of 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.
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- 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



**BCAL Lateral View**



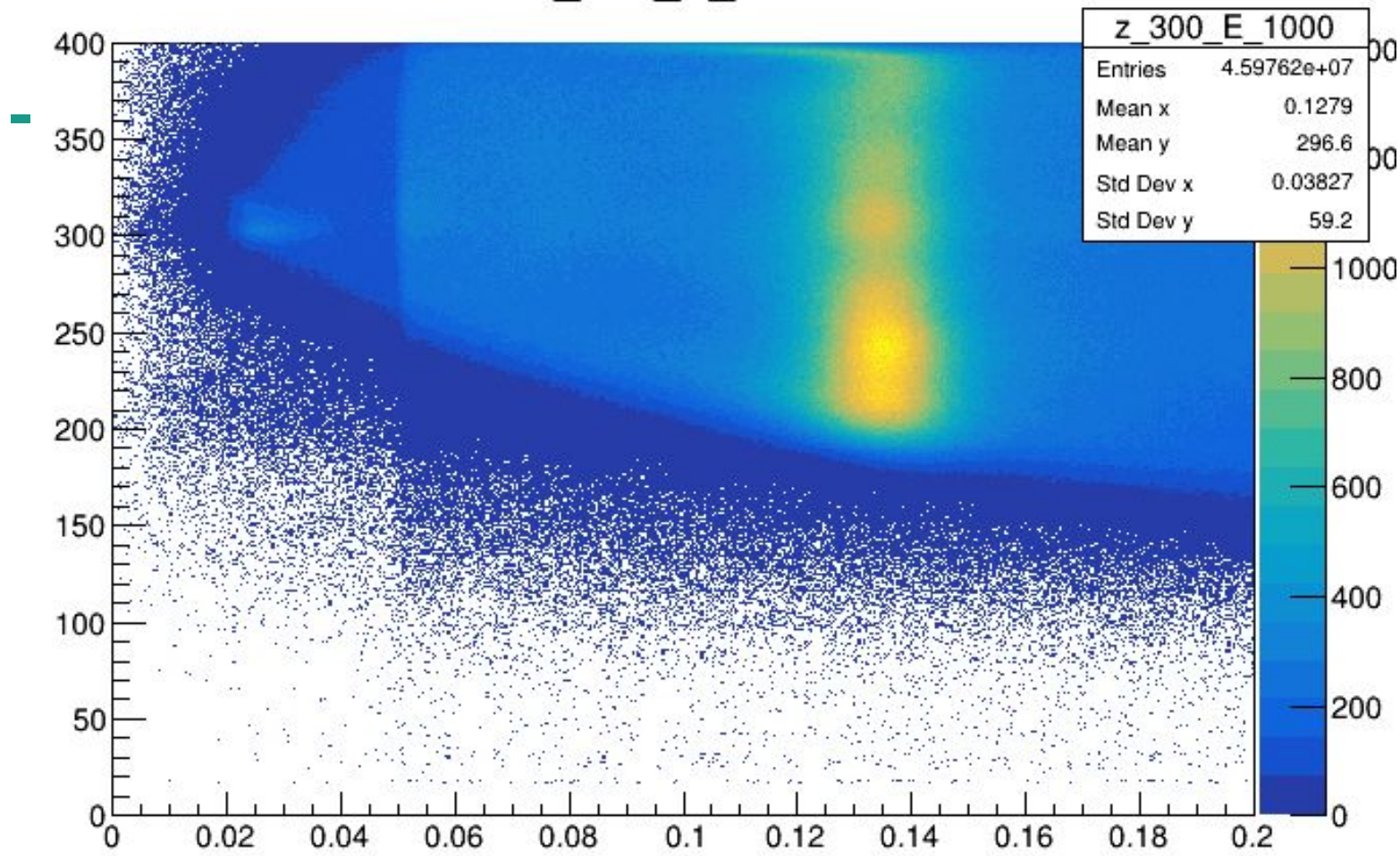
# Procedure

- 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.

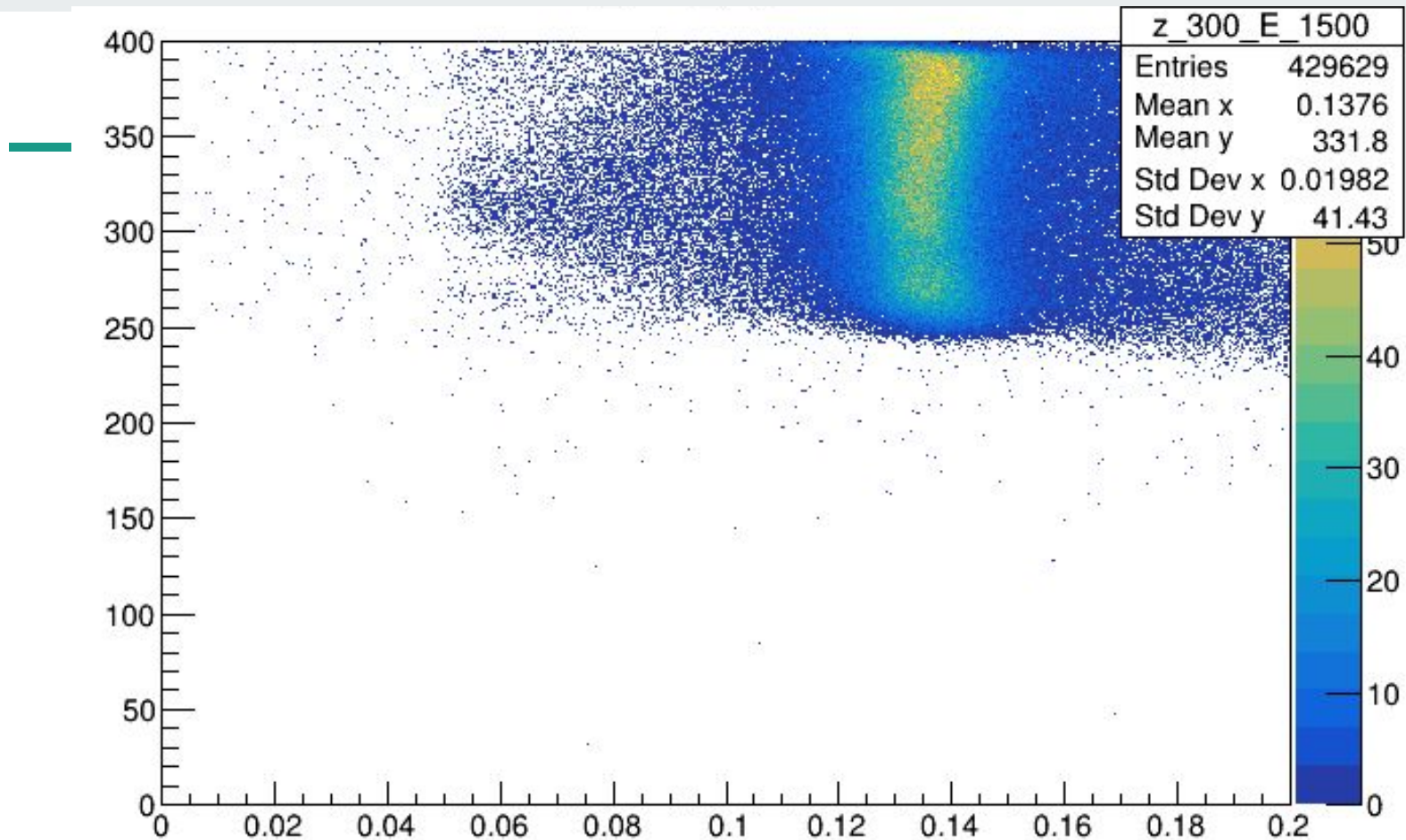


# Invariant mass of $Pi0$ as a function of $z$ in various bins of photon energy bins (500 MeV)

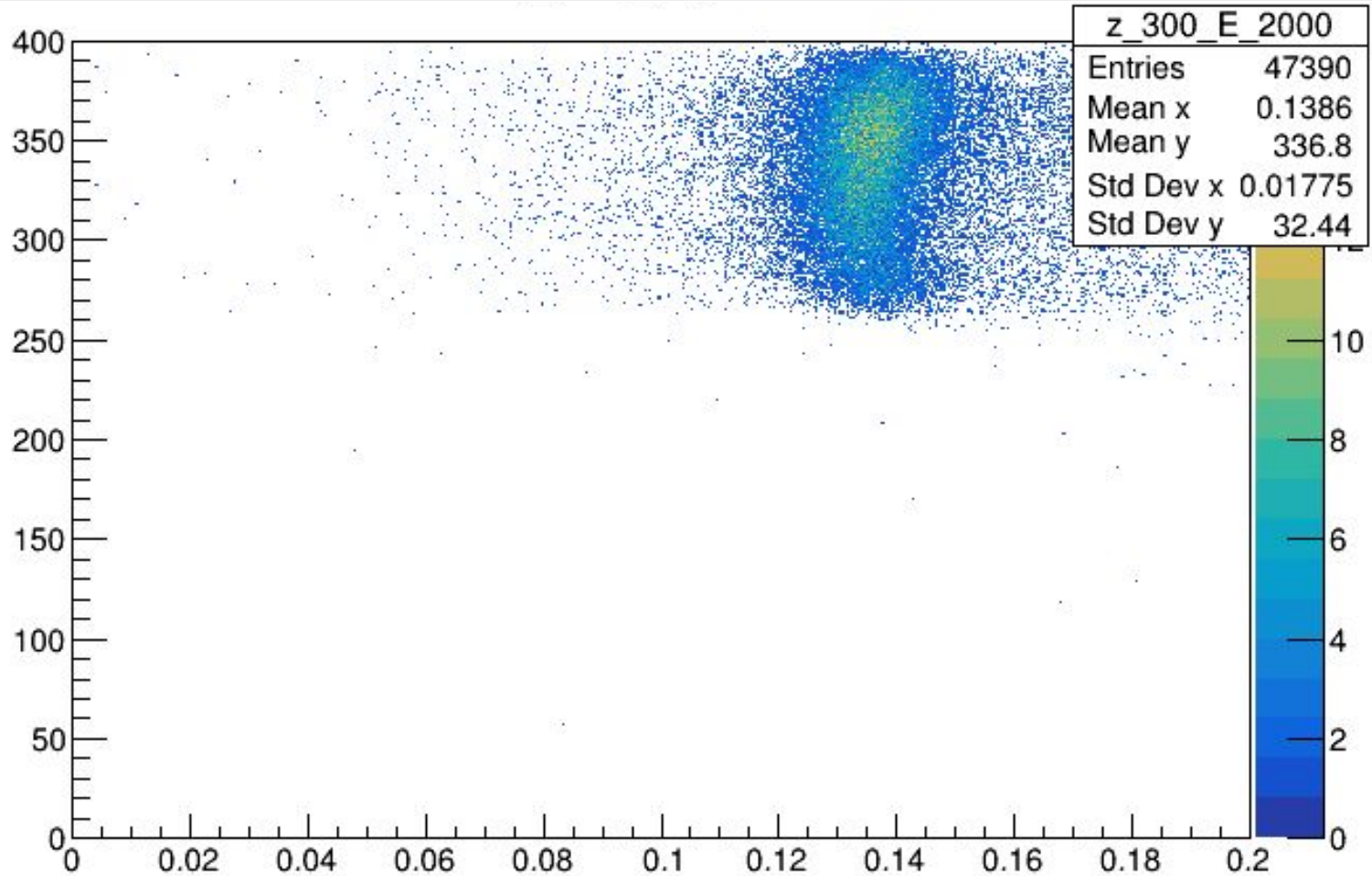
# Invariant mass of $\text{Pio}$ as a function of $z$ with Photons (1 - 1.5 GeV)



# Invariant mass of $\text{P}i_0$ as a function of $z$ with Photons (1.5 - 2.5 GeV)

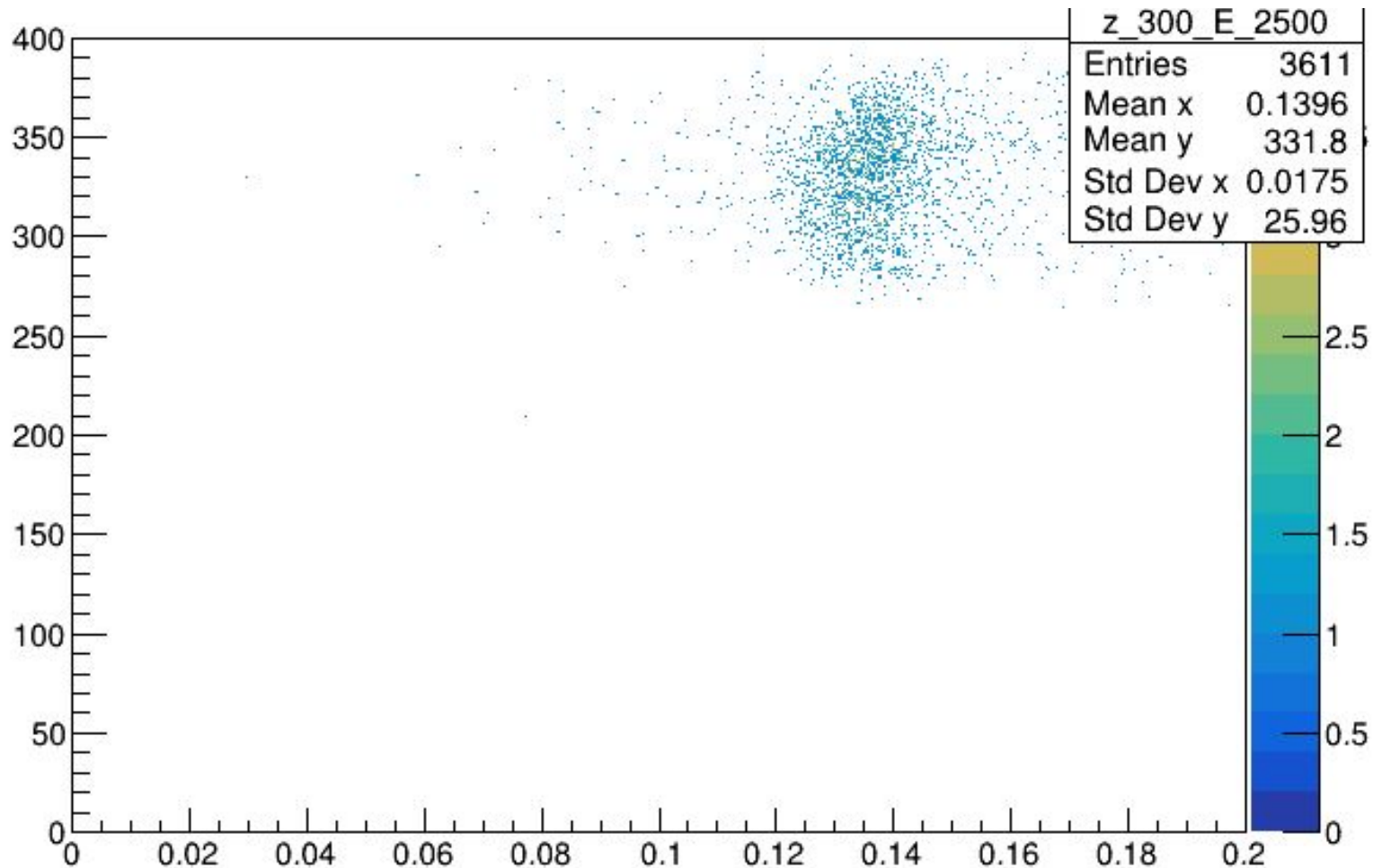


# Invariant mass of $\text{Pio}$ as a function of $z$ with Photons (2- 2.5 GeV)



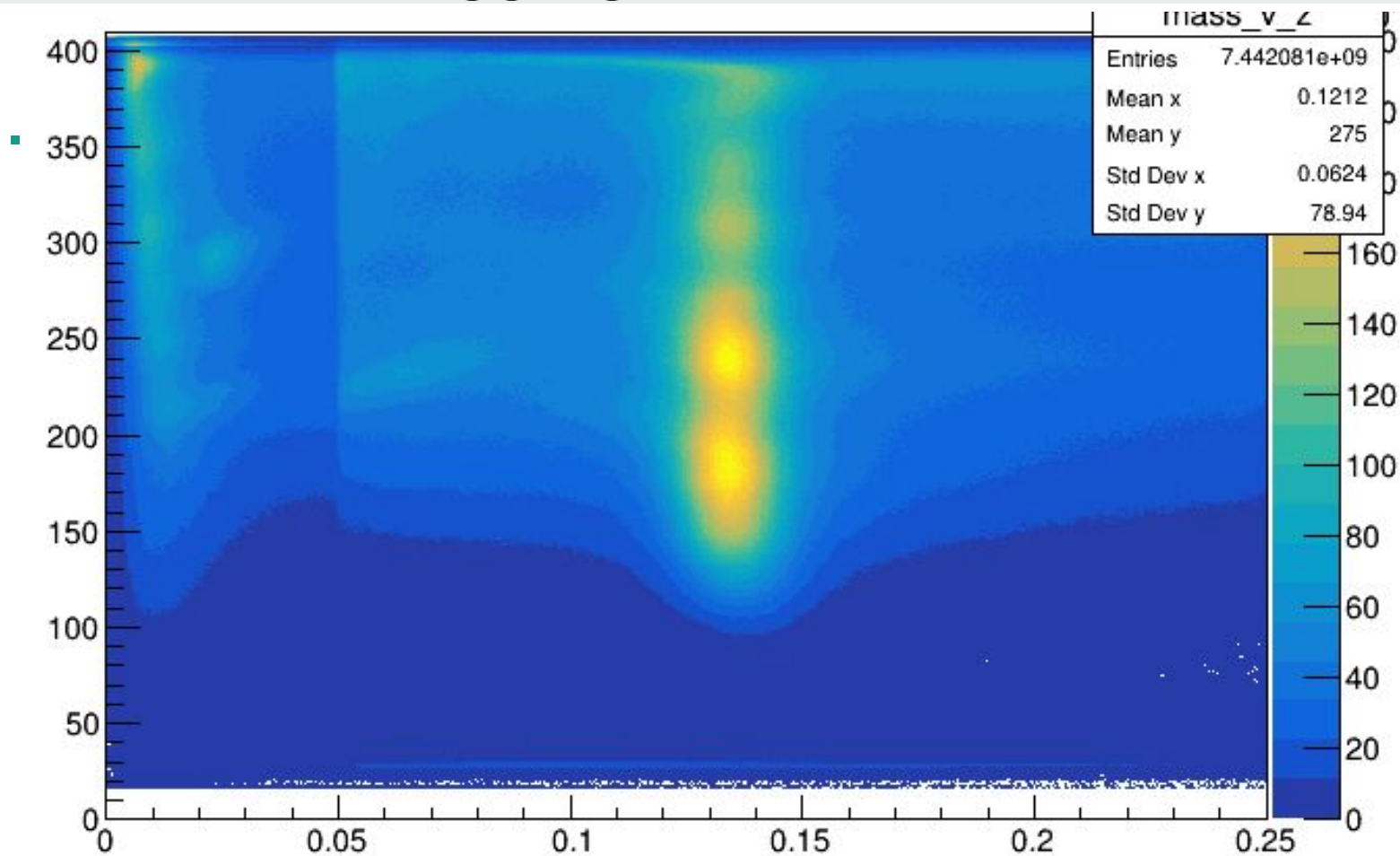


# Invariant mass of $\text{P}_{i0}$ as a function of $z$ with Photons (2.5- 3 GeV)

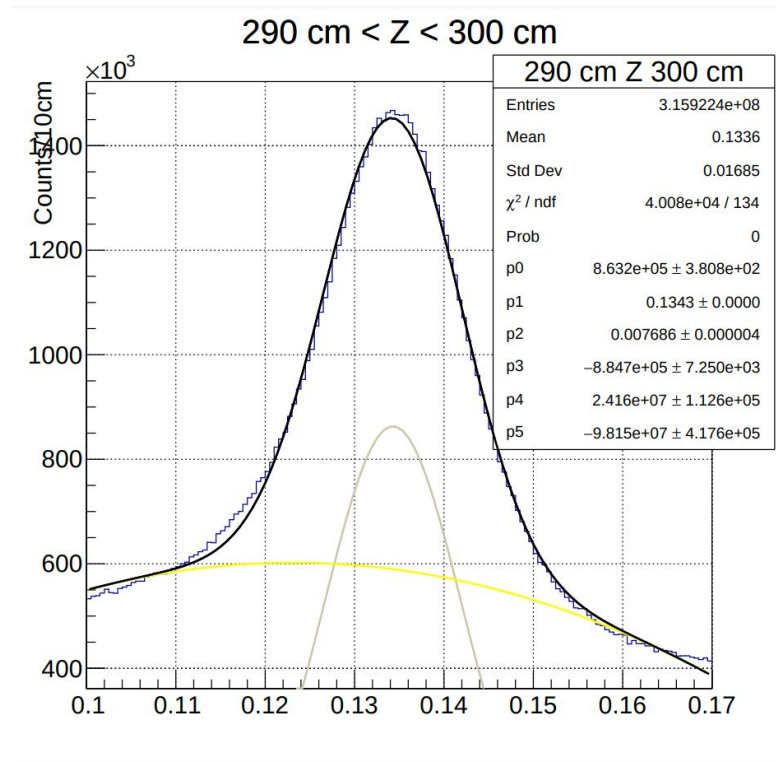
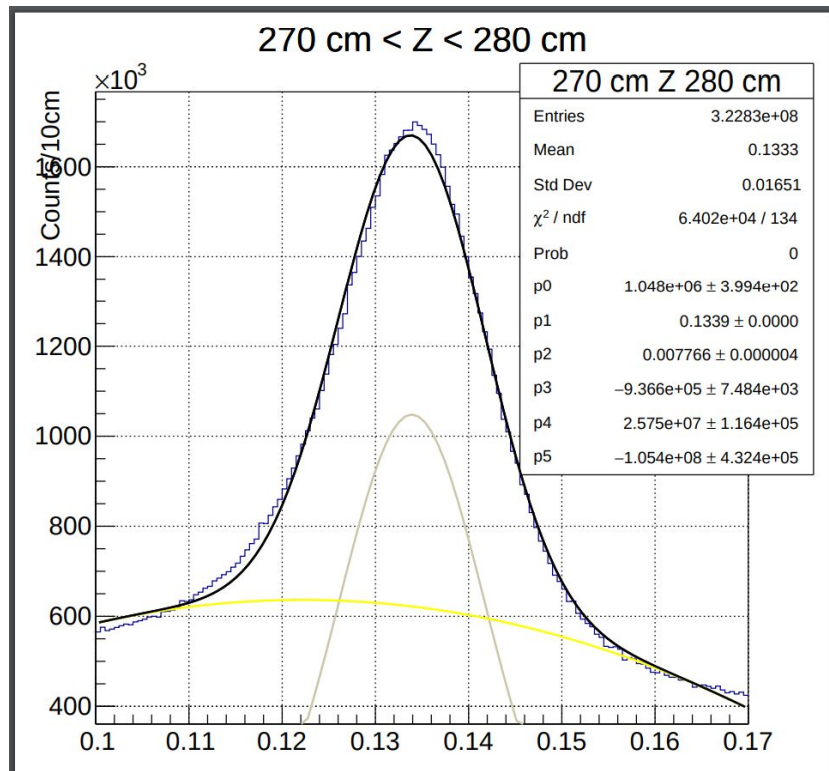




# Made just 1 Bin (aggregate all the events in to 1 bin)



# Sliced them into 10cm bins and fit P<sub>0</sub> mass distribution

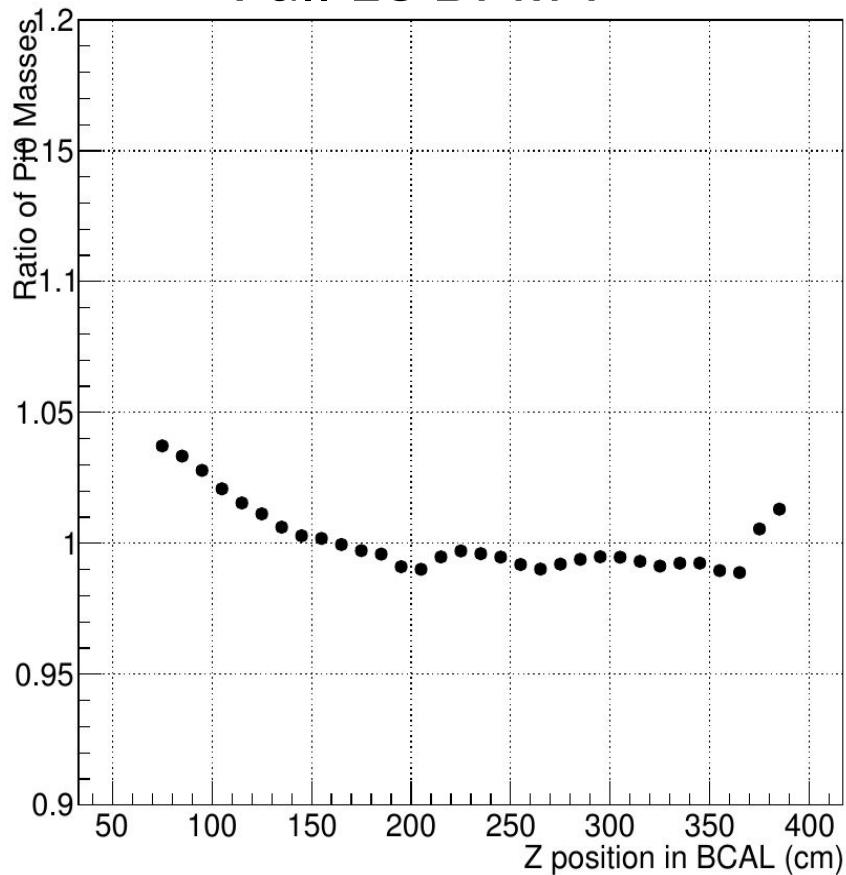


Refer

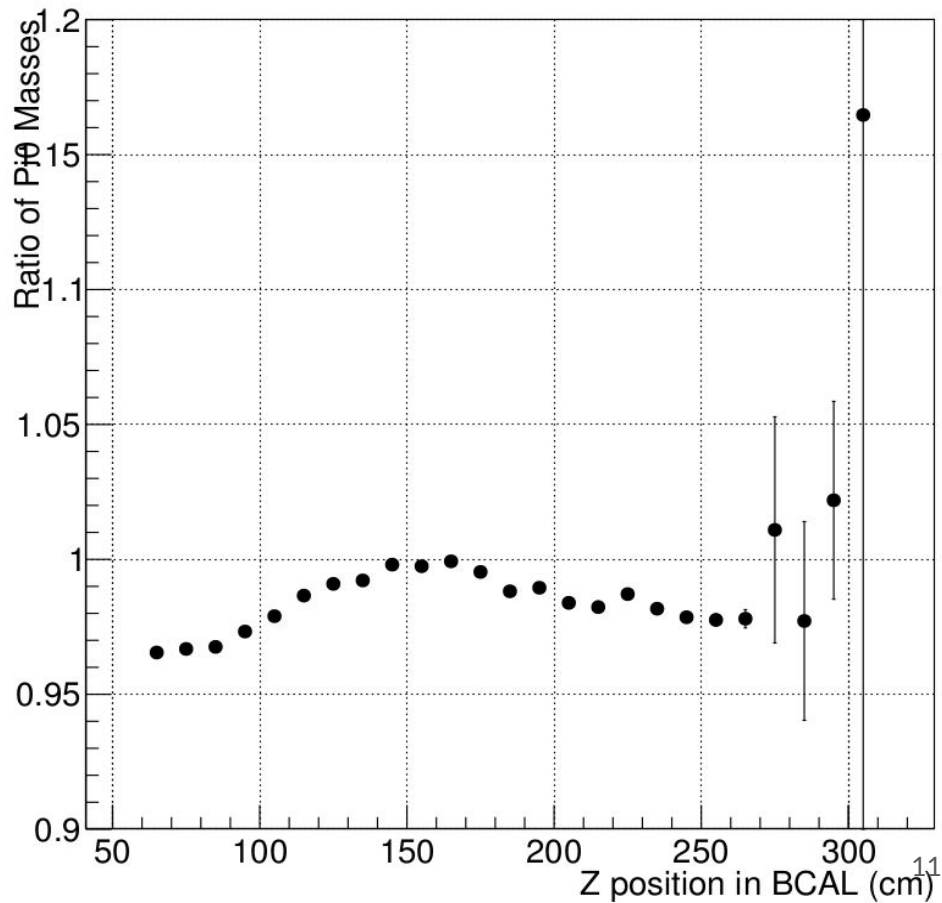
1. [https://halldweb.jlab.org/DocDB/0040/004003/003/z\\_sym\\_0.pdf](https://halldweb.jlab.org/DocDB/0040/004003/003/z_sym_0.pdf)
2. [https://halldweb.jlab.org/DocDB/0040/004003/002/z\\_sym\\_0.pdf](https://halldweb.jlab.org/DocDB/0040/004003/002/z_sym_0.pdf)

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

## Fall 18 DATA



## Pi0 MC



# Repeating the same with bggen

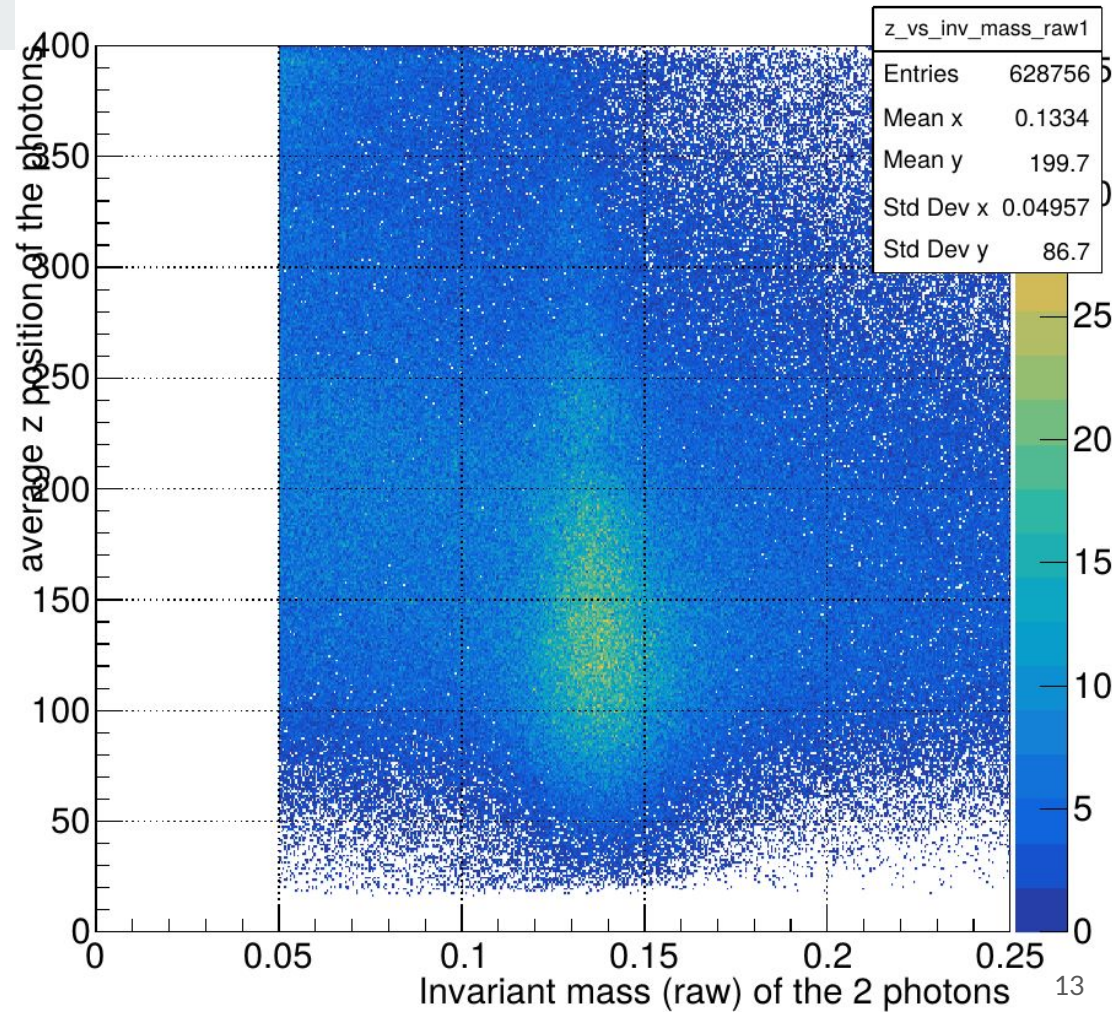


- Potential issue could be the fitting curve and pi0 gun is too pure of a sample to compare with data. Therefore, look into the bggen
- Started off with a bggen sample with run number 30965 (**recon-2017\_01-ver03\_10.xml**) with 5 Million events with no random noise embedded (had showers peaking at 220 cms).
- Then repeated the same procedure on the bggen sample

Mass Distribution of 2 photons symmetric in the z position

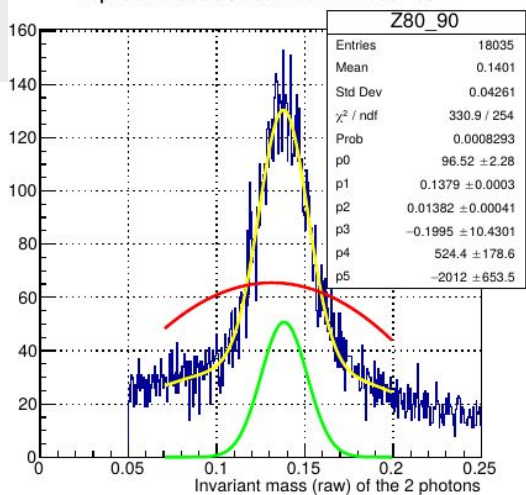


- Not enough statistics
- No Of points in shower > 1
- $0.05 < \text{Invariant mass} < 0.25$
- Increase statistics ?

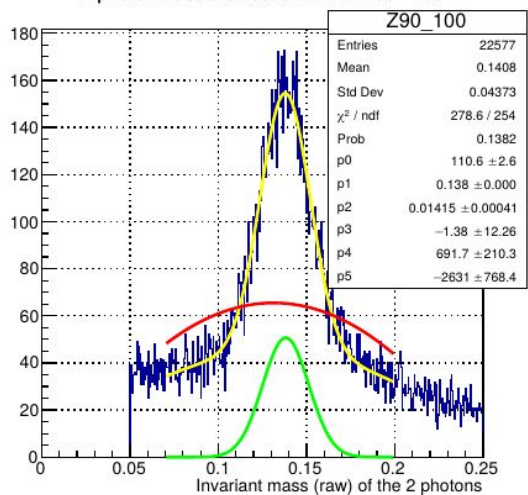




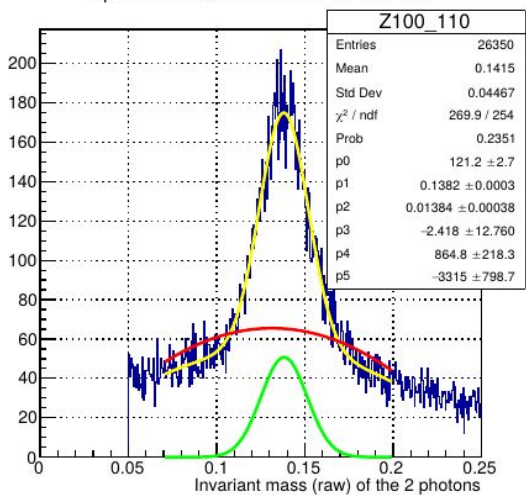
2 photon Mass distribution within z 80 - 90



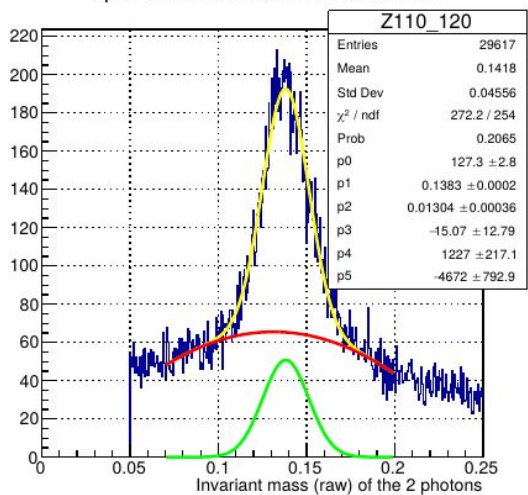
2 photon Mass distribution within z 90 - 100



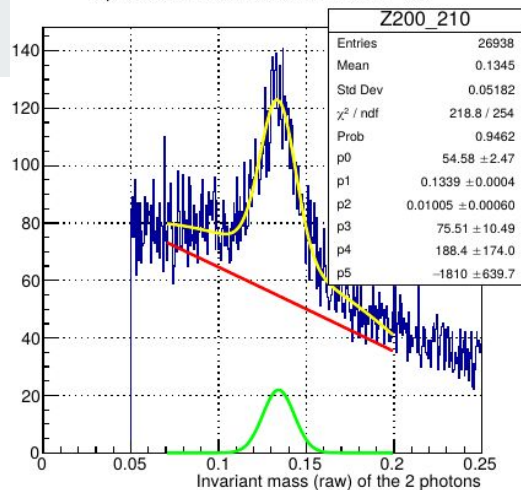
2 photon Mass distribution within z 100 - 110



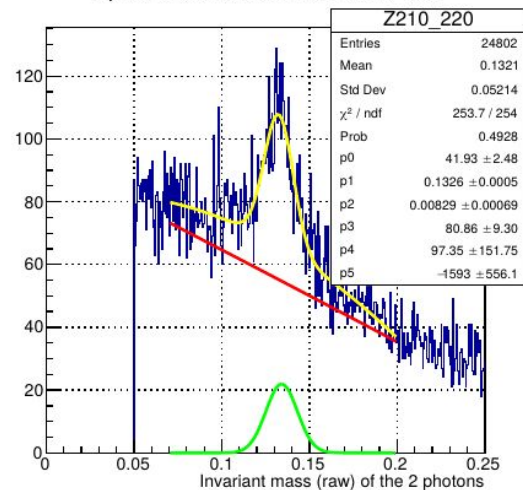
2 photon Mass distribution within z 110 - 120



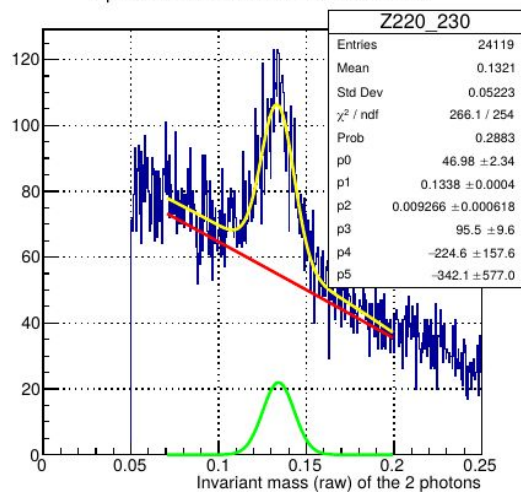
2 photon Mass distribution within z 200 - 210



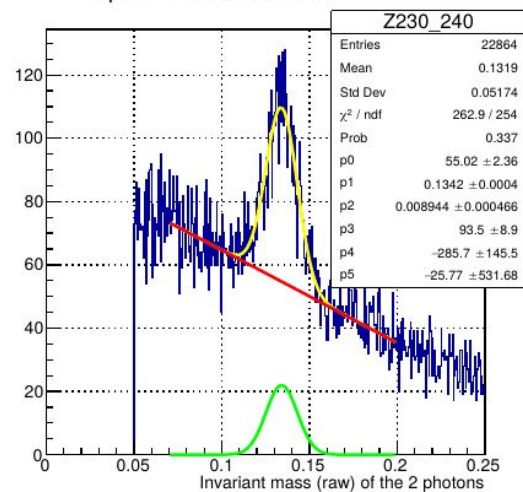
2 photon Mass distribution within z 210 - 220



2 photon Mass distribution within z 220 - 230

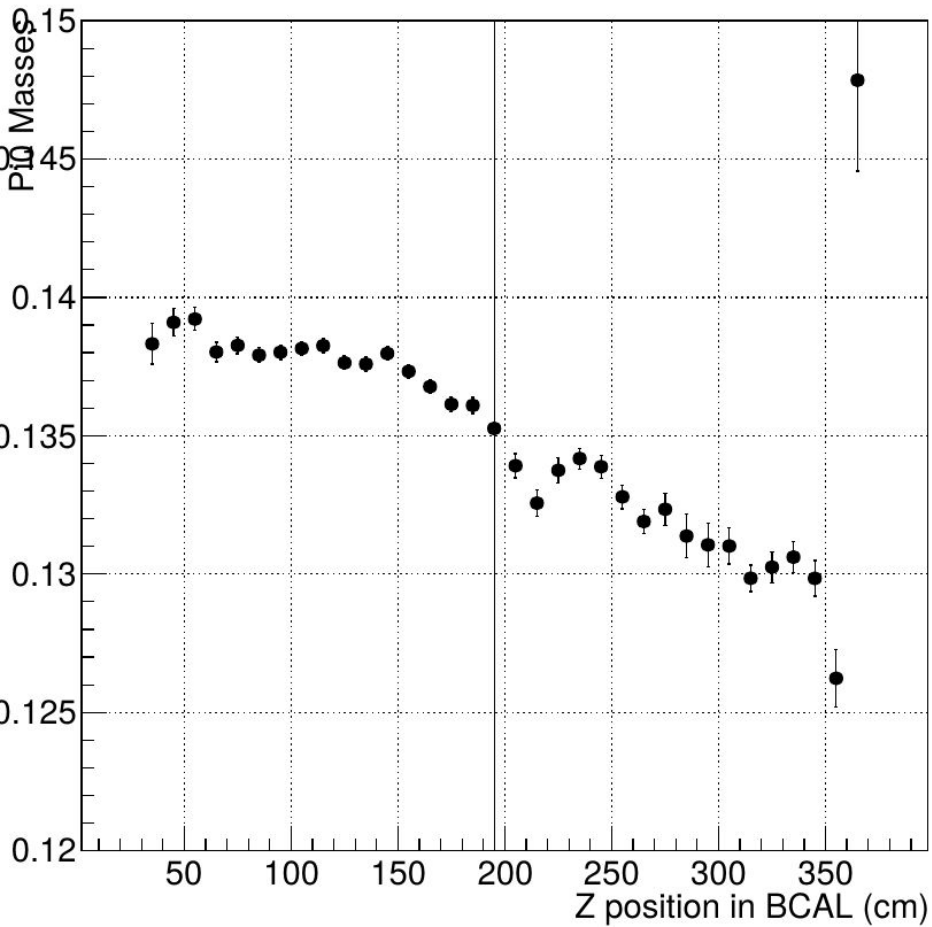


2 photon Mass distribution within z 230 - 240

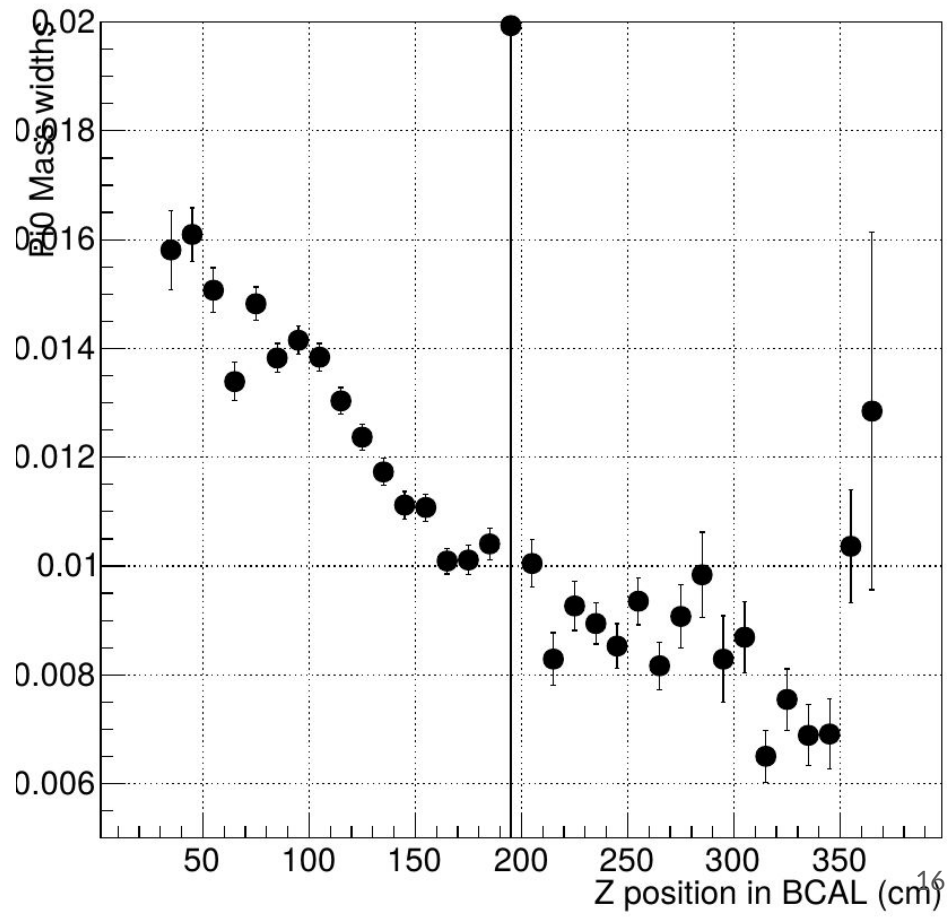




Pi0 mass as a function of Z



Pi0 mass width as a function of Z





## Next steps

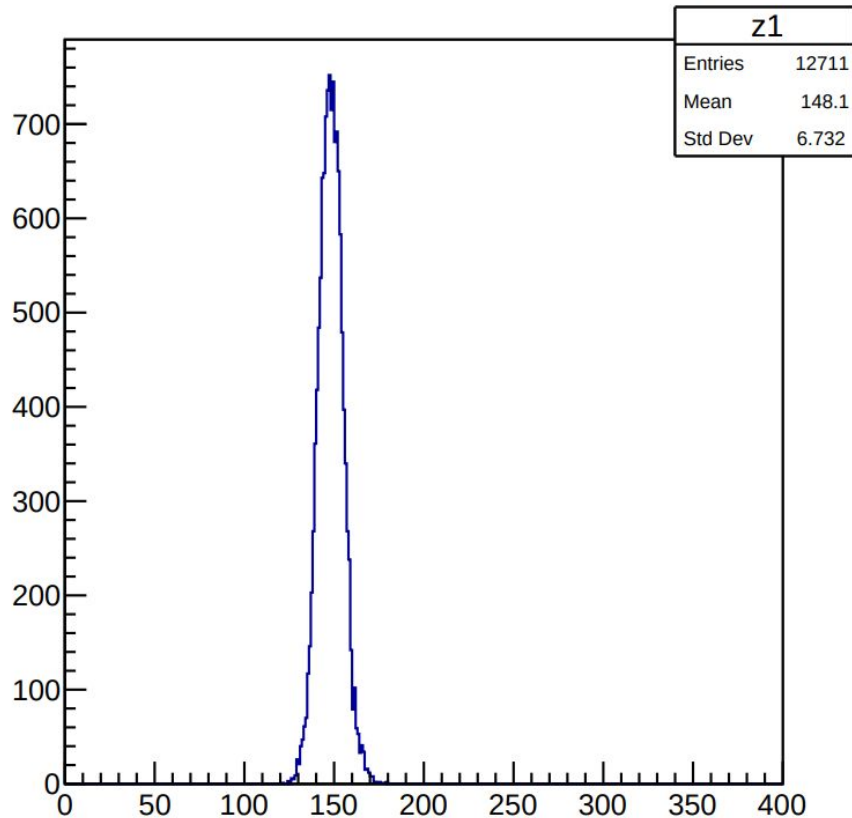
- Increased the statistics by another 10M now. Compiling the new results
- Understand the background for fitting once enough statistics is produced



# backups

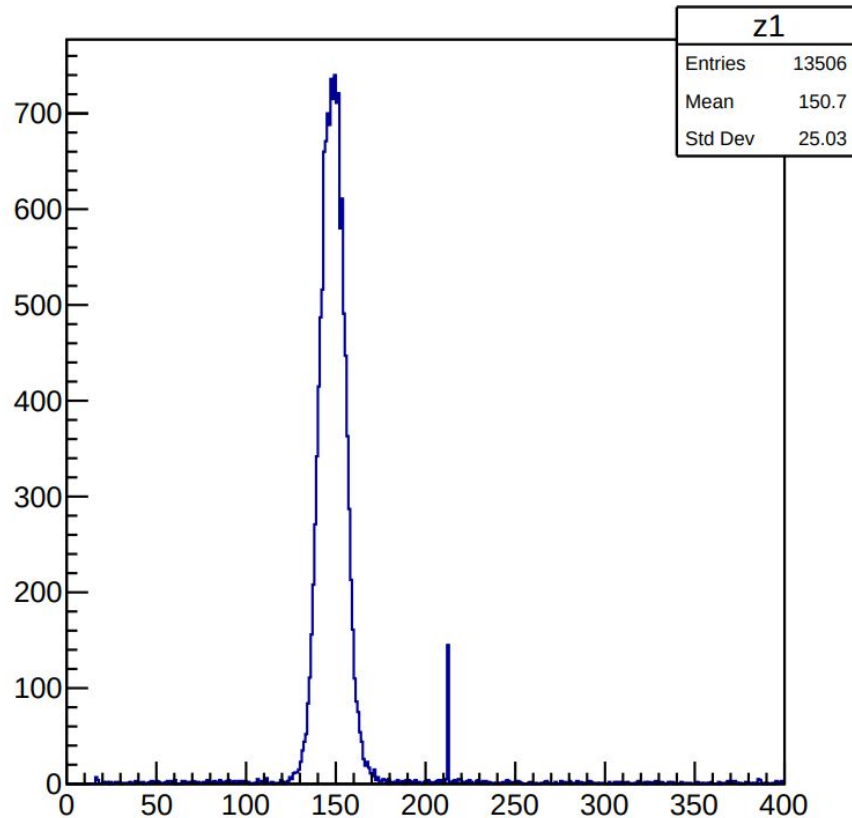
# Embedding noise (pio gun , thrown z = 150 cms)

Z of bcalShowers in dNeutralShower without RandomBkg



Run 50904 pi0 gun sample has BKG=None

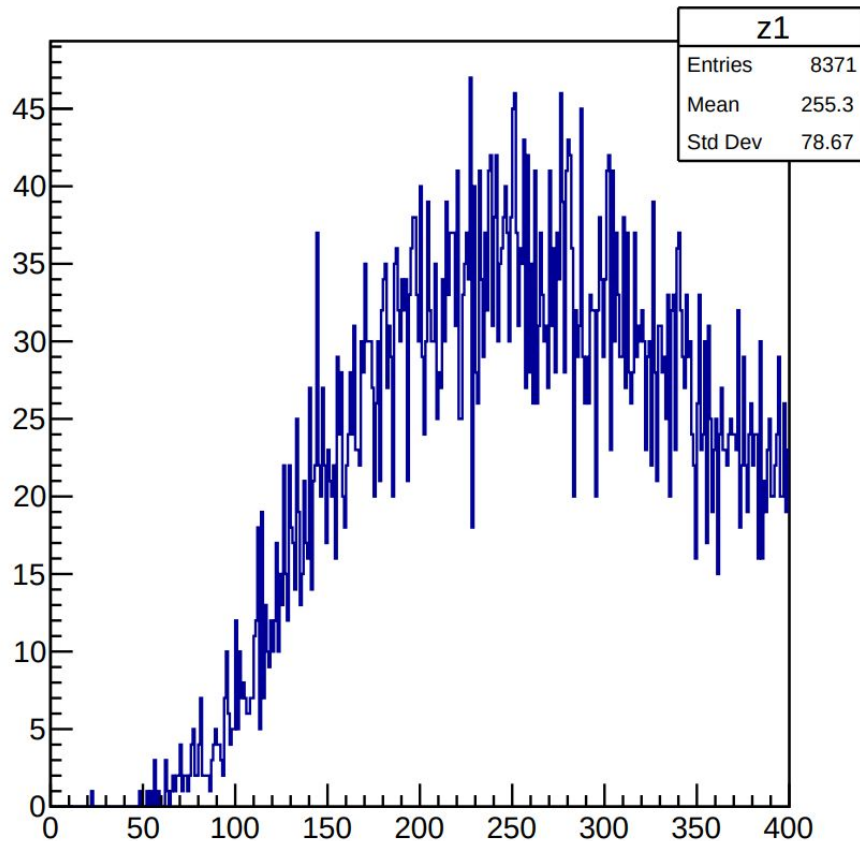
Z of bcalShowers in dNeutralShower with RandomBkg



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

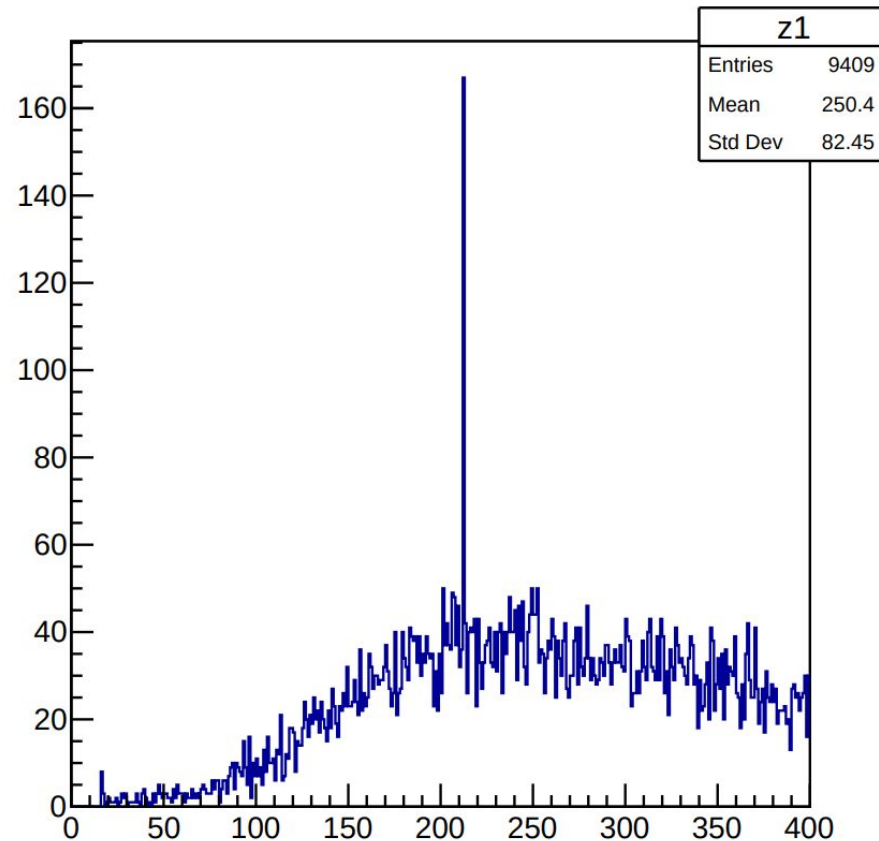
# Embedding noise (bggen , thrown z = 150 cms)

Z of bcalShowers in dNeutralShower without RandomBkg



Run 50904 bggen sample has BKG=None

Z of bcalShowers in dNeutralShower with RandomBkg



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