

A detailed wireframe model of a particle accelerator complex. It shows a large, oval-shaped main ring with several smaller, more complex structures branching off, including a series of smaller rings and a large, rectangular structure on the right side. The model is rendered in a light gray wireframe style, showing the internal structure and components of the accelerator.

# Kinematic refit of $\pi^0 \rightarrow \gamma\gamma$ decay

Adam Strach

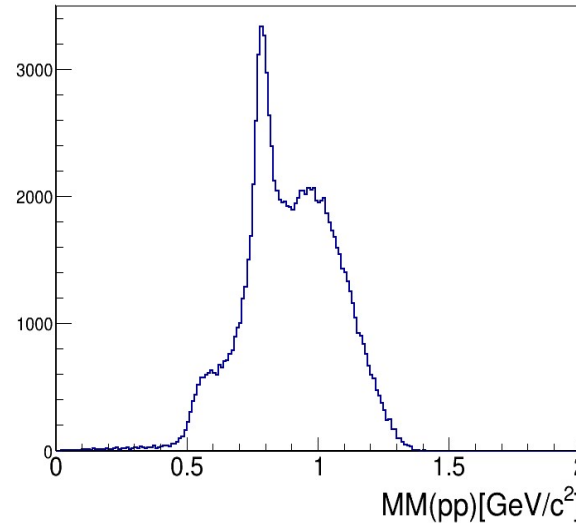
## Plan of Presentation

- Motivations of my studies.
- Preparation of simulation.
- Error parametrization.
- Kinematic fit configuration.
- Results of refit on simulation.
- Results of refit on data.
- Conclusions and outlook.

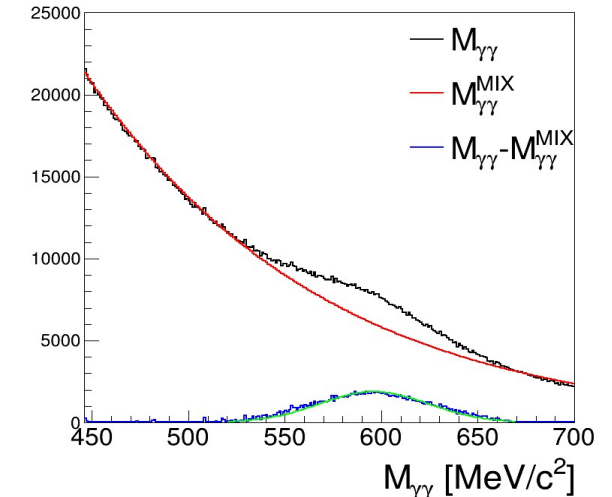
# Motivations

- Improvement of resolutions of channels with neutral mesons decays.

$$pp \rightarrow pp\pi^+\pi^-X$$



$$pp \rightarrow pp\gamma\gamma$$



- Exclusive or inclusive analysis for example:

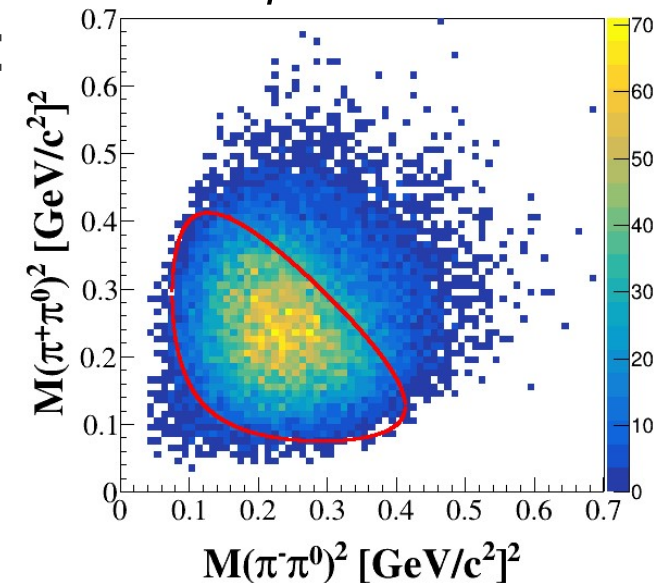
$$pp \rightarrow K^+ \Lambda(1405) \left[ \rightarrow \pi^0 \Sigma^0 \left[ \rightarrow \gamma \Lambda \left[ \rightarrow p \pi^- \right] \right] \right]$$

$$\eta \rightarrow \pi^- \pi^+ \pi^0 \left[ \rightarrow \gamma \gamma \right]$$

- Check of correctness of refit procedures.

- Plots provided by Izabela Ciepał.

$$\eta \rightarrow \pi^- \pi^+ \pi^-$$



- Official Pluto DST for channel 921 (Jochen):  
 $pp \rightarrow pp[\eta \rightarrow \pi^- \pi^+ \pi^0 [\rightarrow \gamma\gamma]]$
- Particle selection:
  - Simulations GEANT PID
  - Data:  $E > 150$  MeV and  $0.8 < \beta < 1.2$
- Simulation- 5 000 000 events analyzed
- Data- day 60 - 9 230 000 events analyzed

- Error estimation and parametrization:

- photon energy resolution:  $\frac{\sigma_E}{E} = \frac{5.8\%}{\sqrt{E[GeV]}}$  [A. Rost phd thesis]

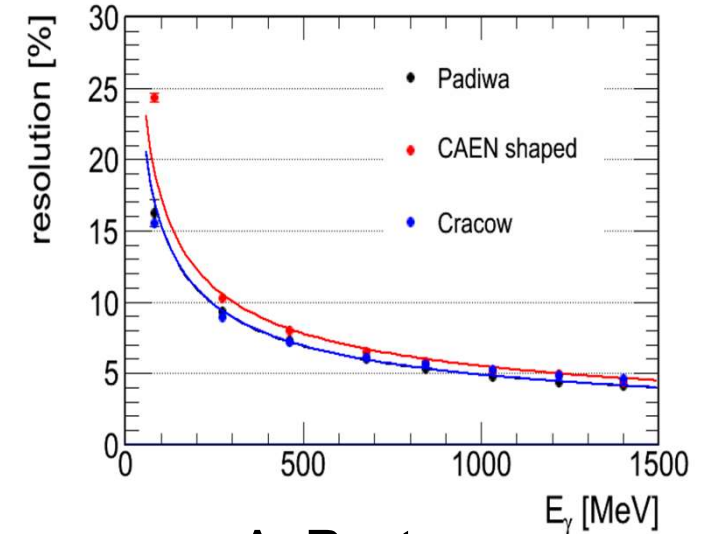
- photon  $\theta$  and  $\phi$  resolution:  $\sigma_\theta = \sigma_\phi = 2.5^\circ$  [EMC geometry]

- R, Z are not used, errors set to  $\sigma_R = \sigma_Z = 9999.9$

- $\gamma\gamma \rightarrow \pi^0$  refit using  $\pi^0$  mass constraint:

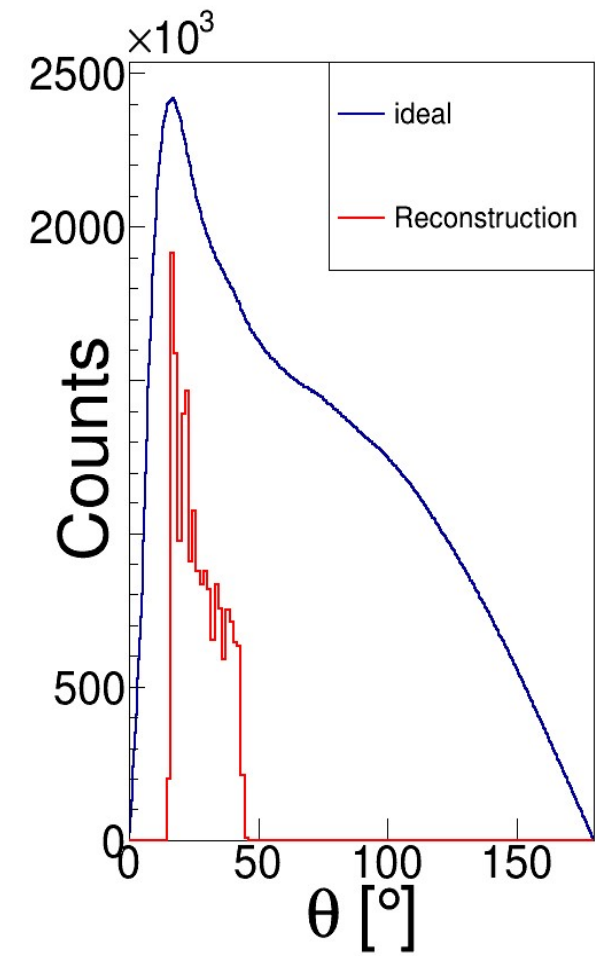
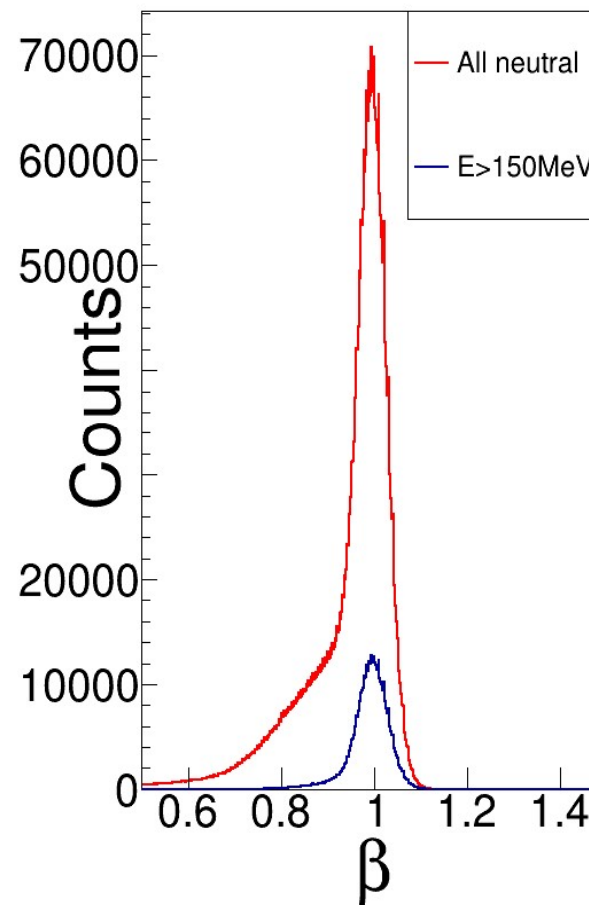
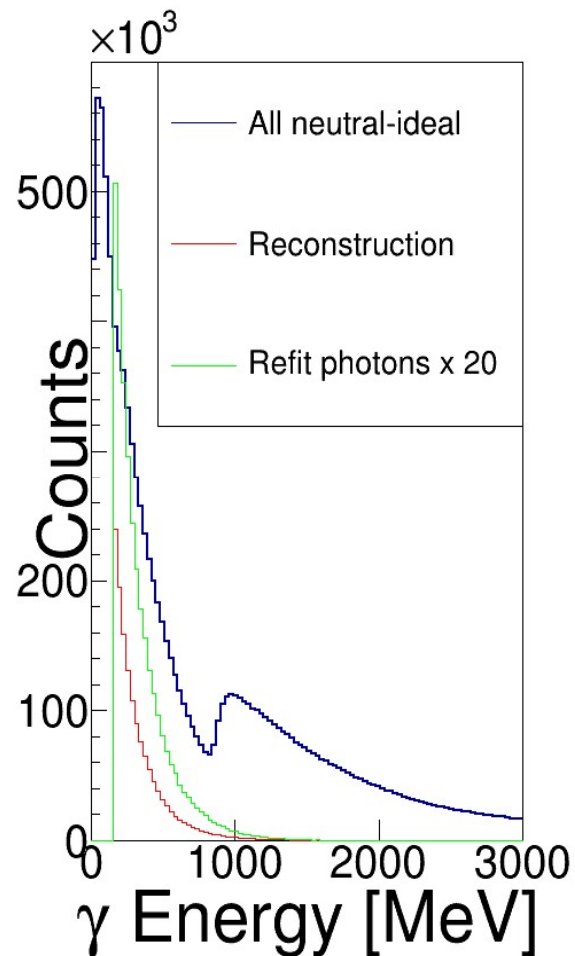
- Convergence: max 10 iterations  $\Delta\chi^2 < 1$

- Probability cut  $P > 0.01$



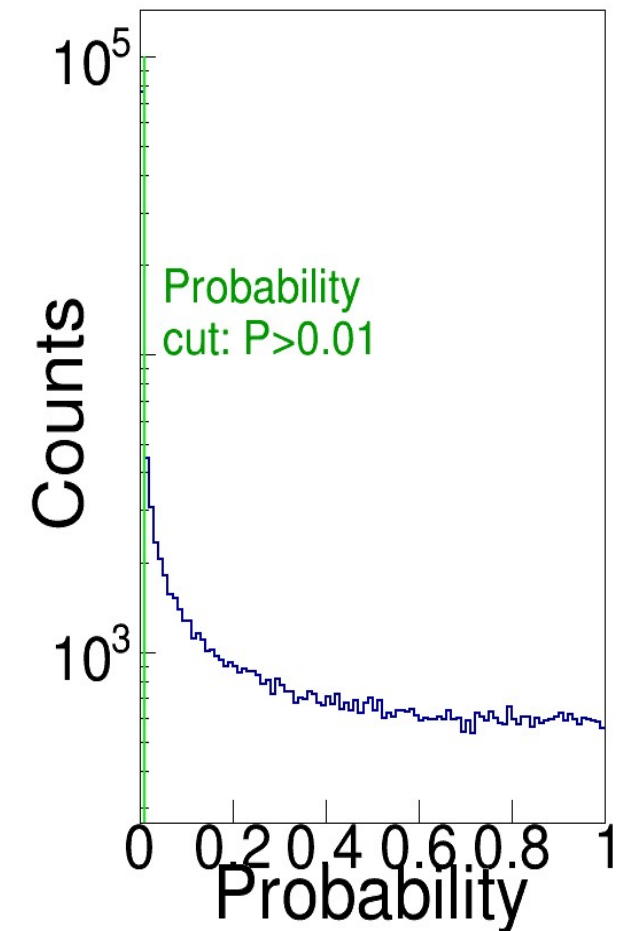
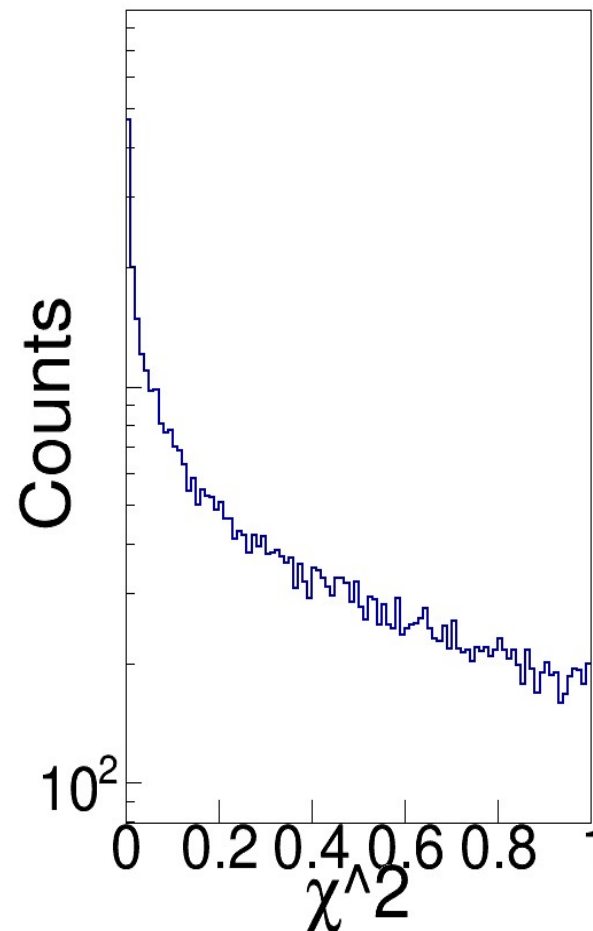
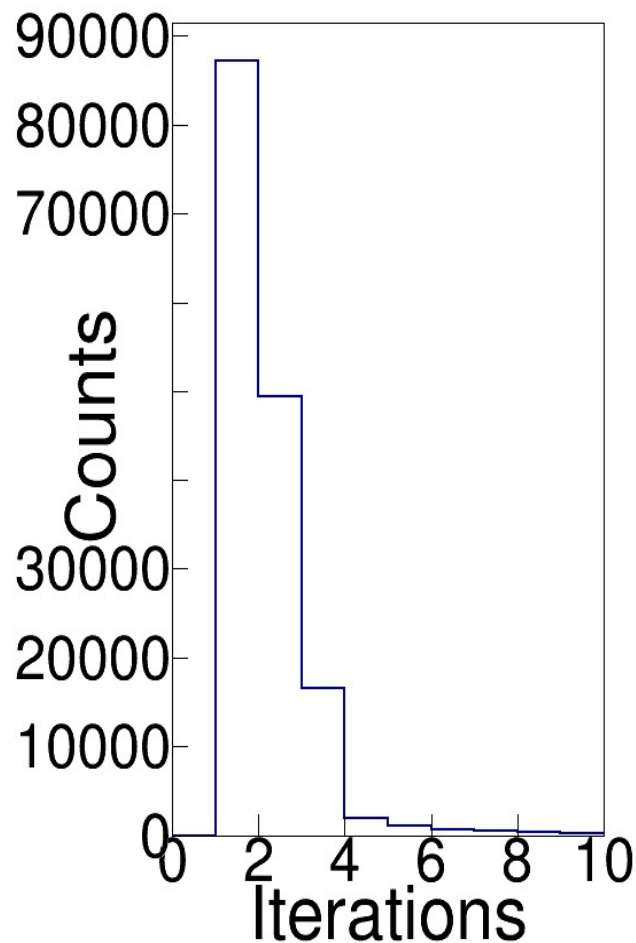
A. Rost

# Simulation- $\gamma$ distributions



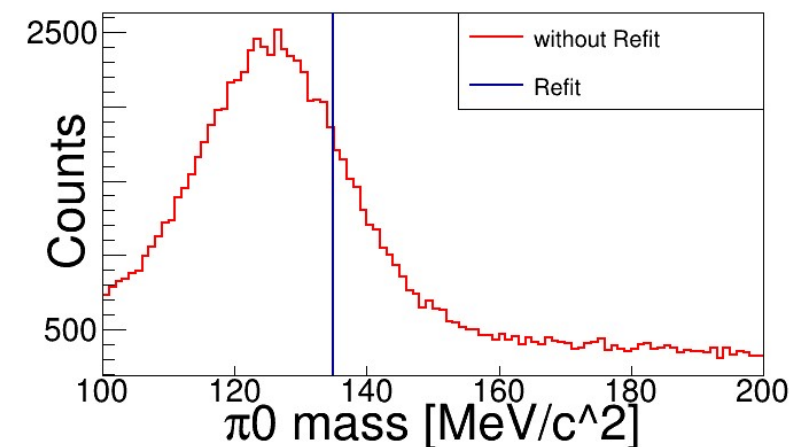
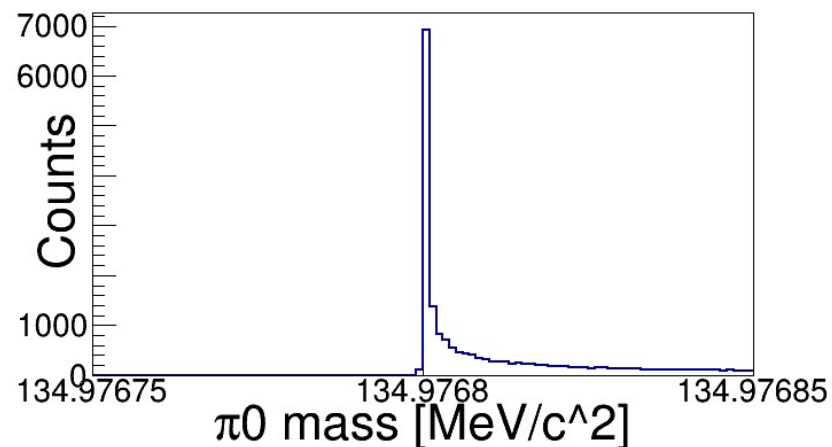
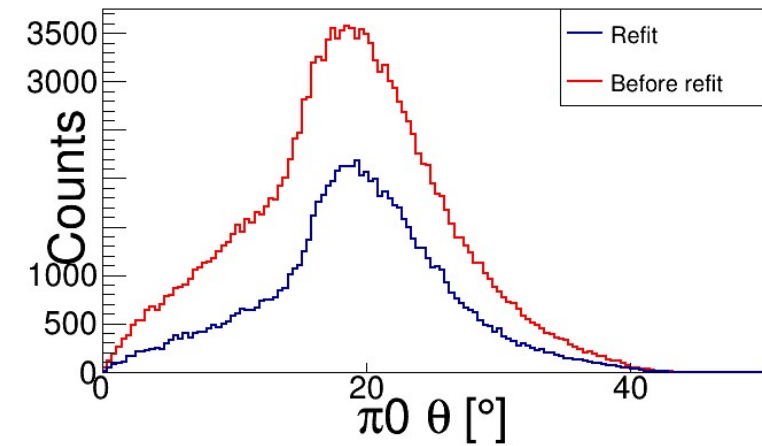
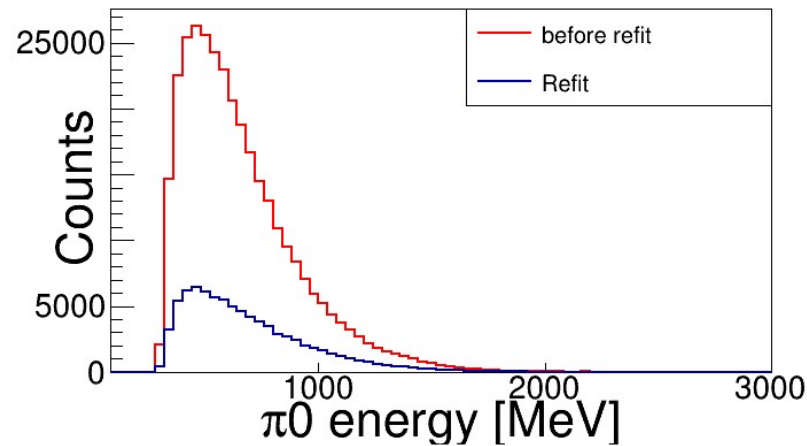
## Results-Simulations-QA plots

- Efficiency after cut on probability:  $\text{Eff} = \frac{82224}{159638} \approx 51.51\%$





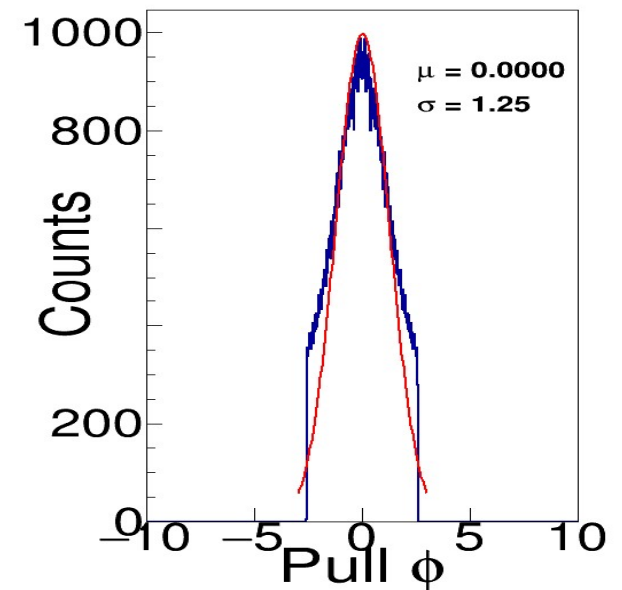
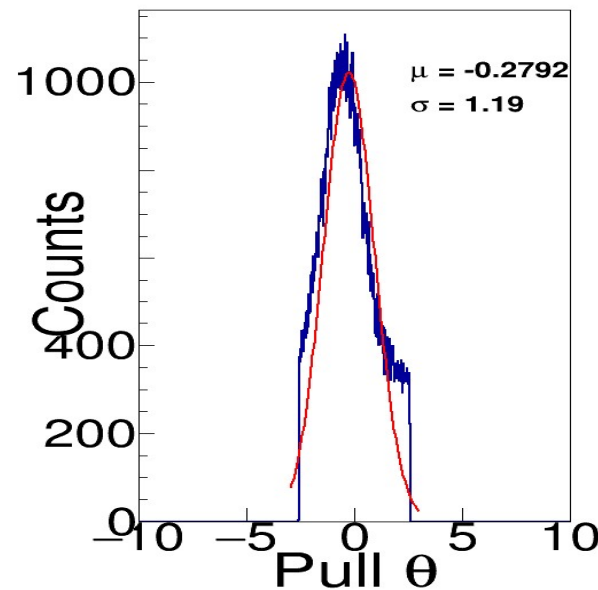
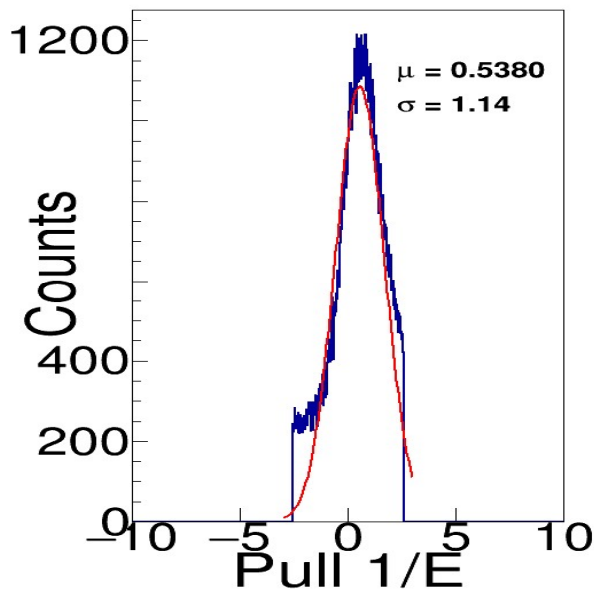
# Results for simulations



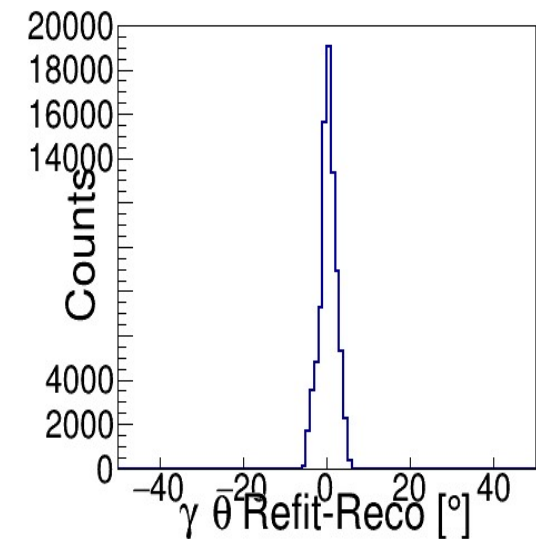
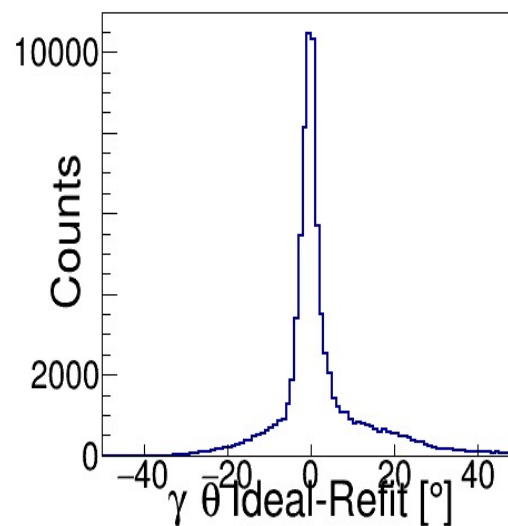
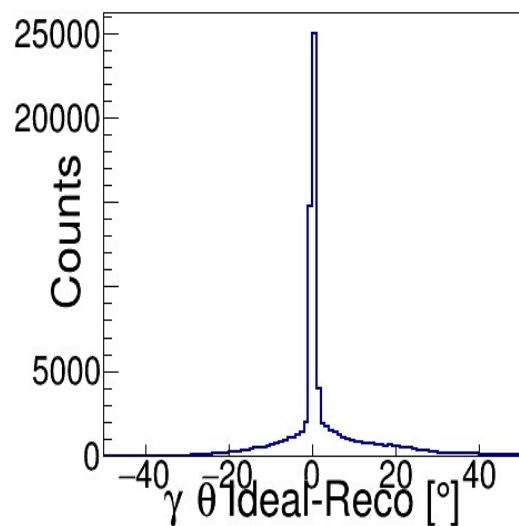
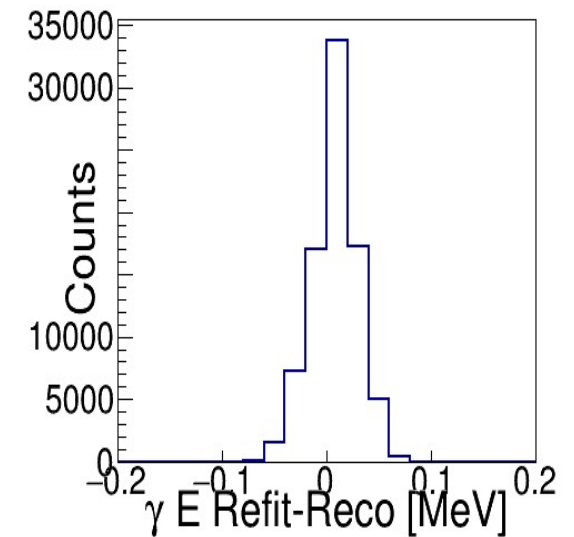
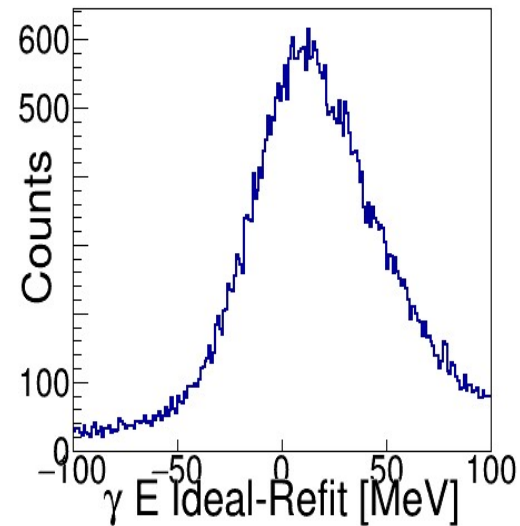
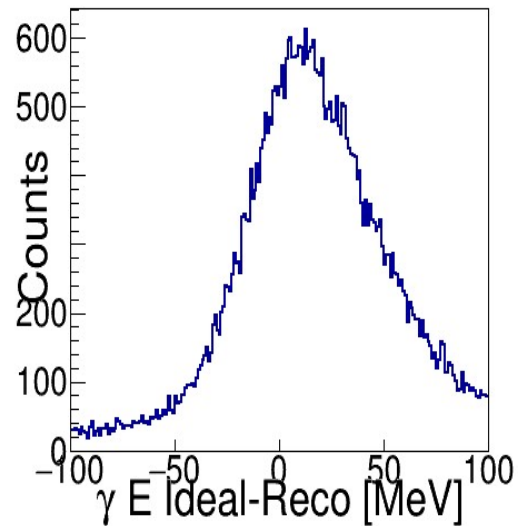
- Large improvement in  $\pi_0$  mass resolution.



$$\bullet \text{ Pull} = \frac{y - \eta}{\sqrt{\sigma_y^2 - \sigma_\eta^2}}$$

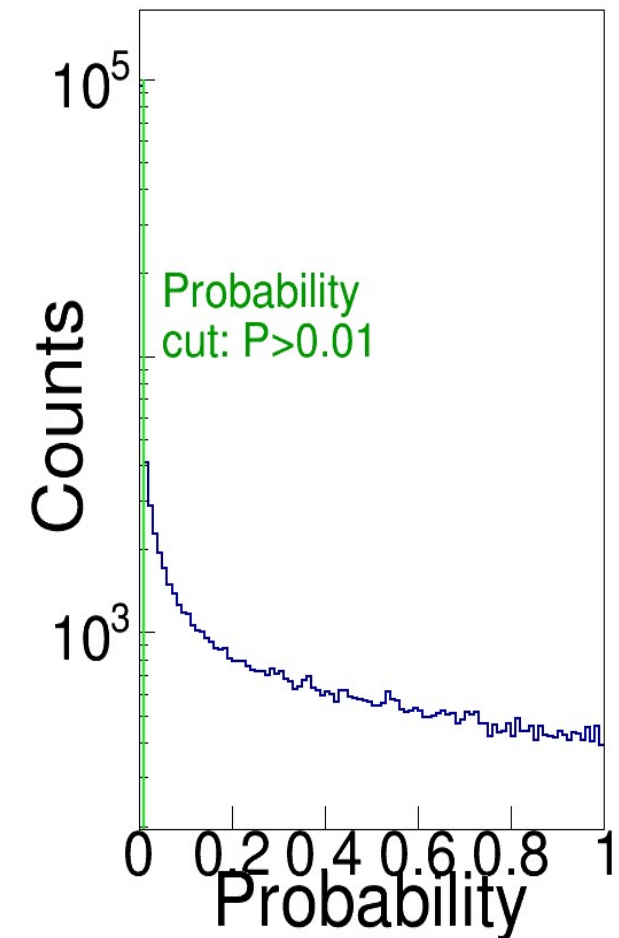
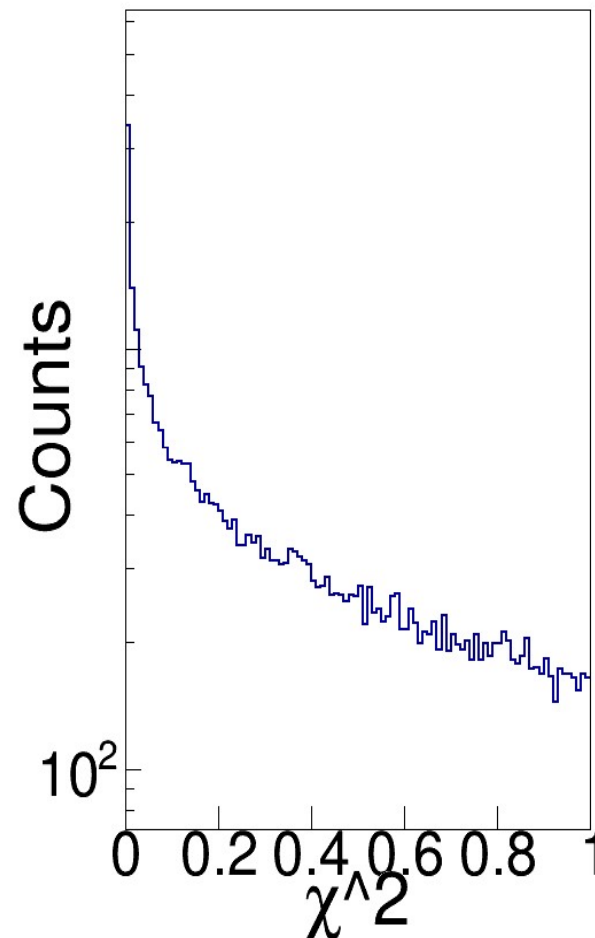
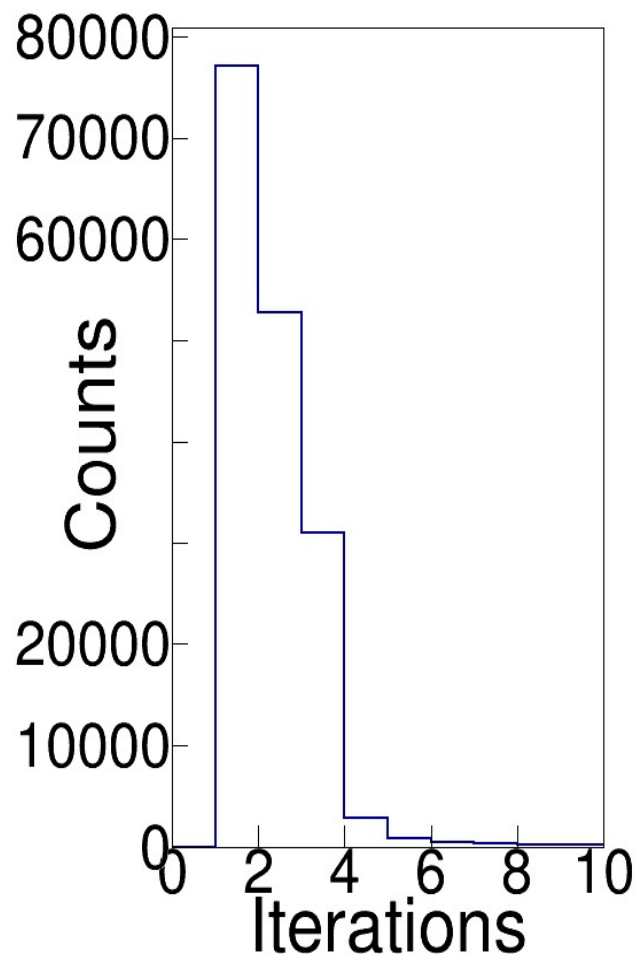


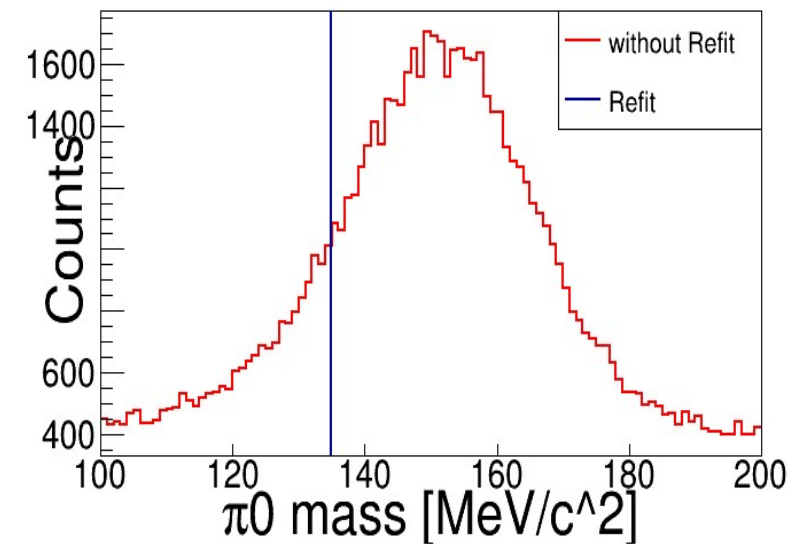
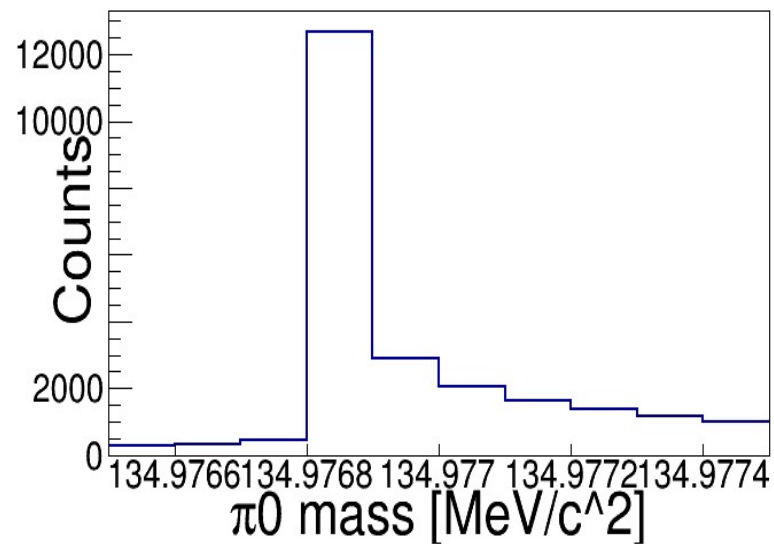
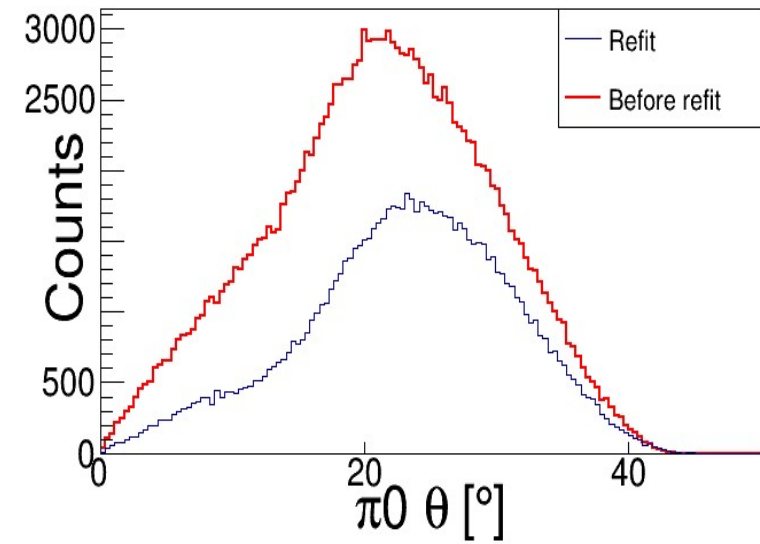
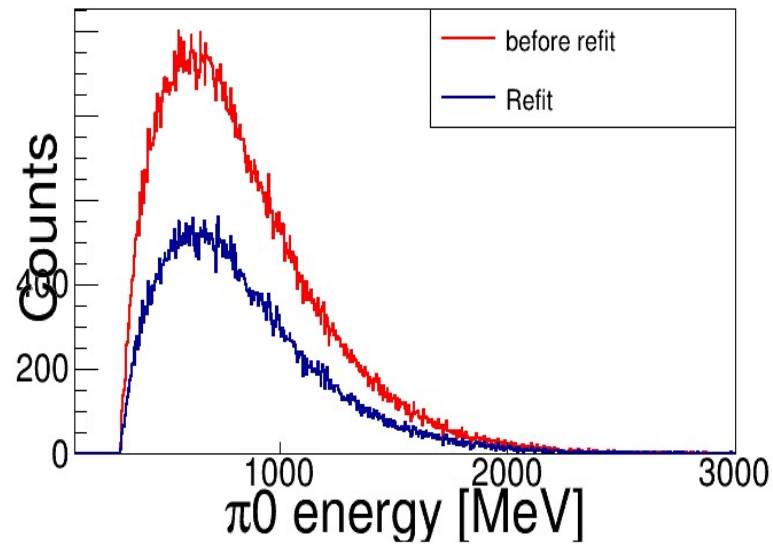
- Pulls for  $1/E$  and  $\theta$  are shifted from 0, and are asymmetric. It may imply existence of systematic effects.
- All pulls have  $\sigma \approx 1$  and are gaussian.



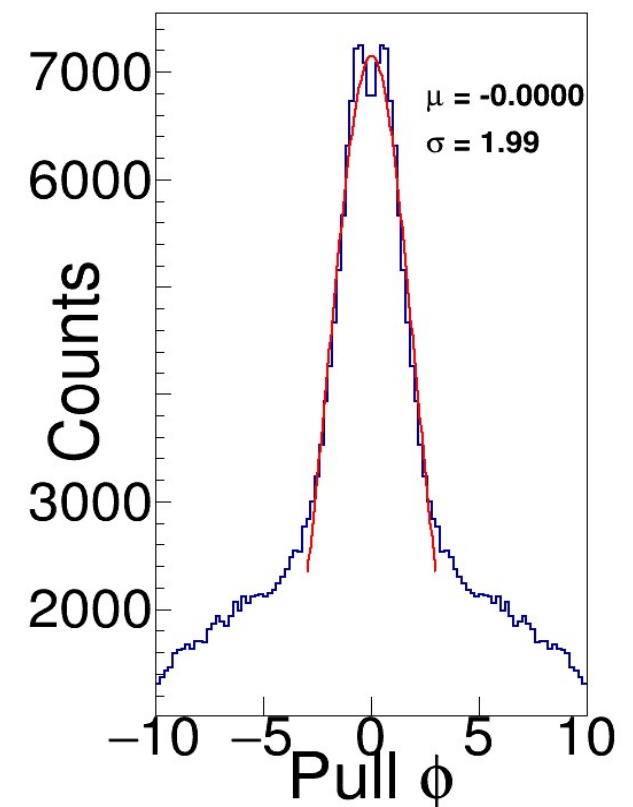
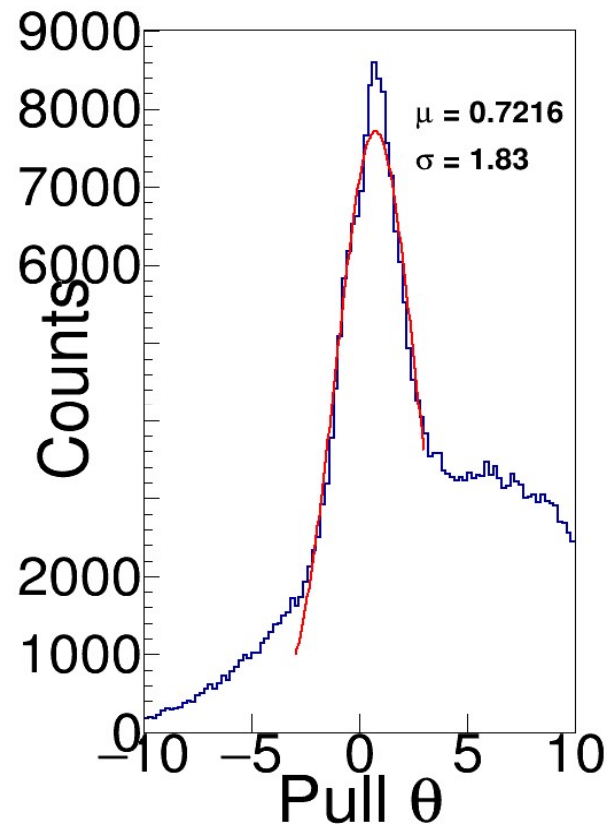
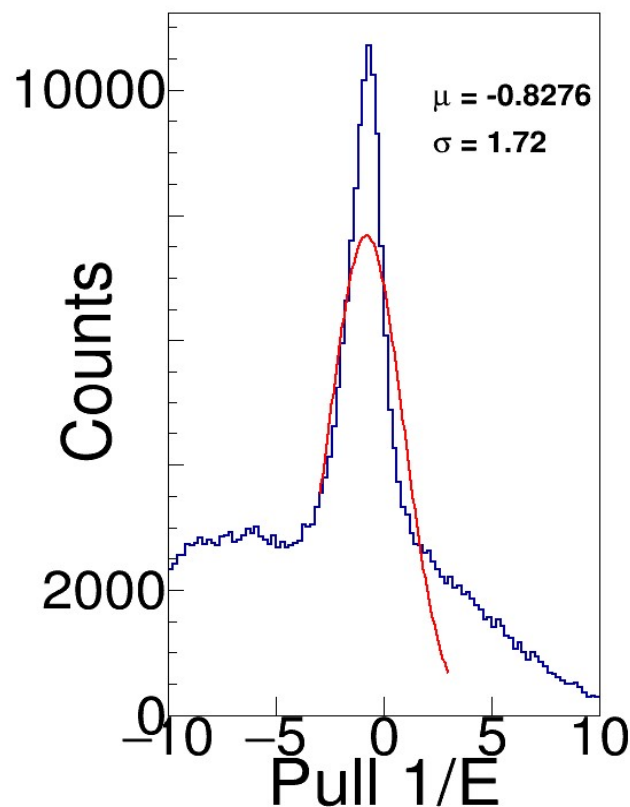
## Results-Data-QA plots

- Efficiency after cut on probability:  $\text{Eff} = \frac{95033}{171100} \approx 55.54\%$





- Energy and  $\theta$  pulls are asymmetrical- require further investigation.



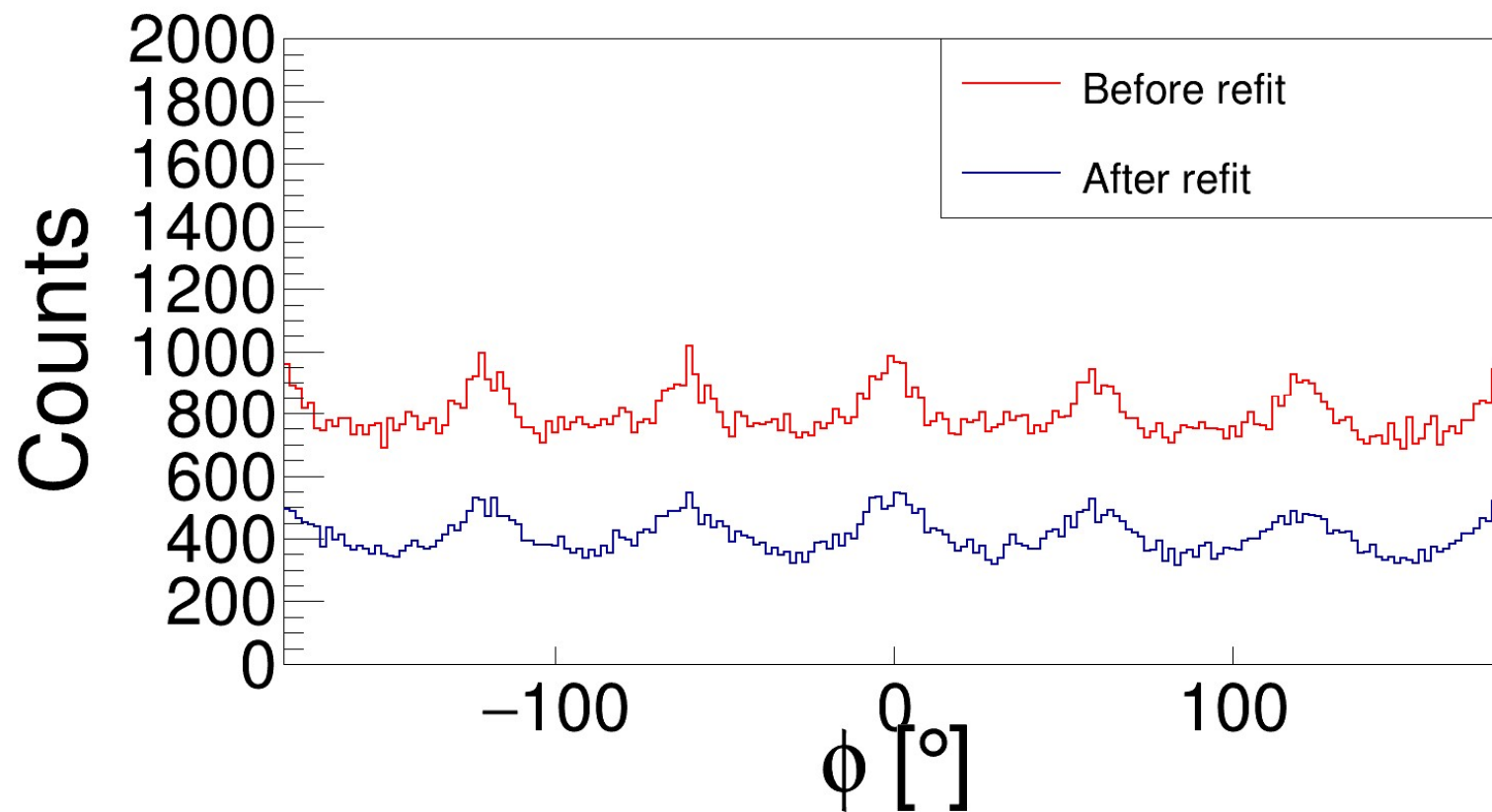
- Kinematic refit improves resolution in  $\pi_0$  mass reconstruction.
- Our results need further work.
- Outlook:
  - -study and understand pulls and resolution asymmetry.
  - -test additional constraints (3c,4c)  
in  $pp \rightarrow pp\eta(\rightarrow \pi^+\pi^-\pi^0)$

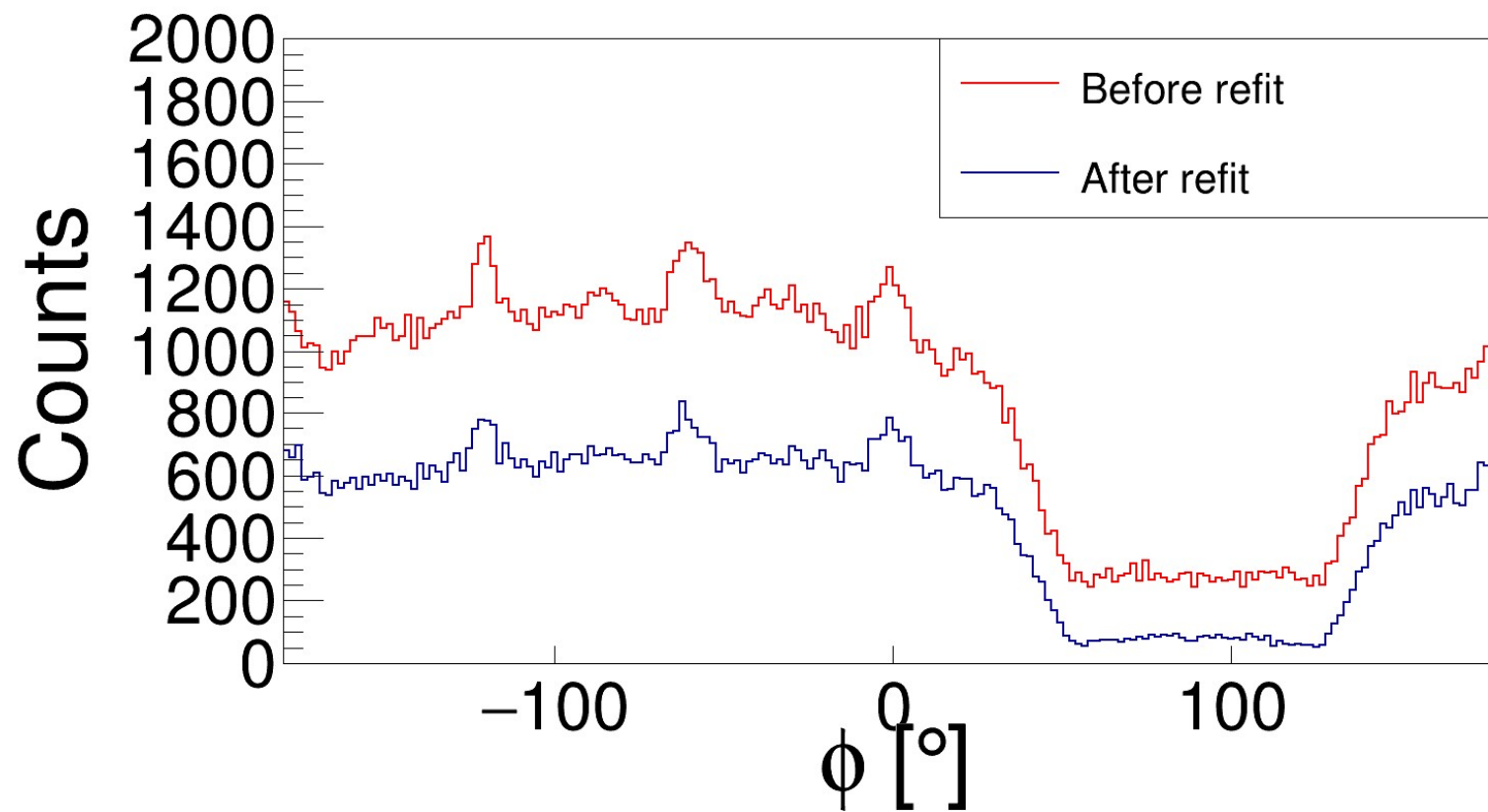
# BACKUP



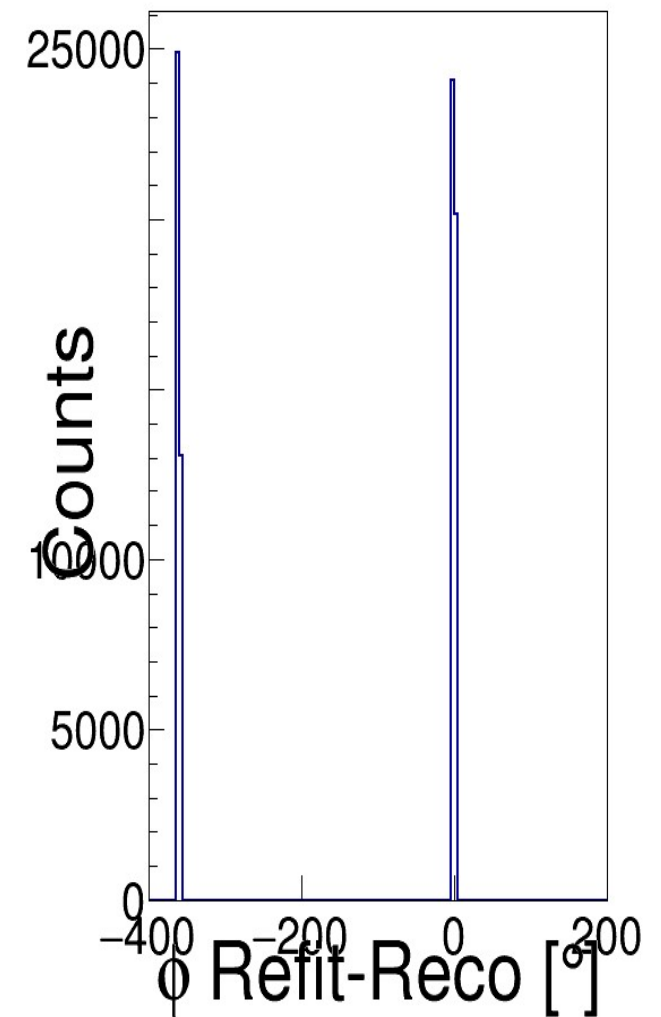
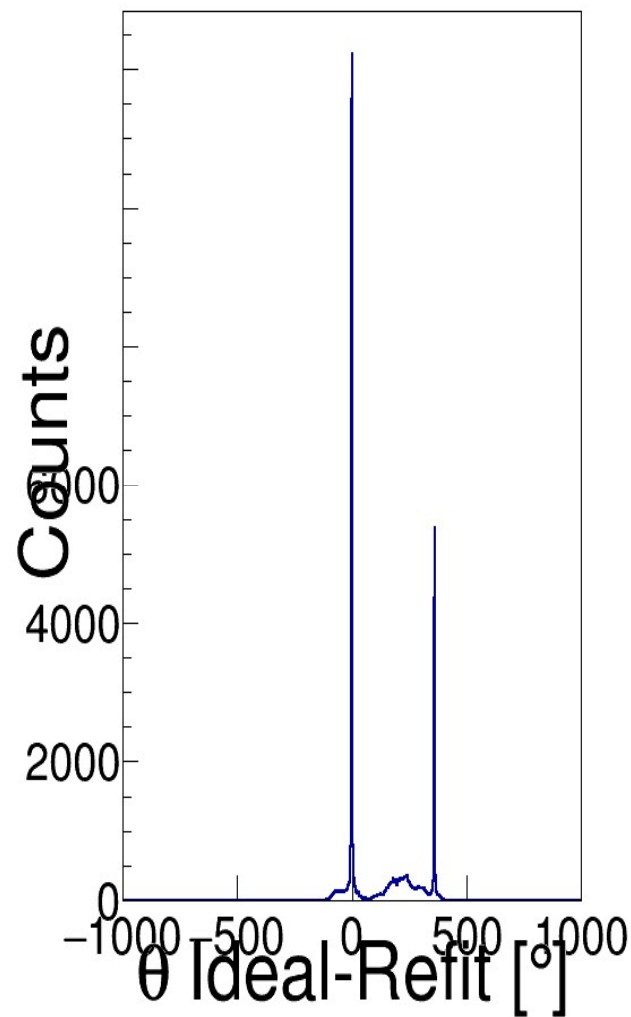
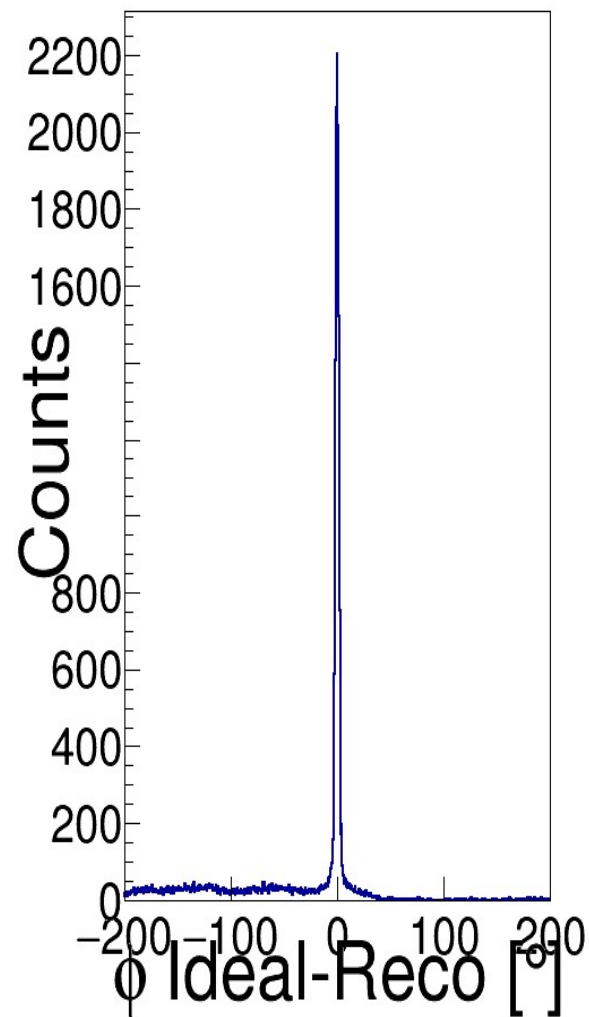


# $\pi^0$ $\phi$ distribution in Simulation





# $\phi$ residuals



# PULLS WITHOUT $P > 0.01$

