Update on $\eta \to \pi^+\pi^-\gamma$ from g11 data

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Outline

- Background
- The g11 Experiment
- Analysis
- Preliminary results

Anomalies in QFT

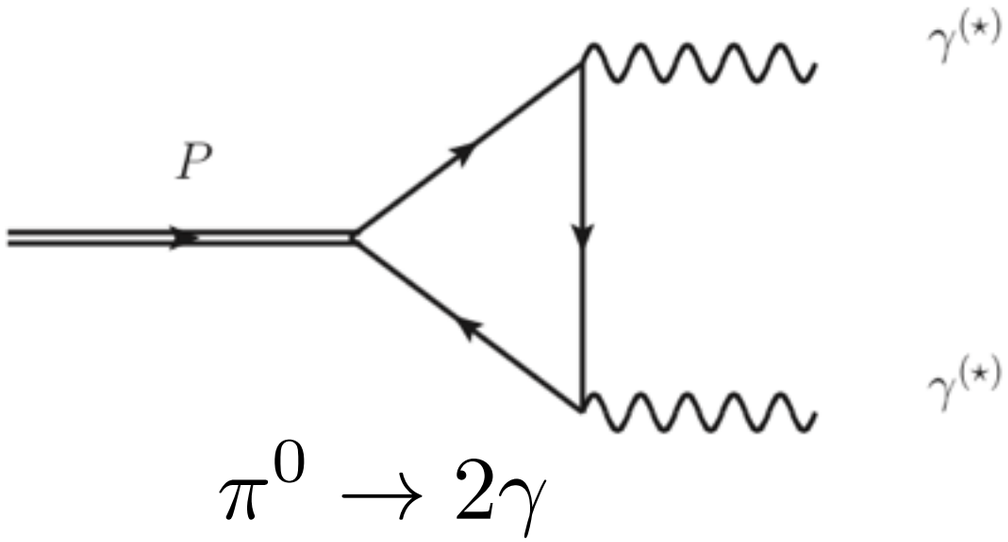
- Anomalies occur when classical symmetries break due to quantization

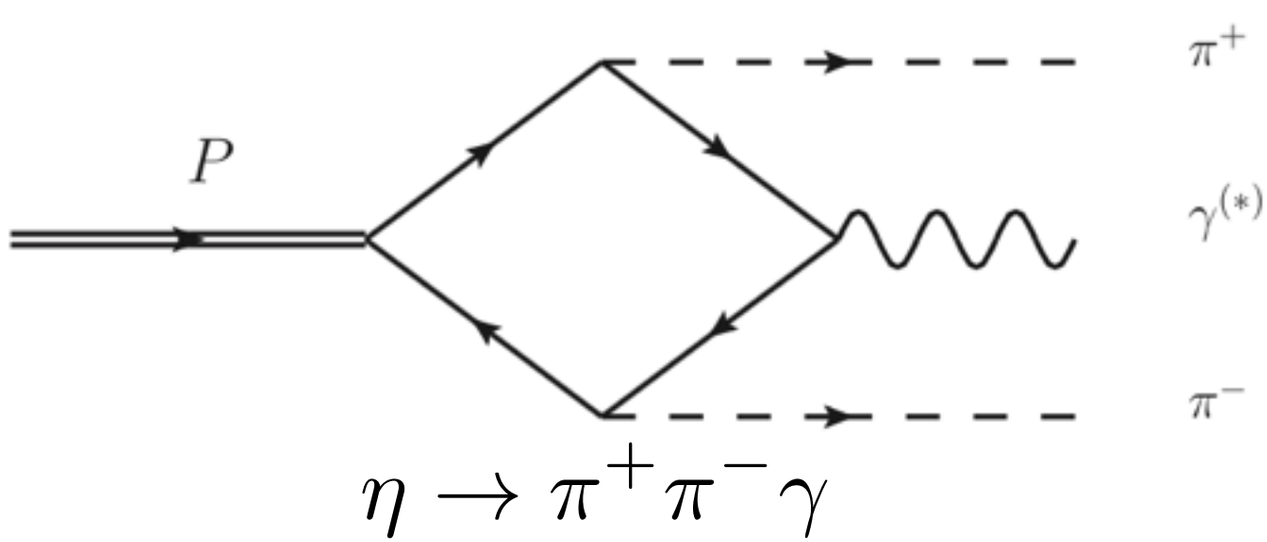
- Classically, $\partial^\mu j_{\mu 5} = 0$ for massless particle

- With gauge fields present,

$$\partial^\mu j_{\mu 5} = 2im\bar{\psi}\gamma_5\psi - \frac{e^2}{16\pi^2}\epsilon^{\mu\nu\alpha\beta}F_{\mu\nu}F_{\alpha\beta}$$

Wess-Zumino-Witten Lagrangian





- anomalies correspond to some higher order terms in WZW Lagrangian
- fit two pion invariant mass distribution with free parameter alpha

Alpha parameter

$$\frac{d\Gamma}{ds_{\pi\pi}} = |AP(s_{\pi\pi})F_v(s_{\pi\pi})|^2 \, \Gamma_0(s_{\pi\pi})$$

$$P(s_{\pi\pi}) = 1 + \alpha s_{\pi\pi} + O(s_{\pi\pi}^2)$$

- alpha has been measured previously by various institutions and predicted with different theoretical models

Previous measurements of alpha

Experiments	α parameter
Gormley et al	1.8 ± 0.4
Layter et al	-0.9 ± 0.1
GAMS-200	2.7 ± 0.1
CRYSTAL BARREL	1.8 ± 0.53
WASA-at-COSY	1.89 ± 0.86
KLOE	1.32 ± 0.08
CLAS	ongoing
BESIII	ongoing
Theoretical Models	**α parameter**
N/D	0.64 ± 0.02
HLS	0.23 ± 0.01
(O(p^6) + 1 - loop)	-0.7 ± 0.1
Box anomaly	-1.7 ± 0.02

The g11 experiment

- run period: May 17th 2004 - July 29th 2004
- beam energy: 4 GeV
- beam current: ~60 nA
- gold radiator used to produced photon beam via bremsstrahlung
- 40 cm liquid H2 target

Event selection

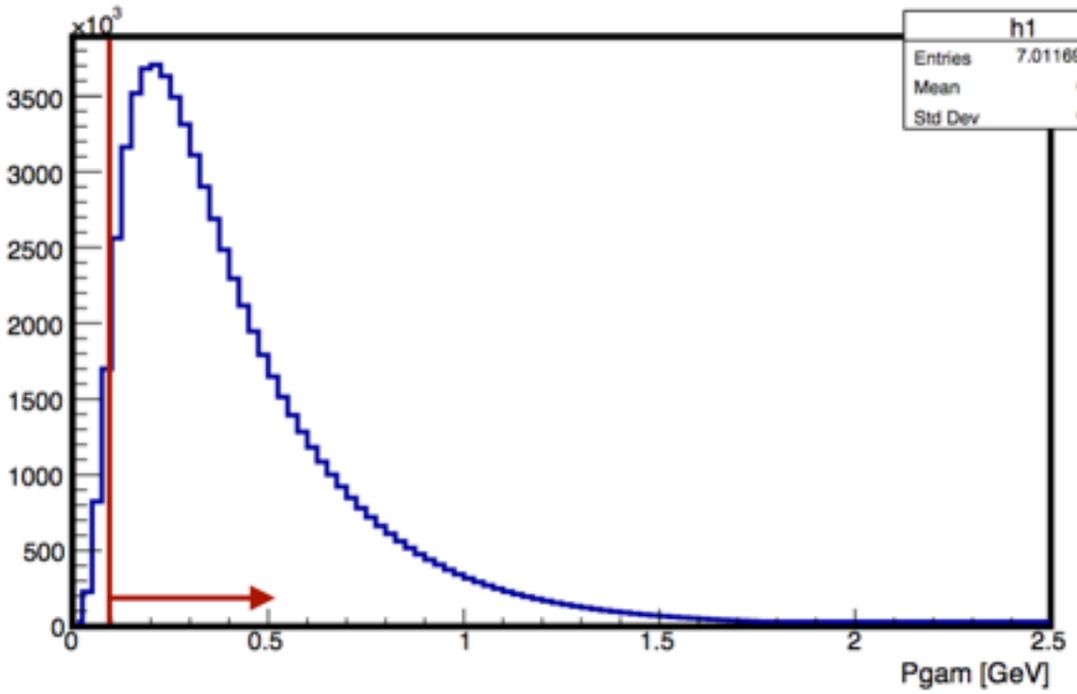
- trigger required two charged tracks in different sectors

- require events with three charged tracks corresponding to proton, pions, and at least one photon present

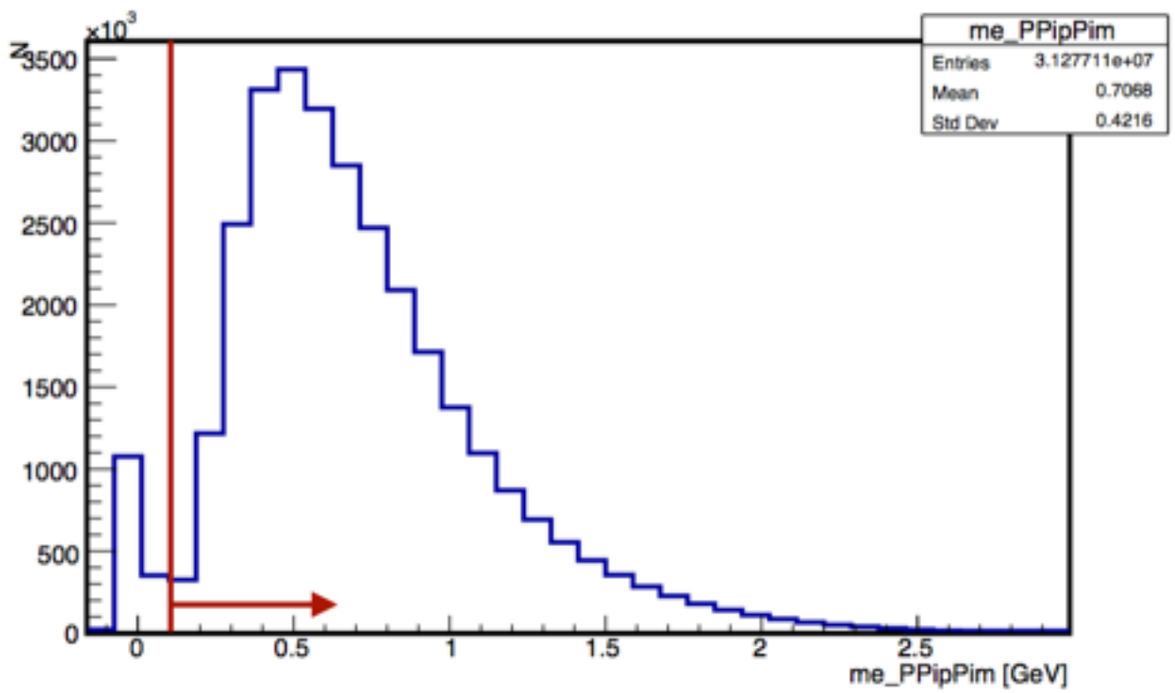
- time of flight used for particle ID

Cuts

$P_\gamma > 0.1GeV$

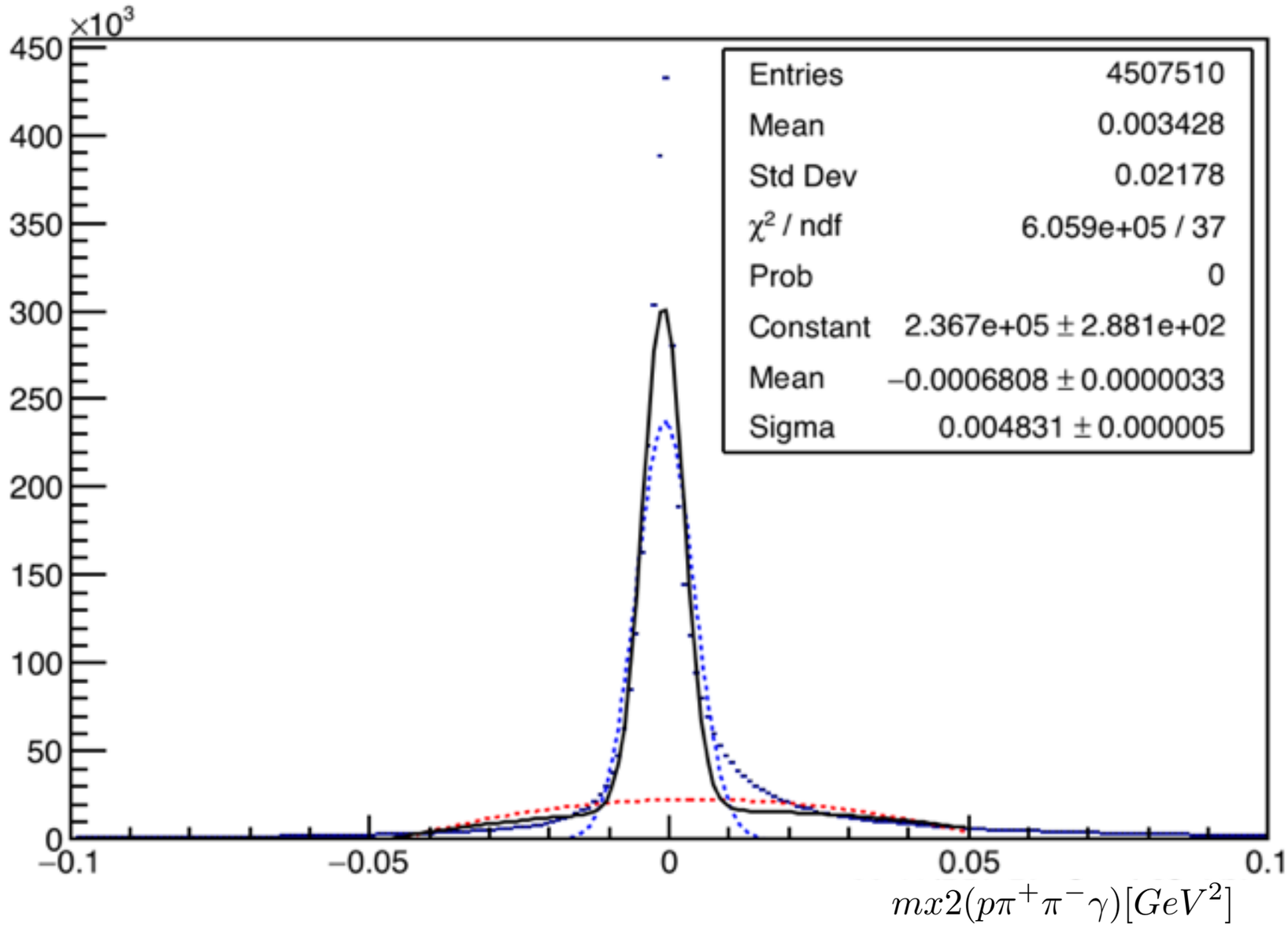


$me(p\pi^+\pi^-) > 0.1GeV$



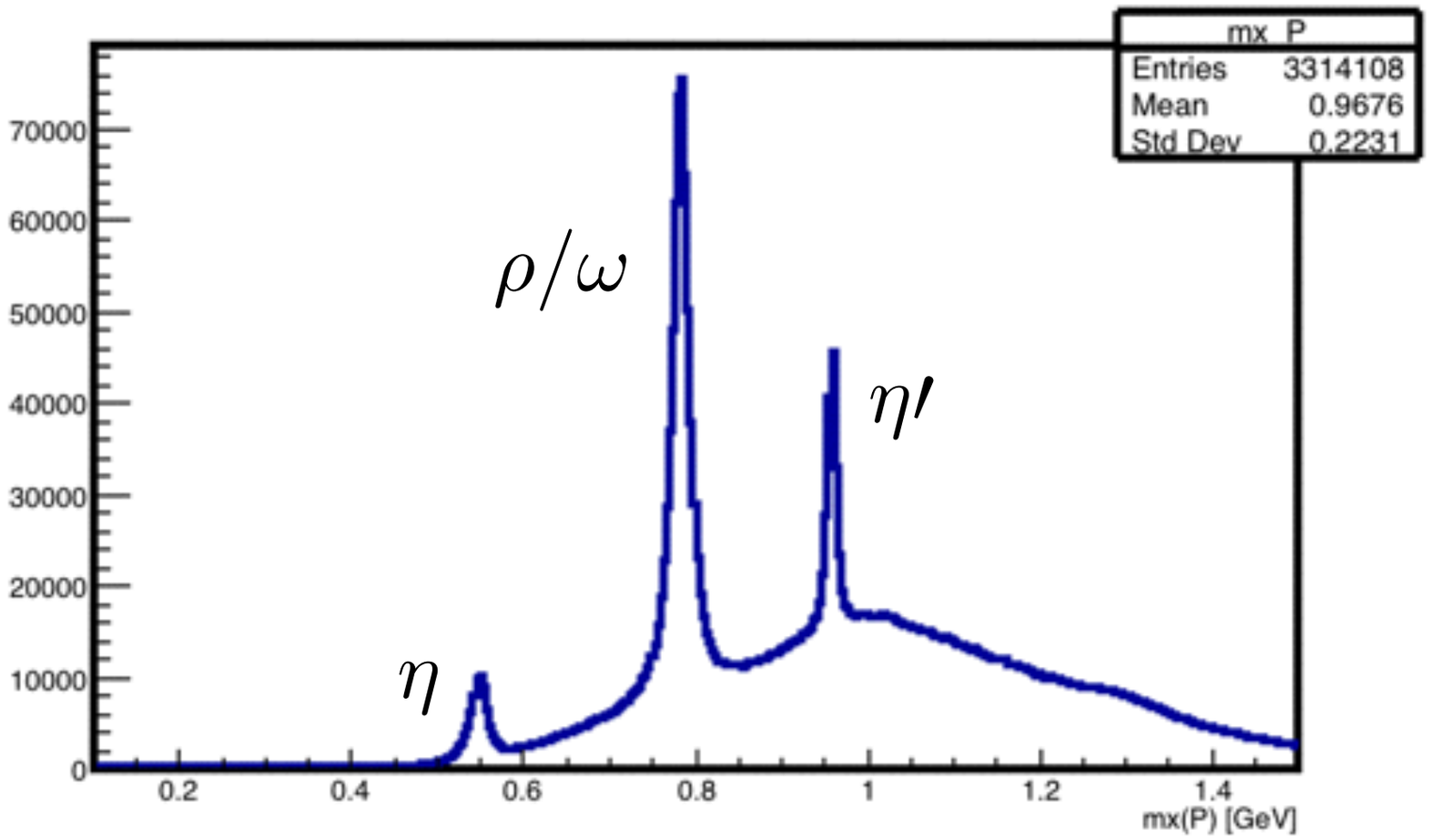
calorimeter threshold ~ 0.075 GeV

missing mass squared of all detected particles

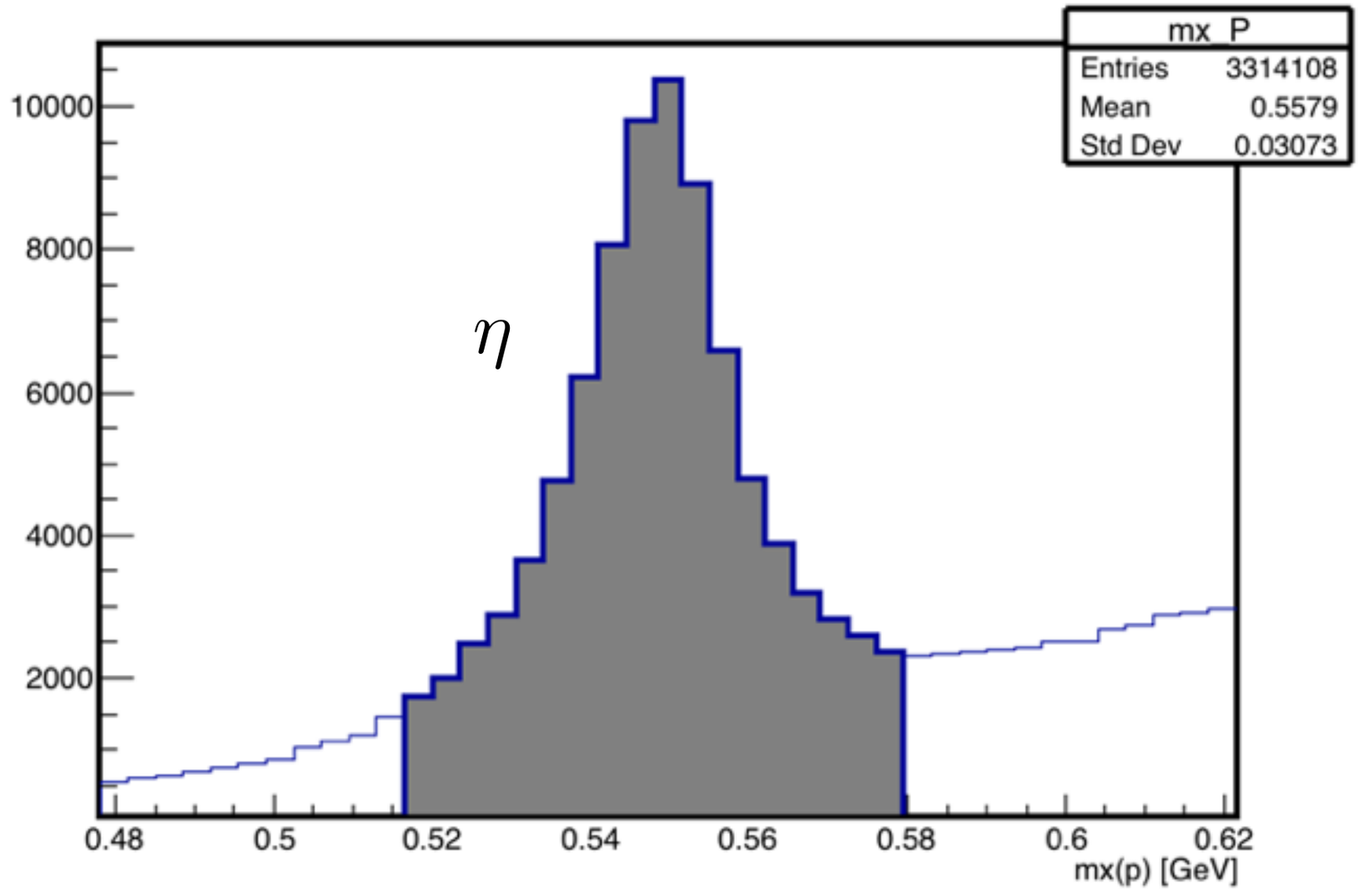


Missing mass of the proton

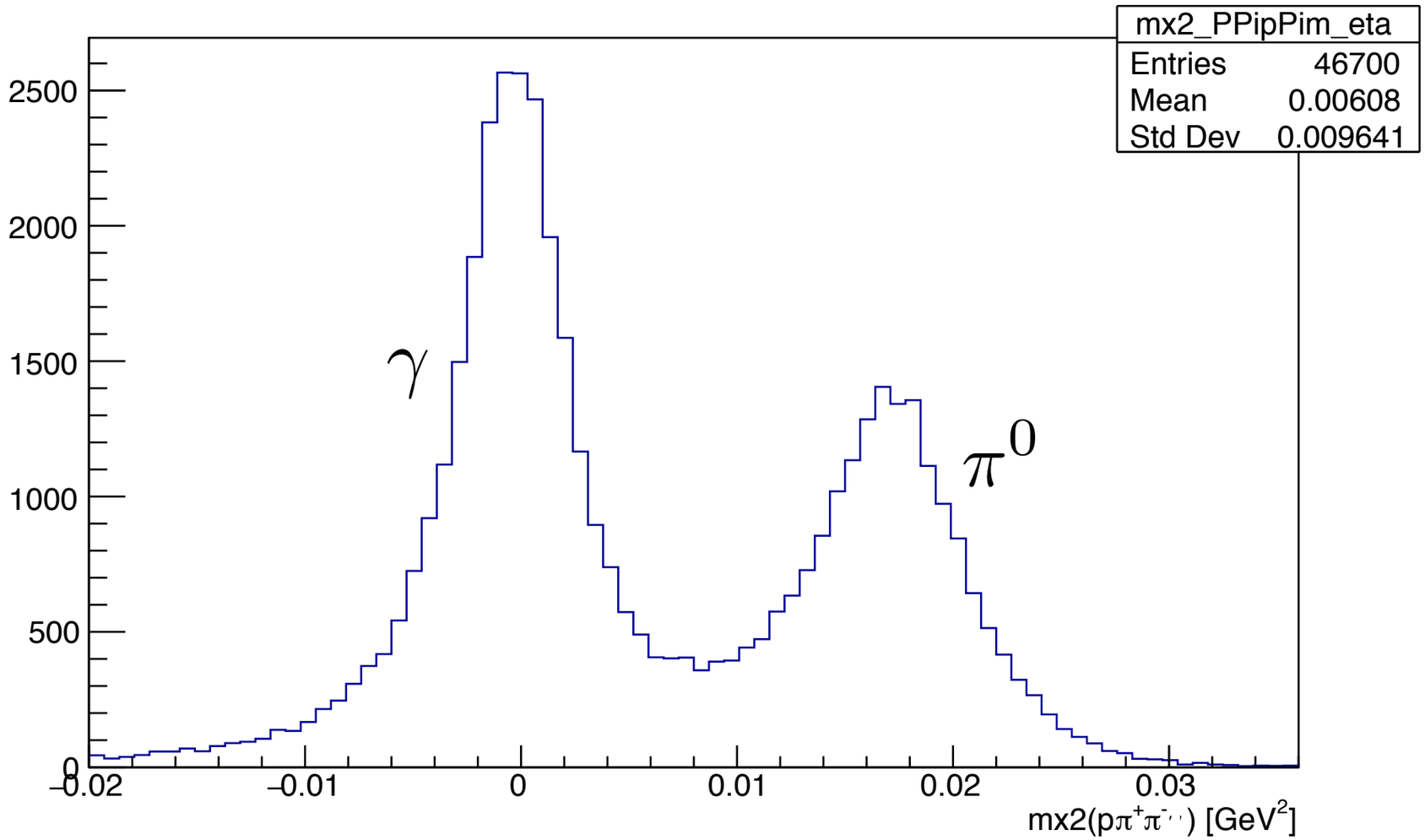
$$mx(P)$$



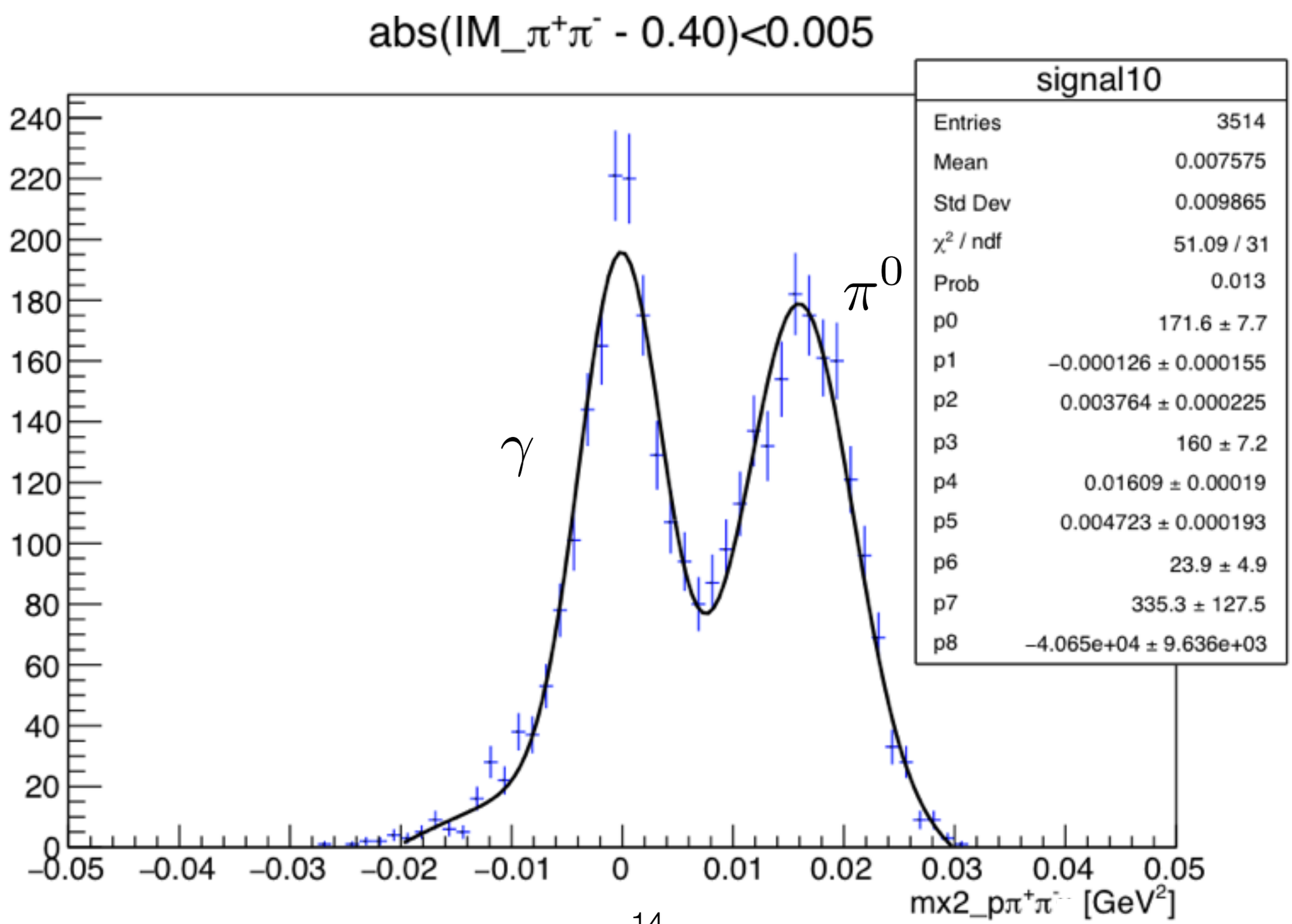
Missing mass of P in region of eta



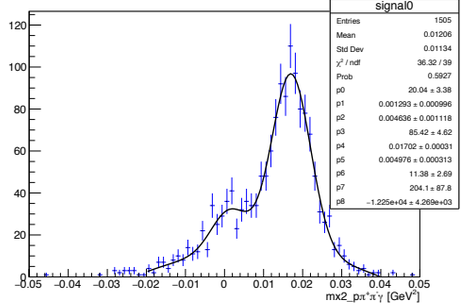
missing mass squared of
$(p\pi^+\pi^-)$



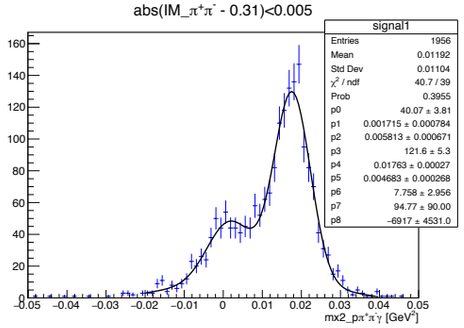
missing mass squared of $(p\pi^+\pi^-)$



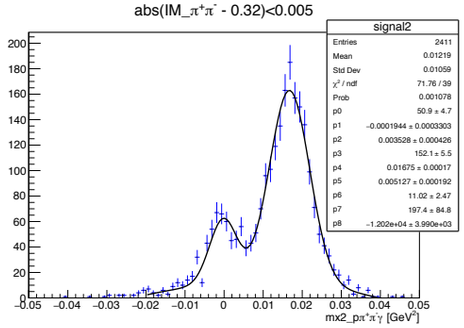
abs(IM_$\pi^+\pi^-$ - 0.30)<0.005



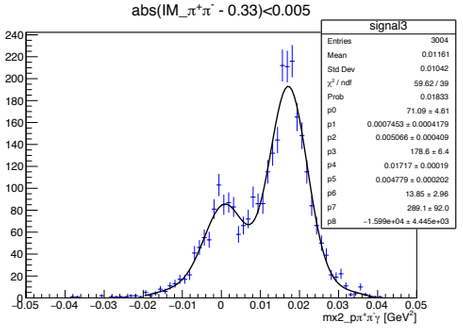
abs(IM_$\pi^+\pi^-$ - 0.31)<0.005



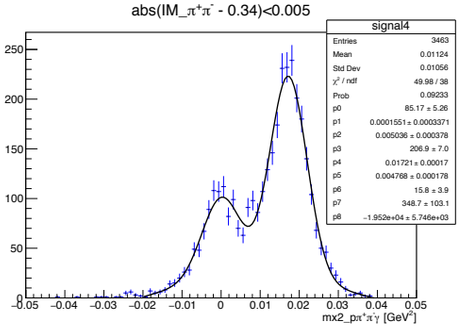
abs(IM_$\pi^+\pi^-$ - 0.32)<0.005



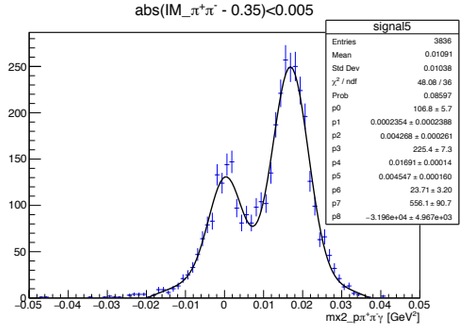
abs(IM_$\pi^+\pi^-$ - 0.33)<0.005



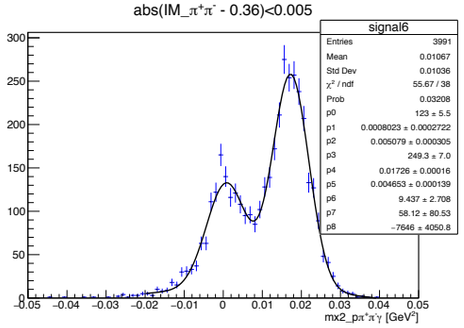
abs(IM_$\pi^+\pi^-$ - 0.34)<0.005



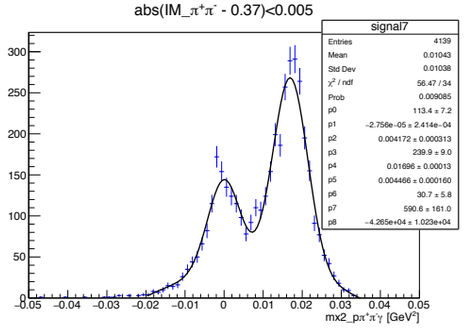
abs(IM_$\pi^+\pi^-$ - 0.35)<0.005



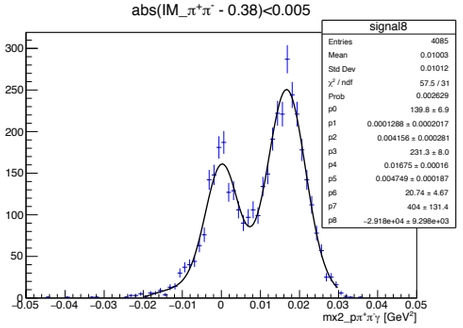
abs(IM_$\pi^+\pi^-$ - 0.36)<0.005



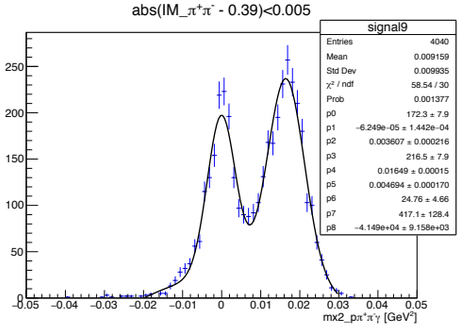
abs(IM_$\pi^+\pi^-$ - 0.37)<0.005



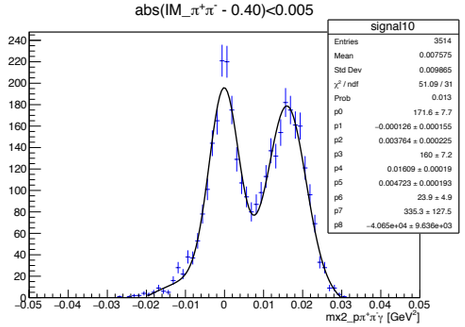
abs(IM_$\pi^+\pi^-$ - 0.38)<0.005



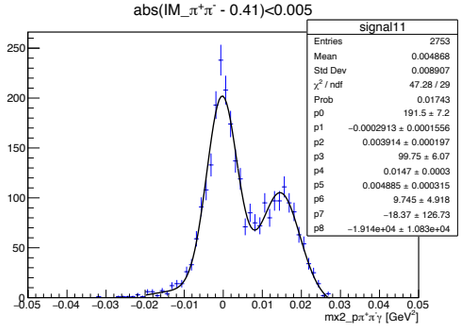
abs(IM_$\pi^+\pi^-$ - 0.39)<0.005



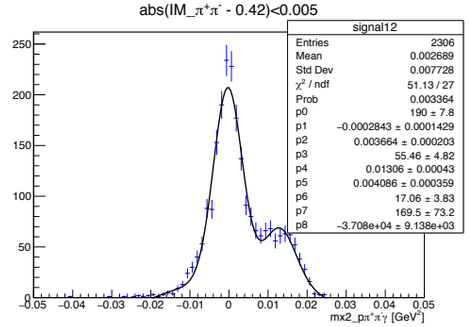
abs(IM_$\pi^+\pi^-$ - 0.40)<0.005



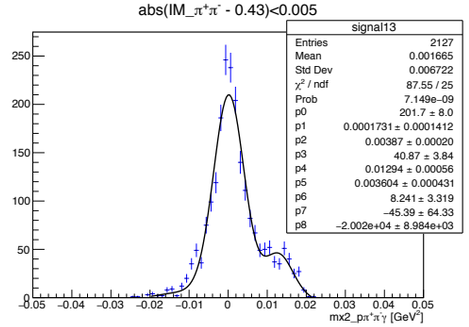
abs(IM_$\pi^+\pi^-$ - 0.41)<0.005



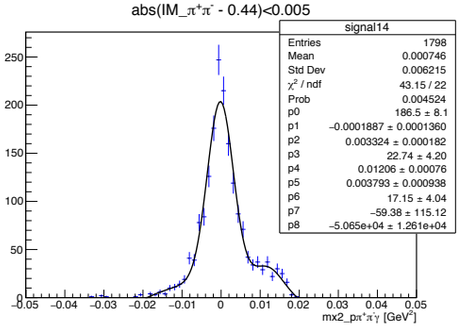
abs(IM_$\pi^+\pi^-$ - 0.42)<0.005



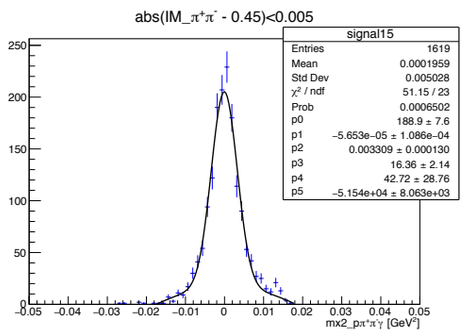
abs(IM_$\pi^+\pi^-$ - 0.43)<0.005



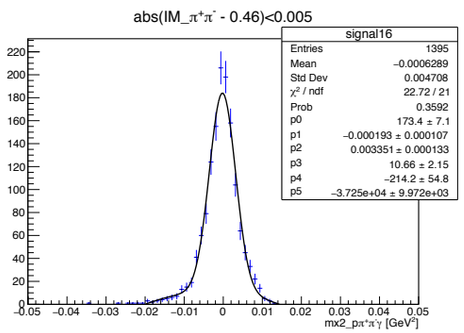
abs(IM_$\pi^+\pi^-$ - 0.44)<0.005



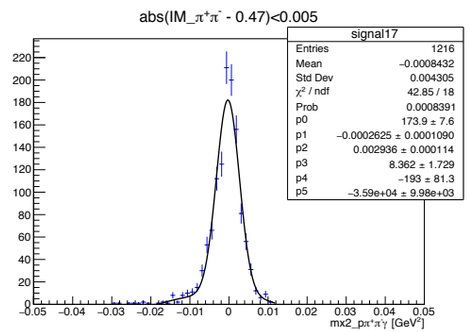
abs(IM_$\pi^+\pi^-$ - 0.45)<0.005



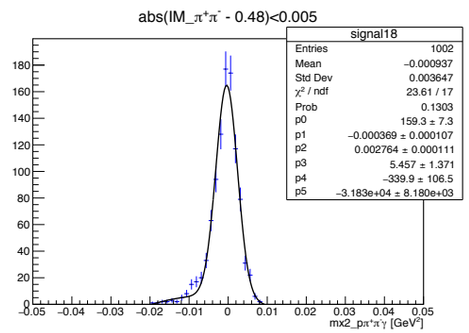
abs(IM_$\pi^+\pi^-$ - 0.46)<0.005



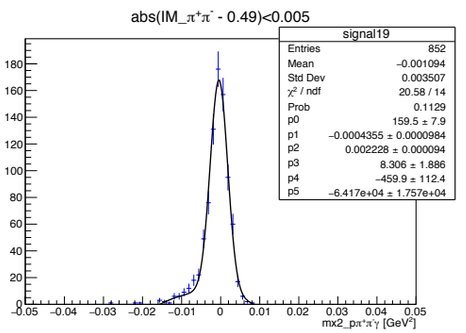
abs(IM_$\pi^+\pi^-$ - 0.47)<0.005



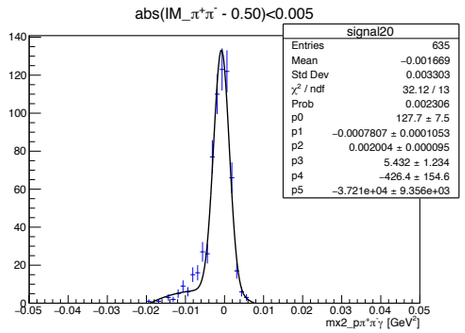
abs(IM_$\pi^+\pi^-$ - 0.48)<0.005



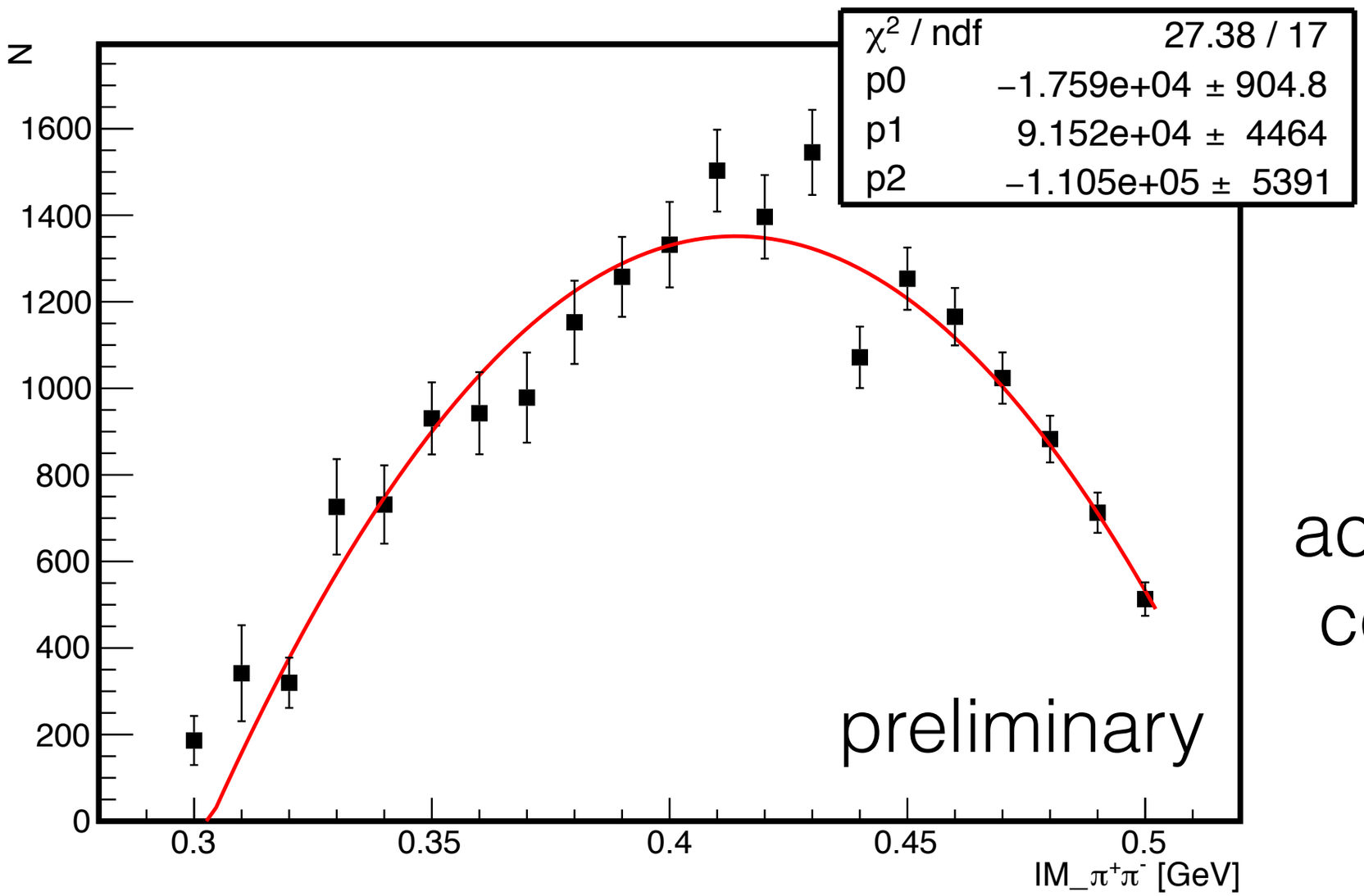
abs(IM_$\pi^+\pi^-$ - 0.49)<0.005



abs(IM_$\pi^+\pi^-$ - 0.50)<0.005



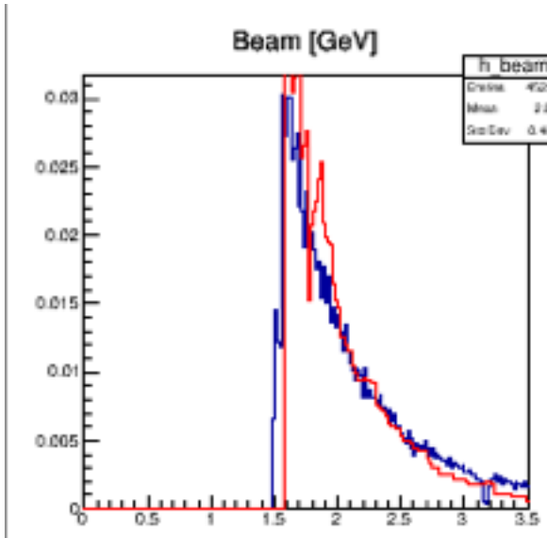
N vs M($\pi^+\pi^-$) distribution

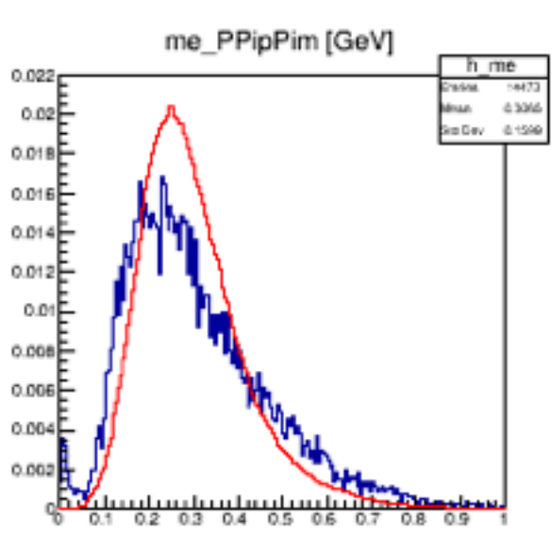


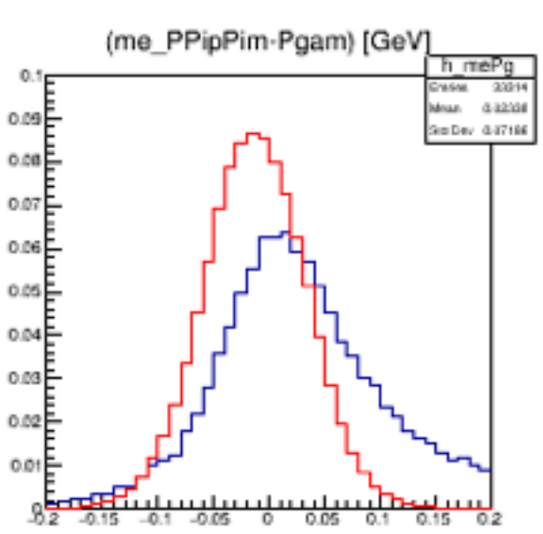
not acceptance corrected!

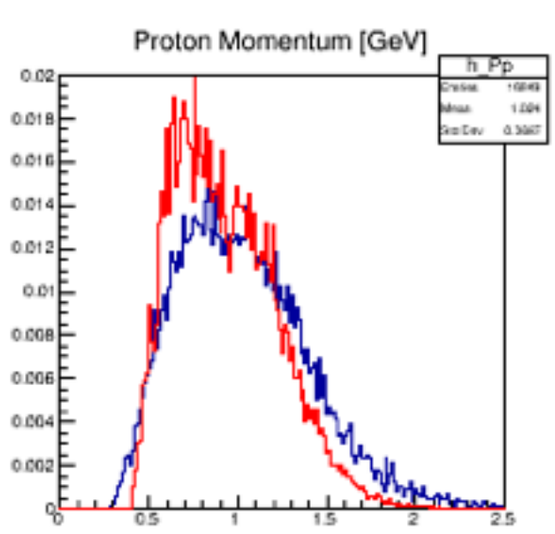
relative error on p1 ~ 4 %

reconstructed MC (red) vs data (blue)









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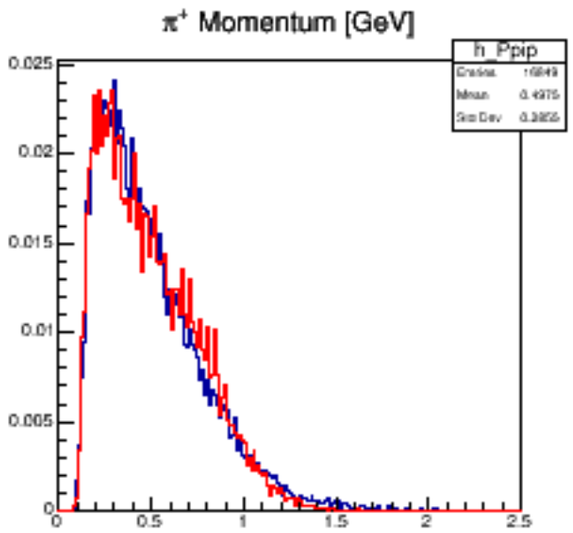

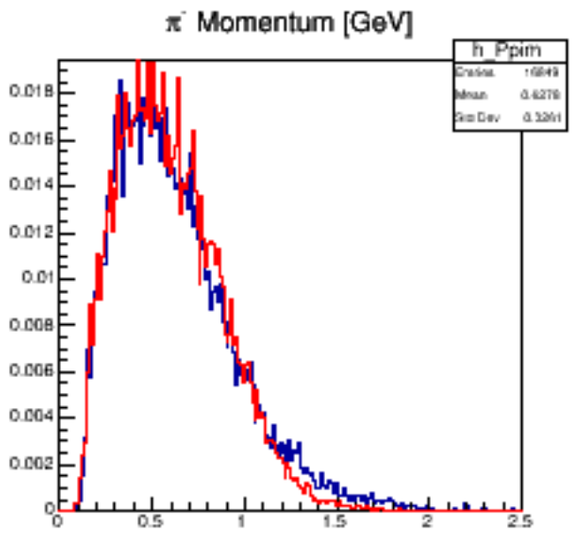

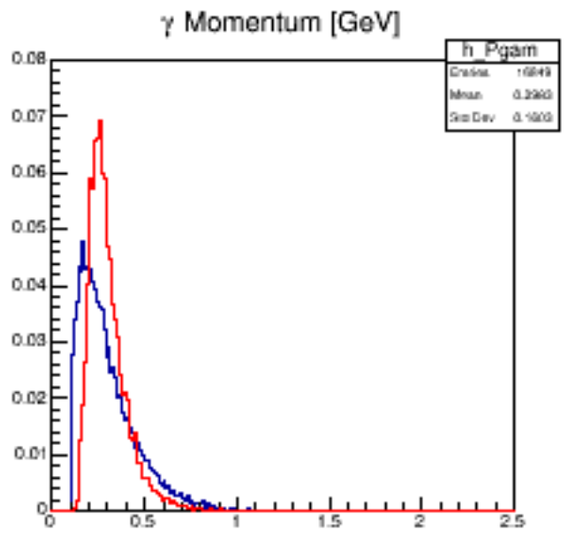

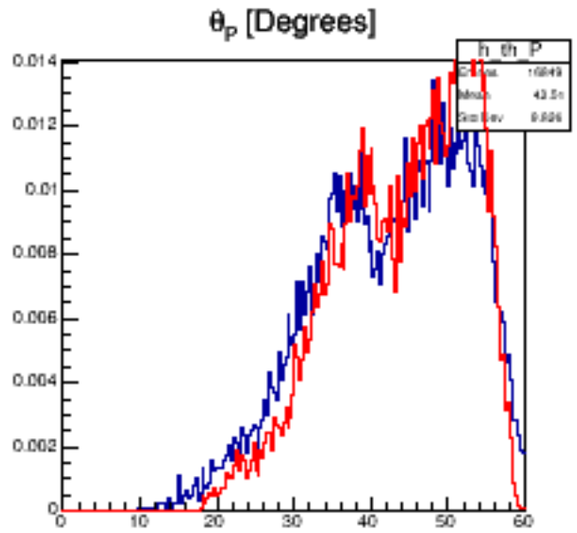

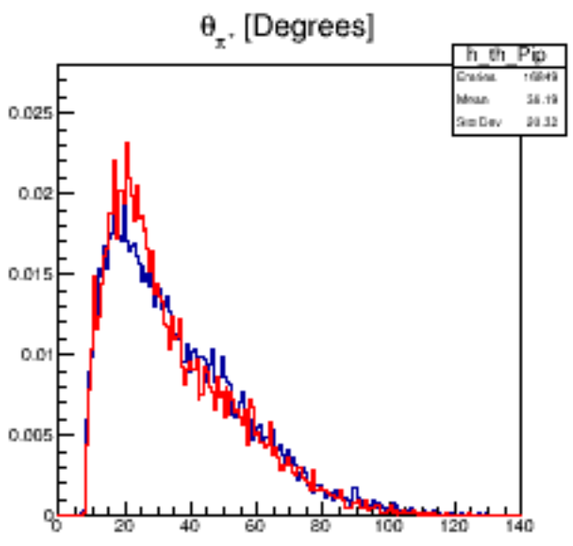

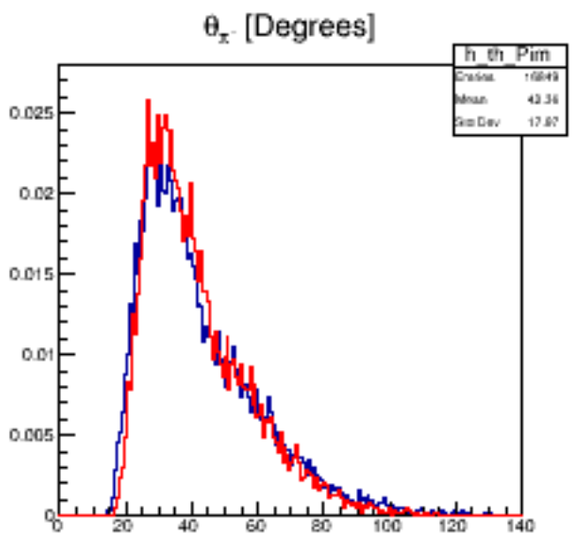

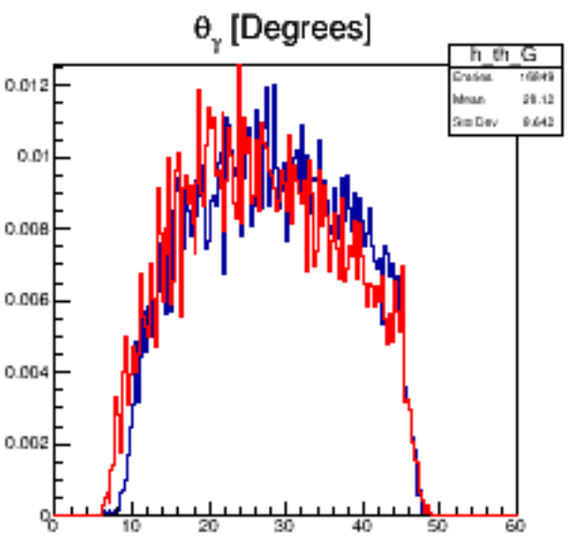

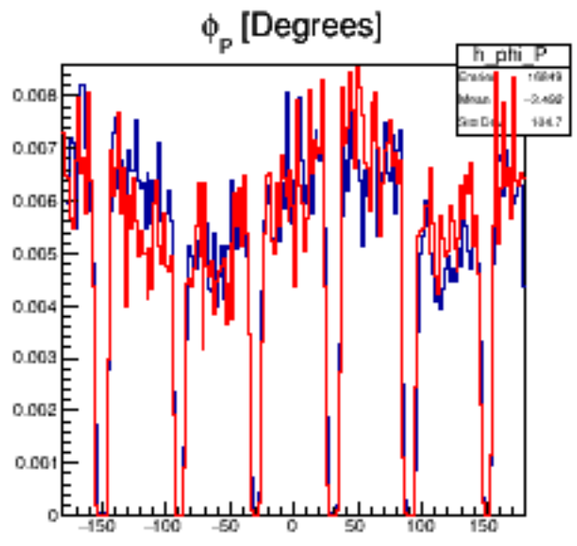

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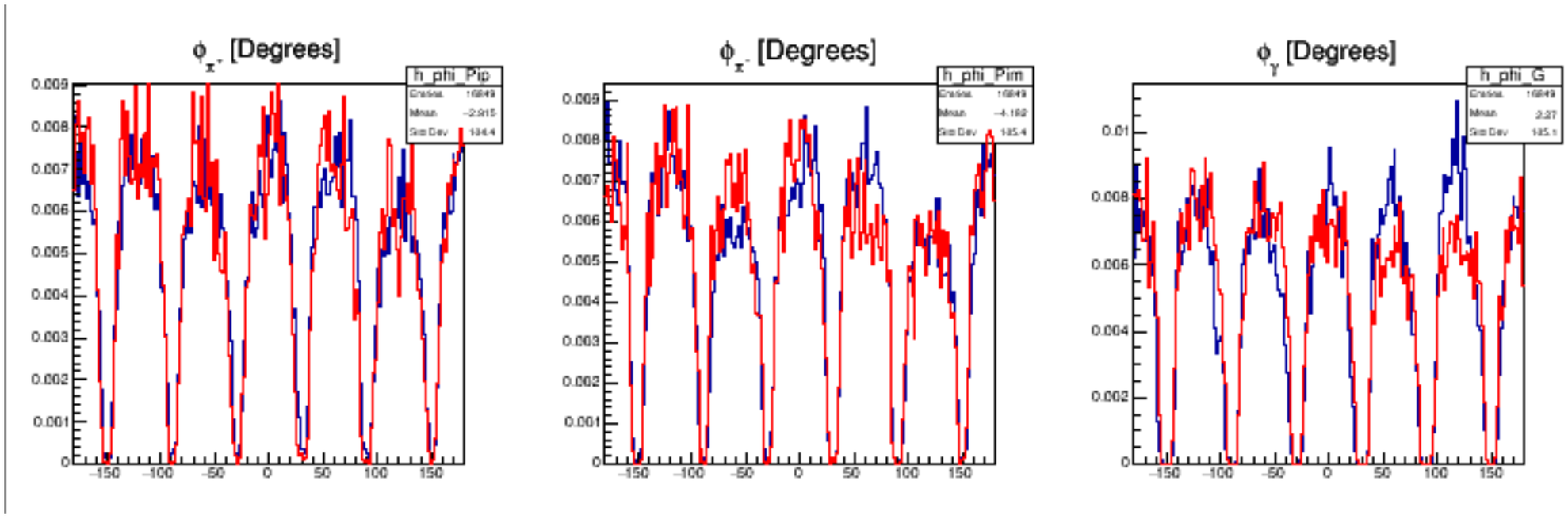

Summary

- finalize simulations
- obtain acceptance corrected IM(PipPim) distribution
- obtain alpha parameter with 5-10% stat error
- analyze $\rho \rightarrow \pi^+\pi^-\gamma$