Photo-production of η' mesons with the GlueX experiment

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GLUEX

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Outline

- Data Selection and applied cuts
- Channel $\pi^+\pi^-\eta$ with branching ratio 43.4 %, $\eta \rightarrow \gamma\gamma$ with branching ratio 39.3 %
- Channel $\pi^+\pi^-\gamma$ with branching ratio 29.3%.
- Yield comparison
- Summary

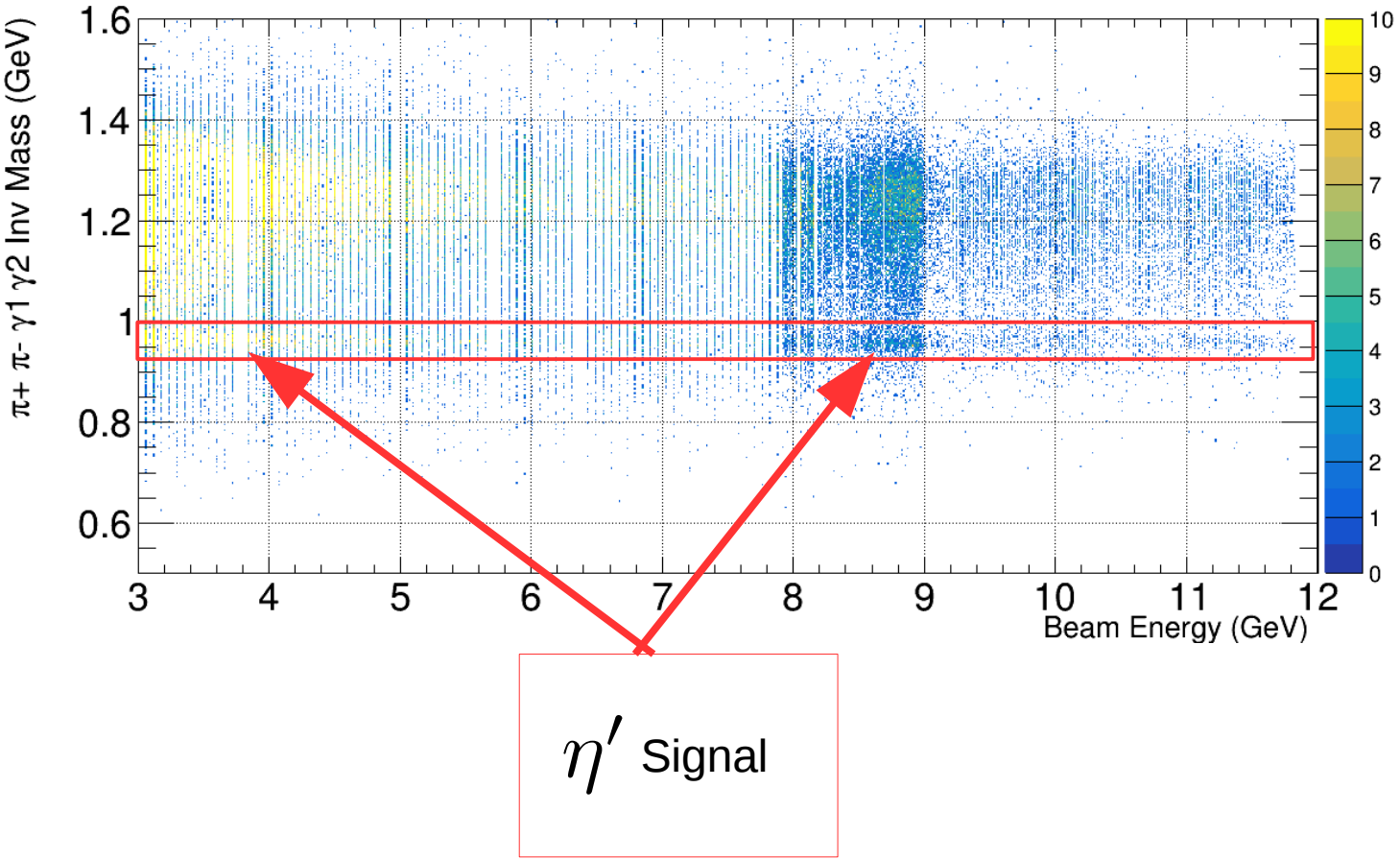
Data Selection and Applied Cuts

- Approximately 15 % of spring 2016 data were used.
- Loose particle ID cuts and kinematic fitting conserving energy, momentum, and vertex are applied.
- Applied standard fiducial Cuts ($P_p > 0.25 GeV/c$, vertex cut, same beam bunch).
- Missing mass squared cut = $\pm$ 5 MeV^2
- Missing energy cut = $\pm$600 MeV

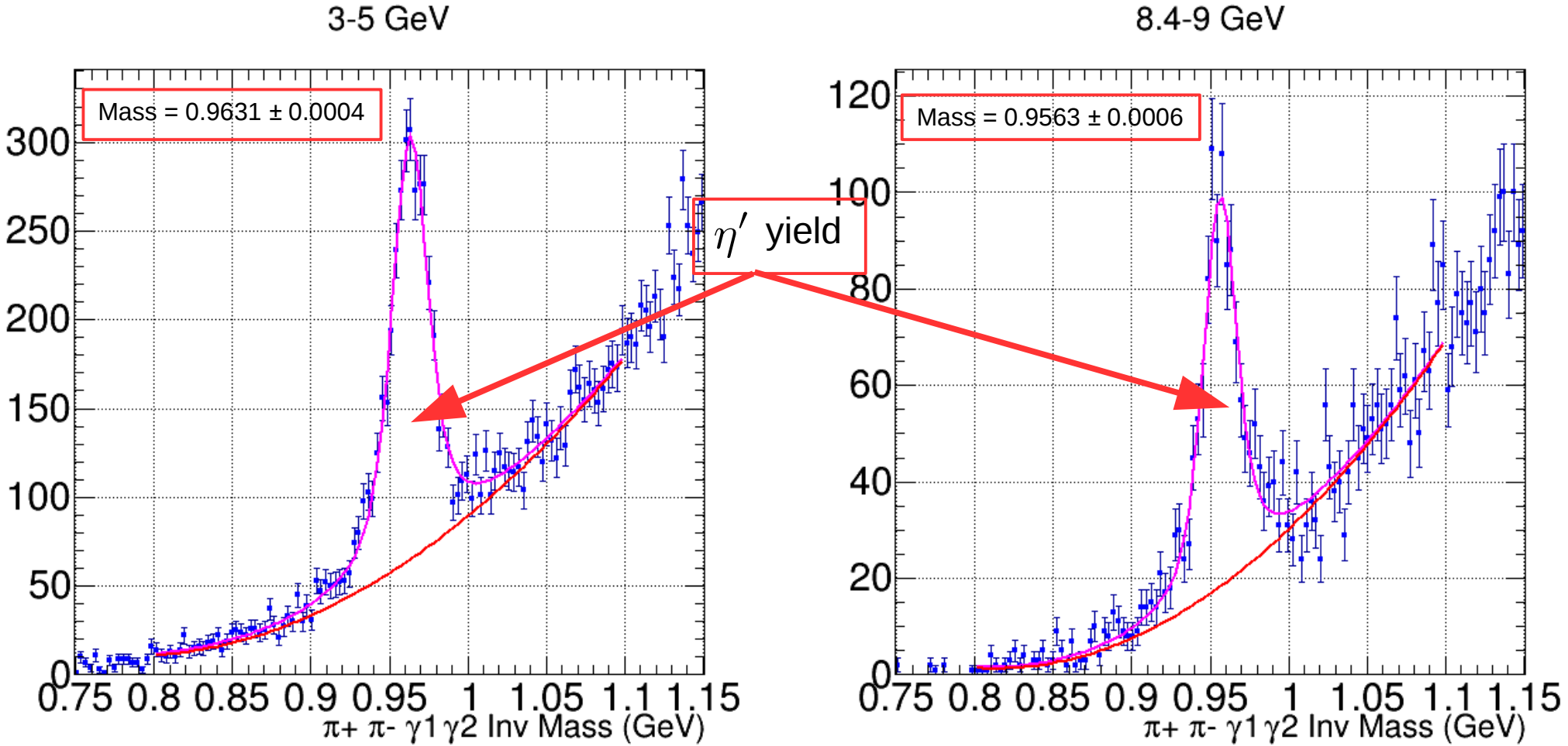
$\pi^+\pi^-\eta$ Channel

Y projection for 4 beam energy intervals is obtained in order to calculate the yield

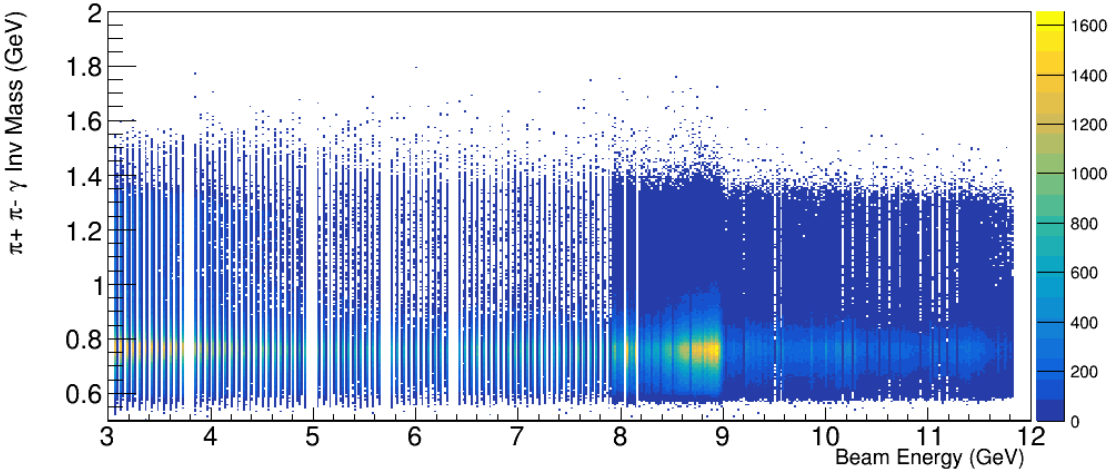
Beam energy intervals are 3-5 GeV, 5-7 GeV, 7-8.4 GeV, and 8.4 to 9.0 GeV.



$\pi^+\pi^-\eta$ Channel



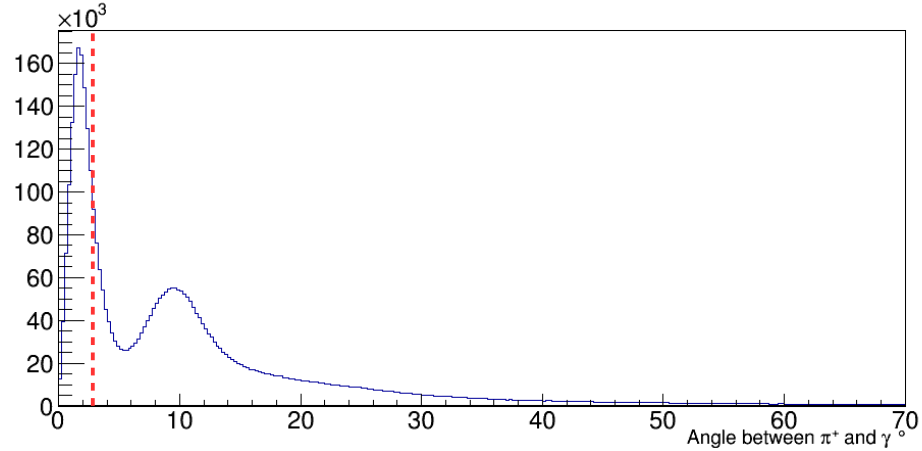
$\pi^+\pi^-\gamma$ Channel



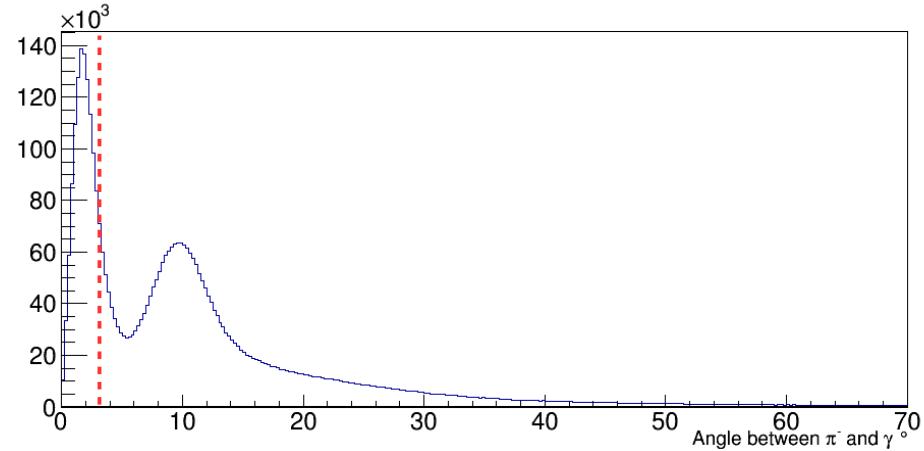
Huge background around ρ and ω from hadronic split off

Several Angle cuts between pions and photons have been studied in intervals of 1^o from 3^o to 7^o. The cut of 3^o has been chosen by optimizing signal significance

Angle distribution between positive pion and the photon

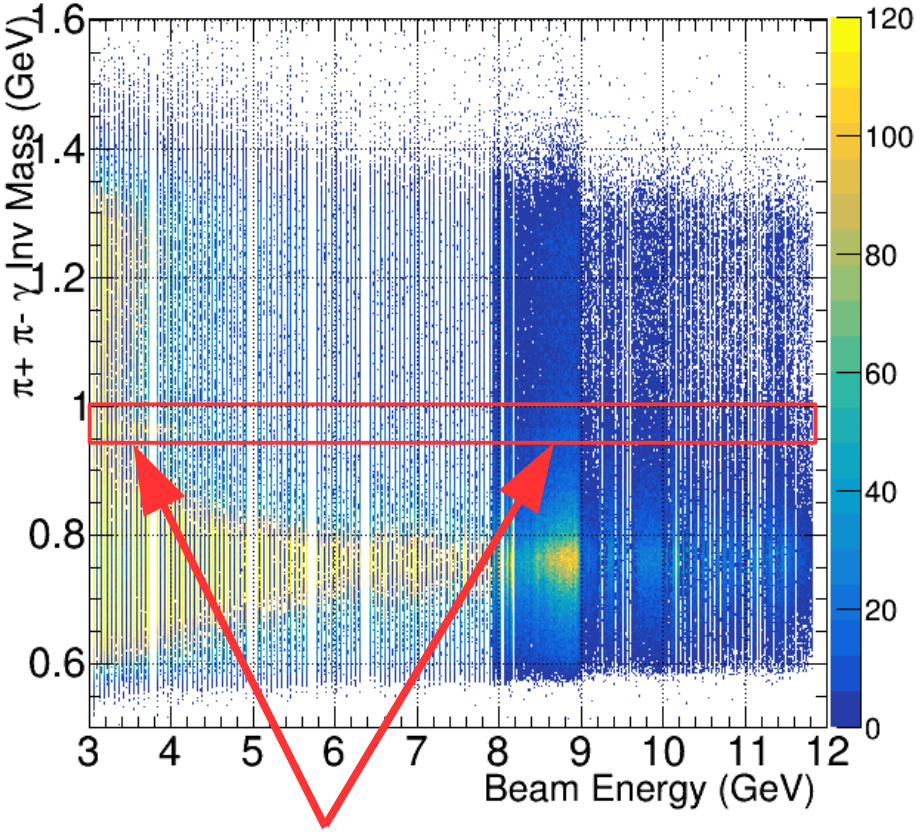


Angle distribution between negative pion and the photon

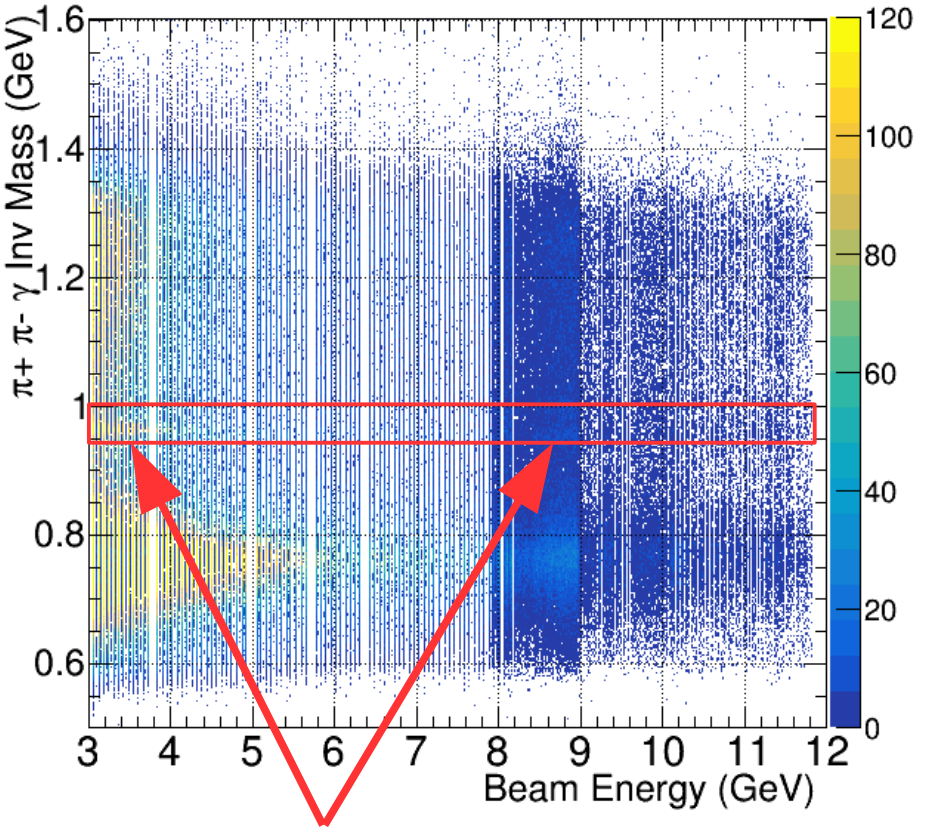


$\pi^+\pi^-\gamma$ Channel

Invariant mass vs beam energy with angle cuts of 3° and 6°



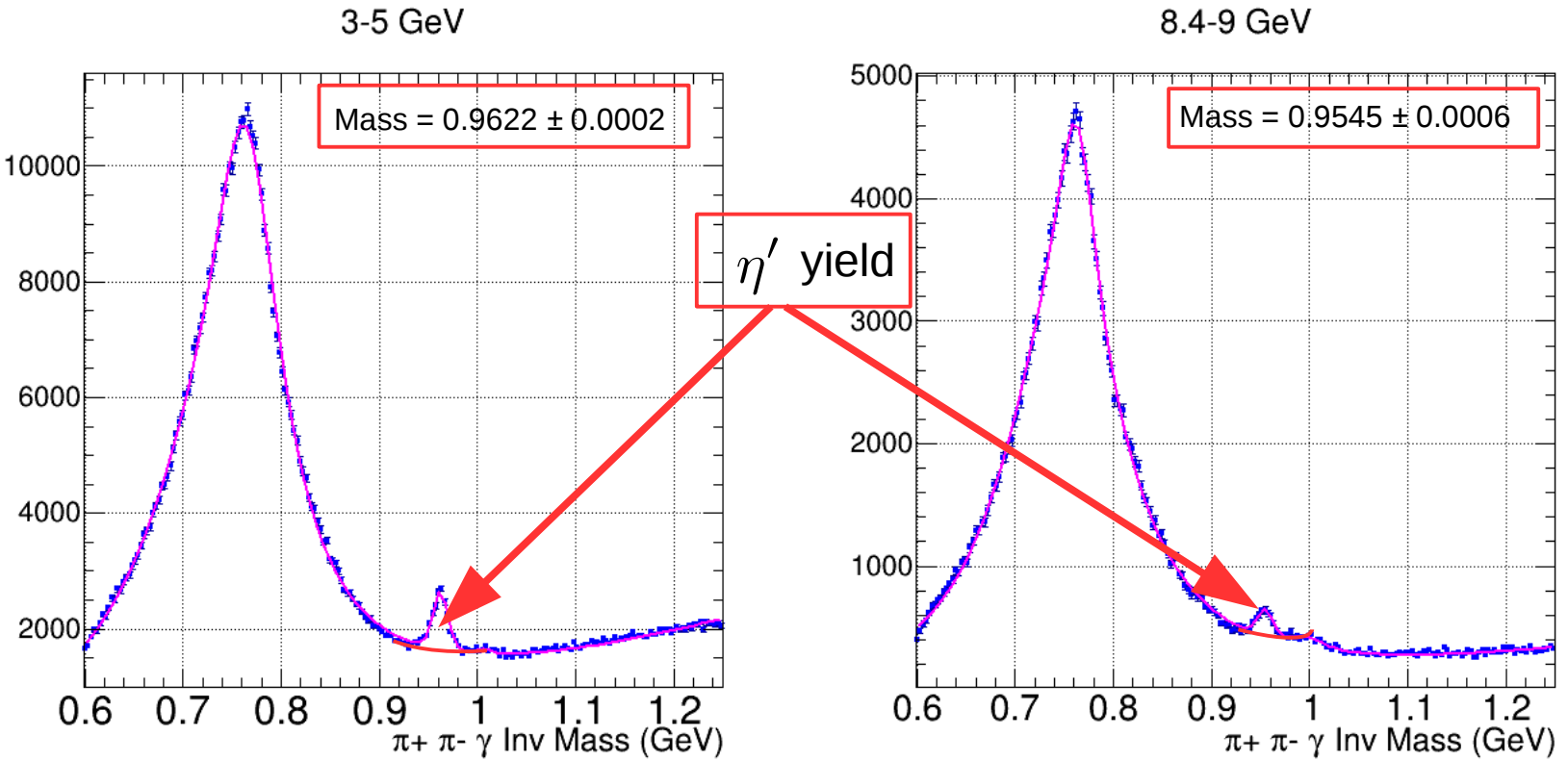
Signal



Signal loss with larger angle cuts

$\pi^+\pi^-\gamma$ Channel

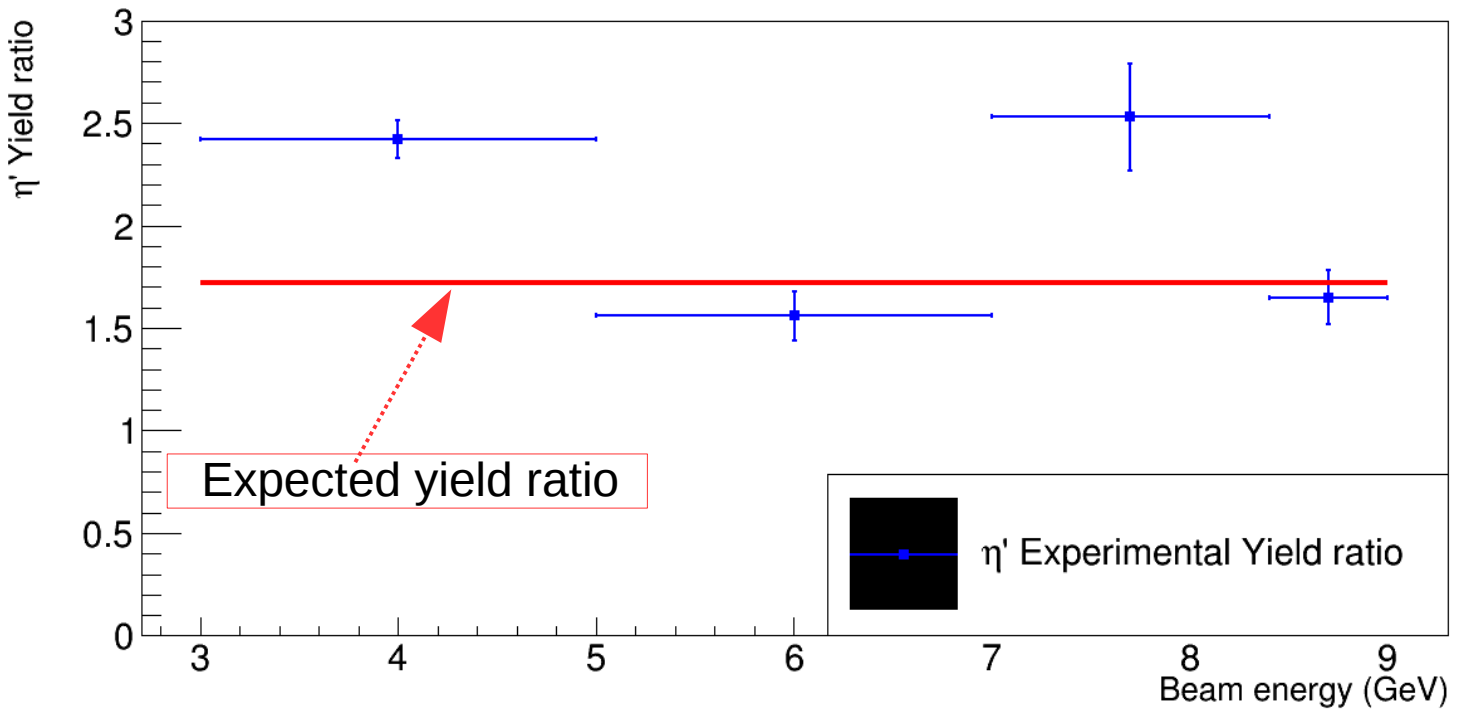
Y projection for 4 beam energy intervals (same as before) is obtained in order to calculate the yield



Yield Comparison

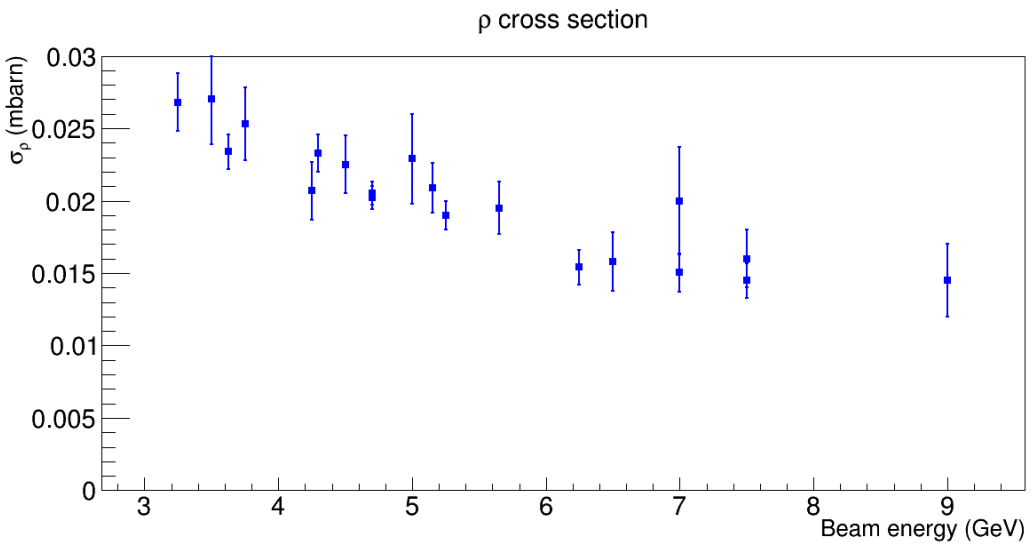
$$\text{Expected yield ratio} = \frac{(\pi^+\pi^-\gamma)Yield}{(\pi^+\pi^-\eta)Yield} = \frac{(29.3\pm0.6)\%}{(43.4\pm0.7)\% * (39.3\pm0.2)\%} = 1.72 \pm 0.05$$

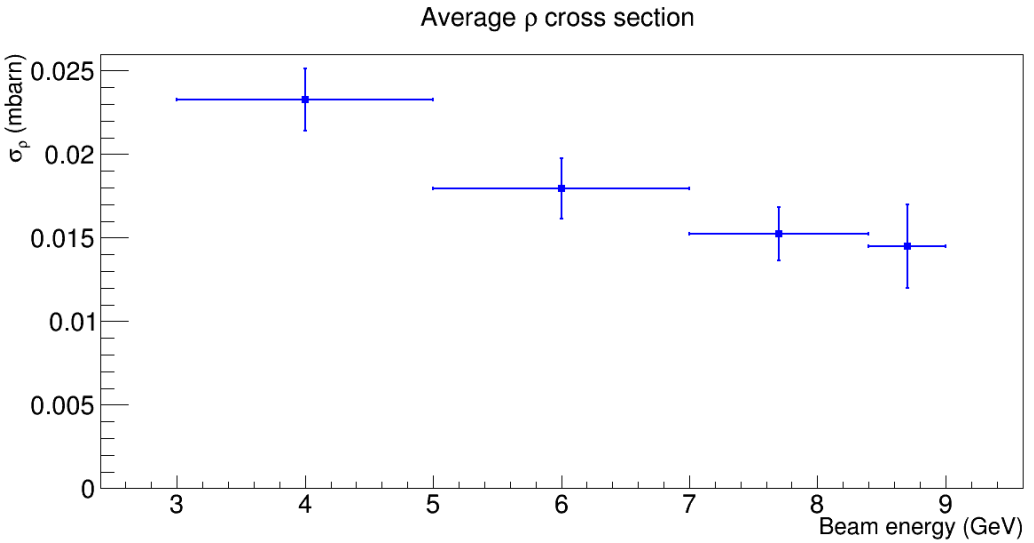
- The experimental yield ratio deviates from the expected one by ~ 50 %
- **Reason:** Missing acceptance and efficiency corrections.
- Blue horizontal line indicates beam energy integration range
- **The errors are statistical only.**



Cross Section Estimate

- Based on the well known ρ cross section, the η' cross section can be estimated.





Baldini, A., et al. "Total cross-sections for reactions of high energy particles." (1988), Eisenberg,PRD5,15-72; Davier,PRL21,841-68; Struczinski,NPB108,45-76; Bingham,PRL24,955-70; Ballam,PRD5,545-72; Park,NPB36,404-72; Alexander,NPB104,397-761; Ballam,PRL21,1541-68

Future Cross Section Estimate

- The total cross section of η' from both channels must be the same. $\sigma_{\eta'} = \frac{(\eta')Yield}{(\rho)Yield}\ \sigma_{\rho}$

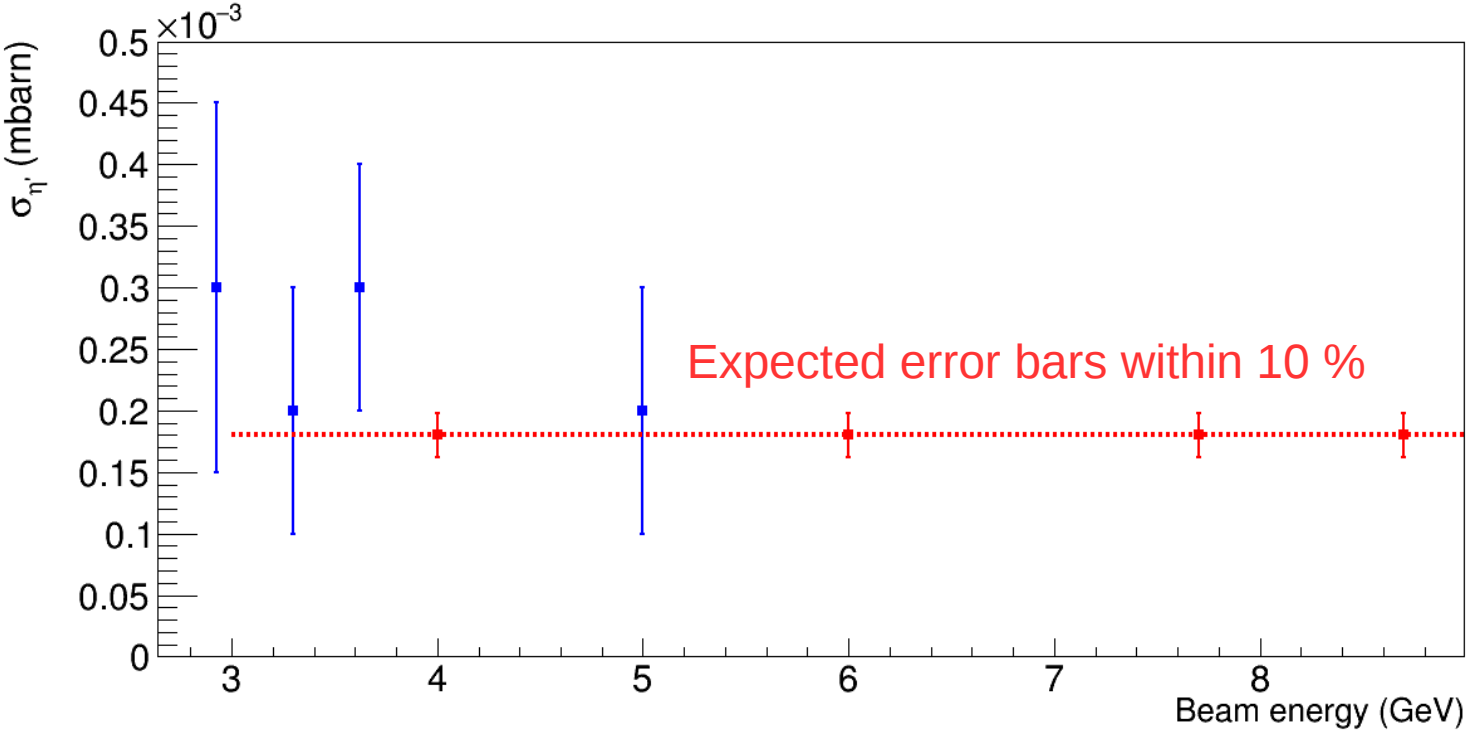
For each decay channel Needed:

- Corrections for acceptance, efficiency, and systematics.

Goal:

- Improve the precision of the measurements from 3 to 5 GeV.

- Provide new cross section measurements for beam energy greater than 5 GeV. The errors will not be statistically limited



Summary

- Gluex is ready for physics production run in a couple of days.
- **Gluex will improve the precision of the cross section measurements at 3 to 5 GeV beam energy.**
- **Provide new cross section measurements for beam energy greater than 5 GeV without statistical limitation**
- **Corrections for systematics, acceptance, and efficiencies are the next steps**

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