Performance Studies of $pp \to pp\pi^0$ and $pp \to pp\eta$ Reconstruction for the $\bar{\text{P}}$ANDA Day-1 Setup

$\bar{\text{P}}$ANDA Physics Analysis Meeting

TECHNISCHE UNIVERSITÄT DARMSTADT

Overview

PandaRoot Simulations

- October 2019 release
- Geant3
- Full Simulation
- Day-1 Setup

Single particle reconstruction

$$pp \rightarrow pp\pi^0/\eta$$

Full final state reconstruction
Cross sections

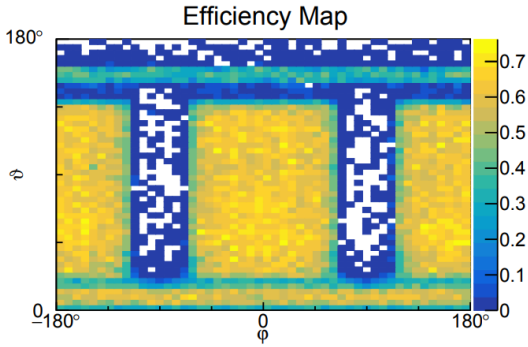
π^0 Reconstruction Efficiency

Simulation

- 10^6 isotropically generated π^0
- p_{π^0} from $0.05\,\mathrm{GeV}/c$ to $5\,\mathrm{GeV}/c$

Reconstruction

- Decay: $\pi^0 \to \gamma\gamma$
- Fit π^0 peak in $\gamma\gamma$ invariant mass spectrum to calculate yield
- Divide by generated π^0



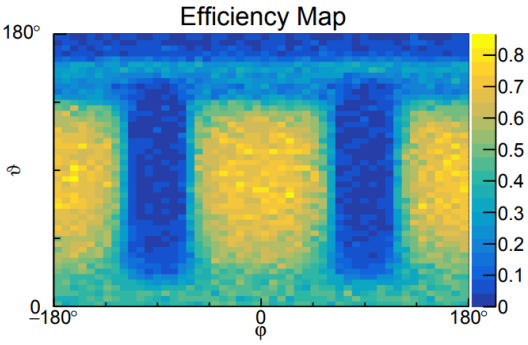
η Reconstruction Efficiency

Simulation

- 10^6 isotropically generated η
- p_η from $0.05\,\mathrm{GeV}/c$ to $5\,\mathrm{GeV}/c$

Reconstruction

- Decay: $\eta \to \gamma\gamma$ ($\mathrm{BR} = 39.41\,\%$)
- Fit η peak in $\gamma\gamma$ invariant mass spectrum to calculate yield
- Divide by generated η, BR corrected



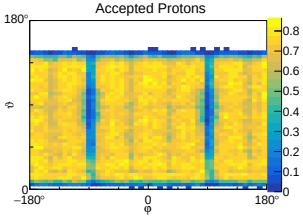
Proton Reconstruction

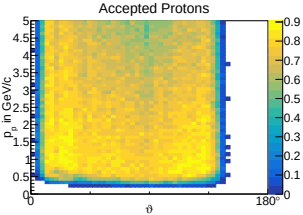
Simulation

- $5 \cdot 10^5$ isotropically generated *p*
- p_p from $0.05\,\mathrm{GeV}/c$ to $5\,\mathrm{GeV}/c$

Reconstruction

- Requirements: 4 hits in MVD or 6 hits in any tracking detector, charge +1
- Use momentum direction of associated MC track for bin assignment

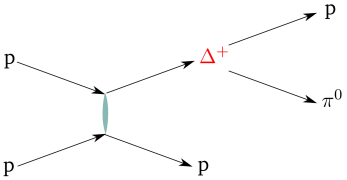




$pp \to pp\pi^0$

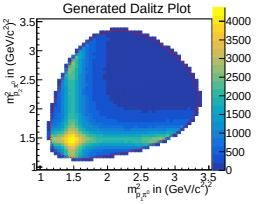
Simulation

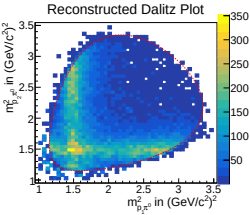
- p beam momentum: $1.5\,\mathrm{GeV}/c$, $3\,\mathrm{GeV}/c$, $5.4\,\mathrm{GeV}/c$ and $15\,\mathrm{GeV}/c$
- Event generation: Phase-space (EvtGen), including $\Delta^+(1232)$ resonance (Pluto)
- 10^6 events each



Reconstruction

- 4C fit on full final state, $200\,\mathrm{MeV}/c^2$ cut around π^0 mass
- Fit π^0 peak in $\gamma\gamma$ invariant mass spectrum to calculate yield

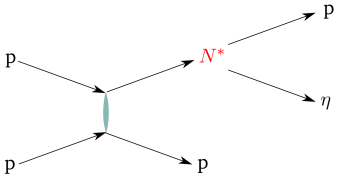




$pp \to pp\eta \to pp\gamma\gamma$

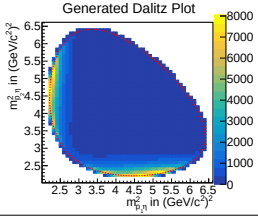
Simulation

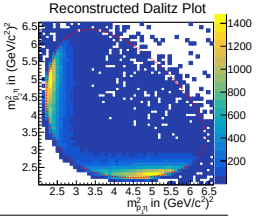
- p beam momentum: $2.06\,\mathrm{GeV}/c$, $3\,\mathrm{GeV}/c$, $5.4\,\mathrm{GeV}/c$ and $15\,\mathrm{GeV}/c$
- Event generation: Phase-space (EvtGen), including $N^+(1535)$ resonance (Pluto)
- 10^6 events each



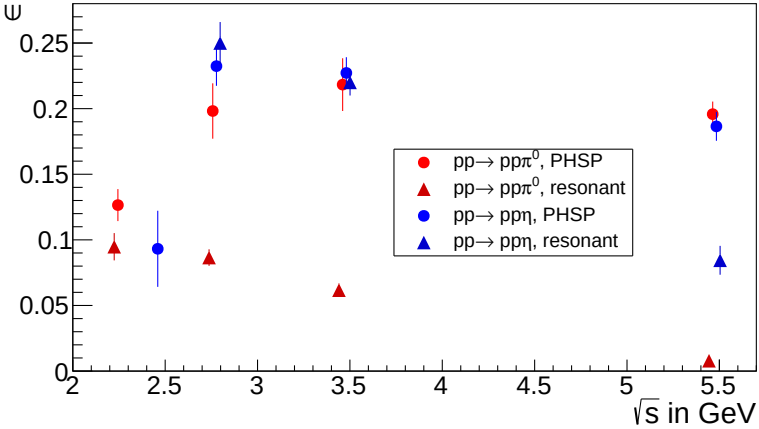
Reconstruction

- 4C fit on full final state, $500\,\mathrm{MeV}/c^2$ cut around η mass
- Fit η peak in $\gamma\gamma$ invariant mass spectrum to calculate yield



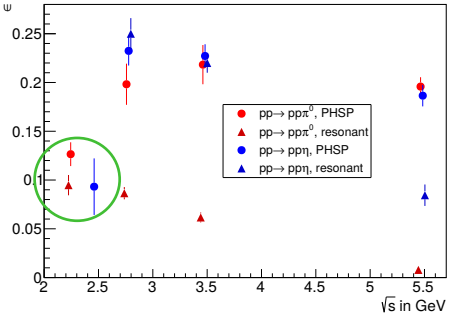


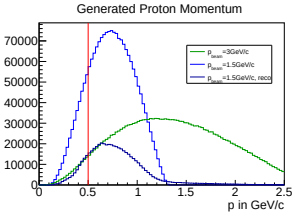
Full Final State Reconstruction Efficiencies

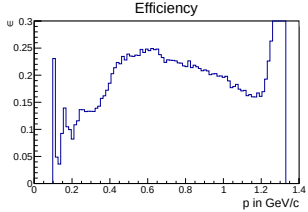


Full Final State Reconstruction Efficiencies

Low Efficiency at Low Energy

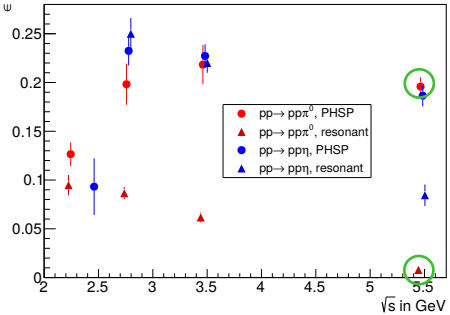


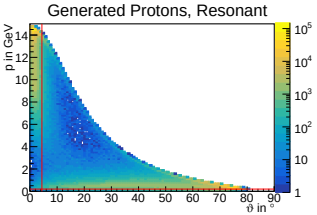


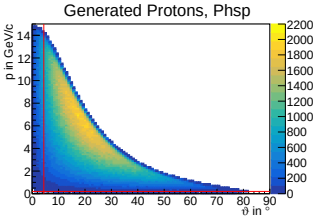


Full Final State Reconstruction Efficiencies

π^0: Resonant vs. Phase Space Scenario

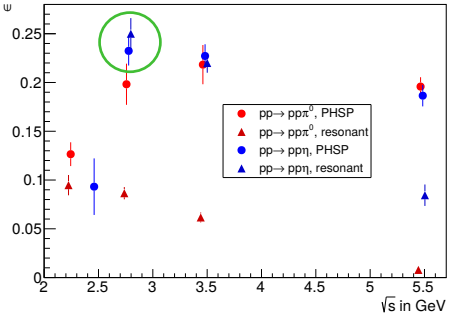


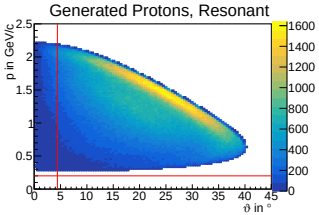


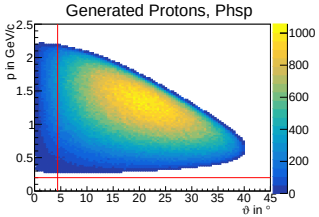


Full Final State Reconstruction Efficiencies

η: Resonant vs. Phase Space Scenario





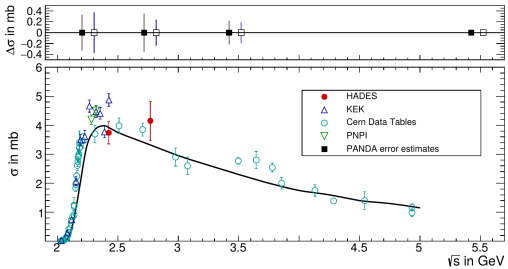


Uncertainty Estimates for Cross Section Measurements

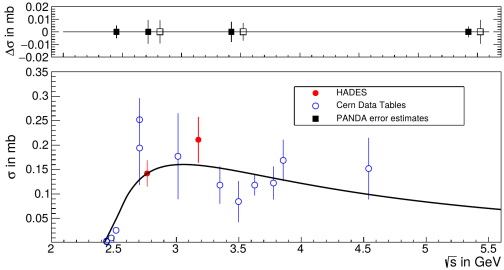
Let's Assume...

- $\mathcal{L} = 10^{30}\,\mathrm{s}^{-1}\mathrm{cm}^{-2}$
- Measuring time $t = 10\,\mathrm{min}$

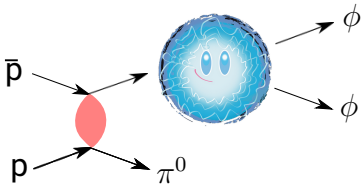
π^0

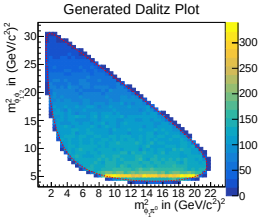


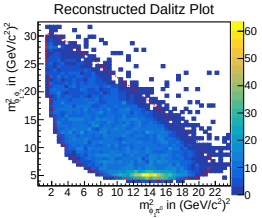
η



The 2^{++} Glueball Candidate







Simulation

- PAWIAN: Simulate reaction
- $f_2(2300)$ resonance in $\phi\phi$
- Detector response in PandaRoot
- Reconstruct full final state, 4C fit

Conclusion

- Good understanding of single particle reconstruction
- Good proton track reconstruction crucial for exclusive reconstruction
- Suitable model for contributing resonances needed
- $pp \rightarrow pp\pi^0/\eta$ cross section measurements very good channel for P̄ANDA in Commissioning Phase
- 2^{++} Glueball candidate addressable with Day-1 setup