

Technical aspects of the reconstruction of $\bar{p}p \rightarrow \phi\phi$

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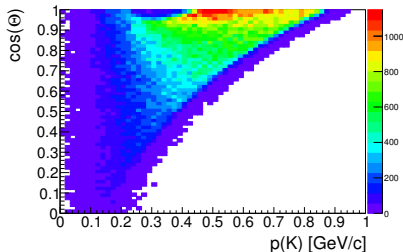
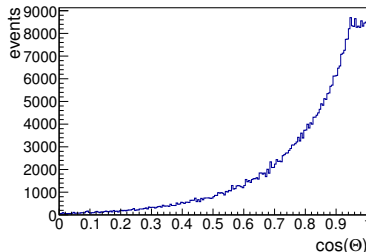
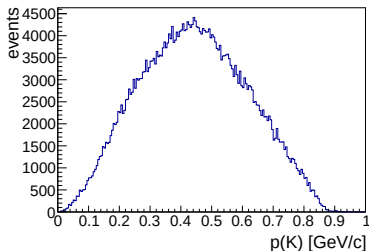
Motivation

- Feasibility study of the reconstruction of the decay
 $\bar{p}p \rightarrow X \rightarrow \phi\phi \rightarrow K^+K^-K^+K^-$
- Scan the cross section in the mass region of the tensor glueball candidate ($\sqrt{s} = (2.25 - 2.7)\text{GeV}/c^2$)

Technical Aspects

- Phase 1 detector setup $\rightarrow$ day1 macros
- PandaRoot release dec17 on kronos
- Fairroot v-16.06b
- Fairsoft may16root6
- Ideal tracking
- Track reconstruction with kaon hypothesis
- 100k $\bar{p}p \rightarrow \phi\phi \rightarrow K^+K^-K^+K^-$ events at $p_{\bar{p}} = 1.5 \text{ GeV}/c$

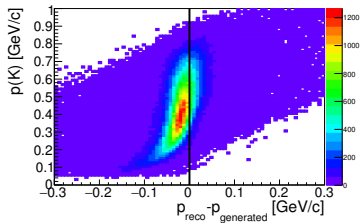
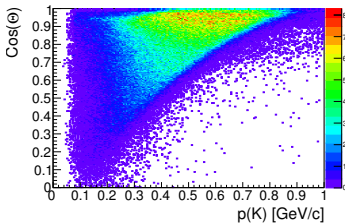
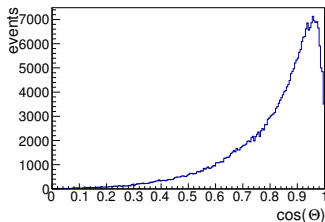
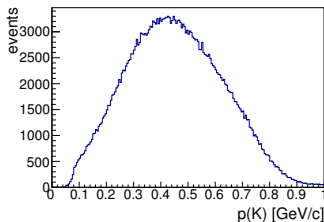
Generated Monte Carlo Truth



- $\sim 25\%$ of tracks
 $\cos(\Theta) > 0.9$
($0^\circ < \Theta(K) < 20^\circ$)
- $\sim 7\%$ of tracks $p(K) < 0.2$

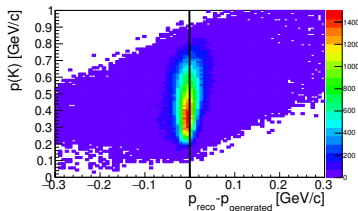
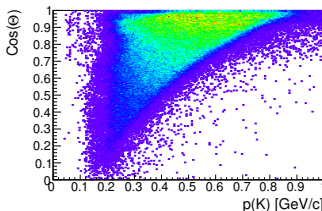
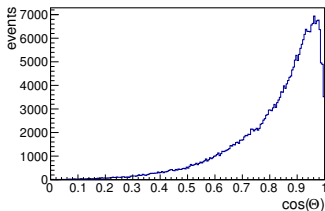
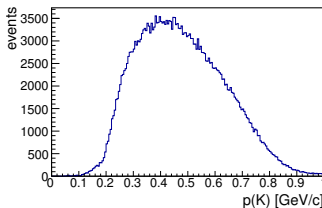
Reconstruction of Kaons with default (muon) Hypothesis

- Shift in $p_{\text{reco}} - p_{\text{generated}}$
- Bad efficiency for tracks with $\cos(\Theta) > 0.9$



Reconstruction of Kaons with kaon Hypothesis

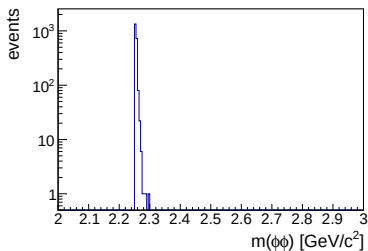
- Shift in $p_{\text{reco}} - p_{\text{generated}}$ gets reduced
- Bad efficiency for tracks with $\cos(\Theta) > 0.96$ and $p(K) < 0.2$



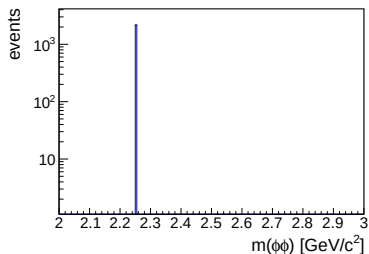
Selection Criteria

- ❶ List of $\bar{p}p$ candidates by forming all combinations of 2 K^+ and 2 K^-
- ❷ Vertex Fit (RhoKinVtxFitter) $P_{\bar{p}p} > 0.001$
- ❸ 4C Fit (Rho4CFitter) $P_{\bar{p}p} > 0.001$
- ❹ Select combination with minimal
$$r = \sqrt{(m(K_1 K_2) - m_\phi)^2 + (m(K_3 K_4) - m_\phi)^2}$$
- ❺ Mass window $r < 10 \text{ MeV}/c^2$

RhoKinFitter

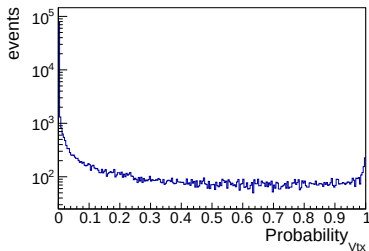


Rho4CFitter

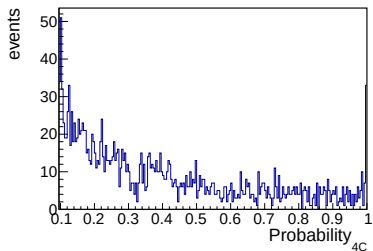
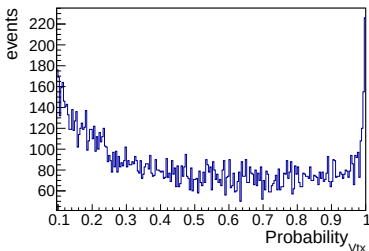
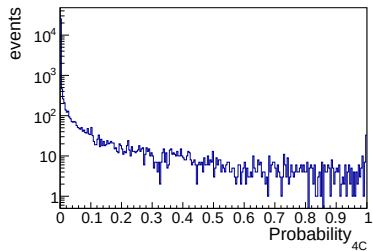


Probabilities

Probability Vertex Fit

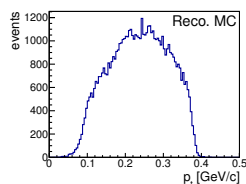
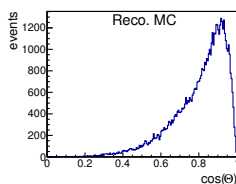
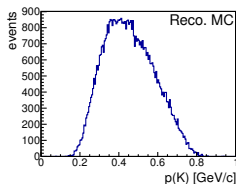
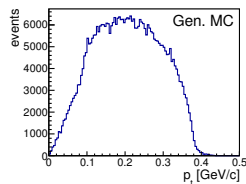
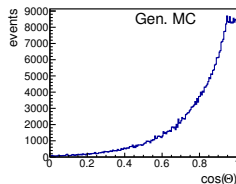
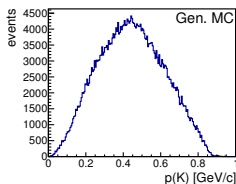


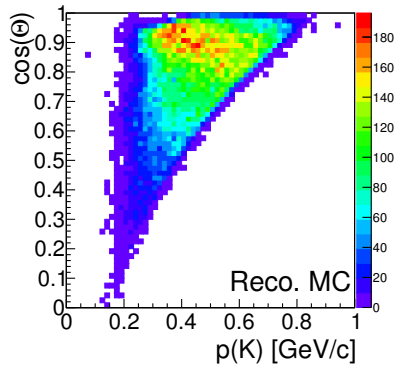
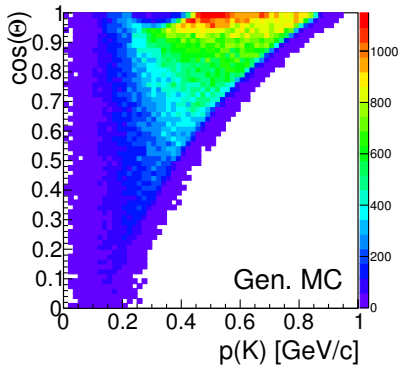
Probability 4C Fit



Mom and $\cos(\Theta)$ after all selection criteria

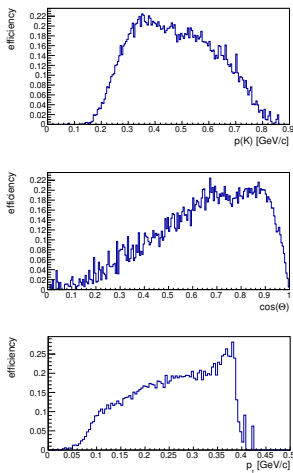
- Bad efficiency for tracks with $\cos(\Theta) > 0.9$ and $p(K) < 0.2$



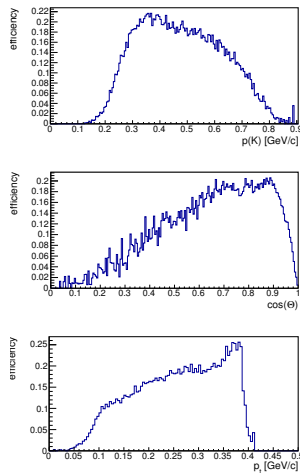
Momentum Vs. $\cos(\Theta)$ 

Efficiencies

Phase 1 detector setup



Full detector setup



- → Loss of tracks not deriving from phase 1 detector setup

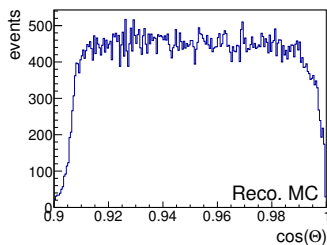
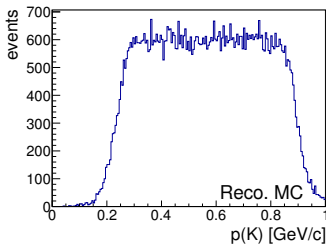
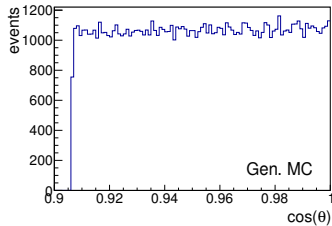
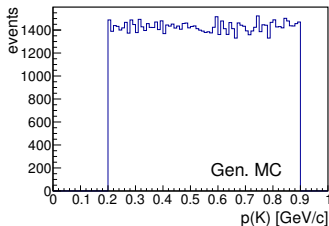
Efficiency

PandaRoot Option	Efficiency
Day1 + Default (muon) hypothesis	6.9%
Day1 + Kaon hypothesis	14.9%
Efficiency PANDA Physics Book 2009	25%

Kinematics with Box Generator

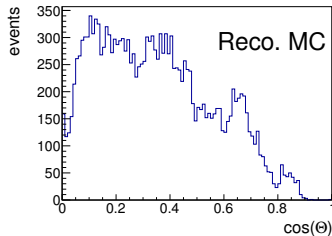
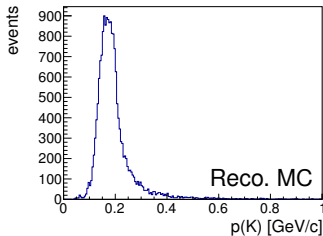
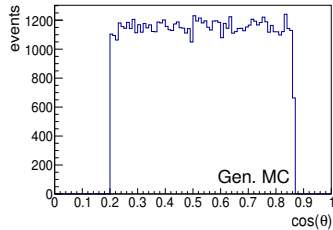
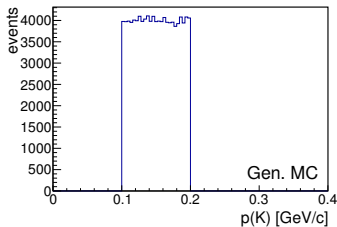
- Flat distribution in $0.2 \text{ GeV}/c < p(K) < 0.9 \text{ GeV}/c$ and $0.9 < \cos(\Theta) < 1$
→ What happens to kaons with $0^\circ < \Theta < 20^\circ$?
- Flat distribution in $0.1 \text{ GeV}/c < p(K) < 0.2 \text{ GeV}/c$ and $0.2 < \cos(\Theta) < 0.86$ ($30^\circ < \Theta < 80^\circ$)
→ What happens to kaons with $p(K) < 0.2 \text{ GeV}/c$?

Flat Distribution in $0.2 \text{ GeV}/c < p(K) < 0.9 \text{ GeV}/c$ and $0.9 < \cos(\Theta) < 1$



- $\rightarrow$ No reconstruction of kaons with small Θ angles

Flat Distribution in $0.1 \text{ GeV}/c < p(K) < 0.2 \text{ GeV}/c$ and $0.2 < \cos(\Theta) < 0.86$



- → Reconstruction of tracks with $p(K) < 0.2 \text{ GeV}/c$ possible with box generator

Summary and Outlook

- Better results when reconstructing with kaon hypothesis
- No proper reconstruction of tracks with $0^\circ < \Theta(K) < 20^\circ$
- No proper reconstruction of tracks with $p_K < 0.2 \text{ GeV}$
→ Lower limit for kaon reconstruction with PANDA?
- Efficiency: 14.9%
- Background studies with generic DPM events
- Possible decay channels:
 $\bar{p}p \rightarrow K^+ K^- \pi^+ \pi^-$
 $\bar{p}p \rightarrow \pi^+ \pi^- \pi^+ \pi^-$
 $\bar{p}p \rightarrow \pi^+ \pi^- \pi^+ \pi^- \pi^0$
...
→ Ability to reconstruct with all hypothesis is absolutely needed

Summary and Outlook

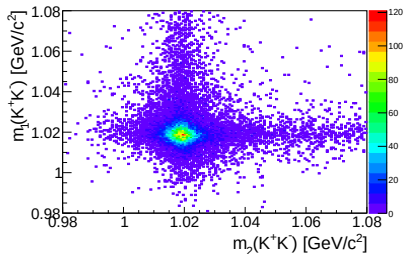
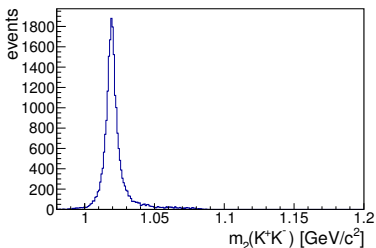
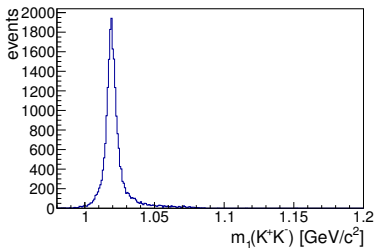
- $\mathcal{L}_{p=1.5\text{GeV}/c} = 788/(\text{nb} \cdot \text{day})$
- $\sigma_{\bar{p}p \rightarrow \phi\phi} \approx 4\mu\text{b}$
- $\epsilon = 14.9\%$

→ For $1 \cdot 10^6$ reconstructed $\bar{p}p \rightarrow \phi\phi \rightarrow K^+K^-K^+K^-$ events
run time of < 8 days needed

→ For background analysis: $\sim 15 \cdot 10^9 \bar{p}p \rightarrow \pi^+\pi^-\pi^+\pi^-$
 $\sim 15 \cdot 10^9 \bar{p}p \rightarrow 3\pi^+3\pi^-\pi^0$
 $\sim 2.5 \cdot 10^9 \bar{p}p \rightarrow K^+K^-\pi^+\pi^-$
generic DPM events needed

- Huge amount of background events
→ FairFilteredPrimaryGenerator will be used!

Reconstructed K^+K^- mass after Vertex and 4C Fit



- Selection of events with $r < 10 \text{ MeV}/c^2$