

PANDA Scrutiny

Analysis of $\bar{p}p \rightarrow K^+K^-\pi^0$
- Search for glueballs $G(2400)$ & $G(3900)$
at $p_{\bar{p}} = 2.4$ and $15 \text{ GeV}/c$

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Analysis Overview

Search for glueballs in light meson sector

Decays into K^+K^-

$G(3900)$ $J^{PC}=1^{--}$ $\Gamma=10$ MeV

$G(2400)$ $J^{PC}=2^{++}$ large Γ

Feasibility: Figures of merit

- 100 signal events
- Signal to background ratio $> 1:1$
- Dalitzplot & production angles
→ homogeneity, acceptance

PandaRoot

Scrut14

Release 24944

Decay modes and beam momenta

$\bar{p}p \rightarrow G(3900)\pi^0$

$G(3900) \rightarrow K^+K^-$

$\pi^0 \rightarrow \gamma\gamma$

$\bar{p}p \rightarrow K^+K^-\pi^0$

$\pi^0 \rightarrow \gamma\gamma$

$p_{\bar{p}} = 15$ GeV/c

$\bar{p}p \rightarrow K^+K^-\pi^0$

$\pi^0 \rightarrow \gamma\gamma$

$p_{\bar{p}} = 2,4$ GeV/c
(G2400 threshold)

Reconstruction

charged: no PID + kaon PID lists

neutral: use Neutral list

π^0 mass window

4C fit, no mass constraint on π^0

select best candidate based on χ^2

Data samples and cross sections

Signals and Background (2,4 GeV/c)

200,000 signal events $\sigma \sim 10 \text{ nb}$

1,000,000 $\pi^+\pi^-\pi^0$ $\sigma \sim 0.65 \text{ mb}$

78,000,000 DPM $\sigma \sim 80 \text{ mb}$

Signals and Background (15 GeV/c)

200,000 signal events each for diff. detector

Setups $\sigma \sim 10 \text{ nb}$

6,000,000 $\pi^+\pi^-\pi^0$ $\sigma \sim 0.03 \text{ mb} (??)$

4,000,000 $\bar{p}p\pi^0$ $\sigma \sim$

200,000 $K^+K^-\pi^0\pi^0$

900,000,000 DPM $\sigma \sim 50 \text{ mb}$

+200,000,000 DPM each for diff. detector setups

Production rates

Glueball

Assume $\sigma = 10 \text{ nb}$

Int. Lum. $1 \cdot 10^{32} \text{ cm}^{-2}\text{s}^{-1}$

$\rightarrow 86,400/\text{d} = 1/\text{s}$

Total $\bar{p}p$

$\bar{p}p \rightarrow X$ $\sigma = 50 \text{ mb}$ (15 GeV/c)

$\sigma = 80 \text{ mb}$ (2,4 GeV/c)

$\rightarrow 5,000,000/\text{s}$ (15 GeV/c)

$\rightarrow 8,000,000/\text{s}$ (2,4 GeV/c)

Time needed for 100 Glueballs

$t=100/\text{eff. [s]}$

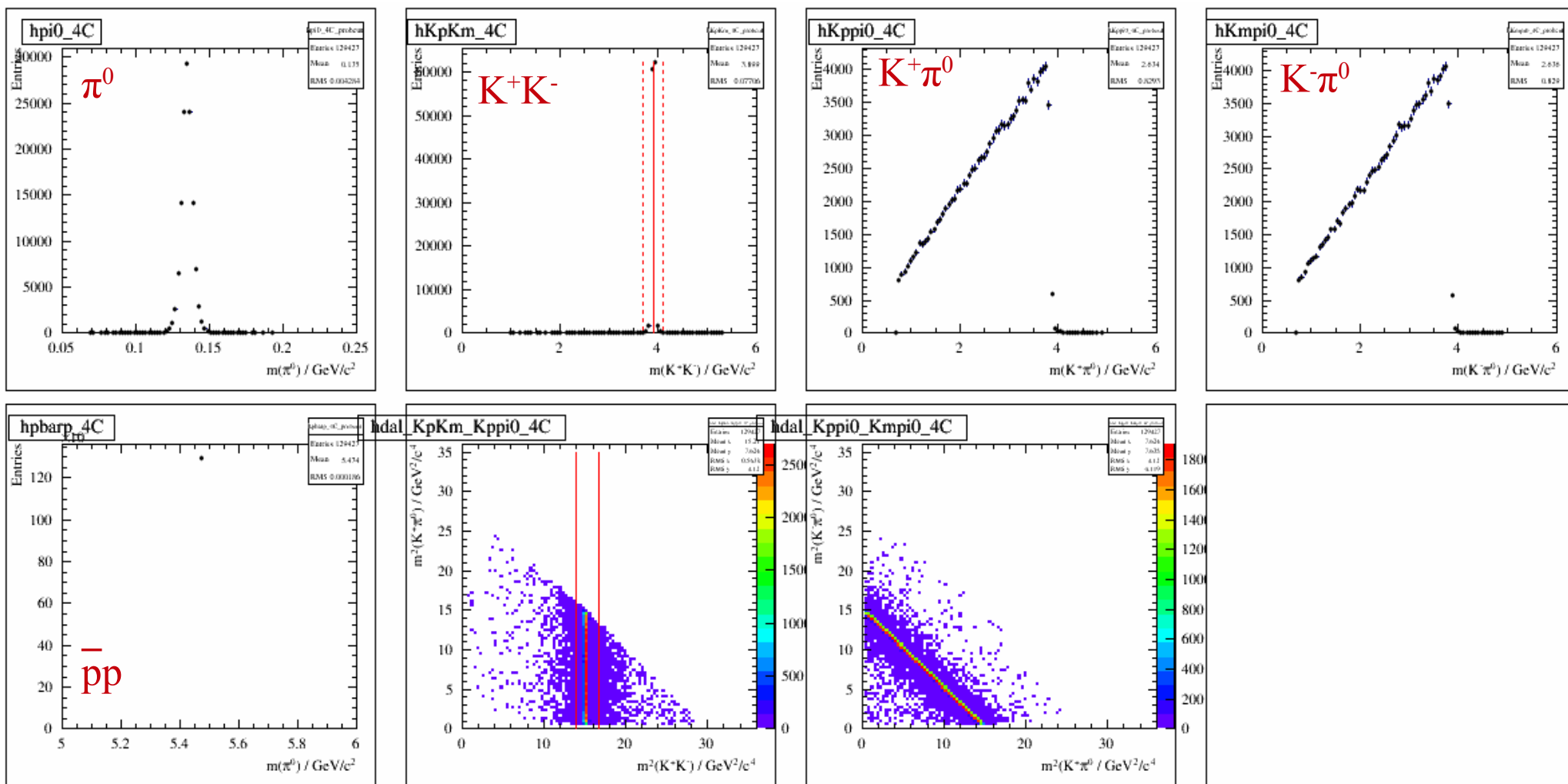
Number of DPM for background studies: (100 Glueballs)

$= t \cdot 5,000,000$

Req. ≤ 100 background events left

$K^+K^-\pi^0 - G(3900) - 15 \text{ GeV}/c$ (Signal) – Full Det.

200,000 events generated



No PID efficiency $\varepsilon = 65\%$

130,000 events reconstructed

4C fit prob > 0.05

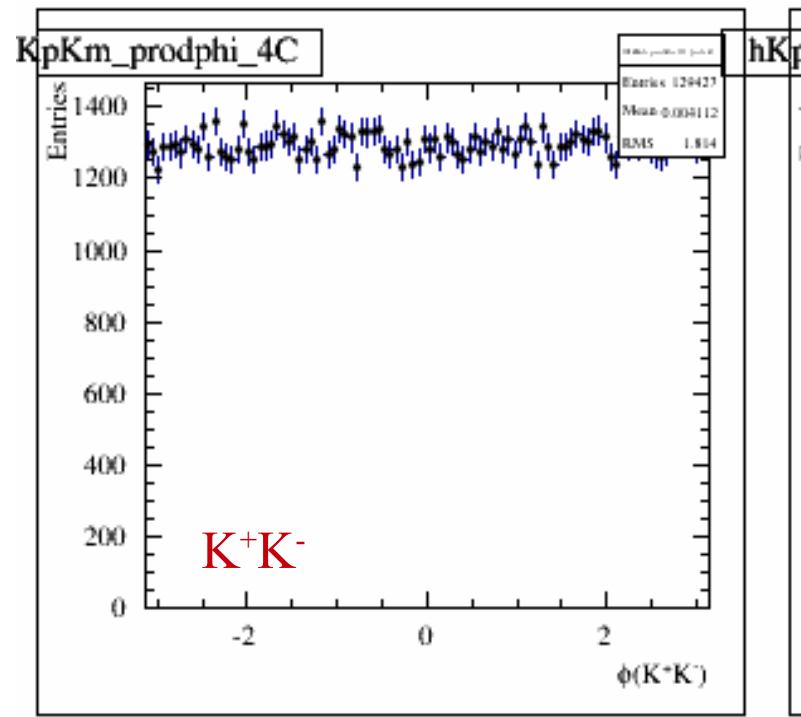
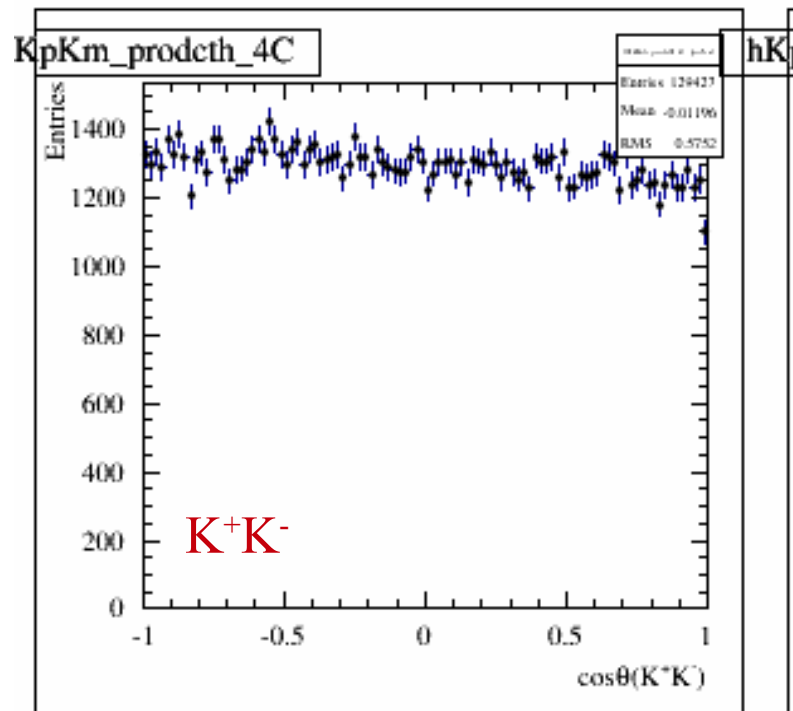
Signal window $m(KK) = 3.8 \dots 4.0 \text{ GeV}/c^2$

Full detector

$\sqrt{s} = 5.47 \text{ GeV}$

$K^+K^-\pi^0 - G(3900) - 15 \text{ GeV}/c$ (Signal) - Full Det.

KK production angles



No PID efficiency $\varepsilon = 65\%$

130,000 events reconstructed

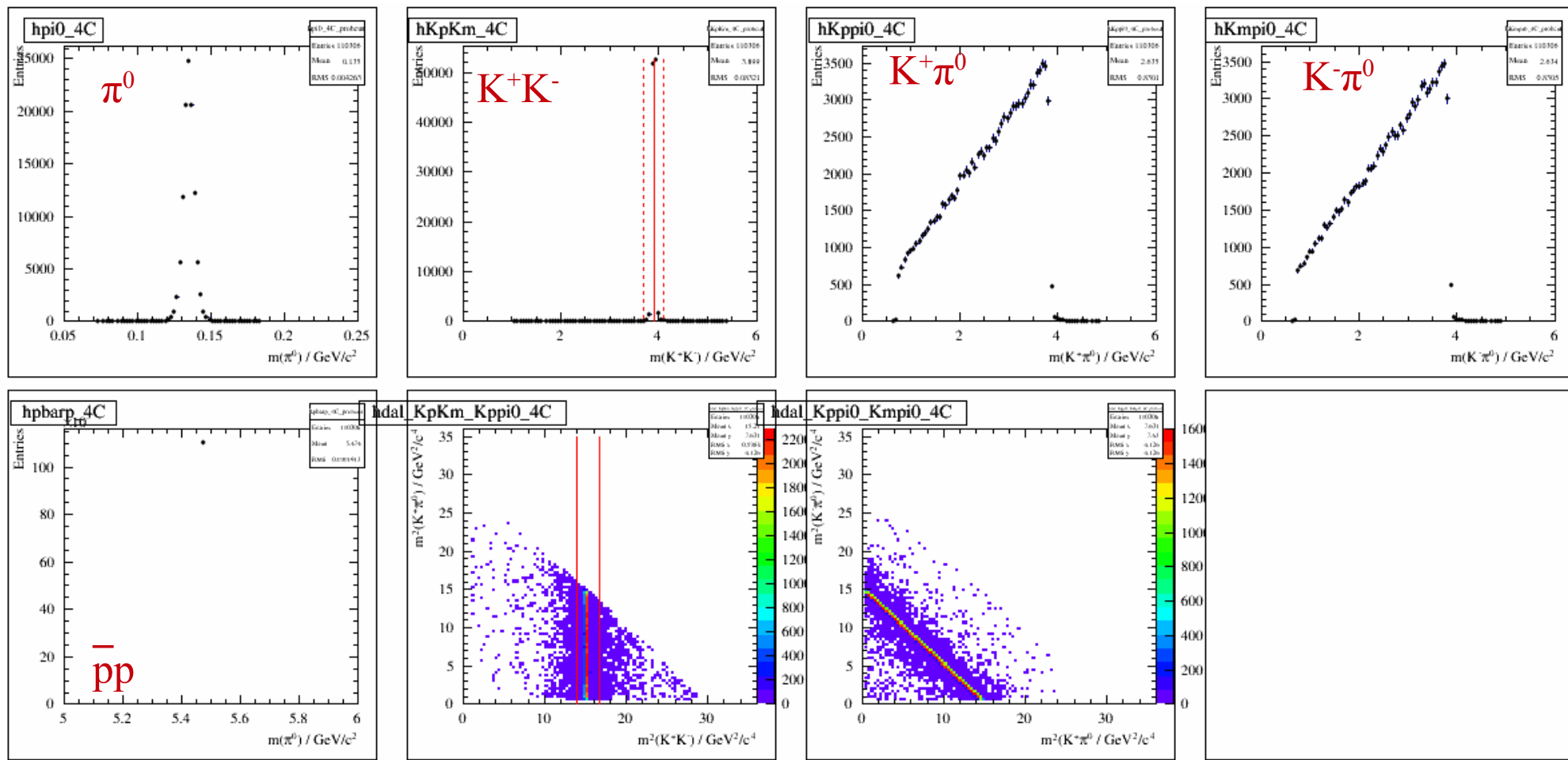
4C fit prob > 0.05

Signal window $m(KK) = 3.8...4.0 \text{ GeV}/c^2$

Full detector

$K^+K^-\pi^0 - G(3900) - 15 \text{ GeV}/c$ (Signal) – Full Det.

200,000 events generated



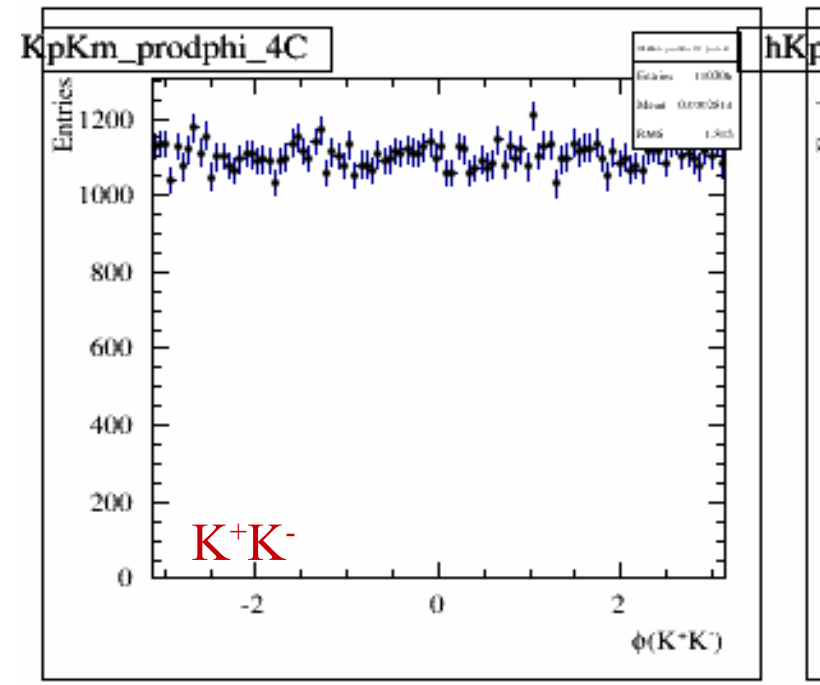
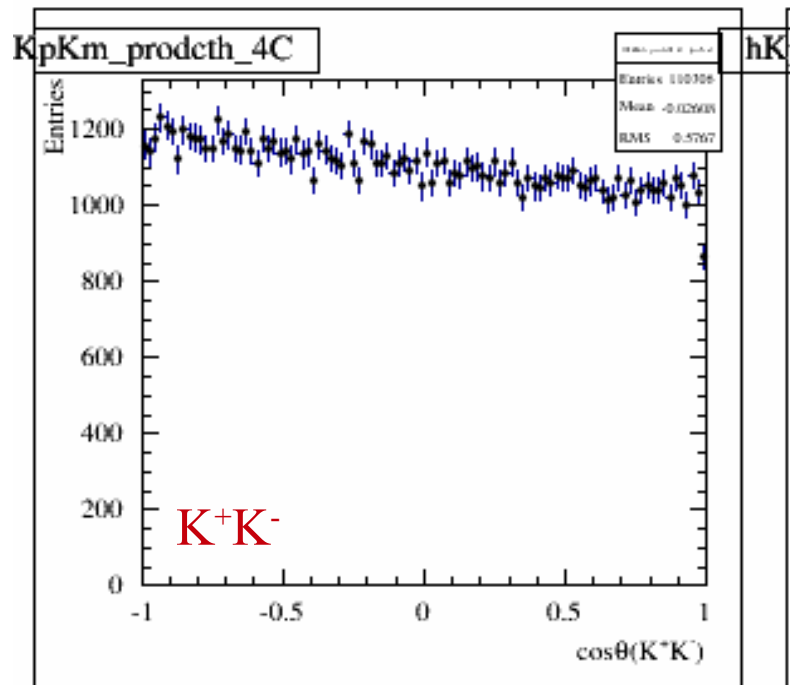
PID: KaonLoose
 4C fit prob > 0.05
 Full detector

$\epsilon = 55\%$ 110,000 events reconstructed

sqrt(s)=5.47 GeV

$K^+K^-\pi^0 - G(3900) - 15 \text{ GeV}/c$ (Signal) - Full Det.

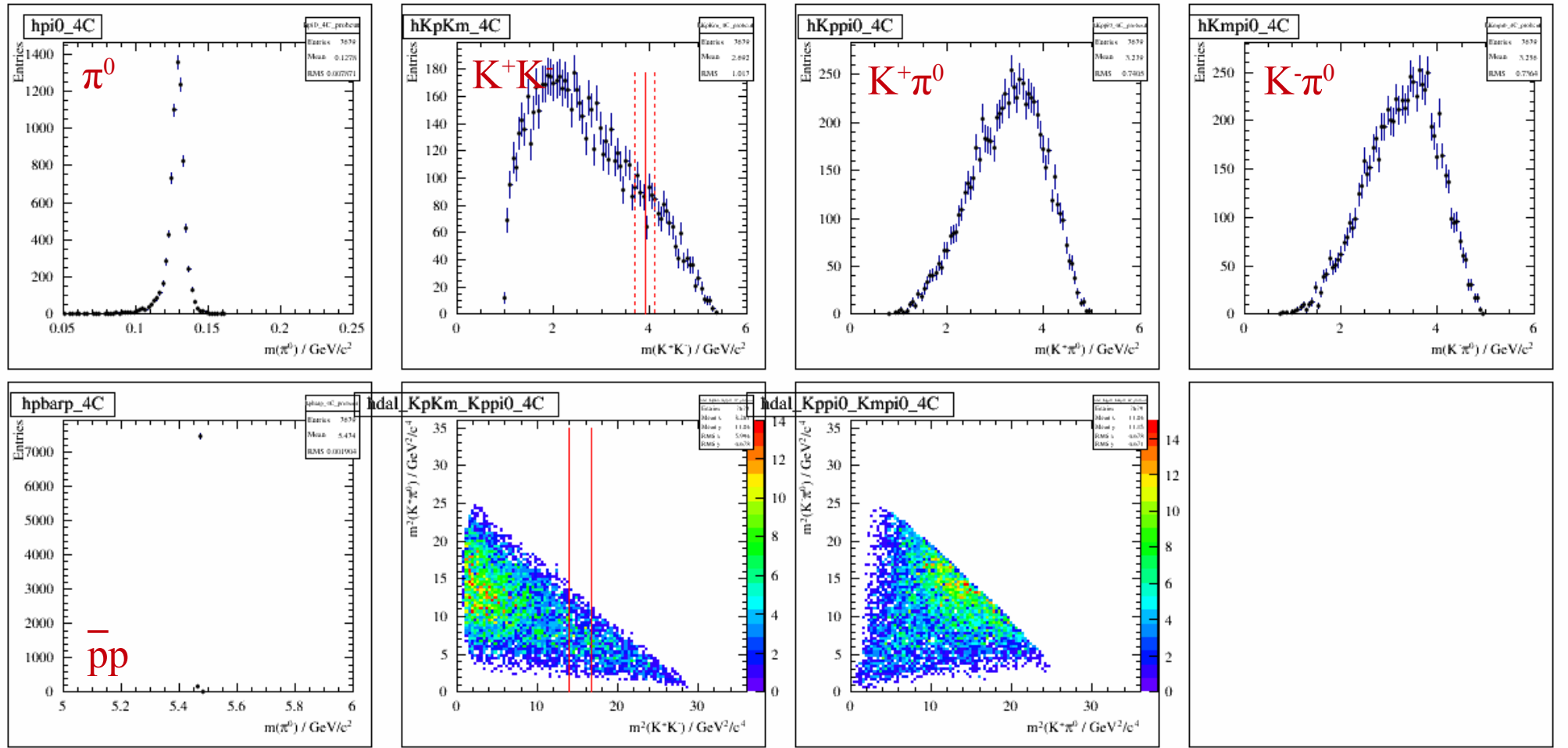
KK production angles



PID: KaonLoose $\epsilon = 55\%$ 110,000 events reconstructed
4C fit prob > 0.05
Full detector

$\pi^+\pi^-\pi^0$ – 15 GeV/c (BG) – Full Detector

1,000,000 events generated



No PID

4C fit prob > 0.05

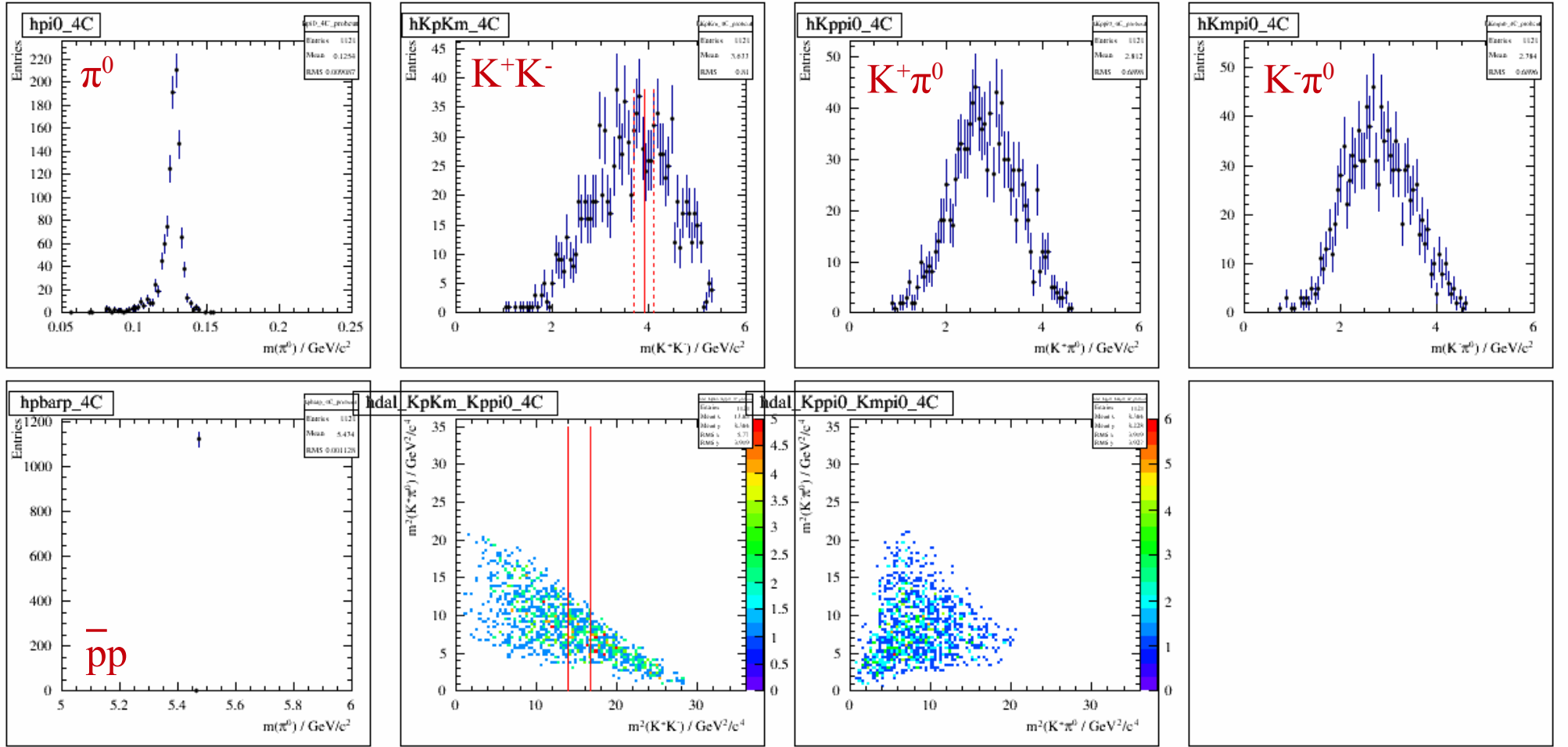
Full detector

278 events in $m(KK) = 3.8...4.0 \text{ GeV}/c^2$
 scaled S/B $\approx 1/1.3$ assuming $\sigma=0.03 \text{ mb}$

$\sqrt{s}=5.47 \text{ GeV}$

$\pi^+\pi^-\pi^0$ – 15 GeV/c (BG) – Full Detector

1,000,000 events generated



PID: KaonLoose
 4C fit prob > 0.05
 Full detector

96 events in $m(KK) = 3.8...4.0$ GeV/c²
 scaled S/B \approx 2/1 assuming $\sigma=0.03$ mb

sqrt(s)=5.47 GeV

$\pi^+\pi^-\pi^0$ – 15 GeV/c (BG) – Full Detector

BG data sample and reconstruction	Events in $m(KK)=3.8..4.0$ GeV/c ² (S/B)	Signal efficiency	Time for 100 signal events ($\sigma=10$ nb)
1,000,000 no PID	278 (1/1.3)	65%	155s
1,000,000 KaonLoose	96 (2/1)	55%	180s
1,000,000 KaonTight	2	27%	370s
6,000,000 KaonVeryTight	0	11%	900s

4C fit prob > 0.05

Full detector

assuming $\sigma=0.03$ mb

100 signal events in 180s
Background studies
→ 900,000,000 DPM events

sqrt(s)=5.47 GeV

DPM – 15 GeV/c (BG) – Detector studies

Setup	Signal gen.	Signal rec.	Events in m(KK) = 3.8..4.0 GeV/c ²	Efficiency	Time for 100 signal events ($\sigma=10\text{nb}$)
1 2 3 4 5 (full)	200,000	110,306	106,901	55%	180s
1 2 3 4 (no FwSp)	200,000	63,745	61,844	31%	320s
1 3 4 5 (no EMCBarr)	200,000	56,573	54,886	27%	370s
1 2 4 5 (no Drc)	200,000	102,915	99,812	50%	200s
1 2 3 5 (no Dsc)	200,000	109,104	105,712	53%	190s
2 3 4 5 (no MvdGem)	200,000	36,542	24,747	12%	830s

Setup	DPM events	Events in m(KK)= 3.8..4.0 GeV/c ²	S/B (scaled)	
1 2 3 4 5 (full)	900,000,000	2	(50/1)	KaonLoose 4C fit prob > 0.05
1 2 3 4 (no FwSp)	200,000,000	0		
1 3 4 5 (no EMCBarr)	200,000,000	0		
1 2 4 5 (no Drc)				
1 2 3 5 (no Dsc)				
2 3 4 5 (no MvdGem)	200,000,000	5	1/1	sqrt(s)=5.47 GeV