

Search for X(2175)

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- Search for $X(2175)$:
 - $\bar{p}p \rightarrow X(2175) + X$
 - recoil $X : \pi^0$ or $\pi^+\pi^-$
 - $X(2175) \rightarrow \phi\pi^+\pi^-, \phi\pi^0\pi^0$
- Figure of Merit: Time needed to achieve 5σ significance and 1000 events

$$\text{Significance}(t) = \sqrt{L \cdot t} \cdot \frac{\sigma_s \epsilon_s f_{BR}}{\sqrt{\sigma_s \epsilon_s f_{BR} + \sigma_b \epsilon_b}}$$

- Using scrut14 release, revision #24995

- Generated signal events:

$$1: \bar{p}p \rightarrow X(2175)\pi^+\pi^- \rightarrow \phi\pi^+\pi^-\pi^+\pi^- \rightarrow K^+K^-\pi^+\pi^-\pi^+\pi^-$$

$$2: \bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^+\pi^-\pi^0 \rightarrow K^+K^-\pi^+\pi^-\pi^0$$

$$3: \bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^0\pi^0\pi^0 \rightarrow K^+K^-\pi^0\pi^0\pi^0$$

→ 100.000 events, PHSP

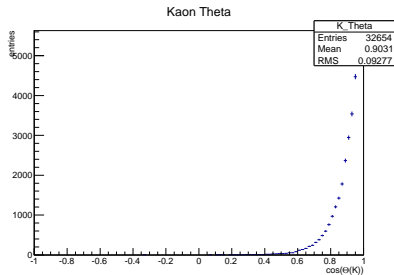
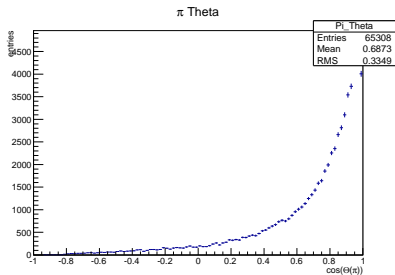
- Generated $5 \cdot 10^7$ background events with DPM
- Generated 100.000 signal events for the four detector options
- Background events for the four detector options

	DPM (1)	DPM (2)	DPM (3)
w/o EMC	$4.3 \cdot 10^7$	$4.2 \cdot 10^7$	$4.3 \cdot 10^7$
w/o FS	$4.6 \cdot 10^7$	$4.6 \cdot 10^7$	$4.5 \cdot 10^7$
w/o Disc DIRC	$3.4 \cdot 10^7$	$5 \cdot 10^7$	$4.1 \cdot 10^7$
STT only	$4.8 \cdot 10^7$	$5 \cdot 10^7$	$3.9 \cdot 10^7$

$$\bar{p}p \rightarrow X(2175)\pi^+\pi^- \rightarrow \phi\pi^+\pi^-\pi^+\pi^- \rightarrow K^+K^-\pi^+\pi^-\pi^+\pi^-$$

- PID:
 - Pion: Loose
 - Kaon: Loose
- 4C kinematic fit
⇒ Choosing candidate with minimal χ^2 for each event
- Selection:
 - Cut on probability of 4C-Fit: $\text{Prob}(\chi^2, 4) > 0.05$
 - $m(\phi)$ within [1.01;1.03] GeV

$$\bar{p}p \rightarrow X(2175)\pi^+\pi^- \rightarrow \phi\pi^+\pi^-\pi^+\pi^- \rightarrow K^+K^-\pi^+\pi^-\pi^+\pi^-$$



$$\bar{p}p \rightarrow X(2175)\pi^+\pi^- \rightarrow \phi\pi^+\pi^-\pi^+\pi^- \rightarrow K^+K^-\pi^+\pi^-\pi^+\pi^-$$

CM

Lab

PhiPipPim
Cos(Θ)

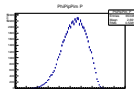
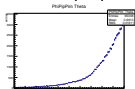
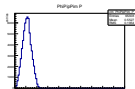
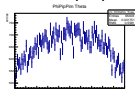
PhiPipPim
P

PhiPipPim
Cos(Θ)

PhiPipPim
P

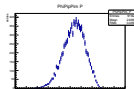
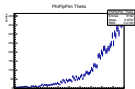
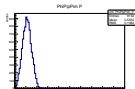
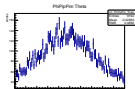
Eff

full



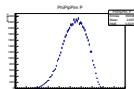
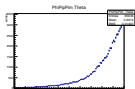
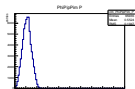
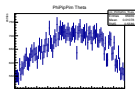
16.3 %

STT only



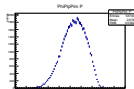
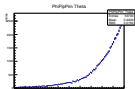
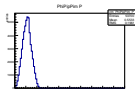
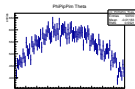
2.3 %

w/o EMC



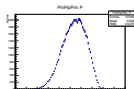
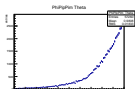
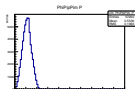
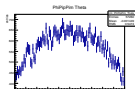
16.5 %

w/o Dsc



13.4 %

w/o FS



14.3 %

$$\bar{p}p \rightarrow X(2175)\pi^+\pi^- \rightarrow \phi\pi^+\pi^-\pi^+\pi^- \rightarrow K^+K^-\pi^+\pi^-\pi^+\pi^-$$

- FoM: Time needed to achieve 5σ significance and 1000 events

- $\sigma_b = 70$ mb
- $\varepsilon_s = 16.3\%$
- $\varepsilon_b = 1.6 \cdot 10^{-6}$
- $\sigma_s = 1 \mu\text{b}$

	$f_{BR} = 5\%$	$f_{BR} = 10\%$	$f_{BR} = 30\%$
$L = 2 \cdot 10^{30}$	17 h	8 h	2.8 h
$L = 2 \cdot 10^{31}$	1.7 h	0.8 h	0.28 h
$L = 2 \cdot 10^{32}$	0.17 h	0,08 h	0.028 h

- $\sigma_s = 100$ nb

	$f_{BR} = 5\%$	$f_{BR} = 10\%$	$f_{BR} = 30\%$
$L = 2 \cdot 10^{30}$	7.1 d	3.6 d	1.2 d
$L = 2 \cdot 10^{31}$	0.71 d	0.36 d	0.12 d
$L = 2 \cdot 10^{32}$	0.071 d	0.036 d	0.012 d

$$\bar{p}p \rightarrow X(2175)\pi^+\pi^- \rightarrow \phi\pi^+\pi^-\pi^+\pi^- \rightarrow K^+K^-\pi^+\pi^-\pi^+\pi^-$$

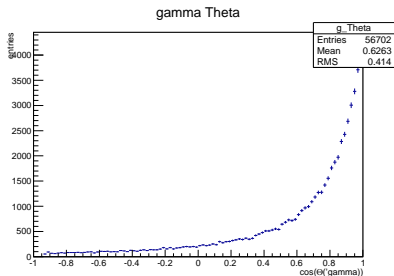
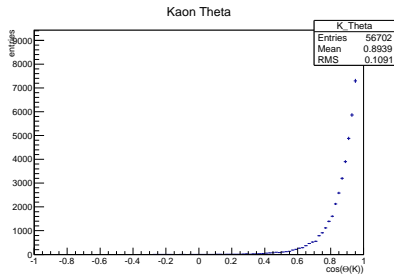
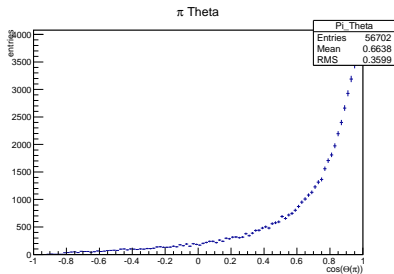
- FoM: Time needed to achieve 5σ significance and 1000 events
 - $\sigma_b = 70$ mb
- FoM: $L = 2 \cdot 10^{32}$, $f_{BR} = 10\%$

	ϵ_s	ϵ_b	FoM ($\sigma_s = 1 \mu\text{b}$)	FoM ($\sigma_s = 100$ nb)
w/o EMC	16.5 %	$3.1 \cdot 10^{-6}$	0.08 h	0.12 d
w/o FS	14.3 %	$2.6 \cdot 10^{-6}$	0.1 h	0.13 d
w/o Dsc	13.4 %	$3 \cdot 10^{-6}$	0.1 h	0.17 d
STT only	2.3 %	$2.9 \cdot 10^{-6}$	1.35 h	5.6 d

$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^+\pi^-\pi^0 \rightarrow K^+K^-\pi^+\pi^-\pi^0$$

- PID:
 - Pion: Loose
 - Kaon: Loose
 - Neutral: All
- 4C kinematic fit
 - ⇒ Choosing candidate with minimal χ^2 for each event
- Selection:
 - Cut on probability of 4C-Fit: $\text{Prob}(\chi^2, 4) > 0.05$
 - $m(\phi)$ within [1.01;1.03] GeV
 - $m(\pi^0)$ within [0.124;0.146] GeV

$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^+\pi^-\pi^0 \rightarrow K^+K^-\pi^+\pi^-\pi^0$$



$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^+\pi^-\pi^0 \rightarrow K^+K^-\pi^+\pi^-\pi^0$$

CM

Lab

 PhiPipPim
 Cos(Θ)

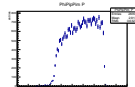
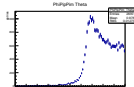
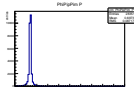
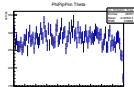
 PhiPipPim
 P

 PhiPipPim
 Cos(Θ)

 PhiPipPim
 P

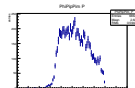
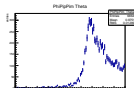
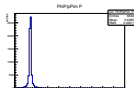
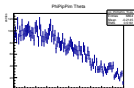
Eff

full



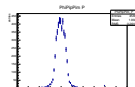
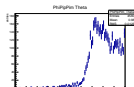
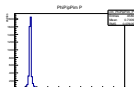
28.4 %

STT only



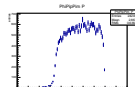
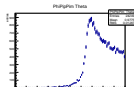
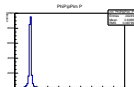
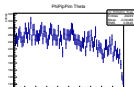
6.9 %

w/o EMC



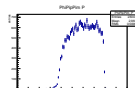
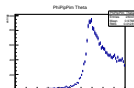
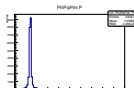
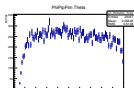
4.6 %

w/o Dsc



24.2 %

w/o FS



23 %

$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^+\pi^-\pi^0 \rightarrow K^+K^-\pi^+\pi^-\pi^0$$

- FoM: Time needed to achieve 5σ significance and 1000 events

- $\sigma_b = 70 \text{ mb}$
- $\varepsilon_s = 26.7 \%$
- $\varepsilon_b = 1.4 \cdot 10^{-5}$
- $\sigma_s = 1 \mu\text{b}$

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 2 \cdot 10^{30}$	24.1 h	6 h	1.6 h
$L = 2 \cdot 10^{31}$	2.4 h	0.6 h	0.16 h
$L = 2 \cdot 10^{32}$	0.24 h	0,06 h	0.016 h

- $\sigma_s = 100 \text{ nb}$

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 2 \cdot 10^{30}$	99.5 d	24.9 d	2.8 d
$L = 2 \cdot 10^{31}$	9.95 d	2.49 d	0.28 h
$L = 2 \cdot 10^{32}$	0.995 d	0.249 d	0.028 h

$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^+\pi^-\pi^0 \rightarrow K^+K^-\pi^+\pi^-\pi^0$$

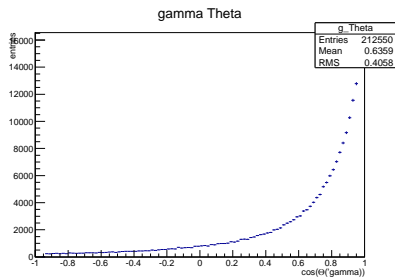
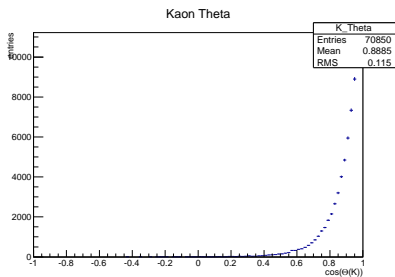
- FoM: Time needed to achieve 5σ significance and 1000 events
 - $\sigma_b = 70 \text{ mb}$
- FoM: $L = 2 \cdot 10^{32}$, $f_{BR} = 10 \%$

	ϵ_s	ϵ_b	FoM ($\sigma_s = 1 \mu\text{b}$)	FoM ($\sigma_s = 100 \text{ nb}$)
w/o EMC	4.6 %	$2.2 \cdot 10^{-5}$	2.53 h	10.6 d
w/o FS	23 %	$1.6 \cdot 10^{-5}$	0.08 h	0.3 d
w/o Dsc	24.2 %	$\cdot 10^{-5}$		
STT only	6.9 %	$2.4 \cdot 10^{-5}$	1.23 h	5.1 d

$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^0\pi^0\pi^0 \rightarrow K^+K^-\pi^0\pi^0\pi^0$$

- PID:
 - Kaon: Loose
 - Neutral: All
 - $m(\pi^0)$ within [0.11;0.15] GeV
- 4C kinematic fit
 - ⇒ Choosing candidate with minimal χ^2 for each event
- Selection:
 - Cut on probability of 4C-Fit: $\text{Prob}(\chi^2, 4) > 0.05$
 - $m(\phi)$ within [1.01;1.03] GeV
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$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^0\pi^0\pi^0 \rightarrow K^+K^-\pi^0\pi^0\pi^0$$



$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^0\pi^0\pi^0 \rightarrow K^+K^-\pi^0\pi^0\pi^0$$

CM

Lab

 PhiPipPim
Cos(Θ)

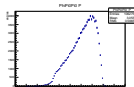
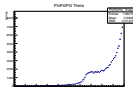
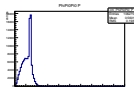
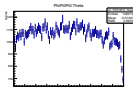
 PhiPipPim
P

 PhiPipPim
Cos(Θ)

 PhiPipPim
P

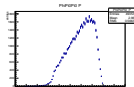
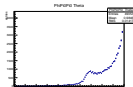
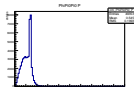
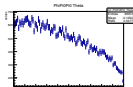
Eff

full



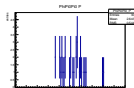
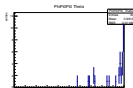
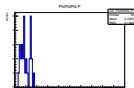
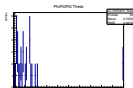
35.4 %

STT only



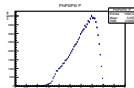
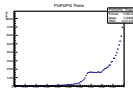
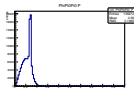
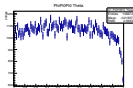
16.5 %

w/o EMC



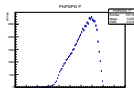
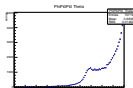
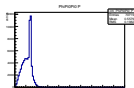
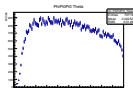
<0.1 %

w/o Dsc



35.2 %

w/o FS



23.6 %

$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^0\pi^0\pi^0 \rightarrow K^+K^-\pi^0\pi^0\pi^0$$

- FoM: Time needed to achieve 5σ significance and 1000 events

- $\sigma_b = 70 \text{ mb}$
- $\varepsilon_s = 35.4 \%$
- $\varepsilon_b = 4.4 \cdot 10^{-6}$
- $\sigma_s = 1 \mu\text{b}$

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 2 \cdot 10^{30}$	7.8 h	3.9 h	1.3 h
$L = 2 \cdot 10^{31}$	0.78 h	0.39 h	0.13 h
$L = 2 \cdot 10^{32}$	0.078 h	0,039 h	0.013 h

- $\sigma_s = 100 \text{ nb}$

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 2 \cdot 10^{30}$	343 h	86 h	13 h
$L = 2 \cdot 10^{31}$	34.3 h	8.6 h	1.3 h
$L = 2 \cdot 10^{32}$	3.43 h	0.86 h	0.13 h

$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^0\pi^0\pi^0 \rightarrow K^+K^-\pi^0\pi^0\pi^0$$

- FoM: Time needed to achieve 5σ significance and 1000 events
 - $\sigma_b = 70 \text{ mb}$
- FoM: $L = 2 \cdot 10^{32}$, $f_{BR} = 10 \%$

	ϵ_s	ϵ_b	FoM ($\sigma_s = 1 \mu\text{b}$)	FoM ($\sigma_s = 100 \text{ nb}$)
w/o EMC	<0.01 %	$4.9 \cdot 10^{-6}$		
w/o FS	23.6 %	$5 \cdot 10^{-6}$	0.06 h	4.2 h
w/o Dsc	35.2 %	$5.1 \cdot 10^{-6}$	0.04 h	1 h
STT only	16.5 %	$4.7 \cdot 10^{-6}$	0.084 h	2.2 h