

Search for X(2175)

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- Search for $X(2175)$:
 - $\bar{p}p \rightarrow X(2175) + X$
 - recoil $X : \pi^0$ or $\pi^+\pi^-$
 - $X(2175) \rightarrow \phi\pi^+\pi^-, \phi\pi^0\pi^0$
- $E_{CMS} = 3 \text{ GeV}$
- 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

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

CM

Lab

 PhiPipPim
Cos(Θ)

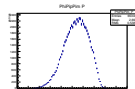
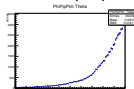
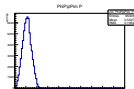
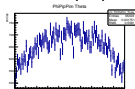
 PhiPipPim
P

 PhiPipPim
Cos(Θ)

 PhiPipPim
P

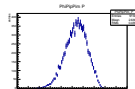
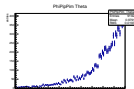
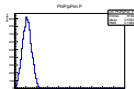
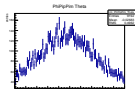
Eff

full



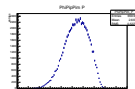
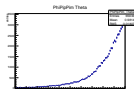
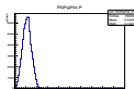
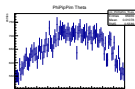
16.3 %

STT only



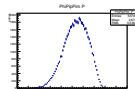
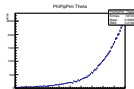
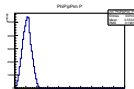
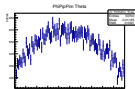
2.3 %

w/o EMC



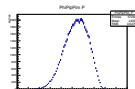
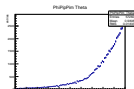
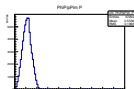
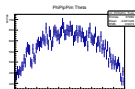
16.5 %

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

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

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 1 \cdot 10^{30}$	2.84 d	1.4 d	11 h
$L = 1 \cdot 10^{31}$	6.8 h	3.4 h	1.1 h
$L = 1 \cdot 10^{32}$	0.68 h	0.34 h	0.11 h
S/B	0.036	0.07	0.22

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

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 1 \cdot 10^{30}$	196 d	49 d	5.5 d
$L = 1 \cdot 10^{31}$	19.6 d	4.9 d	13 h
$L = 1 \cdot 10^{32}$	1.96 d	0.49 d	1.3 h
S/B	0.004	0.007	0.022

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

- FoM: Time needed to achieve 5σ significance and 1000 events
 - $\sigma_b = 70 \text{ mb}$
- FoM: $L = 1 \cdot 10^{32}$, $f_{BR} = 10 \%$

	ϵ_s	ϵ_b	FoM $\sigma_s = 1 \mu\text{b}$	FoM $\sigma_s = 0.1 \mu\text{b}$	S/B $\sigma_s = 1 \mu\text{b}$	S/B $\sigma_s = 0.1 \mu\text{b}$
full	16.3 %	$1.6 \cdot 10^{-6}$	0.34 h	0.49 d	0.07	0.007
w/o EMC	16.5 %	$3.1 \cdot 10^{-6}$	0.34 h	0.93 d	0.04	0.004
w/o FS	14.3 %	$2.6 \cdot 10^{-6}$	0.39 h	1.03 d	0.04	0.004
w/o Dsc	13.4 %	$3 \cdot 10^{-6}$	0.41 h	1.36 d	0.03	0.003
STT only	2.3 %	$2.9 \cdot 10^{-6}$	10.7 h	44.4 d	0.006	0.0005

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

- 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

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

CM

Lab

 PhiPipPim
 Cos(Θ)

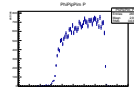
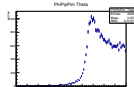
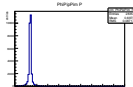
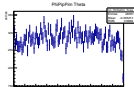
 PhiPipPim
 P

 PhiPipPim
 Cos(Θ)

 PhiPipPim
 P

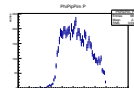
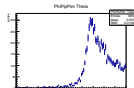
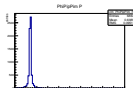
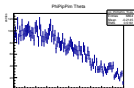
Eff

full



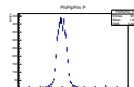
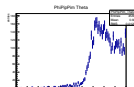
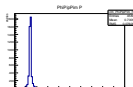
28.4 %

STT only



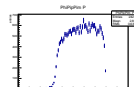
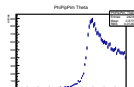
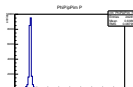
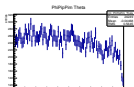
6.9 %

w/o EMC



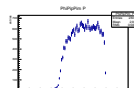
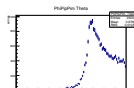
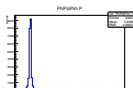
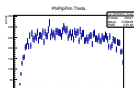
4.6 %

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

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

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 1 \cdot 10^{30}$	8 d	2 d	6.5 d
$L = 1 \cdot 10^{31}$	0.96 d	4.8 h	0.65 h
$L = 1 \cdot 10^{32}$	0.096 d	0.48 h	3.9 min
S/B	0.005	0.01	0.03

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

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 1 \cdot 10^{30}$	796 d	199 d	22 d
$L = 1 \cdot 10^{31}$	79.6 d	19.9 d	2.2 d
$L = 1 \cdot 10^{32}$	7.96 d	1.99 d	0.22 d
S/B	0.0005	0.001	0.003

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

- FoM: Time needed to achieve 5σ significance and 1000 events
 - $\sigma_b = 70 \text{ mb}$
- FoM: $L = 1 \cdot 10^{32}$, $f_{BR} = 10 \%$

	ε_s	ε_b	FoM $\sigma_s = 1 \mu\text{b}$	FoM $\sigma_s = 0.1 \mu\text{b}$	S/B $\sigma_s = 1 \mu\text{b}$	S/B $\sigma_s = 0.1 \mu\text{b}$
full	28.4 %	$1.98 \cdot 10^{-5}$	0.48 h	1.99 d	0.01	0.001
w/o EMC	4.6 %	$2.2 \cdot 10^{-5}$	20.2 h	84.2 d	0.001	0.0001
w/o FS	23 %	$1.6 \cdot 10^{-5}$	0.59 h	2.4 d	0.01	0.001
w/o Dsc	24.2 %	$1.9 \cdot 10^{-5}$	0.64 h	2.6 d	0.009	0.0009
STT only	6.9 %	$2.4 \cdot 10^{-5}$	9.8 h	40.8 d	0.002	0.0002

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

- 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
 - $m(\pi^0)$ within [0.124;0.146] GeV

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

CM

Lab

 PhiPipPim
 Cos(Θ)

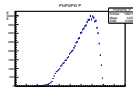
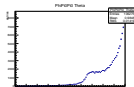
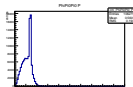
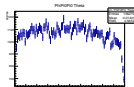
 PhiPipPim
 P

 PhiPipPim
 Cos(Θ)

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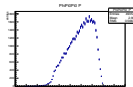
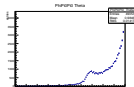
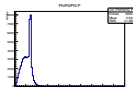
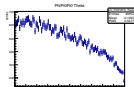
Eff

full



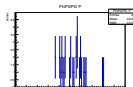
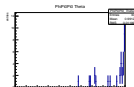
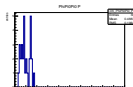
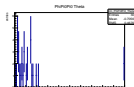
35.4 %

STT only



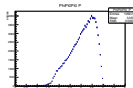
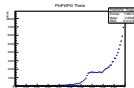
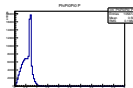
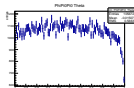
16.5 %

w/o EMC



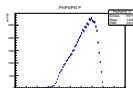
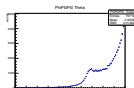
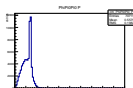
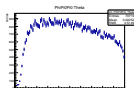
<0.1 %

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

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

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 1 \cdot 10^{30}$	1.3 d	15.7 h	5.2 d
$L = 1 \cdot 10^{31}$	0.13 d	1.57 h	0.52 h
$L = 1 \cdot 10^{32}$	0.31 h	0.157 h	3.1 min
S/B	0.03	0.05	0.16

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

	$f_{BR} = 5 \%$	$f_{BR} = 10 \%$	$f_{BR} = 30 \%$
$L = 1 \cdot 10^{30}$	119 d	29.9 d	3.4 d
$L = 1 \cdot 10^{31}$	11.9 d	2.99 d	8 h
$L = 1 \cdot 10^{32}$	1.19 d	0.299 d	0.8 h
S/B	0.003	0.005	0.016

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

- FoM: Time needed to achieve 5σ significance and 1000 events
 - $\sigma_b = 70 \text{ mb}$
- FoM: $L = 1 \cdot 10^{32}$, $f_{BR} = 10 \%$

	ϵ_s	ϵ_b	FoM $\sigma_s = 1 \mu\text{b}$	FoM $\sigma_s = 0.1 \mu\text{b}$	S/B $\sigma_s = 1 \mu\text{b}$	S/B $\sigma_s = 0.1 \mu\text{b}$
full	35.4 %	$4.4 \cdot 10^{-6}$	9.4 min	7.2 h	0.05	0.005
w/o EMC	<0.1 %	$4.9 \cdot 10^{-6}$	>1 a	>104 a	<0.0002	< $2 \cdot 10^{-5}$
w/o FS	23.6 %	$5 \cdot 10^{-6}$	14 min	15.8 h	0.04	0.004
w/o Dsc	35.2 %	$5.1 \cdot 10^{-6}$	9.5 min	7.7 h	0.05	0.005
STT only	16.5 %	$4.7 \cdot 10^{-6}$	23.2 min	37.9 h	0.02	0.002