

# 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  $5\sigma$  significance

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

- Started with  $X(2175) \rightarrow \phi\pi^+\pi^-$  at  $E_{CMS} = 3 \text{ GeV}$
- Using scrut14 release, revision #24735

- Generated signal events:

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

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

→ 100.000 events, PHSP

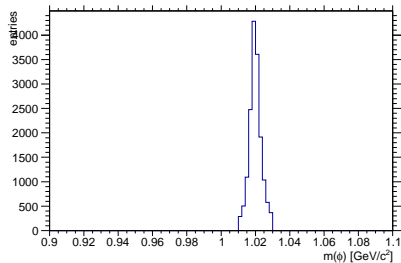
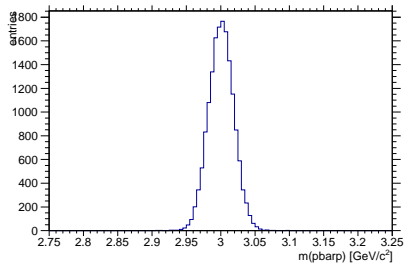
- Generated about  $1.4 \cdot 10^7$  background events with DPM
- Events for the four detector options

|               | $X(2175)\pi^+\pi^-$ | $X(2175)\pi^0$ | DPM                   |
|---------------|---------------------|----------------|-----------------------|
| w/o EMC       | 100.000             | 100.000        | $\sim 9.8 \cdot 10^6$ |
| w/o FS        | 100.000             | 100.000        | $10^7$                |
| w/o Disc DIRC | 100.000             | 100.000        | $10^7$                |
| STT only      | 100.000             | 100.000        | $\sim 5.8 \cdot 10^6$ |

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

- PID:
  - Pion: Loose
  - Kaon: Loose
- 4C kinematic fit  
⇒ Choosing candidate with minimal  $\chi^2$  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

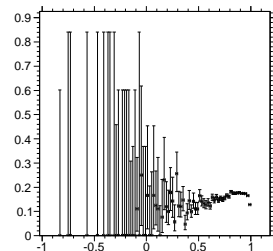
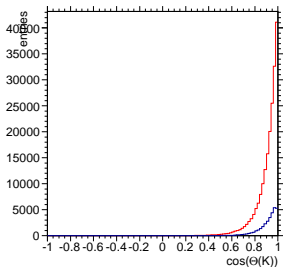
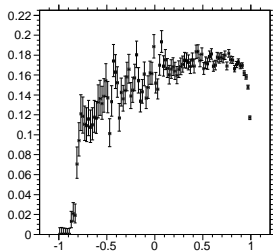
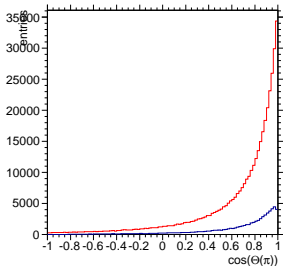
$$\bar{p}p \rightarrow X(2175)\pi^+\pi^- \rightarrow \phi\pi^+\pi^-\pi^+\pi^- \rightarrow K^+K^-\pi^+\pi^-\pi^+\pi^-$$



Efficiency signal: 15.9%

Efficiency background:  $2.2 \cdot 10^{-6}$

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



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

- FoM: Time needed to achieve  $5\sigma$  significance

- $\sigma_s = 1 \mu\text{b}$
- $\sigma_b = 70 \text{ mb}$
- $\varepsilon_s = 15.9 \%$
- $\varepsilon_b = 2.2 \cdot 10^{-6}$

|                       | $f_{BR} = 5 \%$ | $f_{BR} = 10 \%$ | $f_{BR} = 30 \%$ |
|-----------------------|-----------------|------------------|------------------|
| $L = 1 \cdot 10^{28}$ | 9.1 d           | 3.2 d            | 0.8 d            |
| $L = 1 \cdot 10^{27}$ | 90 d            | 32 d             | 7.6 d            |

- FoM:  $L = 1 \cdot 10^{28}$ ,  $f_{BR} = 10 \%$

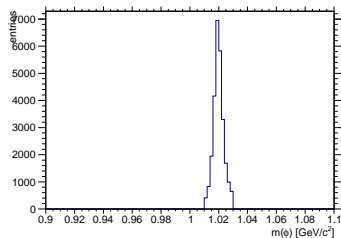
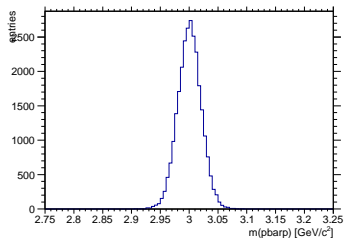
|               | $\varepsilon_s$ | $\varepsilon_b$     | FoM   |
|---------------|-----------------|---------------------|-------|
| w/o EMC       | 15.9 %          | $1.7 \cdot 10^{-6}$ | 3.2 d |
| w/o FS        | 1.3 %           | $1.8 \cdot 10^{-6}$ | 237 d |
| w/o Disc DIRC | 12.1 %          | $2.4 \cdot 10^{-6}$ | 5.7 d |
| STT only      | 13.7 %          | $2.2 \cdot 10^{-6}$ | 4.5 d |

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

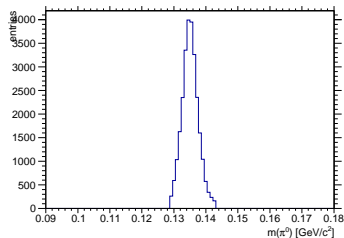
- PID:
  - Pion: Loose
  - Kaon: Loose
  - Neutral: All
- 4C kinematic fit
  - ⇒ Choosing candidate with minimal  $\chi^2$  for each event
- Selection:
  - Cut on probability of 4C-Fit:  $\text{Prob}(\chi^2, 4) > 0.05$
  - $m(\phi)$  within [1.01;1.03] GeV
  - $m(\pi^0)$  within [0.129;0.143] GeV



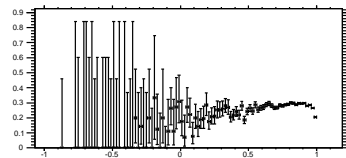
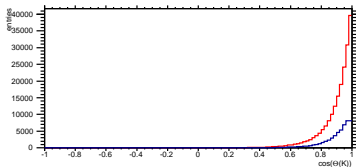
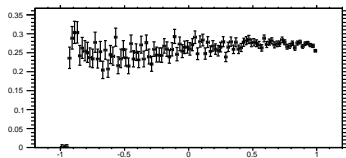
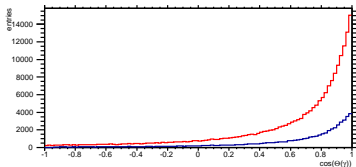
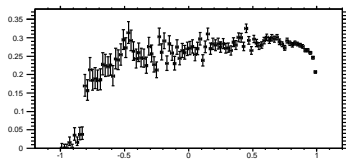
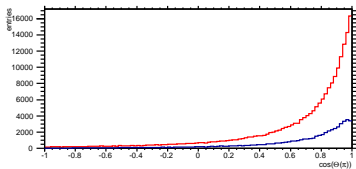
$$\bar{p}p \rightarrow X(2175)\pi^0 \rightarrow \phi\pi^+\pi^-\pi^0 \rightarrow K^+K^-\pi^+\pi^-\pi^0$$



Efficiency signal: 26.7 %  
Efficiency background:  $1.4 \cdot 10^{-5}$



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



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

- FoM: Time needed to achieve  $5\sigma$  significance

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

|                       | $f_{BR} = 5 \%$ | $f_{BR} = 10 \%$ | $f_{BR} = 30 \%$ |
|-----------------------|-----------------|------------------|------------------|
| $L = 1 \cdot 10^{28}$ | 18 d            | 5.1 d            | 0.8 d            |
| $L = 1 \cdot 10^{27}$ | 181 d           | 51 d             | 8 d              |

- FoM:  $L = 2 \cdot 10^{32}$ ,  $f_{BR} = 10 \%$

|               | $\varepsilon_s$ | $\varepsilon_b$     | FoM   |
|---------------|-----------------|---------------------|-------|
| w/o EMC       | 4.3 %           | $1.3 \cdot 10^{-5}$ | 149 d |
| w/o FS        | 3.7 %           |                     |       |
| w/o Disc DIRC | 21.7 %          | $1.2 \cdot 10^{-5}$ | 6.5 d |
| STT only      | 21.8 %          |                     |       |

- Generate more background events ( $\sim 5 \cdot 10^7$ )
- FoM: Time to achieve  $5\sigma$  and 1000 signal events
- Analyse channels with  $X(2175) \rightarrow \phi\pi^0\pi^0$