# Instrumental asymmetries

$$D^+ \to K^0_S \pi^+$$

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Analysis meeting
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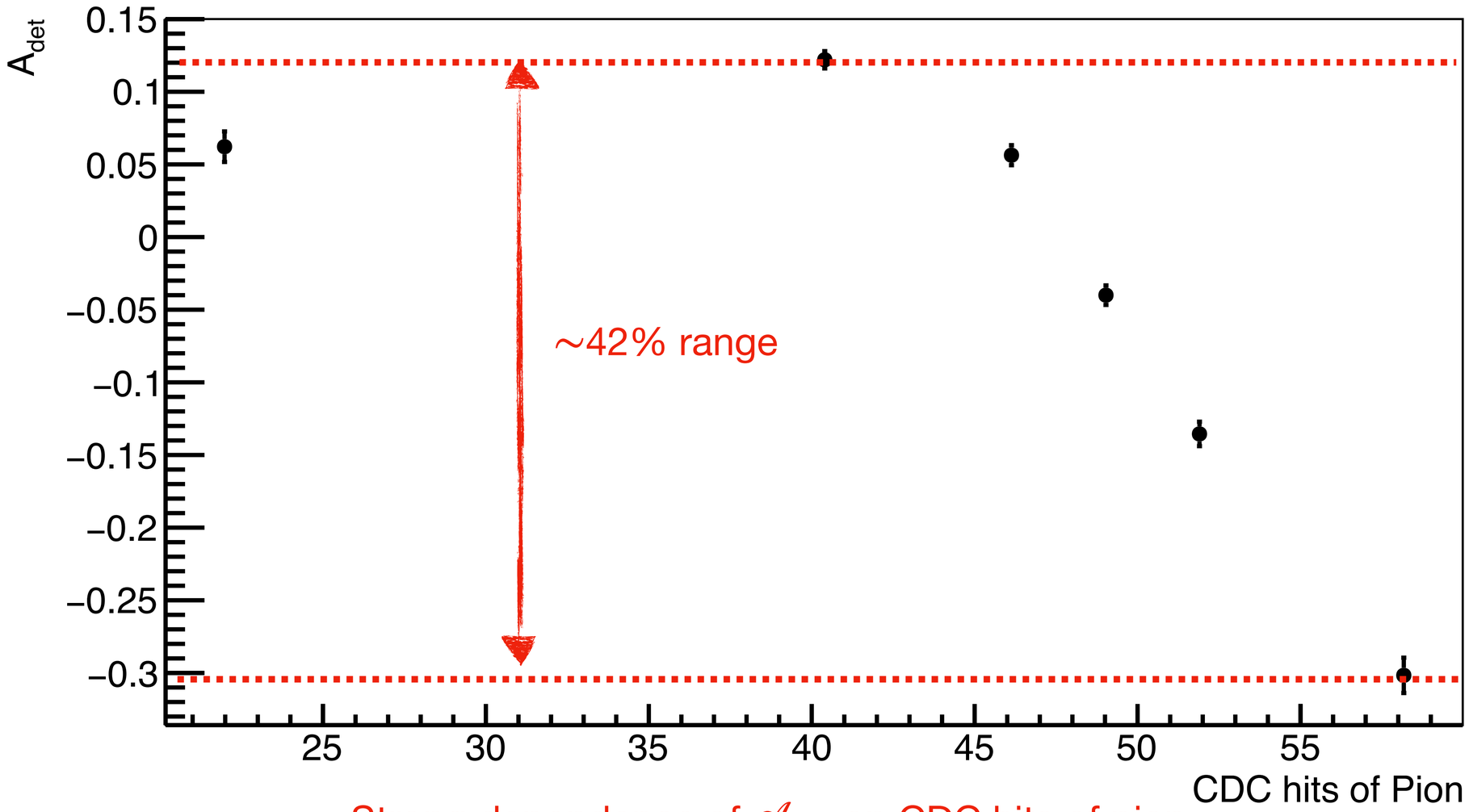
# $\mathscr{A}_{\mathrm{det}}(\pi)$ dependence on CDC hits

$$\mathscr{A}_{\mathrm{obs}} = \frac{N_{D^-} - N_{D^+}}{N_{D^-} + N_{D^+}}$$

- Study $\mathscr{A}_{\mathrm{det}}(\pi)$ as a function of pion variables. Assume $\mathscr{A}_{det}(K^0_S) = 0$.

Integrate over all kinematic variables.

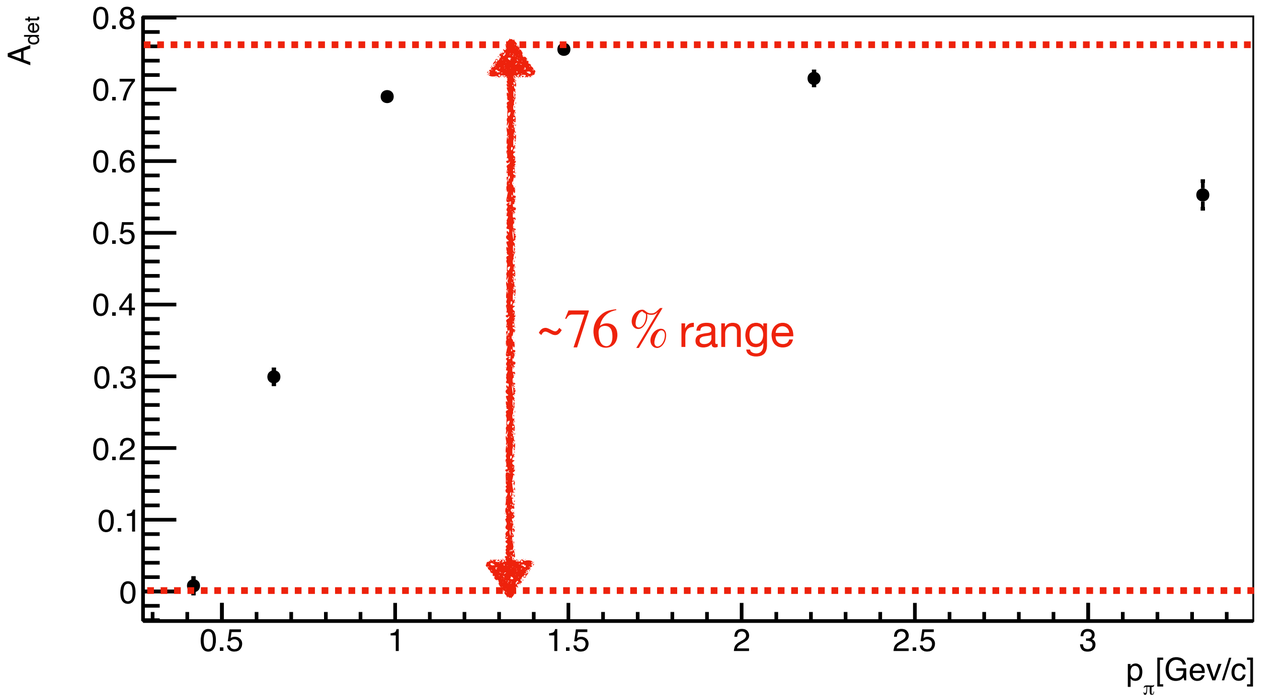



Strong dependence of $\mathscr{A}_{det}$ on CDC hits of pion.

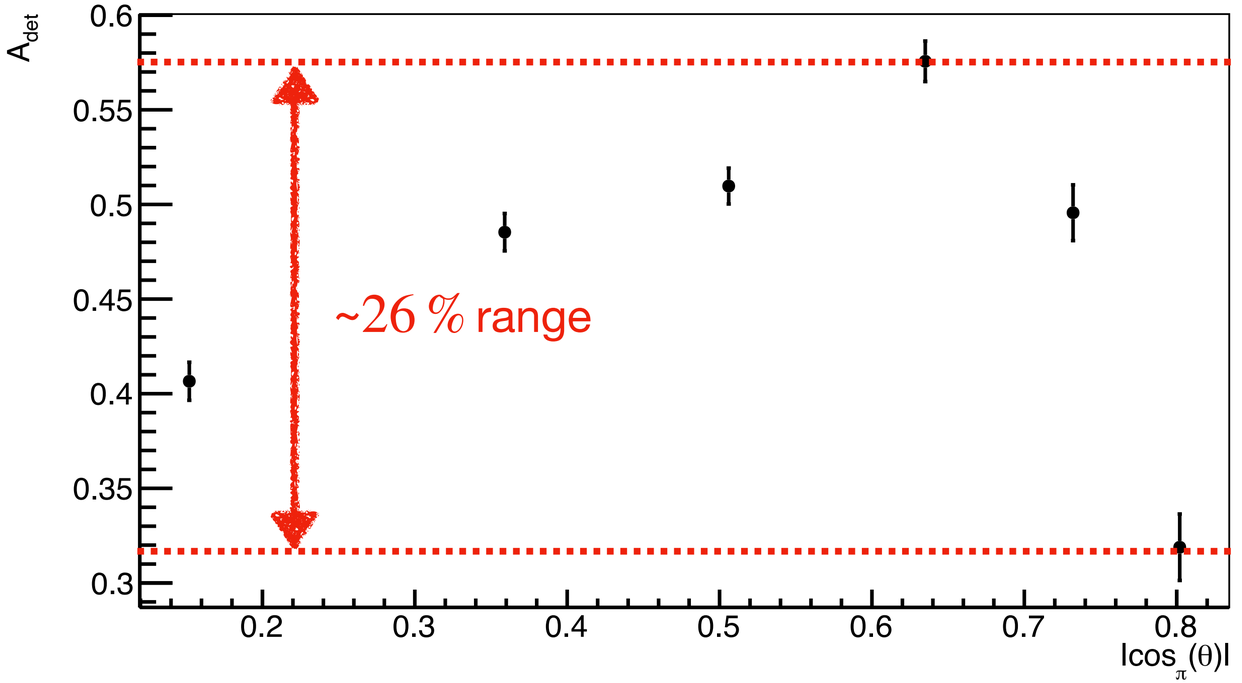
# $\mathscr{A}_{\mathrm{det}}(\pi)$ dependence check on MC

$$\mathscr{A}_{\mathrm{obs}} = \frac{N_{D^-} - N_{D^+}}{N_{D^-} + N_{D^+}}$$

$\mathscr{A}_{det}(\pi)$ as a function of $\pi$'s momentum
in a particular region of CDC hits (54 to 60 hits)




$\mathscr{A}_{det}(\pi)$ as a function of $\pi$'s polar angle
in a particular region of CDC hits (54 to 60 hits)




Strong dependence of $\mathscr{A}_{det}$ on $p_\pi$ and $cos_\pi(\theta)$ in
bins of CDC hits of pions

# $\mathscr{A}_{\mathrm{det}}(\pi)$ for physics analyses

- $p$, $cos(\theta)$,CDChits distributions of target analyses can be different from our control channel.
- Correct the distributions of the control channel to match those of any target decay:

    1. Split the control channel in bins of CDC hits;
    2. In each bin:
        A. Correct the ($p$, $cos(\theta)$) distributions of the control channel (weights from MC);
        B. Determine $\mathscr{A}_{\mathrm{det}}$ on the corrected-sample.
    3. Average the $\mathscr{A}_{\mathrm{det}}$ values considering the CDC hits distribution of the target decay (from data).

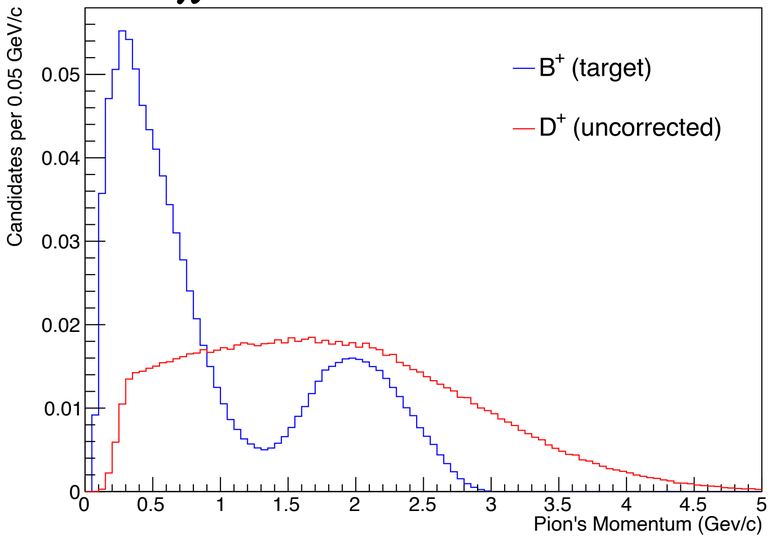
# $\mathscr{A}_{\mathrm{det}}(\pi)$ closure-test with MC

- Consider $B^+ \to \rho^+(\to \pi^+\pi^0)\,\rho^0(\to \pi^+\pi^-)$ decays
- $\mathscr{A}_{\mathrm{det}}(\pi) = -0.0042 \pm 0.0012$ (target).
- $D^+ \to K^0_S\pi^+$ control channel.

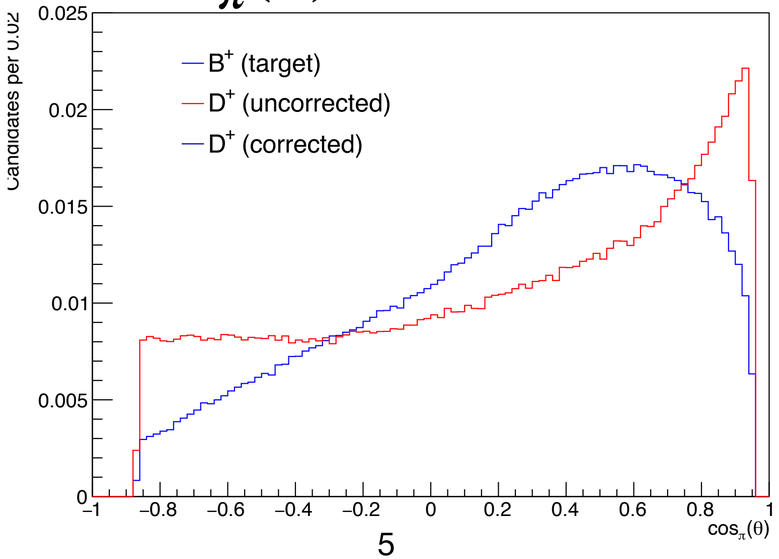
  $\mathscr{A}_{\mathrm{det}}(\pi) = 0.0014 \pm 0.0015$ (start value).

- Different $\mathscr{A}_{\mathrm{det}}(K\pi)$ values are expected since $p_K$, $cos_K(\theta)$,CDChits(K) distributions differs:

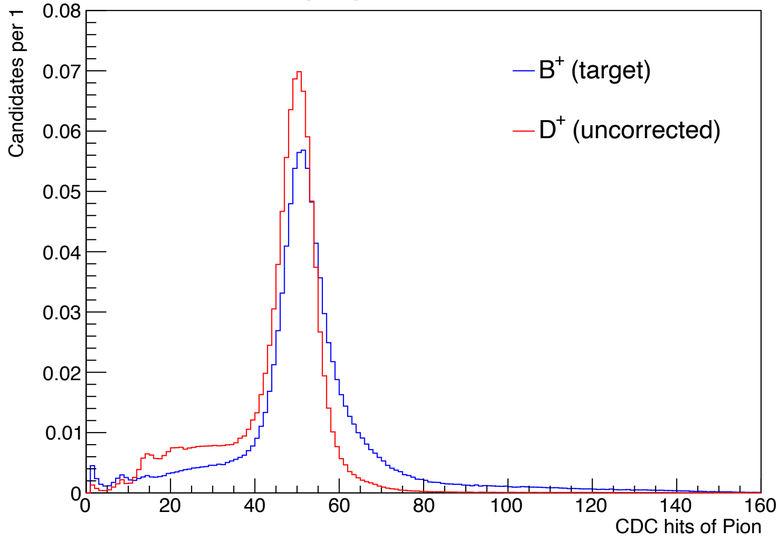
$p_\pi$ distributions




$cos_\pi(\theta)$ distributions

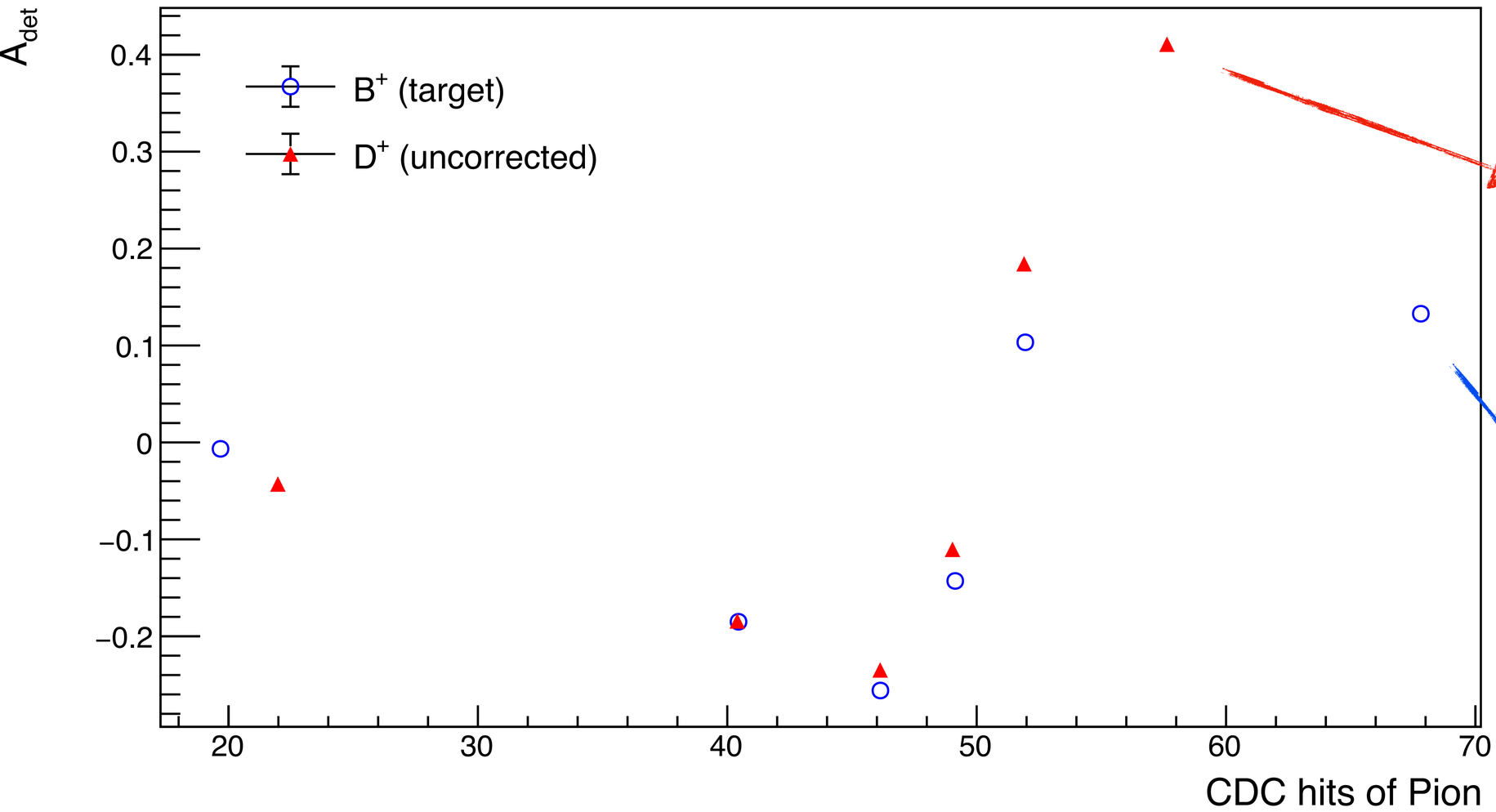



CDChits($\pi$) distributions



# $\mathcal{A}_{\mathrm{det}}(\pi)$ closure-test with MC

$$\mathcal{A}_{\mathrm{obs}} = \frac{N_{D^-} - N_{D^+}}{N_{D^-} + N_{D^+}}$$




$\mathcal{A}_{det}$ from $D^+ \to K^0_S\pi^+$ without any correction for $p_\pi$ and $cos_\pi(\theta)$.

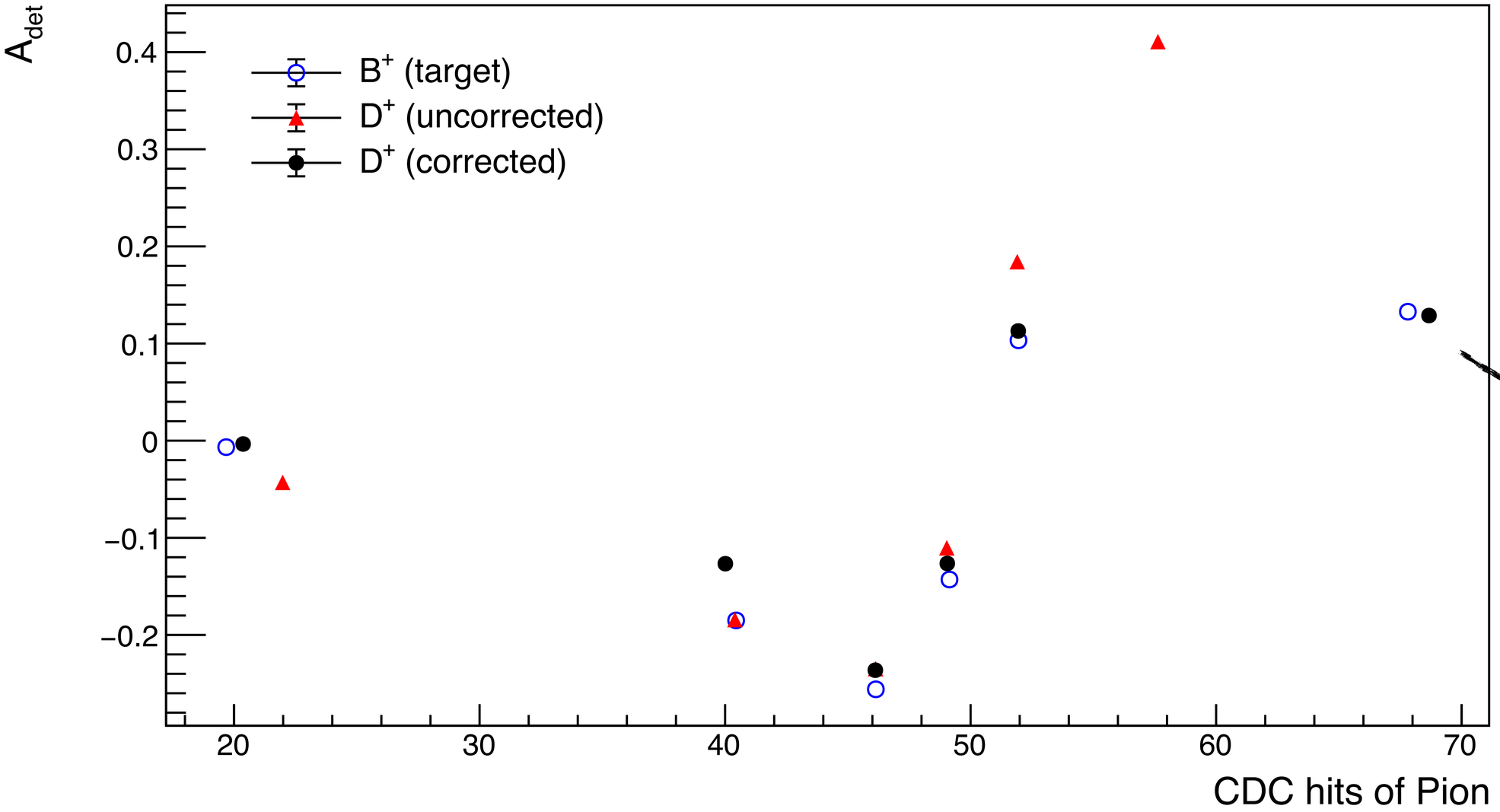
$\mathcal{A}_{det}$ from $B^+ \to \rho^+\rho^0$

The points are placed at the average of the CDC hits distribution in the bin.

# ..correction with only momentum

# $\mathcal{A}_{\mathrm{det}}(\pi)$ closure-test with MC

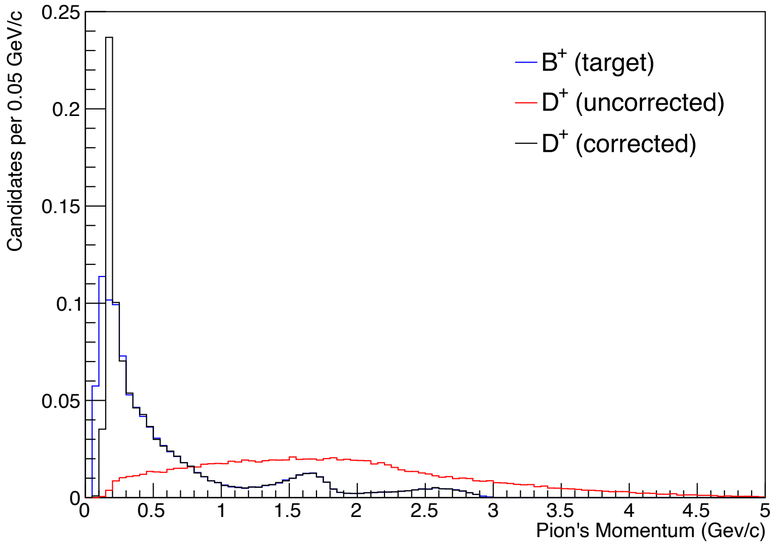
$$\mathcal{A}_{\mathrm{obs}} = \frac{N_{D^-} - N_{D^+}}{N_{D^-} + N_{D^+}}$$



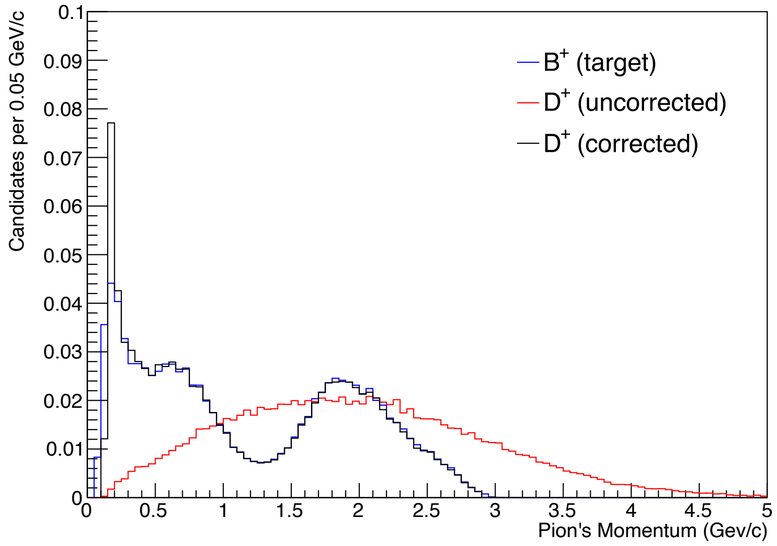

$\mathcal{A}_{det}$ from $D^+ \to K^0_S \pi^+$ after the correction with only momentum

# $p_\pi$ distribution

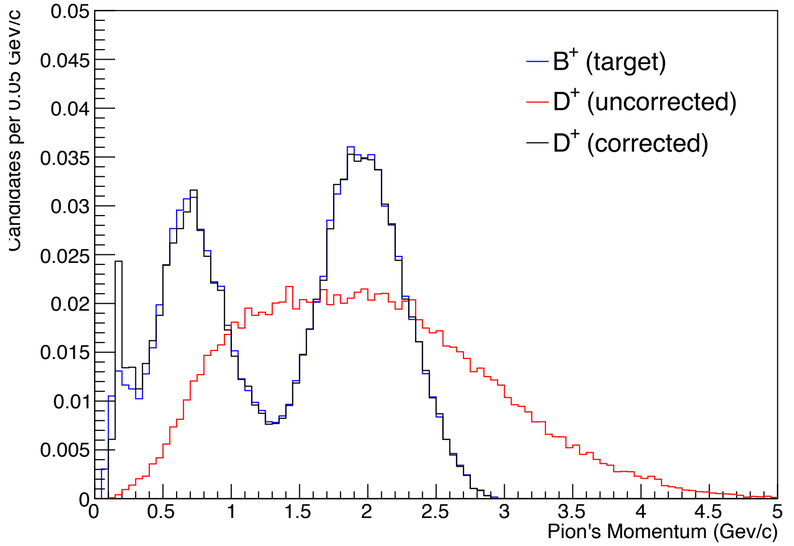
**Bin1:** $0 <$ **hits** $< 45$



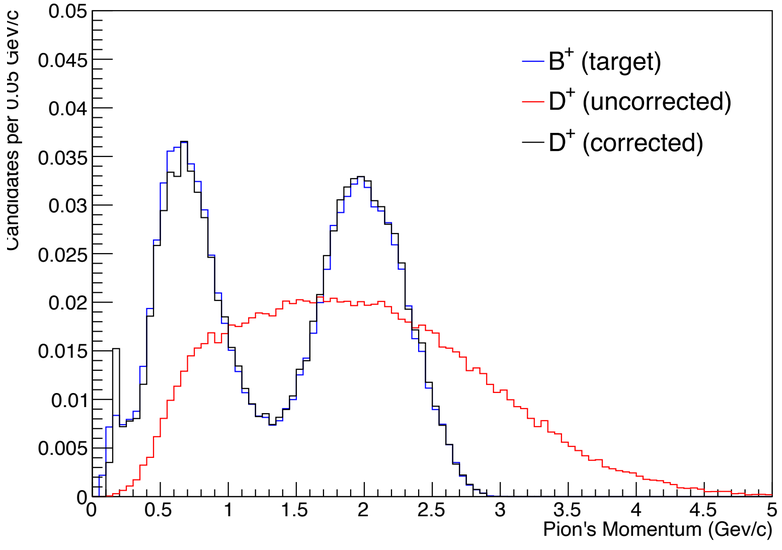

**Bin2:** $34 \leq$ **hits** $< 45$



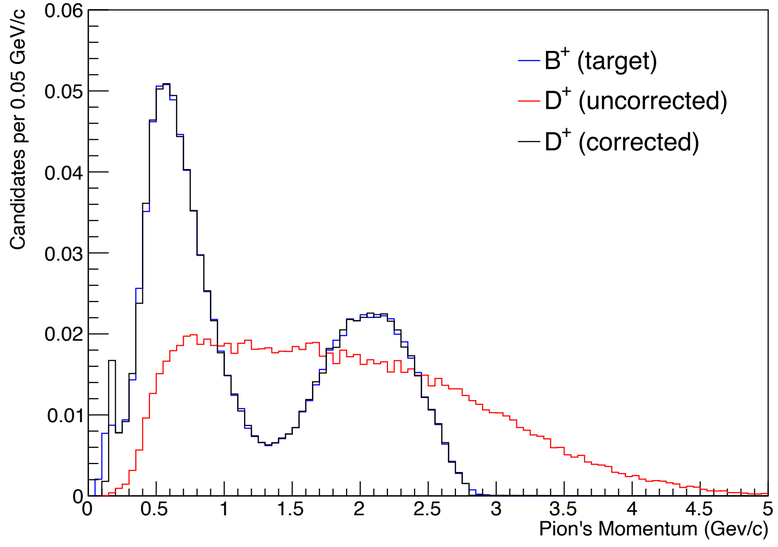

**Bin3:** $45 \leq$ **hits** $< 48$



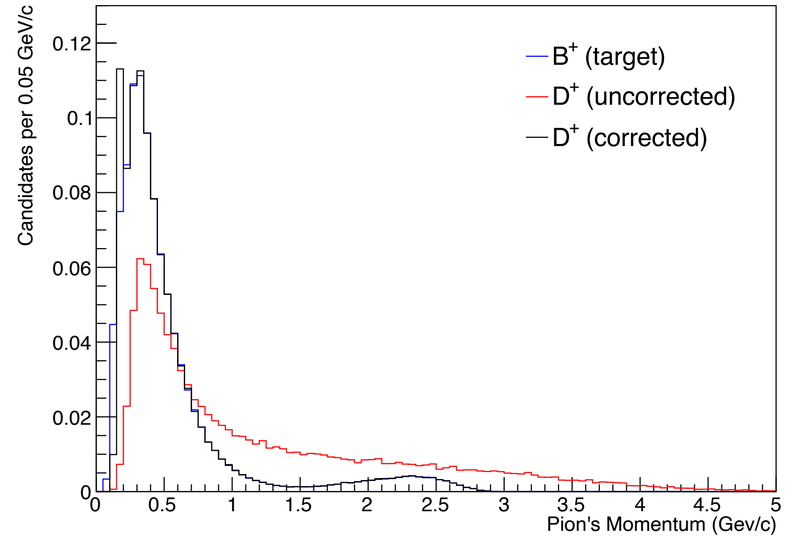

**Bin4:** $48 \leq$ **hits** $< 51$




**Bin5:** $51 \leq$ **hits** $< 54$




**Bin6: hits** $\geq 54$



# $\mathcal{A}_{\mathrm{det}}(\pi)$ closure-test with MC

| Bin of CDC hits | Fraction |
|---|---|
| $0 <$ **hits** $< 34$ | 0.10537331 |
| $34 \leq$ **hits** $< 45$ | 0.10926004 |
| $45 \leq$ **hits** $< 48$ | 0.10091464 |
| $48 \leq$ **hits** $< 51$ | 0.15813711 |
| $51 \leq$ **hits** $< 54$ | 0.15879321 |
| $54 \leq$ **hits** | 0.36752167 |

No. of events in a bin of CDC hits of $B^+$ target sample

Total events

$$w_{bin} = \left(\frac{N_{bin}}{N_{total}}\right)_{B\to\rho\rho}$$

$$\mathcal{A} = \frac{\sum_{bin} \frac{w_{bin} \times (\mathcal{A}_{bin})_{D\to K_S\pi}}{\sigma^2_{bin}}}{\sum_{bin} \frac{1}{\sigma^2_{bin}}}$$

$$\sigma^2 = \frac{1}{\sum_{bin} \frac{1}{\sigma^2_{bin}}}$$

$$\mathcal{A}_{det}(\pi) = 0.0013 \pm 0.0015$$

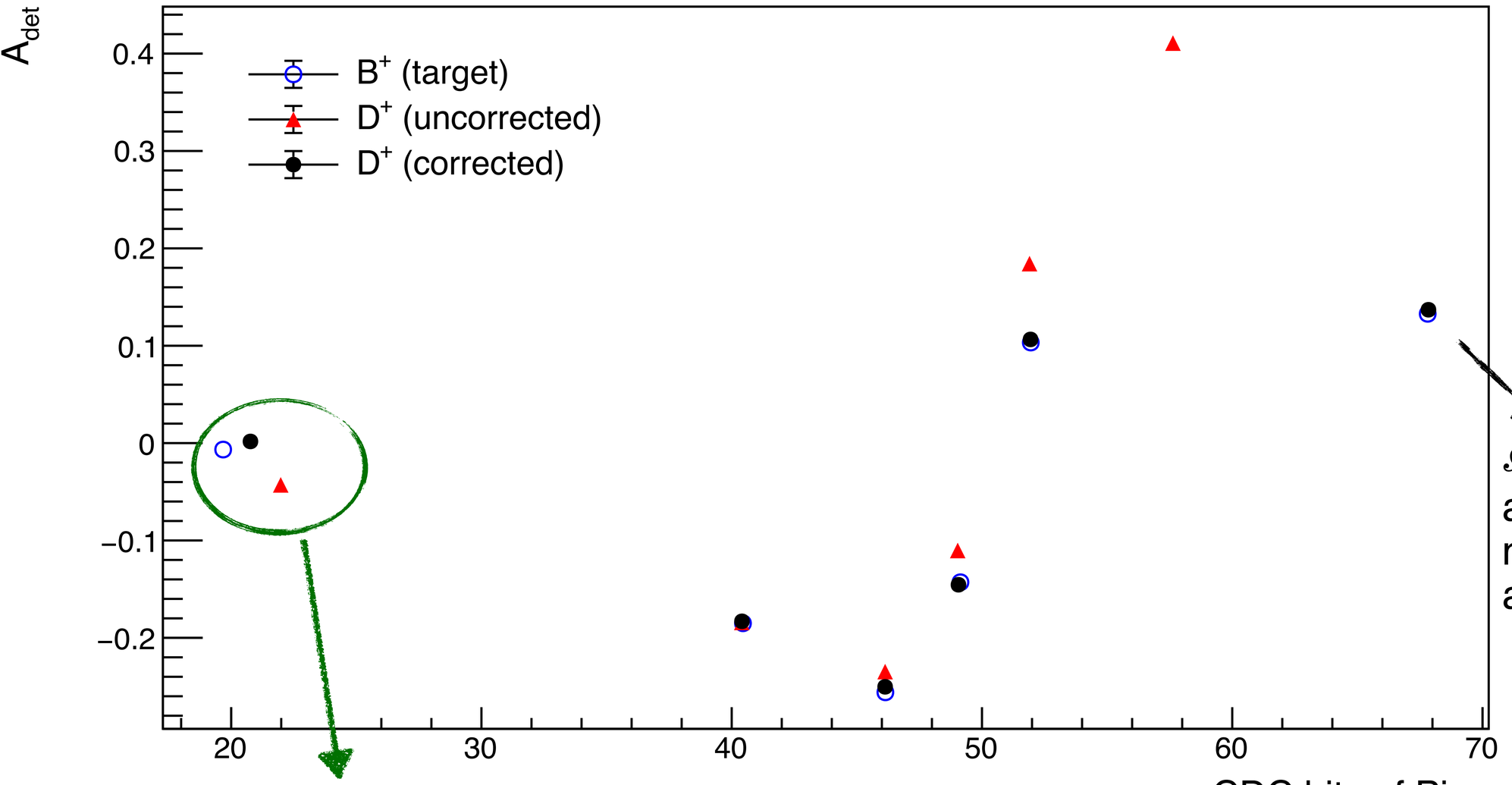
(after correction with only momentum)

$\mathcal{A}_{\mathrm{det}}(\pi) = -0.0042 \pm 0.0012$ (target)

# ..correction with momentum and polar angle

# $\mathcal{A}_{\mathrm{det}}(\pi)$ closure-test with MC

$$\mathcal{A}_{\mathrm{obs}} = \frac{N_{D^-} - N_{D^+}}{N_{D^-} + N_{D^+}}$$

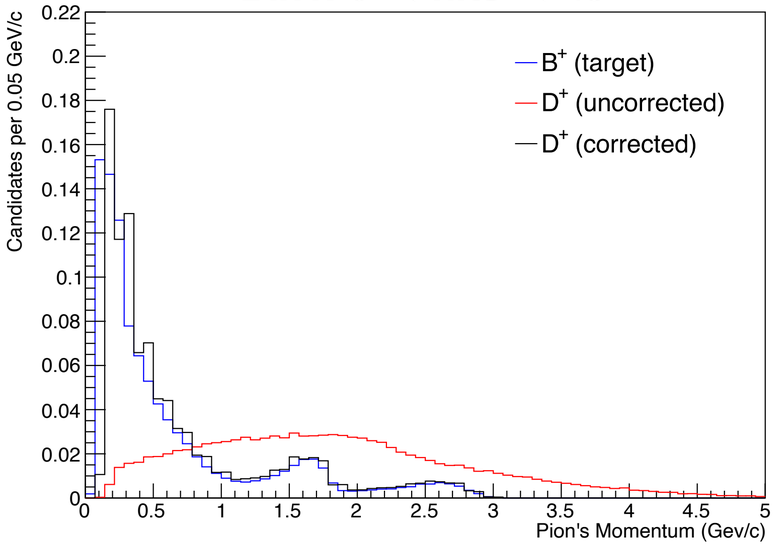



$\mathcal{A}_{det}$ from $D^+ \to K^0_S \pi^+$ after the correction with momentum and polar angle

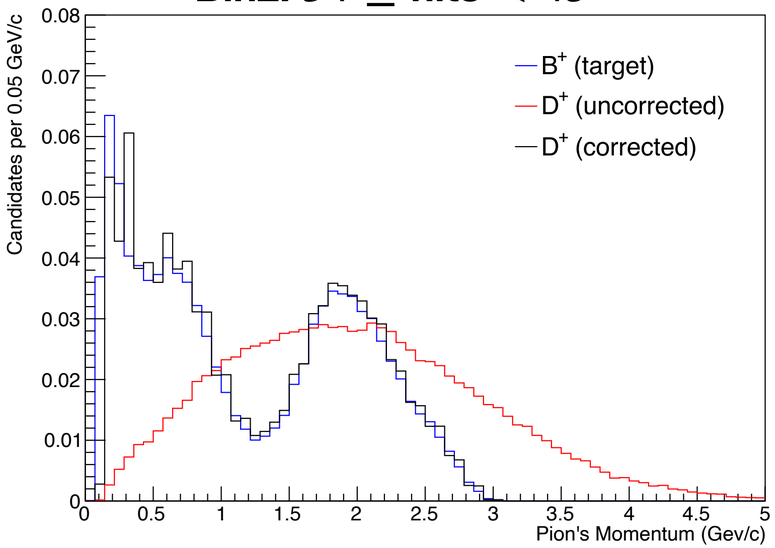
weight is not good: very large weight
weight above 1000 forced to 1
(may relate to $cos_\pi(\theta)$ distribution)

# $p_\pi$ distribution

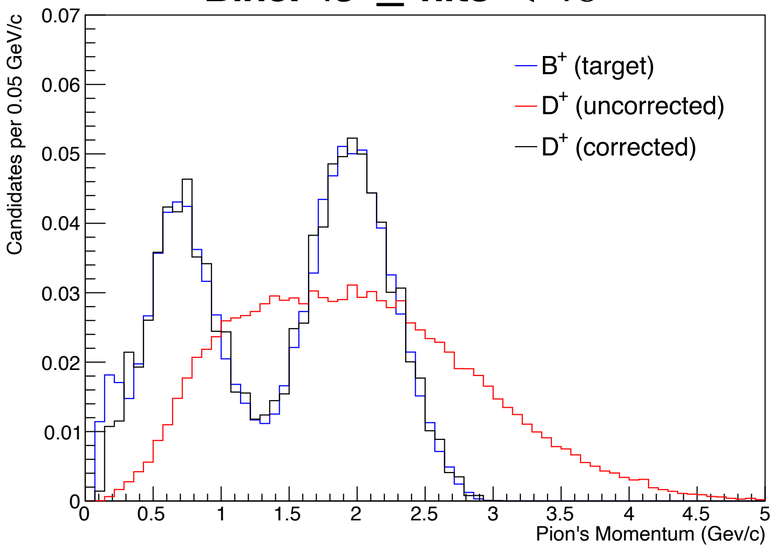
**Bin1:** $0 <$ **hits** $< 45$



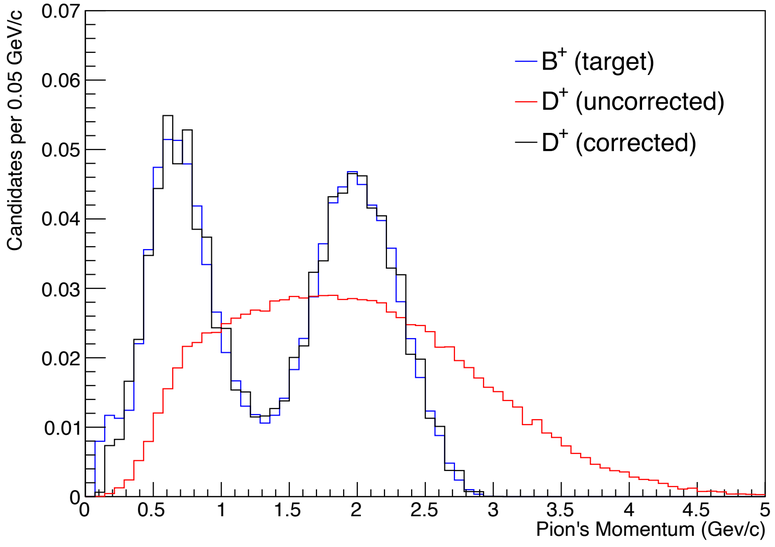

**Bin2:** $34 \leq$ **hits** $< 45$




**Bin3:** $45 \leq$ **hits** $< 48$




**Bin4:** $48 \leq$ **hits** $< 51$

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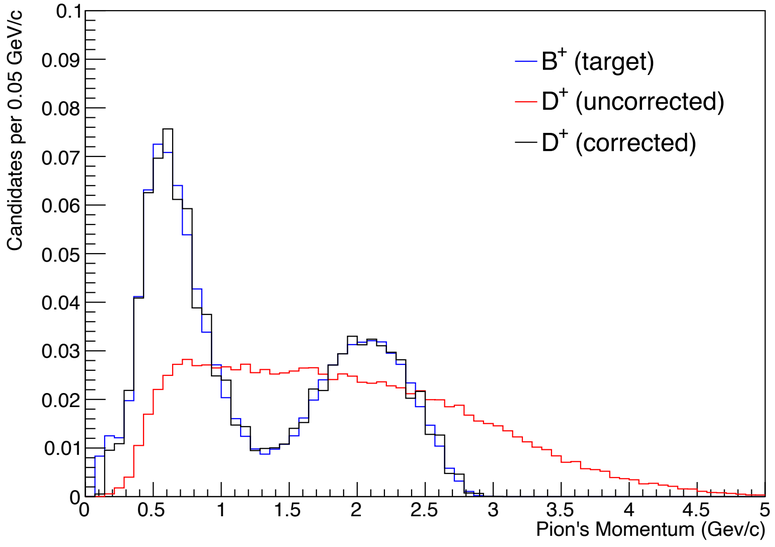


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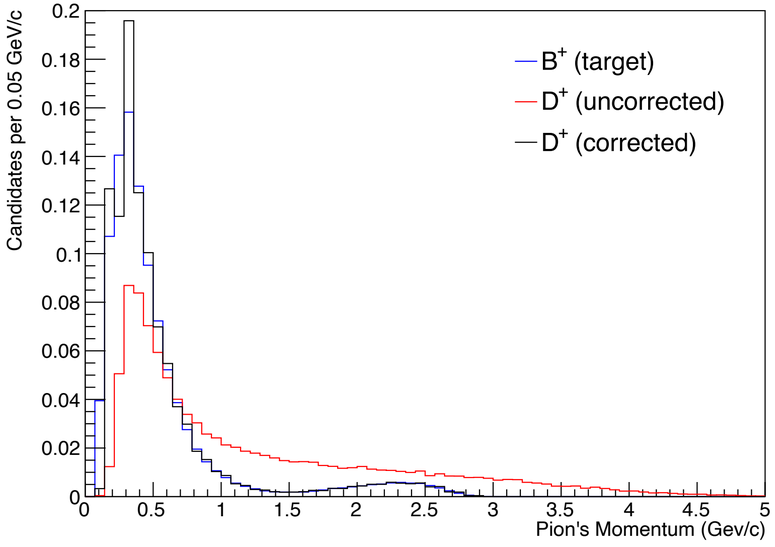
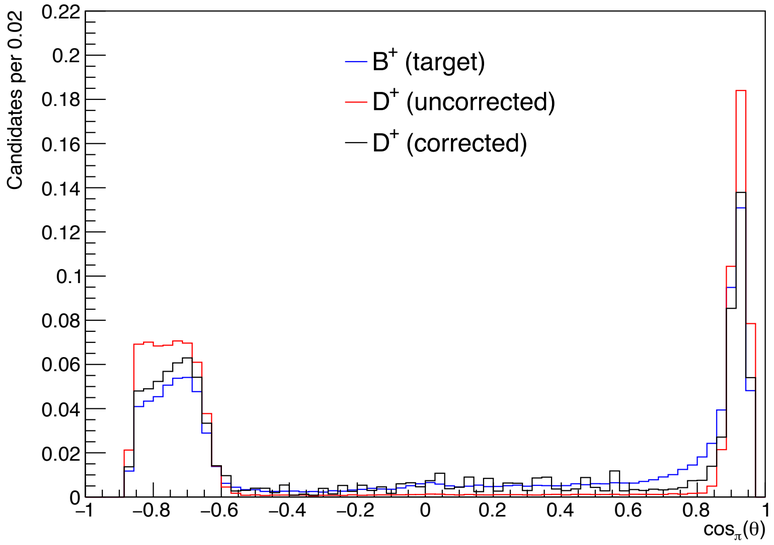


# $cos_{\pi}(\theta)$ distribution

**Bin1:** $0 <$ **hits** $< 45$

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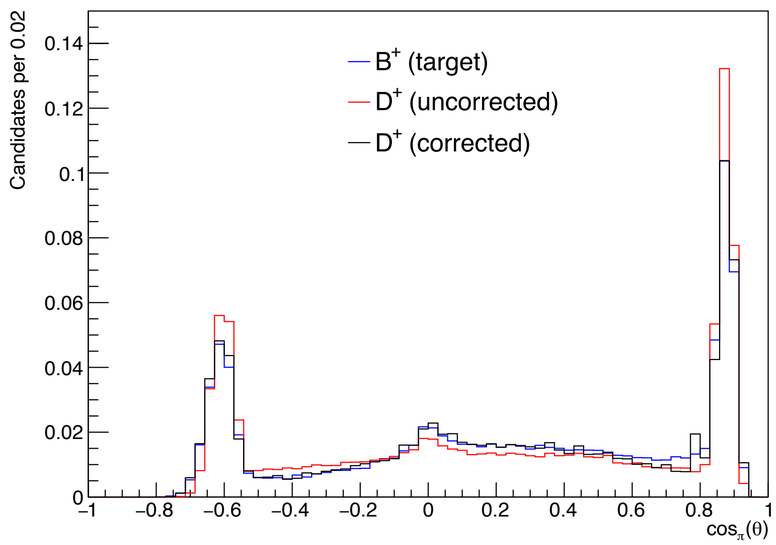


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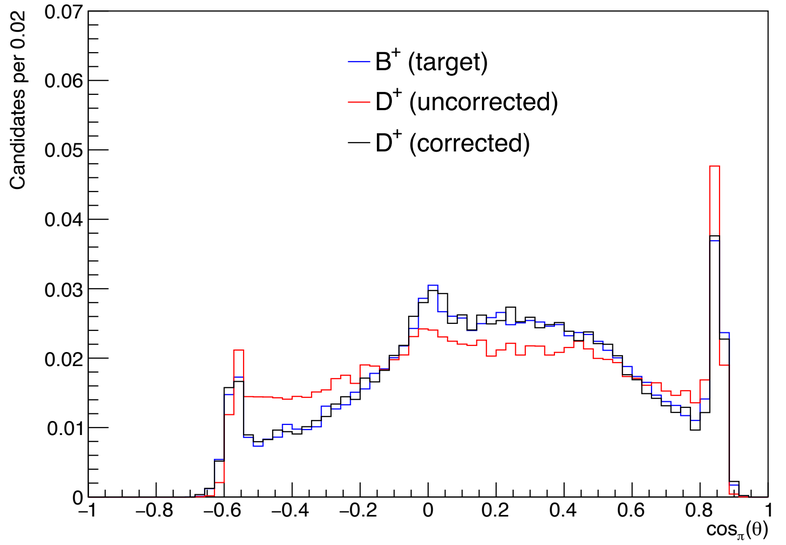


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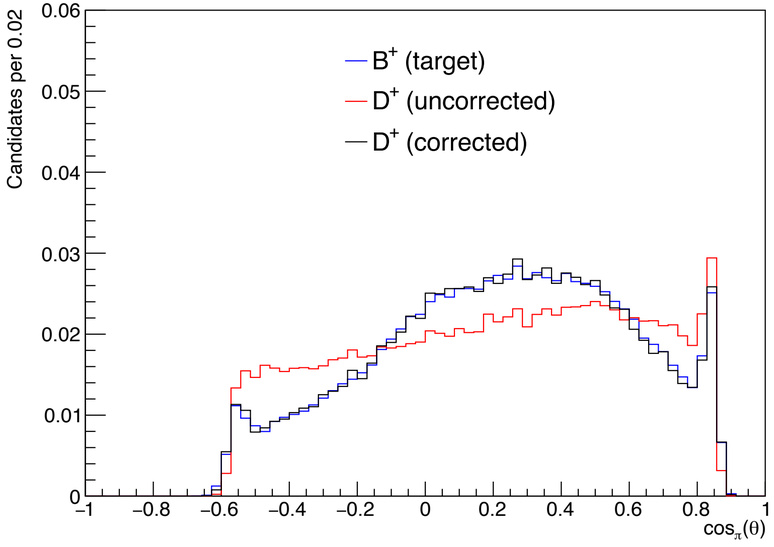


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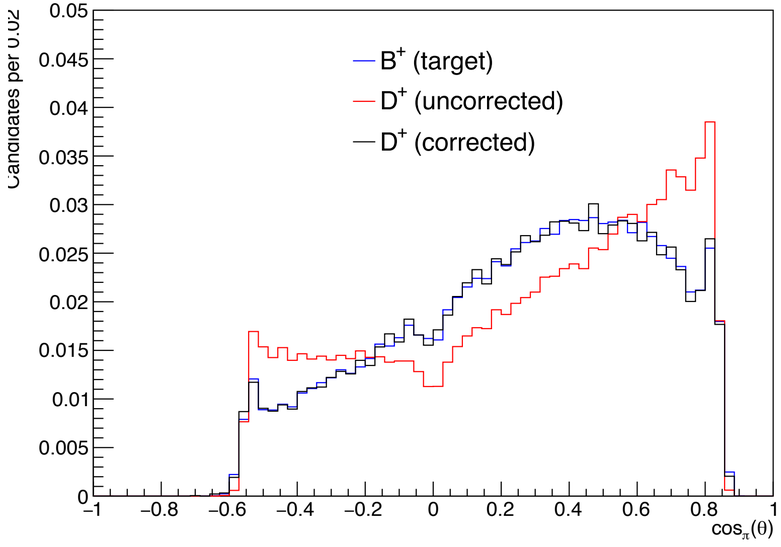


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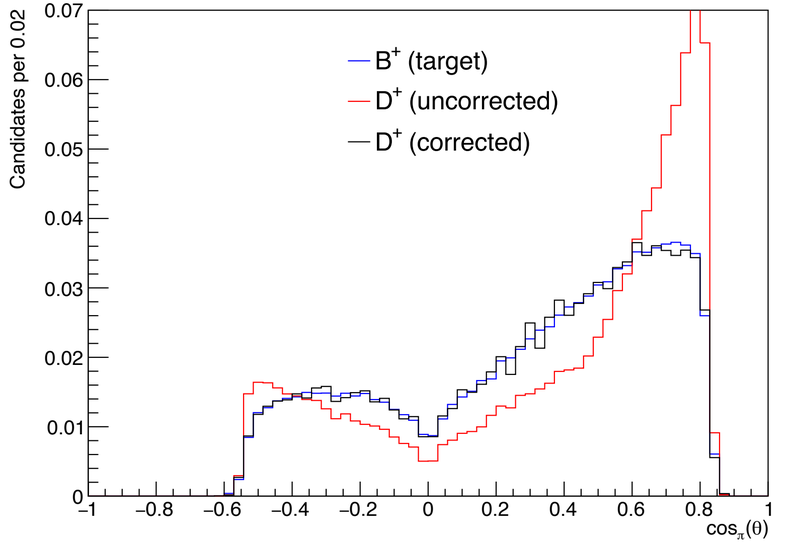

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| $54 \leq$ **hits** | 0.36752167 |

No. of events in a bin of CDC hits of $B^+$ target sample

Total events

$$\mathcal{A}_{det}(\pi) = -0.0002 \pm 0.0015$$

(after correction with momentum and polar angle)

$\mathcal{A}_{\mathrm{det}}(\pi) = -0.0042 \pm 0.0012$ (target)

~$2.1\sigma$ away