

# Detector induced assymetry in CP violation measurements

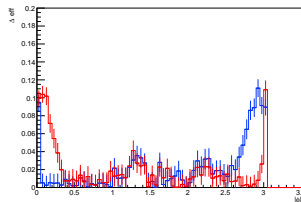
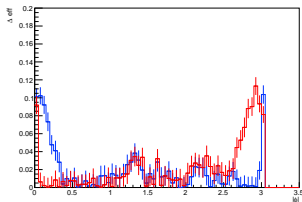
Eugenia Spedicato, Lina Maria Ortiz Parra, Jonah Blank

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- normalization ( $N_{tot} = 3 \cdot 10^6$ ) has no measurable effect
- mean origin vertex:
  - UP:  $(0.84 \pm 0.03, -0.18 \pm 0.03, -2.64 \pm 44.56)$
  - DOWN:  $(0.84 \pm 0.03, -0.18 \pm 0.03, -3.14 \pm 37.46)$
- $x$  and  $y$  many  $\sigma$  from 0  
→ asymmetric distribution of particles flying into the detector

# Idea 1

- form of detector: difference in eff. of different charges with  $\pm\phi$
- for  $|\phi| < 0.5$  &  $|\phi| > 2.5$  big differences in reconstruction for both charges  
→ cut these out



# Total Efficiencies - before cut

Polarity	$\epsilon_{\pi}$	$\epsilon_K$	$\epsilon_{\pi,s}$	$\epsilon_{D^0}$	$\epsilon_{D^*}$
<i>UP</i>	$86.65 \pm 0.01$	$84.63 \pm 0.01$	$76.65 \pm 0.02$	$73.34 \pm 0.02$	$56.31 \pm 0.02$
<i>DOWN</i>	$86.68 \pm 0.01$	$84.67 \pm 0.01$	$76.66 \pm 0.02$	$73.39 \pm 0.02$	$56.35 \pm 0.02$

# Total Efficiencies - after cut

Polarity	$\epsilon_{\pi}$	$\epsilon_K$	$\epsilon_{\pi,s}$	$\epsilon_{D^0}$	$\epsilon_{D^*}$
<i>UP</i>	$86.65 \pm 0.01$	$84.63 \pm 0.01$	$50.23 \pm 0.02$	$73.34 \pm 0.02$	$36.61 \pm 0.02$
<i>DOWN</i>	$86.68 \pm 0.01$	$84.67 \pm 0.01$	$50.25 \pm 0.02$	$73.39 \pm 0.02$	$36.58 \pm 0.02$

**Charge: +**

# Numbers - before cut

UP	$\pi$	$K$	$soft\ \pi$	$D^0$	$D^*$
$N_{reco}$	2 669 990	2 620 280	2 352 910	2 249 370	1 720 940
$N_{tot}$	3 000 000	3 000 000	3 000 000	3 000 000	3 000 000
DOWN	$\pi$	$K$	$soft\ \pi$	$D^0$	$D^*$
$N_{reco}$	2 674 000	2 626 350	2 374 360	2 253 370	1 737 460
$N_{tot}$	3 000 000	3 000 000	3 000 000	3 000 000	3 000 000

# Numbers - after cut

UP	$\pi$	$K$	$soft\ \pi$	$D^0$	$D^*$
$N_{reco}$	2 669 990	2 620 280	1 546 670	2 249 370	1 121 530
$N_{tot}$	3 000 000	3 000 000	1 961 330	3 000 000	1 961 330
DOWN	$\pi$	$K$	$soft\ \pi$	$D^0$	$D^*$
$N_{reco}$	2 674 000	2 626 350	1 552 010	2 253 370	1 125 280
$N_{tot}$	3 000 000	3 000 000	1 963 510	3 000 000	1 963 510



**Charge: -**

# Numbers - before cut

UP	$\pi$	$K$	$soft\ \pi$	$D^0$	$D^*$
$N_{reco}$	2 669 990	2 620 280	2 352 910	2 249 370	1 720 940
$N_{tot}$	3 000 000	3 000 000	3 000 000	3 000 000	3 000 000
DOWN	$\pi$	$K$	$soft\ \pi$	$D^0$	$D^*$
$N_{reco}$	2 674 000	2 626 350	2 374 360	2 253 370	1 737 460
$N_{tot}$	3 000 000	3 000 000	3 000 000	3 000 000	3 000 000

# Numbers - after cut

UP	$\pi$	$K$	$soft\ \pi$	$D^0$	$D^*$
$N_{reco}$	2 669 990	2 620 280	1 549 090	2 249 370	1 132 970
$N_{tot}$	3 000 000	3 000 000	1 960 630	3 000 000	1 960 630
DOWN	$\pi$	$K$	$soft\ \pi$	$D^0$	$D^*$
$N_{reco}$	2 674 000	2 626 350	1 549 160	2 253 370	1 134 370
$N_{tot}$	3 000 000	3 000 000	1 964 560	3 000 000	1 964 560

# Deviation before & after cut

Table: The deviation  $\frac{N_+ - N_-}{N_+ + N_-} / 10^{-3}$

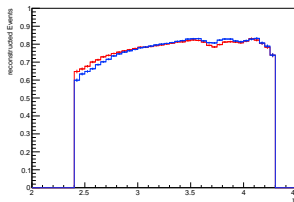
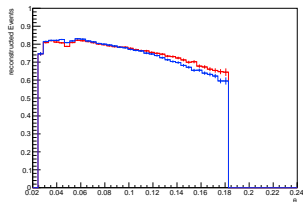
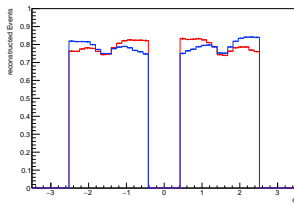
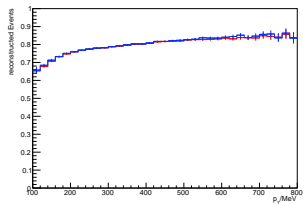
Polarity	$\pi$	$K$	$soft\pi$	$D^0$	$D^*$
<i>UP</i>	$-0.1 \pm 0.4$	$4.7 \pm 0.4$	$-3.8 \pm 0.5$	$-4.7 \pm 0.5$	$-8.2 \pm 0.5$
<i>DOWN</i>	$-0.3 \pm 0.4$	$5.2 \pm 0.4$	$3.7 \pm 0.5$	$-5.0 \pm 0.5$	$-0.8 \pm 0.5$

Polarity	$\pi$	$K$	$soft\pi$	$D^0$	$D^*$
<i>UP</i>	$-0.1 \pm 0.4$	$4.7 \pm 0.4$	$-0.8 \pm 0.6$	$-4.7 \pm 0.5$	$-5.1 \pm 0.7$
<i>DOWN</i>	$-0.3 \pm 0.4$	$5.2 \pm 0.4$	$0.9 \pm 0.5$	$-5.0 \pm 0.5$	$-4.0 \pm 0.7$

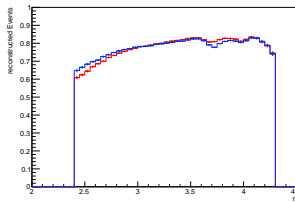
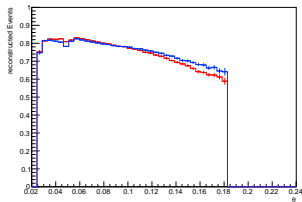
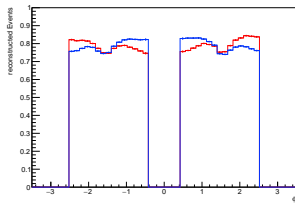
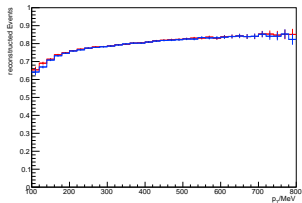
- deviation in  $\pi$  gets smaller, in  $D^*$  equals out
- $\approx 33\%$  of events is rejected

# Comparison of different charges with $UP$ polarity - soft $\pi$

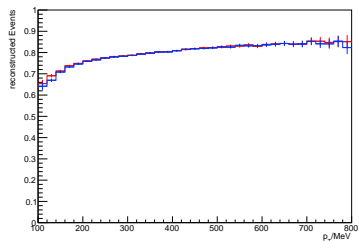
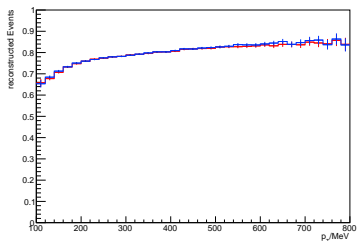


# Comparison of different charges with *DOWN* polarity - soft

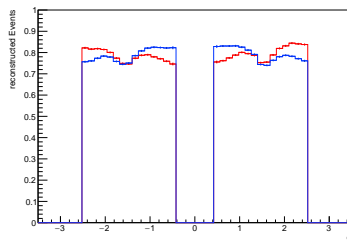
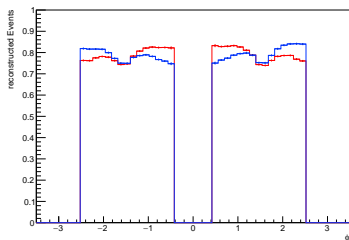
$\pi$



# Comparison - soft $\pi p_T$

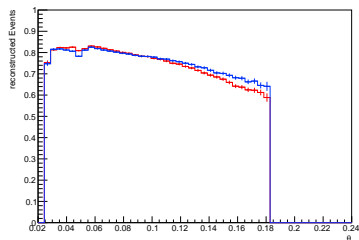
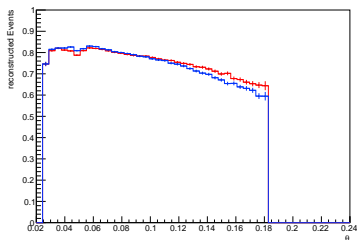


# Comparison - soft $\pi\phi$

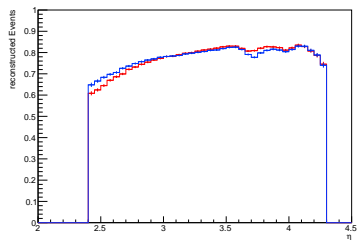
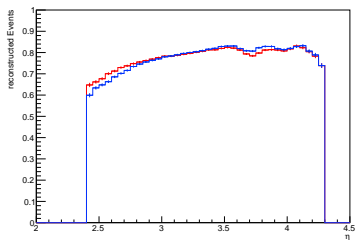




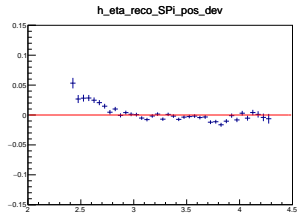
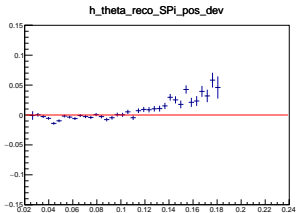
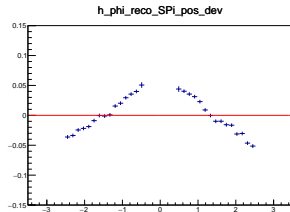
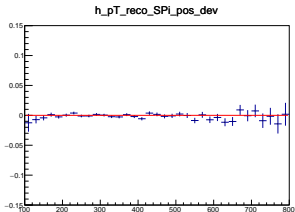
# Comparison - soft $\pi\theta$



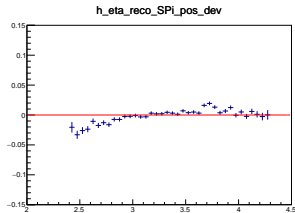
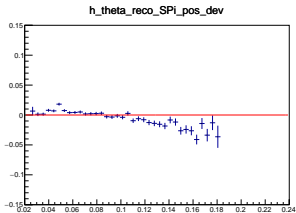
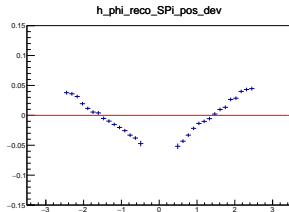
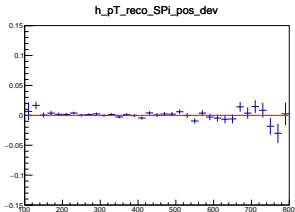
# Comparison - soft $\pi\eta$



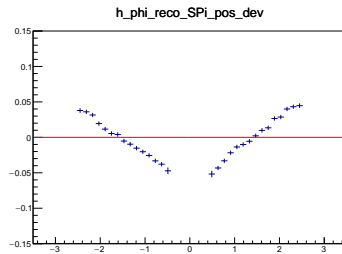
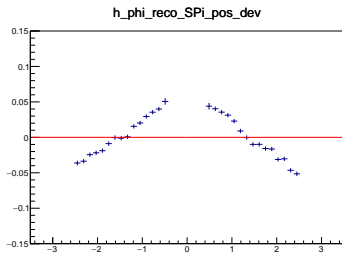
# soft $\pi$ deviation dependencies - $UP$ polarity



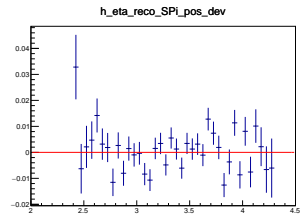
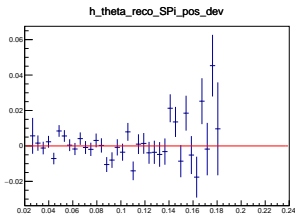
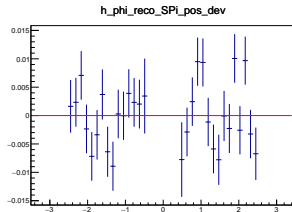
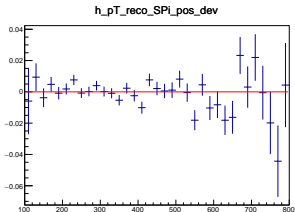
# soft $\pi$ deviation dependencies - *DOWN* polarity



# soft $\pi$ deviation - $\phi$

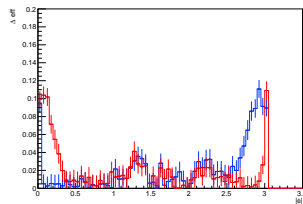
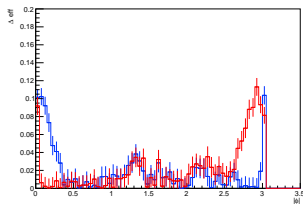


# soft $\pi$ deviation UP+DOWN



# Idea 2

■  $|\phi| < 0.3 \& |\phi| > 2.5 \& \eta > 3$



# Deviation before & after cut

Table: The deviation  $\frac{N_+ - N_-}{N_+ + N_-} / 10^{-3}$

Polarity	$\pi$	$K$	$soft\pi$	$D^0$	$D^*$
<i>UP</i>	$-0.1 \pm 0.4$	$4.7 \pm 0.4$	$-3.8 \pm 0.5$	$-4.7 \pm 0.5$	$-8.2 \pm 0.5$
<i>DOWN</i>	$-0.3 \pm 0.4$	$5.2 \pm 0.4$	$3.7 \pm 0.5$	$-5.0 \pm 0.5$	$-0.8 \pm 0.5$

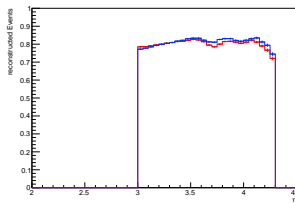
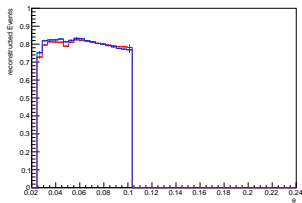
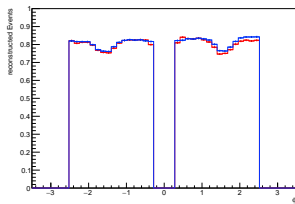
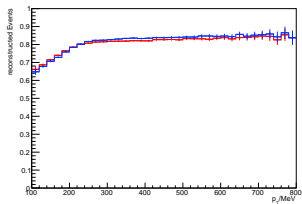
  

Polarity	$\pi$	$K$	$soft\pi$	$D^0$	$D^*$
<i>UP</i>	$-0.1 \pm 0.4$	$4.7 \pm 0.4$	$-4.4 \pm 0.6$	$-4.7 \pm 0.5$	$-8.7 \pm 0.7$
<i>DOWN</i>	$-0.3 \pm 0.4$	$5.2 \pm 0.4$	$4.1 \pm 0.6$	$-5.0 \pm 0.5$	$-0.2 \pm 0.7$

- deviation is even worse than before
- $\approx 50\%$  of events is rejected

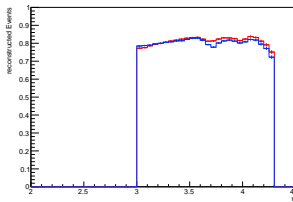
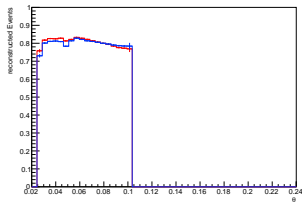
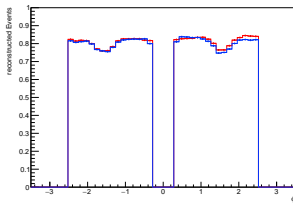
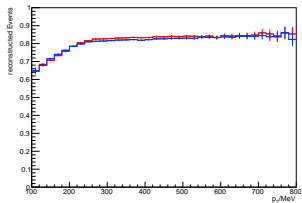


# Comparison of different charges with $UP$ polarity - soft $\pi$

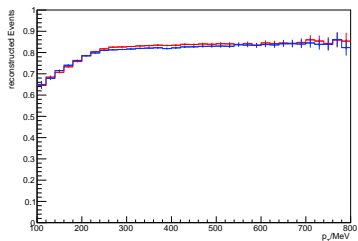
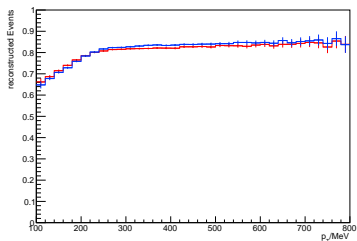


# Comparison of different charges with *DOWN* polarity - soft

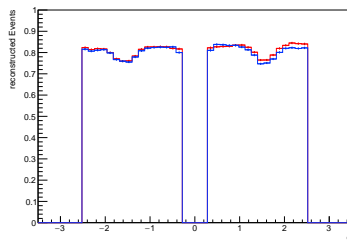
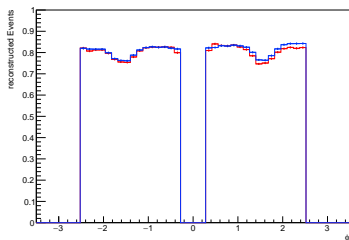
$\pi$



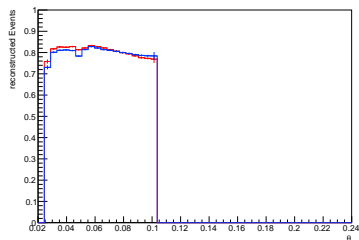
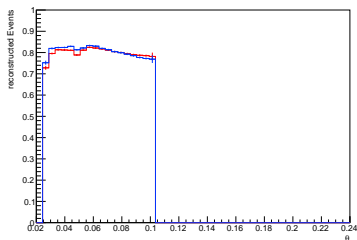
# Comparison - soft $\pi p_T$



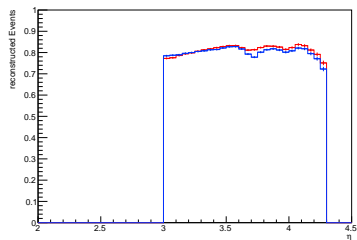
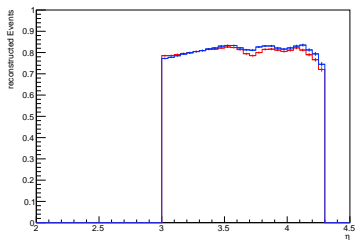
# Comparison - soft $\pi\phi$



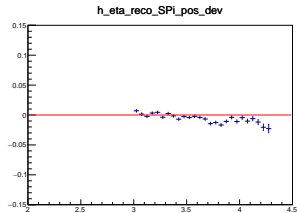
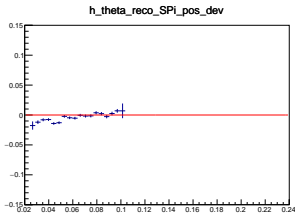
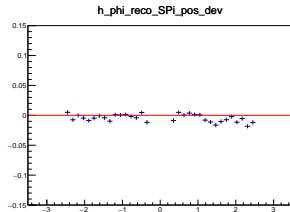
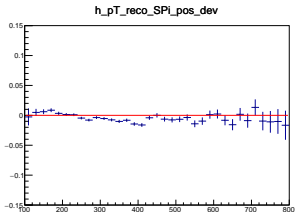
# Comparison - soft $\pi\theta$



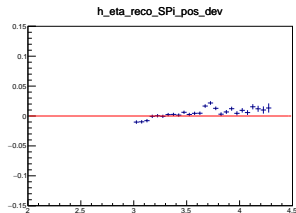
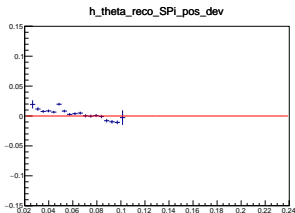
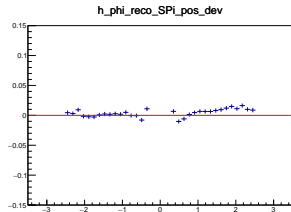
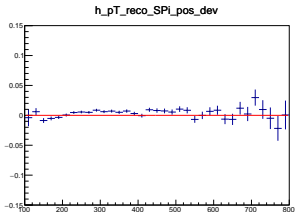
# Comparison - soft $\pi\eta$



# soft $\pi$ deviation dependencies - $UP$ polarity

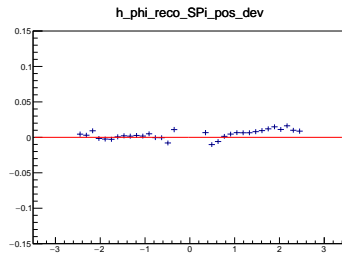
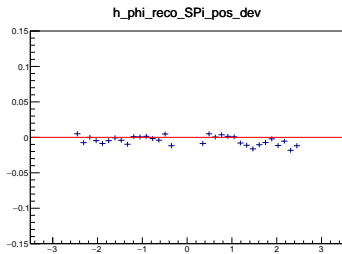


# soft $\pi$ deviation dependencies - *DOWN* polarity

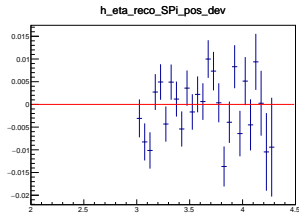
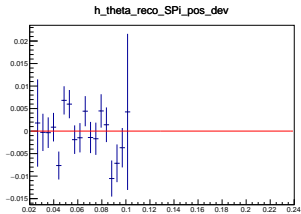
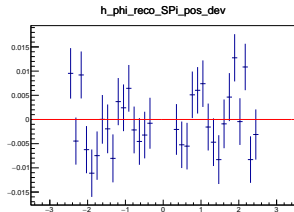
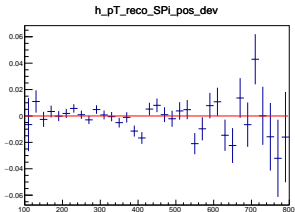




# soft $\pi$ deviation - $\phi$

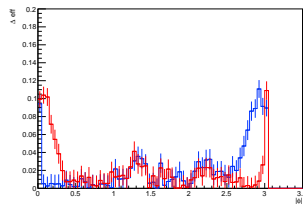
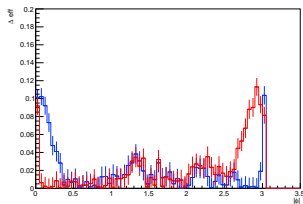


# soft $\pi$ deviation UP+DOWN



# Idea 3

■  $|\phi| > 0.3 \& |\phi| < 2.5 \& \theta < 0.13$



# Deviation before & after cut

Table: The deviation  $\frac{N_+ - N_-}{N_+ + N_-} / 10^{-3}$

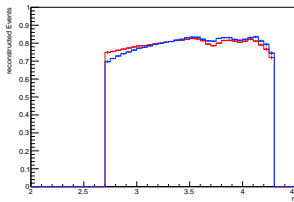
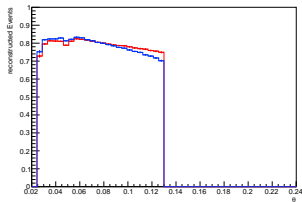
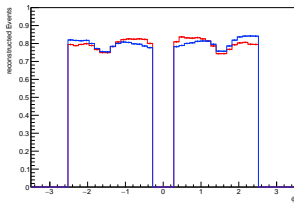
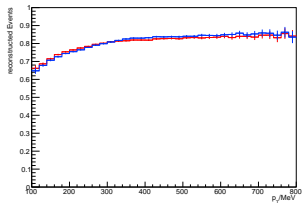
Polarity	$\pi$	$K$	$soft\pi$	$D^0$	$D^*$
<i>UP</i>	$-0.1 \pm 0.4$	$4.7 \pm 0.4$	$-3.8 \pm 0.5$	$-4.7 \pm 0.5$	$-8.2 \pm 0.5$
<i>DOWN</i>	$-0.3 \pm 0.4$	$5.2 \pm 0.4$	$3.7 \pm 0.5$	$-5.0 \pm 0.5$	$-0.8 \pm 0.5$

Polarity	$\pi$	$K$	$soft\pi$	$D^0$	$D^*$
<i>UP</i>	$-0.1 \pm 0.4$	$4.7 \pm 0.4$	$-1.0 \pm 0.6$	$-4.7 \pm 0.5$	$-5.2 \pm 0.6$
<i>DOWN</i>	$-0.3 \pm 0.4$	$5.2 \pm 0.4$	$0.3 \pm 0.6$	$-5.0 \pm 0.5$	$-4.0 \pm 0.6$

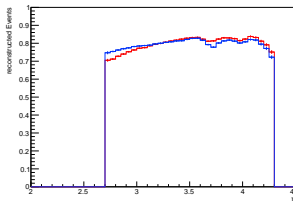
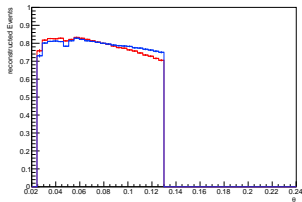
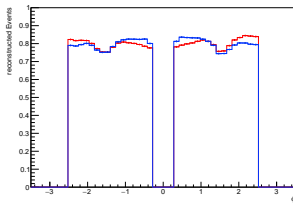
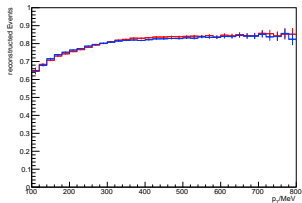
- lower deviation in soft  $\pi$ , but polarities are affected differently
- $\approx 33\%$  of events is rejected

# Comparison of different charges with $UP$ polarity - soft $\pi$

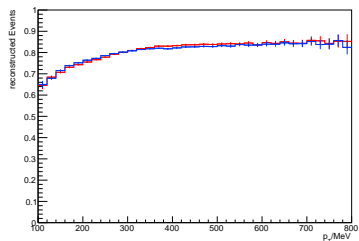
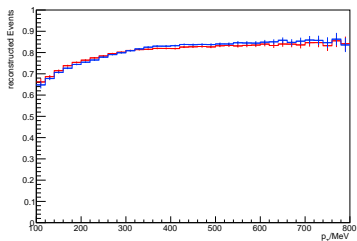


# Comparison of different charges with *DOWN* polarity - soft

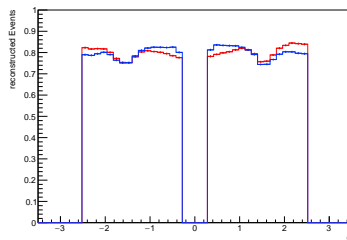
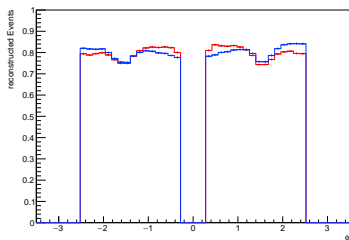
$\pi$



# Comparison - soft $\pi p_T$

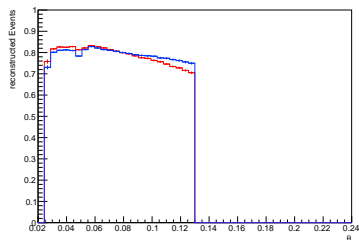
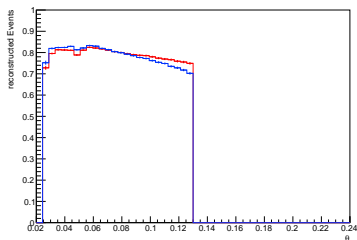


# Comparison - soft $\pi\phi$

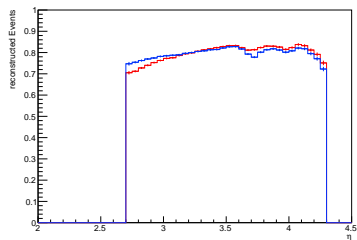
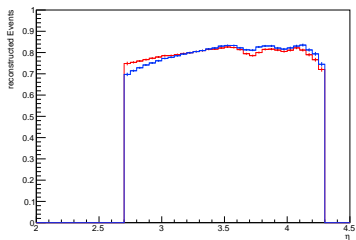




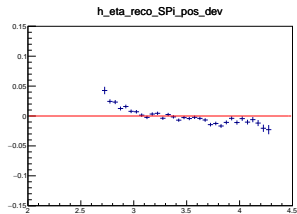
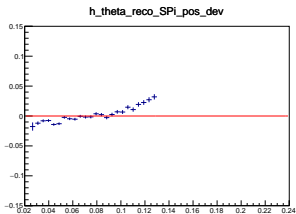
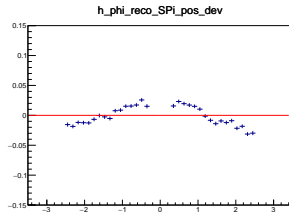
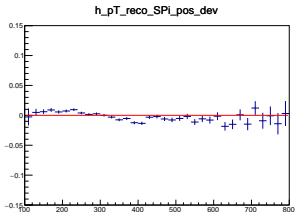
# Comparison - soft $\pi\theta$



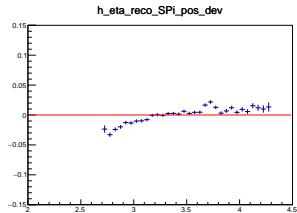
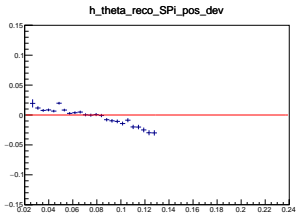
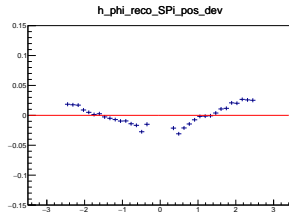
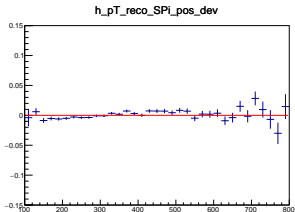
# Comparison - soft $\pi\eta$



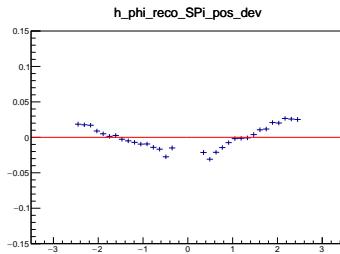
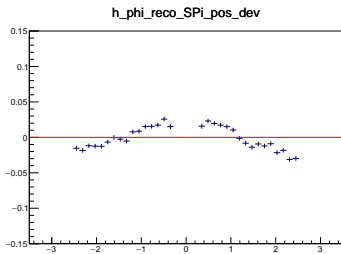
# soft $\pi$ deviation dependencies - $UP$ polarity



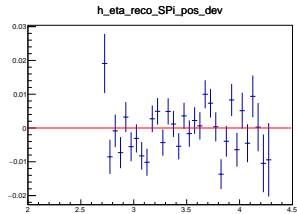
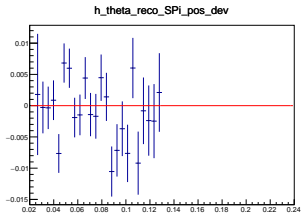
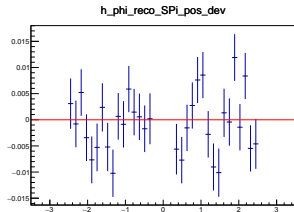
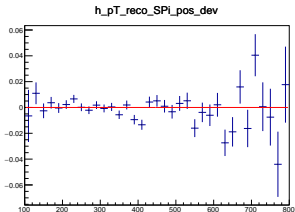
# soft $\pi$ deviation dependencies - *DOWN* polarity



# soft $\pi$ deviation - $\phi$

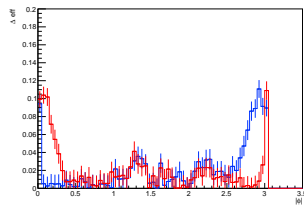
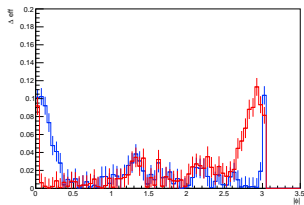


# soft $\pi$ deviation UP+DOWN



# Idea 4

■  $|0.35 < |\phi| < 2.65$



# Deviation before & after cut

Table: The deviation  $\frac{N_+ - N_-}{N_+ + N_-} / 10^{-3}$

Polarity	$\pi$	$K$	$soft\pi$	$D^0$	$D^*$
<i>UP</i>	$-0.1 \pm 0.4$	$4.7 \pm 0.4$	$-3.8 \pm 0.5$	$-4.7 \pm 0.5$	$-8.2 \pm 0.5$
<i>DOWN</i>	$-0.3 \pm 0.4$	$5.2 \pm 0.4$	$3.7 \pm 0.5$	$-5.0 \pm 0.5$	$-0.8 \pm 0.5$

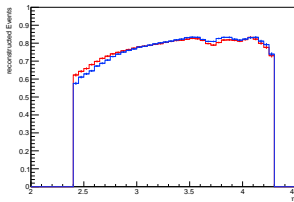
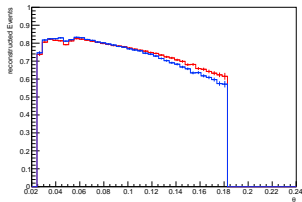
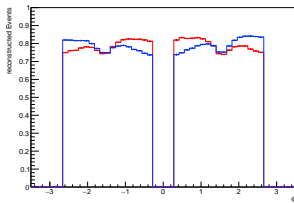
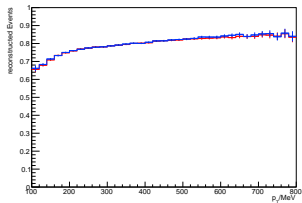
  

Polarity	$\pi$	$K$	$soft\pi$	$D^0$	$D^*$
<i>UP</i>	$-0.1 \pm 0.4$	$4.7 \pm 0.4$	$-0.7 \pm 0.6$	$-4.7 \pm 0.5$	$-5.1 \pm 0.6$
<i>DOWN</i>	$-0.3 \pm 0.4$	$5.2 \pm 0.4$	$0.7 \pm 0.6$	$-5.0 \pm 0.5$	$-3.9 \pm 0.6$

- lower deviation in soft  $\pi$ , but polarities are affected differently
- $\approx 25\%$  of events is rejected

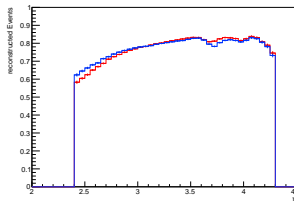
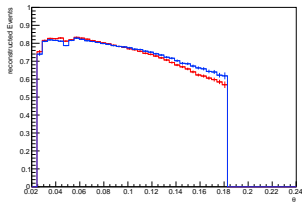
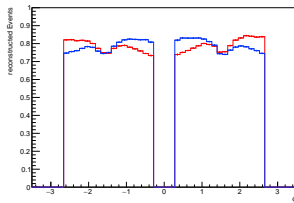
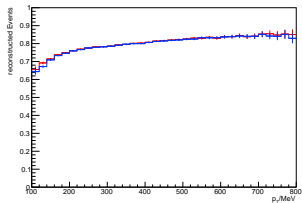


# Comparison of different charges with $UP$ polarity - soft $\pi$

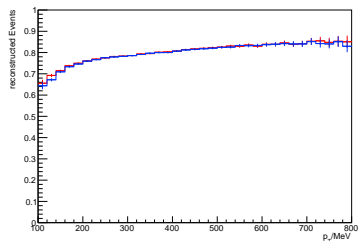
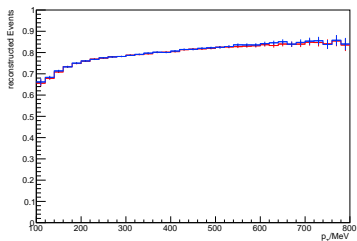


# Comparison of different charges with *DOWN* polarity - soft

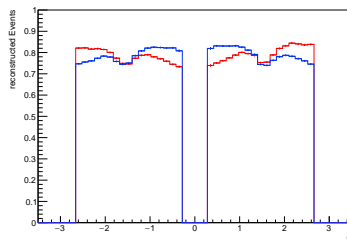
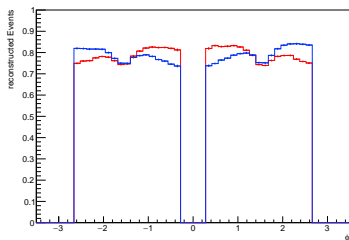
$\pi$



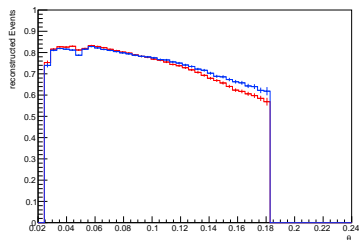
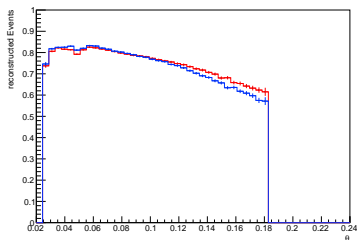
# Comparison - soft $\pi p_T$



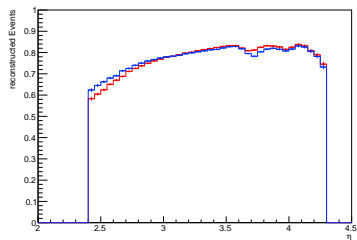
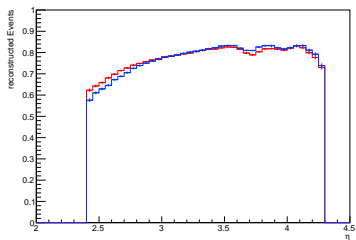
# Comparison - soft $\pi\phi$



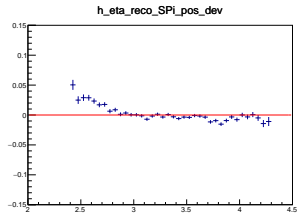
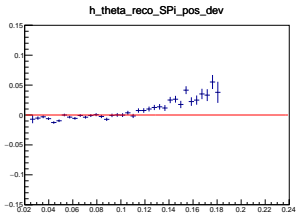
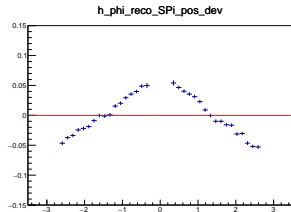
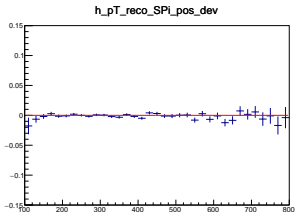
# Comparison - soft $\pi\theta$



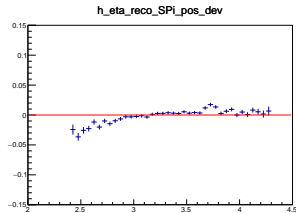
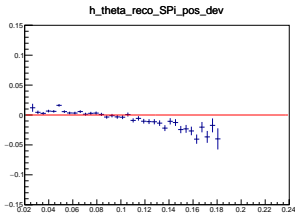
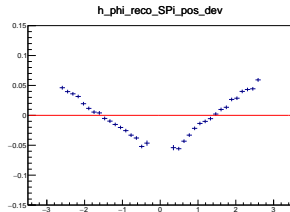
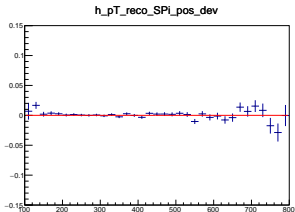
# Comparison - soft $\pi\eta$



# soft $\pi$ deviation dependencies - $UP$ polarity

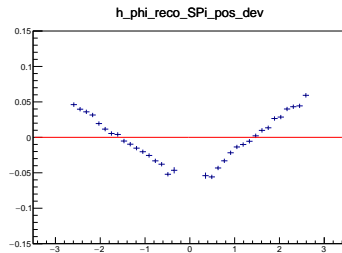
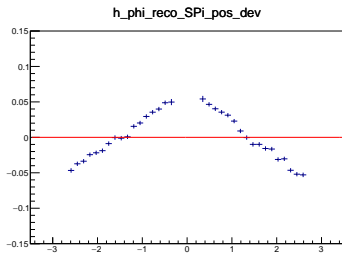


# soft $\pi$ deviation dependencies - *DOWN* polarity





# soft $\pi$ deviation - $\phi$



# soft $\pi$ deviation UP+DOWN

