Some Ideas about Efficiency und Purity of the CEDARs

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COMPASS Mainz Meeting
June 11, 2012

Outline

Step 5: Use likelihoods to identify particles

- Compare log likelihoods to get an ID for each CEDAR:
  - $\log L^K > \log L^\pi + A \Rightarrow$ PID **K**
  - $\log L^\pi > \log L^K + B \Rightarrow$ PID π
  - else no PID given
- Tune **A** and **B** due to efficiency/purity.
- Combine CEDARs afterwards with OR combination

C2 \ C1	?	π	**K**
?	?	π	**K**
π	π	π	?
K	**K**	?	**K**

Additional quality cuts

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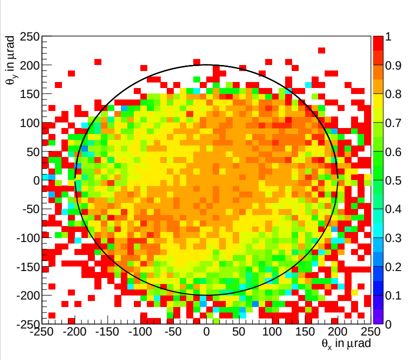
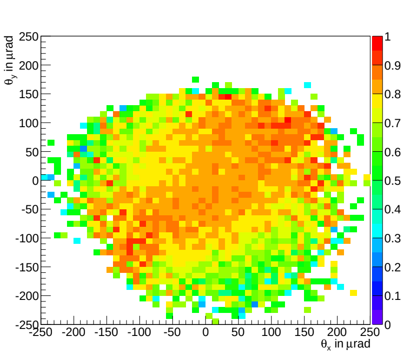
1. Cut on
$$\mathbf{r} = \sqrt{\theta_x^2 + \theta_y^2} < 200 \times 10^{-6}$$



Additional quality cuts

Two possibilities for quality cuts on probabilities:

1. Cut on $\mathbf{r} = \sqrt{\theta_\mathbf{x}^2 + \theta_\mathbf{y}^2} < \mathbf{200} \times \mathbf{10^{-6}}$
2. Take out Bins with $\mathbf{P} = \mathbf{0}$ (no statistics) and $\mathbf{P} = \mathbf{1}$ (very low statistics)



Outline

Method 1: Comparing Histograms

Starting Point

$\mathbf{n}$ Histograms $\mathbf{H_i}$ (invariant Masses of $\mathbf{K\pi\pi}$), consisting of signal $\mathbf{S}$ (unknown) and background $\mathbf{B}$ (known) with an unknown ratio:

$$\mathbf{H_i = s_i \cdot S + b_i \cdot B}$$

Question

Can one get coefficients $\mathbf{b_i}$ as a measure for purity?

Method 1: Comparing Histograms

Some Thougts

It is:

$$\mathbf{S} = \frac{1}{\mathbf{s_i}}\left(\mathbf{H_i} - \mathbf{b_i} \cdot \mathbf{B}\right)$$

S is the same for every $\mathbf{H_i}$.
Thus:

$$\frac{1}{\mathbf{s_i}}\left(\mathbf{H_i} - \mathbf{b_i} \cdot \mathbf{B}\right) - \frac{1}{\mathbf{s_j}}\left(\mathbf{H_j} - \mathbf{b_j} \cdot \mathbf{B}\right) = \mathbf{0}$$

Goal

Find $\mathbf{b_i}$,$\mathbf{b_j}$ ($\mathbf{s_i}$,$\mathbf{s_j}$) that

$$\mathbf{S_{ij}} = \frac{1}{\mathbf{s_i}}\left(\mathbf{H_i} - \mathbf{b_i} \cdot \mathbf{B}\right) - \frac{1}{\mathbf{s_j}}\left(\mathbf{H_j} - \mathbf{b_j} \cdot \mathbf{B}\right) \stackrel{!}{=} \mathbf{0}$$

Method 1: Comparing Histograms

Plan

Minimize quadratic sum over all bins

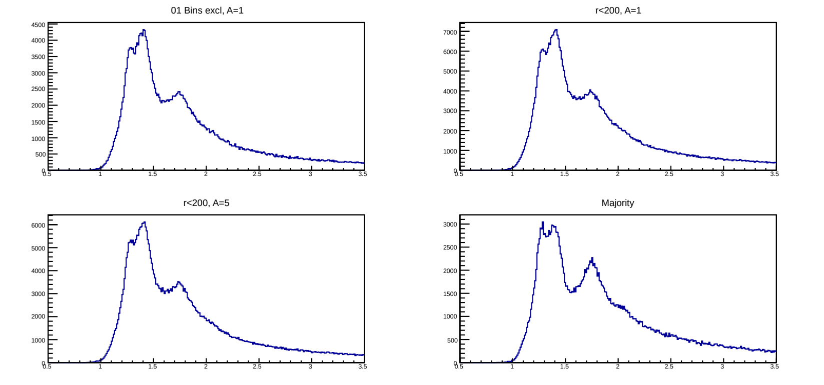
$$\mathbf{\Sigma_{ij} = \sum_{nbins} \left(S_{ij}\right)_n^2}$$

for each pair $\mathbf{(i, j)}$ of Histograms.

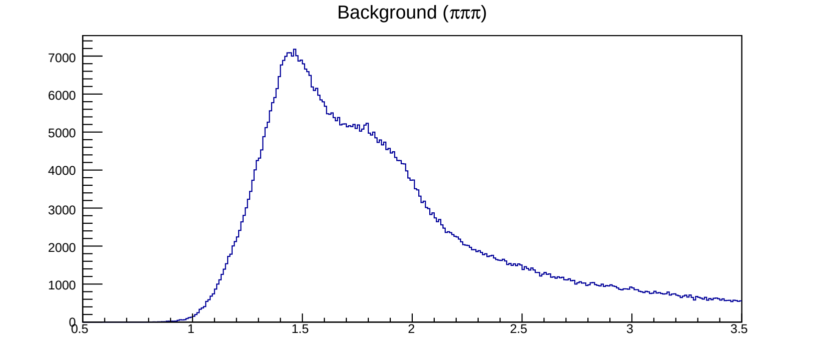
Problem

Coefficients can only be determined up to a common factor.
$\Rightarrow$ Only possible to obtain ratios (relative background contributions)

Different Histograms



Background


Background (πππ)
7000
6000
5000
4000
3000
2000
1000
0
0.5
1
1.5
2
2.5
3
3.5

Problem

No convergence!

$\mathbf{S_{ij} \approx \mathcal{O}(10^5)}$

Method 2: $\mathbf{K}^*$ oder not $\mathbf{K}^*$

Idee

Look at

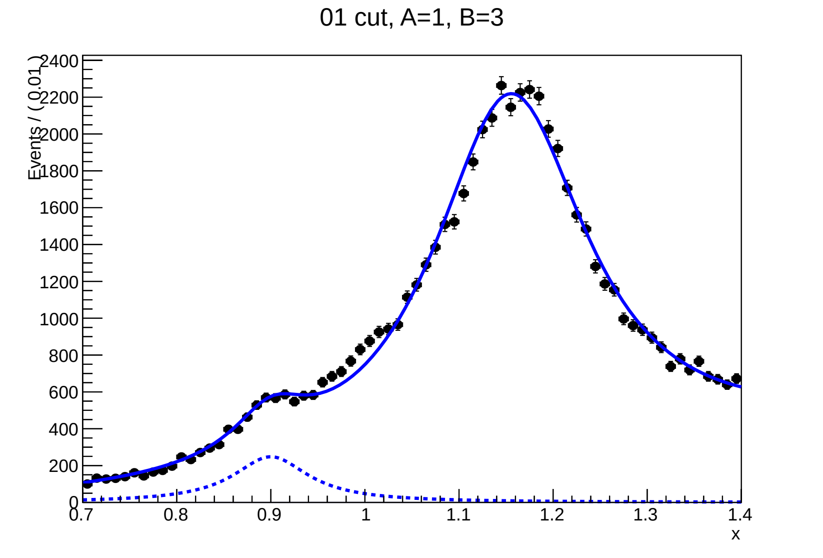
$$\mathbf{h^- p \to h'^- K^0_S p}$$

Then one knows (due to conservation of strangeness):

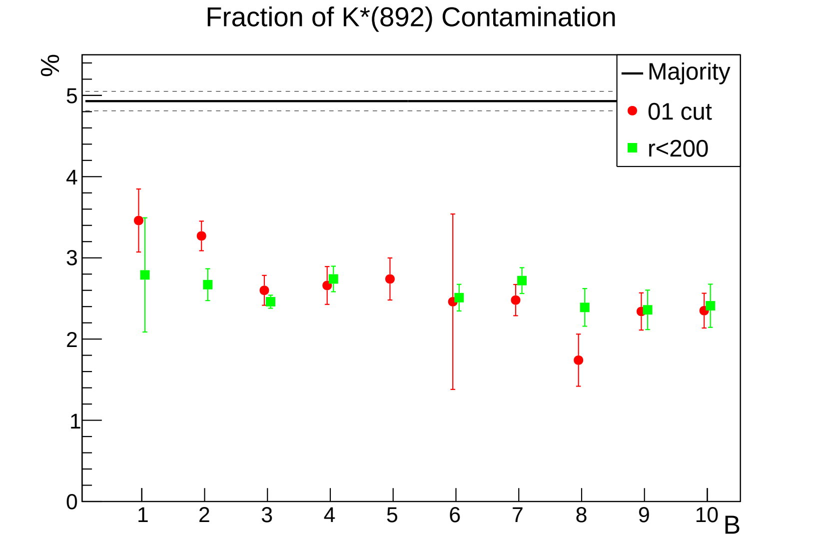
$\mathbf{h'^-}$	$\mathbf{h^-}$
$\mathbf{K^-}$	π^-
π^-	$\mathbf{K^-}$

Take invariant mass of $\mathbf{h'^- K^0_S}$ assuming $\mathbf{h'^-} = \pi^-$. Look at $\mathbf{K^*(892)}$ and $\mathbf{K^*(1430)}$. Selecting pions in the CEDAR these should disappear.

Example

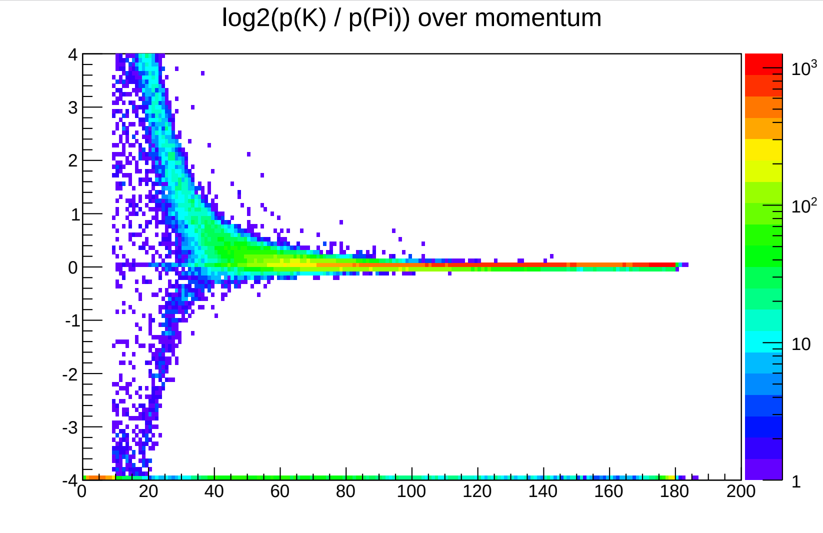

01 cut, A=1, B=3
Events / (0.01)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
x

Result

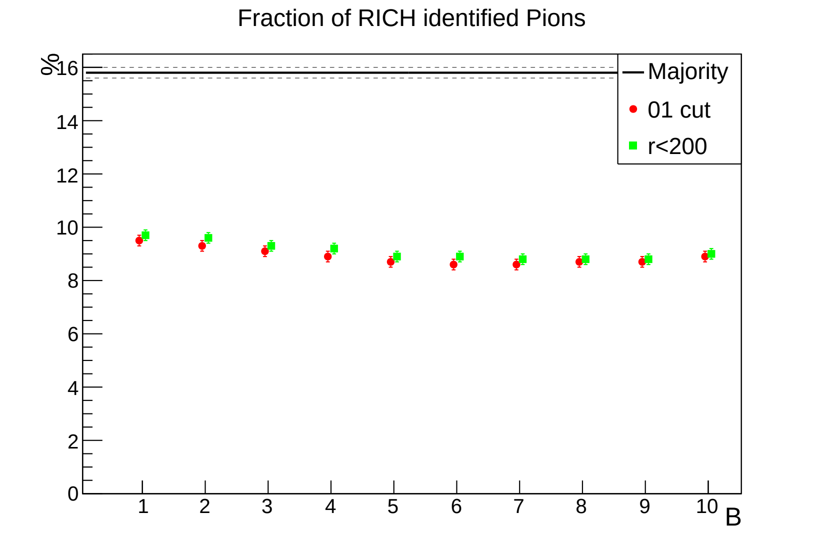

Fraction of K*(892) Contamination
%
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
B
Majority
01 cut
r<200

Different Possibility

Use RICH information to identify $\mathbf{h'^-}$

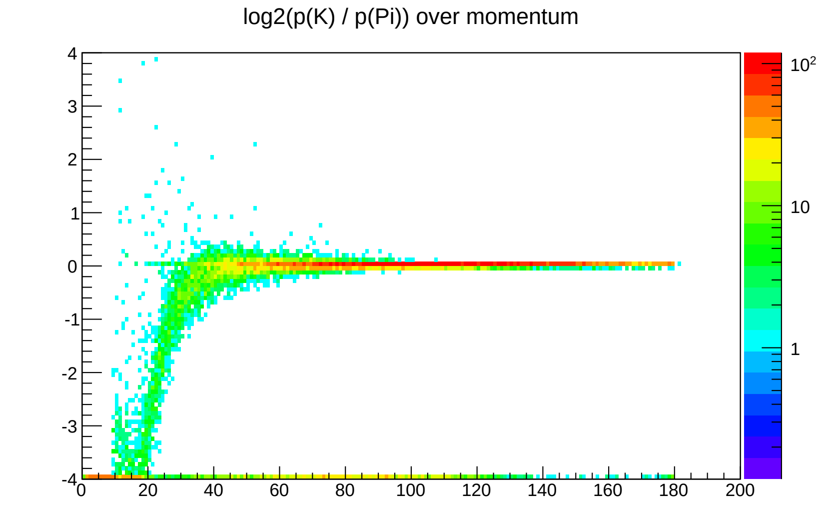


Result

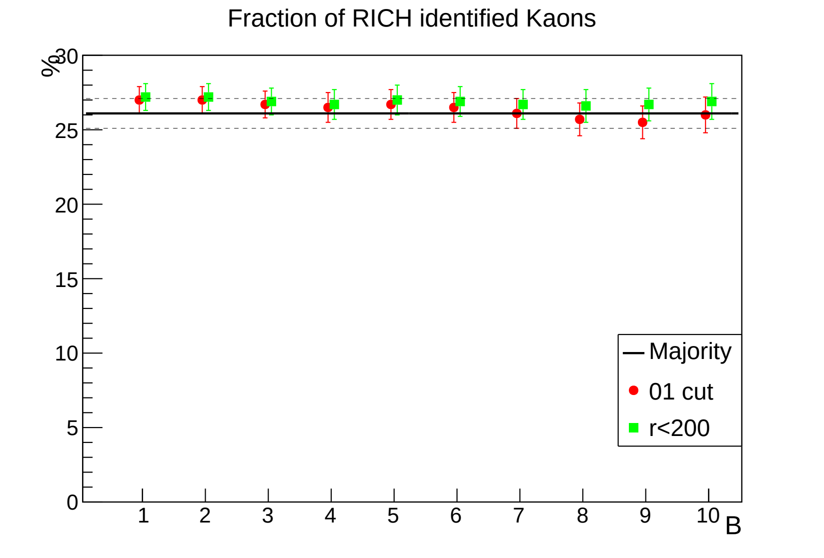

Fraction of RICH identified Pions
%
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
B
Majority
01 cut
r<200

Kaon Purity

Also use RICH information to identify $\mathbf{h}'^{-}$



Result

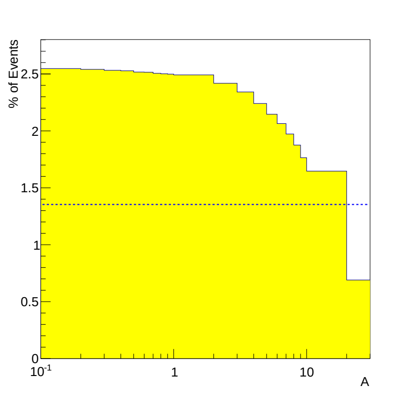

Fraction of RICH identified Kaons
%
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
B
Majority
01 cut
r<200

Outline

Only Idea so far

Look at expected number of Kaons (2.4%) and Pions (97%)

r < 200



01-cut