Hadron Identification at *BABAR*

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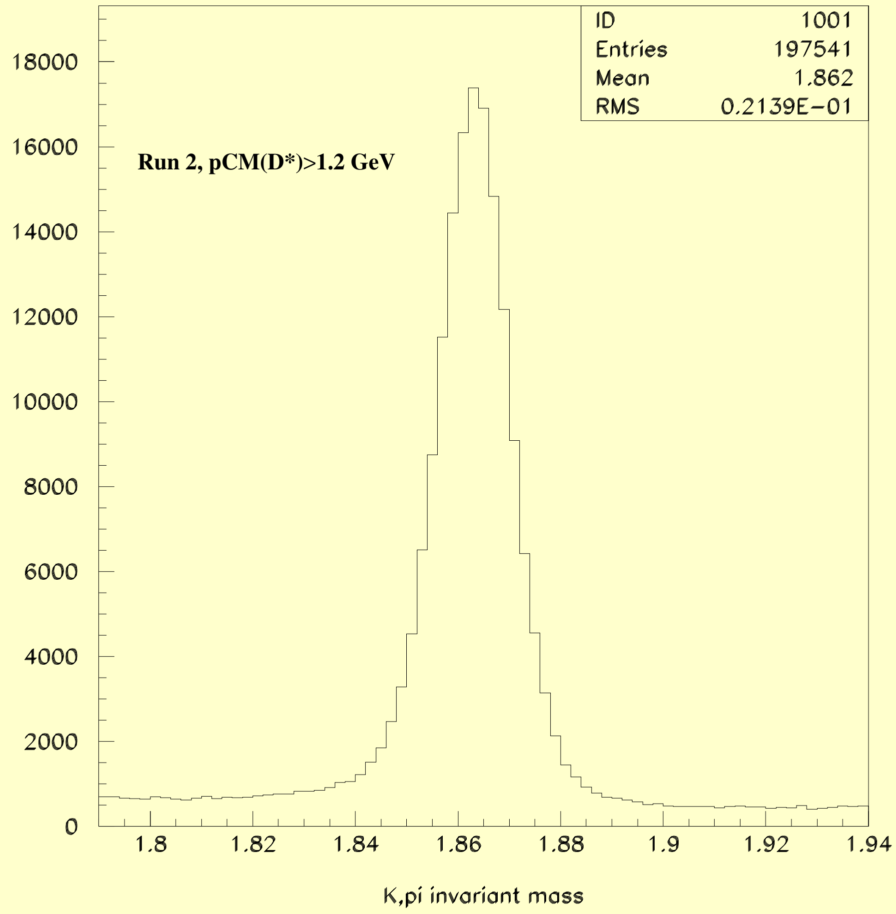
- dE/dx and DIRC
- Control samples
- Algorithms
- Efficiency and MisIdentification
- Conclusions

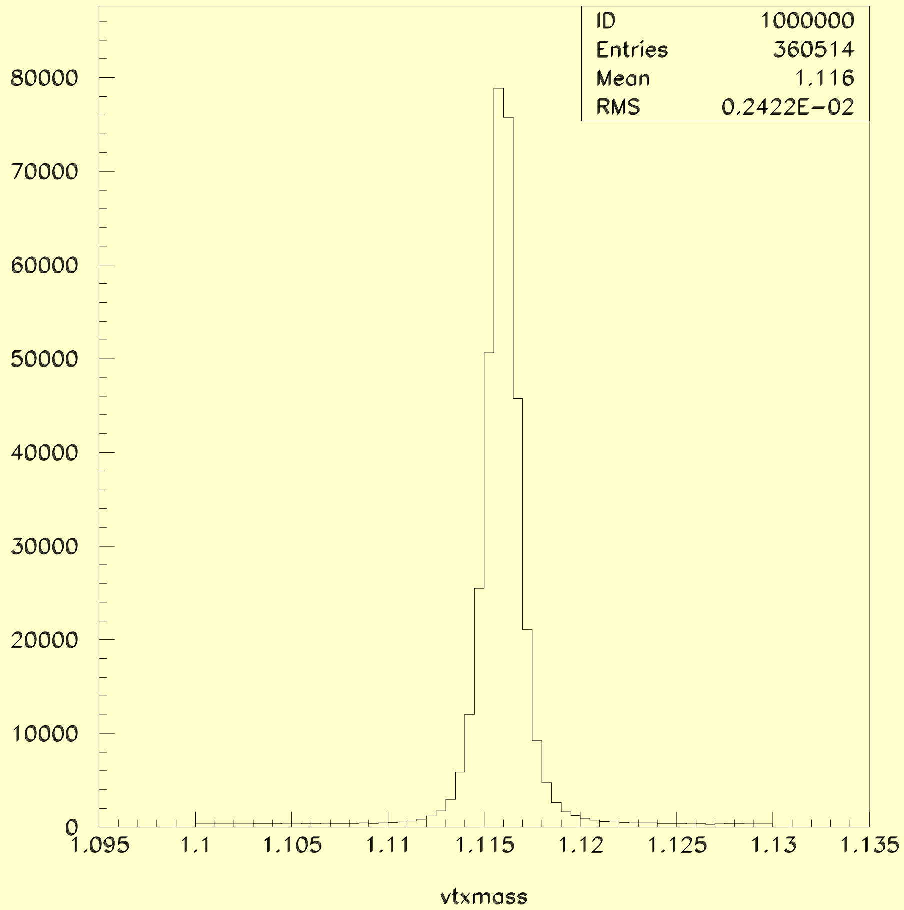
thanks to Mike Sokoloff, Giampiero Mancinelli

D^* sample



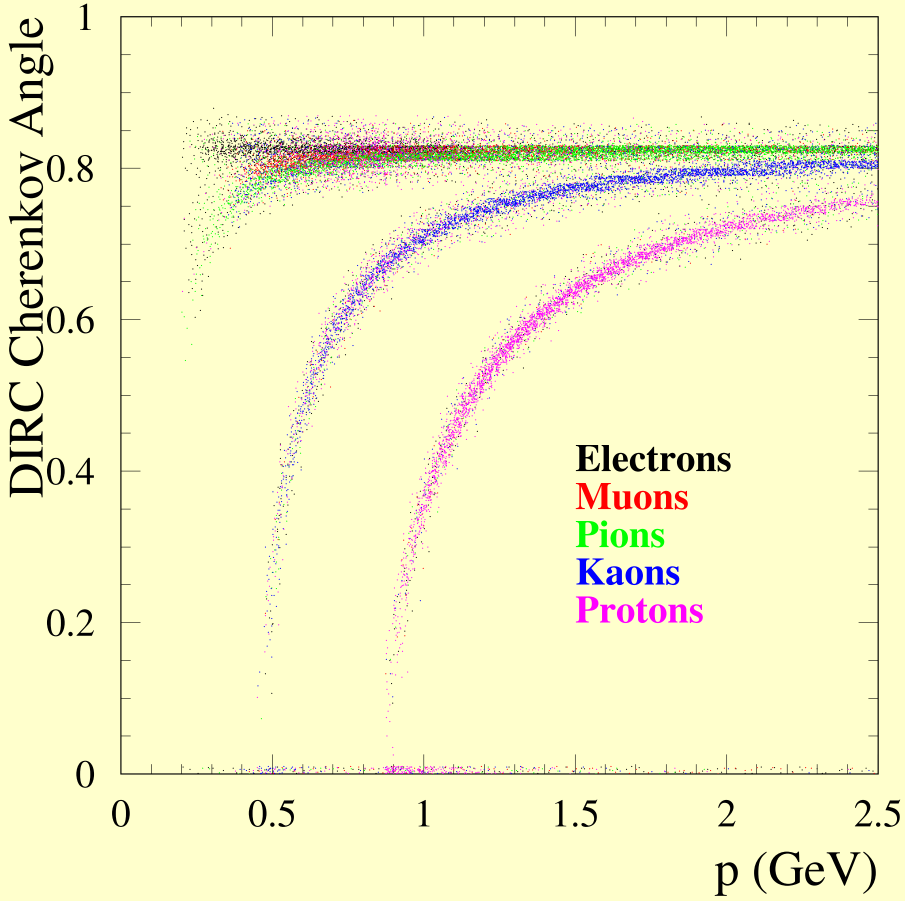
Kaon and pion samples from $D^* \to D^0\pi$ and $D^0 \to K\pi$.
Background in the kaon sample less than 10%

Lambda sample



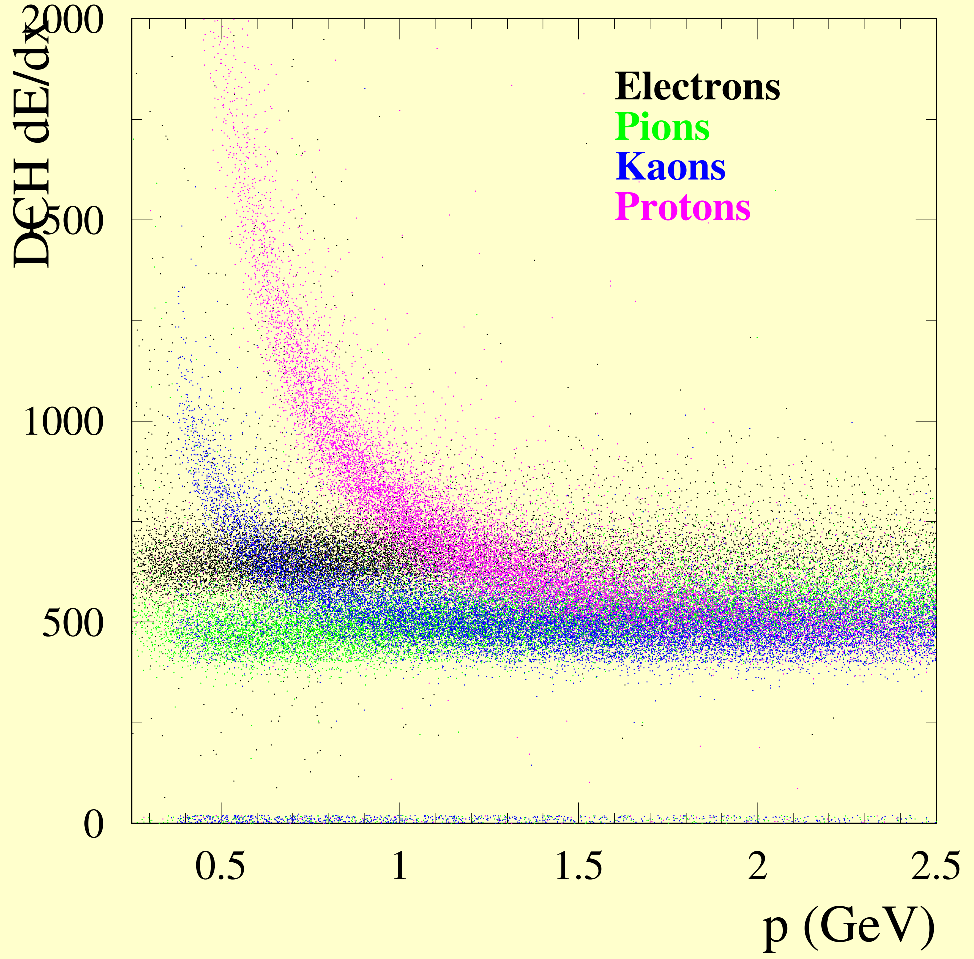
Proton sample from $\Lambda \to p\pi$

DIRC Cherenkov Angle



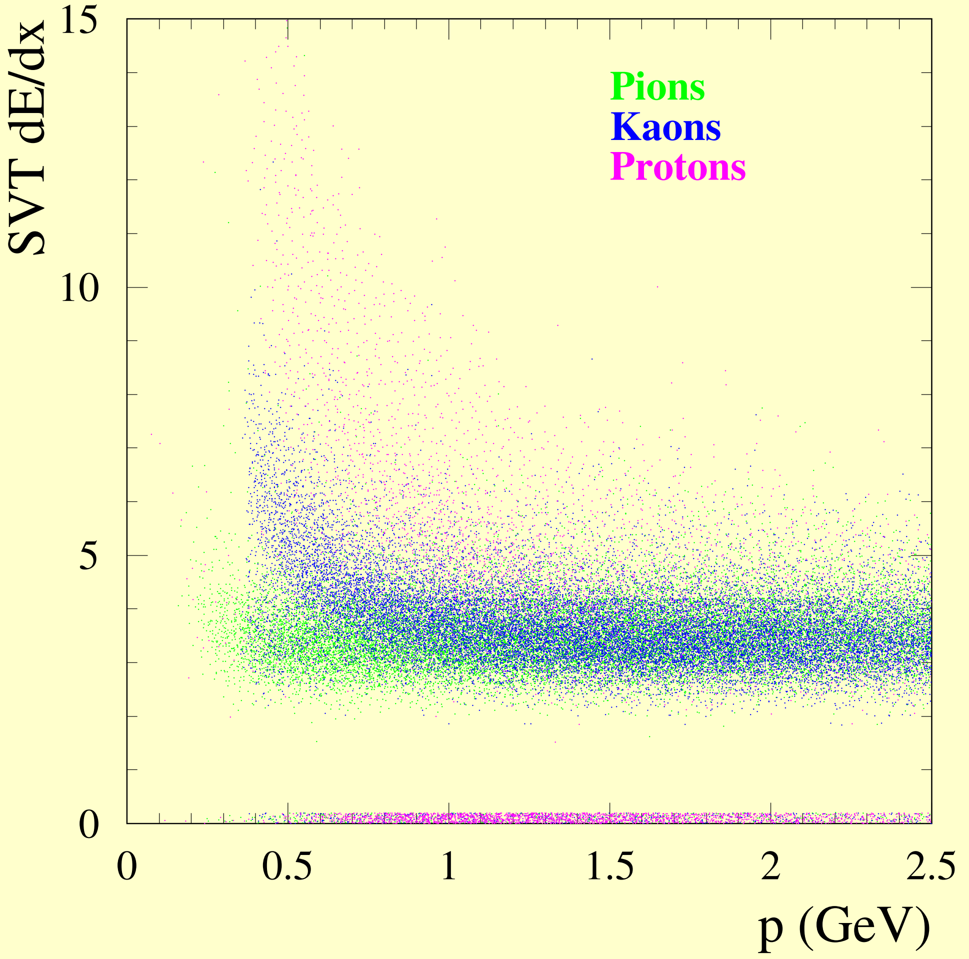
- Global $\mathcal{L}$
- $\mathcal{L} = \text{Gaussian}((\theta_C^{\text{meas}} - \theta_C^{\text{exp}})/\sigma_{\theta_C}) \times \text{Poisson}(N_\gamma^{meas}, N_\gamma^{exp})$
- $\mathcal{L}(\theta_C^{\text{meas}})$ formed from Simulation derived lookup tables binned in momentum, N_γ, and track quality

DCH dE/dx



- $\mathcal{L} = \text{Gaussian}((dE/dx^{\text{meas}} - dE/dx^{\text{exp}})/\sigma_{dE/dx}(p, \theta, n_{dch}))$

$SVT\ dE/dx$



- $\mathcal{L} = \mathrm{BiGaussian}((dE/dx^{\mathrm{meas}} - dE/dx^{\mathrm{exp}})/\sigma_{dE/dx}(p, n_{svt}))$

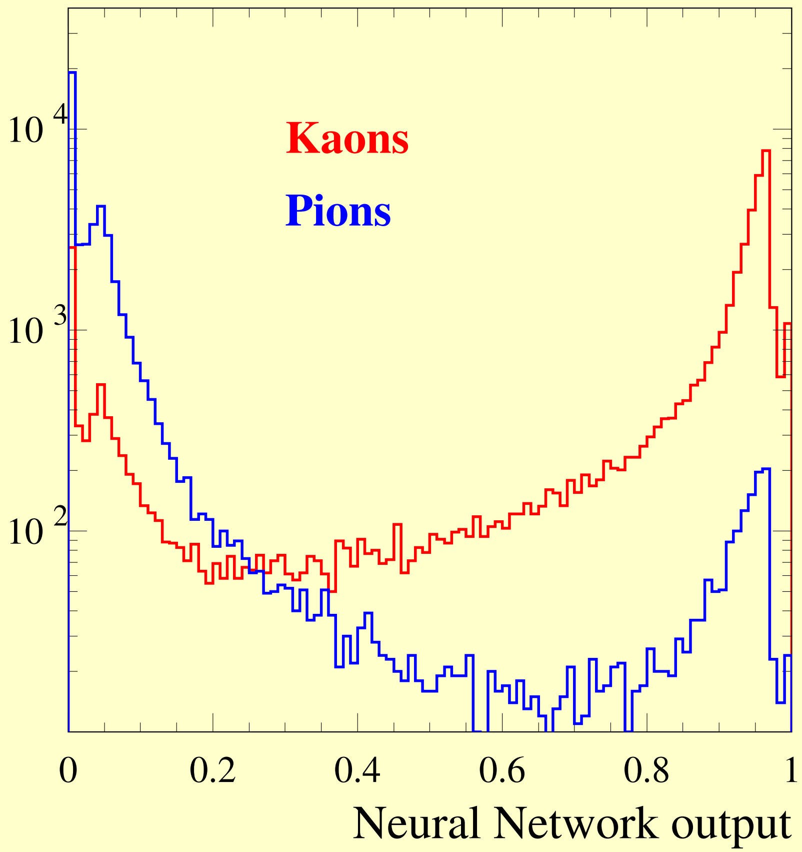
Hadron Id Algorithms

Cut and Likelihood

- $\mathcal{L} = \left\{ \begin{array}{c} \mathcal{L}_{SVT} \\ 1 \end{array} \right\} \times \left\{ \begin{array}{c} \mathcal{L}_{DCH} \\ 1 \end{array} \right\} \times \left\{ \begin{array}{c} \mathcal{L}_{DIRC} \\ 1 \end{array} \right\}$
- each detector's $\mathcal{L}$ is used depending on momentum.
- The DIRC $\mathcal{L}$ is not used in the *veto* region.
- Momentum dependent cuts are applied on the ratio $\mathcal{L}(K)/\mathcal{L}(pi)$

Hadron Id Algorithm

Neural Network



input variables

- $\mathcal{L}_{SVT}(K)/\mathcal{L}_{SVT}(\pi)$
- $\mathcal{L}_{DCH}(K)/\mathcal{L}_{DCH}(\pi)$
- $\mathcal{L}_{DIRC}(K)/\mathcal{L}_{DIRC}(\pi)$

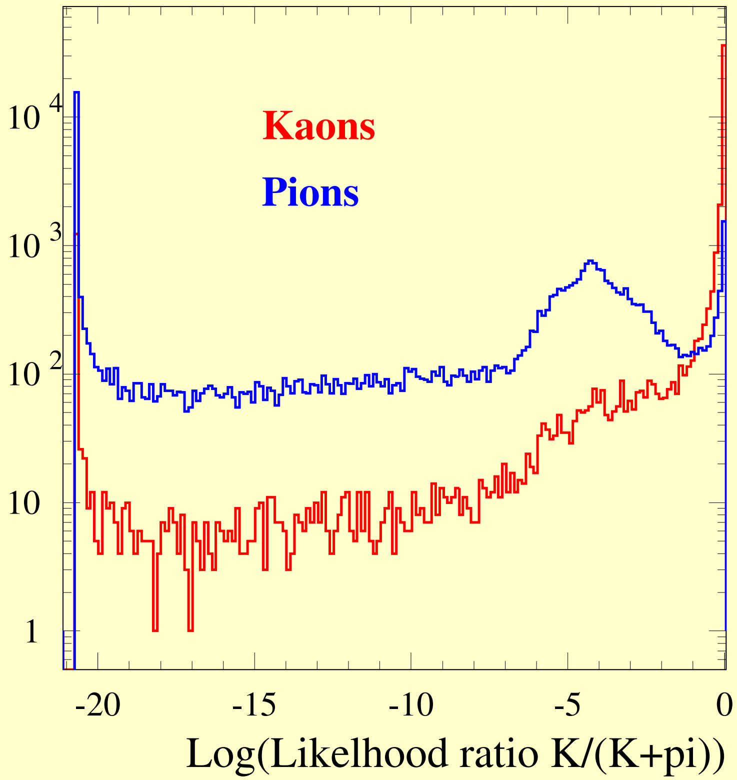
  using Global $\mathcal{L}$

summed over all momentum, background has not been subtracted

Hadron Id Algorithm

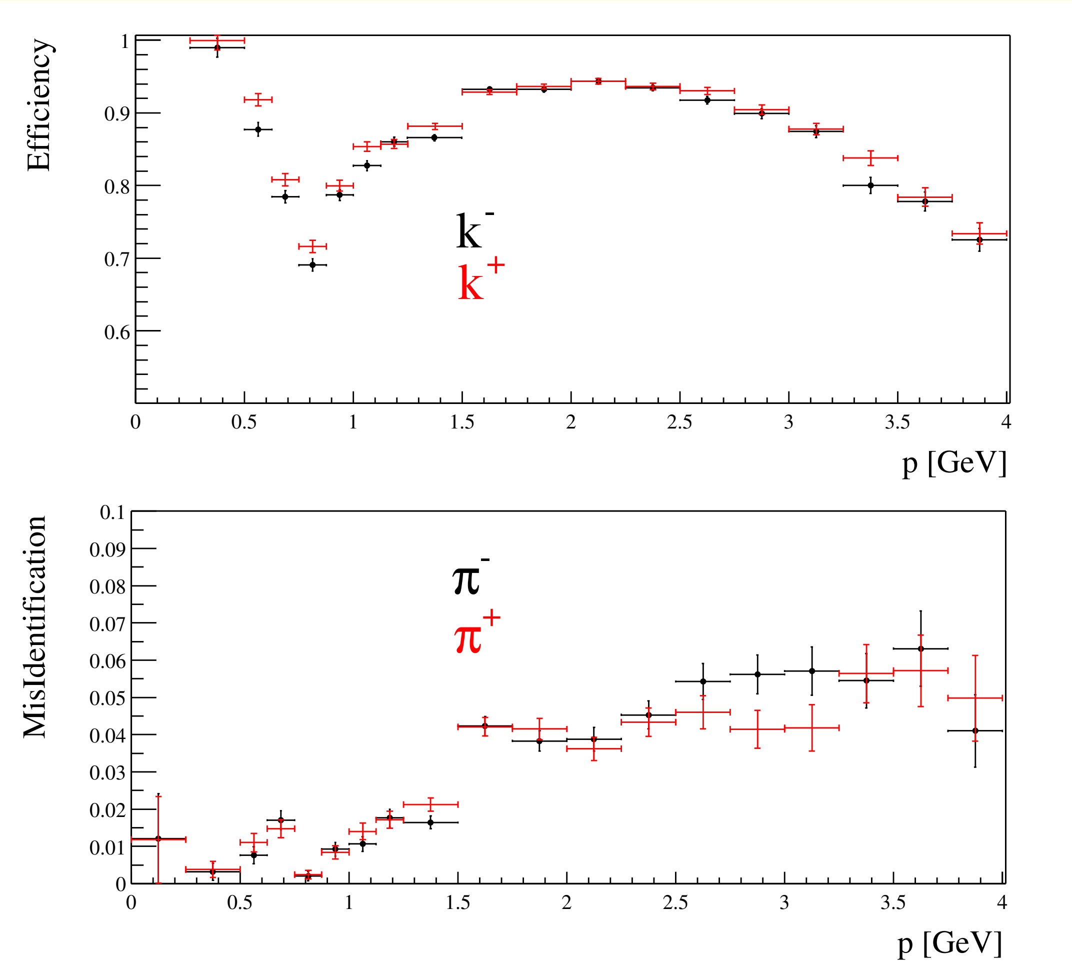
Likelihood

- $\mathcal{L}_{SVT} \times \mathcal{L}_{DCH} \times \mathcal{L}_{DIRC}$
- use look-up based $\mathcal{L}_{DIRC}$
- identify Kaons with $\mathcal{L}(K)/(\mathcal{L}(\pi) + \mathcal{L}(K))$
- identify pions with $\mathcal{L}(K)/(\mathcal{L}(\pi) + \mathcal{L}(K))$
- identify protons with $\mathcal{L}(p)/(\mathcal{L}(p)+\mathcal{L}(K))$ and $\mathcal{L}(p)/(\mathcal{L}(p) + \mathcal{L}(\pi))$



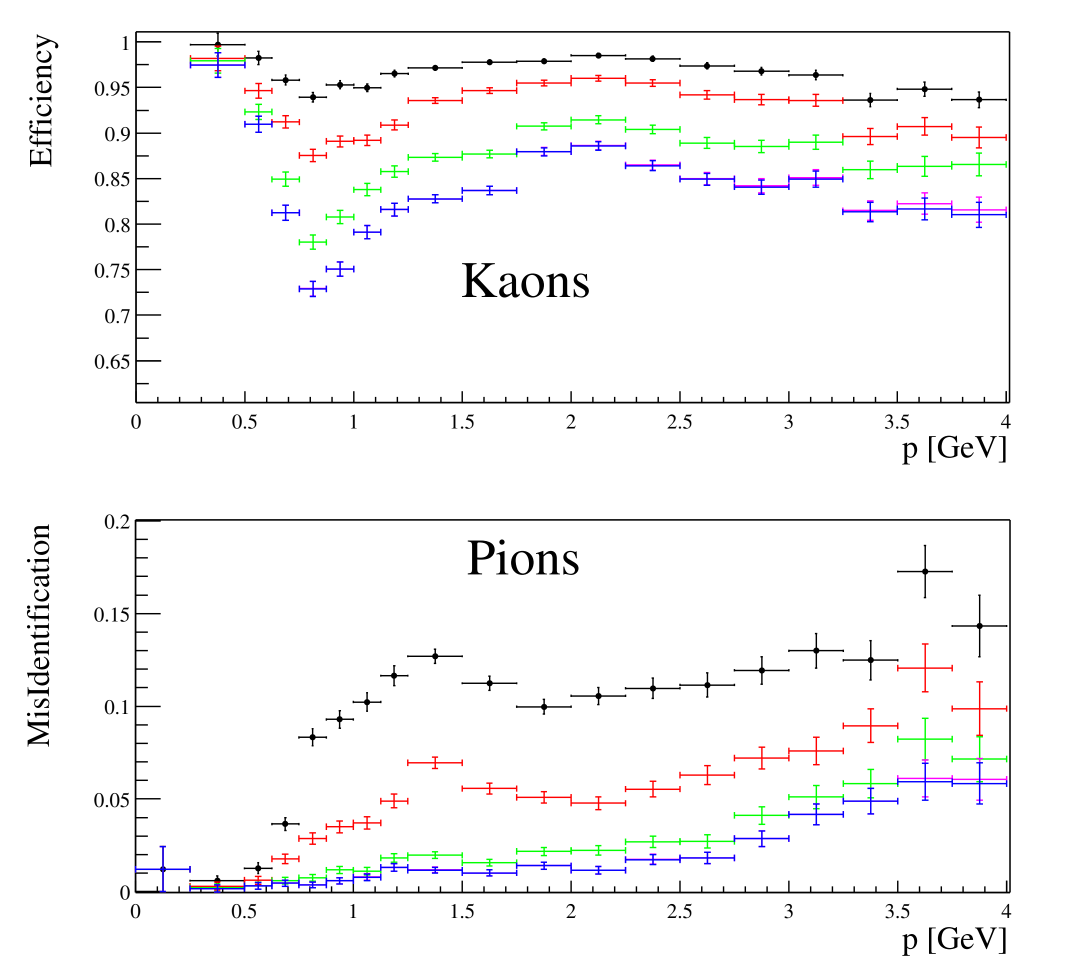
summed over all momentum, background has not been subtracted

Kaon Efficiency and MisIdentification



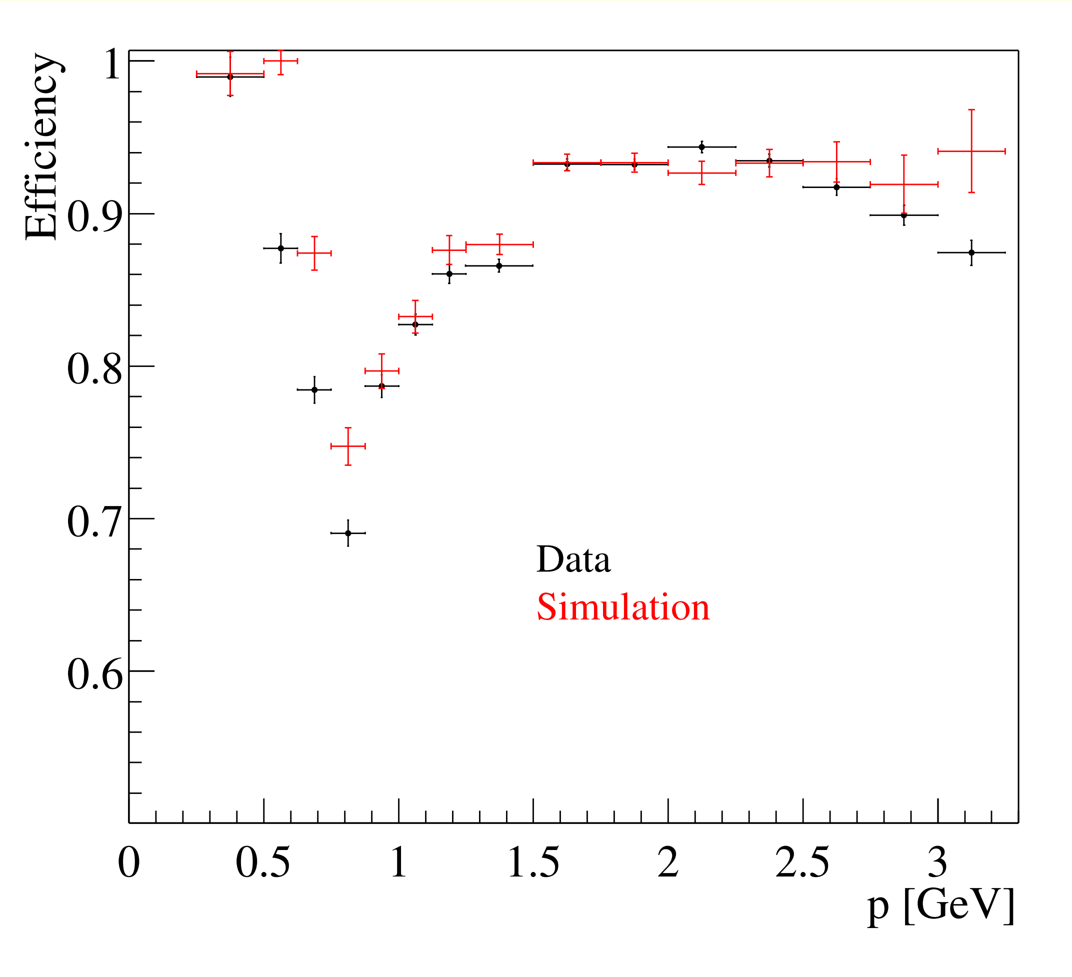
Charge asymmetry relevant for $B^0 \to K^{\pm}\pi^{\mp}$and $B \to K^*\gamma$ direct CP violation measurements.

Kaon Efficiency and MisIdentification



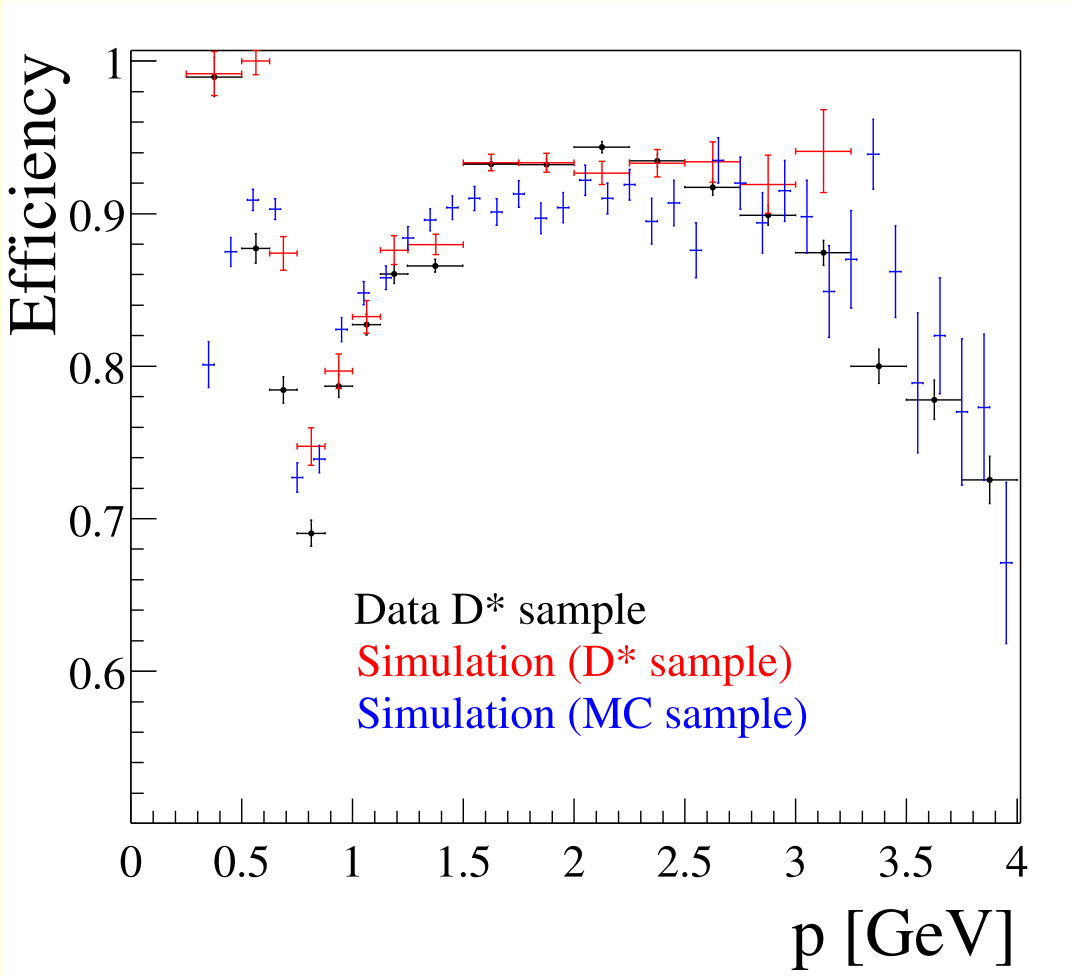
Trade-off between efficiency and mis-identification for the Likelihood kaon selector.

Kaon Efficiency Data vs. Simulation



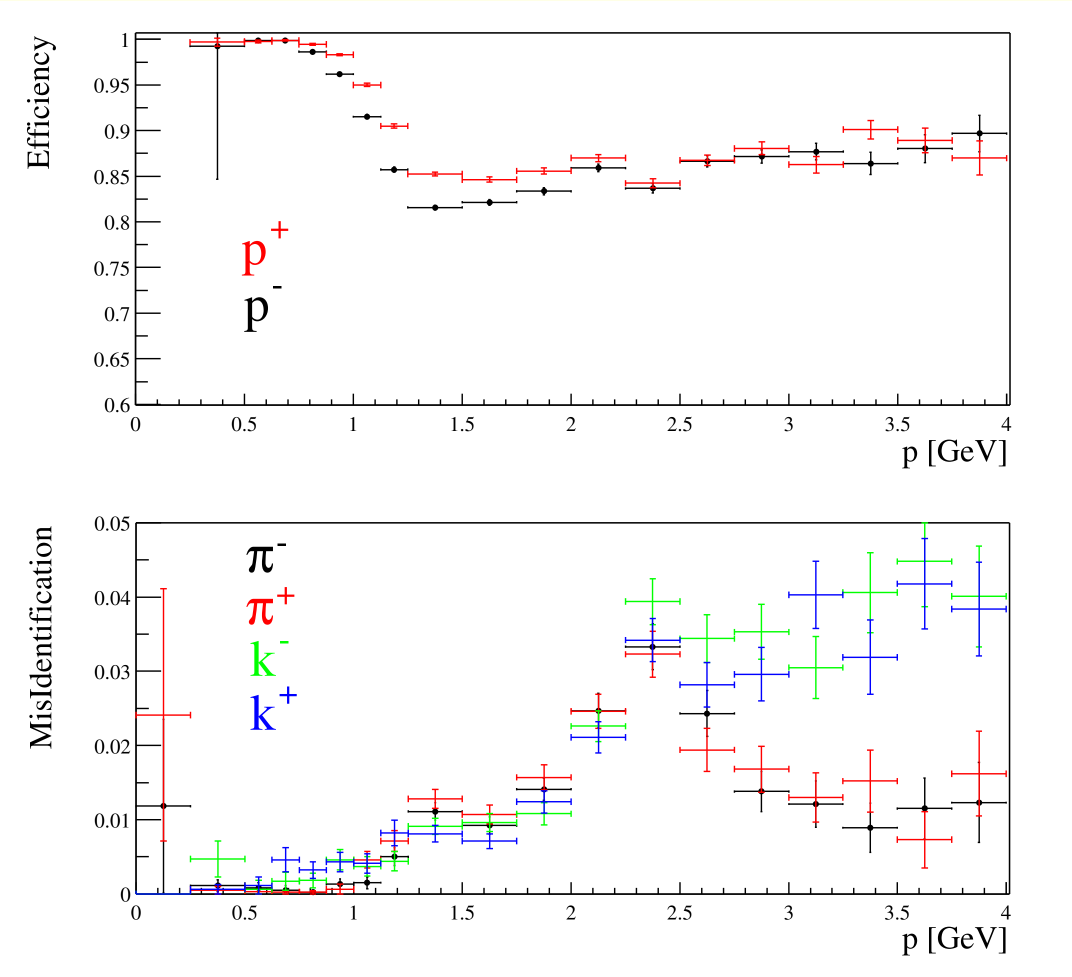
good agreement between data and simulation above the DIRC threshold.

Kaon Efficiency Data vs. Simulation



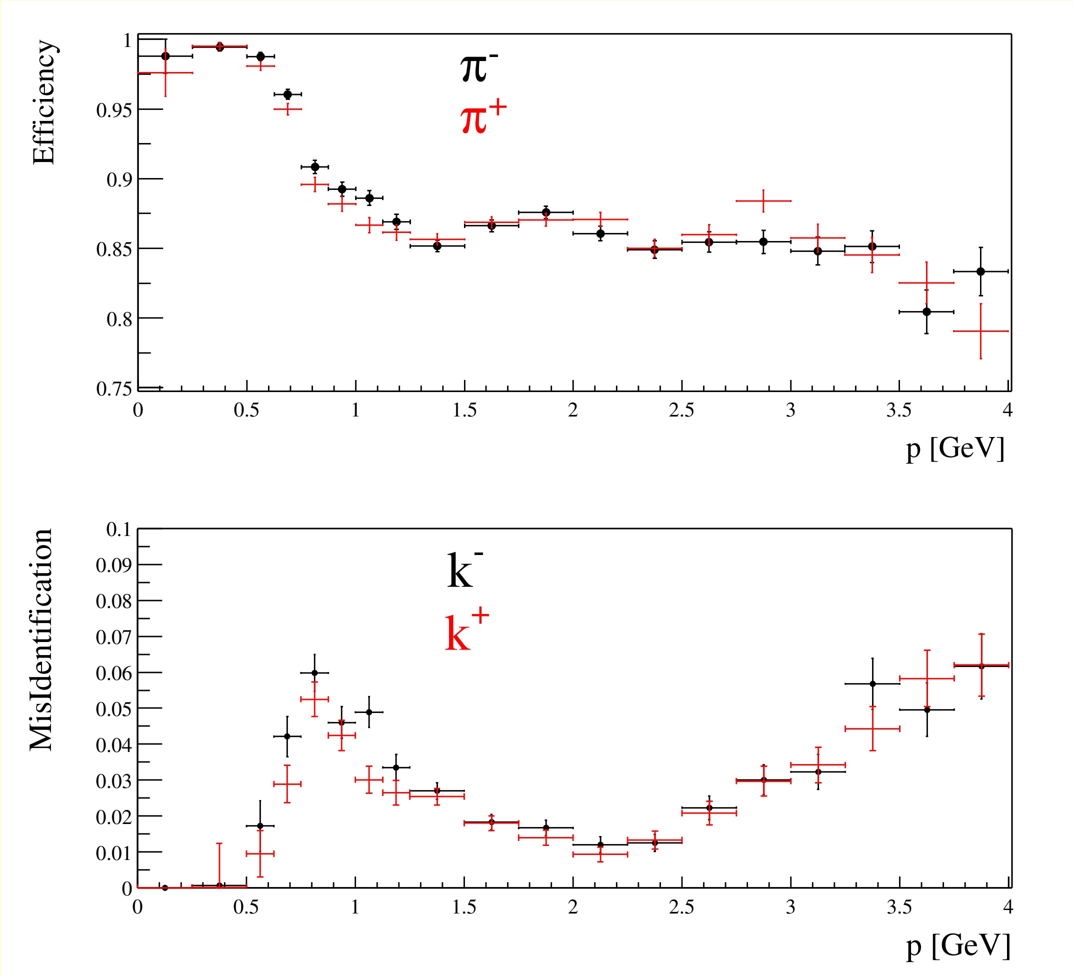
simulation shows a shift in the efficiency between Kaons which are reconstructed from D^* decays and all Kaons. Issue for low momentum kaons only.

Proton Identification



Likelihood based Proton selection

Pion Identification



lower Kaon misidentification can be achieved with addition cuts

Conclusions

- DIRC and dE/dx provide excellent hadronic identification at all momentum
- kaon identification at high momentum is well understood with little charge asymmetry
- kaon identification at low momentum is quite good, but small systematic uncertainty and a small charge asymmetry are present