Expectation of Charge-Parity and Forward-Backward Asymmety Measurements in the Decay $D \rightarrow \varphi\pi^{\pm} \rightarrow K^{+}K^{-}\pi^{\pm}$ at CDF

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Outline

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- Simulation and Analysis
- KK Mass and Impact Parameter Fits
- KKπ Mass Fits

Introduction

We plan to measure the Charge-Parity (CP) and Forward-Backward (FB) asymmetries in $D \to \varphi\pi^{\pm} \to K^{+}K^{-}\pi^{\pm}$.

This should be small, so a significantly large asymmetry could be a sign of new physics.

We look at the difference between asymmetries for D and D_s to remove bias that would affect both.

Calculation of A_{CP} and A_{FB}

$$A_{\rm CP} = \frac{1}{2}\left(\frac{N(D^+_{y>0}) - N(D^-_{y>0})}{N(D^+_{y>0}) + N(D^-_{y>0})} + \frac{N(D^+_{y<0}) - N(D^-_{y<0})}{N(D^+_{y<0}) + N(D^-_{y<0})}\right)$$

$$A_{\rm FB} = \frac{1}{2}\left(\frac{N(D^+_{y>0}) - N(D^-_{y>0})}{N(D^+_{y>0}) + N(D^-_{y>0})} - \frac{N(D^+_{y<0}) - N(D^-_{y<0})}{N(D^+_{y<0}) + N(D^-_{y<0})}\right)$$

$$\Delta A_{\rm CP} = A_{\rm CP}(D) - A_{\rm CP}(D_s)$$

$$\Delta A_{\rm FB} = A_{\rm FB}(D) - A_{\rm FB}(D_s)$$

Simulation

We simulated D and D_s decays to check our analysis strategy

These decays are run through a detector and trigger simulation

This simulates the two track triggers used in data for these decay modes

We apply selection to remove background while minimizing signal loss

Remaining events are divided in bins of charge and rapidity necessary to calculate A_{CP} and A_{FB}, and bins of KKπ mass for fitting

We use fits to reduce background and determine the numbers of D and D_s

Fitting

To reduce background we fit the KK mass spectrum

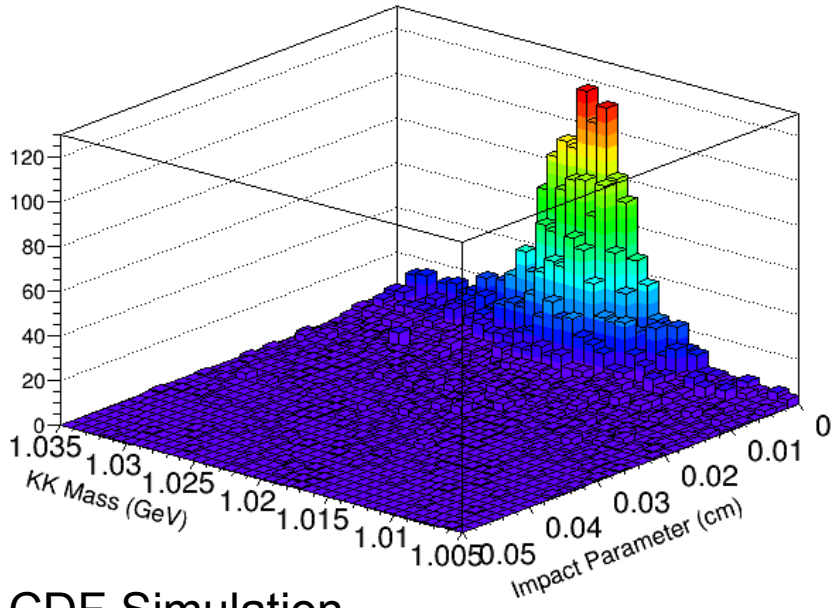
To remove D's that come from B decays we fit for prompt decays in impact parameter

These are combined into a 2-D fit in each bin of KKπ mass.

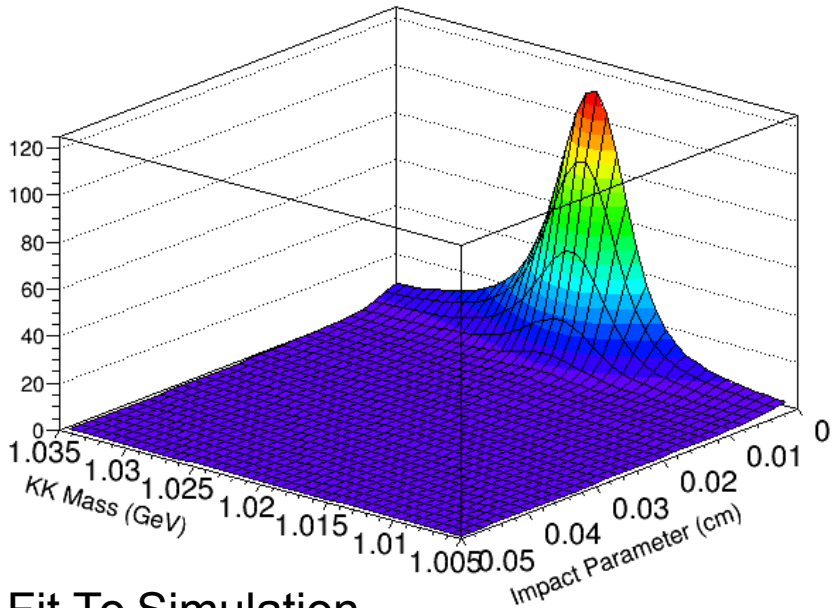
The number of prompt signal events are used to create the final KKπ mass historgams.

2D Fits

An example histogram of KK mass and impact parameter on the left and the corresponding model used to fit on the right



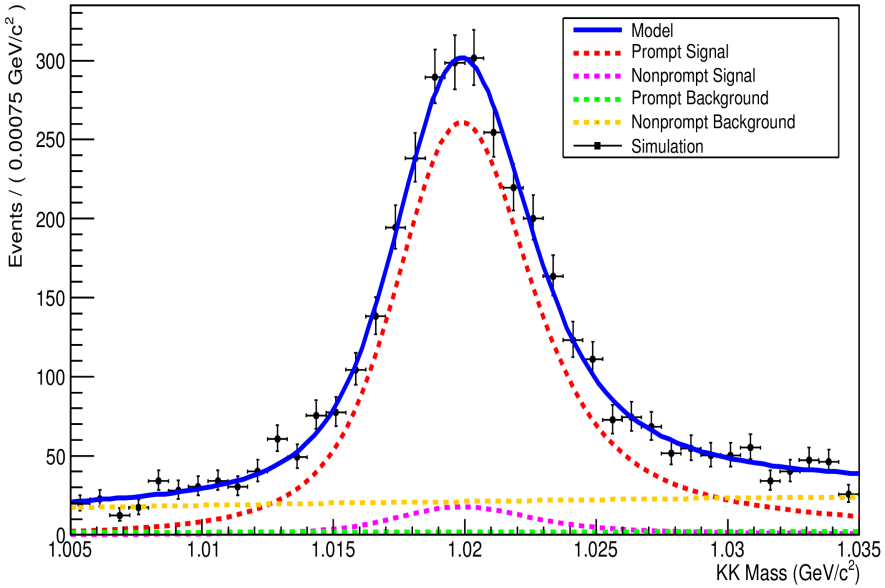
CDF Simulation



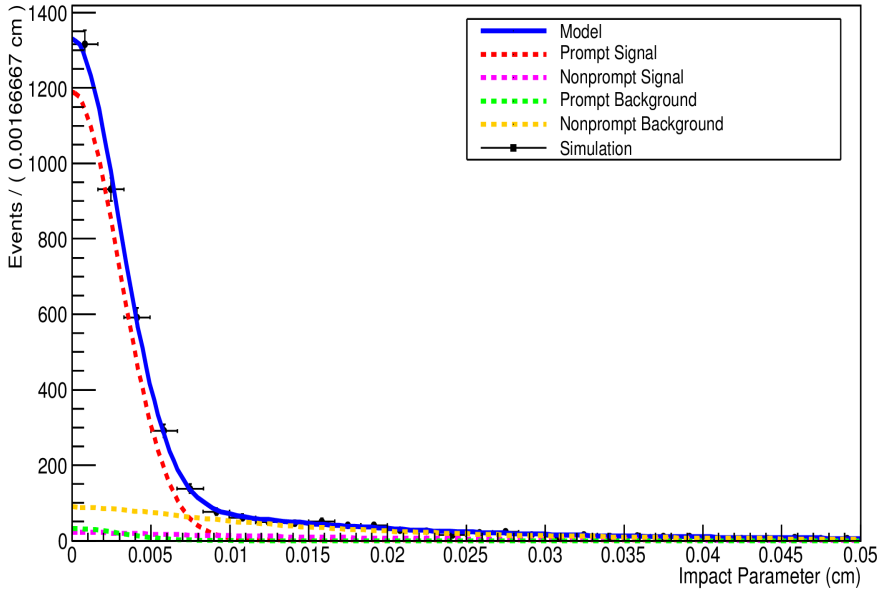
Fit To Simulation

2D Fits

Projections of the previous fit on the KK mass axis (left) and impact parameter axis (right)



CDF Simulation

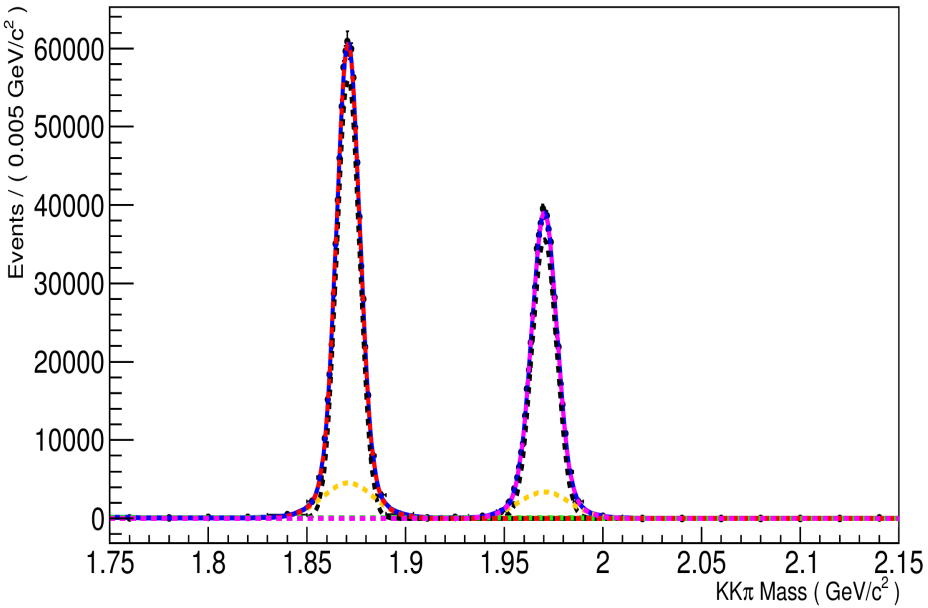


CDF Simulation

KKπ Mass Fits

We fit each KKπ mass histogram to determine the number of D and D_s in each bin of charge and rapidity

The results of these fits are used to calculate A_{CP} and A_{FB} for D and D_s as well as the difference between them



CDF Simulation

Summary

- We are going to measure A_{CP} and A_{FB} in $D \rightarrow \varphi\pi^{\pm} \rightarrow K^{+}K^{-}\pi^{\pm}$
- We will get data using a two track trigger
- The data will be divided as necessary for fitting and calculation
- We fit to reduce background and determine the number of D and D_s
- We use these numbers to calculate the asymmetries
- We have an expected sensitivity of 0.3%

Backup

KK Mass Fits

KK mass signal is fit by a relativistic Breit-Wigner convoluted with a Gaussian

$$BW(x, m, \Gamma) \otimes G(x, m, \sigma)$$

KK mass background is fit by an Argus function

$$A(M, p) = \frac{x}{M}\left(\left(\frac{x^2}{M^2} - 1\right)^p\right)$$

Impact Parameter Fits

Prompt decays are fit by a Gaussian in impact parameter centered at 0

$$G(x, 0, \sigma)$$

Non-prompt decays are fit by an exponential convoluted with a Gaussian

$$e^{-x/\tau} \otimes G(x, 0, \sigma)$$