IFR PHYSICS GROUP REPORT

\[ D_s \to \mu \nu \]

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Overview

Search for Ds decays into muon and muon neutrino. Muon is the core of this analysis. High muon efficiency and low hadron fake rates are very much relevant.

In this short talk, we will show a set of standard plots suggested by Jeff in his email announcement.

This is a very first look at the IFR features of muon selected after essentially the full set of cuts for the original analysis. Everything is highly preliminary.

Datasets and Cuts

This is a Monte Carlo study. Roughly 1.3 fb\(^{-1}\) of SP4 MC are processed for this study. (now more than 10 fb\(^{-1}\) of MC have been processed. Unfortunatley, due to time constraint they are not analyzed yet for this talk).

We will focus on \(uds\) and \(c\bar{c}\) background only. (\(b\bar{b}\) and \(\tau\bar{\tau}\) events are very much irrelevant for the on-peak analysis). Almost all cuts for this analysis are applied. The most signal-inefficient cut, \(p > 2.4\) GeV/c in CM, is applied to remove nearly all \(b\bar{b}\) background. Photons are required to be at least 150 MeV. Muon candidates are required to be muMicroVeryTight. Detailed kinematic cuts are described in BAD 398.
Muon Momentum P and PT

Muon lab momentum.

Muon pT.
Muon P vs Cos$\theta$

Muon p vs cos in lab.
Muon $p$ in bins of $\cos \theta$ in the lab.
Measured Interaction Lengths

Interaction lengths for real, pion fake, and kaon fake muons, respectively. The spectrum peaks near $\lambda \sim 5$ for real muons, and peaks at lower values for hadron fakes.
Interaction Lengths (Measured - Expected)

Measured $\lambda$ - expected $\lambda$, for real muons, pion fakes, and kaon fakes. Adding absorbers to the IFR will reduce the hadron punchthrough peak at near 0 and therefore reduce hadron fake rates.
measured $\lambda$ vs $\cos\theta$ for real muons and pion fakes.
measured $\lambda$ vs $p$ for real muons and pion fakes. Hadron fakes have a similar momentum do not traverse as many IL as real muons. Adding more absorbers to the IFR will provide more discrimination between real muons and hadron fakes.
Cumulative Spectra for Measured Interaction Lengths

Cumulative interaction lengths for real muons and pion fakes. If we require $\lambda > 5$, we can see directly from the plots that the muon efficiency loss would be around 50%, and the pion-fake rate would drop by about 80%. Again, we see that fake muons do not traverse as many IL as real muons do.
\( \Delta M \) distributions for all muons.
$\Delta M$ distributions for real muons, inflight decays, tau decays, semileptonic D decays, and pion and kaon fakes.
Summary

We have taken a first look at the IFR-related features of muons using the Ds2munu analysis. (To remove bb background a $p > 2.4$ (CM) cut is applied, which is a default cut for the on-peak analysis.)

Among these plots, the cumulative spectra of interaction lengths for real and fake muons are most interesting because the effect of interaction length cut on signal efficiency and fake rates can be read out directly from the plots. For example, if we require $\lambda > 5$, muon efficiency loss would be around 50%, and the pion-fake rate would drop by about 80%.

Next step would be to relax the momentum cut and look at how the cumulative interaction length spectra for real muon and fake muon change. This will benefit the off-peak analysis, for which the hard momentum cut is not necessary.