Measurement of the B^- and $\bar{B}^0$ Meson Lifetimes Using Semileptonic Decays with Single Lepton Datasets in CDF Run II

(CDF 7458)

Feb-24 2005 @ B meeting
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— Blessing (continuation) —

Questions from last week:

1. **χ^2 constraints to measure the sample composition**
2. **Why do the $p_T(\mu^- D^0)$ distributions disagree between the data and MC?**
   And is the $p_T(B)$ spectrum tuning with the B monte carlo right?
3. **Why are the systematics from resolution scale factor different betwee B^- and $\bar{B}^0$?**
4. **Give the fit probabilities for all the plots.**
5. **Make the ct^* plots with wider lifetime window (-0.15 $\sim$ 0.5 cm)**

Issue 1

Issue : Use a chi2 constraint term to measure the systematics such as the sample composition.

Current answer : Currently we do not have a fitter framework that includes the sample composition parameters as fit parameters. To make such framework will take some time, and so far we have not been able to work on it.

Issue 1 (cont'd)

But there are some comments from Fumi:

This point was studied in the past, namely in Run I, and documented in CDF 3009.

The f^{**}, P_V and pion efficiency with uncertainties are added as chi-2 terms to the log-likelihood, then I re-did the lifetime fit.

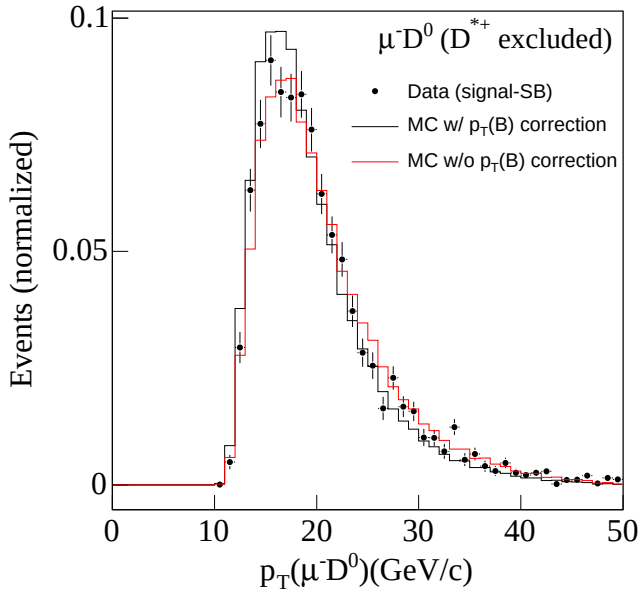
1. **At the conversion point of the fit, the central values or the uncertainties of the above parameters did not change from the initial values. That means there is no information in the data that allows the sample mixture (B^- vs $\bar{B}^0$). Those are the parameters you need to know beforehand.**

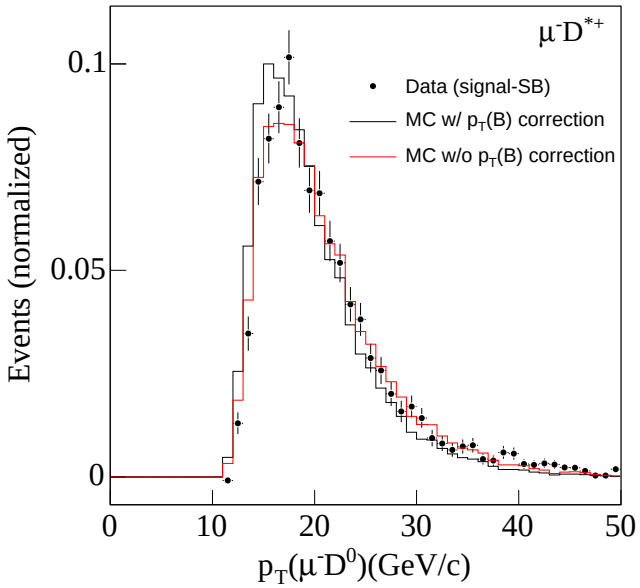
2. **The statistical uncertainties in the lifetimes changed by the same amount estimated by fixing these parameters, changed to another value corresponding to the uncertainties above. That means you are just trading statistical and systematic uncertainties; the total stays the same. But from a point of view of the principles, I am against making them fit parameters, as I stated during the meeting last week.**

Although we have not repeated this study in Run-II data, I am pretty sure that we will reproduce the same results.

Issue 2

Issue 2: Why do the $p_T(\mu^- D^0)$ distributions disagree between the data and MC?
And does the $p_T(B)$ spectrum tuning with the B monte carlo look resonable?





A : MC distributions were not quite complete.

Issue 2 (cont'd)

We examine following facts for the comparison:

Item 1 - slow pion reconstruction efficiency

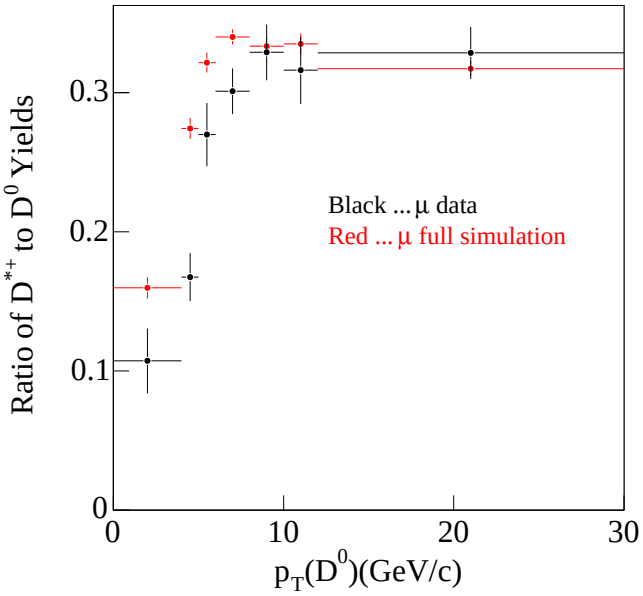
The full-simulation overestimates the π_s reconstruction efficiency than the real data.(left plot) We tune the full simulation sample to have the similar π_s reco. efficiency with the data.

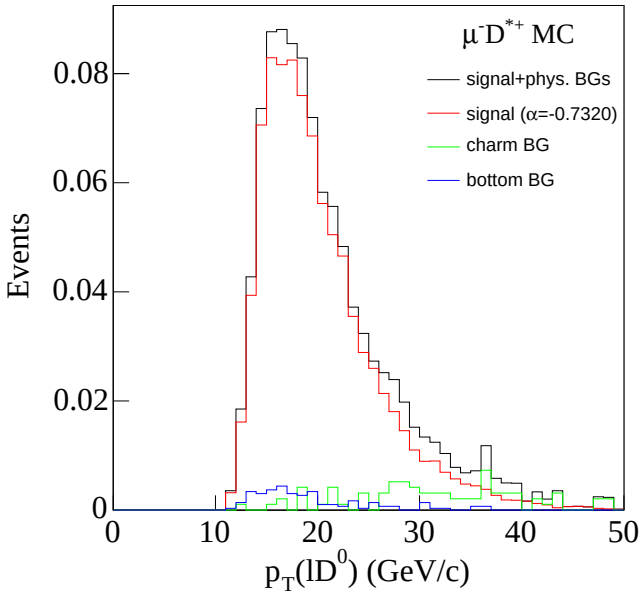
Item 2 - Adding physics background components

We obtained the $p_T(\ell^- D^0)$ distributions for charm and bottom BGs, and add them to the signal MC with proper fraction.(right plot)

Item 3 - XFT trigger turn-on effect

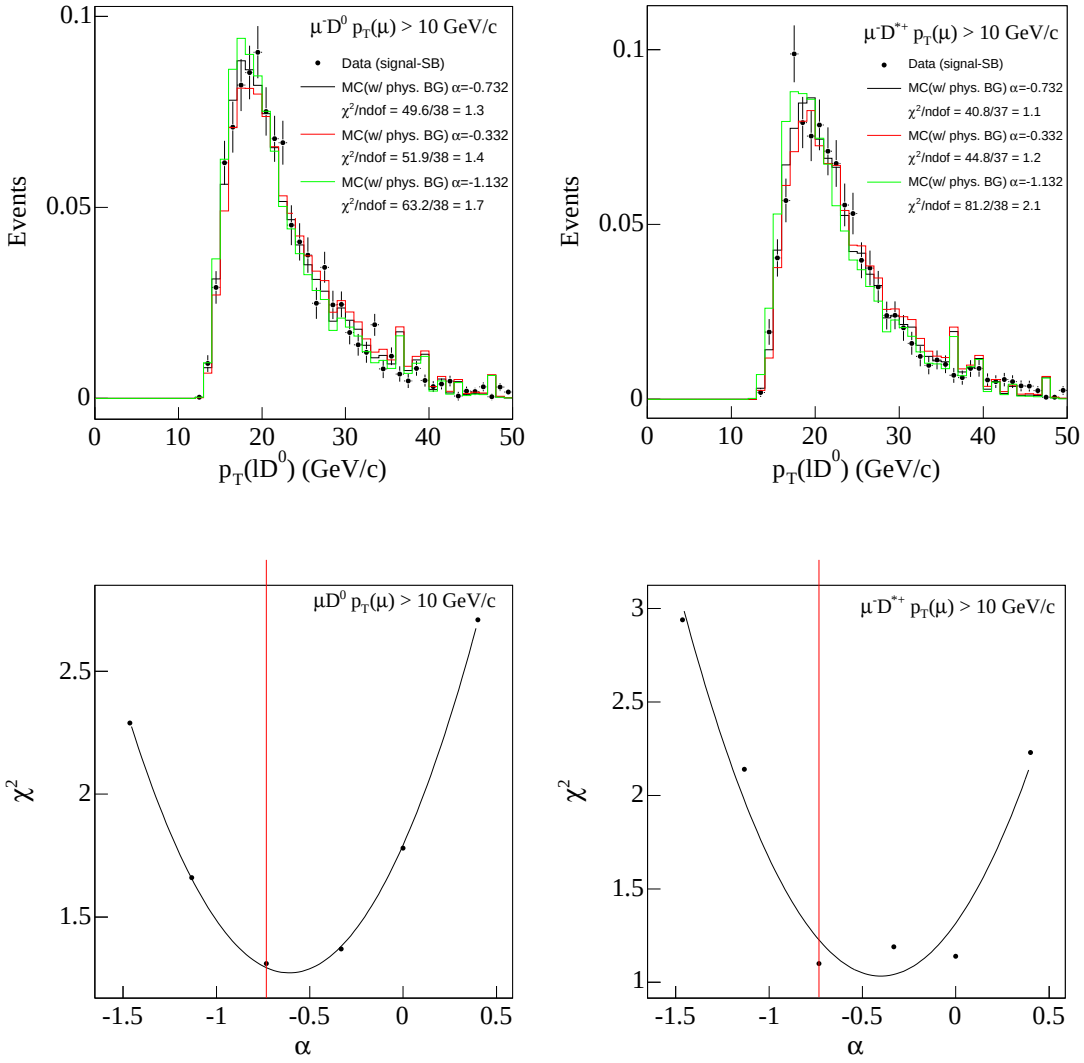
We examine $p_T(\mu) > 10$ GeV/c cut to avoid the trigger turn-on effect.





Issue 2 (cont'd)

Updated comparisons of the $p_T(\mu^- D^0)$ between the data and MC: (under $p_T(\mu) > 10$ GeV/c cut)



Now the data and MC show the good match, and the MC with $\alpha = -0.732$ show the best agreement.
From this result we think that the measured value of α (=-0.7320) is reasonable, and range of $\alpha = -0.7320 \pm 0.4$ would be reasonable for the systematics evaluation.

Issue 3

Issue 3: Why are the systematics from resolution scale factor different between B^- and $\bar{B}^0$?

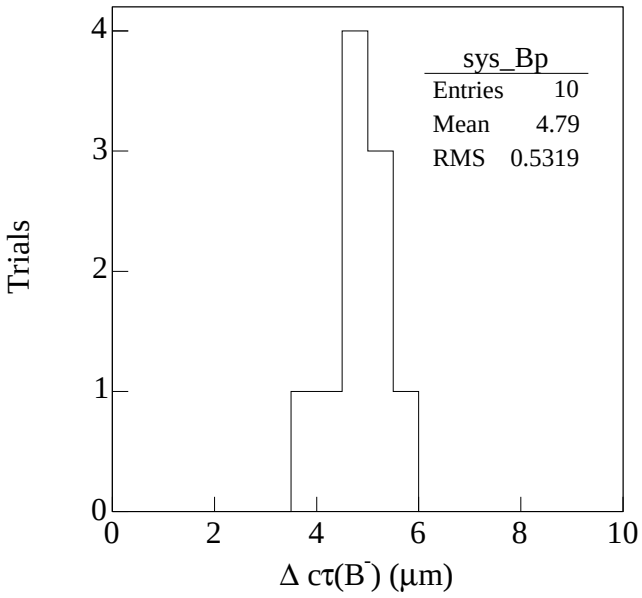
Current answer : We have not yet find any sole answer for this question. But there is a simple toy MC study we have done to investigate the effect:

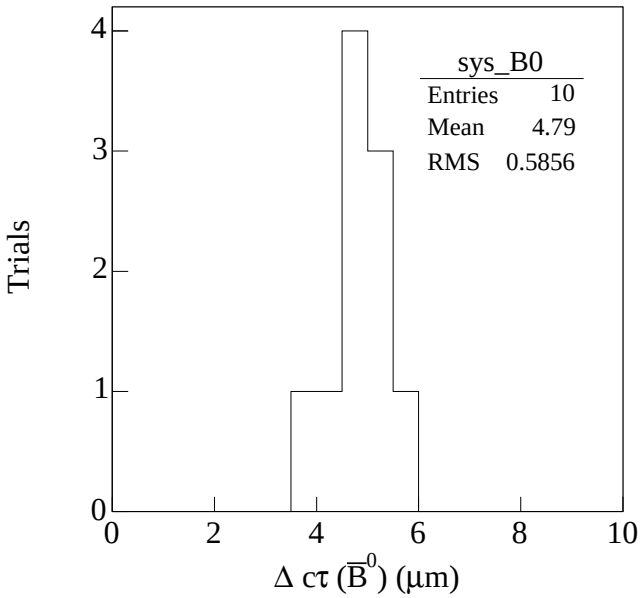
Issue 3 (cont'd)

Shift in the lifetimes in real data, when the scale factor is changed from 1.52 to 1.:
$\Delta c\tau(B^-) = 9.5$ μm, $\Delta c\tau(\bar{B}^0) = 5.3$ μm

We examine the same thing with toy MC sample.

- **Generate toy MC with scale factor 1.5**
- **Fit the toy MC sample with scale factor 1.5 and 1, and plot the shift of the lifetimes.**
- **10 trials examined**





Toy MC reproduces the shift seen in $c\tau(\bar{B}^0)$, but not $c\tau(B^-)$.
Reason unknown.

Issue 4

Issue : Give the fit probabilities for all the plots.

A : We've update the plots in the cdfnote, but tne new version is not posted yet. Since I have two additional plots ask to bless today (shown later), I will post the new version of the cdfnote with all the updates immediately after the blessing.

Issue 5

Issue : Make the ct^* plots with wider lifetime window (-0.15 $\sim$ 0.5 cm)

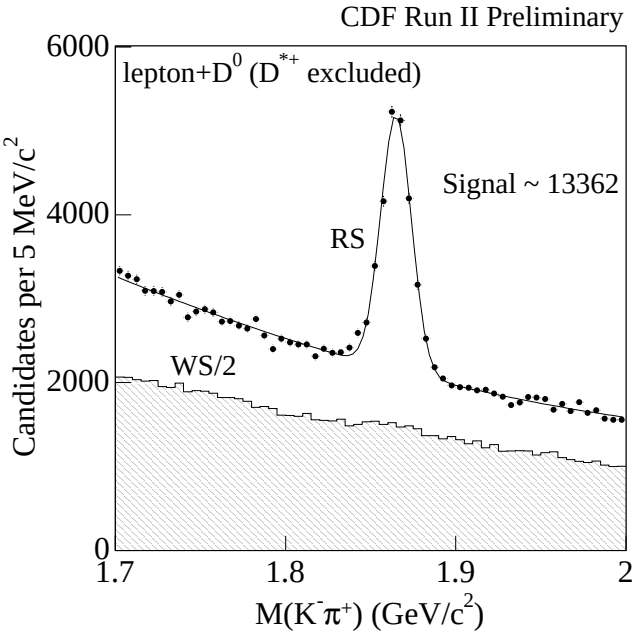
A : I will not show them here, but the plots are on the web page,
http://hep-www.px.tsukuba.ac.jp/ satoru/cdf/widerplots/

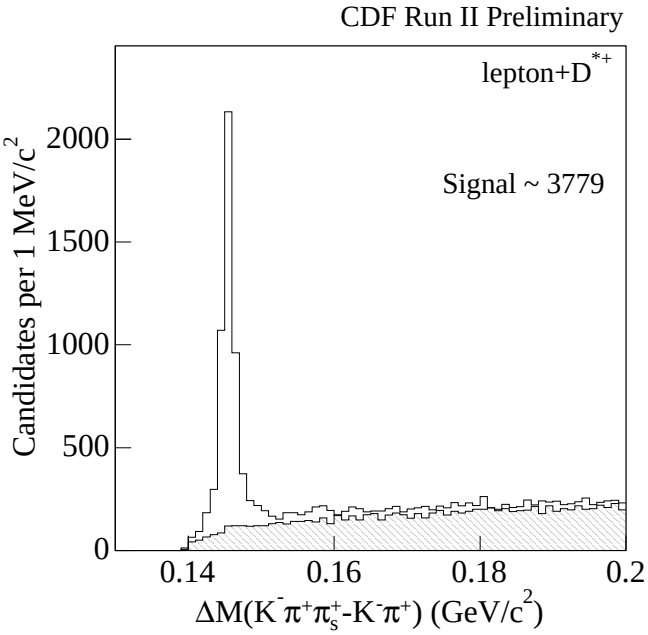
Systematic uncertainties (red ones to bless)

Source	Contribution to		
	$c\tau(B^-)$ (μm)	$c\tau(\bar{B}^0)$ (μm)	$\tau(B^-)/\tau(\bar{B}^0)$
Charm background			
Charm BG fraction (f_c)	$^{+3.7}_{-1.9}$	$^{+5.7}_{-3.7}$	$^{+0.006}_{-0.007}$
Charm BG shape ($\mathcal{F}_c$)	± 2.6	± 5.2	± 0.007
Bottom background			
Bottom BG fraction (f_b)	$^{+0.3}_{-0.9}$	$^{+0.7}_{-1.5}$	$^{+0.001}_{-0.002}$
Bottom BG shape ($\mathcal{F}_b$)	± 2.6	± 1.4	± 0.002
Sample composition (B^- vs $\bar{B}^0$)			
D^{**} fraction (f^{**})	$^{+2.5}_{-0.6}$	$^{+6.5}_{-10.1}$	$^{+0.032}_{-0.018}$
D^{**} composition (P_V)	$^{+0.7}_{-1.4}$	$^{+11.0}_{-8.6}$	$^{+0.023}_{-0.031}$
π_s^+ reconstruction	$^{+0.1}_{-0.6}$	$^{+0.8}_{-0.0}$	$^{+0.000}_{-0.004}$
K factor			
$p_T(B)$ spectrum	± 6.1	± 5.3	-
(new)	± 3.3	± 2.9	-
B decay model	± 1.0	± 1.3	-
Electron cuts	± 2.0	± 1.4	-
Signal fraction ($f_{\rm sig}$)	± 2.4	± 0.9	± 0.003
Resolution scale factor	± 9.5	± 5.3	± 0.008
(new)	± 3.6	± 1.9	± 0.003
Decay length cut	$^{+0.0}_{-1.8}$	$^{+0.0}_{-2.2}$	$^{+0.001}_{-0.000}$
Combinatorial BG shape	± 0.7	± 0.1	± 0.002
Detector alignment	± 2.0	± 2.0	-
Total	$^{+13.3}_{-12.8}$	$^{+17.0}_{-17.0}$	$^{+0.041}_{-0.039}$
(new)	$^{+8.6}_{-7.8}$	$^{+15.7}_{-15.7}$	$^{+0.041}_{-0.039}$

Two additional plots to bless

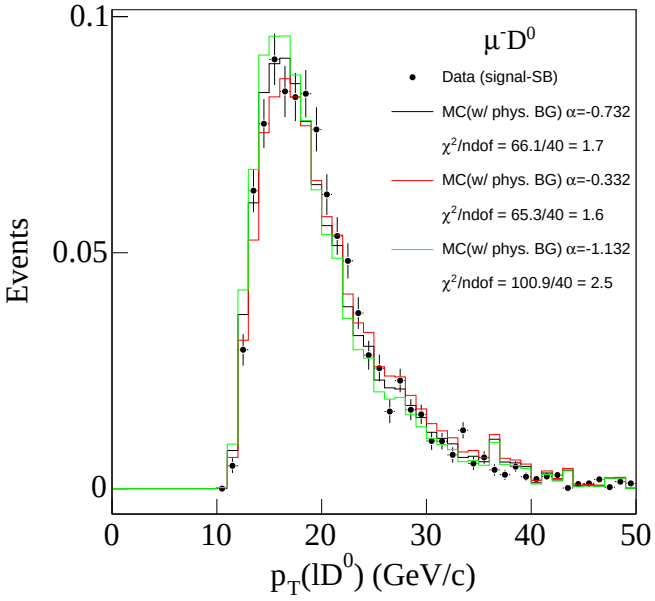
D^0 and D^{*+} mass plots for μ, e combined sample:

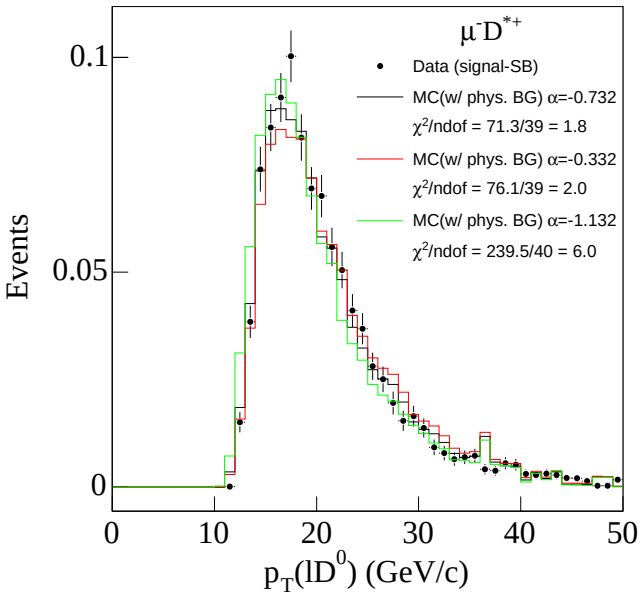


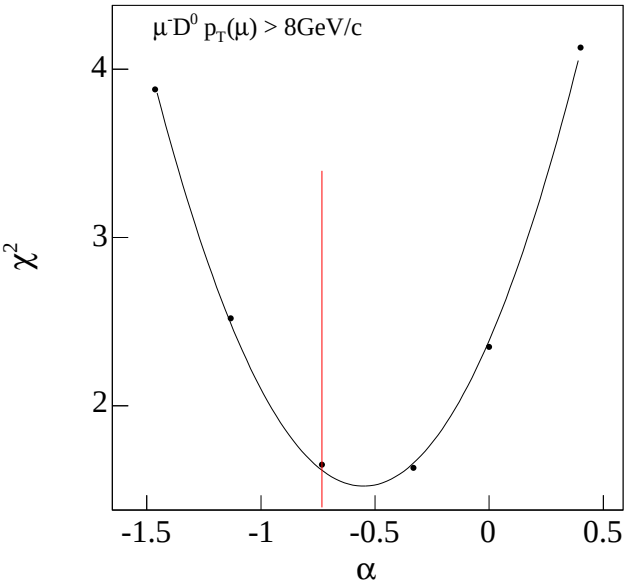


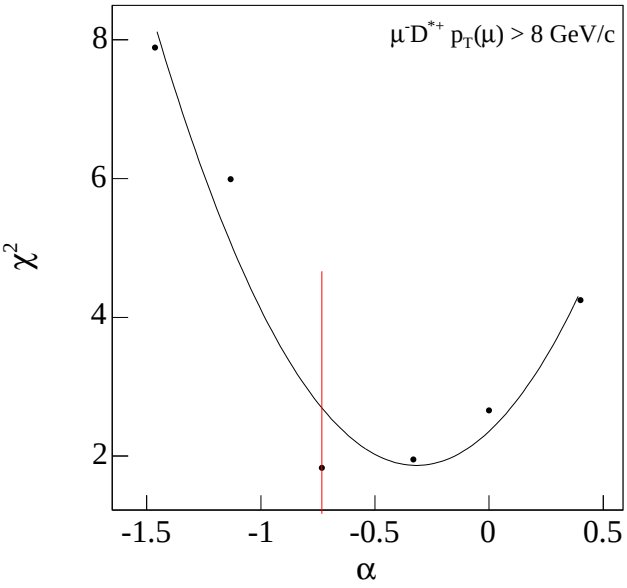
Backup slides

$p_T(\mu^- D^0)$ comparison with $p_T(\mu) > 8$ GeV/c cut



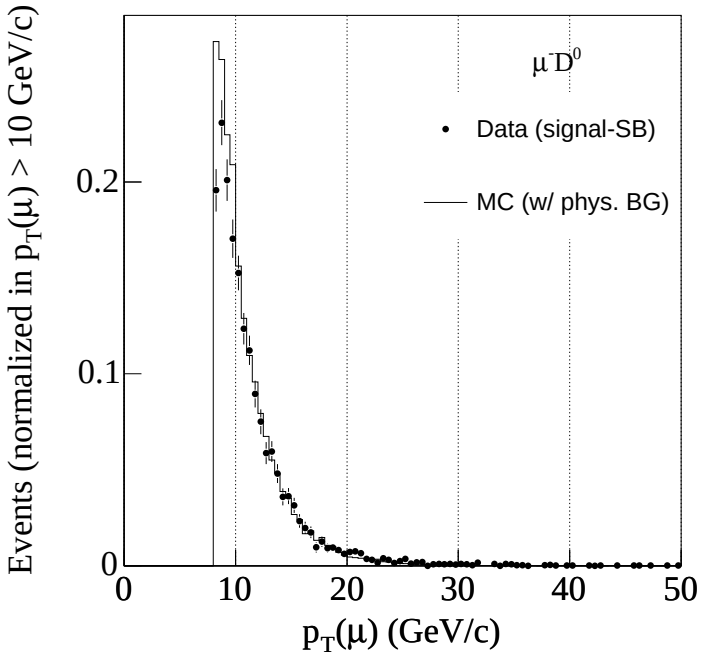






Effect of XFT turn-on to the K factor distributions

Lepton p_T distributions for $\mu^- D^0$ sample, data vs MC (including physics BG components):



We tune the MC in the region $p_T(\mu) < 10$ GeV/c to match the data vs MC, and look at the shift of the K factor mean values.

Mean of the K factors with and without realistic XFT turn-on effect:

	$B^- \to \mu^- D^0$	$B^- \to \mu^- D^{*+}$	$\bar{B}^0 \to \mu^- D^0$	$\bar{B}^0 \to \mu^- D^{*-}$
full sim.	0.8563	0.7822	0.7914	0.8559
full sim. w/ realistic XFT turn-on	0.8569	0.7832	0.7923	0.8567
effect of XFT turn-on	0.07%	0.13%	0.11%	0.09%

As shown in the table, the effect of the XFT turn-on is very small (about 0.1%, which corresponds to 0.5μm in the lifetime fit).