Λ_b^0 Lifetime Fit Status

Outline

- Split the sample according to trigger tracks
- Generate Efficiency for each trigger category
- 2-D Punzi term; $\sigma_{ct}$and *"*$TrigCode$"
- Signal MC lifetime fits

Monte Carlo Summary

Old MC only had $\Lambda_c \rightarrow pK^*$ and $\Lambda_c \rightarrow \Delta^{++}K$ decays.
New MC now includes all 4 Dalitz modes:

- $\Lambda_c \rightarrow pK^*$
- $\Lambda_c \rightarrow \Delta^{++}K$
- $\Lambda_c \rightarrow \Lambda(1520)\pi$
- $\Lambda_c \rightarrow pK\pi$

Modes are re-weighted to match PDG values.
Sample includes $337k$ events (w/ more events to be added soon).

Trigger Codes

Because we have no way to measure the σ_{ct} scale factor, it is difficult to map σ_{ct} values between data and MC.

This makes it impossible to slice the sample in σ_{ct} slices without incurring massive systematic errors in the process.

We choose instead to split our sample in terms of which stable track pairs satisfy the Two Track Trigger.

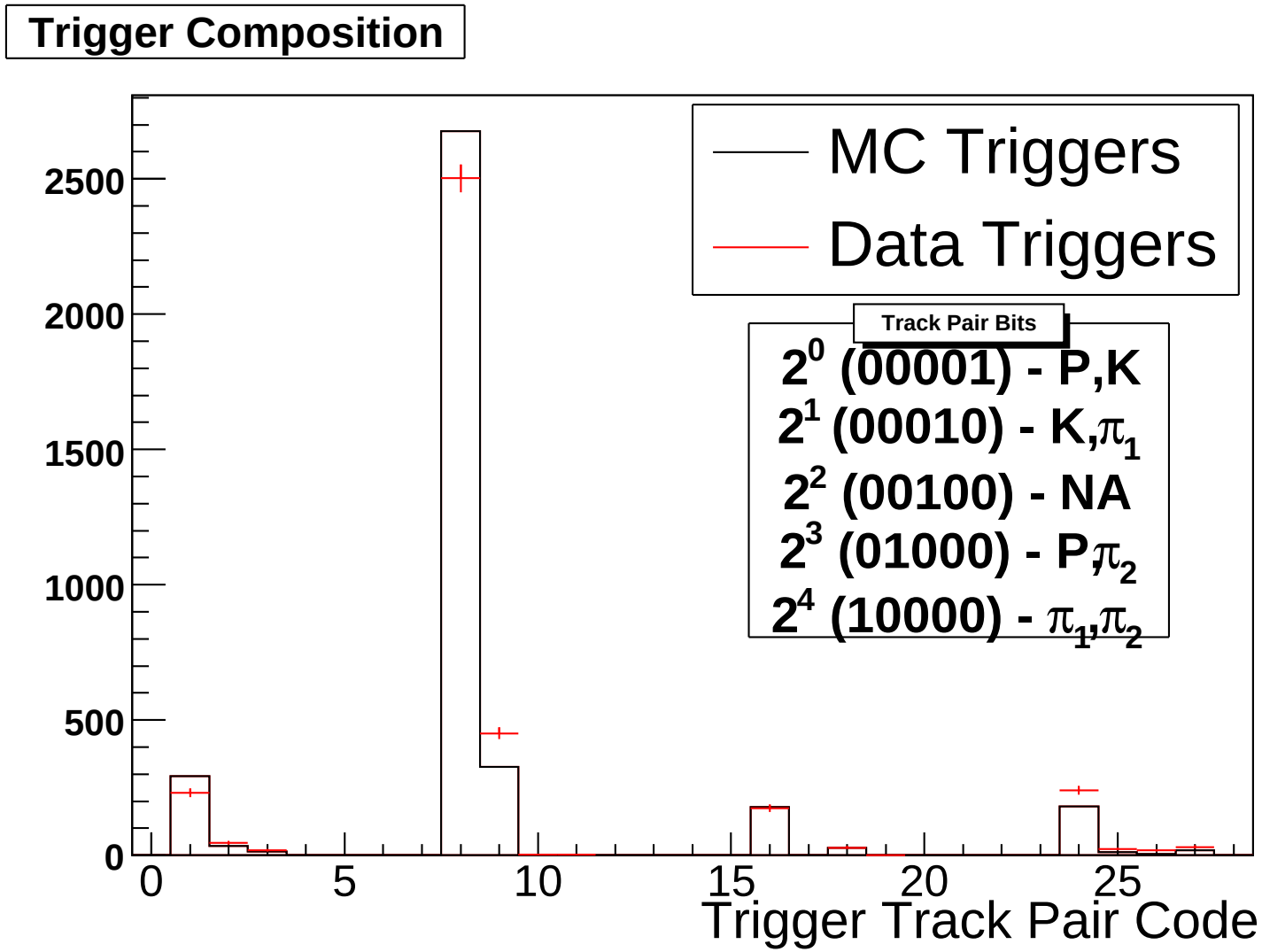
Allowed combinations of p,K,π_1, and π_2 are considered to determine if the combination passes the TTT requirements.

Trigger Code Convention

Labeling Convention: $\Lambda_b^0 \to \Lambda_c \pi_2; \Lambda_c \to pK\pi_1$

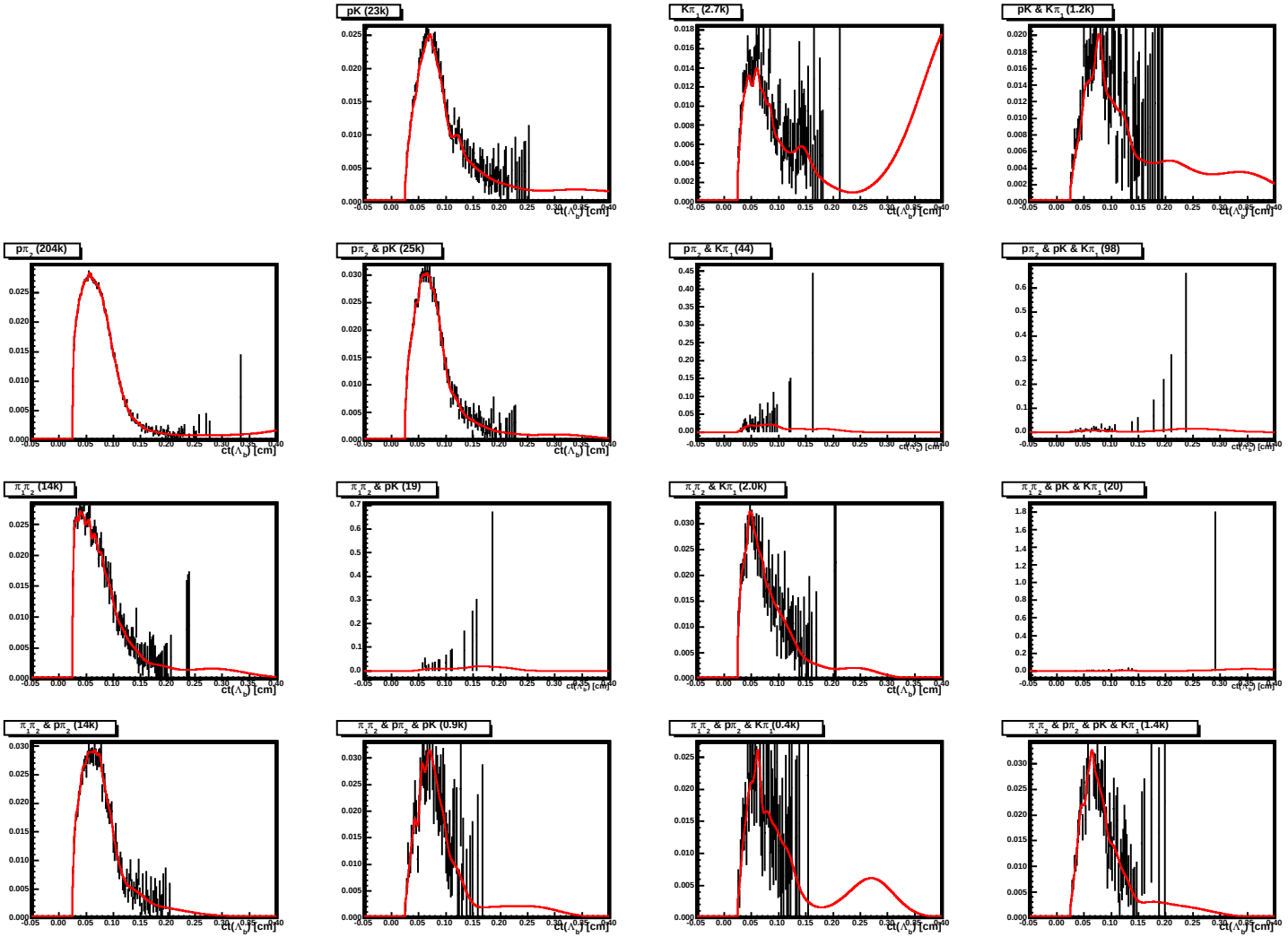
Code	Bits	Description	Nevts
1	00001	pK	$26,071$
2	00010	$K\pi_1$	$3,216$
3	00011	$pK + K\pi_1$	$1,428$
8	01000	$p\pi_1$	$237,704$
9	01001	$p\pi_1 + pK$	$29,206$
10	01010	$p\pi_1 + K\pi_1$	60
11	01011	$p\pi_1 + pK + K\pi_1$	164
16	10000	$\pi_1\pi_2$	$17,711$
17	10001	$\pi_1\pi_2 + pK$	17
18	10010	$\pi_1\pi_2 + K\pi_1$	2454
19	10011	$\pi_1\pi_2 + pK + K\pi_1$	16
24	11000	$p\pi_1 + \pi_1\pi_2$	$17,398$
25	11001	$p\pi_1 + \pi_1\pi_2 + pK$	$1,212$
26	11010	$p\pi_1 + \pi_1\pi_2 + K\pi_1$	533
27	11011	$p\pi_1 + \pi_1\pi_2 + pK + K\pi_1$	$1,664$

Monte Carlo vs. Data Triggers



Efficiencies by TrigCodes

Trigger efficiency is calculated for each TrigCode.



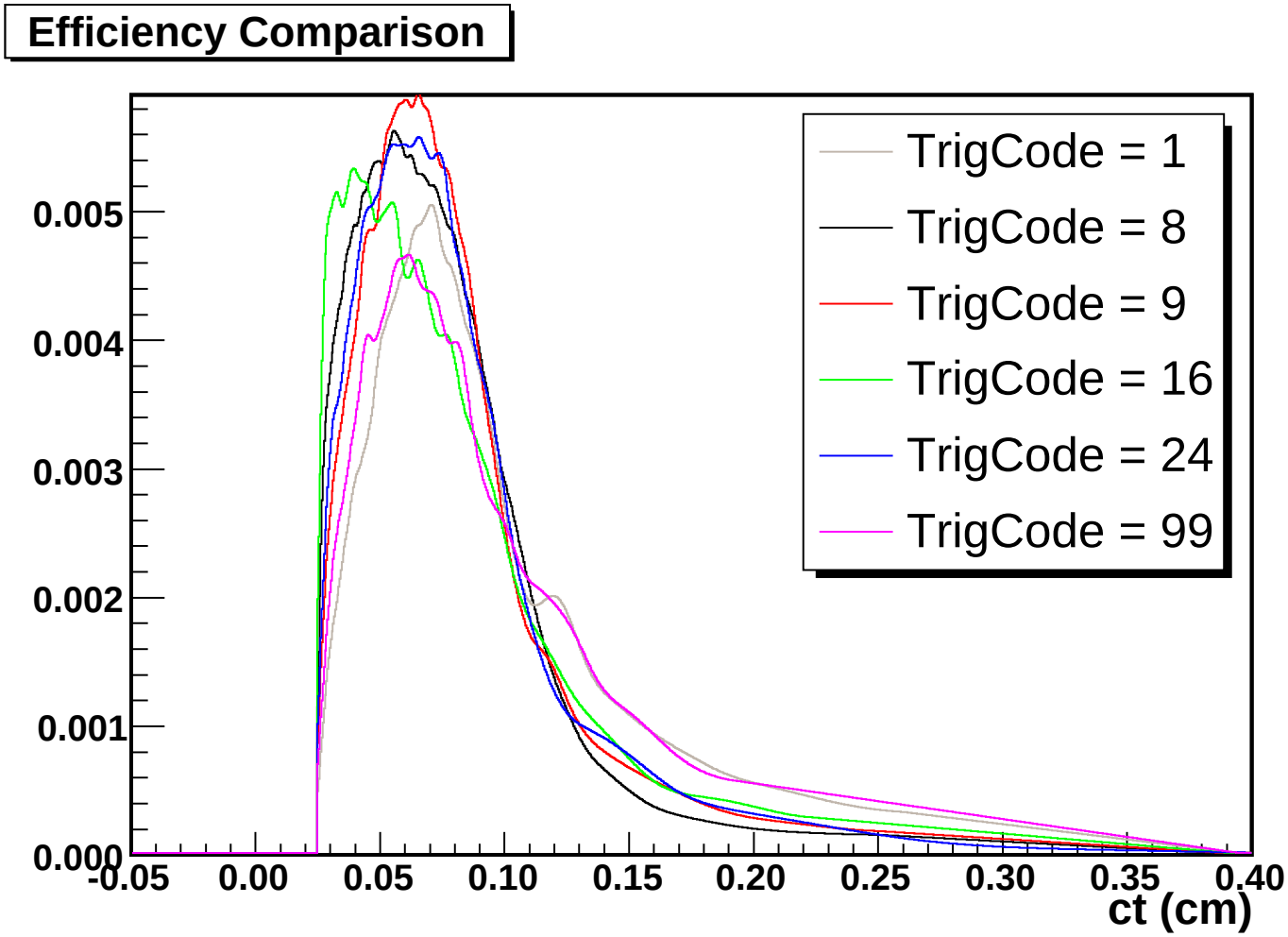
Splitting by TrigCodes

Decide to split the sample into 6 categories:

Code	Description	Nevts
1	pK	$26,071$
8	$p\pi_1$	$237,704$
9	$p\pi_1 + pK$	$29,206$
16	$\pi_1\pi_2$	$17,711$
24	$p\pi_1 + \pi_1\pi_2$	$17,398$
99	All other combinations	$10,402$

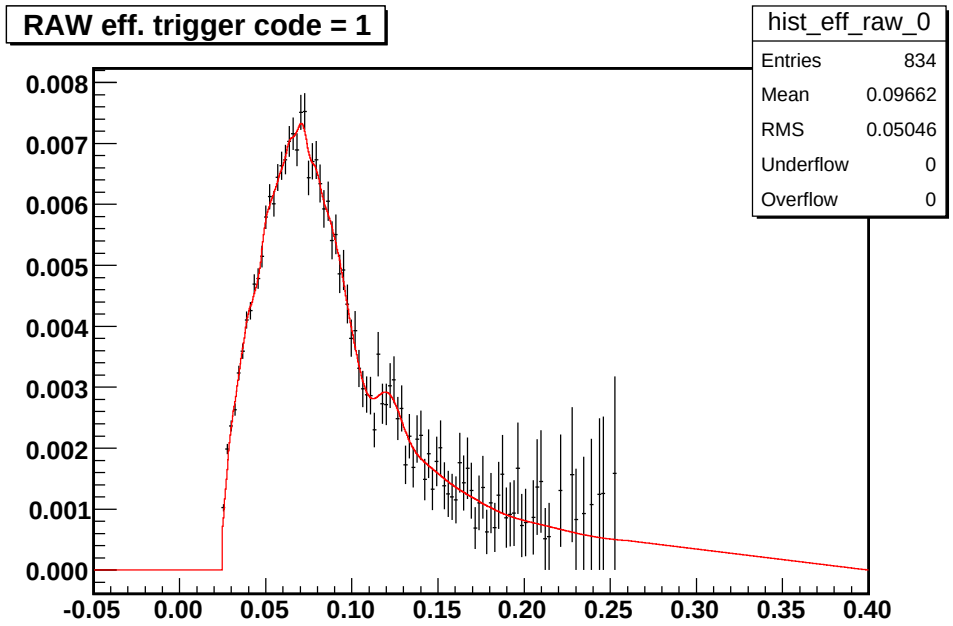
Efficiencies by TrigCode I

A comparison of the final efficiencies that are currently used.

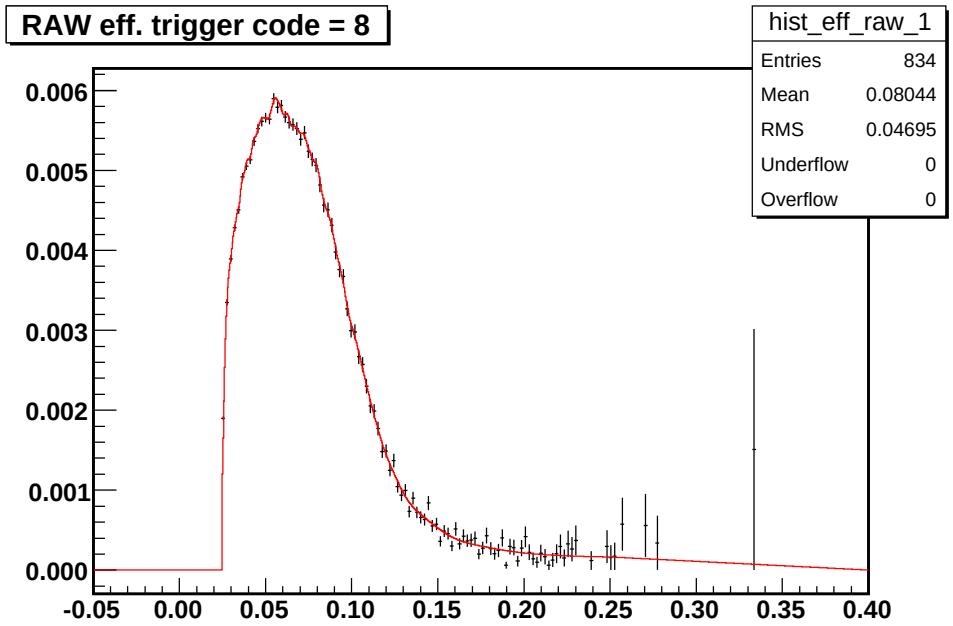


Efficiencies by TrigCode II

Efficiencies are calculated using `RooKeysPdf` smoothing.
The original data is rebinned (from 1000 to 200 bins) before plotting.

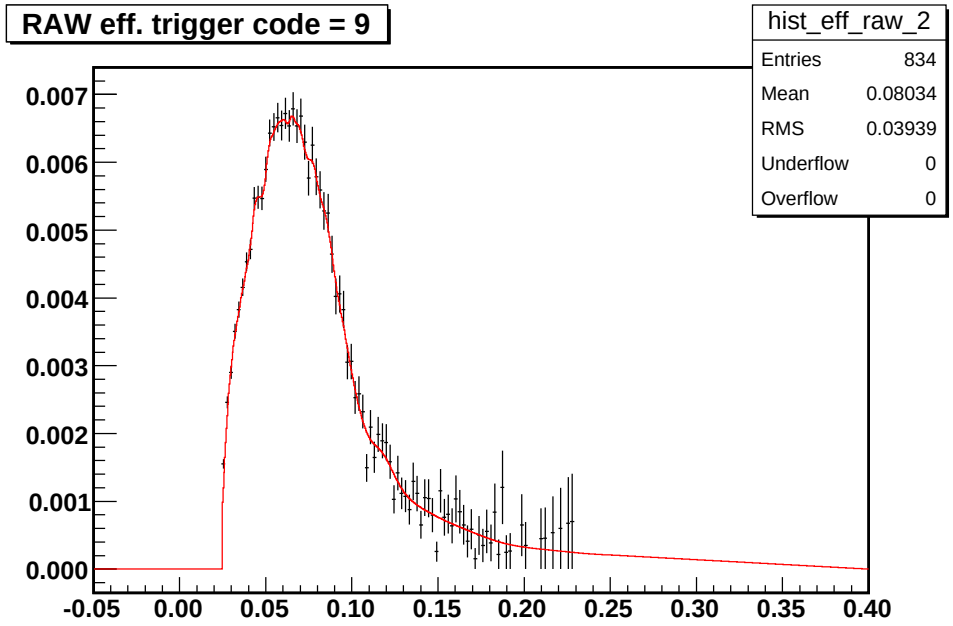


TrigCode=1 (pK)

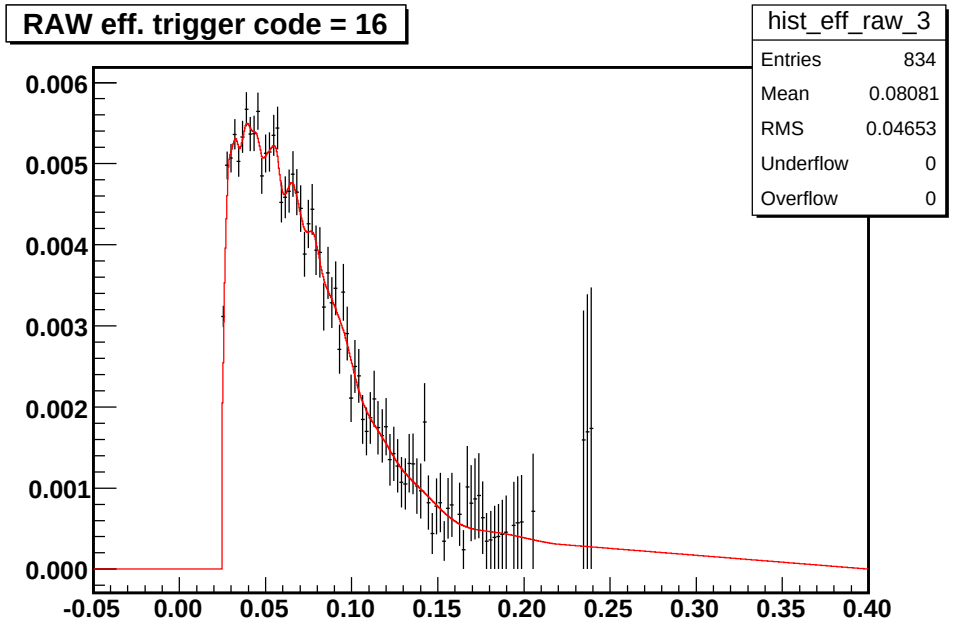


TrigCode=8 ($p\pi_1$)

Efficiencies by TrigCode III

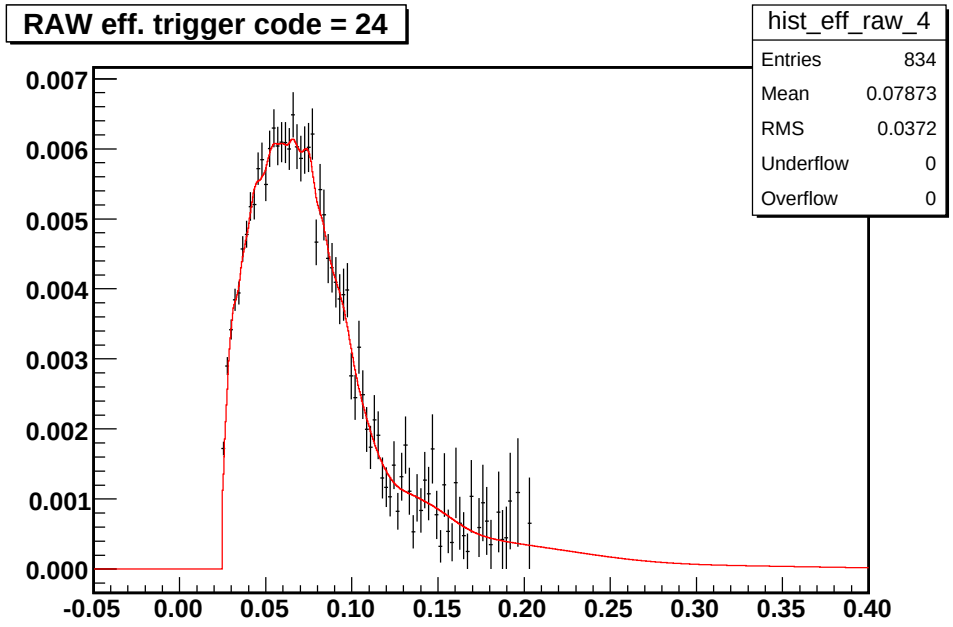


TrigCode=9 $(p\pi_1 + pK)$

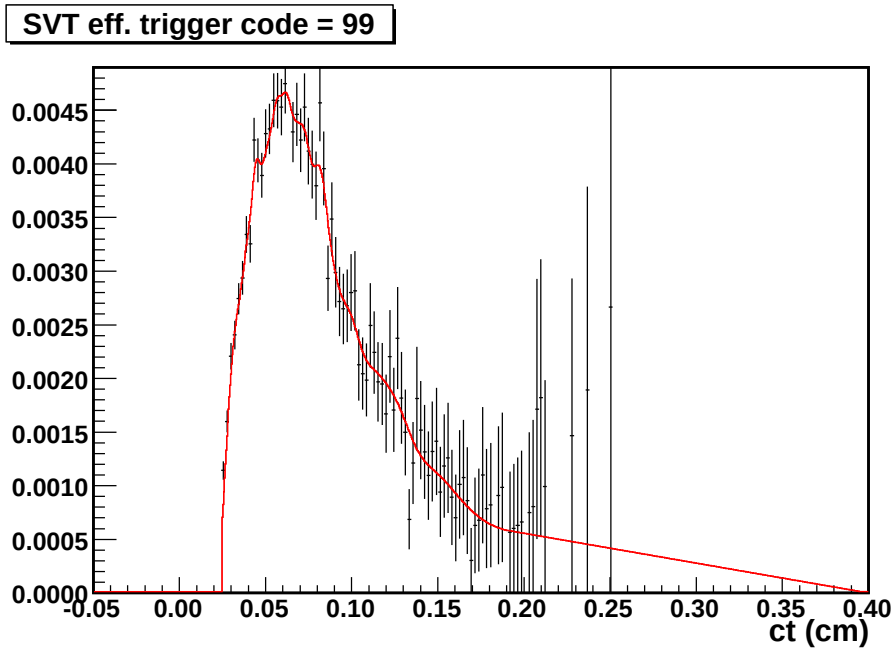


TrigCode=16 $(\pi_1\pi_2)$

Efficiencies by TrigCode IV



TrigCode=24 ($p\pi_1 + \pi_1\pi_2$)



TrigCode=99 (All Other)

2-D σ_{ct} and TrigCode Punzi Term

- 2-D (σ_{ct},TrigCode) `RooDataHist` is created from the Data in the Λ_b^0 mass window.
- 2-D `RooHistPdf` is created from the RDH.

Note: in the `RDH` and `RHP`, we have a `RooRealVar` (double) in one dimension with a `RooCategory` (int) in the other. The distinction of type is very important for RooFit.

Not sure that it is possible to create a `RDH` from a 2-D histogram that will work with `RooCategory`. This could be a problem when we try to fit data because we need to create the `RDH` with a 2-D, sideband-subtracted histogram.

Likelihood looks like this:

$$\mathcal{L}(ct, \sigma_{ct}) = P(ct|\sigma_{ct}, T) \cdot P(\sigma_{ct}, T)$$

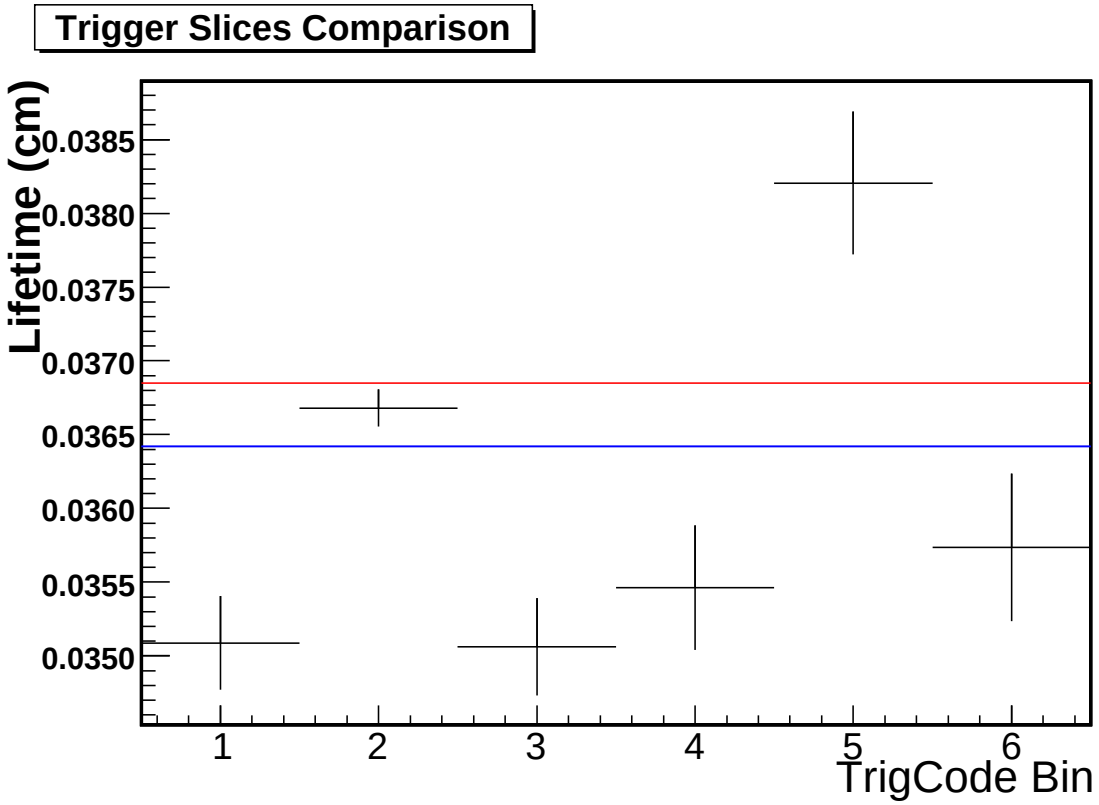
We've got everything we need now for the fit.

We test the fit in stand-alone RooFit. The fit gives a lifetime around $364\mu m$ on the $\sim 340k$ MC sample.

Fit in Separate TrigCode Slices

What happens when we fit in TrigCode slices?

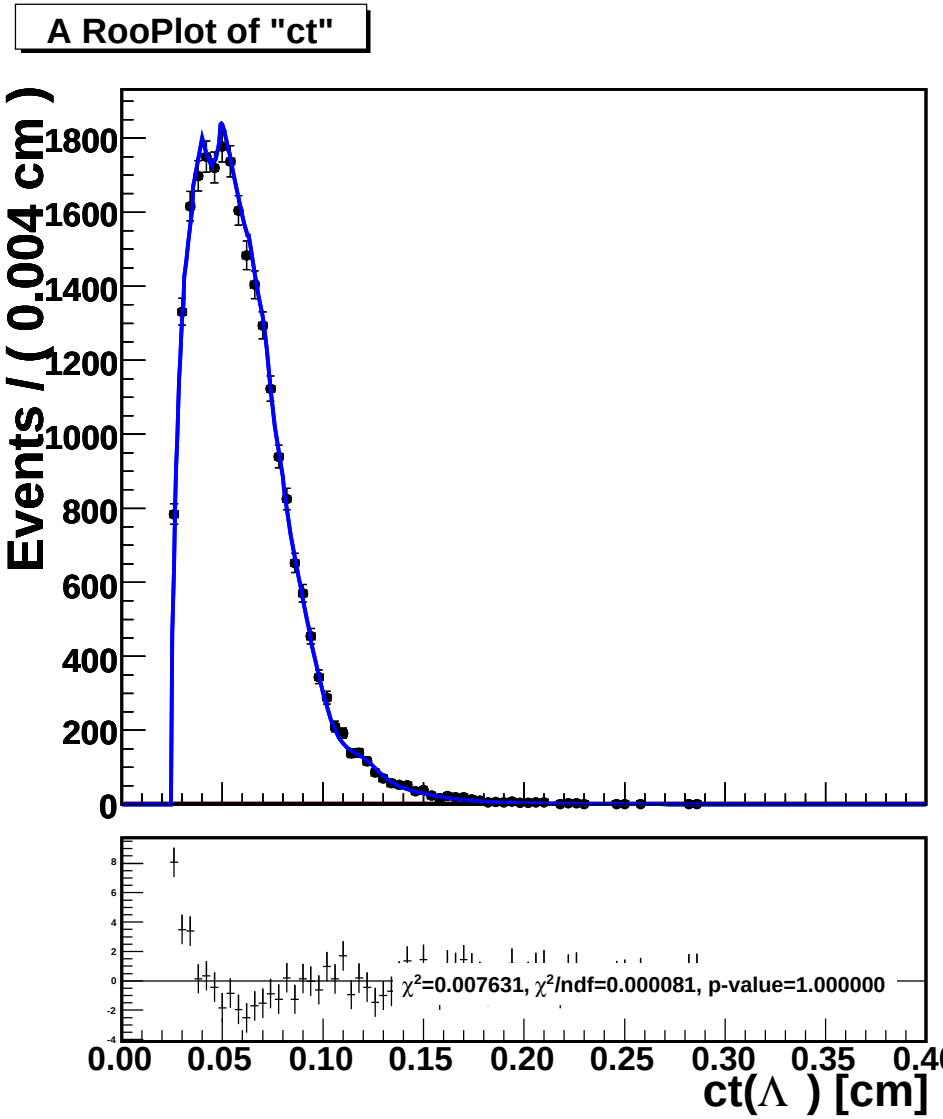
Red:$368.5\mu m$ generation : Blue:$364.2\mu m$ weighted mean

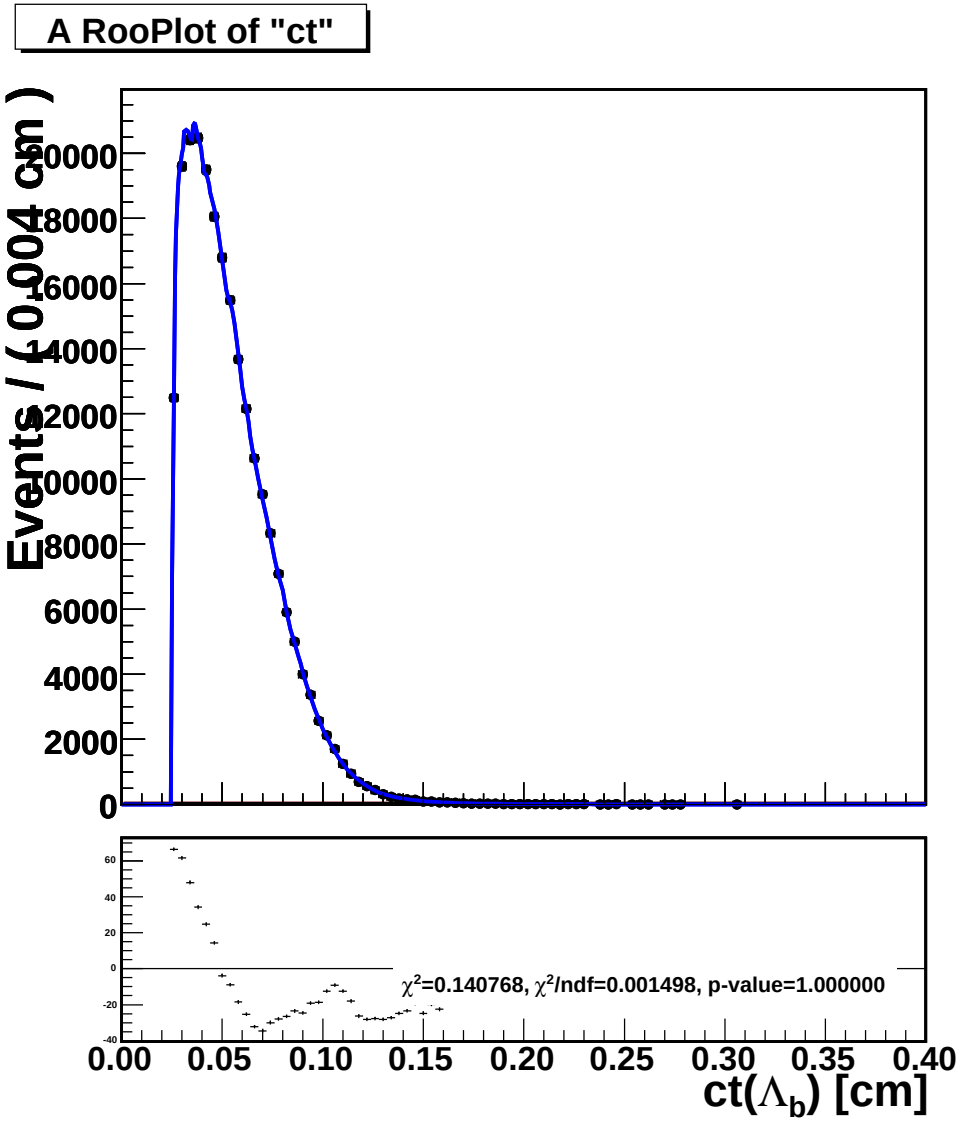


Each fit is shown on the following slides

Note: Disregard the residual plots as I believe that they are wrong!

Fit Results I

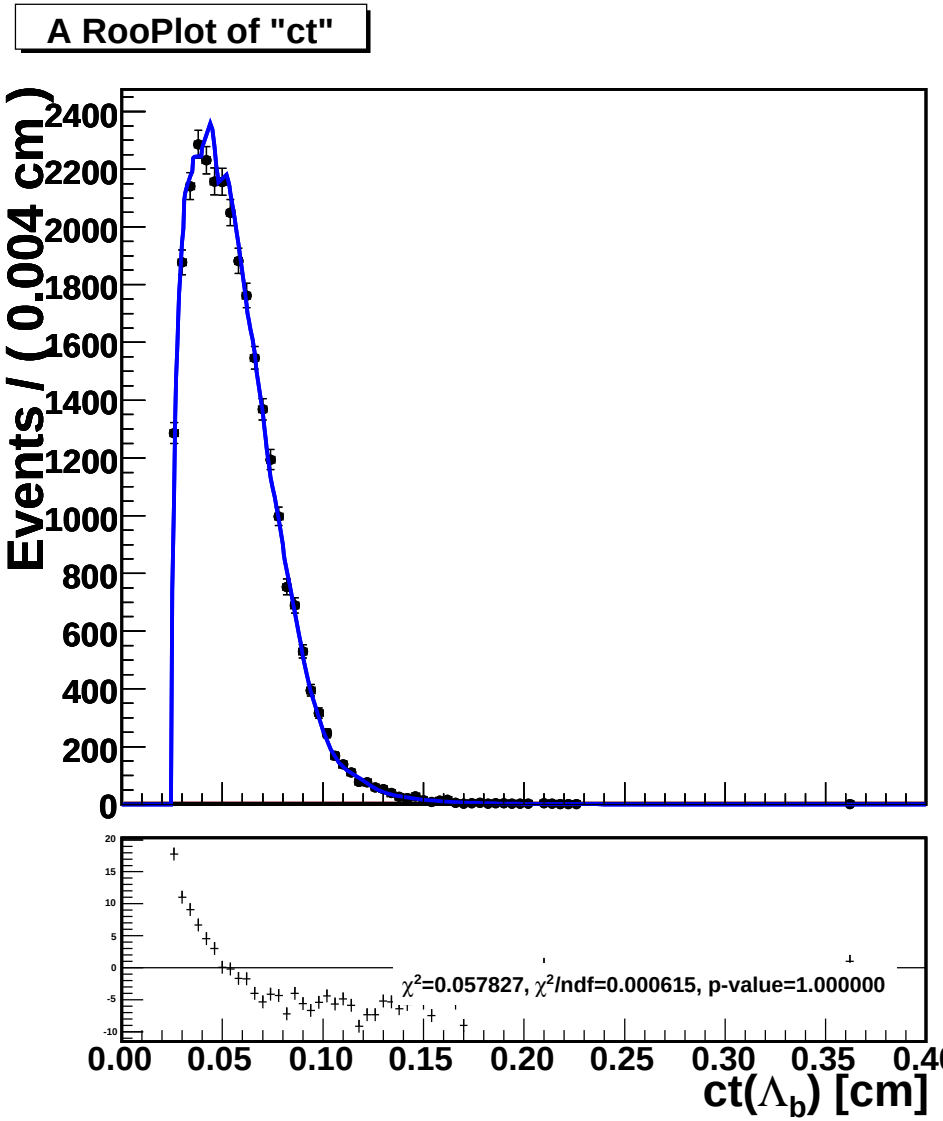


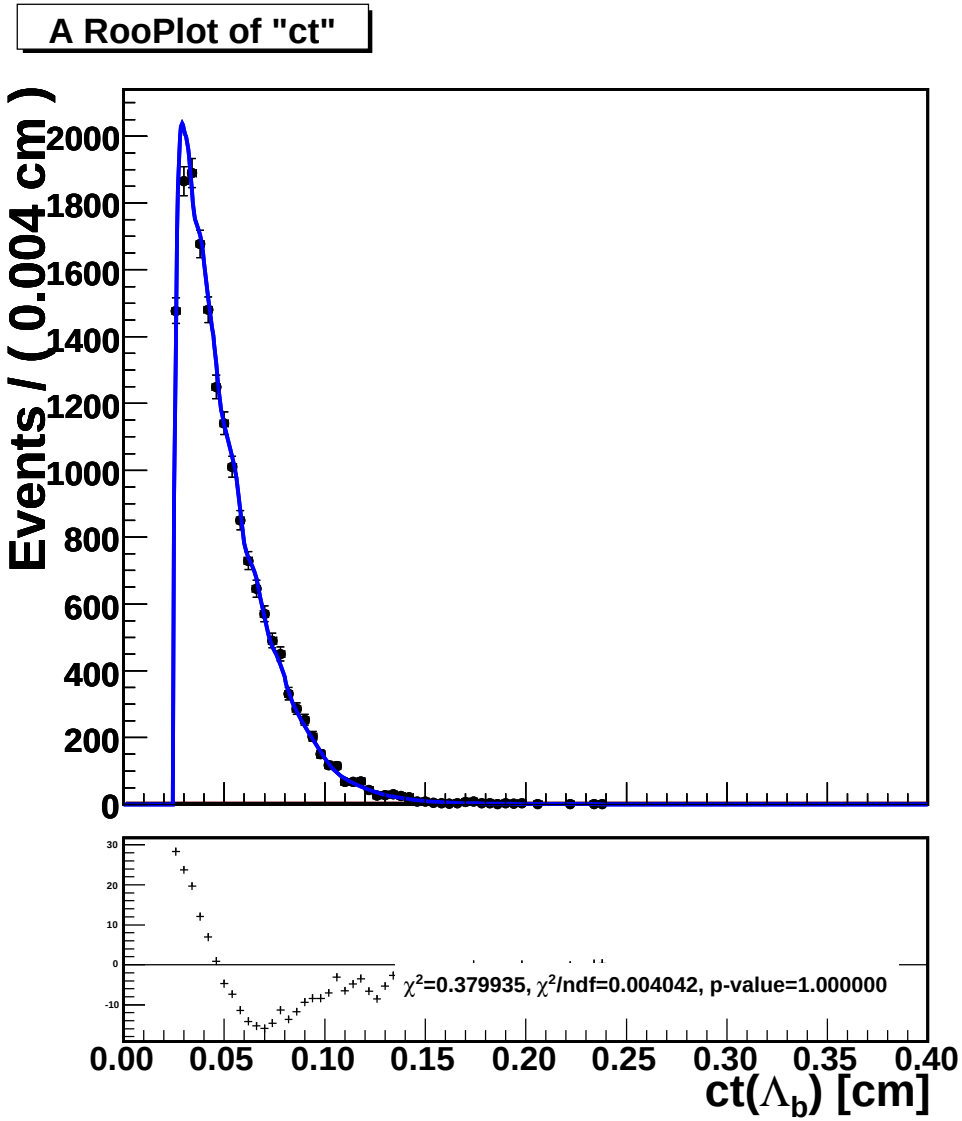


$c\tau = 350.8\mu m$: TrigCode=1 (pK)

$c\tau = 366.8\mu m$: TrigCode=8 $(p\pi_1)$

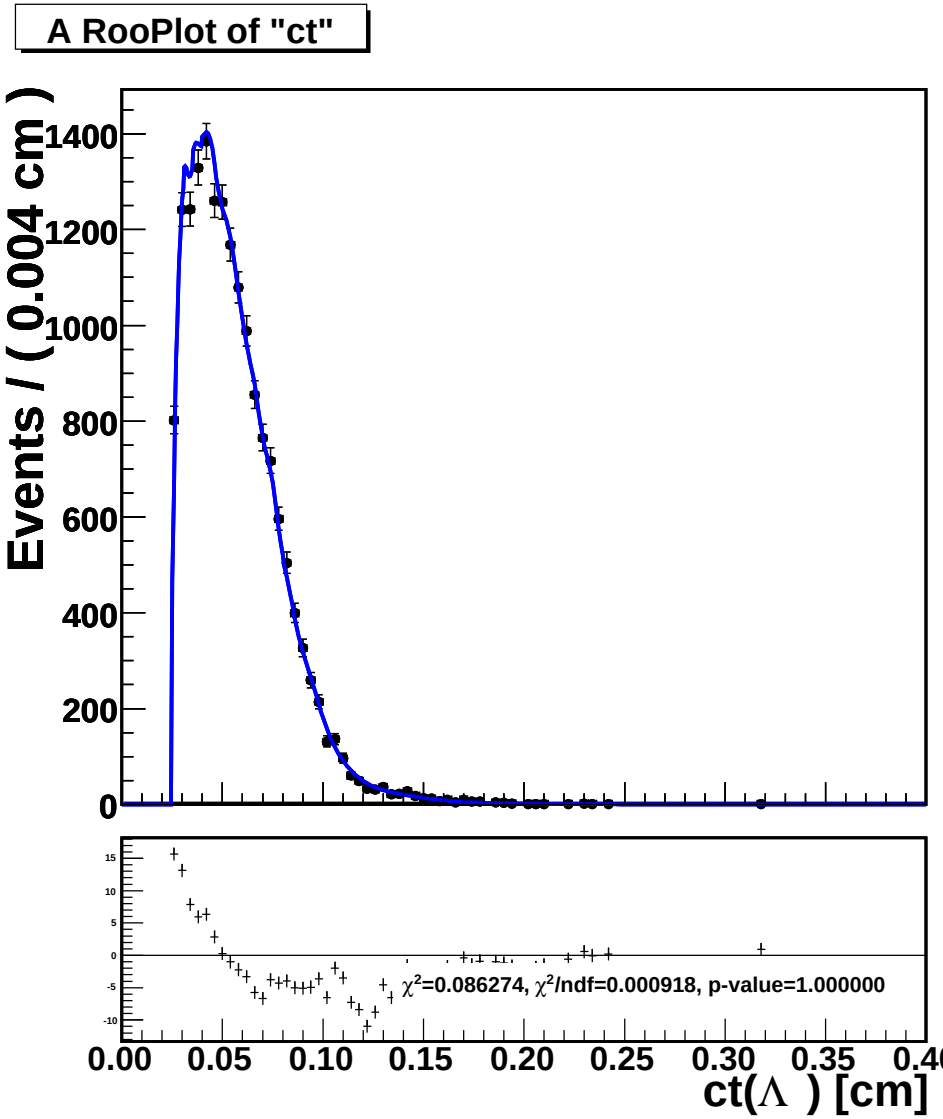
Fit Results II

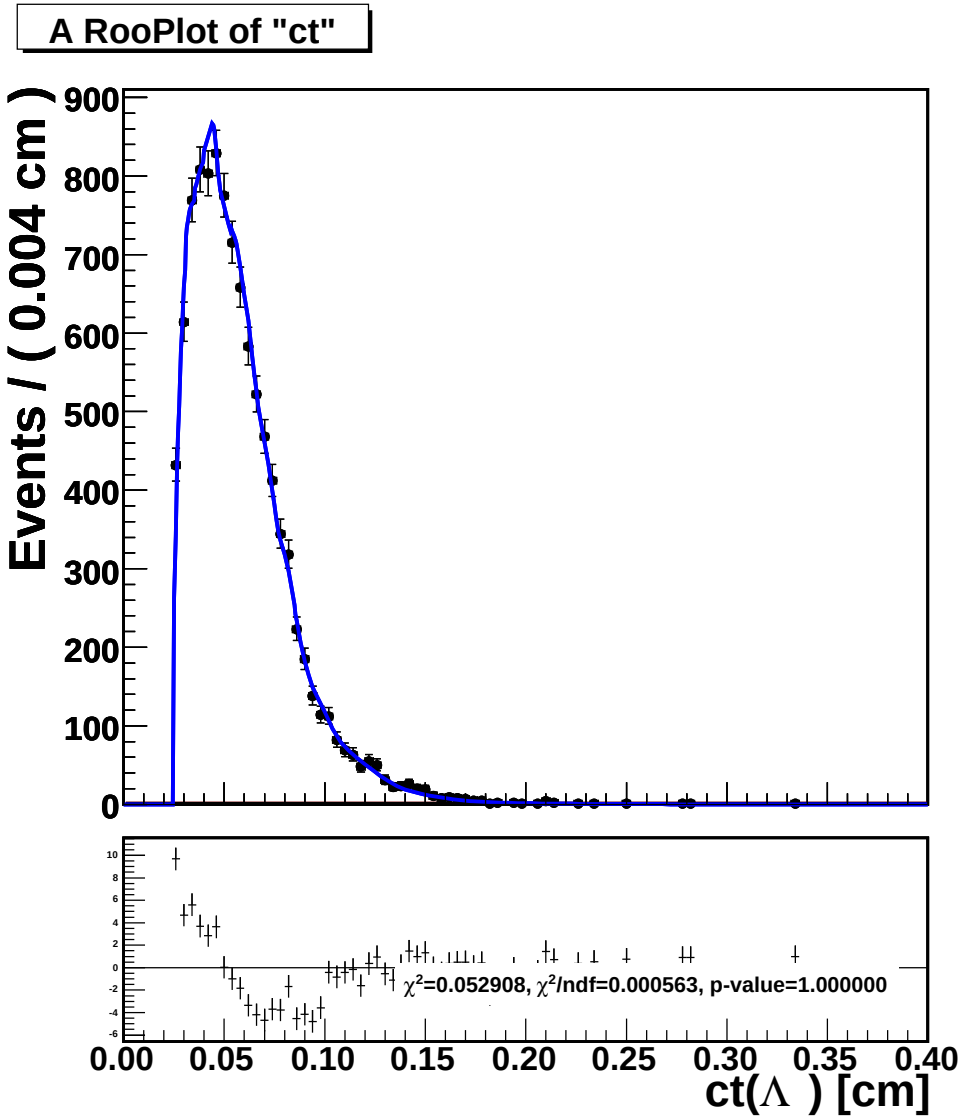




$c\tau = 350.6\mu m$: TrigCode=9 $(p\pi_1 + pK)$ $c\tau = 354.6\mu m$: TrigCode=16 $(\pi_1\pi_2)$

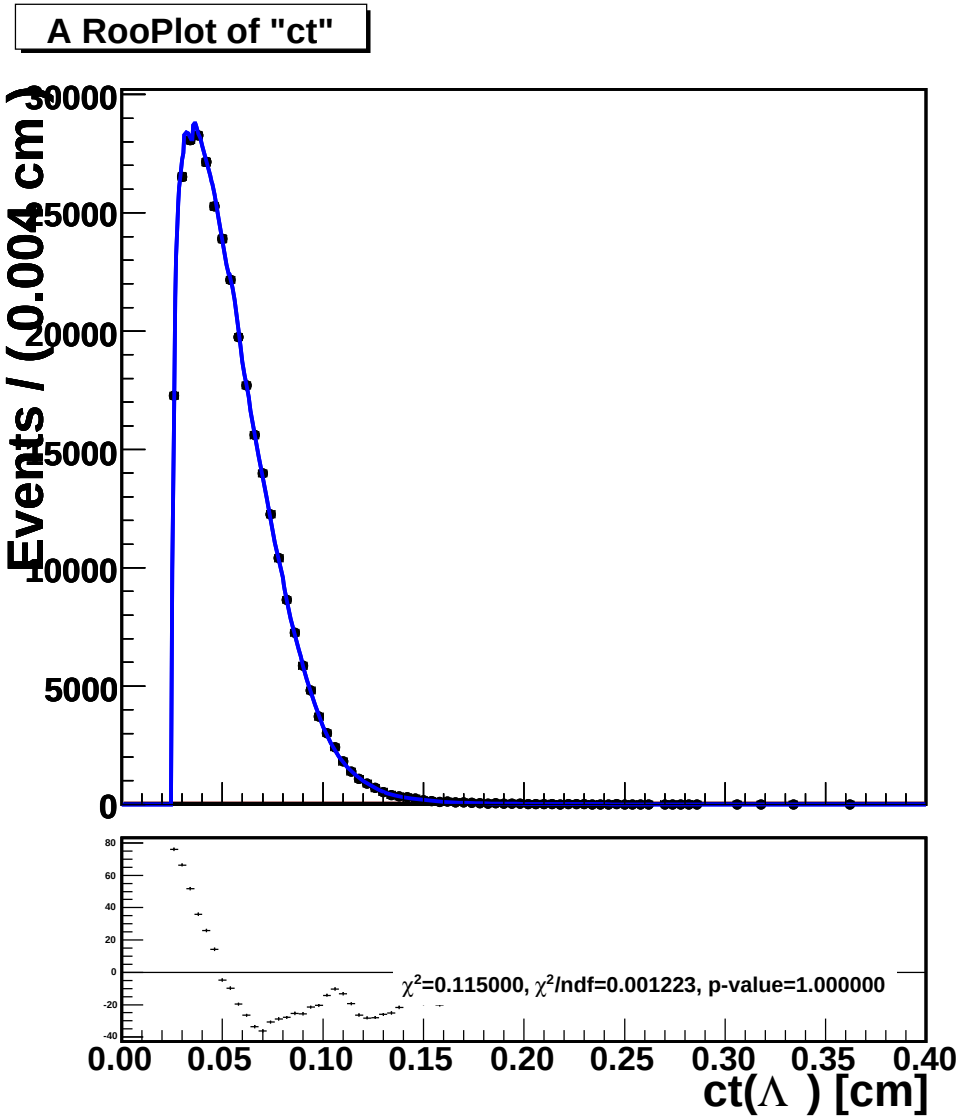
Fit Results III





$c\tau = 382.0\mu m$ TrigCode=24 $(p\pi_1 + \pi_1\pi_2)$ $c\tau = 357.4\mu m$ TrigCode=99 (All Others)

Fit Results IV



$c\tau = 363.6 \pm 10.1 \mu m$ (All MC events)

- Ave. of per-slice fits agrees w/ entire sample fit.
- Fits are $4\mu m$ lower than expected!!!
- NOT AGAIN!?!?!
- Possible sources of the bias?
  - σ_{ct} scale factor?
  - efficiency smoothing?