B_d Mixing with Kaon Tag Update

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SLD Week March 2000

- Introduction and Motivation
- CRID Cut Studies
- Pion MisID Calibrations Using K_S
- "Kaon" Efficiency Using Λ
- Kaon Efficiency Using D^*
- Conclusions and Plans

Why study B_d mixing?

A. B_d mixing can determine the V_{td} element of the CKM matrix:

$$\Delta m_d = \frac{G_F^2}{6\pi^2}\eta_B m_{Bd} m_t^2 f_{Bd}^2 B_{Bd} S_0 \left|V_{td}V_{tb}^*\right|^2$$

However, the theory is not that good (error on magnitude of $f_{Bd}\sqrt{B_{Bd}} \cong 20\%$).
Thus, we need B_s mixing:

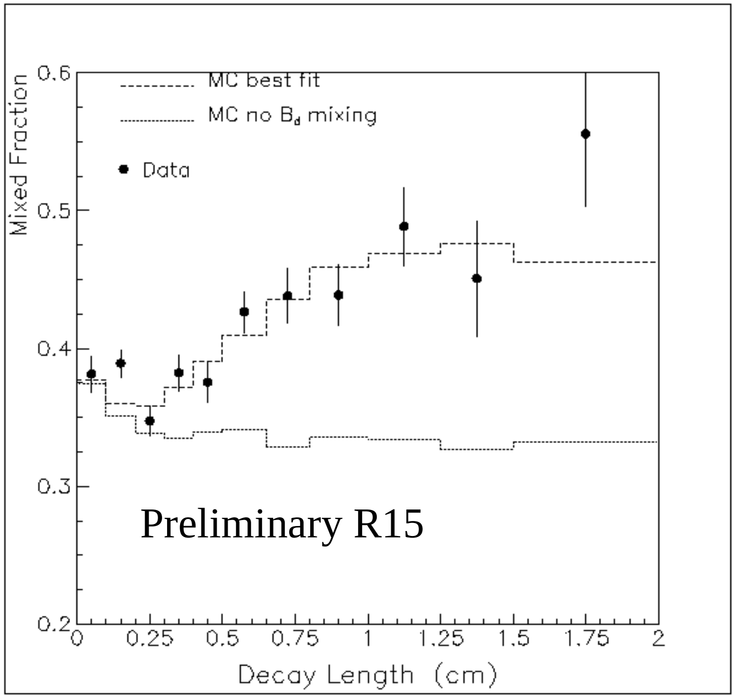
$$\frac{\Delta m_s}{\Delta m_d} = \frac{m_{Bs} f_{Bs}^2 B_{Bs}}{m_{Bd} f_{Bd}^2 B_{Bd}} \cdot \frac{\left|V_{ts}\right|^2}{\left|V_{td}\right|^2} = (1.15 \pm 0.05)^2 \cdot \frac{\left|V_{ts}\right|^2}{\left|V_{td}\right|^2}$$

B. Once a likelihood fit for the Kaon right sign fraction is developed, one could “swap in” other tags and measure the right sign fractions for those tags from the data, giving a cross check for other analyses.

Why Study The Kaons?

Because we use them to tag the flavor of the final state meson!

- Kaons are good tags for B_d Mixing: $B_d \rightarrow D^- \rightarrow K^+$ and $\overline{B}_d \rightarrow D^+ \rightarrow K^-$
- Use charge of kaon to tag flavor of final state B. Right Sign Fraction (RSF) (82±5) %, from Argus. Thus, high purity tag.
- Problem: The kaons are the largest source of error in the measurement. (CRID knowledge + RSF error).
- Goal: Fit for RSF in end fit (Summer 2k).
- But, we need to understand CRID well…and we need to update CRID constants and calibrations.



•15, 600 Decays using 96-98 R15 Data

•Δm_d= (0.499 ±0.032) ps^{-1} (stat only)

•χ^2/ndf=15.6/10

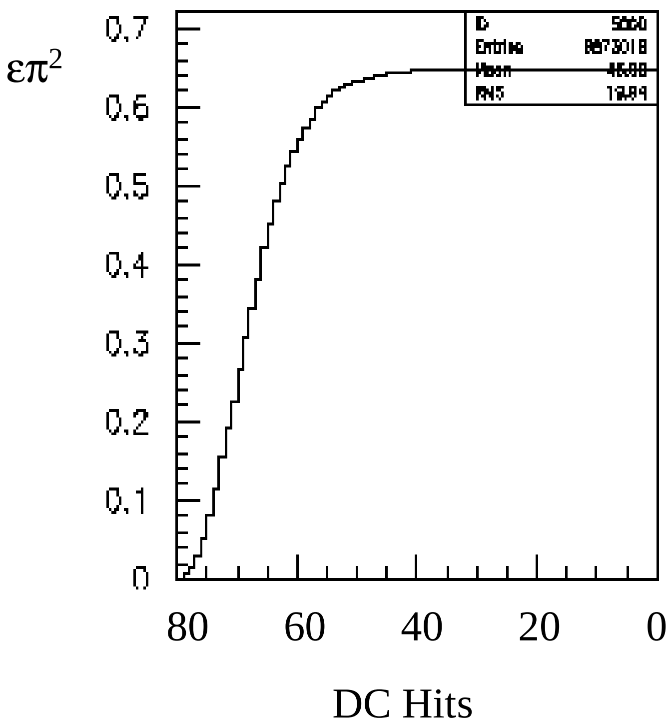
CRID Cut Studies

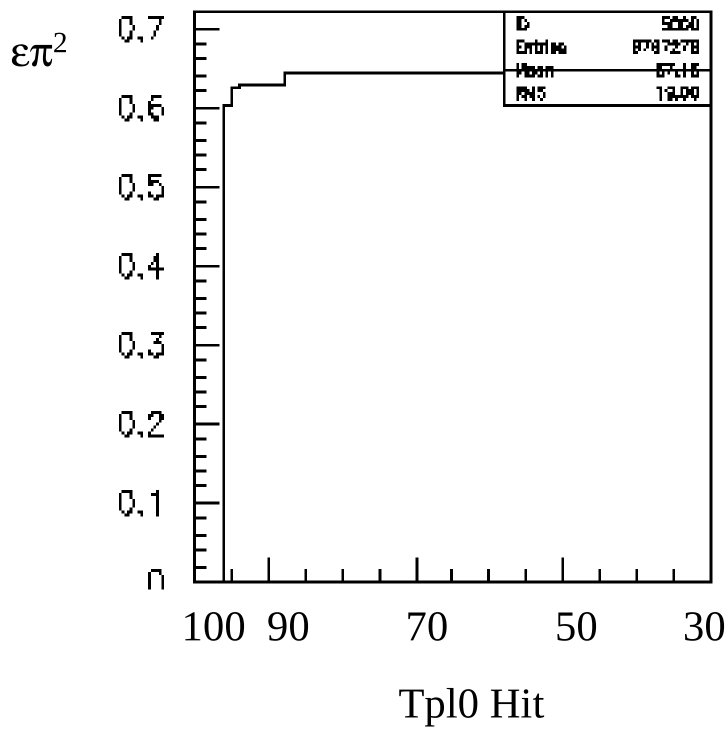
- The last time CRID cuts were studied was with VXD2 (R12) data!
- Study cuts to see if we can improve kaon purity and efficiencies, and optimize for VXD3.
- Studies were done using R16 Monte Carlo.

Cuts Studied Were:

- DC hits
- Tpl0 (outermost hit in DC)
- χ^2/ndf for track fit
- Minimum p_{tot}
- Likelihood differences for (K-pi) and (K-p)
- $\cos(\theta)$ of track
- MIP matches for track in CRID
- Liquid ring requirement

DC and Tpl0 Requirements

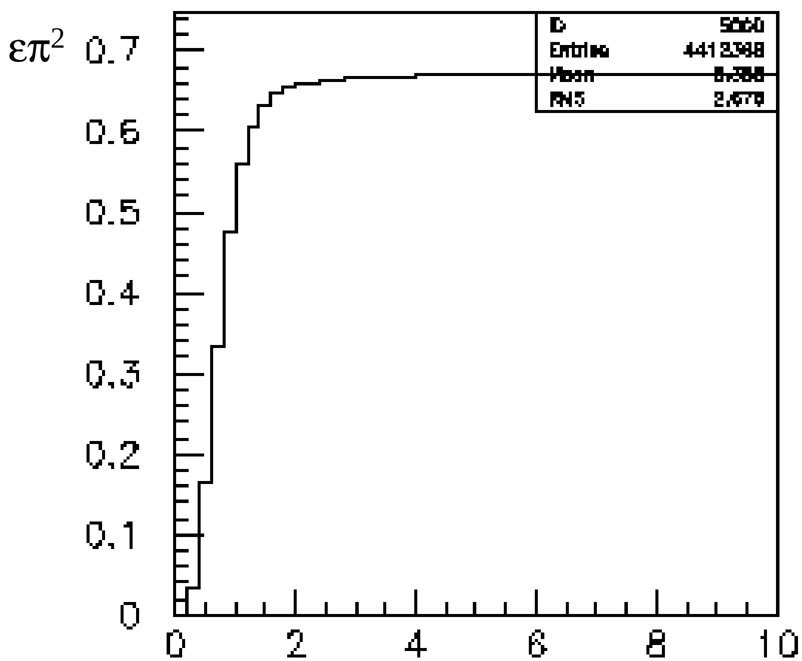




Shift DC hit requirement from 40→23

Shift Tpl0 hit requirement from 90→50

χ^2 /ndf for track fit and results



Shift χ^2 requirement from $5 \rightarrow 8$

Net Results with all revised cuts:

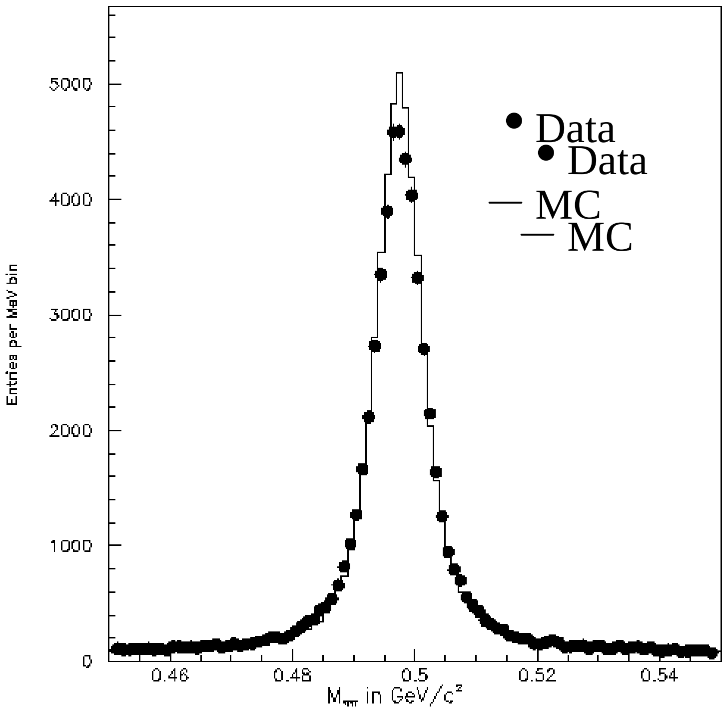
	Old Cuts	Revised Cuts
ε	0.374	0.396
π	0.821	0.810
$\varepsilon\ \pi^2$	0.252	0.260

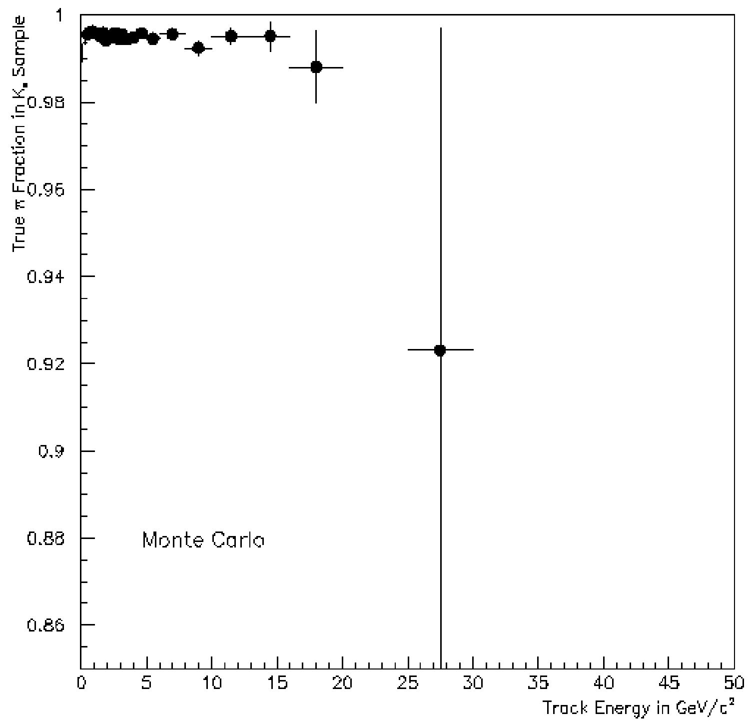
Marginal Improvement.

Efficiency and Mis-ID Calibrations

- Need good handle on mis-ID and efficiency rates for the kaons.
- Use K_{short} for very pure sample of pions to do $\pi \rightarrow K$ mis-ID rate.
- Use Λ sample for a pure sample of protons to model kaons in 2.5-9 GeV region to do kaon efficiencies (kaons and protons are both separated from pions in this region by the absence of liquid rings.)
- Use D* sample for pure kaon sample for kaon ID efficiency measurement.
- All studies done using R16 Monte Carlo and Data
- Efficiency is defined as: $\dfrac{\text{(“kaon” tracks passing all CRID cuts plus llkpi)}}{\text{(“kaon” tracks passing all CRID cuts EXCEPT llkpi)}}$
- Mis-ID rate defined as: $\dfrac{\text{(pion tracks passing all CRID cuts plus llkpi)}}{\text{(pion tracks passing all CRID cuts EXCEPT llkpi)}}$

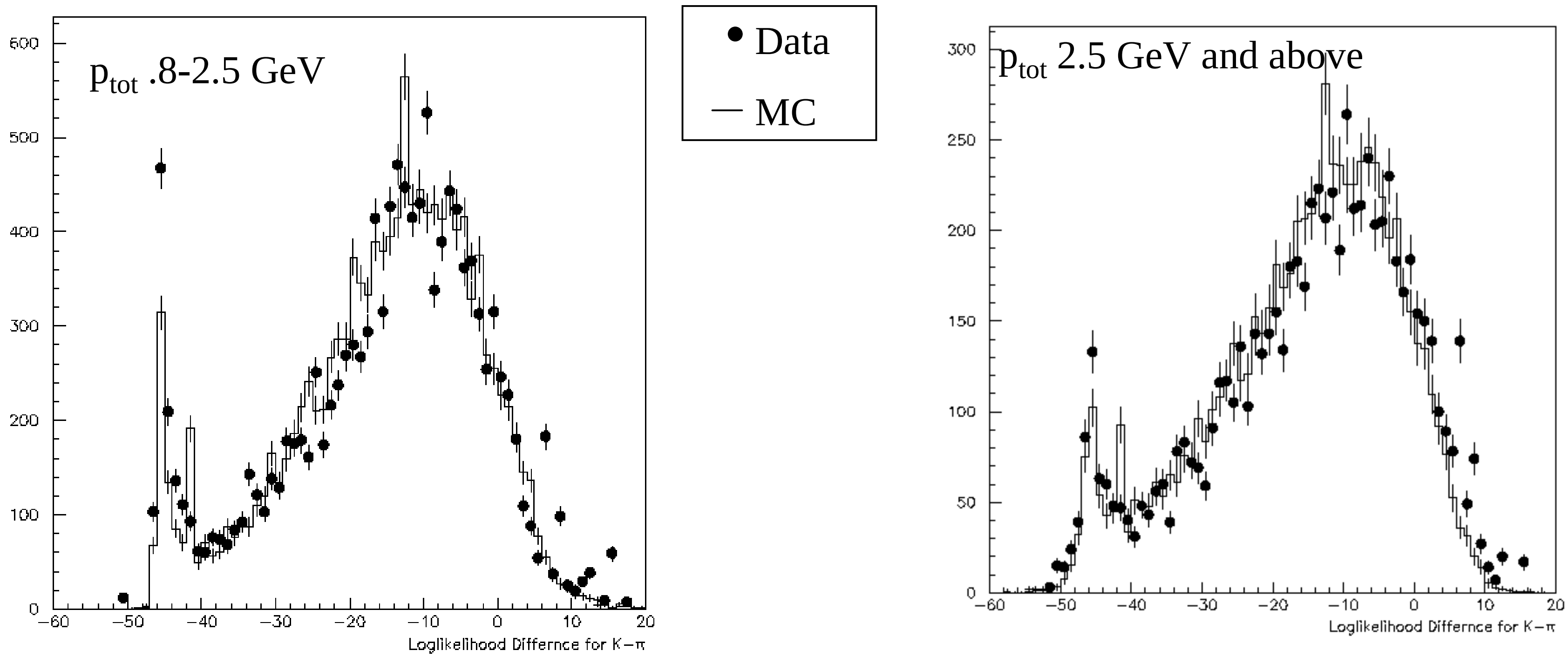
K_{short}s give a very clean sample of pions!





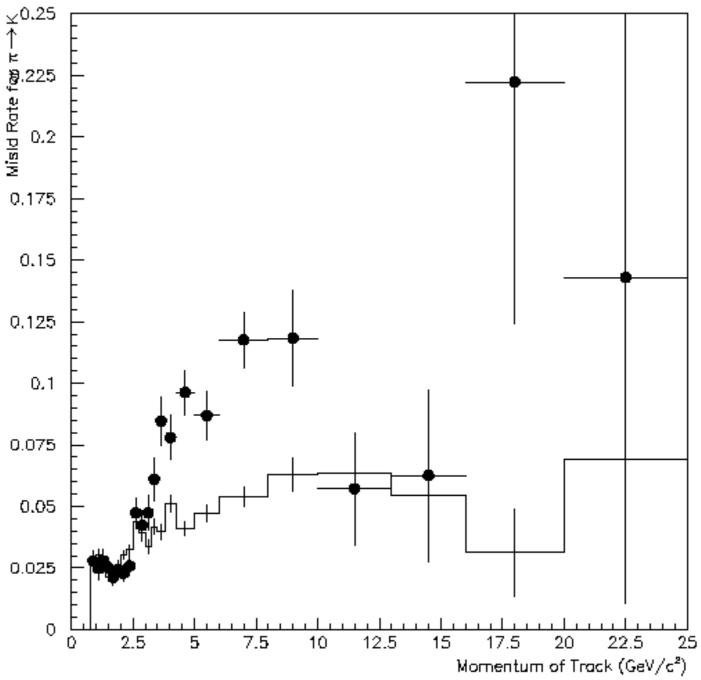
Overall purity: (99.5±0.1)%

Mis-ID Matching between Data and MC



- Data and MC are poorly matched for the mis-ID and ID rates for pions, especially above 2.5 GeV
- This is a known issue due to CRID hardware and is corrected for by use of a “smearing” technique of loosening the likelihood cuts in CKID.
- We have recalculated the smearing for R16 MC.

Good Match between data and MC once smears applied.



Before Smear Application

Stay

Tuned!

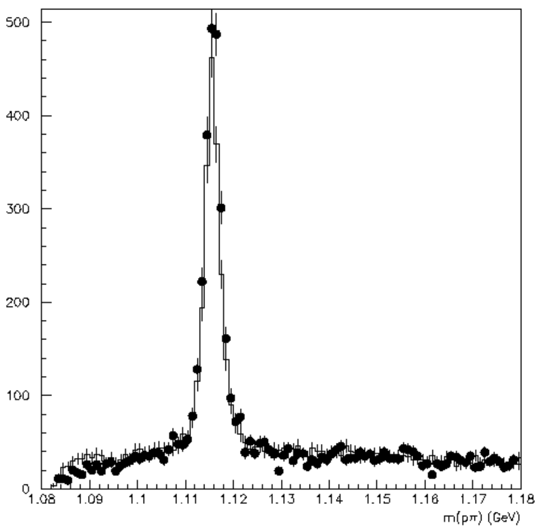
☺

After Smear Application

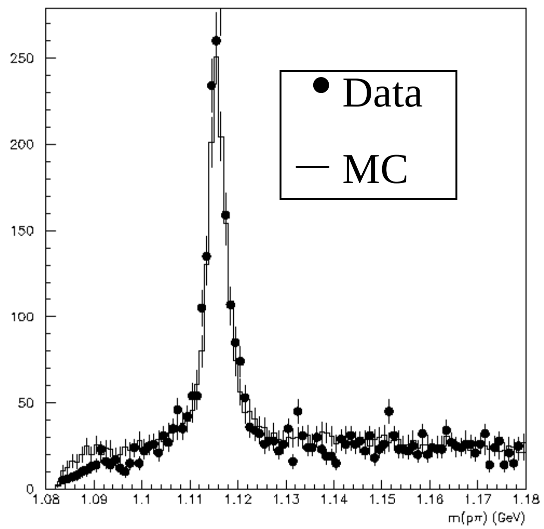
• Data

— MC

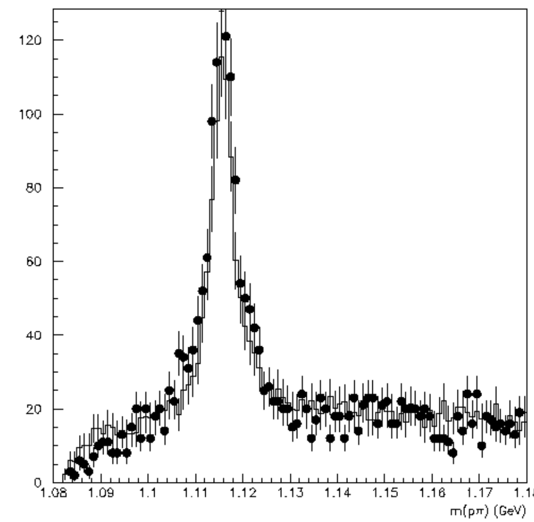
We have a clean sample of Λs with good agreement between data and MC.



Proton p_{tot} 2.5 - 4 GeV



Proton p_{tot} 4 - 6 GeV

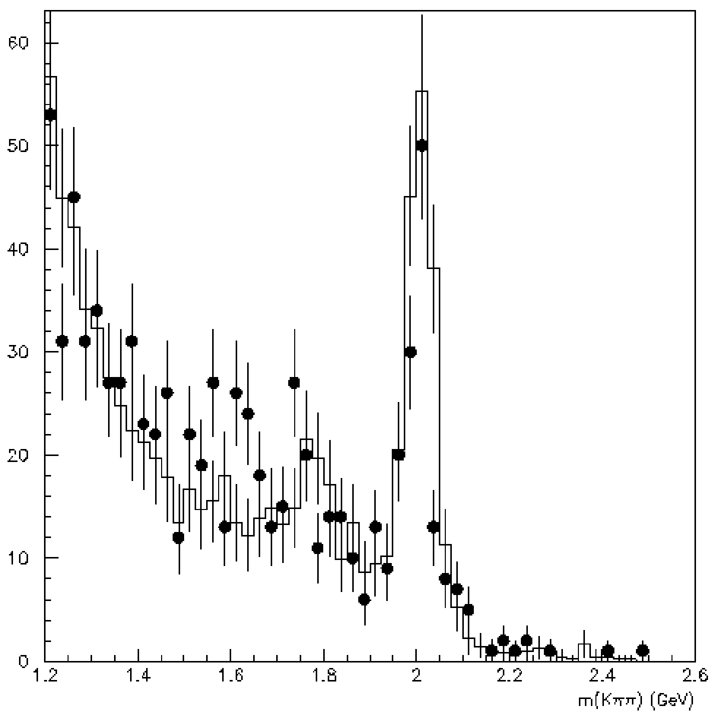


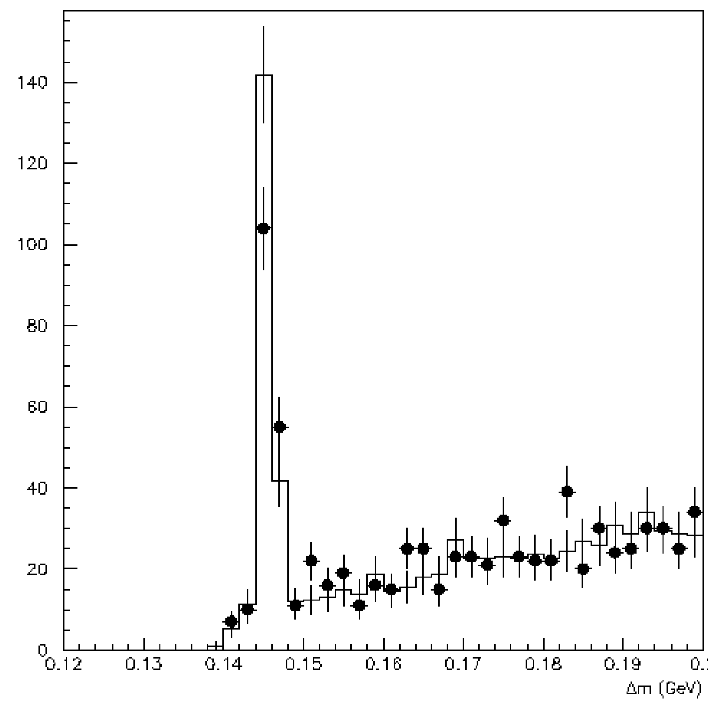
Proton p_{tot} 6 - 9 GeV

Efficiencies (%):

Data:	81.4±0.8	88.4±0.9	82.6±1.3
MC:	76.2±0.5	90.2±0.4	88.2±0.6

Kaon Efficiencies in 2.5-10 GeV region





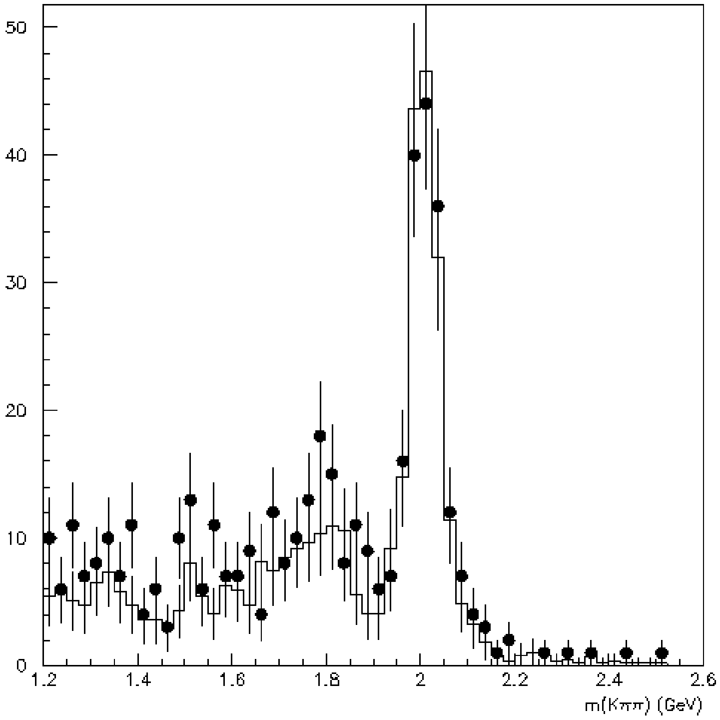
MC Efficiency: (86.0 ± 1.7) %

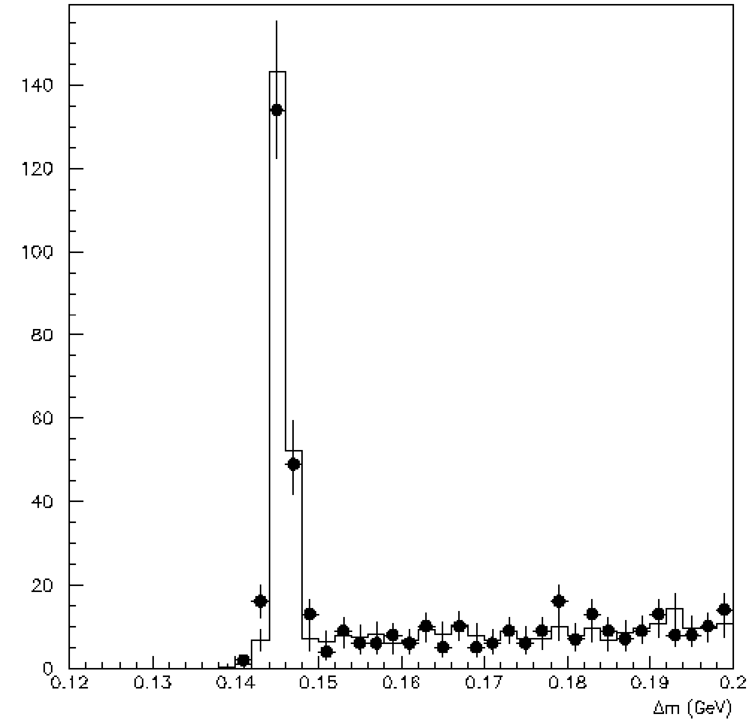
Data Efficiency: (88.3 ± 4.0) %

● Data

— MC

Kaon Efficiencies in 10 GeV and up region





MC Efficiency: (88.2 ± 1.5) %

Data Efficiency: (82.6 ± 4.0) %

• Data

— MC

Conclusions and Plans

- We have done a number of studies to recalibrate CKIDP.constant for R16 data which results in improved sensitivity and errors for kaon ID.
- Next up: develop a likelihood fit for Δm_d which will allow us to reduce the errors from the RSF by fitting to it instead of inputting it.
- Goal: Initial result to release for summer conferences.