PID Paper

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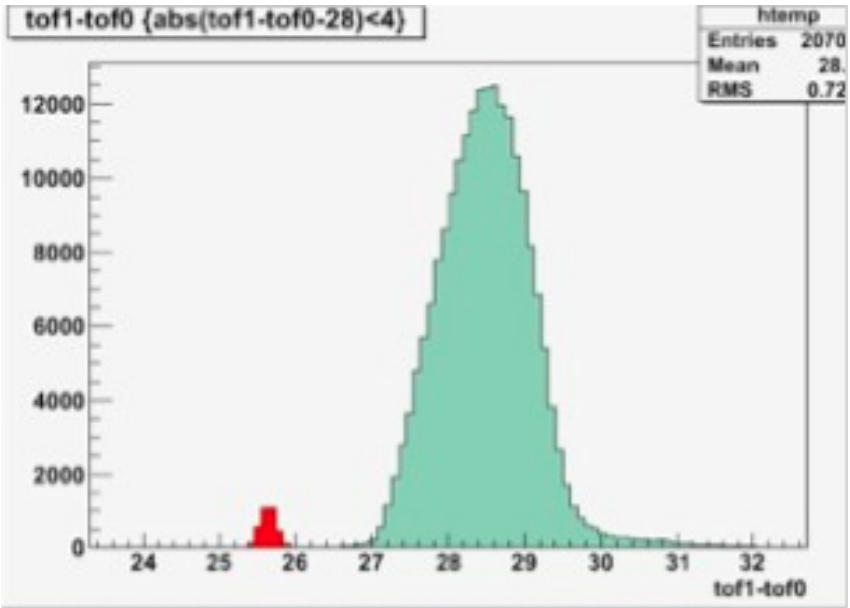
Analysis Principle

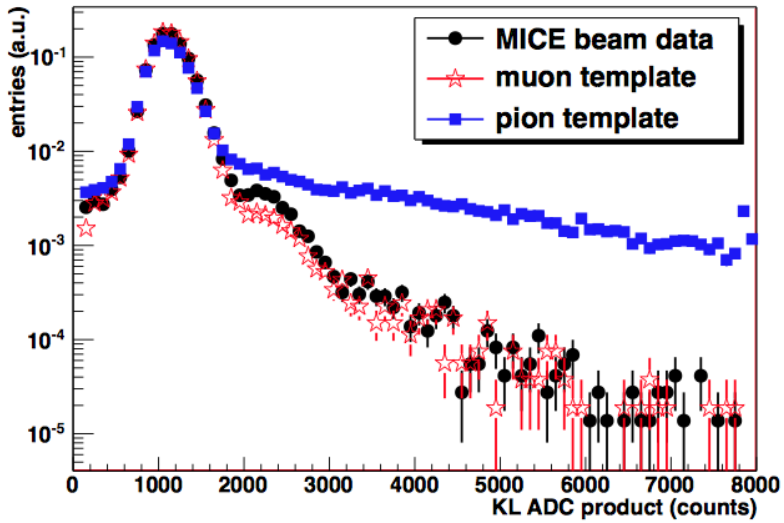
In Step I we measured the TOF, not P, of particles

While electrons are easy to spot, MICE μ beam unknown mixture of μ & π

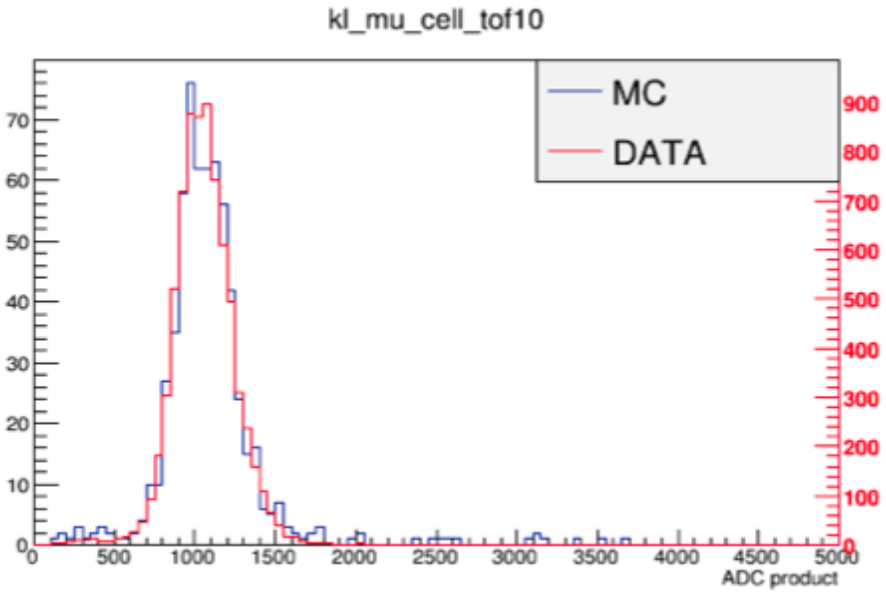
Each species will interact differntly in the KL, use this information to perform particle identification

KL response P dependant so split into TOF windows for analysis





MAUS

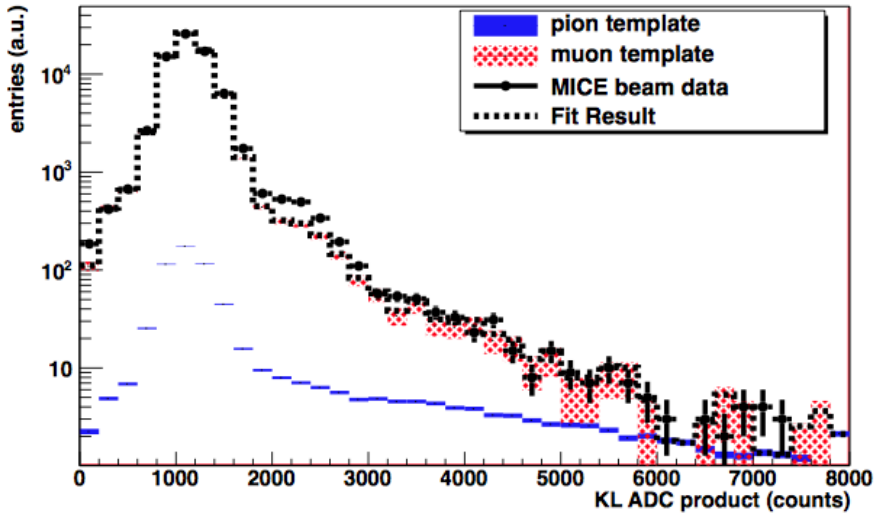


- Since CM39 further levels of smearing in the KL response have been introduced, smearing due to pmt gain - modelled as gaussian. (Mariyan Bogomilov)
- Fine tuning of KL parameters completed

- Production threshold can now be set by volume. (Chris Rogers)
- Threshold reduced in KL volume, track delta rays which populate tails of KL reponse plots

Analysis Code

- Double peak structure due to multiplicity of hits in KL
- Analysis simulates this behaviour, add next event to current event for fraction of responses.



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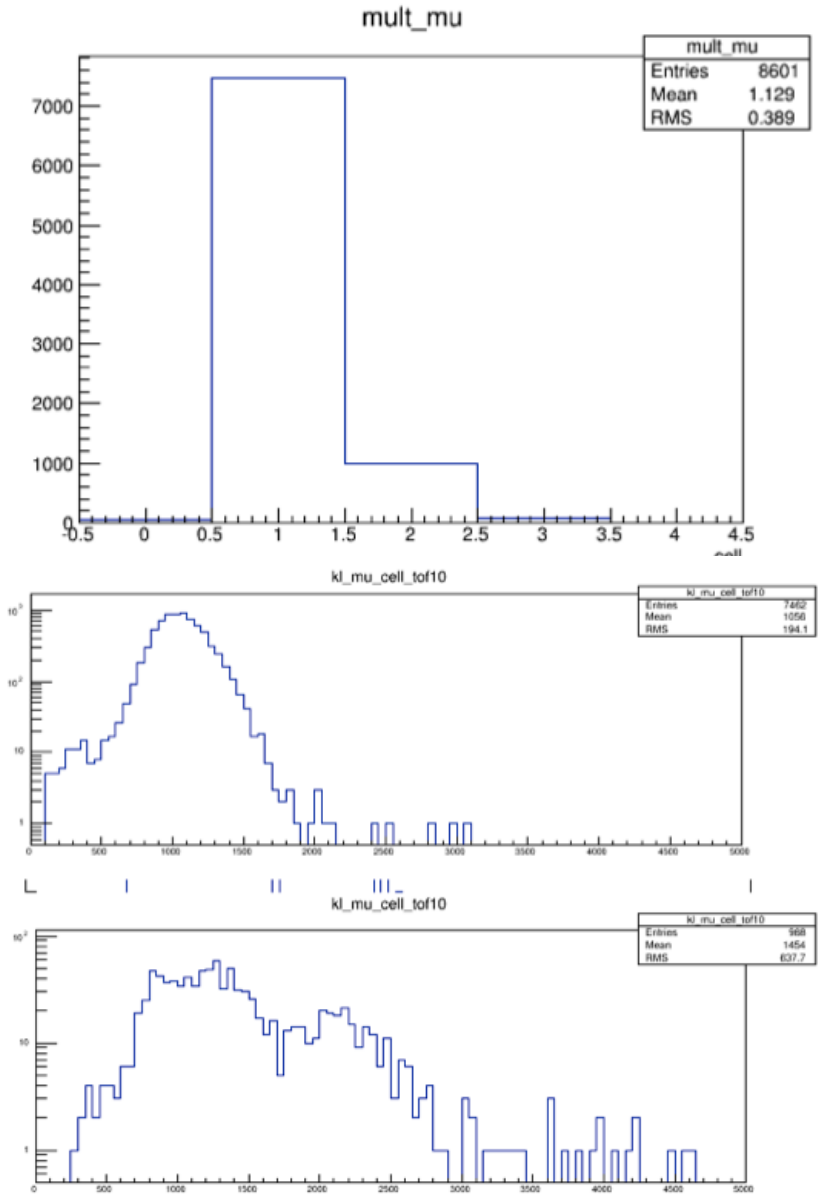


Monte Carlo Beam

- Beamline from target to upstream face of TOF0 simulated in G4beamline
  - Output run through interface to MAUS, converts to json documents in MAUS geometry system
- Using MAUS Step I legacy geometry
- Beams generated are (6, 200) & two pion beams 3253, 3426

TOF Plots

- Reproduce all plots from PID Note 416 in MAUS
- Labels correspond to figure numbers in Note 416

4b)

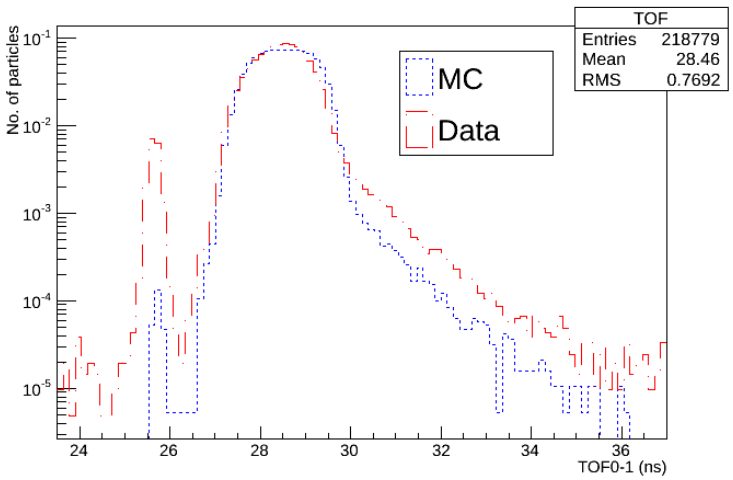


Figure: TOF (6,200) beam

4d)

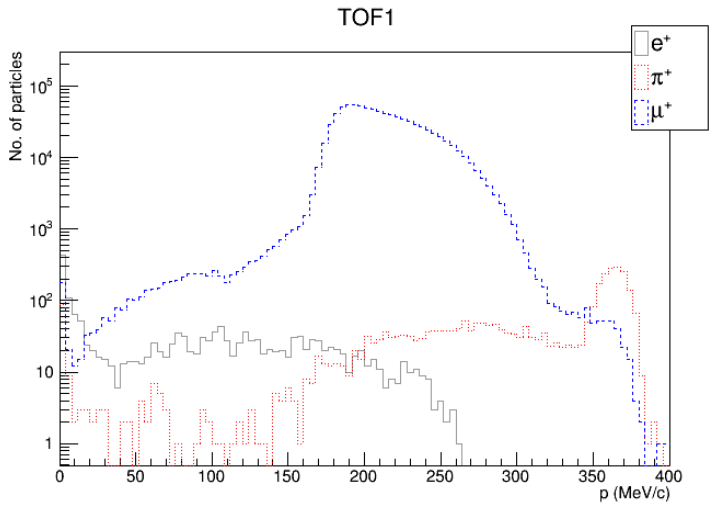
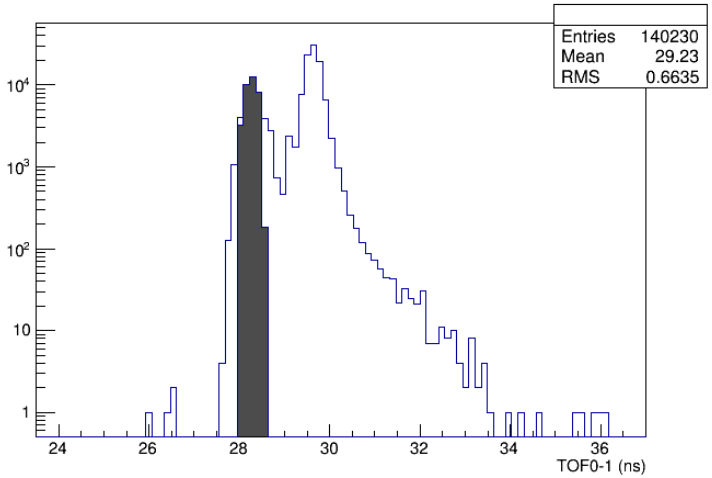


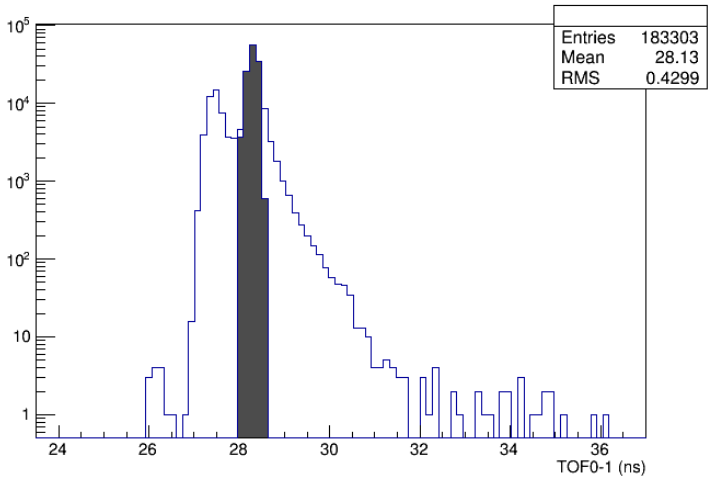
Figure: MC Truth P TOF1

TOF Plots

6a)



6b)

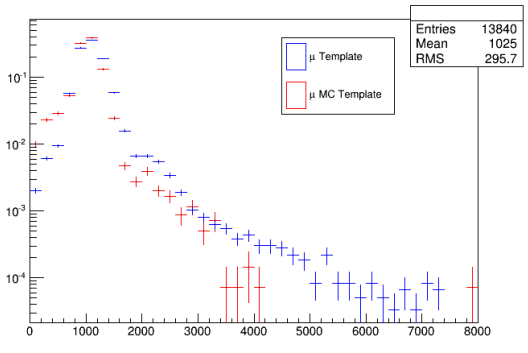


- Selection for PID analysis
- Measure the KL response to 100% μ sample and 100% π sample in same TOF window
- Correction applied to TOF
  - Fit peaks with gaussian in MC and data & calculate $\langle p \rangle$
  -

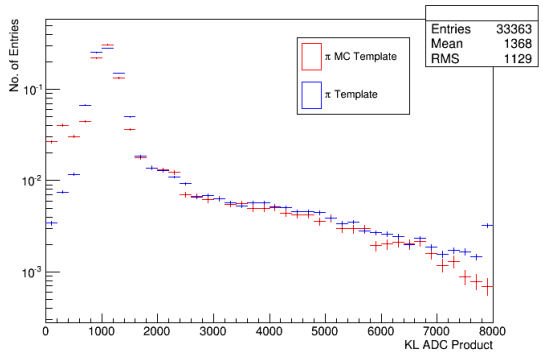
$$\frac{\frac{\Delta t_{\mu/\pi}}{\Delta t_e}_{MC}}{\frac{\Delta t_{\mu/\pi}}{\Delta t_e}_{Data}} = \frac{\sqrt{1+\frac{m^2_{\mu/\pi}}{\langle p^2 \rangle_{\mu/\pi,MC}}}}{\sqrt{1+\frac{m^2_{\mu/\pi}}{\langle p^2 \rangle_{\mu/\pi,Data}}}} \quad (1)$$

KL ADC Counts

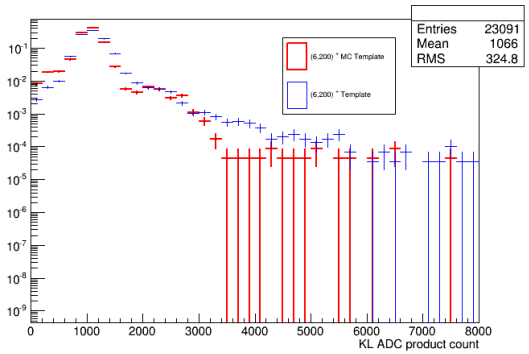
7a)



7b)



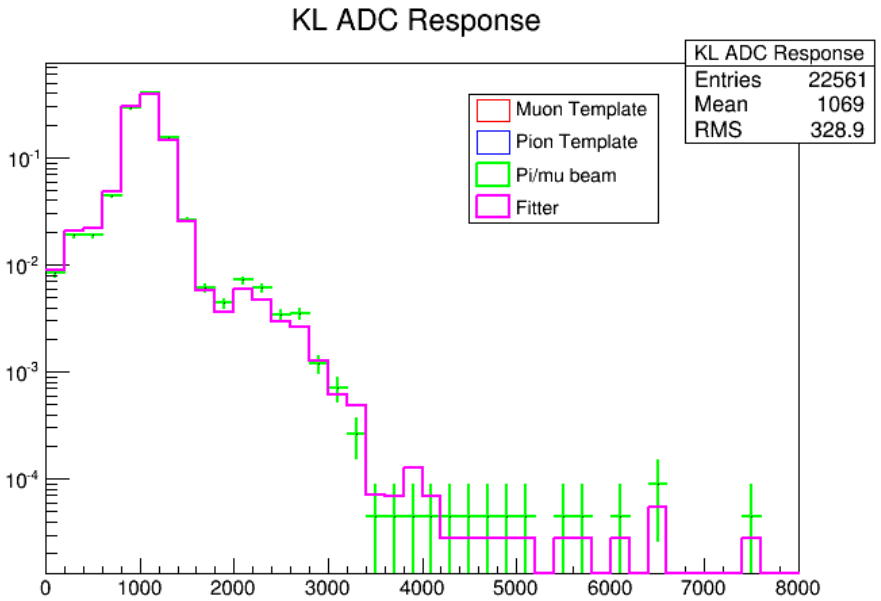
7c)



- KL response after selection for μ, π templates & (6.200) beam
- Below threshold signals in first bin suppressed
- Peak width and position both in good agreement with data
- Behaviour of tails is much improved
- Double peak feature present - due to pile-up in KL

KL ADC Counts

7d)



Pion Contamination

π fraction MC recon 0.30 $\pm$ 0.07 %

π fraction MC Truth 0.40 $\pm$ 0.06 %

π fraction Data 0.60 $\pm$ 0.02 %

Systematic Error

Template Contamination

- Templates are selected based on TOF, some contamination
- Using MC Truth can create uncontaminated templates and estimate π fraction

Pileup

- Fraction of pileup events tuned in data driven way
- Increase/decrease pileup fraction by 10% and estimate π fraction

Table: Systematic Error

Contamination	$\pm$ 3.58 %
Pileup	$\pm$ 0.17 %

Error have to be combined, looking into Feldman Cousins confidence interval

1 Analysis Principle

2 KL Digitisation

3 KL Monte Carlo

4 PID Paper

Paper Status

Complete

- KL digitisation is complete and in MAUS trunk
- All plots for PID paper produced
- First draft of PID Note available at:
  `https://micewww.pp.rl.ac.uk/issues/1473/`

In progress

- Larger MC samples may be useful in completing the PID study
- Apply fix to Step I geometry
- Generate template beams with differnet momenta
- Complete systematic error study