

# Progress with Pion Contamination Paper

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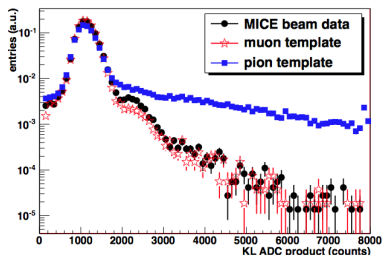
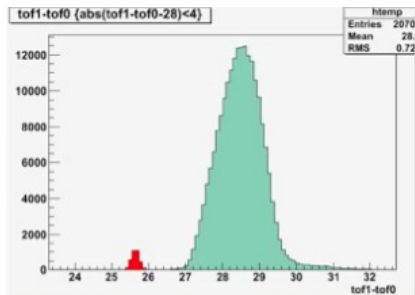
# Analysis Principle

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

While electrons are easy to spot, MICE  $\mu$  beam unknown mixture of  $\mu$  &  $\pi$

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

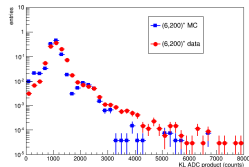
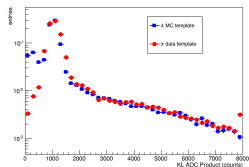
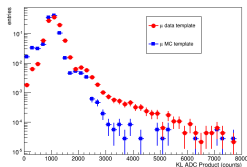
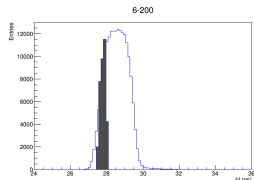
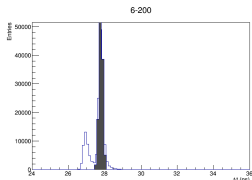
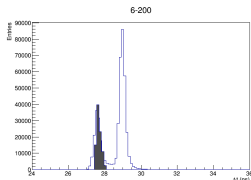
KL response  $P$  dependant so split into TOF windows for analysis



# Monte Carlo Beam

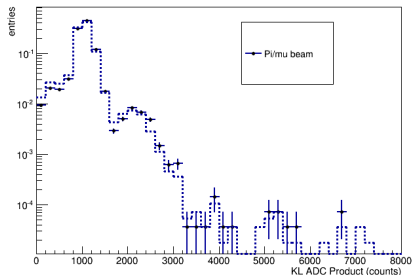
- Beamline from target to upstream face of TOF0 simulated in G4beamline
  - ▶ Output run through interface to MAUS, converts to json documents in MAUS geometry system
- Using MAUS Step I legacy geometry
- Beams generated are (6, 200) & several pion beams 3253, 3426, 3250, 3261, 3256, 3454

# KL ADC Counts



# KL ADC Counts

7d)



## Pion Contamination

$\pi$  fraction MC recon  $0.30 \pm 0.07$  %

$\pi$  fraction MC Truth  $0.40 \pm 0.06$  %

$\pi$  fraction Data  $0.60 \pm 0.02$  %

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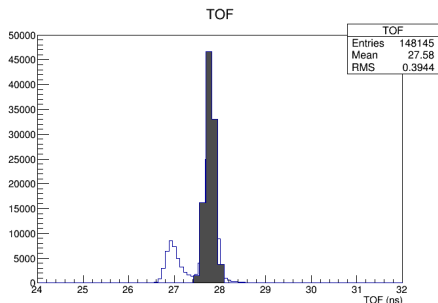


# Status at CM40

- Working version of KL digitisation and analysis code
- First draft of PID Note was circulated
  - ▶ Work required to understand systematic bias of measurement
  - ▶ Investigate the origin of double peak in KL
- Repeat analysis across MICE  $\mu$  beam TOF with calibration beams of different  $P$
- Address issues raised during discussions at CM40
  - ▶ Second draft of PID Note available:  
<https://micewww.pp.rl.ac.uk/issues/1473/> (item 20)

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# Systematic Bias of Measurement



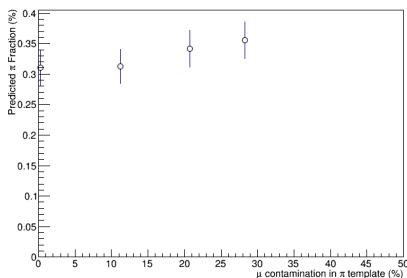
- Select 'pure' sample of  $\pi$ s based on TOF with calibration beam.
- Tails of muon template lie under  $\pi$  peak

- By how much does this contamination affect the measurement of the  $\pi$  contamination in the MICE  $\mu$  beam?
- Re-ran the analysis with various levels of contamination in the  $\pi$  template and note the change in the predicted  $\pi$  fraction

# Systematic Bias of Measurement

Table: Predicted  $\pi$  fraction with  $\mu$  contamination

$\mu$ conta.	Predicted $\pi$ fraction
0%	$0.310\% \pm 0.028\%$
11.3%	$0.313\% \pm 0.028\%$
20.67%	$0.342\% \pm 0.030\%$
28.27%	$0.356\% \pm 0.030\%$



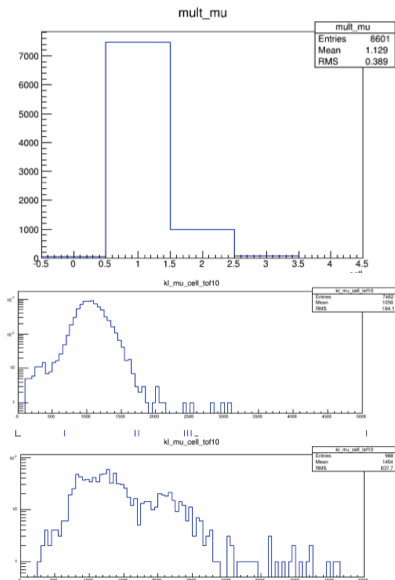
- Systematic error due to  $\mu$  contamination - 0.032%
- This systematic give a non-negligible but small error on the measurement

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# Pileup in KL

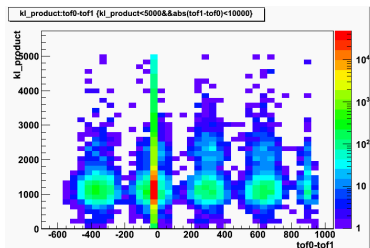
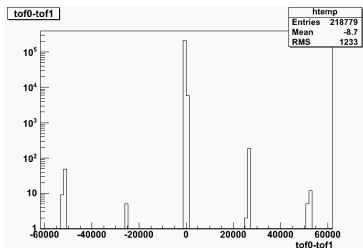
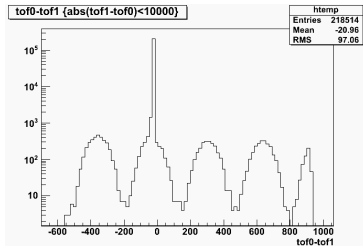
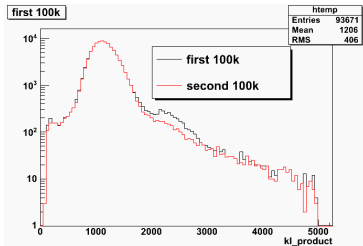
(Issue is in flux at the moment! -  
Updates to follow)

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



# Pileup in KL

- To understand the origin of pileup  $\rightarrow$  must understand the time structure of the MICE beam



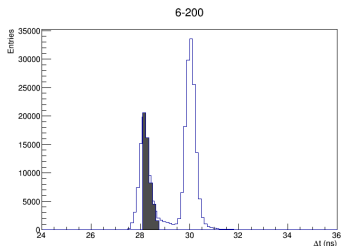
## Pileup in KL

- Re-processed MICE data in MAUS v0.9.1 and these effects are still present
- Effects are not present in MC - no MC trigger in MAUS
- Rate not recorded in run conditions spreadsheet & luminosity monitor scalar not filled in data nTuple
- Reprocessing more data currently held up by MAUS bug - flagged on issue tracker and requested experts to take a look
- Determine if there is a correlation between beam profile in KL & TOF2 and double peak.
- (Data processed with MAUS v0.9.1 does not have double peak!)

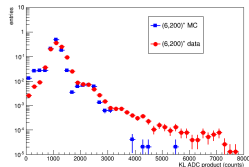
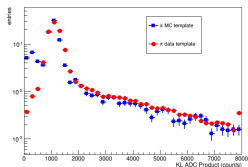
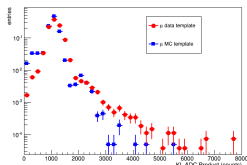


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# Analysis at P2 & P3



- Repeat process at later TOF windows
- Contamination P2  
 $= 0.13 \pm 0.05 \pm 0.03\%$ 
  - ▶ Match within errors MC Truth
- Contamination of P3 to follow



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# Paper Status

## Complete

- Applied fix to Step I geometry
- Generated template beams with different momenta
- Completed a systematic error study
- Second draft of PID Note available at:  
<https://micewww.pp.rl.ac.uk/issues/1473/>

## In progress

- MAUS bug for processing data - top priority
- Larger MC samples may be useful in completing the PID study