Global PID

MICE CM41

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Previous talks

- Introduction to PID framework and first PID variable (upstream time of flight, PIDVarA).

- Expansion of framework to use 2D PDFs and inclusion of PID within global reconstruction.

- Second PID variable (upstream time of flight/tracker momentum, PIDVarB), updates to global datastructure and detector event importing.

- Third PID variable (KL ADC charge product/downstream tracker momentum, PIDVarC), preliminary work on PID efficiency and purity.

Outline

Main points for this talk:

- Detector importing into global event.
- Status of PID.
- Updates to efficiency calculation.
- PID next steps.
- PID during commissioning.
- PID analysis of Step IV data.

Detector importing into the global event

- Currently within MAUS there are importers to bring detector information into the global event for the TOFs, trackers, Ckovs and KL. EMR importer is in development.

- Global track reconstruction requires the positions of the hits in the detectors, within the global coordinate system. Positions can be obtained from all detectors other than the Ckovs.

- The tracker reconstruction provides positions in the global system. Other reconstructions provide positions as local bar/slab numbers, which can be translated into global coordinates for a given geometry.

Detector importing into the global event

- In release version of MAUS, TOF importer currently has translation to legacy Step IV coordinates hard coded in. Same is done for KL (currently only in personal development branch).

- Would be better if all detectors returned positions within the global coordinate system of whatever geometry was being used at run time.

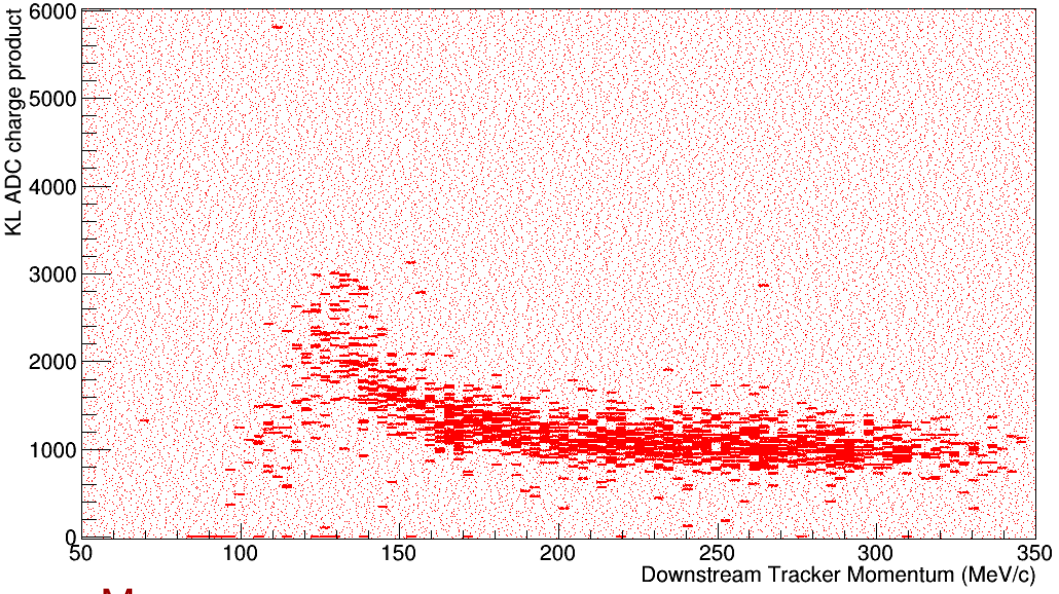
- Chris Hunt and Chris Heidt are now developing a system for translating local detector coordinate systems into the global MAUS coordinate system.

Status of PID

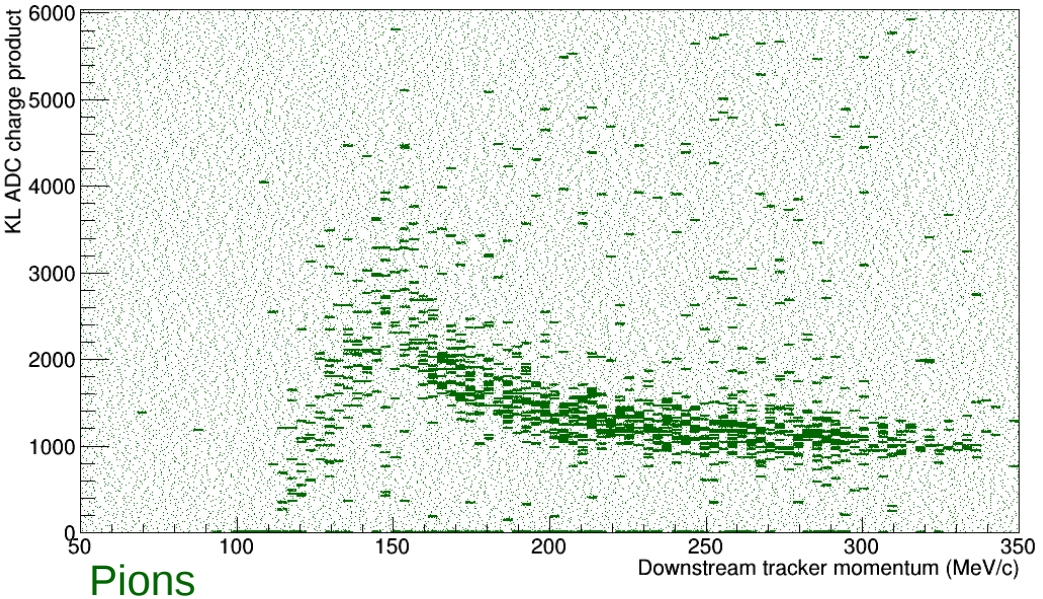
- Most up-to-date PID work can be found in my branch lp:~c-e-pidcott/maus/1389a.
- PIDVarC is now in release version of MAUS.
- PID documentation continues to be updated as framework and variables evolve.
- Started to consider inclusion of EMR to PID.
- Updated PID efficiency calculation.

- Performed PID for the first time on DS tracks produced by the global reconstruction.

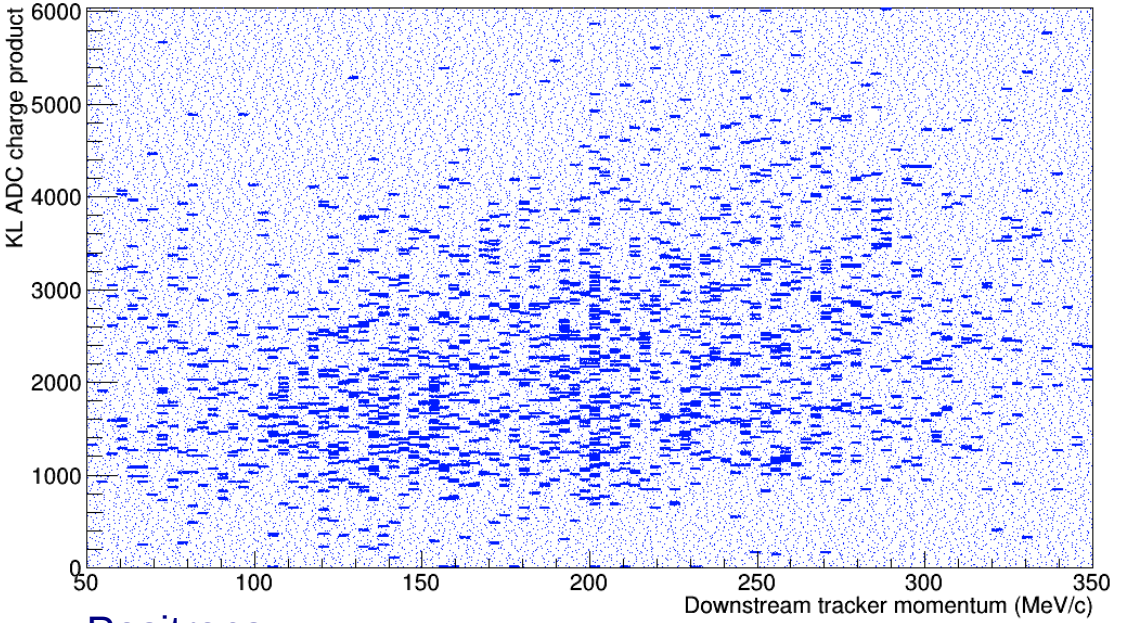
PIDVarC (KL ADC charge product vs Downstream Tracker Momentum)



Muons



Pions



Positrons

Efficiency of PID

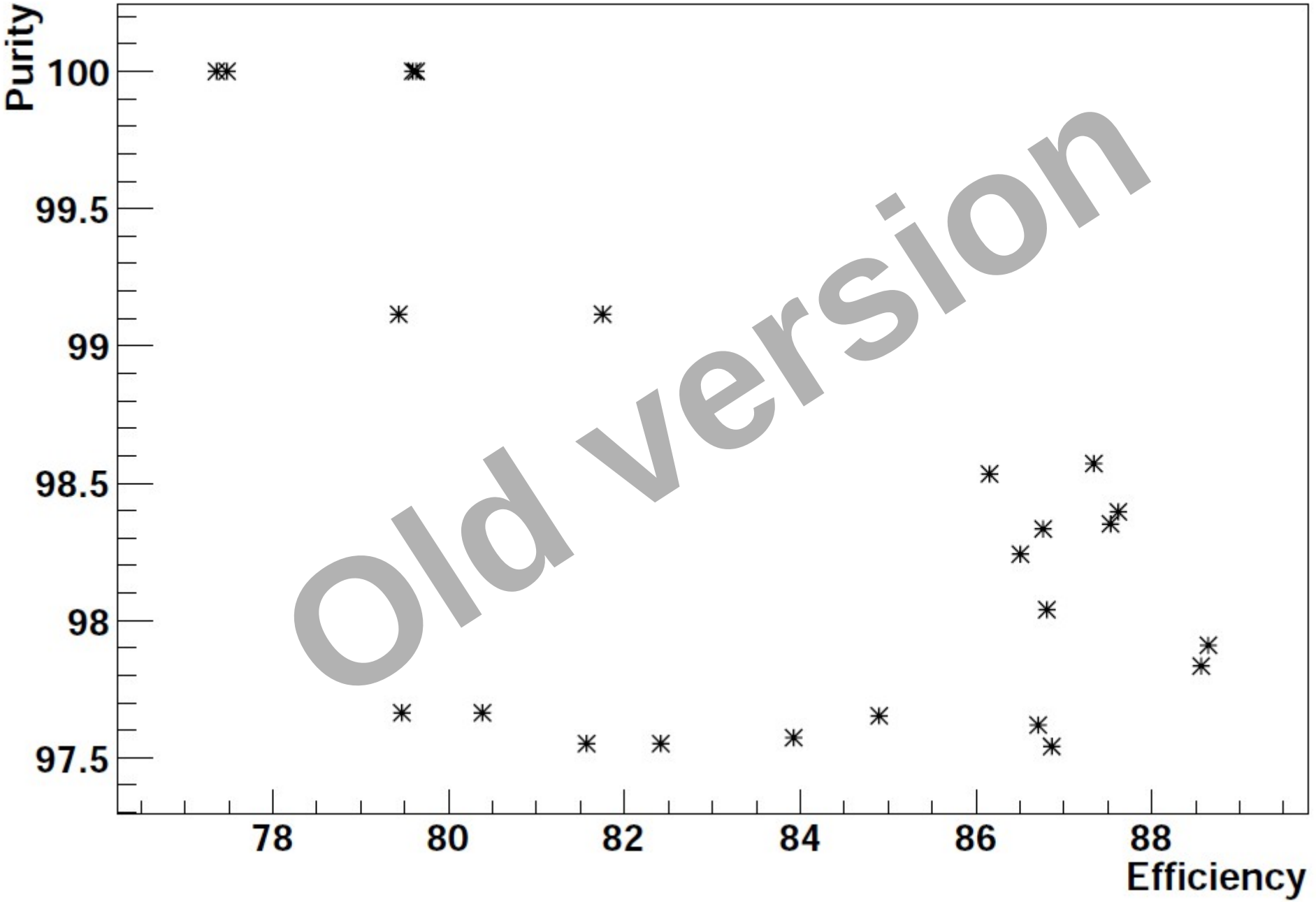
- At last CM, showed the beginnings of work on determining preliminary efficiency and purity for Global PID.
- Considered the case for a 200 MeV/c muon beam, with decays off, for PIDVarA and B separately.
- Following discussions after CM, it was decided that the efficiency calculation needed to be corrected, as having tracks omitted from the calculation due to heavy cuts was artificially inflating the value of the efficiency.

Efficiency of PID

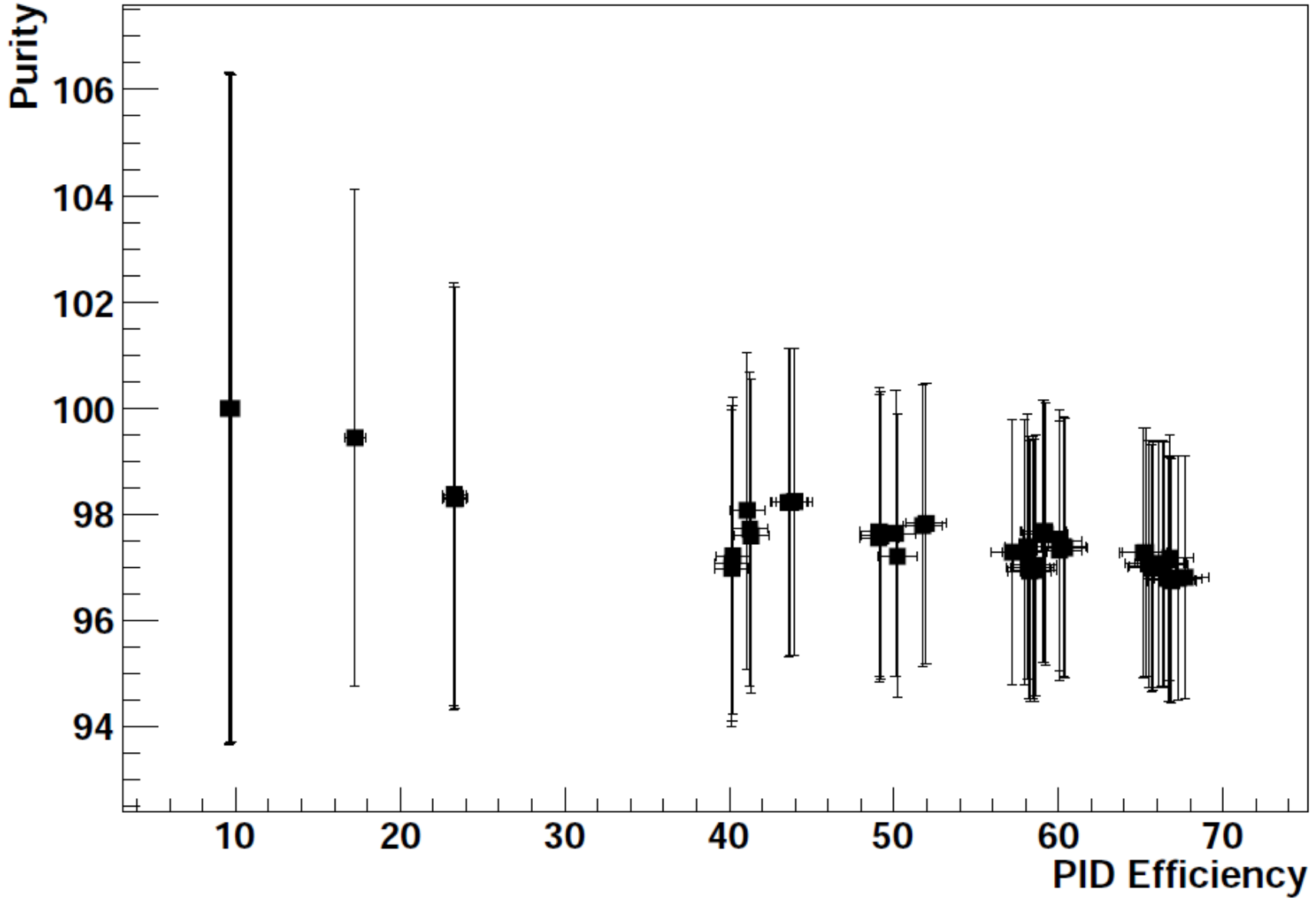
$$\text{PID efficiency} = \frac{\text{\# of correct PID tracks}}{\text{\# MC tracks - \# unsuitable tracks}}$$

- Unsuitable track : One which does not meet the requirements to calculate the value of a PID variable, i.e., missing detector information, extra detector hits, value outside of physical range.
    - This is a problem with the reconstructed track, not the PID, and so when calculating the efficiency strictly for the PID should not be considered.

PID Efficiency and Purity for PIDVarB (TOF/Tracker)



Updated PID Efficiency and Purity for PIDVarB (TOF/Tracker)



PID next steps

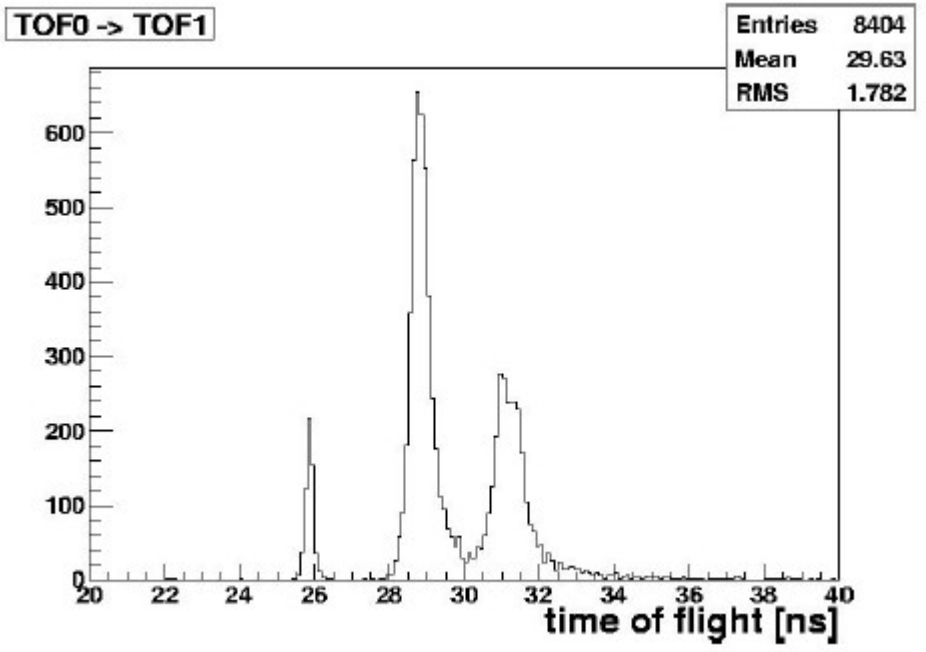
- Formalise hypothesis construction and output of PID.
- Develop downstream PID variable incorporating EMR data.
- Perform PID on complete US and DS tracks produced by global reconstruction using RK.
- Perform full efficiency and purity on MC tracks.
- Develop version of PID to use during global alignment work.
- Develop method to determine performance of PID using Step IV data.

PID during commissioning

- Want to perform PID during global alignment work.
- No magnetic fields, so no momentum from trackers.
- Need a separate set of commissioning PID variables.
- For commissioning, do not need to blind US and DS, so can use cross-channel PID variables, i.e. time of flight between TOF1 and TOF2.
- Plans underway, straight tracks simulated and development on new variables has begun.

PID analysis of Step IV data

- By using a pion beam ($P_{D1} \approx P_{D2}$) obtain a mixed beam with clearly separated TOF peaks.
- By cutting on TOF, can select a sample of pions upstream. Given that pions decay, the expected number of pions downstream can also be calculated.
- The performance of the PID can then be tested on this sample.
- The same principle can be applied to muons and (minus the decay step) electrons.



PID analysis of Step IV data

- Upstream and downstream PID should be independent during Step IV data analysis.

- As with during global alignment, for the purposes of studying the performance of the upstream and downstream PID variables, extra variables that cross the cooling channel could be considered, to perform extra checks of the standard PID variables.

- Need to develop the method and code that will perform the analysis and test on MC data.

Summary

- PID has been performed on a track produced by the RK global track reconstruction.
- There are now three PID variables in MAUS, two upstream and one downstream.
- EMR importer and an EMR based PID variable are in development.
- Finalising the output of the PID.
- Work is ongoing on the performance of the PID for both MC and data.
- Developing PID for use during field-free commissioning of experiment.