Global PID

MICE CM42

22/06/15

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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.
- Introduction to commissioning PID, updates on efficiency and purity.

Outline

Main points for this talk:

- Status of PID.
- Using PID – input and output, for commissioning and Step IV.
- PID variables.
- Efficiency/purity of (online) variables.

Status of PID

- Most up-to-date PID work can be found in my branch lp:~c-e-pidcott/maus/1389a.
- Collection of PID variables, for Step IV and commissioning, now exists, using all detectors except Cherenkovs.
- PID has now been run on (MC) tracks produced by global reconstruction.
- Once unit tests have been updated/written for the new variable classes, should be ready to push to MAUS.
- Updates to documentation are on the way.

Using PID - input

• Global PID can be used for commissioning (field off) or Step IV data, by setting the **pid_config** datacard to “step_4” or “commissioning”.

• If step_4 is selected, the PIDVar set of variables will be used. If commissioning is selected, the ComPIDVar variables will be used.

• The actual variables then used is determined by the **pid_mode** datacard, which can be set to “online”, “offline”, or “custom”.

• If custom is selected, the user must set the variables to be used using the **custom_pid_set** datacard. However, this setting should only really be used by someone developing the PID... i.e. someone in Globals.

PID input – online vs offline

• “Online” variables are ones which are beam (momentum) independent, and so are suitable for online running, and for which their PDFs can be pre-produced and packaged with MAUS.

• “Offline” variables depend on the beam settings, and so should be produced by the user once they have determined their simulation settings. A library of the core MICE settings can be included with MAUS, but for anything off-menu, the user would need to produce their own PDFs.

Using PID - input

• Particle identification is performed by the MapCppGlobalPID mapper in MAUS. An input_json_file_name and output_json_file_name must also be set in the datacards.

• PDFs are produced using the ReduceCppGlobalPID reducer. An input_json_file_name, global_particle_hypothesis and unique_identifier (i.e. time stamp) must also be set in the datacards.

•The precursors to using the global PID (both to run PID using pre-existing PDFs and to produce new PDFs) are MapCppGlobalReconImport and MapCppGlobalTrackMatching*.

*** The version of MapCppGlobalTrackMatching currently in MAUS is soon to be replaced by one that incorporates the Runge-Kutta, users should wait until that is in place to use global PID**

Using PID – input/output

- TrackMatching supplies multiple potential tracks to the PID, each with an assigned pid.

- The PID clones these tracks, into Candidate PID tracks, and performs PID on each of them (using the log-likelihood method described in previous talks).

- Each candidate track is then assigned an object that holds the likelihoods for each hypothesis.

Using PID - output

• The confidence level for each hypothesis is calculated for the track. If the confidence level of a given hypothesis clearly distinguishes it from the others, this is set as the pid of the candidate track.

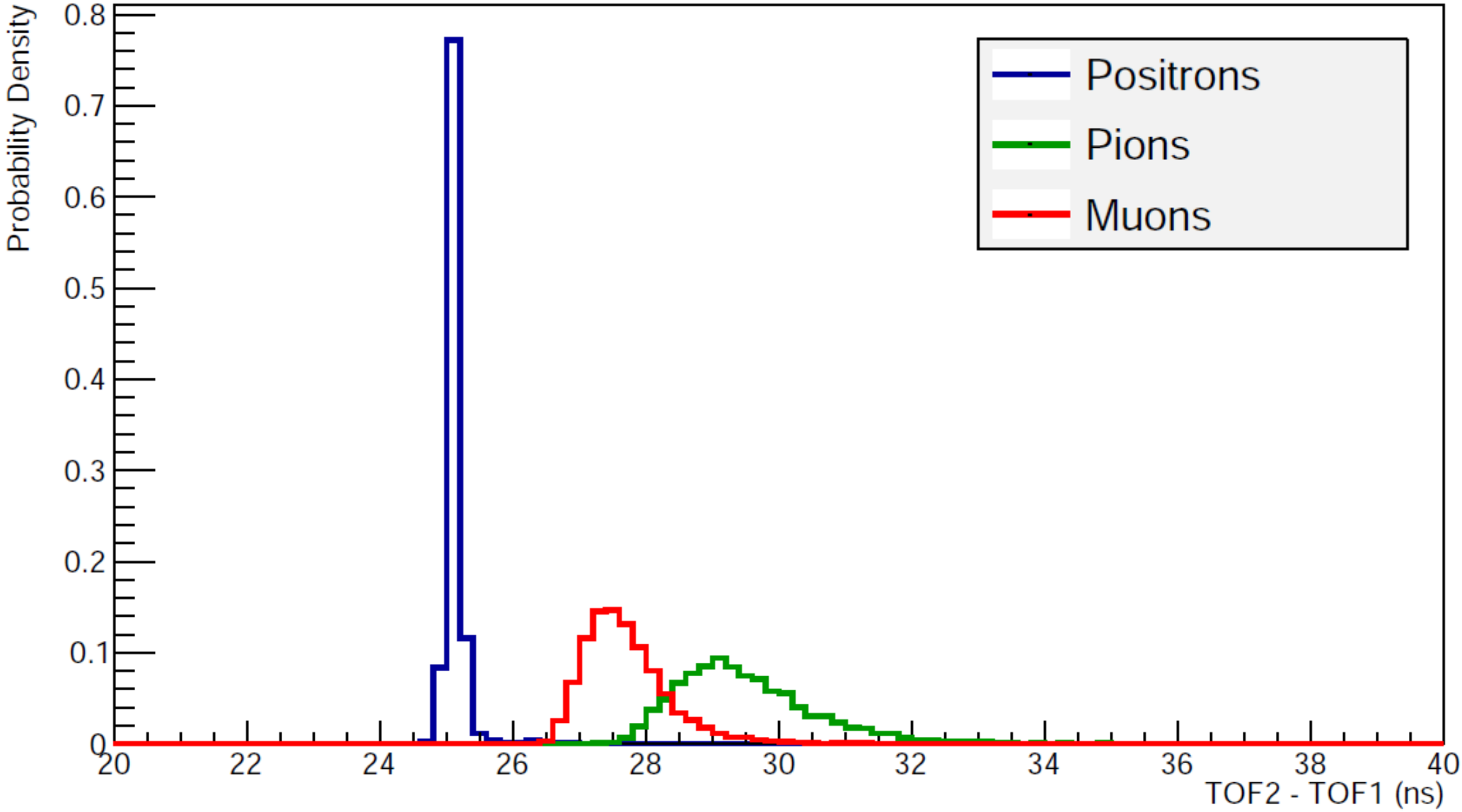
• If the pid of the candidate track matches the pid of the original trackmatching track, then this is taken to be the correct track, and is added to the global event as the Final PID track.

• All candidate tracks are retained by the event, so that during analysis they can be referred back to by the user.

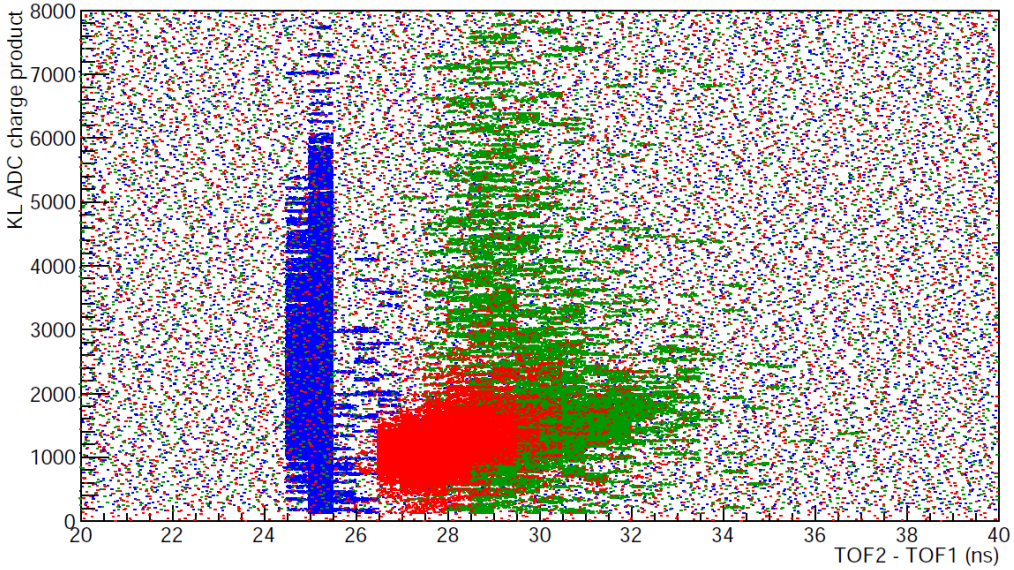
Commissioning PID Variables

Class Name	Variable Name	Description	Online/ Offline	Notes
ComPIDVarA	diffTOF1TOF2	Time of flight between TOF1 and TOF2.	Offline	Suitability as a variable will be investigated via efficiency/purity studies.
ComPIDVarB	KLChargeProdvsDiffTOF1TOF2	KL ADC charge product vs the time of flight between TOF1 and TOF2.	Online	Reduces dependence on beam momentum, making it suitable for online use.
ComPIDVarC	Commissioning KLADCChargeProduct	KL ADC charge product	Offline	Suitability as a variable will be investigated via efficiency/purity studies.
ComPIDVarD	Commissioning EMRrange	Range of particle in EMR	Offline	Suitability as a variable will be investigated via efficiency/purity studies.
ComPIDVarE	Commissioning EMRrangevsDiff TOF1TOF2	Range of particle in EMR vs the time of flight between TOF1 and TOF2.	Online	Reduces dependence on beam momentum, making it suitable for online use.

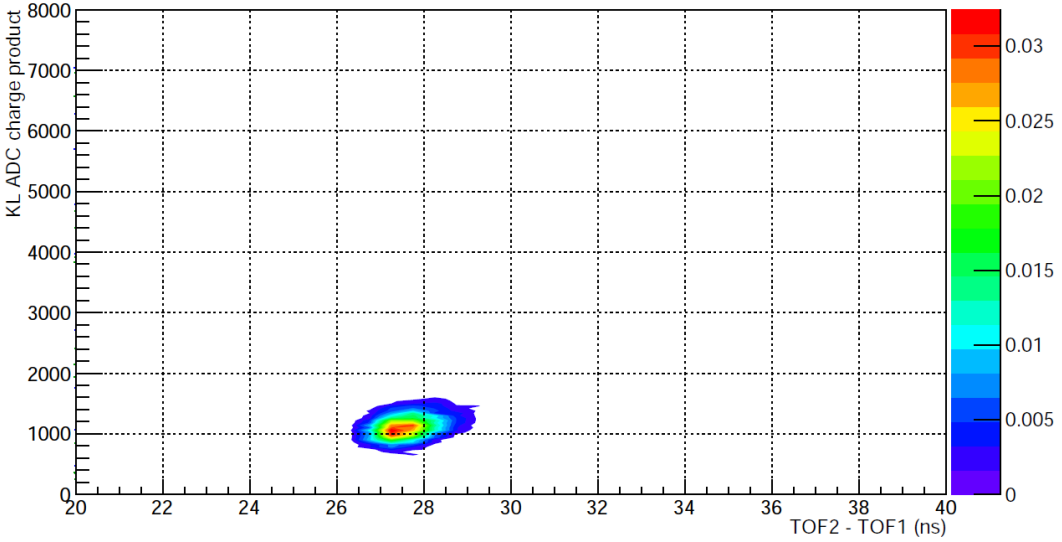
ComPIDVarA- diffTOF1TOF2



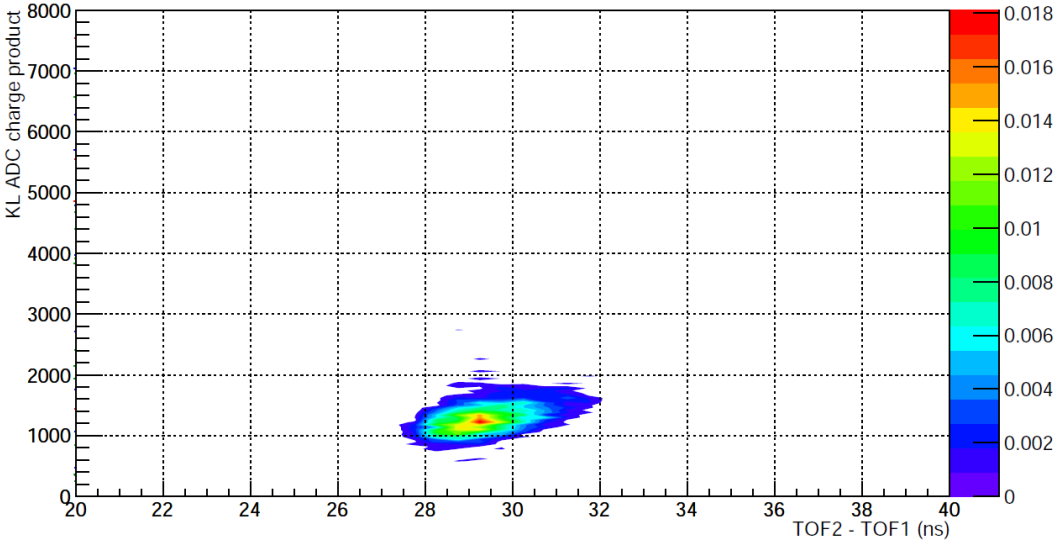
ComPIDVarB-KLChargeProdvsDiffTOF1TOF2



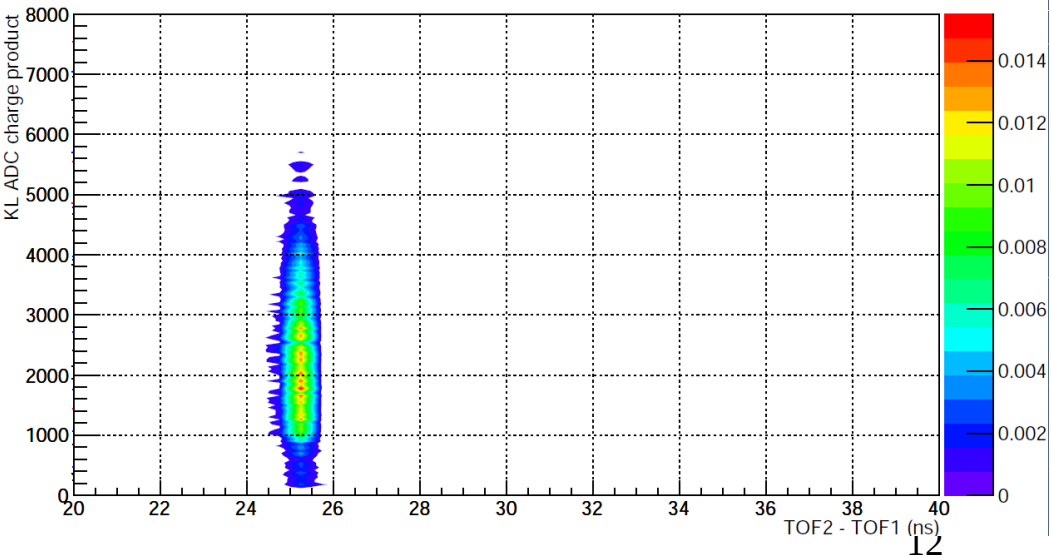
Muons



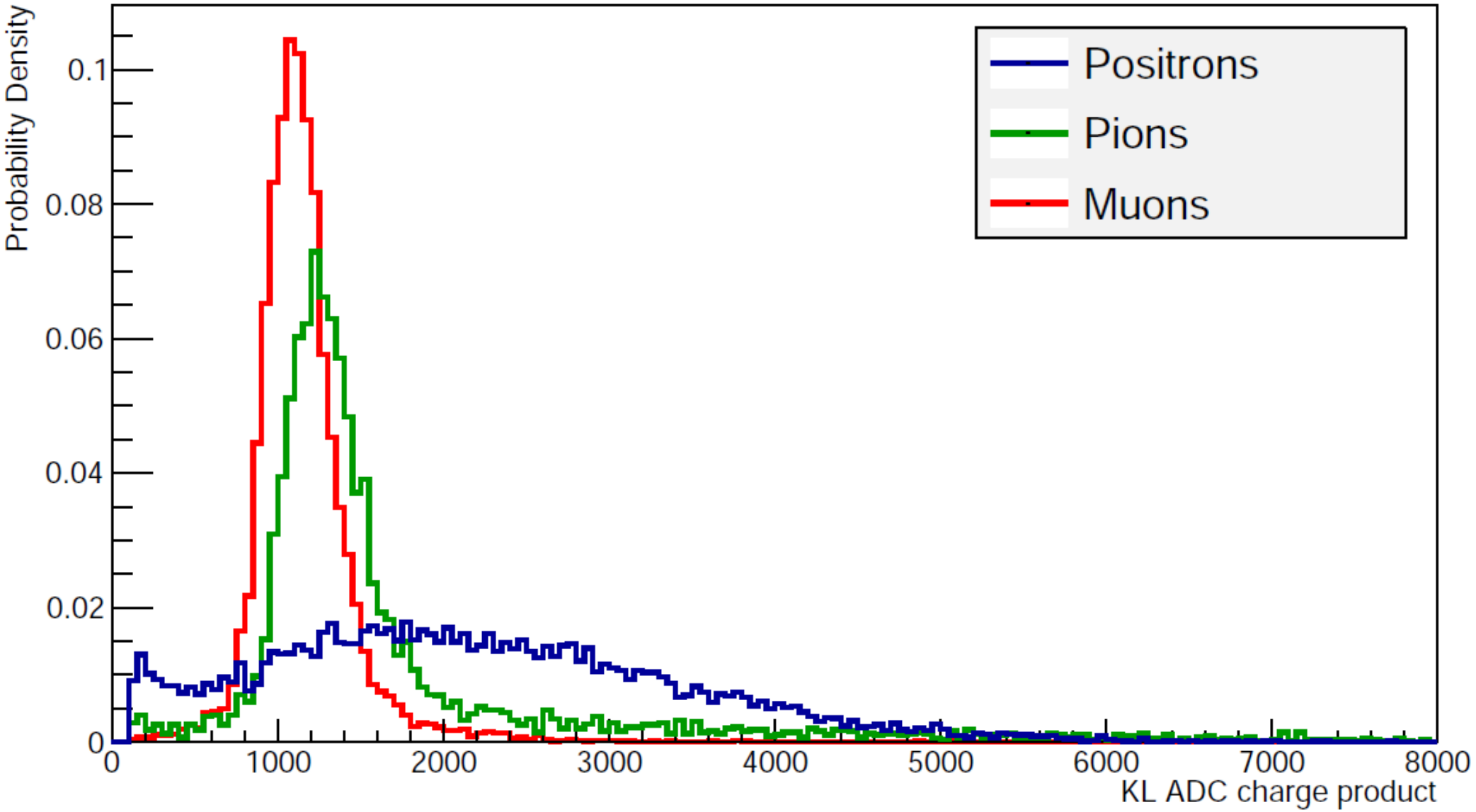
Pions



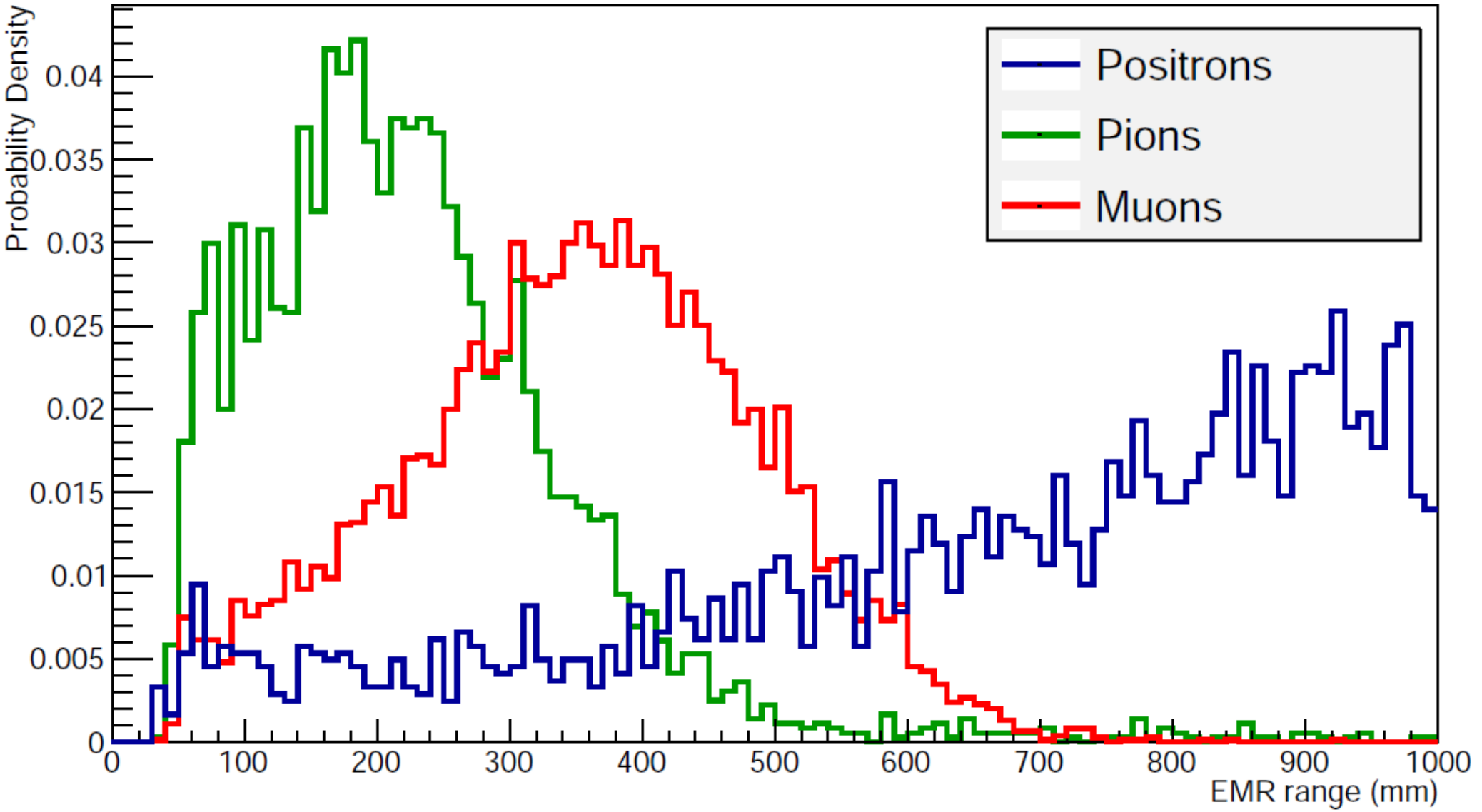
Positrons



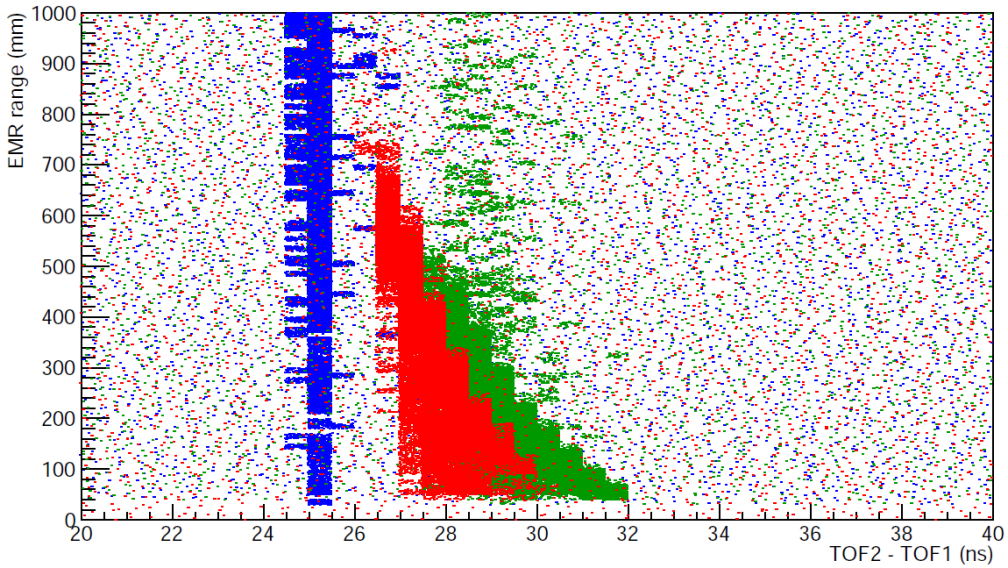
ComPIDVarC-CommissioningKLADCChargeProduct



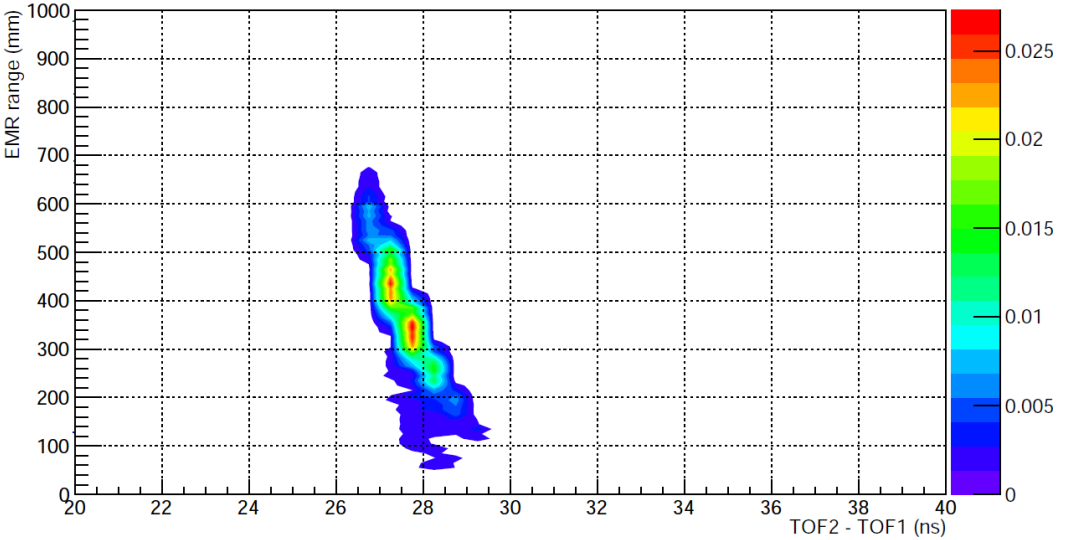
ComPIDVarD- CommissioningEMRRange



ComPIDVarE-CommissioningEMRrangevsDiffTOF1TOF2



Muons



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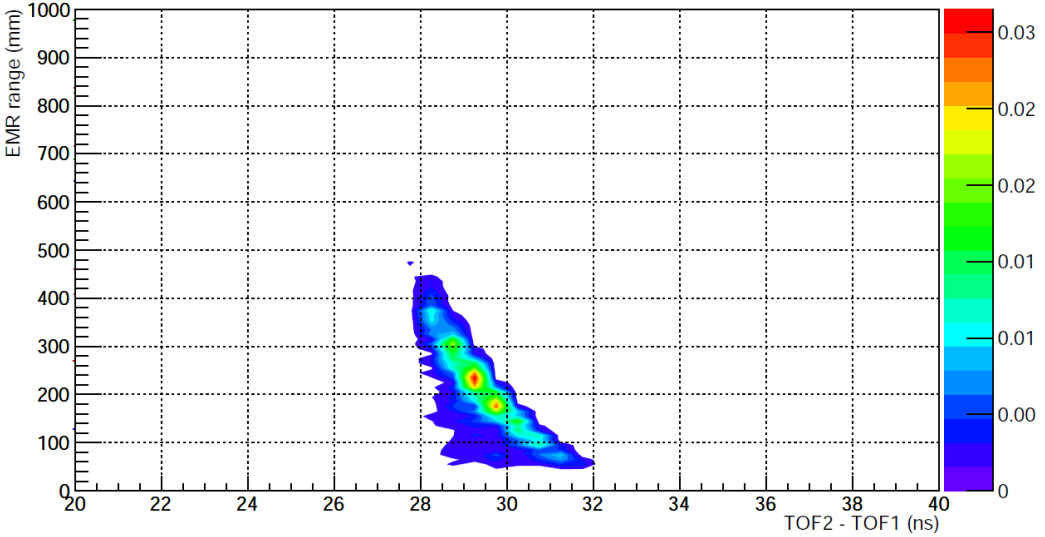
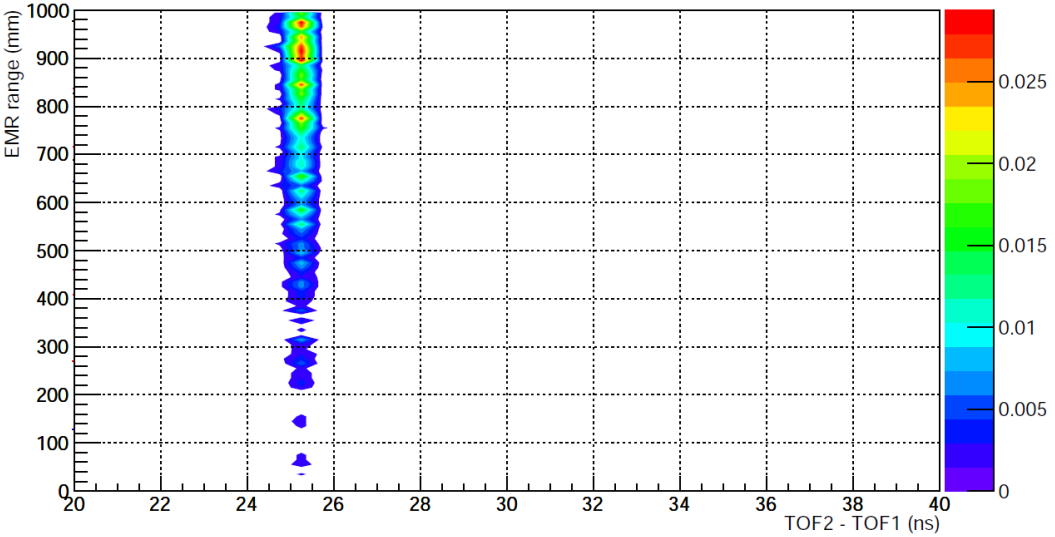


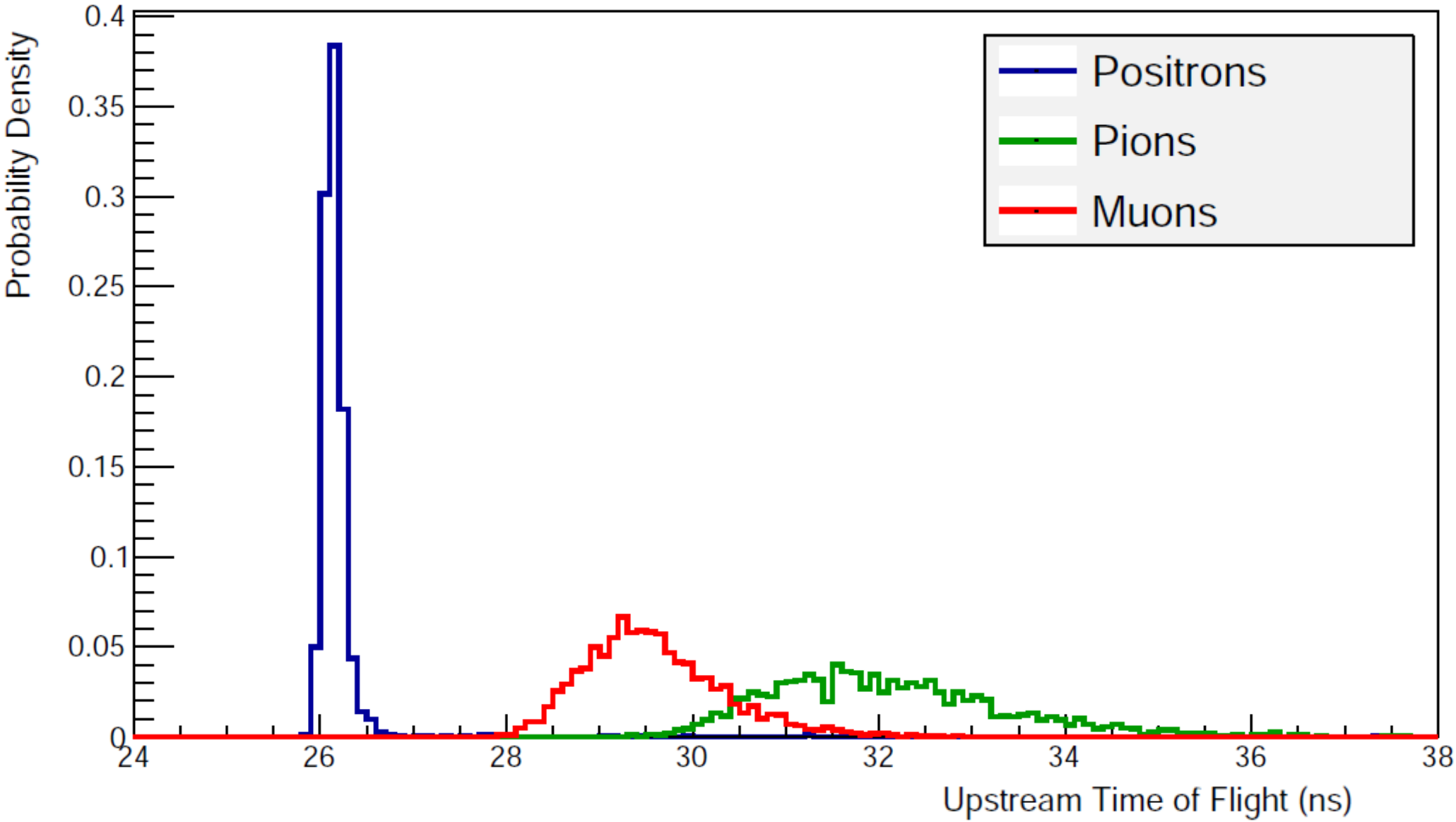
Positrons



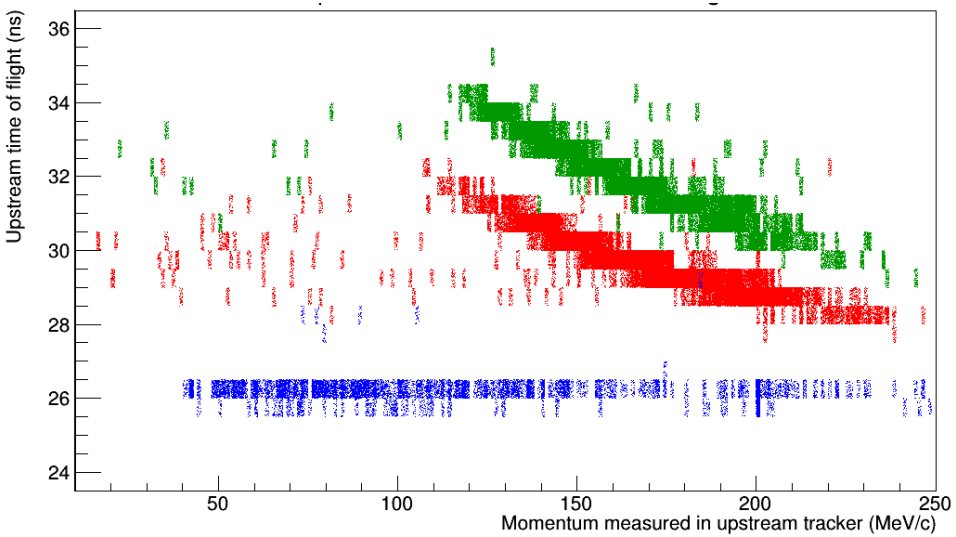
Step IV PID Variables

Class Name	Variable Name	Description	Online/ Offline	Notes
PIDVarA	diffTOF1TOF0	Upstream time of flight	Offline	Suitable for offline use only, as momentum dependent.
PIDVarB	diffTOF0TOF1vs TrackerMom	Upstream time of flight vs momentum measured in upstream tracker	Online	Reduces dependence on beam momentum, making it suitable for online use.
PIDVarC	KLChargeProdv sDSTrackerMom	KL ADC charge product vs momentum measured in DS tracker	TBD	Suitability as an online/offline variable will be investigated via efficiency/purity studies.
PIDVarD	KLADCChargeP roduct	KL ADC charge product	Offline	Suitability as a variable will be investigated via efficiency/purity studies.
PIDVarE	EMRrange	Range of particle in EMR	Offline	Suitability as a variable will be investigated via efficiency/purity studies.
PIDVarF	EMRrangevsDS TrackerMom	Range of particle in EMR vs momentum measured in DS tracker	Online	Reduces dependence on beam momentum, making it suitable for online use.

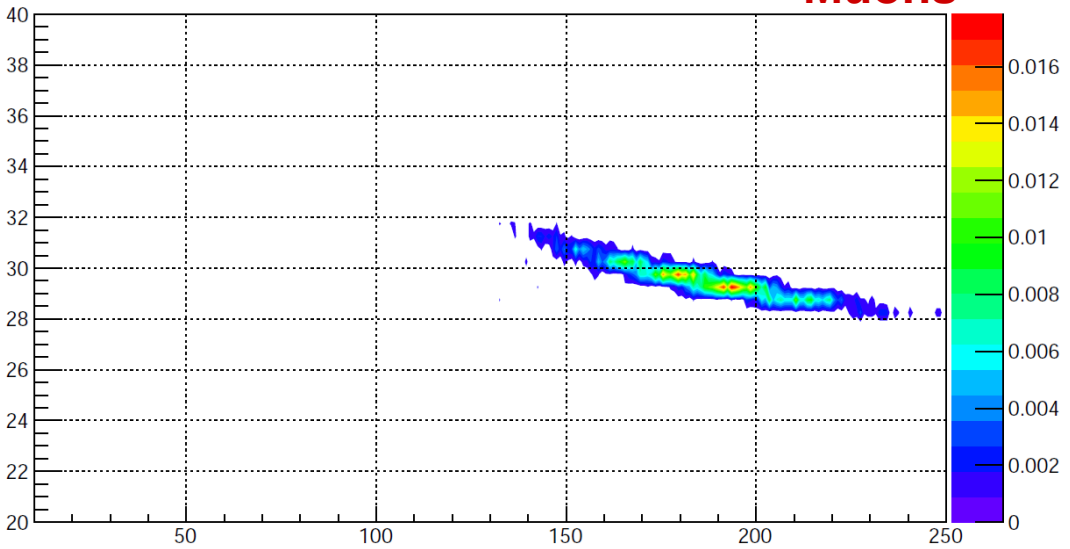
PIDVarA- diffTOF1TOF0



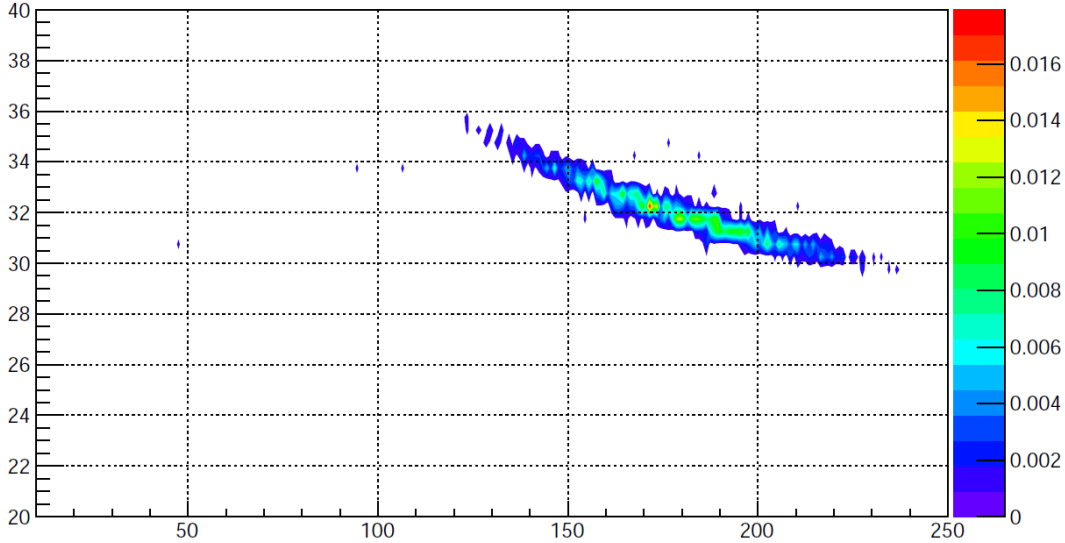
PIDVarB- diffTOF0TOF1vsTrackerMom



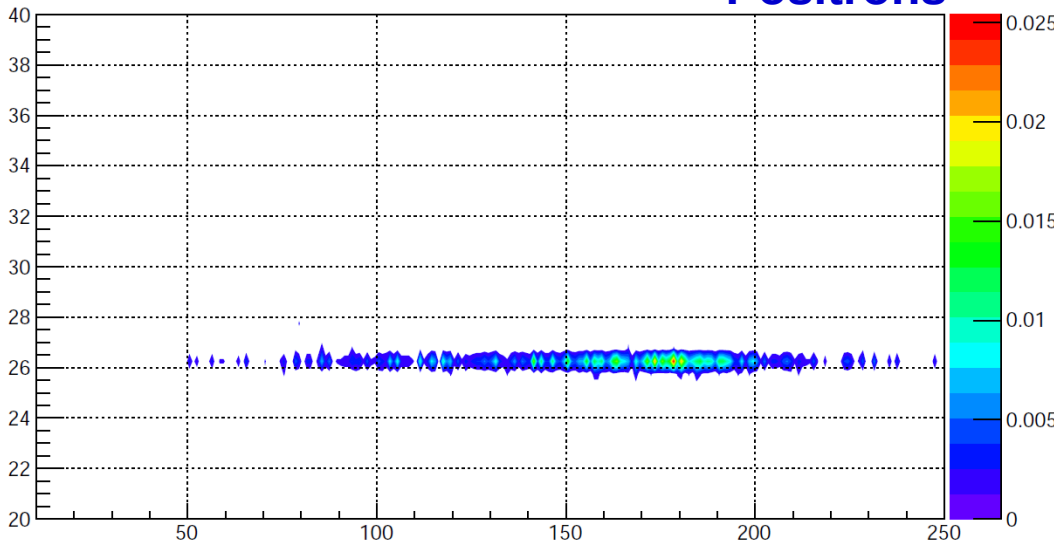
Muons



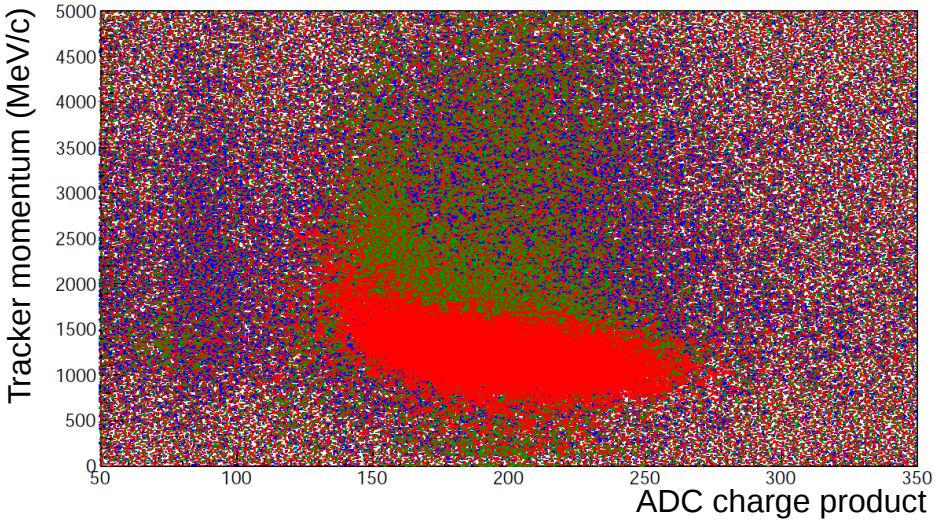
Pions



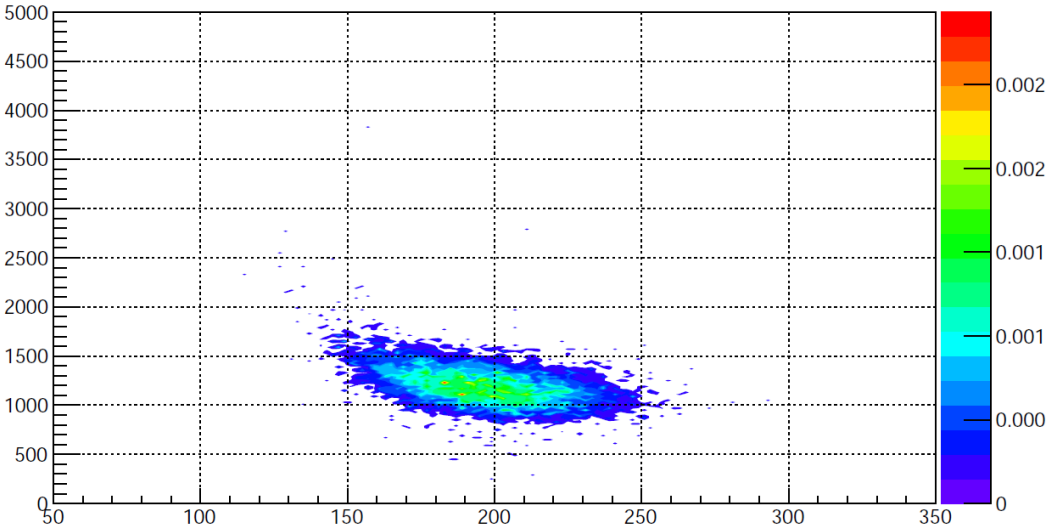
Positrons



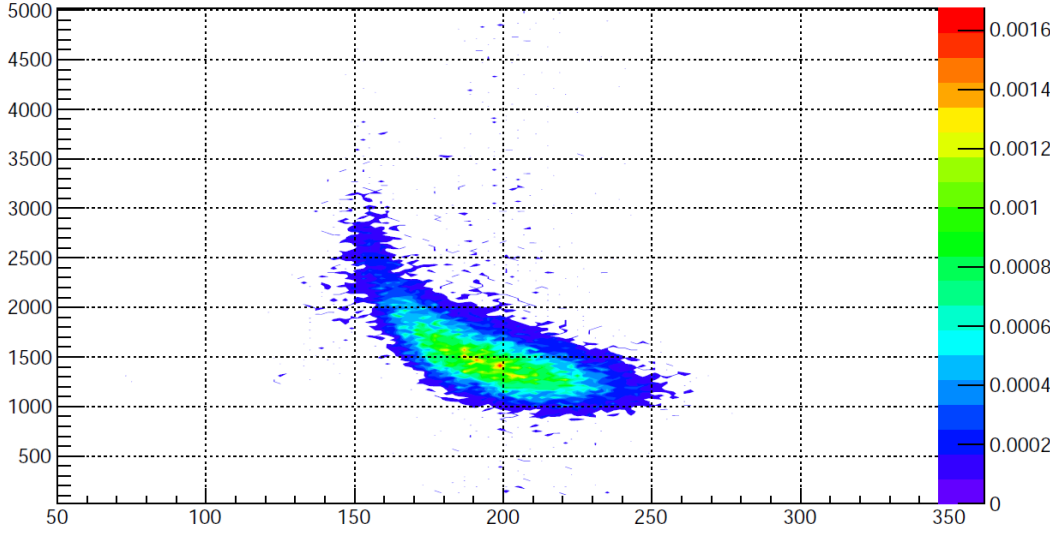
PIDVarC-KLChargeProdvsDSTrackerMom



Muons



Pions



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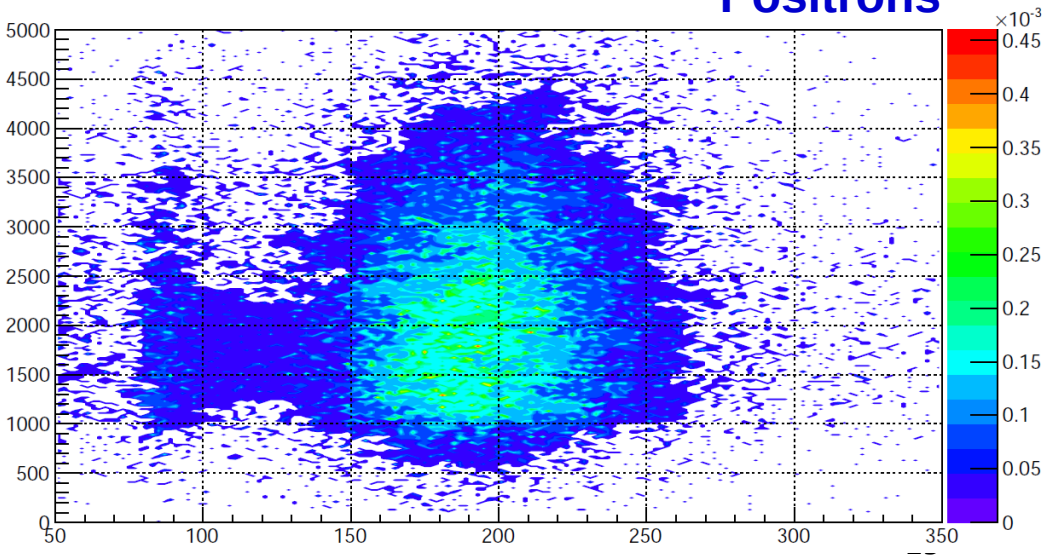
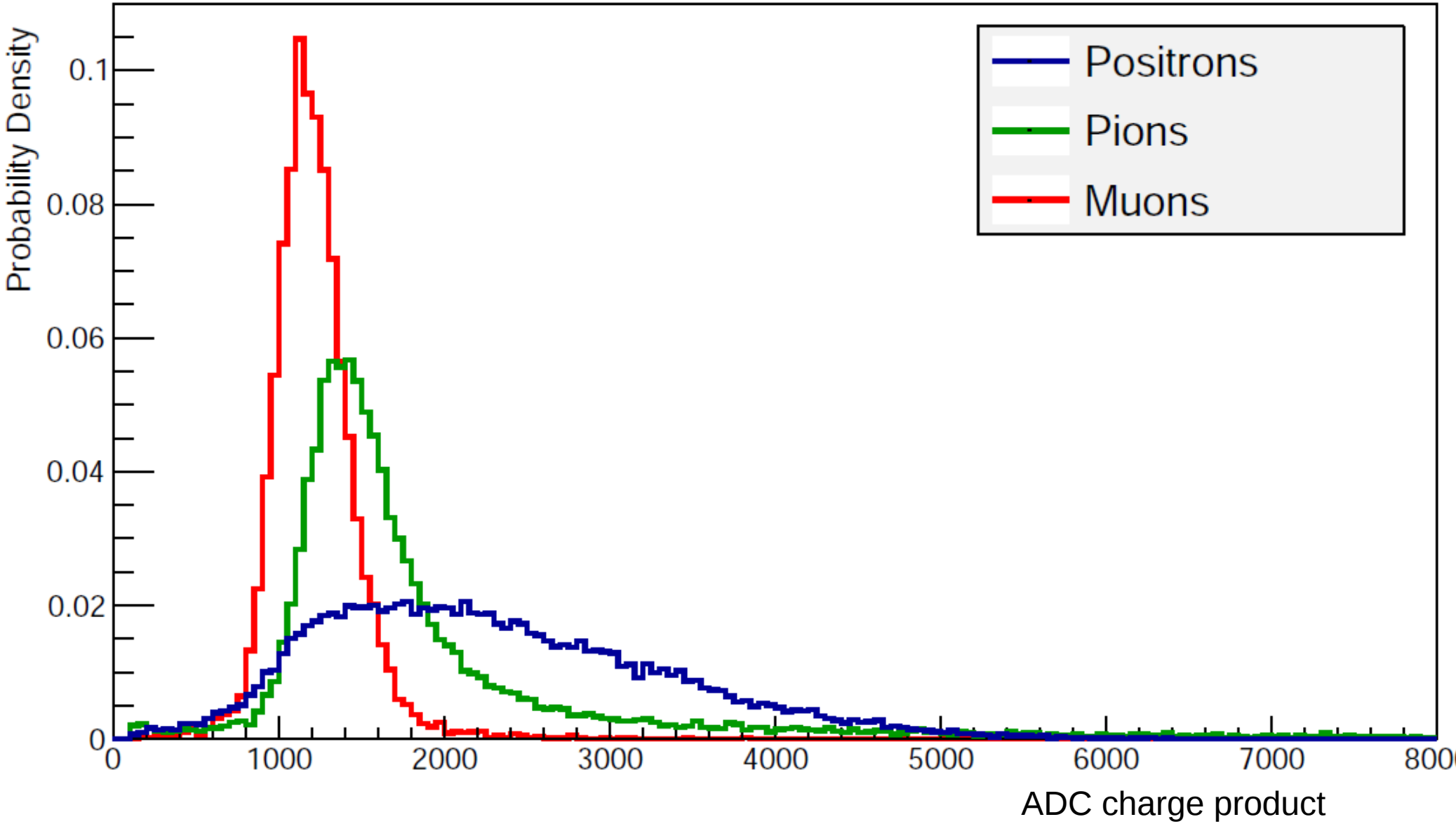
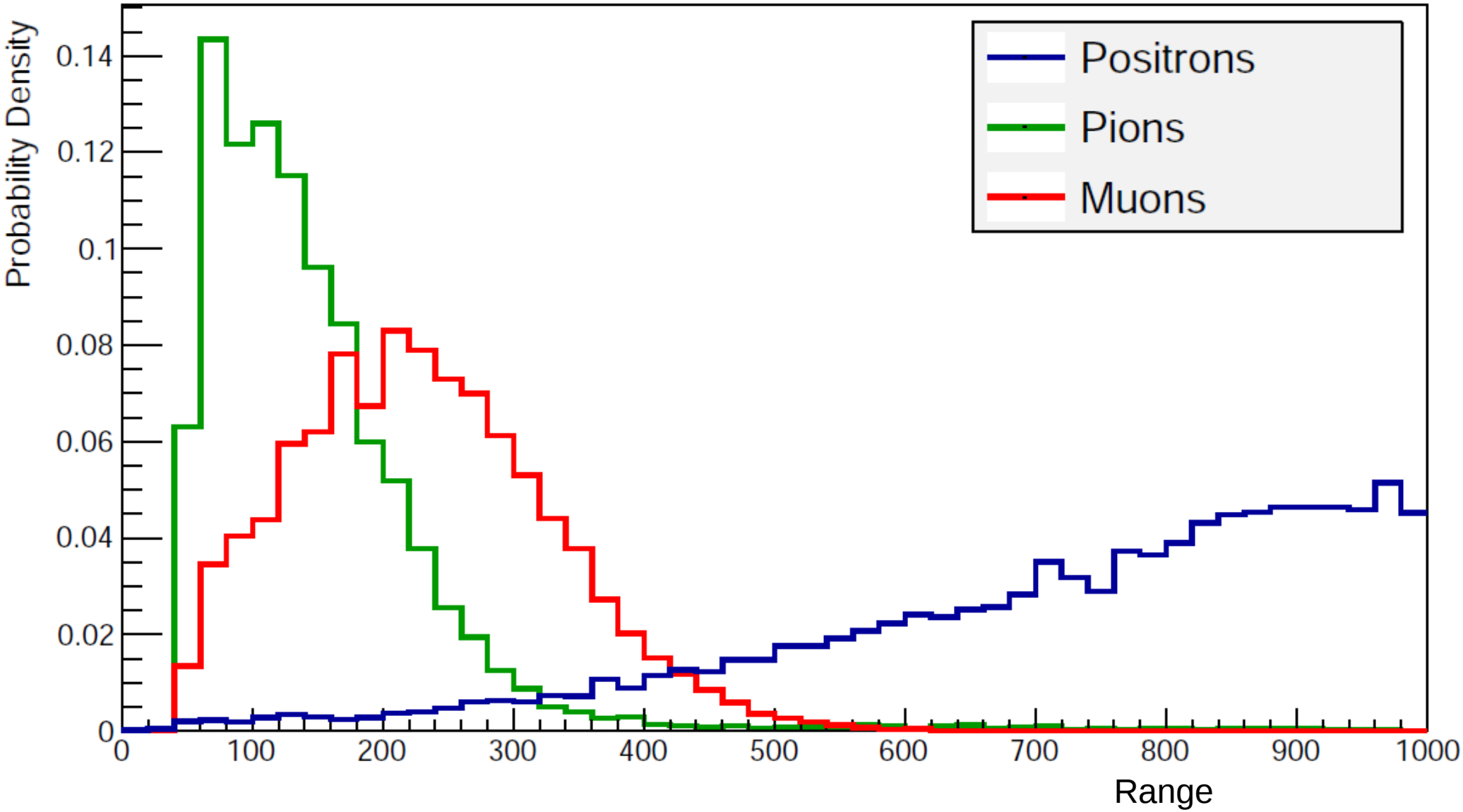


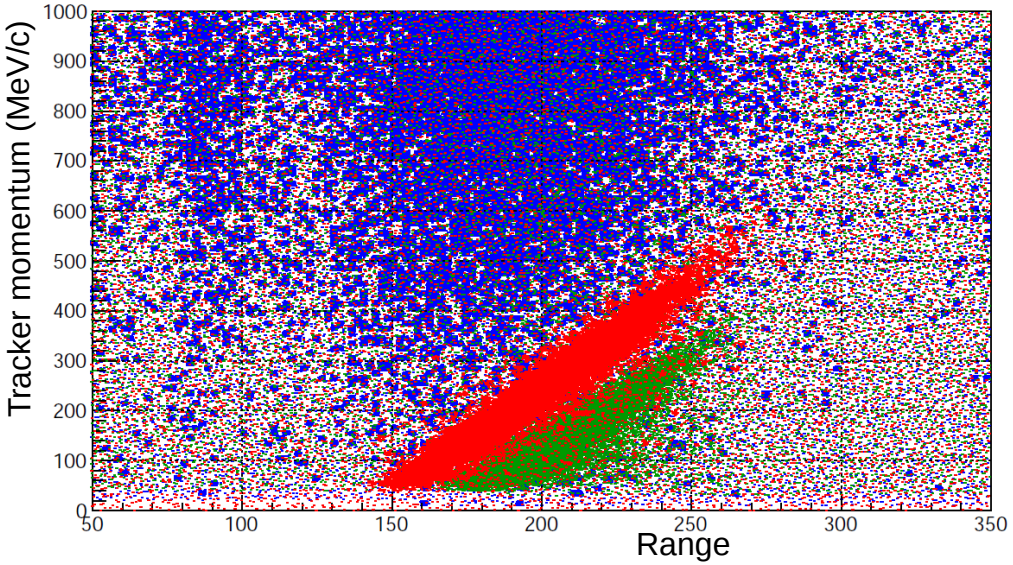
PIDVarD- KLADCChargeProduct



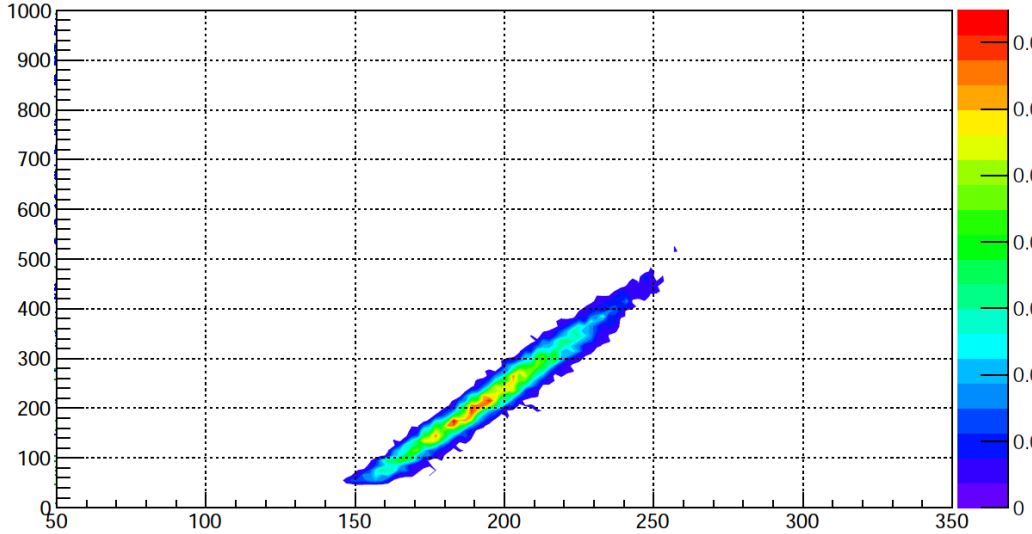
PIDVarE- EMRrange



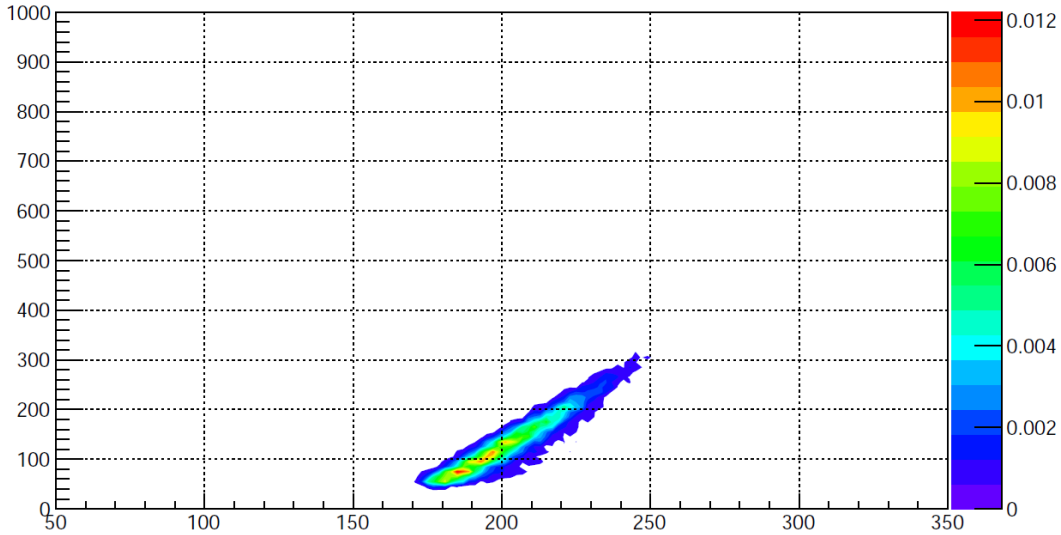
PIDVarF- EMRrangevsDSTrackerMom



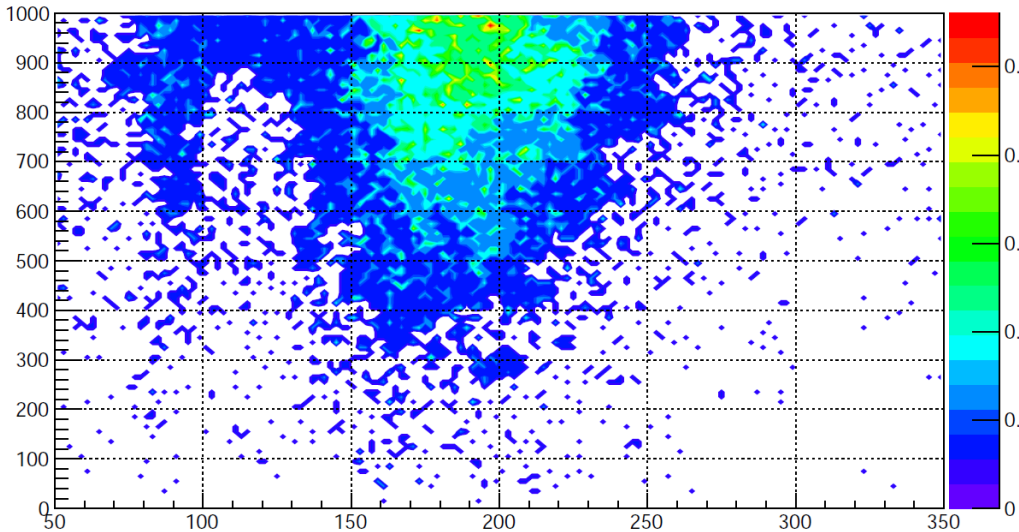
Muons



Pions



Positrons



Efficiency/Purity plots

- So far concentrating on online variables, so PIDVarB,C,F and ComPIDVarB,E

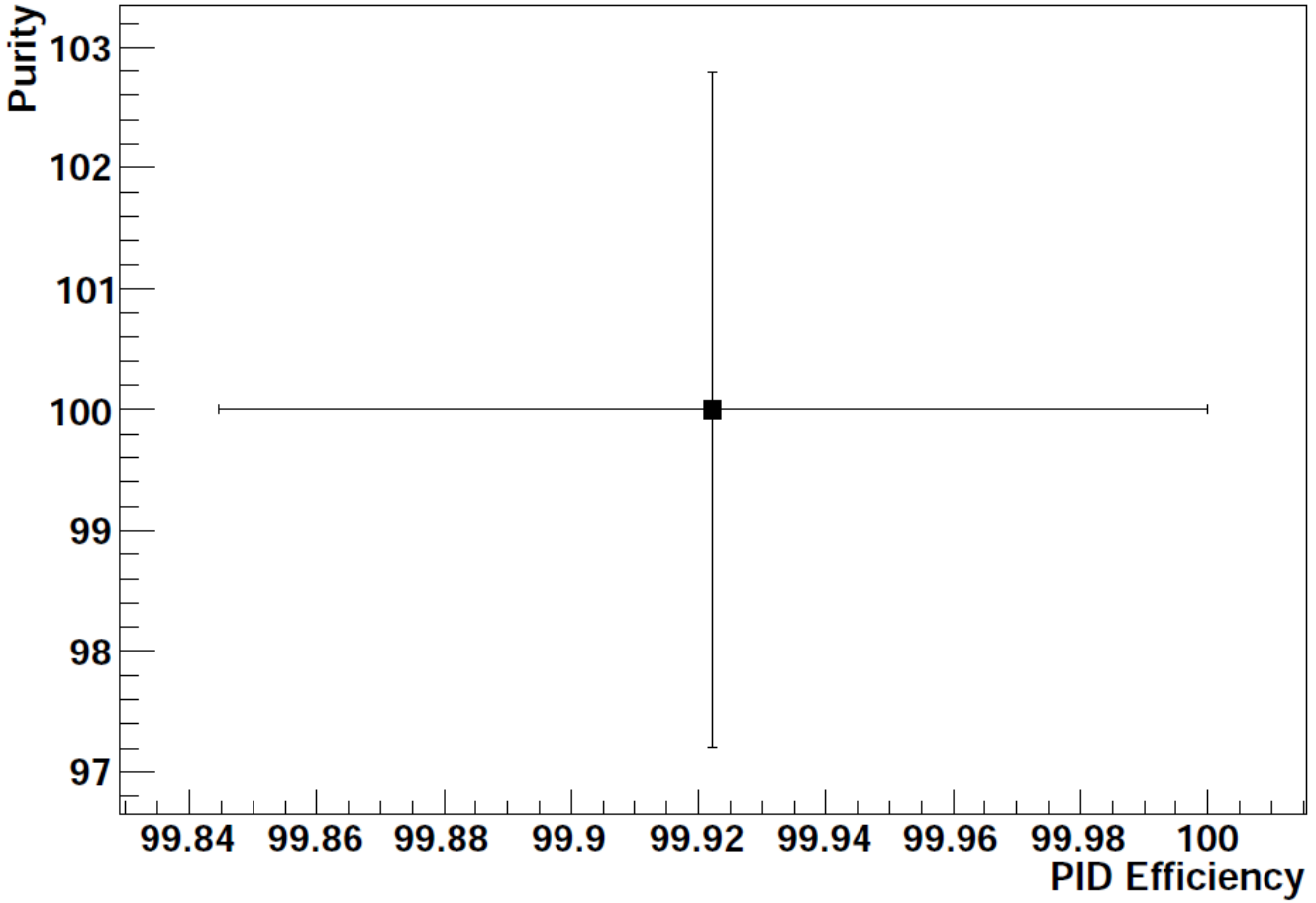
- Running PID over samples of 200MeV/c muons produced by Jan's track matching.

- Improvements to the variables will be made based on these studies, which are ongoing.

- Will also reproduce these plots with larger statistics.

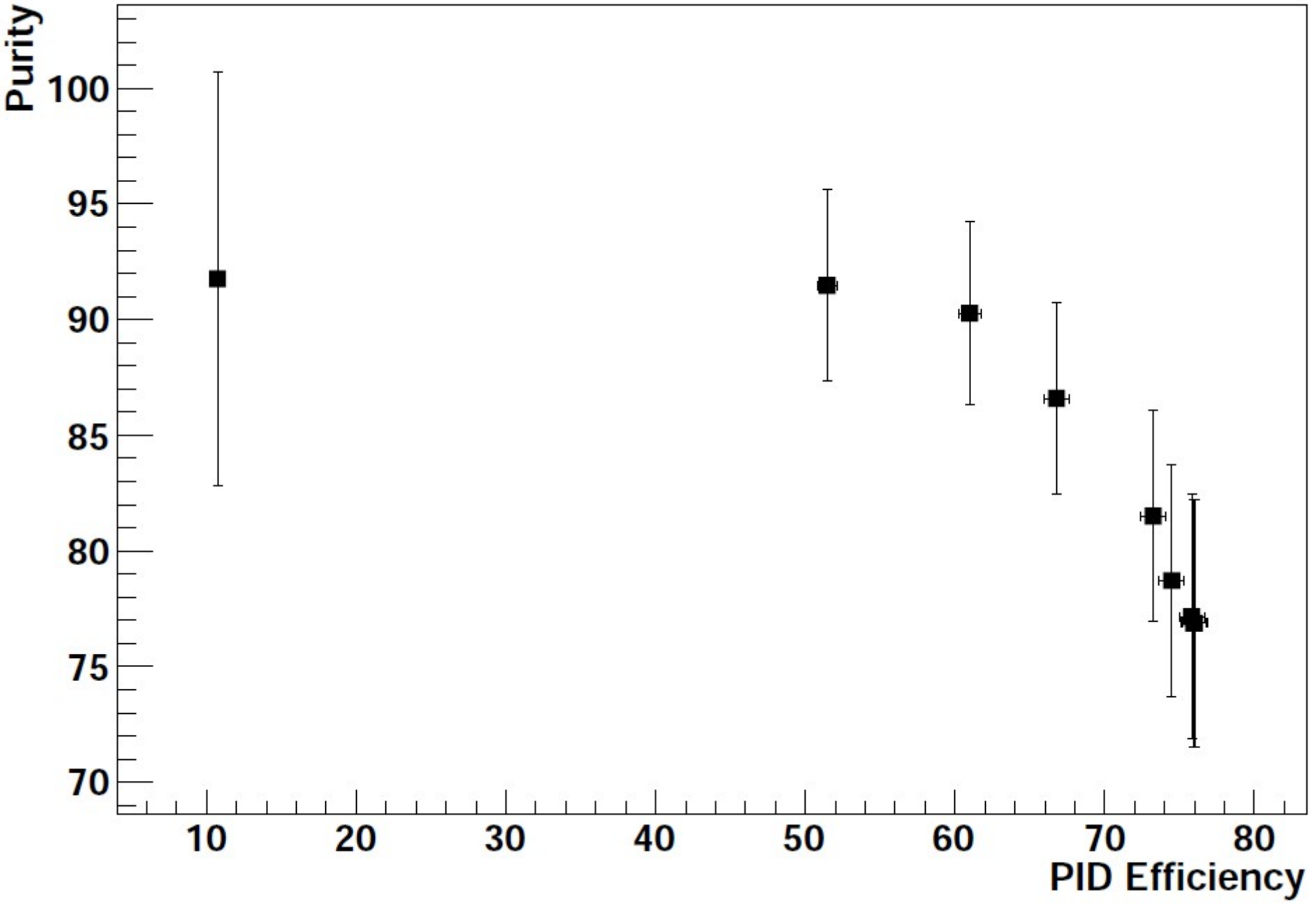
PIDVarB- diffTOF0TOF1vsTrackerMom

- No cuts applied.
- Sample contained 1287 tracks that had both TOF and tracker information.
- 1286 correctly identified muons. 1 could not be ID'd.
- Applying cuts would only decrease the efficiency, hence the sparsely populated plot.

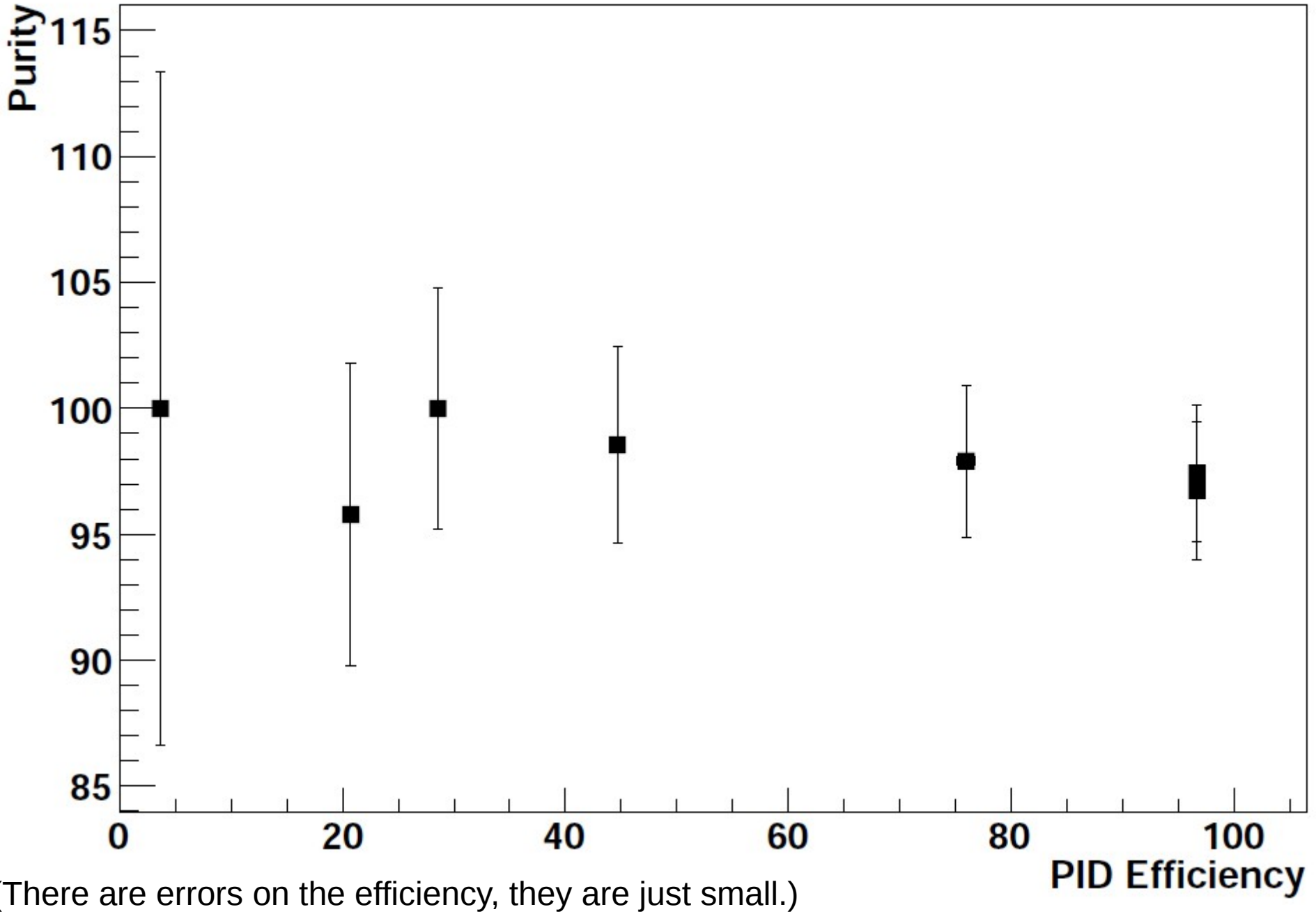


Efficiency:
99.9222 ± 0.0776698 %
Purity:
100 ± 2.78964 %

PIDVarC-KLChargeProdvsDSTrackerMom

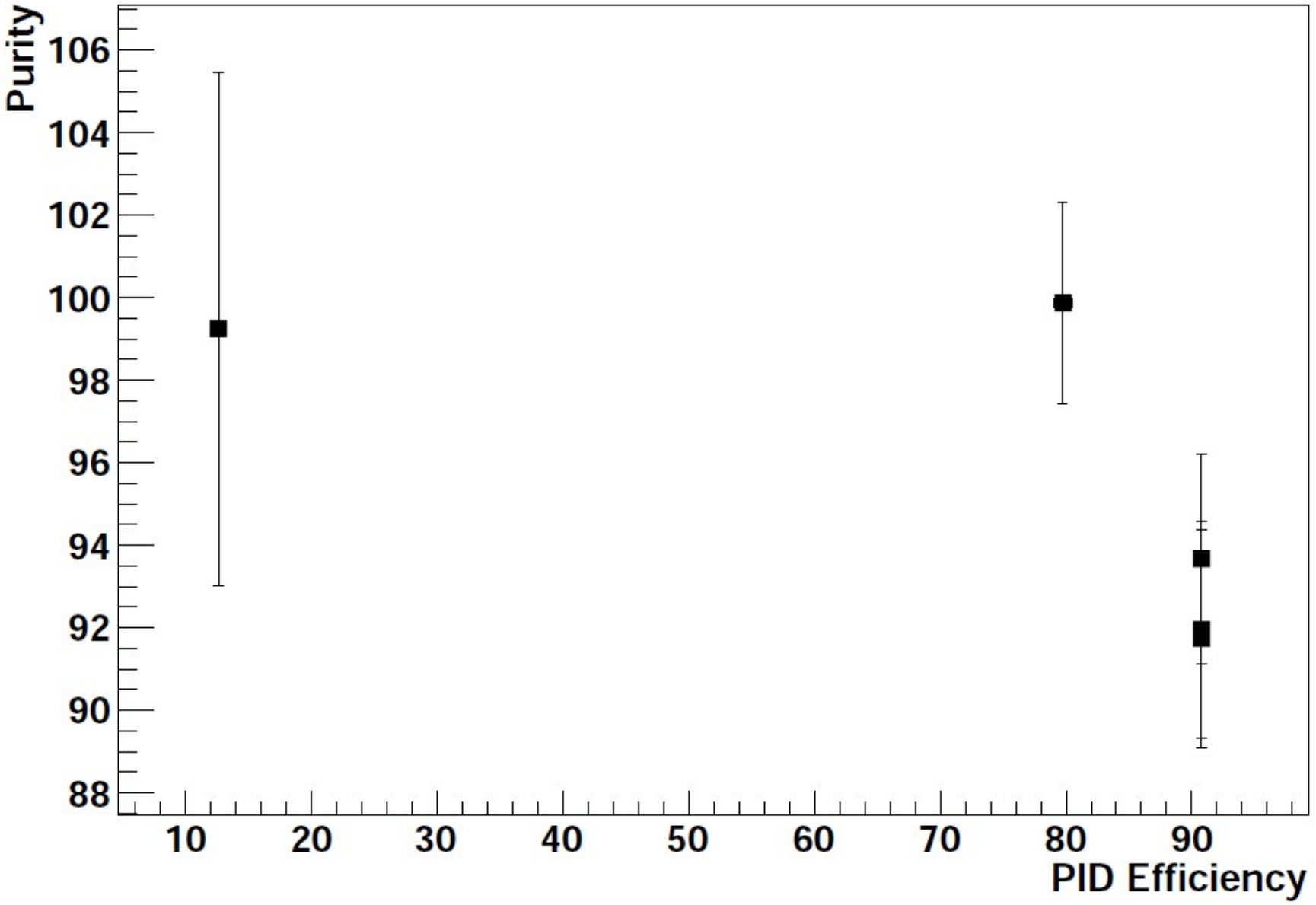


PIDVarF - EMRrangevsDSTrackerMom



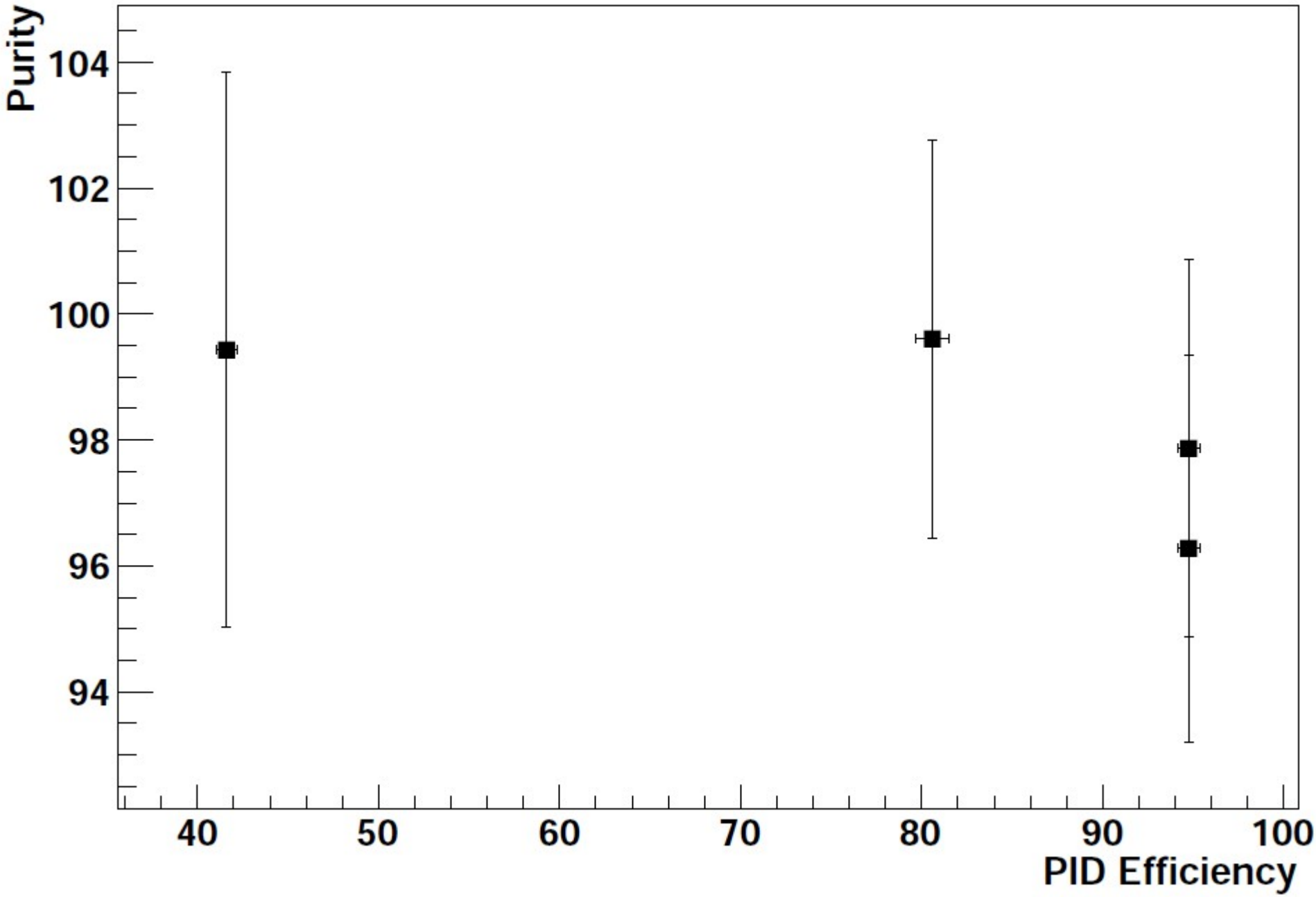
(There are errors on the efficiency, they are just small.)

ComPIDVarB-KLChargeProdvsDiffTOF1TOF2



(There are errors on the efficiency, they are just small.)

ComPIDVarE-CommissioningEMRrangevsDiffTOF1TOF2



Next steps

- Ongoing efficiency and purity studies.

- Improvements to PID variables based on these studies.

- Complete unit tests of new variables so that they can be merged into MAUS release.

- Update documentation and write a simplified guide to using PID.

Summary

- PID now includes input from all detectors other than Ckovs.
- PID can be run for commissioning data and Step IV data. There are 5 commissioning and 6 Step IV variables.
- Input and output of PID has been finalised.
- Efficiency and purity studies are ongoing.

- Updates to tests and documentation are on the way.