Global PID Framework

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Present Goal:

    To produce a functioning framework of the
    global PID.

Future Goals:

    To develop robust PID variables and
incorporate information from all MICE detectors
into the PID.

    To be able to break down the PID for
different regions of the experiment.

    To obtain from the PID a list of possible
particles, each with a figure of merit.

Outline of framework

The framework consists of two parts:

1) Creation of probability density functions (PDFs) from MC data for different particle hypotheses and PID variables.

2) Tracks from data passed through Global Reconstruction then have PID variables computed, and these are compared with the PDFs to obtain a log-likelihood value for each particle hypothesis.

Outline of framework within the code

A base PID class contains the functions to:
- Create the PDFs
- Use the PDFs with tracks
- Populate the PDFs
- Perform the log-likelihood for an incoming track
- Calculate the value of the PID variable (virtual)

Derived classes for each PID variable define the function that calculates the value of their PID variable.
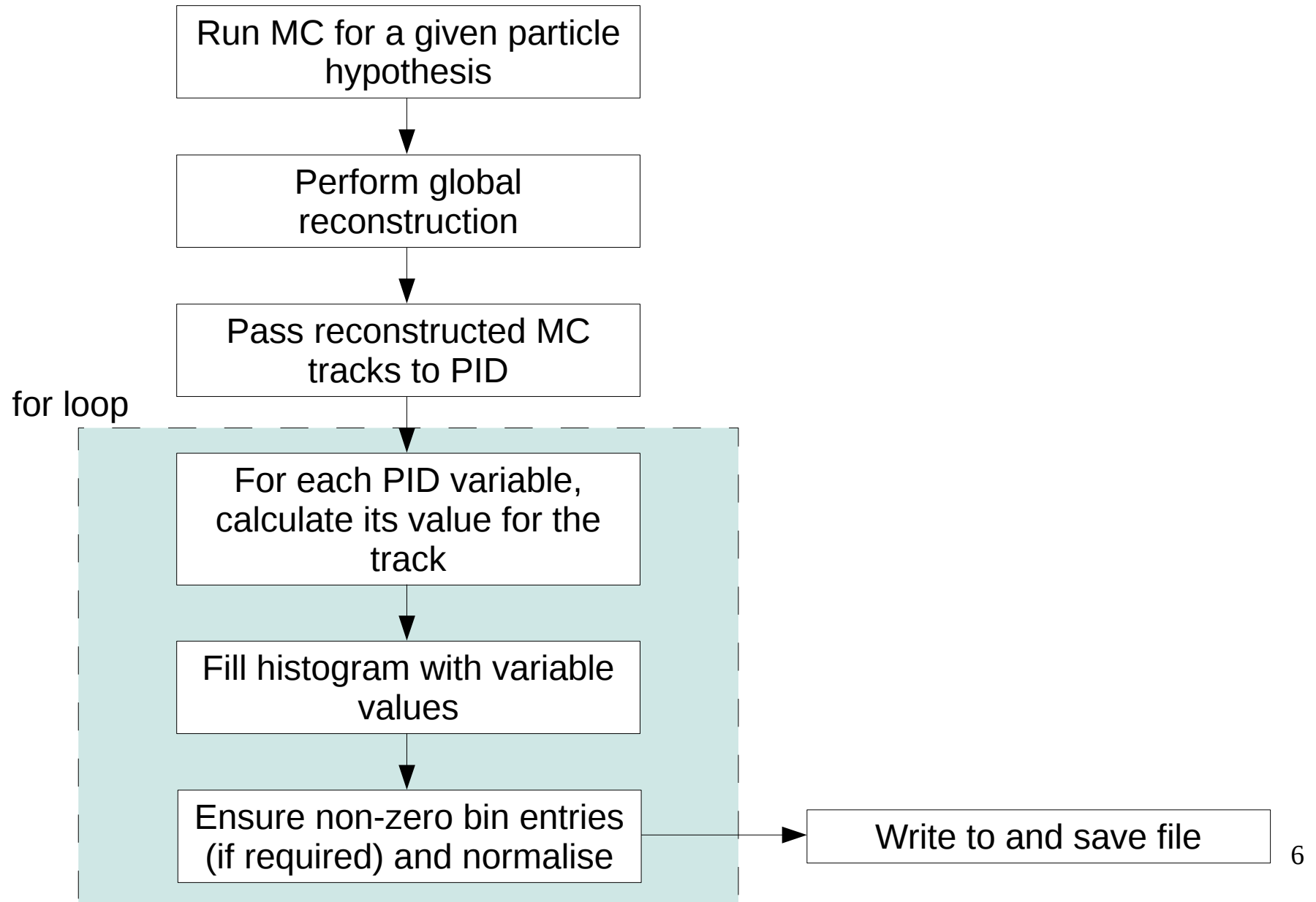
PDFs and log likelihoods

To distinguish between PIDs, the difference between log likelihood values is used.

In the example to the right, the PDFs representing two particle hypotheses for a given PID variable are shown.
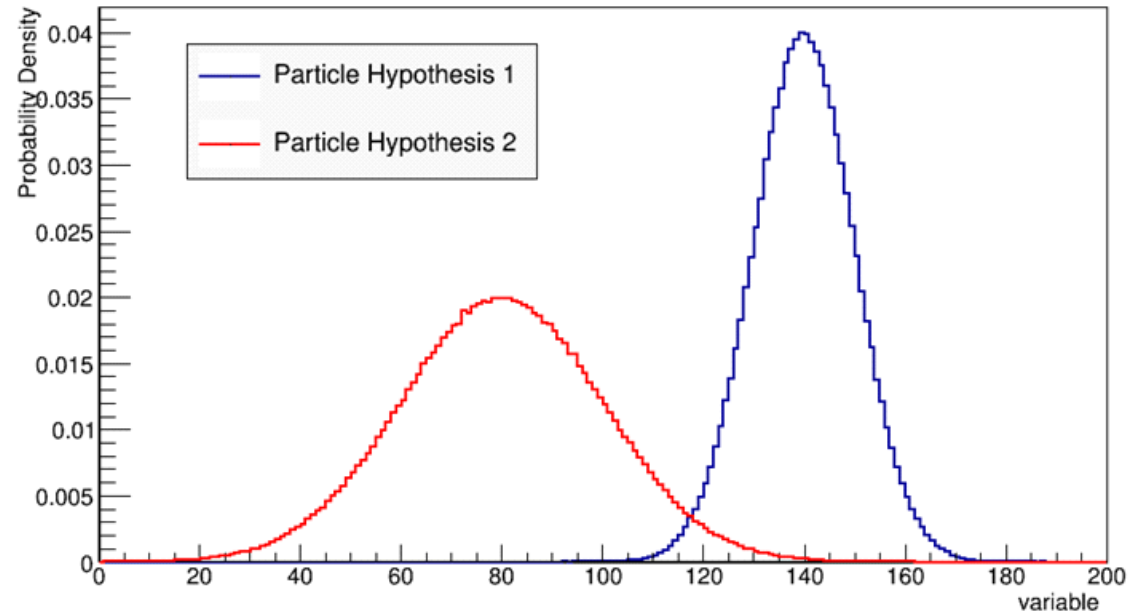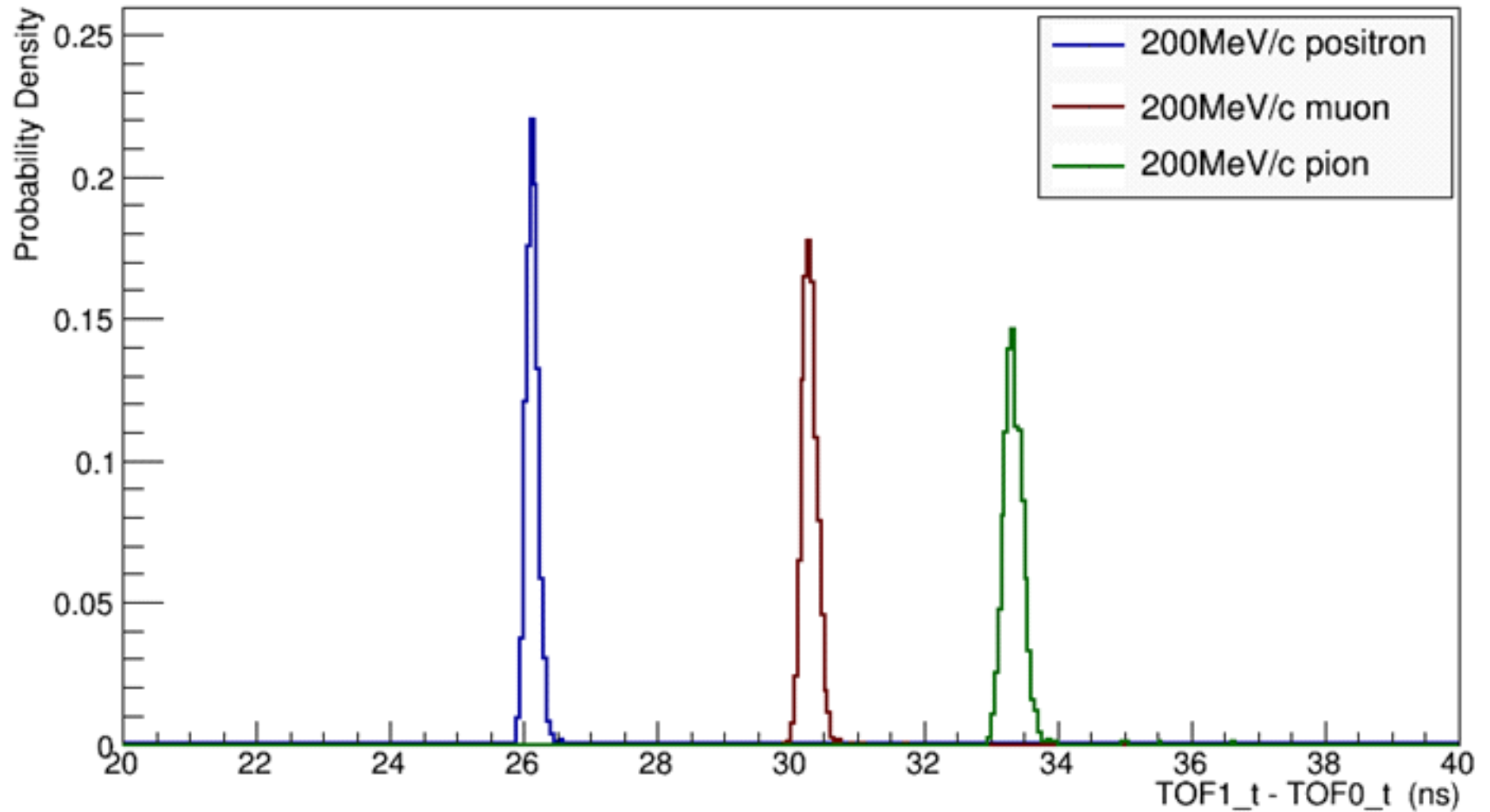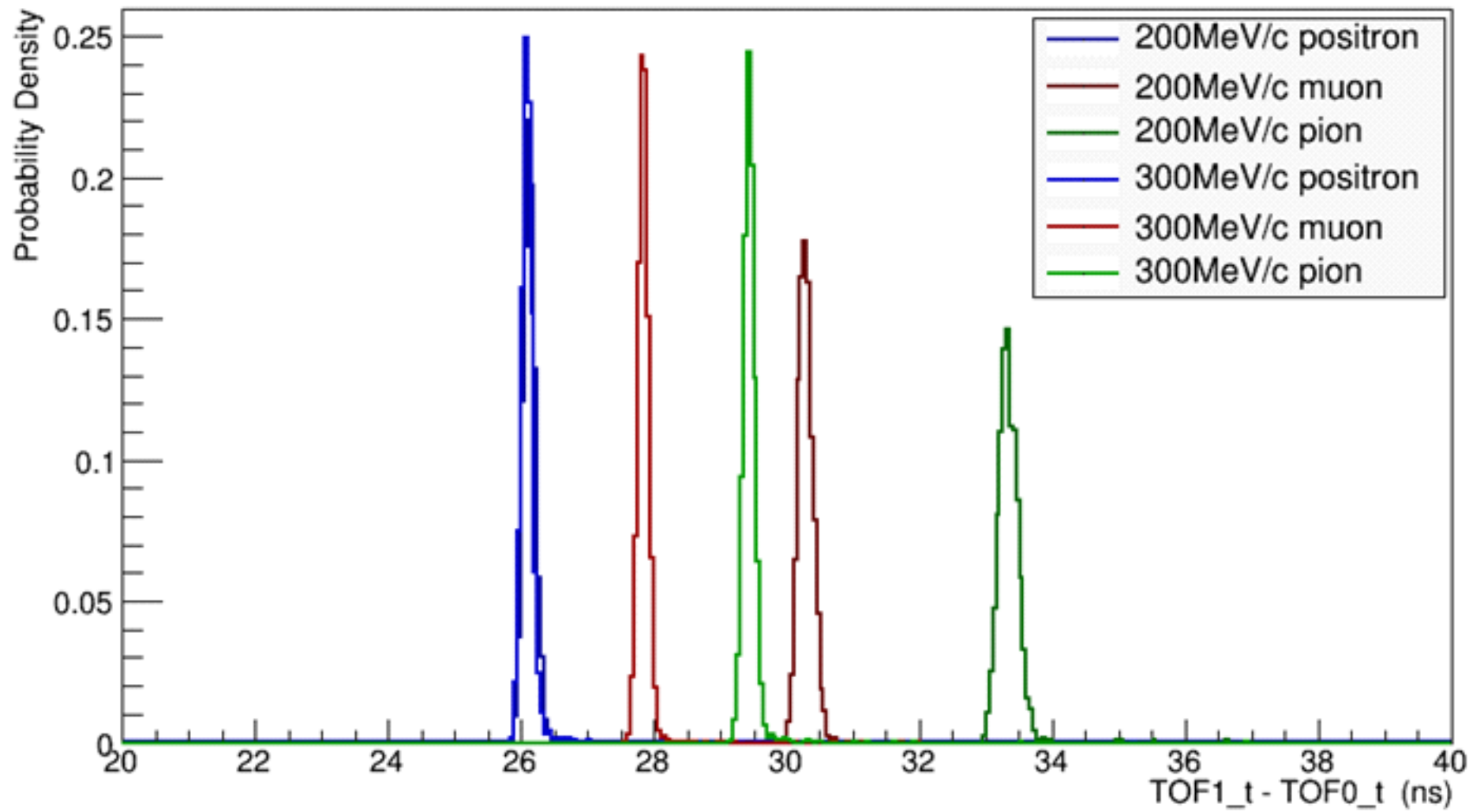

As an example, if the observed value of "variable" was 80, the log likelihoods for the hypotheses would indicate that hypothesis 2 is the most likely given the observed value, whereas for an observed value of 140, the log likelihoods for the hypotheses would indicate that hypothesis 1 is the most likely.

PDF production

Run MC for a given particle hypothesis

↓

Perform global reconstruction

↓

Pass reconstructed MC tracks to PID

for loop

For each PID variable, calculate its value for the track

↓

Fill histogram with variable values

↓

Ensure non-zero bin entries (if required) and normalise
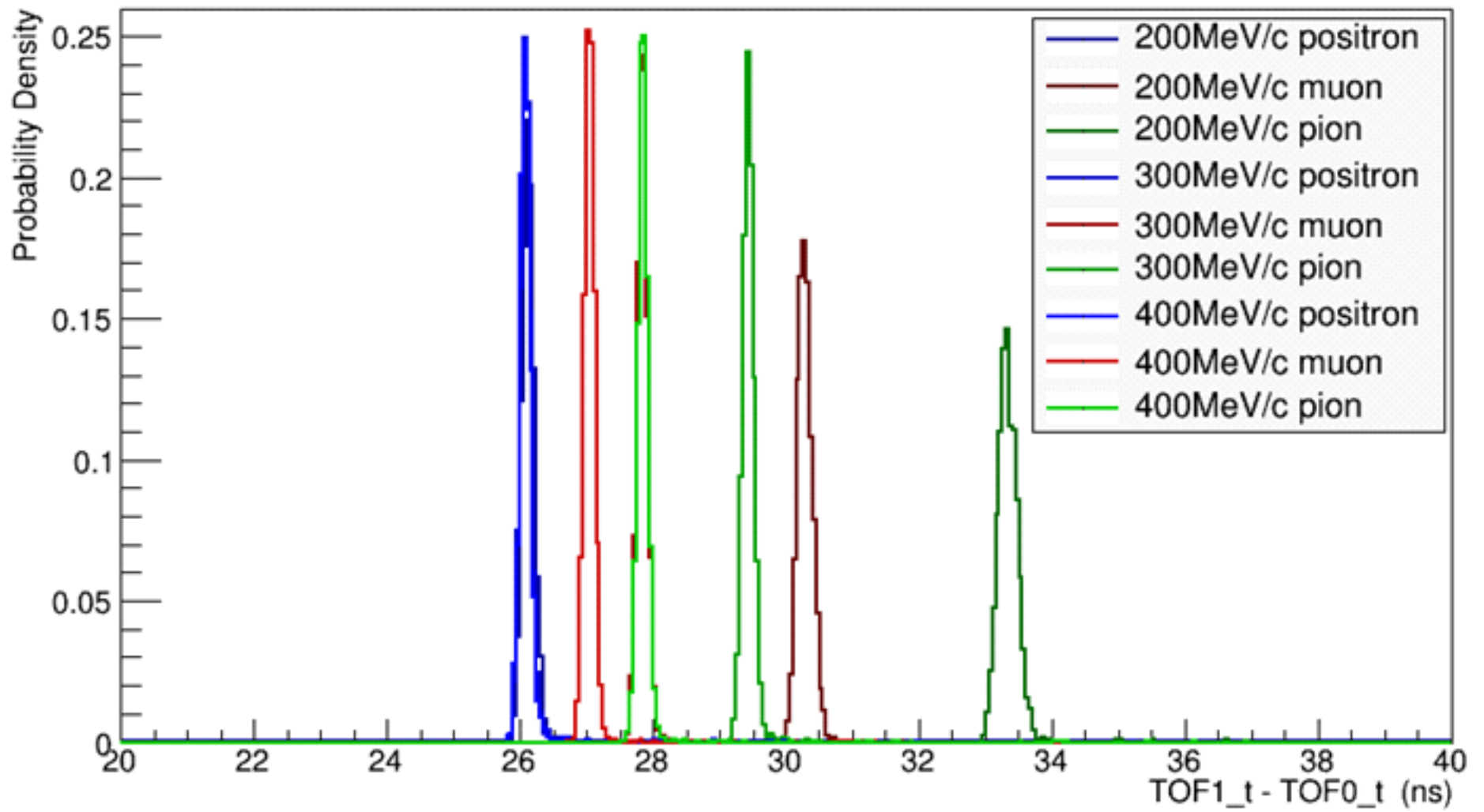
→

Write to and save file

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Test case: using difference between TOF0 and TOF1 times as PID variable:

Calculating log-likelihoods from PDFs

Get tracks from global reconstruction

Pass reconstructed tracks to PID

for loop

Calculate PID variables for global tracks

Open PDFs and find corresponding entry (for all particle hypotheses)

Calculate log likelihood from entry

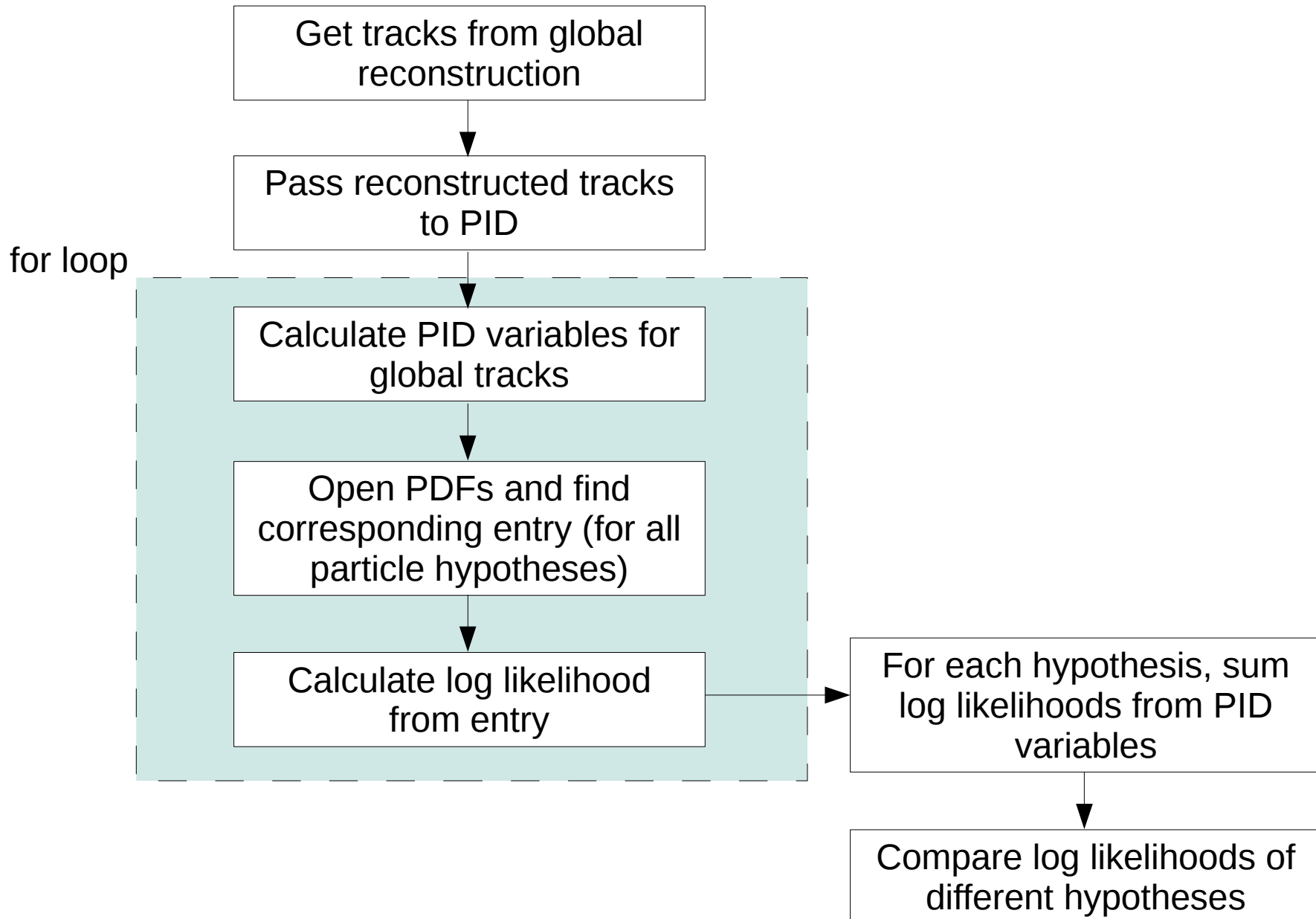For each hypothesis, sum log likelihoods from PID variables

Compare log likelihoods of different hypotheses

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Test case for 200 MeV/c pions

As an example of the PID in action, a 200 MeV/c pion beam was simulated, once with decays switched off, and once with decays allowed, and compared with the 3 hypotheses from slide 7, the 200 MeV/c e^+, μ^+ and π^+.

For the case with decays switched off, the simulation produced 1511 (reconstructed) tracks, all of which the PID identified as pions (as would be expected).

For the case with decays allowed, the simulation produced 667 (reconstructed) tracks, 566 of which were identified as pions and 26 as muons, and for 75 tracks the PID could not be determined.
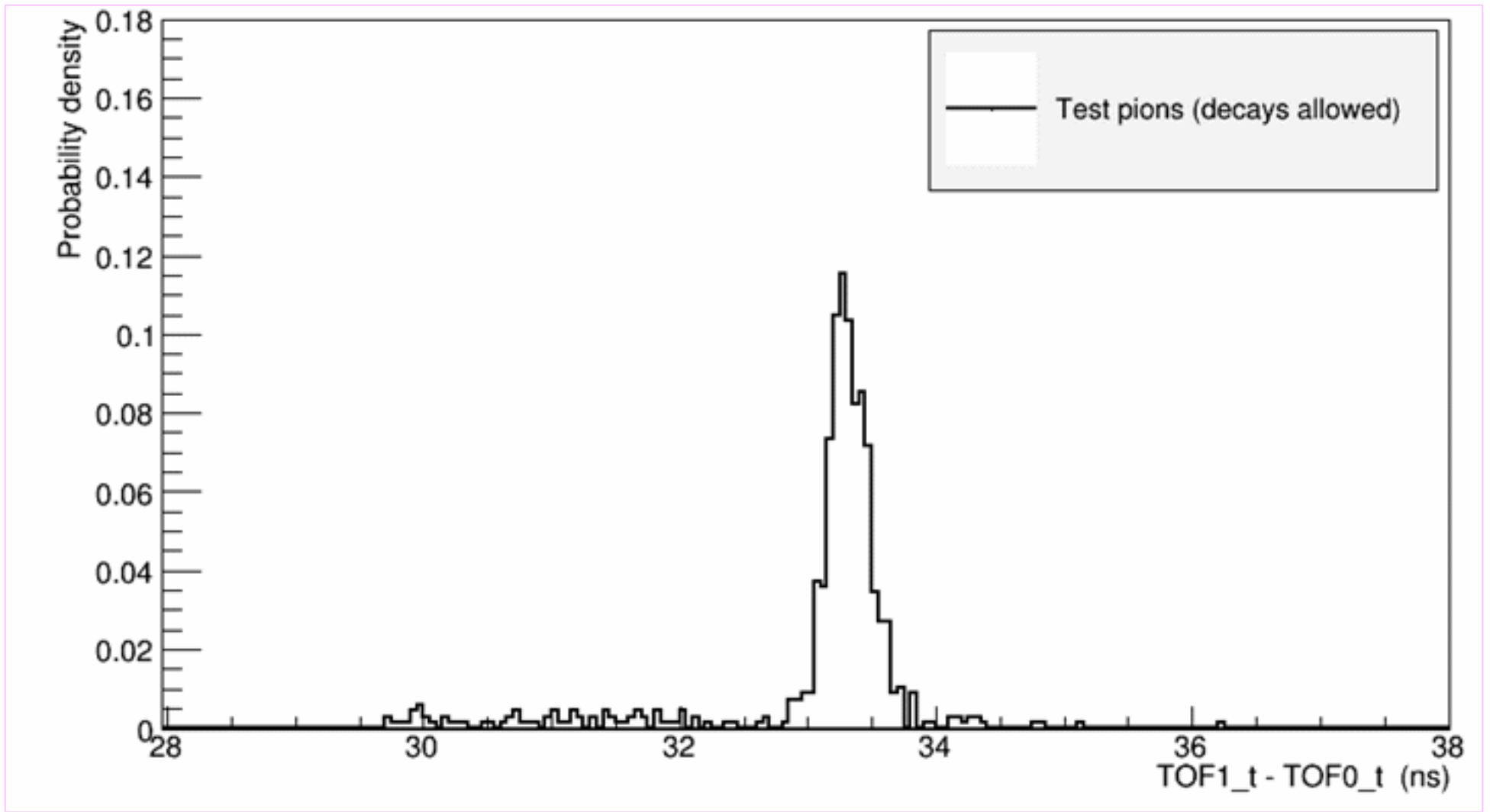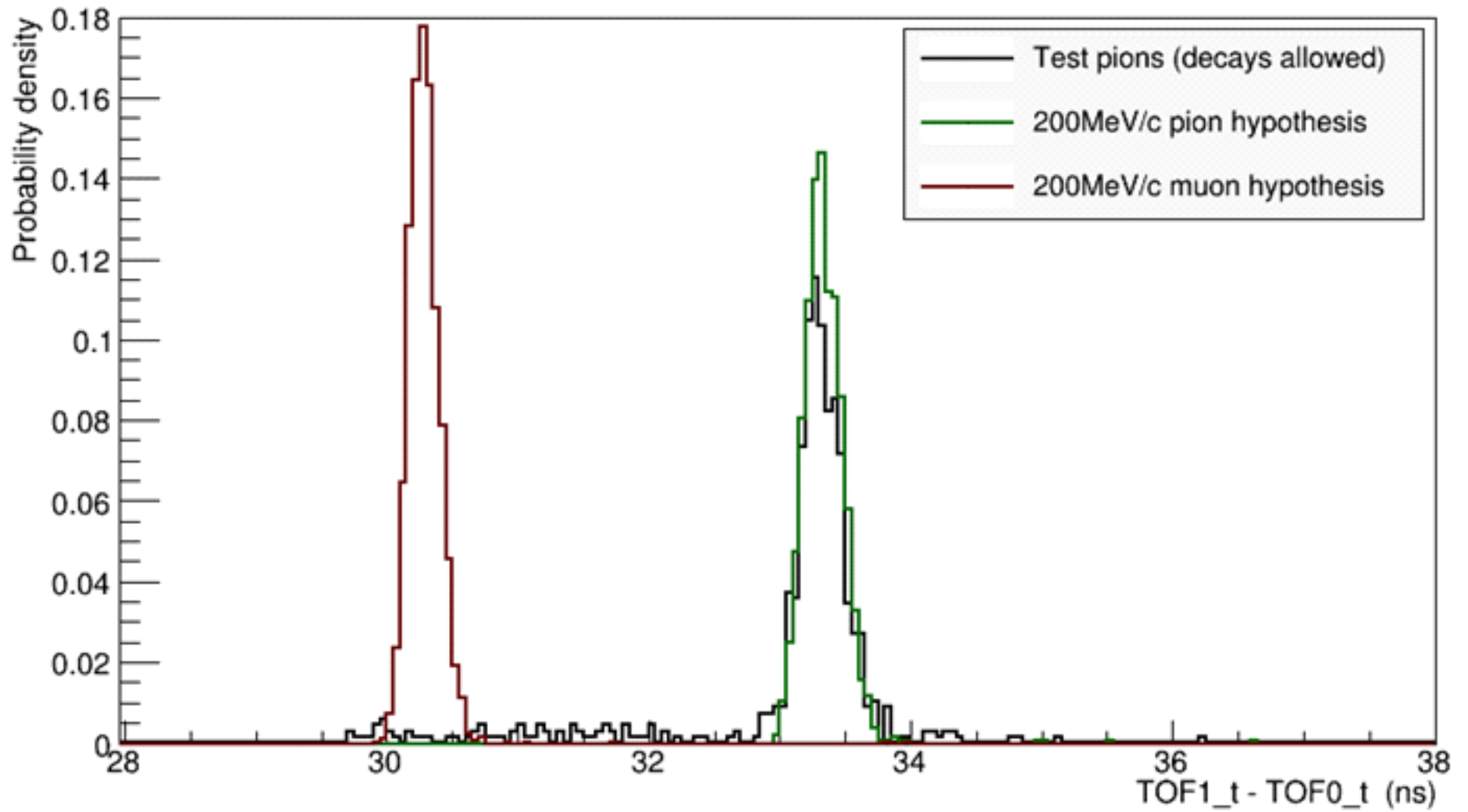
Next steps

• Deadline of Dec 1st for a working framework for the PID in the code – should be achievable, tests have been written and passed, and documentation is a work in progress.

• Determining what variables to use for PID, and what information is available from detectors.

• Determining what set of PDFs are required.

• Understanding the effects of e.g. Different beamline set-ups, different beam momenta, etc.

Conclusions

- Have a working framework of the Global PID capable of distinguishing between different particle tracks.

- Now need to start considering more robust PID variables, which PDFs to use, and complications due to beamline configurations.