Identifying anode piercing tracks by matching PD and TPC information in data and MC

Joshua Thompson

DRA meeting

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Anode piercing tracks

- Particles which do not pass through the entire detector perpendicular to the drift direction must either pass through an anode or stop within the detector.
- These particles produce anode piercing tracks that are reconstructed to either enter from a side of the TPC and disappear within the readout window or vice versa.
- By assuming that all such disappearing tracks are in fact anode piercing, a t_0 for each particle can be calculated – this can then be compared to other information to verify whether it does pass through an anode.
- Comparing this t_0 to the times recorded by the photon detector system selects the anode piercers by finding a suitable flash within a time window around the TPC t_0.

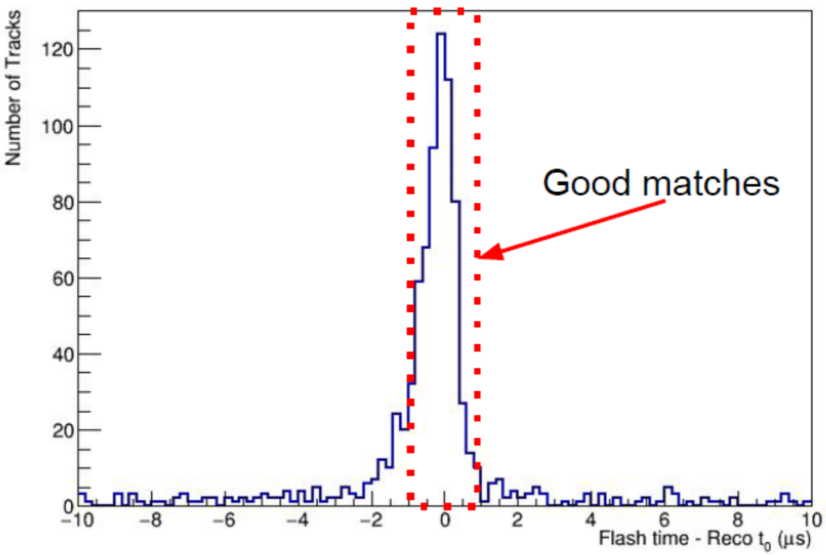
Running over data

- Using code ported from MicroBooNE by Hannah Rogers, I have looked at events in several runs with a variety of beam energies or no beam, over a significant amount of time (~2.5 weeks), to look for any variation in the time matching in changing conditions. I have also analysed MCC10 to replicate Hannah's results from last year, and MCC11 to determine whether it more closely resembles the data.
- The TPC t_0 is calculated by dividing the x distance from the anode of the disappearing end of the reconstructed track by the nominal drift velocity and adding an offset. The t_0 of each flash in the event is compared to the TPC t_0 and the smallest difference selected.
- Further requirements on the track and flash are imposed to improve the purity of the selection – there are required to be 20 photoelectrons forming the flash, and a cut on track length has been used in the similar MicroBooNE study which I may apply in future.

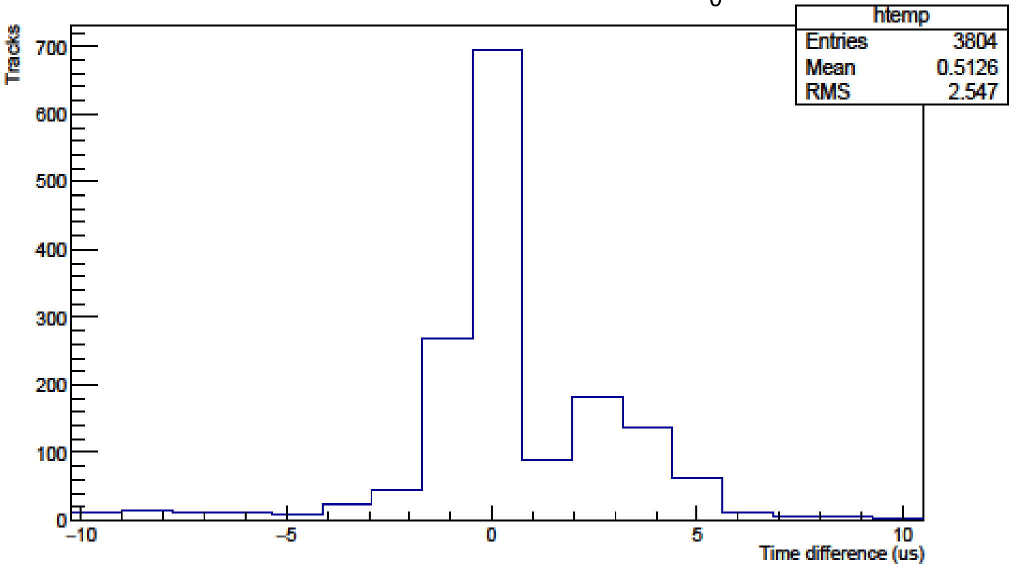
Previous measurements of MC

- Hannah showed last year (left) and I have confirmed (right) that simple timing matching between PD and TPC information was able to correctly identify anode piercing tracks with an associated flash, in MCC10.

Flash Time - Reconstructed t_0



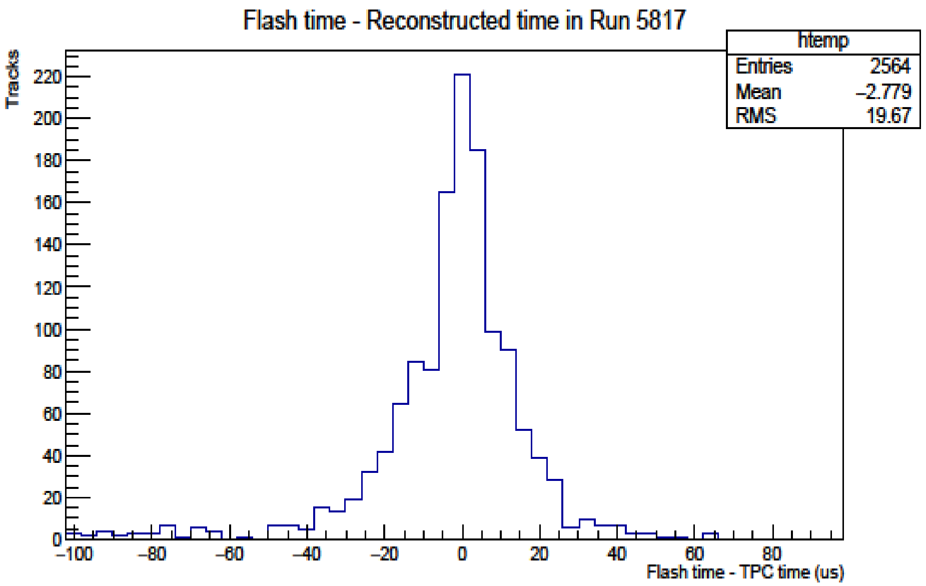
Flash time – Reconstructed t_0

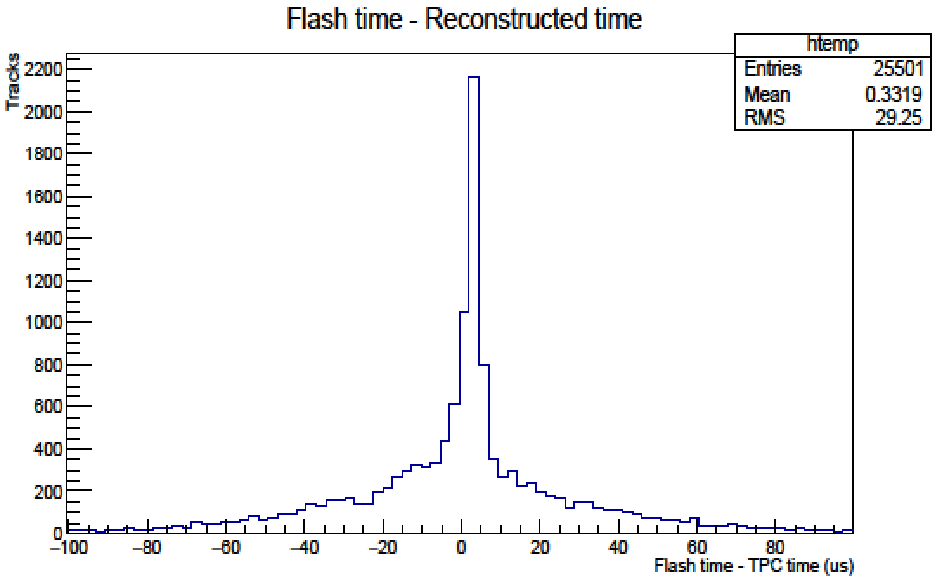


- A sharp peak in the time difference around zero strongly suggests a correct match – this can be confirmed using truth.

Previous measurements of data

- However, when I look at data (left), the peak is far wider and doesn’t suggest a correct match but random coincidence.

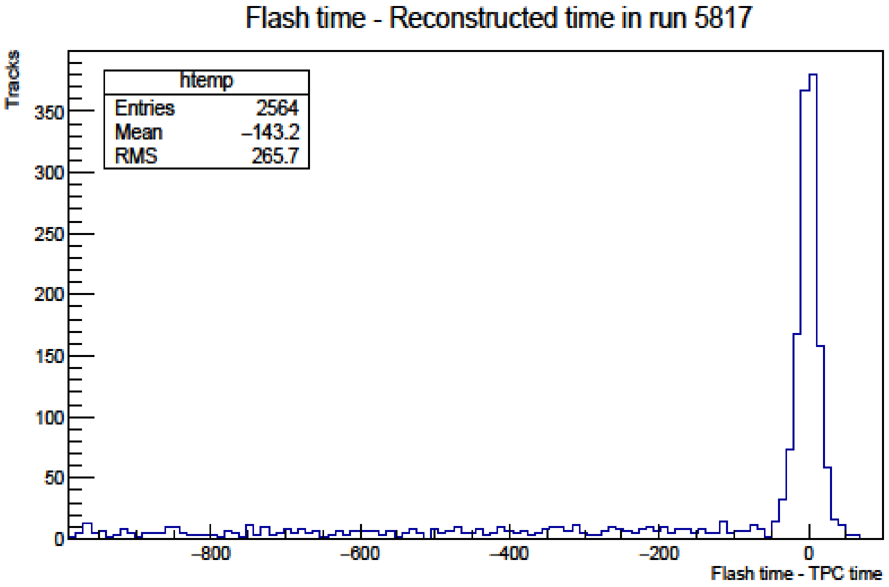




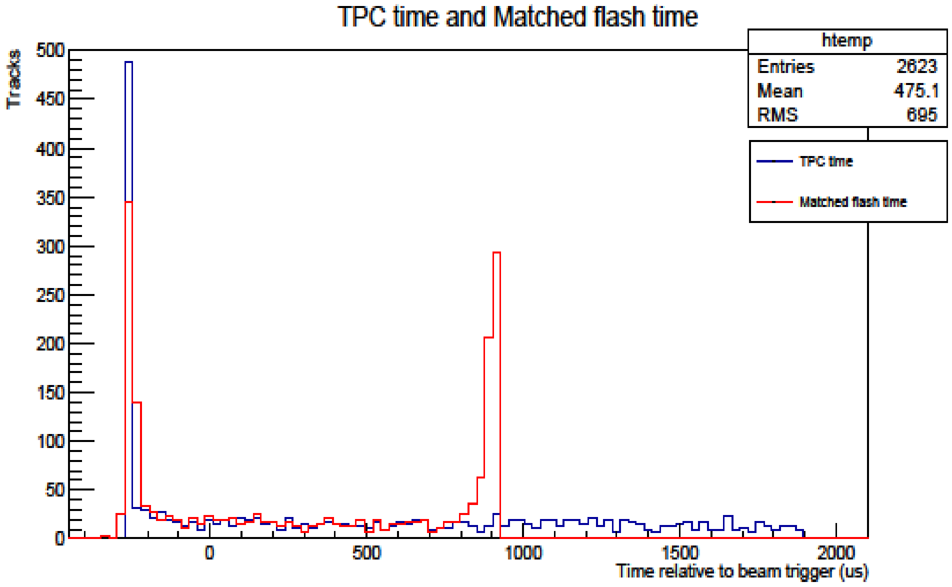
- This is also the case in MCC11 with fluid flow (right), where the distribution is even broader.

Data tail and flash cutoff

- The data plots all show a long tail of matches only with a negative difference (the reco time later than the flash time), which is not present in the MC (left).



Flash time - Reconstructed time in run 5817

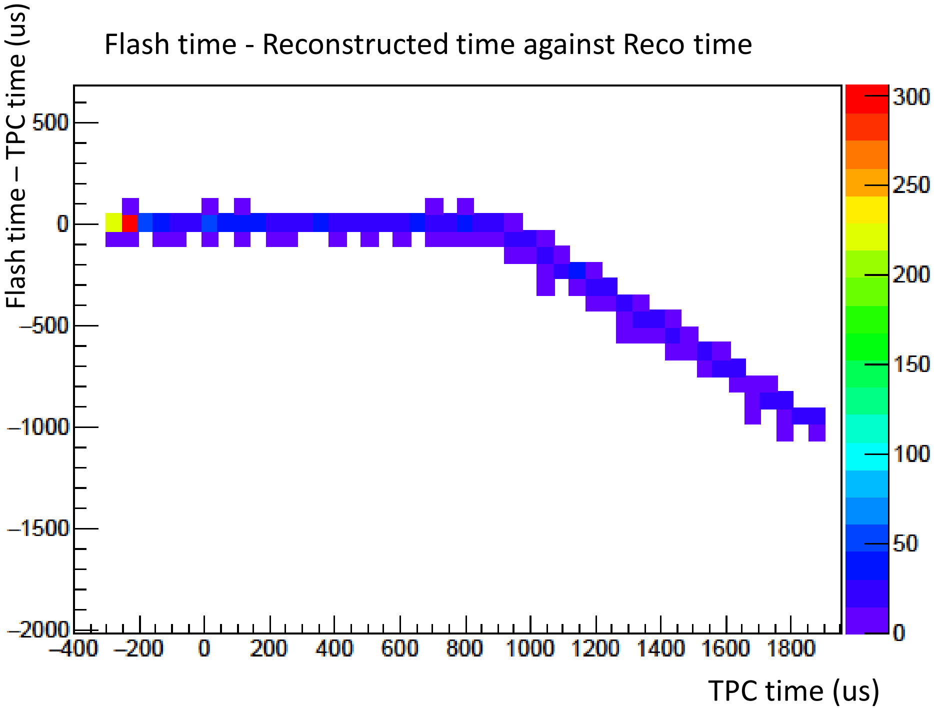


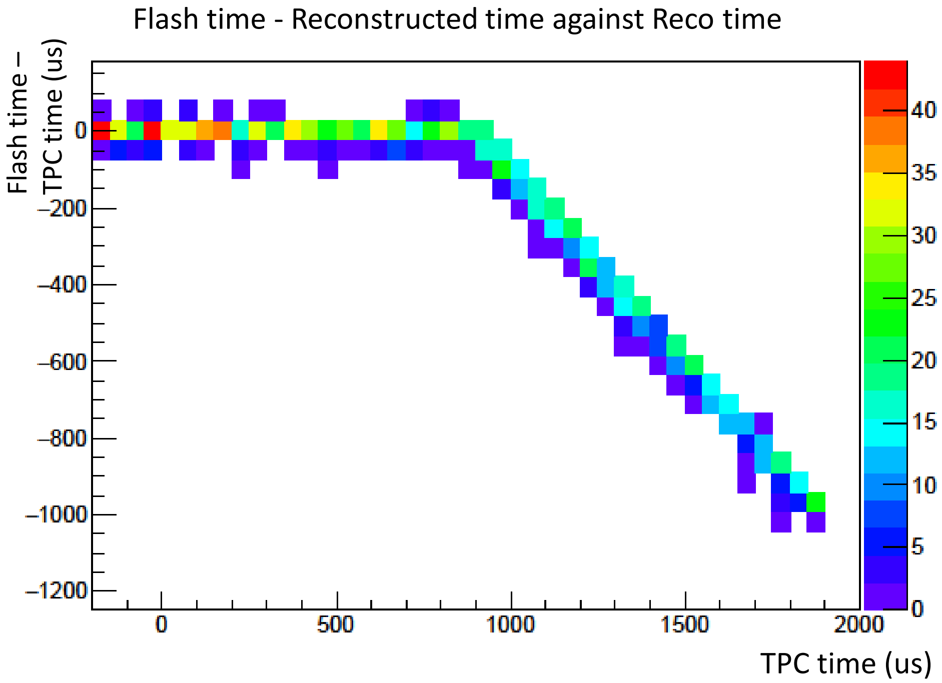
TPC time and Matched flash time

- I then found the flash times in data do not span the whole readout window as they should but are truncated roughly half way, with the later tracks all matched to flashes at ~900µs.

Time difference against reco time

- To confirm this, I have looked at the time difference as a function of the reconstructed time.

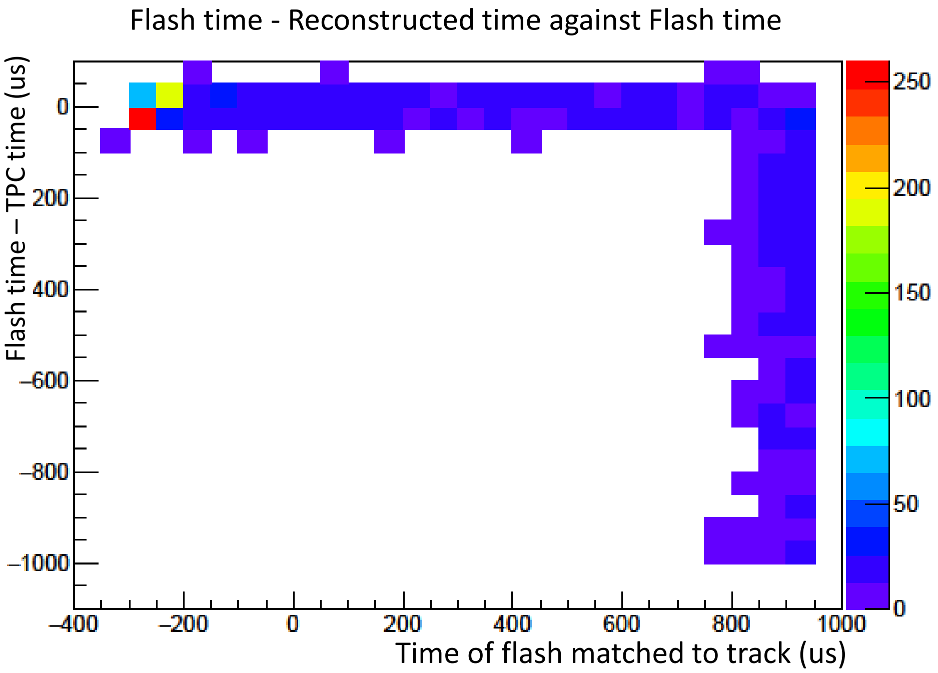


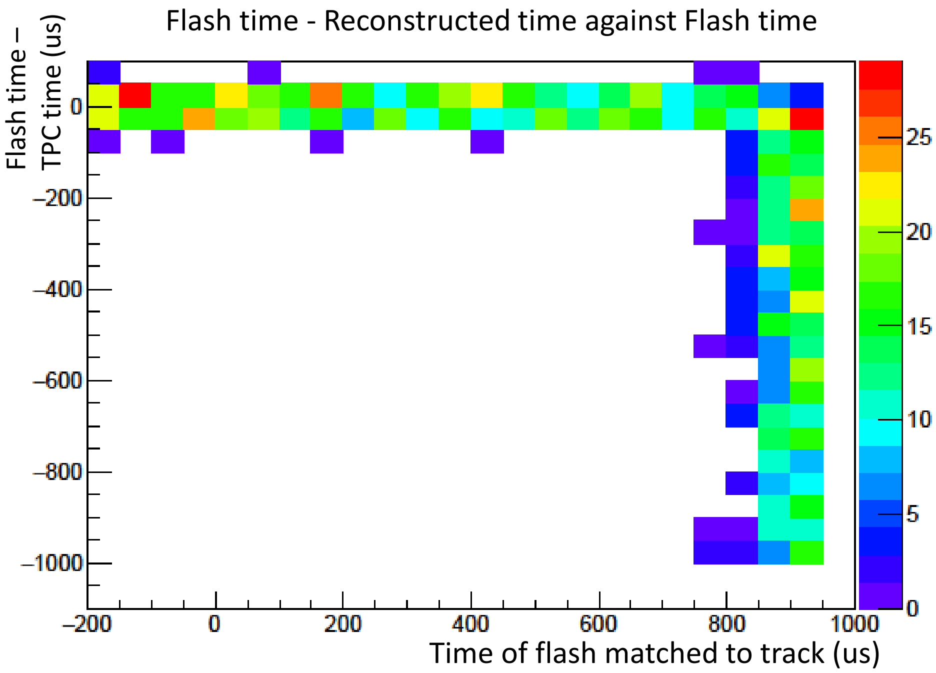


- The false matches with negative difference only occur for later reco time, where the tracks are matched to flashes at ~900µs.

Time difference against flash time

- Comparing against flash time shows this.

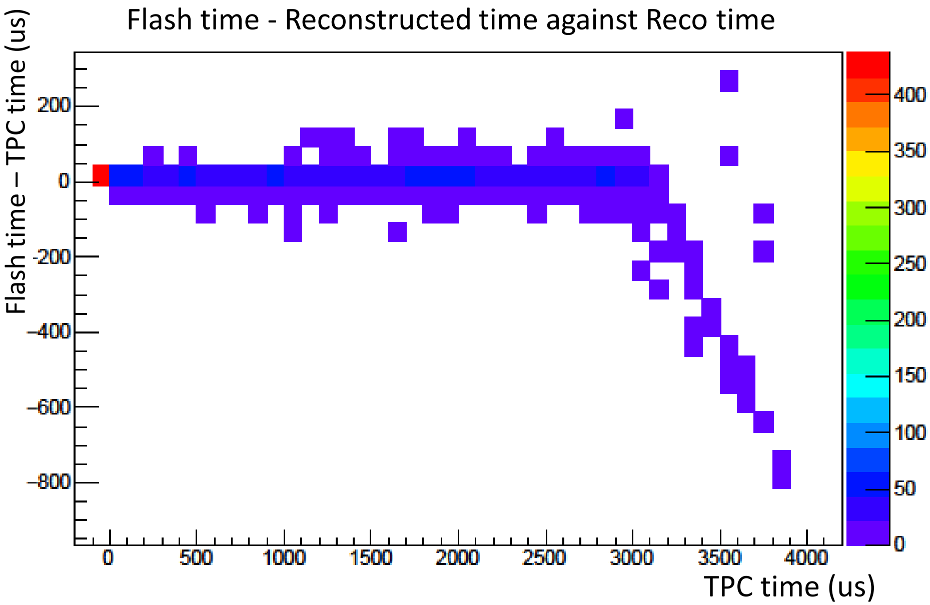


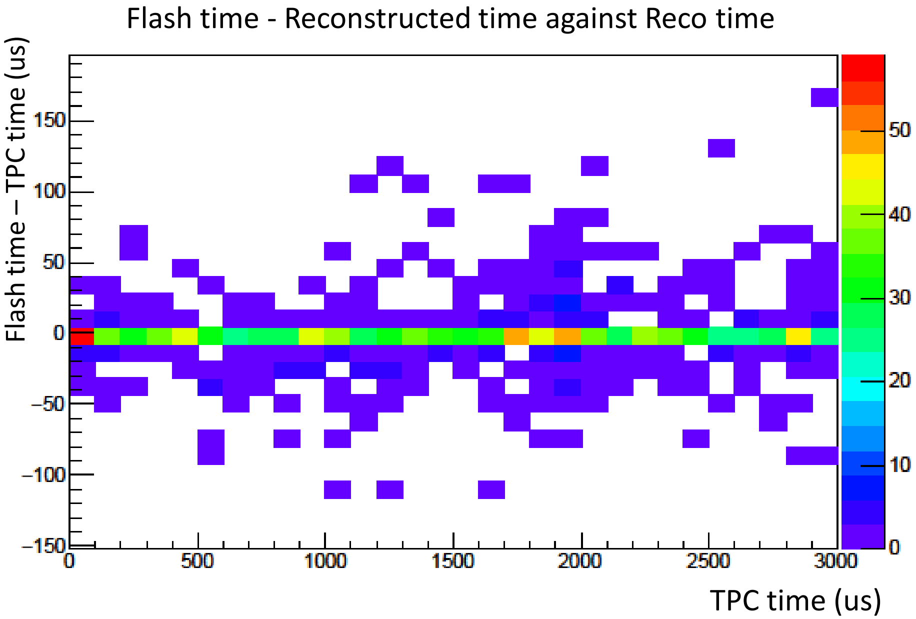


- The peak at the start of the readout window shows every track which is already passing through the detector is matched to the flash closest to this time and shouldn't be used to select anode piercing tracks.

Plots in MCC10

- Comparing these to the plots from MCC10, it is clear that in the reliable region of the readout that tracks are correctly matched most of the time.

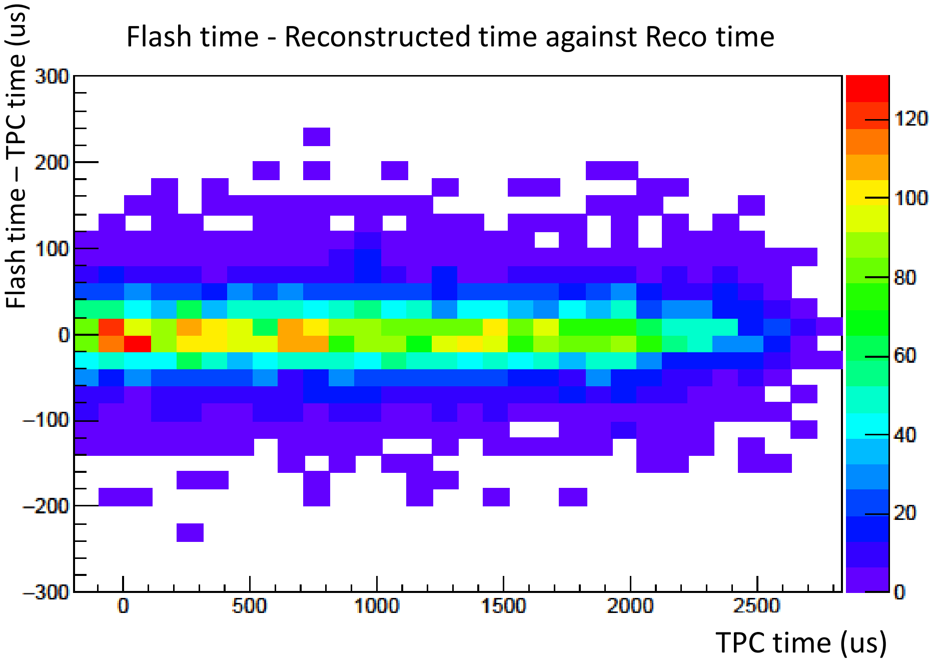


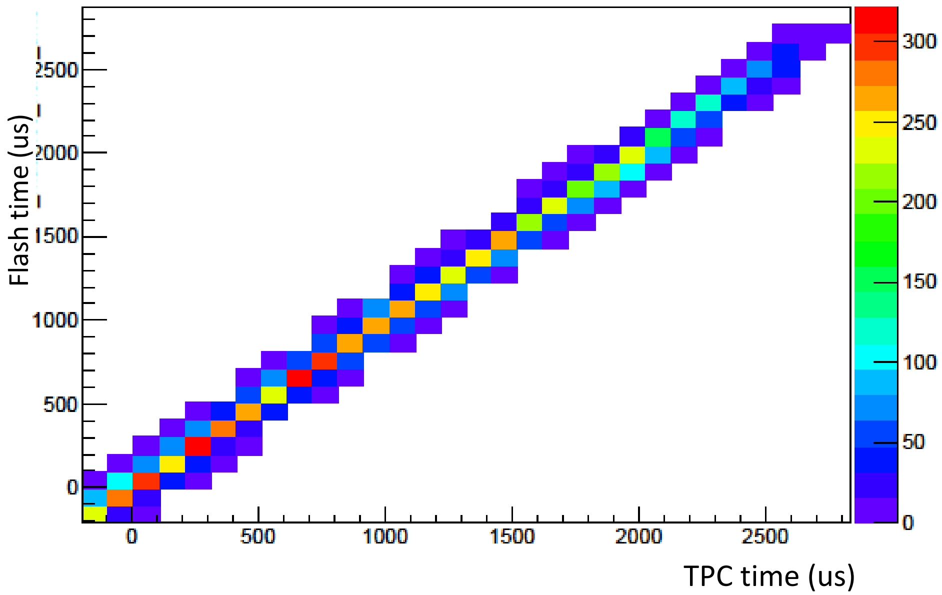


- The spread of seemingly false coincidences outside the central correct band looks fairly similar to the distribution of matches in data and MCC11, reinforcing that as the cause of the spread.

Plots in MCC11

- As expected, in MCC11 the pattern is fairly consistent after the opening of the readout window, with little change to the spread.


Flash time - Reconstructed time against Reco time

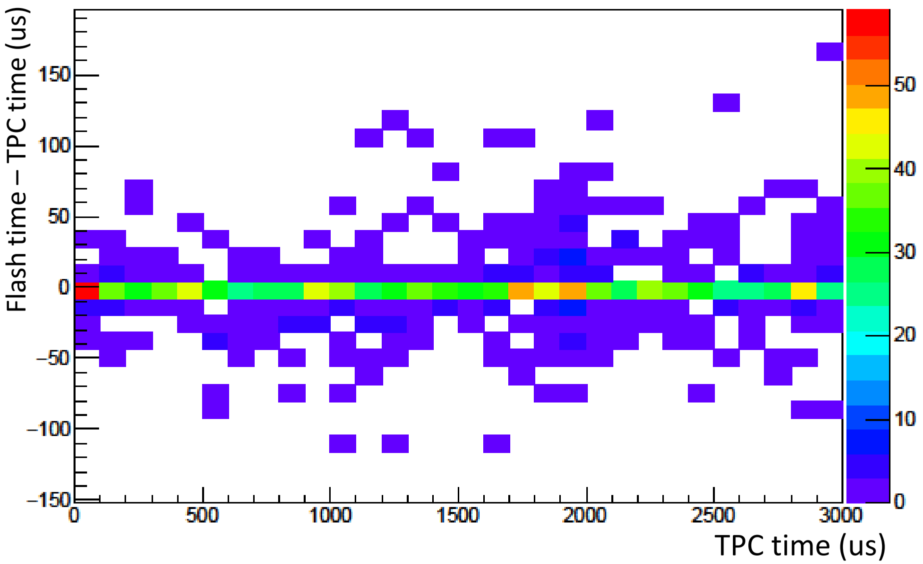

Flash time against Reconstructed time

- The flashes in MCC11 cover the whole readout window, but fail to be matched correctly to the tracks – this suggests an offset, but it wouldn’t be large as it should affect one end of these plots.

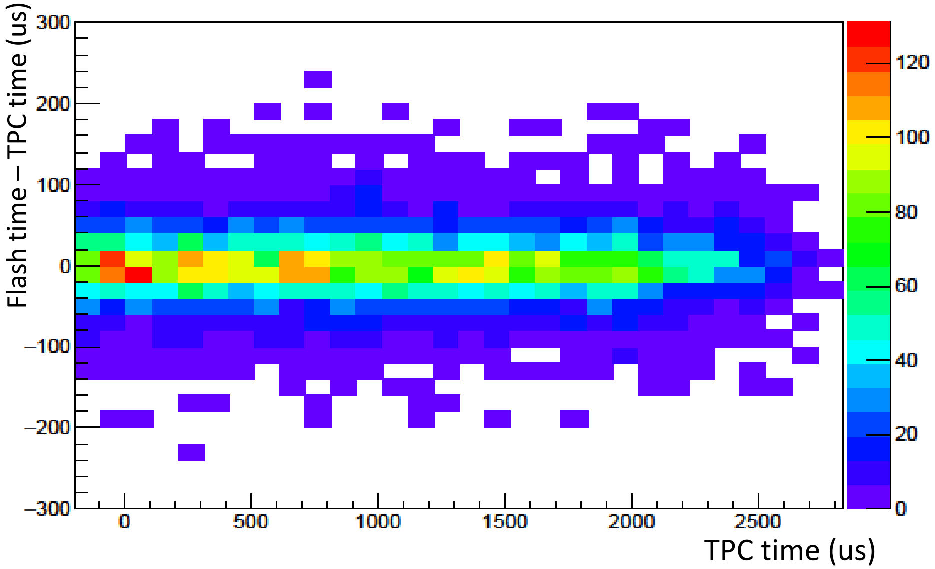
MCC10 against MCC11

- Between MCC10 (l) and 11 (r), a change is causing the flash match algorithm to fail completely.

Flash time - Reconstructed time against Reco time



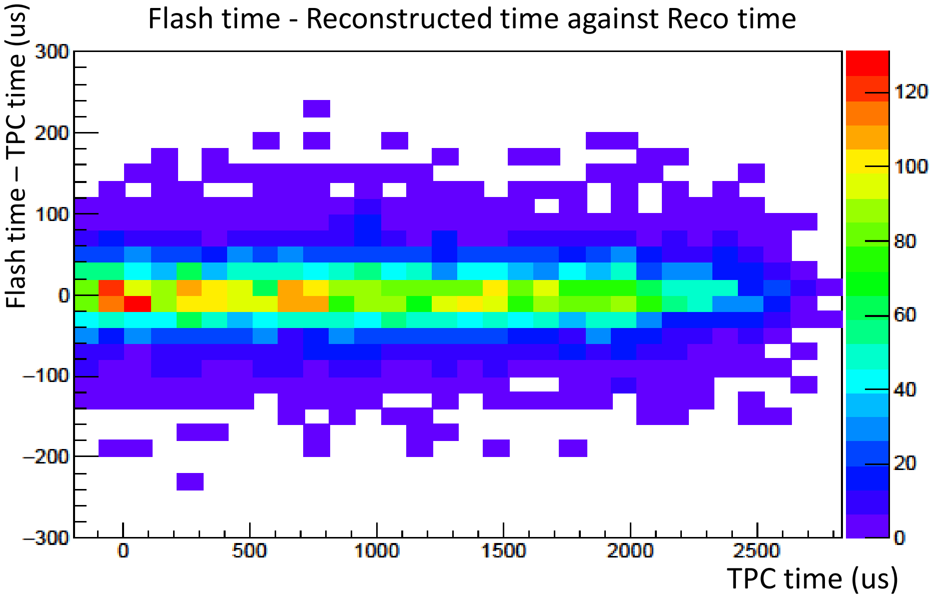
Flash time - Reconstructed time against Reco time

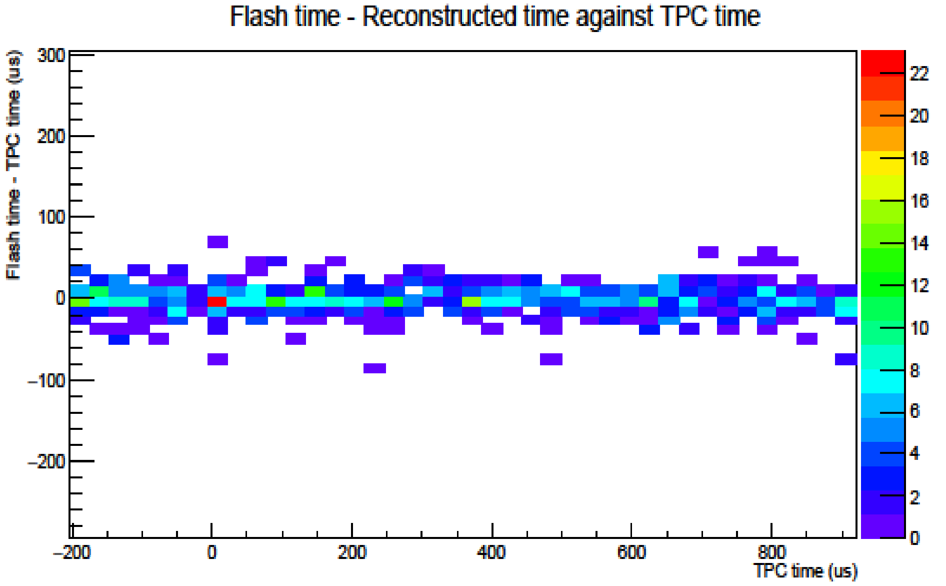


- As the TPC time is calculated using the position of the anode start/end of the track, something seems to have changed with the reconstruction of the optical flashes.

MCC11 against data

- The width of the distribution in the region with potentially correct flash timing looks significantly narrower in data than in MCC11.


Flash time - Reconstructed time against Reco time


Flash time - Reconstructed time against TPC time

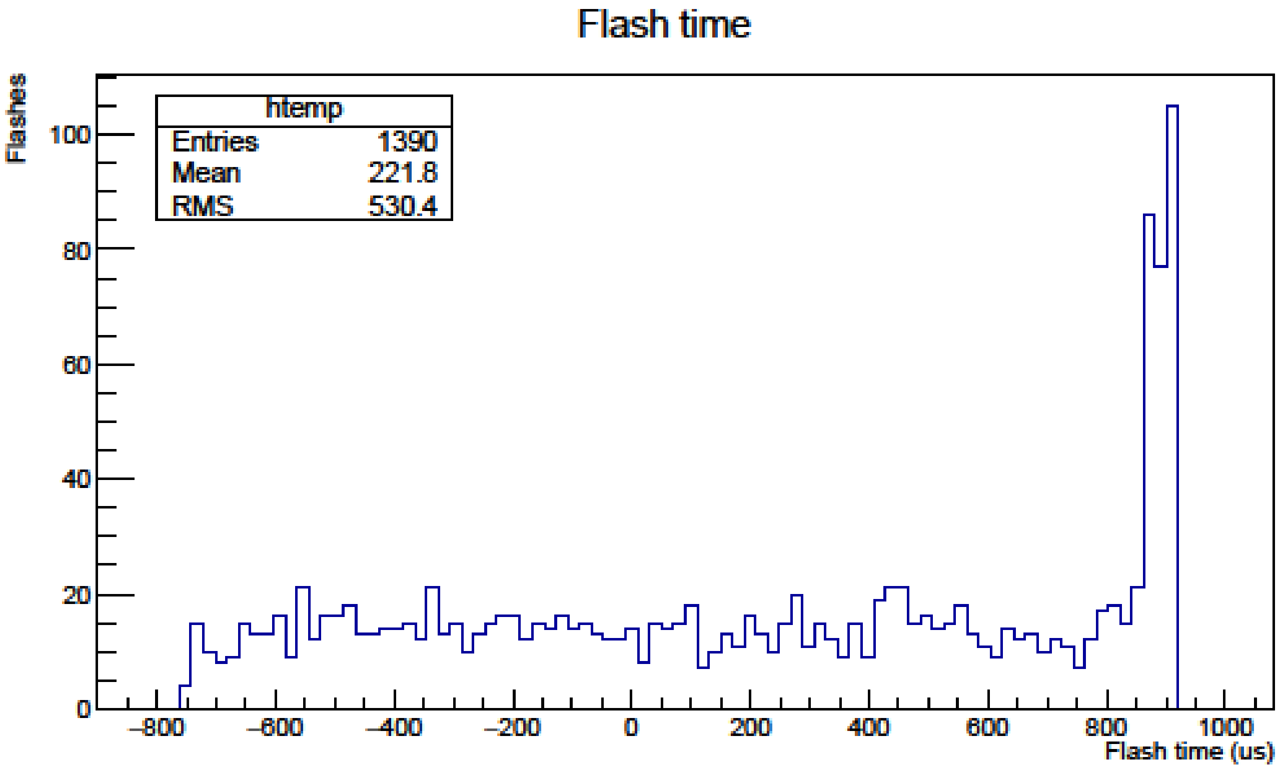
- This may suggest that the tracks in the ‘normal’ region have the correct times and are matched correctly to anode piercing tracks – however, it could mean that more flashes are reconstructed in data than in MCC11.

Next steps

- For the MCC11 study, I have integrated PhotonBackTracker in order to confirm that the flashes are matching incorrectly and to establish whether the correct flashes have a time offset – I will look into this information next.
- I will also run on a sample of MCC11 with SCE off and SCE without fluid flow, to see if the incorrect matching is present throughout or is caused by implementing the SCE simulation.
- For data, I'll increase my sample size and compare features of the flash and track to the time difference to attempt to remove the poorly matched tracks.
- If these help, I will take more information from the events to improve the selection.

Final note

- The flash times in the data (run 5817) are not what they are expected to be!


Flash time
htemp
Entries 1390
Mean 221.8
RMS 530.4
Flashes
Flash time (us)