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CHARGE DEPOSITIONS IN THE APA GAPS

SOFTWARE UPDATES

IN THIS PRESENTATION

- New features and methodology for gap finding algorithms
- Results of module on larger data samples
- Required improvements
- First estimates of DAQ time requirements.

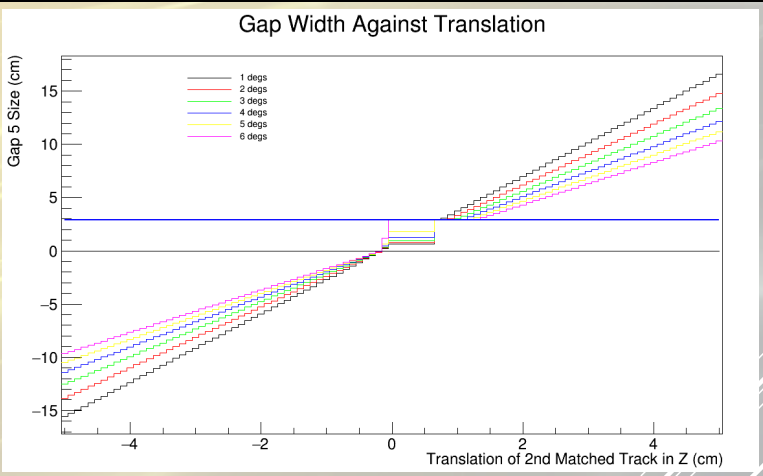
DUNETPC CHANGES

- Two analysis modules have now been ported into LArSoft, in the dunetpc repository, in a directory called 'Gaps'.
- The first analyses hits and creates plots/vectors of which events cross which gaps in the cryo.
- The second takes gap crossing events and calculates a gap width by matching unstitched tracks in adjacent TPCs and doing a 1D minimisation of the alignment coordinate such that the best value for a gap width is recorded per event.
- The gap width module is slow and uses a lot of track information to create appropriate cuts and alignment parameters.
- It translates one of the two matched tracks ±5cm in the alignment coordinate to find a best value for the gap size.
- Requires knowledge of track end and start points only – this is being updated now to use space points associated with a track to partially remove recourse to the simulation geometry. Almost ready for data.

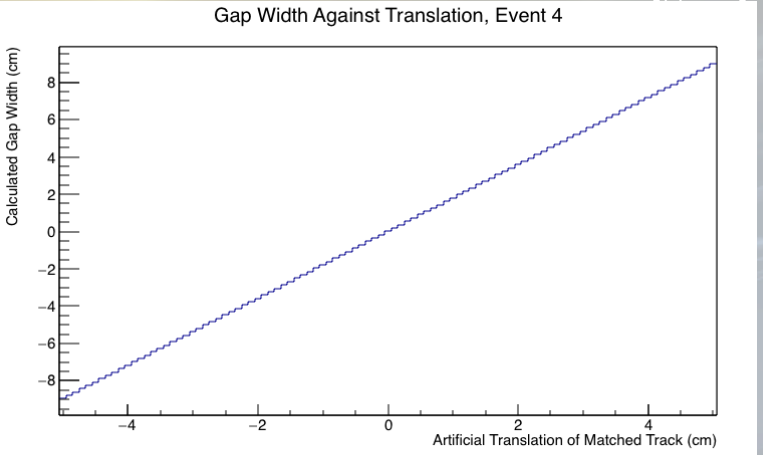
- Changed the gap minimising algorithm from one I wrote myself, which I presented at the collaboration meeting, to TMinuit.
- The plateaus that existed due to the 'good range' extrapolation have disappeared. Now have a linear fit.
- No longer subject to specified angular range of limits.
- Trade-off is inaccessible (or very difficult to access) errors on the calculation.

BEFORE & AFTER TMINUIT

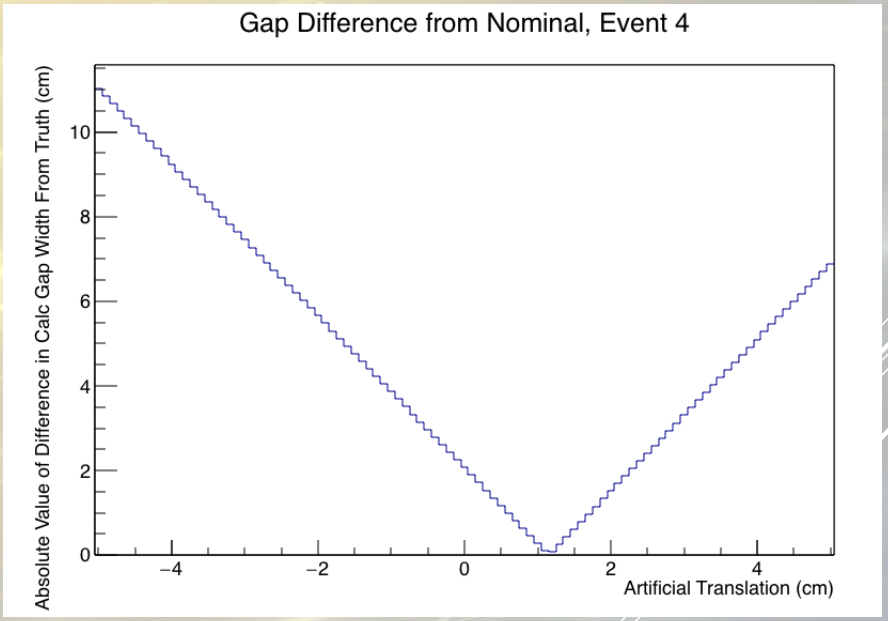
Before



After



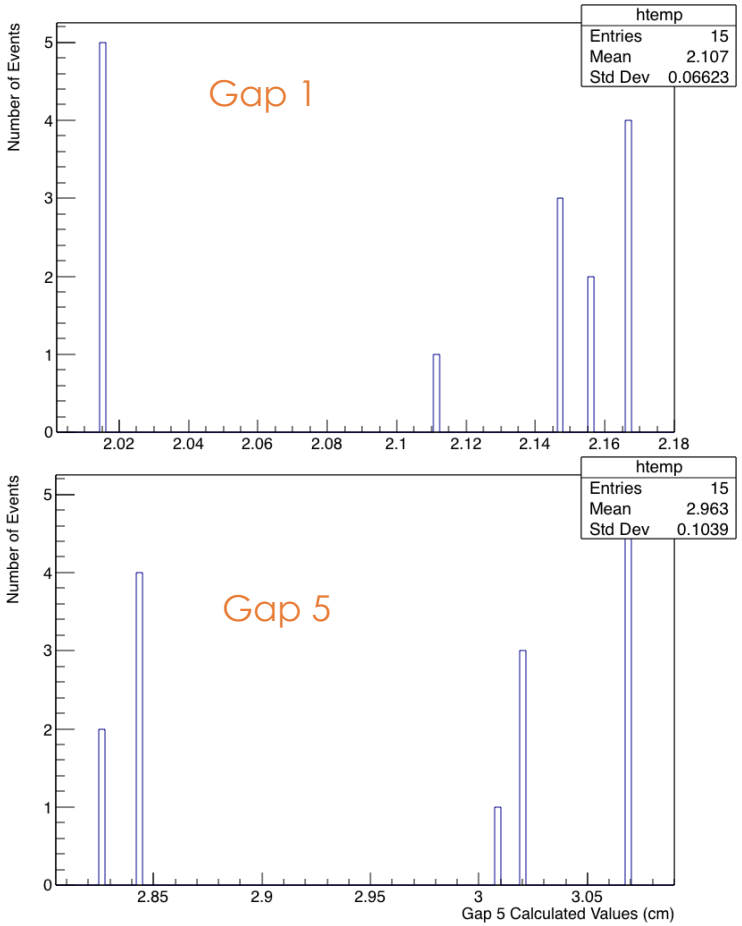
- Shown, is a plot of the absolute value of the difference between the calculated gap width and truth, against the artificial translation.
- Would expect the gap width to be optimised for translation = 0.
- The distortions at the ends of the unstitched track are what I believe to be the source of error. These arise from the projection of hits outside of the TPC onto nodes that extend beyond the TPC boundaries in pmtrack.
- Over many statistics, the mean of the calculated gap widths tends to the true gap width value, but is statistically limited.



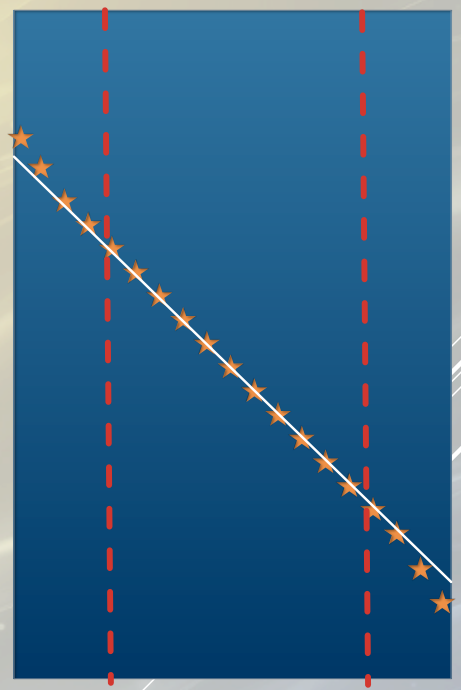
LOOKING AT THE MISALIGNMENT PER EVENT

- Running the module over 100 events from the Anti-Muon MCC4 sample, 15 events are found to cross gap 1 (top plot) and 15 are found to cross gap 5 (bottom plot).
- The mean of the gap 5 samples is 2.963, the true value is 2.9091
- The mean of the gap 1 results is 2.107, the true value is 2.0789
- These appear to be close but are still not ideal. Values were far worse before adding requirement that both tracks are > 15cm in length. This requirement greatly reduces the sample size.

AVERAGING WIDTHS OVER EVENTS



- Instead of using tracks as output from the track finding algorithm, use space points that produced the track.
- Make cuts (the red lines in the cartoon) which miss the distorted edge segments of the TPC hits that distort the overall track gradient.
- Make a 3d fit to the XYZ coordinates within the cuts.
- Extrapolate this fit to the TPC edge.
- This provides perfectly straight unstitched track segments which should then reduce the error in gap width.
- Gap width module is now essentially fitting its own 'linearity optimised' tracks.



COMING IMPROVEMENT

- Still unclear on the exact time required to accurately measure gaps. At the moment ~100 gap crossing anti-muon events gives a measurement of a gap size within 5% of truth – assuming gap size is single valued along any given gap.
- This would take less than an hour of DAQ time. To ere on safe side, a day of data would be optimal.
- The external scintillation counters are aligned such that they can filter events that cross two gaps easily. Will need the photo-cathode from G10 boards to identify events that unambiguously cross gap 5 and the two gaps not in the path of counter 'pairs'.
- After implementing the changes on slide 7, I will run over a large MCC4 sample and adjust the precision/timing estimate depending on the output
- Need to switch to 10-drift window format of data - have already run current code on this, and it works as expected. Will test again with new changes.
- Take away message is that all five gaps should be measurable with a day of data without a significant degree of statistical imprecision.

TIME TO MAKE MEASUREMENTS

- Almost ready for data.
- Need to write a dumb track finding algorithm that maximises track linearity – half done. This should reduce the spread of calculated gap width data.
- The current implementation of code produces an 'okay' gap width estimate but with a large standard deviation.
- Shouldn't need more than a day of data to make accurate estimates of all five gaps. This requires the G10 board information.
- With scintillation counters only the module can determine two of five gap widths. Gap 5 is also accessible to this sample but not every event necessarily crosses the gap – subject to higher error.
- Impossible to entirely remove recourse to GDML geometry, all reconstruction modules use it to some degree.
- Need method to associate wires in one TPC with Z coordinates that are accurate with respect to adjacent TPCs.
- Need to add feature for gap 4 to accommodate the charge deflector.

CONCLUSIONS