

Dive into TOF calibration issues

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Disclaimer

- ▶ The following findings reflect my attempt to understand the issue #1912
- ▶ Let me know if I missed something
- ▶ The conclusions are still only partial

Issue #1912

<http://micewww.pp.rl.ac.uk/issues/1912>

► Issues raised:

1. Low efficiency in reconstruction of space points, mainly in TOF2
2. Offset in slab ΔT of about 20 to 50 ps

Space point reconstruction efficiency

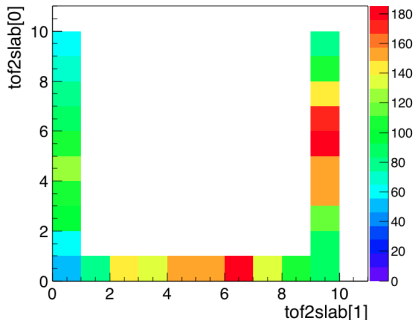
- ▶ **Problem:** Space point in TOF not reconstructed although there were hits in both planes and there was a space point created in TOF1
- ▶ Several runs observed significantly decreased efficiency:
~ 98% → ~ 95%
- ▶ Reported runs: 8447, 8448, 8450, 8451, 8681, 9970

Runs 8447, ..., 8681

- ▶ Example run 8450, TOF2
- ▶ 2 planes hit
- ▶ 2 slab hits only (one per plane)

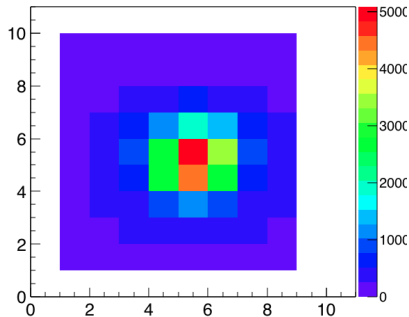
Slab position in X-plane vs Y-plane

tof2slab[0]:tof2slab[1] {tof2nslabs==2}



- ▶ No space point reconstructed

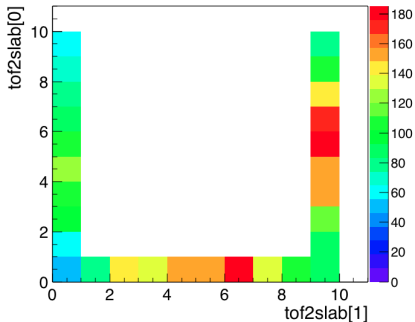
tof2slab[0]:tof2slab[1] {tof2nslabs==2 && tof2npoints}



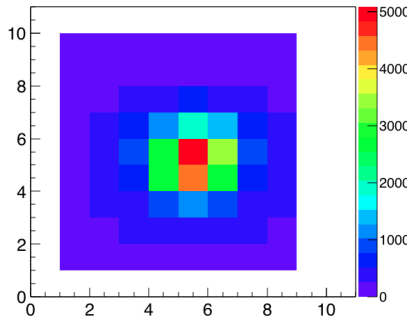
- ▶ Space point reconstructed

Runs 8447, ..., 8681

tof2slab[0]:tof2slab[1] {tof2nslabs==2}



tof2slab[0]:tof2slab[1] {tof2nslabs==2 && tof2npoints}

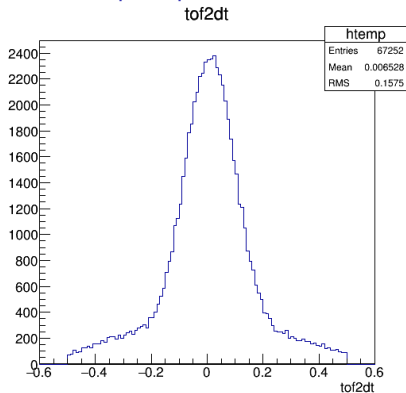


- ▶ Space points were not reconstructed in the outer regions
- ▶ Indicates missing calibration for the 3 slabs (the PMT hits were indeed not calibrated)

Run 9970

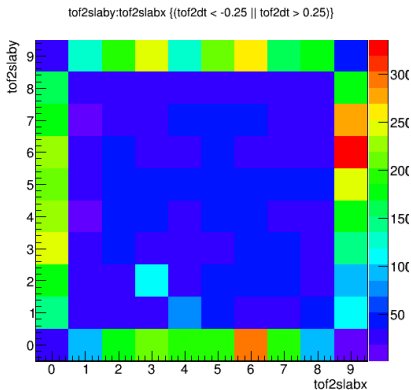
- ▶ Lower efficiency caused by longer tails in slab ΔT distribution
- ▶ Reconstruction cuts off anything with $|\Delta T| > 0.5$ ns
- ▶ calibrated slab times, in ns

ΔT of 2 space point slabs



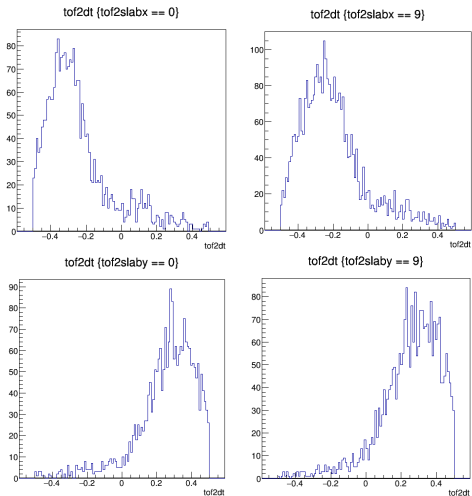
Run 9970 – tails in ΔT

- ▶ X–Y distribution of the outliers ($\Delta T > 0.25$ ns)



- ▶ Again, bad events in outer regions

Run 9970 – Slab ΔT distribution

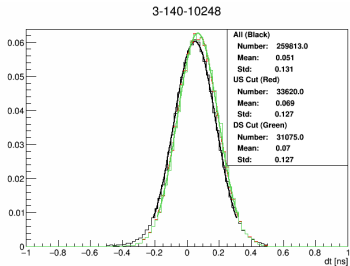
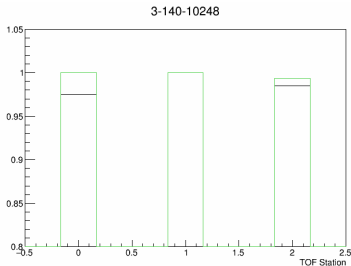


- ▶ Outer slabs are miscalibrated
- ▶ They are calibrated to about 0.3 ns too late

Troubles in runs 10248 and 10250

Chris reported for runs 10248 and 10250:

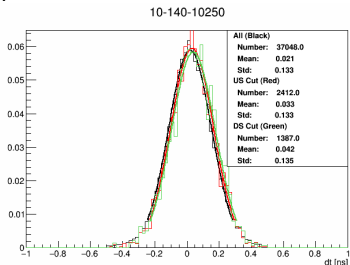
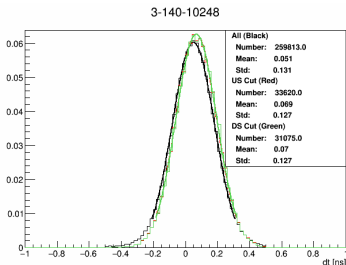
“Scott, I still see poor efficiency in the recent data. Why is that?”



Troubles in runs 10248 and 10250 – II

Chris reported for runs 10248 and 10250:

“I note that there is a run dependence on the TOF dt; these are two nearly adjacent runs, run 10248 and run 10250. Note that the beamline is different so (a) the rate is probably different and (b) the beam is likely wider”



- ▶ Mean: 0.05 ns (10248) vs 0.02 ns (10250)

Troubles in runs 10248 and 10250 – III

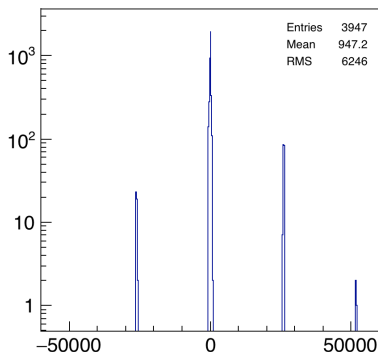
- ▶ TOF2 calibration is alright
- ▶ There seems to be residual inefficiency of about 2-3%
- ▶ Mean slab ΔT of reconstructed space points vary at the level ~ 0.01 ns

Residual space point reconstruction inefficiency

- ▶ I took a look at events in with slab hits in both planes but no reconstructed space point:
 - ▶ Run 10248
 - ▶ TOF0 events
 - ▶ TOF1 has 1 space point
 - ▶ TOF0 has only 2 slabs, both planes have a hit

Residual space point reconstruction inefficiency – II

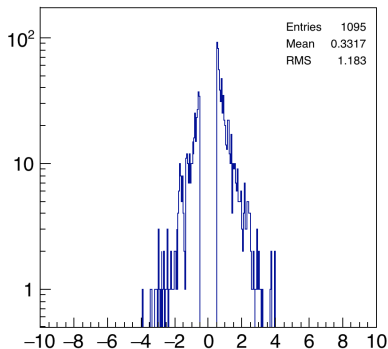
Slab ΔT



- ▶ There is a certain amount of events completely off

Residual space point reconstruction inefficiency – III

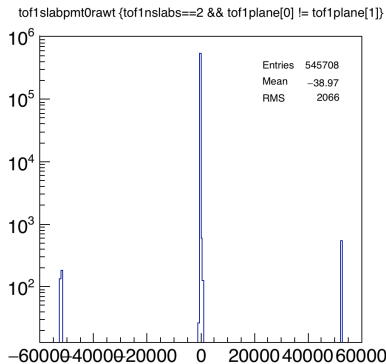
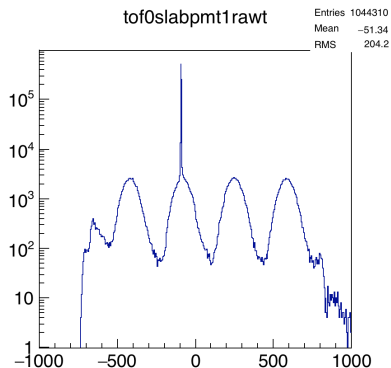
Slab ΔT



- ▶ Reconstruction algorithm cuts off hits with $|\Delta T| > 0.5ns$
- ▶ These are in tails of a gaussian like distribution
- ▶ $\sim 28\%$ (1095/3947) of not reconstructed space points
- ▶ The rest have ΔT completely off (see previous slide)

Additional issues found

- ▶ The observed structures in slab ΔT seem to be due so two different reasons
 1. Different particle triggers from one bunch
 2. PMT hit TDC out of range



Summary

- ▶ Observed abnormal inefficiencies in space point creation are caused by bad calibration of outer slabs
- ▶ Residual inefficiencies are due to 0.5 ns reconstruction cut and additional structures in ΔT distribution
- ▶ I have not investigate the cause of the offset of slab ΔT from zero investigated yet
- ▶ I will coordinate with Scott in order to come with a global solution to bad calibrations in TOF's outer slabs