

# TOF Space-Point Reconstruction Efficiency

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January 18, 2018

# TOF Efficiency

- ▶ Currently only efficiency of space-point reconstruction investigated
- ▶ It is easily determined from TOF data only
- ▶ Serves as diagnostics tool for the system
- ▶ Certain runs show abnormally large decrease of efficiency

# Space Point Reconstruction Efficiency

- ▶ Reconstruction is efficient when:
- ▶ Theoretically:
  - ▶ space point is reconstructed after **particle** left signals in both planes of TOF
- ▶ In practice:
  - ▶ space point is reconstructed after there were hits in both planes (can be caused by the same particle, different particles, or noise)

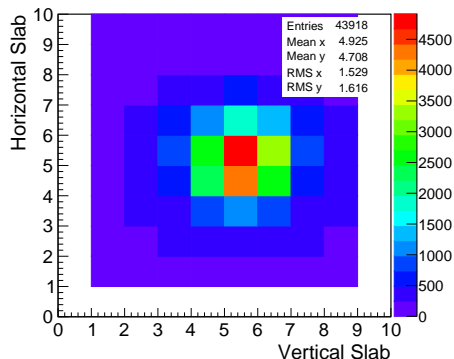
## Method

- ▶ A trigger must have a space-point reconstructed in other 2 TOFs
- ▶ TOF under test must have only two hits, one per plane
- ▶ Efficiency =  $N(\text{space point reconstructed})/N(\text{all})$
- ▶ Space point is reconstructed if:
  - ▶ PMT times were properly calibrated
  - ▶ time separation ( $\Delta T$ ) between slab hits  $< 0.5$  ns

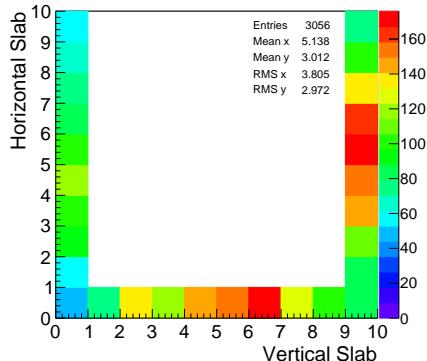
# No calibration in outer slabs

- ▶ Example run 8450
- ▶ Exhibited poor space-point (SP) reconstruction efficiency in TOF2
- ▶ Selection:
  - ▶ 1 SP in TOF0 and 1 SP in TOF1
  - ▶ 1 hit in each plane of TOF2
- ▶ TOF2 slab pairs:

TOF2 efficient events ( $|\Delta T| < 0.5$  ns)



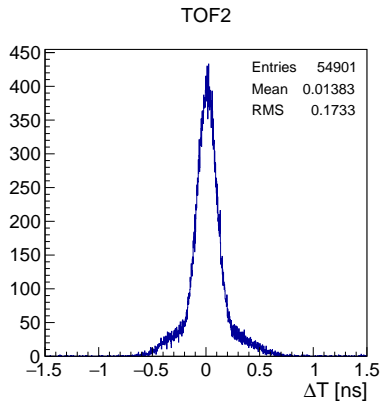
TOF2 inefficient events ( $|\Delta T| < 0.5$  ns)



- ▶ Inefficient due to no calibration in the outer slabs
- ▶ When the outer slabs excluded 92.5%  $\rightarrow$  98.9%

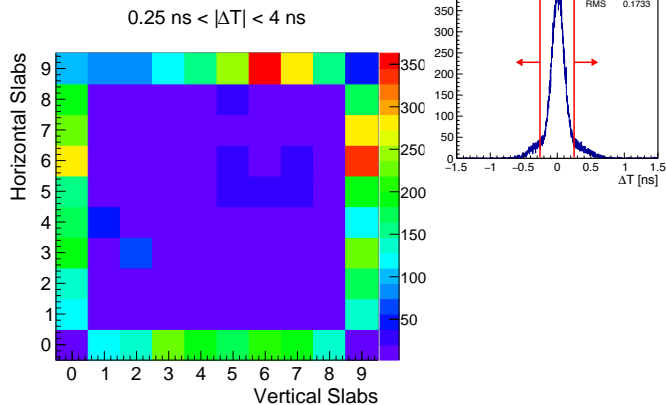
# Miscalibration of outer slabs

- ▶ Example run 9970
- ▶ Also exhibited poor space-point (SP) reconstruction efficiency in TOF2
- ▶ Slab time separation  $\Delta T$  does not have expected normal distribution:



## Miscalibration of outer slabs II

- Distribution of slab pairs in the tails of  $\Delta T$ :

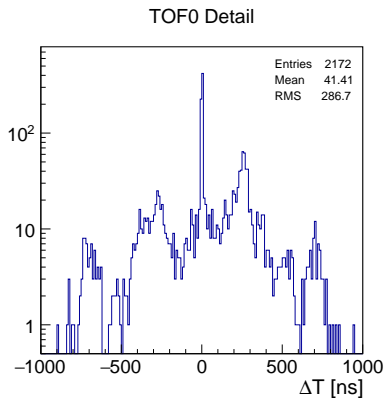
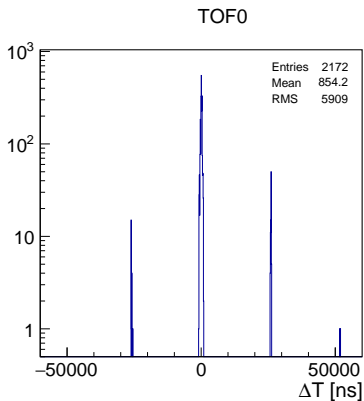


- When the outer slabs excluded in the efficiency calculation:
  - 97.3%  $\rightarrow$  99.3%

## Properly calibrated run

- ▶ Example run 10248
- ▶ When TOF calibration is alright
  - ▶ TOF0: 97.8%
  - ▶ TOF1: 99.8%
  - ▶ TOF2: 98.9%
- ▶ Still apparent inefficiencies in TOF0 and TOF2

## Closer look at inefficient events

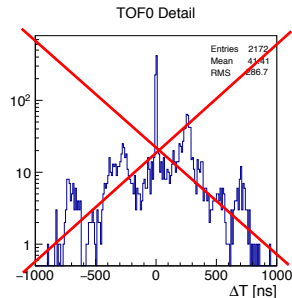
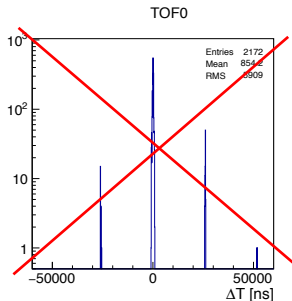


- ▶ Some slab hits clearly separated in time
- ▶ Separation of  $\sim 25 \mu\text{s}$ 
  - ▶ is related to PMT hit TDC overflow
- ▶ Structures at  $< 1 \mu\text{s}$ 
  - ▶ likely coupling of hits from two different particles from one bunch



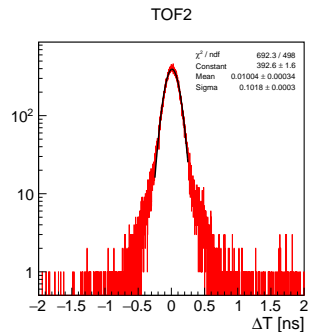
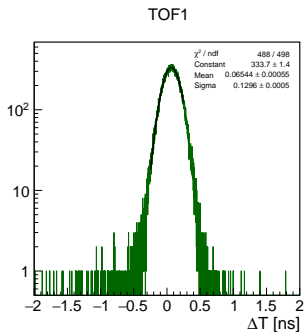
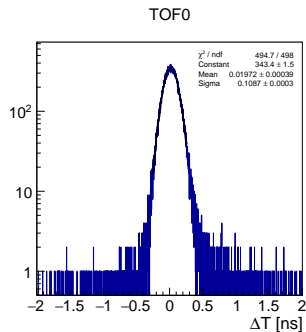
# Modified definition of efficiency

- ▶ Disregarding events where  $|\Delta T| > 4ns$
- ▶ Calculated efficiency improves:
  - ▶ TOF0: 97.8%  $\rightarrow$  99.4%
  - ▶ TOF1: 99.8%  $\rightarrow$  99.8%
  - ▶ TOF2: 98.9%  $\rightarrow$  99.2%



## Slab $\Delta T$ off-set

- ▶ Still run 10248
- ▶ Slab hit time separation  $\Delta T$ :



- ▶ Times are supposed to be calibrated such that mean  $\Delta T = 0$
- ▶ TOFs have different mean  $\Delta T$
- ▶ The means change in between runs
- ▶ No explanation yet
- ▶ TOF2 shows residual tail in  $\Delta T$  distribution

# Summary

- ▶ Some runs suffer from incomplete calibration
  - ▶ mainly outer slabs in TOF2
  - ▶ too small statistics in calibration run
- ▶ Low statistics for calibration runs seems to be general issue for TOF2
- ▶ Apparent space-point rec. inefficiency caused by inclusion of events with uncorrelated hits
  - ▶ not sure if “TDC overflow” issue caused by uncorrelated hits
- ▶ Modified space-point reconstruction inefficiency (avoiding problematic events)  $< 1\%$
- ▶ There are unknown offsets in TOF's slab  $\Delta T$  – sign of further issues with the calibration
- ▶ **Notice:**
  - ▶ space-point reconstruction efficiency is NOT TOF's efficiency to detect a particle

# Backups

# Slab $\Delta T$ off-set run 10248 (top) vs 10250 (bottom)

