Drift Chamber Calibrations

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Reference Times

- It is important to check the reference times and timing windows first in order to move on to the detector calibrations.
- As the pre-trigger is accepted, a lookup-window is opened and hcana chooses the first hit in that window if multiple hits are present per event.
- However, the first hit might not be a good cut and setting the reftime cut allows hcana to choose the most probable good first hit.
- For eg. in the figure to the right, about 19% of the events would have a wrong reference time and this error would propagate onto the detector calibrations/timings used for analysis.

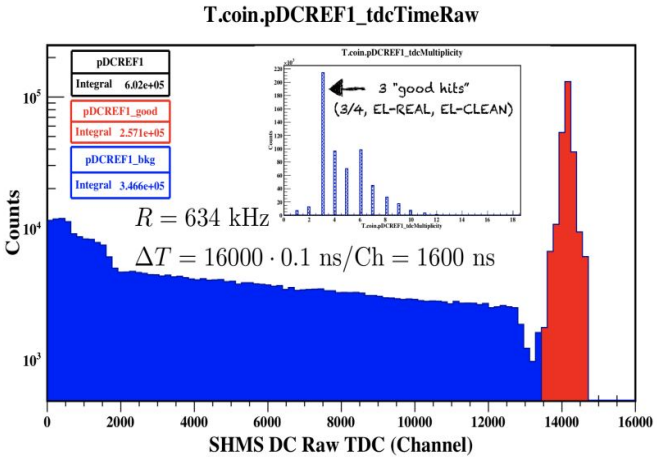


Fig. from Dr. Yero's general analysis document.

Runlist for checking reference times.

- Broadly four kinematics:
  - KinC_x36_*
  - KinC_x50_*
  - KinC_x60_*
  - KinC_x25_*
- Reftimes checked for several runs from the above. Runs selected on the following basis:
  - Events > 1M
  - Different trigger settings (T3, T4 and T6)
  - If the triggers are mostly the same in that kinematics, then two runs far apart in time.
- What's a good reference time? (in a nutshell)
  - Red line denotes the real signals
  - Blue line denotes the background signals.
  - Orange vertical line is the cut that's defined.
  - Good cut: **Orange vertical line completely separates the blue region from the red**.

Quick Remarks on Reference Times

- 44 runs were checked for KinC_x36_* and KinC_x50_*
- 27 runs were checked for KinC_x60_* and KinC_x25_*
- For each kinematic, a least one run at the beginning and one run at the end
- The shape of the signal peak is different for different trigger (T6 / T3 / T4)
- The shape of the signal peak for a certain trigger doesn't change for different kinematics
- The existing reference time cuts are always to the left of the signal peak
- **Do we need to adjust the cuts?** (See slides below)

Reference Time Cuts

PARAM/HMS/GEN/h_reftime_cut_nps23.param

```
hdc_tdcrefcut=-14000
; cut variable = hT2
hhodo_tdcrefcut=-1700
; cut variable = hFADC_TREF_ROC1
hhodo_adcrefcut=-4000
hcer_adcrefcut=-4000
hcal_adcrefcut=-4000
```

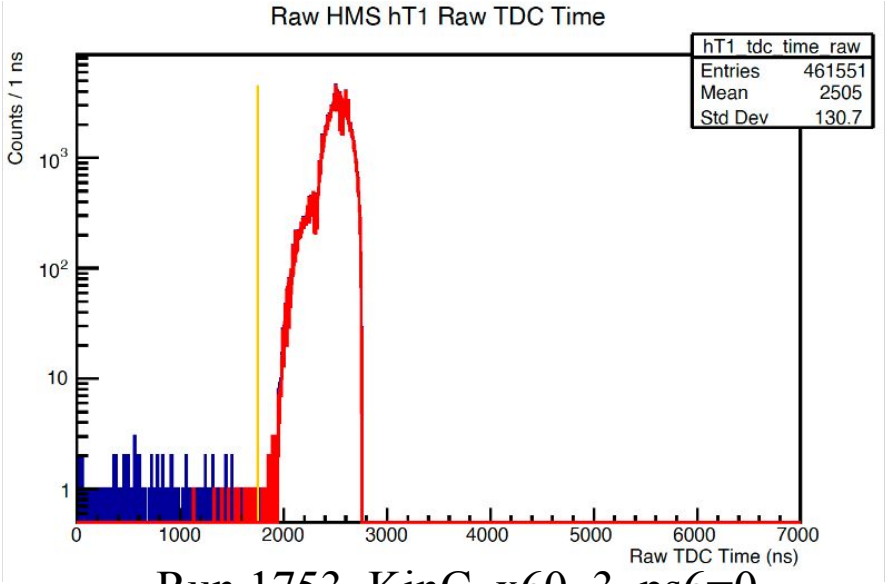
PARAM/TRIG/thms_nps23.param

```
; cut variable is hT1
; NOTE: *_{ta}dcrefcut are integers
; UPDATED Sep.22 2023
t_hms_trig_tdcrefcut = -1700
; cut variable is hFADC_TREF_ROC1
t_hms_trig_adcrefcut = -4000
```

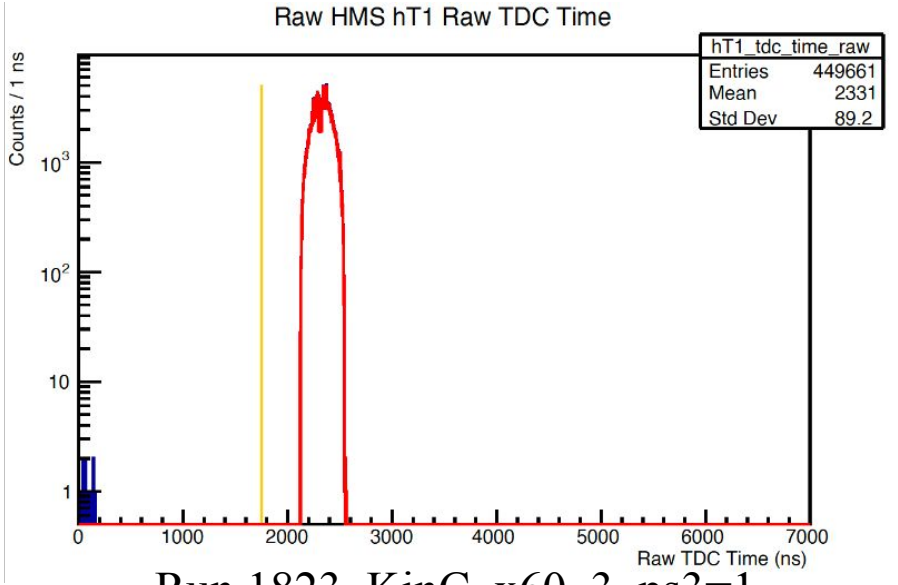
Reference times	Cuts (ns)
hT1	-1700
hT2	-1700
hFADC	-4000
hDC	-14000 (channel)

Reference times	Cuts (ns)
hT1	-1700

TDC Reference Time



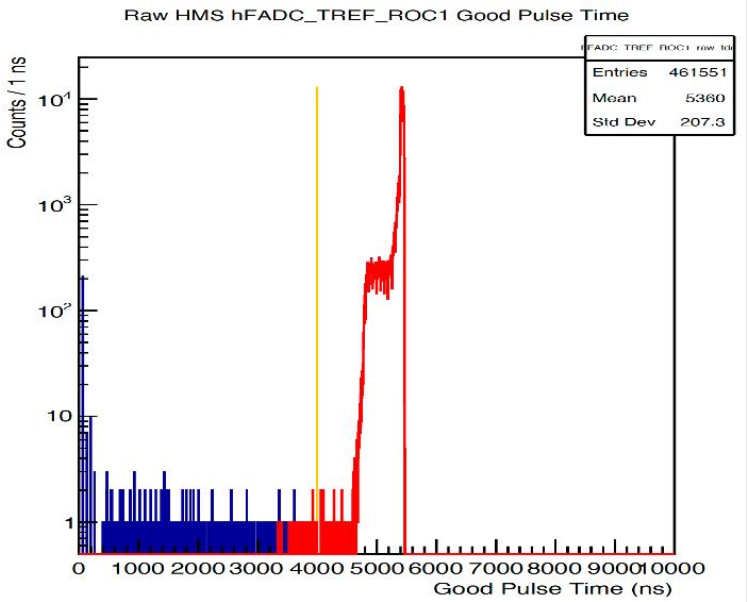
Run 1753, KinC_x60_3, ps6=0



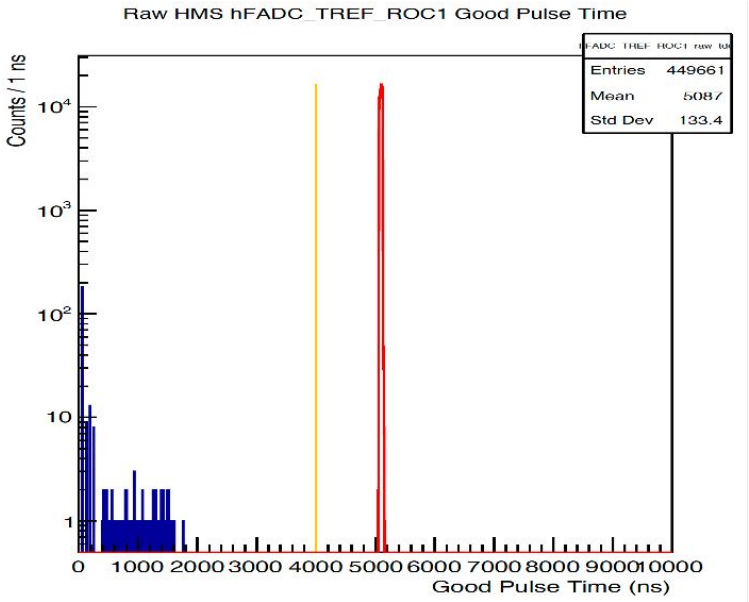
Run 1823, KinC_x60_3, ps3=1

Reference times	Cuts (ns)
hFADC	-4000

FADC Reference Time



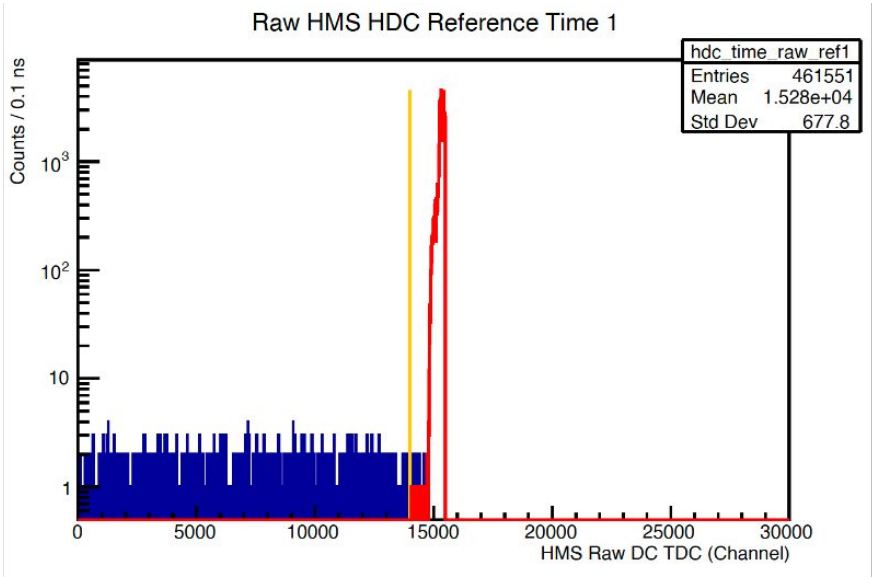
Run 1753, KinC_x60_3, ps6=0



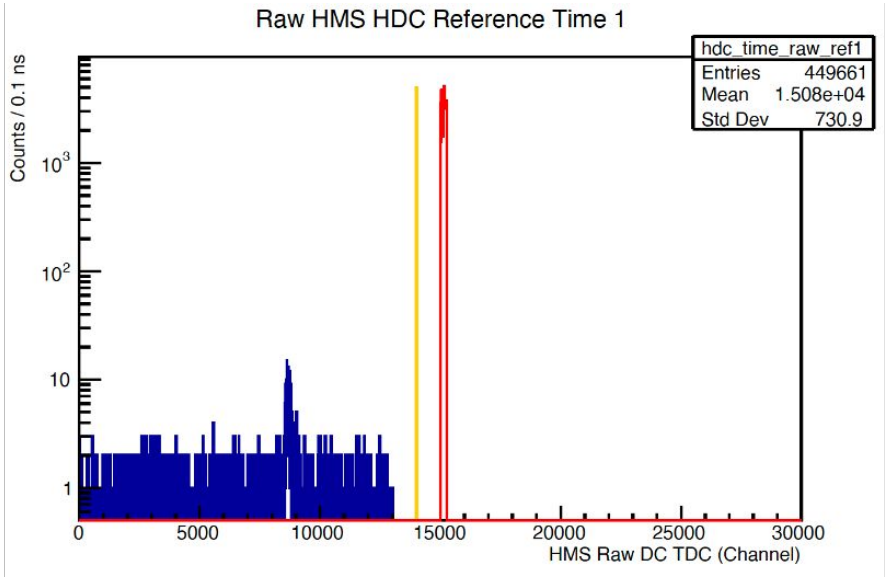
Run 1823, KinC_x60_3, ps3=1

Reference times	Cuts
hDC	-14000

DC Reference Time



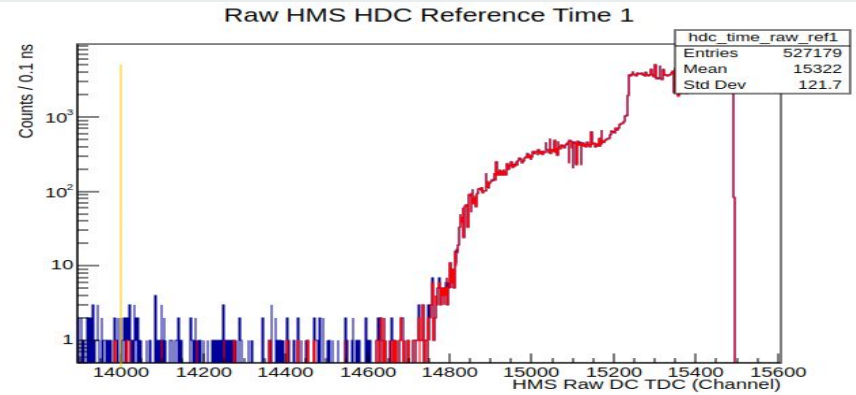
Run 1753, KinC_x60_3, ps6=0

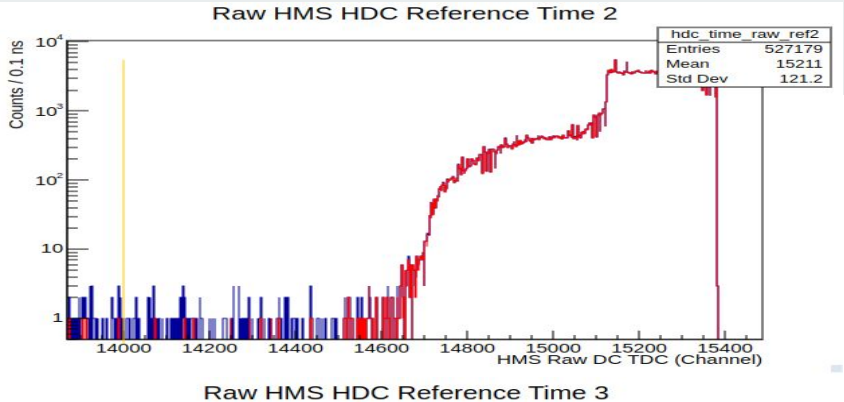


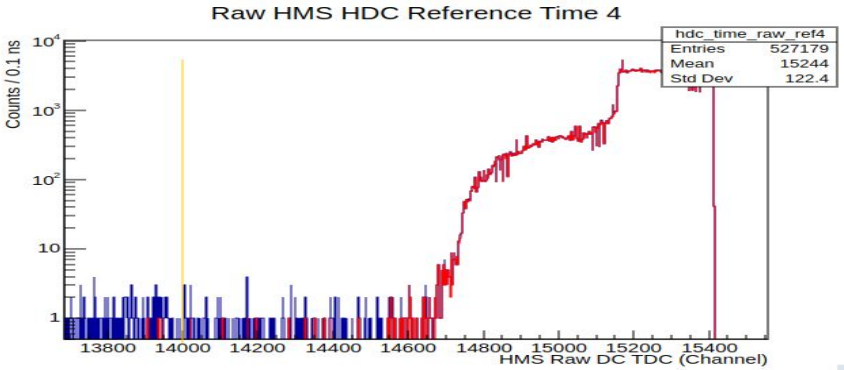
Run 1823, KinC_x60_3, ps3=1

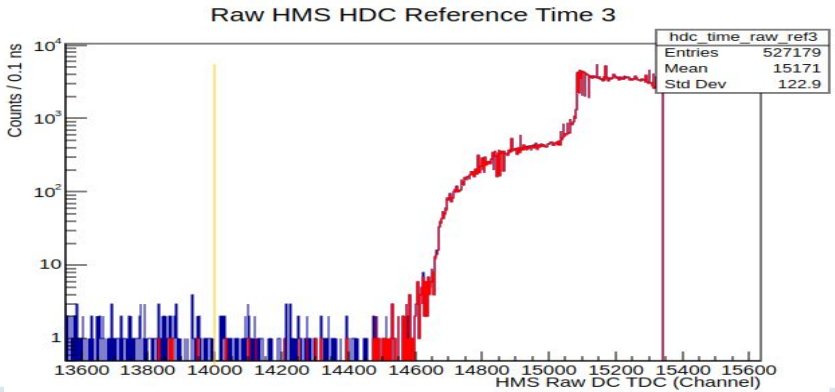
Some reference time plots from run 3063.

- The plots are relevant as the same trend is seen in all the runs analysed for reference times.

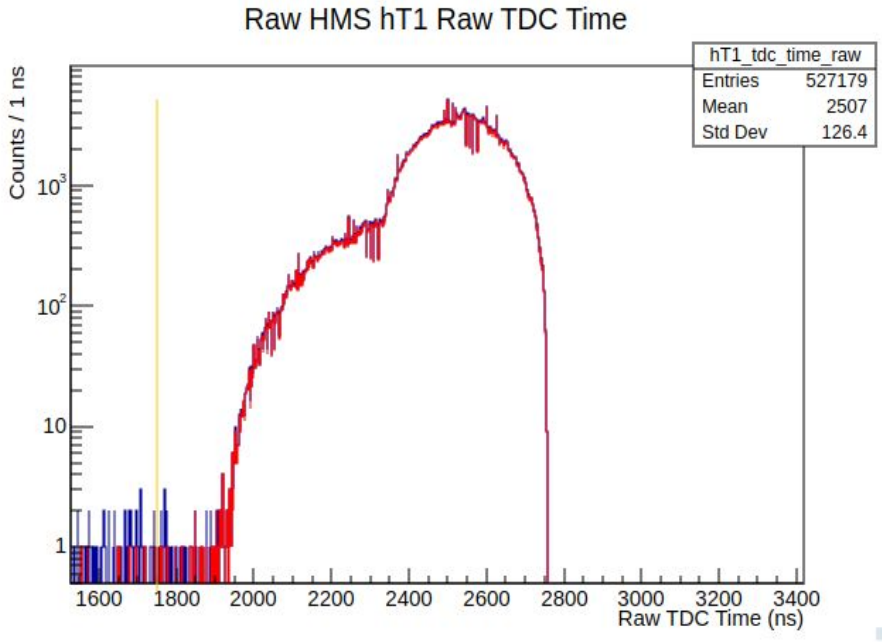


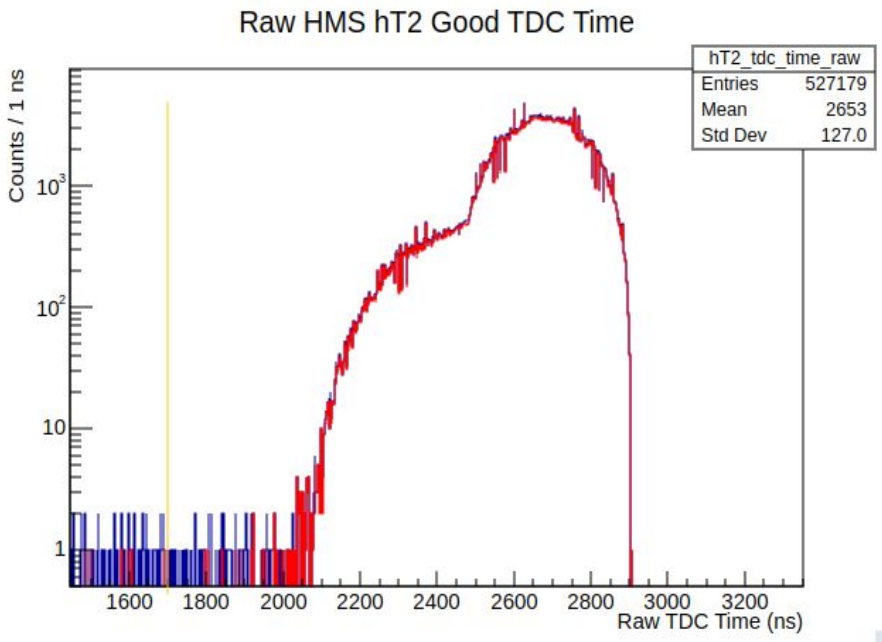






- Similar trend is observed in all the selected runs.
- The cuts can be fine tuned from **hdc_tdcrefcut = -14000 —> hdc_tdcrefcut = -14300**
- A finer cut can be chosen with a more thorough comparisons of the runs.
- Do we want this fine tuning?





- **thms_trig_tdcrefcut=-1700 —> thms_trig_tdcrefcut=-1800**
- A more in-depth analysis is needed to determine whether this cut is necessary, as it is not as consistently visible across all the runs compared to the cut shown in the previous slide.

Reference Times & Timing Windows Revisited

- Proper reference times and timing windows are very important for getting good detector calibrations.
- Made a bash script which “streamlines” the process of setting the reference times. The output files are stored as “move_me_runnumber.root” building on the convention of the script.
- Allows us to produce the reference time plots for any number of runs (from a runlist) at one go and also ensures that the same process is followed for every run.
- We’ll run this script (needs slight modification for swif2) over the selected runs from each kinematic settings, compare the plots from those runs, and then decide the final parameters to be used.
- Updated the timing windows script and been pushed to git. It should be available for everyone soon.

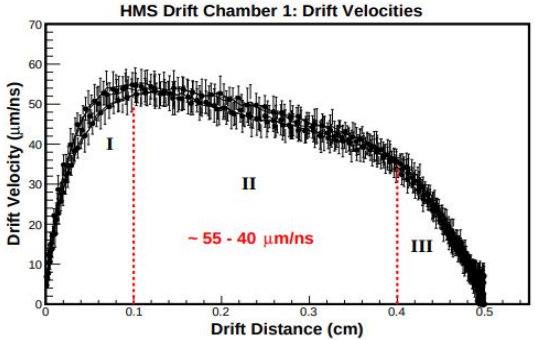
Drift Chamber Calibrations Progress

- Bash script under progress.
- Almost all the calibration plots/parameters given in Dr. Yero's document reproduced.
- The only thing left is "efficiency per plane" defined as:

of a particle. Mathematically, the efficiency of the i^{th} plane is given by

$$\epsilon_i = \frac{\#\text{ hits that were detected by the } i^{th} \text{ plane}}{\#\text{ hits that } \textit{should} \text{ have been detected by the } i^{th} \text{ plane}}$$

with the condition that the hit was also detected by the remaining five planes in the chamber. The efficiencies of both



(a) Drift velocity vs. drift distance for all planes in chamber 1.

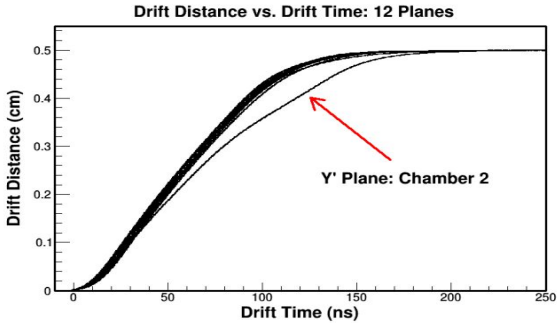
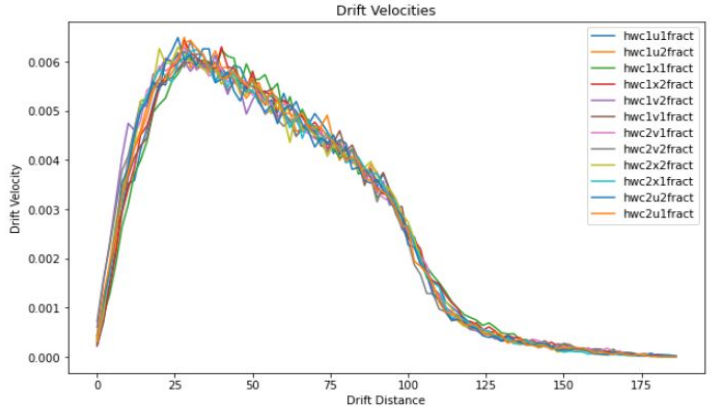
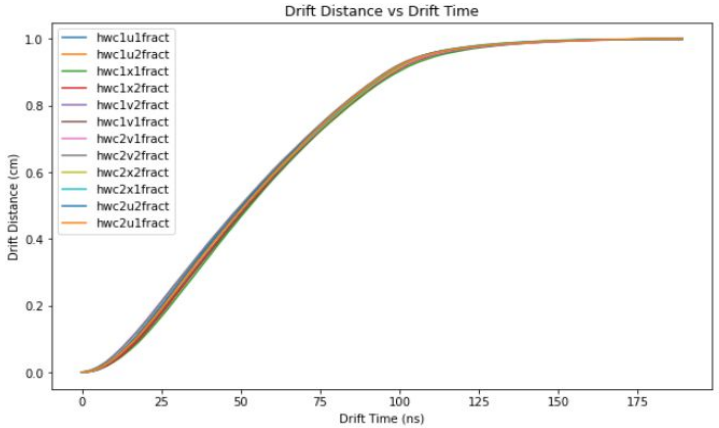


Fig. 12: Correlation between drift distance and drift time for both drift chambers.





Lookup table: Drift time to Drift distance

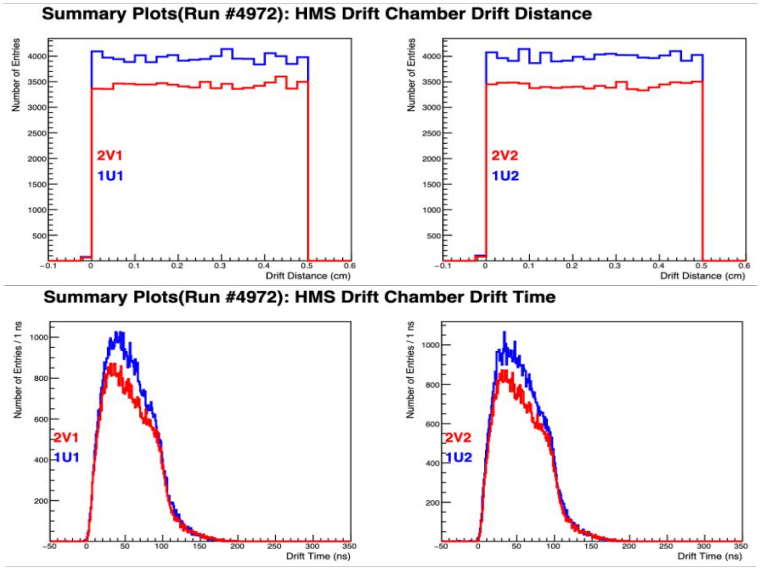
```
; Lookup Table: RUN 6810
; number of bins in time to distance lookup table
hdriftbins = 190
; number of 1st bin in table in ns
hdrift1stbin=1.000000
; bin size in ns
hdriftbinsz=1
hwc1u1fract=0.00018,0.00062,0.00137,0.00277,0.00471,0.00758,0.01151,0.01599,0.02107,0.02699,0.03330,0.04034,0.04750,0.05467,0.06287,0.07130,0.08021,0.08946,0.09951
0.10979,0.12060,0.13172,0.14301,0.15406,0.16595,0.17792,0.18956,0.20182,0.21339,0.22580,0.23834,0.25046,0.26272,0.27443,0.28627,0.29819,0.31007,0.32180,0.33361
0.34478,0.35644,0.36819,0.37990,0.39132,0.40332,0.41516,0.42665,0.43841,0.44954,0.46071,0.47246,0.48344,0.49417,0.50513,0.51572,0.52595,0.53667,0.54712,0.55757
0.56750,0.57812,0.58883,0.59865,0.60864,0.61897,0.62935,0.63944,0.64916,0.65894,0.66838,0.67782,0.68771,0.69696,0.70650,0.71531,0.72447,0.73325,0.74152,0.74997
0.75880,0.76774,0.77642,0.78522,0.79312,0.80117,0.80897,0.81719,0.82443,0.83201,0.83952,0.84713,0.85403,0.86118,0.86864,0.87539,0.88217,0.88890,0.89520,0.90123
0.90687,0.91267,0.91754,0.92258,0.92746,0.93197,0.93602,0.93973,0.94317,0.94625,0.94931,0.95182,0.95474,0.95726,0.95950,0.96130,0.96333,0.96511,0.96692,0.96844
0.97003,0.97152,0.97288,0.97423,0.97550,0.97683,0.97793,0.97905,0.97999,0.98078,0.98180,0.98275,0.98353,0.98428,0.98490,0.98568,0.98637,0.98721,0.98783,0.98836
0.98895,0.98959,0.99008,0.99055,0.99106,0.99160,0.99205,0.99259,0.99300,0.99345,0.99384,0.99420,0.99451,0.99484,0.99514,0.99539,0.99570,0.99604,0.99640,0.99663
0.99694,0.99717,0.99738,0.99754,0.99777,0.99802,0.99824,0.99845,0.99859,0.99869,0.99878,0.99887,0.99896,0.99909,0.99916,0.99929,0.99938,0.99946,0.99951,0.99956
0.99971,0.99976,0.99981,0.99985,0.99988,0.99993,0.99995,0.99997,0.99998,1.00000,1.00000
```

Notice the absence of commas at the end of each line.

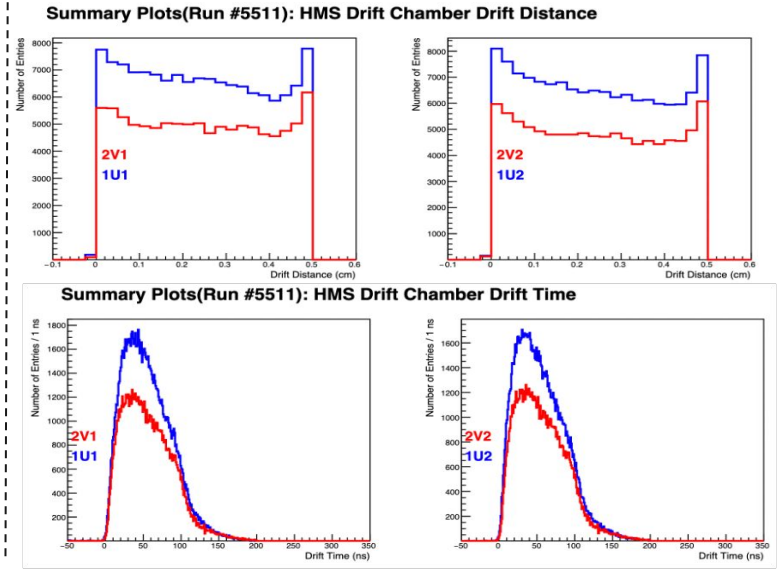
- This is located at /PARAM/HMS/DC/hdc_calib_nps23.param
- The absence of delimiters, or “commas” here, do present a problem when analysing these file. It’s not “impossible”, just considerably harder to tell the code what to do.

The drift distance distribution becomes not flat after numbers of runs

An Issue for DC Calibration



03/04/2024



04/02/2024

An Issue for DC Calibration

- Need to do the calibrations in the following order:
  - Reference time cuts check (ongoing)
  - Time window cuts check
  - Hodoscope calibration
  - Drift chamber calibration
- Do one calibration for each kinematics at first
- Decide the criteria for if additional calibration is needed (how flat the drift distance is?)

DC Calibration summarised:

- The DC calibration script has been tested on several runs and it works well
- Drift velocity plot is not included in the scripts on git but the script for it is also ready now.
- “Efficiency per plane” remains. Working on retrieving them
- At least one calibration for each kinematics, need to check if it’s enough (criteria TBD)
- Studying to get a better idea on what other parameters could be relevant for quantifying the calibration.
- Updated timing window script and pushed it to git. It should be available to all as the pull request is approved.