Software Workshop

HMS/SHMS Drift Chambers Calibration

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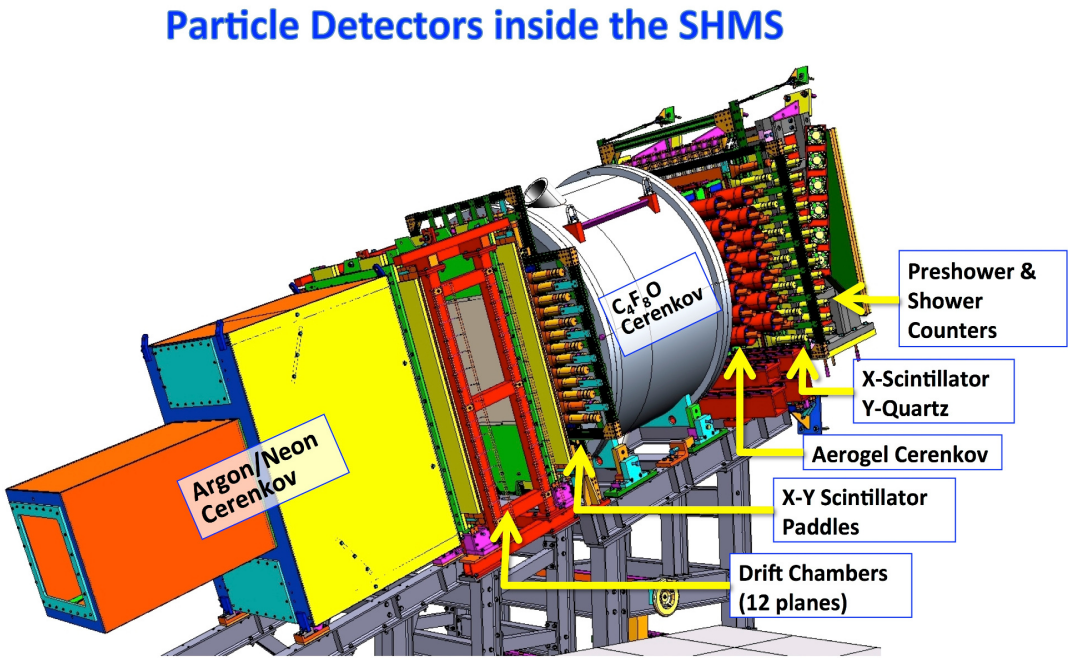
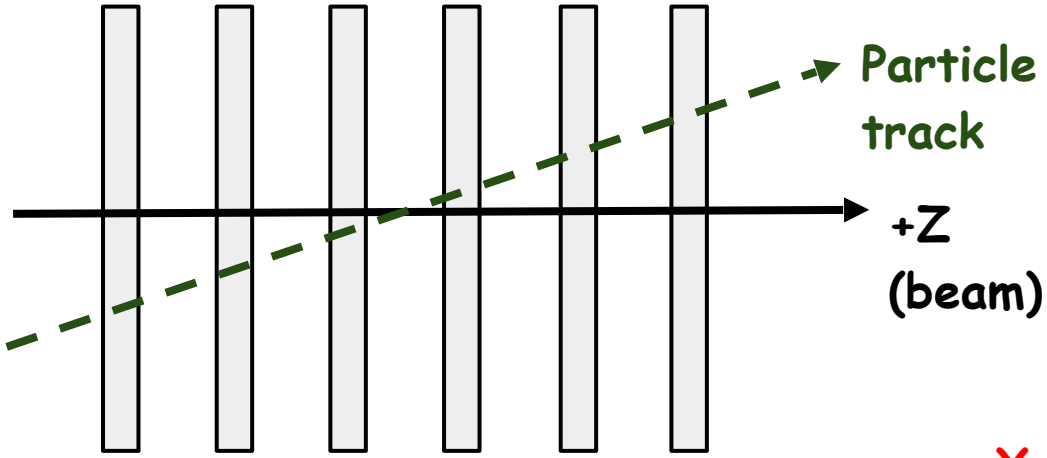
SHMS Detector Stack

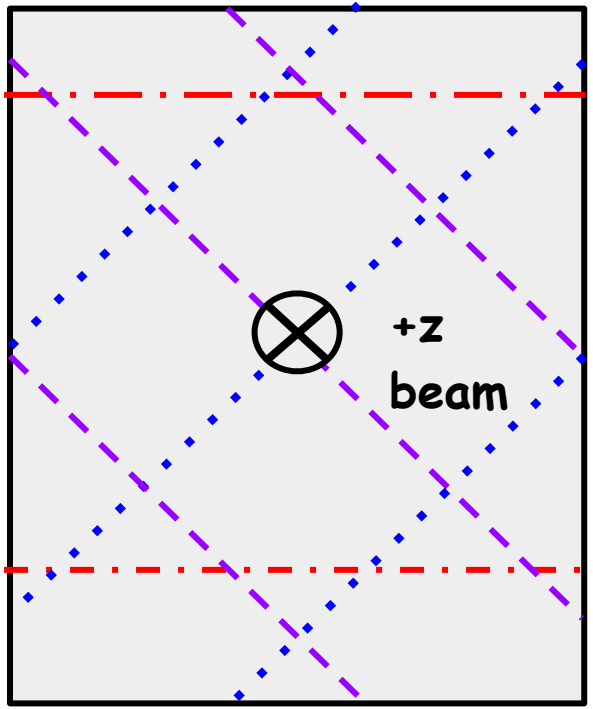
- Drift Chambers are tracking detectors
- Calibration is necessary for high precision particle track reconstruction
- Calibration involves the conversion of drift times to drift distances to obtain accurate track position



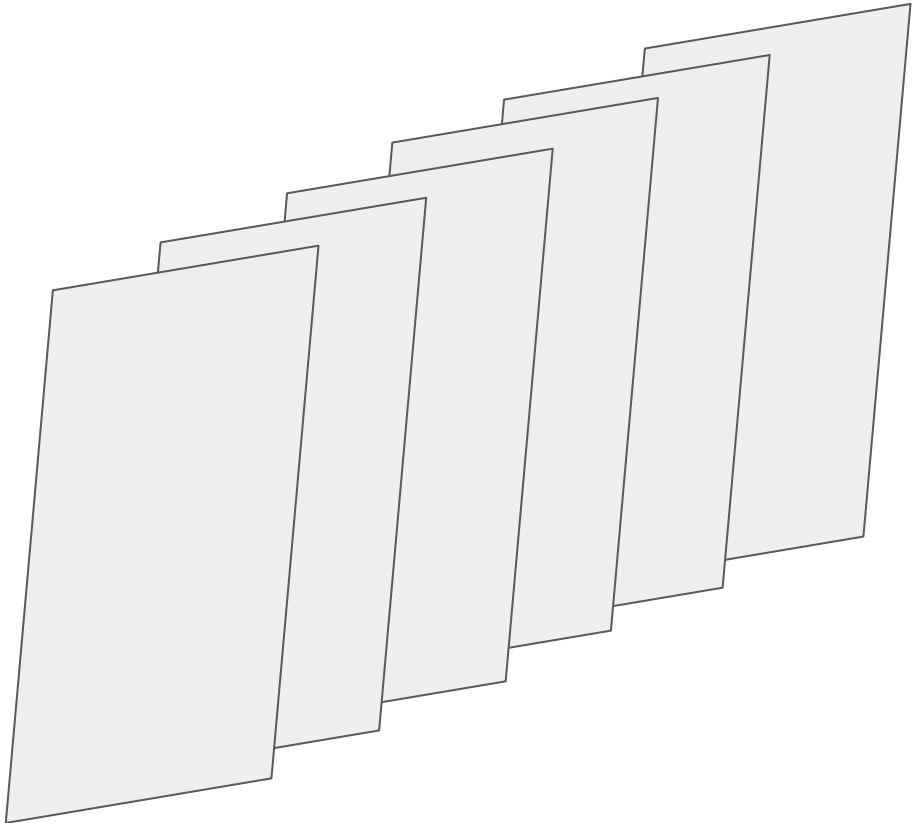
SHMS Drift Chamber Planes

Drift Chamber 1





How Does Tracking Work?



- Passage of the particle ionizes gas inside chamber
- Electrons from the gas drift towards the sense wire
- Drift times measured by TDC
- Calibration creates a lookup table used to convert drift times to drift distances
- Drift distance represents how far was the track from the sense wire that fired
- A collection of sense wire hits (stubs) are the fitted in each chamber and the best chi2-fit is chosen as best track.

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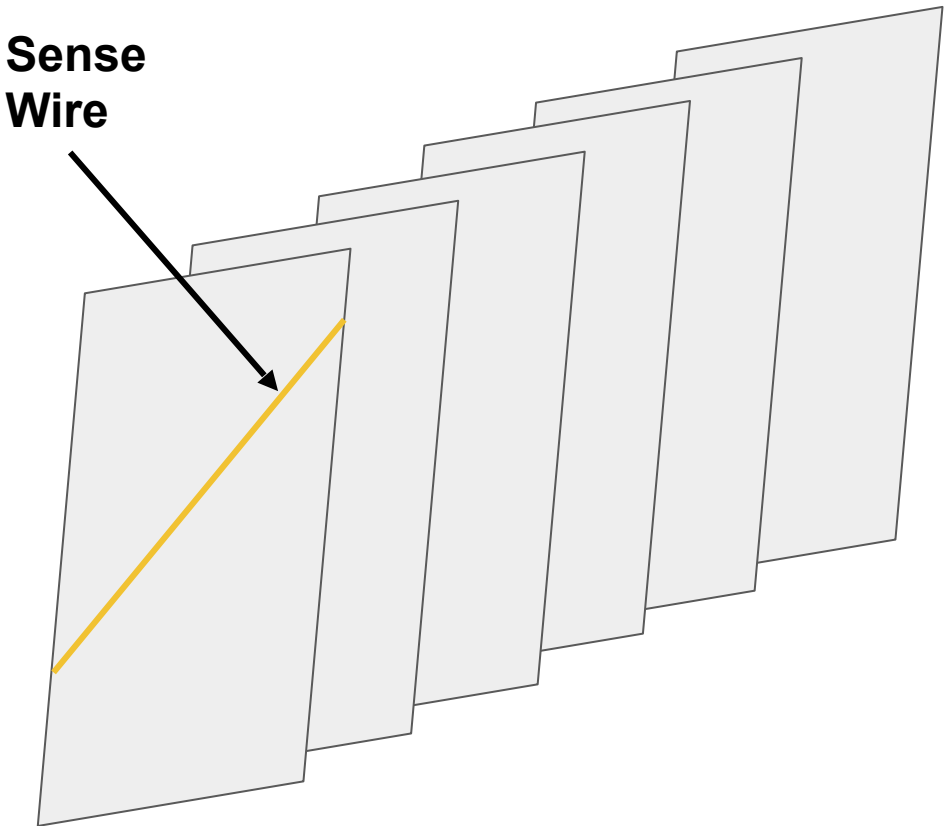

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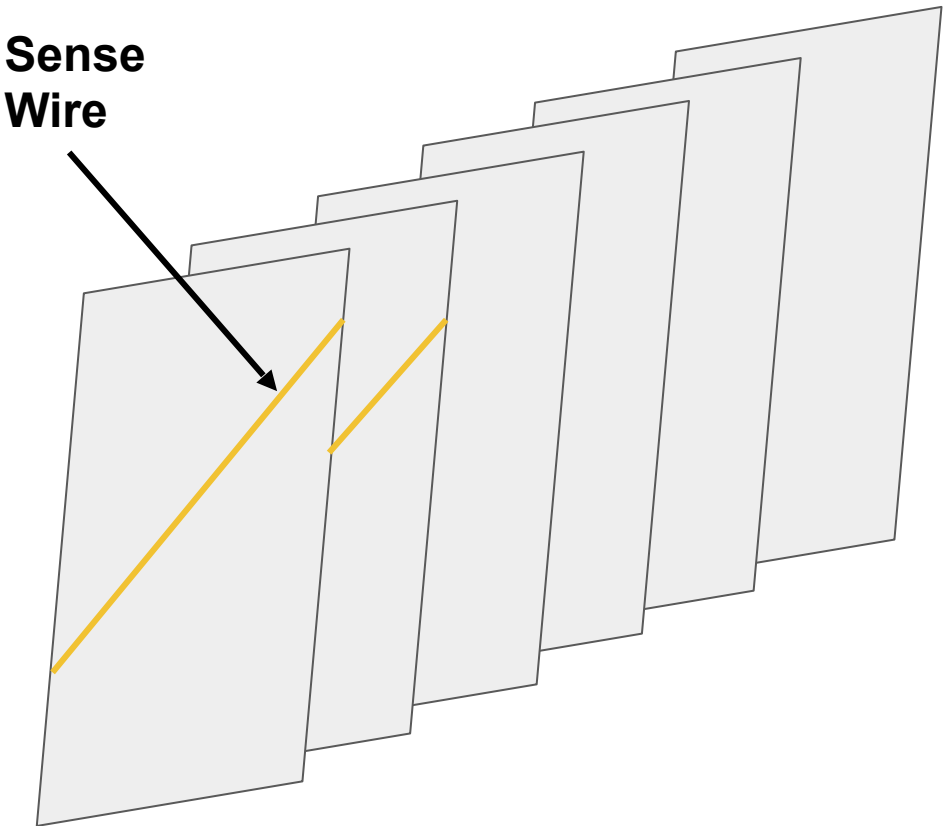

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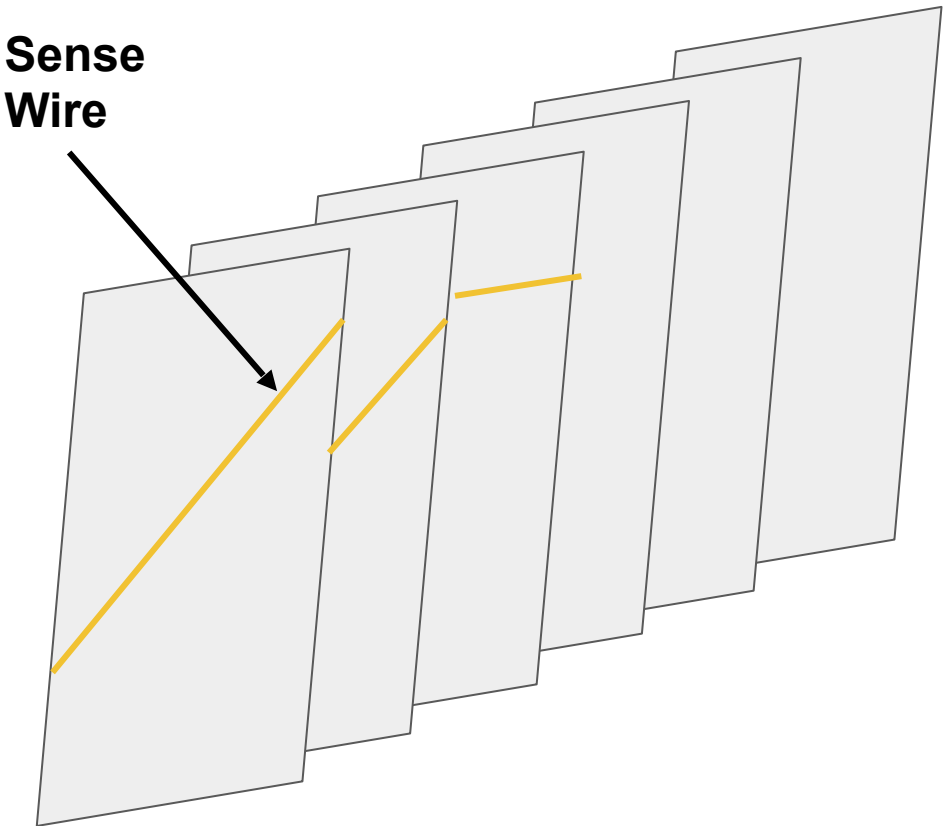

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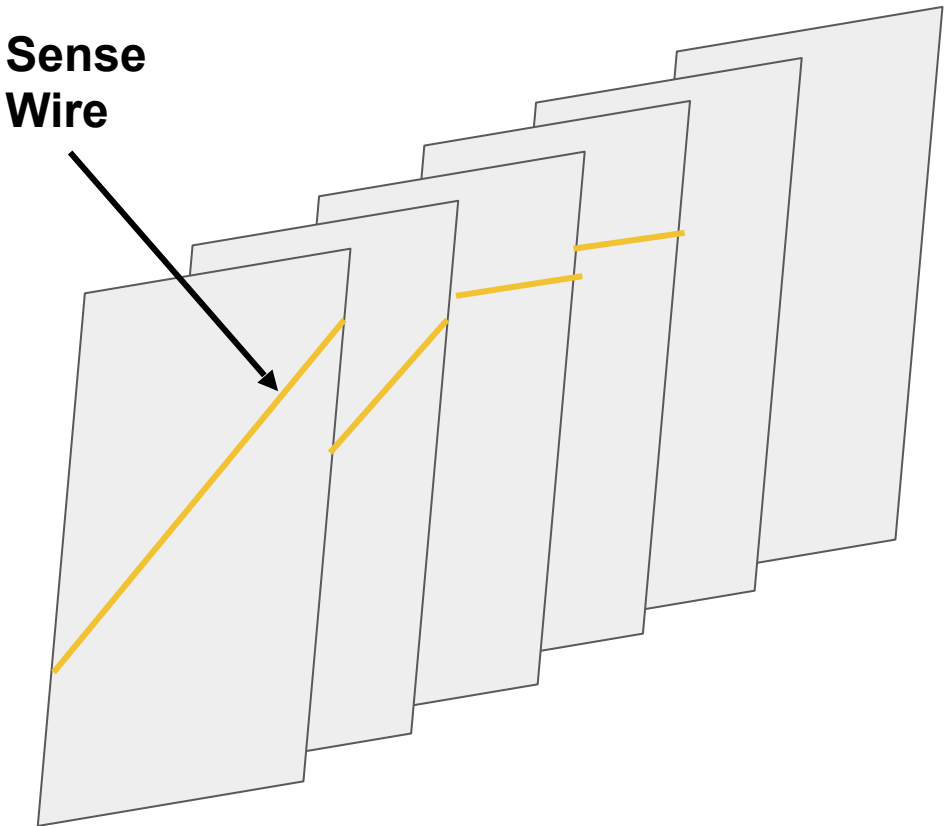

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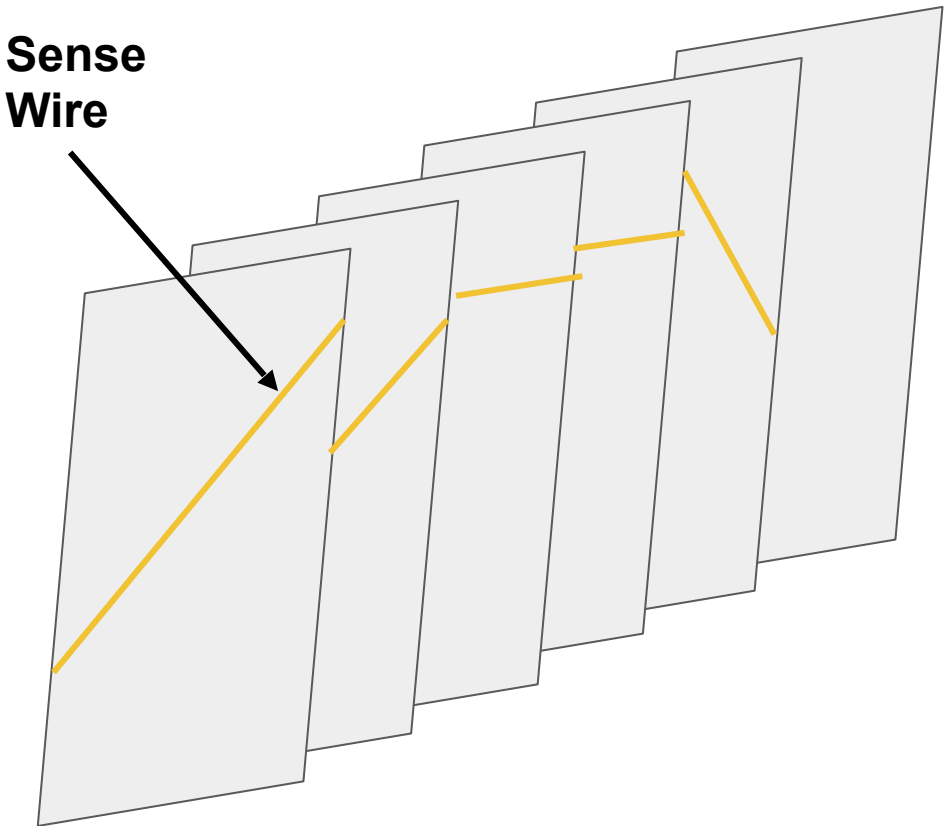

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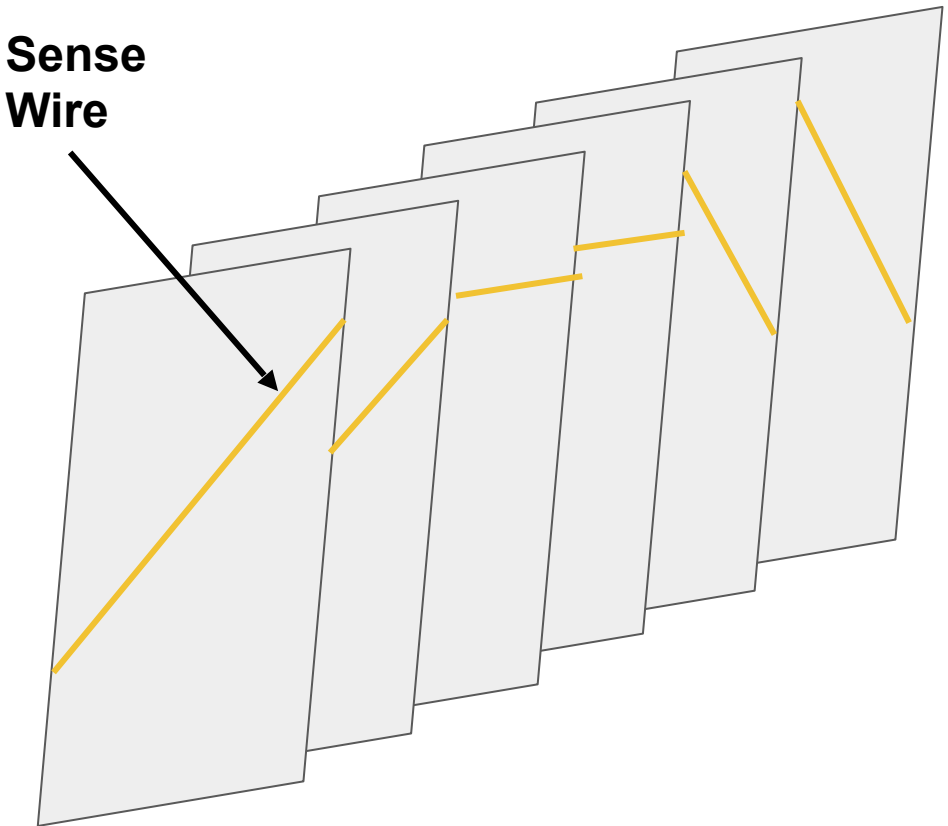

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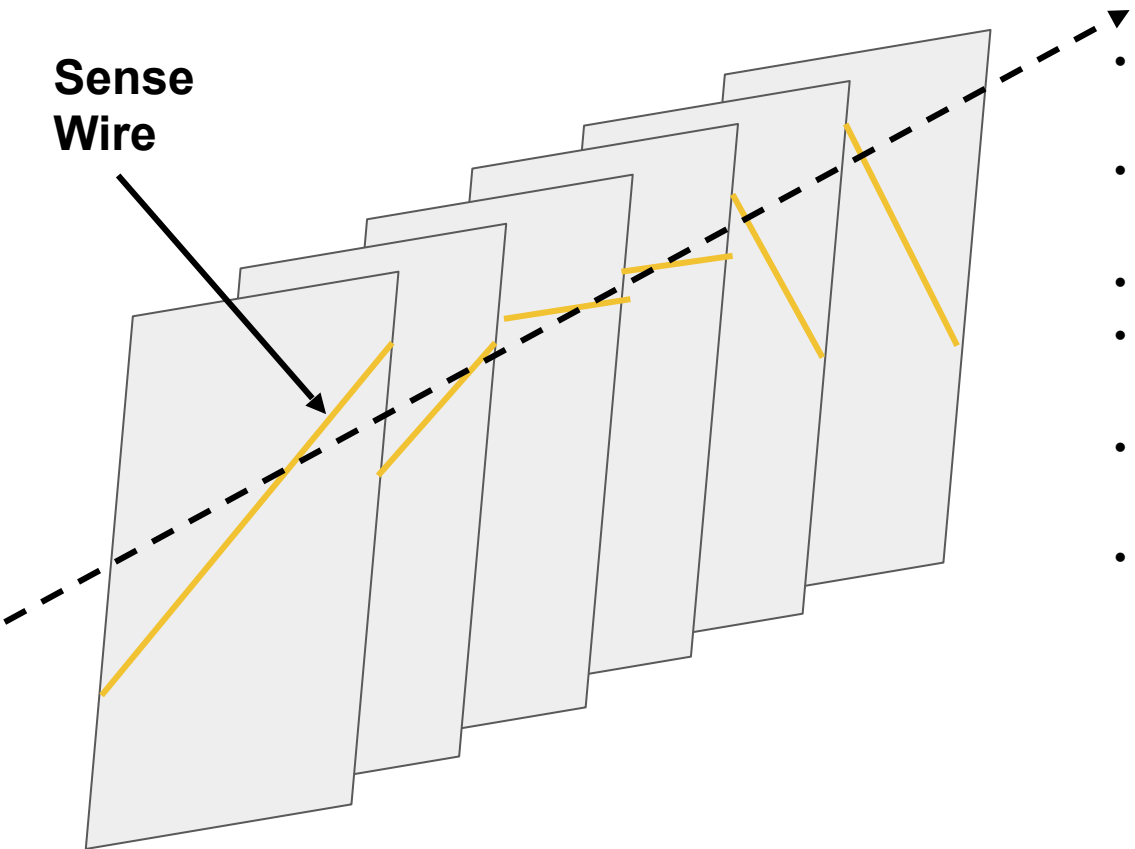

Particle Track

- Passage of the particle ionizes gas inside chamber
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Interactive Session Begins ....

Directory structure

>> cd hallc_replay/CALIBRATION/dc_calib/scripts/

In this directory, you can find:

main_calib.C (STEERING SCRIPT)

{SPEC}_DC_{method}Log_{runNUM} (OUTPUT Directory OF CALIBRATION)

SPEC: 'HMS' or 'SHMS' —> which spectrometer DC was calibrated

method: 'card' or 'wire' —> which calib. method was used.

1. First set the parameter 'p_using_tzero_per_wire = 0' in the parameter file located at:

hallc_replay/PARAM/SHMS/DC/pdc.param

2. Replay the data to produce the uncalibrated root file to be used as input in the Calibration

From the hallc_replay execute: ./hcana SCRIPTS/SHMS/replay_shms.C

3. Run the calibration script with the newly produced root file as input. The script is located at:

hallc_replay/CALIBRATION/dc_calib/scripts/

From this directory,type:

>> emacs main_calib.C. (Modify the calibration input parameters. SEE NEXT SLIDE BEFROE RUNNING CODE)
>> root -l main_calib.C

Inside main_calib.C, you will find something along the lines of:

DC_calib obj (“SHMS”, “../../../ROOTfiles/shms_replay_2342_-1.root”, 2342, -1, “pid_kFALSE”, “card”)

1. Spectrometer Drift Chamber to be calibrated. SHMS or HMS
2. Path from current directory to the ROOTfile to be calibrated
3. Run Number
4. Number of Events to be calibrated
5. Flag to turn on/off PID cuts. “pid_kFALSE” or “pid_elec”
6. Method to calibrated DC. “card” will do the ‘t0’ fits on groups of DISC. CARDS (up to 16 wires). “wire” will do ‘t0’ fits on individual wires. (“wire” NOT recommended if #evts < 1 Million)

The steering script (main_calib.C) runs a series of methods that work together to perform the calibration.

The methods are located in: hallc_replay/CALIBRATION/dc_calib/scripts/ DC_calib.C(and .h)

The end result of the calibration is a directory of the form:

{SPEC}_DC_{method}Log_{runNUM}

ex. SHMS_DC_cardLog_3288/

Inside this output directory, there will be:

☑ **t_zero{MEHTOD}_values_{DC_PLANE}.txt**

These txt files contains the zero values and errors assigned to each wire.

```
#Plane_1u1
#Card       tzero  t_zero_err      entries
0    40.50000     0.00000             75
1    16.50000     0.00000             519
2    12.04339     1.92925             24765
3    12.32124     0.91240             79755
4    16.15021     2.53332             31351
5    8.68120     2.05103             9380
6    24.50000     0.00000             324
```

☑ p{h}dc_calib_{runNUM}.param

Contains the look-up values to convert time to distance

```
; Lookup Table: RUN 3259
; number of bins in time to distance lookup table
pdriftbins = 190
; number of 1st bin in table in ns
pdrift1stbin=1.000000
; bin size in ns
pdriftbinsz=1
pwc1u1fract=0.00087,0.00254,0.00514,0.00893,0.01389,0.01968,0.02646,0.03418,0.04283,0.05185,0.06138,0.07136,0.08131,0.09187,0.10256,0.11389,0.12480,0.13599,0.14791
0.16041,0.17282,0.18440,0.19645,0.20839,0.22046,0.23223,0.24447,0.25648,0.26873,0.28059,0.29240,0.30473,0.31684,0.32890,0.34082,0.35264,0.36463,0.37613,0.38818
0.39982,0.41157,0.42292,0.43469,0.44595,0.45715,0.46813,0.47888,0.49012,0.50108,0.51253,0.52301,0.53447,0.54519,0.55591,0.56727,0.57822,0.58967,0.60024,0.61117
0.62174,0.63201,0.64257,0.65334,0.66407,0.67415,0.68480,0.69545,0.70624,0.71643,0.72644,0.73621,0.74661,0.75653,0.76682,0.77711,0.78736,0.79724,0.80682,0.81659
0.82651,0.83605,0.84511,0.85491,0.86430,0.87340,0.88247,0.89118,0.89995,0.90824,0.91623,0.92436,0.93169,0.93879,0.94574,0.95168,0.95697,0.96234,0.96674,0.97082
0.97448,0.97753,0.98040,0.98301,0.98518,0.98707,0.98882,0.99027,0.99165,0.99287,0.99373,0.99458,0.99528,0.99588,0.99641,0.99684,0.99726,0.99761,0.99788,0.99811
0.99830,0.99850,0.99867,0.99874,0.99887,0.99898,0.99908,0.99916,0.99920,0.99925,0.99929,0.99933,0.99935,0.99936,0.99940,0.99941,0.99942,0.99949,0.99951,0.99952
0.99957,0.99958,0.99960,0.99960,0.99962,0.99963,0.99964,0.99966,0.99967,0.99968,0.99970,0.99971,0.99972,0.99973,0.99973,0.99973,0.99973,0.99973,0.99974,0.99975
0.99976,0.99977,0.99978,0.99979,0.99981,0.99981,0.99982,0.99982,0.99982,0.99982,0.99983,0.99983,0.99984,0.99986,0.99986,0.99988,0.99989,0.99991,0.99991,0.99992
0.99993,0.99994,0.99994,0.99995,0.99995,0.99996,0.99997,0.99997,0.99997,0.99998,1.00000
pwc1u2fract=0.00090,0.00279,0.00600,0.01055,0.01617,0.02283,0.03102,0.03987,0.04955,0.06000,0.07063,0.08168,0.09233,0.10371,0.11507,0.12653,0.13820,0.14998,0.16190
0.17380,0.18619,0.19822,0.21009,0.22186,0.23381,0.24601,0.25793,0.26972,0.28164,0.29348,0.30506,0.31688,0.32875,0.34032,0.35158,0.36288,0.37381,0.38501,0.39650
```

☑ p{h}dc_tzero_per_wire_{runNUM}.param

Contains t-zero values for each wire

```
ptzero1u1=
40.5,40.500000,40.500000,40.500000,40.500000,40.500000,40.500000,40.500000,40.500000,40.500000,40.500000, 40.500000, 40.500000, 40.500000, 16.500000
16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 16.500000, 12.043389
12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.043389, 12.321235
12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 12.321235, 16.150207
16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 16.150207, 8.681195
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24.500000, 24.500000, 24.500000, 24.500000, 24.500000, 24.500000, 24.500000, 24.500000, 24.500000, 24.500000, 24.500000
ptzero1u2=
50.500000,50.500000,50.500000,50.500000,50.500000,50.500000,50.500000,50.500000,50.500000,50.500000,50.500000,50.500000, 14.500000, 14.500000, 14.500000, 14.500000
```
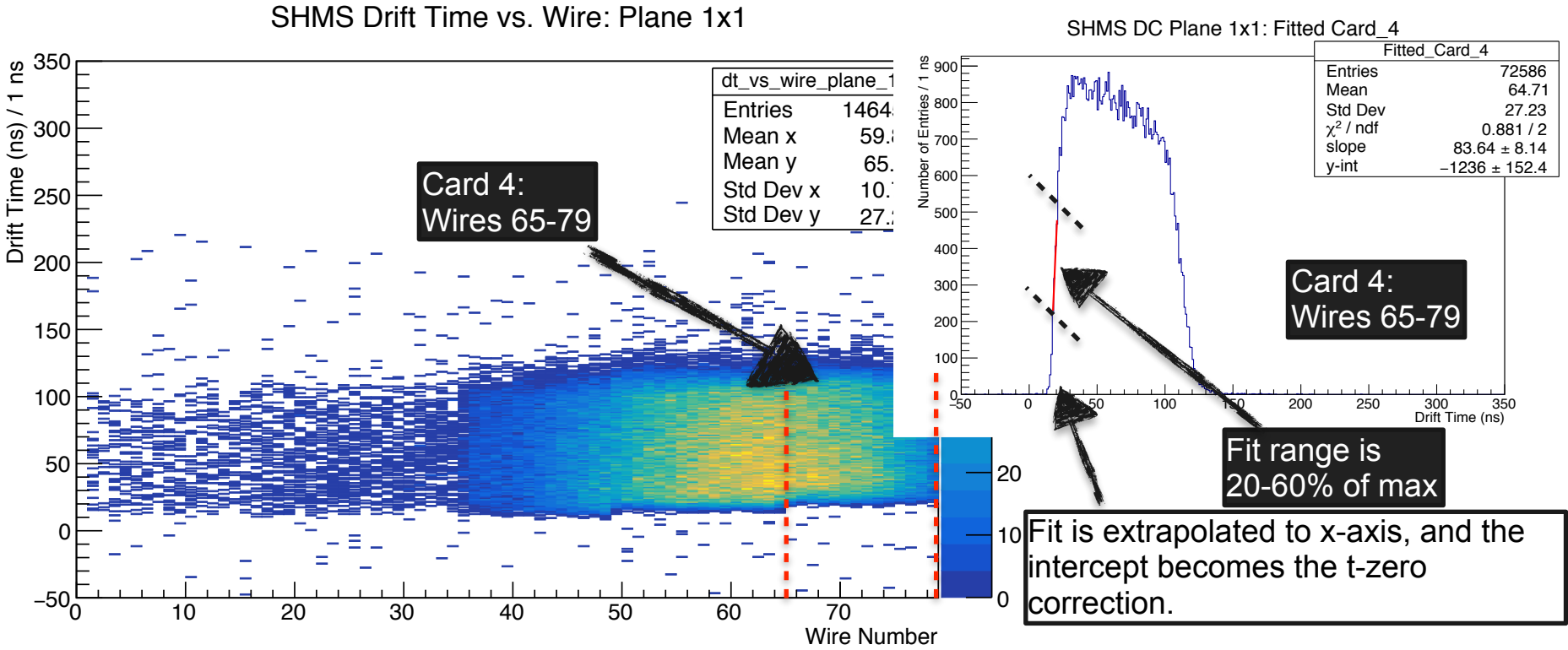
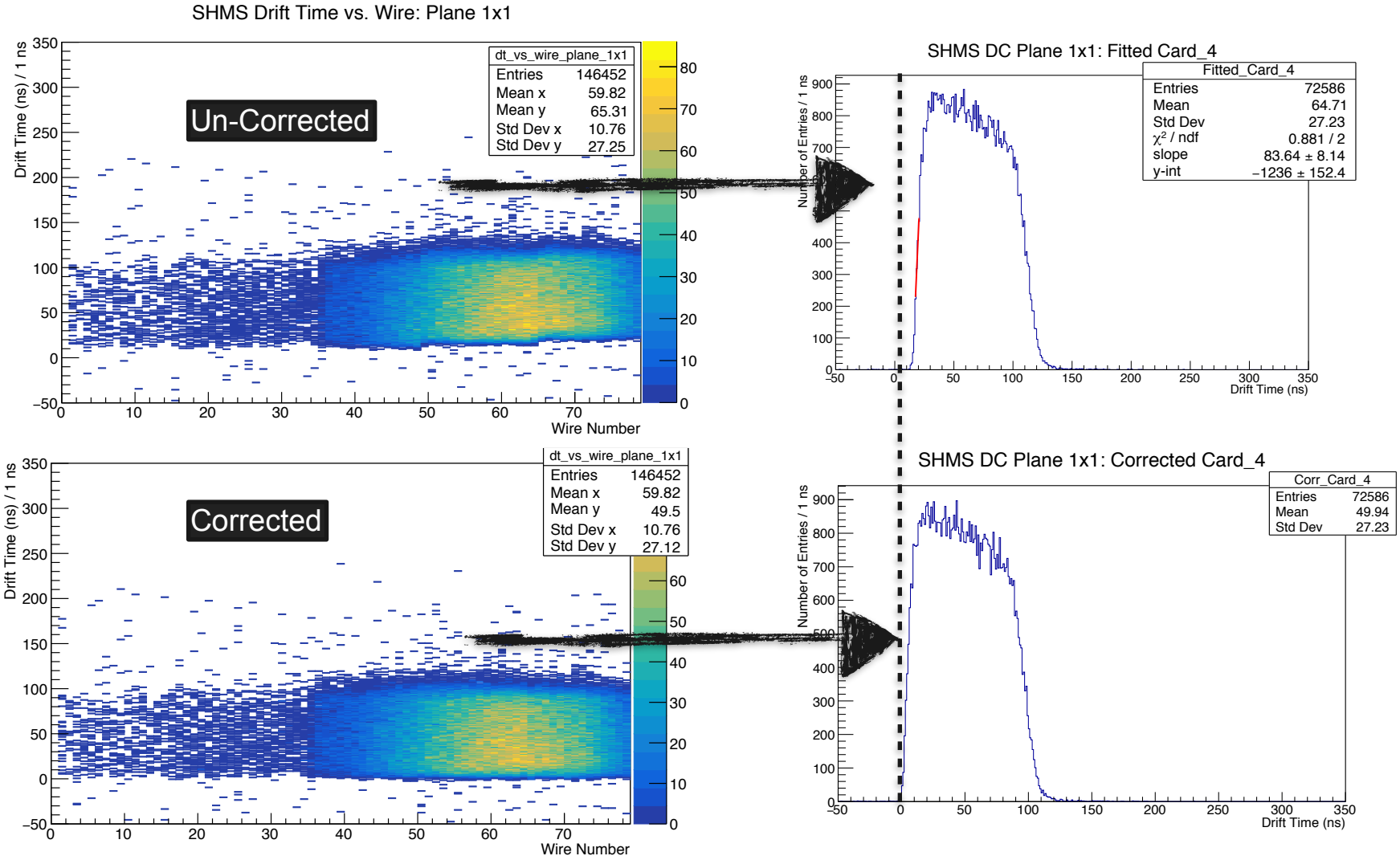

☑ {SPEC}_DC_drifttimes.root

Contains ROOTfile with diagnostic plots such as drift times and 2D drift times vs. wire number before and after calibration.




SHMS Drift Time vs. Wire: Plane 1x1
Un-Corrected
dt_vs_wire_plane_1x1
Entries 146452
Mean x 59.82
Mean y 65.31
Std Dev x 10.76
Std Dev y 27.25
Drift Time (ns) / 1 ns
Wire Number
SHMS DC Plane 1x1: Fitted Card_4
Fitted_Card_4
Entries 72586
Mean 64.71
Std Dev 27.23
χ² / ndf 0.881 / 2
slope 83.64 ± 8.14
y-int −1236 ± 152.4
Number of Entries / 1 ns
Drift Time (ns)
Corrected
dt_vs_wire_plane_1x1
Entries 146452
Mean x 59.82
Mean y 49.5
Std Dev x 10.76
Std Dev y 27.12
Drift Time (ns) / 1 ns
Wire Number
SHMS DC Plane 1x1: Corrected Card_4
Corr_Card_4
Entries 72586
Mean 49.94
Std Dev 27.23
Number of Entries / 1 ns
Drift Time (ns)

Running the code ...Continued

4. After the calibration is finished, two parameter files are created in

   hallc_replay/PARAM/SHMS/DC/

- pdc_tzero_per_wire_run#.param
- pdc_calib_run#.param

From the directory mentioned above, copy these files to the parameter files that will actually be read by hcana as follows:

```
>> cp pdc_tzero_per_wire_run#.param pdc_tzero_per_wire.param

>> cp pdc_calib_run#.param pdc_calib.param
```

Running the code ...Continued

5. In the parameter file located at:

hallc_replay/PARAM/SHMS/DC/

Open the "pdc.param", locate the following parameter, and make sure it reads as follows:

p_using_tzero_per_wire = 1

6. Replay the data with the updated parameters to produce the new calibrated root files with the corrected drift times and drift distances.

From hallc_replay directory type:

>> ./hcana SCRIPTS/SHMS/replay_shms.C

Running the code ...Continued

7. Compare the calibrated an uncalibrated root files located at:

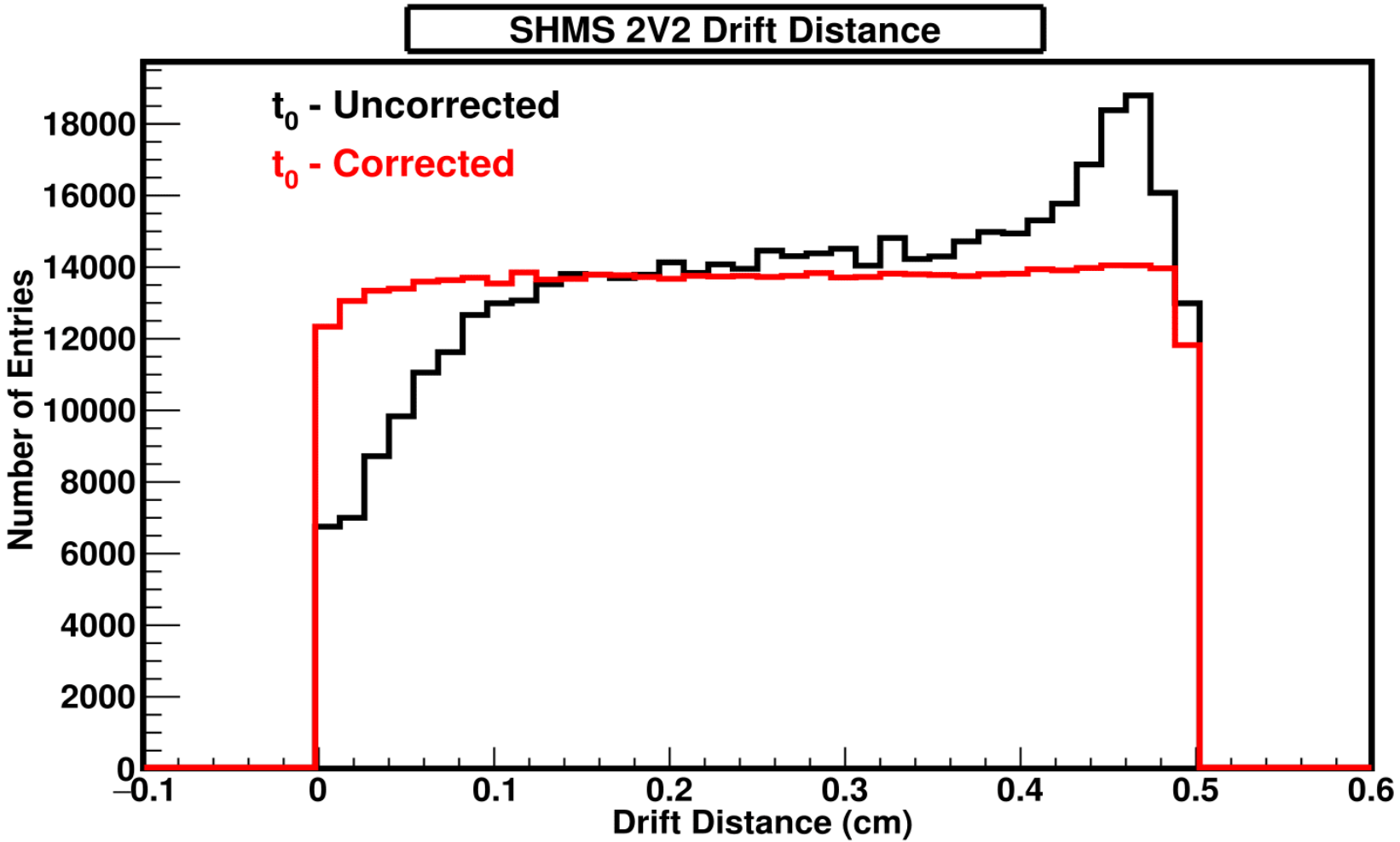
hallc_replay/ROOTfiles/

The files generic name will be:

shms_replay_run#_#events.root

shms_replay_run#_#events_dc_uncal.root

HINT: Compare the drift distances, the calibrated drift distances should be flat.


SHMS 2V2 Drift Distance
t_0 - Uncorrected
t_0 - Corrected
Number of Entries
Drift Distance (cm)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
−0.1
0
0.1
0.2
0.3
0.4
0.5
0.6

QUESTIONS?