DRIFT CHAMBER

Analysis workshop

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SHMS detector stack

Drift-chamber is a detector used to determine the position of the particle and hence the trajectory.

Fig: drift chamber mounted on hut frame
Components of chamber

- 2 chamber in each spectrometer
- Each chamber has 6 wire planes
- Each wire plane is sandwich between 2 cathode plane

Gas mix
Ethane+Argon 50:50
By volume

Ar = Ionization
Ethane = Quench
Working Principle of Drift Chamber

Incoming particles ionize the gas molecules, primary electrons are accelerated by electric field and knocks out the secondary electrons and eventually produces avalanche which induces a current signal on the sense wire.
Working Principle of Drift Chamber

1. Charged particle passes through the drift cell.
2. The gas mixture is ionized into + and − charges.
3. Field wires shape the electric field so limited particles drift to the center of the cell.
4. Negative charges (electrons) collect to the sense wires.

A signal from the sense wire is detected indicating a particle passed through the cell.

Single drift cell

Read out

1010011

TDC (time-to-digital converter)

card attached directly to DC

amplified

Disc
• TDC values from all of the wire in a given plane for a large number of events is taken to obtain a drift time distribution which is then averaged over all the wire of a plane to form a drift time distribution per plane.
It is difference between this two time

A part of calibration is to find the $t_0$ offset of each plane
After correcting $t_0$ offset

- Calibration procedure makes a lookup table to convert drift times to drift distances
Calibration procedure

Skinny rootfile

- To speed up the calibration we can trim the rootfiles
  - cd DEF-files/{spec}/DC/PRODUCTION/BLOCK
  - Change the pblock_vars.def

```bash
# Block Definitions *
#************************
block T.shms.*
block P.ngcer.*
block P.dc.*
block P.hod.*
block P.hgcer.*
block P.aero.*
block P.cal.*
block P.tr.*
block P.gtr.*
block P.kin.*
block P.rb.*
block P.react.*
```
Turning on only the dc block
Getting uncorrected rootfile

✔ Set the parameter 'p_using_tzero_per_wire = 0' in the parameter file located at:
  hallc_replay/PARAM/{spec}/DC/pdc_cut.param

```plaintext
; Utilize per wire tzero offsets, 1 means true
p_using_tzero_per_wire = 1

; TEST-STAND PARAMETERS
; Custom parameter file which should be loaded when aiming to analyze HMS DC
; data with no tracking.
pSEL_using_scin = 0

; TDC window limits for each plane.
pdc_tdc_min_win = -13000, -13000, -13000, -13000, -13000, -13000
               -13000, -13000, -13000, -13000, -13000, -13000
pdc_tdc_max_win = -10000, -10000, -10000, -10000, -10000, -10000
               -10000, -10000, -10000, -10000, -10000, -10000

pdc_fix_lr = 1
pdc_fix_propcorr = 1

; Zero time correction for each plane in ns that is added to TDC time.
pdc_plane_time_zero = 1290.00, 1290.00, 1290.00, 1290.00, 1290.00, 1290.00
                   1290.00, 1290.00, 1290.00, 1290.00, 1290.00, 1290.00
```
Replay the Run

• From hallc_replay

Execute

./hcana

./hcana SCRIPTS/{spec}/PRODUCTION/{spec}_replay_production_all_{spec}.C

With run Number and the event number as argument

( take higher event number for better result)

Example:

./hcana SCRIPTS/SHMS/PRODUCTION/shms_replay_production_all_shms.C(2248, -1)
Main Calibration code

- Run the calibration script with the newly produced root file as input.

Code reside at:

```
halilc_replay/CALIBRATION/dc_calib/script
```

Open file `main_calib.C`
DC_calib obj("SHMS", ".//../ROOTfiles/shms_replay_production_all_2248_-1.root", 2248, -1, "pid_kFALSE", "card");

pid_kFALSE = no pid

pid_elec = pid cut

(P.ngcer.npeSum>1.0 && P.cal.etot>0.1)

- Run the script by:
  root -l main_calib.C

  Produce folder SHMS_DC_cardlog_run#
This folder contains

pdc_calib_2248.param
pdc_tzero_per_wire_2248.param
SHMS_DC_driftimes.root
t_zeroCARD_values_1u1.dat
t_zeroCARD_values_1u2.dat
t_zeroCARD_values_1v1.dat
t_zeroCARD_values_1v2.dat
t_zeroCARD_values_1x1.dat
t_zeroCARD_values_1x2.dat
t_zeroCARD_values_2u1.dat
t_zeroCARD_values_2u2.dat
t_zeroCARD_values_2v1.dat
t_zeroCARD_values_2v2.dat
t_zeroCARD_values_2x1.dat
t_zeroCARD_values_2x2.dat
Copy this two file

pdc_calib_2248.param
pdc_tzero_per_wire_2248.param

To this location:

hallc_replay/PARAM/SHMS/DC/
In the DC folder:

```bash
~cp pdc_calib_run#.param     pdc_calib.param
~cp pdc_tzero_per_wire_run#.param pdc_tzero_per_wire.param

(hallc_replay/{spec}/DC)

~Turn on the flag
p_using_tzero_per_wire = 1
```

From the hallc_replay directory replay the script again:
Look for this two variables in rootfile to validate the calibration

\[ \text{P.dc.}\{\text{plane}\}.\text{dist} \& \text{P.dc.residual}[i] \]

(biased by other plane)

\begin{itemize}
  \item Planes = "1u1" = residual [0]
  \item Planes = "1u2" = residual [1]
  \item Planes = "1x1" = residual [2]
  \item Planes = "1x2" = residual [3]
  \item Planes = "1v1" = residual [4]
  \item Planes = "1v2" = residual [5]
  \item Planes = "2v2" = residual [6]
  \item Planes = "2v1" = residual [7]
  \item Planes = "2x2" = residual [8]
  \item Planes = "2x1" = residual [9]
  \item Planes = "2u2" = residual [10]
  \item Planes = "2u1" = residual [11]
\end{itemize}

\[ \text{P.dc.}\{\text{plane}\}.\text{residualsExclPlane}[i] \]
Drift-distance from chamber 1

[Graphs showing drift-distance from chamber 1 for different conditions]
Drift-distance from chamber 2
Residual of all the corresponding planes

\[ \chi^2 / \text{ndf} \]
2336 / 11

Constant
7.562e+04 ± 1.318e+02

Mean
-0.0138 ± 0.0000

Sigma
0.01941 ± 0.00003

residual
Unbiased residual

\[
\chi^2 / \text{ndf} = 2333 / 20
\]

Constant \(2.934e+04 \pm 6.352e+01\)
Mean \(-0.003263 \pm 0.000061\)
Sigma \(0.03402 \pm 0.00006\)
Questions??

Thank you
Residual is the difference between the final track position and the hit location obtained from individual drift chamber planes.

Residual for a particular plane is the difference between the solid line and the hit position on that plane.

Sense wire

DC 1

DC 2

Particle track