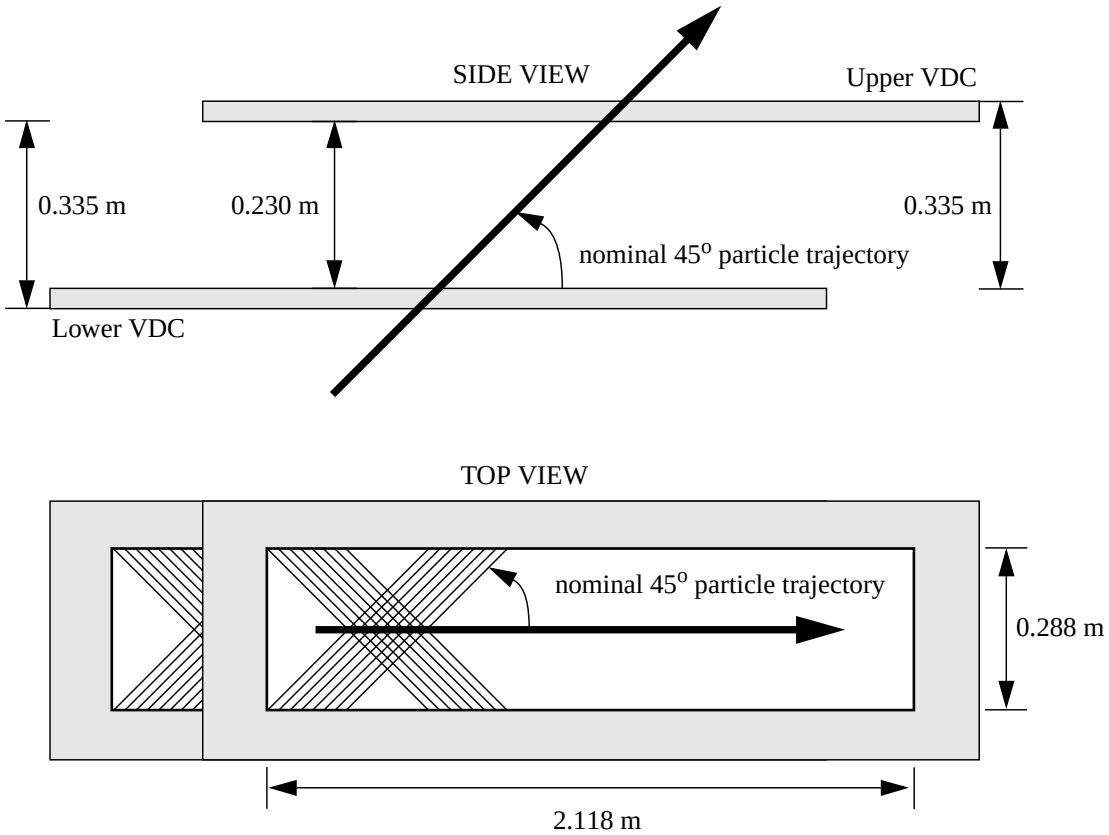
HRS VDC Calibration

Ole Hansen

Jefferson Lab

Hall A & C Analysis Workshop
June 26, 2017

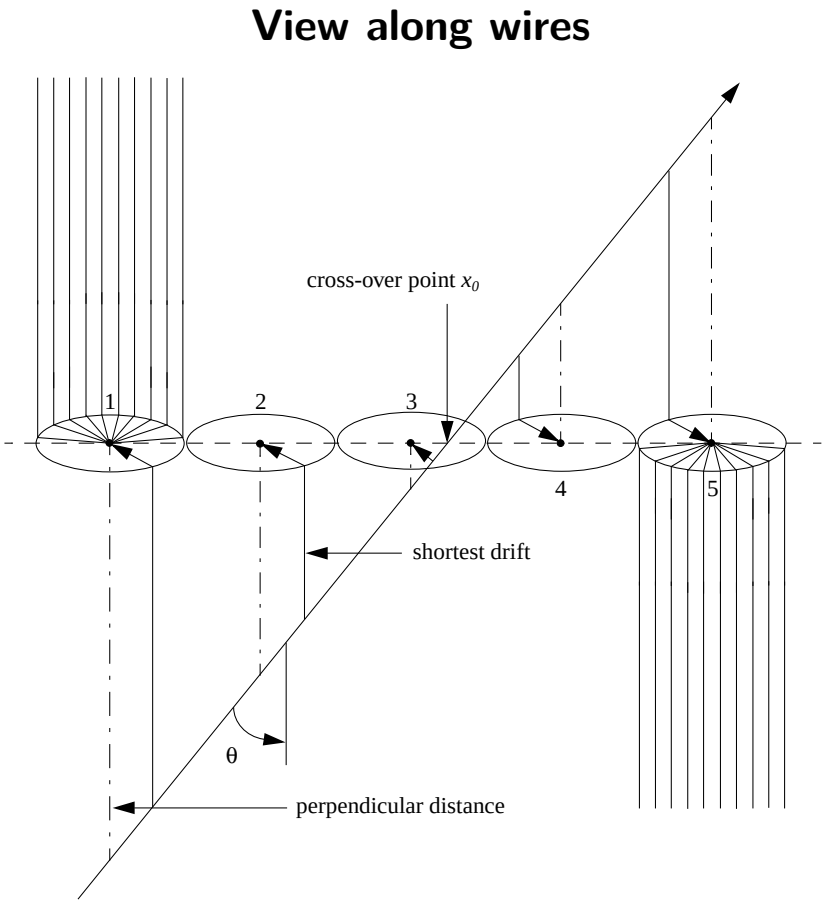
HRS Tracking System: VDCs



- *Vertical* Drift Chambers. (Ions drift vertically, see next slide.)
- Optimized for precision measurement of single tracks
- Two chambers, each with two wire planes (u/v) at $\pm 45^\circ$
- 368 wires per plane, 4.24 mm wire spacing
- Standard tracking system for both HRSs. In use since 1996

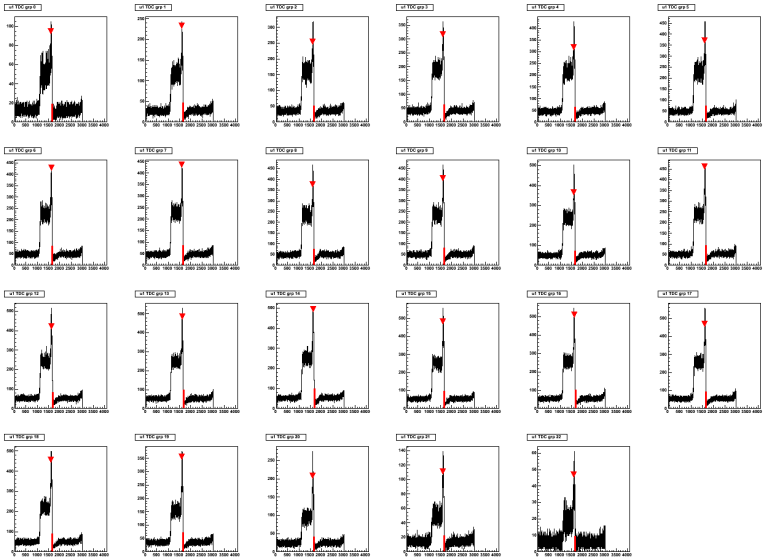
VDC Operation: Clusters

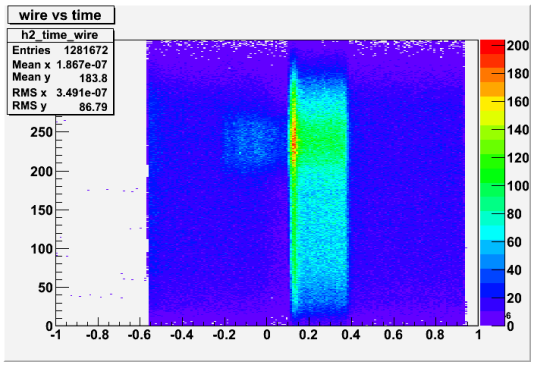
- Nominal track typically activates 4–6 wires $\rightarrow$ cluster
- Hit times w.r.t. trigger $\rightarrow$ drift times
- Must convert drift times $\rightarrow$ drift distances. Non-linear function
- Advantage of VDCs: Cross-over coordinate x_0 to first order independent of errors in the drift time-to-distance conversion
- Fit yields an x_0 position resolution of $\approx$ 225 μm FWHM



VDC Calibrations

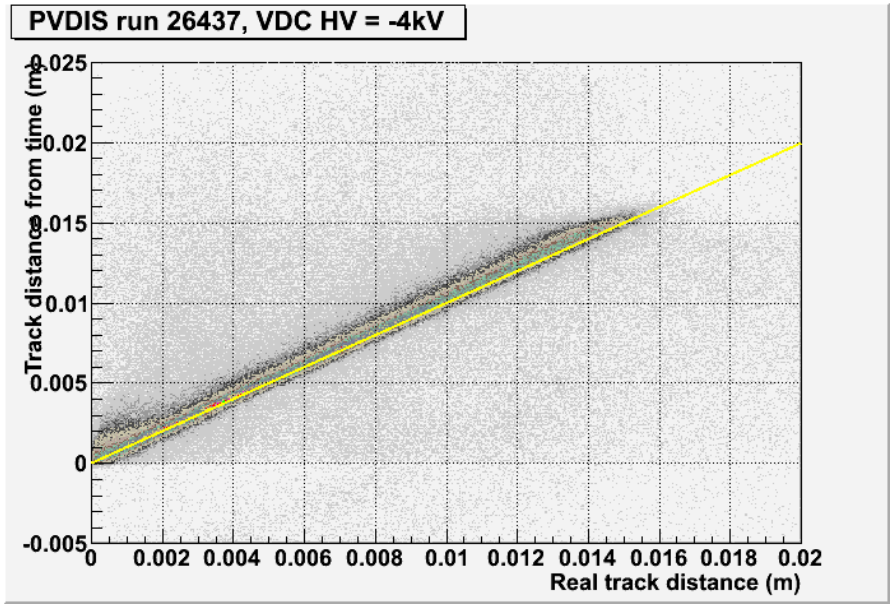
VDC time offsets





- Search for edge of timing spectrum peak in white spectrum calibration runs

VDC time-to-distance conversion



- Fit analytic expression approximating time-to-distance relation
- Two linear sections with dependence on 1/tan(track angle)
- Resulting drift distance distribution should be flat
- Can use the same calibration runs as time offset calibration

Before We Get Started

Please update the "tutorial" subdirectory in your virtual machine

```
[me@centos7 ~]$ cd ~/tutorial
[me@centos7 tutorial]$ git pull
```

Exercise 1: VDC Calibration Replay

The goal is to have white spectrum runs (near-flat focal plane coverage) with very high statistics.
Let's create a special ROOT file with only the data needed for VDC calibration:

VDC Calibration Replay

```
[me@centos7 ~]$ cd ~/tutorial/vdccalib
[me@centos7 vdccalib]$ source ~/tutorial/setup.sh
[me@centos7 vdccalib]$ analyzer
analyzer [0] .x replay_vdccalib.C
Run number (-1 to quit)? 23062
Will analyze file data/gmp_23062.dat.0
Number of events to analyze? (-1 for all)? -1
Creating new output file: rootfiles/vdccalib_23062.root
... takes about 2-3 minutes
```

Exercise 2: Checking If We Have a Good Calibration Run

VDC Calibration Run Check

```
// Continue from previous session, or open the ROOT file just created
analyzer [1] cv = new TCanvas("cv","VDC wire spectra");
analyzer [2] cv->Divide(2,2);
analyzer [3] vector<string> planes {"u1","v1","u2","v2"};
analyzer [4] for( int i : {0,1,2,3} ) { cv->cd(i+1);
  T->Draw(Form("R.vdc.%s.wire",planes[i].c_str())); }

// When done, quit
analyzer [5] .q
```

Well . . . what do you think?

Exercise 3: VDC TDC Offset Calibration

The TDC offsets can be found by fitting the raw TDC spectra. Here's where a special calibration script comes in:

VDC TDC Offset Calibration

```
// Restart the analyzer for a fresh session
[me@centos7 vdccalib]$ analyzer
// Compile and load the TDC offset calibration script
analyzer [0] .L calibVDCtdc.C+
Info in <TUnixSystem::ACLiC>: creating shared library
/home/me/tutorial/vdccalib/./calibVDCtdc_C.so
// Run the script on the calibration ROOT file we just created
analyzer [1] calibVDCtdc("R","/data/ROOTfiles/vdccalib_23062.root")
... (lots of messages)
plane = v2 grp = 21 tdcoff = 1506.86
plane = v2 grp = 22 tdcoff = 1507.86
plane = v2 grp = 23 ==== Error: no good peak
WARNING: some groups failed. Bad channels or low statistics?
Offsets in blue are approximate.
```

VDC TDC Offset Calibration Results

- Results are in four text files: `tdcoff_R_[uv][12].txt`
- When satisfied, copy-and-paste each block of numbers into the VDC database file `db_R.vdc.dat`:

```
R.vdc.u1.tdc.offsets =
   1533.3  1533.3  1533.3  1533.3  1533.3  1533.3  1533.3  1533.3
   1533.3  1533.3  1533.3  1533.3  1533.3  1533.3  1533.3  1533.3
...
```

Exercise 4: Checking VDC TDC Offset Calibration

Note: This will check the original TDC calibration, not the one we just ran.

VDC TDC Offset Check

```
// Load a ROOT file containing the "wire" and "time" VDC plane variables
[me@centos7 vdccalib]$ analyzer /data/ROOTfiles/gmp_23062_good.root
analyzer [1] htime = new TH2I("htime","Wire vs time R.vdc.u1",
   300,-100e-9,500e-9,368,0,368);
analyzer [2] T->Draw("R.vdc.u1.wire:R.vdc.u1.time>>htime","","COLZ");
```

- How does that look to you? Anything odd?
- Can the calibration be improved?
- Any other things to investigate?
- Exercise 5
  - Put in the new calibration constants from Exercise 3 into the correct database, replay, and repeat the check.
  - Prepare "before" and "after" plots for comparison.