Operation and Tracking of HKS Drift Chamber

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Contents

This document describes the operational parameters and tracking for HKS drift chamber. The cosmic ray test results are also summarized.

1 Operational Parameters

Table 1: Geometrical parameters

Dimension (L×W×T)	59.25"×22.75"×3"
Active Region	48.2"×12"
Wire plane configuration	U,U',X,X',V,V'

Table 2: Operational parameters

Operation HV	1970 V
Threshold	3.0 V
Gas content	Argon/Ethane 50:50 mixture
Gas pressure:	$\sim$ 16 psi

The cathode foil planes and field wires are applied the same HVs. Each chamber has 4 HV input connectors, two for foil planes and two for field wires. The signals from sense wires goes into Nanometrics N277 cards for preamplifying and discriminating. There are 20 preamplifier cards for

each chamber, 10 on one side and 10 on the other side of the chamber. These Nanometrics cards need both +5 and -5 power input. The voltages are supplied by two Acopian power supplies, for +5 V and -5 V respectively.

2 Wire Layout and Coordinates System

The wire planes measure positions in three directions X,U and V. These coordinates are then transformed into focal plane coordinates X,Y and Z.

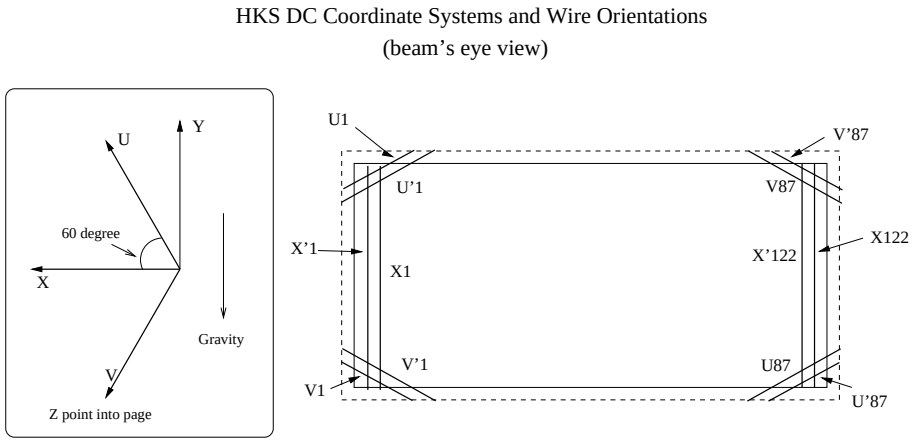


Figure 1: HKS DC wire layout and coordinate system

3 Flowchart of DC tracking code

4 Tracking Parameters

The parameter set for HKS DC tracking comprises geometrical constants, tracking criterion and other wire chamber constants. They are needed in the tracking routine to convert raw wire hit into coordinates and fitting the tracks.

Each wire plane of the chamber is described by the following constants:

1. Plane number: From 1 to 12.

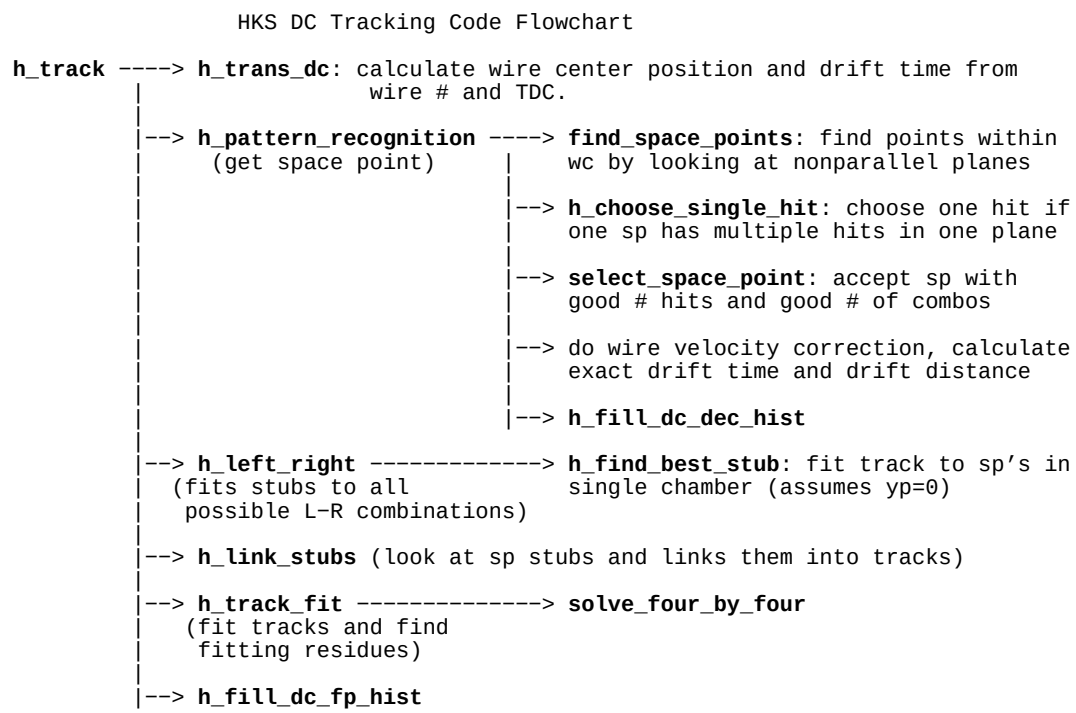


Figure 2: Flowchart of DC tracking code

2. `hdc_zpos`: The coordinate in the particle traveling direction.

3. `hdc_beta`, `hdc_gamma` and `hdc_alpha`: These are the three rotation angles of wire plane about the Y axis, X axis and Z axis.

4. `hdc_nrwire`: number of wires in plane.

5. `hdc_central_wire`: The fictitious wire number of the middle wire. It is used in calculation of the wire center position:

```
" hdc_wire_center(goodhit) = hdc_pitch(plane)
     &                   * ( (hdc_nrwire(plane) + (1 - wire))
     &                   - hdc_central_wire(plane) ) - hdc_center(plane)"
```

6. `hdc_wire_counting`: A flag that indicates whether wire is counted along positive (-1) or negative (+1) x direction. For HKS DC, all wires are counted from the positive X side. So it is +1 for all the planes.

7. `hdc_center`: offsets of the planes along local coordinates.

8. `hdc_length_x` and `hdc_length_y`: The dimensions of the DC active area in x and y directions.

9. `sigma`: the Gaussian width of the tracking fitting residues

Currently, the parameter values used in the tracking are:

Table 3: Tracking parameters

Plane	No	Zpos (cm)	α (degree)	nrwire	Central Wire	sigma (cm)
1u1	1	-1.905	30	87	43.75	0.02
1u2	2	-1.270	30	87	44.25	0.02
1x1	3	-0.635	90	122	61.75	0.02
1x2	4	+0.3175	90	122	61.25	0.02
1v1	5	+0.9525	150	87	43.75	0.02
1v2	6	+1.5875	150	87	44.25	0.02

The β, γ angles are 0 degree for all planes. `hdc_center` are 0 now. The wire plane Z positions in the table are relative positions within one chamber. Assuming a 1 meter seperation between the 2 chambers after they are mounted on the spectrometer, the actual Z positions for DC1 wire planes will be $Zpos - 48.095$ cm from the HKS reconstruction plane, for DC2, it will be $Zpos + 51.905$ cm.

An important tracking criterion constant is `space_point_criterion`, the minimum squared distance to combine two hit pairs into one space point. `hpace_point_criterion` is 1.2 cm currently.

These tracking parameters are set in files according to standard Hall C CTP file structure.

5 Performance Test By Cosmic Rays

The two chambers have been tested by cosmic rays. In cosmic ray test, the two chambers were layed horizontally on the test bench with a distance of ~ 29 cm between them. Cosmic ray trigger

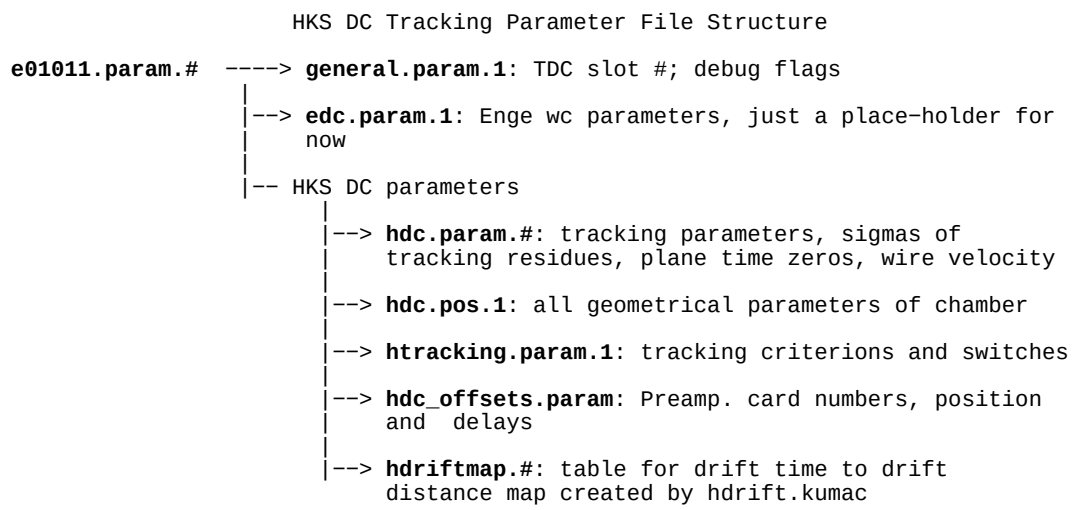


Figure 3: File structure of DC tracking parameters

was provided by two scintillator hodoscopes put on top and under the two DCs. The hodoscope has a active region of $\sim 20 \times 80$ cm. The two hodoscopes are layed parallel to each other and cover the central region of the DCs. A cosmic ray trigger is generated when the four PMTs on each side of the hodoscope give signals in coincidence.

5.1 Threshold Scan

The threshold scan was carried out by directly recording the counting rate of cosmic ray signals (including noise background) from a single wire after discriminator by visual scaler. We chose wire number 52 of plane V of both chambers for this purpose. The counting rate vs. threshold curves show a smooth rise with decreasing threshold above 0.8 V. Below 0.8 V, the counting rate make a sharp turn up.

5.2 Chamber Detection Efficiencies

To calculate the detection efficiency of one wire plane, only the information from the other 5 planes is used to reconstruct a trajectory, and the intersection point of the trajectory with the efficiency plane is calculated. If the fitting Chisqure of the trajectory from the 5-plane fitting is below a criterion ("`chi2_max<50`"), this event is taken as a good event. Then we check if there is a wire got

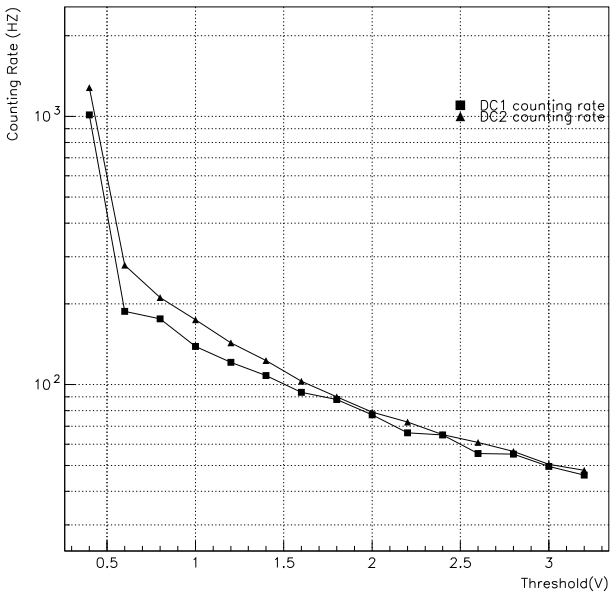


Figure 4: Counting rate vs. threshold

hit in the efficiency plane within a range ("`dist_max<1.8 cm`") of the intersection. The efficiency is the proportion of the the event number detected by the wire plane over the total good events.

The efficiency test shows a HV plateau region from 1850 V for the two chambers. At the voltage of 1970 V, all the wire planes have detection efficiencies above 99%.

5.3 Chamber Single Plane Resolution

The position resolution of the chamber can be determined by looking at the residues after the track has been fit to a straight line through both chambers. Notice in our test setup, the distance between the two chambers is small than that in experimental setup. Also, the test setup has a much larger cosmic ray angle acceptance than the angle coverage of the particle tracks at HKS focal plane (± 0.5 rad vs. ± 0.2 rad). Thus, we expect the resolution will be better in real experiment than the current test result.

Assuming a 200 μm tracking residue (σ) for each wire plane of the two chambers, a simulation gives us the HKS focal plane position and angle resolutions:

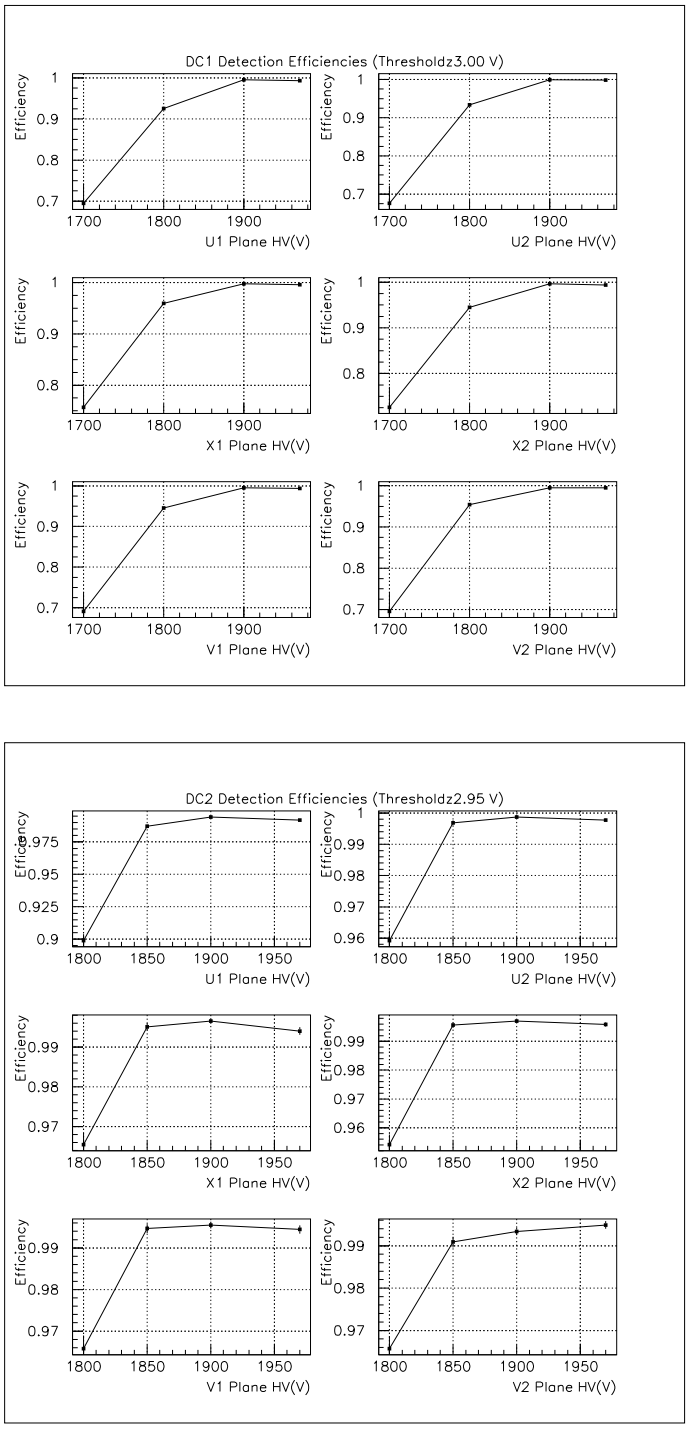
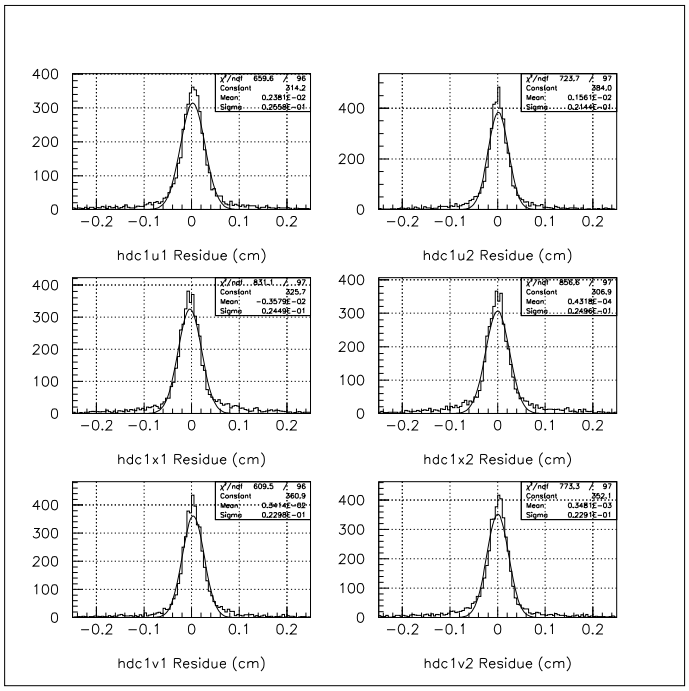


Figure 5: HKS DC1(top) and DC2(bottom) plane detection efficiencies vs. HV



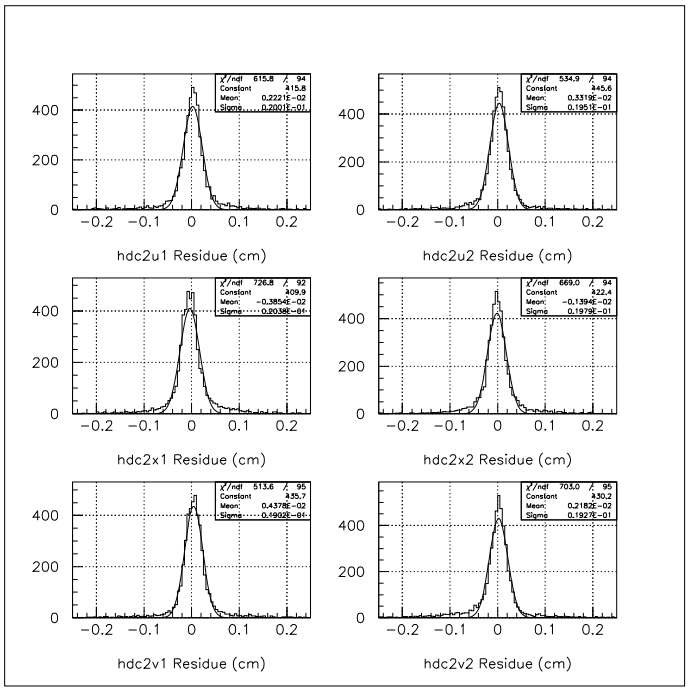


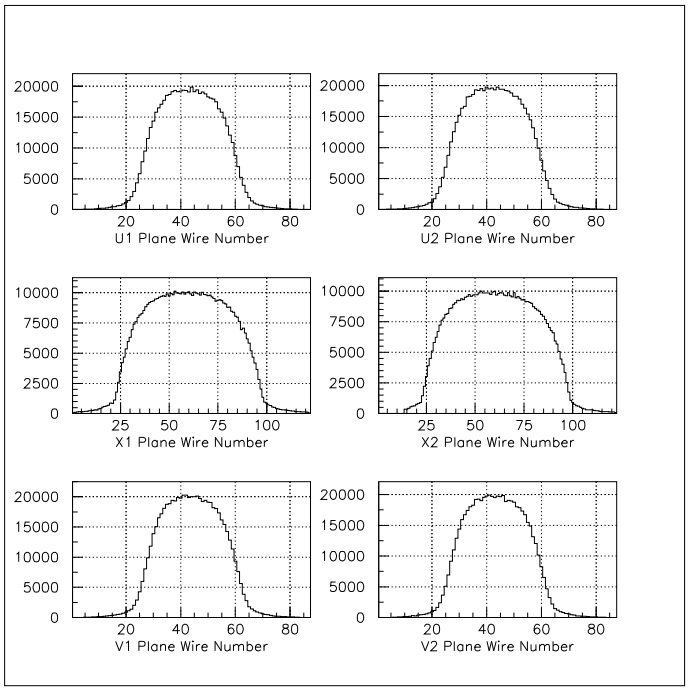
Figure 6: HKS DC1(top) and DC2(bottom) tracking fit residues

Table 4: HKS focal plane position and angle resolutions

Position(X)	162 μm(rms)
Position(Y)	163 μm(rms)
Angle(X')	0.33 mr(rms)
Angle(Y')	0.33 mr(rms)

5.4 Whole Chamber Wire Scan

No missing channels are found from the scan.



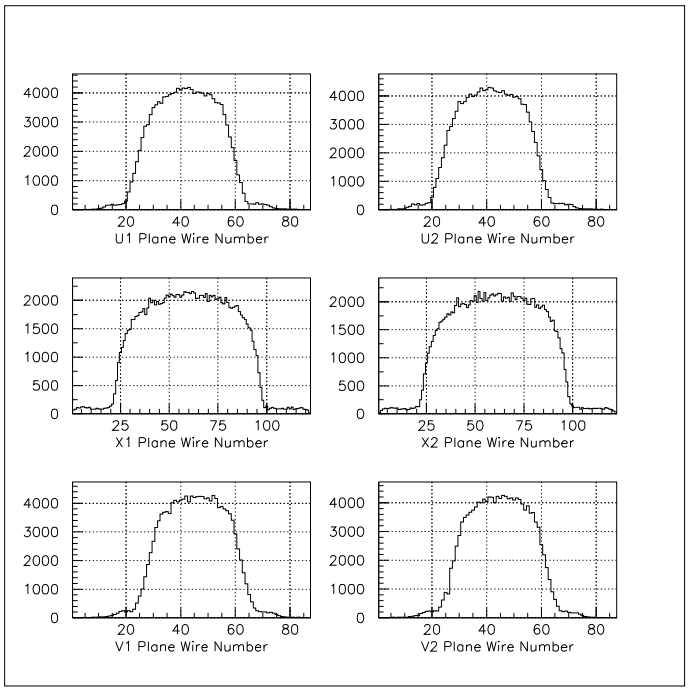


Figure 7: HKS DC1(top) and DC2(bottom) wire scan