

Drift Chamber Calibration

Latif Kabir

Mississippi State University
for the DC Team



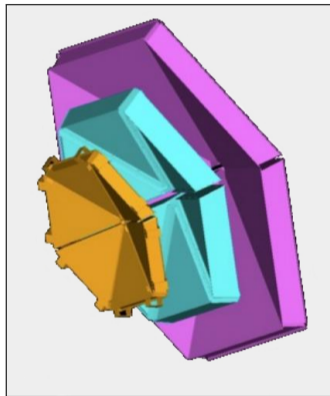
March 6, 2018



Drift Chamber Calibration for CLAS12

- Ultimate goal is to achieve $\sigma \sim 250 - 350 \mu\text{m}$.
- Utilize Time based tracking (TBT) in addition to Hit Based Tracking (HBT).
- TBT \rightarrow Utilizes the time information.
- This requires extraction of distance (Distance Of Closest Approach - DOCA) from TBT.
- The challenge is the exact relation between time and distance is not known.
- HBT \rightarrow Tracked DOCA, TBT \rightarrow DOCA.
- Achieve convergence on time-residual, where

Time residual = Distance from T2D function (DOCA) - Distance from the fitted track (tracked DOCA).



Time to Distance Relation: Functional Form

The total drift time t has three contributions,

$$t(x) = t_d + \Delta t_\beta + \Delta t_B$$

i) Main drift time contribution:

$$t_d(x) = \frac{x}{v_0} + a\hat{x}_\alpha^n + b_\alpha\hat{x}_\alpha^m \quad \text{with} \quad \hat{x}_\alpha = \frac{x}{x_{max}^\alpha} = \frac{x}{x_{max} \cos(30 - \alpha)} \quad (1)$$

ii) Beta-dependent time-walk correction:

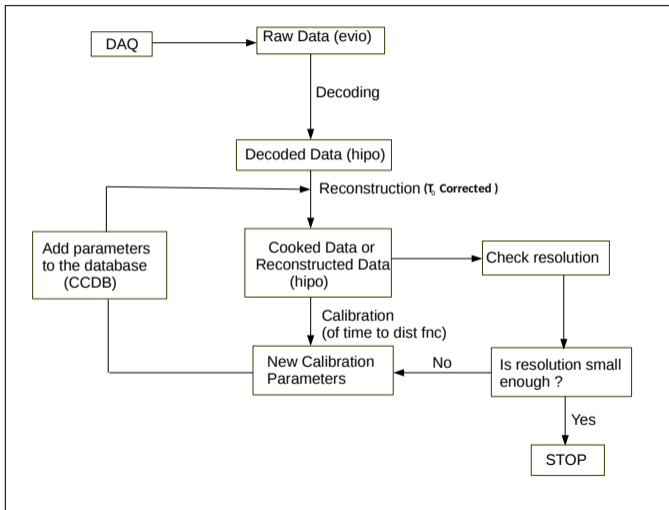
$$\Delta t_\beta = \frac{\sqrt{x^2 + (x_\beta \beta^2)^2} - x}{v_0} \quad (2)$$

iii) B field dependent contribution:

$$\Delta t_B = \delta_B B^2 t_{max} (b_1 \hat{x}_\alpha + b_2 \hat{x}_\alpha^2 + b_3 \hat{x}_\alpha^3 + b_4 \hat{x}_\alpha^4) \quad (3)$$

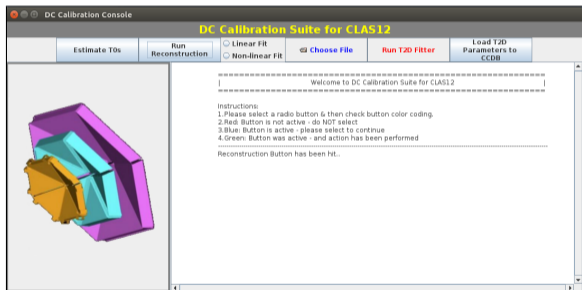
$$p_0 = v_0, \quad p_1 = \delta_{mn}, \quad p_2 = t_{max}, \quad p_3 = x_\beta, \quad p_4 = \delta_B, \quad p_5 = b_1, \quad p_6 = b_2, \quad p_7 = b_3, \quad p_8 = b_4, \quad p_9 = \Delta T_0 \quad (4)$$

DC Calibration Flow Chart

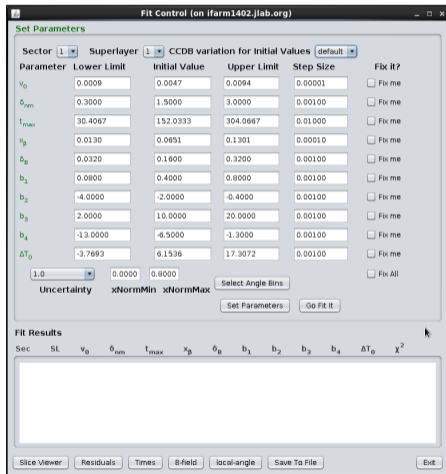


DC Calibration Suite

- GUI driven complete calibration for DC



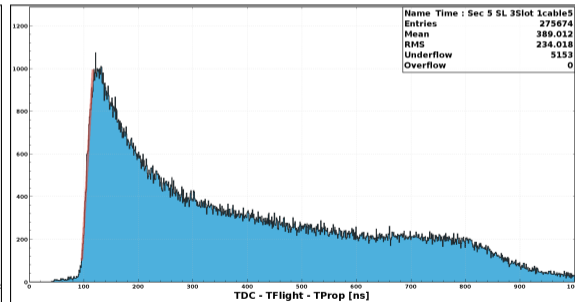
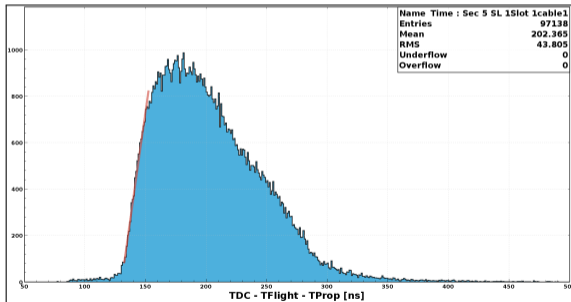
(DC calibration main GUI)



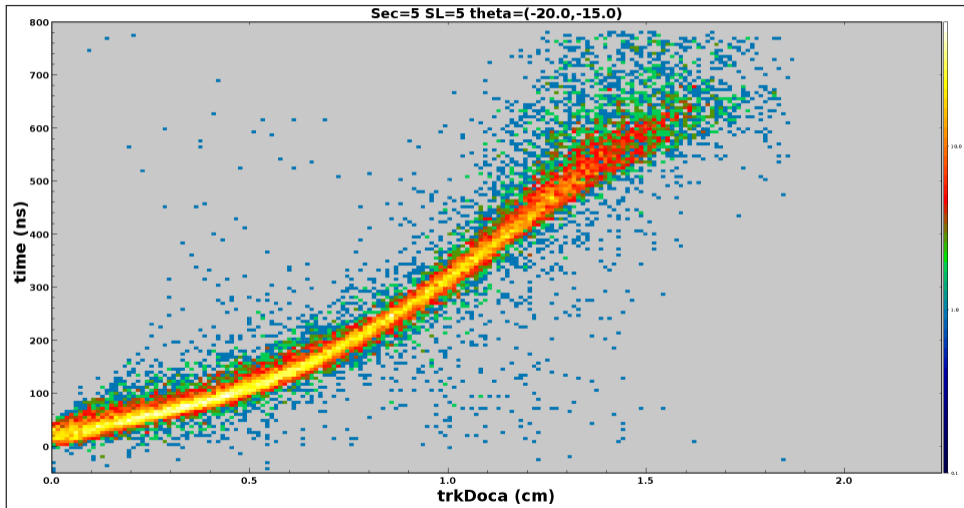
(DC calibration fit control panel)

Correction for T_0

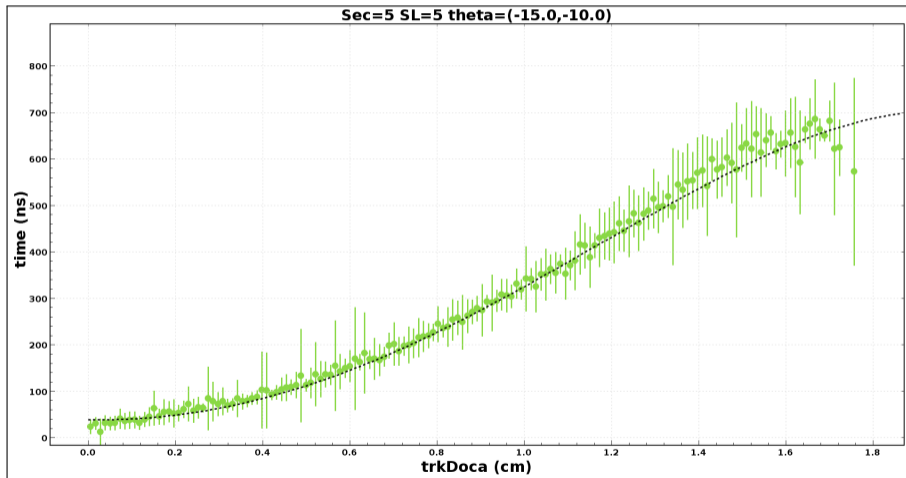
- The rising edge is fitted to a straight line $y = aT + b$.
- T_0 is calculated using $T_0 = (y_0 - b)/a$.



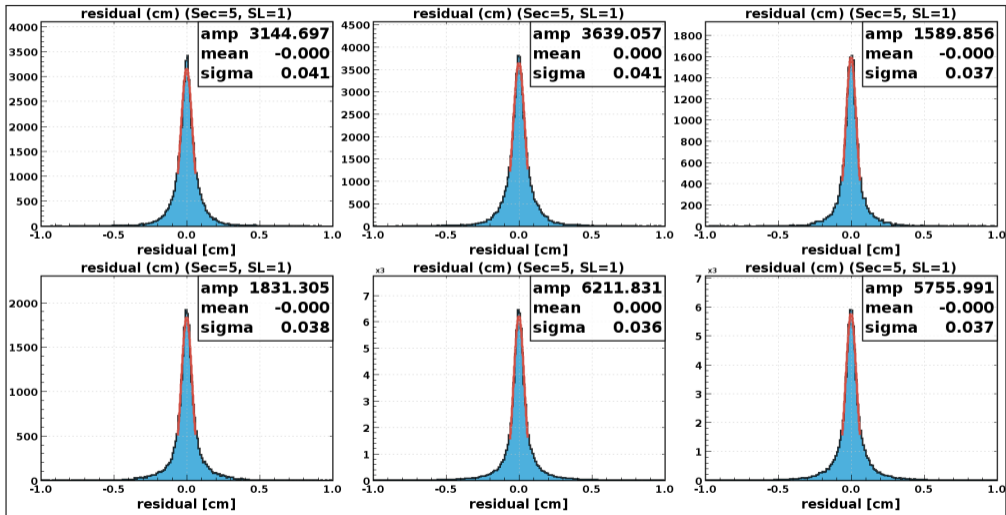
Drift Chamber Calibration: Example Distribution



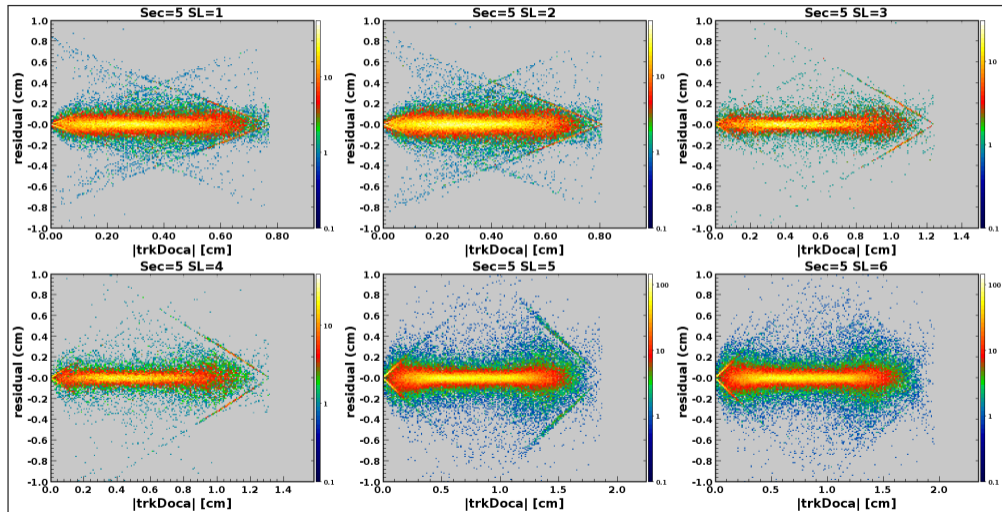
Drift Chamber Calibration: Example Fit



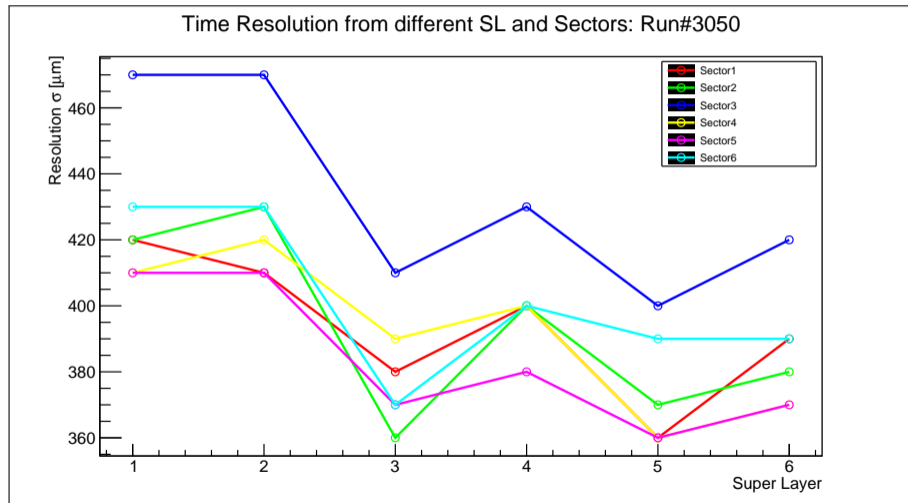
Drift Chamber Calibration: Run#3050



Drift Chamber Calibration: Run#3050



Drift Chamber Calibration: Run#3050



Result from different run configurations

Run#	E_b (GeV)	Current (nA)	Target	Torus/Solenoid (%)	Resolution (μm)
2052	10.6	5	LH2	-85 / -100	340 - 500
2091	10.6	10	LH2	-85 / -100	350 - 450
3050	6.4	15	LH2	-100 / -100	360 - 470
3105	6.4	10	LH2	75 / -100	330 - 480

Git Repository & Documentation

JeffersonLab / clas12dc

Code Issues Pull requests Projects Insights

clas12 DC calibration code

28 commits 1 branch 3 releases 1 contributor

Branch: master New pull request Find file Clone or download

latifkabr Updated README Latest commit 7f8d5b0 3 minutes ago

- Calibration Updated README 3 minutes ago
- DataExplorer Reorganized the repository. It now contains all DC related packages u... 20 hours ago
- Monitoring Reorganized the repository. It now contains all DC related packages u... 20 hours ago
- .gignore Save fit parameters in run number appended file 2 days ago
- README.md Updated README 3 minutes ago
- clas12dc Added farm cooking status checking 17 hours ago

README.md

CLAS12 DC Software

- CLAS12 DC Calibration: DC Calibration suite for CLAS12.
- DC Monitoring: DC Monitoring GUI.
- CLAS12 Data Explorer: Data Explorer for CLAS12 data. It allows plotting any CLAS12 detector sub-system with cuts with few clicks.

Please read the README file inside each package for detailed instructions for that specific package.

Calibration of CLAS12 Drift Chambers

Krishna Adhikari, Mac Mestayer, Latif Kabir

Abstract

In this document the process of DC calibration, mainly the calibration of the time-to-distance function is described. Additionally, the GUI for the calibration suite which is written in Java using CLAS12 common tools is described.

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Unified DC Software Packages

```

Terminal
File Edit View Search Terminal Help
ifarm1402:Clas12DC $ mclas12 -h
-----
                Welcome to CLAS12 Software Packages
                For a list of options type "mclas12 -h"
-----

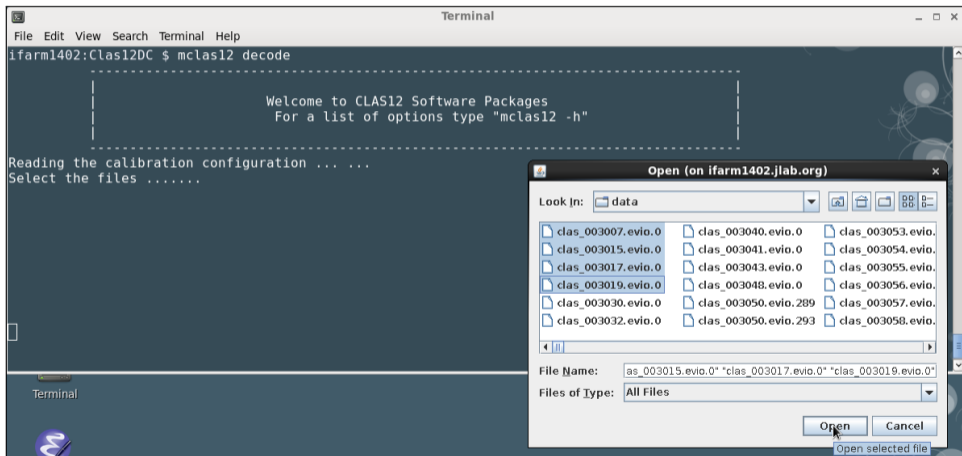
Syntax: mclas12 <OPTION>

----- List of available options -----
tbh          : Plot different variables from TBHits bank
t2d          : Compare time-to-distance function used in reconstruction and calibration suite
explorer     : Open Data Explorer GUI
t0           : Estimate T0 correction
calib        : Open DC Calibration GUI
clas12mon    : Open Clas12 monitoring GUI
dcmon        : Open DC monitoring GUI
effi         : Open DC efficiency studies GUI
decode       : Decode evio files to Hipo files
cook_local   : Data Cooking on local machine
cook_farm    : Data Cooking on farm machine
cooking_status : Farm Data Cooking Status
cancel_jobs  : Cancel submitted farm jobs
det_def      : Print Bank information of the detector given as 2nd argument
bank_def     : Print variable information of the detector and bank.
              Issue detector name followed by bank name
ced          : Open CLAS12 event display
update       : Update CLARA and CoatJava to latest version
add2ccdb     : Upload file to CCDB
addT0ccdb    : Upload T0 correction to CCDB
-----

ifarm1402:Clas12DC $

```

Unified DC Software Packages: Decoding Step-1

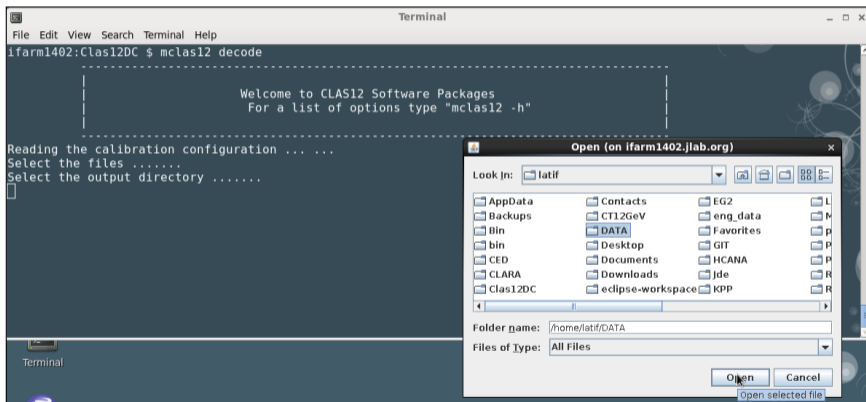


The image shows a terminal window titled "Terminal" with a menu bar (File, Edit, View, Search, Terminal, Help). The prompt is "ifarm1402:Clas12DC \$". The command "mclas12 decode" has been executed, resulting in a welcome message for CLAS12 Software Packages and instructions to type "mclas12 -h" for options. Below this, the terminal shows "Reading the calibration configuration" and "Select the files".

An "Open" dialog box is overlaid on the terminal, titled "Open (on ifarm1402.jlab.org)". The "Look in:" field is set to "data". The file list contains 21 files, all with ".evio.0" extensions. The file "clas_003019.evio.0" is selected. The "File Name:" field contains the wildcard pattern "as_003015.evio.0*" "clas_003017.evio.0*" "clas_003019.evio.0*". The "Files of Type:" is set to "All Files". The "Open" button is highlighted, and a tooltip "Open selected file" is visible below it.

File Name	File Name	File Name
clas_003007.evio.0	clas_003040.evio.0	clas_003053.evio.0
clas_003015.evio.0	clas_003041.evio.0	clas_003054.evio.0
clas_003017.evio.0	clas_003043.evio.0	clas_003055.evio.0
clas_003019.evio.0	clas_003048.evio.0	clas_003056.evio.0
clas_003030.evio.0	clas_003050.evio.289	clas_003057.evio.0
clas_003032.evio.0	clas_003050.evio.293	clas_003058.evio.0

Unified DC Software Packages: Decoding Step-2



Unified DC Software Packages: Decoding Step-2

```

Terminal
File Edit View Search Terminal Help

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    ??? ?????????????? ???????      ???????      ???????
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    ??? ???????????      ???????????   ??????????????????????????
    ??? ???????????      ???????????   ??????????   ??? ??????????
    Physics Division (c) Jefferson Lab (2017)

[HipoWriter] --> schmea dictionary written with 114 entries.
[HipoWriter] --> compression type
INPUT LIST SIZE = 1
--> Warning the CLAS12DIR property is not defined.
[EvioDataDictionary]--> loading bankdefs from directory : /home/latif/work/CLARA/clara/plugins/clas12
//bin/./etc/bankdefs/clas12
[EvioDataDictionary]-----> number of XML files located : 22
[EvioDataDictionary]--> total number of descriptors found : 109
[EvioDataDictionary]--> loading bankdefs from directory : /home/latif/work/CLARA/clara/plugins/clas12
//bin/./etc/bankdefs/clas12
[EvioDataDictionary]-----> number of XML files located : 22
[EvioDataDictionary]--> total number of descriptors found : 109
[EvioSource] --> Factory loaded descriptor count : 109
  
```

Unified DC Software Packages

```

Terminal
File Edit View Search Terminal Help
ifarm1402:Clas12DC $ mclas12 bank_def dc TimeBasedTrkg::TBHits

-----
                Welcome to CLAS12 Software Packages
                For a list of options type "mclas12 -h"
-----

-----
| Item Name | Type | Info |
-----
| id        | int16 | id of the hit |
| status    | int16 | id of the hit |
| sector    | int8  | DC sector |
| superlayer | int8  | DC superlayer (1..6) |
| layer     | int8  | DC layer in superlayer (1..6) |
| wire      | int16 | wire id of DC |
| time      | float | raw time of the hit |
| doca      | float | doca of the hit calculated from TDC (in cm) |
| docaError | float | uncertainty on doca of the hit calculated from TDC (in cm) |
| trkDoca   | float | track doca of the hit (in cm) |
| timeResidual | float | time residual of the hit (in cm) |
| LR        | int8  | Left/Right ambiguity of the hit |
| X         | float | wire x-coordinate in tilted-sector |
| Z         | float | wire z-coordinate in tilted-sector |
| B         | float | B-field intensity at hit position in tilted-sector system |
| TProp     | float | t propagation along the wire |
| TFlight   | float | time of flight correction |
| clusterID | int16 | ID of associated cluster |
| trkID     | int8  | ID of associated track |
-----

ifarm1402:Clas12DC s
ifarm1402:Clas12DC s

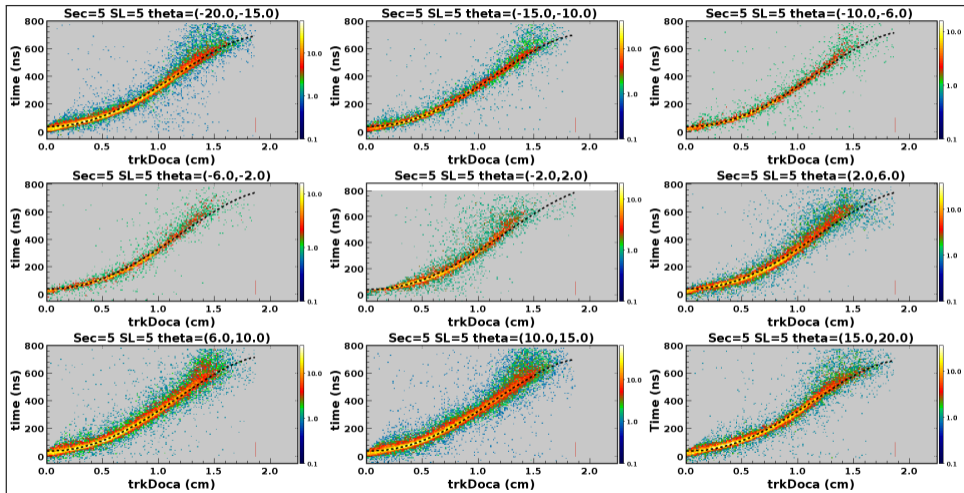
```

Current Status & Future Plan

- DC calibration for all sectors is working fine. The calibration suite is fully functional.
- First version of the documentation is posted on the wiki. All source codes are on Github (JLab account).
- Attempt to correct for event start time is on-going to make T0 more realistic.
- Automate some of the steps.
- Finer binning for B-field dependent region.
- Standard procedure for calibration.
- Improvement based on user feedback.

Backup Slides

Drift Chamber Calibration: Example Fit



Drift Chamber Calibration: Run#2052

