Drift Chamber Calibration

Latif Kabir

Mississippi State University
for the DC Team

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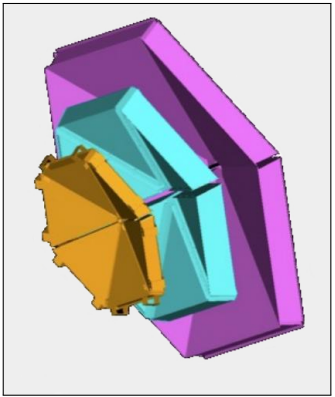
Drift Chamber Calibration for CLAS12

- Ultimate goal is to achieve $\sigma \sim$ 250 - 350 μm.
- 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:

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

ii) Beta-dependent time-walk correction:

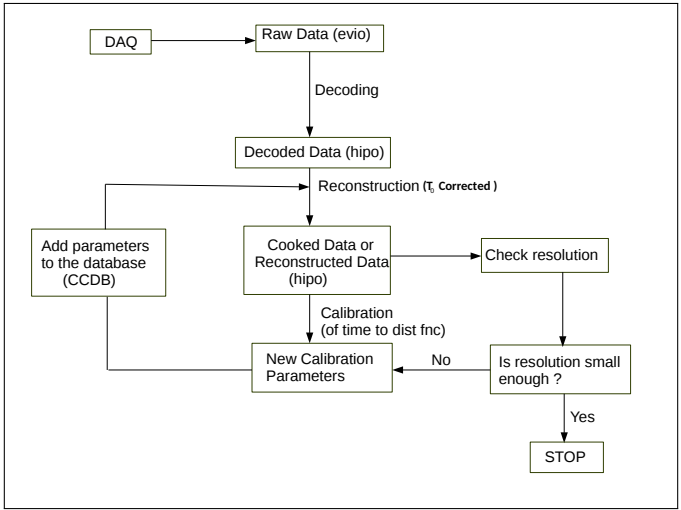
$$\boxed{\Delta t_\beta = \frac{\sqrt{x^2 + (x_\beta \beta^2)^2} - x}{v_0}} \tag{2}$$

iii) B field dependent contribution:

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

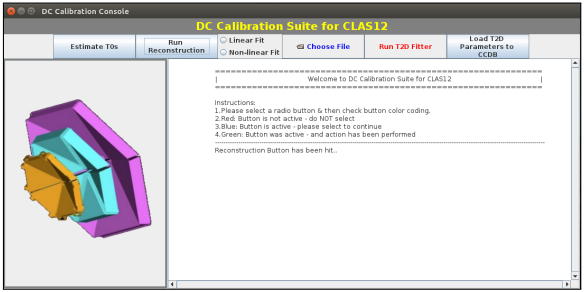
$$\boxed{p_0 = v_0,\ p_1 = \delta_{mn},\ p_2 = t_{max},\ p_3 = x_\beta,\ p_4 = \delta_B,\ p_5 = b_1,\ p_6 = b_2,\ p_7 = b_3,\ p_8 = b_4,\ p_9 = \Delta T_0} \tag{4}$$

DC Calibration Flow Chart

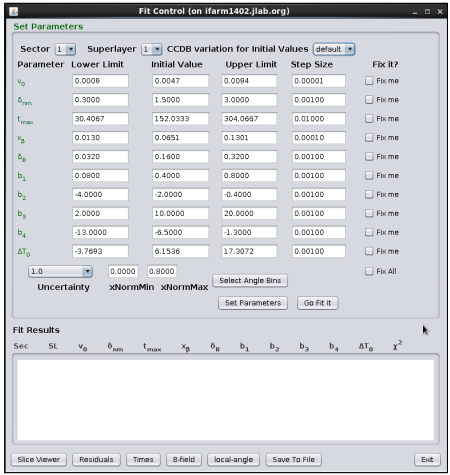


DC Calibration Suite

- GUI driven complete calibration for DC



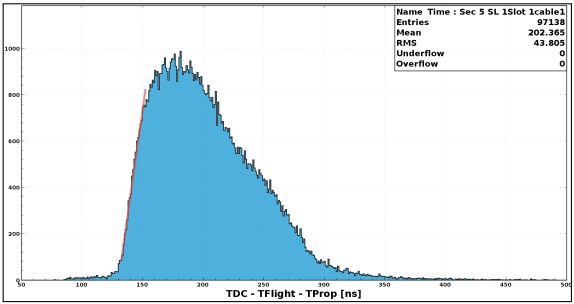
(DC calibration main GUI)

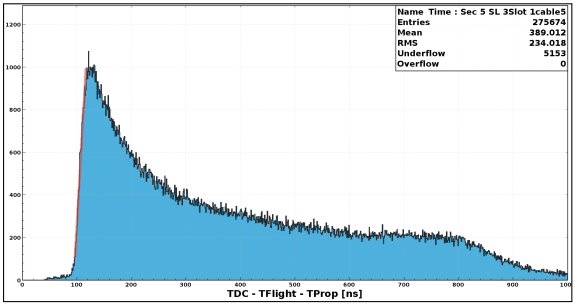


(DC calibration fit control panel)

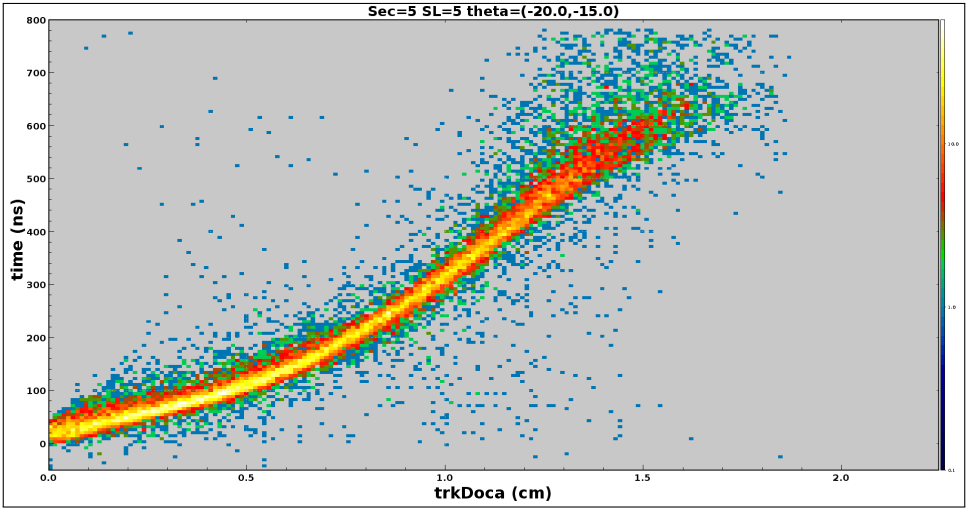
Correction for T_0

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

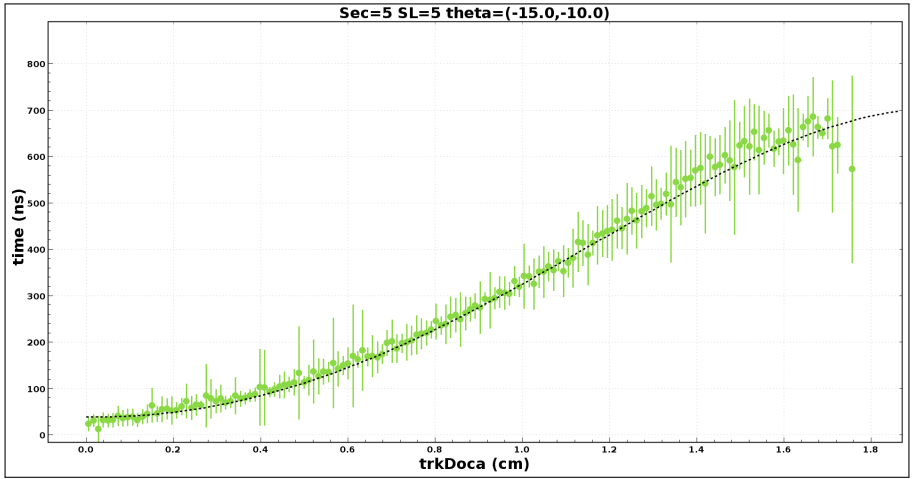




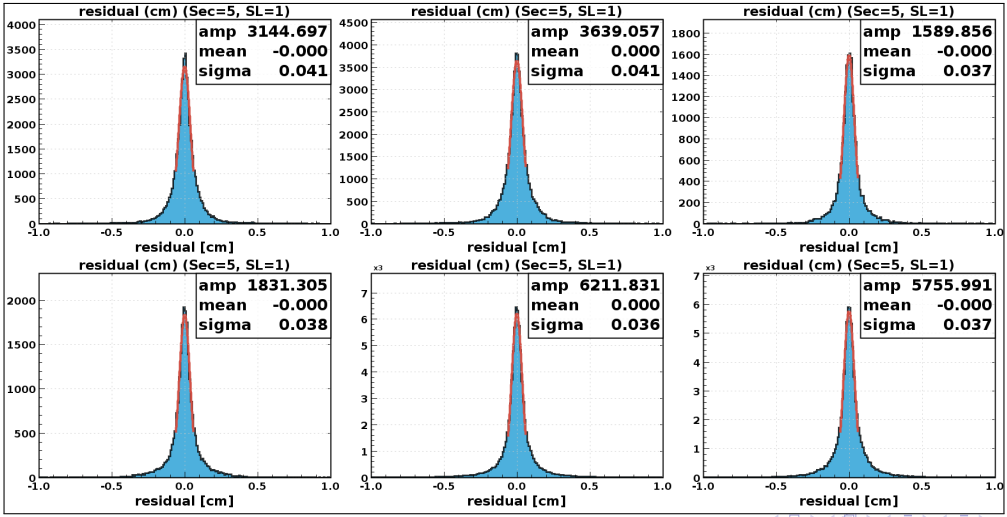
Drift Chamber Calibration: Example Distribution



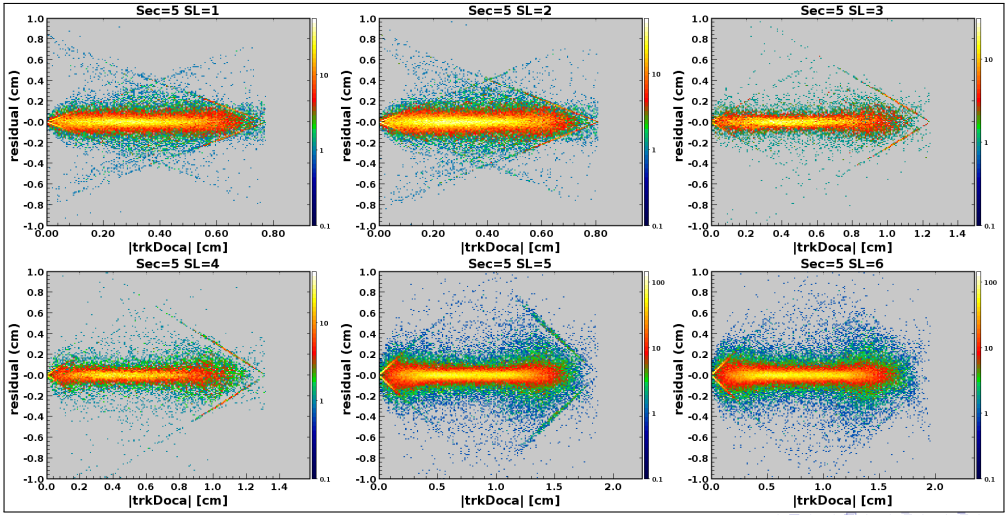
Drift Chamber Calibration: Example Fit



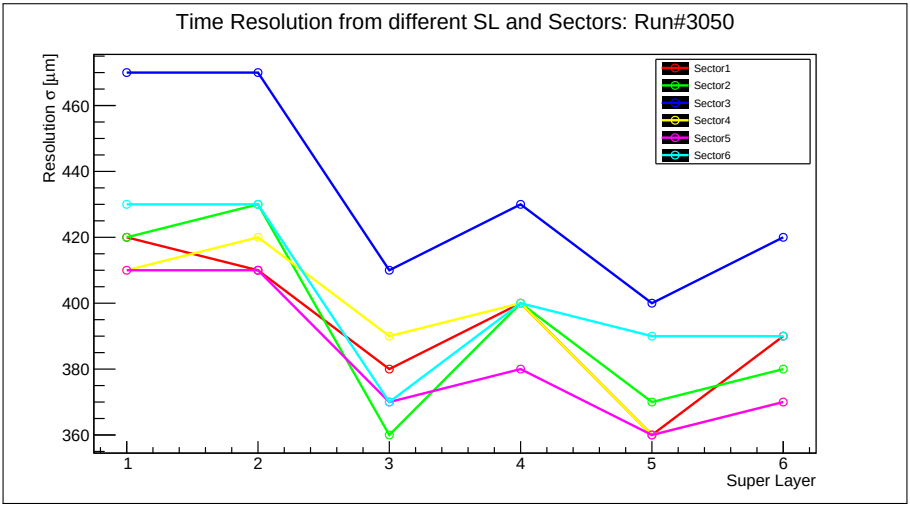
Drift Chamber Calibration: Run#3050



Drift Chamber Calibration: Run#3050



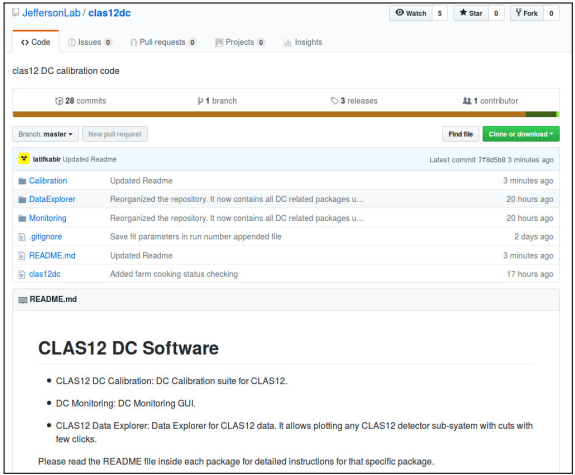
Drift Chamber Calibration: Run#3050

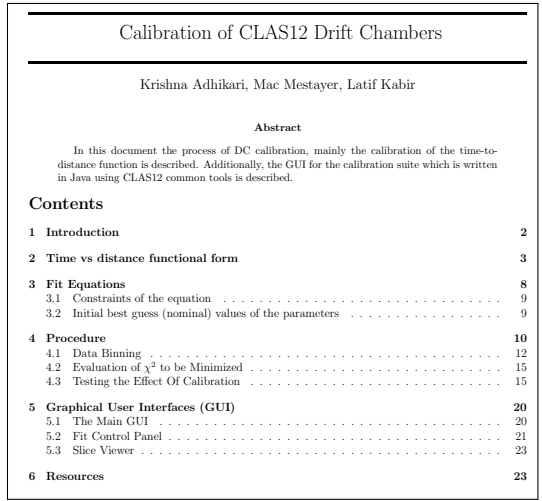


Result from different run configurations

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





Calibration of CLAS12 Drift Chambers

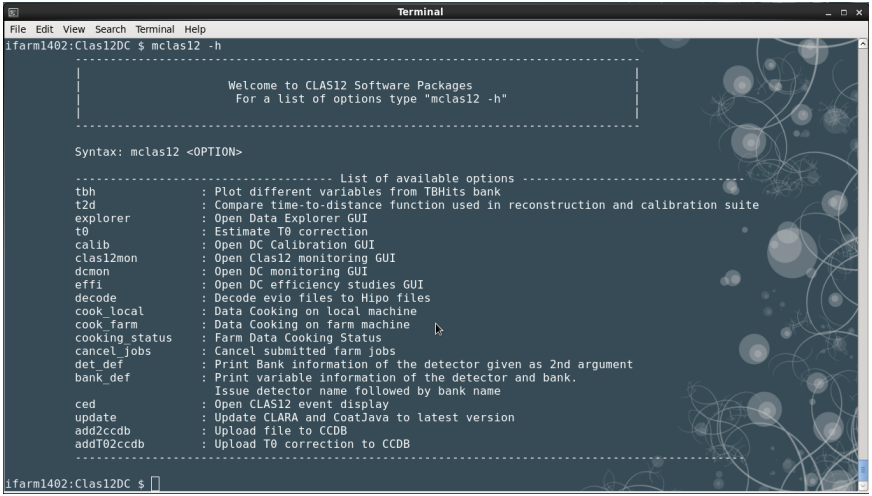
Krishna Adhikari, Mac Mestayer, Latif Kabir

Abstract

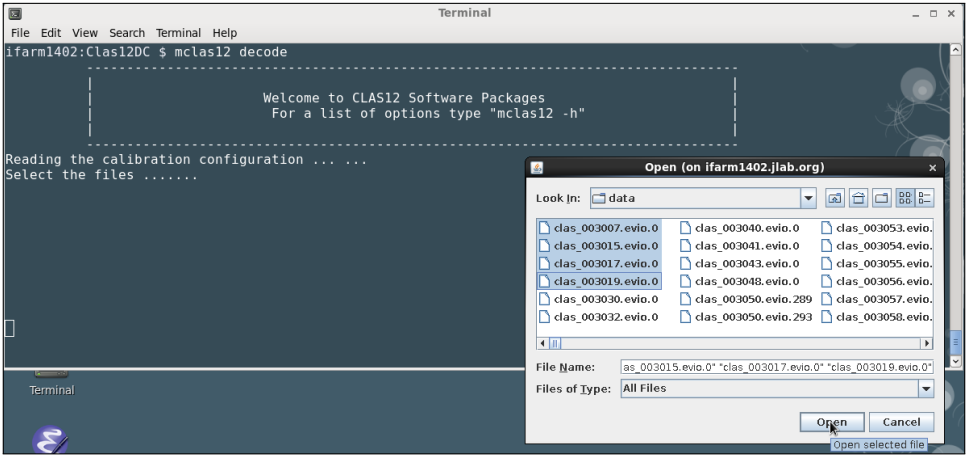
In this document the process of DC calibration, mainly the calibration of the time-to-distance function is described. Additionally, the GUI for the calibration suite which is written in Java using CLAS12 common tools is described.

Contents

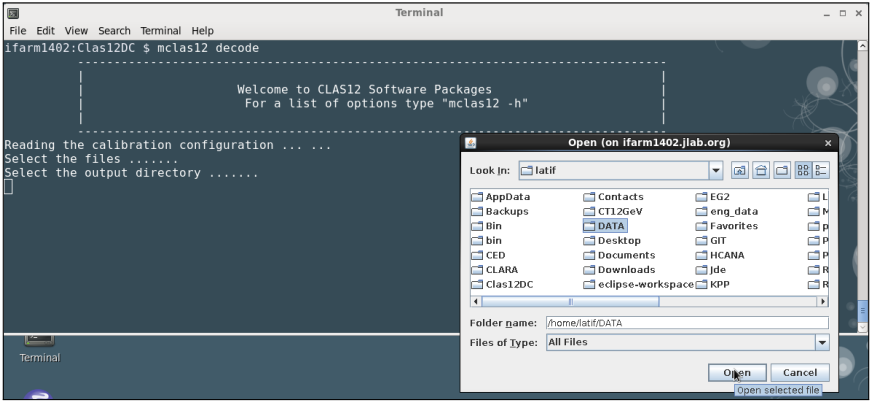
Unified DC Software Packages



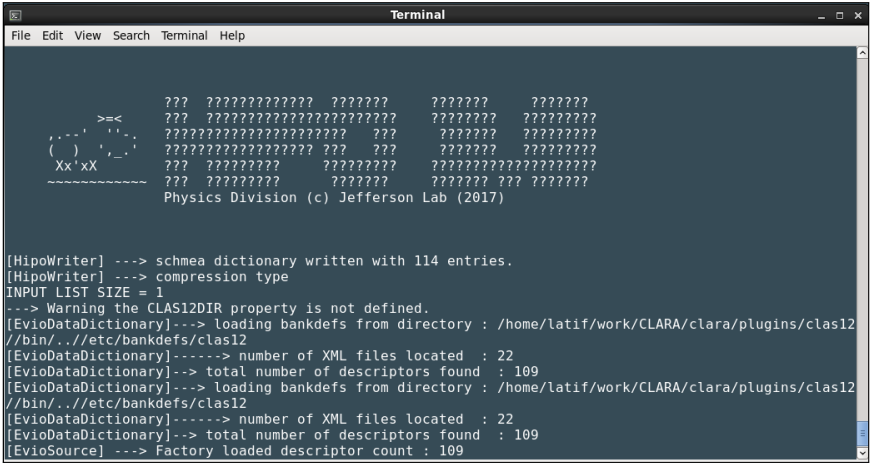
Unified DC Software Packages: Decoding Step-1



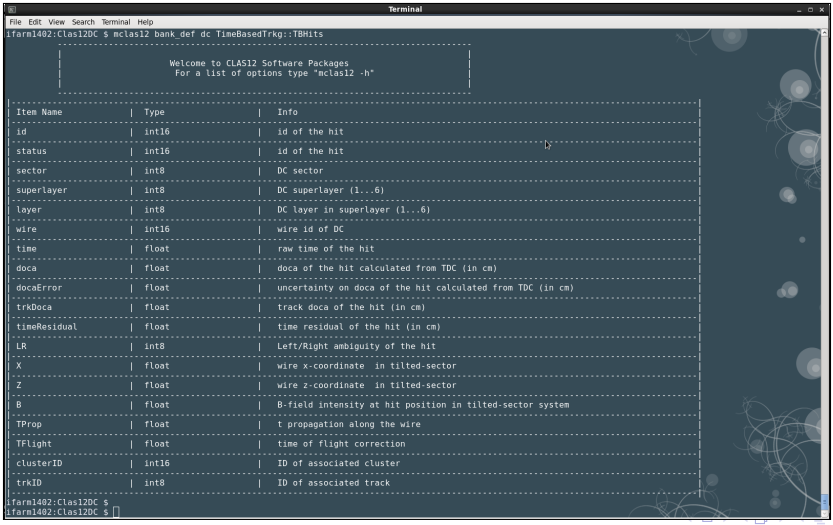
Unified DC Software Packages: Decoding Step-2



Unified DC Software Packages: Decoding Step-2



Unified DC Software Packages

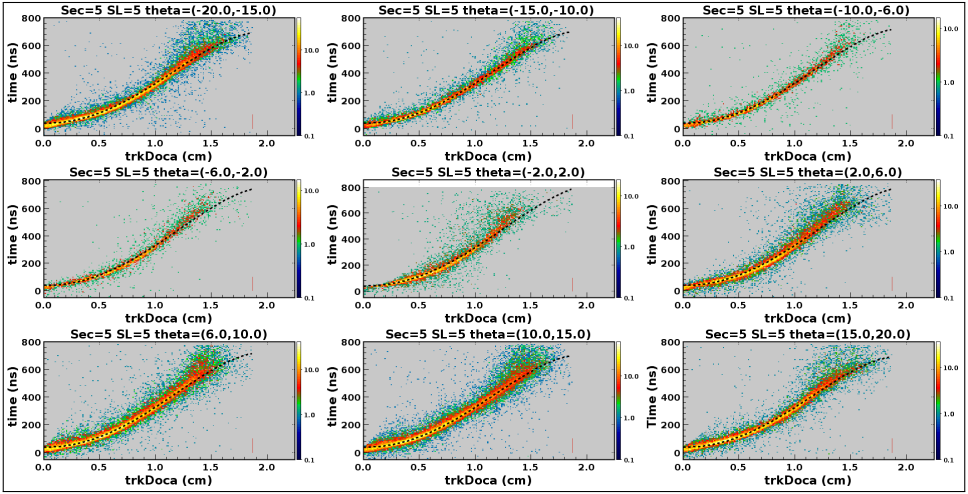


Current Status & Future Plan

- 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