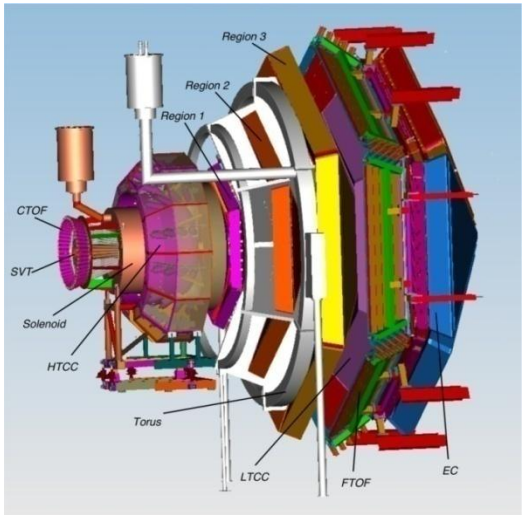
DC Calibration Update

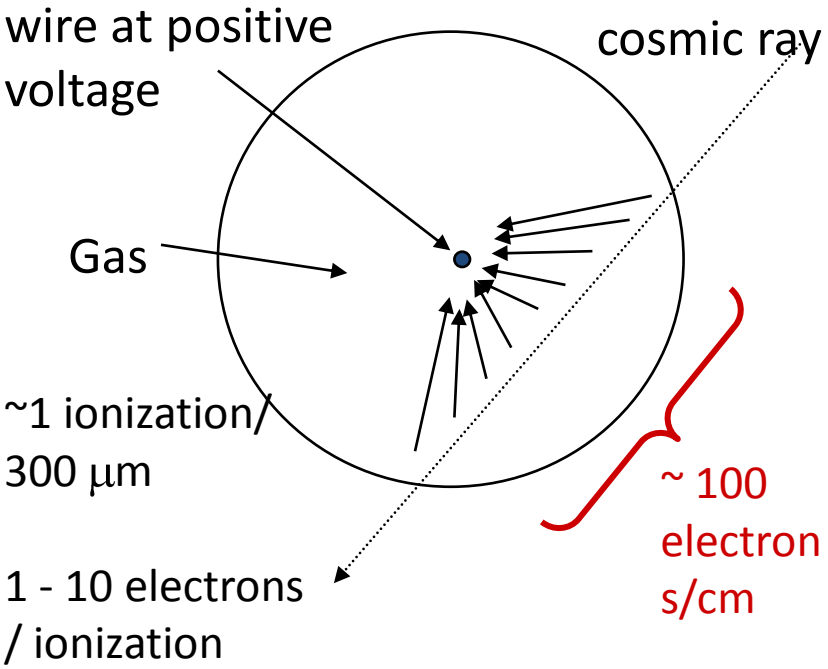
Krishna Adhikari (MSU)
Mac Mestayer (JLab)

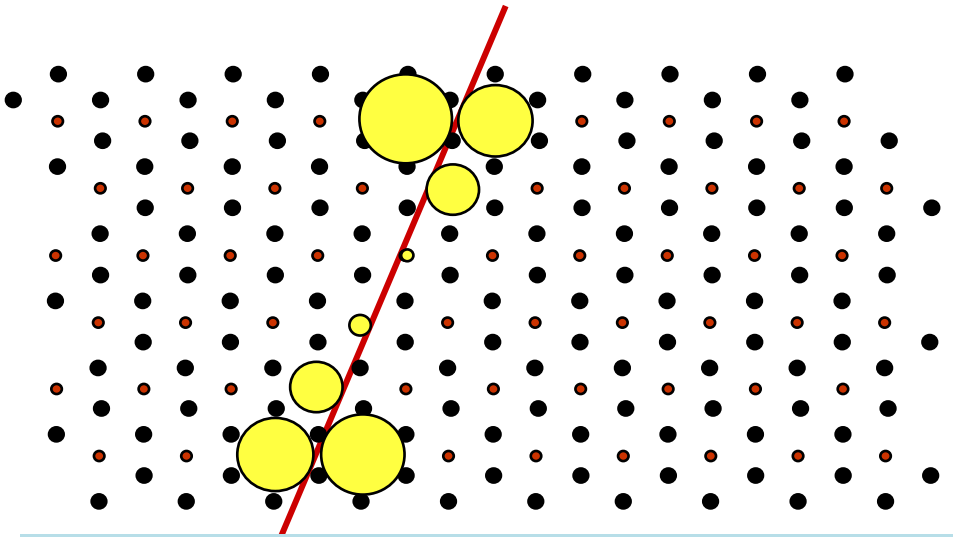
CLAS12 Workshop
3/28/2017

Drift Chambers for CLAS12 Tracking



- Wire chambers provide economical ways for tracking in large volumes.
- Electrons drift towards wires (at +ve voltage)
- Strike a molecule every 2 μm
- Velocity ~ 50 μm/ns (max)
- Drift distances (calculated from the measured drift times) can be used to determine the tracks.



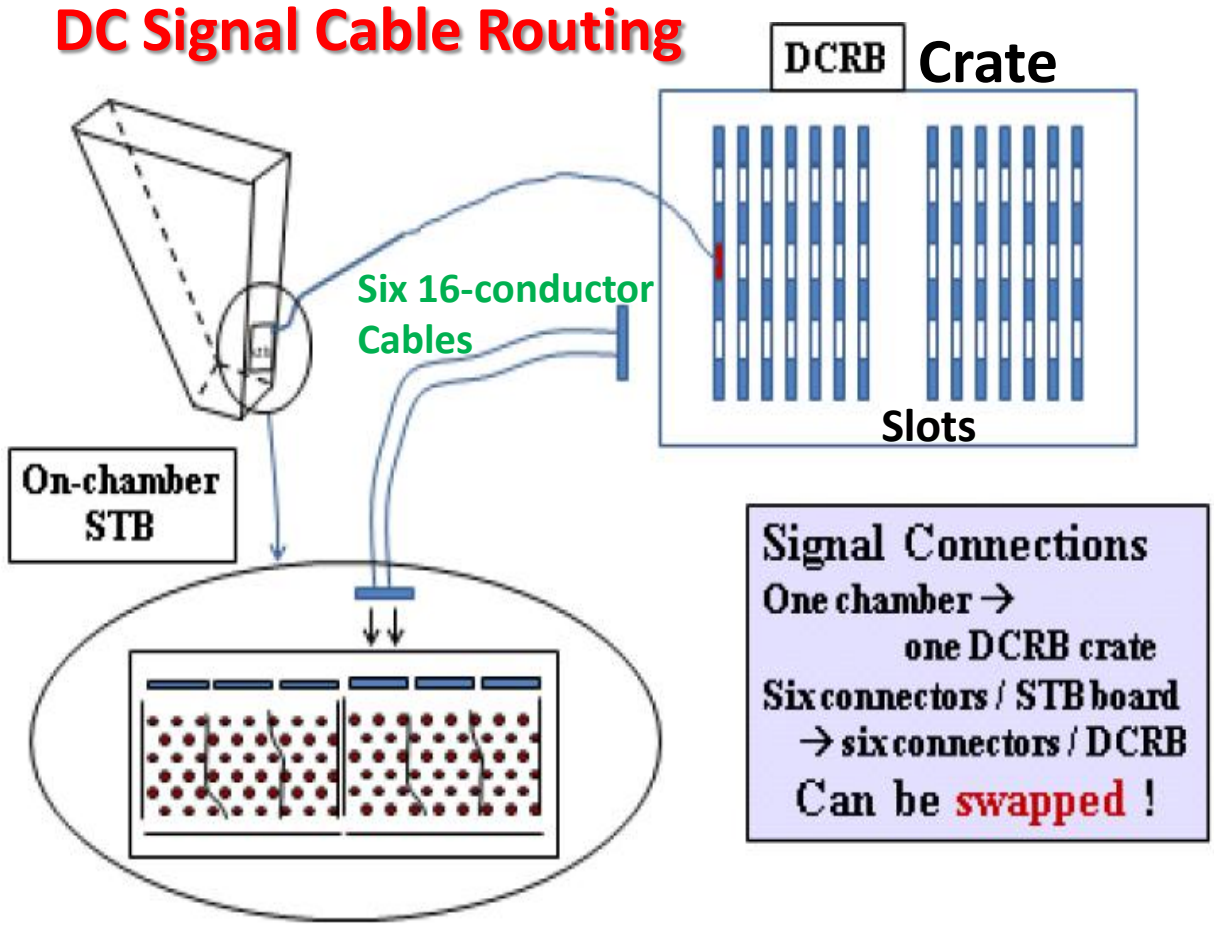


Minimize rms between track and calculated distance

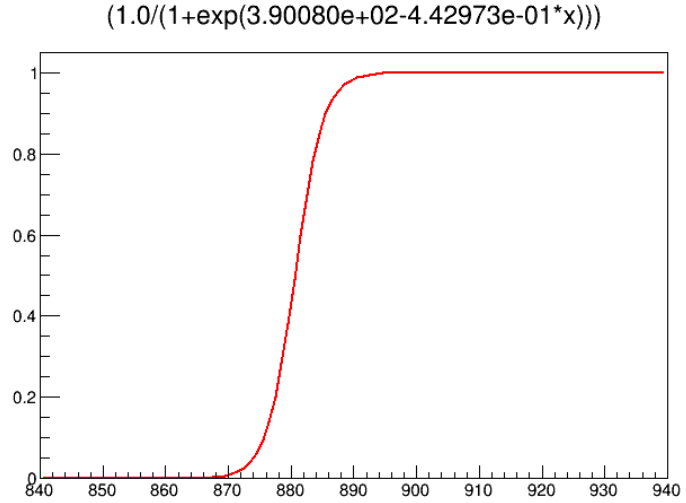
Time Corrections

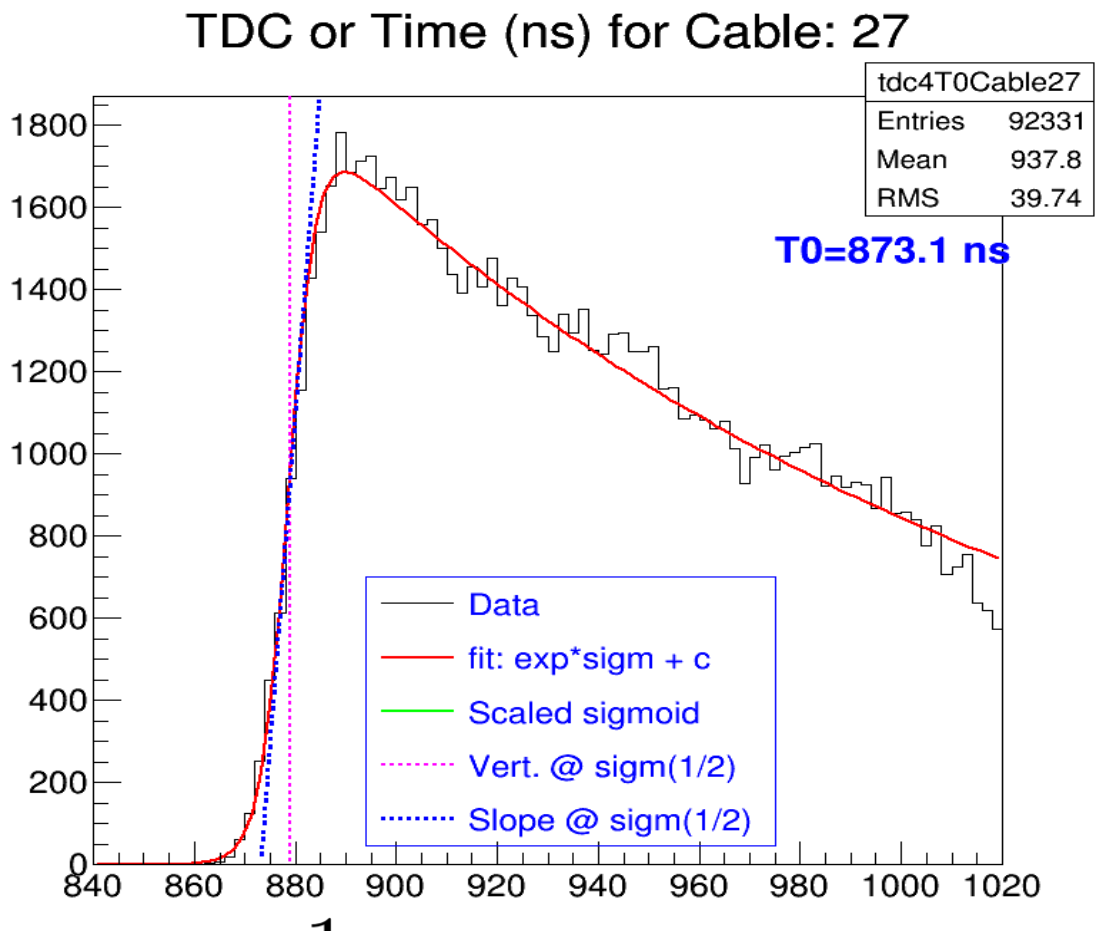
Measured times must be corrected for various delays to get the true drift times.

- DC raw data – in the form of TDC digits.
- TDC digits have to be corrected for fixed and event dependent delays.
- Signal cable delay (T0) contributes the most to the fixed delay.



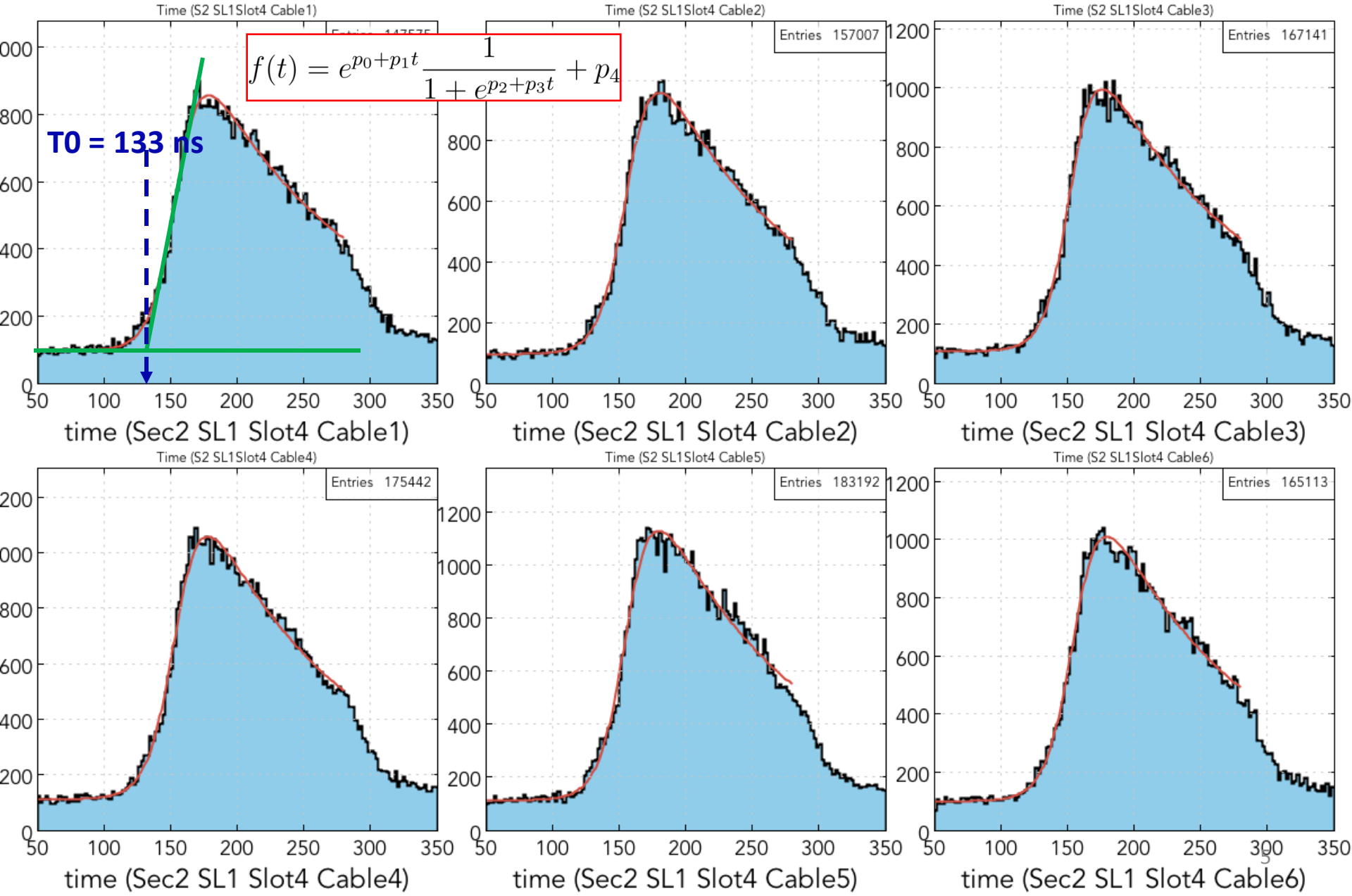
Automated Method for T0s: Fit the rising edge





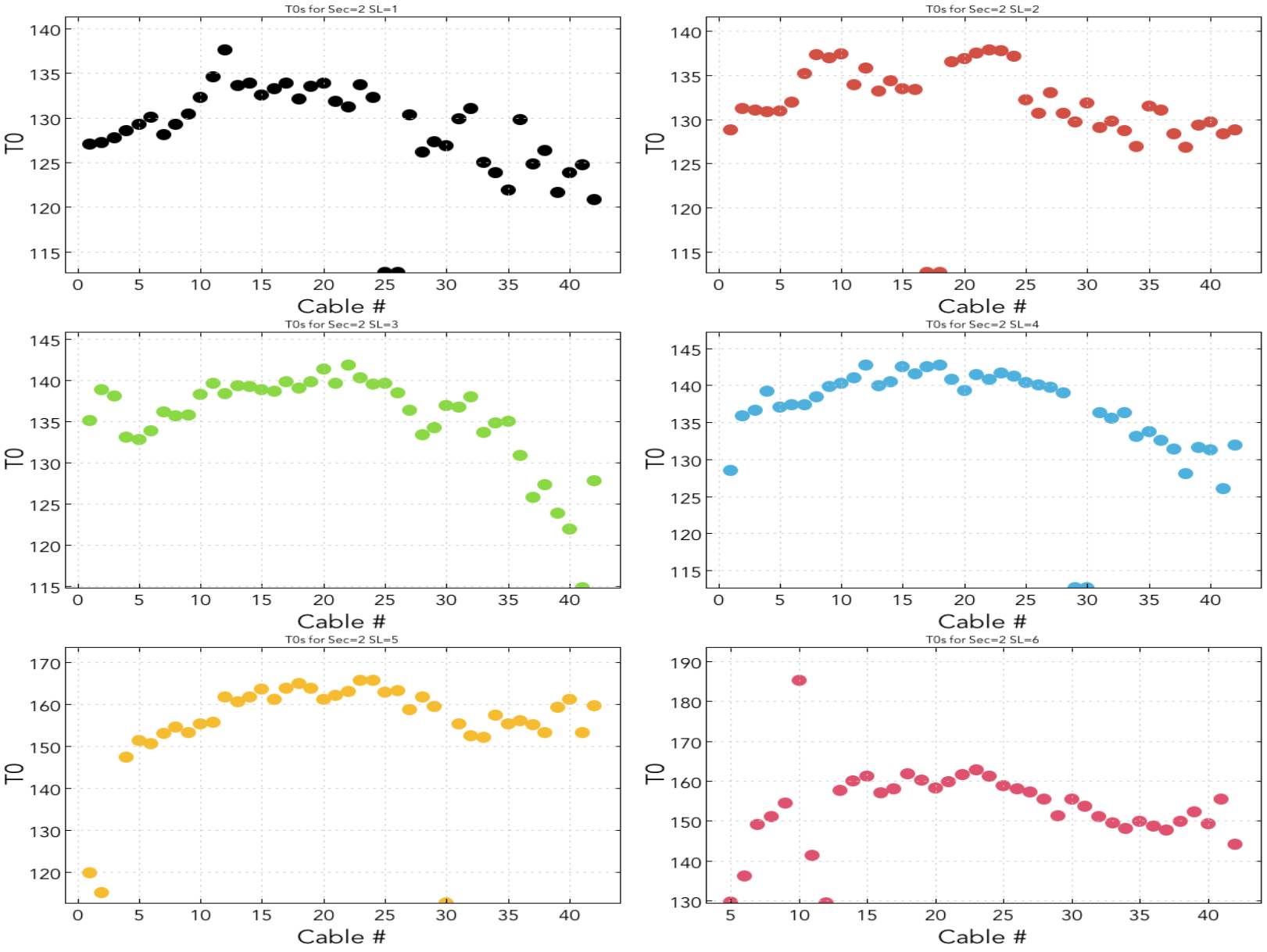
$$f(t) = e^{p_0+p_1 t}\frac{1}{1+e^{p_2+p_3 t}} + p_4$$

Rising Edge Fits & T0 extraction

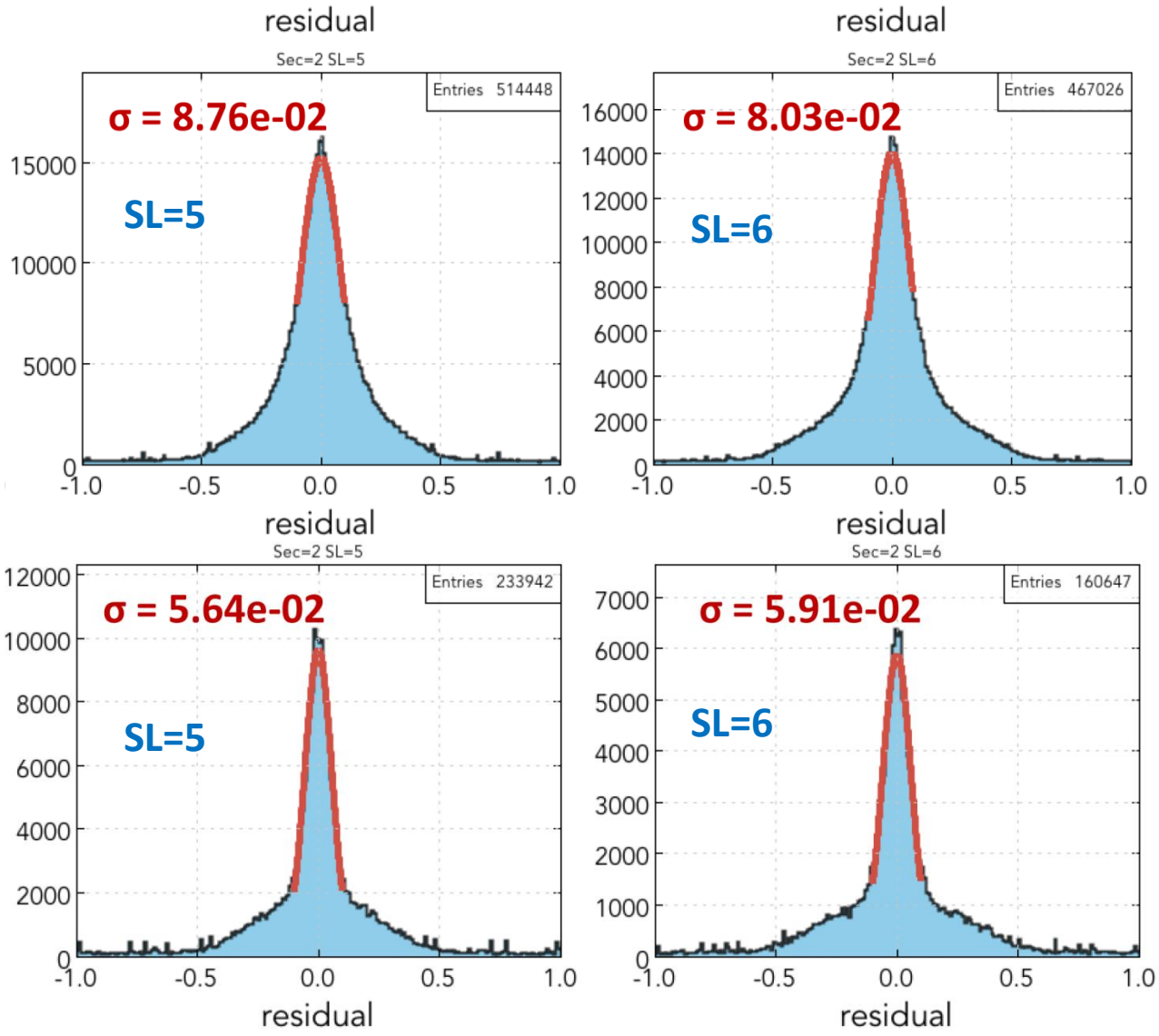


Estimated T0s (in ns) vs Cables

Nanoseconds



Effect of T0-correction



Before

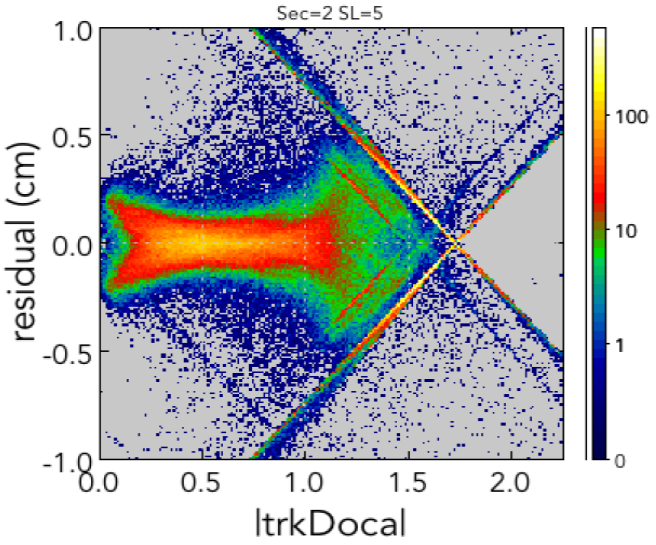
After

Residuals from TBHits bank.

Effect of T0-correction

Residuals vs trkDocaTBHits bank.

SL=5



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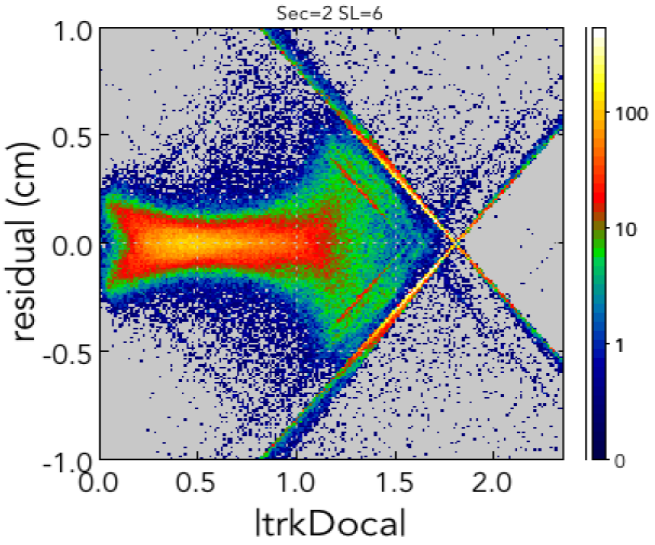
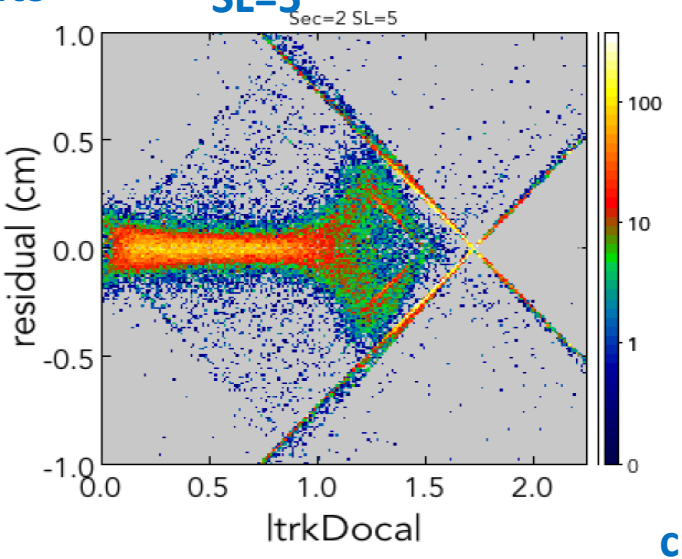


Before

SL=5



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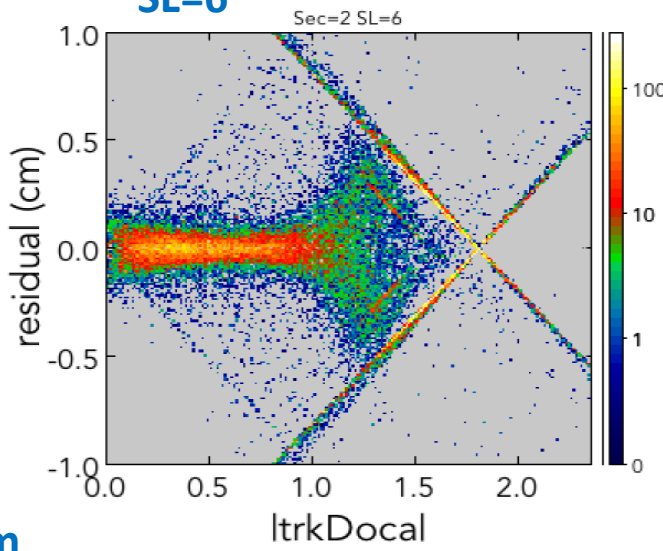


After

cm

Time-to-distance Calibration

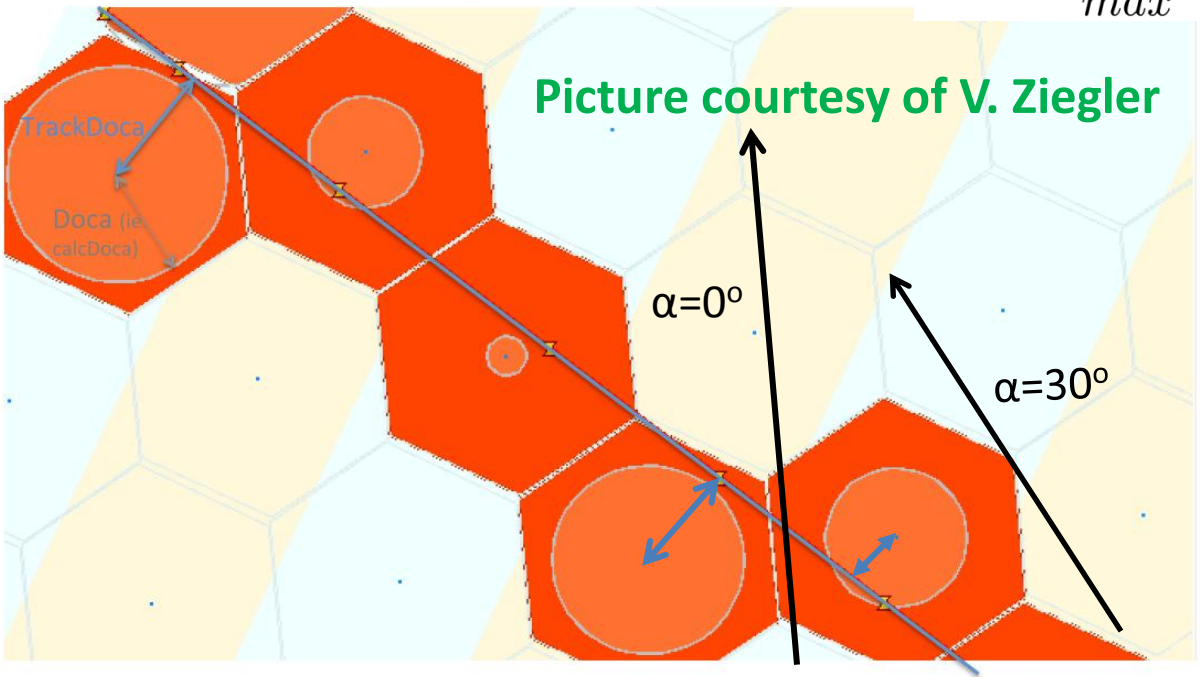
A formula is required to translate drift times into drift distances in order to use in tracking.

Here we determine a reverse formula, and which is used to make translation tables.

$$t_{calc} = \frac{x}{v_0} + a \cdot \hat{x}^n + b \cdot \hat{x}^m + t_\beta + t_{B-field}$$

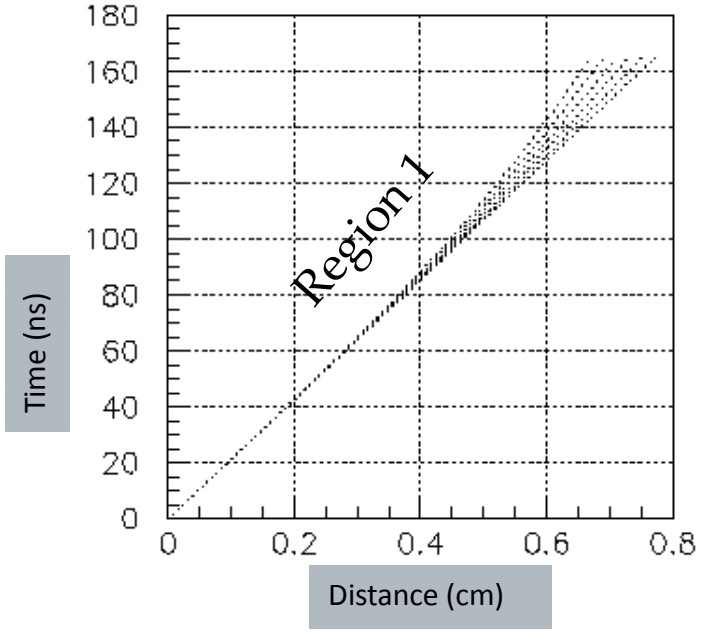
Saturated drift velocity at t ~ 0

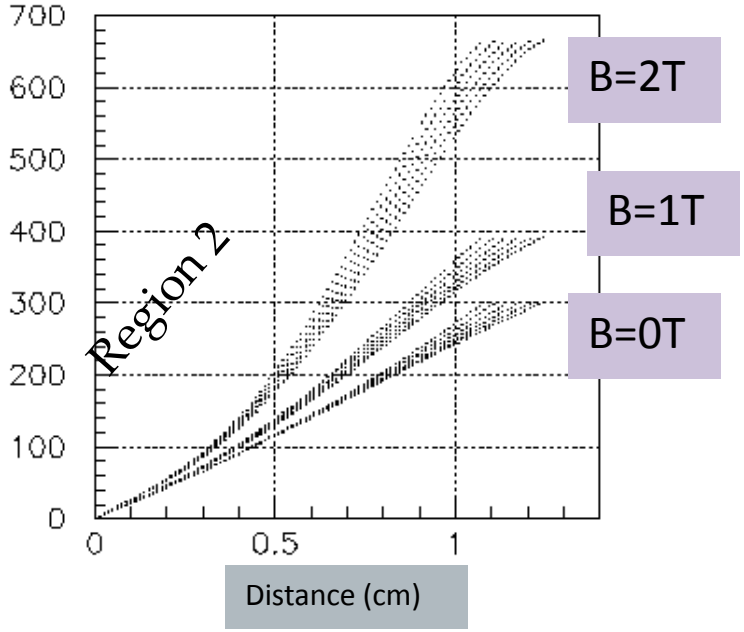
$$\hat{x} = \frac{x}{x^{\alpha}_{max}} = \frac{x}{x_{max} \cdot cos(30° - \alpha)}$$

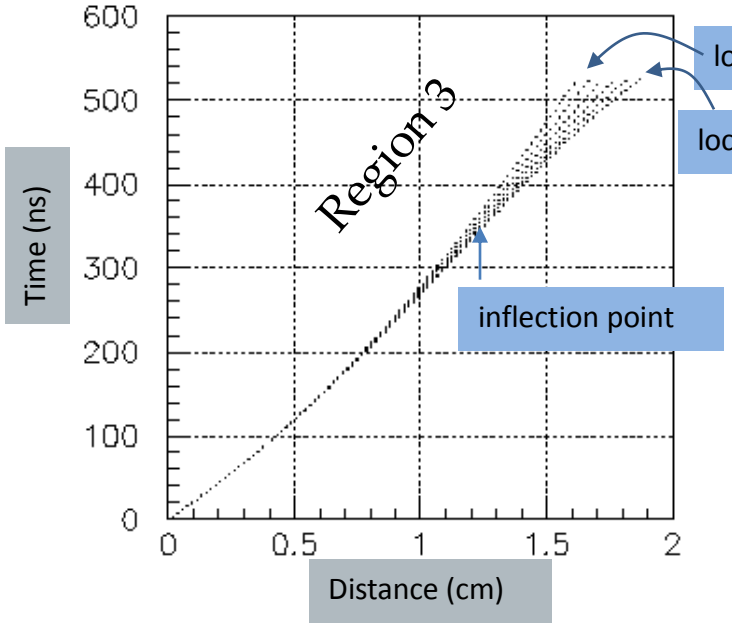


Picture courtesy of V. Ziegler

- **CalcDoca** : DOCA calculated from time
- **TrackDoca** : Distance of hit wires from fit tracks
- **α** : Local Angle
  - Angular dependence arises because drift cells and isochrones are not circular but hexagonal.





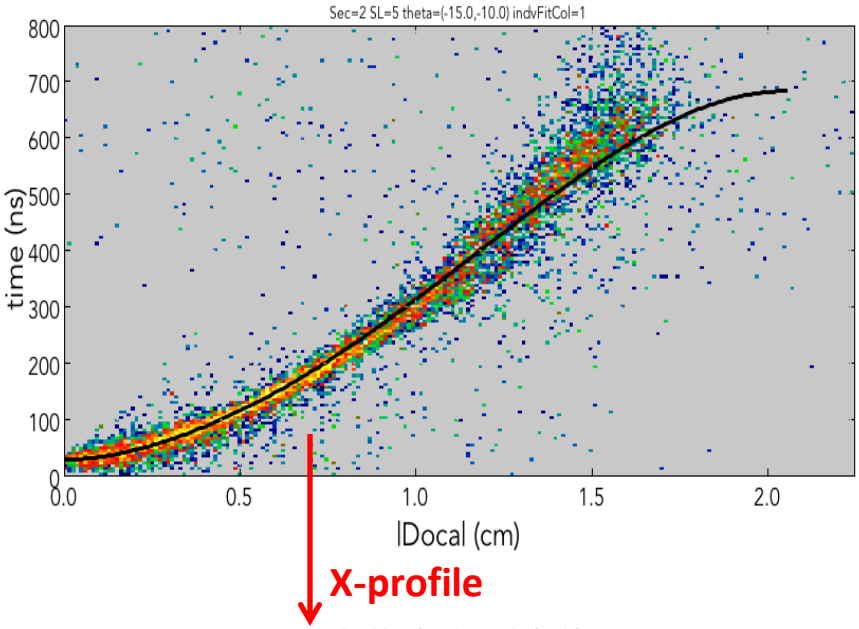


Distance → Time
-local-angle and B-field dependence
-consistent with GARFIELD
-inversion done numerically
-thicker wire → more linear
→ easier to calibrate

Initial parameters in software now

Method: Time-to-distance Calibration

- **Make time-vs-doca 2D histograms** by selecting hits (TBTracks -> TBSegments -> TBHits; nHits>5 in a segment) in bins of sector, superlayer and local angle (α).
- **Histograms are then transformed into corresponding X-profiles** (essentially graphs with each point representing the y-average inside each X-bin).
- Profiles provide data points for **Chi-square minimization**
  - **Uses Minuit from FreeHEP java libraries** included in **Coatjava package.**

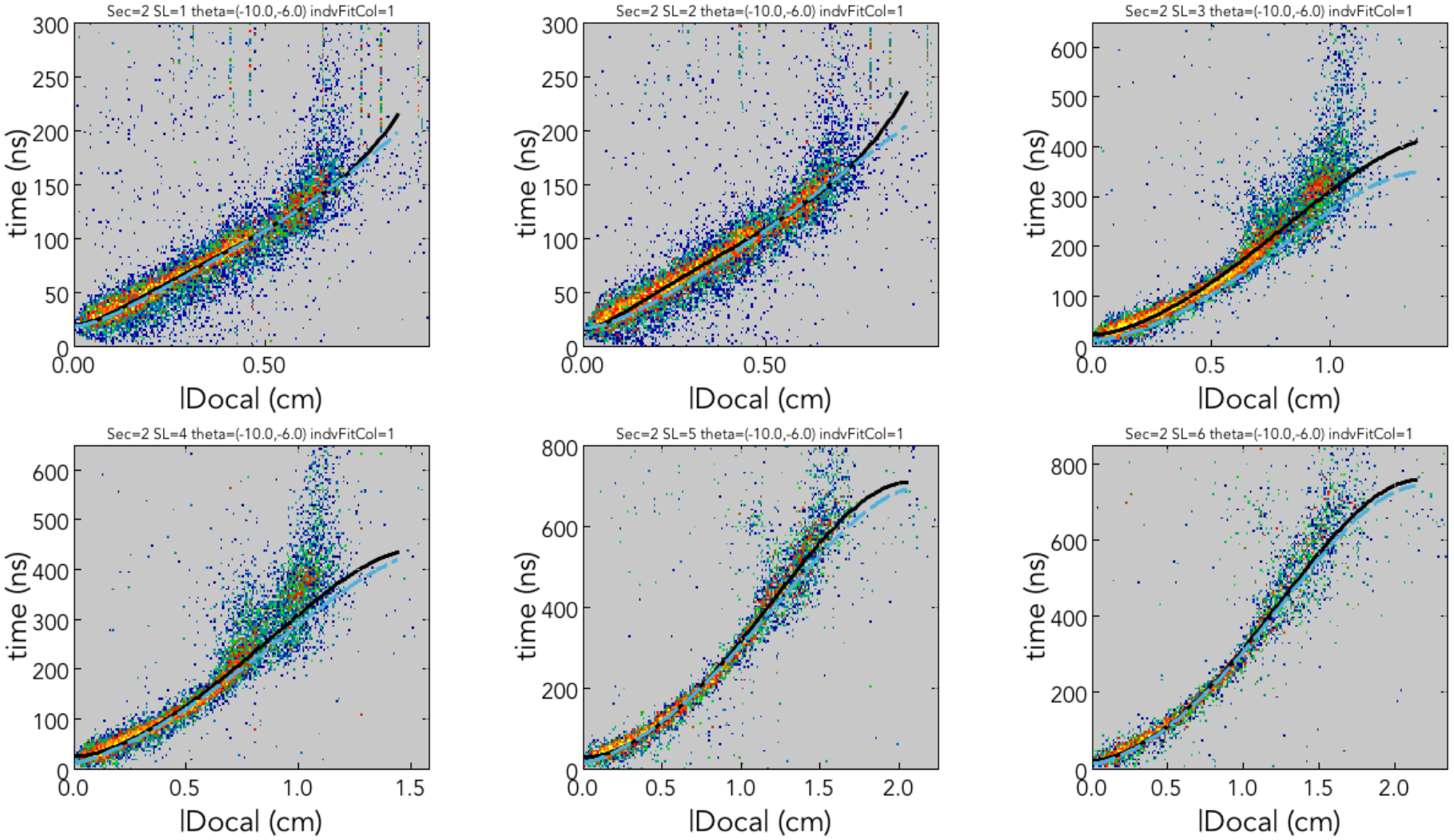


$$\chi^2 = \sum_{i=1}^{N} \left(\frac{t_{calc} - t_{xprof}}{t_{Err}} \right)^2$$

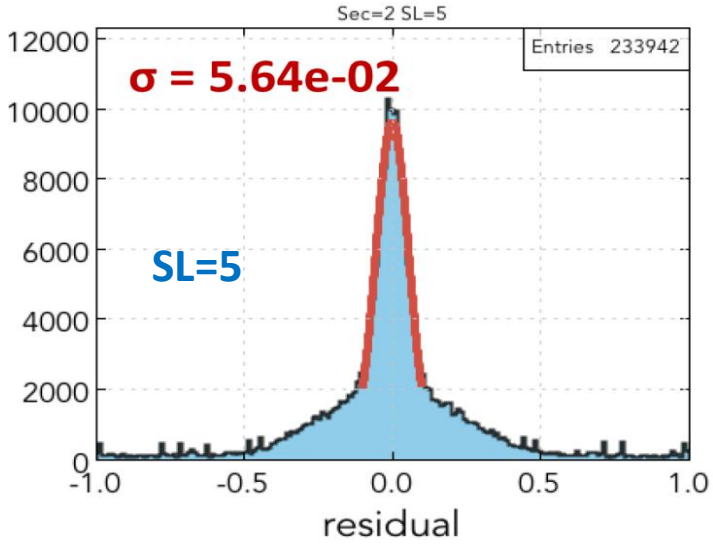
t(x,α, B, p1, …, p9)

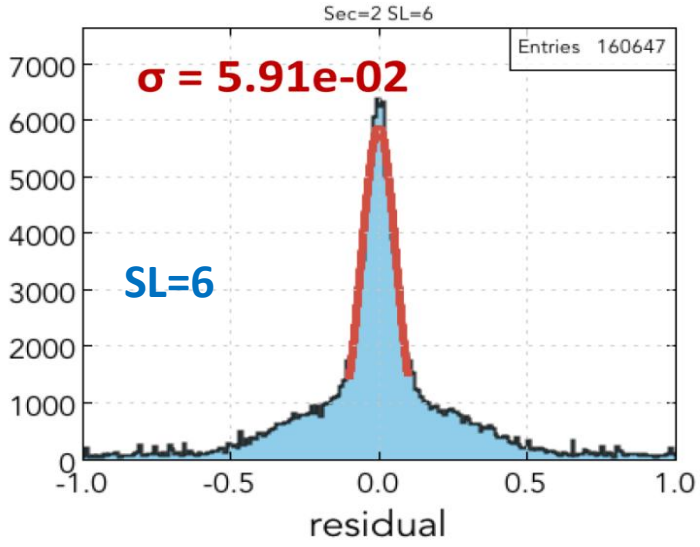
Time-to-distance Fits

TB-Hits of Segments in one local angle bin α (-10.0,-6.0)

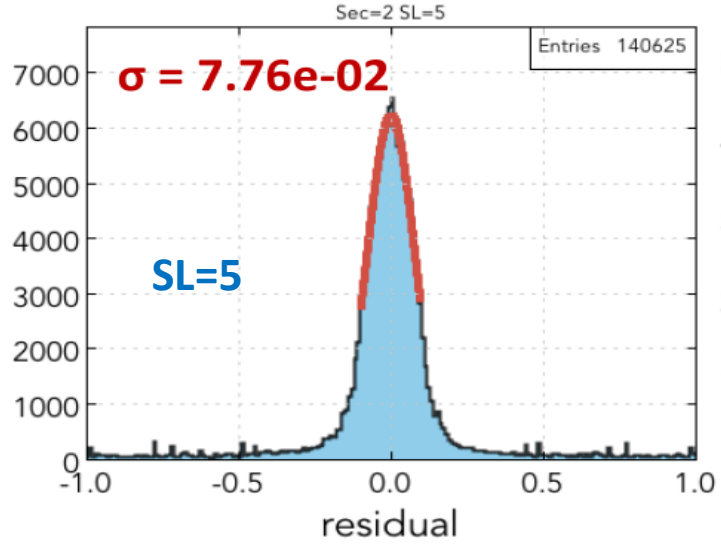


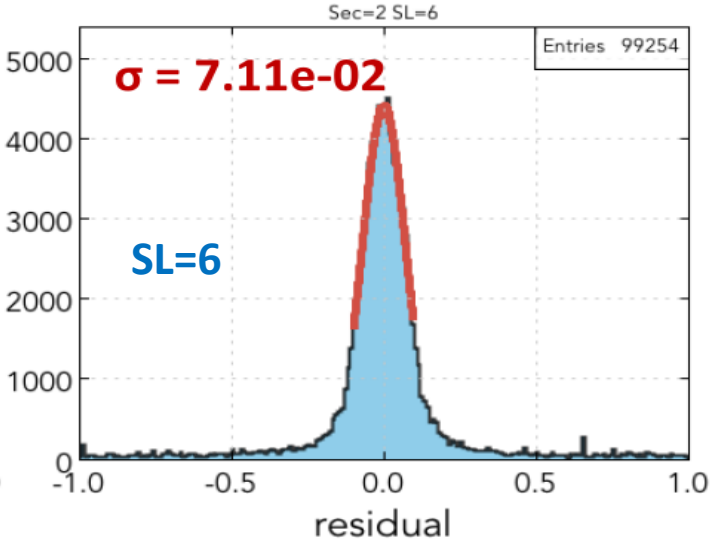
Effect of First T-to-D Iteration





Before





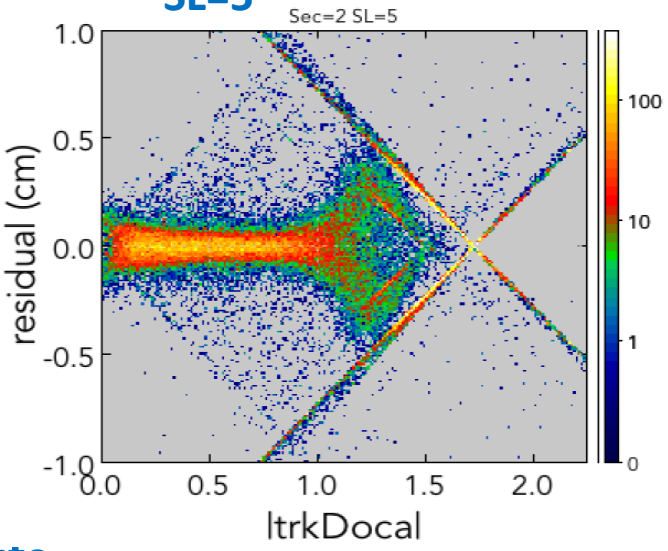
After

Residuals from TBHits bank.

Effect of First T-to-D Iteration

Residuals vs trkDocaTBHits bank.

SL=5



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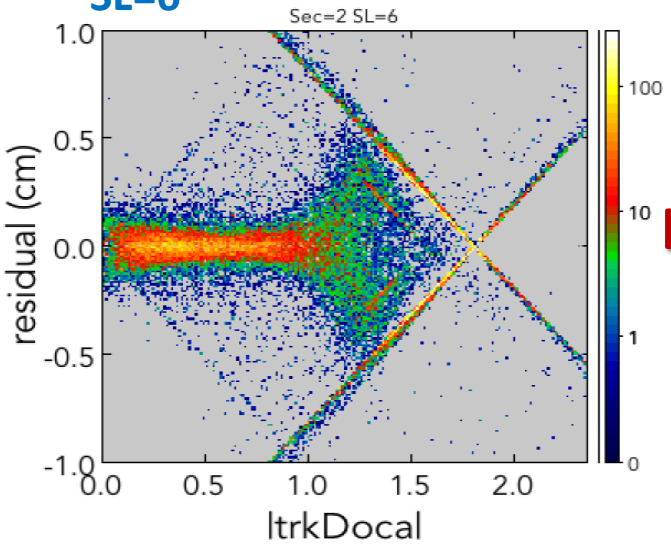

Before

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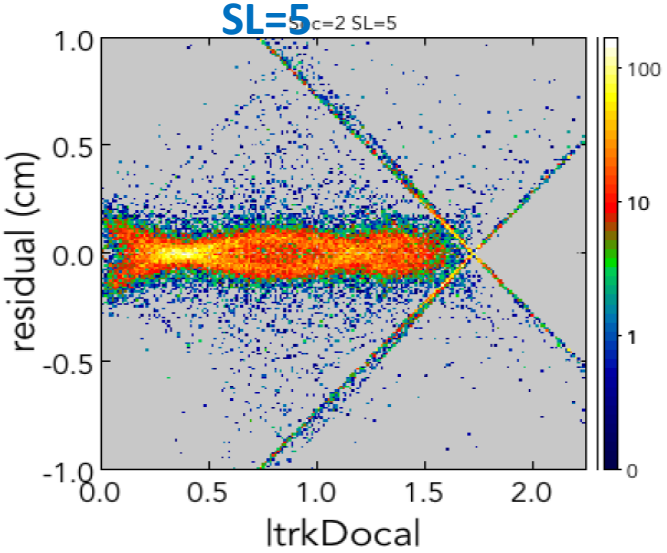

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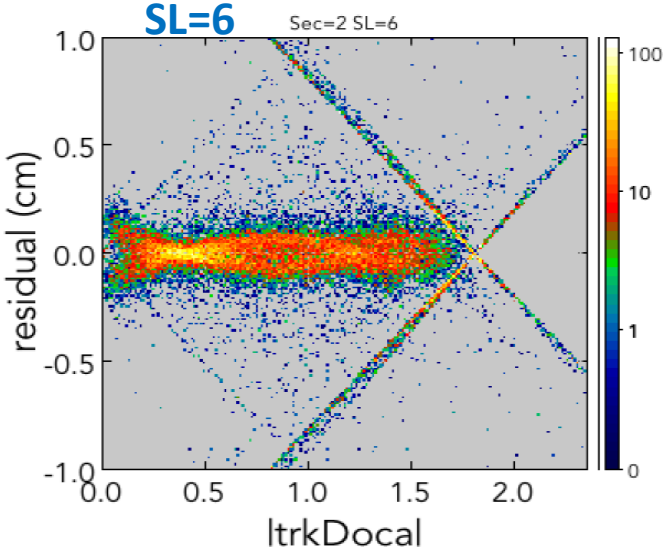
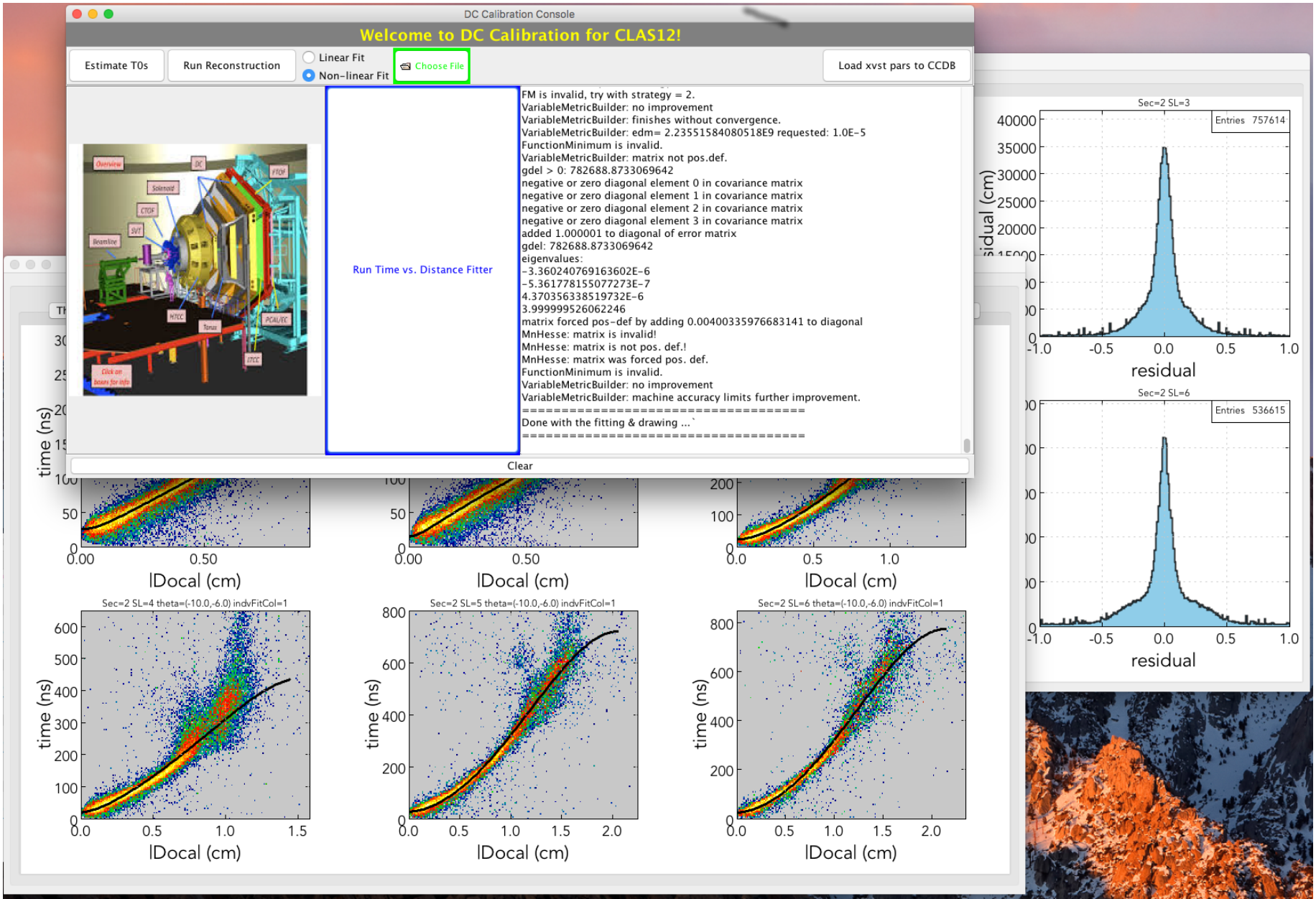


After

cm

GUI Driven Calibration Suite



Summary

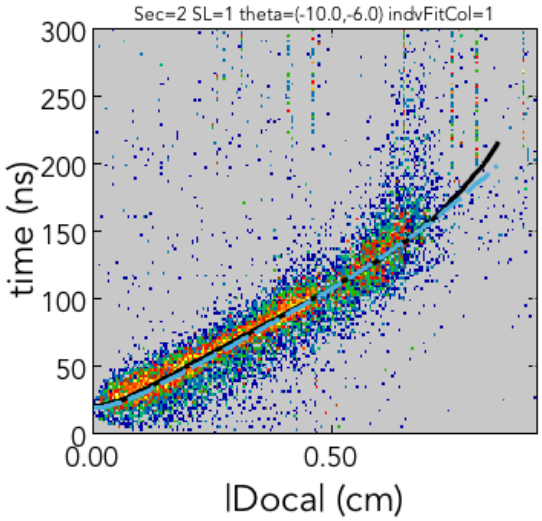
- Automated Determination of T0 corrections Completed.
- A first full pass of **reconstruct ->calibrate -> Write-to-CCDB -> reconstruct** accomplished.
  - Trying to understand why resolution got worse.
- GUI development is in progress.
  - Fields and buttons to control/constrain fit parameters.
  - First working version of the suite expected in about 2 weeks.

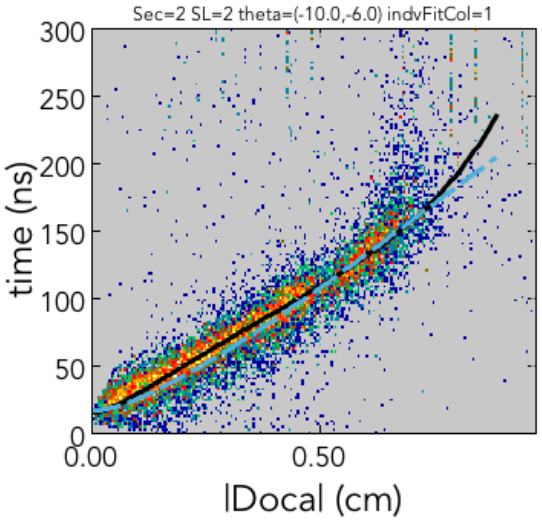
Special Thanks
to
Veronique Ziegler,
Michael Kunkel, Daniel Lersch, Olga Cortes

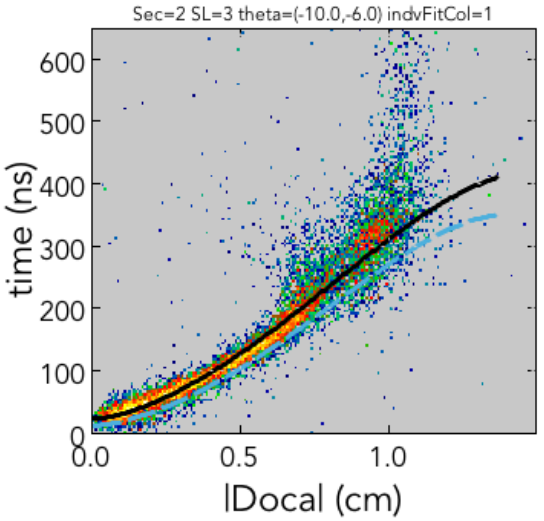
Back Up Slides

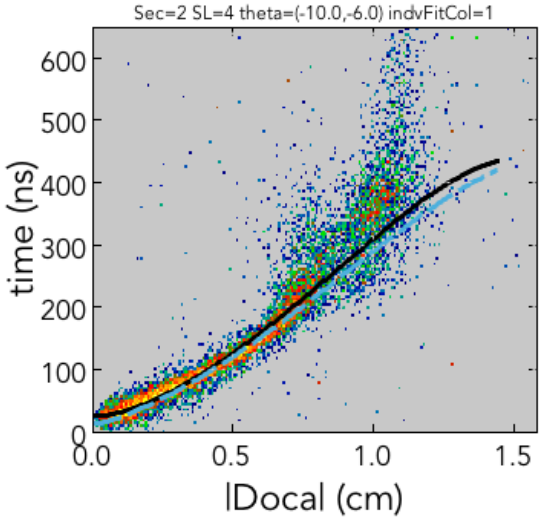
Time-to-distance Fits

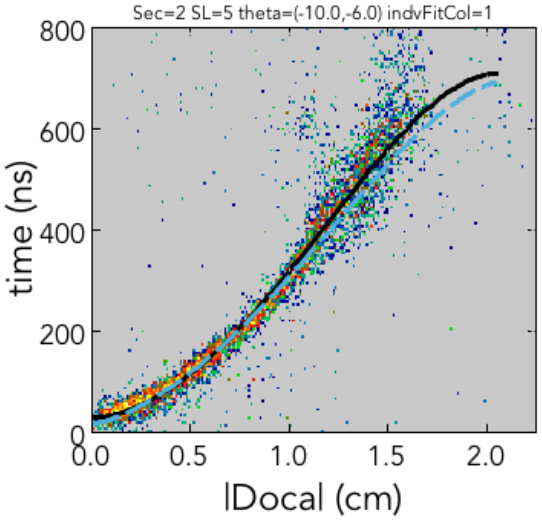
TB-Hits of Segments in one local angle bin α (-10.0,-6.0)

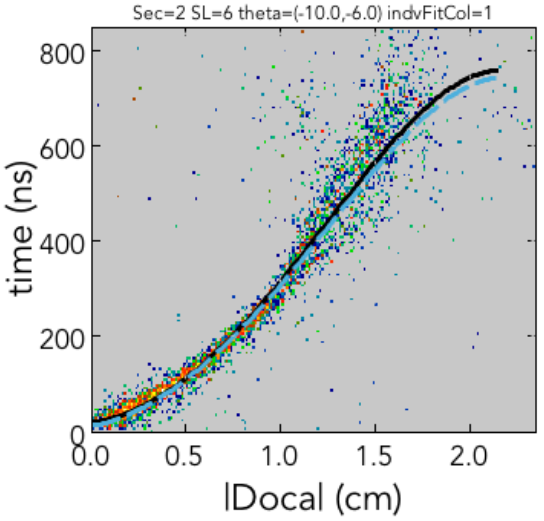






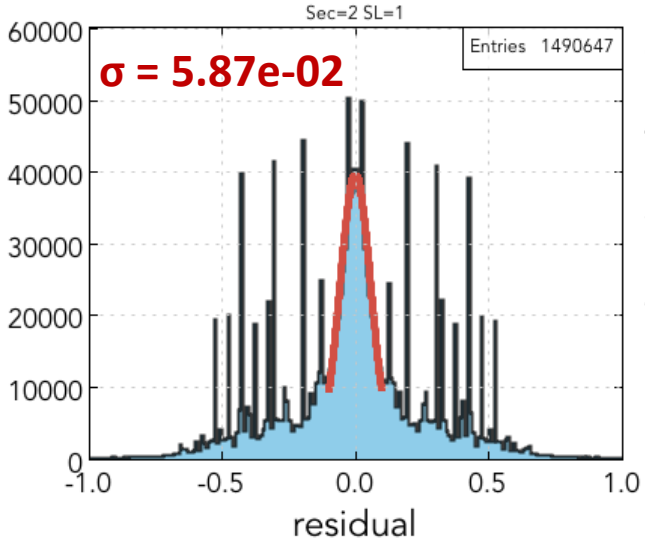


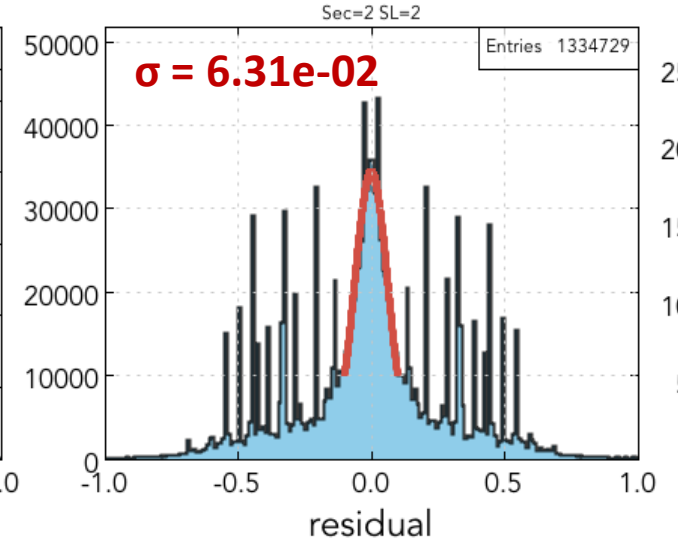


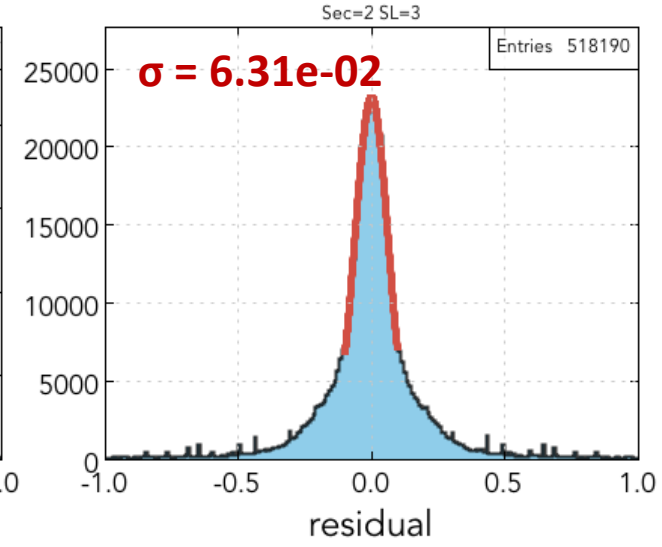


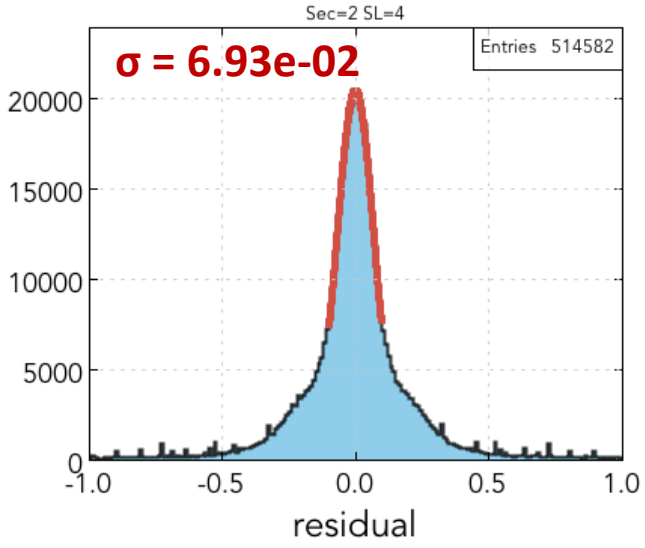
Effect of T0-correction

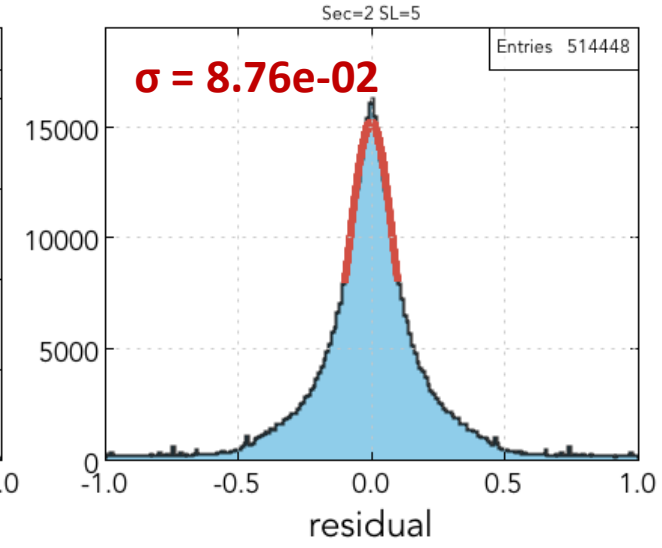
Residuals before T0 correction

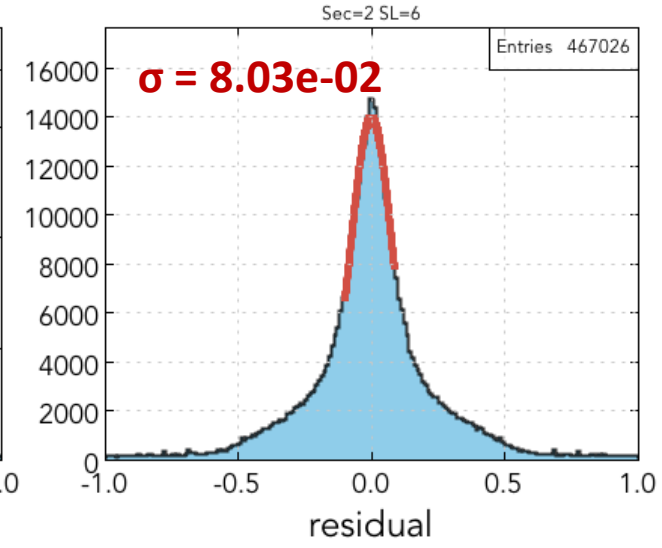






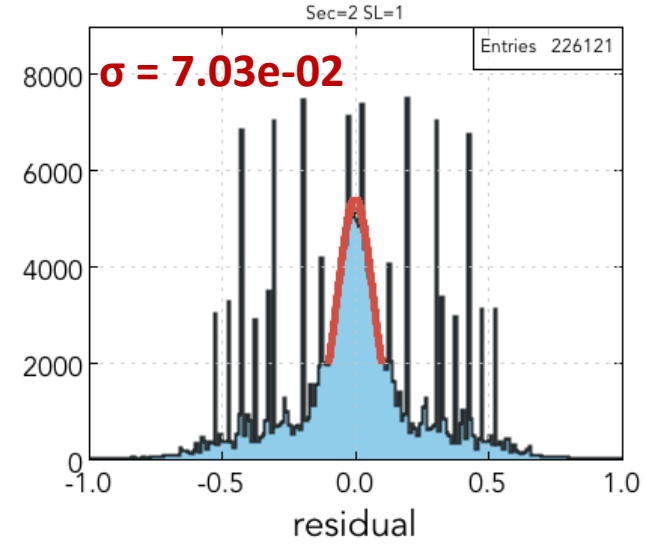


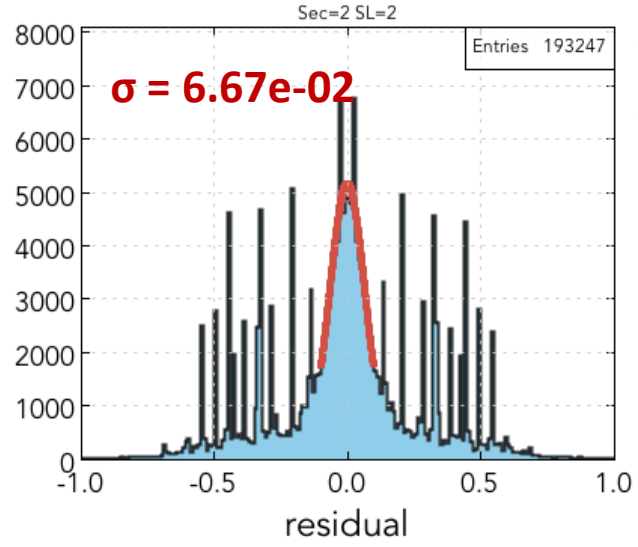


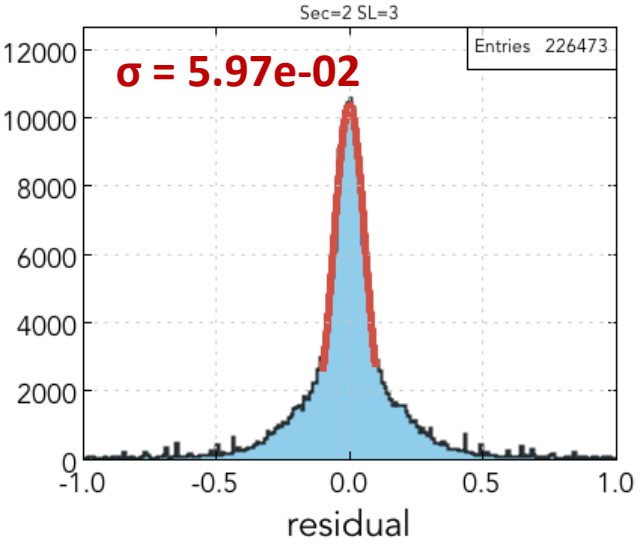


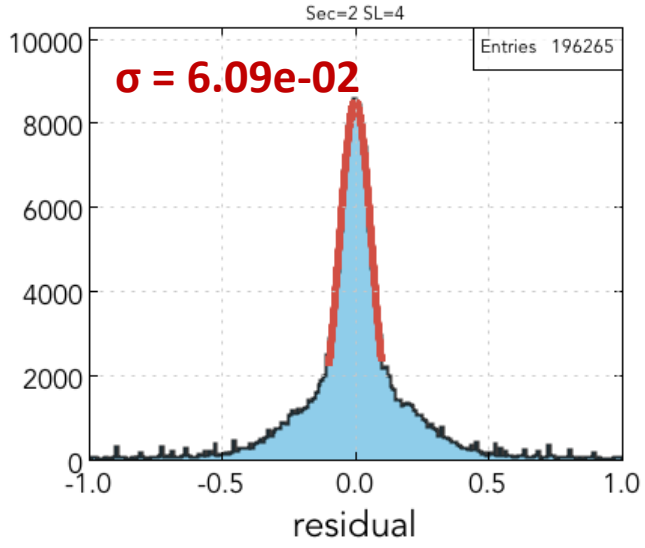
Effect of T0-correction

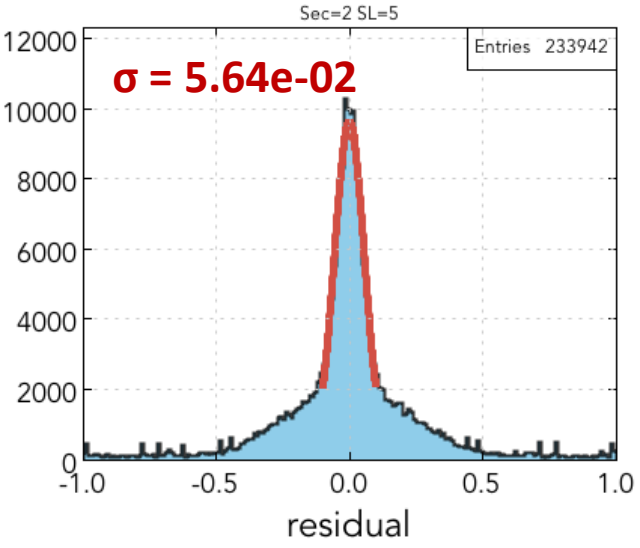
Residuals before first iteration

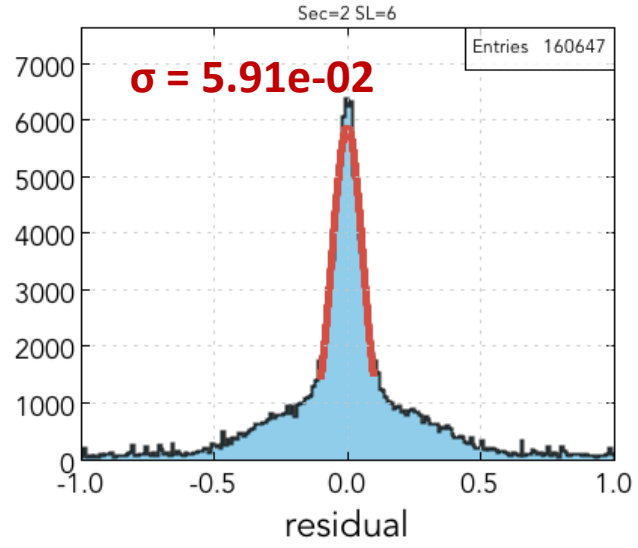






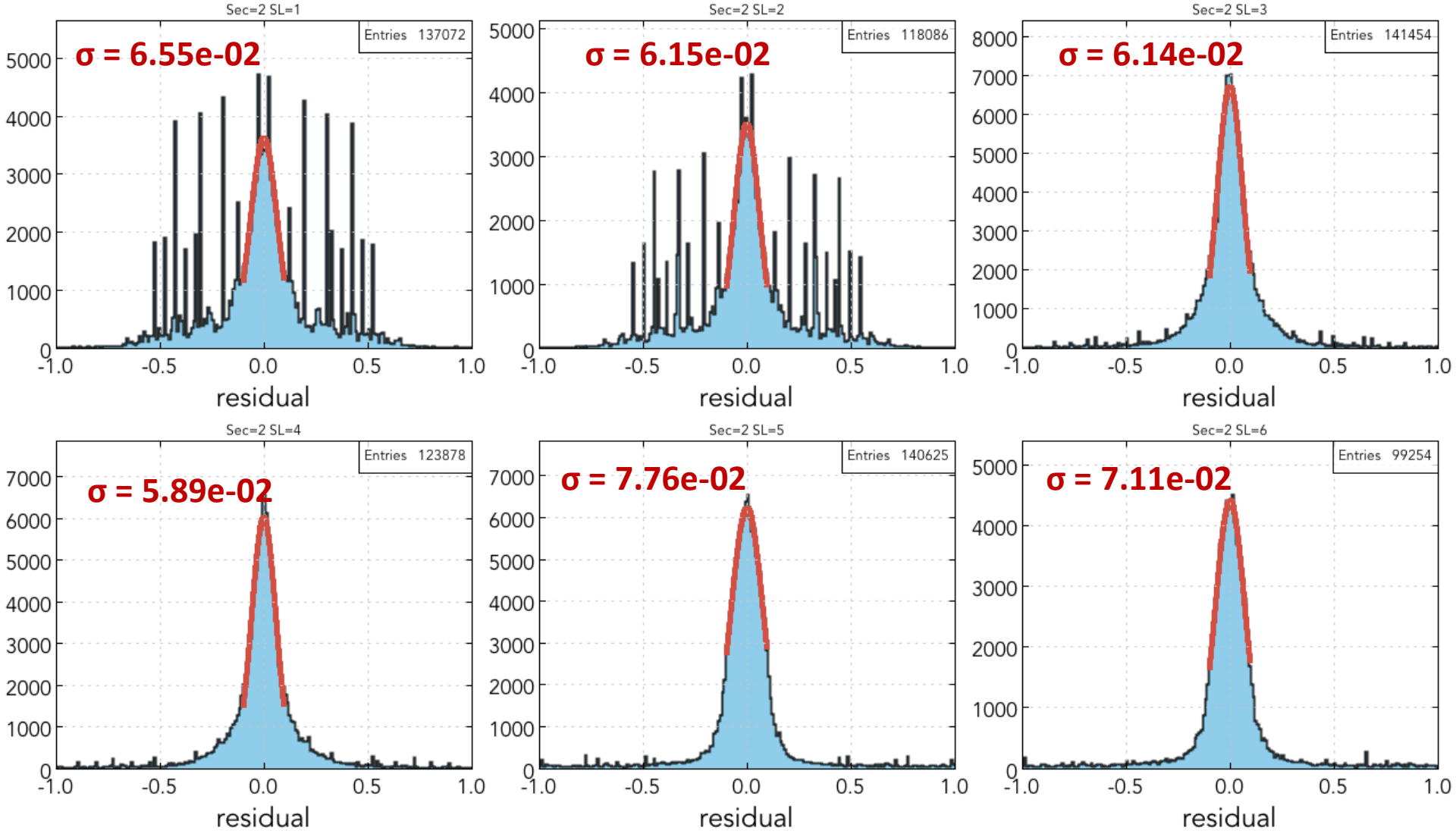






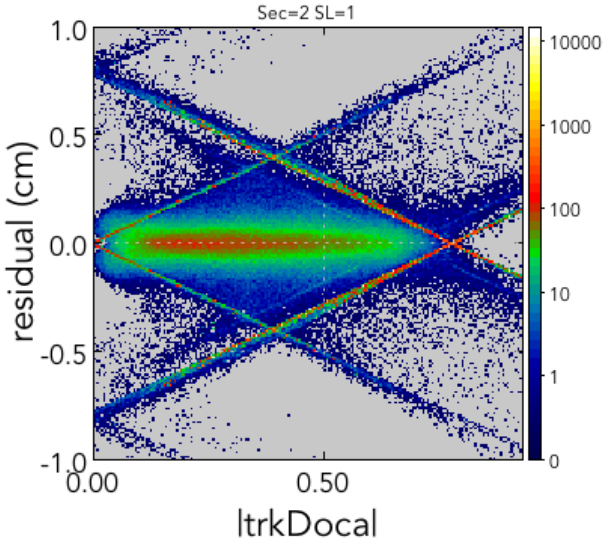
Effect of new D2T parameters

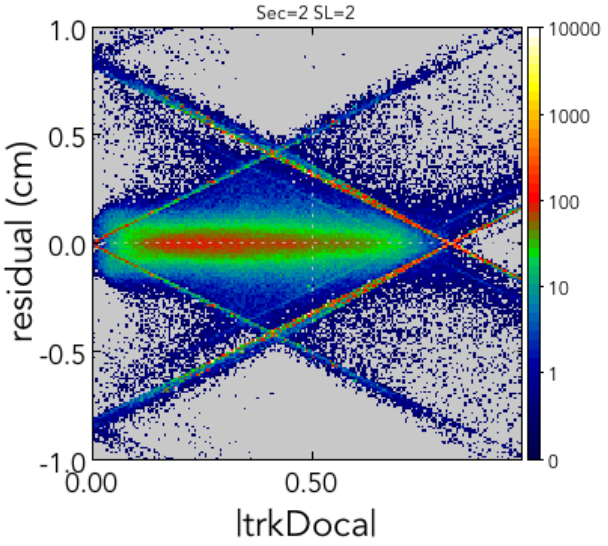
Residuals after after first iteration

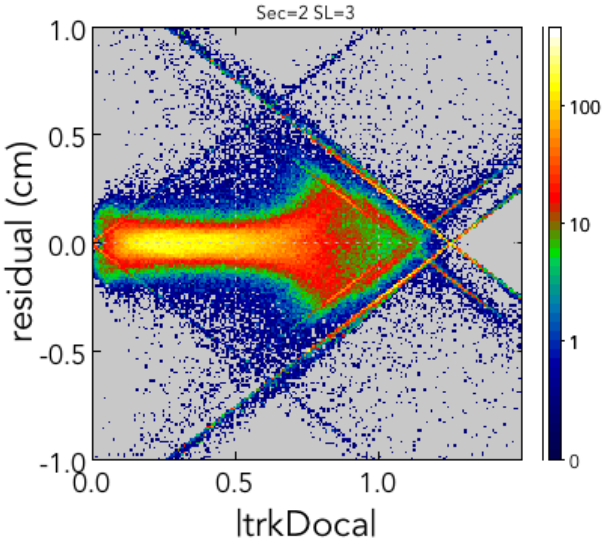


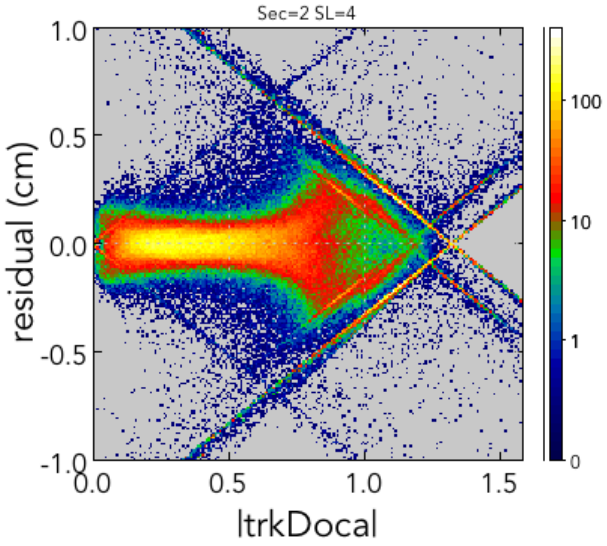
Effect of T0-correction

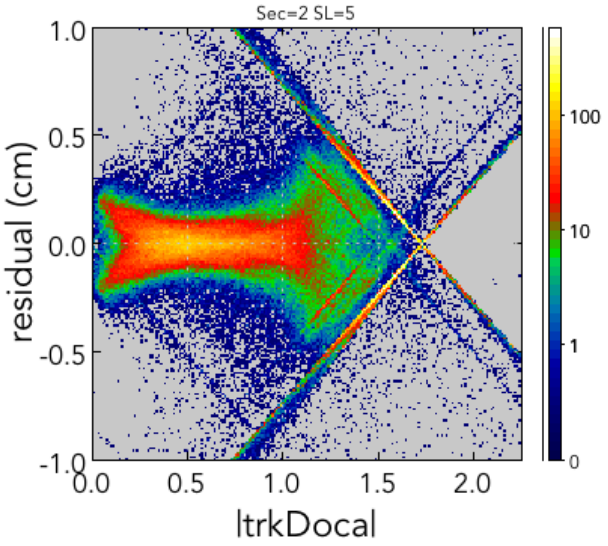
Residuals vs trkDoca before T0 correction

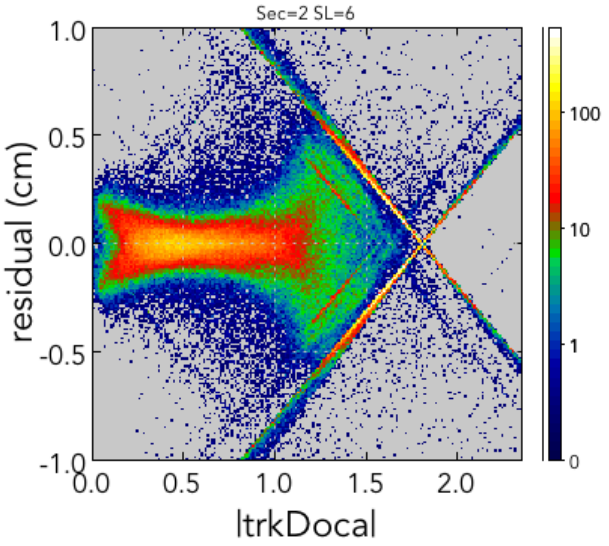






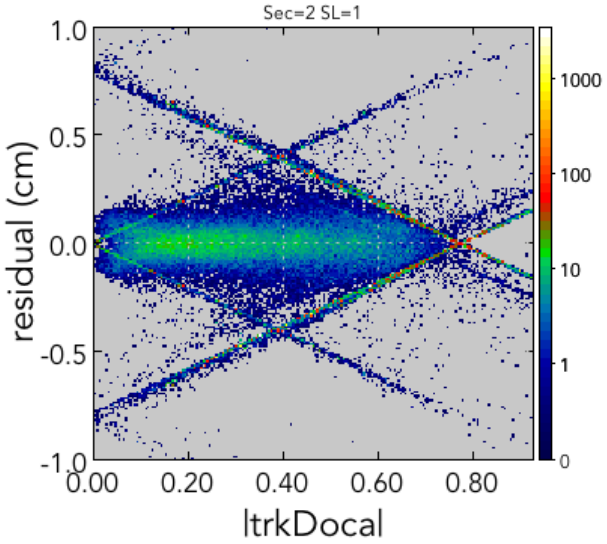


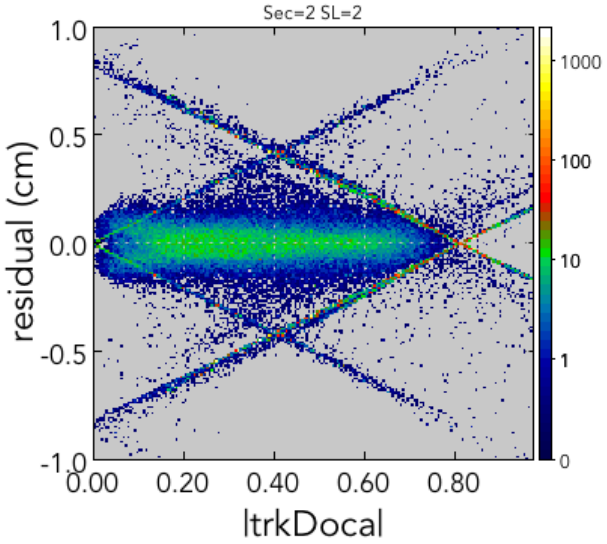


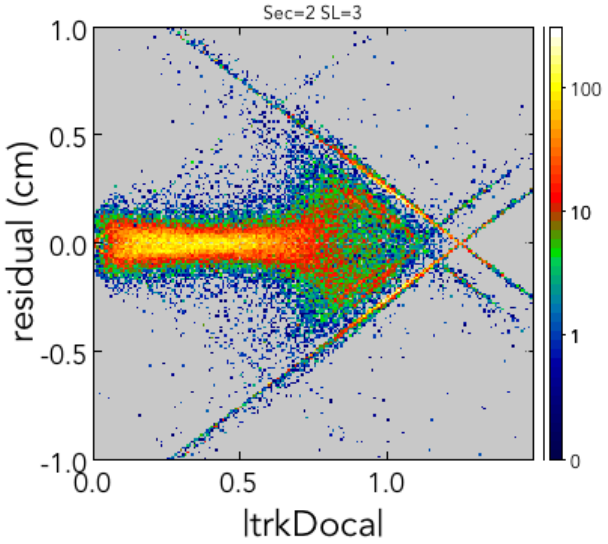


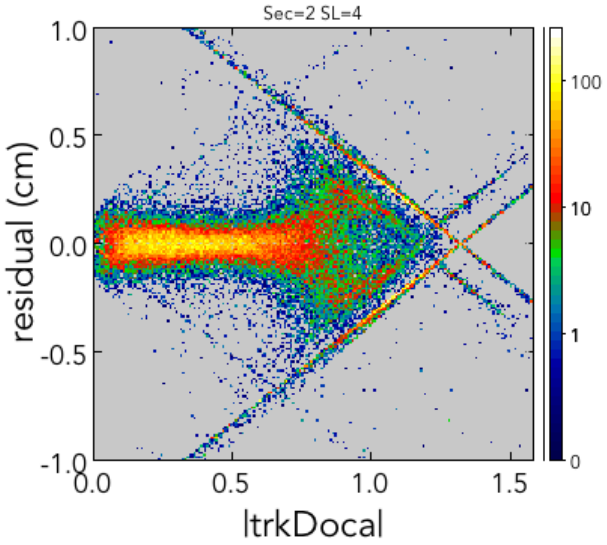
Effect of T0-correction only

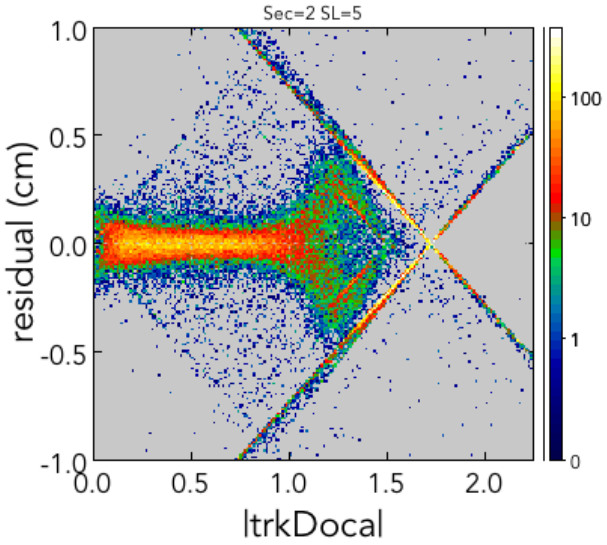
Residuals vs trkDoca before first iteration (after T0 correction)

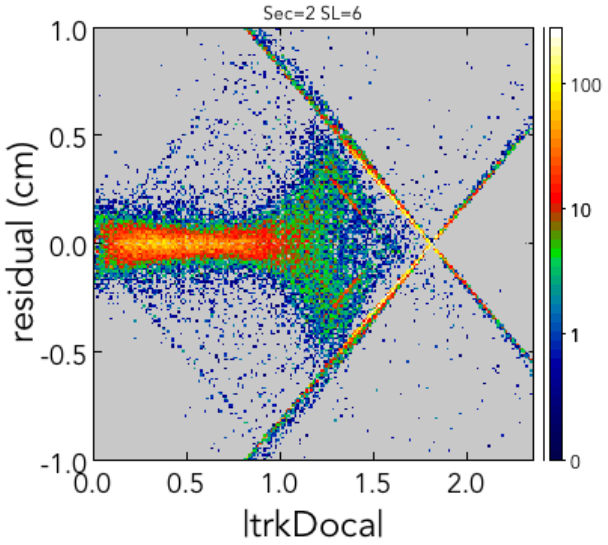






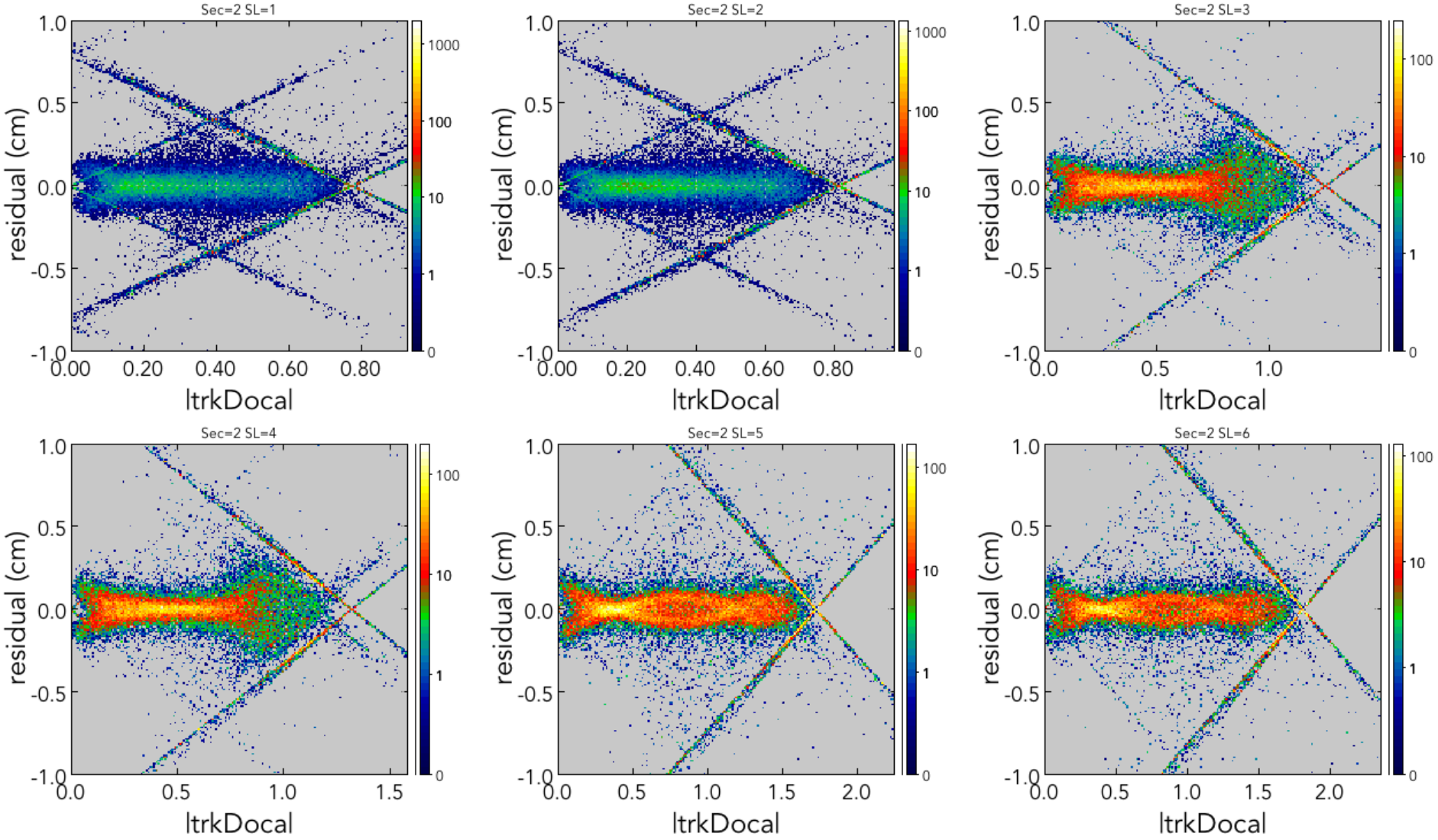






Effect of new D2T parameters

Residuals vs trkDoca after first iteration



Effect of T0-correction

Times from TBHits Bank