DC Status for First Run

Krishna P. Adhikari
Mississippi State University

CLAS12 Workshop
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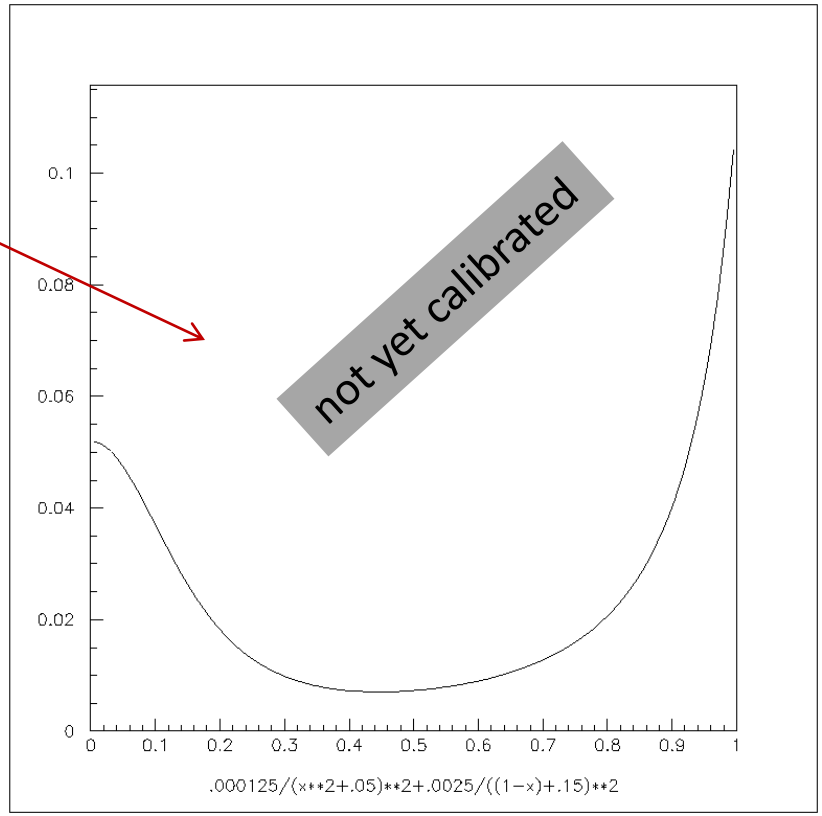
Many thanks to Mac Mestayer, Olga Cortes, Johann Goetz, Brook Byrd

Outline

- Installation, Commissioning – not covered
- Data structures: banks, etc. – not covered
- Simulating inefficiencies
  - intrinsic → GEMC digitization
  - malfunction-related → status tables
- Calibrations: raw time → time → distance
- Monitoring and track validation

Simulation of Efficiency & Resolution

- Three sources of inefficiency:
  - Intrinsic (applies to all wires),
  - Equipment malfunction-related (applies to specifc wires),
  - Background-related
- Worked with Maurizio to improve the digitization in GEMC
  - parameters added to CCDB
  - intrinsic inefficiency (distance dependent) is added in GEMC

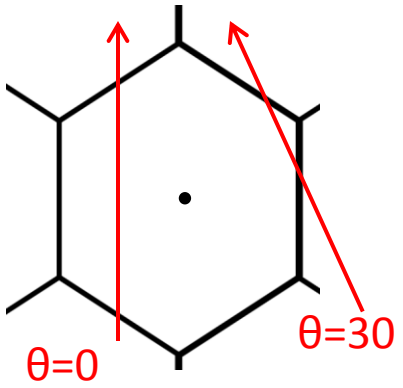


The intrinsic inefficiency function:

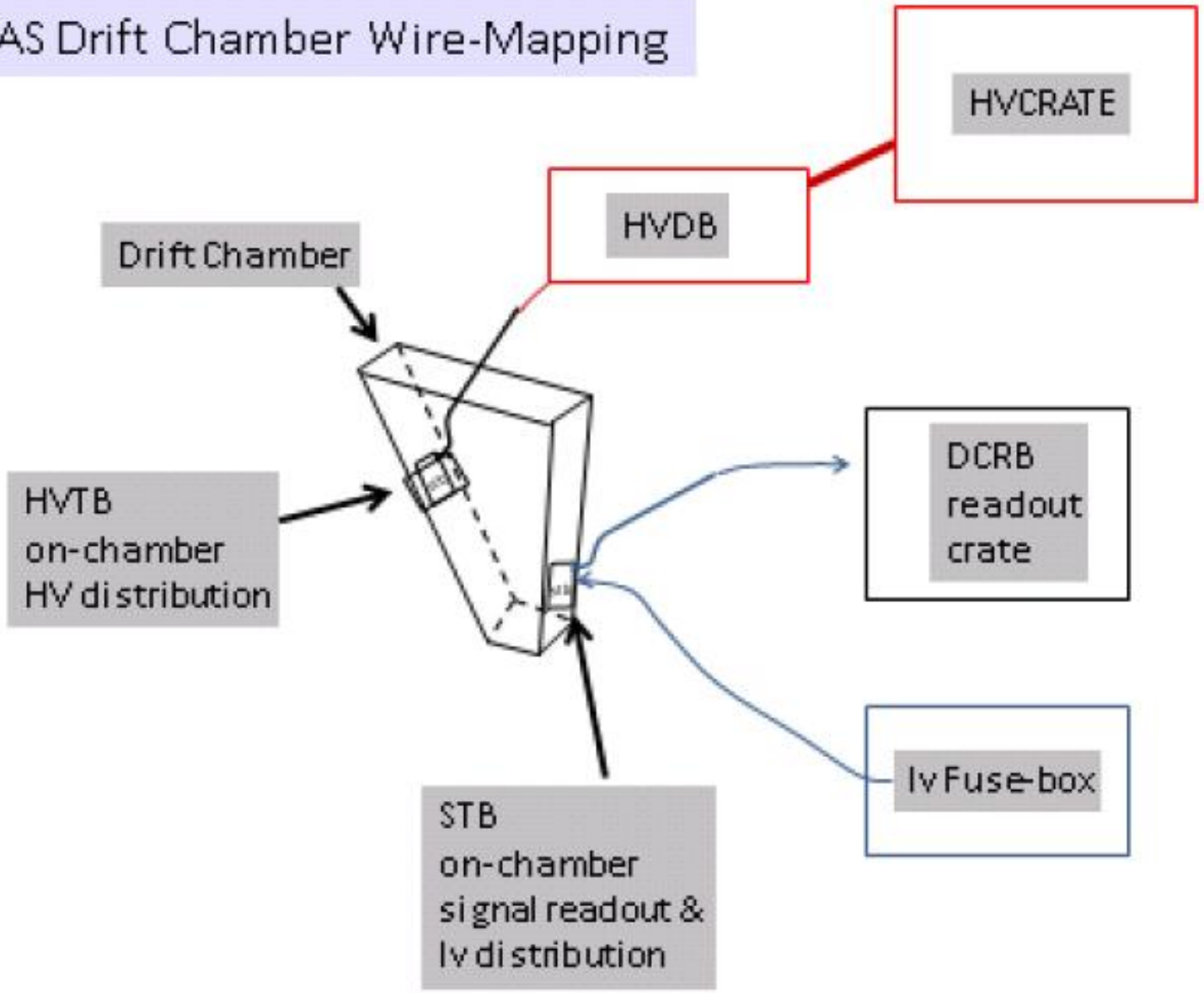
$$f(X) = \frac{P_1}{(X^2 + P_2)^2} + \frac{P_3}{((1 - X) + P_4)^2}$$

where X = doca/docaMax & docaMax = 2 d_{layer}

- Hit times generated by GEMC digitization routine will be smeared by a random number with position-dependent magnitudes as given by above intrinsic inefficiency function.
- Same inefficiency function and parameters are used by the track reconstruction software to form error matrix in the Kalman-filter.



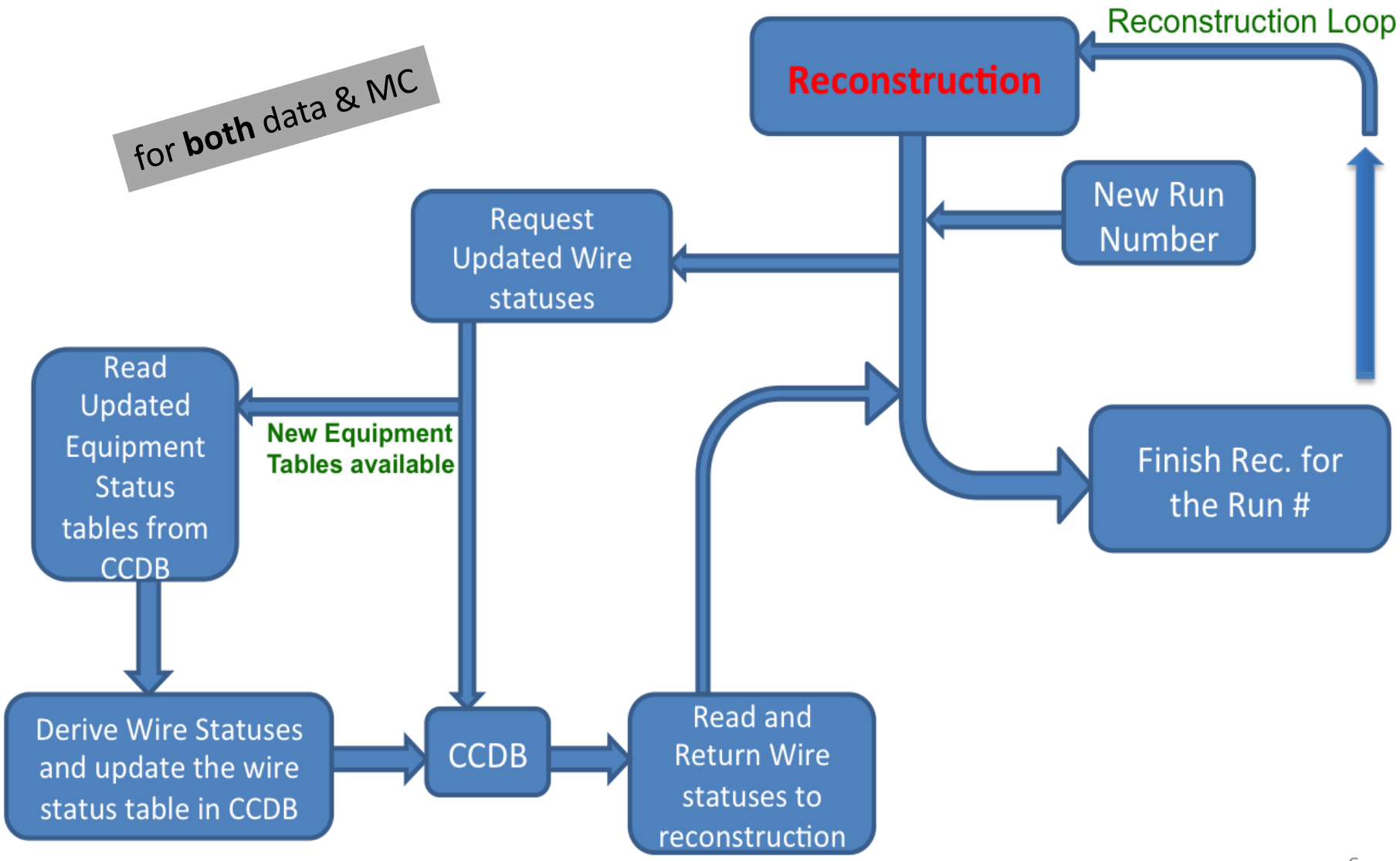
CLAS Drift Chamber Wire-Mapping



Malfunction-related inefficiency: Status Database

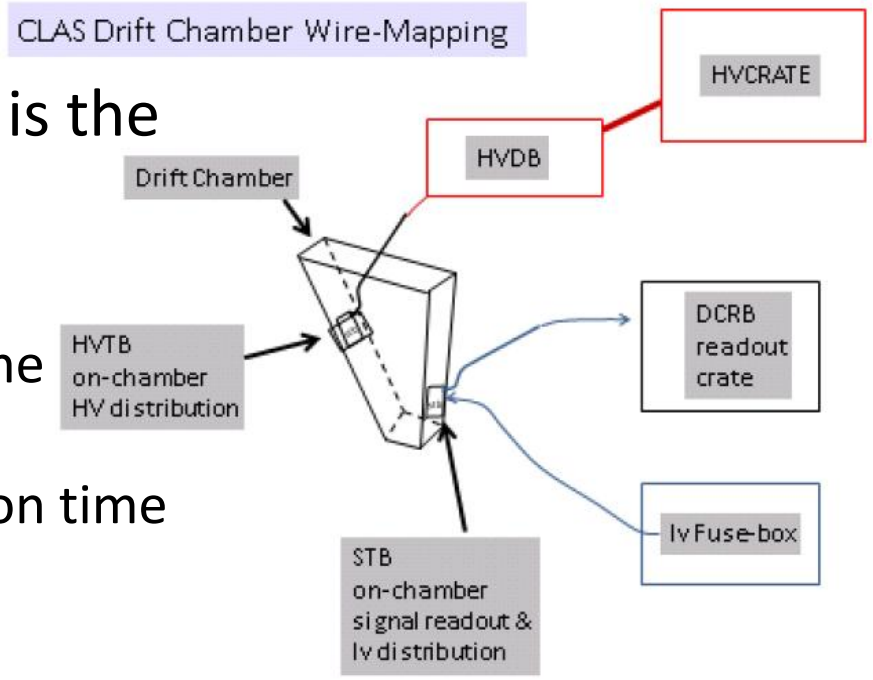
- **Equipment Status Tables**
  - **Fuse status** (Sec, SL, Row, Col,Polarity) – Good/Bad; notes
  - **Signal Connection status** (Sec, SL, STB, Connector, DCRB slot, DCRB connector) – Good/Bad; notes
  - **HV-supply status** (Crate,Slot,Channel) – Good/Bad; notes
  - **HV-distribution status** (Sec, SL, Box, Quad, Doublet, Polarity, Pin) – Good/Bad; notes
  - **Individual dead wires** (Sec, Layer, Wire) – Good/Bad; notes
  - **Individual hot wires** (Sec, Layer, Wire) – Good/Bad; notes
- **Derived Channel/Wire Status Tables**
- **Work underway to create the tables**

Conditions/Status Database



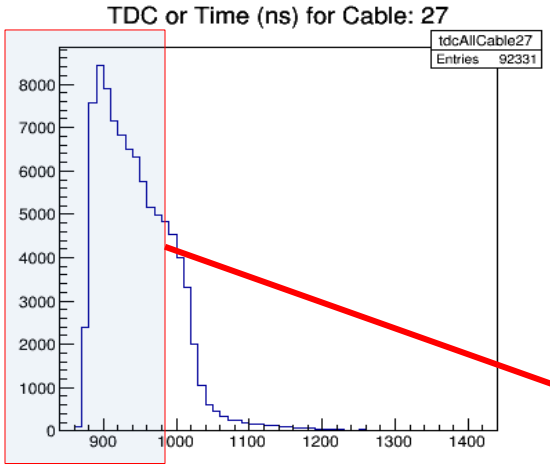
DC_calibration: Signal Cable Delay (T0)

- The measured drift time must be corrected for various delays before it can be used to get drift distance used in tracking.
- One of the major corrections is the signal cable delay (T0).
- Other time corrections are:
  - Correction for particle flight time (beta),
  - Correction for signal propagation time along sense wire,
  - Correction for time-walk,
  - Correction for beta-dependent smearing effect.



DC_calibration: Fitting Time Distributions for T0

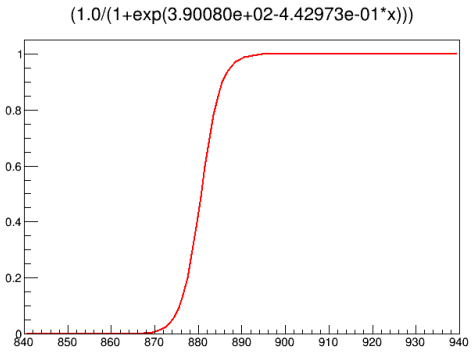
Fit leading edge of time distribution to get the slope in order to obtain **T0** (the start time)

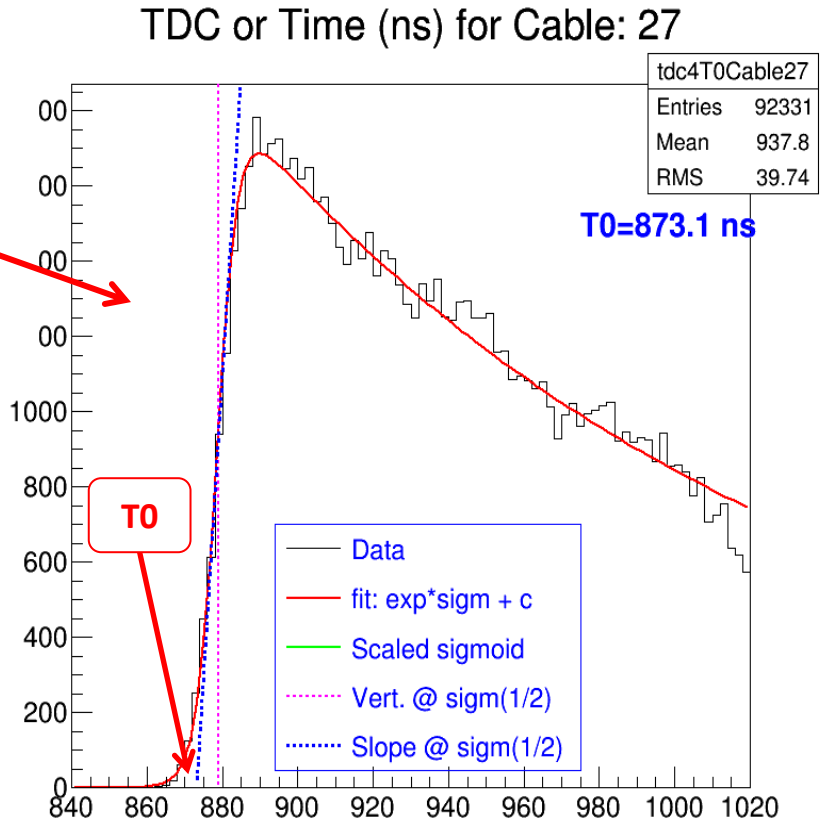


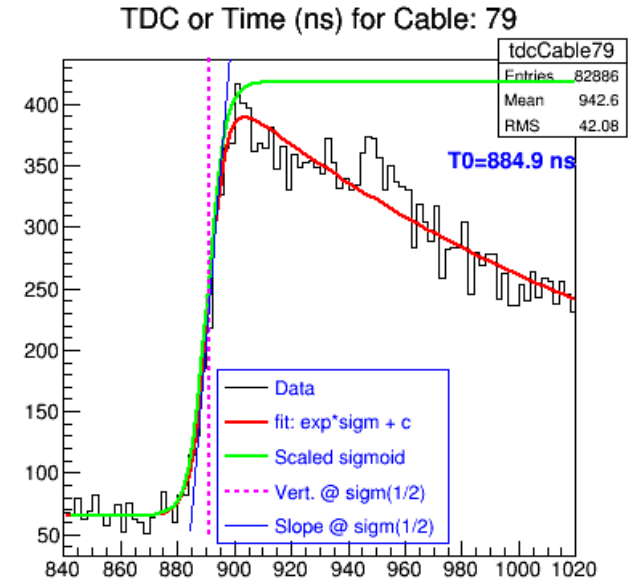
Fit function for T0:

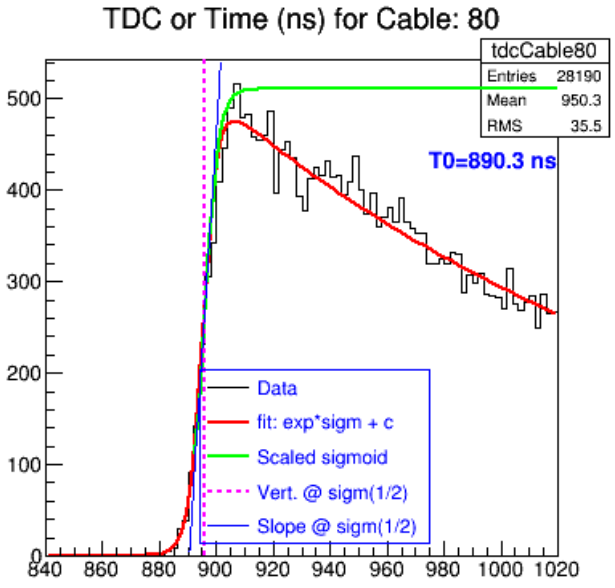
$$f(t) = sigmoid \times exponential + constant$$

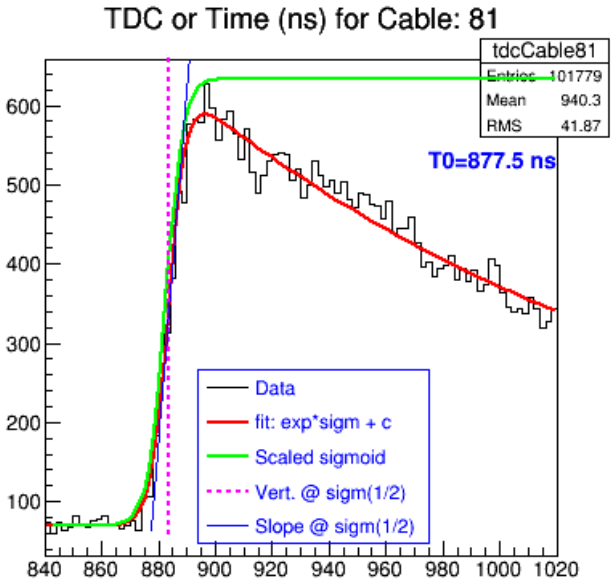
$$f(t) = \frac{1}{1 + e^{A-Bt}} \times e^{C-Dt} + E$$

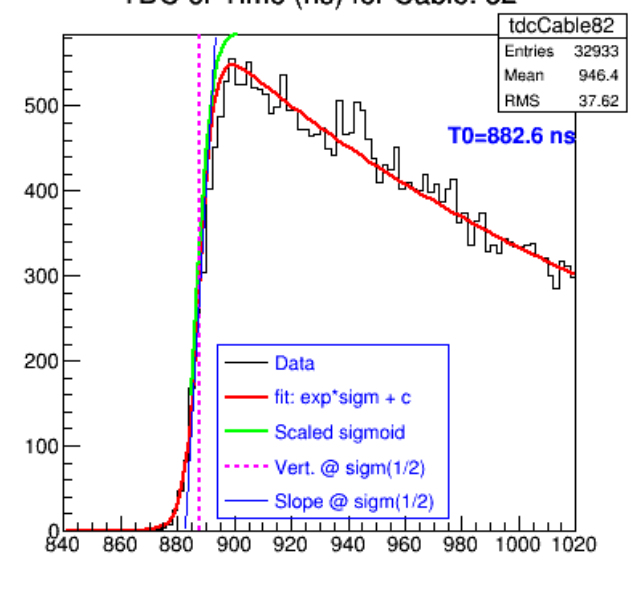


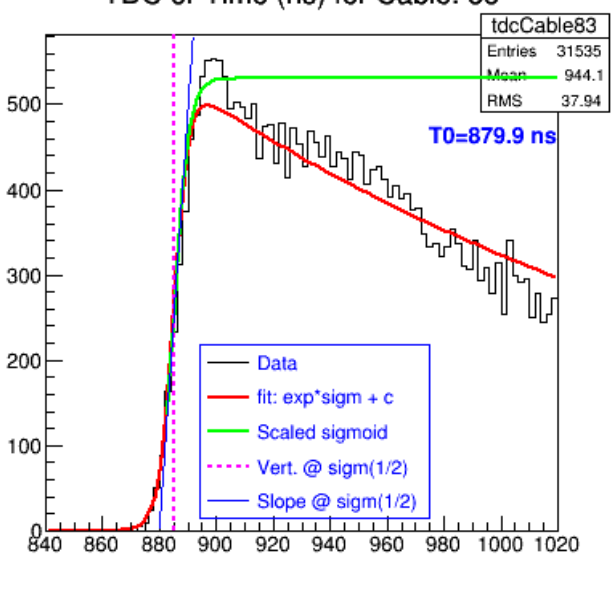


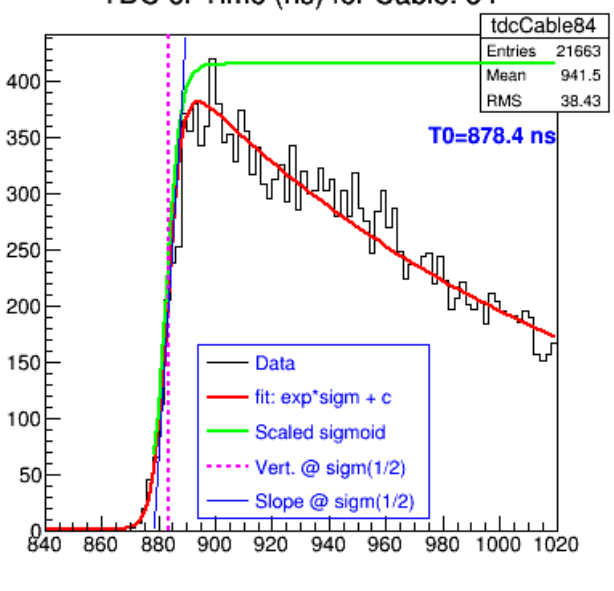

TDC or Time (ns) for Cable: 79
tdcCable79
Entries 82886
Mean 942.6
RMS 42.08
T0=884.9 ns
Data
fit: exp*sigm + c
Scaled sigmoid
Vert. @ sigm(1/2)
Slope @ sigm(1/2)


TDC or Time (ns) for Cable: 80
tdcCable80
Entries 28190
Mean 950.3
RMS 35.5
T0=890.3 ns
Data
fit: exp*sigm + c
Scaled sigmoid
Vert. @ sigm(1/2)
Slope @ sigm(1/2)

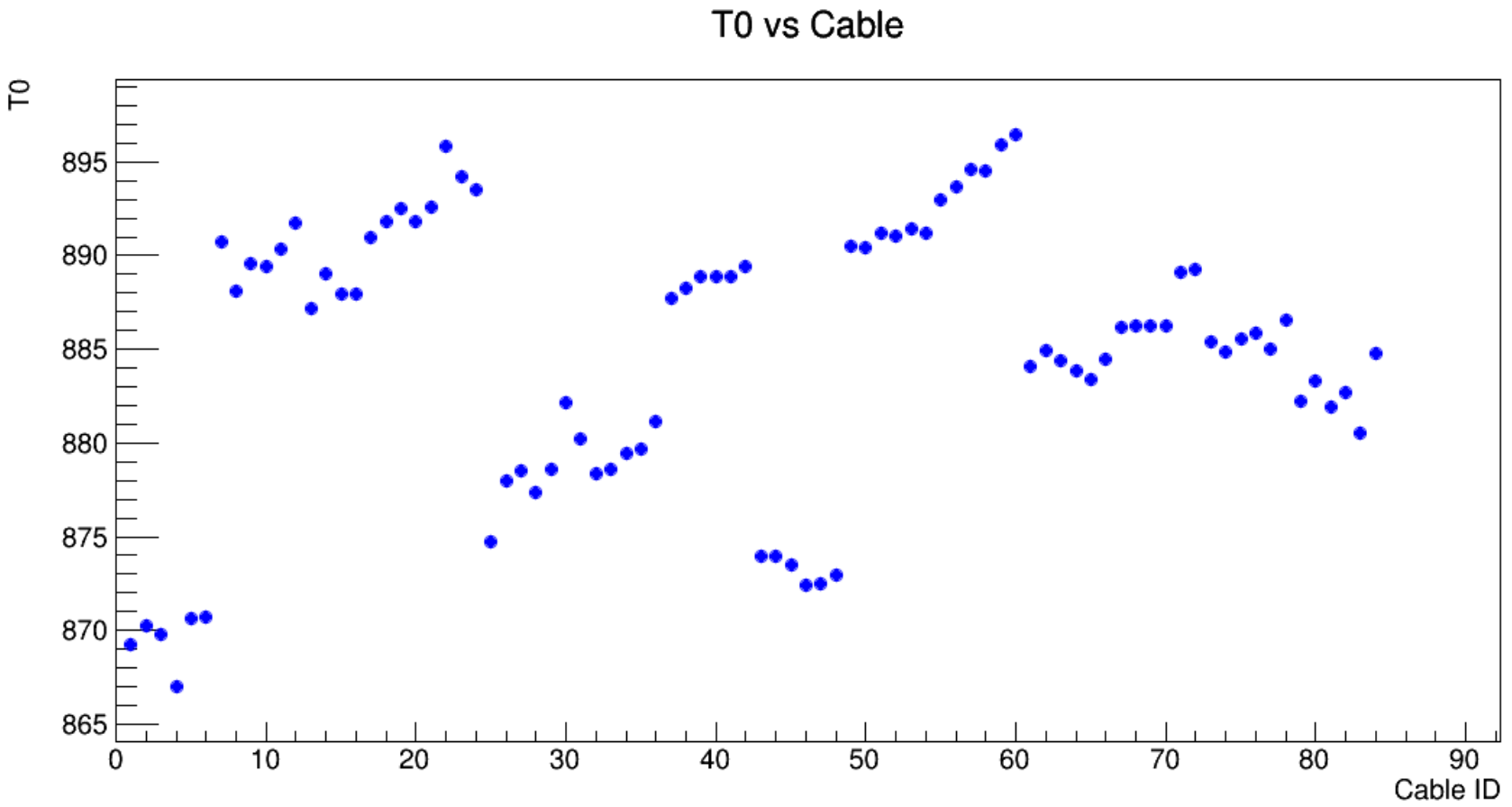

TDC or Time (ns) for Cable: 81
tdcCable81
Entries 101779
Mean 940.3
RMS 41.87
T0=877.5 ns
Data
fit: exp*sigm + c
Scaled sigmoid
Vert. @ sigm(1/2)
Slope @ sigm(1/2)


TDC or Time (ns) for Cable: 82
tdcCable82
Entries 32933
Mean 946.4
RMS 37.62
T0=882.6 ns
Data
fit: exp*sigm + c
Scaled sigmoid
Vert. @ sigm(1/2)
Slope @ sigm(1/2)

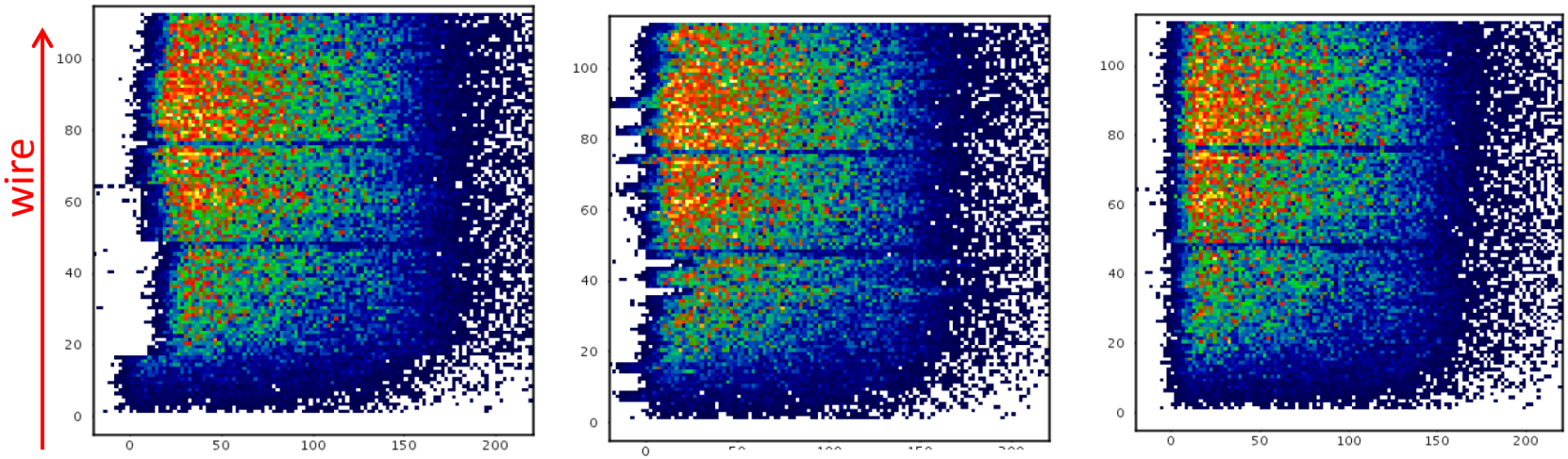

TDC or Time (ns) for Cable: 83
tdcCable83
Entries 31535
Mean 944.1
RMS 37.94
T0=879.9 ns
Data
fit: exp*sigm + c
Scaled sigmoid
Vert. @ sigm(1/2)
Slope @ sigm(1/2)

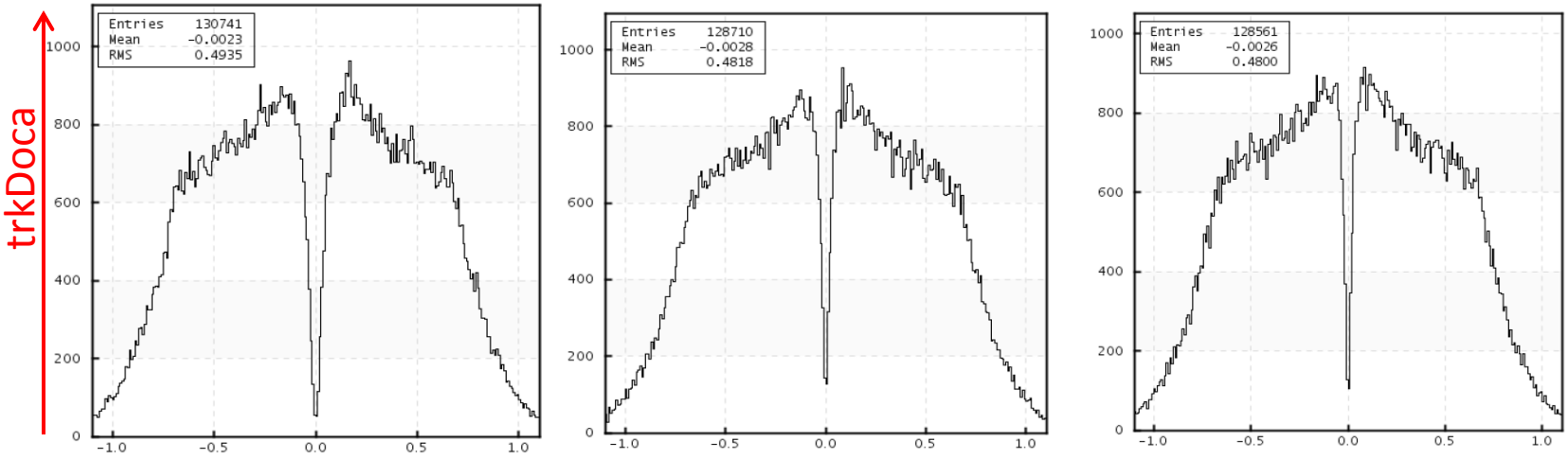

TDC or Time (ns) for Cable: 84
tdcCable84
Entries 21663
Mean 941.5
RMS 38.43
T0=878.4 ns
Data
fit: exp*sigm + c
Scaled sigmoid
Vert. @ sigm(1/2)
Slope @ sigm(1/2)

T0 vs Cable


T0 vs Cable
T0
895
890
885
880
875
870
865
0
10
20
30
40
50
60
70
80
90
Cable ID

Effect of T0 Corrections





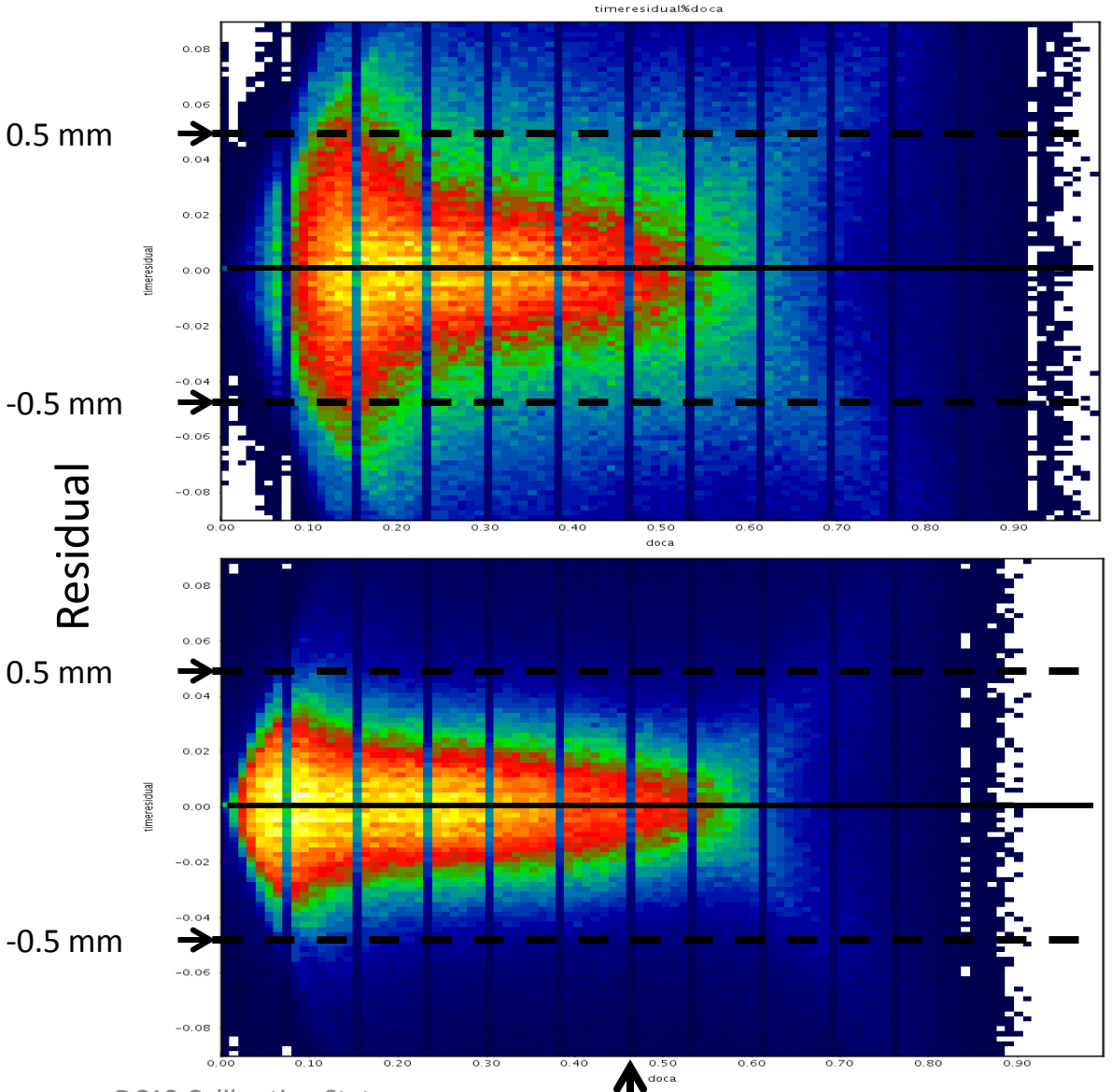
Same T0=850 ns for all cables

Handpicked T0 for different cables

Automated T0 for different cables

Effect of T0 Corrections

Time-residual vs doca from un-calibrated & calibrated data using same T → X curve as GEMC !

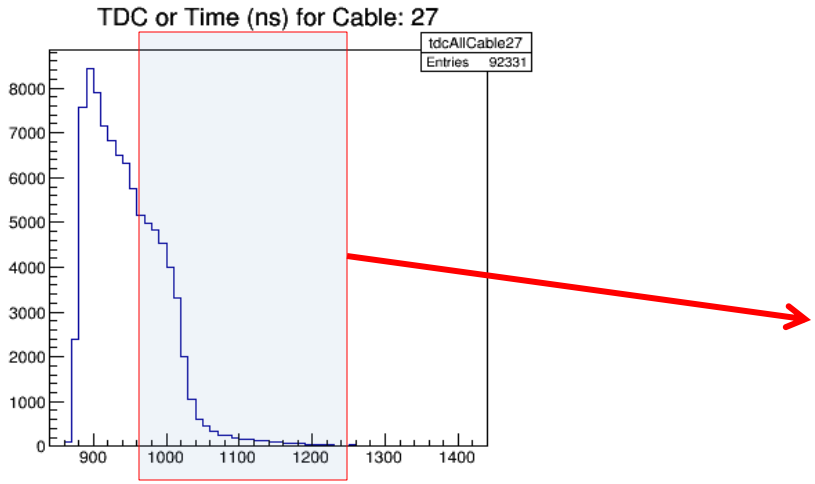


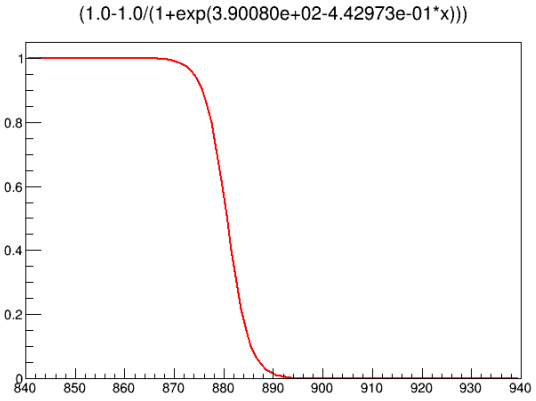
Tmax estimation

- Knowledge of Tmax required in the time-to-distance parameterization.
- Useful also in monitoring the detector condition and performance. For example, if the gas density changes, (Tmax-T0) will change.

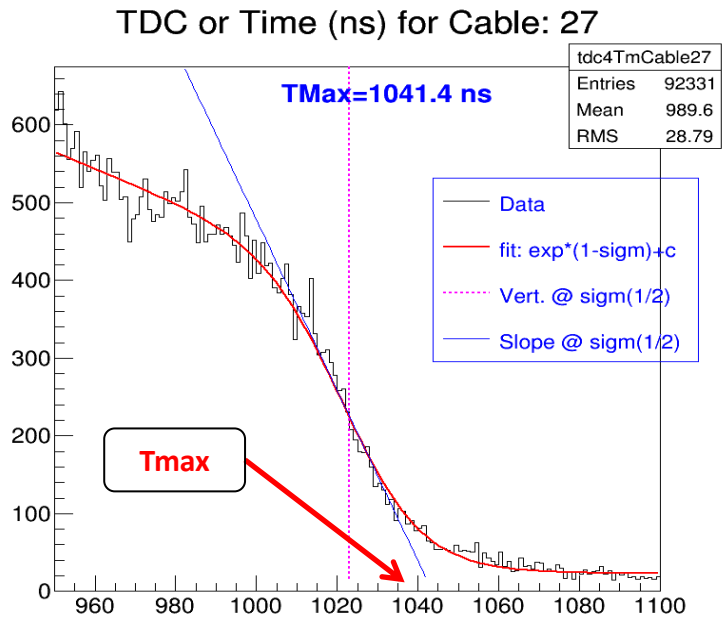
DC_calibration: Fitting Time Distributions for Tmax

Fit trailing edges of time distribution to get the slope in order to obtain **Tmax** (the maximum drift time)





Estimating Tmax

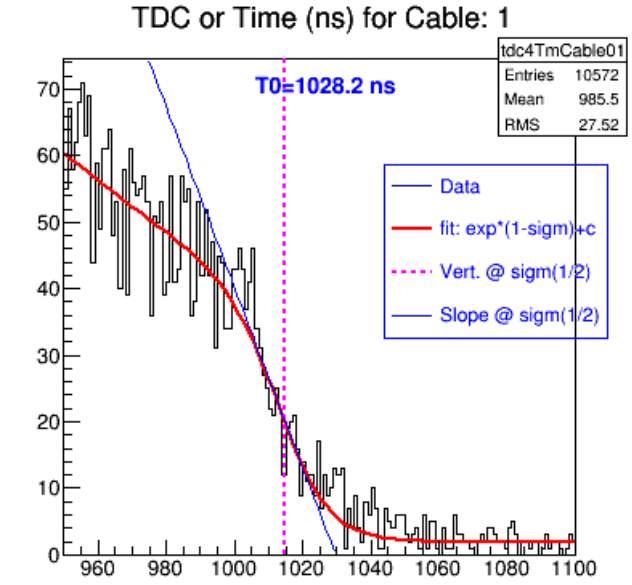


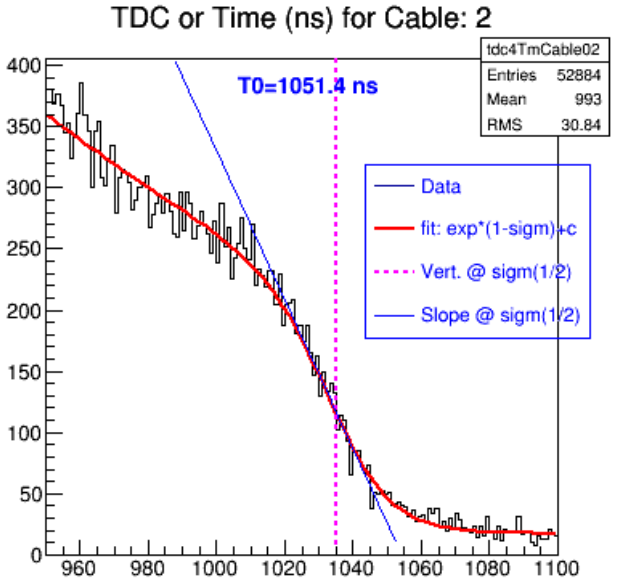
Knowledge of TMax can be useful in DC condition & performance. For example, if the gas density changes, TMax will change.

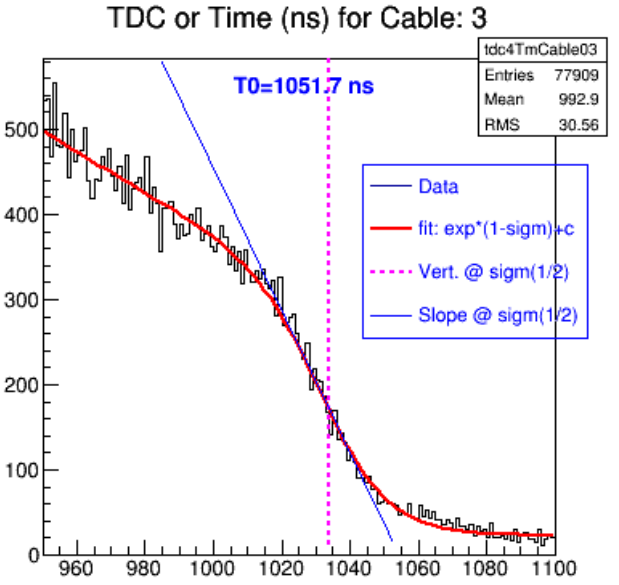
Fit function for Tmax:

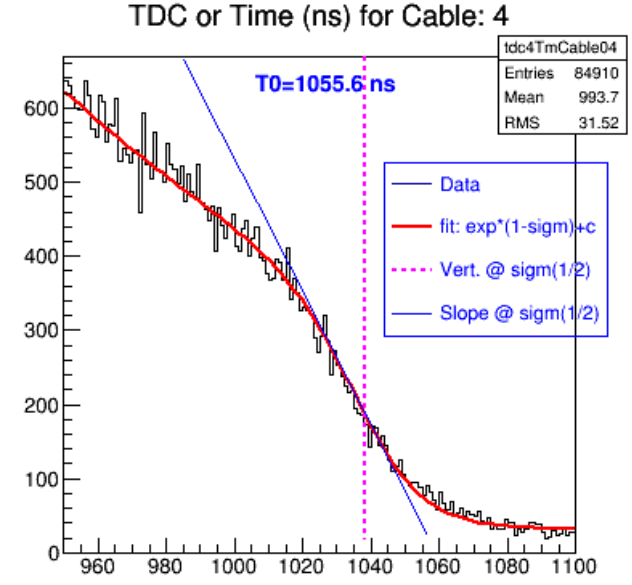
$$f(t) = (1 - sigmoid) \times exponential + constant$$

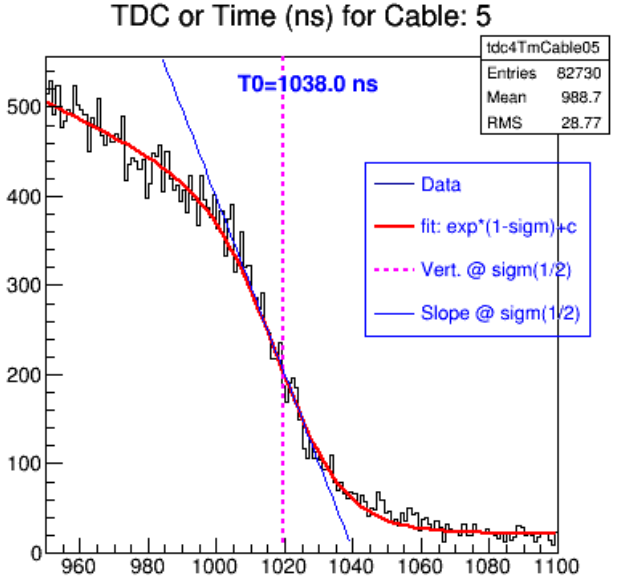
$$f(t) = (1 - \frac{1}{1 + e^{A-Bt}}) \times e^{C-Dt} + E$$

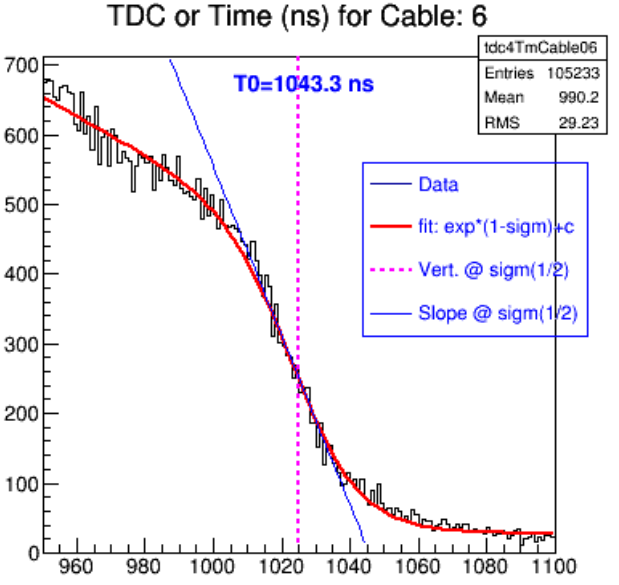

TDC or Time (ns) for Cable: 1
tdc4TmCable01
Entries 10572
Mean 985.5
RMS 27.52
T0=1028.2 ns
Data
fit: exp*(1-sigm)+c
Vert. @ sigm(1/2)
Slope @ sigm(1/2)

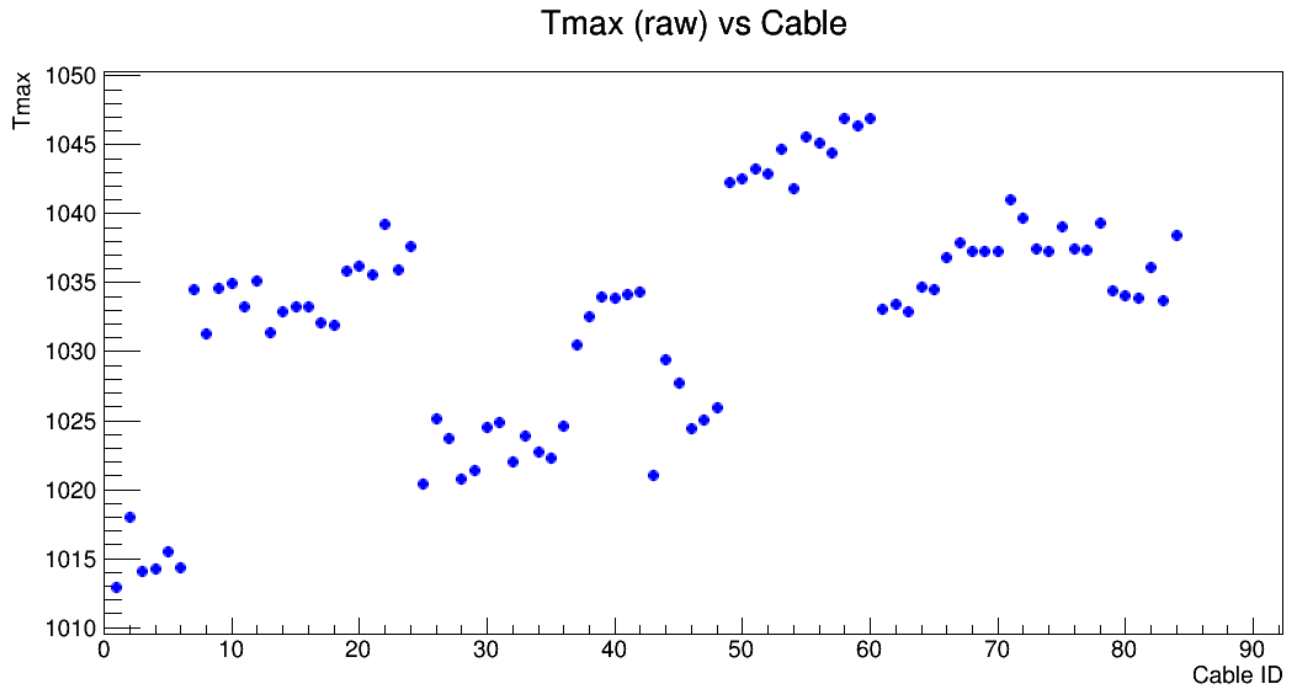

TDC or Time (ns) for Cable: 2
tdc4TmCable02
Entries 52884
Mean 993
RMS 30.84
T0=1051.4 ns
Data
fit: exp*(1-sigm)+c
Vert. @ sigm(1/2)
Slope @ sigm(1/2)

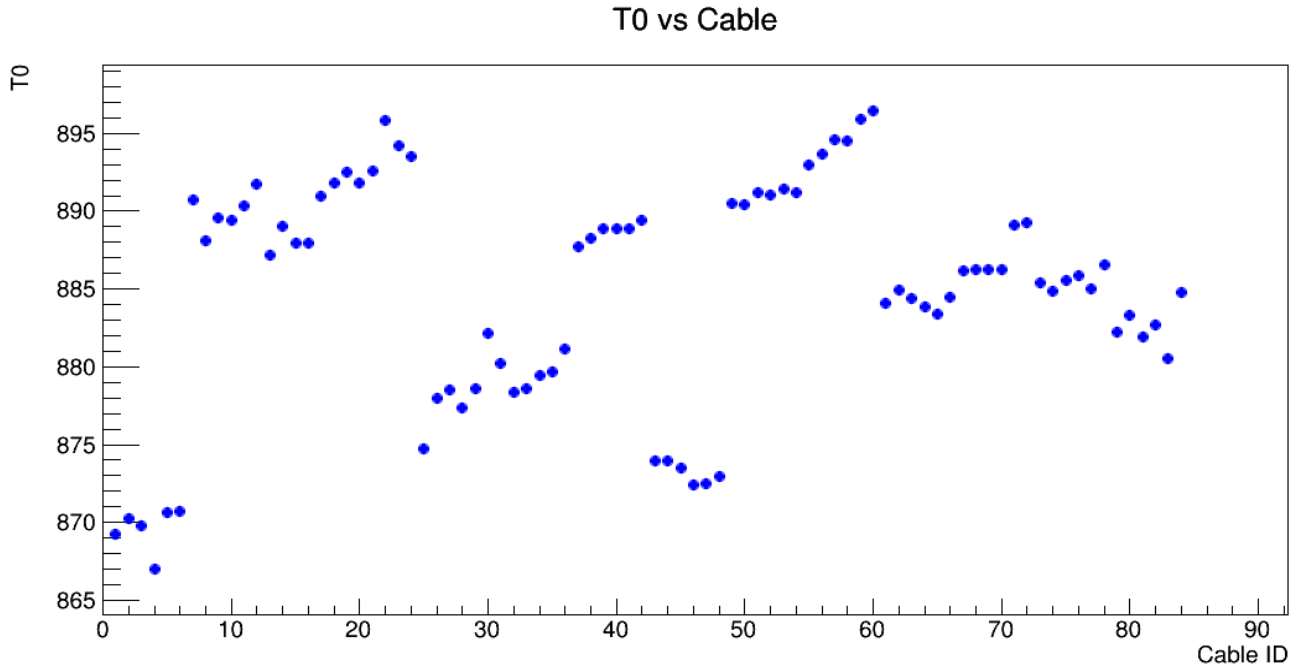

TDC or Time (ns) for Cable: 3
tdc4TmCable03
Entries 77909
Mean 992.9
RMS 30.56
T0=1051.7 ns
Data
fit: exp*(1-sigm)+c
Vert. @ sigm(1/2)
Slope @ sigm(1/2)


TDC or Time (ns) for Cable: 4
tdc4TmCable04
Entries 84910
Mean 993.7
RMS 31.52
T0=1055.6 ns
Data
fit: exp*(1-sigm)+c
Vert. @ sigm(1/2)
Slope @ sigm(1/2)

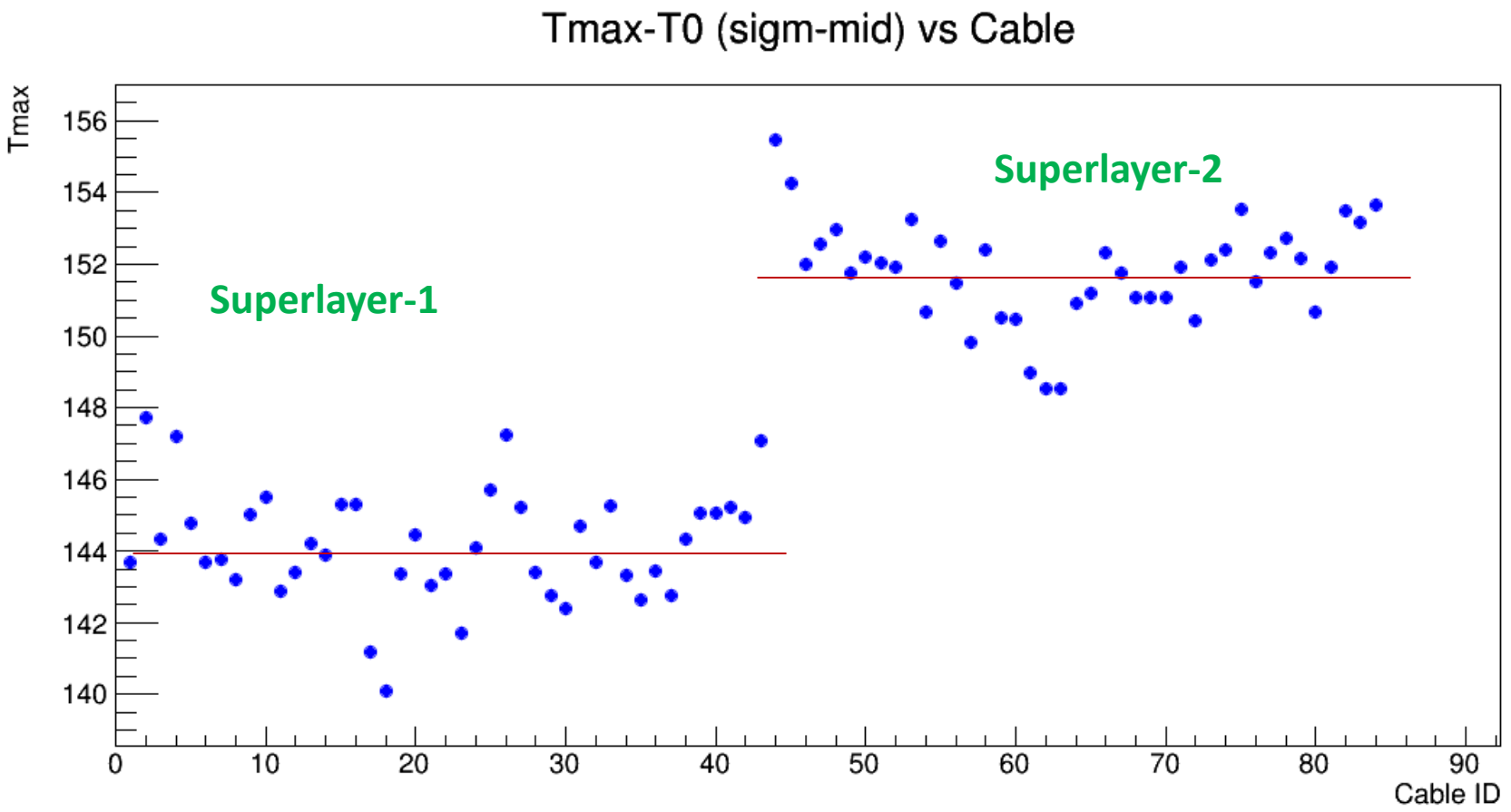

TDC or Time (ns) for Cable: 5
tdc4TmCable05
Entries 82730
Mean 988.7
RMS 28.77
T0=1038.0 ns
Data
fit: exp*(1-sigm)+c
Vert. @ sigm(1/2)
Slope @ sigm(1/2)


TDC or Time (ns) for Cable: 6
tdc4TmCable06
Entries 105233
Mean 990.2
RMS 29.23
T0=1043.3 ns
Data
fit: exp*(1-sigm)+c
Vert. @ sigm(1/2)
Slope @ sigm(1/2)


Tmax (raw) vs Cable
Tmax
1050
1045
1040
1035
1030
1025
1020
1015
1010
0
10
20
30
40
50
60
70
80
90
Cable ID


T0 vs Cable
T0
895
890
885
880
875
870
865
0
10
20
30
40
50
60
70
80
90
Cable ID

T0 Corrected Tmax

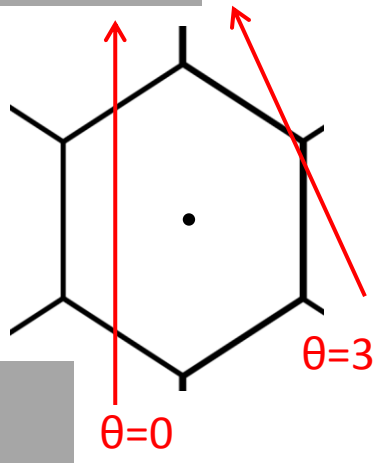


Time-to-distance function

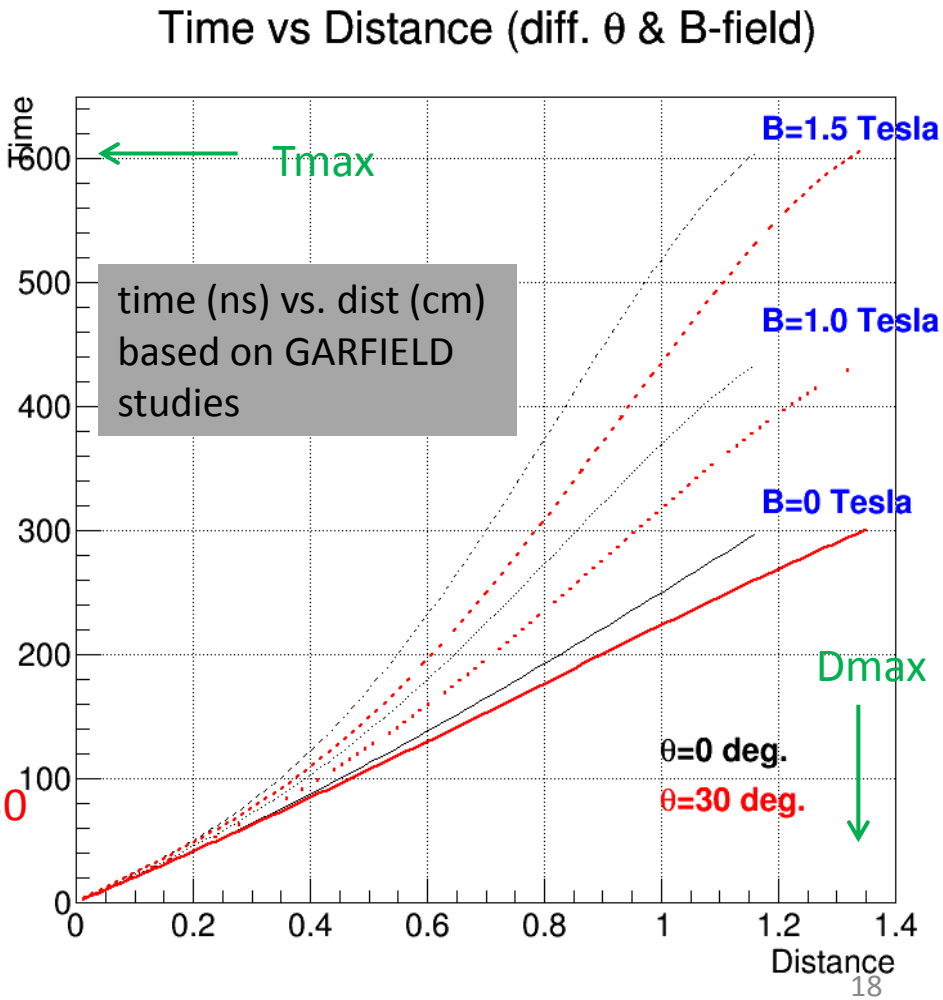
In the procedure known as the "time-based" tracking, in order to reconstruct tracks more precisely, the time-to-distance function is used to convert the drift-times (after the various time corrections) to drift distances (CALCDOCA), which are then used to evaluate the "exact" hit positions.

$$t(x) = \frac{x}{v_0} + a\left(\frac{x}{x_{max}}\right)^n + b\left(\frac{x}{x_{max}}\right)^m$$

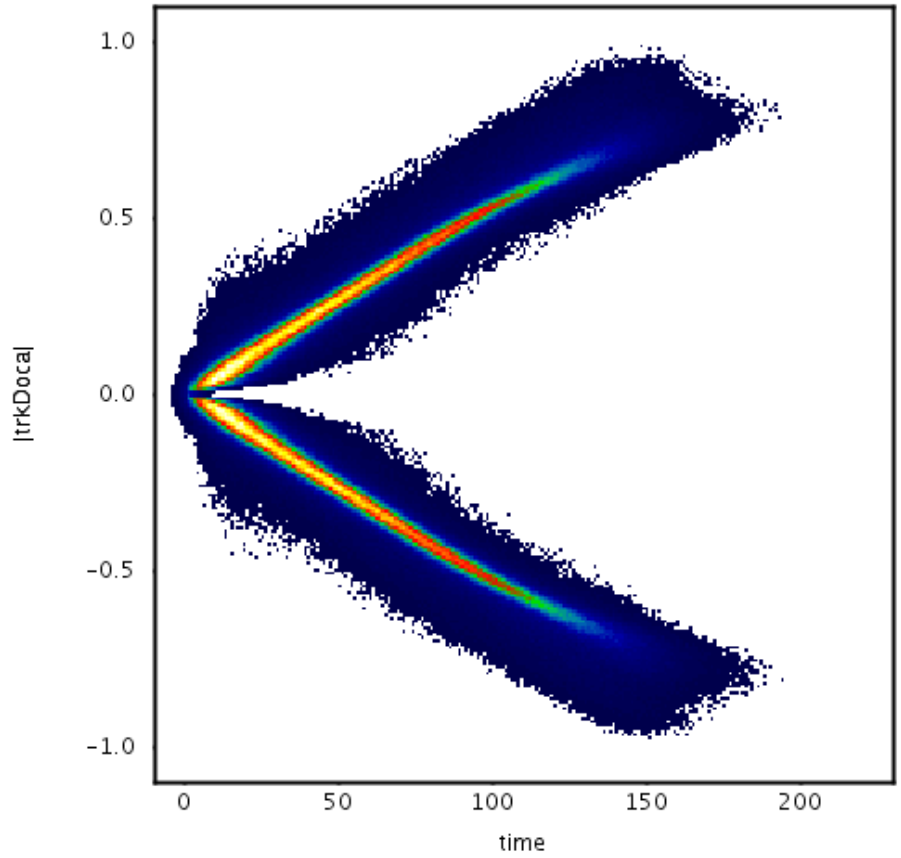
Constraints
- time = tmax when dist = dmax
- slopes equal at 0, 1
- inflection at x/xmax=0.615

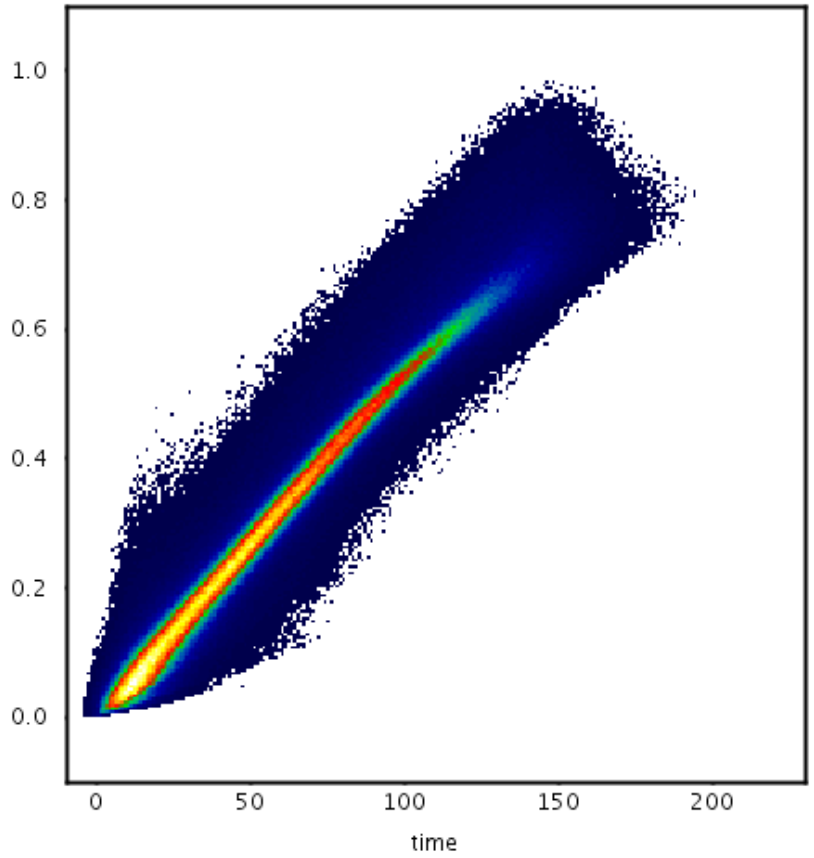


Use this function to fill a time → distance table



trkDoca vs T0-corrected time

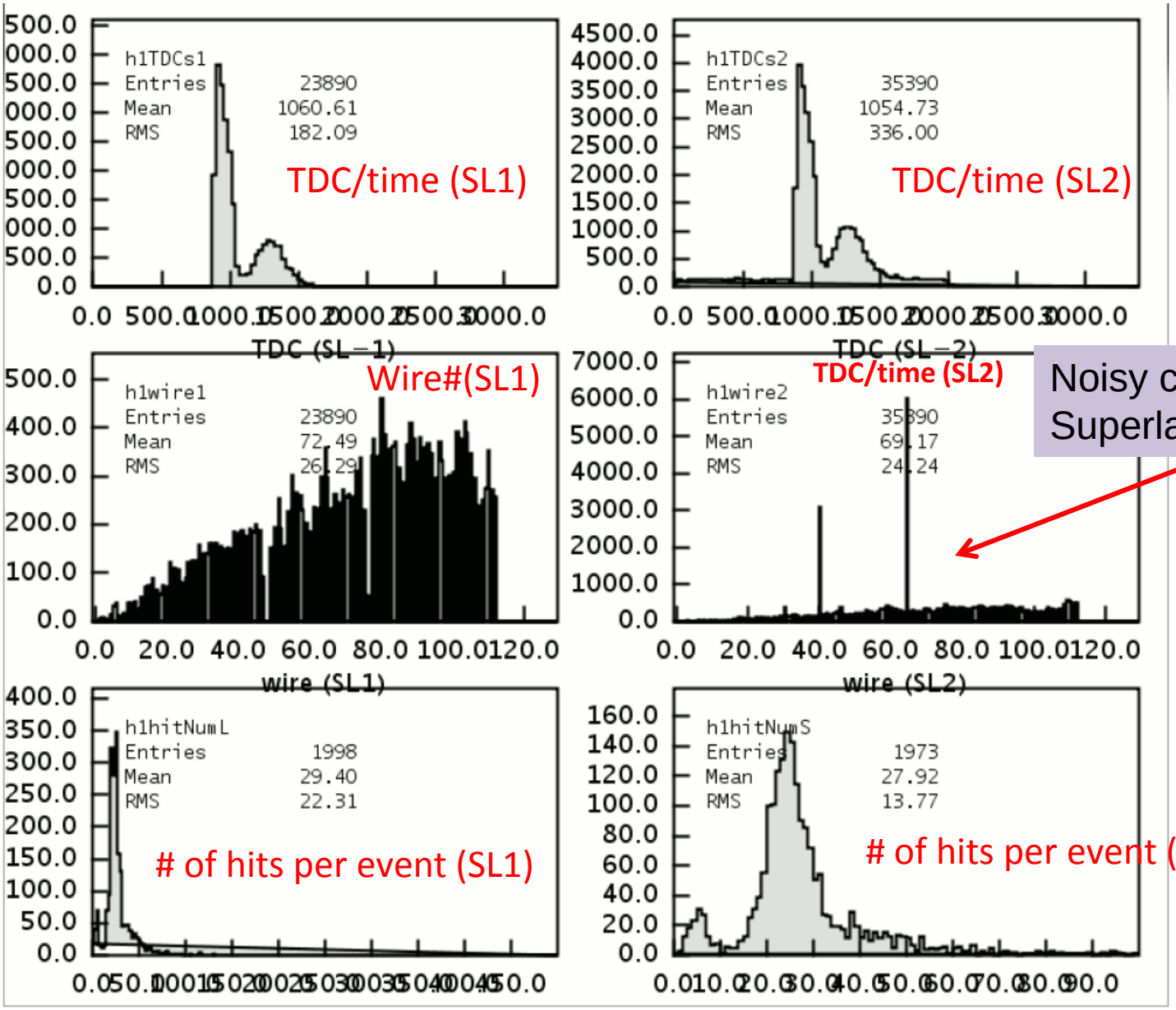




DC12 Monitoring

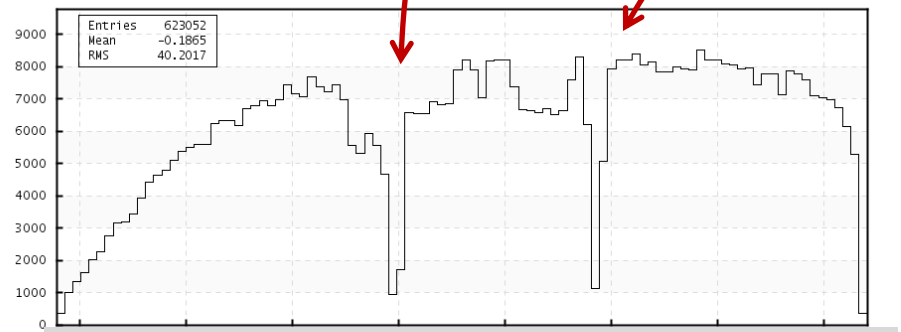
- List of items to be monitored is ready.
- ntuples – allow real-time investigations
  - We can plot tracks, crosses, segments, hits and the correlations between them;
  - e.g. a plot of the #hits/cross vs. angle of the cross
- Some histograms and plots – code validation and operational monitoring

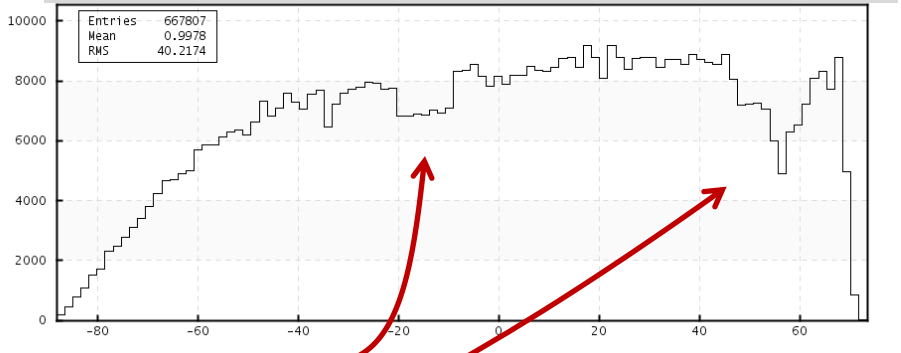
DC12 Monitoring (Cosmic studies)



Noisy channels in Superlayer-2

DC12 Monitoring (Cosmic studies)





unplugged connectors ?

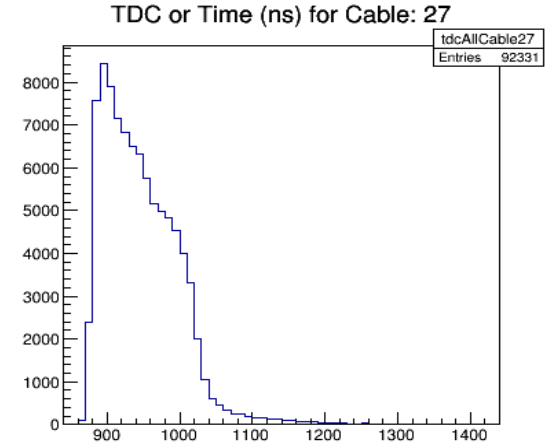
SL 1

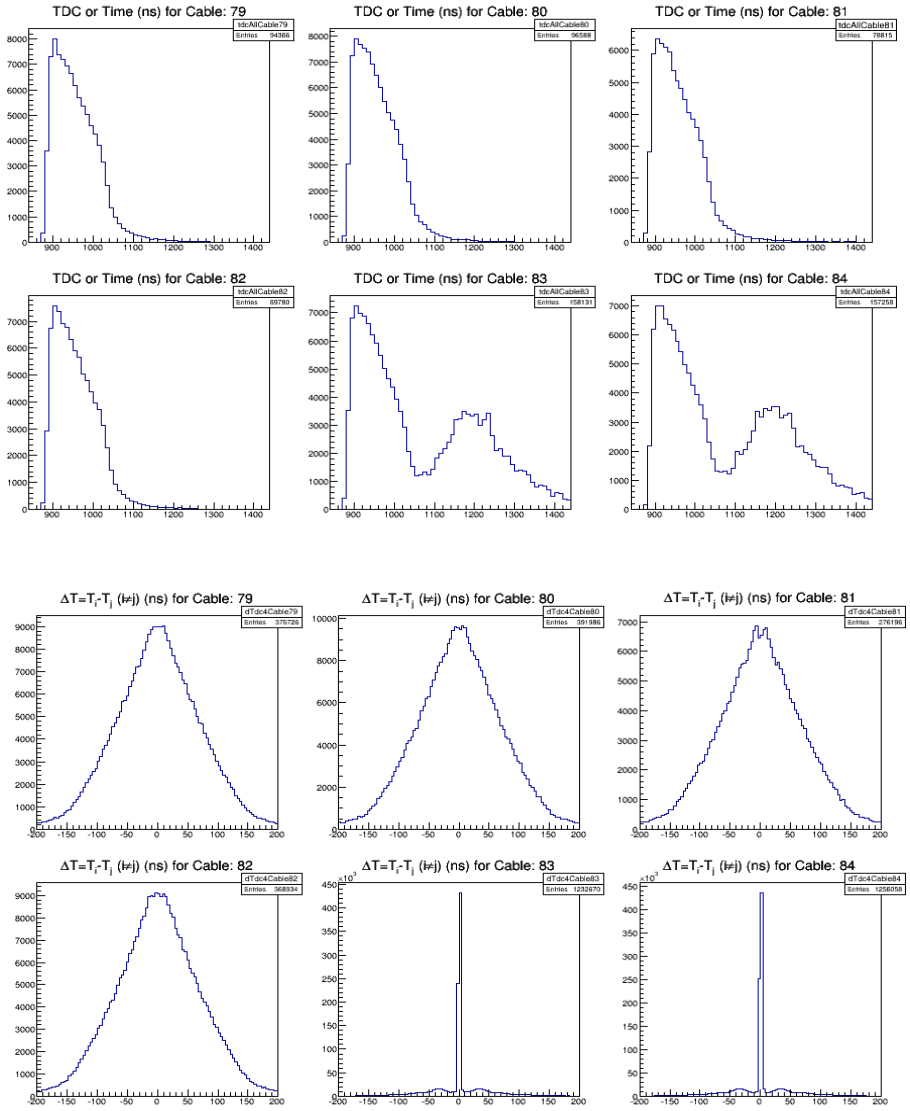
SL 2

swapped connectors ?

DC12 Monitoring ΔT = T(wire1) - T(wire2)

ΔT is useful to identify correlated noise originating from common electronic equipments.





DC12: Calibration Status Summary

DC Calibration:

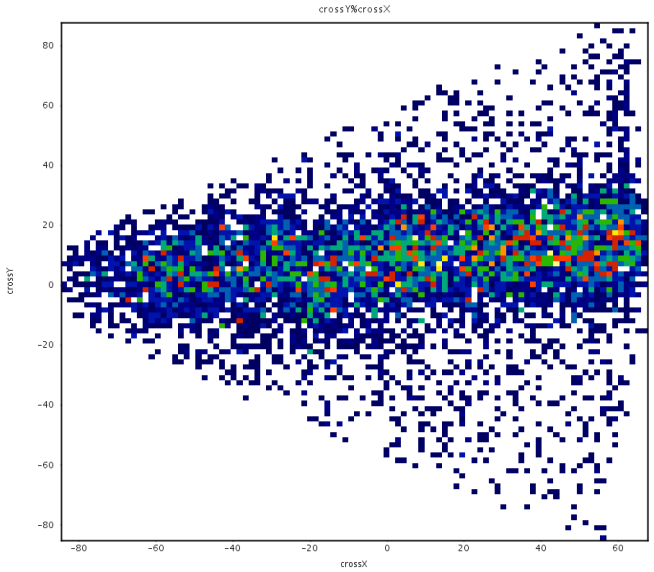
- **Intrinsic inefficiency**
  - Inefficiency implemented in GEMC
  - Parameters yet to be calibrated
- **Status Tables –**
  - keep time history of HV, lv, wire status …GUI's, Maps… … underway…
- **Time Correction –**
  - cable delays (T0, Tmax) …DONE…
  - signal velocity along wire, particle TOF, time walk … in progress
- **Drift Velocity –**
  - parameters to determine DOCA as a function of time … underway…

Monitoring:

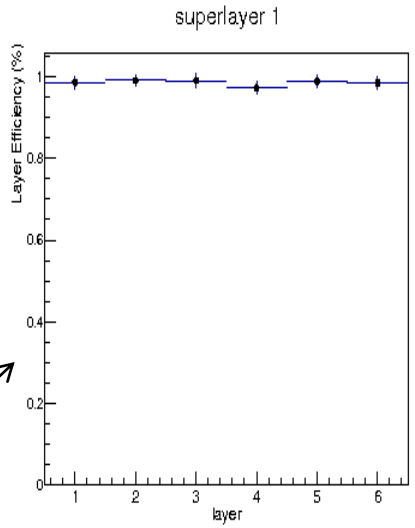
• ntuple-maker, mouse-over web interface ready, plots defined, still need to select a subset for reconstruction validation.

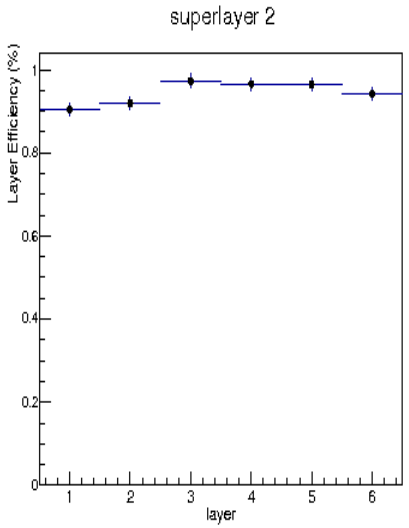
Backup Slides

DC12 Cosmic Studies: Efficiency



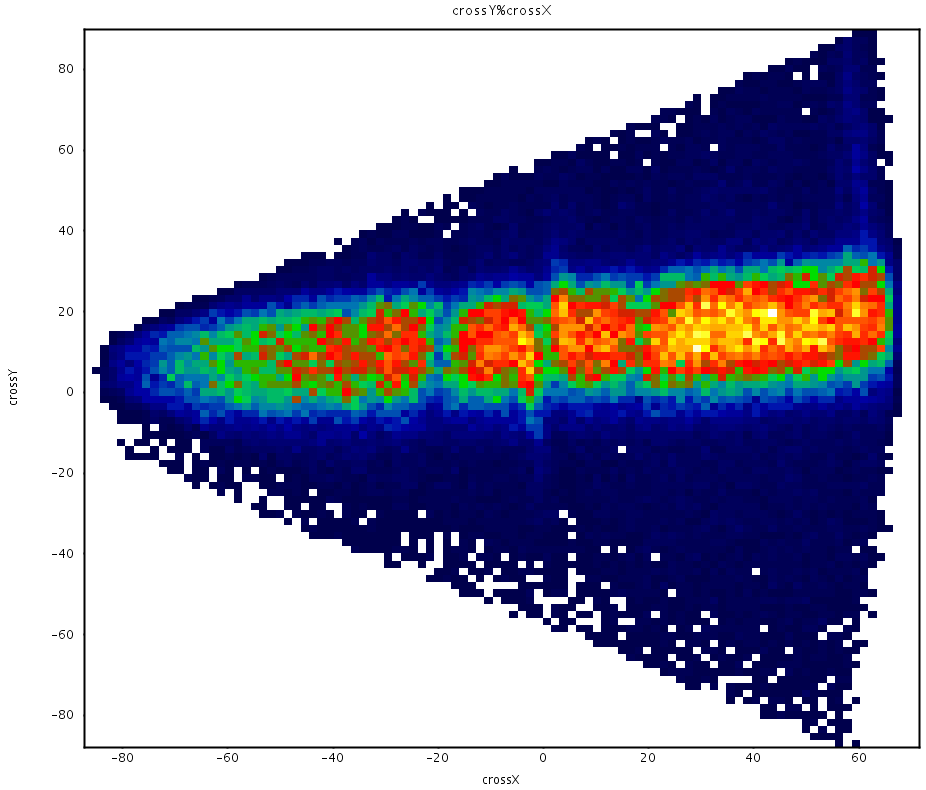
Location of 2-superlayer ‘crosses’
→ image of scintillator paddle
→ reg.1 chamber

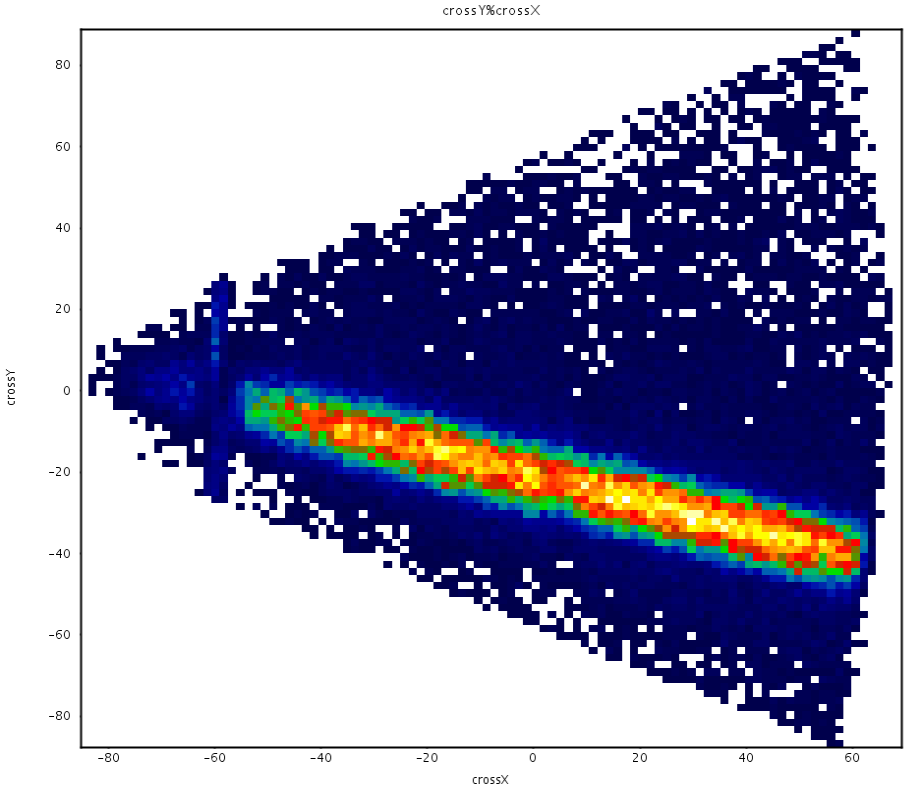


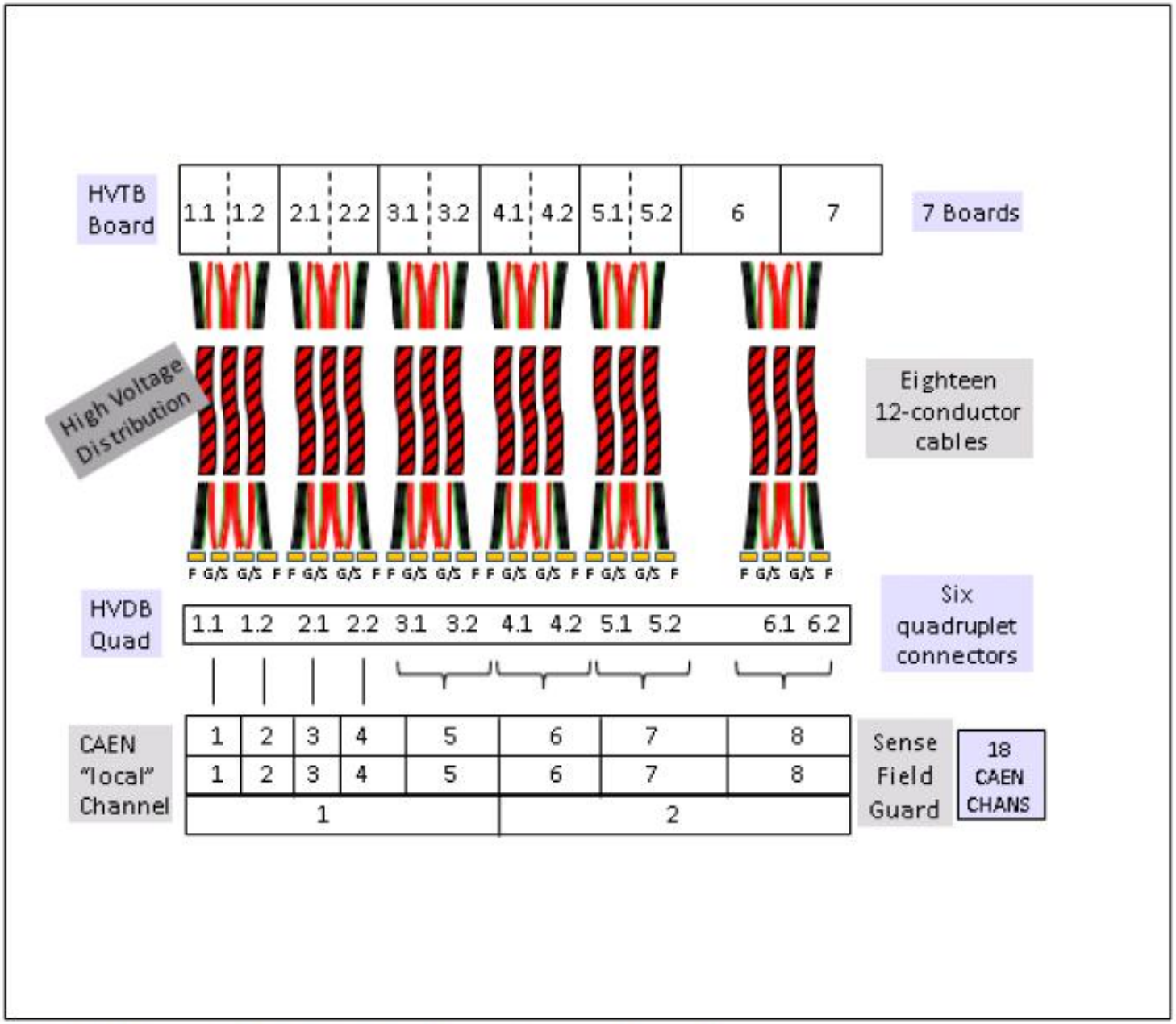


Layer efficiencies
at 2250 V

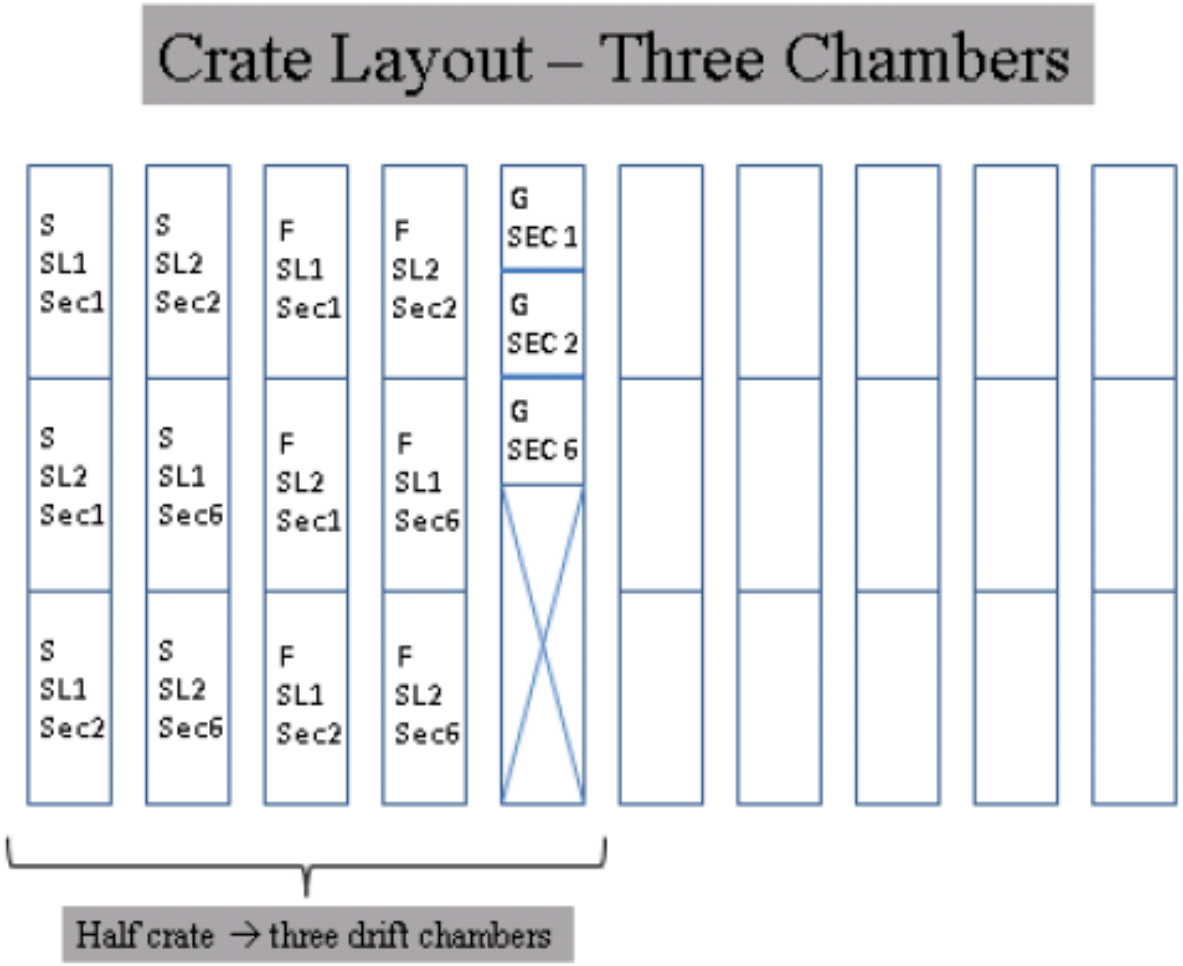
Location of 2 superlayer crosses





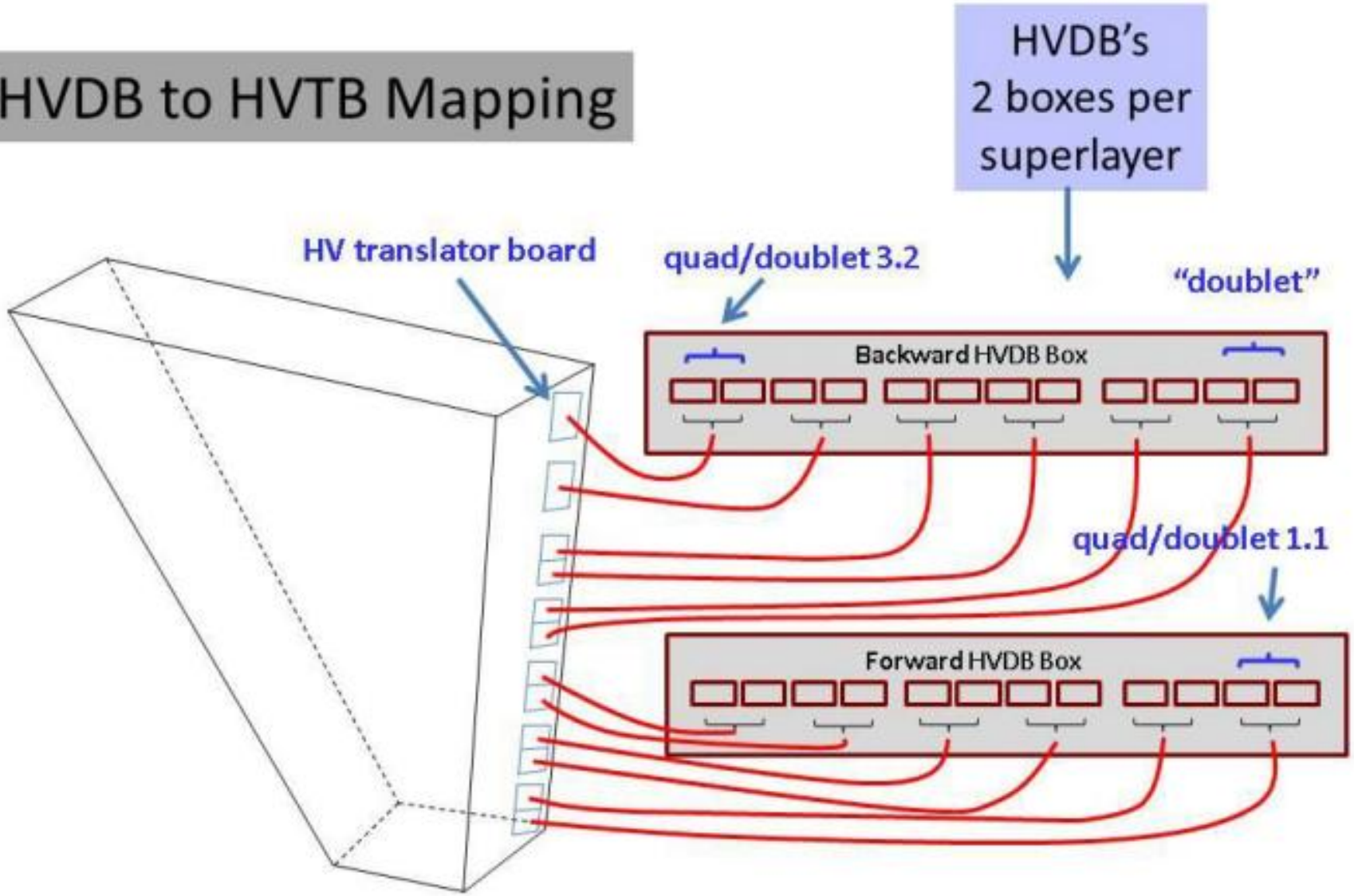


High Voltage Distribution (each superlayer)



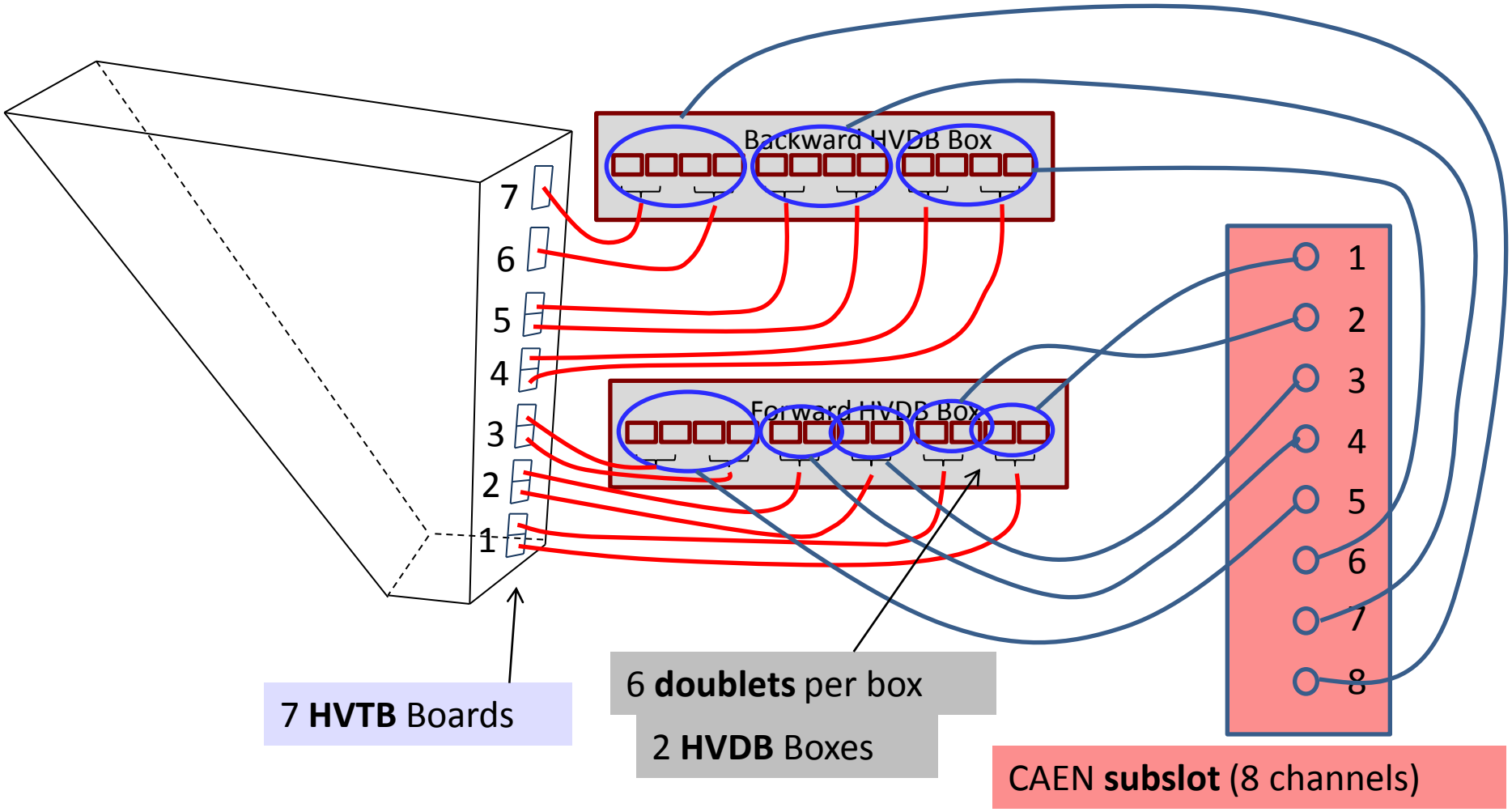
High Voltage Slot Assignments

HVDB to HVTB Mapping

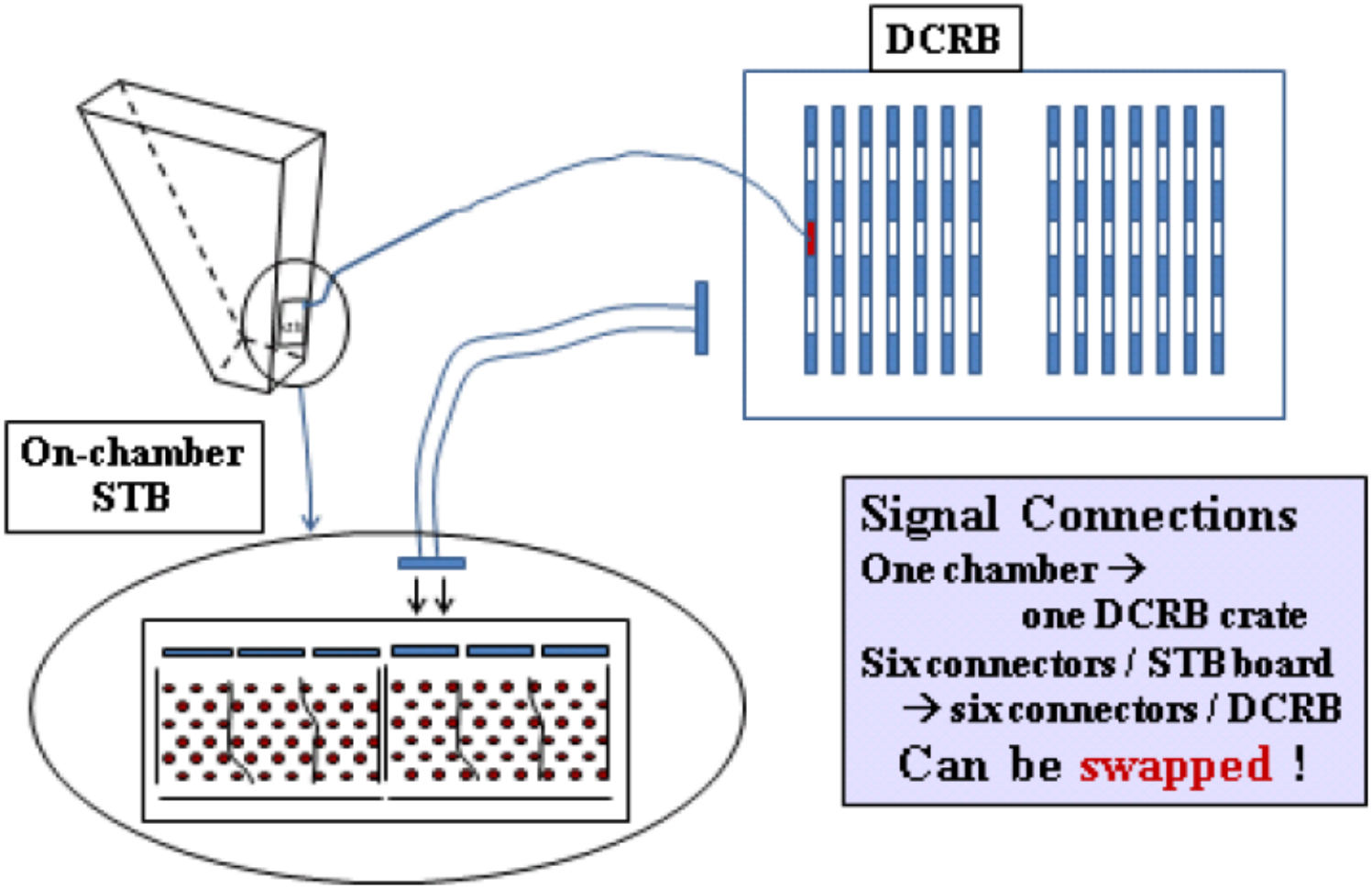


CAEN **Subslot** to **HVDB** to **HVTB** Mapping

- example of functional mapping of HV, lv, sigcables → wires



CLAS Drift Chamber Signal Routing

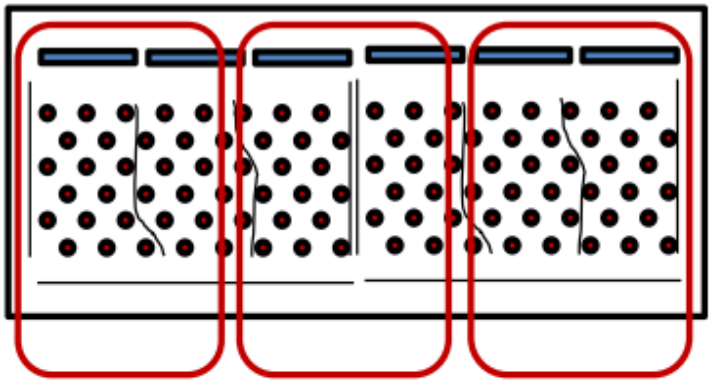


Signal Connections

One chamber →
one DCRB crate

Six connectors / STB board
→ six connectors / DCRB

Can be swapped !



Low-Voltage Power

One STB board →
three fuses

<u>One fuse</u>
→ 2 connectors
→ 32 wires

Low Voltage Power Distribution