DC++
Status and Plans

Florian Hauenstein
CLAS Collaboration Meeting
07/08/25

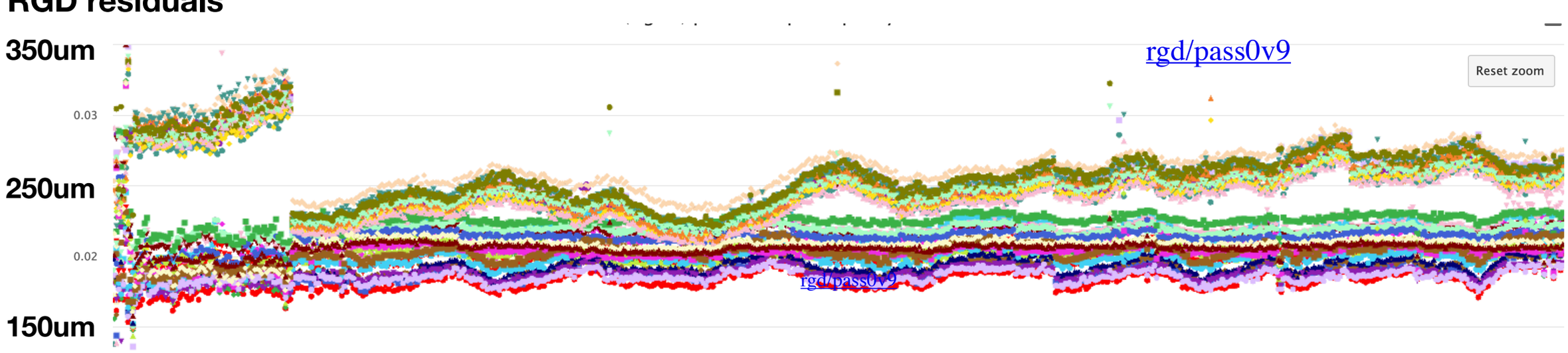
Overview

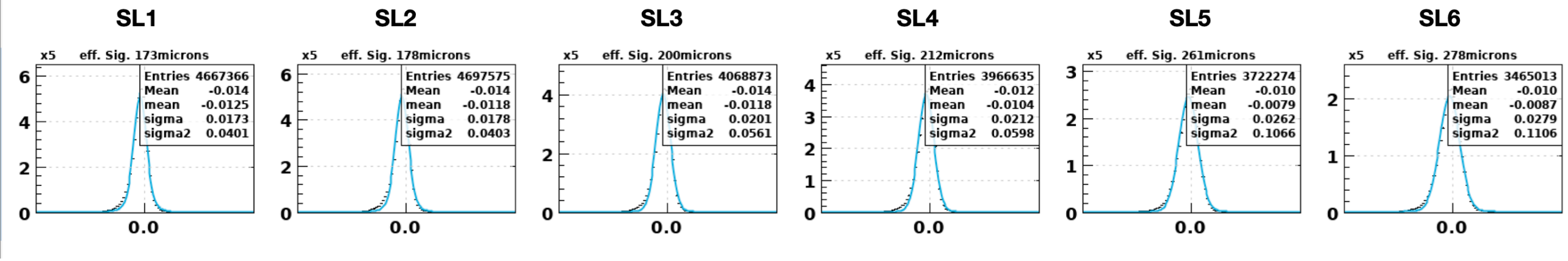
- **Current developments**
  - **Version2 - T2D Calibration**
  - **TDC window cuts and multihits in previous data**
- **Future plans**
  - **Time-over-threshold and multi-hits with new firmware**
  - **GEMC matching improvements**

V2 - Time to Distance Calibration

Why Calibration Updates

- **Pass2 T2D calibrations for RGA/B/K sometimes cumbersome (convergence problems, manual adjustments required)**
- **ToF correction calculation for DC hits with a bug (shifted T0)**
- **Non-monotonic T2D behavior for R2 at large docas due to B-field dependent term**
- **Calibration with pass2 software and protocol didn't work for newer HV settings**





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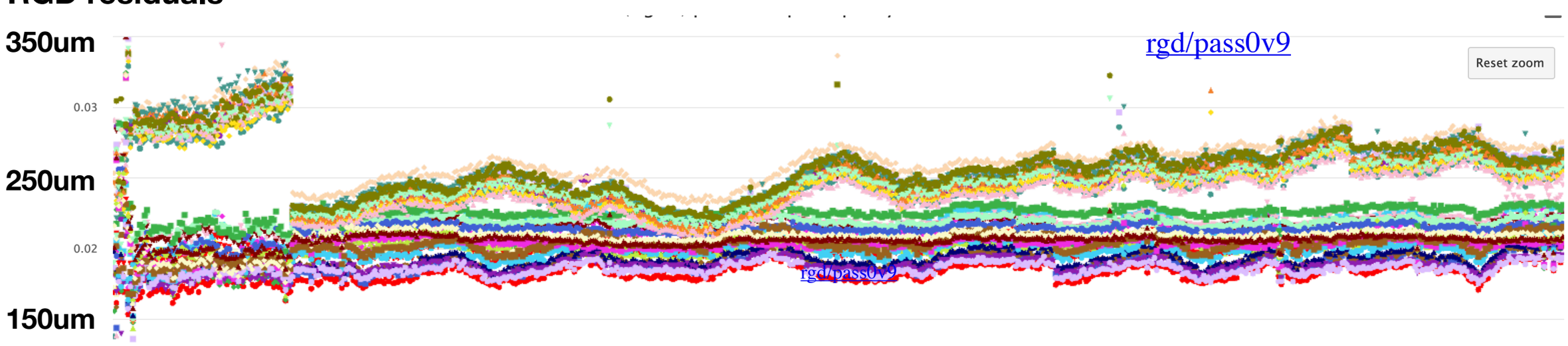
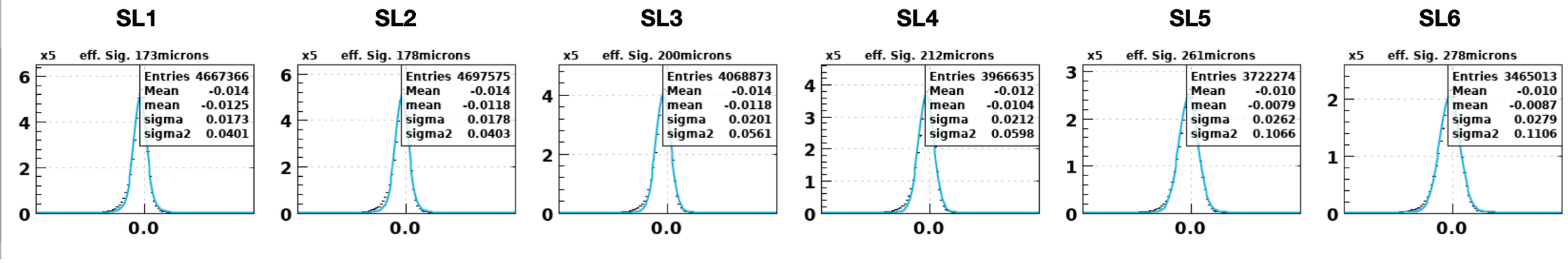
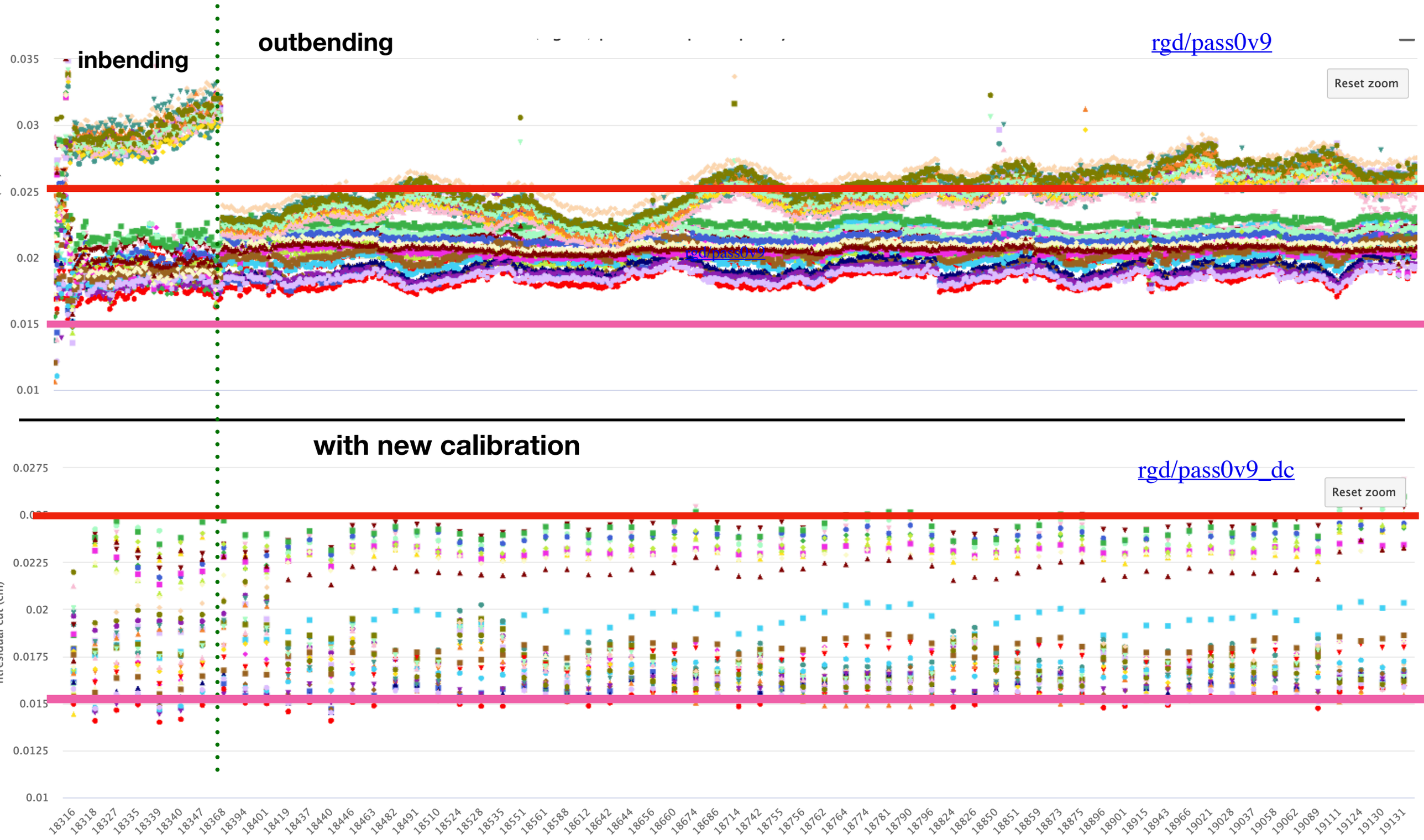




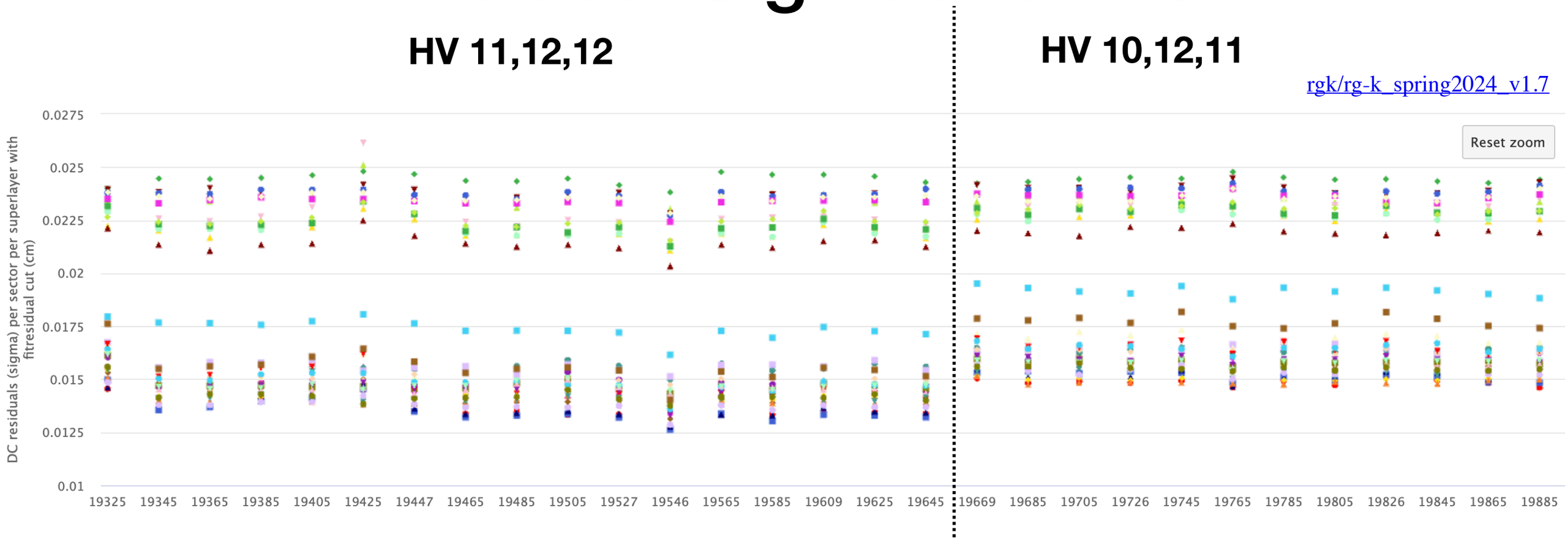
—> Updates to calibration software and methods which break backward compatibility!!!!

Residual Sigmas for RGD



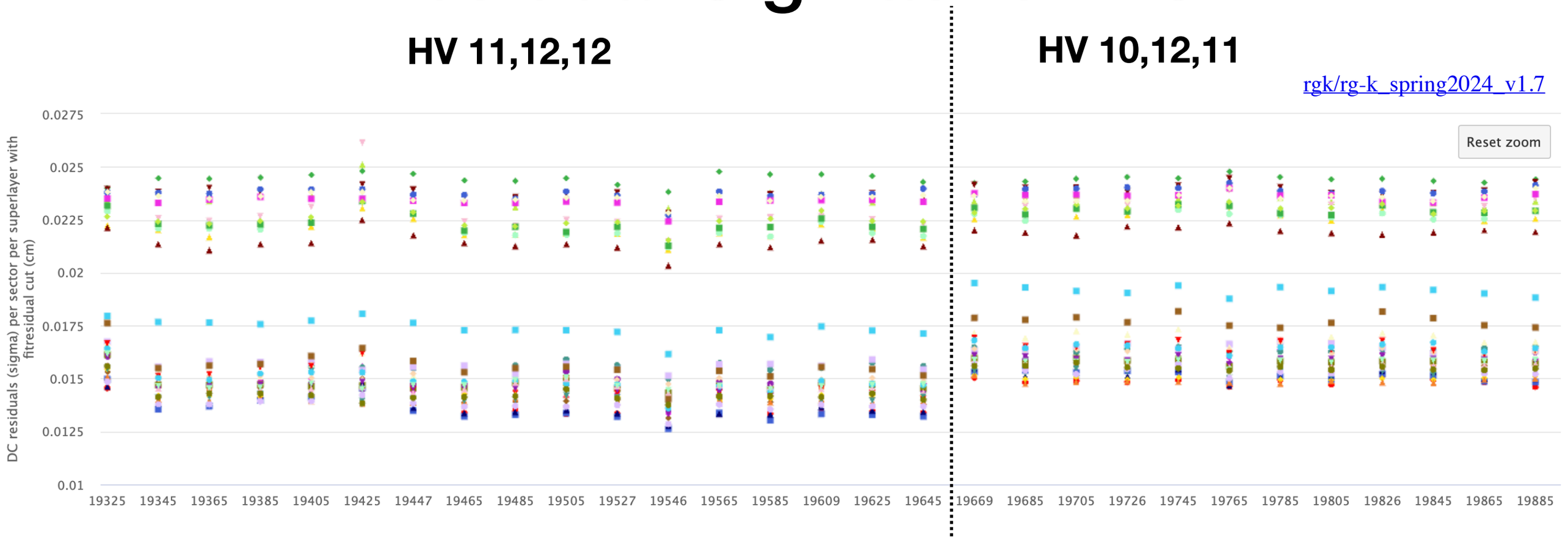
- **R1 and R3 under 200um, R2 around 250um**
- **New calibration works very well!**

Residual Sigmas for RGK



- **Sigmas nicely improved with R1/3 below 200um and R2 below 250um**

Residual Sigmas for RGK



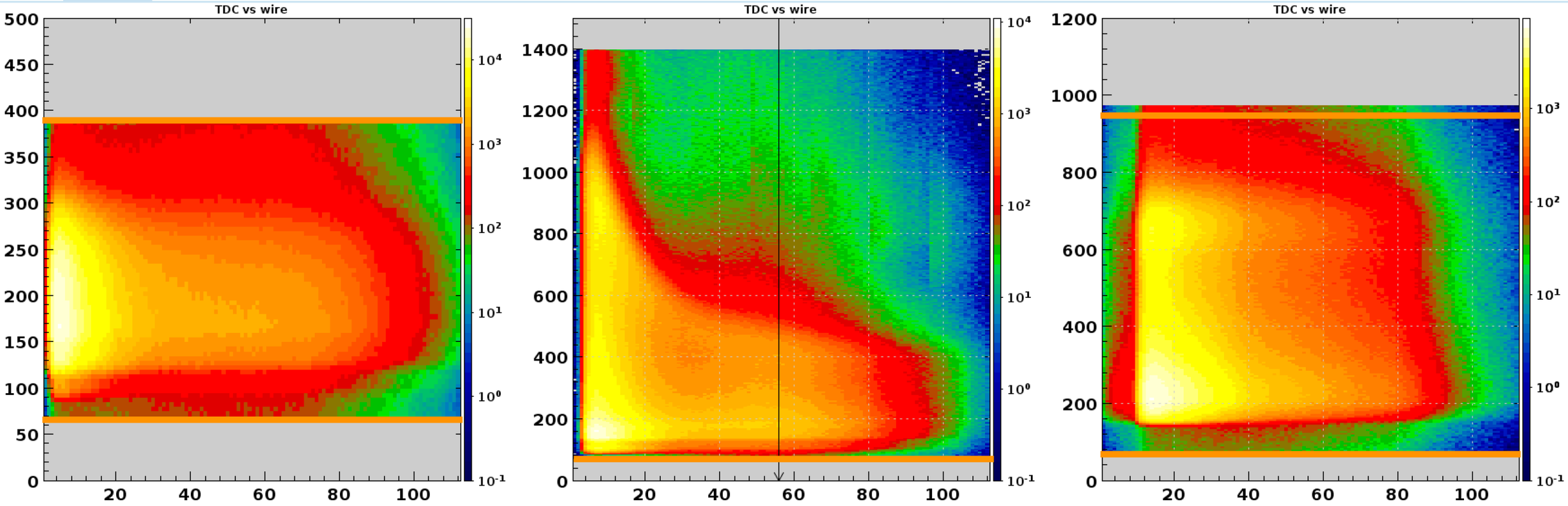
- **Sigmas nicely improved with R1/3 below 200um and R2 below 250um**

- **New suite and methods work very well on all HV settings**
- **Calibration routines more reliable - less prone to errors**
- **Constants for v2 updates in new CCDB tables under /calibration/dc/v2/***
- **All coatjava versions > 12.0**

TDC Window Cut

What is TDC Window cut?

TDC



- DC readout window wider than TDC spectrum of hits on track
- Define min/max cuts to reduce noise
  - depends on HV setting —> higher HV = lower Tmax
  - Also depends on trigger delay

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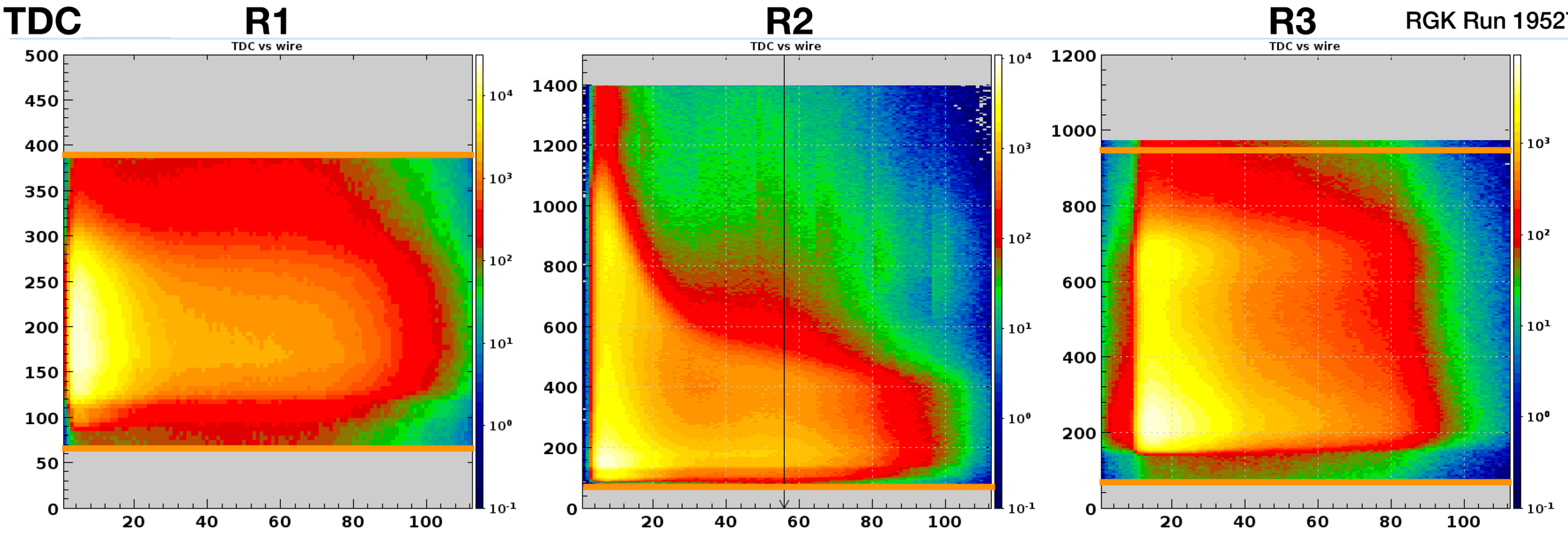


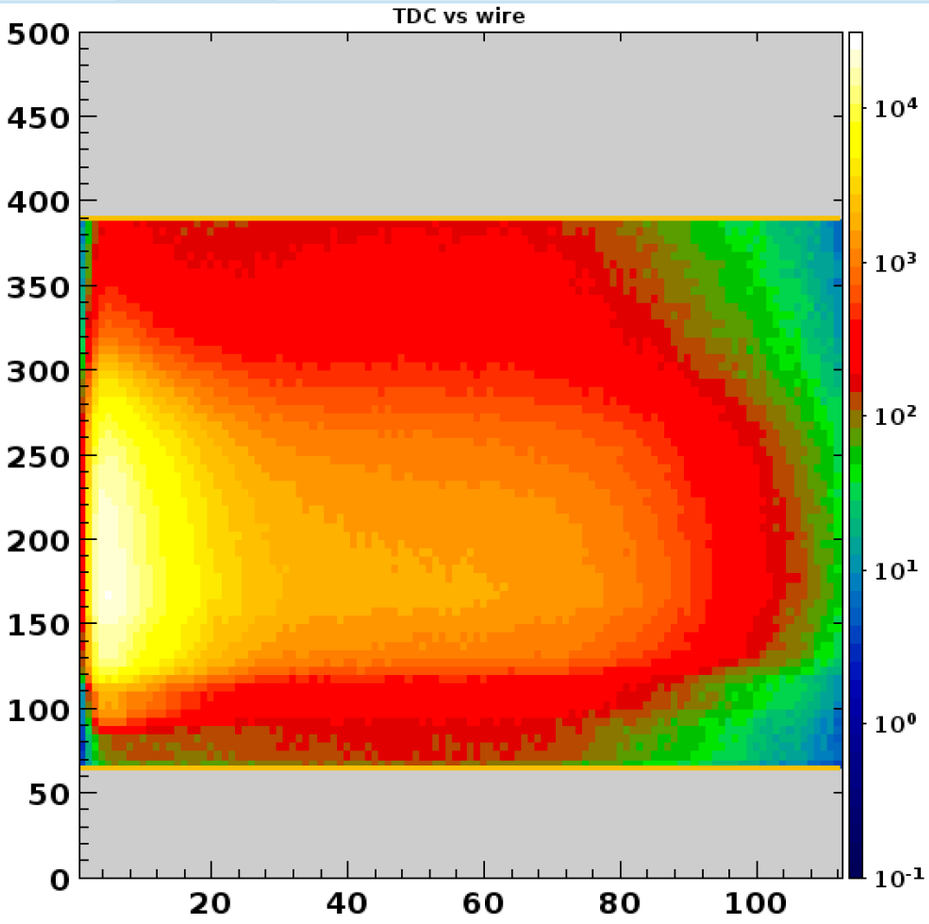
- DC readout window wider than TDC spectrum of hits on track
- Define min/max cuts to reduce noise
  - depends on HV setting —> higher HV = lower Tmax
  - Also depends on trigger delay

Additional aspect for old firmware (before RGL):

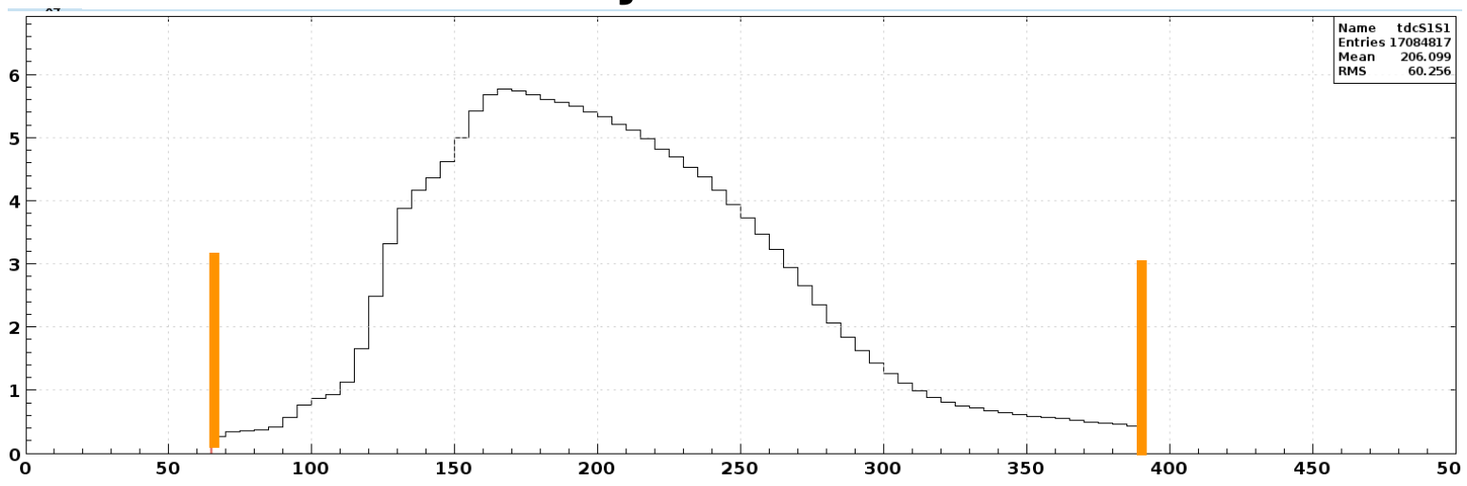
- Window cut < DCRB deadtime (setting in readout board, defines window where no second hit is recorded) —> avoids double hits per wire per event

Region 1 Cut

TDC



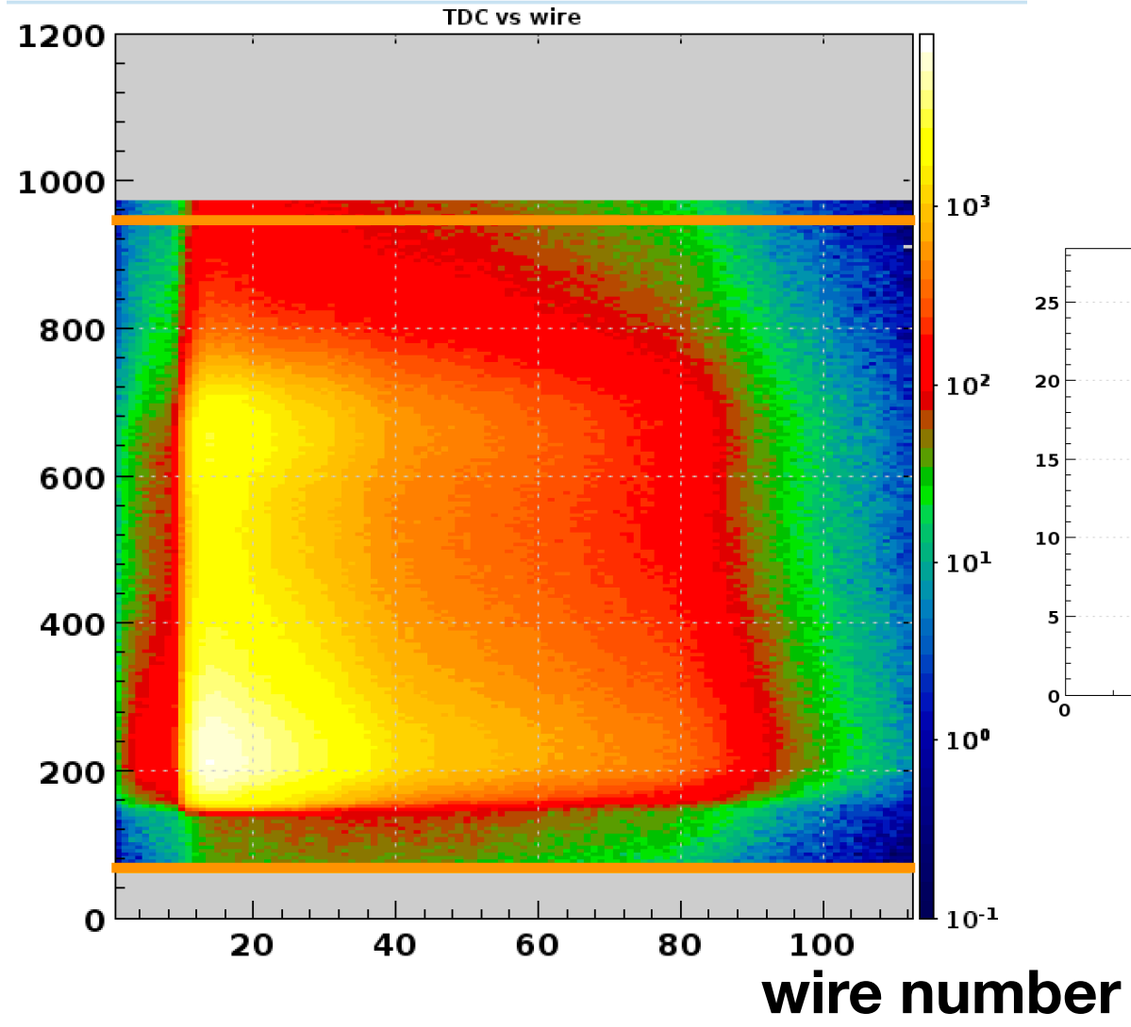
Projection



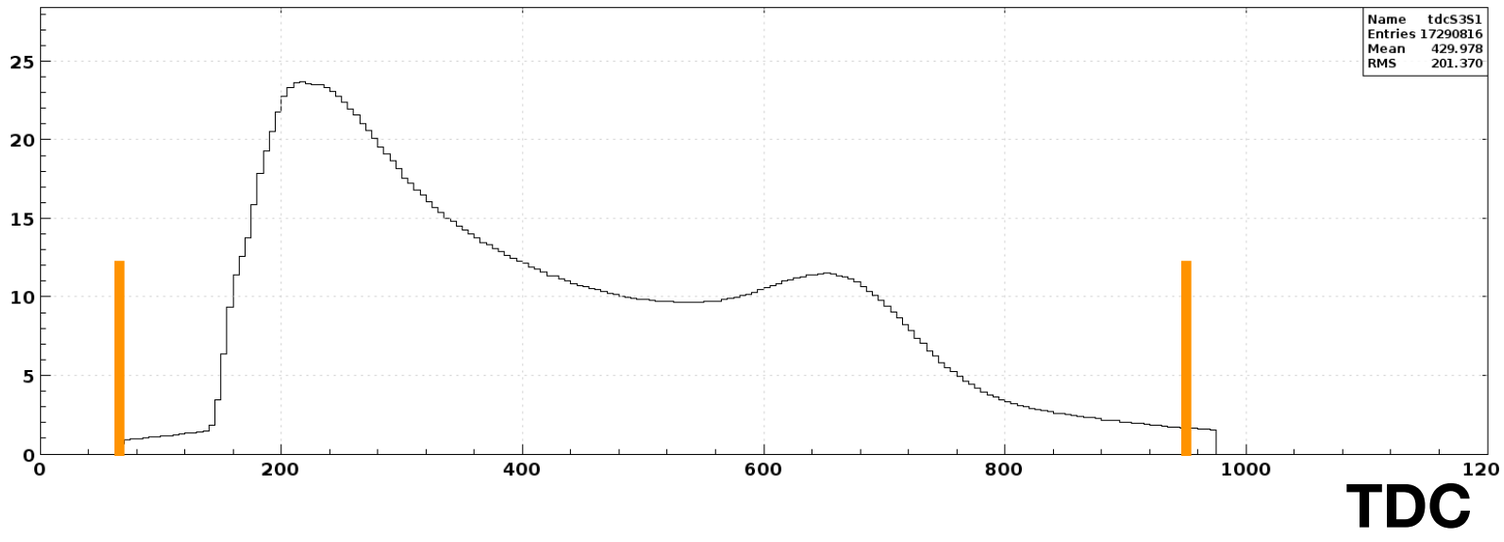
- **Existing TDC window cut in CCDB is not doing anything**
- **DCRB dead time is 350ns —> this leads to possible double hits per wire per event eve with old firmware —> change TDC window cut to 350**

Region 3 Cut

TDC

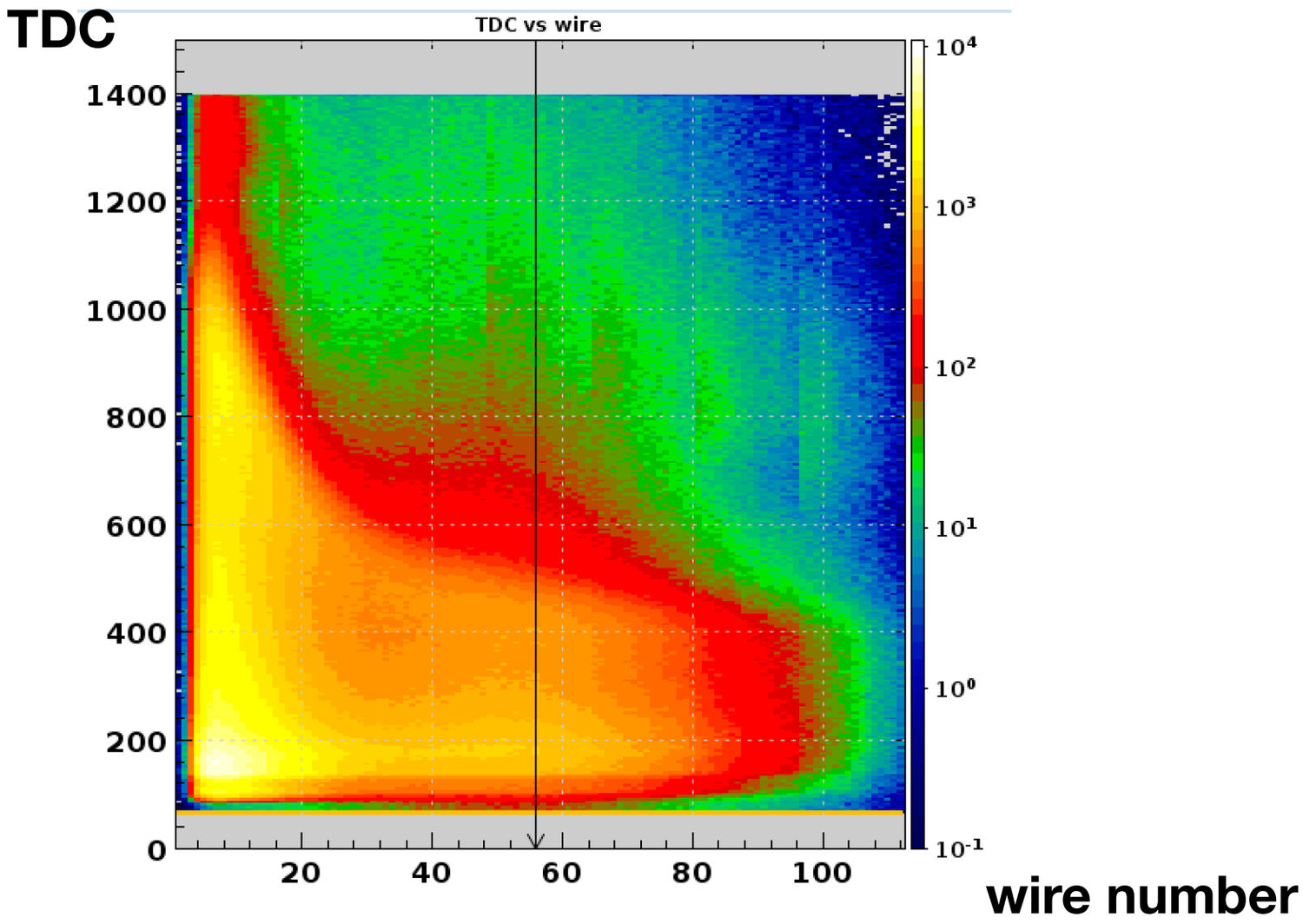


Projection



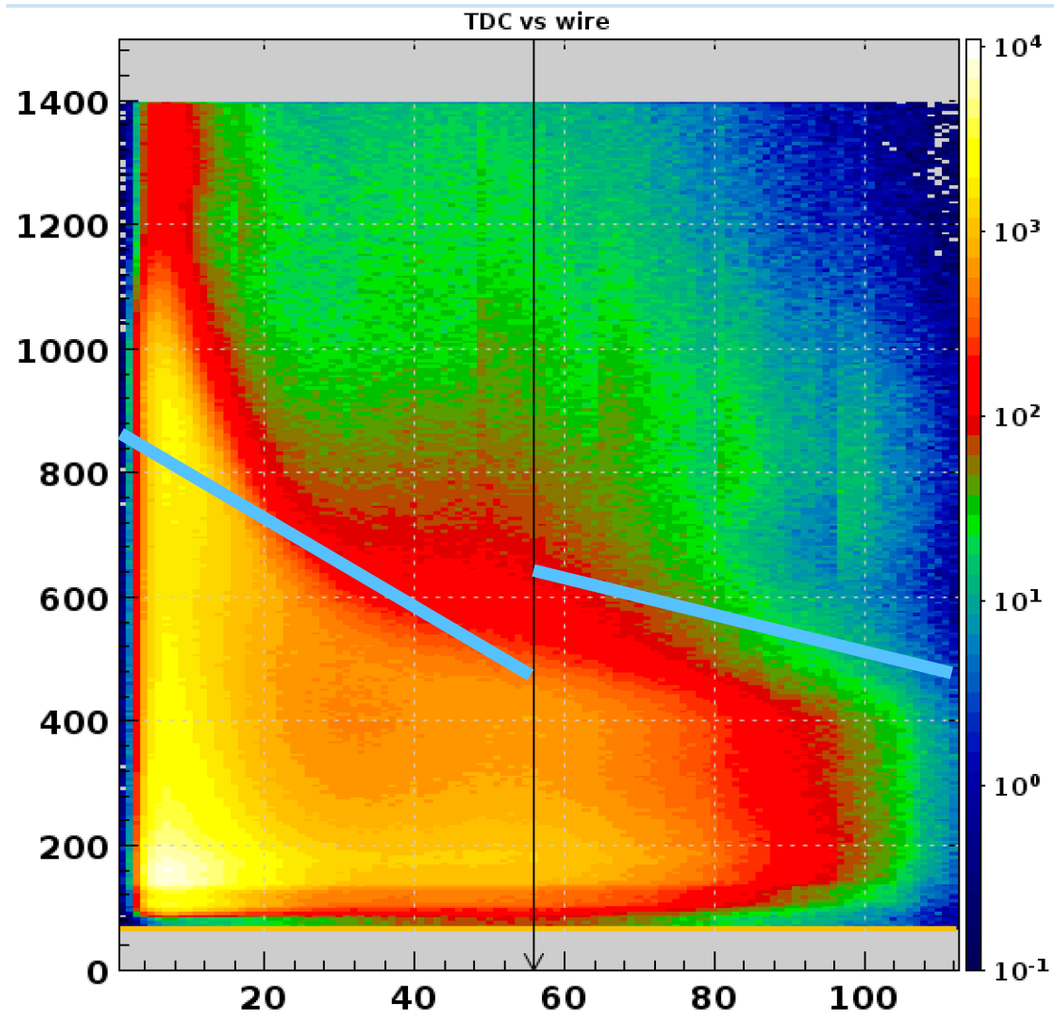
- **Existing TDC window cut in CCDB is cutting slightly**
- **DCRB readout deadtime is 1000ns so no more than 1 hit per wire per event**
- **Change cut to about 100 to 900ns**

Region 2 Cut



- **Currently(!) R2 uses a linear function depending on wire number for maximum TDC cut**
- **Max TDC cut not applied due to bug in coatjava when wire dependent cut is calculated**

RGK Run 19527 - R2



- **Corrected function with existing CCDB values would cut too much, also discontinuity around wire 56**

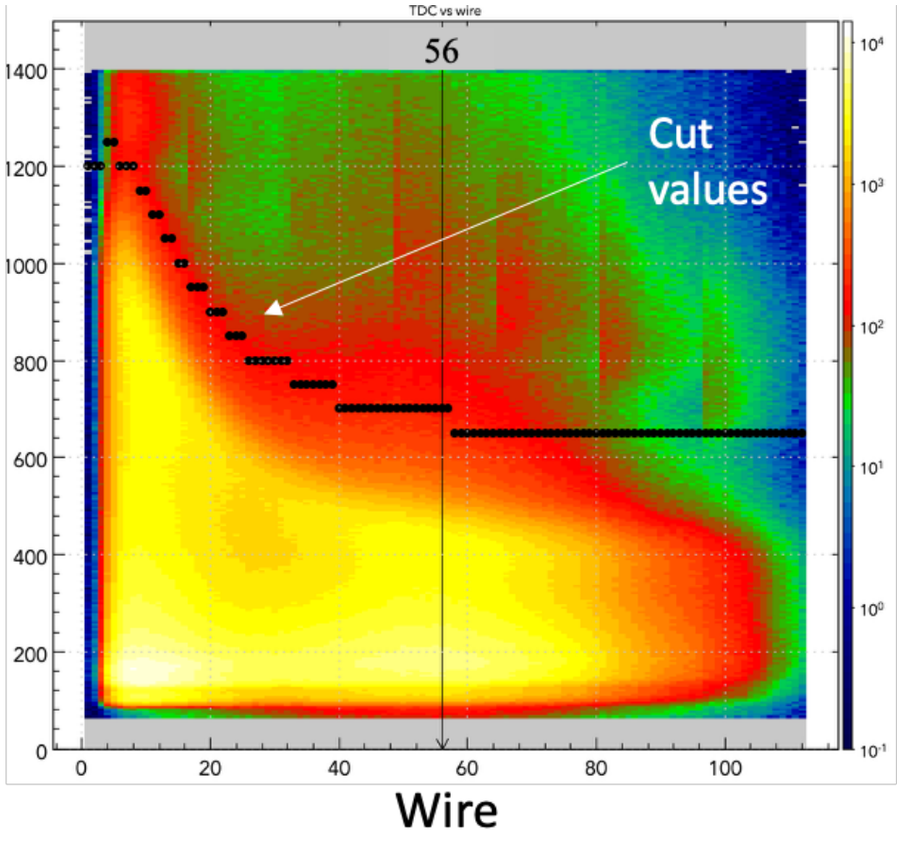
—> Reconstruction Update - coatjava > 14.x

- **Make new table for v2 with cuts per wire in R2 —> easy readable and usable in coatjava**
- **Update reconstruction software to read new table and remove existing linear function calculation**

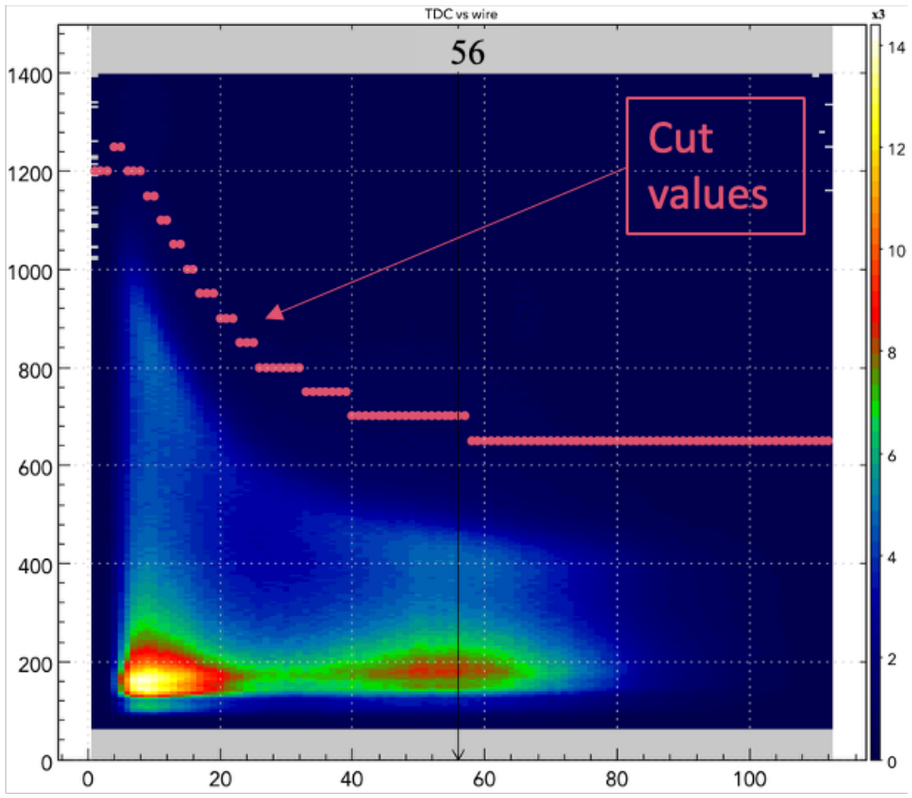
Example Calibration from Veronique

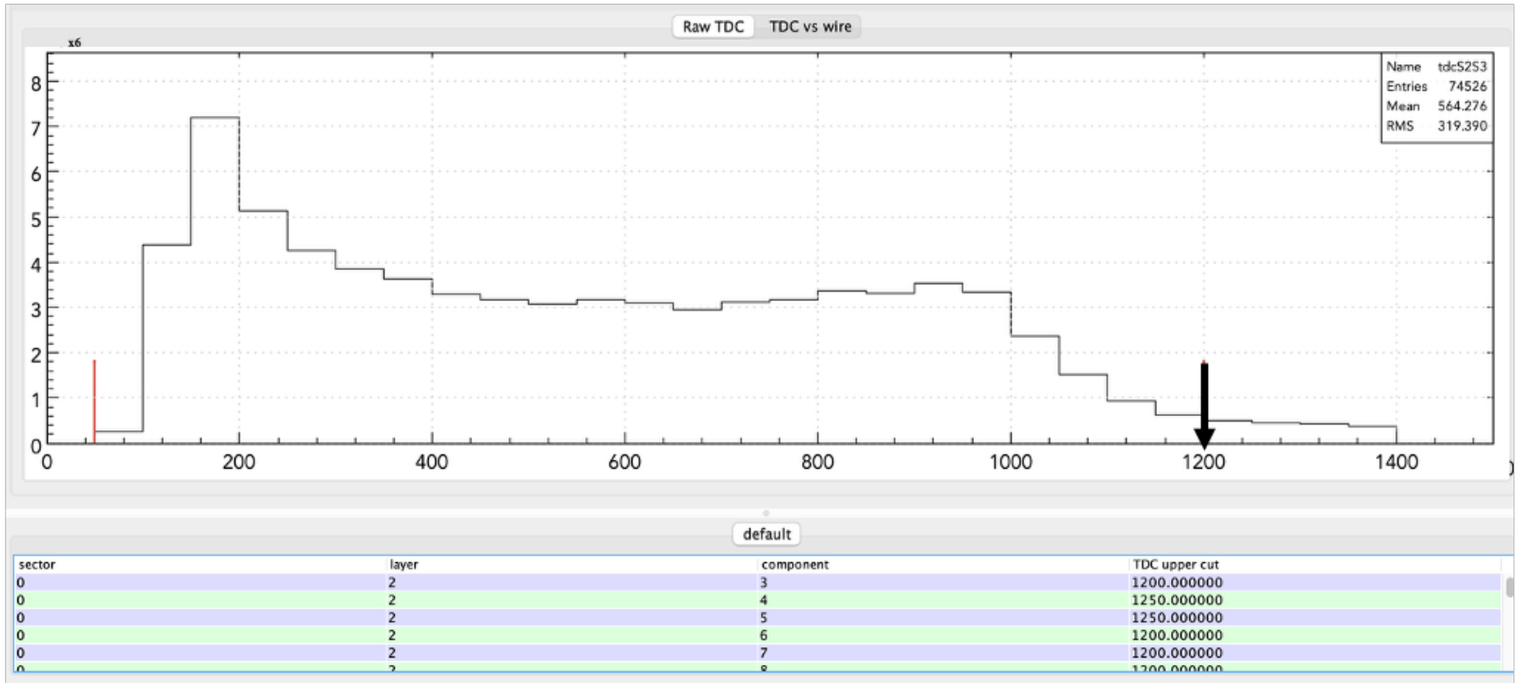
Log scale

TDC

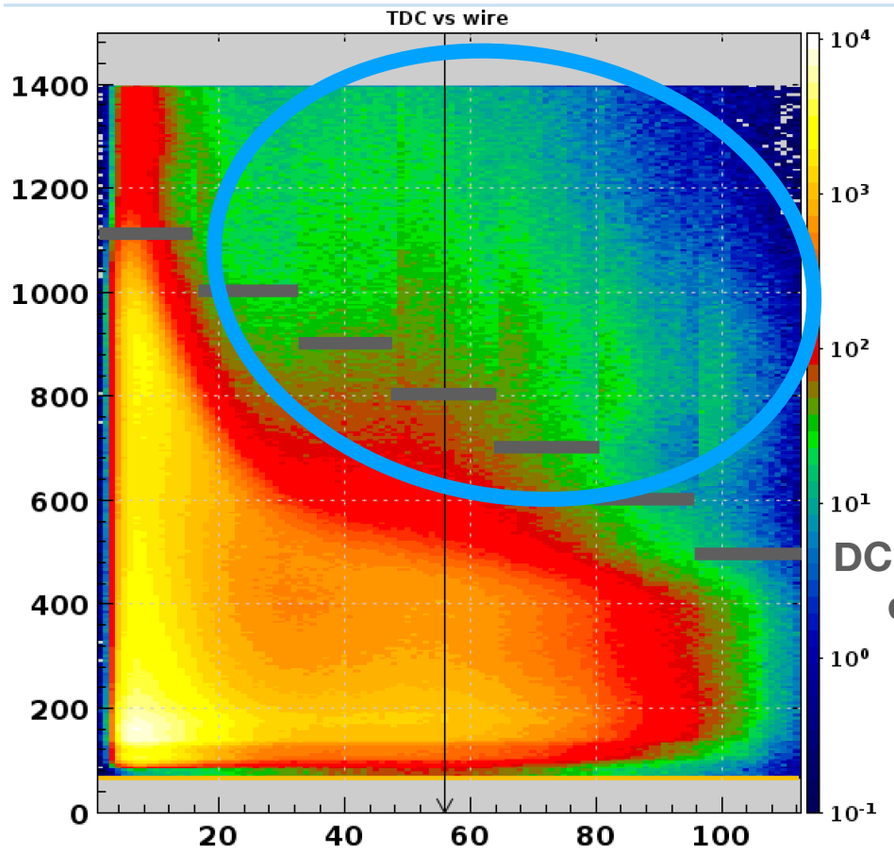


TDC



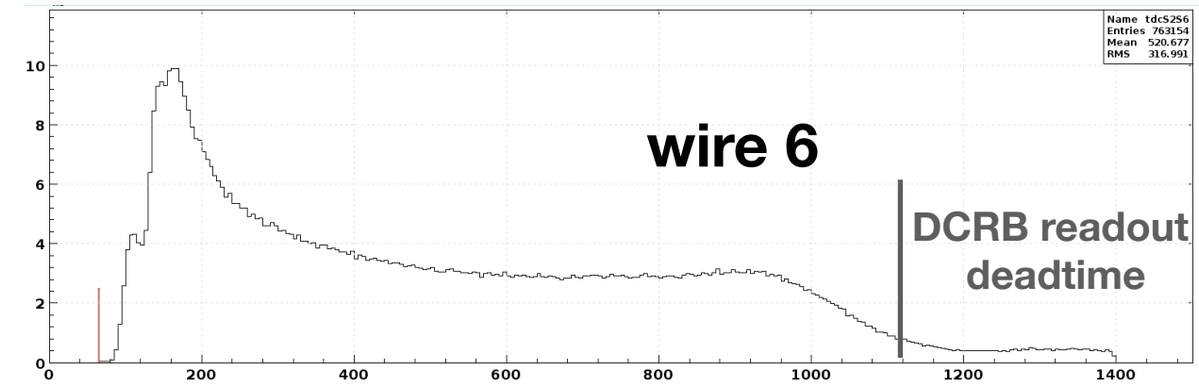


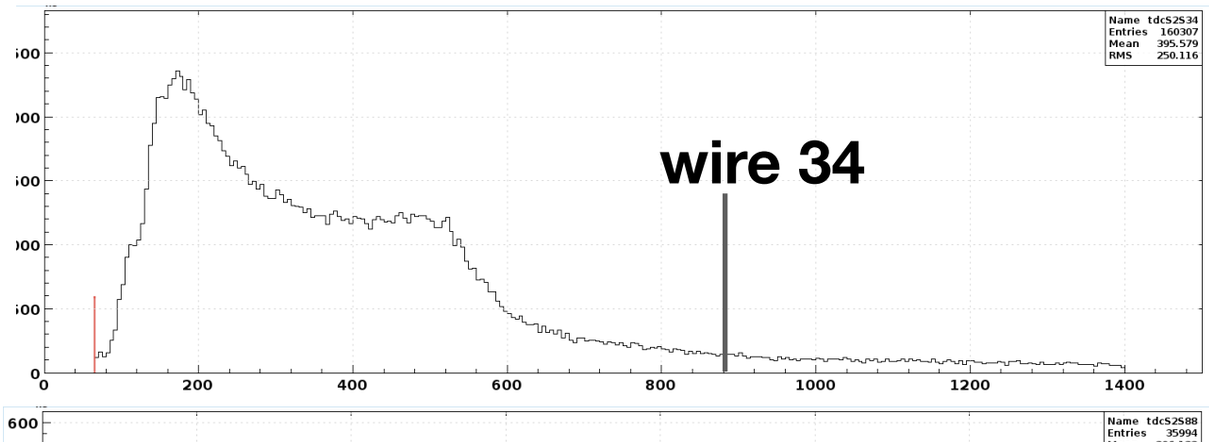
RGK Run 19527 - R2 Other Issues

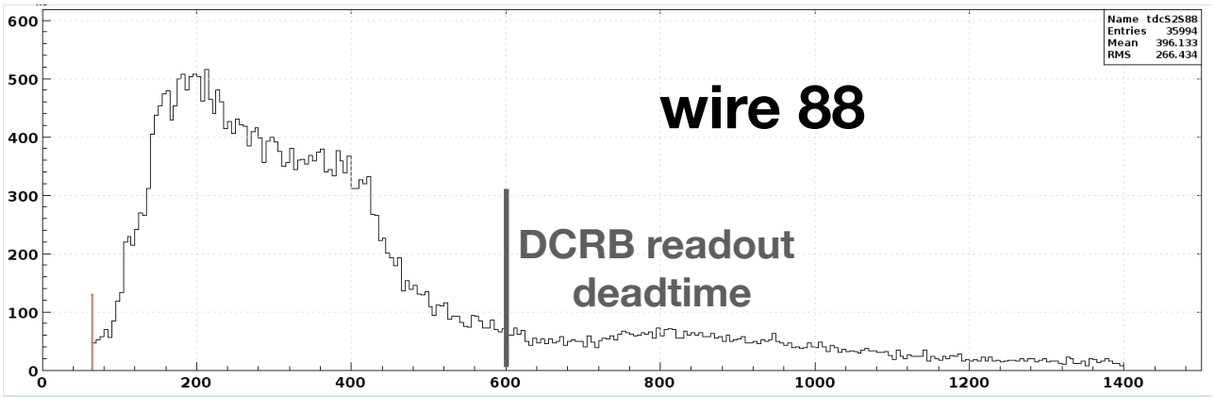


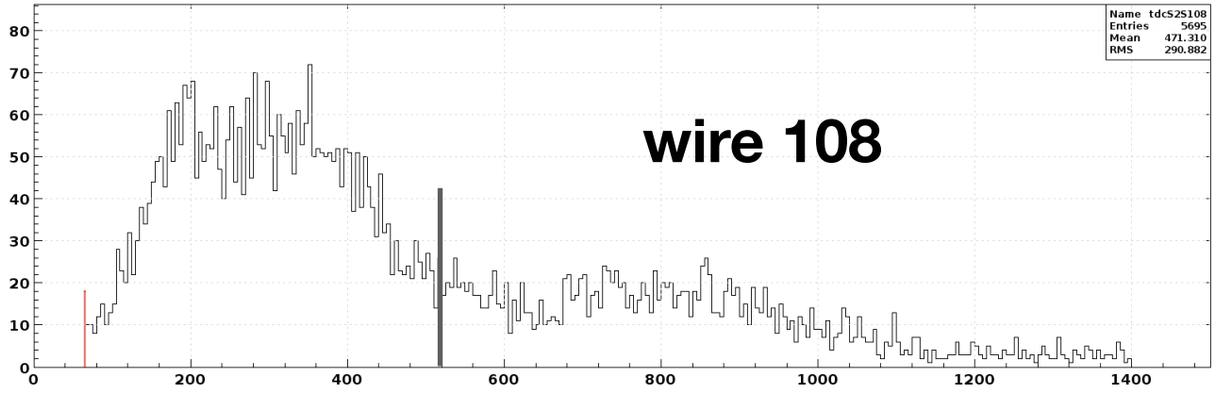
- **Secondary bump for larger wire numbers**

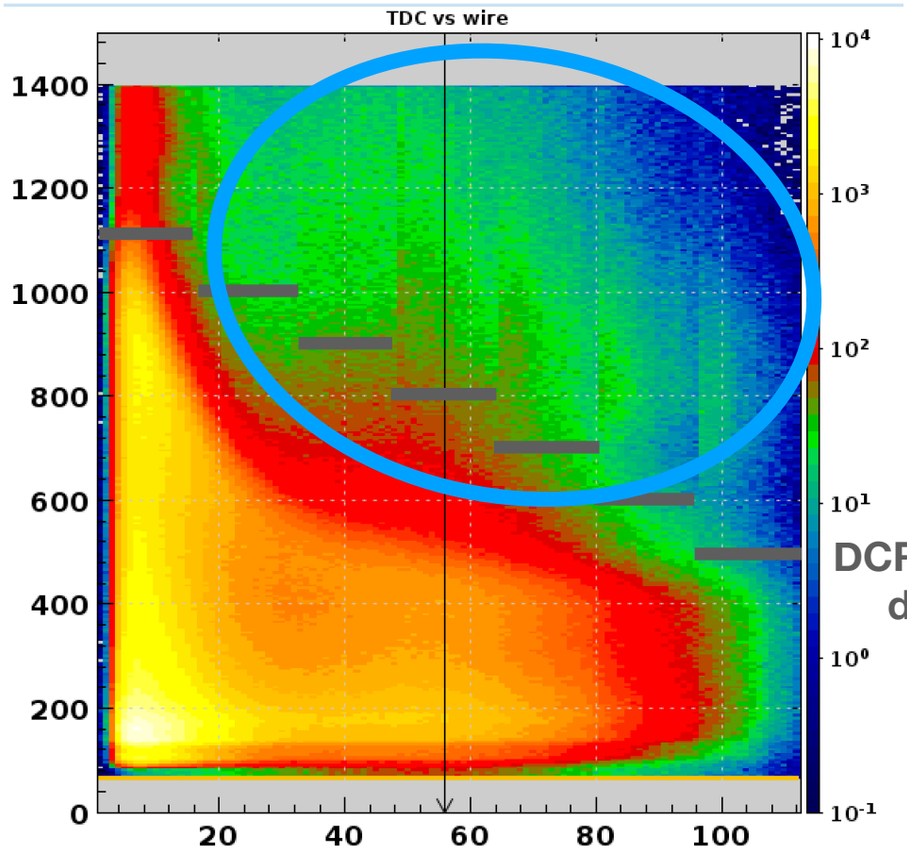
RGK Run 19527 - R2 Other Issues











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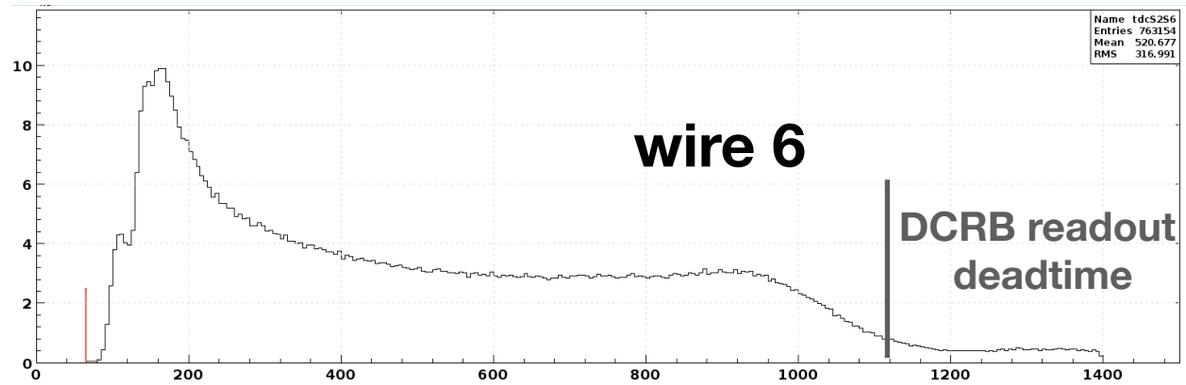
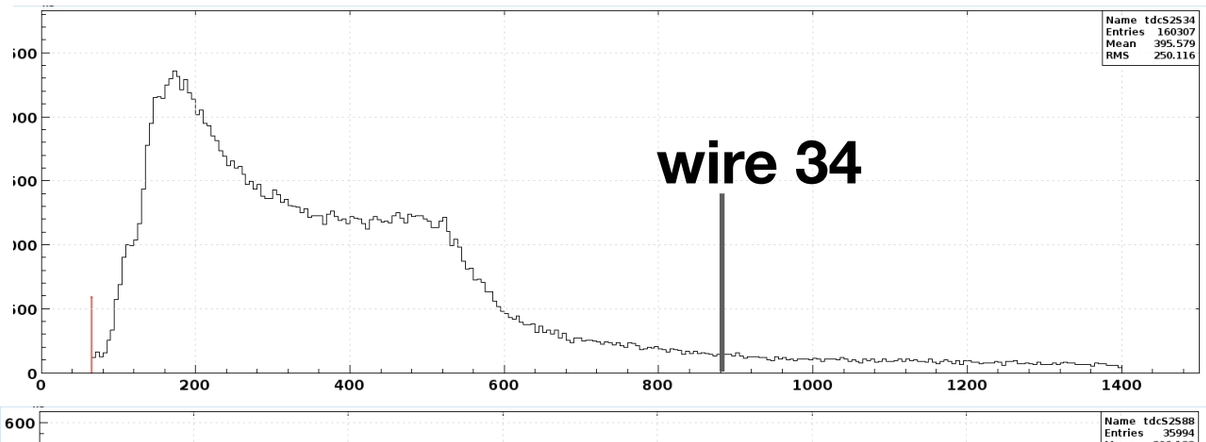
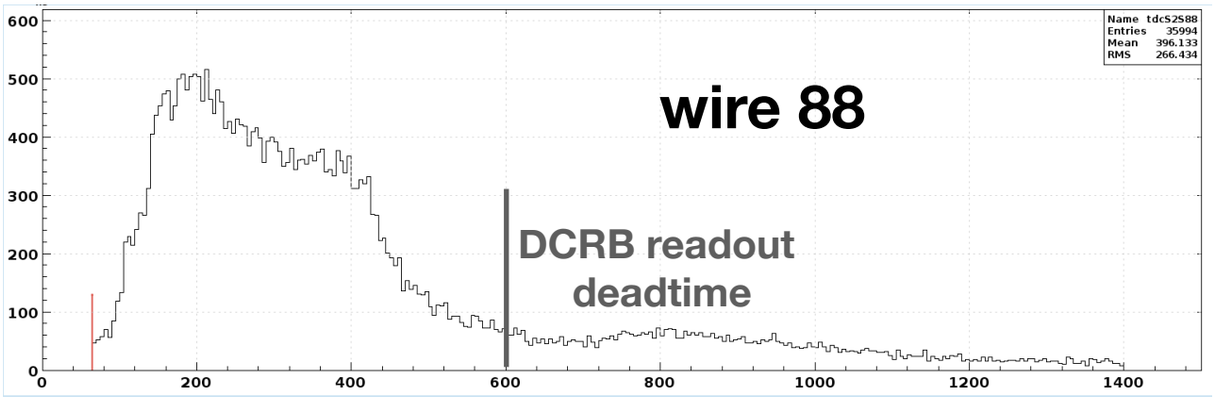
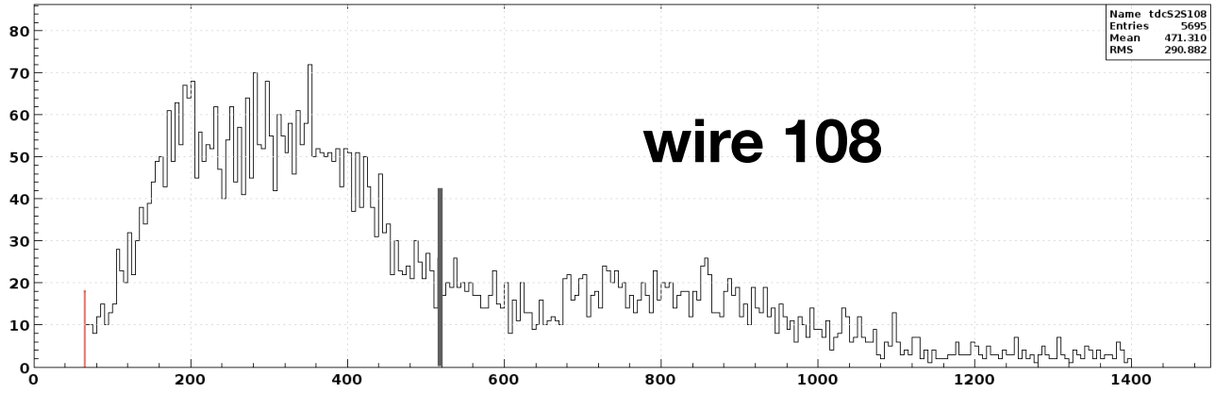
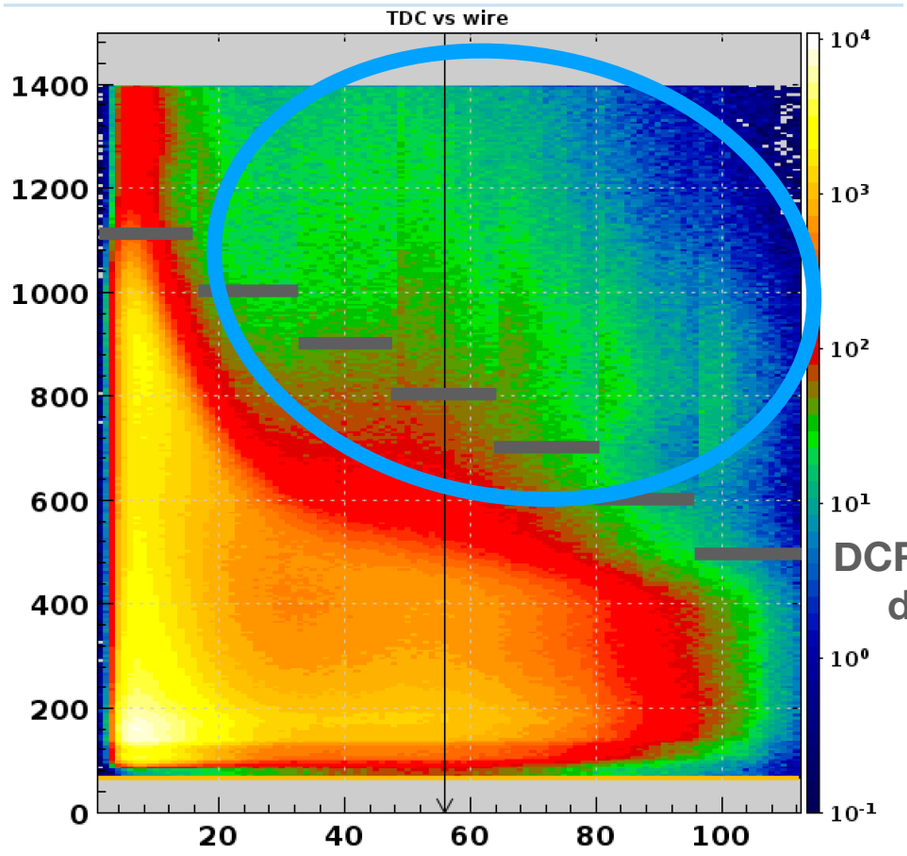








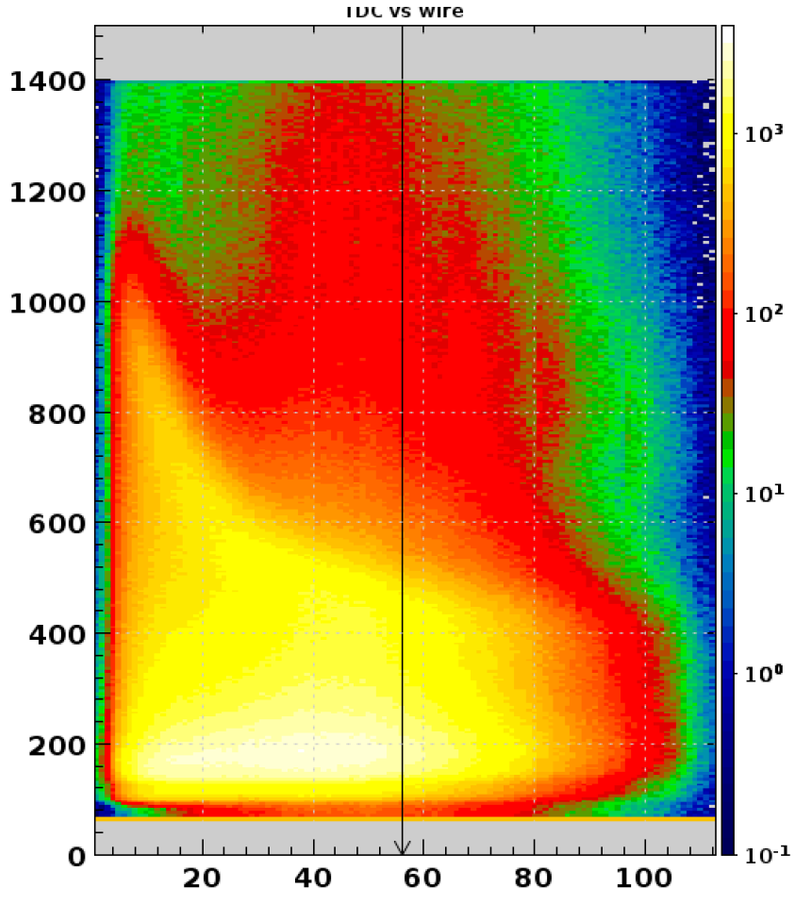


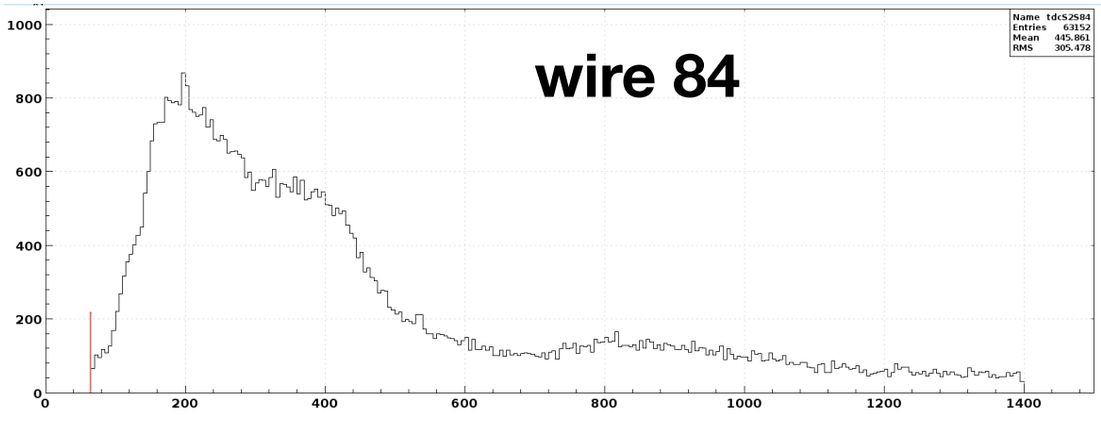
- **Secondary bump for larger wire numbers**

- **Origin: Double hits on a wire per event. Second hit overwrites first hit in decoder (coatjava 12 or lower). Only for times above DCRB dead time**
- **Fixed in coatjava > 13.0**

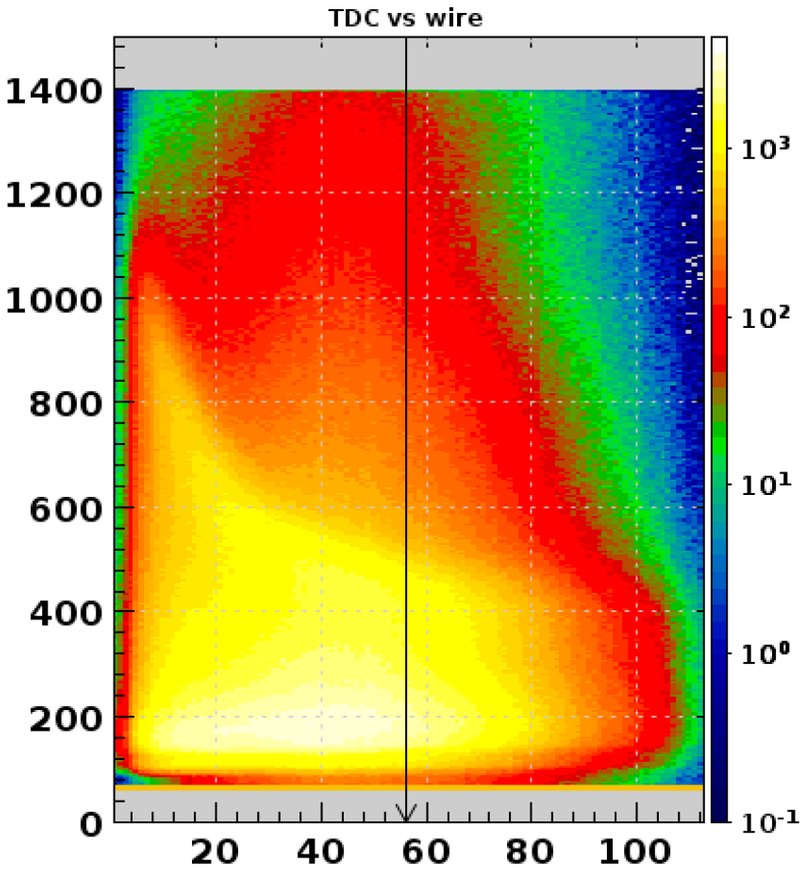
R2 Comparison for RGE (coatjava 12 and 13)

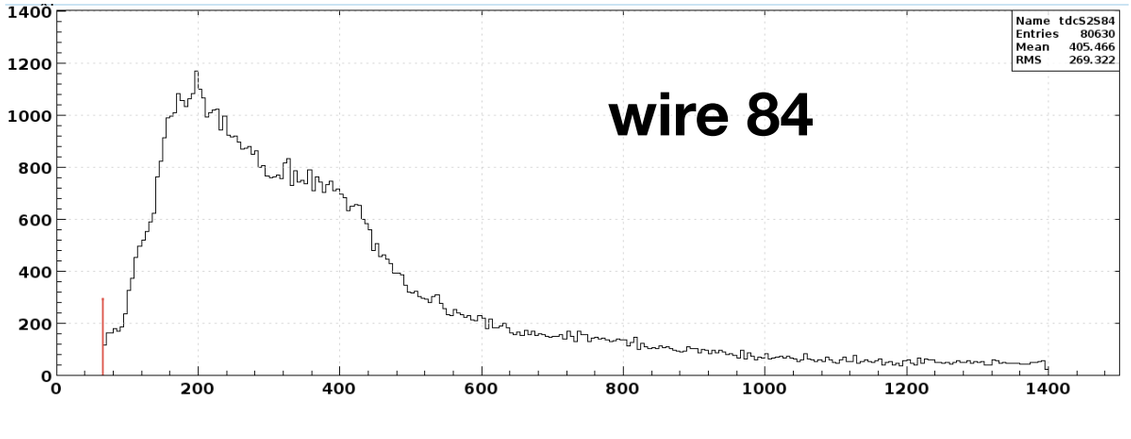
coatjava 12:
2nd hit on wire overwrites first





coatjava 13:
no overwrite of first hit in time





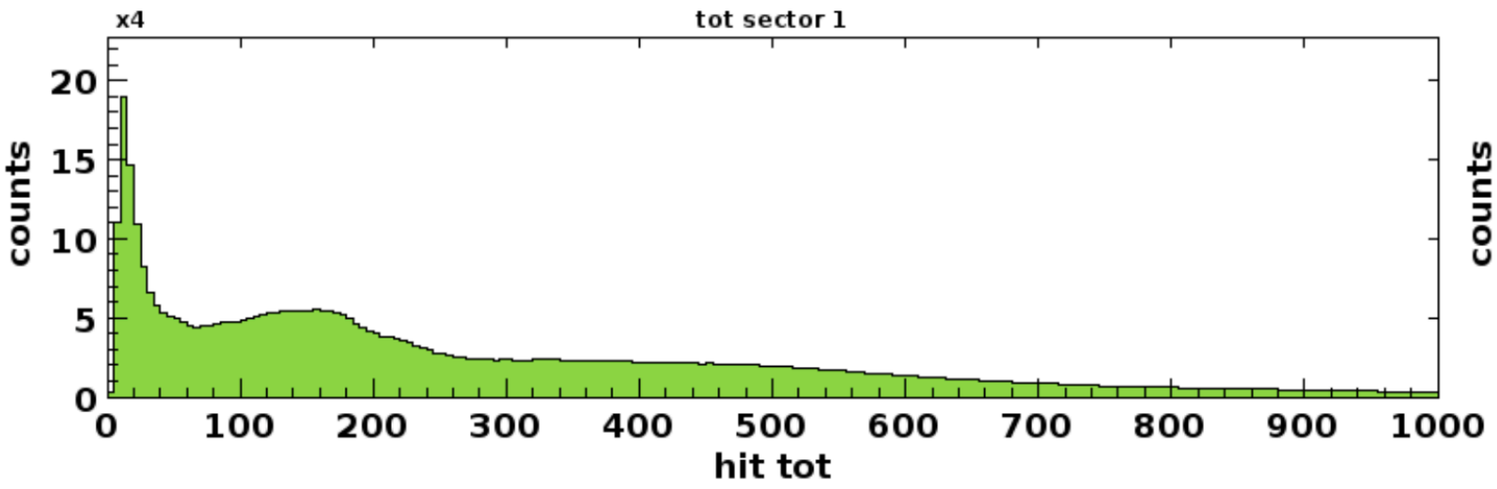
- **Issue fixed with new decoder**

ToT and Multihits with new firmware

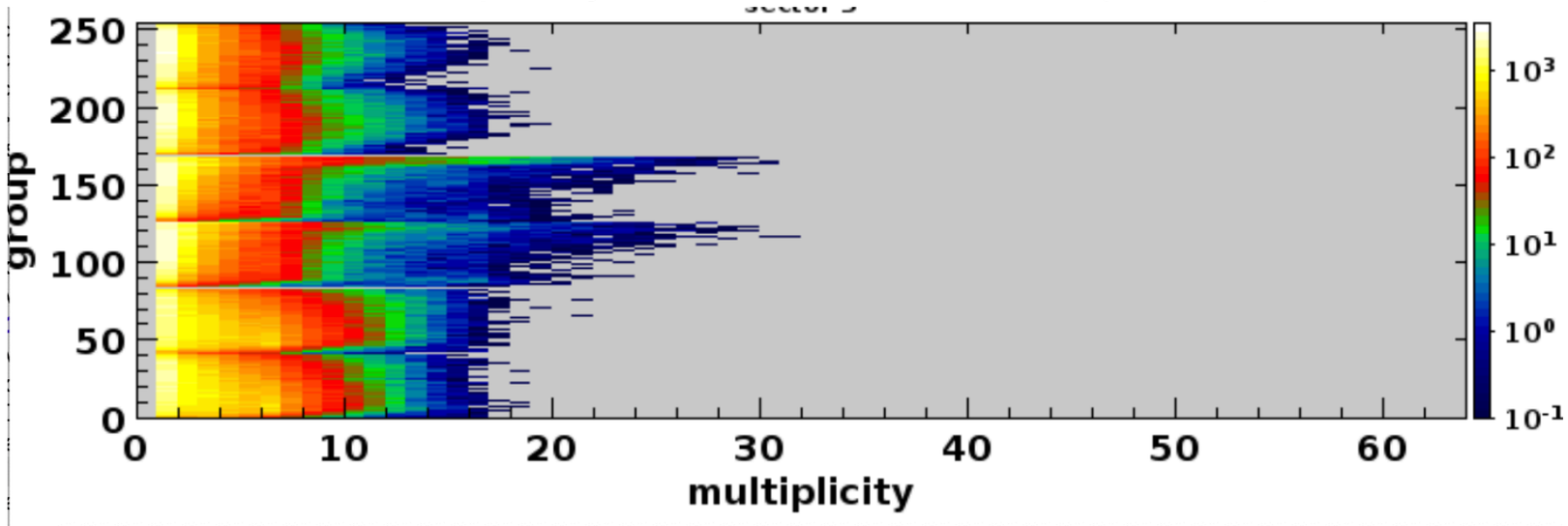
New DCRB Firmware

- **Trailing Edges of hits are recorded —> Time-over-threshold is known**
- **More than one hit per wire is allowed (dead time is 4ns)**
- **Monitoring/correction of single event upsets (SEU) which recently showed up more often**

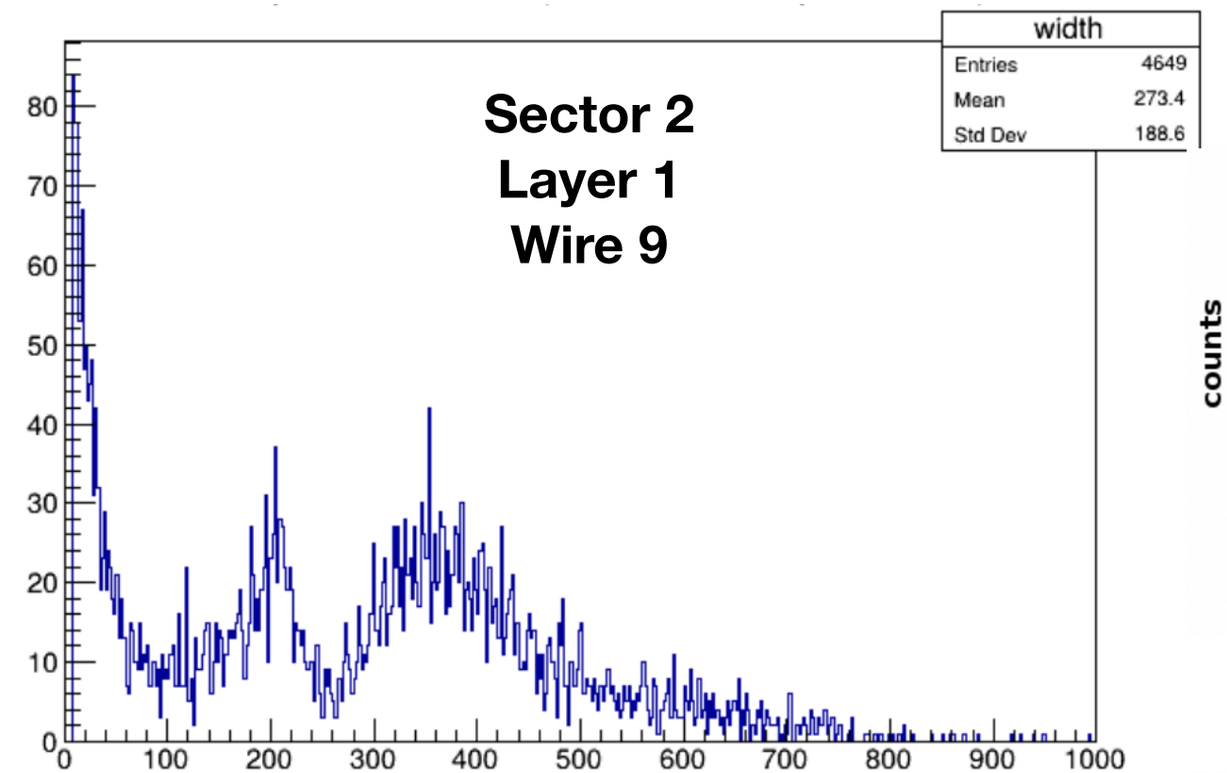
ToT spectrum Sector 1 Run 22389 (ALERT)



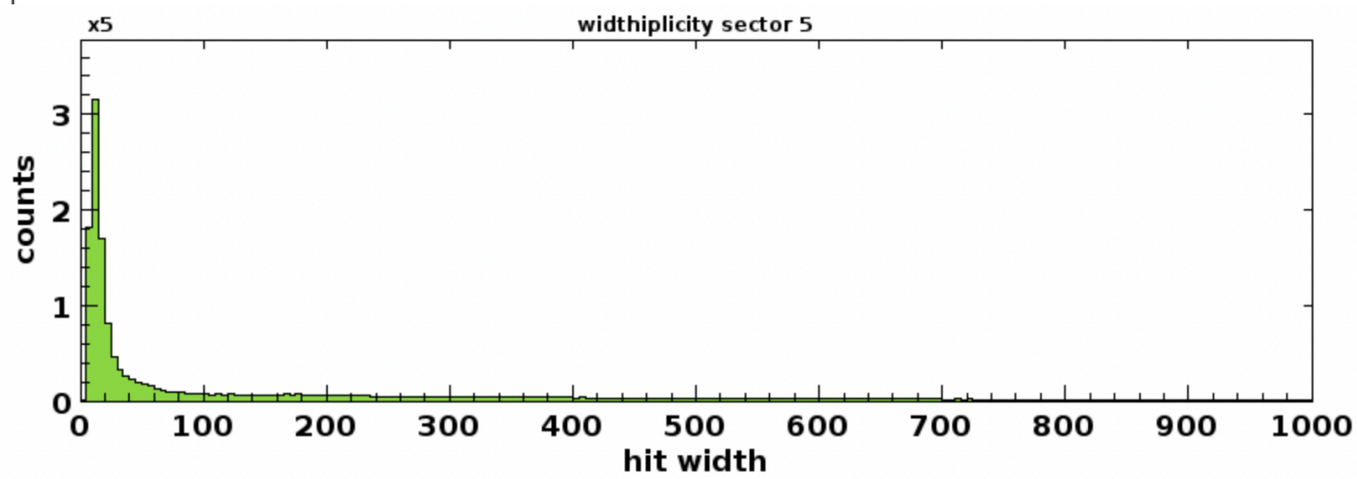
Hit Multiplicity Sector 1 Run 22389 (ALERT)



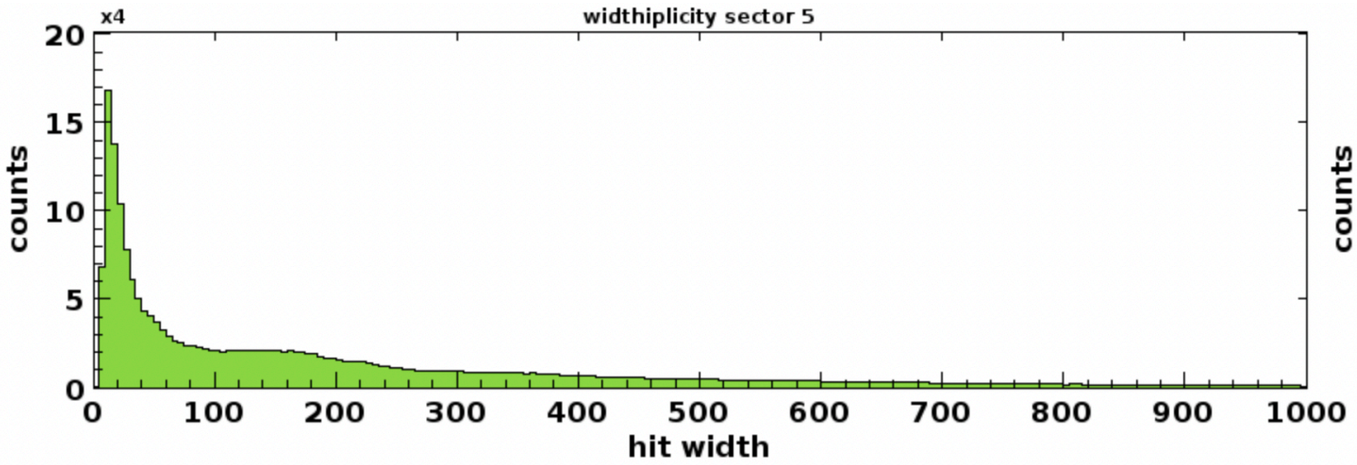
ToT Spectrum correlates with DCRB threshold



Run 20285 (low DCRB threshold)



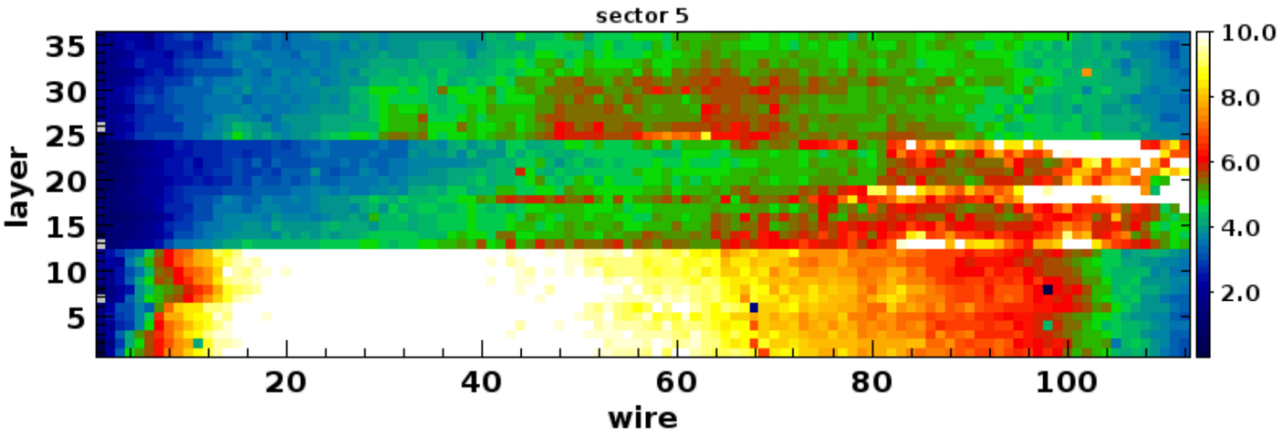
Run 20284 (high DCRB thresholds)

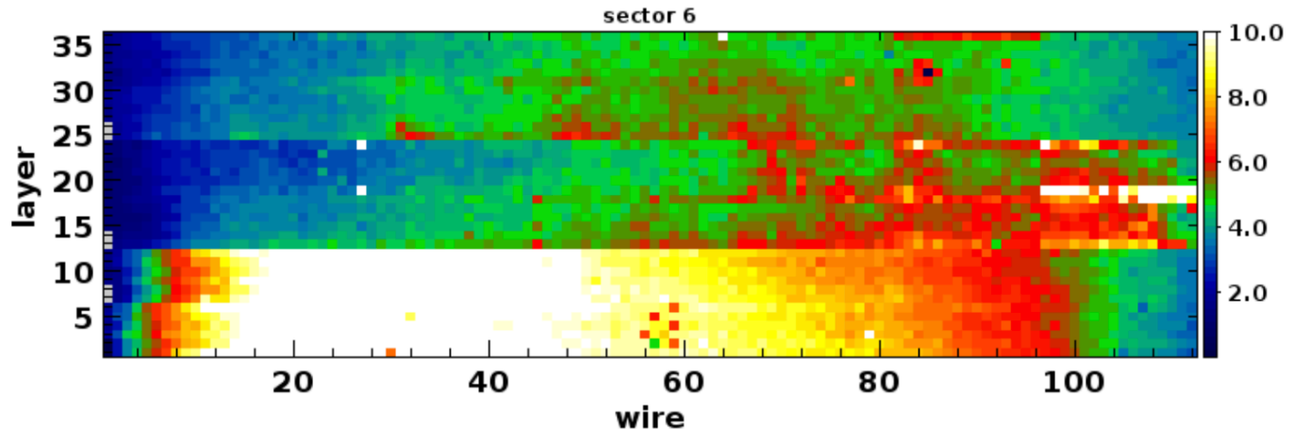


- **Low width correlated with noisy hits**
- **More noisy hits with lower thresholds as expected**

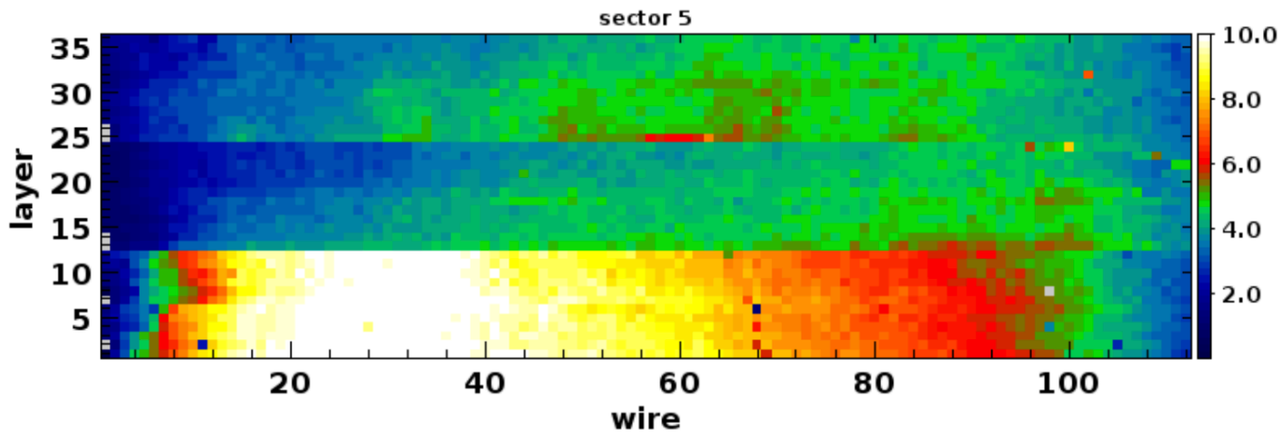
ToT Cut removes noise

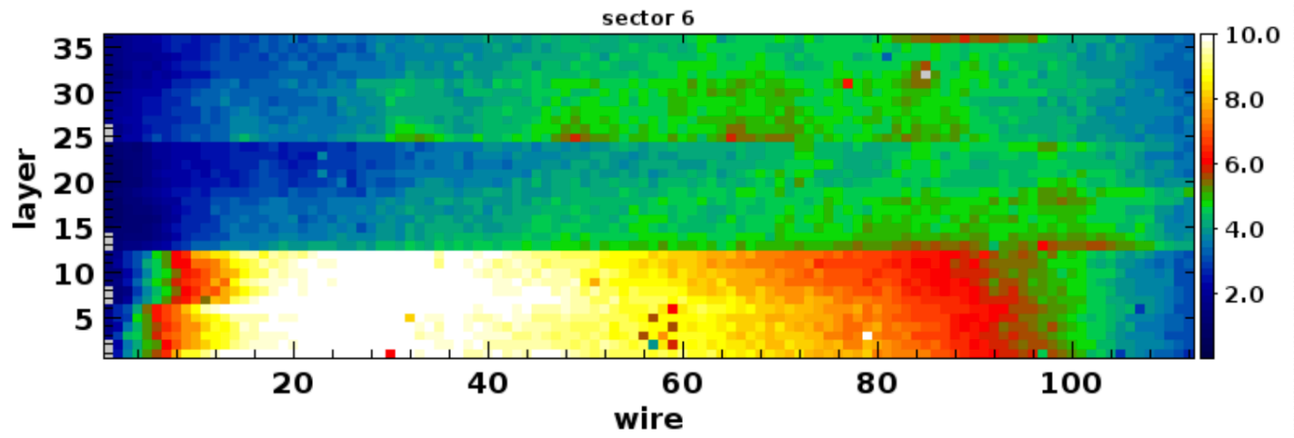
- **DC Occupancy ALERT Run 22389 - 325nA on He**





- **DC Occupancy ALERT Run 22389 with 40ns ToT cut - 325nA on He**





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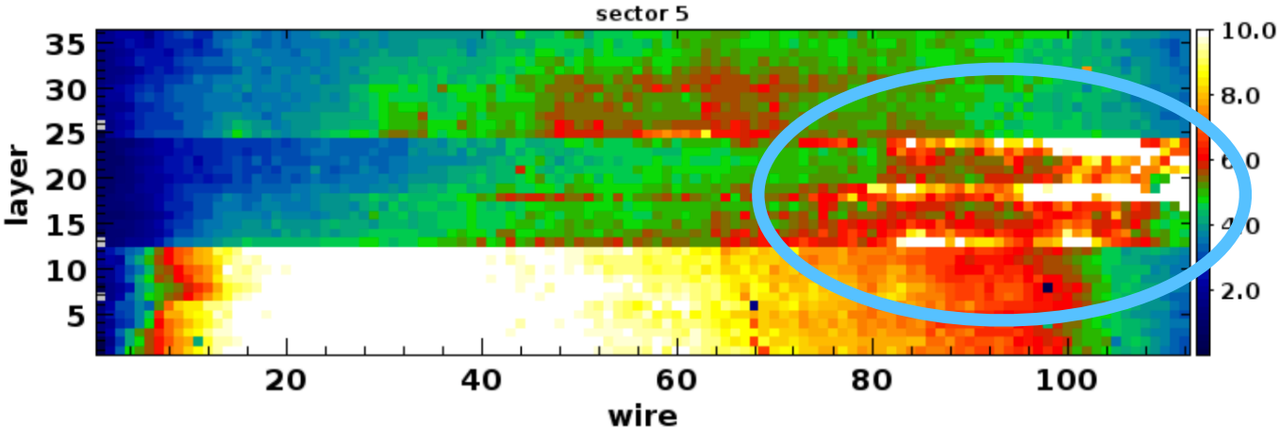

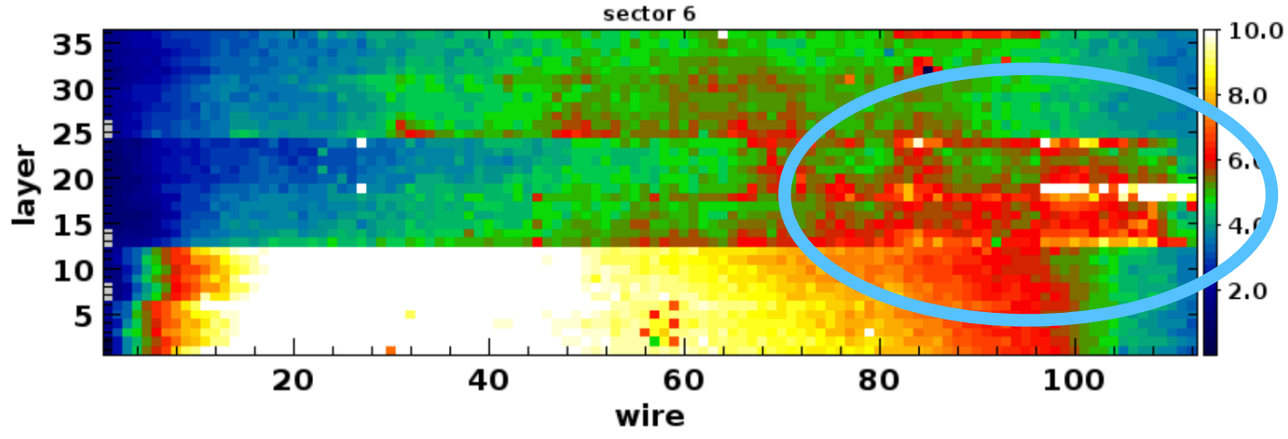

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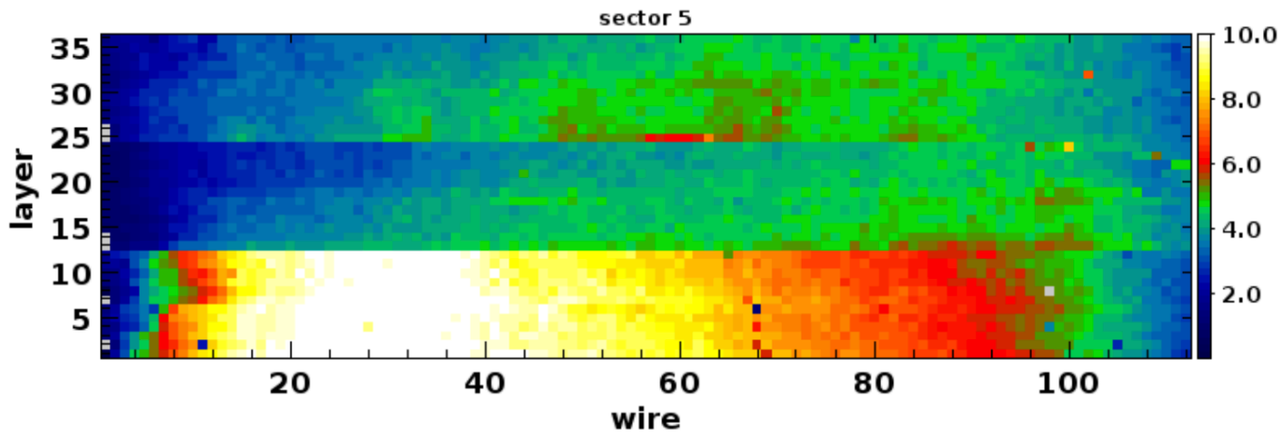
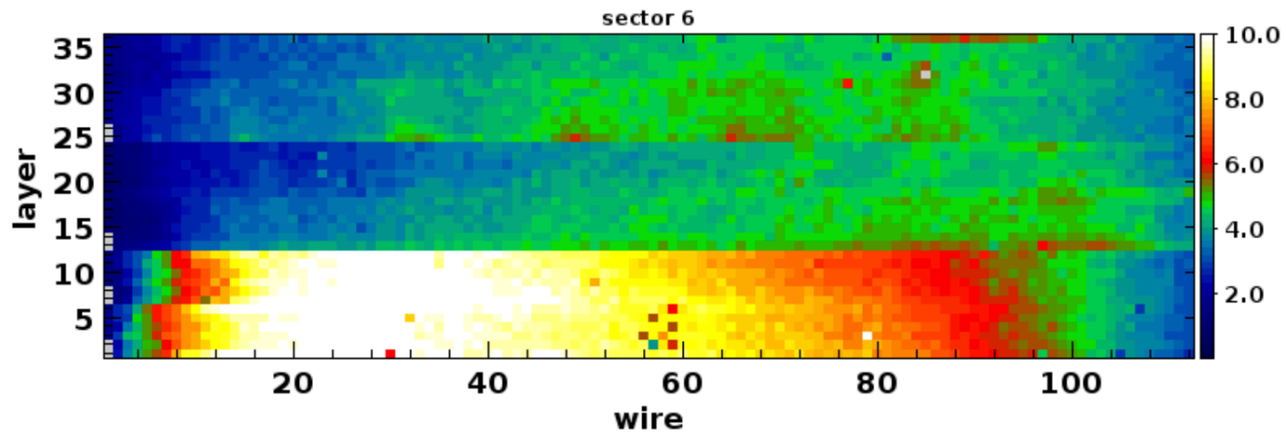
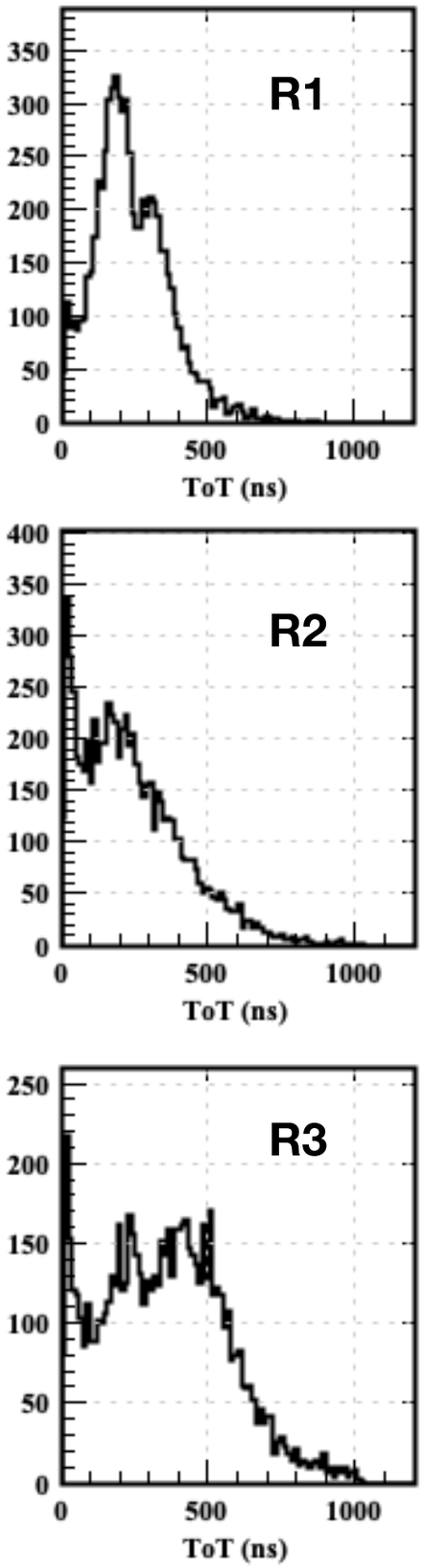




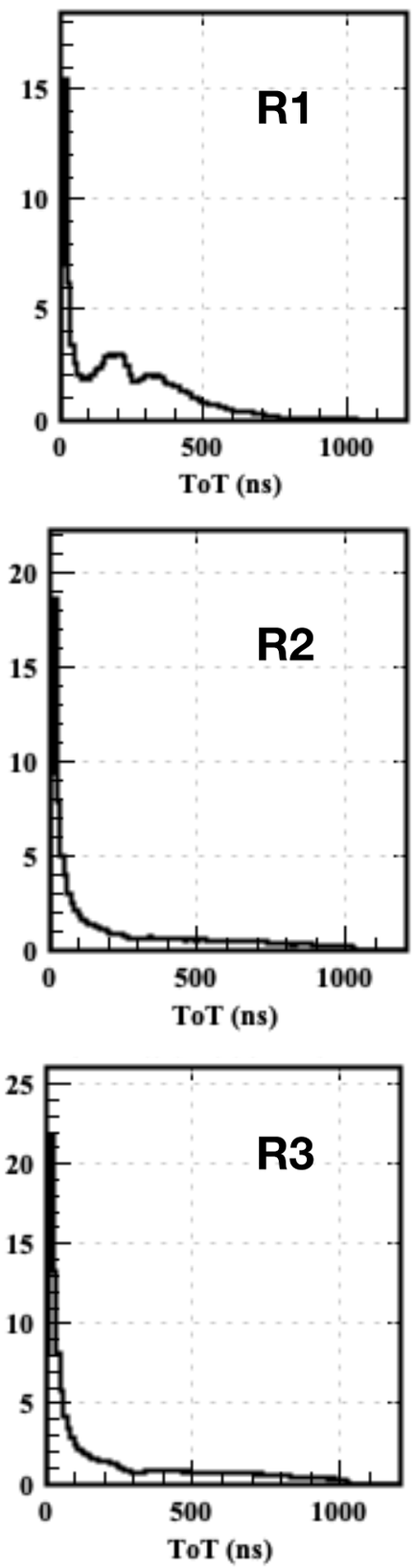
- **R2 areas cleaned from vacuum pump noise (typically short signals)**

ToT for Reconstructed Hits (Raffaella)

hits on tracks



hits not on tracks



- **Analysis done for run 20287 (35nA, LD2+Pb target), Sector 2 and 5 with new firmware**
- **Modified coatjava version to handle ToT and multiple hits per wire**
- **Kept first hit in time window (no ToT cut)**

- **More studies in the next months**

GEMC Matching Improvements

DC Geometry (work by Raffaella in 2024)

- DC cells changed to hexagons instead of rectangles
  - affect resolution and efficiency

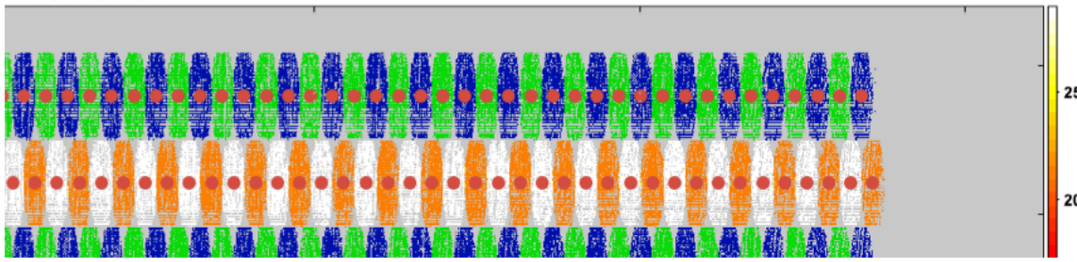
- Removal of non-existing wires in the first two layers of super layers 1, 2, 3 and 5

- 300μm shift of wire positions in SL 5 and 6 to account for mini stagger of reference wire

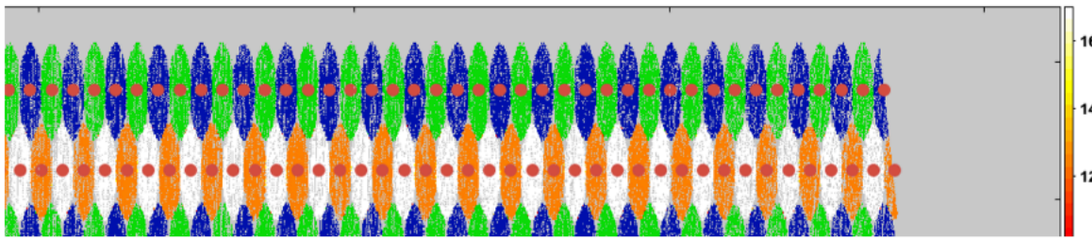
- Implementation of wire feed-throughs
  - Shifts along wire direction
  - Change of stereo angle

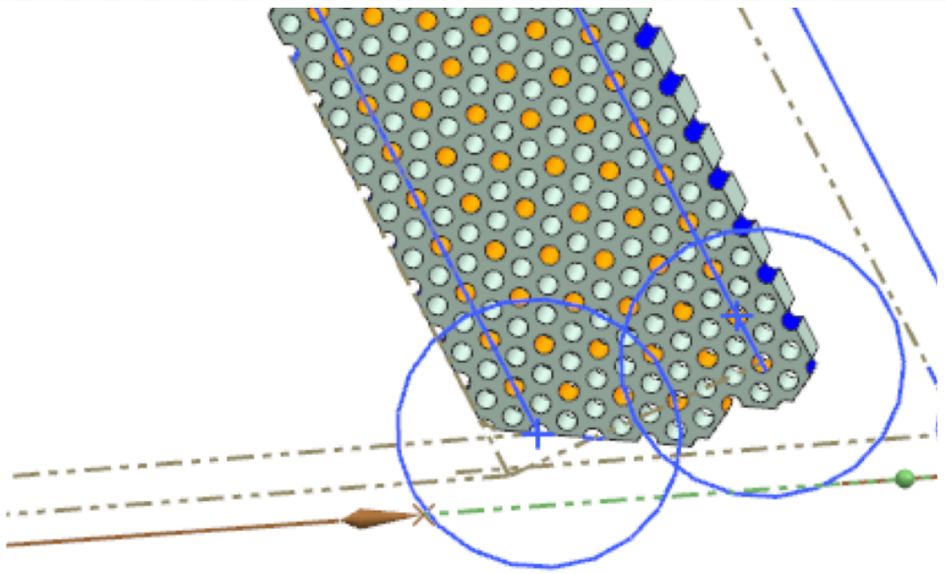
- Open tasks:
  - Phi coverage in Region 2 seems larger in simulation than in data
  - CLAS12 Note with details on updated geometry

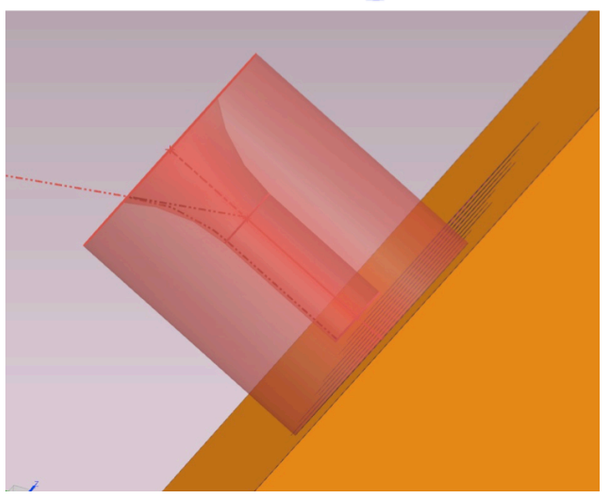
Before:



After:

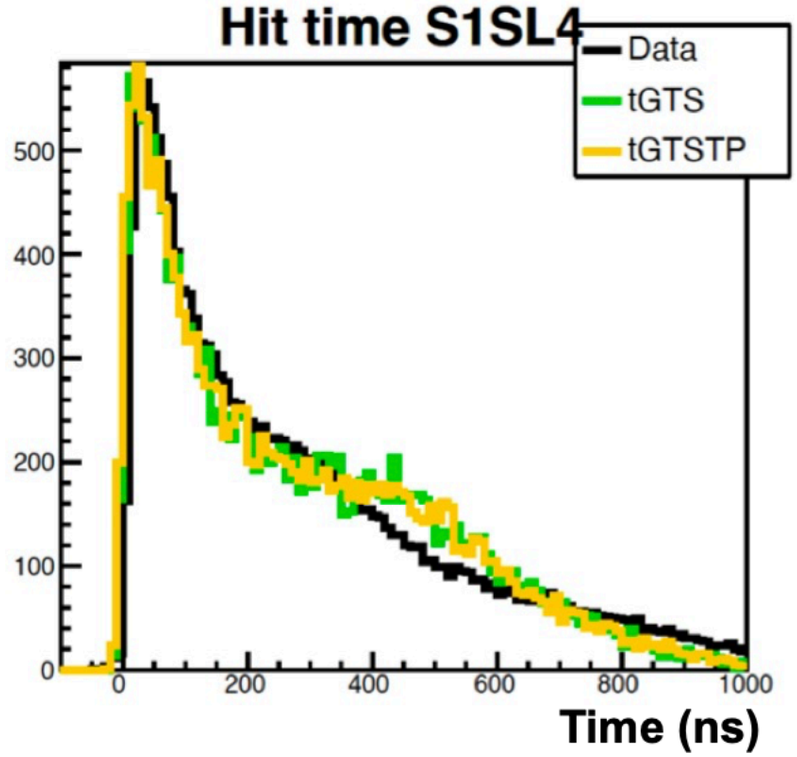






DC Data-MC Matching Update

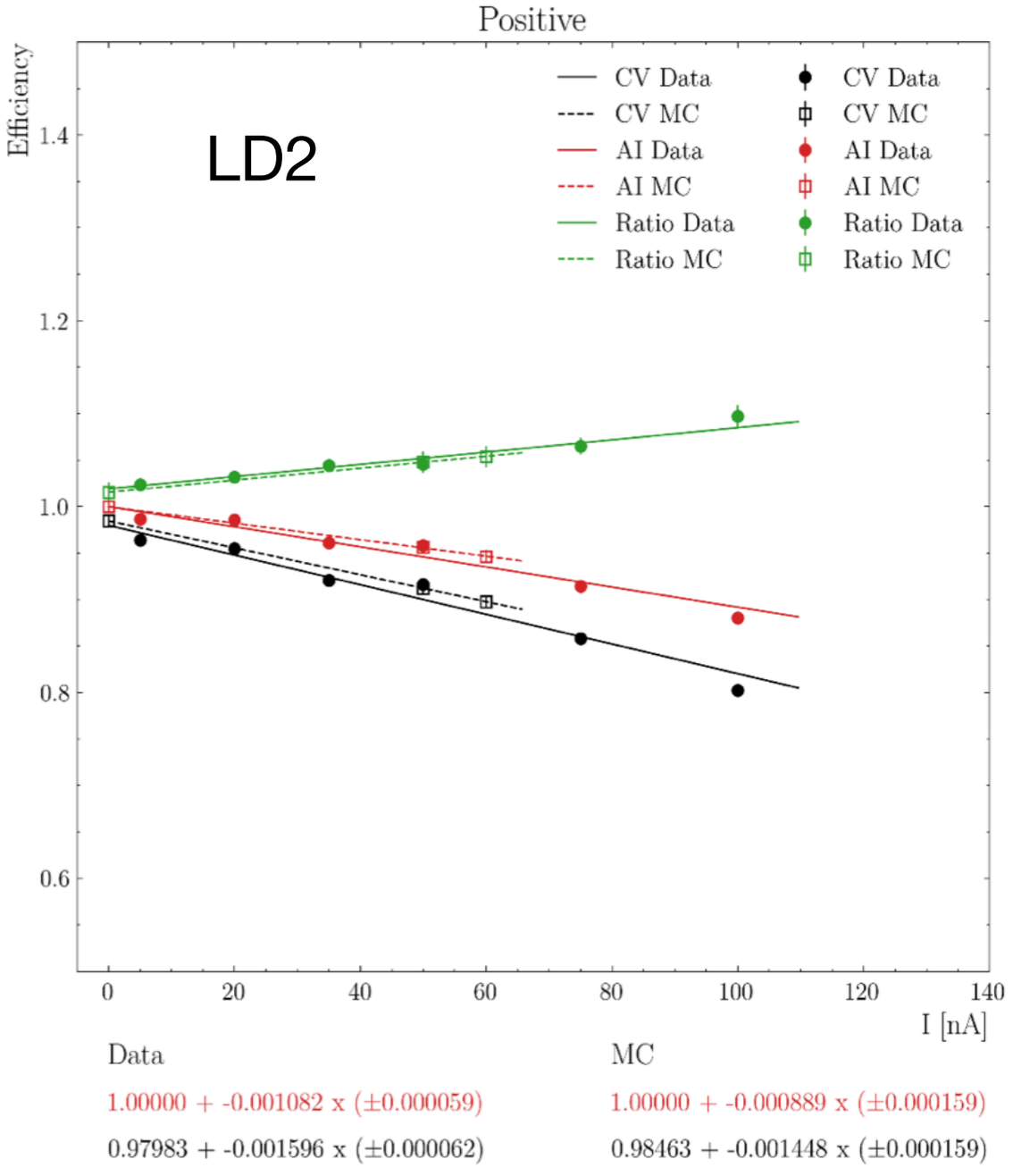
- **Updates to DC digitization (2024):**
  - **Missing terms added to simulated time(TProp, TFlight)**
  - **Optimization of smearing function**
  - **Read from new pressure dependent T2D tables**
- **Findings from initial tests:**
  - **Bias in calibrated time offsets for MC**
  - **Simulated doca dependent inefficiency might not be correct**
- **Plans for next month:**
  - **T0/T2D Calibration of MC to study impact on resolution of biases**
  - **Calibration of smearing and inefficiency function for each run group and HV setting**
  - **Make Time-to-distance function run dependent i.e. pressure dependent**

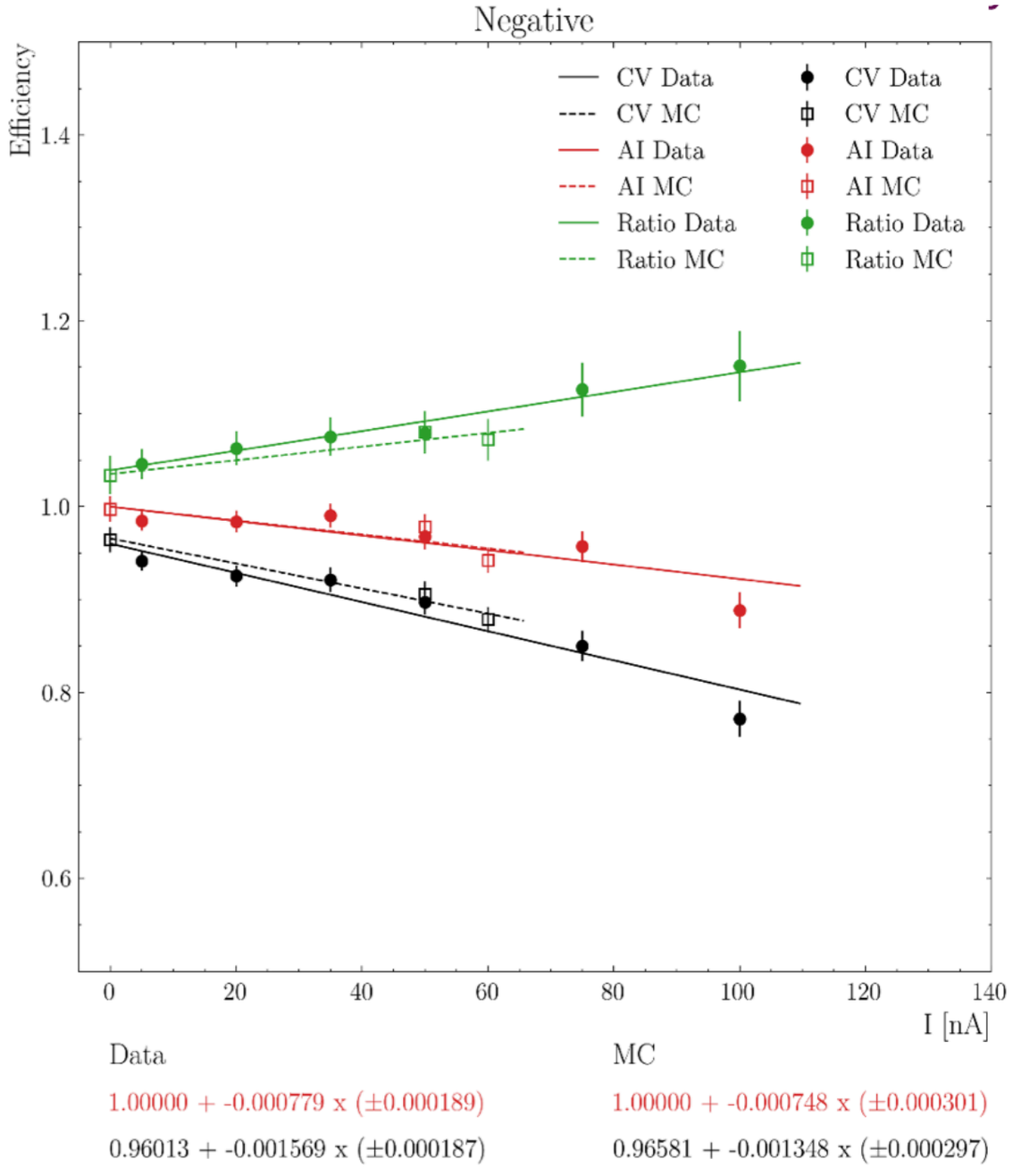


Comparison data and MC hit time including particle flight time (IGTS) and propagation time along the wire (IGTSTP), courtesy of M. Tenorio Pita

Goal: Updated run-dependent DC digitization for v2 cooked data by the end of the year

Tracking Efficiency Matches well Data





Slide by Lamiaa from RGD cooking review

- **Best matching between slopes of data and MC so far - most likely due to increased HV and FT-off configuration compared to previous run groups**

Summary/Outlook

- **Version 2 - T2D Calibration works very well**
- **TDC window cuts:**
  - **New coatjava version (>14.x) and table - validation in progress**
  - **Updated calibration software by Veronique**
  - **New values for RGK/RGE soon**
- **Work in next months:**
  - **Study of Time-over-threshold cuts on reconstruction quality**
  - **Multihit handling in reconstruction**
  - **GEMC:**
    - **Calibrations for T2D, inefficiency and smearing functions to each rungroup**
    - **Run dependence of T2D values**