

GEn-II Timing: In Preparation for Pass 3

JACOB KOENEMANN

MARCH 3rd, 2026



Timing Calibration – Quick Overview

- The timing calibration process

Timing Calibration – Quick Overview

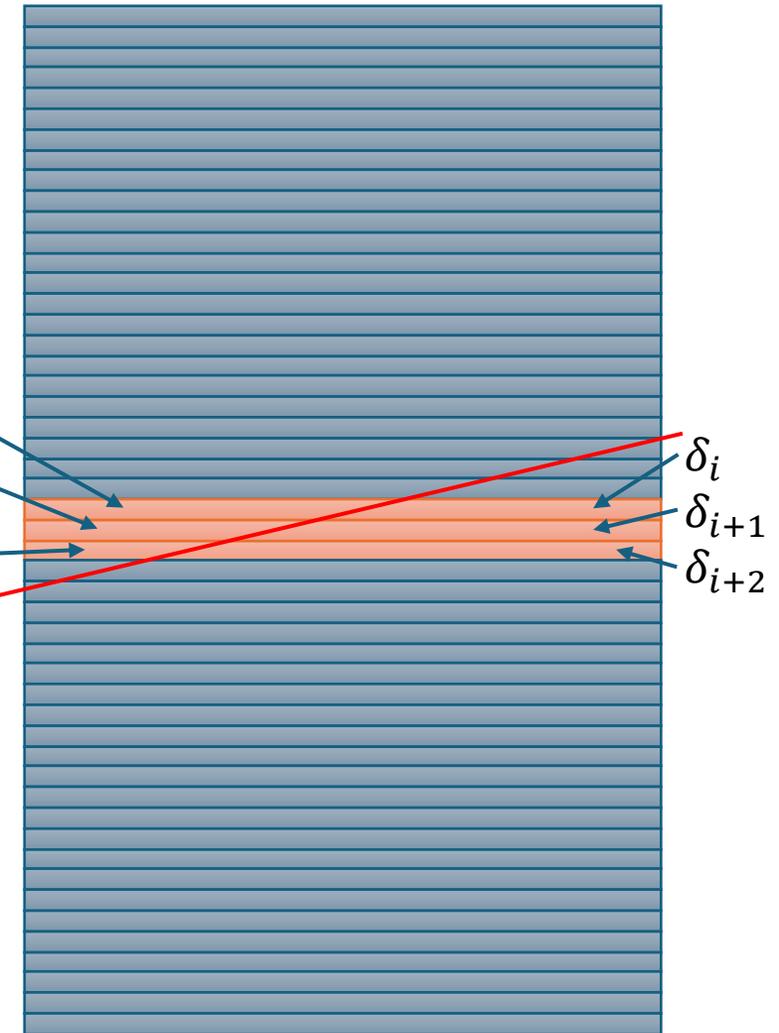
□ The timing calibration process

1. Internal Alignment of the Hodoscope

- An event will form a cluster on the detector.
- Each bar (or block) in a cluster should have a small time difference between each other.
 - hodoscope resolution $\sim 200\text{-}300\text{ps}$
- Minimize the χ^2 of the cluster difference for all events to extract the detectors offsets δ

$$\chi^2 = \sum_{k=1}^{N_{events}} \sum_{i < j} \left[[(\delta_i - \delta_j) - (t_i^k - t_j^k)]^2 \right]$$

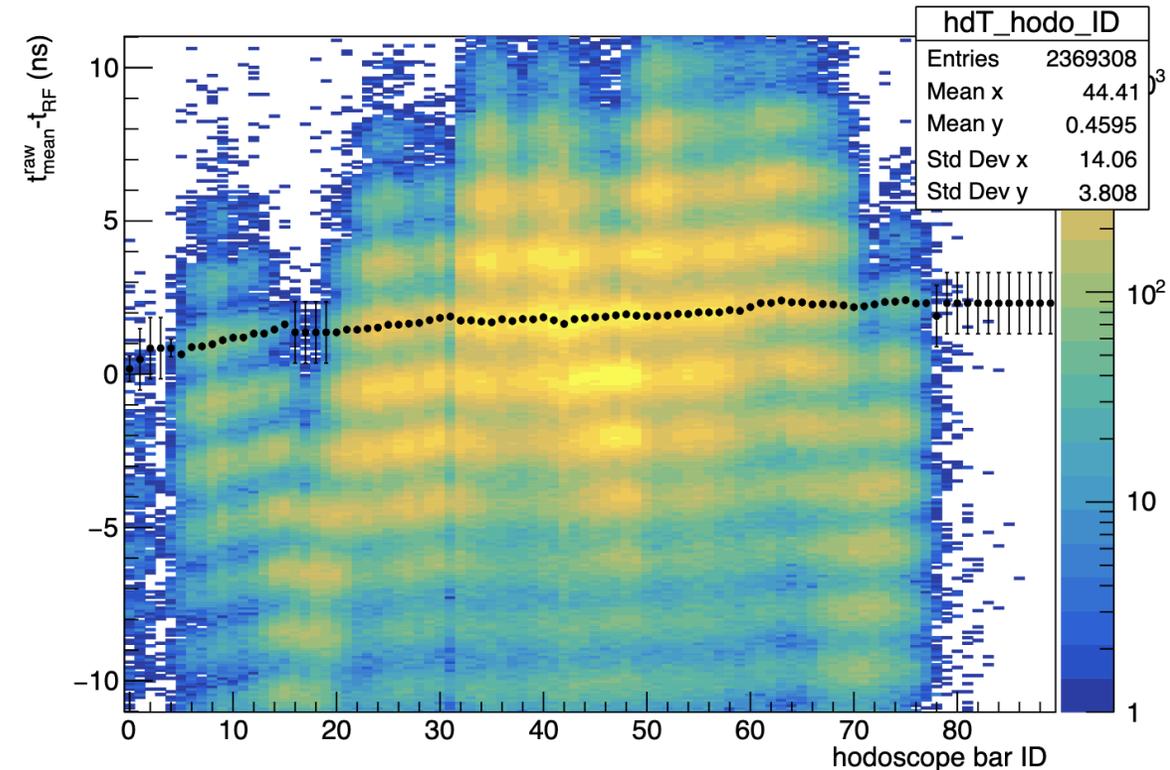
$$t_{meas} = t_{true} + \delta \pm \sigma_{hodo}$$



*not exact model of hodoscope. For illustrative purposes only

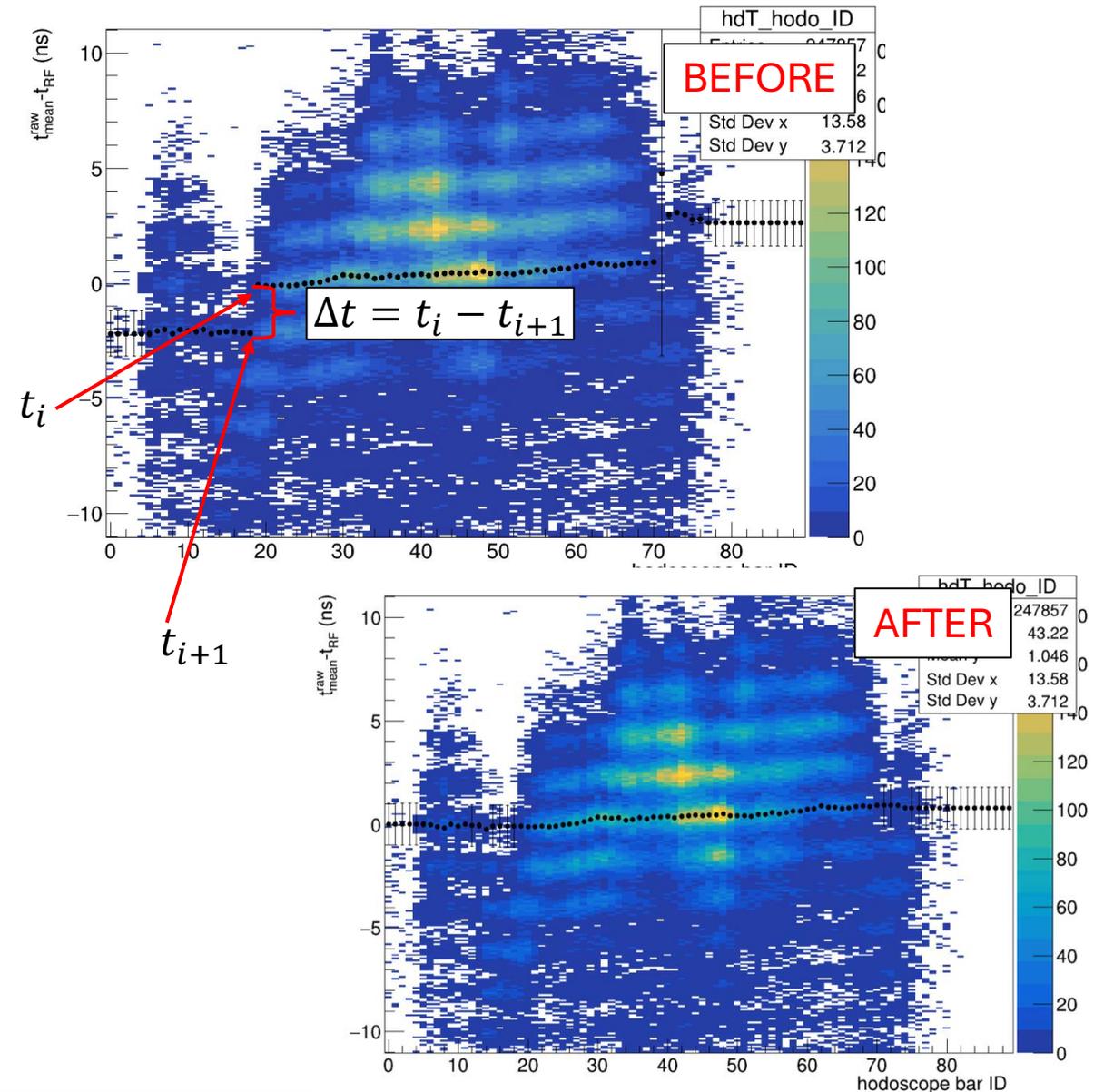
Timing Calibration – Quick Overview

- The timing calibration process
 1. Internal Alignment of the Hodoscope
 2. Alignment of hodoscope w/ accelerator RF pulse.
 - Accelerator RF time comes in at times modulo the beam bunch spacing (~2ns for GEn-II)



Timing Calibration – Quick Overview

- The timing calibration process
 1. Internal Alignment of the Hodoscope
 2. Alignment of hodoscope w/ accelerator RF pulse.
 - Accelerator RF time comes in at times modulo the beam bunch spacing ($\sim 2\text{ns}$ for GEn-II)
 - Made changes in the calibration script here to fix the alignment process for the dead bars in GEn-II
 - Put a condition on $|\Delta t| < 0.5\text{ns}$.
 - If true, then keep t_{i+1}
 - If false, $t_{i+1} = t_i$

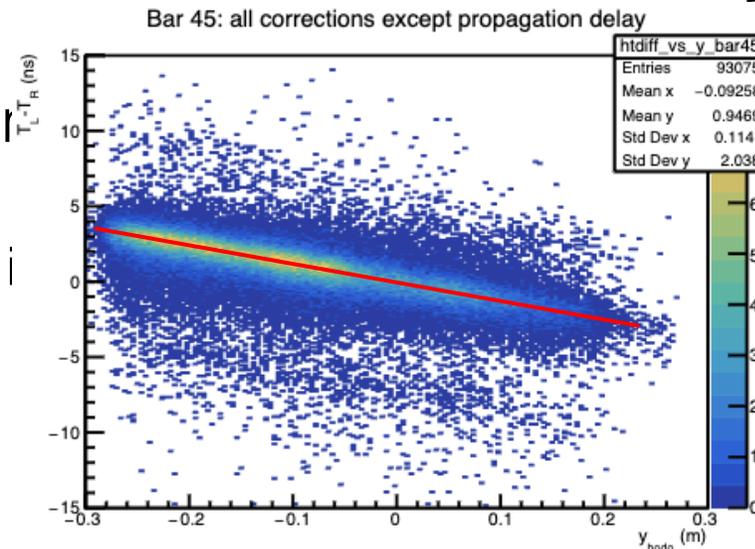
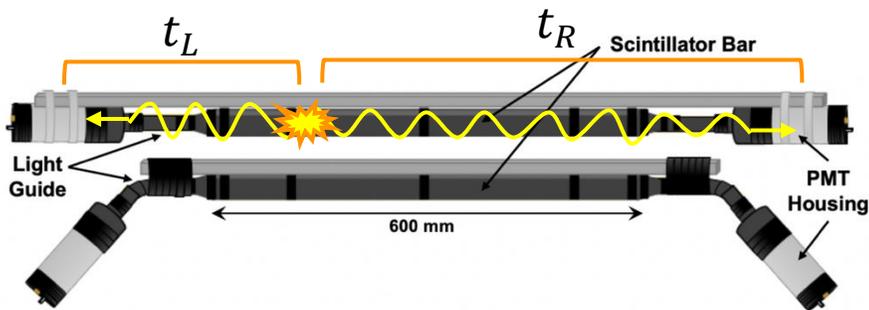


Timing Calibration – Quick Overview

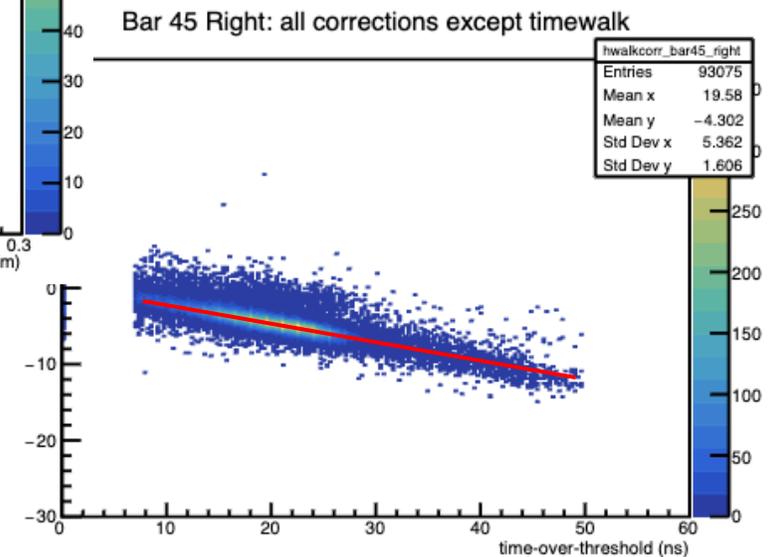
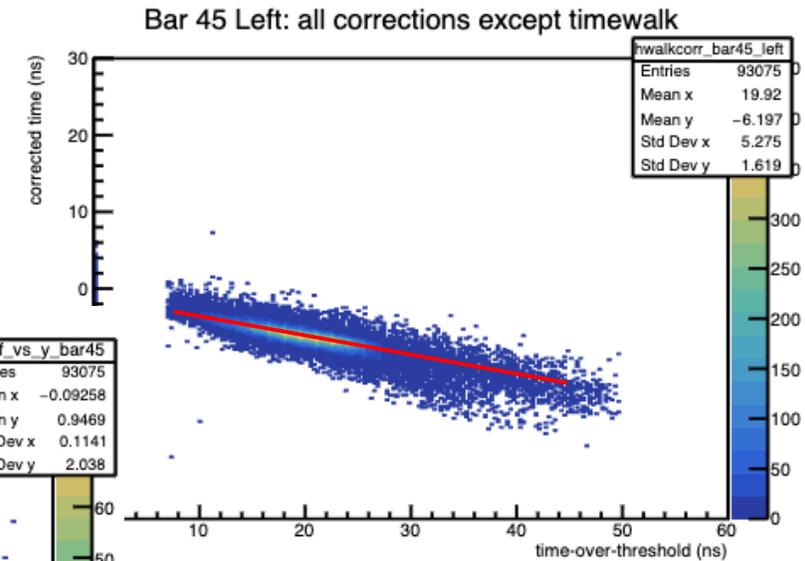
□ The timing calibration process

1. Internal Alignment of the Hodoscope
2. Alignment of hodoscope w/ accelerator RF pulse.
3. Internally align calorimeters, Hodoscope time walk and scint speed calibration.
 - Same process as Hodoscope i alignment.

$$t_{LE} = aToT$$

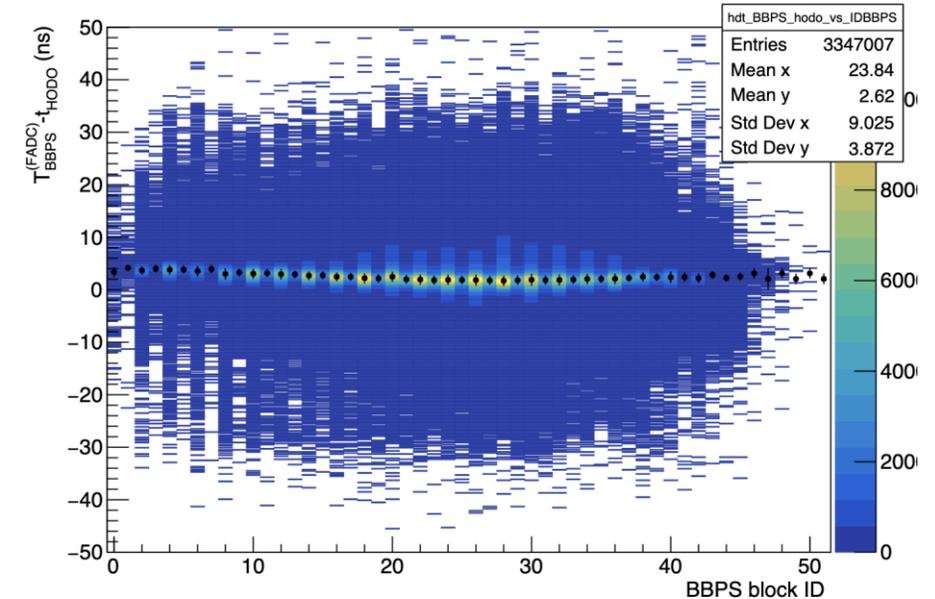
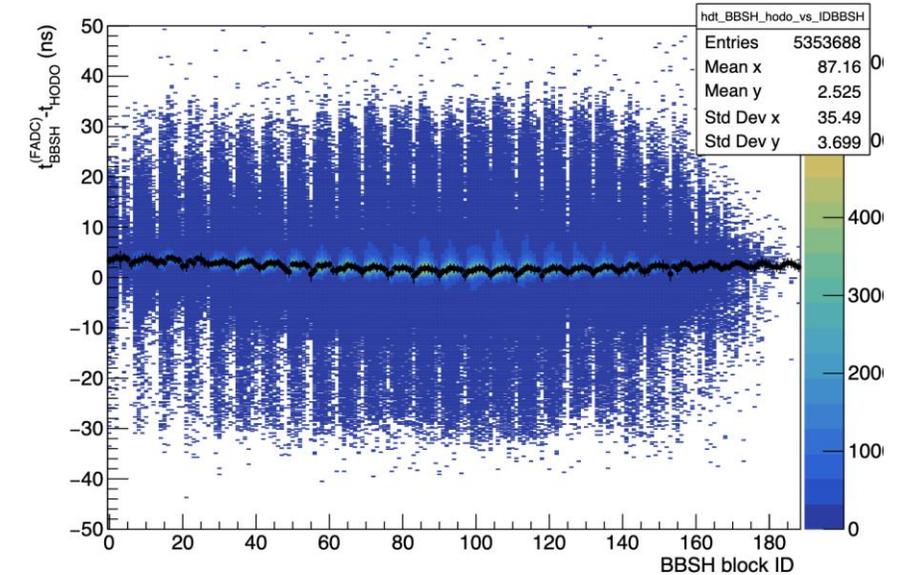
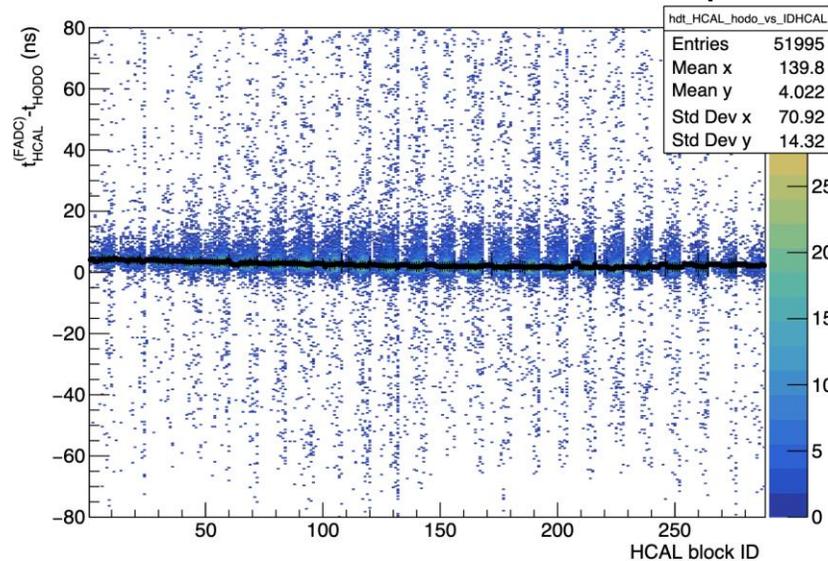


$$t_L - t_R = v_{scint} y_{hodo}$$



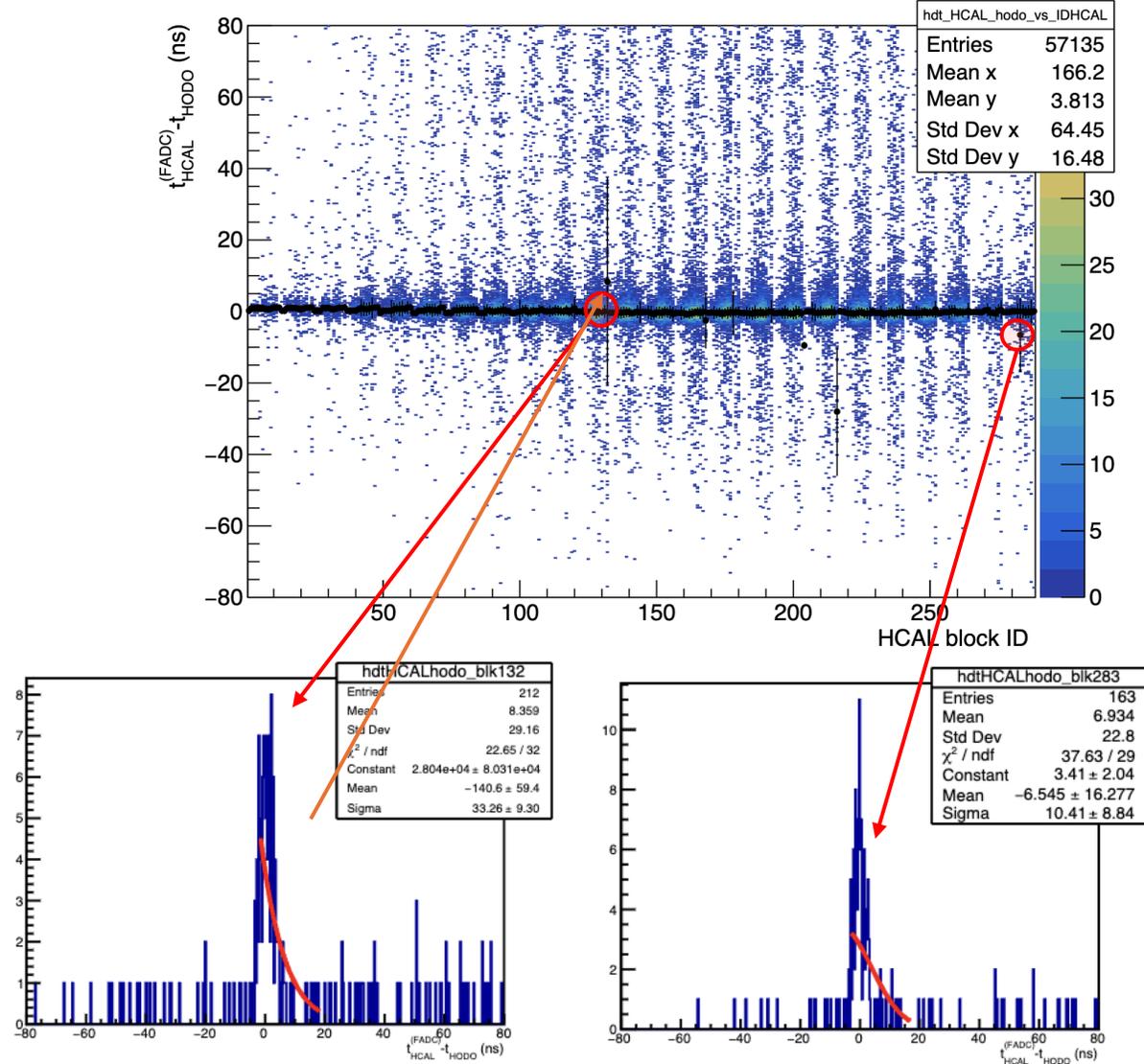
Timing Calibration – Quick Overview

- The timing calibration process
 1. Internal Alignment of the Hodoscope
 2. Alignment of hodoscope w/ accelerator RF pulse.
 3. Internally align calorimeters, Hodoscope time walk and scintillation speed calibration.
 4. Align calorimeters to Hodoscope



Timing Calibration – Quick Overview

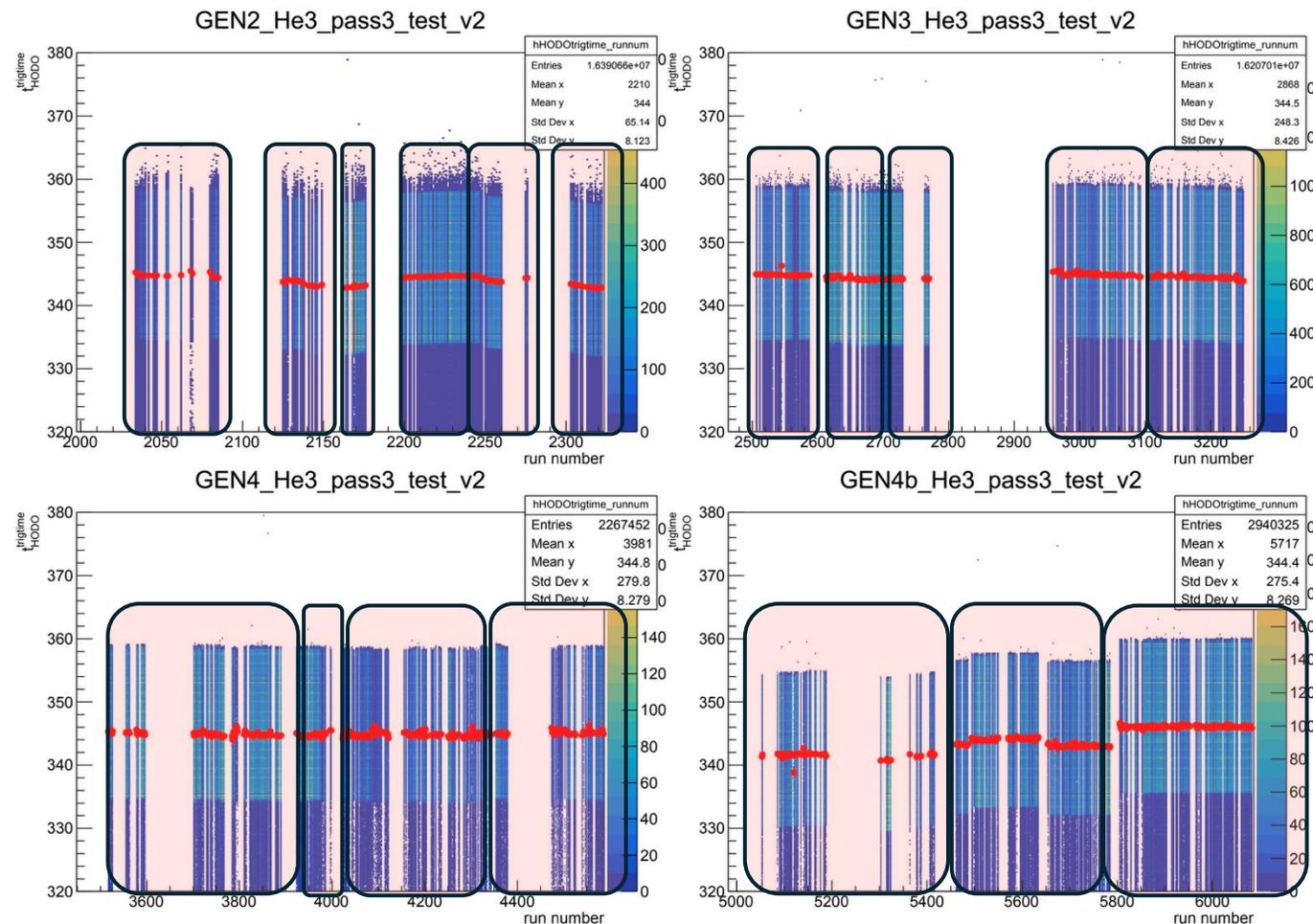
- The timing calibration process
 1. Internal Alignment of the Hodoscope
 2. Alignment of hodoscope w/ accelerator RF pulse.
 3. Internally align calorimeters, Hodoscope time walk and scintillation speed calibration.
 4. Align calorimeters to Hodoscope
 - Minor change to per bar peak fit
 - If $\sigma_{fit} > 4.0ns$ label block as “bad block” and use average of nearest neighbor blocks offset algorithm.



Towards Pass 3

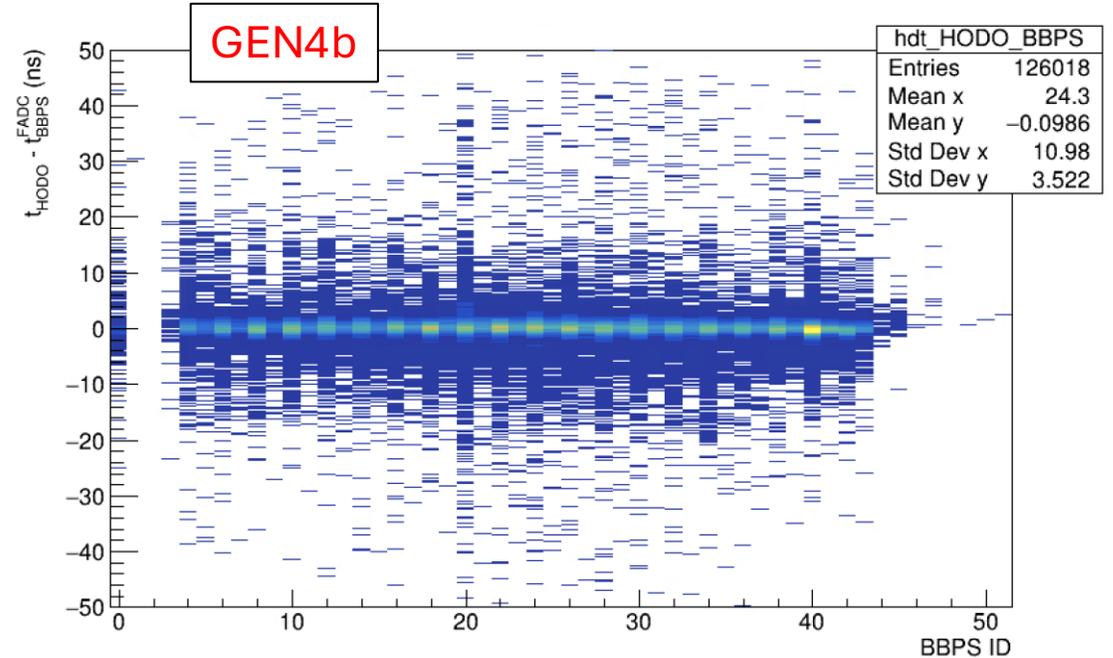
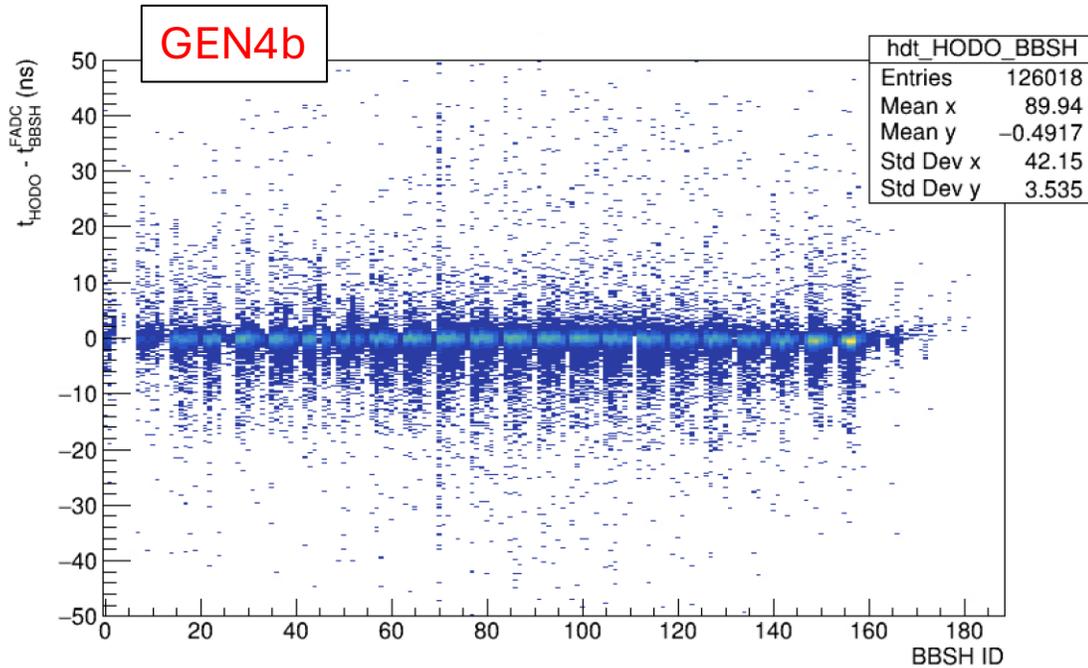
□ Current method for calibrating GEN-II timing

- ❖ Create groups of calibrations for each kinematic.
- ❖ Run the calibration script for each group.
- ❖ Timestamp the outputs separately in the database for the kinematics timing calibration.



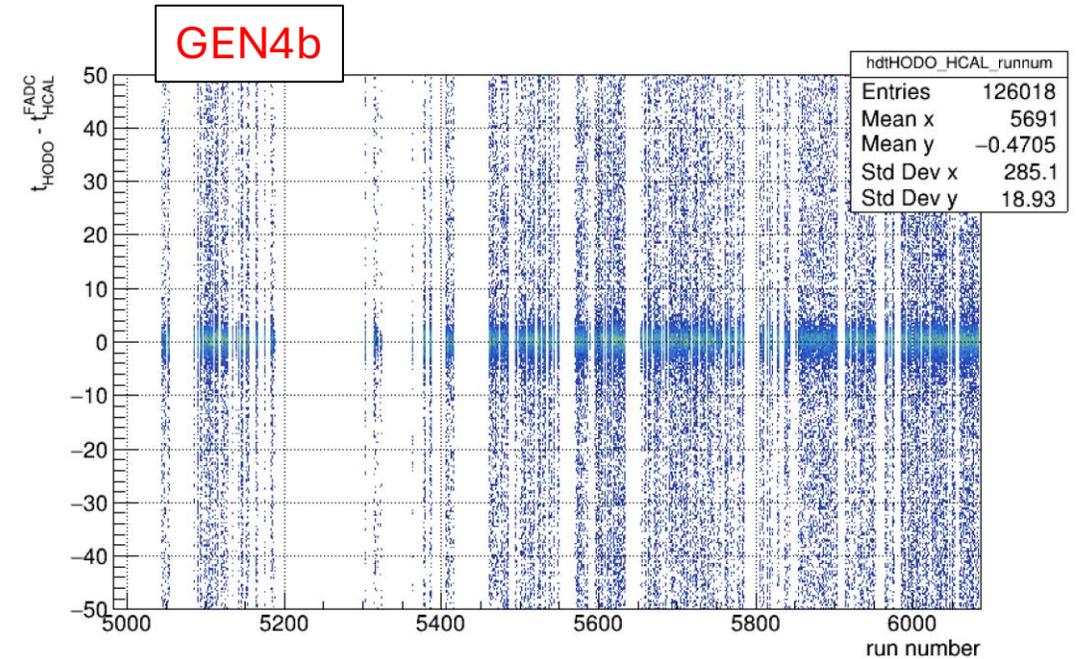
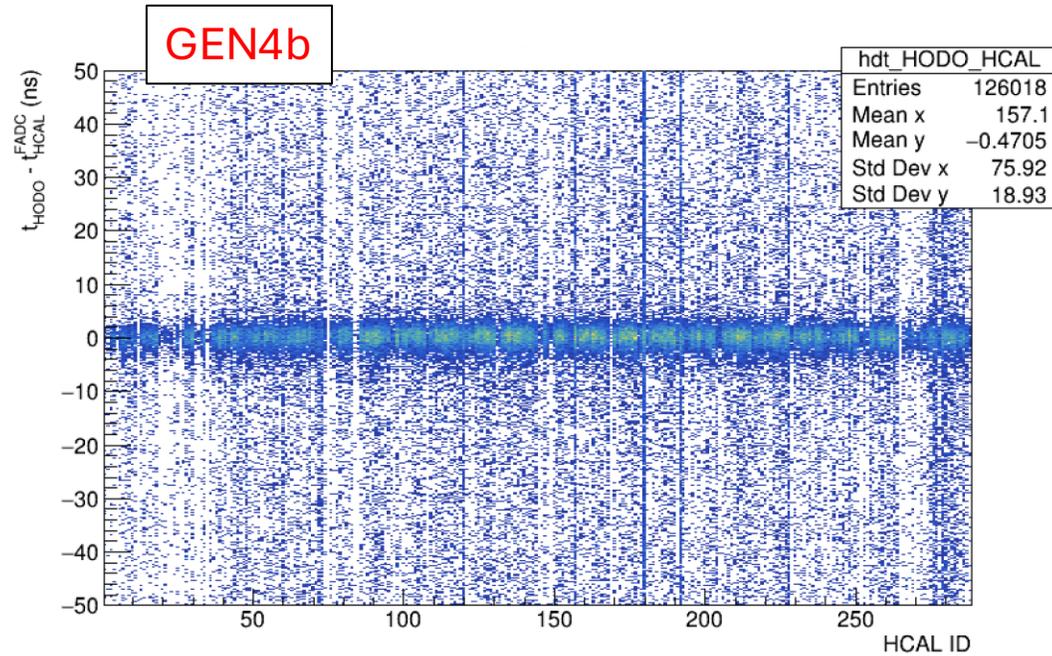
Towards Pass 3 cont.

- Preliminary results for timing calibration (only have GEN4b)



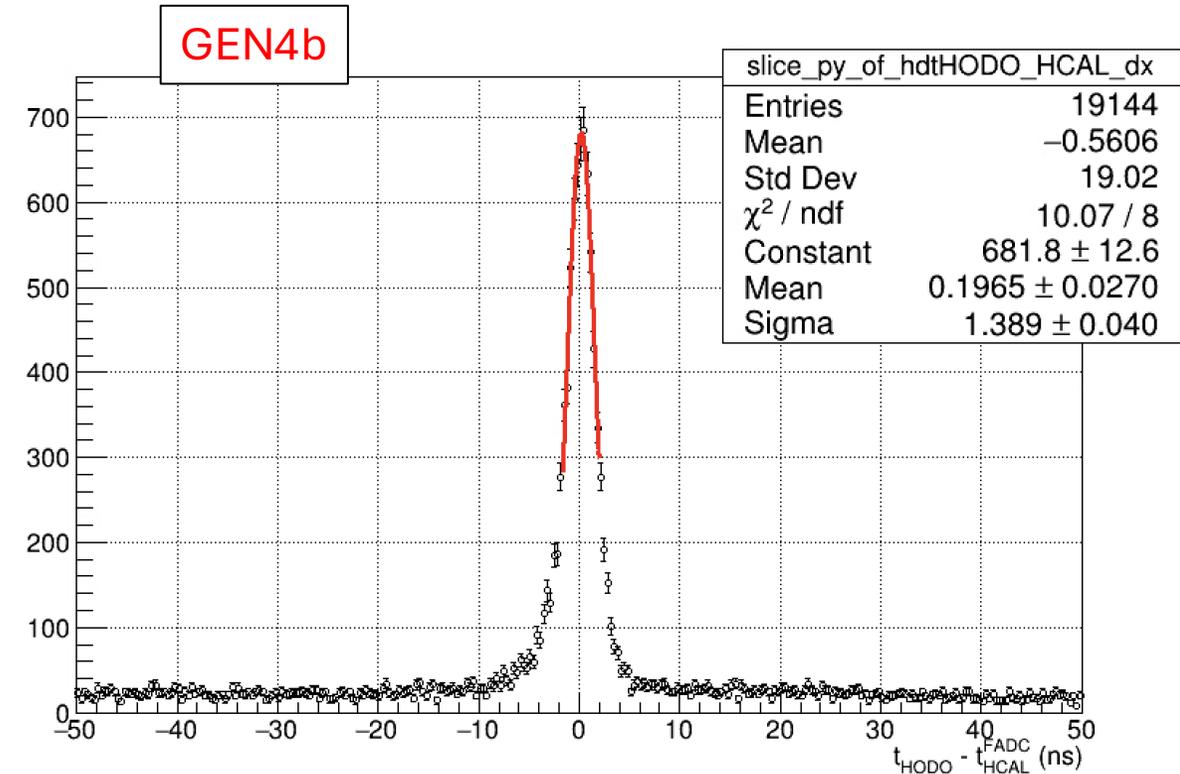
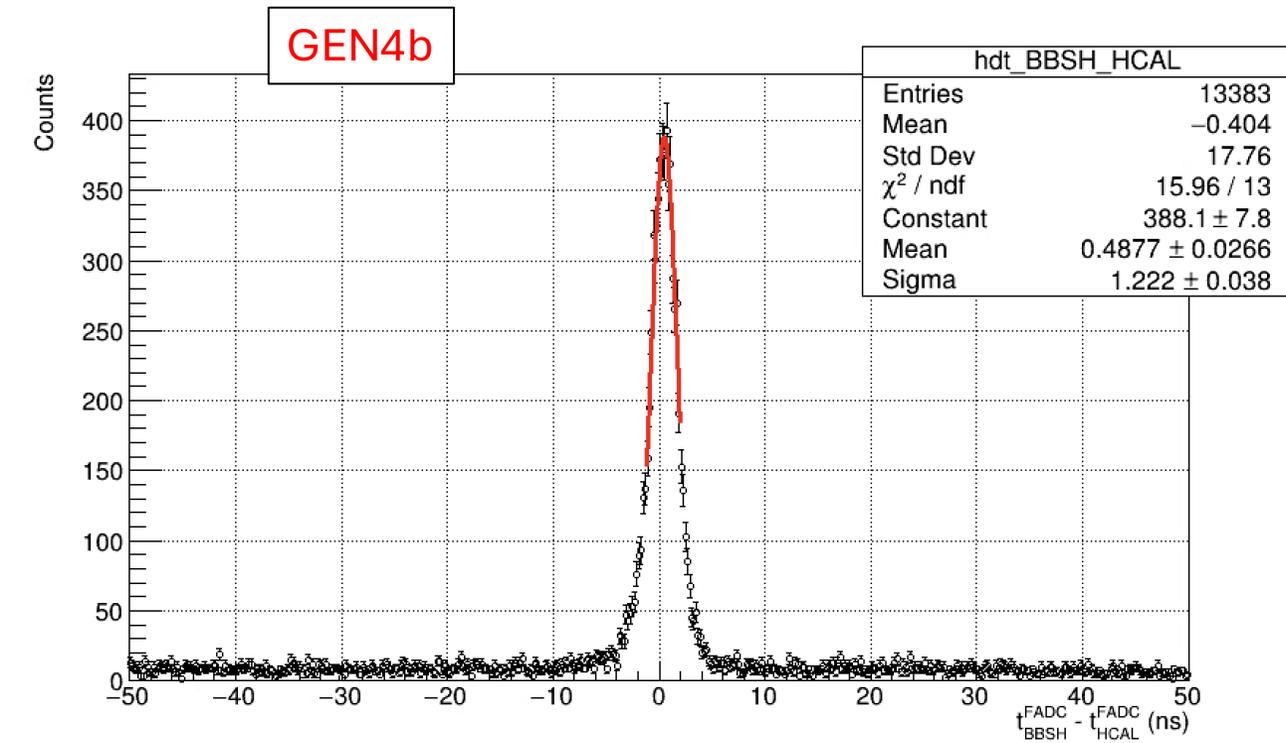
Towards Pass 3 cont.

- Preliminary results for timing calibration (only have GEN4b)



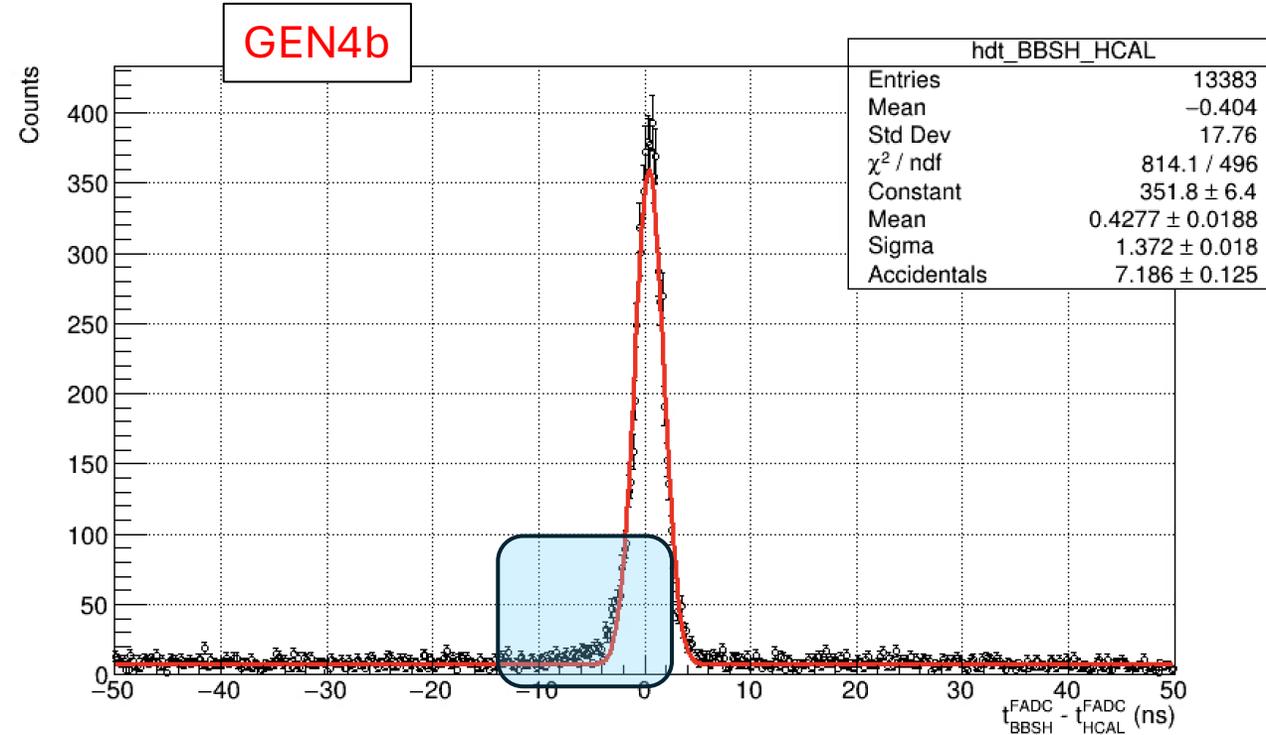
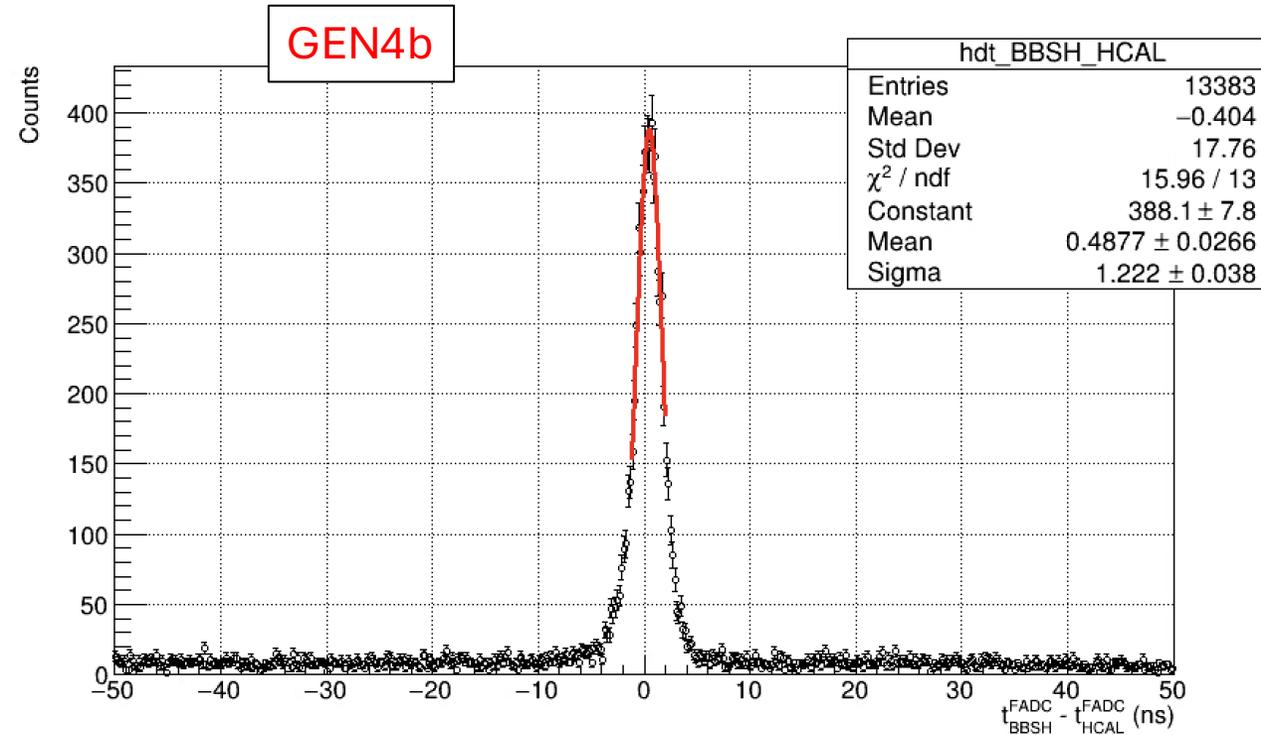
Towards Pass 3 cont.

□ Preliminary results for timing calibration (only have GEN4b)



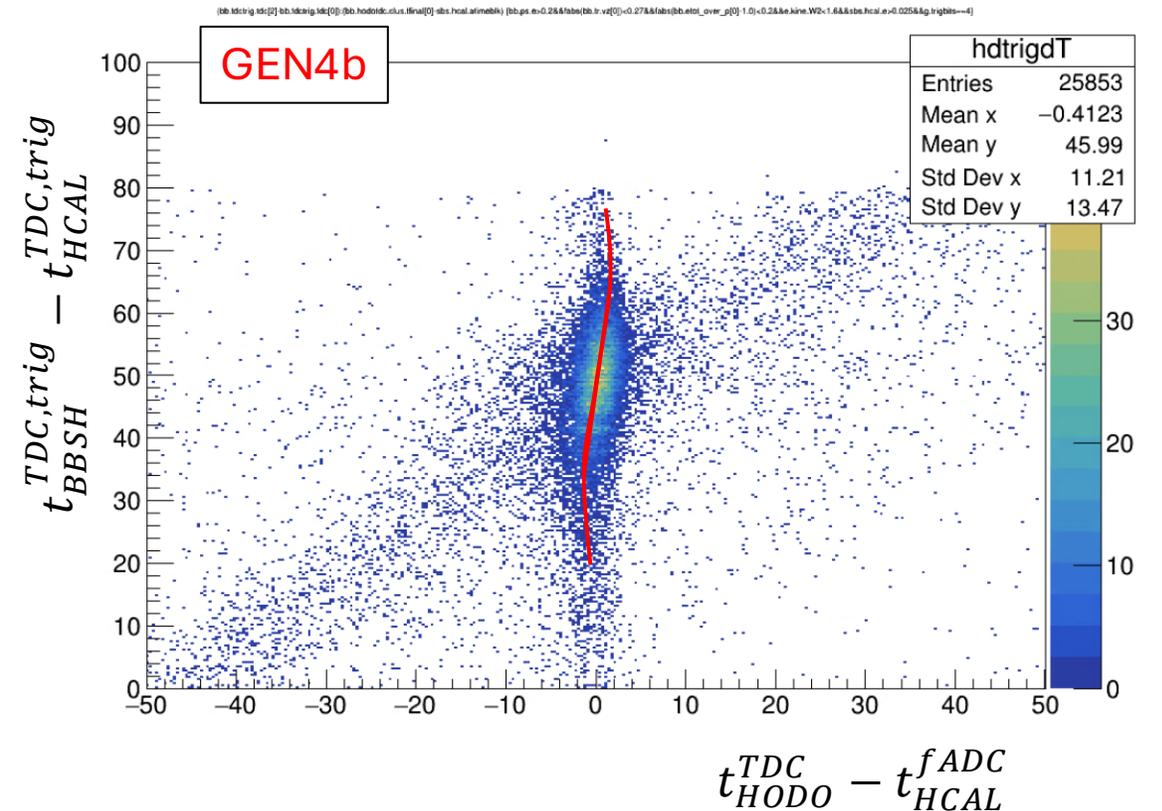
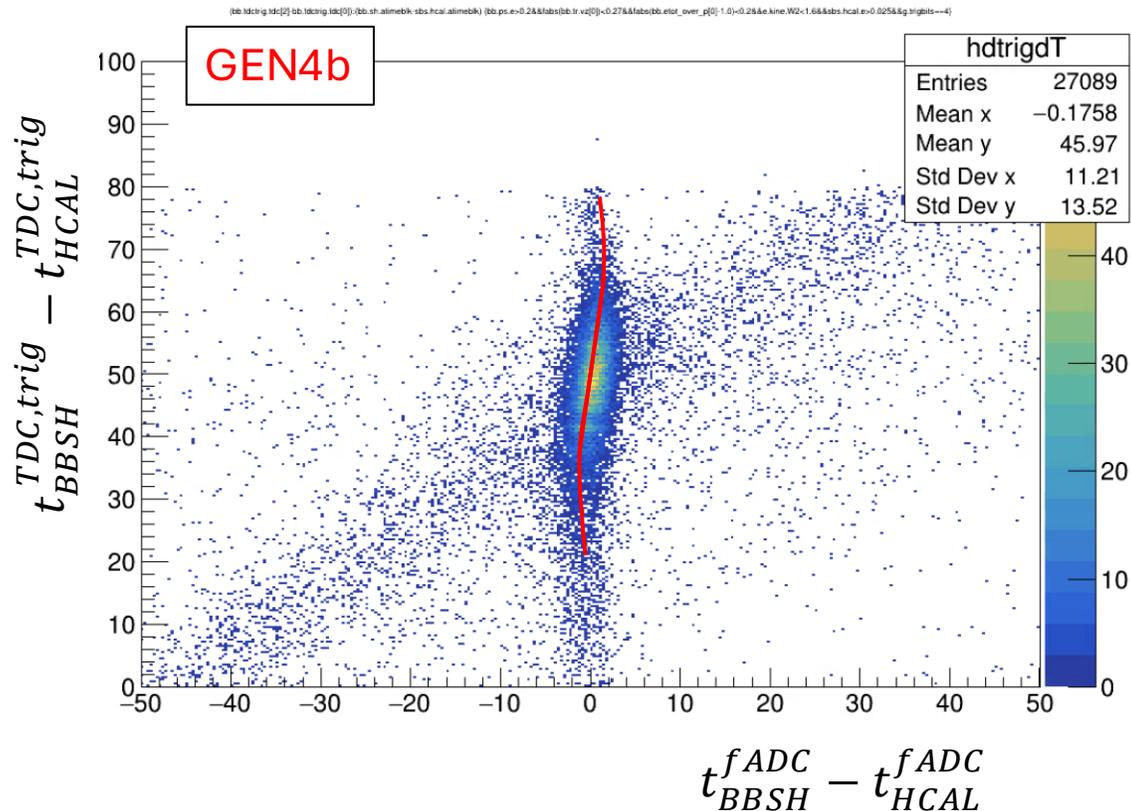
Food for Thought

□ The coincidence time is non-gaussian. Why?



Food for Thought cont.

- ❑ The coincidence time is non-gaussian. Why?
- ❑ Potentially due to dependency to the BBCAL – HCAL trigger time
 - ❖ Needs to be investigated further



Looking Ahead

- ❑ Completed running calibration script on all groups across all kinematics.
 - ❖ Only had a chance to test GEN4b.
- ❑ Need to test the other kinematics.
 - ❖ Produce very similar QA plots shown earlier in this presentation.
- ❑ Investigate the trigger – coincidence correlation across the other kinematics
 - ❖ recent calibrated data and for pass 2 data

Acknowledgements

- Spokespeople
 - ❖ Todd Averett – William & Mary
 - ❖ Gordon Cates – University of Virginia
 - ❖ Bogdan Wojteskhowski – Jefferson Lab
- Graduate Students
 - ❖ Current
 - Faraz Chahili – Syracuse University
 - Kate Evans – William & Mary
 - Vimukthi Gamage – University of Virginia
 - Jack Jackson – William & Mary
 - Braian Mederos – University of Virginia
 - ❖ Graduated
 - Sean Jeffas – University of Virginia; July 2024
 - Gary Penman – University of Glasgow; March 2025
 - Hunter Presley – University of Virginia; June 2025
- Special Thanks
 - ❖ Andrew Puckett – University of Connecticut
 - ❖ Arun Tadepalli – Jefferson Lab

Questions?

Backup Slides

Pass 2 timing

