DAPHNE V2A Self-trigger Modules Test

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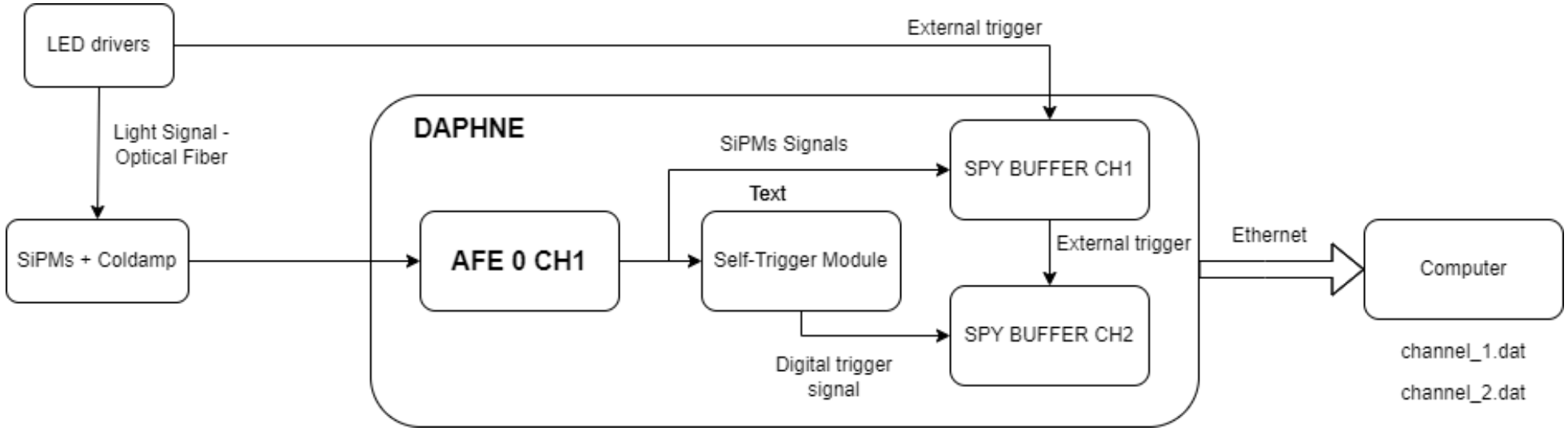
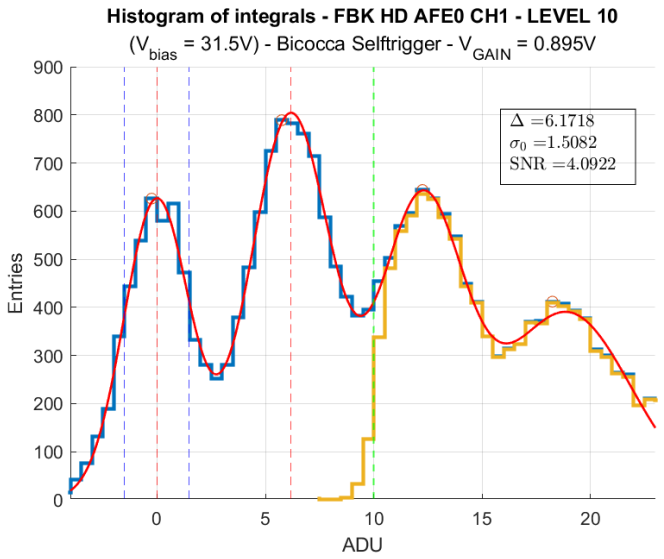
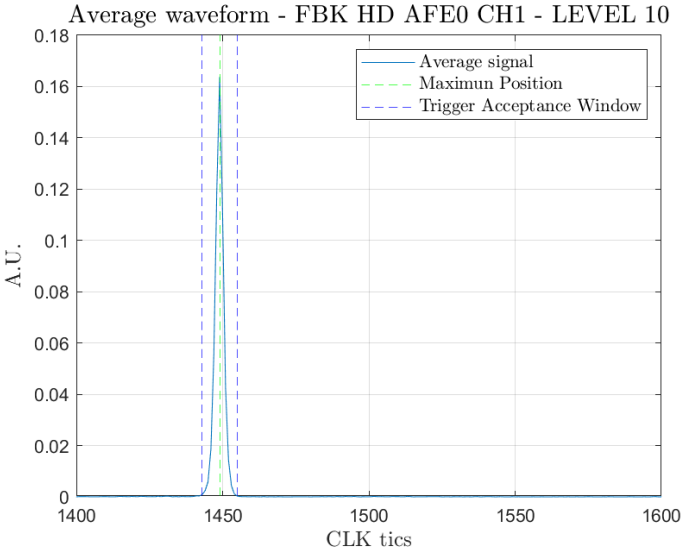
Test setup

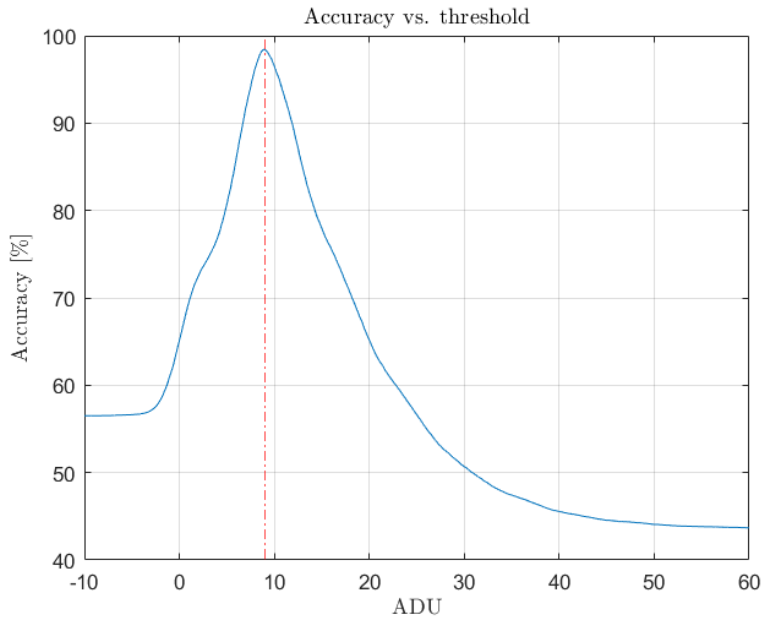


- DAPHNE is configured in such a way to save both the SiPM signals and the internal digital trigger signal, while being triggered externally by a signal that is synchronized with the LED pulser.
- In this way, the reference histogram (blue), and the triggered histogram (yellow) can be built.
- The threshold (green line), separates the populations P and N.
  - TP (true positive): Signals entries that are above the threshold with a trigger signal within the acceptance window.
  - FP (false positive): Signals entries that are below the threshold with a trigger signal within the acceptance window.
  - TN (true negatives): the difference between blue and yellow entries below the threshold.
  - FN (false negatives): the difference between blue and yellow entries above the threshold.

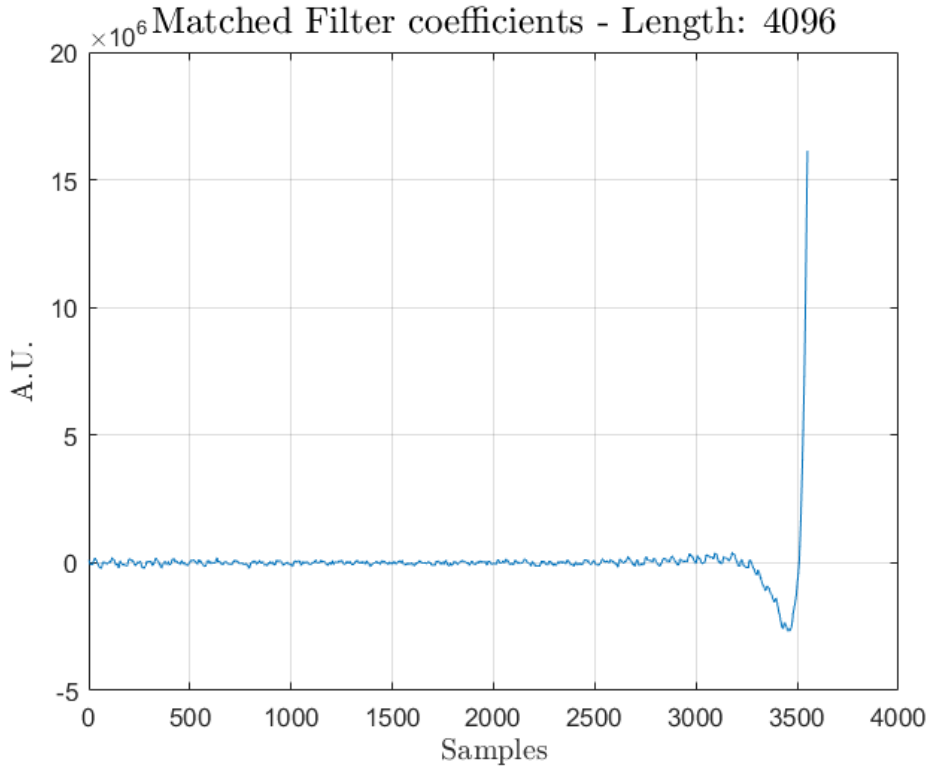




Considerations



$$Accuracy[\%] = \frac{TP + TN}{TP + TN + FP + FN} \times 100$$

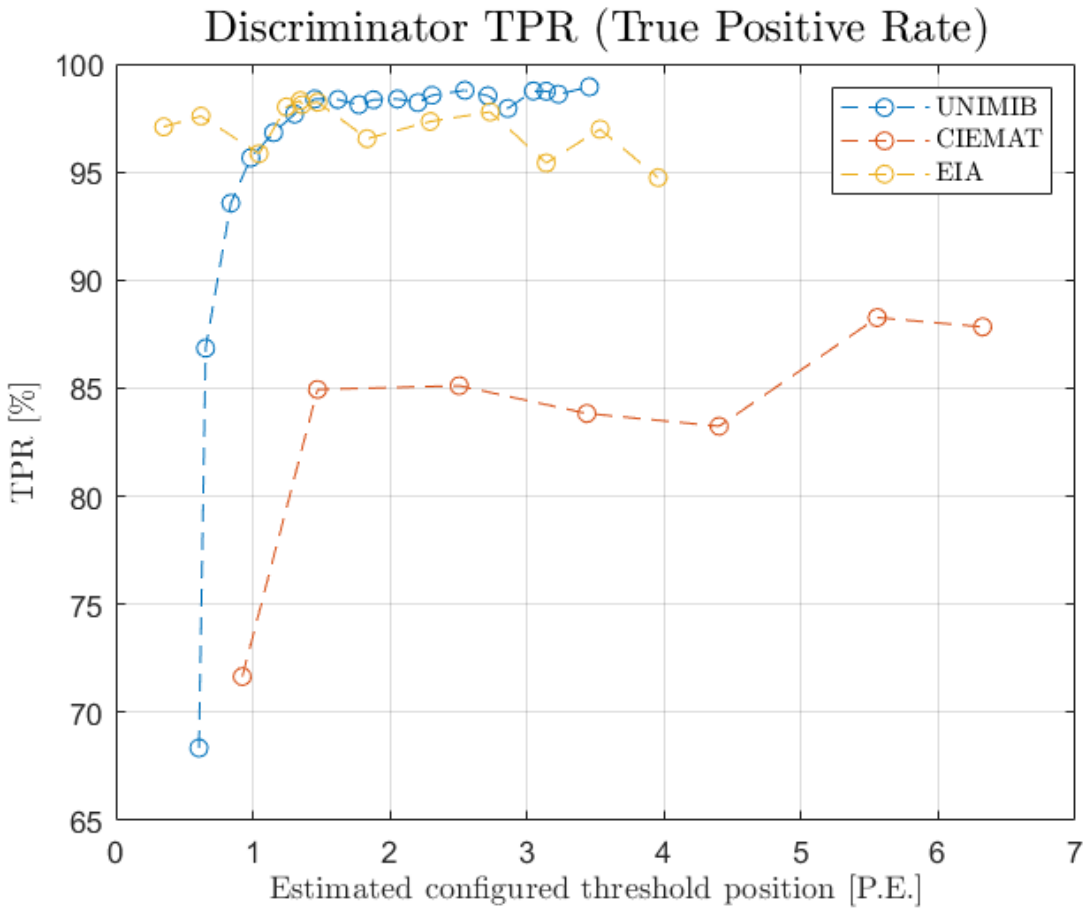


- For each threshold configuration, we sweep the histogram and calculate the FP, TP, TN and FN.
- Given that the threshold position must be calibrated for a given analysis method to generate the histogram, the estimated threshold position is considered the point of maximum accuracy.

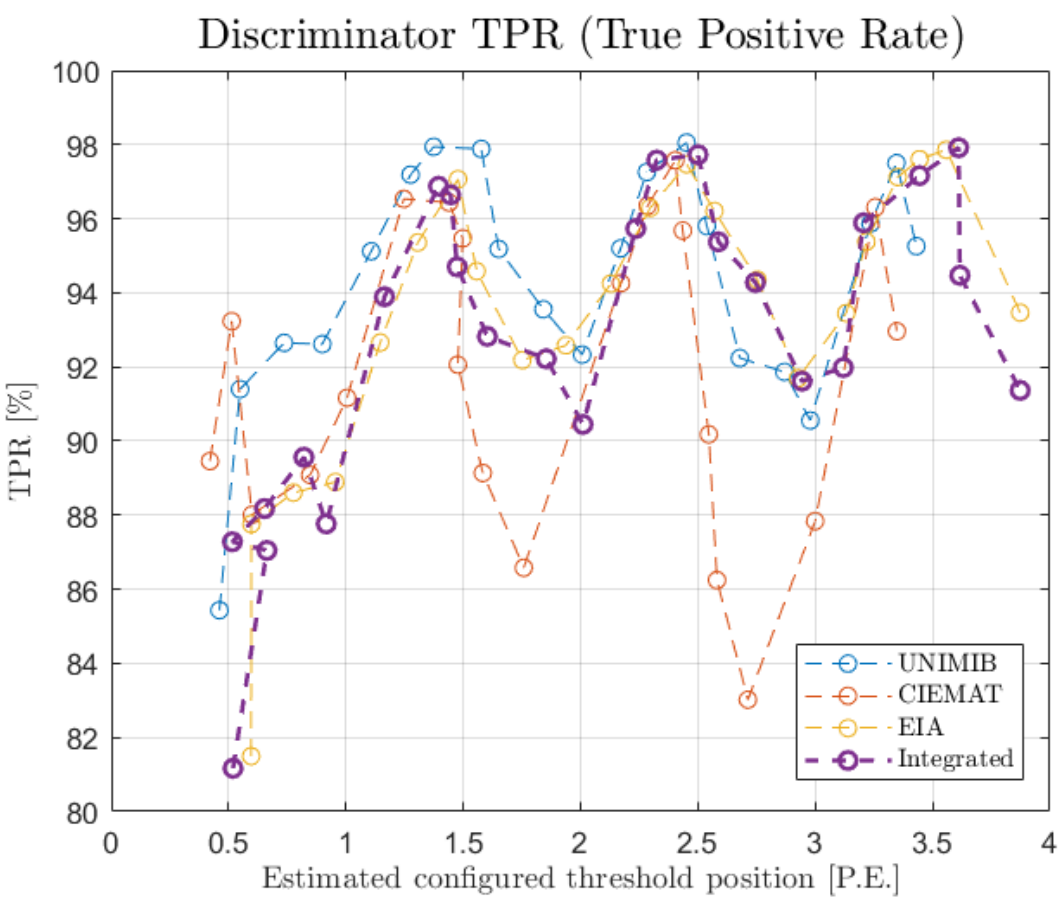
- To avoid a bias in the analysis:
  - RUN 1 analysis (and preliminary RUN 2) used the HPF+MAVG to generate the histograms and calculate the figure of merits.
  - The following figures show the figure of merits calculated using the Matched filter, using the average SiPM signal as template, and the noise under the breakdown as noise profile.

True Positive Rate

RUN 1



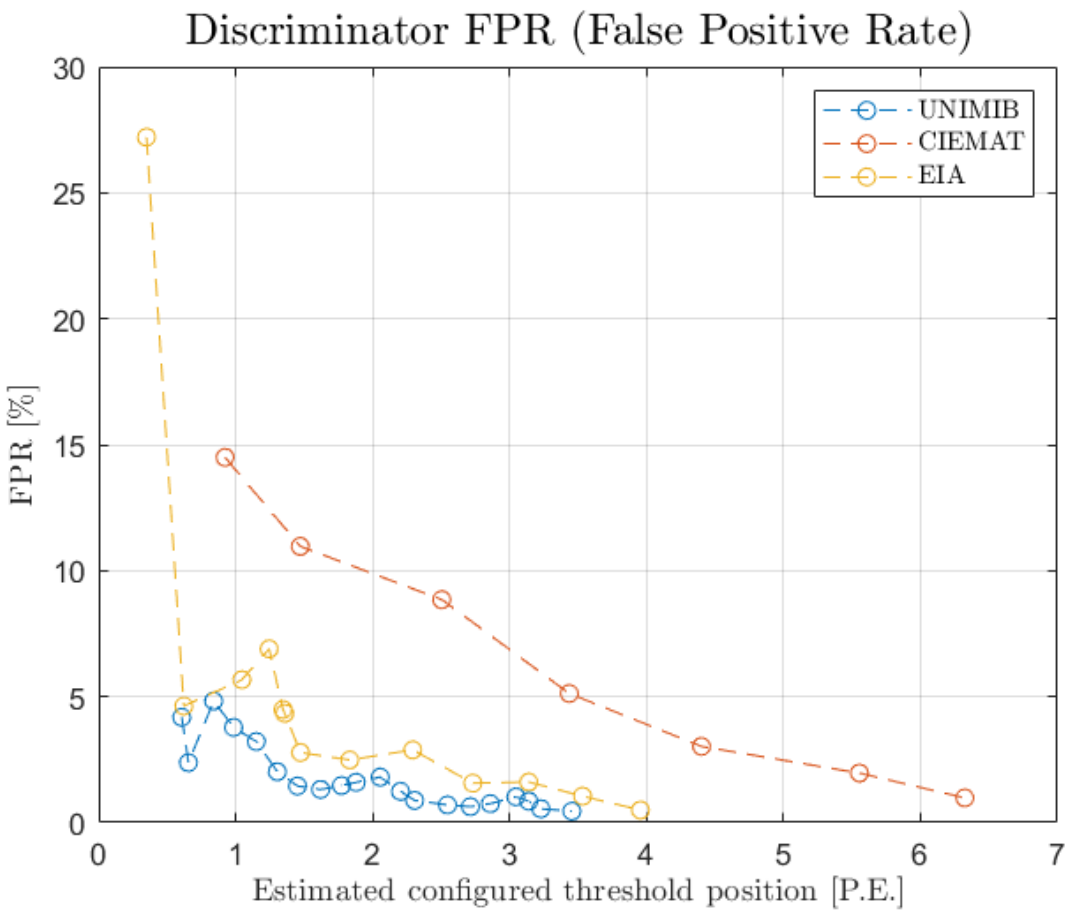
RUN 2



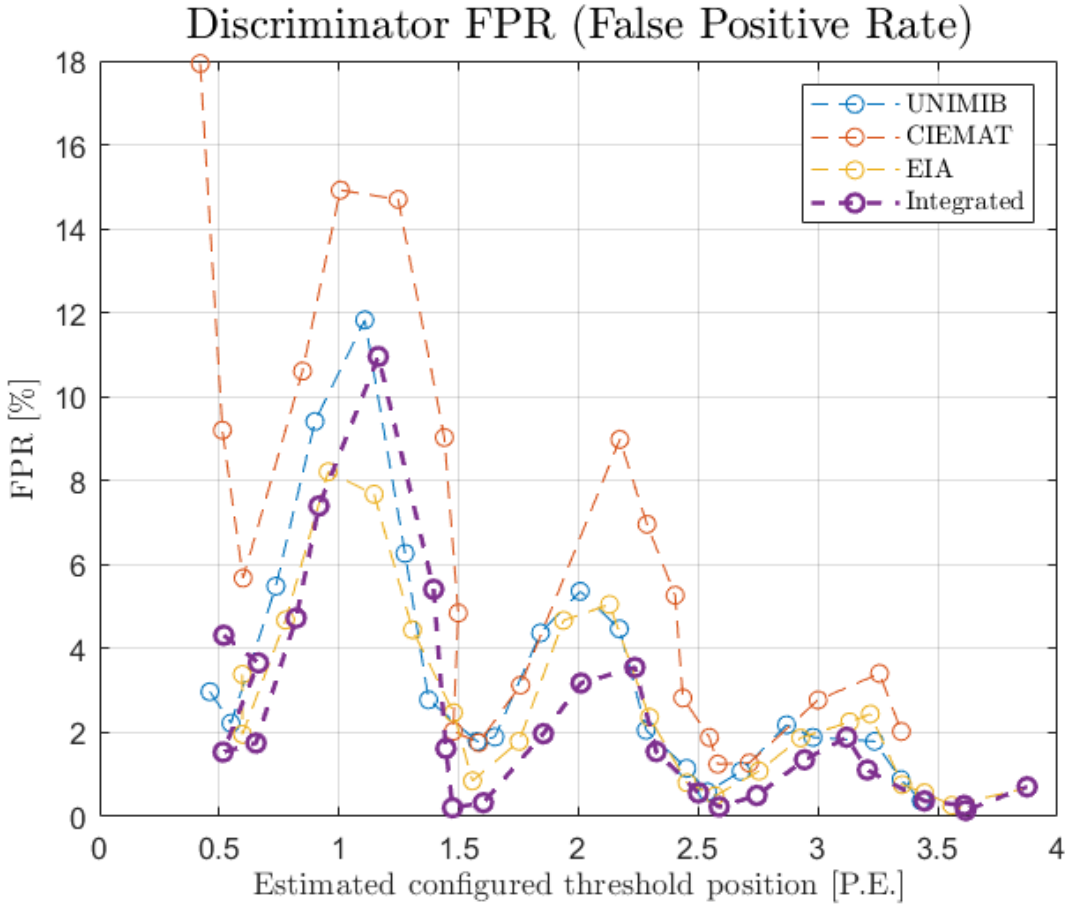
Closer to 100% is better

False Positive Rate

RUN 1



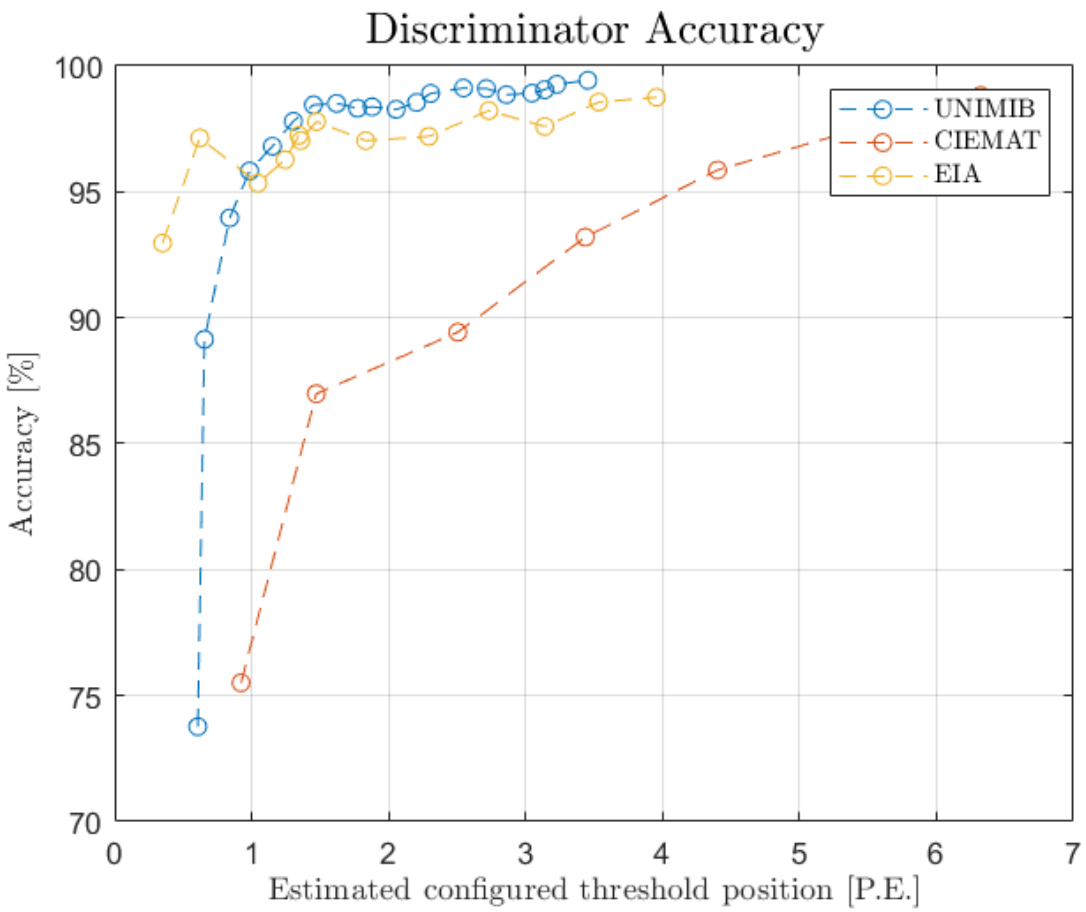
RUN 2



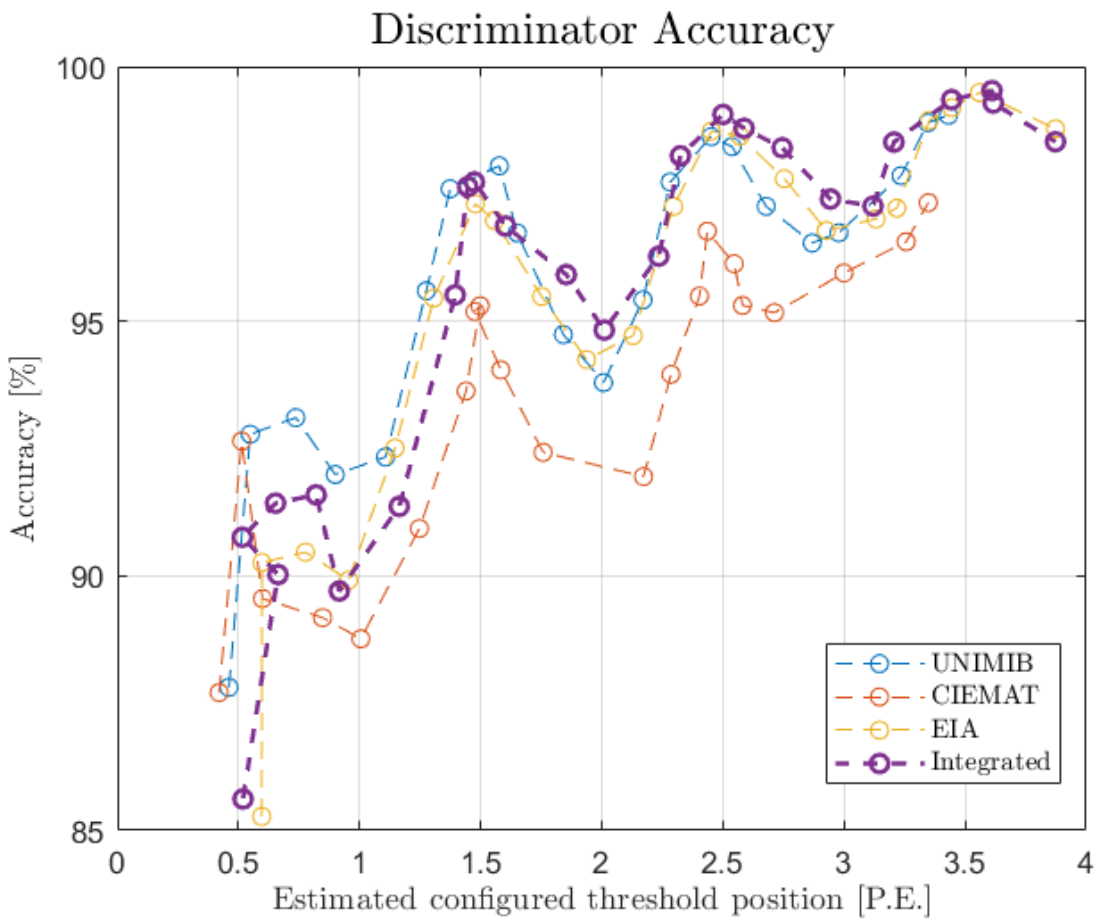
Closer to 0% is better

Accuracy

RUN 1



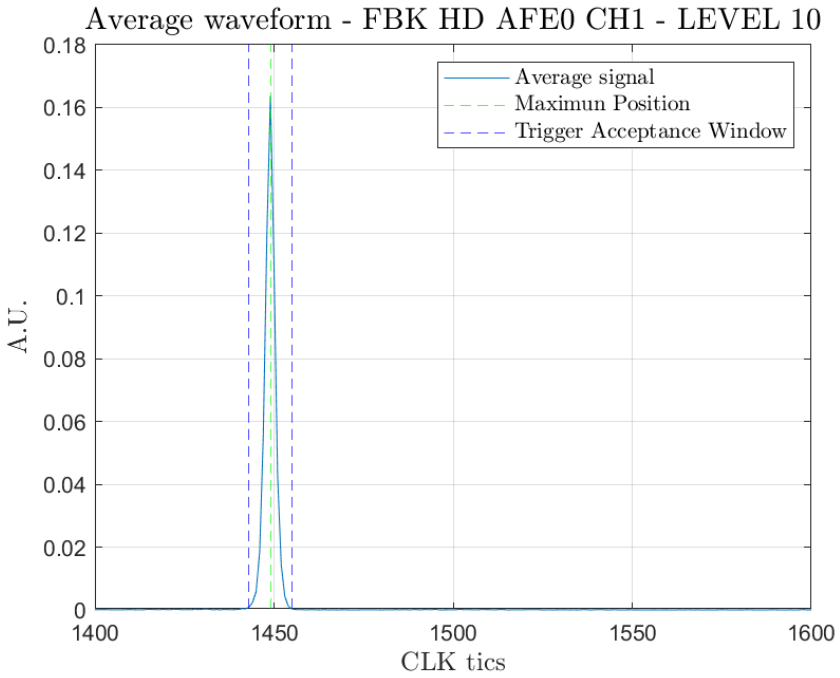
RUN 2



Closer to 100% is better

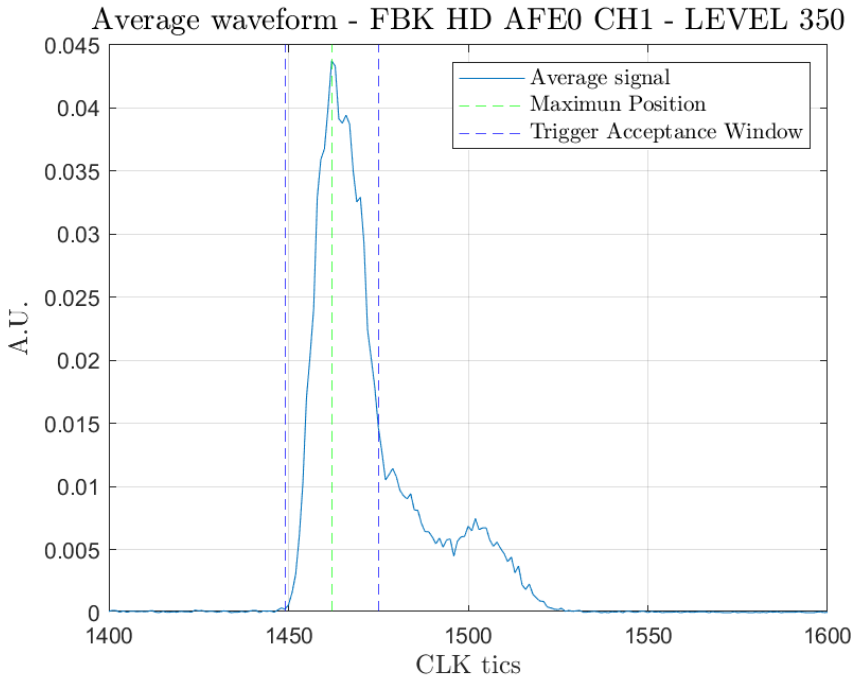
Trigger Jitter – RUN 1

UNIMIB



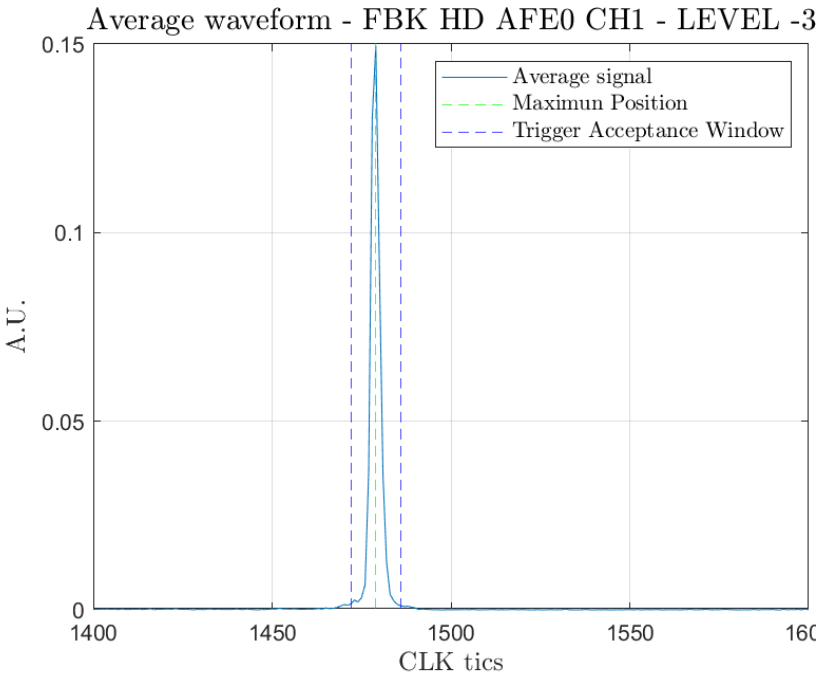
$TAW = 12\ tics$

EIA



$TAW = 26\ tics$

CIEMAT

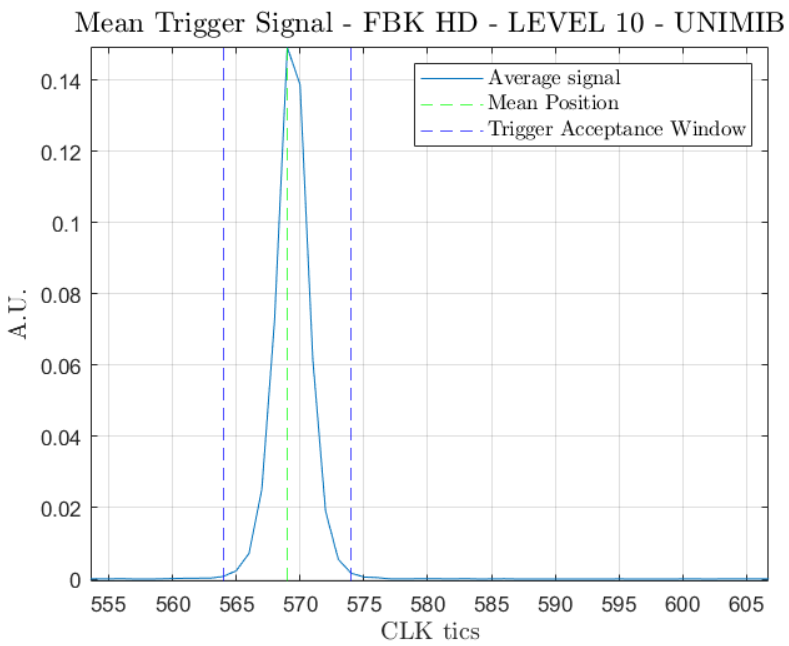


$TAW = 14\ tics$

TAW: Trigger Acceptance Window

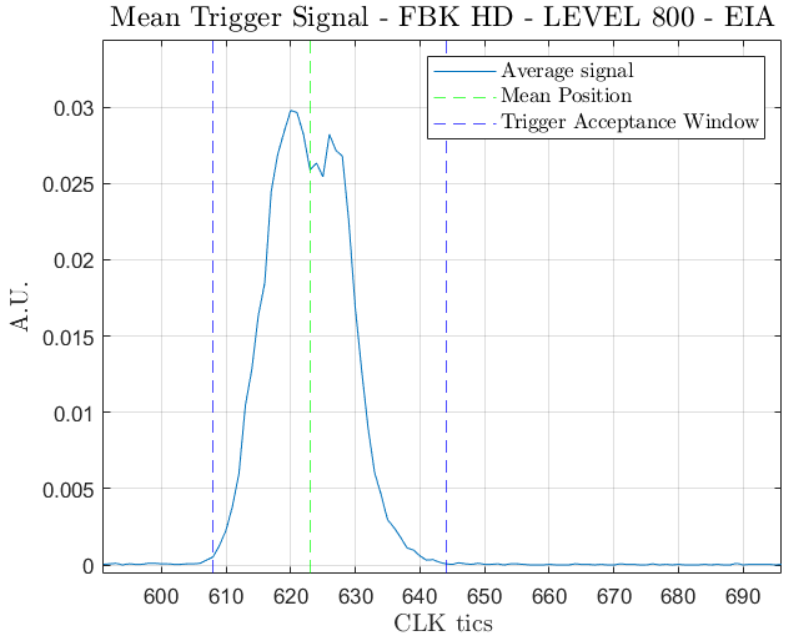
Trigger Jitter – RUN 2

UNIMIB



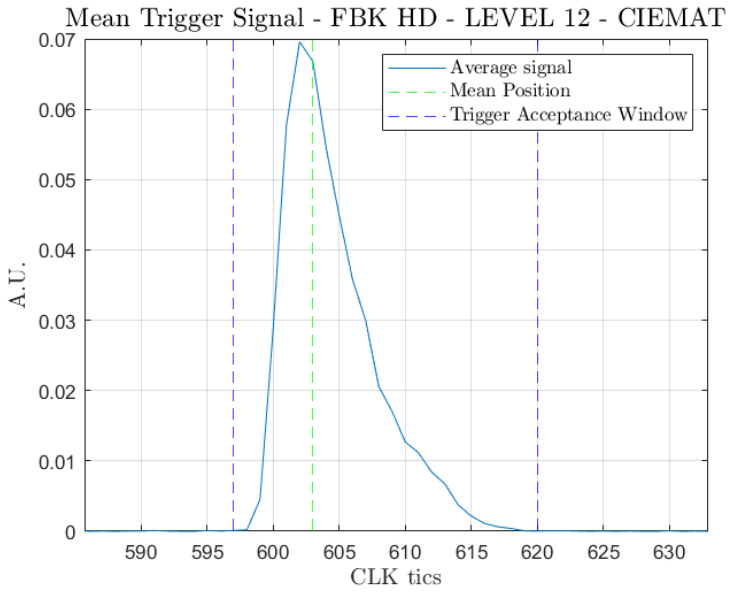
$TAW = 10\ tics$

EIA



$TAW = 36\ tics$

CIEMAT

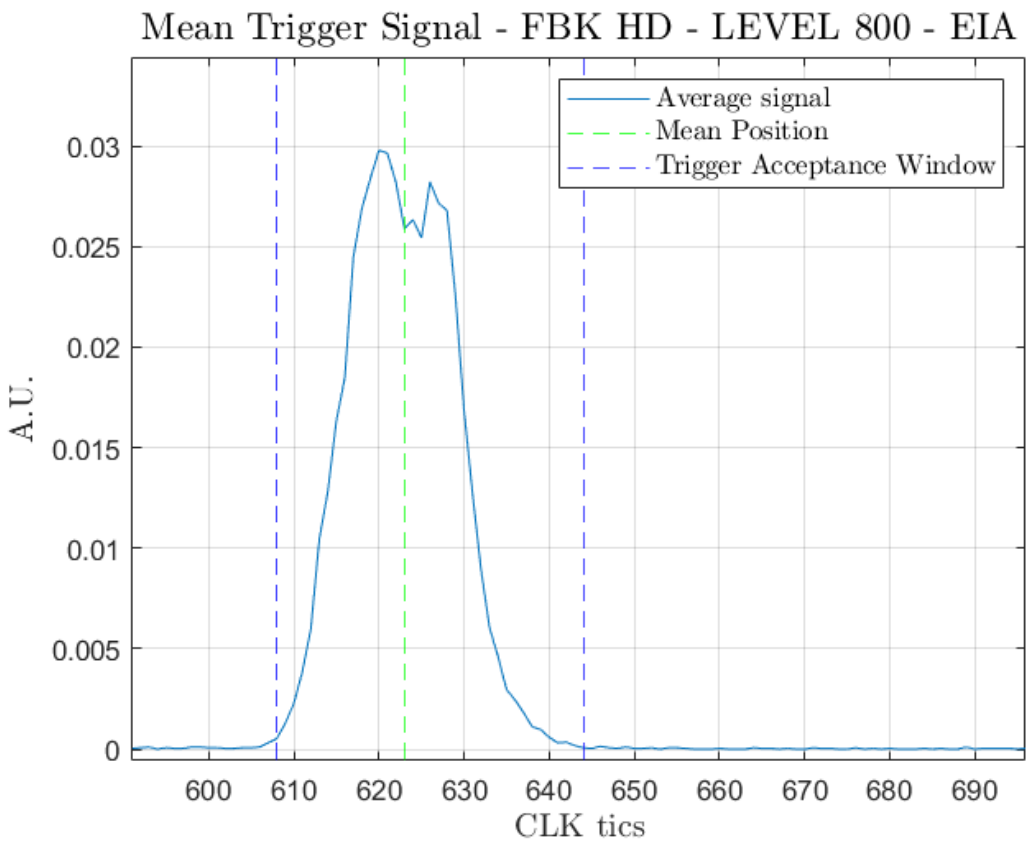


$TAW = 23\ tics$

TAW: Trigger Acceptance Window

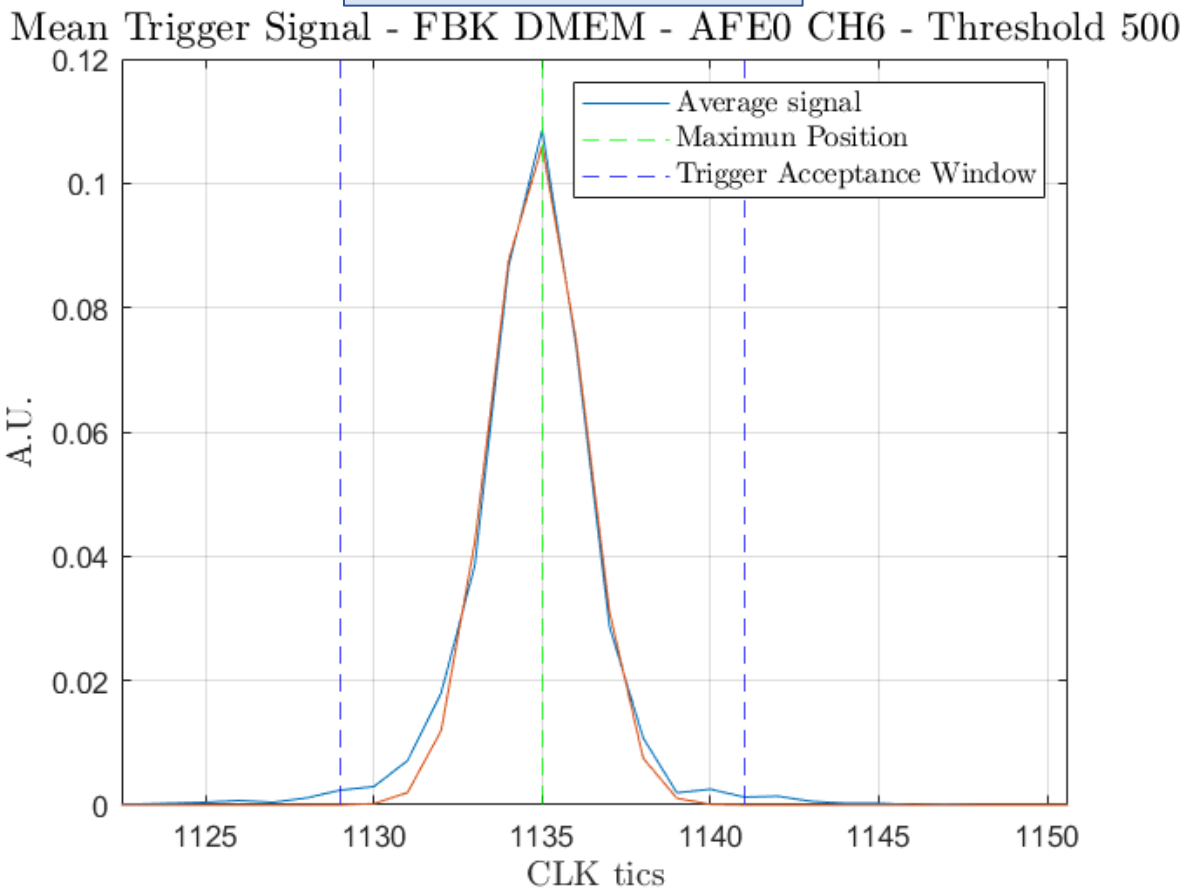
Trigger Jitter – RUN3

EIA



$TAW = 36\ tics$

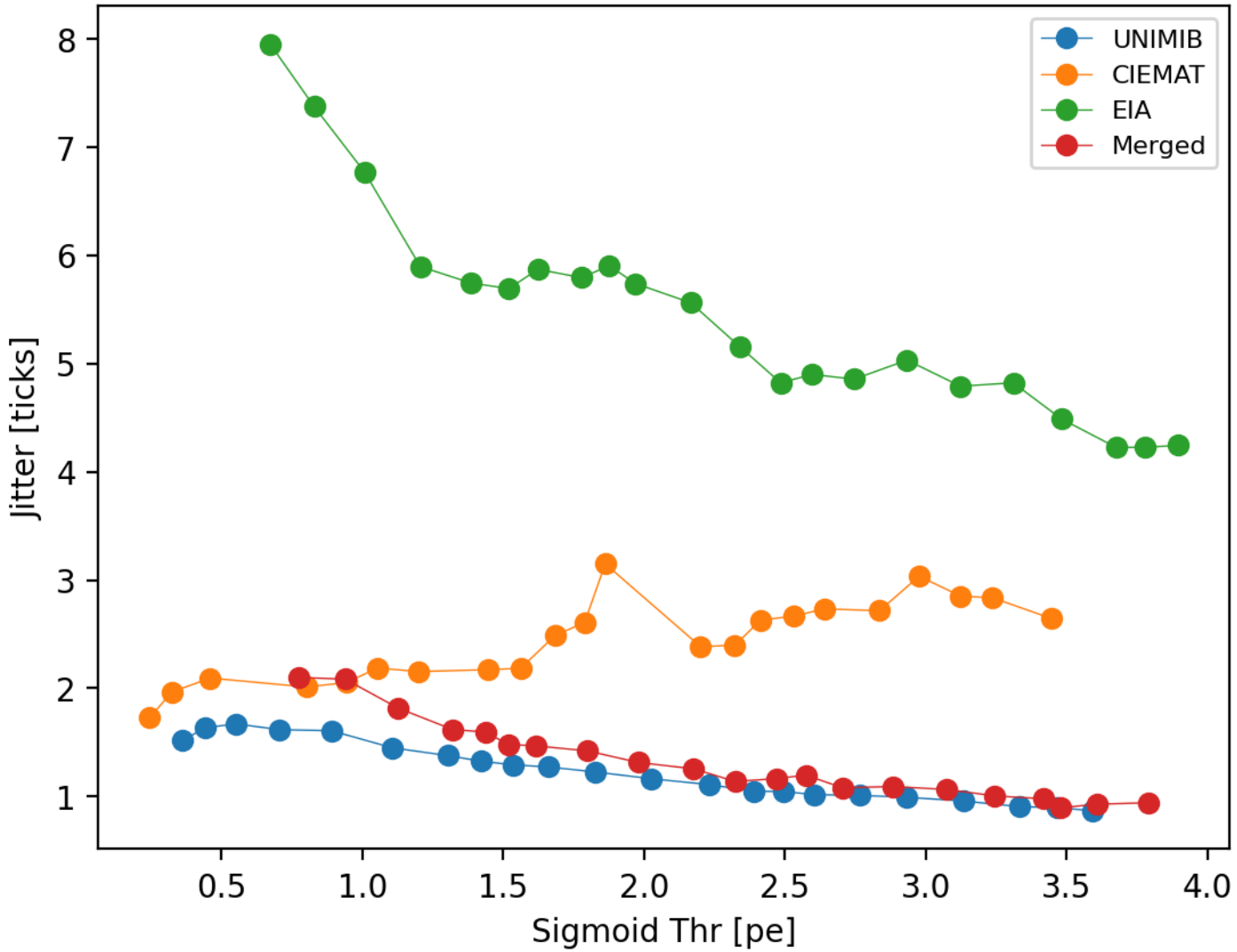
INTEGRATED



$TAW = 12\ tics$

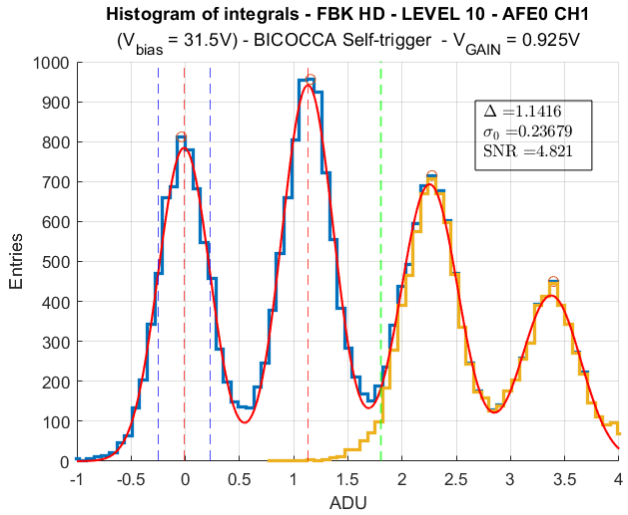
TAW: Trigger Acceptance Window

Trigger Jitter – RUN3

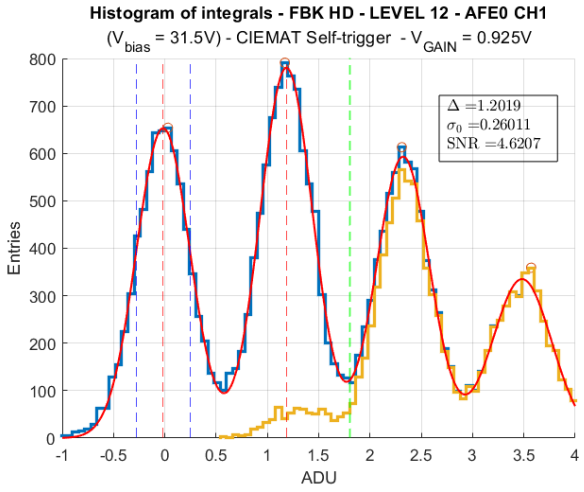


Histograms – RUN 2

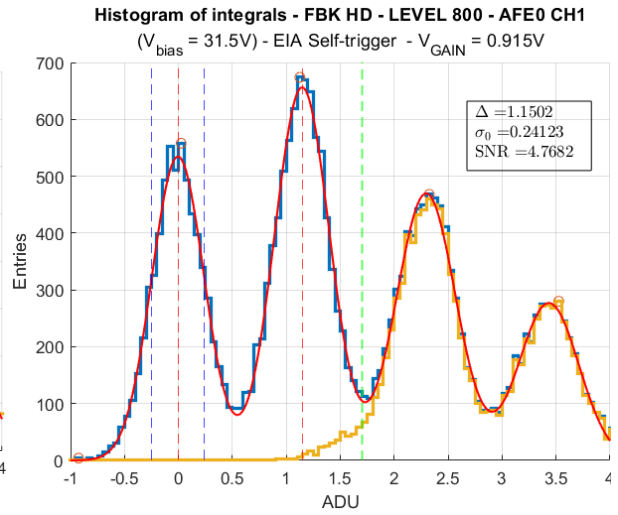
UNIMIB



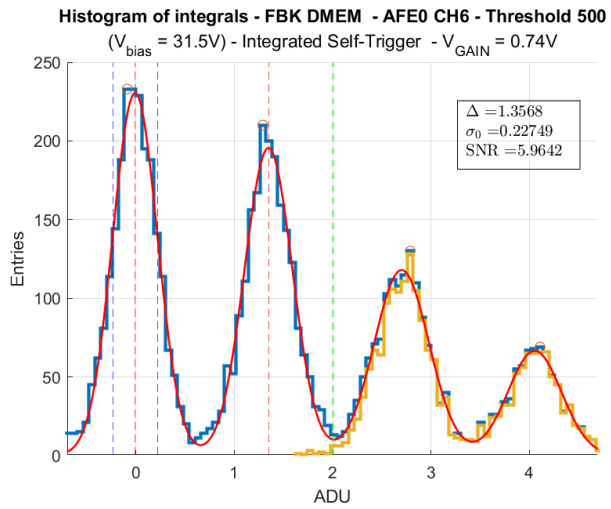
CIEMAT



EIA



INTEGRATED



$$Threshold\ Level\ \approx 1.5\ P.E.$$

Conclusions

- The integrated design improved the response of the self-trigger, specially improving the jitter response and the false positive rate, bringing it to a level of 0,2% at 1,5 PE threshold level.
- The firmware was modified to replicate this test at NP04 with the daq system.
- This new firmware was tested and produced the expected results. We see the signals and the associated triggers.
- We still need to parse the data to align the timestamps.
- In the following days we will launch more runs to produce the relevant data.
- Daniel has ported most of the code to DAPHNE V3 and in principle, migration can be done in the near future.