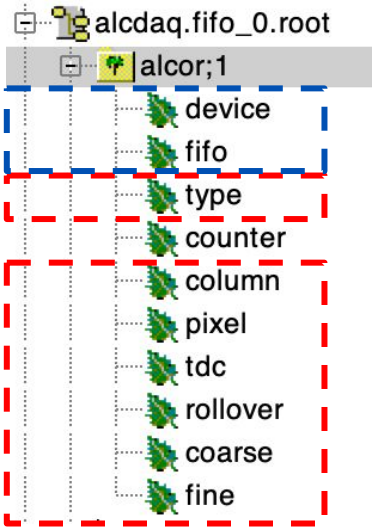
Summary of beam test data format

Nicola Rubini[(1)]

[(1)]INFN Bologna

7th March 2025

ALCOR decoded raw data



ALCOR data is decoded in a TTree structure. This is the purely ALCOR data, device and fifo are informations added later related to Beam Test configuration

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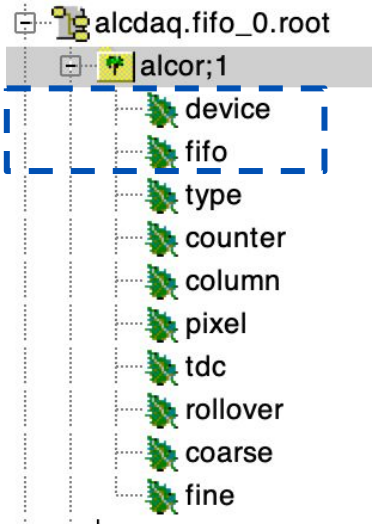

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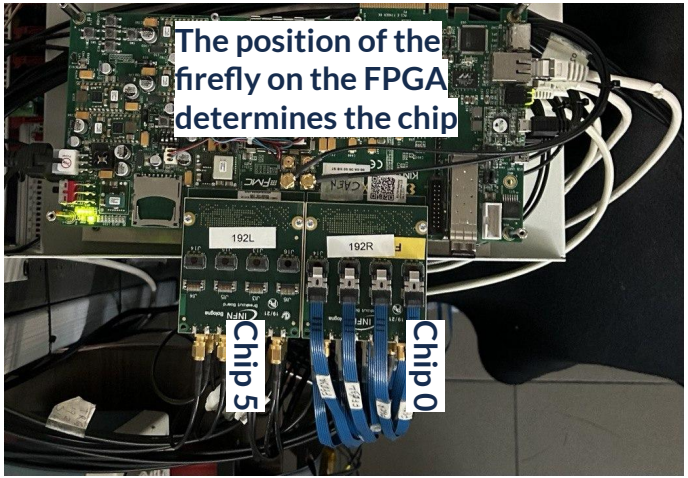

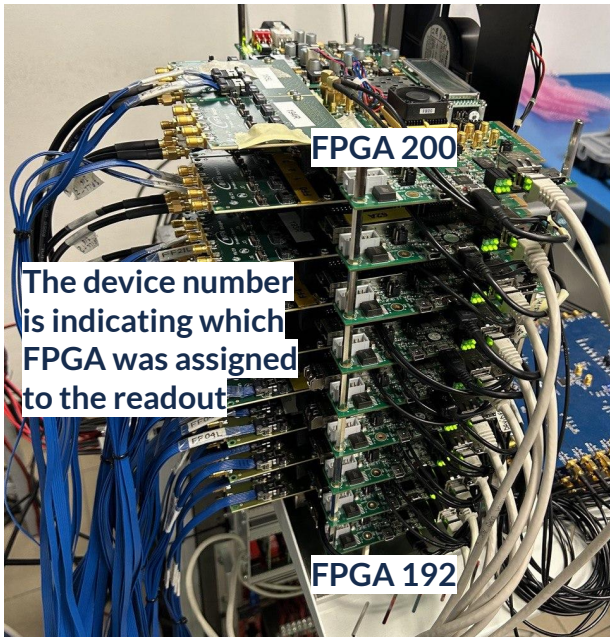

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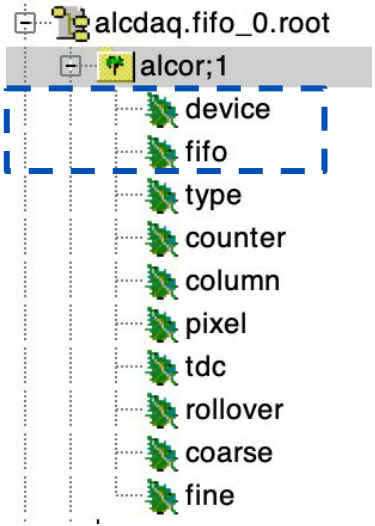

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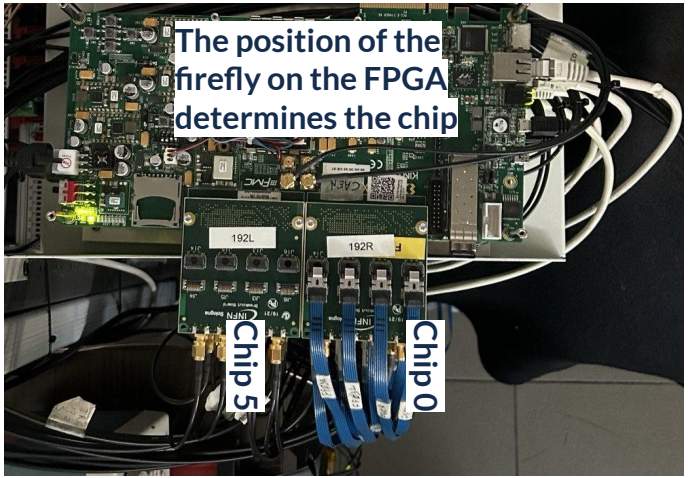

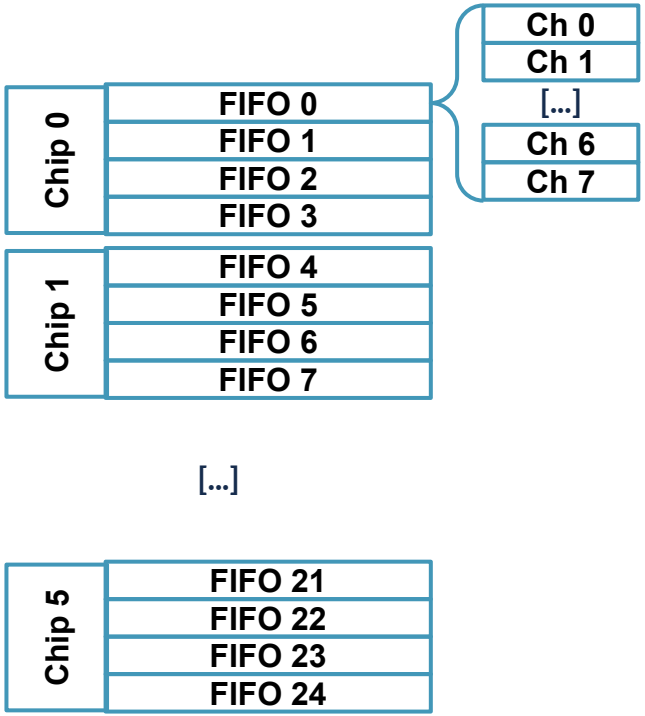

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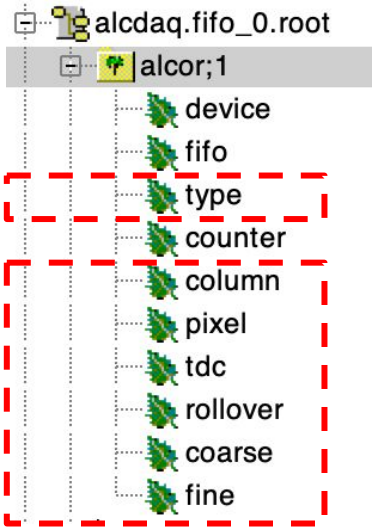
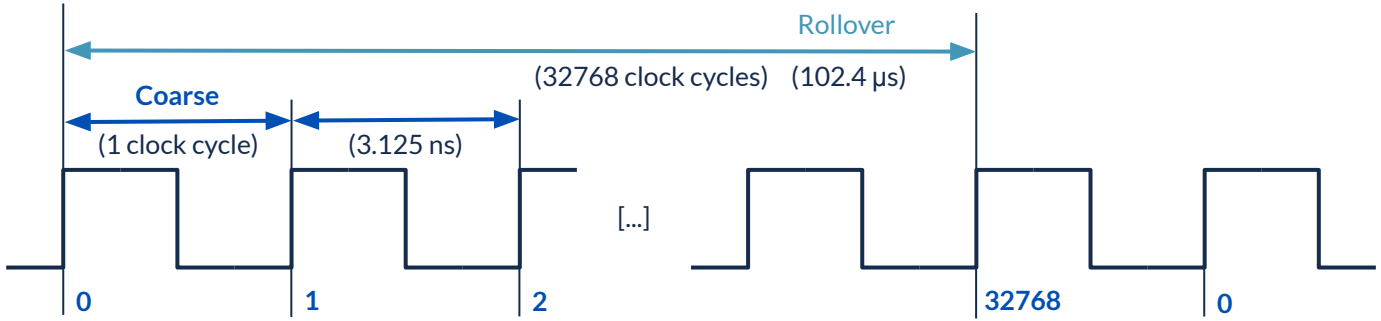


ALCOR clock
(320 MHz)

ALCOR data is decoded in a TTree structure. This is the purely ALCOR data, device and fifo are informations added later related to Beam Test configuration

Focusing on ALCOR data, the chip works as follows



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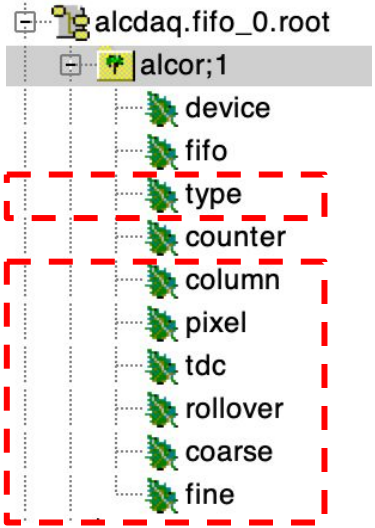

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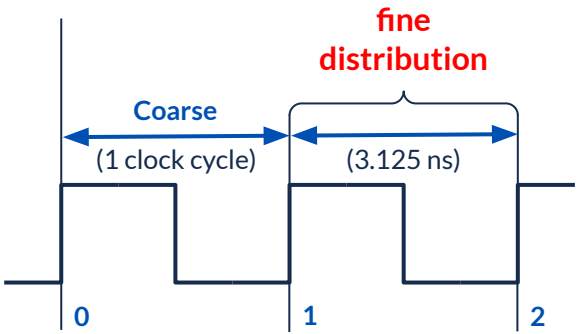
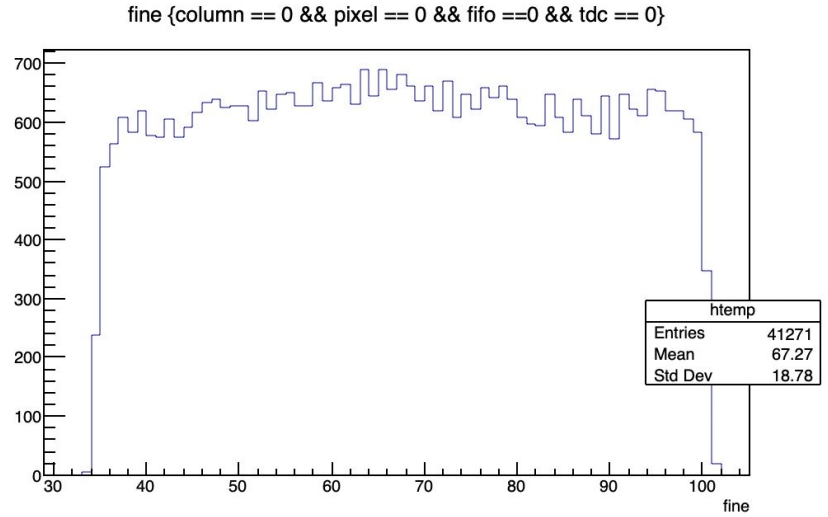


Fine distribution subdivide the coarse counter (clock cycle) into roughly ~70 parts bringing down the resolution potentially to ~45 ps

w/ fine info > fine data
w/o fine info > coarse data



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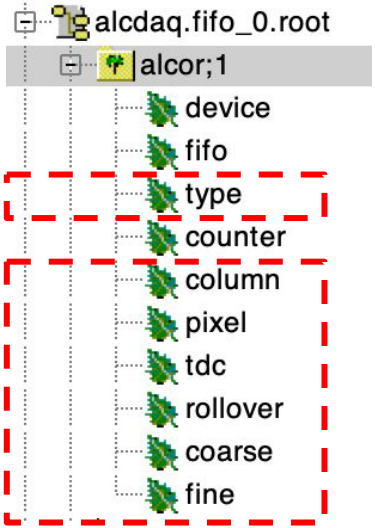

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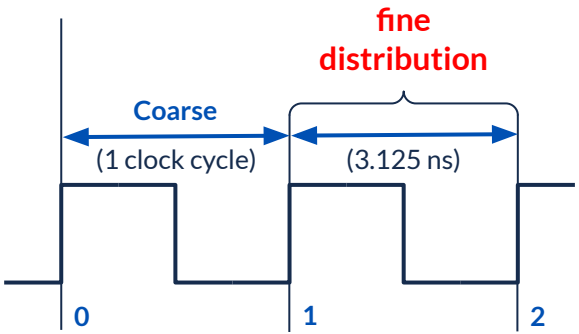


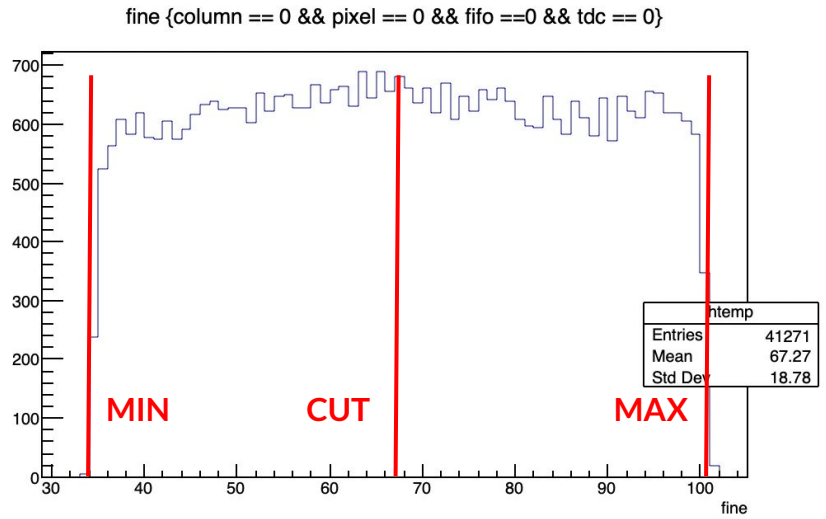
Fine correction is done by:
$t_{corr} = t_{coarse}$ - phase

ALCOR v1:

phase = (fine-MIN)/(MAX-MIN) + (fine > CUT) + off

ALCORv2:

phase = (fine-MIN)/(MAX-MIN) + off



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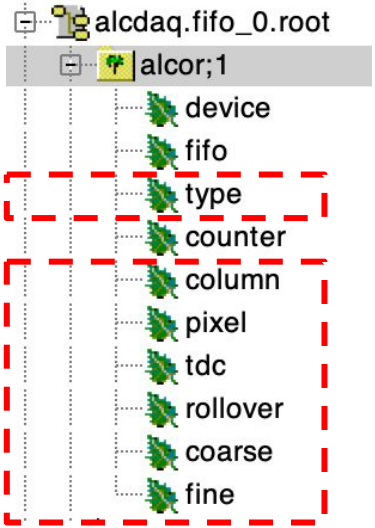

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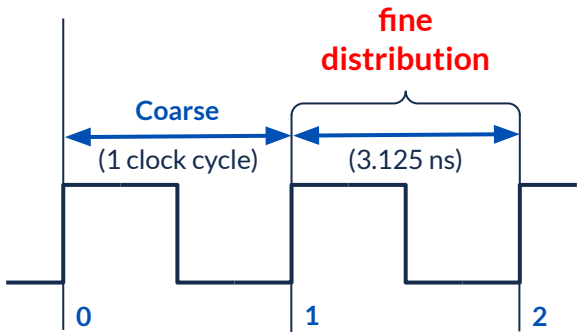
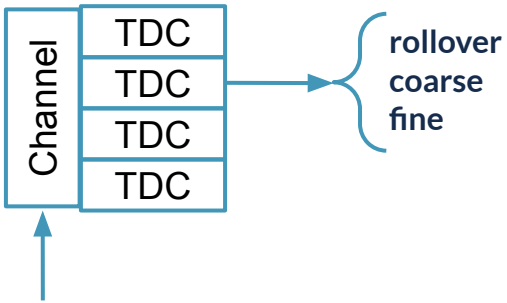


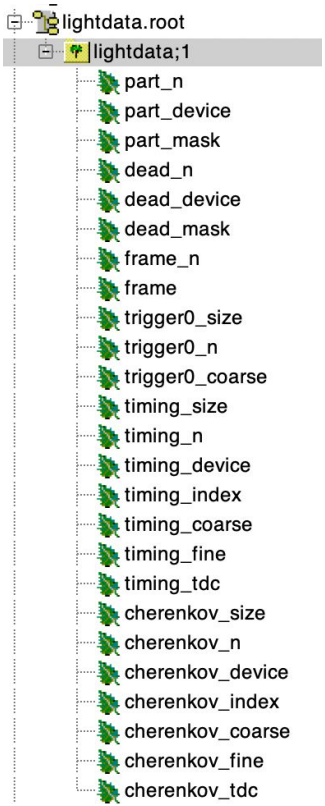


electronics oriented:
pixel + 4*column

type:
Defines whether the hit is a SiPM signal, a spill start/stop, a trigger, etc.

Lightdata

Each event in the tree is a spill



With the knowledge of the connections each device and fifo can be labeled as trigger, cherenkov, timing etc.
ALCOR gives a continuous readout which means that we need a way to optimise reading through the data

Lightdata

Each event in the tree is a spill

*this number is arbitrary and can be changed

- lightdata.root
  - lightdata;1
    - part_n
    - part_device
    - part_mask
    - dead_n
    - dead_device
    - dead_mask
    - frame_n
    - frame
    - trigger0_size
    - trigger0_n
    - trigger0_coarse
    - timing_size
    - timing_n
    - timing_device
    - timing_index
    - timing_coarse
    - timing_fine
    - timing_tdc
    - cherenkov_size
    - cherenkov_n
    - cherenkov_device
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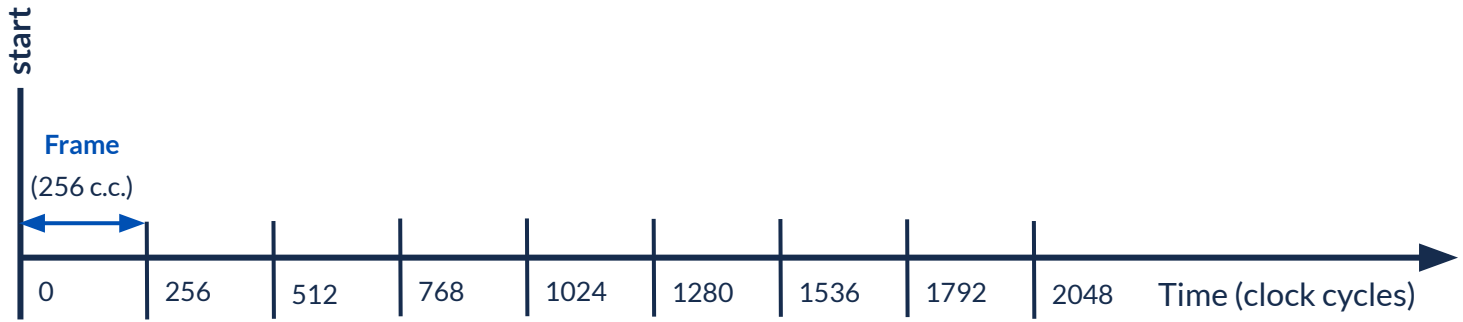
This is achieved by subdividing the time in frames of 256* clock cycles (800 ns)



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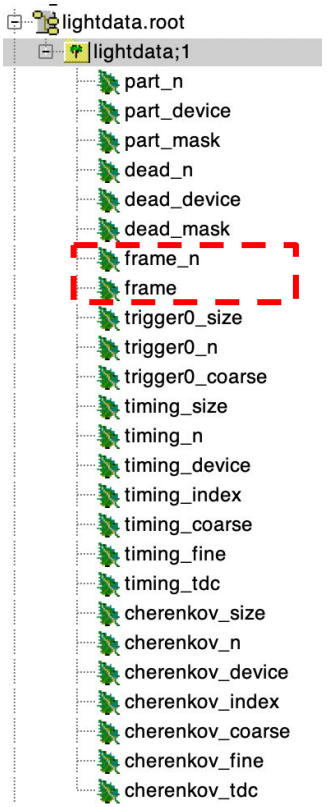

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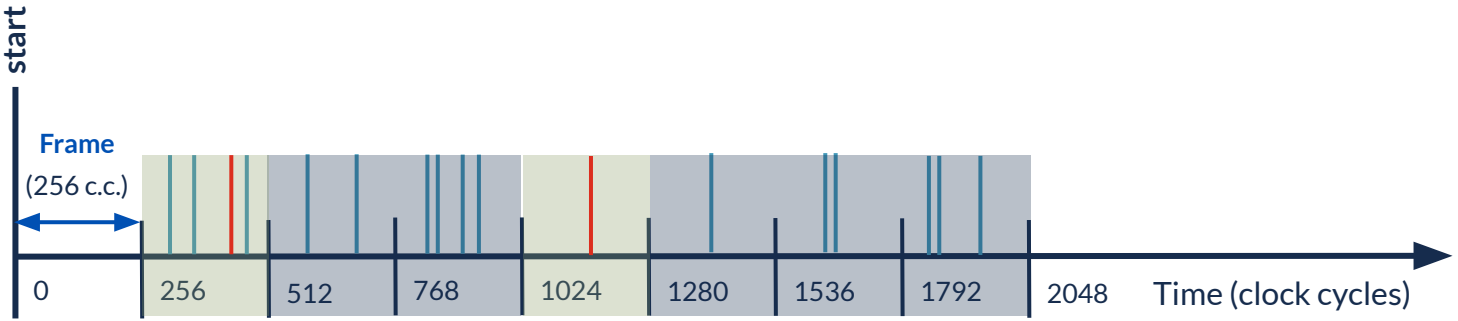
In each frame you can have cherenkov hits and trigger signal

Then, only frames with a trigger are accepted into the lightdata.
This format essentially filters for frames with a trigger.



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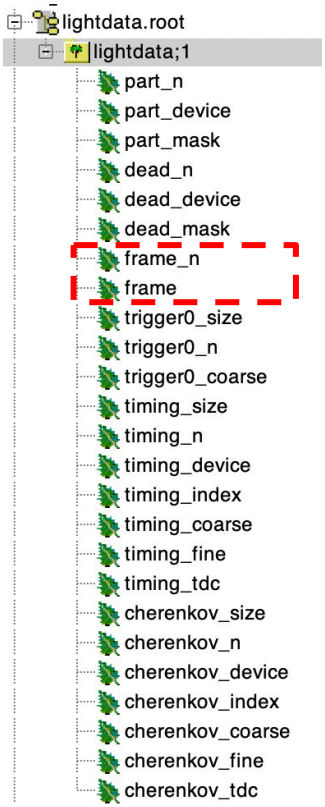
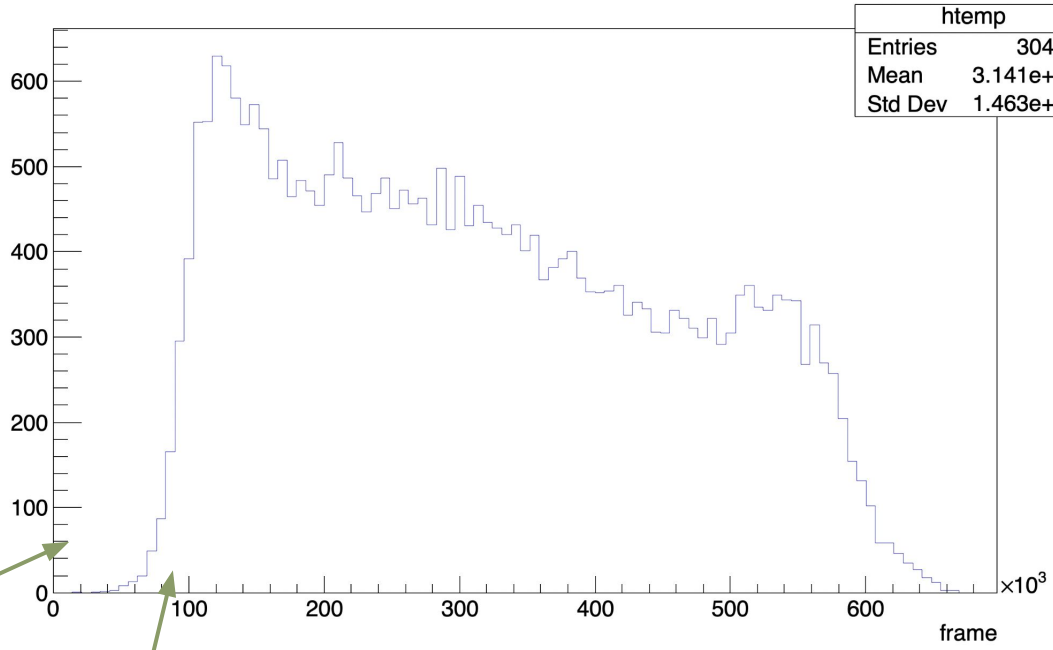
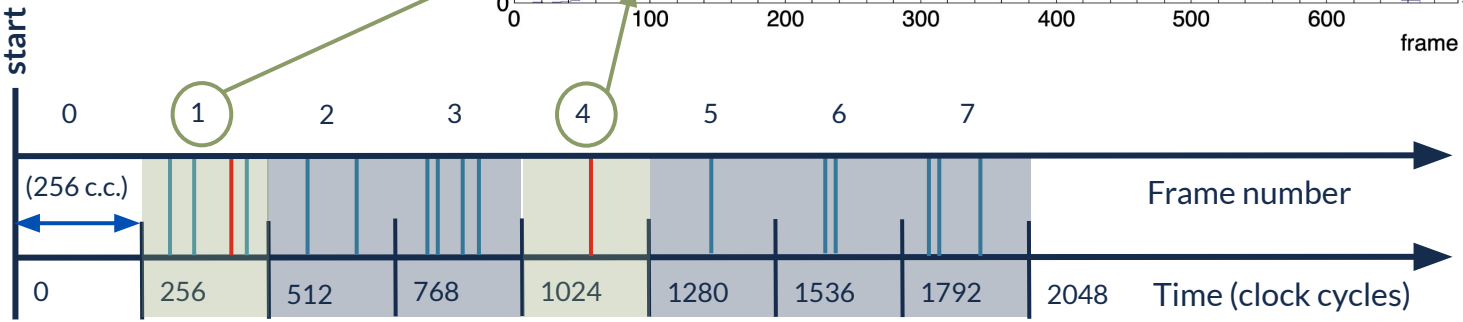


The event in the TTree is a spill.
In frame_n the number of accepted frames is stored.
In frame the array of the frames saved. In this case:

frame_n: 2

frame: {1,4}





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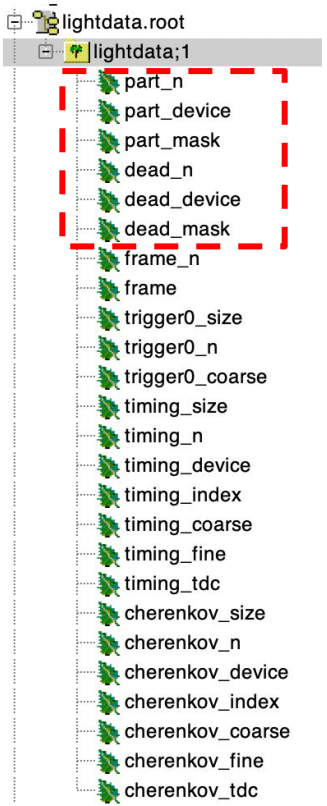

part indicates which device and FIFO is participating in the run. The device refers to the reading FPGA IP address [192-208] and the mask is a bit map for the participating FIFOs:
(1001010111) > (1,4,6,8,9,10)

dead follows the same pattern but refers to FIFOs which reported issues during the run

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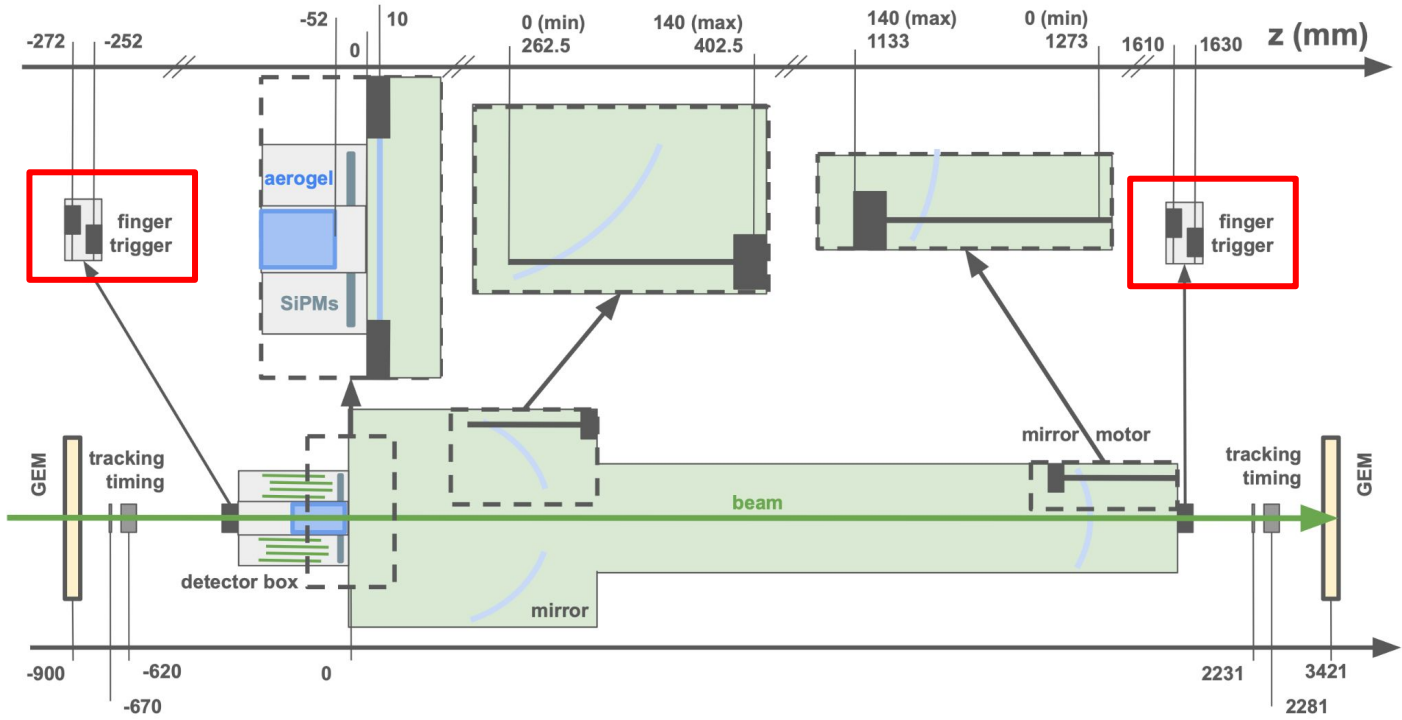

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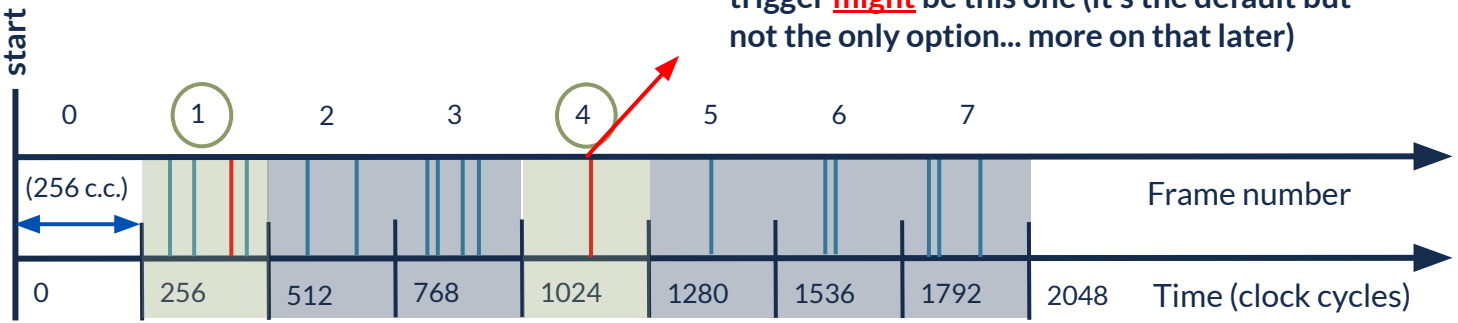
trigger indicates the recorded number and time the finger triggers fired*

(*) if you remember the frame system, the trigger might be this one (it's the default but not the only option... more on that later)



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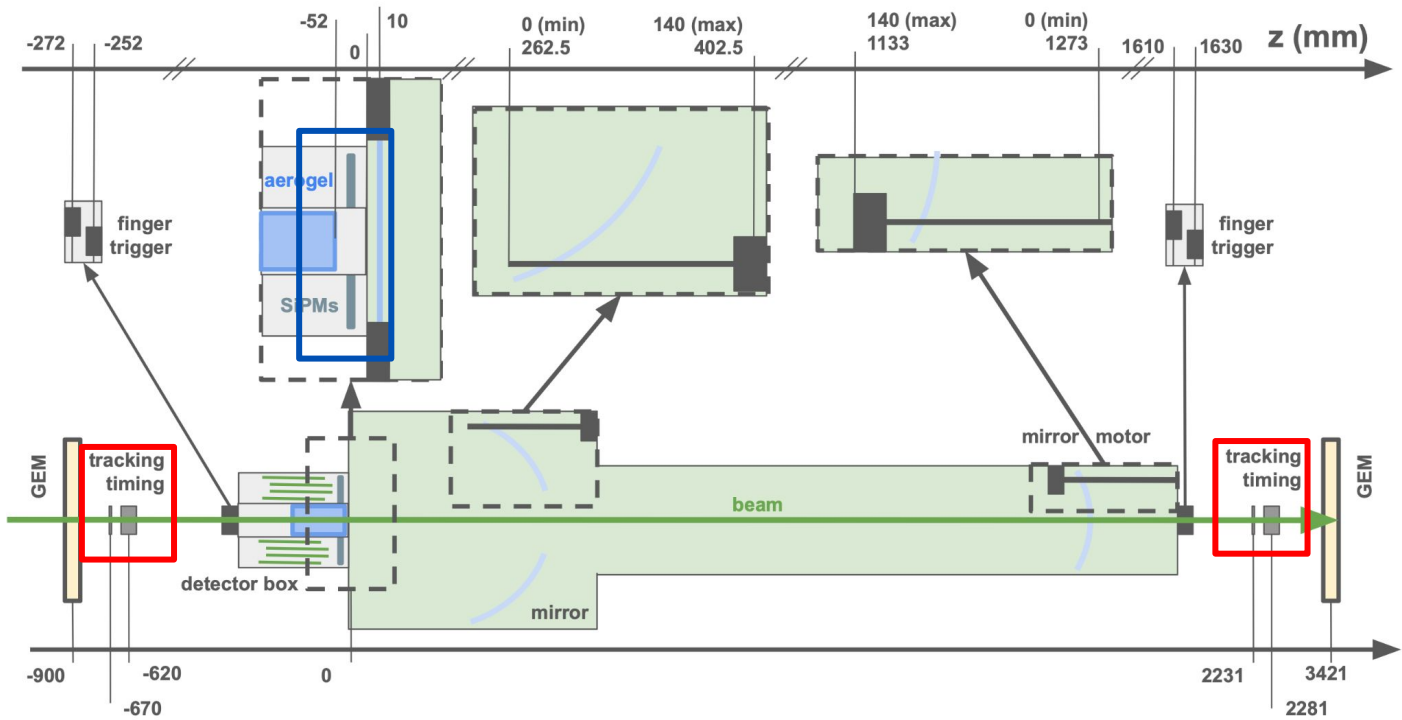

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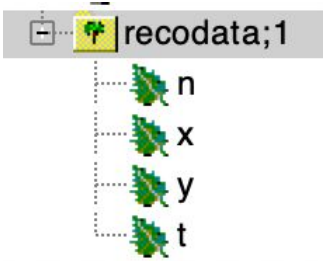

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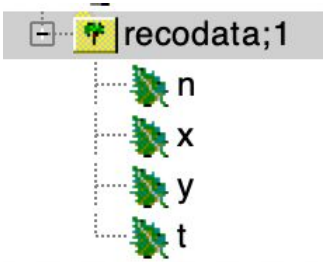

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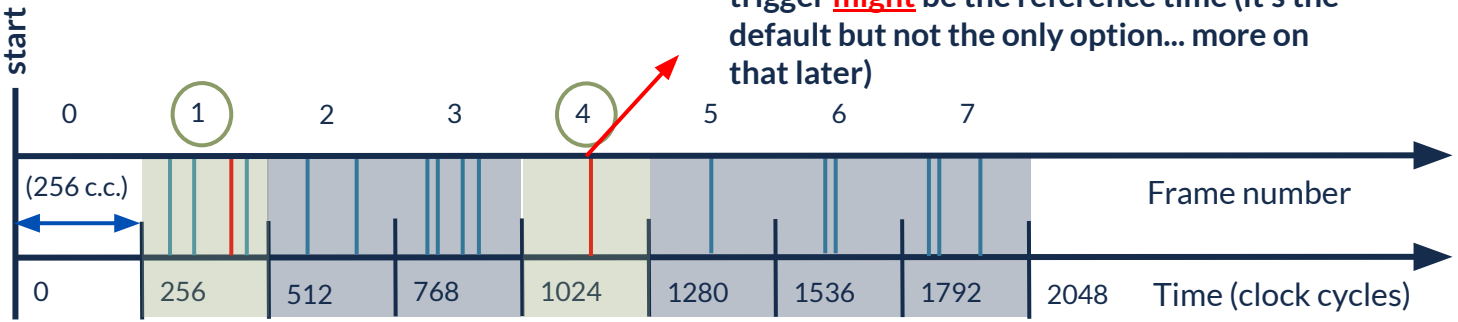

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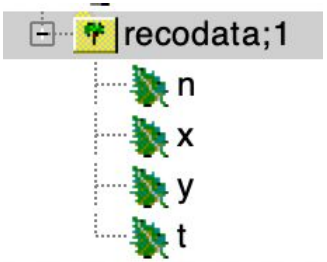

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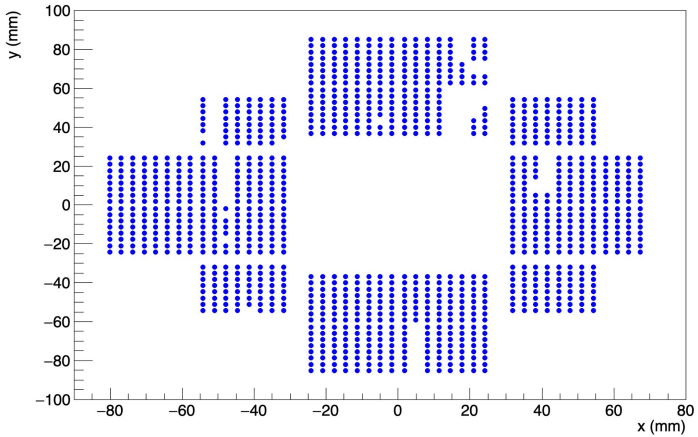

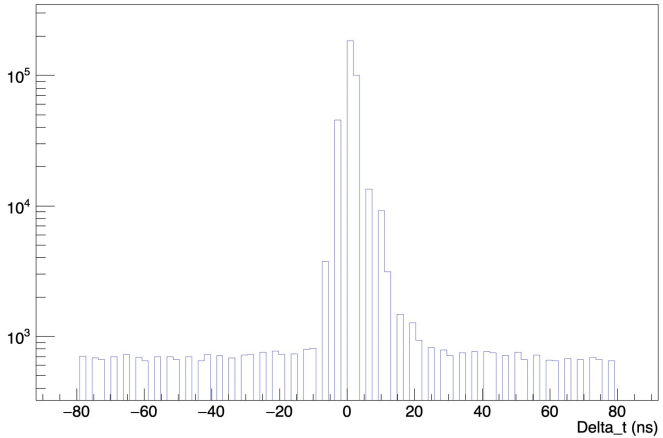

Known readout issues

Fine Tune

[2023BT][Timing][Fixed->ALCORv2]

- Fine tune has an ambiguity at the cut threshold where a wrong clock cycle is assigned (effectively shifting the phase of one clock cycle)

Clock cycle shift

[All][Filtered->Upon req.]

- Data sometimes start shifted by a clock cycle, making the coincidence of cherenkov light (or anything else) more difficult or cut-out if not taken into consideration

Rollover shift

[All][Filtered->Upon req.]

- Data sometimes start shifted by a rollover word, making the coincidence of cherenkov light (or anything else) more difficult or cut-out if not taken into consideration

Other known issues

Background during spill

[All][Still under inv.]

- Fluctuating levels of background have been found in both beam tests, a more thorough investigation is in progress

Analysis targets

SPR and Photon yield

[NR][Ongoing]

- Develop a standard approach to systematically and precisely measure SPR and photon yield of cherenkov light

Afterpulse

[TBA]

- Develop a standard analysis to measure and/or treat afterpulse impact in data. It's possible to match results with characterisation results.

Cross-talk

[TBA]

- Develop a standard analysis to measure and/or treat cross-talk impact in data. It's possible to match results with characterisation results.

Mirror scan

[TBA]

- Develop an analysis to measure and evaluate impact of focusing mirrors on SPR and photon yield

Other investigations

Background

[NR][Ongoing]

- Characterise the bkg and evaluate its impact on the SPR and find source

GEM-available runs

[NR][Stopped][Available]

- Merge GEM and ALCOR data with QA to enhance precision

SiPM Timing

[NR][Stopped][Available]

- Work on ALCOR based timing to minimise time reference in recodata

SiPM Tracking

[NR][Stopped][Available]

- Work on ALCOR based tracking

Thank you!

Back-up