FEBv6 characterization and performances: paper outline

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Paper Outline

Characterization and performances of an upgraded front-end-board for the NectarCAM camera

(NectarCAM collaboration)

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- SCOPE: describing the technical aspects and performances of the 10 preseries FEBv6
- Target journal: **NIM-A**
- Paper length (including 11 figures): ~ 10 pages
- Corresponding authors: FB
- Authors: opt-in procedure

Paper content

1. Introduction

- Introduction on CTA and NectarCAM
- Motivation for the FEB upgrade

2. The front-end-board

- Description of FEB hardware, nectar ASIC, firmware, software (NMC), functional tests, NECTAr chip, test bench

3. Performances

- Analogue bandwidth
- Deadtime
- Linearity
- Timing resolution

4. Conclusions

2. The Front-End-Board

2.1 FEB hardware

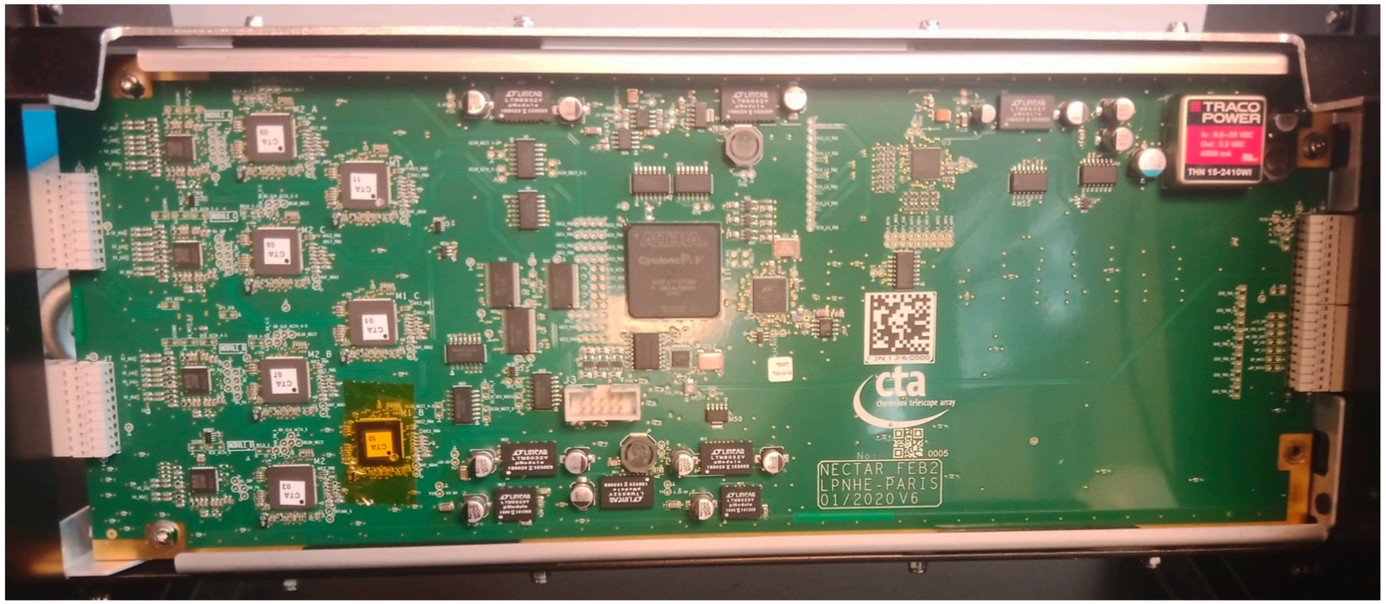

Figure 1: New version for the Front-End-Board used for NectarCAM.

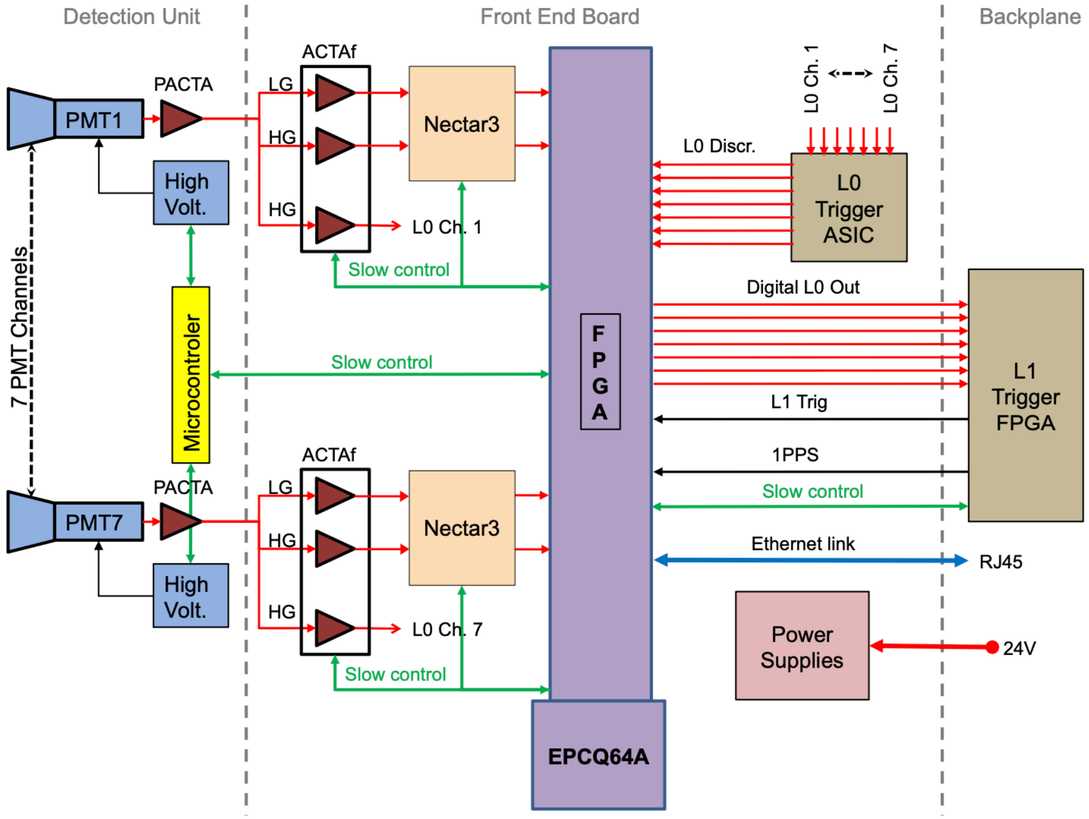

Figure 2: Diagram showing the components of the new version of the FEB.

2. The Front-End-Board

2.1 FEB firmware

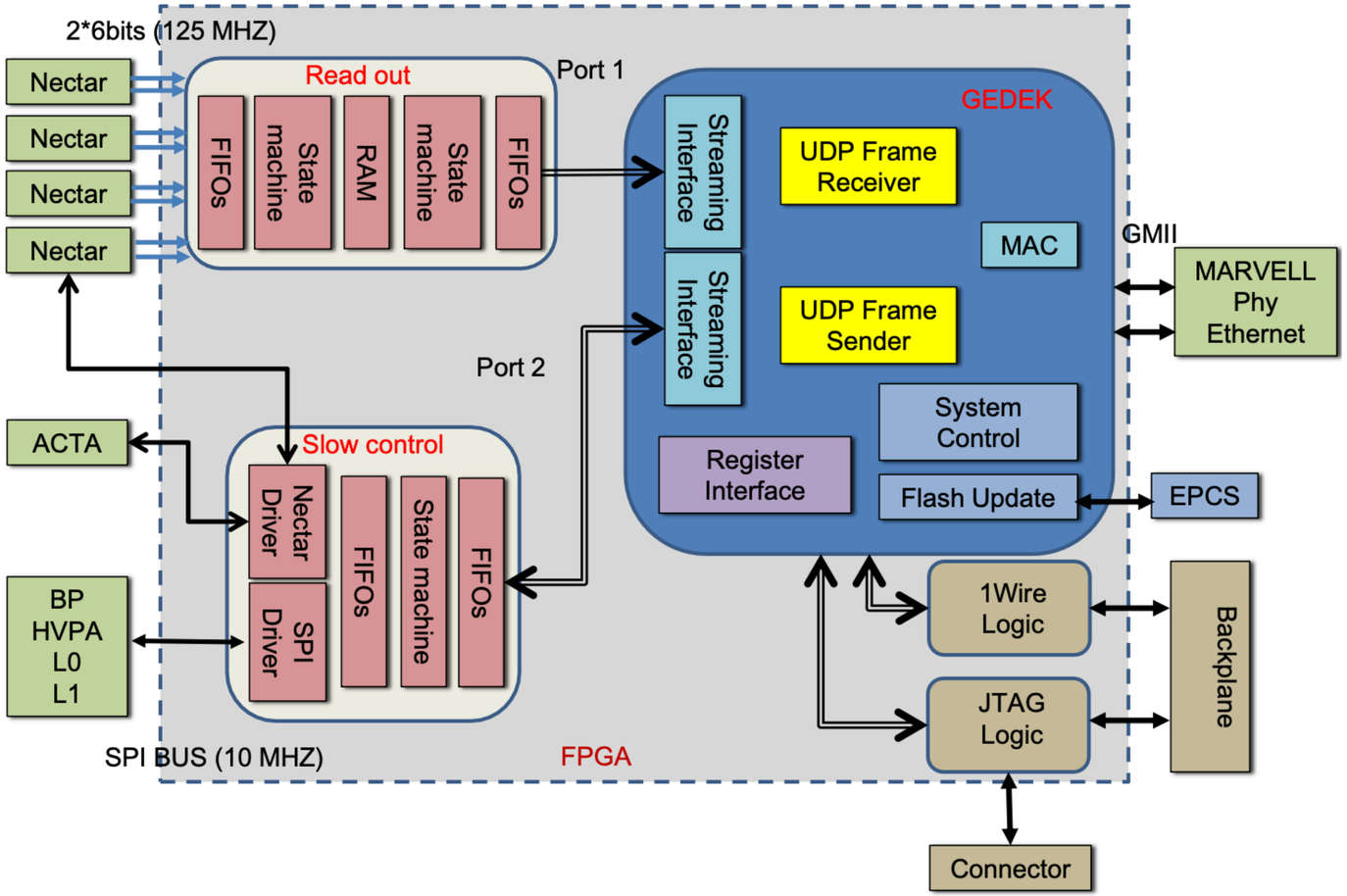

Figure 3: Scheme of the FEB firmware

3. Performances

2.2 Deadtime

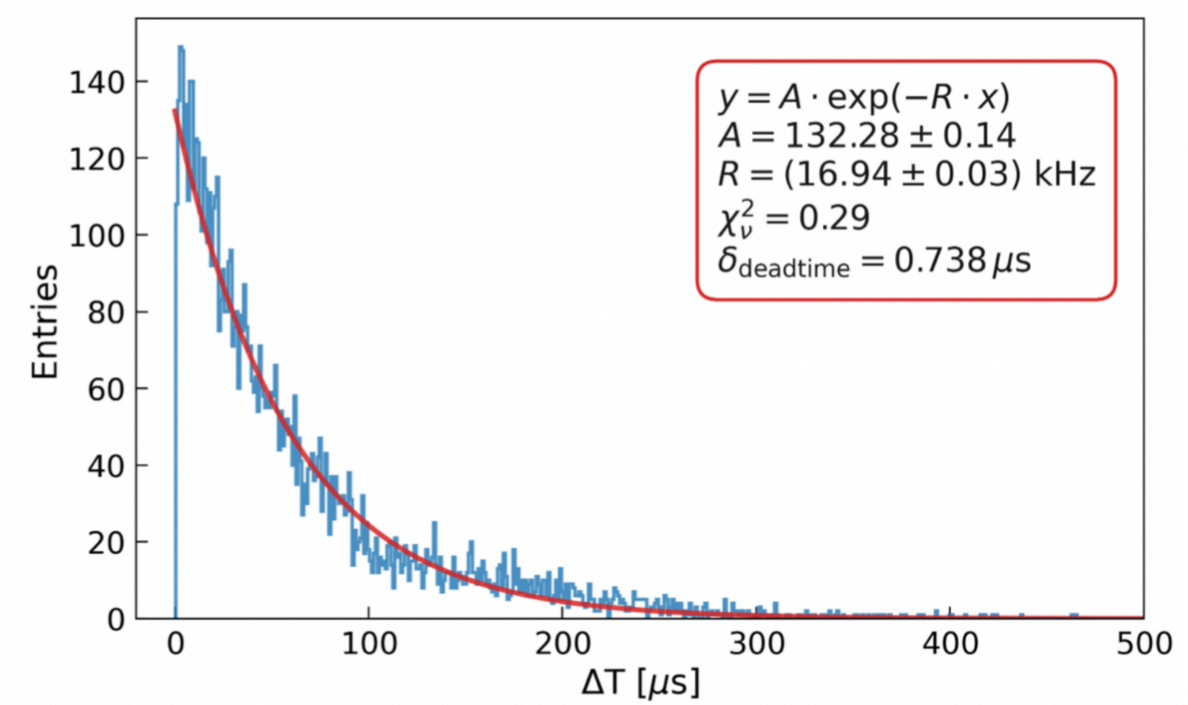

Figure 4: Distribution of time differences (in μs) between 2 triggers using the NSB source with 35 mA current. The exponential fit is shown in red. The exponential parameter R represents the trigger rate.

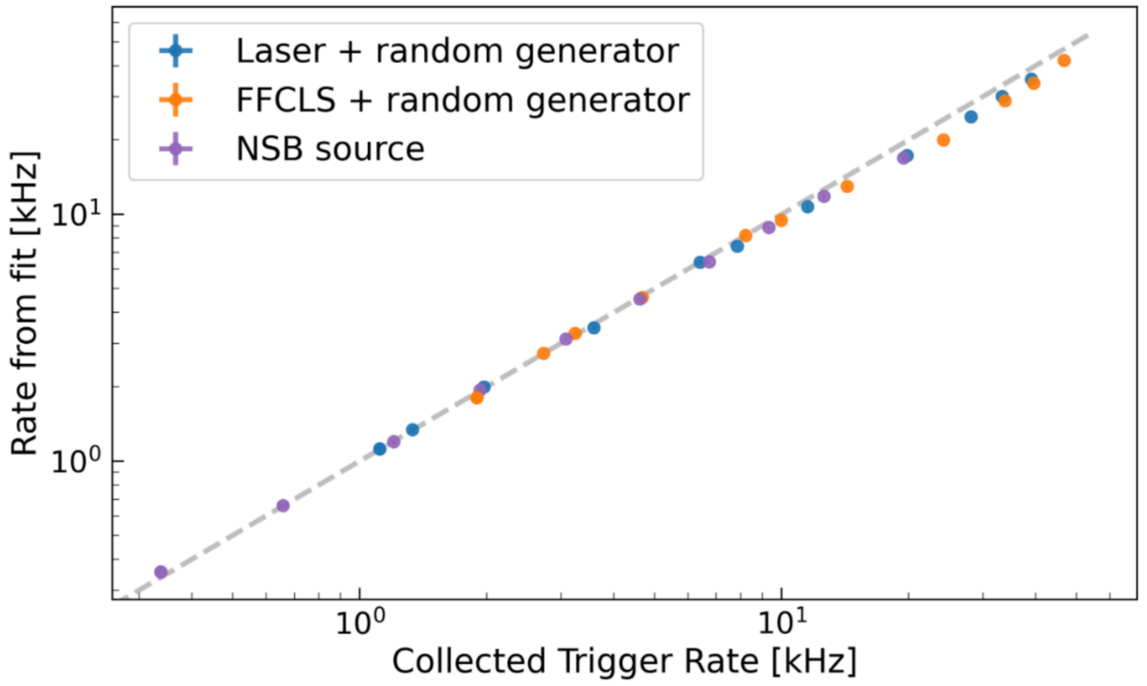

Figure 5: Trigger rate derived from the exponential fit as a function of the collected trigger rate for all runs for the measurement using the laser and the random generator (in blue), the FFCLS and the random generator (in orange) and the NSB source (in violet).

3. Performances

2.2 Deadtime

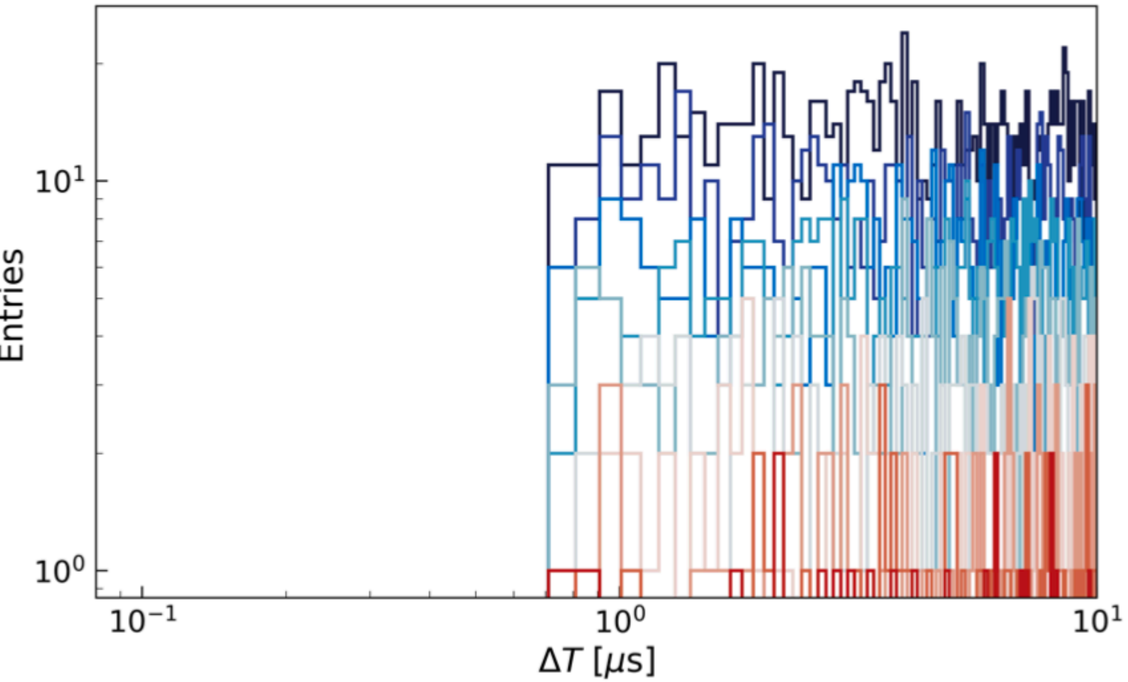

Figure 6: Distribution of time differences (in μs) between 2 triggers for all runs for time differences below 10 μs for the NSB source.

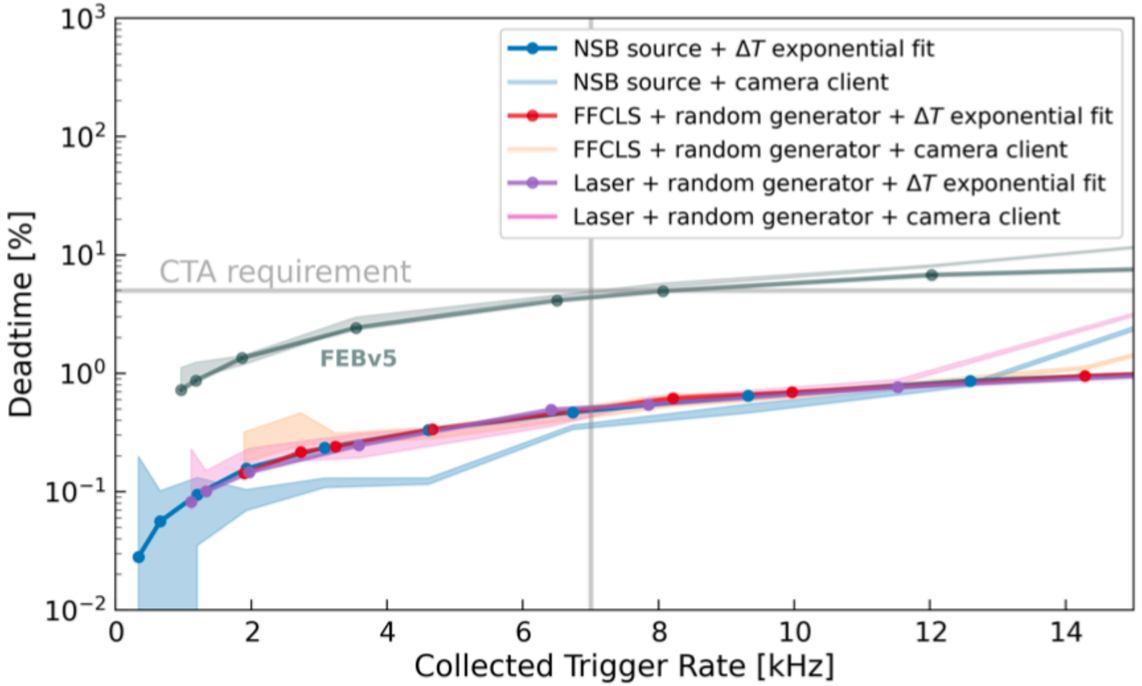

Figure 7: Deadtime fraction for the 10 FEBv6. The deadtime estimated by the ratio between the busy trigger rate and the total trigger rate (orange and violet lines) and is compared with that obtained from an exponential fit (blue line). Both the random generator (dots) and the NSB source (triangles) measurements are shown. The CTA requirement of deadtime fraction at 7 kHz is shown by the red lines.

3. Performances

2.3 Linearity

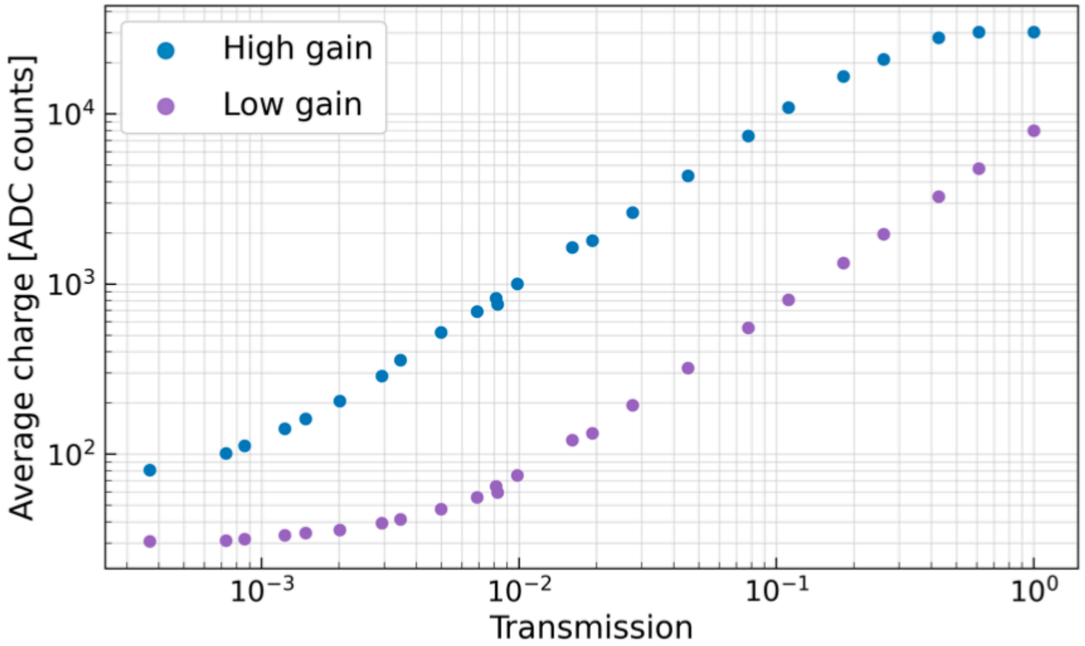

Figure 8: Average deposited charge over all pixels as a function of the transmission of the filters for the high gain (circles) and low gain (triangles) channels. The marker colors show the corresponding run.

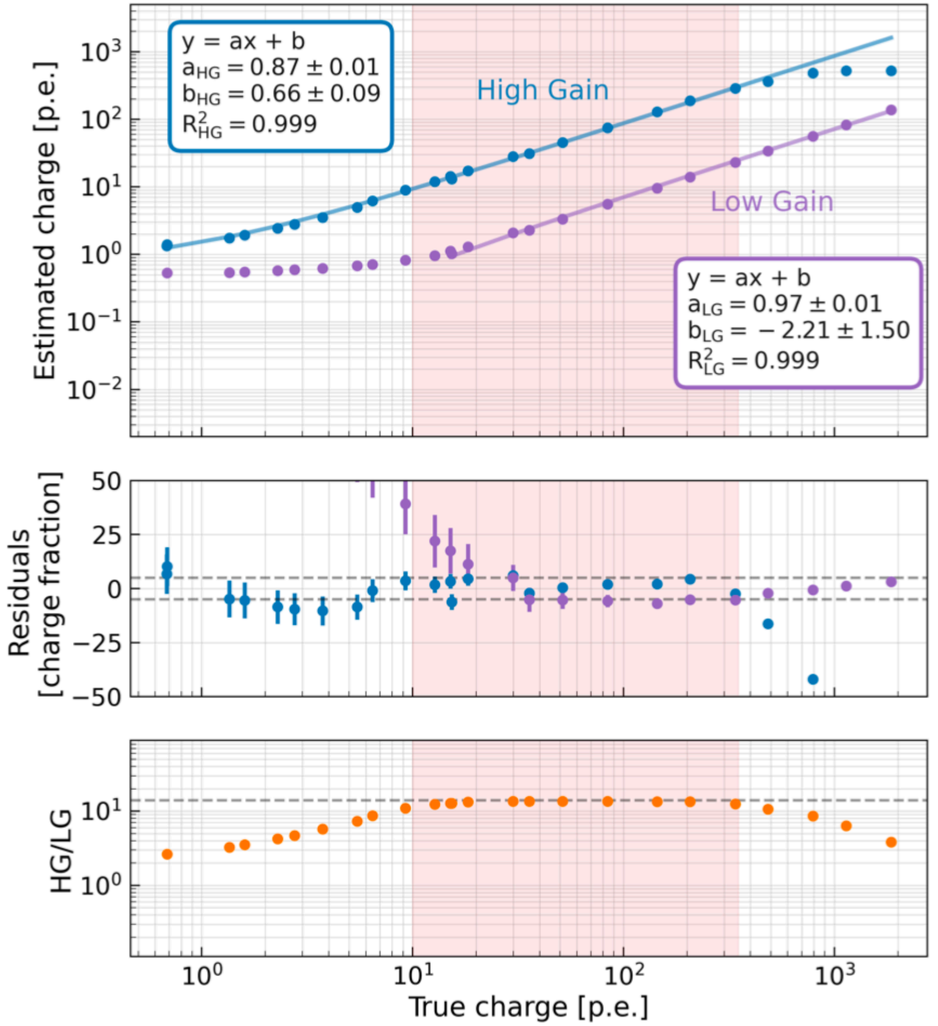

Figure 9: Linearity of the FEB modules. The top frame shows the measured charge as a function of the input pulse intensity for the high (blue points) and low (violet points) gain. The two linear fits with the corresponding parameters are shown. The fit residuals are displayed in the middle panel. The bottom panel shows the ratio between the two gains, and the red area indicates the overlapping range between the two gain channels of 10–500 p.e.

3. Performances

2.4 Timing resolution

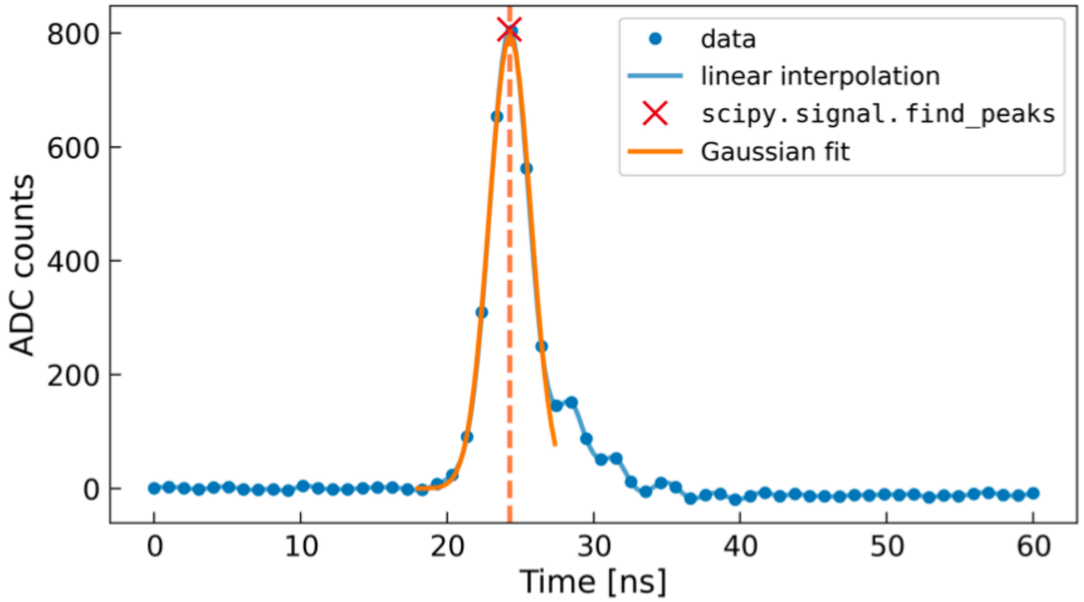

Figure 10: Waveform for one event after pedestal subtraction. The data points are interpolated using the `scipy` function (blue line). The two methods used to identify the TOM are shown. The red cross shows the maximum of the peak found with the `signal.find_peaks scipy` function. The orange curve represents the Gaussian fit. The vertical orange and red dashed lines show the TOM positions found with the first and second method, respectively.

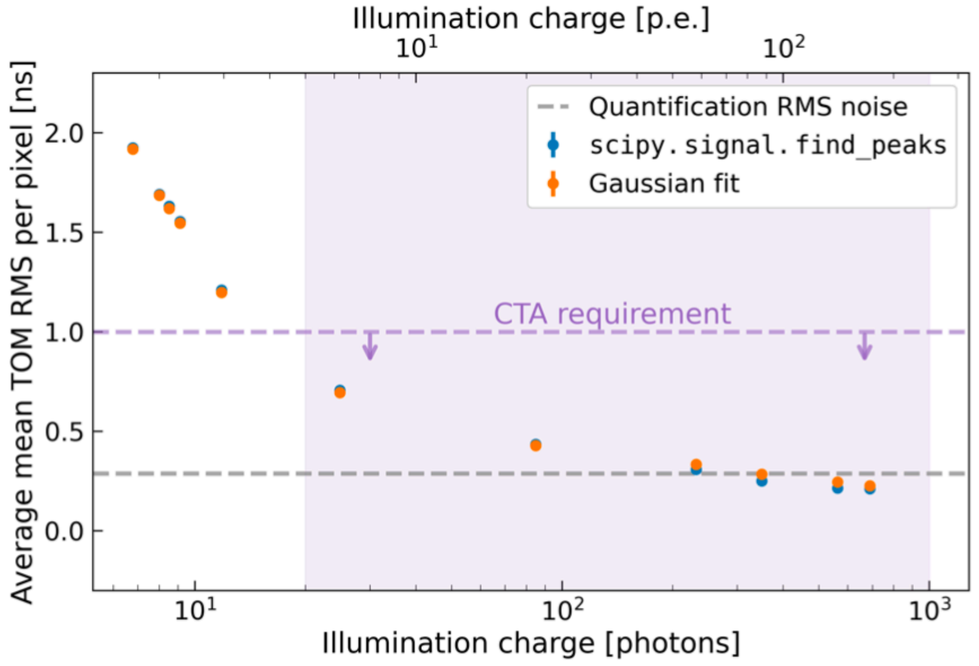

Figure 11: Timing resolution per pixel (in ns) as a function of the charge of the illumination signal (in photons and photo-electrons on the bottom and top of the x-axis, respectively). The timing resolution is given by the mean of the RMS distribution over all the pixels. Both methods are shown (in blue and orange). The gray dashed line shows the quantification RMS noise given by $\frac{1}{\sqrt{12}}$ ns. The dashed violet line shows the 1 ns requirement limit to be valid between 20[5] and 2000[500] photons [photoelectrons] (violet area).

Summary and Outlook

- Paper about timing resolution of NectarCAM
- Title: "*Characterization and performances of an upgraded front-end-board for the NectarCAM camera*"
- Description of the hardware, firmware, software and NECTAr chip of the new version of the FEB to be used in NectarCAM
- Description of the deadtime, linearity and timing performances of the new 10 FEBv6 (preseries)
- Target journal: **NIM-A**
- Measurements and analysis done, writing on going
- Opt-in procedure for author list