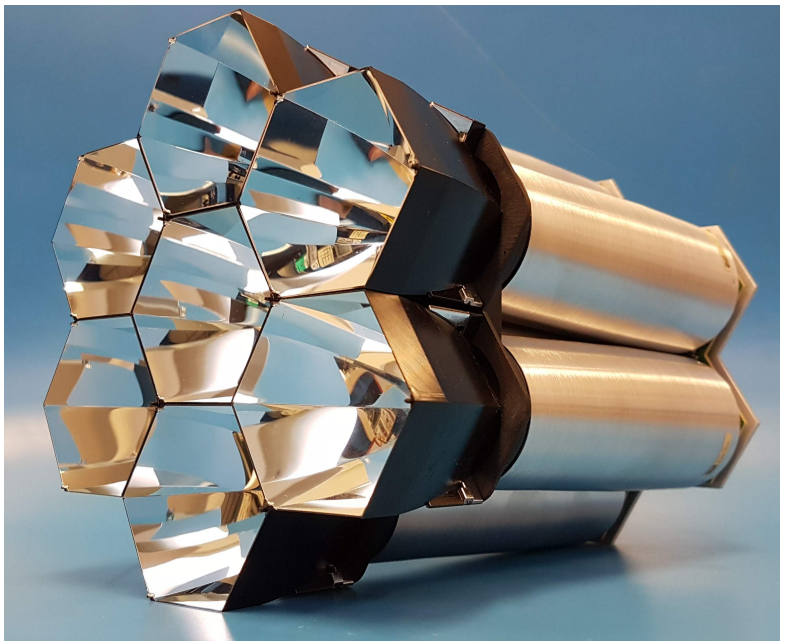
Status of FPM activities



NectarCAM team at IRAP

Ch. Jarnot, P. Jean, G. Jobert, J. Knödlseder, Ch. Marty,

J.F. Olive, Th. Ravel, V. Touzard & A. Tsiahina.

P. Jean – NectarCAM meeting – 6-7 April 2021

Progress status since April 2020

• Production, test and delivery of FPM for the QM

- History:

> Kick off meeting at MICROTEC the November 27th 2018.

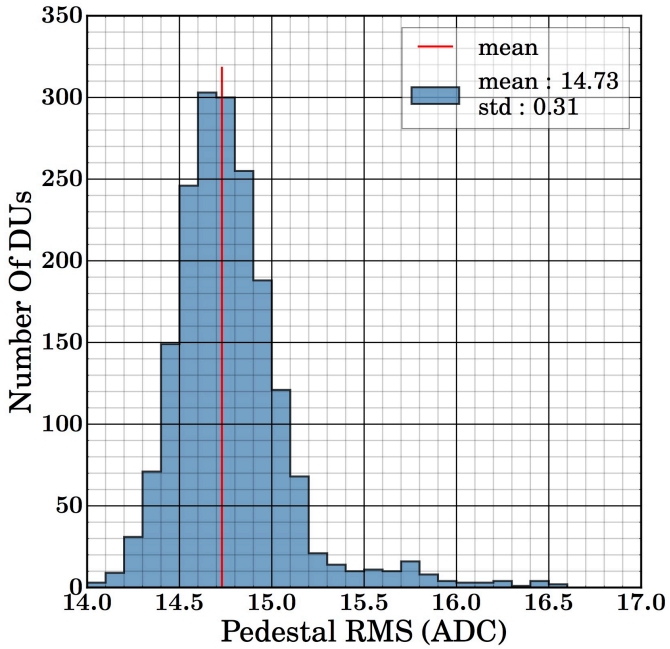
> Production of 27 FPMs/week from November 2019 to February 2020.

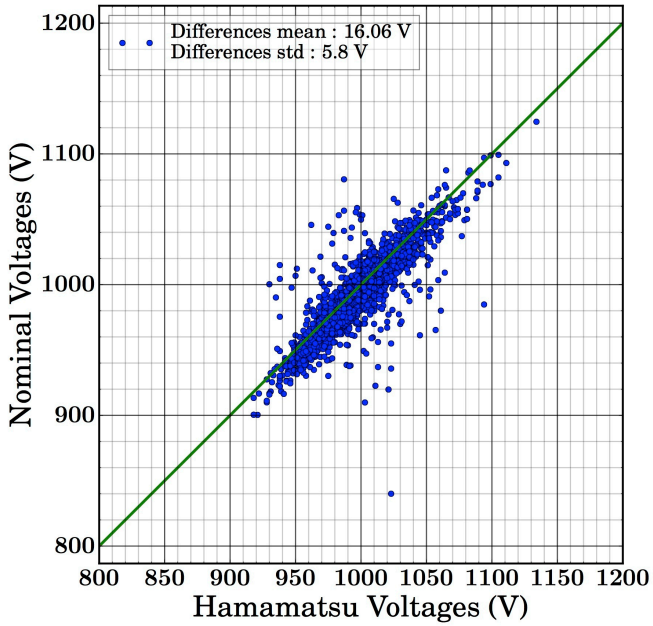
> Performance tests with the FPM test bench in the dark room.

> Performance tests completed in mid May 2020.

> Issues: i - Few noisy detectors.

ii - Bad PMT/DU/channel associations in the database.





Progress status since April 2020

• Production, test and delivery of FPM for the QM

- Activities with those new received FPMs (managed by Christophe Marty)

> Verification and correction of the PMT/DU/Channel associations.

> Check the tropicalisation varnish of HVPA PCBs.

> Re-flash the new version of the firmware of microcontrollers.

> Functional tests in the dark room.

> Packing and delivery to IRFU.

> To do: selection and re-flash of FPMs used in the Adlershof tests as spare FPMs for the QM.

Progress status since April 2020

• Production, test and delivery of FPM for the QM

- Summary of performance tests:

  > Sanity check.

  > SPE at 1400 V.

    => low charge fraction & resolution.

  > Nominal HV (NSB rate of 300 MHz).

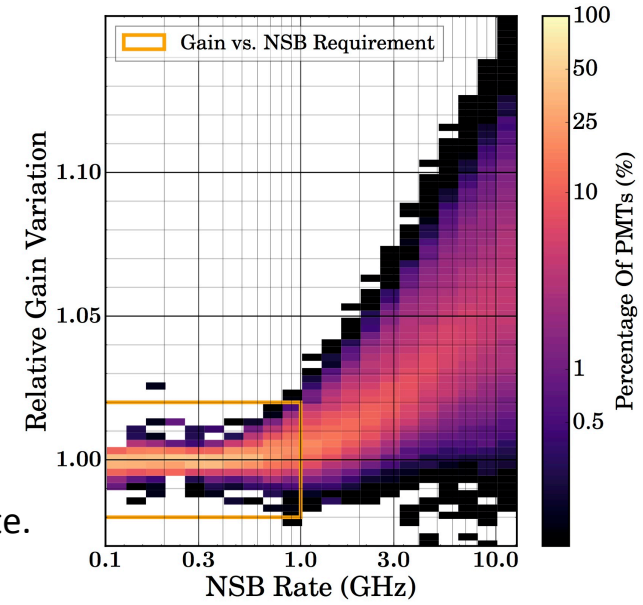
  > Gain stability as a function of NSB rate.

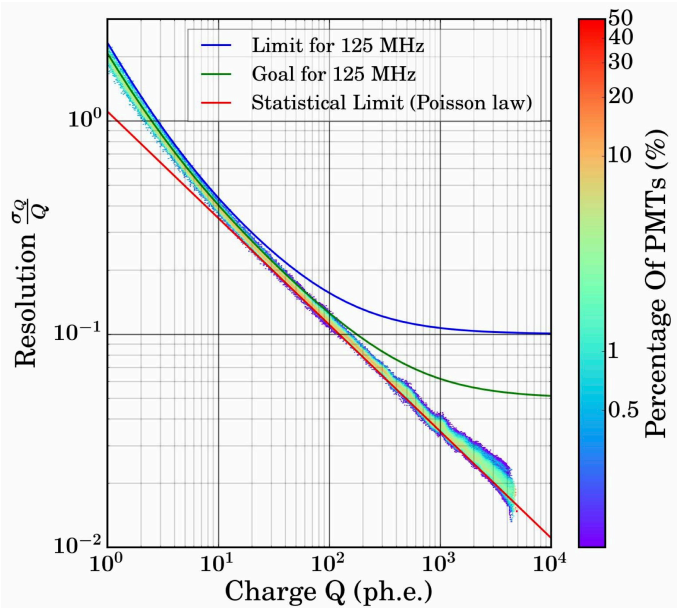
  > Current as a function of NSB rate.

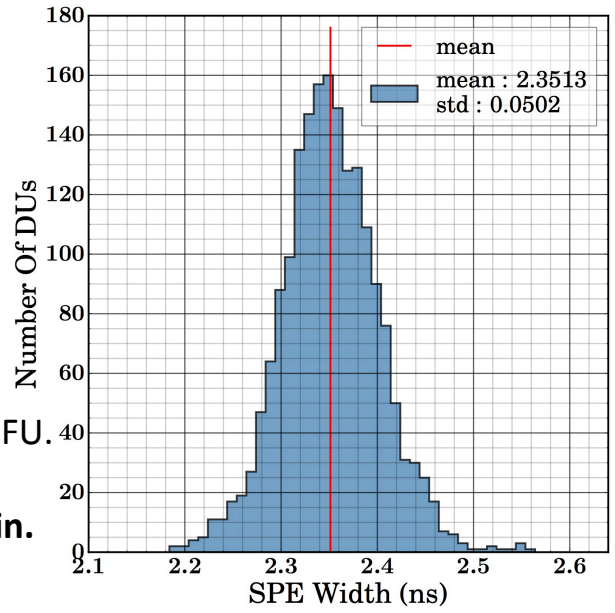
  > Charge resolution.

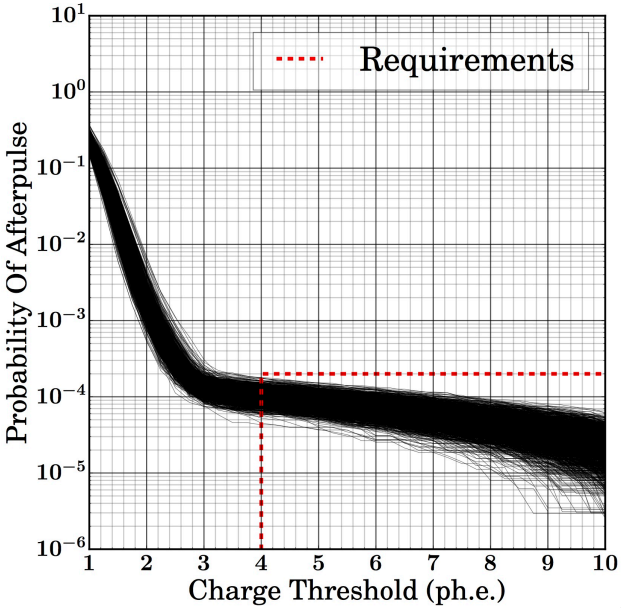
  > Pulse shape and TTS.

  > Afterpulse rate.









- Some results are in databases sent to IRFU.

See the PhD thesis manuscript of Adellain.

Progress status since April 2020

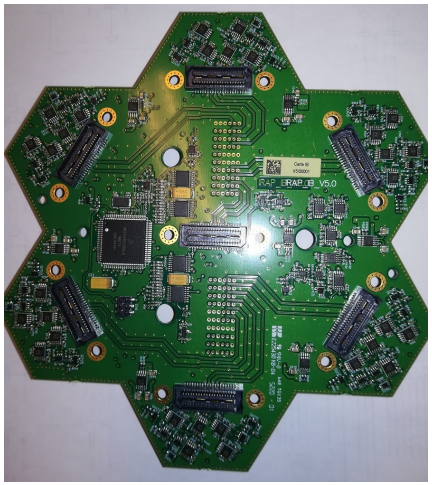
• Preparation of the mass production

- HVPA v5

> HVPA board slightly modified to report automatically a capacitor.

> Re-routing and production of prototypes.

> Preliminary tests with a PMT are fine.



- IB v5

> Christian Jarnot and Thierry Ravel modified the design of the electronic chains that read HK_IA and HK_IHVPA currents:

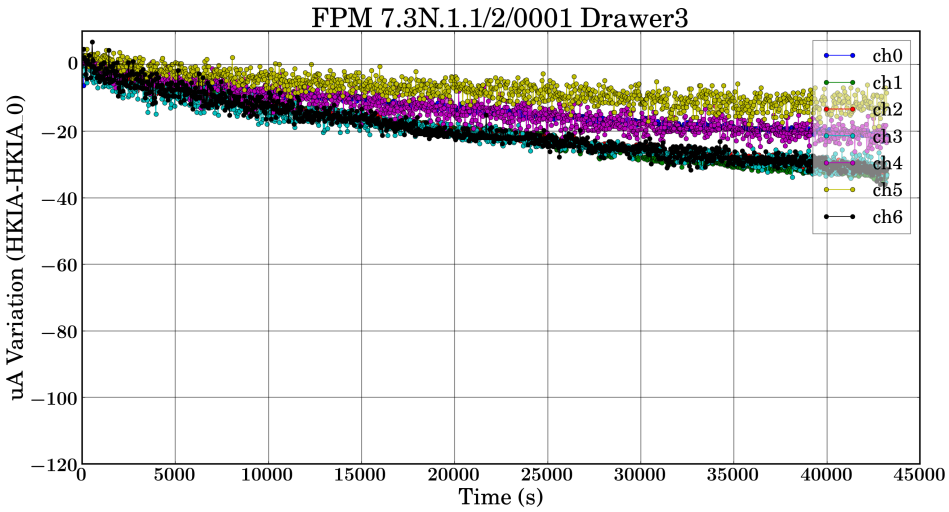
(i) reduction of the current offsets,

(ii) reduction of the drift by a factor of ~2.

> Change position of the switch to flash the firmware.

> Re-routing and production of 2 prototypes.

> Preliminary tests within a FPM are fine.



Progress status since April 2020

• Preparation of the mass production

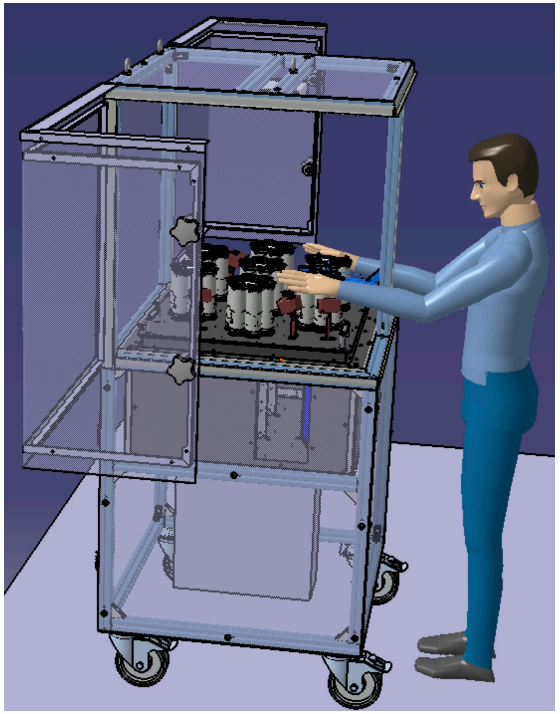
- FPM test bench for the industry.

> Aim to perform functional tests and main performance tests.

> Mechanical design (Frédéric Bouley internship in summer 2020).

> Control of light sources (internship of Victoria Touzard 2021).

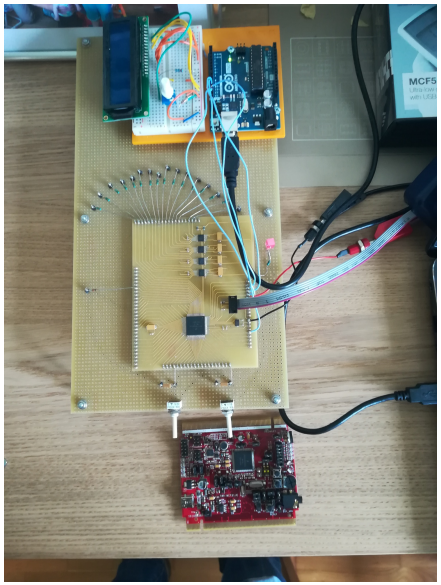
> Work in progress.



- Remote programming of IB firmware (Christian Jarnot & Jean-François Olive)

> Aim: flash the firmware of the microcontroller via the SPI bus.

> Work in progress: a simple code was successfully installed on an IB's microcontroller prototype (internship of Gautier Jobert).



Progress status since April 2020

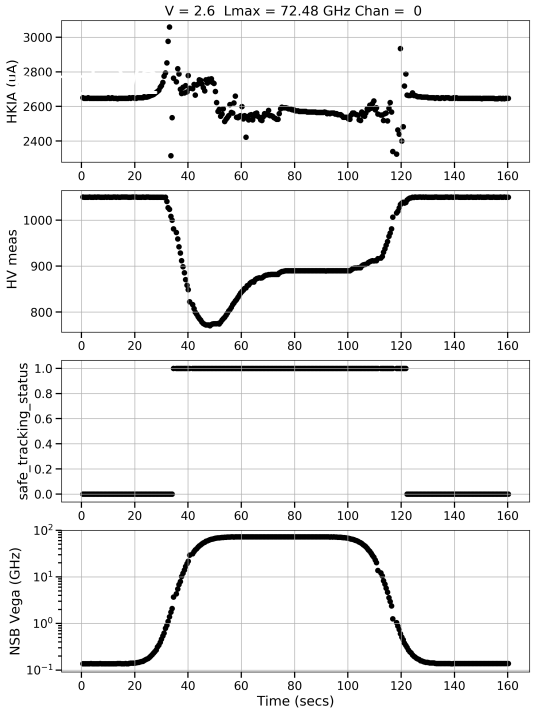
• Other activities

- New IB's firmware developed by Jean-François Olive.

> Star transit mode (requirement B-MST-1670).

> Keep the nominal HV value in the microcontroller memory.

> Tested/validated by Patrick Sizun and Vincent Voisin.



- Quantum efficiency verification (internship of Victoria Touzard 2020)

> Calculation of NSB rates using:

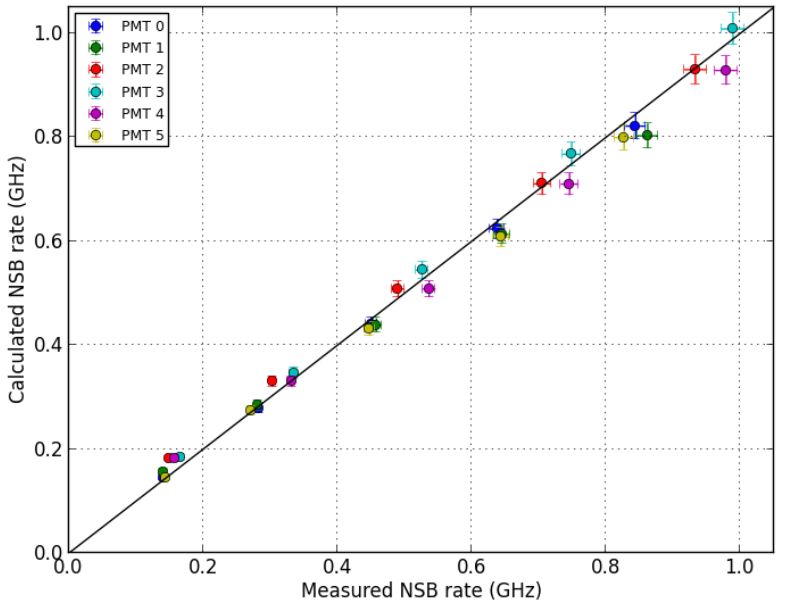
(i) measured light power,

(ii) spectral distribution of light and

(ii) the QE(λ) values provided by Hamamatsu for 6 PMTs.

> Comparison of the calculated rates with the measured NSB rates.

> Results presented in the section 4 of the FPM performance report.



Main CDMR outcomes for the FPI WP

• Summary

- 22 RIX ("Review Item Discrepancy / Comment / Question") listed for the FPI WP.

- Most of them are minor: version number, definition of abbreviations, missing specifications, missing text...

- Most of our answers seemed to be satisfactory.

- Modification/correction of 9/21 documents:

> MST-CAM-UM-0373-IRAP_FPM_user_manual

> MST-CAM-JF-0369-IRAP_NCAM_FPI_Validation_Matrix

> MST-CAM-ICD-0054-IRAP_HVPA_Electrical_ICD

> MSTCAM-SP-0404-IRAP_FPM_specification

> MST-CAM-JF-0372-IRAP_Performance_FPMv2_Report

> MST-CAM-RP-0094-NectarCAM_FPI_Description

> MST-CAM-TP-0371-IRAP_FPM_Test_Plan

> MST-CAM-TR-0101-Perf_over-current_protection_system

> MST-CAM-TR-0287-IRAP_Report-B-MST-1670-verification

- No "High priority action", only 5 "Normal-priority open actions”.

Main CDMR outcomes for the FPI WP

• Open actions

- Five "Normal-priority open actions”: (i) should have been closed and (ii) no clear assignment (PhG, JFG?)

RIX	Question (Reviewer)	Answer
42538 Safety	No safety sections or advice: as the interface board hosts an HV unit one essential safety measure is the protection against electrical shocks (Karl Tegel).	We add advices to protect against electrical shocks in the FPI description document and in the user manual of FPM.
42742 Pulse width	Assuming that NectarCAM uses the same PMT of LST, it is unclear why the two teams reports different pulse widths, respectively ~2.4ns and 2.9/3.0ns (Francesco Dazzi).	Our pulse width is obtained after transit time correction. LST measured pulse width of 2.6 ns using a mask with a small pinhole in front of the photocathode in order to reduce the TTS effect (general LST meeting, 2020).
42746 Afterpulse	The technique adopted to measure the after-pulse rate seem to be focused on after-pulses with high amplitude. why not considering to measure the entire after-pulse spectrum (Francesco Dazzi)?	We did not measure the entire after-pulse spectrum because we do not have the adapted instrumental setup to do so. The goal of our measurements is to check whether the requirement of an afterpulse rate < 2e-4 for charge > 4 ph.e. is fulfilled.
42747 Old plot	Why the charge resolution is so different in figure 10 and 22 (Francesco Dazzi)?	The figure 10 was made at a time when we did not take into account the low charge component in the gain estimation. Therefore, the PMT gains were not correctly estimated for that plot. We added a corrected charge resolution plot.
42748 French	There are terms in French in fig. 26 of the FPM performance report (Francesco Dazzi).	We translated the terms from French to English.

Draft schedule for the production of the next 4 cameras

• Next tasks to complete:

- Validation of the HVPAv5 board (final tests).	Spring 2021
- Validation of the IBv5 (final tests & remote programming).	Summer 2021
- FPM test bench for industry (mechanics, integration, calibration).	Winter 2021
- HVPA, IB and DU test benches (maintenance).	Fall 2021
- Tests of other transformers (backup solution).	Spring 2021

• Production planning (managed by Christophe Marty)

- Update of the cost estimate.

- PMTs: purchase order sent to Hamamatsu for 4 cameras.