



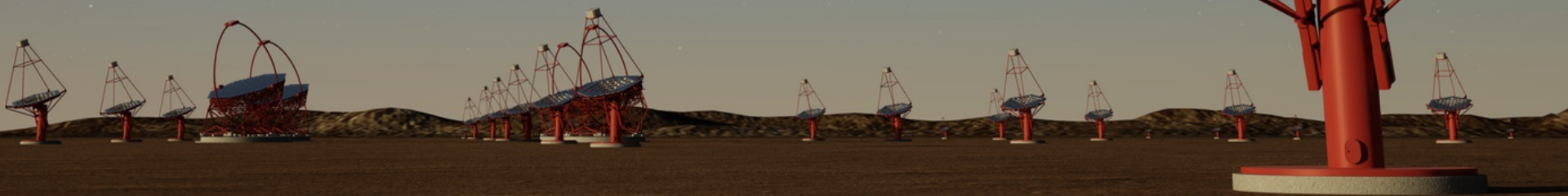
cherenkov
telescope
array



NectarCAM Management

Bordeaux F2F meeting, 10/10/2022

Philippe GALDEMARD (CEA/Irfu)



Project organisation (WBS)

- 16 laboratories are involved (4 Spanish, 1 German, 11 French)
- Each lab manufactures one or several sub-systems for NectarCAM. The subsystems are integrated at CEA/Irfu. The document 'NectarCAM workpackages' shows the responsibilities of each lab.

	MST-CAM / NectarCAM	Ref: MST-CAM-MG-0275-IRFU
	NectarCAM Workpackages	Version: 1.1 Date: 18/07/2019 Page: 1/50

NECTARCAM WORKPACKAGES	
------------------------	--

Prepared by Philippe GALDEMARD, IRFU <i>all WP coordinators:</i> J.F. Glicenstein, J. Prast, F. Toussenet, P. Jean, O. Ferreira, J.A. Barrio, J. Houles, J. Biteau, F. Louis <i>and sub-tasks leaders</i>	Verified by See signatures on pages 2-4
--	---

Released by	Function	Date	Signature
Philippe GALDEMARD	NectarCAM Project Manager	18/07/2019	

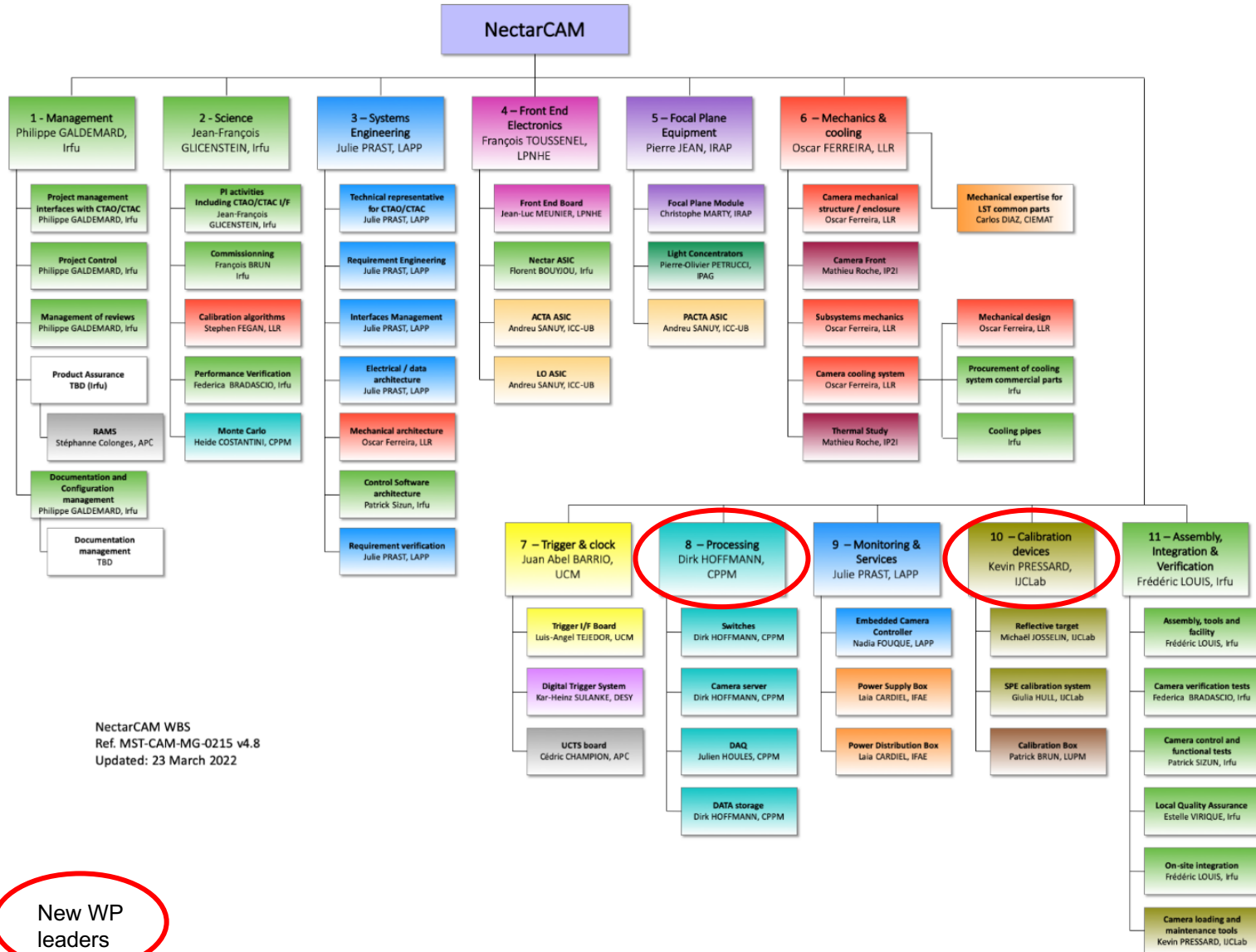
Change record		
Version	Date	Document changes
0.0	30/11/2018	First draft
1.0	15/07/2019	Version for last check of WP leaders
1.1	18/07/2019	Version distributed for signature

Distribution	See Distribution list at the end of this document
---------------------	---

Notes:

- IFAE is not involved in the production of the next cameras (PSBs and PDBs will be produced in France, under the responsibility of Irfu)
- DESY cannot pay the digital Trigger (CEA/Irfu will pay) but DESY will manufacture and test their sub-systems
- CEA/Irfu will pay the TIBs manufactured by UCM

Work Breakdown Structure (WBS)



New WP
leaders

Project organisation

- Project Committee meetings every 2 – 3 weeks
- Regular Project Office meetings (PI, PM, SE, AIV manager, PA manager)
- MST consortium : MST-CG and MST-TCG regular meetings
- CTAO System Engineering meetings (one per month)

NectarCAM Organisational Diagram
Ref. MST-CAM-PL-0311-IRFU V2.1
Updated: 23 March 2022

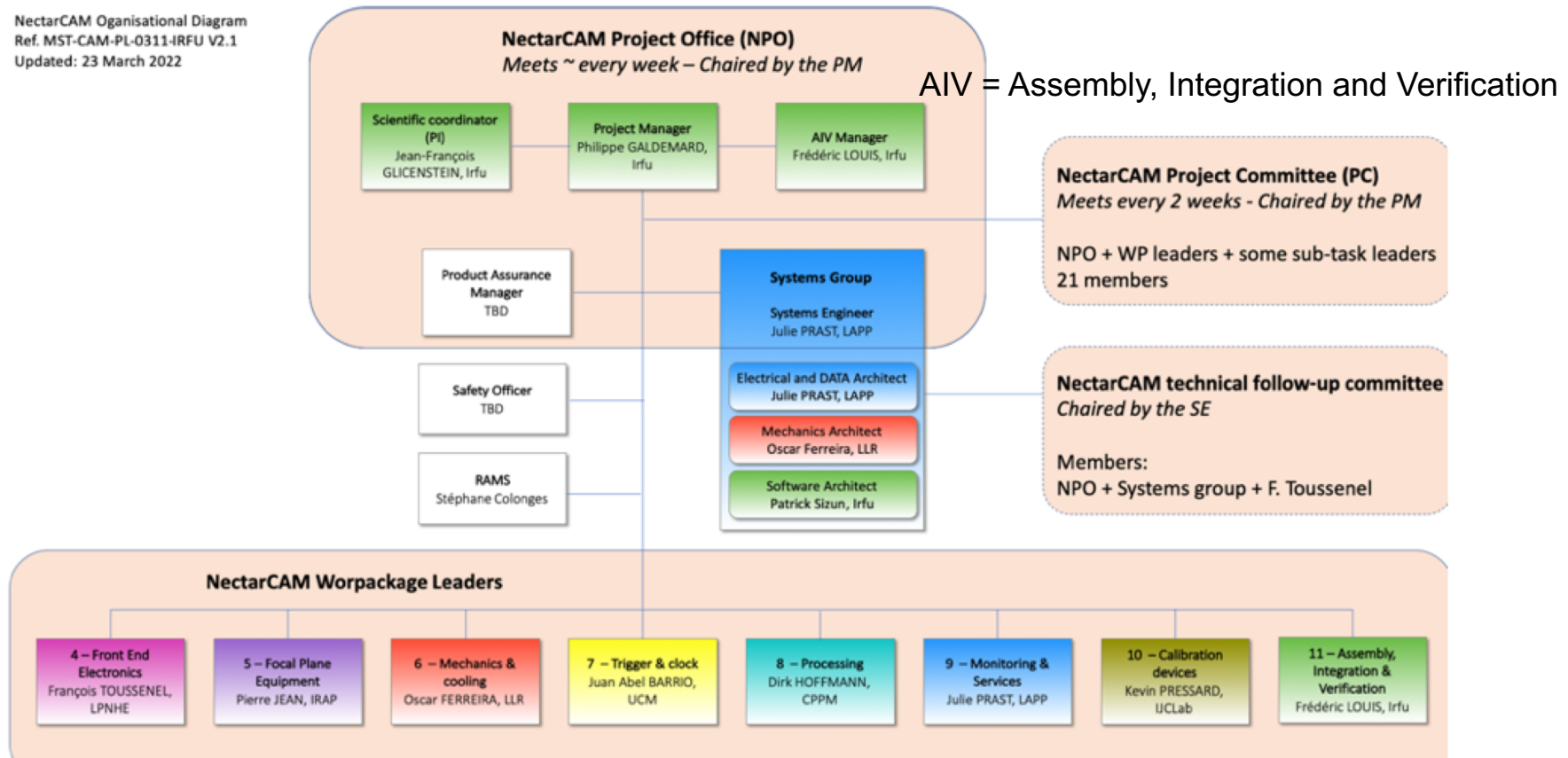


Figure 3: NectarCAM project organisational diagram

MST-Coordination Group: meetings every two weeks

- J.F. Glicenstein, Ph. Galdemard (CEA/Irfu)
- D. Berge, Markus Garczarczyk (DESY)
- G. Hermann, M. Barcelo (FlashCam)
- Monica Vazquez Acosta (IAC)

MST- Technical Coordination Group: meetings every week (Monday morning)

- J. Prast (LAPP), Ph. Galdemard (CEA/Irfu)
- A. Steiner, Markus Garczarczyk (structure, DESY)
- G. hermann, M. Barcelo (FlashCam)

- The Camera/Structure ICD, together with the camera chiller, are the main topics.

MST- System Engineering meetings: meetings every month, chaired by Nick Whyborn

- J. Prast (LAPP), Ph. Galdemard (CEA/Irfu)
- A. Steiner, Markus Garczarczyk (structure, DESY)
- G. Hermann, M. Barcelo (FlashCam)

CEA/Irfu will hire a PA manager for the production of the next cameras (mid or end of 2023 ?).

Each lab must write and distribute a test procedure for their sub-systems. The sub-systems must be tested according to the procedure and a certificate of conformance must be delivered with the sub-system.

Note: We received at Saclay several sub-systems which did not work ! They were probably not well tested !

The Irfu PA manager should be involved in the test of sub-systems in each lab to check that the test procedures are followed.

NectarCAM CDMR closure



There is only one High Priority RIX that needs to be addressed:

- This RIX is related to Software and Firmware Product Assurance.

A meeting has been held with SW developpers. The text concerning SW PA has been agreed.

The firmware PA part is still to be discussed among the FW developpers. The text exists, we have to talk with FW developpers to be sure that it will be applied. Changes can be proposed by the developpers.

There are also some **Normal or Low Priority RIXes**, that must be worked out and closed.

Please have a look at https://forge.in2p3.fr/projects/cdmr-review/issues?set_filter=1&tracker_id=4 and work on the closure of these RIXes.

Juan Abel has 23 RIXes to close, Stéphane has 2, Oscar has 13, Philippe has 5, Jean-François has 28, Dirk has 1, Pierre has 2, Frédéric has 5, Julie has 8, Patrick has 2, François has 7.

The old Sharepoint 2010 system is no more available ! We cannot access the NectarCAM documentation and we cannot add new documents !

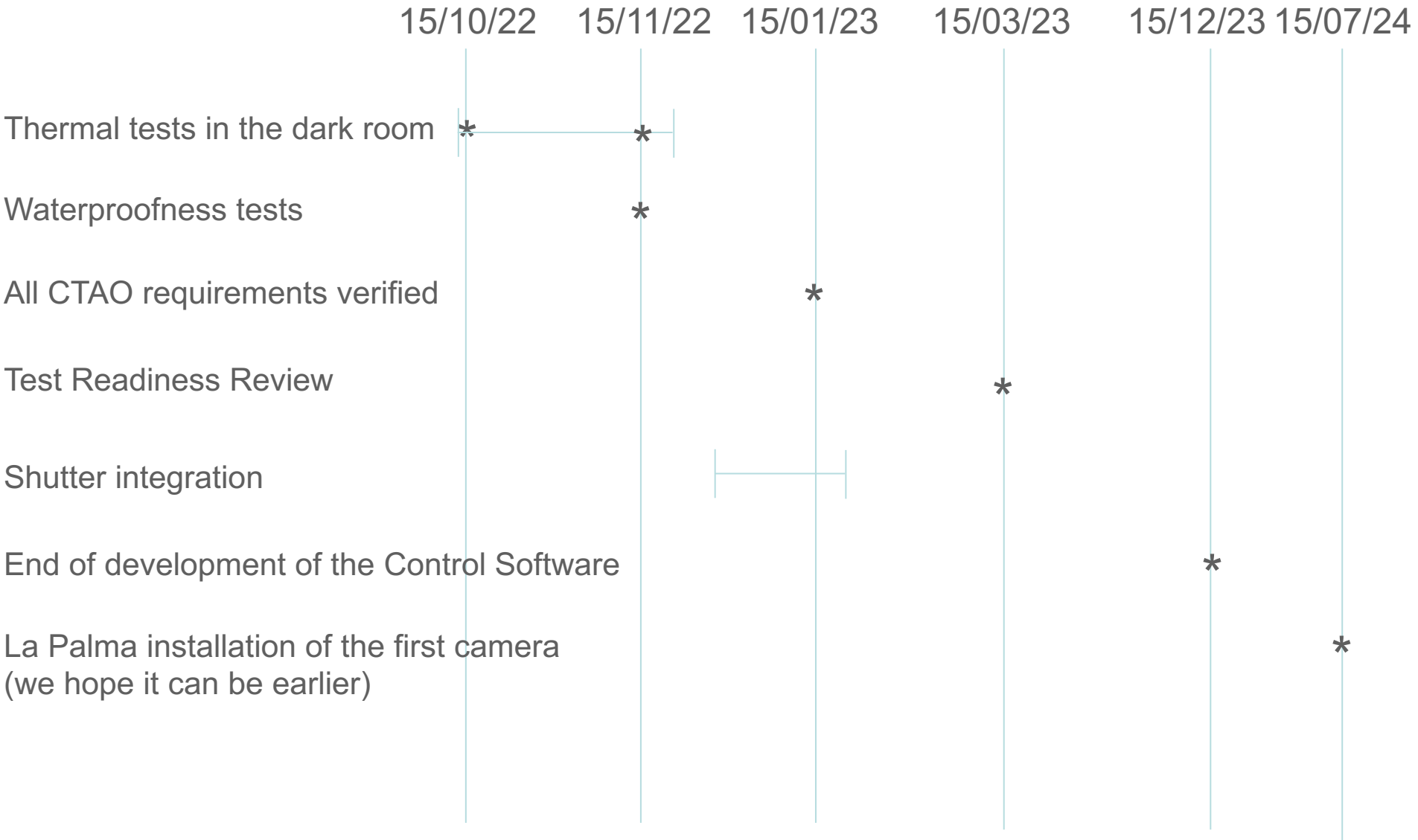
- CTAO is working on a new system, they should transfer the entire NectarCAM documentation on the new system (agenda still very uncertain !).
- Dirk has made a temporary solution. It will be presented on Wednesday morning.

Technology Readiness Level of the sub-systems

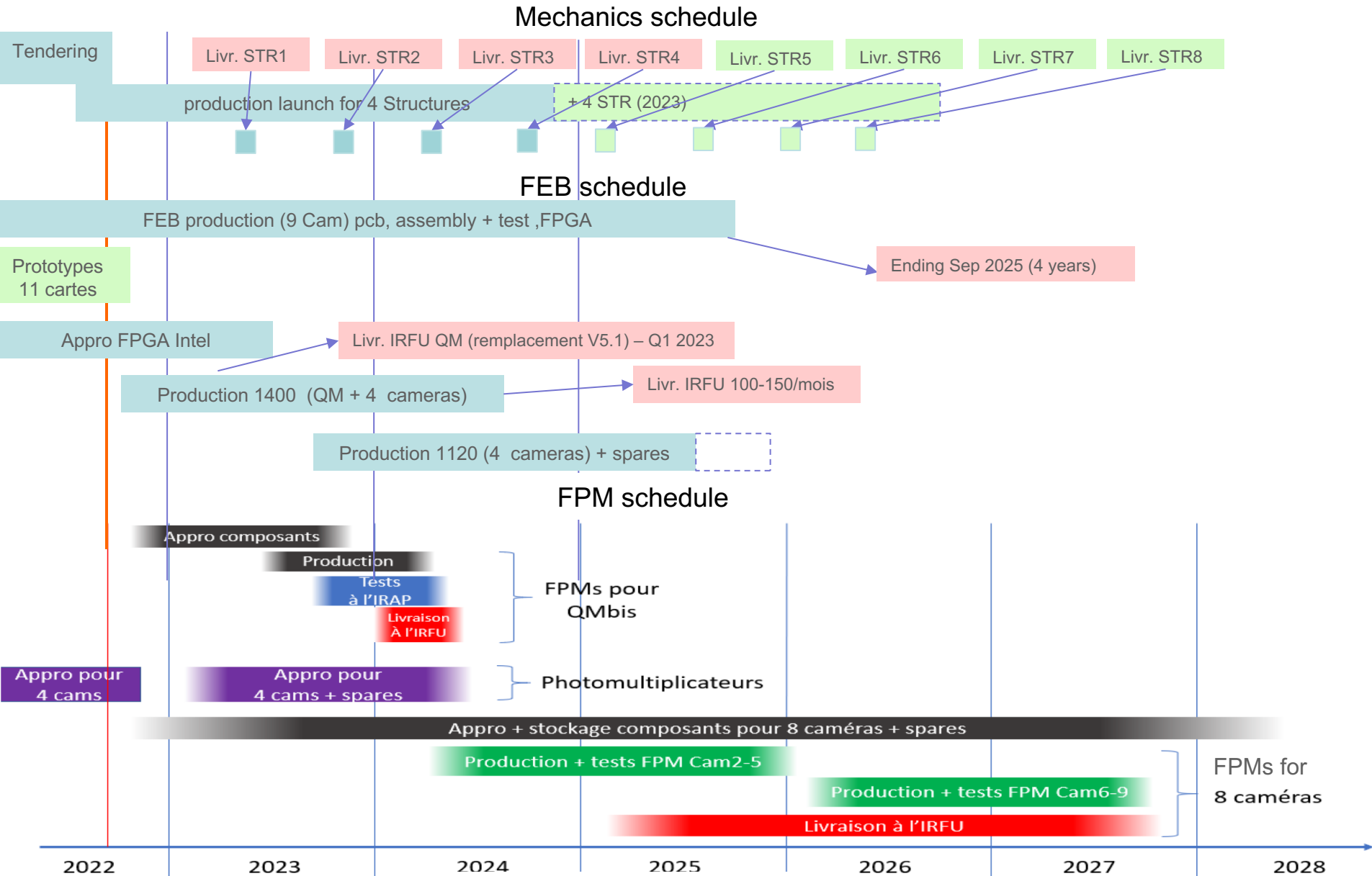


Système	WP	Resp	TRL	Comment
Focal Plane Module (FPM)	FPI	IRAP	7-8	QM Validated
Guides de lumières (Light guide)	FPI	IPAG	8	QM Validated. Production finished.
Front End Board (FEB)	FEE	LPNHE	8	QM Validated. Production soon
ASIC Nectar	FEE	IRFU	8	Validated on FEB V6. Production ongoing
Other ASICs (ACTA, PACTA, TL0, TL1)	FEE	ICC-UB	8	QM Validated. Production finished.
Ethernet switches	Processing	CPPM	7-8	QM Validated, tendering ongoing
Event builder	Processing	CPPM	6-7	V4 Validated on QM, V5 ongoing
Mechanics : Camera frame, module holder , ...)	Mechanics	LLR	8	QM validated. Production soon (in Spain)
Mechanics : Camera front	Mechanics	LP2I B	6-7	QM Validated, Shutter still to be integrated
Embedded camera controller (ECC)	Mon.&Serv.	LAPP	8	QM Validated, tendering ongoing
Digital Trigger System	Trig&Clk	DESY	7-8	QM Validated, tendering soon by DESY
Power suply box and power supply distribution	Mon.&Serv.	IRFU	7-8	QM Validated, tendering ongoing at Irfu
Camera cooling	Mechanics	LLR	6-7	QM Validated, thermal tests ongoing
Calibration sources	Calibration	LUPM	7-8	QM Validated, production ongoing
Calibration system (mechs)	Calibration	IJCLab	6-7	Tests ongoing on the QM
UCTS	Trig&Clk	APC	7-8	QM Validated,Opération on LST
Trigger interface board	Trig&Clk	UCM	7-8	QM Validated, Opération on LST
AIT/AIV tools	AIV	IRFU	8	QM Validated
NECTARCAM	All	All	7	Tests Prototype at Berlin, QM at Saclay Verification of Reqs : almost finished

Schedule



SCHEDULE



- The schedule is still very uncertain. The good news is that the building permit for the first MST (MST3) has been granted. The Spanish did not launch yet the call for tenders for the first 5 MST structures. DESY informed us in June 2022 that the first MST will be assembled at La Palma only in May 2024 (They set the priority to the first MST at CTA-South.) This means that the first NectarCAM should not be on the first structure before July 2024.
- We plan the production of the next 8 NectarCAMs:
 - One in 2023 (probably end of 2023)
 - Three cameras in 2024
 - Three cameras in 2025
 - The last NectarCAM in 2026
- This schedule might be adjusted because there is a shortage of some electrical components (Some FPFAs have a procurement time of 90 weeks !). The schedule for the manufacturing of new FPMs for the first camera is also uncertain. All the FPMs will be re-manufactured because the PCBs manufactured in China are faulty.
- There is also an uncertainty concerning the funding of the last 4 MST structures at CTA-North. The ERIC statuses mention 9 MSTs at La Palma, but nobody confirmed the funding of the last 4 structures, yet.

- A review held by Rodolphe Clédassou occurred on September 15, 2022
- The NectarCAM status has been presented, together with the cost estimates and the manpower estimates in each lab for the production of the next 8 NectarCAMs.
- The final review report is not released yet
- The main goal of this review was the commitment of the laboratories directors, to provide the necessary manpower for the production of the next 8 NectarCAMs
- The Workpackage document will be probably completed, indicating the needed manpower in each lab. The laboratories directors will sign this document.

- Test Readiness Review:

This review should occur by March 2023. CTAO wants to check that all procedures allowing to check each requirement are written, and that the test reports are provided.

- Pre-Shipment Review

This review, when passed, is the formal authorisation to ship the first camera to La Palma. CTAO will check that everything is ready, including the maintenance manuals and the requirement verifications.

- Acceptance Review

This review is the formal acceptance of each camera. It is held after the commissioning period.

- The project risks are mentionned in the new version of the Project Management Plan (NectarCAM_Management_Plan_220323)
- Karl Tegel helped us a lot to improve the risks documentation. The associated CDMR RIX is closed.

- Main risks:
 - Procurement delays of some electronic components.
 - Continuous drift of the infrastructure schedule in La Palma
 - Change of the CTAO management (2023 or 2024 ?)
 - Lack of « Project Culture » in some labs
 - CDMR closure not done after 1 year and 7 months !
 - Some sub-system verifications should be improved.
 - Some people will leave the project (retirements)
 - CTAO Requirements still not frozen ! (Normally all requiremenst are frozen before any CDR, in a project)
 - The documentation system is no more available !

Project costs

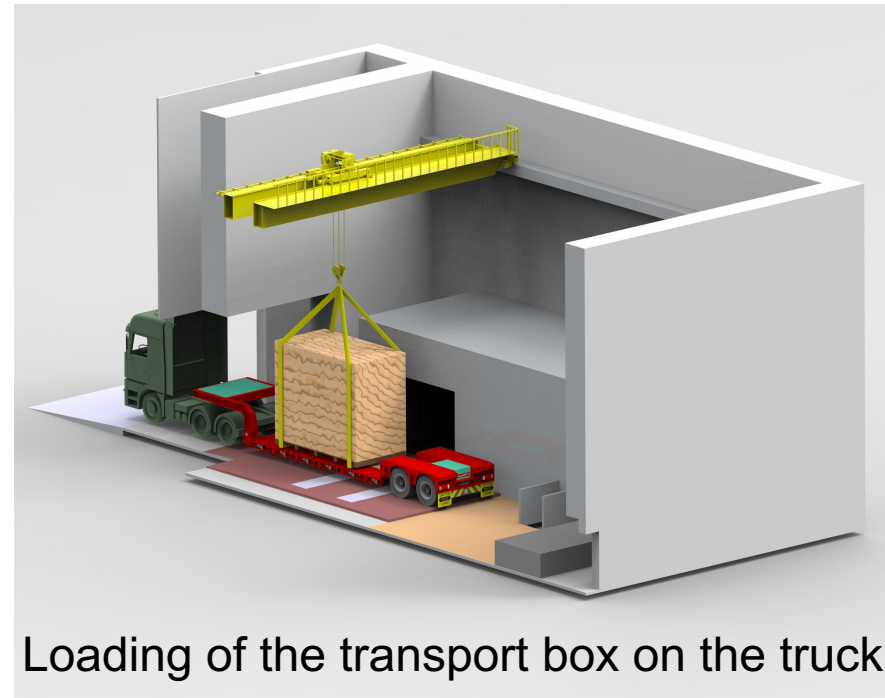
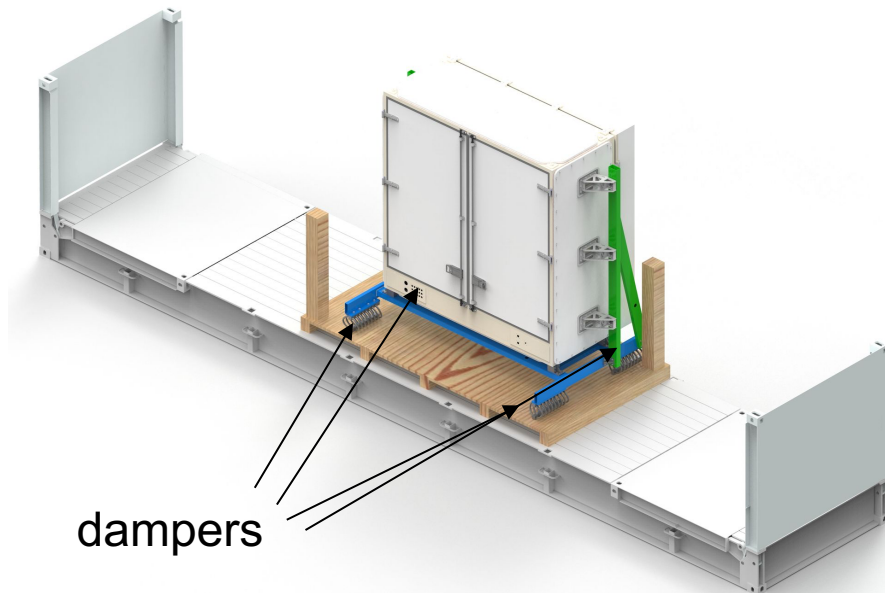
- The complete costs are still not known, because all tenders are still not launched.
- The cost of each camera is estimated to be around 2 M€, but this should be adjusted. The shipment cost of the cameras is still not known, but CEA/Irfu is working on this.
- Stéphane Collonges wrote a very good RAMS report. Please check in this report the number of spares needed per camera. The spares are needed at the observatory for a camera lifetime of 15 years. All spares should be included in the procurement contracts.

		Irfu	IN2P3	INSU	
1	2022	344 664 €	580 463 €	855 071 €	
3	2023	1 033 992 €	1 741 389 €	2 565 213 €	
3	2024	1 033 992 €	1 741 389 €	2 565 213 €	
1	2025	344 664 €	580 463 €	855 071 €	
Total production		2 757 312 €	4 643 703 €	6 840 567 €	14 241 582 €

- Total cost for 9 caméras estimated around 17.84 M€. The TGIR funding for NectarCAM is 22.5M€. → No funding issue to build 9 NectarCAMs.
- The first camera costed around 3.6 M€ (test benches included).

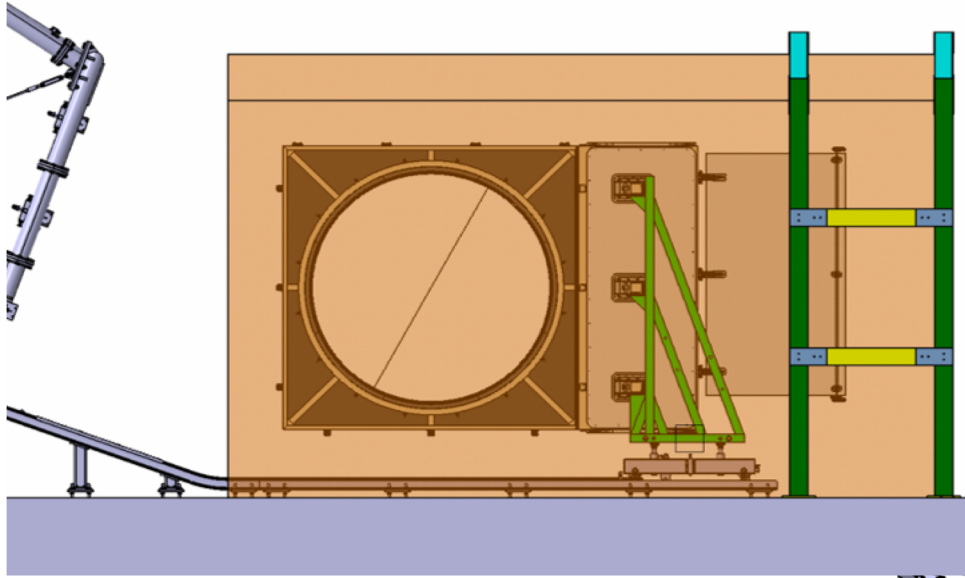
Shipment of the NectarCAM camera

- The NectarCAMs are shipped fully integrated, in special boxes with dampers.
- We did the same with the prototype for Berlin-Adlershof in 2019 (camera shipped to Saclay fully integrated), and everything worked well.
- We intend to check everything in front of the telescope, before mounting the camera on the structure. I did this everytime I mounted an instrument in an observatory.



Loading of the transport box on the truck

Retractable tunnel (Design by Kevin Pressard)

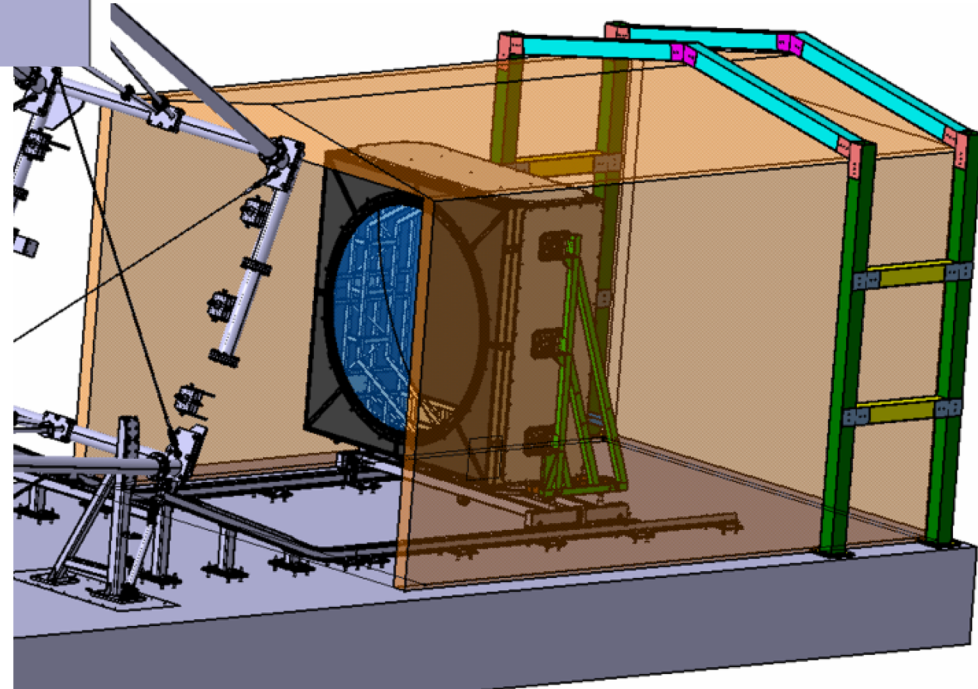


The mounting of the tunnel takes around 2 days

All verifications after transport are performed under a retractable tunnel. This takes around 2 days.

The back maintenance is performed in parking position, with the camera attached on the structure.

The tunnel is also used when we need to change some focal plane modules (the PMT must not be exposed to sunlight !) or when we need to maintain the front part.



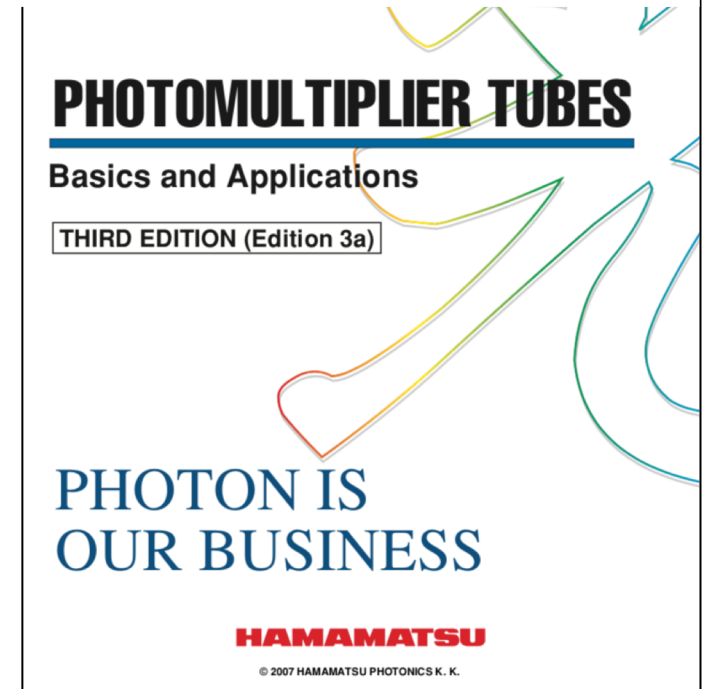
Exposing a PMT to intense light

Hamamatsu PMT handbook 2007, P. 68

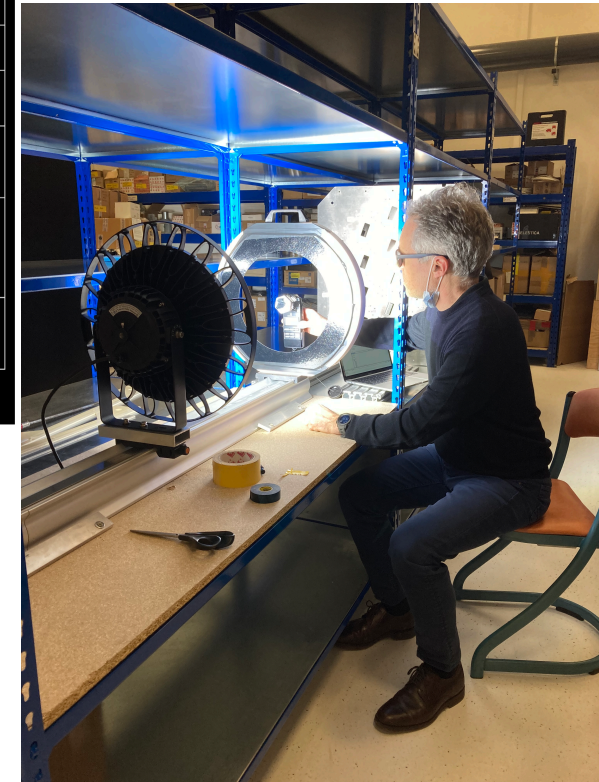
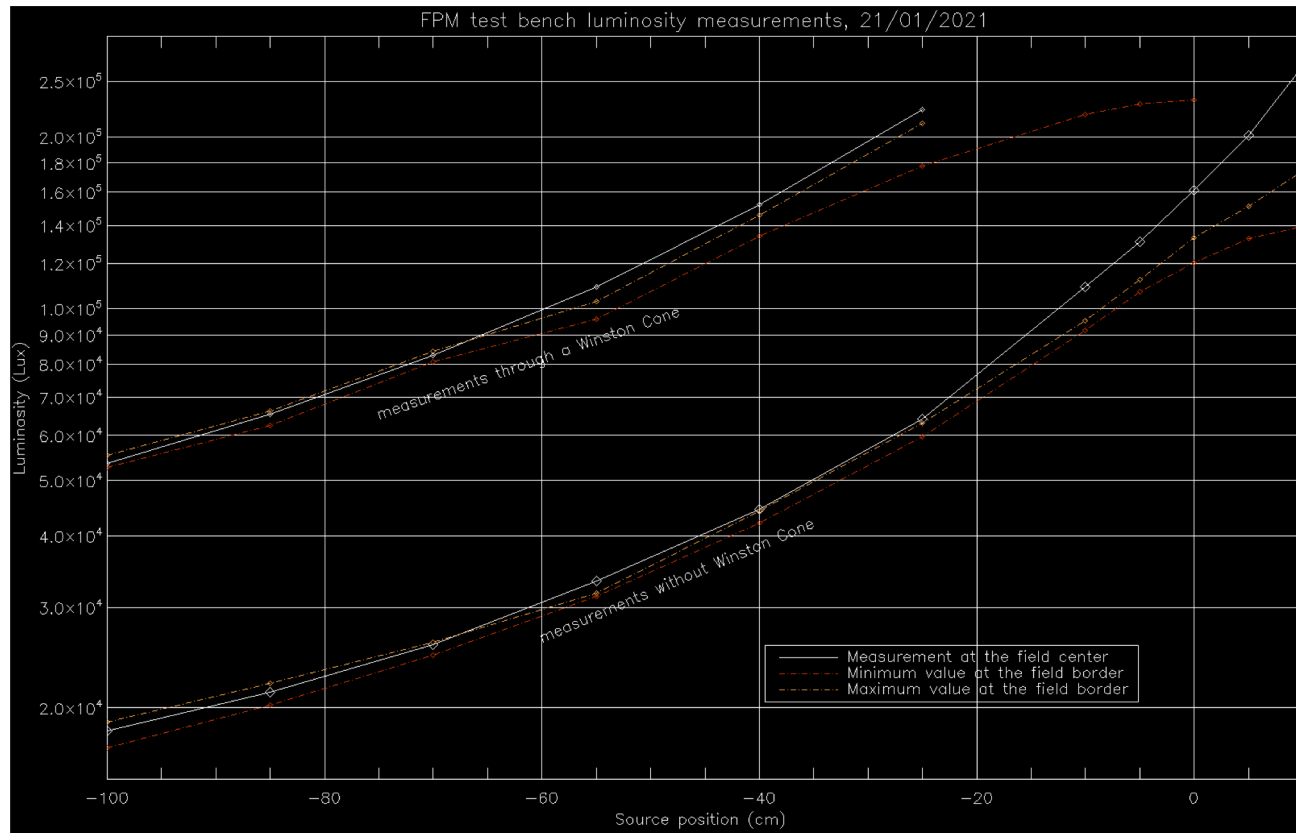
When a photocathode is exposed to room illumination, the dark current will return to the original level by storing the photomultiplier tube in a dark state for one to two hours. However, if exposed to sunlight or extremely intense light (10,000 lux or higher), this may cause unrecoverable damage and must therefore be avoided. It is recommended to store the photomultiplier tube in a dark state before use.

E-mail from Hamamatsu, Jan. 15, 2021

In general, when a photocathode is exposed to high-intensity light, the dark current tends to be temporarily increased. Also, as the section 4.3.6 (1) in PMT handbook shows, when a photocathode is exposed to sunlight or extremely intense light (10,000 lux or higher), this may cause unrecoverable damage. (There is a possibility that the photocathode is damaged by extremely intense light, causing the degradation of the cathode sensitivity. Once the photocathode is damaged, the cathode sensitivity cannot be recovered.) In addition, if PMTs are operated when the photocathode of the PMTs are exposed to high-intensity light, the gain will be also degraded. Therefore, please avoid exposing the PMTs to high-intensity light.



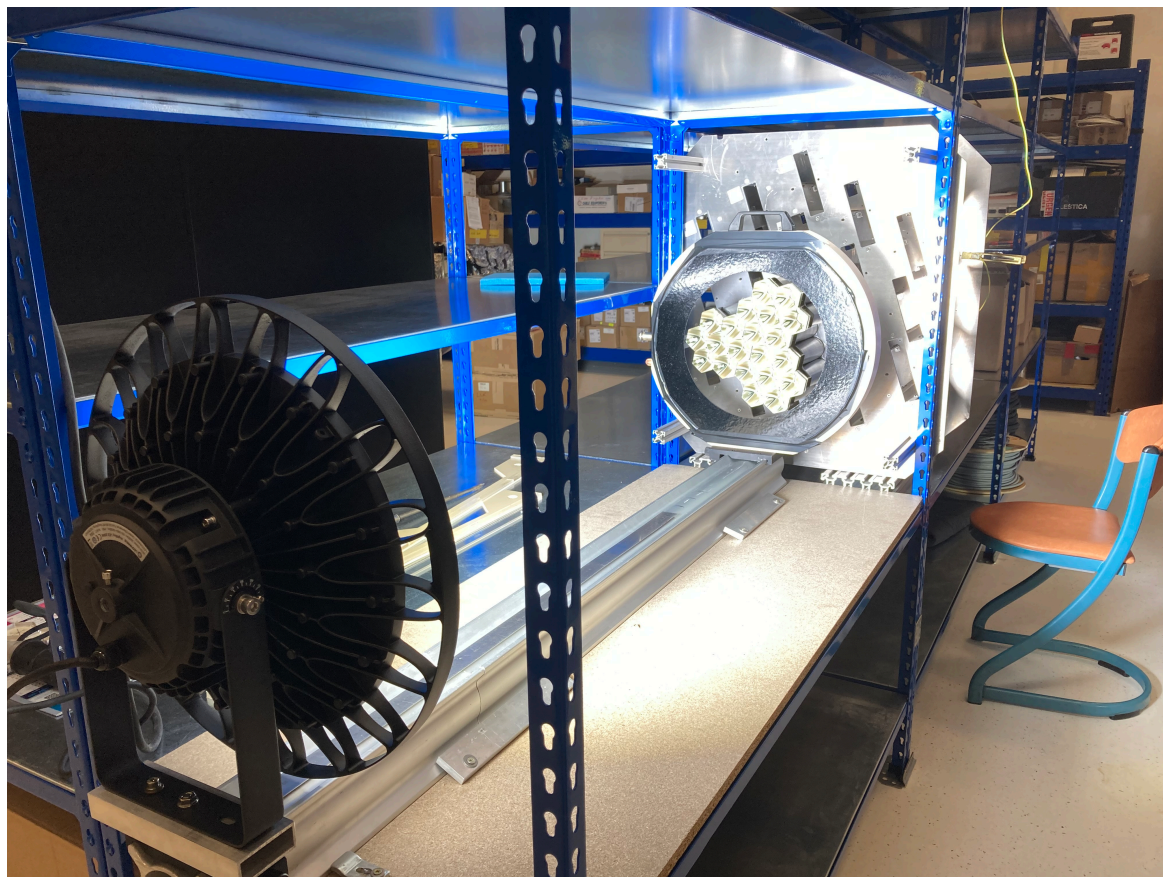
Exposing a PMT to intense light



A dedicated test bench has been installed on January 21 2021 at the NectarCAM AIV facility, to expose some unpowered NectarCAM modules to adjustable illumination levels (18 000 to 250 000 Lux at the Winston Cone entrance).

The test bench has been calibrated with a Konica/Minolta T-10A Luxmeter

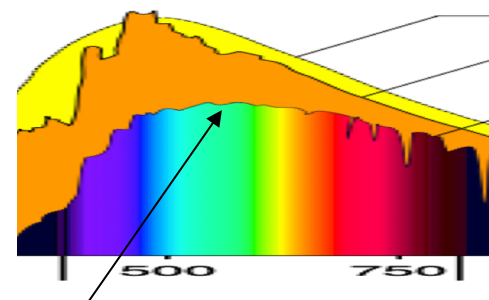
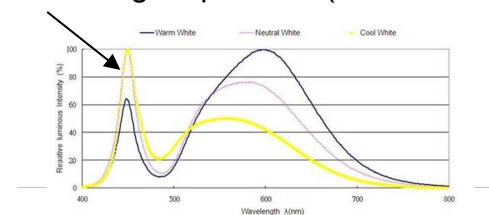
Exposing a PMT to intense light



Set-up example: Exposure conditions providing 18 000 Lux at the cones entrance plane (→ 54 000 Lux at the PMT photocathode)
The light source is brought closer from the modules to increase the light intensity



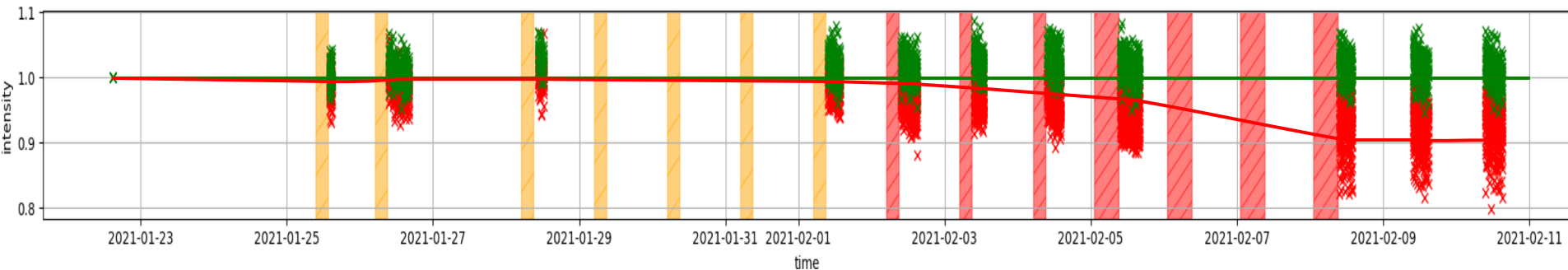
Test bench light spectrum (Yellow curve)



Sunlight spectrum at ground level

Preliminary results (experience still ongoing !)

The graph below shows the repeated measurements (average number of pe/pulse) of a constant intensity light source in the dark room, between illumination sequences on the PMTs.



- x— 14 reference PMTs (not exposed to Illumination sequences)
- x— 21 PMTs exposed to light
 - 7 sequences of 4 hours at 18 000 Lux
 - 3 sequences of 4 hours at 120 000 Lux
 - 4 sequences of 8 hours at 120 000 Lux

Illumination sequences

- 18 000 +/- 940 Lux at the cone input plane
(representative of modules looking at blue sky)
- 119 000 +/- 11900 Lux at the cone input plane
(representative of modules looking at the sky with the sun in the fov)

The experiment is not finished yet and the data processing has to be fully validated, **but it seems that we already observe a loss of quantum efficiency** as mentioned by Hamamatsu (up to 20%, and 10% in average).

Note: The PMTs placed in the dark during 7 days did not recover at all.

View of the tunnel installed at Berlin-Adlershof

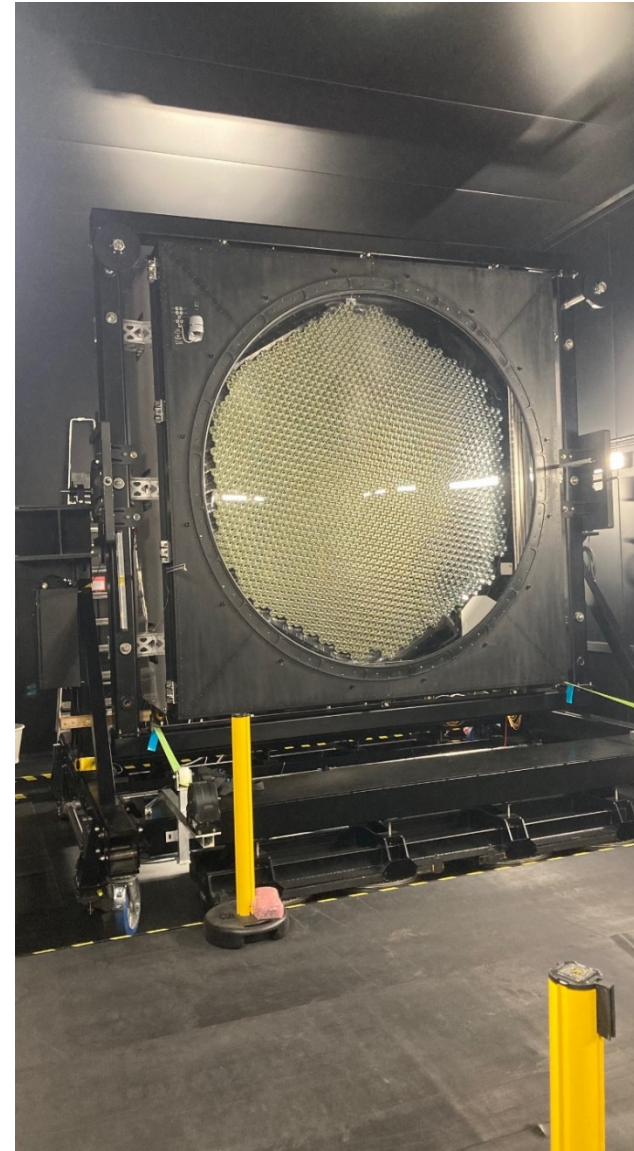
The tunnels will be reinforced with a metallic structure to avoid damages during strong winds. There will be one tunnel per MST.



- Shipping of the NectarCAMs fully integrated and tested at Saclay.
- Verification of all camera functions near the telescope, under a retractable tunnel. Need of additional harnesses including fiberoptics to reach ACADA.
- The mounting on the MST structure is performed when we are sure that all is working well. Need of a crane. The mounting on the MST structures takes around 4 hours.
- Then the commissioning can start

Tests of the NectarCAM QM

- The first NectarCAM is finalised, except the shutter.
- The dark room tests at Sacaly allowed to check almost all CTAO requirements. The thermal tests and the waterproofness tests are still to be performed.
- The test procedures needed for the CTAO Test Readiness Review (TRR) are being written.
- Thermal tests will occur in october 2022. (The dark room can be temperature controlled between 18°C and $+20^{\circ}\text{C}$)
- The waterproofness test will occur in Novembre 2022.
- **For each camera, there is a warranty period of 2 years. During this time, the labs must do the camera maintenance. This will allow to train the local teams to the camera maintenance. We have to write detailed instructions for any sub-system replacement.**



Questions ?

