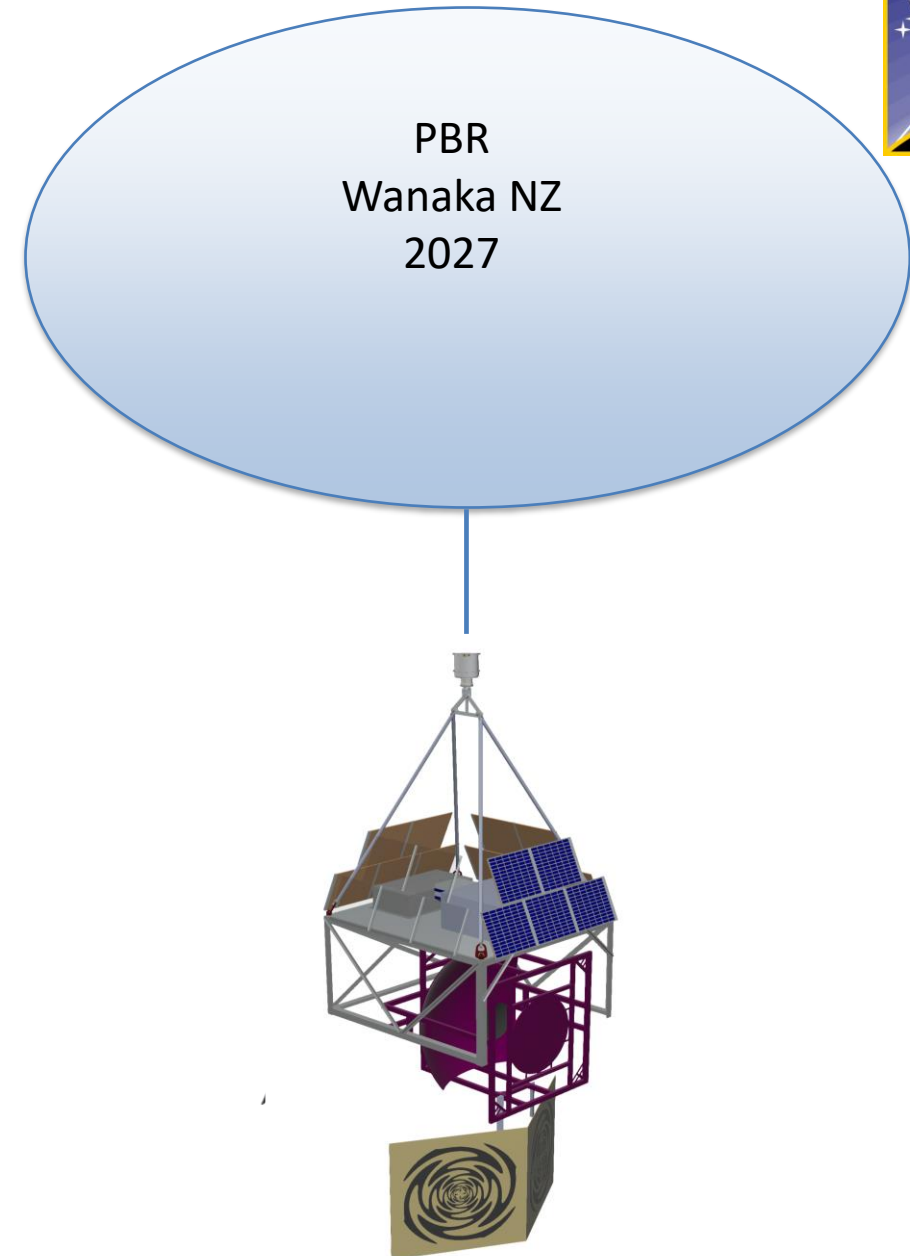




CHERENKOV CAMERA: STATUS

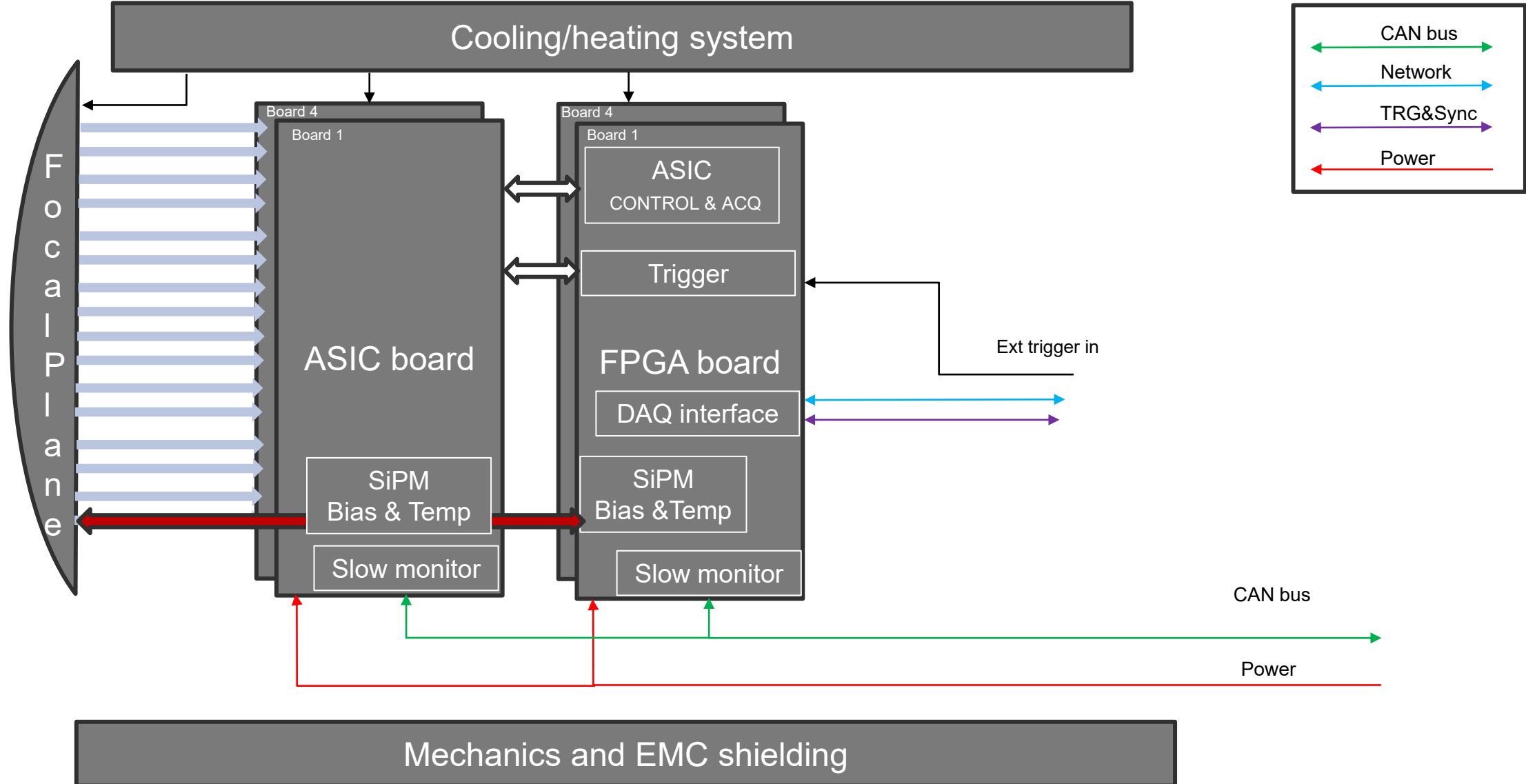
G. OSTERIA ON BEHALF OF THE CC GROUP

THE CC WORKING GROUP

- **Bari**
 - F. Cafagna ([system SW](#))
- **Catania**
 - R. Caruso, C. Petta ([SiPM arrays characterization](#))
- **Lecce**
 - V. Scherini, L. Perrone ([simulation](#))
- **Napoli**
 - G. Osteria, M. Mese, F. Perfetto, V. Scotti, A. Anastasio, V. Masone, G. Passeggio, Qureshi Haroon Akhtar ([CC architecture, CC mechanics, SiPM connection, ASIC Radioroc2 board \(plan B electronics\), procurement](#))
 - D. Campana, B. Panico ([simulation](#))
- **Roma2**
 - C. De Santis, Badoni, Ammendola, M. Casolino, A. Sotgiu ([FPGA board](#))
- **Torino**
 - M. Bertaina, A. Di Salvo, S. Garbolino, M. Mignone, A Rivetti, S. Zugravel ([MIZAR ASIC, ASIC board](#))
- **Trento**
 - E. Ricci ([SiPM Bias system](#))
- **Trieste**
 - R. Munini, I. Buckland

CC Zoom meeting: fortnightly Tuesdays (alternating with Trigger) at 14:00 UTC

CHERENKOV CAMERA: BLOCK DIAGRAM



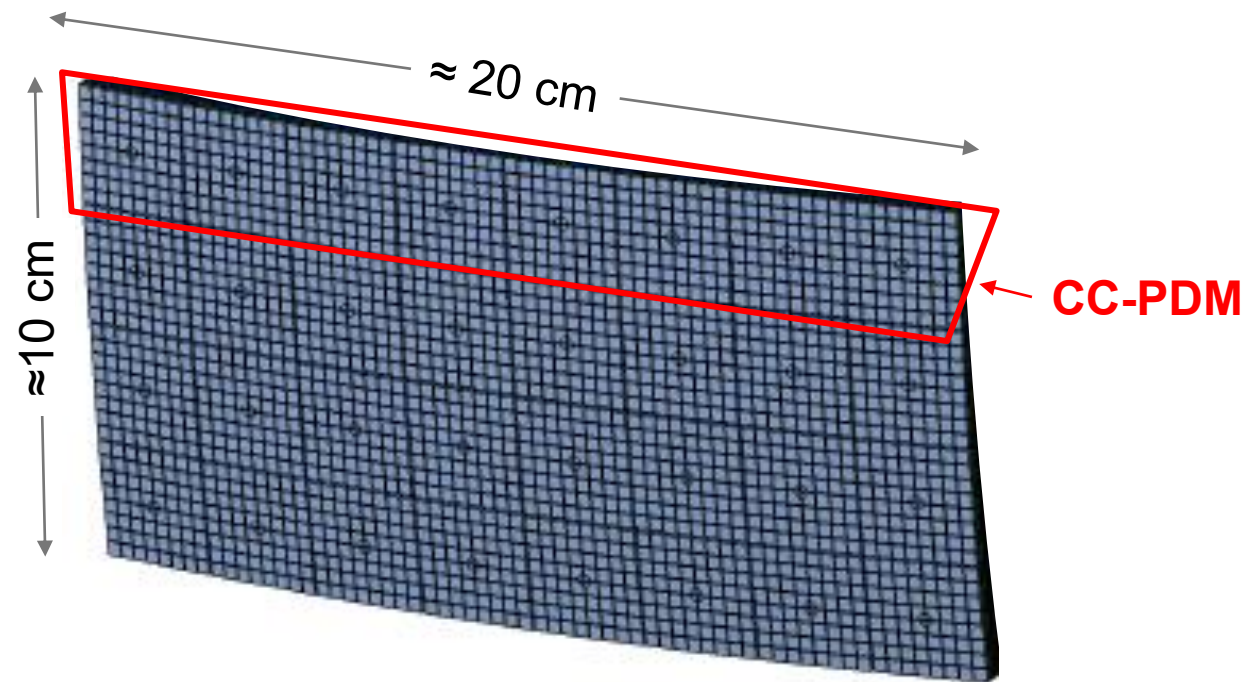
CHERENKOV CAMERA OVERVIEW

Requirements: (from simulations)

- Pixel size: $3 \times 3 \text{ mm}^2$
- Pixel FoV: 0.2°
- Total FoV: $12^\circ \times 6^\circ$

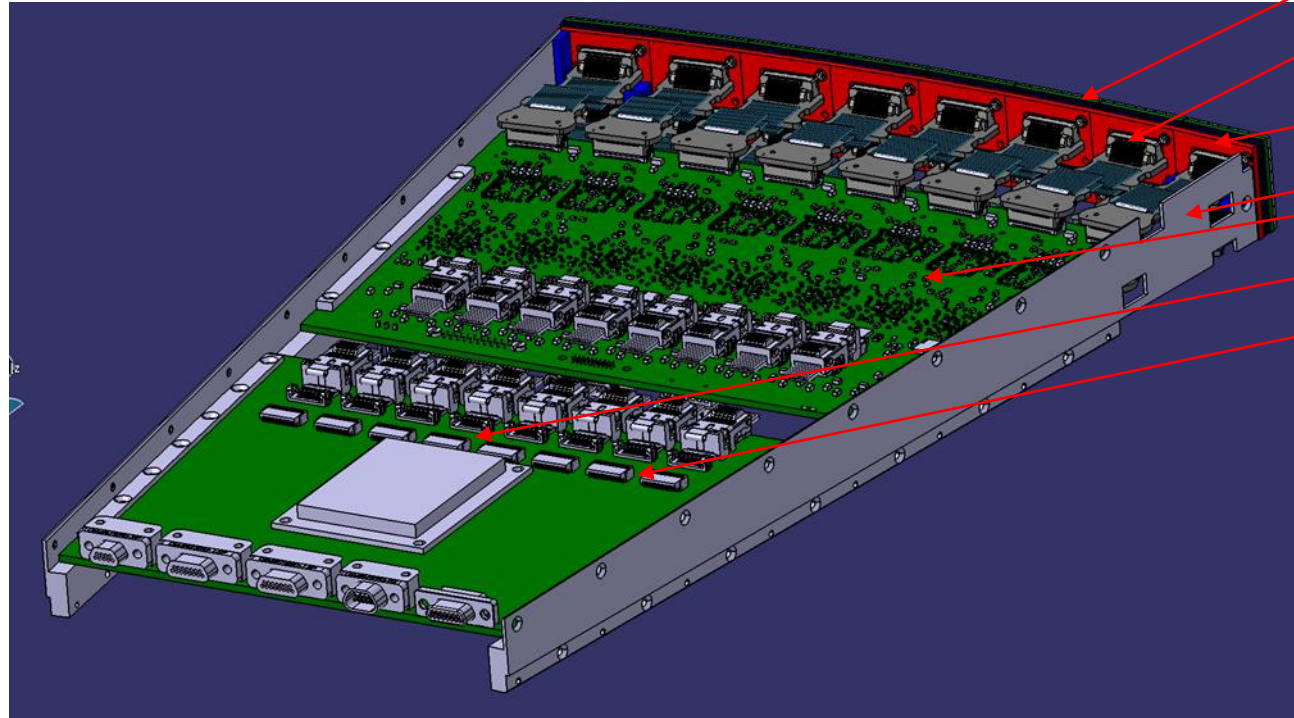
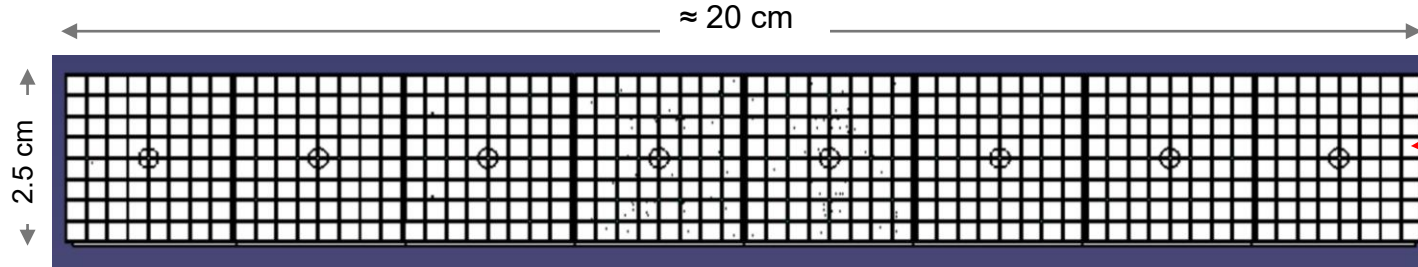
Implementation:

- SiPM arrays:
 - 64 pixels (8×8)
 - $4 \times 8 = 32$ SiPM arrays
 - 2048 pixels
 - four **CC-PDMs** (1x8 SiPM arrays, 512 pixels)



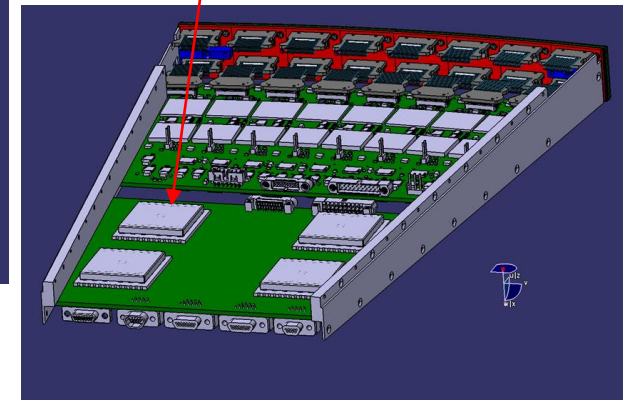
THE CC-PDM (CAD)

The Cherenkov Camera Photo Detection Module (CC-PDM) (1x8 matrix of 64 pixels SiPM arrays) 512 pixels



CC PDM elements:

- SiPM arrays (8)
- CC-Elementary Cells (8)
- Samtec microcoax cables (2x8)
- Mechanics:
 - Focal plane
 - Housing and cooling
- ASIC board
- FPGA board
- DC-DC converters
- Bias system



SIPM ARRAY STATUS

Hamamatsu S13361-3050 series

- S13361-3050-NE-08 (8x8ch), pixels 3mm²

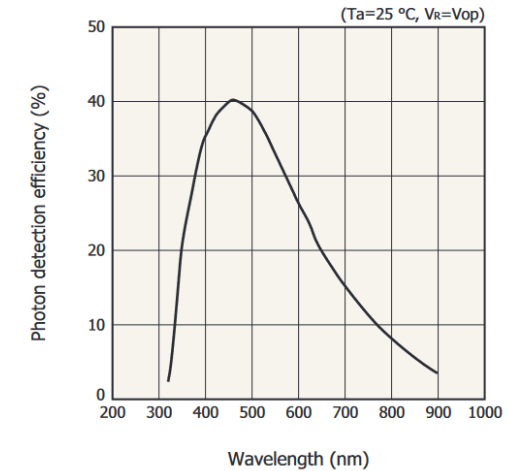
❏ Absolute maximum ratings

Parameter	Symbol	S13361-3050NE-04	S13361-3050AE-04	S13361-3050NE-08	S13361-3050AE-08	Unit
Operating temperature* ²	Topr	-20 to +60				°C
Storage temperature* ²	Tstg	-20 to +80				°C
Soldering temperature* ³	Tsol	240 (twice)	-	240 (twice)	-	°C

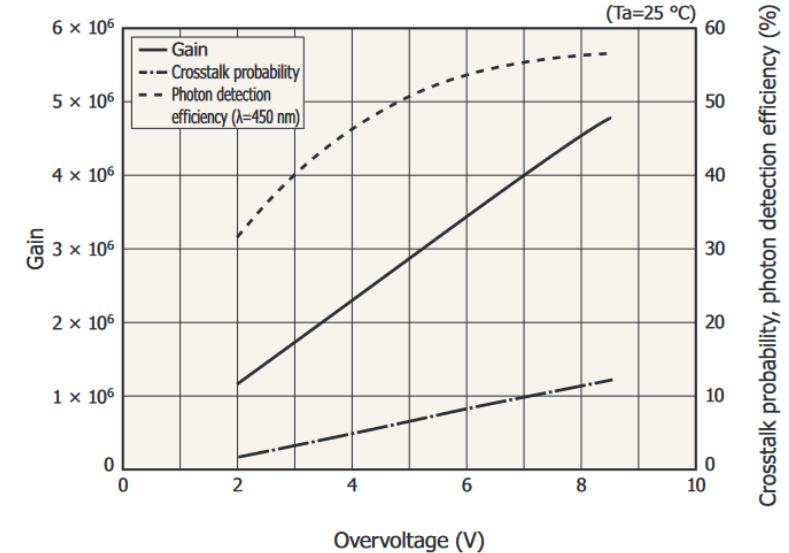
❏ Electrical and optical characteristics (Typ. Ta=25 °C, Vover=3 V, unless otherwise noted)

Parameter	Symbol	Value	Unit
Spectral response range	λ	320 to 900	nm
Peak sensitivity wavelength	λ_p	450	nm
Photon detection efficiency ($\lambda=\lambda_p$)* ⁴	PDE	40	%
Dark count* ⁵	Typ.	0.5	Mcps
	Max.	1.5	
Terminal capacitance	Ct	320	pF
Gain	M	1.7×10^6	-
Breakdown voltage	VBR	53 ± 5	V
Recommended operating voltage	Vop	VBR + 3	V
Vop variation between channels in one product	Typ.	0.1	V
	Max.	0.3	
Temperature coefficient of recommended operating voltage	$\Delta T V_{op}$	54	mV/°C

❏ Photon detection efficiency vs. wavelength (typical example)



❏ Overvoltage specifications of gain, crosstalk probability, photon detection efficiency



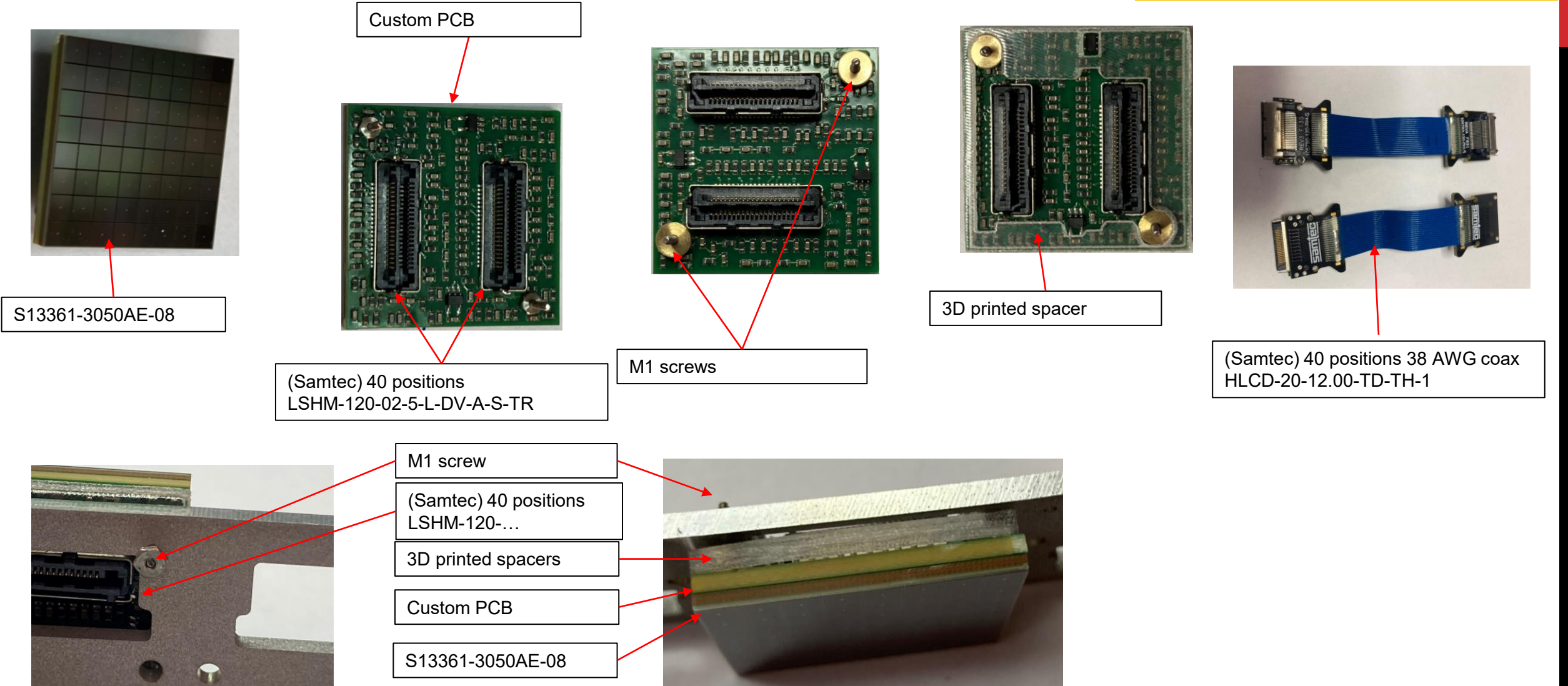
S13361-3050-NE-08

- 17 available for prototyping studies
- 50 ordered and delivered

THE ELEMENTARY CELL

Status:

- 40 prototypes manufactured
 - only 30 are useful for the FM
- 25 will be delivered in one week



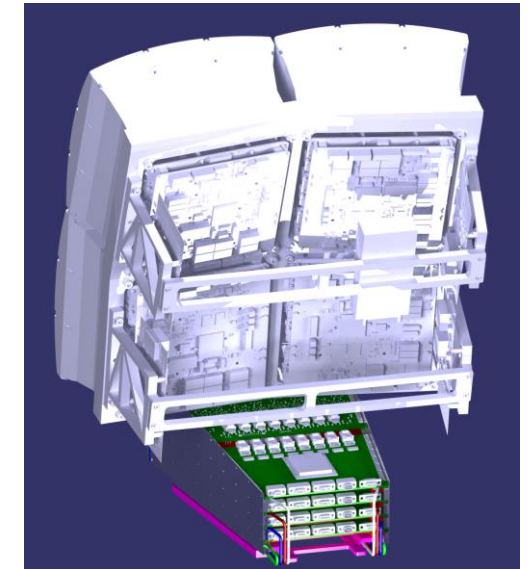
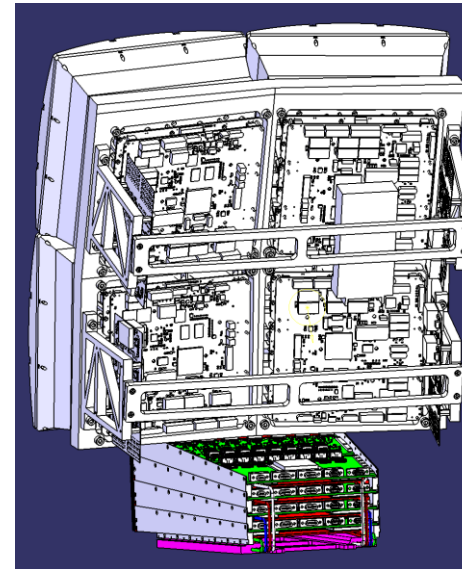
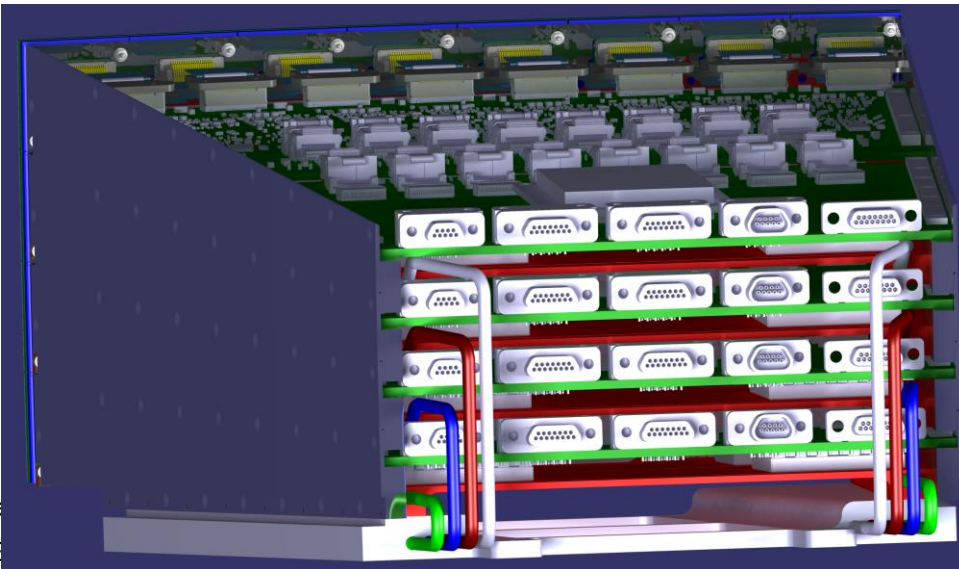
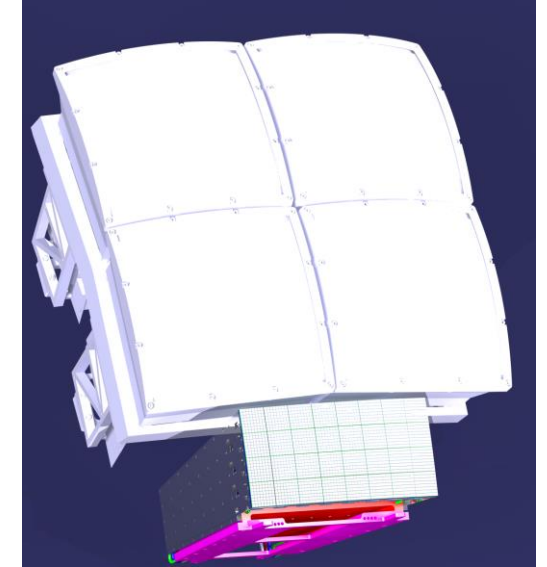
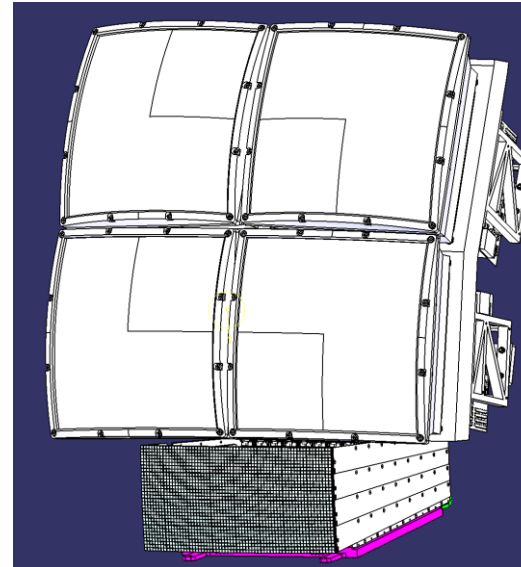
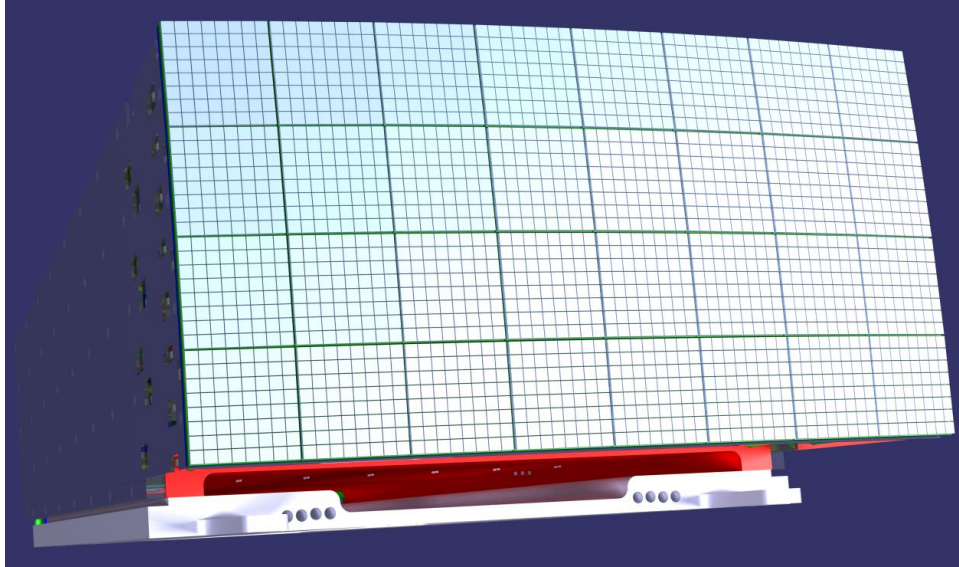
Elementary cell (side view)

CHERENKOV CAMERA MECHANICS: DESIGN

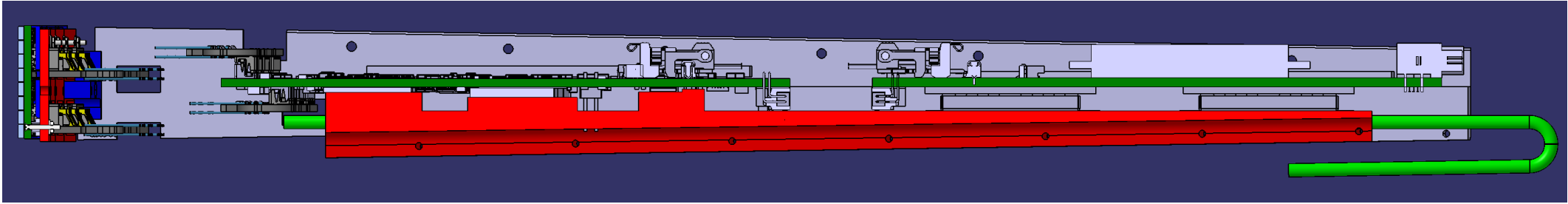
The Cherenkov Camera

Status:

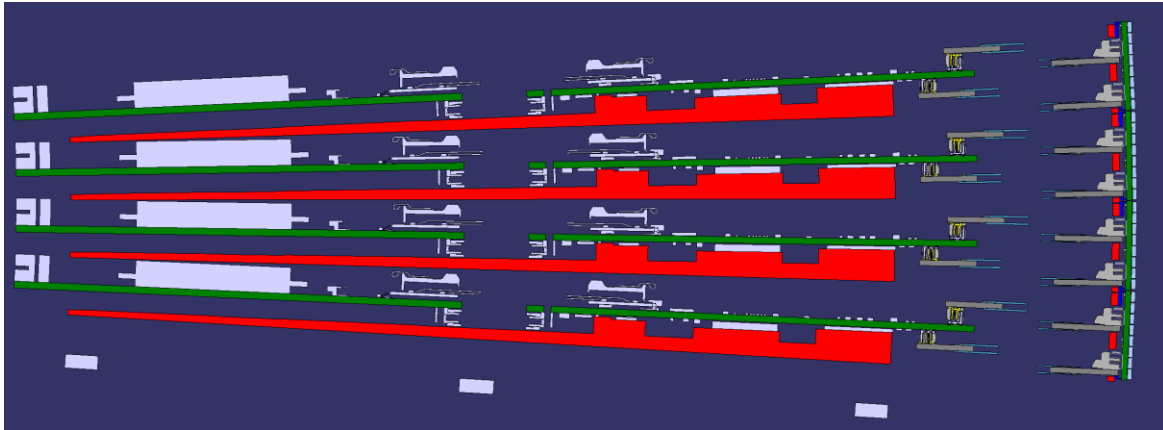
- First design completed



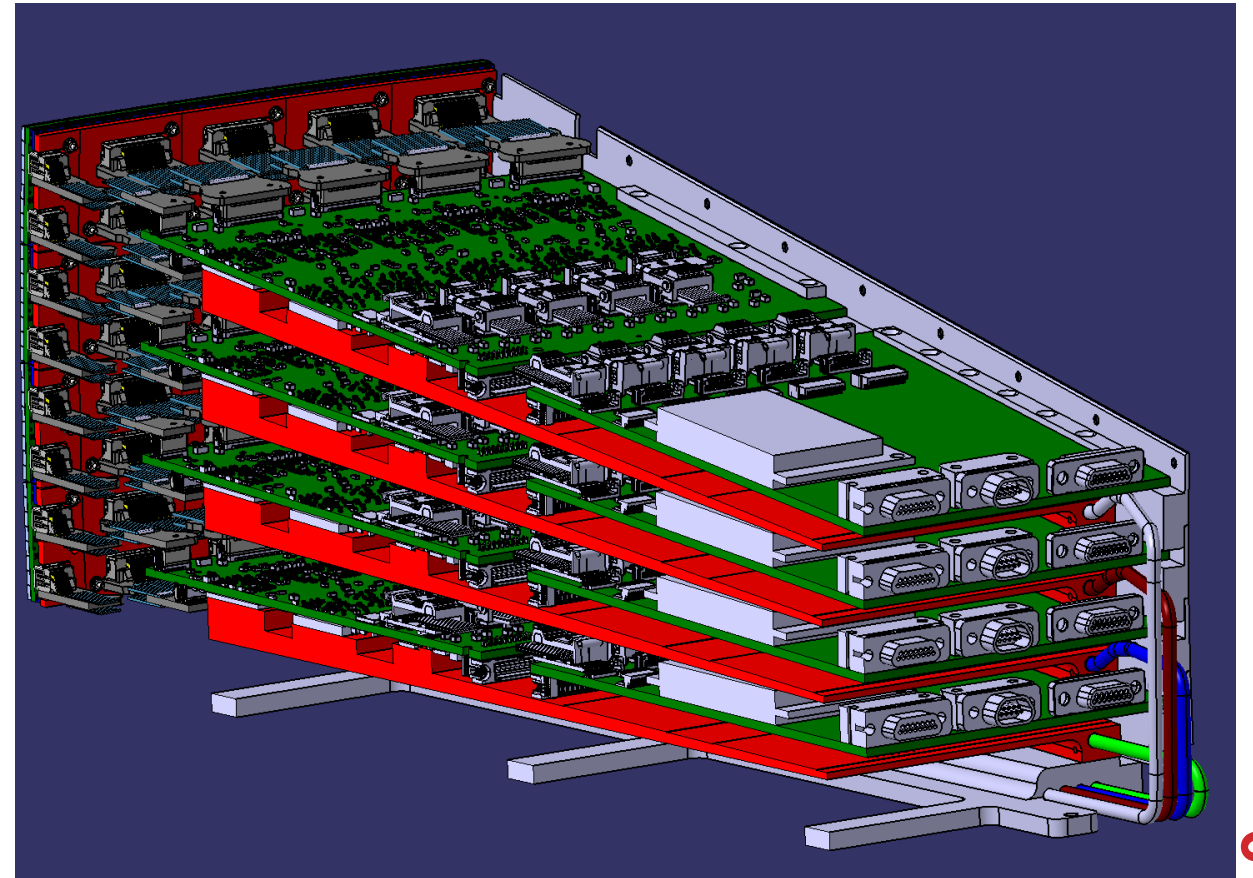
CHERENKOV CAMERA MECHANICS: DESIGN



Section view of the CC PDM



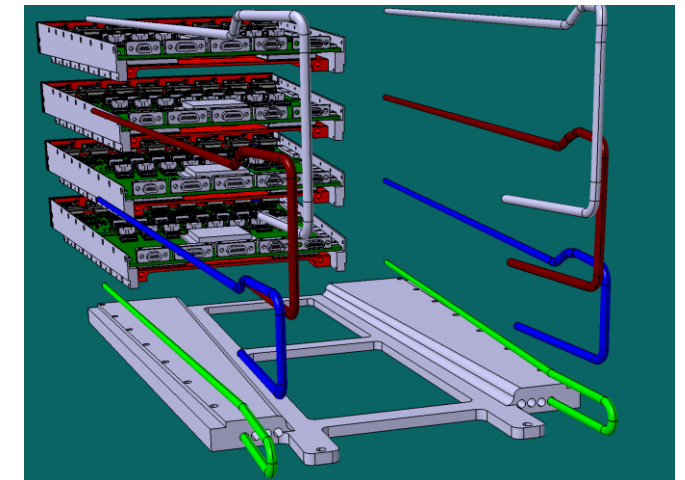
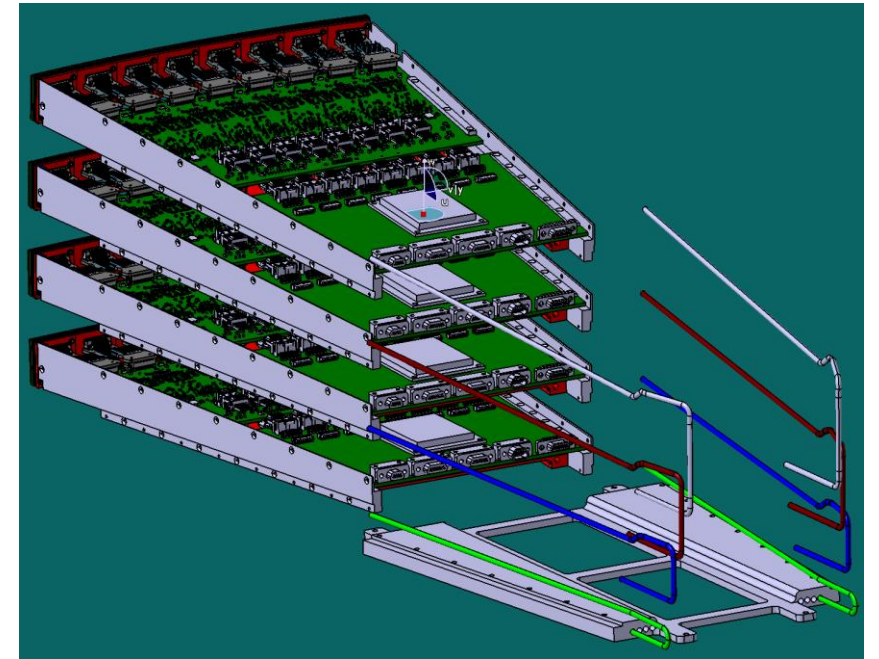
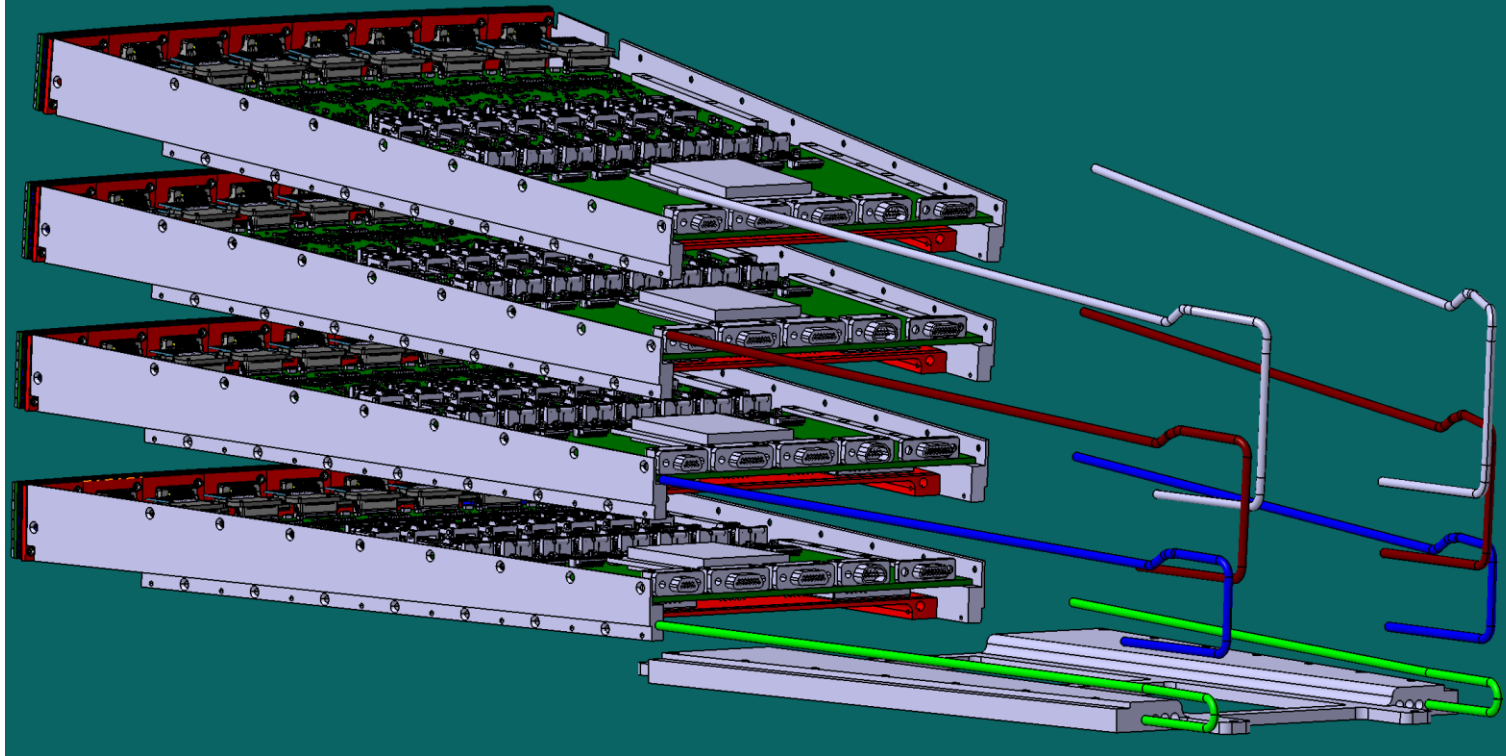
CC section view (in plane)



CC section view

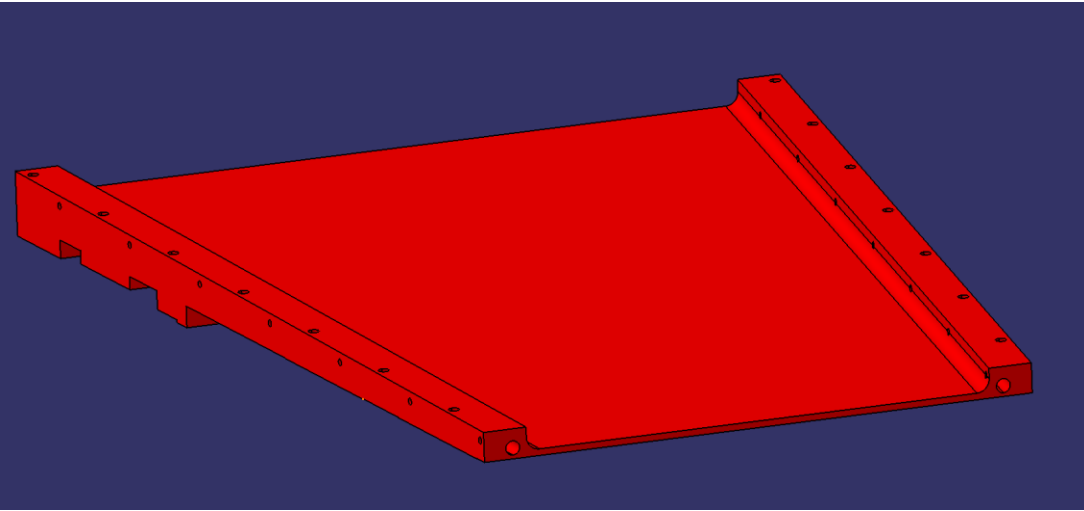
CHERENKOV CAMERA MECHANICS: DESIGN

CC cooling extracted exploited view

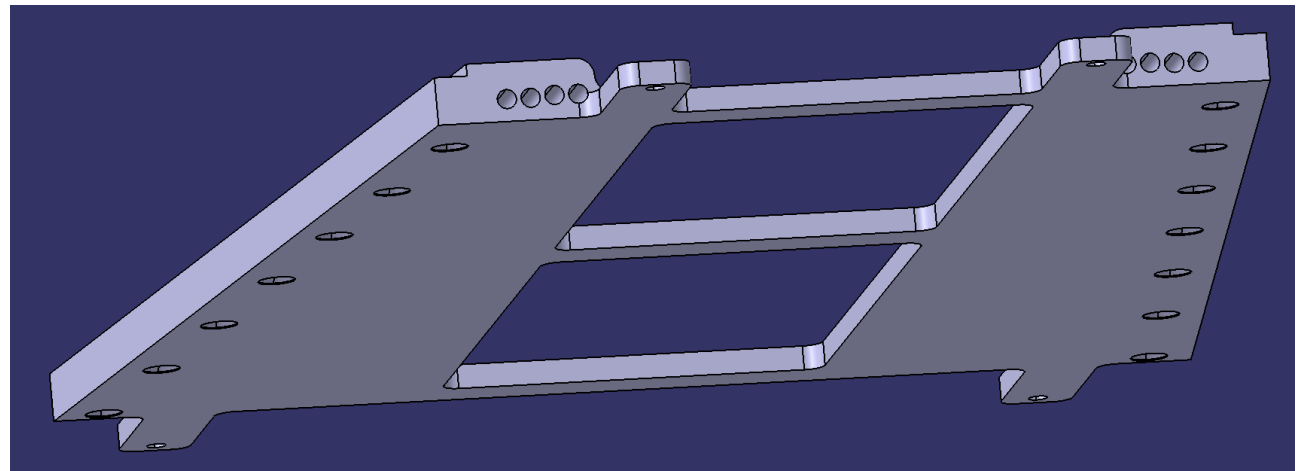
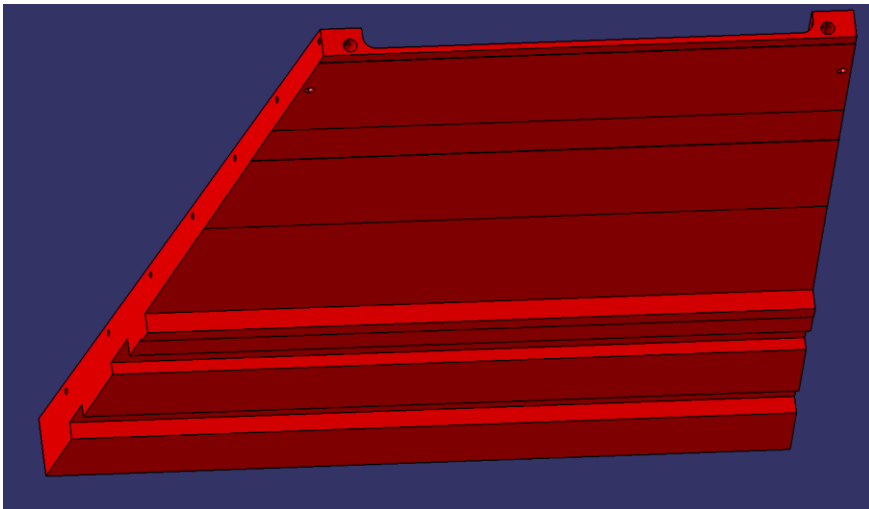
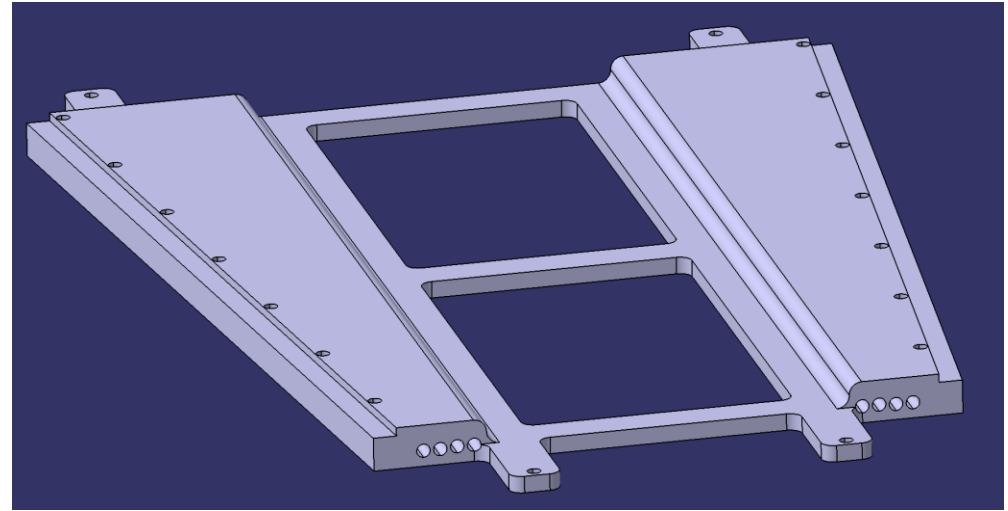


CHERENKOV CAMERA MECHANICS: DESIGN

CC PDM cooling plate



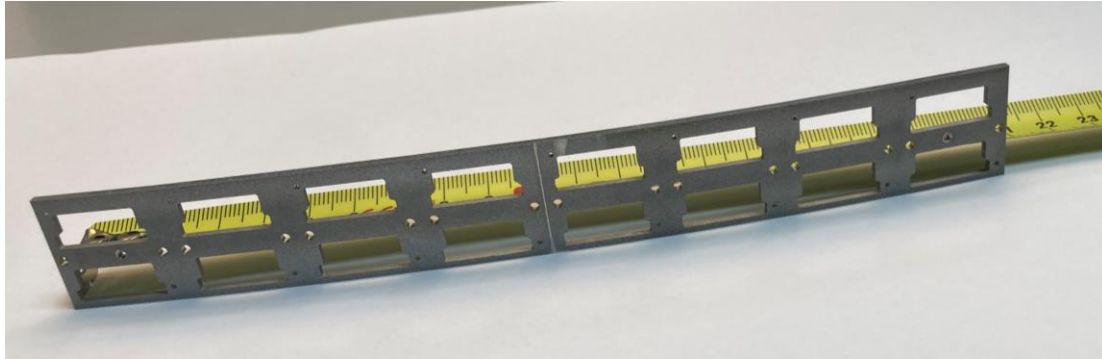
CC fixing and cooling plate



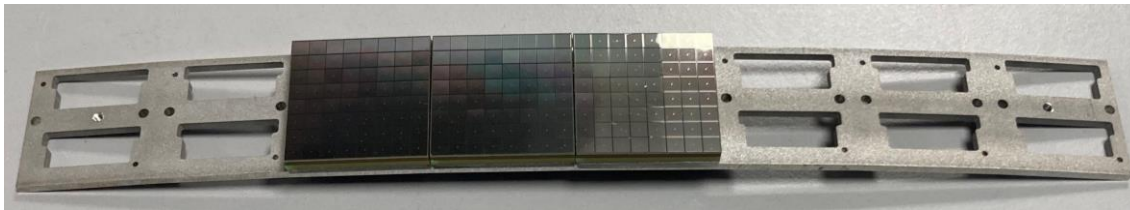
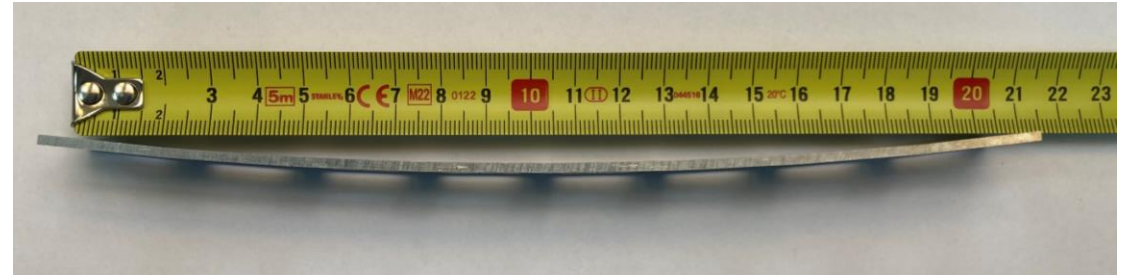
CC PDM MECHANICS: FOCAL PLANE

Status:

4 (of four) manufactured



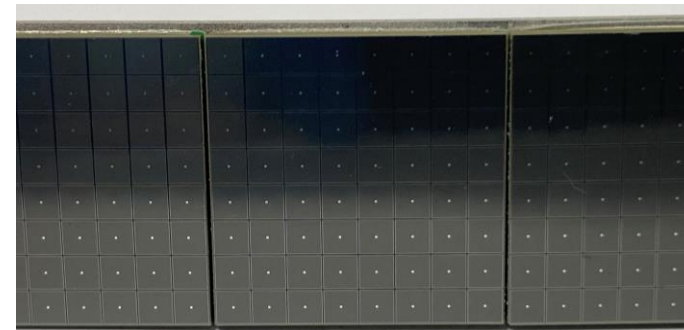
aluminum prototype of the mechanics of the focal plane



Three CC-EC fixed to the aluminum prototype of the mechanics of the focal plane



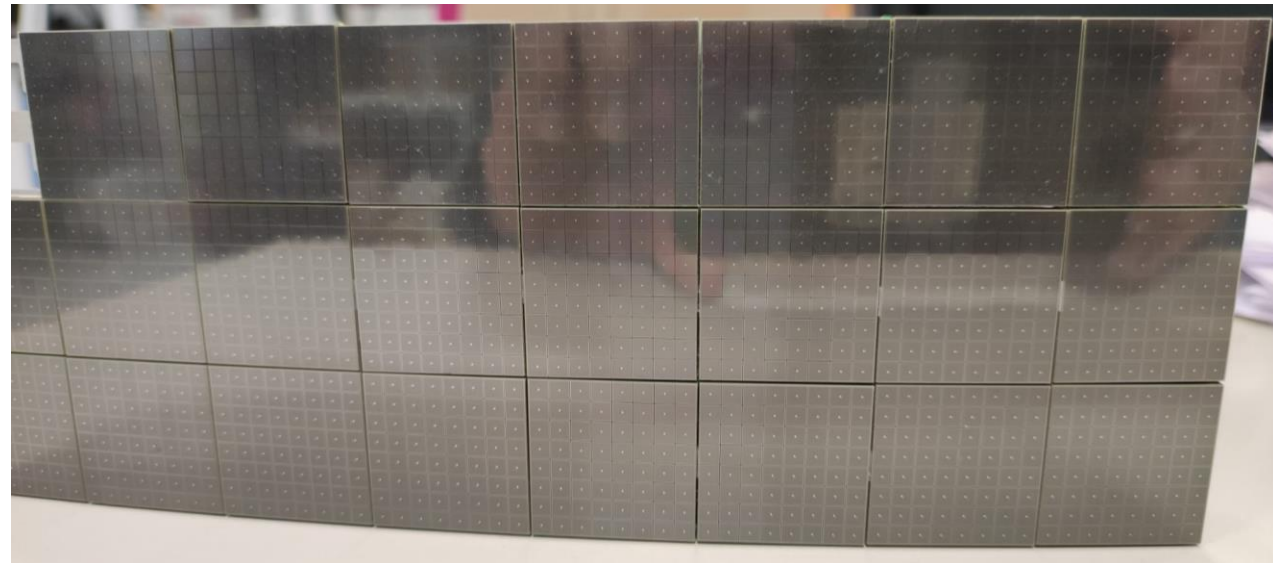
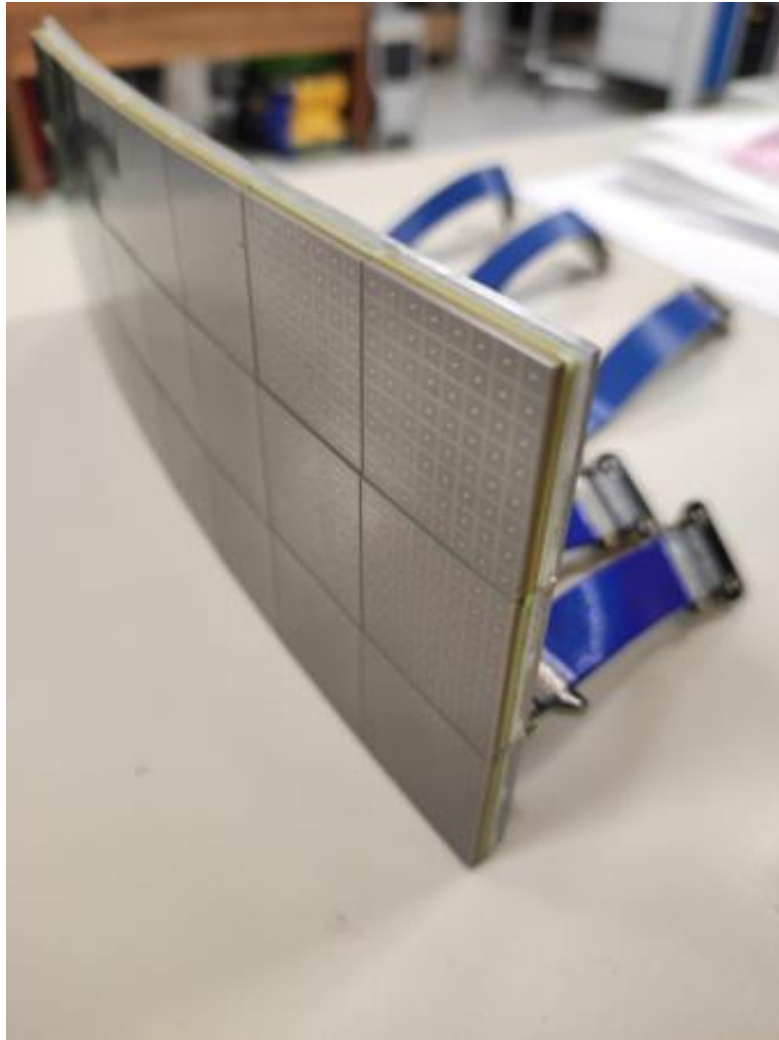
Good SiPM arrays alignment
Dead space among arrays minimized



CC-PDM MECHANICS: FOCAL PLANE

Status:

- 4 (of four) manufactured



G. Osteria

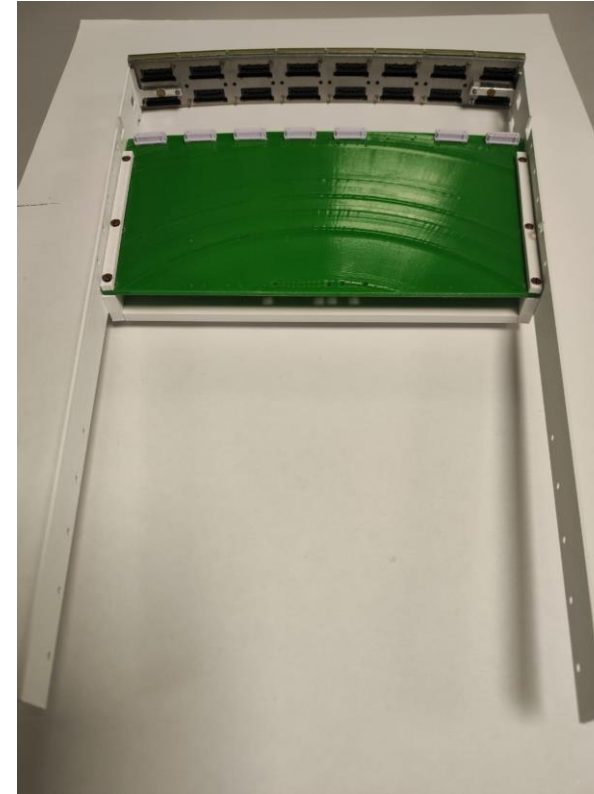
37th JEM-EUSO Collaboration meeting June 2 - 6, 2025 - Paris

CC-PDM MECHANICS: HOUSING AND COOLING (3D PRINTED PROTOTYPE)

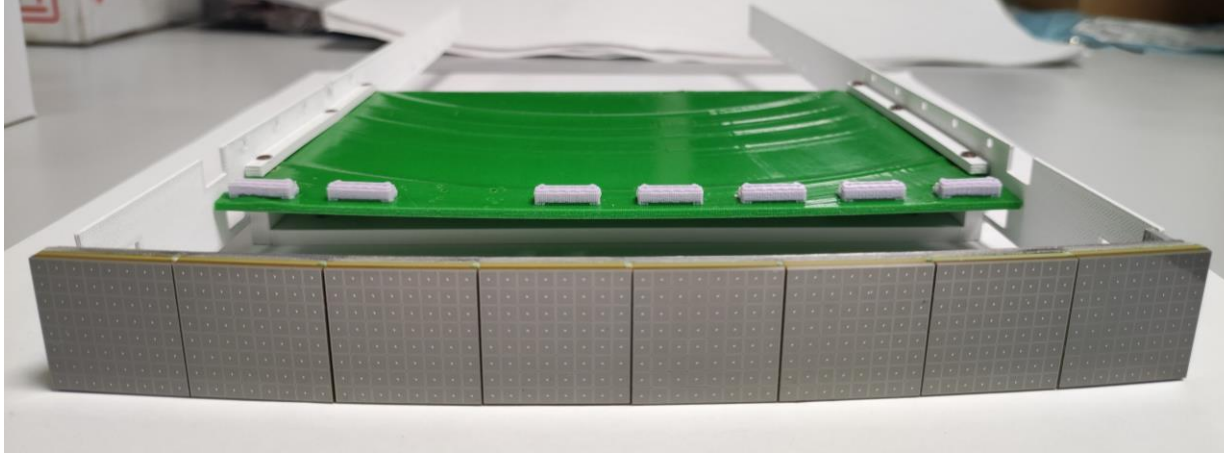
Status:

- 3D printed mode (show at Chicago meeting)

Side view



Top view



Bottom view



G. Osteria

37th JEM-EUSO Collaboration meeting June 2 - 6, 2025 - Paris

CC-PDM housing and cooling mechanics fixed to the focal plane

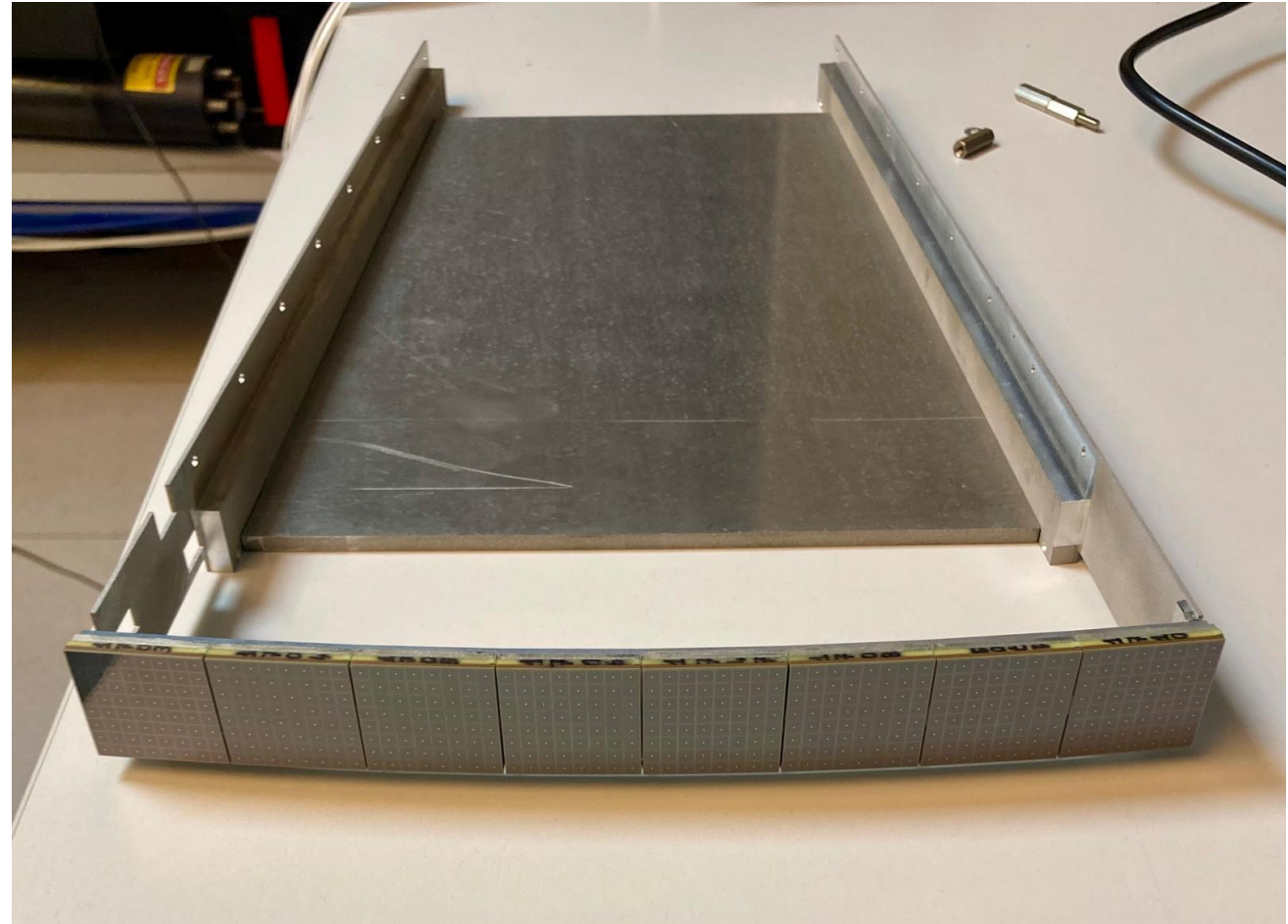
CC-PDM MECHANICS: HOUSING AND COOLING (FLIGHT MODEL)

Status:

- Aluminum model manufacturing in progress



Work in progress



CC-PDM housing and cooling mechanics fixed to the focal plane

RADIOROC-2: 512 CH ASIC BOARD

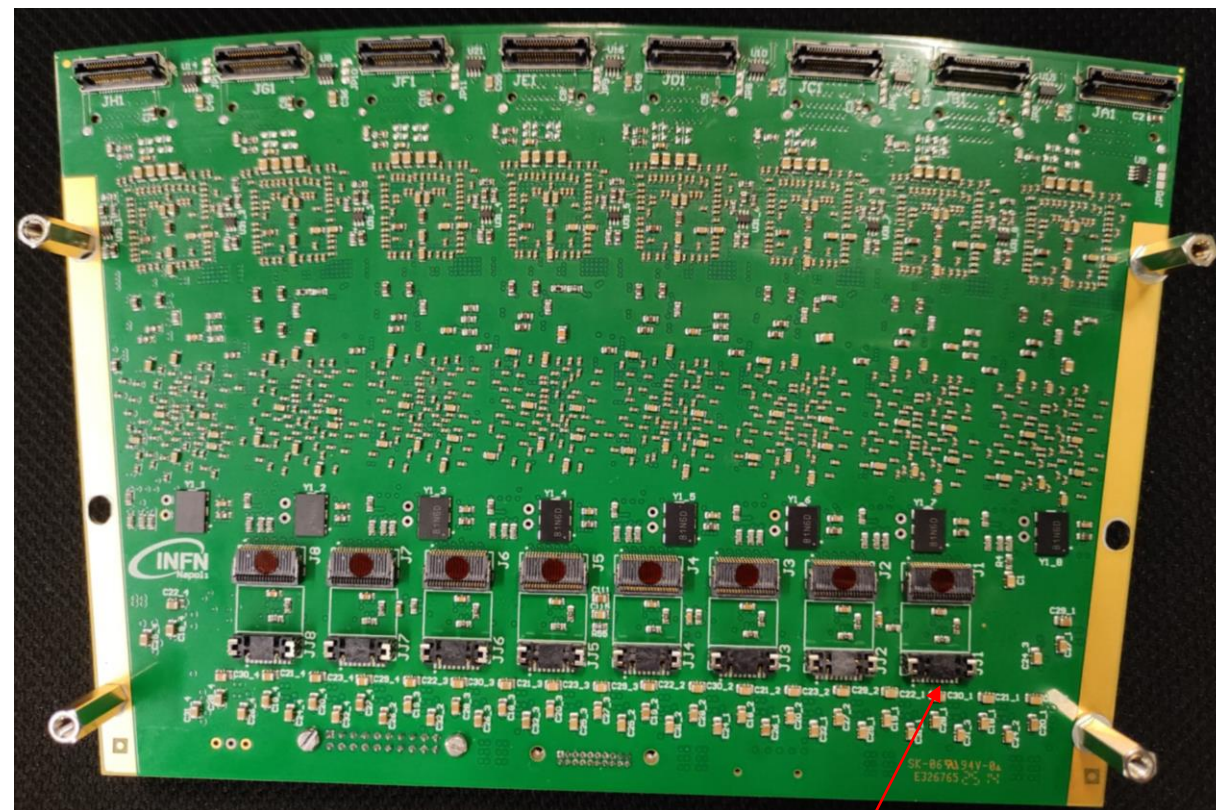
Radiatoroc-2; 512 ch board (prototype top view)



Bias Voltages connector

Power connector

Radiatoroc-2: 512 ch board (prototype bottom view)



Samtec UEC5+UCC8 Firefly data connector

RADIOROC-2: 512 ch ASIC board status:

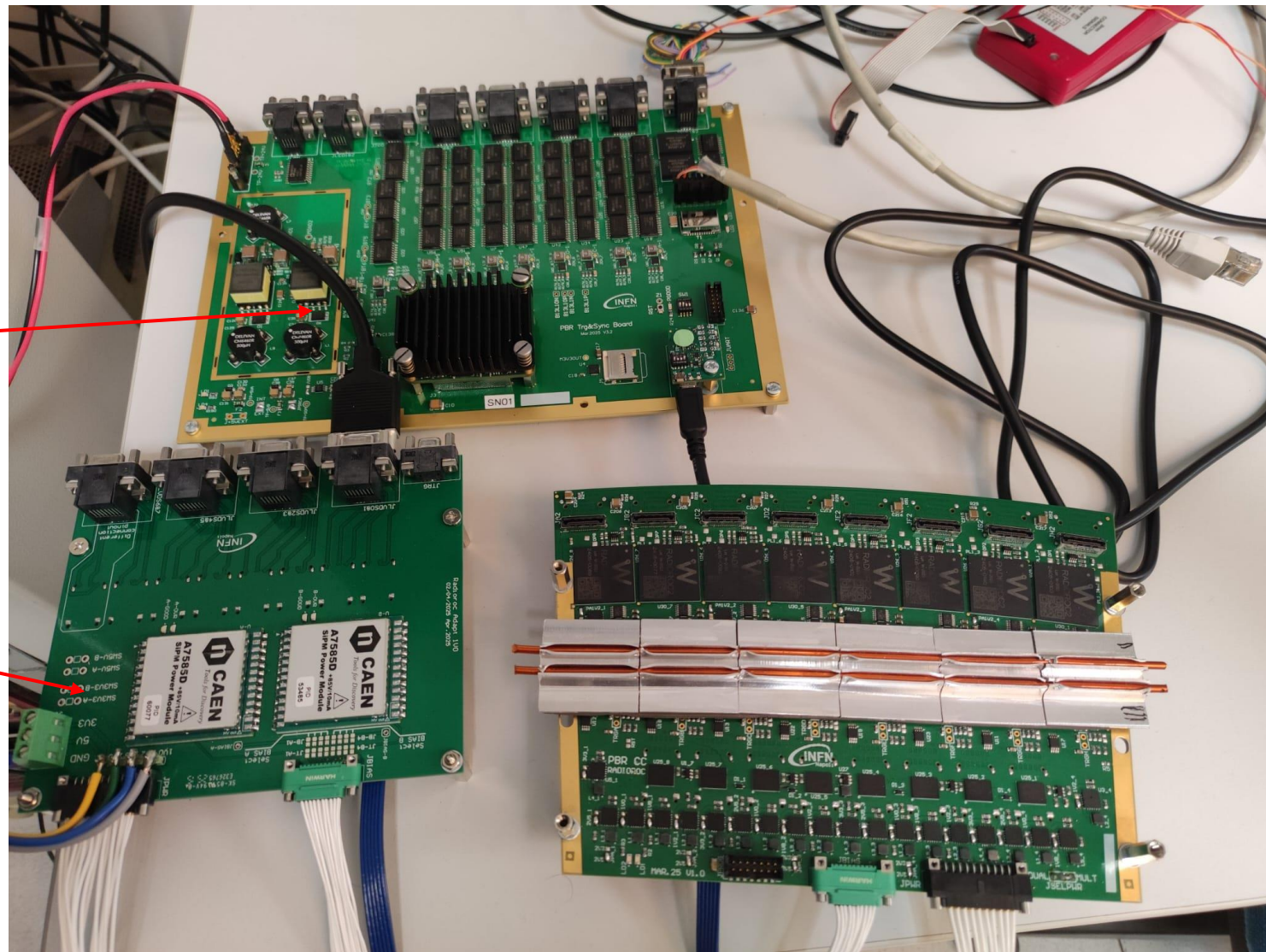
- Prototype completed
- Test in progress
- FPGA programmed (with a preliminary version of the FW)
- Absorbed current measured (steady state): 14W $\rightarrow$ 7W by passing the voltage regulators

RADIOROC-2: 512 CH ASIC BOARD

Test setup

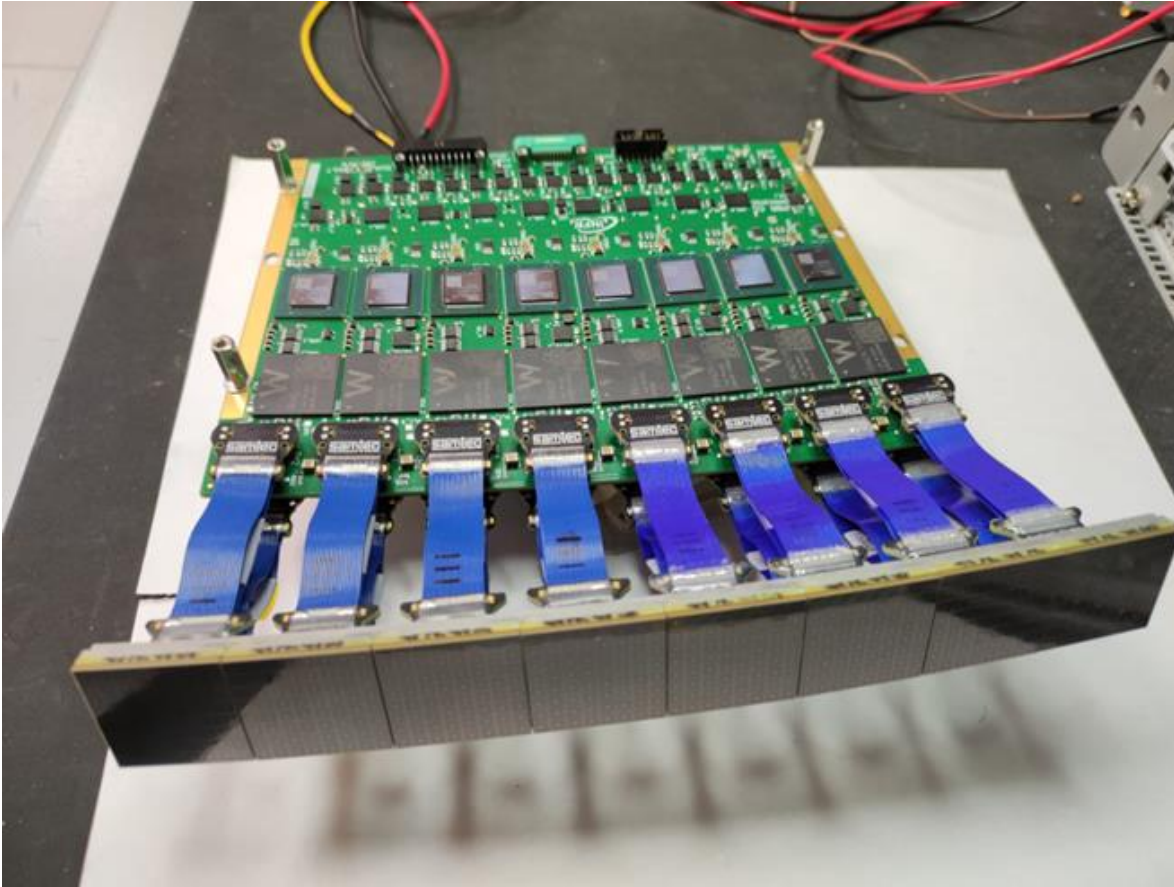
«Adapted»
FPGA card

Adapter card

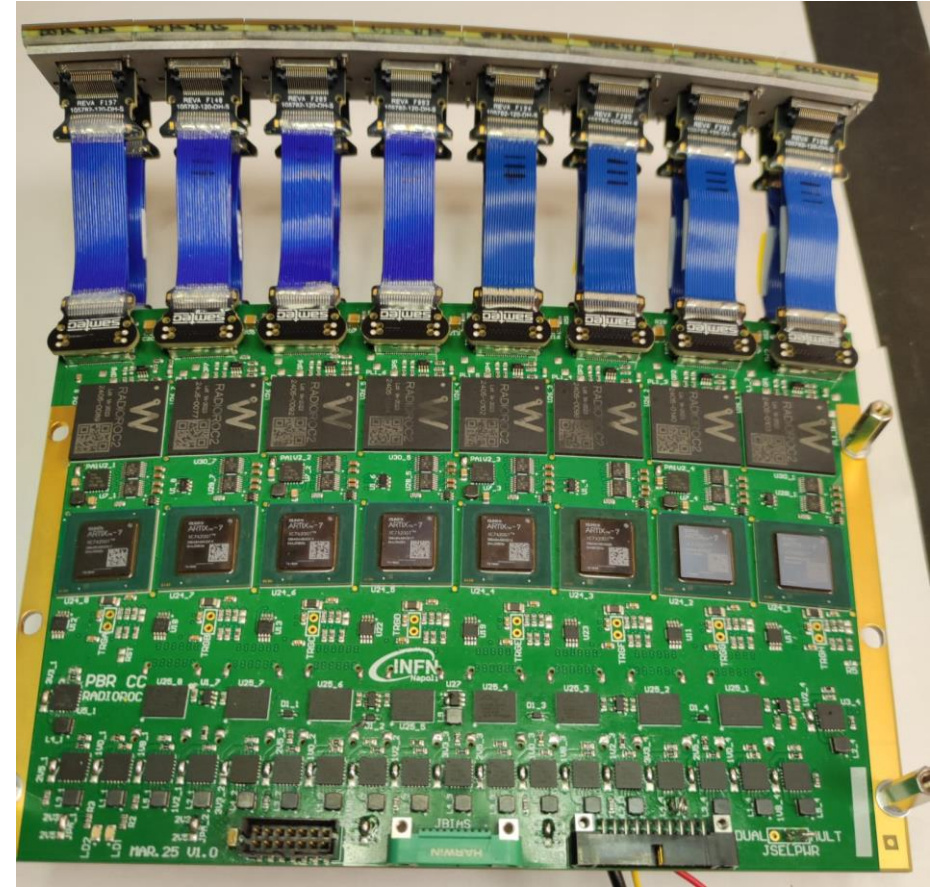


RADIOROC-2: 512 CH ASIC BOARD

Radoroc-2; 512 ch board



Radoroc-2: 512 ch board



RADIOROC-2: 512 ch ASIC board status:

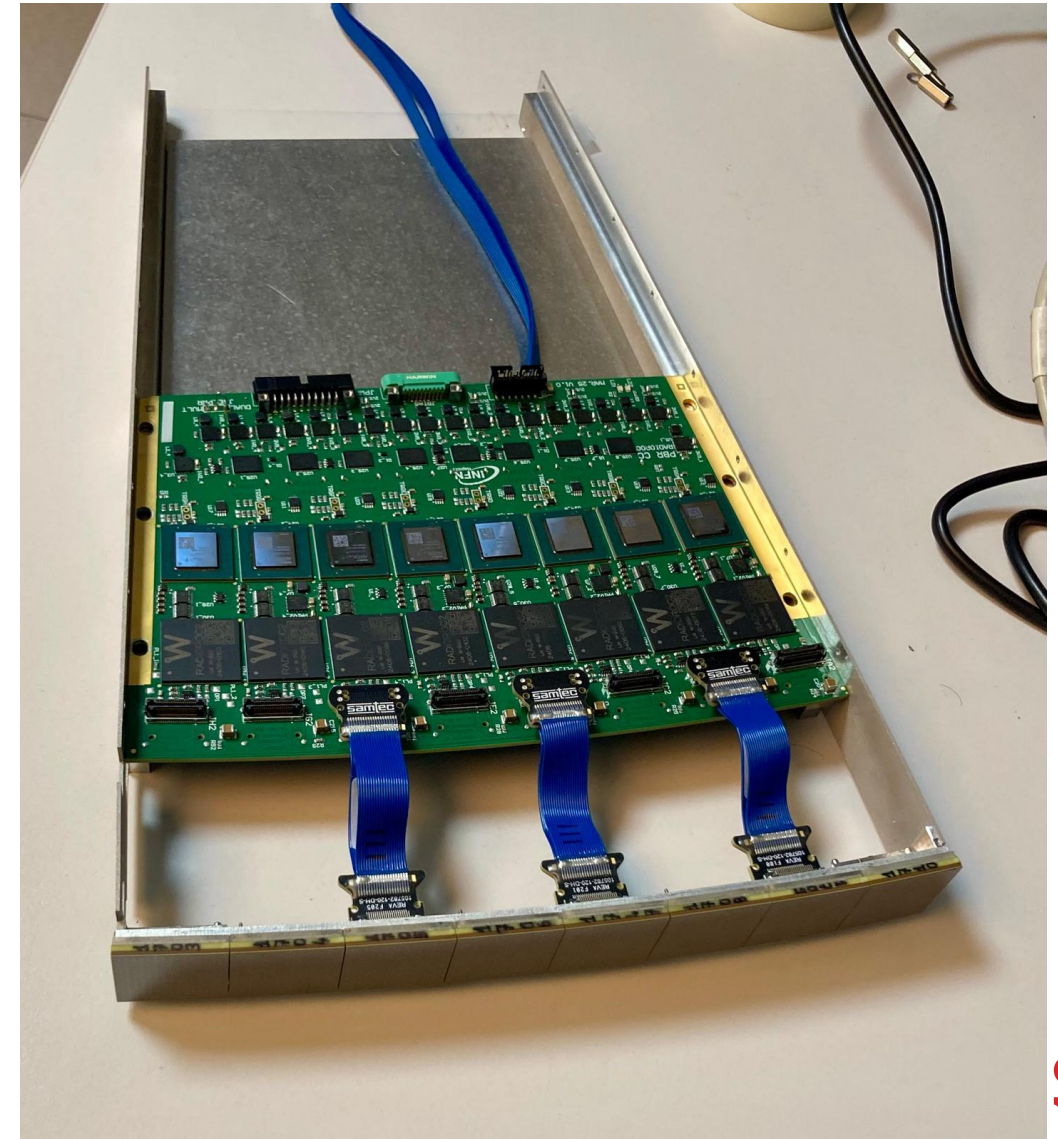
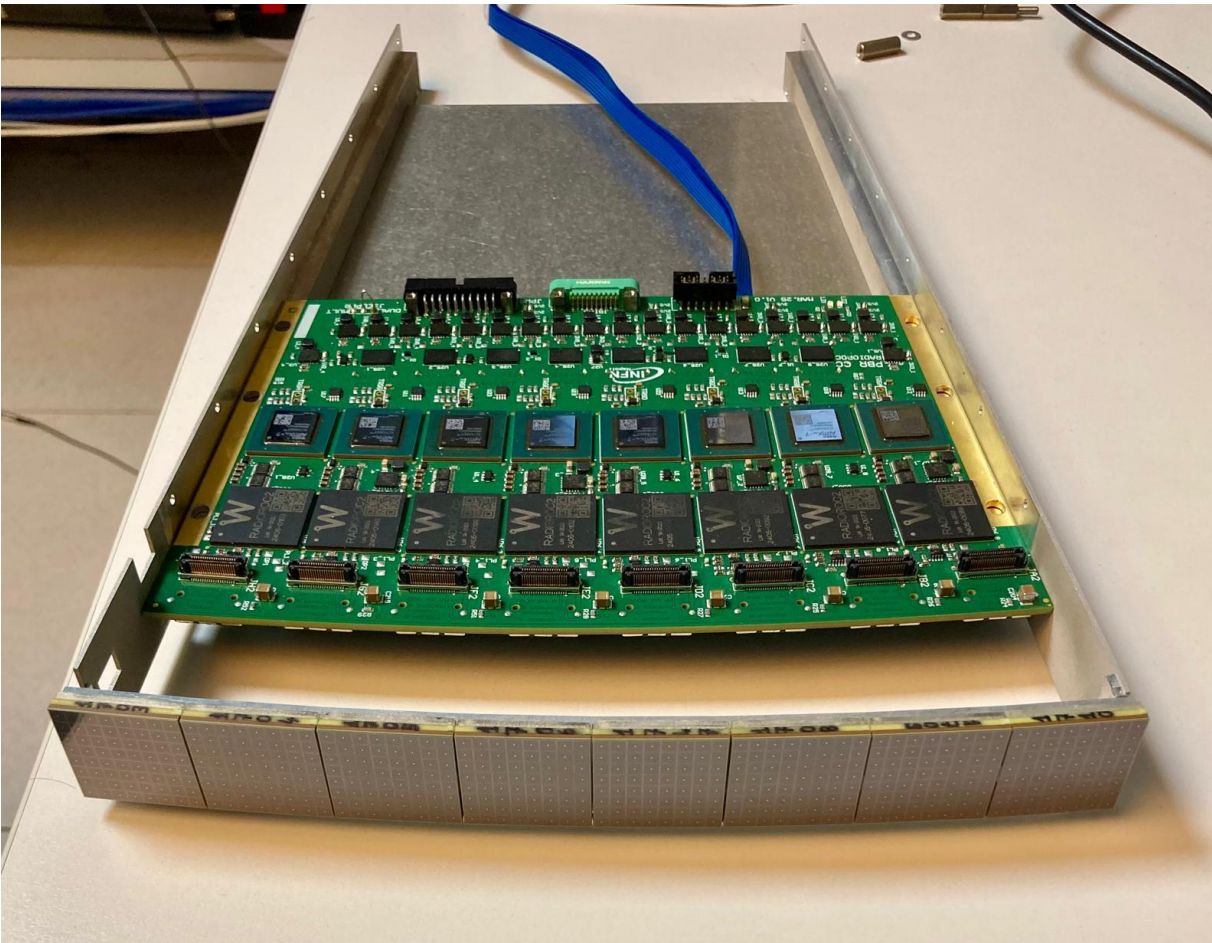
- CC PDM integration test: Radoroc ASIC board connected to the focal plane

CC-PDM MECHANICS: HOUSING AND COOLING (FLIGHT MODEL)

Status:

- Aluminum model manufacturing in progress

Radioroc ASIC board integrated into the housing and cooling mechanics



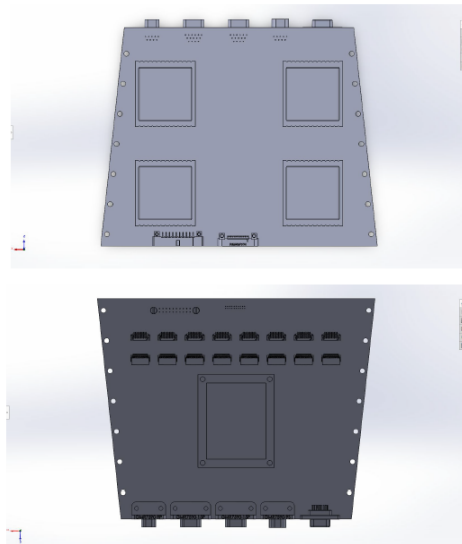
FPGA BOARD

Status:

- Design in progress

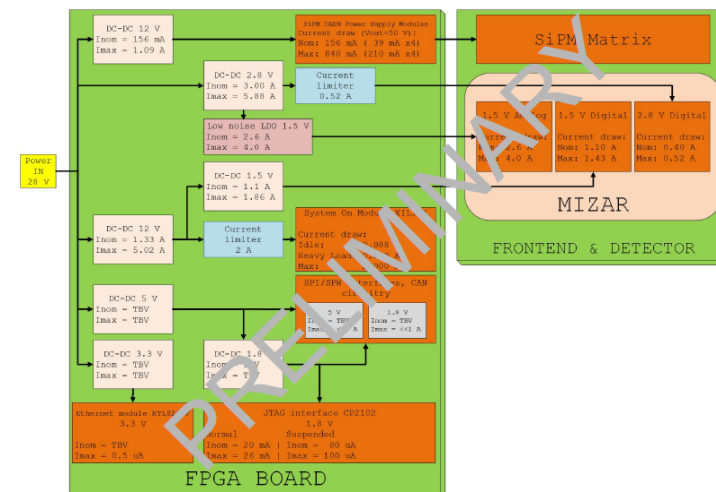
Mechanical layout and interfaces

- Connectors and main ICs are defined
- 4 regulators for SiPM
- SOM XCAU15P (can be upgraded to XCAU25P)
- Electrical interfaces towards FE board:
 - 8 Firefly for ASIC interface
 - Harwin M80 for power
 - Harwin G125 for bias+temp
- Electrical interfaces towards TriggerBoard/Satellite:
 - Glenair 9 pin for CAN
 - 2 Glenair 15 pin for LVDS
 - Glenair 9 pin for 28V Power Supply
 - Norcomp for Ethernet



Power Supply Tree development

- Working on 28V single input scenario.
- Producing 12 V for SiPM regulators and SOM
- 1.5V Analog, 1.5V Digital, 2.8V Digital for Front end board
- 5V, 3.3V and 1.8V for SPI, CAN, JTAG, Ethernet...



DC-DC CONVERTERS

Both the ASIC boards need low voltages

- MIZAR ASIC board (1.2 V AN, 1.2 V DIG, 2.5 V DIG)
- Radioroc2 ASIC board (5V, 2.3V)

These voltages should be provided by DC-DC converters located on the FPGA board

Studies are underway to determine whether they can be hosted on the FPGA board or if a dedicated board is required. → possible impact on the general mechanics design of the CC camera.

The problem of «who designs/procures the DC-DC converters and where they should be located» is common to several sub-systems. Dedicated discussion should be planned.

SIPM BIAS PROPOSED SOLUTION

- Developing of the bias system of PBR Cherenkov camera
- Best candidate: CAEN A7585D
- Issues: the component is not validated for temperatures higher than 60°C
- Circuit and component test currently ongoing
- We have the expertise and the infrastructure to do that in house from HEPD-02 tracker

People involved:

E. Ricci (researcher)

R. Iuppa (associate professor)

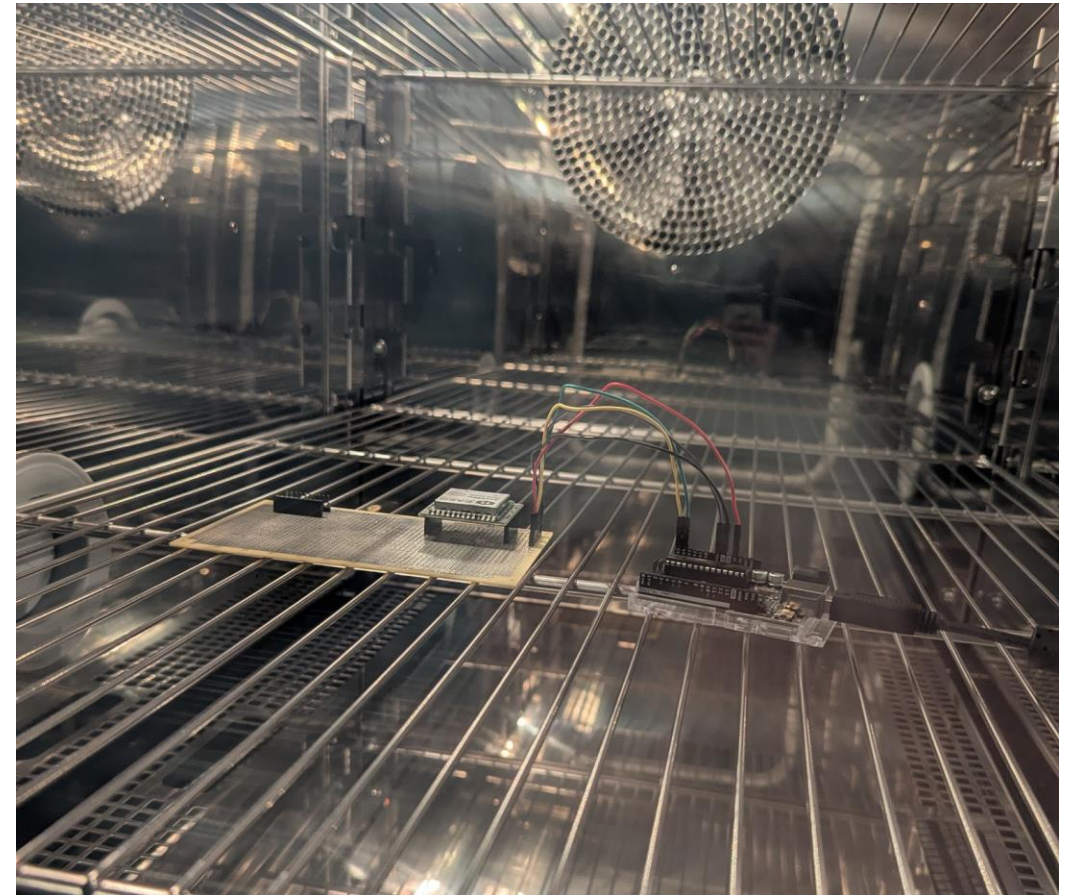
P. Zuccon (associate professor)

D. Schledewitz (PhD student)



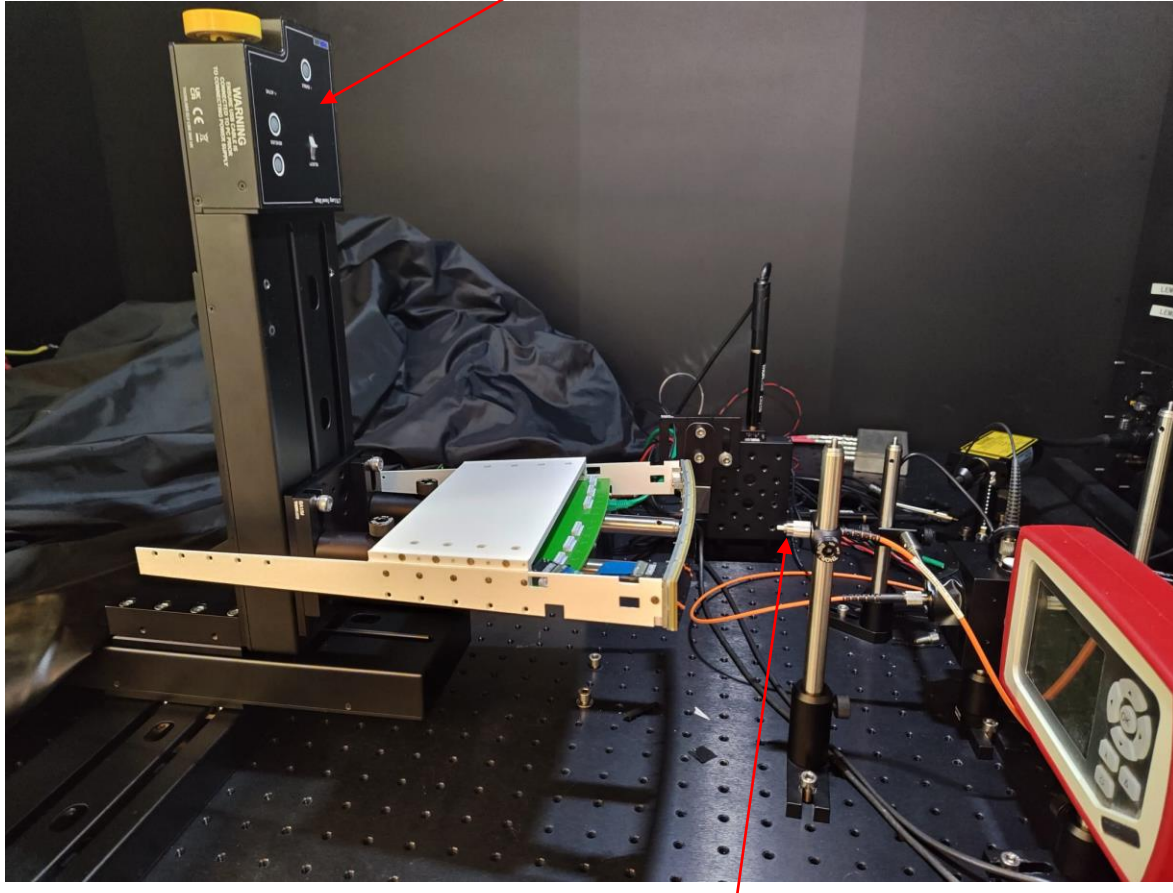
SETUP UNTIL NOW

- **Proposed setup thermal test:**
 - Arduino controlled SiPM PS
 - SiPM readout over multiple thermal cycles
- **Setup ready for testing the SiPM PS module in climate chamber:**
 - 25.5 Thermal cycles from -35°C to 90°C
 - Arduino responsiveness (serial communication, timing)
 - Output voltage from PS module across temperature
 - Power-on stability and cold start behavior



MEASUREMENT: SETUP

Thorlabs 3 motorized stages in XYZ configuration.



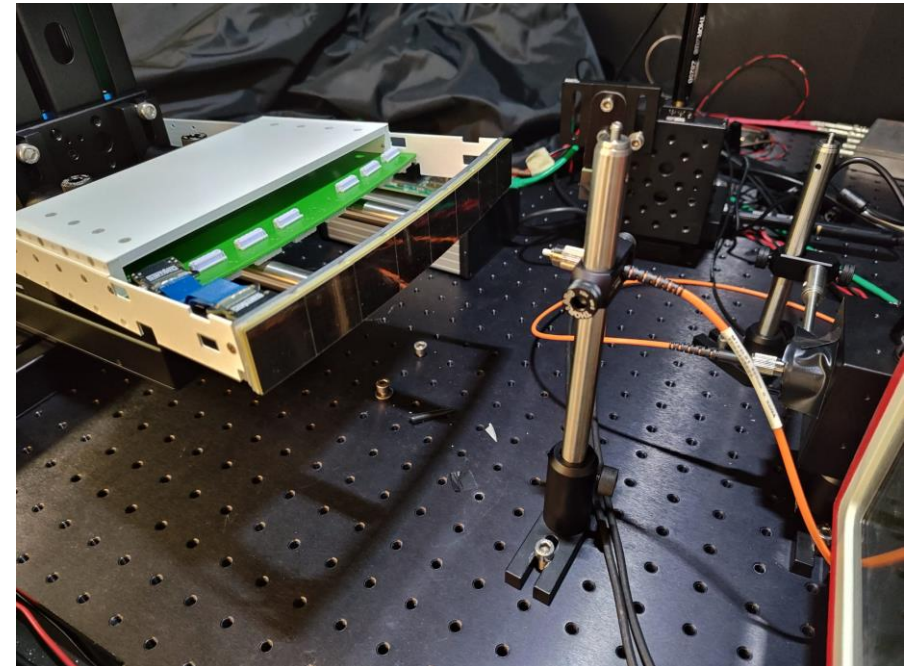
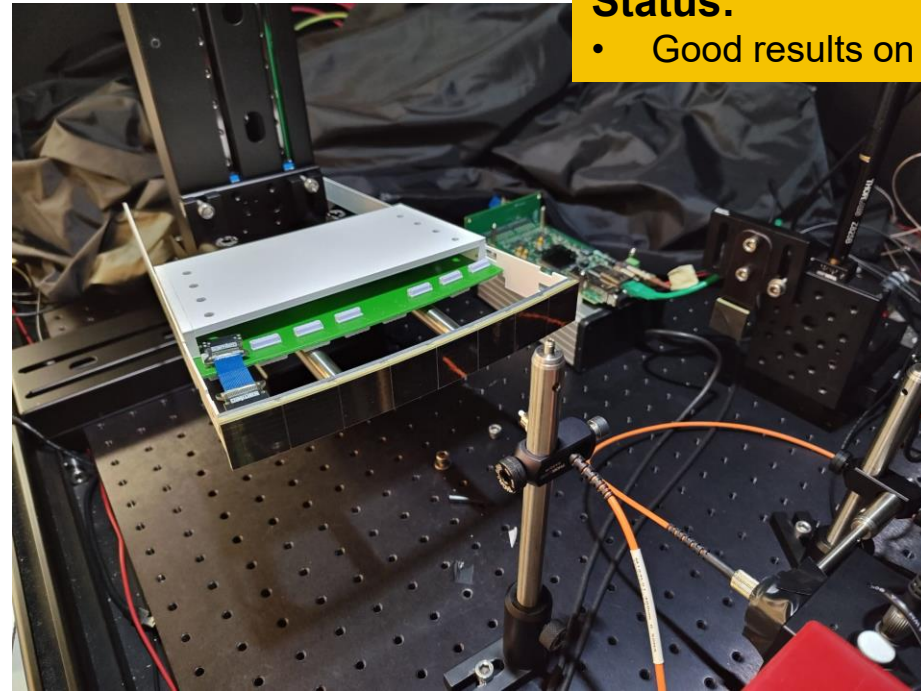
Optical fiber connected to a Hamamatsu PLP-10 Laser diode head 405 nm

G. Osteria

37th JEM-EUSO Collaboration meeting June 2 - 6, 2025 - Paris

Status:

- Good results on PDE measurements



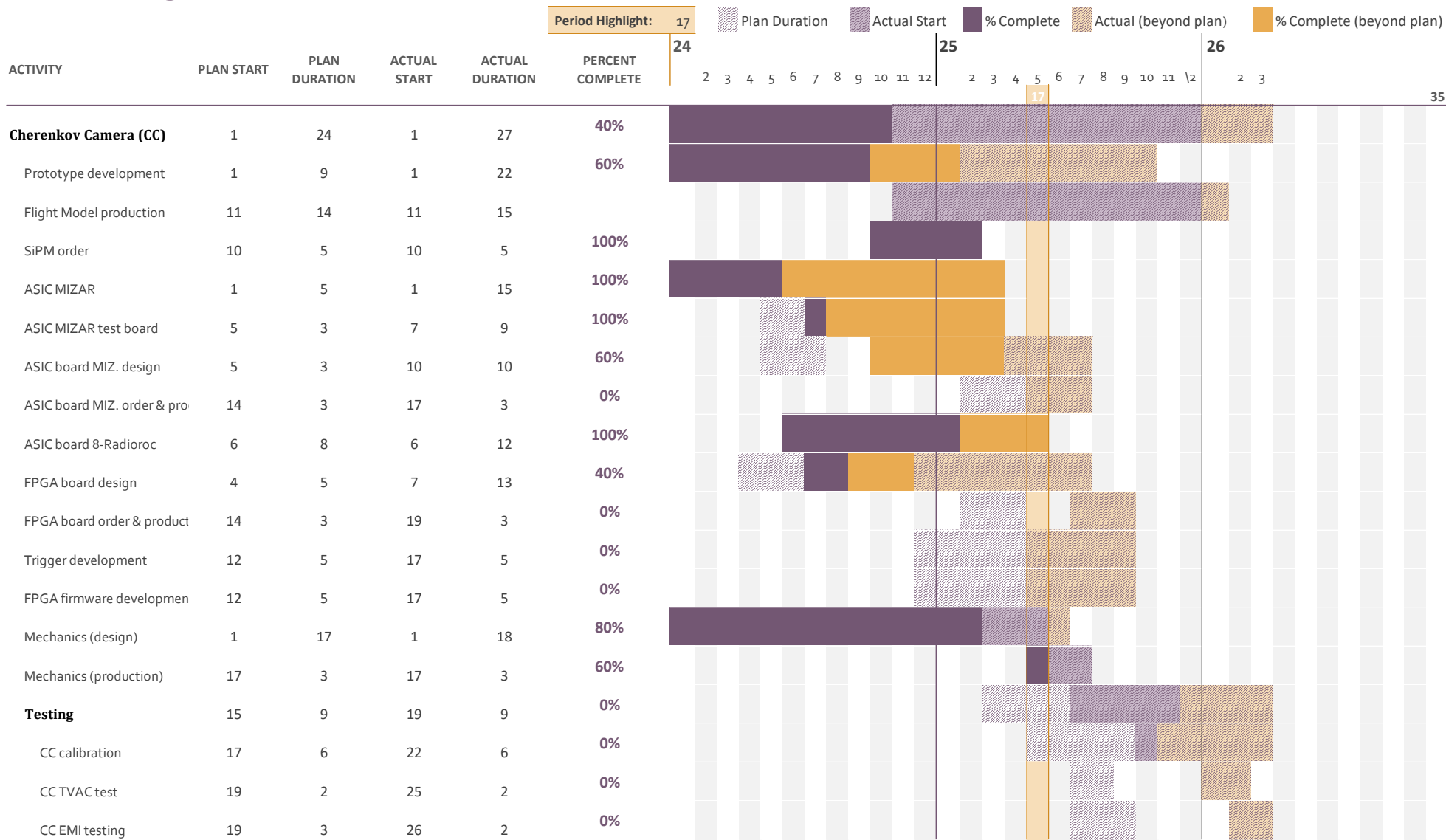
CC-PDM DESIGN & PROCUREMENT STATUS (SUMMARY)

CC PDM elements:

item	design	procurement	Expected delivery
SiPM arrays (8)	Ham. S13361	50 ordered	Delivered
CC-Elementary Cells (8)	completed	50 pcb ordered	Delivered
Focal plane mech.	completed	4 of 4 manufact.	Delivered
Housing and cooling mech	Completed (TBC)	Manufacturing in prog.	End of July
Samtec microcoax cables	completed	50 + 50 ordered	Delivered
ASIC board (MIZAR)	In progress	Order by end of June	End of July
ASIC board (Radioroc2)	V2 board tested	8-asic board ordered	Delivered
FPGA board	started	Order by end of July?	End of September
Bias system	started	Order after qualif. test	End of September
DC-DC converters	tbd		

SCHEDULE & MILESTONES

CC Project Planner



Thank you