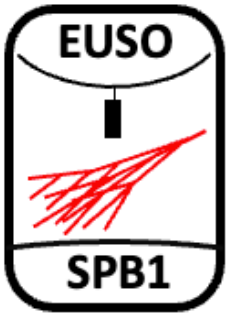
INFN Sezione di Catania –
Riunione Gruppo 2 "FisicaAstroparticellare"
Catania , 3 Luglio 2025

Uni ct FISICA E ASTRONOMIA "ETTORE MAJORANA"

INFN CATANIA

Preventivi INFN – Anno 2026 - Sigla SPB2



JEM-EUSO: Joint **E**xploratory **M**issions towards an **E**xtreme **U**niverse **S**pace **O**bservatory

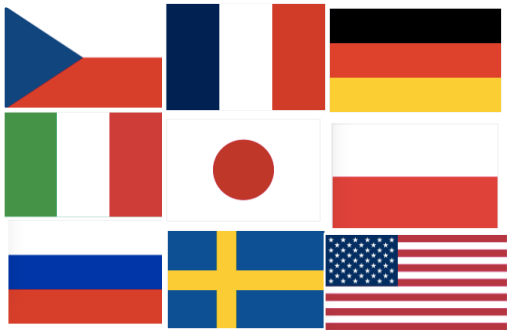
ROSSELLA CARUSO, Responsabile locale sigla SPB2 (Collaborazione JEM-EUSO)

Dipartimento di Fisica e Astronomia "E.Majorana" & INFN – Sezione di Catania

The JEM-EUSO Collaboration (https://www.jemeuso.org)

- **International Collaboration: ~170 authors, ~60 institutions, 16 Countries**

Member Countries



Czeck Republic, France, Germany, Italy, Japan, Poland, Russia, Sweden, USA

Associated Members

Algeria, Mexico, Republic of Korea, Romania, Slovakia, Spain, Switzerland,

- **Supported by Space Agencies and research funding agencies**

NASA esa JAXA РОСКОСМОС ASI Agenzia Spaziale Italiana cnes CENTRE NATIONAL D'ÉTUDES SPATIALES

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Deputy Spokesperson
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T. Ebisuzaki

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(Ex-officio PCC)
M. Casolino, E. Parizot, P. Picozza

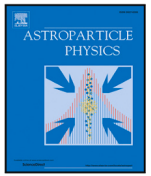
Key white paper in the domain: 2023 state-of-the-art and perspectives. TO BE READ!

Astroparticle Physics 147 (2023) 102794

Contents lists available at ScienceDirect

Astroparticle Physics

journal homepage: www.elsevier.com/locate/astropartphys



Review

Ultra high energy cosmic rays
The intersection of the Cosmic and Energy Frontiers☆

A. Coleman [1,a], J. Eser [2,a], E. Mayotte [3,a], F. Sarazin [3,a,*], F.G. Schröder [1,4,a,*], D. Soldin [1,5,a],

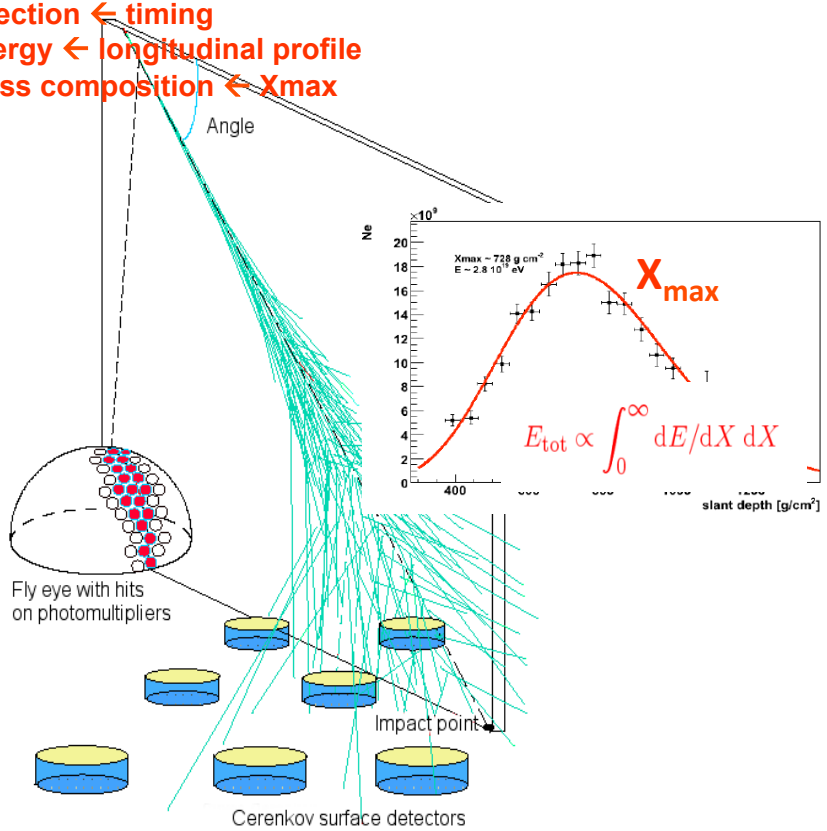
- The next-generation experiments (GCOS, GRAND, and POEMMA) will provide complementary information needed to meet the goals of the UHECR community in the next two decades.
  They should proceed through their respective next stages of planning and prototyping.
- Full-sky coverage with low cross-hemisphere systematic uncertainties is critical for astrophysical studies. To this end, next generation experiments should be space-based or multi-site.

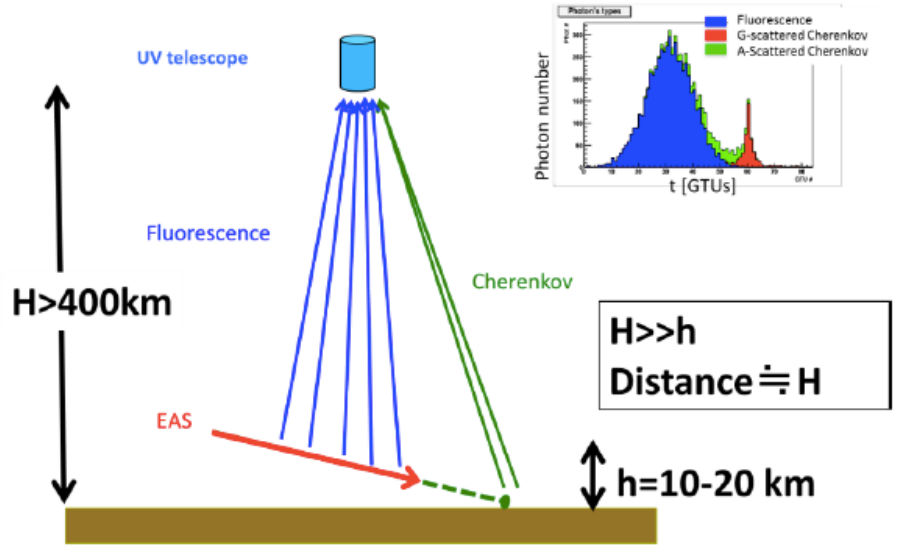
UHECR indirect measurements from Space: basic concepts

A) Ground-based observations → of the Extensive Air Shower ← B) Space-based observations

Fluorescence Detector

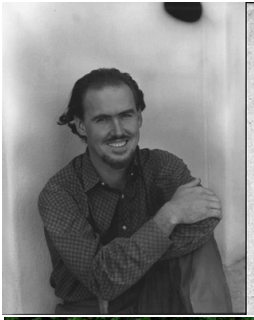
- direction ← timing
- energy ← longitudinal profile
- mass composition ← Xmax

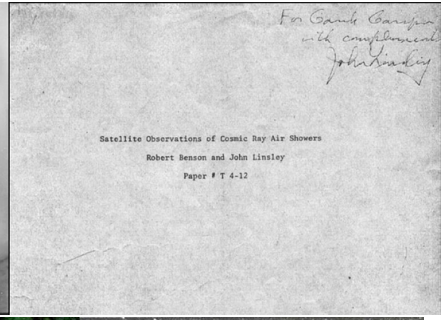


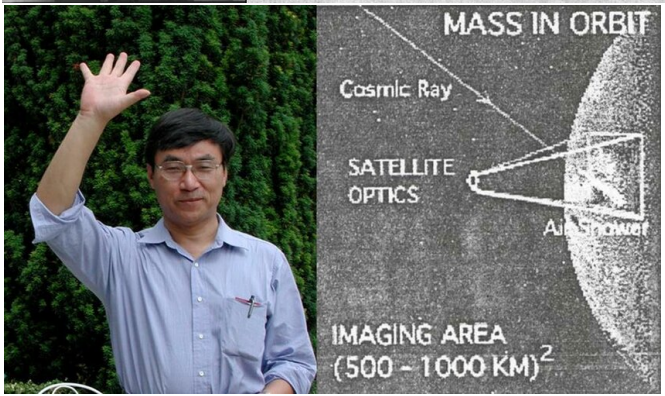


- UV wide-field telescope (Fluorescence and/or Cherenkov)
- flying at low-Earth orbits
- whole Earth's atmosphere as 10^{12} tons target volume
- Nadir/tilted (30°) configuration

Genesis of the JEM-EUSO Program

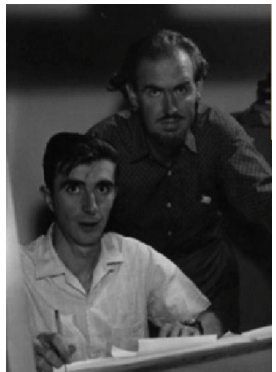






1979: John Linsley – first original idea
1981: **SOCRAS (Satellite Observatory of Cosmic Ray Showers) Project**
included in Field Committe Report of NASA "Call for Projects and Ideas in High Energy Astrophysics for the 1980s"

1995: Yoshuyuki Takahashi – new imaging technology
MASS (Maximun-energy Auger (Air-)Shower Satellite) Approach
1° Workshop in Huntsville (USA) - August 1995
1996: OWL (Orbiting Wide angle Light concentrators) Proposal
included and selected in NASA's SEU Mid-term Strategic Plan (2010's)



1996: **Livio Scarsi**
1° Symposium in Catania (Italy) "Airwatch" Project
EUSO (Extreme Universe Space Observatory) Concept
2000: EUSO Proposal submitted to the ESA Call for the F2/F3 Missions and selected for accomodation study onto ISS
2001: 1° EUSO Meeting at RIKEN (Japan)

Times's Arrow of the JEM-EUSO Program

Space Shuttle Columbia disaster

Fukushima nuclear disaster

Covid19 pandemy

Ukraine-Russia War

ESA approval for EUSO@Columbus on ISS

EUSO>PhaseA but ESA posponed PhaseB

- OWL (USA)+EUSO (Europe)=JEM-EUSO @JEM on ISS
- KLIPVE Program (Russia)

VI intermediate Missions

EUSO-TA

EUSO-Ballon

TUS

Mini-EUSO

EUSO-SPB

EUSO-PB2

KEUSO

EUSO-PBR

POEMMA

2000 2005 2010 2015 2020 2025 2030 2035

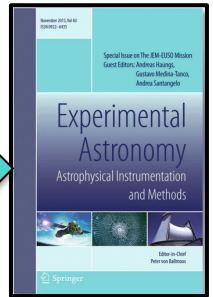
EUSO

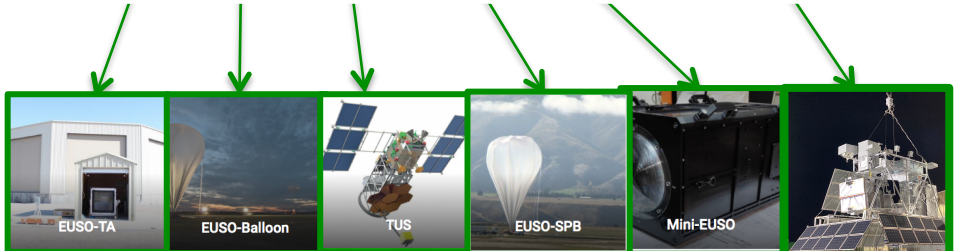
JEM- EUSO (Japanese Experiment Module for EUSO)

JEM- EUSO (Joint Exploratory Mission for EUSO)

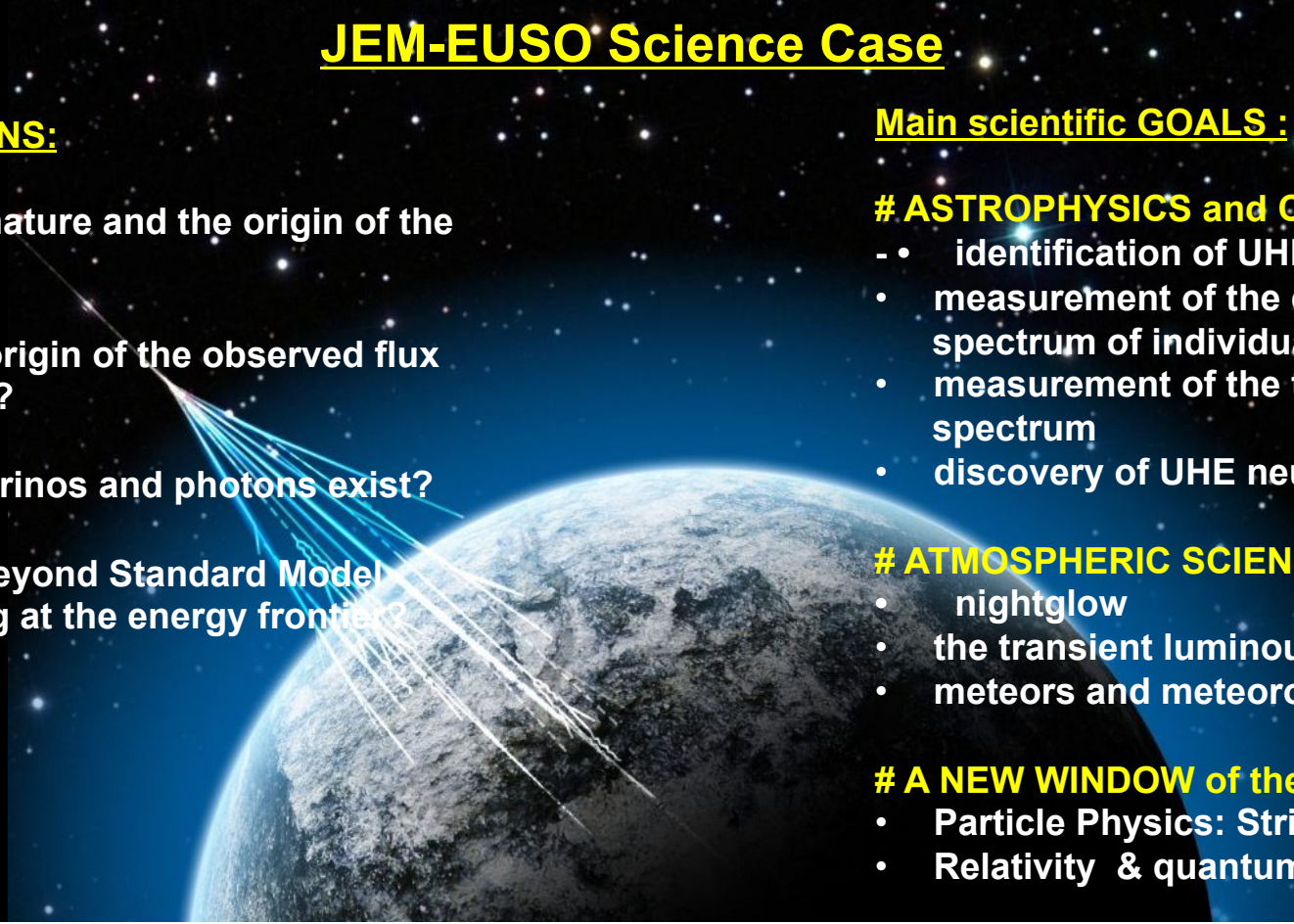
Future Missions

ISSN 0922-6435
Vol. 40 N. 1





JEM-EUSO Science Case



OPEN QUESTIONS:

- What is the nature and the origin of the UHECRs?
- What is the origin of the observed flux suppression?
- Do UHE neutrinos and photons exist?
- Is Physics Beyond Standard Model (BSM) hiding at the energy frontier?

Main scientific GOALS :

 # ASTROPHYSICS and COSMOLOGY

- identification of UHE sources
- measurement of the energy spectrum of individual sources
- measurement of the trans-GZK spectrum
- discovery of UHE neutrinos

 # ATMOSPHERIC SCIENCE

- nightglow
- the transient luminous events (TLE)
- meteors and meteoroids

 # A NEW WINDOW of the UNKNOWN

- Particle Physics: String Theory
- Relativity & quantum gravity effect

Pioneer in detecting UHECR-induced Extensive Air Showers **from Space** with precise measurements and unprecedented atistical accuracy by means of **a single instrument** with **highly increased statistics**, **full-sky coverage**, **minimized systematics** using a target volume far greater than from the ground, at energies beyond the human-made accelerators!

EUSO-Balloon

P:I.: P. von Ballmoos

FLIGHT:

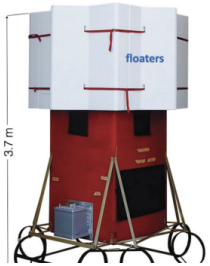
- Launch: August 25, 2014, Timmims CNES Balloon base, CANADA;
- Landing in a solitary Lake
- Altitude: 38 km;duration: 5 hours, 100km

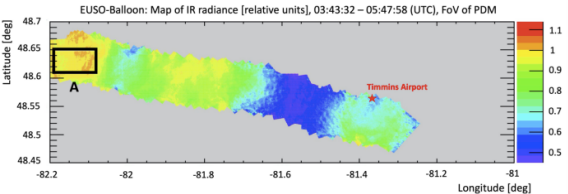
DETECTOR:

- two 1 m^2 Fresnel lenses (6°x 6°) F.o.V.
- 1 PDM, 36 MAPTS, 2304 pixels
- SPACIROC1-ASIC; HVPS

GOALS & RESULTS:

- test EUSO-TA technology on air
- study its response to cosmic rays and artificial sources (laser by helicopter)
- first accurate NSB meausurement





B) Balloon-born intermediate Missions

EUSO-SPB (Super Pressure Balloon)

P:I.: A. Olinto, L. Wiencke

FLIGHT:

- Launch: April 24, 2017,

Wanaka NASA Balloon base, New Zealand;

- Landing: May 7, 2017 in South Pacific Ocean
- Altitude: 35 km; Duration: 12 days

DETECTOR:

- two 1 m^2 Fresnel lenses (6°x 6°) F.o.V.
- 1 PDM, 36 MAPTS, 2304 pixels (II Generation)
- SPACIROC3-ASIC

GOALS & RESULTS:

- upgraded triggers
- development of data acquisition system
- real-time monitoring in ground stations via NASA
- raising of TRL (Technology Readiness Level)
- 25.1 hours of dowloaded data
- instrument's photometric stability within ±5%

EUSO-SPB2

P:I.: A. Olinto, L. Wiencke

FLIGHT:

- Launch: May 13, 2023, Wanaka NASA Balloon base, New Zealand;
- Landing: May 14, 2023 South Pacific Oc.
- Altitude: 33 km; Duration: 37 hours

DETECTORS:

- **Fluorescence Telescope:**
  1 m Schmidt optics, (36°x 12°) F.o.V.
  3 PDM, 108 MAPTS, 6912 pixels
- **Cherenkov Telescope:**
  1 m Schmidt optics, (6.4°x 12.8°) F.o.V.
  512 HAMAMATSU SiPMs

GOALS & RESULTS:

- two different telescopes, new technology
- serch for UHECRs and PeV neutrinos
- nominally working instruments!

Benefits of the stratospheric balloons flights and next balloon-born mission

- technology demonstraters
- studies of background and data acquisition
- advancing the Technology Readiness Level (TRL)
- pioneering missions of JEM-EUSO Program
- precursors of the future missions (POEMMA)

NEW Balloon Mission!

- **approved and funded by NASA**
- **planned Launch Spring 2027**

+

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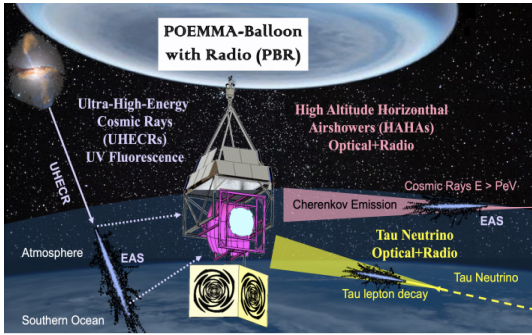
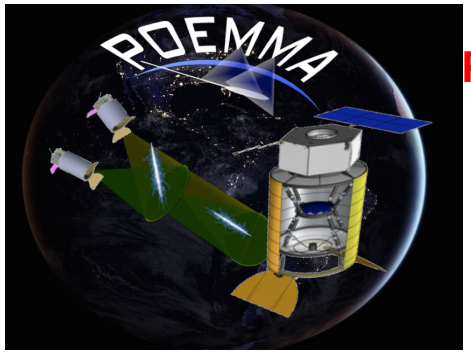




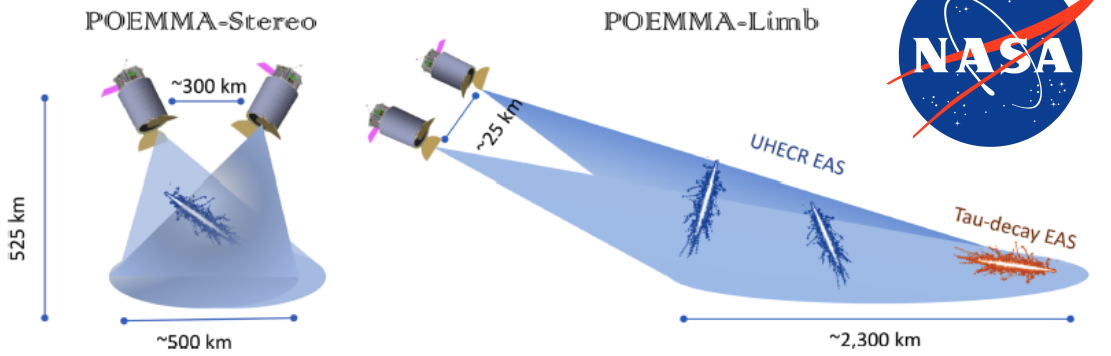
EUSO - SPB3

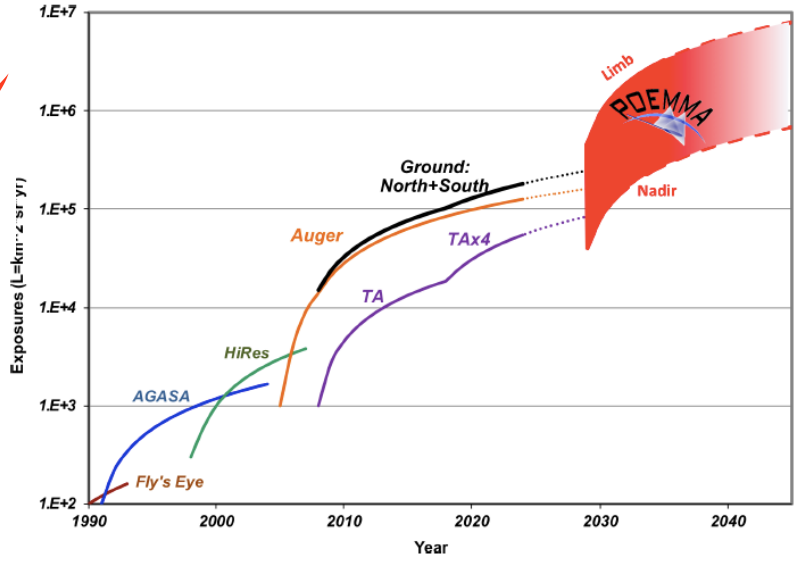
PBR (POEMMA Balloon with Radio)

POEMMA

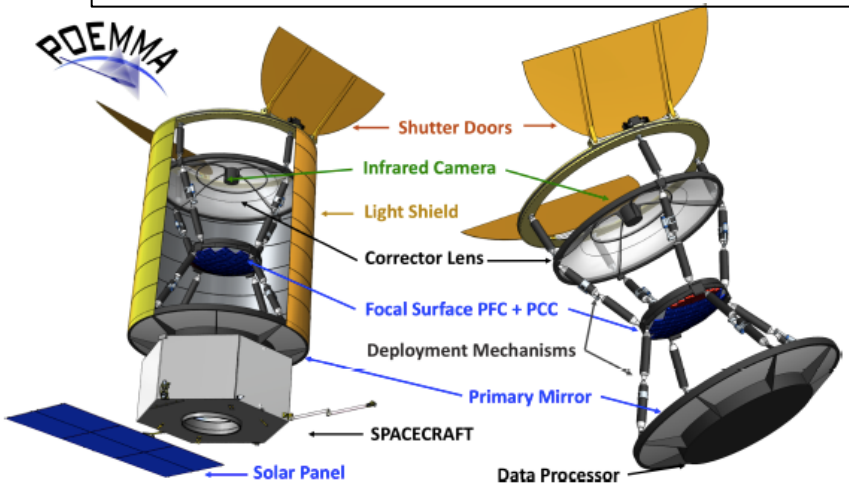
Probe of **E**xtreme **M**ulti-messenger **A**strophysics

Future large space-based Missions: POEMMA

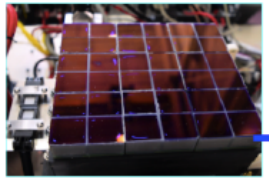




4 m photometer with Schmidt (45◦ F.o.V) optics

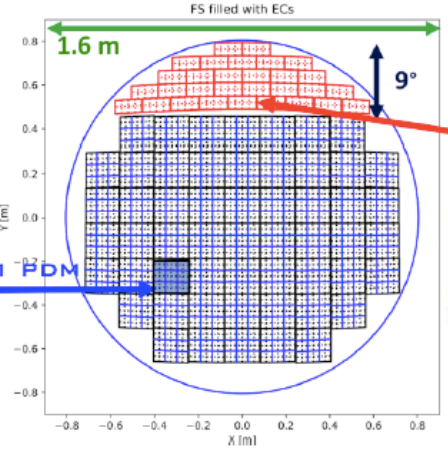


PFC: POEMMA FLUORESCENCE CAMERA

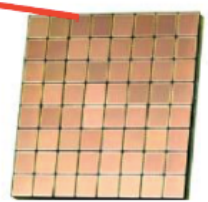


MAPMTs

Δt = 1 μs



PCC: POEMMA CHERENKOV CAMERA



SiPMs

Δt = 10 ns

ASSEGNAZIONI 2025 – ANAGRAFICA sigla SPB2- INFN-CT

RICERCATORI

			%
1.	Anzalone Anna	Ric. INAF/IASF PA	50
2.	Del Popolo Antonino	Ric. Univ. UniCT	20
3.	Caruso Rossella	Prof. Ass. UniCT (Resp.locale)	40
4.	Pagliaro Antonio	Ric. INAF/IASF PA	50
5.	Petta Catia	Prof. Ass. UniCT	30

TOTALE: 5 unità **<FTE/persone> = 0.4** **FTE TOT. 1.9**

SERVIZI

Servizi ELETTRONICA 2 MESI UOMO

Agenzia Spaziale Italiana

ACCORDO ATTUATIVO N. 2021-8-HH.0

DELLA CONVENZIONE QUADRO N. 2016-4-Q.0

Codice Unico di Progetto (CUP) F15F21000140005

PER

NOTA: IN ESSERE dal 27/04/2021 fino al 30/04/2025
Nuovo Addendum ("Addendum 3") siglato a partire da maggio 2025 per altri 9 mesi

"EUSO-SPB2 (Extreme Universe Space Observatory – Super Pressure Balloon

OBIETTIVI:

- progettazione, prototipazione e produzione di hardware per i telescopi di fluorescenza (FT) e Cherenkov (CT) della missione SPB2;
- sviluppo SW di simulazione, ricostruzione, analisi dati e monitoraggio ambientale;
- campagna di integrazione e test del FT.

PARTNERS: ASI

- INFN – Sezioni di Catania, Napoli (capofila con il P.I. Dott. Giuseppe Osteria),
- Roma Tor Vergata, Torino e Laboratori Nazionali di Frascati;
- Università di Catania, Università di Napoli "Federico II".

UNIVERSITÀ degli STUDI di CATANIA

DIPARTIMENTO DI FISICA E ASTRONOMIA "ETTORE MAJORANA"

INFN CATANIA

Agenzia Spaziale Italiana

I PART: PREMISE

Study of performances and characterization of SiPMs for the next generation of telescopes in balloon-borne & space-based experiments

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The test and calibration system of the Elementary Cell for the PBR Cherenkov Camera

UNIVERSITÀ degli STUDI di CATANIA

Dipartimento di Fisica e Astronomia "Ettore Majorana"

INFN CATANIA
Istituto Nazionale di Fisica Nucleare
Sezione di Catania

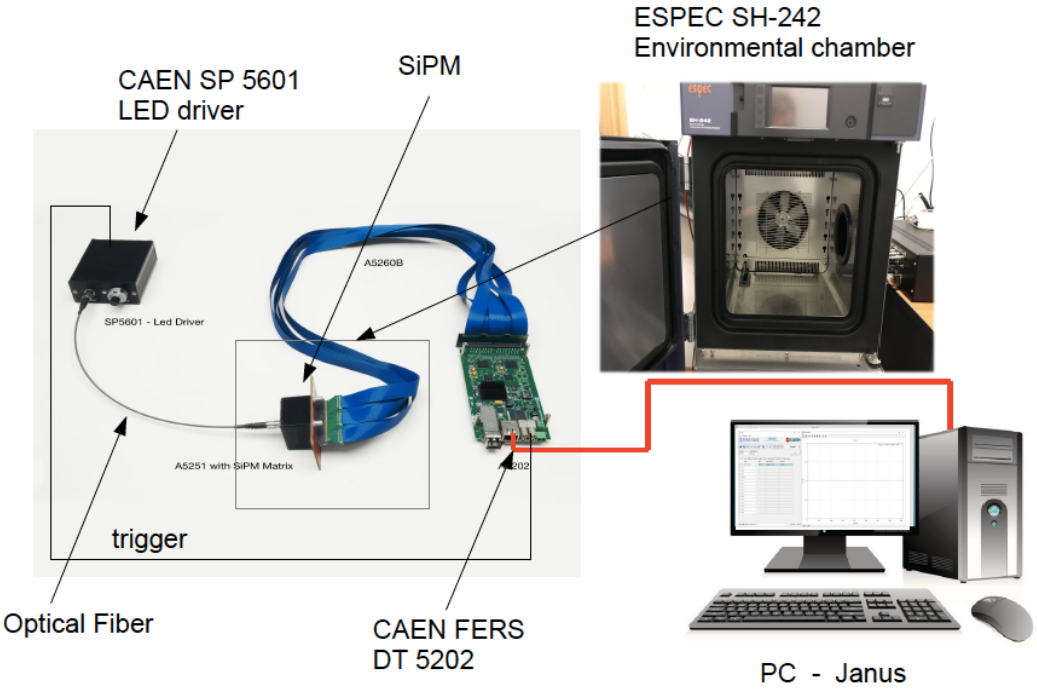
Past Activities: a) R&D on SiPMs for the SPB2 mission

Involved members: **Rossella Caruso, C.Lombardo, R. Persiani, C. Petta, C. Lombardo, Servizi Elettronica**

Measurements of SiPM features:

- R&D on SiPMs: several prototypes from Hamamatsu, SensL, AdvanSid (FBK), Kernell, Ketek manufactures;
- Visual inspection (scratches, bubbles…): in clean room using a microscope;
- Measurements at temperature variations (- 40 °C ÷ + 150 °C) in a climate chamber: Dark Current Ratio (DCR); Gain; Cross-Talk; After-Pulse; I-V (Current-Voltage) curve, Multi-photon Spectrum;

Experimental set-up and kit of SiPMs



Available SiPMs

SiPM w/o connector

SiPM w conenctor

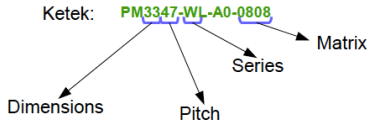
SiPM characterized

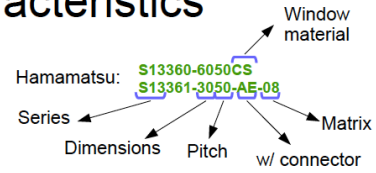
SenSL:
ARRAYJ 30035 16P PCB
ARRAYC 60035 64P PCB
MICROFC 10010 SMT TR1
MICROFC 30035 SMT TR1
MICROFC 60035 SMT TR1
MICROFC SMA 10010 GEVB
MICROFC SMA 30035 GEVB
MICROFC SMA 60035 GEVB
MICROFC SMTPA 10010 GEVB
MICROFC SMTPA 60035 GEVB

Ketek:
PM3315-WL-A0
PM3335-WL-A0
PM3347-WL-A0
PM3347-WL-A0-0808

Hamamatsu:
S14160-1310PS
S14160-1315PS
S14160-3010PS
S14160-3015PS
S14160-4050HS
S13360-1325CS
S13360-1350CS
S13360-6025C
S13360-6050CS
S13361-3050-AE-08

SiPM characteristics





Operating temperature: -40 °C / 60 °C

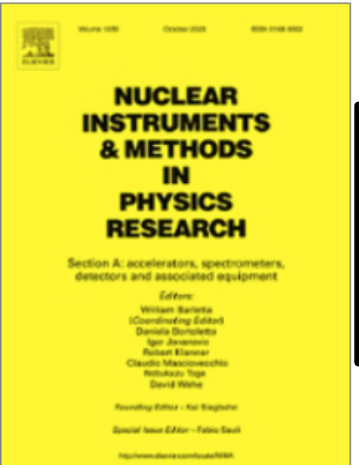
Spectral response range: 320 – 900 nm

Peak sensitivity wavelength: 450 nm

Operating temperature: -20 °C / 60 °C

(270 – 900 nm for HPK with CS option)

	N of pixels	Fill Factor (%)	Window R-index	Active Area (mm²)
PM3335-WL-A0	7396	80	1.52	3.0 x 3.0
PM3347-WL-A0	4096	80	1.52	3.0 x 3.0
PM3347-WL-A0-0808	4096	80	1.52	3.0 x 3.0
S13360-1350CS	667	74	1.41	1.3 x 1.3
S13360-6050CS	14400	74	1.41	6.0 x 6.0
S13361-3050-AE-08	3584	74	1.55	3.0 x 3.0



NOTA:
Lavoro sviluppato nell'ambito di una sinergia locale ***"SynWorkingGroup SiPMs"*** tra diverse sigle sperimentali INFN di R&D sui SiPMs

Characterisation of Hamamatsu S13161-3050AE-08 SiPM (8 x 8) array at different temperatures with CAEN DT5202

R. Persiani[a,b], C. Lombardo[a,b,*], S. Millesoli[a,b], F. Tortorici[a,b], S. Albergo[a,b], F. Cappuzzello[a,c], R. Caruso[a,b], C. M. A. Petta[a,b], C. Tuvè[a,b]

[a]*Department of Physics and Astronomy "E.Majorana", University of Catania, Via S. Sofia 64, Catania, 95125, Italy,*
[b]*INFN section of Catania, Via S. Sofia 64, Catania, 95125, Italy,*
[c]*INFN Laboratori Nazionali del Sud, Via S. Sofia 62, Catania, 95125, Italy,*

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Abstract

Silicon PhotoMultipliers, SiPMs, constitute the enabling technology for a diverse and rapidly growing range of applications: medical imaging, experimental physics, and commercial applications are only a few examples. In this work, a characterisation protocol for SiPM qualification has been applied to Hamamatsu S13161-3050AE-08 SiPM (8 x 8) array in the (-40 ÷ +30)°C temperature range. The protocol foresees to measure several parameters: breakdown voltage, quenching resistance, gain, dark count rate and probability of cross-talk. Methods to extract them and their dependence on temperature at fixed overvoltage are shown and the results are discussed.

Keywords: SiPM characterisation, breakdown voltage, quenching resistance, gain, dark count rate, probability of Cross-Talk.

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The test and calibration system of the Elementary Cell for the PBR Cherenkov Camera

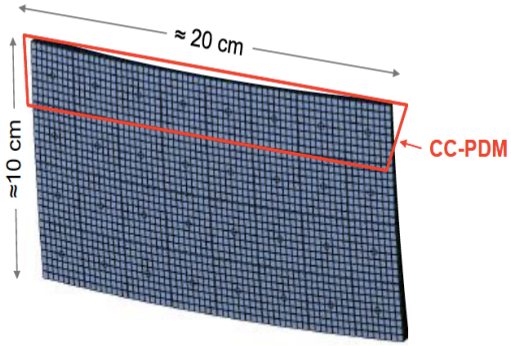
CHERENKOV CAMERA OVERVIEW

Requirements: (from simulations)

- **Pixel size: 3 x 3 mm²**
- **Pixel FoV: 0.2°**
- **Total FoV: 12° x 6°**

Implementation:

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



SIPM ARRAY STATUS

Hamamatsu S13361-3050 series

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

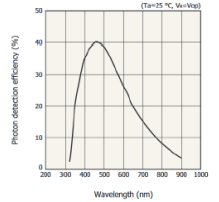
Absolute maximum ratings

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

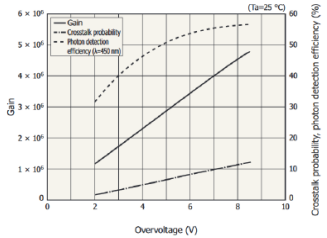
Electrical and optical characteristics (Typ. Ta=25 °C, Vover=3 V, unless otherwise noted)

Parameter		Symbol	Value	Unit
Spectral response range		λ	320 to 900	nm
Peak sensitivity wavelength		λp	450	nm
Photon detection efficiency (λ=λp)*4		PDE	40	%
Dark count*5	Typ.	CD	0.5	Mcps
	Max.		1.5	
Terminal capacitance		Ct	320	pF
Gain		M	1.7 × 10⁶	-
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		ΔTVop	54	mV/°C

Photon detection efficiency vs. wavelength (typical example)



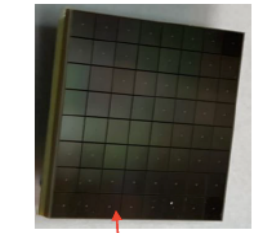
Overvoltage specifications of gain, crosstalk probability, photon detection effici



S13361-3050-NE-08
- 17 available for prototyping studies
- 50 ordered (delivery by the end of January)

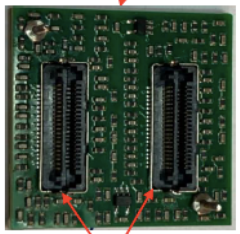
THE ELEMENTARY CELL

Status:
- 13 prototypes manufacture

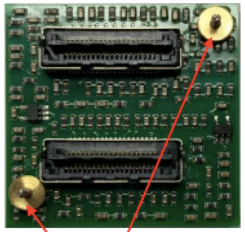


S13361-3050AE-08

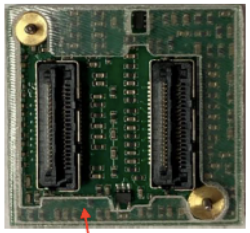
Custom PCB



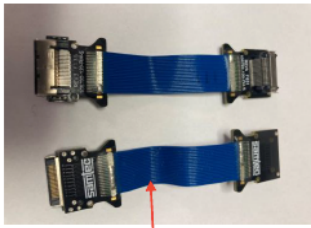
(Samtec) 40 positions
LSHM-120-02-5-L-DV-A-S-TR



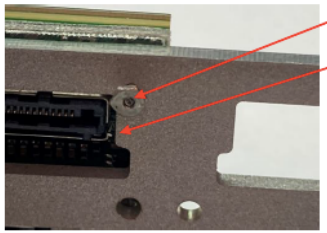
M1 screws



3D printed spacer



(Samtec) 40 positions 38 AWG coax
HLCD-20-12.00-TD-TH-1



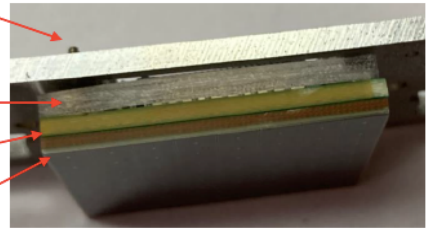
M1 screw

(Samtec) 40 positions
LSHM-120-…

3D printed spacers

Custom PCB

S13361-3050AE-08



Elementary cell (side view)

- **On April 17th, 2025, the shipment of one Elementary Cell arrived in Catania from Naples.**
- **We started with test and meaurements of basic parameters at different temperatures!**

Current Activities: **a) Test & Calibration Elementary Cell units for PBR Cherenkov Camera**
involved members: **R. Caruso, C.Petta, A.Crocco, Servizi Elettronica**

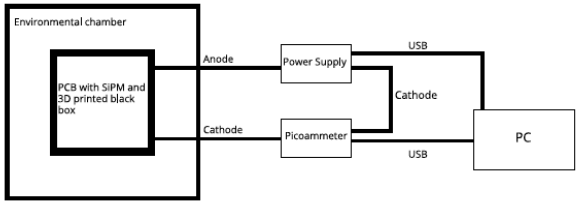
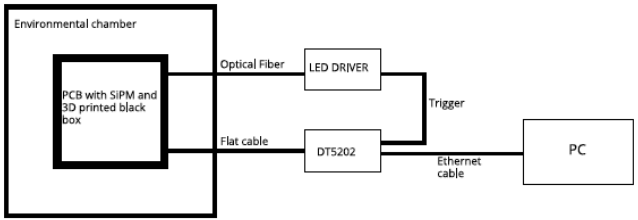


Fig. 1. Schematic view of the set-up used for I-V measurements.



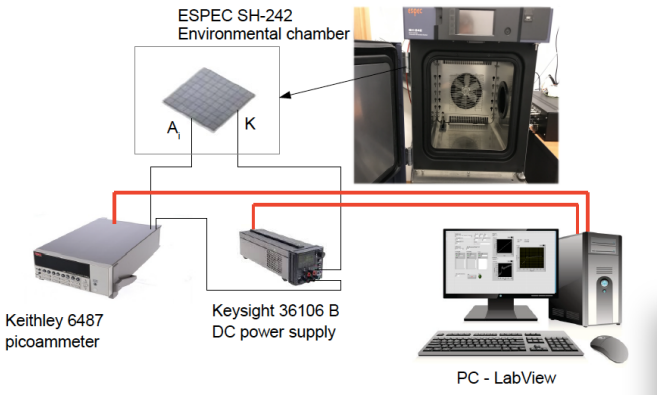
NEXT STEPS

- waiting for next stock of EC of the PBR CC in Catania for testing and calibrating all them step by step

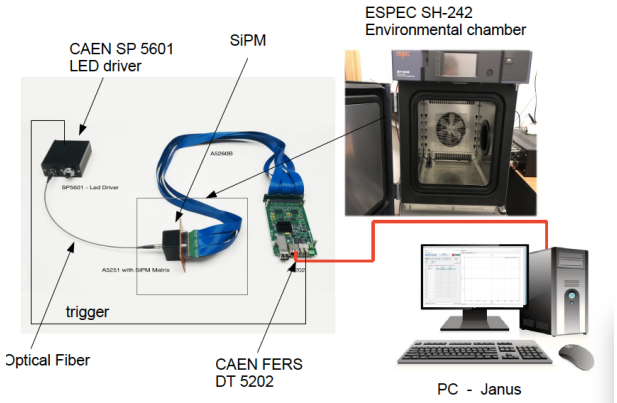
WE ARE READY!

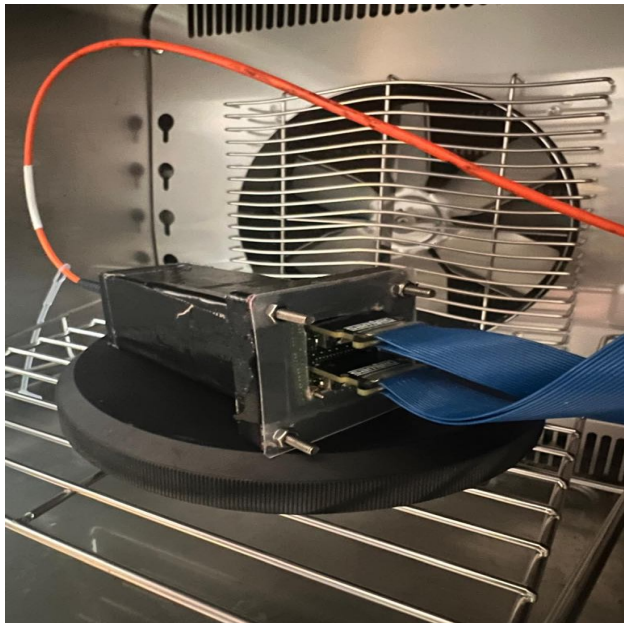
- next calibration of the each CC PDM or the whole PBR Focal Surface?
- possible improvements in the set-ups
- Catania SIPM Test Facility as Calibration Site for the PBR Collaboration!

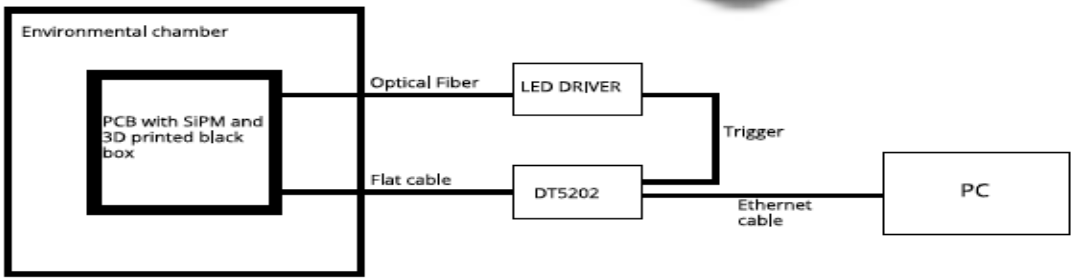
I-V measurement setup

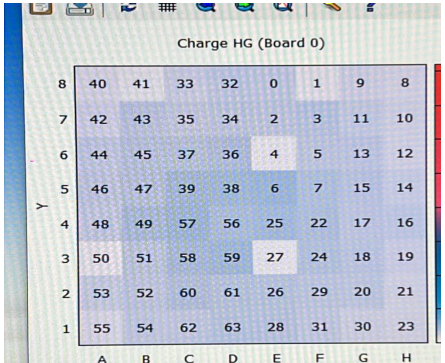


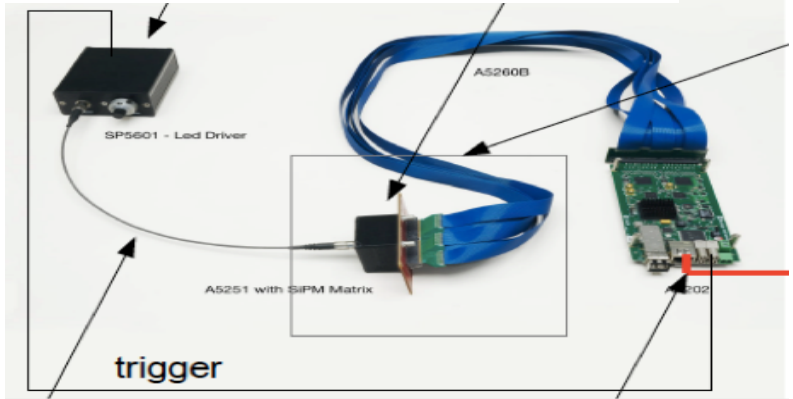
Multiphoton & staircase setup

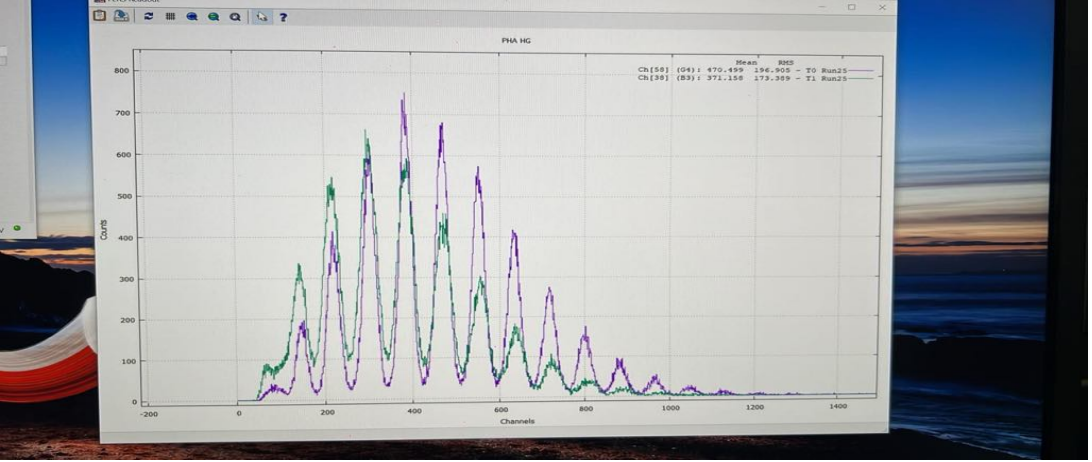




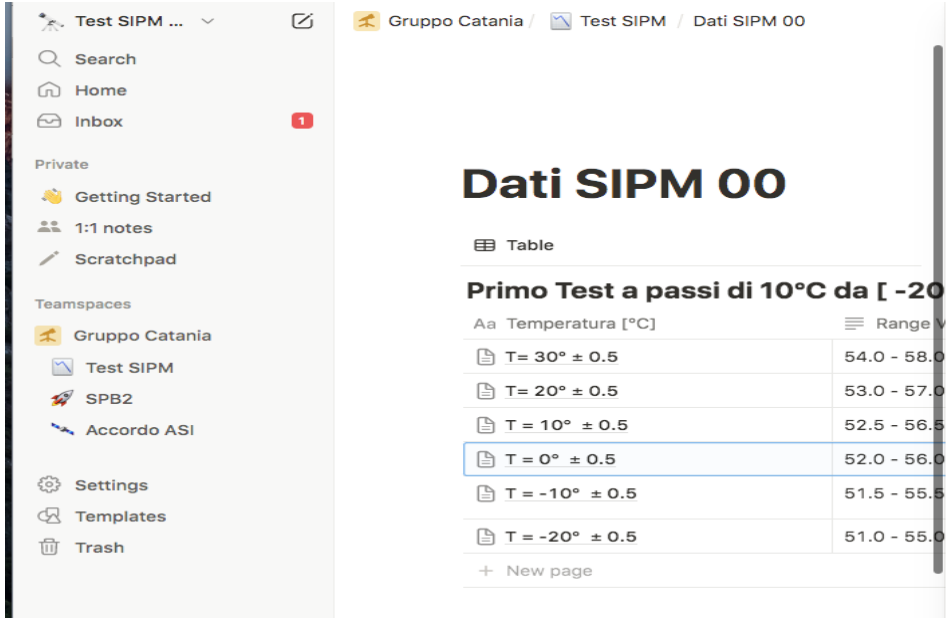

Environmental chamber
PCB with SiPM and 3D printed black box
Optical Fiber
Flat cable
LED DRIVER
DT5202
Trigger
Ethernet cable
PC

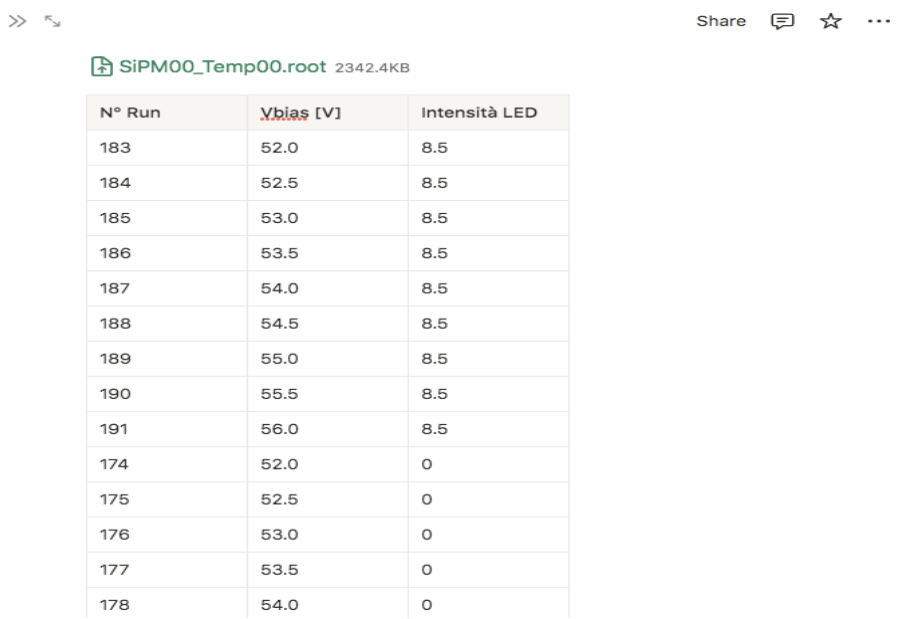

Charge HG (Board 0)
8 40 41 33 32 0 1 9 8
7 42 43 35 34 2 3 11 10
6 44 45 37 36 4 5 13 12
5 46 47 39 38 6 7 15 14
4 48 49 57 56 25 22 17 16
3 50 51 58 59 27 24 18 19
2 53 52 60 61 26 29 20 21
1 55 54 62 63 28 31 30 23
A B C D E F G H


SP5601 - Led Driver
A5260B
A5251 with SiPM Matrix
trigger



Use of **Notion Sotware**:
the open AI Workspace for archive and sharing data files,
documents, plots, …



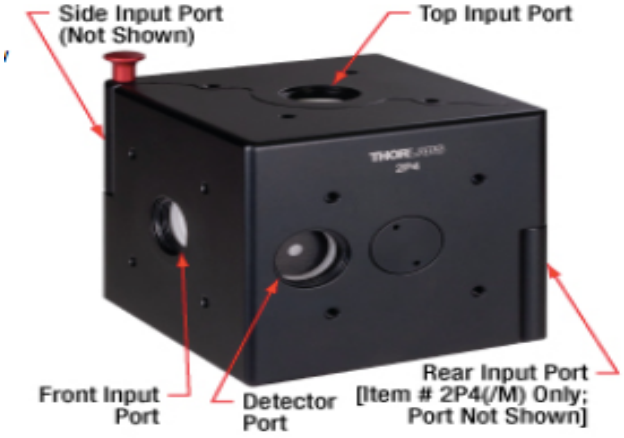


N° Run	Vbias [V]	Intensità LED
183	52.0	8.5
184	52.5	8.5
185	53.0	8.5
186	53.5	8.5
187	54.0	8.5
188	54.5	8.5
189	55.0	8.5
190	55.5	8.5
191	56.0	8.5
174	52.0	0
175	52.5	0
176	53.0	0
177	53.5	0
178	54.0	0

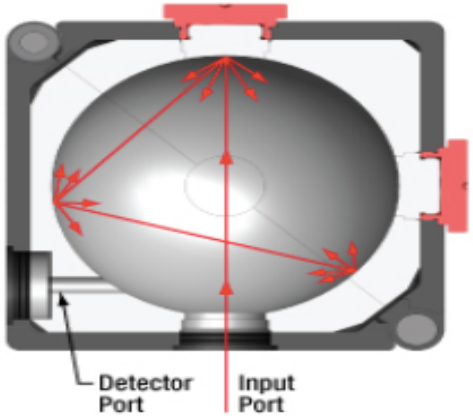
N.2 Integrating Spheres & accessories

2P4M Thorlabs 50 mm

available at Laboratory of photosensors for Astroparticle Physics
for uniform illumination of the CC EC and/or PDE and/or FS
and **photon detection efficiency (PDE)** of the EC

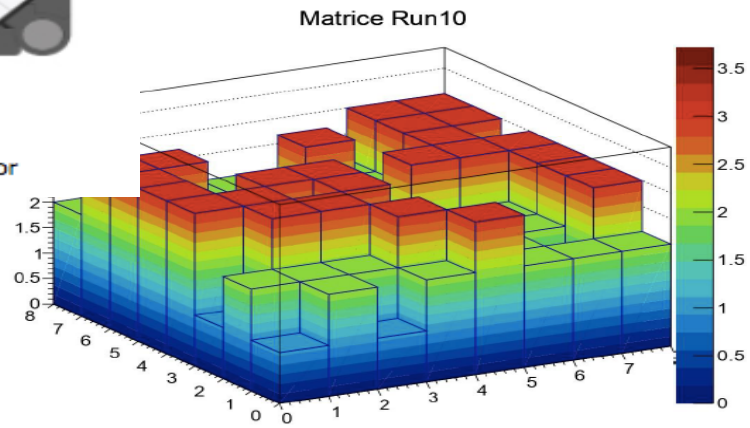


Click to Enlarge
Layout of Ports on Integrating Sphere Housing



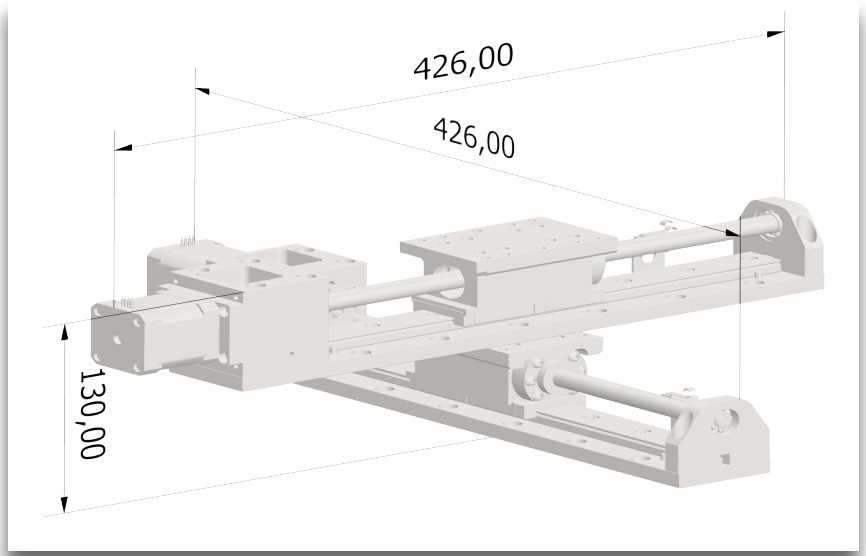
Click to Enlarge
Integrating Sphere Interior

POSSIBLE DEVELOPMENT in the set-up!

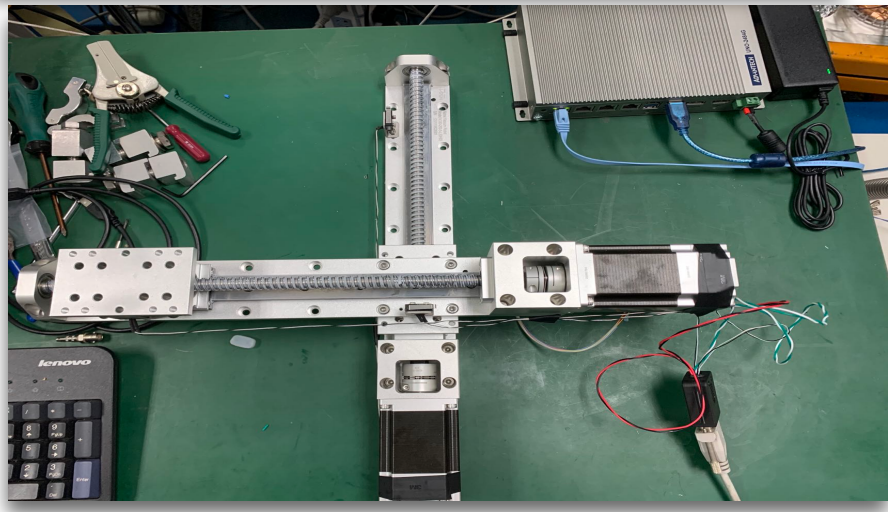


POSSIBLE DEVELOPMENT in the set-up!

STANDA XYZ translation system
426mm (X) x 426mm (Y) x 130 (Z)
operation temperature range
(-50° + 85°)
possible to be procured
for regular precise moviments in illuminating the CC



Alternatively:
Thorlabs XY Ztranslation stage
150 or 300 mm
not for lower temperatures

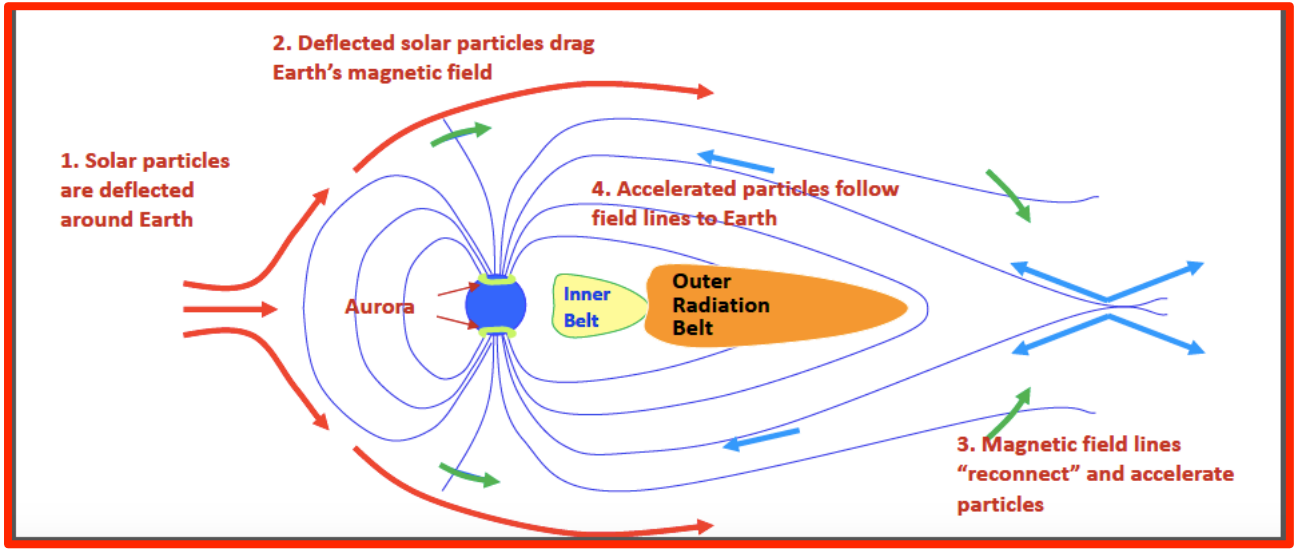


Parameter	Value
Travel range:	200 mm
Max speed:	5 mm/sec
Operation temp.:	-50 ÷ +85 C
Weight:	3 kg

Activities: b) *CME (*) solar events and U.V. Transient Luminous Events in MiniEUSO data*

involved members: R. Caruso, A. Crocco (laureanda Magistrale)

(*) CME = Coronal Mass Ejection



Sequence of Events leading to Geo-Effective CMEs

- Active Region on the Sun Erupts
  1. Solar Flare (Visible, UV, EUV, X-ray)
  2. Shock (energetic particles)
  3. Coronal Mass Ejection (particles and fields)
- Radiation reaches Earth in 8 minutes (speed of light)
- Energetic Particles reach Earth in 15 min to 24 hours
- **Coronal Mass Ejection reaches Earth in 1-4 Days**

A CME is **geo-effective** when:

- It takes place close to the solar disk center
- The source AR is located in the western side of the solar disk
- It is a Halo CME
- The magnetic field embedded in the plasma cloud has a component opposite to the Earth magnetic field.

FLOW-CHART - Data Analysis CME vs MiniEUSO

1. **Compilation of candidate geo-effective CME** events using different catalogues:
   - https://www.helcats-fp7.eu/catalogues/wp2_cat.html
   - http://www.srl.caltech.edu/ACE/ASC/DATA/level3/icmetable2.htm
   - https://wind.nasa.gov/ICME_catalog/ICME_catalog_viewer.php
   - https://helioforecast.space/arrcat
2. **determination of CME arrival time** in the Earth atmosphere in order to correlate with MiniEUSO events;
3. **determination of the CME angular width** in order to evaluate its geo-magnetic effectiveness;
3. **dowload MiniEUSO data e lista Sessioni dati utili** ("Sessions" i.e. ROOT files);

4. **comparison** between geo-effective **CME arrival time at Earth** with **data acquistion time of MiniEUSO data** in order to search for possible candidates;

6. **analysis of possible candidate files using ETOS** code searching for signature in the data (i.e. no new or strange signal) ;

7. **cross-check** by means of comparison between CME arrival time at Earth **with the DST index**;
   - https://www.ngdc.noaa.gov/stp/GEOMAG/dst.html
   - https://wdc.kugi.kyoto-u.ac.jp//dstdir/
   - https://web.archive.org/web/20120209110443/http://www.esa-spaceweather.net/swenet/login_cmd=swenet_latest_alerts

8. **further cross- check** for any evidence of significance in the **Kp index level**
   - https://www.spaceweatherlive.com/en/auroral-activity/top-50-geomagnetic-storms/year/2022.html

MiniEUSO Data Sets:

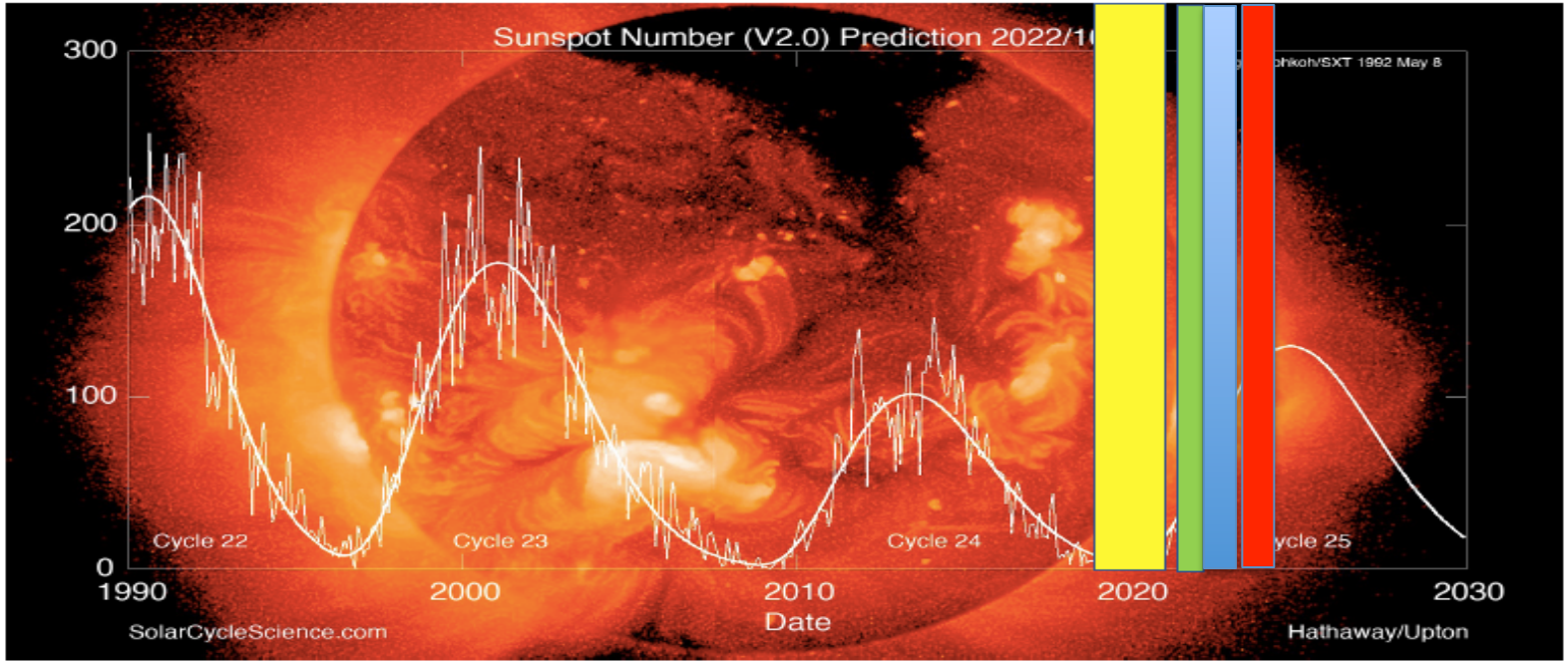
- **44 Sessions (n.1 ÷ n. 44)**
  November 6, 2019 ÷ August 12, 2021;
- **19 Sessions (n.45 ÷ n. 63)**
  November 6, 2021 ÷ August 26, 2022;
- **42 Sessions (n.64 ÷ n. 101)**
  September 30, 2022 ÷ November 28, 2023;
- **39 Sessions (n.102 ÷ n. 141)**
  December 21, 2023 ÷ January 2, 2025;

A) Possible CME candidates in MiniEUSO Sessions **(n.1 ÷ n. 114):**
- **June 24, 2020**
- **June 29, 2020**
- **February 3, 2022**
- **July 3, 2022**

RESULTS: NO CORRELATION!

B) 4 CME candidates in MiniEUSO Sessions **(n.115 ÷ n. 141)**
RESULTS: CORRELATION NOT EXCLUDED!
Cross checks ongoing

The first Mini-Euso dataset was acquired during the phase of minimum of solar activity (Nov 2019 – Aug 2021), indicated by the yellow box.
The second dataset was acquired during the growing phase of Cycle 25 (Nov 2021 – Aug 2022), indicated by the green box.



The third dataset was acquired during the more growing phase of Cycle 25 (Sep 2022 – Nov 2023) indicated by the blue box.
The fourth dataset was acquired during the maximum phase of Cycle 25 (Dec 2024 – Jan 2025) indicated by the

INAF - IASF Palermo
ISTITUTO DI ASTROFISICA SPAZIALE E FISICA COSMICA DI PALERMO

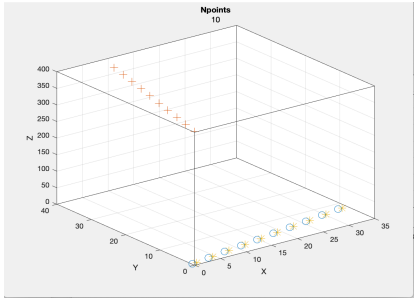
Activity in Palermo (Associated to Catania)

Involved members: A.Anzalone, A.Pagliaro

Mini-EUSO Data Analysis:

3D reconstruction of meteor trajectory

- Test of the computer vision method on the real meteor data

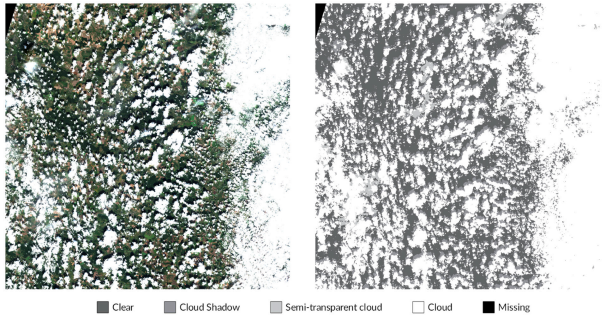


Cloud Masking:

“Application of Machine and Deep Learning methods for Cloud Mask Retrieval: a review”

Invited Review Paper in preparation for Applied Sciences Journal, Special issue

"Hardware-Aware Deep Learning"



Pubblicazioni JEM-EUSO (MiniEUSO, SPB2, POEMMA) luglio 2024/luglio 2025 = N.3

- **EUSO-SPB1 mission and science**
  JEM-EUSO Collaboration *Astropart.Phys.* **154** (2024) 102891

- ***EUSO-Offline: A comprehensive simulation and analysis framework***
  JEM-EUSO Collaboration *JINST* 19 (2024) 01, P01007

- ***Overview of the JEM-EUSO Program, R.Caruso for the JEM-EUSO Collaboration***

PoS(UHECR2024)060 - Proceeding of Science March 2025 DOI:10.22323/1.484.0060

Presentazioni a Conferenze&Congressi luglio 2024/luglio 2025

- **R. Caruso** *on behalf of the JEM-EUSO Collaboration*

Talk: "Overview of the JEM-EUSO Program"

UHECR 2025 (7th International Symposium on Ultra High Energy Cosmic Rays)

Malargue, ARGENTINA dal 17 al 21 NOVEMBRE 2024

- **R. Caruso** *on behalf of the ASI_EUSO-SPB2 Project*

***Poster:* "Study of performances and characterization of SiPMs (Hamamatsu S13161-3050AE -08) for the next generation of telescopes in balloon-borne & space-based experiments"**

ASAPP 2025 (Advances in Space AstroParticle Physics – Second Edition)

Saint Feliu de Guixols (Girona) , SPAGNA dal 12 al 16 MAGGIO 2025

- **R. Caruso** *on behalf of the PBR Collaboration*

***Poster:* "The test and calibration system for the SiPM arrays of the Cherenkov Camera for the PBR Mission"**

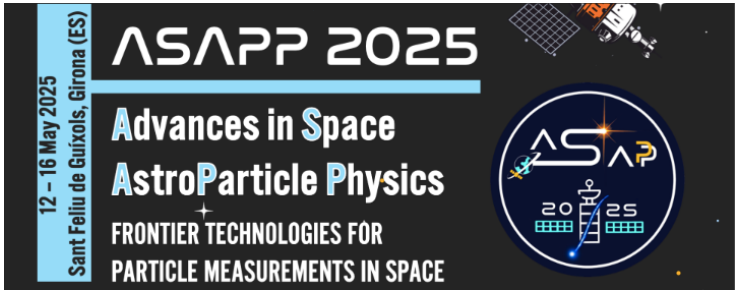
ICRC2025 (39th International Cosmic Ray Conference)

(Ginevra, SVIZZERA) dal 14 al 25 LUGLIO 2025

- **R. Caruso** *on behalf of the JEM-EUSO Collaboration*

***Relazione su Invito:* "Il Programma JEM-EUSO"**

SIF 2025 (111° Congresso Nazionale)– PALERMO (Italia) dal 22 al 26 SETTEMBRE 2026



PREVENTIVI 2026 – ANAGRAFICA sigla SPB2- INFN-CT

RICERCATORI

			%
1.	Anzalone Anna	Ric. INAF/IASF PA	50
2.	Del Popolo Antonino	Ric. Univ. UniCT	30
3.	Caruso Rossella	Prof. Ass. UniCT (Resp.locale)	40
4.	Pagliaro Antonio	Ric. INAF/IASF PA	50
5.	Petta Catia	Prof. Ass. UniCT	20

TOTALE: 5 unità **<FTE/persone> = 0.4** **FTE TOT. 1.9**

SERVIZI

Servizi ELETTRONICA 2 MESI UOMO

Planning attività 2026

- **Responsabilità internazionale: "Test & Calibration Elementary Cell units for PBR Cherenkov Camera" per la missione PBR (lancio 2027)": Rossella Caruso**

- **Il Laboratorio di R&D SiPMs di Catania (postazione SPB2 presso "Laboratorio di fotorivelatori per la Fisica Astroparticellare" – Sezione INFN di Catania & DFA-UniCT) diviene SITO di CALIBRAZIONE e TEST della Camera Cherenkov per la missione PBR nel 2027 per l'intera Collaborazione internazionale PBR: previsti turni di misura e test da parte di altri gruppi italiani ed esteri.**

- **Test, calibrazione e caratterizzazione delle singole Elementary Cell (EC) della Superficie Focale della Camera Cherenkov IN SEDE e presso i siti di assemblaggio e integrazione elettronica di NAPOLI e ROMA2 e di caratterizzazione in condizioni realistiche di volo presso il TurLab di TORINO**

- **Monitoraggio atmosferico, cloud imaging, analisi dati traiettorie meteore, etc.**
- **Analisi dati CME solari e ricerca di Eventi Transienti Luminosi nei dati di MiniEUSO e di SPB2 per ottimizzazione rapporto segnale/rumore e trigger Telescopi di Fluorescenza e Cherenkov.**