Riunione Gruppo 2 – Preventivi 2024

20 Giugno 2023

JEM-EUSO Program

Extreme Universe Space Observatory

Sigla SPB2

Gruppo 2 - Sezione di Catania

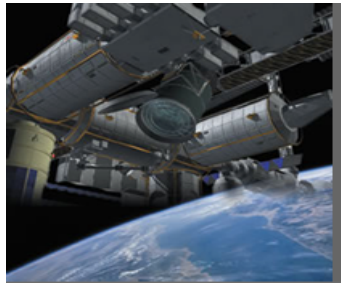
PREVENTIVI 2024

Responsabile locale: Rossella Caruso
Dipartimento di Fisica e Astronomia “Ettore Majorana”
Università degli Studi di Catania
INFN – Sezione di CATANIA

Commissione Scientifica Nazionale 2
Fisica Astroparticellare

OGGI

4 linee scientifiche



JEM-EUSO Program

Extreme Universe Space Observatory

https://jemeuso.org

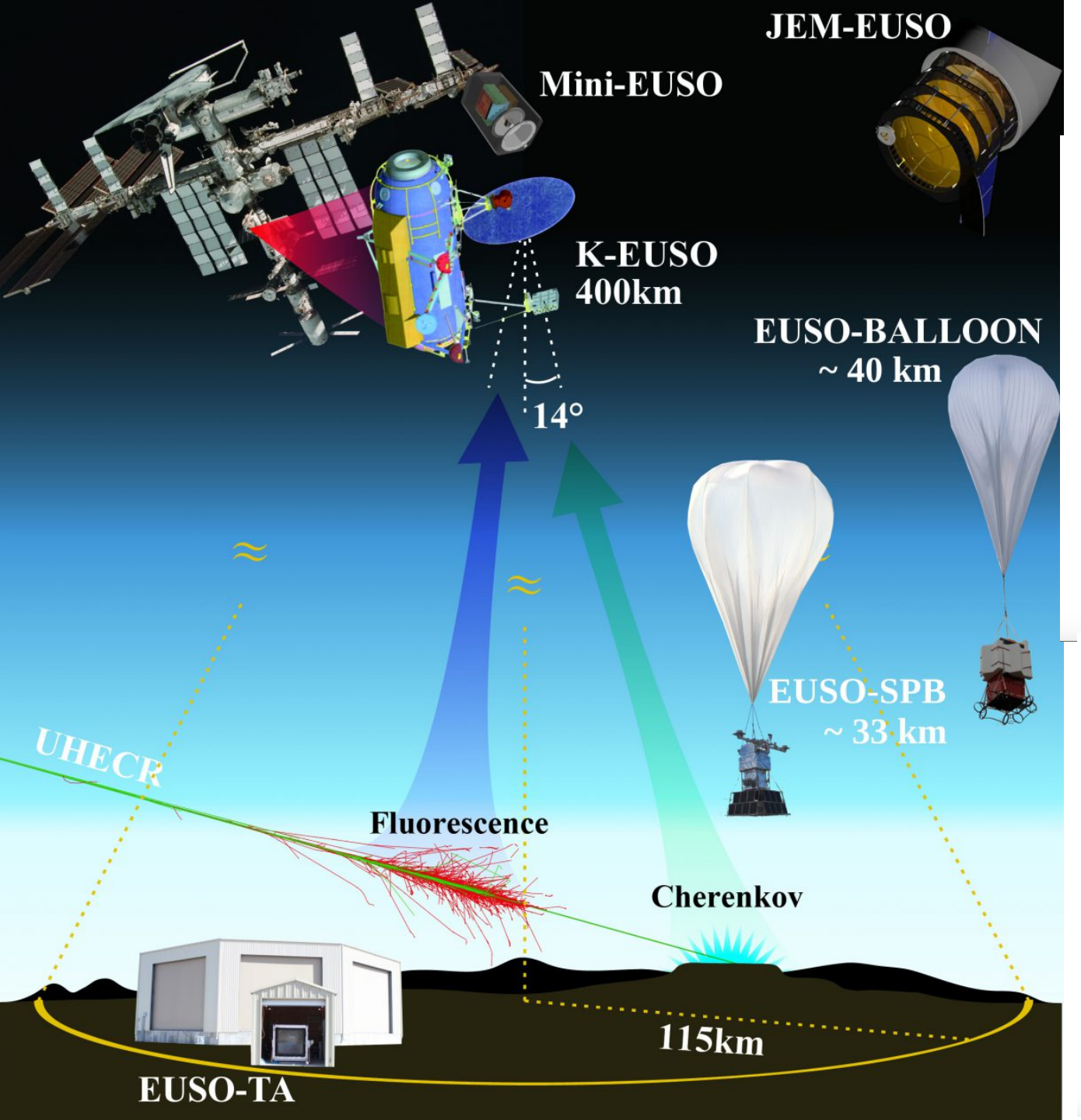
LINEA 2: Radiazione dall'Universo
(raggi cosmici, neutrini, fotoni)
SPB2, AUGER, CTA, KM3

LINEA 1: Fisica del Neutrino
(masse, oscillazioni, ββ, etc.)
ICARUS, JUNO

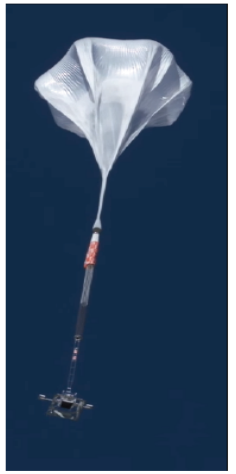
LINEA 3: L'Universo Oscuro
(materia oscura e energia oscura)
DARKSIDE

LINEA 4: Onde gravitazionali, Fisica Generale e Quantistica

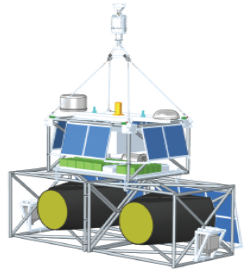
INFN Istituto Nazionale di Fisica Nucleare



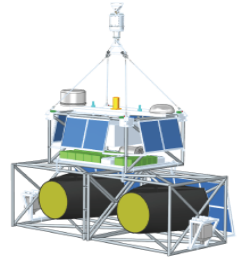
Attività SPB2 (Super Pressure Balloon 2)



Proposta di partecipazione italiana alla missione NASA SPB2 Super Pressure Balloon-2



Il Gruppo Italiano proponente



Torino Univ. e INFN (M. Bertaina)
Roma Tor Vergata Univ. e INFN (M. Casolino)
INFN Laboratori Nazionali Frascati (M. Ricci)
Napoli Univ. e INFN (G. Osteria)
Bari Univ. e INFN (F. Cafagna)
Catania Univ. e INFN + gruppo assoc. INAF Palermo (R. Caruso)

La Collaborazione Internazionale

USA e NASA (MSFC)
Francia
Giappone
Polonia
Russia
Svezia
Slovacchia

EUSO-SPB2

Extreme Universe Space Observatory on NASA Super Pressure Balloon

Altitude of ~ 33km, from Wanaka, NZ around the Southern Ocean

EUSO-SPB2 objectives:

1. FT observe **1st extensive air showers with fluorescence** from suborbital space;

2. CT observe **Cherenkov light from extensive air showers** initiated by cosmic rays;

3. CT measure the **background for the detection of neutrino** induced upward going air showers

4. CT **search for neutrinos from astrophysical transient** events (binary neutron star mergers…)

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

"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

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- Roma Tor Vergata, Torino e Laboratori Nazionali di Frascati;
- Università di Catania, Università di Napoli "Federico II", Università di Torino

ASSEGNAZIONI 2023 – Anagrafica sigla SPB2- INFN-CT

ANAGRAFICA

RICERCATORI		%
1. Anzalone Anna	Ric. INAF/IASF PA	50
2. Caruso Rossella	Prof. Ass. UniCT (Resp.locale)	40
3. Lombardo Claudio	Dottorando	20
4. Pagliaro Antonio	Ric. INAF/IASF PA	40
5. Persiani Rino	RTDA-UniCT	30
6. Petta Catia	Prof. Ass. UniCT	30

TOTALE: 6 unità **FTE TOT. 2.1**

SERVIZI

Servizi ELETTRONICA (G.Saccà, F. Fichera, M.D'Andrea)

TOTALE: 3 mesi uomo **FTE TOT. 0.3**

UNIVERSITÀ degli STUDI di CATANIA

Dipartimento di Fisica e Astronomia "Ettore Majorana"

INFN CATANIA
Istituto Nazionale di Fisica Nucleare
Sezione di Catania

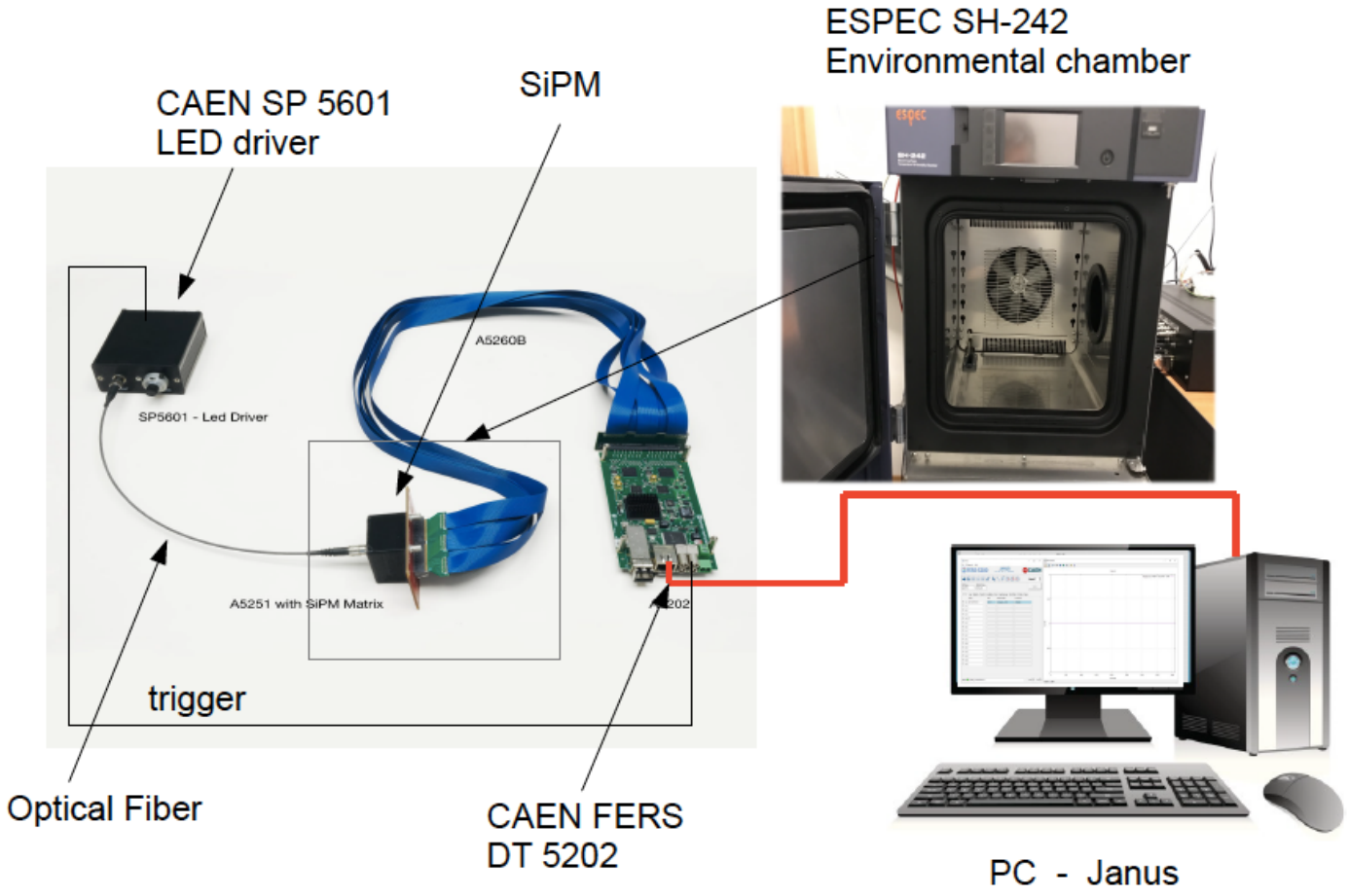
Activities: a) R&D on SiPMs for the SPB2 mission

Involved members: **Rossella Caruso, C.Lombardo, C.Petta, R. Persiani, G.Saccà, F. Tortorici**

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

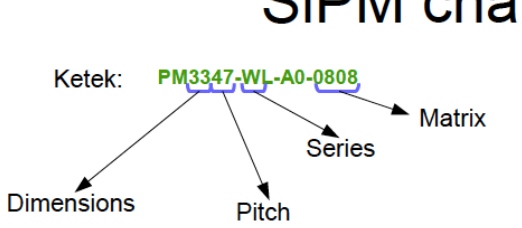
SiPM characterized

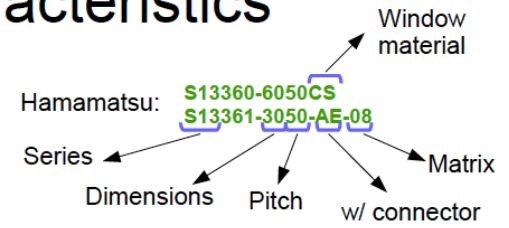
SenSL:
ARRAYJ 30035 16P PCB
ARRAYC 60035 64P PCB
MICROFC 10010 SMT TR1
MICROFC 30035 SMT TR1
MICROFC 60035 SMT TR1
MICROFC SMA 10010 GEVB
MICROFC SMA 30035 GEVB
MICROFC SMA 60035 GEVB
MICROFC SMTPA 10010 GEVB
MICROFC SMTPA 60035 GEVB

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

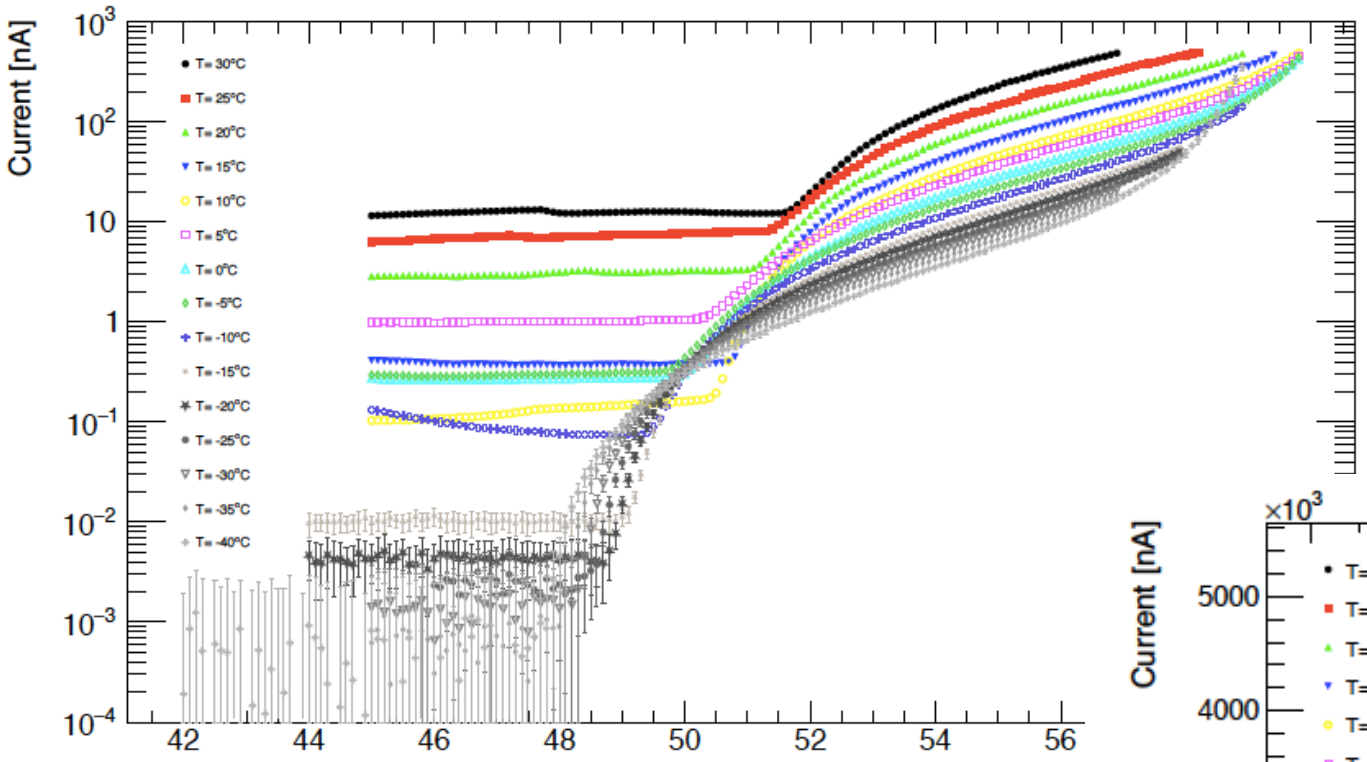
Operating temperature: -20 °C / 60 °C

Spectral response range: 320 – 900 nm (270 – 900 nm for HPK with CS option)

Peak sensitivity wavelength: 450 nm

	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

I-V curve in reverse bias and forward bias at different temperatures



igure 4: Reverse-bias I-V curves acquired at different temperatur

- I-V curves at different temperature
- Automated fit procedure to extract V_{bd}
- Measurement of single curve: 1 hour
- Temperature dependance of Vbd:
  - HPK: 55 mV/°C
  - Ketek: 29 mV/°C

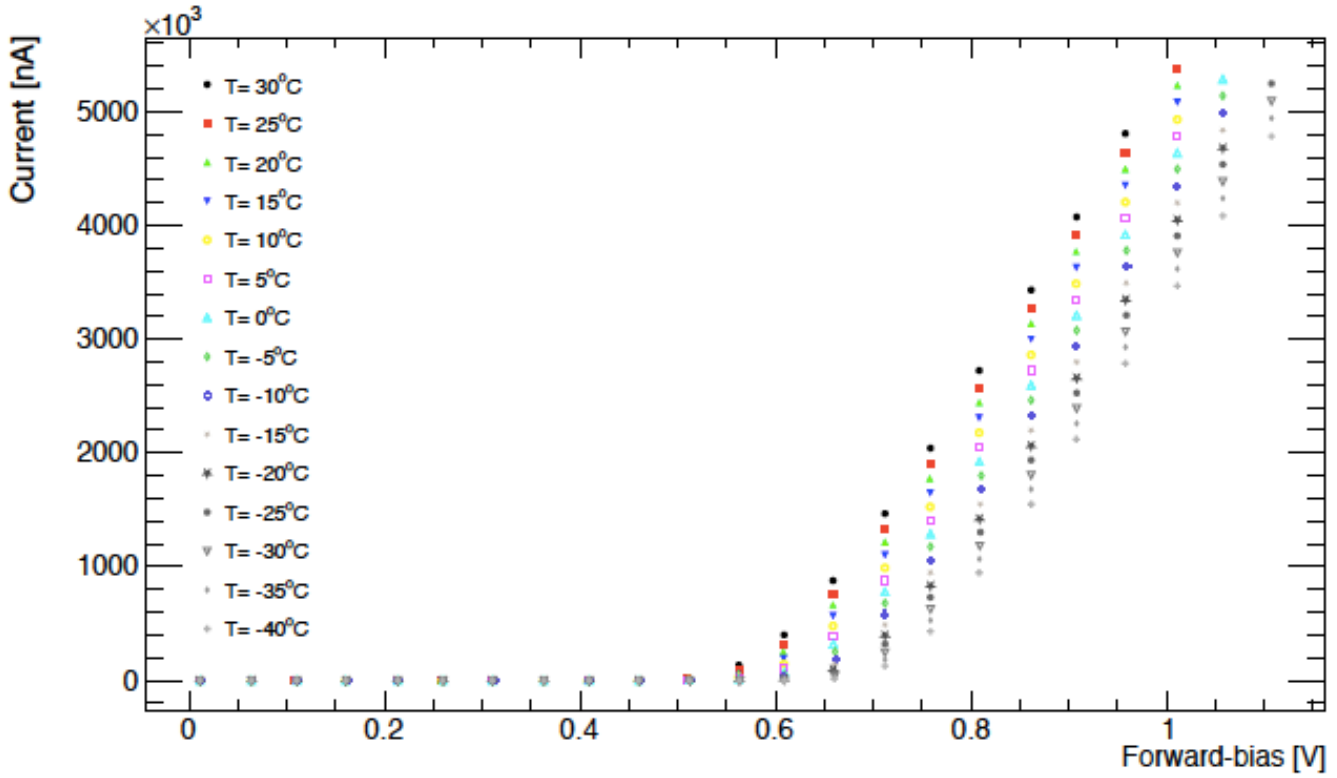
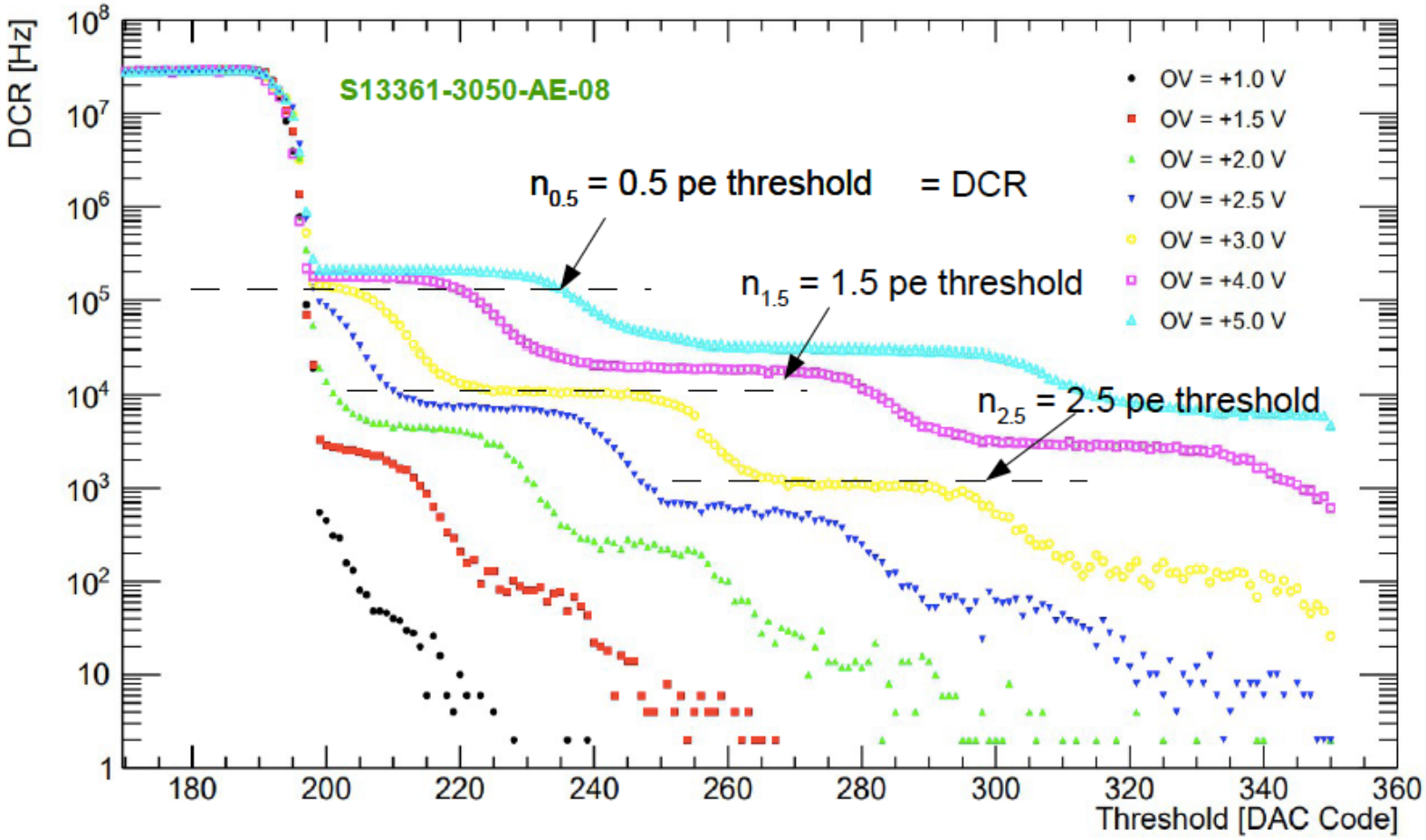


Figure 7: Forward-bias I-V curves acquired at different temperatures. The errors depen

Staricase - DCR(V_{ov})



- Staircases are well defined for matrices
- Automatic fit to extract the step height
- DCR = $N_{0.5}$

- DCR decreases with decreasing temperature
- Both matrices has the lowest DCR
- The decreas is important for both matrices

Conclusions

- Developped a laboratory for SiPM characterization:
  - Physical setup
  - Software development (LabView)
  - Analysis tools (almost automated)

- Characterization of HPK S13361-3050 matrix 8x8 → Paper accepted today on NIM A

- Characterization and test of 4 single channel SiPM (2 from HPK and 2 from ketek)

- Characteirzation and test of ketek SiPM matrix 8x8
  - breakdown voltage
  - quenching resistance
  - Gain
  - DCR
  - PCT

- KETEK SiPMs are less dependent by temperature variations and show a smaller power consumption.

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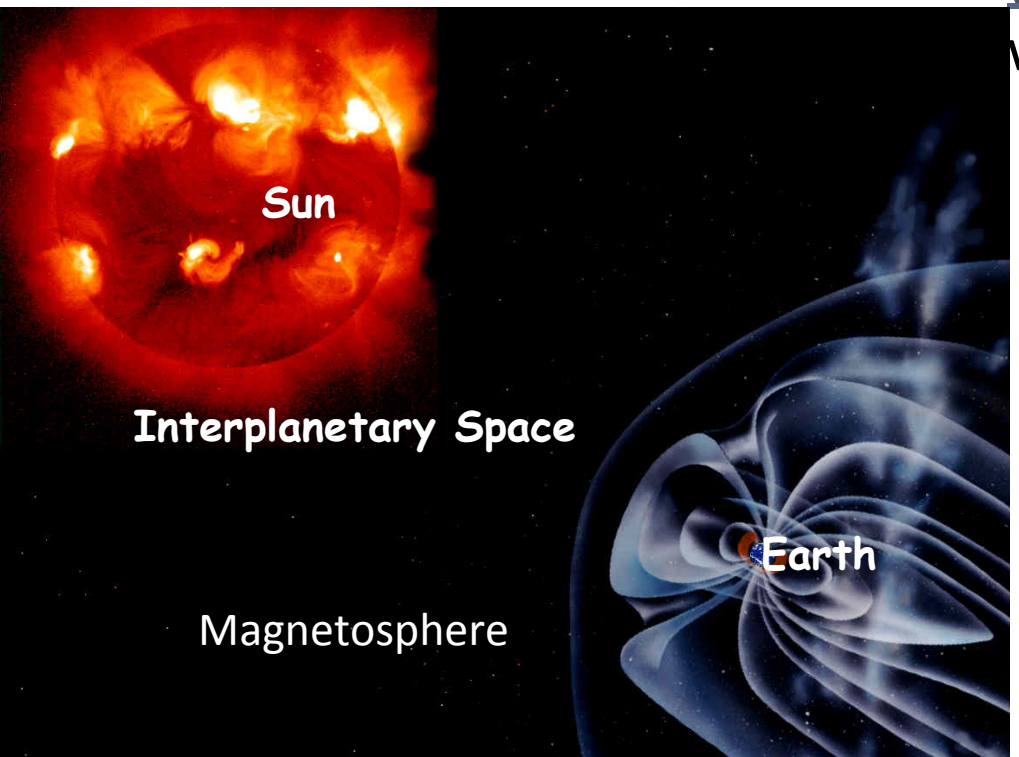
Activities b):

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

involved members: F. Zuccarello



(*) CME (Coronal Mass Ejection): A disturbance in the solar wind caused by an eruption on the Sun.

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

Focus on the possible detection of transient events related to solar activity phenomena (CMEs) in the framework of Space Weather.

First step: build-up of a list of geo-effective CMEs using different catalogues available on the web:

- 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

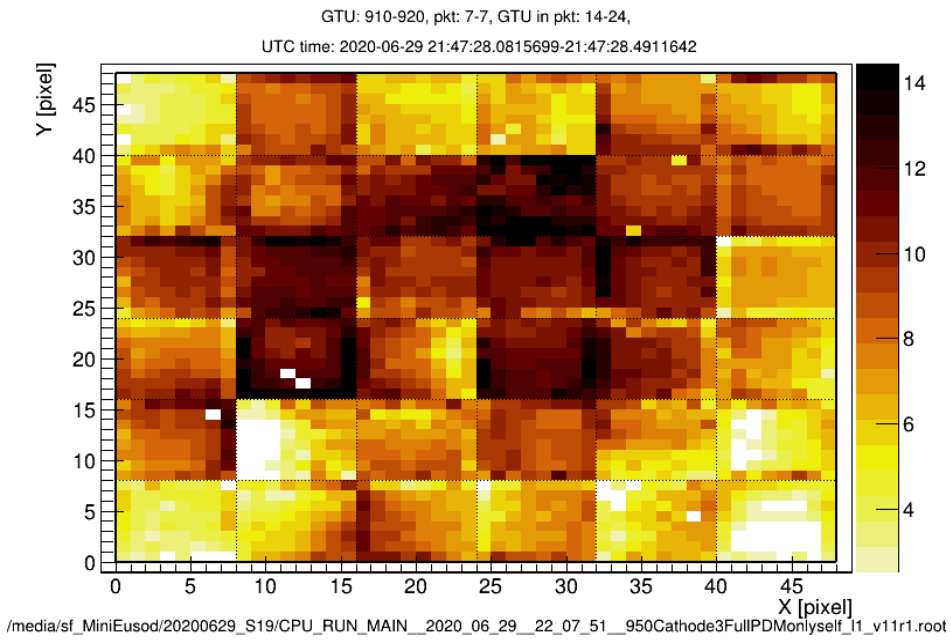
#	id	sc	target_name	sse_launch_time	target_arrival_time
199	HCME_A__20200126_01	A	Earth_L1	2020-01-25T21:26Z	2020-01-31T05:01Z
190	HCME_A__20200303_01	A	Earth_L1	2020-03-02T21:42Z	2020-03-10T04:15Z
186	HCME_A__20200304_01	A	Earth_L1	2020-03-04T04:23Z	2020-03-12T02:48Z
180	HCME_A__20200415_01	A	Earth_L1	2020-04-15T06:28Z	2020-04-20T09:45Z
175	HCME_A__20200427_01	A	Earth_L1	2020-04-27T13:06Z	2020-05-01T18:57Z
165	HCME_A__20200623_01	A	Earth_L1	2020-06-22T18:33Z	2020-06-29T07:31Z
153	HCME_A__20200725_01	A	Earth_L1	2020-07-25T07:35Z	2020-08-05T18:33Z
151	HCME_A__20200810_01	A	Earth_L1	2020-08-11T01:03Z	2020-08-17T14:58Z
147	HCME_A__20200830_01	A	Earth_L1	2020-08-29T22:04Z	2020-09-01T16:43Z
143	HCME_A__20200830_02	A	Earth_L1	2020-08-30T05:48Z	2020-09-08T02:33Z
138	HCME_A__20200916_01	A	Earth_L1	2020-09-16T07:21Z	2020-09-25T06:06Z
137	HCME_A__20200930_01	A	Earth_L1	2020-09-30T10:21Z	2020-10-06T02:25Z
131	HCME_A__20201010_01	A	Earth_L1	2020-10-09T23:05Z	2020-10-16T10:56Z
127	HCME_A__20201018_01	A	Earth_L1	2020-10-18T09:58Z	2020-10-22T20:17Z
116	HCME_A__20201129_01	A	Earth_L1	2020-11-29T11:12Z	2020-12-03T07:05Z

Second step: comparison between the geo-effective CMEs arrival time at Earth and the time of data acquisition by the Mini-Euso experiment. Two datasets found in the list of Mini-Euso Session:

- June 24, 2020
- June 29, 2020

Thirth step: 19 new sessions of MiniEUSO data (November 6th, 2021 - August 26°, 2023) under analysis

RESULTS: despite the detailed analysis performed, no signature of a CME was identified so far.



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

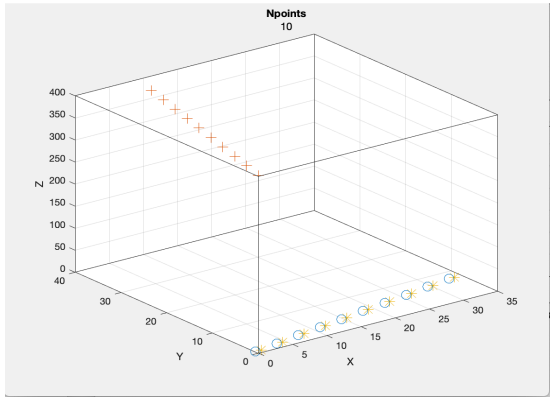
Activity in Palermo (Associated to Catania)

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

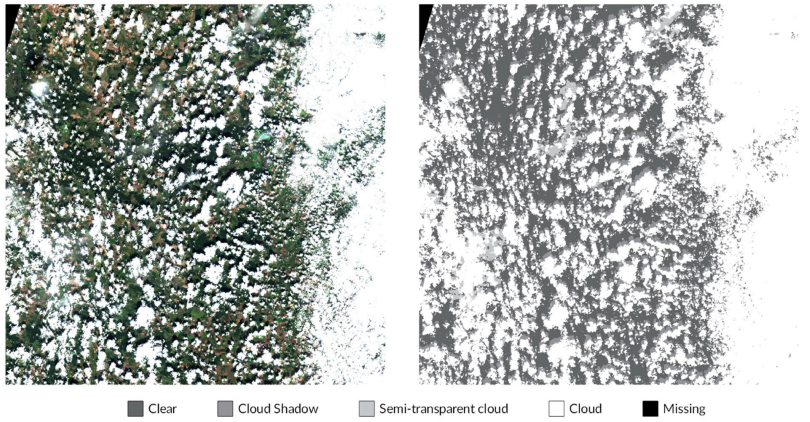


Cloud Masking:

“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"



Lancio di SPB2 – 13 maggio 2023

Base **NASA-CSBF** (Columbia Scientific Balloon Facility) **@ Wanaka – Nuova Zelanda** in grado di raggiungere **30 km** s.lm. e **100 giorni** di durata

durata effettiva **36 ore!!**

Agenzia Spaziale Italiana

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PER

NEWS!! A dicembre 2022 →RINNOVO per 2 ANNI fino al 2025!

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We are a strong, efficient and resilient collaboration!

Efficient:

EUSO-Balloon
EUSO-TA
EUSO-SPB1
MINI-EUSO
EUSO-SPB2
+TUS

Not a single failure !!!

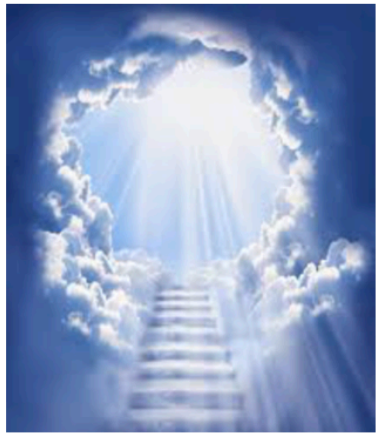
+ our technology is used in other projects…

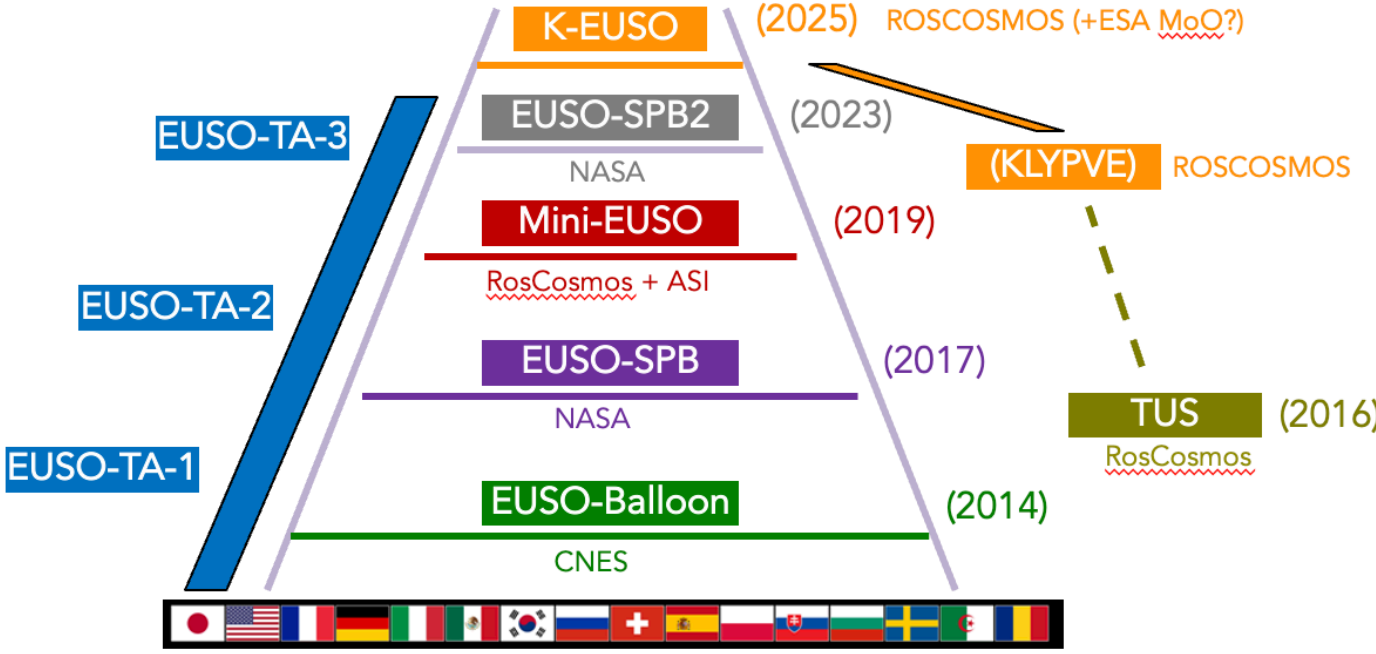
Strong: 33rd Collaboration meeting!

Strong together and credible together!

The JEM-EUSO collaboration delivers!

Stairway to heaven!





SBP3: possibile lancio NASA 2026

Goal: 2026

Fluorescence camera + Cherenkov camera

Same telescope

Tiltable, from 0°to 90°

Fluorescence: CR showers (nadir+inclined) + High-altitude CRs showers (tilted)

Cherenkov: CRs + neutrinos (tilted) [+ anitons (nadir)]

Optics: same design, maybe larger + bifocal only for CT to be studied

A lot of simulations needed to figure out what can really be seen + the optimum pointing strategy

Auxiliary devices: IR, Radio, gamma-ray, X-ray, SQM

TASK Italia: realizzazione integrale del Telescopio di Fluorescenza? +?

The future is bright!

TASK Catania:

- **realizzazione superficie focale del Telecopio di Fluorescenza? SiPMs? per INFN**
- **realizzazione rivelatori ancillari (gamma-ay, X-ray, SQM) per ASI**

PREVENTIVI 2024 – Anagrafica sigla SPB2- INFN-CT

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4. Pagliaro Antonio	**Ric. INAF/IASF PA**	**40**
5. Petta Catia	**Prof. Ass. UniCT**	**30**

TOTALE: 5 unità **FTE TOT. 1.8**

SERVIZI

Servizi ELETTRONICA (G.Saccà, F. Fichera, M.D'Andrea)

TOTALE: 3 mesi uomo **FTE TOT. 0.3**