Extreme Universe Space Observatory

JEM-EUSO
Osservazione dei Raggi Cosmici di altissima energia (UHECR) dallo Spazio

M. Bertaina – Consiglio di Sezione INFN
30 Giugno 2016

Marco ha gia' scritto il codice VHDL per il trigger di EUSO-Balloon/SPB e **sta scrivendo quello per MINI-EUSO**.
Saranno necessarie interazioni, limature del codice, test al TurLab.
Il supporto di Marco e' fondamentale perche' il tutto venga inserito correttamente e funzioni come previsto.

INFN Torino ha il ruolo CHIAVE nel volo di EUSO-SPB (e' il nostro trigger che permettera' di rivelare EAS!) e nel lancio di MINI-EUSO.

Il numero di mesi richiesto rimane limitato perche' siamo gia' avanti con il lavoro

M. Mignone 2 mesi

DOMANDA DI UTILIZZO DEI SERVIZI DI BASE

Data della richiesta: 16.06.2016

Lab. Tecnologico	Lab. Elettronica	Centro di Calcolo
	✓	

nuova richiesta	
richiesta di continuazione	✓

Esperimento: JEM-EUSO_RD

Responsabile locale: M. Bertaina

Responsabile dell'attivita': M. Bertaina

Descrizione dettagliata dell'attivita' richiesta

L'ASI ha approvato MINI-EUSO come esperimento che dovra' essere lanciato durante la missione di Nespoli sulla ISS nella seconda meta' del 2017. L'INFN di Torino e' responsabile dello sviluppo della logica di trigger di primo livello per MINI-EUSO. Marco Mignone ha gia' imbastito una prima versione della logica di trigger in VHDL, durante la rimanente parte di quest'anno dovra' essere completata la scrittura. Nel 2017 si prevedono test ed eventuali ottimizzazioni del codice in funzione delle risorse disponibili a livello di FPGA. Si richiede pertanto il supporto di Marco per tali ottimizzazioni, essendo lui l'autore del codice.

PLANNING													MILESTONES	
Subattivita'	G	F	M	A	M	G	L	A	S	O	N	D	Data-mese	Descrizione
Trigger MINI-E			✓	✓										

Tecnici e tecnologi attualmente assegnati all'attivita'					Richieste di supporto tecnico per		
INFN		ALTRI ENTI				l'anno:	
Nome	mesi/U	Ente	Nome	mesi/U	Tipologia	N.	mesi/U
M.Mignone	2				Tecnici mecc. /elettr/CdC	1	2
					Disegnatori meccanici		
					Microsaldatori		
					Tecnologi progett. mecc.		
					Tecnologi elettronici/CdC		
					Tecnologi microelettronica		

Note:

Summary of the (JEM)-EUSO program

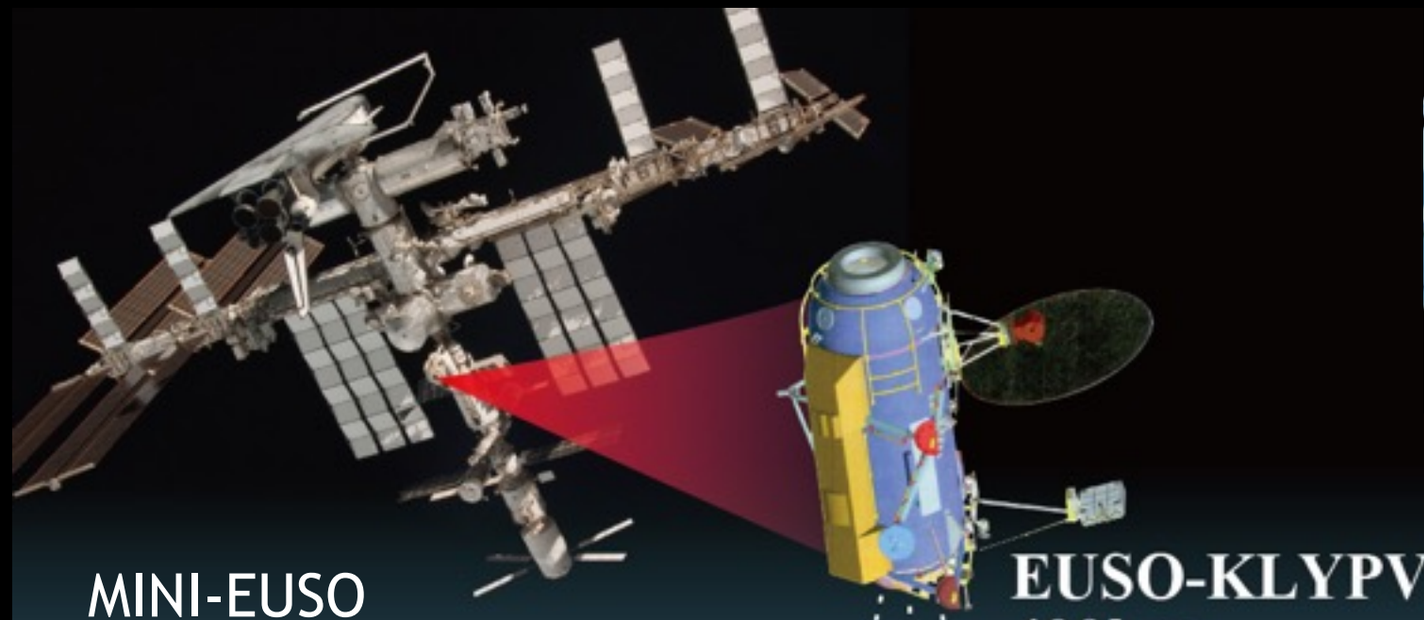
1. **EUSO-TA: Ground detector at Telescope Array site: 2013-**

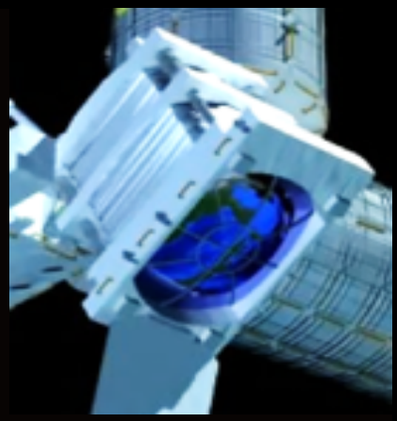
2. **EUSO-BALLOON: 1st flight Timmins, Canada (CNES) Aug 2014; Ultra long duration flight (EUSO-SPB) New Zealand, 2017**

3. **MINI-EUSO (2017)**

4. **K-EUSO (2019)**

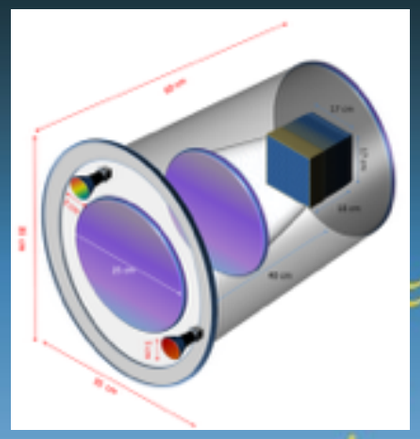
5. **JEM-EUSO (>2020+)**





JEM-EUSO

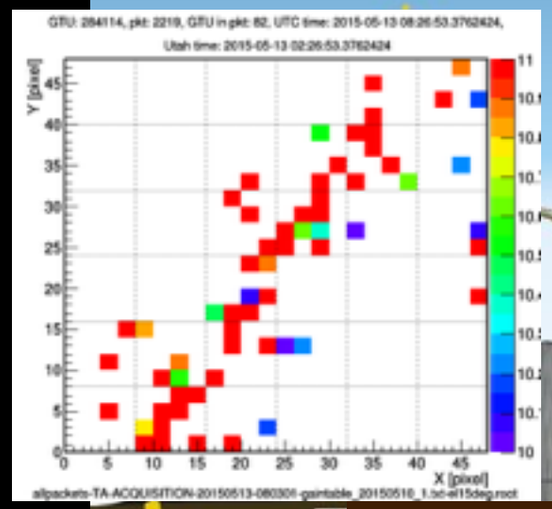
MINI-EUSO



EUSO-KLYPVE
400km

14º

EUSO-BALLOON
(2014)
40km



Fluorescence

Atmosphere

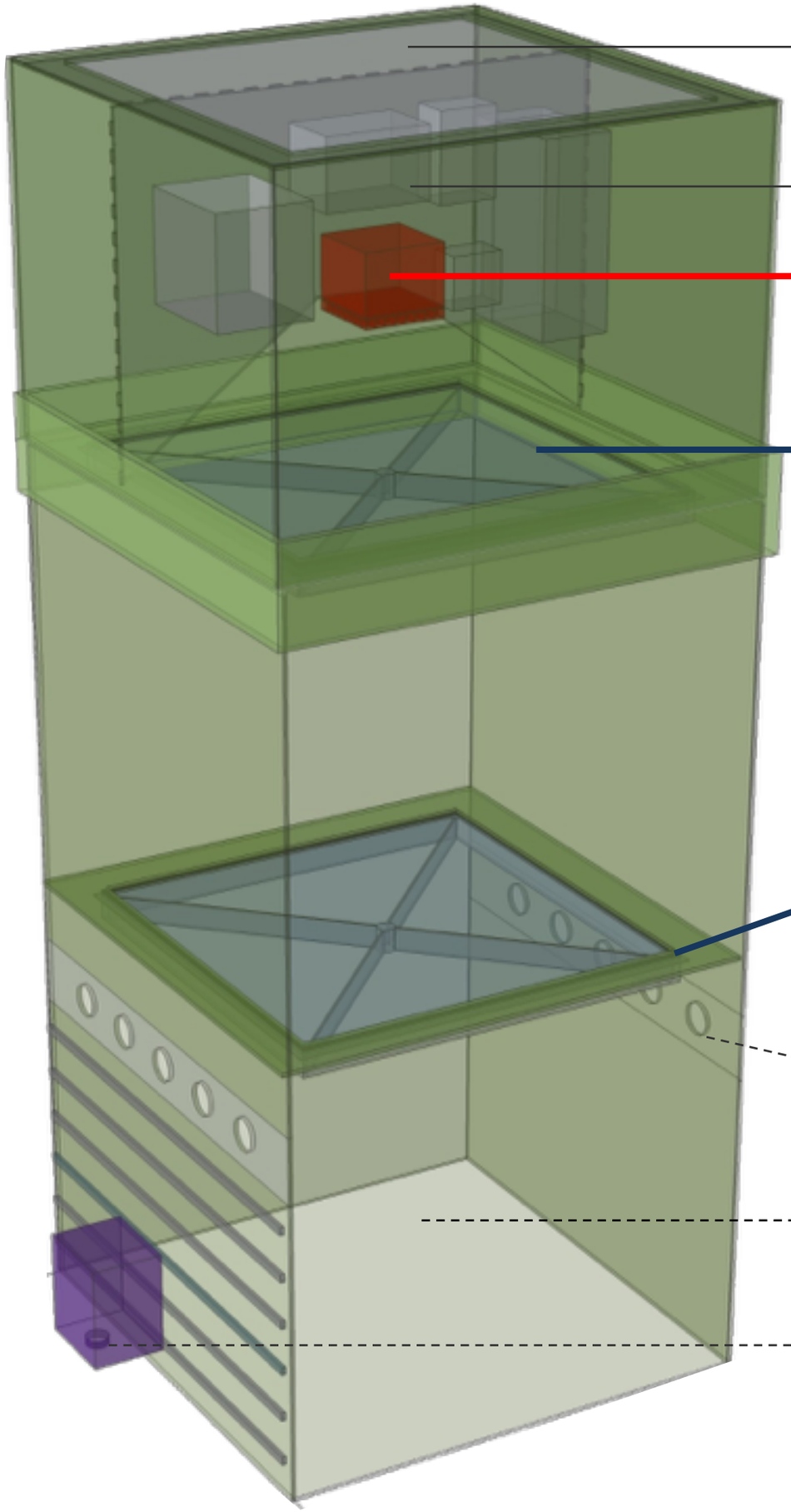
Cherenkov

EUSO-TA (2013-)

100km

instrument booth

optical bench



radiator

electronics (DP)
on "dry shelf"

PDM

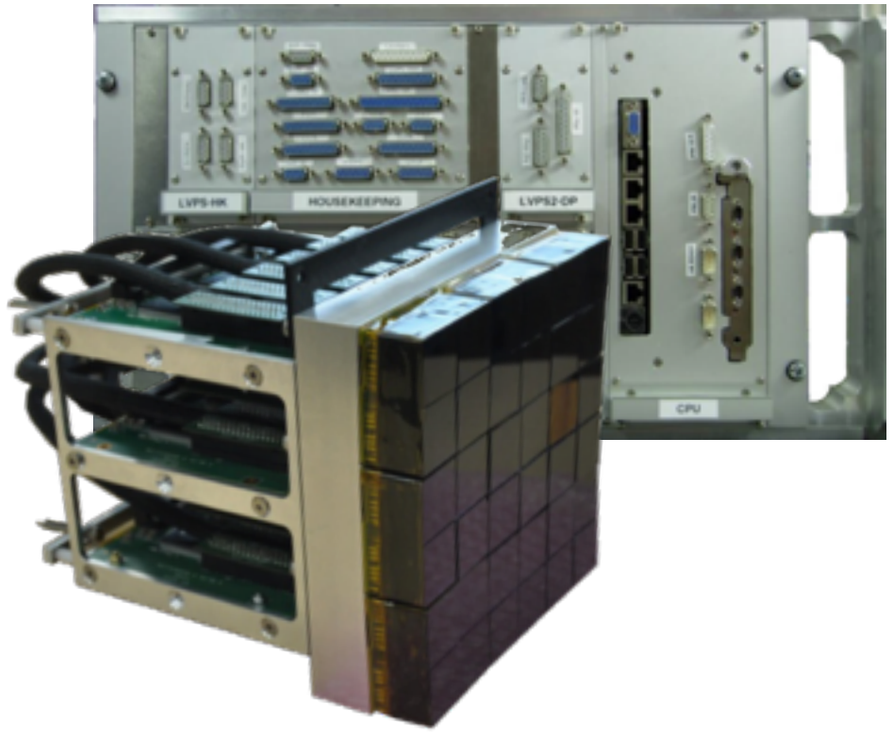
Fresnel lens L3
fixed/tight

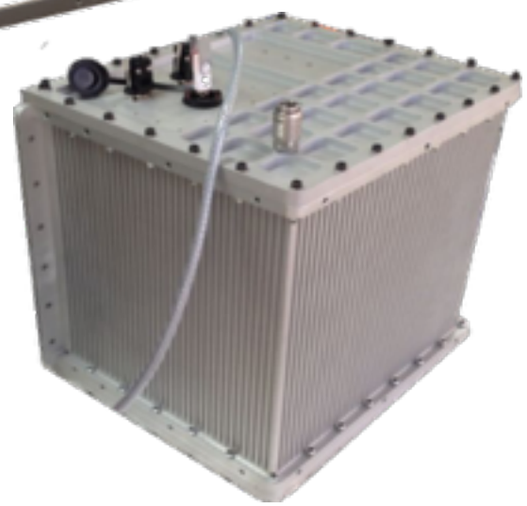
Fresnel lens L1
adjustable

evacuation holes

Baffle &
"deceleration cylinder"

IR Camera





EUSO@Turlab

Implementation2: light sources, materials, DAQ & monitoring

PMT_C with BG3 filter connected to ASIC_D

bkg by "Super-LED" lamp

moss

pure water

Cloud with LED below

Meteor

glass with LED

bricks

glass

sand

ARDUINO

DCPS for bkg S-LED, 36V/0.624A (max)

Oscilloscope moniotor probe FSU

PC with LabView & ROOT

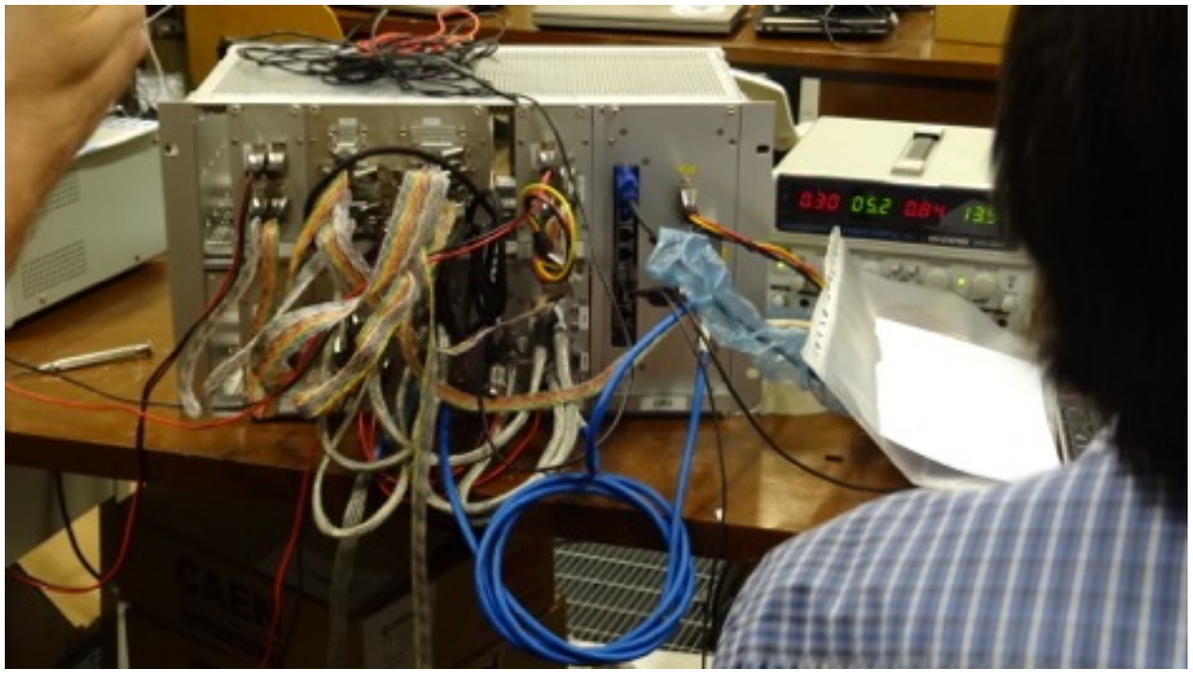
DCPS for test_ec_asic

Func. Gen. for LEDs and meteor, and lightning afterward

July - August 2015

PDM: test L1 trigger (INFN-Torino)

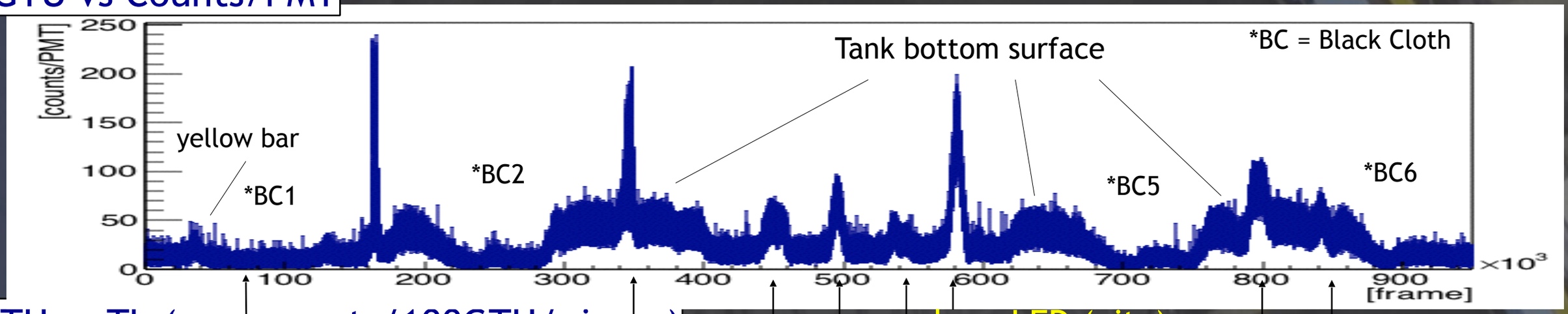
Data Processor



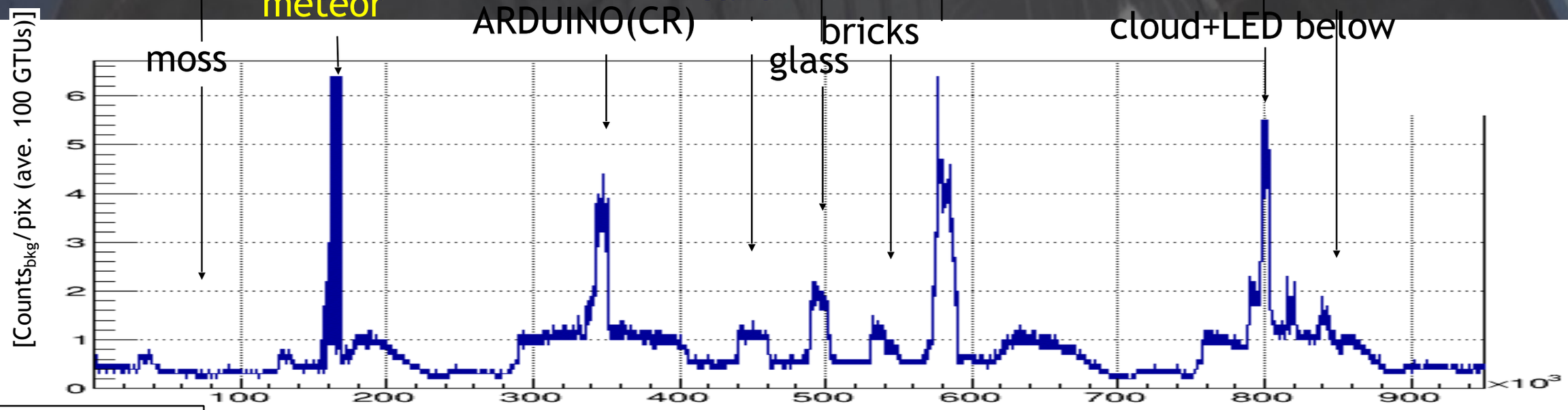
PDM + DP on the ceiling

Bkg & L1 Trigger during the rotation (9m15s)

GTU vs Counts/PMT



GTU vs Th (ave. counts/100GTU/pix$_{peak}$)



GTU vs

Triggered mainly ARDUINO-CR events and first part of meteor!!

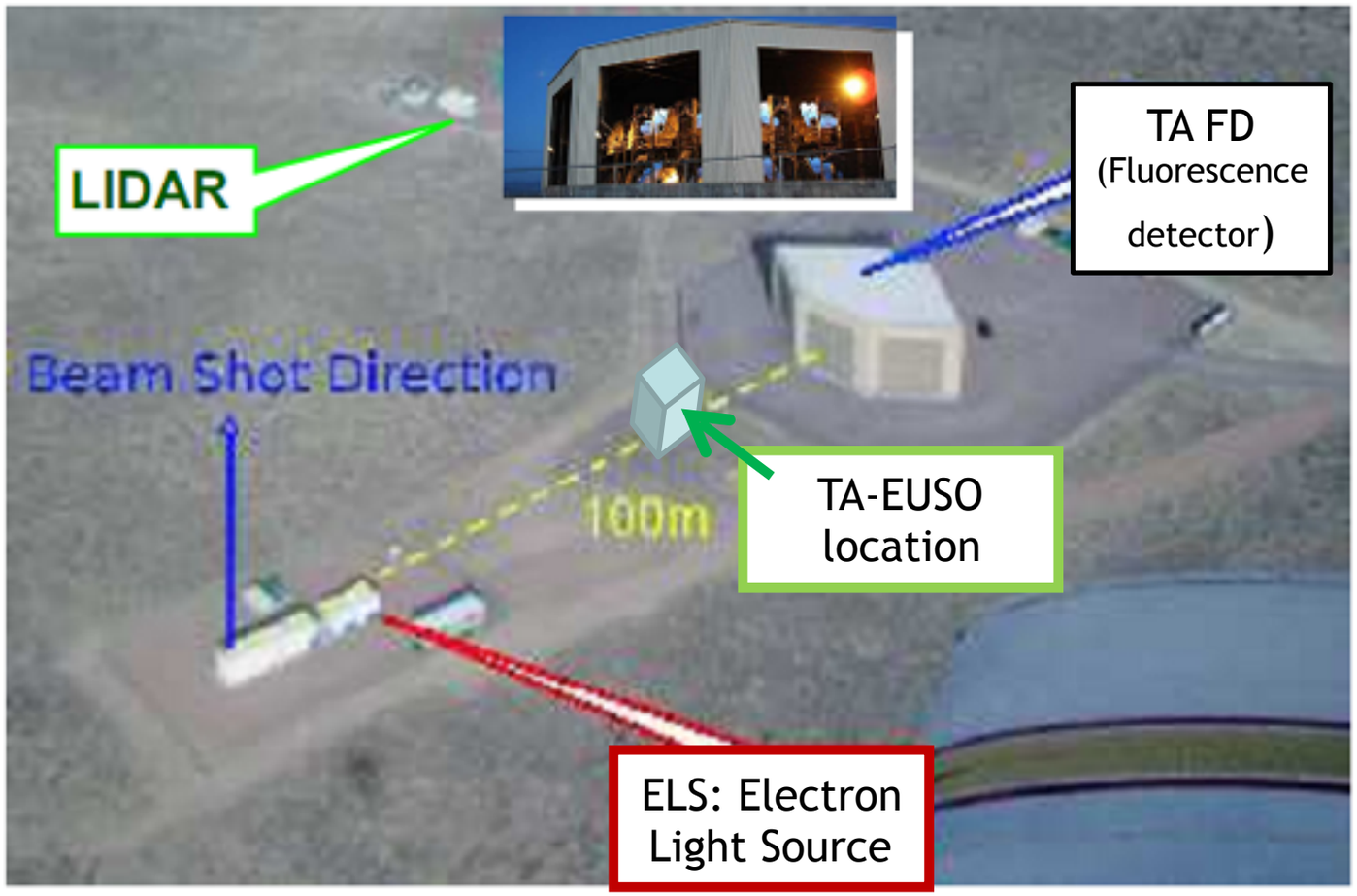
Trigger logic by M. Mignone

Pathfinders: EUSO-TA

EUSO-TA: *Cross-Calibration tests at the Telescope Array site* in Utah in collaboration with the ICRR in Tokyo and the TA collaboration

EUSO-TA is currently successfully operating taking a wealth of data

TA site, UTAH, Black Mesa



located at Black Rock Mesa FD Station

- *Electron Light Source at 100m*
- *Most nearby SD is at ~3.5 km*
- *Central Laser Facility ~21km*

TA-EUSO in Utah

Telescope mechanics M. Marengo, B. Giraudo, F. Borotto

Trigger test

@ TA -EUSO

F. Fenu & H. Miyamoto

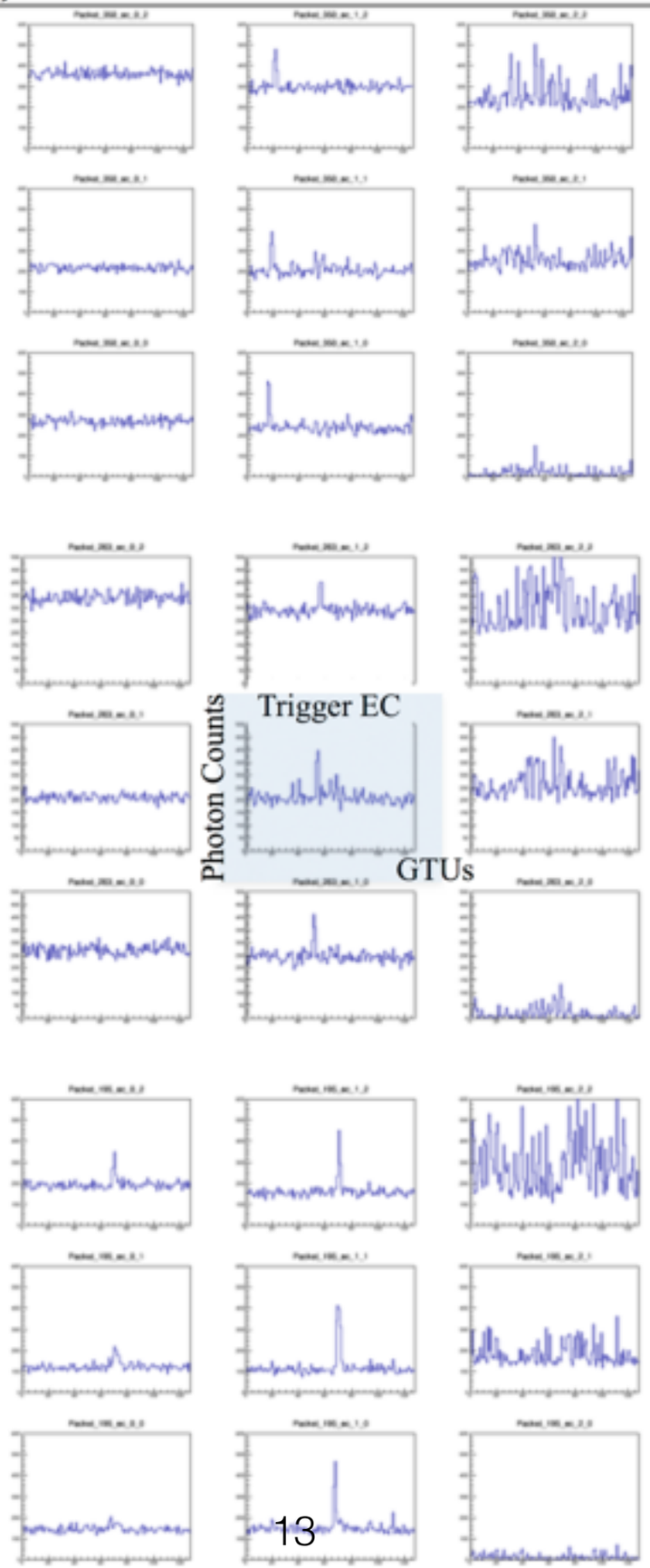
Test results in EUSO-TA site, USA

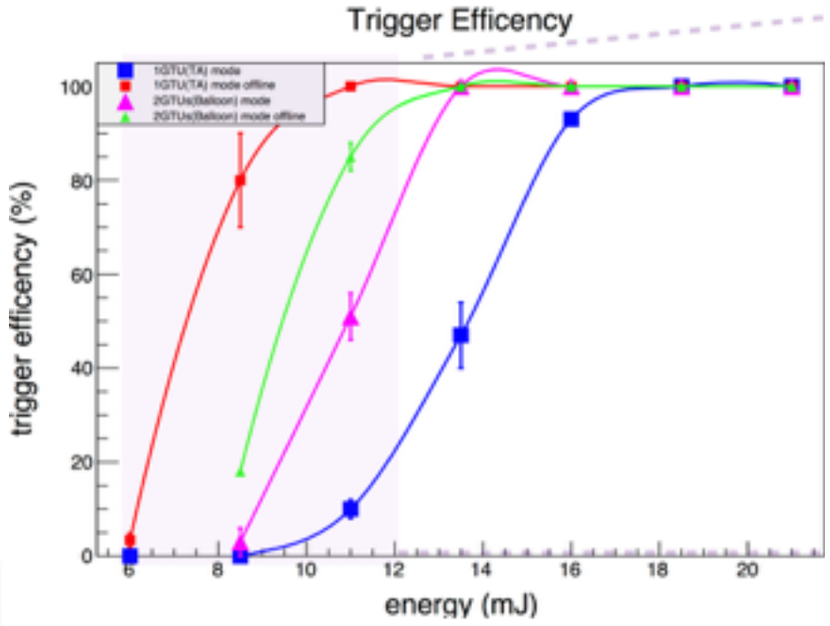
Trigger logic by M. Mignone

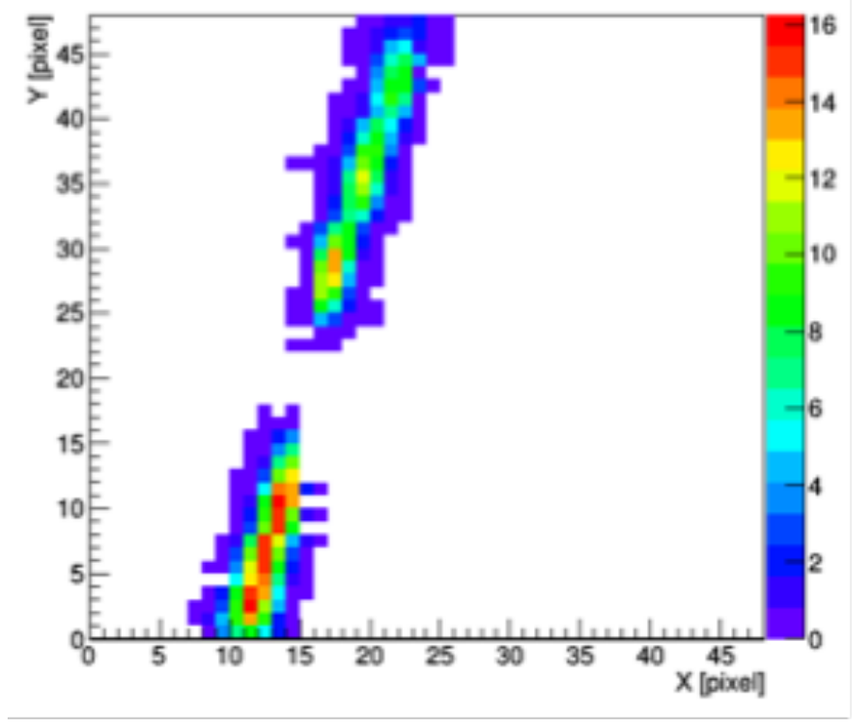
External GPS trigger
trigged from EUSO balloon laser.
Signal position: **~20**GTUs

L1 trigger
trigged from CLF laser (TA laser). (or EUSO balloon laser)
Signal position: **~53**GTUs

External TA trigger
trigged from CLF laser.
Signal position: **~70**GTUs



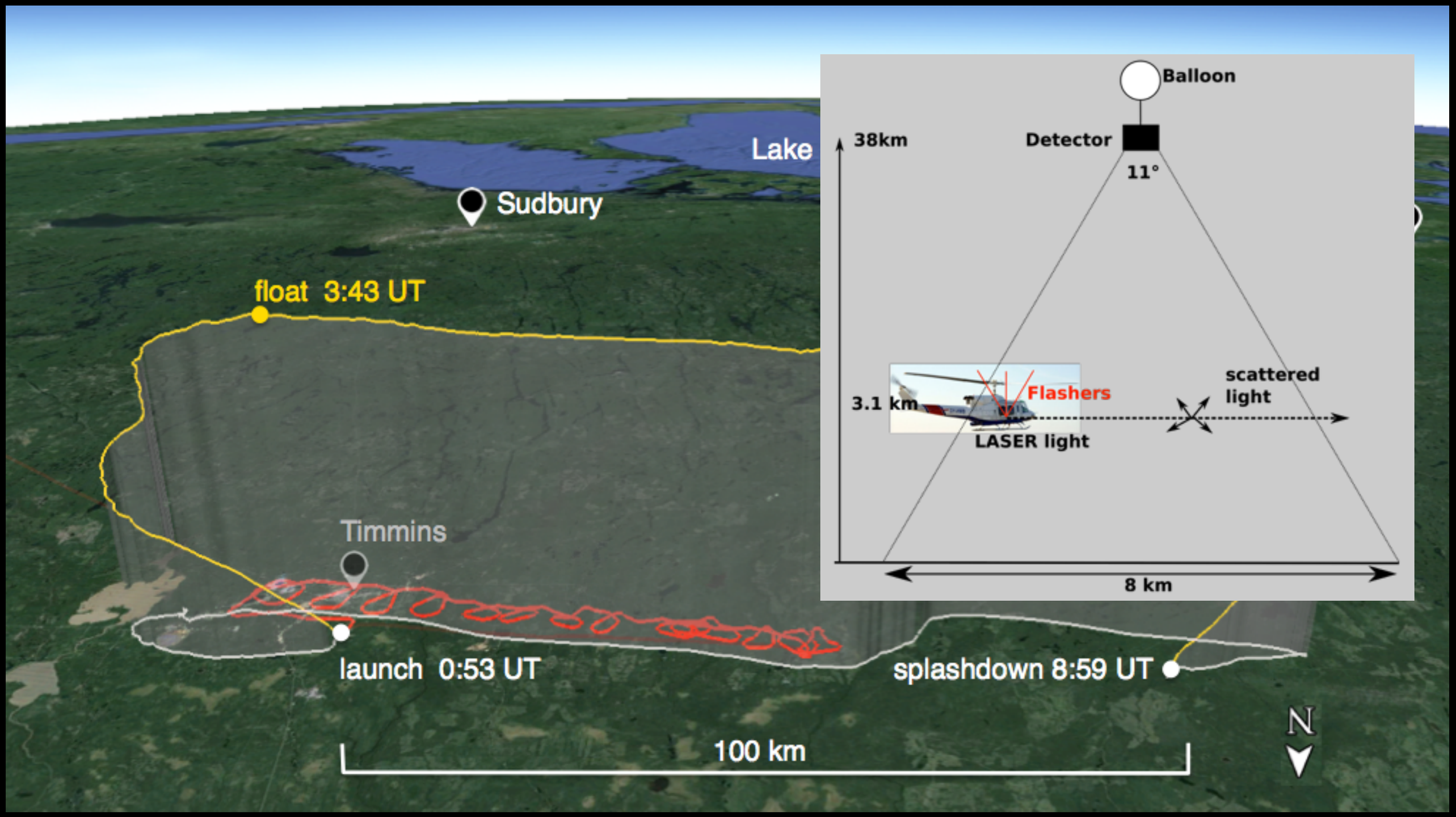




1st EUSO-Balloon flight (August 25th 2014 Timmins, Ontario)

CNES (agenzia spaziale francese)

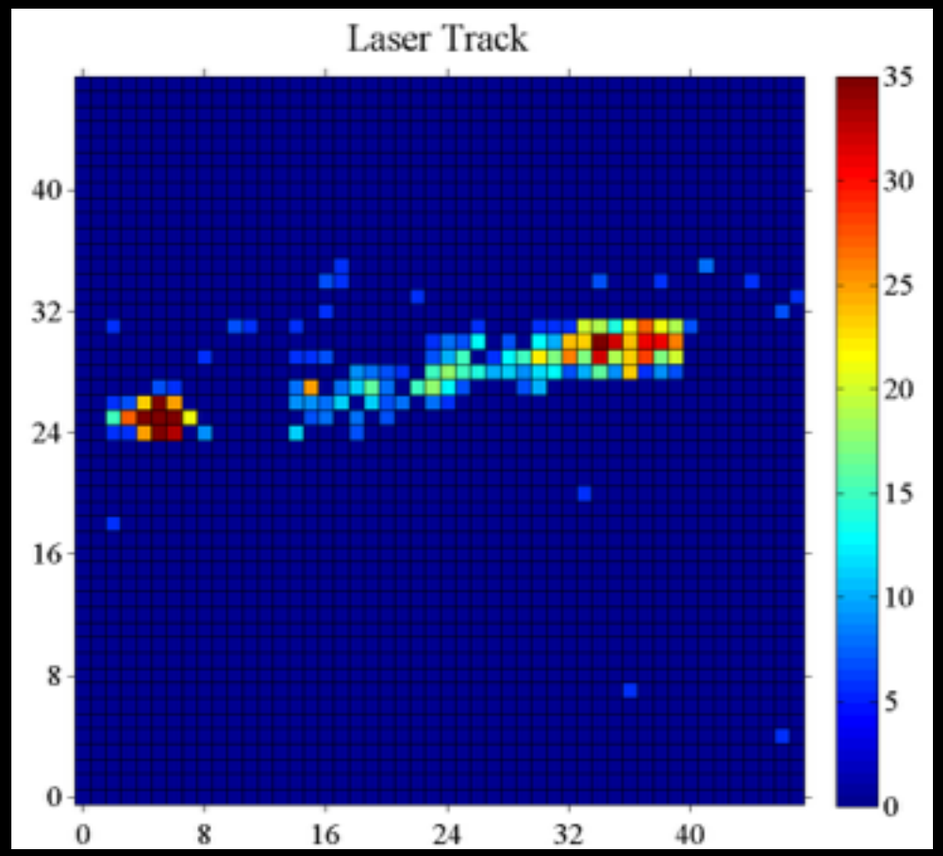
Artificial tracks! (supported by NASA)



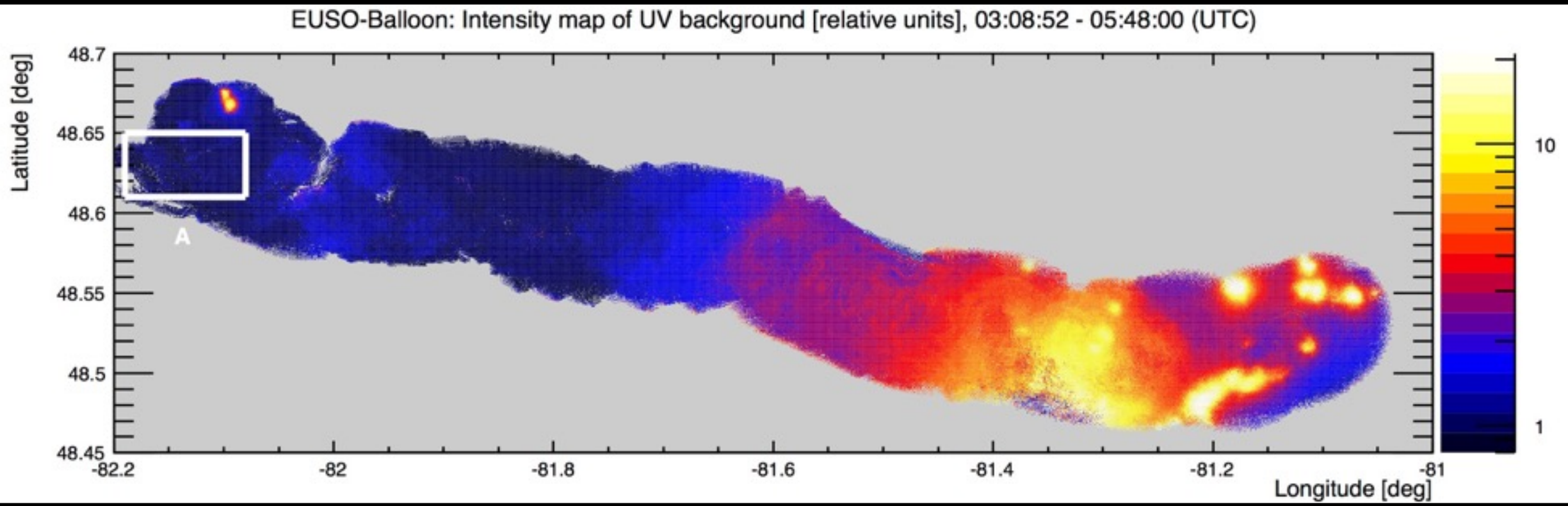
EUSO-Balloon: was *launched on August, 24 2014 from Timmins, (Canada)*

Main results of EUSO-Balloon

Laser track



UV intensity map



EUSO-SPB Extreme Universe Space Observatory on a Super Pressure Balloon

Successful PIC (Project Initiation Conference)
March 11, 2016 at Wallops Flight Center
OK to go for flight in Spring 2017 Campaign from Wanaka, NZ

COSI payload flight
start May 16, 2016
Up for 34 days

Expected flight duration:
>1 month
(it could last longer…)

GOAL: First EAS observation
from space with Cherenkov albedo on clouds

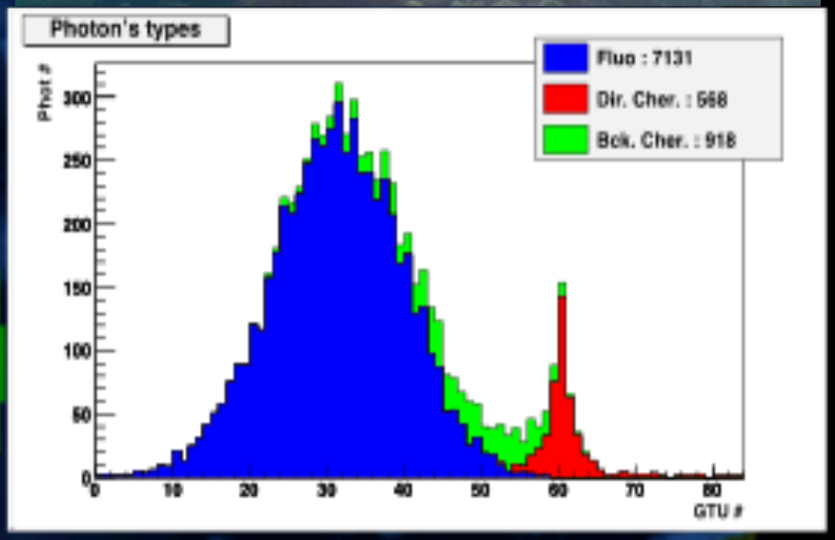
EUSO-SPB

Successful F

Marc

OK to g

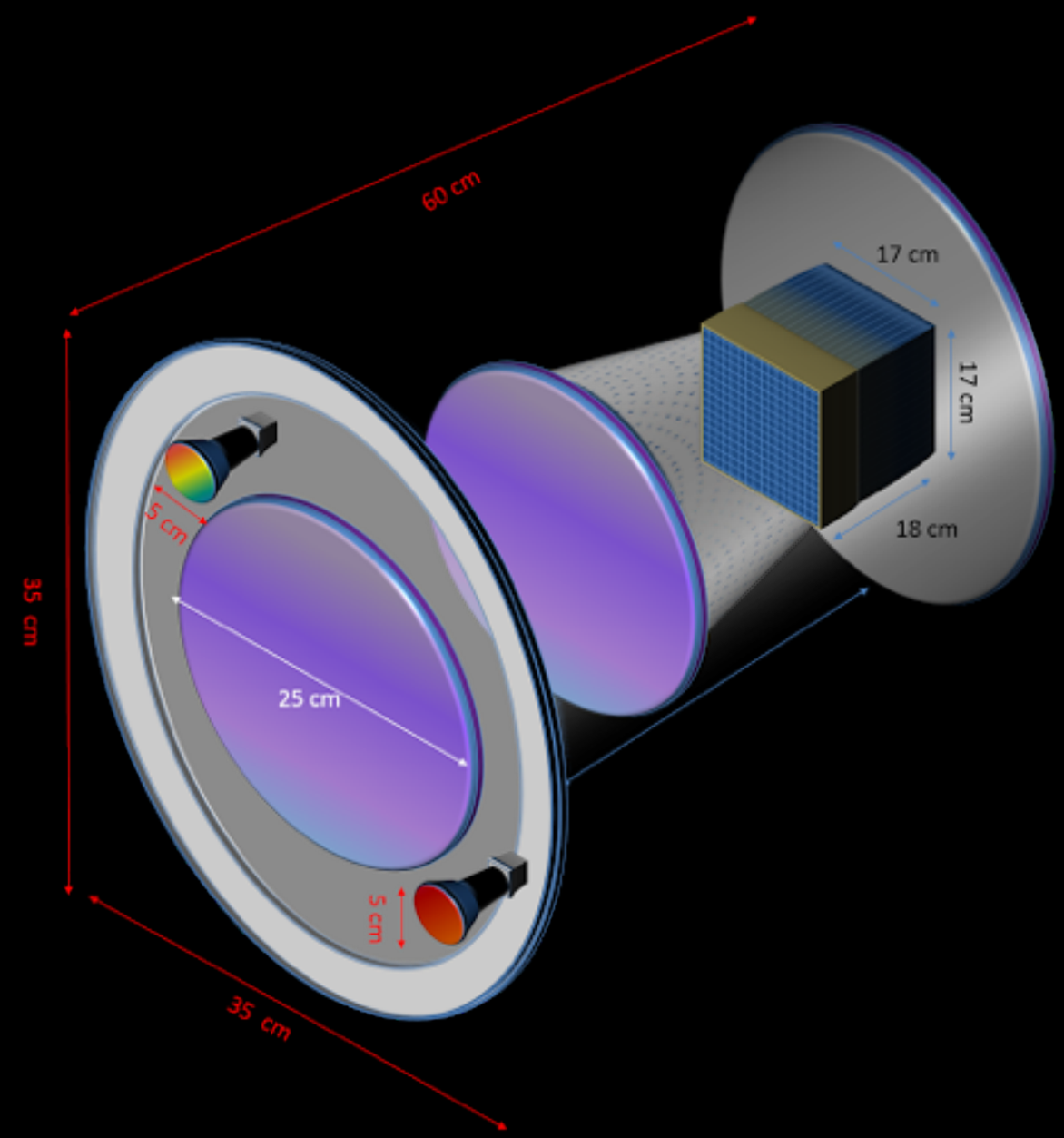
43 giorni al 29/6



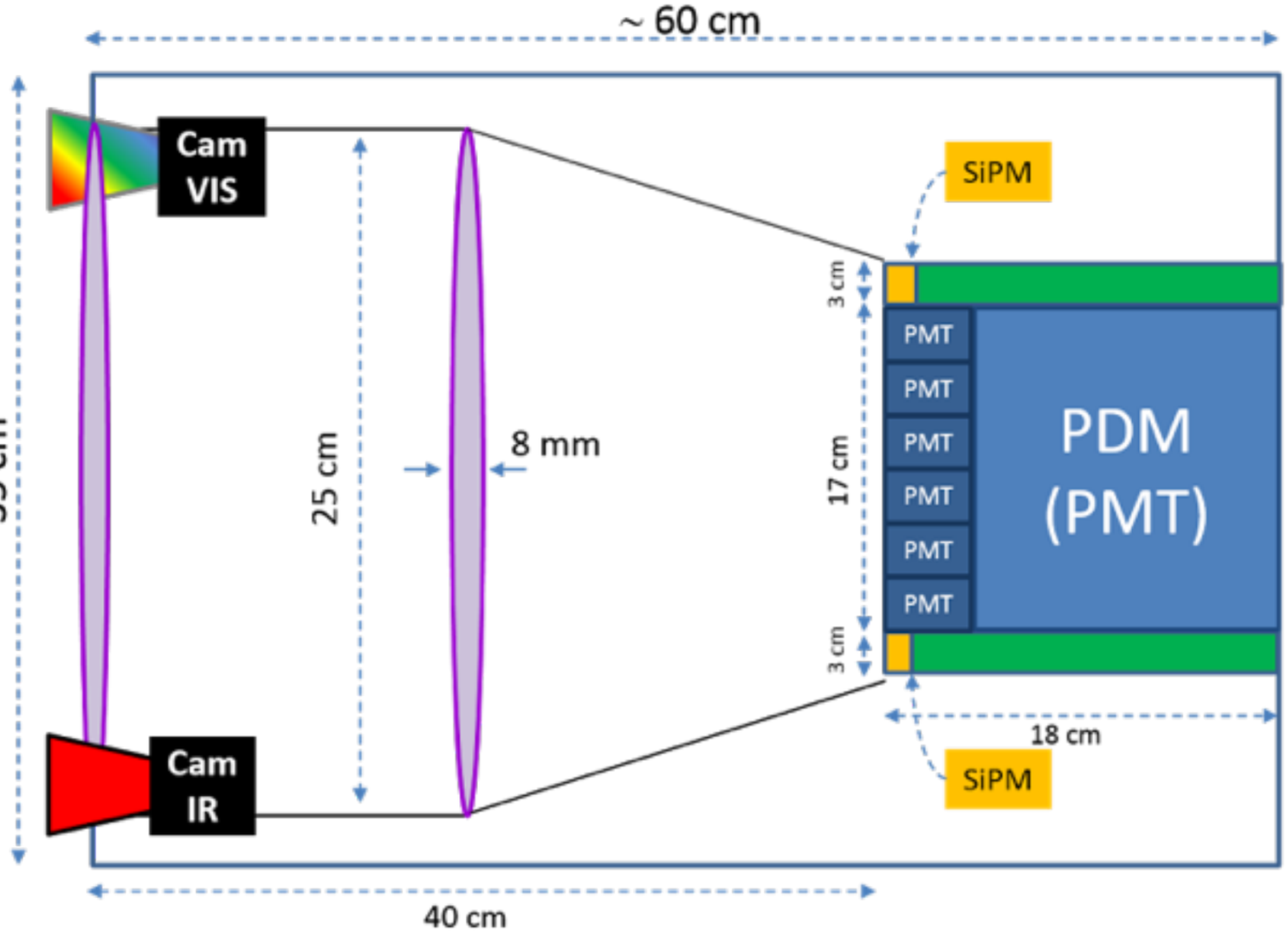
http://www.csbf.nasa.gov/newzealand/wanaka.htm

Mini-EUSO

A precursor mission on board ISS to measure Earth's UV intensity



Mini-EUSO

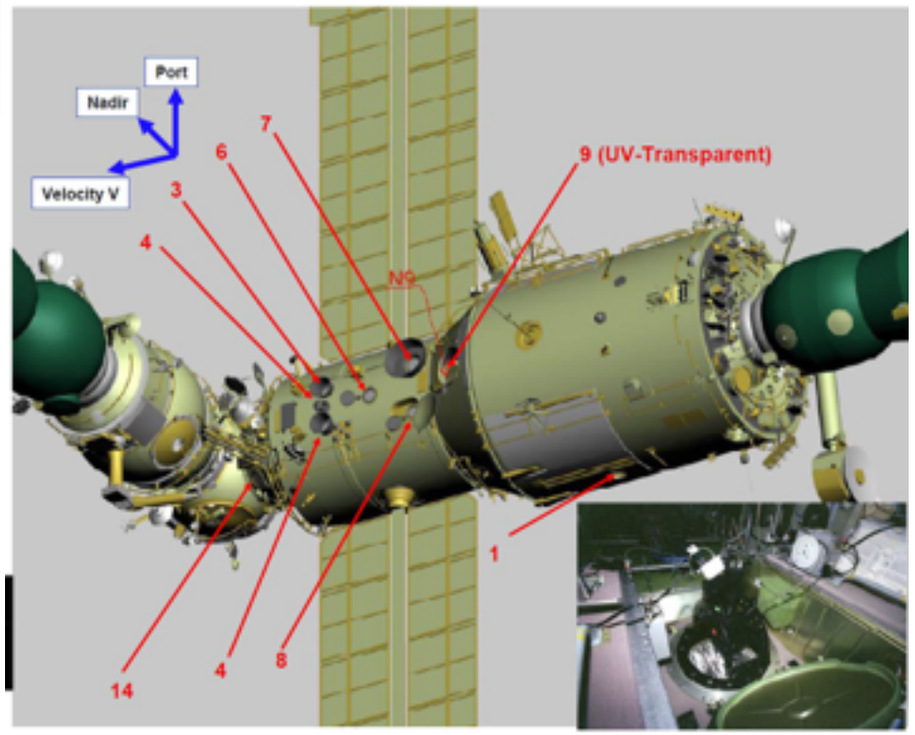


Mini-EUSO block scheme: a refractive optics based on two Fresnel lenses images UV light on 1 PDM (36 MAPMTs). A SiPM module is an option.

Mini-EUSO
Scientific objectives

- a.1) UV emissions from night-Earth
  - *6.5 km resolution, from 2.5 μs and above ± 51°*
  - *UV intensity from different lightning conditions, moon phase*
  - *UV intensity from different inclinations*
- *a.2) Map of the Earth in UV*
- *a.3) Study of atmospheric phenomena*
- *a.4) Study of meteors*
  - *Search for Strange quark matter*
  - *Space Debris assessment*
- *a.5) Test of UHECR observation*
  - *Use laser events like for EUSO-Balloon*

Pathfinders: Mini-EUSO



It will be hosted in the **Zvezda Module of the ISS. UV transparent Nadir looking window.**

Based on a proposal approved by ASI- the Italian Space Agency

Mini-EUSO is included, with the name **UV Atmosphere,** into the Russian **"Stage program of scientific and applied research and experiments"**

Flight is scheduled in 2017 with Paolo Nespoli

L1+L2 Logic

8x8 Pixel Matrix

Write is disabled upon L1 Event (after some delay...)

SPACIROC

2.5us GTU

WRITE

128*2.5us GTU MEM. (=320us)

5.24s

2.5us GTU

L1

Spaciroc EVENT

320us “GTU”

Write is disabled upon L2 Event (after some delay...)

L2

320us GTU

WRITE

128*320us GTU MEM. (=40.96ms)

5.24s

320 us GTU EVENT

40,96ms “GTU”

WRITE

128*40.96ms GTU MEM. (=5.24s)

5.24s

DISK

M. Mignone sta scrivendo la logica di trigger in VHDL del L1

SPACIROC

CR TRIGGER (L1)

2.5us GTU
-8 Serial Data
-1 Transmit_ON

SIPO

8x8 Pixel
Data Byte

-8x8 Pixel Cell
-Sum on 128 GTU

Spaciroc
SUM

64 SUM_pixel

FIFO
0 63
64x15bit

SUM_pixel
(320us "GTU")

L2

8x8 Pixel
Data Byte

64 AVG_pixel

64 "S_pixel" value
S_pixel=SUM_pixel/16+2*SQRT(SUM_pixel)

8*Sigma THRESHOLD
S calculation every 128 GTU

8x8x8 Pixel register
(8 GTU)

8x8 SUM_pixel Register

8x8 0 .... 8x8 7

Circular Buffer
(8 GTU 2.5us memory)

+

GTU SUM
(ON CIRCULAR BUFFER)

D0 0 7
D7 0 7

IF
SUM_pixel
>S_pixel

EVENT check every GTU

Spaciroc EVENT

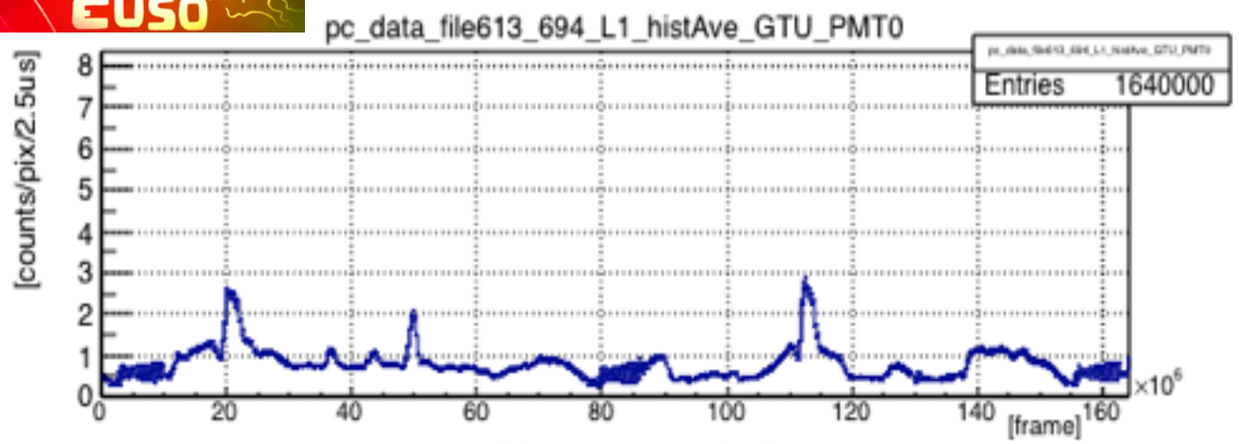
2.5us GTU

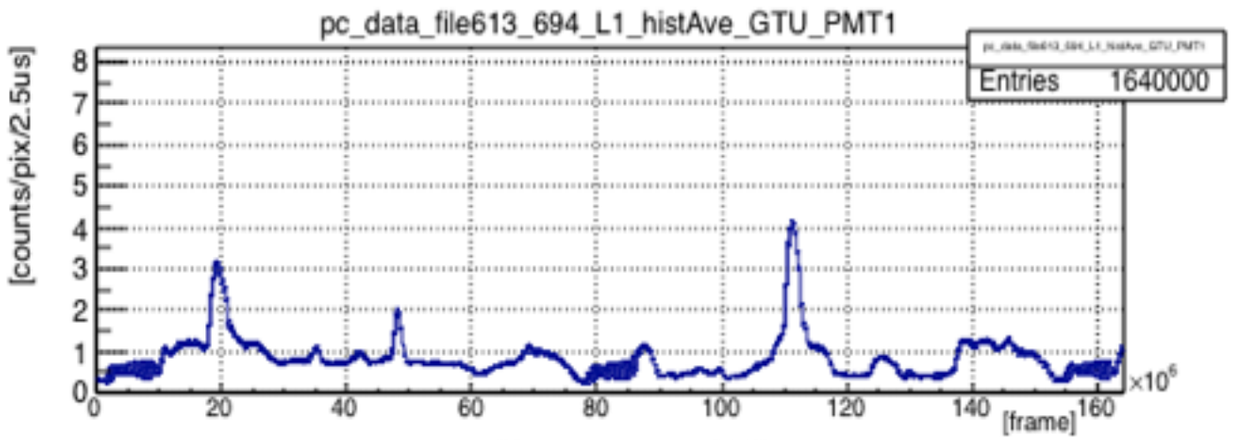
WRITE

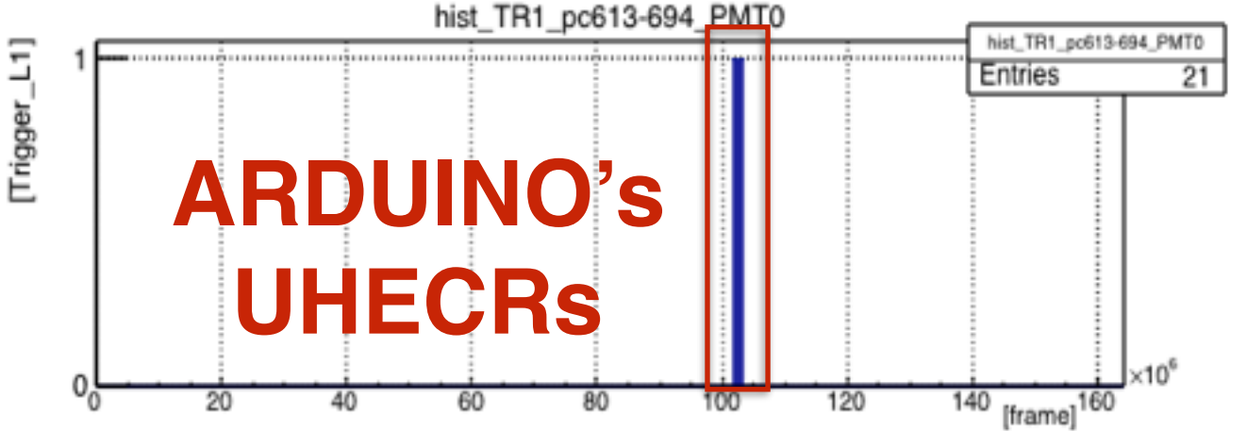
128*2.5us GTU MEM.
(=320us)

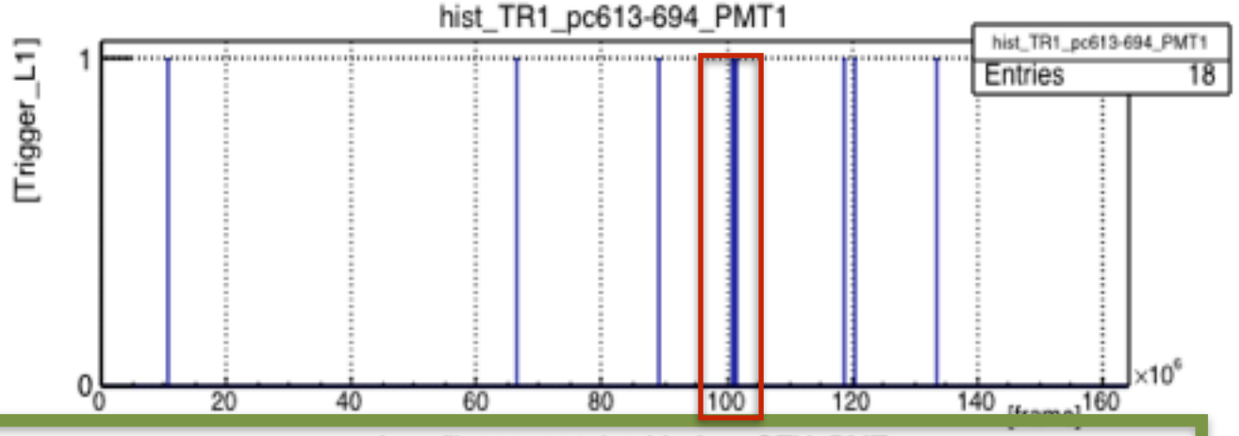
M. Mignone sta scrivendo la logica di trigger in VHDL del L1

Background vs L1 trigger

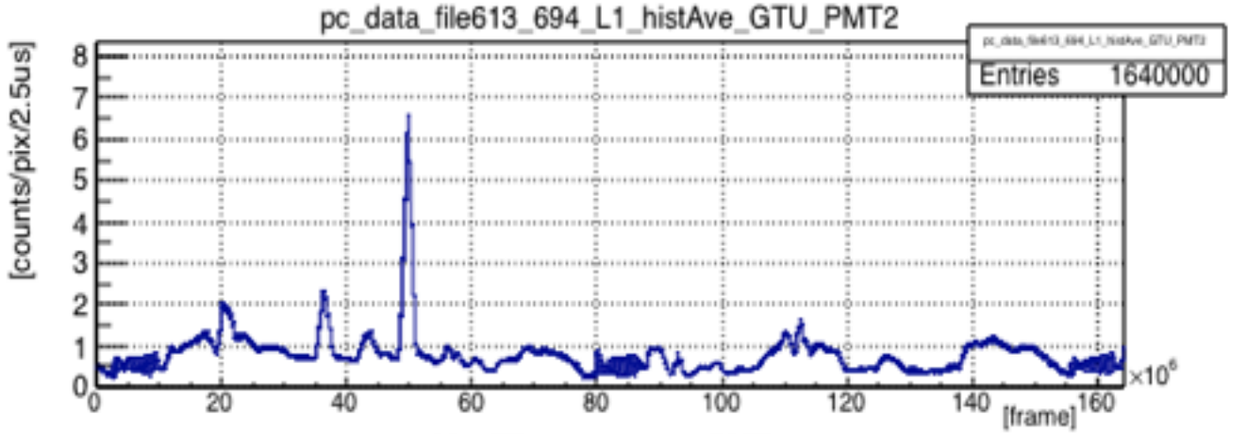


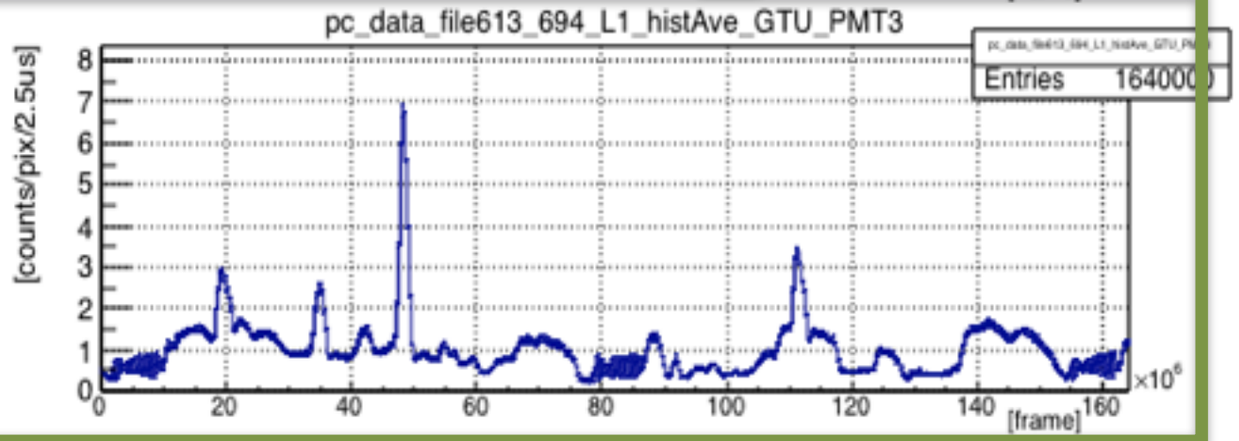


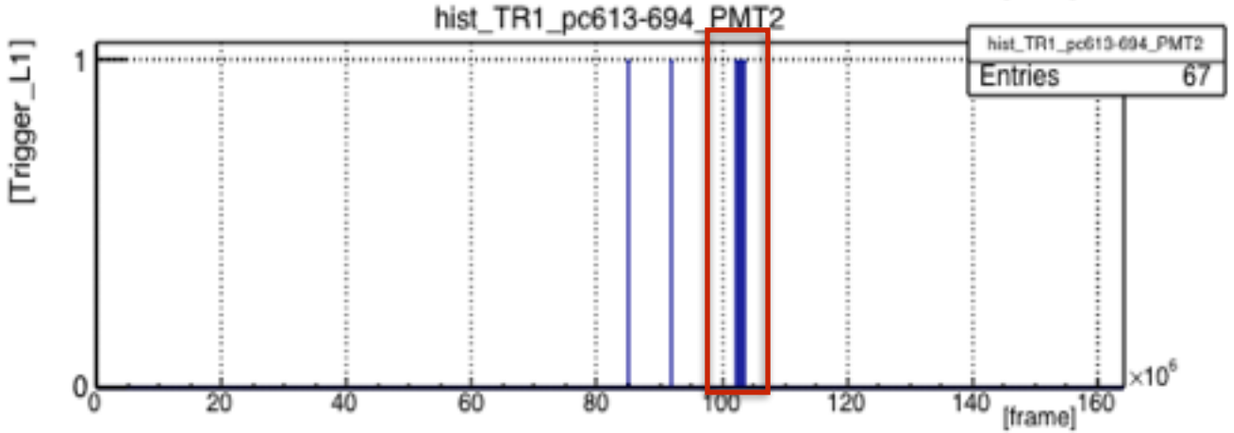


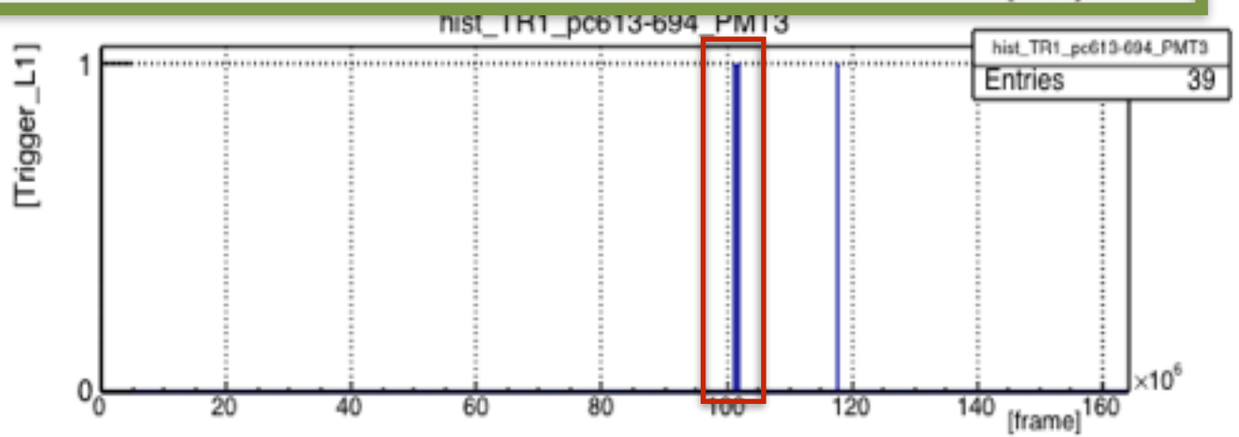


ARDUINO's
UHECRs









EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

LoI submitted

Letter of Intent
In response to the ESA Cosmic Vision 2015-2025 M5 Call
June, 6 2016

Tübingen, June 6, 2016

Dear Madam/Sir,

With this Letter we express our intention to respond to the Call, opened by ESA, for a Medium Size Mission, the fifth of the Cosmic Vision program to be launched in 2029-2030.

Proposal Title: *The Extreme Universe Space Observatory – Free Flyer* (EUSO-FF)

Core Team Members

ESA Member States

Prof. Mario Edoardo Bertaina, Dipartimento di Fisica, Università di Torino, Italy
Dr. Pavol Bobik, Institute of Experimental Physics, Kosice, Slovakia
Prof. Luis Del Peral, Universidad de Alcalá (UHA), Madrid, Spain
Dr. Andreas Haungs, Karlsruhe Institute of Technology (KIT), Germany
Prof. Christer Fuglesang, KTH Royal Institute of Technology, Stockholm, Sweden
Prof. Andrii Neronov, ISDC Data Centre for Astrophysics, Versoix, Switzerland
Prof. Etienne Parizot, AstroParticle and Cosmology Institute, Paris, France
Dr. Mihnea Popescu, Institute of Space Science, Magurele, Ilfov, Romania
Dr. Marco Ricci, Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Frascati, Italy
Prof. Maria Dolores Rodríguez Frías, Universidad de Alcalá (UHA), Madrid, Spain
Prof. Andrea Santangelo, IAAT, University of Tübingen, Germany
Dr. Jacek Szabelski National Centre for Nuclear Research, Lodz, Poland
Dr. Galina Vankova-Kirilova, Faculty of Physics, University of Sofia, Sofia, Bulgaria
Dr. Peter Von Ballmoos, IRAP, Université de Toulouse, CNRS, Toulouse, France

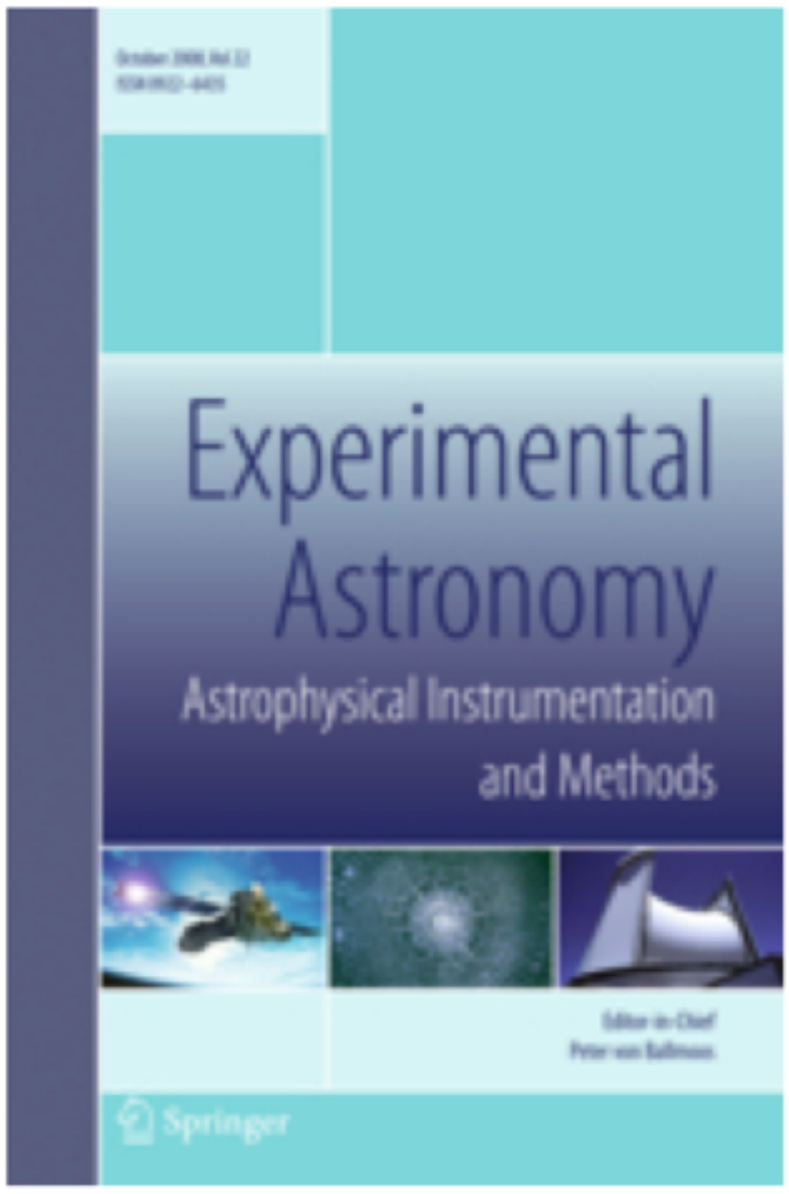
EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

M5 ESA's Schedule

Event	date (or tentative date)
M5 Call release	April 29, 2015
Letters of Intent due	June 6, 2016 (noon!)
Proposals due	**October 5, 2016 (noon!)**
Letters of Endorsement	**February 8, 2017 (noon!)**
Study selection	June 2017
Phase 0	November 2017
Phase A kick-off	January 2018
Mission selection	November 2019
Mission adoption	November 2021
Launch (for an ESA-only mission)	Mid–2029 to mid–2030

- The Call is foreseen to solicit proposals for a ***mission with a cap to the ESA Cost at Completion (CAC) of 550 M€.***

We published *the enormous information, studies, results obtained in the last years:*



Focus Issue of Experimental Astronomy published: *Volume 40, Issue 1, November 2015*

155 printed copies have been ordered and will be sent to you according to your requests

15 Papers: **Torino involved in 1/3 of them**

http://link.springer.com/journal/10686/40/1/page/1

GRAZIE per l’attenzione!