



Extreme Universe Space Observatory

JEM-EUSO

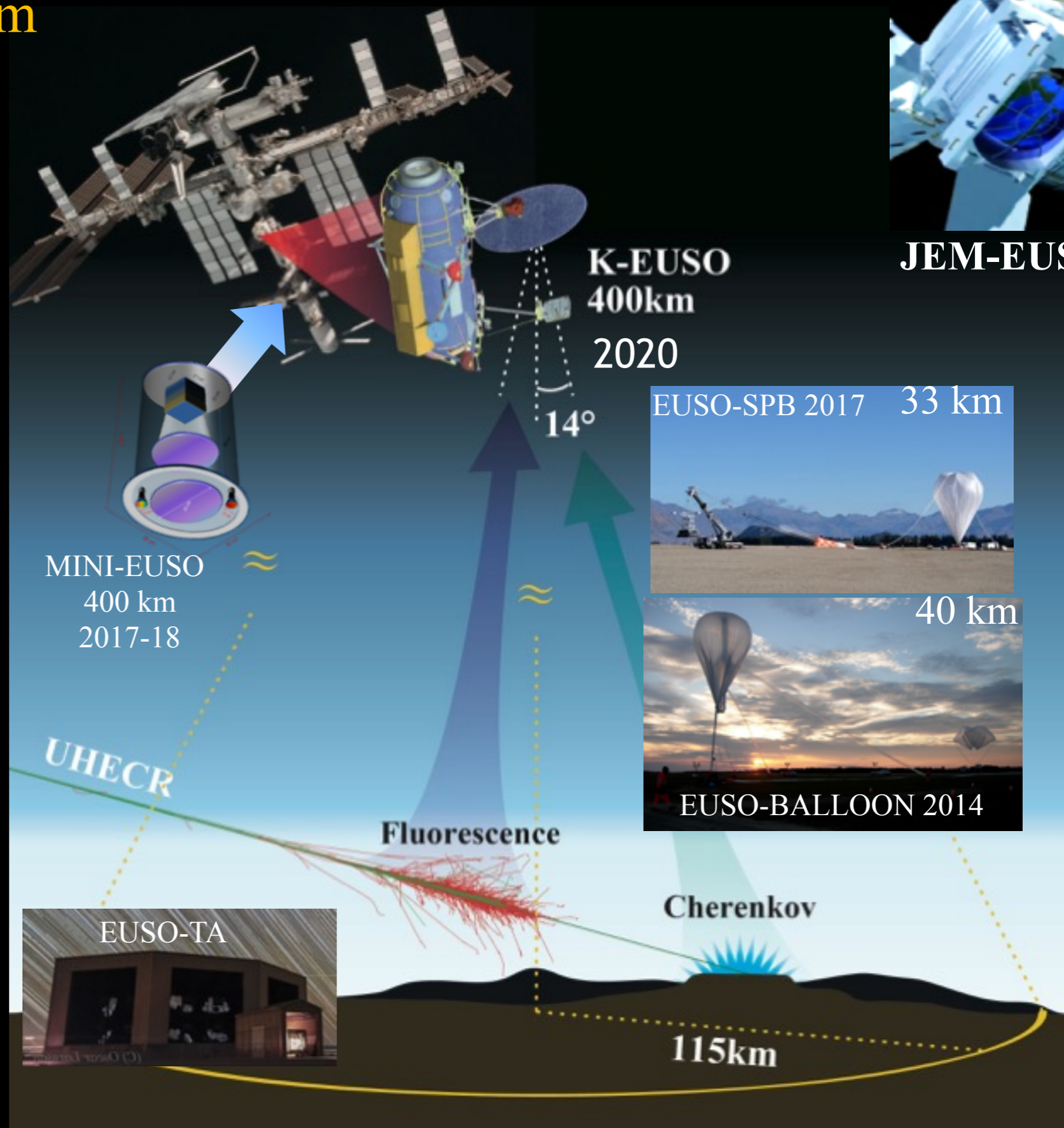
**Osservazione dei Raggi
Cosmici di altissima energia
(UHECR) dallo Spazio**

**M. Bertaina – Consiglio di Sezione INFN
30 Giugno 2017**

The JEM-EUSO program

*Ultra-High Energy
cosmic rays from space*

- EUSO-TA:** Ground detector installed in 2013 at Telescope Array site: currently operational
- EUSO-BALLOON/ EUSO-SPB:** 1st flight from Timmins, CA (French Space Agency) Aug 2014; 2nd NASA SPB flight: April 2017. Approved by Italian Space Agency
- MINI-EUSO (2017):** Precursor from International Space Station (ISS: 2017). Approved by Italian and Russian Space agencies
- K-EUSO (2020):** ISS Approved by Russian Space Agency



www.jem-euso.roma2.infn.it

JEM-EUSO collaboration

16 Countries, 93 Institutes, 351 people



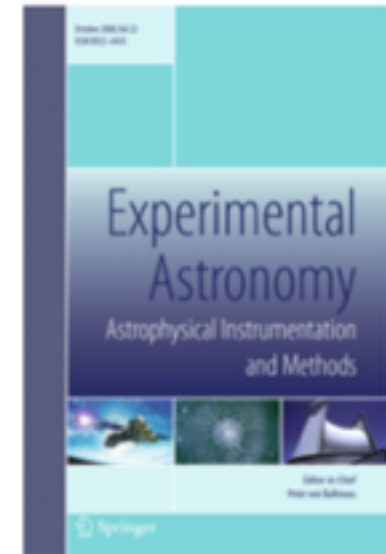
Involvement of the Univ. Torino group in the JEM-EUSO program

- Development of the trigger logic for the different instruments
- simulation of the performance of the detectors
- simulation of physical phenomena like: cosmic rays, meteors, space debris
- data taking on site (EUSO-TA) or remotely (EUSO-SPB)
- data analysis related to cosmic rays & meteor science
- analysis of meteorological data useful for the interpretation of the measurements.

Work (publications...)

Experimental Astronomy, Vol. 40 (2015):

- JEM-EUSO observational technique and exposure (M. Bertaina & F. Fenu)
- Performances of JEM-EUSO: energy and X_{\max} reconstruction (F. Fenu)
- The infrared camera onboard JEM-EUSO (R. Cremonini)
- JEM-EUSO: Meteor and nuclearite observations (M. Bertaina & A. Cellino)



-Astroparticle Physics, Vol. 44, p.76 (2013), An evaluation of the exposure in nadir observation of the JEM-EUSO (M. Bertaina)

- Planetary & Space Science accepted (accepted, electronic version already existing)
Meteor Studies in the Framework of the JEM-EUSO Program

- Nucl. Instr. & Methods A, Vol. 866, p.150-163 (2017)

The first trigger level of the JEM-EUSO telescope for cosmic ray detection (M. Bertaina, M. Mignone, H. Miyamoto, G. Cotto, M. Manfrin, R. Forza)

- Nucl. Instr & Methods A, Vol. 824, p. 253 (2016)

The First Level Trigger of JEM-EUSO: Concept and tests (M. Bertaina, F. Fenu, M. Mignone)

- IEEE transaction on Geoscience and Remote Sensing (submitted)

Methods to retrieve the Cloud Top Height in the frame of JEM-EUSO mission (C. Cassardo, S. Ferrarese)

Torino Collaboration

- R. Bechini, R. Cremonini (ARPA Piemonte)
- M. Bertaina, G. Cotto, C. Cassardo, F. Fenu, S. Ferrarese, P. Galeotti, M. Manfrin, H. Miyamoto, K. Shinozaki, C. Vigorito (UniTO)
- A. Castellina, A. Cellino, P. Vallania (INAF)
- G. Giraud, M. Mignone (INFN)

EUSO-SPB campaign (April 25th - May 6th)



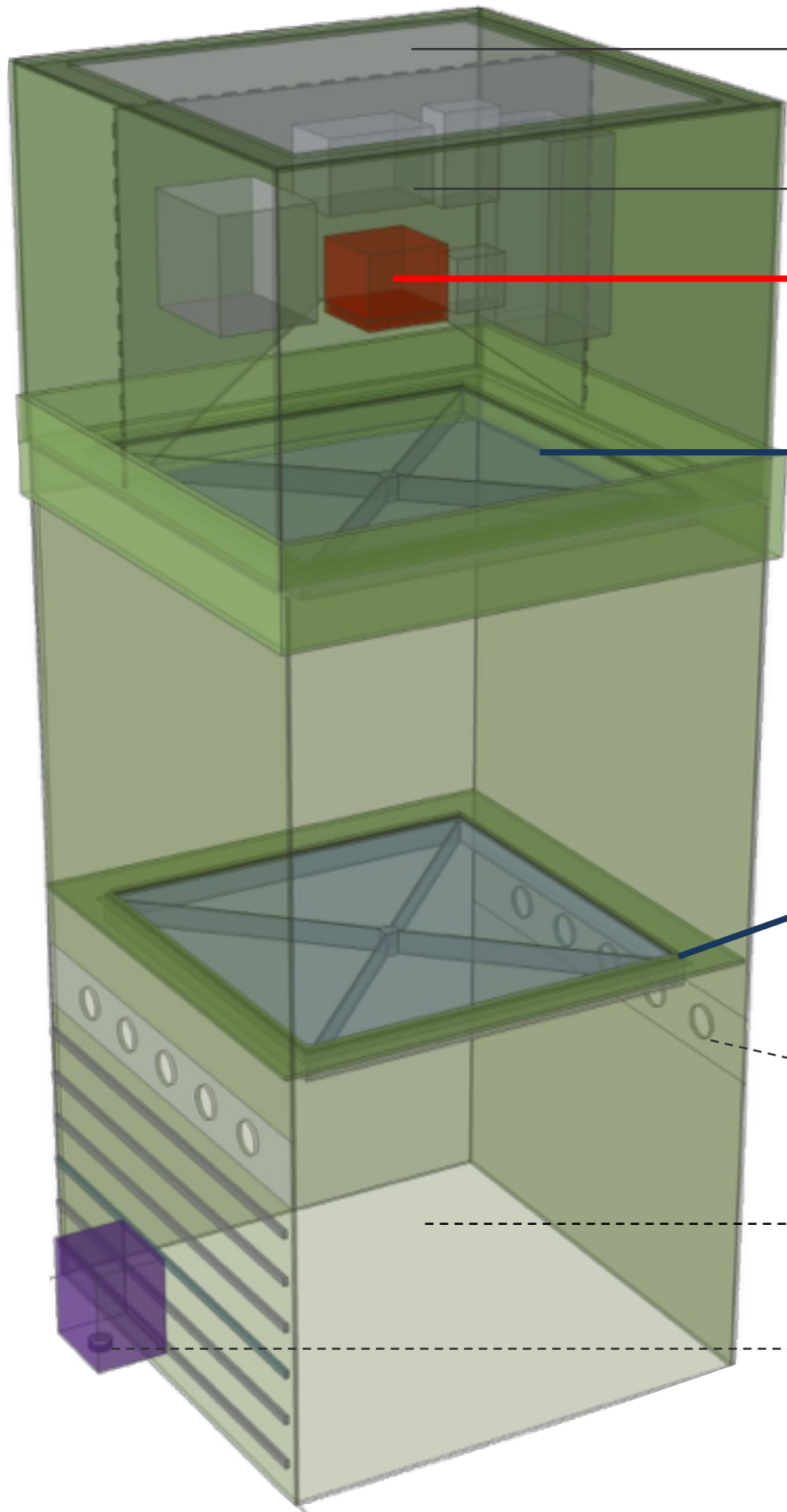
GOAL: First cosmic ray observation from space using fluorescence light & Cherenkov albedo on clouds

April 25th, Wanaka (New Zealand)



instrument booth

optical bench



radiator

electronics (DP)
on "dry shelf"

PDM

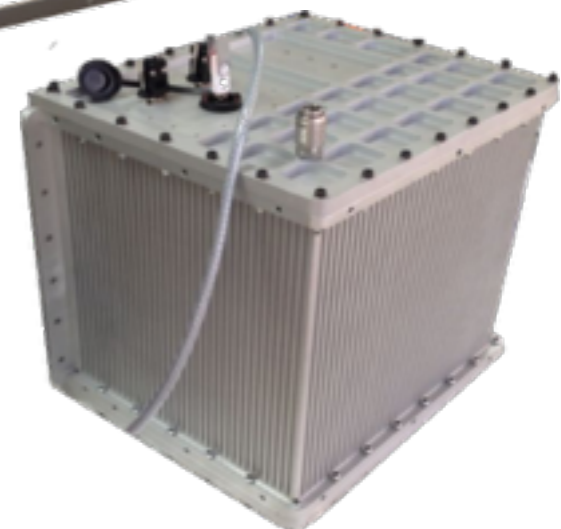
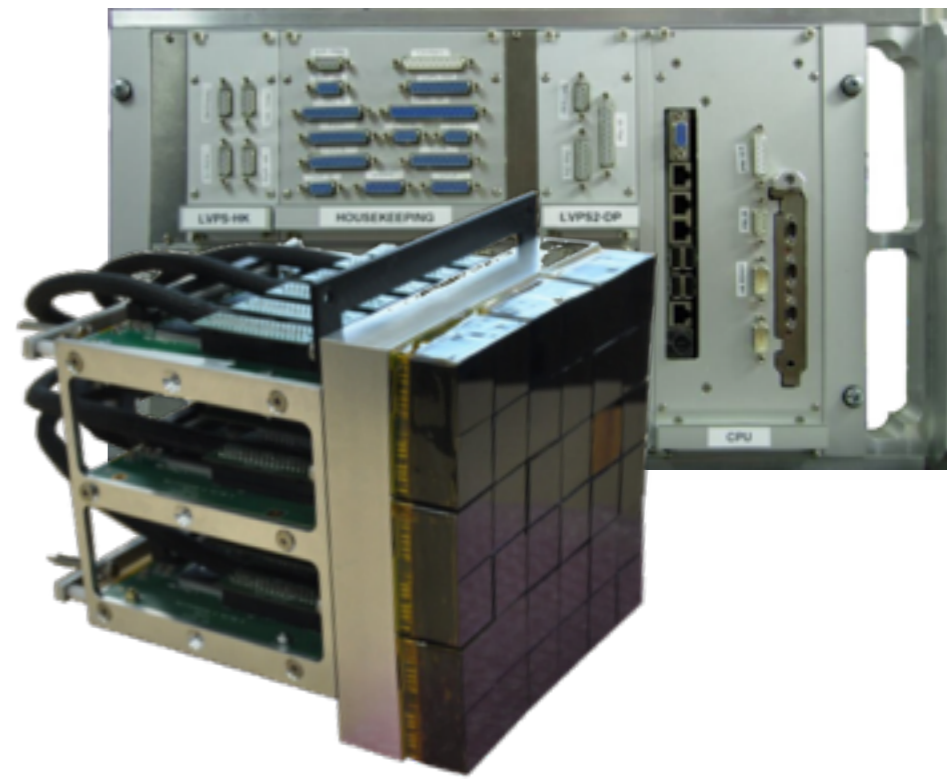
Fresnel lens L3
fixed/tight

Fresnel lens L1
adjustable

evacuation holes

Baffle &
"deceleration cylinder"

IR Camera



Science Objectives for EUSO-SPB long duration flight Wanaka 2017

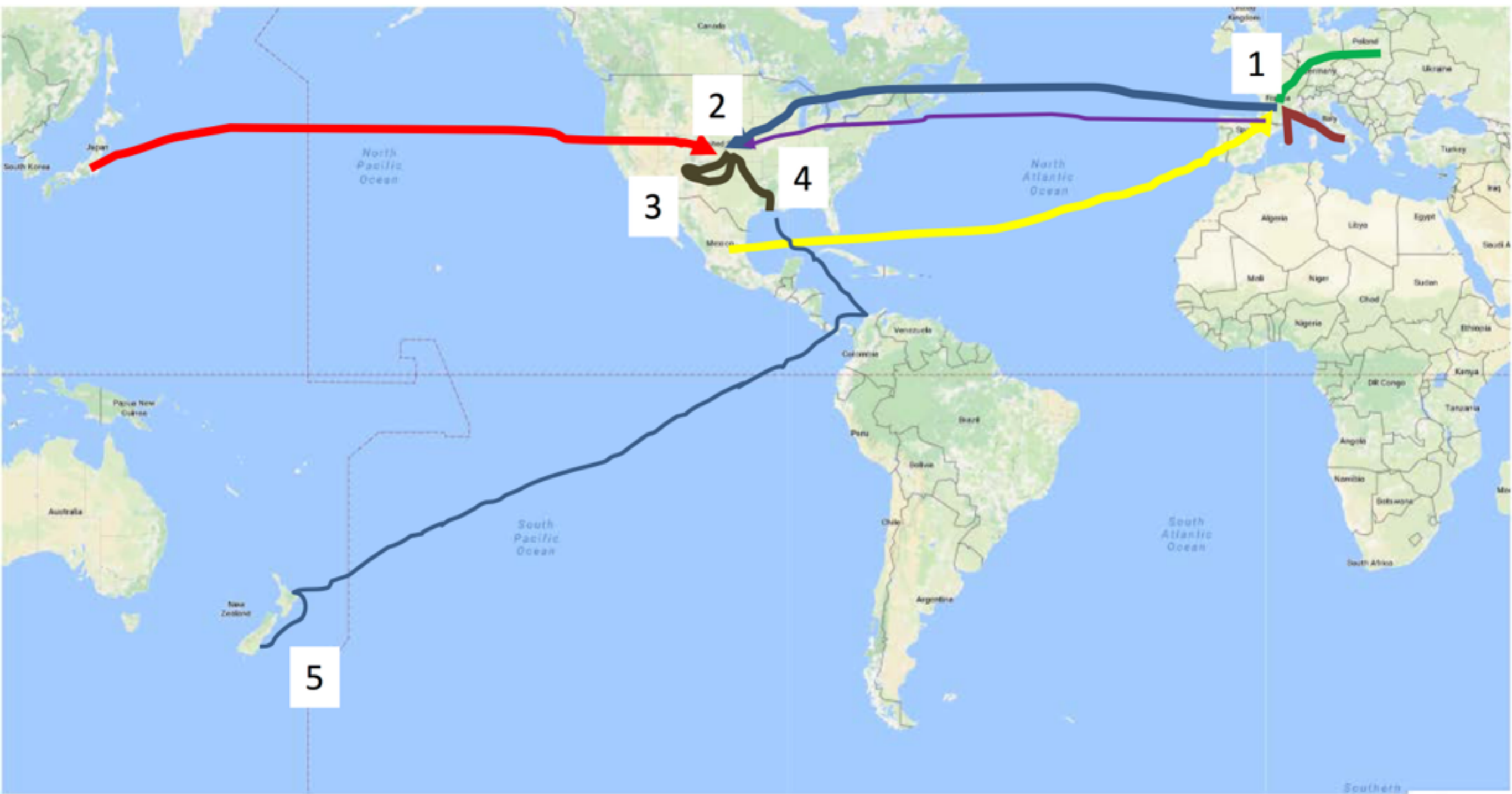


Make the **first observations** of Ultra High Energy Cosmic Ray Air Showers **by looking down** from suborbital space with an air fluorescence detector.

Measure **background UV light** at night over ocean, clouds

Search for **fast UV pulse** like signatures from other objects:
Meteoroids, atmosphere transient luminous events, ...

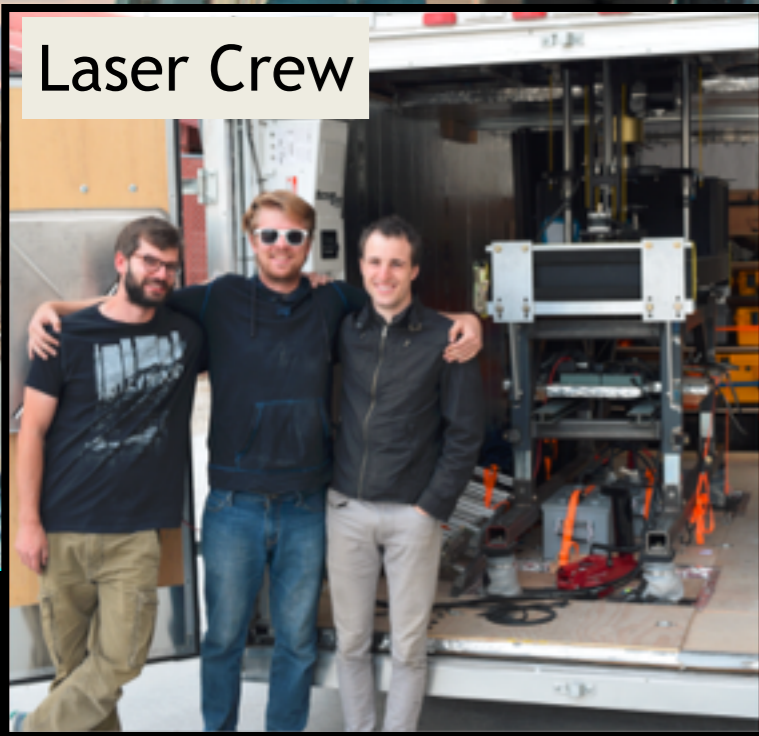
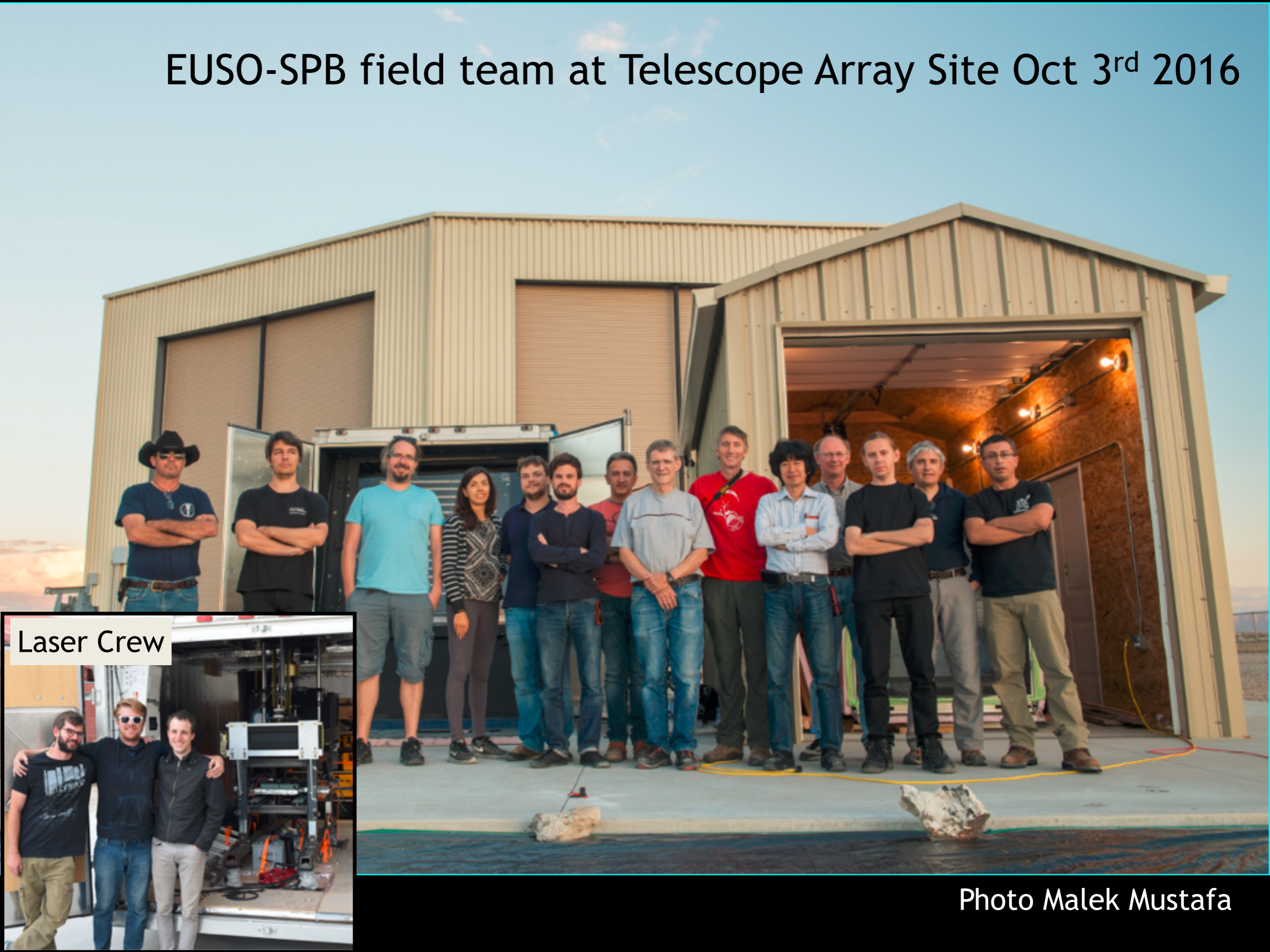
Discovery Potential



1. Electronics/Light Sensor Integration
2. Assembly
3. Field tests – Utah Desert
4. Hang Tests Palestine Tx (NASA)
5. Wanaka (4 boats)

All done in ~1 year

EUSO-SPB field team at Telescope Array Site Oct 3rd 2016

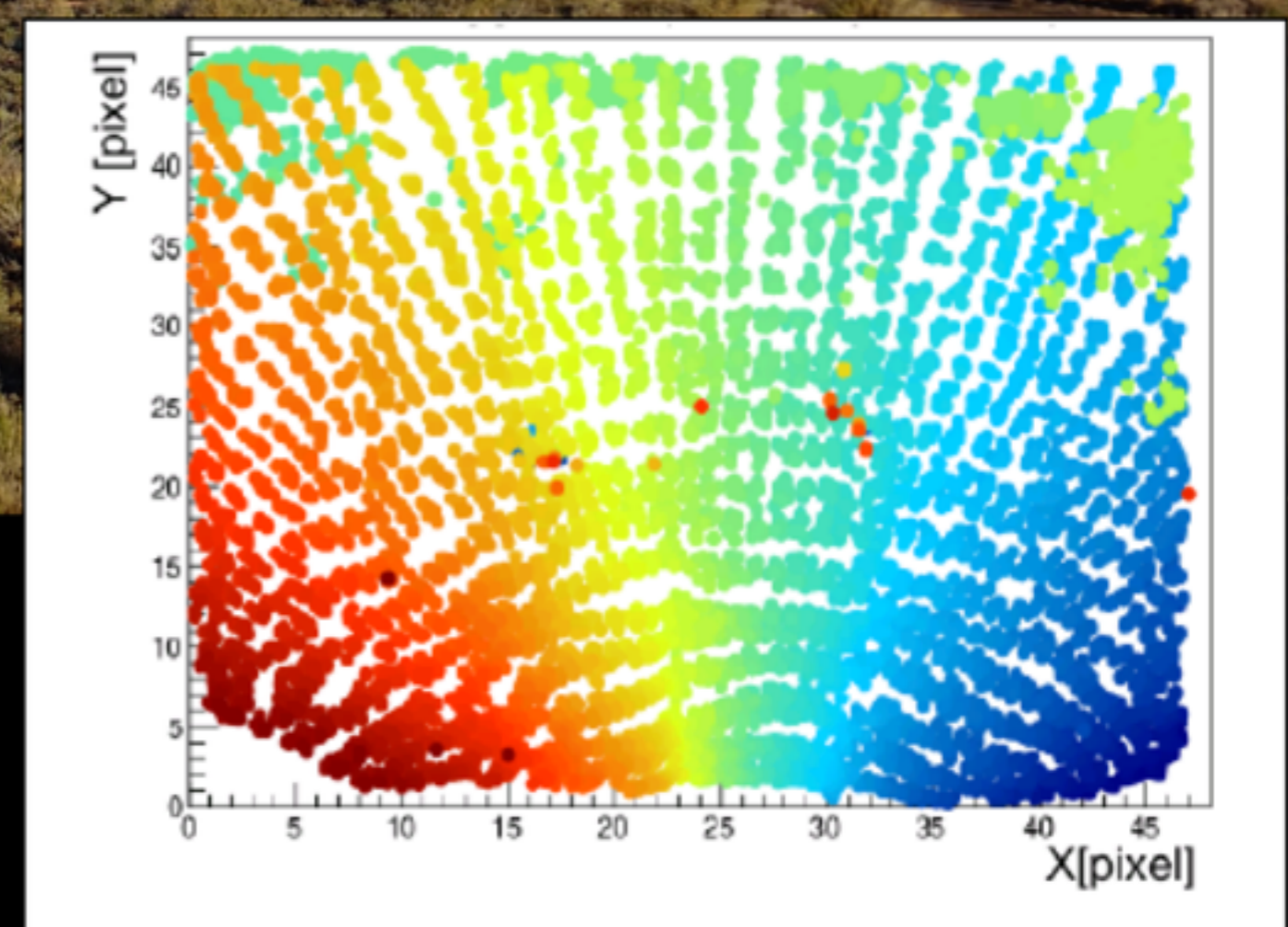
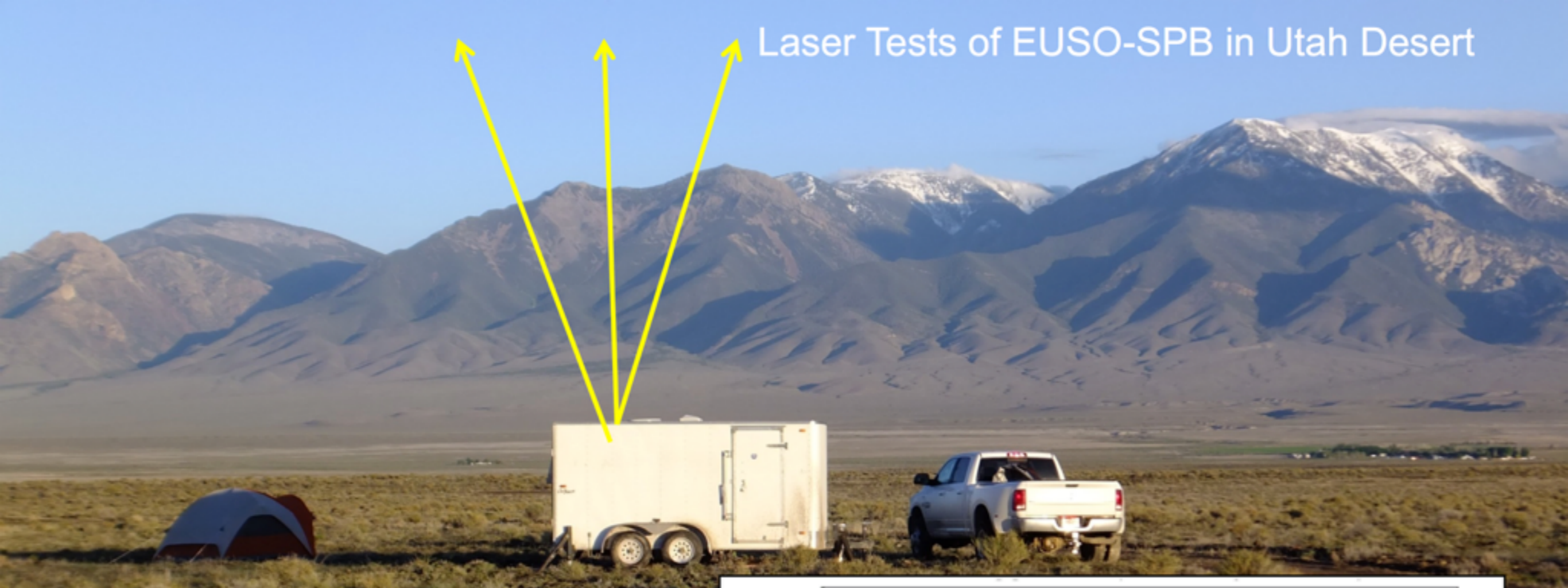


Laser Crew

Photo Malek Mustafa



Laser Tests of EUSO-SPB in Utah Desert

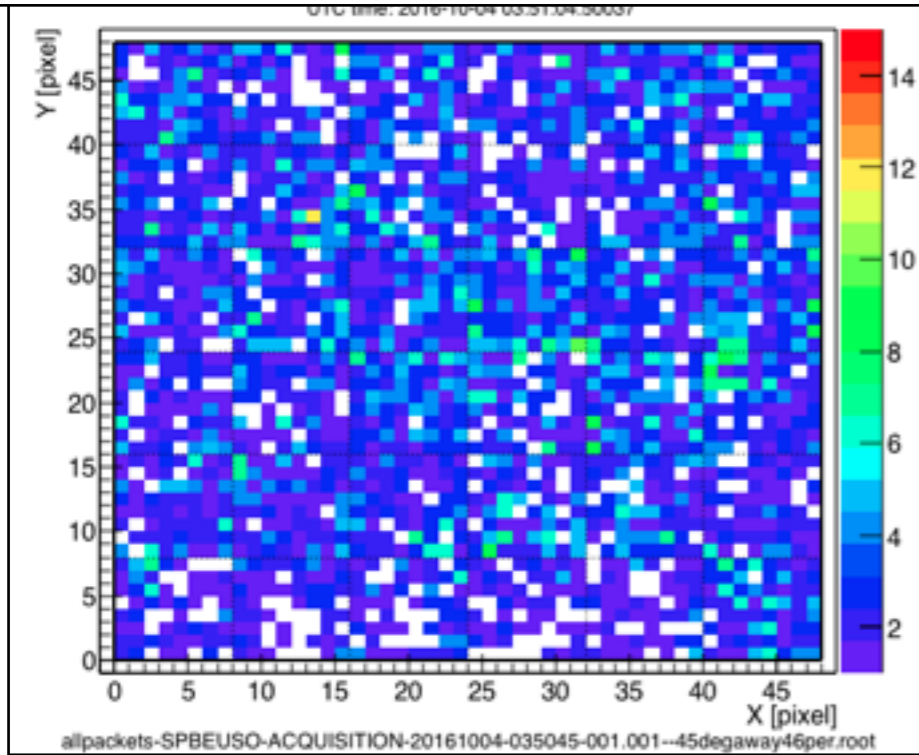


Oct 4th 2016: 2 lens configuration -GLS

DATA: allpackets-SPBEUSO-ACQUISITION-20161004-0350450991.991--45degaway46per

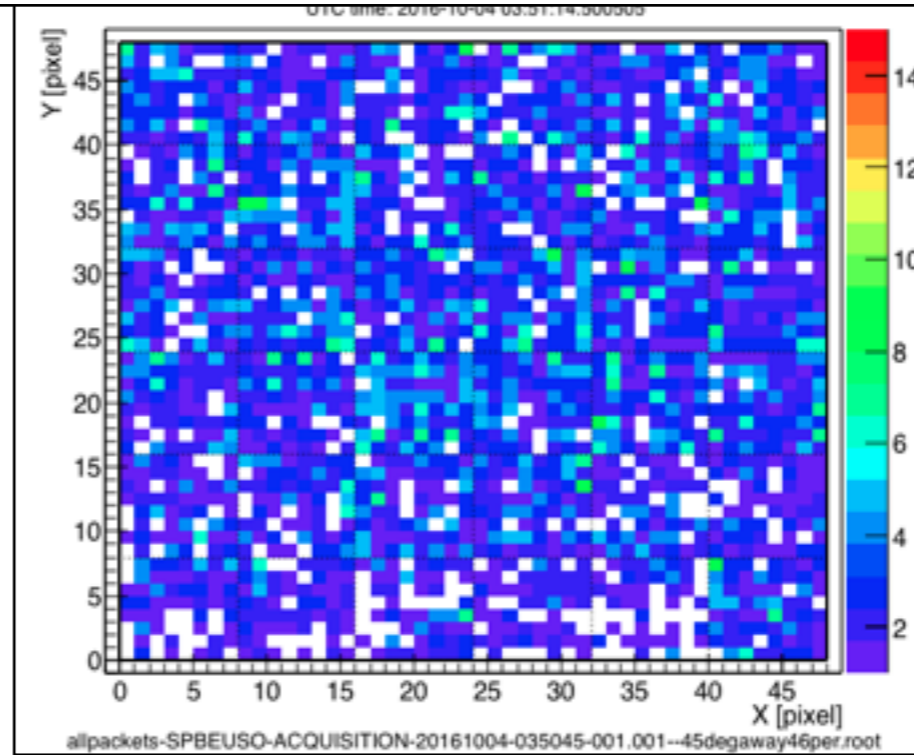
packe41, GTU39~61

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packe85, GTU38~60

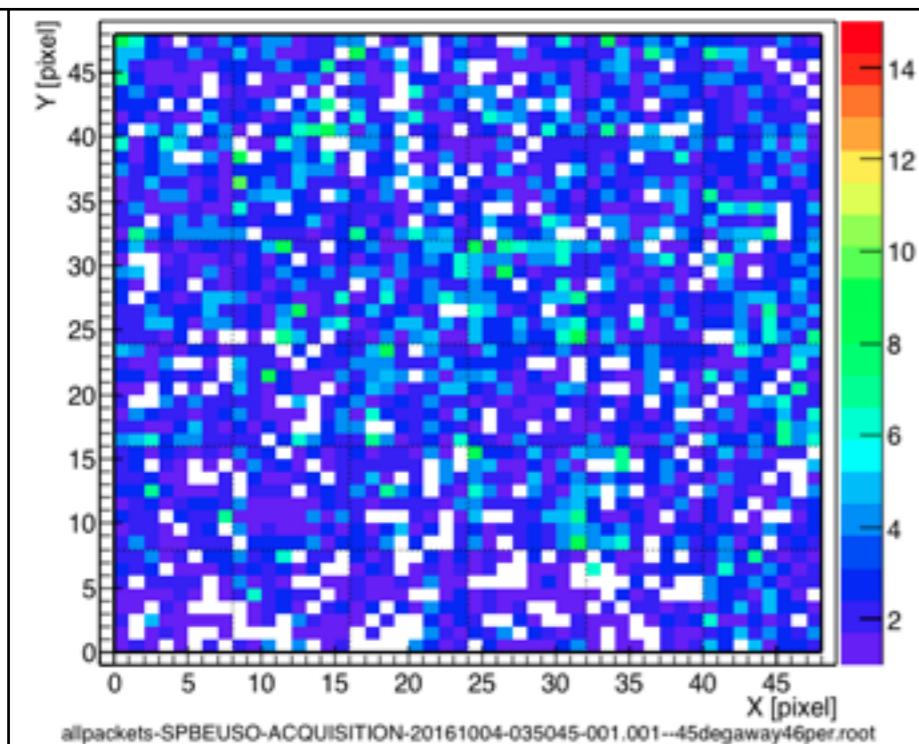
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Trigger
INFN To
(M. Mignone)

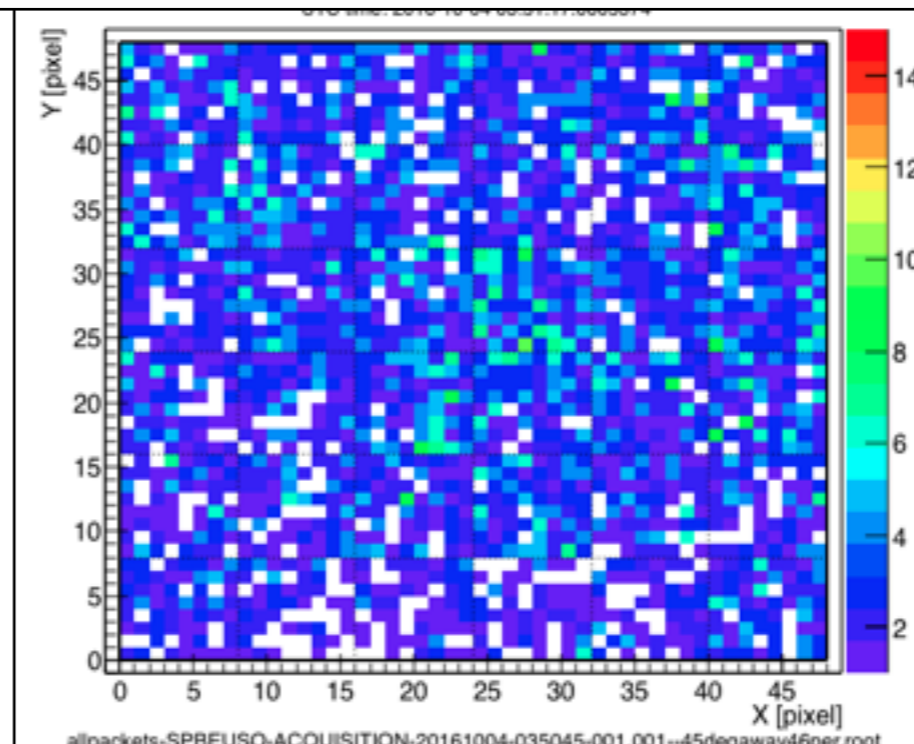
packe42, GTU39~61

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packe97, GTU38~60

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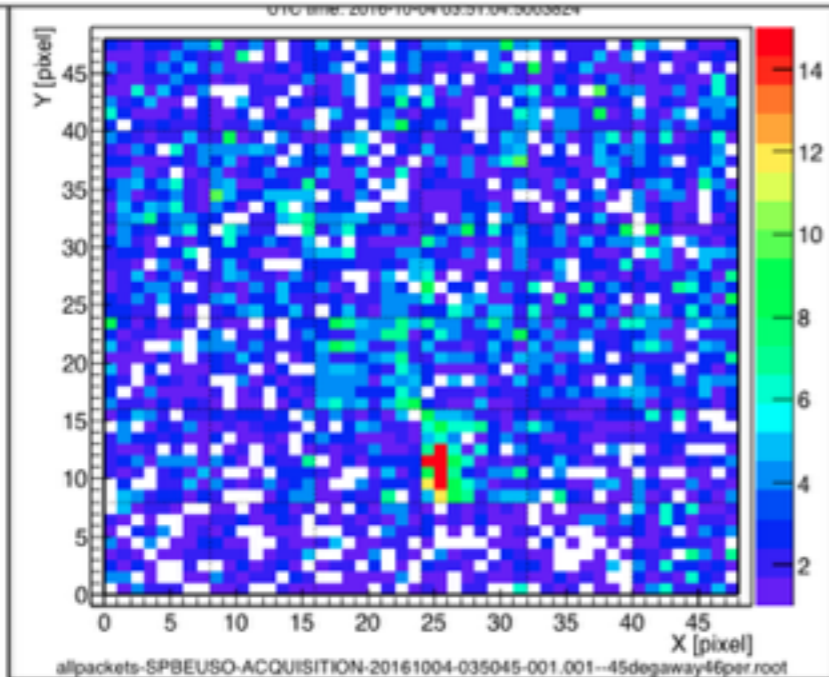


Oct 4th 2016: 2 lens configuration -GLS

DATA: allpackets-SPBEUSO-ACQUISITION-20161004-0350450991.991--45degaway46per

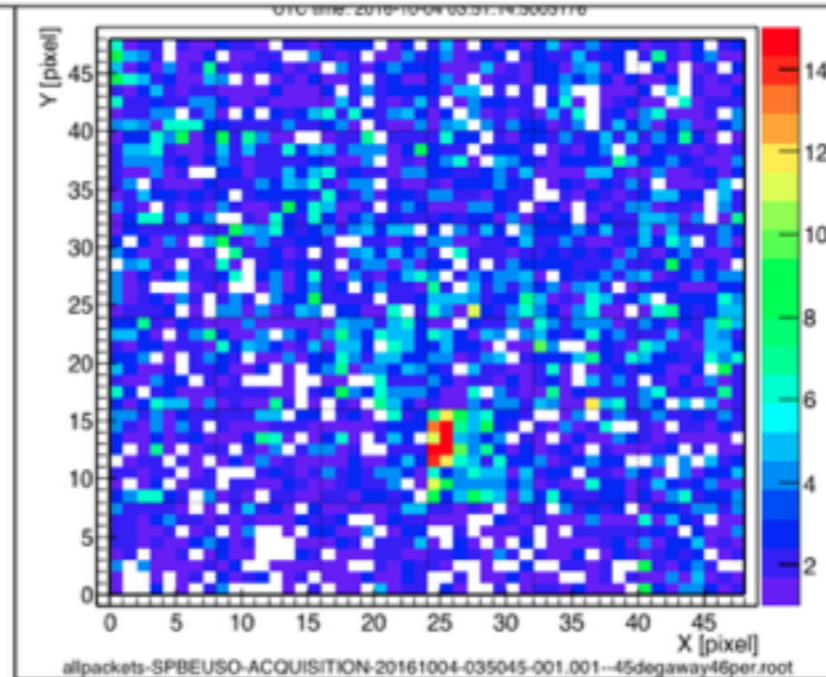
packe41, GTU39~61

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packe85, GTU38~60

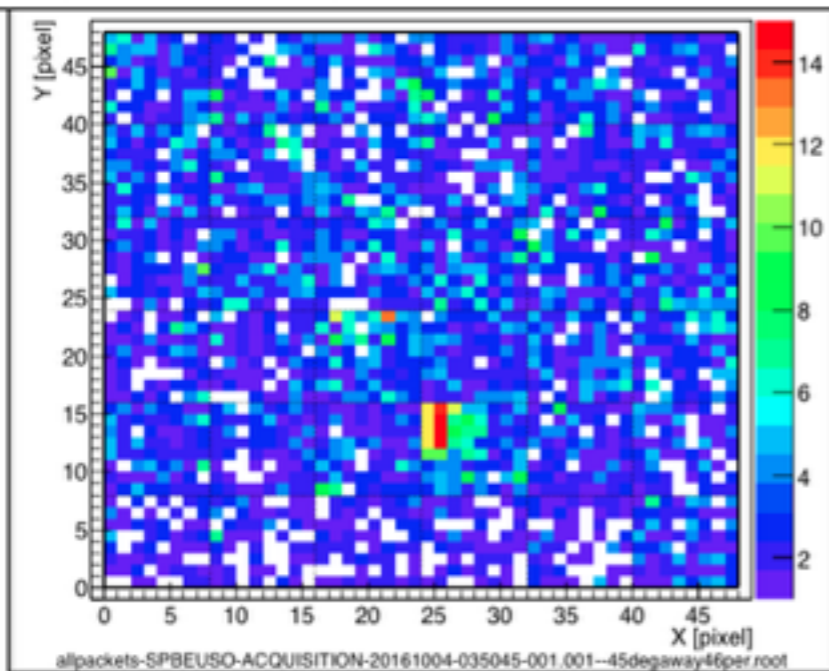
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Trigger
INFN To
(M. Mignone)

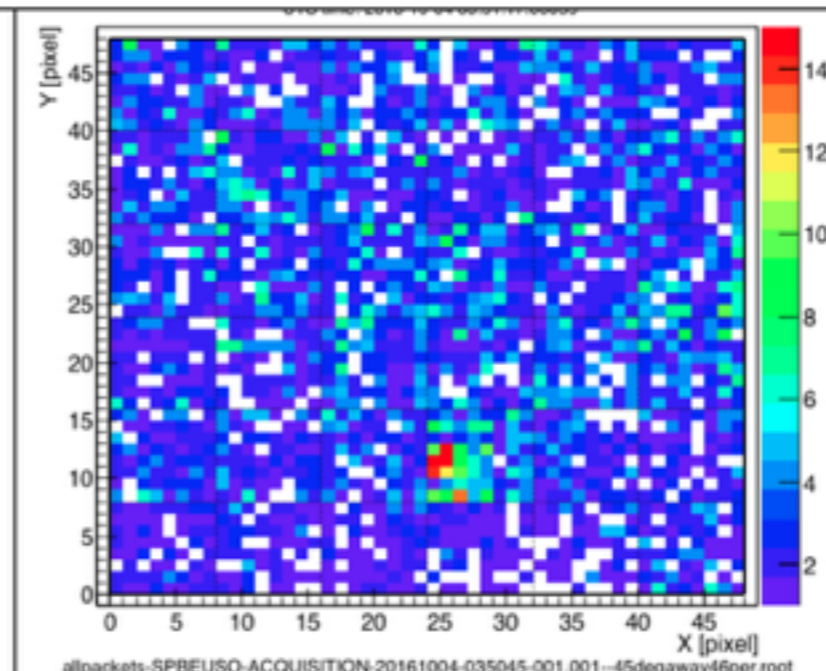
packe42, GTU39~61

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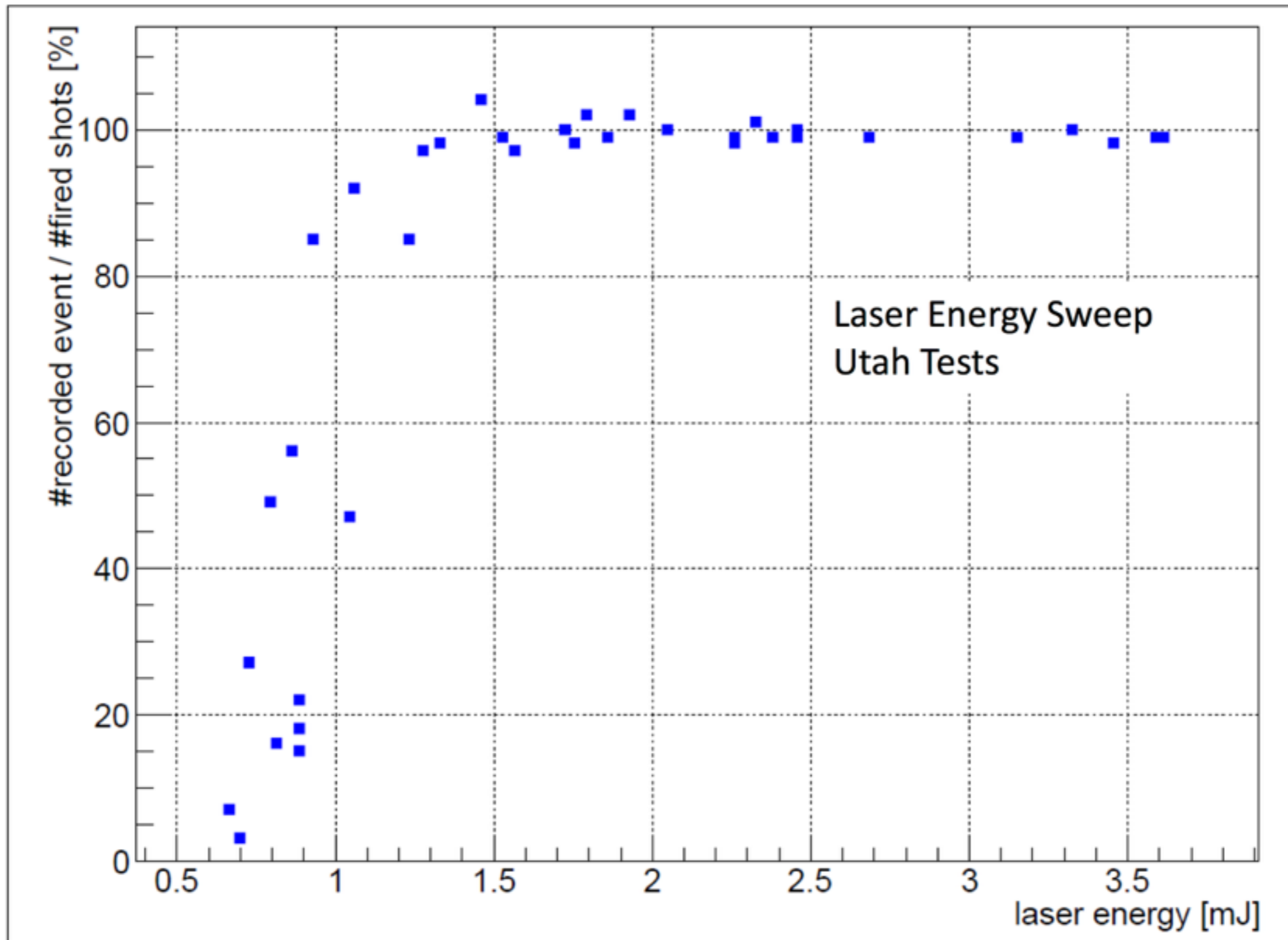


packe97, GTU38~60

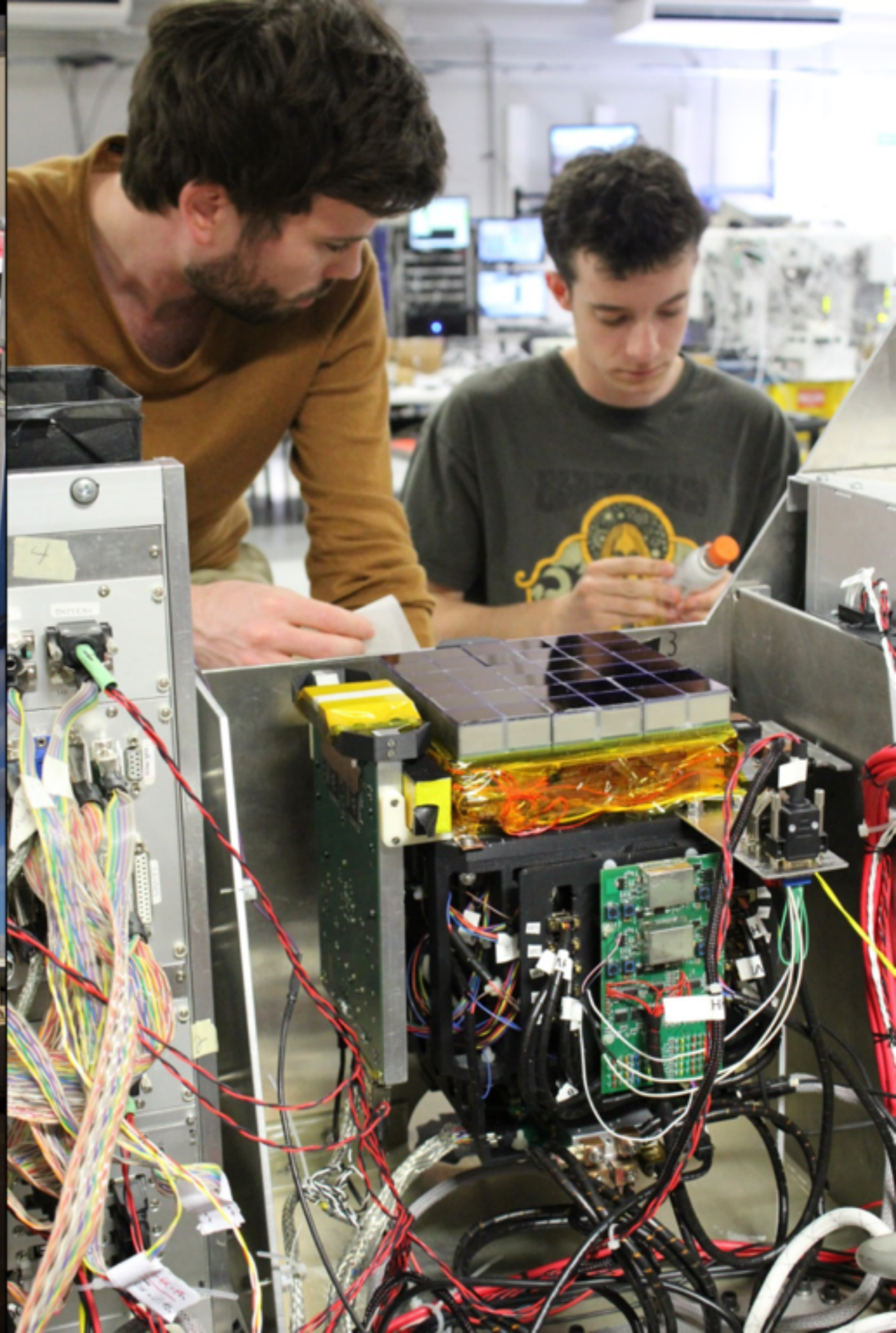
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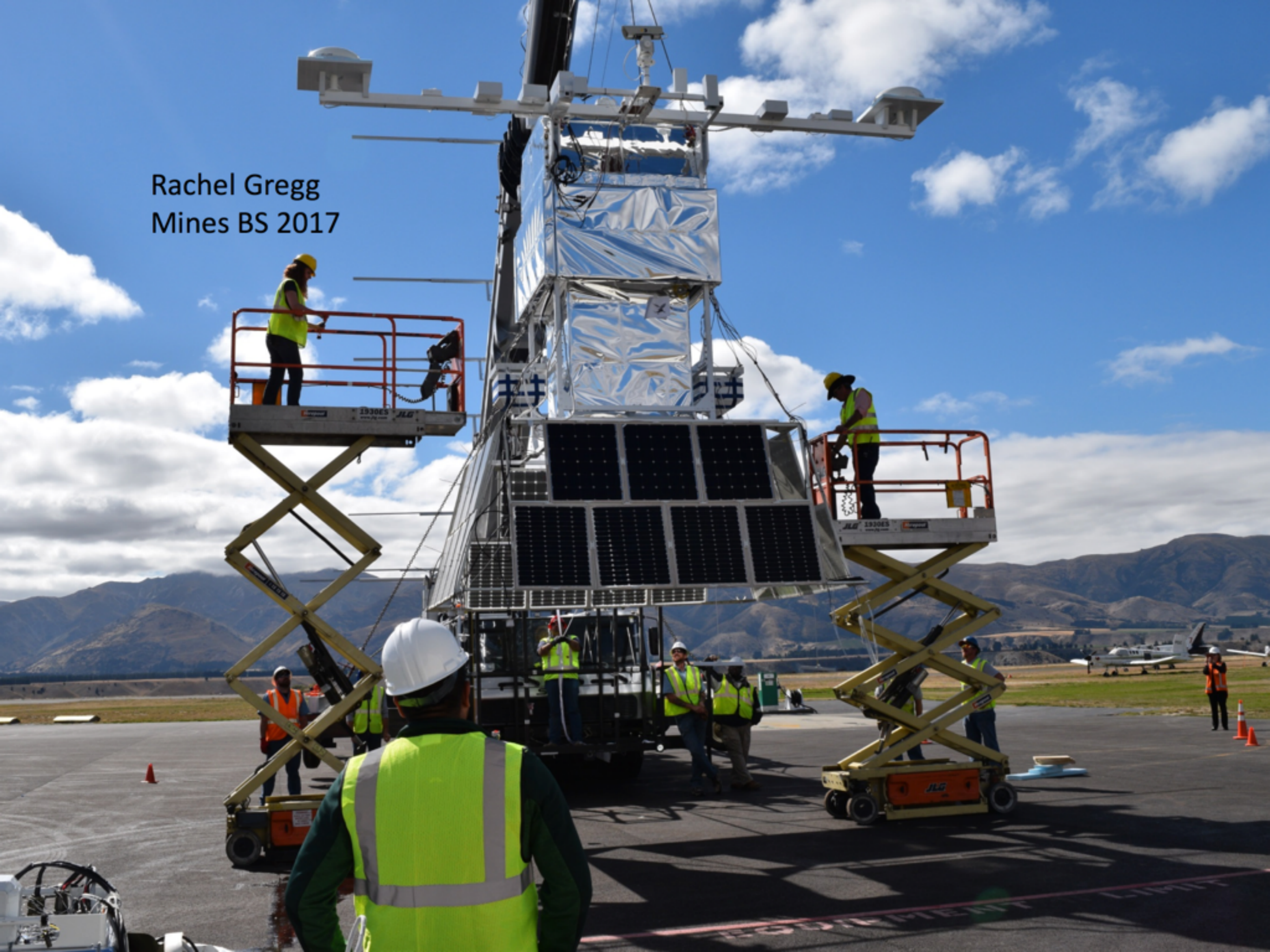
UV pulsed laser 24 km distant



Equivalent Energy Trigger Threshold $\sim 3 \times 10^{18}$ eV

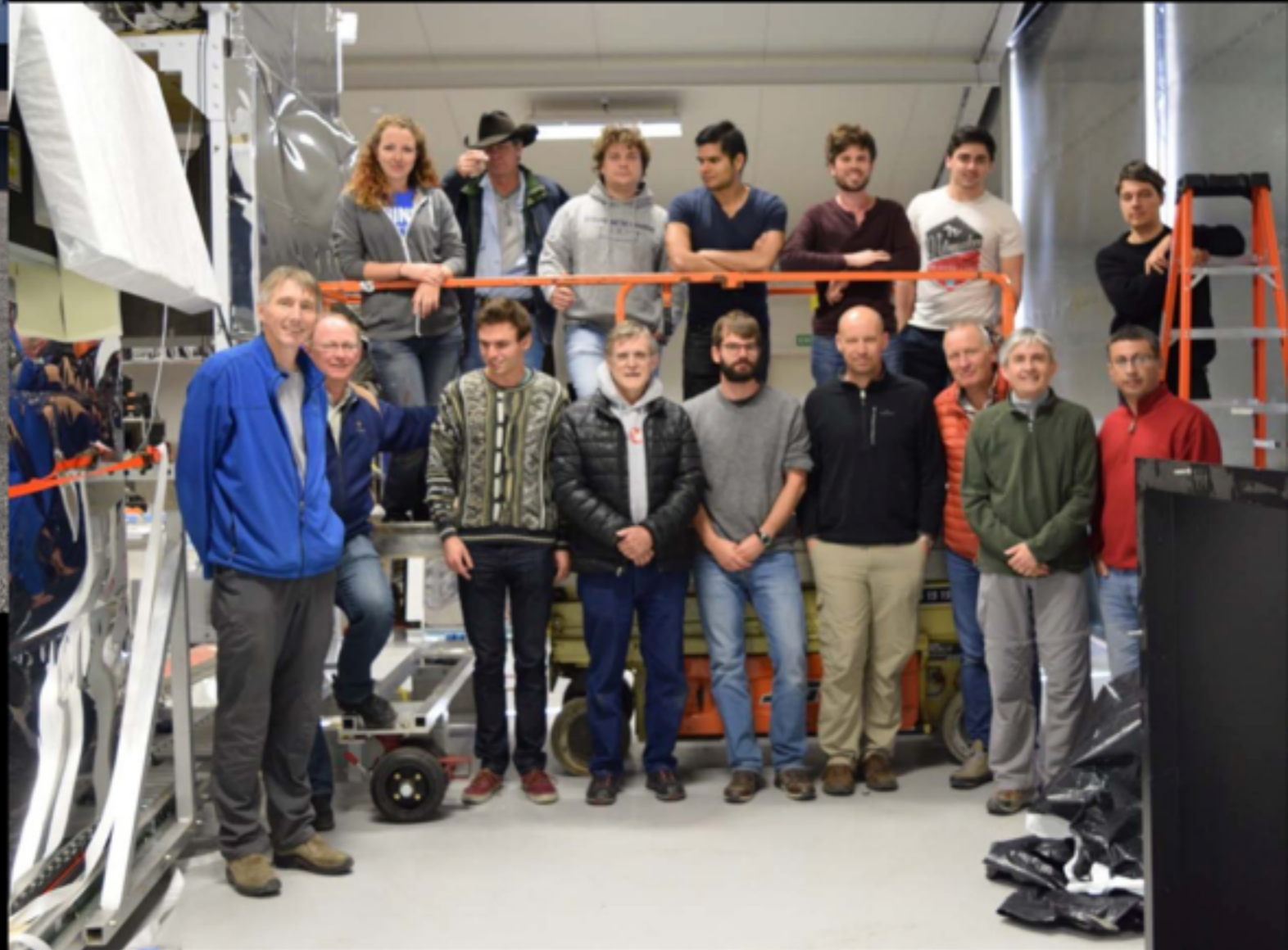
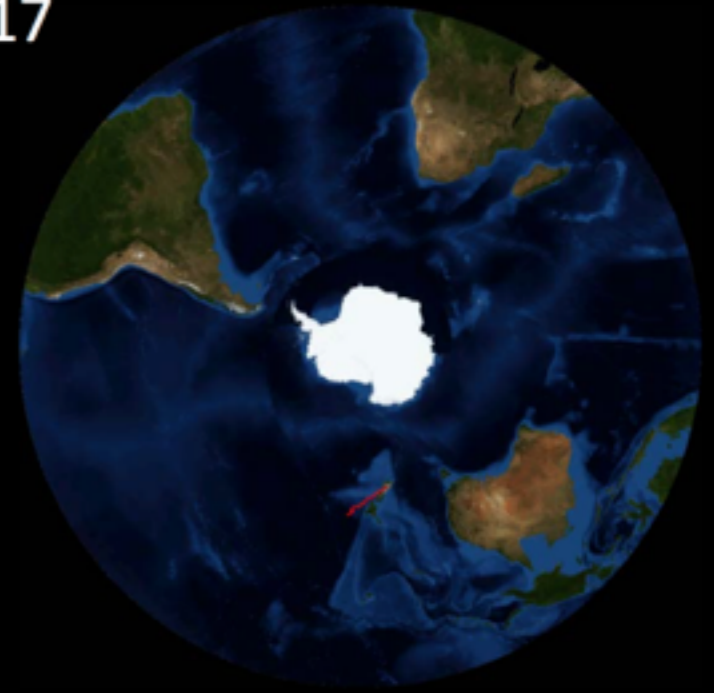


Rachel Gregg
Mines BS 2017



Launch Ready March 25 2017

Our Basic Plan:
Run EUSO-SPB1
into the ground
in 100 days!



EUSO-SPB1 2017 Wanaka NZ

Date	Outcome	Reason	Notes	Try
April 25	Launch	All GO	YEAH!!!!!!!!!!!!!!	8
April 22	Scrubbed	Safety Trajectory	Picked Up	7
April 21	Scrubbed	Wind (surface)	At launch pad w/balloon	6
April 17	Scrubbed	Wind direction	At launch pad (foggy)	5
April 16	Scrubbed	Safety Trajectory	Picked Up	4
April 9 th	Scrubbed	Wind	Picked Up	3
April 8 th	Scrubbed	Crane	No show	2
April 7 th	Scrubbed	Wind/Trajectory	Rolled Out	1
Mar. 25 th			Launch Ready	

Final "Score"
 4 Weather
 2 Safety
 1 Crane
1 EUSO_SPB ← Winner

CSBF OPS HD

2017-04-16 18:52:08:22



Attempt 5

humidity test ok, surface winds got too high

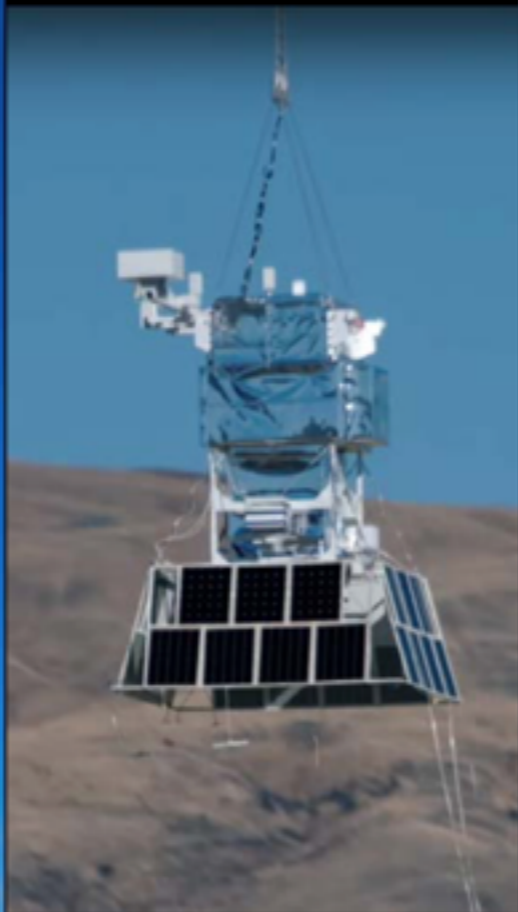
Roll Out

https://www.youtube.com/watch?v=t0t28cDa4tA&index=3&list=PLiuUQ9asub3Sn5RJVTozgzDOtlxZGWM_c

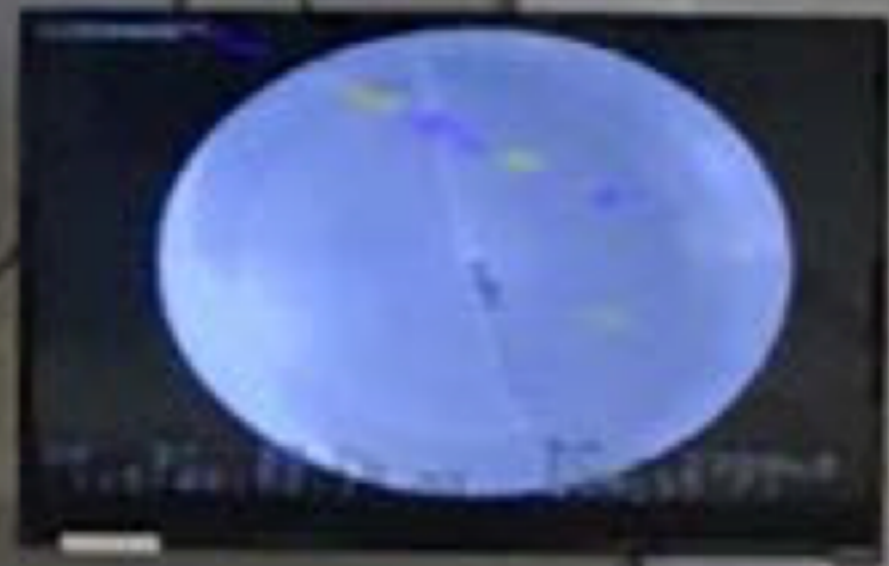
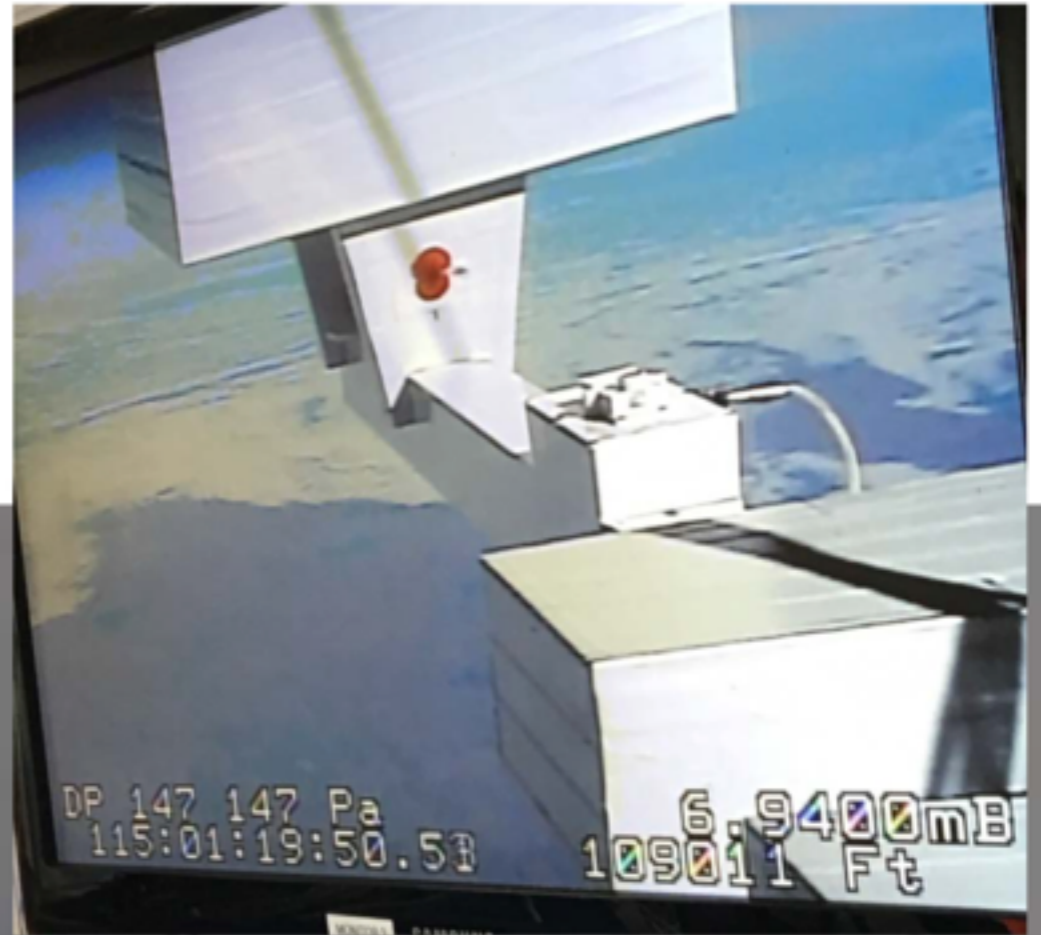
Launch April 25th 2017 (4/24 23:50 UTC)

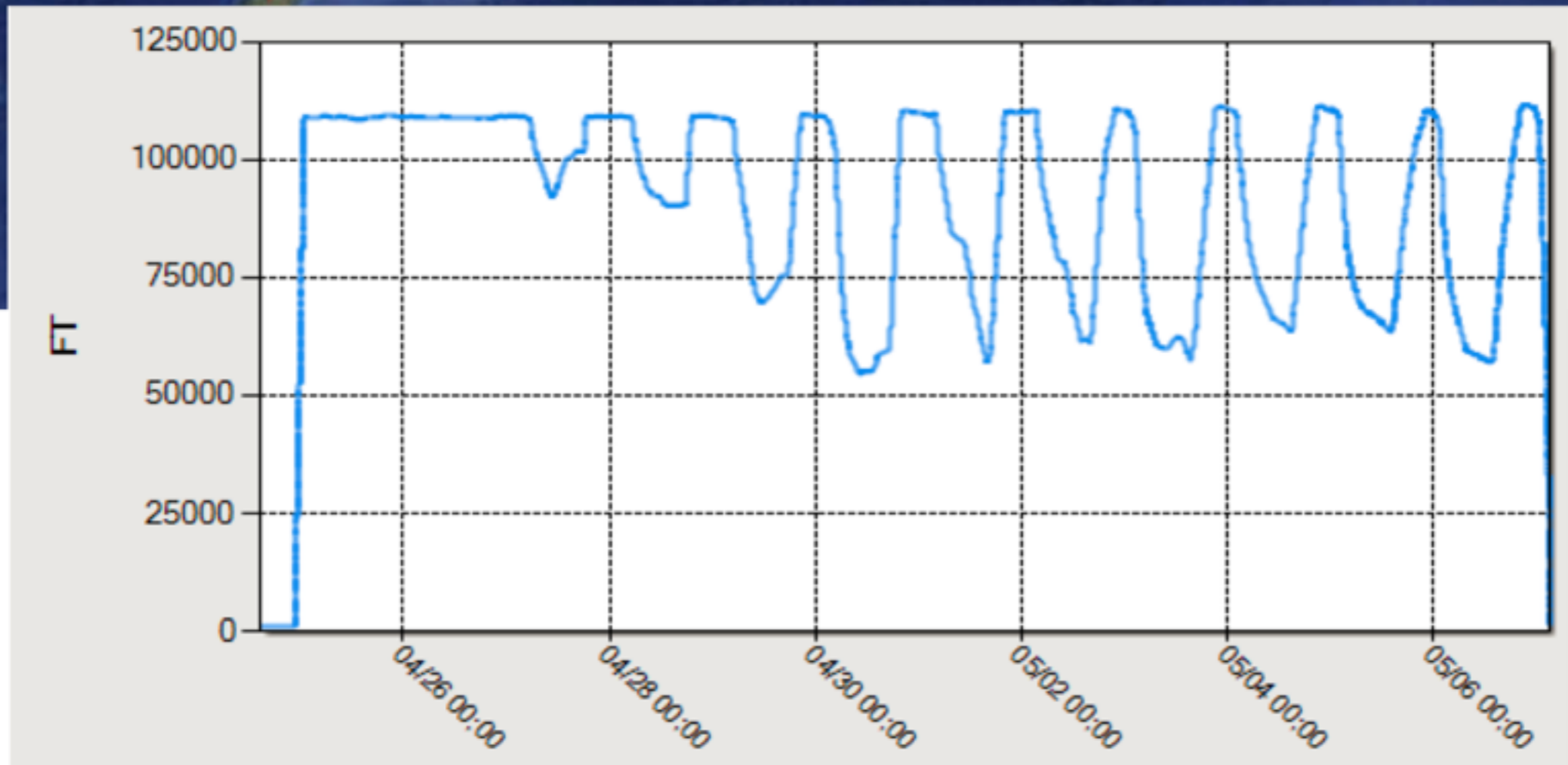
https://www.youtube.com/watch?v=VaPbQFRAVcs&list=PLiuUQ9asub3Sn5RJVTozgzDOtlxZGWM_c&index=1



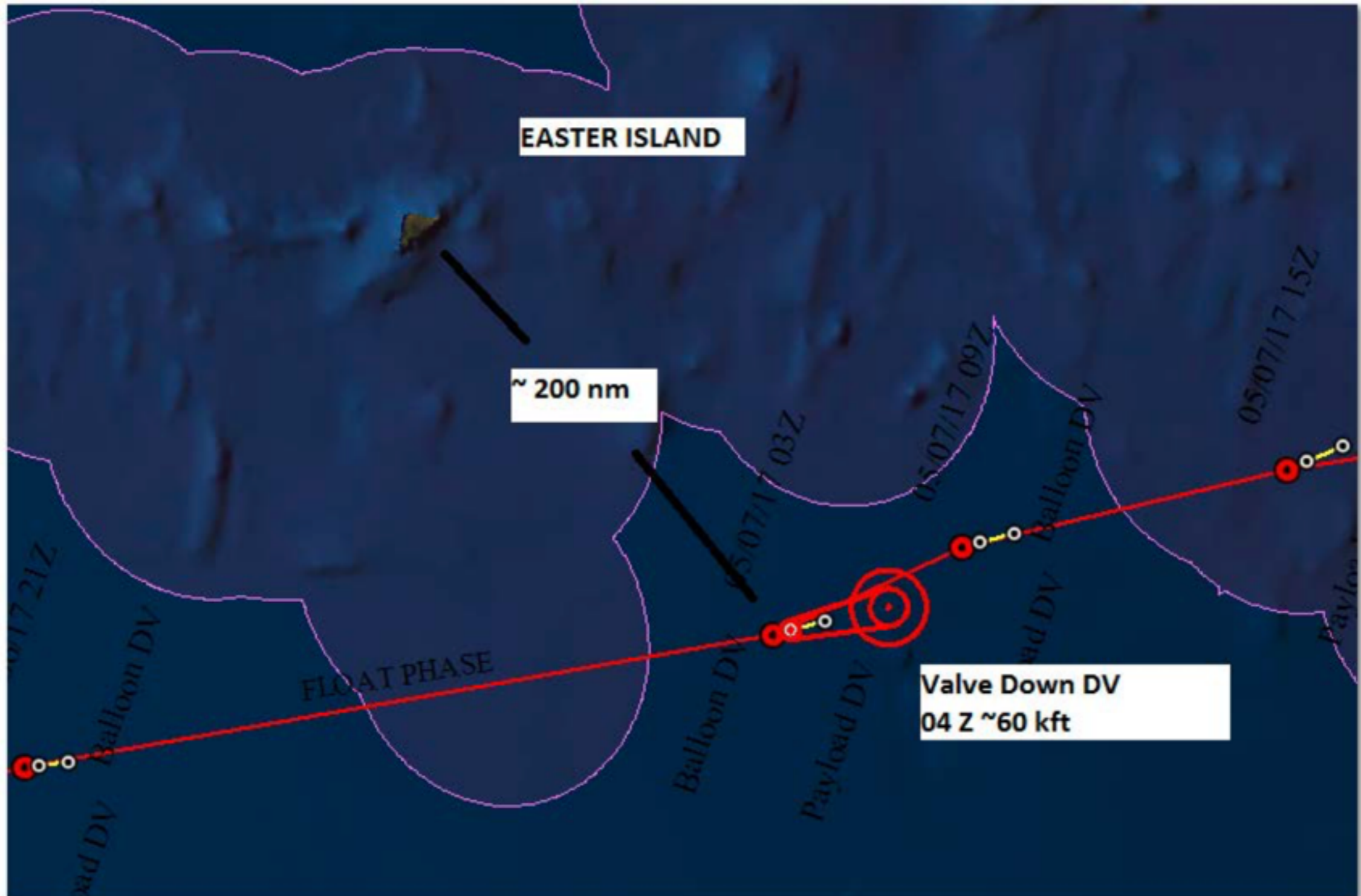






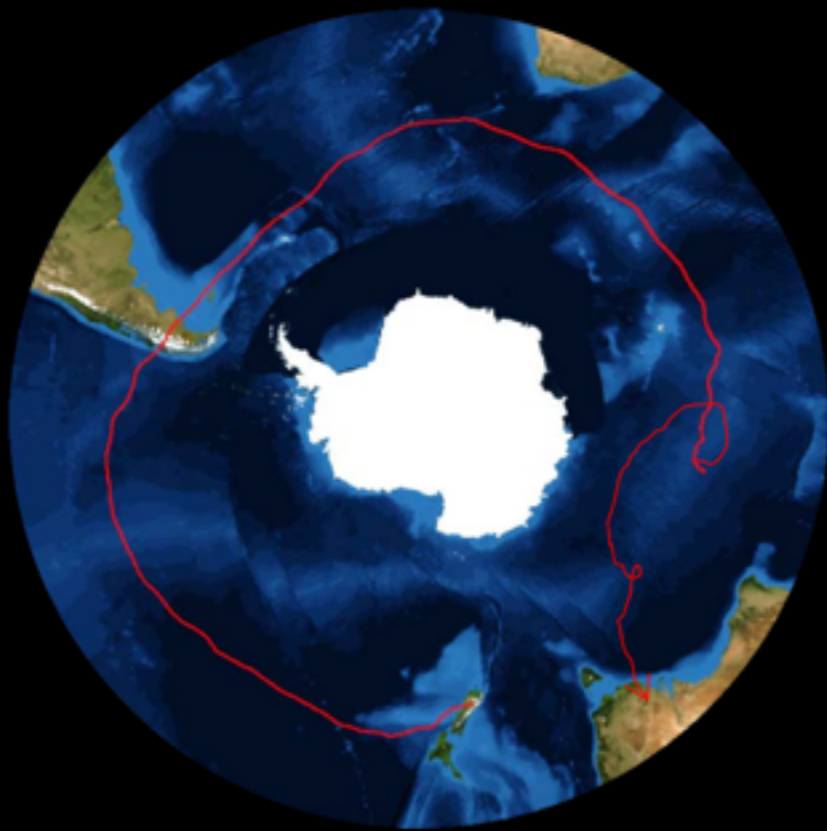


EUSO-SPB Termination May 6th 2017



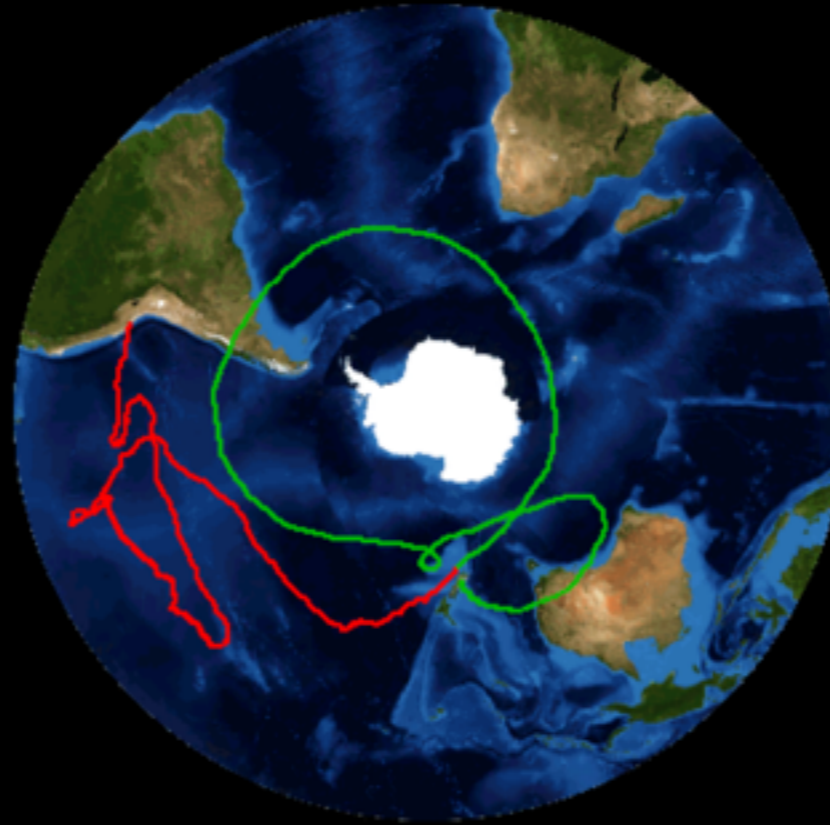
NASA Super Pressure Balloon

2015: 32 d 5 h



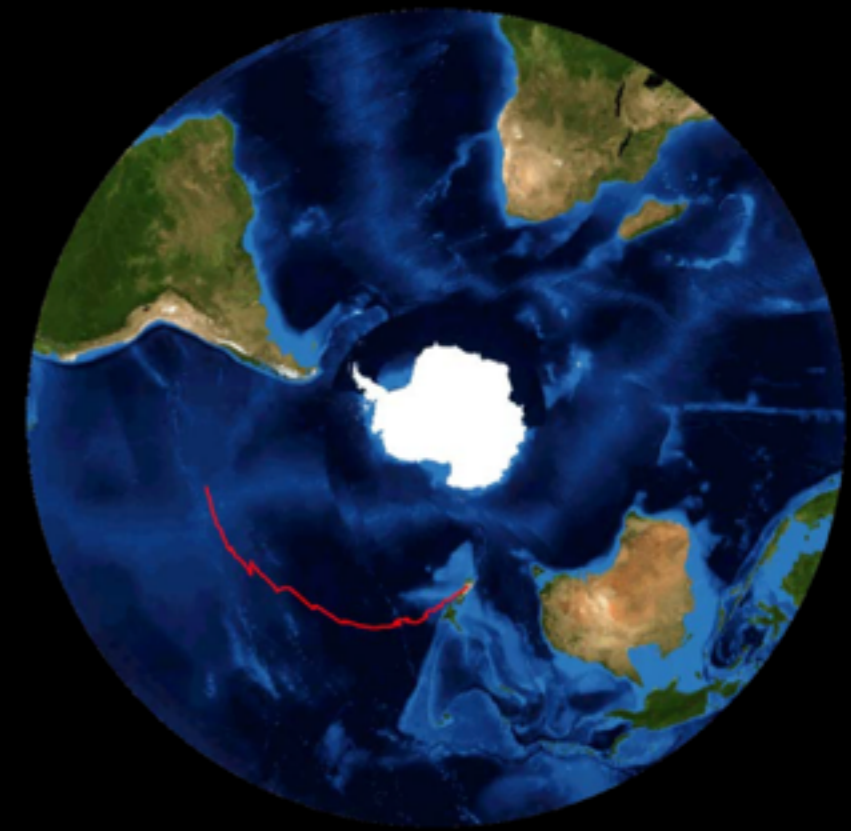
NASA Engineering Flight

2016: 46 d 20 h



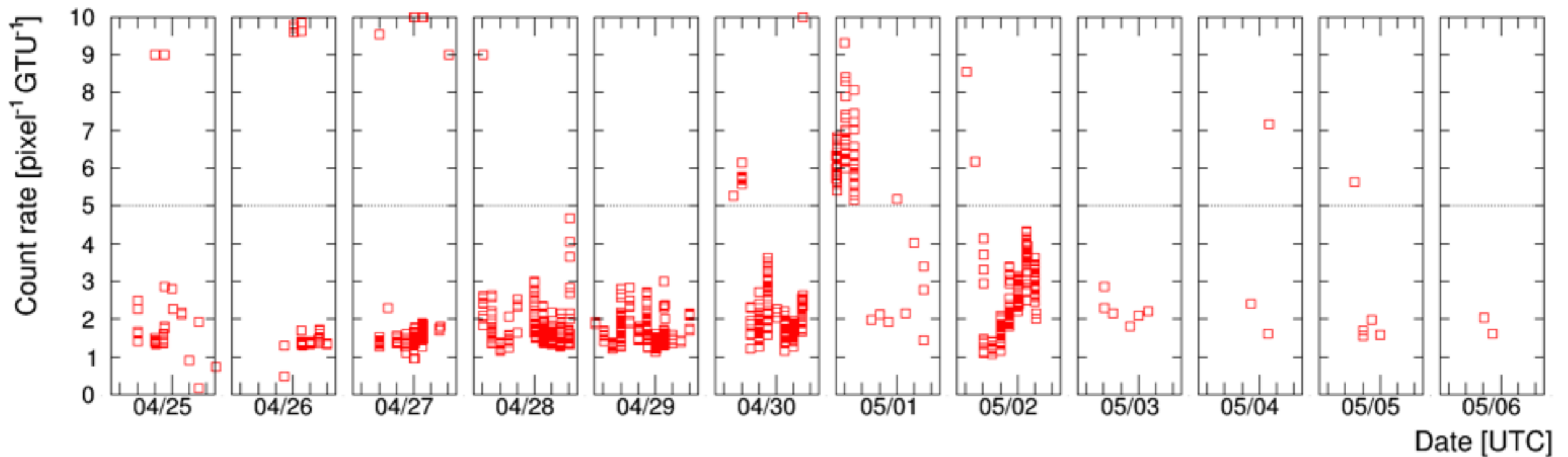
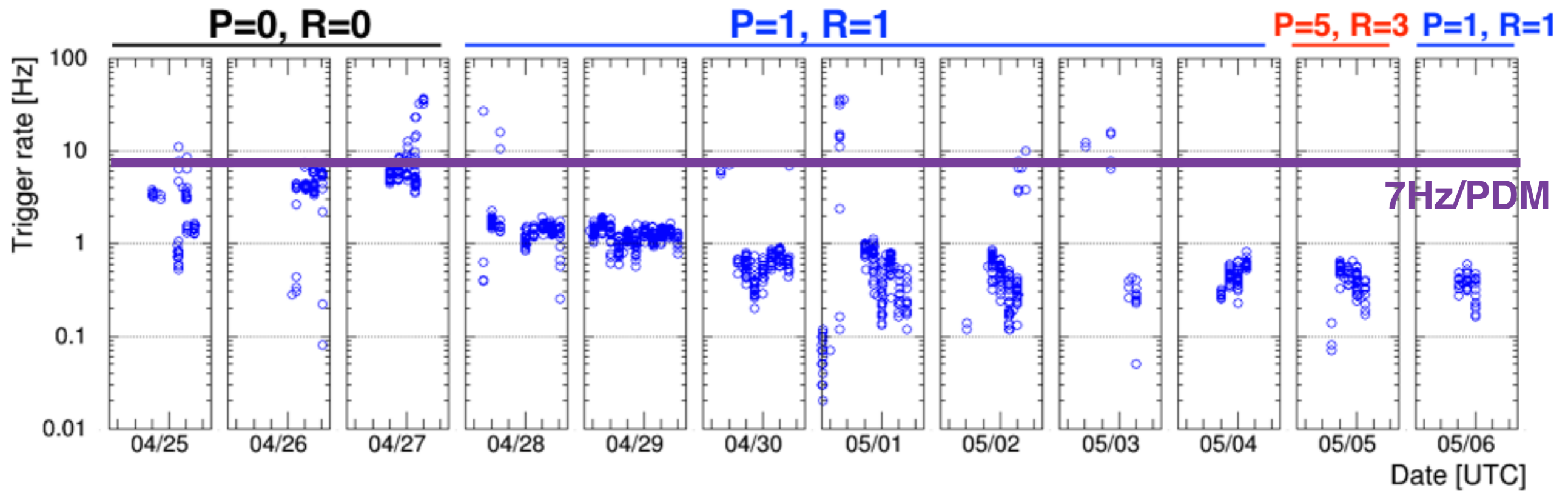
COSI

2017: 12 d 4 h

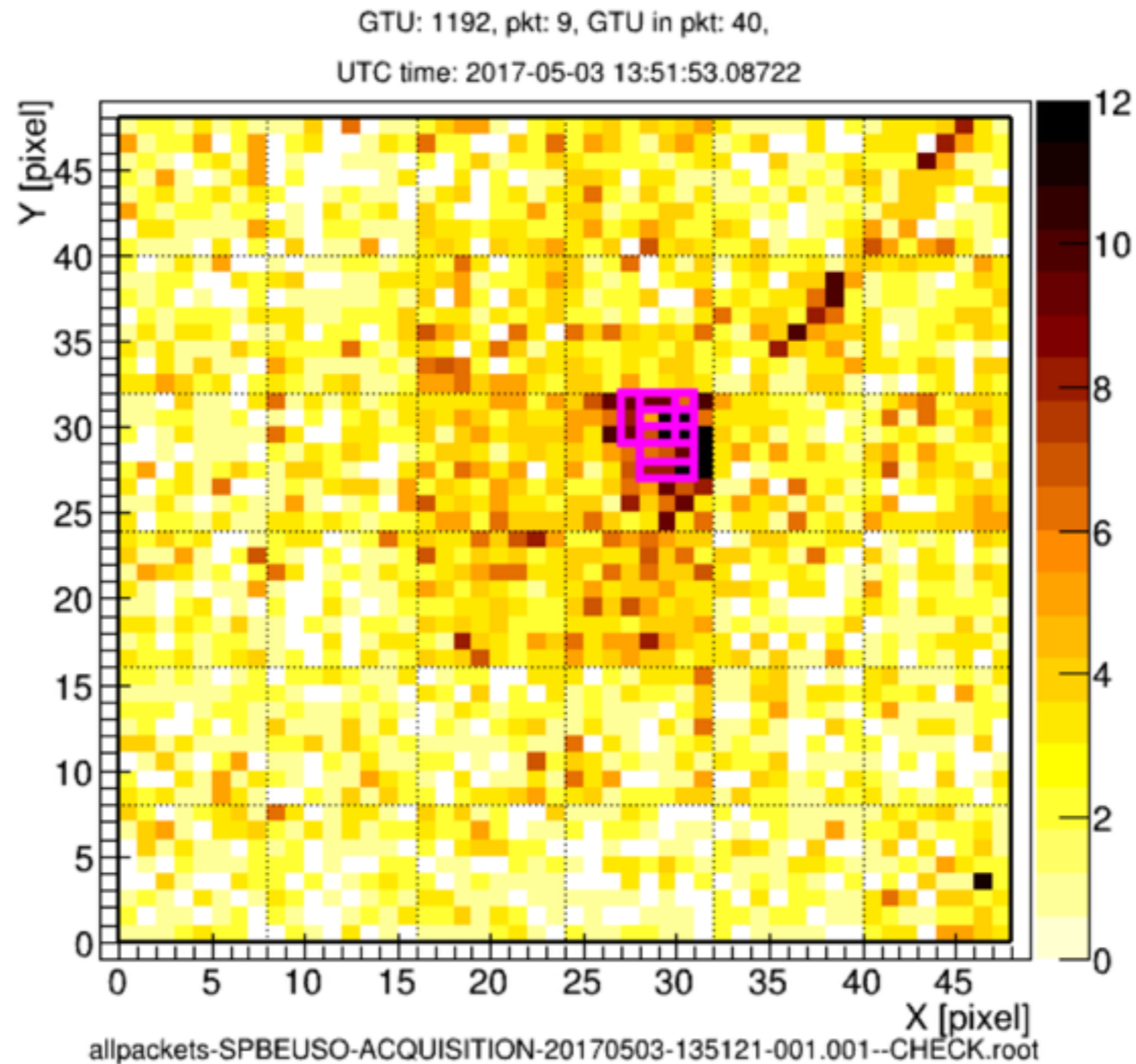


EUSO

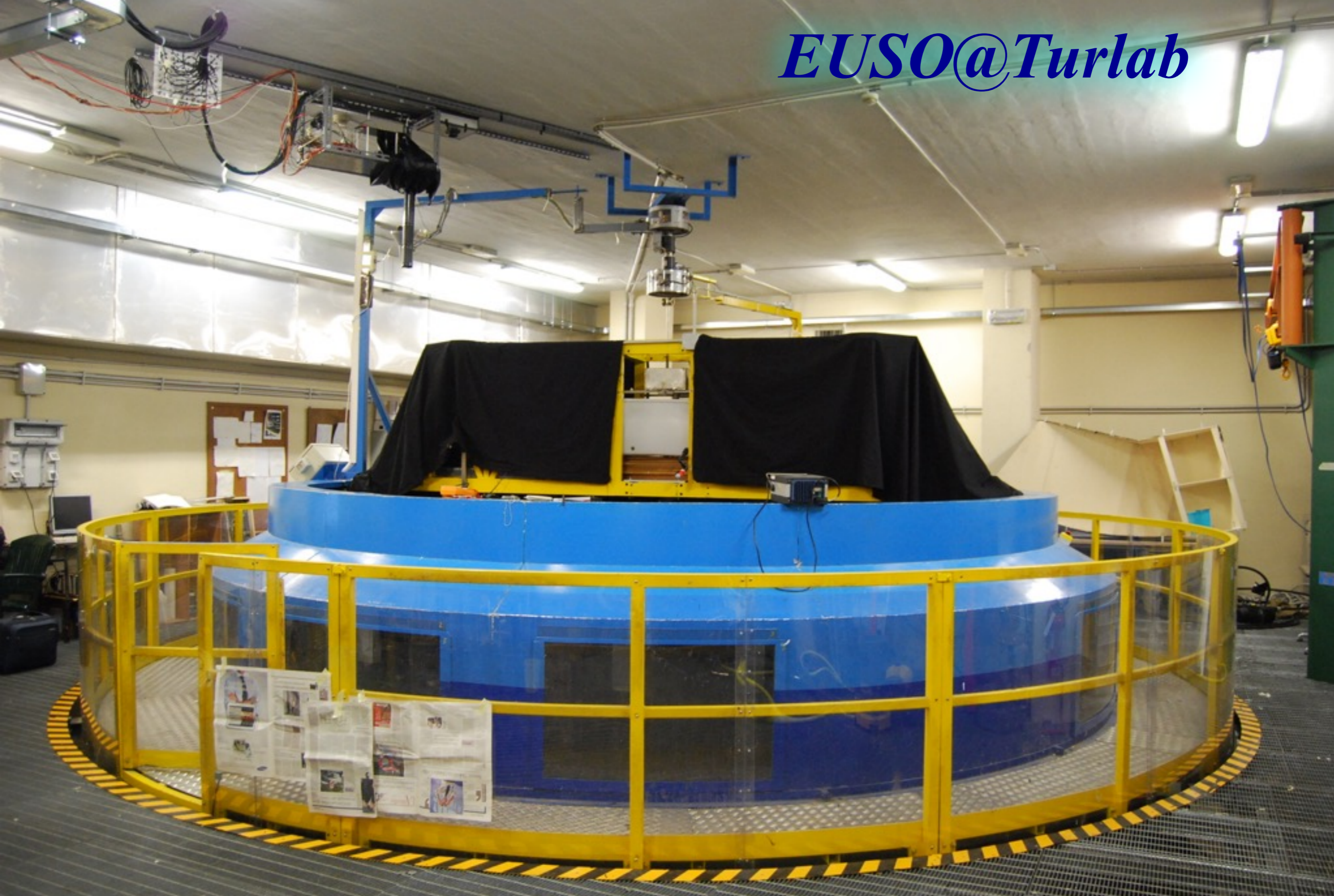
How the First Level Trigger operated in flight



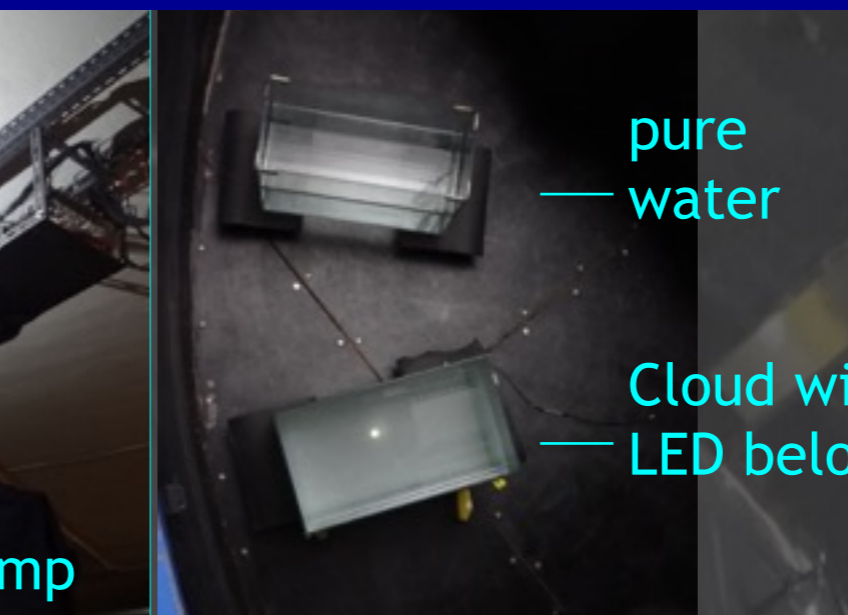
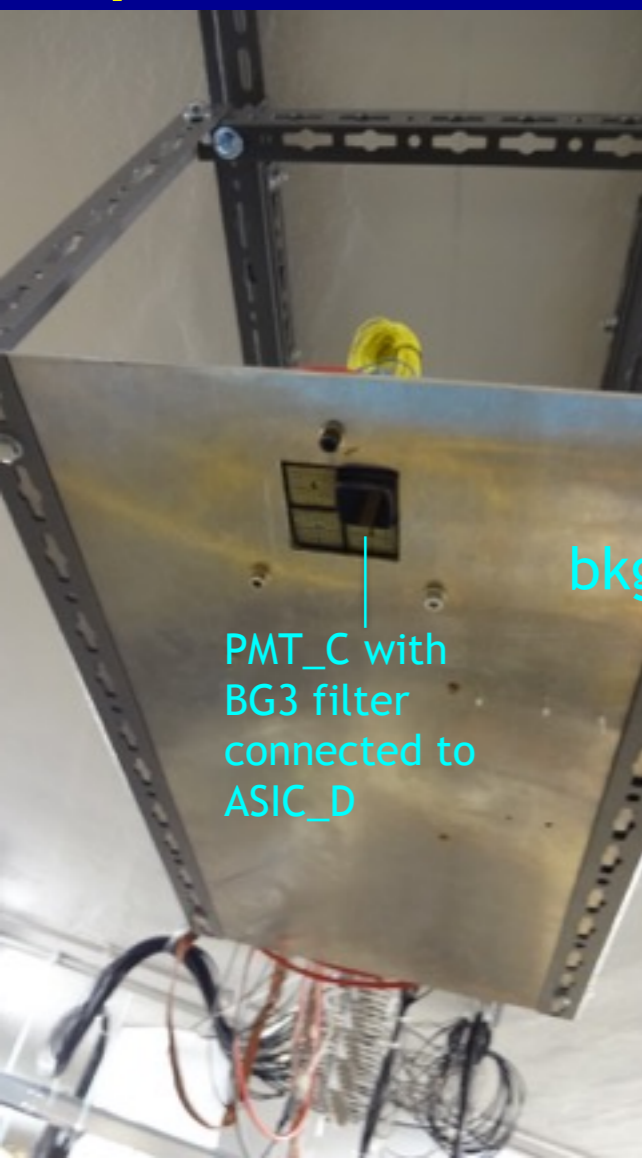
A direct cosmic ray in the detector?



EUSO@Turlab

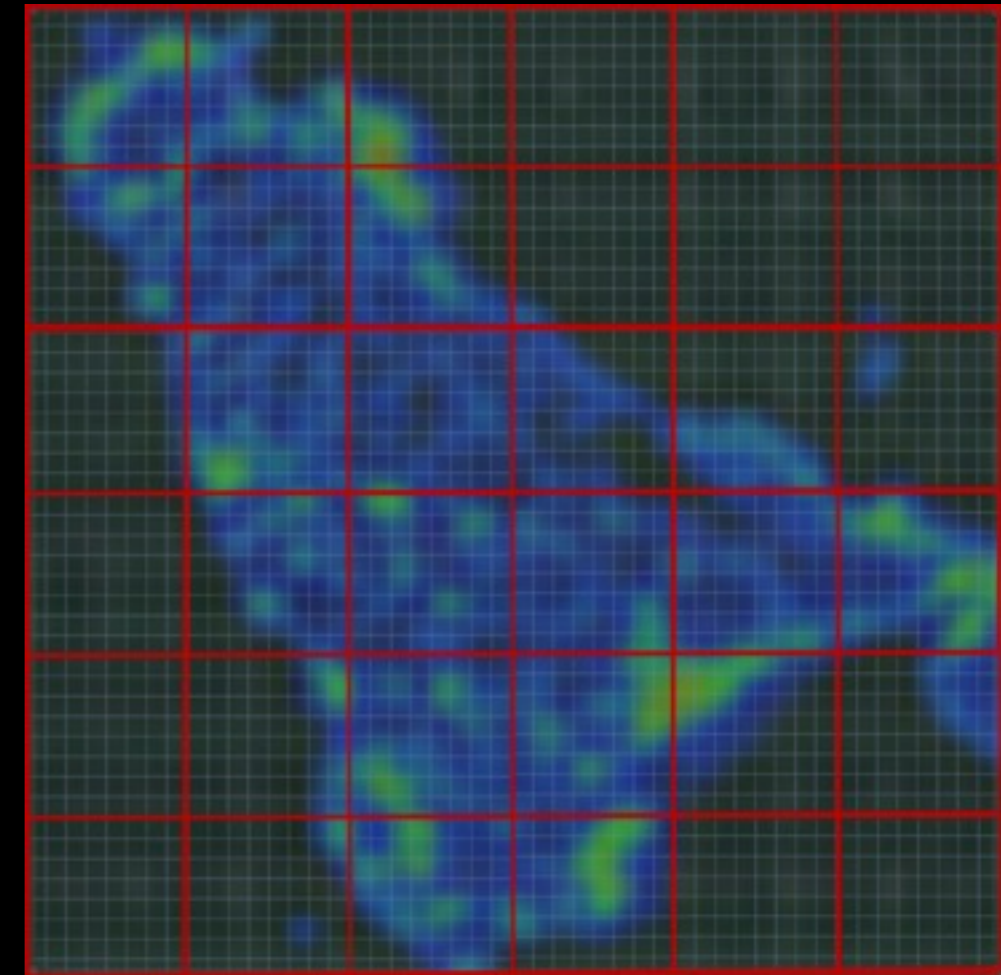
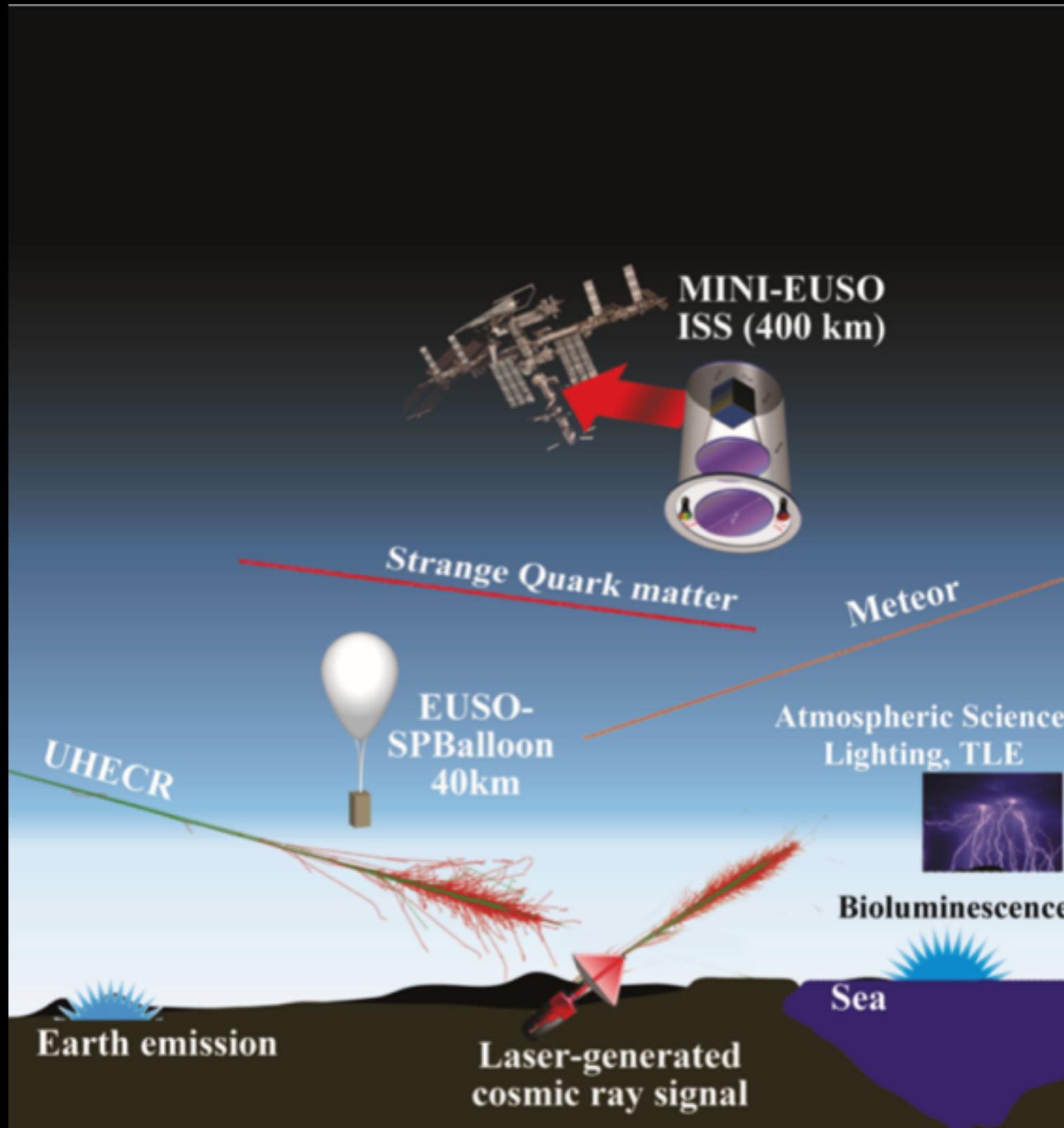


Implementation2: light sources, materials, DAQ & monitoring



MINI-EUSO

Scientific objectives

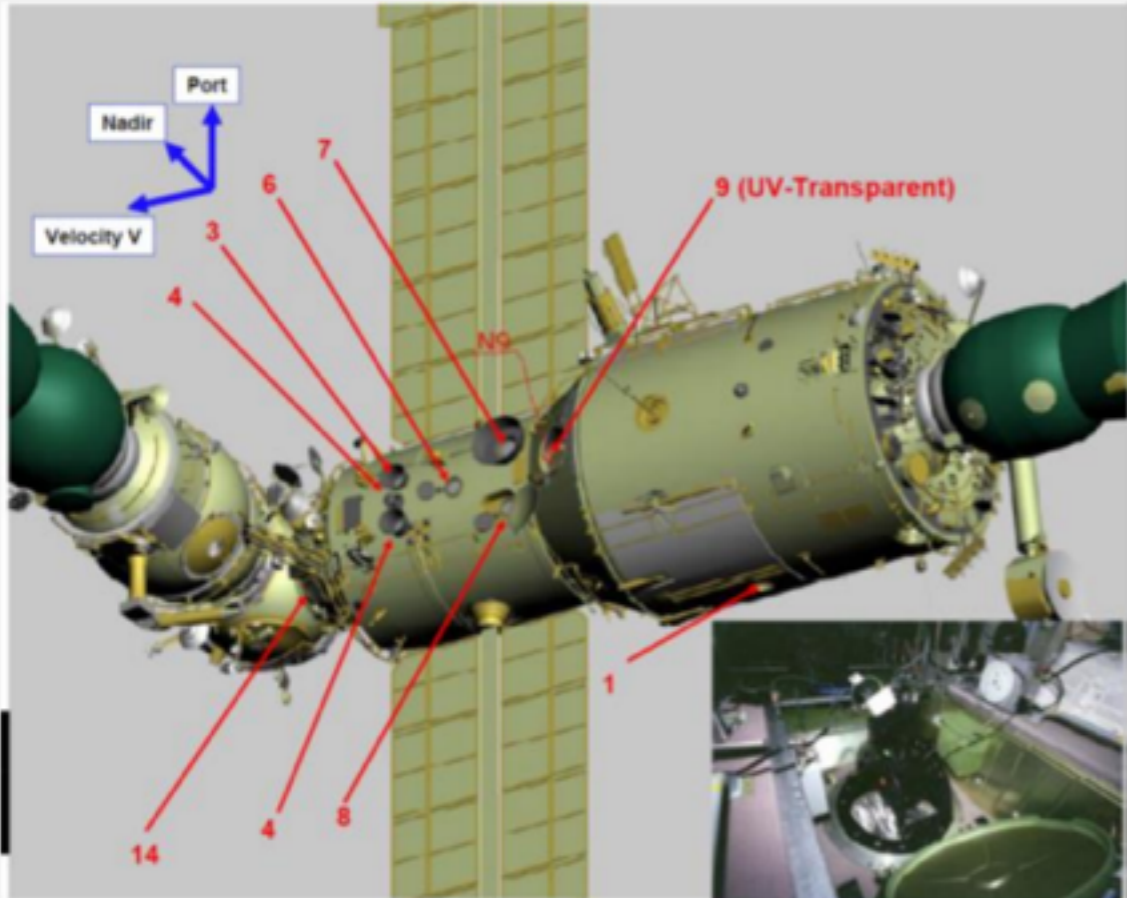


Launch 2017 or 2018

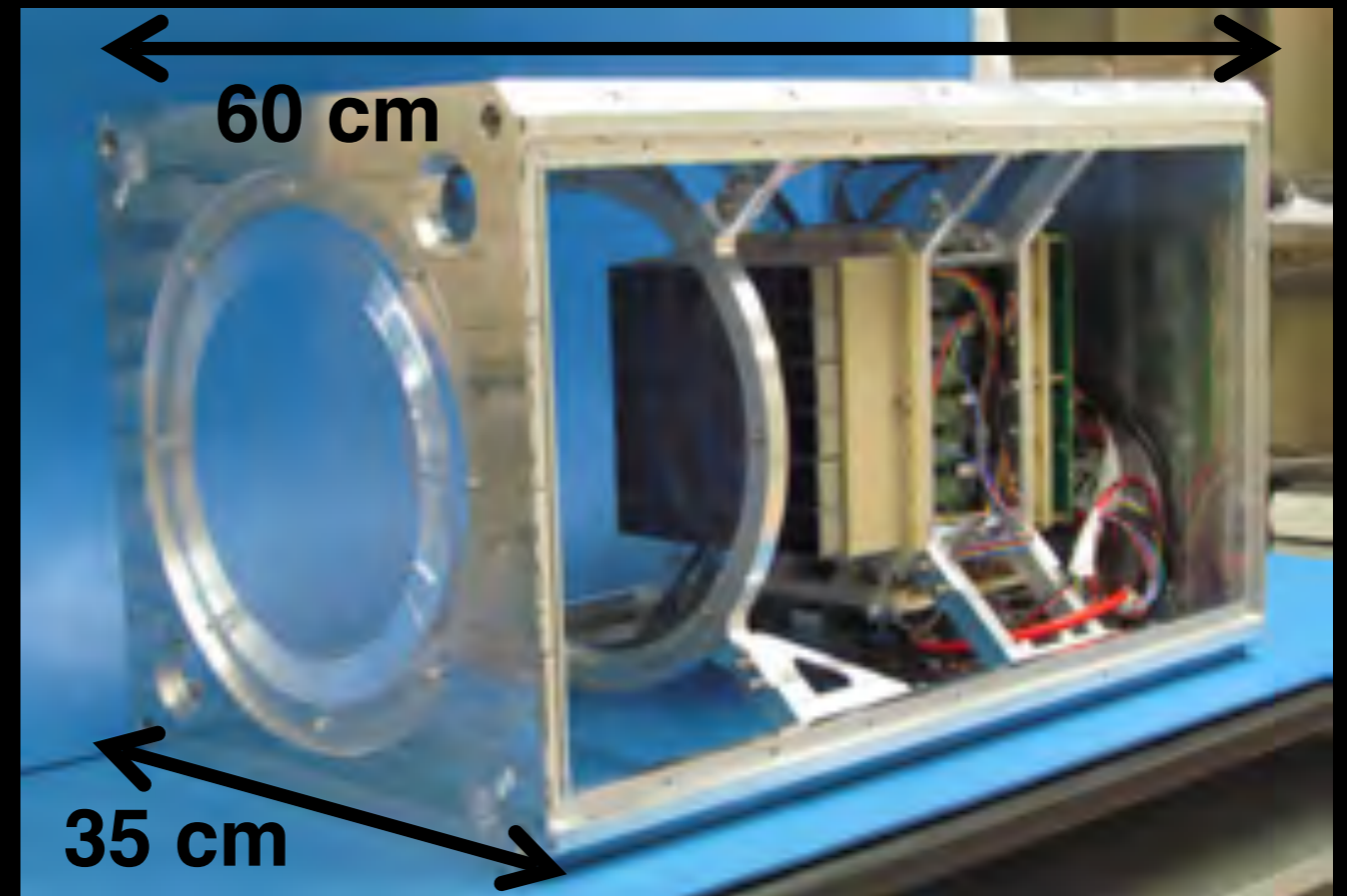
MINI-EUSO/UV-Atmosphere



- Approved by Italian & Russian Space Agencies
- Inside the ISS
- 2 Fresnel lenses and one PDM
- 30W @ 27V
- 30kg not incl SSD



UV atmosphere is a wide field of view telescope to be installed on board the Russian Segment of the ISS (UV transparent window of Service module)

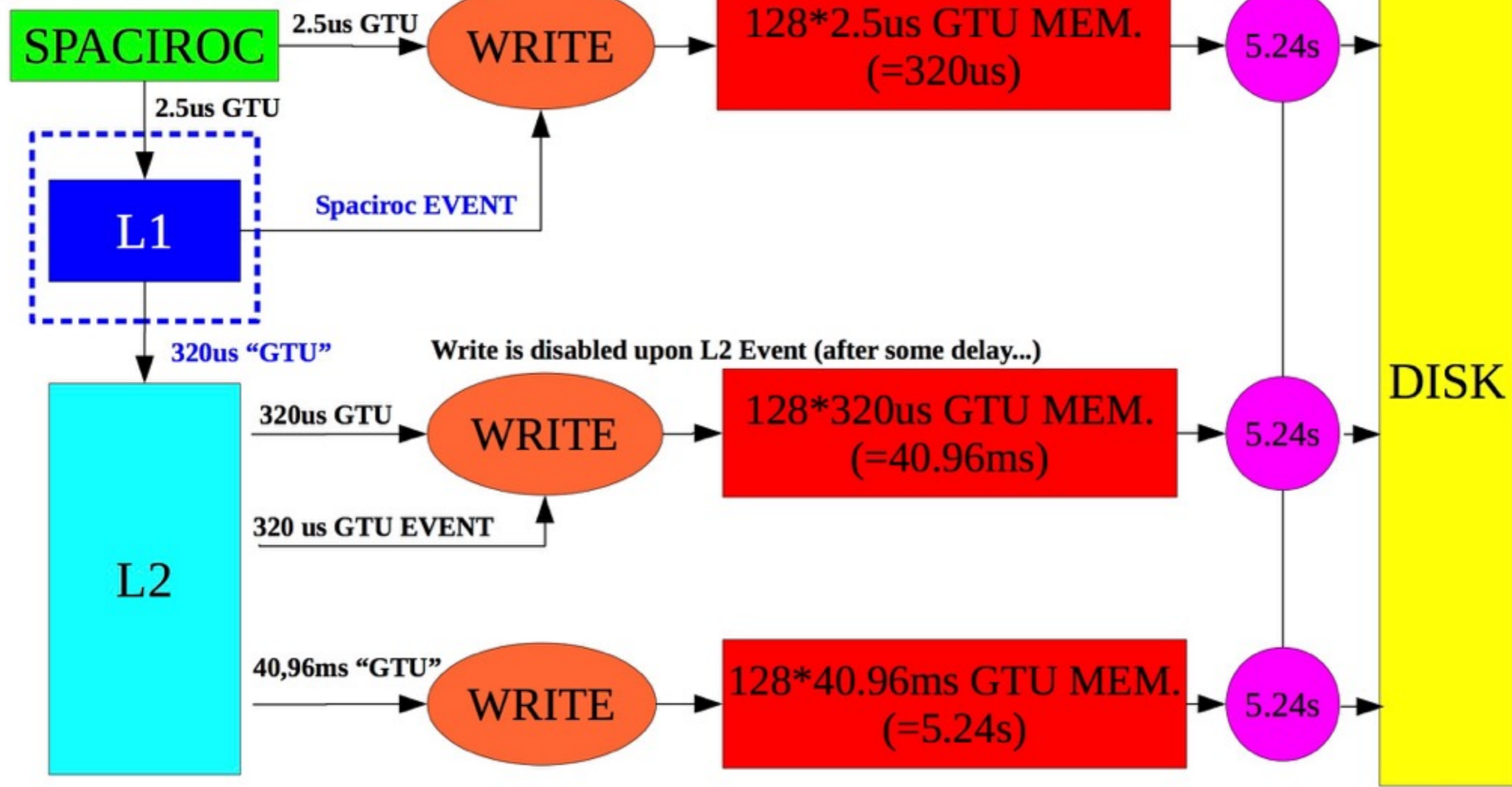




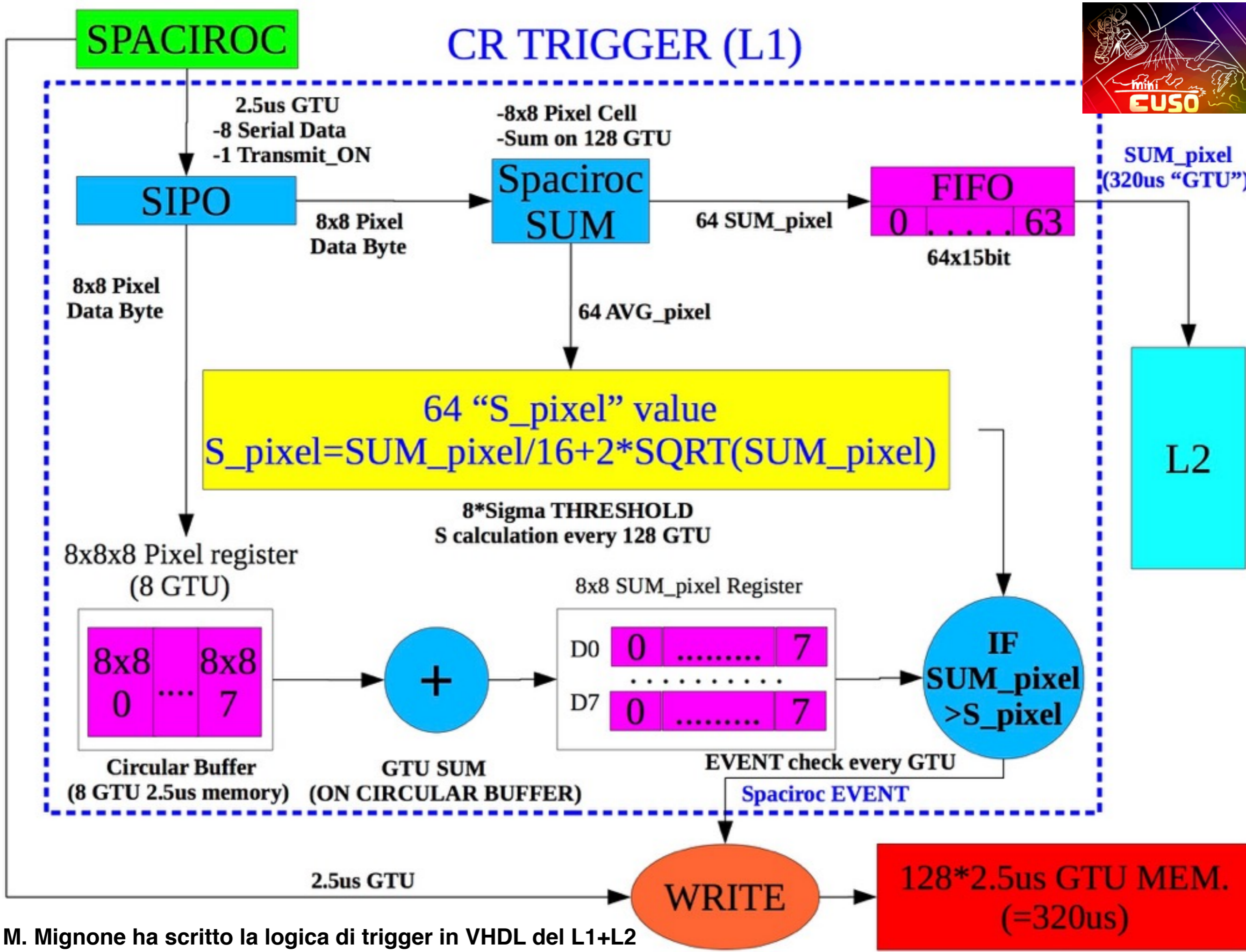


L1+L2 Logic

8x8 Pixel Matrix



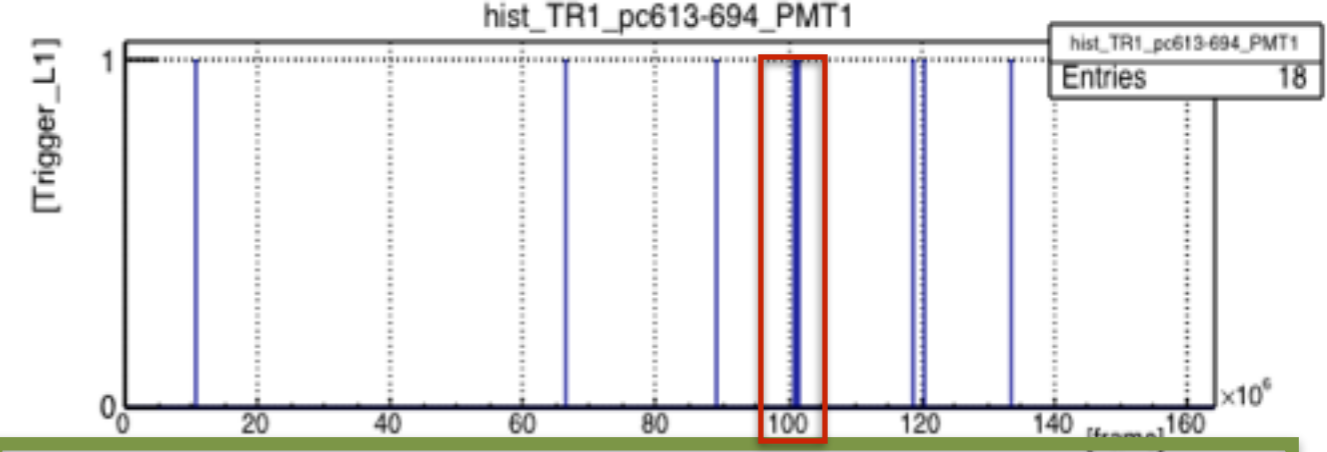
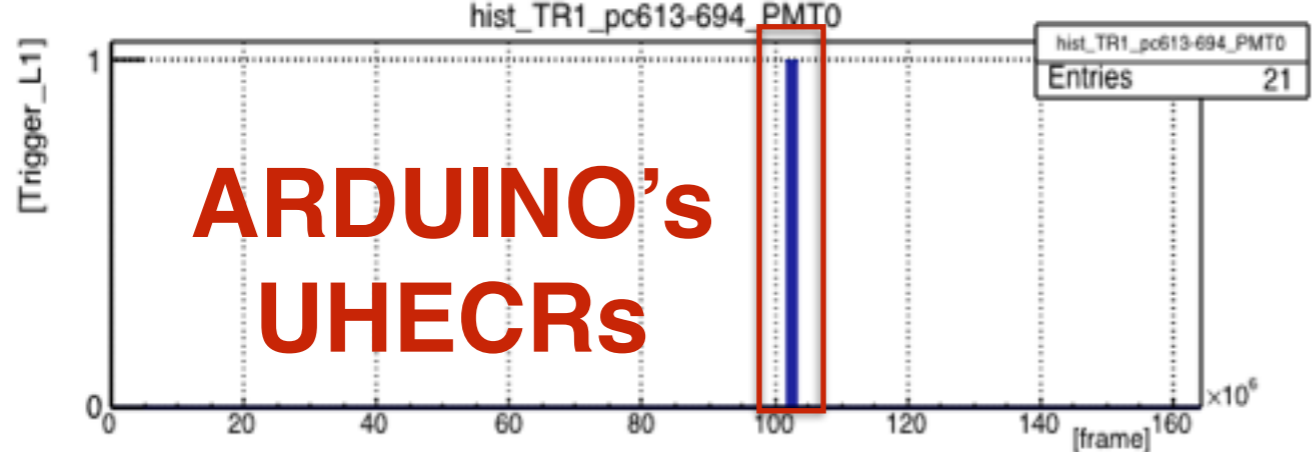
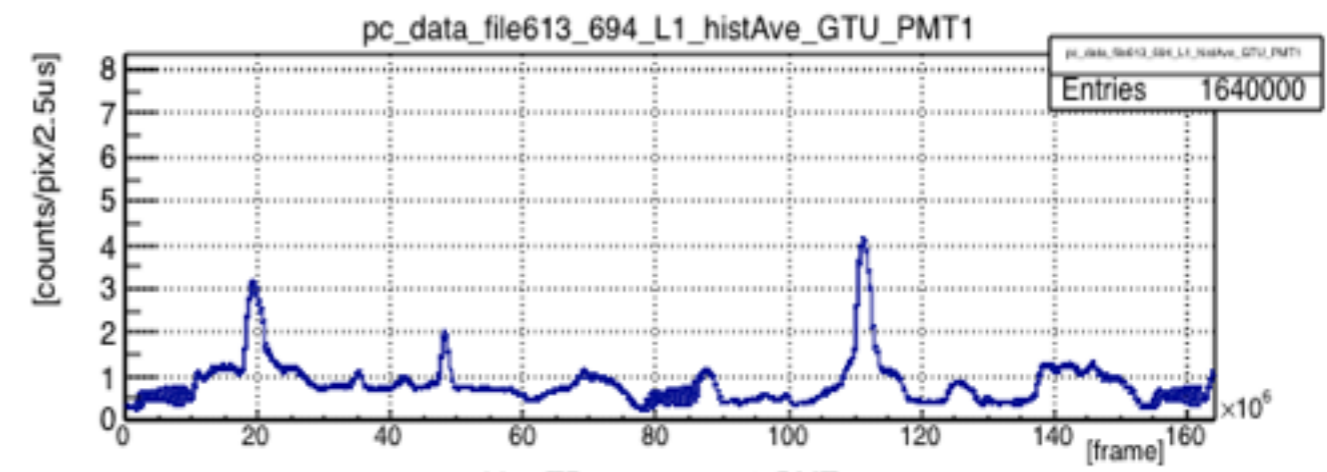
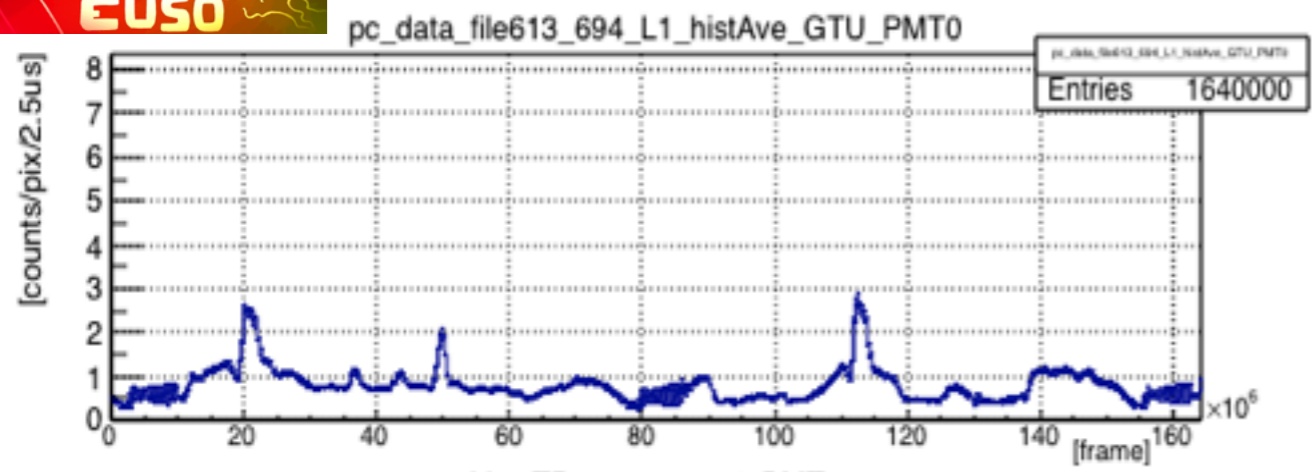
M. Mignone ha scritto la logica di trigger in VHDL del L1+L2



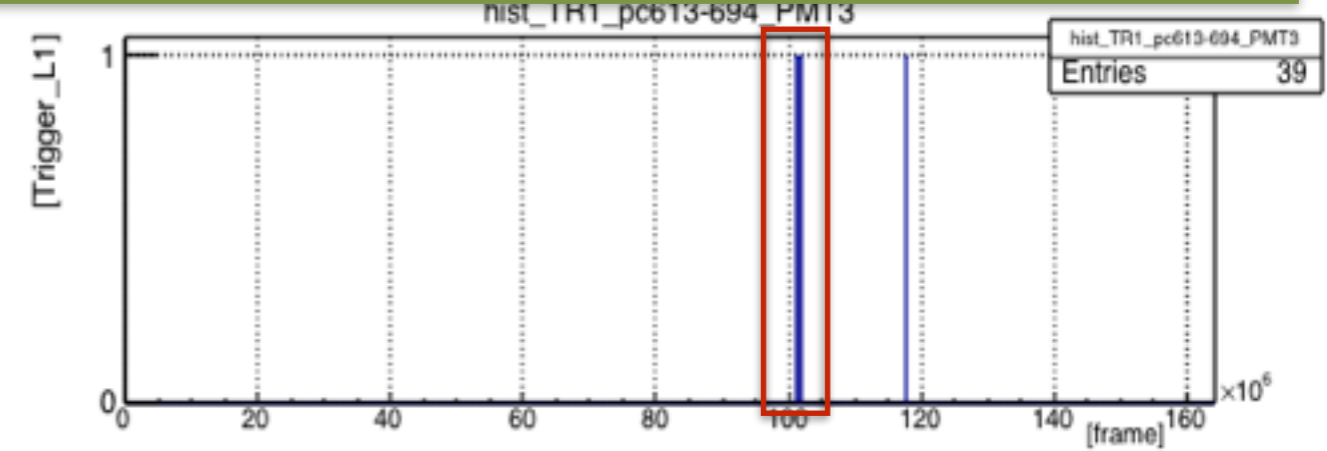
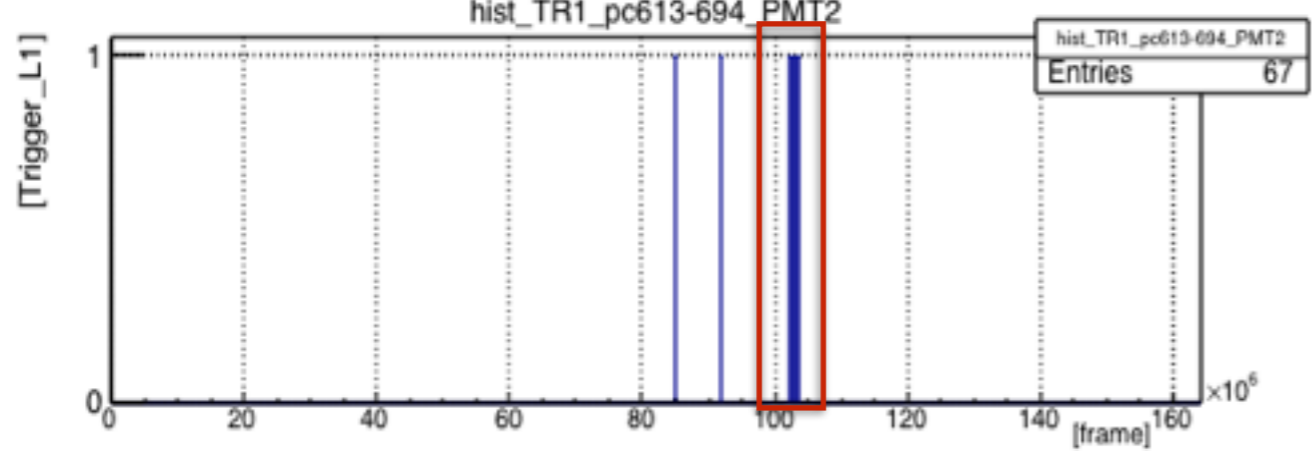
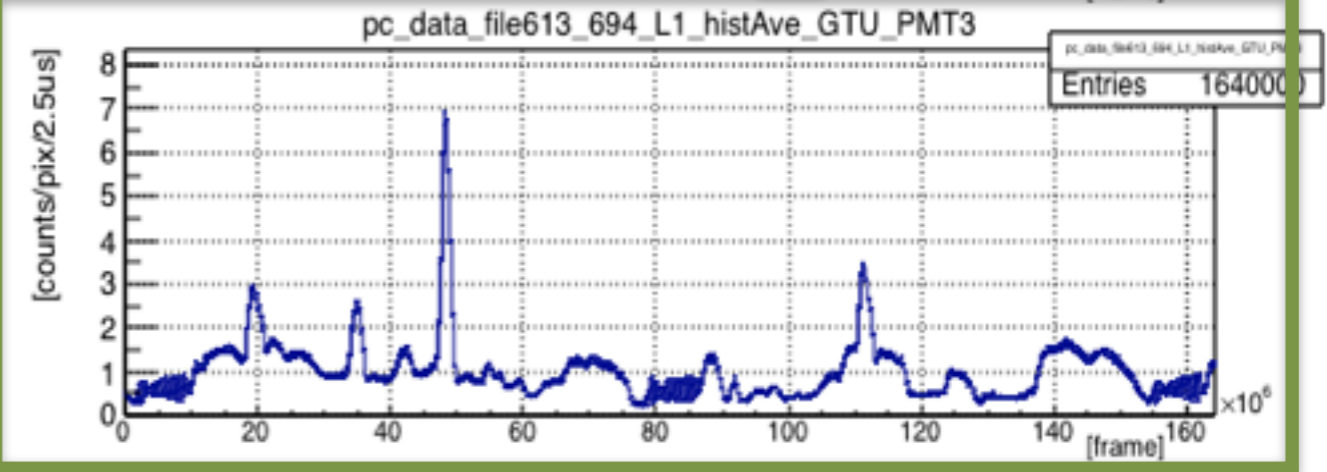
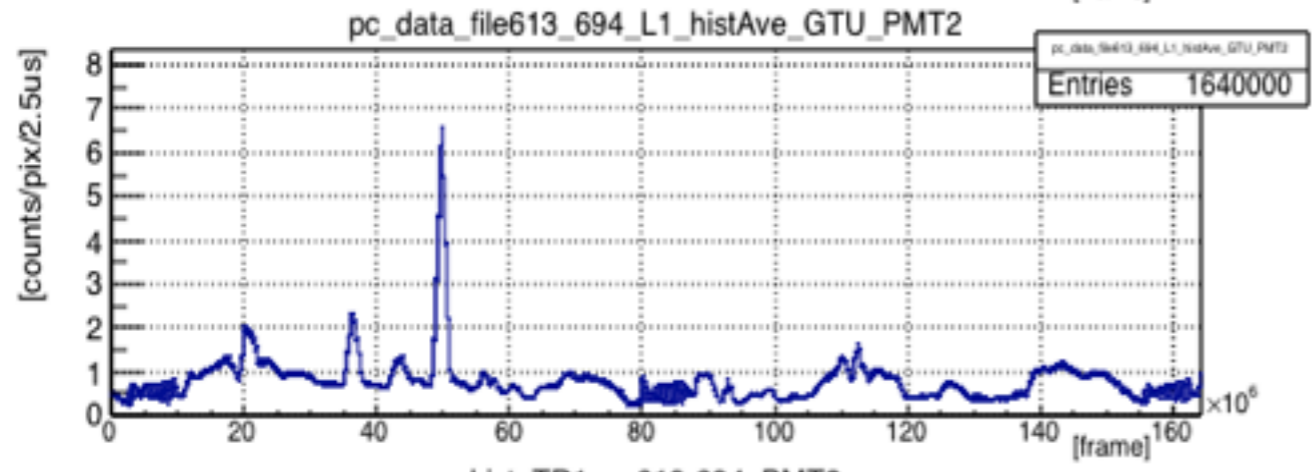
M. Mignone ha scritto la logica di trigger in VHDL del L1+L2



Background vs L1 trigger



**ARDUINO's
UHECRs**



ELETTRONICA

Marco ha già scritto il codice VHDL per il trigger di EUSO-Balloon/SPB e **ha completato la prima versione per MINI-EUSO.**

Saranno necessarie interazioni, limature del codice, test al TurLab.

Il supporto di Marco è fondamentale perché il tutto venga inserito correttamente e funzioni come previsto.

INFN Torino ha il ruolo CHIAVE nella missione MINI-EUSO (così come lo aveva in EUSO-SPB!).

Il numero di mesi richiesto rimane limitato perché siamo già avanti con il lavoro

M. Mignone 1 mese



DOMANDA DI UTILIZZO DEI SERVIZI DI BASE

Data della richiesta: 24 giugno 2017

Lab. Tecnologico <input type="checkbox"/>	Lab. Elettronica <input checked="" type="checkbox"/>	Centro di Calcolo <input type="checkbox"/>	nuova richiesta <input type="checkbox"/>
			richiesta di continuazione <input checked="" type="checkbox"/>

Esperimento: JEM-EUSO_RD

Responsabile locale: M. Bertaina

Responsabile dell'attività: M. Bertaina

Descrizione dettagliata dell'attività richiesta

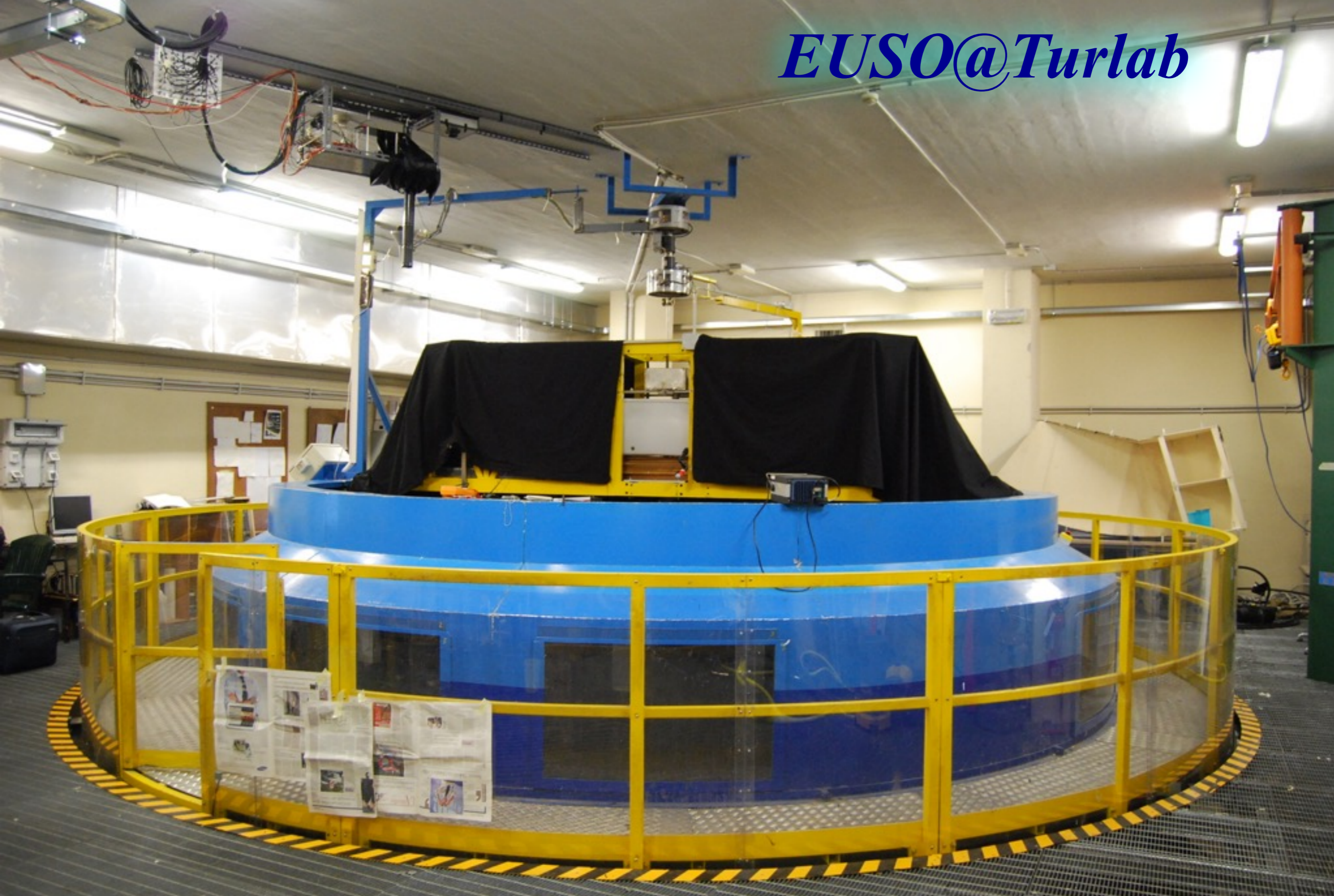
Il codice di trigger di primo e secondo livello di trigger è stato codificato da Marco Mignone nel 2017. In questo momento è in corso di test la logica e la sua performance. La disponibilità di Marco è necessaria laddove ci siano ancora delle piccole modifiche da fare in funzione dei test che verranno condotti pre-lancio.

Subattività	PLANNING												MILESTONES	
	G	F	M	A	M	G	L	A	S	O	N	D	Data-mese	Descrizione
Trigger Mini-E	✓													

Tecnici e tecnologi attualmente assegnati all'attività					Richieste di supporto tecnico per		
INFN		ALTRI ENTI			l'anno:		2018
Nome	mesi/U	Ente	Nome	mesi/U	Tipologia	N.	mesi/U
M. Mignone	1				Tecnici mecc. /elettr/CdC	1	1
					Disegnatori meccanici		
					Microsaldatori		
					Tecnologi progett. mecc.		
					Tecnologi elettronici/CdC		
					Tecnologi microelettronica		

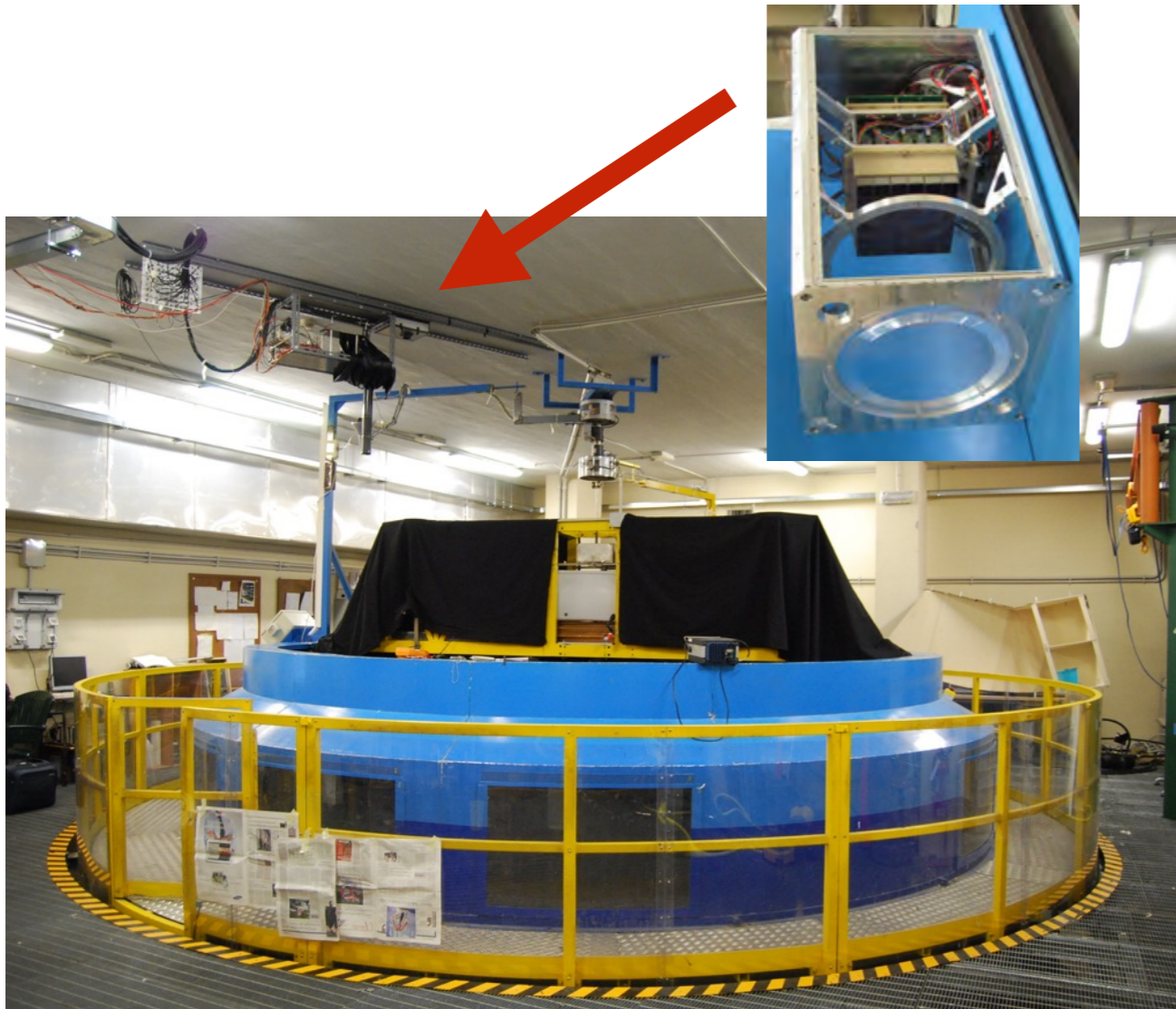
Note:

EUSO@Turlab



MECCANICA

Fare una simulazione di volo di Mini-EUSO al TurLab



INFN **DOMANDA DI UTILIZZO DEI SERVIZI DI BASE**

Data della richiesta: 24 giugno 2017

Lab. Tecnologico Lab. Elettronica Centro di Calcolo

nuova richiesta
richiesta di continuazione

Esperimento: JEM-EUSO_RD Responsabile locale: M. Bertaina
Responsabile dell'attività: M. Bertaina

Descrizione dettagliata dell'attività richiesta

Progettazione e realizzazione di un piccolo supporto meccanico per testare Mini-EUSO. Non è evidente ancora se si tratti del modello ingegneristico di Mini-EUSO caratterizzato da una lente di fresnel, 4 fotomoltiplicatori, un paio di schede di elettronica che ha le dimensioni di 50 x 20 x 20 cm³. O se si tratti piuttosto di Mini-EUSO stesso che ha dimensioni dell'ordine 50x50x100 cm³. Si tratta di un'attività che era stata prevista per il 2016 ma che è stata rinviata perché si è deciso di testare Mini-EUSO stesso al TurLab (vasca al -4 di Fisica).

Subattività	PLANNING												MILESTONES	
	G	F	M	A	M	G	L	A	S	O	N	D	Data-mese	Descrizione
Mini-EUSO	✓	✓												vedi descrizione attività

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

Note:

M. Marengo 2 mesi

GRAZIE per
l'attenzione!