平成29年度東京大学宇宙線研共同利用研究成果発表会

EUSO-TA and EUSO-SPB testing and calibration at Telescope Array Site: status and perspectives.

Marco Casolino

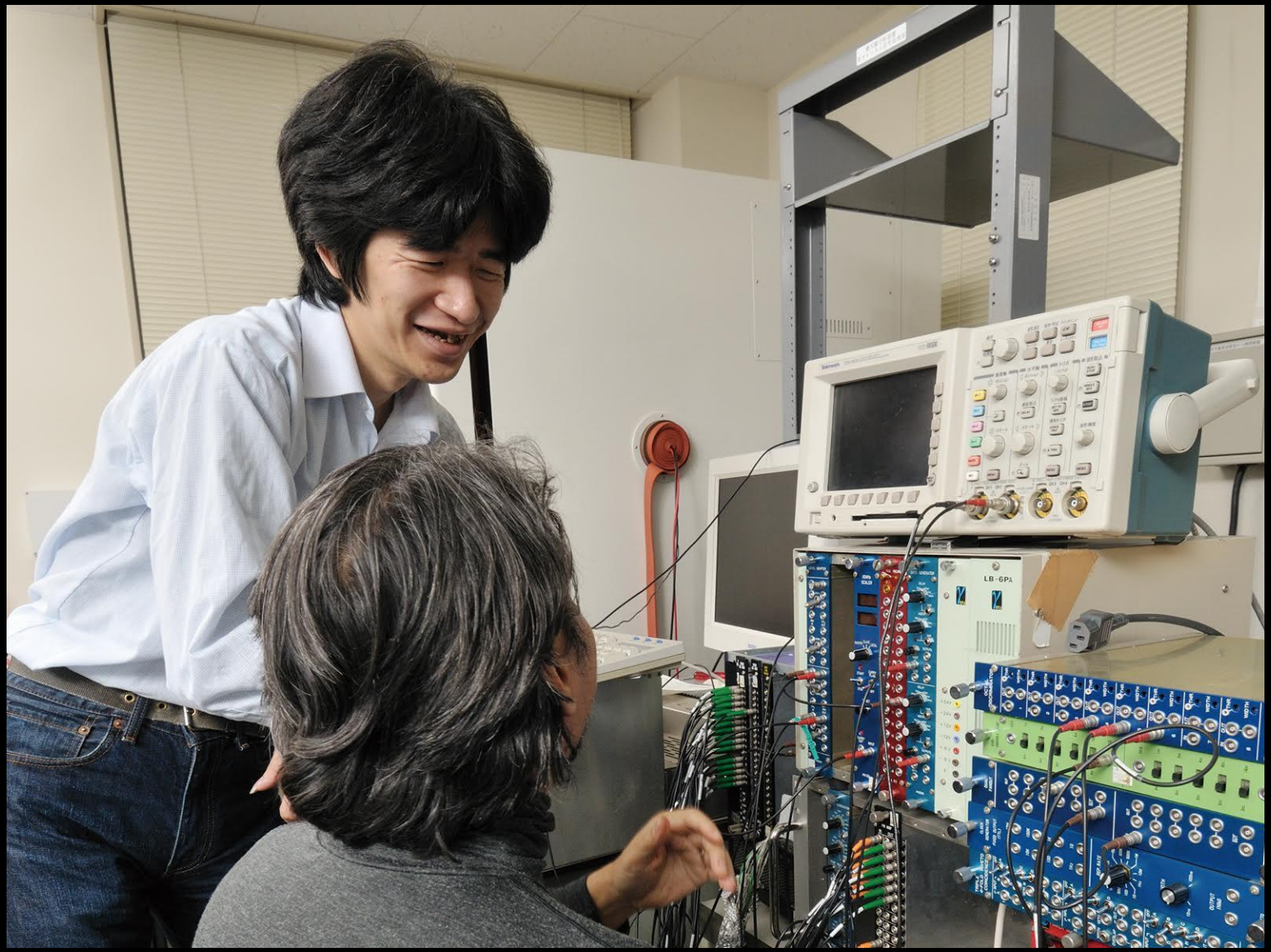
On behalf of the JEM-EUSO collaboration

09/12/2017

RIKEN

INFN Istituto Nazionale di Fisica Nucleare

In memory of Yoshiya Kawasaki



The EUSO program

1. **EUSO-TA:** *Ground detector installed in 2013 at Telescope Array site: currently operational*

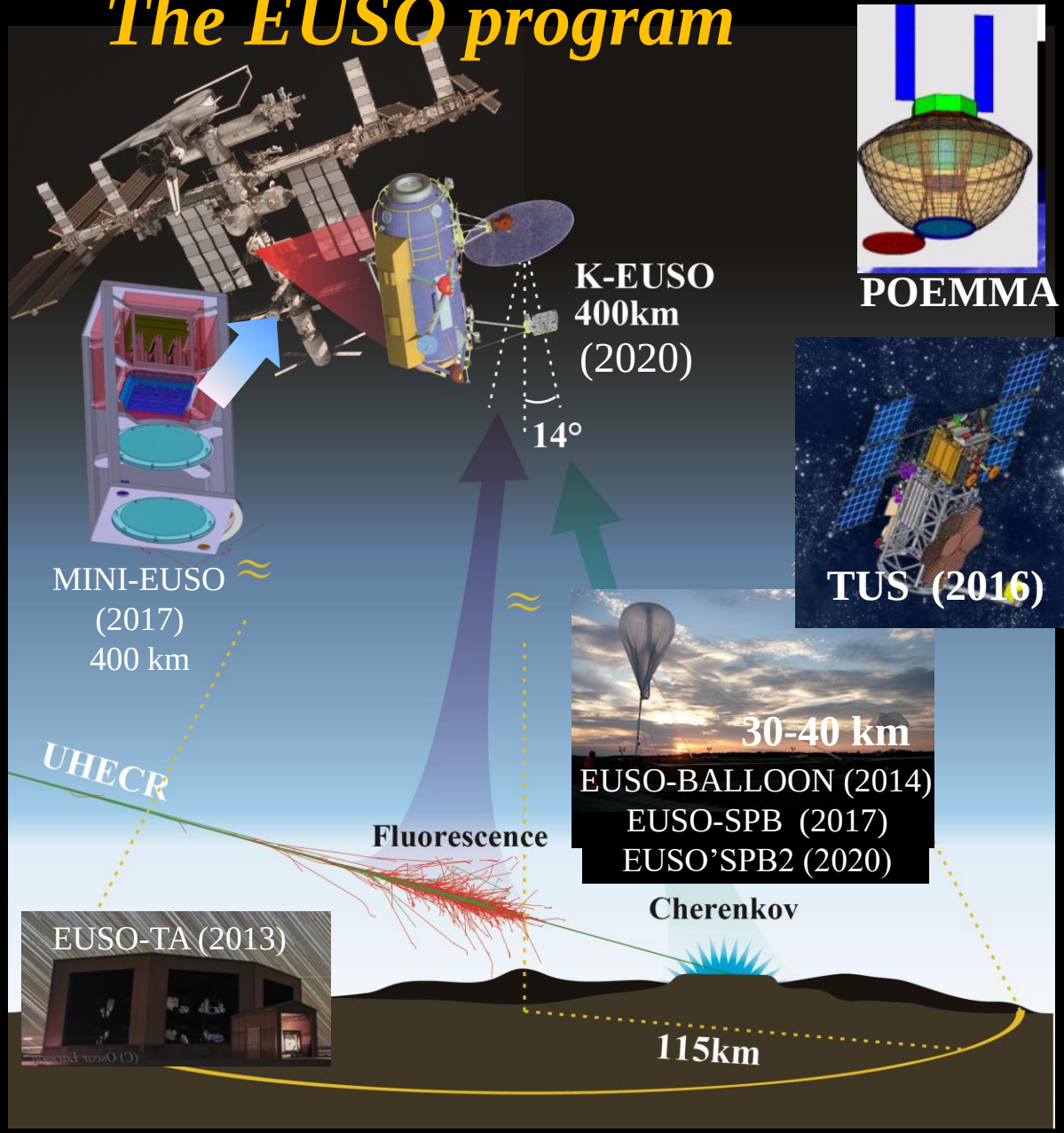
2. **EUSO-BALLOONS**: *1st balloon flight from Timmins, CA (French Space Agency) Aug 2014; NASA Ultra long duration flight: SPB 2017; NASA SPB-2 2020*

3. **TUS (2016):** free-flyer [307][CRI128]

4. **MINI-EUSO (2017):** *Detector from International Space Station (ISS: 30kg 2017). Approved by Italian and Russian Space agencies*

5. **K-EUSO (2022):** *ISS Approved by Russian Space Agency*

6. **POEMMA (2025+):** *NASA twin free-Flyer*



JEM-EUSO collaboration 16 Countries, 93 Institutes, 351 people


EUSO-TA
(C) Oscar Larsson

EUSO-TA

2013: Installation, building, lenses

2014: Auger/Fast tests

2015:

February/March

- •Detector installation
- •Focusing, initial calibration
- •Initial CLF and CSOM laser observations

May

- •Cosmic ray observations – one UHECR detected
- •CLF and CSOM laser observations
- •Flat screen and LED calibration

September

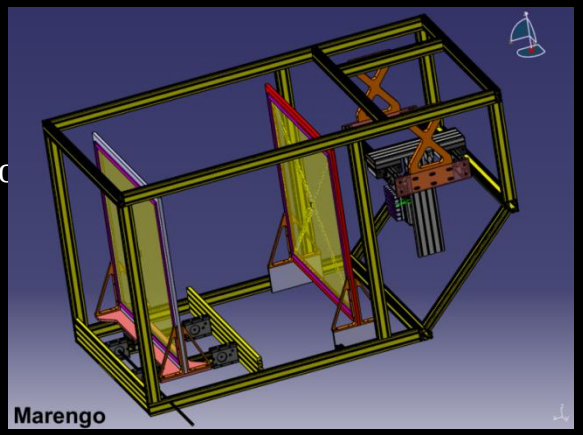
- •Cosmic ray observations – analysis ongoing
- •CLF and CSOM laser observations

October

- •Cosmic ray observations – analysis ongoing
- •Internal trigger tests on the balloon PDM board – successful triggering o laser
- •CLF and CSOM laser observations

November

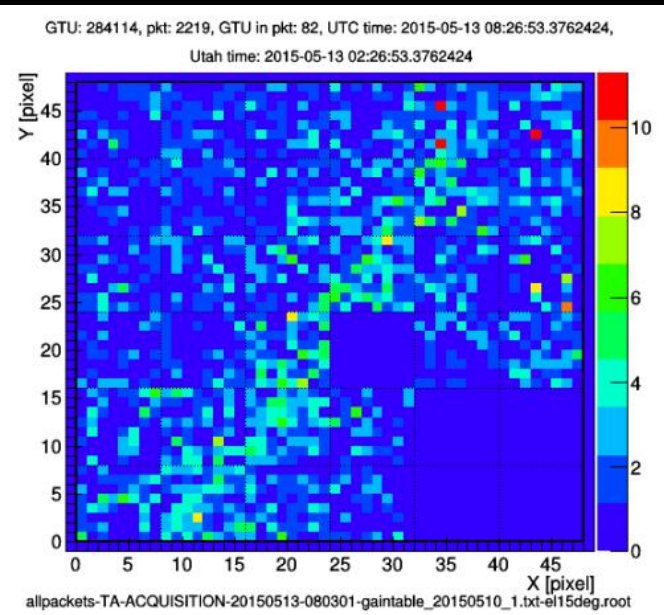
- •Cosmic ray observations
- •CLF laser observations

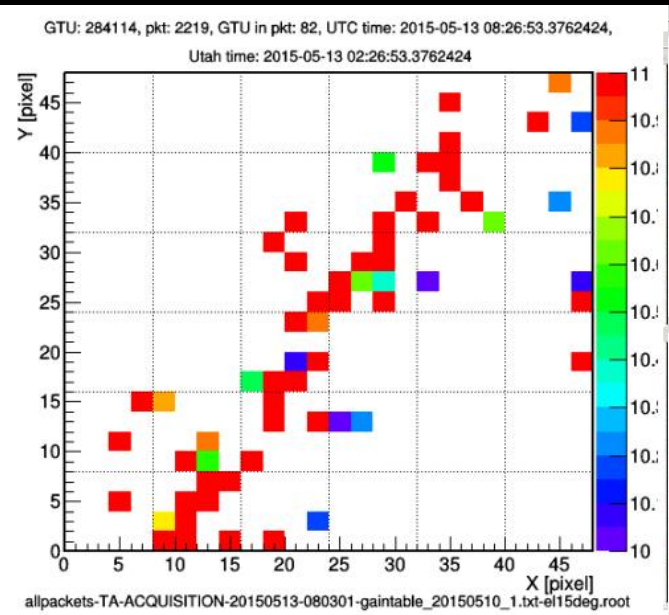


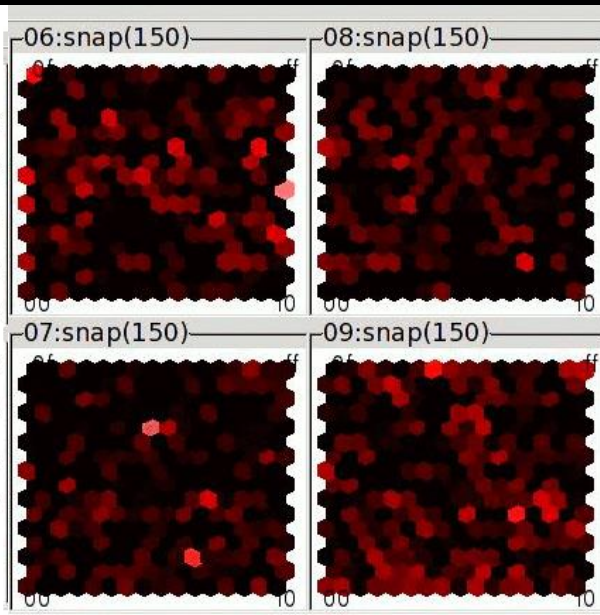
2016: refurbishment of focal surface, joint tests with super pressure balloon

Cosmic ray event, 13/5/2015

Telescope Array reconstruction
Zenith = 35°
Azimuth = 7° (clockwise from N)
E = 10^18 eV
Rp = 2.5 km
Core = (14.8 km, -10.9 km) respect CLF







EUSO, 1 frame, 2.5micros

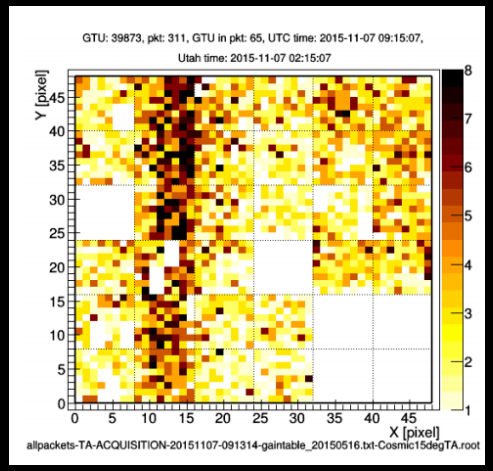
EUSO, 2*2

TA signal

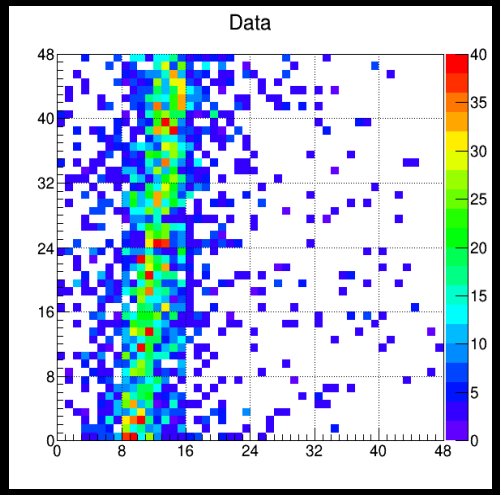
Cosmic ray event 7/11/2015

Telescope Array reconstruction
Zenith = 8°
Azimuth = 82°(Clockwise from N)
E = 10^18.36 eV
Rp = 2.6 km
Core = (14.8 km, -10.6 km) respect CLF

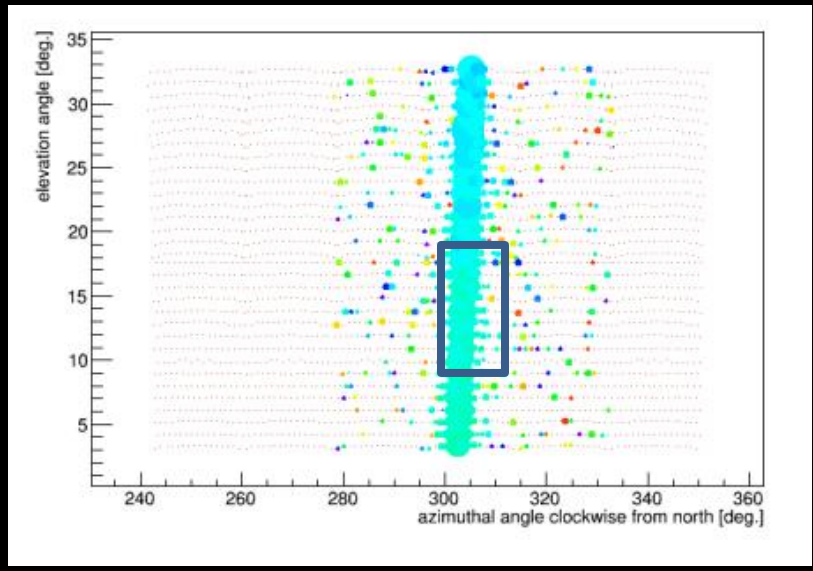
EUSO-TA elevation = 15°



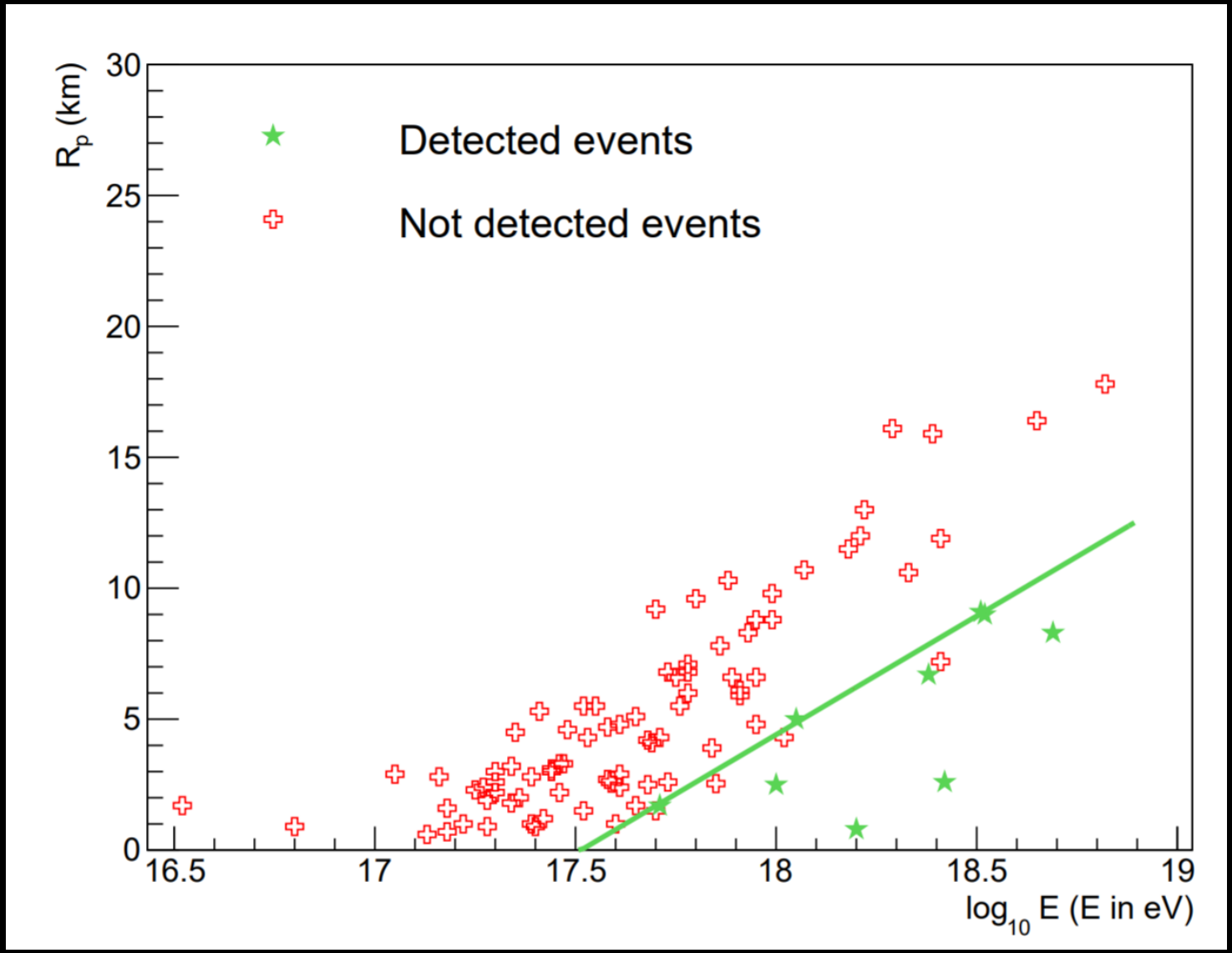
EUSO data ,
1 frame, 2.5micros



EUSO Simulation ,
1 frame, 2.5micros



TA signal



From F. Bisconti

Current and Next Steps

Funding (number E25)
for this fiscal year 50万円

2017 work:

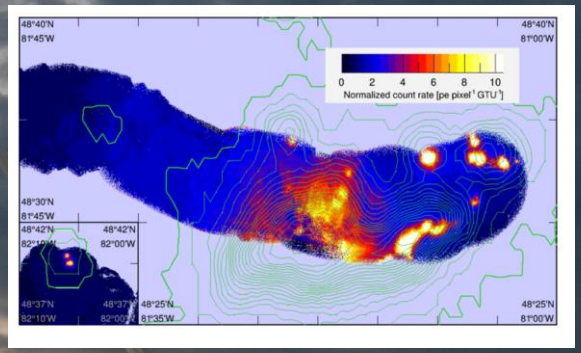
- Test in TA of Automatization of acquisition (nov 2017)
- Refurbishment of Focal surface.
- Self-triggering

2018 (March-):

- Mini-EUSO tests
- Cosmic Ray acquisition
- Meteors, search for Strange Quark Matter
- Satellites

[316] [CRI232] The EUSO-TA detector: status and performance
[1290] [CRI031] Point Spread Function of EUSO-TA detector
[1277] [CRI027] Simulation study of the detected and expected events for the EUSO-TA
[1278] [CRI026] New simulation and reconstruction software for the EUSO pathfinders, with example applications
1424] [DM051] Study of Fast Moving Nuclearites and Meteoroids using High Sensitivity CMOS Camera with EUSO-TA
Paper in progress

EUSO Balloon 1st flight, Aug 2014 Timmins (CA)



Payload built by JEM-EUSO collaboration

CNES (French Space Agency) mission

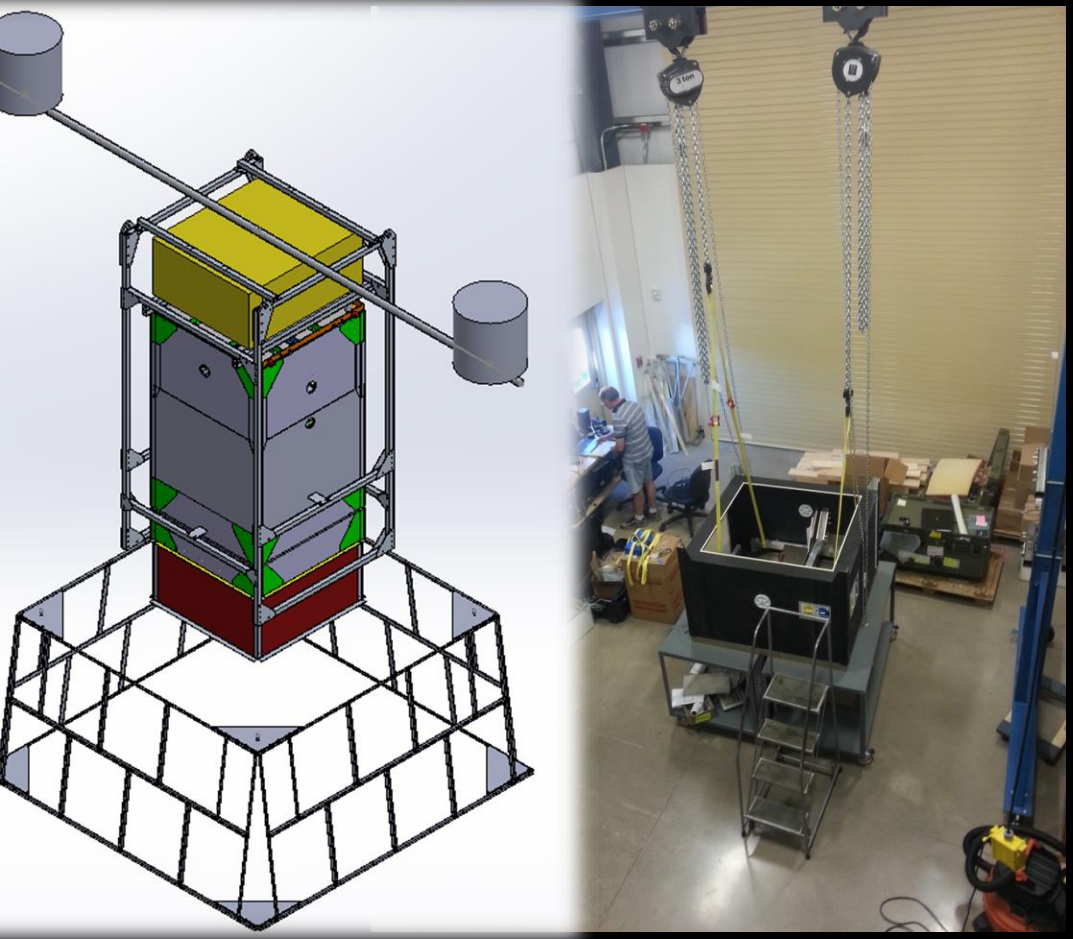
EUSO-Balloon 2nd flight, March 2017 Wanaka, New Zealand

NASA Mission. 2nd Payload built by JEM-EUSO collaboration
New lenses, Focal Surface,
Improved Electronics

First UV UHECR shower observation from above

[306] [CRI306] EUSO-SPB Mission and Science
[1261] [CRI054] Calibrating and Testing EUSO-SPB in Flight using a Laser and LEDs on an Aircraft
[1273] [CRI201] The EUSO-SPB instrument
[1274] [CRI061] The trigger logic of EUSO-SPB and its performance
[1280] [CRI041] Preflight calibration and testing of EUSO-SPB in the lab and the desert
[1294] [CRI088] Expected number of Extensive Air Showers observable by EUSO-SPB
[1336] [CRI030] The Data Processor System of EUSO-SPB
1337] [CRI074] UCIRC: Infrared Cloud monitor for EUSO-SPB

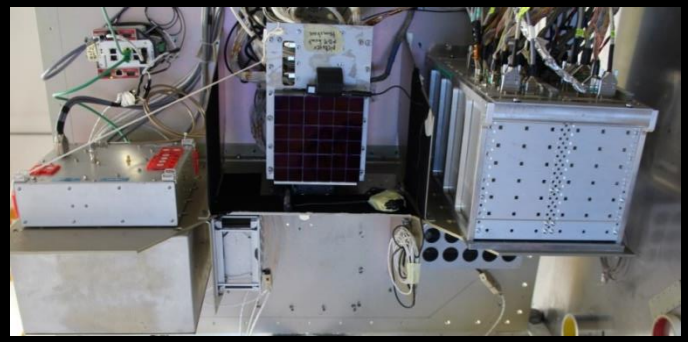
Super Pressure Ballon Integration in Colorado



New structure, solar panels, telemetry

New 1sp m lens system

New focal surface and electronics

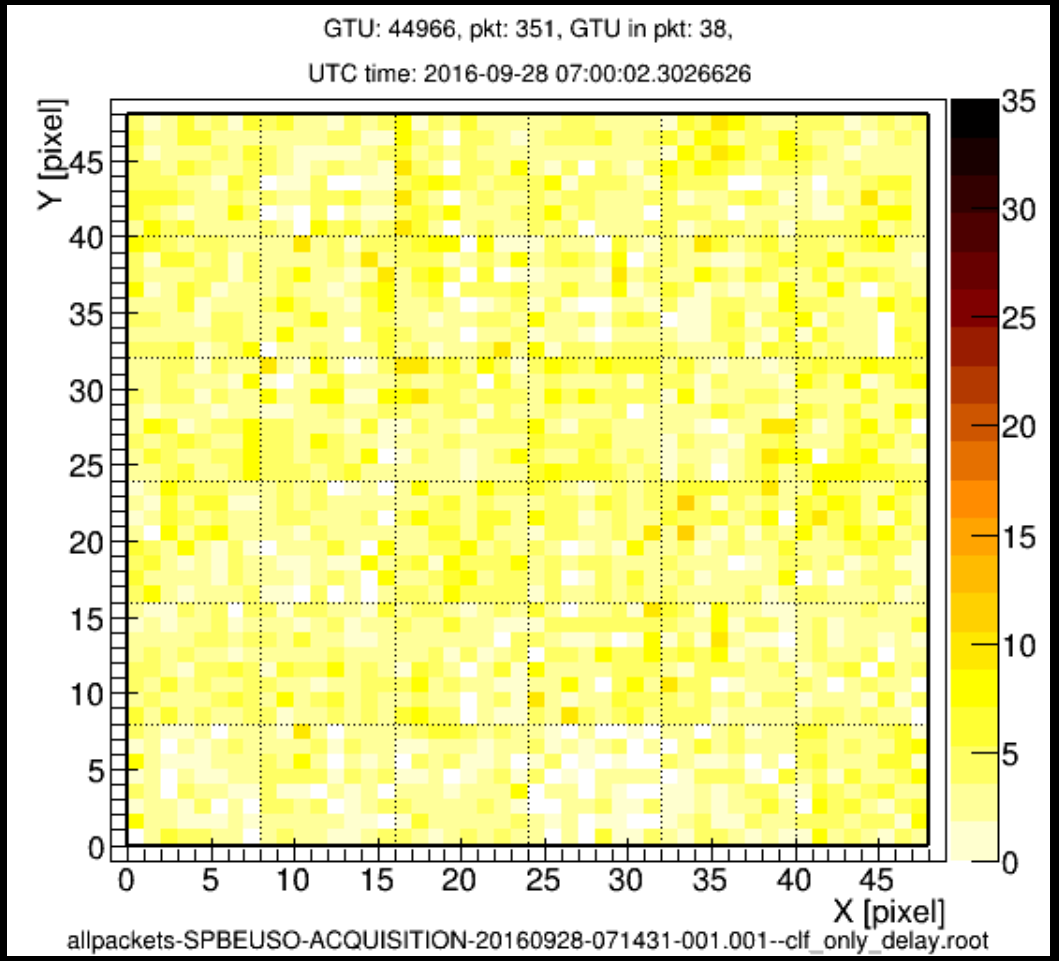


2016 EUSO-SPB EUSO-TA joint campaign

2016 EUSO-SPB EUSO-TA joint campaign

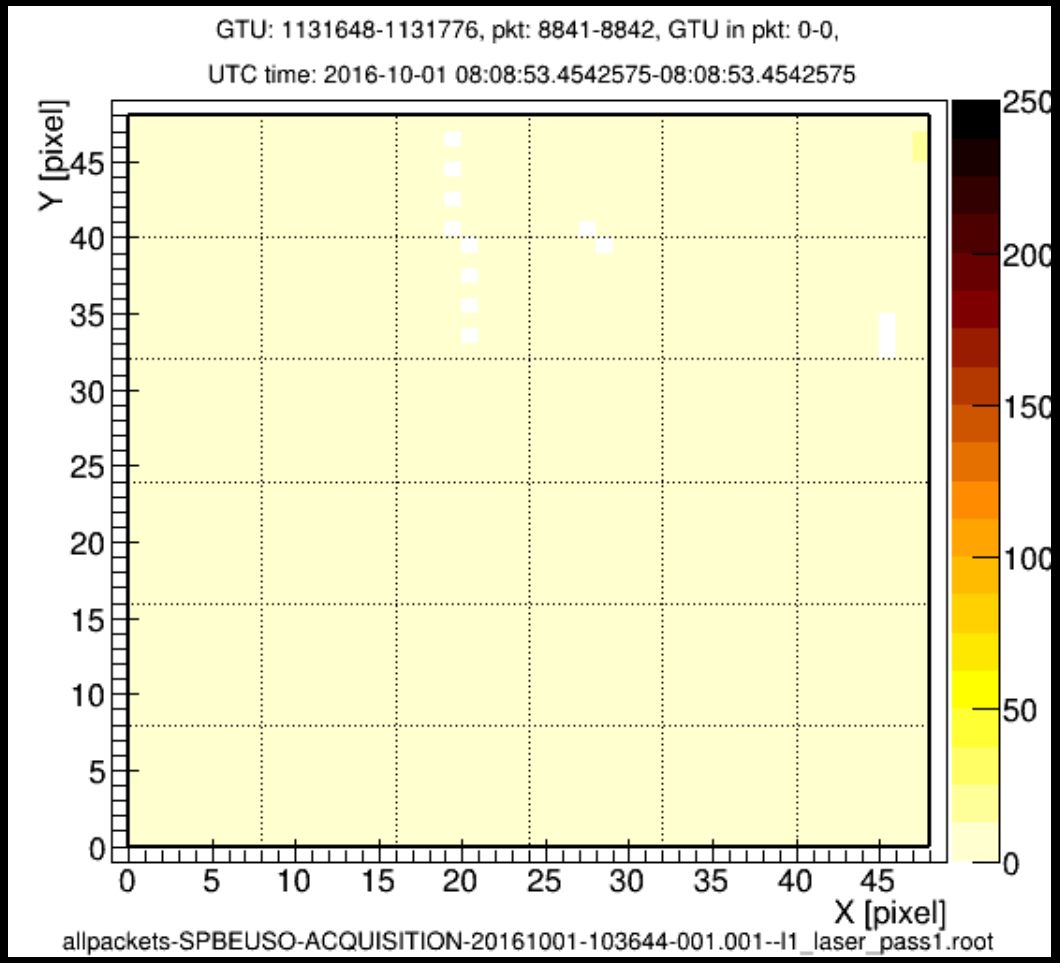
TA CLF Laser event with SPB

2.5 micros sampling



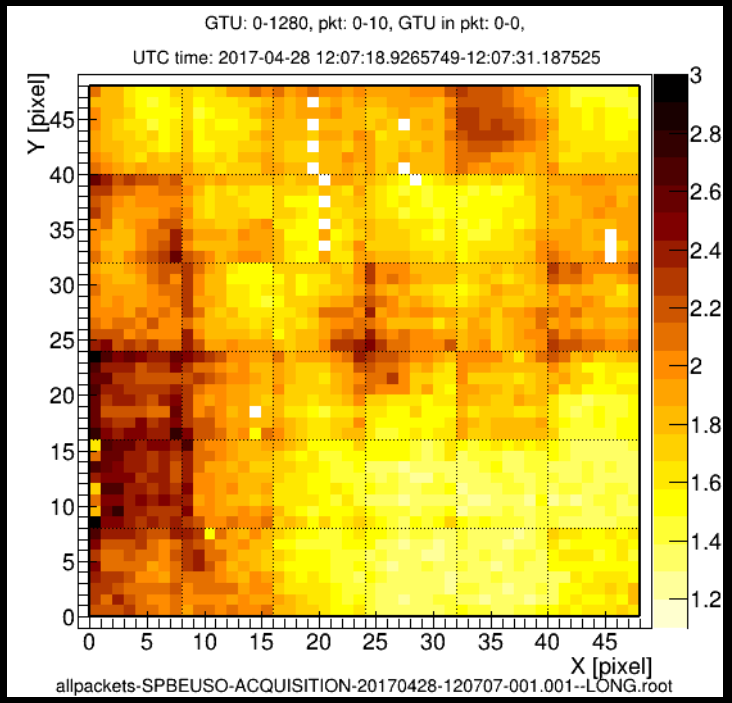
Meteor as seen by SPB

4 ms averages



Launched on 25 April 2017

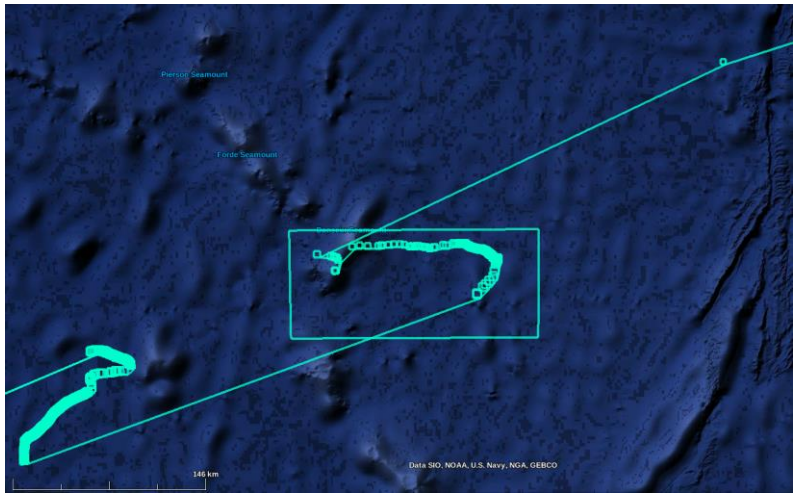
RAW data after launch

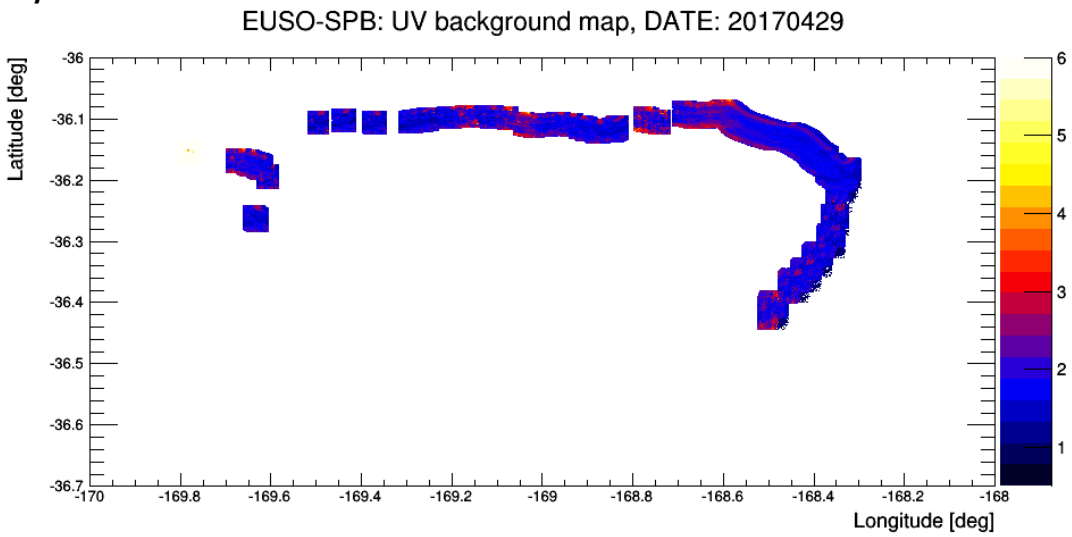


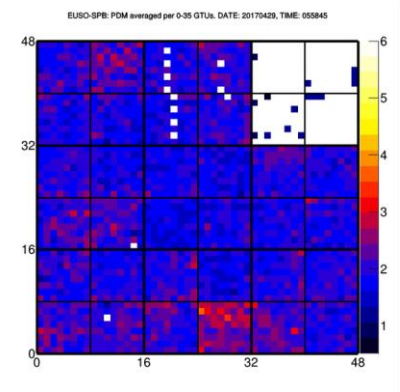
[Launch April 25th 2017 (4/24 23:50 UTC)]

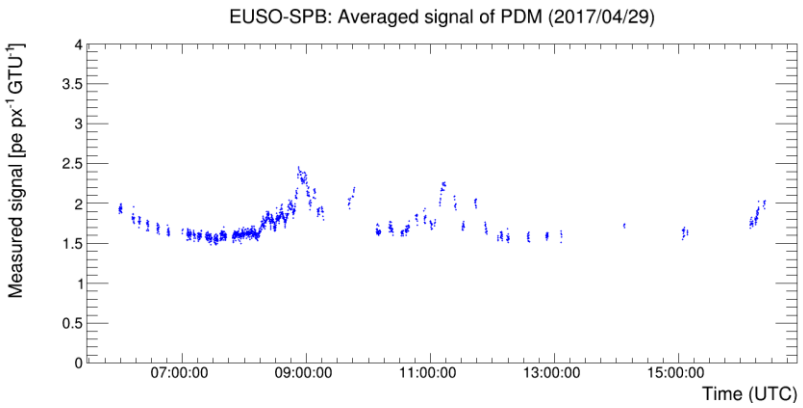
PRELIMINARY

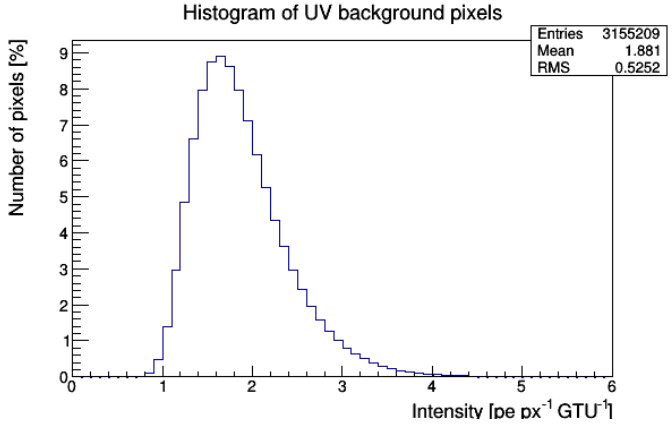
EUSO-SPB1: UV background - 2017/04/29











From S. Mackovjak

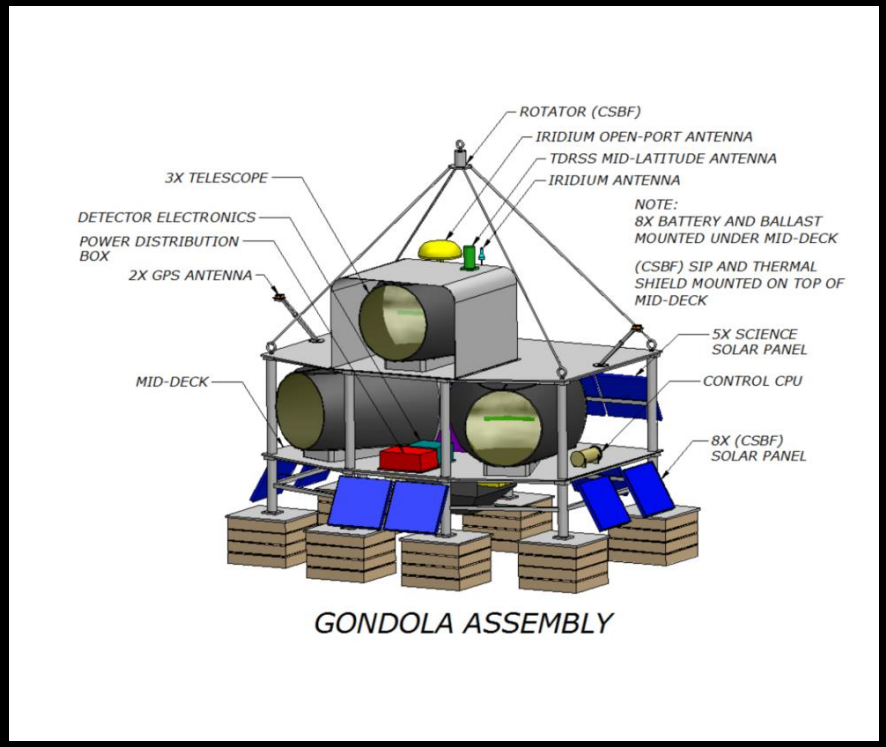
EUSO-SPB 12 days flight

Data analysis in progress

EUSO-SPB2

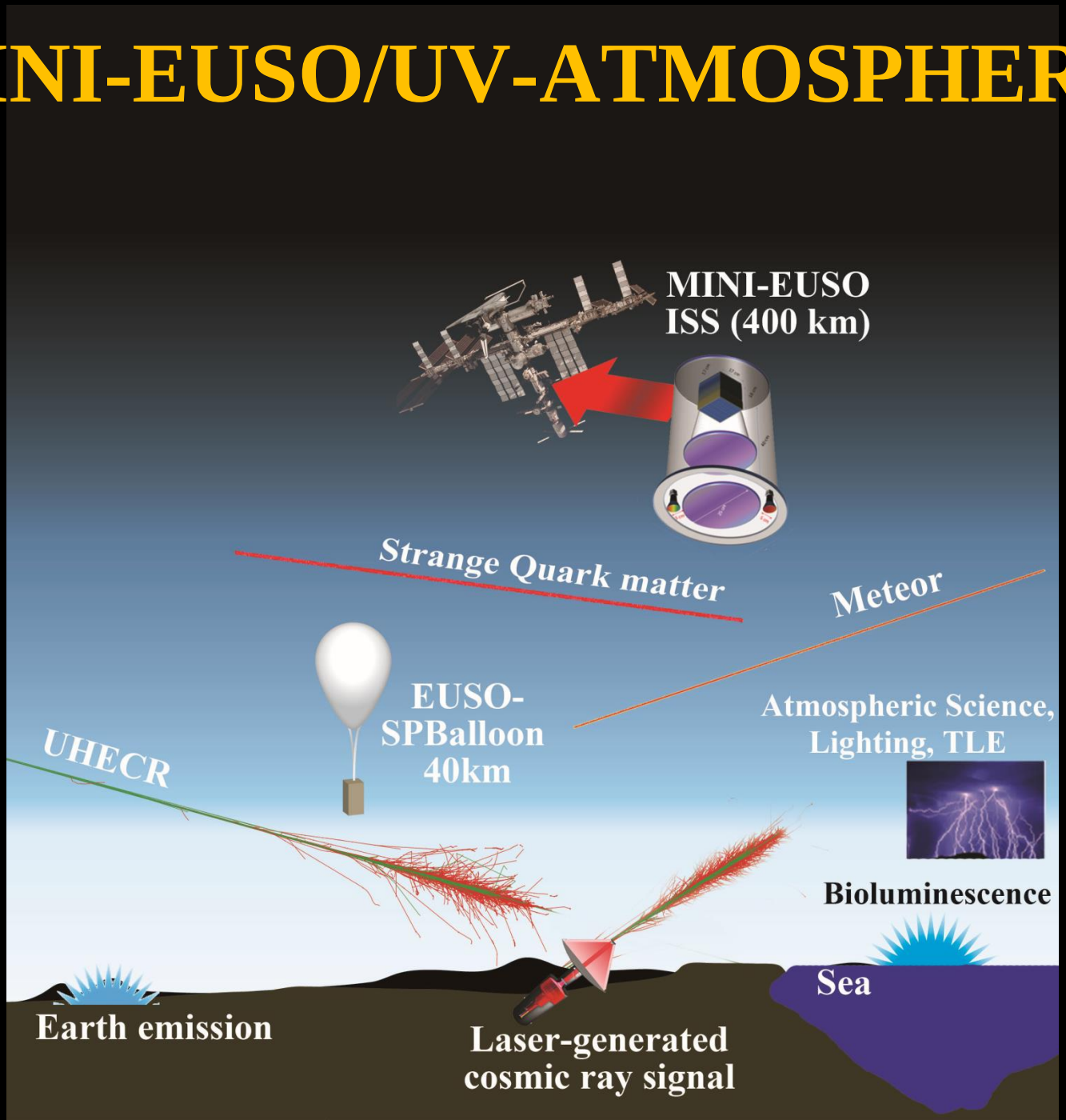
- Approved by NASA
- UHECR air-showers, Cherenkov light from stratosphere. $10^{16} < E < 10^{17}$ eV
- Discrimination of p, nuclei, photons looking at Cherenkov profile
- Mission in 2021

→Will be tested in TA site



Arxiv 1703.04513

MINI-EUSO/UV-ATMOSPHERE



MINI-EUSO

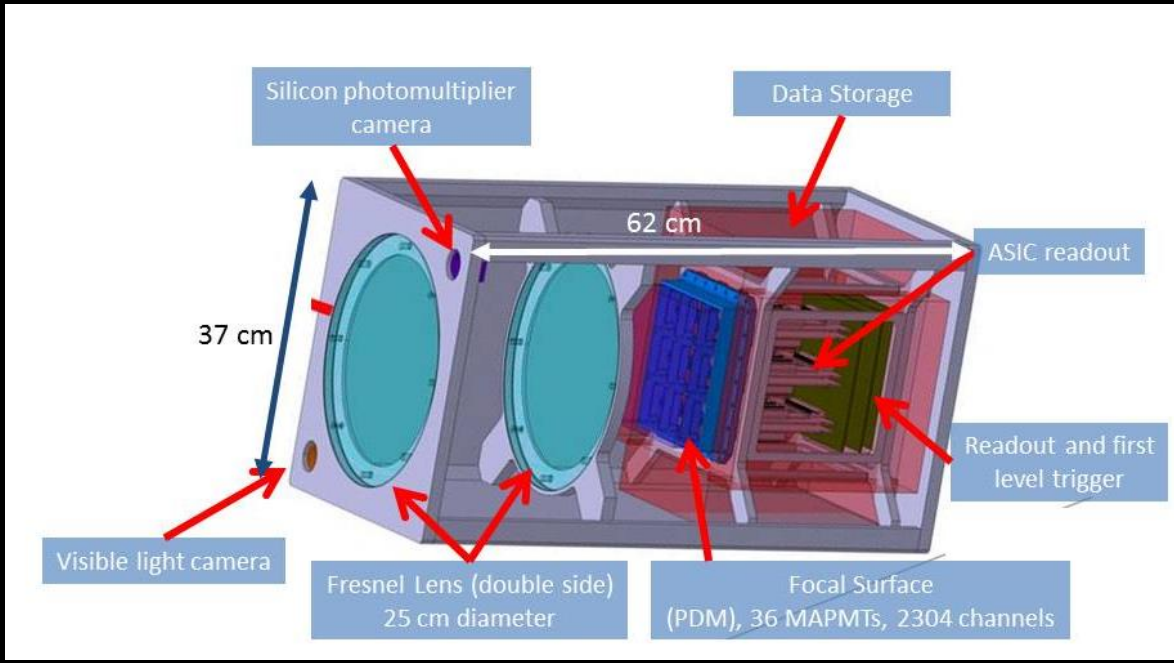
- Approved and funded by Russian and Italian Space Agencies

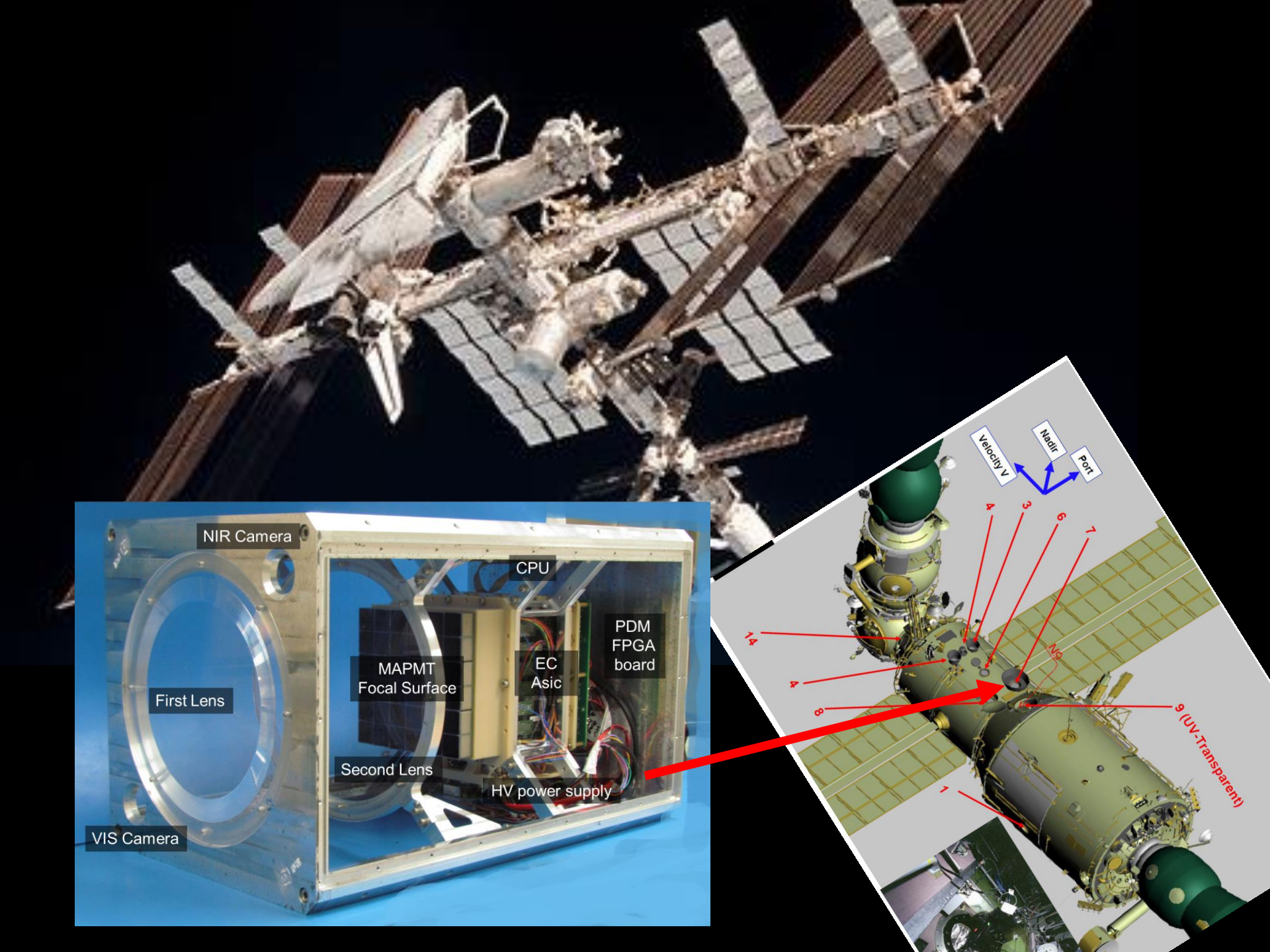
- Launch Dec 2018

- Inside the ISS
- 2 Fresnel lenses and one PDM
- 60W @ 27V
- 30kg
- Night observations
- About 40% orbit
- Nadir observations

- Exchange of data disk
- 2TB/week

- →Will be tested in TA site



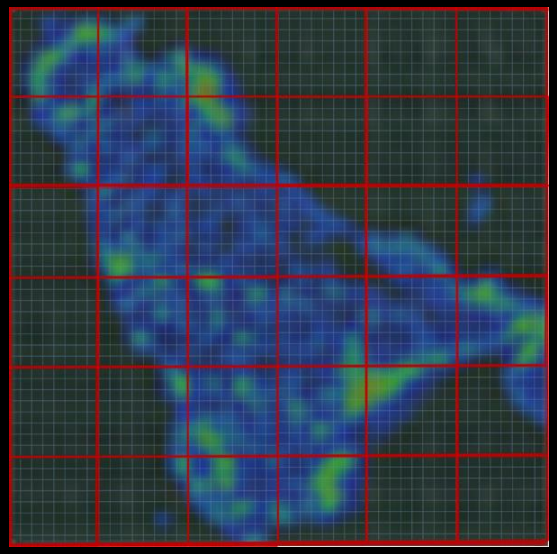

NIR Camera
CPU
PDM
FPGA
board
MAPMT
Focal Surface
EC
Asic
First Lens
Second Lens
HV power supply
VIS Camera
Velocity V
Nadir
Port
4
3
6
7
14
4
8
9 (UV-Transparent)
1

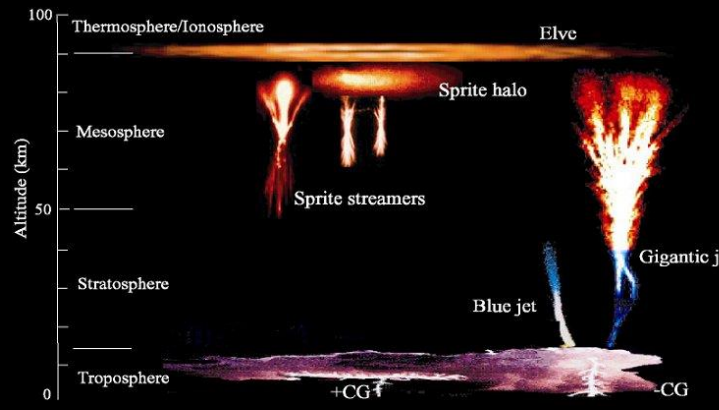
Mini-Euso *Scientific Objectives*

- Search for Strange quark matter
- Search for 1E21 eV UHECR

- UV emissions from night-Earth
  - *6.5 km resolution, from 2.5mus and above +-51°*
  - *Noise from different lightning conditions, moon phase, year*
  - *Noise from different inclinations*
- *Map of the Earth in UV*
- *Transient Luminous effects*

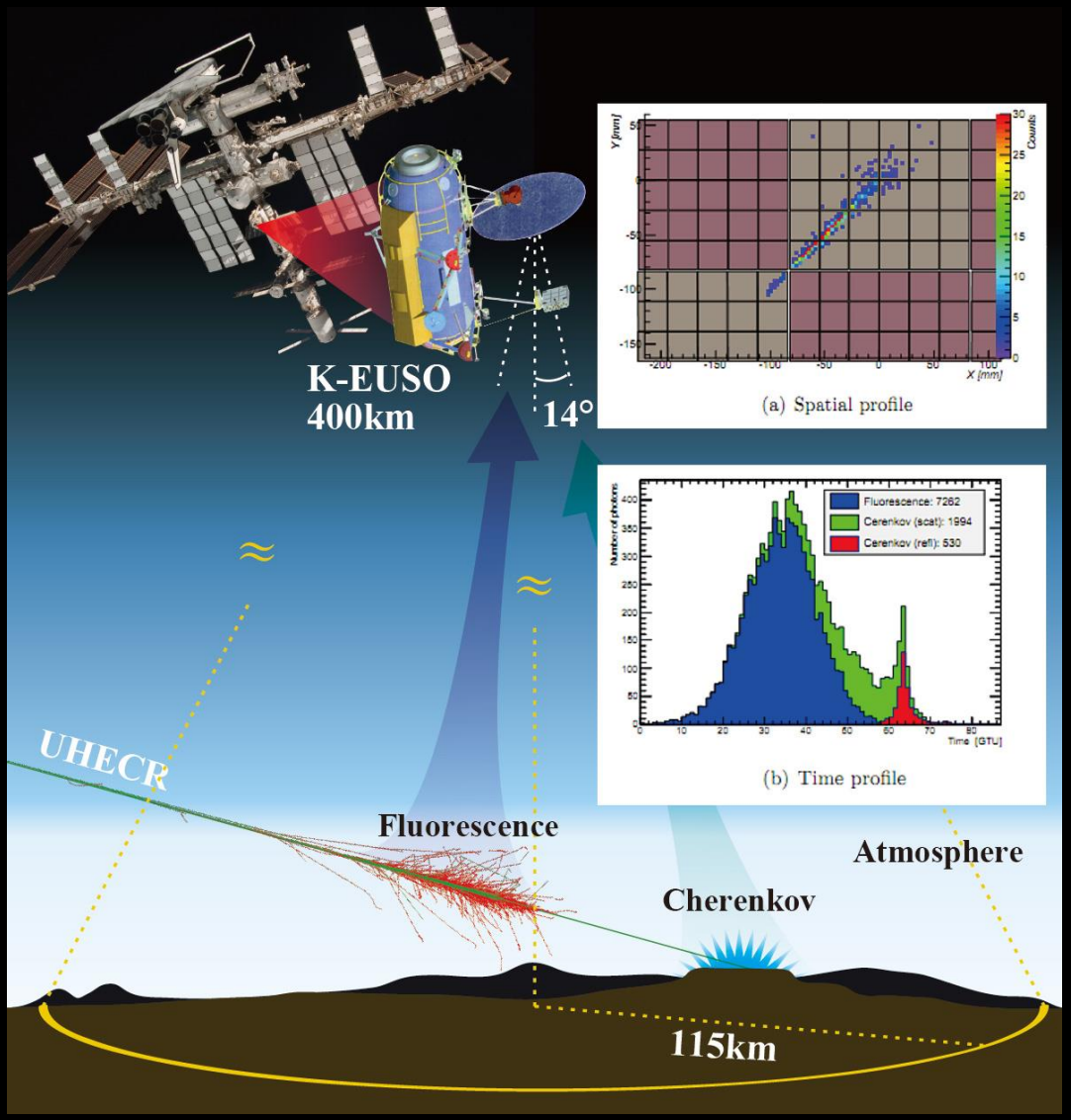
- Bioluminescence of Animal and vegetal organisms
- *Milky sea*





K-EUSO

- In the Russian Federal Space Program
- Passed the stage of preliminary design with Roscosmoc
- Technical requirements, accomodation, operations study performed by Energia space corporation
- Evolution of KLYPVE Russian detector (reflector)
- Launch in 2022



Science of K-EUSO

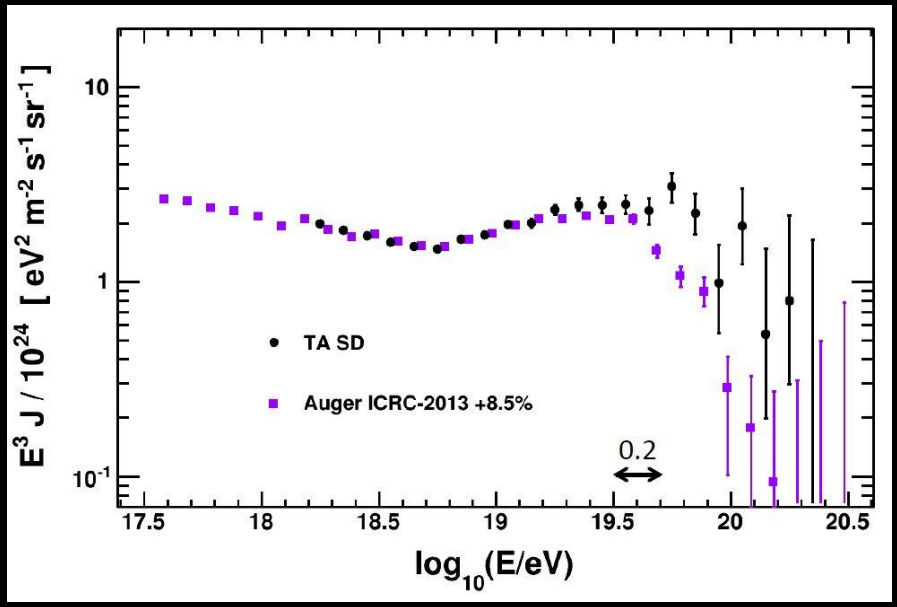
KLYPVE goes from technological demonstrator to instrument capable of:

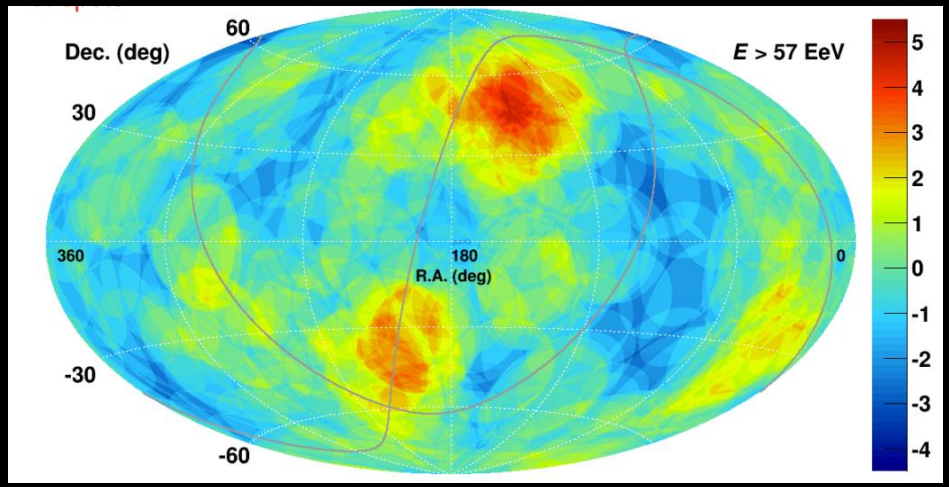
1. Study of UHECR fux from space with uniform response

2. Are the North and South fluxes different or not?

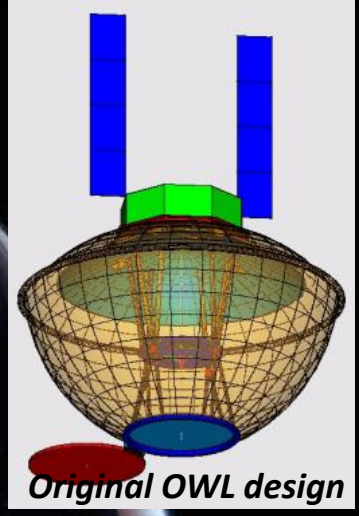
4. Anisotropy, Hotspot

5. Earth observations



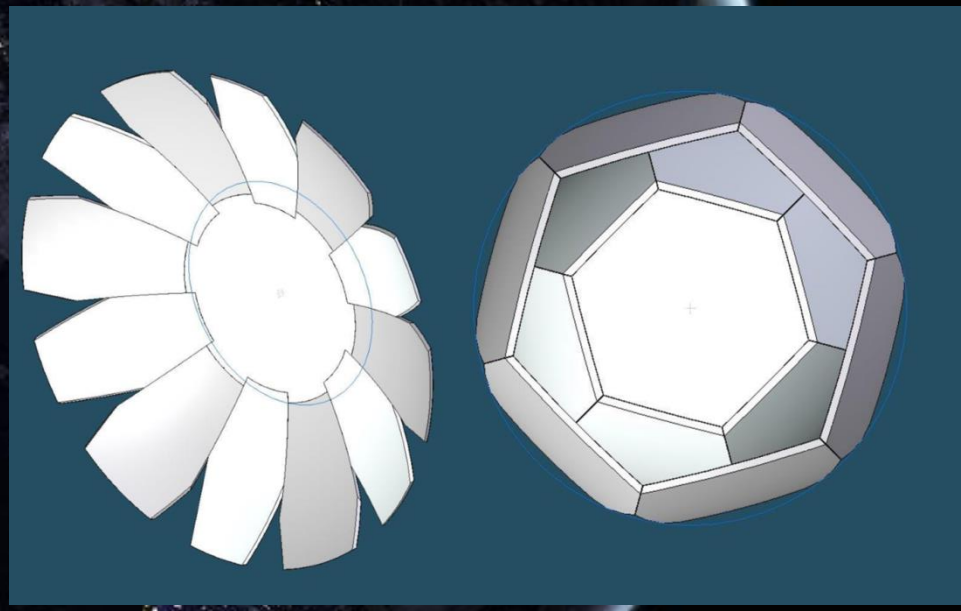


POEMMA:
Probe of Extreme Multi-Messenger Astrophysics (2025)


Original OWL design

Multi-messenger probe

Selected by NASA for an in-depth probe mission concept study in preparation for the next decadal survey.



POEMMA combines Orbiting Wide-field Light collectors (OWL) concept and Cherenkov from Astrophysical Neutrinos Telescope (CHANT) concept

Conclusions

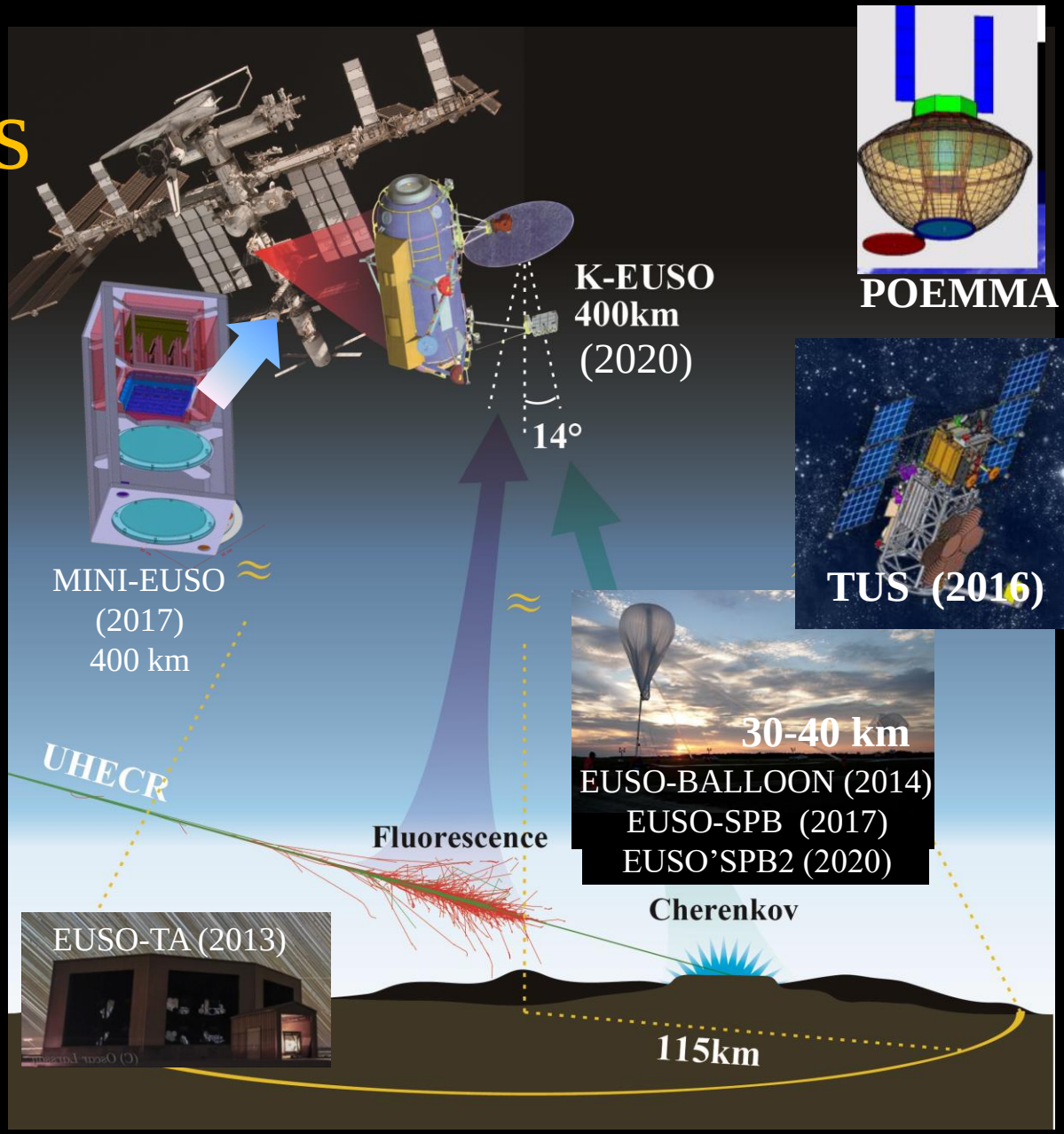
Measurements at TA site are of crucial importance for understanding and calibrating our systems

Roadmap to space

Detector development

K-Euso is a concrete mission at a fraction of the cost of JEM-EUSO

In one year address several fundamental physics issues, N/S spectra, hotspot



JEM-EUSO collaboration 16 Countries, 93 Institutes, 351 people