TeVPA
29/10/2015

K-EUSO and the JEM-EUSO program: Ultra-High Energy Cosmic Ray Observation from Space

M. Casolino

on behalf of the JEM-EUSO collaboration

RIKEN – GRC
INFN & University of Rome Tor Vergata

RIKEN

EUSO
International collaboration and programmatic status

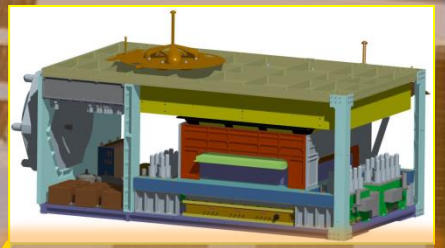
- 16 countries, 200+ researchers

- Evaluated positively by ESA, NASA, Roscosmoc and national agencies

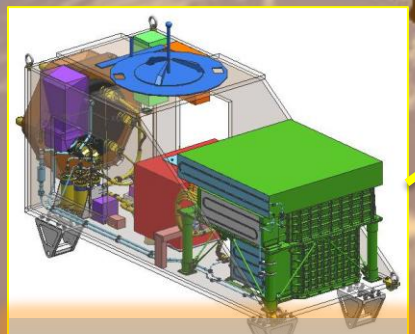
- Funding for detector and precursors ongoing in all countries

View from NASA: “Cosmic Ray Observatory on the ISS”

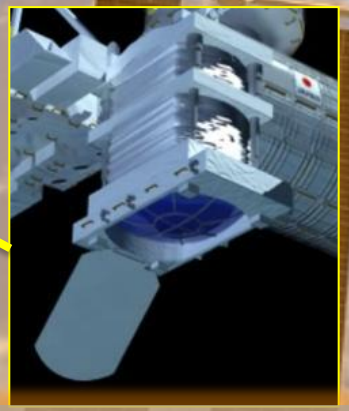
AMS Launch
May 16, 2011



ISS-CREAM
Sp-X Launch 2014



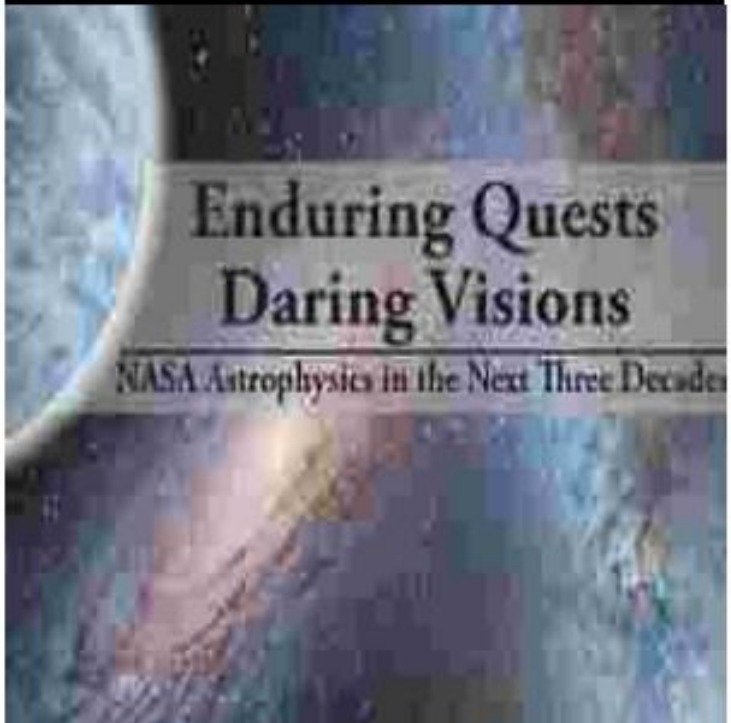
CALET on JEM
HTV Launch 2014



JEM-EUSO
Launch Tentatively
planned for 2019

image from Drs.
Julie A. Robinson,
Program Scientist,
ISS, NASA &
W. Vernon Jones,
Senior Scientist,
SMD, NASA

NASA Astrophysics Roadmap 2014



The EUSO program

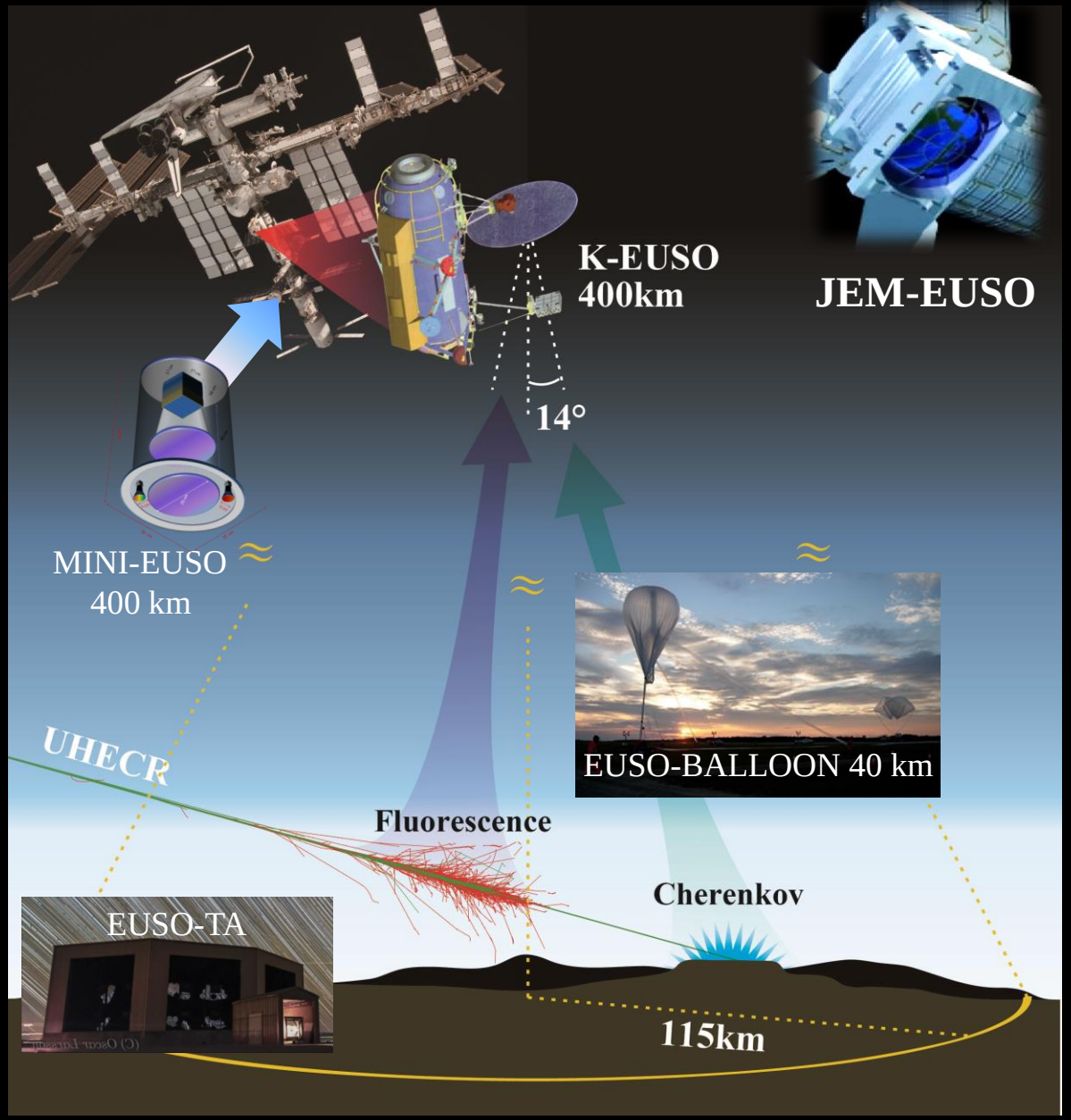
Ultra-High Energy cosmic rays from space

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

2. **EUSO-BALLOON**: *1st balloon flight from Timmins, CA (French Space Agency) Aug 2014; 2nd flight: 2016, NASA Ultra long duration flight: 2017*

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

4. **K-EUSO (2019 JFY):** *ISS Approved by Russian Space Agency*



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

1. EUSO-TA

EUSO-TA

First data taking campaign in March 2015

Also used for Auger/Fast tests

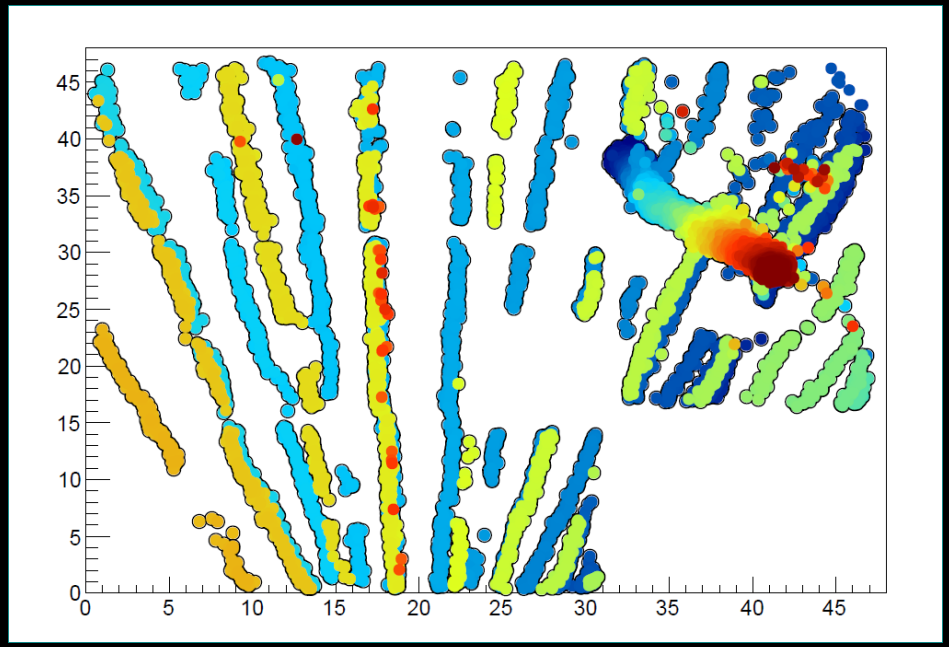
- Stars: 0.34 deg PSF

(work also with Moon)

- UV Background
- Laser:

  Mobile, LED

  CLF of TA
- Cosmic ray



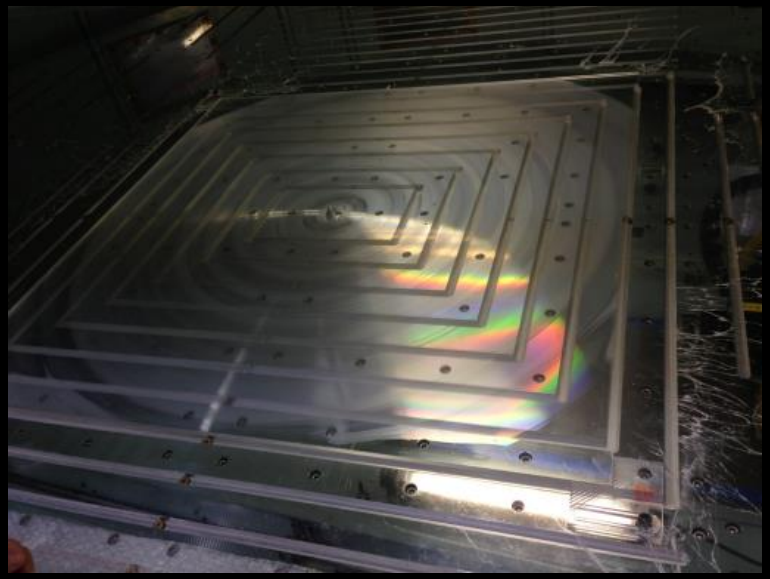
2. EUSO-Balloon flights

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

Payload built by JEM-EUSO collaboration

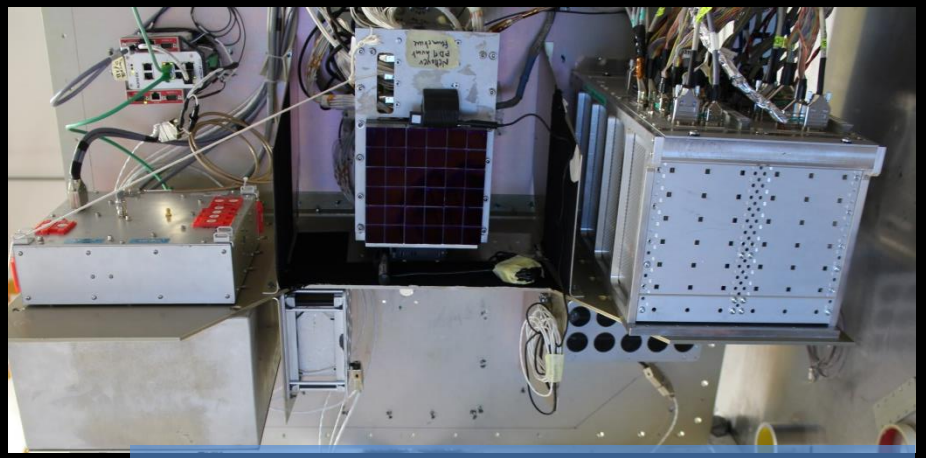
CNES (French Space Agency) mission

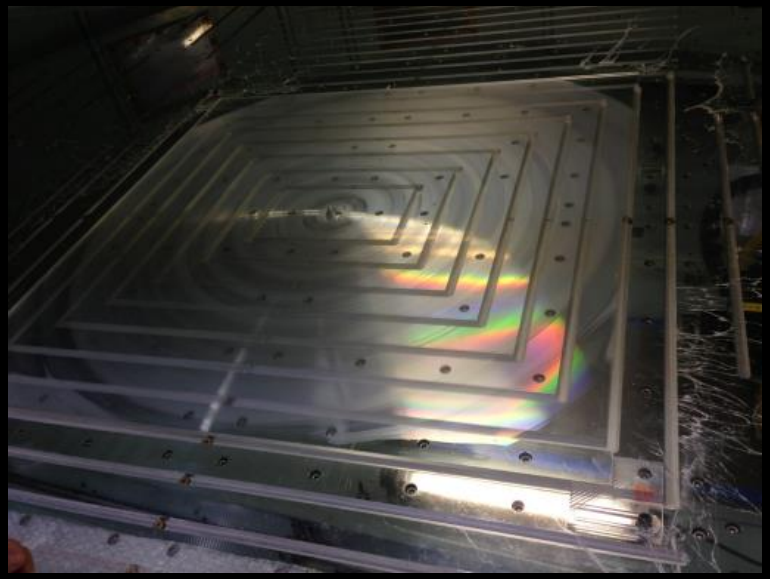
Optics



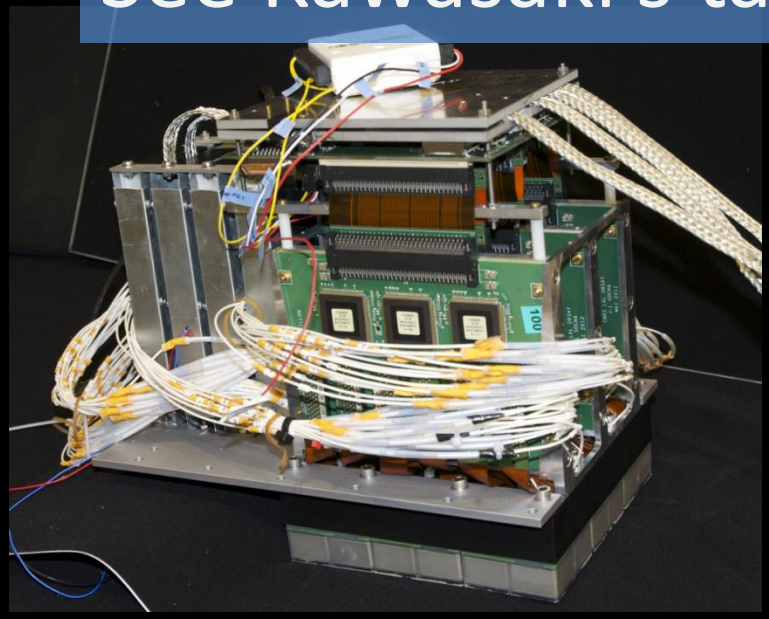
See Takizawa's talk

Optics and Electronics



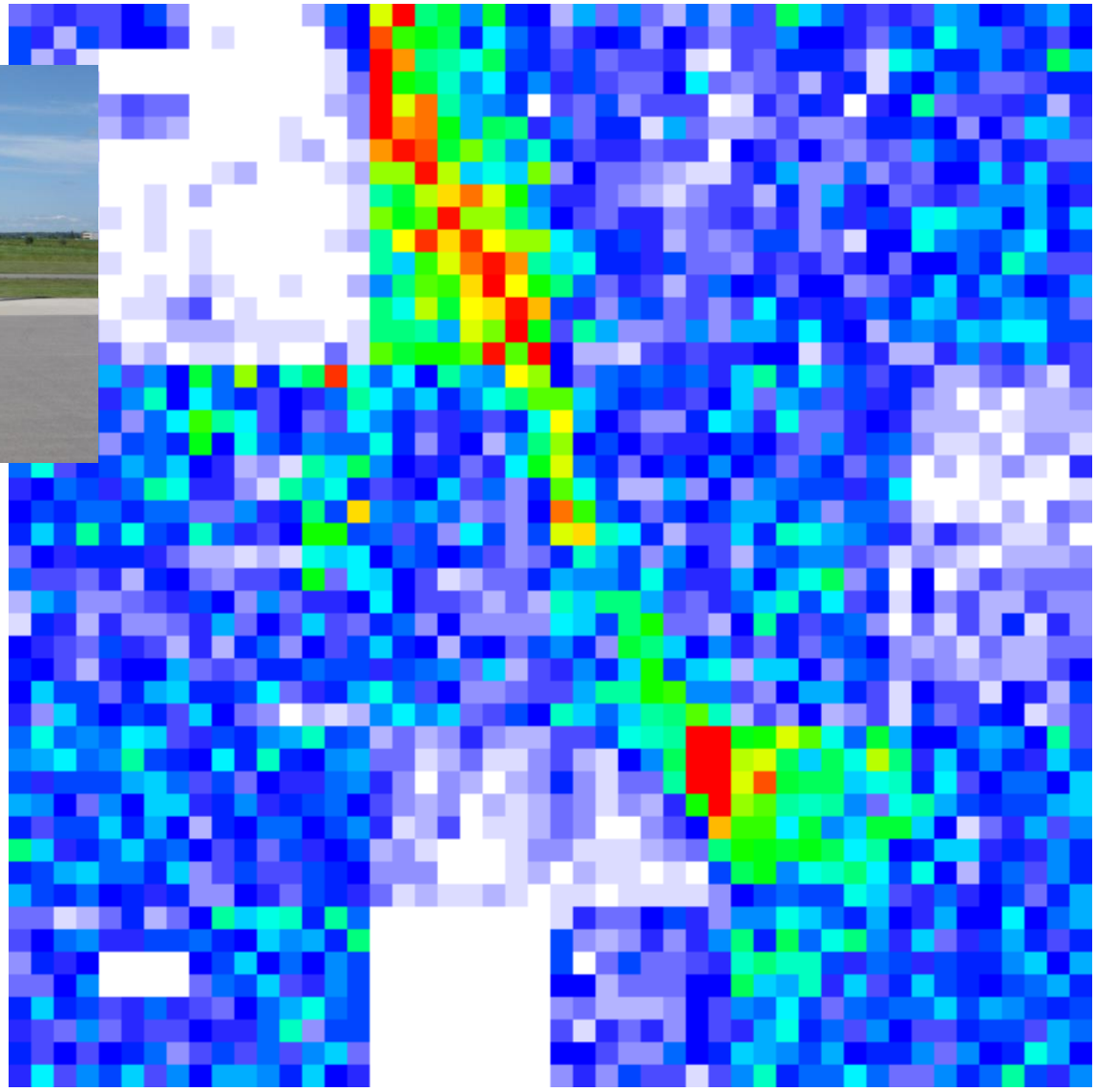


See Kawasaki's talk

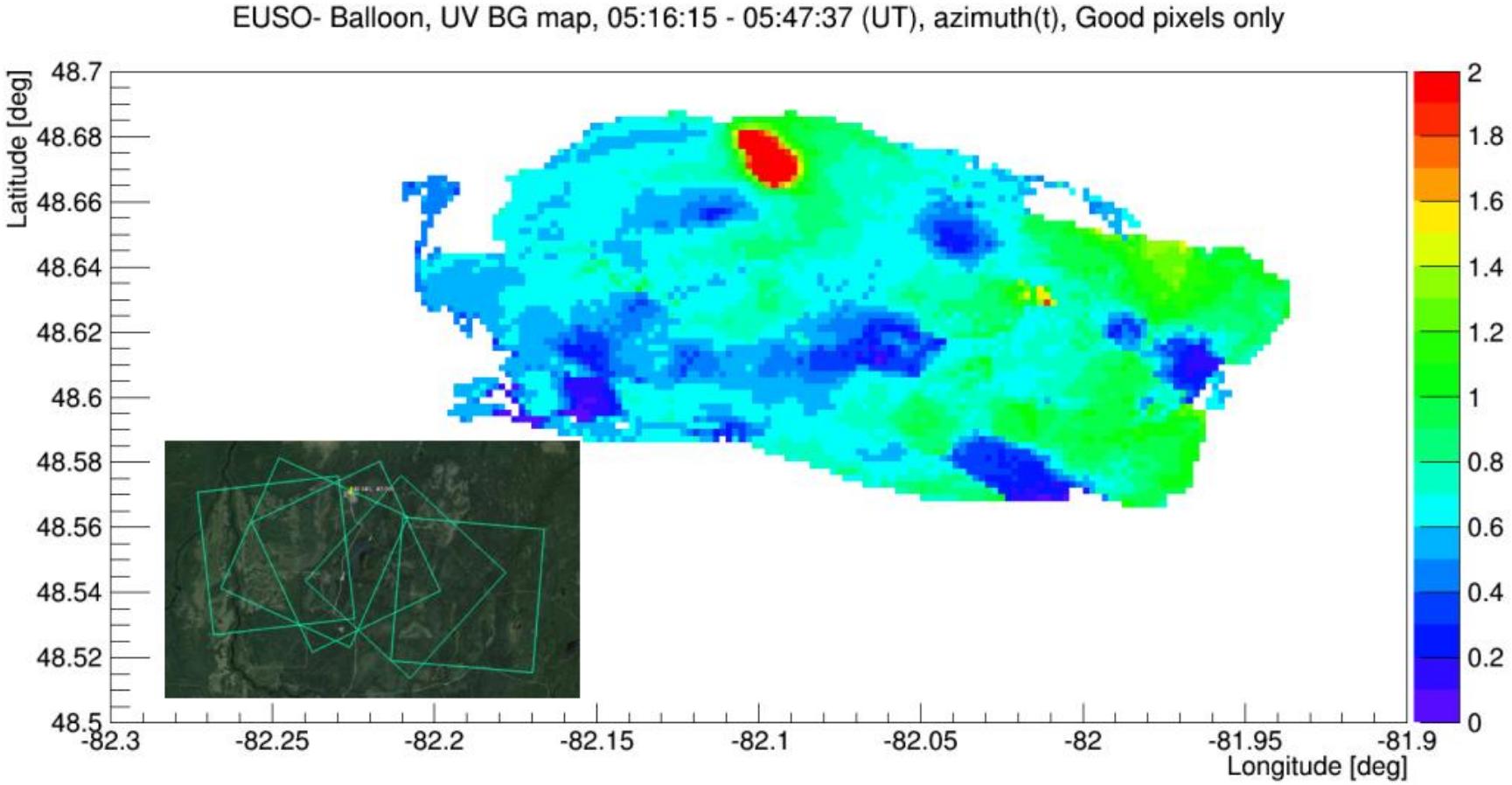


Integration in Timmins 11-24 Aug 2014

Xe flasher and Laser events from NASA helicopter



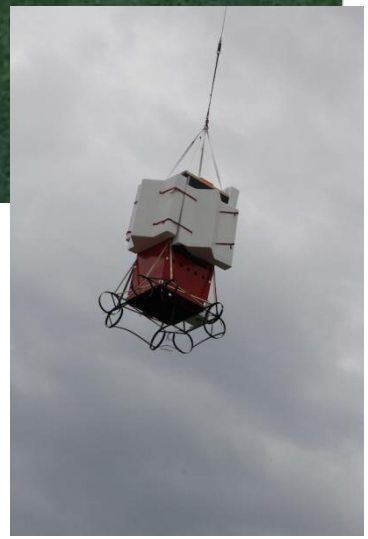
UV background map



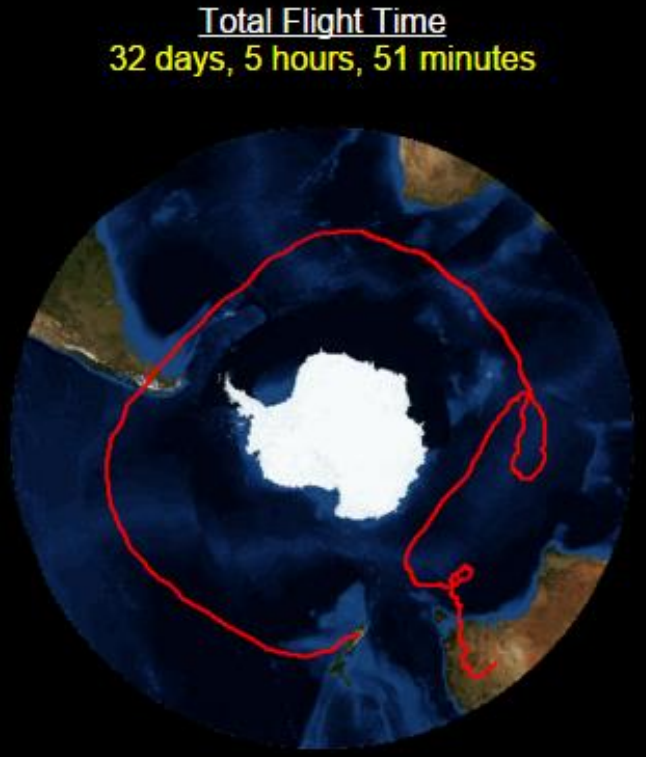
each observed value of PDM pixel was associated with its calculated ground position

Landing and recovery

Refurbished, new long duration flight in 2017



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



NASA Mission. 1st Super Pressure Science Flight

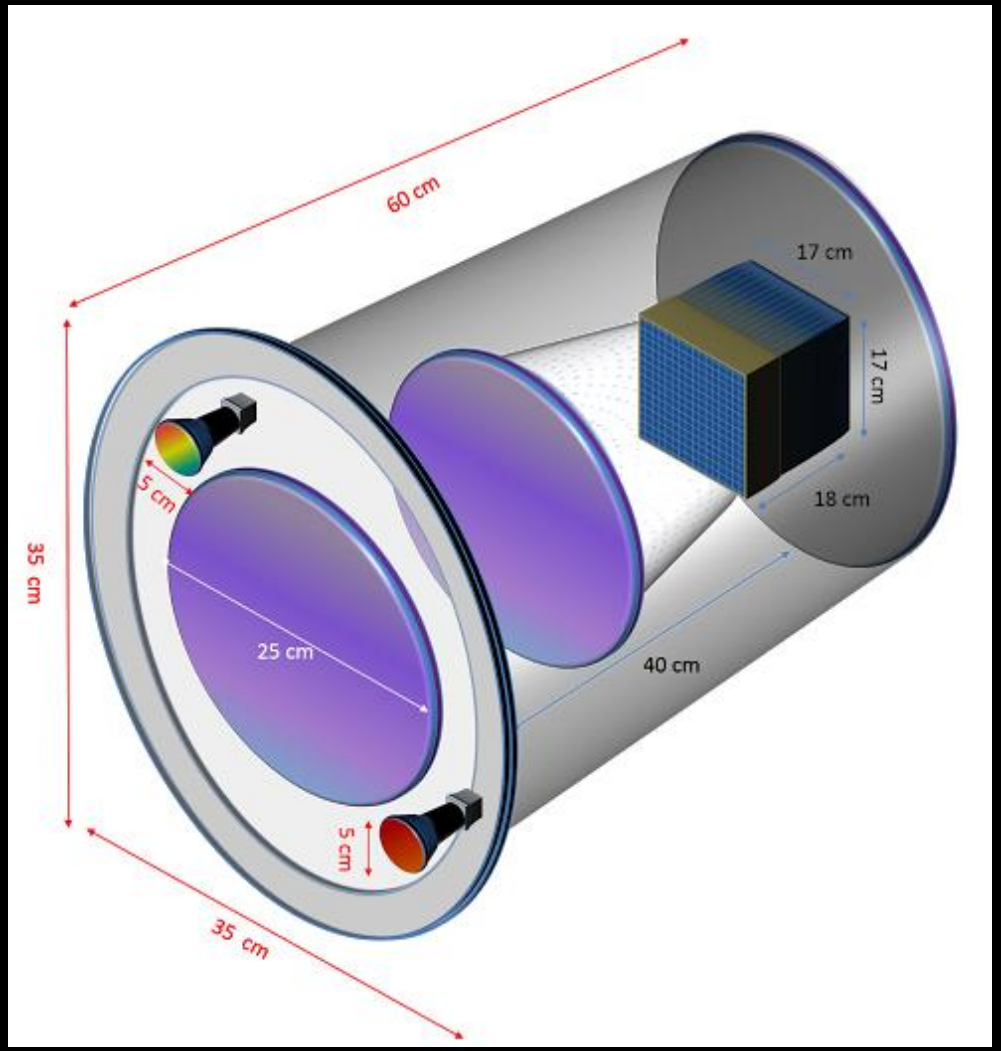
Payload built by JEM-EUSO collaboration

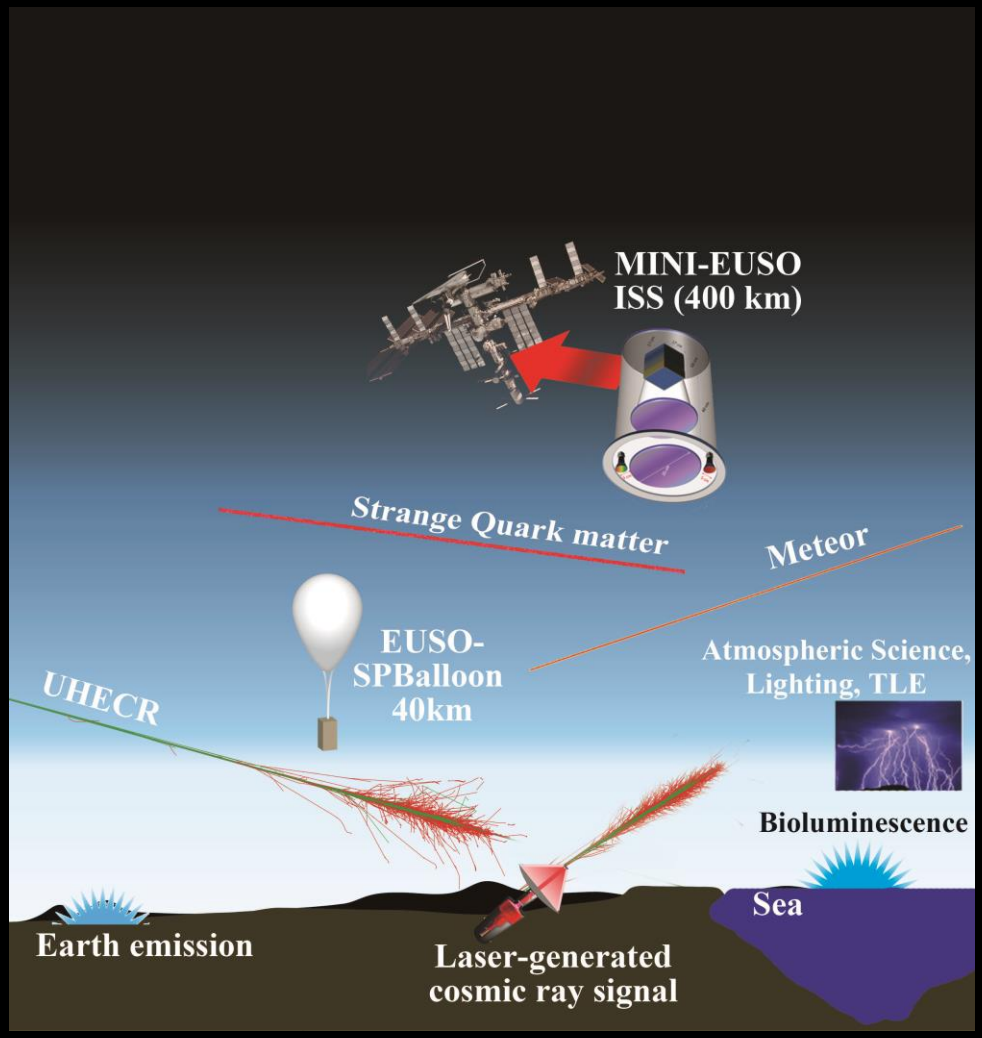
New lenses, Focal Surface, Electronics

3. MINI-EUSO

- Approved by Italian Space Agency
- Approved by Russian Space Agency
- Inside the ISS
- 2 Fresnel lenses and one PDM

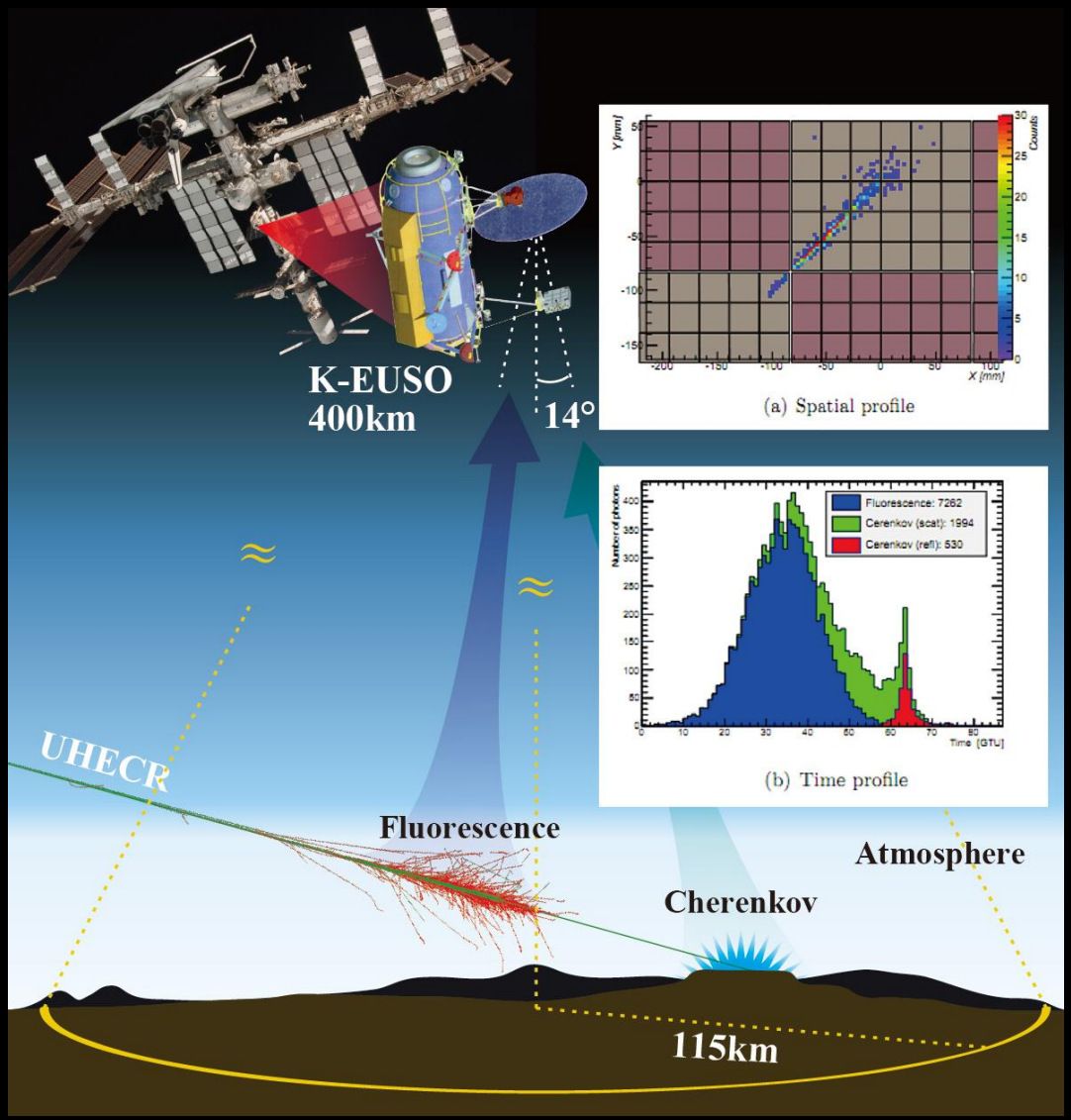
See Oscar's talk




MINI-EUSO
ISS (400 km)
Strange Quark matter
Meteor
EUSO-
SPBalloon
40km
UHECR
Atmospheric Science,
Lighting, TLE
Bioluminescence
Sea
Earth emission
Laser-generated
cosmic ray signal

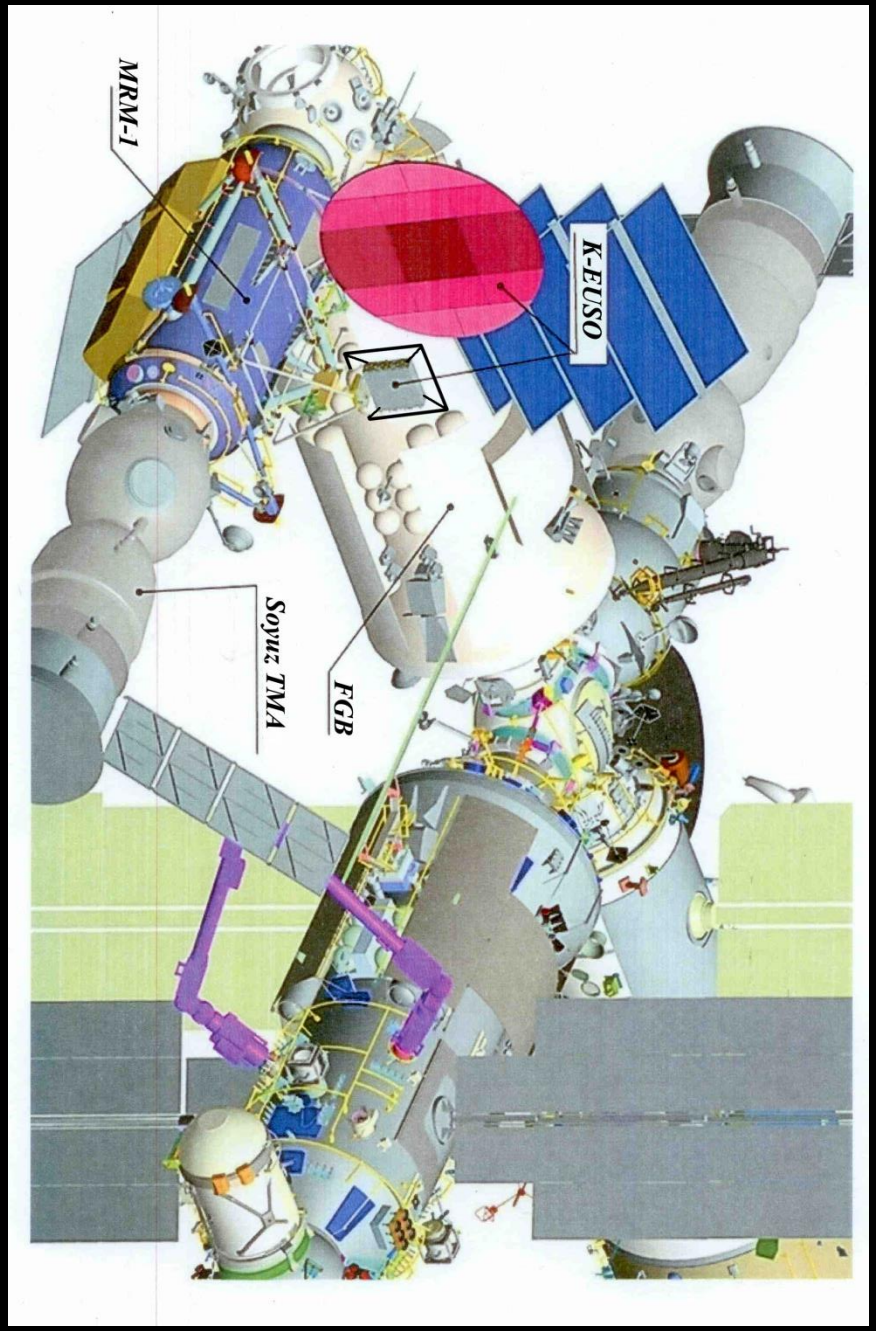
Scheduled for 2017 Paolo Nespoli flight on ISS

4. K-EUSO


K-EUSO
400km
14°
(a) Spatial profile
Fluorescence: 7262
Cerenkov (scat): 1994
Cerenkov (refl): 530
(b) Time profile
UHECR
Fluorescence
Atmosphere
Cherenkov
115km

KLYPVE+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
- Launch in FY 2019



Slide from TSNIIMASH-Roscosmoc, Dec 2014

According to NASA-Roscosmos Protocol dedicated to Utilization Sharing Plan on-board ISS TsNIIMASH and NASA selected about 37 projects for USOS-Russian Research Collaboration for 2015.

TsNIIMASH and NASA Program science office selected K-EUSO like one from 37 projects for joint research.

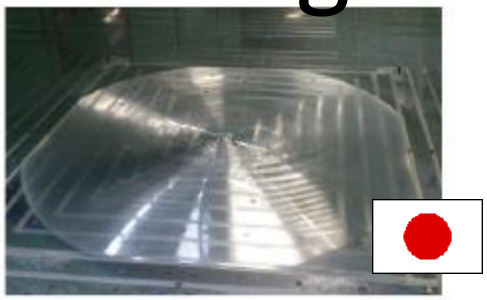
TsNIIMASH together with NASA assigned Impact rank for each experiment which was included in the research collaboration list. Impact Rank was from low to compelling.

TsNIIMASH and NASA Program science office gave K-EUSO project Compelling rank.

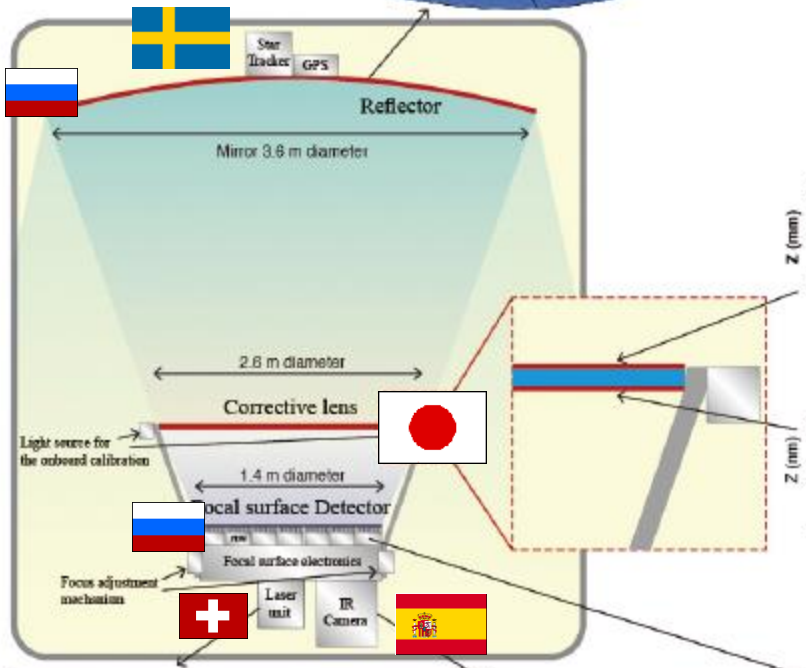
This research Collaboration list was submitted to ISS program managers from Russia and US (Mr. M. Suffredini and Mr.A. Krasnov).

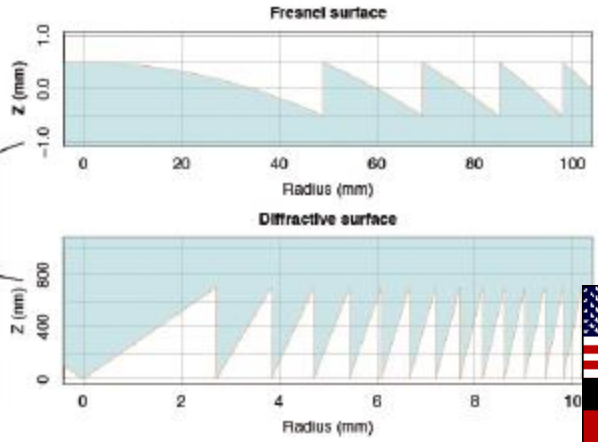
As you can see we prepared both agencies for negotiations concerning the project.

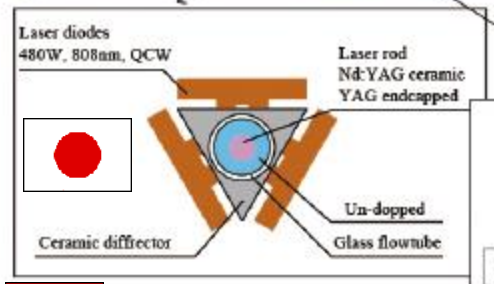
General Role Sharing



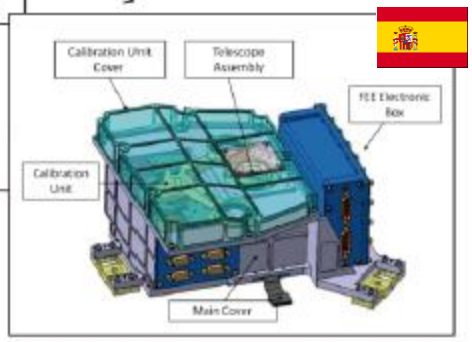
LENS

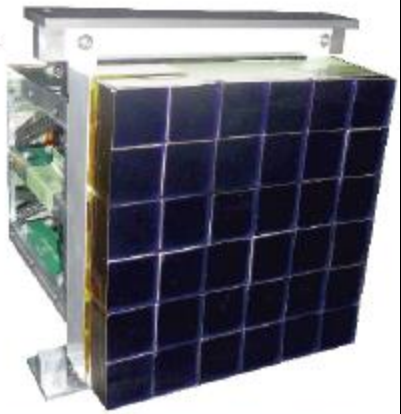






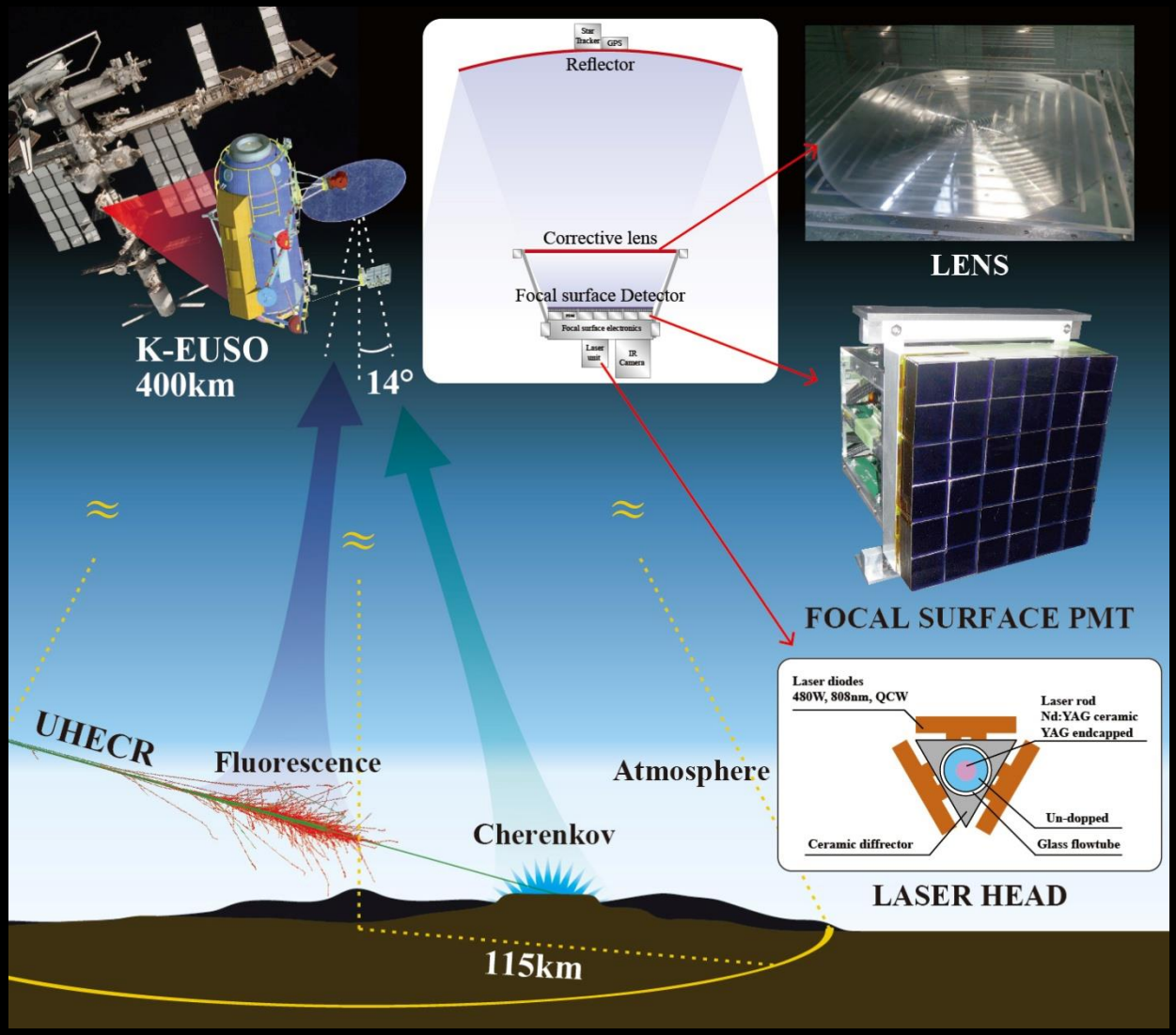
LASER HEAD



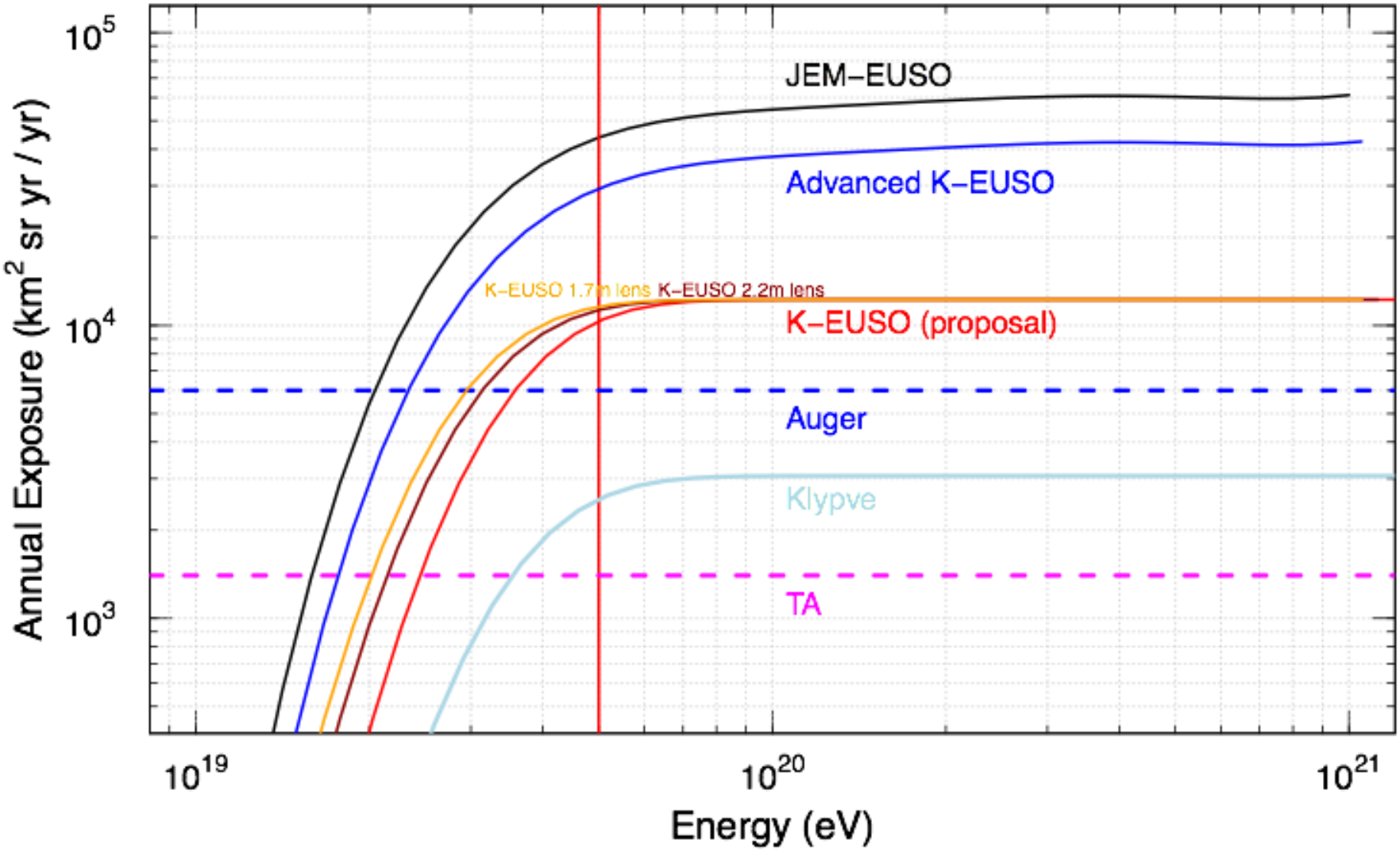


FOCAL SURFACE PMT

K-EUSO Japan contribution (JAXA 2014 proposal)



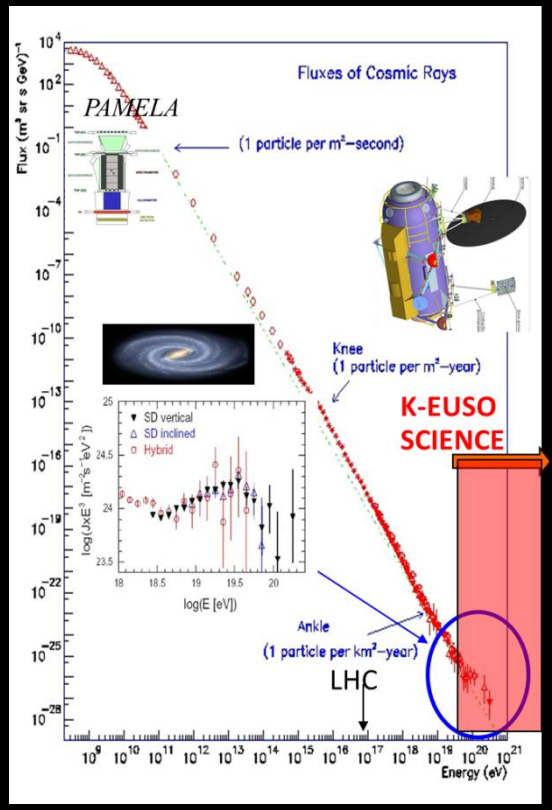
K-EUSO exposure

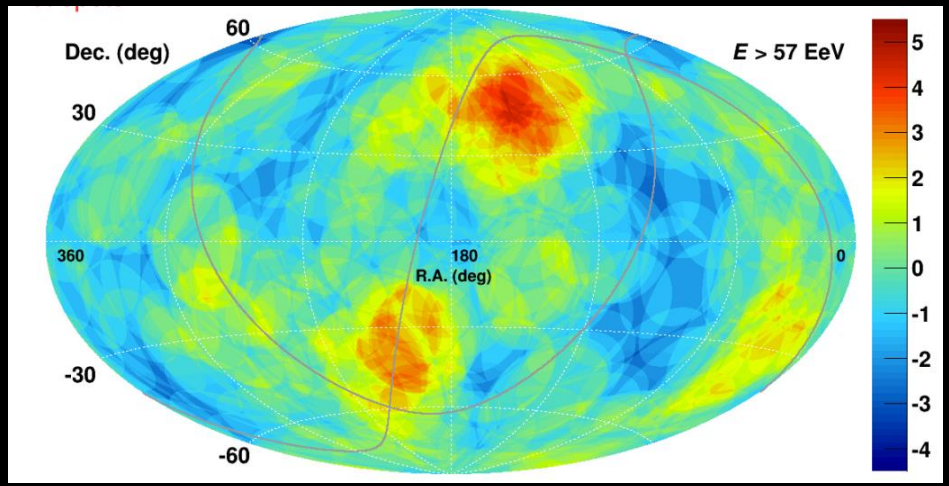


Science of K-EUSO

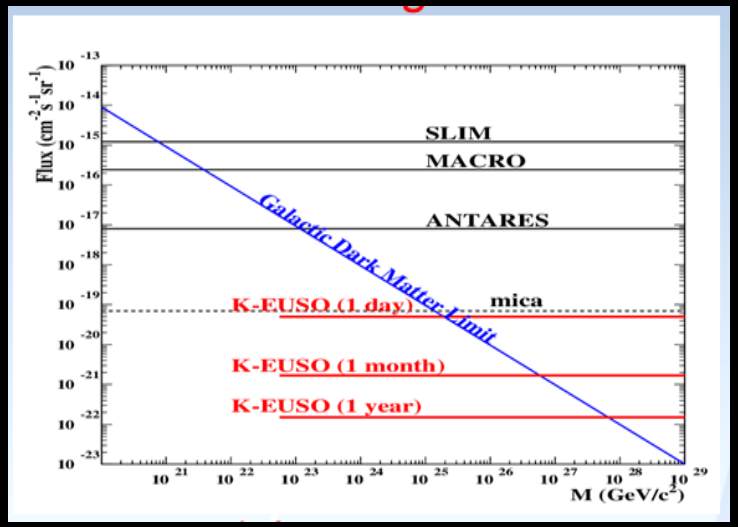
KLYPVE detector goes from technological demonstrator to instrument capable of:

1. Study of UHECR fux from space with uniform response
2. flux E>5 10^{19} eV
4. Anysotropy
3. Earth observations

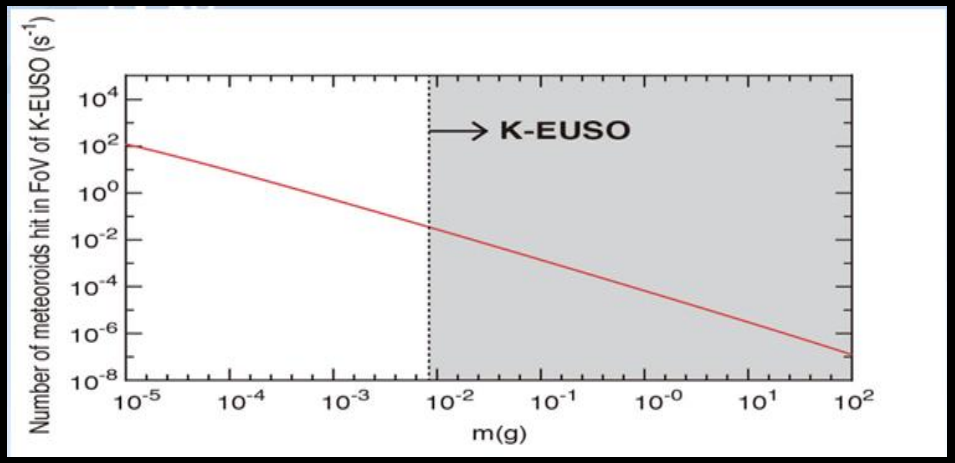




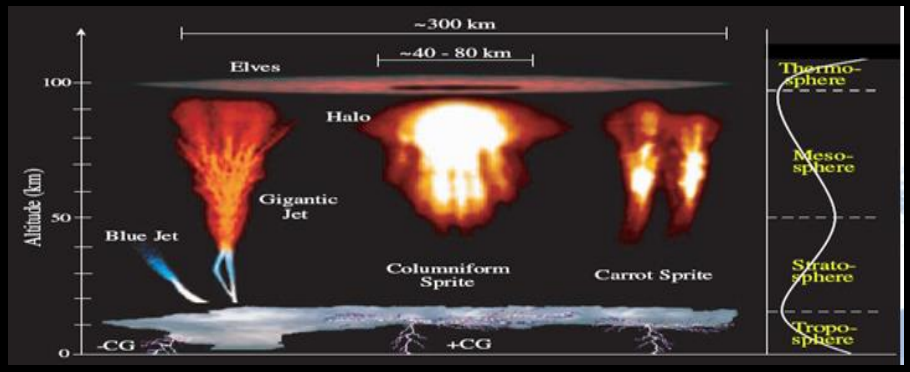
Additional Science objectives



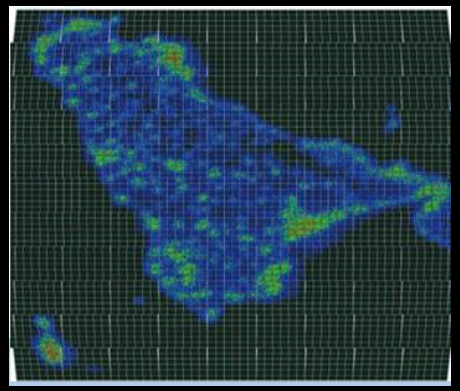
Search for Strange Quark Matter



Measurement of Meteorites



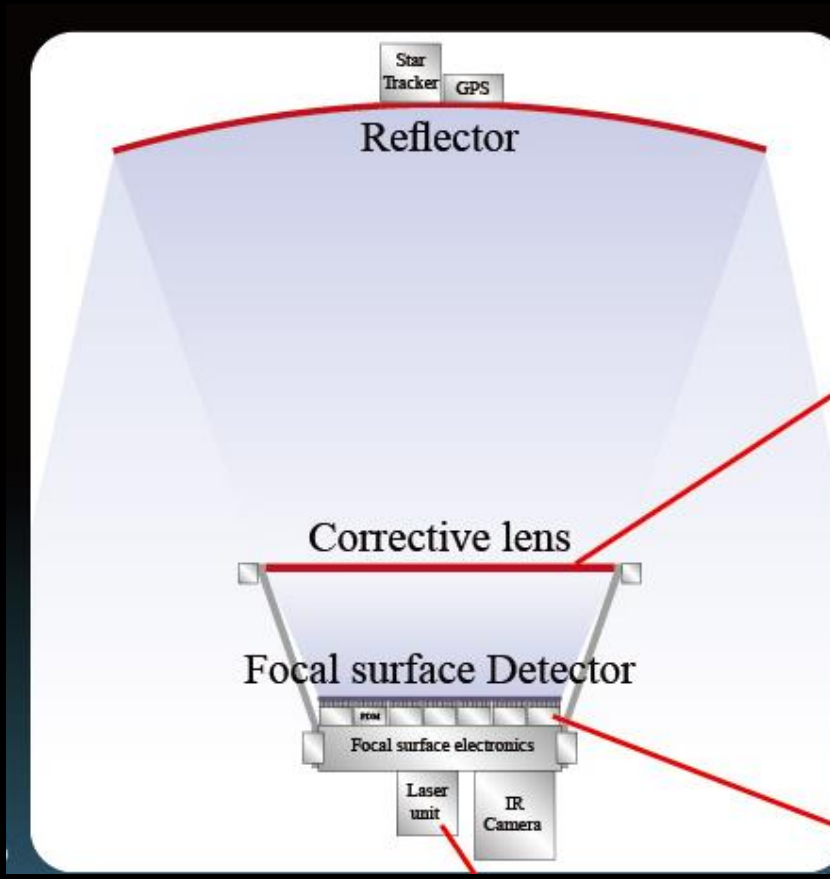
Study of Transient Luminous effects
In μs range



Map of night Earth in UV
Bioluminescence

Programmatic status

1. 2013 MSU proposal of KLYPVE included in Russian space program
2. 12-2013 MSU invited JEM-EUSO collaboration to join KLIPVE
4. 2014 JAXA call mission of opportunity
5. 2-2014 Proposal Submitted
6. 8-2014 passed MDR
7. Roscosmos-NASA joint 9-2014 Signing of science protocol and role sharing between MSU and Riken, 12/2014 with int. Partners
8. 12-2014 SRR docs submitted to JAXA (>500 pages)



Conclusions

K-Euso is a mission of opportunity improving with high international component a factor 10 Russian Klypve with advanced lens and PMT technology

Address several fundamental physics issues

Approved by Russian Space Committee

Excellent precursor capable of performing for the first time UHECR physics from space