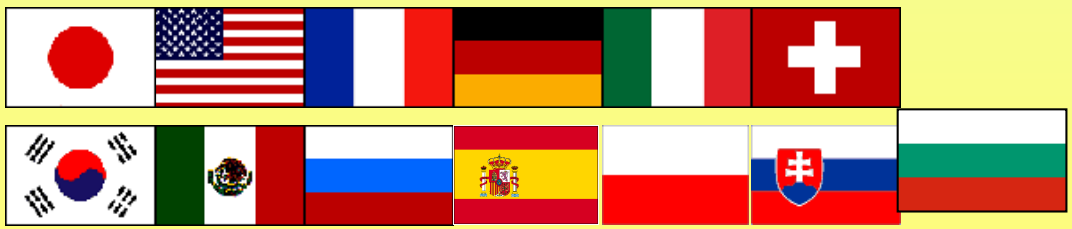
JEM EUSO Collaboration

- Japan, USA, Korea, Mexico, Russia
- Europe: Bulgaria, France, Germany, Italy, Poland, Slovakia, Spain, Switzerland
- 13 Countries, 77 Institutions, more than 270 researchers
- RIKEN: Leading institution



Vincent Van Gogh, "The starry night"

Extreme Universe Space Observatory

An Innovative Space Mission doing astronomy by looking downward from the Space Station at the Earth Atmosphere.

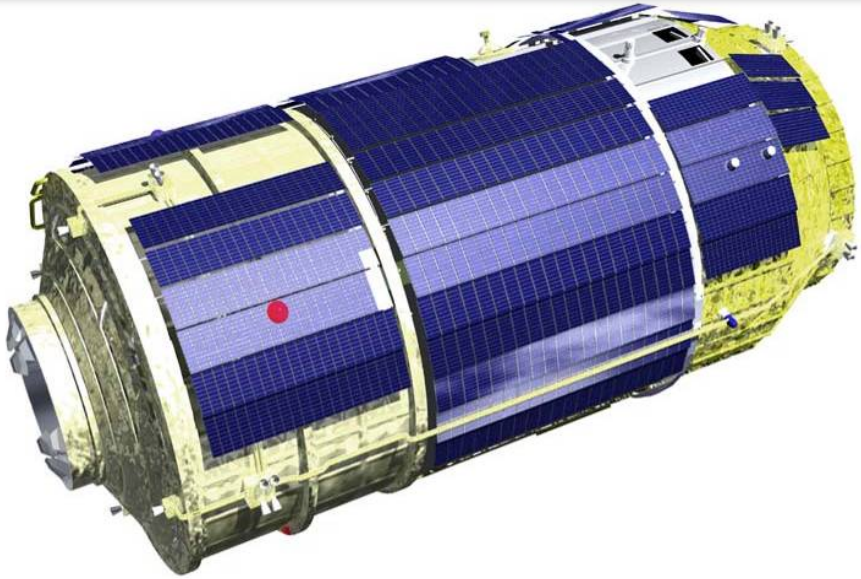
EUSO is devoted to the exploration from space of the highest energy processes present and accessible in the Universe. They are directly related to the extreme boundaries of the physical world.

DETECTION TECHNIQUE

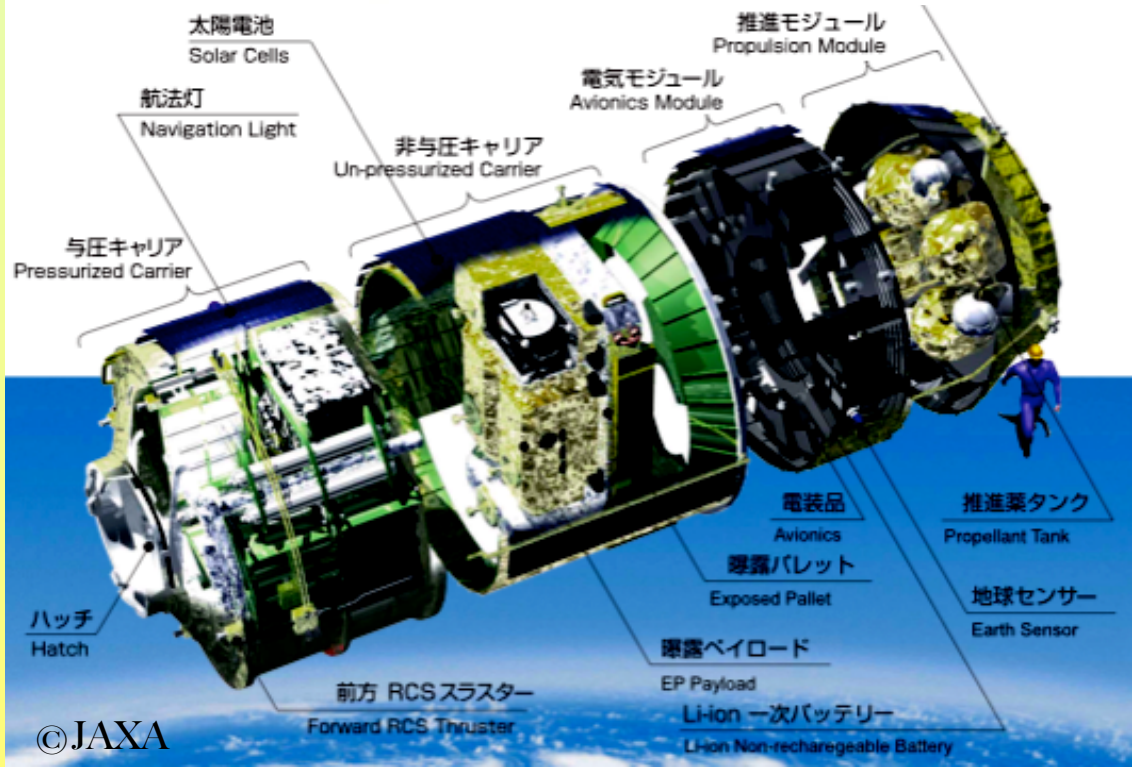
Euso will observe the fluorescence signal looking to Nadir at the dark Earth atmosphere from its location on the ISS under a 60° full field of view. Fluorescence light will be imaged by a large Fresnel lens onto a finely segmented focal surface. A Cerenkov signal will be detected in a delayed coincidence with the fluorescence signal.

The segmentation and the time resolution adopted will enable the reconstruction of the arrival direction and EAS energy, with an accuracy of order $\Delta E/E \sim 30\%$, and arrival direction ranging from a fraction of a degree to a few degrees depending on energy and zenith angle of the primary particle.

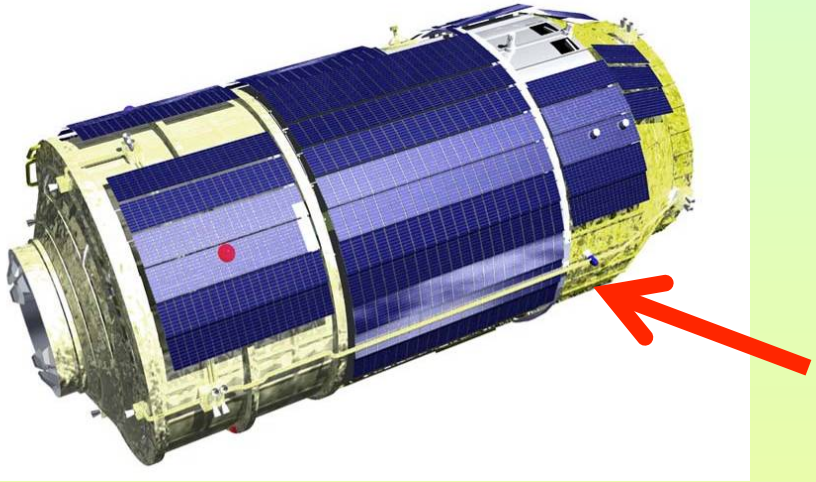
HTV Transfer Vehicle



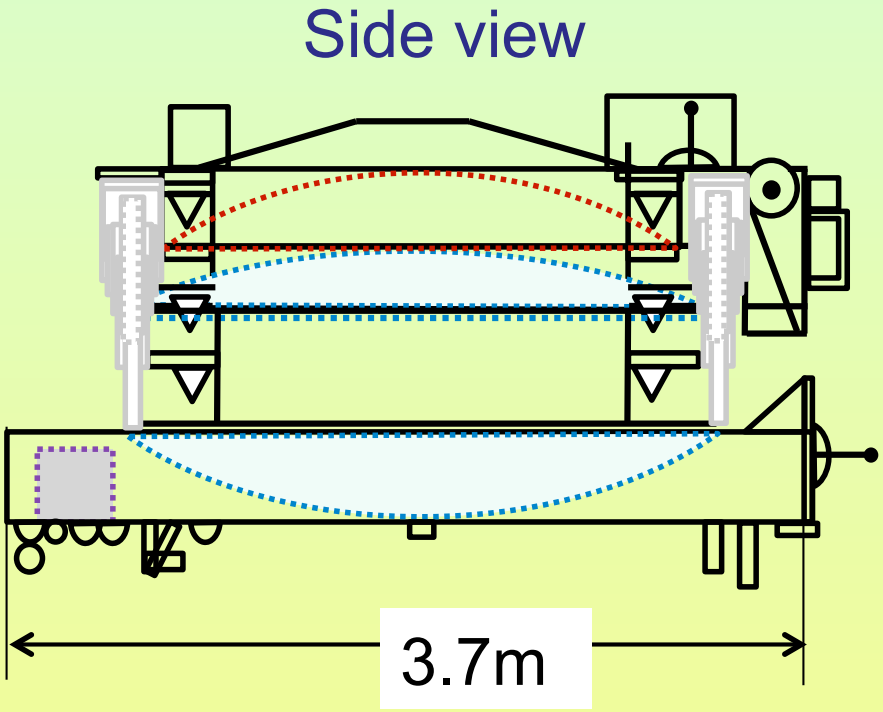
4m diameter, 10 m long



Science Instrument on HTV



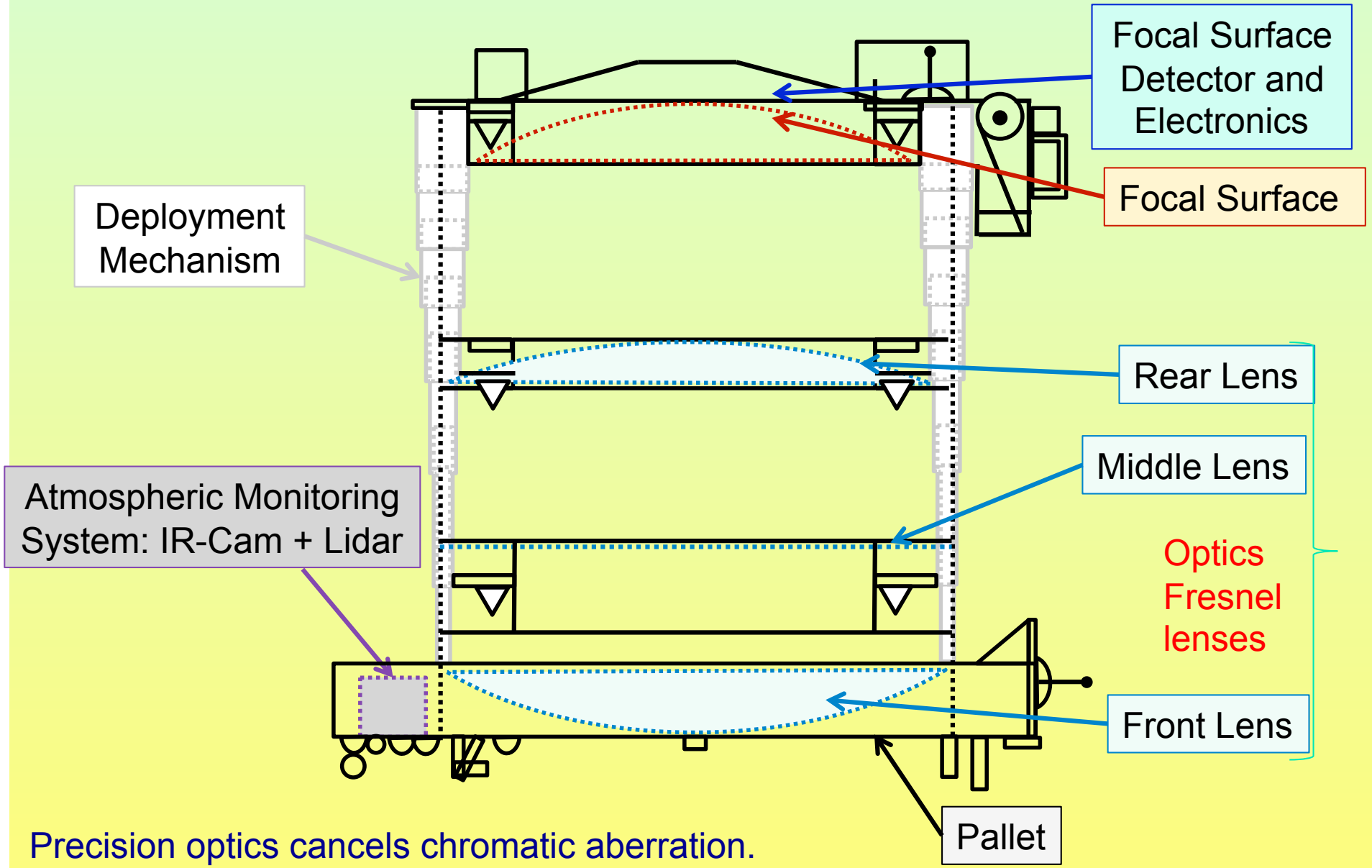
H2B Transfer Vehicle (HTV)



JEM-EUSO Telescope will be deployed after it is attached at the ISS

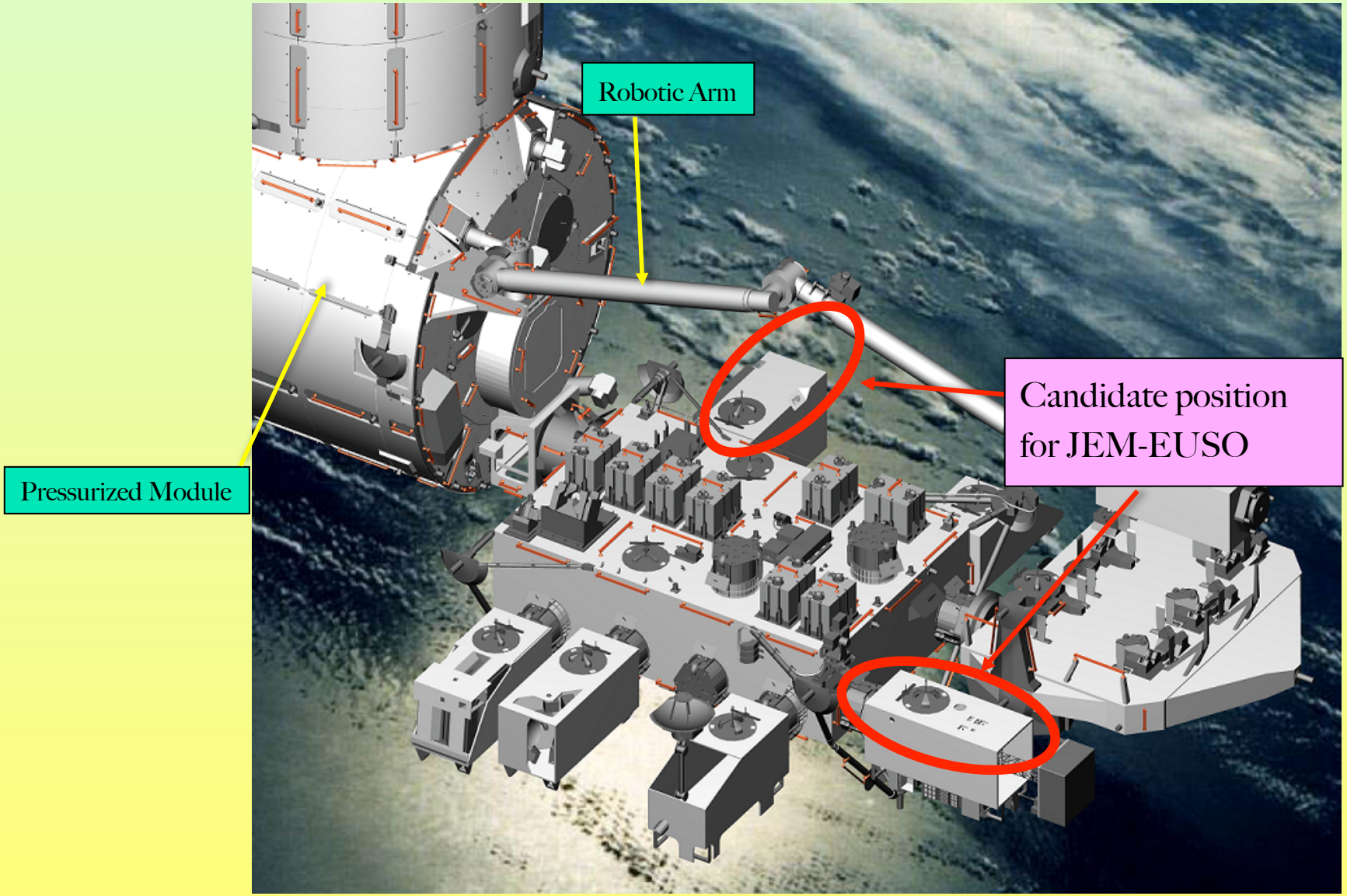
HTV was successfully launched on September 2009

Science Instrument: deployed

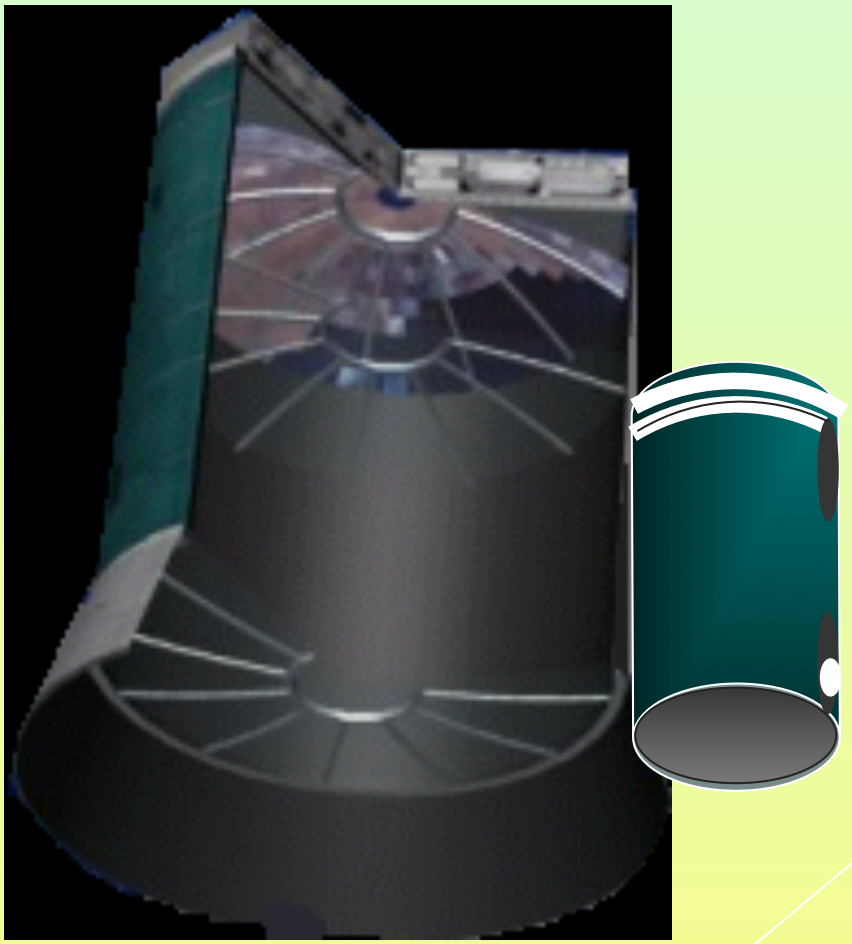


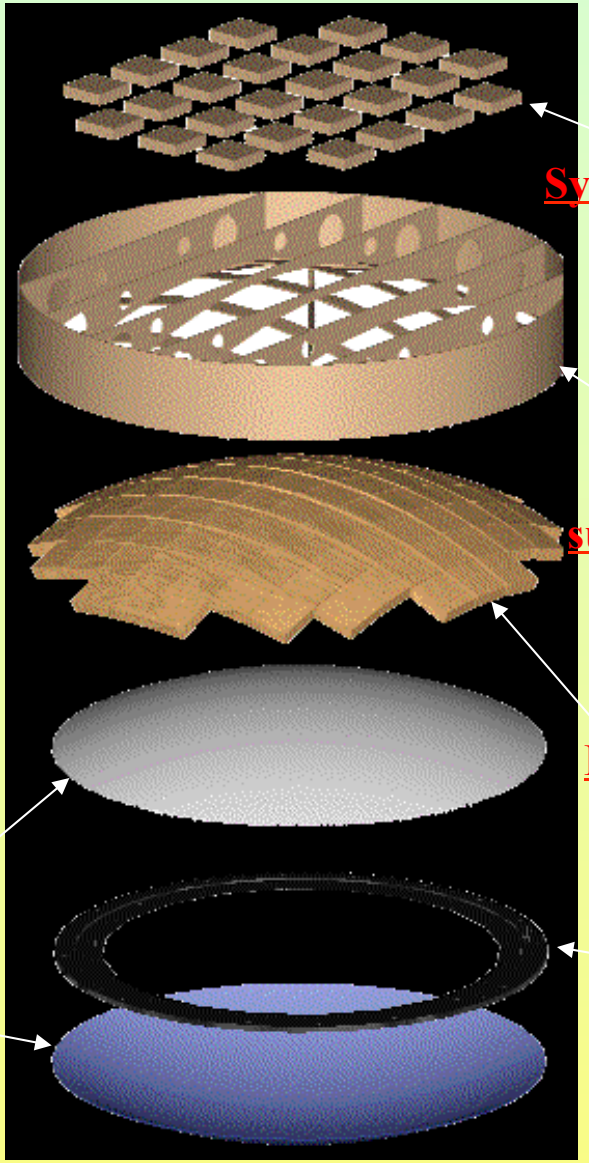
Precision optics cancels chromatic aberration.
Materials: PMMA+CYTOP

Outline of JEM Exposure Facility



A monocular compact instrument





The UV Telescope Parameters

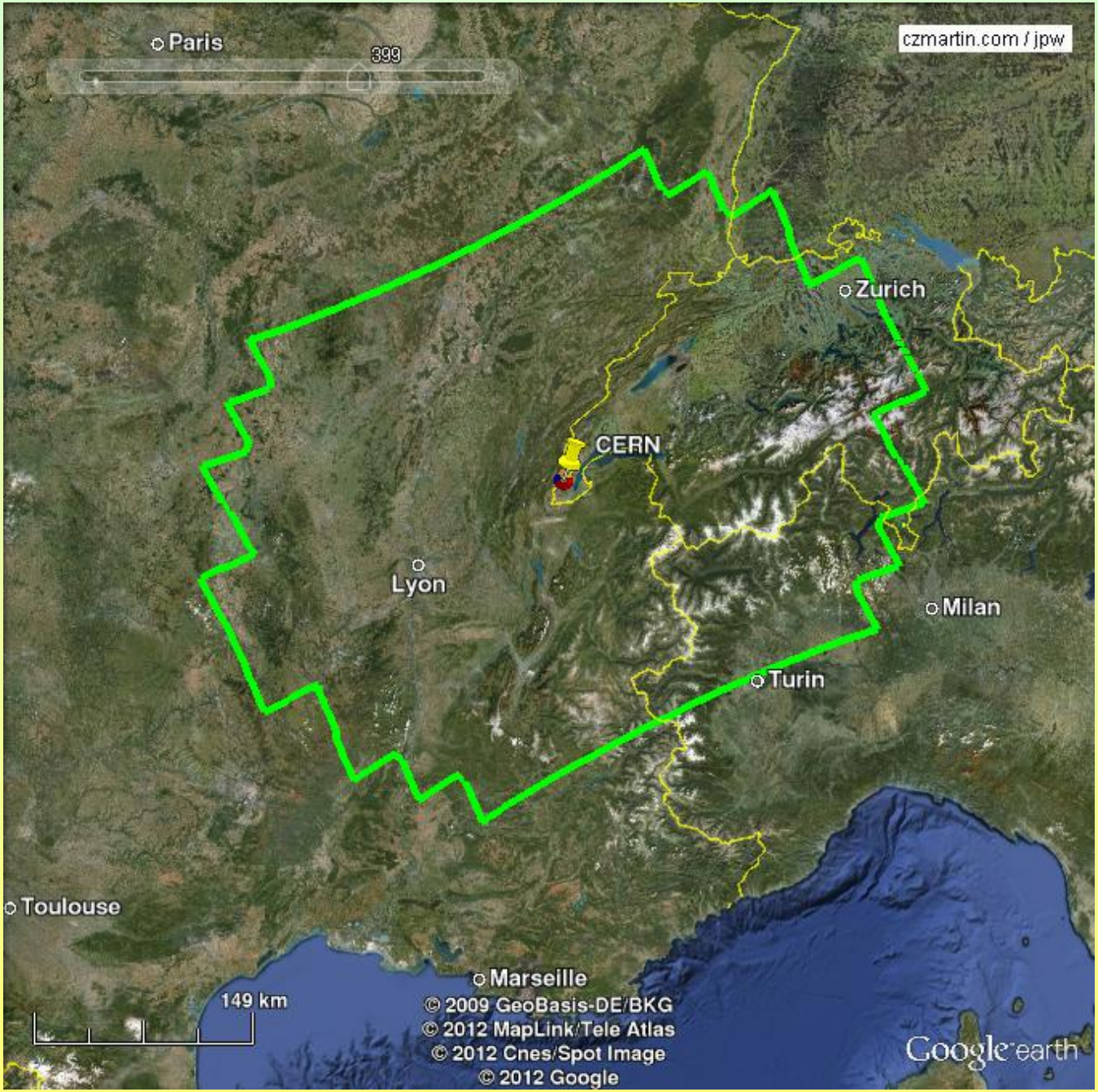
Parameter	Value
Field of View	±30°
Monitored Area	>1.3×10^{5}km^2
Telescope aperture	≥2.5 m
Operational wavelength	300-400 nm
Resolution in angle	0.075°
Focal Plane Area	4.5 m^2
Pixel Size	<3 mm
Number of Pixels	≈3×10^5
Pixel size on ground	≈560 m
Time Resolution	2.5 μs
Dead Time	<3%
Detection Efficiency	≥20%

Observation mode of JEM-EUSO

Vertical Mode

Tilted Mode

Larger exposure can be obtained


Paris
399
czmartin.com / jpw
Zurich
CERN
Lyon
Milan
Turin
Toulouse
Marseille
149 km
© 2009 GeoBasis-DE/BKG
© 2012 MapLink/Tele Atlas
© 2012 Cnes/Spot Image
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Google earth


czmartin.com / jpw
399
Paris
Zurich
CERN
Lyon
Milan
Turin
Bordeaux
Toulouse
Marseille
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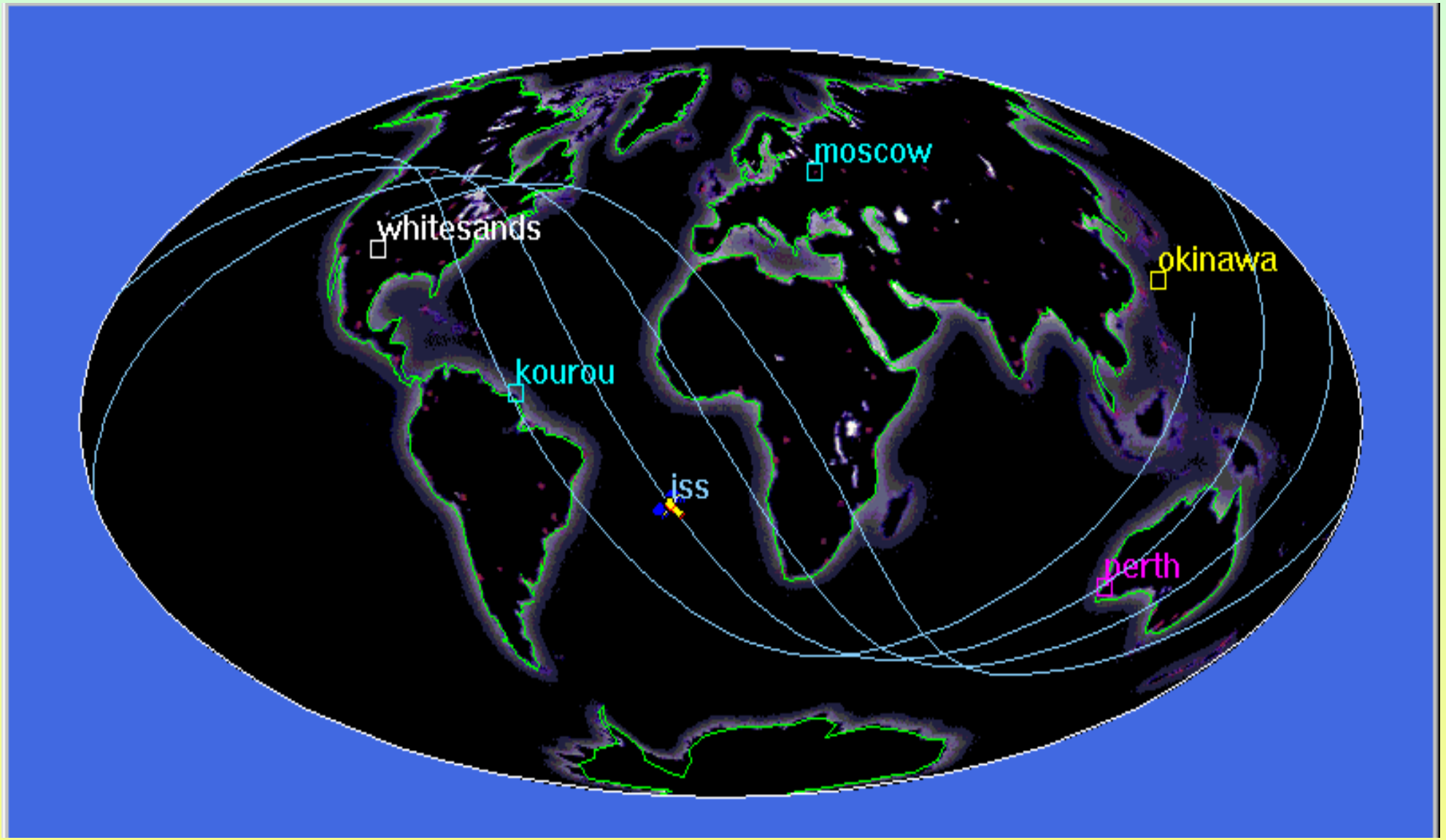
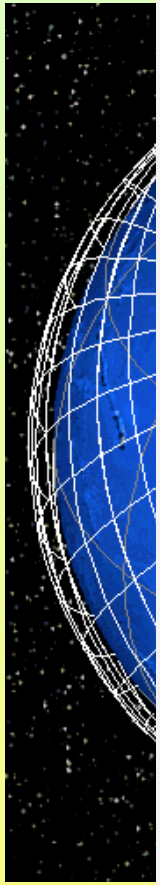
Madrid
Lisbon
400 km
© 2009 GeoBasis-DE/BKG
US Dept of State Geographer
© 2012 MapLink/Tele Atlas
© 2012 Google
Google earth

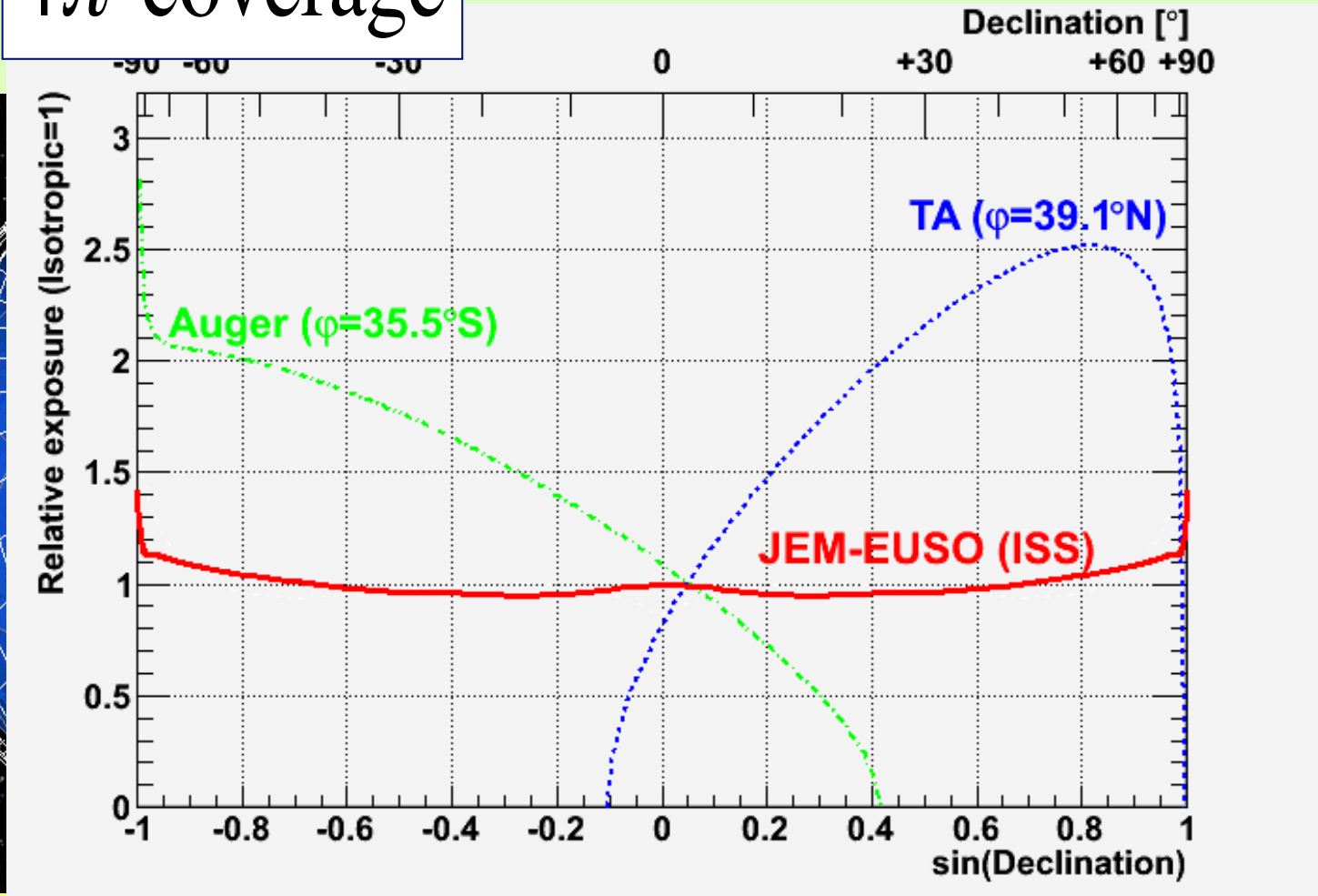


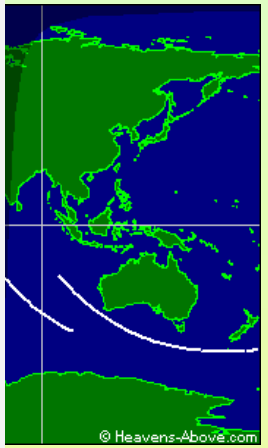
In a year of operation, EUSO will cover all sky directions

ISS Orbit→ Full sky Coverage…

4π coverage





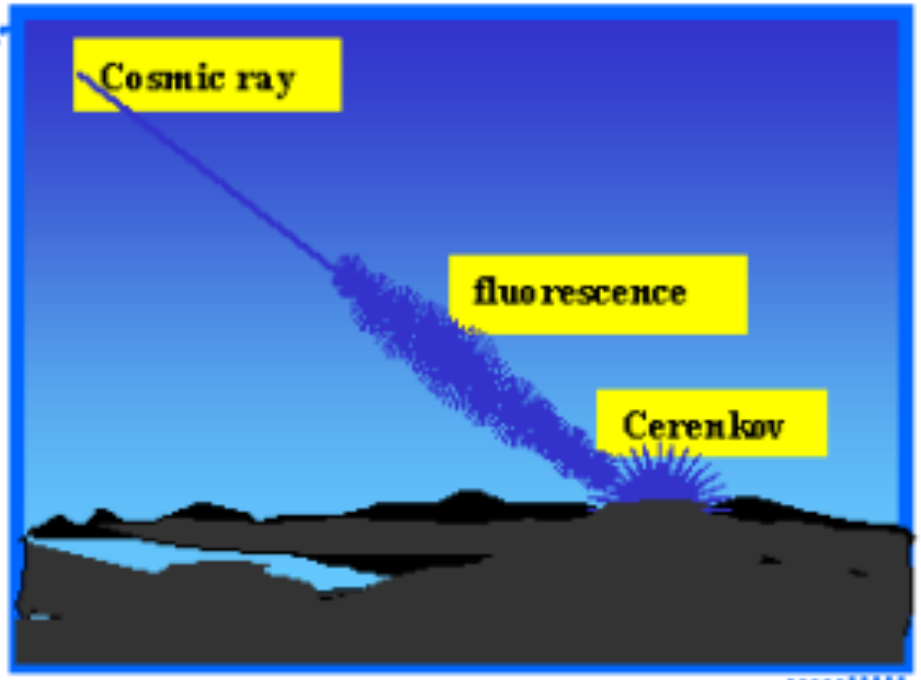


http://www.nlsa.com/

…ve the
…CR very
uniformly owing to the nature of the ISS orbit.

… and uniform exposure


EUSO on ISS
30°
400 km
230 km
Earth surface


Cosmic ray
fluorescence
Cerenkov

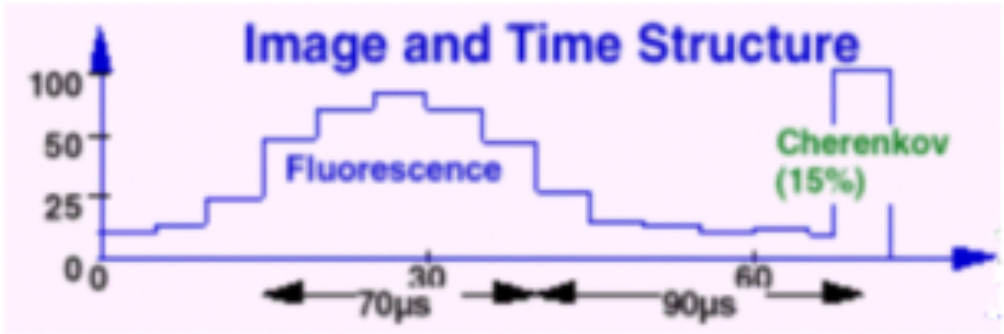
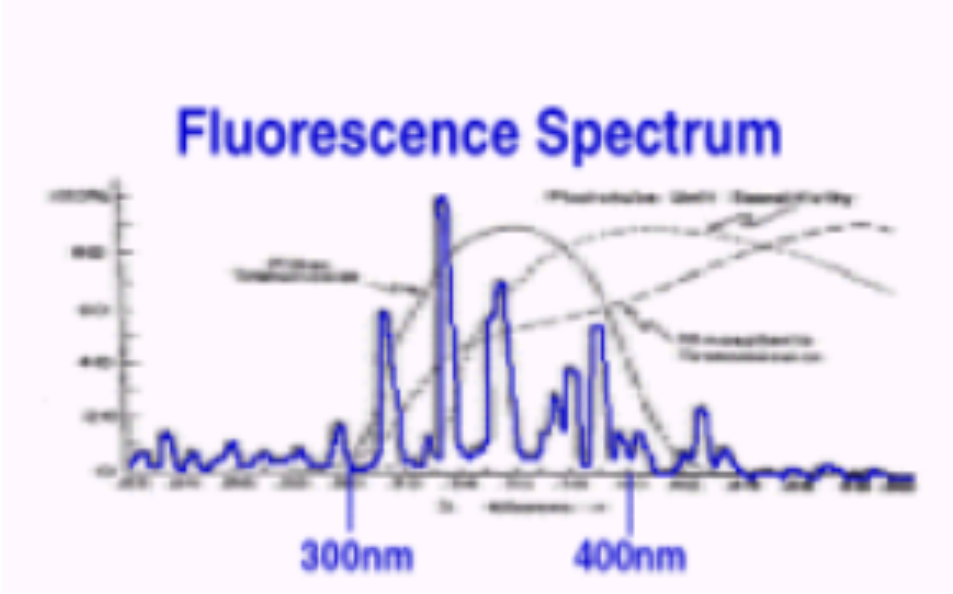
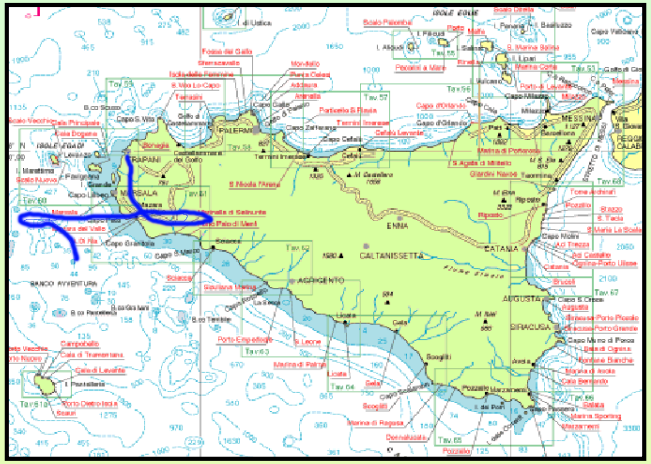


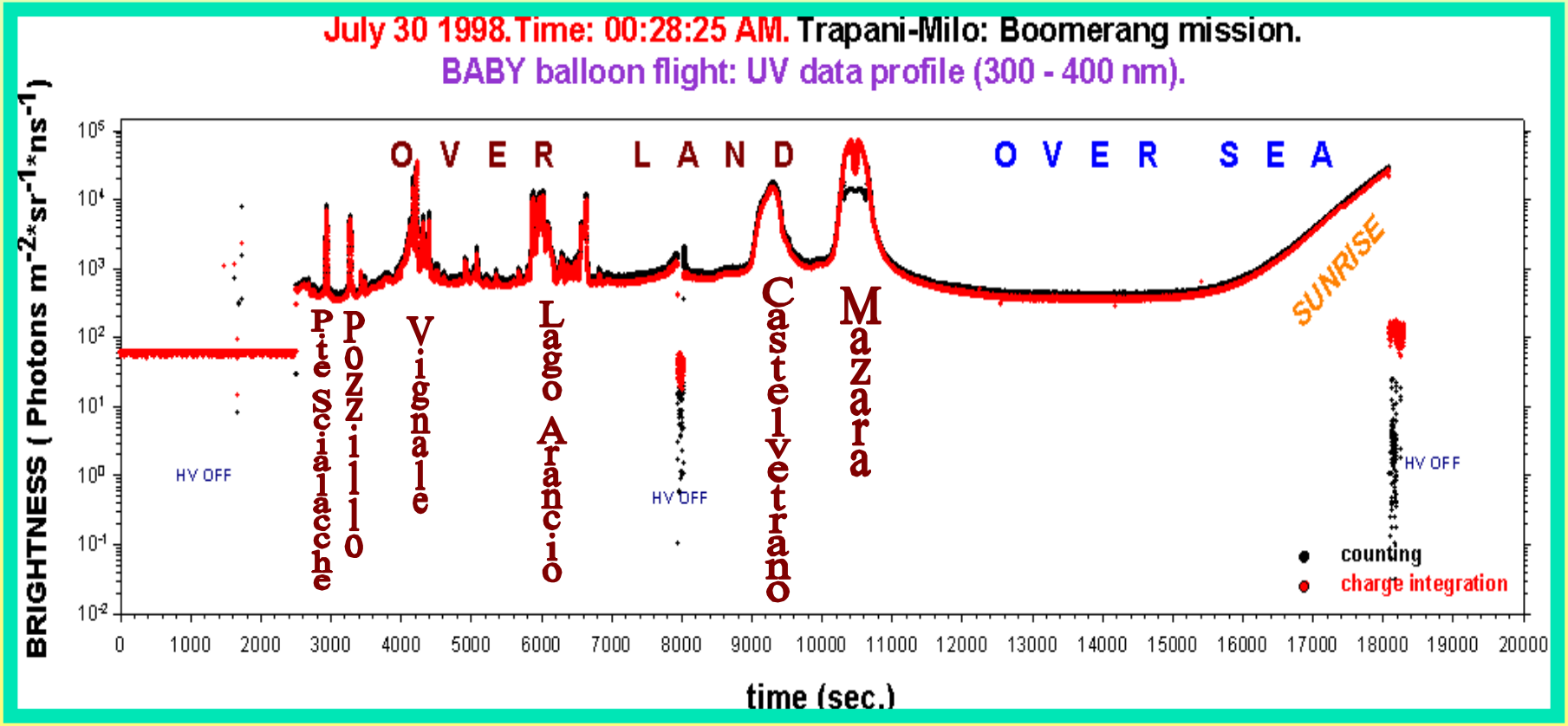
Image and Time Structure
100
50
25
0
0
30
60
Fluorescence
Cherenkov
(15%)
70μs
90μs

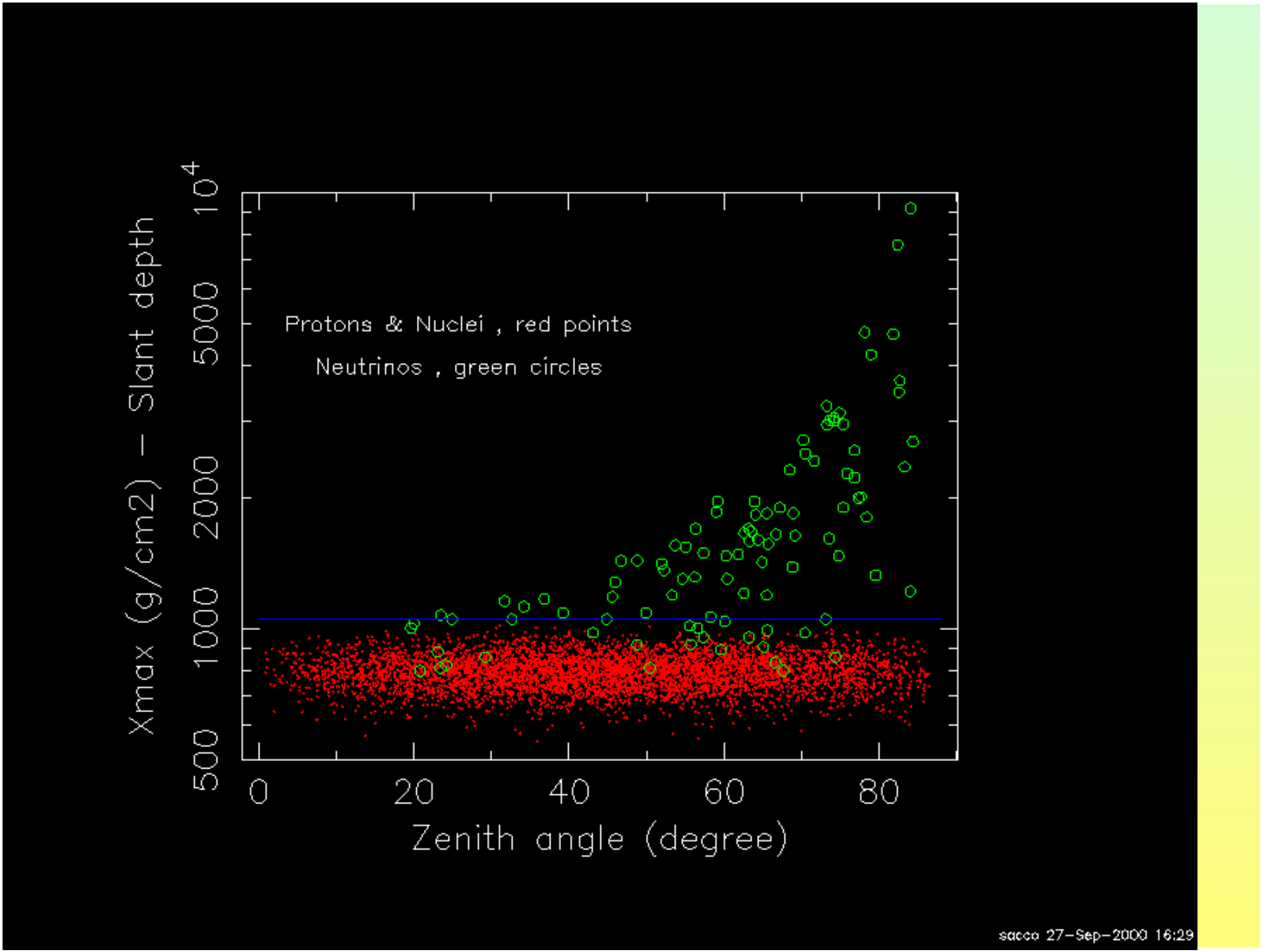

Fluorescence Spectrum
300nm
400nm

EUSO DETECTION TECHNIQUE

background measurement



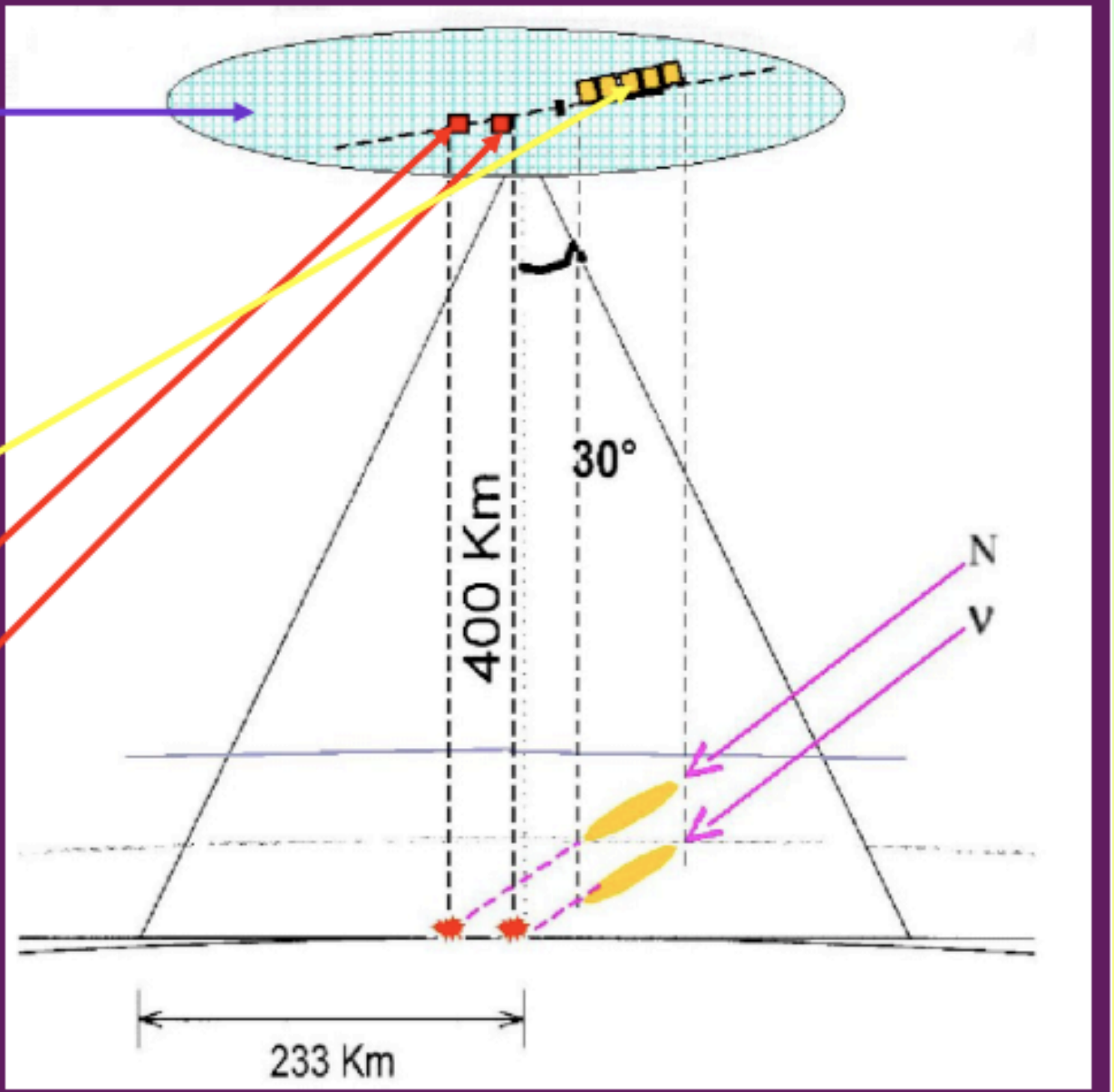



Xmax (g/cm2) – Slant depth
500
1000
2000
5000
10^4
Protons & Nuclei , red points
Neutrinos , green circles
0
20
40
60
80
Zenith angle (degree)
sacco 27-Sep-2000 16:29

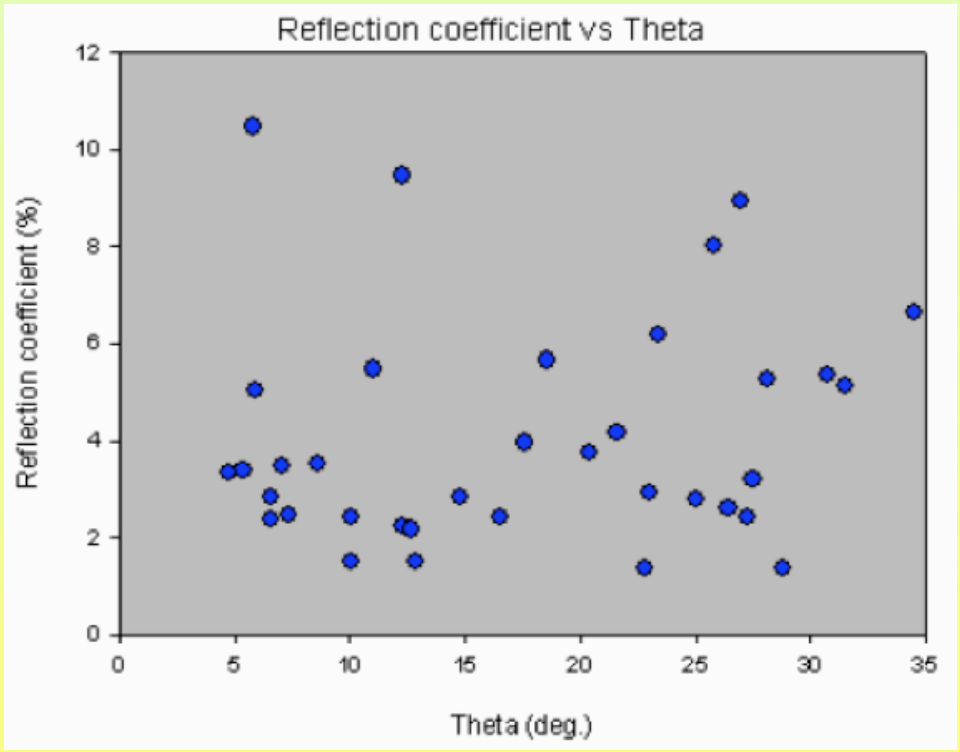
Focal Surface

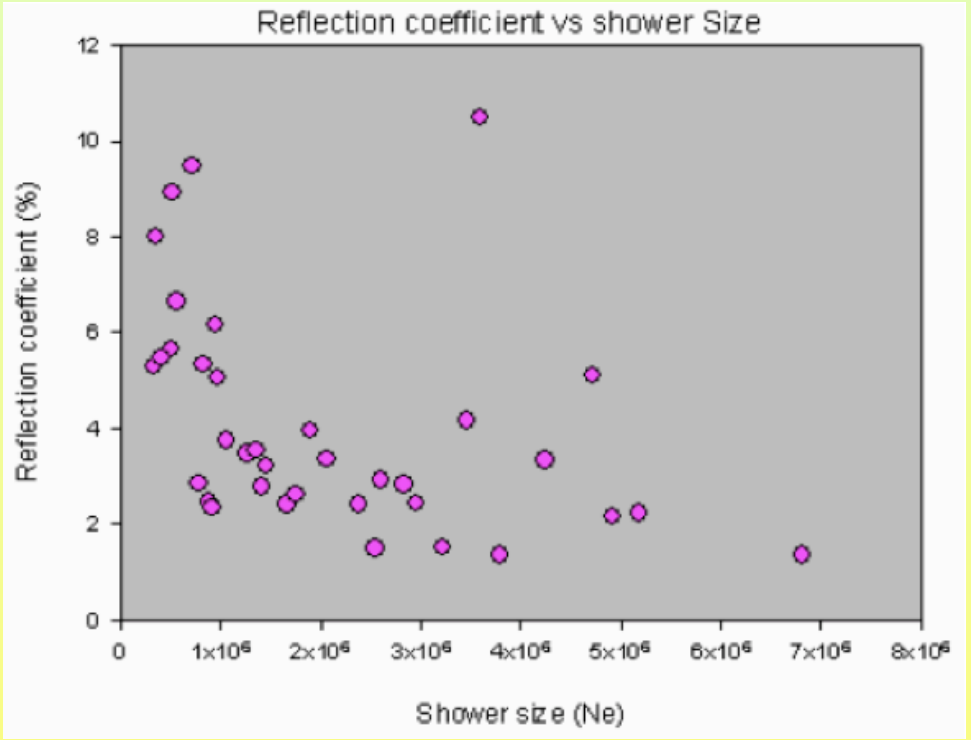
Fluorescence signal

Čerenkov signal




2005 - ULTRA @ Capo Granitola
ex-tonnara di Torretta Granitola, Mazara del Vallo (TP, Italy)


Reflection coefficient vs Theta
Reflection coefficient (%)
Theta (deg.)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35


Reflection coefficient vs shower Size
Reflection coefficient (%)
Shower size (Ne)
0
2
4
6
8
10
12
0
1x10⁶
2x10⁶
3x10⁶
4x10⁶
5x10⁶
6x10⁶
7x10⁶
8x10⁶

Science Objectives

- Fundamental Objective

  Extreme energy astronomy by particle channel

  Determine their origin and the acceleration mechanism

- **Exploratory Objectives**
  - Detection of extreme energy gamma rays
  - Detection of extreme energy neutrinos
  - Study of the galactic magnetic field
  - Verification of the relativity and the quantum gravity effect in extreme energy
  - Global observations of nightglows, plasma discharges and lightning

EAS DETECTOR: EUSO APPROACH

To obtain a statistical significant sample of EECR events at $E > 10^{20}$ eV, with flux value at the level of:

1 particle/year/100 km^2

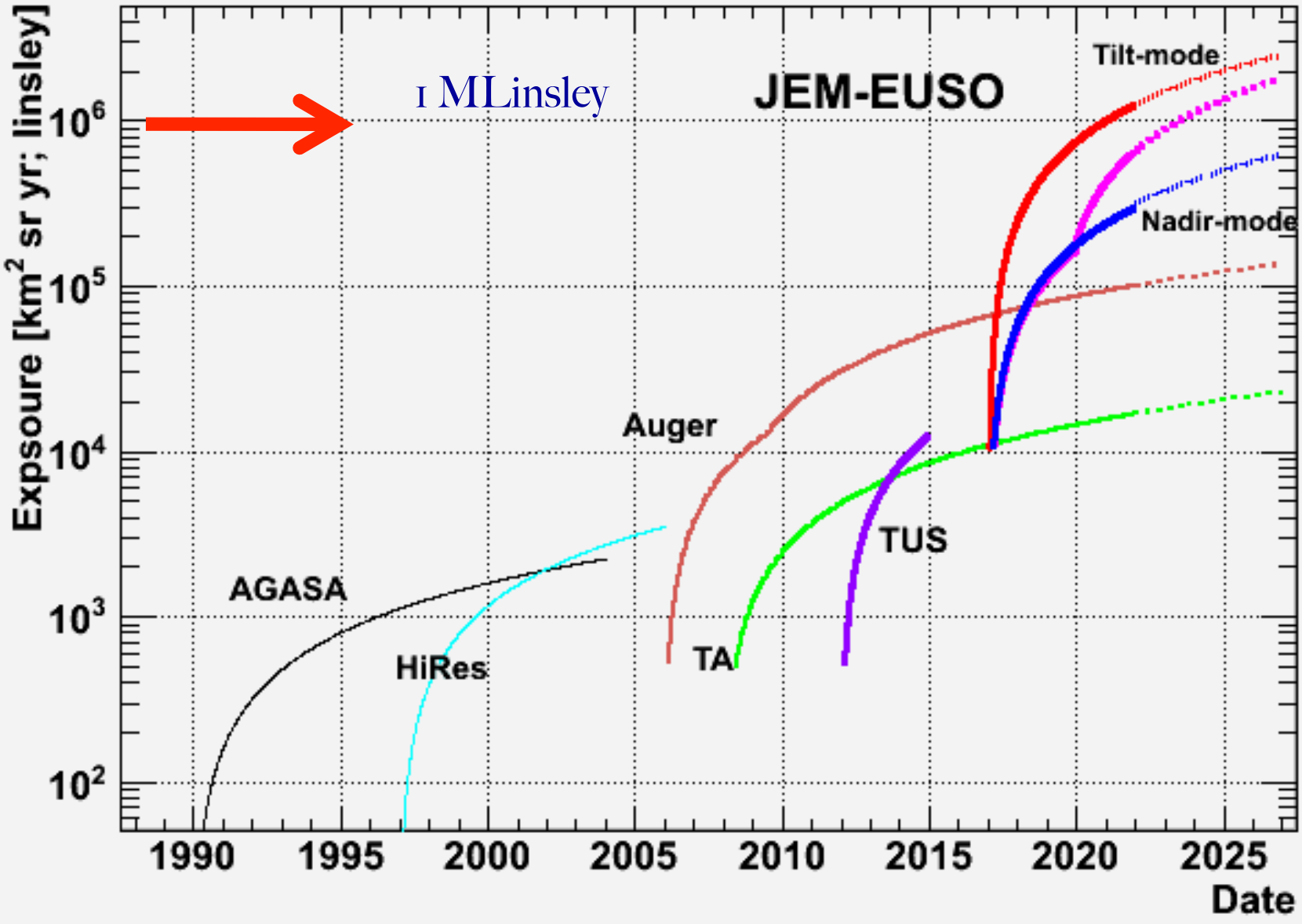
or with very low interaction cross section (neutrinos), a giant detector is required.

The Earth atmosphere, viewed from space with an acceptance area of the order of **$5 \cdot 10^5$ km^2 sr**, and a target mass of the order of **$3 \cdot 10^{12}$ tons** constitutes an ideal target to UHE CR and cosmic neutrinos.

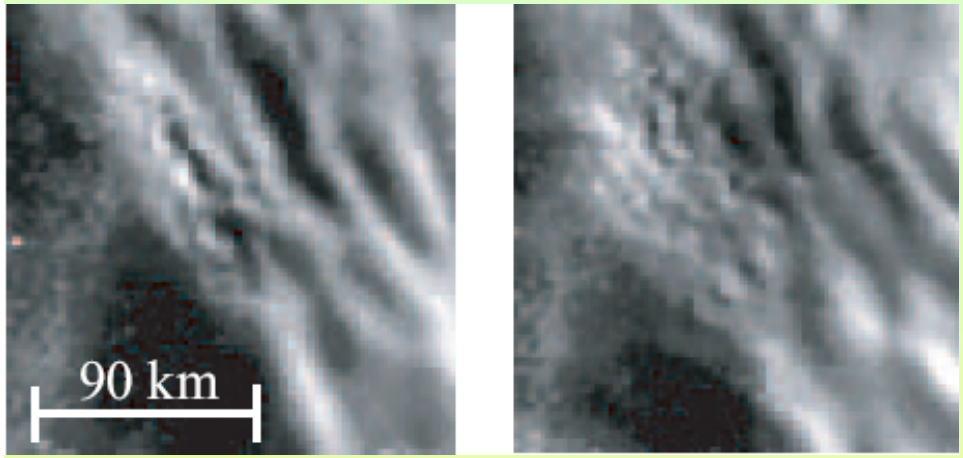
Comparison with current observatories

Experiment	Aperture km² sr	Status	Start	Lifetime (years)	Duty cycle (incl. clouds)	Exposure (km² sr y)	Relative to Auger
Auger	7,000	Operations	2006	4 (16)	1.0	27,370 (110,000)	1
TA	1,200	Operations	2008	2 (14)	1.0	2400 (16.000)	0.1
TUS	30,000	developed	2012	5	0.14	18,750	0.2
JEM-EUSO (E~100 EeV) Nadir-Mode	470,000 (10xAuger including DC)	proposed	2017	5	0.14	330000 (5 years Nadir)	3
JEM-EUSO (highest Energies) Tilted-Mode	1,300,000 (26xAuger including DC)	proposed	2017	5	0.14	910000 (5 years tilted)	8

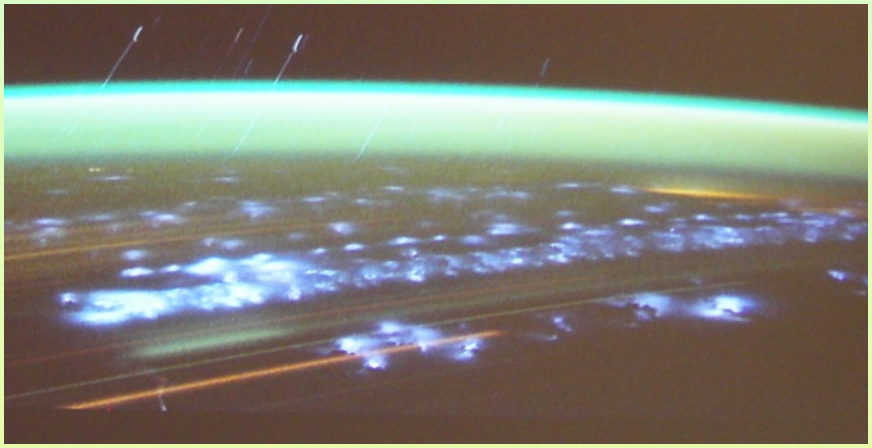
Why JEM-EUSO? Large exposure + Full sky coverage



Atmospheric Luminous Phenomena

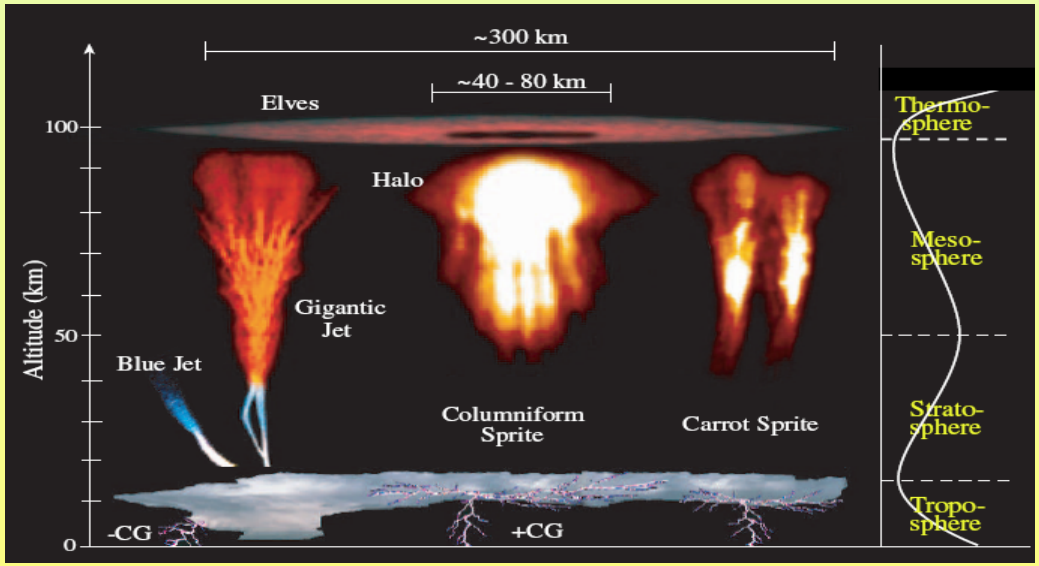


OH airlow from ground



Lightning picture observed from ISS

Leonid meteor swarm in 2001



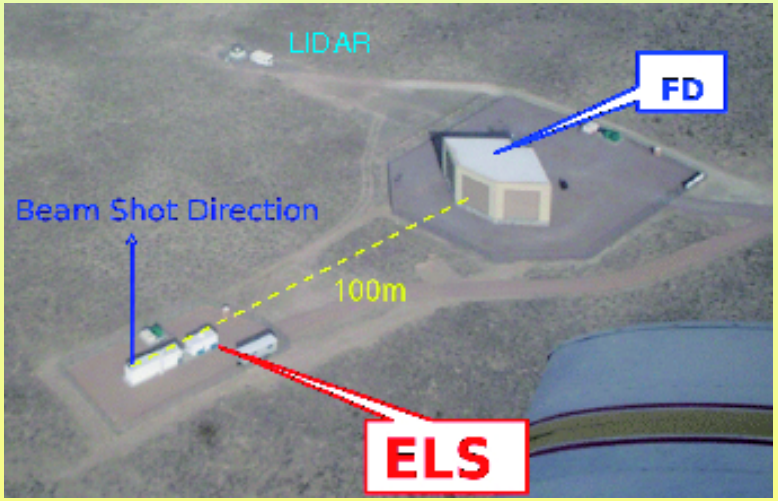
Various airglows

TA-EUSO

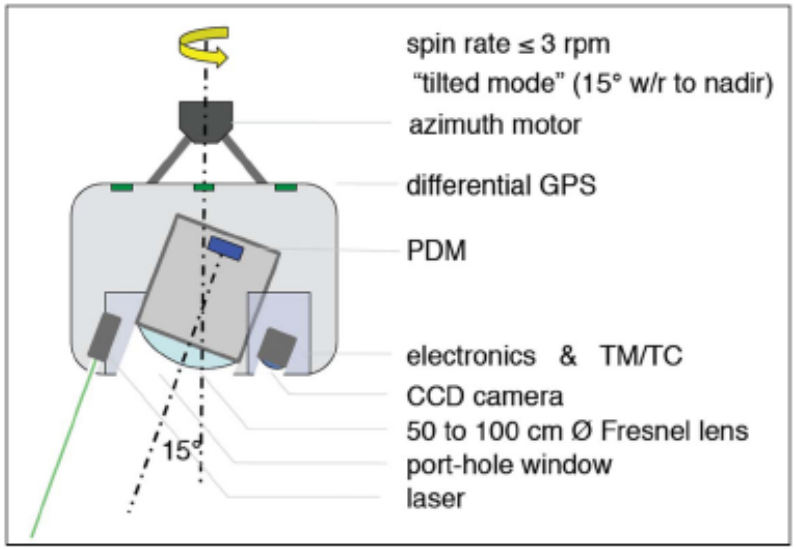
In September integration of the PDM then integration of the Digital Processor Unit, and delivery to Utah

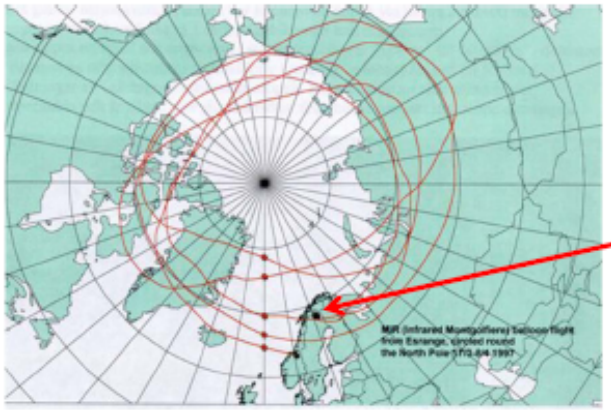
Operation: December 2012?

Test of the prototype at the Telescope Array (TA) site in Utah



JEM-EUSO Prototype Test by Balloon





The first integrated test using various elements developed for the JEM-EUSO UV telescope from a high altitude of ~40km.

~10-50 CR events/10hr
$E \geq 10^{18}$ eV

Launch : ~ Jan. 2013

Launch base : Kiruna, Sweden

SUMMARY AND CONCLUSIONS


Vincent Van Gogh, "The starry night"

JEM EUSO is an innovative Space Mission doing astronomy by looking downward from the Space Station at the Earth Atmosphere

JEM EUSO will provide unique results in:

- 1 – Astrophysics
- 2 – Astroparticle Physics
- 3 – Cosmology
- 4 – Neutrino Astrophysics
- 5 – Fundamental Physics
- 6 – Atmospheric sounding