



JEM-EUSO Update

Jim Adams U. Alabama Huntsville

Lawrence Wiencke

Colorado School of Mines

Angela Olinto U. Chicago

April APS Meeting

Salt Lake City, April 17th 2016

JEM-EUSO Science objectives

Study of Cosmic Particles at the Highest Energies

Main Science Objectives:

Identify **UHE sources** $E > 5 \times 10^{19}$ eV

Measure energy spectra of individual sources

Measure the trans-GZK spectrum

Exploratory objectives:

Discover UHE Gamma-rays

Discover UHE neutrinos

Study Galactic and Extragalactic Magnetic Fields

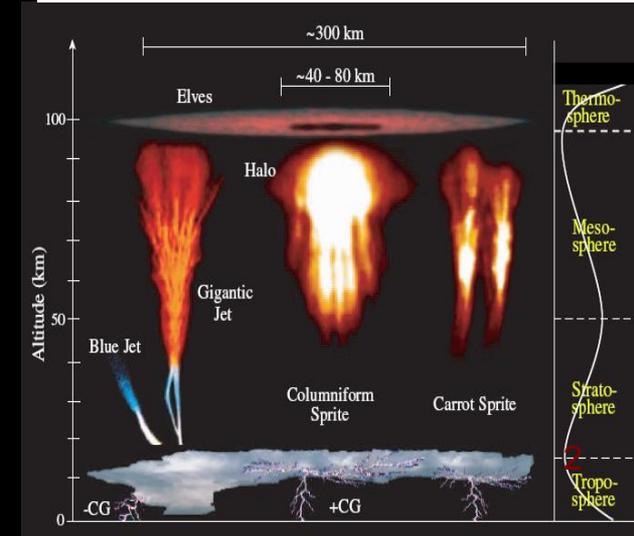
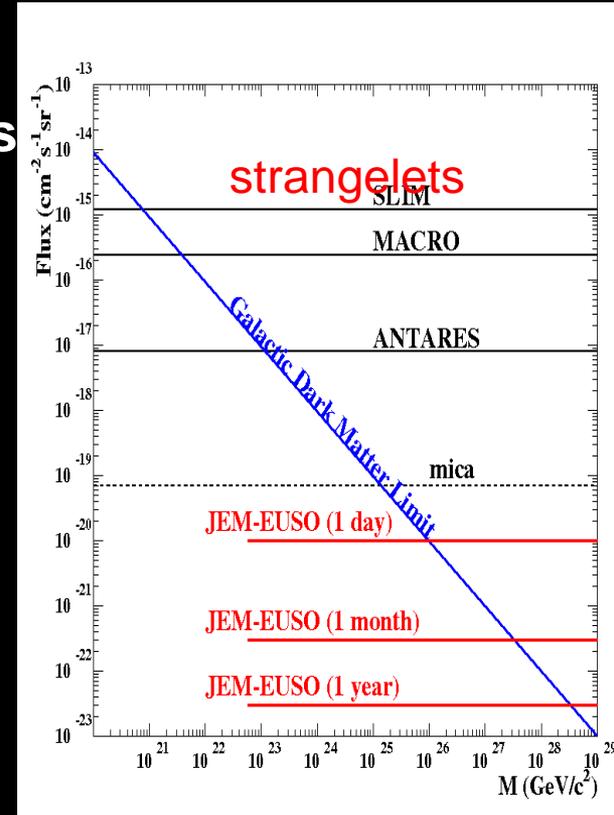
Discover Relics from the Early Universe (e.g., SHDM)

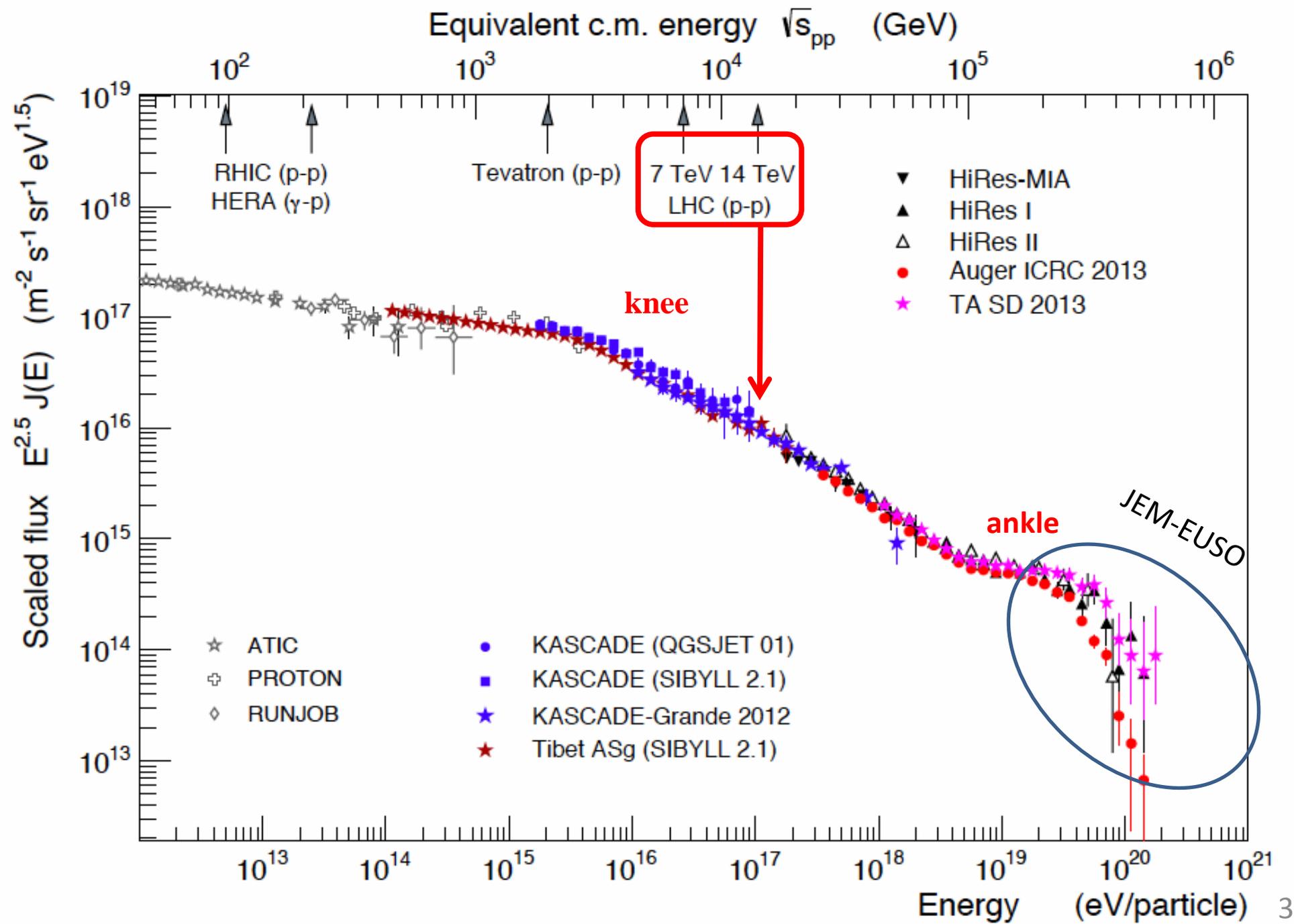
Atmospheric Science

Nightglow

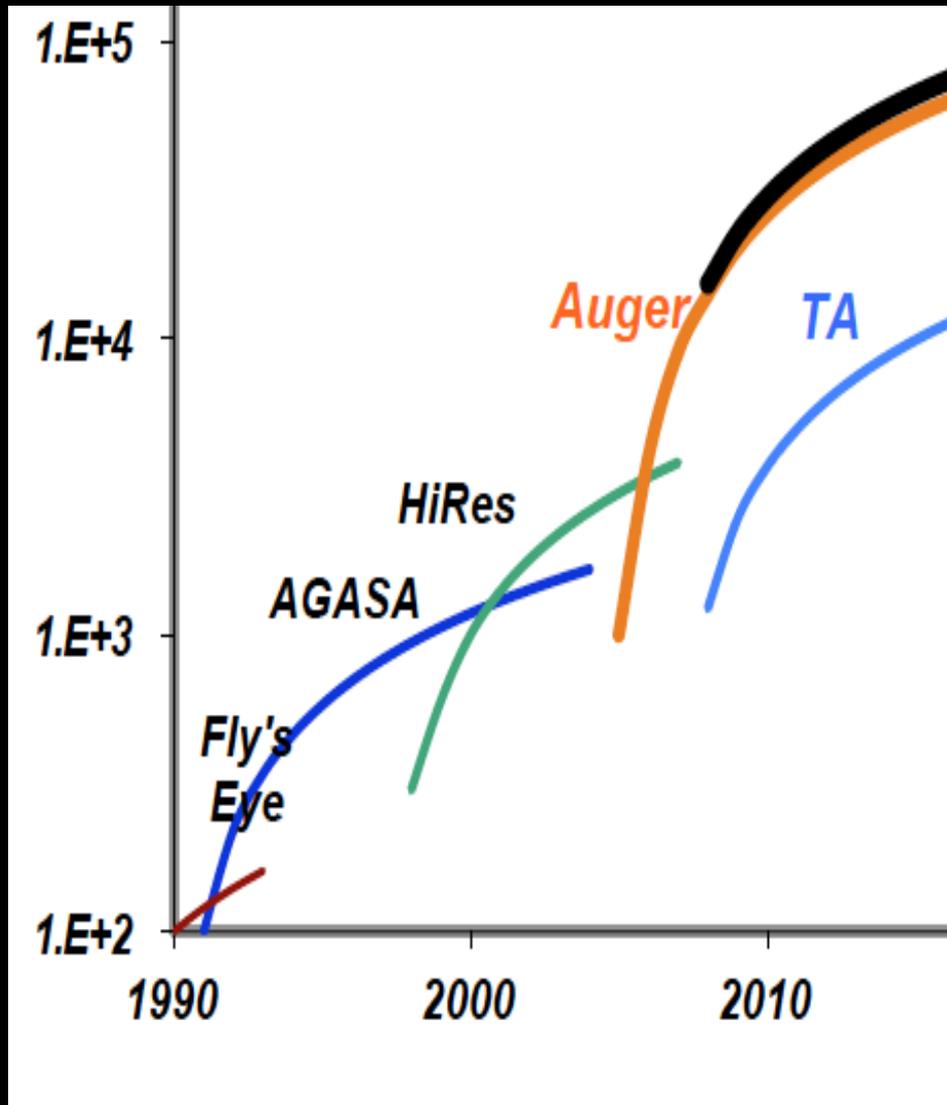
Transient luminous events (TLE)

Meteors and meteoroids



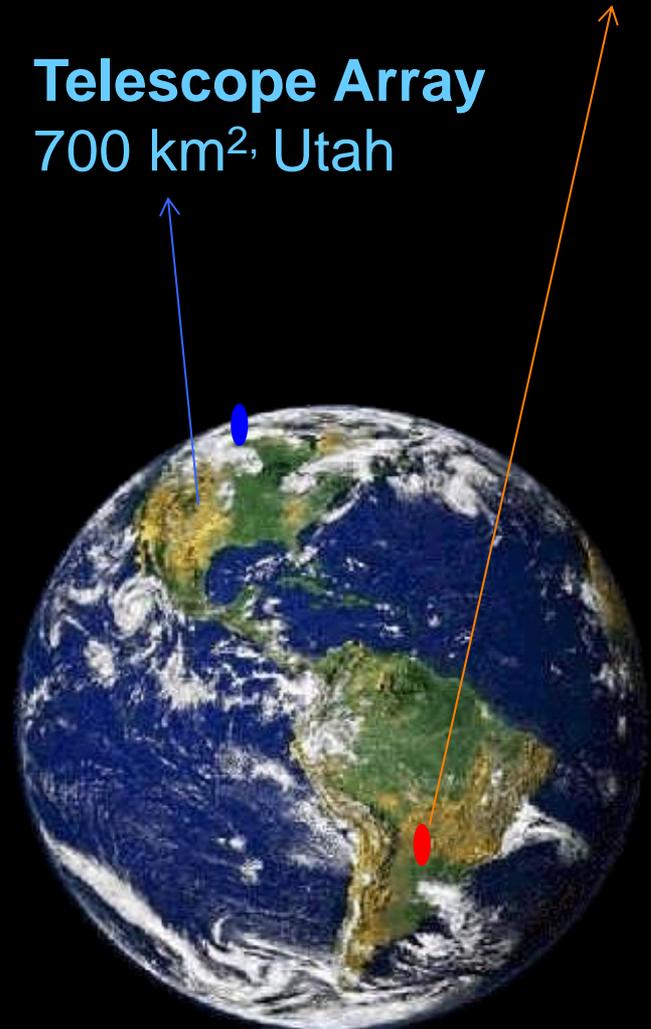


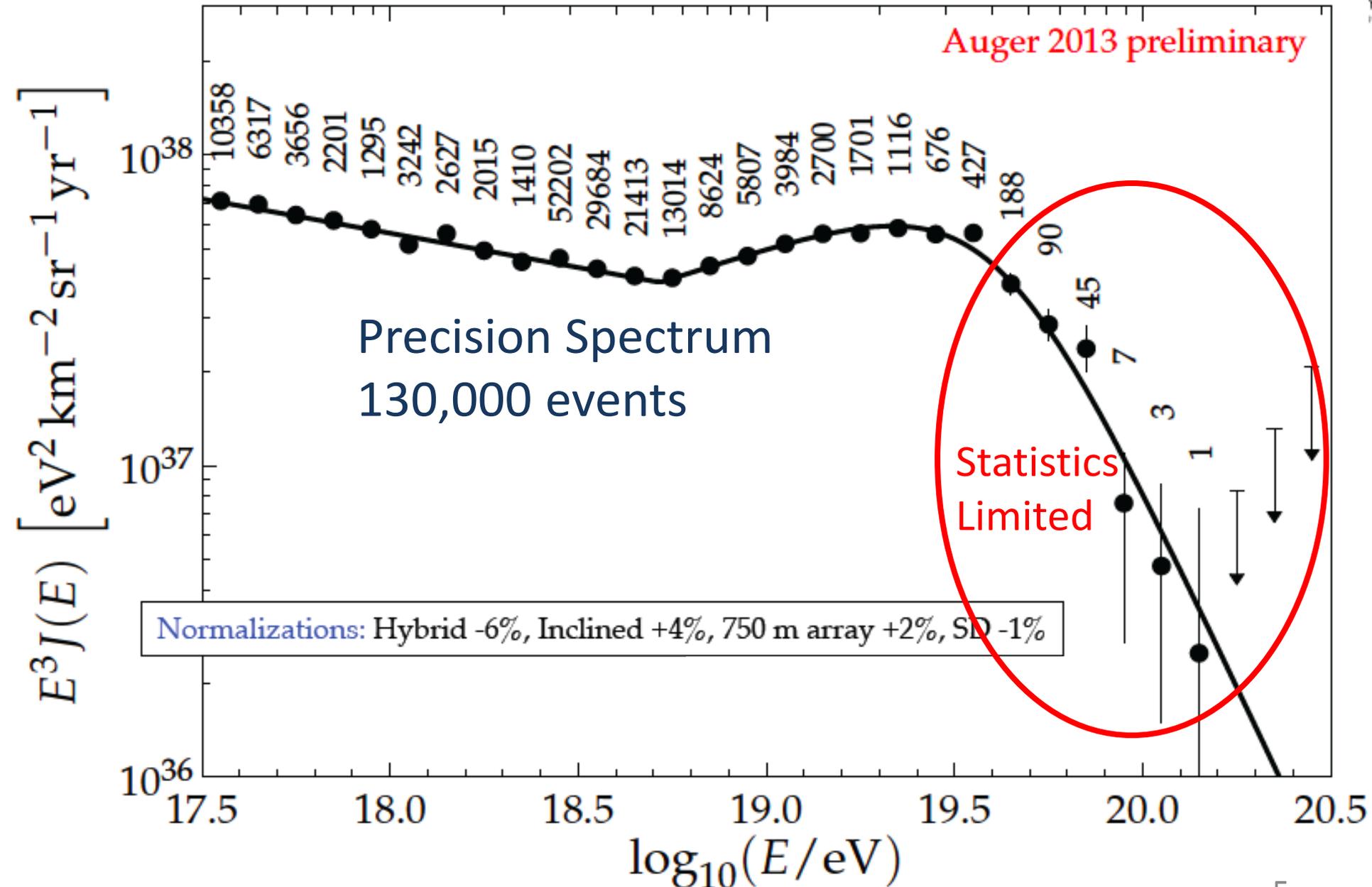
UHECR Current Situation



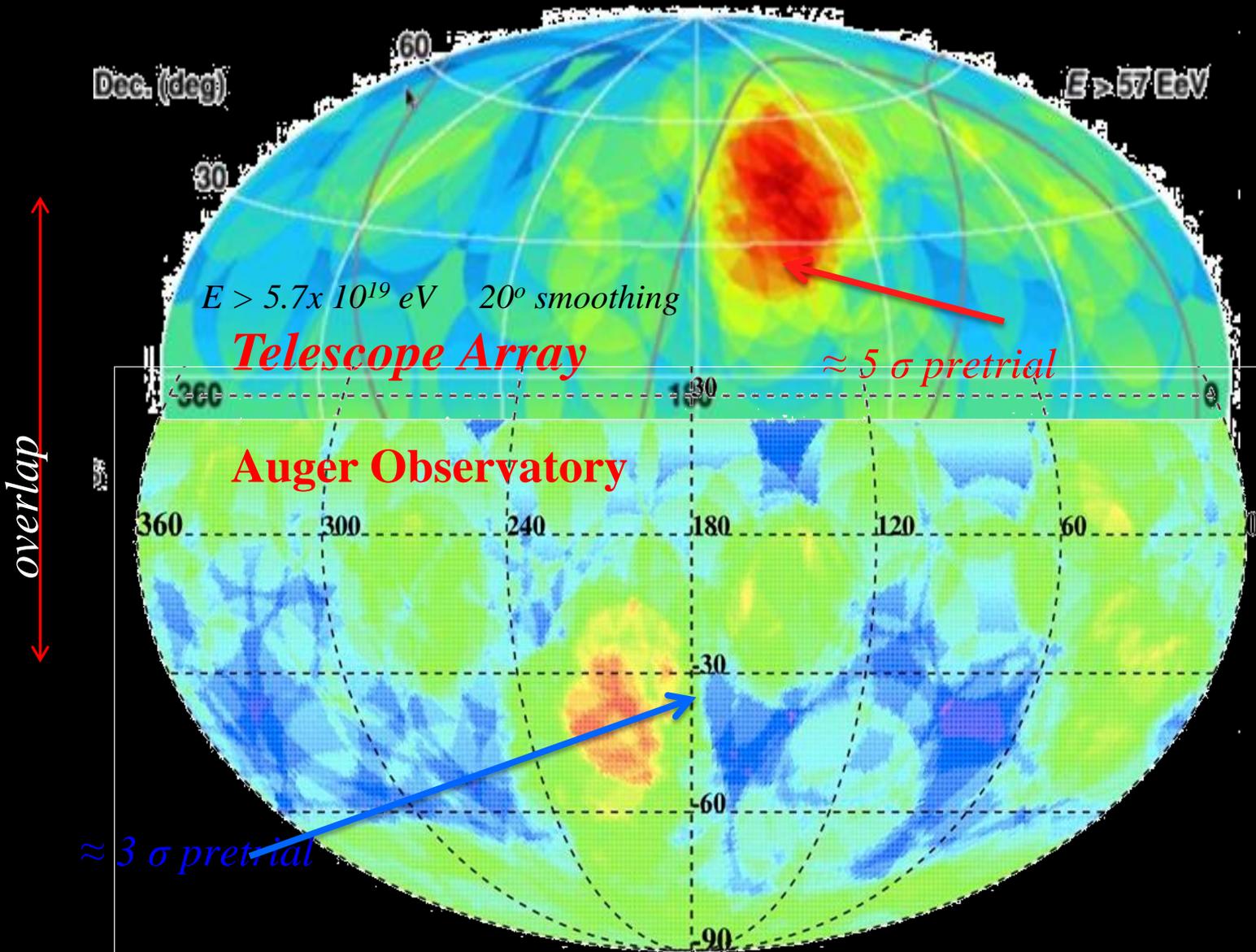
Pierre Auger Observatory
3,000 km², Argentina

Telescope Array
700 km², Utah





Anisotropy Hints > 60 EeV

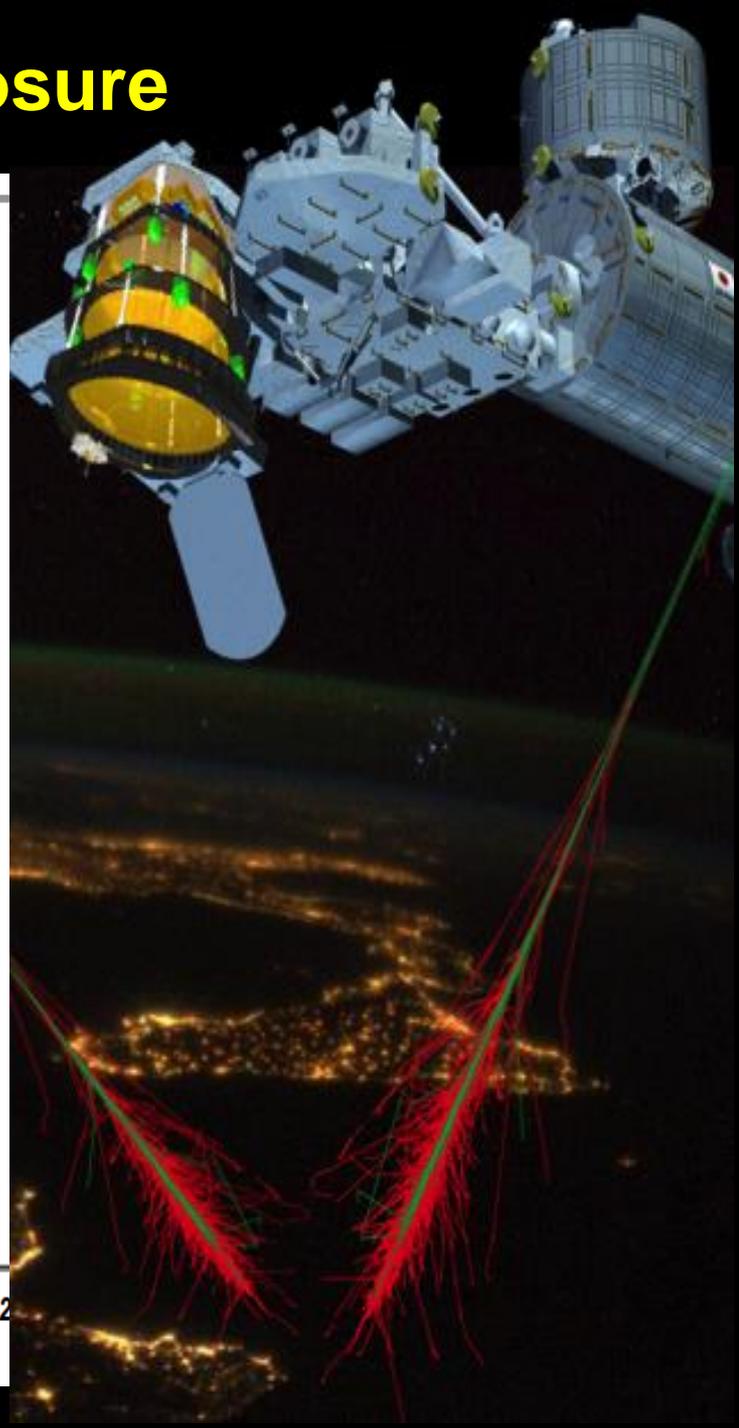
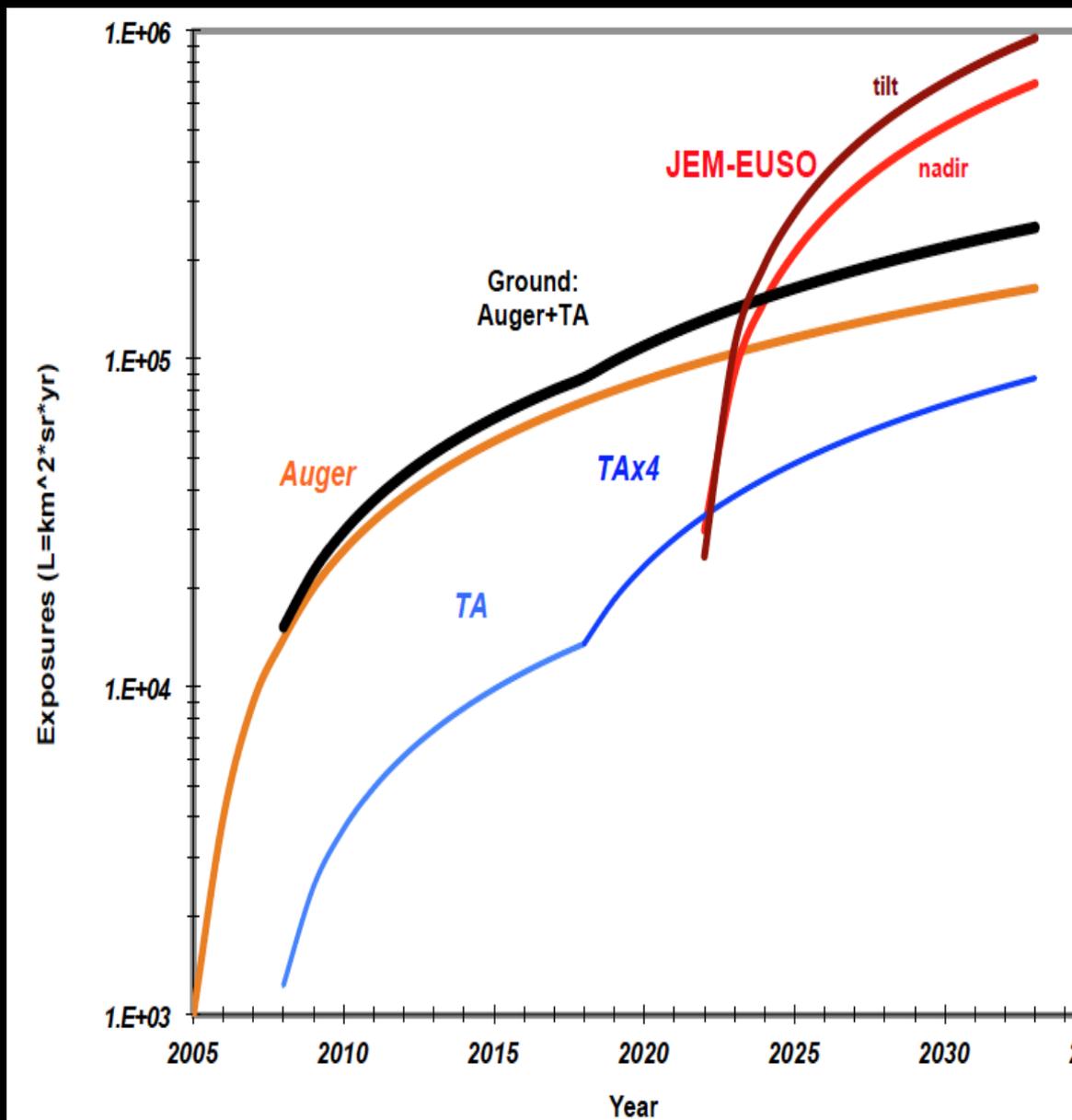


Next significant increase in exposure
Go to Space!

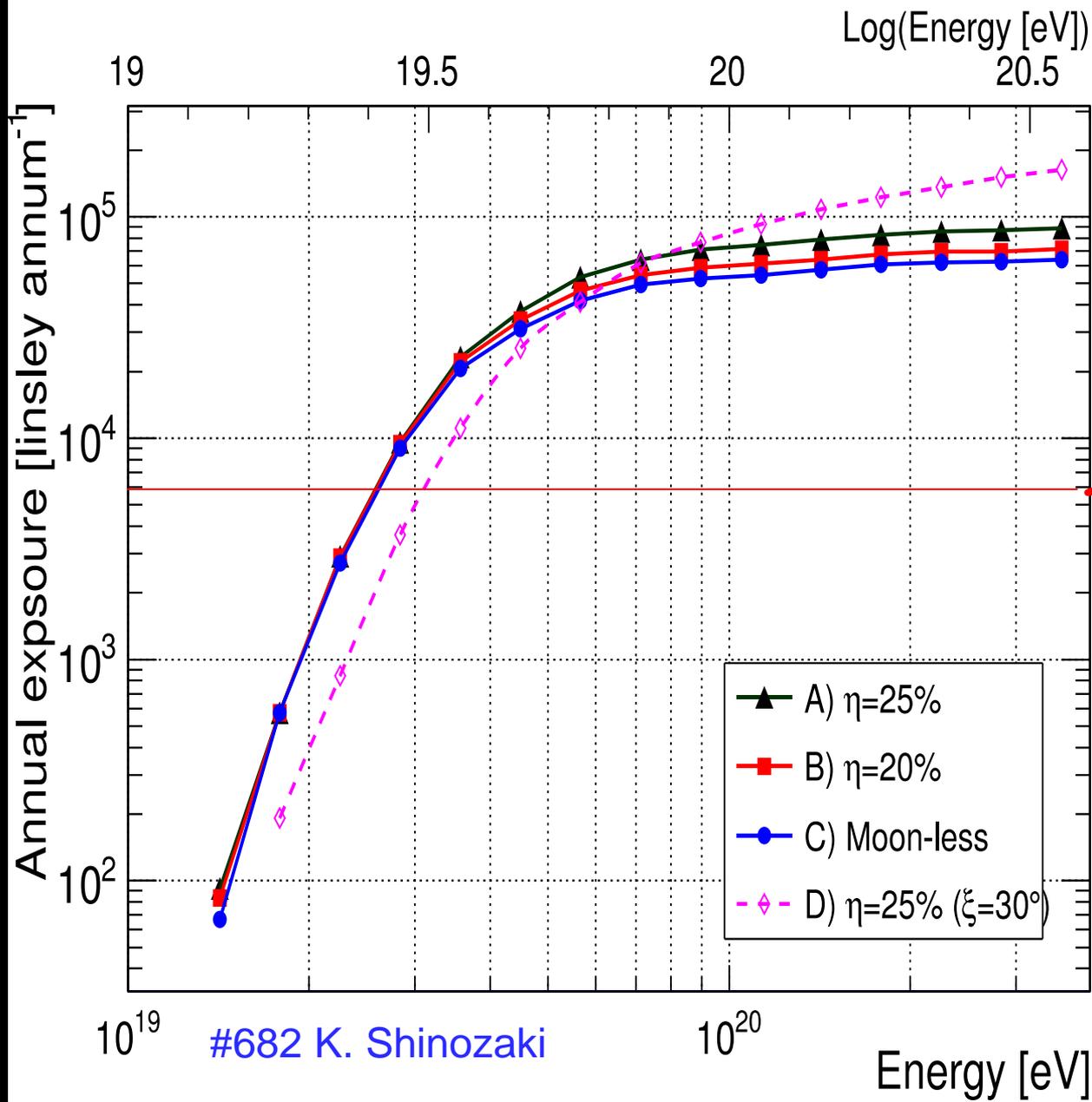
The atmosphere: largest possible calorimeter the earth can provide.



Next Significant Increase in Exposure

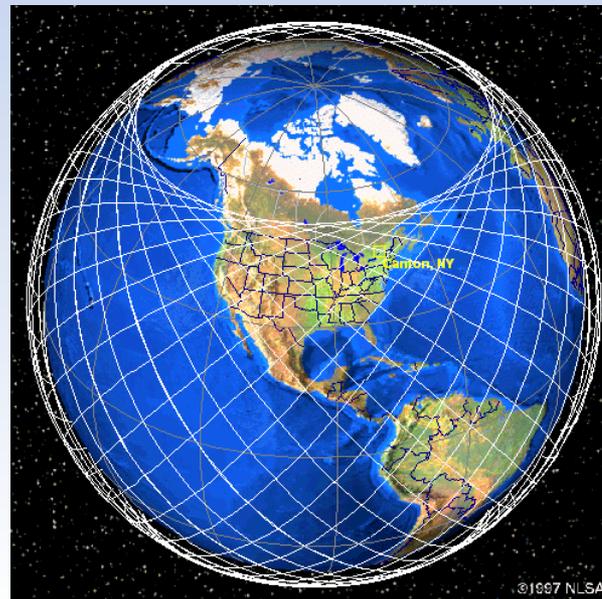
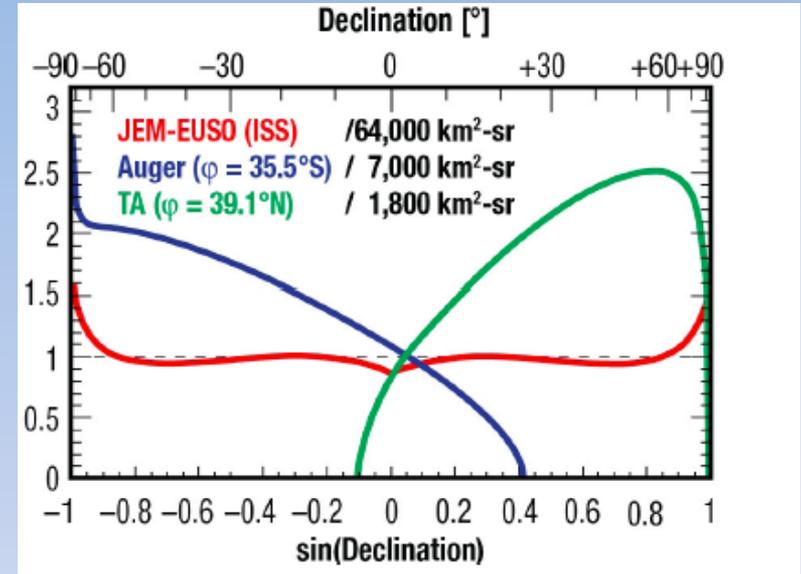
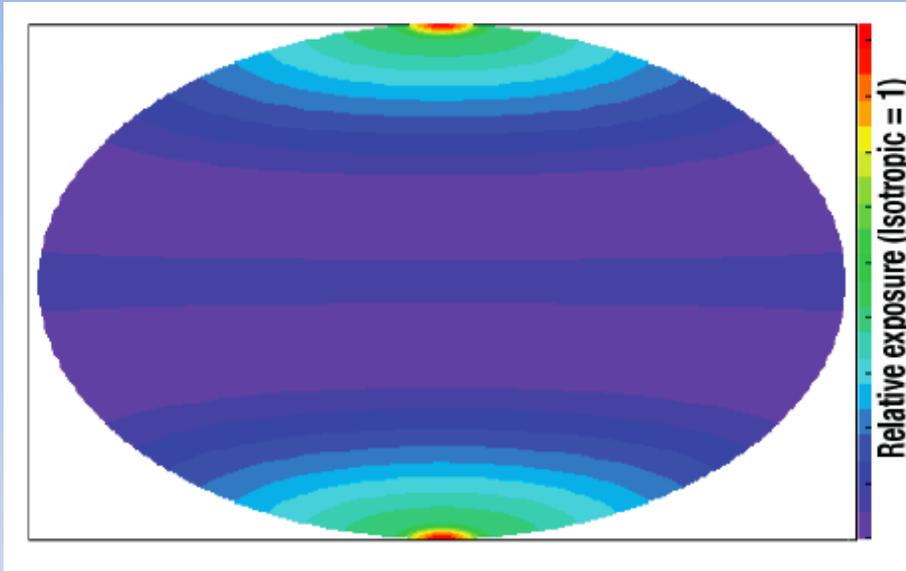


JEM-EUSO Annual Exposure



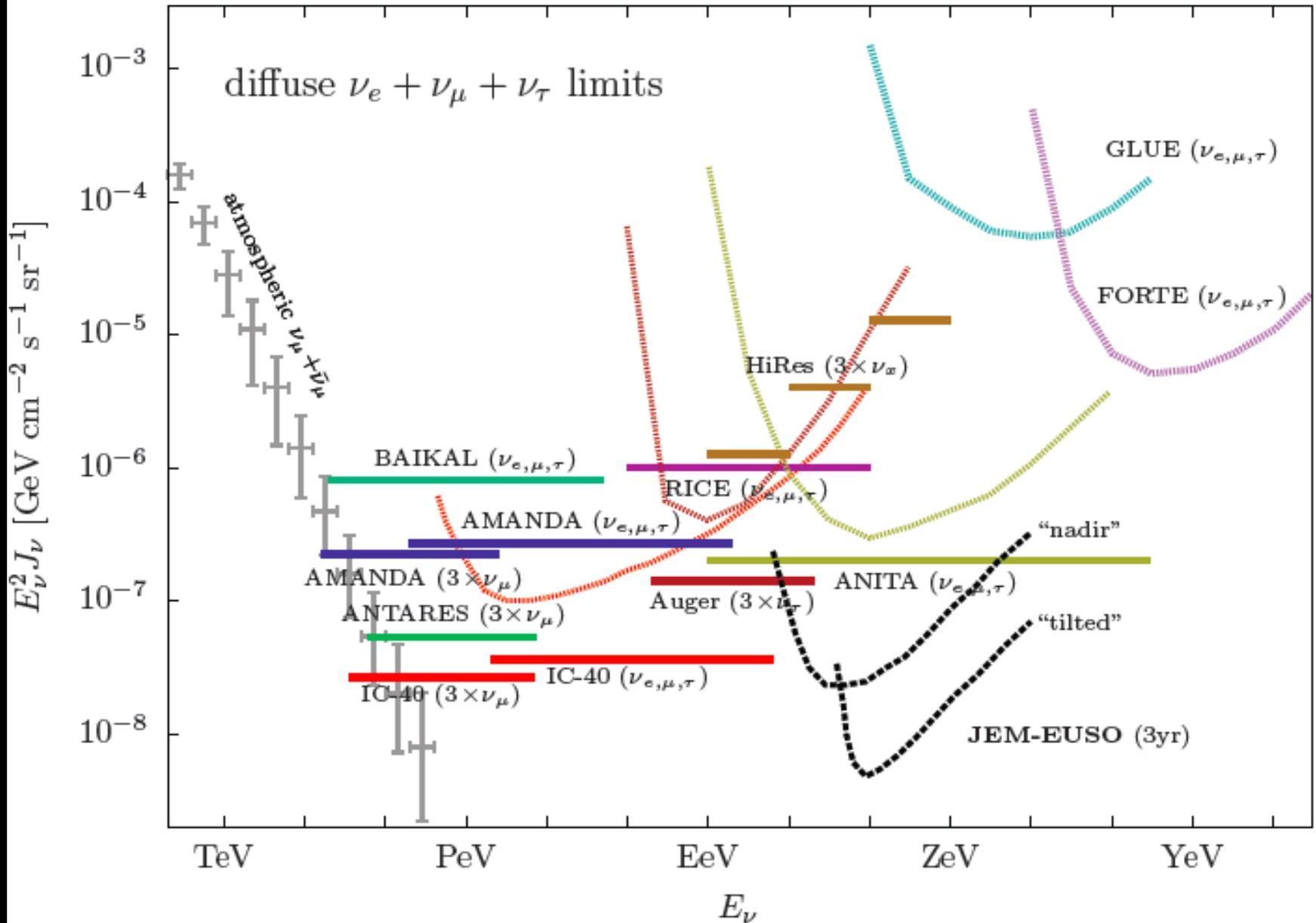
Full Sky Coverage

nearly uniform exposure with one detector



Inclination: 51.6°
Height: 350-400km

ZeV neutrinos?

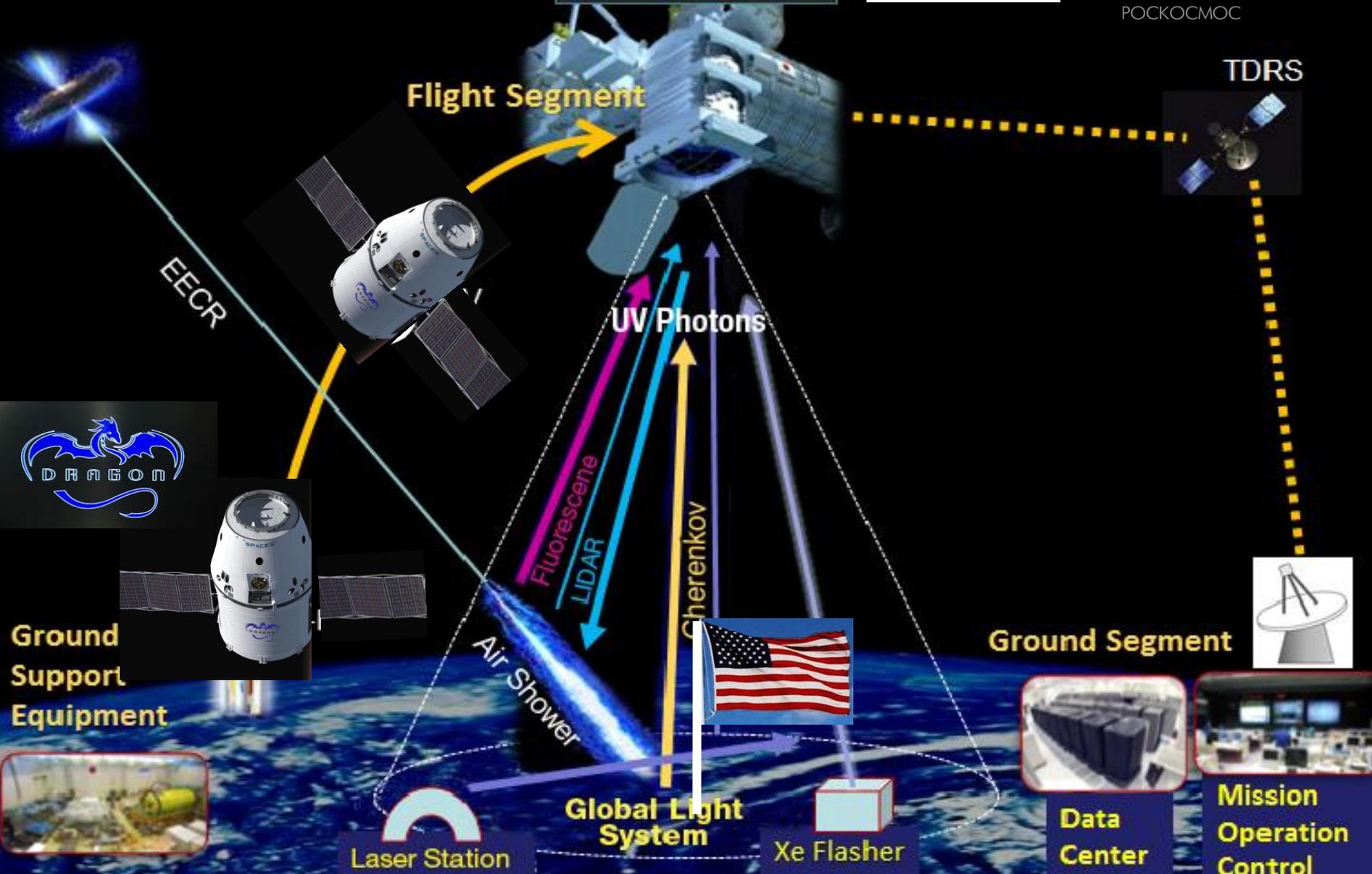




JEM-EUSO



POCKOCMOC



Ground Support Equipment



Ground Segment



Data Center



Mission Operation Control

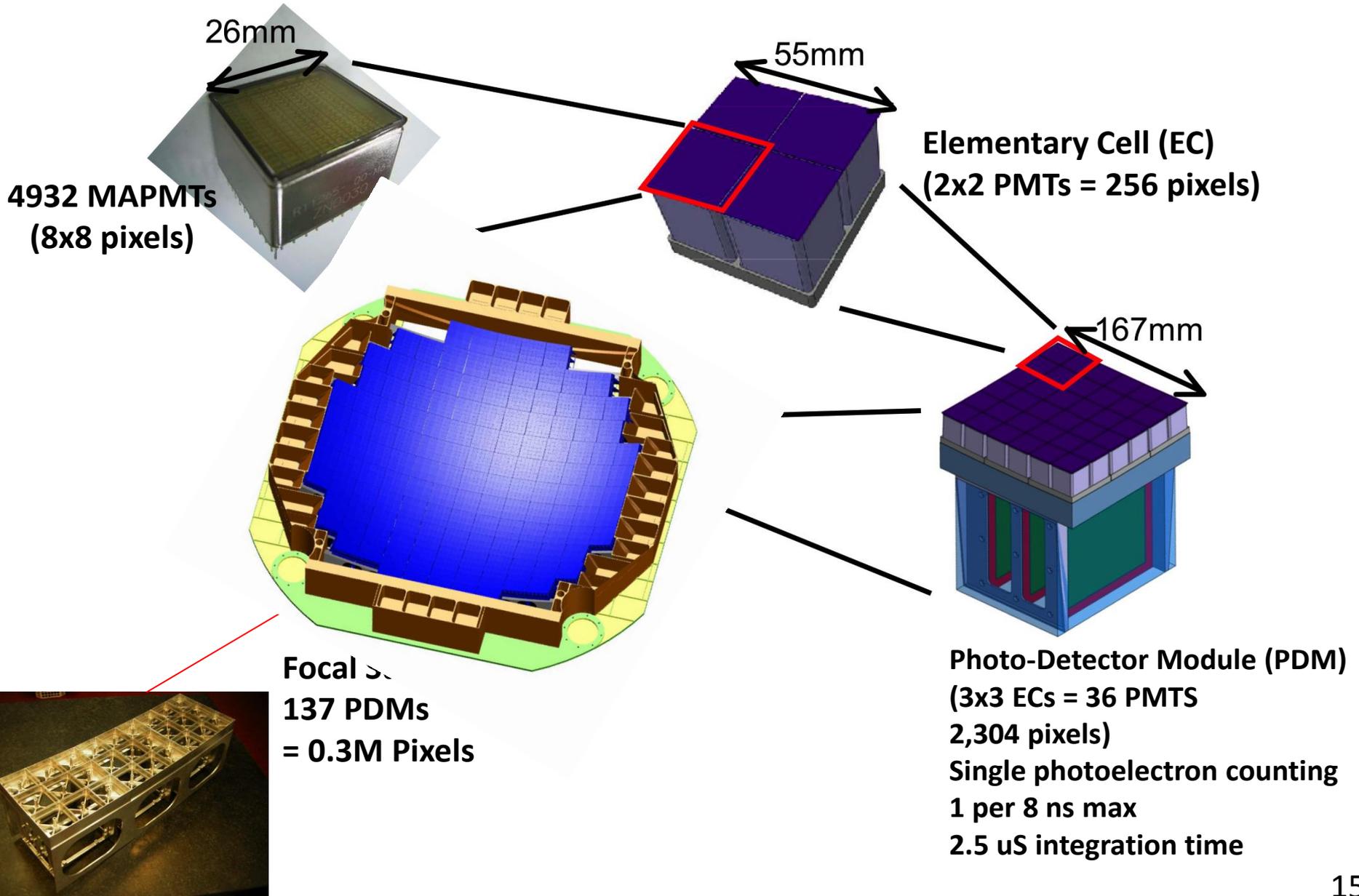
Three Prototypes

- Ground
 - EUSO-TA Delta UT
- Suborbital
 - EUSO-Balloon
 - Aug 2014 Timmins Canada – 8 hrs
 - April 2017 Wanaka NZ - 50 days
- Space
 - Mini-EUSO
 - October 2017 ISS - Several years

Three Prototypes

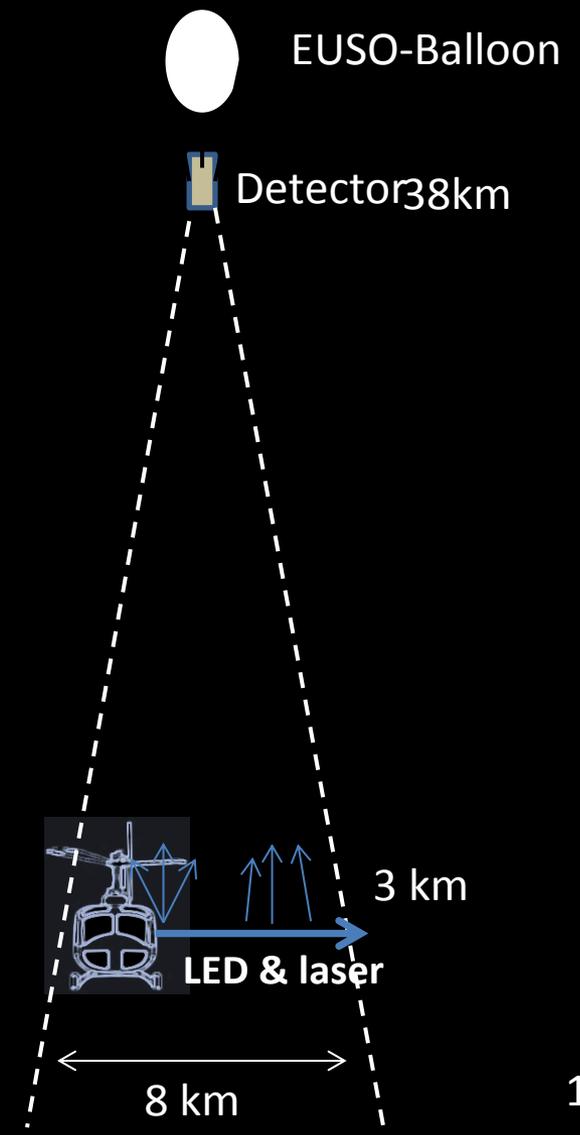
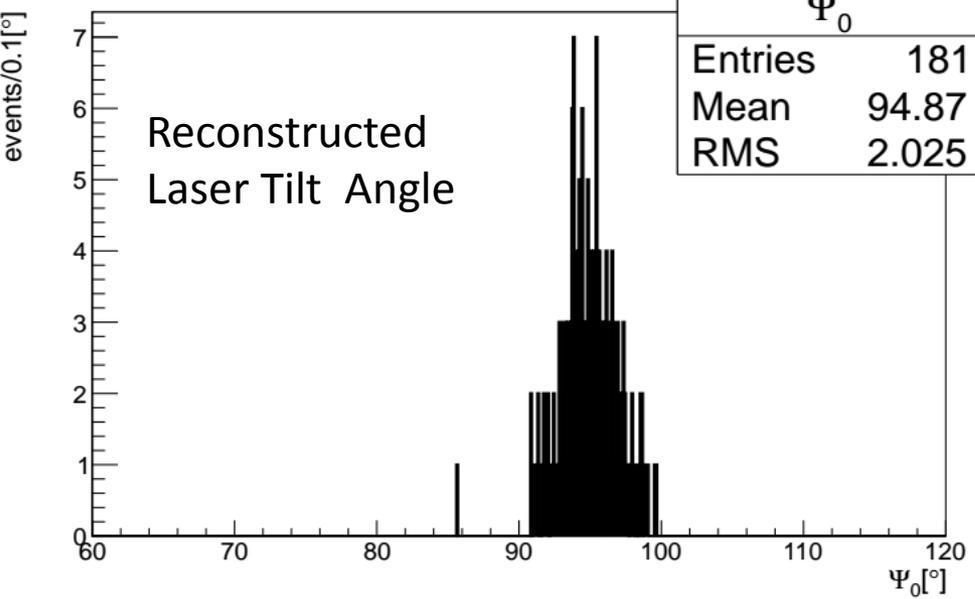
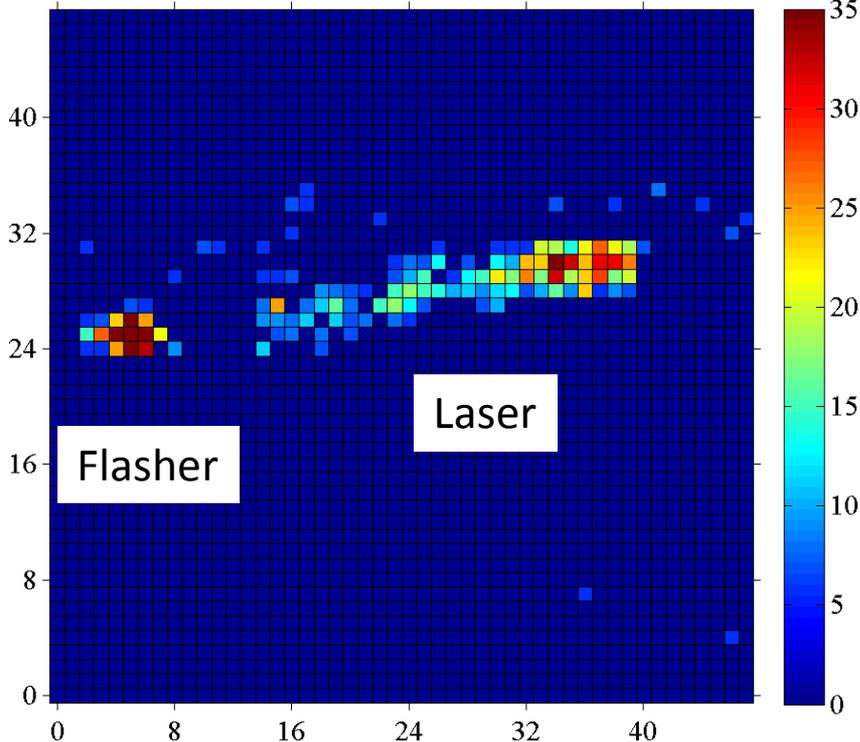
- Ground
 - EUSO-TA Delta UT
- Space: Suborbital
 - **EUSO-Balloon**
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- Space
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Focal Surface Detector



EUSO-Balloon Timmins Flasher & Laser

Laser Track



ICRC 2015 Timmins Flight

Author

The EUSO-Balloon mission	P. von Ballmoos
EUSO-Balloon: Observation and Measurement of Tracks from a laser in a Helicopter	J. Eser
Absolute calibration of the Photo-Detector Module of the EUSO-Balloon experiment and improvements for future missions	C. Moretto
Determination of the detection performances of the Euso-Balloon UV camera	S. Dagoret
Night Time Measurement of the UV Background by EUSO-Balloon	S. Mackovjak
Pattern recognition study for different levels of UV background in JEM-EUSO experiment	B. Pastircak
The Spanish Infrared Camera onboard the EUSO-BALLOON (CNES) flight on August 24, 2015	M. Firas
Performance of the Spanish Infrared Camera onboard the EUSO-Balloon (CNES) flight on August 25, 2014	J. F. Soriano / L. Del Peral
Cloud top height estimation from WRF model: Application to the infrared camera onboard EUSO-Balloon	J. Fernandez / A. Merino
Cloud Optical Depth obtained from the Infrared Camera data and the UV Flashers mounted on a helicopter flying under the EUSO-Balloon during its flight	J. Fernandez / G. Saez
EUSO-Balloon mission to record extensive air showers from near space	L. Wiencke
The Simulation of cosmic rays in EUSO-Balloon: performances of the direction and energy reconstruction	F. Fenu
The Calibration of EUSO Balloon using airborne light sources mounted to a Helicopter	J. Admas
Preliminary results from the EUSO-Balloon flight	M. Bertaina
The WRF model contribution to the Cloud Top Height retrieval in EUSO-Balloon experiment	I. Tabone
Search for significant background variations in the EUSO-Balloon data	A. Jung
Performance of the EUSO-Balloon optics	C. Catalano
Analysis of EUSO-Balloon data with Offline	B. Panico
The Data Processor System of EUSO-Balloon: in flight performance	G. Osteria
EUSO-Balloon trigger efficiency in preparation of a long duration flight	S. Bacholle

EUSO-SPB long duration flight Wanaka NZ April 2017

First observations of UHECRs by looking down from suborbital space with an air fluorescence detector.

Measure background UV light at night over ocean, clouds

Other objects:

meteoroids, TLEs,
Discovery Potential
(Dim, Fast, UV)

Establish the design and technique of a future space mission



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

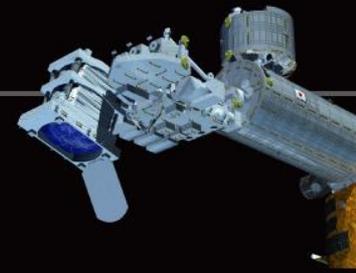


**Extreme Universe Space Observatory
Super Pressure Balloon Mission**

Today 3:42 pm Rm 250DE

**Lawrence Wiencke
Colorado School of Mines**

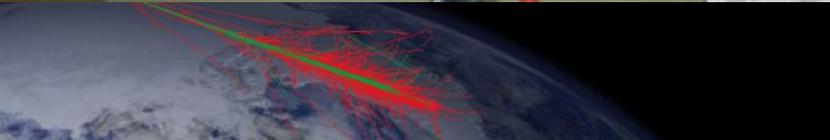
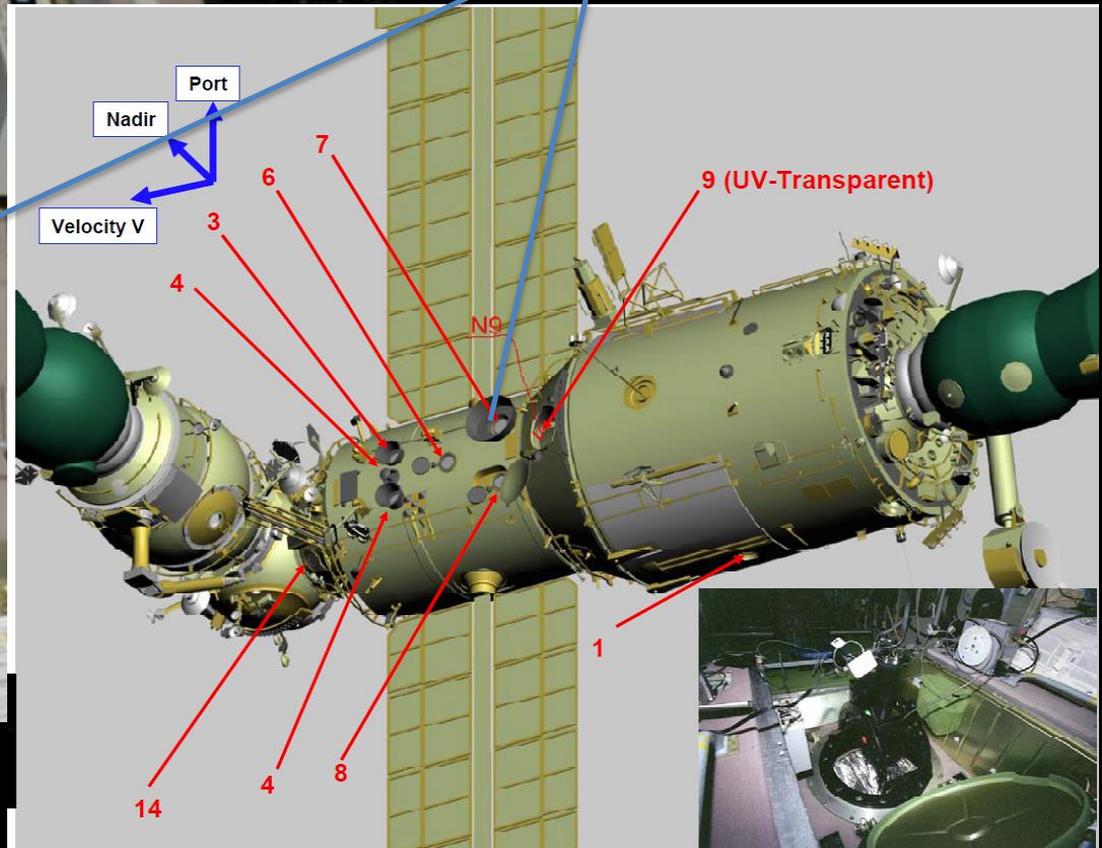
APS April 17th 2016



Mini-EUSO inside the ISS



UV transmitting Window



MINI-EUSO

measurement of UV from ISS

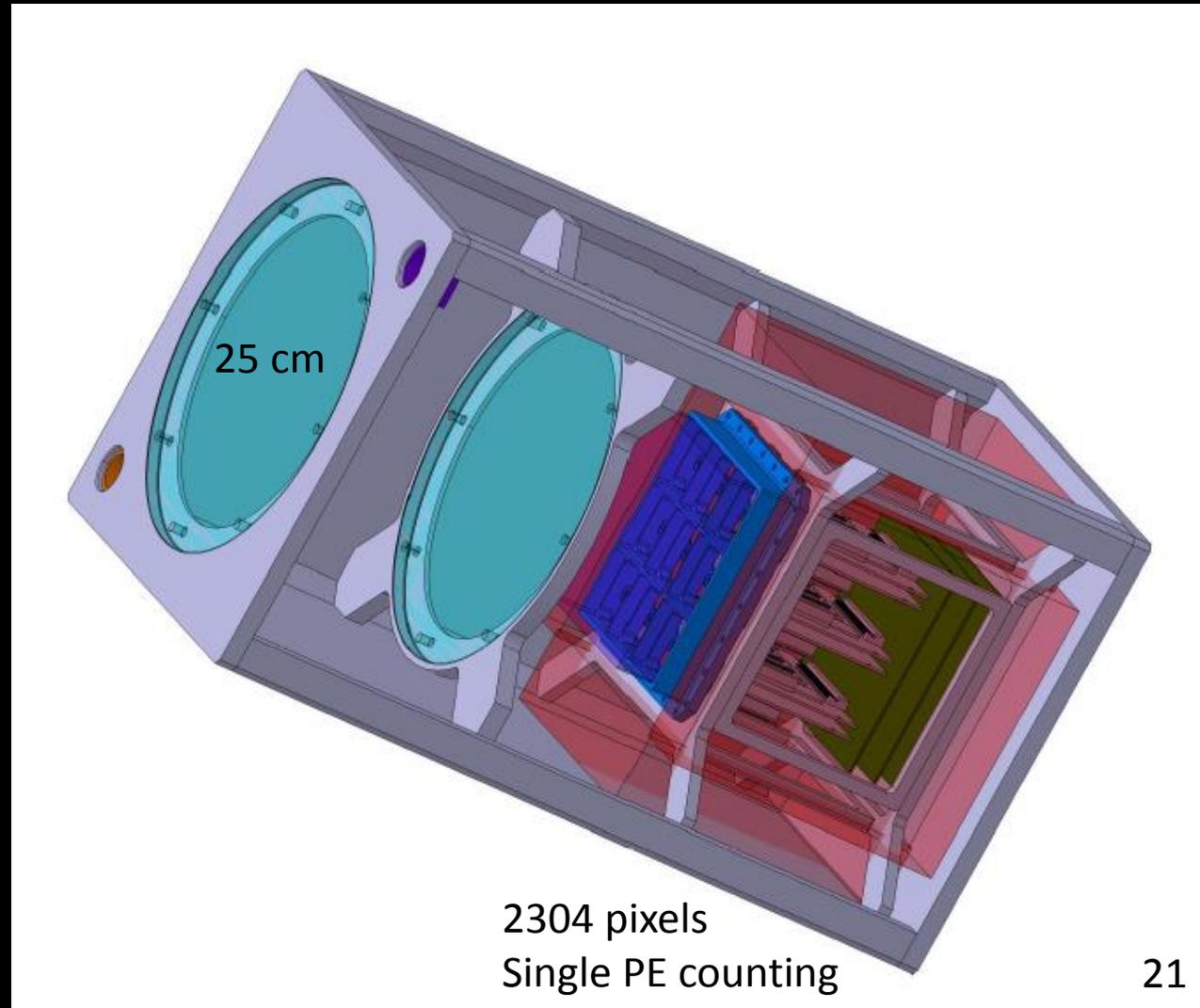
Approved by

Italian space agency

Russian space agency

Travel to ISS (w/ astronaut)

Oct 2017



2304 pixels
Single PE counting

MINI-EUSO

Scientific objectives

1) UV emissions from night-Earth

6.5 km resolution, from 2.5ms

*Noise from different lightning conditions,
moon phase, inclinations*

2) Map of the Earth in UV

3) Study of atmospheric phenomena

4) Bioluminescence

4) Study of meteors

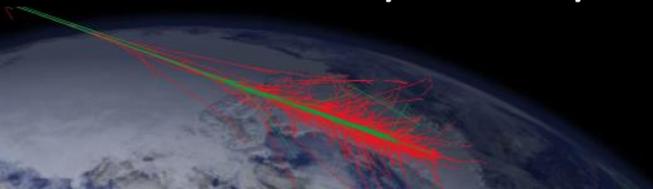
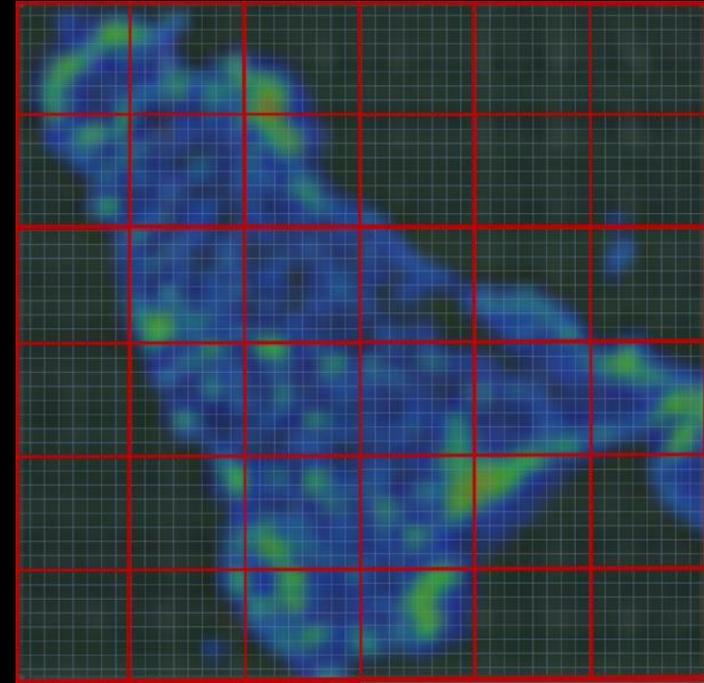
Search for Strange quark matter

Space Debris assessment

Also

Attempt to observe UV laser tracks from space

$\sim 10^{21}$ eV optical equivalent



JEM-EUSO collaboration 13 Countries, 80 Institutes as of March, 2013



JEM-EUSO Collaboration

- Japan, USA, Korea, Mexico, Russia, Algeria
- Europe: Bulgaria, France, Germany, Italy, Poland, Romania, Slovakia, Spain, Switzerland, Sweden
- 16 Countries, 77 Institutions, more than 300 researchers



JEM-EUSO in USA



Institutions on NASA APRA

University of Chicago, PI Institution
University of Alabama in Huntsville
Marshall Space Flight Center
University of Wisconsin-Milwaukee
Colorado School of Mines
Vanderbilt University

Other US Institutions in the Collaboration

University of California, Berkeley
University of California, Los Angeles
Fermilab
University of Kansas, Wichita
others interested in joining