

The EUSO-Super Pressure Balloon

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Extreme **U**niverse **S**pace **O**bservatory



EUSO: the main idea

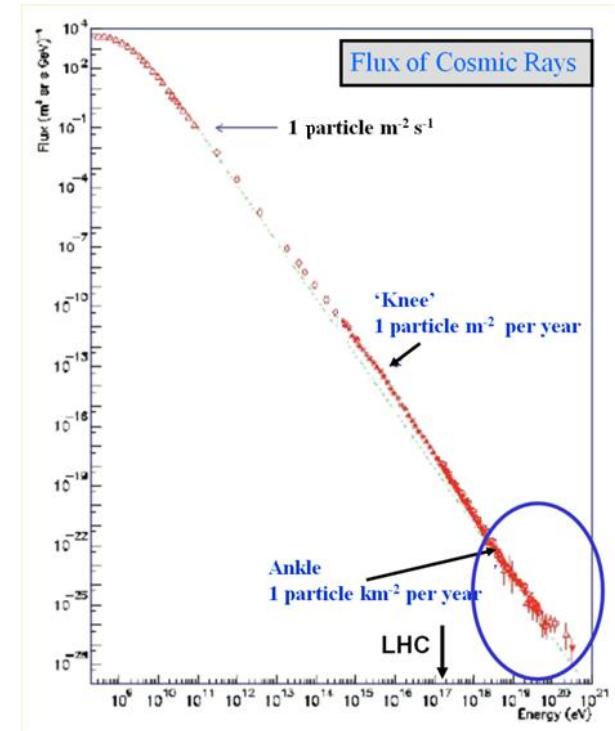
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Observing from space transient luminous phenomena occurring in the Earth's atmosphere

Main objective: study the **Extreme Energy Cosmic Rays**

EECR: $E > 5 \times 10^{19}$ eV

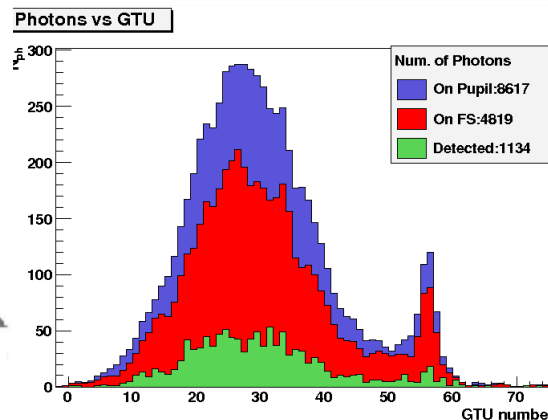
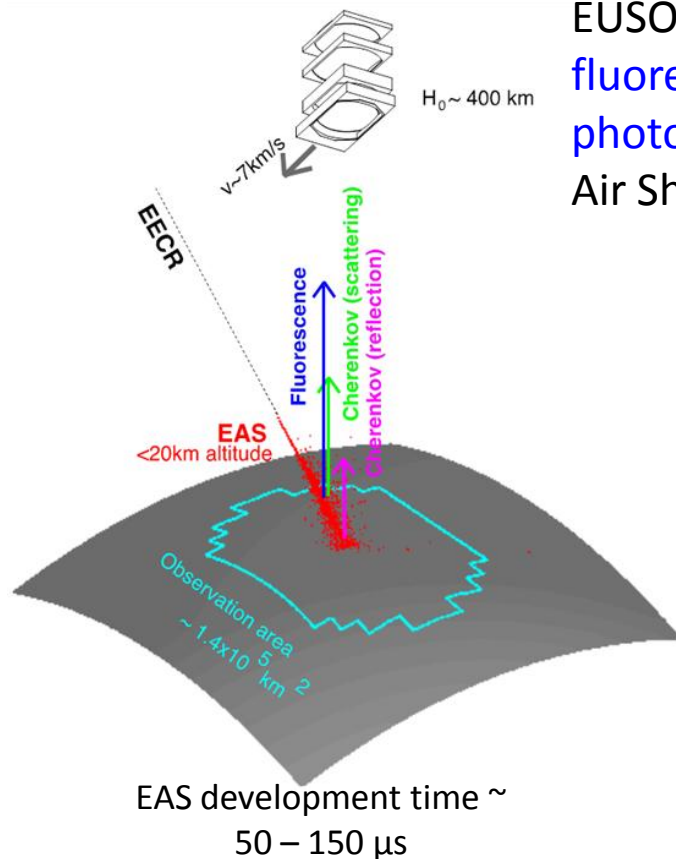
EUSO telescope will observe **fluorescence and Cherenkov UV photons** generated by Extensive Air Showers created by EECR



Main advantages:

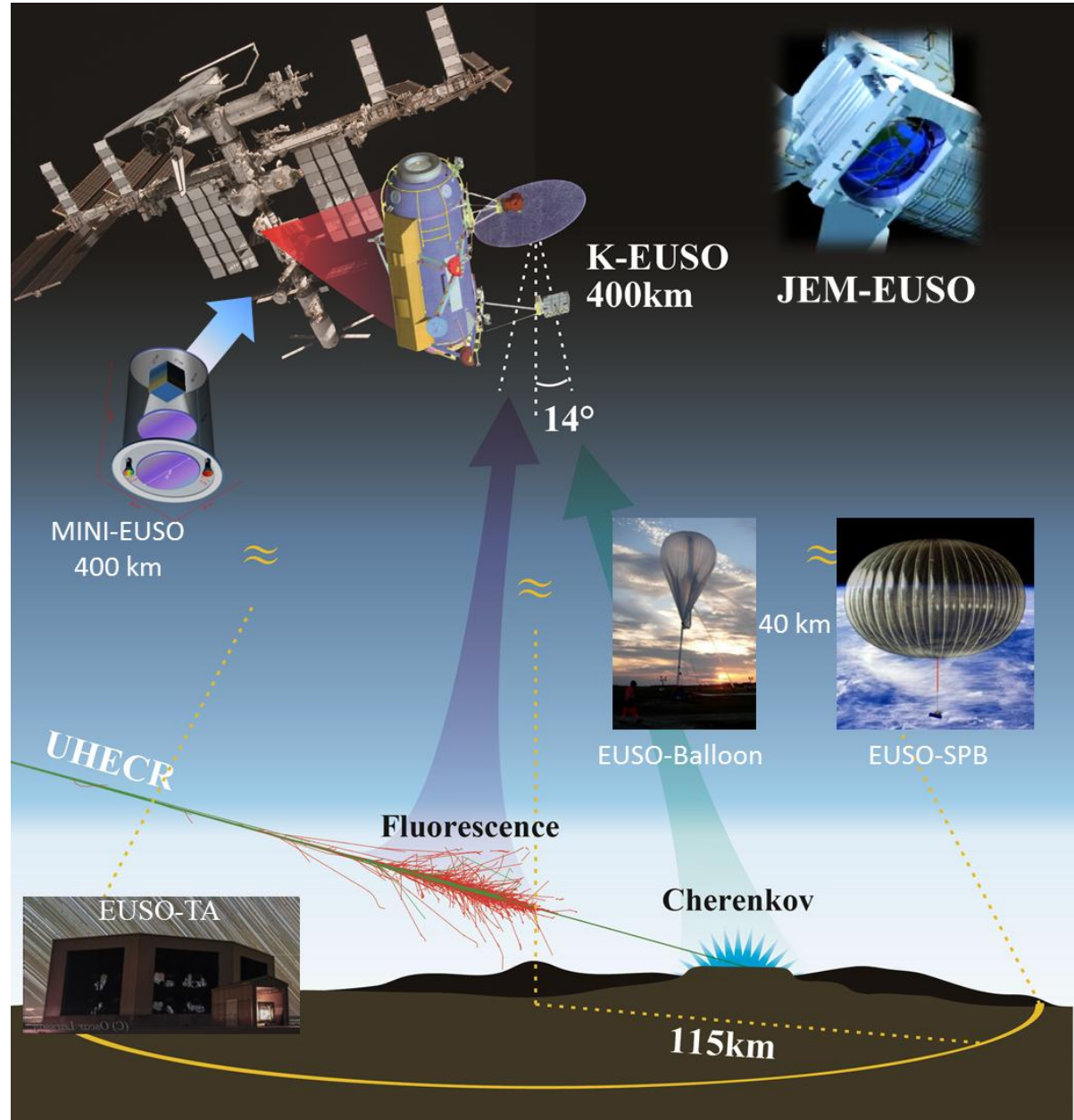
1. The target volume is far greater than possible from the ground
2. Full sky coverage

First idea: J. Linsley, late '70



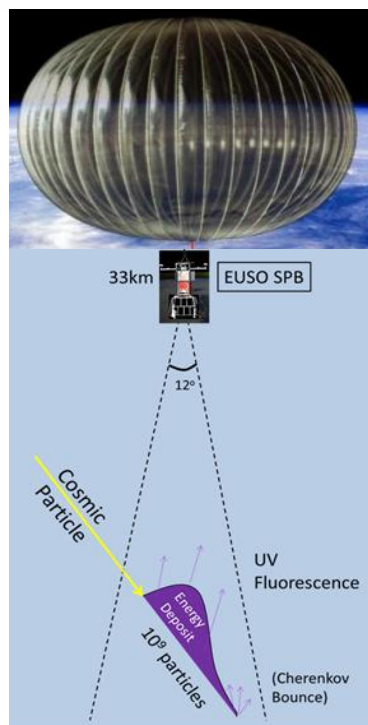
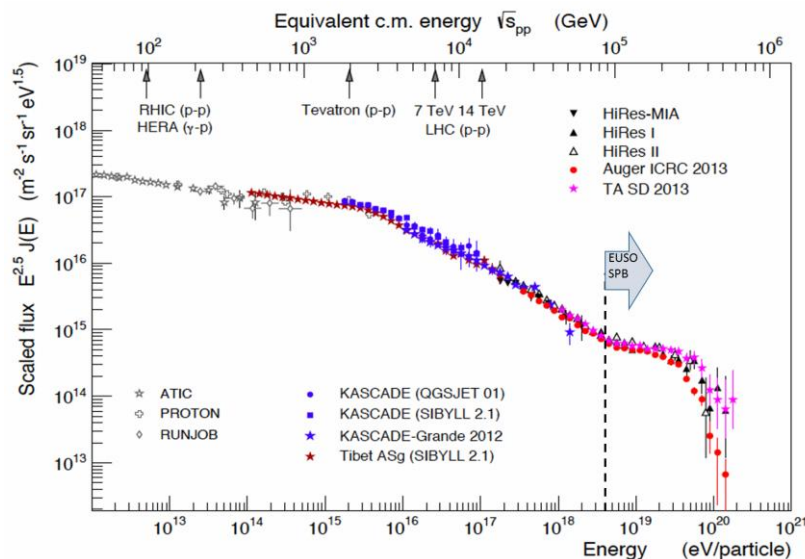
Simulation of the light profile observed at the entrance pupil and through the instrument

-
- K-EUSO**
400km
- JEM-EUSO**
- MINI-EUSO**
400 km
- EUSO-Balloon**
40 km
- EUSO-SPB**
40 km
- EUSO-TA**
- UHECR**
- Fluorescence**
- Cherenkov**
- 115km**
- 14°**



Scientific objectives

1. First fluorescence observations of cosmic ray from above
2. Measure UV background light at night from space
3. Search for faint and ultrafast UV signatures in the atmosphere from other phenomena
4. Establish methods and techniques for a future high energy astroparticle space observatory



SPB Float Height	110,000 ft = 33.5 km
Weight	
Detector	2250 lbs
Payload	2700 lbs w/ SIP, Antennas, Empty Ballast Hoppers
Dimensions	1.2m x 1.2m x 3m
Power consumption	40 W Day, 70 W Night (assumes 20W PDM heater @ 50%)
Telescope	Refractor with 2 Fresnel lenses
FOV	11. deg (measured w/ stars)
Camera:	2,304 pixels; 36 MAPMTS (Hamamatsu R11265-113-M64-MOD2)
Data volume:	Downlinked ~1-1.5 Gb/day
Recorded	~3 GB/Day w/ 10 hour dark run
	with trigger rate of 0.2 Hz
Energy threshold	for h=33 km ~3 EeV
Ground equivalent Trigger Aperture	
	250 km ² sr @ 3 EeV to ~500 km ² sr @ 10 EeV

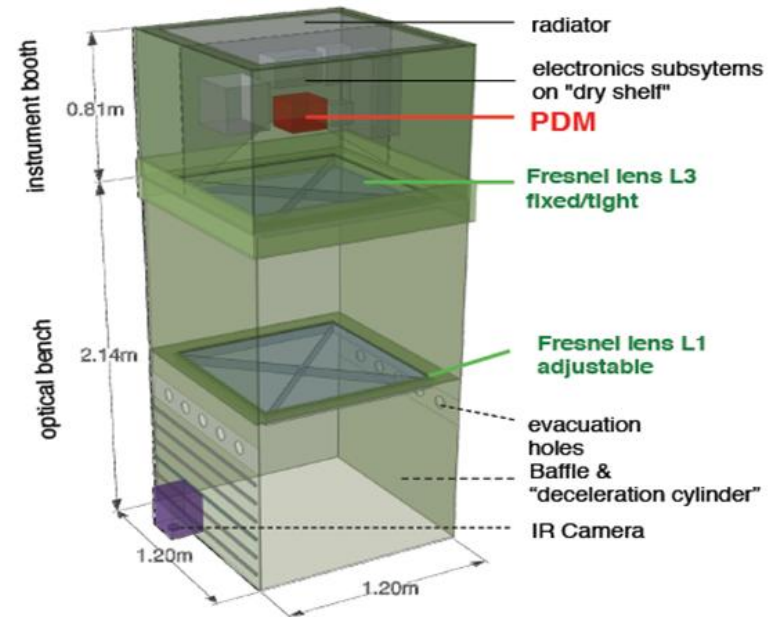
EUSO-SPB instrument

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Optics: 2 $\Phi 1\text{m}$ Fresnel type lenses
+ UV filter (330-400 nm)
FoV = $\pm 5.5^\circ$

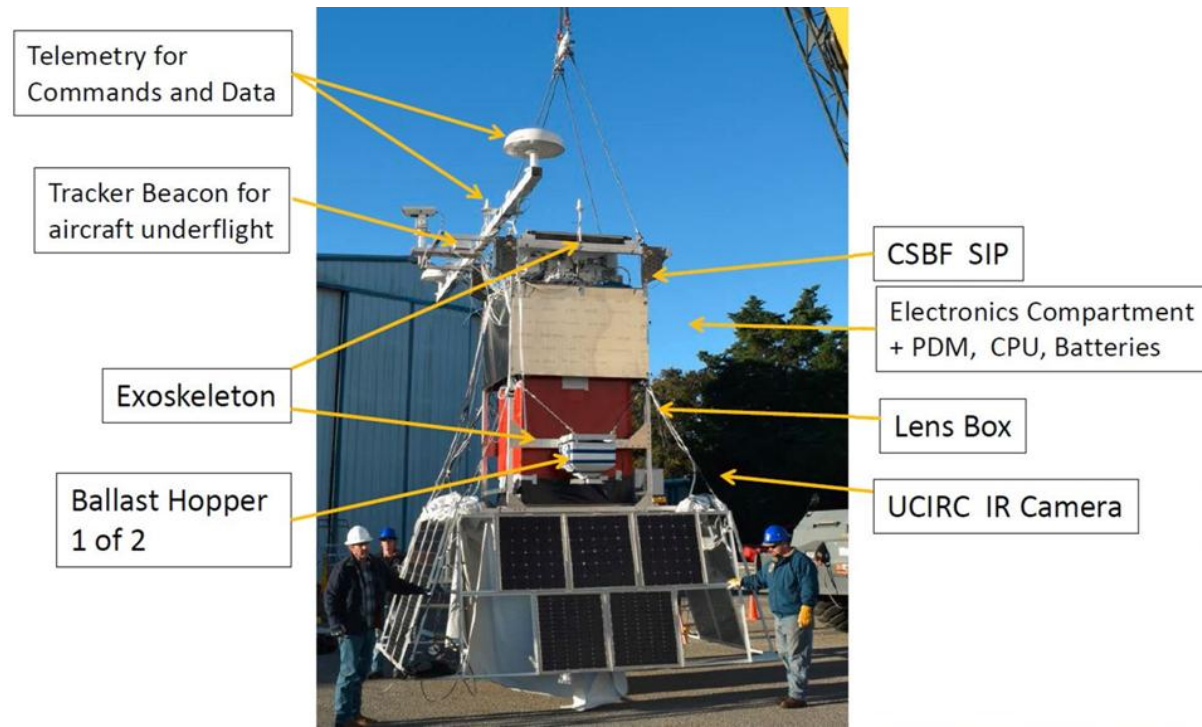
Photo Detector Module: array of 36 Multi-Anode
PhotoMultiplier Tubes (MAPMTs) of 64 pixels
2304 channels in total

Data Processor: readout performed by one ASIC per
MAPMT + multiple trigger levels to filter out
noise and identify events of interest



+ an **infrared camera** to
provide complementary
information on the
observation conditions

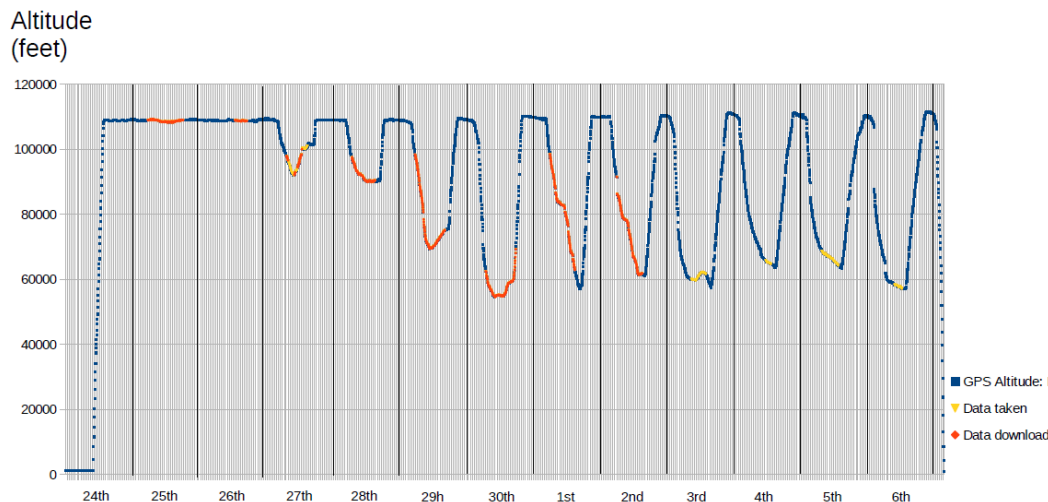
+ a **SiPM Photo Detector** in
a dedicated box (talk by M.
Renschler)



The first EUSO-SPB flight

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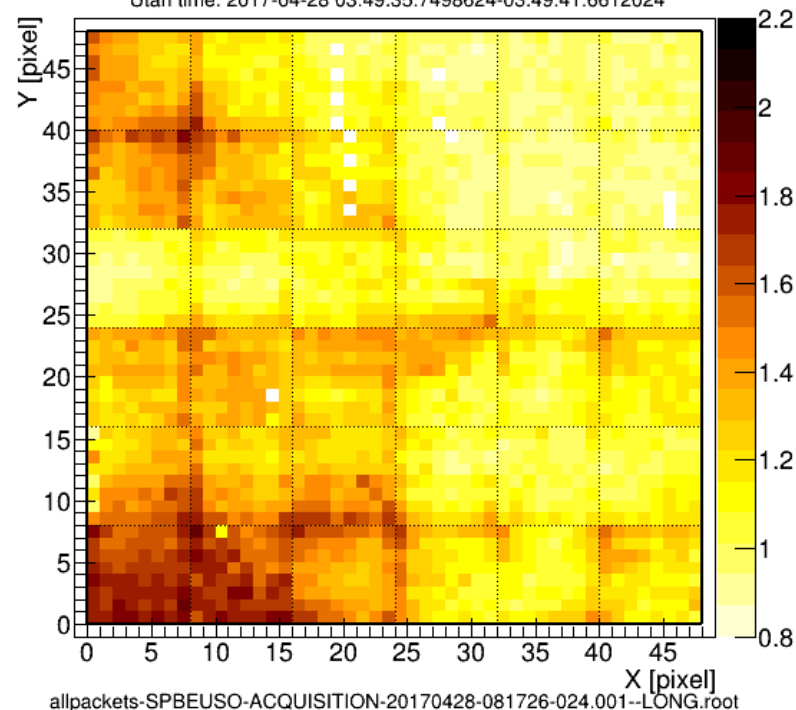
- launched from Columbia Scientific Balloon Facility base in Wanaka (NZ) on 24/4/17 at 22:50
- 12 days, 4 hours and 34 minutes aloft
- more than 60 GB of data downloaded to ground



	Data Taken	Data downloaded
Per day	0425: 34 min 0426: 100 min 0427: 276 min 0428: 370 min 0429: 338 min 0430: 304 min 0501: 172 min 0502: 330 min 0503: ~200 min 0504: 206 min 0505: 212 min 0506: 138 min	0425: 34 min 0426: 100 min 0427: 160 min 0428: 370 min 0429: 338 min 0430: 304 min 0501: 172 min 0502: 330 min 0503: 330 min 0504: 206 min 0505: 212 min 0506: 138 min
Total	2500 min → 41.7 h	1828 min → 30h

0-1280, pkt: 0-10, GTU in pkt: 0-0, UTC time: 2017-04-28 09:49:35.7498624-09:49:41.661

Utah time: 2017-04-28 03:49:35.7498624-03:49:41.6612024



Clouds moving in the SPB FoV (averages of 1280 GTUs)