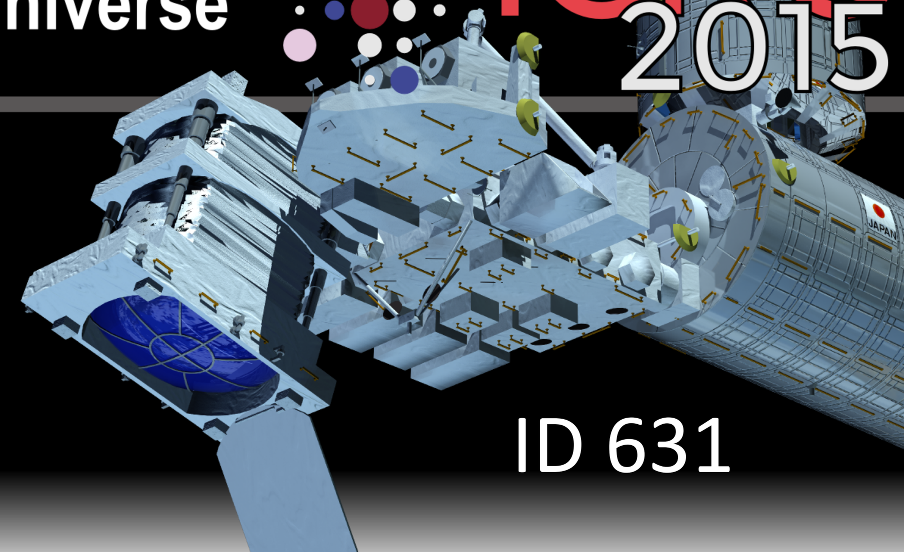
JEM-EUSO on ISS explores the origin of the highest energy particles in the Universe

ICRC 2015



EUSO-Balloon mission to record extensive air showers from near space

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ID 631

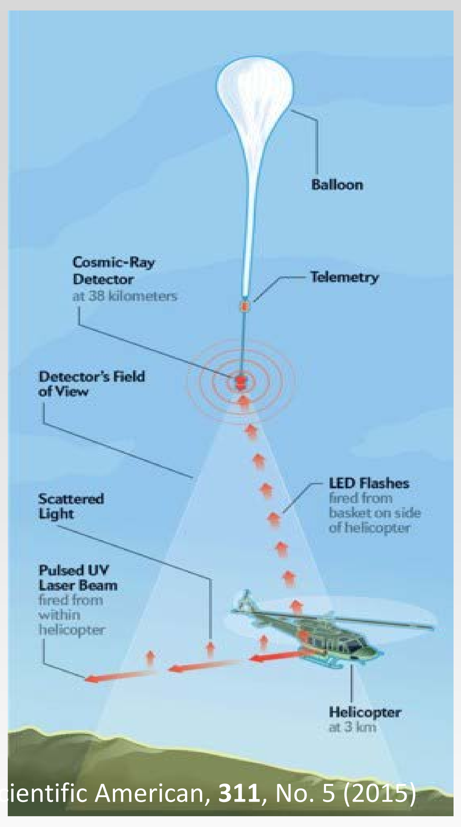
Introduction

EUSO-Balloon 2014

First ever observation of UV light tracks by looking down

Tracks were produced by scattered light from a pulsed UV laser.

Time at float altitude was 5 hours as planned. Too short to observe cosmic ray extensive air showers (EASs)



Scientific American, **311**, No. 5 (2015)

Inspiration

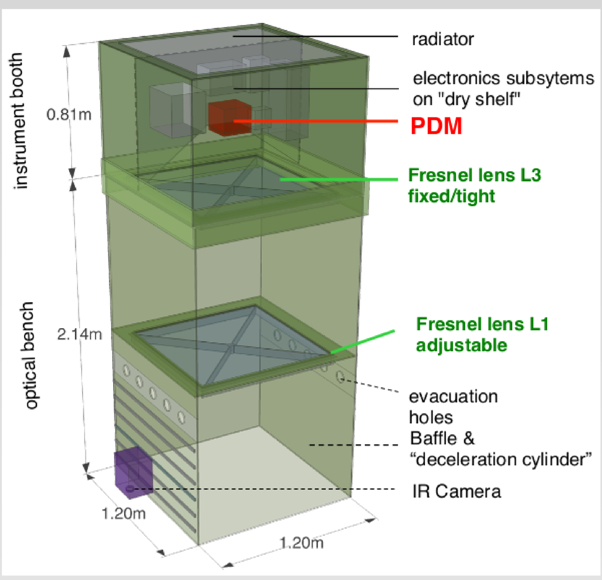
On March 27th 2015 NASA launched the first successful engineering super pressure balloon (SPB) test flight from Wanaka NZ. 32 nights at float altitude

The planned EUSO-SPB mission

Objectives

1. First fluorescence measurements of cosmic ray EASs from above
2. Search for other faint fast UV signatures with discovery potential
3. First extended operation of cosmic ray EAS UV detector in near space
4. Extended end-to-end test of JEM-EUSO prototype

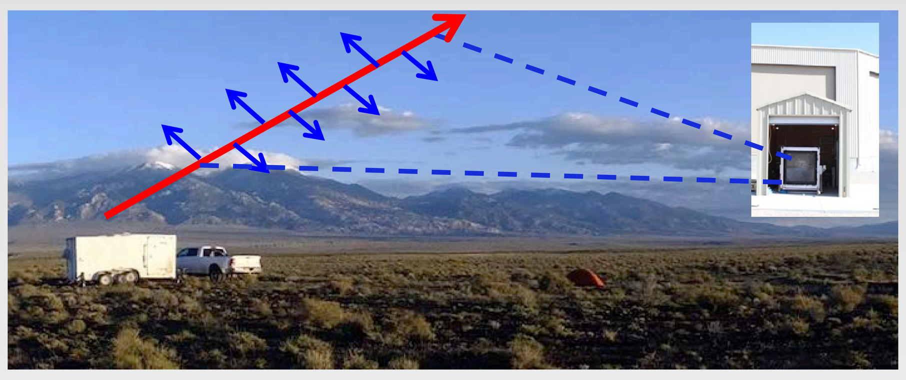
The Instrument



Item	Description
Lens area	1 m²
# Pixels	2304 (48 x 48)
Field of view	12° x 12°
Pixel field of view	0.25° x 0.25°
Wavelength range	290 nm - 430 nm
Sensitivity	Single photoelectron
Integration time	2.5 μS
Readout duration	320 μS (128x2.5 μS)
Cosmic EAS energy threshold	≈ 10^{18} eV

Upgrades to the 2014 instrument in progress

Item	Description
MAPMTs	Higher quantum efficiency multi-anode photomultiplier tubes (Hamamatsu R11265-113-M65 MOD2)
Solar Power	Solar Panels and updated power system.
Optics	3rd fresnel lens from original instrument design for chromatic correction over the EAS UV spectrum.
HV	Updated HV distribution system
Trigger	Upgraded trigger for EASs
Control	System control programming for extended mission
Telemetry	Interface to CSBF's Support Instrument Package



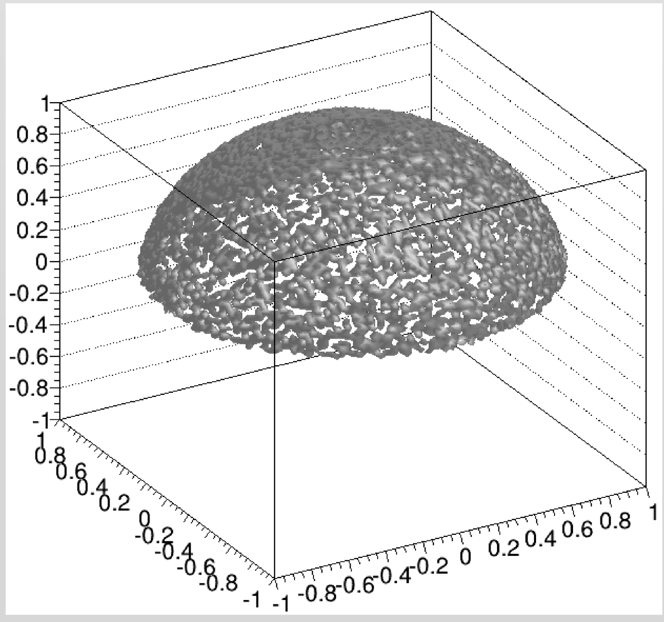
Development of preflight ground tests using global light system GLS laser and flasher prototypes and EUSO-TA. ICRC #626 (Hunt) ICRC #582 (Adams)

Mission Parameters

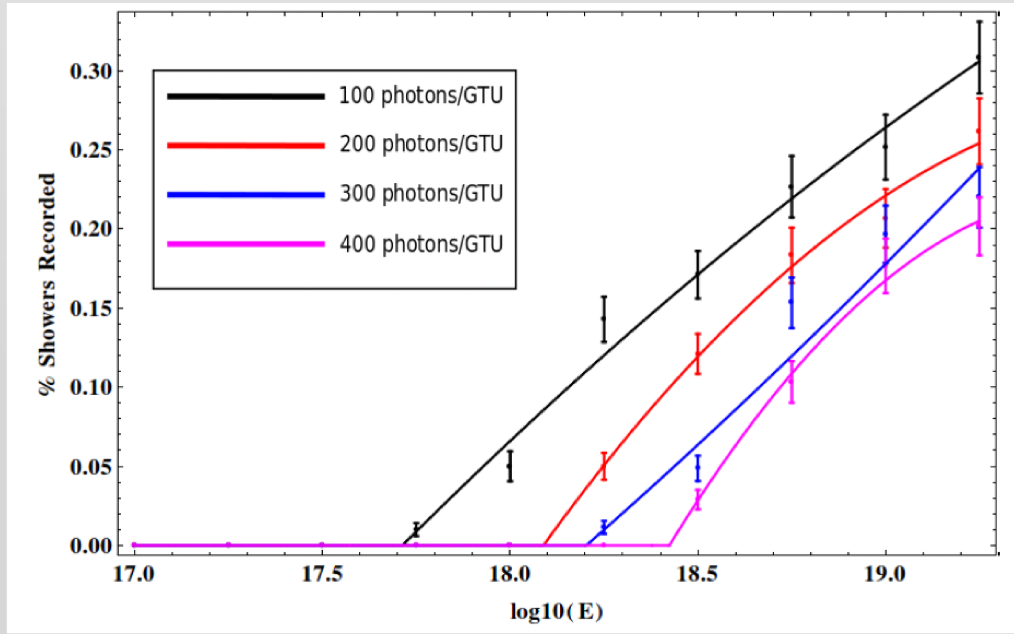
Launch Date	March/April 2017	Proposed
Launch Site	Wanaka NZ	
Duration	50 days (20 minimum)	Spanning 2 dark periods
Altitude	110,000 ft (33.5 km)	
Data/Comms	180 kbits/s (Data) Irridium (Comms)	Data: 2 Tracking and Data Relay Satellite System links (TDRSS) to support average event rate of ~ 0.25 Hz
Calibration under flight	UV flasher + Laser	2 hours under balloon at Float on first night (similar to Timmins 2014)

How many EASs will the mission measure?

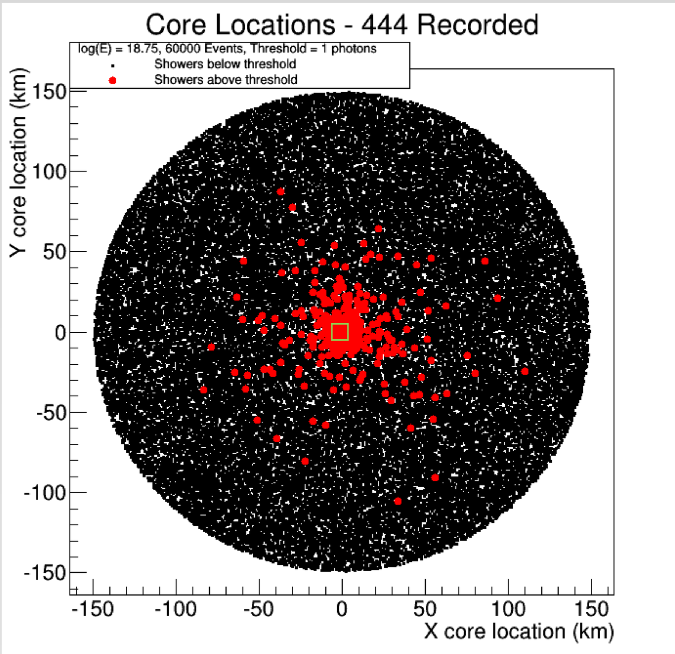
J. Fenn (CSM)



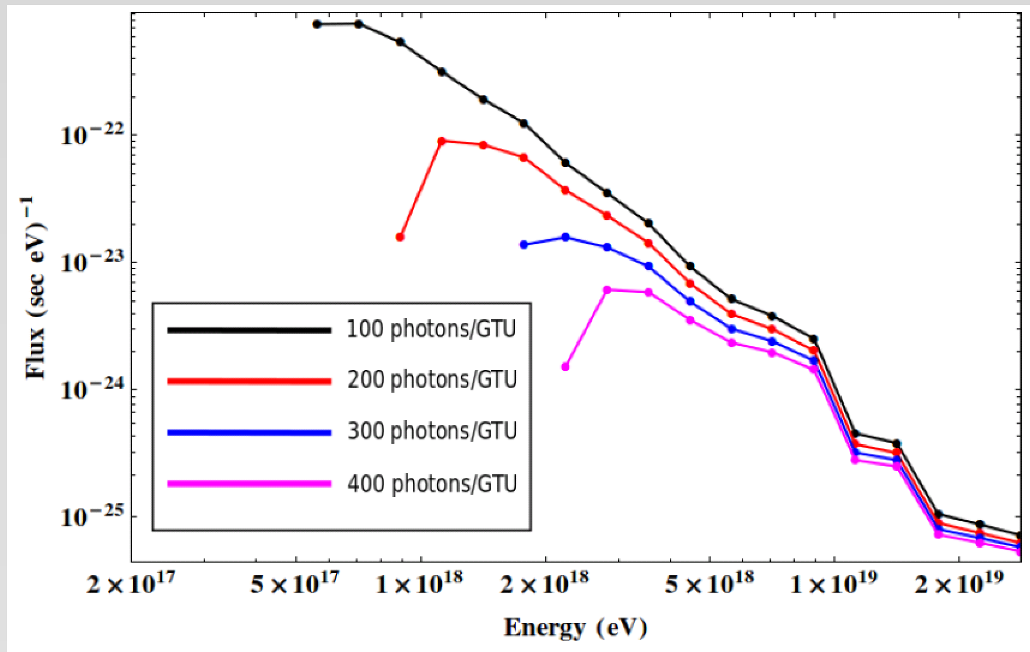
1) Use CONEX [1] to generate sets of EAS 0°- 80° zenith. Make isotropic sets of 60,000 EASs for 8 energies: $10^{17.5}$, $10^{17.75}$, $10^{18.0}$, . . . $10^{19.25}$ eV



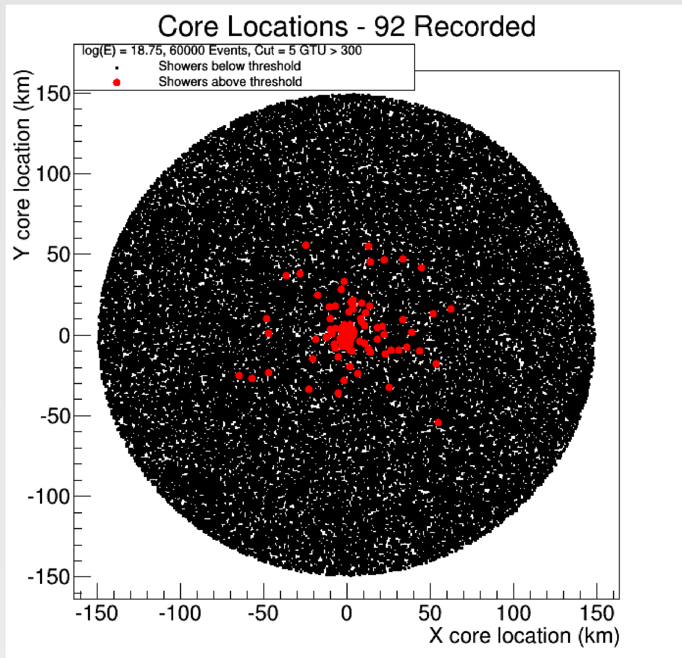
4) Fraction, $f(E)$, of thrown EAS that pass simple trigger



2) Randomize EAS core locations (black) around EUSO-SPB's field of view (green). Red events have chance of being recorded.



5) Multiply by the cosmic ray flux [2] and the simulated aperture. The product, $J(E)A_{sim}f(E)$, is the expected detectable cosmic ray flux in the EUSO-SPB field of view.



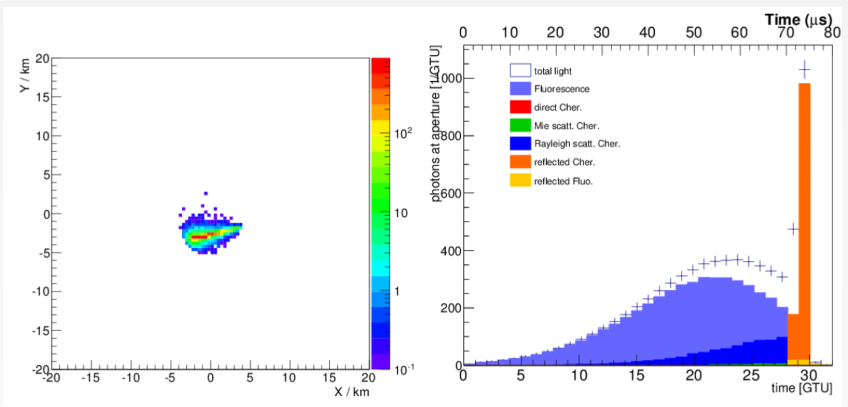
3) Select EAS recorded with simple trigger: the number of photons (200, 300, 400) reaching the instrument optical entrance aperture in each of 5 consecutive 2.5 μs time bins.

300 photons corresponds to ~8 photo electrons/time bin/pixel. The expected background is ~1 photo-electron/time bin/pixel

6) Integrate:

$$N = \int J(E) A_{sim}\, f(E)\, dE$$

N	Number EASs detected/unit time
$J(E)$	Cosmic ray flux
A_{sim}	Simulated aperture 3.7x10⁵ km² sr
$f(E)$	see step (4)



Example Cosmic Event: E = $10^{18.75}$ eV, 27° zenith

Simulation Results

Event Rate for detection of "obvious" cosmic ray air showers 1×10^{18} eV –> 2×10^{19} eV

Trigger (photons)	Events/ hour	Events/ dark period	Pass weather/quality selection
>1000	0.42	50	25
>1500	0.18	21	10.5
>2000	0.09	11	5.5

The event totals correspond to 118 hours of moon-down darkness, ie March 2017.

If the requested 50 day flight spans 2 dark periods, these statistics could double.

References
(1) T. Bergmann et al. Astropart. Phys., **26**:420–432, 2007.
(2) The Pierre Auger Collaboration, J. Abraham et al., Physics Letters B, **685**(45):239 – 246, (2010).

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