

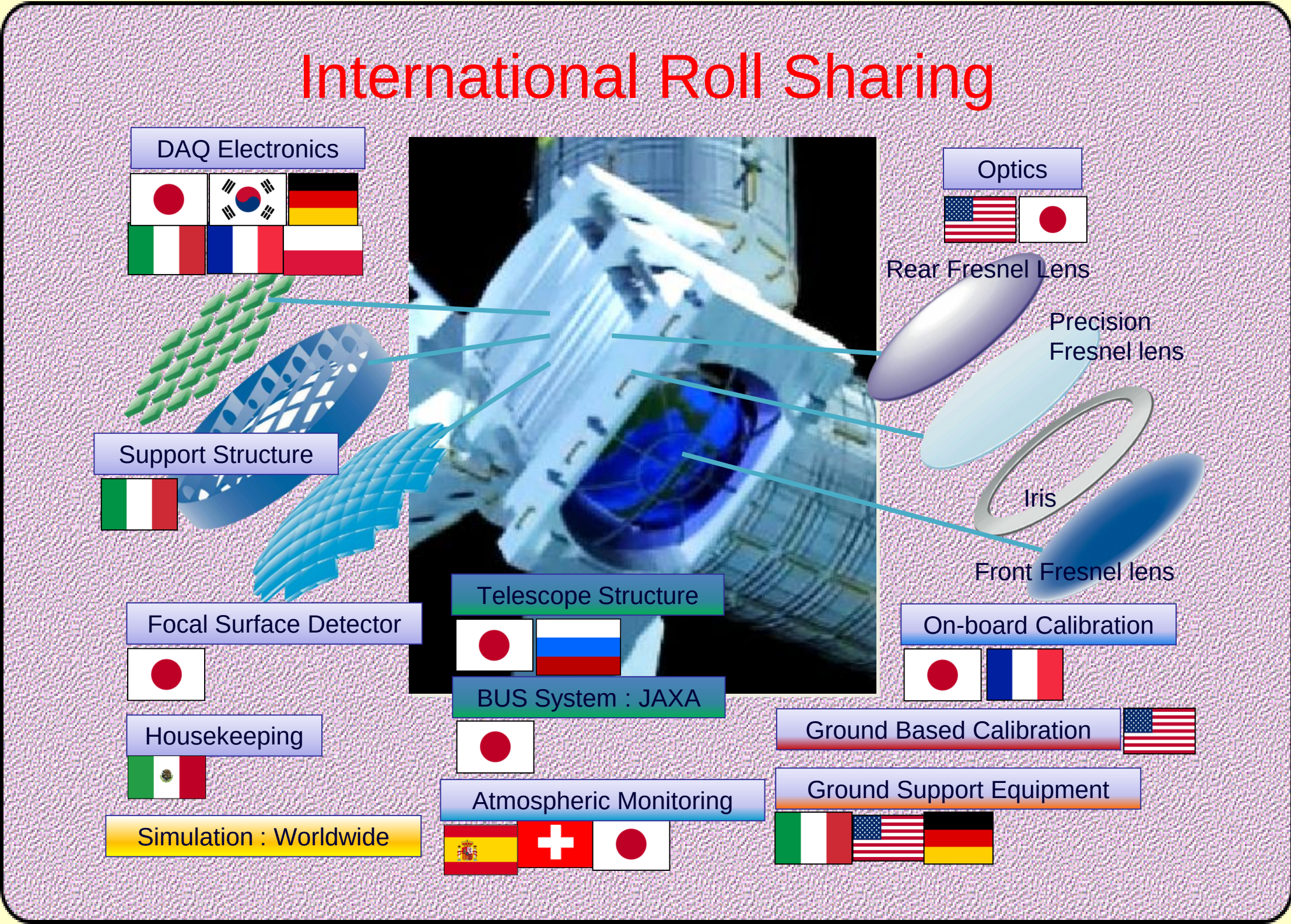
Instruments of the JEM-EUSO telescope

Y.Kawasaki, for the JEM-EUSO Working Group

EUSO Team, Advanced Science Institute, RIKEN

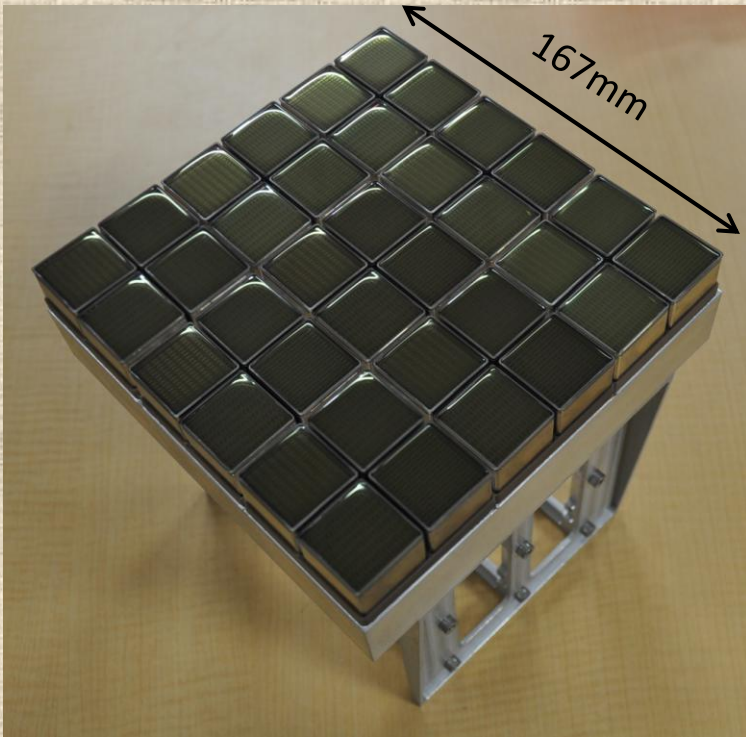
Abstract

The Extreme Universe Space Observatory on JEM/EF (JEM-EUSO) is a space mission to study extremely high-energy cosmic rays. The JEM-EUSO instrument is a wide-angle refractive telescope in the near-ultraviolet wavelength region which will be mounted on the International Space Station. Its goal is to measure time-resolved fluorescence images of extensive air showers in the atmosphere. In this paper we report the current developing status of the JEM-EUSO telescope. And also we report two side projects. One is TA-EUSO, which is one of the ground based end-to-end test experiment in Utah, U.S. The other is EUSO balloon, which is end-to-end test balloon experiment led by CNES.

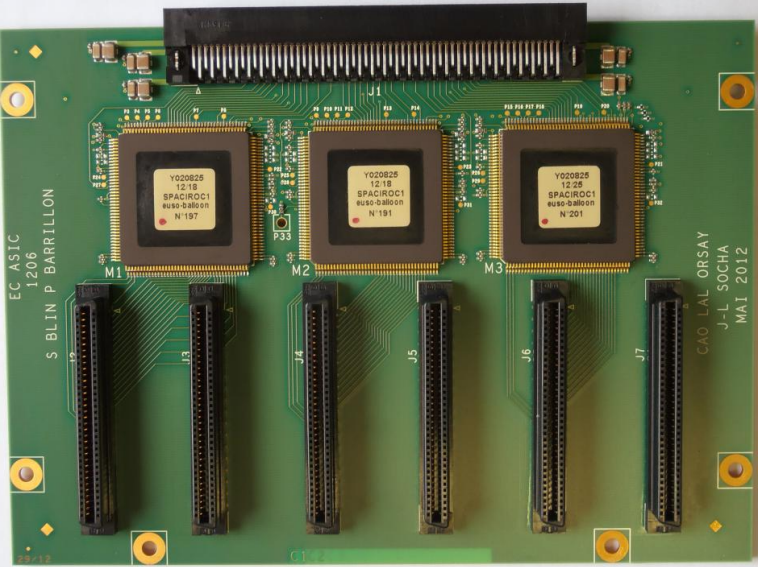


Focal Surface Electronics

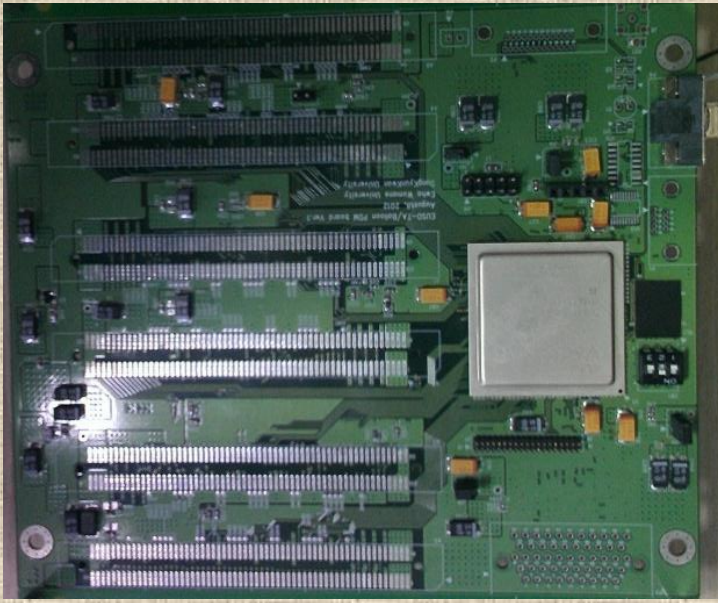
The Focal Surface (FS) of JEM-EUSO has a curved surface of about 2.35 m in diameter, and it is covered with about 4,932 Multi-Anode Photomultiplier Tubes, MAPMTs, each of which has 64 channels. It makes $\pm 30^\circ$ FOV and 0.07° angular resolution. The FS detector consists of 137 Photo-Detector Modules (PDM), each of which contains 36 PMTs.



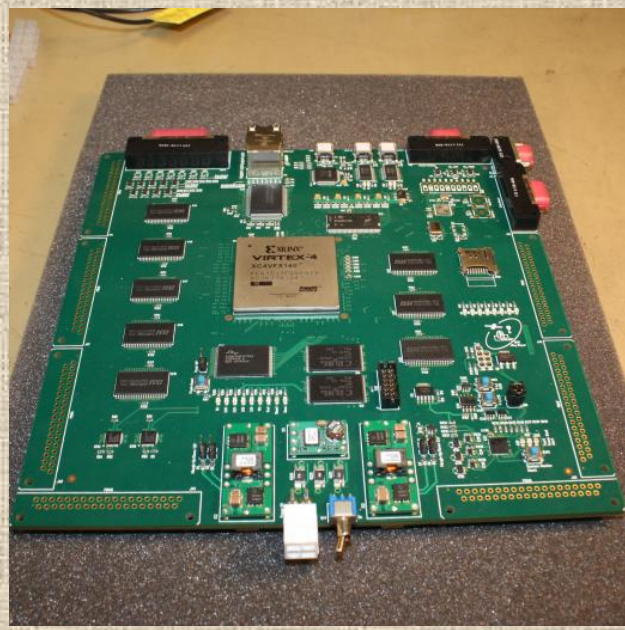
PMT Array. This has 36 PMTs, each of which has 64 channel. This is the basic unit of the JEM-EUSO FS Electronics; PDM. JEM-EUSO has 137 PDMs on the FS.



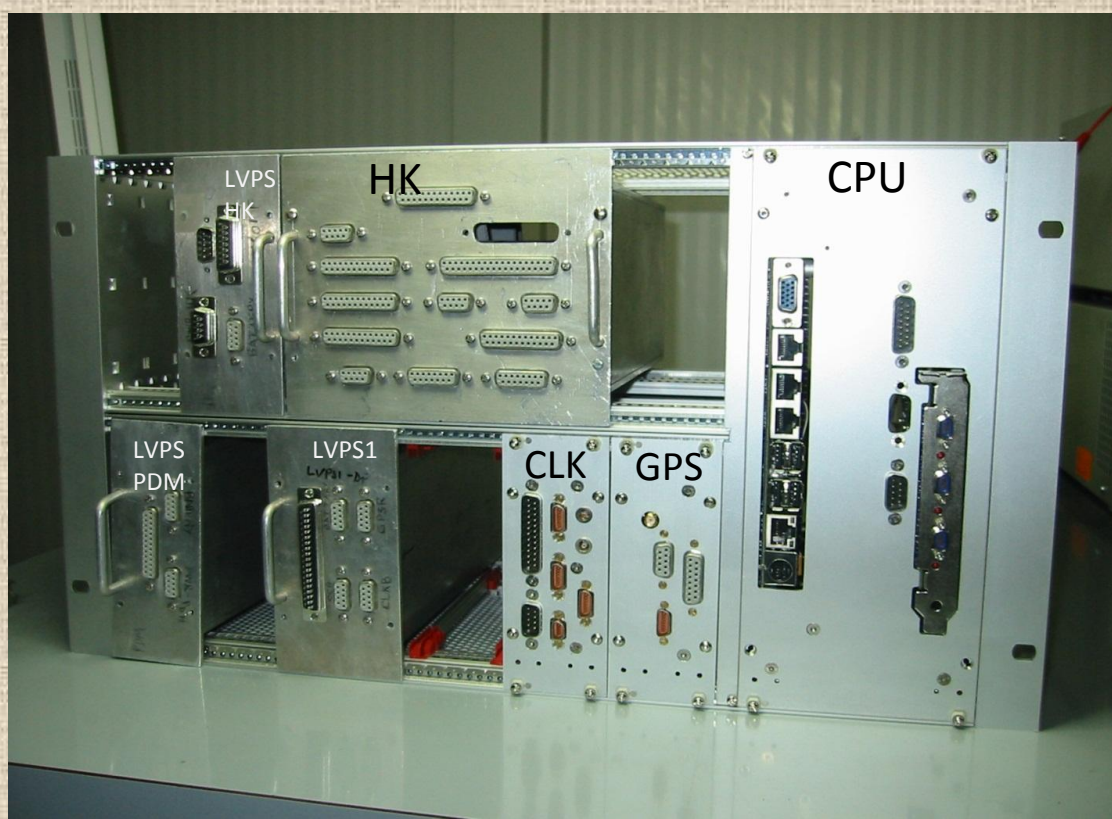
The prototype of the Front-End ASIC Board. This has 6 ASIC, which has 64 channel photon-counting circuits.



The prototype of the PDM board. This reads data of one PDM, 2,304 channel, and performs 1st level trigger, which average rate is 7 Hz/PDM.



The prototype of the Cluster Control board (CCB). This reads the data from 8 PDMs and performs 2nd level trigger, which average rate is 0.1 Hz/FS.

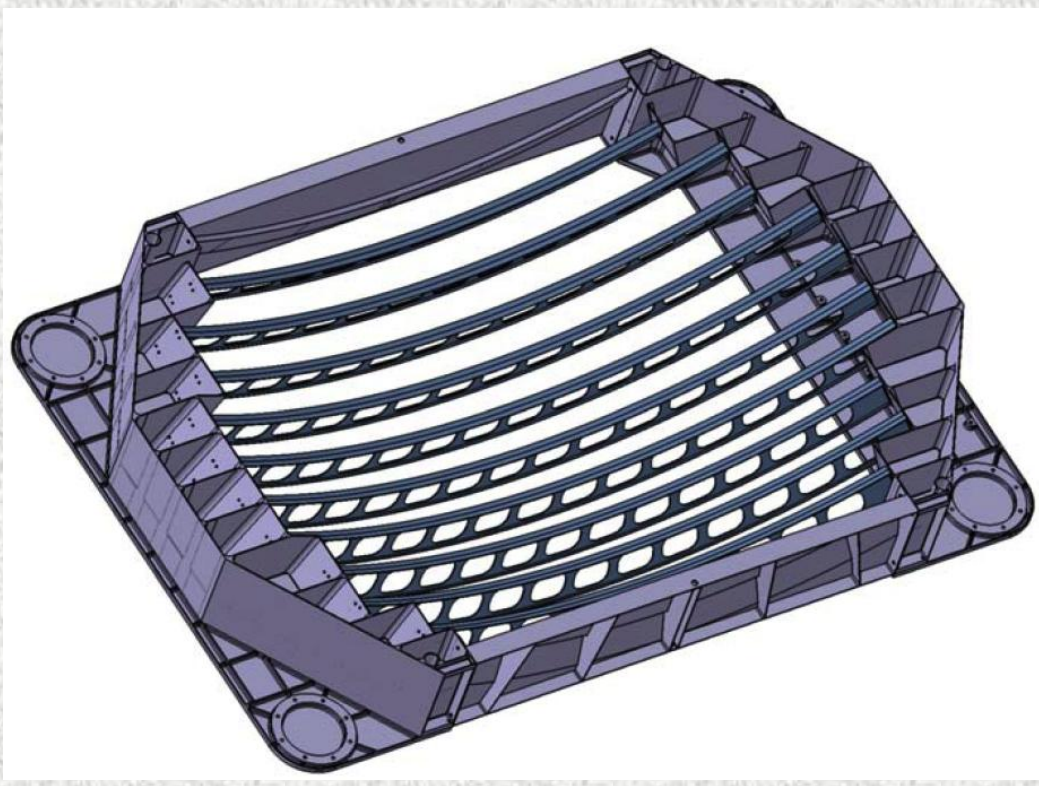


The prototype of the DP Box for TA-EUSO. This has the slots for the CPU board, Clock distributor, GPS, LV power supplies, House Keeping Box, and CCB.

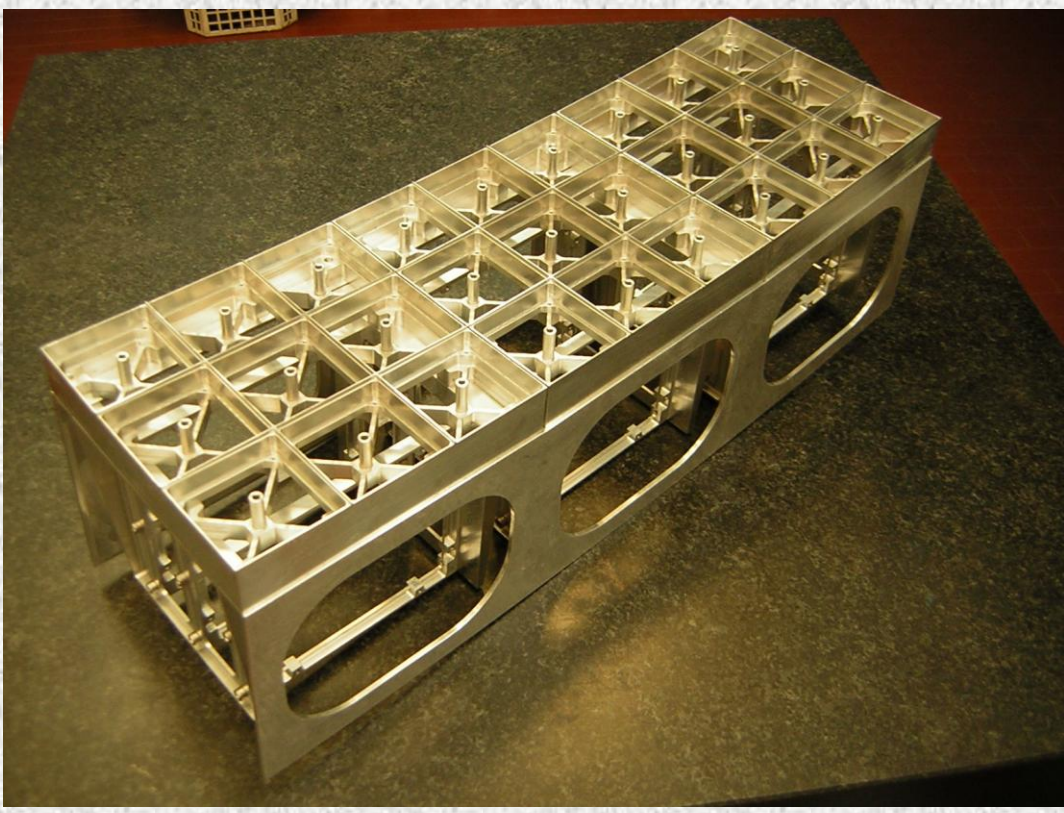


Focal Surface Support Structure

The FS support structure holds 137 PDMs on the optical focal surface, which is a portion of a sphere of radius 2,785 mm.



The FS Frame has the rib structure. This is made by an aluminum alloy type 7075 T4.



The prototype of the rib structure and 3 PDM structures.



Optics

The JEM-EUSO optics consists of two double sided Fresnel lenses and one precision Fresnel lens, which diameters are 2.6 m. The supported field of view is $\pm 30^\circ$.



The prototype Lenses. These are the center part ($\phi 1.5\text{m}$) of the full lens system ($\phi 2.6\text{m}$).



EUSO Balloon

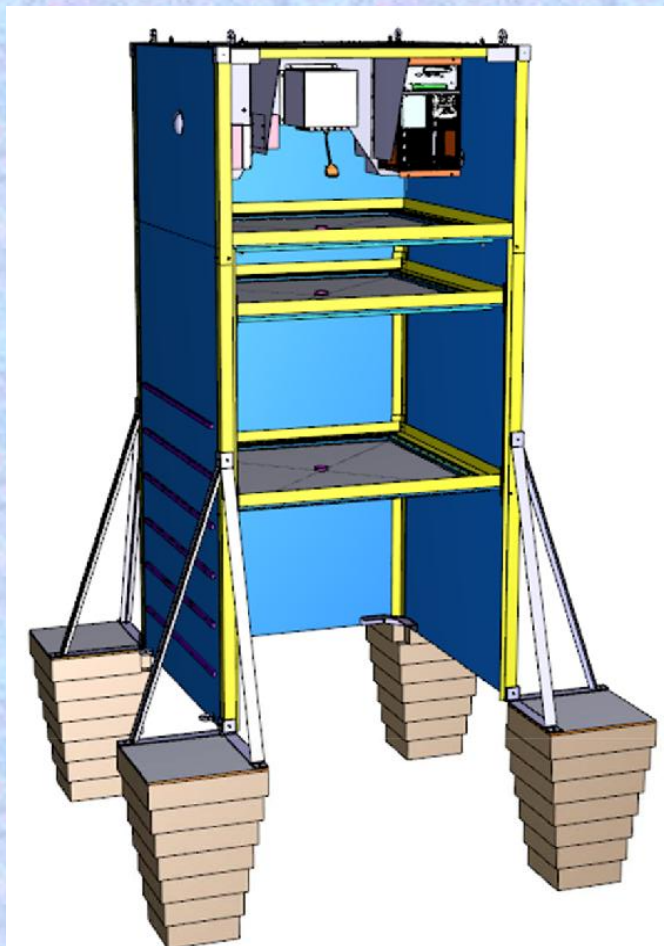
Objectives

- Full scale end-to-end test JEM-EUSO's key technologies and instrumentation
- A-level (technology demonstrator):**
 - the entire PDM, its ASIC's, the FEE, Trigger, HV power supplies, HV switches
 - onboard hard- and software algorithms for triggering and recognition of air-showers
- B-level (cosmic ray acquisition and background study)**
 - experimental confirmation of the effective background below 40 km
 - acquisition of 2.5 μs frames, ground-pixels representative for JEM-EUSO
 - test and adjust trigger and switching algorithms, observational modes
 - testing of the acquisition capability of the IR camera (TBC)
- C-level (precursor mission) :**
 - 1st optical detection of air-showers by looking down from the edge of space
 - detection of laser induced events from space ...

The first flight in spring 2014 from Timmins, Canada (48°34' N, 81°22' W)



View of Timmins



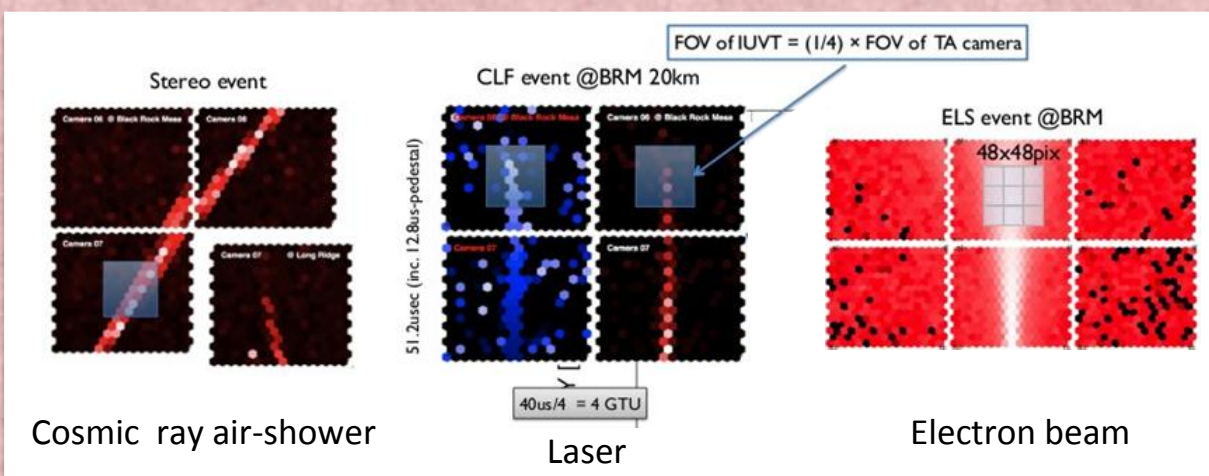
The payload of the EUSO Balloon.



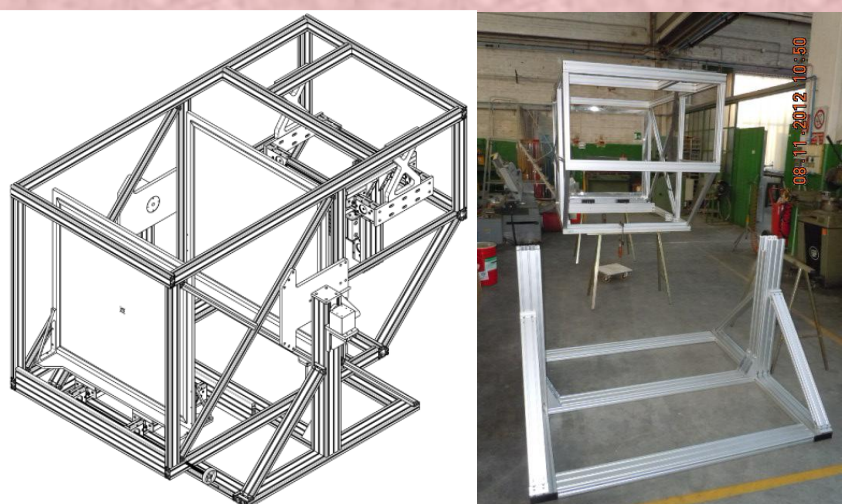
TA-EUSO

Objectives

- Main purpose: calibration using one PDM and two lens system:
 - Cross calibration with Telescope Array Fluorescence Detector
- a) When Laser or electron beam shoots, store the data to have an absolute calibration.
- b) Take few showers in coincidence with TA.
- c) repeat the game in Auger. Cross-calibration of the system in Auger and TA.



The TA Images of the cosmic ray air-shower, Laser and Electron beam. The small square is our FoV. We can see them in detail with our PDM, which has 48x48 pixels.



The telescope Structure of TA-EUSO. This supports two lenses and a PDM.



Our telescope will be put in front of the TA FD building, which is the location to see the Laser and Electron beam in the same direction.



The concrete pad is prepared by TA group.