

**Extreme Universe Space Observatory**

# **JEM-EUSO**

## **Osservazione dei Raggi Cosmici di altissima energia (UHECR) dallo Spazio**

**M. Ricci – CL LNF  
7 Luglio 2011**

# Science Objectives

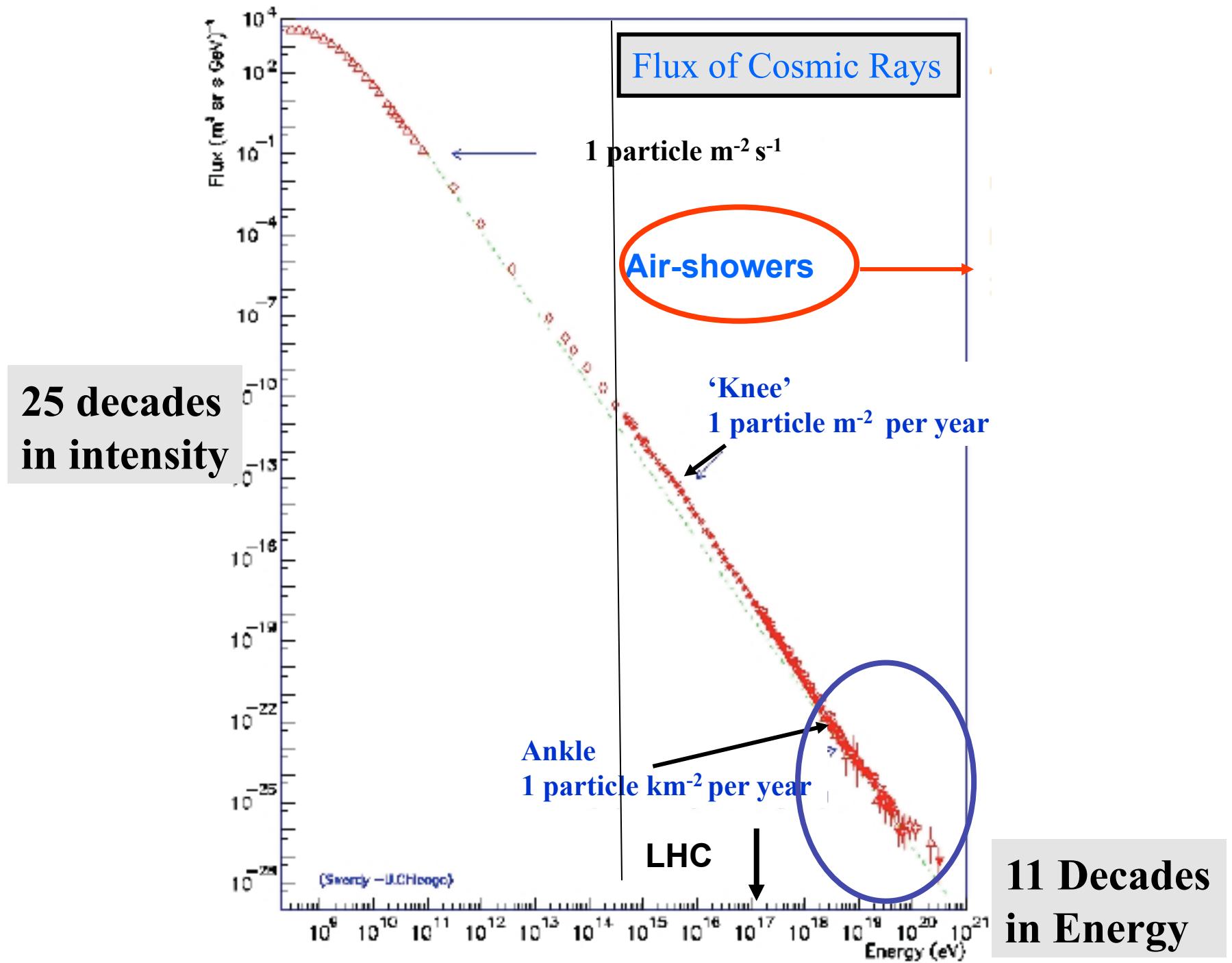
- **Main Objective :**

## **Astronomy and astrophysics through particle channel with extreme energies $> 10^{20}$ eV**

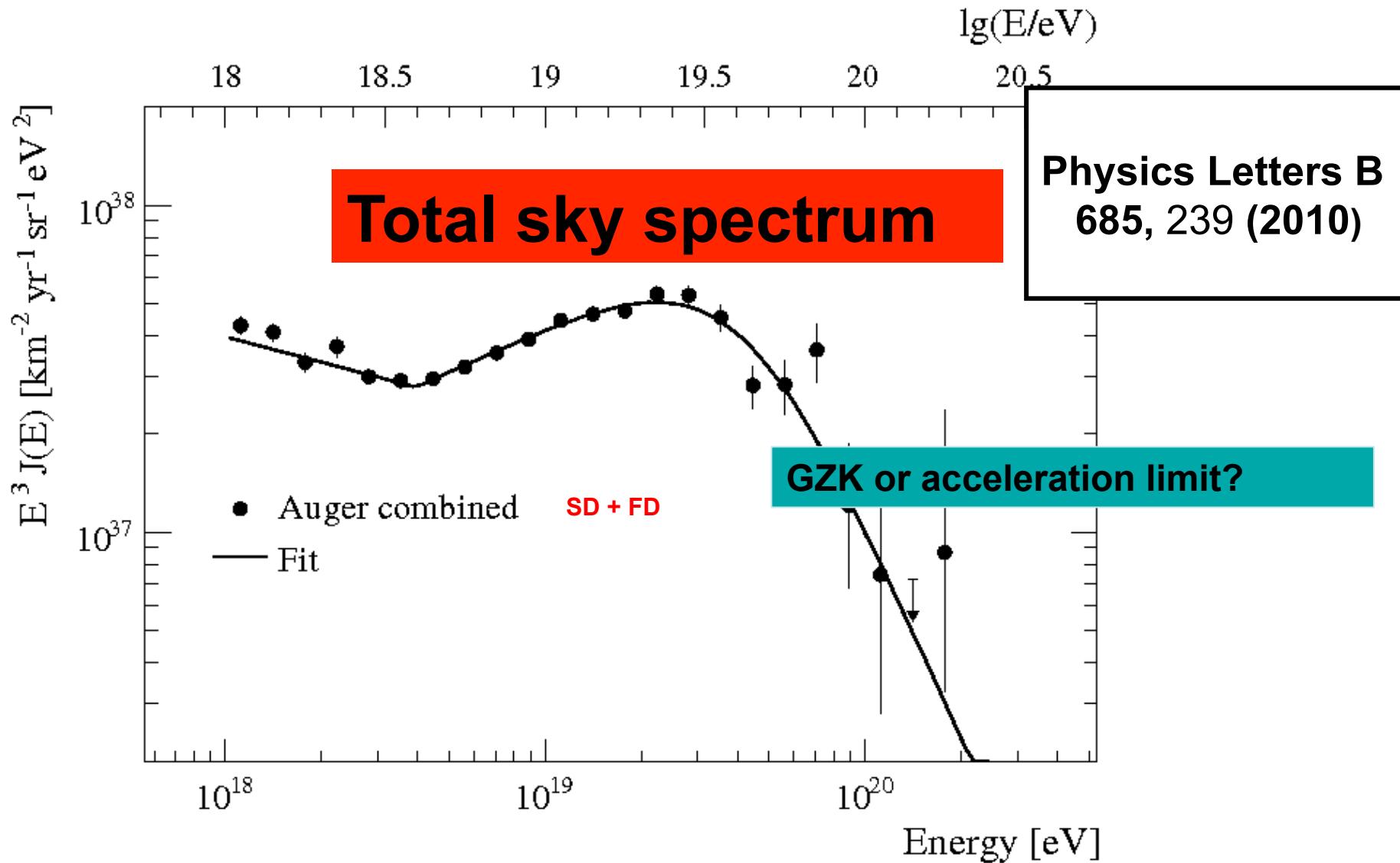
- Identification individual **sources** with high statistics
- Measurement of the **energy spectrum** of individual sources
- Understanding of the acceleration processes and source dynamics

- **Exploratory objectives :**

- Detection of extreme energy **neutrinos**
- Measurement of extreme energy **gamma rays**
- Study the intensity and topology of Galactic and extragalactic **magnetic fields**
- Test the effects of quantum gravity on the propagation of HE particles
- Global observation of **atmospheric** phenomena: nightglows, lightning and plasma discharges

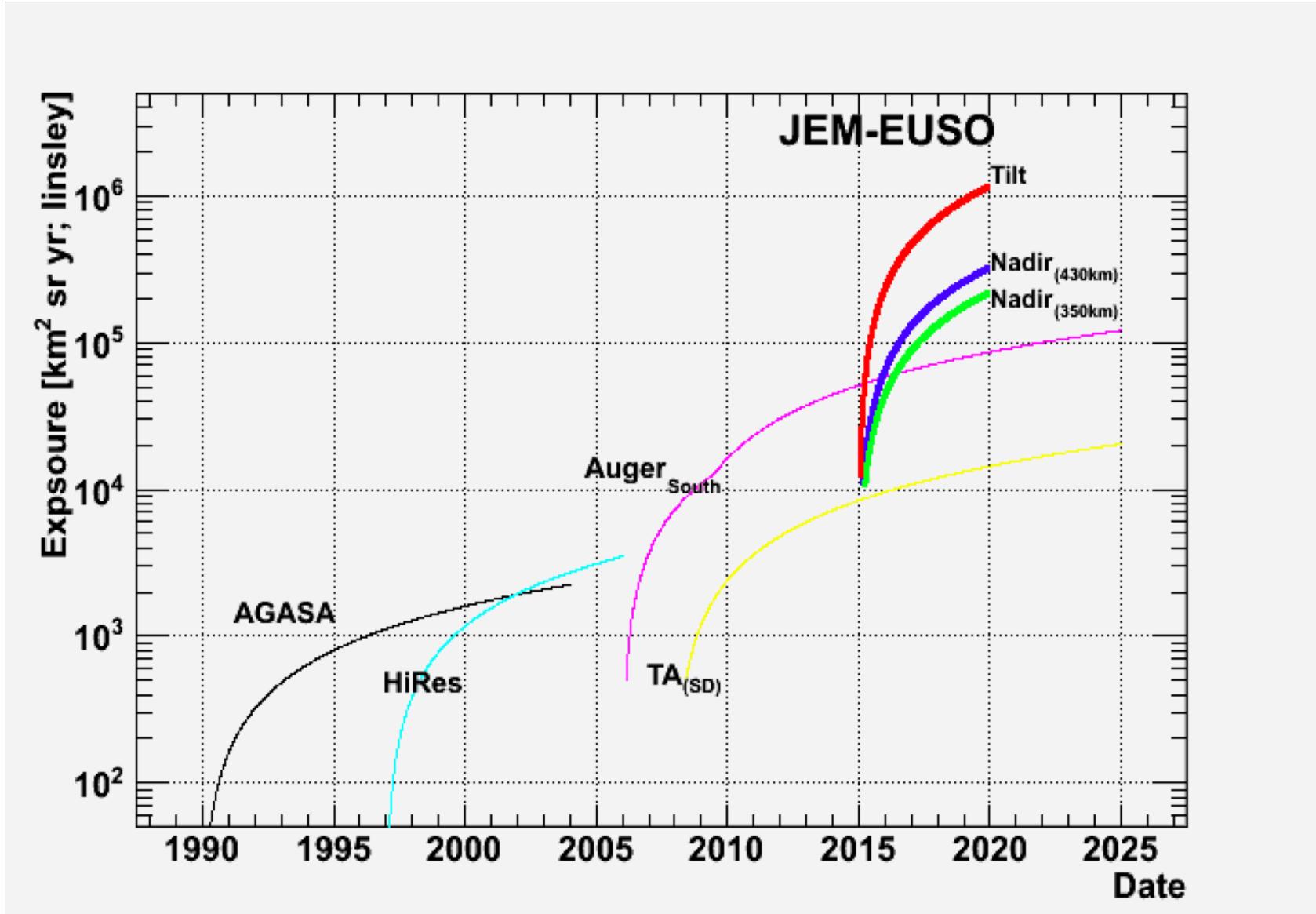


# Energy Spectrum from Auger Observatory

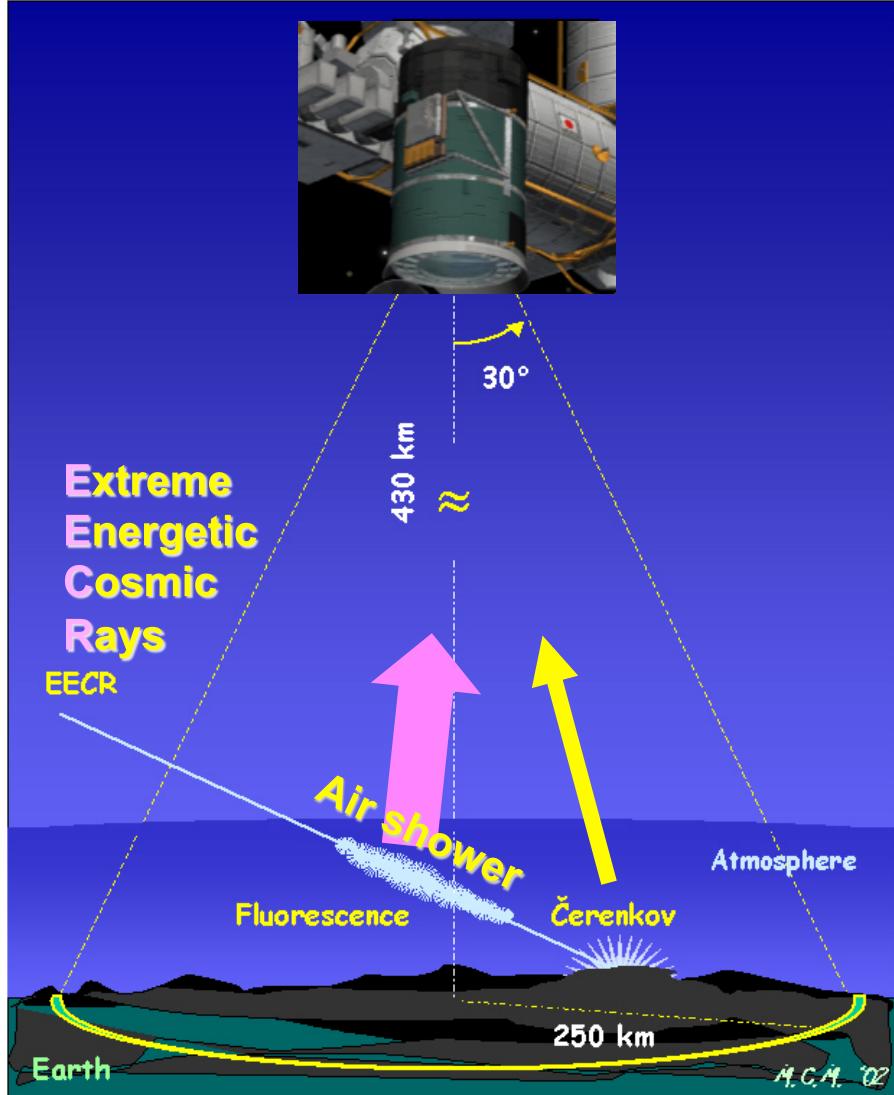


Above  $3 \times 10^{18}$  eV, the exposure is energy independent: 1% corrections in overlap region

## JEM-EUSO exposure



# JEM-EUSO Observational Principle



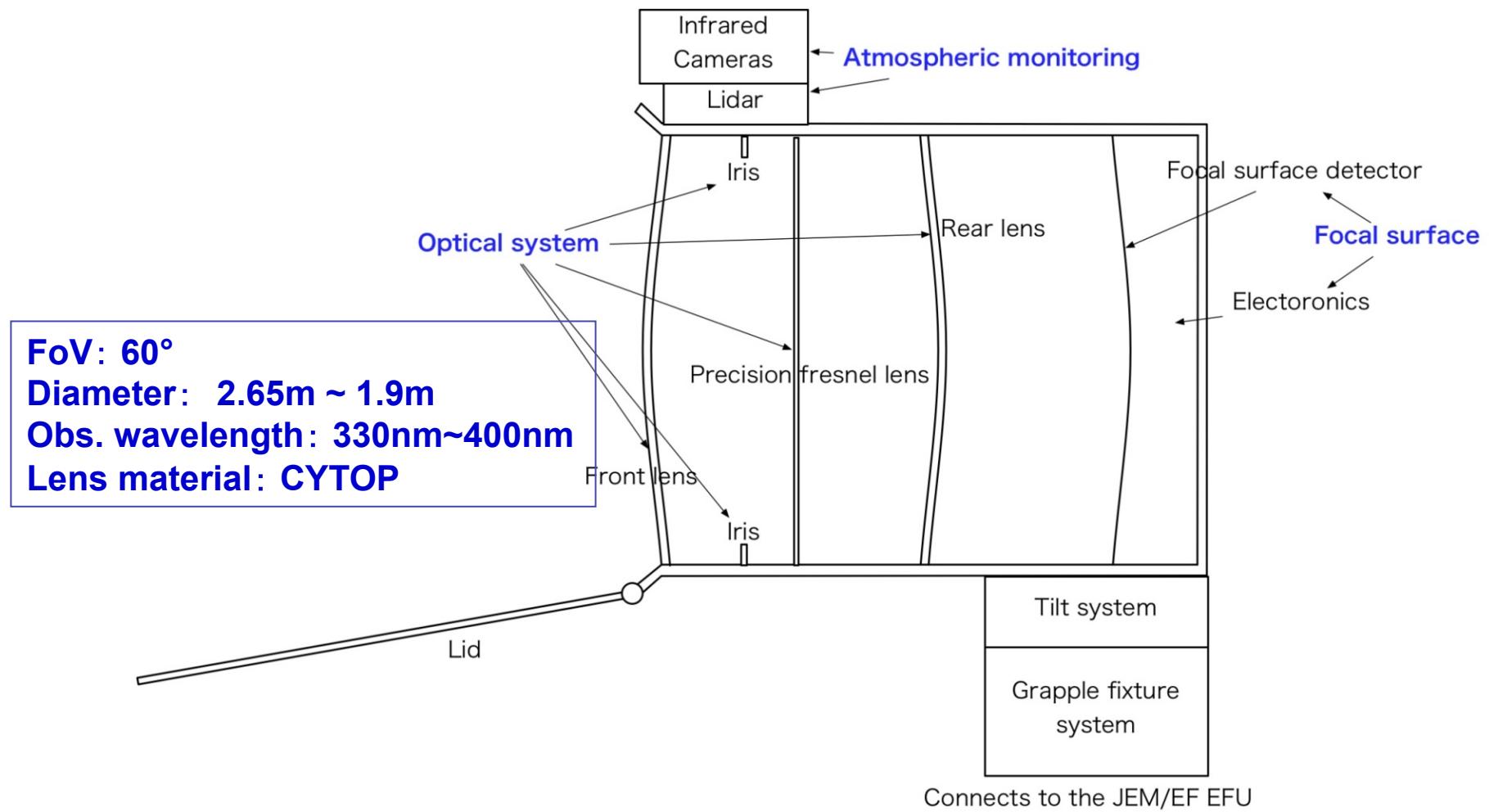
JEM-EUSO is a new type of observatory on board the International Space Station (ISS), which observes transient luminous phenomena occurring in the Earth's atmosphere.

The telescope has a super wide field-of-view ( $60^\circ$ ) and a large diameter (2.5 m).

JEM-EUSO mission will initiate particle astronomy at  $\sim 10^{20}$ eV.

JEM-EUSO telescope observes fluorescence and Čerenkov photons generated by air showers created by extreme energetic cosmic rays

# Conceptual View of JEM-EUSO Telescope



# Atmospheric Monitoring System

- IR Camera

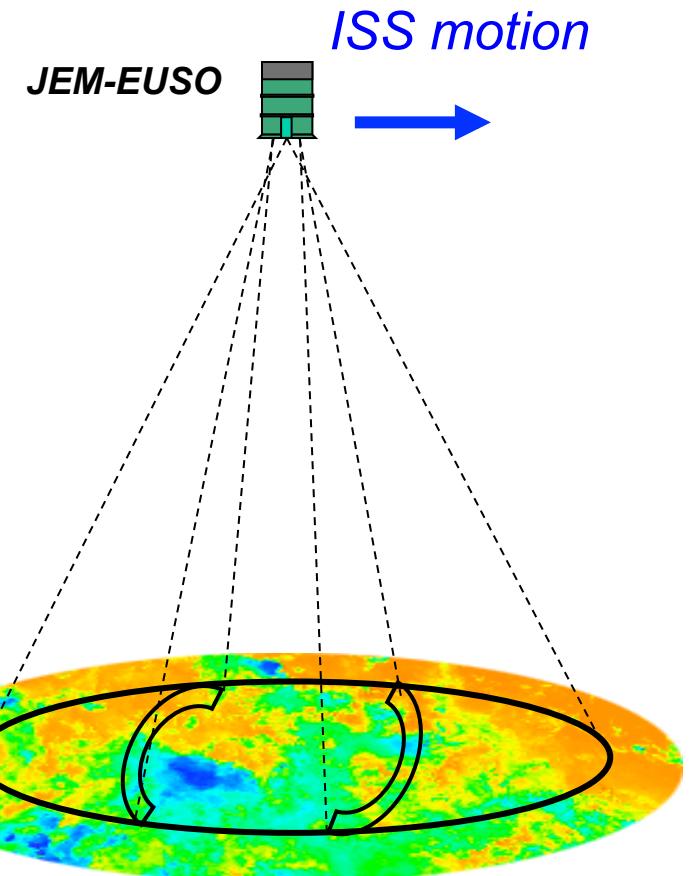
Imaging observation of cloud temperature  
inside FOV of JEM-EUSO

- Lidar

Ranging observation using UV laser

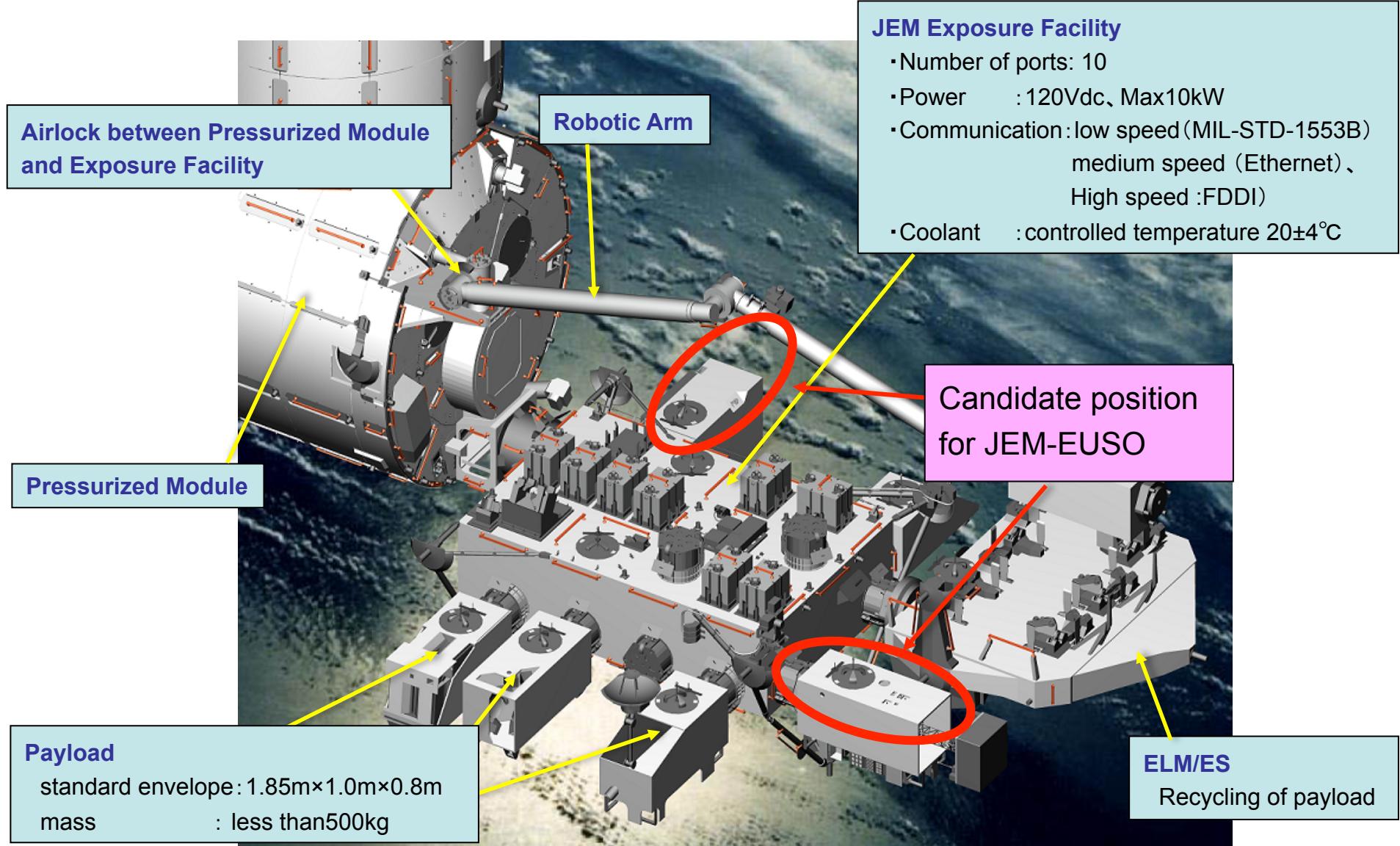
- JEM-EUSO “slow-data”

Continuous background photon counting



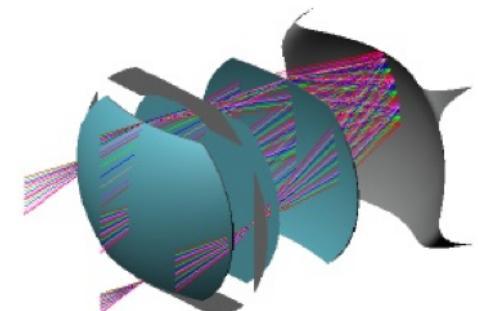
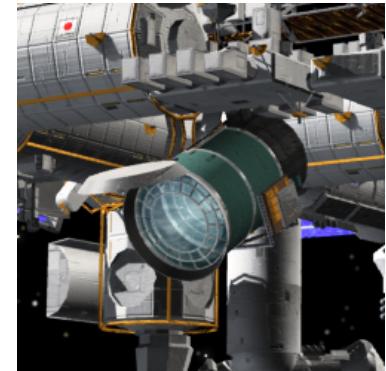
- *Cloud amount, cloud top altitude:* (IR cam., Lidar, slow-data)
- *Airglow:* (slow-data)
- *Calibration of telescope:* (Lidar)

# Outline of JEM Exposure Facility Japanese Experiment Module “KIBO”



# Mission Parameters

- Time of launch: year 2016
- Operation Period: 3 years (+ 2 years)
- Launching Rocket : H2B
- Transportation to ISS: un-pressurized Carrier of H2 Transfer Vehicle (HTV)
- Site to Attach: Japanese Experiment Module/ Exposure Facility #2
- Height of the Orbit: ~ 400km
- Inclination of the Orbit: 51.64°
- Mass: 1983 kg
- Power: 926 W (operative),  
352 W (non-operative)
- Data Transfer Rate: 285 kpbs



# *JEM-EUSO*

*The Extreme Universe Space Observatory (EUSO)  
onboard the Japan Experiment Module (JEM) of  
the International Space Station*

*The JEM-EUSO Collaboration, led by RIKEN-  
Japan, brings together about 250 scientists, 76  
Institutes from 13 Countries:*

*Japan, Europe, US, Korea, Mexico*

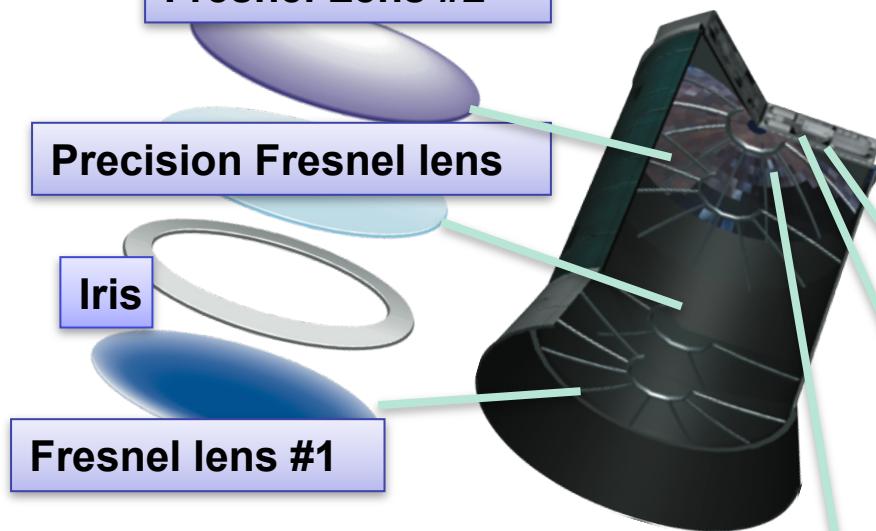


# International Role Sharing

Optics: USA + Japan + Italy



Fresnel Lens #2



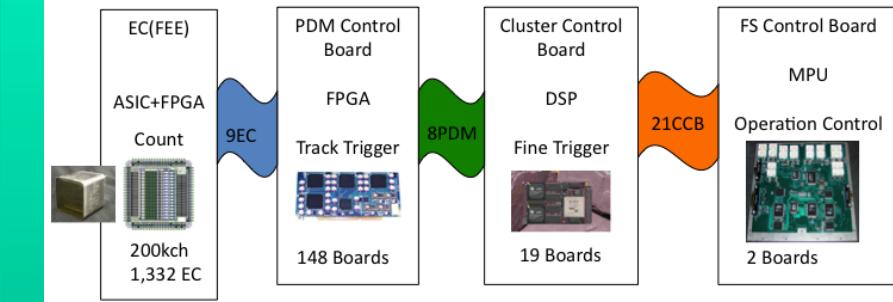
Fresnel lens #1

Calibration: Japan + France + Italy



Simulation: Worldwide

JEM-EUSO Data Acquisition Core Outline



DAQ Electronics & Trigger



Support Structure: Italy



Focal Surface: Japan+Italy



# LE AGENZIE INTERNAZIONALI



Japan Aerospace Exploration Agency



POCKOCMOC

# *Status of the Mission at ESA (1)*

*June 2010: JEM-EUSO selected and included  
in the ELIPS\* program of the  
Human Spaceflight and Exploration.*

*\* European Life and Physical Sciences in Space Programme*

## *Scientific evaluation of JEM-EUSO*

*The review of the proposal in ESA was very strict:*

*Positive recommendations on the science potential*

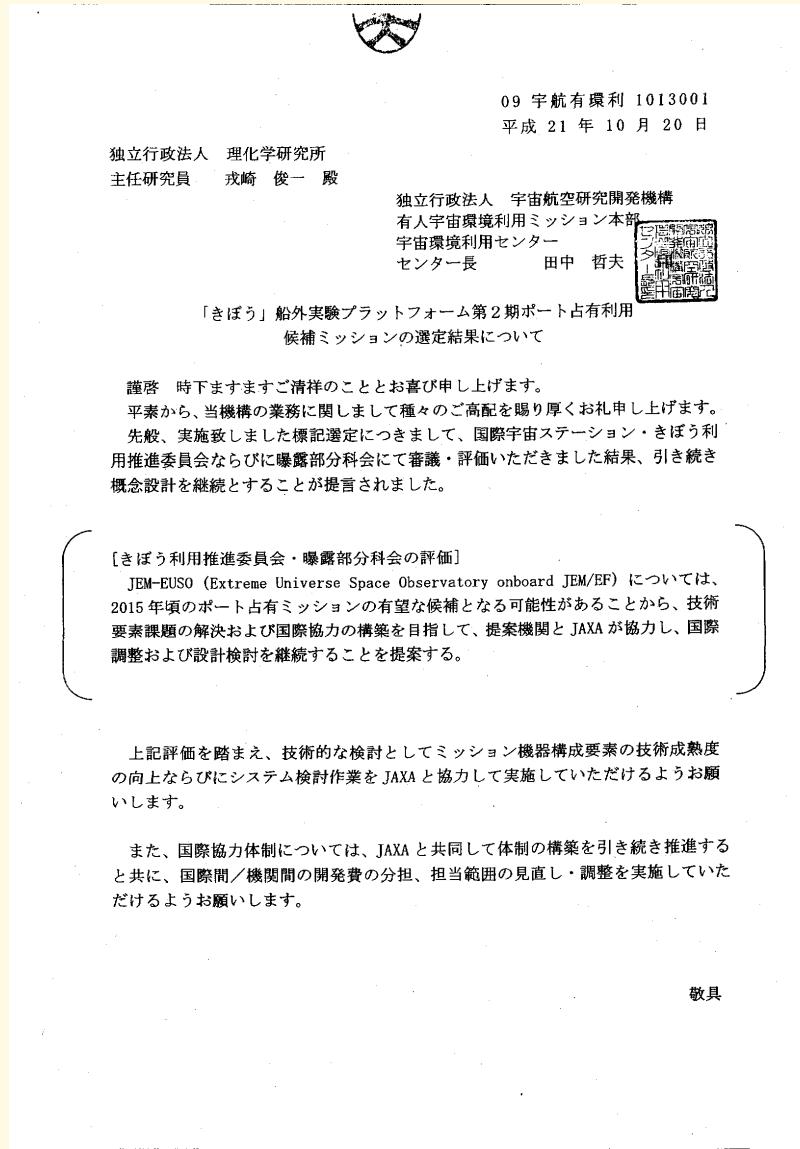
*from the following bodies:*

- ESA's Fundamental Physics Roadmap Team
- European Science Foundation (ESF)
- ESA's Astronomy Working Group
- ESA's Physical Sciences Working Group

## *Status of the Mission at ESA (2)*

- *In 2010-11:* Contacts and meetings with *Christer Fuglesang* (Head, ISS science) and *Olivier Minster* (responsible of the Physics Sciences Program) to verify all necessary steps toward the implementation of the proposal
- ESA recognizes that **JEM-EUSO is a flagship-type mission for the ISS**, which requires the joint efforts of JAXA, NASA, ESA (and National Agencies)

# Review by JAXA



- Exposure Facility working Group (Chaired by Prof. F. Makino) of ISS “KIBO” utilization promotion committee of JAXA, reviewed JEM-EUSO and recommended JEM-EUSO as a mission around 2016 on October 20, 2009.

- Science was highly recognized
- Several technical issues to be confirmed
- Programmatic issues
  - International role sharing
  - Resource sharing among ISS partners



## ***Status of NASA***

- **US EUSO Proposal** (submitted 16 Feb., 2011)
  - Selections are to be announced in September
- Selection Schedule:
  - Step 1 selections (target date: Aug., 2011)
  - Phase A concept study (Sept., 2011 – Aug., 2012)

# ***FATTI RILEVANTI DELA PRIMA META' 2011***

- Piergiorgio Picozza nuovo P.I. della Collaborazione Internazionale
- Superamento presso la JAXA, Tsukuba della ***System Requirement Review*** di un prototipo di laboratorio (milestone di fase finale A)
- General Meeting a Parigi 6-10 Giugno:
  - Incontro con rappresentanti ESA
  - Attivazione accordi con Ag. Spaziale Russa Roscosmos
  - Decisione di condurre un test al sito del telescope Array (Utah, USA) a Primavera 2012 (eventuale test successivo anche al sito di AUGER in Argentina)
  - Decisione di effettuare un volo di test su pallone (approvato dal CNES, Francia) dalla base di Kiruna (Svezia) Gen-Feb 2013 (EUSO-Balloon)
  - Avanzamento verso la fase B



# Il Gruppo Italiano



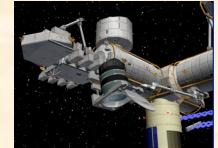
Italy

INFN and Univ.Bari	R. Bellotti, A. Bruno, F. Cafagna
INFN and Univ.Catania	A.Insolia, R.Caruso, S.Riggi, M. Scuderi
CNR-INO Firenze	A.Zuccaro Marchi
CNR-IFAC Firenze	G. Castellini
INFN-LNF	A.Franceschi, A.Marini, G.Modestino, M.Ricci, F.Ronga, T.Napolitano
INFN-Naples	M.Ambrosio, C.Aramo, D.Campana, R.Carbone, L.Consiglio, G.Osteria , L.Valore
Univ. "Federico II" di Napoli	D.D'Urso, F.Guarino, F.Isgro, M.Paolillo
IASF-PA/INAF	O. Catalano, M.C. Maccarone, G. La Rosa, B. Sacco, A.Segreto, E. Strazzeri, A. Anzalone
INFN & Univ. Rome "Tor Vergata"	M.Casolino, M.P.De Pascale, P.Picozza, F. Iacoangeli, G. Masciantonio
INAF-IFSI Torino	P.Vallania
Univ. Torino	P.Galeotti, C.Vigorito, M.Bertaina, C.Cassardo, S.Ferrarese
Univ. Torino / ARPA Piemonte	R.Cremonini
INAF-OATO	A.Cellino, M.Di Martino, A.Dell'Oro

**48 tra Ricercatori e Tecnologi (~ 25 FTE)**  
**INFN, INAF, CNR e Università**



## Ruoli di responsabilità italiane nella Collaborazione Internazionale



Piergiorgio Picozza P.I., **EB, CB**

Mario Bertaina (TO) Instrument Scientist, **CB**

Marco Casolino (RM2 e Riken) Project Scientist, **EB, CB**

Guido Castellini (FI) Instrument Advisor

Osvaldo Catalano (PA-CT) Instrument Advisor

Piero Galeotti (TO) Outreach

Marco Ricci (LNF) Project Scientist (Balloon flight), **CB, SB**

**EB**= Executive Board

**CB**= Collaboration Board

**SB**= Speakers' Bureau



# Italia-Passi compiuti (1)

- 2008-2009: ASI/INAF Contract I/088/06/0

Nuove missioni e opportunità per nuove missioni: anno 2º e 3º.  
(Coordinatore: O. Catalano, INAF-IASF Palermo)

- 2008 – 2011: Progetti di Grande Rilevanza Ministero  
Affari Esteri:

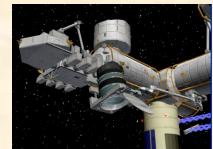
in the framework of the bilateral agreements between Italy and Japan for cooperation on  
scientific and technological projects  
(Coordinatore: P. Galeotti, Univ. & INFN Torino)

Progetto:

The JEM-EUSO Project: observing cosmic rays and  
neutrinos from the International Space Station



# Italia-Passi compiuti (2)



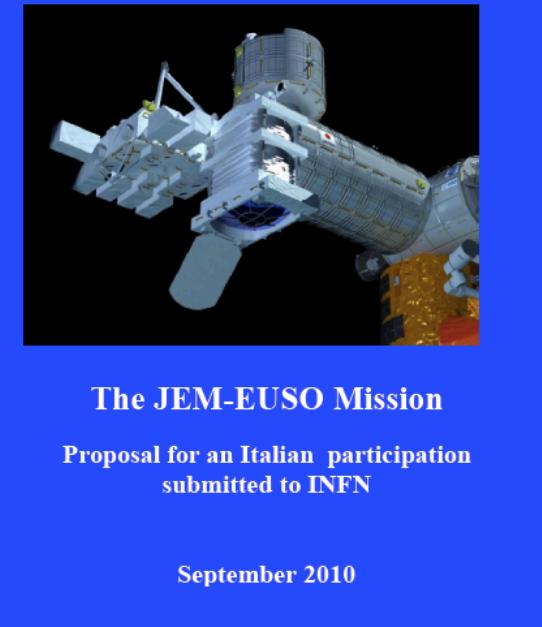
- Proposal sottomesso e presentato alla CSN2 INFN Settembre 2010:  
Nomina del Collegio dei Referee

- Approvazione scientifica nella CSN2 del 31/1/2011

- Aprile 2011: presentazione e discussione all'ASI con esito positivo.

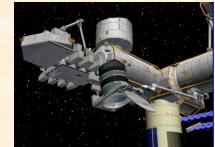
- JEM-EUSO compare nel Documento ASI di Visione Strategica 2010-2020

- Primi contatti con Thales Alenia Aerospace (studi di fattibilità, qualifiche spaziali)

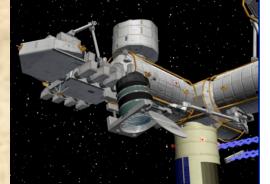




# Contributions and Responsibilities in Italy



- **Optics**: design of the basic system of the Fresnel lens.
- **Electronics**: CPU, Data handling, Storage system, Clock, High-speed serial line.
- **Trigger System**: Definition of track recognition algorithms.
- **Mechanics**: Support structure of the Focal Surface; Mechanical Ground Support Equipment.
- **Simulations**: study and optimization of the detection efficiency and of the resolution (energy, nuclear, incident angle) of the experiment; event reconstruction.
- **Tests** of radiation hardness and qualification of components.
- **Beam tests** of detector elements and components.
- **Calibrations** with ground equipment (LIDAR, fluorescence systems, UV sources).
- **Atmosphere monitoring**: development of software and algorithms for the calibration of on-board systems (LIDAR and Infrared Camera) and for the determination of cloud coverage and height from satellite images.
- Participation and contributions to **ground test at TA** and to **balloon flight**



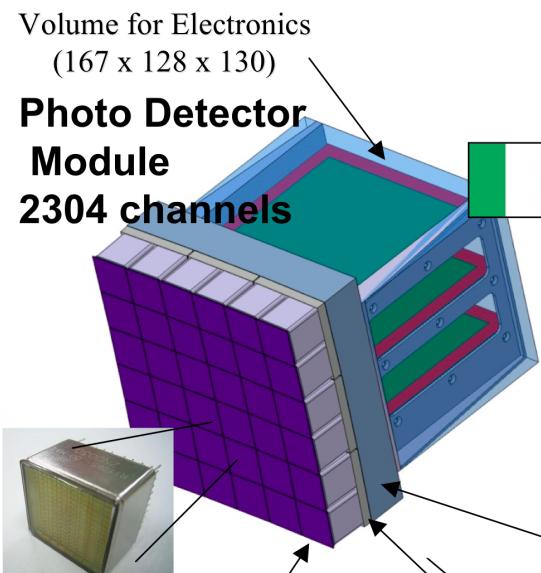
## Il gruppo JEM-EUSO-LNF

- M.Ricci (Resp.) 60%, A. Marini 40%,  
G. Modestino 80%, F. Ronga 40%,  
A. Franceschi 30%, T. Napolitano 30%
- TOT FTE 2.8

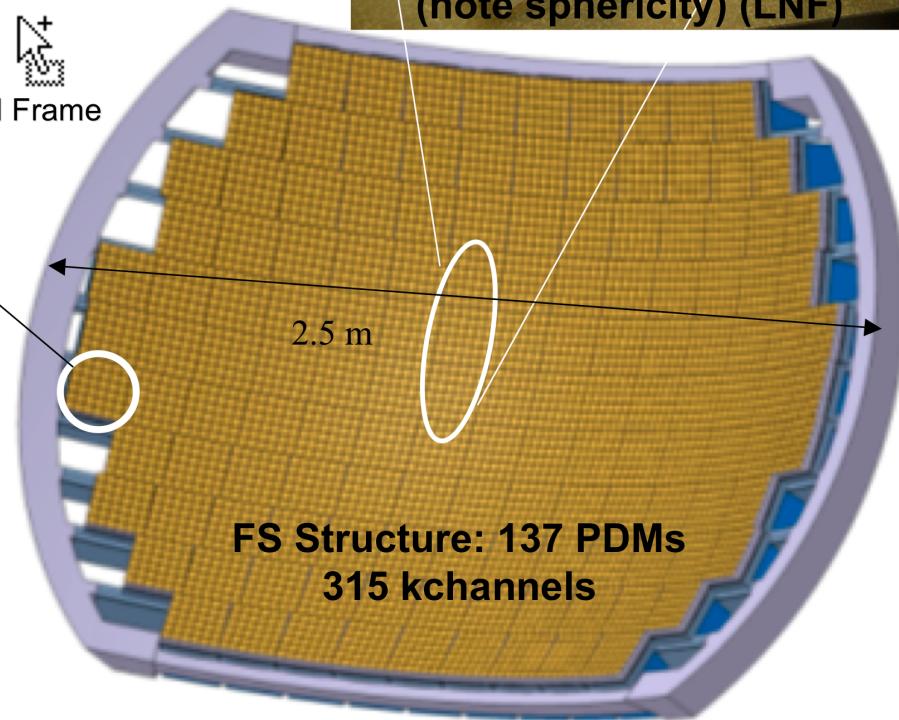
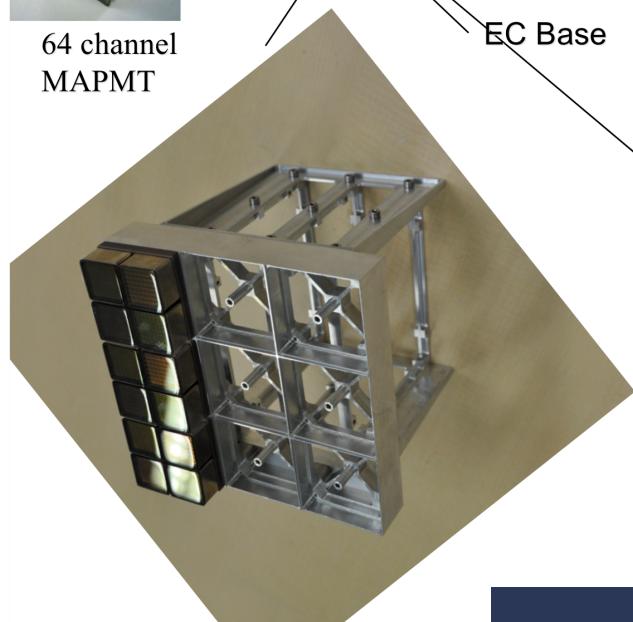
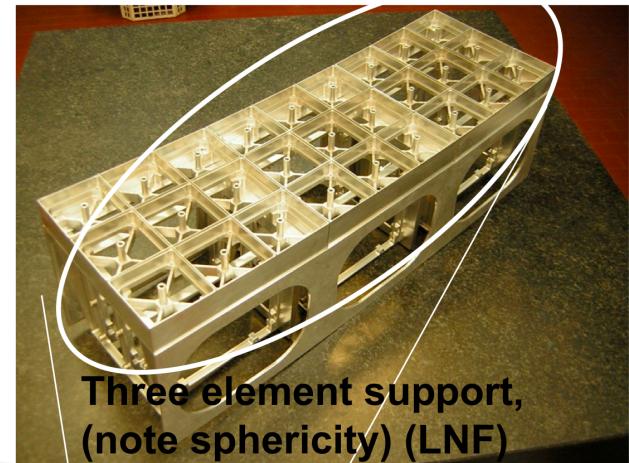
# Attività svolta e in corso nei LNF

(SPCM-LNF A. Franceschi, T. Napolitano)

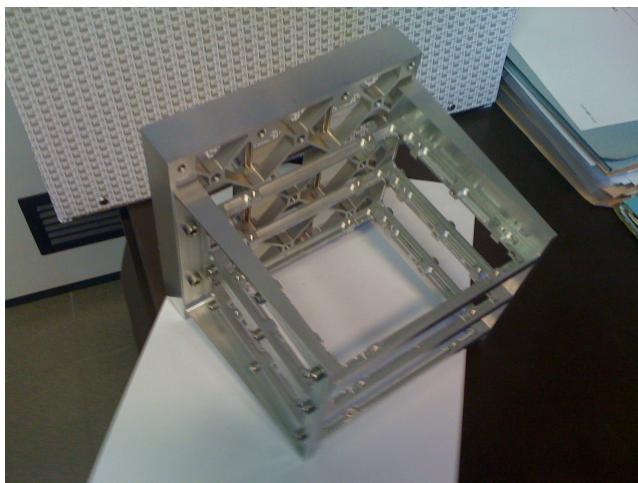
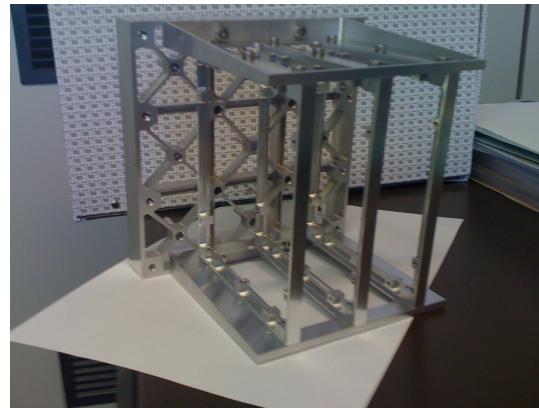
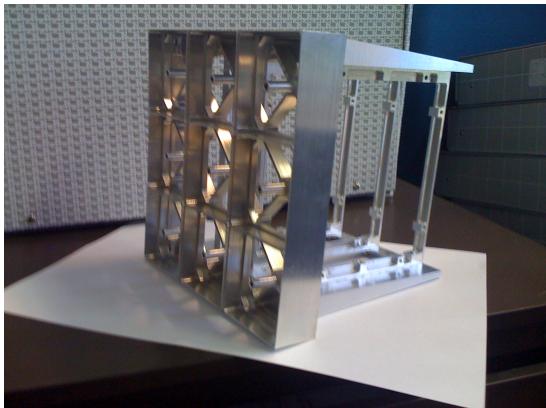
- Progetto struttura meccanica di supporto del Piano Focale (PF).
- Progetto supporti PDM (Photo Detector Module) per l’alloggiamento dei PMT e dell’elettronica associata sulla superficie del Piano Focale.
- Realizzazione prototipo supporto PDM.
- Studi di Analisi FEM delle strutture in progetto.
- Entrambi i progetti sono stati approvati dalla Collaborazione e costituiscono la “baseline” ufficiale per la struttura del PF.

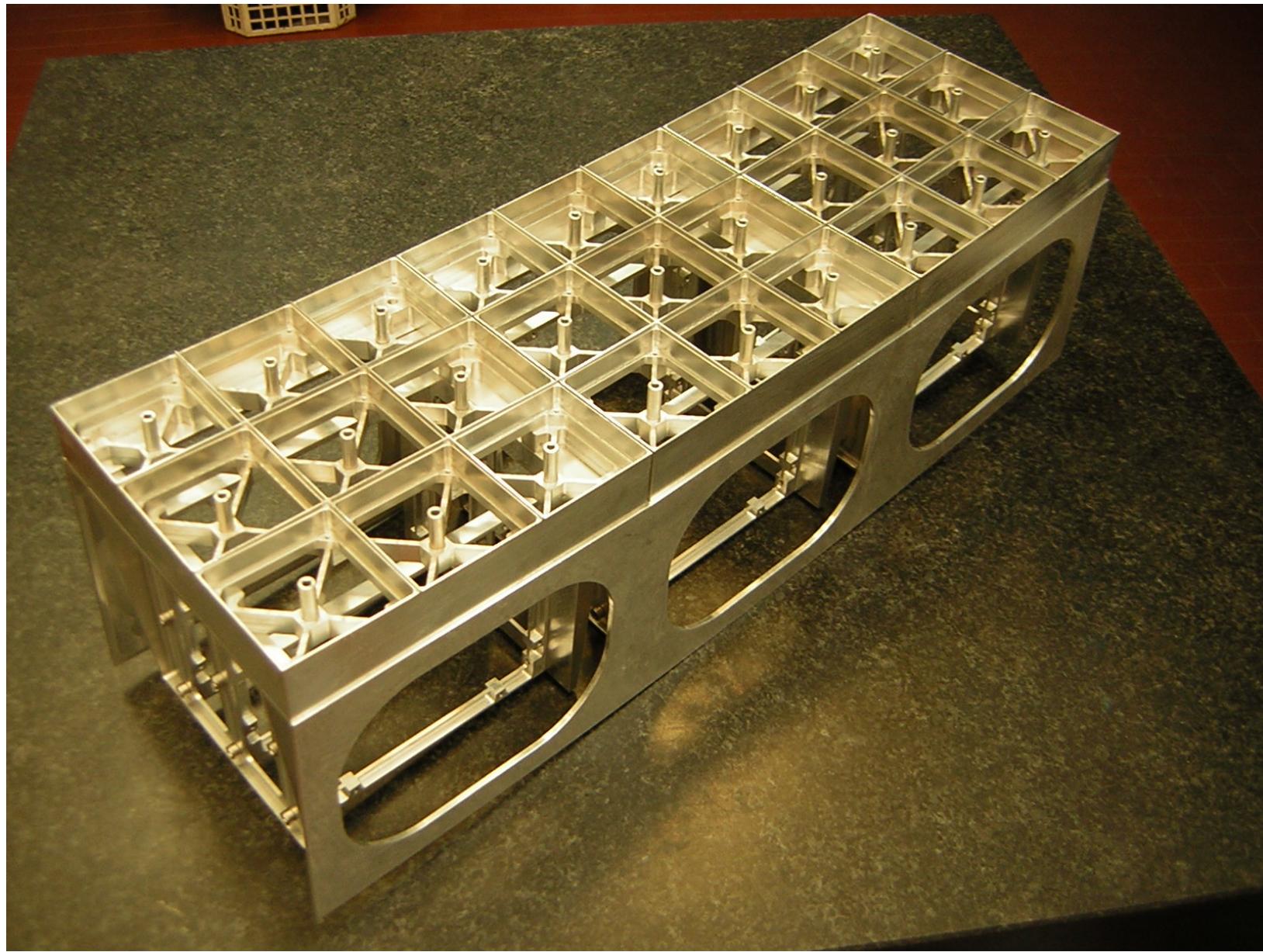


## Focal Surface Mechanics: Design + Manufacturing INFN-LNF



## Prototipo supporto meccanico PDM (SPCM-LNF)



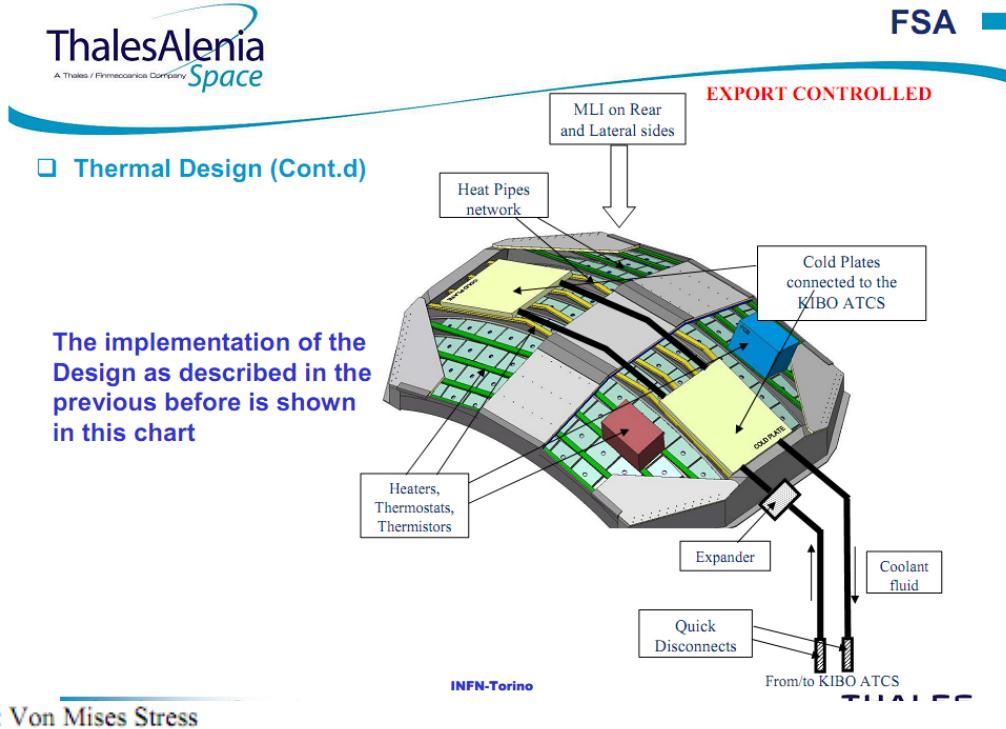


**SPCM-LNF 3 moduli supporto PDM assemblati**

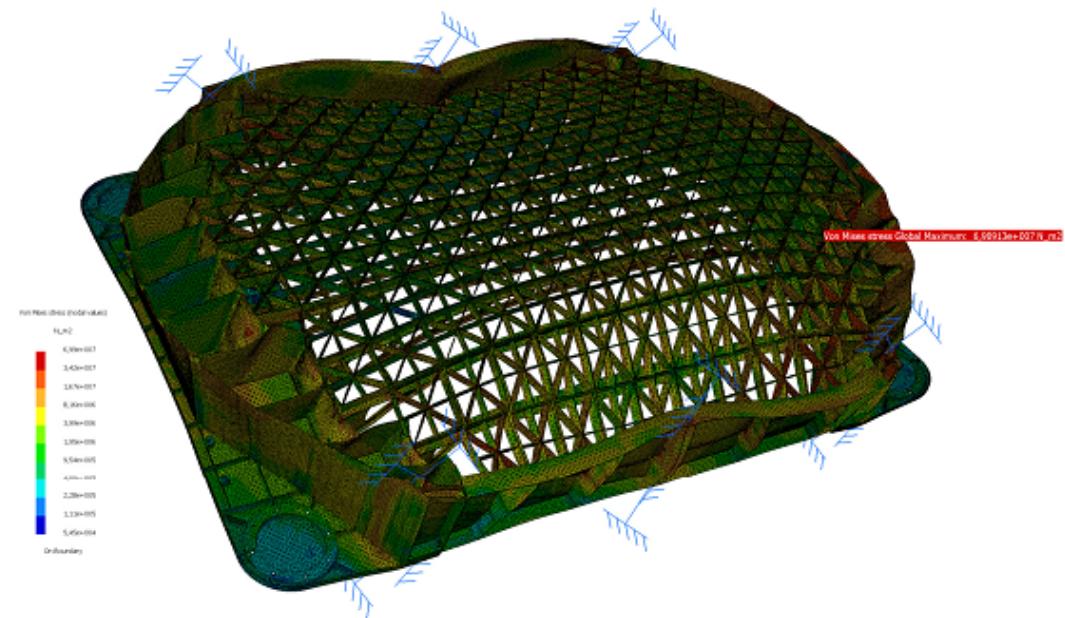
# Integration of the Focal Surface

Study and accommodation by Thales Alenia Space

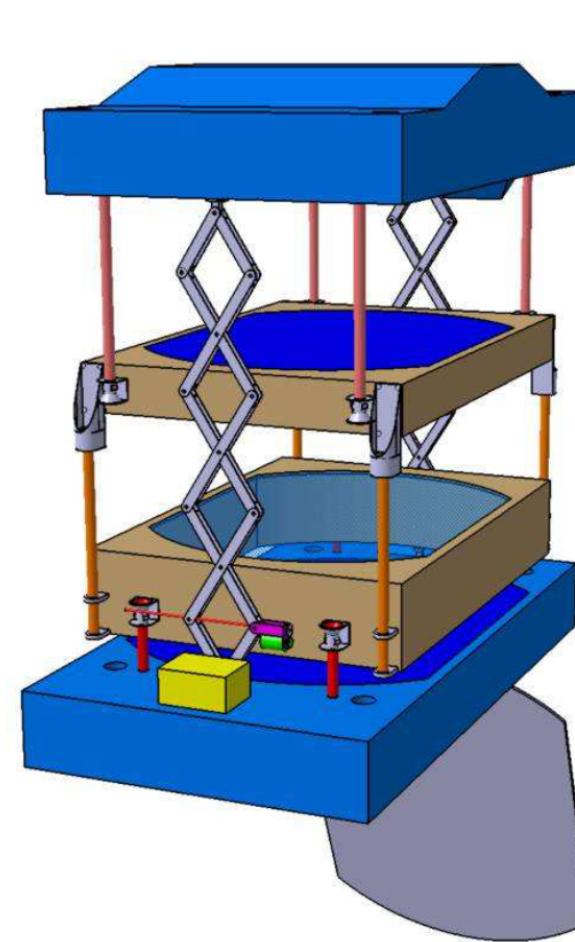
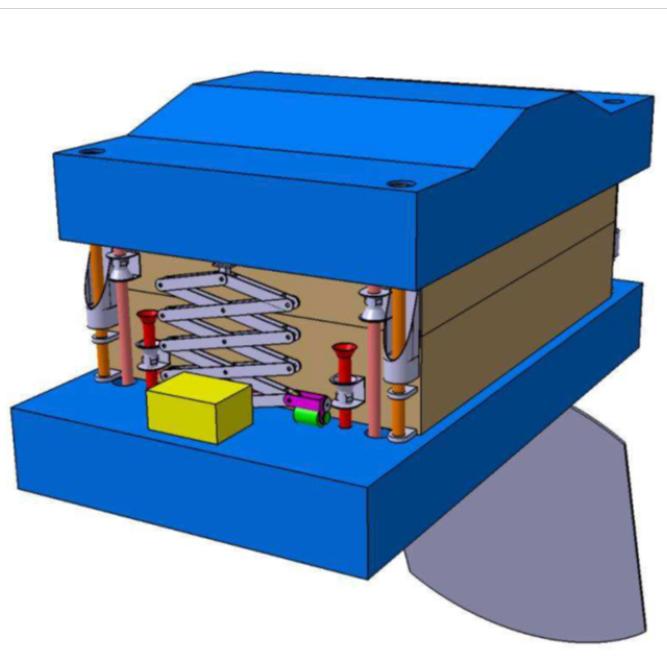
Vibrational analysis  
45 hz 1st resonance frequency



C3 Case: Von Mises Stress



# Expansion Mechanism and FS Study in Thales-Alenia



# Responsabilità gruppo LNF

- Struttura meccanica FS e PDM
- Integrazione e test parti della struttura con i PDM
- Simulazioni, Ricostruzione evento
- Volo di test su pallone (collegamento JEM-EUSO  $\leftrightarrow$  CNES)
- Tests e calibrazioni alla BTF (v. precedente di Airfly 2005: misure di fluorescence yield)
- Tests di Rad. Hardness e di SEE su fascio

## **Richieste finanziarie LNF 2012(*Preliminari*)**

Miss. Interne 5.0

Miss. Estere 15.0

Consumo 25.0

Tot 50 k€

**Rich. Finanziarie globali 2012 Gruppo INFN: ~ 200 k€**

- Richieste ai Servizi per il 2012
  - Div. Tecnica-SPCM
    - Progettaz. 4 mu
    - Off. Mecc. 4 mu
    - Metrologia 1mu