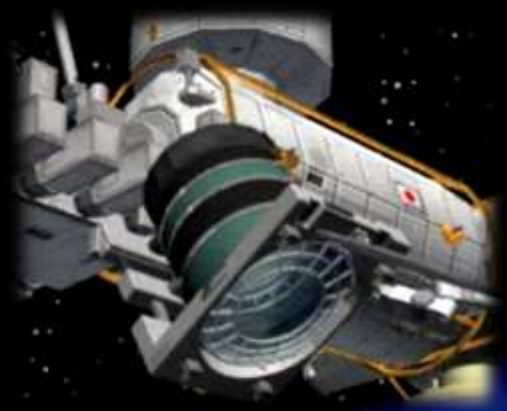


Extreme Universe Space Observatory

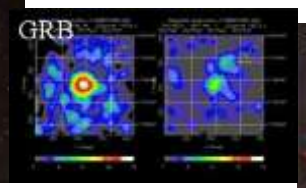
The JEM-EUSO Mission

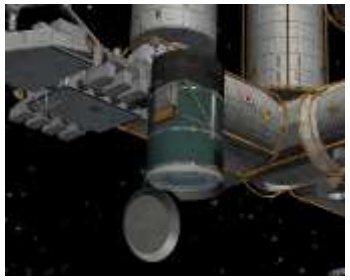
Toshikazu Ebisuzaki
RIKEN
for the JEM-EUSO Collaboration

宇宙線研究者会議将来計画シンポジウム20109月17日宇宙線研究所

地を見て天を知る天文台=地文台

JEM-EUSO





極限エネルギー粒子

荷電粒子

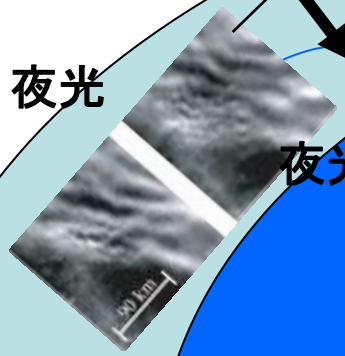
固体微粒子

近紫外線

紫外線
X線
ガンマ線

ガンマ線
X線

太陽風



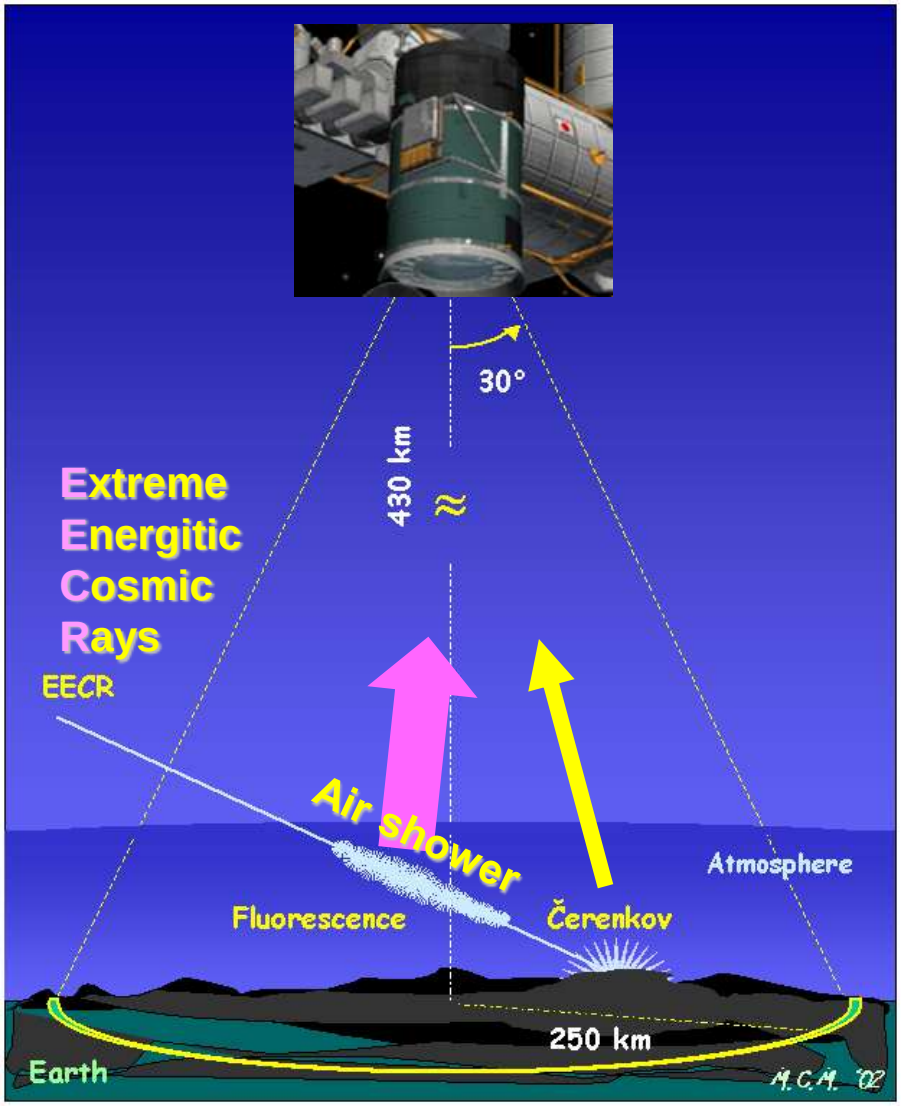
夜光

夜光

プラズマ放電

極限エネルギーニュートリノ

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˚) and a large diameter(2.5m).

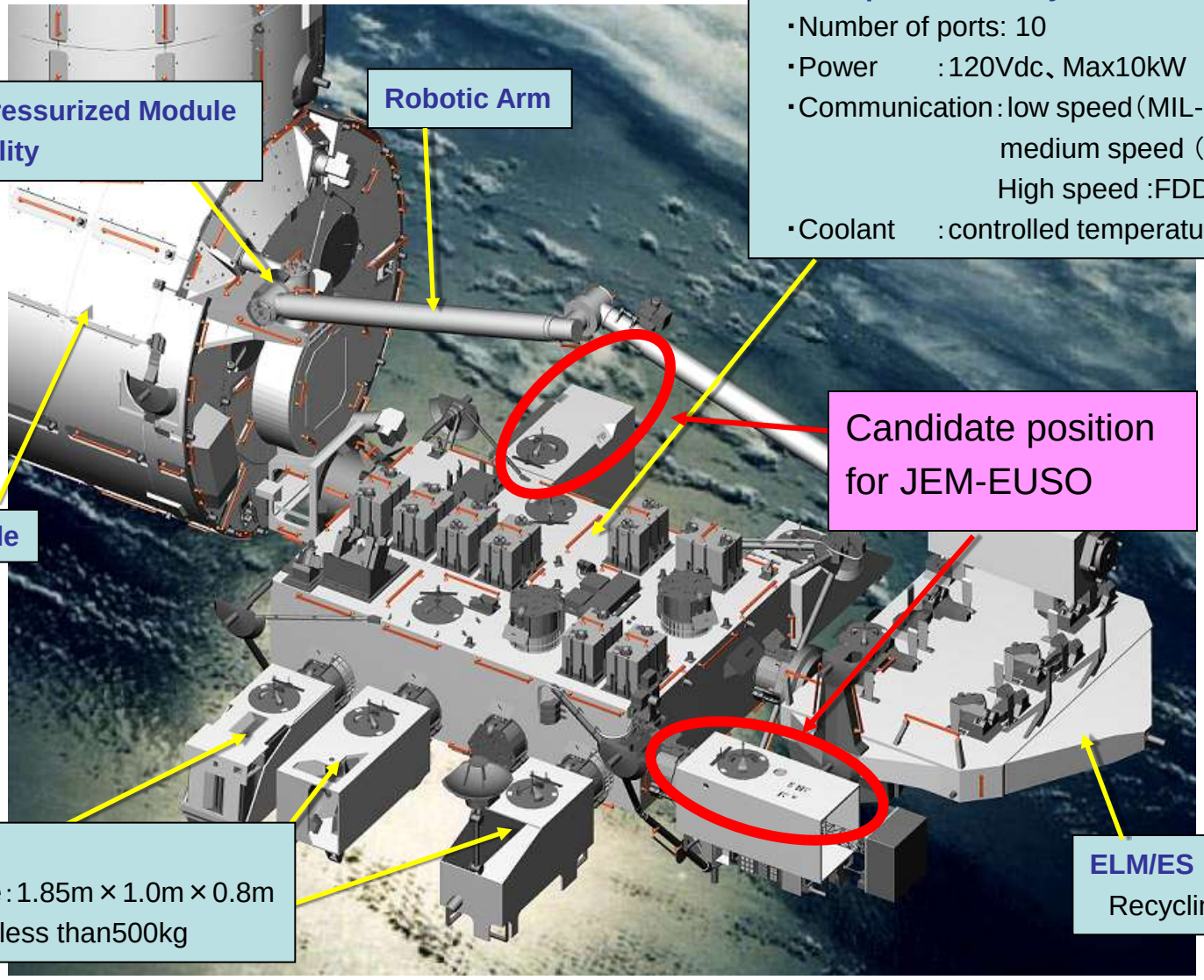
JEM-EUSO mission will initiate particle astronomy at ~10^{20}eV.

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

Japanese Experiment Module "Kibo" : July 2009

S127E011186

Outline of JEM Exposure Facility



JEM Exposure Facility
- Number of ports: 10
- Power : 120Vdc、Max10kW
- Communication : low speed（MIL-STD-1553B）
  medium speed（Ethernet）、
  High speed :FDDI）
- Coolant : controlled temperature 20±4℃

Airlock between Pressurized Module and Exposure Facility

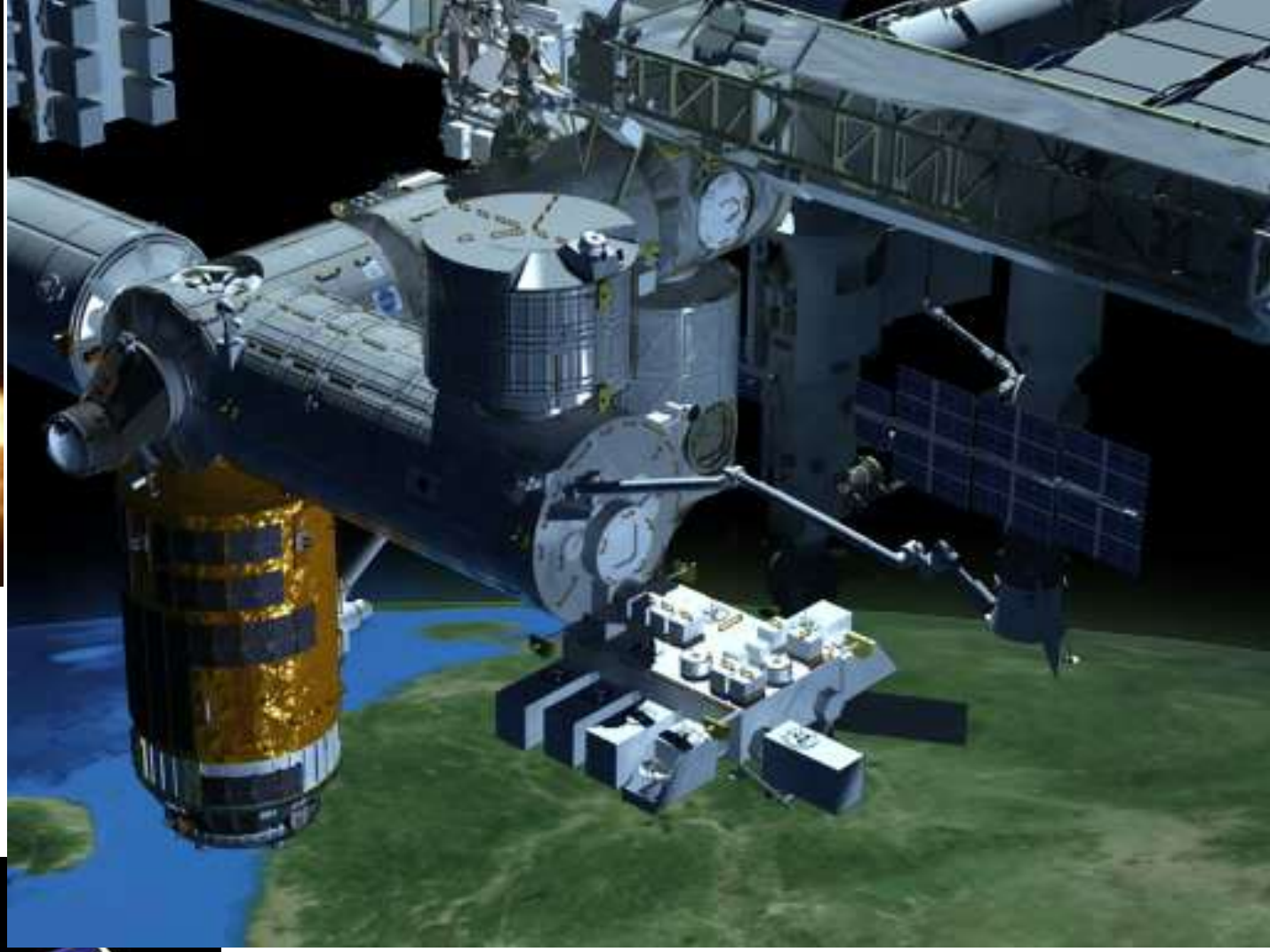
Robotic Arm

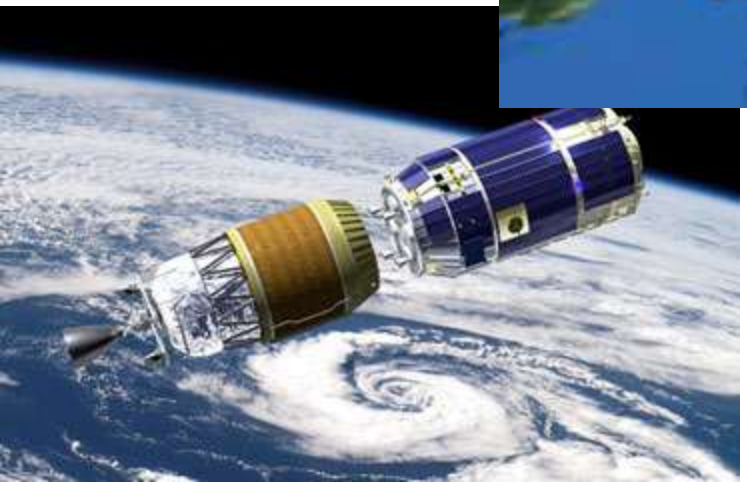
Candidate position for JEM-EUSO

Pressurized Module

Payload
- standard envelope : 1.85m × 1.0m × 0.8m
- mass : less than500kg

ELM/ES
Recycling of payload

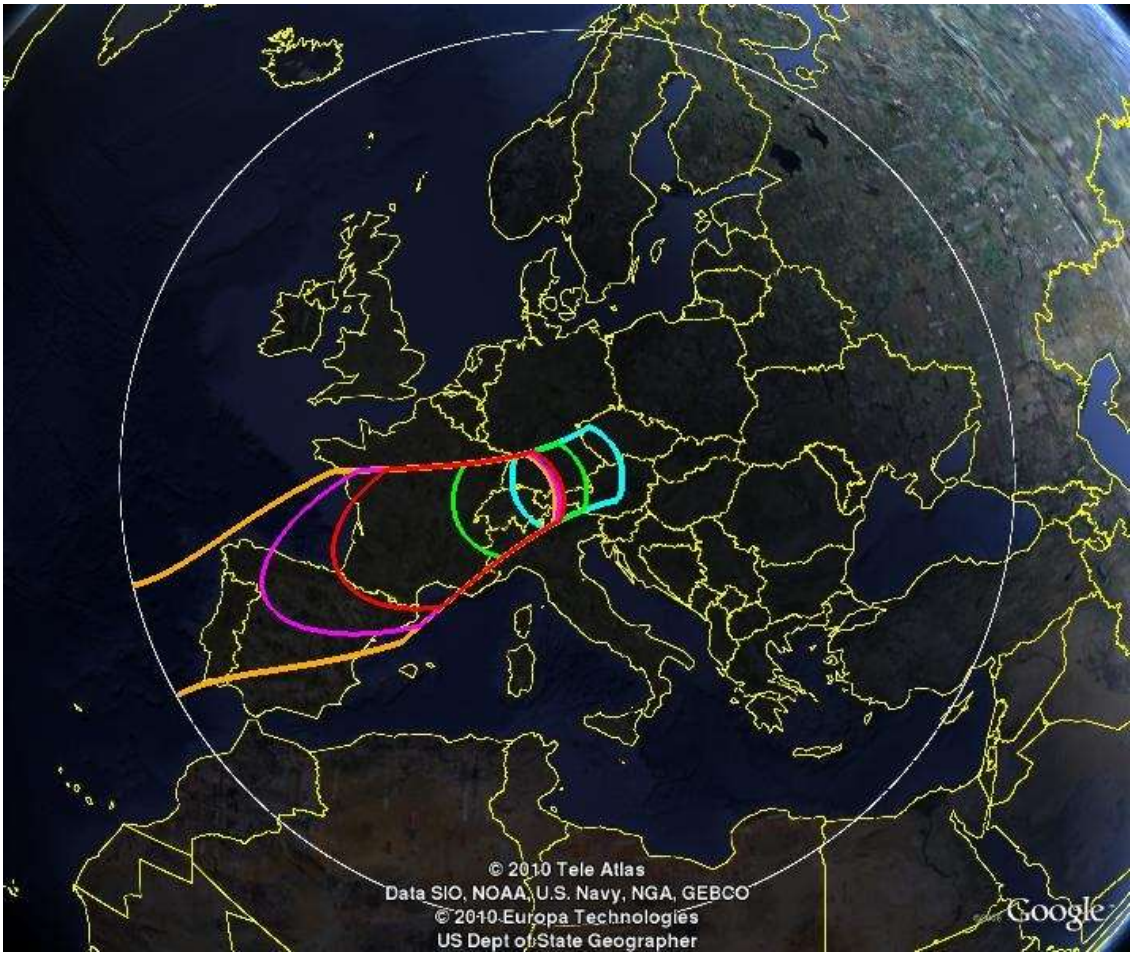


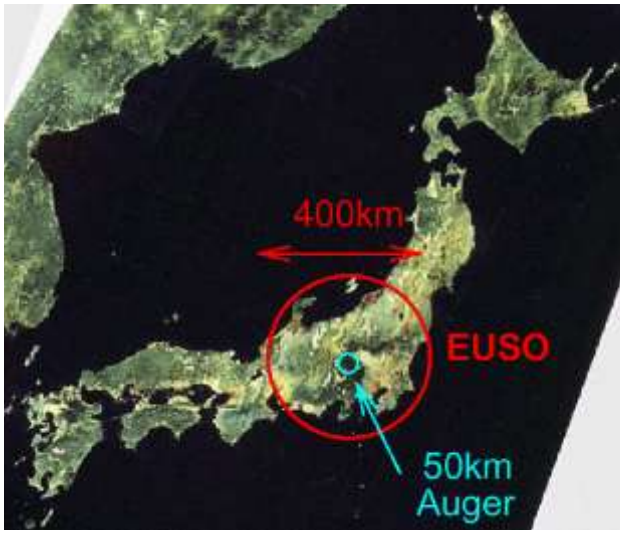


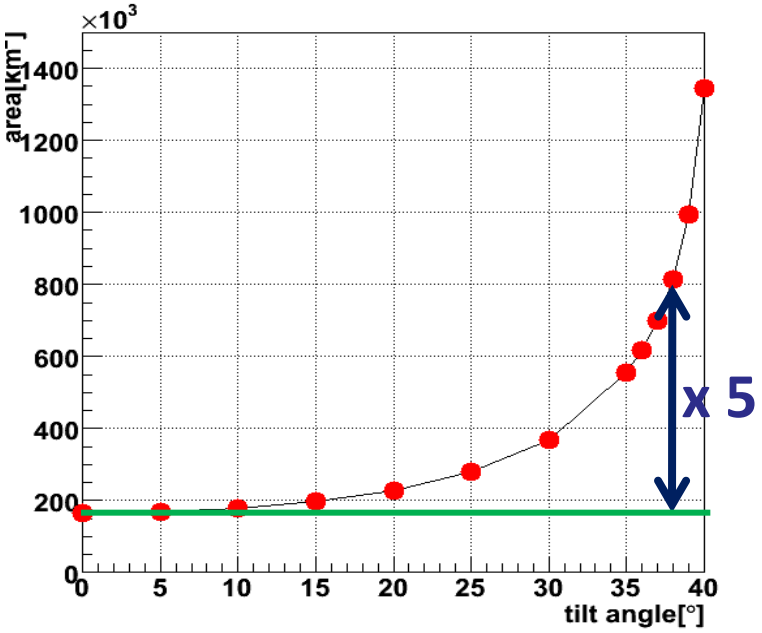
Successful Launch of HTV

September 11, 2009

Field of View



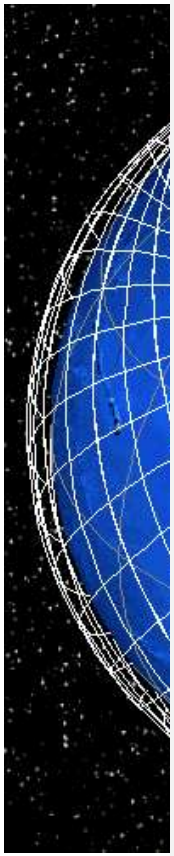


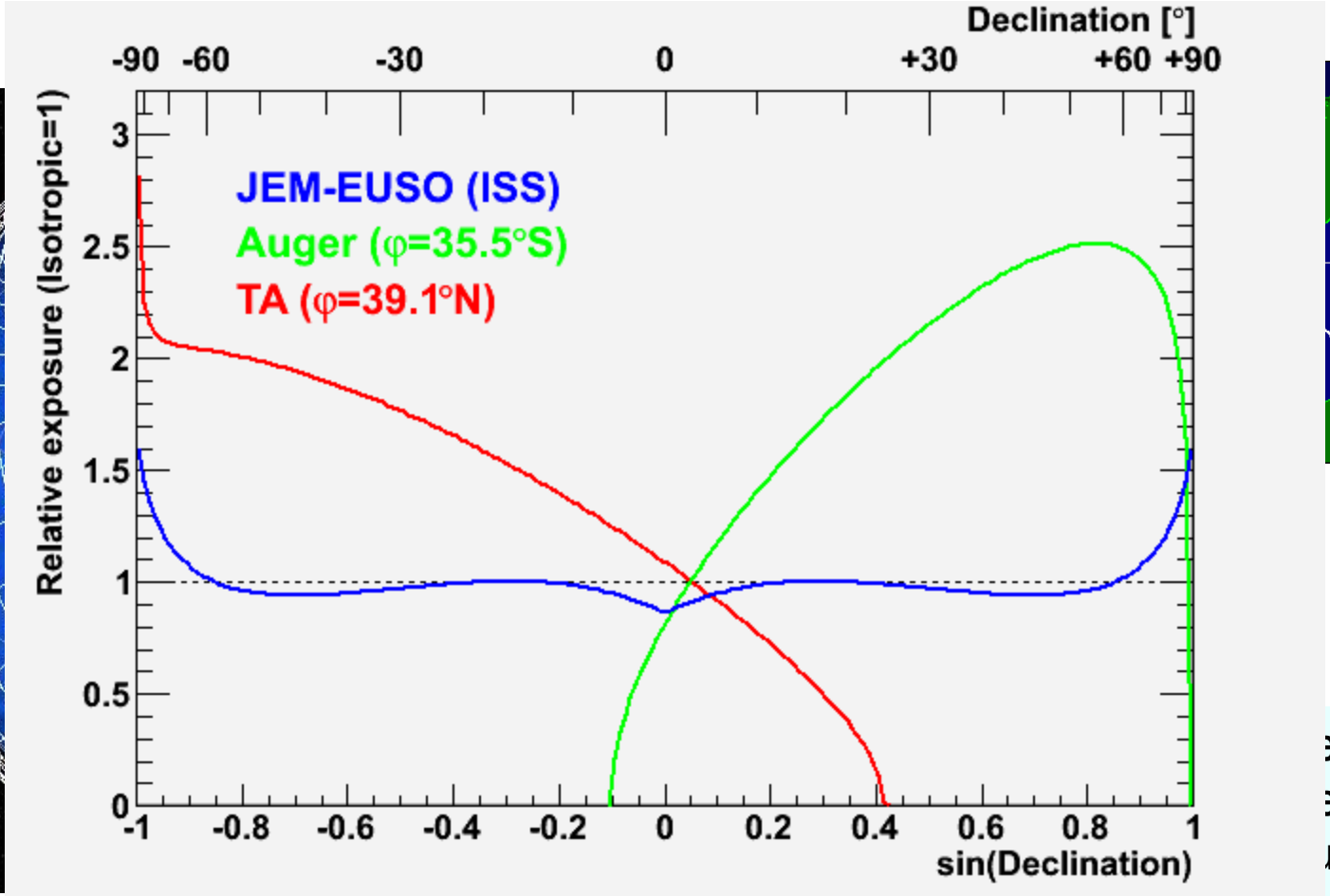


Mission Parameters

- Time of launch: year 2015
- 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

ISS Orbit





http://www.nlsa.com/

e
ery
ure
of the ISS orbit.

Full-Sky Coverage

Science Objectives

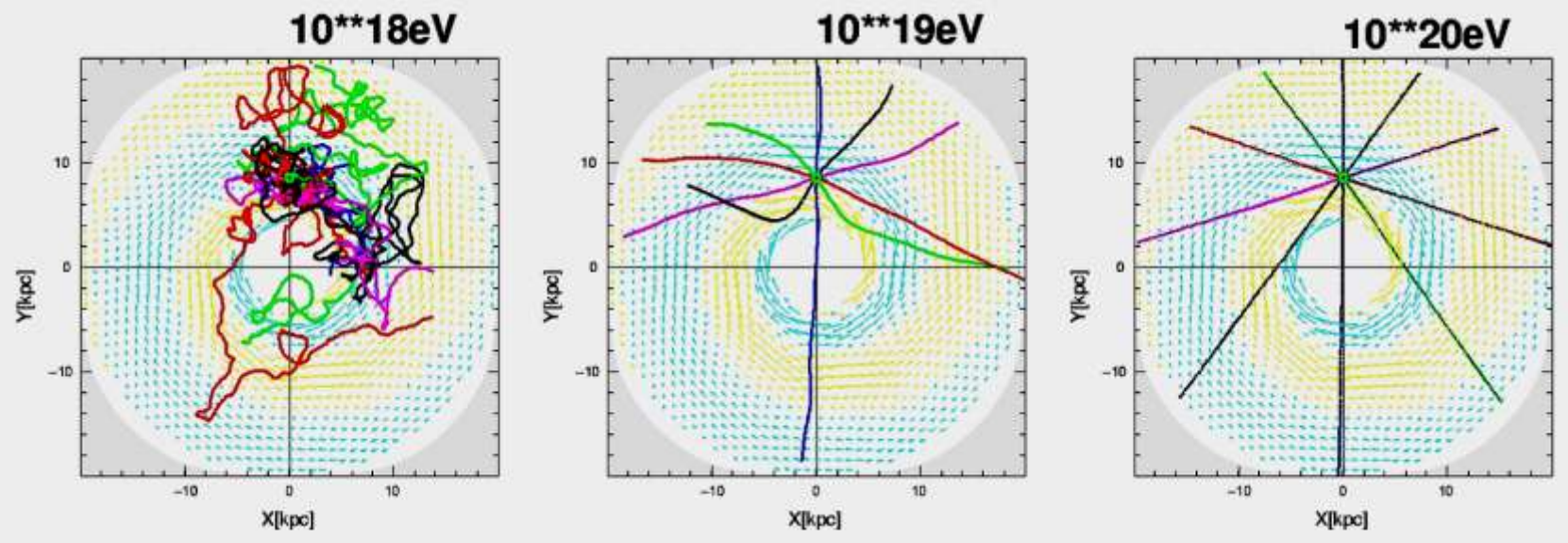
- **Fundamental Objective**

  Extreme energy astronomy by particle channel

  Determine their origin and the acceleration mechanism

- **Exploratory Objectives**
  - Detection of extreme energy gamma rays
  - Detection of extreme energy neutrinos
  - Study of the galactic magnetic field
  - Verification of the relativity and the quantum gravity effect in extreme energy
  - Global observations of nightglows, plasma discharges and lightning

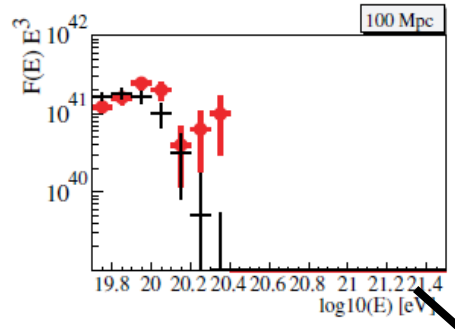
$E>10^{20}$ eV particles do not bent



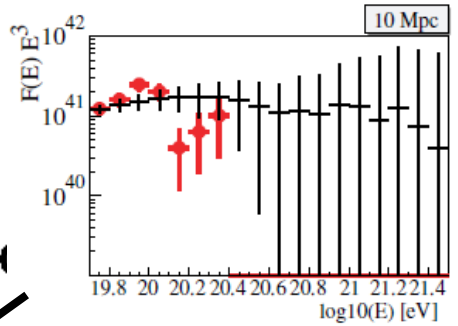
銀河内の伝播シミュレーション

We can specify origin of EECRs by arrival direction

Arrival Map



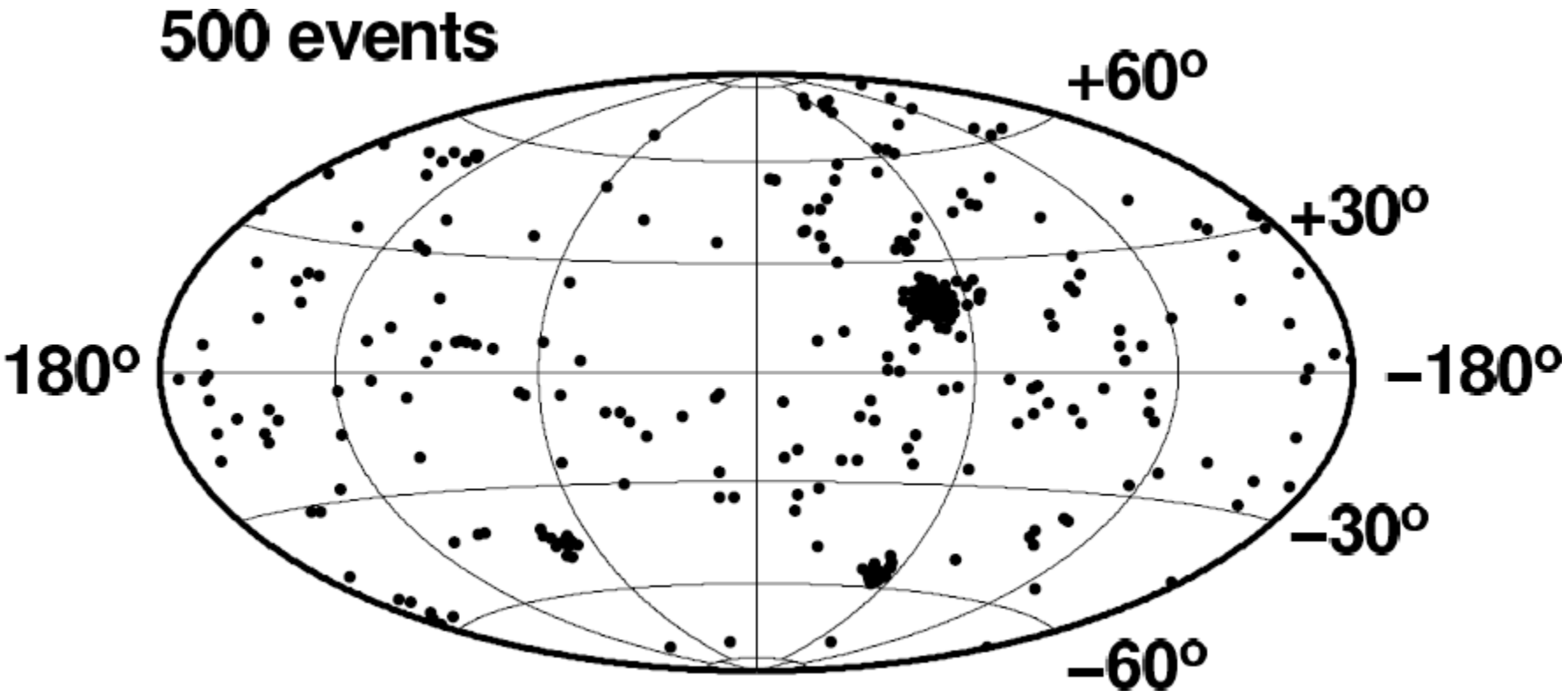
シミュレーション



- Identify the sources
- Confirmation of GZK
- Clarify acceleration mechanism

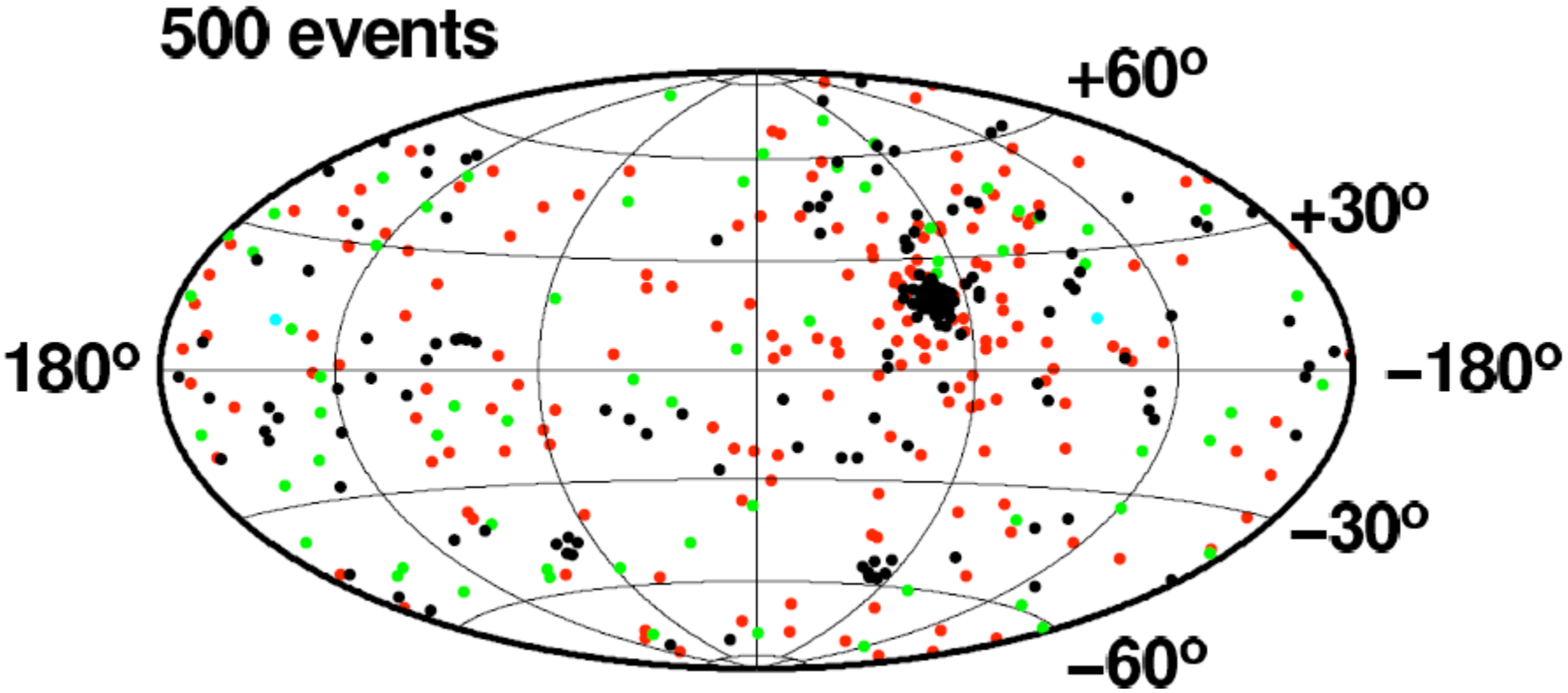
STAR Burst Galaxies

打ち上げ後3年後:
500事例(陽子)

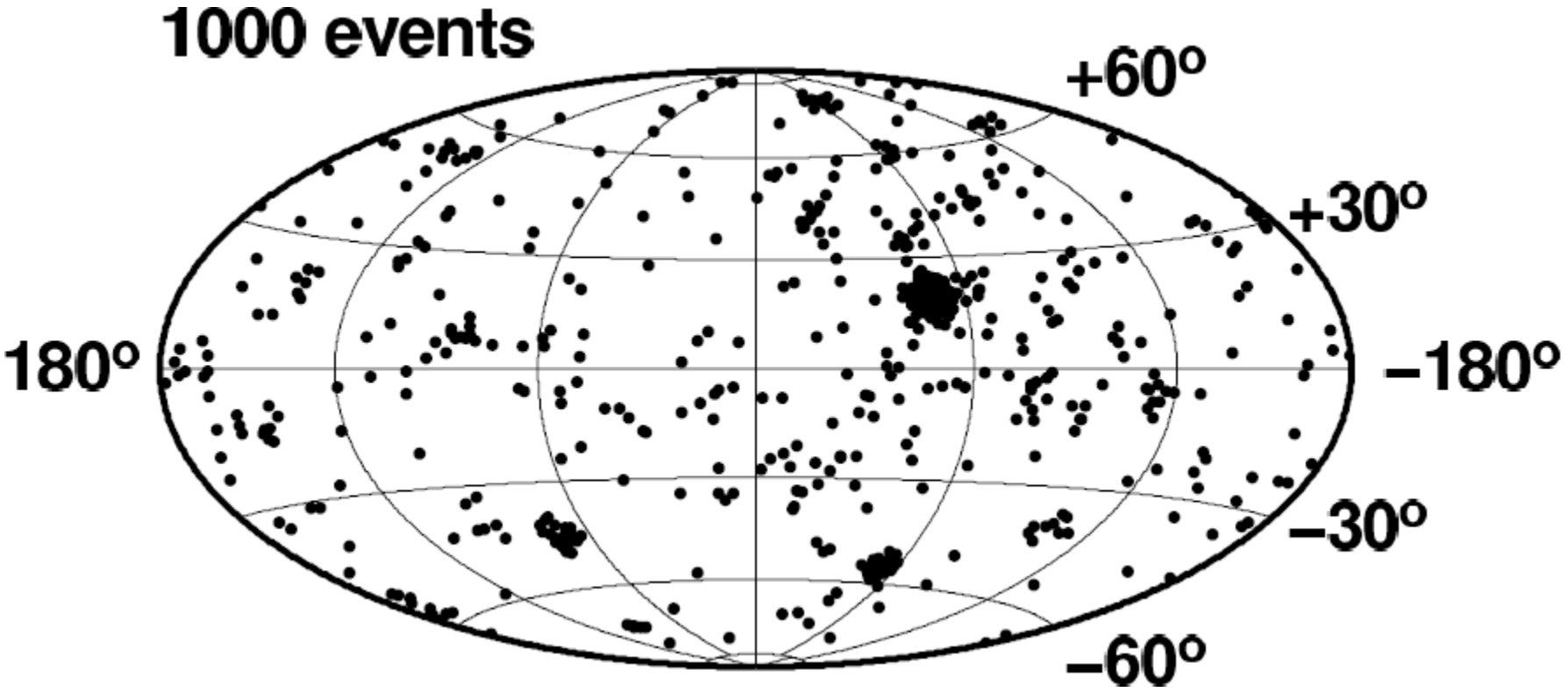


打ち上げ3年後

500事例（陽子：鉄=1：1）



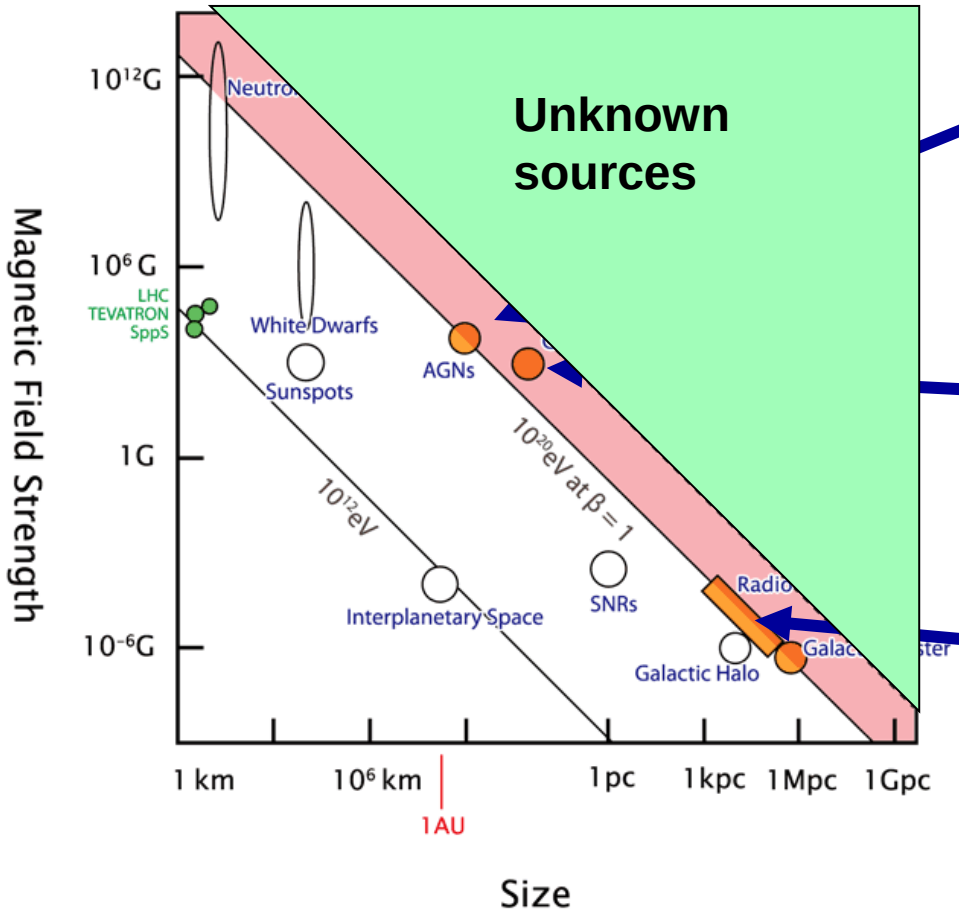
打ち上げ5年後:1000事例

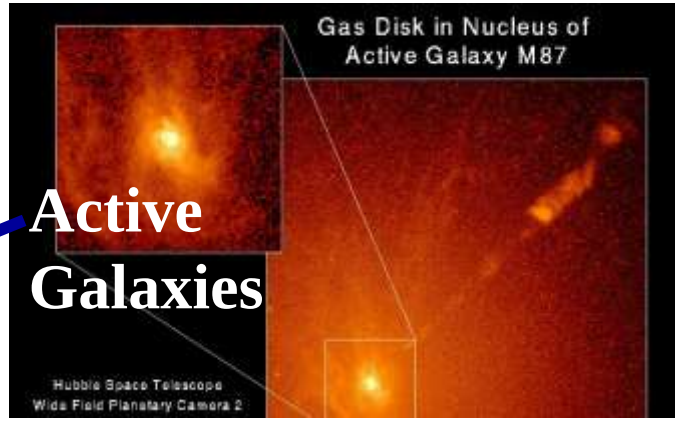


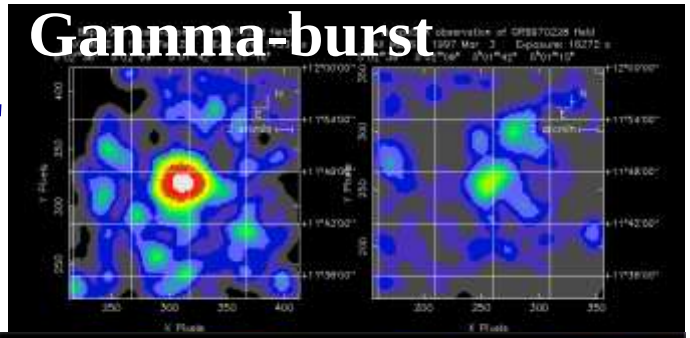
Possible Sources

Blackhole related objects

New mechanism of acceleration

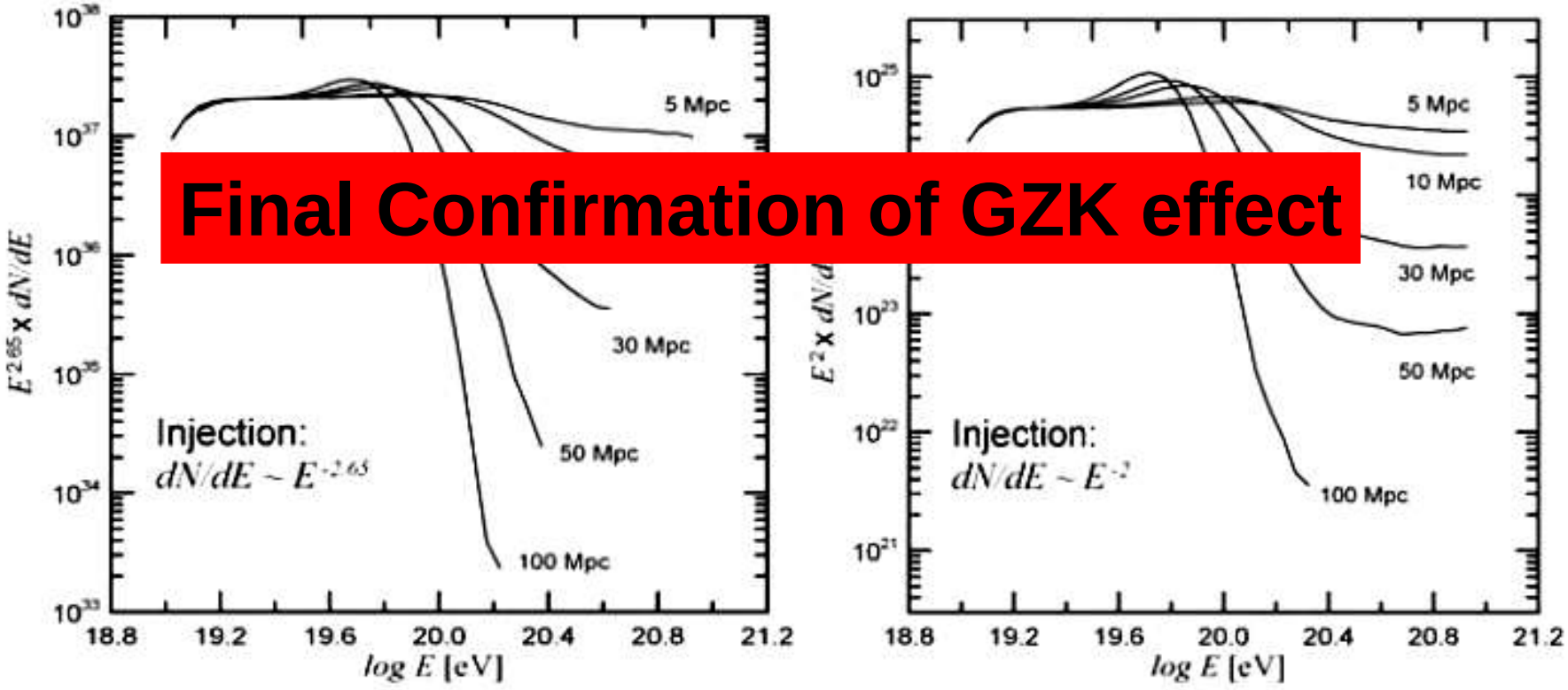






EECR Energy Spectra for Various Source Distance

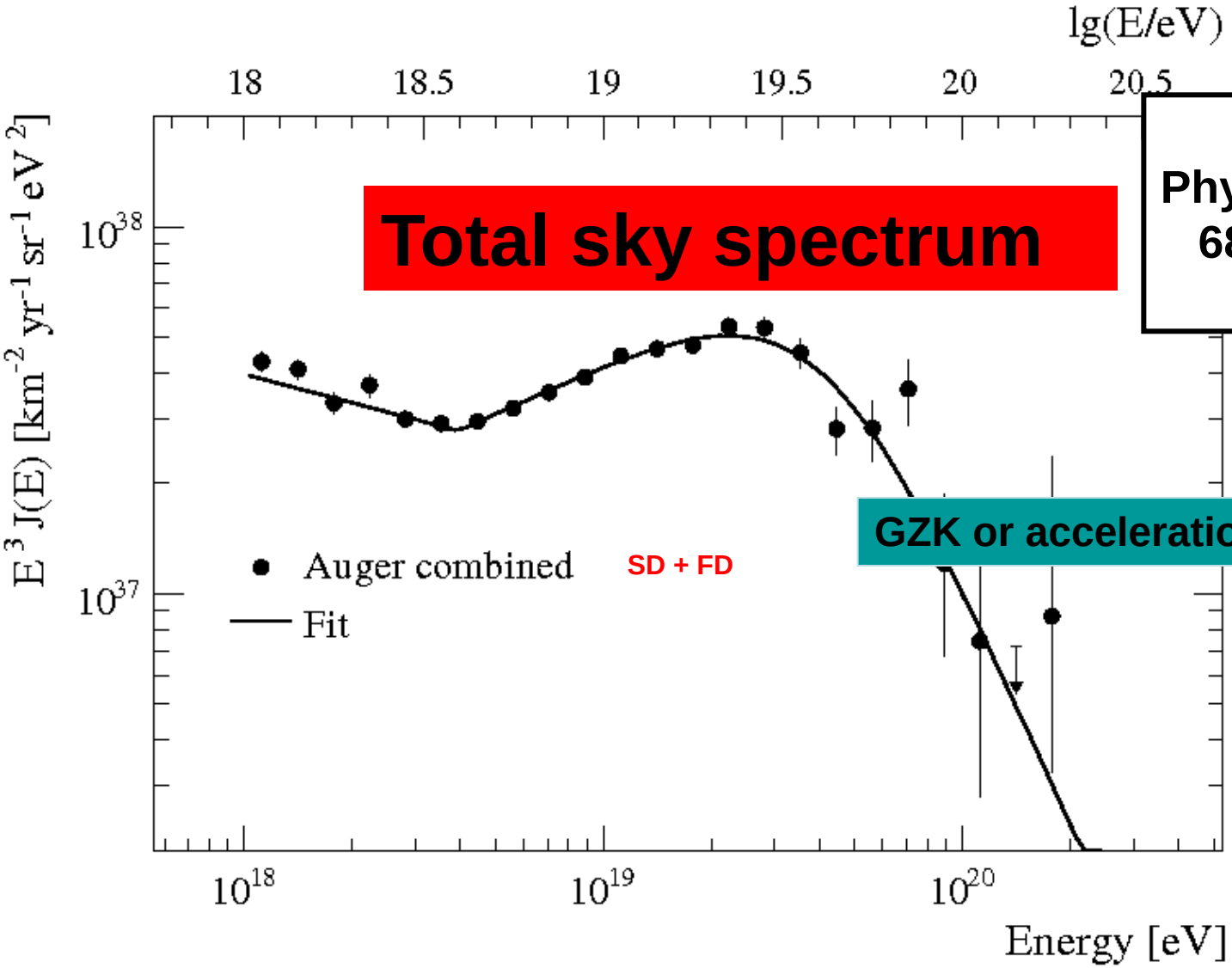
The energy spectra at around 10^{20} eV differs for different source distances affected by the GZK process.



Final Confirmation of GZK effect

Medina-Tanco 2008

Energy Spectrum from Auger Observatory



Total sky spectrum

Physics Letters B
685 239 2010

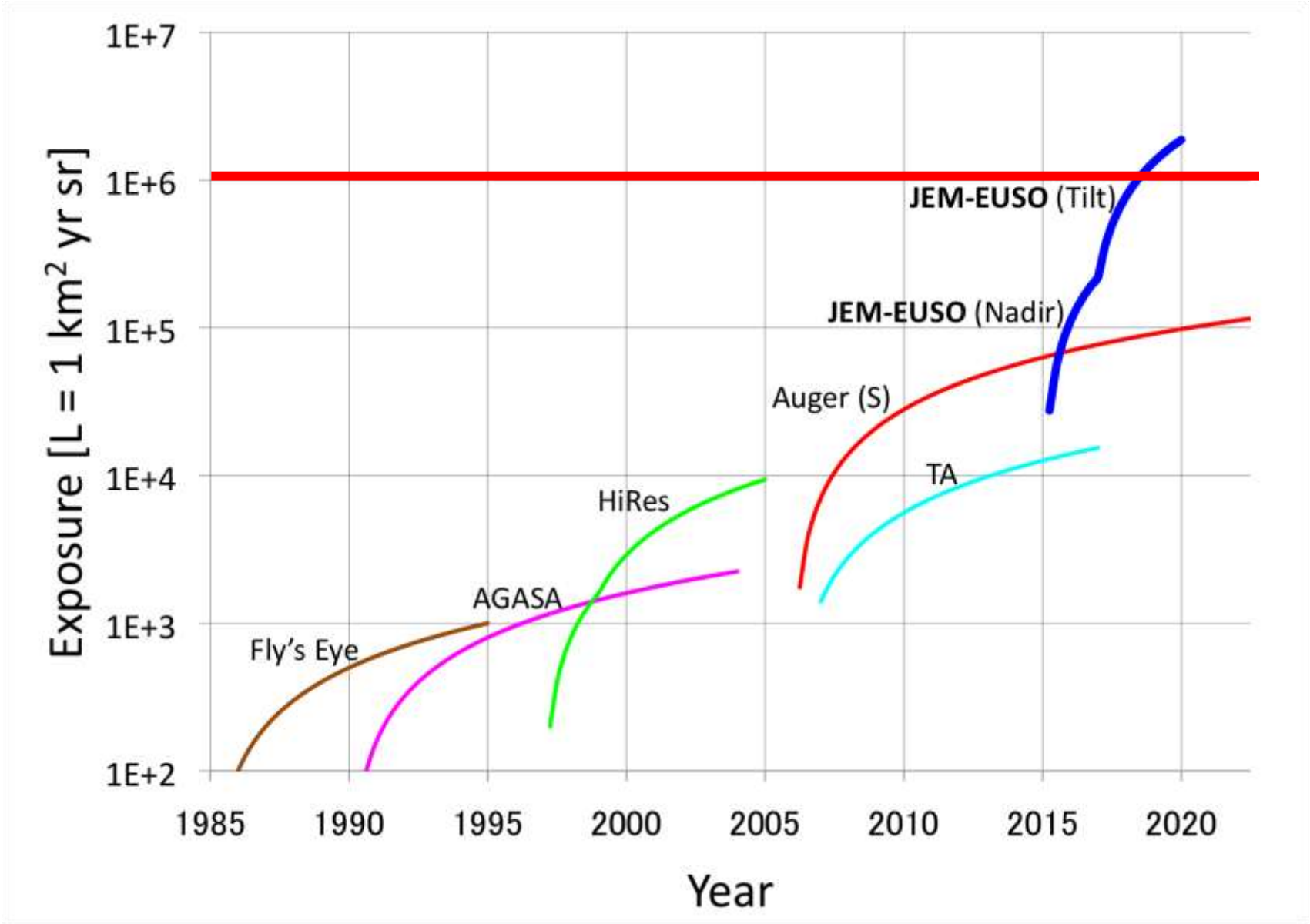
GZK or acceleration limit?

Schuessler

HE 0114

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

Exposure Evolution

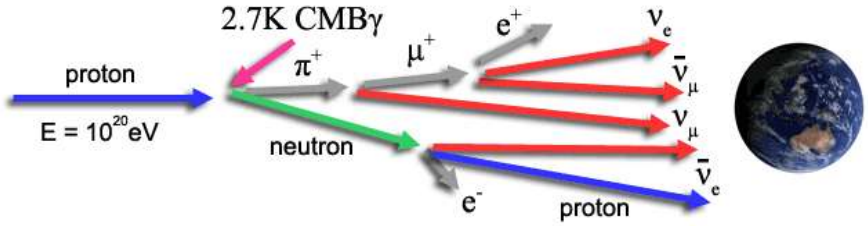


JEM-EUSO as gamma ray & neutrino observatory

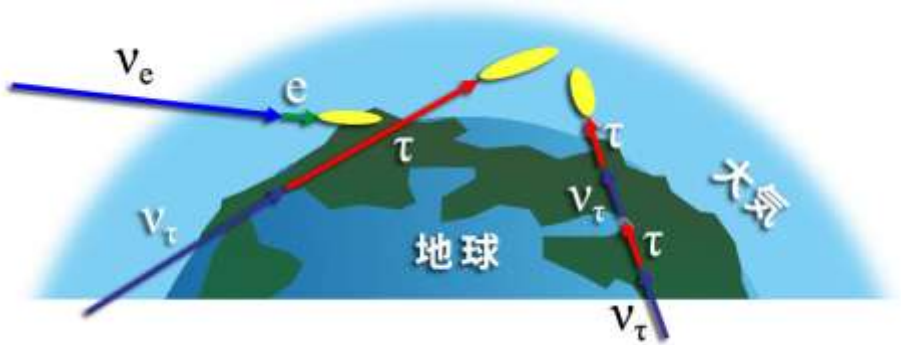
- **International Space Station-aboard EECR observatory**
  - Orbiting at ~400 km in ±51.6 degrees latitudes
  - Flight in varying geomagnetic field (~0.6 gauss) around orbit

- Viewing night atmosphere in ~500 x 400 km area (nadir mode)
  - Wide FOV allows to measure entire slowly developing showers
  - Target volume exceeding an order of 10^{12} tons

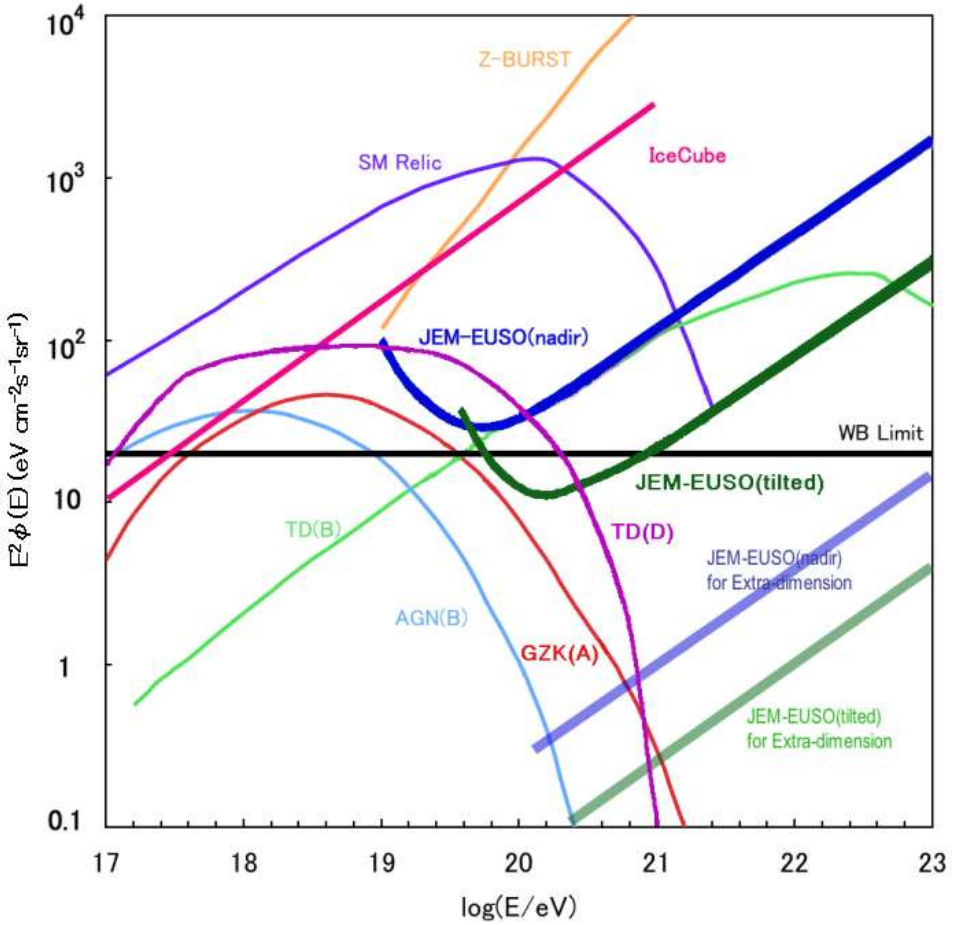
Extreme Energitic Cosmic Neutrinos



Neurino production by the GZK process

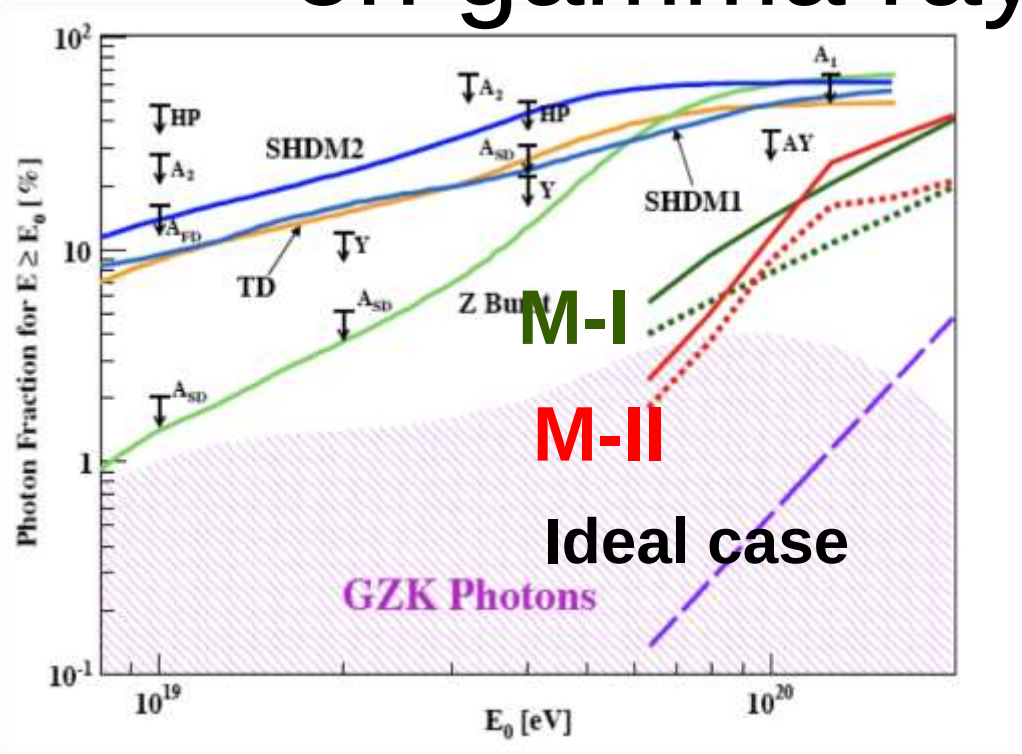


Air showers initiated by different kind of neutrinos



Neutrino fuxes for various models and detection capability of JEM-EUSO

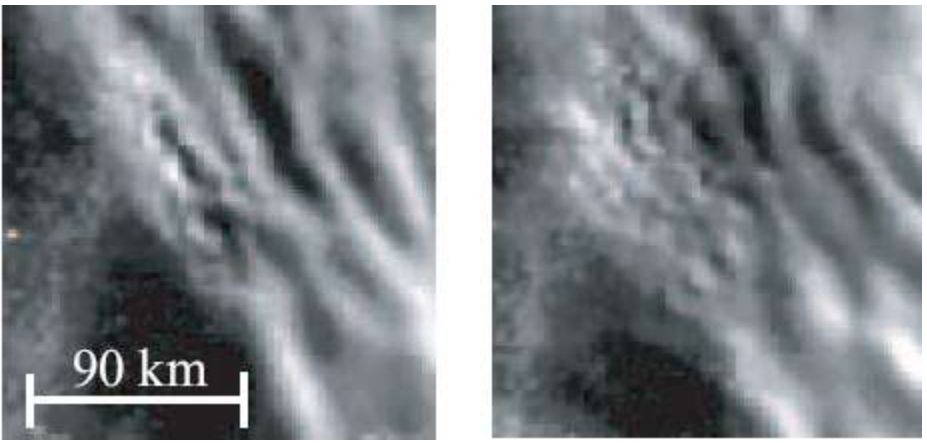
Expected sensitivity on gamma ray fraction



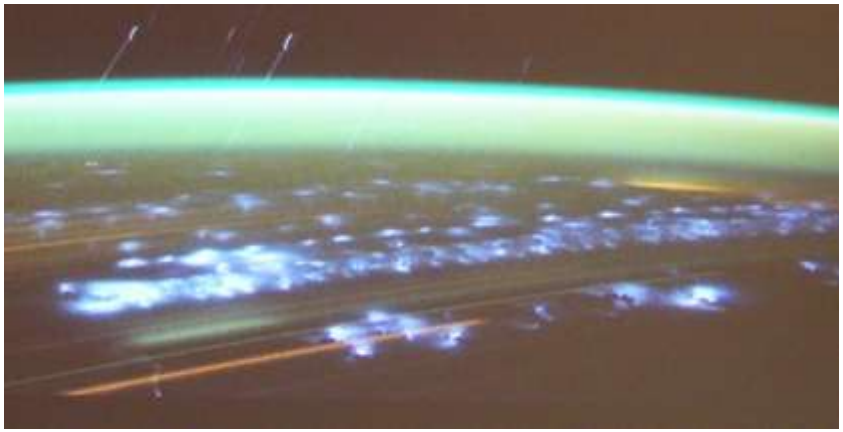
Expected limit by 5 year mission compared with upper limits set by existing experiments (95%CL)

- Ideal case (only statistics): Xmax strong discriminator for gamma ray
- More realistic estimate (assumed experimental errors in *X*max) using 2 different approaches to evaluate flux limit
  → New and stringent limit expected @ the highest energies (~10^{20}eV)
  - Possible detection of GZK photons during the Mission

Atmospheric Luminous Phenomena

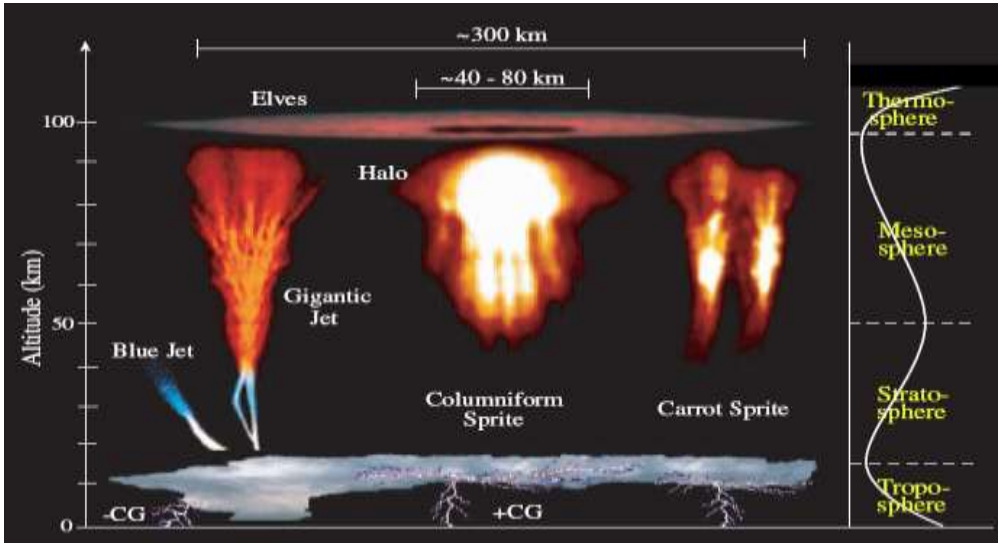


OH airlow observed from ground



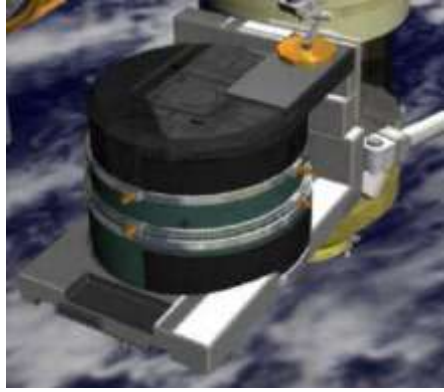
Lightning picture observed from ISS

Leonid meteor swarm in 2001 taken by Hivison

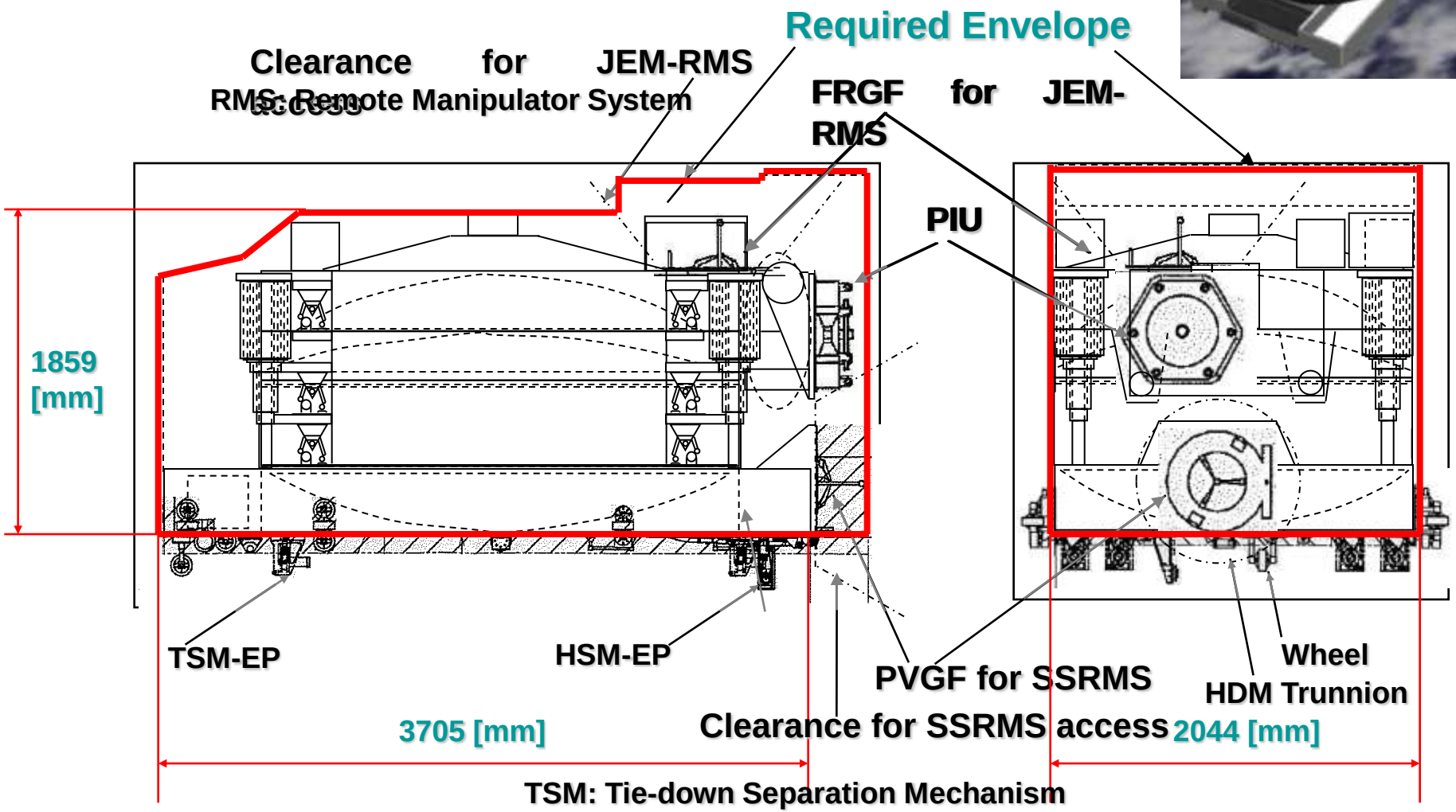


Various trangent airglows

JEM-EUSO Launch Configuration

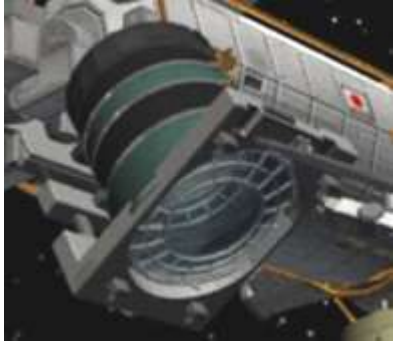


JEM-EUSO telescope will be squeezed at launch.

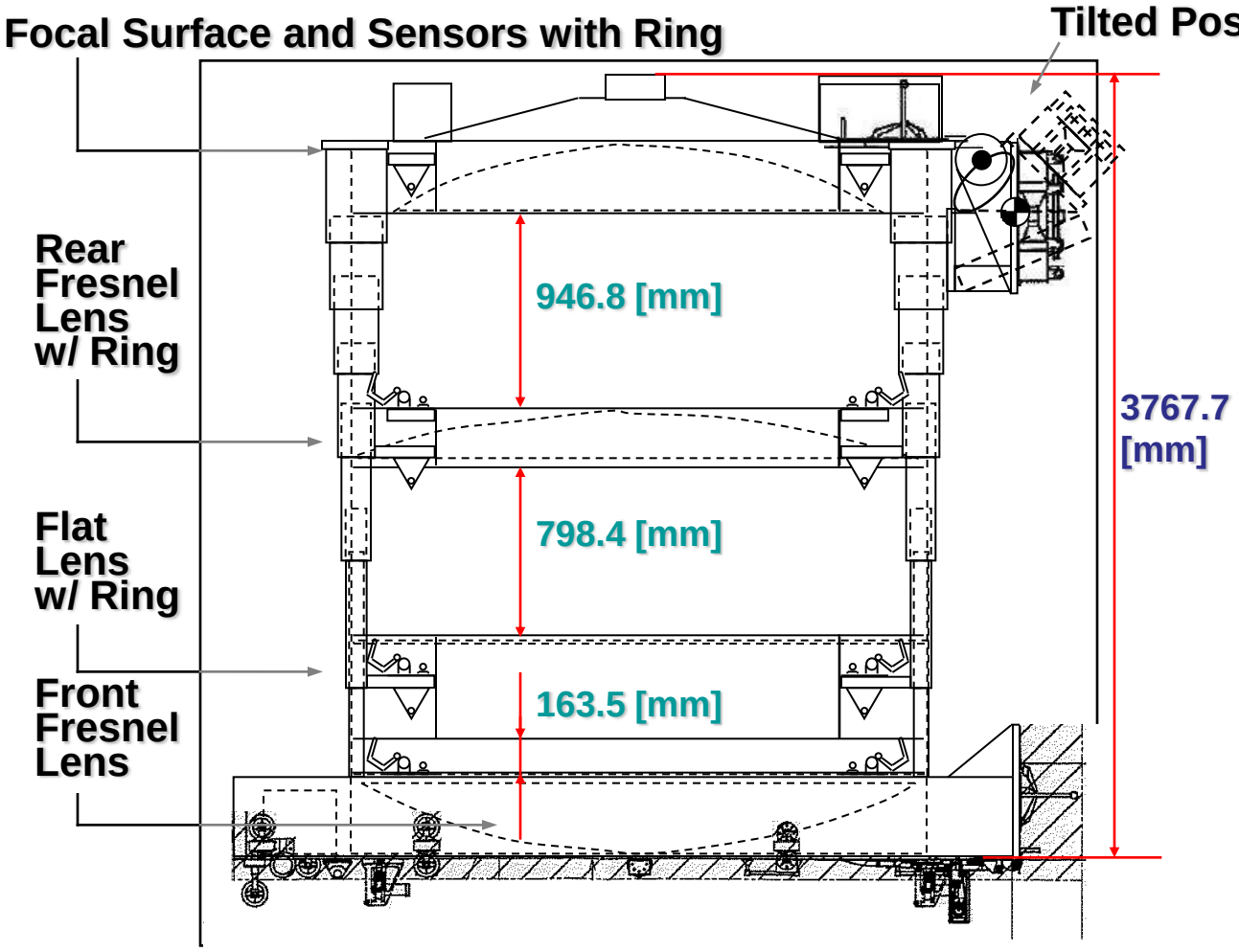


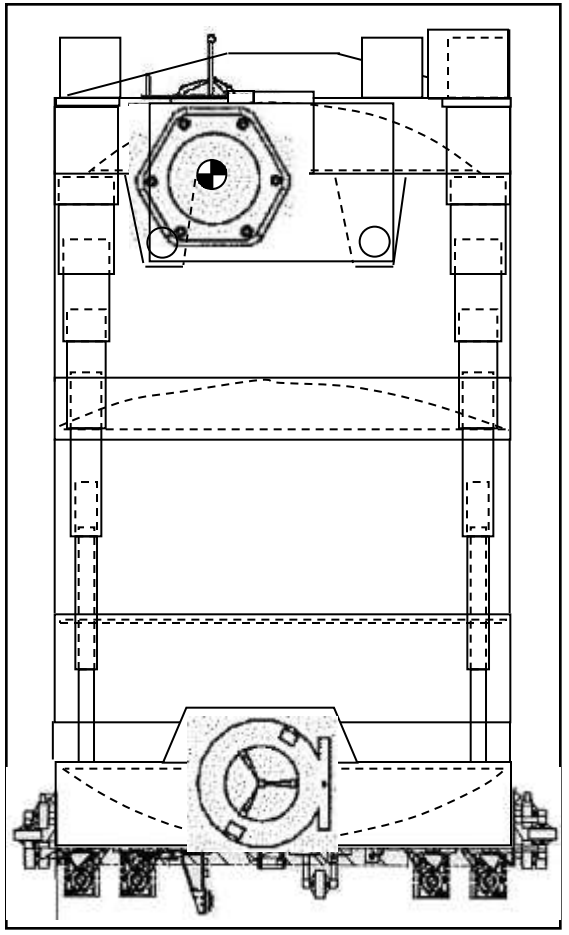
TSM: Tie-down Separation Mechanism
HSM: Harness Separation Mechanism
HDM: Hold Down Mechanism
SS: Space Station

JEM-EUSO On-orbit Configuration



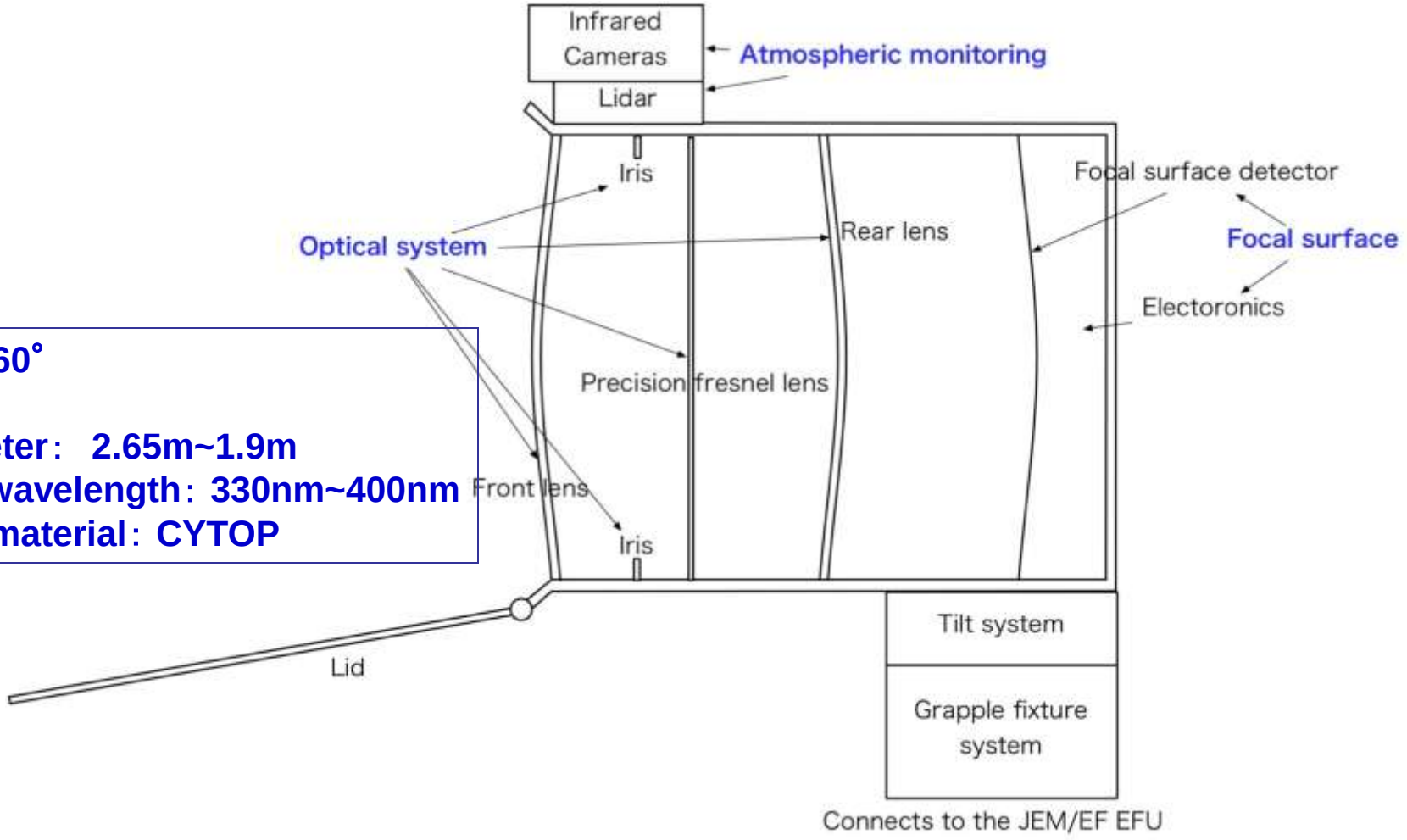
JEM-EUSO telescope will be elongated on orbit.





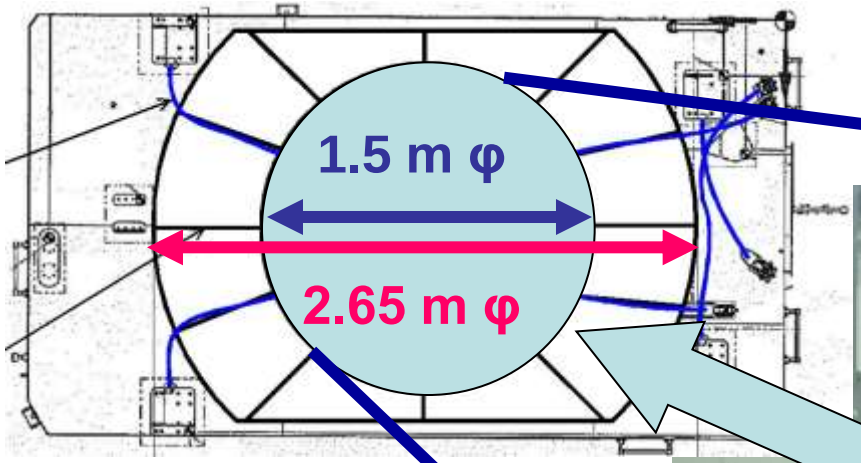
Telescope Barrel is not shown.

Conceptual View of JEM-EUSO Telescope

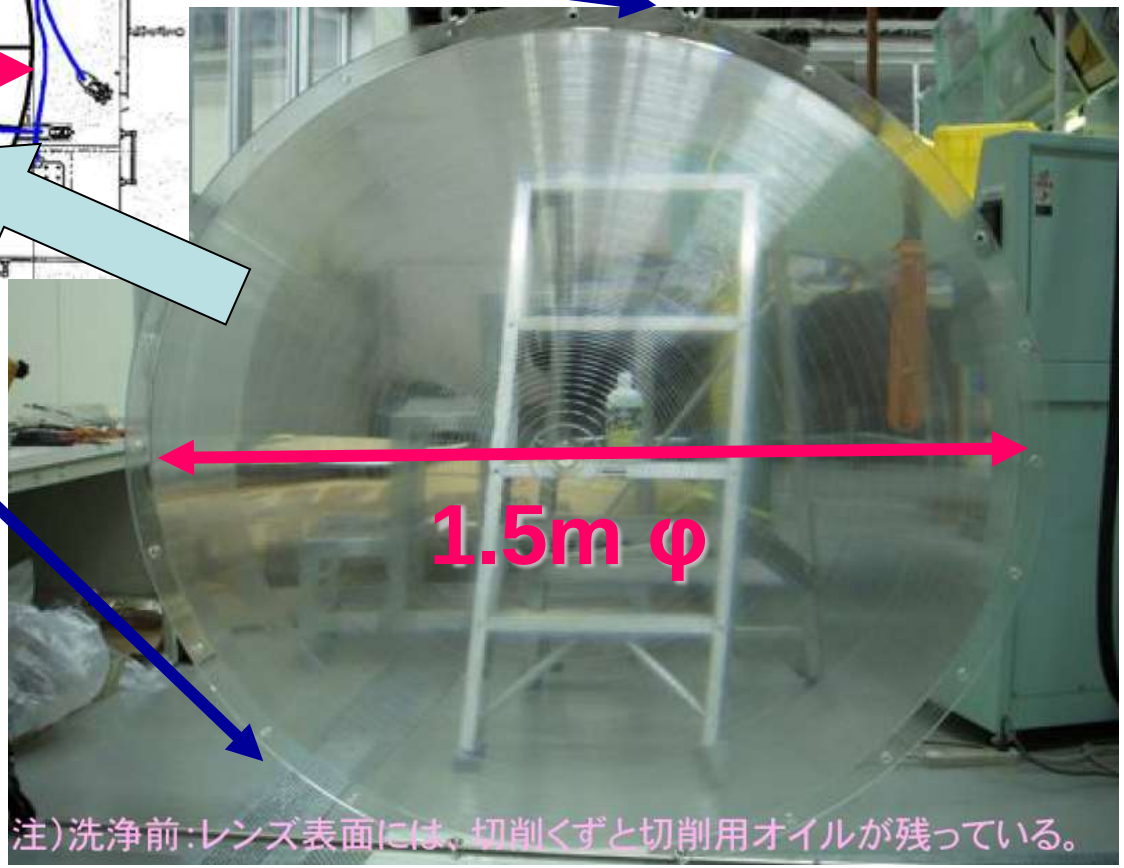


FoV：60°
F/1.0
Diameter： 2.65m~1.9m
Obs. wavelength：330nm~400nm
Lens material：CYTOP

Optics



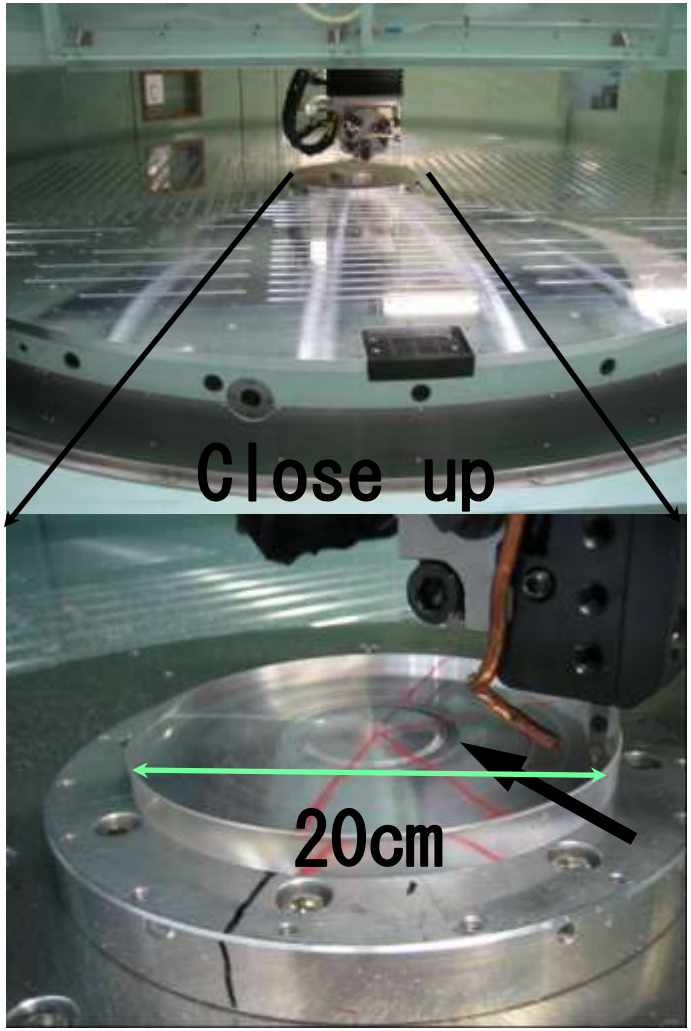
Manufacturing large diameter Fresnel Lens



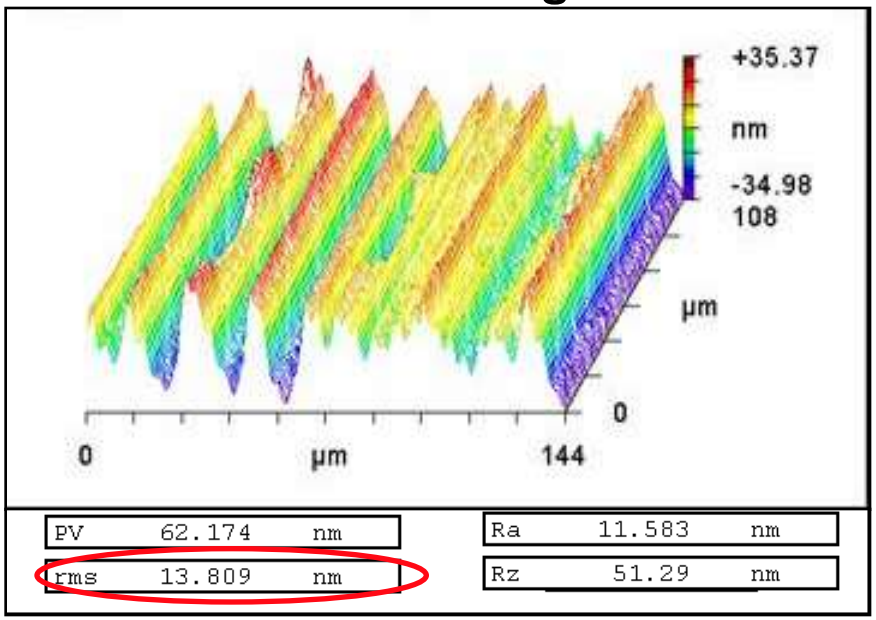
We obtained a cutting machine with a 3.4m dia. turn table to make a 2.65m dia. Fresnel Lens.

Optics

Sample cutting test



Surface roughness

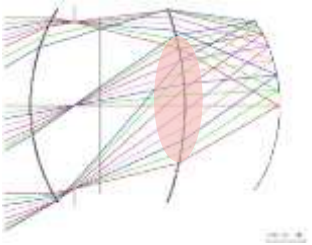


Surface roughness < 20nmRMS

(Requirement : ±72 nm)

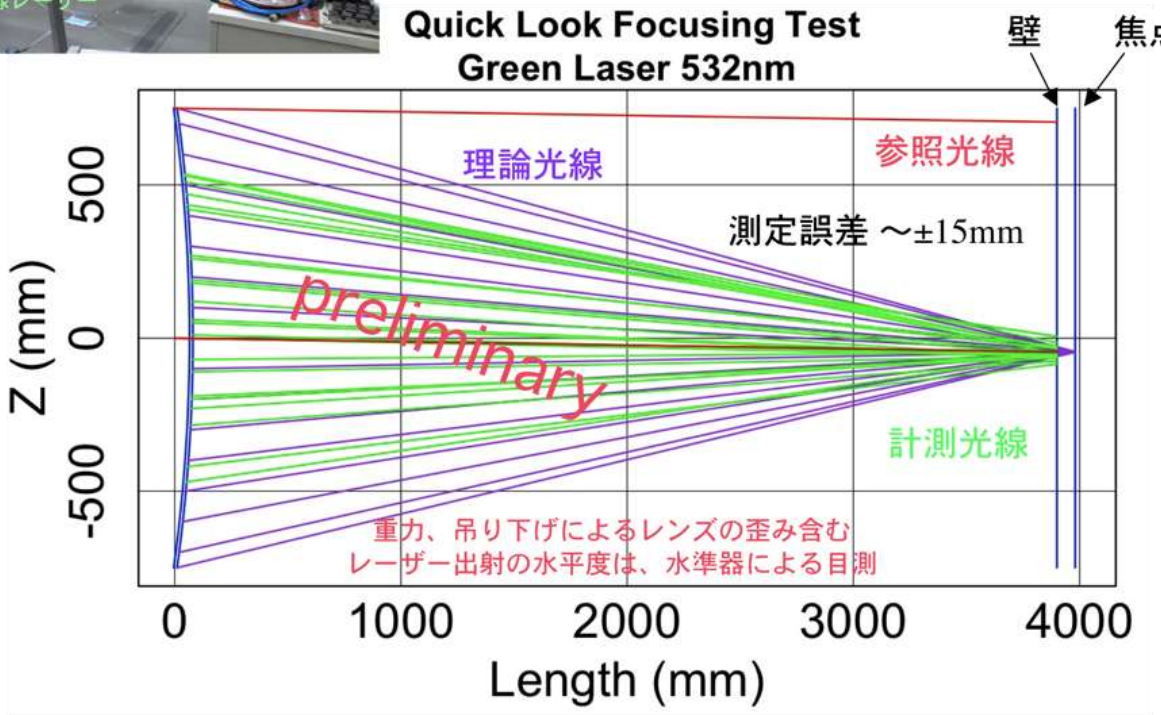
リアレンズ（第3レンズ）（2008年末完成）

簡易集光テスト（緑レーザー 532nm）

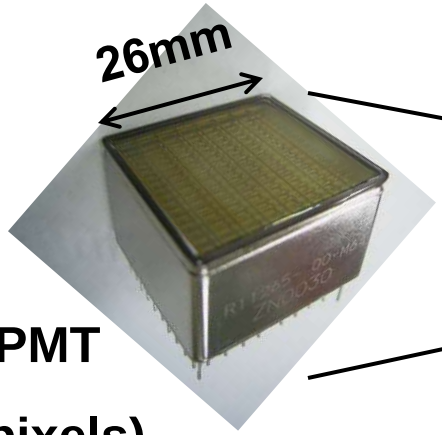


NASAでの詳細光学テストに備え簡易確認

製作パラメタの確認（データの符号など）

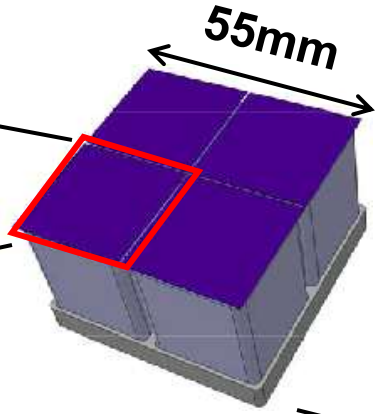


JEM-EUSO Focal Surface Detector



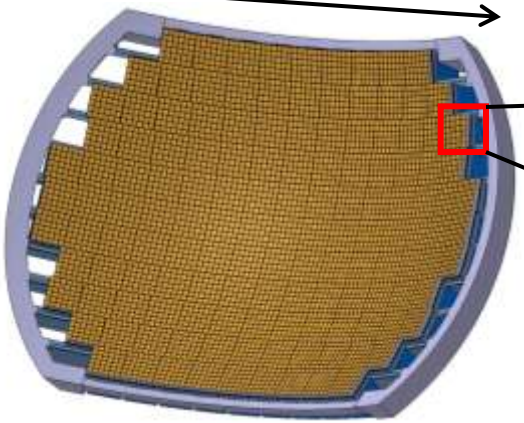
MAPMT

(8x8 pixels)



Elementary Cell

(2x2 PMTs = 256 pixels)



Focal Surface detector

137 PDMs = 0.3M Pixels

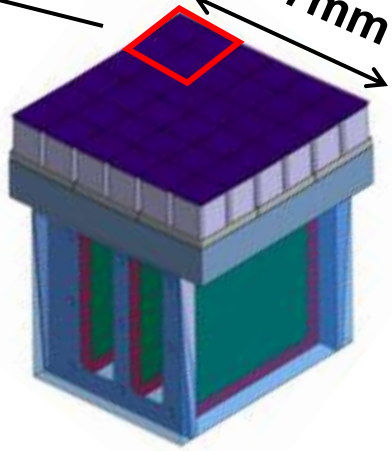
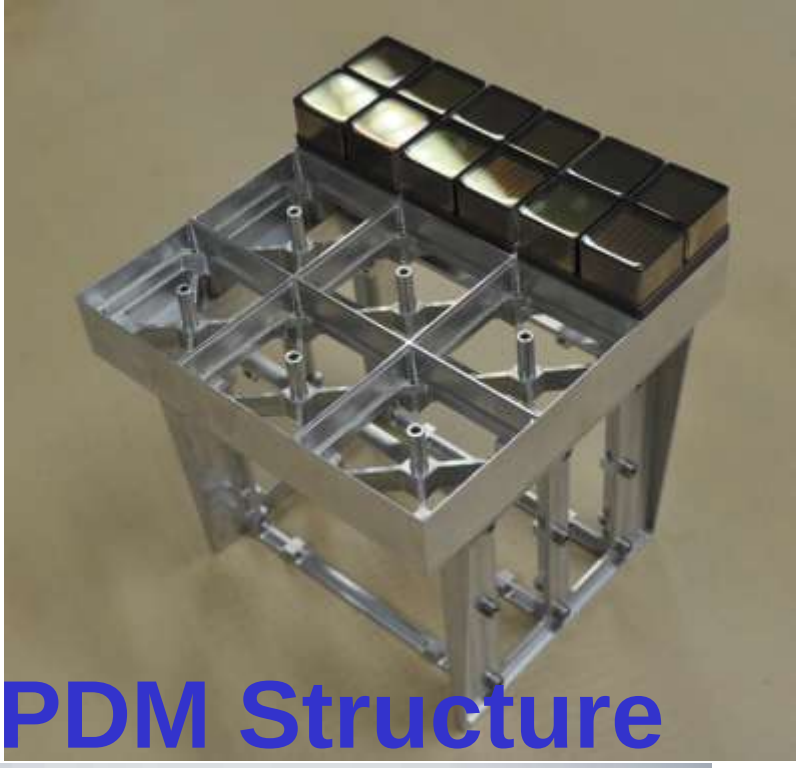


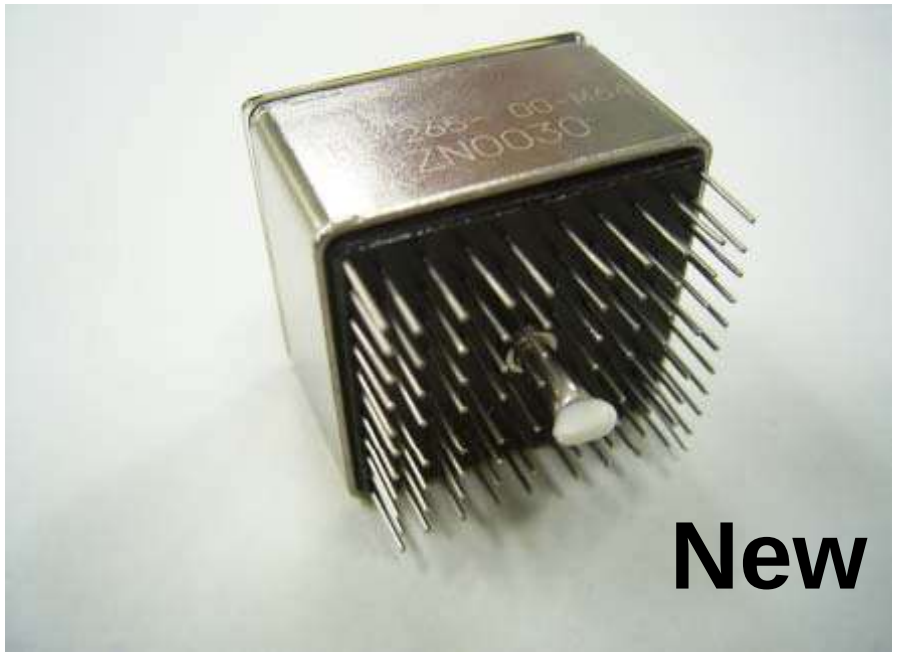
Photo-Detector Module

(3x3 ECs = 2,304 pixels)

New MAPMT M64
and PDM structure

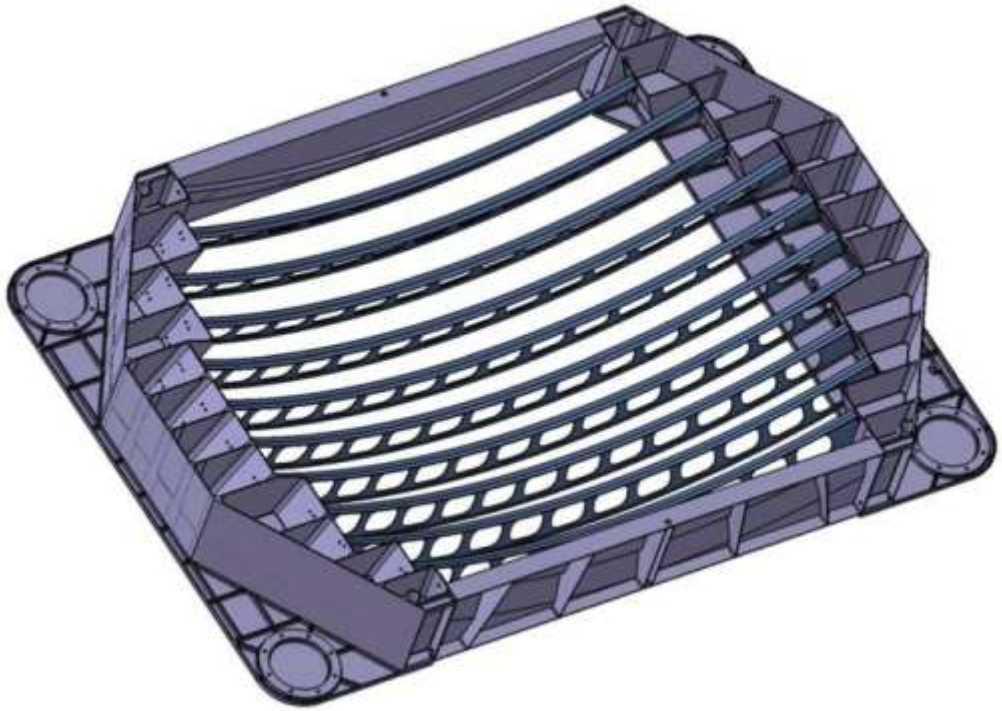


New PDM Structure



New M64

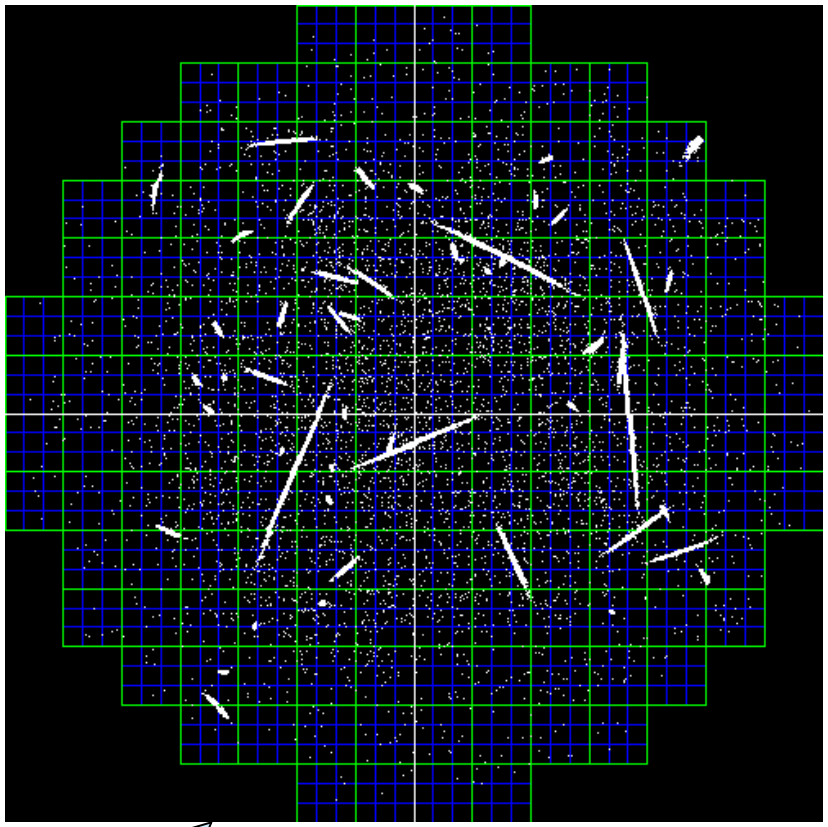
FS Support Structure



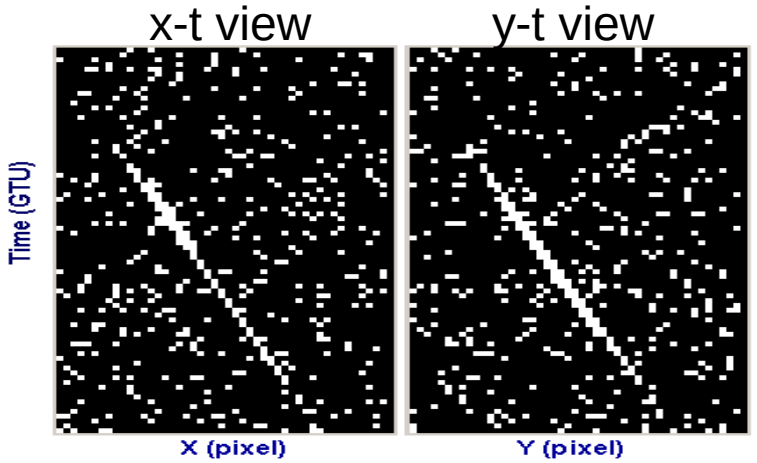
The prototype of the rib structure and 3 PDM stru

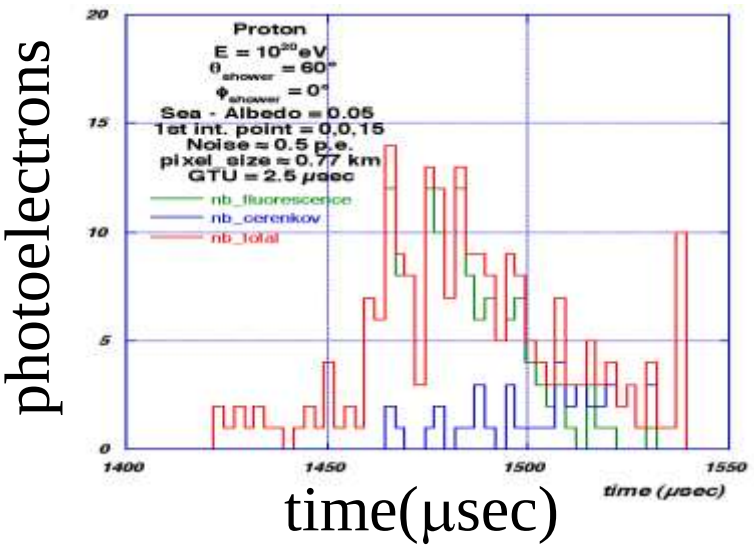
Air shower Image on the Focal Surface

simulation



50 events of 10^{20}eV proton showers are superimposed on the EUSO focal surface with 192 k pixels.

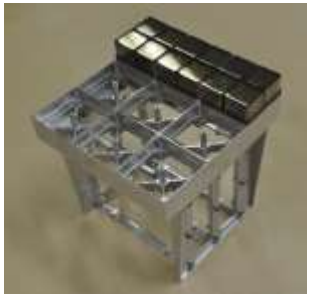




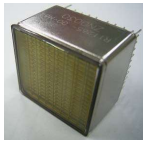
Proton E=10^{20}eV, θ=60º
GTU = 2.5 μsec

JEM-EUSO DAQ – Data reduction block scheme

9.6 GB/s (FS) — $4*10^{-3}$ compression — 10^{-3} compression → 297 kbps, 3 Gbyte/day



Storage on SSD will give factor 3, up to 10 Gbyte/day Return with Soyuz



FEE ASIC Count

9EC

PDM Control Board

FPGA

Track Trigger

8PDM

PhotoDetector Modules

Cluster Control Board

DSP/FPGA

Fine Trigger

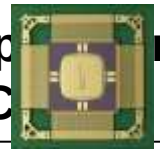
18CCB

FS Control Board

MPU

Op n

C



315kch

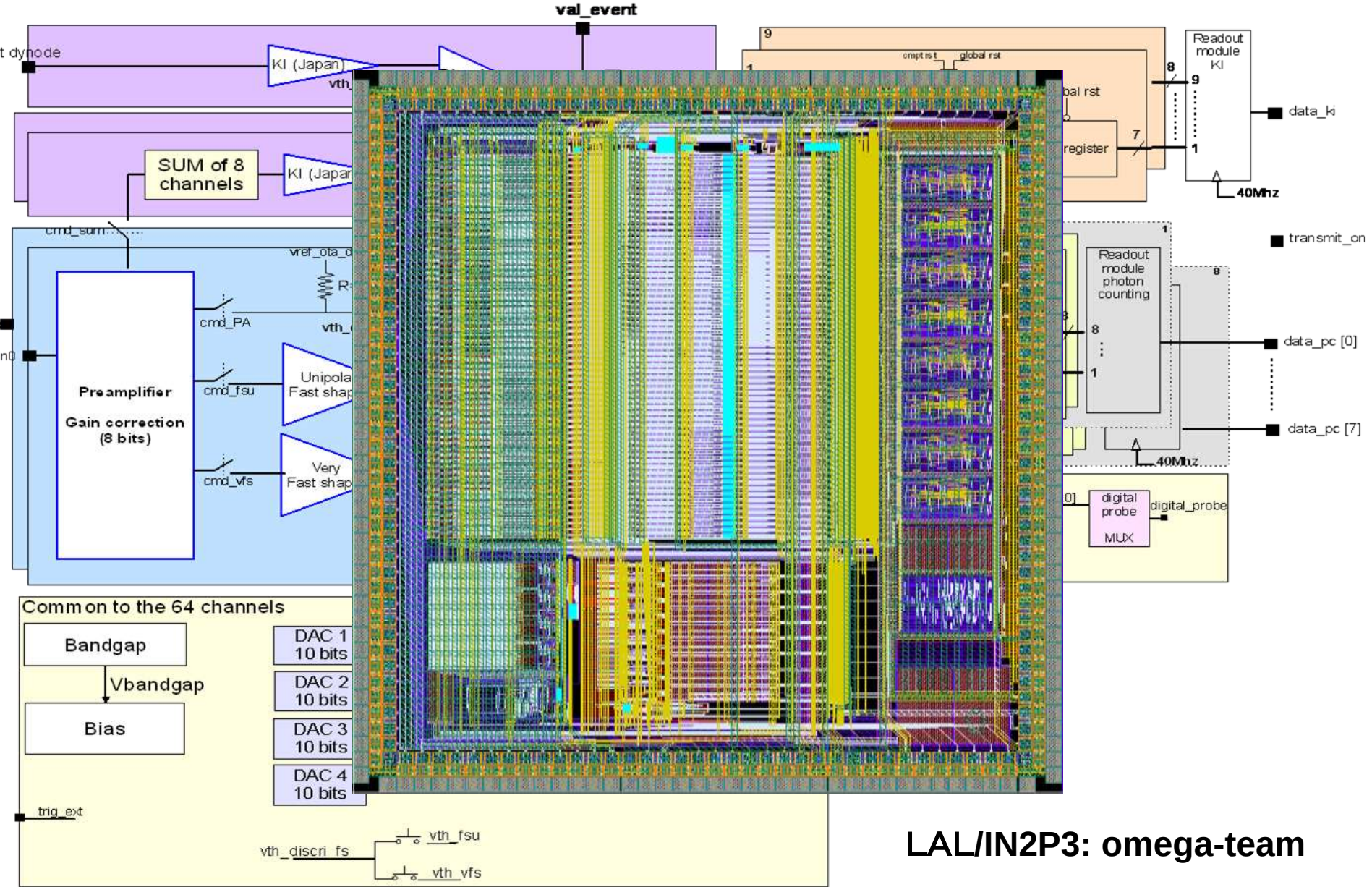
137 Boards

18 Boards
18 Spares

1 Board
1 Spare

LVDS with SpaceWire (ECSS-E-50-12A)

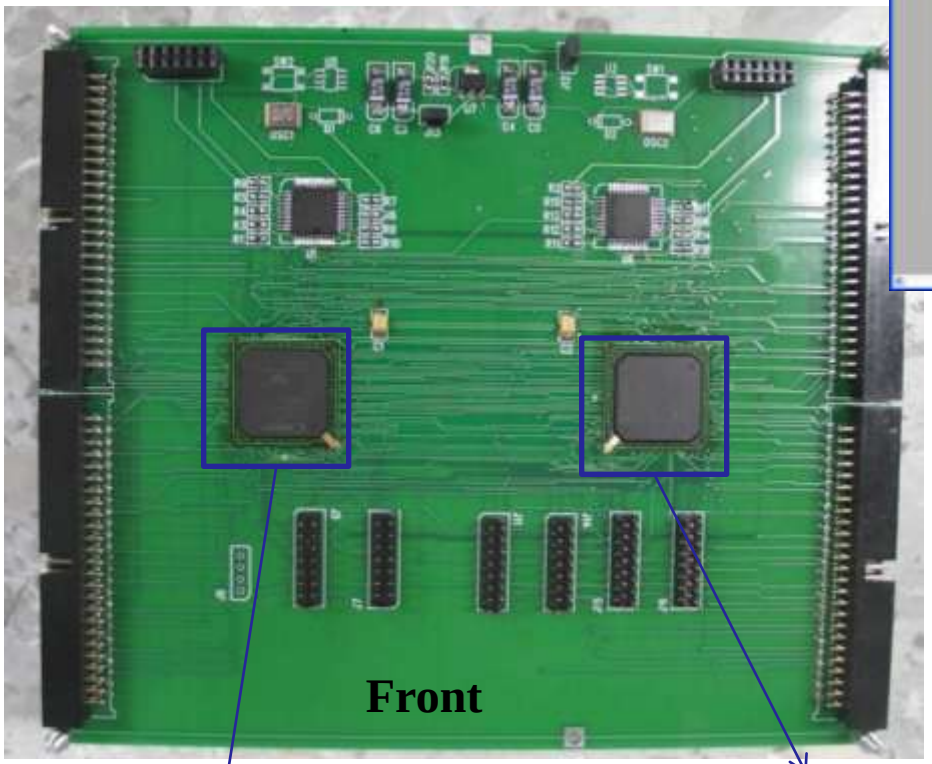
Read-out ASIC : SPACIROC



LAL/IN2P3: omega-team

EWHA DAQ BOARD

EWHA TEST BOARD

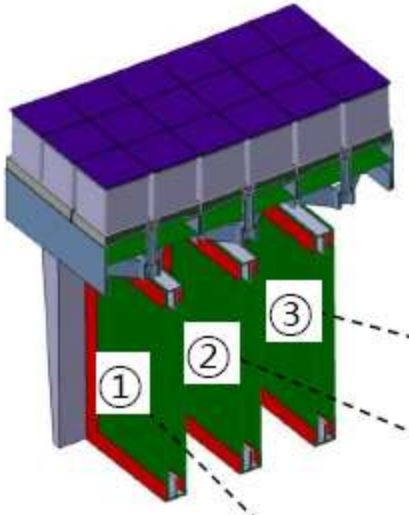


PC interface chip

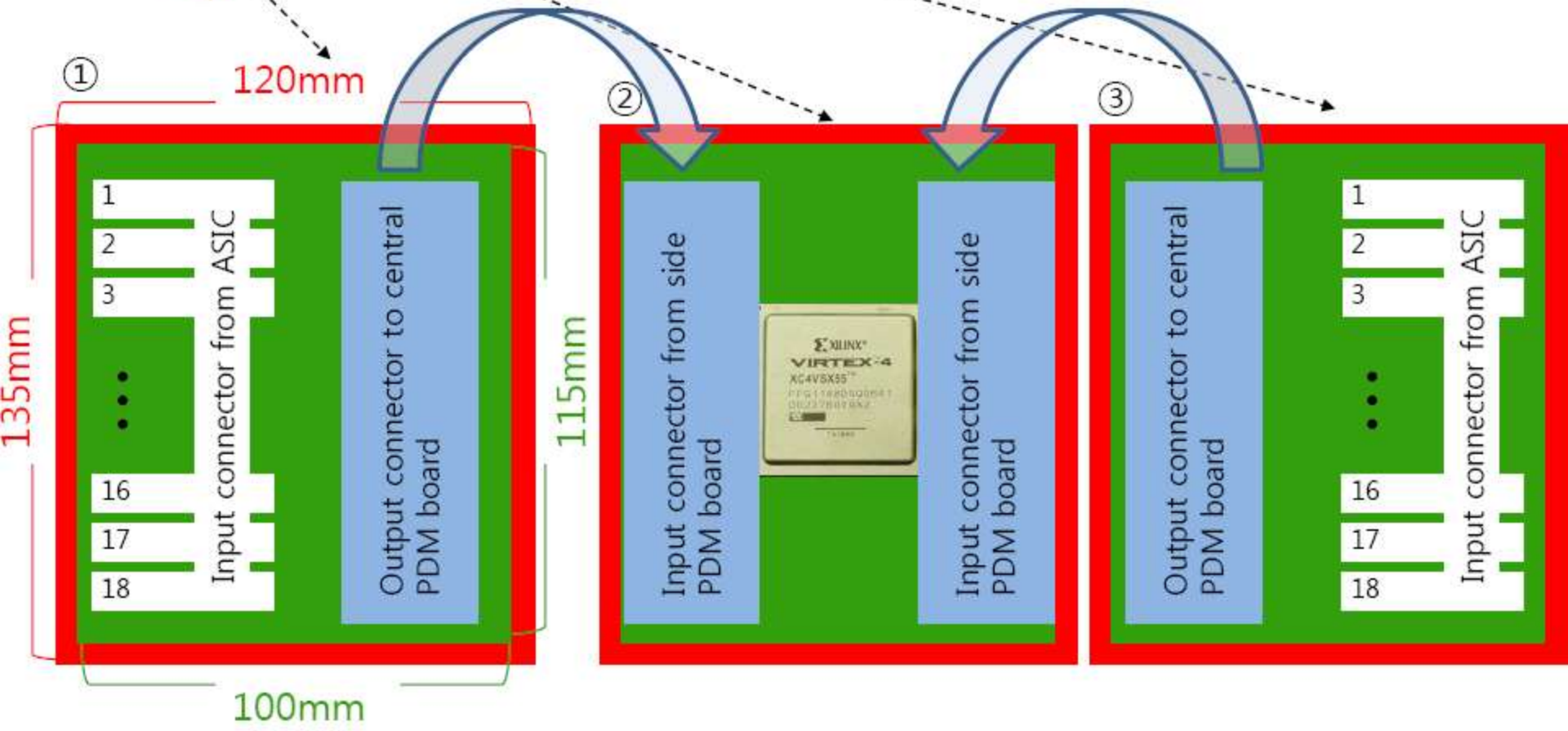
JEM EUSO trigger FPGA chip

Set up for Lab test

PDM Board design

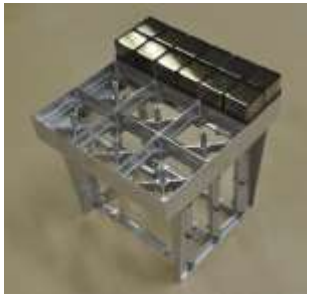


Maximum connector size : 41.7mm x 9mm
Cable : FFC(Flexible Flat Cable)



JEM-EUSO DAQ – Data reduction block scheme

9.6 GB/s (FS) $4*10^{-3}$ compression 10^{-3} compression 297 kbps 3 Gbyte/day



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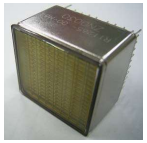

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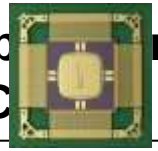


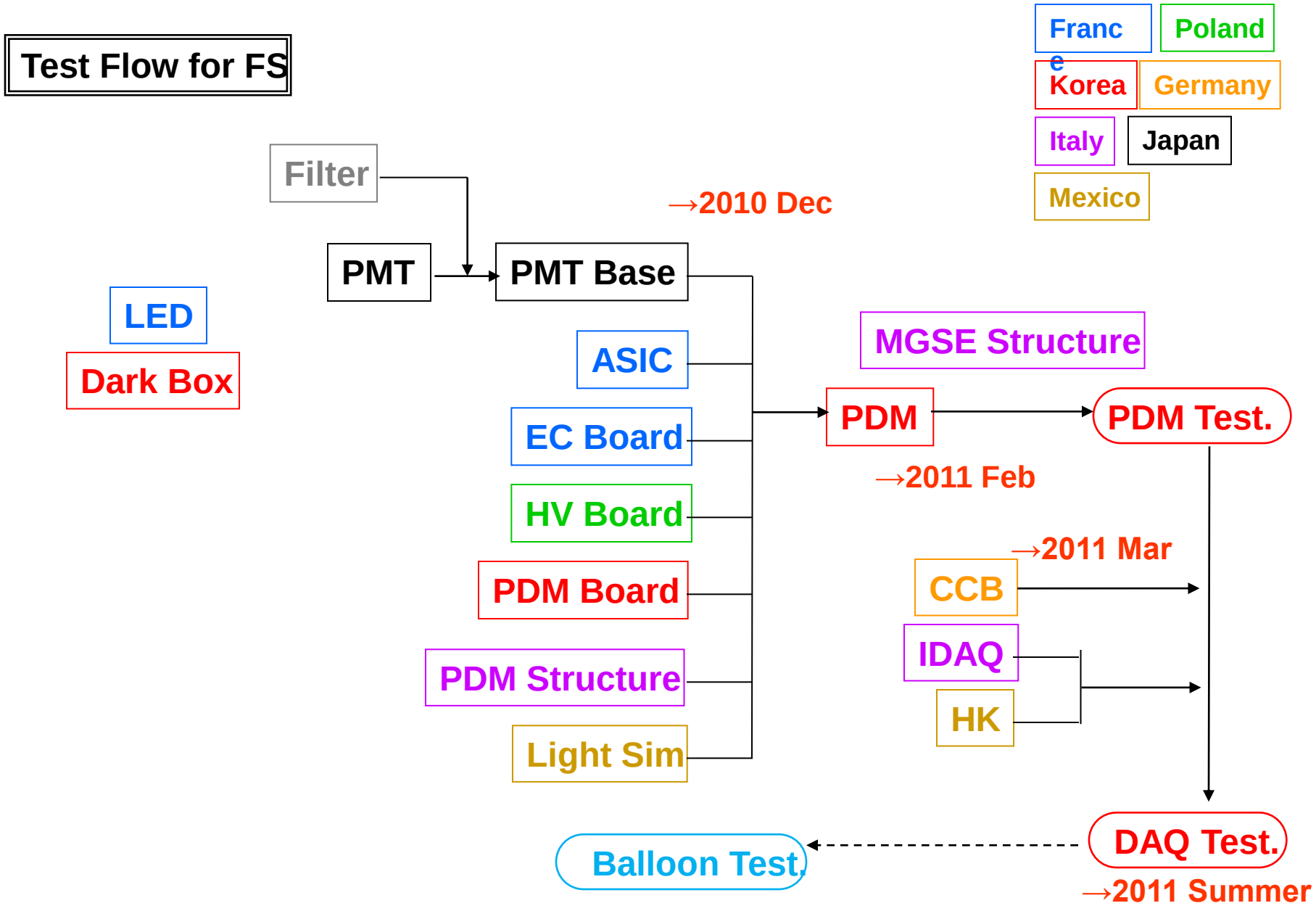
1 Board
1 Spare

LVDS with SpaceWire (ECSS-E-50-12A)

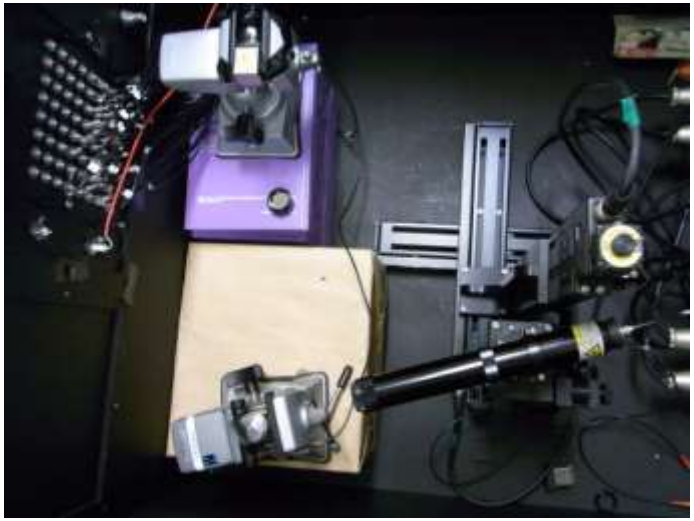
Hardware of the Cluster Control Board (CCB)

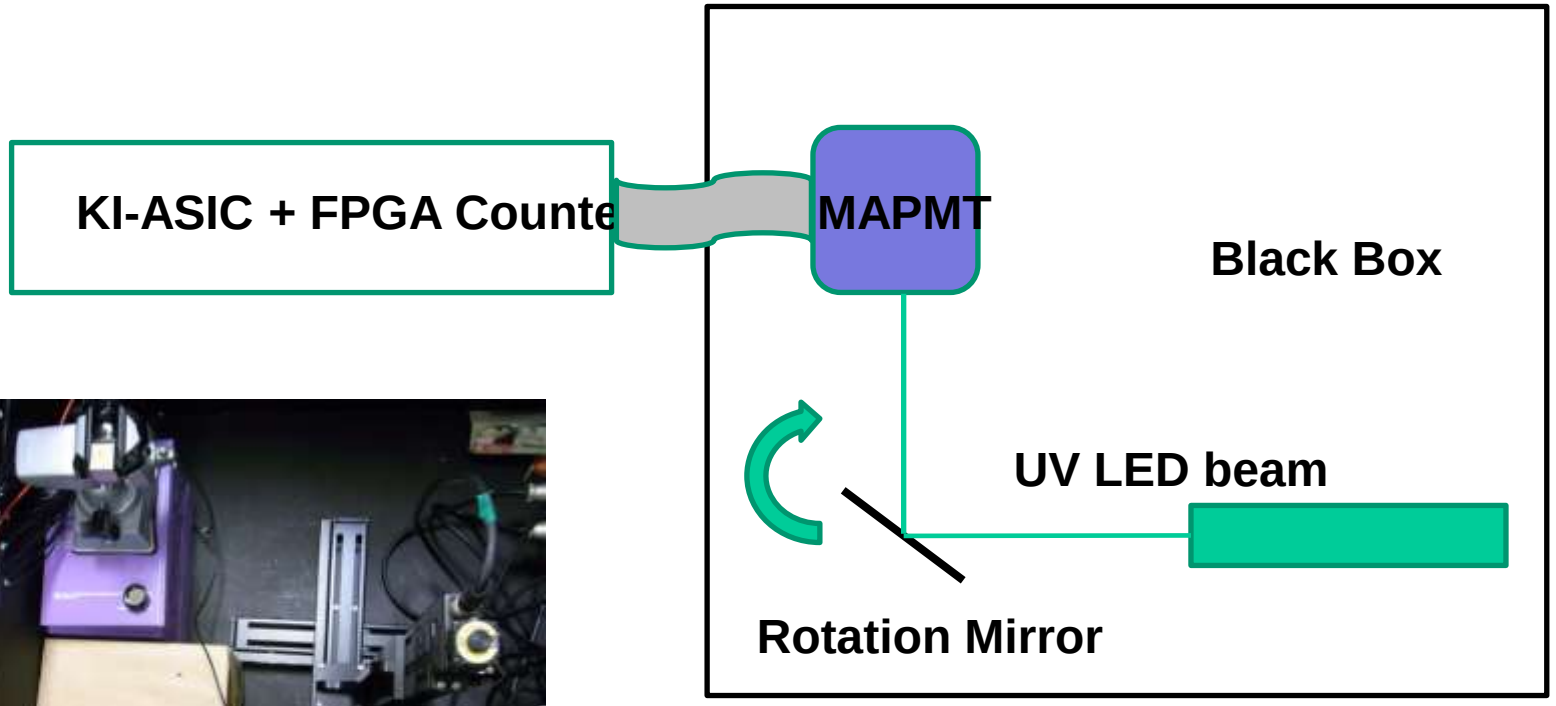
FPGA instead of DSP:

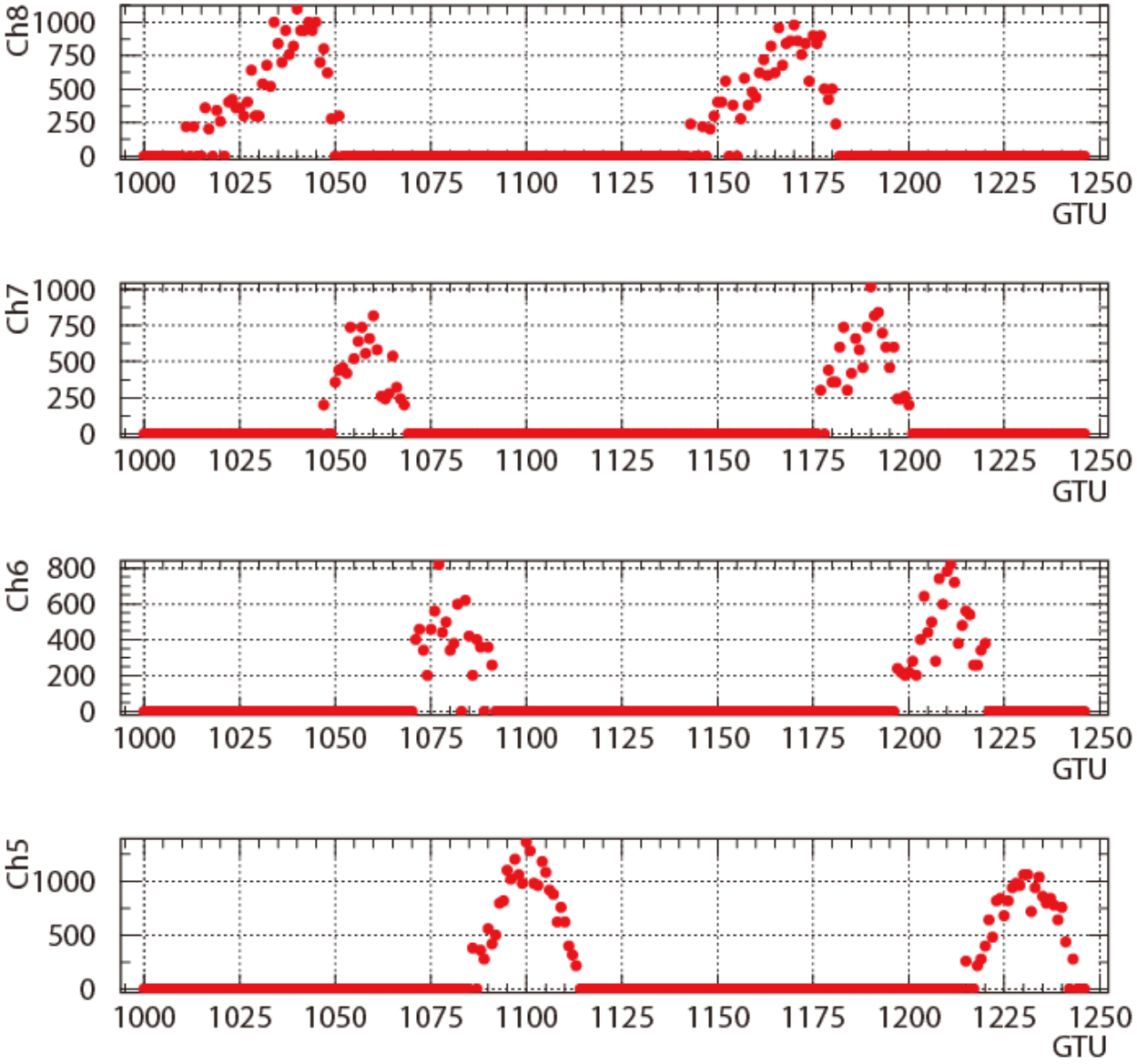
- for the current L3-Trigger
  - ⇒ no need for floating point operations
  - ⇒ only integer sums (but a lot)
  - ⇒ a lot of internal RAM
  - ⇒ dedicated for parallel processing
- interfaces:
  - ⇒ main I/O standard is LVDS
  - ⇒ main datapath (PDM→CCB): ≈300 I/Os
  - ⇒ no need for external I/O expansion
  - ⇒ no need for external LVDS drivers


Test Flow for FS
France
Poland
Korea
Germany
Italy
Japan
Mexico
Filter
PMT
PMT Base
→2010 Dec
LED
Dark Box
ASIC
EC Board
HV Board
PDM Board
PDM Structure
Light Sim
MGSE Structure
PDM
PDM Test.
→2011 Feb
→2011 Mar
CCB
IDAQ
HK
DAQ Test.
→2011 Summer
Balloon Test.

Test of PMT and AISC with the scanning UV b





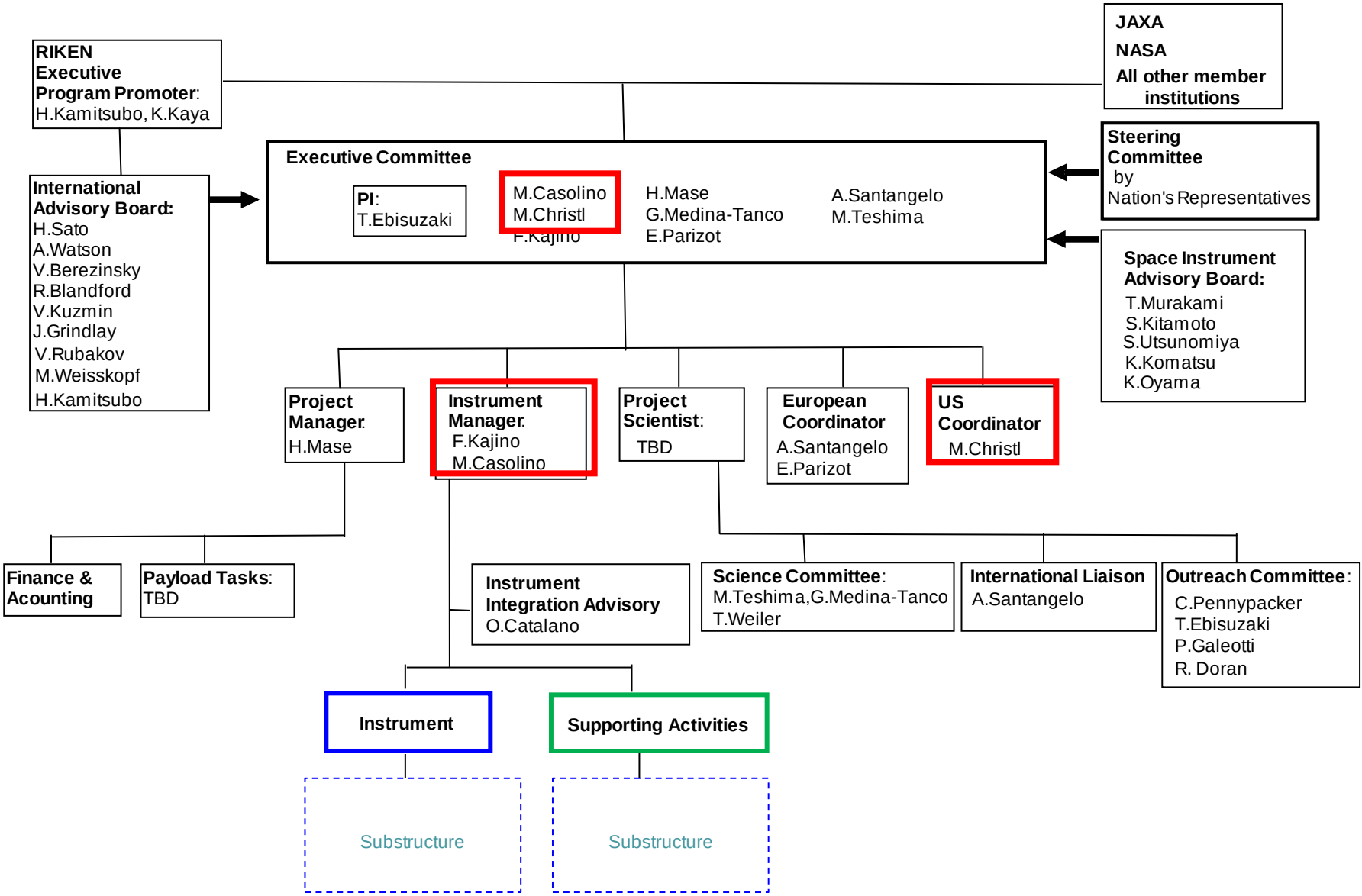


鏡の回転速度より算出される光点の移動速度83.8m/sに対して、19GTU/画素(84.2m/s)で光点が移動している

第7回国際JEM-EUSO会合

- ハンツビル：2010年6月21-25日
- 推進体制を変更
- システム構成を変更

新推進体制


RIKEN
Executive
Program Promoter:
H.Kamitsubo, K.Kaya
JAXA
NASA
All other member institutions
Steering Committee
by
Nation's Representatives
Executive Committee
PI:
T.Ebisuzaki
M.Casolino
M.Christl
F.Kajino
H.Mase
G.Medina-Tanco
E.Parizot
A.Santangelo
M.Teshima
International Advisory Board:
H.Sato
A.Watson
V.Berezinsky
R.Blandford
V.Kuzmin
J.Grindlay
V.Rubakov
M.Weisskopf
H.Kamitsubo
Space Instrument Advisory Board:
T.Murakami
S.Kitamoto
S.Utsunomiya
K.Komatsu
K.Oyama
Project Manager:
H.Mase
Instrument Manager:
F.Kajino
M.Casolino
Project Scientist:
TBD
European Coordinator
A.Santangelo
E.Parizot
US Coordinator
M.Christl
Finance & Acounting
Payload Tasks:
TBD
Instrument Integration Advisory
O.Catalano
Science Committee:
M.Teshima,G.Medina-Tanco
T.Weiler
International Liaison
A.Santangelo
Outreach Committee:
C.Pennypacker
T.Ebisuzaki
P.Galeotti
R. Doran
Instrument
Supporting Activities
Substructure
Substructure

International Role Sharing

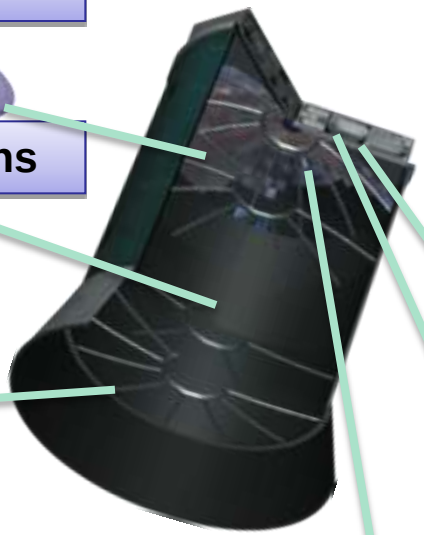
Optics: USA + Japan

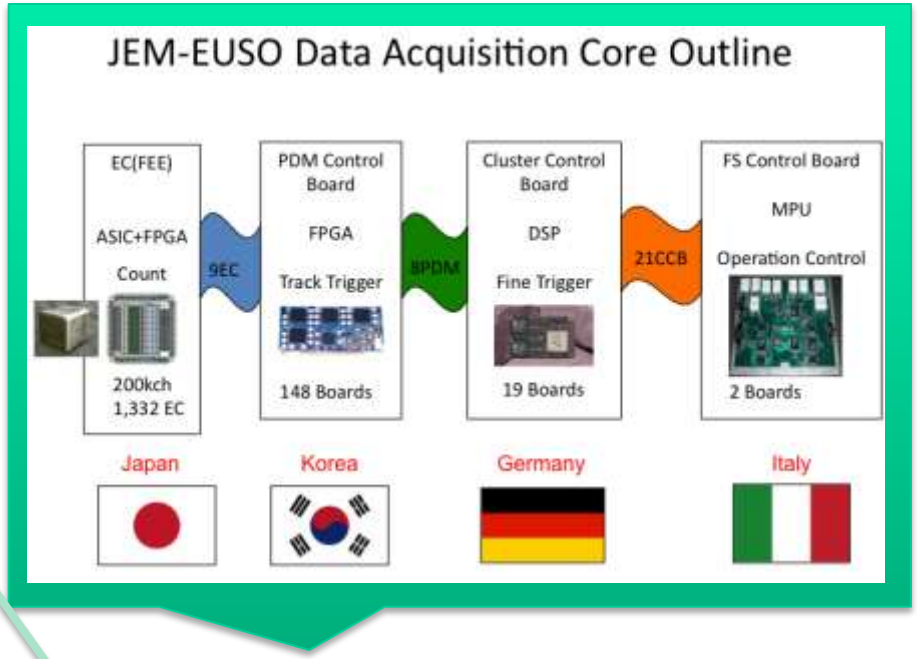
Fresnel Lens #2

Precision Fresnel lens

Iris

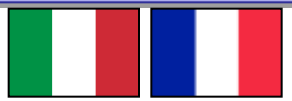
Fresnel lens #1





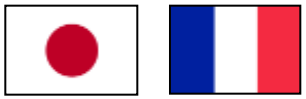
DAQ Electronics

Support Structure: Italy + France



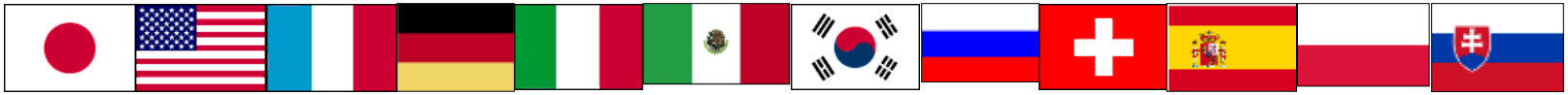
Focal Surface: Japan

Calibration: Japan + France



Simulation: Worldwide

JEM-EUSO Collaboration



12 countries, 62 institutions, 170 members

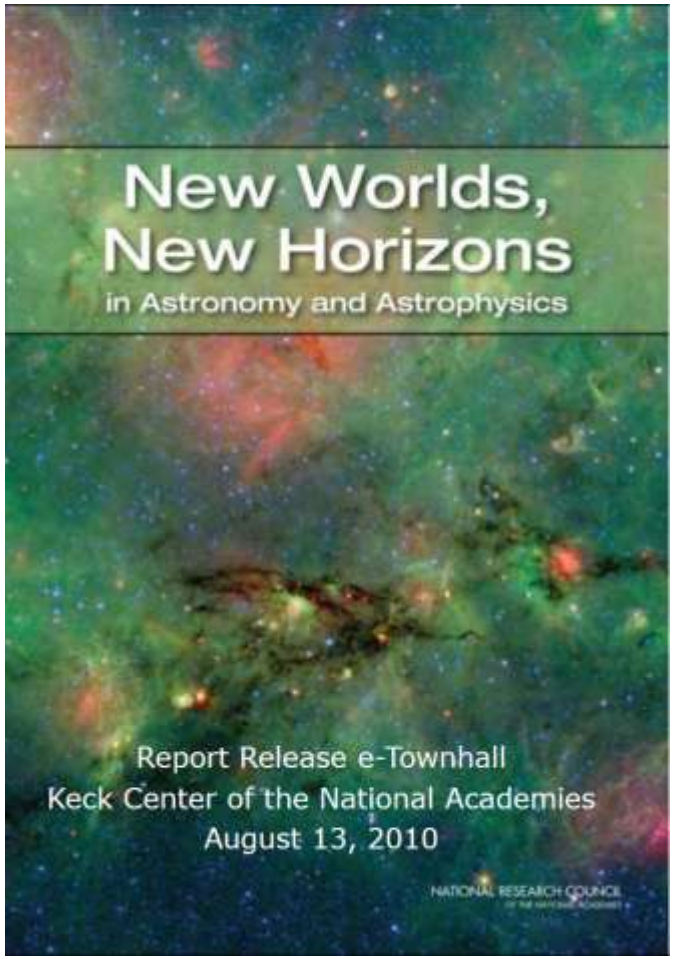
- **Japan** : T. Ebisuzaki, Y. Uehara, H. Ohmori, Y. Kawasaki, M. Sato, Y. Takizawa, K. Katahira, S. Wada, K. Kawai, H. Mase (*RIKEN*), F. Kajino, M. Sakata, H. Sato, Y. Yamamoto, T. Yamamoto, N. Ebizuka, (*Konan Univ.*), M. Nagano, Y. Miyazaki (*Fukui Inst. Tech.*), N. Sakaki, T. Shibata (*Aoyama Gakuin Univ.*), N. Inoue (*Saitama Univ.*), Y. Uchihori (*NIRS*), K. Nomoto (*Univ. of Tokyo*), Y. Takahashi (*Tohoku Univ.*), M. Takeda (*ICRR, Univ. Tokyo*), Y. Arai, Y. Kurihara, H.M. Shimizu, J. Fujimoto (*KEK*), S. Yoshida, K. Mase (*Chiba Univ.*), K. Asano, S. Inoue, Y. Mizumoto, J. Watanabe, T. Kajino (*NAOJ),* H. Ikeda, M. Suzuki, T. Yano (*ISAS, JAXA*), T.Murakami, D. Yonetoku (*Kanazawa Univ.*), T. Sugiyama *(Nagoya*), Y. Ito (*STEL, Nagoya Univ.*), S. Nagataki (*YITP, Kyoto Univ.*), A. Saito(*Kyoto Univ.*), S. Abe, M. Nagata (*Kobe Univ.*), T. Tajima (*KPSI, JAEA*)、M. Chikawa (*Kinki Univ*.), and M. Tajima (*Hiroshima Univ*.)
- **USA** : J. H. Adams Jr., S. Mitchell, M.J. Christl, J. Watts Jr., A. English, R. Young (*NASA/ MSFC*) , Y. Takahashi, D. Gregory, M. Bonamente, P. Readon, V. Connaughton, K. Pitalo, J. Hadaway, J. Geary, R. Lindquist, P. Readon (*Univ. Alabama in Huntsville*), H. Crawford, C. Pennypacker (*LBL, UC Berkeley*), K. Arisaka, D. Cline, J. Kolonko, V. Andreev (*UCLA*), T. Weiler, S. Csorna (*Vanderbilt Univ*.),
- **France** : J-N. Capdevielle, P. Gorodetzky, D. Allard, J. Dolbeau), T. Patzak, J.J. Jaeger, E. Parizot, D. Semikoz, J. Weisbard (*APC,IN2P3,CNRS*), S. Dagoret-Campagne *(LAL,IN2P3,CNRS)*
- **Germany**: M. Teshima, T. Schweizer (*MPI, Munich*), A. Santangelo, E. Kendziorra, F. Fenu (*Univ. Tuebingen*), P. Biermann (*MPI Bonn*), K. Mannheim (*Wuerzburg*), J. Wilms (*Univ. Erlangen*)
- **Italy** : E. Pace, M. Focardi, P. Spillantini (*U. Firenze*) V.Bratina, A. Zuccaro, L. Gambicorti (*CNR-INOA Firenze*), A. Anzalone, O. Catalano, M.C. Maccarone, P. Scarsi, B. Sacco, G. La Rosa (*IAS-PA/INAF*), G. D'Ali Staiti, D. Tegolo (*U. Palermo*), M. Casolino, M.P. De Pascale, A. Morselli, P. Picozza, R. Sparvoli (*INFN and Univ. Rome "Tor Vergata"*), P. Vallania (*IFSI-INAF Torino*), P. Galeotti, C. Vigorito, M. Bertaina (*U. Torino*), A. Gregorio (*Trieste*), F. Isgro, F.Guario, D. D'urso, D. Supanifsky (*U. "Federico II" di Napoli*), G. Osteria, D. Campana, M. Ambrosio, C. Aramo (*INFN-Nappli*)
- **Mexico**: G. Medina-Tanco, J.C. D'Olivo, J.F.Valdes (*Mexico UNAM*), H. Salazar, O. Martines (*BUAP*), L. Villasenor (*UMSNH*)
- **Republic of Korea** : S. Nam, I. H. Park, J. Yang (*Ehwa W. Univ*.), T.W. Kim (*Ajou University*), S.W. Kim (*Yonsei University*), K.K. Joo (*Chonnam National University*)
- **Russia**: Garipov G.K., Khrenov, B.A., Klimov P.A. Panasyuk M.I., Yashin I.V. (*SINP MSU*), D. Naumov, Tkachev. L (*Dubna JINR*)
- **Switzerland** : A. Maurissen, V. Mitev (*Neuchatel, Switzerland*) :
- **Spain**: D.Rodriguez-Frias, L.Peral, J.Gutierrez, R.Gomez-Herrero (*Univ. Alcala*)
- **Poland**: T. Batsch, B. Szabelska, J. Szabelski, T. Wibig(IPJ), T. Tymieniecka(Podlasie Univ.), Z. Wlodarczyk(Kielce Univ.), G. Siemieniec-Ozieblo(Jagiellonian Univ.)
- **Slovakia**: K. Kudela, R. Bucik, R. Bobik, M. Slivka (Inst. Experimental Physics, KOSICE)

米国

- NASA内部予算獲得に成功
  - 光学系BBMテスト
- SALMON公募に応募（2010年9月？発表）
  - PI: Jim Adams, 副PI: Mark Christl
- 理研・JAXAワシントン訪問
  - NASA、DOE、NSF
- Astro2010報告発表（8月13日）

ASTRO2010サマリレポート

- 大規模・中規模ミッションについて格付け
- NASA/Explorerプログラム
  - 2番目に推薦
  - 予算の2.5倍増を要求
  - 海外ミッションへの参加を明示
  - SALMONに該当
- 科学については高く評価
  - 極限エネルギー宇宙線
  - 極限エネルギーニュートリノ
- 明示的な記述なし
  - JEM-EUSOの米国分は小規模ミッション
  - 小規模ミッションに関しては、固有の選考過程に任せる



Explorer Augmentation – Program Details

- In past, program reduced to pay for costs of major NASA activities
- **RECOMMEND Restoration of Explorer line to enable astrophysics launch rates originally envisaged**
- Proposed increase from $40M to $100M per year for astrophysics missions -- Low risk
- Support two new MidScale (MIDEX), two new Small (SMEX) Explorers, and at least four Missions of Opportunity (MoO) over decade
- Essential to maintaining breadth and vitality of space astrophysics program

ESA

- 3つのピア・レビューで高い評価
  - Fundamental Physics Advisory Team
    - COSPAR10での報告：強力にJEM-EUSO欧州担当部分を推薦
  - Astronomy WG
  - European Science Foundation
- ELIPSEプログラムに採用

- The Advisory Team supports the active participation of the European community in ultra-high energy cosmic rays in the Japanese mission JEM-EUSO on the Japanese module of the ISS. This is an excellent opportunity to test the possibility of detecting such cosmic rays from space. If successful, this would open the road to an even higher statistics of cosmic rays of the highest energy.

AO-2009-Phvs-BIOSR (ELIPS)

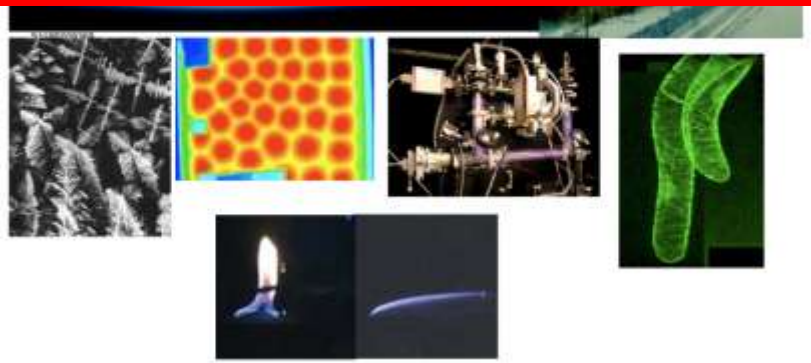
esa

ANNOUNCEMENT OF OPPORTUNITY
for
RESEARCH IN PHYSICAL SCIENCES
ON SOUNDING ROCKETS AND THE ISS
and
RESEARCH IN LIFE SCIENCES (BIOLOGY)
ON SOUNDING ROCKETS

- Letter of Intent submitted on the 15th June 2009

採択！

6年ぶりにESAミッションとして復活



- *Main requests to ESA: resources on the ISS*

日本

- 理研・JAXA共同研究報告書
  - 提出：9月上旬
  - ヒアリング：9-10月
- 宇宙ステーション延長に関する決断
  - 延長期の活動の詳細については今後
- 第8回国際JEM-EUSO会合
  - 12月3日ー9日　筑波/和光　日本

宇宙ステーション延長

- 米国が2016-2020年の宇宙ステーション運用を正式に決定
- 宇宙開発委員会
  - ISS運用延長に関する中間報告を発表
    - 有効利用の体制の構築が条件（理研との協力など）
- 宇宙会開発戦略本部
  - 2016年以降のISS運用延長を決定（8月27日）
    - 我が国としては、平成28年度以降もISS計画に参加していくことを基本とし、今後、我が国の産業の振興なども考慮しつつ、各国との調整など必要な取組を推進する。
  - 詳細は文部科学省/JAXAで議論

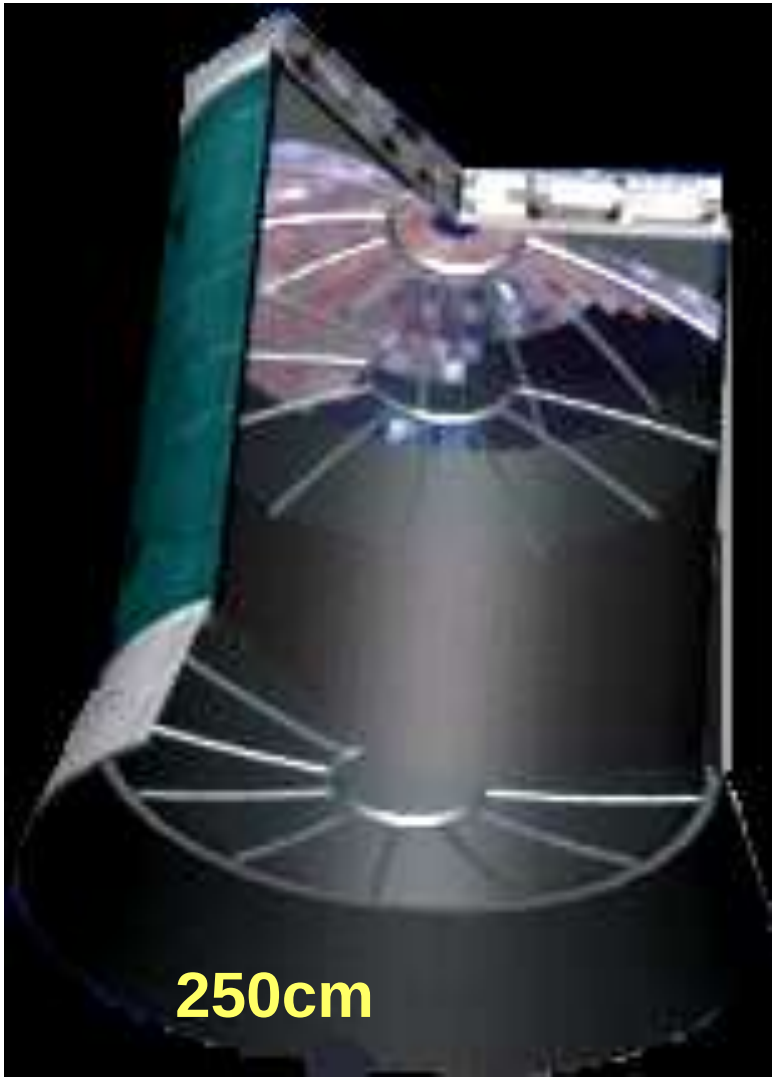
理研・JAXAの協力協定

- ISS科学利用にかんする包括協定
  - MAXI、EUSO、放射線被ばく、無重力、空間認知、
- 5月12日に契約発効
  - 宇宙科学委員会で報告
  - 理研・JAXA連携委員会（9月開催予定）
    - WG発足：宇宙観測（戎崎）、船内実験（中野）、心理実験（入来）
    - 基幹研連携部門内に宇宙観測実験G（牧島）を組織
      - MAXIチーム（牧島）
      - EUSOチーム（戎崎→カソリーノ：10月1日採用内定）
      - 船内実験チーム（中野）：10月1日発足内定

EUSO :
Ever Largest Refractive Telescope

1897

2015



Principle of Relativity

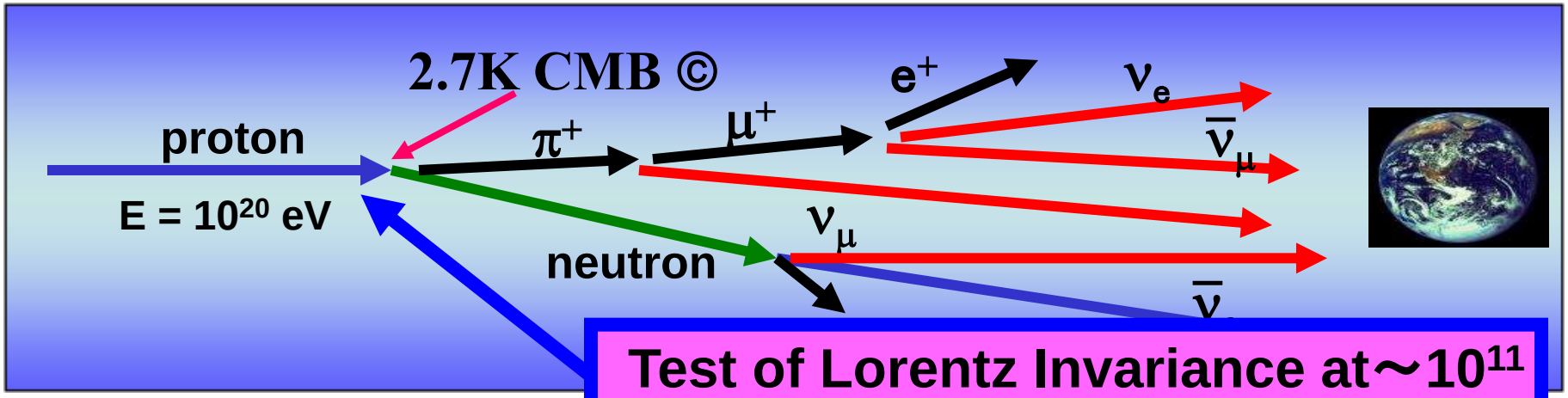
Principle of Relativity: Galileo Galilei: There are no differences in physical laws at any velocity

Theory of Relativity: Einstein: Lorentz Invariance

Are there realy no limits?

Greisen-Zatsepin-Kuz'min Process

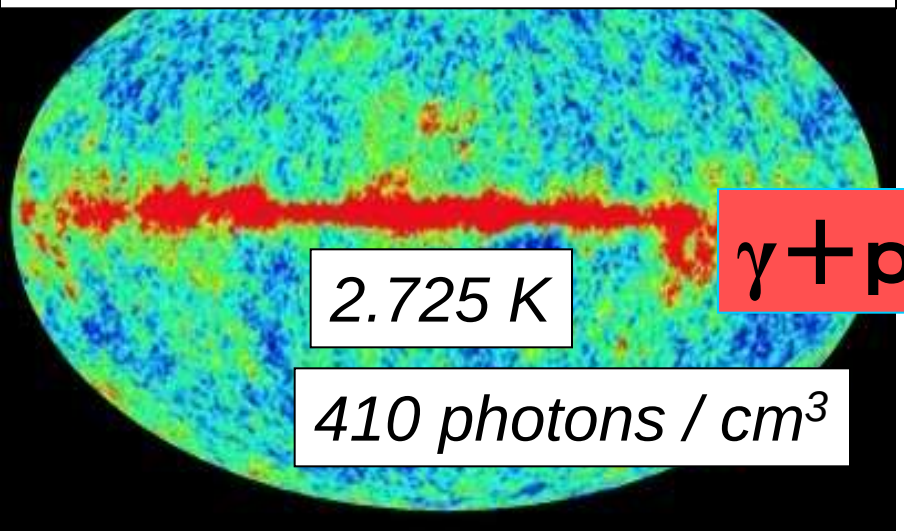
Greisen1966; Zatsepin and Kuz'min1966

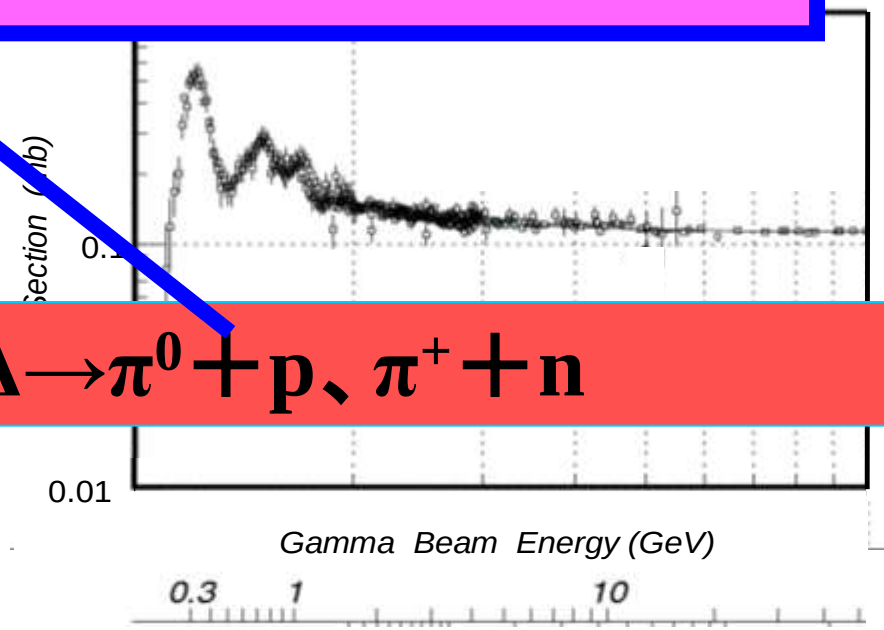


Test of Lorentz Invariance at~10^{11}

Sato and Tati 1972

Microwave Cosmic Backgro Radiation





$\gamma + p \rightarrow \Delta \rightarrow \pi^0 + p$、$\pi^+ + n$

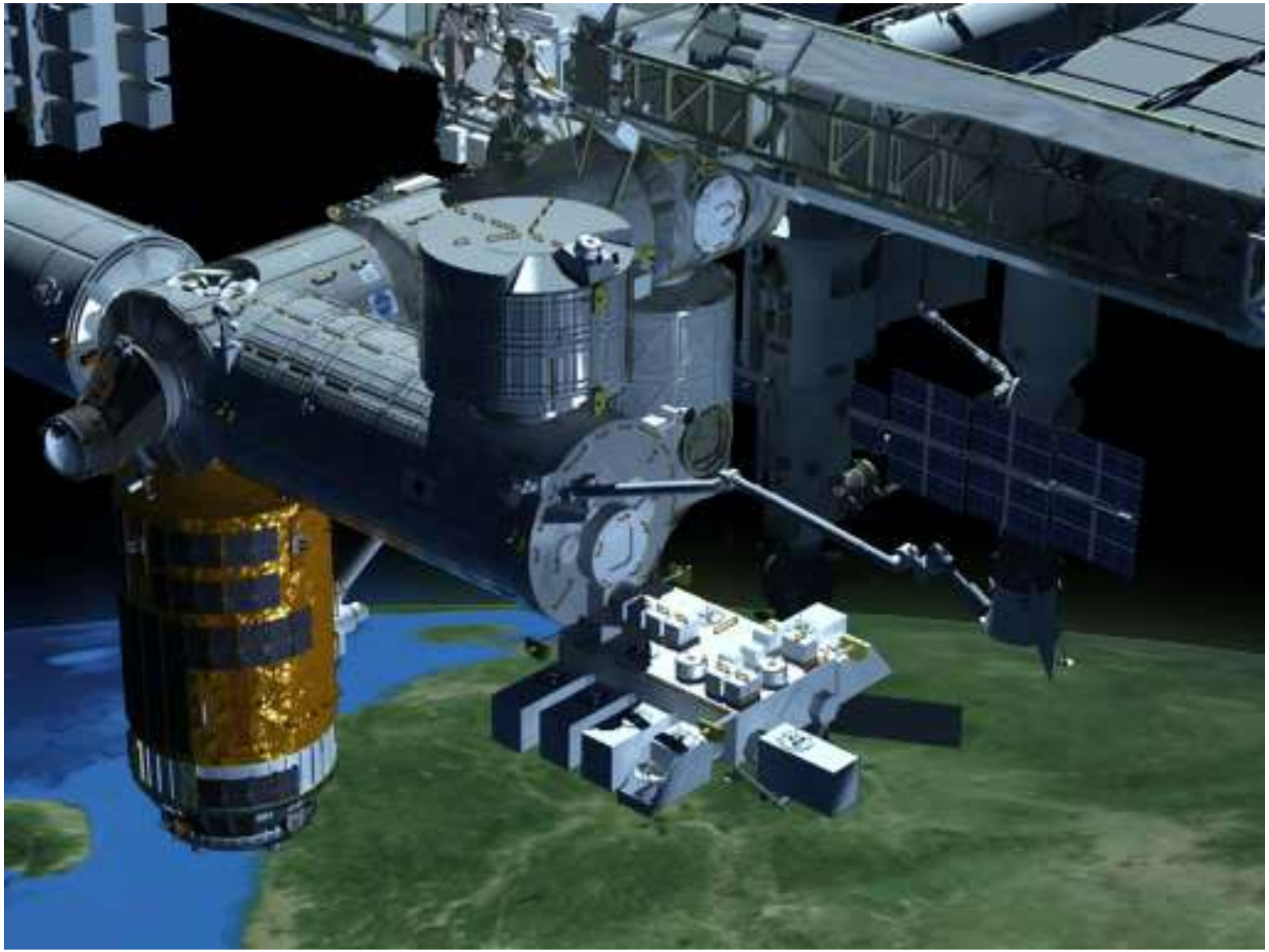
まとめ1：三つの挑戦

- 荷電粒子天文学への挑戦
  - 極限エネルギー粒子の**起源**を明らかにする
  - 宇宙の巨大加速器の謎を解明
- 宇宙の基本相互作用の限界への挑戦
  - 高エネルギー極限における**ローレンツ不変性**の検証（$\gamma \sim 10^{11}$）
  - **ガンマ線とニュートリノ**の検出
- 史上最大の屈折望遠鏡への挑戦
  - **超軽量フレネルレンズ**
  - 高速・低消費電力の焦点面検出器

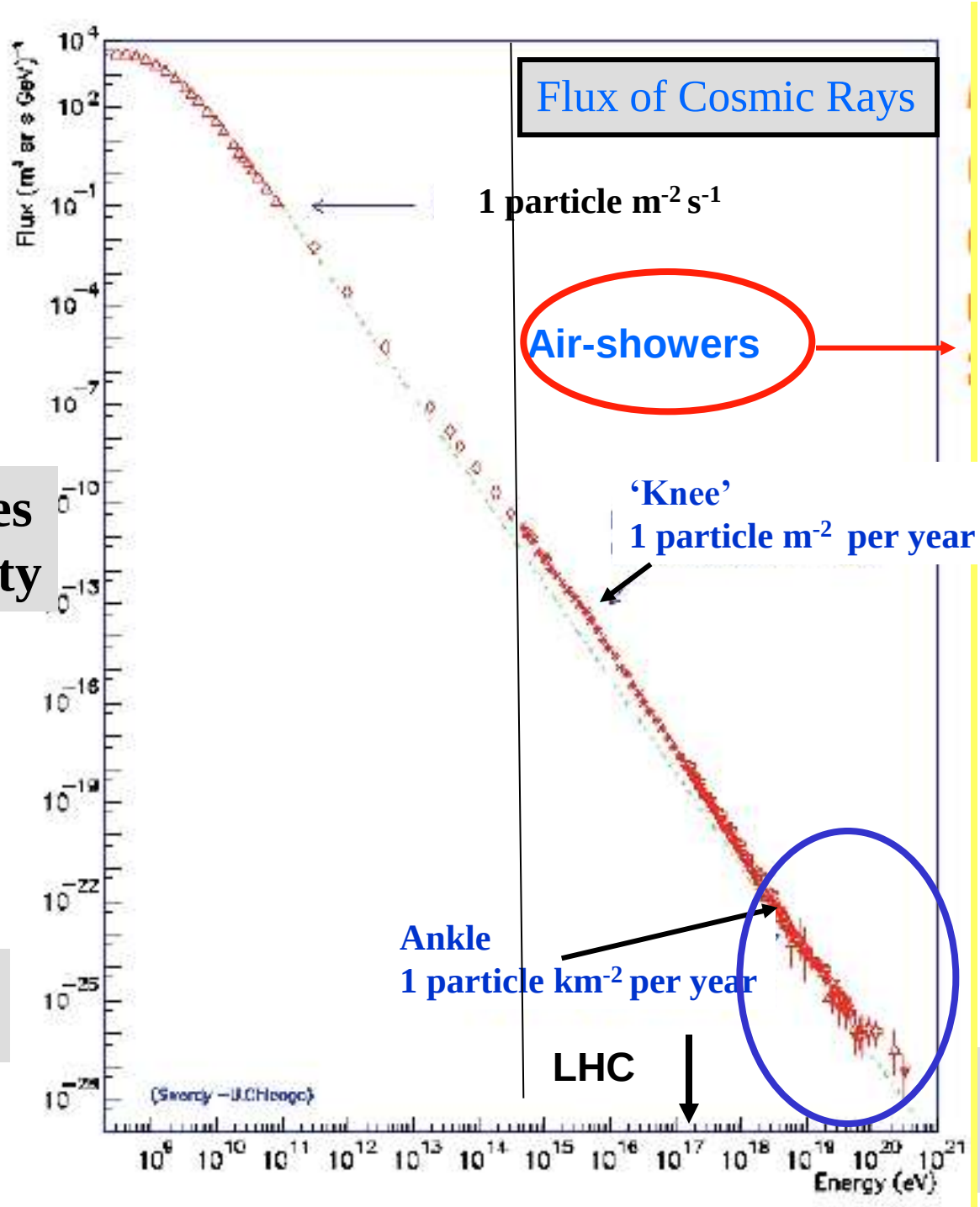
まとめ2：国際協力

- 米国
  - 光学系試験のテスト予算獲得
  - 今年秋発表のSALMON公募に応募
- 欧州
  - ELIPSEプログラムに採用
    - 6年ぶりにESAミッションとして復活
  - 欧州の3つの科学委員会で高い評価
- 日本
  - 2016年以降の宇宙ステーション運用延長決定
  - JAXA・理研の宇宙ステーション利用に関する連携協定：基幹研内に対応する組織

予備スライド



Back-up

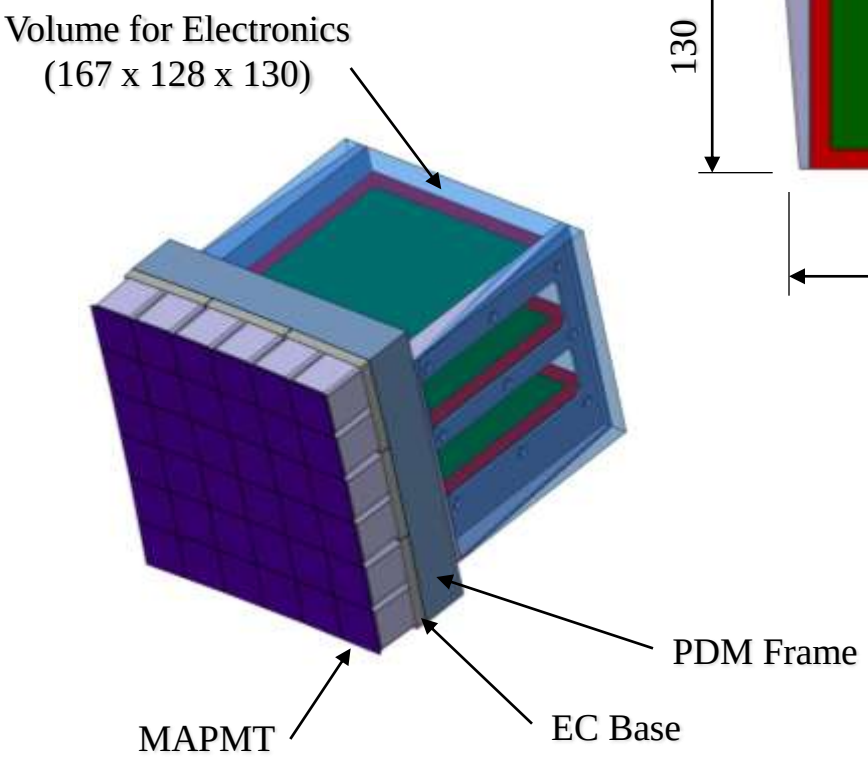


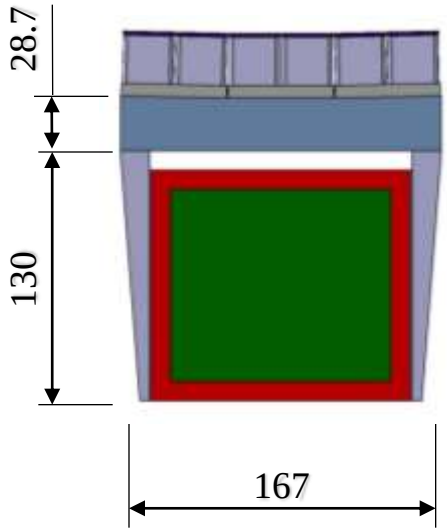
25 decades in intensity

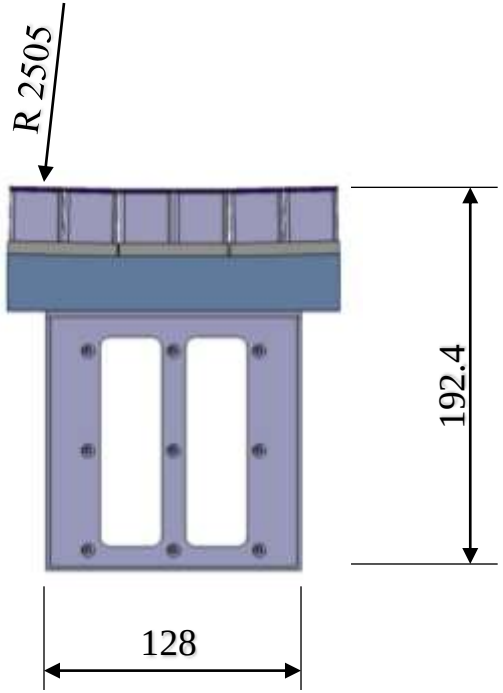
S Swordy (Univ. Chicago)

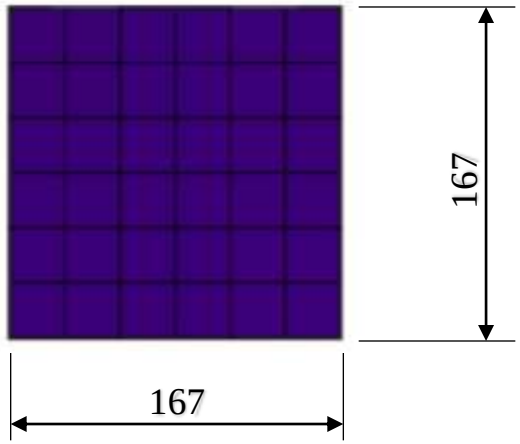
11 Decades in Energy

PDM Dimensions (mm)

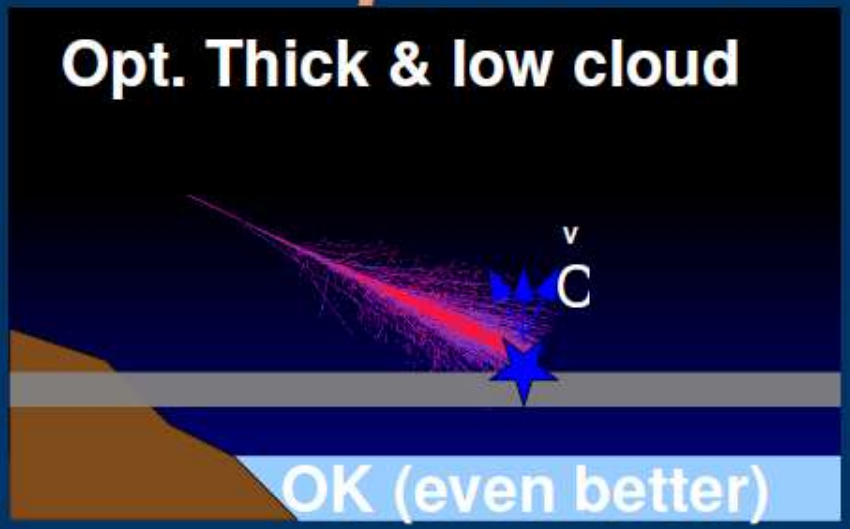


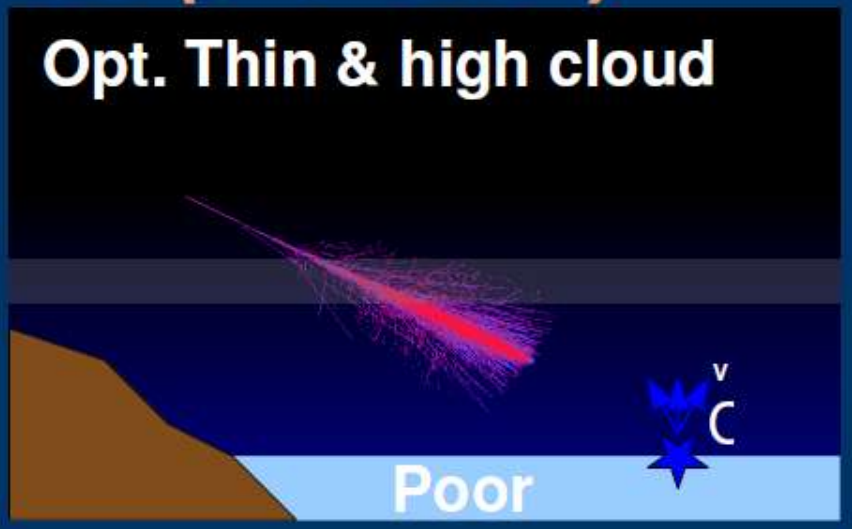


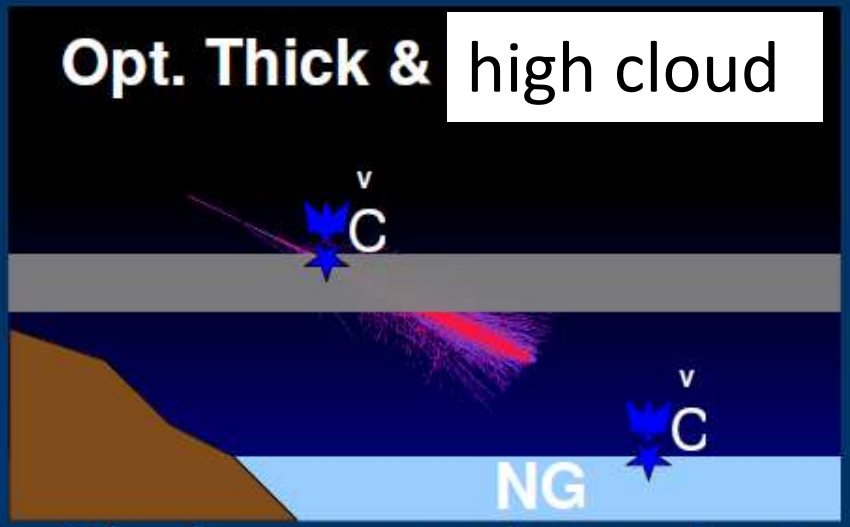


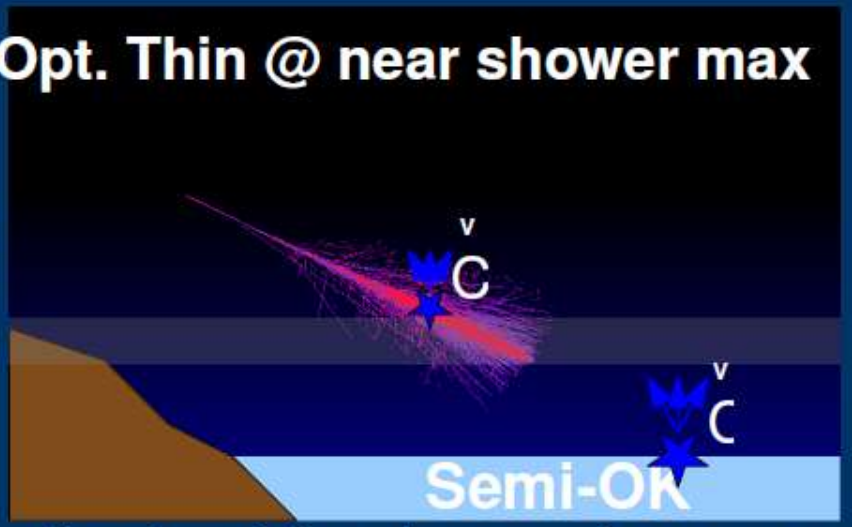


Impact of clouds (a sketch)



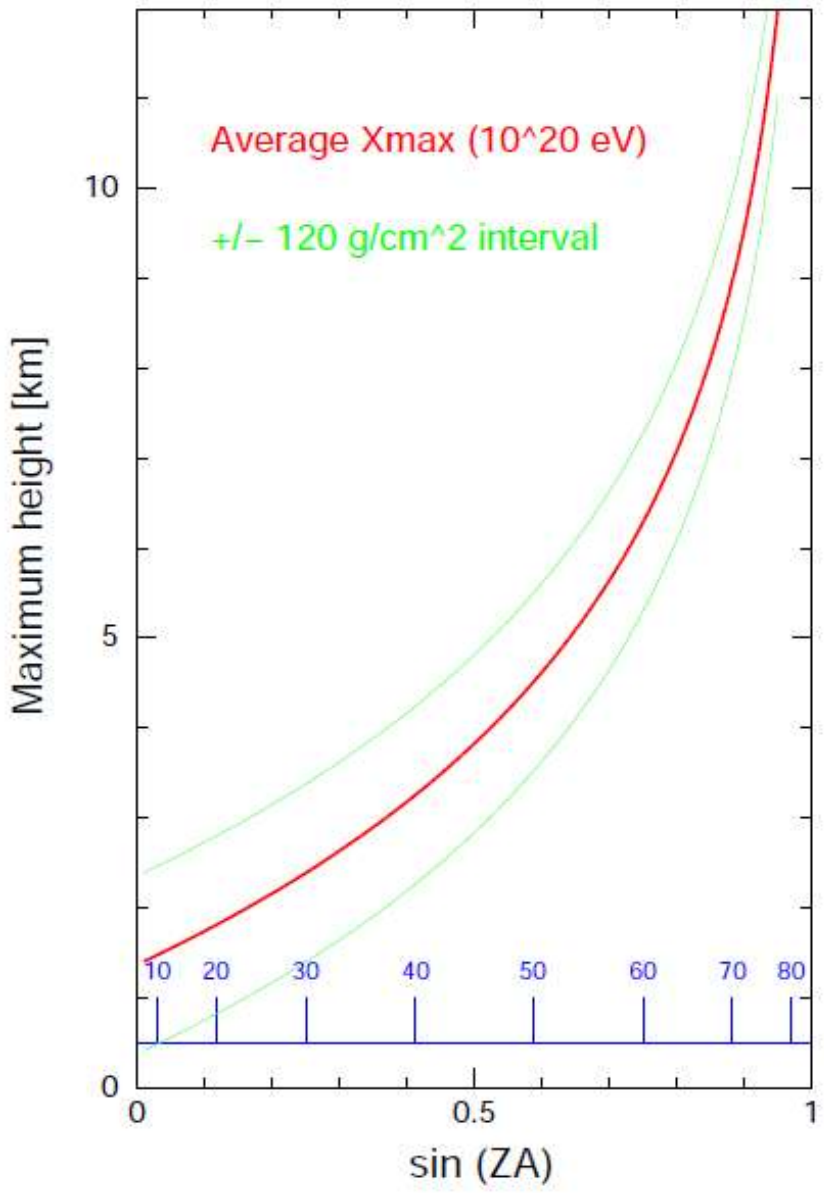


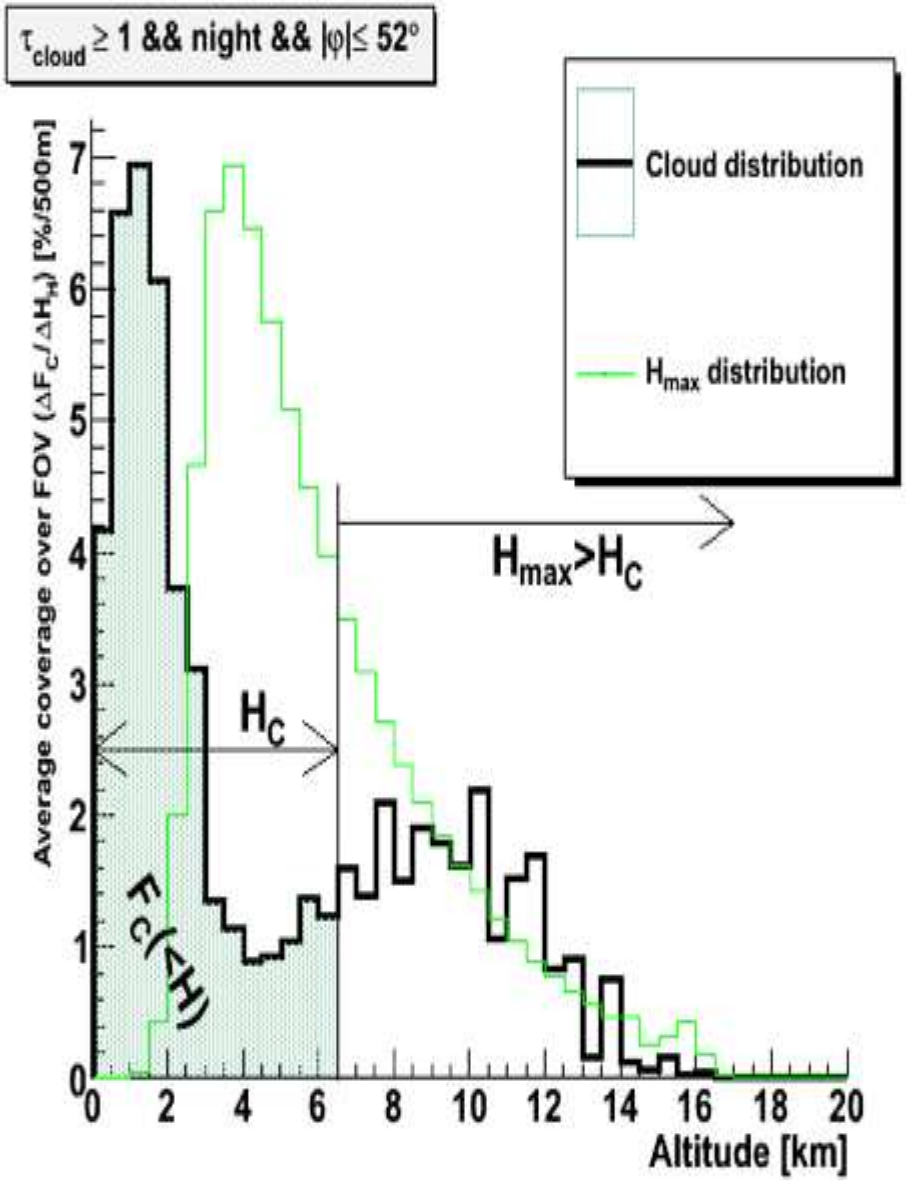




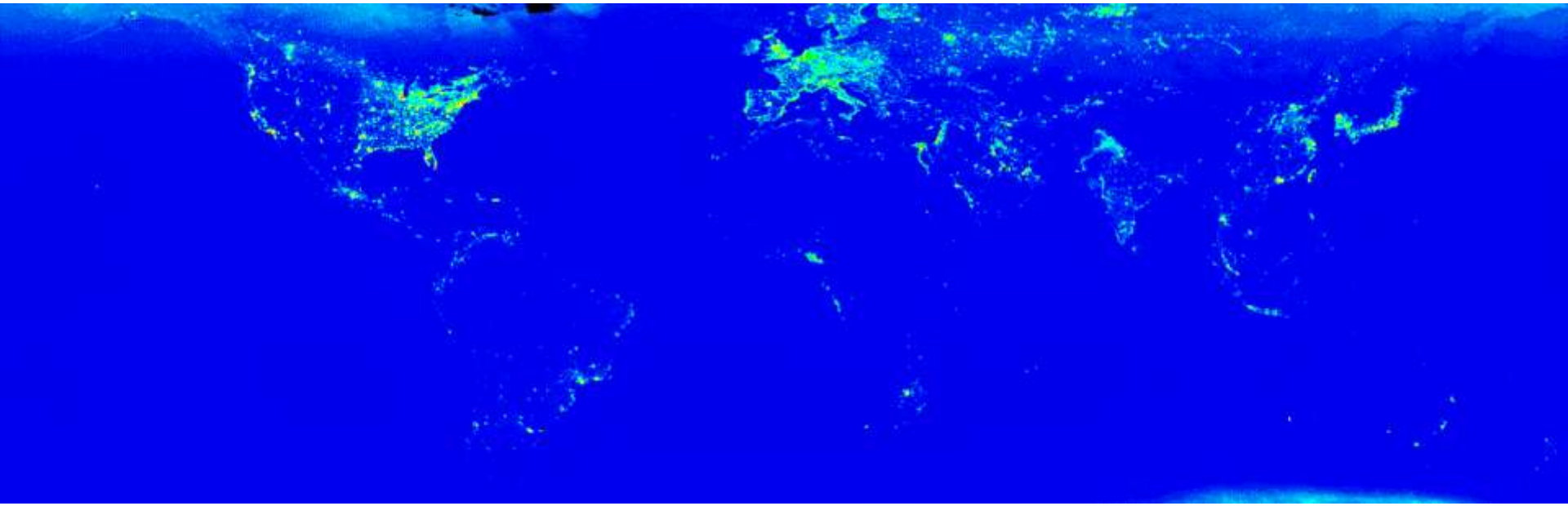
- Cloud coverage also matter to estimate of the observed exposure
- Info: UNAM (Mexico) stared intensive cloud studies (new work)

TOVS cloud presence





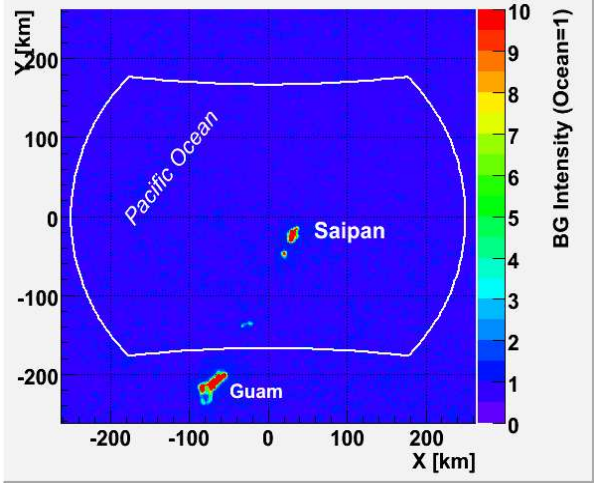
市街光



- **DMSP衛星による「夜の地球」の観測データベースから**
  - 30”角グリッド（~JEM-EUSOの<位置分解能>）での
    年間平均の可視光の強度データ

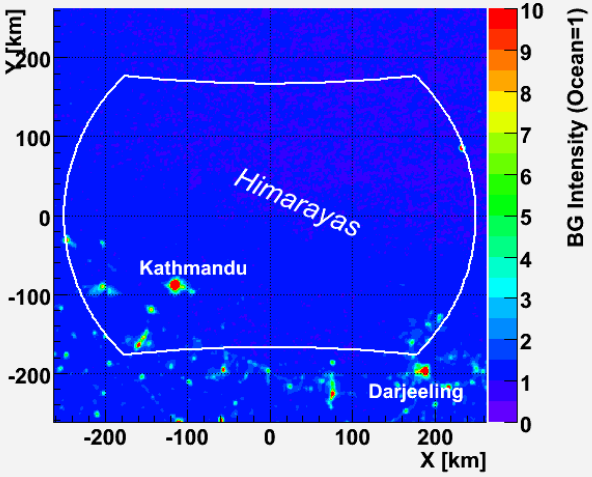
Saipan

サイパン近海



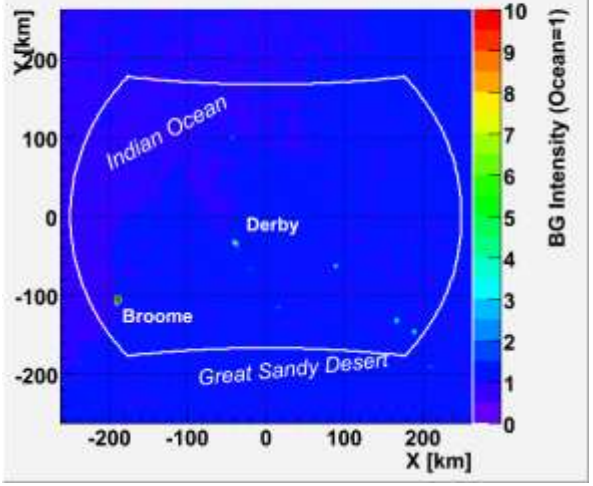
Himalayas

ヒマラヤ山脈



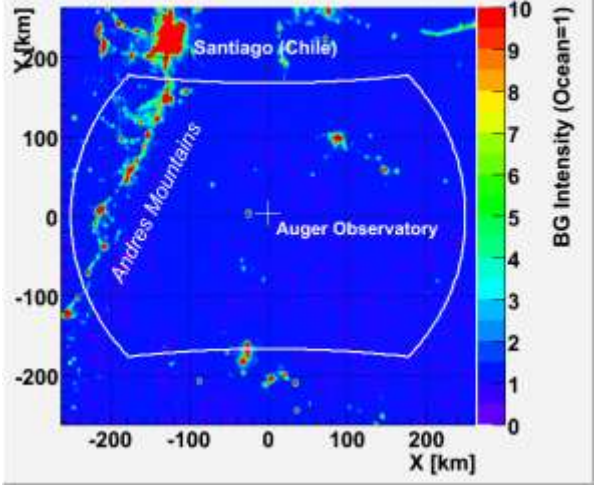
West Australia

西部オースラリア （砂漠）



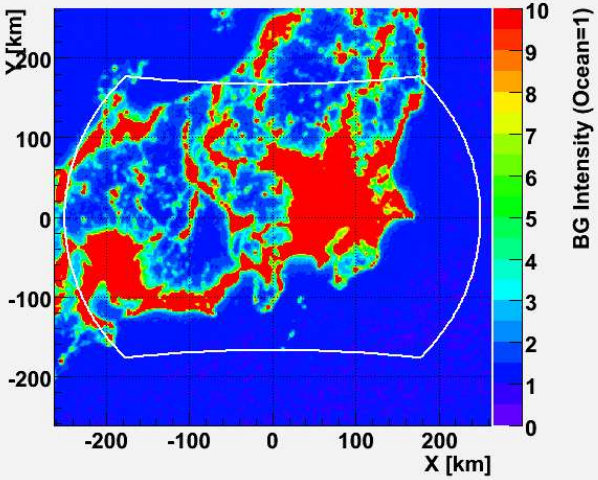
Auger

オージェサイト周辺 （草原）



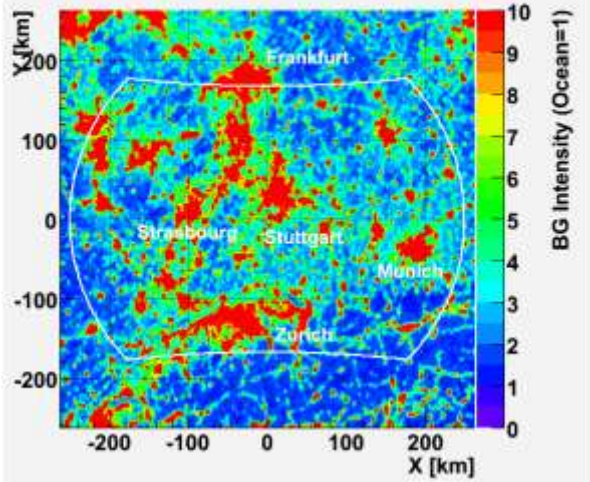
Tokyo

関東・東海



Central Europe

中部ヨーロッパ



- 小規模の街・都市部: 背景光の数倍程度以上の市街光
- 山岳地帯・砂漠・草原など: 海上からの背景光と同レベルの強度