

The Trasgo project

Present status and results

Damián García-Castro

On behalf of all TRASGO research groups

LabCAF, F. Física. Univ. Santiago de Compostela

Outline

- Cosmic rays: main detection techniques
- The Trasgo project:
 - Complete simulations of cosmic rays
 - TRAGALDABAS
 - TRISTAN
 - MuTT
 - Forthcoming detectors: STRATOS
- Summary

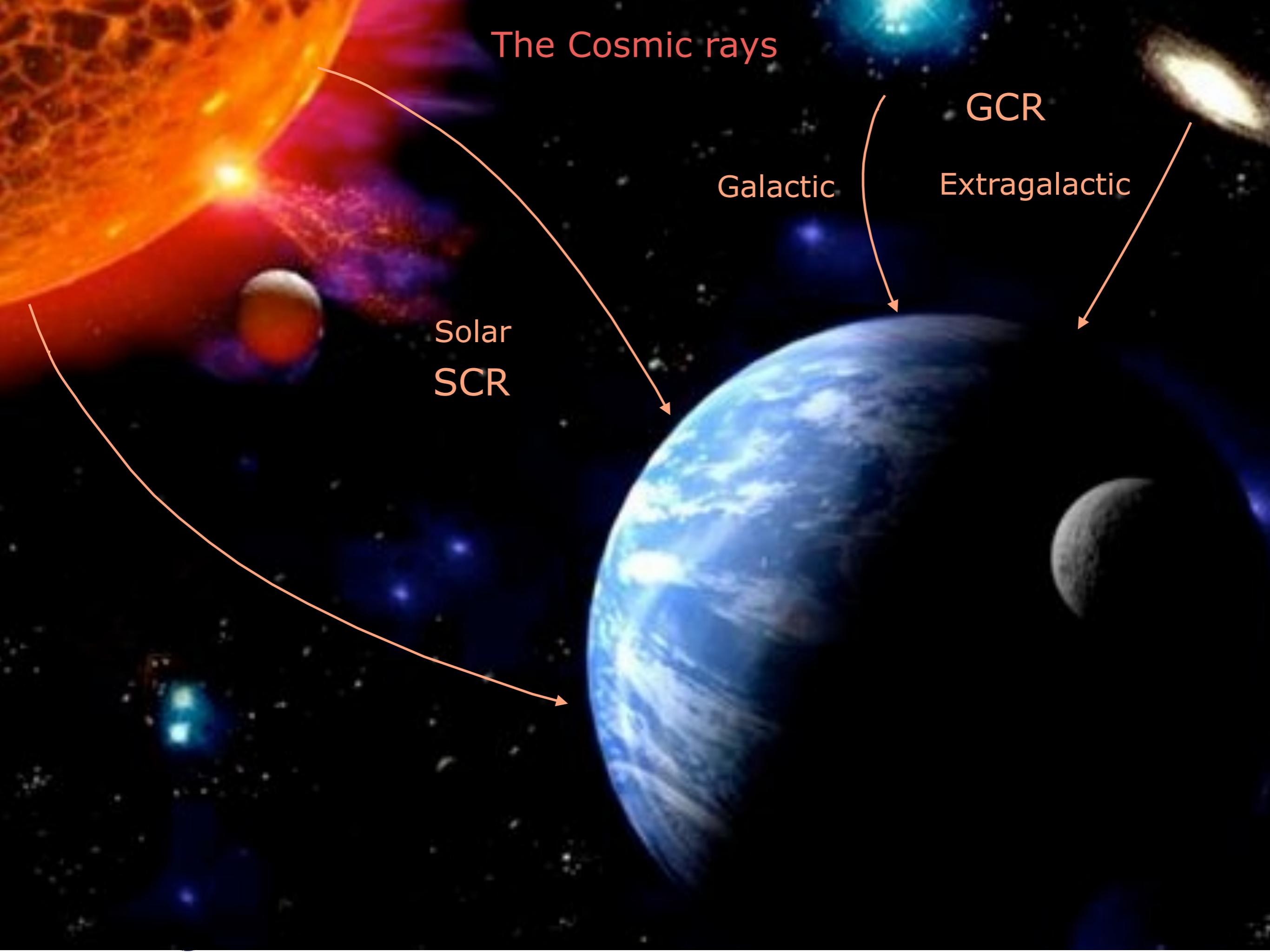
The Cosmic rays

Solar
SCR

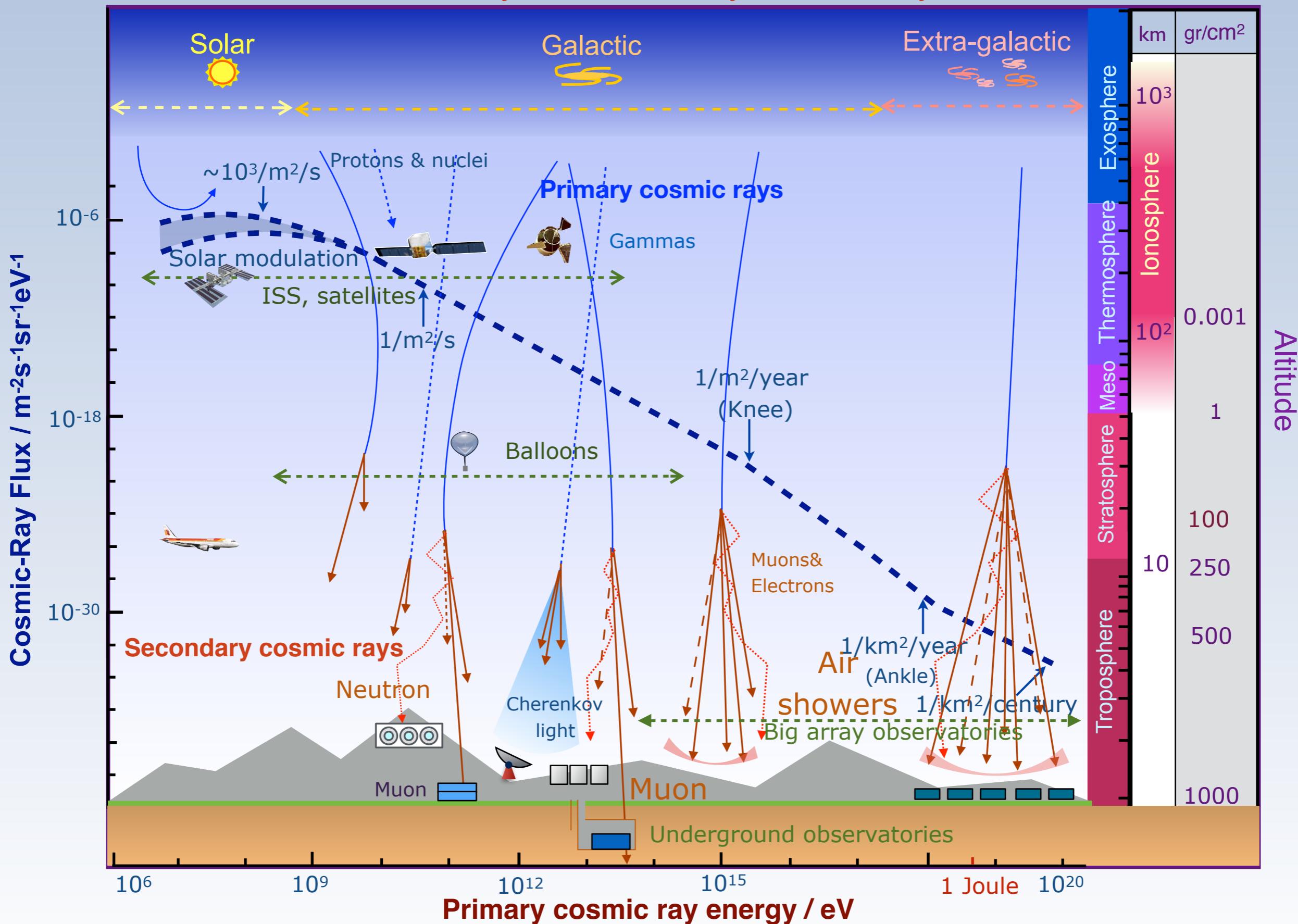
Galactic

GCR

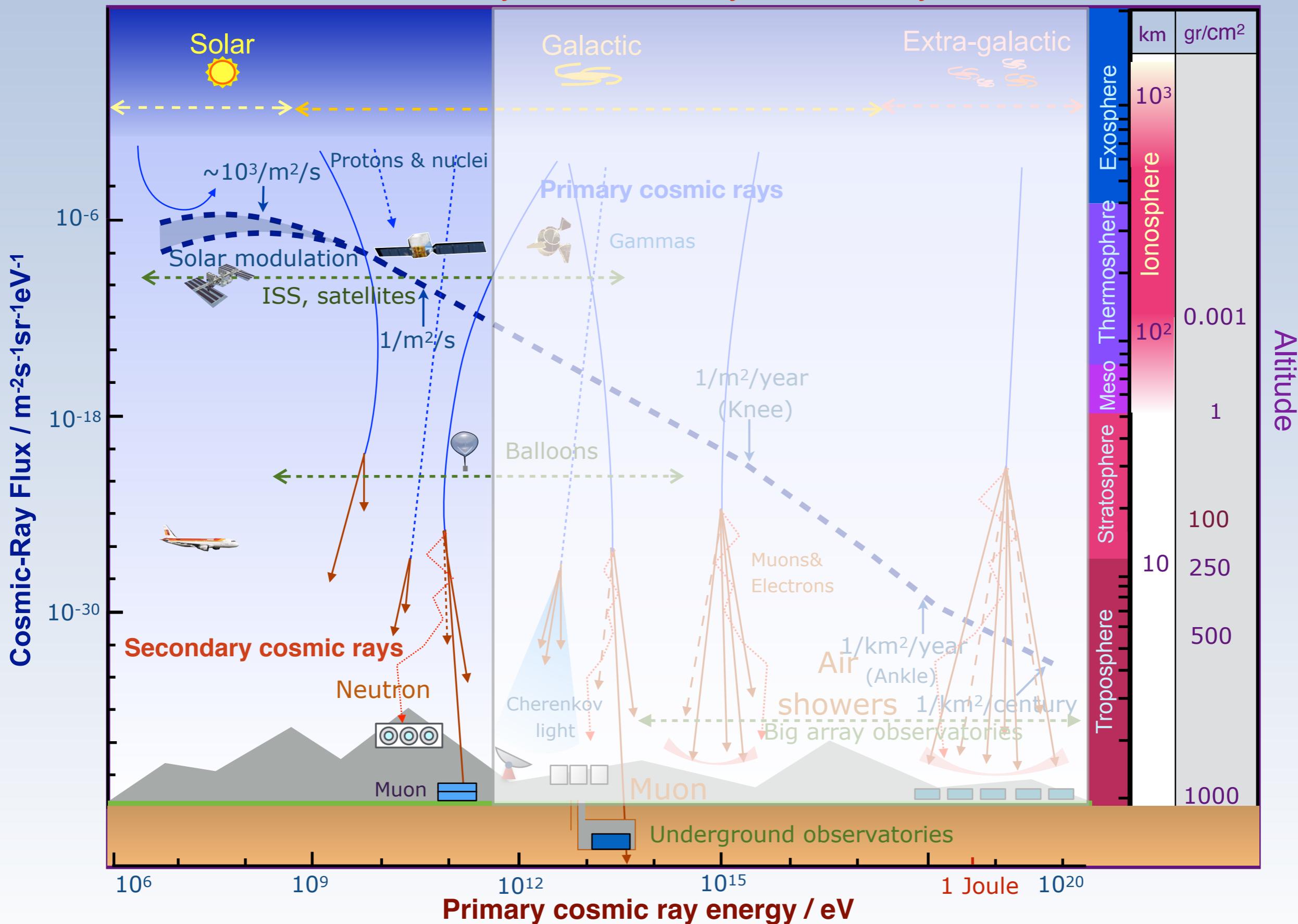
Extragalactic



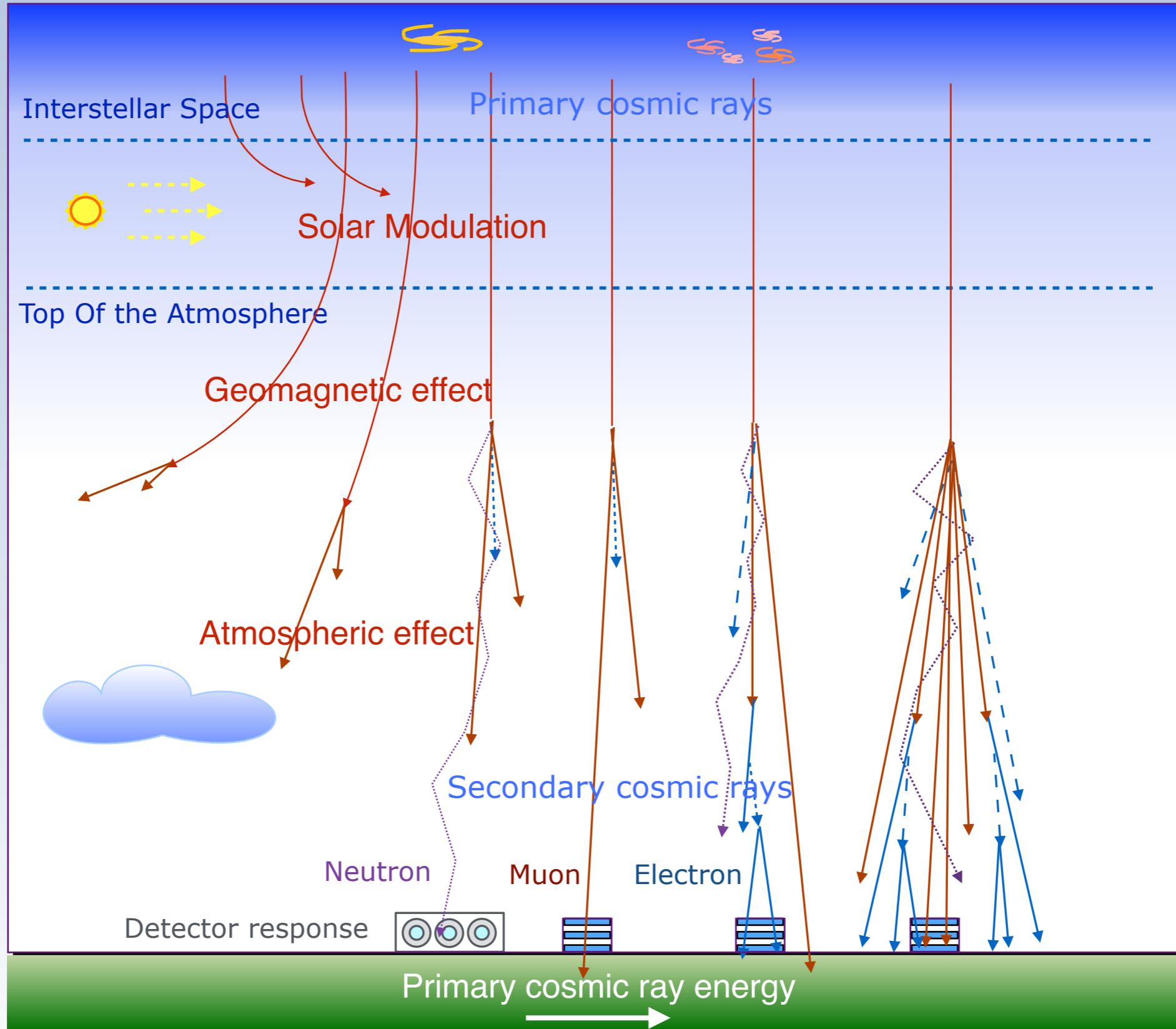
Primary and secondary Cosmic Rays



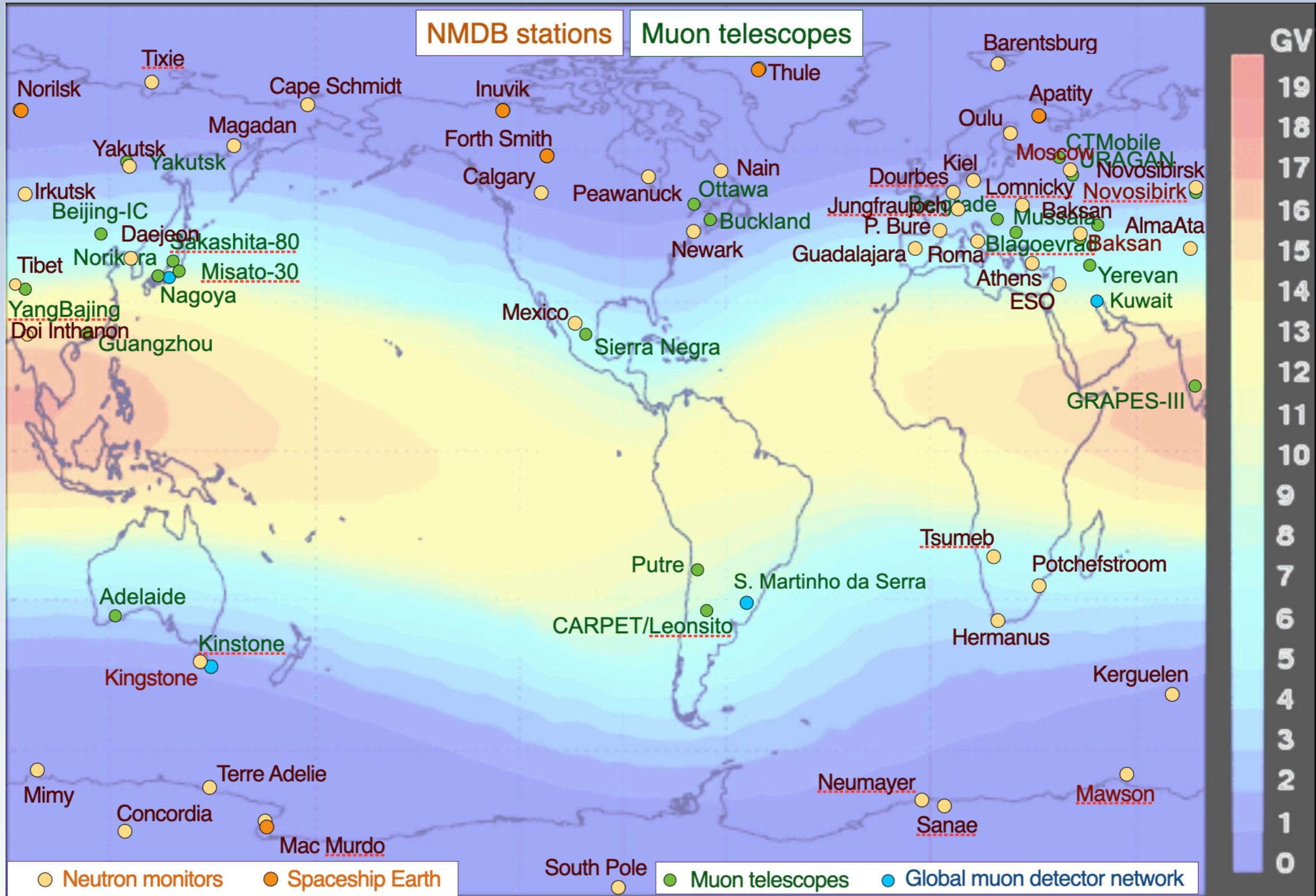
Primary and secondary Cosmic Rays



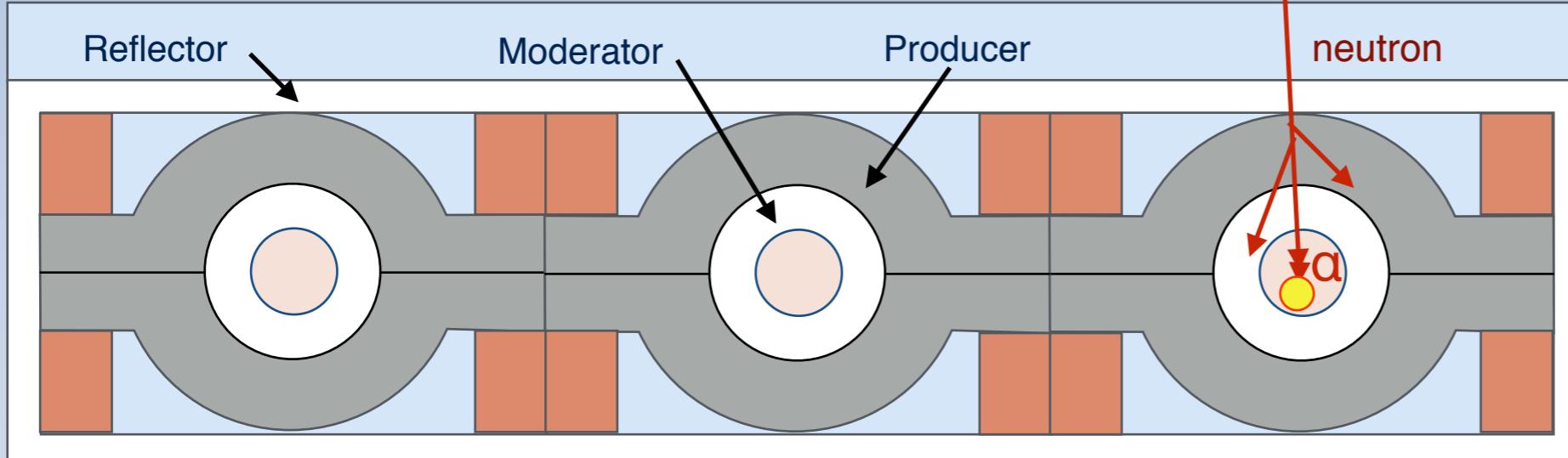
Secondary Cosmic Rays measurement : Main effects



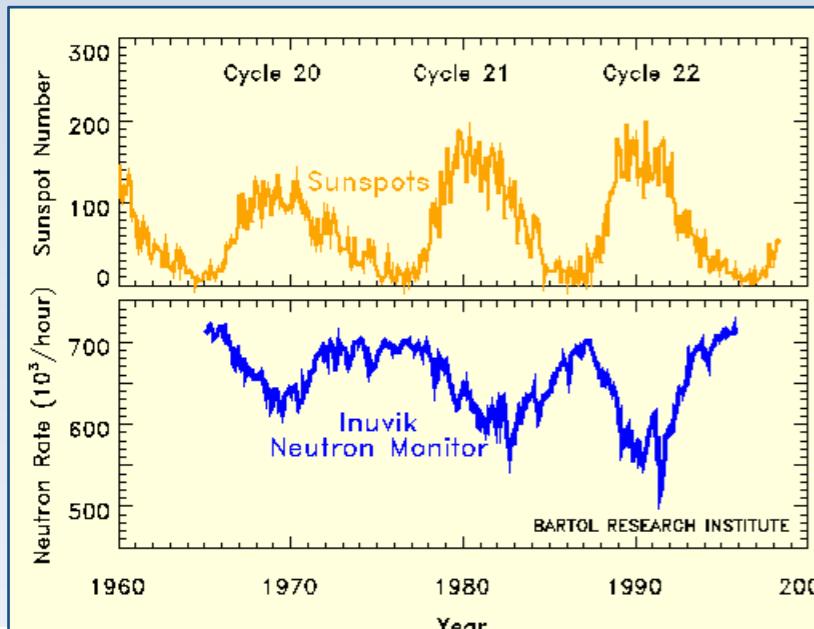
Main Cosmic Ray Stations around the world



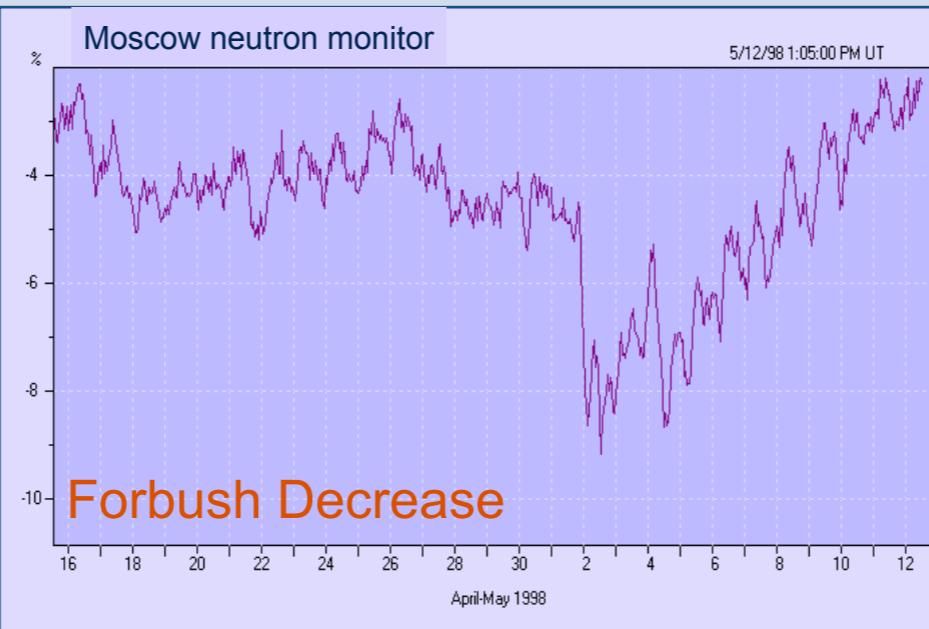
Neutron monitors



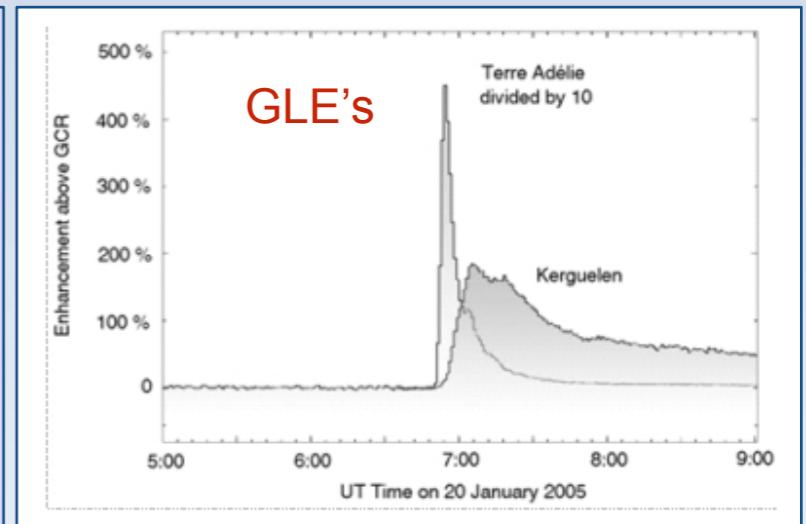
Standard layout: International Geophysical Year 1957 design (^{10}B or ^3He models)



Solar activity: sunspot number (up)
and neutron rate (down)



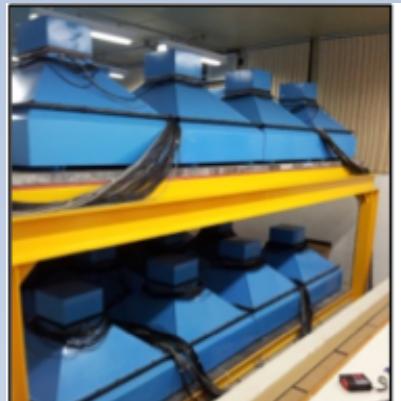
Solar Forbush Decreases associated with a
big CMEs (Coronal Mass Ejection)



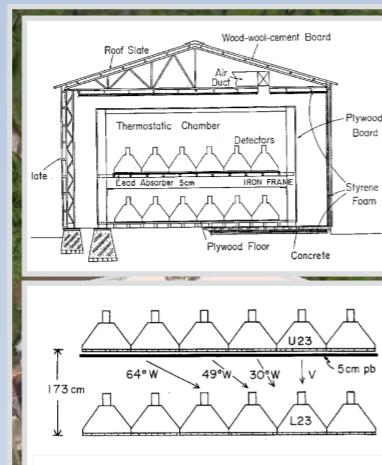
GLEs (Ground level enhancement)
measured by the Kerguelen and
Terre Adelie neutron monitors

Sensitive to integrated low energy CR flux. Optimal detectors for solar activity survey

Muon Telescopes



S. Martinho da Serra



Nagoya



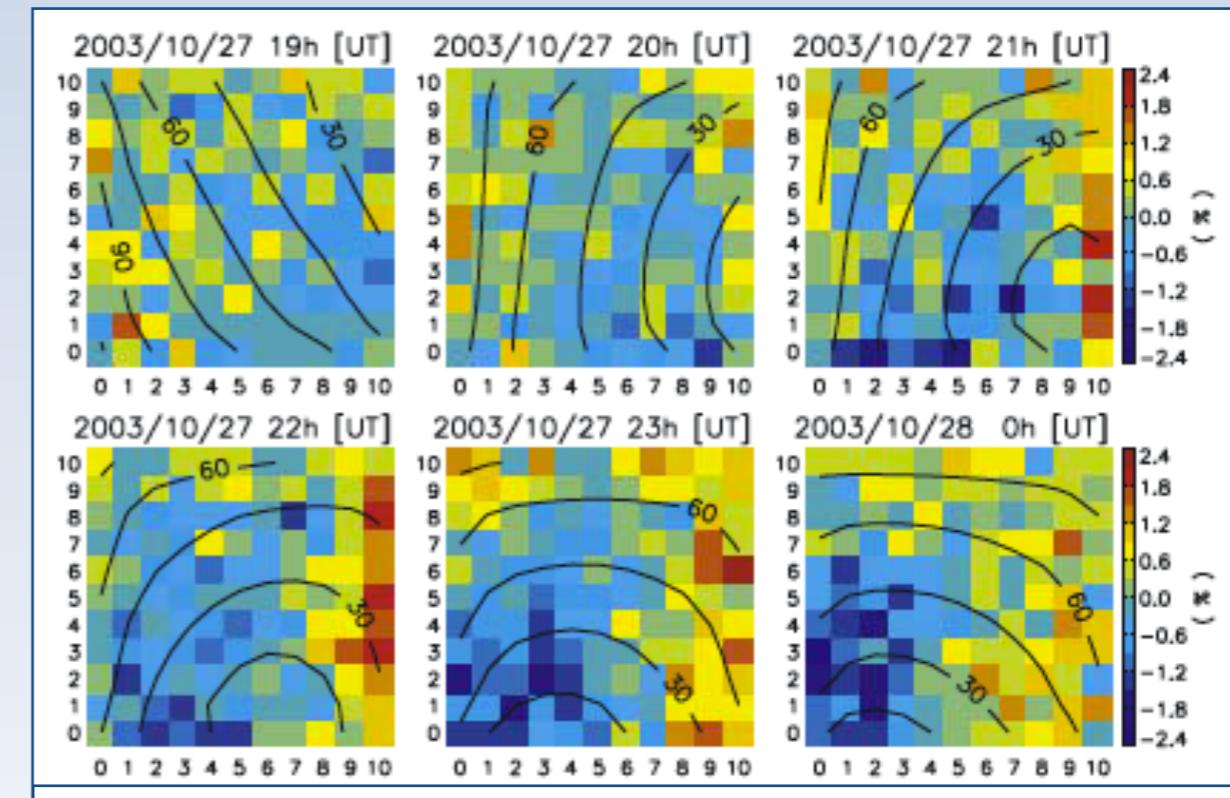
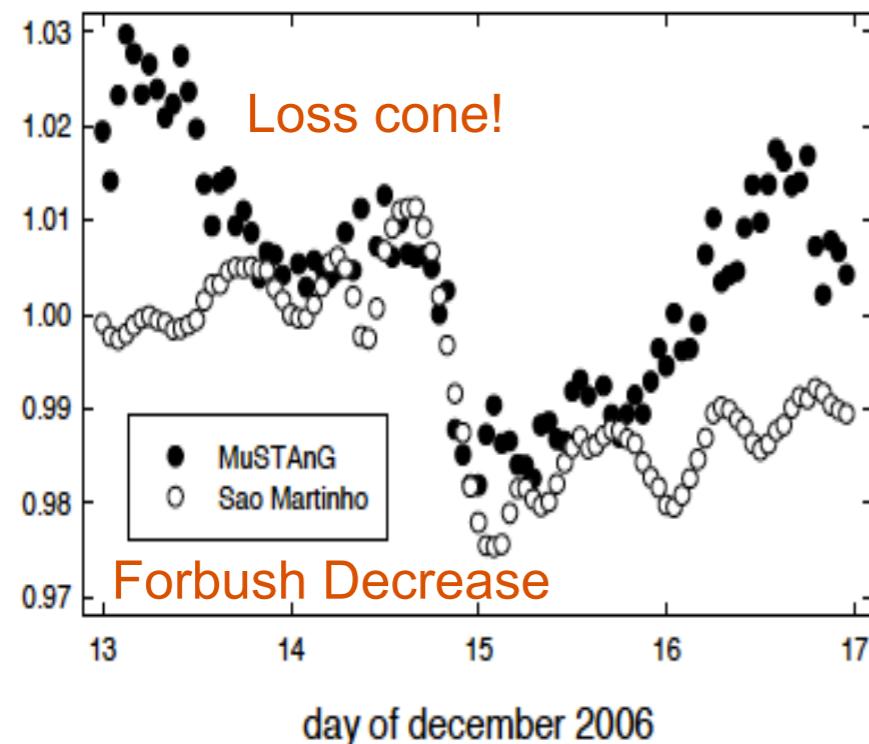
Hobart



Kuwait

Different techniques and layouts (Mainly scintillator detectors or proportional counter tubes)

MuSTAnG — Muon Spaceweather Telescope for Anisotropies at Greifswald



Directional detectors. Sensitive to forecasting the arrival direction of solar plasma clouds

The NEVOD-URAGAN complex

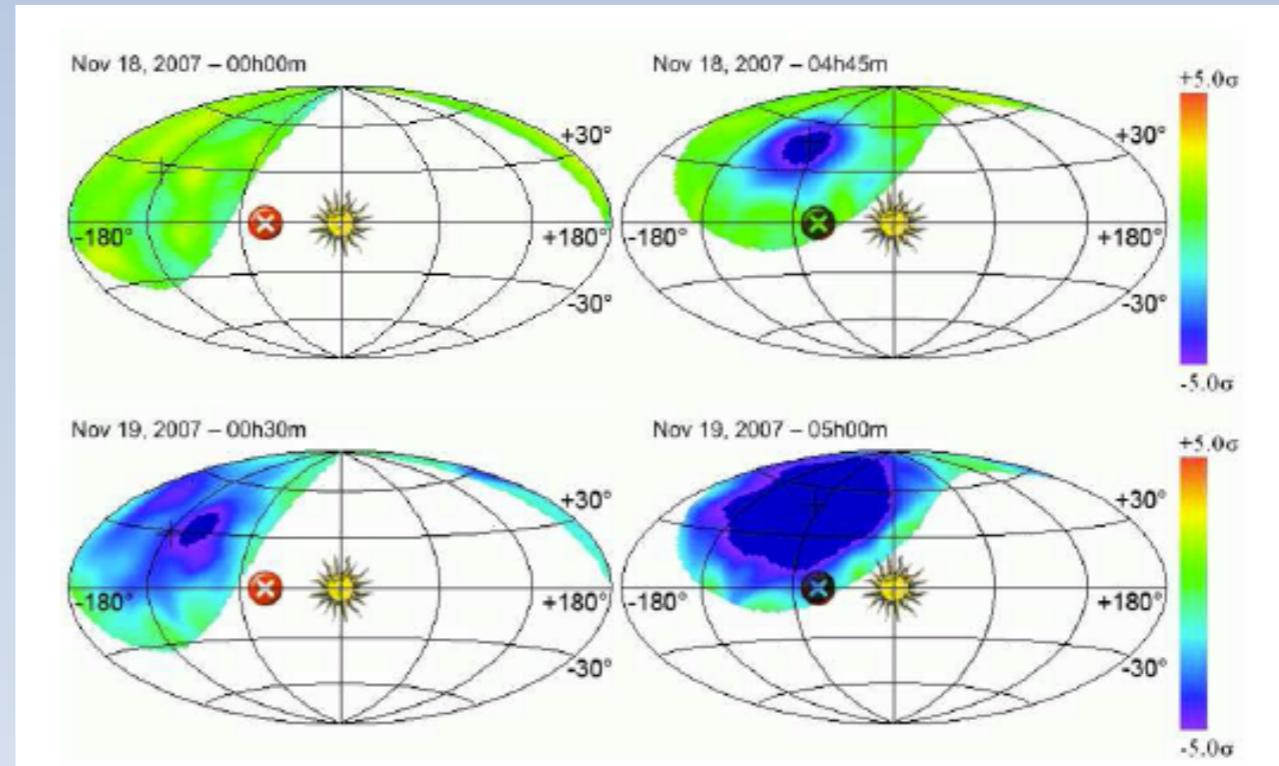
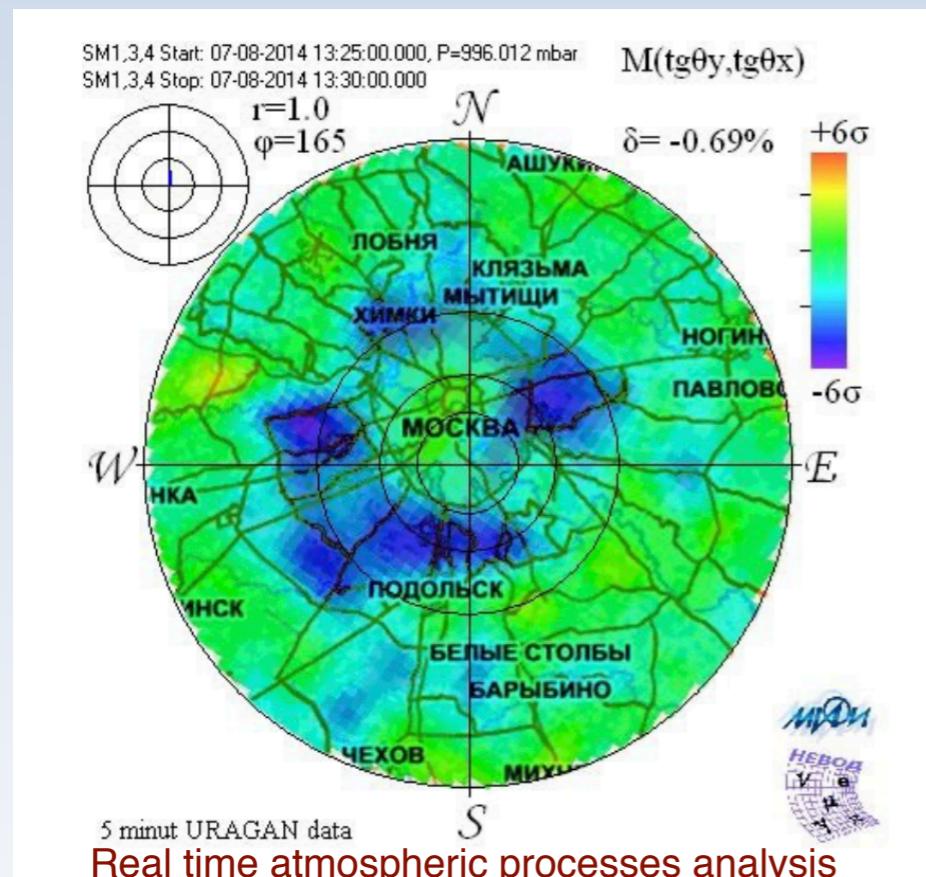
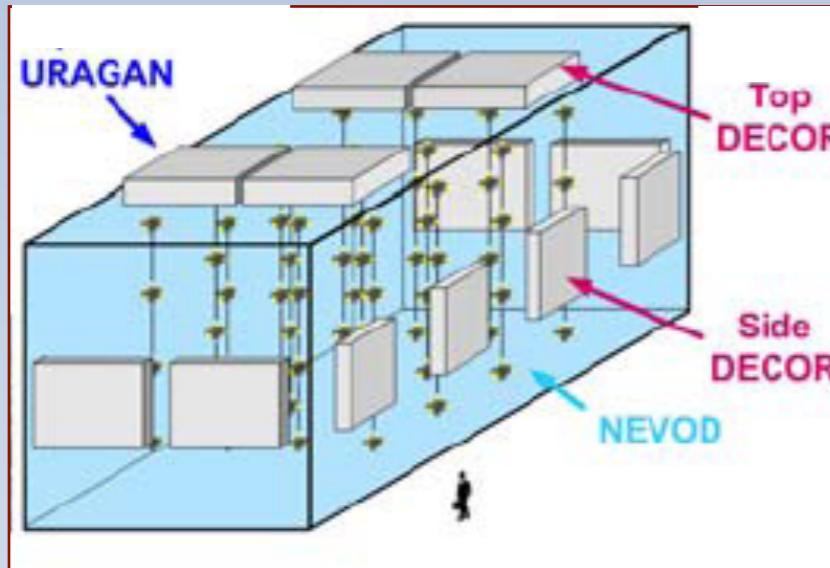
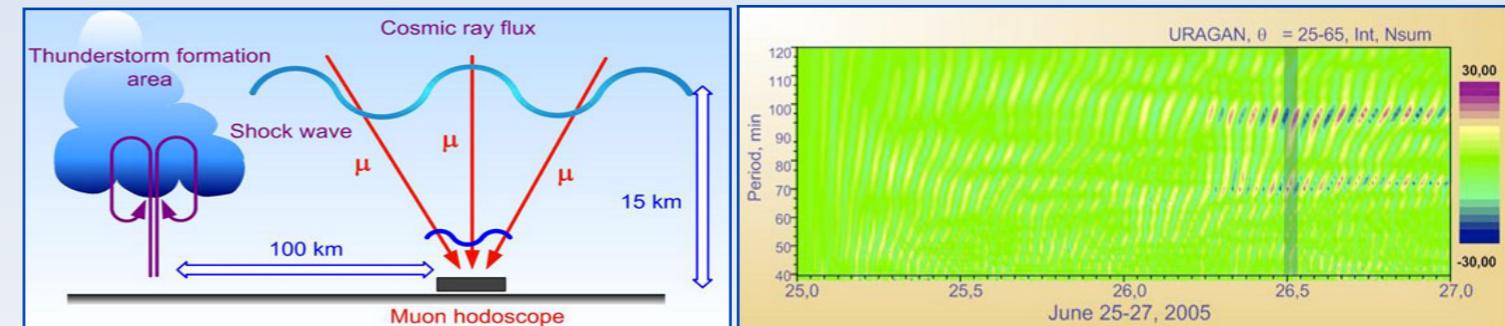


Figure 2. GSE-images of magnetic cloud approaching the Earth obtained by means of muon hodoscope URAGAN. Circle with X-sign denotes direction to IMF line; the Sun direction is pointed in centers of images.

FD detection and imaging in Geocentric Solar Ecliptic Coordinates



Wavelet transformation of URAGAN muon rate during June 25–27, 2005.

URAGAN as thunderstorm detector

The Nevod-URAGAN complex shows how a single detector could cover several research fields



The TRASGO project

About Trasgos:

In the previous scenario of cosmic rays detection techniques, the TRASGO project aims the development of compact, high resolution and affordable detectors for the regular survey of the cosmic rays background, either as stand-alone detectors or in small arrays.

Main features:

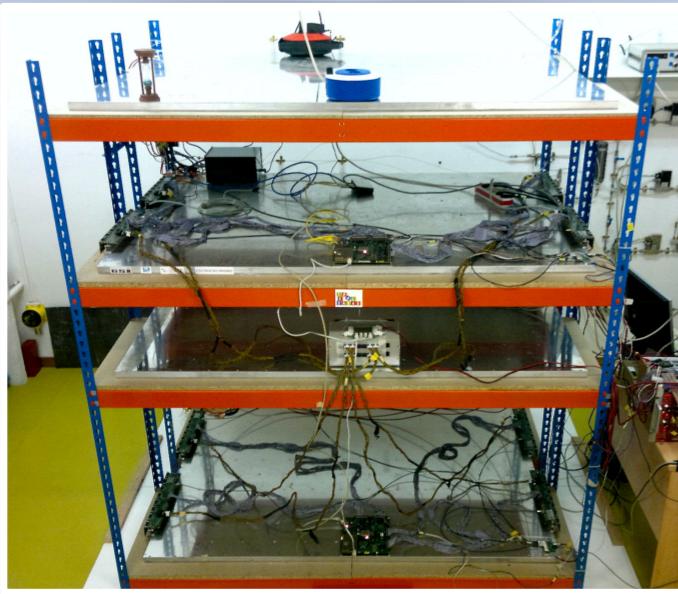
- RPC (Resistive Plate Chambers) based tracking detectors
- Muon / Electron PID capability
- Sensitive to clusters or bundles of particles (mainly electrons and muons)

Main research fields:

- Solar activity and space weather
- Tomography
- Geomagnetic field
- Atmosphere studies

The TRASGO project

TRAGALDABAS : Santiago de Compostela, Spain



TRISTAN : JCI Spanish Base, Antarctica



MUTT : Vigo, Spain

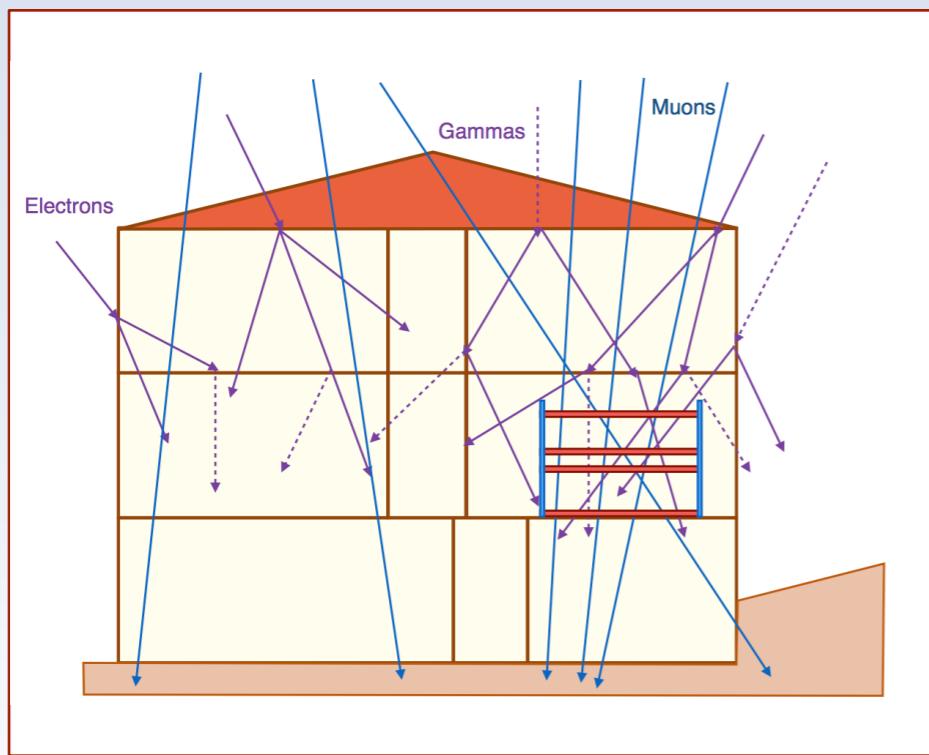
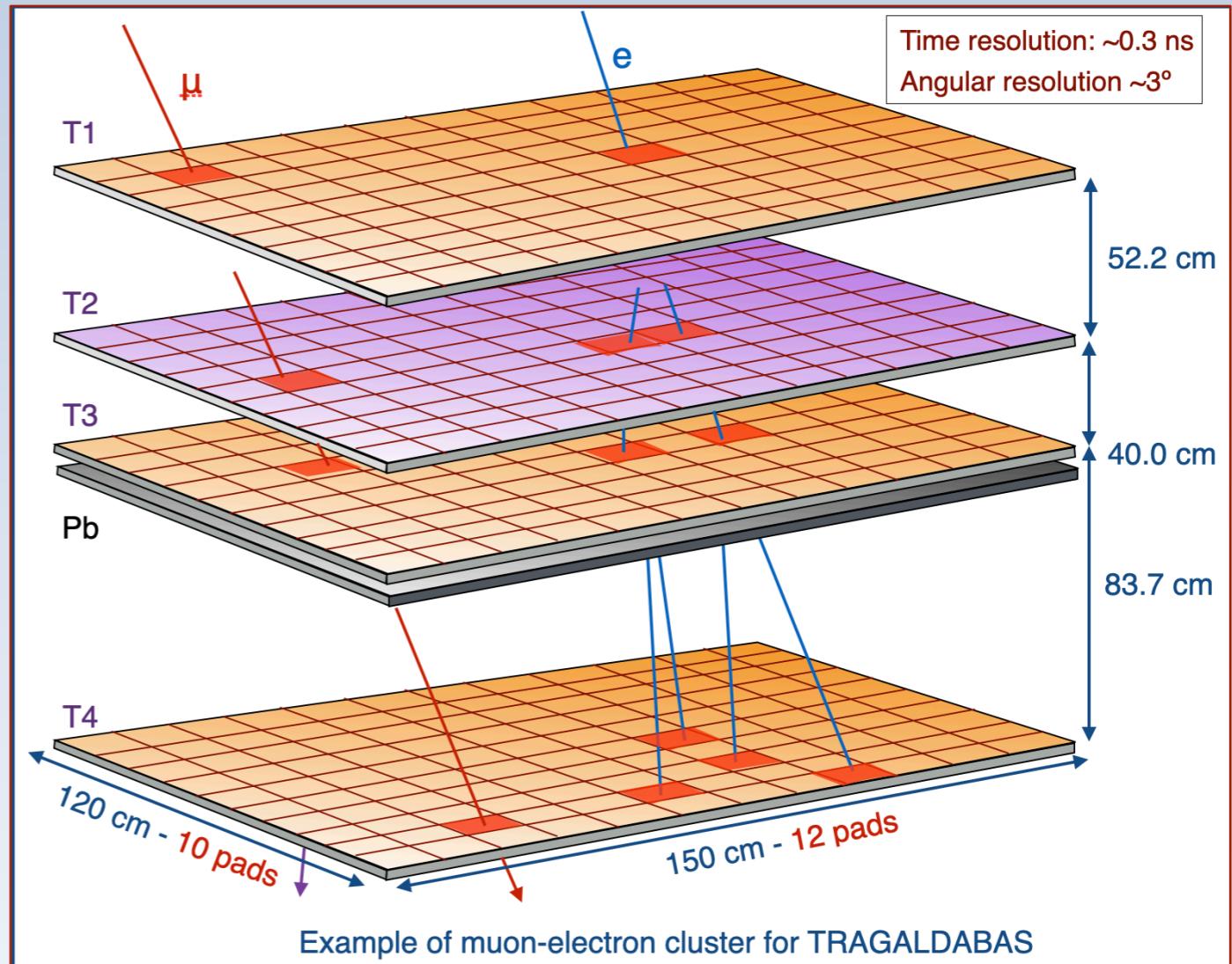
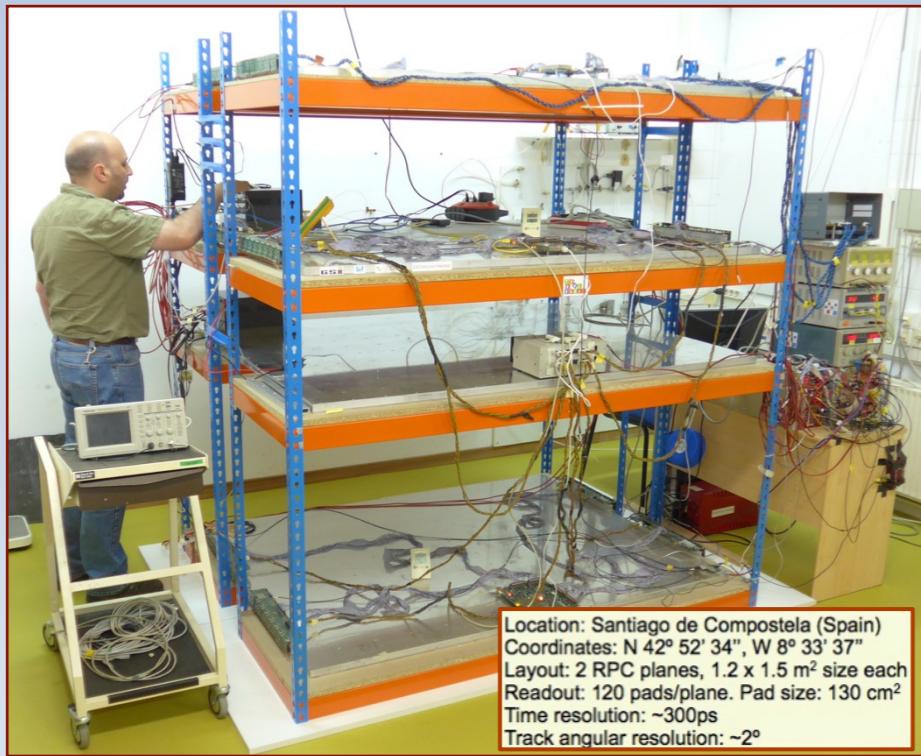


STRATOS : Vigo, Spain



The TRASGO project

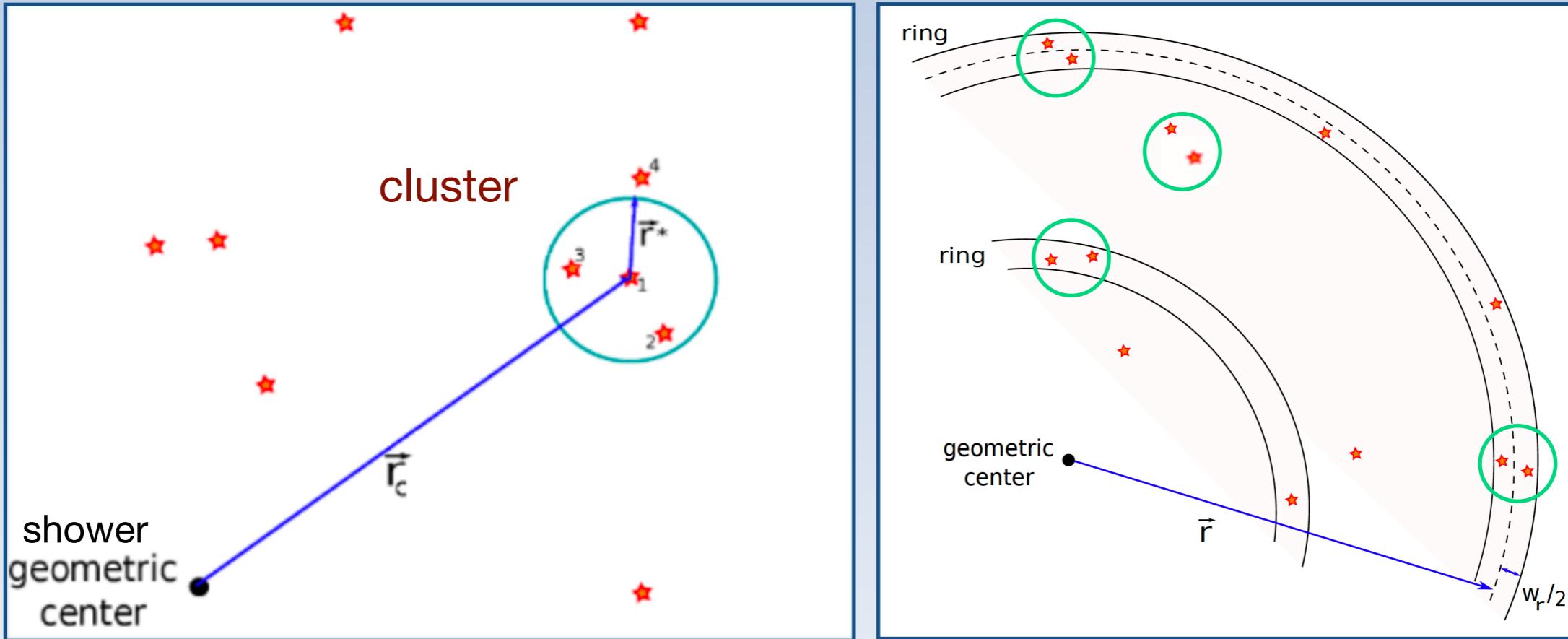
The TRAGALDABAS detector



The TRASGO project

The TRAGALDABAS detector. Cluster simulation

Simulation of the properties of single particles and clusters of particles (muons and electrons) arriving closely.



Simulation package: Corsika 7.7400. Interaction model: GGSJET (Fluka is foreseen for later studies)

Energy cuts / GeV: 0.3 0.1 0.05 0.05 (hadrons, muons, electrons, gammas)

Observation level: 235m (S. Compostela, ES) and 2820 (Tunja, CO)

Primary Particles: P, ${}^4\text{He}$, ${}^{12}\text{C}$ and ${}^{56}\text{Fe}$

Incident zenith angle: (0°, 25.8°)

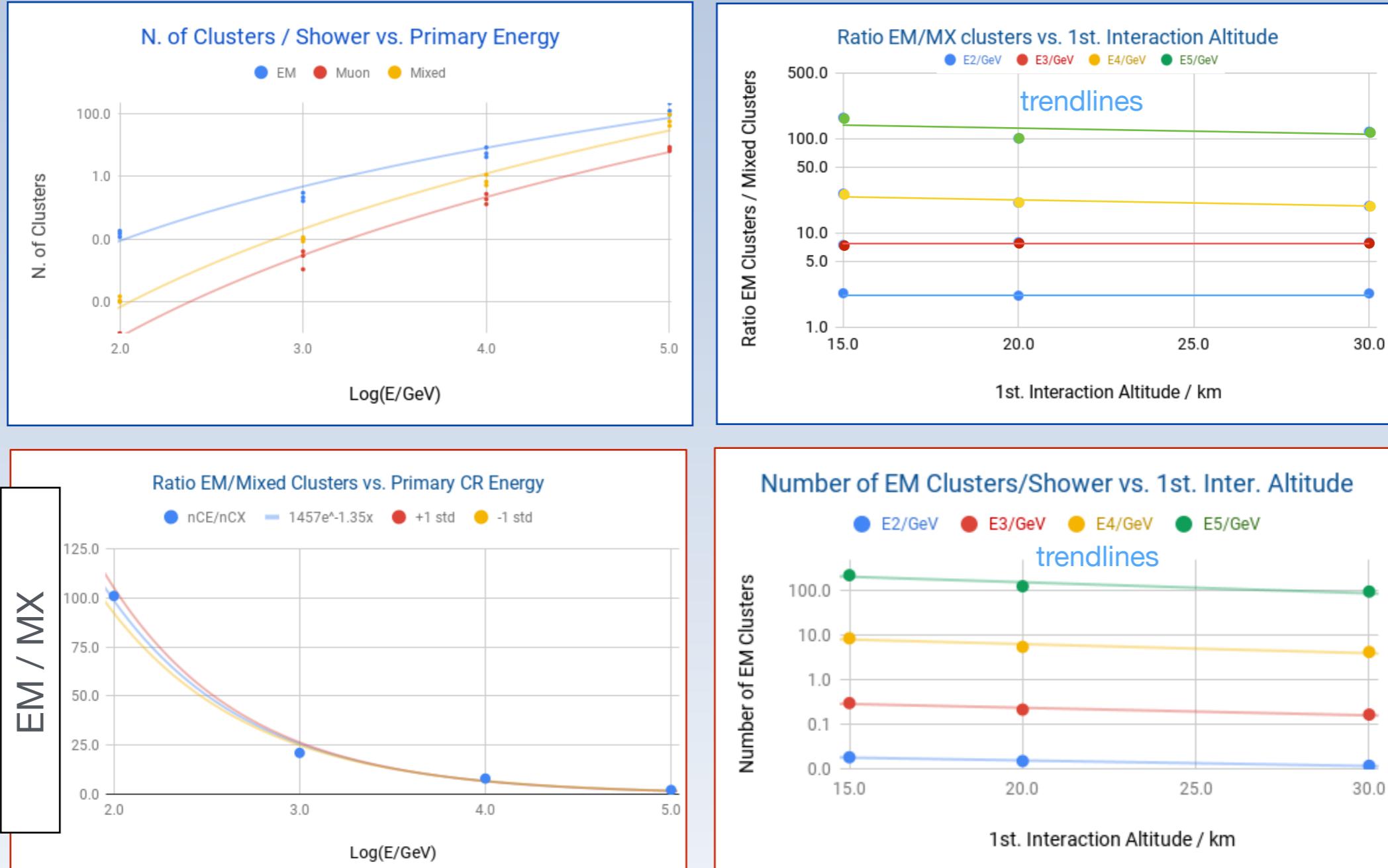
Energy range / GeV: 10 - 10^5

Height of 1st. Interaction: 15, 20 and 30 km

Main clusters: EM (> 1 electrons)
MU (> 1 muons)
Mixed of MX (1 electron + 1 muon)

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The TRAGALDABAS detector. Cluster simulation

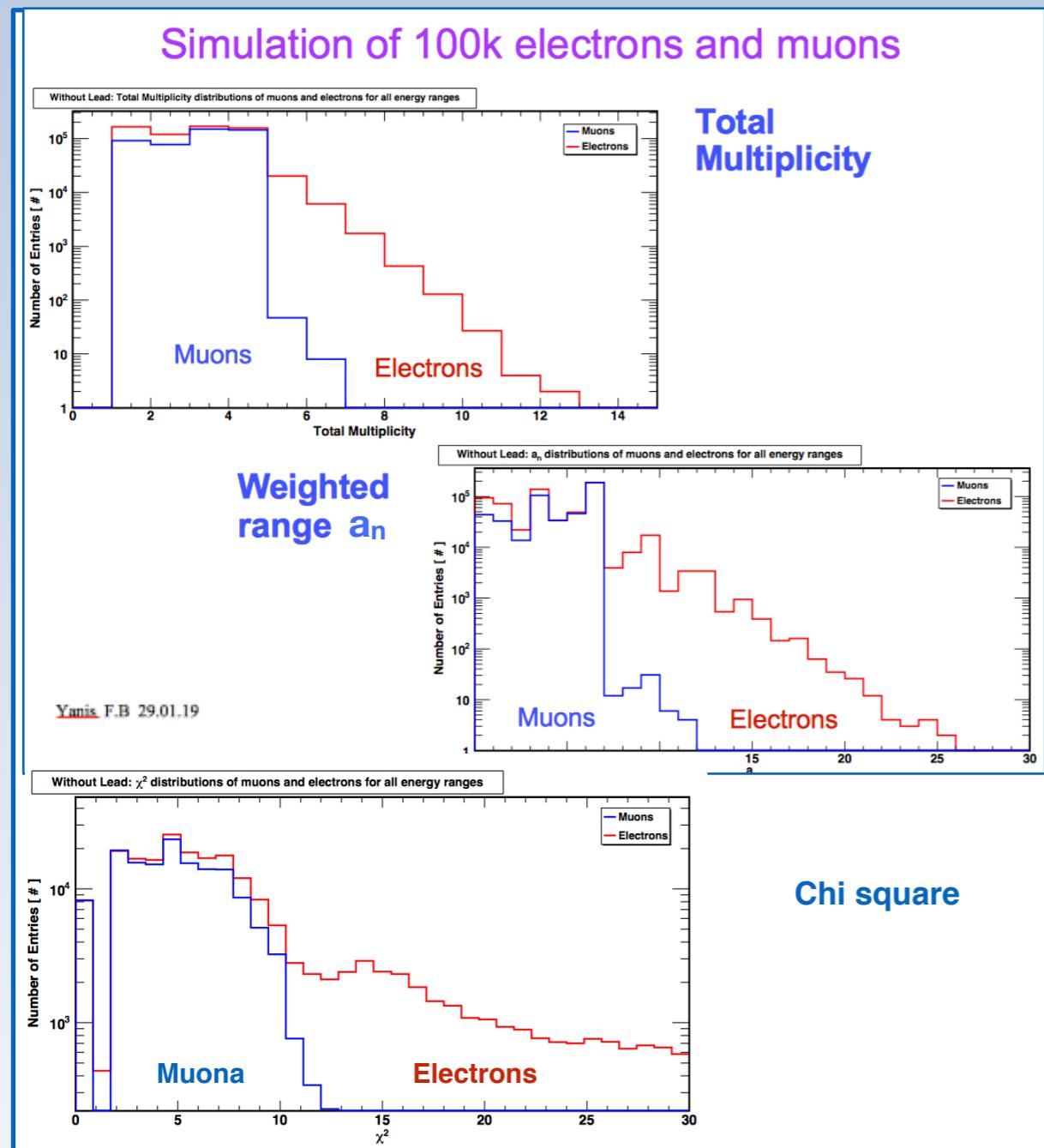


- Ratio of EM/MX is very sensitive to the energy of the primary cosmic rays.
(~a new proxy for the solar modulation?)

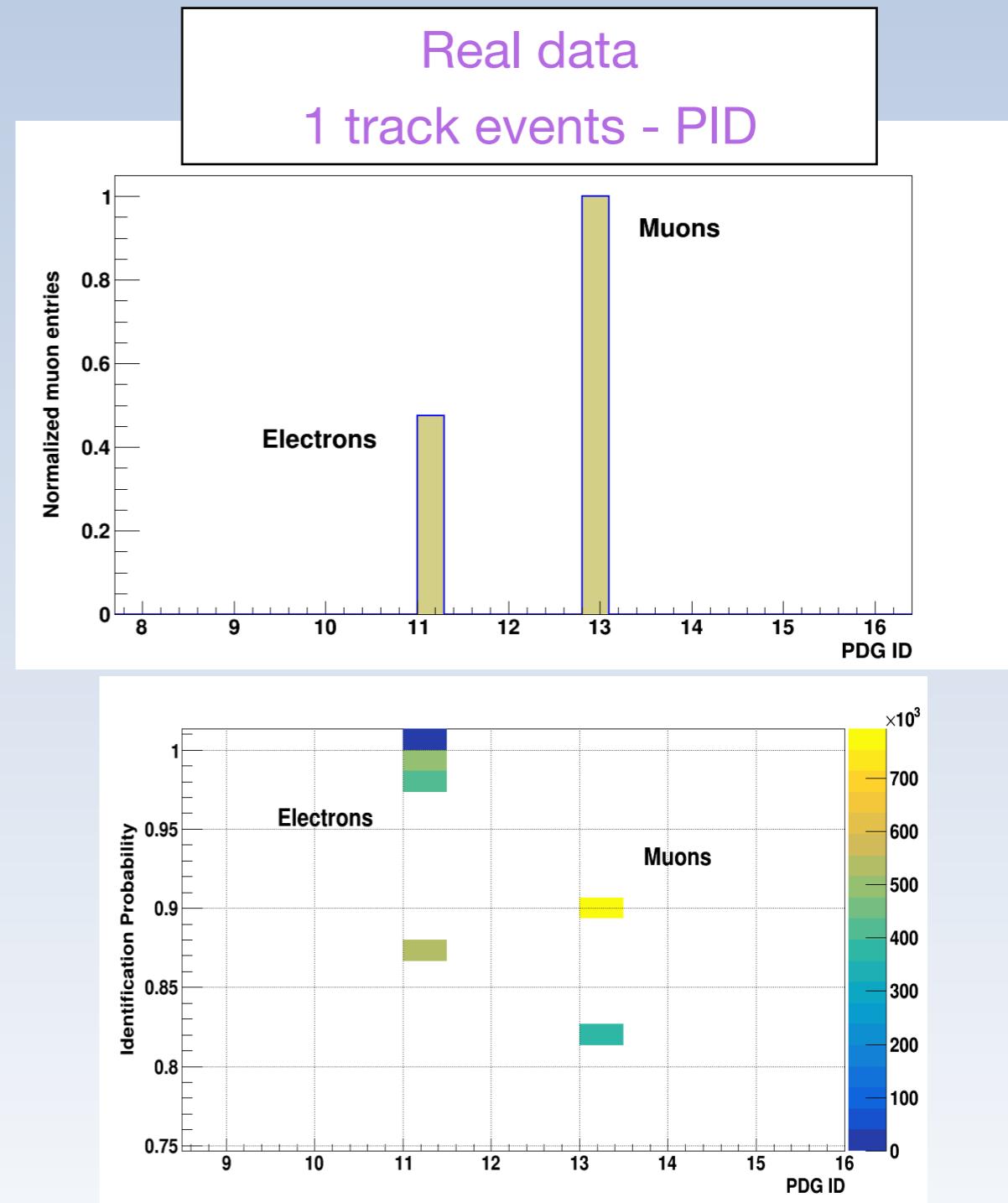
- Nb. of EM Clusters/Shower seems to decrease with the altitude of the first interaction.
(~a good proxy of the stratosphere temperature?)

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The TRAGALDABAS detector. Particle Identification - PID



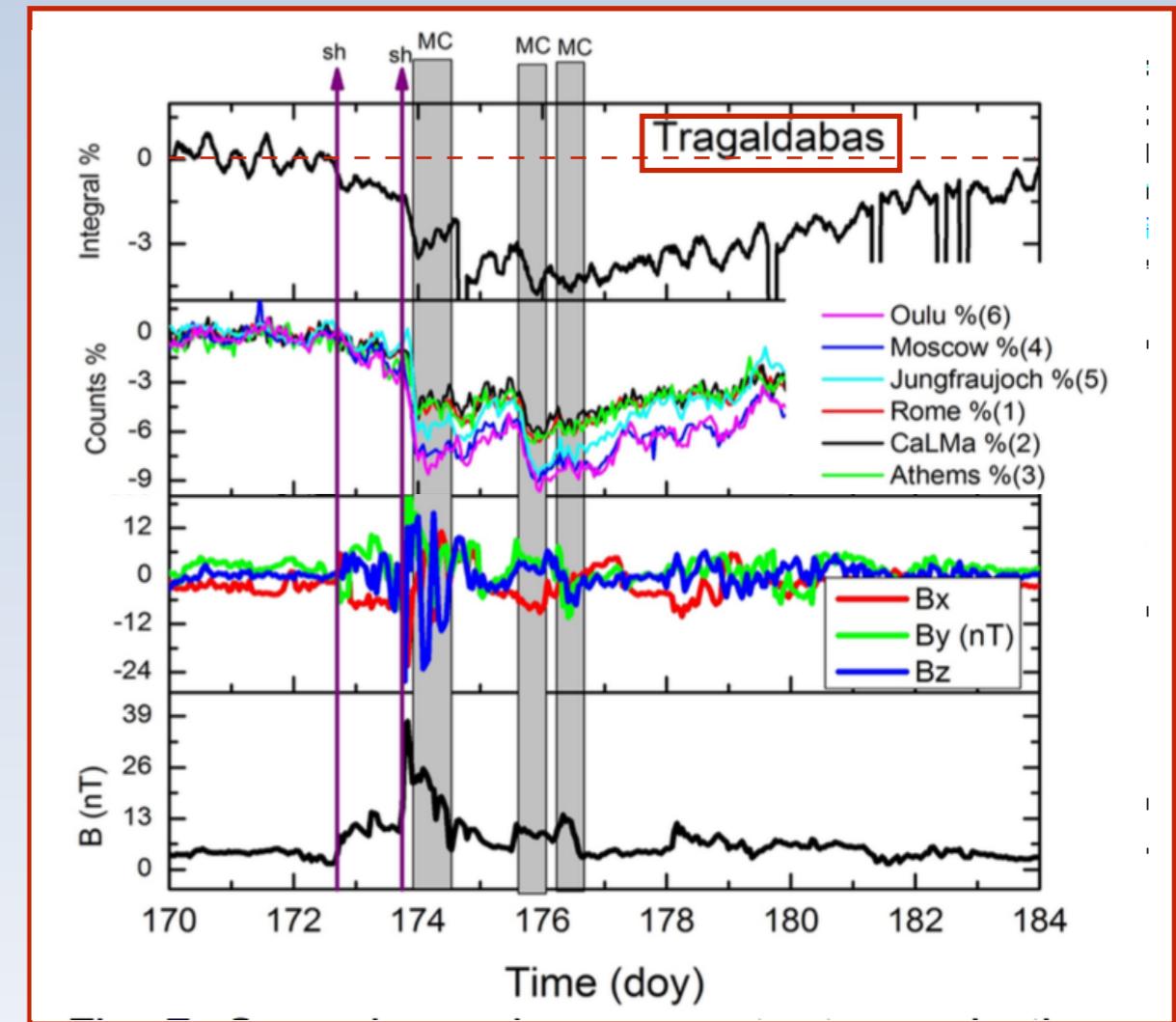
Multiplicity, Weighted range and χ^2 dist. for muons and electrons



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The TRAGALDABAS detector : Forbush Decrease

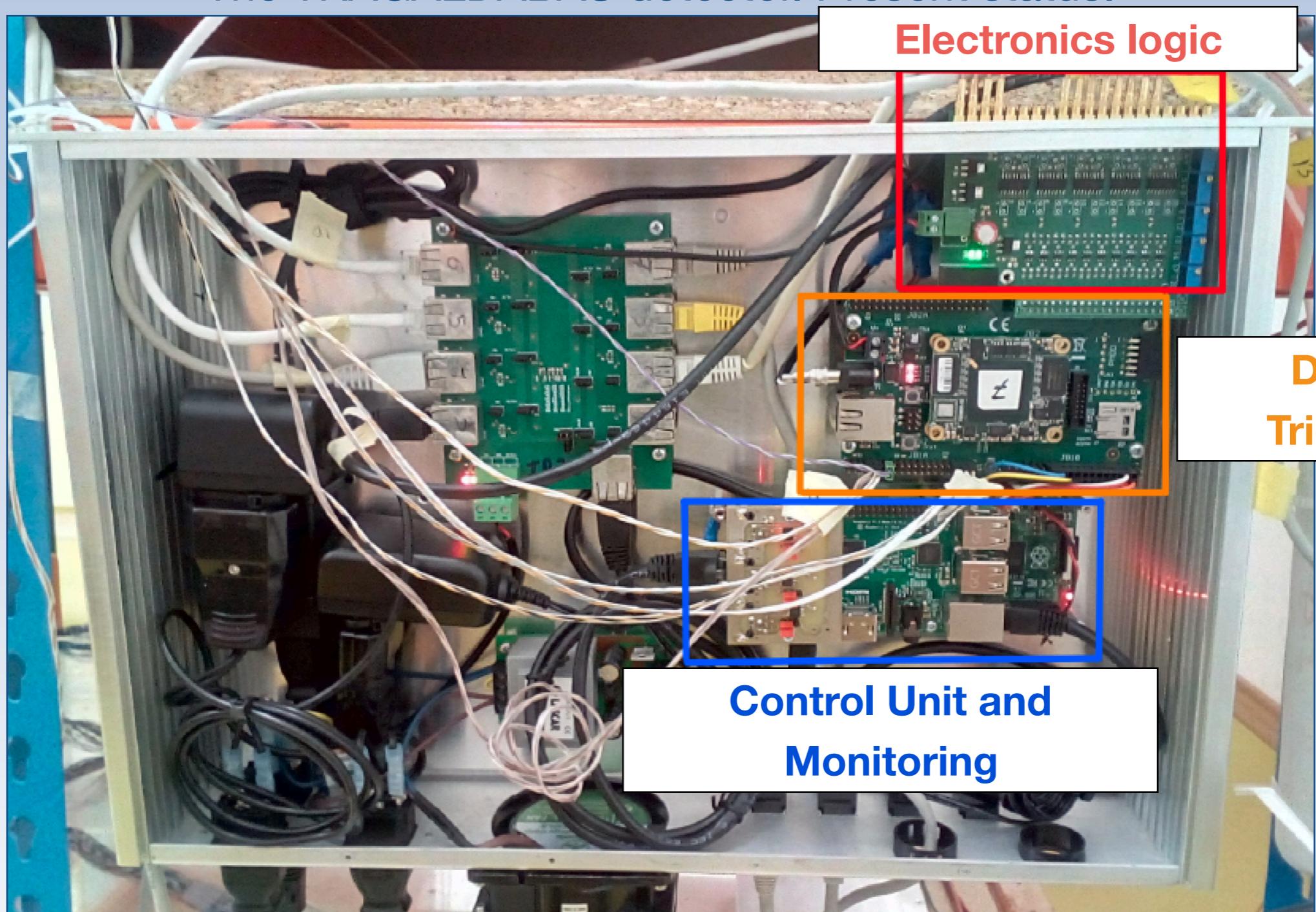
The Forbush Decrease of June 2015



Comparison with other neutron monitors.

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The TRAGALDABAS detector. Present status.

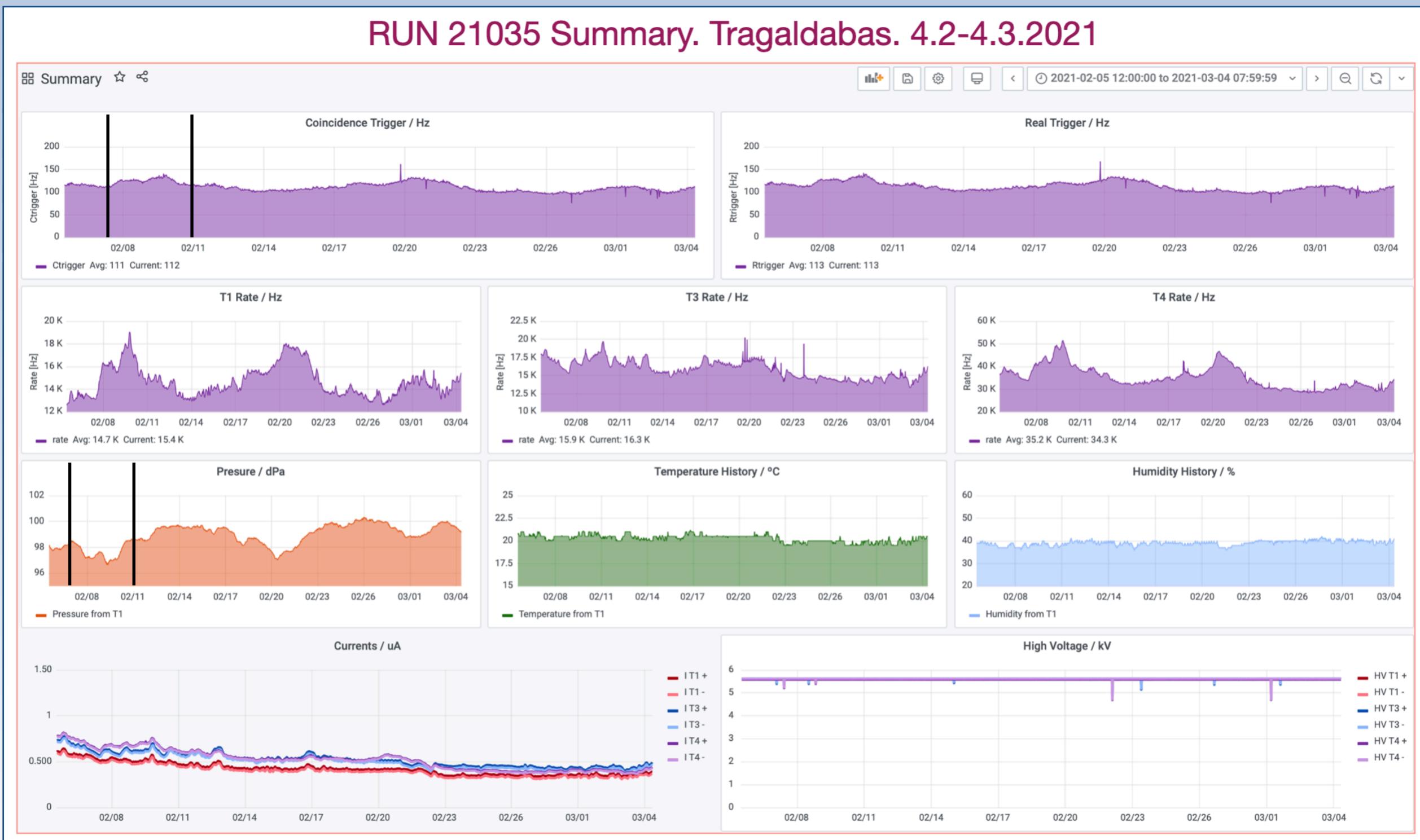


We removed the old NIM modules and implemented an improved DAQ (Data Acquisition) system based on a FPGA (Field Programmable Gate Arrays) allowing any type of trigger logic: 2 plane coincidence, 1 plane multiplicity or others

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The TRAGALDABAS detector. Present status.

RUN 21035 Summary. Tragaldabas. 4.2-4.3.2021

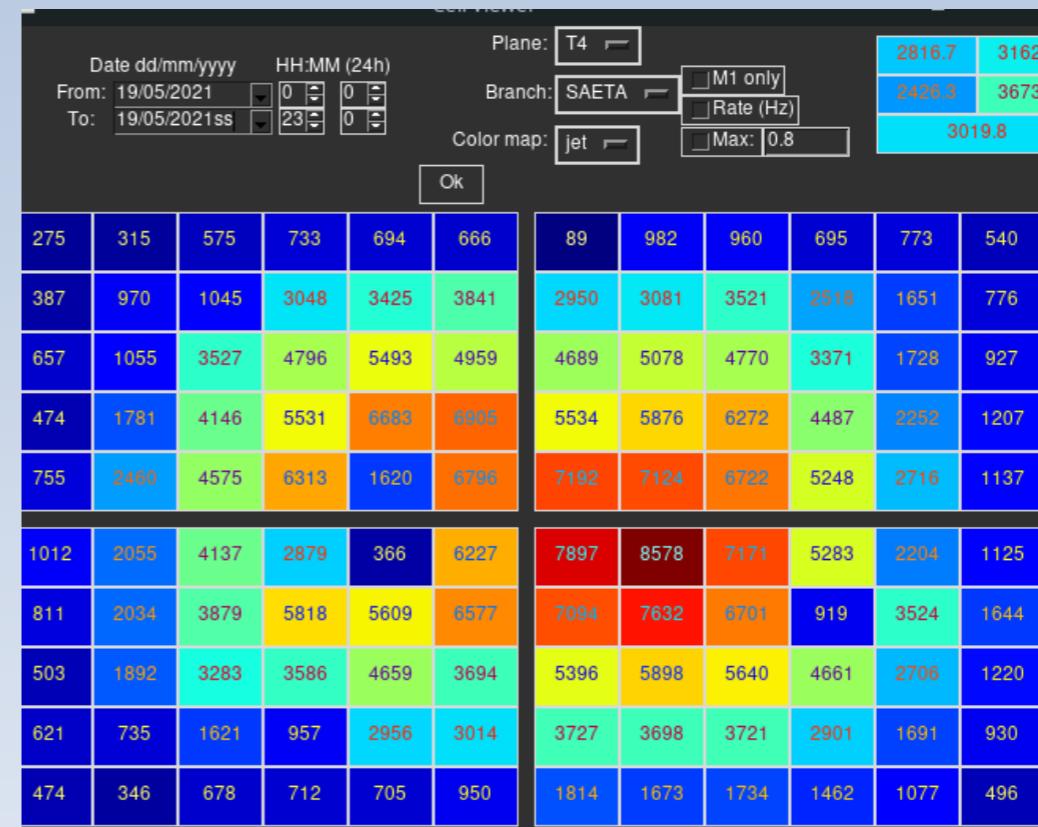


Run summary

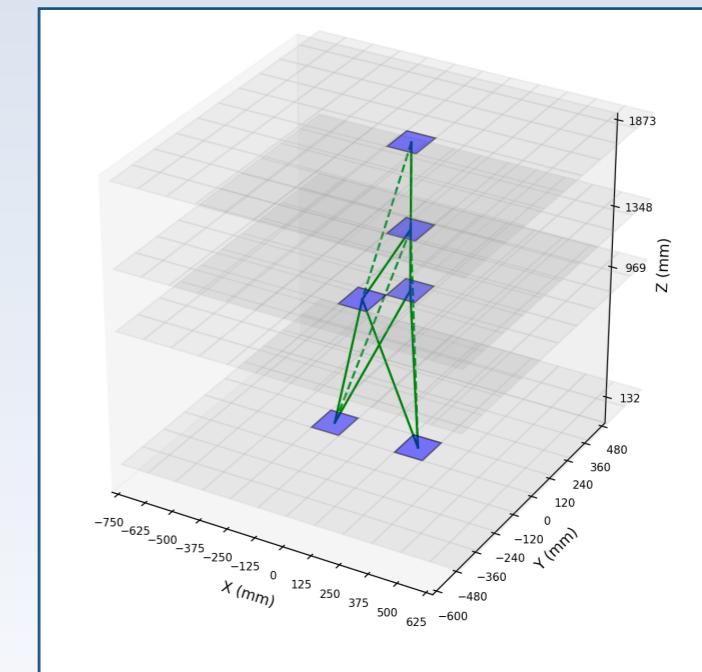
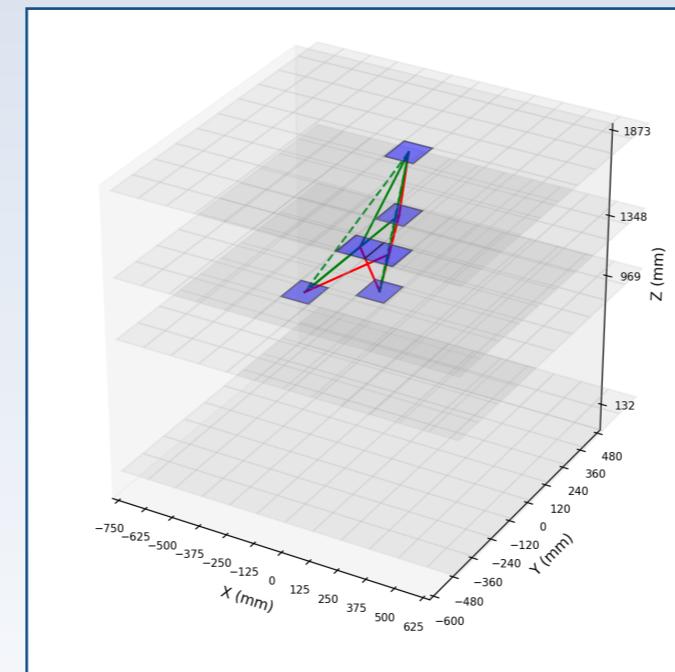
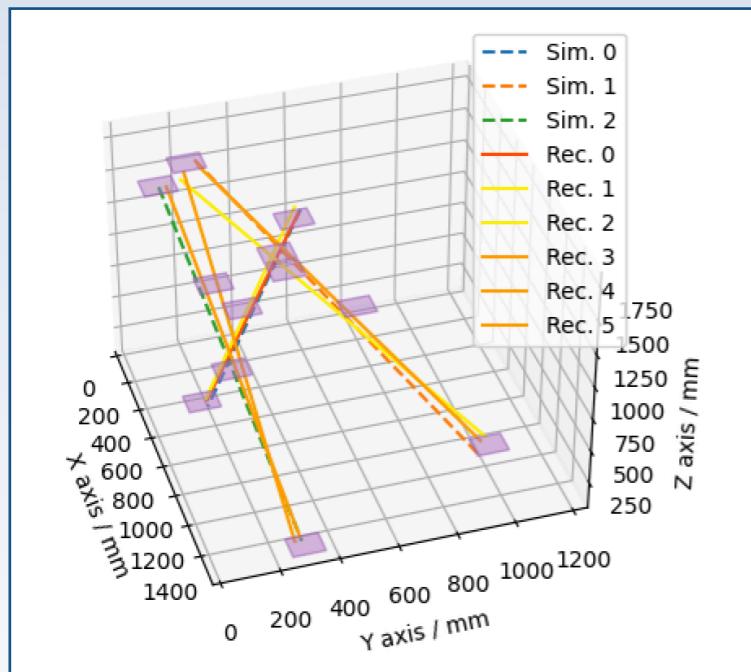
The TRASGO project

The TRAGALDABAS detector. Present status.

**Hit
Cell-map**



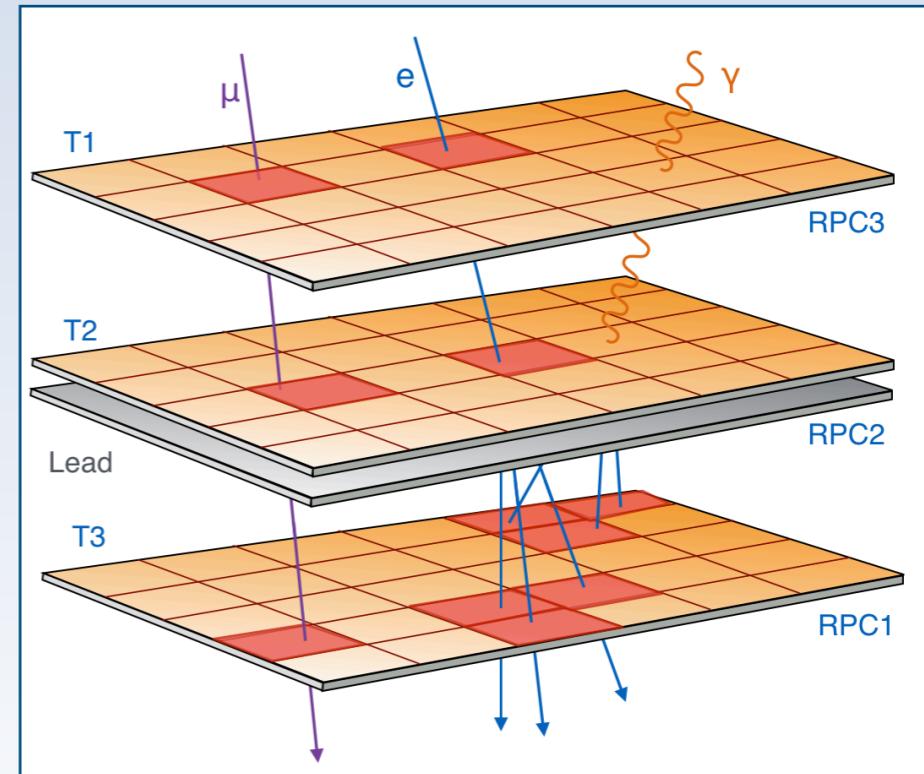
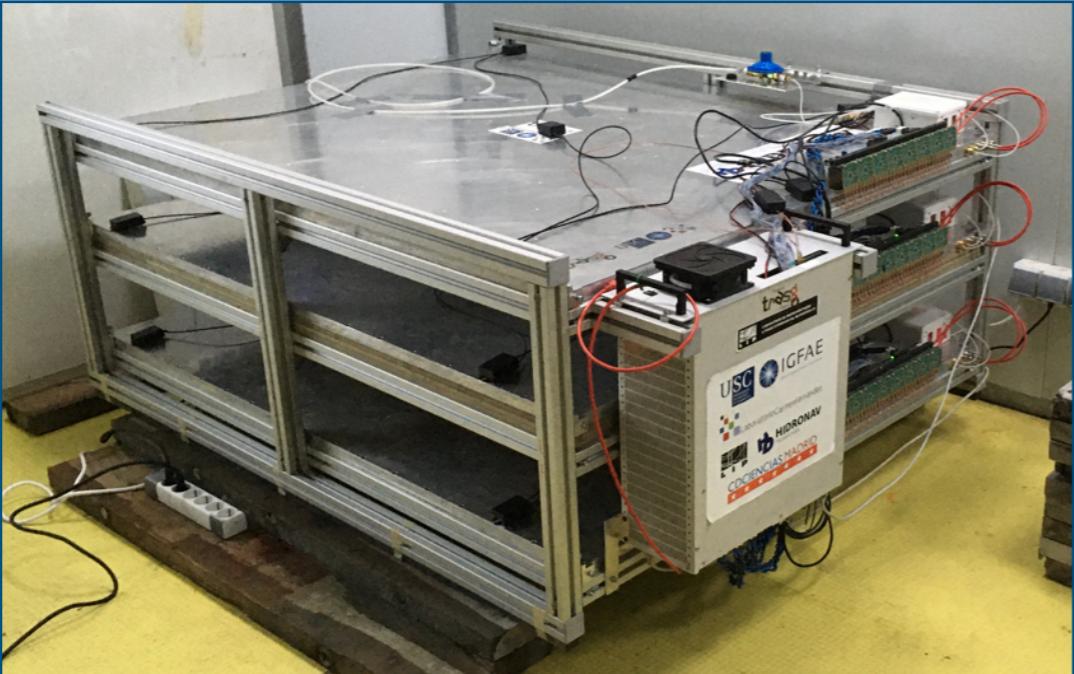
**Track
Cell-map**



Imaging and scanning tools

The TRASGO project

TRISTAN detector (Trasgo for Antarctic Studies)

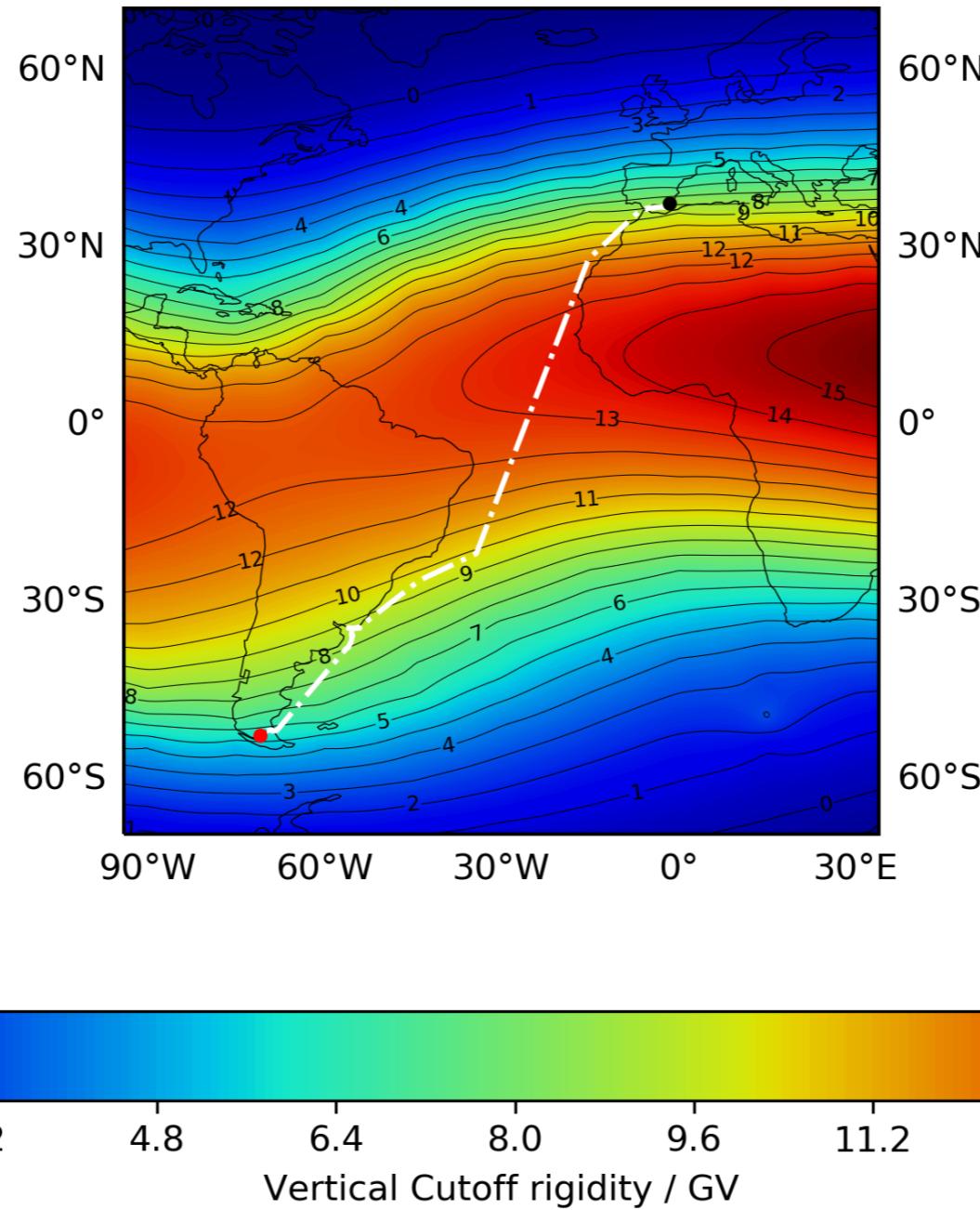


The TRASGO project

TRISTAN detector (Trasgo for Antarctic Studies)



Vertical Cutoff rigidity : Cartagena-P.Arenas 2019



3 latitudinal surveys
from Spain
to Punta Arenas (Chile)

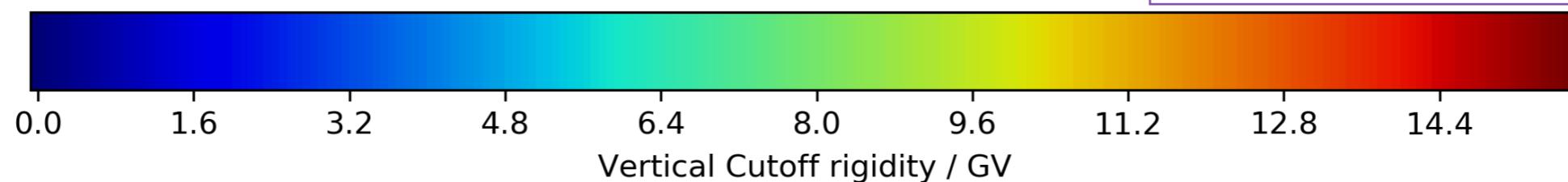
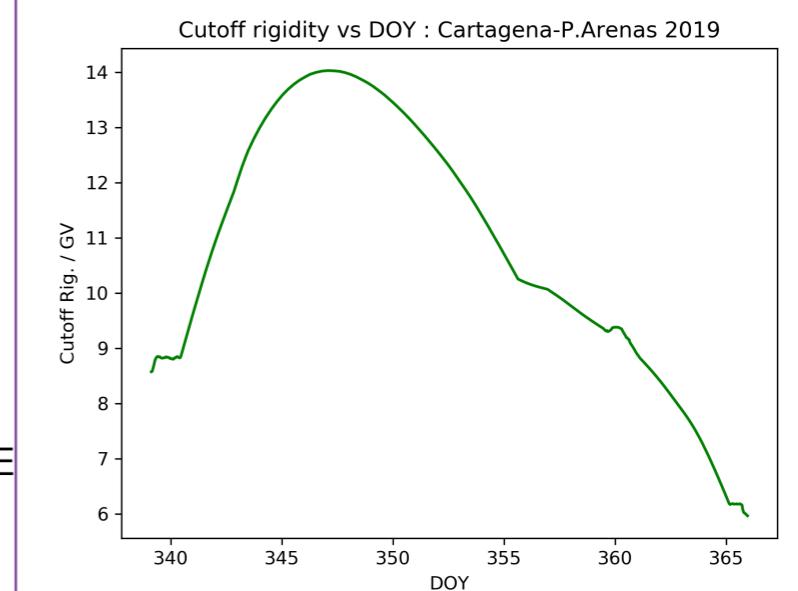
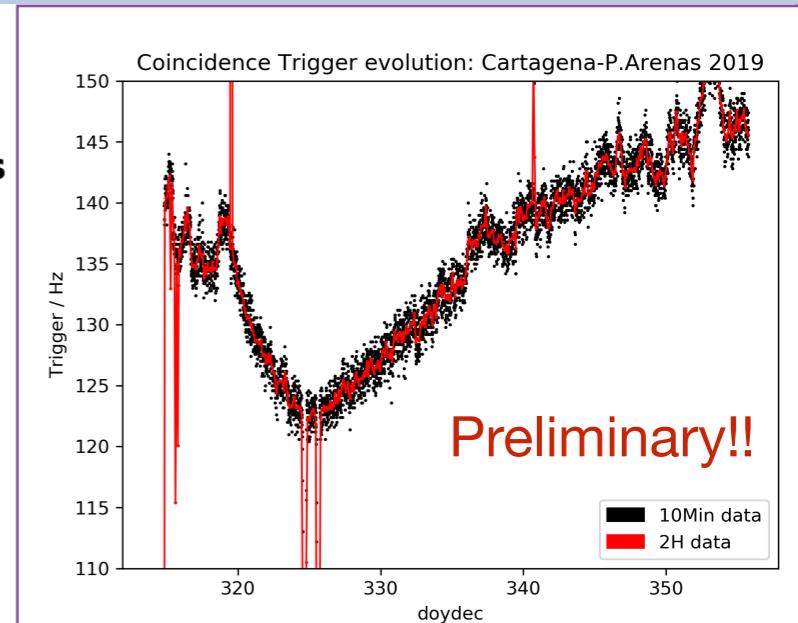
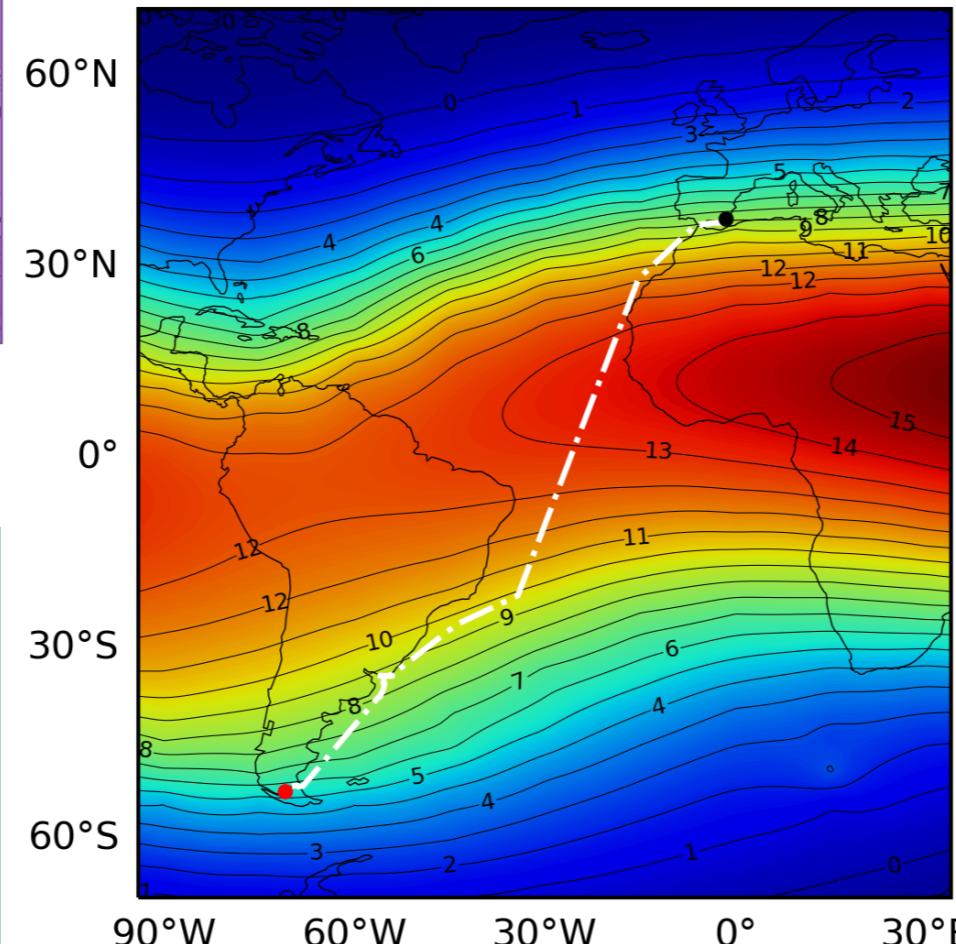
Now Located at the
Antarctic Spanish Base
JCI

The TRASGO project

TRISTAN detector (Trasgo for Antarctic Studies)

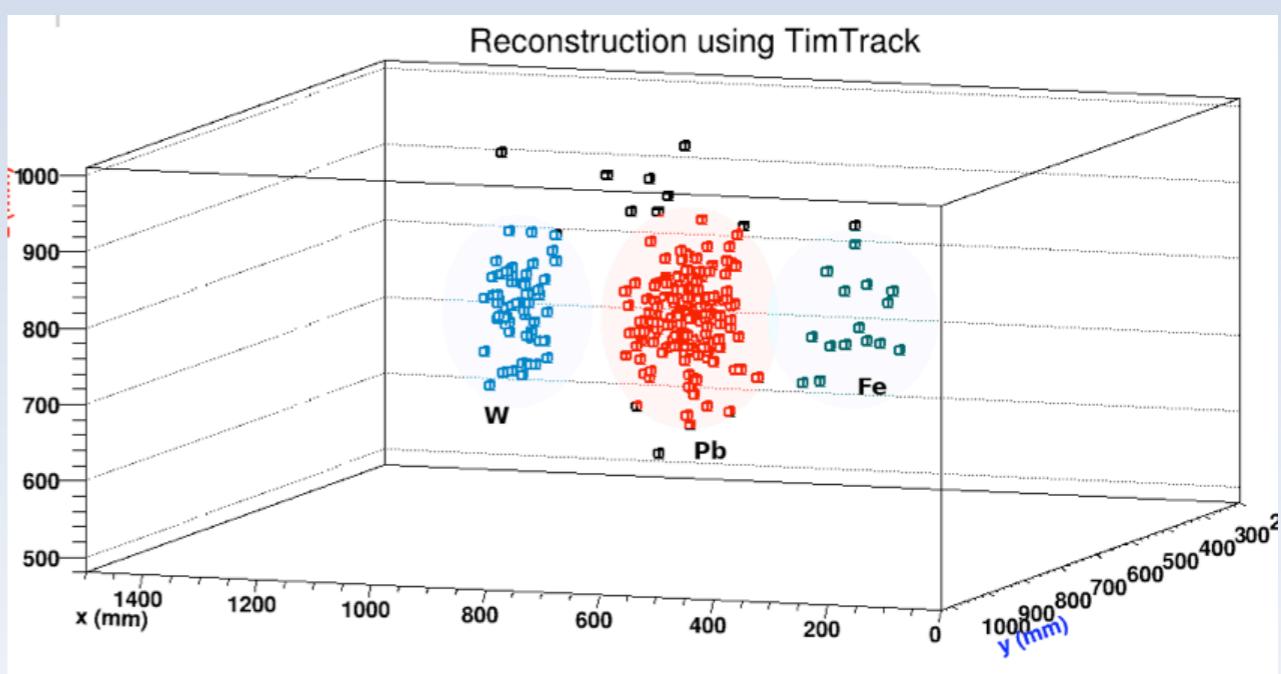
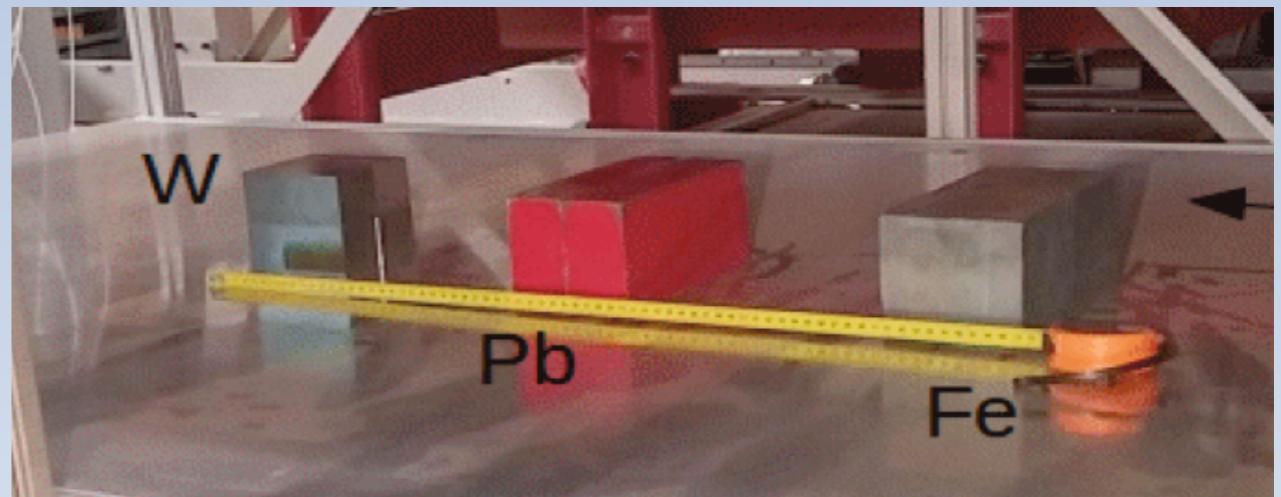
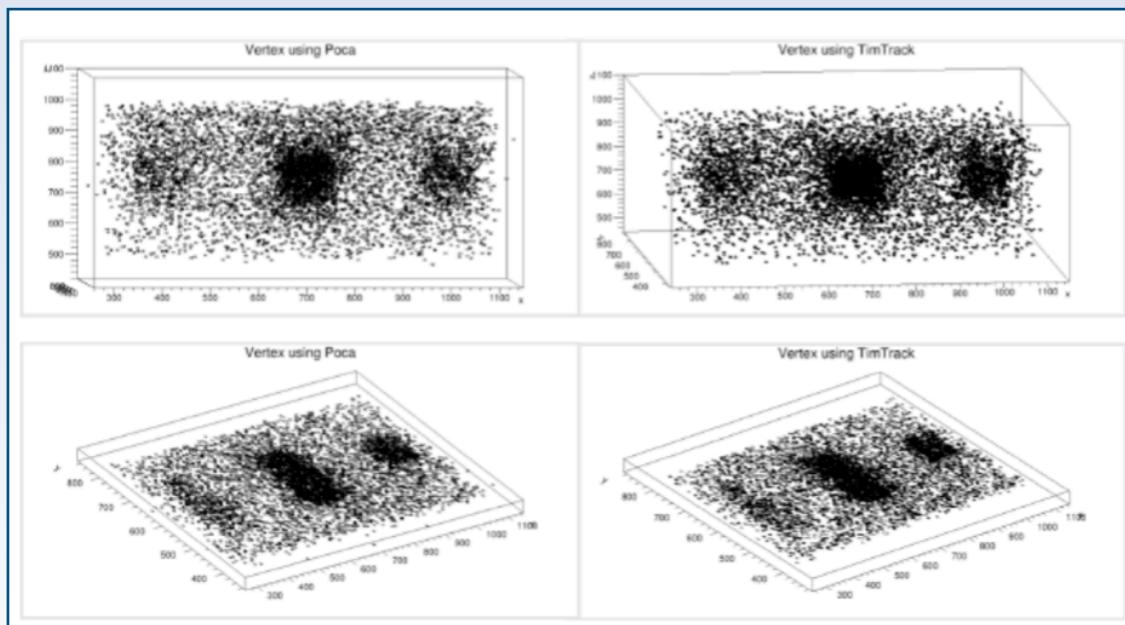


Vertical Cutoff rigidity : Cartagena-P.Arenas



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MuTT detector



Target and density reconstruction

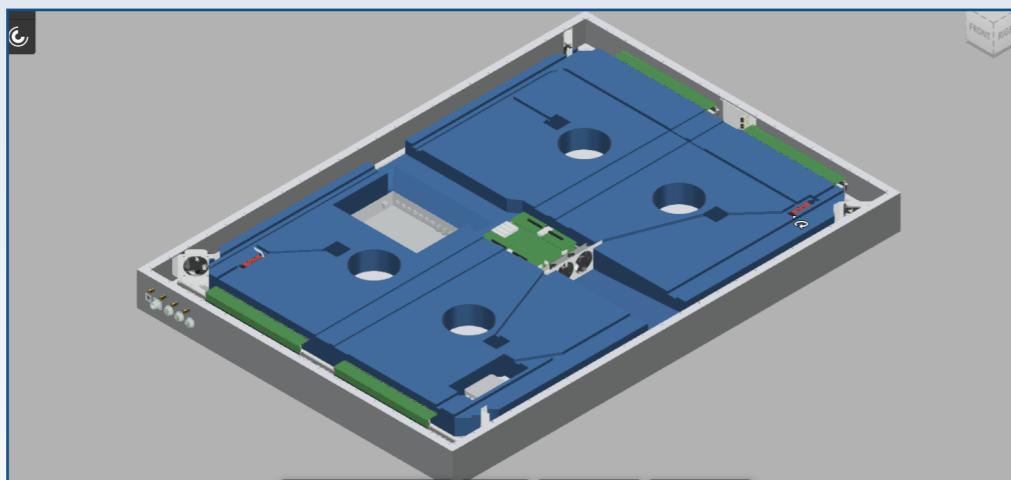
The TRASGO project

The STRATOS detector

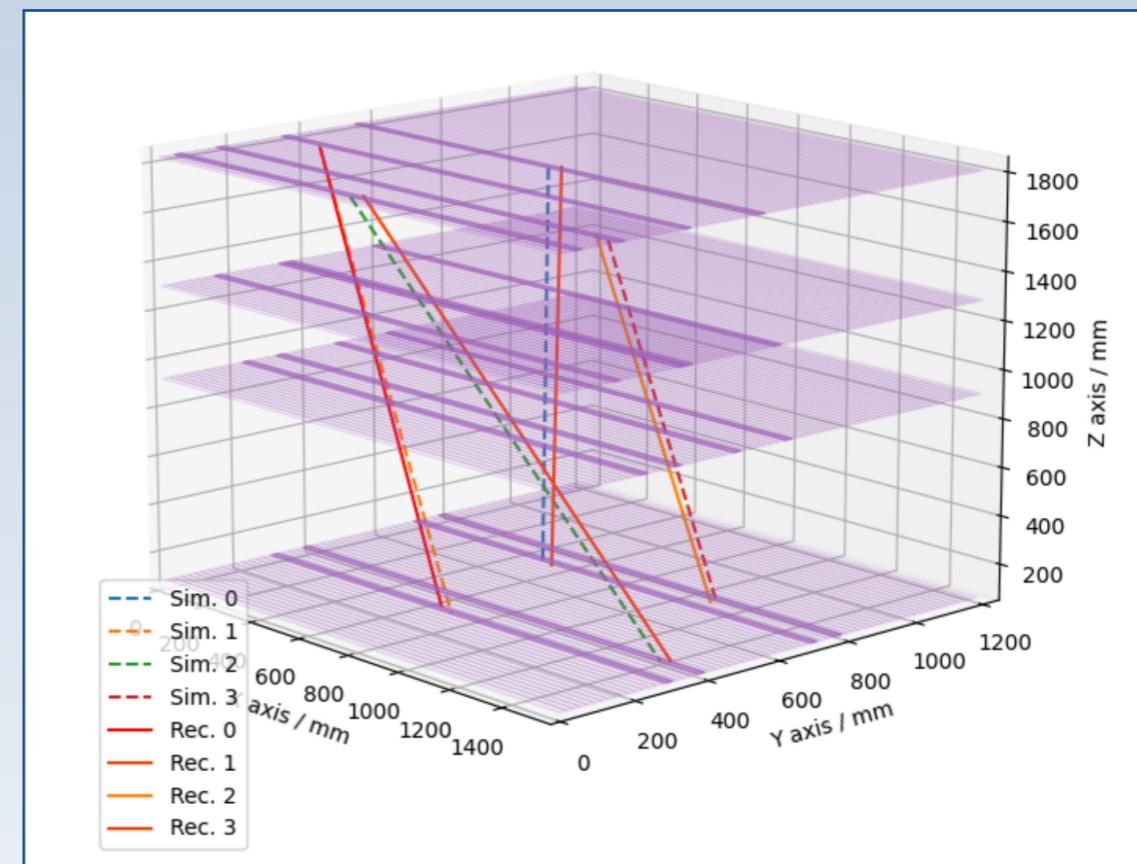
Developed by the company Hidronav Technologies for atmospheric studies.



The STRATOS-1 detector



STRATOS all-in-one design: everything included in a tight box with almost no gas losses.



Main goal: study of correlations between the measured trends in cosmic rays with the atmosphere temperature profile. 2 detectors are being assembled.

The TRASGO project

Summary

- TRASGOS are very interesting devices that may allow us to improve significantly our knowledge of the properties and the evolution of showers induced by high energy cosmic rays.
- Complement the existing techniques
- Several TRASGOS are operative and new are being built for different purposes.
- We are going (slowly) on. It's being a very big challenge...

The TRASGO project

Summary

H. Alvarez-Pol⁵, M. Ajoor⁷, A. Blanco³, P. Cabanelas⁵, F. Clemencio², J. Callón¹¹, J. Collazo¹¹, M. Cruces⁶, J. Cuenca⁷, P. Fonte³, J. Flores⁸, Y. Fontenla⁷, D. García-Castro⁷, J.A. Garzón⁷, A. Iglesias¹³, G. Kornakov⁴, T. Kurtukian¹, L. Lopes³, C. Loureiro², I. Martínez¹³, M.A. Pais³, A. Pazos⁹, C. Rodríguez-Alemparte⁹, J. Saraiba³, M. Seco⁶, M. Valladares⁹, J. Xuna⁷

Laboratory / Task

1. CEN - Bordeaux, France / Data Analysis
2. LYBPhys U. Coimbra, Portugal/ DAQ Instrumentation
3. LIP- Coimbra, Portugal / RPC detectors and instrumentation
4. Warsaw Univ of Technology. Warsaw, Poland/ Software development
5. GENP - Univ. Santiago de Compostela, Spain / Software development and simulation
6. IGFAE - Univ. Santiago de Compostela, Spain / Monitoring and Slow control
7. LabCAF - Univ. Santiago de Compostela, Spain / Software development, track reconstruction and analysis
8. CITIUS - Univ. Santiago de Compostela, Spain / PID and 3D Imaging
9. Hidronav - Vigo, Spain / Detector and Electronic development, Data management and event reconstruction

The TRASGO project

Summary



FCT Fundação para a Ciéncia e a Tecnologia
MINISTÉRIO DA CIÉNCIA, TECNOLOGIA E ENSINO SUPERIOR