

International School of Space Science “Ground based and space instruments
for researches in Solar-Terrestrial physics”

Astroparticle Physics in Colombia

Julián RODRÍGUEZ-FERREIRA^{1,2}

H. Asorey³, N. Ascencio¹, A. Balaguera¹, J. Bonilla¹, R. Calderón-Ardila^{1,2}, J. Grisales¹, C. Gualdrón¹, A. Jaimes-Motta¹, A. Martinez¹, L.A. Núñez^{1,2}, J. Núñez-Castiñeyra, D. Otero¹, J. Peña-Rodríguez¹, S. Pinilla¹, J. Pisco¹, F. Quiñones, J. Rodríguez-Ferreira^{*1,2}, P. Salgado¹, C. Sarmiento-Cano¹, D. Sarques¹, M. Suárez-Duran^{1,2}, A. Valbuena¹, M. Valencia¹, A. Vesga-Ramirez^{1,2}

¹ Grupo de Investigación en Relatividad y Gravitación

² Grupo Halley de Astronomía y Ciencias Aeroespaciales

Universidad Industrial de Santander, Bucaramanga – Colombia

mailto: jrodrif@saber.uis.edu.co twitter: [@cosmojules](https://twitter.com/cosmojules)

Gran Sasso Space Institute – GSSI.

6-10 June 2016, L'Aquila, Italy.

Escuela
de Física



Universidad
Industrial de
Santander

Grupo Halley
Astronomía y Ciencias Aeroespaciales





BUCARAMANGA

Escuela
de Física



Universidad
Industrial de
Santander



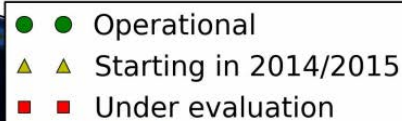
The Latin American Giant Observatory (LAGO) Project

Is a very long baseline **array of water Cherenkov detectors (WCD)** giving strength to a **Latin American network** of HEP and Astroparticle students and researchers. Developments, expertise and data are **shared across the network** conformed by : Argentina, Bolivia, Brazil, **Colombia**, Ecuador, Guatemala, Mexico, Peru, Spain & Venezuela.

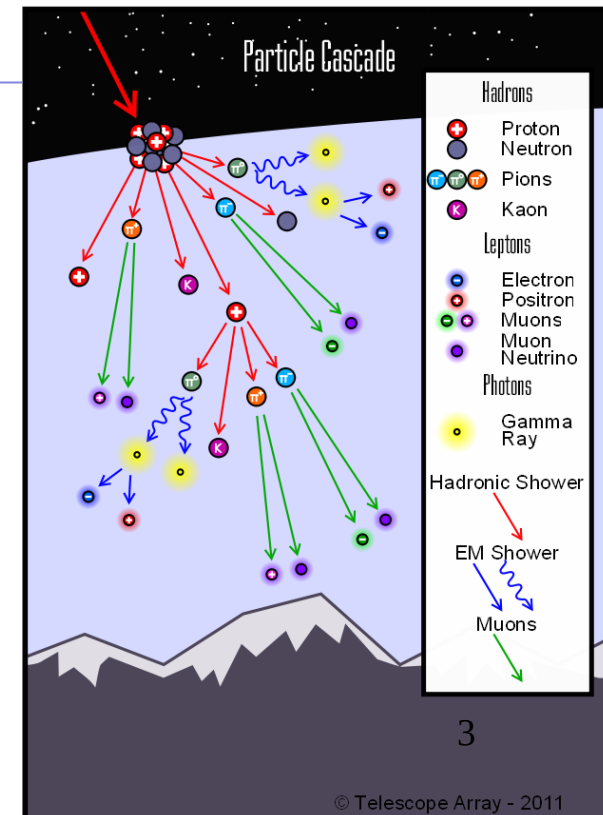
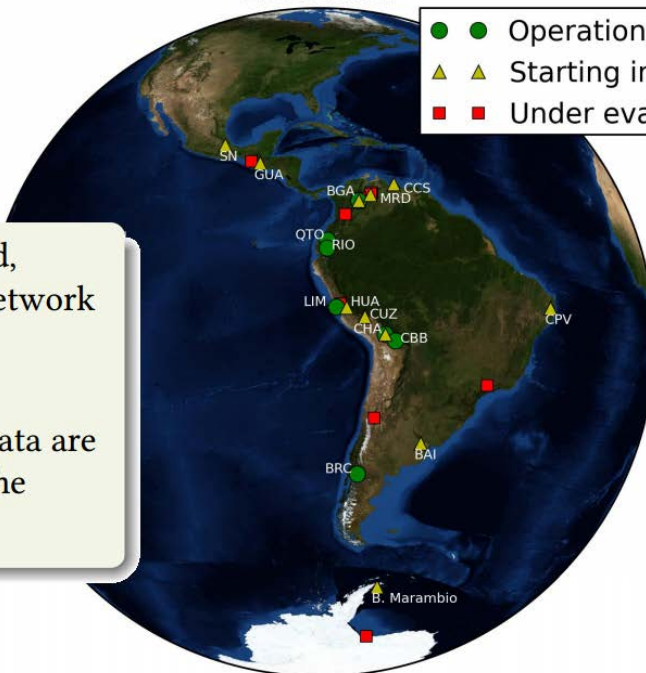
Main goals →

- Measure Astroparticles up to the Cosmic Rays (CR) knee
- Study transient and long term Space Weather phenomena trough Solar modulation (SM) of CR
- Measurements of background radiation at ground level

LAGO Sites



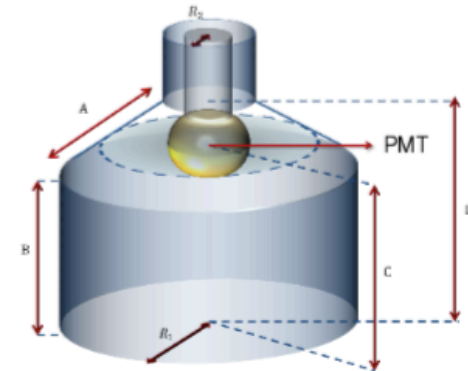
- Non-centralized, collaborative network of institutions
- Developments, expertise and data are shared across the network



Our detector: sWCD (Water Cherenkov Detector)

s as in smart

- Autonomous, reliable, simple and cheap detector
- Commercial tanks with $1,5\text{ m}^2 - 10\text{ m}^2$ of detection area filled with purified water
- Inner coating of Tyvek (UV diffusive and reflective fabric)
- PMT + Digitizer board (own design)
- FPGA + Raspberry Pi: detector control, telemetry, data acquisition and on board data pre-analysis (including machine learning techniques)



- Digitized signals by a 10-14 bits FADC at 40-100 MHz (10-25 ns)
- Temporal synchronization: GPS in PPS mode
- Station consumption: $\lesssim 8\text{ W}$

The Latin American Giant Observatory (LAGO) Project

WG1: Physics

S. Dasso (ARG)

WG2: Detectors

L. Otiniano (PER)

WG3: Data

L. A. Núñez (COL)

LAGO-Extreme Universe

- High energy astroparticles
- Towards CR knees region

LAGO-Space Weather

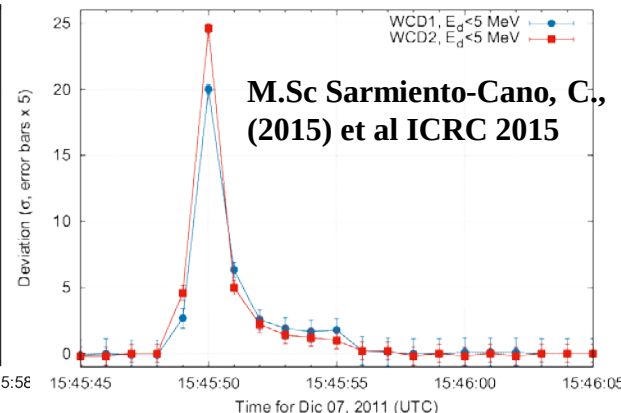
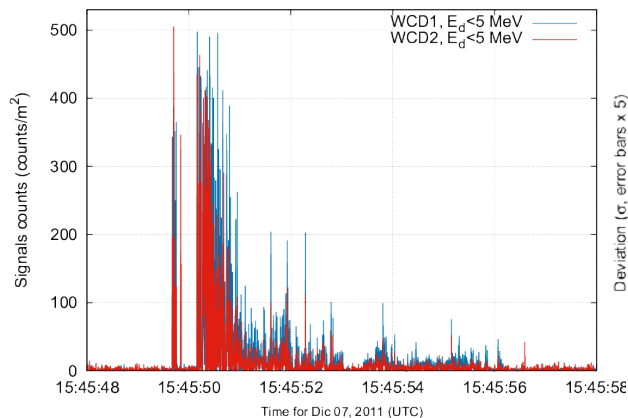
- Cosmic ray solar modulation
- Possible connections with physics of the atmosphere
- Background radiation at ground (and flight) level

LAGO-Universities

- Astrophysics and particle physics in undergraduate courses
- Data analysis and statistic
- Muon decay
- Detector physics and interaction of radiation with matter
- Construction and characterization of particles detectors

LAGO-Virtual

- Acquire, produce, collect and preserve LAGO data



GRB candidate in the LAGO data Collaboration.
Detected at Chacaltaya (Bolivia site)

The Latin American Giant Observatory (LAGO) Project

WG1: Physics

S. Dasso (ARG)

WG2: Detectors

L. Otiniano (PER)

WG3: Data

L. A. Núñez (COL)

LAGO-Extreme Universe

- High energy astroparticles
- Towards CR knees region

LAGO-Space Weather

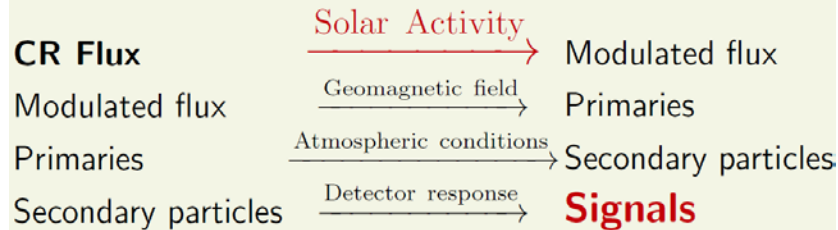
- Cosmic ray solar modulation
- Possible connections with physics of the atmosphere
- Background radiation at ground (and flight) level

LAGO-Universities

- Astrophysics and particle physics in undergraduate courses
- Data analysis and statistic
- Muon decay
- Detector physics and interaction of radiation with matter
- Construction and characterization of particles detectors

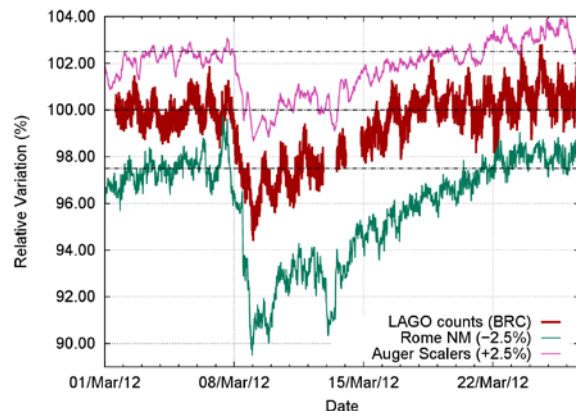
Flux variation of signals at detector level <-> Solar Activity

Connections



LAGO-Virtual

- Acquire, produce, collect and preserve LAGO data



Using data and the simulation M.Sc Mauricio Suarez on 08/03/2012 located a Forbush event (left) with a single LAGO detector at Bucaramanga and validated it with different observations from other observatories

The Latin American Giant Observatory (LAGO) Project

WG1: Physics

S. Dasso (ARG)

WG2: Detectors

L. Otiniano (PER)

WG3: Data

L. A. Núñez (COL)

LAGO-Extreme Universe

- High energy astroparticles
- Towards CR knees region

LAGO-Space Weather

- Cosmic ray solar modulation
- Possible connections with physics of the atmosphere
- Background radiation at ground (and flight) level

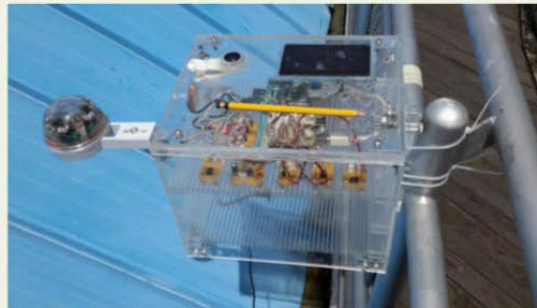
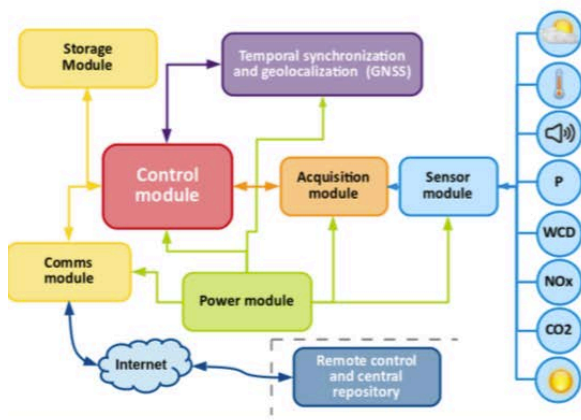
LAGO-Universities

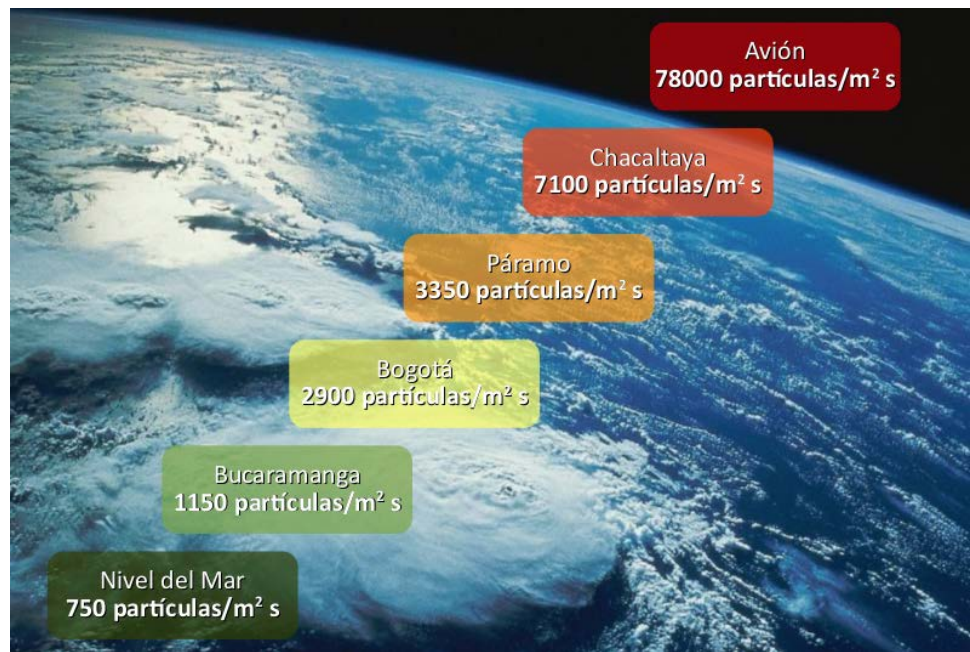
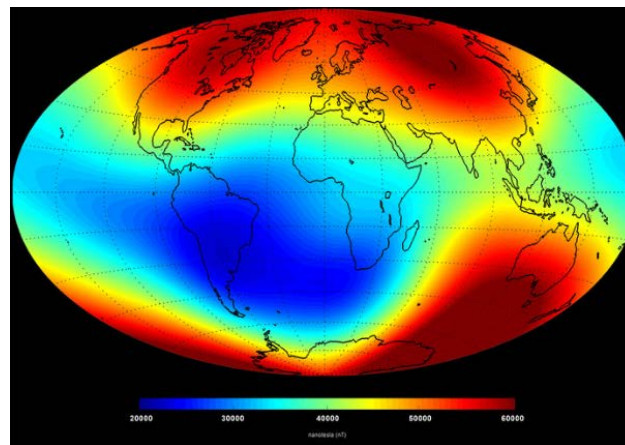
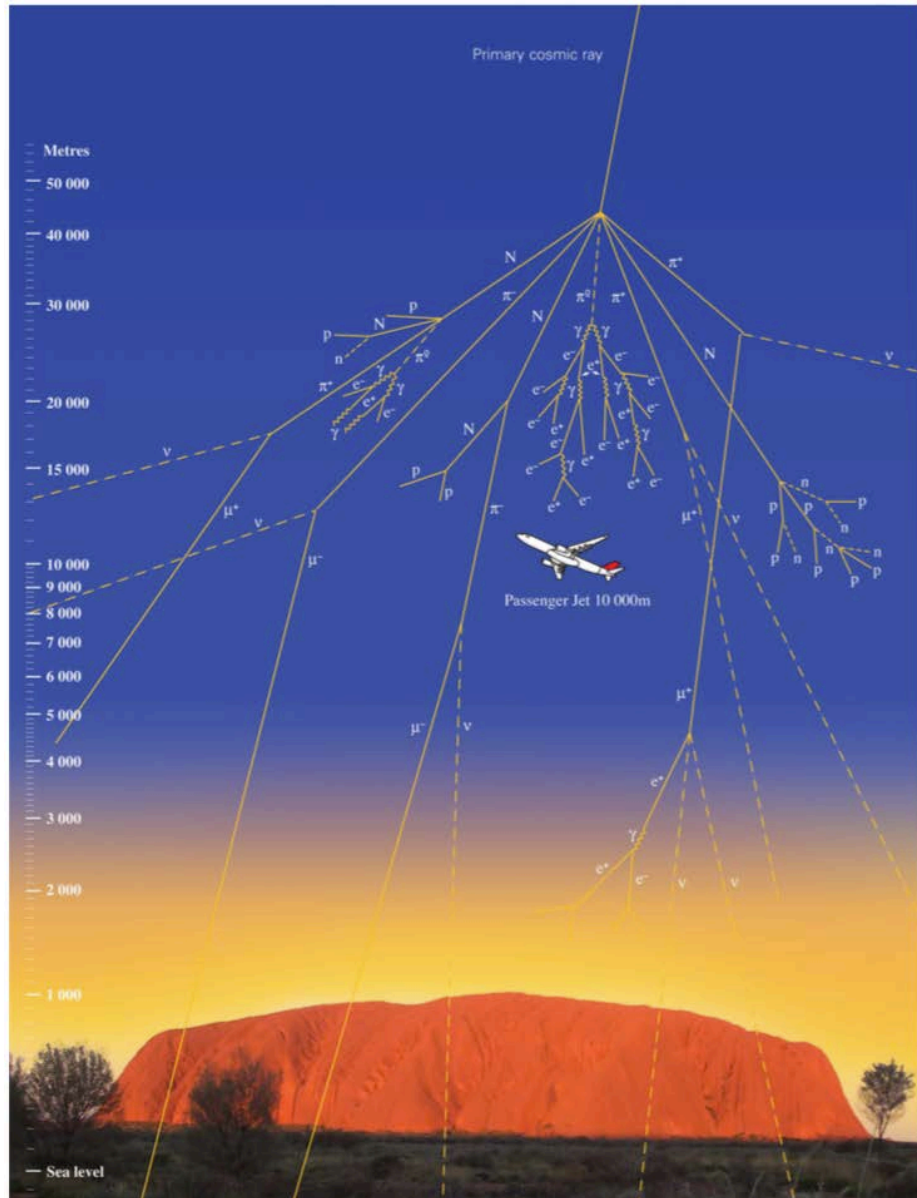
- Astrophysics and particle physics in undergraduate courses
- Data analysis and statistic
- Muon decay
- Detector physics and interaction of radiation with matter
- Construction and characterization of particles detectors



LAGO-Virtual

- Acquire, produce, collect and preserve LAGO data





Ruta	γ	e^+	e^-	μ^+	μ^-	n^0	p^+	Otros	Total
BOG-BUE	55.5	56.0	56.2	3.5	3.9	84.6	165.8	122.6	46.1
BUE-MAD	56.6	57.0	57.3	3.6	4.0	90.7	175.9	124.6	47.1
JNB-SYD	93.3	89.3	90.3	6.2	6.5	388.7	638.0	195.6	82.2
NYC-TYO	91.0	87.2	88.1	6.1	6.3	380.6	621.9	190.4	80.2
SAO-JNB	71.3	70.5	70.8	4.9	5.3	162.7	296.6	151.7	60.3

$$d_N = \frac{N_{\text{ruta}} - N_{\text{BGA}}}{N_{\text{BGA}}}$$

Normalized to Bucaramanga (BGA)
measurements

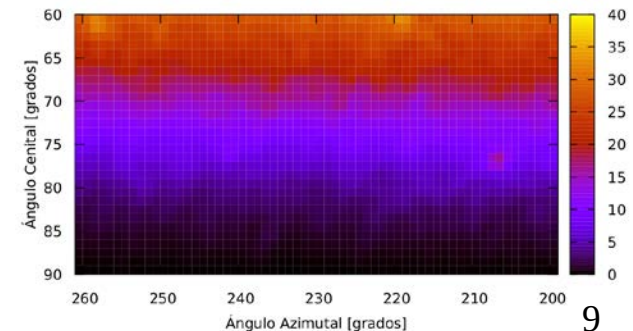
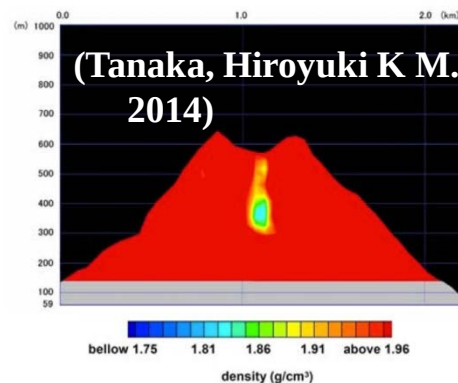
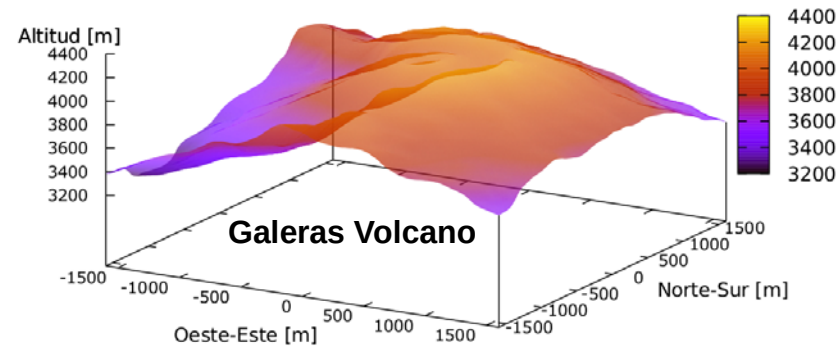
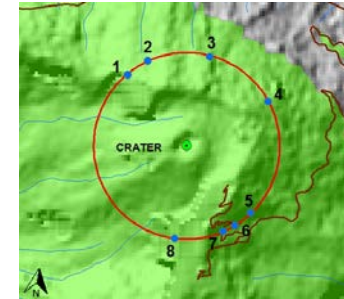
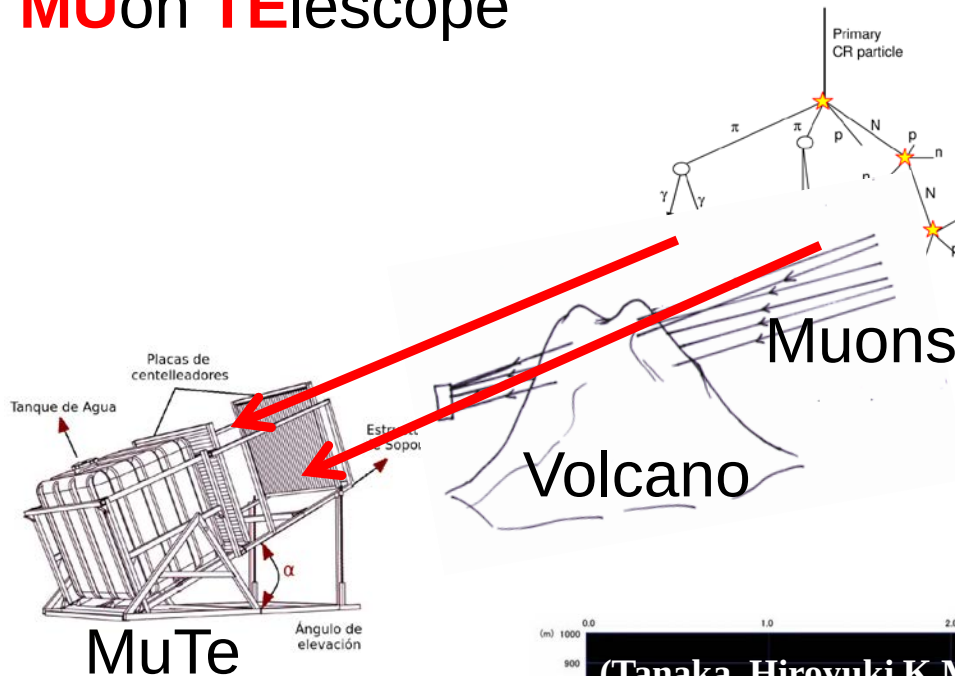


Colombia a land of active volcanoes:

i.e: The Galeras Volcano (Col)

<http://halley.uis.edu.co/fuego>

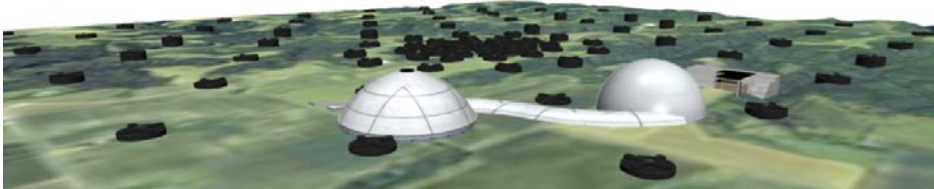
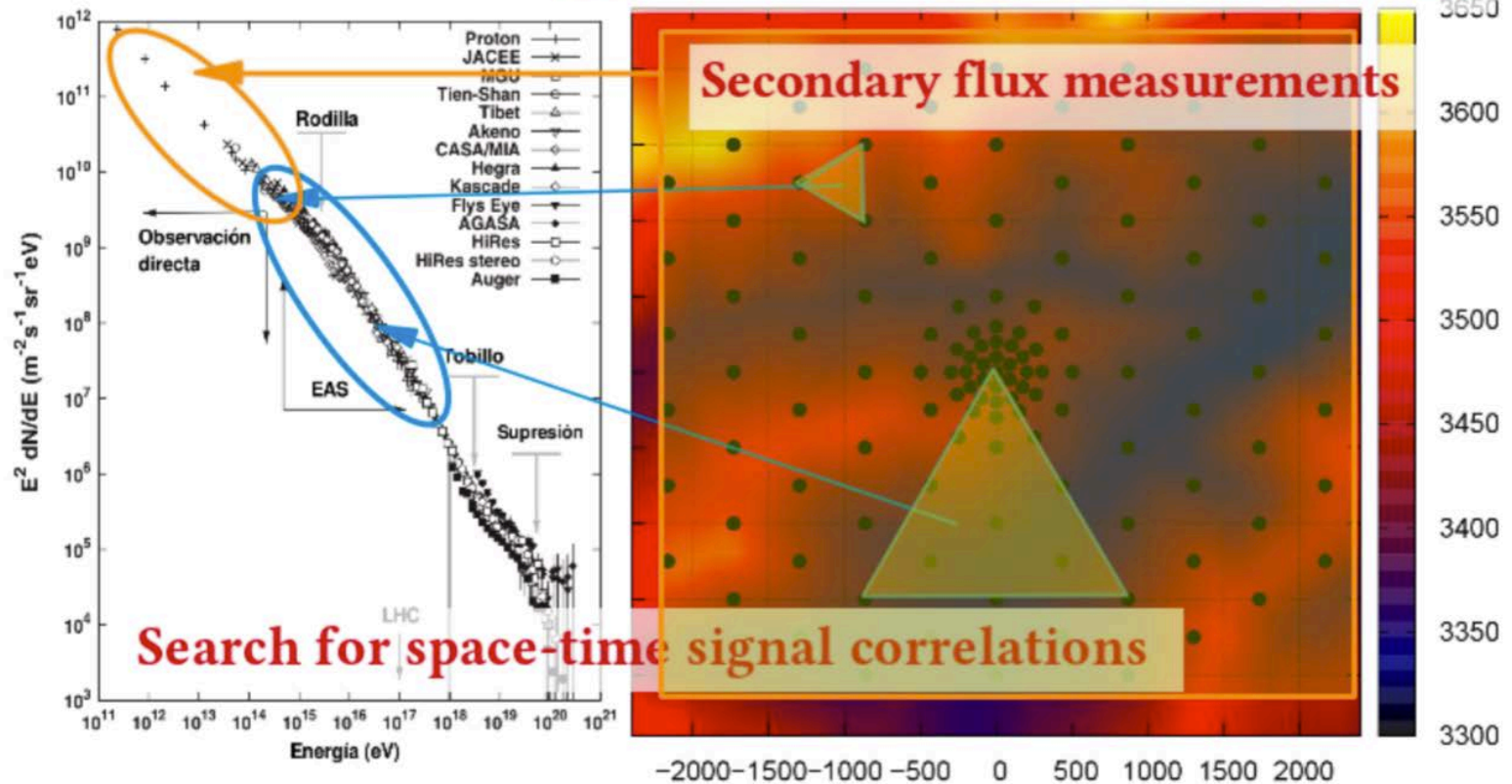
MuTe
MUon TElescope



(M. Valencia, L.A. Núñez, C. Sarmiento-Cano, 2016)

OCoCo: Observatorio Colombiano de Rayos Cósmicos

121 WCD on a triangular modular array



A novel design is proposed for a new observatory that will have 127 WCD on a triangular modular array to study cosmic rays in a wide energy range to complement present measurements in the so called **knee region** of the cosmic ray energy spectrum ($E \sim 10^{15}$ eV). It is also a link between Science and Society.

Thanks

Stay tuned:

[**http://halley.uis.edu.co**](http://halley.uis.edu.co)

[**@lagoproject**](#)

[**@nunezluis**](#)

mailto: [**jrodrif@saber.uis.edu.co**](mailto:jrodrif@saber.uis.edu.co)

twitter: [**@cosmojules**](#)