
www.auger.org.ar
KATHY TURNE

(Some)
Astroparticles observatories in Latin America

(and some close related experiments)

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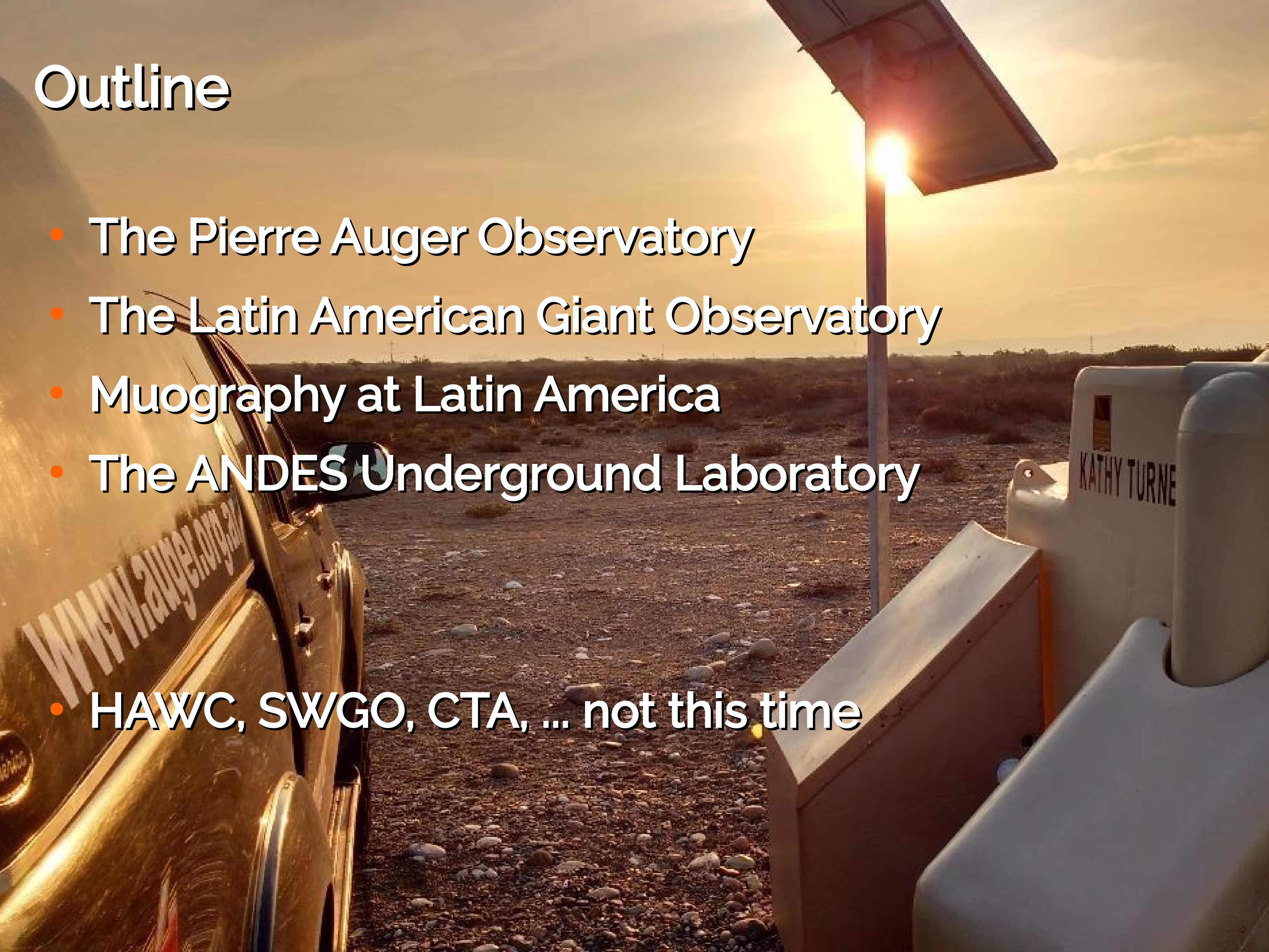
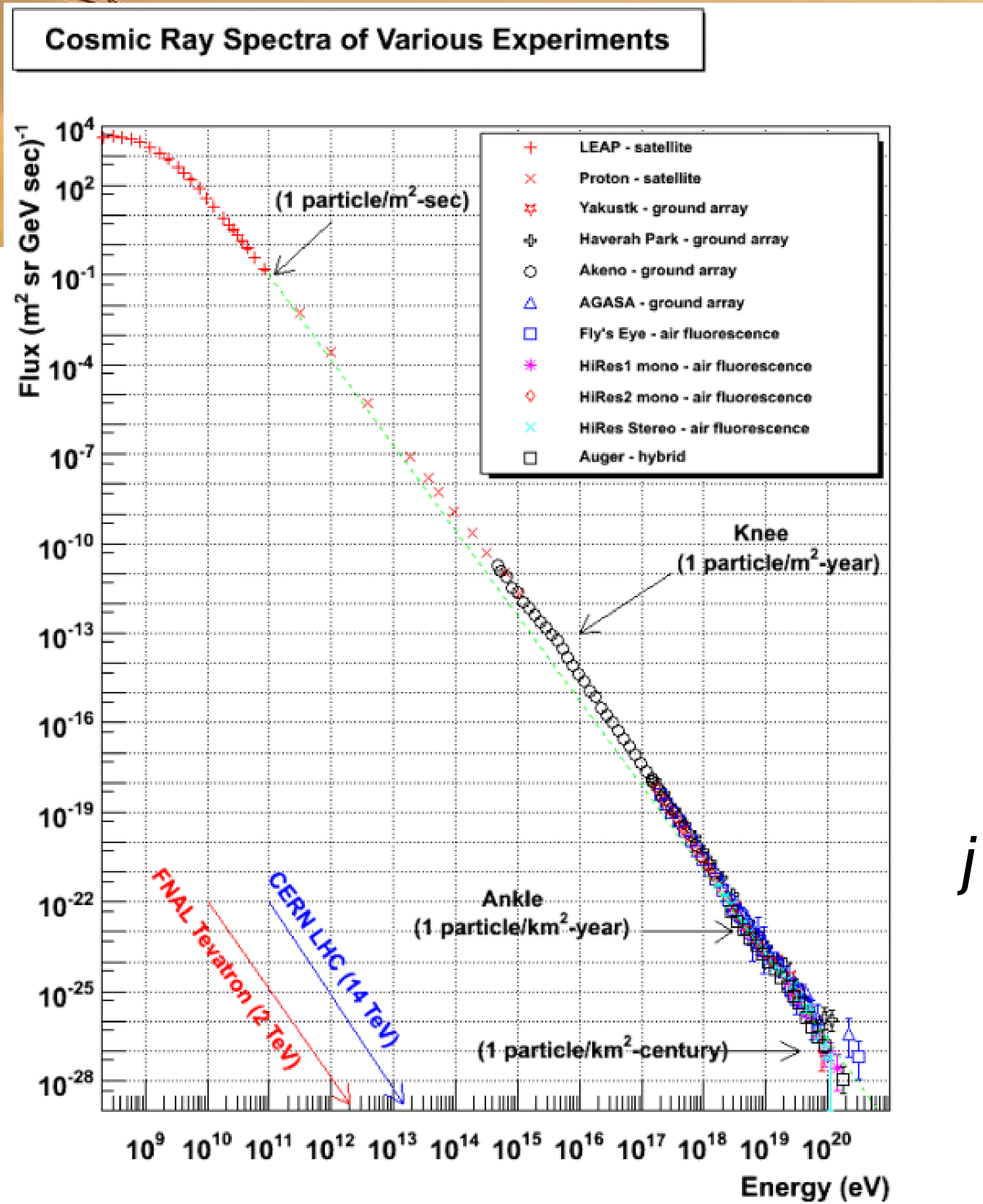
Outline

- The Pierre Auger Observatory
- The Latin American Giant Observatory
- Muography at Latin America
- The ANDES Underground Laboratory

- HAWC, SWGO, CTA, … not this time





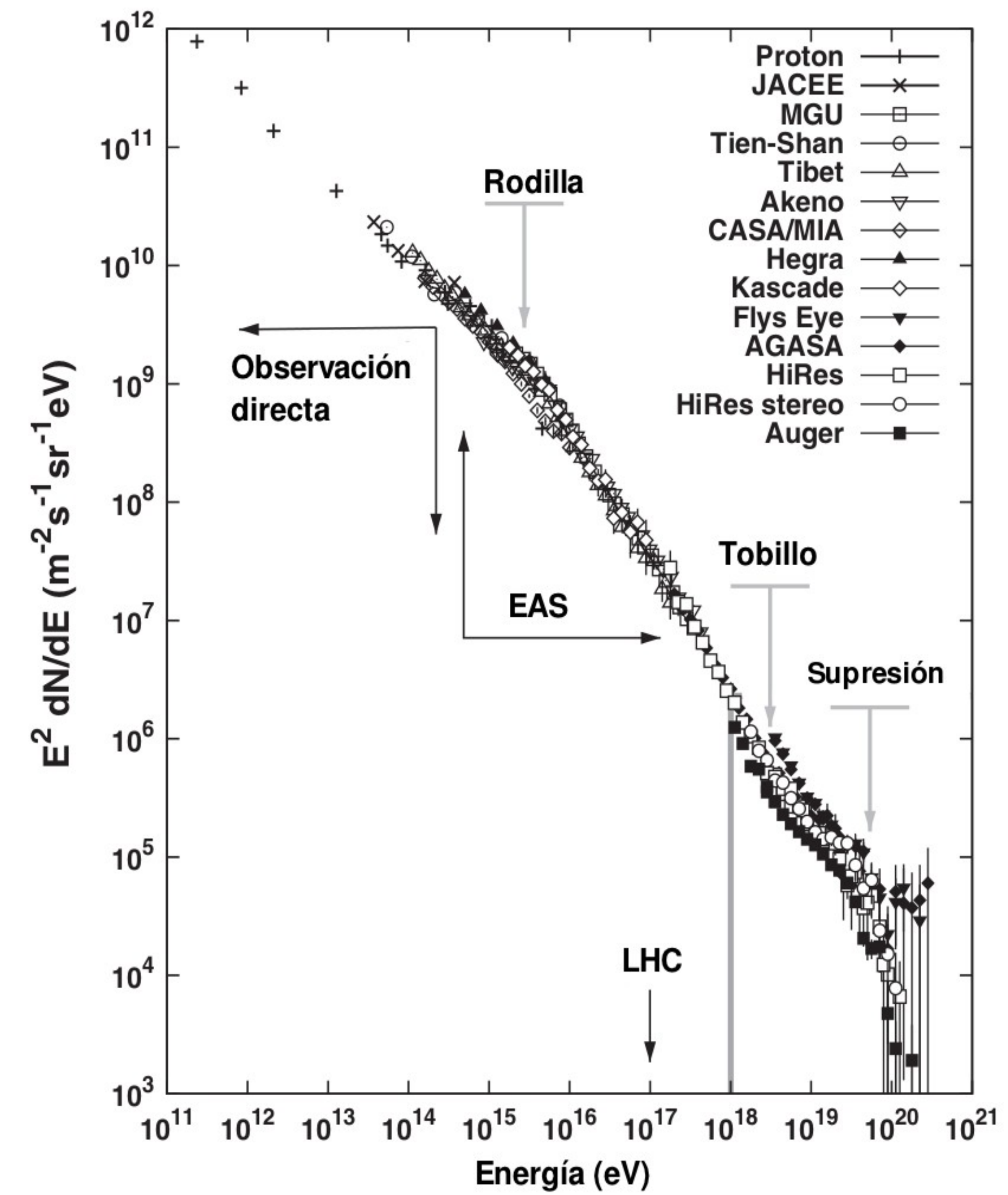
The CR spectrum

It extends for more than 10 orders of magnitude in energy, and comprises more than 30 orders of magnitude in flux

$$j(E) \stackrel{\text{def}}{=} \frac{\mathrm{d}N}{\mathrm{d}A\,\mathrm{d}\Omega\,\mathrm{d}t\,\mathrm{d}E} \approx E^{-3}$$

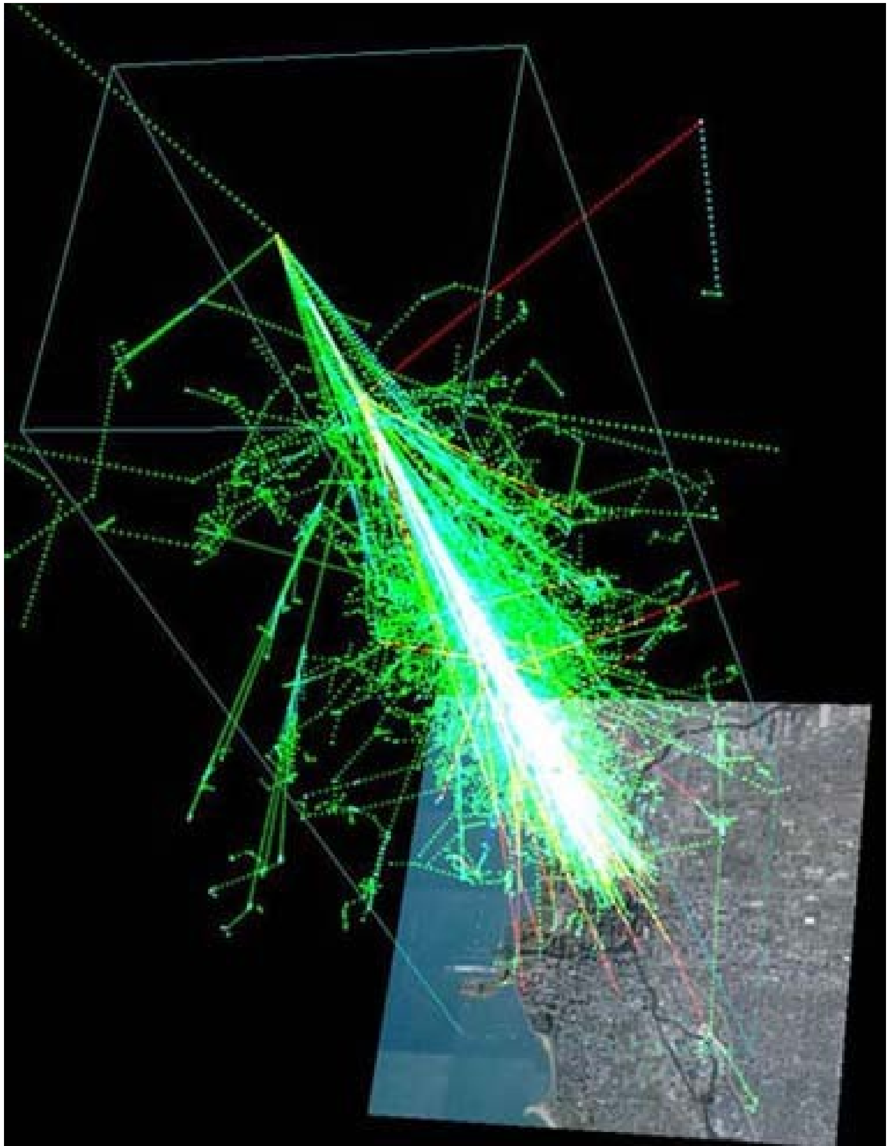
in LA

UHE Cosmic rays spectrum x E²

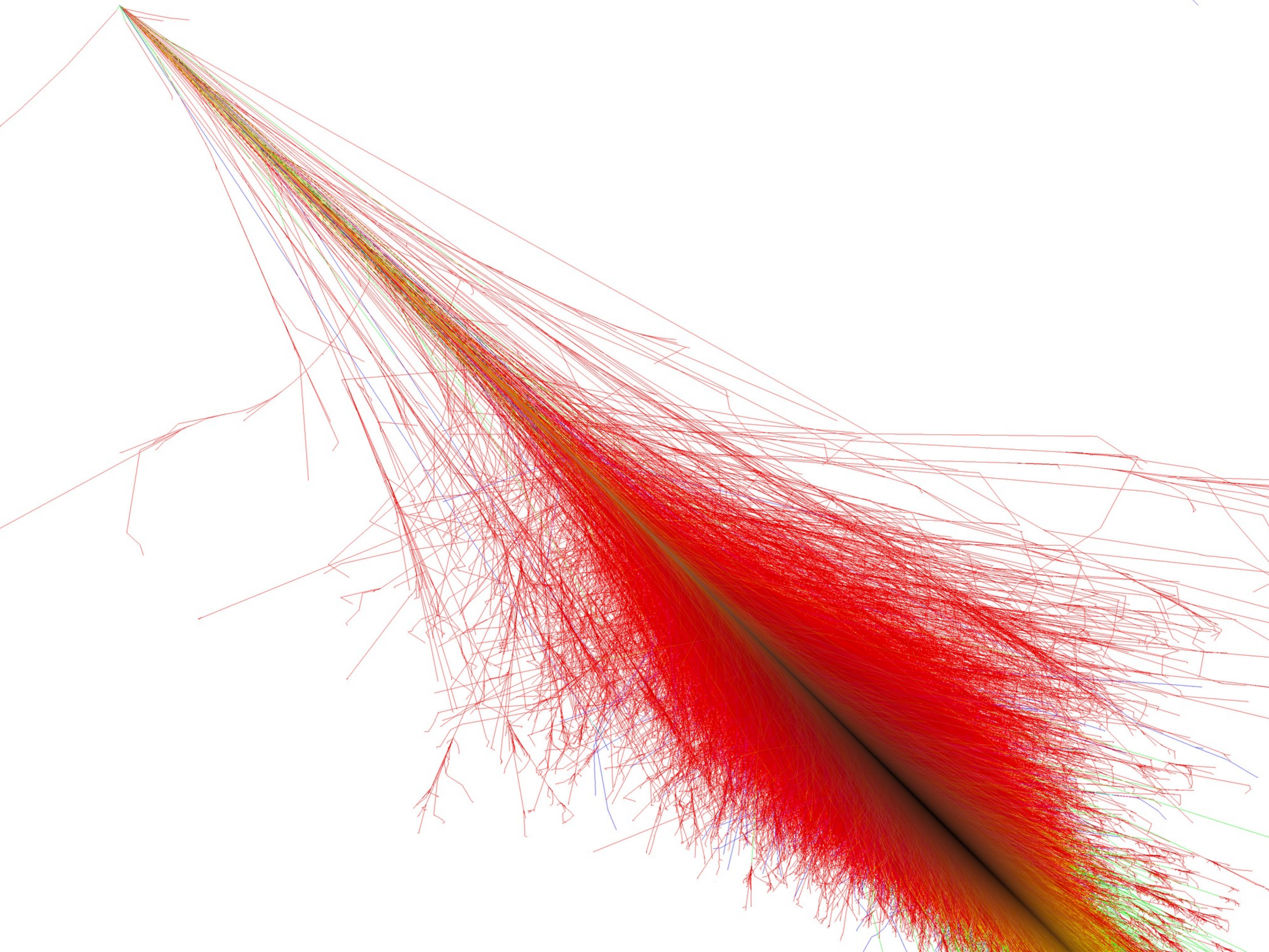


- Some people see a leg here (a multiple broken one)
- Spectral index changes:
  - 1st knee → $10^{15.5}$eV
  - 2nd knee(!) → ~0.1 EeV
  - Ankle →(5.0±0.1±0.8) EeV
  - 3rd knee(?)→(13±1±2) EeV
  - Suppresion → (46±3±6) EeV

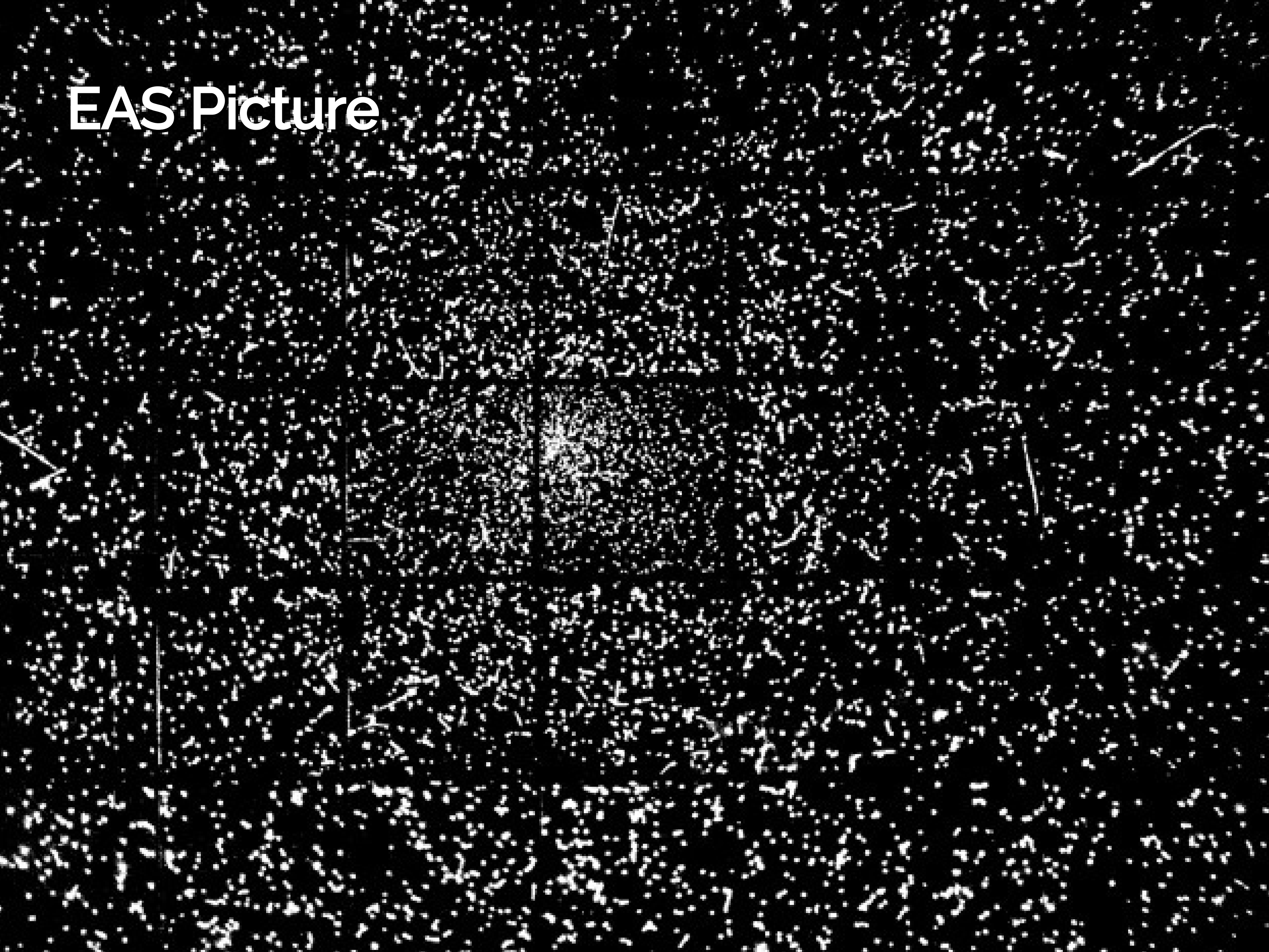
Extensive Air Showers



- At high energies, the flux is so low that direct observation is almost impossible
- Indirect observations
  - Extensive air showers are produced by the interaction of high energy particles with atmospheric nuclei

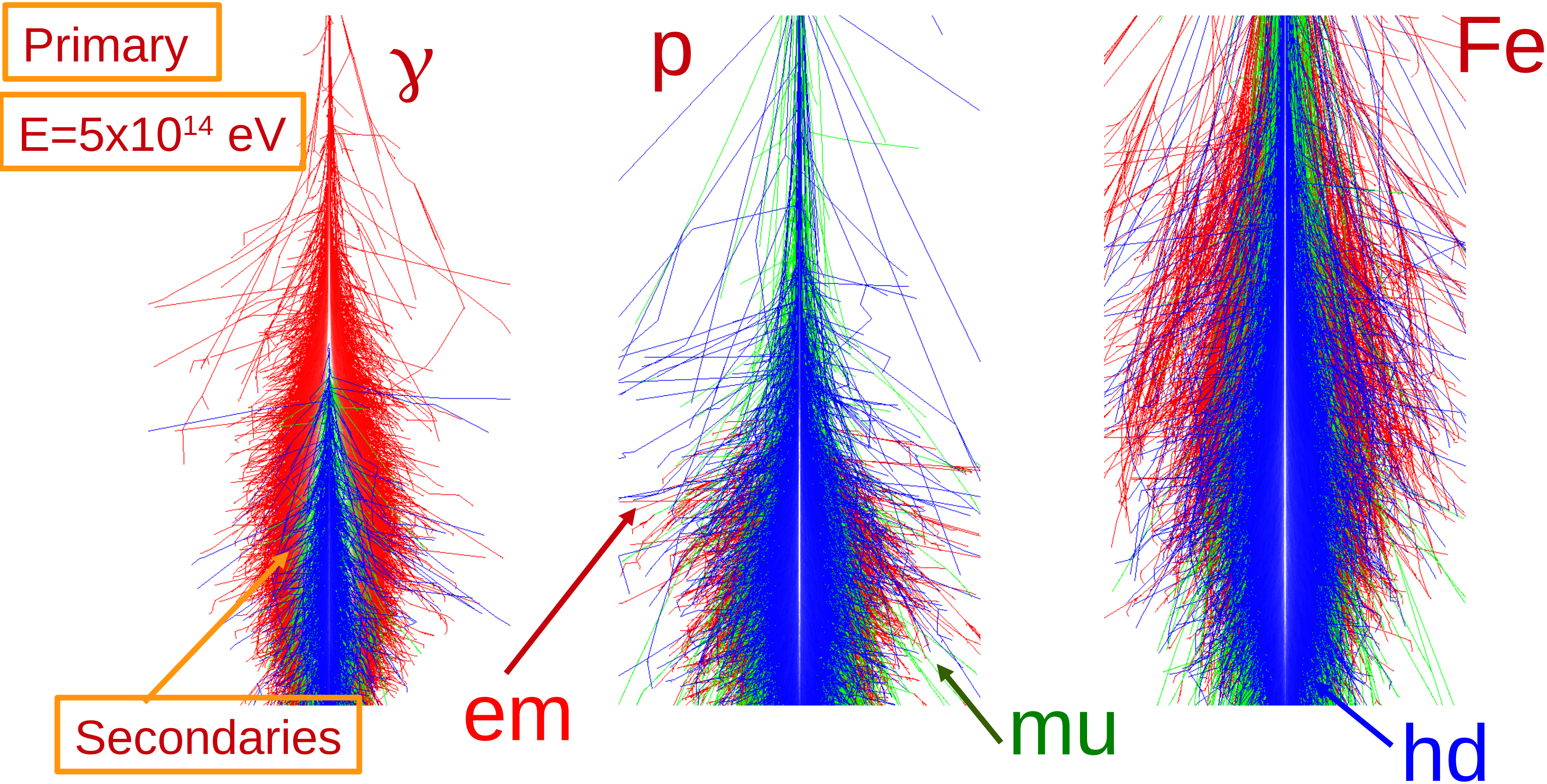


EAS Picture



EAS development depends on composition, ...

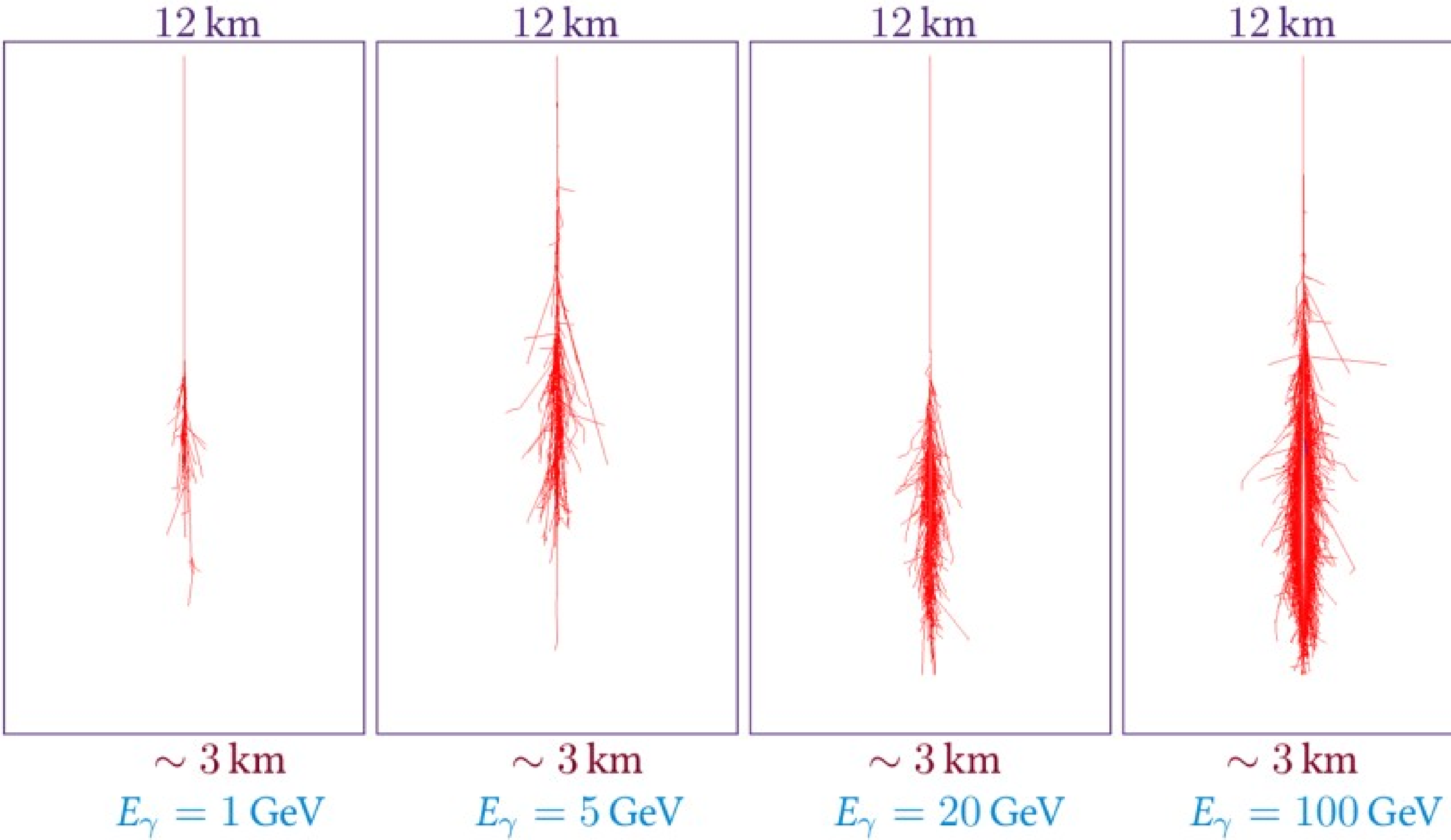
$$p^{+}+Y_{A}^{Z}\rightarrow\gamma+e^{\pm}+\mu^{\pm}+\pi^{\pm,0}+K^{\pm,0}+p^{+}+n+\ldots$$



… energy, atmosphere and altitude

See Grisales’ talk today

See Becerra’s talk today



Secondaries
(from one of my lectures)

- X_0 **Punto de primera interacción**
- $N_{\text{máx}}$ **Número máximo de partículas en la lluvia:** $N_{\text{máx}} \propto E_p$
- $X_{\text{máx}}$ **Profundidad del máximo:** $X_{\text{máx}} \propto \ln(E_p)$

EM

- Decaimiento de π^0:
  $\pi^0 \to \gamma\gamma$
  $\pi^0 \to \gamma e^+ e^-$
- Bethe-Heitler:
  Frenado: $e^\pm \xrightarrow{{}^A_Z\text{Y}} e^\pm \gamma$
  Pares: $\gamma \xrightarrow{{}^A_Z\text{Y}} e^+ e^-$
- Domina $N_{\text{máx}} \to X_{\text{máx}}$
- $E_{\text{EM}} = (80\,\% - 90\,\%) E_p$

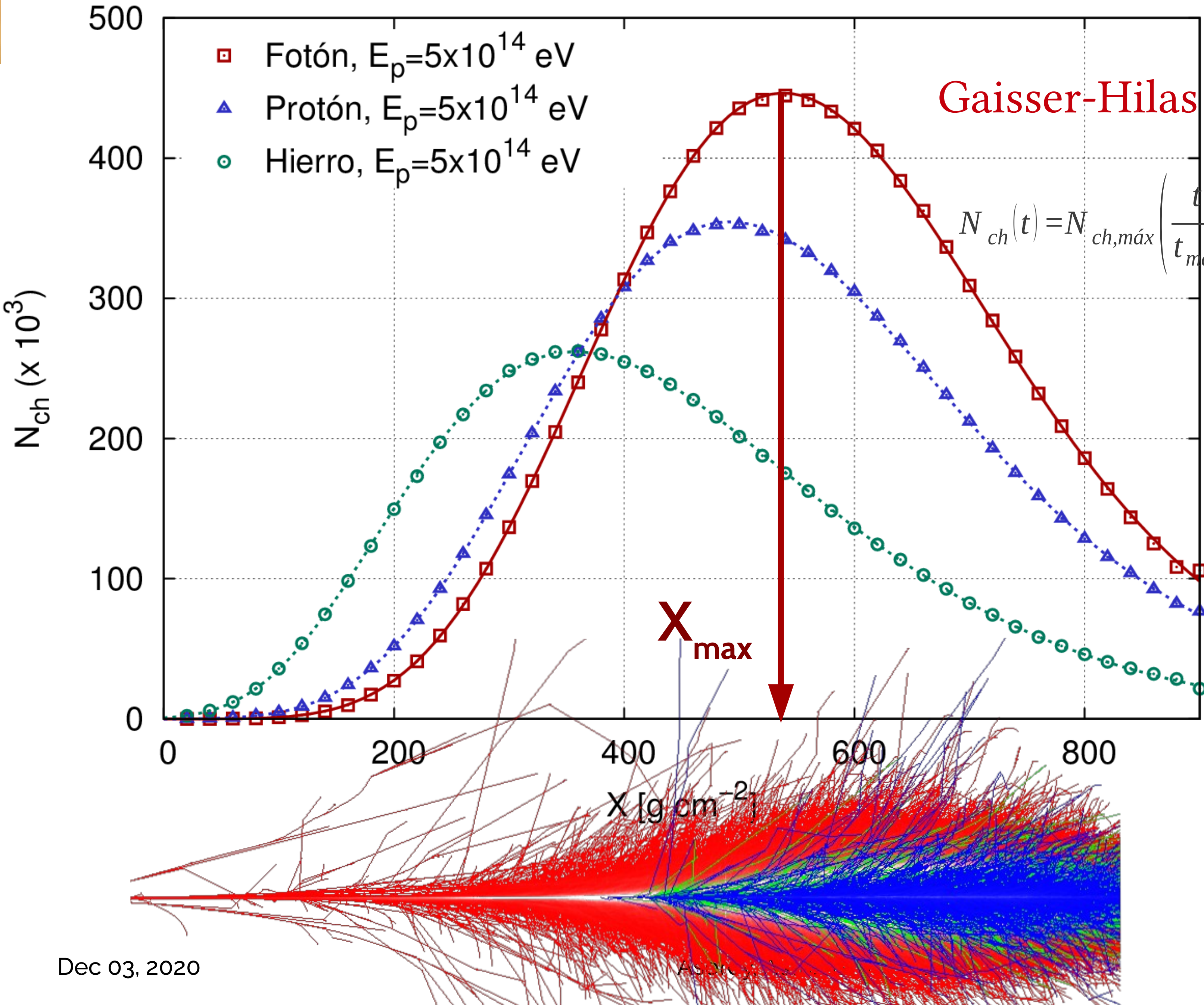
Muónica

- Dec. de $K^\pm$ y $\pi^\pm$:
  $K^+ \to \mu^+ \nu_\mu$
  $K^+ \to \pi^+ \pi^0$
  $\pi^+ \to \mu^+ \nu_\mu$
- Procesos radiativos
  $\mu^\pm \xrightarrow{{}^A_Z\text{Y}} \mu^\pm e^+ e^-$
  $\mu^\pm \xrightarrow{{}^A_Z\text{Y}} \mu^\pm + \text{had}$
- $N_\mu \propto A^{0,1} E_p^{0,9}$

Hadrónica

- Fragmentos nucleares
- $p, n, \pi^\pm, K^\pm$
- Mesones encantados
- *Leading particle effect*
- Concentrada en el eje de la lluvia
- $N_h \propto N_e^{0,95}$
- $N_h / N_e \sim 10^{-2} - 10^{-4}$

Longitudinal development

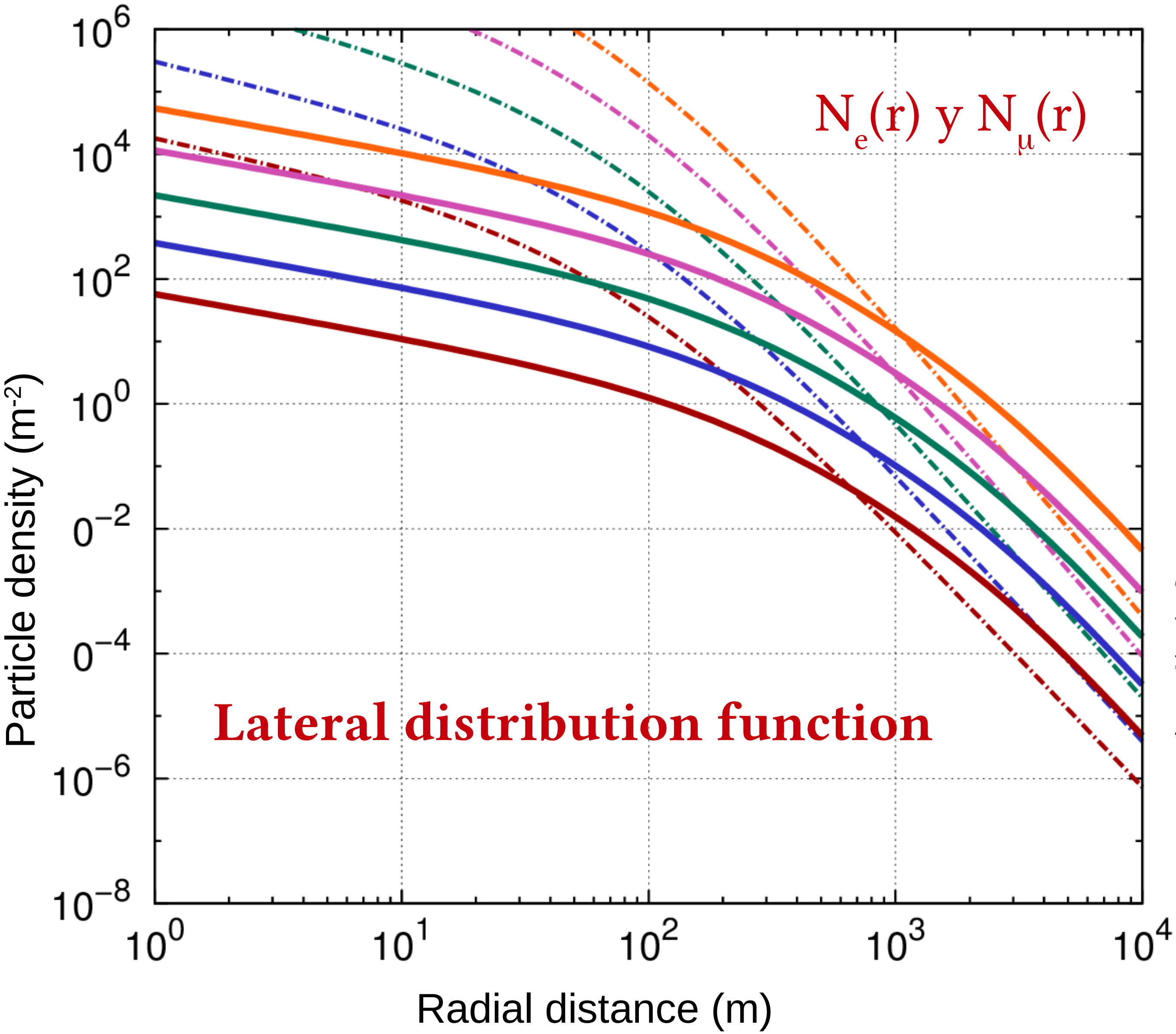


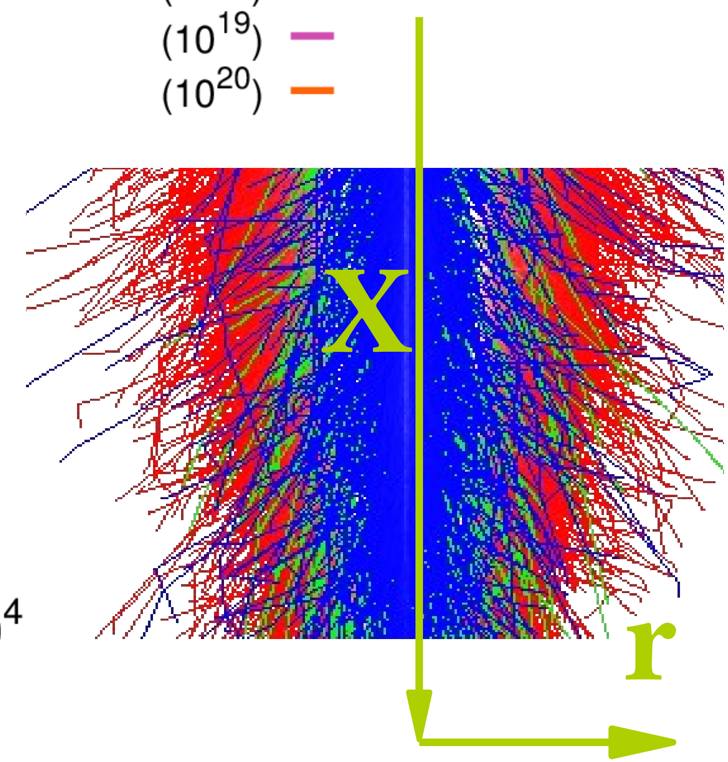
Gaisser-Hilas parametrization

$$N_{ch}(t) = N_{ch,máx}\left(\frac{t-t_0}{t_{max}-t_0}\right)^{f(t)(t_{max}-t_0)} e^{f(t)(t_{max}-t_0)}$$

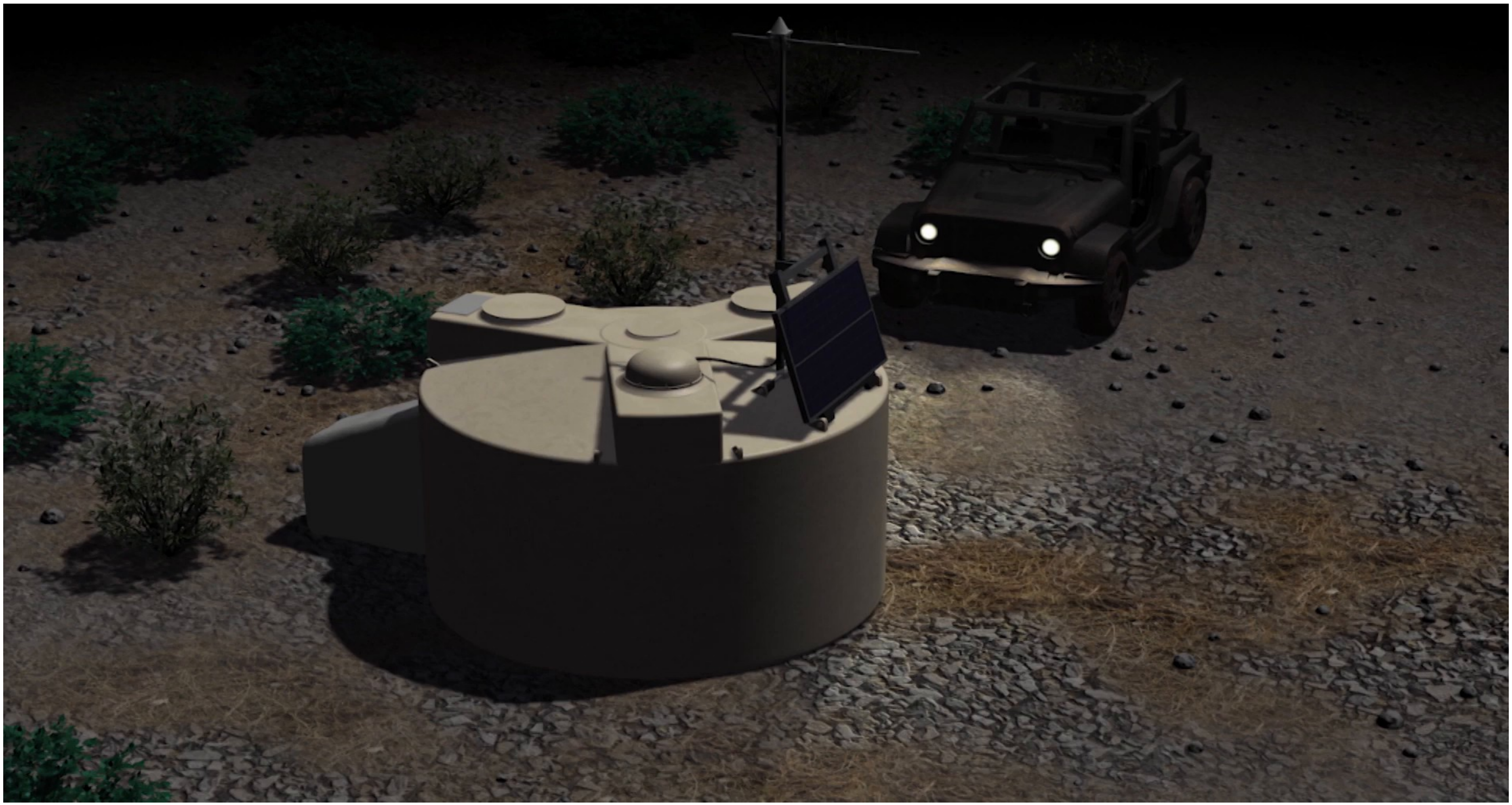
$$f(t) = \frac{1}{\sum a_j t^j}$$

Lateral development at ground

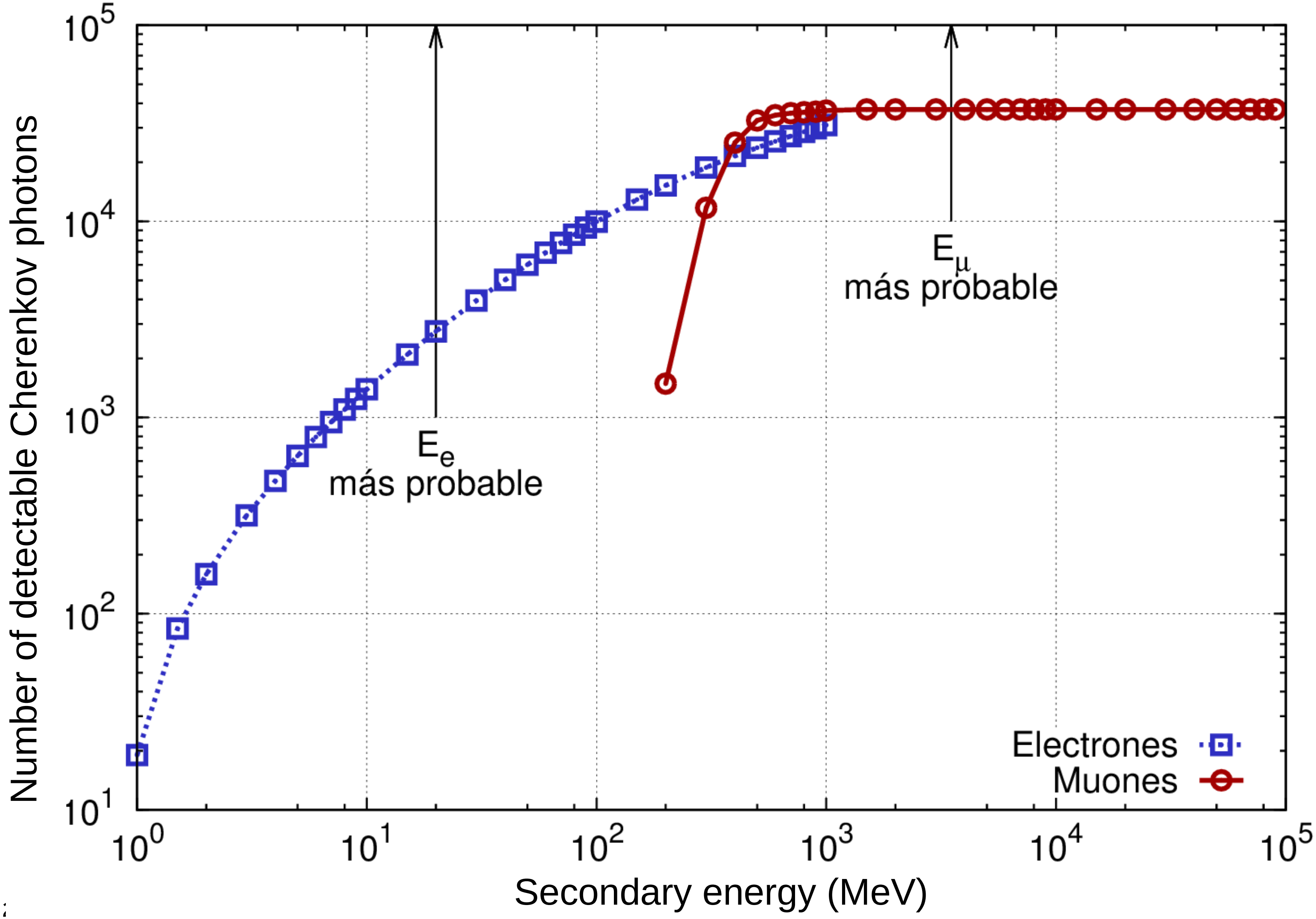




Autonomous Water Cherenkov Detector



Cherenkov production (from my lectures)



AUGER

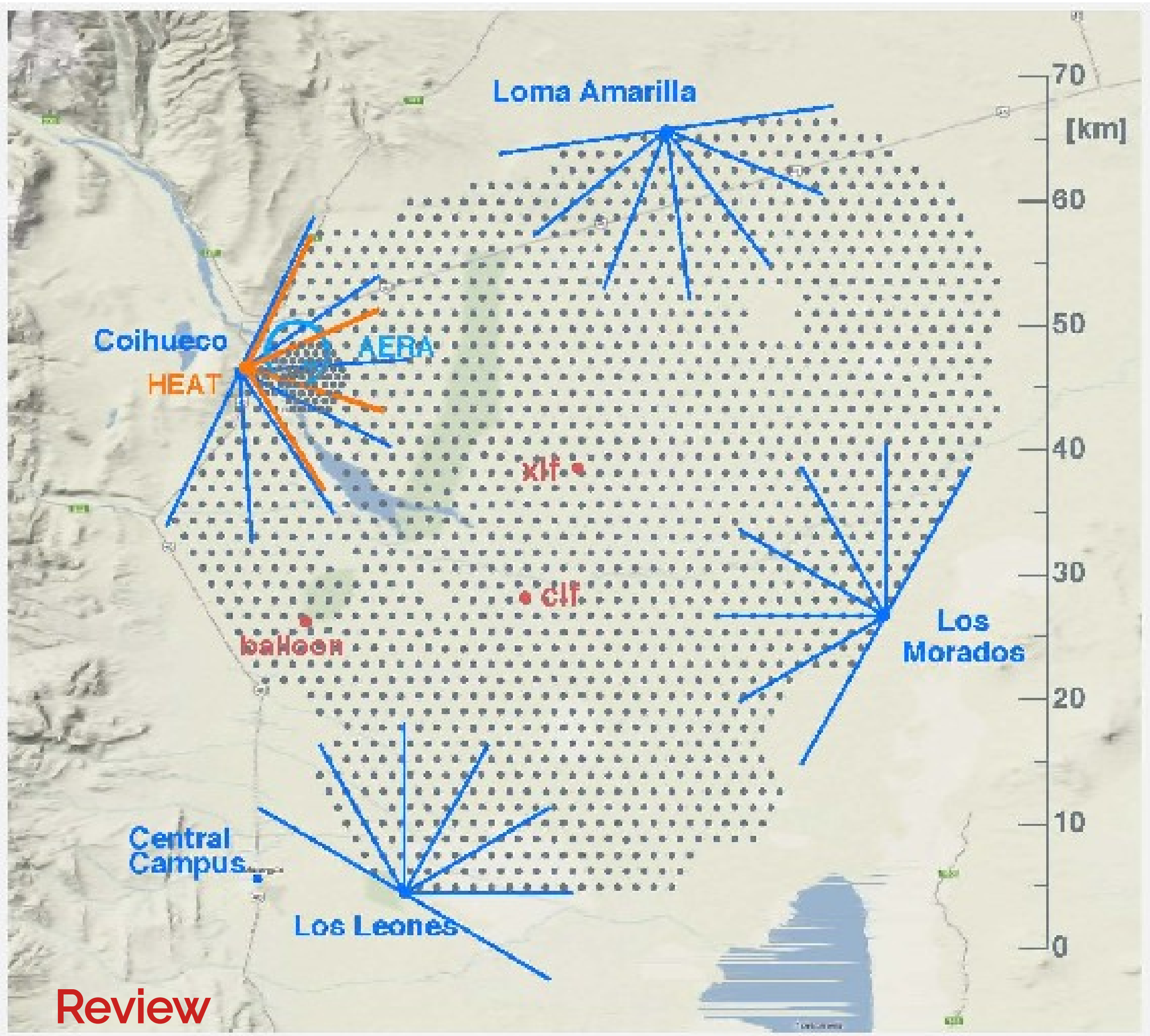
The Pierre Auger Observatory

https://auger.org

Ultra High Energy Cosmic Rays

Auger Prime (The Auger Upgrade → 2025)

Extreme detectors for extreme astrophysics
The Pierre Auger Observatory



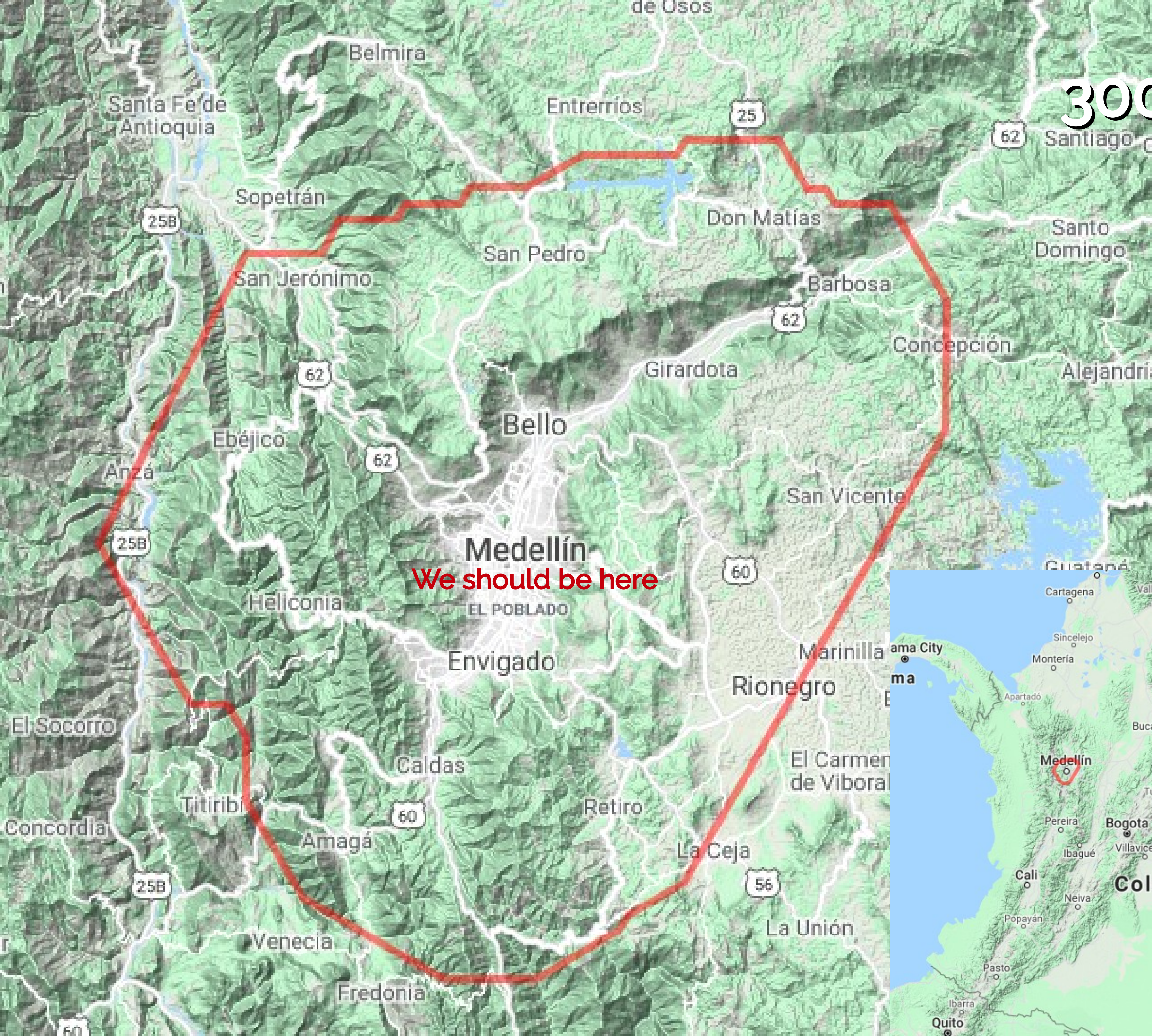
Review
The Pierre Auger Observatory and its Upgrade
Sci. Rev. F.E.W. **1** (4) 8–33 (2020)

- **3000 km² of detection area**
  - 1660 WCD 10 m²
  - 24+3 Fluorescence Telescopes
  - Auger Prime: Low energy extensions and composition
- **Hybrid synergy**
  - Longitudinal development
    - Fluorescence detector
  - Transversal development
    - Surface Detector
  - Muon development
    - Surface Scintillator Detector
    - AMIGA Detector

The Pierre Auger Observatory in numbers

- **3000 km^2 of instrumented area (16600 m^2 of detection area)**
- 1660 Water Cherenkov detectors → 20000 m^3 of ultra purified water
- 27 fluorescence telescopes
- 40 buried modules of 5 m^2 – 10 m^2 scintillators detectors (AMIGA)
- 1000 upgraded stations with scintillators surface detectors (SSD)
- 2 Vertical laser facility + 8 weather stations
- **94 institutions from 17 countries**
- Supported HE&AP development at 10 Latin American countries (LAGO)
- **400 people** "working" + **30 local people working**
- +100 Refereed journal articles + thousands of presentations at conferences
- **449 PhD thesis** (344 finished + 101 on going thesis, **109 PhD in LA!)**

3000 km²



de Osos
Belmira
Santa Fe de Antioquia
Entrerríos
25
62
Santiago
Sopetrán
25B
Don Matías
Santo Domingo
San Pedro
San Jerónimo
Barbosa
62
Concepción
62
Girardota
Alejandría
Bello
Ebéjico
62
Anzá
San Vicente
25B
Medellín
We should be here
60
EL POBLADO
Heliconia
Marinilla
Envigado
Rionegro
El Socorro
Caldas
El Carmen de Viboral
Titiribí
Retiro
Concordia
60
Amagá
La Ceja
25B
56
Venecia
La Unión
Fredonia
Maracaibo
Cartagena
Valledupar
Barquisimeto
Sincelejo
Montería
Mérida
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Cúcuta
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Tunja
Parque Nacional Natural El Tuparro
Pereira
Bogota
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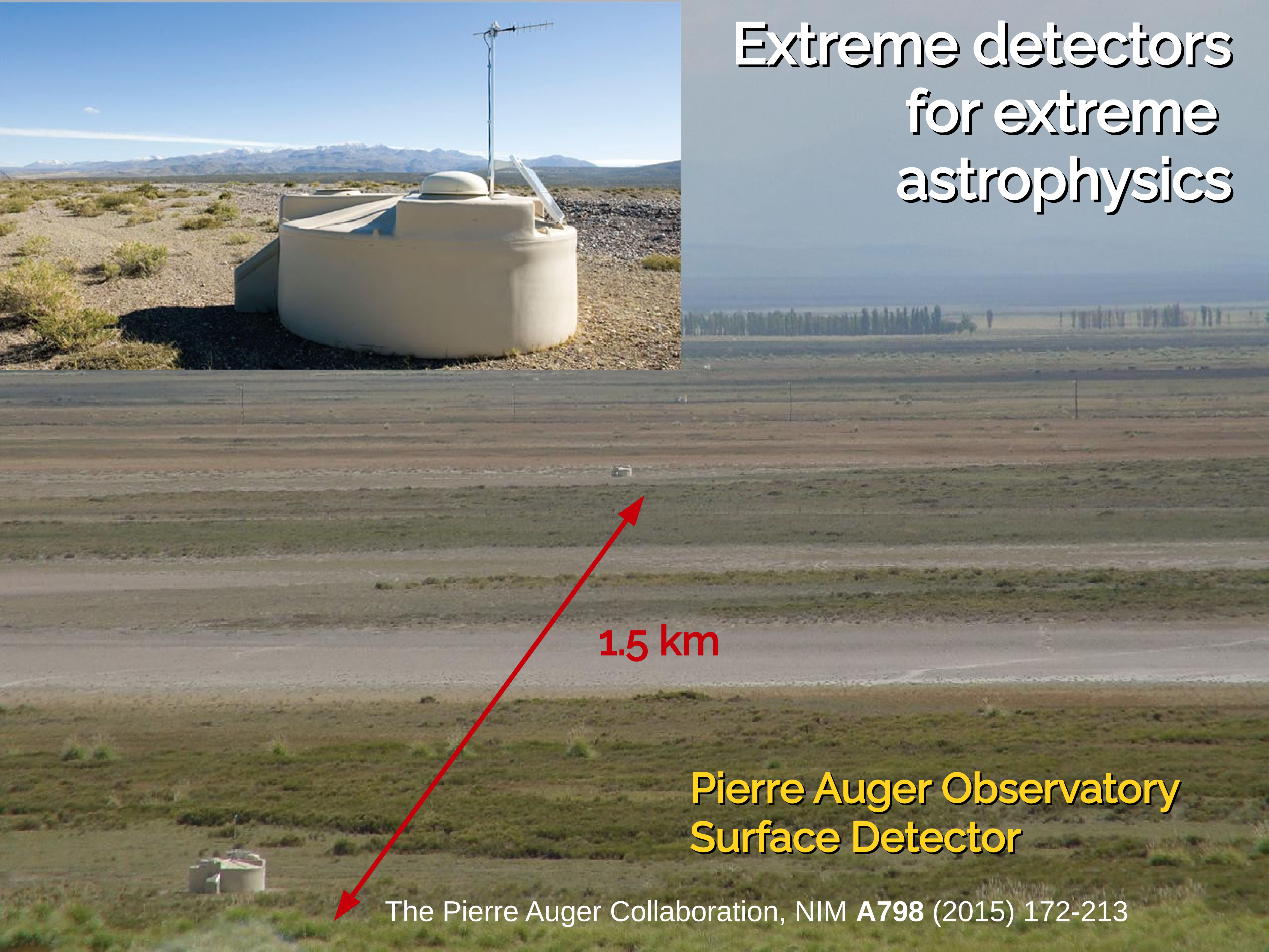
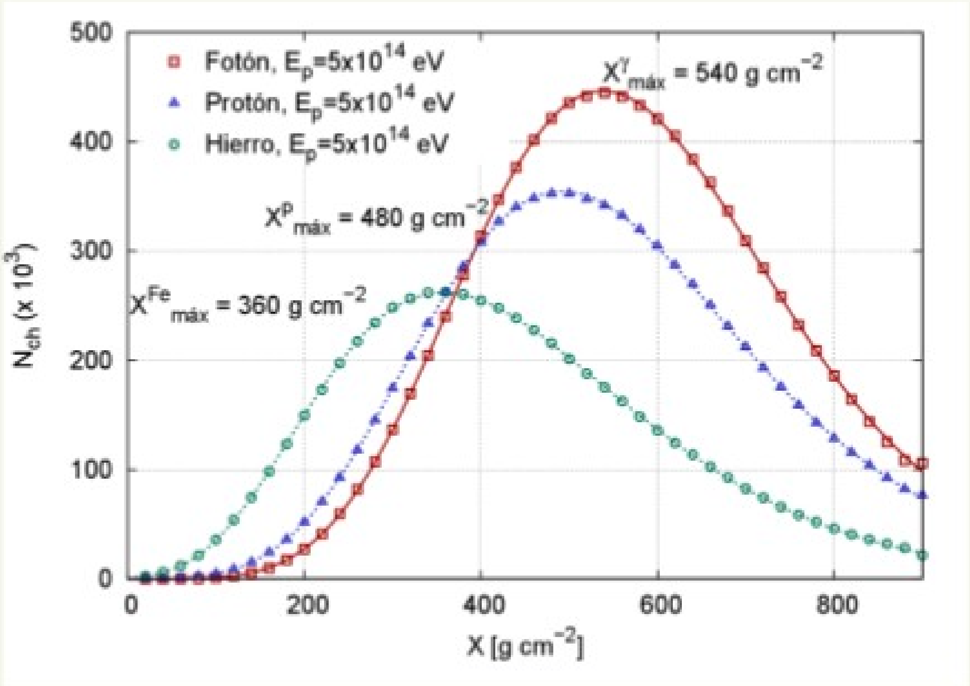
Villavicencio
Cali
Colombia
Neiva
Popayán
Pasto
Ibarra
Quito

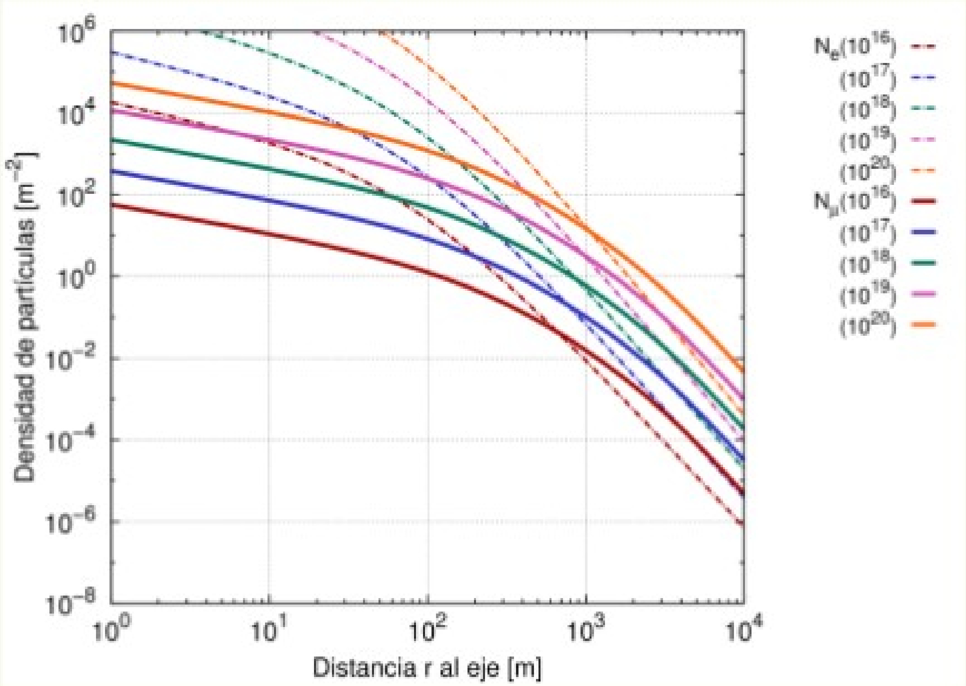

Extreme detectors
for extreme
astrophysics
1.5 km
Pierre Auger Observatory
Surface Detector
The Pierre Auger Collaboration, NIM A798 (2015) 172-213

Hybrid strategy

$E_d^{atm} \rightarrow$ Gaisser-Hillas

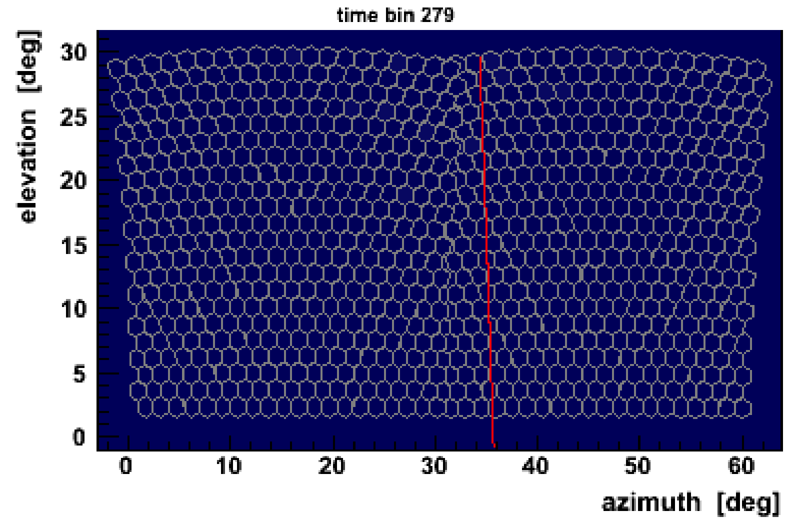


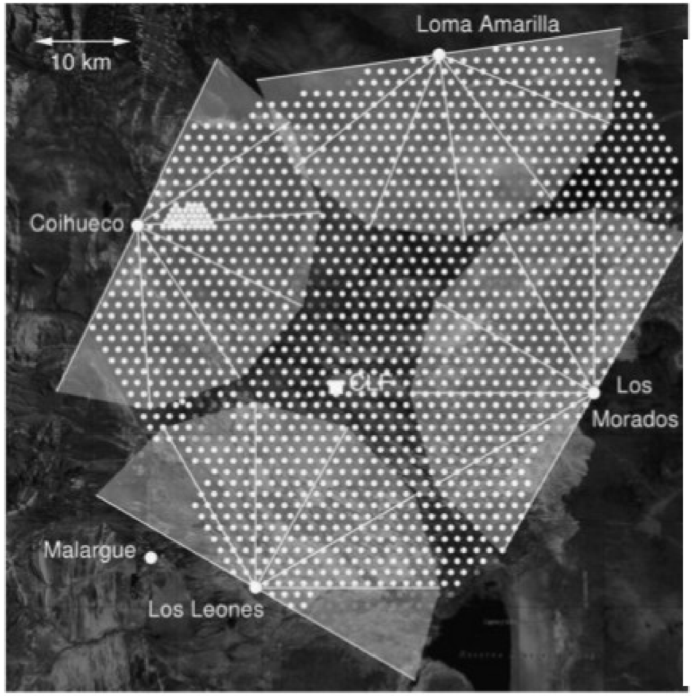
$E_d^{suelo} \rightarrow$ LDF: $\rho_e(r)$ y $\rho_\mu(r)$

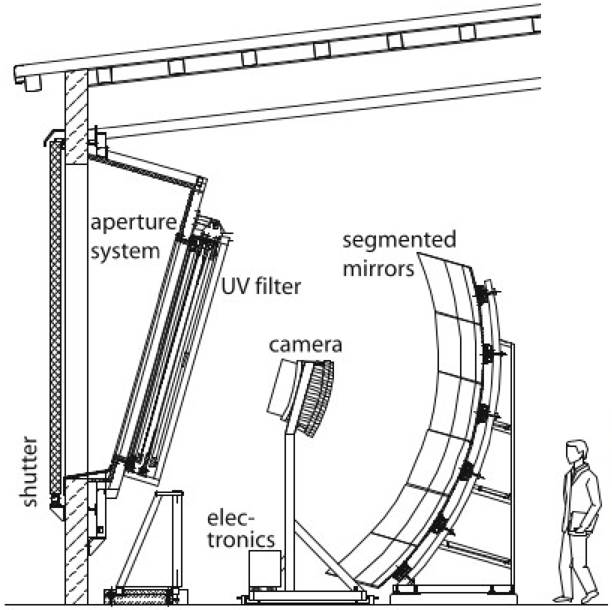


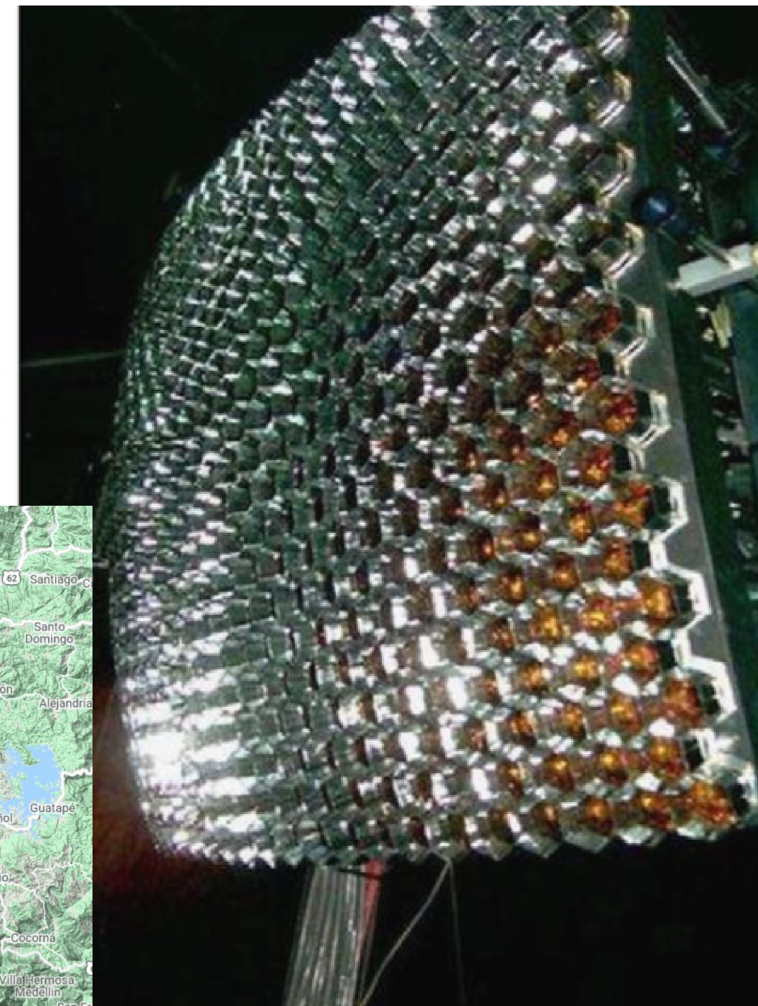
$$S_L(X) \propto N_{ch}(X) \propto E_d^{atm}(X) \qquad S_T(r) \propto \rho(r) \propto E_d^{gnd}(r)$$

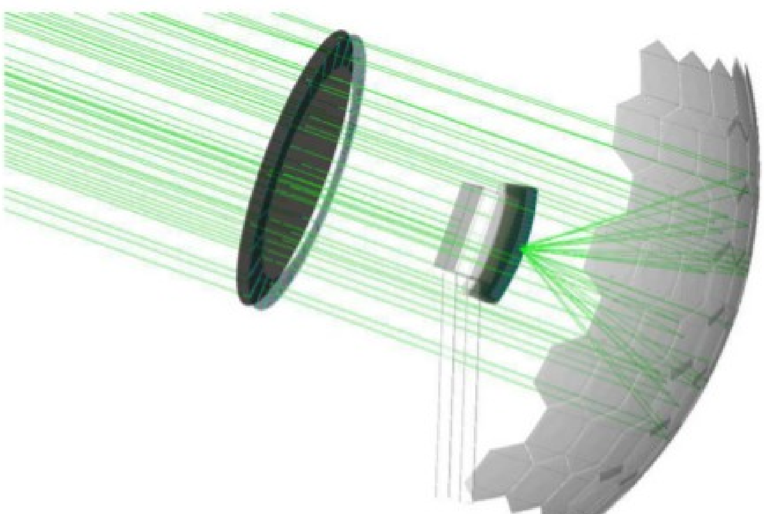
Fluorescence detector

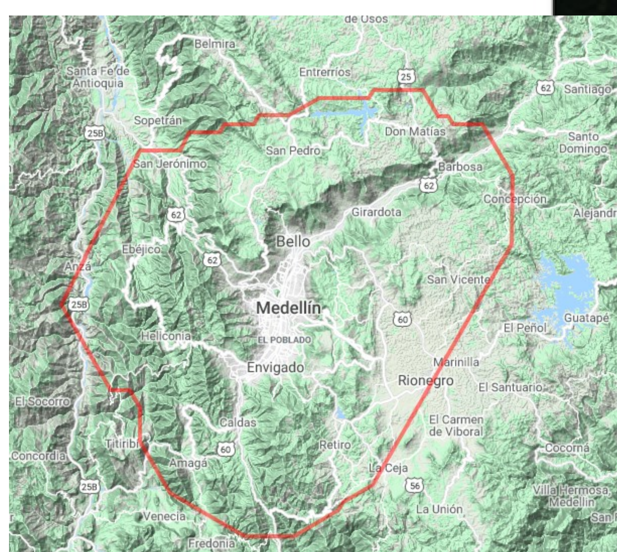








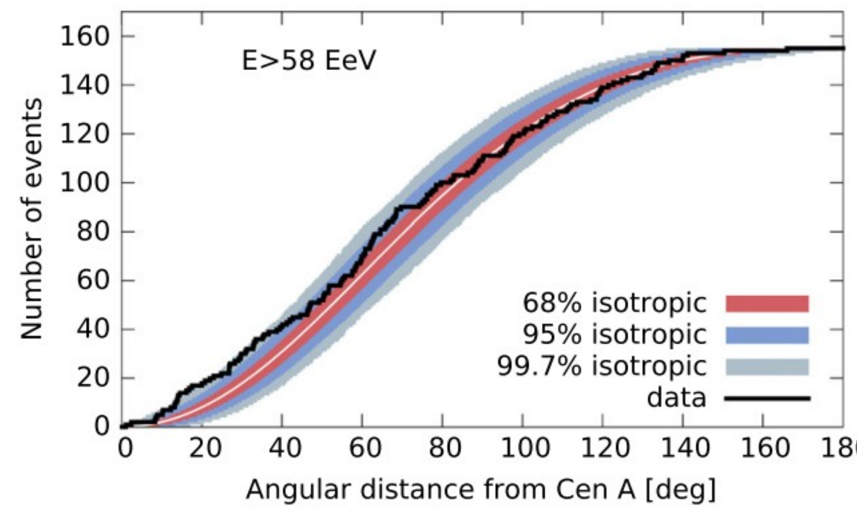


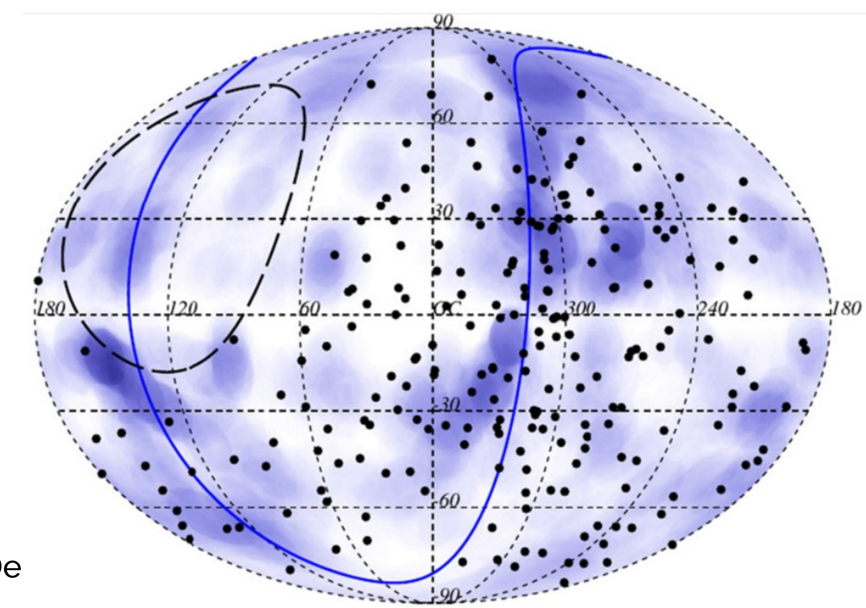


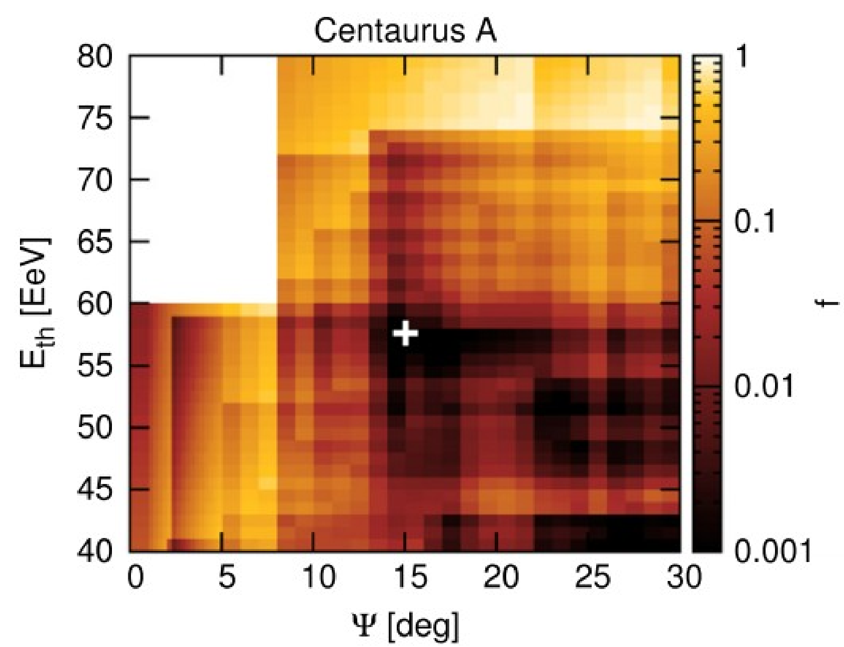
Search for UHECR Anisotropies

Table 1
Summary of the Parameters of the Minima Found in the Cross-correlation Analyses

Objects	E_{th} (EeV)	Ψ (°)	D (Mpc)	$\mathcal{L}_{min}$ (erg s^{-1})	f_{min}	$\mathcal{P}$
2MRS Galaxies	52	9	90	...	1.5×10^{-3}	24%
Swift AGNs	58	1	80	...	6×10^{-5}	6%
Radio galaxies	72	4.75	90	...	2×10^{-4}	8%
Swift AGNs	58	18	130	10^{44}	2×10^{-6}	1.3%
Radio galaxies	58	12	90	$10^{39.33}$	5.6×10^{-5}	11%
Centaurus A	58	15	...	...	2×10^{-4}	1.4%

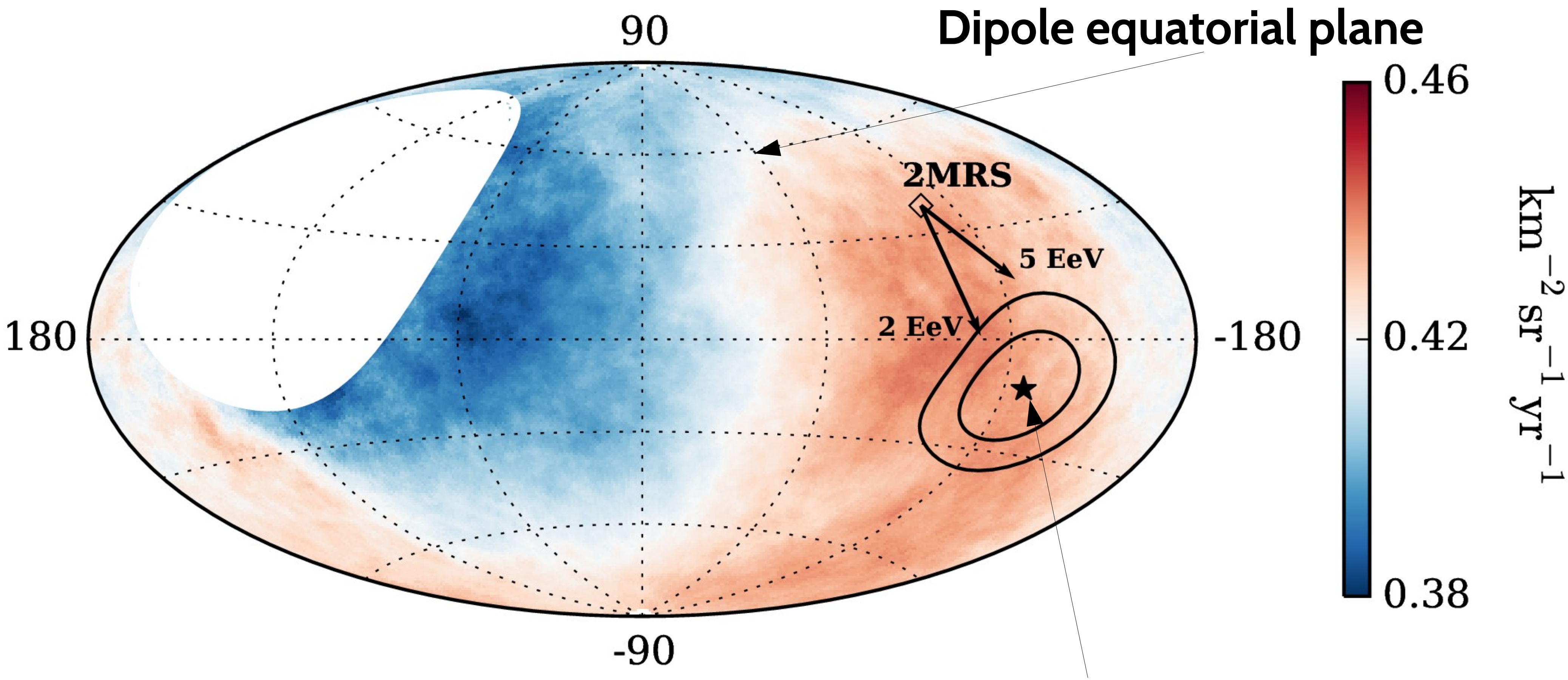






Flux map at E > 8 EeV (galactic coordinates)
The UHECR dipole is now discovered

The Pierre Auger Collaboration, Science **357**(2017)1266, arXiv:1709.07321 [astro-ph.HE]



125° from GC → indicates EG origin
55° from 2MRS dipole improved by including GMF E/Z (2-5)EeV

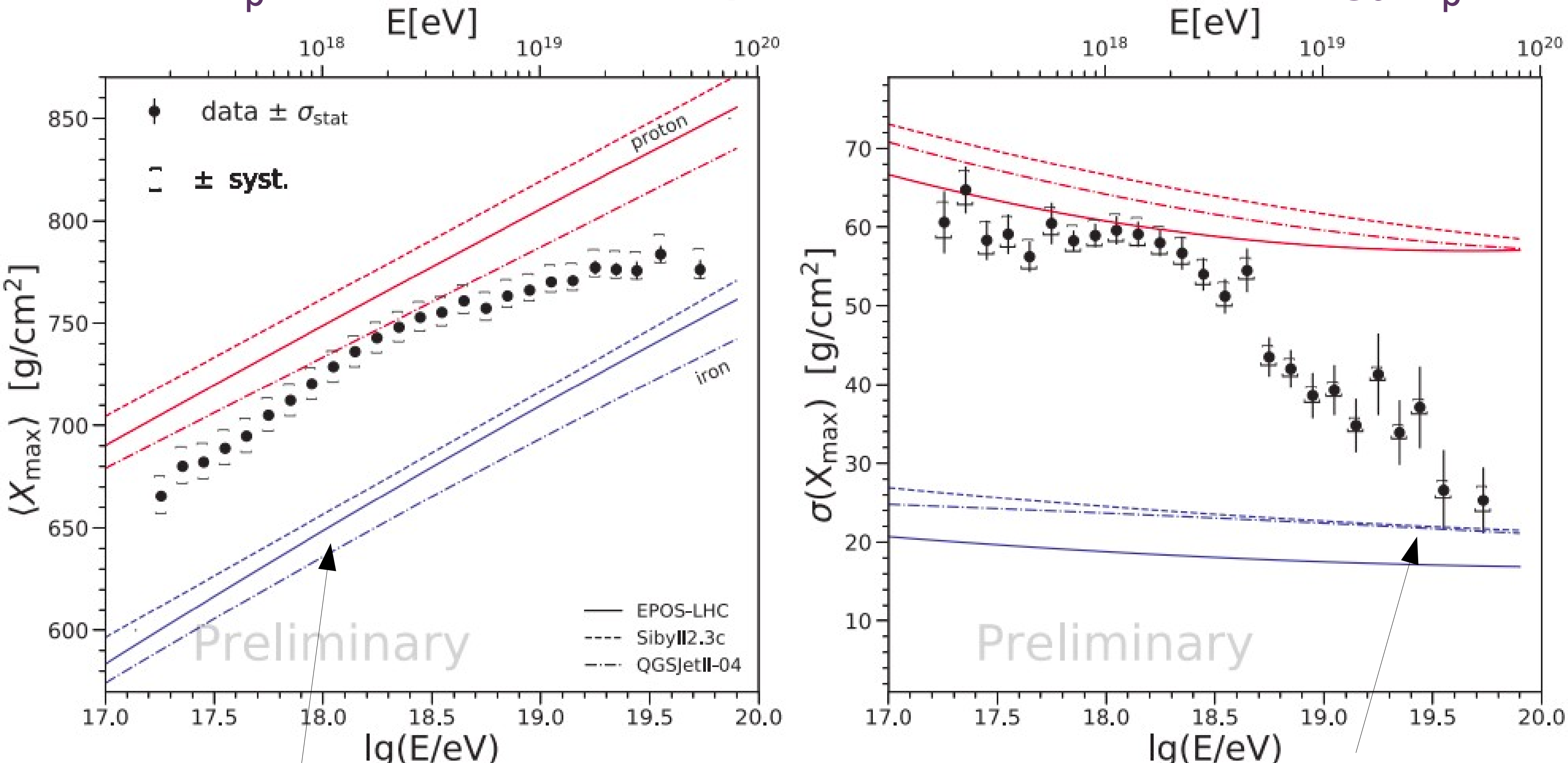
Amplitude: $6.5^{+1.3}_{-0.9}\%$ @ 5.2σ

$\alpha_d = 100^\circ \pm 10^\circ$; $\delta_d = -24^{\circ}{}^{+12^\circ}_{-13^\circ}$

X_{max} and X_{max} fluctuations

Semi-superposition principle

A shower E_p and mass A develops as A showers with energy E_p/A

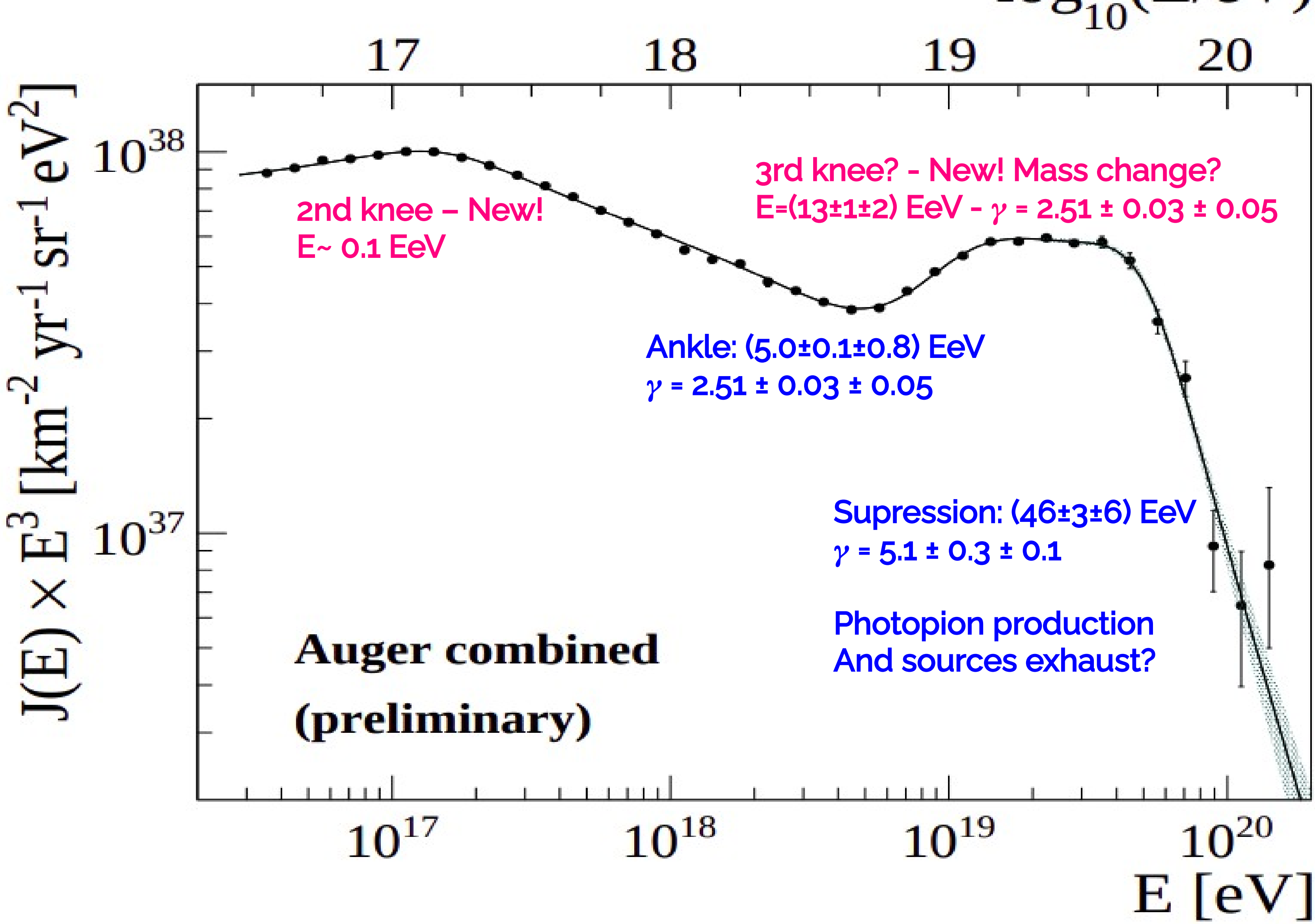


EAS corsika simulations with post-LHC hadronic models

The Pierre Auger Collaboration, ICRC 2019

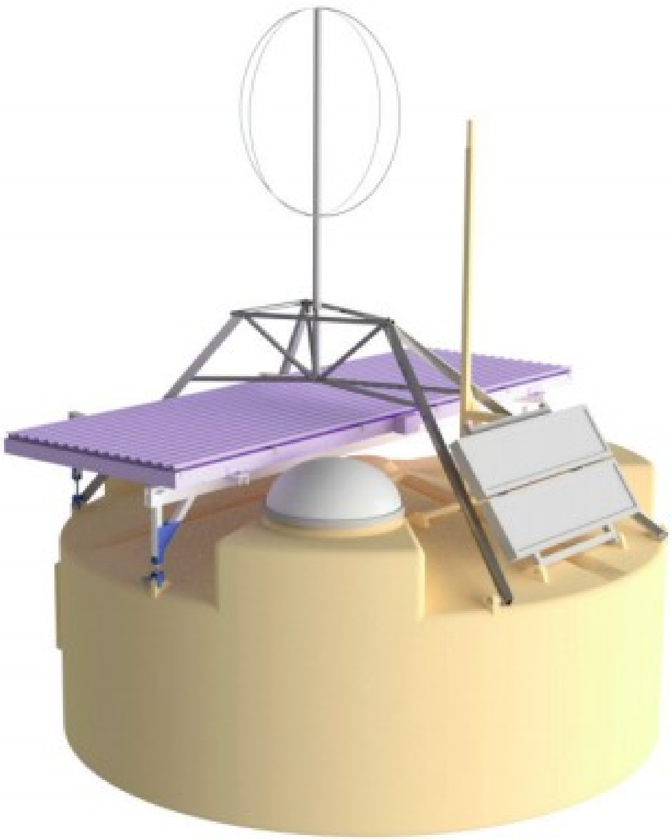
Auger Combined Spectrum x E^3

Combined exposure: 80000 Ly (km^2 sr yr)



The Pierre Auger Collaboration, ICRC 2019, arXiv:1909.10791 [astro-ph.HE]

The Auger upgrade: Auger Prime



- Hadronic physics for s > (140 TeV)?
- Rigidity (=pc/Ze) dependence of anisotropies?
- Proton fractions and composition at UHE
- Origin of the flux suppression?

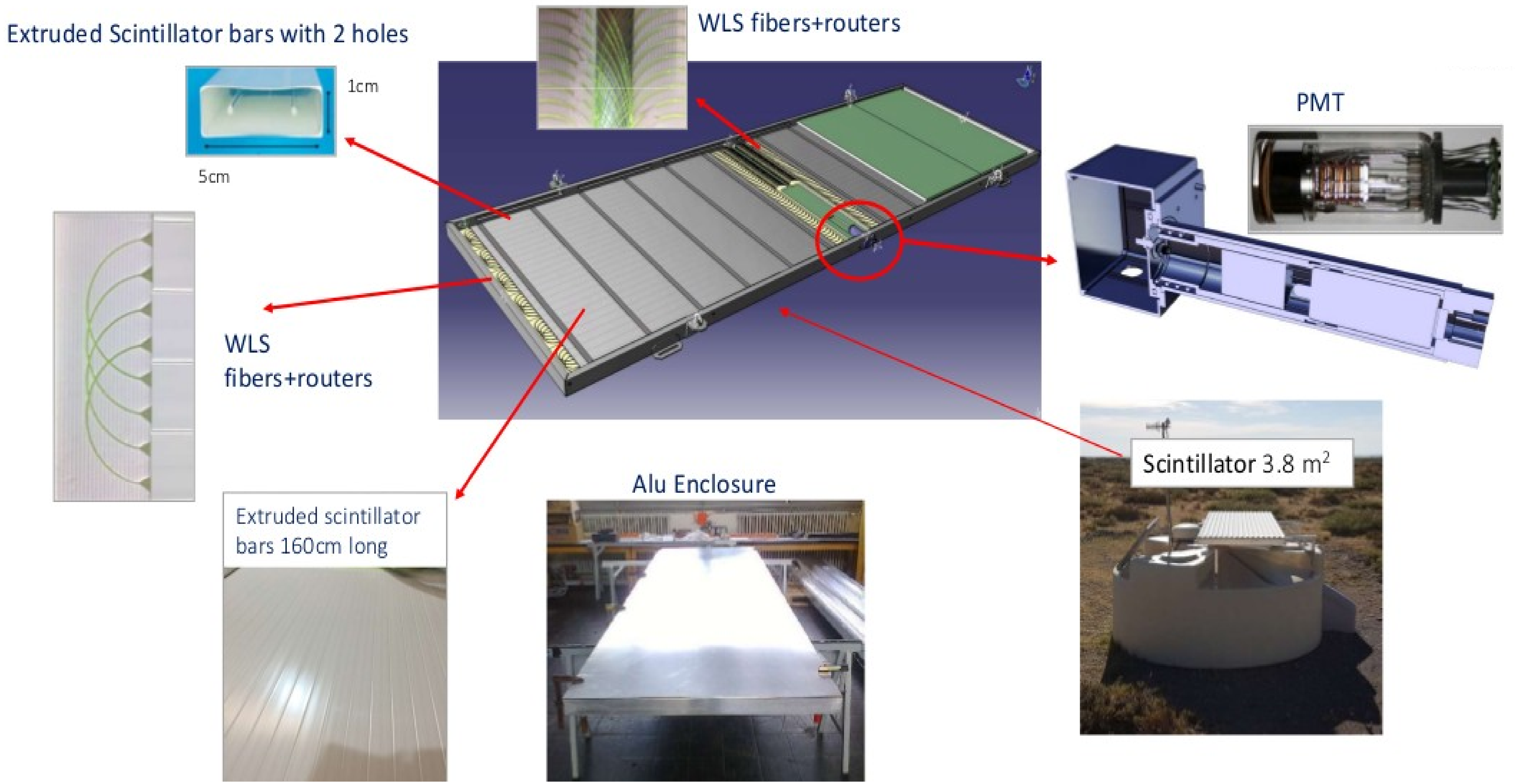
→ **Auger +Upgraded electronics + Scintillators + Infill + Buried detectors + Radio detection**

Auger Prime strategy → operation up to 2025

- Add Scintillator Surface Detectors (SSD) to improve the measurement of WCD mass composition observables
- Add a single small PMT to extend the dynamic range
- Upgrade the SD electronics to improve performance and new detectors
- Buried muon detectors (AMIGA) to have direct muon measurements (+ SSD+WCD cc)
- Extend FD duty cycle to increase statistics

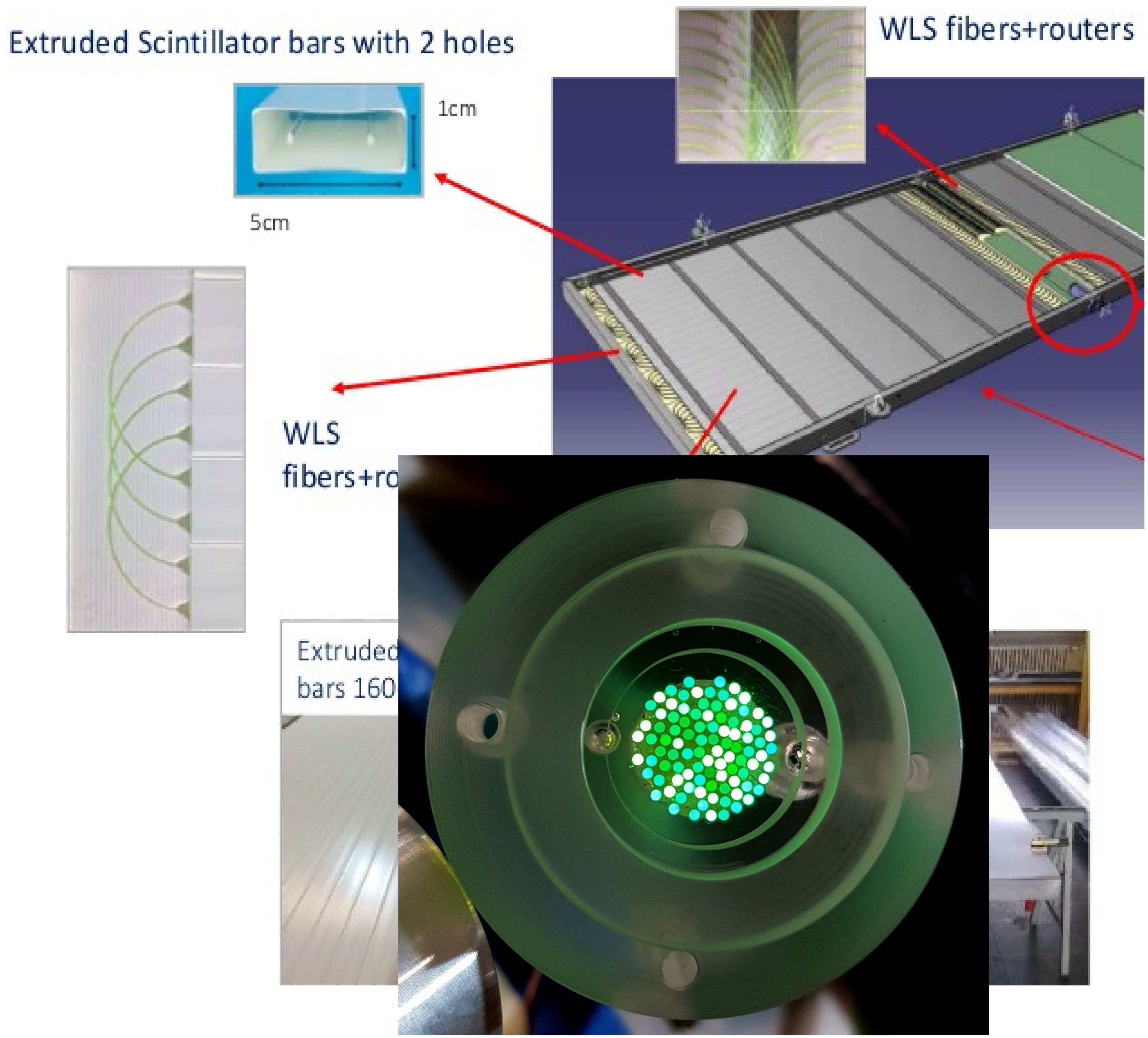
The Pierre Auger Collaboration, ICRC 2017

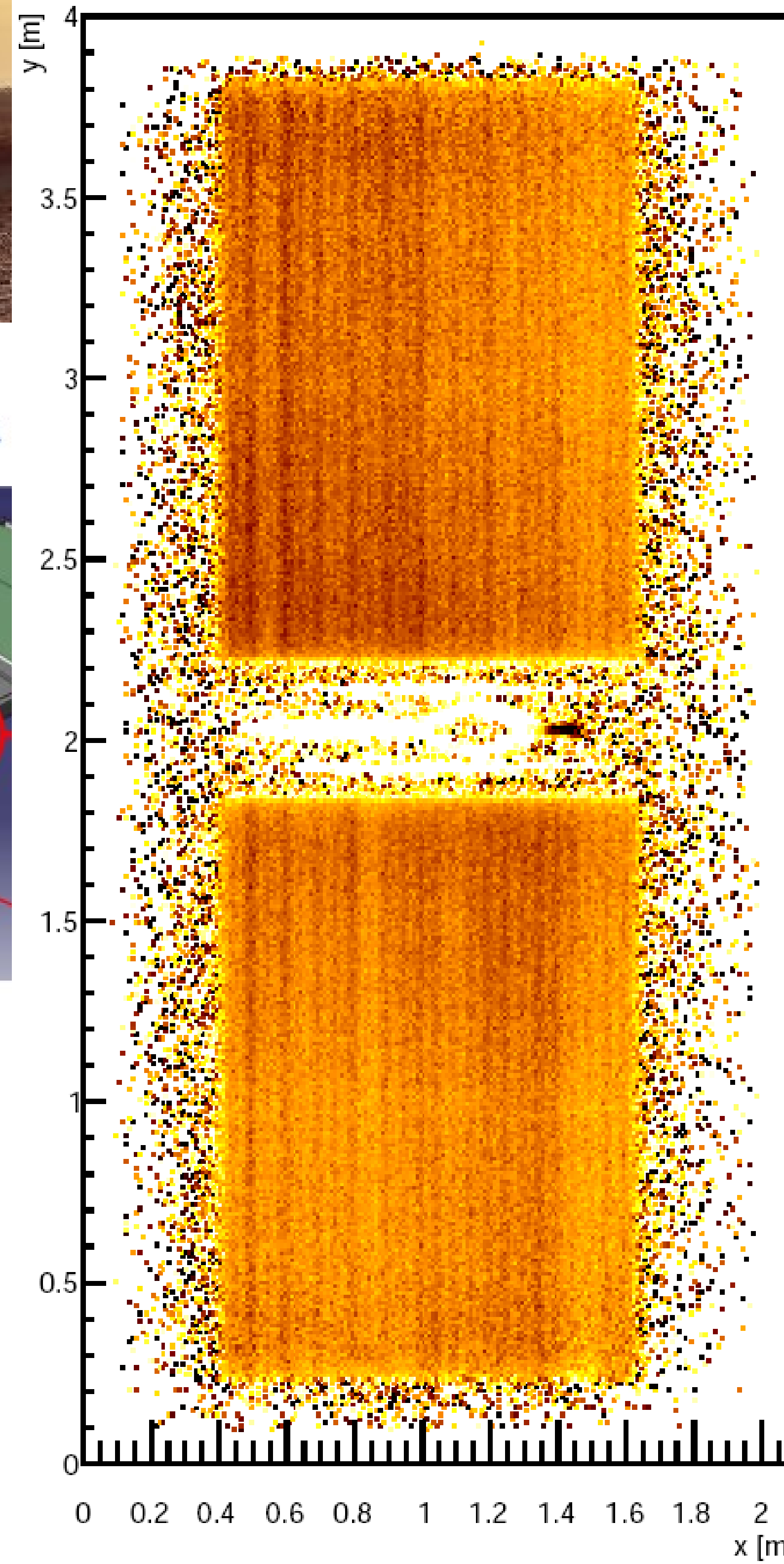
The SSD



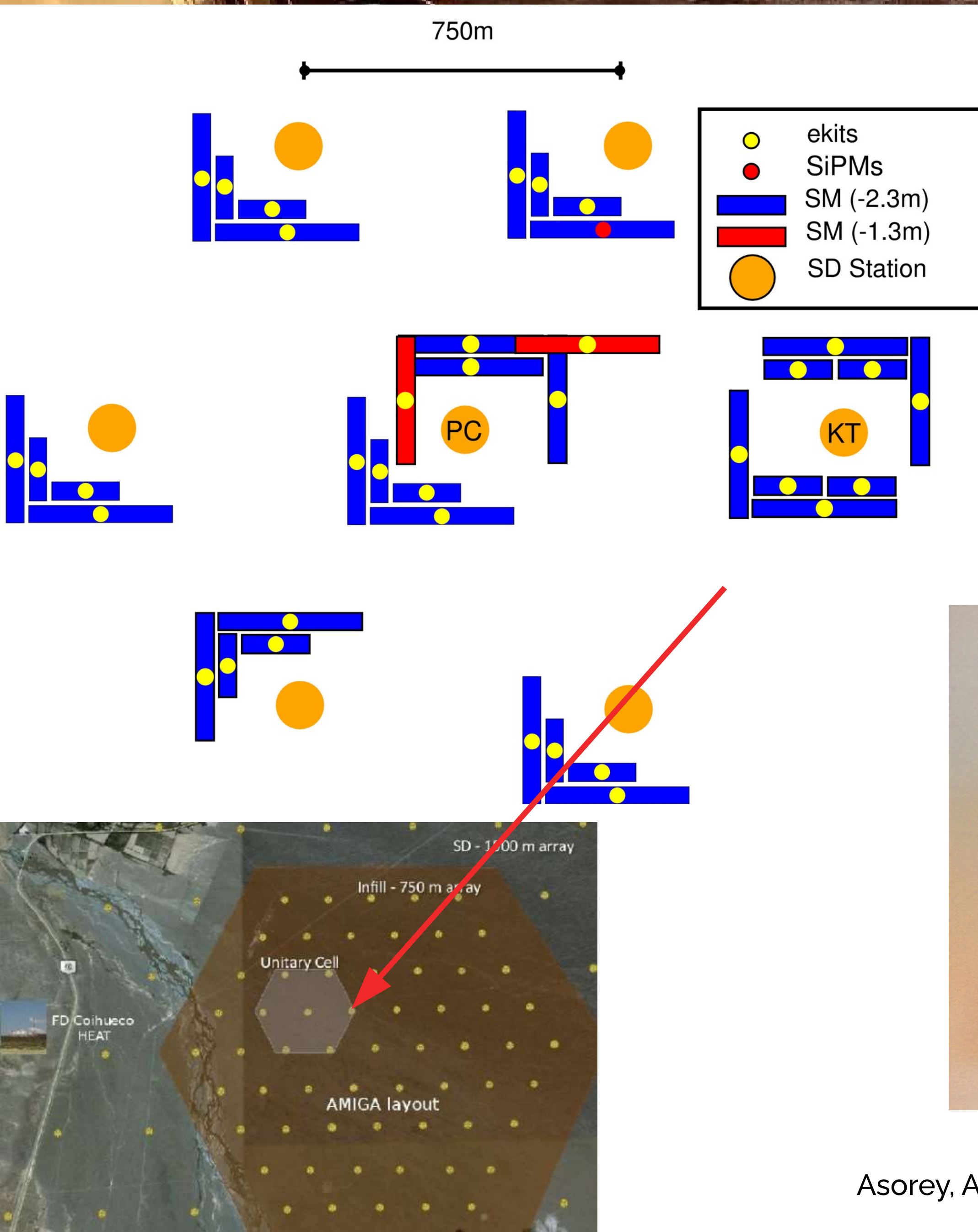
The Pierre Auger Collaboration, ICRC 2017

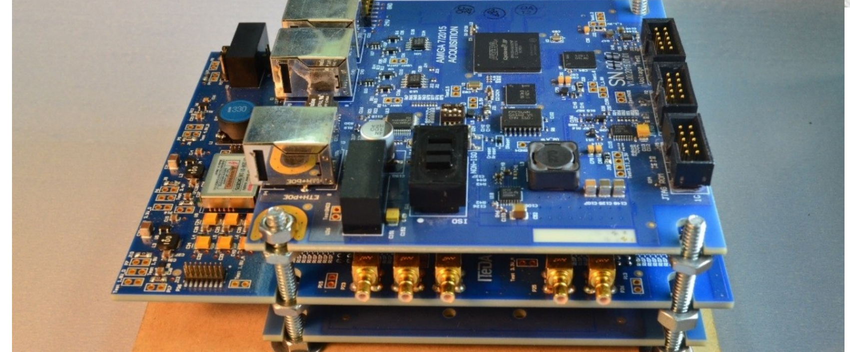
The SSD calibration using cosmic rays muon flux!

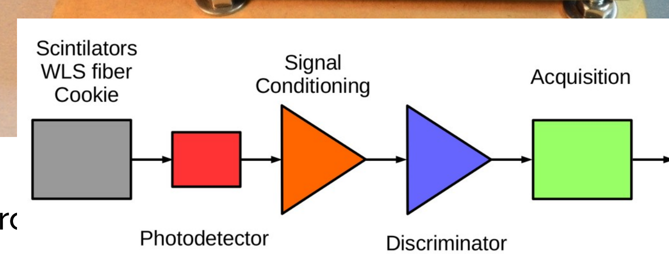




The underground muon detector (AMIGA)







LAGO

The Latin American Giant Observatory

https://lagoproject.net

Measuring CR at LA

Latin America Giant Observatory
lagoproject.net

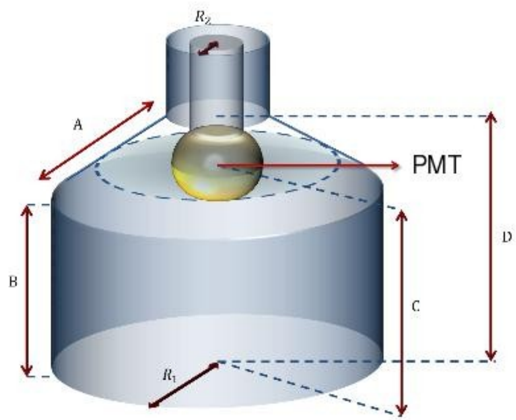
The Latin American Giant Observatory (LAGO)

- A giant network of WCD at continental scale: from Mexico to Antarctica
  - 31 LA sites: 9 ops + 17 dev + 5 planned
  - 2 Antarctic Nodes at Arg and Per bases.
- Non-centralized, **collaborative** network of 131 people from 36 institutions at 11 countries.
- Governance: coordination committee: 11 country representatives + 1 PI
- Hardware, expertise and data are shared across the network
- Primary objectives carried out by programs:
  - Scientific: HE Gamma sources and transients; Space Weather
  - Academic: Astroparticle physics seeder at LA

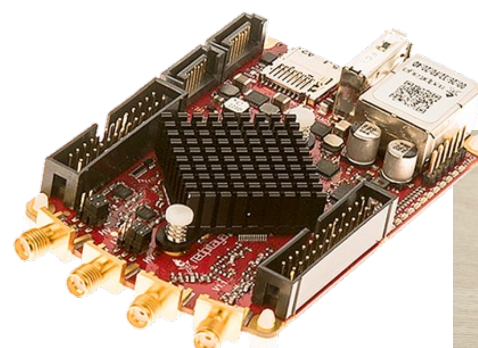
LAGO Activities

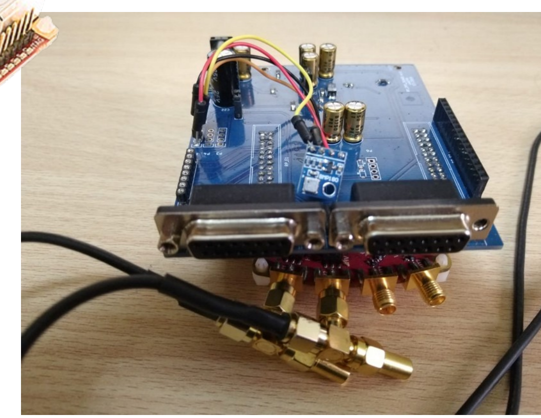
- **LAGO HE**
  - Small WCD Arrays at high altitude sites (>4500m asl)
  - Gamma sources & transient phenomena: HE GRBs
- **LAGO Space Weather**
  - Space weather and climate from ground level
  - Atmospherics physics
  - Background radiation at ground and flight level
- **LAGO Universities**
  - Astro-ph & hep-ph undergraduate and graduate courses
  - Building and callibration of particle detectors and muon decay exp.
  - Integrated programs for support teaching in experimental courses
- **LAGO Virtual**
  - DART initiative on all LAGO data
  - EOSC Synergy: EC cloud based services integration
  - ARTI: A complete simulation chain: from geomagnetic field to detector response
  - Cloud data analysis and simulations

The LAGO detector: *s*-WCD (*s* is for smart)

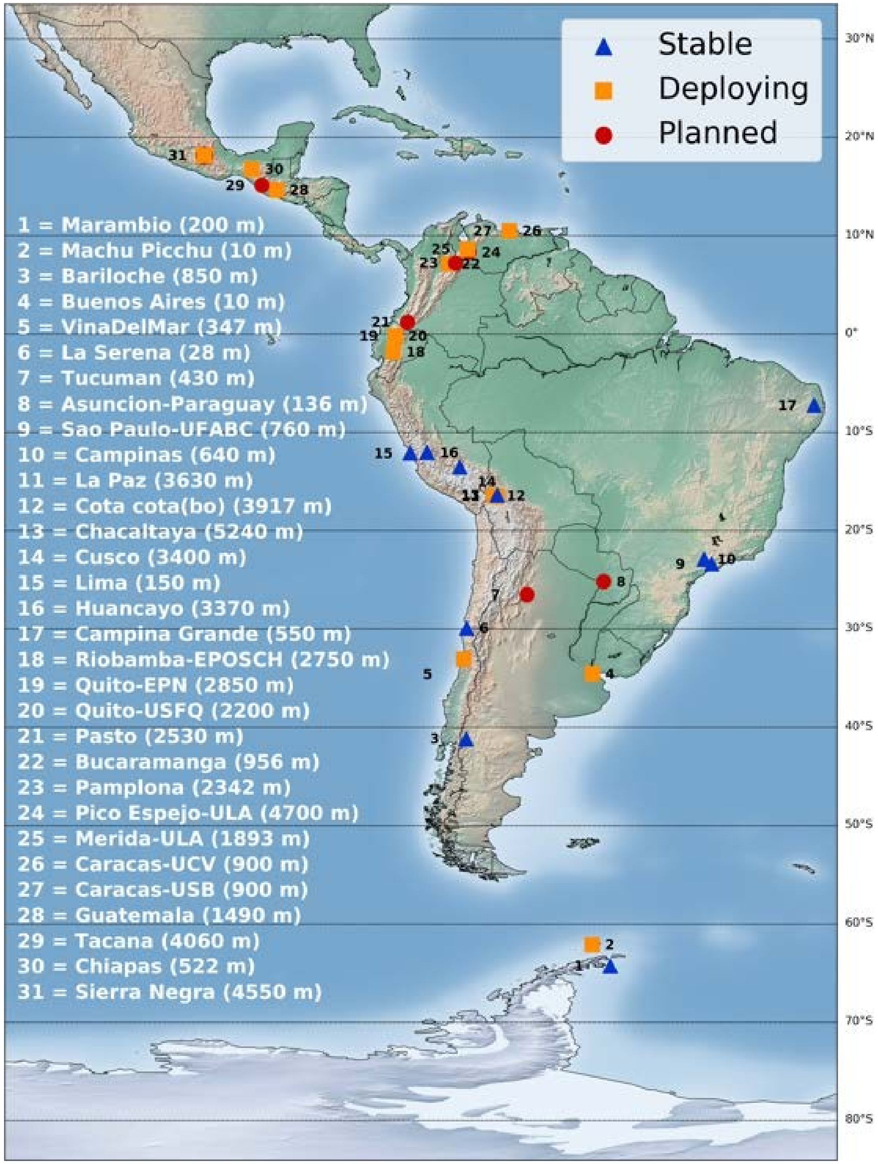


- Autonomous, realiable, simple, cheap and smart WCD
  - Commercial water tanks 1.5-10 m³ filled with pure water
  - 1 central 8"-9" PMT
  - Internal difussive coating
- Internal programs to **provide PMTs** for Universities at Low Income Countries
- New, own designed SteamLab based electronic
  - "Sensors as Service" (SAS) concept:
    - Atmospheric sensors (RACIMO)
    - WCD is just another sensor
  - FADC 10-14 bits-125Msps
  - s is for smart: Linux on board
    - C Compiler, rsync, crontab, python, deep learning data analysis, ...
  - Average station power consumtion: <8W



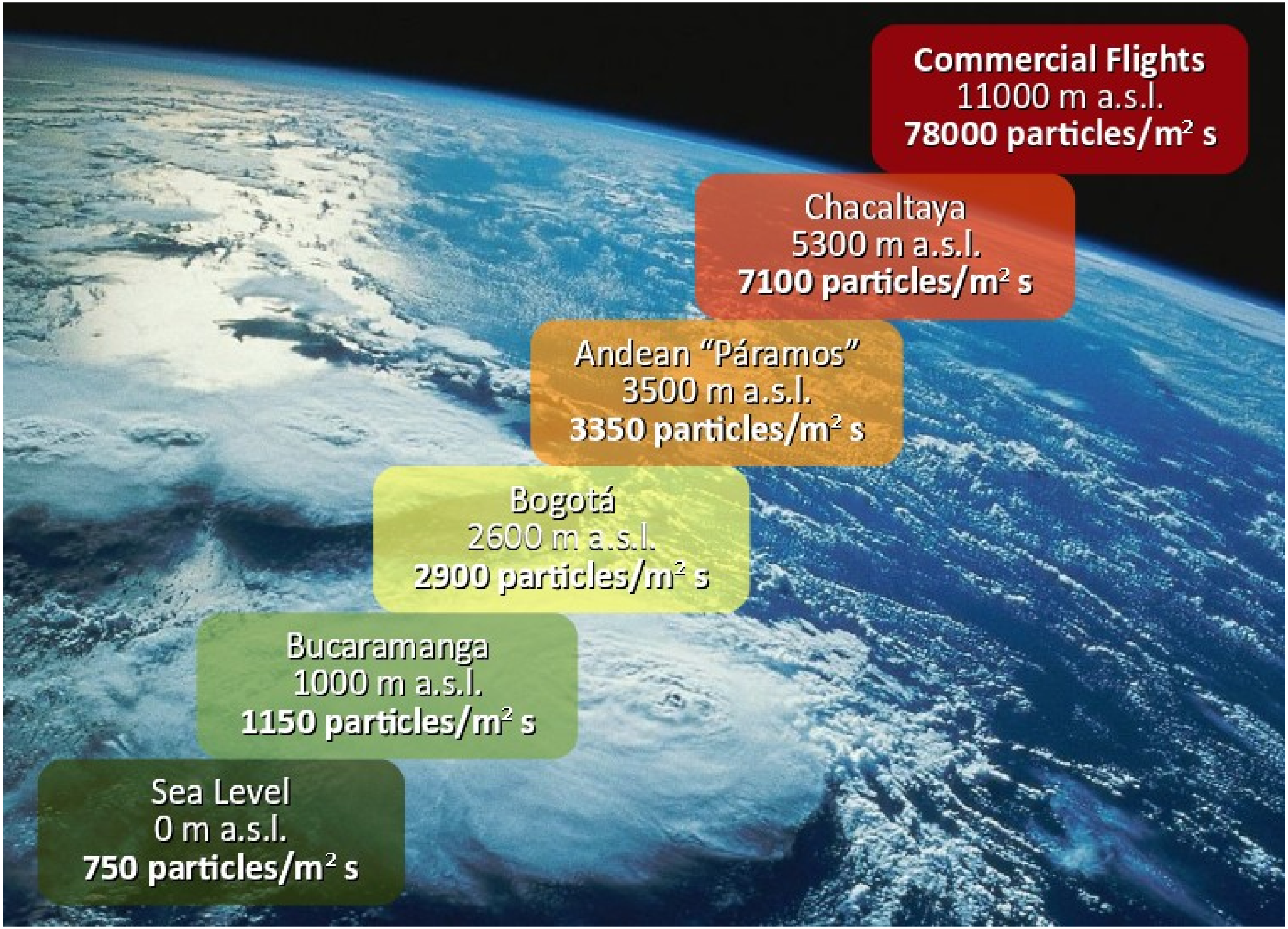


LAGO Virtual



- Two types of data: measured and synthetic
  - Measured data: 4 quality levels
    - L1: raw data
    - L2: preliminary
    - L3: Data Quality
    - L4: High Quality
  - Massive data production:
    - raw (~ 1 TiB/(year det));
    - sims (~ 3 TiB/(year site))
- LAGO & RedCLARA
  - Main data repository located at UIS
  - Data transfer from Sites to Repository using RedCLARA (where available)
  - Data mirrors @ BsAs and Madrid
  - EOSC-Synergy: Cloud integration

Atmospheric reaction produces background radiation



Space weather → Sun-Earth Connection

LAGO Capabilities: Multi-spectral analysis

- Simultaneous measurements of secondaries at ground level
- Intensive simulation and data analysis frameworks

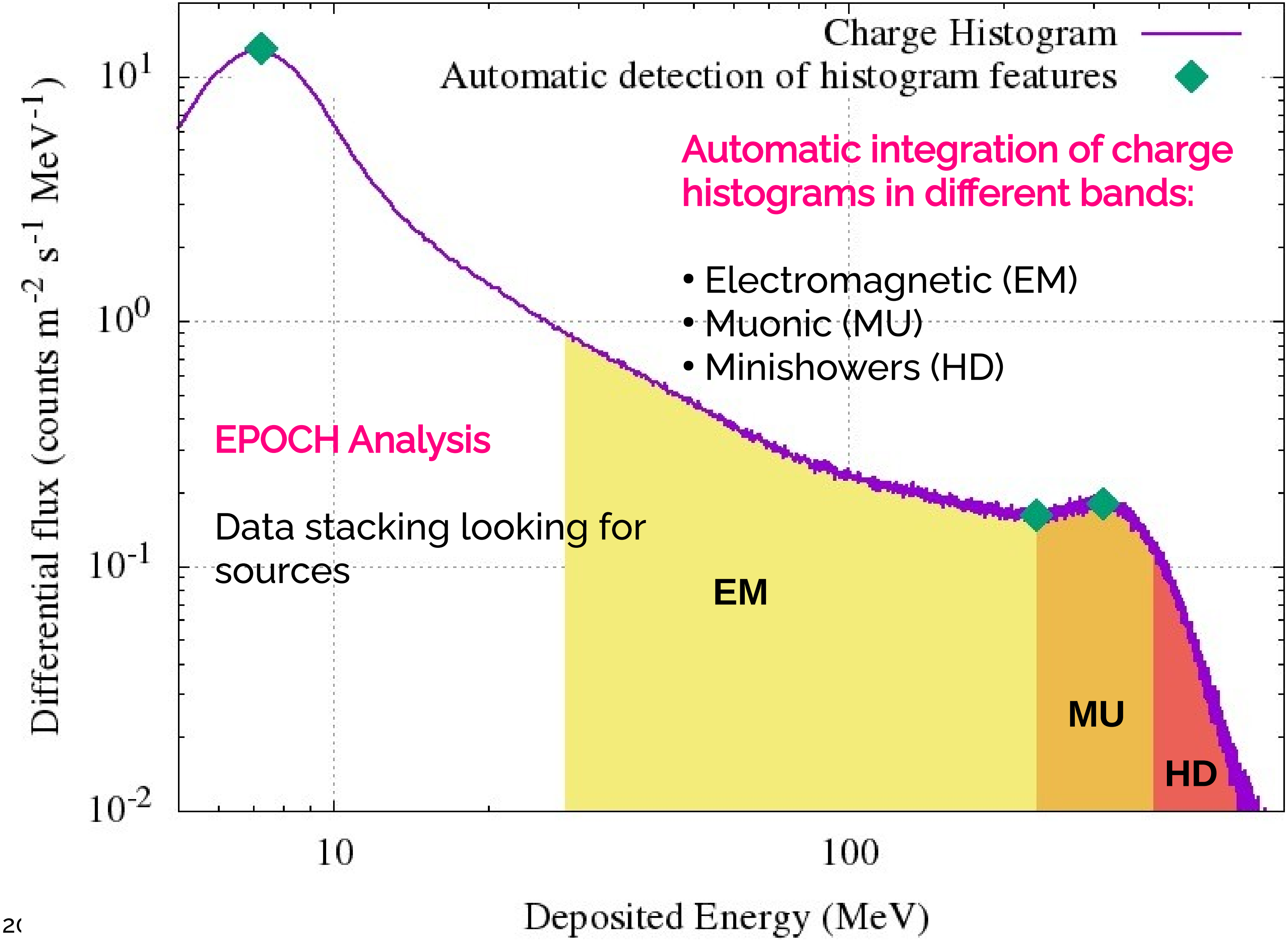
Connections

CR Flux	$\xrightarrow{\text{Astrophysics transients}}$	Modulated flux ···
··· Modulated flux	$\xrightarrow{\text{Geomagnetic field}}$	Primaries ···
··· Primaries	$\xrightarrow{\text{Atmospheric conditions}}$	Secondary particles ···
··· Secondary particles	$\xrightarrow{\text{Detector response}}$	Signals

Synergy

Flux variation of signals at detector level ⇔ Transients

Data analysis for Space Weather



Automatic integration of charge histograms in different bands:

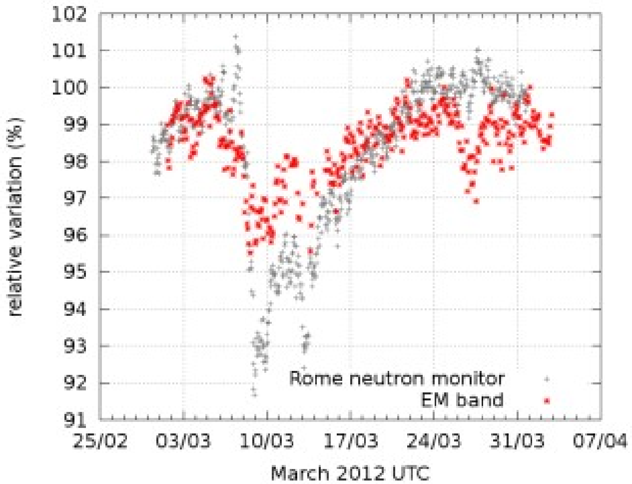
- Electromagnetic (EM)
- Muonic (MU)
- Minishowers (HD)

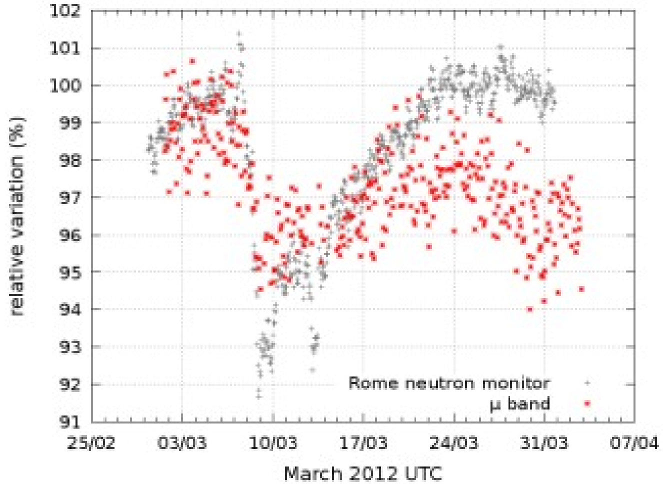
EPOCH Analysis

Data stacking looking for sources

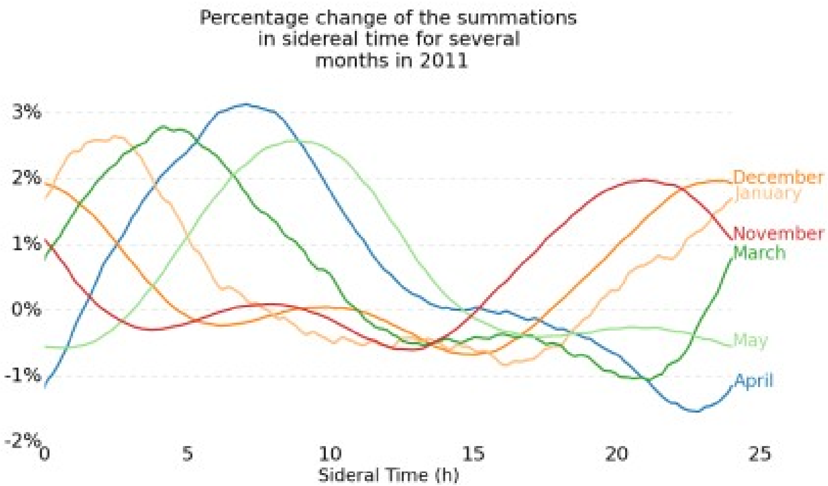
Space weather and climate using WCD

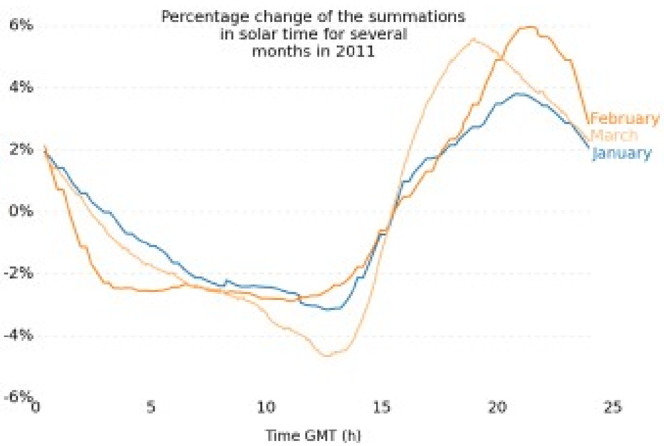
- Multi-spectral analysis of the March/08/2012 Forbush event:





- EPOCH Analysis in Solar and Sidereal times: Solar Daily Modulation

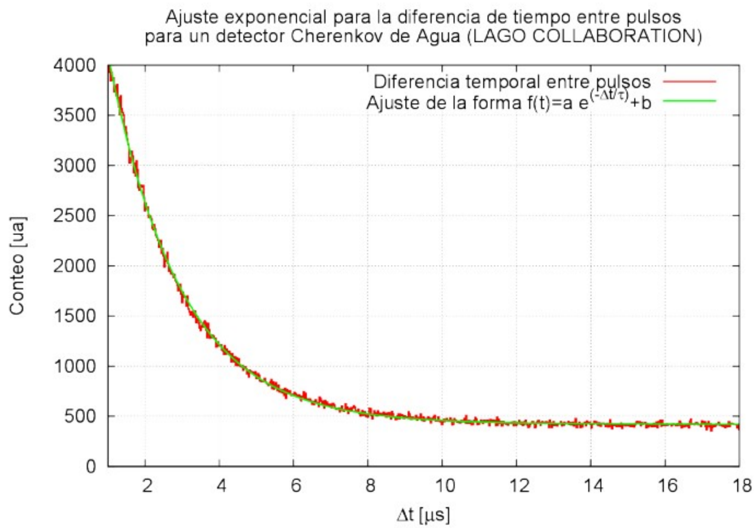




LAGO Universities

Experimental, astro-ph & hep-ph courses availables

Muon decay: electroweak therory, python, data analysis, simulations, detector physics, statistics, ...



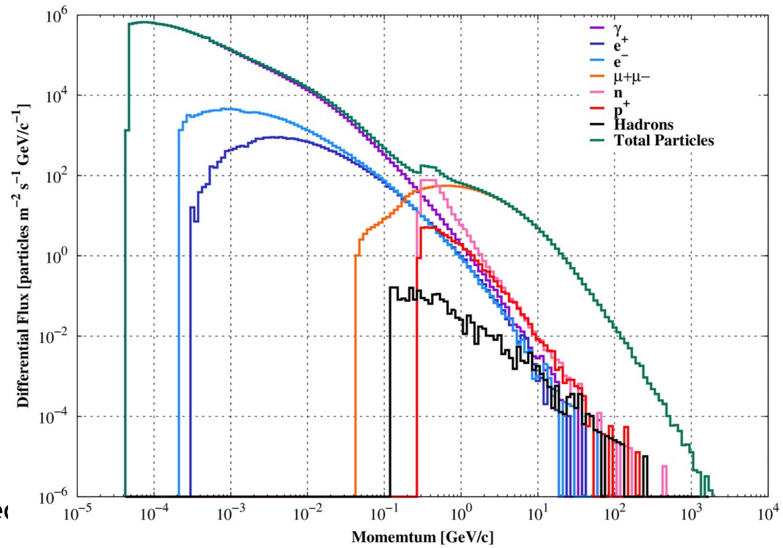
$$\tau_\mu = (2020 \pm 0{,}1)\ \mathrm{ns}$$

$$\rightarrow g_w = \frac{m_W}{m_\mu \tau_\mu^{1/4}} \left(\frac{12\hbar(8\pi)^3}{m_\mu c^2} \right)^{1/4}$$

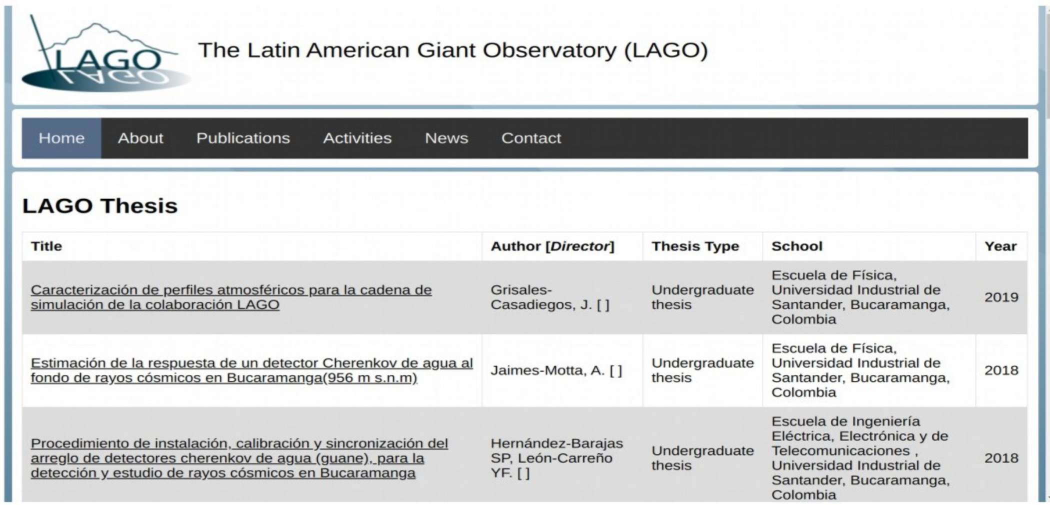
$$g_w = 0{,}7 \pm 0{,}1$$

Annual LAGO Workshop and AP School

AP physics, sims, data analysis + presentations



Some LAGO Universities figures see http://lagoproject.net for more fun

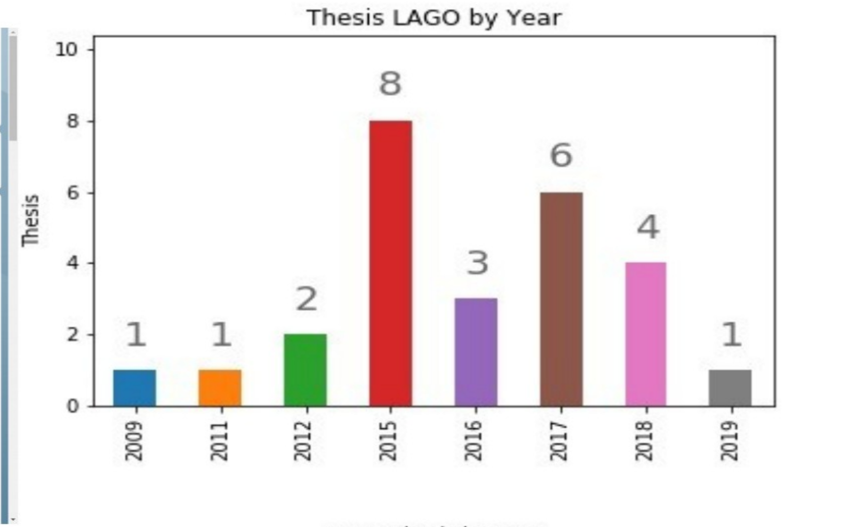


The Latin American Giant Observatory (LAGO)

Home | About | Publications | Activities | News | Contact

LAGO Thesis

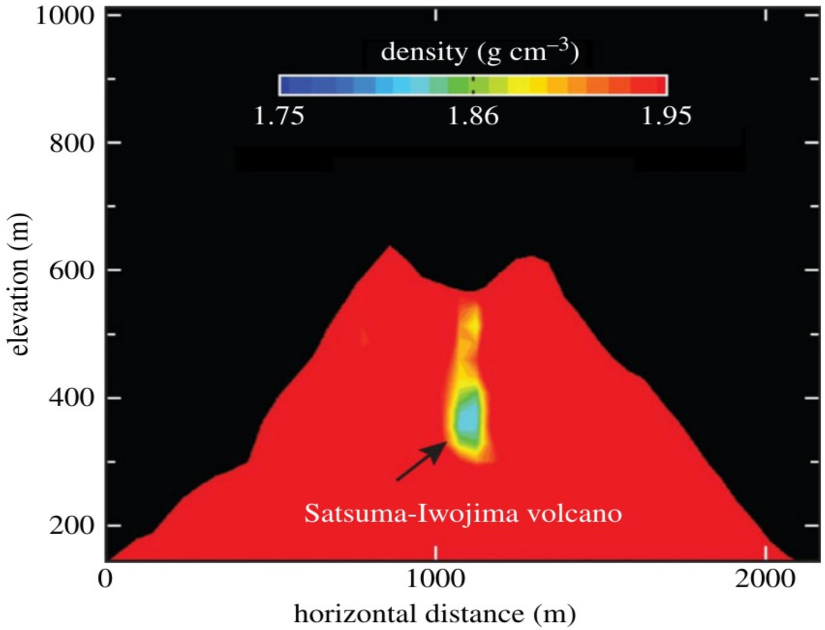
Title	Author [*Director*]	Thesis Type	School	Year
Caracterización de perfiles atmosféricos para la cadena de simulación de la colaboración LAGO	Grisales-Casadiegos, J. [ ]	Undergraduate thesis	Escuela de Física, Universidad Industrial de Santander, Bucaramanga, Colombia	2019
Estimación de la respuesta de un detector Cherenkov de agua al fondo de rayos cósmicos en Bucaramanga(956 m s.n.m)	Jaimes-Motta, A. [ ]	Undergraduate thesis	Escuela de Física, Universidad Industrial de Santander, Bucaramanga, Colombia	2018
Procedimiento de instalación, calibración y sincronización del arreglo de detectores cherenkov de agua (guane), para la detección y estudio de rayos cósmicos en Bucaramanga	Hernández-Barajas SP, León-Carreño YF. [ ]	Undergraduate thesis	Escuela de Ingeniería Eléctrica, Electrónica y de Telecomunicaciones , Universidad Industrial de Santander, Bucaramanga, Colombia	2018



- 26 thesis: mostly undergraduate/graduate and master thesis from Brasil, Colombia, Ecuador, Argentina, Guatemala, Bolivia, México and Venezuela
- 44 publications (mostly on conferences proceedings)
- 15 Astroparticle physics schools in LA
- Since 2020: virtual courses on AP physics
- **Efficiency: production / investment → tends to infinity**

Muography

Social astroparticles applications

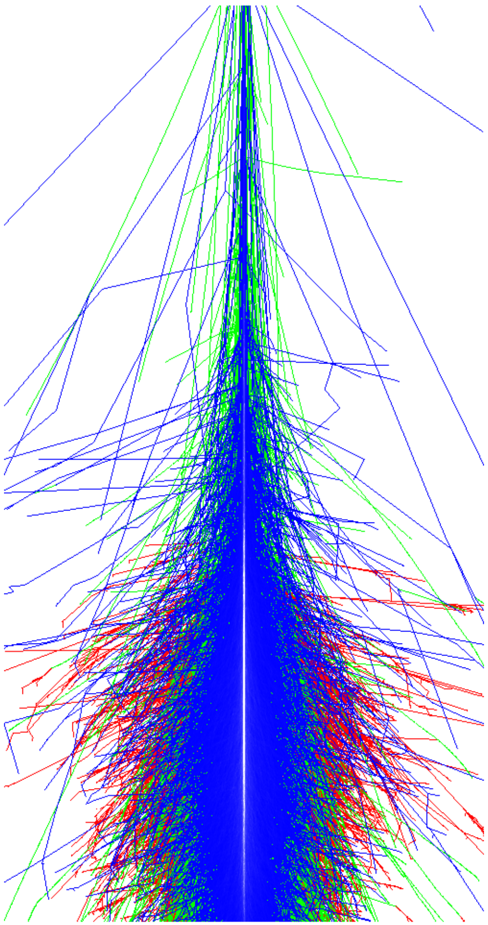


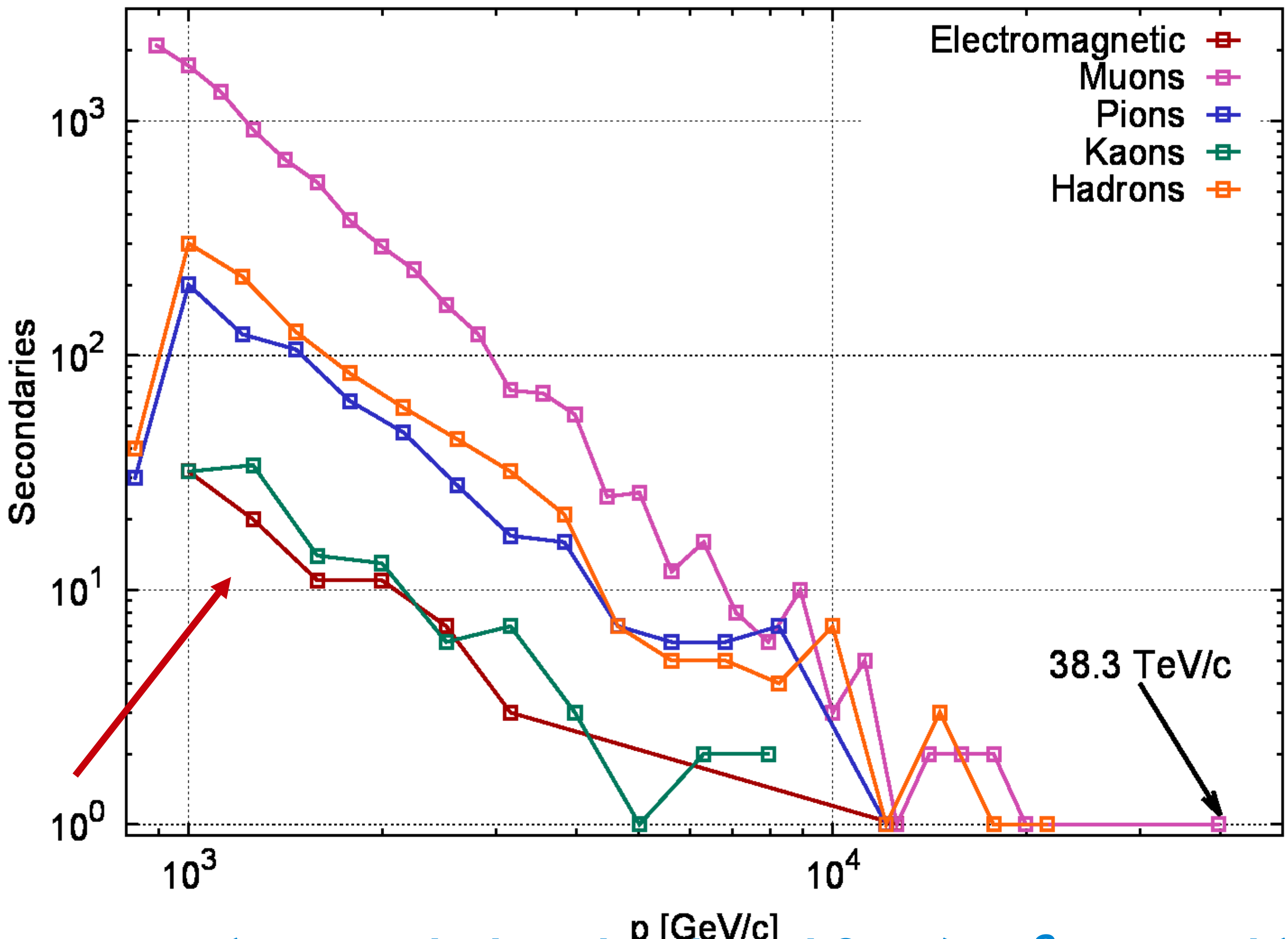
Muongraphy (from my lectures)

- **Problem:**
  I want to look "into" my hand
- **Solution #1:**

- **Solution #2:**
  - Using penetrating radiation (RX)
  - RX will be differently absorbed depending on material type and average density
  - Put a RX sensitive detector and get density distribution by studying RX profiles

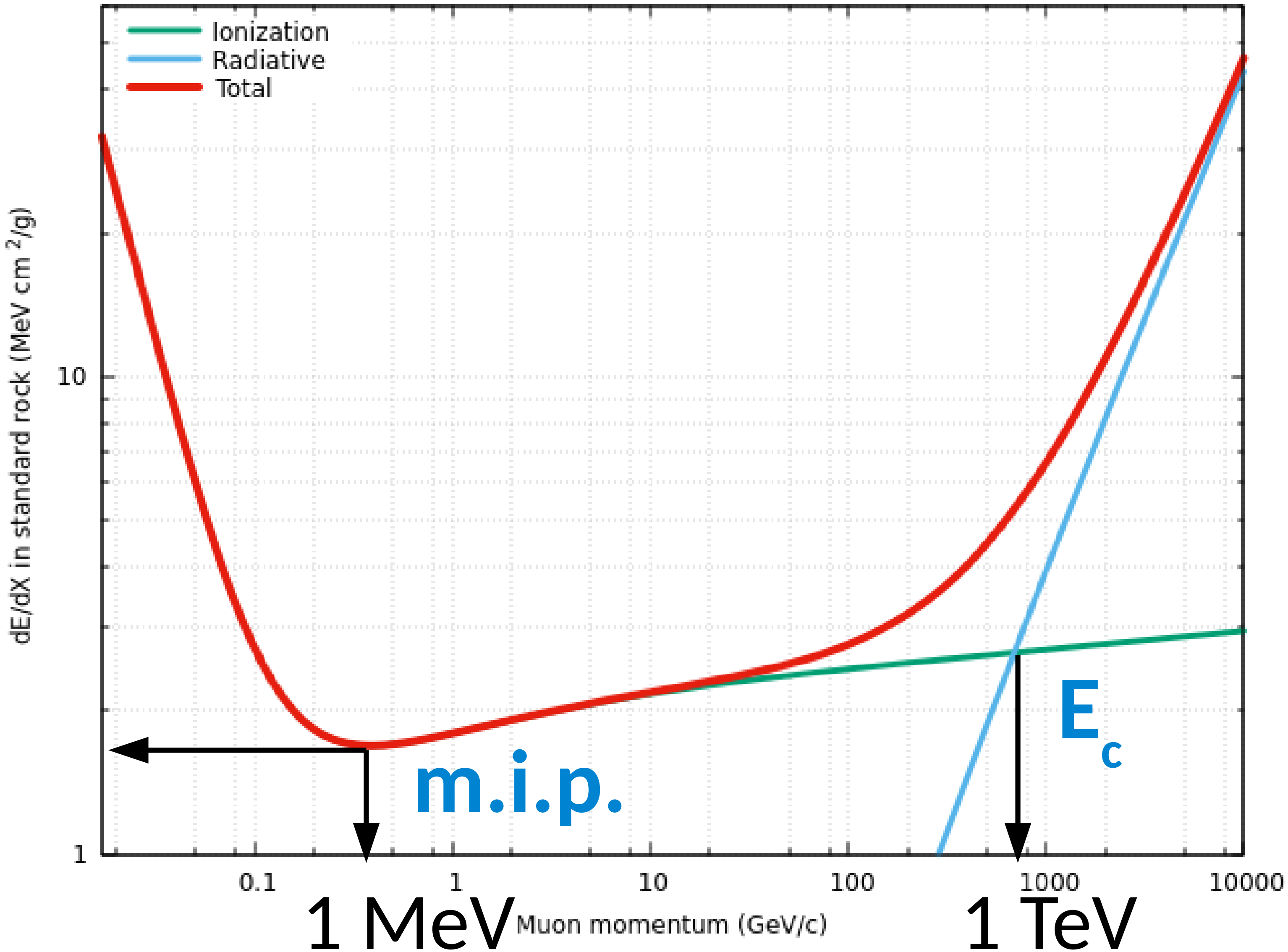
High energy atmospheric muons



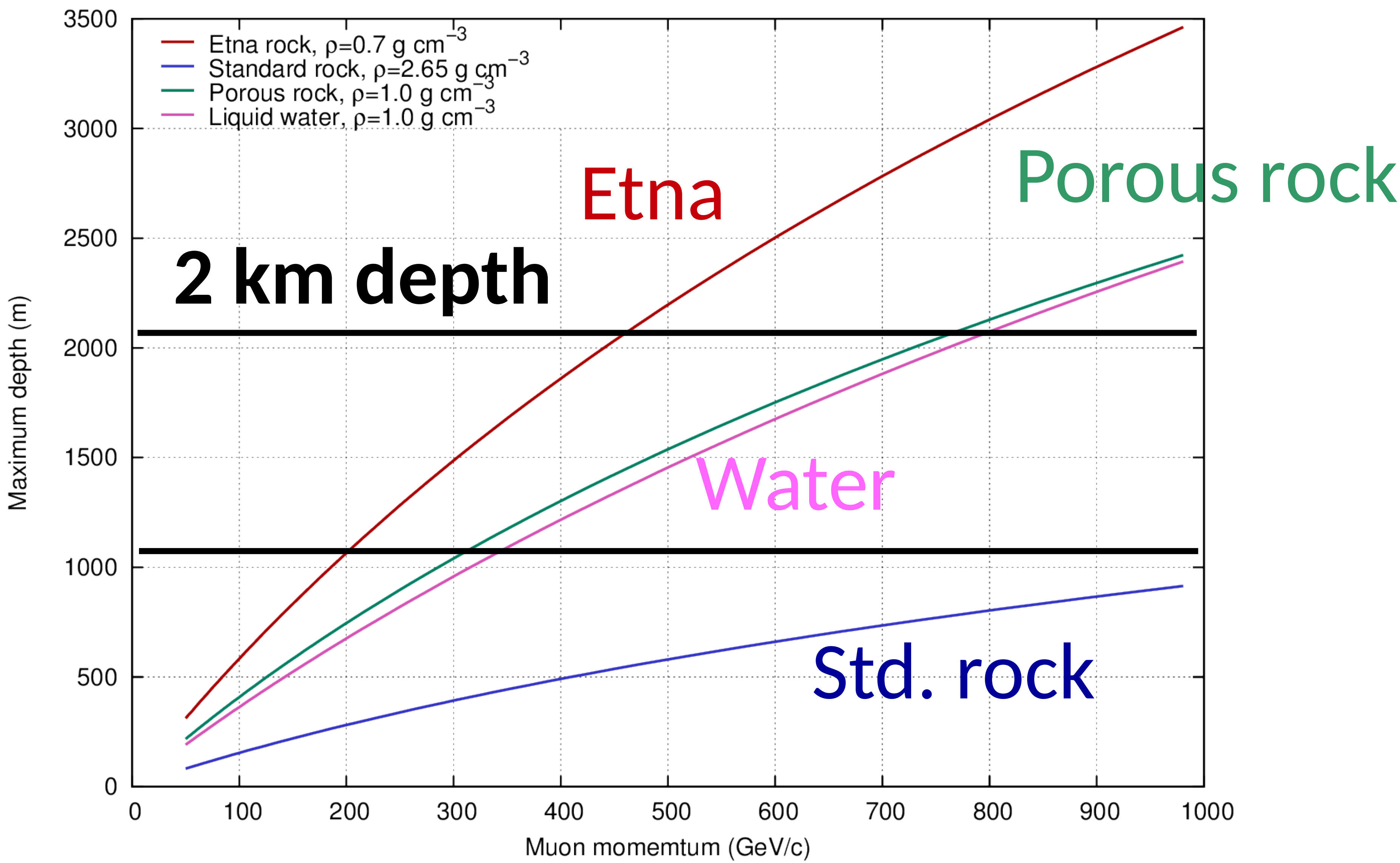


4000 m a.s.l. HE (E>800 GeV) secondaries simulated flux (1 m^2, 1 month)

Stopping power for muon in standard rock

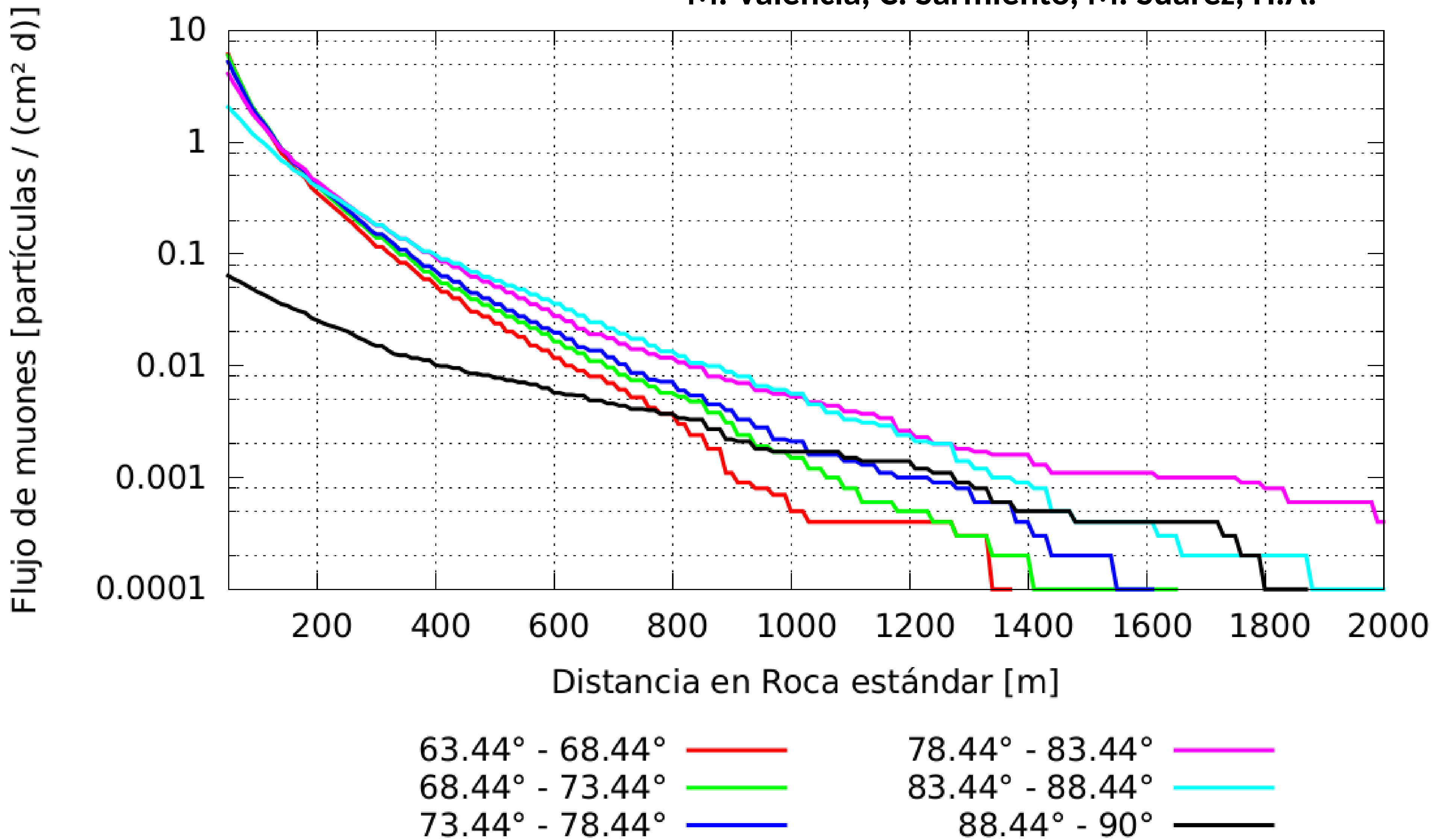


Muon range in some standard materials

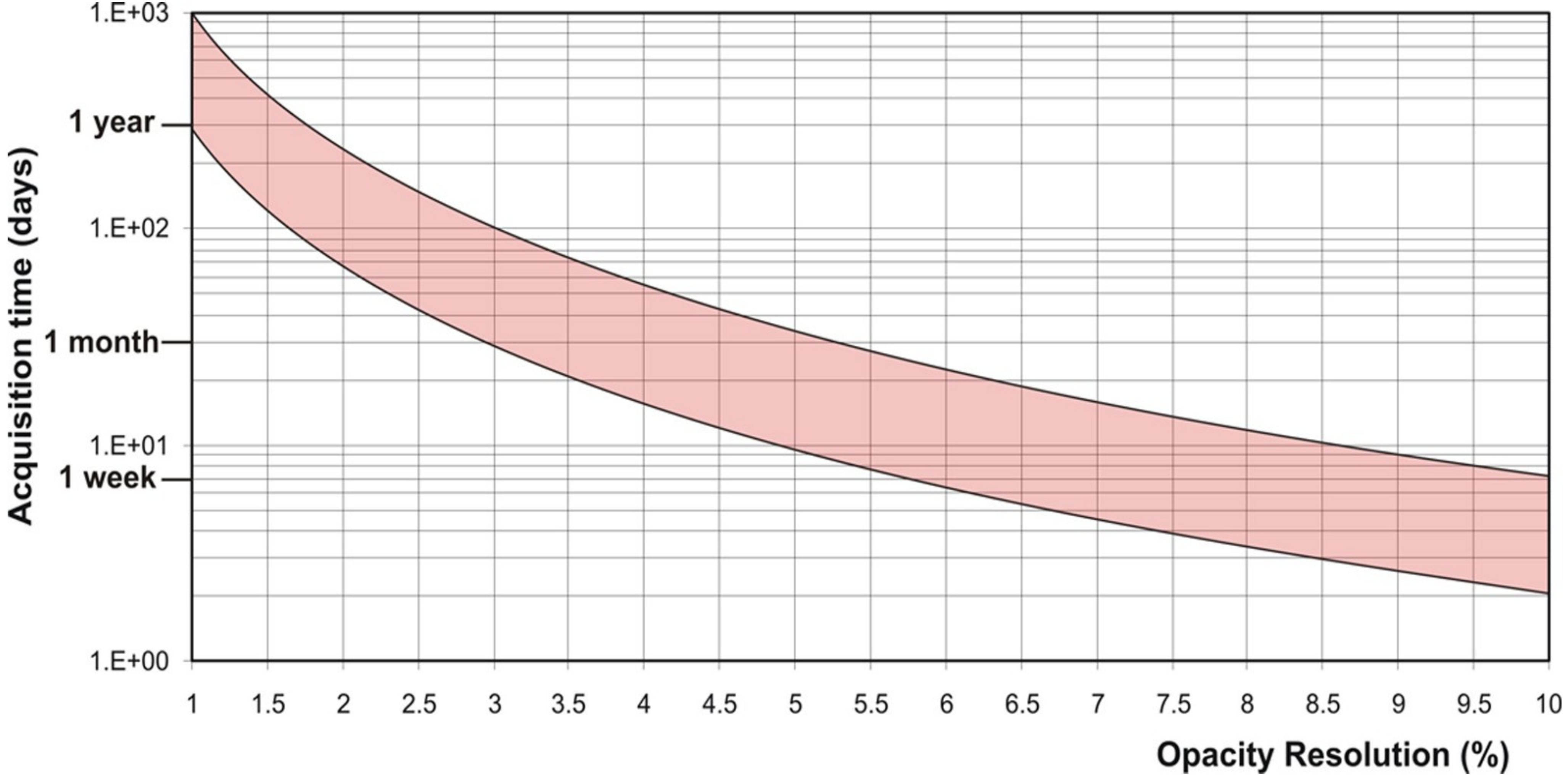


Directional muon flux + rock interaction (first model, quasi adiabatic integration)

M. Valencia, C. Sarmiento, M. Suarez, H.A.



Opacity resolution and observation times



So, up to here...

- We found **muons**, a high penetrating particle, originated by the interaction of cosmic rays with the atmosphere

- **Muons** are available everytime and everywhere (and they are free)

- **Muons** are able to go across hundreds and even thousands of meters of rock

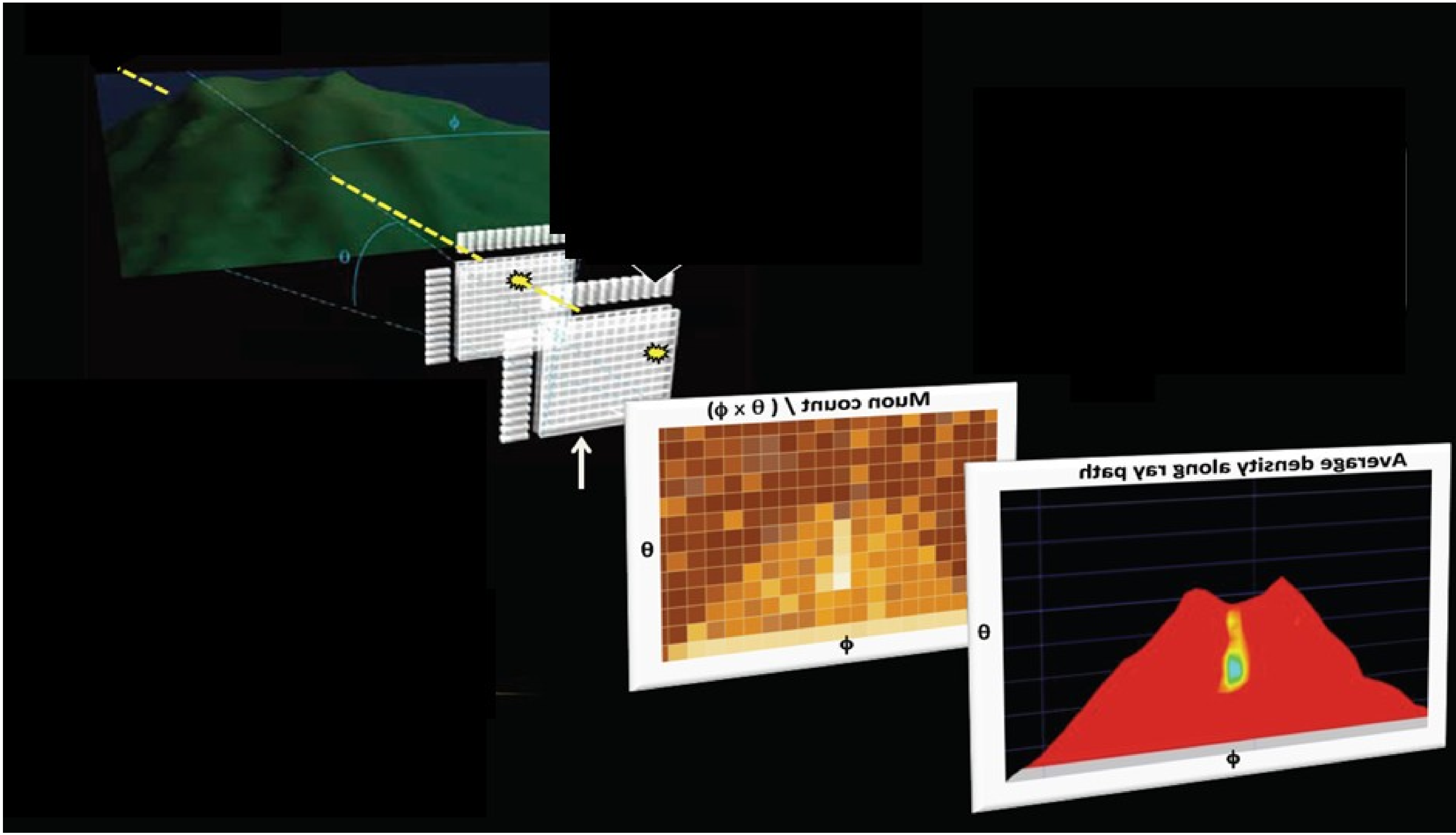
Muon radiography → "Muography"

- Suppose you have an object with an unknown density profile, then...
  - ... measure the directional muon flux through this object
  - ... and compare with the muon reference flux
    - → **you get the directional opacity of this object [g/cm²]**
- Additionally...
  - ... obtain the external geometry of the object
    - → **and calculate the directional interaction distance [cm]**

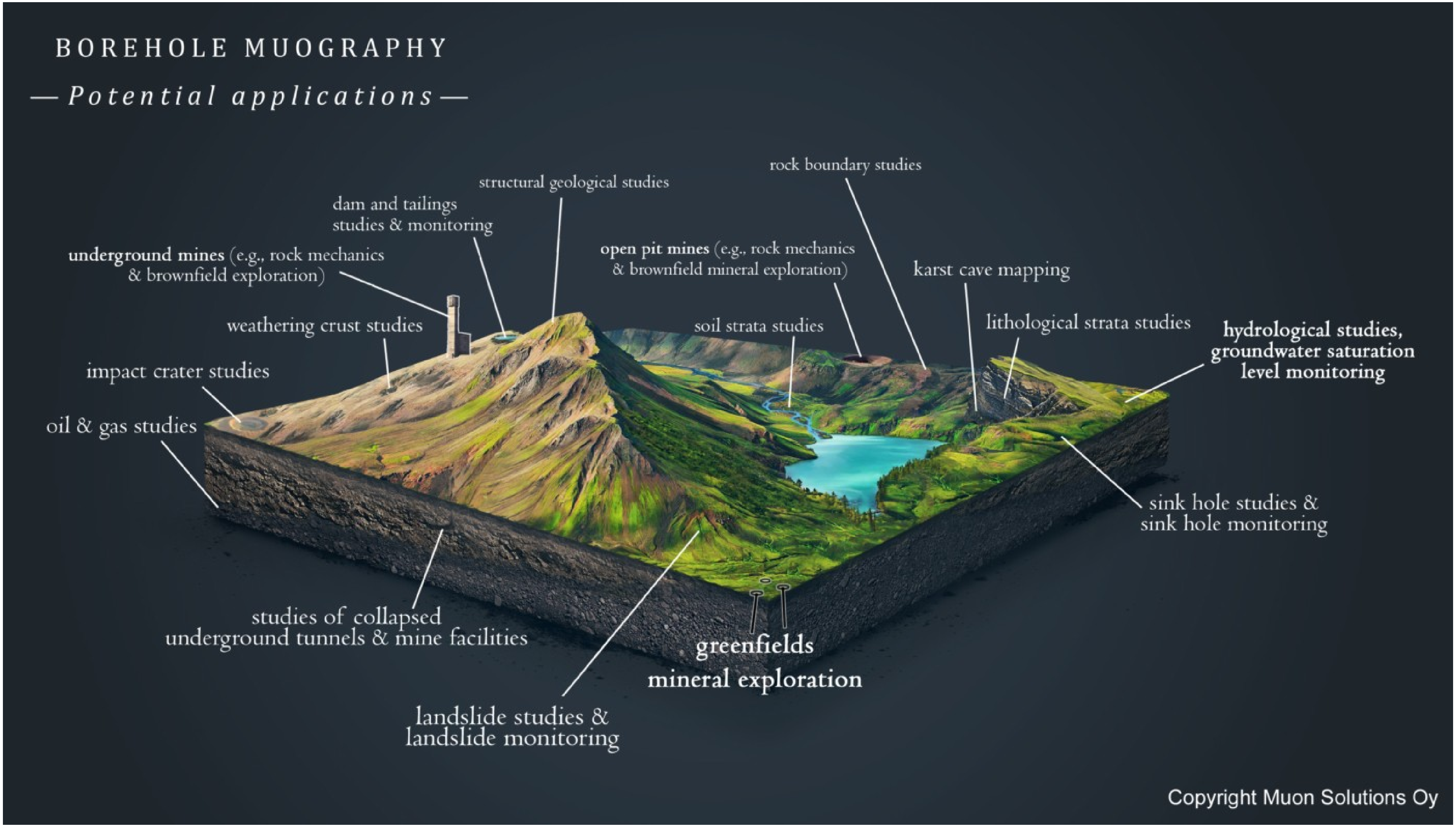
$$\varrho(L) \equiv \int_L \rho(\xi)\, \mathrm{d}\xi\,,$$

- Finally, from...
  - directional opacity
  - directional interaction distances
    - → **you get the internal density profile along muon propagation direction**

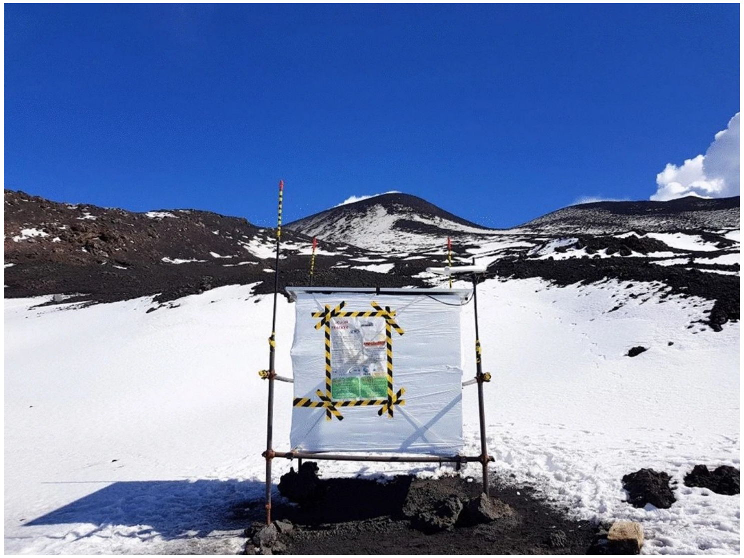
Muon directional flux measurement

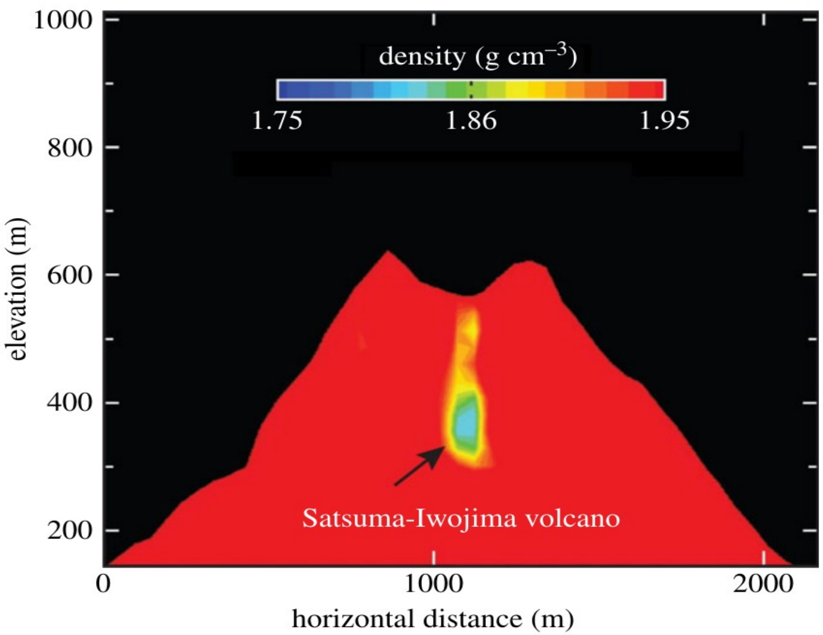


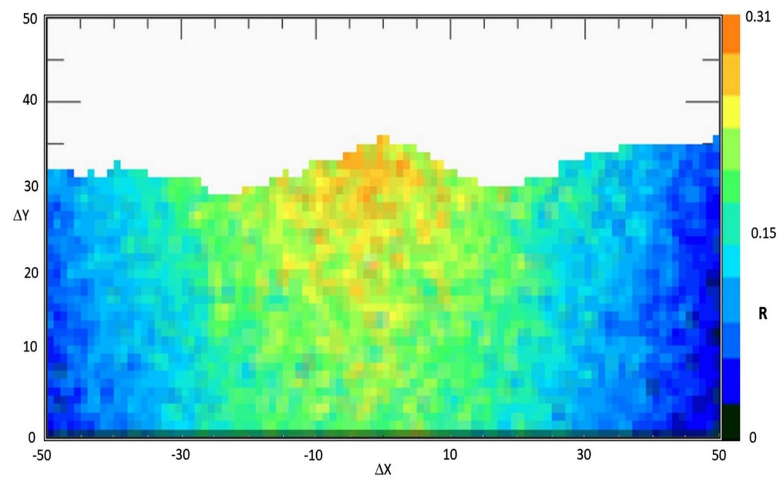
Mugraphy applications



Two volcanoes: Satsuma (JP), Etna (IT)







MuTe (Muon Telescope) Bumangués

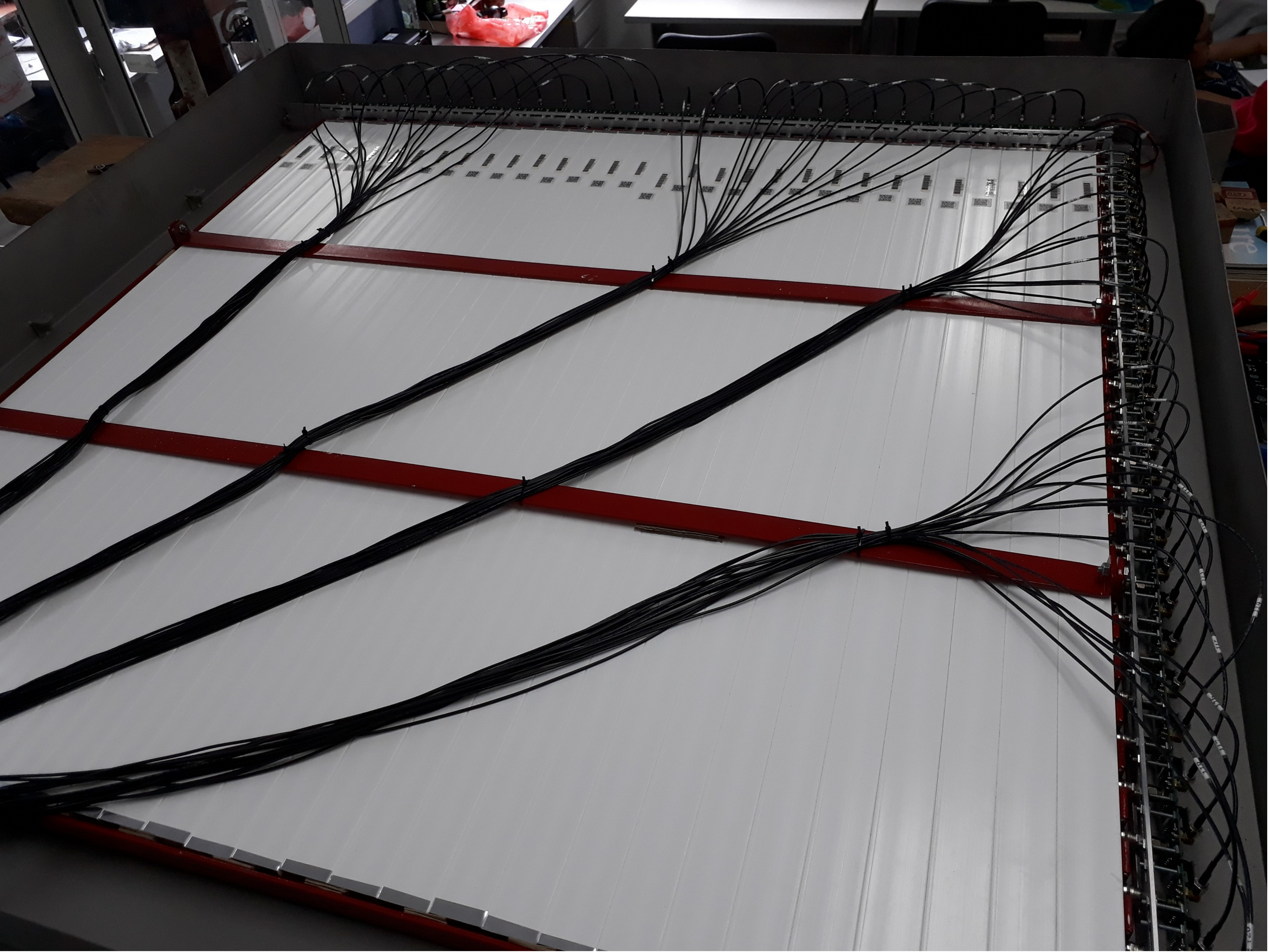
See de Leon’s talk today

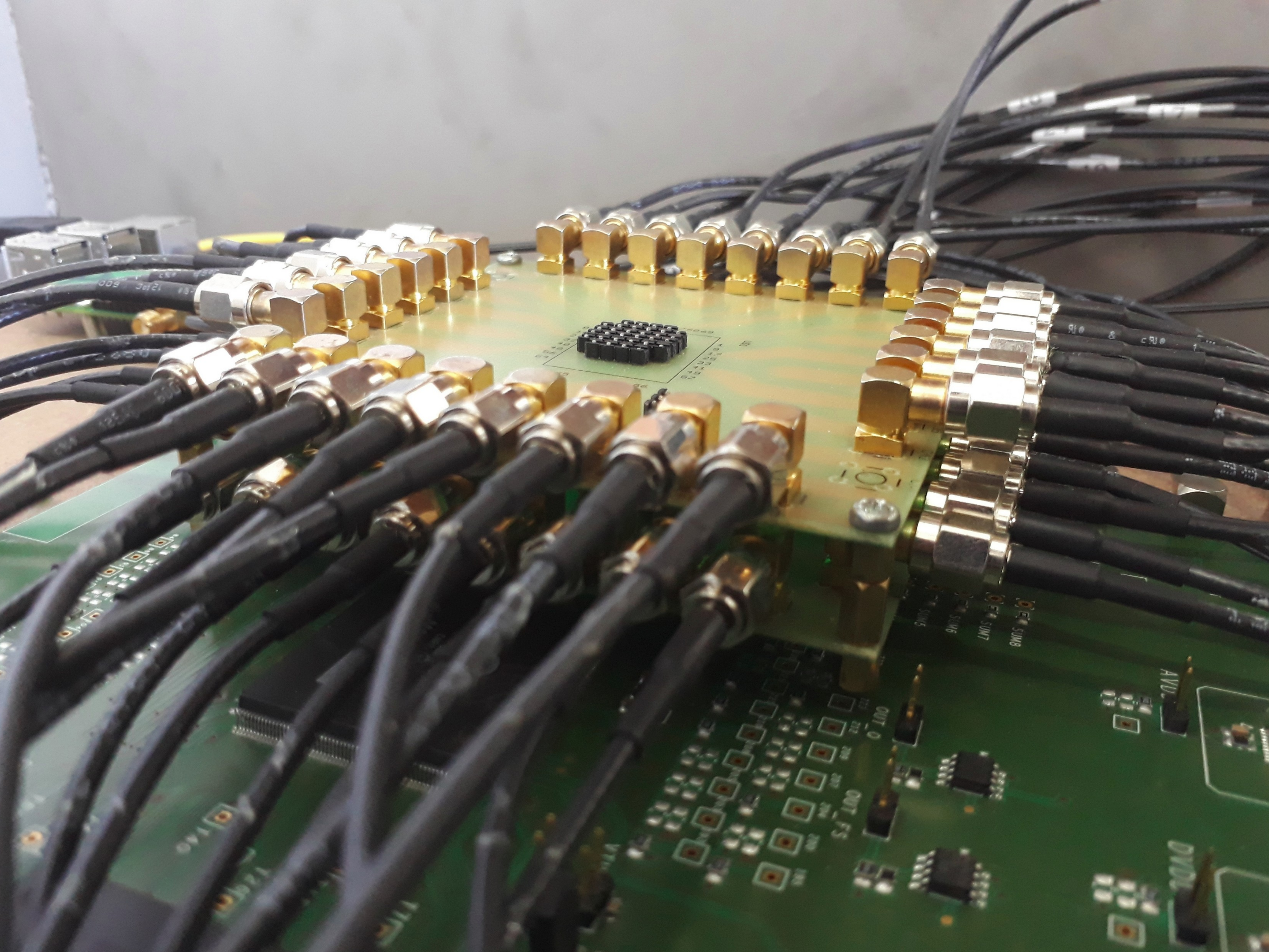
MuTe, funded, designed, built and calibrated integrally in Colombia at UIS

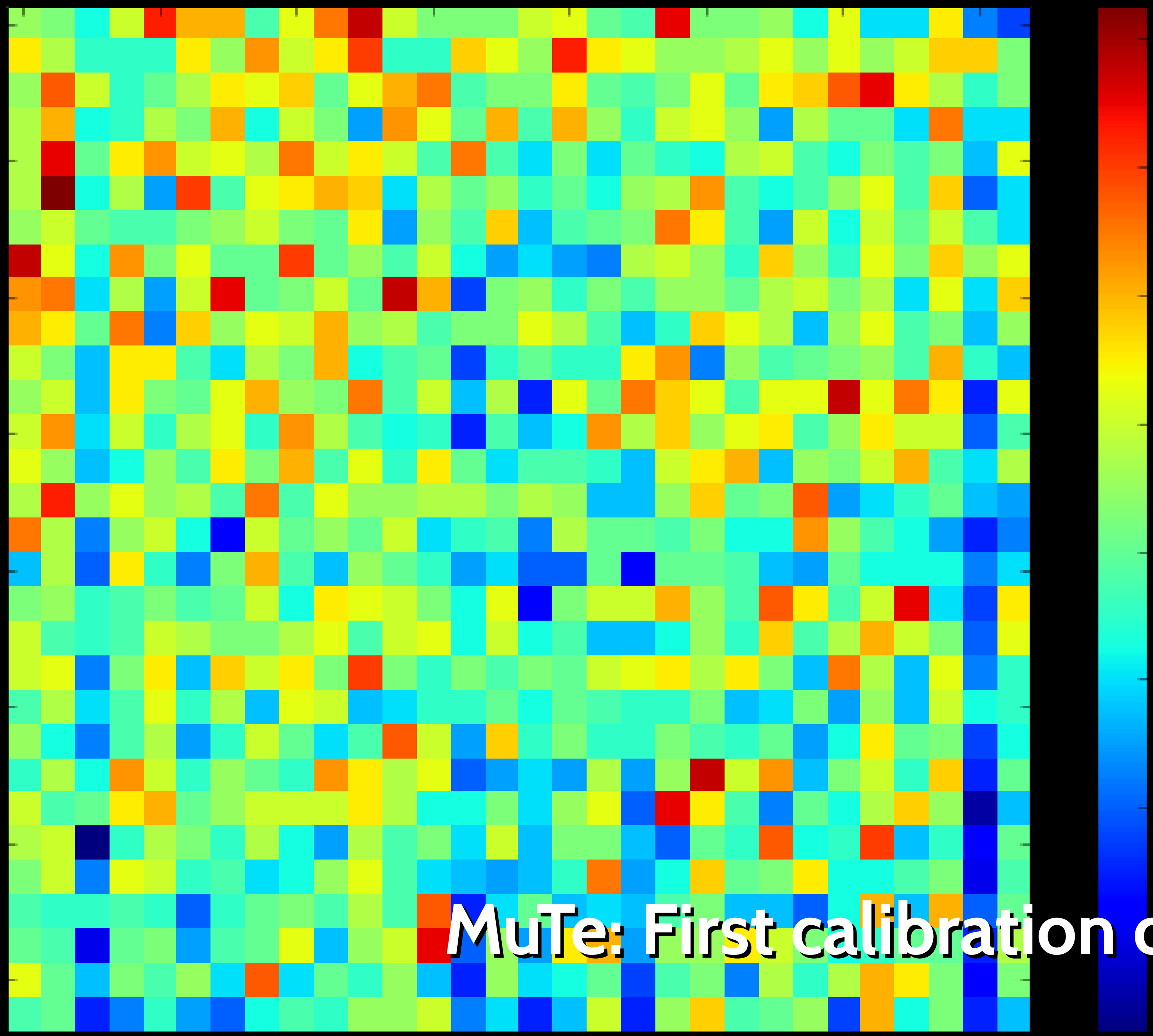
- Two separated XY planes
  - 30 (4x1)cm plastic scintillator strips
  - → 900 pixels (XY plane)
  - Adjustable separation between planes
- One LAGO cubic s-WCD detector

- Two planes of "Minos" like polyestyrene plastic scintillator
- Claded and wavelength shifter optical fiber at strip centre
- 120 SiPM (Hamamatsu MPPC)
- Raspberry-Arduino based atmospheric monitoring system
- 64ch MAROC based electronic
- Integrated TOF measurements
- Programmable and configurable on board self trigger using FPGA
- Low power automatic and autonomous system


90




SUM7
SUM8
OUT_0

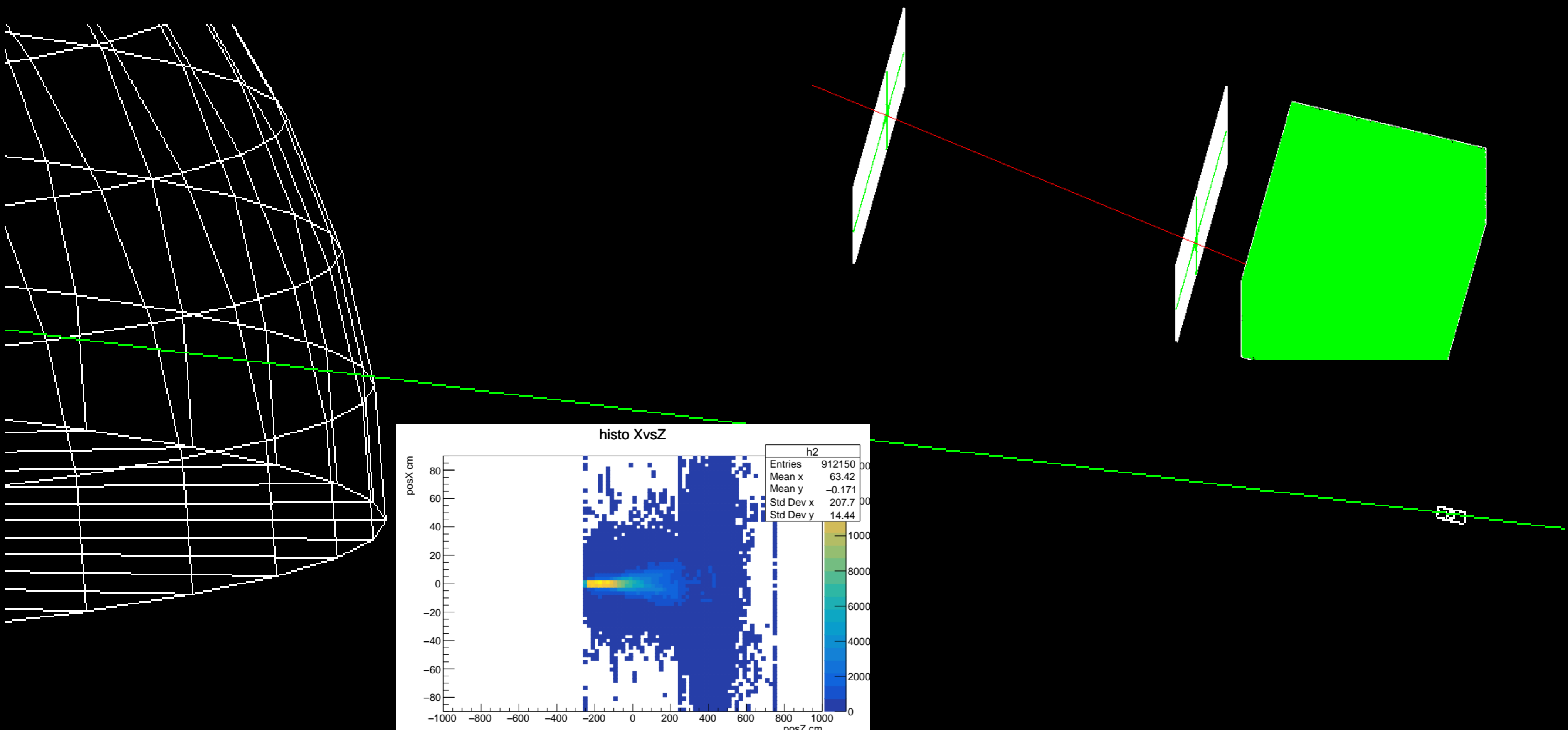


MuTe: First calibration data

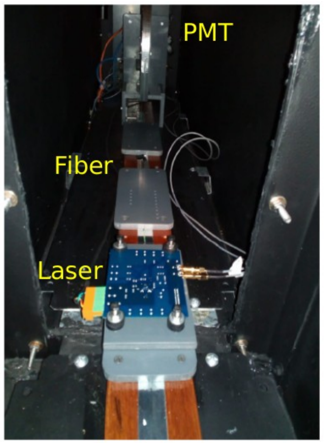

MuTe Target: Machin dome
SERVICIO
GEOLÓGICO
COLOMBIANO

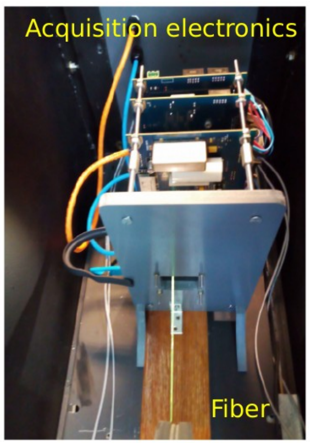
Complete simulation chain using and adapting LAGO simulation tools

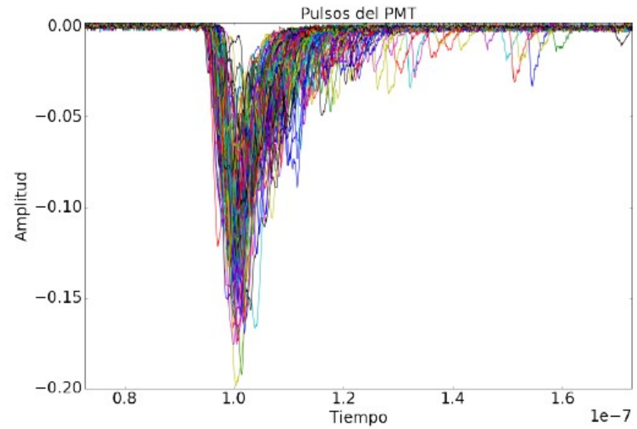
Machin dome

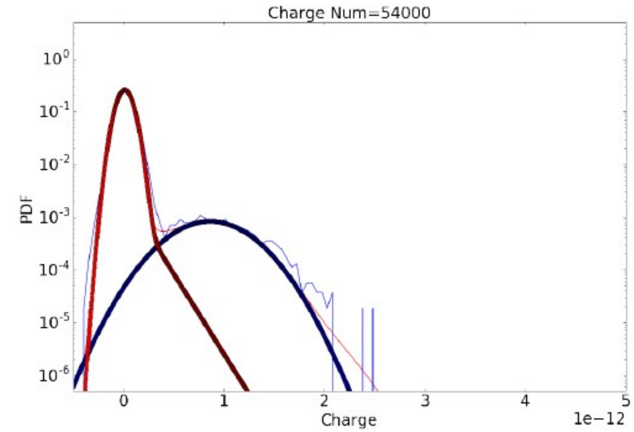


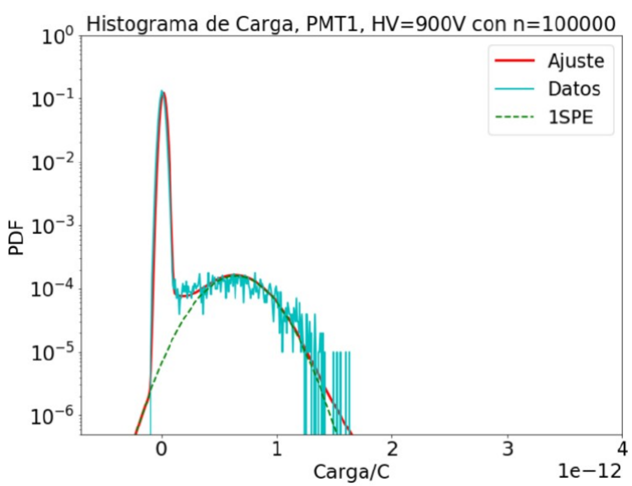
New R&D at Argentina
Subpixel resolution using signal attenuation

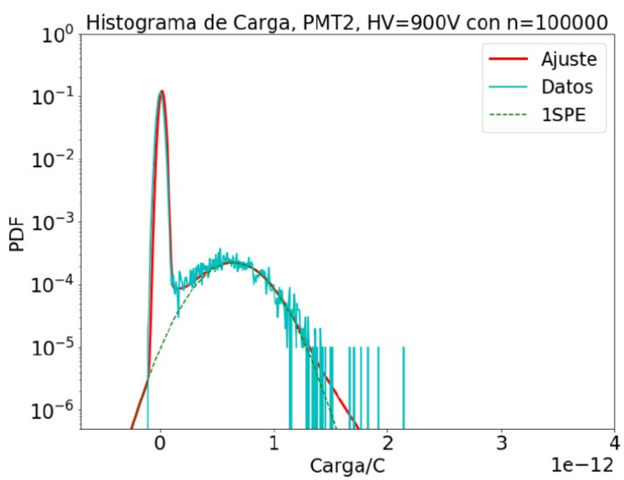


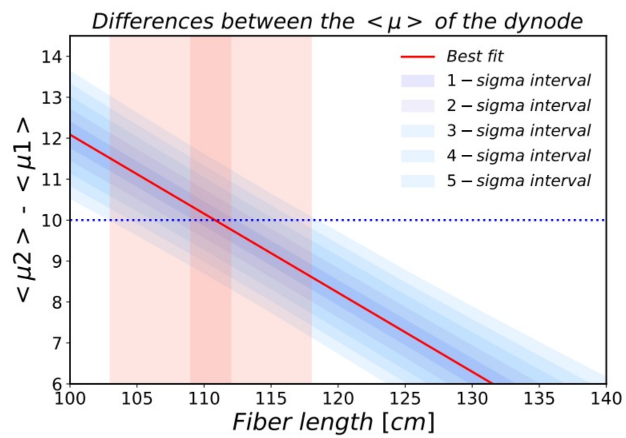




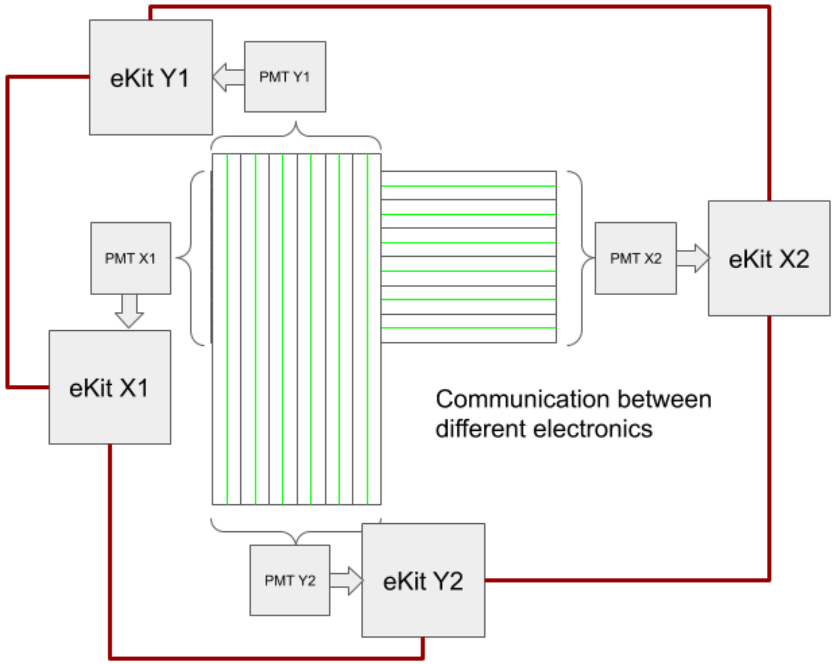


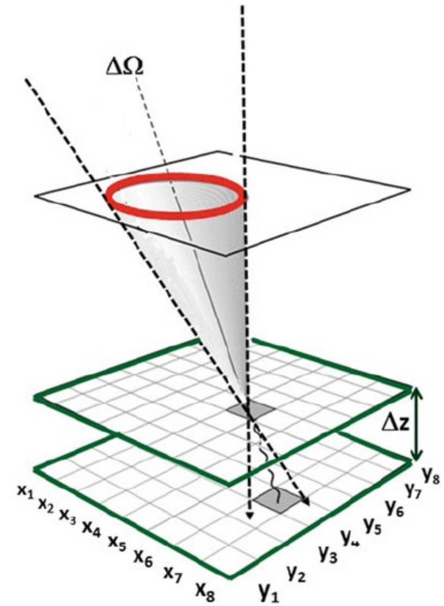


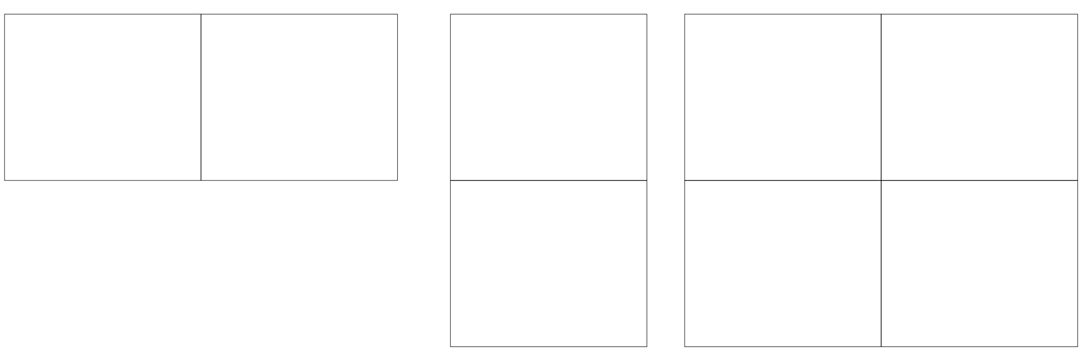




New R&D at Argentina
Adaptative shape and modular configuration

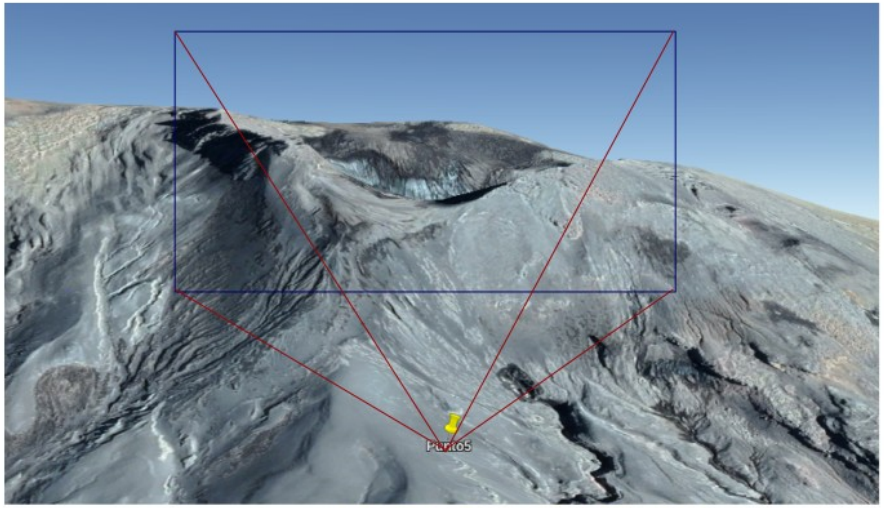




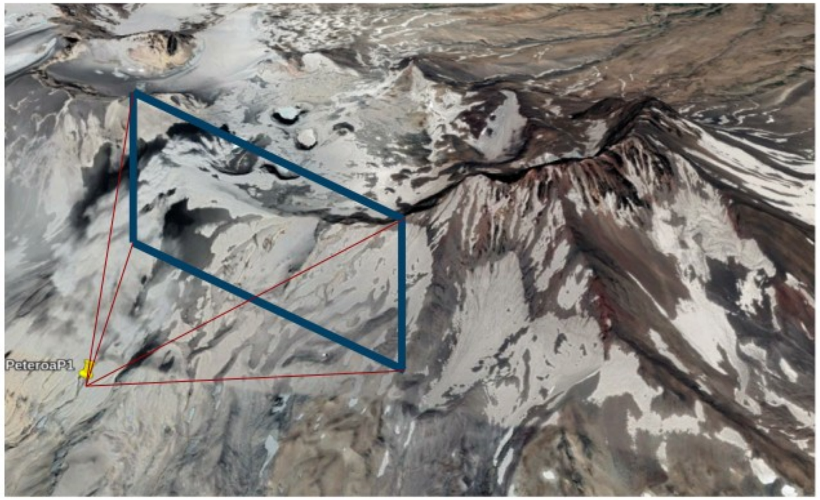


- New R&D:
  - Subpixel resolution
  - Adaptable shape
  - Wireless modular configuration
  - TOF technology
- Potential applications in industrial, nuclear, mining and medical uses

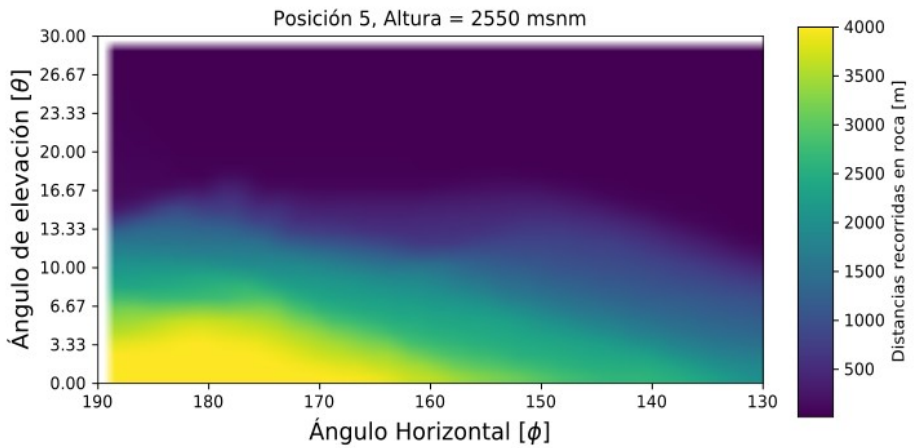
Two possible Arg targets under evaluation

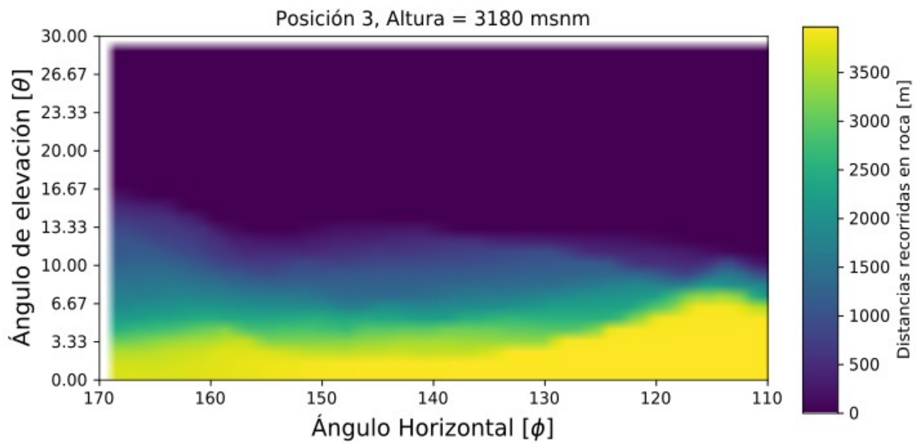


Copahue (-37.857456°, -71.152180°)



Peteroa (-35.245635°, -70.548824°)





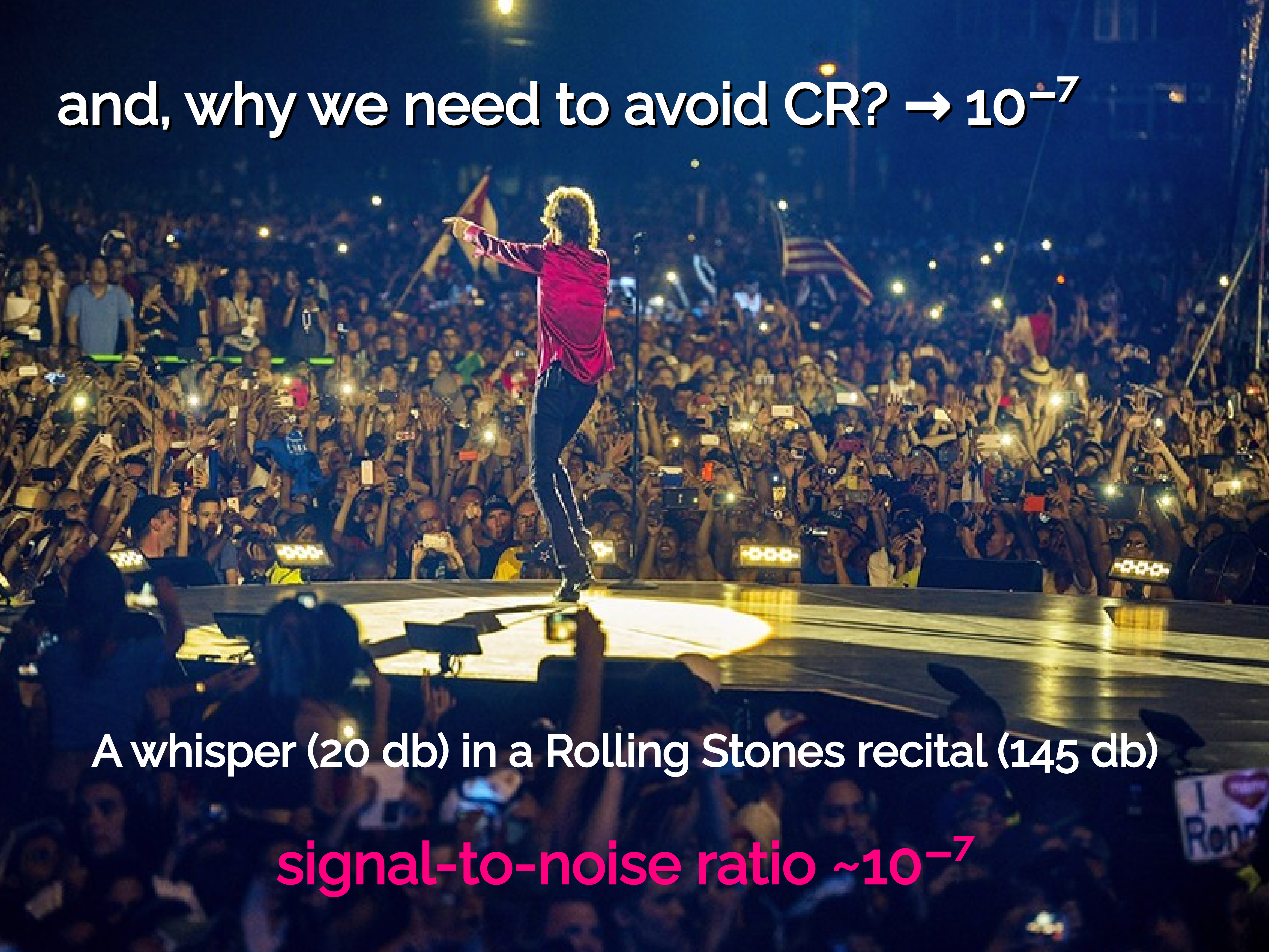
Rolando Calderón-Ardila / ICES 2020

ANDES

An underground laboratory at the Andean Range in the Southern Hemisphere

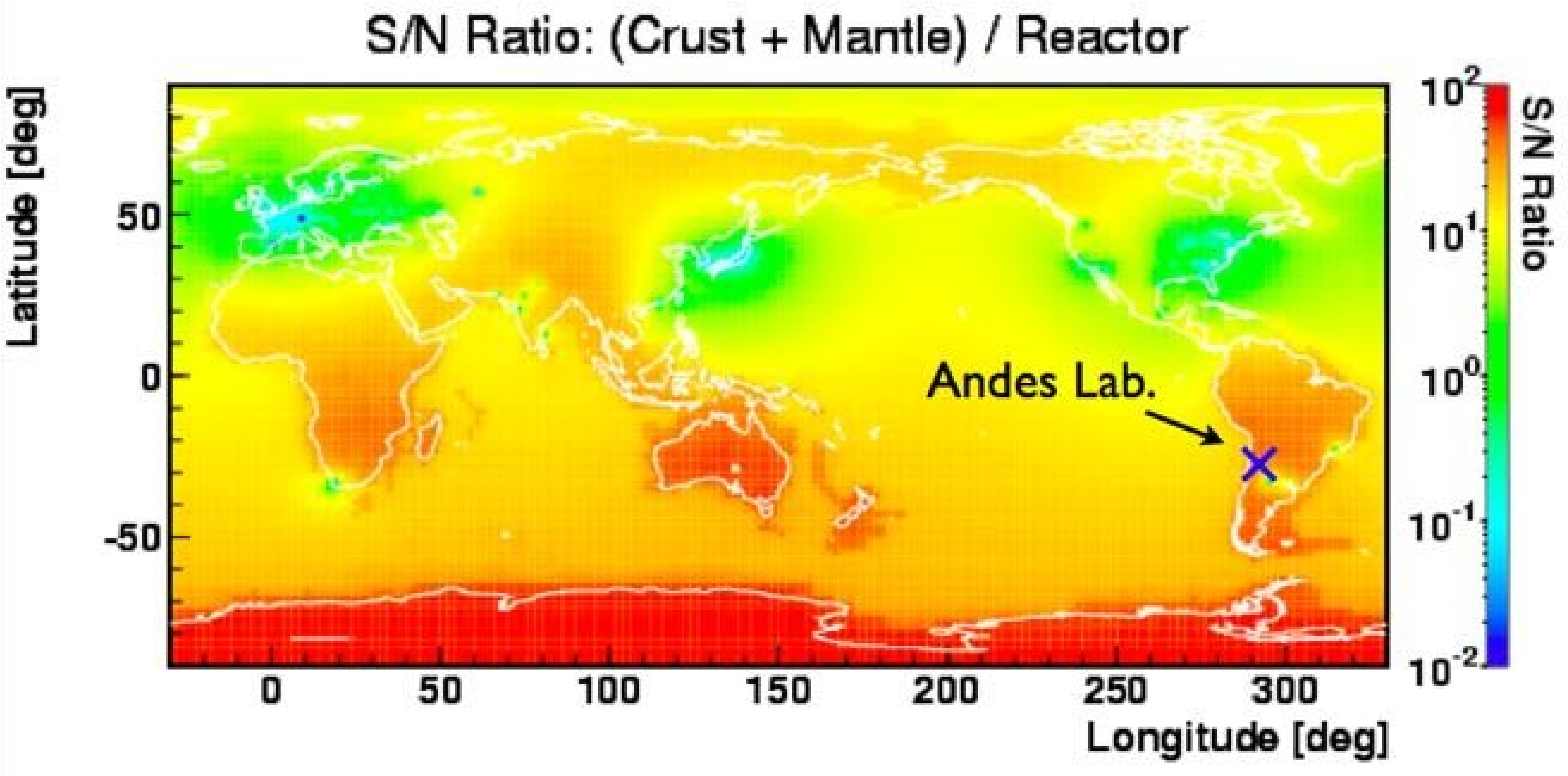
https://andeslab.org

(after so many time measuring CR, now we want to avoid them)

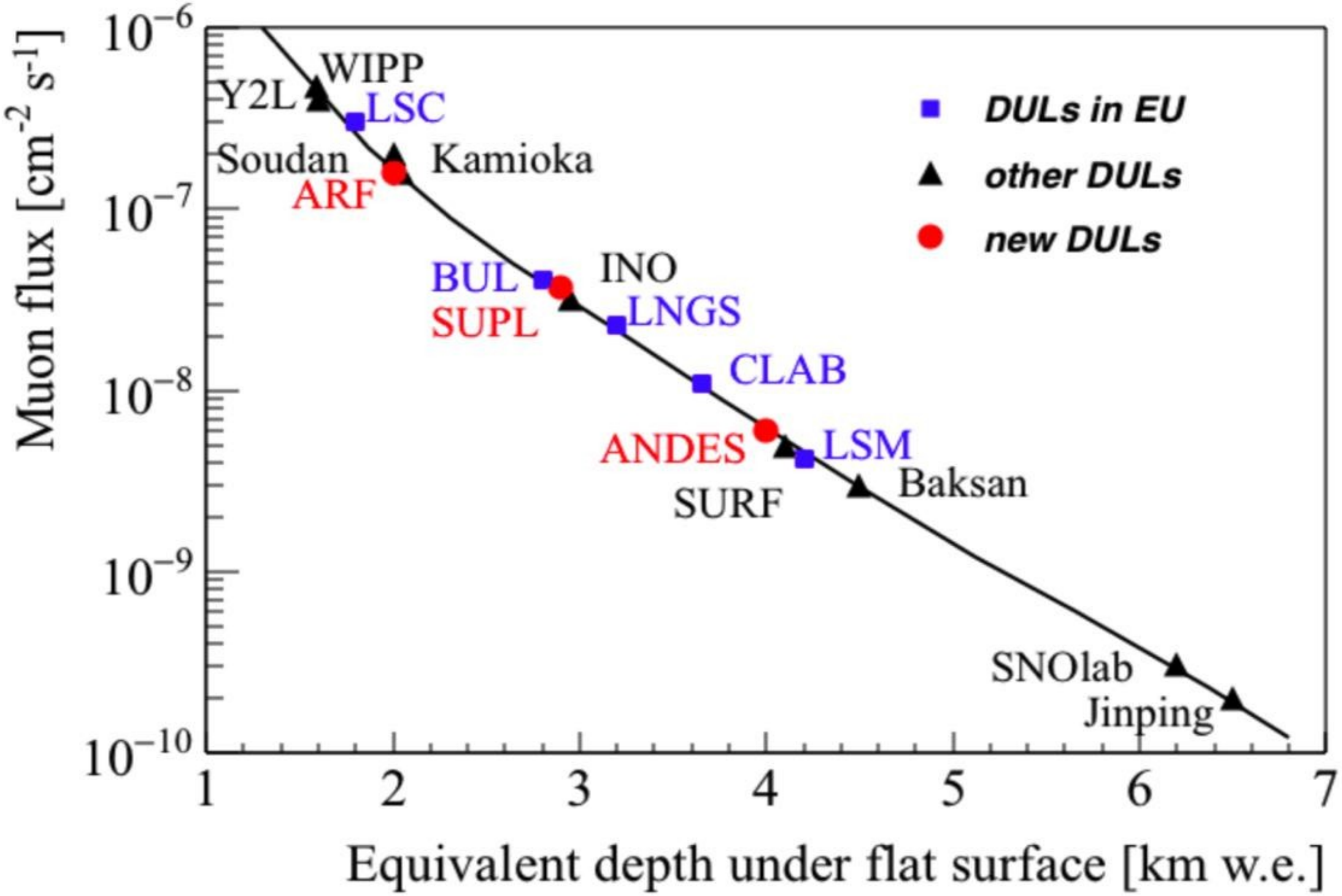

and, why we need to avoid CR? → 10^{-7}
A whisper (20 db) in a Rolling Stones recital (145 db)
signal-to-noise ratio ~10^{-7}

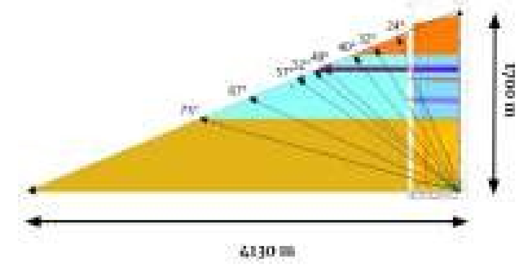
Why South?
Underground labs around the World

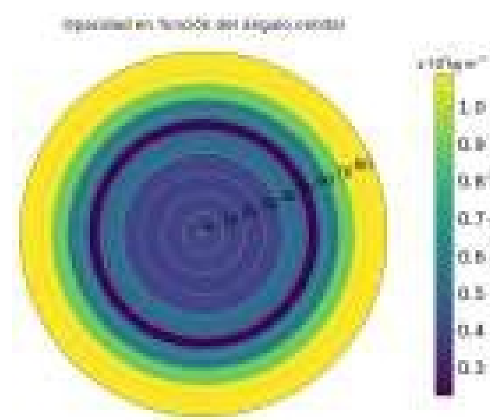
A unique opportunity at South



ANDES: under 1750m of rock neutrino physics and DM searches







Integrated muon flux: $\Phi_{\mu} < 5 \times 10^{-9}$ cm^{-2} s^{-1}

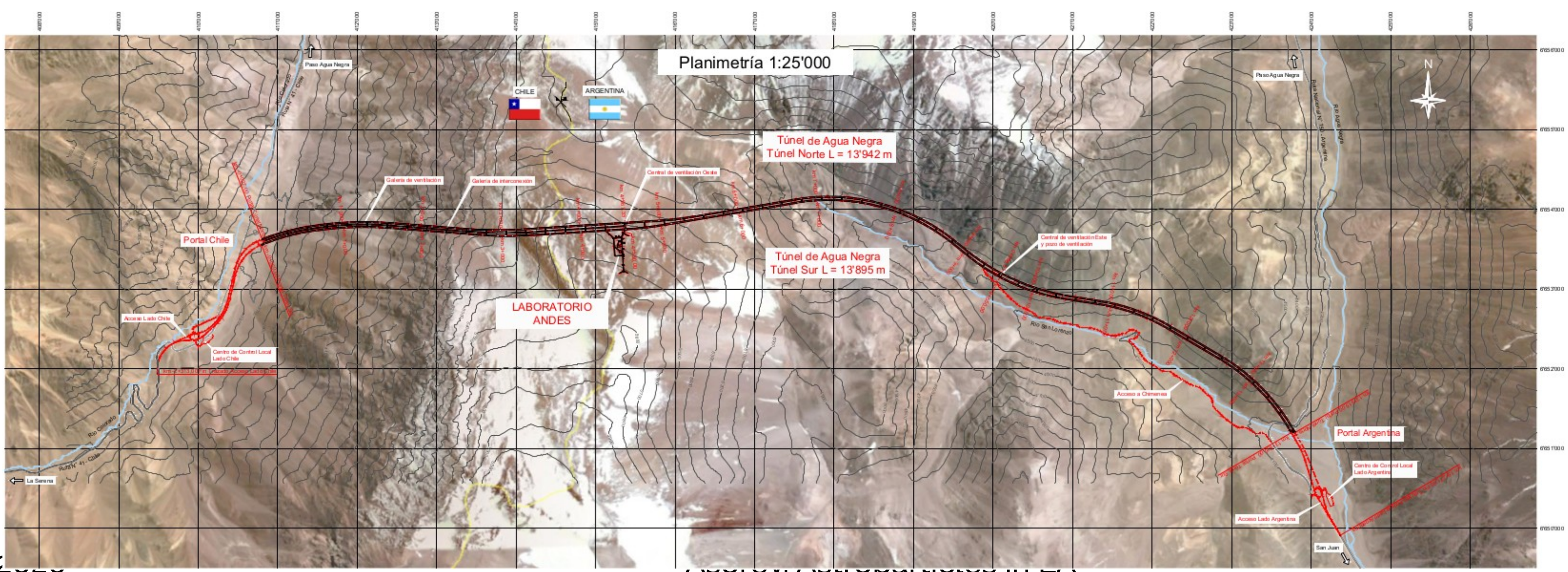
Perez-Bertolli[(1)], Sarmiento-Cano[(1)] & Asorey (in preparation).

AFA Luigi Masperi Award to the Best Undergraduate thesis in Physics 2020!

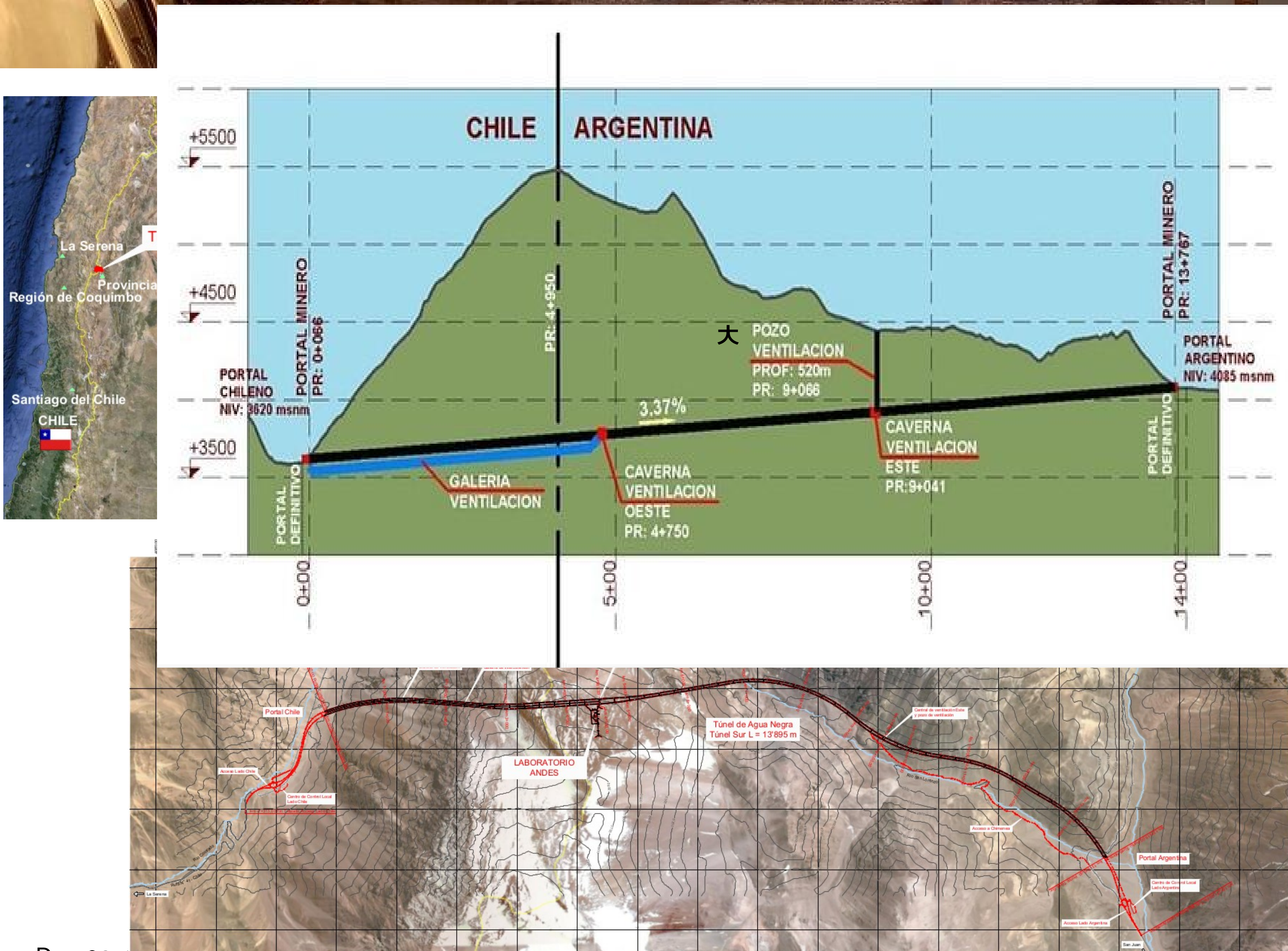
(1) Former LAGO Students

Why ANDES? The Agua Negra Tunnel

- Bi-national tunnel
- Two tunnels of 12m diameter
- Longitude: 14km
- Deepest point: 1750m



Why ANDES? The Agua Negra Tunnel



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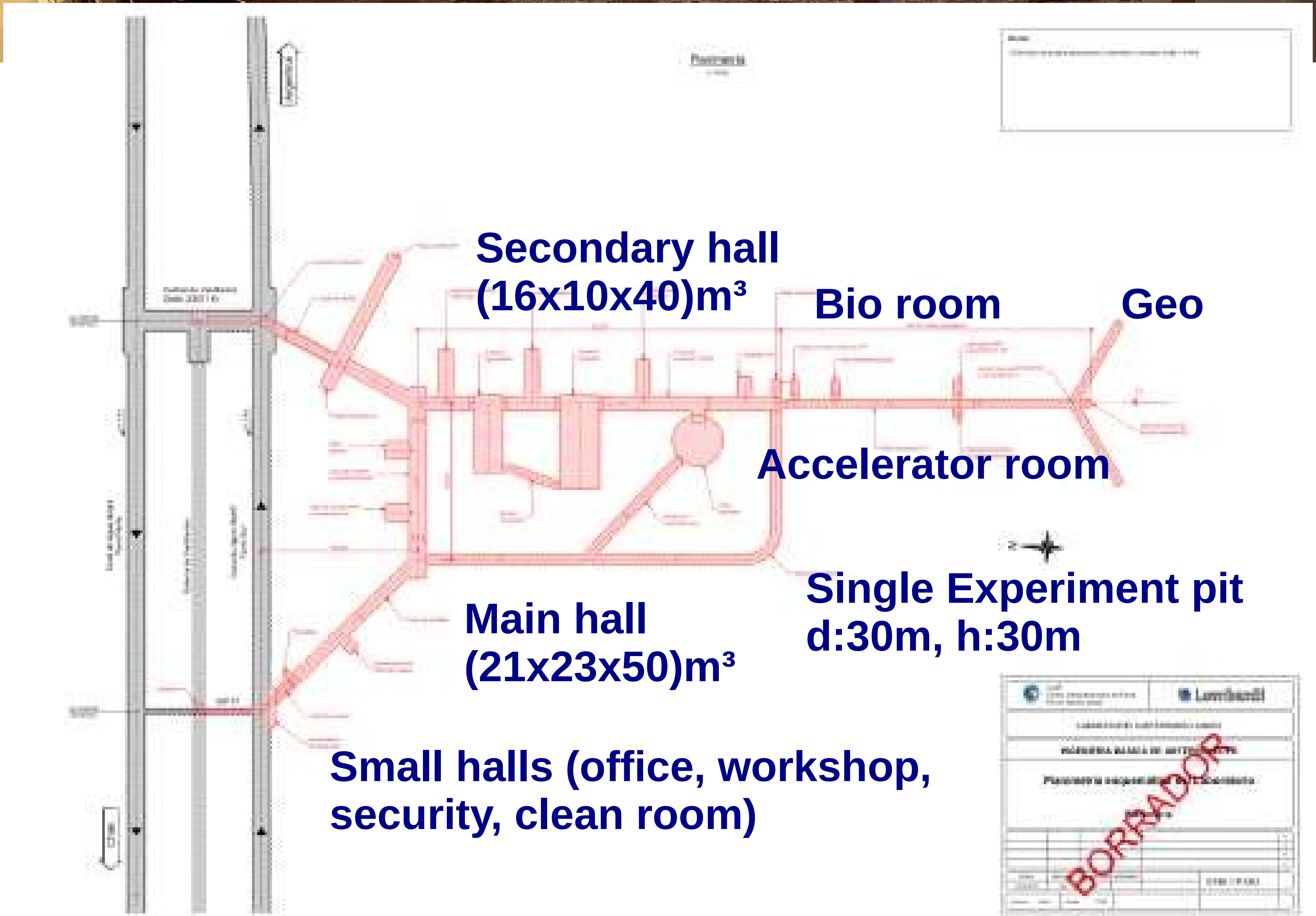
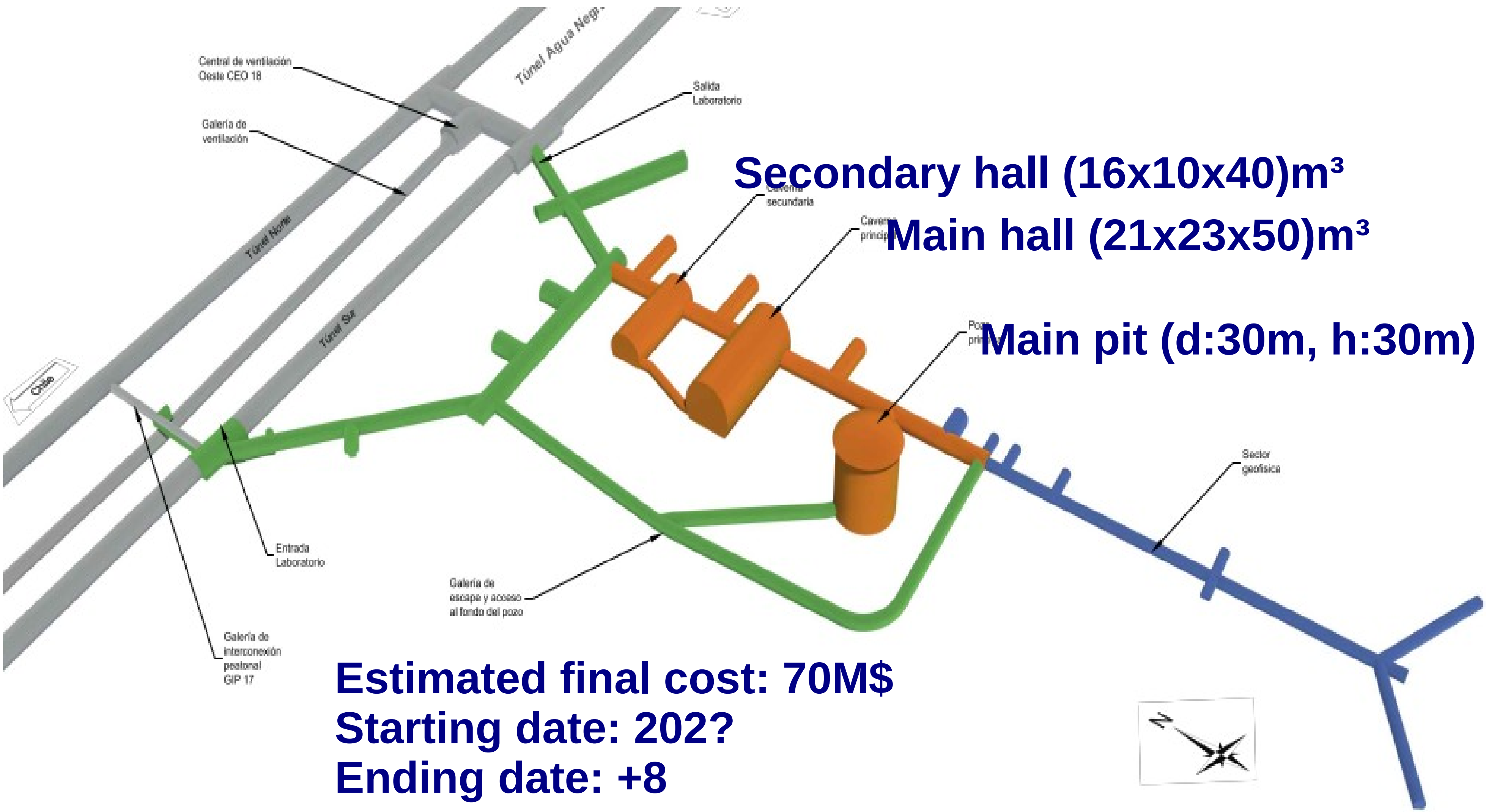
Detailed Engenieering (2018-2019)



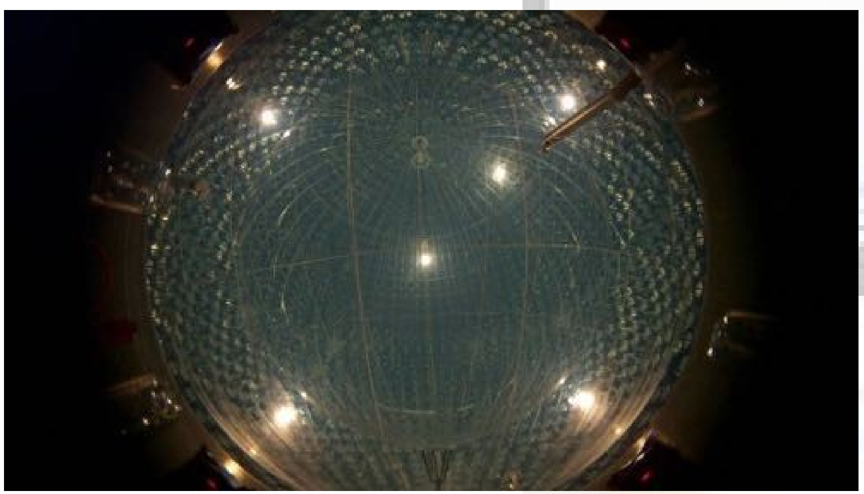
Detailed Engenieering (2018-2019)
Analysis and feedback from CNEA

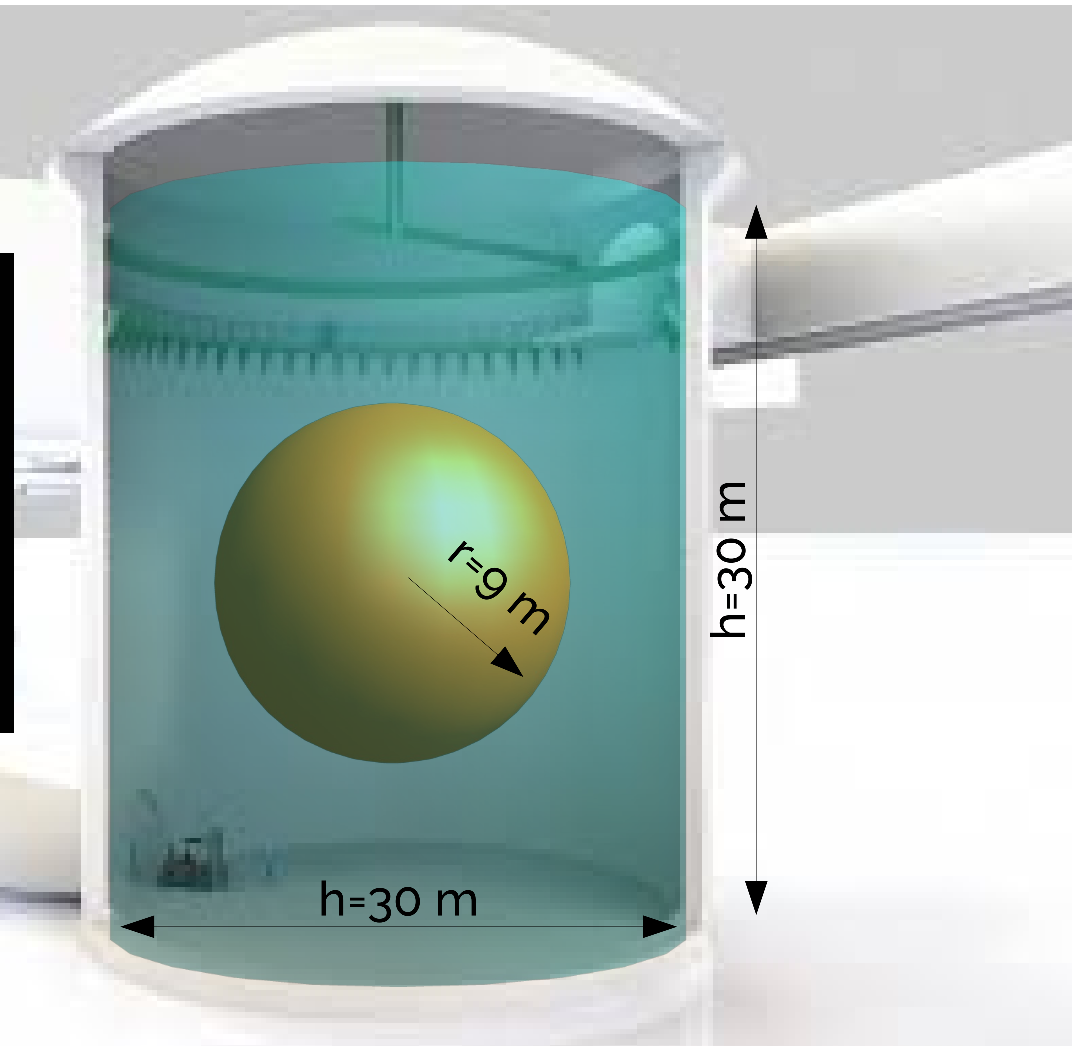


Estimated final cost: 70M$
Starting date: 202?
Ending date: +8

ANDES main pit

Neutrino experiment in ANDES





18000 m³ of ultrapurified water + r:9 m copper sphere

International and institutional support

- Memorandum of Understanding signed during the first ANDES workshop (includes the signaturs of the director of Modane, the emeritus director of Homestake, the spokespersons of SuperNEMO and Edelweiss II).
- EBITAN (Entidad Binacional Túnel Agua Negra), supported the ANDES laboratory in its Xth meeting and agreed on including it in the Agua Negra tunnel project in its XXXVth meeting
- Support and interest by latin american institutions:
  - CONICET, Argentina
  - MinCyT, Argentina
  - Universidad de La Plata, Argentina
  - Universidad de San Juan, Argentina
  - ANDES Unit in CLAF
  - Universidad La Serena, Chile
  - Gobierno de la provincia de San Juan, Argentina
  - CONICYT, Chile
  - Gobierno de la provincia de Elqui, Chile
  - Gobierno de la región de Coquimbo, Chile
  - CCHEN, Chile
  - MinRel, Chile
- Support and interest by representatives of latin american scientists
- and institutions:
  - Claudio Dib, representing groups from 4 Chilean universities
  - Juan Carlos D'Olivo, High Energy Physics Network, Mexico
  - Ronald Shellard, CBPF and SBF vice director, Brazil
  - Eduardo Charreau, ANCEFN president, Argentina
  - Francisco Tamarit, AFA president, Argentina
- Support from scientists and international experiments:
  - Stephen Adler, Princeton
  - M. Miller, A. Garcia, University of Washington
  - Bob Svoboda, LNBE Spokesperson
  - Nigel Smith, SNOLAB Director
  - Kunio Inoue, KamLAND Spokesperson
  - Hiro Ejiri, Former RCNP Director
  - Yoichiro Suzuki, Kamioka Director, Super Kamiokande Spokesperson
  - Takaaki Kajita, ICRR Director
  - P. Brink et al., DM modulation
  - D.A. Harris, K. McFarland, MINERvA Spokespersons
  - A.B. McDonald, Nobel Physics Laureate

Manifested interest in contributing to ANDES

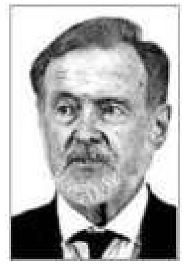
- Interest for collaboration and instrument installation in ANDES:
  - Jennifer Thomas, SuperNEMO CB Chair
  - Daniel Santos, MIMAC Spokesperson
  - Kai Zuber, COBRA Spokesperson
  - J. Conrad, M. Shaevitz, DAEDALUS Spokespersons
  - A. Galindo-Uribarri et al., ORNL
- Interest in collaborating to the construction and operantion of the ANDES laboratory by latin american groups
  - Argentina:
    - IFLP, UNLP
    - Neutrones y Reactores, CAB
    - Partículas y Campos, CAB
    - Bajas Temperaturas, CAB
    - Instituto Geofísico Sismológico Volponi, San Juan
    - ITeDA, CNEA-CAC
    - I&D - PNGRR, CNEA-CAC
    - Física Experimental Altas Energías, UBA
    - Instituto de Matemática Aplicada, San Luis
    - Empresa SOLYDES
- Brasil:
  - Rede Nacional de Física de Altas Energias
  - ICE, UFRJ
  - IFRW, UNICAMP
  - ICRA, CBPF
  - Neutrino Physics group, UFABC
  - HEP, PUC Rio
  - Instituto de Física, USP
- Chile:
- CCTVAL, UTFSM
- Pontificia Universidad Católica de Chile
- Universidad de Santiago de Chile
- Dpto Ciencias de la Tierra, Universidad de Concepción
- ICFM, Universidad Austral
- Mexico:
  - Instituto de Biotecnología, UNAM
- Instituto de Ciencias Nucleares, UNAM
- Grupo Astropartículas, UMSNH
- FCFM, BUAP

Conclusion

En la agenda de la próxima generación

"De vez en cuando la vida" nos da una buena noticia. En mi caso tuvo nombre y apellido: Carmina Pérez Bertolli.

Carmina es tucumana, feminista y tiene 27 años. Se licenció en Física por la Universidad de Buenos Aires, y obtuvo su doctorado en la misma materia por el Instituto de Tecnologías en Detección y Astropartículas, que depende de la Comisión Nacional de Energía Atómica. Además, su tesis de licenciatura ganó la edición 2020 del Premio "Luis Másperi", que otorga la Asociación Física Argentina.



La tesis laureada se titula "Estimación del flujo de muones en el laboratorio subterráneo ANDES". El laboratorio ANDES (Agua Negra Deep Experiment Site) será construido en el marco de la obra del Túnel Agua Negra, obra de infraestructura que unirá vialmente a Chile y Argentina por el paso homónimo, a la altura de Coquimbo y San Juan, respectivamente.

Así, bajo 1.700 metros de roca sudamericana, se alzará un laboratorio de 60.000 m^3 de volumen, que emprenderá experimentos de vanguardia en física del neutrino, búsqueda de la materia oscura, geofísica, biología, impacto ambiental; gracias —entre otras cosas— a su ambiente libre de radiación. Todo esto, guiado por un consorcio latinoamericano, con el apoyo de varios premios Nobel. Música para algunos oídos.

En su tesis, la Lic. Pérez Bertolli revisó las estimaciones realizadas originalmente respecto del flujo de muones (otra partícula subatómica que forma parte de la radiación cósmica) como factor de "ruido" para las mediciones que se proponen realizar desde el laboratorio ANDES.

Una nueva generación es premiada, y los que hace ya rato caminamos esta Tierra, tenemos el deber de hacer sitio de honor a las enseñanzas y la renovación que trae. En la región: ciencia binacional e igualdad de género.

Las nuevas camadas llevan la marca de un pensamiento que hace y hará a este planeta cada vez más igualitario. Muchas veces nos planteamos refundarlo, mientras dábamos oxígeno a la injusticia respecto de nuestras compañeras. Tratamos de aprender.

El mundo acentúa cada vez más las brechas entre los países desarrollados y los que todavía estamos intentándolo. El capitalismo de plataformas exige un nivel de concentración de capital y de tecnología jamás visto. Si Chile y Argentina no nos unimos para producir conocimiento científico y tecnológico, no solo no alcanzaremos el desarrollo, sino que las asimetrías globales se volverán cada vez más pronunciadas sobre nosotros. ¿Cómo mantener el equilibrio de la estabilidad sistémica sin pérdida de autonomía? Esa es una buena pregunta, aunque no necesariamente nueva.

Tal vez la agenda de la generación que empieza a ocupar los espacios de toma de decisiones exija, para mayor bienestar y autonomía de todos, una inversión de polaridad radical: priorizar los proyectos científicos conjuntos por sobre las obras de infraestructura. En otros términos: hasta ahora las grandes obras contenían a la ciencia aplicada; la idea consiste en que los proyectos científicos abarquen a los emprendimientos infraestructurales, y los titulen.

Los túneles se postergan y tienen sus tiempos de maduración y ejecución. La ciencia, que no se pregunta "¿debo?" sino "¿puedo?", no tiene tiempo que perder. Avancemos con laboratorios, y que el resto venga por añadidura.

RAFAEL BIELSA
Embajador de Argentina en Chile

"Avancemos con los laboratorios* [en América Latina] *y que el resto venga por añadidura" **(R. Bielsa, Embajador Argentino en Chile)**

Muchas Gracias