EU-LAC infrastructure collaboration: The case of the Giant Latin American Observatory (LAGO)

Luis A. Núñez

PI Latin America Giant Observatory

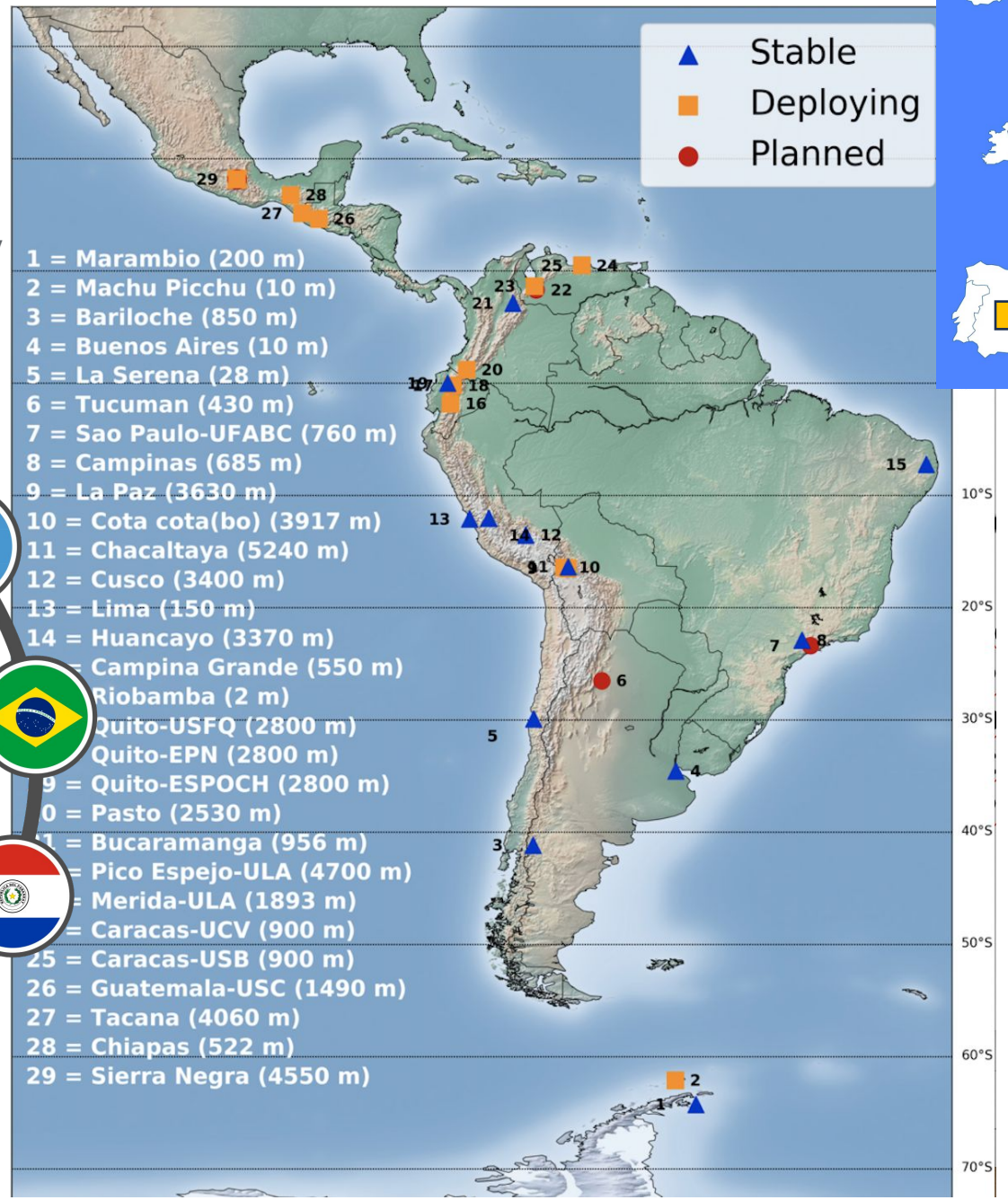
Escuela de Física, Universidad Industrial de Santander, Colombia

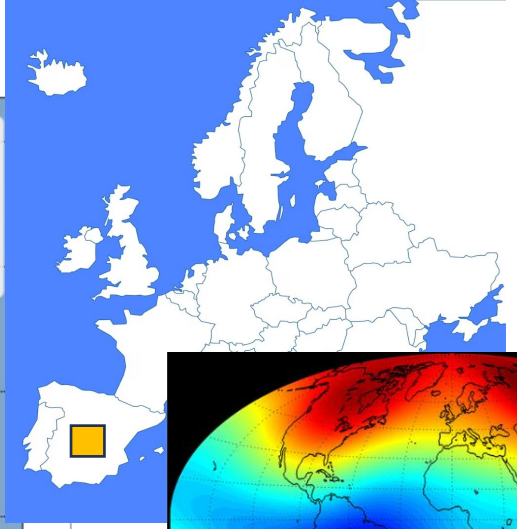
Latin American alliance for Capacity buildiNG in Advanced physics

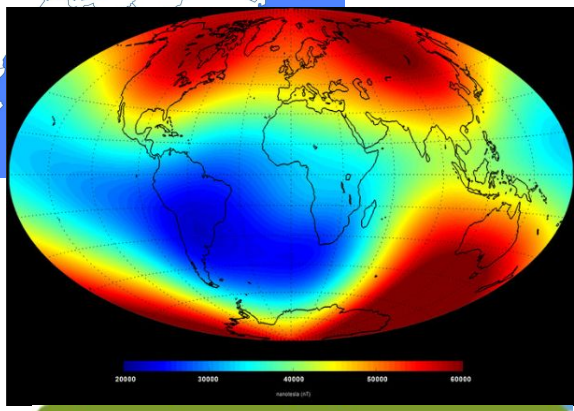
LA-CoNGA physics

Universidad Industrial de Santander

Latin American Giant Observatory







How it works?

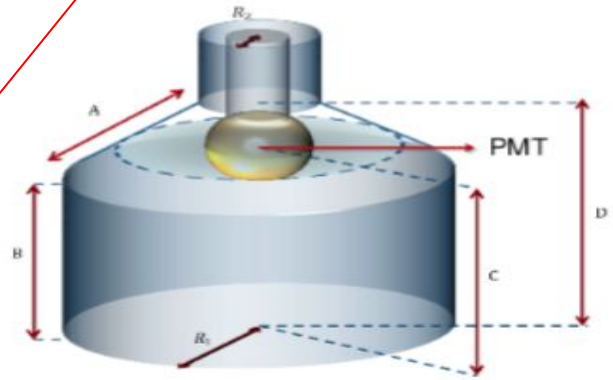
- Non-centralized, collaborative network of institutions
- 3 working groups, 9+2 members coordination committee, 1 PI
- Developments, expertize and data are shared across the network

Our detector: sWCD (Water Cherenkov Detector)

s as in *smart*

- Autonomous, reliable, simple and cheap detector
- Commercial tanks with $1{,}5\,m^2 - 10\,m^2$ 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)

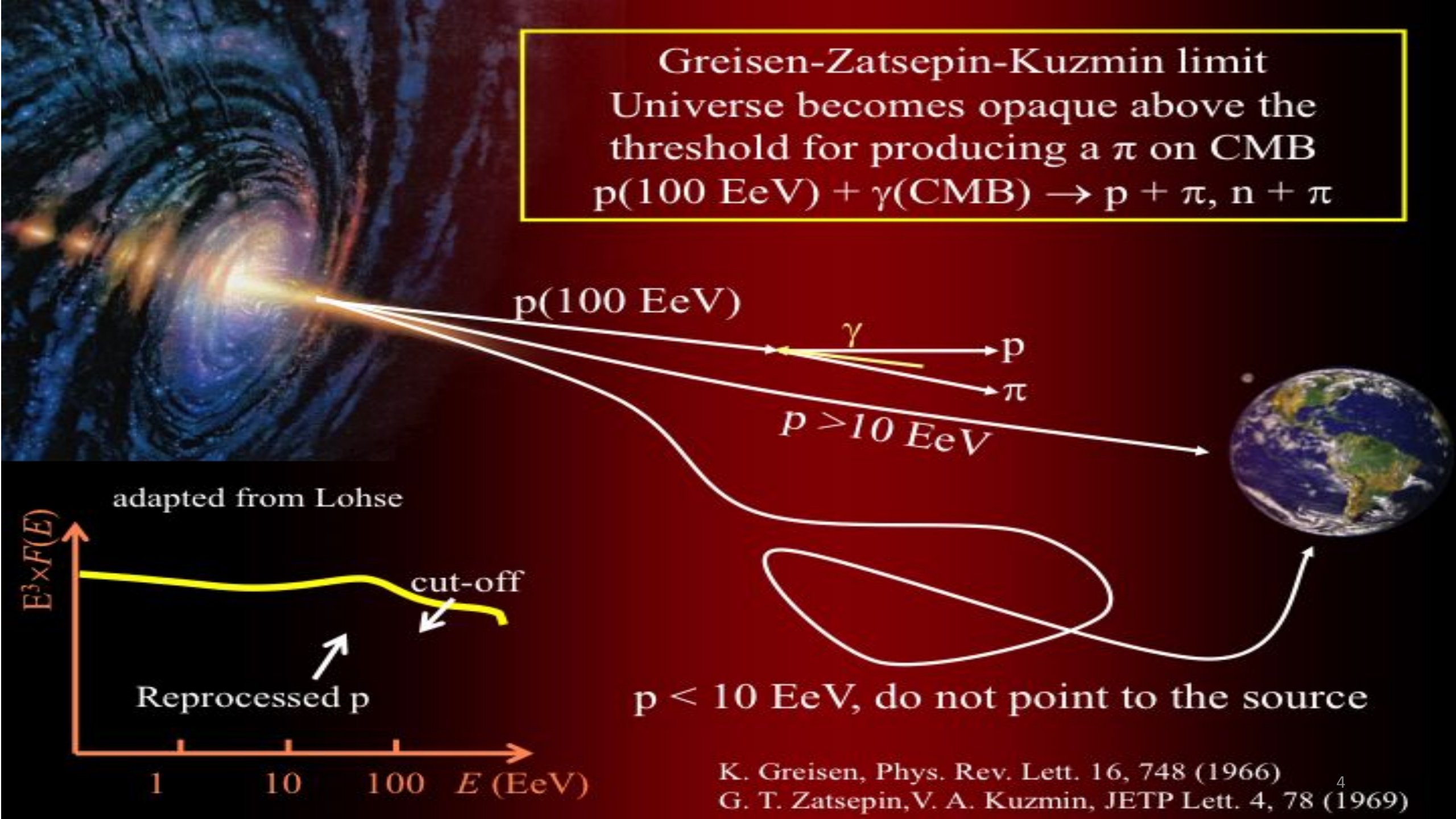
US$ ~7500



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

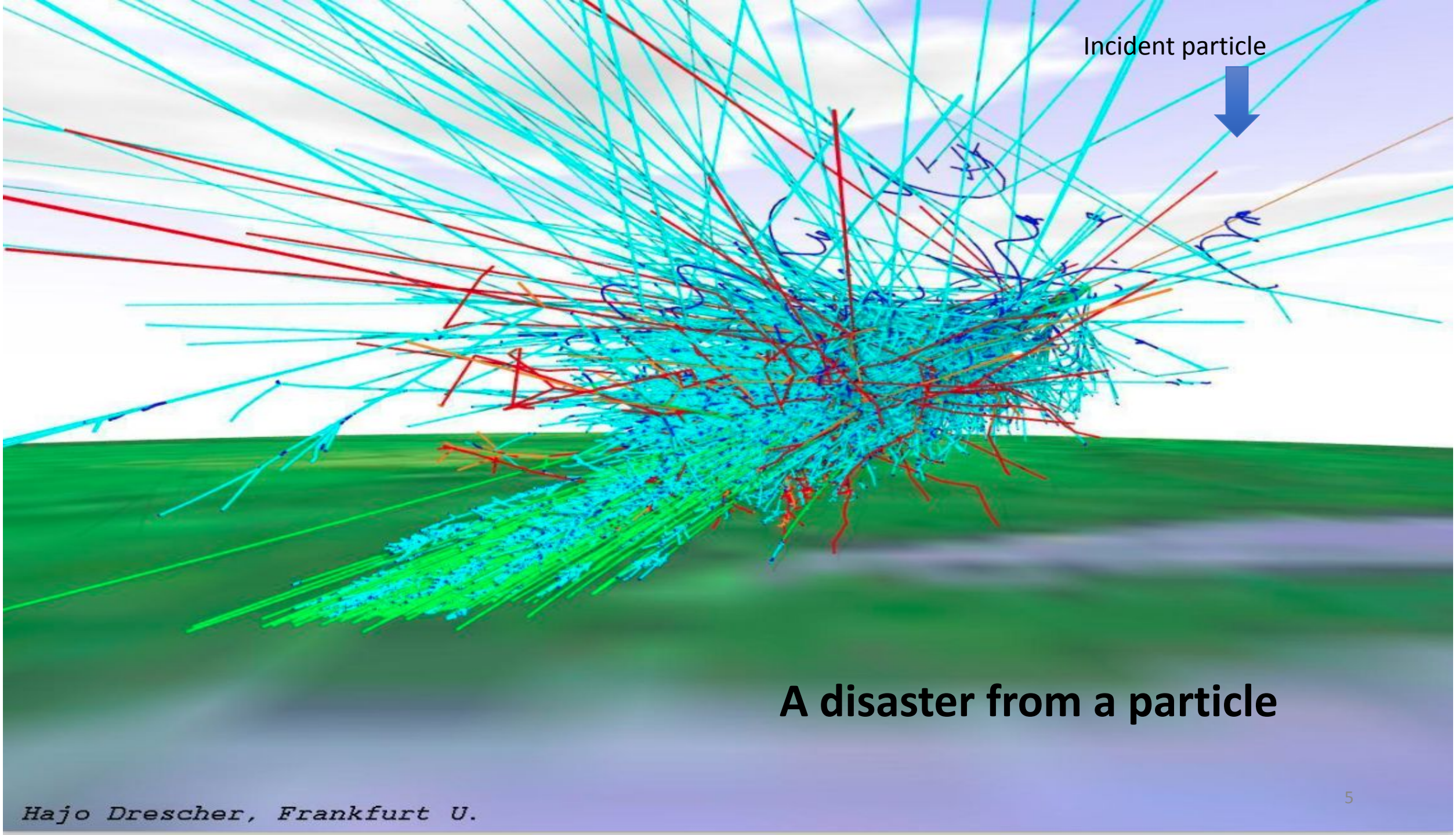
H. Asorey and S. Hernández-Baraja and F. León-Carreo and L. A. Núñez and J. Peña-Rodríguez and J. Pisco- Guabave and D. Sierra-Porta and M. Suárez-Durán (2019). Hardware-level calibration of the Chitaga Water Cherenkov Detector in the GUANE array for space weather study. Scientia et technica, 23(4), 563-568.

Greisen-Zatsepin-Kuzmin limit
Universe becomes opaque above the threshold for producing a π on CMB
$p(100\ EeV) + \gamma(CMB) \rightarrow p + \pi,\ n + \pi$



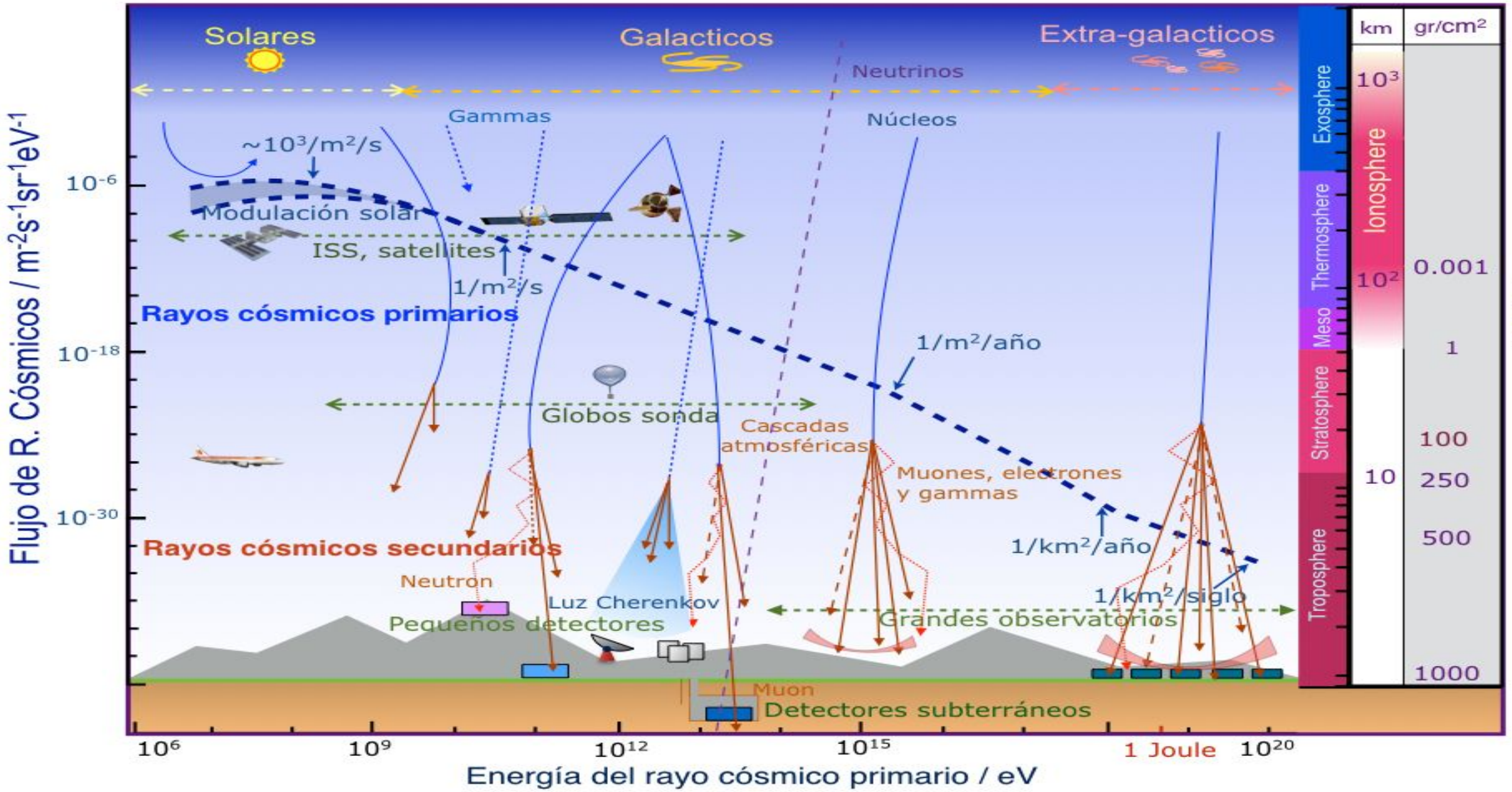
p ≺ 10 EeV, do not point to the source

K. Greisen, Phys. Rev. Lett. 16, 748 (1966)
G. T. Zatsepin,V. A. Kuzmin, JETP Lett. 4, 78 (1969)



A disaster from a particle

Hajo Drescher, Frankfurt U.

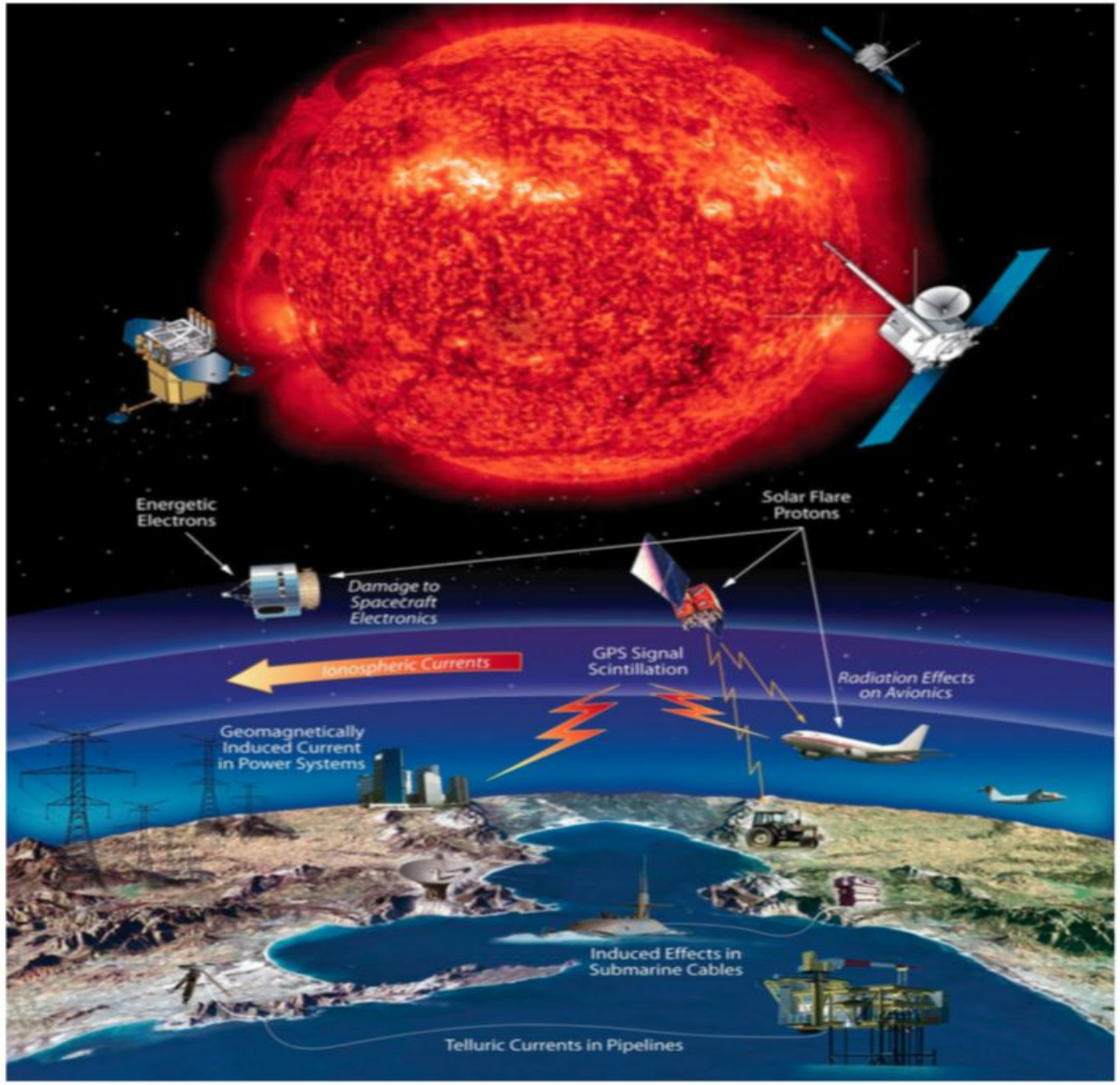


Los rayos cósmicos: una nueva ventana al universo

A. Ferriz Mas, *Universidad de Vigo e IAA/CSIC* y J. A. Garzón-Heydt, *Universidad de Santiago de Compostela*

http://revista.iaa.es/content/los-rayos-cósmicos-una-nueva-ventana-al-universo

Space Weather



Sun-Earth connection

- Dynamic conditions in the Earth outer space environment:
  - Disruption of electrical power grids
  - Contribute to the corrosion of long pipelines
  - HF radio communications and GPS interferences
  - Operational anomalies and damage or degradation of critical electronics on spacecraft, satellites and even on board of commercial airplanes

The LAGO Space Weather Program

via Solar modulation of low energy cosmic rays

Connections

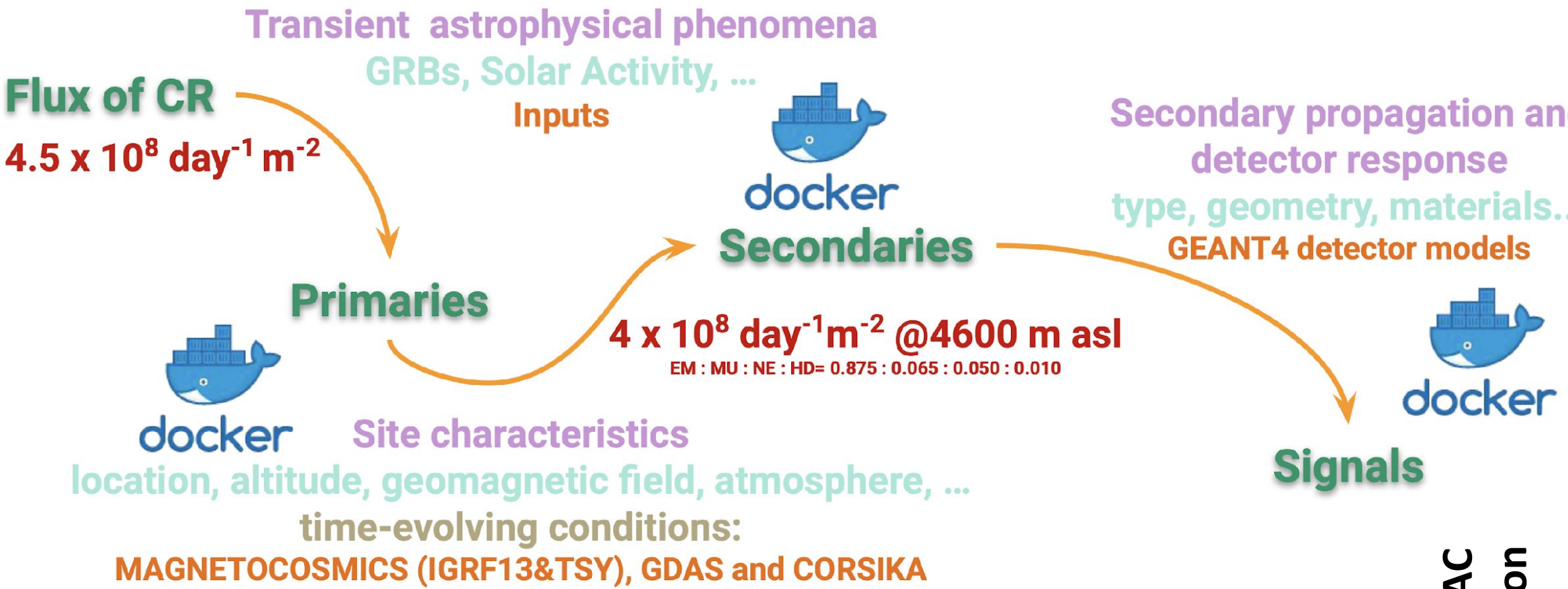
CR Flux	Solar Activity →	Modulated flux
Modulated flux	Geomagnetic field →	Primaries
Primaries	Atmospheric conditions →	Secondary particles
Secondary particles	Detector response →	**Signals**

Synergy

Flux variation of signals at detector level ⇔ Solar Activity

Asorey, H. Et al "The LAGO space weather program: Directional geomagnetic effects, background fluence calculations and multi-spectral data analysis" Proceedings of The 34th International Cosmic Ray Conference, PoS(ICRC2015) 142, 2015

Our secondary flux simulation framework



- Europe Latin America Collaborative e-Infrastructure for Research Activities (ELCIRA)
- Co-ordination and Harmonisation of Advanced e-INfrastructures CHAIN
- Coordination and Harmonisation of Advanced e-Infrastructures for Research and Education Data Sharing (CHAIN-REDS)
- Grid Initiatives for E-Science Virtual Communities in Europe and Latin America (GISELA)
- E-Science Grid Facility for Europe and Latin America EELA2
- E-Infrastructure shared between Europe and Latin America EELA

LAGO EU-LAC Collaboration

https://www.egi.eu/case-study/lago/

To manage this heterogeneity and take advantage of the poject contributors, LAGO progressively incorporates the continuous generation of data (measurements, processing and simulations) and code into standardised mechanisms that follow the FAIR principles.

The objective is to enable the universal profit and contribution of this research, within and outside LAGO Collaboration, through a sustainable Virtual Observatory and standardised computational model. These objectives can only be achieved in federated, open, and non-privative environments, which must integrate the mechanisms for publication and curation of large datasets. This is, LAGO needs a procedural and computational ecosystem focused on continuous research by a large community of scientists.

Technical support

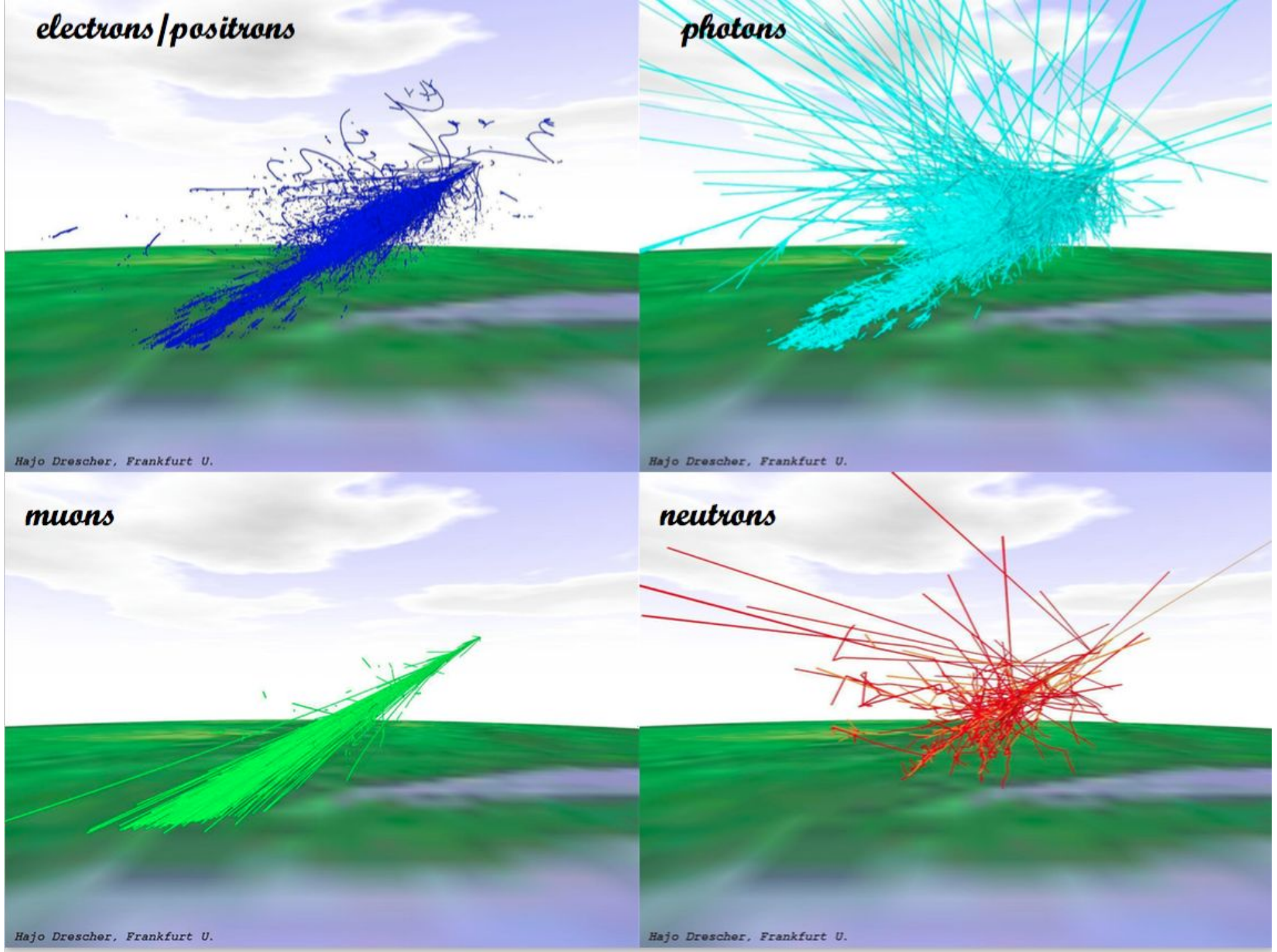
Thanks to the creation of the LAGO Thematic Service within the EOSC-Synergy project and to the continuous and kind support from several infrastructure providers, being CIEMAT, CETA-CIEMAT, CESGA, ICFA, BIFI , LIP and NCG from INCD as those of May 2022, LAGO is now able to expand its capabilities from astrophysics studies and support other important areas with social impact, such as contributing to a better understanding of the risk associated with active volcanoes at largely populated areas; estimating the moisture and the presence of natural fertilizer compounds at the soil, and even, helping in the detection of homemade antipersonnel mines at warfare fields in Latin America.

EGI services used by LAGO

The EGI Cloud Compute for distributing the computational load to a scalable and flexible computing platform by user-demand. Virtualisation allows researchers to obtain the computational environment required by LAGO software.

The EGI Check-in, to enable delegated identification and granting access to EGI services.

The EGI DataHub, to store, publish, and re-use results and metadata. It allows researchers several ways to access the data and metadata of their interest. Collaboration members can directly explore the directory tree at the we service or mount it on their PCs.


electrons/positrons
Hajo Drescher, Frankfurt U.
photons
Hajo Drescher, Frankfurt U.
muons
Hajo Drescher, Frankfurt U.
neutrons
Hajo Drescher, Frankfurt U.

rsta.royalsocietypublishing.org Phil. Trans. R. Soc. A 377: 20180049

Figure 3. Schematic infographic illustrating the different applications of muography, courtesy of Lynkeos Technology Ltd.

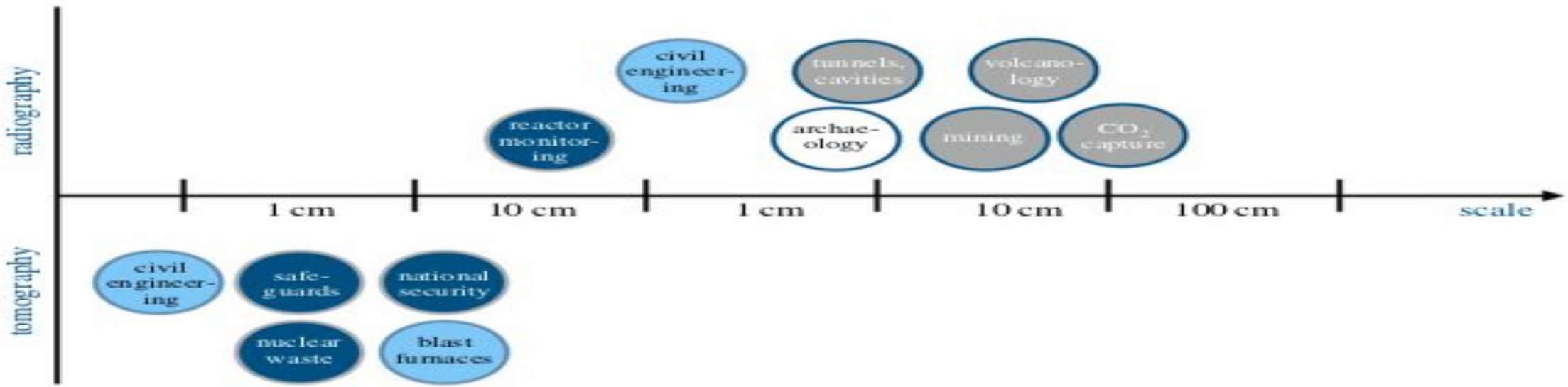
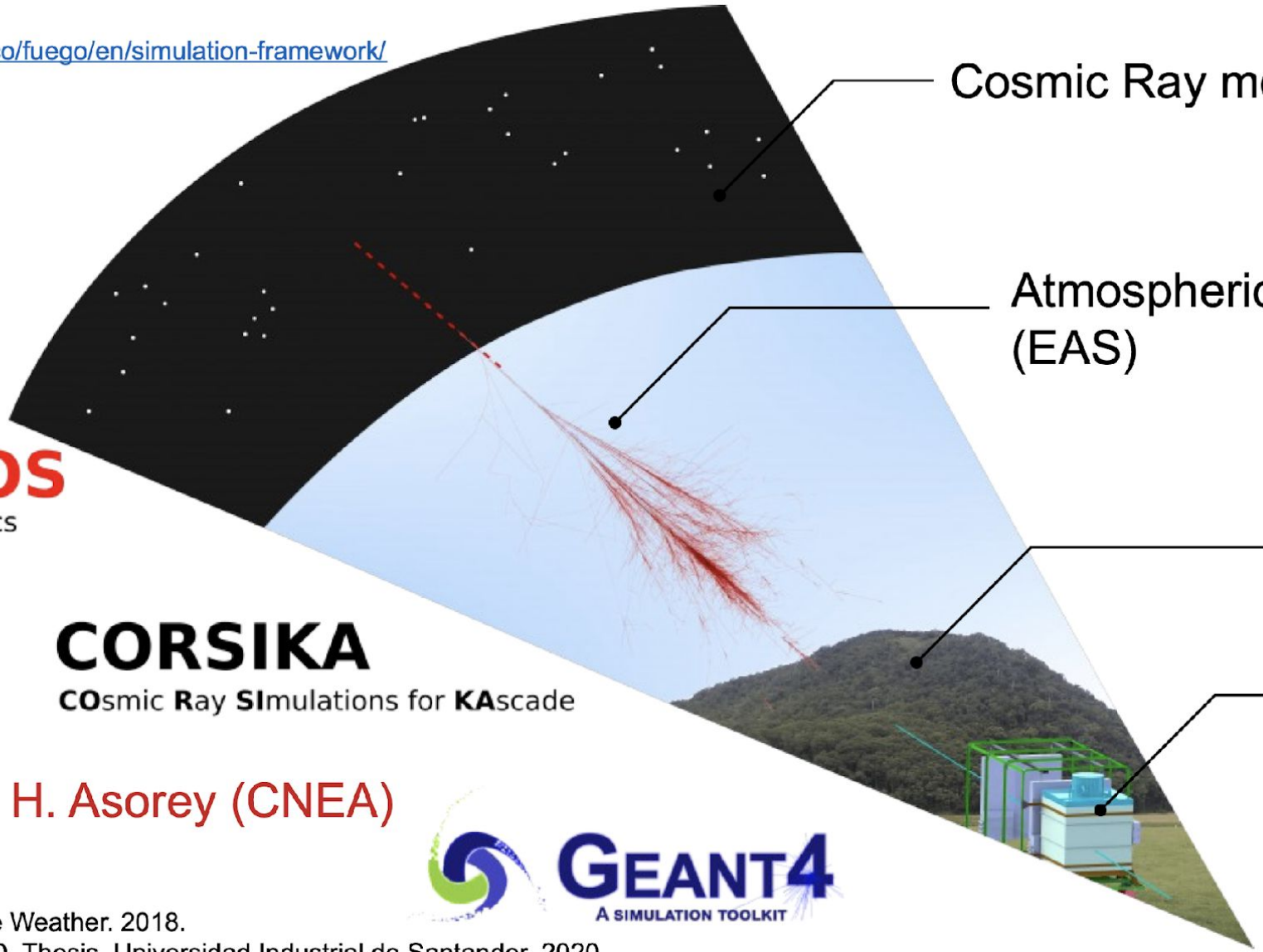


Figure 4. Typical scale of muon radiography and tomography applications, with civil engineering applications in light blue, nuclear safety and security applications in dark blue and geoscience applications in grey. (Online version in colour.)

Simulation framework

https://halley.uis.edu.co/fuego/en/simulation-framework/



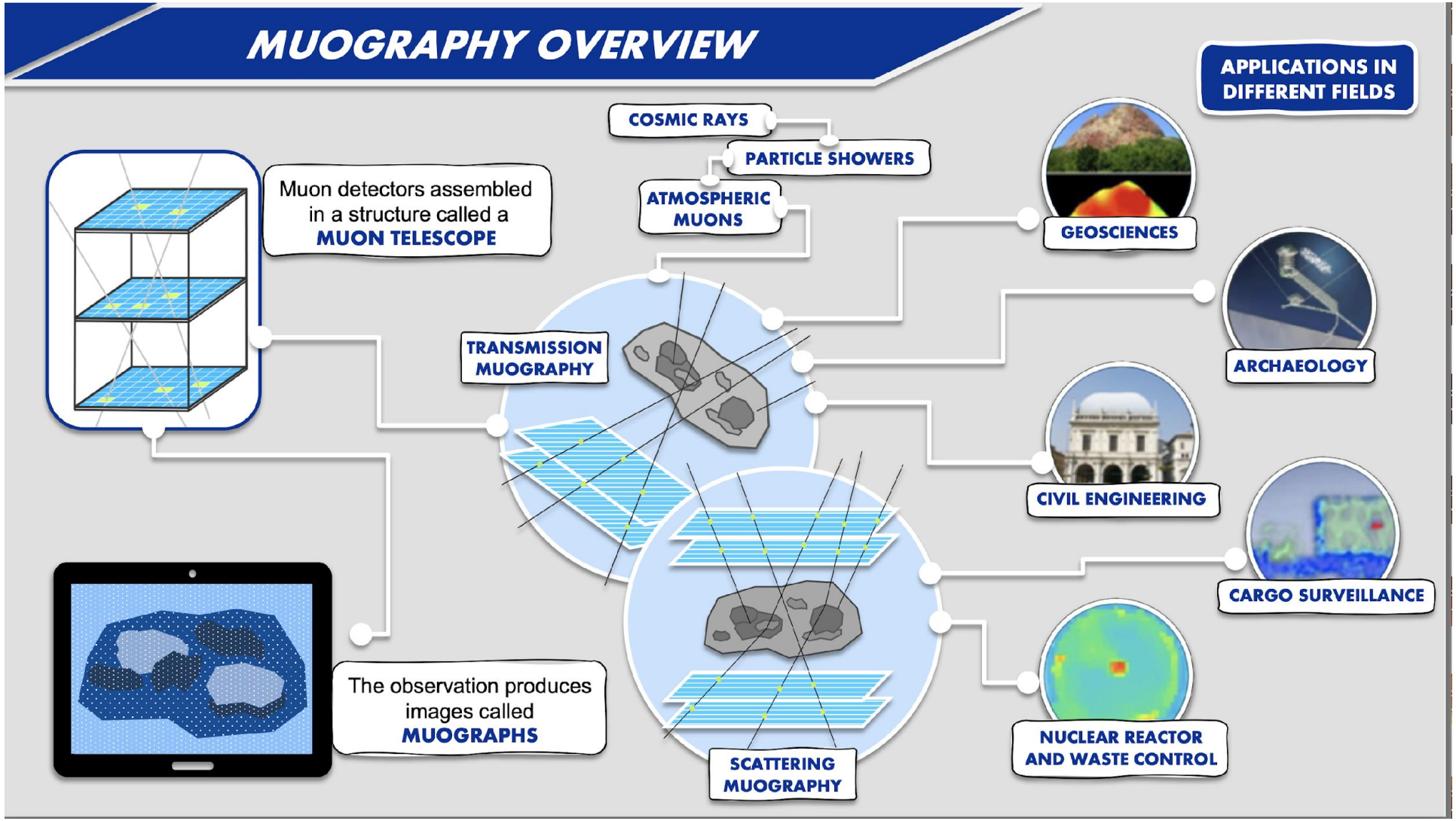
MAGCOS
MAGnetoCOSmics

CORSIKA
COsmic Ray SImulations for KAscade

next talk … H. Asorey (CNEA)

GEANT4
A SIMULATION TOOLKIT

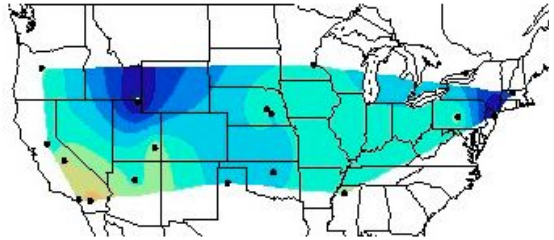
H. Asorey et al. Space Weather. 2018.
M. Suárez-Durán. PhD. Thesis. Universidad Industrial de Santander. 2020

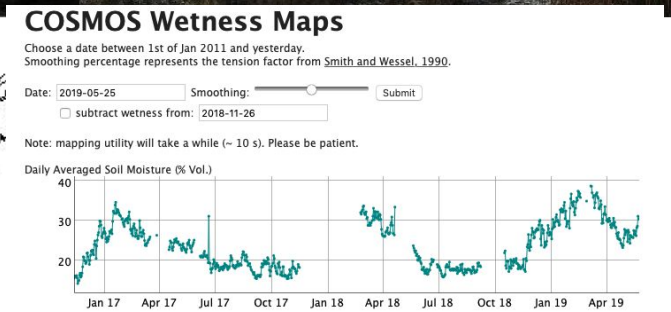


P. Teixeira et al *International Workshop on Cosmic-Ray Muography (Muography2021)*

COSMOS

Cosmic-ray Soil Moisture Observing System





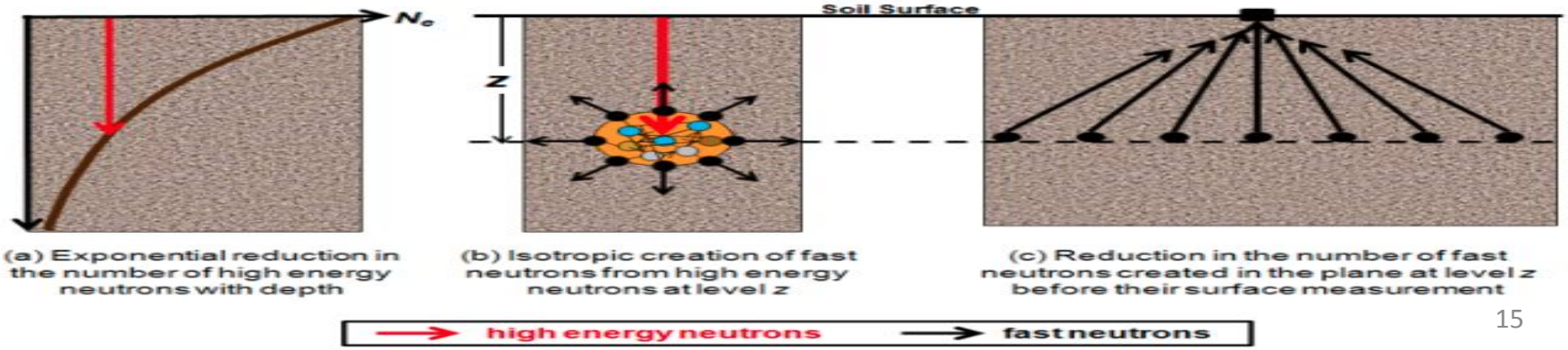
COSMOS probes measure soil moisture at the horizontal scale of hectometers and depths of decimeters using cosmogenic neutrons.

COsmic-ray Soil Moisture Interaction Code (COSMIC)

Date: August 2013

The COsmic-ray Soil Moisture Interaction Code (COSMIC) is a simple, physically based and analytic model used for data assimilation applications of cosmic-ray soil moisture sensors. The model includes simple descriptions of (a) degradation of the incoming high-energy neutron flux with soil depth, (b) creation of fast neutrons at each depth in the soil, and (c) scattering of the resulting fast neutrons before they reach the soil surface, all of which processes may have parameterized dependency on the chemistry and moisture content of the soil (see below).

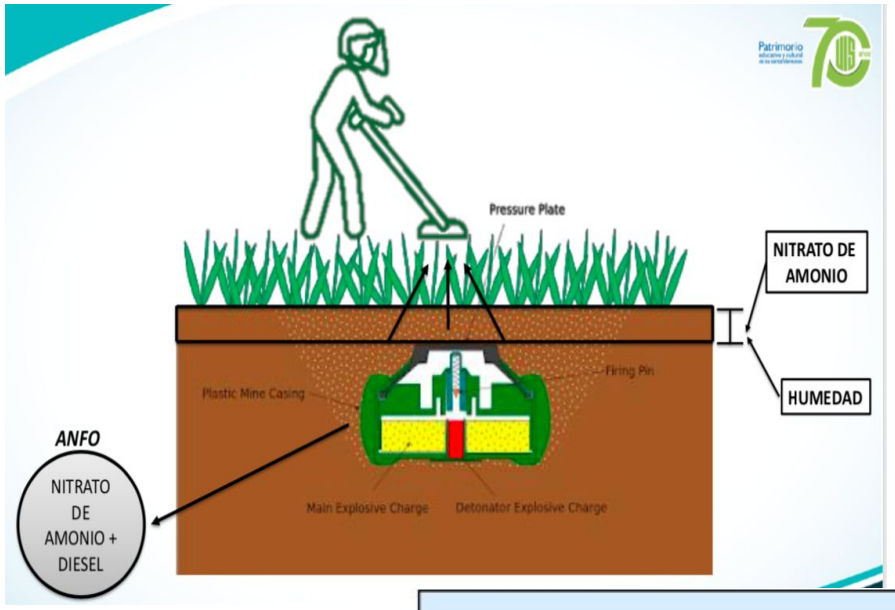
The three physical processes represented in the COSMIC that control the above ground fast neutron count rate.



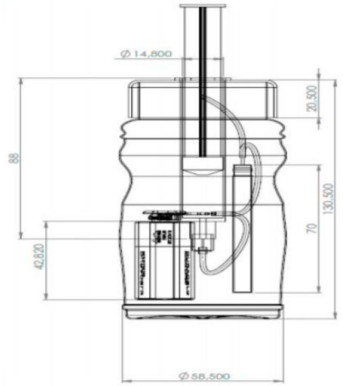
(a) Exponential reduction in the number of high energy neutrons with depth

(b) Isotropic creation of fast neutrons from high energy neutrons at level *z*

(c) Reduction in the number of fast neutrons created in the plane at level *z* before their surface measurement



Geometría IED



M. D. E. Posconflicto, "TIPOS DE MINAS ANTIPERSONAL EN COLOMBIA," 2011.

Fabricación:

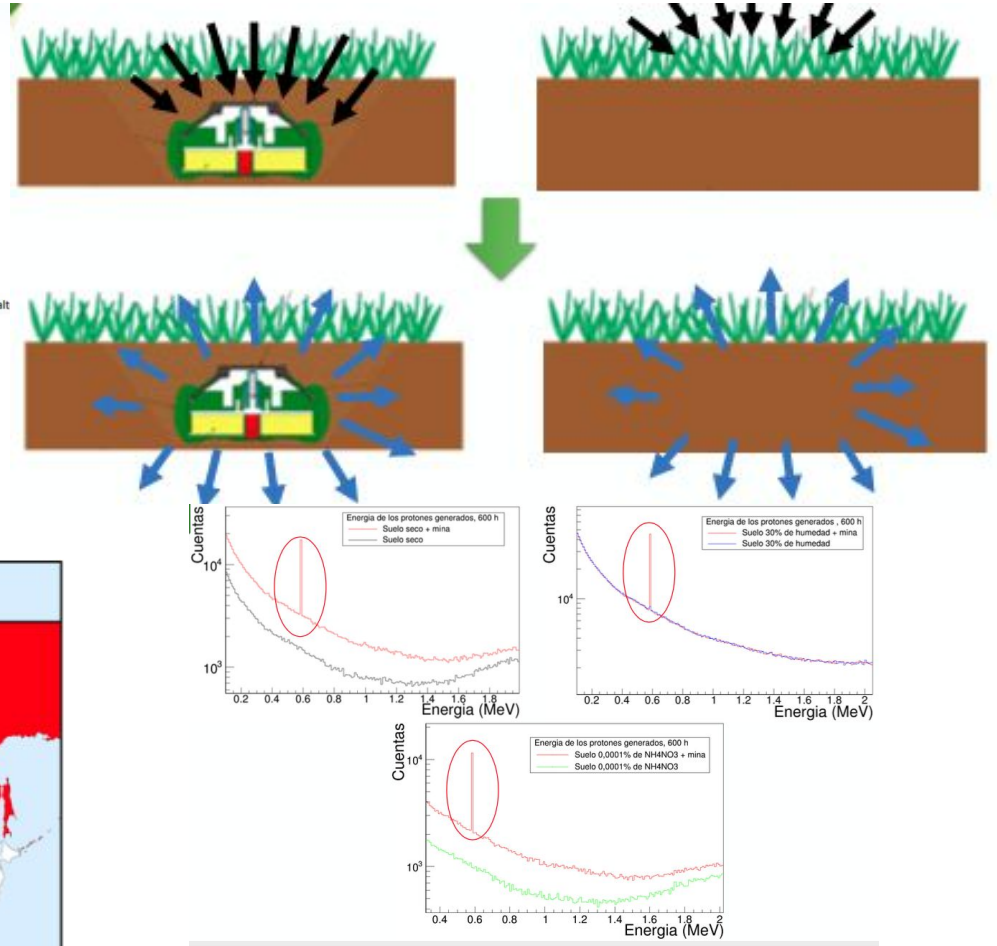
Autodenominado Farc y Eln.

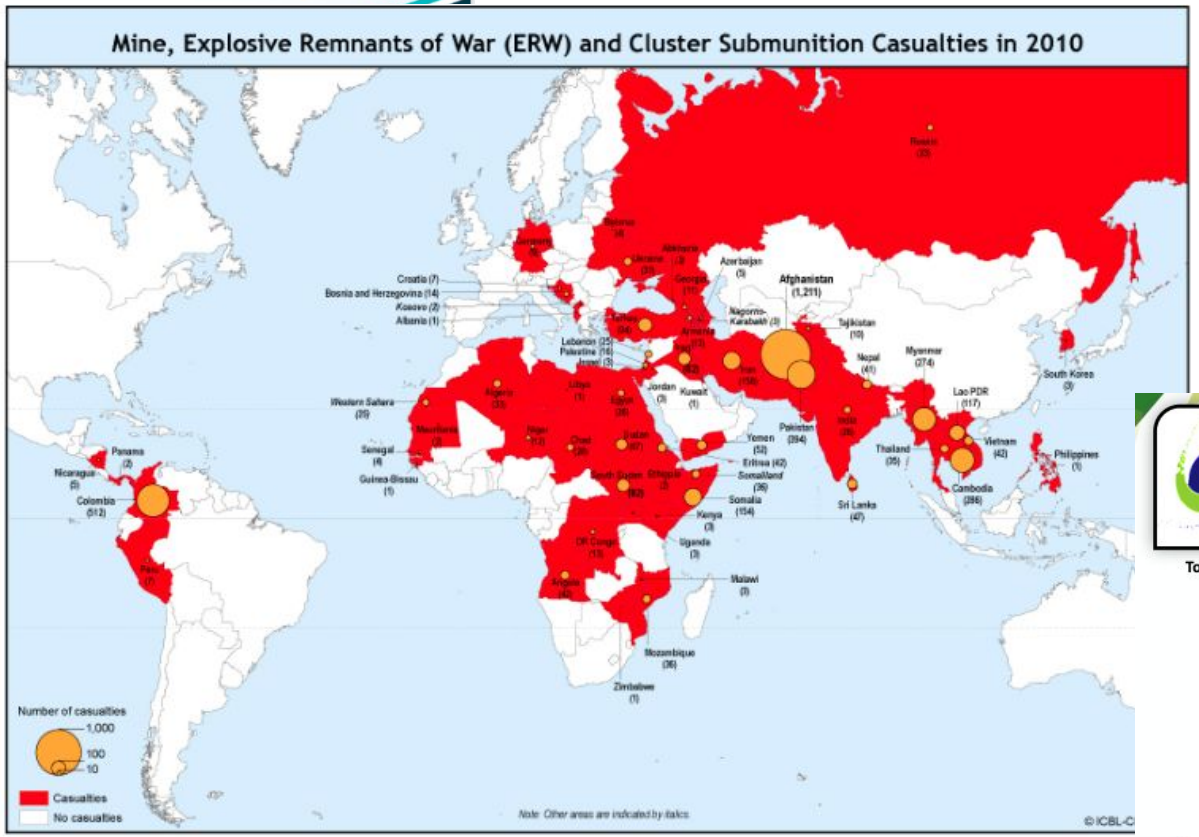
Información general :

- Contenedor plástico
- 58.50 mm de ancho, 130.50 mm de alt
- 450 g de peso aproximado.
- Espoleta que emplea una jeringa
- Rojo o pintado color verde oliva.
- Detonador Eléctrico

Activación:

- Presión: 5 kg Aproximadamente



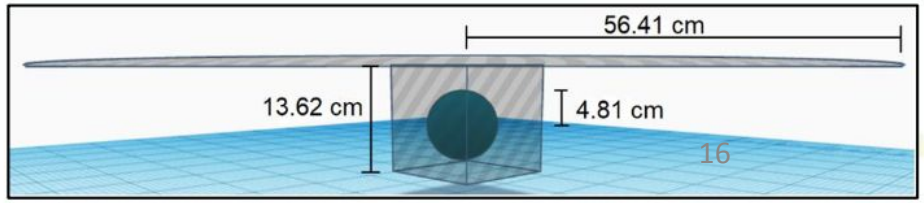


GEANT4
A SIMULATION TOOLKIT

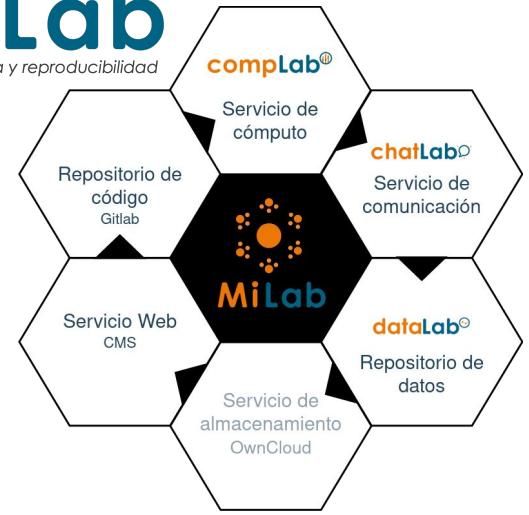
Tomado de: https://geant4.web.cern.ch/

Variables introducidas:

- Elementos químicos
- Fracción porcentual
- Densidad
- Dimensiones de la geometría
- Tipo de partículas
- Cantidad y energía de partículas
- Paquete de física



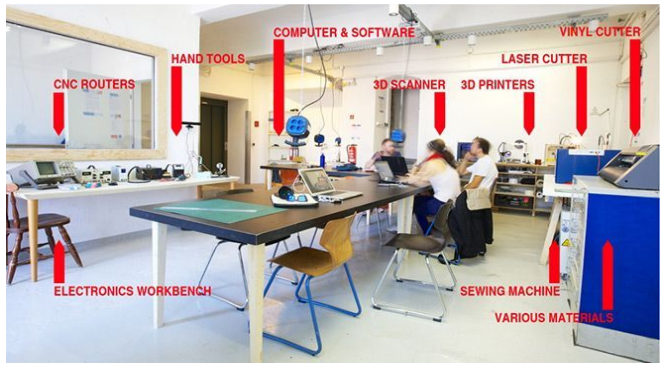
MiLab
Ciencia abierta y reproducibilidad



Latin American alliance for Capacity buildiNG in Advanced physics
LA-CoNGA physics

Melquíades Physics FabLab:
A collaborative network of Environmental co-creation spaces

Schools → Undergrad Education → Graduate Education

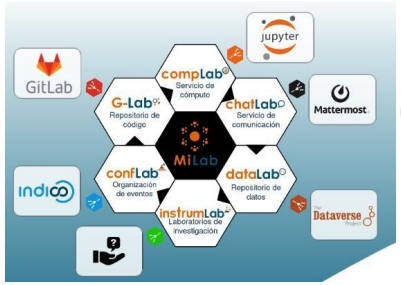


OpenScience Platform-as-a-service to preserve the history and facilitate the management of small/medium research groups (10-30 researchers):

- **Research data,**
- **Computational codes and environments**
- **Communication, Web visibility**

Looking for partners to build EU-LAC OpenEdu

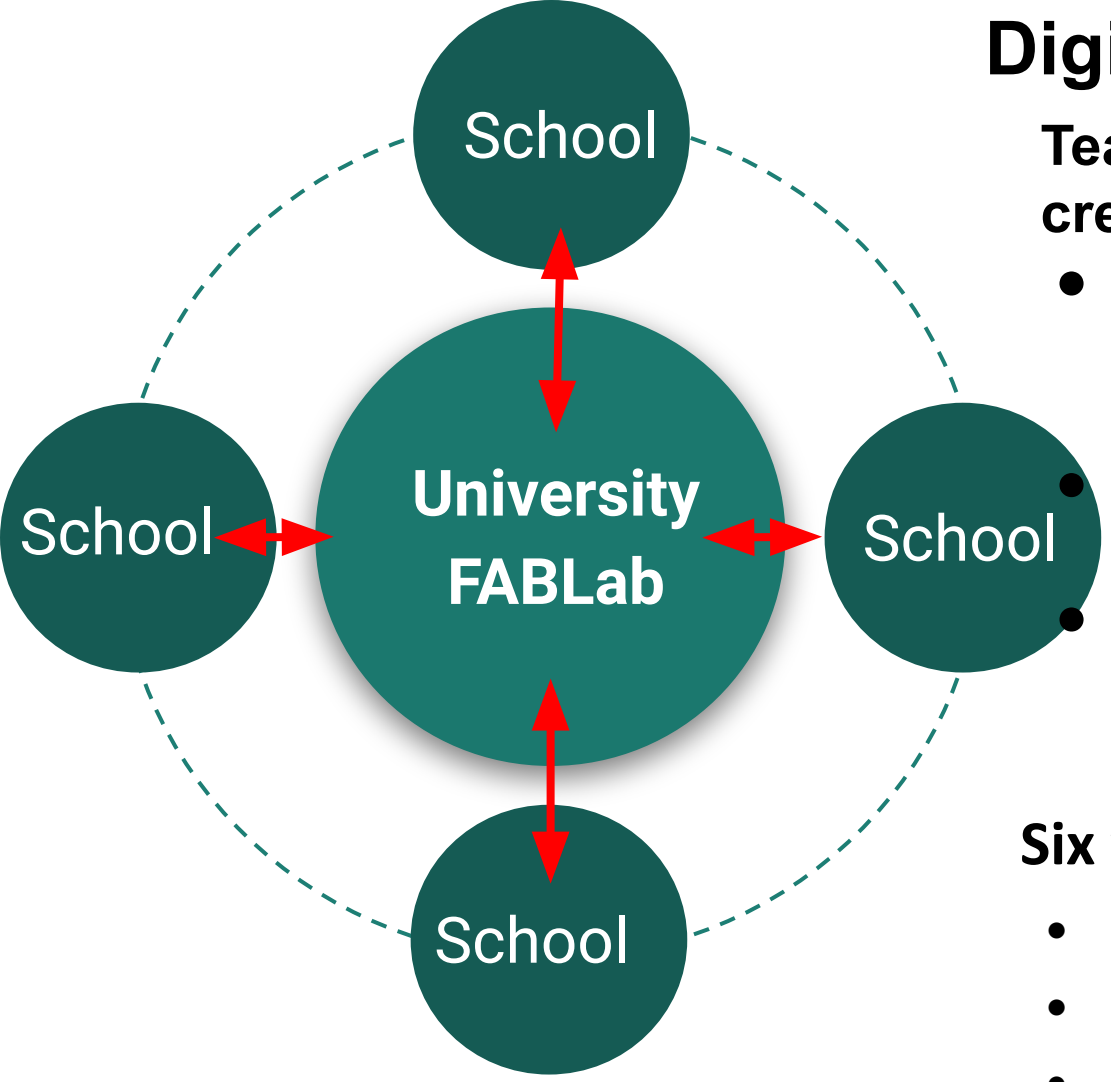
Melquíades FabLAB for environmental spaces for creative collaboration:



FAB LAB

- **Shared environments equipped** with low-cost, versatile, computer-controlled rapid prototyping tools.
- 3D printers, 3D scanners, laser cutting machines, embedded electronics and open source software stations.
- MiLAB professional Open Science education platform
- **Challenge and discovery learning**
- **Environmental Science and climate change adaptation as drivers of innovation.**

- **Design and construction of devices that support climate change adaptation and precision agriculture.**
- **Design and implementation of sensor devices for environmental variables**
- Virtual reality environments for remote use of instruments.



DigitalFAB Clubs Network (STEM)

Teachers and students share experiences in the creation and maintenance of equipment.

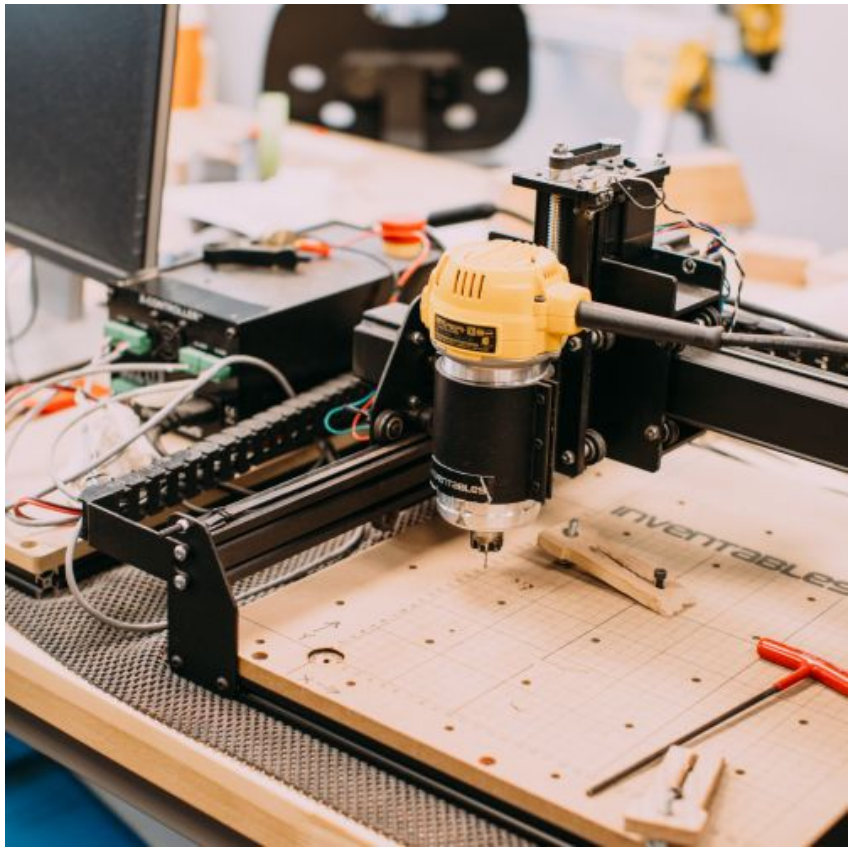
- Each school will have f**our hours/week in the Melquíades FabLab** to design, create and maintain equipment.
- For **16 weeks,** an instructor guides them in making three pieces of lab equipment for their schools.
- **Teachers follow a Diploma in Digital Fabrication** for Innovation as part of a continuing education programme at the Universidad Industrial de Santander.

Six weeks of introduction to FabLab techniques and tools,

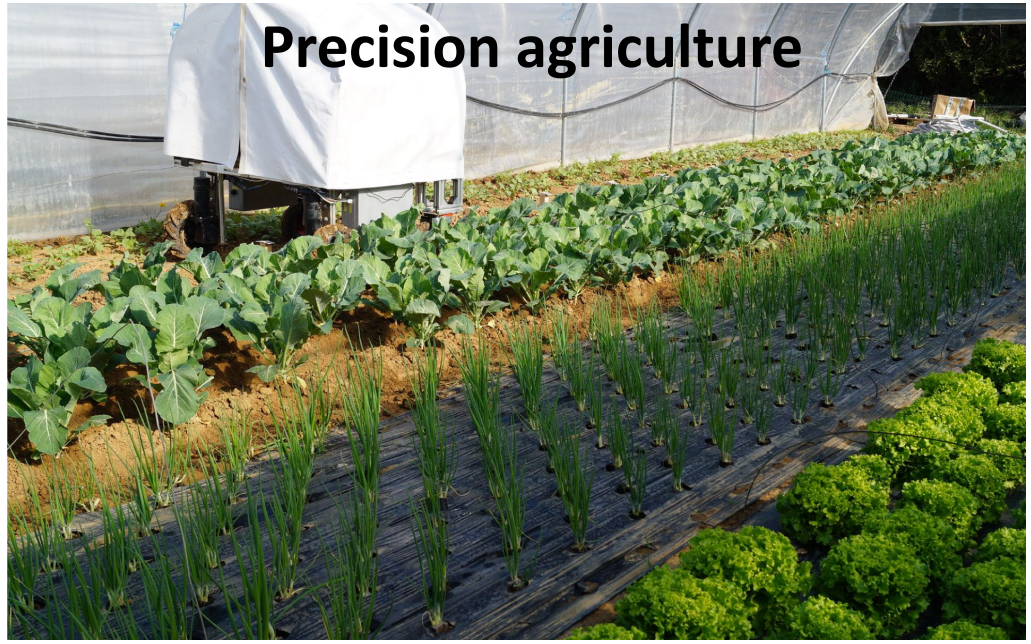
- Project management,
- Computer Aided Design,
- Computer Controlled Cutting,
- integrated electronics and programming,
- Scanning and 3D printing,
- Interface and application programming
- Data analysis

Nine weeks for the development of climate change adaptation projects

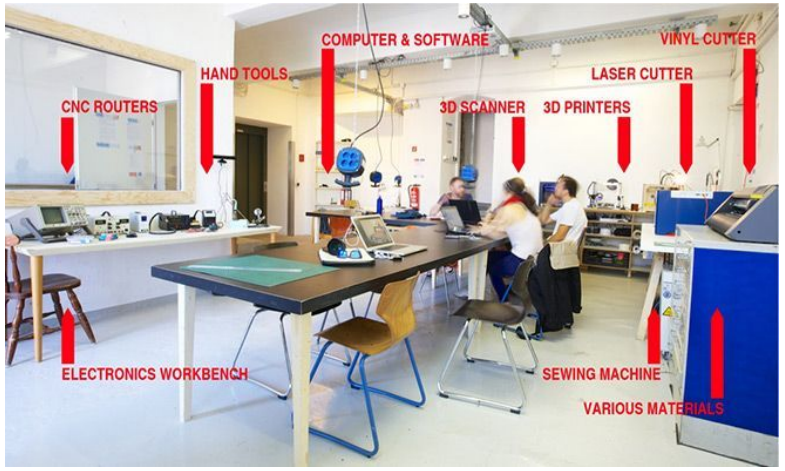
Virtual and augmented reality



https://fablabbcn.org/blog/make-things/open-source-sensor-tools-to-measure-air-pollution



Laboratory equipment

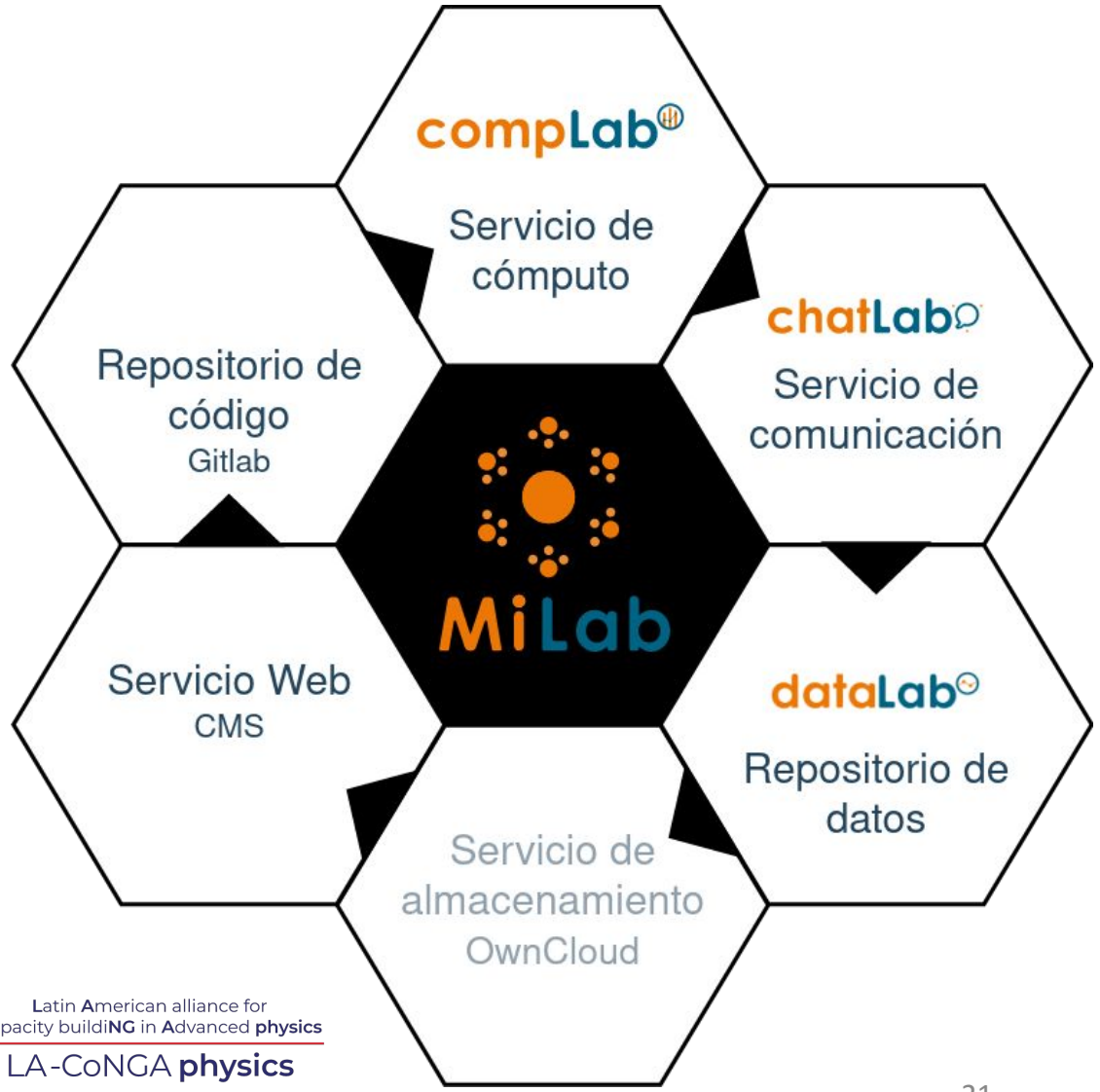


https://fablabbcn.org/projects/romi-robotics-for-microfarms-9

MiLab

Ciencia abierta y reproducibilidad

- Platform as a service in the cloud to preserve the history and facilitate the management of small/medium research groups (10-30):
- Research data
- Computational codes
- Computational environments
- Communication
- Web visibility



CEDIA

Red CLARA

Latin American alliance for Capacity buildiNG in Advanced physics

LA-CoNGA physics

Professional platform for courses

Content y Access

Class n

Videos

Text

Data

Computations

Instruments

VideoConf

Admin

Course 1
Repository Git

GitLab

carpetas

Class 1 | Class 2 | Class 4 | Class 5 | Class 6 | Class n

compLab Servicio de cómputo
chatLab Servicio de comunicación
Repositorio de código Gitlab
MiLab
Servicio Web CMS
dataLab Repositorio de datos
Servicio de almacenamiento OwnCloud

Push/Pull

Repository Git Prof

Repository Git Prof

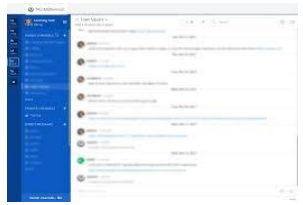
Push/Pull

Push/Pull

Repository Git Student

Repository Git Student

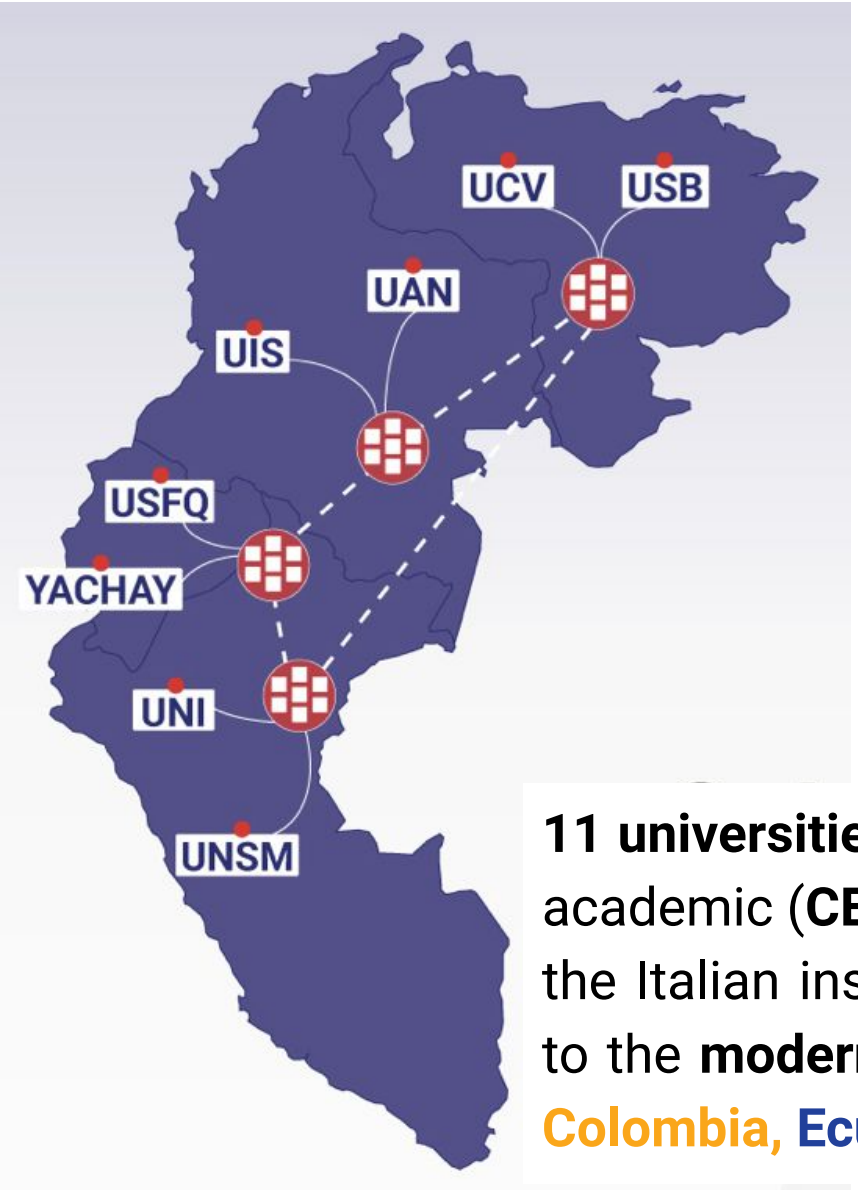
Repository Git Student



Instant messaging

Platform LA-CoNGA

What is LA-CoNGA physics?



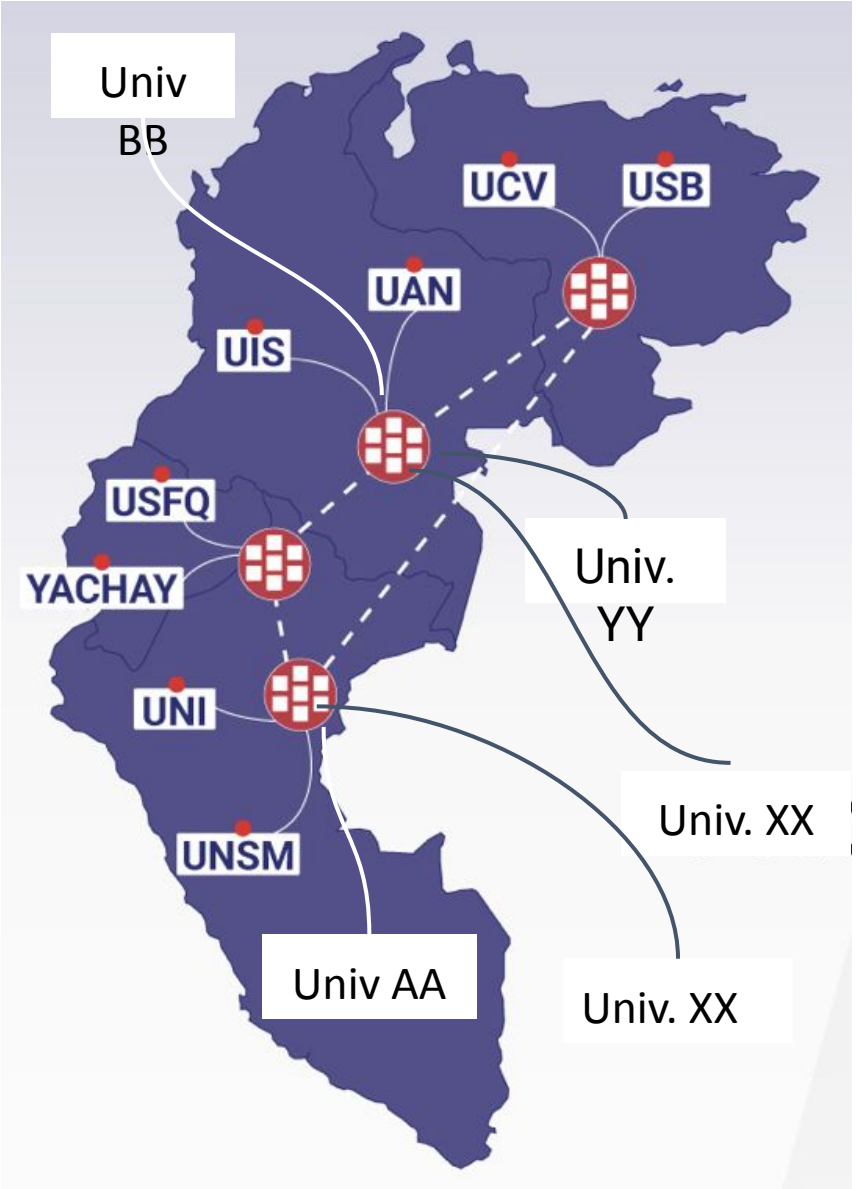
An **Erasmus+CBHE (Capacity Building in Higher Education)** project co-funded by the European Commission's Education, Audiovisual and Culture Executive Agency:

- Responding to the strategy of the participating institutions and the capacity building in higher education strategy promoted by the EU
- **Initially a 3-years project. Officially started in January 2020 (extended 1 extra year due to COVID/pandemic)**

Erasmus+

11 universities from Latin America and Europe join efforts with other scientific and academic (**CERN, CNRS, DESY, ICTP, IRFU, RedCLARA**) and **industrial** partners (like the Italian instrumentation company CAEN & data science start-ups) to contribute to the **modernisation, accessibility** and **internationalisation of higher education in Colombia, Ecuador, Perú and Venezuela**

LA-CoNGA physics beyond 2023



- Scientific and capacity building based on:
  - International collaboration
  - Shared infraestructures
  - Open resources
  - Organization/common strategies

- But without forgetting to adapt to local realities in the work/teaching dynamics!

- Current objective: **ensure the sustainability** beyond initial funding period and **continue contributing to the capacity building, talent pipeline and intraregional and European-Latin american networking**

LA-CoNGA physics beyond 2023

- Expanded in **Disciplines**
  - **Astrophysics**
  - **High Performance Computing**
  - **Geophysics**
  - **Nuclear Physics**
- **Expanded Geographically** (Central América)
- **Consolidated training model**, skills highly in demand inside and outside academia:
  - **Data Science,** *(64h)*
  - **Disciplinary Instrumentation** *(64h)*
  - **Disciplinary Basic Course** *(64h)*
  - **Disciplinary Advanced Course** *(64h)*
  - **Hackaton & Citizen Science experience**
  - **Intership** (12week)
- **MarketPlace for advanced education resources**
  - Videos, Presentations, computer codes, Assignments of advanced Courses
  - Intership offers

An innovative syllabus for the region!

LAGO + LA-CoNGA = Continental astroparticle tranning

LA-CoNGA

- Expertise
- Platform
- Remote labs
- Academic links

LAGO

- Continental observatory
- Capillarity
- Simulation framework
- Working instrumentation

http://laconga.redclara.net http://lagoproject.net/

contacto@laconga.redclara.net

lacongaphysics

Latin American alliance for
Capacity buildiNG in Advanced physics

LA-CoNGA physics

The Latin American Giant Observatory (LAGO)