

# LAGO: the Latin American Giant Observatory



Luis Otiniano on behalf of the LAGO Collaboration<sup>1,2</sup>

<sup>1</sup>Comisión Nacional de Investigación y Desarrollo Aeroespacial (CONIDA)

CLAF / MCTI High-Level Seminar

20 April 2023, Rio de Janeiro, Brazil

<sup>3</sup><https://lagoproject.net>



**LAGO is a giant non centralized collaborative network of astroparticle detectors at global scale, currently operating in 11 countries**

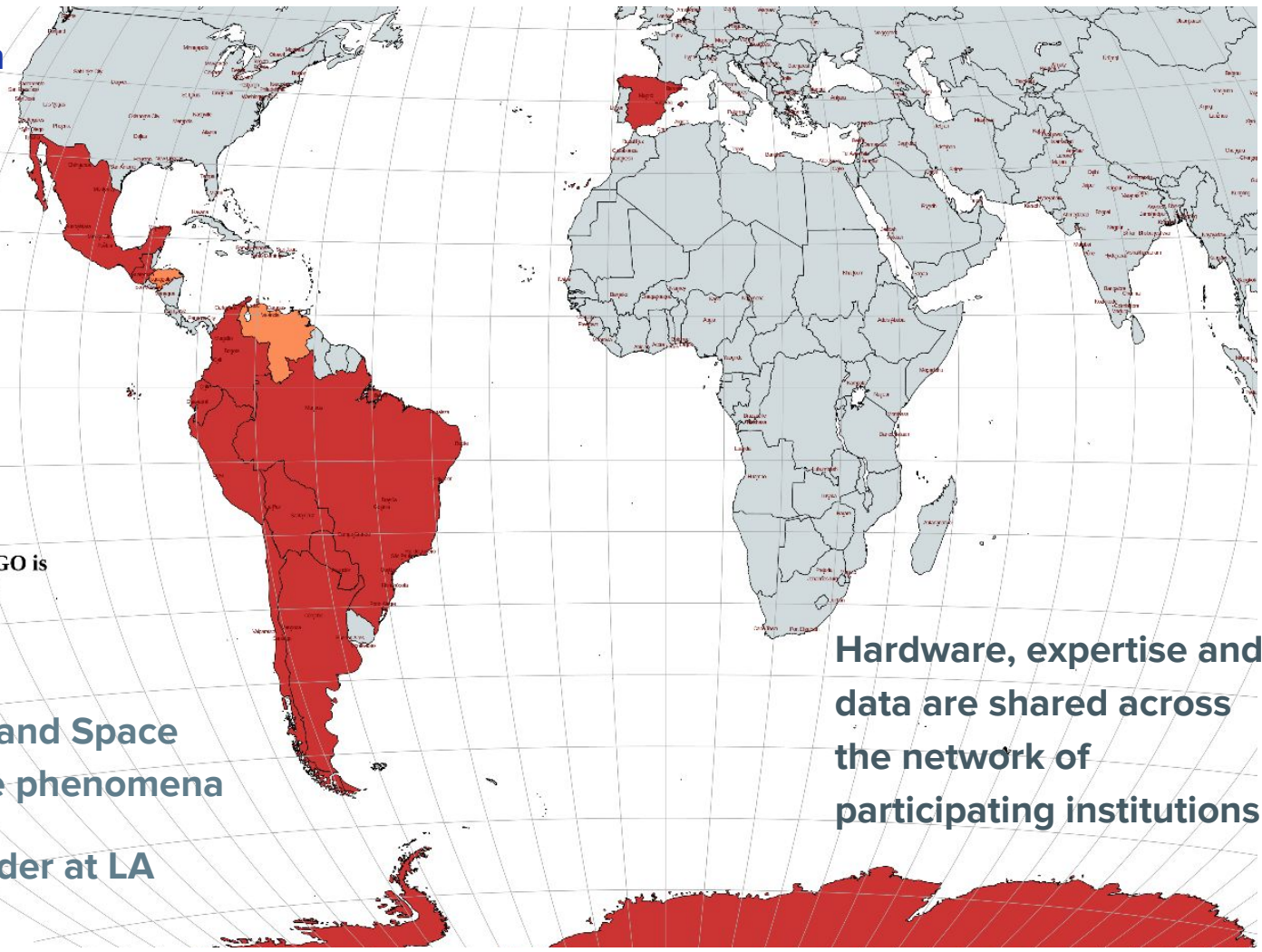
**Countries where LAGO is operating**

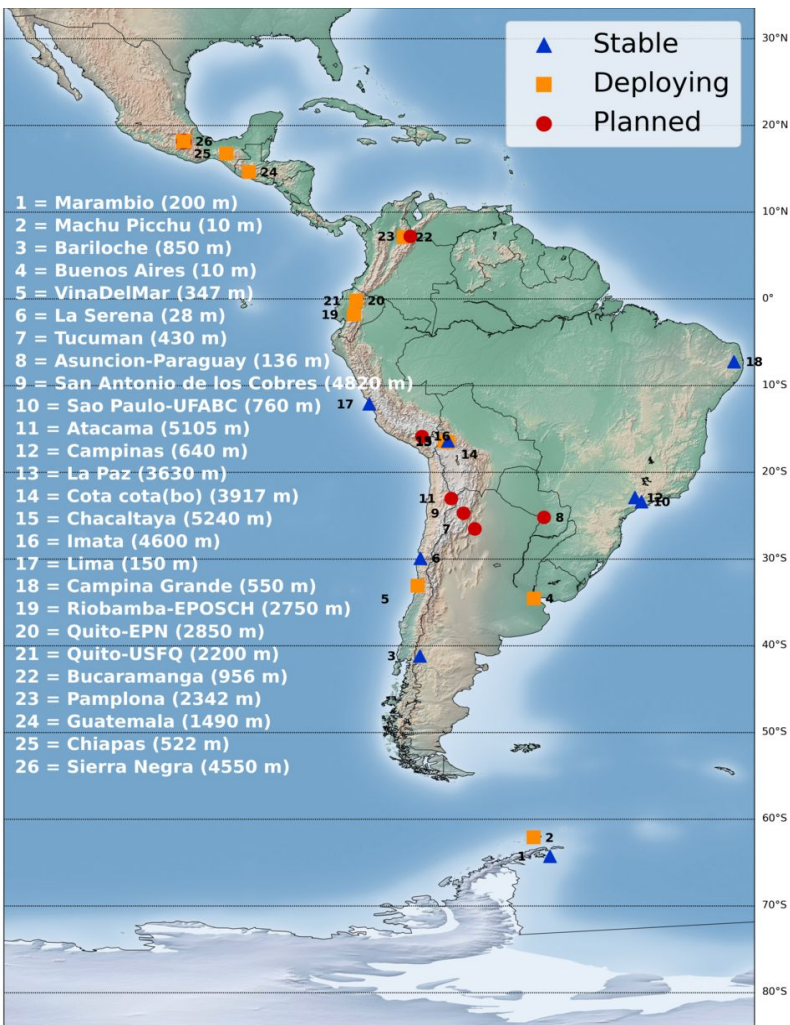
- Active
- Development

**HE Gamma Sources and Space Weather and Climate phenomena**

**AP & HE physics seeder at LA**

**Hardware, expertise and data are shared across the network of participating institutions**



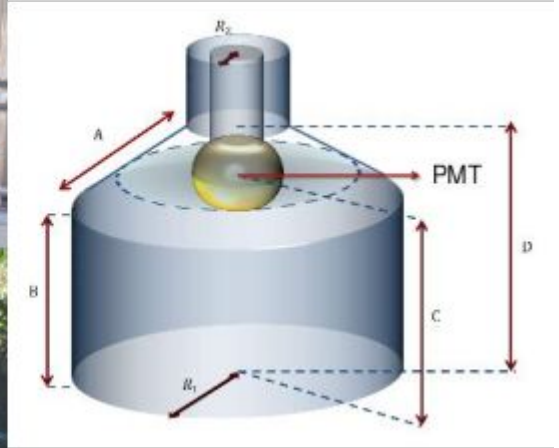


## LAGO is an extended astroparticle observatory at continental scale: from México to Antarctica

- **Scientific goals**
  - Astroparticle physics to study the extreme universe
  - Transient and long term space weather phenomena trough Solar modulation of Cosmic Rays
  - Measurement of background radiation at ground level
- **Academic goals**
  - Train Latin American students in High Energy and Astroparticle physics
  - Build a Latin American network of Astroparticle and Cosmic Rays researchers

# The LAGO detector

Autonomous, reliable, simple, cheap and smart (based on SBC and COTS) WCD with a single PMT (usually provided by LAGO in most of the participating countries)



New own designed electronic based on SteamLab RedPitaya

H. Arnaldi et al, [IEEE2020](#)

SaaS (Sensors as a Service) Concept

H. Asorey et al, [PoS\(ICRC2015\)](#)



# LAGO detectors diversity



# LAGO Space Weather

**LAGO studies Earth-Sun connection** by measuring the time-evolving secondary signals from ground level. Atmospheric and geomagnetic conditions are continuously monitored

**Antarctic dedicated SW sites**



# LAGO Virtual

Own designed hierarchical data analysis  
and virtualized docker-based tools

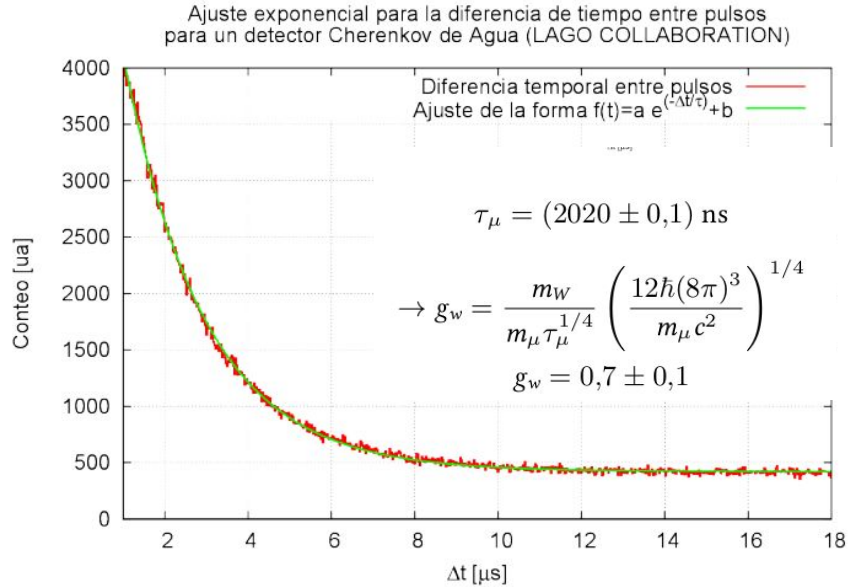
**Measured:** 2 TB/year-detector. 4 quality levels: L1: raw data, L2: preliminary, L3: Data Quality, L4: High Quality

**Simulated:** Up to 1 PB (estimated), EOSC-Synergy thematic service lead by CIEMAT: S0: raw data, S1: simulated and modulated particles at ground, S2: simulated signals at detector level.

**Data is transferred to the central repository and is mirrored to several sites (+ each site has its own local data)**







**Experimental, astro-ph & hep-ph courses** Muon decay: electroweak theory, python, data analysis, simulations, detector physics, statistics, ...

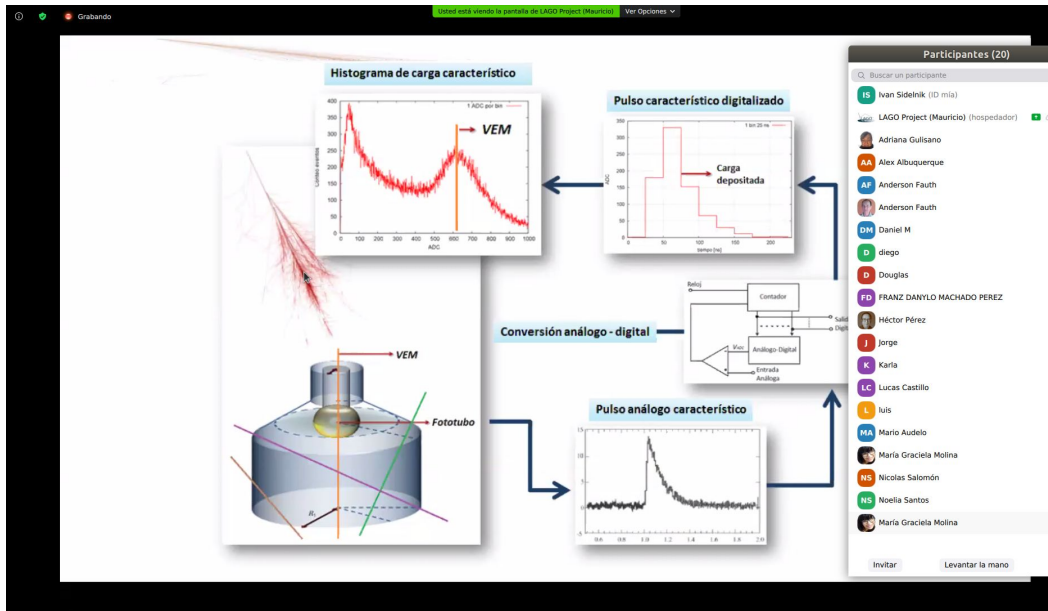
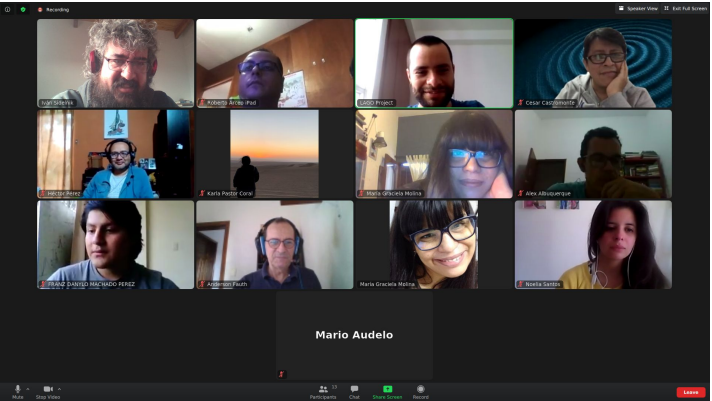
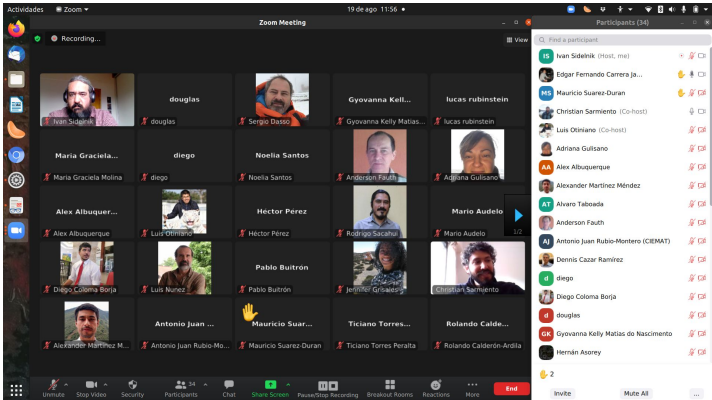
H. Asorey et al, [Rev. Bras. Ensino Fís. 40 \(4\)](#)



Last in person meeting previous to the pandemic -  
Dec. 2019 - @ CAC – CNEA  
Bs As, Argentina



# LAGO Universities – Virtual data analysis workshops



2020-2021-2022  
Virtual workshops and working groups  
meetings

# LAGO Universities

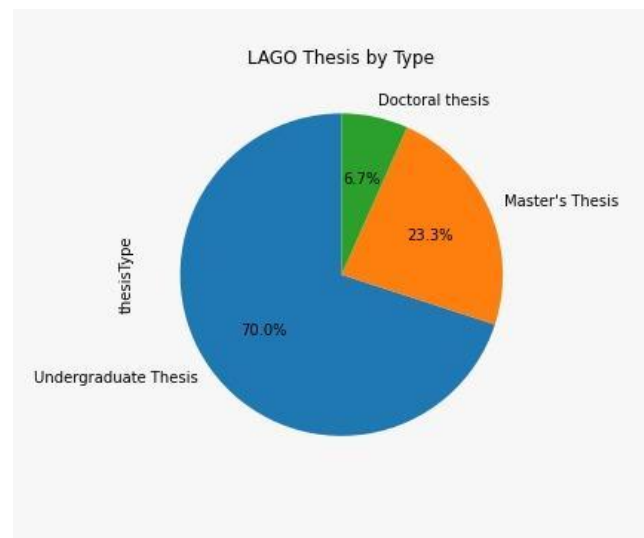
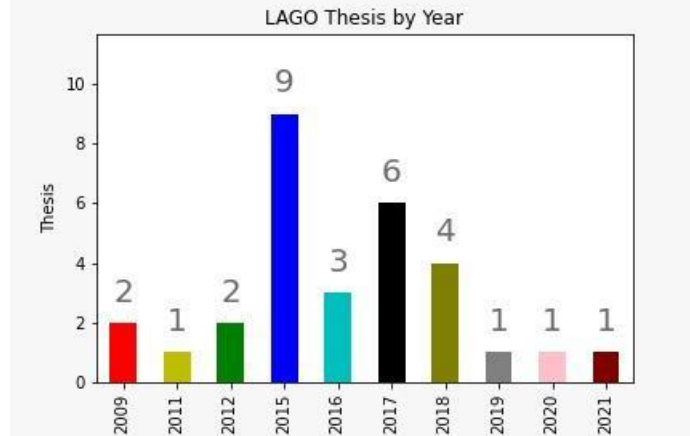


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Home About Publications Activities News Contact

## LAGO Thesis

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



**30 thesis / 44 publications / 15 astroparticle schools in LA**  
**efficiency: (scientific production / investment) tends to infinity**

I. Sidelnik for LAGO, LAS4RI forum, 2020

# LAGO Universities

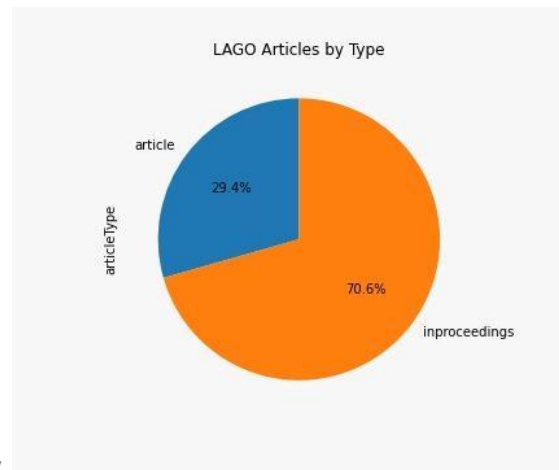
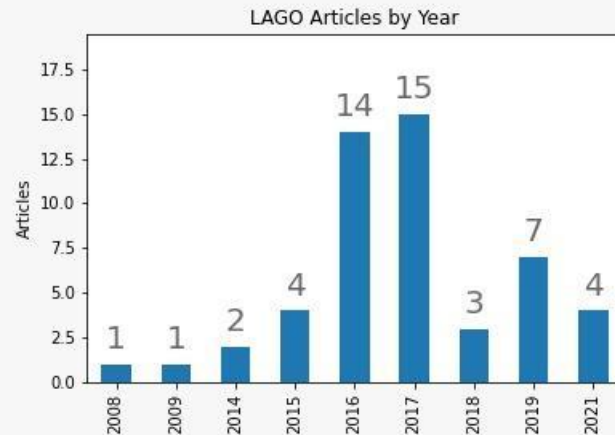


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# LAGO - La Conga Physics

## Erasmus+ project

Aiming to support the modernization of university infrastructure and its pedagogical offer in advanced physics in four Latin-American countries: Colombia, Ecuador, Perú and Venezuela.

A-CoNGA physics has created a set of graduate courses in Advanced Physics (high energy physics and complex systems) that are common to all institutions, supported by the installation of interconnected remote laboratories and on an open e-learning platform.

Incorporated into the master's programs of all participants.

**LAGO** model of Virtual Learning is the base of La Conga Physics and LAGO detector is the most used for laboratories.



# Conclusion

- **LAGO major activities are focused in Latin America**
- Long base **WCD** array **from Mexico to Antarctica**
- Complete simulation chain from the primary cosmic rays flux to signal at the WCD
- Multispectral analysis
  
- **Local and regional integration of universities and institutes**
- Student training in high energy physics @LA: schools and experiment @ different sites
- **Very active LA community with several project funded and ongoing @ different institutions**

**LAGO** constitutes a **Latin American** network of students and researchers in astroparticle and high energy physics

# ¡Thank you, Gracias, Obrigado!

