# LAGO

## El Observatorio Latinoamericano Gigante

## Current State and Future Perspectives

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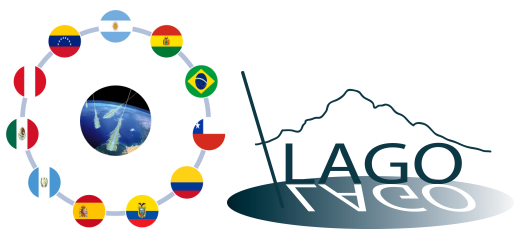
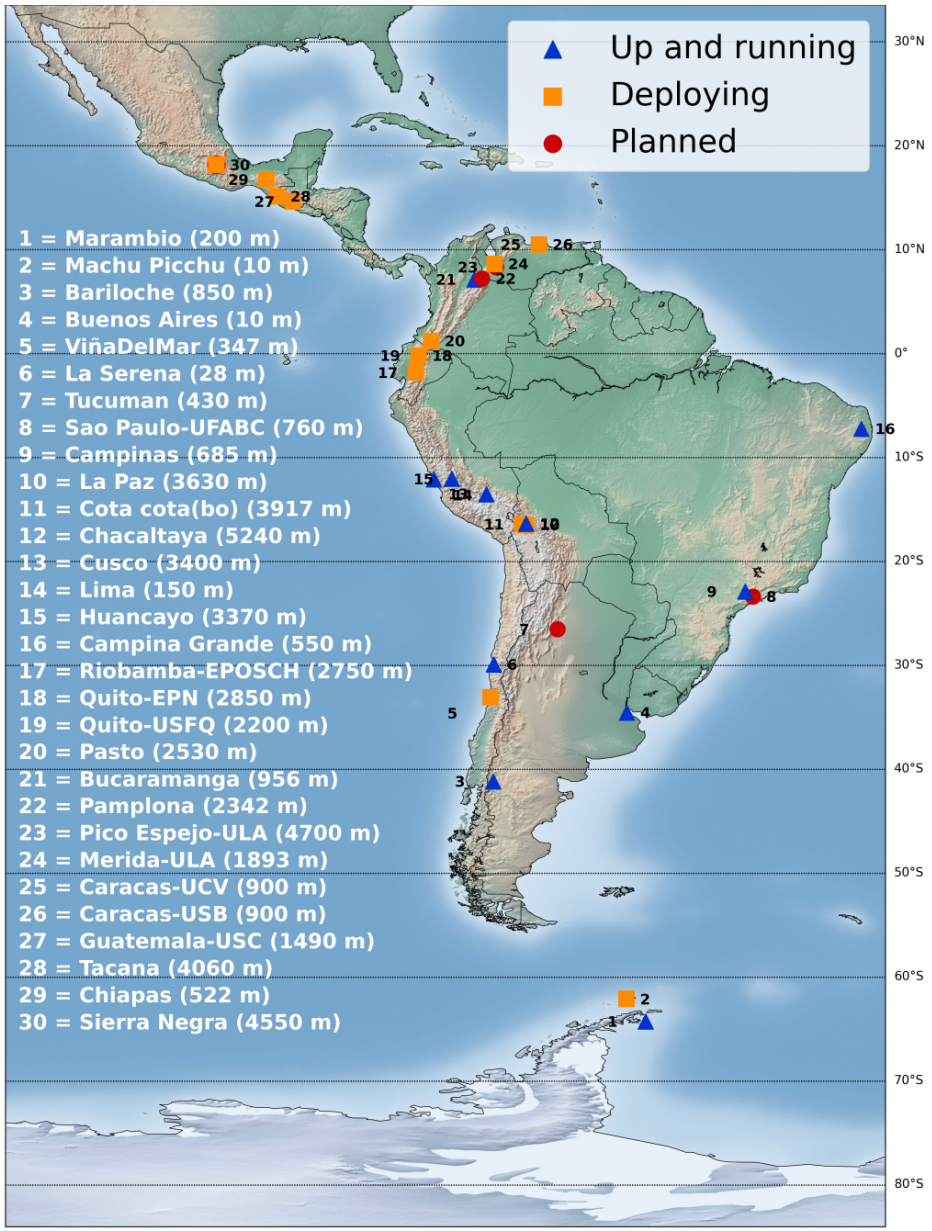
LAGO @ Latin America, July 2020

II Latin American Strategy Forum for Research Infrastructure: an Open Symposium for HECAP
July 6-10, 2020 (by videoconference)
ICTP-SAIFR, São Paulo, Brazil



# The Latin American Giant Observatory (LAGO) Project

A very long baseline "array" of water Cherenkov detectors (WCD)




## The LAGO Collaboration

- 99 members from 30 institutions in 11 countries: **Argentina, Bolivia, Brasil, Chile, Colombia, Ecuador, Guatemala, México, Perú, Venezuela & España**.
- **Scientific goals**:
  - Astroparticle physics to study the Extreme Universe (EU)
  - Transient and long term Space Weather phenomena trough Solar modulation of Cosmic Rays (CR)
  - Measurements of background radiation at ground level
- **Academic goals**:
  - Train Latin American students in HE and Astroparticle physics
  - Build a LA network of Astroparticle researchers

# The Latin American Giant Observatory (LAGO) Project

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## How does it work?

- Non-centralized, collaborative network of institutions and scientists
- 3 working groups (physics, detectors, data)
- 11+1 members coordination committee, 1 P.I.
- Developments, expertize and data are shared across the network
- Primary objectives conducted by specific LAGO programs
  - Build a LA network of Astroparticle researchers

# LAGO Objectives ↔ LAGO Programs @ 3 WG

WG: Physics - Detectors - Data

## LAGO-High Energy:

- Small arrays of WCD
- High energy components of GRB
- Low energy astroparticles

## LAGO-Universities:

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

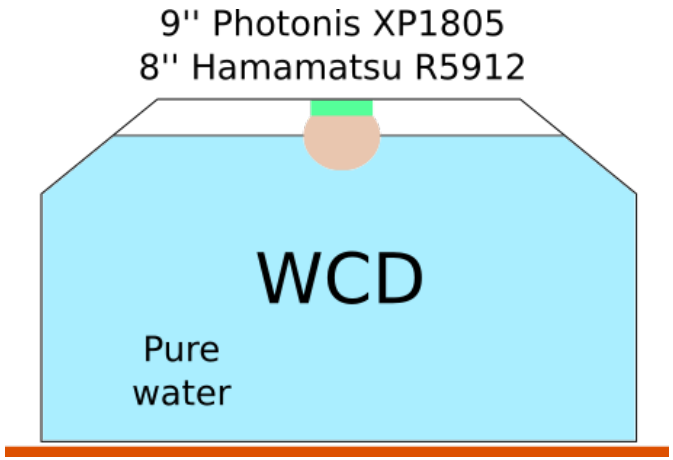
## LAGO-Space Weather:

- Space Weather phenomena from ground level
- Possible connections: atmospheric physics
- Background radiation at ground (and flight) level

## LAGO-Virtual:

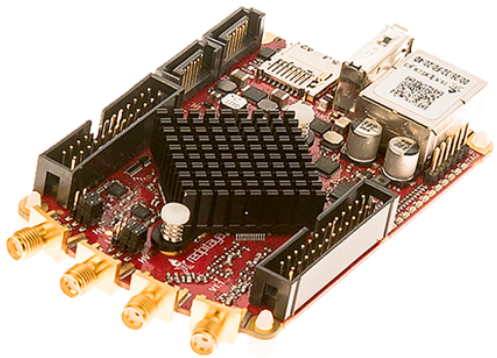
- Acquire, produce, collect and preserve LAGO data
- Integration with EOSC services
- Toolkit development → ARTI (integration of MAGCOS, CORSIKA and Geant 4)

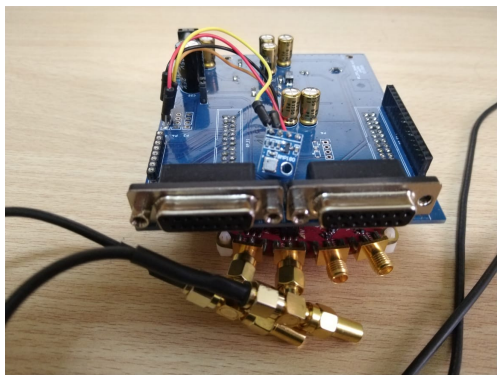
# Our detector: sWCD (Water Cherenkov Detector)
## *s* as in *smart*




- Autonomous, reliable, simple and cheap detector
- Commercial tanks with $1{,}5\,\mathrm{m}^2 - 10\,\mathrm{m}^2$ 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)
- Upgrade of the electronics $\rightarrow$ STEMLab® (redpitaya) system

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





# Latest 'news' on LAGO

## Some recent publications

9th Ring Imaging Cherenkov Detectors Workshop
September 5-9, 2016

CONICET

**LAGO: the Latin American Giant Observatory**

I. Sidelnik[1,2], H. Asorey[2,3,4] for the LAGO Collaboration[5]

[1]Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), [2]Instituto Balseiro, UNCuyo, [3]Comisión Nacional de Energía Atómica (CNEA), Centro Atómico Bariloche,[4]Escuela de Tecnología y Medio Ambiente, UNRN.

PROCEEDINGS OF SCIENCE

**Performance of the LAGO Water Cherenkov dete in Chiapas, Mexico**

O.G. Morales Olivares[a], Hugo de León Hidalgo[a], Karen Salomé Caballe Roberto Arceo Reyes[a], Eduardo Moreno Barbosa[b], Arnulfo Zepeda Don César Álvarez Ochoa[a], Filiberto Hueyotl Zahuantitla[a], Luis Rodolfo Pére Sánchez[a], Elí Santos[d] for the LAGO Collaboration[e].

**Water Cherenkov detector optimization for space weather studies in the Antarctic**

L. Otiniano[1,*], J. Peña[2], J. Vega[1], V.B. Valera[1] and C. Castromonte[1] for the LAGO Collaboration[3],

PROCEEDINGS OF SCIENCE

**Modeling the LAGO's detectors response to secondary particles at ground level from the Antarctic to Mexico**

R. Calderón-Ardila[2,3], A. Jaimes-Motta[1,*], C. Sarmiento-Cano[2,3] M. Suárez-Durán[1,3,4], A. Vásquez-Ramírez[1], for the LAGO Collaboration[5]

**Preliminary results of the design and development of the data acquisition and processing system for the LAGO Collaboration**

L. H. Arnaldi[*1], D. Cazar[2], M. Audelo[3] and I. Sidelnik[4] for the LAGO Collaboration[5†]

How atmospheric conditions affect the observations from the cosmic ray detector at Marambio Base, Antarctic.

N.A. Santos[1], S. Dasso[1,2,3], A.M. Gulisano[3,4], O. Areso[2], M. Pereira[2], for the LAGO collaboration[5].

To be sended for publication
In 1 week

PERFORMANCE OF WATER CHERENKOV DETECTORS TO COSMIC RAYS FLUX

C. SARMIENTO-CANO[B,C,F], M. SUÁREZ-DURÁN[D], R. CALDERÓN-ARDILA[B,C,F], A. VÁSQUEZ-RAMÍREZ[A], A. JAIMES-MOTTA[A], I. SIDELNIK[E,F], L. A. NÚÑEZ[A], H. ASOREY[C,E,F,H], FOR THE LAGO COLLABORATION[G]

## XI LAGO Workshop and VII School: 'The physics of LAGO'


# Projection of major activities separated in two groups

**Uniformization Goals**

- End 2019: New electronic design and characterization (partially/done)
- Mid. 2020: New electronic deployment at all the sites (postponed-covid19)
- 2020/21: Central LAGO Data Repository and data analysis chain (ongoing)
- 2021: Selection and deployment of new detectors in the region
- 2019/21: Replacement and deployment of permanent detectors in Antarctica (done)

WCD of each site (diff. geometries) and most of the PMTs were donated by the Auger Observatory (failing and replacement is expensive).

**Academic objectives → 2 schools per year at different LAGO sites**

- 2019: 2 schools (South America and North America) (1@Perú - 1@BsAs)
- 2020: 2 schools (South America and Central America) (postponed-covid19)
  Replace with Virtual School on LAGO Data Analysis.
- 2021: 2 schools (C-America and S-America)
- 2022: 2 schools (S-America)
- 2023: 2 schools (S-America and C-America)

One school synchronized with the annual Collaboration meeting.

**MoU with Auger Collaboration: data exchange (joint analysis) and technical support.**

**Need a stable and uniform operation of the current sites and the development of new sites. We foresee the need for a common funding support for all the Observatory, it is crucial in the development of the entire scientific program.**

**The core cost of all this development is estimated at the level of 1.5M US$ for the following 5 years.**

# Conclusions

- Ultra long baseline "array" of sWCD from Mexico to Antarctica
- High and low altitude sites across the Andean range: Background radiation, Space Weather and HE physics
- New sWCD with upgrade in the electronics and PMT replacement
- Full simulation chain: from primary flux to detector signals, on going multispectral data analyses (several papers this year)
- New sites along all LA (including Antarctica)

- Local to regional integration of Universities
- Student training in HE physics in LA with schools & experiments @ each site
- **Very active LA community: several projects funded in many LA countries**

**Need a stable and uniform operation of the current sites and the development of new sites. We foresee the need for a common funding support for all the Observatory, it is crucial in the development of the entire scientific program.**

## The LAGO Project: A Latin American network of astroparticle students and researchers