

# A Landscape of High Energy Physics in Latin America

Fernando Quevedo  
New York University Abu Dhabi  
Cambridge University

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Brasil

# Outline

- **Brief History**
- **Recent Developments**
- **LAA-HECAP**
- **Statistical Analysis**
- **Future Perspectives**

## **Brief History**

# Brief History

- From 1950's
- Key individuals (Wataghin, Sandoval Vallarta, Lattes, Moshinsky, Leite Lopes, Giambiagi)
- Key organisations (CLAF, ICTP, CBPF, CIF,...)
- Key initiatives (ELAF, CURCCAF, SILAF AE, HELEN, E-Planet, Lederman programme,...)
- Key experiments (Chacaltaya, Pierre Auger, Chile observatories, LAGO,...)

## **Recent Developments**

# Recent Developments

- **Creation of ICTP-SAIFR** (Nathan Berkovits, Rogerio Rosenfeld, Pedro Vieira,...)
- **LASF4RI** (Latin American Strategic Forum for Research Infrastructures) <https://lasf4ri.org>
- **LAA HECAP** (Latin American Association for High Energy, Cosmology and Astroparticle Physics)
- **LA-CoNGA-PHYSICS, EL-BONGÓ, LATAM, SIEMBRA-HoLAGrav, LAWPHYSICS, ...**

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**Latin American Strategy Forum for  
Research Infrastructures for High Energy,  
Cosmology, Astroparticle Physics  
LASF4RI for HECAP**

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**Latin American Strategy for HECAP**  
Proposal submitted to the High Level Strategy Group

**Strategy Document Committee**

Alfredo Aranda, Diana López Nacir, Marta Losada, Rogerio Rosenfeld,  
Arturo Sánchez, Federico Sánchez, Harold Yepes Ramirez

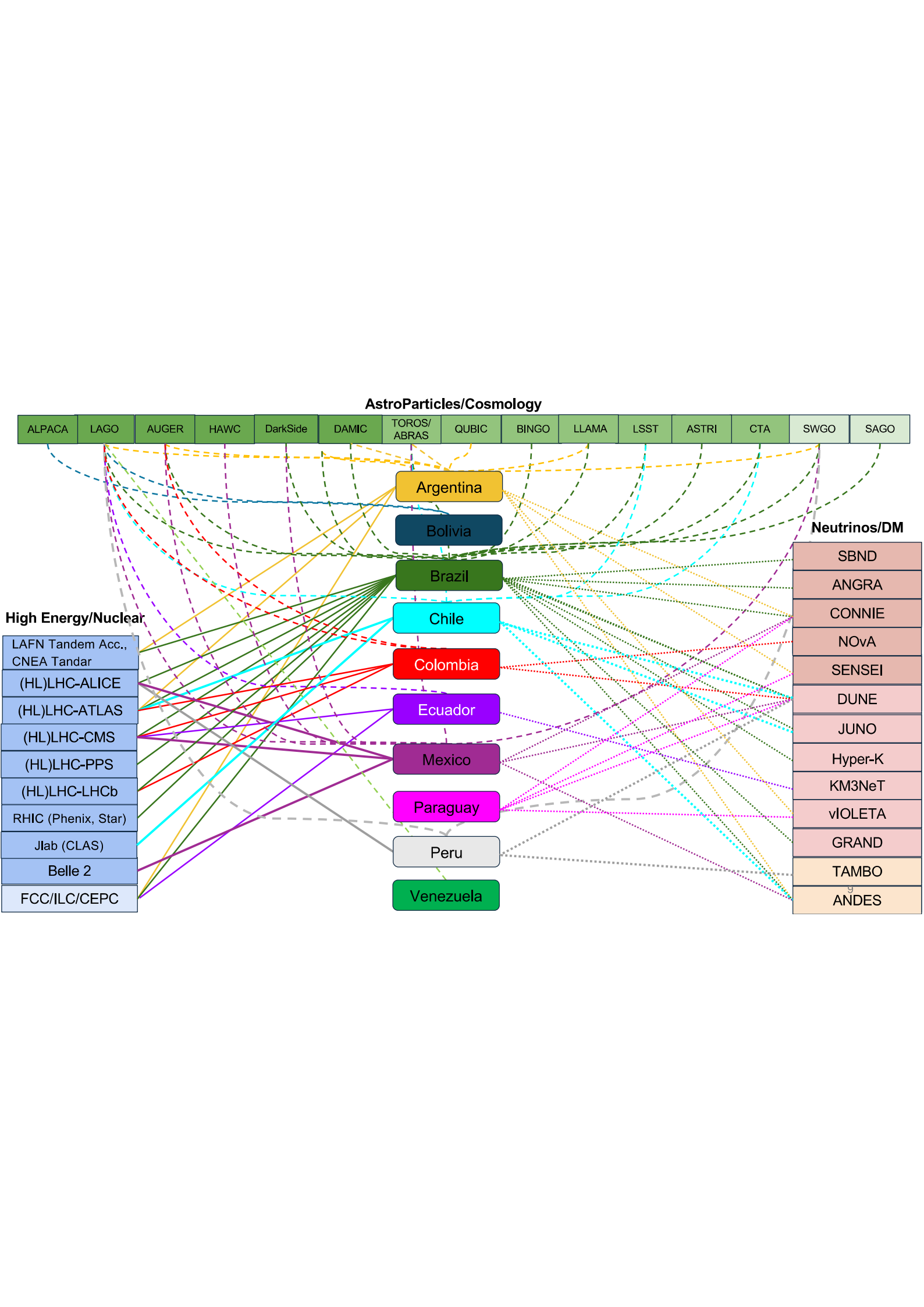
**Preparatory Group**

ARGENTINA: Diana López Nacir, Hernán Wahlberg, Federico Sánchez  
ASIA-JAPAN: Hiroaki Aihara  
BOLIVIA: Martin Subieta  
BRAZIL: Thiago Goncalves, Rogerio Rosenfeld  
CHILE: Mauro Cambiaso, Alfonso Zerwekh  
COLOMBIA: Marta Losada, Diego Restrepo  
ECUADOR: Edgar Carrera, Harold Yepes Ramirez  
EUROPE-CERN: Martijn Mulders  
MEXICO: Alfredo Aranda, Juan Carlos D'Olive, Gerardo Herrera  
PERU: Alberto Gago  
PARAGUAY: Jorge Molina  
USA: Marcela Carena, Marcelle Soares-Santos  
VENEZUELA: Reina Camacho Toro, Arturo Sánchez

Date: October 1, 2020

## PARTICLE PHYSICS & ASTROPHYSICS AROUND LATIN AMERICA





**LAA-HECAP**

# Latin American Association for HECAP (LAA-HECAP)

- **Founded in November 2021 – 626 members today**
- **Board: LASF4RI + SILAFAE**
- **Chair: Rogerio Rosenfeld (UNESP, ICTP-SAIFR)**

- **Executive Committee:**

Diana López Nacir, Edgar Carrera, Diego Restrepo and Alfredo Aranda

Board with representatives from: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Paraguay, Peru, Venezuela

# Statistical Analysis

M. Morales, FQ, M. Ramos-Hamud, D. Restrepo [arXiv:2503.05658](#)

# Sources

- **INSPIRE-HEP Database**

(1967 Stanford Physics Information Retrieval System (SPIRES),  
1<sup>st</sup> website database in America): <https://inspirehep.net>

- **Publications with less than 10 authors**

- **Other sources: United Nations** <http://data.un.org>

**World Bank:** <http://datos.bancomundial.org>

# 1. Latin America in the World

| Country            | Population  |
|--------------------|-------------|
| Argentina          | 45,606,000  |
| Bolivia            | 11,833,000  |
| Brazil             | 213,993,000 |
| Chile              | 19,212,000  |
| Colombia           | 51,266,000  |
| Costa Rica         | 5,139,000   |
| Cuba               | 11,318,000  |
| Dominican Republic | 10,954,000  |
| Ecuador            | 17,888,000  |
| El Salvador        | 6,518,000   |
| Guatemala          | 18,250,000  |
| Honduras           | 10,063,000  |
| Mexico             | 130,262,000 |
| Panama             | 4,382,000   |
| Paraguay           | 7,220,000   |
| Peru               | 33,359,000  |
| Uruguay            | 3,485,000   |
| Venezuela          | 28,705,000  |

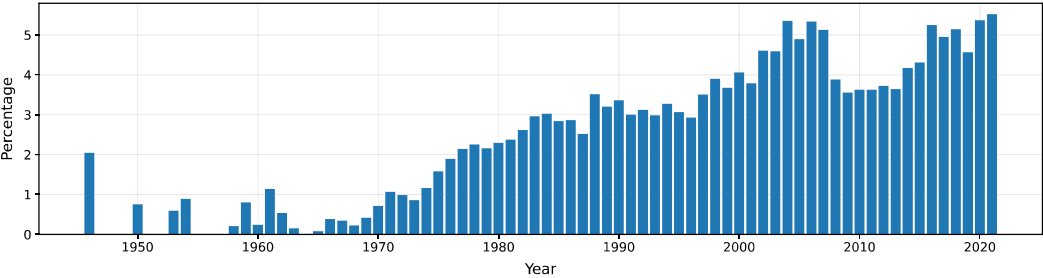
**Roughly < 8% of world's population**

| Country            | Percentage of GDP<br>(most recent) | Average<br>(1996-2021) |
|--------------------|------------------------------------|------------------------|
| Argentina          | 0.46                               | 0.49                   |
| Bolivia            | 0.16                               | 0.28                   |
| Brazil             | 1.21                               | 1.12                   |
| Chile              | 0.34                               | 0.35                   |
| Colombia           | 0.29                               | 0.22                   |
| Costa Rica         | 0.37                               | 0.4                    |
| Cuba               | 0.52                               | 0.47                   |
| Dominican Republic | (No info available)                | (No info available)    |
| Ecuador            | 0.44 (2014)                        | 0.2                    |
| El Salvador        | 0.17                               | 0.11                   |
| Guatemala          | 0.03                               | 0.04                   |
| Honduras           | 0.04 (2004)                        | 0.04                   |
| Mexico             | 0.3                                | 0.36                   |
| Panama             | 0.15                               | 0.2                    |
| Paraguay           | 0.14                               | 0.09                   |
| Peru               | 0.17                               | 0.11                   |
| Uruguay            | 0.48                               | 0.34                   |
| Venezuela          | 0.34                               | 0.29                   |

| Entity                 | Percentage of GDP |
|------------------------|-------------------|
| China                  | 2.24              |
| European Union average | 2.22              |
| OECD average           | 2.67              |
| UN average             | 2.33              |
| United States          | 3.17              |

# Percentage of Publications/Citations in HECAP

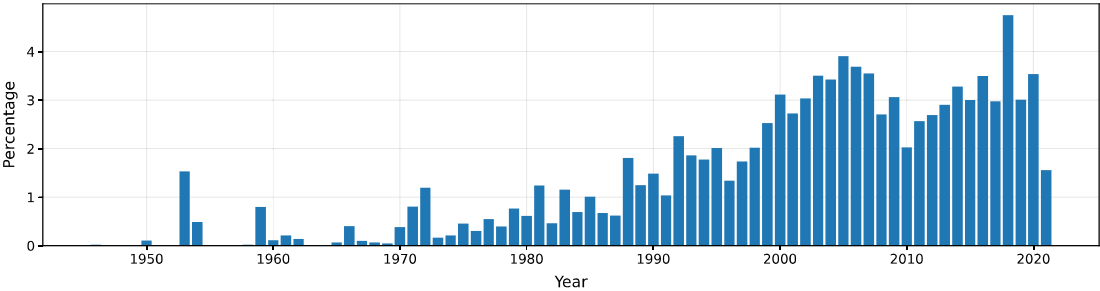
Latin American publications compared to global publications



**Publications**

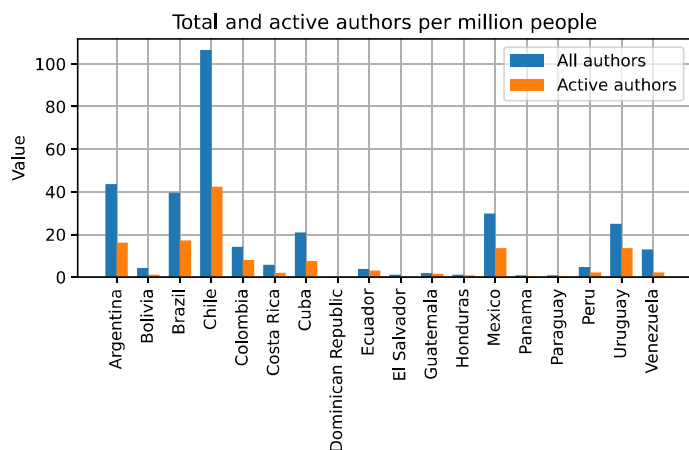
Latin American citations compared to global citations

**Citations**



## 2. Authors and Active Authors

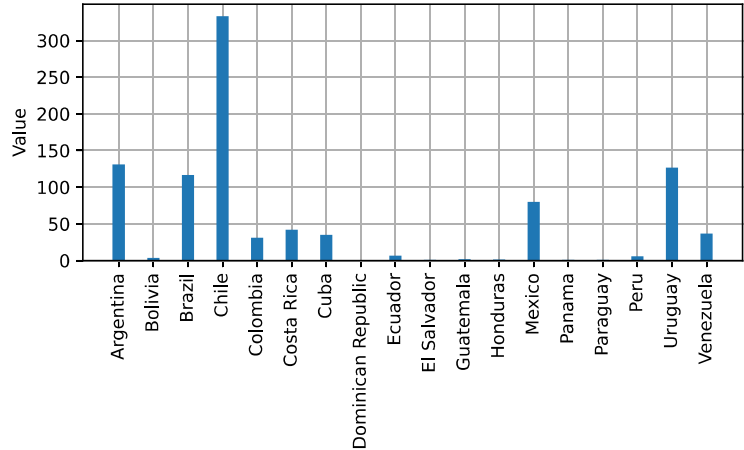
| Country            | Total authors | Active authors | Total authors PMI | Active authors PMI |
|--------------------|---------------|----------------|-------------------|--------------------|
| Argentina          | 1985          | 731            | 44                | 16                 |
| Bolivia            | 50            | 12             | 4                 | 1                  |
| Brazil             | 8456          | 3659           | 40                | 17                 |
| Chile              | 2044          | 812            | 106               | 42                 |
| Colombia           | 723           | 406            | 14                | 8                  |
| Costa Rica         | 29            | 12             | 6                 | 2                  |
| Cuba               | 236           | 85             | 21                | 8                  |
| Dominican Republic | 1             | 0              | 0.1               | 0                  |
| Ecuador            | 66            | 54             | 4                 | 3                  |
| El Salvador        | 6             | 1              | 1                 | 0.2                |
| Guatemala          | 32            | 28             | 2                 | 2                  |
| Honduras           | 11            | 7              | 1                 | 1                  |
| Mexico             | 3867          | 1749           | 30                | 13                 |
| Panama             | 3             | 2              | 1                 | 0.5                |
| Paraguay           | 5             | 3              | 1                 | 0.4                |
| Peru               | 156           | 68             | 5                 | 2                  |
| Uruguay            | 87            | 47             | 25                | 13                 |
| Venezuela          | 370           | 58             | 13                | 2                  |



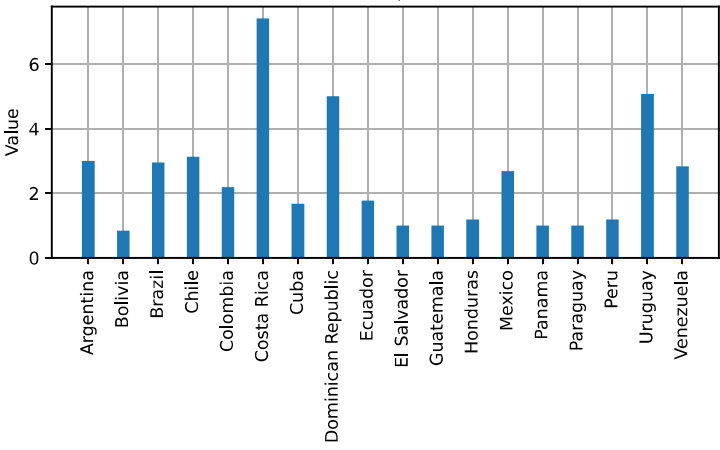
Active: published in past 5 years

### 3. Publications

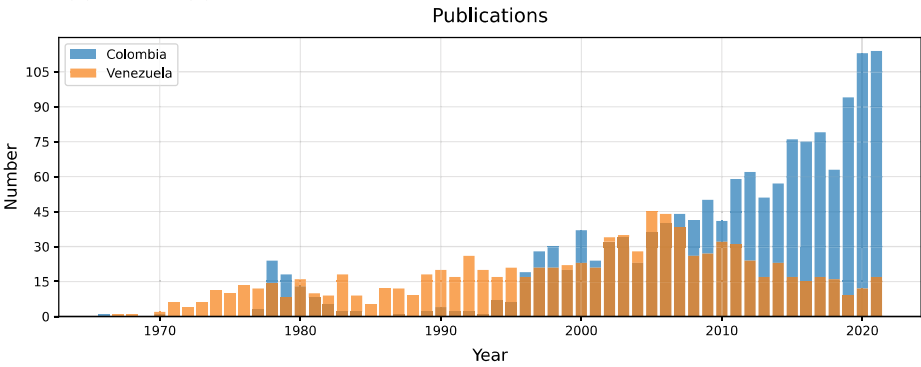
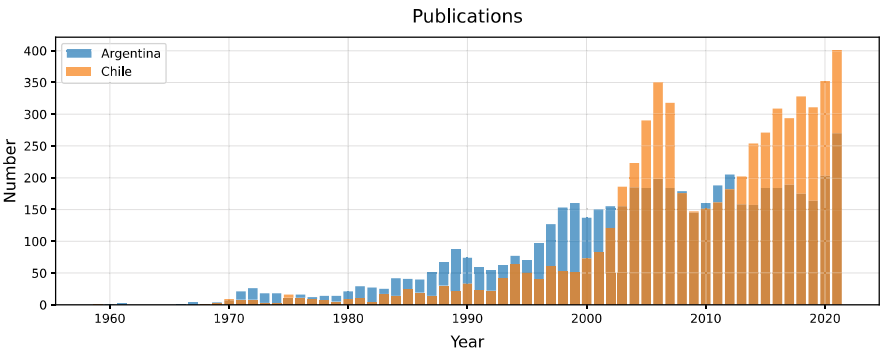
Publications per million people



Publications per author

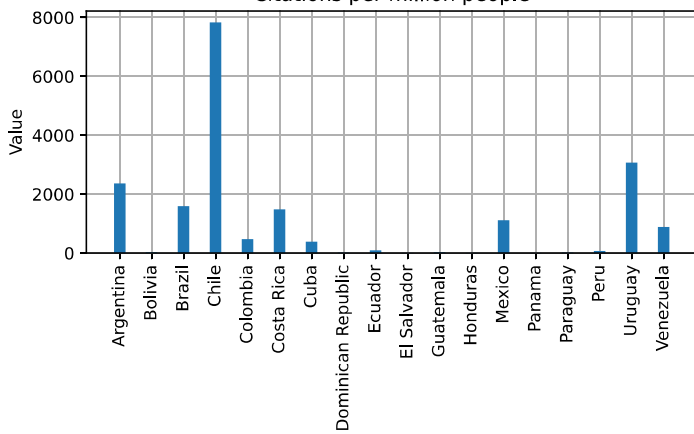


# Comparing similar countries

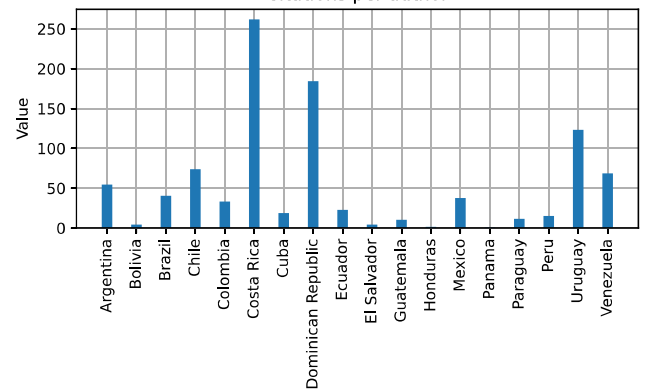


## 4. Citations

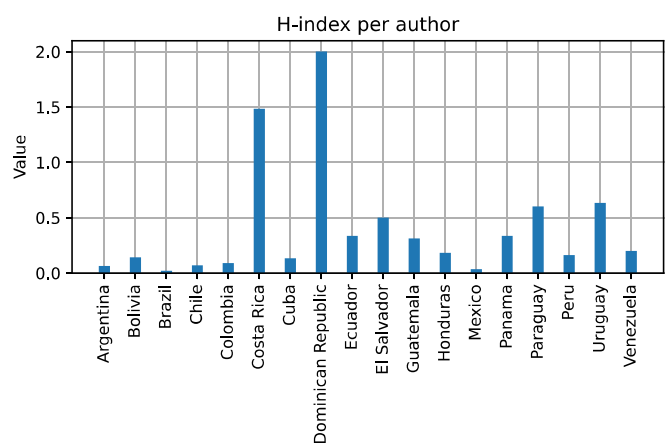
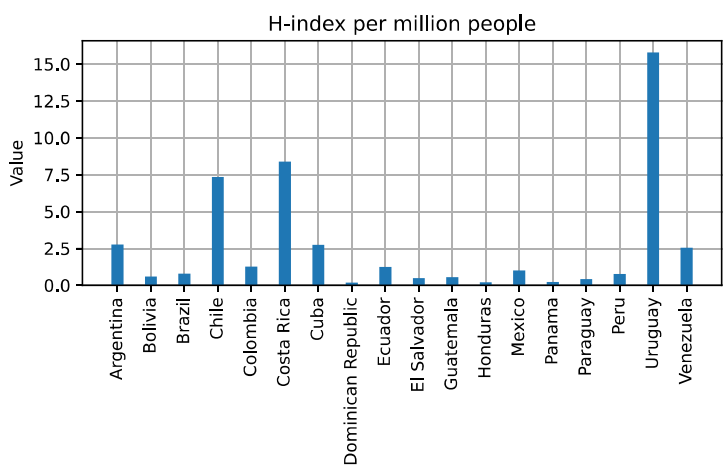
Citations per million people



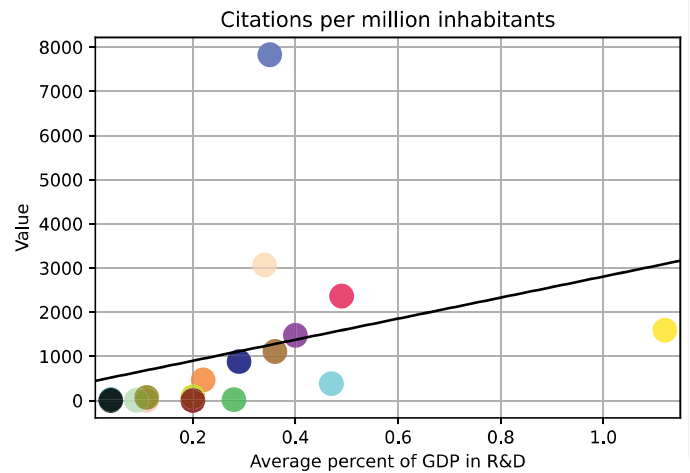
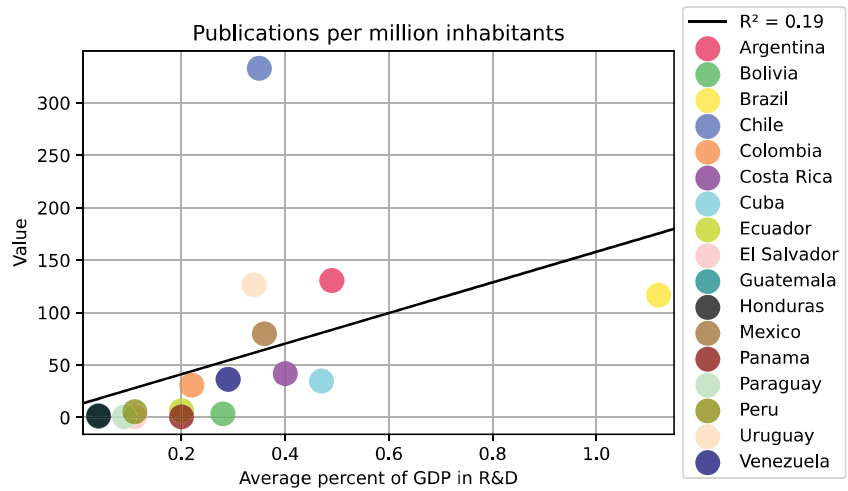
Citations per author



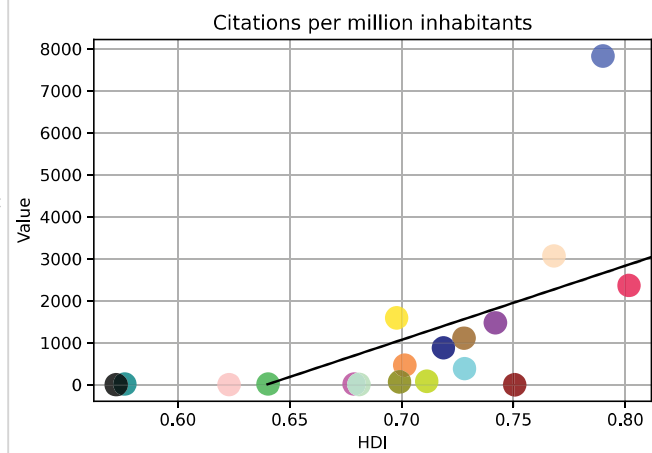
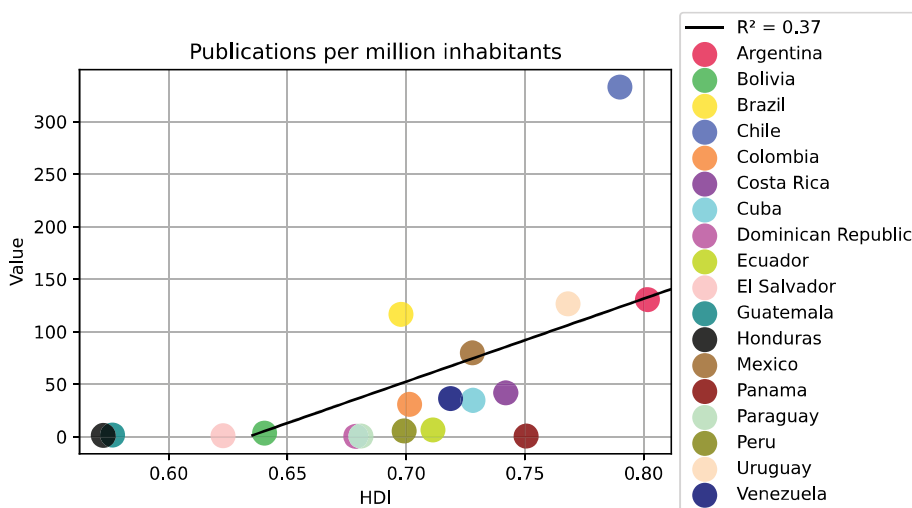
## 5. H-Index



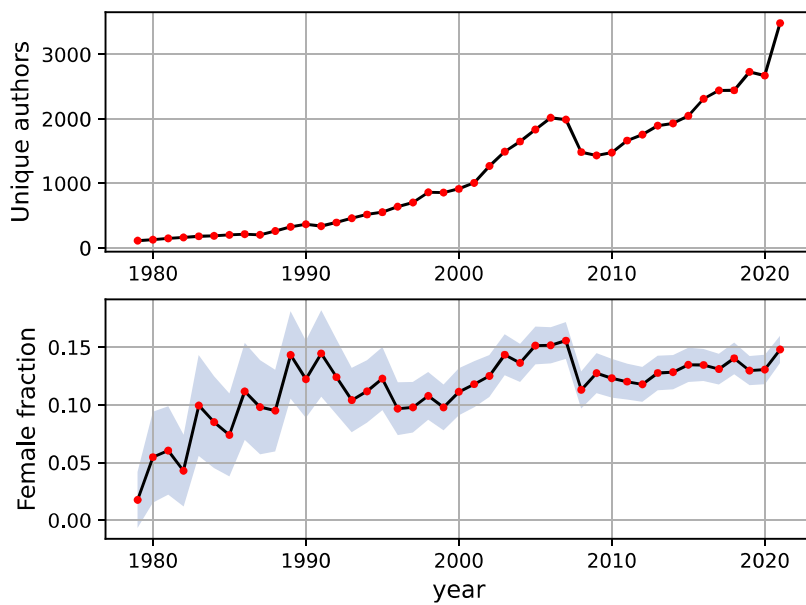
# 6. Correlations with GDP in R&D



## 7. Correlations with HDI



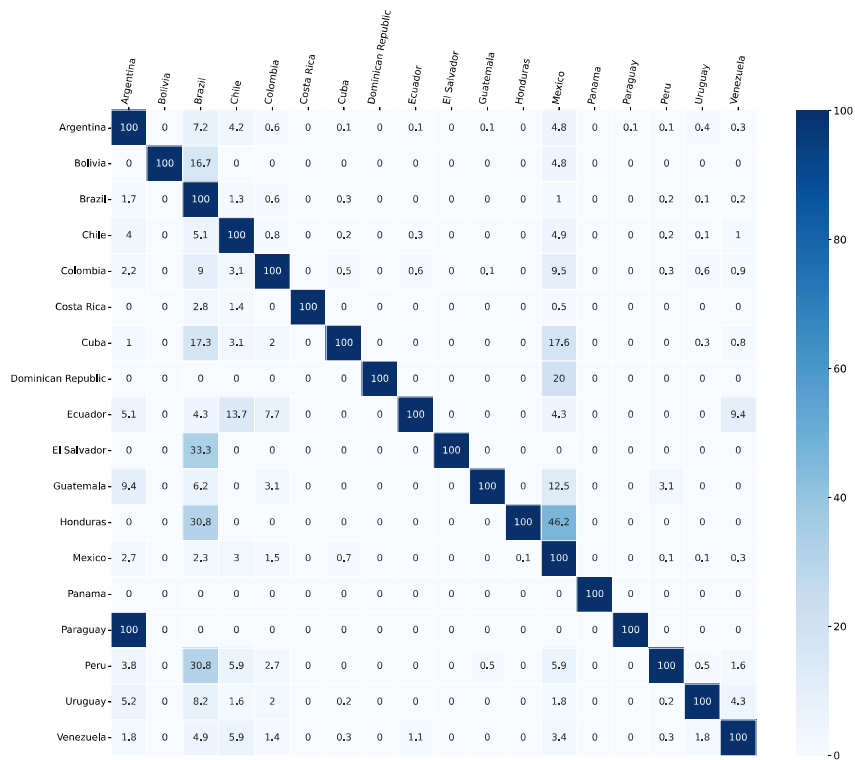
## 8. Gender Analysis\*



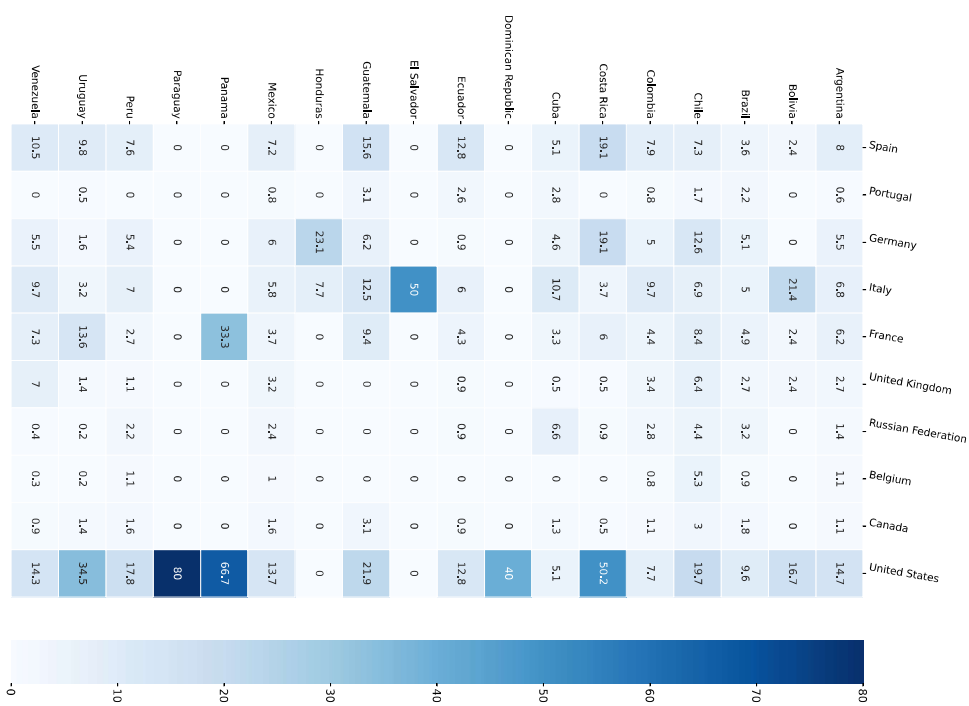
| Rank                       | All  | Female Fraction |
|----------------------------|------|-----------------|
| All ranks                  | 3832 | $12 \pm 1$      |
| Undergraduate, Master, PhD | 1268 | $14.4 \pm 1.9$  |
| Postdoc                    | 1498 | $13.5 \pm 1.7$  |
| Junior or Staff            | 816  | $12.5 \pm 2.3$  |
| Senior                     | 1592 | $7.9 \pm 1.3$   |

Method to identify gender  
more than 90% reliable

## 9. Collaborations within LA

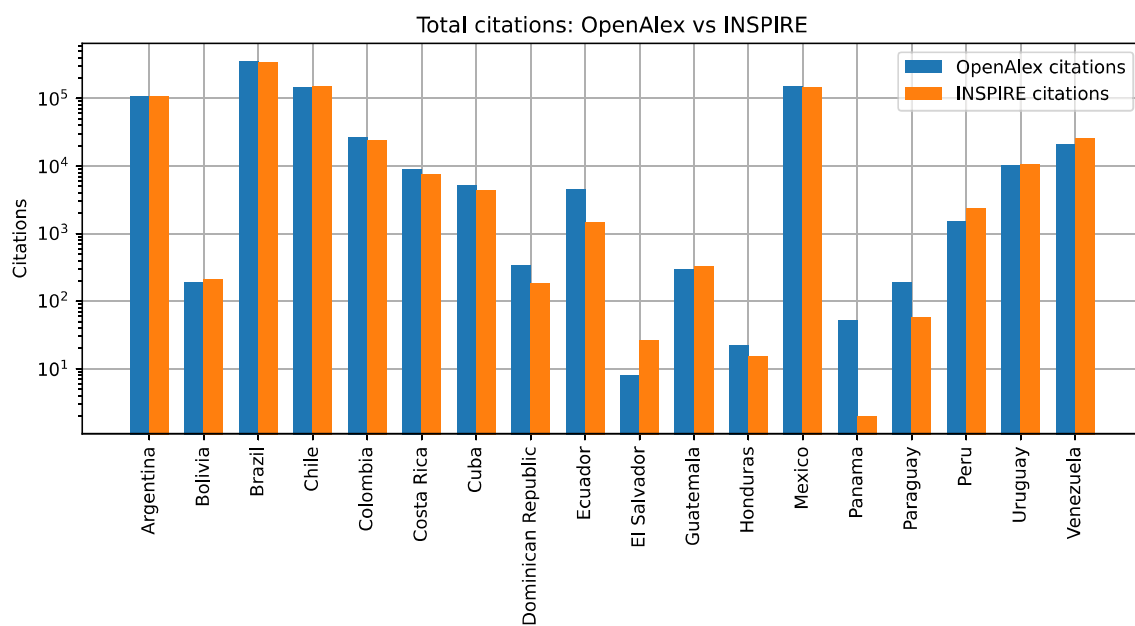


# 10. Collaborations outside LA



# 11. Comparison with OpenAlex

OpenAlex: Database of publications in all sciences, 250 million works



# Conclusions

- Scientific productivity has increased in LA over 70 years. But pace is slowing and in some cases decreasing.
- Correlation among productivity and HDI stronger than GDP in R&D.
- A critical mass in all region by number of active HECAP researchers (positive generosity of bigger countries).
- Gender gap is a steady problem. Worsening for higher ranks.
- International collaborations are key and need to be strengthen.

## **Future Perspectives**

# Future Perspectives

- **Regional sources of funding ?**

(so far LAA-HECAP funded by ICTP (10K Euro), CLAF (\$10K), LACONGA was funded by EC (close to 1M Euro),....but need sustainable sources.

- **Stronger CERN connection ?**

(Brazil CERN member, Chile on its way, many countries in CERN experiments, join FCC as a LA block?, ...)

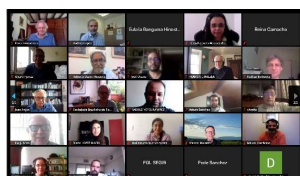
- **Regional LA laboratory ?**

(ANDES (rip?),...)

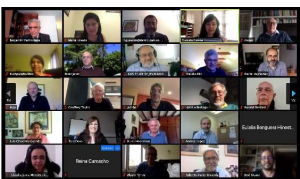
- **Joint PhD programmes ?**

**Thank You!**

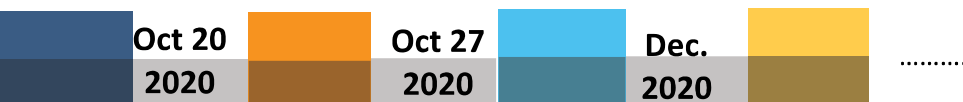
# Timeline



Recognition of advances  
LASF4RI-HECAP  
process



**IB S+T  
Ministerial  
Meeting**



**Creation of LAA-HECAP  
November 2021**

**High-Level  
Strategy Group**

Endorsement of Strategy  
Document to the High-  
Level Strategy Group for  
HECAP

**Preparatory  
Group Meeting**

Next steps for the  
Preparatory Group and  
national processes for next  
cycle

# Timeline

Brainstorming with the HEP community at ICTP-SAIFR 5th ann. and **XI SILAFAE** in Guatemala

## Initial ideas



Iberoamerican Science and Technology Ministerial meeting in Guatemala:  
mandate declaration

## Mandate



National Meetings and formation of the Preparatory Group with delegates from 10 LA countries.

## Preparatory Group



## Initial landscape

Two-page briefs of 18 experiments. Gathering support from national communities.

## Town Hall

Town hall meeting at the **XII SILAFAE** in Peru to discuss mandate and next steps

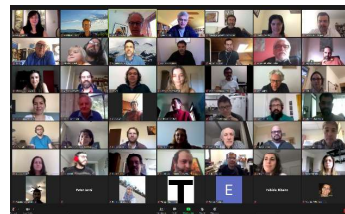


1<sup>st</sup> LASF4RI Workshop and Meeting of the Preparatory Group at ICTP-SAIFR

## LASF4RI Workshop & 1<sup>st</sup> Meeting of Preparatory Group

Deadline for the submission of White Papers to LASF4RI

## White papers



Write-up of the Physics Briefing Book and the Strategy Document.

## Documents write-up



## High-Level Strategy Group

Definition of the composition of the High-Level Strategy Group for HECAP

## HLSG Meeting

Kick-off meeting of the High-Level Strategy Group

## Open Virtual Symposium

Open Virtual Symposium of LASF4RI for HECAP organized by ICTP-SAIFR, delayed from March due to the pandemic

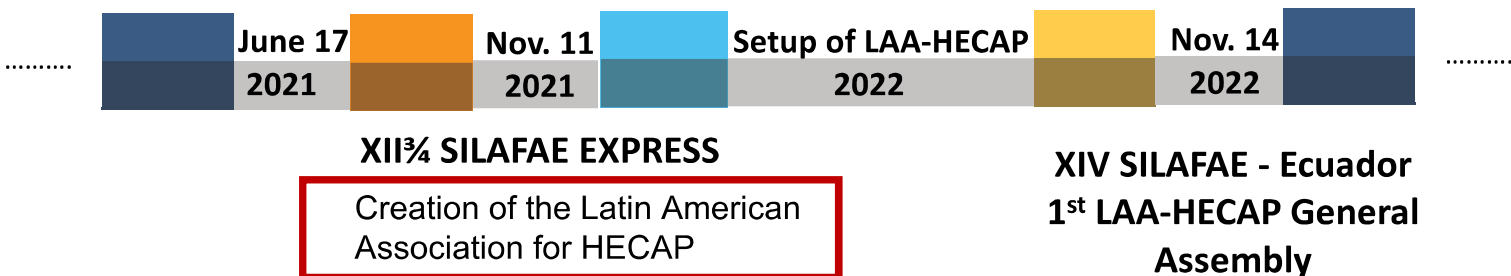
# Timeline

## 1<sup>st</sup> Meeting of the new Preparatory Group

Mandate 2021-2023

You can find the by-laws at:

[www.ictp-saifr.org/wp-content/uploads/2021/10/Latin-American-Association-for-High-Energy-Cosmology-and-Astroparticle-Physics.pdf](http://www.ictp-saifr.org/wp-content/uploads/2021/10/Latin-American-Association-for-High-Energy-Cosmology-and-Astroparticle-Physics.pdf)



# High Level Strategy Group Members

Luciano Maiani – Chair  
Fernando Quevedo - Co-Chair

## Country/Regional Scientific Representatives

**Argentina:** Maria Teresa Dova  
**Brazil:** Joao dos Anjos  
**Chile:** Claudio Dib  
**Ecuador:** Bruce Hoeneisen  
**Mexico:** Jacobo Konigsberg  
**Venezuela:** Jose Ocariz  
**Europe/CERN:** Peter Jenni  
**Asia:** Hesheng Chen  
**US:** Francis Halzen/Gabriela Gonzalez  
**ICFA/Fermilab:** Pushpa Bhat  
**Asia Pacific:** Geoffrey Taylor

## Institute Directors

Nathan Berkovits, ICTP-SAIFR  
Daniel de Florian, ICAS  
Alvaro Ferraz, IIP  
Jose Roque, LNLS  
Ignacio Bediaga, CLAF  
Luis Felipe Rodriguez, MAIS/MCTP

## Endorsement by the High-Level Strategy Group

The **LASF4RI-HECAP Strategy Document** addresses several aspects that need to be simultaneously developed to sustain a thriving research environment which includes fostering R&D for key technologies, enhancing the computing and network infrastructures, advanced training of the younger generations, and broad dissemination of knowledge with increased initiatives for citizen science. The importance of reinforcing connections between theorists and experimentalists to advance the research questions posed and the exploration of answers through experimentation is clearly stated and is considered of great value by the HLSG.

The recommendation for stable and continuous mechanisms for funding and coordination at the level of funding agencies and research councils for HECAP is of paramount importance and this HLSG endorses it enthusiastically.

Finally, the HLSG strongly recommends that the HECAP community put in place a robust structure and mechanisms that would allow the community to come together, on a periodic basis, ideally about every five years, to examine progress and consolidate community input to develop and/or update the strategic plan for the region. The European Particle Physics Strategy Update and the United States “Snowmass” processes are examples of successful national/regional models. Such sustained and recurring community engagement in the strategy development process will ensure regional coordination in the participation, as well as in developing leading roles, in regional and global scientific research infrastructures. This would also facilitate funding agencies in their decision-making process to adequately support the HECAP efforts in Latin America.

**Given the above considerations the High Level Strategy Group expresses its endorsement of the 2020 LASF4RI-HECAP Strategy Document.**

## 2020 Iberoamerican Science +Technology Ministerial Meeting

- [https://www.segib.org/wp-content/uploads/Declaracion-IV-RMCTI\\_ES.pdf](https://www.segib.org/wp-content/uploads/Declaracion-IV-RMCTI_ES.pdf)

Recognition of LASF4RI-HECAP process:

Los avances en el establecimiento del Foro Estratégico Iberoamericano para las Grandes Infraestructuras, a partir del desarrollo de un programa piloto en el área de física de altas energías, astropartículas y cosmología, cuyos resultados se han plasmado en el documento estratégico para el desarrollo de estas disciplinas, que incluye la definición de recomendaciones y el establecimiento de una hoja de ruta.

## LAA-HECAP !

### LATIN AMERICAN ASSOCIATION FOR HIGH ENERGY, COSMOLOGY AND ASTROPARTICLE PHYSICS (LAA-HECAP)

LAA-HECAP is hereby established as an association of the Latin American research community in the fields of High Energy, Cosmology and Astroparticle Physics (HECAP). It aims to leverage and amplify the successful and growing dynamics of research in HECAP in Latin America, as demonstrated by the fruitful and long-term organization of the Latin American Symposium on High Energy Physics (Simposio Latino Americano de Física de Altas Energías - SILAFAE) series and the recent initiative to form a Latin American Strategy Forum for Research Infrastructures for HECAP (LASF4RI-HECAP - lasf4ri.org) with the participation of several countries in the region.

- ▶ Strengthen existing ties within the Latin American HECAP community and foster new and existing collaborations
- ▶ Engage the wider scientific community and the general public through the promotion of HECAP.
- ▶ Represent the Latin American HECAP communities in other scientific international bodies
- ▶ Announce activities in HECAP in the region through means such as periodic newsletters and a website
- ▶ Promote other activities such as the organization of symposia, workshops, schools, university-institution cooperation and exchange programs for students, and the production of educational and outreach material
- ▶ Engage with Ministries, funding agencies and other national authorities related to Science and Technology to promote the rollout and development of the current LASF4RI-HECAP process.
- ▶ Organize SILAFAE (Latin American Symposium on High Energy Physics) every two years.
- ▶ Coordinate periodic assessment and strategic planning within the LASF4RI-HECAP process.

**More than 600 members already!**

### **ADMISSIONS COMMITTEE:**

- Federico Muñoz <[federico.munoz@gmail.com](mailto:federico.munoz@gmail.com)> (Costa Rica)  
•Hermann Albrecht <[albrecht@usb.ve](mailto:albrecht@usb.ve)> (Venezuela)

### **EDUCATION COMMITTEE:**

- Oscar Alberto Zapata Noreña <[osalberto.zapata@udea.edu.co](mailto:osalberto.zapata@udea.edu.co)> (Colombia)  
• Susana Landau <[slandau@df.uba.ar](mailto:slandau@df.uba.ar)> (Argentina)  
•Gabriel R. Bengochea <[gabriel.bengochea@gmail.com](mailto:gabriel.bengochea@gmail.com)> (Argentina)  
•Anamaría Font <[anafont@yahoo.com](mailto:anafont@yahoo.com)> (Venezuela)  
•Jose David Ruiz Álvarez <[josed.ruiz@udea.edu.co](mailto:josed.ruiz@udea.edu.co)> (Colombia)  
•Ana Luiza Serio (ICTP-SAIFR coordinator for high-school teachers) [analuserio@ictp-saifr.org](mailto:analuserio@ictp-saifr.org) (Brazil)  
•Martijn Mulders <[martijn.mulders@cern.ch](mailto:martijn.mulders@cern.ch)> (CERN)

### **JUSTICE, EQUITY, DIVERSITY AND INCLUSION (JEDI) COMMITTEE:**

- Maria Eugenia Cabrera Catalan <[maeu.cabrera@gmail.com](mailto:maeu.cabrera@gmail.com)> (Guatemala)  
•Carla Bonifazi <[carla.bonifazi@me.com](mailto:carla.bonifazi@me.com)> (Argentina)  
•Santiago Paredes <[santiagoparedes6@gmail.com](mailto:santiagoparedes6@gmail.com)> (Ecuador)

### **COMMUNICATION COMMITTEE:**

Arturo Sanchez <[arturos.cern@gmail.com](mailto:arturos.cern@gmail.com)> (Venezuela)  
•Hermann Albrecht <[albrecht@usb.ve](mailto:albrecht@usb.ve)> (Venezuela)

### **STATISTICS COMMITTEE:**

Diego Restrepo <[restrepo@udea.edu.co](mailto:restrepo@udea.edu.co)> (Colombia)  
•Gabriel Abellán de la UCV <[gabriel.abellan@gmail.com](mailto:gabriel.abellan@gmail.com)> (Venezuela)  
•Hernan Wahlberg <[wahlberg@fisica.unlp.edu.ar](mailto:wahlberg@fisica.unlp.edu.ar)> (Argentina)  
•Manuel Morales Alvarado <[mom28@cam.ac.uk](mailto:mom28@cam.ac.uk)> (Chile)

### **COMMUNITY ENGAGEMENT COMMITTEE:**

Martín Makler <[mmakler@unsam.edu.ar](mailto:mmakler@unsam.edu.ar)> (Argentina)  
•Arturo Sanchez <[arturos.cern@gmail.com](mailto:arturos.cern@gmail.com)> (Venezuela)  
•Ignacio De Bediaga Hickman <[ignacio.de.bediaga.e.hickman@cern.ch](mailto:ignacio.de.bediaga.e.hickman@cern.ch)> (Brazil)  
•Jose Feliciano Benitez <[Jose.Benitez@cern.ch](mailto:Jose.Benitez@cern.ch)> (Mexico)

**If not a member yet, you may be interested to join!**

# LASF4RI-HECAP Preparatory Group 2021-2023

Chair: Rogerio Rosenfeld; Co-chair: Diana López Nacir

## **Argentina**

Diana López Nacir  
Federico Sánchez  
Hernán Wahlberg

## **Bolivia**

Martín Subieta

## **Brazil**

Jailson Alcaniz  
Ignácio Bediaga  
Rogerio Rosenfeld

## **Chile**

Alfonso Zerwekh  
Mauro Cambiaso

## **Colombia**

Nicolás Bernal  
José David Ruiz Álvarez

## **Ecuador**

Francisco Yumiceva  
Dennis Cazar Ramírez,  
Harold Yepes

## **Central America**

Maria Eugenia Cabrera - Guatemala  
Melissa Cruz Torres - Honduras  
Federico Muñoz - Costa Rica

## **Mexico**

Alfredo Aranda  
Juan Carlos D'Olive  
Gerardo Herrera

## **Paraguay**

Jorge Molina

## **Peru**

Alberto Gago

## **Venezuela**

Reina Camacho Toro  
Arturo Sánchez Pineda  
José Antonio López

## **International**

Marcela Carena  
Martijn Mulders

Marta Losada (ex-officio)