Latin American Strategy for Large-Scale Research Infrastructures for Particle Physics and Cosmology (a proposal)

Marta Losada

A MULTI-NATIONAL SCIENTIFIC COMMUNITY BASED EFFORT

(Special thanks to M. Carena, F Quevedo)

V Congreso Latinoamericano de Física 2018

OUTLINE

- Science benefits
- Capacity building in LA
- Current Participation in Large-scale Research Infrastructures
- Reference strategies: P5, EPPS, ESFRI, GRI, EU-LAC
- LA Strategy

Benefits of large international science collaborations

It is widely recognized that large-scale long-term science collaborations deliver lasting benefits to participating nations.

These benefits include:

- Major advances of knowledge and real hubs of knowledge
- Building science capability and science leadership
- Technology advances and tech transfer to industry
- Stronger and broader opportunities for STEM education, creating new pathways to the forefront of global science and research
- Outreach to communities about benefits of science and impact outside physics.

Erika Cataño Mur from Bogota joined the NOvA experiment in 2013. Pictured in the Fermilab remote operations center

Some history

Experimental High Energy Physics in LA:
Pre-history: centered in Cosmic Ray Physics

Brazilian exemple:
1934 – **Gleb Wataghin** and **Bernhard Gross** arrive in Brazil from Europe.
1940 – **Penetrating showers** in cosmic radiation discovered by Wataghin, Damy, and Pompeia

1947 – **Meson Pi** discovery by Powell, Lattes and Occhialini.
(Pic du Midi + Chalcataya data)

1948 – **Artificial production of pions** by Lattes and Gardner at Berkeley Laboratory.

1949 – Foundation of CBPF by Lattes, Leite Lopes and Jayme Tiomno.
1962 – Start of the **Brazil-Japan Collaboration in Cosmic Rays** at Chalcataya, Bolivia, proposed by Yukawa (5,200 m).
1970's – Discovery of the exotic **Centauro events** by the Brazil-Japan collaboration.

See J. Dos Anjos talk SILAFAE 2014

Experimental High Energy Physics in LA:
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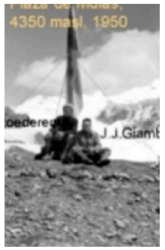

Argentina:
1945 – Study of the intensity of cosmic rays at sea level. Variation with latitude due to the earth magnetic field. Kodak plate NTA exposed during 23 days on "El Condor" - Pampa de Achala - Córdoba province (2108 m).
1949 – Creation of a group at Universidad de Buenos Aires headed by Estrella Mathov to study cosmic rays.
1950 – Measurements at Aconcagua Plaza de Mulas at 4325 m
1952 – Creation of Laboratorio de Placas Nucleares (CNEA)

Mexico:
First Steps with Manuel Sandoval Vallarta.
1932– Study of effects of geomagnetic field on cosmic rays. Collaboration with Geoge Lemaitre.
1934 – Creation at UNAM of a group to study Cosmic Rays lead by Sandoval Vallarta.
1954 – Instalation of Solar Neutron Telescope in Sierra Negra
1958 – New group organized by Ruth Gall at the Institute of Geophysics

Some history

J. Dos Anjos talk 2014

80's: New revival of HEP in Latin America: Particle Accelerators:

1982: "1st Panamerican Symposium on Particle Physics and Technology" held at Cocoyot in Mexico: Leon Lederman FERMILAB Director invites Latin American physicists to participate in experiments at Fermilab.

about 50 attendees from Europe, North America, and Latin America; these included Lederman, M. Moshinsky, C. Avilez, M. Moreno, A. Zepeda, J. Flores, J. Tiomno, S. Glashow, J. Bjorken, B. Richter and G. Charpak.

Clicerio Avilez decided to switch from theoretical to experimental particle physics and to form the UNAM HEP group.

Conference outcomes:

- four subsequent similar symposia over the next decade
- formal Fermilab program to aid Latin American physics (particularly particle physics);

80's: New revival of HEP in Latin America: Particle Accelerators:

1983: 2nd Pan American Symposium in Rio de Janeiro organized by Jaime Tiomno and Moyses Nussenzweig : new offer and support for 4 physicists.

1984: Brazilian group of 4 physicists join experiment E691 of Charm photoproduction at Fermilab.
Clicerio Avilez spent a year at Fermilab and joined experiment E766 of Hyperon production at Brookaven and later E690 of strange/ charm production.

1987: 3rd Pan American Symposium held in Rio, hosted by Leite Lopes, CBPF Director:

1989: 4th Pan American Symposium held in Bariloche, Argentina, organized by Mario Mariscotti.

1992: 5th Pan American Symposium held in Cartagena, Colombia, hosted by Eduardo Posada and led to the "Cartagena Manifesto".

Some history

J. Dos Anjos talk 2014

80's: New revival of HEP in Latin America: Particle Accelerators:

In 1984, through the collaboration of NSF and DOE, FERMILAB made available a grant of $300,000 dollars designed to be used to assist Physics in the five nations with major physics activity.

This was to be spent in journal subscriptions, payment of publication charges, spare parts and maintenance items for existing equipments and per diem support for urgent short trips by physicists to the US. Later another $150,000 was added to the grant.

This made possible to continue the research activities in spite of the severe foreign currency squeeze in Latin American countries at this time

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1987: Herwig Schopper, Director of CERN, and Carlo Rubia, following Lederman iniciative, invited Latin American physicists to join CERN experiments.
In Brazil groups from CBPF and UFRJ joined the DELPHI experiment at LEP.

INDIVIDUAL SCIENTISTS FROM LA COUNTRIES ALSO PART OF THESE EFFORTS

Big Science international collaborations spanning the Americas

- 1981-82: Director and Nobel Laureate Leon Lederman invites Latin American physicists to join Fermilab experiments, marking the start of international particle physics cooperation across the Americas.

- In the 1990s, this led to leadership roles in the discovery of the top quark at the Fermilab Tevatron collider

For example: DZero Collaboration includes Argentina, Brazil, Canada, Colombia, Ecuador, Mexico, U.S., Europe, Asia

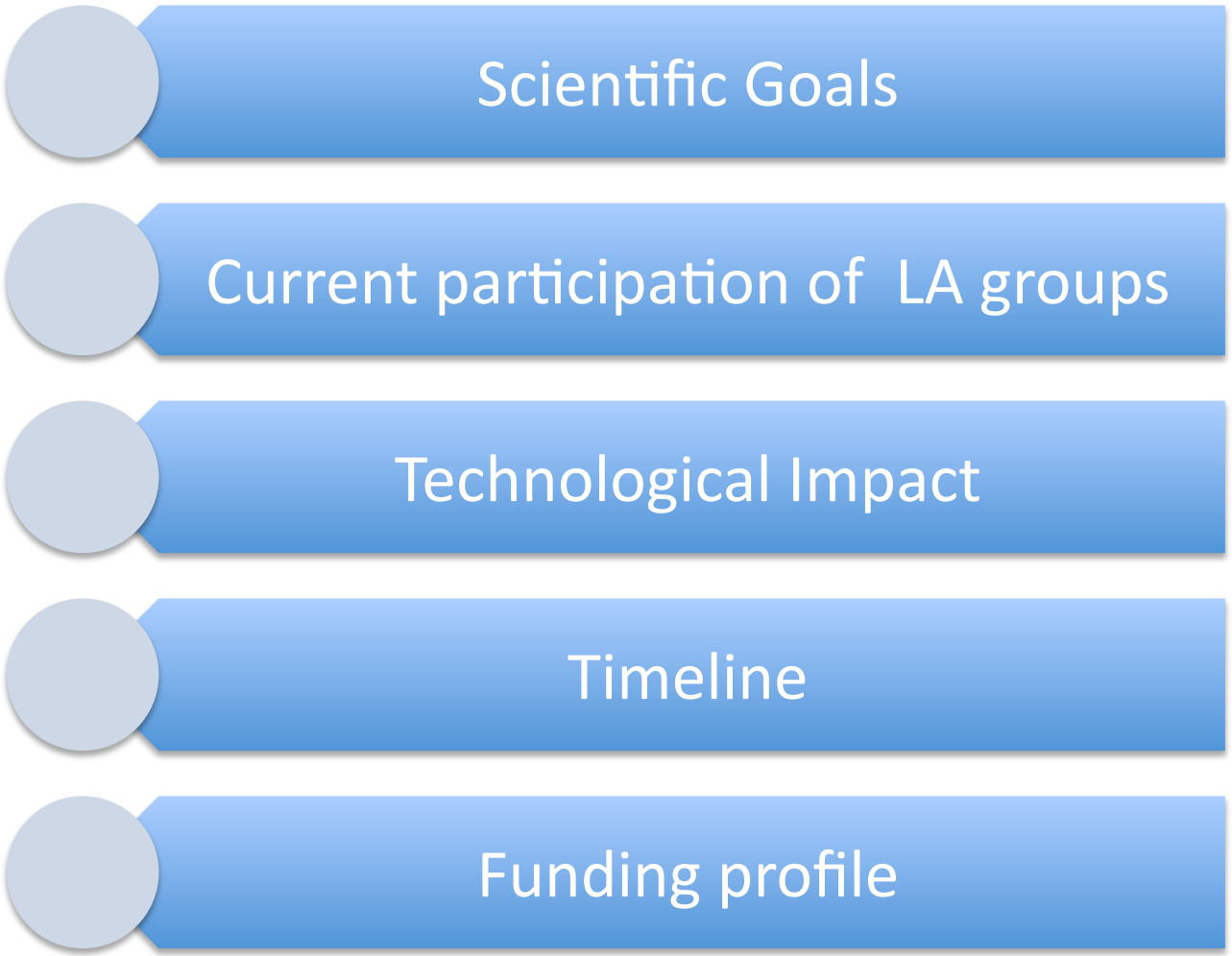
LANDSCAPE ANALYSIS

List of currently documented experiments and facilities in/with Latin American participation:

Cosmology and Gravitation	• **LIGO** • **DES/DESI/LSST/SDSS**
Collider	• **ATLAS, CMS** • **LHCb, ALICE**
Astroparticles	• **AUGER, LAGO** • **HAWC**
Neutrinos	• **DUNE** • **NOvA**
Facilities	• **ANDES** • **LNLS:SIRIUS**

AT THIS STAGE INTENDED TO DOCUMENT NOT TO PRIORITIZE

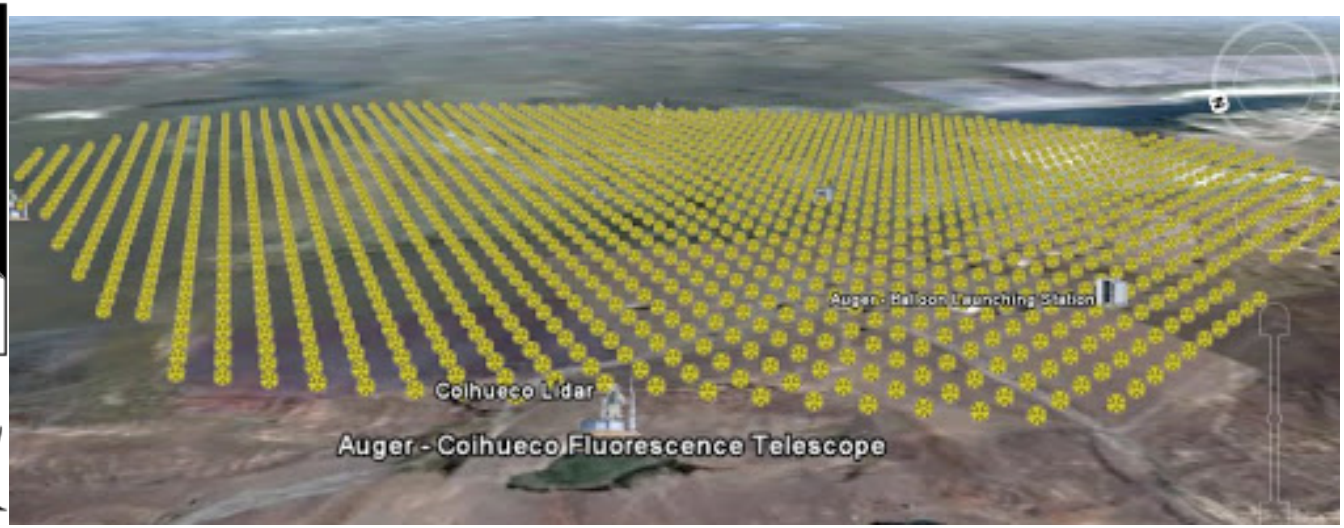
Structure of Scientific Briefs



Pierre Auger Observatory

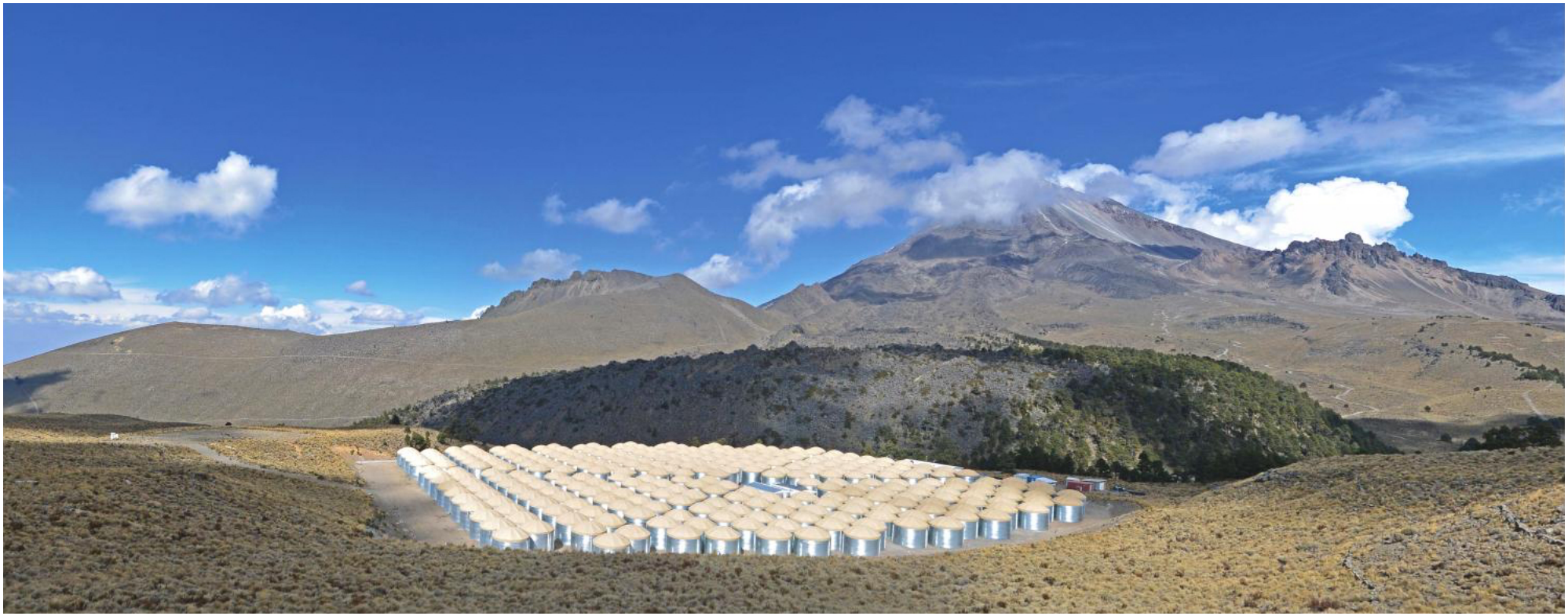
- 1995: Initial design of the Pierre Auger Observatory during workshop at Fermilab
- 2008: Construction of the world's largest cosmic ray observatory completed in Mendoza Province, Argentina, with detectors covering 3,000 square kilometers
- International collaboration from the start, includes Argentina, Bolivia, Brazil, Colombia, Mexico, U.S. and Europe
- Major discoveries about the nature and origin of the highest energy cosmic rays

PIERRE AUGER OBSERVATORY



HAWC Gamma-ray Observatory

- The HAWC Observatory began operation in 2013 near Puebla, Mexico
- The international collaboration includes 14 institutes in Mexico, 18 in the U.S.
- Jointly funded by Mexico CONACyT, U.S. NSF, and U.S. DOE



The Large Hadron Collider

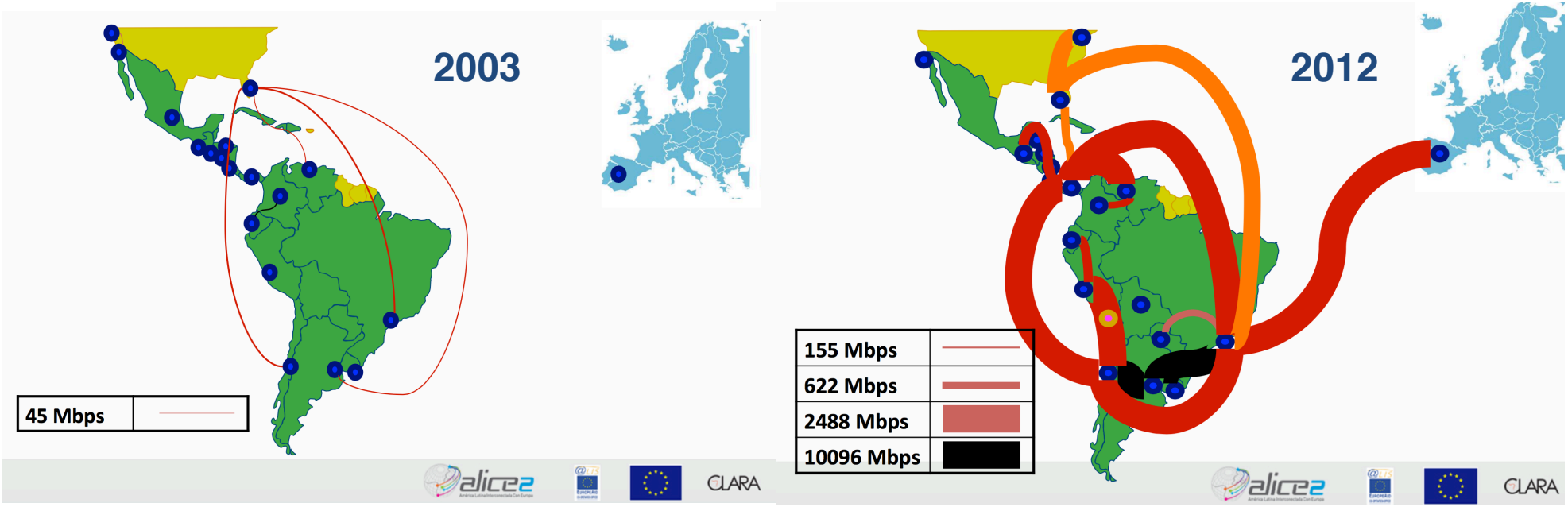
- The largest global science program yet attempted, achieved the discovery of the Higgs boson in 2012

- Latin American collaboration in LHC experiments began around 2000 and grew steadily, helped by two mobility programs: HELEN (2005-2009) and EPLANET

Country	number of institutes
Argentina	9
Brazil	15
Canada	22
Chile	5
Colombia	6
Cuba	1
Ecuador	2
Mexico	9
Peru	2
U.S.	190

LHC scientists at the forefront of big data and fast networks

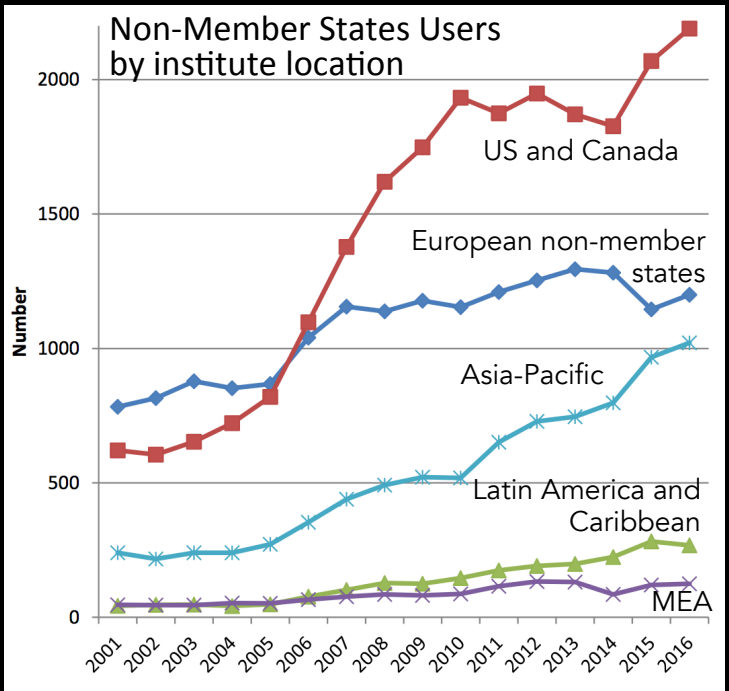
- Big Data analysis for LHC required building a global network of dedicated computing
- This includes Tier 2 data centers in Brazil and Mexico
- Driven partly by LHC needs for big data transfer, Latin American fast networking capabilities grew by orders of magnitude during the period 2003 - 2012



EVOLUTION OF PARTICIPATION AT CERN

LAC institutes: 280 active users (2%) (350 LAC nationals users overall)
Local active communities are usually more than be 2x-3x
(graduate students, early career researchers do not visit RI)

Key Challenge holding back participation:
funding of research stays from LAC to CERN



Marie Curie Actions (now RISE)
HELEN, EPLANET (2005-2015)

EC funding increased 5x users from LAC countries

End of action resulting in users' numbers contraction

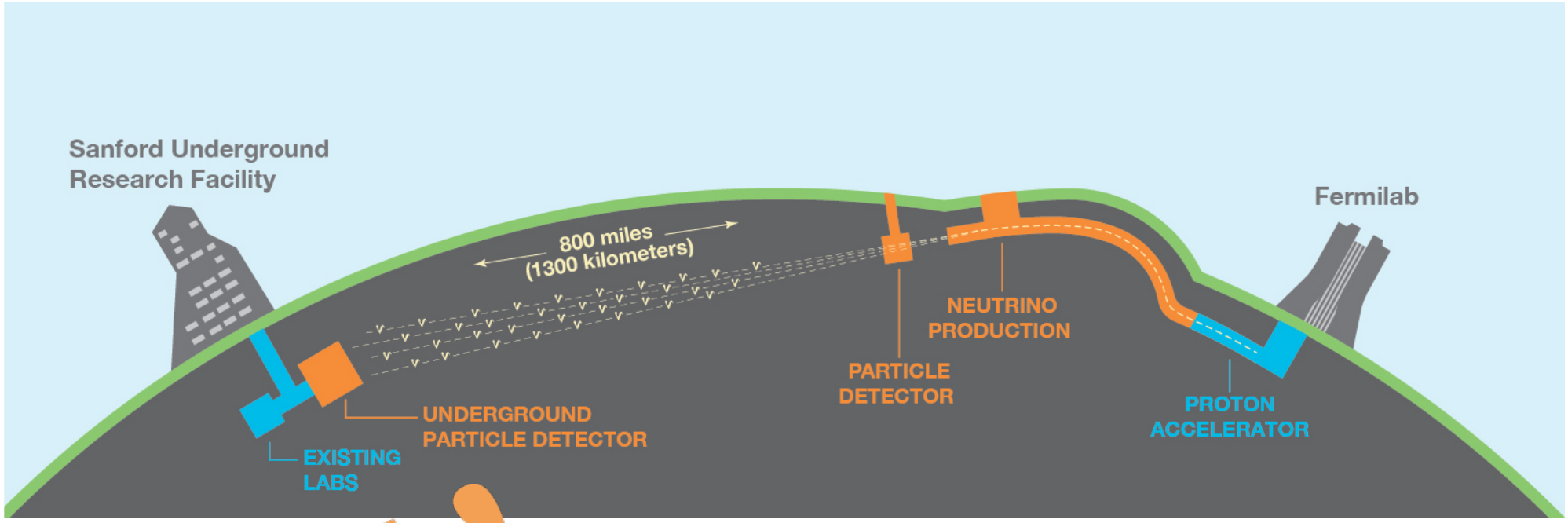
ANDES Laboratory

- A deep underground lab in the planned Agua Negra tunnel for experiments with dark matter, neutrinos, and more.
- Planned as an international consortium from the start.
- Strong interest already expressed by institutions in Argentina, Brazil, Canada, Chile, Mexico, and the U.S, as well as France, Germany and Italy.

Deep Underground Neutrino Experiment (DUNE)

- DUNE will build massive underground neutrino detectors of unprecedented sophistication, sensitive to a neutrino beam from Fermilab, 1300 km away

- It will reveal the fundamental mysteries of neutrinos and their role in the universe.



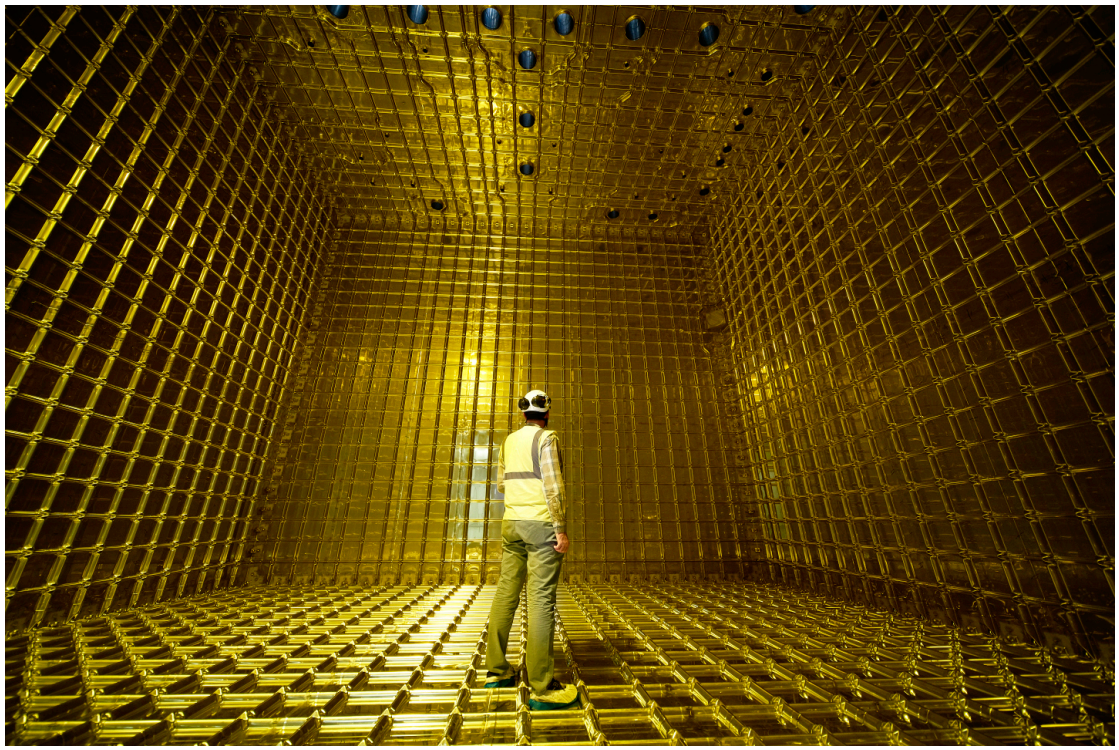
DEEP UNDERGROUND
NEUTRINO EXPERIMENT

Deep Underground Neutrino Experiment (DUNE)

- The largest global initiative in particle physics since the LHC
- An international collaboration from the start: currently 1,020 scientists from 174 institutes in 30 countries, and growing steadily
- DUNE is building a regional collaborative effort in Latin America that focuses on leadership roles in high speed electronics, advanced computing, and a novel light detection technology

Country	number of institutes
Argentina	5
Brazil	10
Canada	1
Chile	1
Colombia	3
Mexico	4
Paraguay	1
Peru	2
U.S.	69

Collaborators in DUNE and/or related Fermilab neutrino experiments



Inside one of the DUNE prototype detectors at CERN, Switzerland

MAIN CONSIDERATIONS FOR DEVELOPING A STRATEGY

Many of these experiments really are a global endeavor.

Enhancing international alignment and participation is beneficial.

From the starting point of a clear mandate:

- An open community wide request for input and feedback is performed.
- Detailed and specific workshops to refine and identify science objectives and priorities.
- Roadmap with consideration to funding scenarios.
- Inclusion on non-regional contributions and perspectives.

Strategic Plan for US Particle Physics in the Global Context
P5 Report

Charge from DOE and NSF to Chair of HEPAP to set up P5 Panel and provide recommendations for priorities under 3 funding scenarios.

Ten year scale with 20 year vision

Report should include how major international projects can fit into the program

P5 Panel set up with international members (5/25)

PROCESS

Multiple activities to receive input from scientific community including younger scientists

Snowmass Study defined Science Drivers

HEPAP Workshops

Higgs physics, neutrino physics, dark matter, dark energy and inflation, the unknown

29 recommendations

Building for Discovery

Strategic Plan for U.S. Particle Physics in the Global Context

US STRATEGY SUMMARY

	Scenarios			Science Drivers					
Project/Activity	Scenario A	Scenario B	Scenario C	Higgs	Neutrinos	Dark Matter	Cosm. Accel.	The Unknown	Technique (Frontier)
Large Projects									
Muon program: Mu2e, Muon g-2	Y, Mu2e small reprofile needed	Y	Y					✓	I
HL-LHC	Y	Y	Y	✓		✓		✓	E
LBNF + PIP-II	Y, LBNF components delayed relative to Scenario B.	Y	Y, enhanced		✓			✓	I,C
ILC	R&D only	R&D, possibly small hardware contributions. See text.	Y	✓		✓		✓	E
NuSTORM	N	N	N		✓				I
RADAR	N	N	N		✓				I
Medium Projects									
LSST	Y	Y	Y		✓		✓		C
DM G2	Y	Y	Y			✓			C
Small Projects Portfolio	Y	Y	Y		✓	✓	✓	✓	All
Accelerator R&D and Test Facilities	Y, reduced	Y, some reductions with redirection to PIP-II development	Y, enhanced	✓	✓	✓		✓	E,I
CMB-S4	Y	Y	Y		✓		✓		C
DM G3	Y, reduced	Y	Y			✓			C
PINGU	Further development of concept encouraged				✓	✓			C
ORKA	N	N	N					✓	I
MAP	N	N	N	✓	✓	✓		✓	E,I
CHIPS	N	N	N		✓				I
LAr1	N	N	N		✓				I
Additional Small Projects (beyond the Small Projects Portfolio above)									
DESI	N	Y	Y		✓		✓		C
Short Baseline Neutrino Portfolio	Y	Y	Y		✓				I

TABLE 1 Summary of Scenarios A, B, and C. Each major project considered by P5 is shown, grouped by project size and listed in time order based on year of peak construction Project sizes are: Large (>$200M), Medium ($50M-$200M), and Small (<$50M). The science Drivers primarily addressed by each project are also indicated, along with th Frontier technique area (E=Energy, I=Intensity, C=Cosmic) defined in the 2008 P5 report.

European Strategy for PP

Mandate from CERN Council

- *the Council will define and update the strategy based on proposals and observations from a dedicated scientific body that it shall establish for this purpose*".

Preparatory Group

- Open approach to obtain scientific community input
- Open Symposium
- Product: Physics Briefing Book
- International members

European Strategy Group

- Input Physics Briefing Book
- Series of meetings
- Large Composition from msmber states, observers, Major European Labs
- Also included EU, ApPEC, NuPECC, ESFRI,etc

Structure of ESPP

a **Preamble,**

two statements on **General issues,**

four statements on **High-priority large-scale scientific activities,**

five more scientific statements on **Other scientific activities essential to the particle physics programme,** i.e. ingredients mandatory for the healthy development of particle physics,

two statements on **Organisational issues** concerning the position of the CERN Organization in the context of the worldwide particle physics community and other European organisations,

three statements on the **Wider impact of particle physics** relating to outreach and communication of physics results, knowledge and technology transfer to society and industry, and the particular importance of engineering education,

the last Strategy Statement, **Concluding recommendations,** relates to the update and implementation of the Strategy.

EUROPEAN STRATEGY FORUM FOR RESEARCH INFRASTRUCTURES

ROADMAP & STRATEGY REPORT

The European Strategy Forum on Research Infrastructures (ESFRI) periodically updates its Roadmap as mandated by the Competitiveness Council of the European Union to provide a coherent and strategic vision ensuring that Europe has excellent Research Infrastructures (RIs) in all fields of science and innovation[1,2,3].

ROADMAP FOR RESEARCH INFRASTRUCTURES IN DIFFERENT SCIENTIFIC DOMAINS INCLUDING PHYSICAL SCIENCES.

SINGLE-SITED RI

DISTRIBUTED-SITED RI

UPDATED STRATEGY AND ROADMAP FOR 2018.

ESFRI PROJECTS

ESFRI LANDMARKS

ESFRI PROJECTS AND LANDMARKS
PHYSICAL SCIENCES AND ENGINEERING

PHYSICAL SCIENCES & ENGINEERING

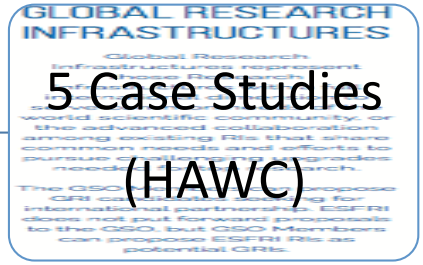
NAME	FULL NAME	TYPE	LEGAL STATUS (Y)	ROADMAP ENTRY (Y)	OPERATION START (Y)	CONSTRUCTION COSTS (M€)	OPERATION COSTS (M€/Y)
EST	European Solar Telescope	single-sited		2016	2029*	200	12
KM3NeT 2.0	KM3 Neutrino Telescope 2.0	distributed		2016	2020*	151	3
CTA	Cherenkov Telescope Array	single-sited	gGmbH, 2014	2008	2024*	400	20
ELI	Extreme Light Infrastructure	distributed	AISBL, 2013	2006	2018	850	80
ELT	Extremely Large Telescope	single-sited	ESO#	2006	2024*	1.120	45
EMFL	European Magnetic Field Laboratory	distributed	AISBL, 2015	2008	2014	170	20
ESRF EBS	European Synchrotron Radiation Facility Extremely Brilliant Source	single-sited	ESRF#	2016	2023*	128	82
European Spallation Source ERIC	European Spallation Source	single-sited	ERIC, 2015	2006	2025*	1.843	140
European XFEL	European X-Ray Free-Electron Laser Facility	single-sited	European XFEL#	2006	2017	1.490	118
FAIR	Facility for Antiproton and Ion Research	single-sited	GmbH, 2010	2006	2025*	NA	234
HL-LHC	High-Luminosity Large Hadron Collider	single-sited	CERN#	2016	2026*	1.408	136
ILL	Institut Max von Laue-Paul Langevin	single-sited	ILL#	2006	2020*	188	97
SKA	Square Kilometre Array	single-sited		2006	2027*	1.000	77
SPIRAL2	Système de Production d'Ions Radioactifs en Ligne de 2e génération	single-sited	GANIL	2006	2019*	281	6

GRI AND EU-LAC ON RI

GRI

- GSO OF G8+5
- Matchmaking exercises (LNLS)

- 5 Case Studies (HAWC)



EU-LAC

- 2 Workshops
- Matchmaking exercises on RI
- Highlights in PP +C: CERN, Auger and LNLS

HIGH LEVEL IBEROAMERICAN MINISTERIAL MEETINGS FOR SCIENCE AND TECHNOLOGY

XXVI CUMBRE IBEROAMERICANA LA ANTIGUA GUATEMALA 2018 | XXVI CÚPULA IBERO-AMERICANA LA ANTIGUA GUATEMALA 2018

Una Iberoamérica próspera, inclusiva y sostenible
Uma Ibero-América próspera, inclusiva e sustentável

FERNANDO QUEVEDO, DIRECTOR OF ICTP, WILL HAVE THE OPPORTUNITY TO ADDRESS THE MINISTERS TO PRESENT THIS INITIATIVE FOR A LATIN AMERICAN STRATEGY FOR RESEARCH INFRASTRUCTURES IN PARTICLE PHYSICS AND COSMOLOGY

WITH SUPPORT FROM THE SCIENTIFIC COMMUNITIES: ARGENTINA, BRAZIL, CHILE, COLOMBIA, ECUADOR, MEXICO, PARAGUAY, PERU

SUPPORT FROM: CERN, FERMILAB, ICTP, VARIOUS MINISTRIES OF IB

HIGH LEVEL IBEROAMERICAN MINISTERIAL MEETING FOR SCIENCE AND TECHNOLOGY GUATEMALA 2018

AIMING FOR:

DECLARATION

We acknowledge the importance and need to further and support the participation of Latin American research groups in scientific discovery by promoting the establishment of large-scale research infrastructures in Latin America and by taking an active part in fundamental research performed at international infrastructures in particle physics and cosmology. We look forward to work with the scientific community to establish the Strategic Scientific Forum to coordinate these activities.

LASF FOR RI

To promote the establishment of the Latin American Strategy Forum (LASF) for Large-Scale Research Infrastructures starting with the fields of Particle Physics and Cosmology .

GOALS

- To build consensus and support a strategy-based approach for the participation in, and development of, large-scale research infrastructure projects in Particle Physics and Cosmology in Latin America.
- To make a call to Latin American scientific communities in Particle Physics and Cosmology to establish a strategic scientific forum in order to coordinate Latin American activities in the area.
- To set-up the LA scientific roadmap for Particle Physics and Cosmology based on actual participation in large-scale research infrastructures and the inherent need for long term planning and funding implementing an open call for input from the scientific communities.
- To enable a more effective development of Latin American research groups, facilitating multilateral participation in regional and global research infrastructures, increasing their impact.
- To inform the Ministerial meetings of the development, implementation and impact of the LA strategy for Particle Physics and Cosmology.

LASC FOR RI

- **To promote the establishment of the Latin American Strategy Forum (LASF) for Large-Scale Research Infrastructures starting with the fields of Particle Physics and Cosmology .**

THIS WOULD JUST BE THE KICK-OFF TO DEVELOP A LONG TERM STRATEGY FOR THE REGION

Thank You