Synchrotrons as Development Accelerators
The Greater Caribbean Project

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Outline

- Proposal of a new Latin American Synchrotron in the Greater Caribbean (3-11)
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Synchrotrons Versatility

Research	Teaching	Society
Nanomaterials	Master & Ph D Thesis	Industrial Development
Materials Science and Engineering	Technician training	Medical imaging
Chemistry		Radioisotopes
Archaeology	Governance	Minerals
Paleontology	Science Diplomacy	Environment
Geophysics		Climate
Cultural Heritage		
Informatics		
Space		

Synchrotrons and SGD

(courtesy of V. Del Río)

Research at Synchrotrons can contribute to the achievement of 13 out of 17 of the UN Sustainable Development Goals.

Some Benefits

Local production of isotopes, overcoming the loss associated to certain short-life isotopes, that distance from the production location can make important

Magnetic Resonance uses Niobium. Its use in accelerators had an effect on its price. The cost has gone down and this has made possible to lower the cost of MR equipments

Radionuclides, like ^{18}F development of Positron emission tomography (PET)

Yearly cost for Diabetes was estimated in Mexico (2013) of the order of 27000 US$, i.e. 2.1/ of its GNP

Synchrotrons in the World

Synchrotrons in the South

In Middle East: **SESAME**. Success case of promotion by international organizations: UNESCO, CERN. Two lessons:

Science can overcome political and diplomatic differences

About twenty years between first proposal and starting of operations

In Africa: No synchrotrons. **AfLS** proposal (1990-2015): reference for our project and potential partner for international lobbying and for training

In Latin America: LNLS (1997), Synchrotrons impact on scientific and industrial development, both direct (SIRIUS built, 86%, by Brazilian enterprises) and indirect, e.g. pharmaceutical industries, production of radioisotopes

Big scientific Infrastructure in Latin America

Astronomy & Astrophysics:

Chacaltaya Lab in Bolivia, 1947 (pion discovery)

Arecibo (1963) closed August 2023

La Silla (ESO) and Cerro Tololo (Interamerican) Observatories, 1969

Pierre Auger Observatory (Mendoza, Cronin) 1999

Several current projects, both open-sky (e.g.HAWC, Puebla, Mexico) and underground (ANDES, Argentina- Chile tunnel)

Synchrotrons. only the Brazilian one; LNLS Campinas: first proposal 1981, VUV (1997), Sirius (2018)

The Greater Caribbean

Our project: Mexico, SICA countries (Central American and Dominican Republic), Colombia, Caribbean islands.

Geographically, also: Venezuela, Cuba, Puerto Rico

If Gulf of Mexico included, also: Southern Texas, Louisiana, Alabama, Mississippi, and Florida

National Synchrotron Initiatives in GC

Colombia: Bernardo Gómez (2015)

Mexico: first in Morelos (Víctor del Rio, 2015), then Hidalgo

Cuba: After Obama's visit (2016), Jeremy Rothstein and Fidel Castro Smirnov

Puerto Rico – beamline at Cornell, the same University that, until 2011, administered Arecibo Observatory, through an agreement with NSF

A regional Proposal (2021)

https://arxiv.org/abs/2109.11979

A Synchrotron as Accelerator of Science Development in Central American and the Caribbean

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The current proposal

GCLS – Merging of the mentiones proposals

LAMISTAD, Latin American International Synchrotron for Technology, Analysis and Development

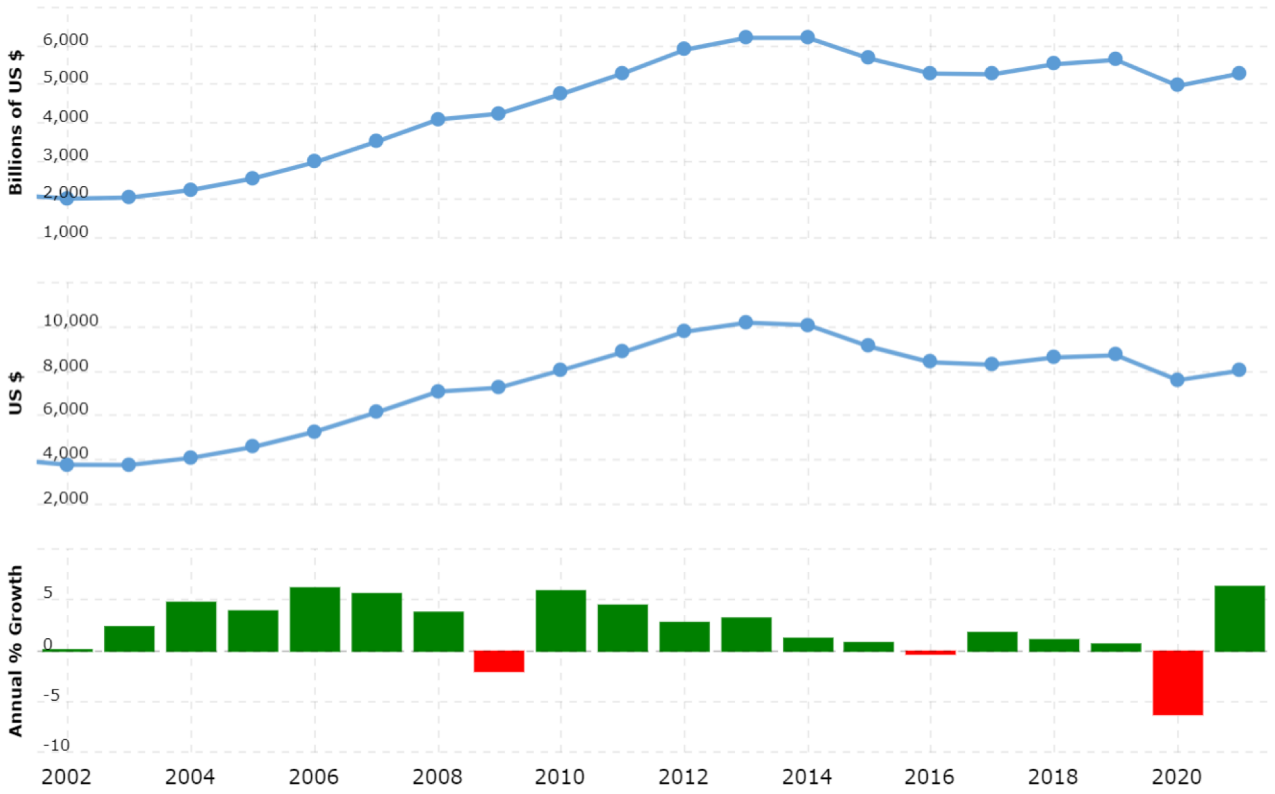
Economic Context: 1- LA Matrix

- Explotation of Natural Resources
- Agriculture
- Tourism
- Trade – Internal economies
- Import of technological goods
- Services
- Migrant Remittances

A need: High Technology industry

Economic Context: 2- LA Economies

https://www.macrotrends.net/countries/LCN/latin-america-caribbean-/gnp-gross-national-product'>Latin America & Caribbean GNP 1966-2022



Educational – Scientific Context
LA Higher Education and Science

- Weak in the colonial period: First University: Santo Domingo 1538 (Harvard one century later). Some 30 universities in Spanish colonies, Differences between Habsburgs and Borbons. First in Brazil, 1792
- Some improvement in the Republican period: visionary statesmen: Santander, Bolívar, Castro Madriz, Sarmiento, García Moreno. Engineering acquires importance, some science, pioneer Argentina
- Córdoba's Reform 1918 (University democratization)
- Science Development only in XX Century
- Institutional development: second half of the Century

XX- Century Science System Development

Atomic Energy Commissions (AIEA)

Science Research Councils (UNESCO)

Ministries of Science (Costa Rica (first one), Argentina, Brazil, Cuba, Venezuela, Chile, Colombia

In some countries (Dominican Republic, El Salvador): Viceministers in Ministries of (Higher) Education

National Scientific Societies, Federations of NSS

Science in Greater Caribbean (2018)

Country	Res/1000 labor force (%) 2018 (year)	HEExp/GNP	Ph D students (%)	Publications	R & D/GNP
Mexico	0.71	1.02	43774	23508	0.31
Colombia	0.17	1.05	6225	11193	0.24
SICA countries					
Guatemala	0.03	0.41	881 (2017)	269	0.03
Belize*					
El Salvador	0.15	0.33	63	69	0.16
Honduras	0.08	0.88	492 (2017)	181	0.04
Costa Rica	0.79	1.36	2805 (2019)	1053	0.39
Nicaragua				118	
Panama	0.08	1.1	107 (2016)	727	0.15
Dominican Rep.				232	

* not considered by UNESCO Science Report becase included in the Caricom section.

Sources: UNESCO Science Report 2021 (Gabriela Dutrénit, Carlos Aguirre, Martín Puchet Mónica Salazar) and Carlos Aguirre, private communiation

Cost and Financing

Rough estimate: Initial investment 500-600 MUS$ over 5-6 years

Operational cost 40 MUS$/year, although SESAME, until now: 90 million US$ (full solar-energy electric power, marginal saving from using BESSY2 injector)

Financing: Affordable. Necessarily from participating countries. International support possible (Development Banks, International Cooperation ?)

Governance: Intergovernmental (CERN-like), Private (Consortium of participants, ESFR-like)

Financing Bottlenecks: 1- S & T Funding

- Low investment in S & T (Average 0.6% of GNP, with big asymmentries, two extreme cases: Brasil (more that 1%) Guatemala 0.04%)
- GNP Percentage poor indicator when population below10-15 millon, and/or low per capita income.
- **Impossibility of investing in big national scientific programs.**

Actual sources of the funding:

- National public financing (**very little, if any, private**)

- International financing – Development Banks, usually earmarked for specific projects in specific areas, not allowing structural actions

- Cooperation, often considered as a primary source and not as a complementary one, external-policy constraints on eligibility of the research object.

Financing Bottlenecks: 2- Science Policy Goals

"It is very common in backward countries an inordinate concern for immediate applications, and therefore it is customary to boast of practical judgment and to call for research exclusively of **immediate application and useful to society.**" Bernardo Houssay, 1954

Regional financing
Interesting, but sleeping, Proposal: FORCyT

First suggestion: GV, June 2015, CSUCA meeting in Cartagena, presented to Guatemala Government by J.A. Fuentes Soria, then CSUCA 's SG .

Endorsement by Guatemala Government (again J. A. Fuentes Soria, as Vicepresident) at a SICA Meeting, El Salvador, December 2015, 25M$/year during 5 years

CTCAP Meeting in Guatemala (September 28, 2016)

Still waiting for the decision of the Heads of State

Fuentes Soria, J. A. (2017), "Fondo Regional de Ciencia y Tecnología del Sistema de la Integración Centroamericana, FORCYT-SICA" in Lemarchand G., Relevamiento de la investigación y la innovación en la República de Guatemala, Paris, UNESCO

Possibilities of Cooperation: 1- US

House Resolution for SESAME: *Funding is intended to promote scientific excellence in the Middle East region and prevent the loss of scientific expertise that is holding back science education and research in the region.*

Science Diplomacy, Latin America strategically important for US, in particular after the pandemic (Vaccines issue)

A Latin American focused program? A Marshall Plan for Central America? Two years ago, Hispanic Law-makers advocated one - Main motivation: social problems. What about the reasons behind these problems?

USAID ? DOE ? NSF ? Puerto Rico? Consortium of institutions with important LA programs? Swedish MAX IV and PRISMAS, model and opportunity for training

Political opportunities – July 2023, US rejoining UNESCO

– August, Lifting Venezuela sanctions

Possibilities of Cooperation: 2- EU

European Union Association Agreement with Central America, enforcement pending since several years, last missing ratifications: two from just one country, Belgium

European Union Program for CELAC Infrastructure

7-year European Union Programs, current one, the ninth: Horizon Europe

Possibility of Bilateral cooperation (CNR ?)

In Italy: Istituto Italo-Latino-Americano

Possibilities of Cooperation: 3- Others

Context: Development Funds. Nominally stable (2000—2020) about 1 billion US$, 35% decrease in real terms

Direct Foreign Investiment: About 15 billion US$

IDB Regional Public Goods Program, WB, BCIE. CAF

Commonwealth programs

Possible form: Matching Funds

Human Capacity in the Region

Potential users (basin of several thousands needed)

Available, especially in areas where Region's non-scientific demand is high, such as health, food safety, biodiversity.

They must be trained and a first need is to broadly explain that main use of synchrotrons is not for physics research.

Not to be forgotten posible users from outside the Region

Engineers, staff and technicians of the to-be Synchrotron.

Only apparent problem.

SESAME's experience: When building the facility, enough time to realize a vigorous training program.

Civil engineering is strong

Training

NECESSARY DEDICATED TRAINING PROGRAM

Civil engineers and users do not require a strong effort, Staff and technicians, in particular for what concerns beamlines, sample environment etc. do.

NOT NECESSARILY AN ONLY-REGIONAL PROGRAM.

Possible sharing with AfLS, through South-South (SESAME, SIRIUS), and North -South cooperation (Elettra?, American synchrotrons?, European synchrotrons, e-g. Alba ?)

NOT ONLY THEORETICAL TRAINING

A beamline at some existing synchrotron ? Joining groups at existing beamlines? The cases of Puerto Rico and Mexico

Some small accelerators in selected countries? Compact Light sources

L**INK WITH DOCTORATES**

Central American Capacity Building Regional Doctorates

History (CSUCA – ICTP cooperation)

Core: Research

Proposal by Quevedo, Ordoñez, GV (2012)

Activation (2014): Physics and Mathematics

In preparation: Chemistry, Biology

Modus operandi: Role (and problems) of national public universities, Role of Technological University of Panama and of University of Panama, University of El Salvador, Universidad San Carlos de Guatemala

Role of extraregional cooperation (support by Mesoamerican Center of Theoretical Physics, SUE-Caribe, Mexico's Conacyt, Swiss and German cooperation)

Location

NOT SO IMPORTANT, FOR THE MOMENT BEING – SESAME EXPERIENCE

Main possibilities:

- Mexico – Possible because of already existing plans. Hidalgo offered land for the Mexican pROject. Political complexity , (federal structure allows local decisions, but eventual decision by Federal government, pre-election period)

- Colombia – New government somewhat supportive of science.

Royalties Law 2056 (Sept.30, 2020)

- Dominican Republic – President announced a City of Knowledge project (February 2021). Not yet implemented. Here too, pre-election period

What else elsewhere?

Wherever the location, it must be a Latin American Synchrotron, located WITHIN the Great Caribbean

Possible problem. Other countries.

Complementary facilities. Mentioned Compact Light Sources and small accelerators, not only an option for intermediate time. Possible a regional System of small accelerators.

Belonging to a unique institution?

If (and probably only if) part of a regional lab. less dependent of national political fluctuations. May be not easy aspect of negotiations.

Time Scale

Optimistic assumption: This project develops faster than similar projects. Beginning of the thirties, Mid-thirties ?

More realistic: end of thirties

LNLS, SESAME, AfLS: 10-15 yrs for first idea to decision

LNLS, SESAME: 10 yrs for decision to operation

AfLS: First idea nineties, Interim Steering Committee 2015, First governmental formal declaration of support: 2019 (Ghana's president Akufo Addo), triggering Benin, South Africa, Nigeria and Ivory Coast

Which Kind of Synchrotron?

0- Technological developments have accelerated the transition from one generation to another (Elder 1947-Bevatron 1954, Daresbury 1981, SLAC 1997, MAX IV 2011)

1- Probably, it should be a 4th generation one. Currently only MaxIV, ESRF and Sirius. Again SESAME case instructive. This should not prevent less ambitious actions.
2- Complementary to Sirius, which is a 3 Gev synchrotron

3- Higher energy? Lower energy? Perhaps 1.5 GeV could be a sound choice considering the areas of application of special interest for the region. Example of MAX IV?

Expected Results - 1

Scientific development of the scientific community, integration of groups from different areas, strengthening of internationalization, increased access to other international facilities, advanced research, increase of publication number (perspective confirmed as attainable in the South by SESAME)

Technological and industrial development, Challenges of the construction and maintenance of the facility, and its beamlines, of the data analisis, Sirius example of CERN patents use.

Academic development. Doctorates, and broadening of the actual range of advanced teaching (less scientific inbreeding)

Expected Results - 2

Social and economical development. Research in sensible areas, food safety, circular economy, pharmaceutical, health (Cardiology, Neuronal degeneration, production of radioisotopes, biodiversity and molecular structure of plants, medicine from natural products, tomography), soil analisis, nanomaterials for energy, biosensors for agriculture

High-tech industrialization, Possible fostering of new industries, even during and for the construction.

Political development. Regional Integration

Political and Science Diplomacy Benefits 1-Integration

- Role of OAS and CELAC
- Spanish-speaking and English-speaking Caribbean
- Central American Integration (Science main actor since eighty years)
- In a globalized society, cnly States of continental dimensions matter. The weight of the others is minimum.

Political and Science Diplomacy Benefits
2- Interregional and intercontinental Aspects

AfLS – link through LAAAMP – Joint presentation at the recent World Science Forum in Cape Town, foreseen a GCLS participation in the forthcoming AfLS Conference. Possibility of joint training activities.

Balkan Project in Montenegro ?

Possibility of joint lobbying to get international support. – A case for UNESCO? Joint support to GCLS, AfLS and SESAME, Role of Brazil. A case for American agencies?

Interregional cooperation, initially for training, long term: prospective research, and not necessarily limited to Africa and Latin America

A crucial Question

Does feasibility justify the necessary financial commitment?
and, make it justifiable for politicians and civil society?

Problem: Cost of opportunity, vis à vis social and educational problems of the region

Specific considerations :

Insufficient scientific education and development, cause of indirect costs

Social relevance of problems like: Natural risk, Environment, Food security, Contamination), Agriculture, Health

Political relevance: Biodiversity

General considerations:

Right of people to develop their capacities

Benefits of international integration

Easy Answers
A politician and a Scientist View

José Francisco Peña Gómez: "Citizens have an individual right to develop, which must be recognized as a fundamental factor for the transformation of a nation".

Bernardo Houssay (1967): "Science, technology and research are the basis of the health, welfare, wealth, power and independence of modern peoples. There are those who believe that scientific research is a luxury or an interesting but dispensable entertainment. Serious mistake, it is an urgent, immediate and unavoidable need to advance. The dilemma is clear: either science, technology and research are cultivated and the country is prosperous, powerful and advances; or it is not properly practiced and the country stagnates and regresses, lives in poverty and mediocrity. Rich countries are rich because they devote money to scientific and technological development. And poor countries remain so if they do not do so. Science is not expensive, ignorance is expensive."

Not-so easy Answers

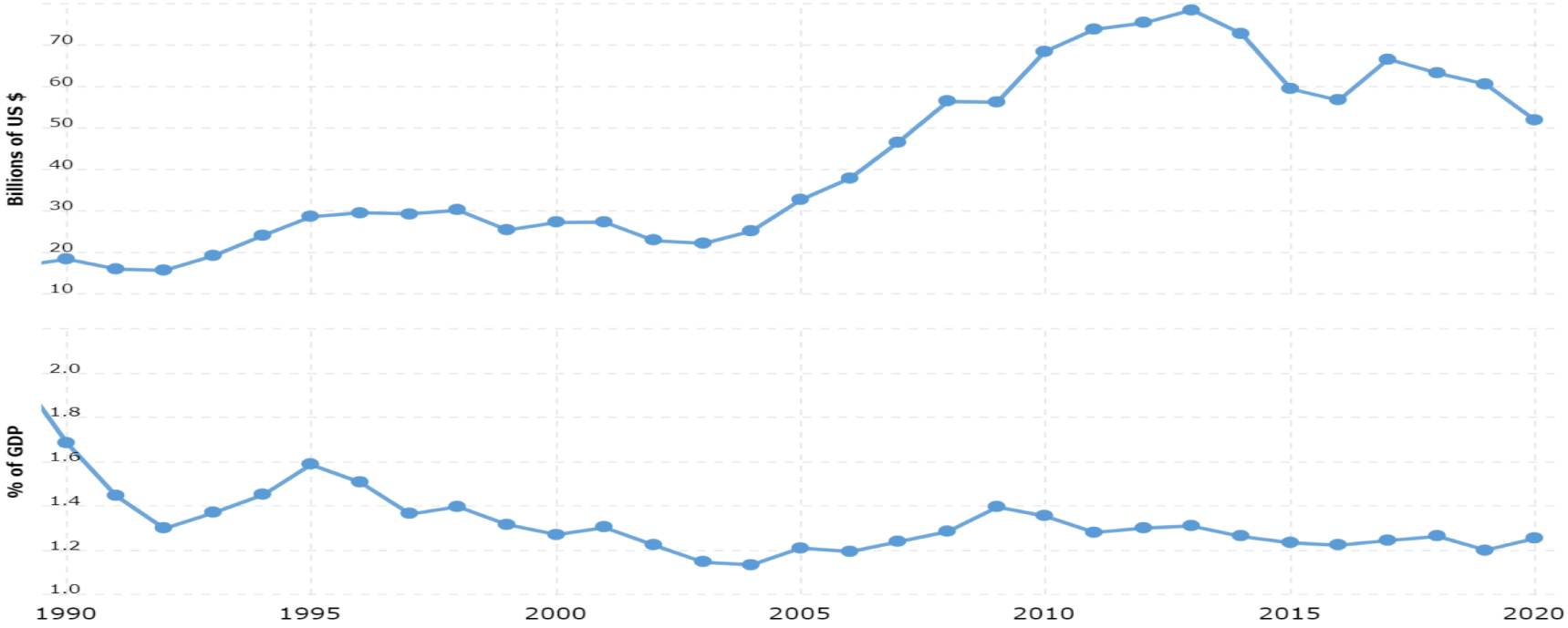
Comparison with other public expenditures

Health: During the pandemic the BCIE (Central American Bank for Economic integration) gave $400 million to the 8 countries it refers to

Education: The argument of the cost of opportunity is rarely used to deny financing in this sector (Average LA: 4.6% GNP, against 0.6% Science)

Military expenditure: in 2021, in the Great Caribbean $21.2 Billion, largest fraction of it by Mexico and Colombia (together $18.9 Billion, broadly justified by the fight to Narcotraffic, especially in the Mexican case), but still remaining countries expenditure is $2.3 Billion
(Source: Stockholm International Peace Research Institute, D. Lopes Da Silva et al.)

LA military Expenditure



Source: https://www.macrotrends.net/countries/LCN/latin-america-caribbean-/military-spending-defense-budget

Time –scale Financing
Two Philosophies

Conservative alternative:

To ensure financing before realizing the Project, by confirmed positive answers, to the question.

Visionary alternative:

Get a positive aswer by promoting a quality Project, with a strong scientific and political endorsement, that responds to a political and social demand

Is it difficult to choose?

Lobbying with civil Society

Necessary

Target: politicians, not all of them statespersons, importance of short and médium-term expected results

Communication: necessary understandable language, and fitting with

THEIR priorities. An example: this talk, in this form, would be not suitable

Important support and endorsement by national Academies:

Already some from Colombian and Dominican Academies of science

Preliminary contacts: Ecuadorian, Guatemalan, Mexican (Engineering) Academies

Past of the Project

Seminars: **Italy** : Frascati Natl. Lab. Universities of Rome, Calabria, L'Aquila, **Colombia**: University of Los Andes, Popular University of Cesar, Pedagogical and Technical University of Colombia, Coast University (Barranquilla), **USA** : Lawrence Berkeley Laboratory, Stanford SLAC, **ICTP** School on Synchrotron Light Sources and their Applications, **Tunisia**'s National Center for Nuclear Science and Technologies

Workshops and Symposia: Central American Network of Researchers in Natural Sciences, Symposium on Megaprojects with Dominican Republic Ministry of Higher Education, Science and Technology, Multivenue Symposium in six countries, Food safety and Biodiversity (Trieste). Science Summit parallel to United Nations 78th General Assembly (New York)

Conferences: El Paso-Ciudad Juárez (Purdue), 5th African Light Source Conference, World Science Forum

Meetings: International Scientific Council-Dominican Academy of Science, VdR with UNESCO Delegations

Connection with LNLS and SESAME, and ICTP-ELETTRA

Working group starting from the authors of the 2020 article,

Interim Executive Committee

Preliminary Results

Synergy with the AfLS project

The experience of the six – country (Colombia, Spain, Jamaica, Mexico, El Salvador, Dominican Republic), Multi-venue Symposium organized this year

Progress in Diplomatic Support – Interest from Brazil (includingAfLS and SESAME)

Road Map of the Project

Creation of an Association (or Foundation) to promote the project, possibly in connection with RCN

Technical detailed article, and feasibility study

Diffusion of the project (Civil Society, Press, Private Sector, Politicians)

Realization of Training Workshops-Courses

Contact with International Organizations (UNESCO, CARICOM, ISC).

Main short term Goal: UNESCO resolution supporting GCS and AfLS

Strengthening contacts with SESAME, LNLS, European and Northern American synchrotrons

Strengthening interregional contacts with similar infrastructures or projects (Africa, Maghreb, Gulf, Eastern Europe, China)

Acknowledgments

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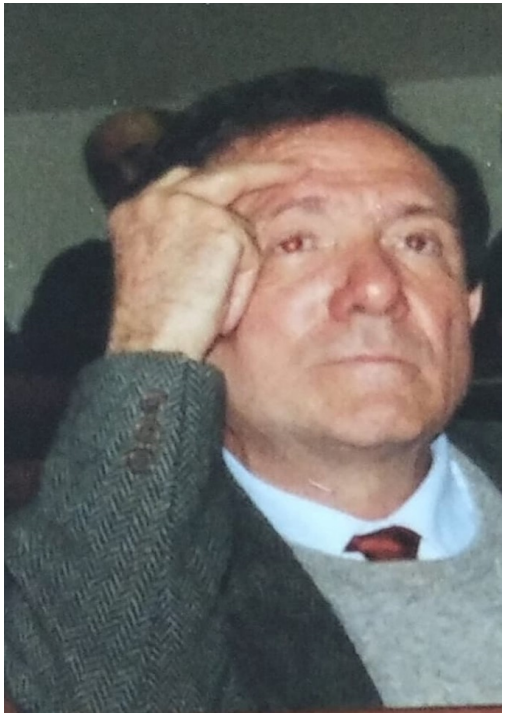
However, without the lesson of Nino and my Science policy mentors, Edoardo Amaldi and Abdus Salam I cannot imagine how this proposal and my half-century activity in Latin America could have ever occurred.




thank you
danke
謝謝
gracias
merci
obrigado
dziękuję
bedankt
go raibh maith agat
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kop khun krap
terima kasih
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