

U.S.-Latin American Cooperation in Physics: The Fermilab Experience*

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Introduction

This article reviews the current status of Fermilab's cooperation program with Latin American physics institutions. It is a program started about six years ago; we know that Fermilab has benefited from it (for example, by having skilled Latin American physicists and engineers work at the Laboratory), and we hope that it has assisted the growth and progress of Latin American physics. Except for our commitment to this goal, the program is not unique - other U.S. institutions can - or have - undertaken some of the same activities. A major aim here is to stimulate discussion of what has been accomplished, and to solicit ideas for future activities.

Background

The program was initiated by Fermilab Director Leon M. Lederman with the goal of assisting the growth of Latin American physics, and particularly (in keeping with Fermilab's mission) of stimulating the study of high-energy physics (HEP) in the region. Inspired by the success of Abdus Salam's Theory Institute for developing-country scientists in Trieste, the hope was that Fermilab (in coordination with other national labs) could provide the same service for experimental science, concentrating on Latin America for the obvious advantages of cultural and geographic proximity. Latin America already has many centers of excellence and many talented physicists, so that these goals seem realistic.

The reasons why less-developed countries should become active in physics have been the subject of many reports and conferences, and we will not repeat the discussions here; among the reasons cited are that in any country, physics is the basis for much technology, with the corollary that a strong physics community is necessary for technological strength and self-sufficiency. The rationale for HEP activities in such countries may be less obvious. One reason frequently cited is the significant technological "spin-off" from the field. In addition, training in HEP, which to a significant extent is training in problem solving, is much valued by other fields. In the U.S., for example, many new HEP Ph.D.'s

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are hired away either by industry or by other branches of physics. Fields such as communications, synchrotron radiation, computers, etc., all have significant numbers of HEP Ph.D.'s.

Some concern has been expressed about the effectiveness of an institution, new to HEP, joining in one of the large collaborations now common in the field. The number of physicists from a single institution taking part in an HEP experiment does not have to be large, and this allows a new group to become established. Although this seems a paradox in view of the 200-person teams now active, each team carrying out an experiment is composed of subgroups of physicists (typically from 1-20 physicists per subgroup) from different institutions. Each subgroup is generally responsible for a particular piece of the experiment, but all take part in the analysis and physics interpretation.

Fermilab and International Activities

Fermilab, with its 900-GeV (eventually 1000-GeV) proton synchrotron used for fixed-target experiments and as a $\bar{p}p$ collider, opens its facilities to all users, with the criteria for acceptance of a research proposal to use these facilities being the scientific merit and technical competence of the proposal. Involved in the currently approved experimental program are 890 physicists and students from 79 U.S. institutions, together with 350 physicists and students from 62 non-U.S. institutions; these latter institutions are located in 17 different countries. In order to serve these foreign scientists (and their frequently accompanying families), Fermilab provides English language classes, has a foreign-visitor desk for scientists, and also a visitor's office to assist their families; in addition, a limited amount of housing for the visiting scientists and their families is available on the Fermilab site.

There are, of course, limitations on Fermilab's ability to help physics in other countries. The Laboratory is funded by the U.S. government through its Department of Energy in order to provide facilities for HEP research; the funds can only be used for this mission, although with some flexibility in interpretation. Fermilab is not a funding agency (like NSF, OAS, UNESCO, etc.), nor is it a university with undergraduate training and degree programs.

There are many areas (in addition to HEP) where Fermilab has expertise and can collaborate with Latin American institutions; among them are superconductivity, cryogenics, advanced computer processors, microprocessor control systems, radiation and environmental safety, neutron and proton therapy, rf engineering, HEP theory, astrophysics, etc., etc.

Brief History of Fermilab's Latin American Activities

In 1981, Lederman visited UNAM, Mexico; amongst the topics discussed was HEP activity at UNAM and in other Mexican institutions. These discussions led to the January 1982 Pan-American Symposium on High Energy Physics and Technology, held at Cocoyoc, Mexico; Fermilab was one of the organizers and sponsors of this symposium. There were about 50 attendees from Latin America, the U.S., and Europe, including such as J. Flores, M. Moshinsky, S. Glashow, J. Bjorken, and G. Charpak. In addition to the invited talks, there were extensive group discussions on HEP and its sociology, and also on the prospects for this activity in Latin America; the meeting gave specific encouragement to the formation of the UNAM HEP group led by C. Avilez.

A September 1982 visit by Lederman to Brazil was followed by the Second Pan American Symposium, held in Rio de Janeiro in July 1983; again, Fermilab was one of the organizers and sponsors. The meeting topic was broader than at Cocoyoc, involving branches of physics other than HEP, and also encompassing collaboration between physics and industry. The meeting was one factor leading to the formation of a Brazilian HEP group (A. Santoro from CBPF and C. Escobar from Sao Paulo). Another important outcome was the request to the U.S. NSF for a grant to aid physics in Latin America; this is discussed further below.

A third symposium in this series will be held in Rio de Janeiro, Brazil, in 1987.

Fermilab Latin American Activities

We give here short descriptions of the activities carried out up to the present time.

Sponsorship of Meetings in Latin America

We have already mentioned Fermilab's co-sponsorship of the Cocoyoc and Rio de Janeiro meetings; there was also co-sponsorship of a 1984 meeting in Guanajuato (Mexico) on advanced computers in HEP. For all of these meetings, Fermilab provided some financial support, help in the organization of the meeting, assistance in obtaining financial support from U.S. funding agencies, and assistance in obtaining U.S. speakers (including those from Fermilab). For the **Guanajuato meeting, Fermilab helped, in addition, to produce the conference proceedings.**

Simposio Panamericano de
Panamerican Symposium on
Física de Partículas Elementales y de Tecnología
Particle Physics and Technology
Enero 5, 6 y 7 de 1982 Cocoyoc, Morelos, México
January 5, 6 and 7, 1982 Cocoyoc, Morelos, Mexico



Entre los Participantes Estarán
Partial List of Participants

J. D. Bjorken • G. Cocho • J. Cronin • R. P. Feynman • C. Garcia Canal • S. Glashow • L. Lederman
J. Leite Lopes • R. Marshak • M. Moravosik • W. Panofsky • B. Richter • R. Saimeron • R. R. Wilson

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Fermilab Staff to Latin America

Many Fermilab physicists have given seminars and lecture courses at Latin American institutions. A partial list follows:

J. Bjorken	CINVESTAV, Mexico - Course on particle physics
I. Gaines	Rio de Janeiro, Brazil - Seminars on the Advanced Computer Program
R. Huson	Tegucigalpa, Honduras - Course on particle physics; advice on cosmic ray experiment UNAM, Mexico - Sabbatical
H. Johnstadt	Sao Paulo, Brazil - Seminars on HEP software development
H. Jöstlein	Bogota, Colombia - Course on vacuum techniques
E. Kolb	Rio de Janeiro, Brazil - Course on astrophysics
R. Rubinstein	Tegucigalpa, Honduras - Course on particle physics techniques; suggestions for physics thesis topics
M. Sokoloff	Rio de Janeiro, Brazil - Three months helping with analysis of collaboration experiment
L. Voyvodic	La Paz, Bolivia; Rio de Janeiro, Brazil - Talks on the interface of cosmic ray and particle physics
A. Wehmann	UNAM, Mexico - Sabbatical

Lectures at recent physics schools in Mexico have been given by R. Dixon, C. Hojvat, E. Kolb, R. Raja, and R. Rubinstein.

So far, all the topics of these visits have been physics related; recently, interest has been expressed in also having Fermilab speakers on engineering topics visit Latin American institutions.

Payment of the costs for these trips has been negotiated in each case between Fermilab and the receiving institution.

Theoretical Physics and Theoretical Astrophysics Visitors

Fermilab has had a program for many years for a limited number of visits by theorists from other institutions to its Theoretical Physics Department and Theoretical Astrophysics Group; these visits are usually, although not exclusively, during the summer months. Theorists from many foreign countries have taken part, including Mexico, Honduras, Brazil, and Argentina.

Ph.D. Students in HEP

CINVESTAV (Mexico) currently has three graduate students (H. Mendez, A. Morelos, and G. Moreno) working towards their Ph.D.'s on experiments at Fermilab; all had previously completed their Ph.D. course requirements at CINVESTAV. They now work under the supervision of Fermilab physicists,

who provide periodic progress reports to CINVESTAV. Assuming that the students' research is satisfactory, they will eventually receive CINVESTAV Ph.D.'s. **Some of them had previously spent a summer working at Fermilab,** before deciding that they wanted to do experimental HEP research. Fermilab has provided accommodations and some salary for the students.

HEP Groups

UNAM - Mexico: This group is led by C. Avilez, who had previously worked in theoretical particle physics. They have taken part in a just-completed Brookhaven National Laboratory experiment on $n+p \rightarrow \Omega$, etc., and are on an approved Fermilab experiment (E-690) studying charm hadroproduction. Avilez and an engineer have spent one-year sabbaticals at Fermilab. In addition to their HEP experiments, the group is also undertaking an ion-source development project, and assistance and information on this topic has been made available by Fermilab. (The history and experiences of the UNAM group was the subject of an invited talk by Avilez at the 1986 APS Washington Meeting.)

Brazil: This group of physicists from CBPF, Rio de Janeiro (J. Anjos, A. Santoro, M. Souza) and Sao Paulo (C. Escobar) is also composed of former theoretical physicists. Those mentioned spent two years at Fermilab working on a charm photoproduction experiment (E-691), and learning the techniques of experimental HEP. In their early days, this group, like their Mexican counterpart, had some difficulties in obtaining adequate financial support from their funding agencies, **but now this appears to be more assured.** They have borrowed equipment from Fermilab, and are in the process of setting up a lab at CBPF to construct and test equipment for future experiments. Currently they are analyzing data at CBPF from the photoproduction experiment, and are exploring the possibility of a computer link to Fermilab. An engineer from their group spent several months at Fermilab working on the Advanced Computer Program.

The CBPF group is now involved in an upcoming Fermilab experiment on hadro-production of charm (E-769); two graduate students are currently here preparing for the experiment, and the senior members will spend periods of several months at Fermilab during the coming year. Discussions are under way on the group joining the D0 detector collaboration, which is building the large second-generation detector to study $\bar{p}p$ collisions.

C. Escobar, of Sao Paulo, has joined an experiment (E-761) to study $\Xi^- \rightarrow \Sigma^- \gamma$; already one graduate student has been at Fermilab, and others are scheduled to come later.

Colombia: One particle physicist (Negret) from ACIF (Bogota) is working at Fermilab for a year on a small $\bar{p}p$ collider experiment (E-710). Other physicists who have received U.S. Ph.D.'s and returned to Colombia are exploring ways to stay in the field.

In each of the above cases of collaboration with Latin American HEP groups, Fermilab and the Latin American institution negotiate agreements on payment of salaries, transportation, and housing costs while the physicists are at Fermilab, and a variety of different arrangements have evolved.

Engineers to Fermilab

Several Latin American engineers have come to Fermilab, where they have been able to acquire experience with state-of-the-art equipment, while Fermilab has benefited from the services of some very skilled people.

- (i) S. Zimmerman (Porto Alegre, Brazil) worked for two years on FASTBUS data-acquisition electronics. During that time he also attended a nearby university in evenings, and obtained an M.S. degree in electrical engineering.
- (ii) O. Calvo (La Plata, Argentina) is currently in his second year here; his two projects have been a computer study of magnet current regulation for the Superconducting Super Collider and writing software for data-acquisition readout.
- (iii) R. Vignoni (La Plata, Argentina) is in his first year, and presently working on a data-acquisition system for speeding up CAMAC readout.
- (iv) C. Da Barros (CBPF, Brazil) worked for six months in Fermilab's Advanced Computer Program.

As in the case of visiting HEP physicists discussed earlier, arrangements for salaries, etc., are negotiated between Fermilab and the engineer's home institution.

Used Books and Journals

For several years, Fermilab has collected used books and journals from its staff for distribution to Latin American institutions; as would be expected, the

books and journals collected are mainly, although not exclusively, related to HEP (such as *Physical Review Letters* and *Physical Review D*). About once a year, a list of the material is sent to around 25 Latin American universities, and based on their requests, about 60 boxes of material are shipped each time.

NSF/APS Grant for Latin American Physics

During the 1983 Rio de Janeiro meeting mentioned earlier, there was considerable discussion of the financial crisis in Latin America, with the consequent shortage of foreign exchange in the countries there. It was realized that a relatively small amount of money could make a substantial impact in overcoming the effects of this crisis on the growing scientific infrastructure of the most developed countries in the region. An estimate was made that the sum of about \$300,000 per year would have a significant effect. This led to a grant request to the NSF by Lederman and Leo Falicov, which subsequently led to a (one-time) grant of \$300,000 to the American Physical Society (APS) for this purpose. The APS designated their International Physics Group (chaired then by Falicov and now by Rubinstein) to oversee the grant. By arrangement with DOE, it was administered by Fermilab, including purchasing, accounting, secretarial, etc., assistance, at no cost.

The five countries which received grant assistance were Argentina, Brazil, Chile, Mexico, and Venezuela; funds were used for per diem during visits to the U.S. (20%), page charges for publications in U.S. journals (15%), subscriptions to U.S. journals (20%), and small equipment items (45%). Representatives in each country solicited and selected requests from physicists and institutions in their countries, which were then transmitted to the U.S. administrators.

At the present time, the grant funds have all been expended; the response to this initiative from the recipient countries has been very positive, and the possibility of applying for a second grant is being explored. A more complete description of the grant and its administration is available (*Fermilab Report*, September 1985, page 11.)

Miscellaneous

A mathematician and computer specialist from UNAH, Honduras, visited Fermilab to study uses of an IBM 4341 computer.

A UNAH graduate student spent a summer here learning to use HEP equipment for a cosmic ray experiment.

Leon Lederman is honorary co-chairman (with Abdus Salam) of the Board of ACIF (Bogota).

In April 1986, a conference on the teaching of modern physics was held at Fermilab; among the attendees were about a dozen from Latin America, who held meetings with Fermilab staff on possible assistance from the Laboratory. Many suggestions were made, amongst them that copies of videotapes of the Fermilab lectures for high school students be made available, and that Fermilab should provide information to help in organizing similar meetings elsewhere.

Summary

Fermilab, which is already, by the nature of the research it undertakes, an international laboratory, has established relations with a number of Latin American physics institutions. The cooperative activities have included HEP, and also related fields such as engineering. Although use of Fermilab's funds is restricted to activities related to its HEP mission, that does not have to be too narrowly interpreted, and consequently many activities have been carried out which, hopefully, have helped advance physics in Latin America. We realize that what has been done so far can be improved and expanded, and are open to comments, criticisms, and suggestions.
