

Fermilab courts Latin American physicists

The lab wants to build on existing connections with Mexico and Central and South America as it begins to build a flagship neutrino lab.

As part of Fermilab's efforts to attract major international participation in the Deep Underground Neutrino Experiment (DUNE), laboratory officials are hoping to entice more Latin American physicists, their institutions, and their governments to join the megaproject.

Due for completion in 2026, DUNE was conceived as a global collaboration right from the start. Hosted by Fermilab, the project also consists of a large underground neutrino detector to be located nearly 1300 km away in South Dakota's Sanford Underground Research Facility (see PHYSICS TODAY, April 2015, page 22).

The \$1.5 billion that the US has committed to DUNE is expected to cover 60–70% of the total project cost. CERN has committed \$100 million in kind to DUNE so far, and that amount is expected to grow, says Tim Meyer, Fermilab's chief operating officer. Although India, Italy, Switzerland, and the UK are expected to be the other major DUNE in-kind contributors, lab officials hope that Brazil, with the largest Latin American economy and physics community, will join their ranks.

"The community of neutrino scientists needs to grow. And to make it grow, you need to support it," says Marcela Carena, director of international relations for Fermilab (see the story on page 25). Although the participation of individuals and institutions in the DUNE project will be arranged through the spokespersons for the collaboration, the lab can catalyze those interactions, she notes.

Fermilab's history of courting Latin American physicists dates to the 1980s, when then-director Leon Lederman helped establish research groups and organize symposiums across Central and South America, says Julian Felix, a physicist at the University of Guanajuato in Mexico. More recently, the Main Injector Experiment for Neutrinos-A



FERMILAB DIRECTOR Nigel Lockyer (left) and Marcela Carena, the lab's director of international relations, chat with Agustin De Madalengoitia, consul general of Peru, at an April workshop at Fermilab on Latin American neutrino physics.

(MINERvA) and particularly lab scientist Jorge Morfin have attracted Latin American participants to the lab, Felix says.

"We are essentially the first generation in Latin American high-energy physics," Felix says of himself and his colleagues. "The next one is getting ready to participate in MINERvA and other collaborations at Fermilab." He expects that his 18 undergraduate students, currently working on high-energy physics hardware, software, and cosmic ray topics, will be working on neutrino experiments at Fermilab as graduate students.

Emulating LHC

A two-day workshop at Fermilab in April on bringing Latin Americans into neutrino physics attracted 35 physicists from 20 institutions in Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Puerto Rico. Also attending were the consuls general from Argentina, Brazil, Mexico, Peru, and El Salvador.

Carena, an Argentinian, leads the lab's effort to attract physicists from abroad. She says the lab would like to see the same degree of international participation in DUNE as at CERN's Large

Hadron Collider, which has dozens of participating nations. In many Latin American countries, she notes, "there isn't a history of science being highly valued within the governments." Some don't even have a ministry for science.

At the workshop, Fermilab director Nigel Lockyer welcomed the consuls general, for whom Latin American lab scientists gave tours in the visitors' native languages. "You need support from ministers, funding agencies, and scientists," says Carena. "Unless you have the three things aligned it's very hard to start things that aren't on the agenda."

As a result of the workshop, she says, Fermilab scientists have been invited to speak at a fall workshop in Mexico that will be attended by representatives from the country's funding agencies. "Mexico really wants to invest in science; the issue is how do scientists get agencies interested enough to invest in their science. This is where we can help," Carena says.

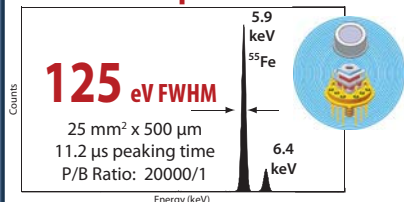
Last year, Carena, Flavio Cavanna (Fermilab's coordinator for CERN's ProtoDUNE facility, a testbed for DUNE detector prototypes), and DUNE co-spokesperson Mark Thomson of the University of Cambridge visited the research

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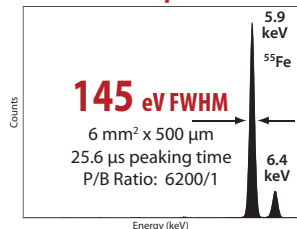
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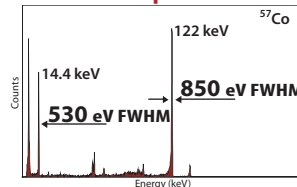
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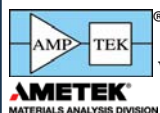
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foundation of São Paulo state in Brazil. Due in part to the trio's intervention, the University of Campinas (Unicamp) secured a \$1 million grant from the foundation in April. That money will go toward equipping a laboratory to develop a new instrument for detecting the flashes of light generated by passing neutrinos in liquid argon. Unicamp physicist Ettore Segreto says Fermilab has further helped his program by providing experimental infrastructure, including a tank of liquid argon.

The April workshop at Fermilab also gave scientists from five Colombian universities the opportunity to meet face-to-face with Thomson about joining DUNE, Carena says. Fermilab's outreach effort is viewed favorably in the US Department of Energy, which funds Fermilab and strongly backs DUNE's international charter.

Fermilab has numerous existing relationships with Latin American scientists and universities. The National Autonomous University of Mexico (UNAM), for example, is part of the MiniBooNE (MiniBooster Neutrino Experiment) collaboration at Fermilab. The Federal University of Goiás in Brazil operates 1 of 10 remote operations centers for Fermilab's Main Injector Neutrino Oscillation Search (MINOS) experiment. Other MINOS collaborating institutions are Unicamp and the University of São Paulo.

About one-quarter of the participating institutions in Fermilab's MINERvA experiment are in Latin America. Participants from Latin American institutions will also be involved in other current and planned neutrino experiments at Fermilab: NuMI Off-axis Neutrino Appearance, Liquid Argon in a Testbeam, and Short Baseline Near Detector.

"We are all getting the science out of the experiments. But we are also strengthening the science in these countries," Carena says.

Fernanda Garcia first came to Fermilab from Brazil as a graduate student in 1996. After completing her PhD in São Paulo, she returned to the lab in 2001, driven by excitement over the findings that the neutrino might have mass. Now leading Fermilab's linac group, she says Brazil's support for physics research has grown substantially since those days, and several Brazilians have now joined her at the lab. "When they get funding, they come and make huge impacts. You

set up a precedent, people are successful, and it grows," she says.

Garcia and Felix both say that participation in Fermilab experiments is especially instructive for Latin American physicists, who have virtually no experience working with industry to build the complex instruments needed for high-energy physics experiments.

Stemming brain drain

One side effect of bringing Latin American scientists to Fermilab, CERN, or other major experimental facilities is that they might not return to their native countries. According to Felix, new labs and research centers will need to be created to woo them back home. "The main challenge is to employ all those new PhDs in their home countries," he says.

One such facility could be in the offing: The Agua Negra Deep Experiment Site (ANDES) could be the Southern Hemisphere's first or second deep underground observatory (Australia's Stawell Underground Physics Laboratory is under construction). The proposed lab, which would piggyback on a 14 km transportation tunnel to be bored through the Andes to connect Argentina and Chile, would be the third deepest in the world. The tunnel has received the go-ahead from the two governments, and funding for it has been secured. It's hoped that the Inter-American Development Bank will provide funds for an experimental hall around 1700 m deep to be dug alongside the tunnel, says Xavier Bertou of Argentina's National Atomic Energy Commission, which is coordinating the ANDES project.

The lab's Southern Hemisphere location is of interest for dark-matter signal modulation studies (see PHYSICS TODAY, July 2016, page 28), and its location far from nuclear reactors offers a quiet background for neutrino experiments.

ANDES would join a growing number of world-class high-energy and astrophysics facilities in Latin America. Others include the Pierre Auger Observatory for cosmic rays in Argentina, the Cherenkov Telescope Array under construction in Chile, and the High-Altitude Water Cherenkov observatory in Mexico. Those are in addition to the numerous optical and radio telescopes in Chile.

David Kramer