

The University of Arizona at Fermilab and Beyond

The university group covers several prestigious experiments around the world, including two at Fermilab

by Donald Sena, Office of Public Affairs

The University of Arizona high-energy physics group may be relatively small with only four professors on the faculty, but the active team participates in three of the premier particle physics experiments in the world.

The Arizona group has responsibilities at the DZero collider detector and at the KTeV fixed-target experiment on the Fermilab campus, as well as at the ATLAS experiment at CERN, the European Laboratory for Particle Physics. All of this research stretches the understanding of how the universe works, and provides the Arizona students, both graduate and undergraduate, with invaluable experience at the forefront of particle physics experimentation.

Elliott Cheu, the newest faculty member at Arizona, said the aggressiveness of the group in pursuing the most interesting physics, as well as its support for his endeavors in matter-antimatter asymmetry, attracted him to the Tucson campus.

Arizona "has a diverse program for a small group of people. There are only four faculty members and [the group is] involved in ATLAS, DZero and KTeV," said Cheu. "And we are all doing significant work."

The University of Arizona graduates about 30 undergraduates with physics majors per year. The high-energy physics group has had six students receive their doctorates in experimental particle physics since the group's inception in 1988.

The Pre-Arizona Years

All four members of the group performed research at Fermilab before Arizona formed the particle physics group. In 1976, John Rutherford, then at the University of Washington, participated in Experiment 439, a dimuon experiment in competition with Fermilab Director Emeritus Leon Lederman's famed Experiment 288, which proved the existence of the bottom quark via the u particle. E439 was the first experiment to confirm E288's results when collaborators observed the u particle a few months later. Through the years, the two experiments spawned more

fixed-target studies that furthered similar physics, including E605, which Rutherford led along with Chuck Brown and Bob McCarthy.

Mike Shupe, first as a postdoc at the University of Illinois and later as a faculty member at the University of Minnesota, worked on several fixed-target experiments in the 1980s, concentrating on charm production and hyperon magnetic moments.

Ken Johns also ran several experiments at Fermilab starting in the early-1980s. The last of these was E800, where Johns was the co-spokesman. The experiment made the world's most precise measurement of the u magnetic moment, which aids in the understanding of the various quark models.

Particle Physics in Tucson

In the mid-1980's the University of Arizona Department of Physics solicited proposals to create a high-energy physics group. Rutherford and Shupe put together the winning proposal and

Some members of the University of Arizona DZero team. From left to right: Kevin Davis, graduate student; Ken Johns, Arizona professor; Ajay Narayanan, graduate student and Freddy Nang, Arizona postdoc.



Photo by Reidar Hahn

started the new group in the fall of 1988 to concentrate on the DZero experiment at Fermilab. A year later Johns and Geoffrey Forden joined the team. (Forden recently changed fields.)

The Arizona team, demonstrating their affinity for attacking various parts of a project, worked on complementary aspects of DZero. Rutherford, Shupe, Forden and their postdocs and graduate students worked on the liquid argon calorimetry, building electronics for the calorimeter test modules. The Arizona team also participated in the development of DZero's test beam.

Around the same period, Johns worked with the muon trigger system of the collider detector. Events produced by the violent proton-antiproton collisions must be "triggered" on by means of hardware electronics or software filters in order to record their presence. The more routine events are not permanently recorded, as the detector only keeps the most interesting, and possibly rare, events for later analysis by the collaborators.

Specifically, Johns and his students helped develop the level 1.5 trigger for muons. The level 1 muon trigger is hardware-based; the trigger is fast—deciding whether or not to keep an event every 3.5 microseconds—but it is not discriminating enough. The level 1.5 trigger is a more sophisticated version of level 1, according to Johns.

All members of Arizona's DZero team participated in the analysis of Run I data, and six Arizona doctorate theses were based on the data.

"Because we worked with the muon trigger, we were naturally drawn to physics that involved muons, so we were involved in studying a variety of topics in b physics. In fact, I was the b physics convener for the last two years at DZero," said Johns. "Our physics thrust, if you will, was tests of QCD using b quarks."

(QCD, or Quantum Chromodynamics, is the theory that explains the strong interactions of quarks and gluons. A "convener" is, in essence, the scientist in charge of organizing the analysis of the data, a demanding and time-consuming task.)

Johns said his group measured the b quark cross section, as well as the angular correlations between a produced- b and anti- b quark. The latter is a test

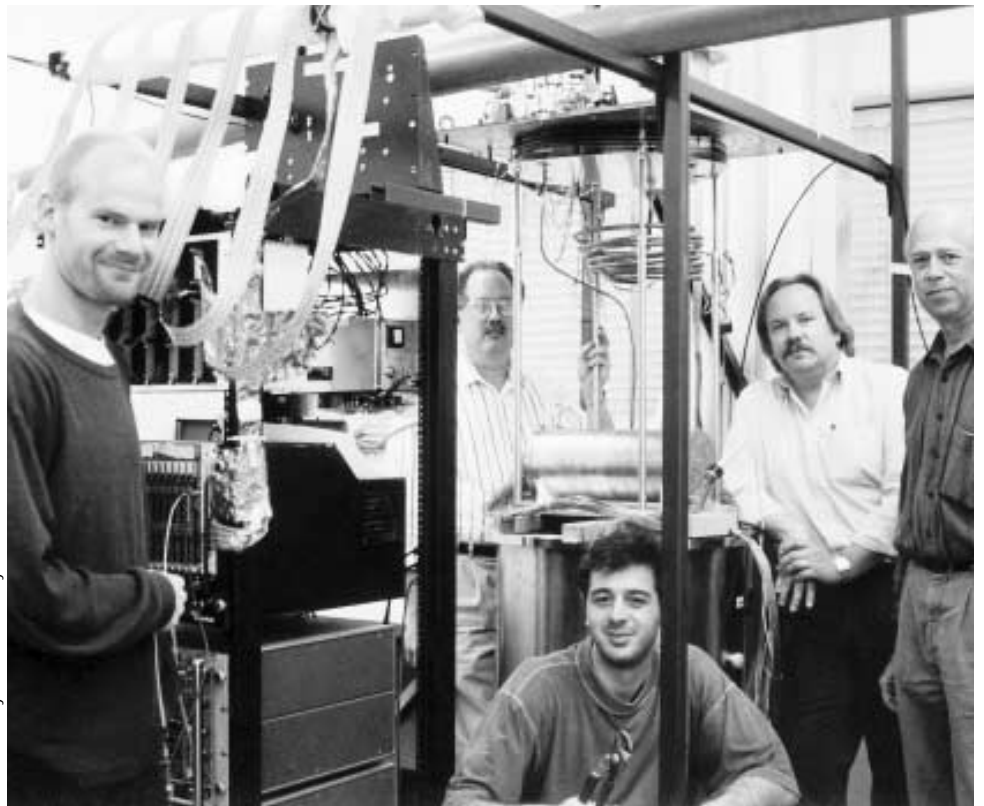


Photo courtesy of the University of Arizona

Some members of the University of Arizona high-energy physics group in a lab on the Tucson campus. Left to right: Dave Fein, postdoc; Mike Shupe; graduate student Levan Baboukhadia (kneeling); Leif Shaver, engineer; and John Rutherford.

of the details of how b quarks are made from protons and anti-protons, said Johns, and this picture can then be applied to other processes and other energies.

The Upgrade

Johns and Shupe have now turned their attention to the DZero upgrade. Johns and John Butler of Boston University are heading the \$8 million muon upgrade project, while the Arizona team is presently building the level 1 muon trigger. Johns said one of the more important aspects of the upgrade is involving students in the cutting-edge work. He said the Arizona group has a good record of including undergraduates at DZero, adding that it is important to him that students are exposed to experimental particle physics at a young age.

"Over the last four years, I have had six or seven [undergraduate] students work with me," said Johns. "For example, two of them right now are doing simulations of some of the designs we have for the level 1 muon trigger. It's really an important aspect of research."

Shupe is also immersed in DZero

upgrade work. Among other tasks, he is the co-chair of the Run II graphics committee for DZero, which is developing the next generation of event displays.

Kevin Davis is one of the graduate students working on analysis of Run I data and producing electronics for the upgrade. Davis said he plans on being around Fermilab for some time in order to see his work come to fruition.

"Working on the upgrade has gotten me interested in the hardware and wanting to see it operational," said Davis, during a recent interview in the DZero trailers.

KTeV

Arizona got back into the fixed-target business with the hiring of Cheu in 1996. At the University of Chicago, where he was a postdoc before coming to Arizona, Cheu worked at Fermilab on experiments researching CPT-violation and CP-violation, two theories that attempt to explain properties of particles and their antiparticle counterparts.

Cheu has continued this line of work by participating in the KTeV (Kaons at

URA Renews Contract

continued from page 1

the document specifies the scope of the physics research and support structure, identifies key personnel appointments requiring DOE approval, details permitted costs and covers many administrative issues as well, such as property and patent rights, foreign travel and employees' salaries and benefits. URA and Fermilab managers said they support the contract reform efforts that DOE is fostering among its laboratories.

"I believe this contract is a step in restoring the partnership between DOE and the university community that served this country well in the first quarter century after the end of World War II," said Fermilab Director John Peoples Jr. "That partnership has frayed badly over the past decade, but under new leadership, including Cherri Langenfeld at the Chicago Operations Office, we have made a great deal of progress in restoring this valuable relationship."

Contract Highlights

Those familiar with the document said the renewal is similar to past contracts except for one fundamental change—the addition of performance criteria and measures. These measures affect nearly all areas of the Laboratory, and include agreed-upon standards for Laboratory administration.

The contract specifies two basic types of performance measures: scientific and administrative. If, for example in the scientific category, the contract specifies 3,410 hours of fixed-target operations in FY 1997 and Fermilab reaches 90 percent or more of that goal, the Lab gets a rating of "outstanding." 80–89 percent is excellent, 70–79 percent is good, 60–69 percent is marginal and less than 60 percent is unsatisfactory.

On the administrative side, the new contract gauges how many procurement actions are awarded through a competitive process; 70 percent or more gains an outstanding rating, 60–69 percent is excellent, 50–59 percent is good, 40–49 is marginal and less than 40 is unsatisfactory.

At the end of the fiscal year, the lab receives an overall rating for the combined science measures and a separate



Photo by Reider Hahn

Andrew Mravca, head of DOE's Fermi Group (left), and Fermilab Associate Director Bruce Chrisman discuss the proposed contract in May 1996.

overall rating for administrative measures. If either the science or administration rating drops a notch from the prior year's performance, URA may lose some of its administrative fee. If Fermilab moves up in either of the two categories, the Lab must maintain that level in the future. (Future *FermiNews* stories will detail more of the performance measures in the contract.)

Some key reforms that DOE added to the contract were recommendations from a recent Energy Research Laboratory Procurement Report. Martha Krebs, director of Energy Research, commissioned the report to find ways to make the procurement process and other business dealings less burdensome on the ER laboratories. The report was well received at the laboratories as a step toward more efficient business practices and less bureaucracy, which save money and time, according to Andrew Mravca, head of DOE's Fermi Group. Jim Miller, also of DOE's Fermi Group, said most of the report's recommenda-

tions were incorporated in the new contract.

Another area of change affects fines and penalties. In the past, fines incurred by the Laboratory were an allowable cost; however, the new contract makes fines and penalties unallowable costs under many conditions, forcing URA to pay from its funds. This change puts more liability than ever before on URA and the Lab's shoulders.

Negotiating Process

DOE provided a draft contract to the URA/Fermilab negotiating team in May, and the team reviewed the contents. The two sides sat down at the table for the first time in mid-July. Bruce Chrisman, Fermilab associate director, said he remembers the timing well, as that was the first day of the 100-year rains in the Fox Valley. During the course of the talks, the two sides would bring in "functional" experts to address specific parts of the contract. These experts helped shape the document in their areas of expertise.

“All in all, it was a productive... atmosphere. Negotiations took longer than in the past because of the changes” toward performance-based measures, said Chrisman.

Not only did the changes affect the length of the negotiations, but also the strategy. Many of the “line-item” points of the contract were negotiated in parallel with the main talks. Since the proposed performance-measures affected specific areas or functions of the Lab, the DOE and URA/Fermilab negotiating teams sent representatives to those areas or functions to get opinions from the Fermilab staff members “in the trenches.”

Jack Pfister, Fermilab assistant director, and Paul Phillips, from DOE’s Fermi Group, visited numerous areas of the Laboratory and solicited comments and recommendations on the proposed measures from the people who actually do the jobs. Based on the staff recommendations, Pfister made counterproposals to Phillips and the two negotiated the fine points. The negotiation representatives would then bring their recommendations to the larger table as they reached compromises. This strategy proved extremely efficient, saving valu-

able time and forcing the negotiations to involve those most affected by the contract—the Fermilab staff and users.

“Clearly, the negotiating teams were a part of this process, but the recognition for the work [on the fine points] goes to Paul Phillips, Jack Pfister and the cast of thousands that reviewed” the points, said Chrisman.

After about two months of negotiations at Fermilab, the two teams reached a tentative agreement on the contract. DOE then went into its internal review process. The local negotiating team first presented the draft contract to Langenfeld at the Chicago office. After various reviews, the Chicago office passed it on to DOE headquarters in Washington, D.C., where it passed through more reviews. Contract changes flowed out of Washington, where the URA/Fermilab and local DOE negotiating teams addressed each revision as it arrived from D.C. Negotiators said there was some disagreement about this strategy, but in the end it proved successful, according to Chrisman.

DOE was also busily working on the contracts for the Princeton Plasma Physics Laboratory in New Jersey and Ames Laboratory in Iowa, along with

Fermilab’s document. The Princeton contract was signed the day after the Fermilab ceremony, and Ames received their signatures two days later.

Many people at DOE, URA and Fermilab praised the negotiators. Maurice Glicksman from Brown University led the URA team; other members included Chrisman, URA Corporate Counsel William Schmidt and consulting counsel Richard Hames from a Seattle-based law firm. DOE sent a team to the table led by Mravca, Miller, John Chapman and lead counselor Alan Handwerker.

“A lot of people from DOE, URA and Fermilab worked very hard on this contract. With that kind of cooperation, we are making good progress toward the objective of placing more responsibility where it belongs, on URA and the Laboratory management,” said Fred Bernthal, URA president. “Maurice Glicksman, of Fermilab’s Board of Overseers, deserves special thanks for service above and beyond the call of duty, working on this contract for long hours and for very, very low pay.” ■

Arizona

continued from page 7



Elliott Cheu works with KTeV hardware at Fermilab.

the Tevatron) study, which is focusing on particle interactions that lead to the observed predominance of matter over antimatter in the universe. The asymmetry between matter and antimatter—the fact that our world seems to be made mostly of matter, despite the fact that matter and antimatter are produced equally when photons pair produce—may hinge on CP-violation. Experimenters are pursuing the origins of CP-violation in the decay of kaon particles.

Specifically, Cheu is working with the software for the experiment, including the programs used by the scientists to reconstruct events. The Arizona assistant professor has also built a hardware trigger processor, which selects neutral energy events.

After KTeV, Cheu said he may turn his attention to ATLAS—one of the detectors planned for the Large Hadron Collider at CERN—where Rutherford and Shupe have been developing the forward calorimeter and working on radia-

tion background calculations and jet resolution calculations. The professors’ initial calorimeter work at CERN was intended for the Superconducting Supercollider experiment in Texas. However, when Congress canceled the SSC in 1993, the Arizona team proposed doing similar work for the CERN experiment, and ATLAS managers agreed. Arizona’s detector development on the Swiss—French border continues today, as Rutherford directs most of his energy there. Shupe, however, splits his time between ATLAS and DZero—a challenge that he says is demanding but still enjoyable.

“They turn out to be similar in some areas of calorimetry and QCD physics,” said Shupe. “There is a common physics thread.” ■