Physics in the fast lane
The John E. Edwards Accelerator Lab is the pride of the physics department

By Carmen Pease


A rare look inside the accelerator, which was opened for maintenance.

Built into a hillside along University Terrace, the boxy, two-story brick building is obscured from view by a fringe of trees. Thousands of students and faculty pass by the structure every day without even realizing it's there. But despite its inconspicuous presence, the John E. Edwards Accelerator Lab has a celebrity all its own, luring the likes of Harvard and MIT scientists to the pride of Ohio University's physics department: a rare 4.5 million-volt tandem accelerator that rushes atomic particles to energies up to 14 percent of the speed of light. Answering questions from the academic (How was the universe formed? How do atoms act?) to the applicable (How can neutrons be used to treat cancer or to detect explosives in airports?), the accelerator has forged a name for itself during its 33-year lifespan.

Deep under ground, inside 4-foot-thick, high-density cement walls, the accelerator works to create a low-energy ion beam that is accelerated as it makes its way through a web of vacuum tubes. Along this pathway are magnets that steer the beam to any one of the laboratory's six experiment stations. This is helpful because scientists can set up several semi-permanent research projects without having to worry about getting in one another's way. An experiment can run anywhere from a few hours to around the clock for a whole week. The magic happens at the end of the ion beam's channel, where the ions' collision with a target causes a reaction that can create neutrons, gamma rays or other charged particles.

Back to the Future

The 5,400-square-foot accelerator laboratory - worth $6 million to $7 million and named for the late John Edwards, BS '30 and MA '32, a 40-year member of the physics faculty - appears to be straight out of a sci-fi movie: Tangles of wires snake around a grid of computers, while control panels swarm with gauges, flashing lights and the ever-emblematic red button. Keep walking and you'll see what looks like a gigantic, orange, egg-shaped spaceship from a kitschy 1950s aliens-invade flick.

It seems fitting because the accelerator has its roots in that era, the heyday of anything and everything nuclear. Kick-started in 1967 with a $1 million

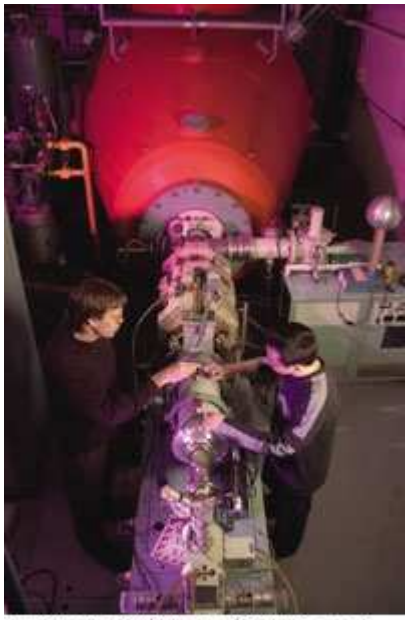
grant from the Atomic Energy Commission, its first experiments took place four years later.

The accelerator has changed little since, remaining true to the vision its makers had for it: "We needed a facility that would be visible on the national scene to do Ph.D.-level research," says Distinguished Professor Emeritus of Physics and Astronomy Roger Finlay, who was pivotal in launching the program. "Some of my greatest thrills came when the grad students discovered something, knew they had discovered something and could run with it."

Because learning was the pith of the project from the outset, this dedication to the accelerator program has yielded 250 to 300 projects through the years. One study looked at how neutrons can be used to treat such maladies as brain cancer, because conventional treatments like gamma rays carry the risk of destroying healthy tissue along with malignancies. The basic research conducted here is now fueling a new facility being built at the Massachusetts Institute of Technology. More recently, tests have been done to determine how neutrons can be used to detect bombs or look inside nuclear weapons. Even the National Institute of Standards and Technology, which determines standards for measurements and time, has turned to the accelerator for research purposes.

When Worlds Collide

The accelerator also links University departments, answering questions rooted in fields from geology to chemistry. This interdisciplinary approach is important especially for materials science, which uses the accelerator to look at the elemental composition of certain materials and identify or modify them. For instance, the accelerator can simulate the radioactive damage that might occur in space flight and help scientists build more resistant materials. Applications also exist in designing nuclear reactors, computer chips and semiconductors, and aerospace and automotive machinery. Finlay believes future research involving the accelerator lies in astrophysics, from deciphering a star's life cycle to delving into the particulars of the big-bang theory.



Assistant Professor of Physics and Astronomy Carl Brune, left, and doctoral student Catalin Matel work in the accelerator lab.

"We try to achieve a balance between pure research and practical, or applications, research because some of the 'impractical' findings can end up having applications that weren't planned," explains Distinguished Professor of Physics and Astronomy Steve Grimes, who has worked with the facility for 25 years. "Sometimes it takes five to 10 years to realize how important the findings really are."

While the lab is used more by faculty and graduate students for research projects, theses and dissertations, undergraduate physics majors also get introduced to the facility early in their collegiate careers. A recent proposal to the University Research Priorities Program strives to increase the role of the accelerator in undergraduate education as well as upgrade the laboratory, which is the only high-current, well-shielded particle accelerator in its energy range in Ohio and neighboring states.

"Operating the accelerator gives you the opportunity to learn and experience many of the things that you otherwise only read about in books," says Asghar Kayani, PHD '04, who used the laboratory for almost four years to study thin films such as those used in semi-conductors and computers. "I am working as a post-doctoral researcher at Montana State University, and I

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was offered this job mainly because of my experience with the accelerator."

Close Encounters

The accelerator helps researchers rake in about $1 million worth of grants every year, putting Ohio University and about half a dozen other academic institutions on par with national laboratories in terms of their capabilities and findings. What makes the Edwards Accelerator stand out is its striking versatility, which means it can be used for research in a broad spectrum of fields.

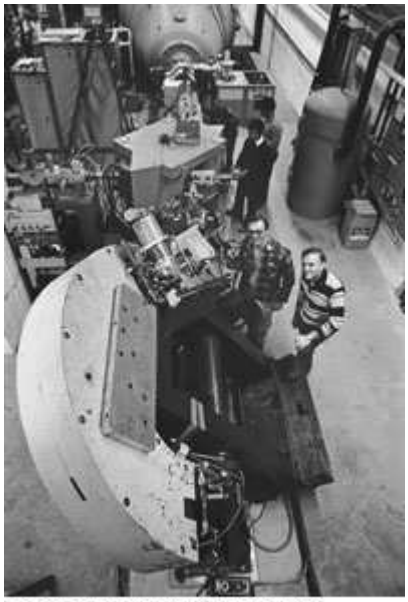
To begin with, there is only one other accelerator in the world with the same design and energy range, and, ironically, it's in Athens, Greece. Another essential facet of the accelerator is its ability to produce an intense, high-current beam. In the early years, it had the highest current around, Finlay remembers, which helped the lab stake its claim to longevity. To stand the test of time, there has to be money, and the diversity helped secure continued grants to keep the operation thriving.

"People come here to test out their idea because we have a general-purpose accelerator," explains Associate Professor of Physics and Astronomy David Ingram, the lab's chairman. "Then they can go to a more specific-purpose accelerator."

For instance, there's an accelerator at the Louvre Museum in Paris similar to the Edwards accelerator, and by using it to look at the elemental composition of certain works of art, scientists can judge whether they're the real deal.

Researchers have flocked to Ohio University from Warsaw to Tokyo; national laboratories in Oak Ridge, Tenn., and Los Alamos, N.M.; and universities that include the University of California at Los Angeles and Harvard.

The lab boasts an innovative 30-meter-long neutron time-of-flight tunnel, added in 1980, that has allowed the accelerator to carve out a sophisticated niche. This tunnel, like the rest of the laboratory, is well-shielded, which protects against radiation exposure. The amount of radiation emitted from the experiments varies depending on the particle beam and voltage, so the tests are administered remotely from a control room that also stores the test data.



Distinguished Professors Jack Rapaport, right, and Roger Finlay with the accelerator in its early days.

But the real advantage of the sturdy shield is that it stops radiation from entering the experiment space and interfering with the neutrons as they travel down the chute to detectors at the end. These detectors clock the time it takes the neutrons to travel the length and, from that, calculate their energy.

Neutrons have no charge and scatter easily, making them hard to accurately detect. The Edwards lab is able to overcome these hurdles with a unique pairing of a swinger magnet that directs the pulses of neutrons in a straight line down the chamber and its well-shielded features.

The Final Frontier

"During the '60s and '70s, there was a boom in this kind of fundamental physics research," says Assistant Professor of Physics and Astronomy Carl Brune, whose research focuses on the beginnings of the universe and processes at work within stars. "After about 10 or 15 years, most of the facilities in the country moved on. Our faculty, though, saw the possibility of

expanding the research and developing applications."

Look at the roster of Distinguished Professors (the University's highest faculty honor, which is given to one professor a year), and the accelerator research faculty is well-represented on the list of 43. Including Grimes, who joined the University shortly after accelerator research began, four of the five originals have been recognized with the title.

"That goes to show the level of accomplishment and how the accelerator has been able to sustain itself and gain permanence," Brune says.

But Grimes, looking outside this brick box of a building, believes the lab's greatest measure of success lies ahead.

"The most obvious long-term achievement of the accelerator is in the students who were able to work with it," Grimes says, hinting at the modest underpinnings of the project.

It may be that these apprentices of the Edwards Accelerator are on their way to making waves that are as yet only in our dreams.

Carmen Pease, BSJ '04, is a former student writer for University Communications and Marketing.

Ohio Today
102 Scott Quad, Ohio University
Athens, OH 45701
Tel: (740) 593-1890 or (740) 593-1891
Fax: (740) 593-1887
Email: ohiotoday@ohio.edu