Argonne NATIONAL LABORATORY

Physics

ATLAS upgrade allows scientists to reach even further for the stars

With an eye toward learning more about the elements that make up the universe and everything in it, Argonne scientists have reached the latest milestone in an upgrade of ATLAS, a leading facility for nuclear structure research in the United States.

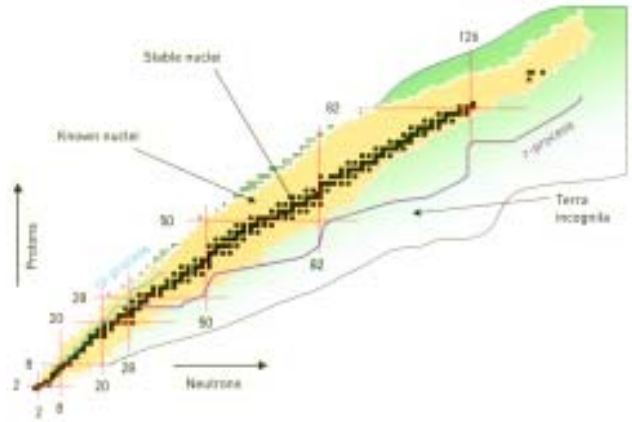
ATLAS — which stands for Argonne Tandem-Linear Accelerator System — provides beams and experimental instruments for nuclear reaction and structure research to scientists from the United States and around the world. In 2006, ATLAS had 436 active users. The upgrade will give the facility more versatility and open up new areas of scientific inquiry.

ATLAS is the world's first superconducting linear accelerator for heavy ions and is used by researchers to study the properties of the nucleus, the core of the atom, representing 99 percent of its mass.

Every element in the universe has its origins in the stars and explosions that started billions of years ago and are still going on in stars today. "If we want to understand these elements, if we want to understand the very material we are made of, we need to find a way to study these nuclei," said Robert Janssens, acting director of Argonne's Physics Division.

The ATLAS upgrade is called CARIBU, which stands for Californium Rare Ion Breeder Upgrade. It will provide for the acceleration of neutron-rich fission fragments from a californium-252 source to study neutron-rich nuclei, particularly those responsible for the production of a large fraction of the heavy elements in the universe. The upgrade will give researchers access to regions of the nuclear landscape – areas of unstable isotopes – that have been beyond the reach of current physics research facilities. The project is led by Project Manager Richard Pardo and Technical Director Guy Savard of the Physics Division.

According to Janssens, about 50 percent of the elements in the universe heavier than iron are created in this area of unstable isotopes. "We've only seen half of the isotopes that we believe actually exist," he said. "We will have the first peek at many new ones."



NUCLEAR LANDSCAPE – The "nuclear landscape" diagram illustrates the range of possible atomic nuclei based on the number of protons and neutrons each contains. Scientists have been able to observe and study only about half the nuclei believed to exist. The CARIBU upgrade to the Argonne Tandem Linear Accelerator System will provide the first glimpse of many more.

A critical component of CARIBU is a "gas catcher cell" developed by a team led by Guy Savard. Researchers recently passed a significant milestone in the design and performance of this device at the intensities needed for the upgrade. The gas catcher provides a new way to generate intense beams of short-lived radioactive isotopes by allowing researchers to manipulate fragments from a fission source into a coherent beam.

"No one else in the world has demonstrated the gas stopping technology to within orders of magnitude of the Argonne results," said Argonne physicist Don Geesaman. "CARIBU will make about 400 new beams available that we've never been able to accelerate before. We're going to have beams no one else has."

Researchers are now preparing to install the gas catcher device. And while the technology has been demonstrated in experiments, using it in the operation of CARIBU/ATLAS will allow physicists to test the

GAS CATCHER – Argonne physicist Guy Savard examines a gas catcher cell being installed for the CARIBU updated to the Argonne Tandem Linear Accelerator System. The cell provides a new way to generate intense beams of short-lived, exotic nuclear isotopes for basic research in nuclear physics and other sciences.

technology in what Geesaman and Janssens call "battle conditions."

"It's extremely challenging technology," said Geesaman. "There is no place but Argonne that could come close to doing this project on this budget. It's a beautifully sweet fit to our technological talents and the equipment we have." He adds that the research carried out at the Argonne facility will be highly complementary to other physics efforts worldwide.

The physics research conducted at the facility may seem esoteric to some, but Geesaman stresses that "our experience shows there are significant applications that can come out of this. For example, measurements we can make on the decay heat of particular fission products are important for people designing advanced fuel cycles." Other future applications also may include new medical applications and insights into materials that could lead to the development of, for example, better disk drives.

But, like all physicists, both Geesaman and Janssens are ultimately driven by the desire to learn how nature works at the most fundamental level. "The nucleus is the core of matter. It is the fuel of stars," said Janssens. "Carl Sagan said we're all stardust, but you know, it's true. Without the stars, we wouldn't be here."

While CARIBU is important for ongoing research at ATLAS, it could also be crucial for the next level of physics research in the United States. That next step is the construction of an Advanced Exotic Beam Laboratory, a project the U.S. scientific community has labeled one of its highest priorities. It is expected that a request for proposals for this new facility will be made in 2008. Argonne's experience with CARIBU will help researchers learn where to focus their attention when they write their proposal for bringing the facility to Argonne.

The cost of CARIBU is $4.75 million, with $3.6 million of that total coming from new funding and the rest coming from redirection of ATLAS funds. Funding comes from the U.S. Department of Energy's Office of Nuclear Physics. Coupled to CARIBU are other facility upgrades including the installation of new classes of accelerating structures in an energy upgrade and the installation of a new experimental device called HELIOS – Helical Orbit Spectrometer – an instrument designed to make optimal use of the new CARIBU beams. The project is scheduled to be completed in the second quarter of fiscal year 2009.

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