ARGONNE
NATIONAL
LABORATORY
Pioneering Science and Technology

THE RARE ISOTOPE ACCELERATOR PROJECT

■ What are the origins of the elements – oxygen, carbon, nitrogen, iron and the other building blocks of the universe and everything in it?

■ What are the laws governing nuclear matter? The elements differ in the numbers of protons and neutrons that make up their nuclei.

■ How do stars evolve, and how does their evolution affect the evolution of galaxies and planets?

■ How much "ordinary" matter is there in the universe, and what is the rest made of?

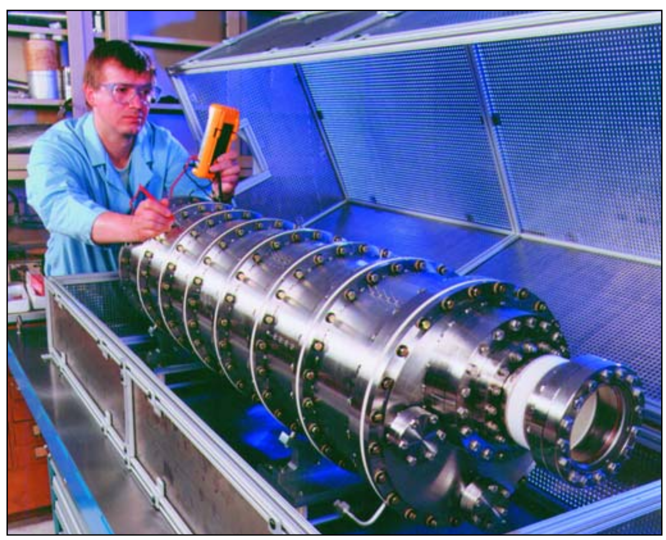
These are some of the fundamental questions of modern physics.

One of the most exciting aspects of today's science is that fundamental physics can be explored simultaneously in the laboratory and in nature. Scientists can look for answers by measuring in the small, observing in the large, and using theory and simulations to synthesize understanding. The tools for simulation and synthesis are ever more powerful computers. The tools for observing the large are the various telescopes used by astronomers – including SNAP, the Supernova/Acceleration Probe. And the tool for observing the small will be RIA – the Rare Isotope Accelerator.

> *"Some of you may ask what is the good of working so hard merely to collect a few facts which will bring no pleasure except to a few long hairs who love to collect such things and will be of no use to anybody, because only a few specialists at best will be able to understand them. In answer to such questions I may venture a fairly safe prediction. The history of science and technology has constantly taught us that scientific advances in basic understanding have sooner or later led to technical and industrial applications that have revolutionized our way of life. It seems to me improbable that this effort to get at the structure of matter should be an exception to the rule. – Enrico Fermi, discussing nuclear research, January 10, 1952*

Why RIA?

RIA would produce and accelerate very short-lived nuclei (rare isotopes). Examination of these isotopes and their reactions will answer important questions in nuclear physics and astrophysics, and the study of fundamental interactions at low energy. Such studies require yields of short-lived nuclei far in excess of what are currently available, a fact long recognized by the international nuclear physics community and reflected by investment in that field around the world. The U.S. nuclear physics community recognizes the impor-



This "gas catcher cell" developed at Argonne for the Rare Isotope Acclerator provides a new way to generate intense beams of short-lived, exotic nuclear isotopes for basic research in nuclear physics and other sciences. The device magnetically separates energetic exotic ions produced in thin targets and brings them to rest in a catcher cell filled with pressurized helium. This new technology will help give physicists high-quality exotic beams of any element in the periodic table.

tance of such studies and recommended in its 2002 long-range plan that the next-generation facility, RIA, be the highest priority for new construction in nuclear physics.

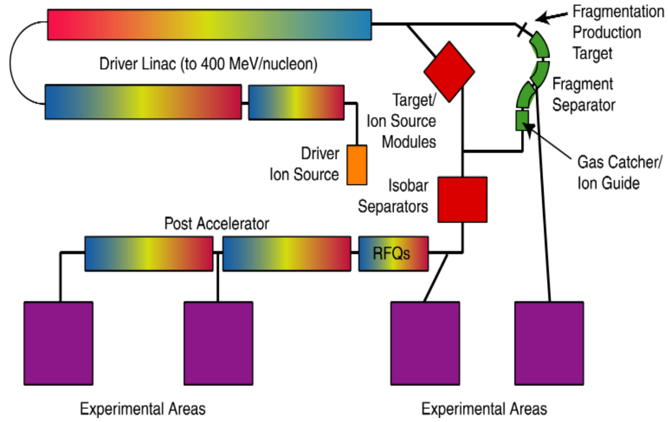
RIA will direct beams of unstable nuclei (rare isotopes) into targets. Examination of the impact will address important open questions that concern our own origins and our understanding of cosmic events. It will provide critical information previously impossible to obtain on such topics as how elements formed during and shortly after the Big Bang, energy generation in stars, heavy-element production in supernovas, nuclear structure effects in unstable nuclei, and nuclear decay, reactions, and structure.

Applications

In addition to helping answer fundamental questions, RIA has important applications in such fields as medical and industrial radiology, and in national security. Expanding knowledge of radioisotopes will pave the way for new ways to track disease and industrial wear. Establishing properties of rare isotopes will permit fingerprinting of nuclear explosions, which will enable identification of the source of devices that might be used by terrorists. It could also facilitate the stewardship program for the nuclear weapons stockpile without requiring testing of the weapons.

Concept

Work at existing facilities has laid the ground work. The concept for RIA evolved from work at Argonne National Laboratory, incorporating new technologies that overcome current limitations and make RIA much more powerful than any related facilities. This is done by combining the best isotope-production and in-flight fragmentation technology with novel approaches to handling high primary-beam power. A versatile primary accelerator allows for various production and extraction schemes to optimize the desired beams. These schemes make extensive use of the superconducting radiofrequency technology developed at Argonne for its existing heavy ion accelerator, the Argonne Tandem-Linac Accelerator System (ATLAS).



Schematic layout of the RIA complex.

Technologies to be used were developed through a vigorous R&D program initiated at Argonne that now involves groups at the Thomas Jefferson National Accelerator Facility; the National Superconducting Cyclotron Laboratory (at Michigan State University); the Texas A&M Cyclotron Institute; Colorado School of Mines; and Los Alamos, Lawrence Berkeley, Lawrence Livermore, Oak Ridge, and Brookhaven national laboratories. These R&D efforts have demonstrated the feasibility and effectiveness of the proposed facility.

Sponsor

U.S. Department of Energy, Office of Nuclear Physics.

Contacts

Robert Rosner
Chief Scientist
Phone: 630/252-7727
Fax: 630/252-7923
r-rosner@anl.gov

Jerry Nolen
Physics Division
Phone: 630/252-6418
Fax: 630/252-9647
nolen@anl.gov

John Schiffer
Physics Division
Phone: 630-252-4066
Fax: 630-252-2864
schiffer@anl.gov

Don Geesaman
Physics Division
Phone: 630/252-4004
Fax: 630/252-3903
geesaman@.anl.gov

Argonne National Laboratory is operated by the University of Chicago for the U.S. Department of Energy's Office of Science.