LEAF

Argonne National Laboratory's

Low-Energy Accelerator Facility

Argonne NATIONAL LABORATORY

LEAF enables life-saving advances and groundbreaking research

Argonne National Laboratory's 50 MeV/25 kW electron linear accelerator can produce a wide range of useful radioisotopes for medical, national security, basic science and industrial applications.

Supporting Peaceful Nuclear Energy Research

From its roots in the World War II-era Manhattan Project, Argonne's Nuclear Energy program has grown to support peacetime uses of nuclear technology for the production of energy, scientific exploration and medical diagnostics and therapy. Particle accelerators are important tools in these efforts.

Particle accelerators use electric fields to speed up and increase the energy of a beam of particles. These particles are steered and focused with magnetic fields. The Low-Energy Accelerator Facility (LEAF) consists of an electron linear accelerator (LINAC) and a Van de Graaff (VDG) electron accelerator. Originally built in 1969, the LINAC recently underwent a significant upgrade to increase the beam power and energy.

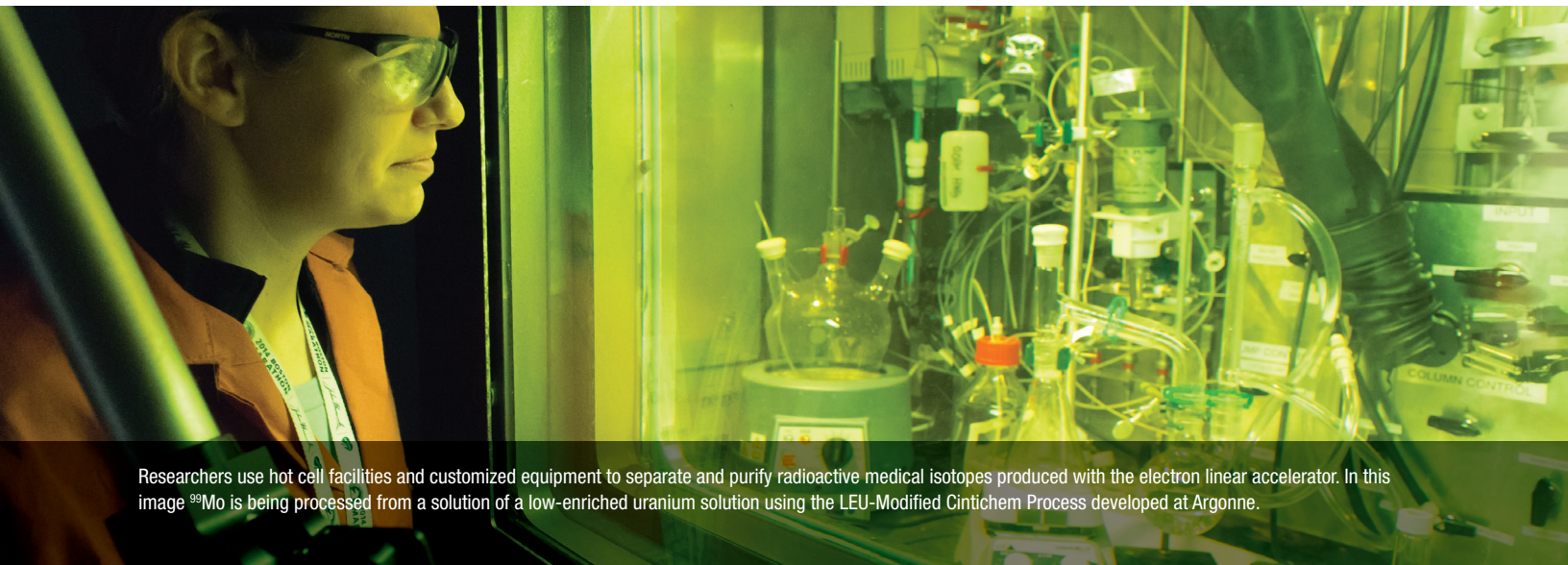
Researchers in the Nuclear Chemical Engineering Department of Argonne's Nuclear Engineering Division use the LEAF for a wide range of applications. This talented team of radiochemists, chemical and nuclear engineers, health physicists and experienced technicians supports multiple programs on behalf of sponsors such as the U.S. Department of Energy's (DOE's) National Nuclear Security Administration, U.S. DOE Office of Science Isotope Program and the Defense Threat Reduction Agency.

General Applications

- Radioisotope separation and purification method development
- Radioisotope production
- Targetry
- Radiation testing and material response to received dose
- Material activation

Applications in Medical Isotopes

- Pilot-scale testing for the production of ^{99}Mo
  - Method 1: sub-critical fission of low enriched uranium solution
  - Method 2: photon absorption (γ,n) on enriched ^{100}Mo targets
- Production and purification of radiotheragnostic isotopes ^{67}Cu and ^{47}Sc
- Development of chemical recycling methods for enriched target materials
- Development of production methods and generators for alpha emitting radioisotopes



Researchers use hot cell facilities and customized equipment to separate and purify radioactive medical isotopes produced with the electron linear accelerator. In this image ^{99}Mo is being processed from a solution of a low-enriched uranium solution using the LEU-Modified Cintichem Process developed at Argonne.

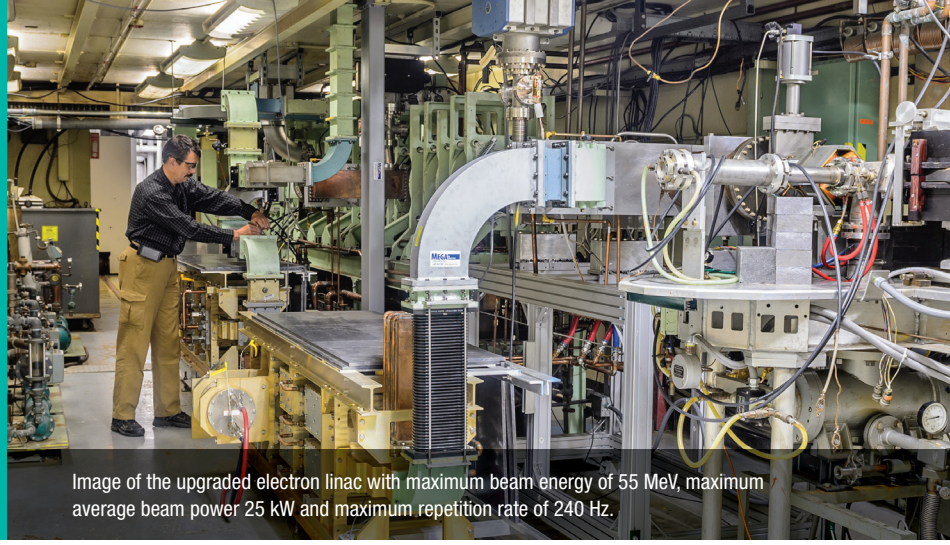


Image of the upgraded electron linac with maximum beam energy of 55 MeV, maximum average beam power 25 kW and maximum repetition rate of 240 Hz.

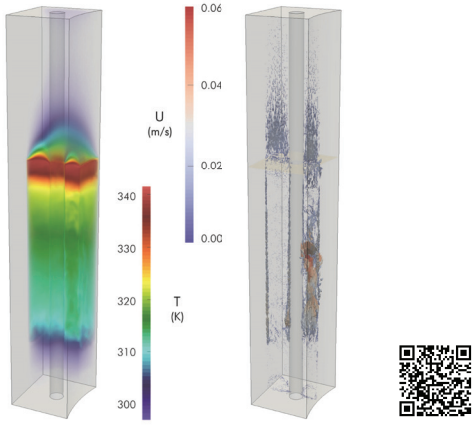
Key Facts about the LEAF

LINAC

- Classified as an accelerator facility by the U.S. Department of Energy, the LEAF operates under an approved accelerator safety envelope. A safety team that includes experts in health physics, ergonomics and industrial hygiene supports the facility.
- The electron linac can deliver continuous or pulsed beams with energy up to 50 MeV and average power of more than 20 kW.
- Several target station locations provide ample access for operations and post-run remote target transfer.

VDG

- The VDG electron accelerator is used to investigate and test critical experimental equipment and materials for radiation hardness and stability.
- The low-energy (3 MeV) VDG accelerator is capable of Pulse and Continuous modes.
- The VDG accelerator provides the capability to deliver high levels of electron/photon dose rates to critical components without presenting activation and handling hazards of the irradiated targets.



Results from an unsteady, 3D, multiphase CFD simulation including heat transfer using modified Open FOAM solver two-phase Euler Foam. Full helium gas headspace and sample in/out flow included and volumetric heat generation rate used directly from MCNP6 simulation results. Scan Qr code for video.

About the Team

The Nuclear Chemical Engineering Department of Argonne's Nuclear Engineering Division offers a wide range of expertise, capabilities and facilities, described below.

Expertise

- Separation sciences and technologies
- Nuclear and chemical engineering process development
- Radiochemistry
- Analytical chemistry
- Targetry
- Electron accelerator physics
- Theoretical simulations
- Radiation effects and dosimetry
- Radiation chemistry

Related Facilities

Hot Cells

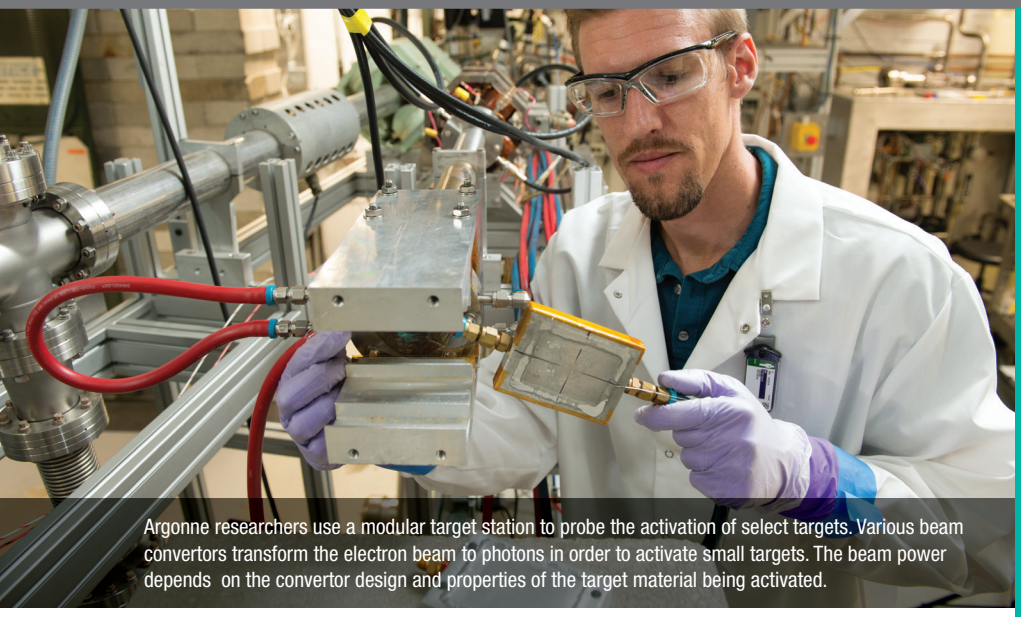
- Support for separations activities and the ability to introduce and remove samples safely and efficiently
- Adequate shielding for hundreds of Ci of medical isotopes
- Large interior working areas
- Interior equipment within each cell, customizable as needed
- Manipulator mock-up area for pre-job testing of equipment and processes

Radiochemical Laboratories

- Available for processing materials, final chemical processing, quality control and quality assessment

Analytical Chemistry Laboratory

- Provides advanced radiometric and chemical analyses and purity checks



Argonne researchers use a modular target station to probe the activation of select targets. Various beam convertors transform the electron beam to photons in order to activate small targets. The beam power depends on the convertor design and properties of the target material being activated.

A World Leader in Nuclear Science and Technology

Argonne National Laboratory imagines, develops and integrates new nuclear technologies and demonstrates them in tangible ways by applying its unrivaled talent and global experience. The laboratory develops future experts and drives collaborative problem-solving among academia, industry, government and international partners to ensure the sustained availability and security of nuclear energy.

Working with Argonne

Cooperation with universities, other laboratories and industry is an important element of our programs.

Access to Argonne's technology, facilities and research assistance is available to industry, universities and other federal agencies through a number of partnership models described at www.anl.gov/technology/partnerships.

Argonne, the Nuclear Engineering Division and the LEAF routinely accept students, postdocs and visiting scientists for short-term appointments on a wide variety of ongoing programmatic research projects.

On the cover

LEAF's electron LINAC is equipped with three beam lines, enabling multiple target stations.

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U.S. DEPARTMENT OF ENERGY

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