

# R&D TECHNOLOGIES

Advancing Nuclear Physics Research



Jefferson Lab is home to more than 35% of the world's integrated operational experience with SRF particle accelerators.

Jefferson Lab's  
advanced SRF  
technology  
enables more  
efficient, highly  
reliable particle  
beams.

Jefferson Lab is home to the Continuous Electron Beam Accelerator Facility (CEBAF), a world-leading particle accelerator for exploring the nature of matter. The laboratory is a preeminent source for accelerator technologies, cryogenics, and imaging and radiation detection systems.

## SRF TECHNOLOGIES

CEBAF is the first large-scale installation of superconducting radiofrequency (SRF) accelerator technologies, which allow energy to flow through a material with very little resistance. SRF components provide enhanced levels of effectiveness, efficiency and precision for particle accelerators, allowing CEBAF, for instance, to run on one-third the power it would

otherwise require.

SRF accelerator technologies are built on niobium, a silvery metal that becomes superconducting at temperatures near absolute zero, enabling it to harness and sustain the high fields needed to accelerate particle beams. In CEBAF, specially fabricated niobium devices, called cavities, carry the RF fields.

Each cavity is meticulously cleaned and performance tested before being assembled with other cavities into a modular SRF accelerator unit, called a cryomodule. A CEBAF cryomodule is about three feet in diameter and 30 feet long. It weighs roughly 12,000 pounds and contains eight SRF cavities and at least 1,000 major parts,

including many Jefferson Lab patented technologies.

All of the cryomodules in the CEBAF accelerator (50+) were built and tested at Jefferson Lab before installation, as were 23 cryomodules for the Spallation Neutron Source at Oak Ridge National Laboratory. Jefferson Lab is currently building 18 cryomodules for the Linac Coherent Light Source II at SLAC National Accelerator Laboratory.

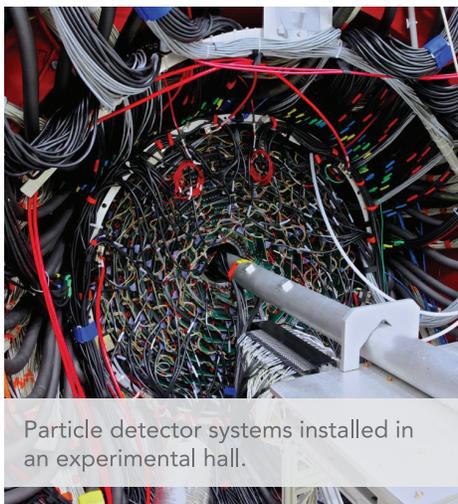
As a world leader in SRF technologies for research and industry, Jefferson Lab is one of the few facilities where cavities are conceived, designed, fabricated, processed and tested. In all, more cryomodules and different cryomodule designs have been built here than anywhere else.

## INJECTORS AND SOURCES

Jefferson Lab staff also has extensive expertise in designing, building and operating accelerator injectors and sources. As nuclear physicists investigate nature ever more deeply, they require

## Our leadership in large-scale cryogenic systems is an important national resource.

increasingly exacting characteristics from CEBAF's electron beams. CEBAF's injector produces the electron beam, establishes its special characteristics, and then injects it into the accelerator. Improvements to the CEBAF injector have enabled it to provide some of the most highly polarized electron beams in the world (most of the electrons are spinning in a preferred direction).



Particle detector systems installed in an experimental hall.

## CRYOGENICS

Jefferson Lab has developed a unique capability in large-scale cryogenic system design and operation.

Inside a cryomodule, a constant stream of liquid helium bathes the niobium cavities to keep them cold enough to maintain superconductivity. Cooling the 50-plus cryomodules in CEBAF requires an industrial-scale refrigeration plant operated and maintained by Jefferson Lab's Cryogenic Engineering Systems department. Nationally, the group is a premier source of cryogenic

engineering and design expertise for large helium refrigerator projects, filling a void in commercially available services for effective design and efficient operation.

## DETECTOR TECHNOLOGIES

Jefferson Lab staff also researches, develops, constructs and tests novel high-resolution and high-sensitivity detector and imaging systems for a



Many different cryomodule designs have been built and tested at Jefferson Lab.

variety of challenging environments and applications.

Detectors are the "eyes" of nuclear physics experiments. In a typical experiment at Jefferson Lab, a beam of electrons is directed into a target material. Sophisticated detector systems capture the sprays of subatomic particles generated by the collisions and measure or calculate the particles' speeds, directions and energies. Physicists can reconstruct the collisions for studying the heart of matter from this data. Beyond nuclear physics, this highly specialized knowledge has also been utilized in medical imaging, plant biology research, and homeland security applications.

THOMAS JEFFERSON  
NATIONAL ACCELERATOR FACILITY

12000 Jefferson Avenue, Suite 15,  
Newport News, Virginia 23606  
(757) 269-7100  
jlabinfo@jlab.org • www.jlab.org

Jefferson Lab is managed and operated by Jefferson Science Associates, LLC, a joint venture between Southeastern Universities Research Association, Inc., and PAE.

