

# JEFFERSON LAB

## WHAT IS JEFFERSON LAB?

Jefferson Lab is a U.S. Department of Energy national laboratory. Its primary mission is to conduct basic research that builds a comprehensive understanding of the atom's nucleus. Scientists from around the world use the laboratory's facilities to conduct their research. In addition, the laboratory also conducts applied research with industry and university partners through its nuclear imaging group and a free-electron laser based on technology developed at the laboratory. Jefferson Lab also provides a variety of teacher and student programs as it reaches out to help educate the next generation in science and technology.

## WHAT MAKES JEFFERSON LAB UNIQUE?

Superconducting electron-accelerating technology makes the laboratory unique. Researchers use Jefferson Lab's Continuous Electron Beam Accelerator Facility (CEBAF) – the first large-scale application of SRF – to conduct experiments. The accelerator provides high-energy electron beams for probing the sub-nuclear realm, revealing how quarks make up protons, neutrons, and the nucleus itself. Using this same superconducting electron-accelerating technology, Jefferson Lab staffers designed and constructed a laser of unprecedented power and versatility called a free-electron laser. This laser offers unique capabilities for defense, basic research and manufacturing processes.

## JEFFERSON LAB FACTS

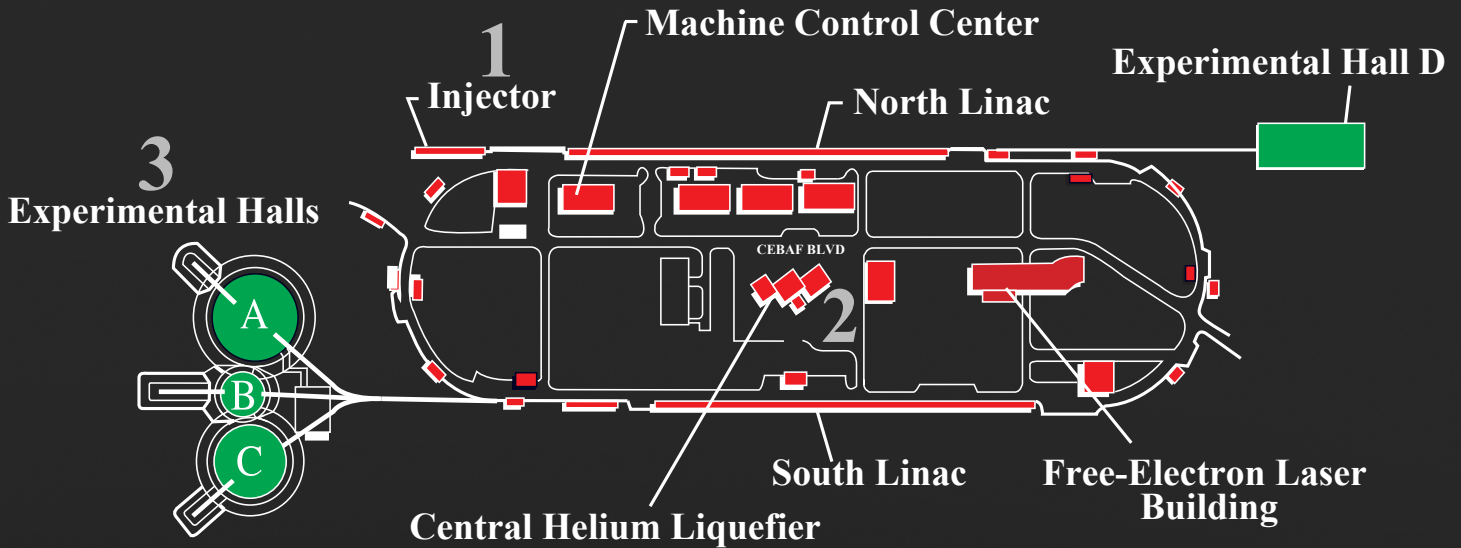
- Jefferson Lab is managed and operated by Jefferson Science Associates, LLC, a joint venture between South-eastern Universities Research Association, Inc., and Computer Sciences Corporation Applied Technologies, LLC, under a contract with the U.S. Department of Energy.
- Jefferson Lab is an investment of the federal government, the Commonwealth of Virginia, the City of Newport News, foreign contributors and the U.S. nuclear physics research community. The laboratory's annual budget is more than \$200 million.
- Jefferson Lab is constructing a 12 GeV Upgrade, a \$310 million project expected to be completed in 2015 that will double the accelerator beam energy. Also part of the project is a new experimental area (Hall D) and associated beamline.
- Approximately 700 people are employed at Jefferson Lab.
- Approximately 1,300 scientists from around the world conduct experiments at Jefferson Lab.



## SIGNIFICANT DATES

- |      |   |
|------|---|
| 1984 | Initial federal funds received  |
| 1987 | Construction began on the Continuous Electron Beam Accelerator Facility (CEBAF)   |
| 1995 | Physics experiments started at CEBAF  |
| 1996 | Name changed from CEBAF to the Thomas Jefferson National Accelerator Facility (Jefferson Lab)   |
| 1997 | CEBAF full-design energy – 4 GeV (billion electron volts) – delivered to all three experimental halls   |
| 2000 | CEBAF ~6 GeV beam delivered to experimental halls, exceeding machine design by 50 percent   |
| 2000 | JLab received contract to engineer and assemble the superconducting accelerator components and to design and oversee installation of the helium refrigeration plant for the Spallation Neutron Source at Oak Ridge National Lab |
| 2003 | Groundbreaking data published on the shape of the proton  |
| 2004 | DOE approved “mission need” for JLab’s 12 GeV Upgrade   |
| 2005 | JLab data revealed that the contribution of strange quarks to proton properties is small  |
| 2005 | Free-Electron Laser earned R&D 100 Award  |
| 2006 | Upgraded Free-Electron Laser surpassed 10kW design to achieve 14.2 kW in the infrared   |
| 2007 | Cryogenics Group wins prestigious White House award for energy-saving advancements  |
| 2009 | Construction begins on 12 GeV Upgrade   |
| 2010 | Construction begins on Technology and Engineering Development Facility  |

## ACCELERATOR SITE



### DID YOU KNOW?

- CEBAF is the world's most powerful "microscope" for studying the nucleus of the atom.
- If CEBAF weren't superconducting, it would require three times as much power to operate and performance would be greatly reduced.
- The accelerator tunnel was built 25 feet below the Earth's surface on the "Yorktown Formation" – an old sea bed. Approximately 25,000 cubic yards of concrete were used to build the tunnel – the equivalent of 12 miles of concrete trucks lined up end-to-end. The tunnel will be expanded as part of the 12 GeV Upgrade.
- More than 2,200 magnets in 58 varieties focus and steer the electron beam. They range in size from a few inches to three yards and weigh as much as five tons.
- Hall B can collect more than two Terabytes of data per day. That's enough data to fill the fronts and backs of a stack of bond paper 12 miles high.
- The electron beam travels around the 7/8-mile racetrack-shaped accelerator five times in about 22 millionths of a second at nearly the speed of light. At that speed, the electron beam could circle the Earth 7.5 times in one second.
- The mass of an object increases as its relative speed increases. At CEBAF's original design energy, (4 GeV), the electrons increase in mass 7.916 times.

### HOW DOES THE CONTINUOUS ELECTRON BEAM ACCELERATOR WORK?

1. The electron beam begins its first orbit at the injector and proceeds through the underground racetrack-shaped accelerator at nearly the speed of light.
2. The accelerator uses superconducting electron-accelerating technology to drive electrons to higher and higher energies. A refrigeration plant, the Central Helium Liquefier, provides liquid helium for ultra-cold (-456°F) superconducting operation.
3. The electron beam can be split for use by three simultaneous experiments in the experimental halls, which are circular, domed chambers with diameters ranging from 98 to 172 feet. Special equipment in each end station (also known as experimental halls) records the interactions between incoming electrons and target materials. The "continuousness" of the electron beam is necessary to accumulate data at an efficient rate and yet ensure that each interaction is separate enough to be fully observed.

Rev. 02/10

Jefferson Lab



12000 Jefferson Avenue, Suite 15, Newport News, Virginia 23606  
Phone (757) 269-7689 • Fax (757) 269-7398 • [www.jlab.org](http://www.jlab.org)