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 worldwide use the laboratory's facilities to conduct their research. In addition, the laboratory performs advanced computing and applied research with industry and university partners through technologies and expertise developed at the laboratory. Jefferson Lab also provides a variety of teacher and student programs designed to encourage workforce development in science and technology fields.

What makes Jefferson Lab unique?

Using Superconducting Radiofrequency (SRF) technology to accelerate its electron beam makes the laboratory unique. Researchers use Jefferson Lab's Continuous Electron Beam Accelerator Facility (CEBAF) – the first large-scale application of SRF technology – to carry out experiments. The accelerator provides high-energy electron beams of up to 12 billion electron-volts (12 GeV) 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 an accelerator that also powers a laser of unprecedented versatility called a free-electron laser.

Jefferson Lab facts

• Jefferson Lab is managed and operated by Jefferson Science Associates, LLC, a joint venture between Southeastern Universities Research Association, Inc., and PAE Applied Technologies under a contract with the U.S. Department of Energy.

• Jefferson Lab is an investment by 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 about $150 million.

• Jefferson Lab is in the final stages of conducting a major upgrade of CEBAF, a $338 million project called the 12 GeV Upgrade, which is scheduled for completion in 2017. It doubles the accelerator beam energy and includes a new experimental area (Hall D) and other upgrades.

• More than 700 people are employed at Jefferson Lab.

• More than 1,500 scientists from around the world carry out 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 the three original experimental halls

2000 CEBAF ~6 GeV beam delivered to experimental halls, exceeding machine design by 50 percent

Experiments revealed the proton's charge distribution is larger than its magnetic field

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

2008 Construction began on 12 GeV Upgrade

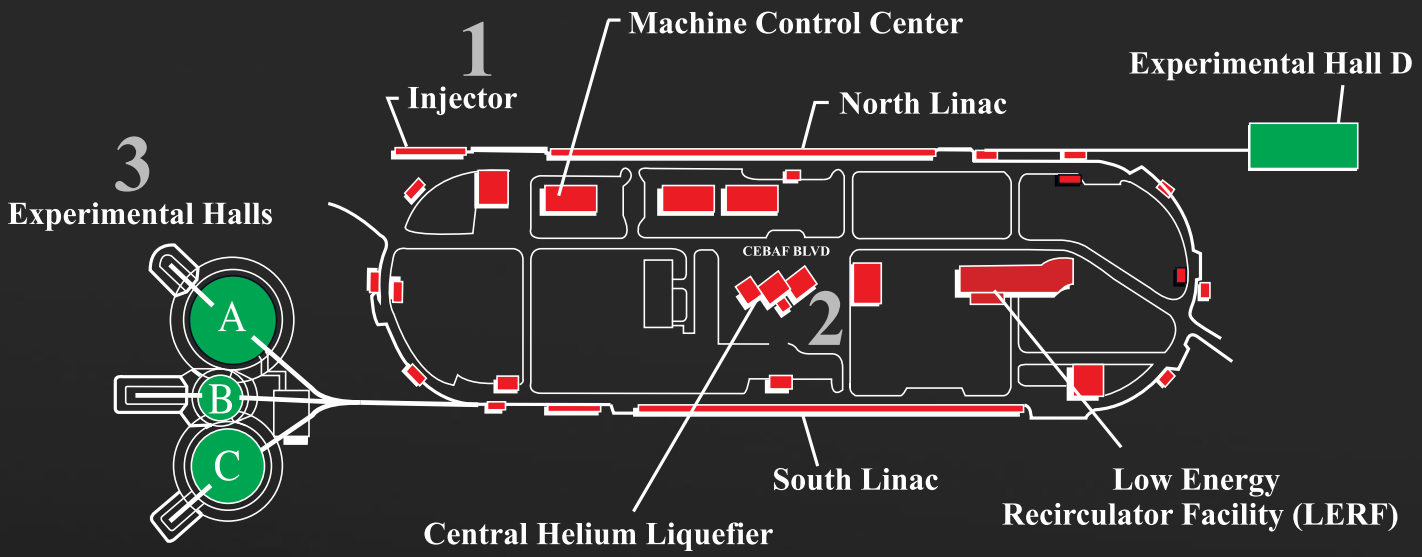
2012 A 12 GeV cryomodule demonstrated full design energy with an hour of stable running

CEBAF ceased 6 GeV operations, completing its 178th experiment

2014 CEBAF accelerator recorded the first data of the 12 GeV era in Experimental Hall A

DOE provided "accelerator project completion and start of operations" approval for Jefferson Lab's 12 GeV Upgrade

CEBAF 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.

• More than 2,400 magnets in more than 66 varieties focus and steer the electron beam. They range in size from a few inches to four meters and weigh as much as five tons.

• The electron beam can travel 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 12 billion electron-volts (12 GeV), an electron's mass will increase by almost 23,500 times.

HOW DOES THE CONTINUOUS ELECTRON BEAM ACCELERATOR WORK?

1. The electron beam begins in 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 may be split for use for simultaneous experiments in the four experimental halls. Special equipment in the halls record the interactions between incoming electrons or photons 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.

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