

## **JEFFERSON LABORATORY (DOE)**

### **Nuclear Physics Program**

Scientists from across the country and around the world visit the Thomas Jefferson National Accelerator Facility to advance mankind's understanding of the atom's nucleus — and thus of matter itself.

Their tools for probing nuclei: continuous beams of high-energy electrons from CEBAF — Jefferson Lab's unique Continuous Electron Beam Accelerator Facility — and the advanced particle-detection and ultra-high-speed- data acquisition equipment in CEBAF's three experimental halls.

### **Accelerator Division**

Jefferson Lab's Accelerator Division contributes to the Lab's main mission of nuclear physics research by driving the operation, maintenance and upgrade of CEBAF Accelerator systems. Accelerator Division maintains over 8km of vacuum beam line aligned to sub-millimeter precision. Through time and as the needs of physics experiments demand, old beam line components are upgraded, newly engineered components are added, and failed components are replaced. These activities draw on Accelerator Division's vast scientific, engineering, computer control, technical, operational, planning and budgeting expertise.

Jefferson Lab's Accelerator Division contributes to the one of the Lab's core competencies. Jefferson Lab fabricates all of its own Superconducting RF accelerating cavities and housing modules. In addition to upgrading design and manufacturing process for CEBAF and FEL replacements, fabrication has been expanded to provide the accelerating cavities for Spallation Neutron Source (SNS). In order to make these cavities superconducting accelerator division runs the world's largest 2k cryogenic cold box. JLAB is recognized as a world leader in Superconducting Radio Frequency Accelerating Cavity Technology.

Accelerator Division runs the FEL light source, the world's highest average power CW light source.

### **FEL Program at Jefferson Lab**

Jefferson Lab operates a kilowatt-class high average-power, sub-picosecond free-electron laser, covering the mid-infrared spectral region. On July 21, 2004 10 kilowatts of cw operation was achieved at a wavelength of 6 microns. This was extended on October 30, 2006 to 14.2 kilowatts of cw light at 1.6 microns. Extensions of the FEL to 250nm in the UV are planned. The short pulses of electrons also produce hundreds of watts of broadband THz light, which is made available in a special user laboratory.

The program and this user facility, derives from the primary mission of Jefferson Laboratory, namely, nuclear physics research and the world's first large superconducting accelerator for generating continuous multibillion-volt beams of electrons, called CEBAF.

The FEL program is led by Fred Dylla under the auspices of the [Laser Processing Consortium](#), a growing partnership of high-technology manufacturers, start-up

companies, research universities, government, the Commonwealth of Virginia and the U.S. Navy.

### **Laser Processing Consortium**

An industry-led private/public partnership for radically advancing the use of light as a manufacturing and research tool

Free-electron lasers being developed at Jefferson Lab in Newport News, Virginia, will offer a wide spectrum of applications in manufacturing and in applied and basic science. Supporting, participating in, and planning to profit from the Jefferson Lab Free-Electron Laser Program are the member institutions of the growing Laser Processing Consortium, or LPC.

### **Applied Research Center**

The Applied Research Center (ARC) is the flagship research facility (adjacent to the Department of Energy's Thomas Jefferson National Accelerator Facility (Jefferson Lab) in the research park, the Jefferson Center for Research and Technology, in Newport News, Virginia. The Applied Research Center, an \$18 million, seven-story, 122,000 square foot office and laboratory facility erected by the City of Newport News, serves as a nucleus for a key center in the development of new technologies in the Commonwealth. The ARC is home to industrial, university and Jefferson Lab researchers collaborating in the development of several important technologies and processes.

The cornerstone of this collaboration is the Jefferson Lab Free-Electron Laser (FEL) Program, a collaborative effort to develop lasers based on Jefferson Lab's superconducting electron-accelerating technology. The free-electron laser program is being conducted with the Laser Processing Consortium, an industry-led private/public partnership for radically advancing the use of light as a manufacturing tool.

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### **Theory Center**

#### Overview

The JLab Theory Center pursues a broad program of theoretical research in support of the physics being studied by the CEBAF experimental program. The center provides opportunities for post-doctoral fellows to develop professionally, trains PhD students, supports a strong visitor program, and advises the Laboratory on the scientific merit of its program and its plans for future development.

#### Research

The center provides scientific leadership on the key issues to be addressed at CEBAF and related facilities around the world:

- Spectra and Decays of Hadrons, and Confinement in QCD
- Hadron Form Factors and Quark-Gluon Distributions
- Strangeness and Parity Violation in Hadrons and Nuclei
- Few-Body Nuclear Physics and the Nucleon-Nucleon force
- Many-Body Nuclear Physics and the Nuclear Medium

- Standard Model Tests and Beyond

### **Education and Professional Development**

The JLab Theory Center provides an opportunity for post-doctoral fellows to develop professionally by doing research in a supportive, intellectually stimulating environment. Through the affiliations of its members with neighboring universities, it trains PhD students and offers advanced courses in special topics needed for work in electronuclear physics. It provides opportunities for interested scientists to visit the Laboratory and work closely with theoretical and experimental colleagues.

### **Service**

The Theory Center helps describe the physics for lay audiences, advises the Laboratory on the scientific merit of proposed experiments, and provides leadership in developing advanced techniques for the analysis and interpretation of data. It plays an active role in planning the future of the Laboratory.