Purpose:

To provide a combined electron-laser facility for the advancement of accelerator physics and medical imaging technology

Operating Costs:

$3 million per year

Sponsor:

U.S. Department of Energy, Division of High-Energy Physics and Office of Basic Energy Science

Users:

40 in 2010

Collaborating Institutions:

Collaborating with over 20 different institutions over its lifetime, ATF currently has close ties with; UCLA, USC, Radiabeam Technologies, Imperial College, London (UK), Universita Di Pisa (Italy), Instituto Nazionale di Fisica Nucleare (Italy) and ENSTA, Paris Tech (France).

Features:

- High-brightness photoinjector electron gun
- 70 MeV linear accelerator
- Four experimental beamlines
- High-powered lasers highly synchronized to the electron beam

Website:

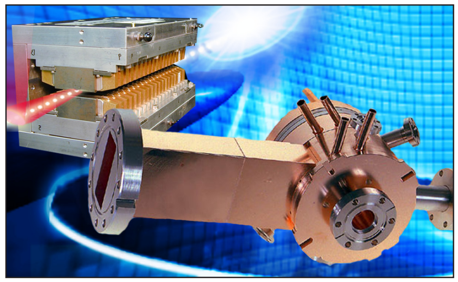
www.bnl.gov/atf

ATF provides support and equipment for students and researchers from around the world

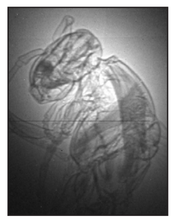
Accelerator Test Facility

A user facility for the advancement of laser and accelerator physics

With the demand for higher energy particle accelerators, facilities such as the Accelerator Test Facility (ATF) at Brookhaven National Laboratory are becoming increasingly important. The ATF provides experimenters with the equipment necessary for the advancement of accelerator technologies, with a view to develop smaller machines and more cost-effective methods of particle acceleration.



ATF's electron gun and tapered undulator used for first-stage laser acceleration



Picosecond X-ray snapshot of a wasp

A Combined Electron-Laser Facility

The ATF provides a very-high brightness electron beam to four beam lines, synchronized with high-power lasers. The electrons are produced by a photoinjector, whose photocathode is illuminated by a frequency quadrupled solid-state laser. The initial spatial and temporal structures of the electron beam are determined by the precisely controlled solid state laser pulses, which also synchronize the CO_2 laser with the electrons. Two S-band (2856 MHz) frequency linear accelerator sections accelerate the electrons. The beam can be manipulated in the transport line to deliver it to one of the experimental locations in the experimental hall. There are more than 40 quadrupoles along 4 transport lines to tailor the beam to particular experiments. More than 50 high-resolution profile monitors measure the beam's particle distribution.

CO_2 Laser

The carbon dioxide laser, installed at the ATF, is the only tera-watt picosecond laser available in the world for users. When the laser interacts with matter or particle beams, new strong-field physics phenomena are revealed and have been successfully exploited for electron and ion acceleration and x-ray generation. Such experiments have many applications in physics and other areas such as medicine, materials, and anthropology.

Experimental Work

Plasma Wakefield Acceleration

Plasma wakefield acceleration is a method for accelerating particle beams over much shorter distances than traditional accelerators, leading to more compact, more energy-efficient production of high-energy particle beams. An electron bunch travelling through a plasma creates wakefields through which subsequent electron bunches may be accelerated at a high gradient.

Medical Imaging

Interaction of the ATF electron beam with the CO_2 laser has proved to be a viable source of fast x-rays. These x-rays, with wavelengths on the scale of pico (one millionth of a millionth of a second) or femtoseconds (one millionth of one billionth of a second), are produced by Thompson scattering of photons during a laser-electron beam interaction. These have uses in ultra fast imaging, positron production, and many other applications.

Ion Generation

The MeV proton beams generated by the CO_2 laser pulses that are focused on a hydrogen gas jet have the potential for positron emission tomography (medical imaging) and hadron cancer therapy. A time-resolved optical diagnostic provides new insight into the physics of laser-plasma interactions at supercritical densities.

(03-11)