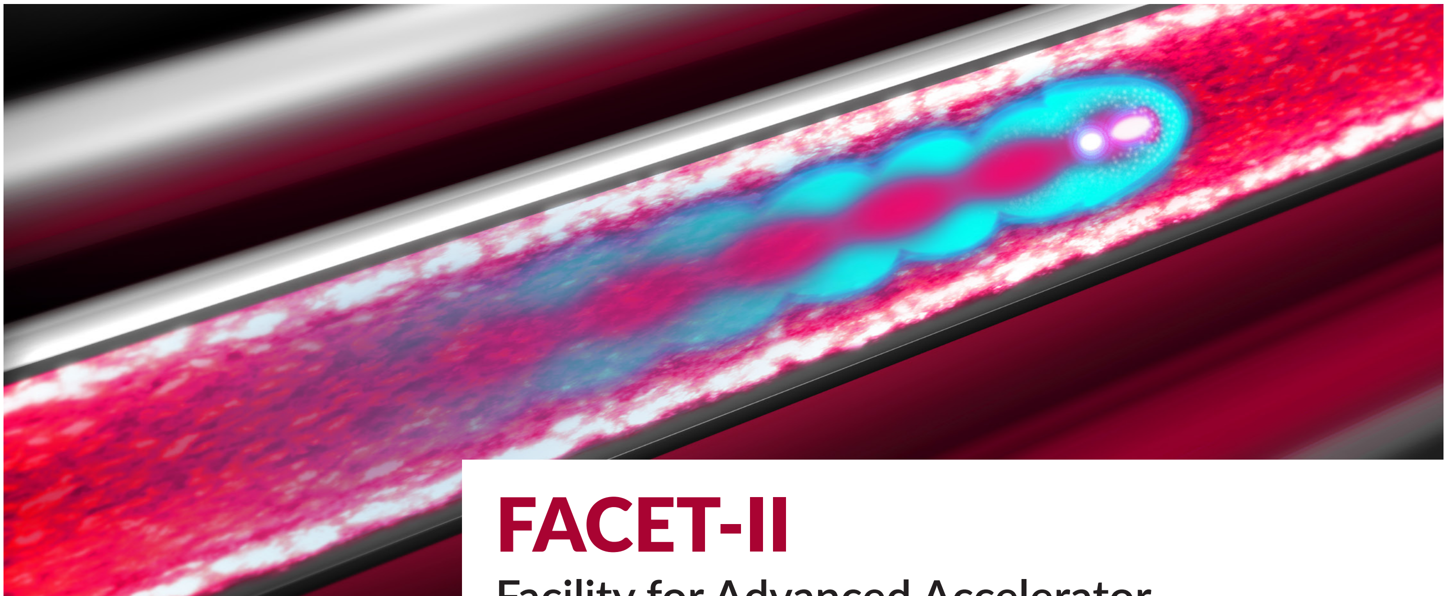

FACET-II

Facility for Advanced Accelerator Experimental Tests-II

FACET-II

slac.stanford.edu
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Facts

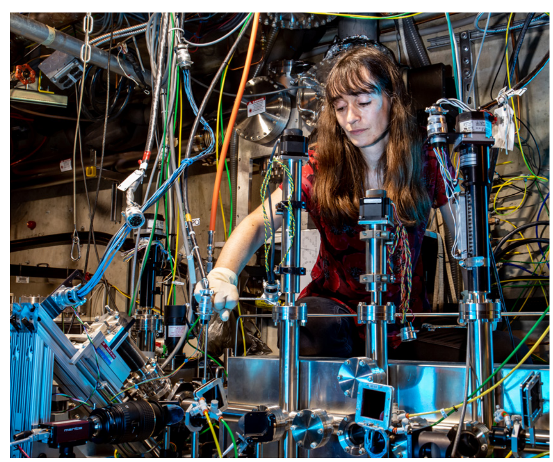
- Experiments began in 2022
- Electrons surf on hot plasma
- Accelerates particles to extremely high energies

Scientists from all over the world come to FACET-II to do experiments aimed at improving the power and efficiency of particle accelerators used in basic research, medicine, industry and other areas important to society.

A unique facility

FACET-II uses part of SLAC's two-mile-long linear accelerator to generate high-density beams of electrons. At their peak its beams are so intense, it's as if they were focusing all the power of the sun on a surface 10 meters square for a fraction of a second. This produces large electric and magnetic fields in a very short time – ideal for creating exotic states of matter and advancing particle accelerator technology.

Societal impact



About 30,000 particle accelerators operate throughout the world today, helping to develop new cancer treatments and see many fundamental parts of nature in atomic detail. FACET-II is discovering new ways to design and build accelerators that are much smaller – potentially reducing the size of the big ones used in high energy physics from a few kilometers to tens of meters. This will broaden their availability and help speed critical research advances in medicine, clean energy, materials engineering, understanding the fundamental forces of nature, and other scientific fields. FACET-II is also developing ways to produce brighter electron beams that can be used to generate more powerful X-rays, which will allow accelerators to contribute to a wider range of research fields.

World-leading research

As a DOE Office of Science user facility, FACET-II is open to researchers from all over the world. The facility builds upon years of valuable research at its predecessor, FACET, which operated from 2011 to 2016. The first round of user experiments at FACET-II began in spring 2022.

Plasma wakefield acceleration

Electrons can "surf" on waves of plasma – a hot, ionized gas of charged particles – thereby gaining very high energies in very short distances. This approach, called plasma wakefield acceleration, has the potential to dramatically shrink the size and cost of particle accelerators. Research at SLAC has demonstrated that a plasma can accelerate electrons to 1,000 times greater energies over a given distance than current technologies can manage.

Dielectric wakefield acceleration

Plasma isn't the only way to accelerate electrons in a short distance. When two well-spaced bunches of particles pass through a dielectric material, such as silica or diamond, their interaction with the material causes the first bunch to lose energy and the second to gain energy. FACET-II is the only facility that provides the high peak fields needed to test the highest possible acceleration with this technology.

Understanding the universe

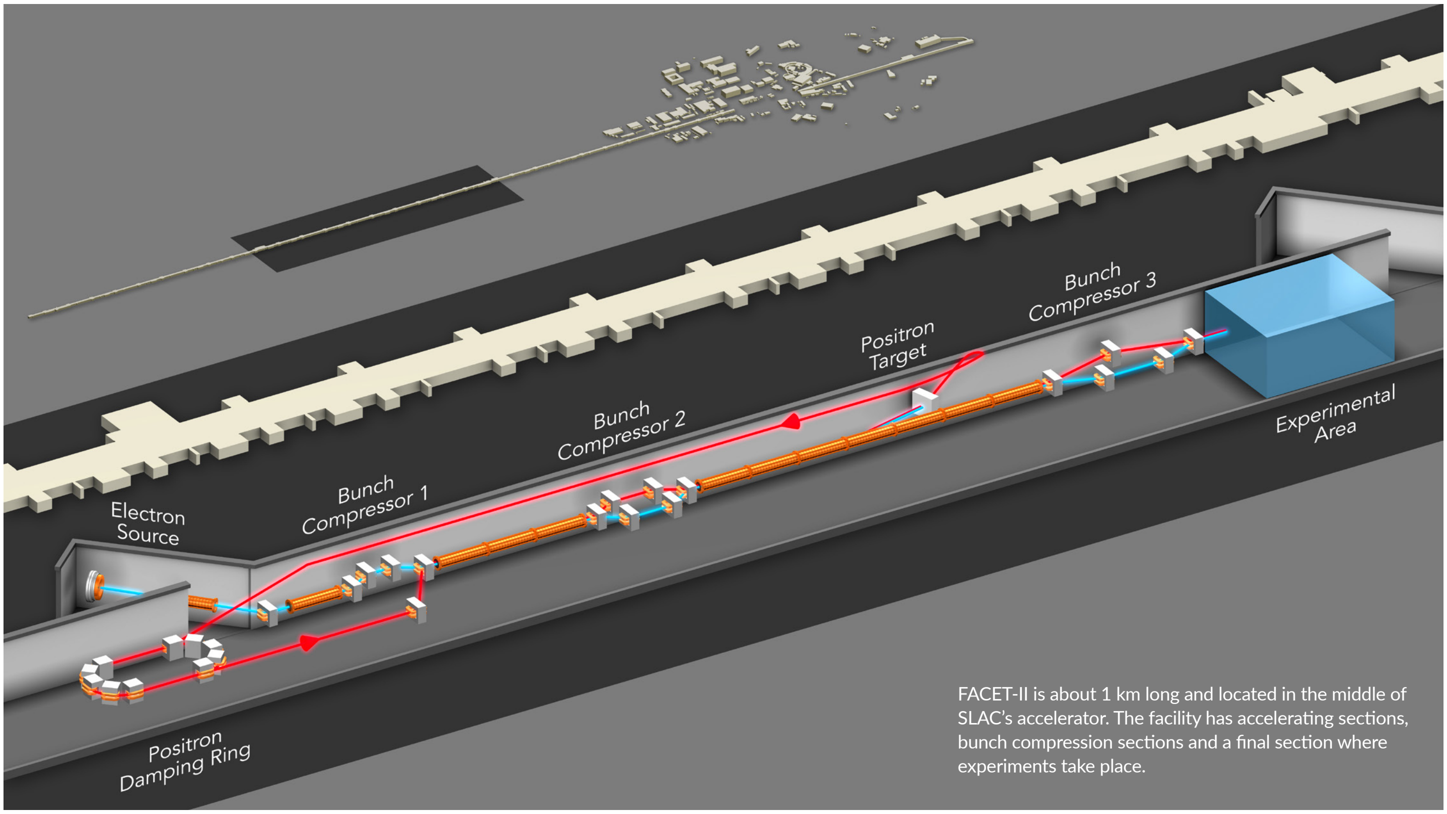
Researchers at the facility study the behavior of certain plasmas that are expected to play a role in generating gamma ray bursts – the strongest and brightest explosions known to exist in outer space. The peak density and intensity of the facility's electron beams allow researchers to study astrophysical events in the lab and compare them to observations and models of deep outer space.

Machine learning and artificial intelligence

When running any accelerator, it's important to know exactly what is going on inside the machine so you can correctly interpret the results of your experiment or project. FACET-II's beams are so intense that they vaporize the materials used by some traditional direct beam diagnostic methods. Machine learning and artificial intelligence techniques will help researchers optimize a beam's size and shape for a wide variety of experiments without destroying the beam, opening additional research opportunities for unique projects perhaps unattainable before.

Reaching high energies

Going forward, FACET-II will work on creating high-density beams of positrons, which are the antimatter particles of electrons. Physicists collide high-energy beams of electrons and positrons to probe the fundamental particles and forces that make up the universe. Positron beams behave differently in a plasma than electrons and will require new approaches to optimize the plasma acceleration process. Much of the infrastructure needed to create positrons already exists at SLAC, and our staff is working to restore this unique capability for the research community.



FACET-II is about 1 km long and located in the middle of SLAC's accelerator. The facility has accelerating sections, bunch compression sections and a final section where experiments take place.