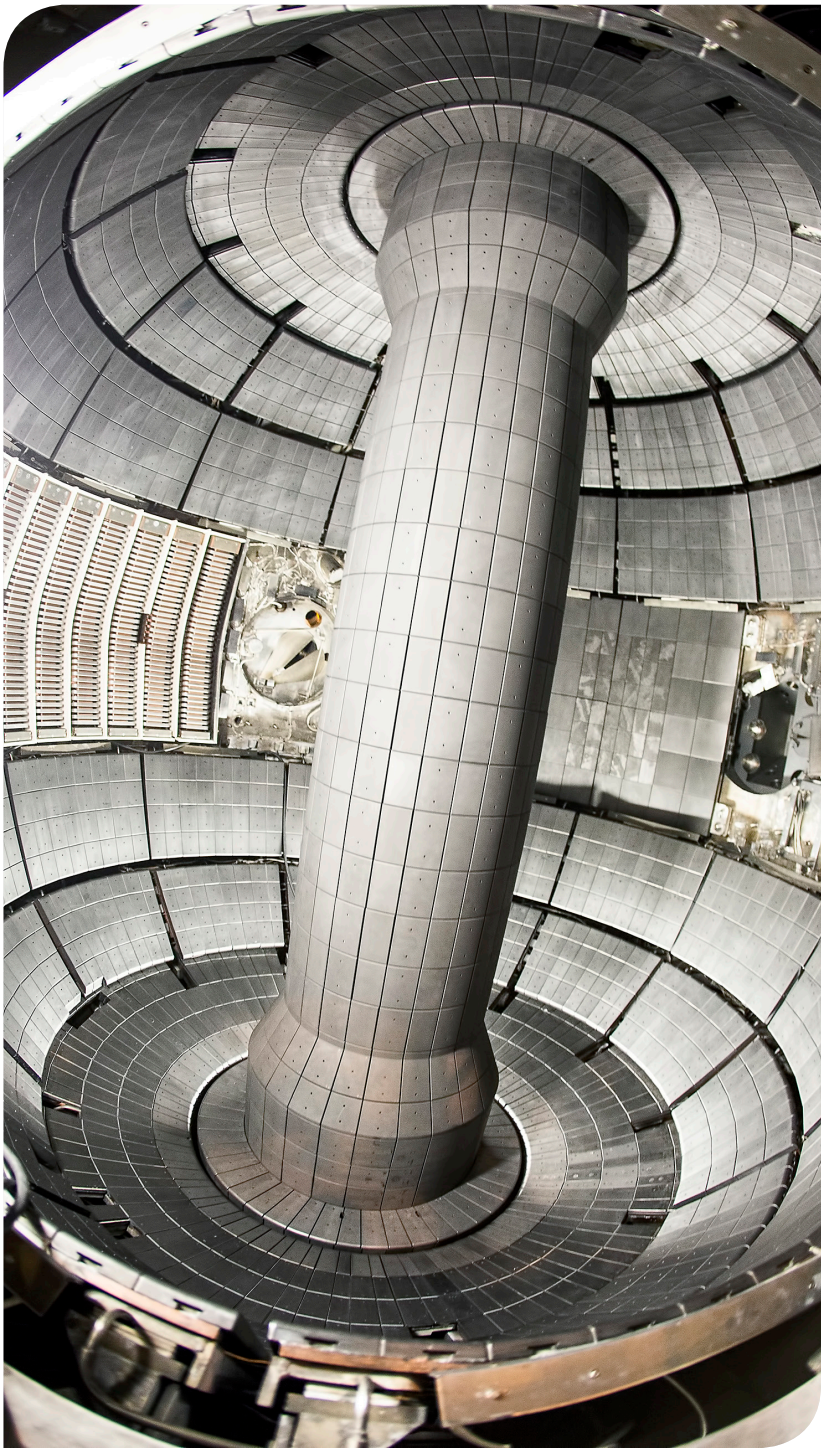
NSTX-U PPPL PRINCETON UNIVERSITY U.S. DEPARTMENT OF ENERGY

A New Era Begins



Welcome to the first major addition to the U.S. fusion program of the 21st century. Today the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) unveils the new $94 million National Spherical Torus Experiment-Upgrade (NSTX-U), the most powerful fusion facility of its kind on Earth and a device poised to bring the world closer to a bold new energy age.

This upgrade doubles the heating power and magnetic field strength of the original facility and enhances the worldwide quest for fusion as a safe, clean and virtually limitless source of energy for generating electricity. The project, which took nearly three years to complete, supports continued U.S. leadership in the development of facilities that will form the basis for commercial fusion power.

PPPL, which is managed by Princeton University, is the only DOE laboratory devoted to fusion science and the broad frontier of plasma physics and is one of 10 national laboratories supported by the DOE's Office of Science. These institutions have a luminous history of scientific innovation and discovery in keeping with the goals of DOE.

Here is a brief description of the NSTX-U, its role in the quest for fusion energy and its mission over the next five-to-10 years.

What's a tokamak? A tokamak is the most successful device yet developed for confining superhot plasma within magnetic fields to produce fusion reactions. Plasma, an electrically charged gas that consists of electrons and atomic nuclei — or ions — makes up 99 percent of the visible universe and is often called the fourth state of matter. The sun and stars are made of plasma.

What's a spherical tokamak? Spherical tokamaks are compact facilities that are shaped like cored apples. This design compares with the bulkier, donut-like shape of conventional tokamaks that are now in wider use.

What's so attractive about the spherical design? The compact shape enables a spherical tokamak to confine highly pressurized plasma within lower magnetic fields than conventional tokamaks must use to create similar pressure. The original NSTX set records for the ratio of outward plasma pressure to inward magnetic field strength, a key ratio known as "Beta." Spherical tokamaks are thus cost-effective since fusion reactions require highly pressurized plasma and high magnetic fields are expensive to produce.

What do PPPL researchers plan to investigate? Scientists aim to see if the NSTX-U can continue to produce high-pressure plasmas with low-level fields under the hotter and more powerful conditions that the upgrade allows. If so, this capability could make the spherical design a strong candidate for the next major step in the U.S. fusion program in preparation for a demonstration fusion power plant.

What else do researchers aim to discover? Further experiments will test the upgrade's ability to tame the hot plasma particles that escape from confinement and can damage the tokamak's walls — an issue of critical importance to ITER, the international fusion experiment under construction in France. Also under investigation will be new ways to start and sustain the electric current that creates the plasma and completes the confining magnetic field.

PPPL
PRINCETON PLASMA PHYSICS LABORATORY

Princeton Plasma Physics Laboratory
P.O. Box 451
Princeton, NJ 08543-0451
GPS: 100 Stellarator Road
Princeton, NJ 08540

www.pppl.gov

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