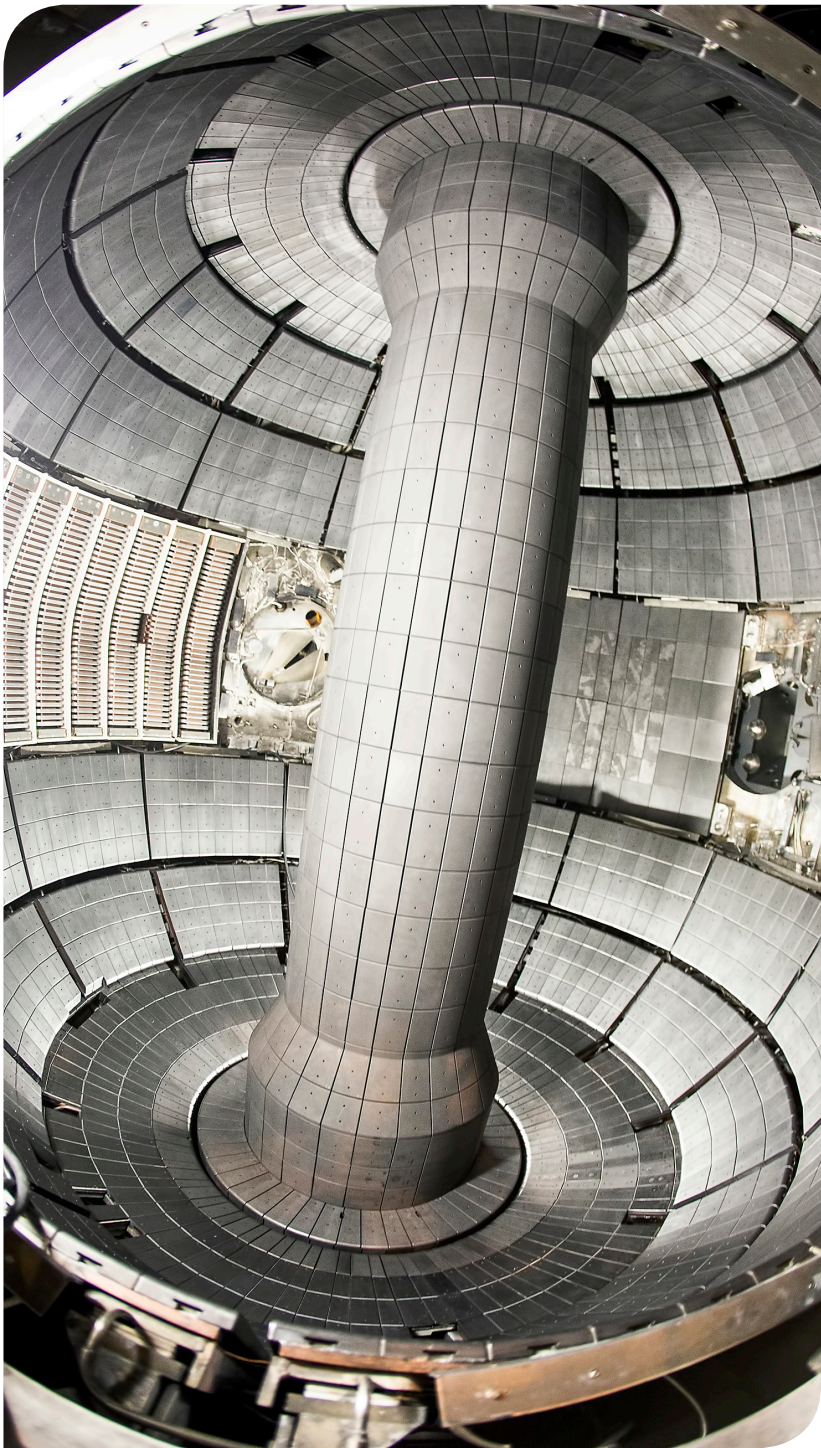
PPPL PRINCETON PLASMA PHYSICS LABORATORY

PRINCETON UNIVERSITY

U.S. DEPARTMENT OF ENERGY

Unveiling the Most Powerful Spherical Tokamak on Earth



Welcome to a new era in fusion research at the U.S. Department of Energy's Princeton Plasma Physics Laboratory. Today we unveil the National Spherical Torus Experiment-Upgrade (NSTX-U), the most powerful spherical tokamak in the world and the first major addition to the U.S. fusion program in the 21st century.

The NSTX-U represents a $94 million, nearly three-year upgrade of the original National Spherical Torus Experiment that ran from 1999 to 2011 in the Laboratory, which Princeton University manages for the U.S. Department of Energy. This overhaul doubles the heating power and magnetic field strength of the facility and increases the length of fusion experiments from one second to up to five seconds.

PPPL is the only DOE laboratory devoted to fusion science and research along the broad frontier of plasma

science and technology, and 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 overview of the NSTX-U spherical tokamak, its role in the worldwide 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 because 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 a Fusion Nuclear Science Facility, a proposed next step in the U.S. fusion program that would test an integrated fusion-energy system 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.