The National Spherical Torus Experiment-Upgrade (NSTX-U) is the primary fusion experiment at PPPL, filling research gaps to bring fusion to the power grid. Its compact design makes it an ideal candidate to serve as the model for a fusion pilot plant followed by a commercial fusion reactor.

The spherical device is shaped more like a cored apple than the doughnut-like shape of conventional tokamaks and can produce high-pressure plasmas — essential ingredients for fusion reactions — with relatively low and cost-effective magnetic fields.

A Worldwide User Facility

The NSTX-U is intricately designed so researchers around the globe can use the machine to better understand the complexities of creating fusion energy. Confining and sustaining plasma (the fuel of fusion) long enough to produce fusion energy remains a challenge in the research community. The NSTX-U allows users to study the confinement of plasma in near-steady conditions.

Not Your Typical Tokamak

This experimental fusion device is stronger, better, and more uniquely designed than ever before with a focus on operational reliability:

- New and strong central magnets, producing the highest magnetic field strength of any large spherical torus
- Pulse lengths enabling plasma to come to full equilibrium
- Robust plasma-facing components to manage the large plasma heat flux
Feel the Heat

Producing fusion requires extremely hot temperatures — at least 100 million degrees or seven times hotter than the sun. The NSTX-U is built to heat the plasma to these fusion temperatures using:

- **Neutral beams**, which heat the plasma by injecting energetic atom beams
- **High-power radio waves**, which drive currents into the device through a sophisticated system

*These complementary approaches facilitate one-of-a-kind sustainment experiments.*

Feel the Power

The NSTX-U enables scientists and engineers to **explore the performance of plasma** thanks to several key features:

- Flexible heating systems that create and heat the plasma
- Strong magnetic fields confine the plasma in a near-spherical shape
- State-of-the-art diagnostics that measure the detailed properties of the plasma

*Combined, these capabilities will allow the physics of the spherical torus plasmas to be better understood.*

The NSTX-U **advances the physics and engineering solutions required** for optimizing the next generation of tokamak fusion devices through experiments that can:

- Measure key plasma characteristics amidst varying magnetic fields to define the necessary magnetic field strength of a future fusion reactor
- Determine which heating configuration best sustains plasma in order to understand the ideal heating system and operating conditions for a future fusion reactor
- Analyze the impact of the materials used on the device’s walls to enable engineering solutions that can withstand the heat and pressure inside future fusion reactors