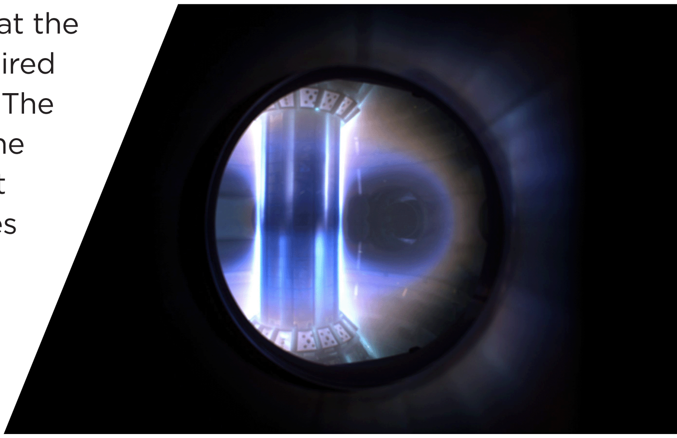
FY 2023

Research Accomplishments

The U.S. Department of Energy's
Princeton Plasma Physics Laboratory

PPPL confirms historic temperature achievement of transatlantic partnership



An advanced computer code developed at PPPL confirmed that the U.K. company Tokamak Energy achieved the temperature required for commercial fusion production: 100 million degrees Celsius. The code, called TRANSP, is critical to the collaboration between the two laboratories, which began in 2019. The recent achievement — produced by Tokamak Energy's ST40 device — demonstrates for the first time that temperatures relevant to commercial fusion energy can be obtained in a compact spherical fusion device known as a tokamak. Partnering in the historic achievement was Oak Ridge National Laboratory, which contributed to ST40's operation and data analysis.

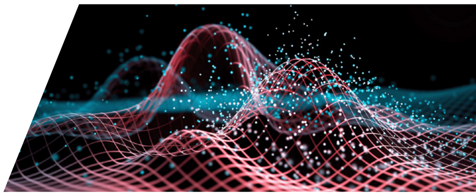
PPPL wins record six public-private grants to speed the arrival of fusion energy

The Lab won an unprecedented six public-private partnership grants to advance fusion science and engineering as part of the DOE's Innovation Network for Fusion Energy. The six awards show that the decades of fusion research at PPPL serve as a key U.S. asset. One collaboration will help Commonwealth Fusions Systems improve deuterium retention in the proposed boron-coated reactor walls. Another will design diagnostics to advance laser-driven proton beams for Focused Energy, while a third will simulate the dynamics of a Helion Energy Field Reversed Configuration fusion facility. The three remaining companies have joined PPPL in engineering partnerships on liquid metal blankets for fusion devices and two types of high-temperature superconductors.

INFUSE

Milestone discovery could accelerate the arrival of controlled fusion energy on Earth

A team of scientists led by PPPL researchers has unveiled a promising approach to taming disruptions that can severely damage tokamak reactors. Key to the new approach is enlisting what are called Alfvén waves to loosen subatomic particles and allow them to escape from the plasma that fuels fusion reactions in a more diffuse, less destructive way.

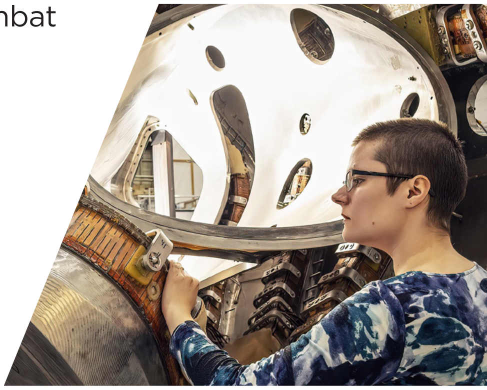


Fusion magnets could lead to improved microchip production

Insights gleaned from PPPL's decades of work on the magnetic fields used in fusion devices could extend the life of machines that create the microchips that drive today's electronics, potentially advancing the $150 billion chip industry. The researchers developed computer simulations demonstrating how to create magnetic fields that confine plasma in machines that fashion microchips — fields that oppose and repel each other. The simulations demonstrate that counterclockwise-flowing magnetic fields can remove fast plasma particles that can damage a crucial machine component, forcing the device to be shut down for cleaning.

Novel shortcut facilitates the design of twisty fusion facilities

A mathematical shortcut that could harness fusion energy on Earth and combat climate change was uncovered by PPPL scientists. The novel method lets researchers more easily predict how well a stellarator — a twisty device designed to reproduce the fusion energy that powers the sun and stars — can retain the heat crucial to fusion reactions. The technique measures how well a stellarator's magnetic field contains the heat by gripping the fastest-moving subatomic particles in the plasma that fuels the reactions. The shortcut computes a number that describes how far the fastest particles drift away from the curved magnetic fields in the center of the plasma, a number that reveals the extent of plasma confinement.



Ripples in the fabric of the universe may reveal the start of time

Scientists at PPPL have discovered how to use ripples in space-time to better peer back to the beginning of everything we know. Such ripples, known as gravitational waves, flow through planets, following the Big Bang that formed the universe some 13 billion years ago. While scientists can't see the early universe directly, they can study it indirectly by looking at how gravitational waves from that time have affected matter and radiation that can be observed today. The study, adapted from Laboratory research into fusion energy, has created theoretical formulas that could lead the waves to reveal hidden properties about celestial bodies many light years away.

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