NSTX project will produce world's most powerful spherical torus

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An interior view of the lower portion of the NSTX vacuum vessel, shown after the center column has been removed in preparation for the upgrade. Radiofrequency antennas for plasma heating are shown on the right (the copper straps).

DOE's Princeton Plasma Physics Laboratory (PPPL) is getting an earlier-than-expected start on a $94 million, nearly three-year project as the next stage of its mission to chart an attractive course for the development of nuclear fusion as a clean, safe and abundant fuel for generating electricity.

The project will upgrade the National Spherical Torus Experiment (NSTX) facility at PPPL, over the next 30 months, with completion slated for 2014. The work will enhance the position of the NSTX as the world’s most powerful spherical torus – or tokamak – a device that controls the superheated and electrically charged gases called plasmas that create fusion power.

The upgrade "will provide a huge boost to all NSTX science missions and enhance U.S. fusion research capability," said Stewart Prager, director of PPPL, which is managed by Princeton University for the DOE Office of Science and has been a leader in fusion research for 60 years. Experiments done on NSTX, he said, "will establish the physics basis to determine next steps in fusion research and development."

Construction has been cleared by DOE officials to begin six months ahead of schedule. As with any such effort, funding for the project remains contingent on congressional appropriations.

Work on the upgrade has brought new excitement to the laboratory. "We're building something that's one of a kind that has never been built before," said Michael Williams, associate director for engineering and infrastructure at PPPL.

Fusion takes place when the atomic nuclei in plasmas combine at extremely high temperatures and release a burst of energy. Such reactions drive the sun and the stars. But sustaining fusion in the laboratory has proven quite difficult because plasmas that leak from the confinement can halt the reaction. Controlling the plasma is thus a basic goal of fusion research.

PPPL physicists will use the upgraded NSTX facility to assess the role of compact reactors for the future development of fusion power. The spherical NSTX torus confines its plasma in the shape of a cored apple, unlike bulkier conventional tokamaks that produce doughnut-shaped plasmas and can be more costly to construct.

A key issue for the NSTX upgrade is to see if it can improve on its record-high level of a measure called "beta" — the ratio of the pressure of a plasma to the strength of the magnetic field that confines it — as the plasma grows hotter. The higher the beta, the more cost-effective the confinement.

The NSTX upgrade will furnish new tools for probing such issues and "provide ample research opportunities for years of productive research," said Michael Zarnstorff, deputy director for research at PPPL. "The whole NSTX group is quite excited by the research opportunities on this leading fusion facility."

How PPPL scientists handle the increased flux could serve as a model for ITER, a major conventional test reactor that a consortium of countries including the United States is building in the south of France. ITER aims to produce a sustained fusion reaction — or "burning plasma" — by the late 2020s that will put out ten more energy than is needed to create it.

The NSTX upgrade could also help determine the path to a possible next-generation spherical torus that would produce a burning plasma to complement the output of ITER. Such a spherical torus would be roughly twice as powerful as the NSTX upgrade, said deputy PPPL director Zarnstorff, and could be used to test components for a commercial fusion reactor by around mid century.

Provided by Princeton Plasma Physics Laboratory