# From Germany comes a new twist for fusion research

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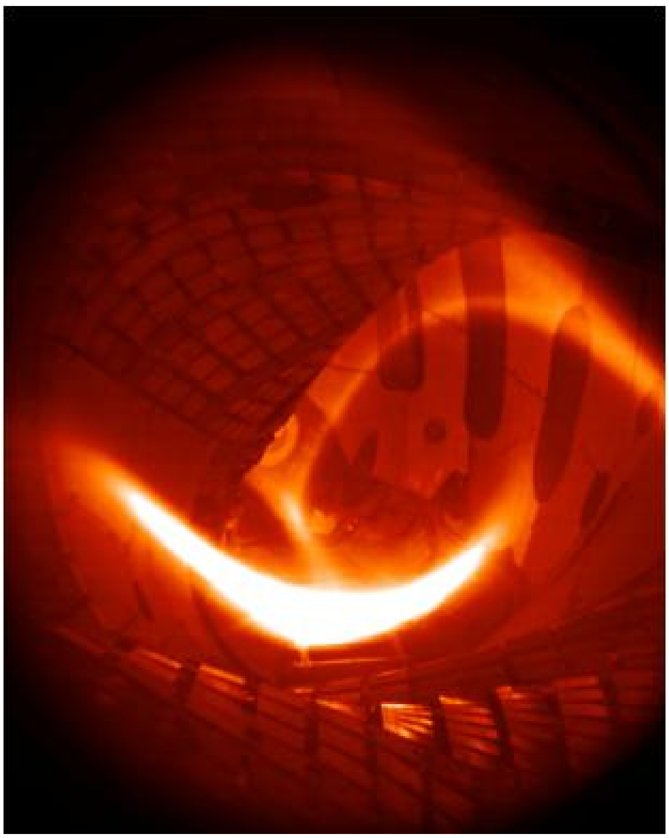

Helically twisted plasma glows during the first hydrogen operation in W7-X on Feb. 3, 2016. Credit: Max-Planck Institute for Plasma Physics

This past year saw the commissioning and initial operation of a new large-scale plasma experiment, the Wendelstein 7-X (W7-X) in Greifswald, Germany. Designed, constructed, and operated by the Max-

Planck Institute for Plasma Physics (IPP) with an international team of collaborators, the device is impressive. But, the worldwide fusion research community, which aims to develop an environmentally benign and abundant source of energy, is finding W7-X's initial plasma results yet more impressive.

Work on W7-X began at IPP in the '80s with years of design optimization that advanced understanding of magnetic confinement. Construction of the experiment began in 2005. It uses 70 large superconducting magnets, cooled cryogenically to avoid electrical resistance, to generate a 30 cubic-meter volume that contains and insulates plasma particles.

At the high temperatures needed for fusion, gas is ionized, meaning that electrically neutral atoms dissociate into charged electrons and nuclei—a plasma. These electrically charged particles can be guided by a magnetic field of sufficient strength, hence the use of magnets.

Among plasma confinement experiments, the magnetic field in W7-X is special. The configuration has a unique twist, shaped by the superconducting coils, that optimizes plasma confinement on the individual-particle and macroscopic scales (Figure 1). As a "stellarator" system, it also avoids the net electrical current running through the plasma of tokamak systems, which are simpler to design and build but prone to dynamic events that release plasma. The special design of the W7-X coils, together with a magnetic strength that can approach 100,000 times that of the Earth's magnetic field at its surface, and the aforementioned volume, puts W7-X in a class by itself.

In recognition of the importance of W7-X research, the American Physical Society Division of Plasma Physics invited Dr. Thomas Sunn Pedersen, Director of Stellarator Edge and Divertor Physics at IPP, to give a plenum presentation at its 58th annual meeting in San Jose, Oct.

31-Nov. 4. He will summarize initial results and convey the excitement of having German Chancellor Angela Merkel initiate the first fully operational plasma experiment earlier this year.

The fusion research community has high expectations for W7-X during future operations. Its maximum magnetic-field strength is somewhat less than that of the superconducting Large Helical Device (LHD) at the National Institute for Fusion Science in Japan, but the latter does not benefit from the W7-X optimization strategy. The Helically Symmetric eXperiment (HSX) at the University of Wisconsin-Madison uses optimization similar to that of W7-X, but its small size precludes the fusion-relevant 20,000,000 degrees Kelvin ion temperatures already obtained in W7-X.

**More information:** meetings.aps.org/Meeting/DPP16/Session/AR1.1

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