CONTACT: **M.E. Fenstermacher**
Phone: 858-455-4159

FOR IMMEDIATE RELEASE

Plasma Bursts Eliminated by Small Archipelagos in a Chaotic Magnetic Sea

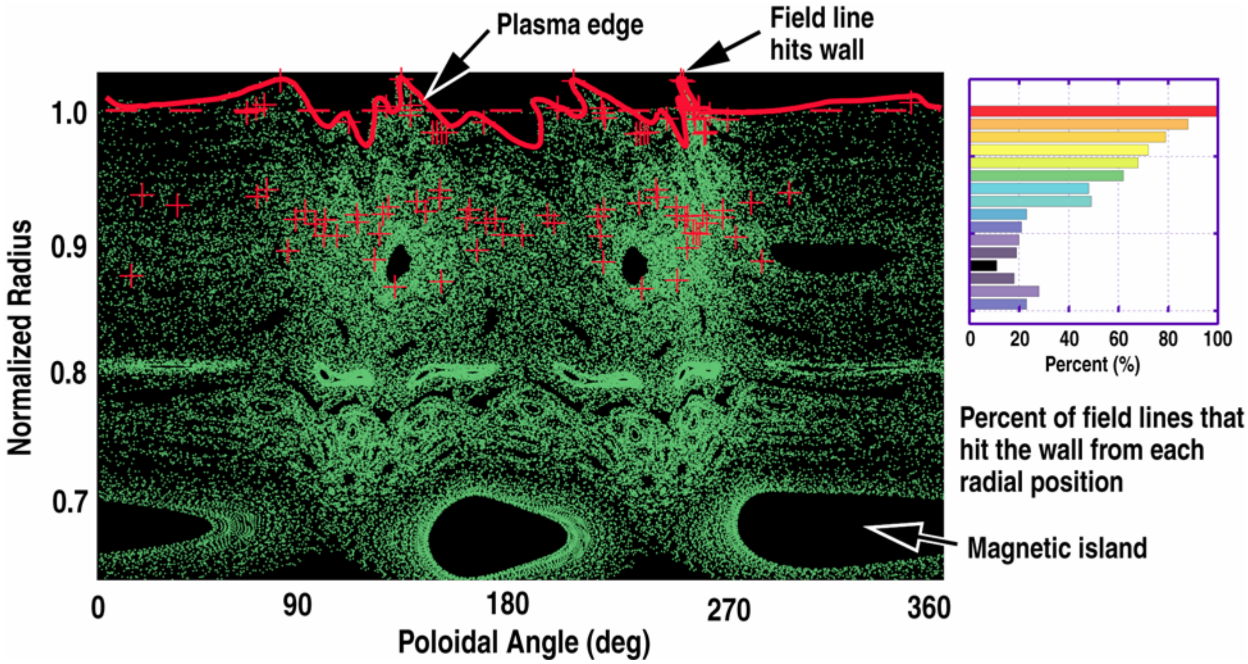
Magnetic islands create an escape route that relieves plasma pressure gradually, preventing plasma eruptions that could damage future fusion power reactors.

ORLANDO, Florida, - Recent experiments in the DIII-D tokamak fusion research lab at General Atomics (San Diego), using controlled chaotic magnetic fields, demonstrated that the theory of magnetic island overlap can be used as the basis for designing specialized magnetic coils that will eliminate large periodic bursts of plasma from the edge of a 100 million C plasma in future fusion reactors. Eliminating these bursts, which can cause significant erosion of the material surfaces in future tokamak power reactors, is a critical step toward making fusion power a reality.

A large international tokamak experiment known as ITER is under construction in Cadarache, France. The understanding gained from the DIII-D experiments has been used recently to guide a team of researchers at DIII-D and other U.S. international fusion laboratories in the development of magnetic perturbation coil systems that may eliminate edge plasma bursts in ITER. Use of such coils in ITER, combined with continuing research in DIII-D and other existing tokamaks, should provide the information needed to design similar control coil systems for future power-producing fusion reactors.

Seeking to harness the same energy source that fuels the Sun, researchers worldwide have developed a variety of techniques for confining hydrogen atoms well enough to achieve the very high temperatures (100 million C) required for fusion. At such high temperatures, the hydrogen fuel takes the form of an ionized gas called plasma. A promising confinement technique called a tokamak uses strong magnetic fields to confine a donut-shaped plasma, taking advantage of the fact that charged particles closely follow the magnetic field lines, like beads on a string. As the plasma is heated and the pressure inside the tokamak plasma increases, there is a natural tendency for this plasma pressure to bend and stretch the confining magnetic field lines. If these distortions become too large or too localized, a burst of plasma particles and energy can occur, releasing enough plasma pressure to relieve the stress caused by this distortion. Conceptually, these bursts originating from the surface of the tokamak plasma are similar to periodic solar flares that originate at the surface of the sun.

These bursts of particles and energy are projected to cause significant erosion of the material surfaces in future tokamak power reactors and therefore several techniques to prevent them are under investigation. Applying complex, 3-dimensional magnetic field perturbations to the normally smooth magnetic field of the tokamak can completely suppress the bursts. This effect was first discovered in the DIII-D tokamak at General Atomics (San Diego) and was described last year in a paper by T.E. Evans [*Nature Physics* **2** (2006) 419-23]. In order to predict what will be needed to suppress such bursts in future tokamak reactors, current research is aimed at determining the minimum required perturbation strength for complete suppression in various conditions.



Recent experiments on the DIII-D tokamak show that the width of the region in the edge plasma that is affected by the magnetic field perturbations increases with the perturbation's strength, and that there is a minimum width to the affected region that is correlated with completely suppressing these violent plasma instabilities, known as ELMs. A magnetic field line, with the particles that follow it, makes many circular trips around the ring of plasma. As it does so, the magnetic perturbation causes it to wander slightly. The figure on the left illustrates how magnetic islands, spread out radially across the edge of the plasma, can form a connected pathway or an island archipelago that allows some of the magnetic field lines and particles on those field lines to escape from the edge of the plasma and hit the wall of the tokamak. The red "+" signs show the pathway, from one trip to the next, that one of these escaping field lines follows along an island archipelago to the wall starting from about 88 percent of the plasma radius. Particles on this particular field line travel around the ring of plasma 93 times — or about 1 kilometer — before hitting the wall. The right hand side of this figure shows the percentage of magnetic field lines, starting at each radial position across the edge of the plasma, that follow the island archipelagos to the wall of the tokamak. Siphoning off just a small fraction of the edge field lines and plasma particles reduces plasma pressure and prevents sudden bursts of energy from the edge.

Details of this work will be presented by Dr. M.E. Fenstermacher of Lawrence Livermore National Laboratory, at the APS-DPP meeting in Orlando, Florida, November 12-16, 2007.

Work supported by the U.S. Department of Energy under contract DE-FC02-04ER54698 and DE-AC52-07NA27344.

Contacts: M.E. Fenstermacher (858) 455-4159, fenstermacher@fusion.gat.com
M.R. Wade, General Atomics (858) 455-4165, wade@fusion.gat.com

Abstract: BI1.00002

Effect of Island Overlap on ELM Suppression by Resonant Magnetic Perturbations in DIII-D

Session BI1: Pedestal, SOL and Divertor

10:00 AM-10:30 AM, Monday, November 12, 2007
Rosen Centre Hotel - Junior Ballroom