NEWS

Steady as she goes: Scientists tame damaging plasma instabilities and pave the way for efficient fusion on Earth

By John Greewald
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(Photo by Greg Cunningham/General Atomics Energy Group)

PPPL physicist Raffi Nazikian, left, and General Atomics physicist Craig Petty in front of a model cross-section of the DIII-D tokamak

Gallery:

(Photo by General Atomics)

Nazikian, left, and Petty in front of the DIII-D tokamak. (Photo by Greg Cunningham/General Atomics Energy Group)

Before scientists can capture and recreate the fusion process that powers the sun and stars to produce virtually limitless energy on Earth, they must first learn to control the hot plasma gas that fuels fusion reactions. In a set of recent experiments, scientists have tamed a plasma instability in a way that could lead to the efficient and steady state operation of ITER, the international experiment under construction in France to demonstrate the feasibility of fusion power. Such continuous operation will be essential for future fusion devices.

Fusion powers the sun and stars by fusing light elements in the form of plasma — the hot, charged state of matter composed of free electrons and atomic nuclei — to produce massive amounts of energy. Scientists are seeking to replicate fusion on Earth for a virtually inexhaustible supply of electricity-generating power.

The most recent findings, developed by a team of researchers led by physicist Raffi Nazikian of the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) and Craig Petty of General Atomics, stem from experiments conducted on the DIII-D National Fusion Facility operated by General Atomics for the DOE in San Diego. The results build on earlier work led by DIII-D scientists that demonstrated the conditions needed for steady-state operation of the core of ITER plasmas and established techniques to control these plasma instabilities.

The new research targets instabilities called Edge Localized Modes (ELMs) that develop at the periphery of fusion plasmas. Such instabilities can cause periodic heat bursts that can damage plasma-facing components in a tokamak. “In these results we observe the suppression of large ELMs, leaving small benign ELMs in plasmas that overlap with the conditions required for steady-state ITER operation,” said Nazikian, lead author of a scientific paper in IAEA's Nuclear Fusion journal that lays out the findings. “These new experiments are a great example of successfully combining two separate advances, in this case 100 percent current drive in the plasma core and large ELM suppression in the edge, in an efficient and effective manner” said Petty, lead author of a prior Nuclear Fusion paper on the DIII-D findings relevant to the steady state core of the ITER plasma.