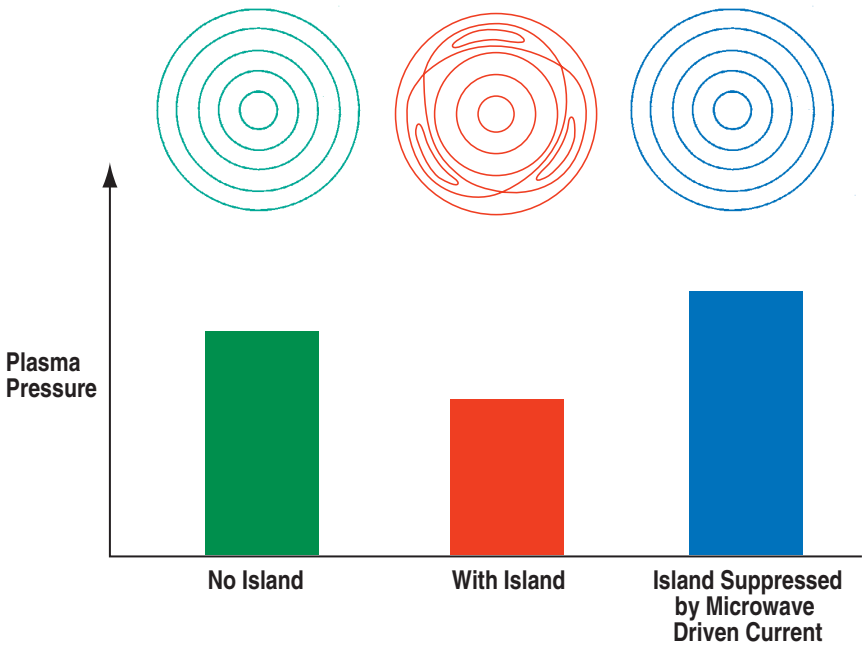
"Search And Suppress" Stabilization Of A Neoclassical Tearing Mode Increases Plasma Pressure

Like most magnetically confined plasmas, tokamaks are subject to the growth of "magnetic islands". These islands break up the magnetic surfaces that confine the plasma, leading to more rapid loss of heat from the plasma and making it more difficult to sustain the high temperatures needed for fusion. Neoclassical tearing modes are magnetic islands that occur at high plasma temperature and pressure, and thus pose a potential problem for fusion plasmas. Recent experiments have confirmed theoretical predictions that the islands can be reduced or eliminated by applying a small electrical current in the island. The current must be located very precisely at the island in order to be effective. This is done in the DIII–D tokamak by using a narrow beam of microwaves that interacts with the electrons in the plasma to drive the desired current.

DIII–D experiments this year demonstrated the first automatic, real-time control of the current drive location to suppress islands caused by a neoclassical tearing mode. The plasma control system is put into a "search and suppress" mode that makes either small shifts of the plasma position (about 1 cm) while the current drive location remains fixed, or small shifts in the current drive location while the plasma position remains fixed. The optimum position in either approach is based on detecting and minimizing the size of the magnetic island. With this approach, the island can be suppressed in a routine way despite possible changes in its location.

In the final experiment of the year, the plasma heating power was programmed to rise gradually after the island was suppressed. With the added stabilizing effect of the microwave-driven current, the plasma pressure could be increased 20% higher than the point where the island had originally appeared, and 55% higher than the pressure that could be sustained when the island had grown to full size.



Applying precisely located microwave power at island heals it with result that plasma energy increases.

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