NEWS

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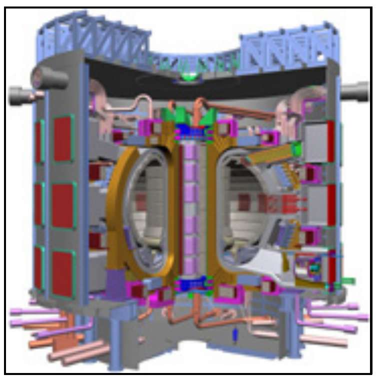
Chaos could keep fusion under control

A leaky magnetic bottle may prove key to making a reactor.

Geoff Brumfiel

Nuclear fusion reactors are all about control, but some chaos may help them run more smoothly.



Could a little bit of chaos keep ITER's magnetic bottle under control?

Credit: ITER consortium

By introducing a little static into the magnetic fields that contain the hot, electrically charged atoms of a fusion reaction, researchers have shown that they can prevent the lightning-like discharges that can damage the reactor. The results, which appear online in Nature Physics[1], could help the US$5.5 billion International Thermonuclear Experimental Reactor (ITER) achieve its goal of generating net energy from fusion.

Fusion occurs when two light elements, usually hydrogen, collide to form a new element, usually helium, releasing an enormous amount of energy. The process, which powers the Sun and other stars, is more powerful than conventional fission reactors and produces less long-lived radioactive waste. Scientists have worked for decades to build a fusion reactor, but have been unable to start a controlled

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reaction that releases more energy than it takes in.

Part of the problem with building a reactor is that the fusing hydrogen gas, called plasma, becomes so hot that it will melt the walls of any machine. The preferred solution is to suspend the plasma in a donut-shaped magnetic field. This field is designed to keep the hot gas away from the walls of the machine, and to squeeze the plasma tightly to increase the chance of atoms colliding.

But as the magnetic donut squeezes, the pressurised plasma becomes more likely to burst out, says Todd Evans, a physicist at General Atomics in San Diego, California. "Think of squeezing a balloon full of water," he says. "The harder you squeeze, the more the balloon bulges out through your fingers."

Eventually the plasma will burst through the field's weakest point. In ITER, a single such burst could release enough power to briefly light one million 100 W lightbulbs, corroding key reactor parts.

Pressure release

Until now, reactor designers have lived with these discharges, but Evans and his team found a way around the problem. The group modified the DIII-D tokamak reactor at General Atomics so as to introduce chaotic static into the magnetic field around the plasma.

This weakens the field just enough to let a little bit of plasma leak out through the bottom, relieving some of the pressure in the system and preventing it from bursting. "It's kind of a beautiful concept," Evans says.

But what exactly is happening is still a mystery. "This area of the machine is far too complicated match the simple theoretical ideas we have been working with," says Philippe Ghendrih, a theoretical physicist at the French Atomic Energy Commission in Cadarache, where ITER will be built. Ghendrih, who helped to pioneer the technique refined by Evans, says that more experiments are needed to better understand why it works.

It is also unclear whether the new technique can be incorporated into the existing ITER design, says Alberto Loarte, a specialist in reactor walls with the European Fusion Development Authority in Garching, Germany. The modified DIII-D reactor contained conducting coils. These would be difficult to install in the hot, radioactive environment of ITER, says Loarte, as their insulating material would tend to fall apart.

The development comes as ITER's seven participants — the United States, European Union, Russia, China, Japan, India and South Korea — finalize their financial commitments to the project. Meanwhile, Loarte says, the engineering team is finalizing its design plans, which could include modifications based on Evan's findings.

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