Innovation & Technology News - Fusion reactor shows its metal - 22/05/2006

Fusion reactor shows its metal

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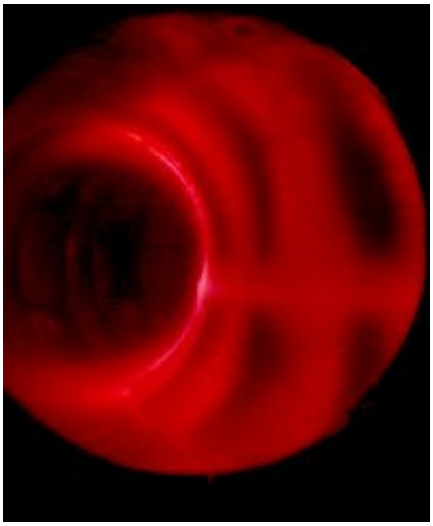
Physicists say they have cracked a problem facing nuclear fusion, touted as the cheap, safe, clean and almost limitless energy source of the future.

The US researchers say they have found a way to cut down erosion of the metal reactor wall, which would be a crucial step to improving efficiency.

They publish their work online today in the journal *Nature Physics*.

In fusion, atomic nuclei are fused together to release energy, as opposed to fission, the technique used for nuclear power and atomic bombs, where nuclei are split.



Glowing plasma inside a fusion test reactor *(Image: Princeton Particle Physics Laboratory)*

In a fusion reactor, particles are rammed together to form the charged gas plasma, contained inside a doughnut-shaped chamber called a tokamak, by powerful magnetic coils.

A consortium of countries signed a deal last year to build the International Thermonuclear Experimental Reactor (ITER) in southern France as a testbed for an eventual commercial design.

But many experts have been shaking their heads at the many challenges facing the ITER designers.

One challenge has been the phenomenon of edge localised modes, or ELMs, sudden fluxes or eddies in the outer edge of the plasma that erode the reaction chamber's inner wall.

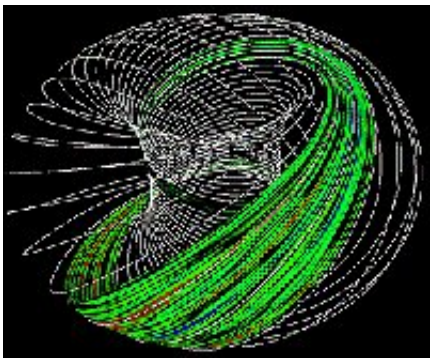
The tokamak's inner wall is an expensive metal skin that absorbs neutrons emitted from the plasma. And erosion would mean that the wall would have to be replaced more often.

Eroded particles also have a big impact on the plasma performance, diminishing the amount of energy it can deliver.

A team led by Todd Evans of General Atomics, California, believes that the problematic ELMs can be cleverly controlled.

The scientists found that a small resonant magnetic field, derived from special coils located inside a reactor vessel, creates 'chaotic' magnetic interference on the plasma edge, which stops the fluxes from forming.

The experiments were conducted at the General Atomics' DIII-D National Fusion Facility, a tokamak in San Diego.



Turbulence inside a tokamak *(Image: US National Energy Research Scientific Computing Center)*

Nuclear fusion is the same process used by the Sun to radiate energy. In the case of our star, hydrogen atoms are forced together to produce helium.

On Earth, the fusion would take place in a reactor fuelled by two istopes of hydrogen, deuterium and tritium, with helium as the waste product.

Deuterium is present in seawater, which would make it a virtually limitless resource. Tritium would be derived from irradiating the plentiful element lithium in the fusion vessel.

The US$12.8 billion (A$21.6 billion) ITER scheme entails building the largest tokamak in the world at Cadarache, near the southern French city of Marseille.

The partners are the European Union, the US, Japan, Russia, China, India and South Korea.

It is designed to be a testbed of fusion technologies, with a construction period of about 10 years and an operational lifespan of 20 years.

If ITER works, a prototype commercial reactor would be built, and if that works, fusion technology would be rolled out across the world.

Other problems facing fusion technology include the challenge of creating a self-sustaining plasma and efficiently containing the plasma so that charged particles do not leak out.

In existing tokamaks, no one has achieved a self-sustaining fusion event for longer than about five seconds, and at the cost of using up far more energy than is yielded.

A huge jolt of heat of nearly 100 million°C is needed to kick-start the process, which then has

to be sustained by tiny amounts of fuel pellets.

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