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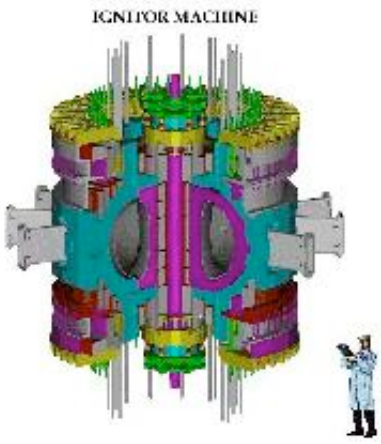
News

Fusion reactor aims to rival ITER

But scientists doubt that IGNITOR will lead to fusion power.

Emiliano Feresin

Italy and Russia plan to fund a compact nuclear-fusion experiment called IGNITOR, according to an intra-governmental memorandum signed on Monday in Milan, Italy. But fusion scientists contacted by *Nature* have dismissed claims made by its inventor that the reactor is a bigger step towards fusion power than the much more expensive international ITER project.



The proposed IGNITOR reactor moved a step closer to reality this week.

M. Romanelli/The IGNITOR project

Nuclear fusion involves the joining together of two nuclei of low atomic mass, usually deuterium and tritium, to release energy. IGNITOR and ITER will both use a doughnut-shaped device known as a tokamak to magnetically confine fusion reactants in a super-heated plasma. But IGNITOR is designed to use a much smaller tokamak (a radius of 1.3 metres compared with ITER's 6.2 metres) and a stronger magnetic field to compress the plasma.

And unlike ITER, the ultimate aim of IGNITOR is to demonstrate the feasibility of plasma ignition — a state in which there is enough fusion power to maintain the reaction without the need for external heat. ITER, on the other hand, aims to maintain fusion by generating up to 10 times more power than it consumes.

The idea behind IGNITOR was first put forward in the 1970s by Italian plasma physicist Bruno Coppi of the Massachusetts Institute of Technology in Cambridge. Supported by funding of about €20 million (US$27 million) from the Italian government, Coppi and a small group of collaborators in the United States and Italy have developed the IGNITOR reactor on paper and built the first prototype parts.

Coppi's long battle to bring the project into being collided with plans to fund ITER, which kicked off in 2006 after long delays and scientific debate about its feasibility. According to the intra-governmental memorandum signed this week, Coppi, together with the Italian National Agency for New Technologies, Energy and the Environment (ENEA) will collaborate with Evgeny Velikhov,

president of the Kurchatov Institute in Moscow, to finalize plans for the machine, which will be built at the Triniti site at Troitsk near Moscow. Velikhov is also the chair of the ITER council.

Fusion fallout

Coppi now claims that his reactor is the right way forward if fusion is ever going to generate useful amounts of energy. "With IGNITOR we can study high-field plasmas at ignition — the only way to get to a nuclear-fusion power plant," he says.

“The idea that there is a simple solution and ITER scientists are going crazy for the most expensive one is really exaggerated.”

Coppi says that ITER's aim of producing 10 times more power than is put in — known as the fusion energy gain factor, or *Q* value — is too low to generate power on a meaningful scale, and that the science that will be carried out at ITER will not be useful for future power plants.

But fusion scientists contacted by *Nature*, while welcoming the project, are less convinced that IGNITOR has the advantages over ITER that Coppi suggests.

Günther Hasinger, the scientific director of the Max Planck Institute of Plasma Physics in Garching, Germany, says that even if IGNITOR is successful it will still require an ITER-like project to scale up because there is no room in the smaller reactor for other components to absorb the energy produced by the fusion reaction.

"The idea that there is a simple solution and ITER scientists are going crazy for the most expensive one is really exaggerated," he says.

"ITER scale is the way to power plants," says Steve Cowley, director of the Culham Centre for Fusion Energy in Oxfordshire, UK. IGNITOR "is a great way to do an exciting experiment but it's a dead end", he says.

Cowley agrees that a *Q* value of greater than 10 would be good, but says *"Q*=10 is a conservative value, it may be 20, some predict ITER may even reach ignition; but we are not bound to ignition".

But Hasinger goes further in his scepticism of the IGNITOR reactor by questioning the feasibility of the whole project. Hasinger says that the IGNITOR team's plan to heat the plasma mostly with a current, a process known as ohmic heating, will not work. ITER complements ohmic heating with two other methods of

plasma heating — neutral-beam injection and electromagnetic waves. "We studied the possibility of a high-field ignition machine and came to the conclusion that relying on ohmic plasma heating has a very narrow corridor for success," he says.

But Coppi refutes the criticism, saying that ohmic heating has been shown to heat plasma to higher temperatures than expected, and points out that IGNITOR has an alternative heating method known as ion-cyclotron resonant heating.

According to a 2003 ENEA estimate, at least an additional €226 million will be needed to build IGNITOR, although neither Italy nor Russia have yet officially committed any funds to the project. Coppi claims that the costs will be lower. He hopes to have the machine built and working within 3–5 years and to have the first results immediately afterwards. "We are in a hurry," he says.

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