NEWS

Iter has to keep all promises

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After years of negotiations, the construction of Iter, the international nuclear fusion test reactor, is now starting.

No harmful waste, no greenhouse gas production, inherent safety and fuel for millions of years. Nuclear fusion has been promising to be the solution to our major environmental and energy problems for decades. After disappointments due to technical problems in the 1970s and reduced budgets due to cheap oil in the 1990s, nuclear fusion now seems to be a viable alternative. A small detail remains: it has not yet been possible to get more energy from a fusion reactor than it should. The International Tokamak Experimental Reactor, Iter for short, should change that.

An international alliance of the EU, Russia, the US, Japan, China, India and South Korea will start building Iter in Cadarache, southern France, next year, following the planned final signature on November 21. Iter promises to be the first fusion reactor to deliver more power than it needs to run: 500 MW for ten minutes, ten times more than what is put into it.

'The techniques are all available in their basic form, but a lot still needs to be done,' says Prof.dr. Niek Lopes Cardozo, professor of plasma physics at Eindhoven University of Technology. Lopes Cardozo is leader of the Dutch nuclear fusion research program at the Fom Institute for Plasma Physics Rijnhuizen in Nieuwegein. Last month, the government allocated fifteen million euros from the Economic Structural Reinforcement Fund (Fes) to the Dutch contribution for Iter. With this support a consortium 'Iter-NL' is formed, consisting of TNO, Fom, NRG and partners from the Dutch industry. The consortium will contribute - within a European context - to the realization of two important scientific instruments for Iter.

'It is not only good for the Dutch research world that we play such a prominent role in two important systems of Iter, Dutch industry will also benefit from this,' says Lopes Cardozo. 'These are complex, advanced instruments. We have specialized companies in the Netherlands that can make an excellent contribution to this. ' Dutch industry is therefore involved at an early stage in the development of these and other systems. Fom contributes the physical knowledge and NRG covers the nuclear aspects. In addition to its own technical input, TNO takes care of the knowledge transfer to industry and coordinates the whole. 'The form of this collaboration is unique. After all, it is not just a test set-up in a laboratory, but a huge international project with great political visibility.

The first system to which the Netherlands makes a contribution is to heat the fusion fuel, a mixture of hydrogen isotopes (see box 'nuclear fusion'). This Upper Port Launcher (UPL) is based on the microwave principle. A set of antennas with a combined power of 20 MW radiates microwaves in the mixture that has a temperature of hundreds of millions of degrees Celsius. By radiating these microwaves accurately - in place and time - and in a dosed manner, turbulence in the plasma can be controlled and the efficiency of the reactor can be optimized. Lopes Cardozo: 'Achieving such high temperatures now seems almost trivial, but was the biggest challenge of the merger research in the 1970s and 1980s. Especially because we have come to better understand the turbulences in the plasma, we are now reaching these temperatures. But there is still a lot to optimize. " The second Dutch system, the Upper Port Viewer (UPV), plays an important role in this. The UPV is an optical instrument that will measure the temperature of the plasma, among other things.

One of the main challenges concerns the removal of the heat from the 850 m3 plasma in the reactor vessel. The highly concentrated generation of power means that the wall of the reactor vessel is subjected to heavy pressure (see box 'Tokamak'). 'The power flux can reach up to 10 MW per square meter. "That is a huge amount," says Lopes Cardozo. 'We think we can manage this properly by choosing the conditions under which the interaction of the plasma with the wall takes place. But this is certainly not a run yet. To investigate this further, Fom-Rijnhuizen is building a unique plasma generator in which the same extreme conditions as in Iter can be realized. '

The construction of Iter will take ten years and is budgeted at 4.7 billion euros. A similar amount has been earmarked for twenty years of business and research. The construction partly coincides with the development of essential parts of the reactor. Lopes Cardozo: 'Iter is really a research reactor and will not generate any energy during his lifetime. The results of the experiments with Iter will be processed in Demo, the first prototype fusion reactor, the construction of which should start between 2030 and 2040. "

Nuclear

fusion **Nuclear** fusion is the process in which nuclear nuclei merge into one heavier nuclear nucleus:

D + T -> 4He + n + 17.6 MeV

Deuterium (D) and tritium (T) are forms of hydrogen nuclei with one or two neutrons, respectively. Amalgamation leads to a helium nucleus (He) with the two protons from the hydrogen nuclei and two from the three neutrons. The third neutron (s) is released, along with a large amount of energy, denoted here in mega electron volt (MeV).
The problem with nuclear fusion is that not only is the amount of energy produced large, but the amount of energy required is also enormous. Because both nuclei are positively charged, they repel each other and an enormous amount of kinetic energy is required to collide them with so much force that they merge. The temperature required for this is at least fifteen million degrees Celsius (but better is tenfold), a temperature at which every material evaporates. At this temperature, nuclear nuclei and electrons tumble together without coherence, a state called 'plasma'. A kilogram of plasma of tritium and deuterium provides as much energy as ten thousand tons of coal.

Tokamak
The word 'tokamak' is a combination of the Russian words 'toroidalnaya', 'kamera', 'magnitnaya' and 'katushka', which means 'magnetic coils around a toroidal chamber'.
The plasma (red) contains the plasma and the wall contains water (blue), which provides electricity after evaporation. The plasma is enclosed in a magnetic field, so that it does not hit the wall. This magnetic field is generated by the D-shaped magnets (gray) around the chamber and by the current flowing through the plasma, so that it actually acts as a secondary coil of a transformer.

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