the way to new energy

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Progress in Fusion

Fusion is one of nature's most spectacular achievements. Billions and billions of fusion furnaces, the Sun among them, are flaring in the Universe, creating light and energy.

The next step after ITER will be a demonstration power plant - or DEMO - that will demonstrate the viability of producing large-scale electricity from fusion.

Some seventy years ago scientists understood the physics behind this wonder: the Sun and stars *transmute* matter, patiently and tirelessly transforming Hydrogen nuclei into Helium atoms and releasing huge amounts of energy in the process.

With this knowledge came the ambition to reproduce, here on Earth, what was happening in the innumerable stars of the Universe. But harnessing the energy of the stars was to prove a formidable task, more complex and arduous than anticipated.

20th Century Fusion

The world's first tokamak device: the Russian T1 Tokamak at the Kurchatov Institute in Moscow. It was the first device to use a stainless steel liner within a copper vacuum chamber.

Following the first fusion experiments in the 1930s, fusion physics laboratories were established in nearly every industrialized nation. By the mid-1950s "fusion machines" were operating in the Soviet [illegible] the U[illegible] States, France, Germany and Japan. Through these, scient[illegible] understanding of the fusion process was gradually refined.

A major breakthrough occurred in 1968 in the Soviet Union. Researchers there were able to achieve temperature levels and plasma confinement times - two of the main criteria to achieving fusion - that had never been attained before. The Soviet machine was a doughnut-shaped magnetic confinement device called a **tokamak**.

From this time on, the tokamak was to become the dominant concept in fusion research, and tokamak devices multiplied across the globe.

Producing fusion energy, it soon became clear, would require marshalling the creative forces, technological skills, and financial resources of the international community. The Joint European Torus (JET) in Culham, U.K., in operation since 1983, was a first step in this direction. JET is collectively used by the EURATOM (European Atomic Energy Community) Associations from more than 20 European countries. In 1991, the JET tokamak achieved the world's first controlled release of fusion power.

Steady progress has been made since in fusion devices around the world. The Tore Supra Tokamak that is part of the Cadarache nuclear research centre holds the record for the longest plasma duration time of any tokamak: six minutes and 30 seconds. The Japanese JT-60 achieved the highest value of fusion triple product - density, temperature, confinement time -of any device to date. US fusion installations have reached temperatures of several hundred million degrees Celsius.

Research and development for ITER pointed to coconut-shell charcoal as the most efficient coating material for the cryopanels that keep the vacuum in the ITER Tokamak clean. A supply of 2002 Indonesian coconut charcoal is being stored at the Karlsruhe Institute of Technology in Germany for

Achievements like these have led fusion science to an exciting threshold: the long sought-after **plasma energy breakeven** point. Breakeven describes the moment when plasmas in a fusion device release at least as much energy as is required to produce them. Plasma energy breakeven has never been achieved: the current record for energy release is held by JET, which succeeded in generating 70% of input power. Scientists have now designed the next-step device - ITER - which will produce more power than it consumes: for 50 MW of input power, 500 MW of output power will be produced.

output power will be produced.

is being stored at the Karlsruhe Institute of Technology in Germany for ITER's cryopumps. Photo: Peter Ginter

ITER will begin writing the chapter on 21st century fusion.