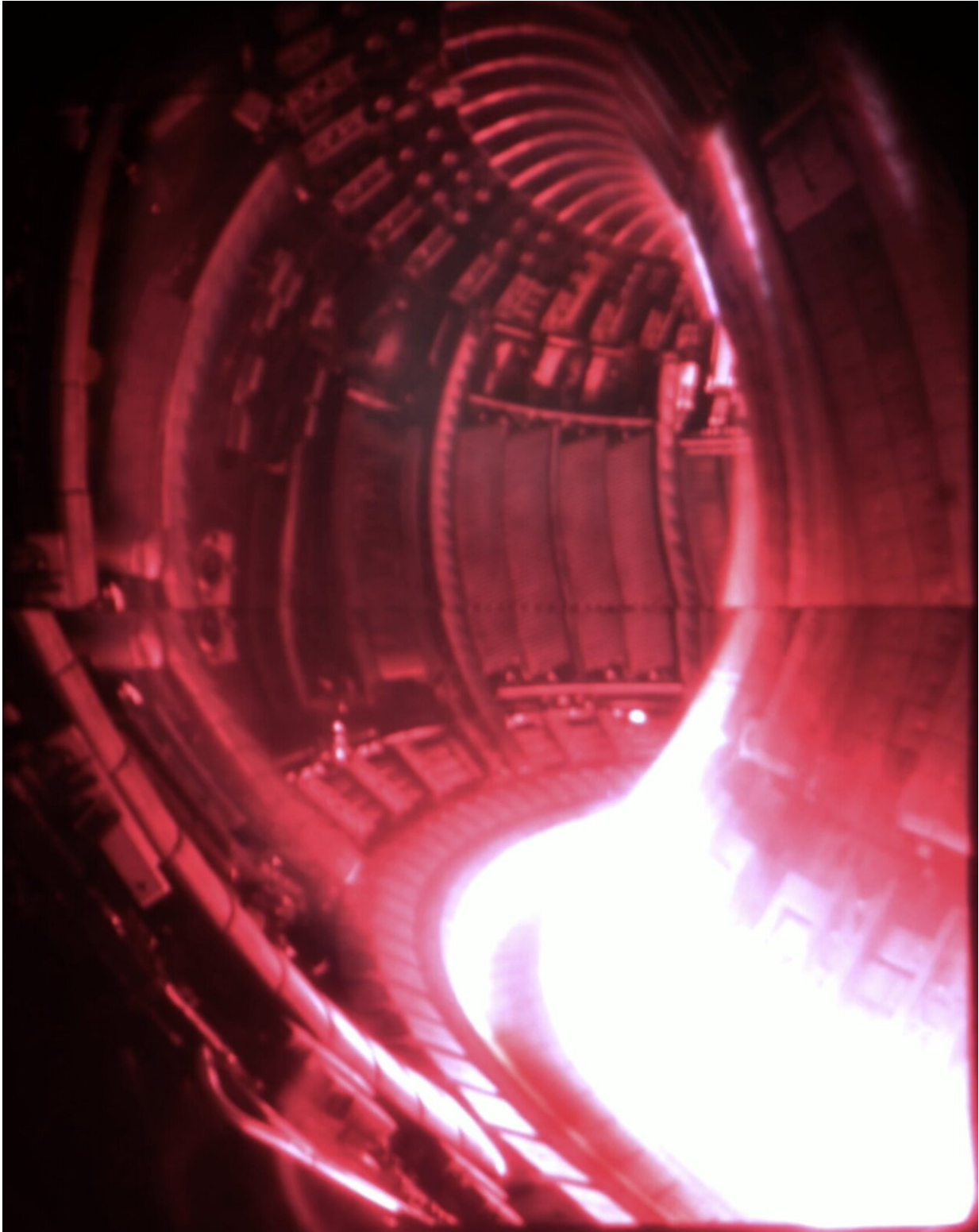


Fusion research facility's final tritium experiments yield new energy record

February 8 2024



Looking inside the Joint European Torus tokamak at pulse #104522 from 3 October 2023, which set a new fusion energy record of 69 megajoules. Credit:

United Kingdom Atomic Energy Authority, courtesy of EUROfusion

The Joint European Torus (JET), one of the world's largest and most powerful fusion machines, has demonstrated the ability to reliably generate fusion energy, while simultaneously setting a world record in energy output.

These notable accomplishments represent a significant milestone in the field of fusion science and engineering.

In JET's final deuterium-tritium experiments (DTE3), high fusion power was consistently produced for five seconds, resulting in a groundbreaking record of 69 megajoules using a mere 0.2 milligrams of fuel.

JET is a tokamak, a design which uses powerful magnetic fields to confine a plasma in the shape of a doughnut. Most approaches to creating commercial fusion favor the use of two hydrogen variants—deuterium and tritium. When deuterium and tritium fuse together they produce helium and vast amounts of energy, a reaction that will form the basis of future fusion powerplants.

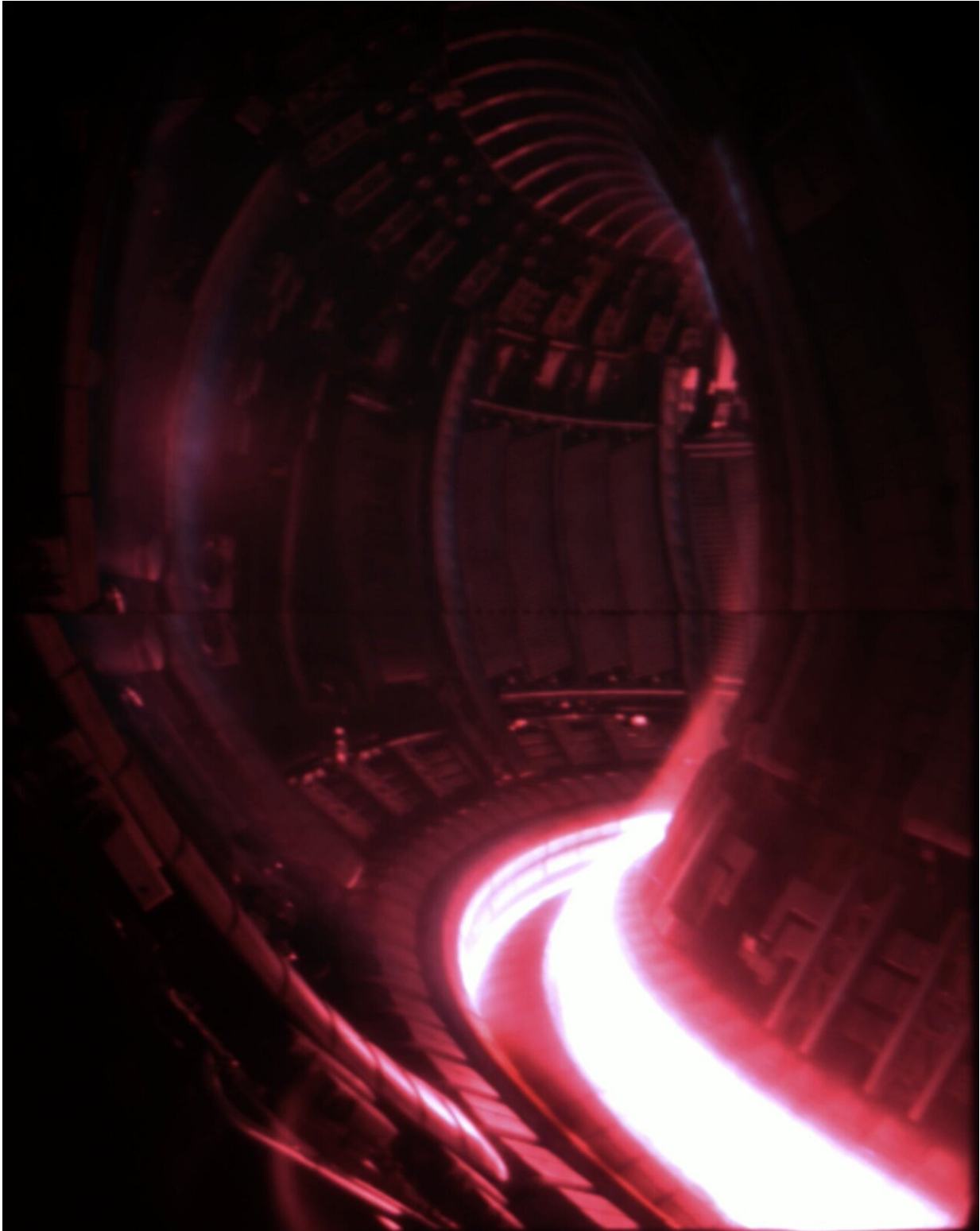
Dr. Fernanda Rimini, JET Senior Exploitation Manager, said, "We can reliably create fusion plasmas using the same fuel mixture to be used by commercial fusion energy powerplants, showcasing the advanced expertise developed over time."

Professor Ambrogio Fasoli, Program Manager (CEO) at EUROfusion, said, "Our successful demonstration of operational scenarios for future fusion machines like ITER and DEMO, validated by the new energy record, instill greater confidence in the development of fusion energy. Beyond setting a new record, we achieved things we've never done

before and deepened our understanding of fusion physics."

Dr. Emmanuel Joffrin, EUROfusion Tokamak Exploitation Task Force Leader from CEA, said, "Not only did we demonstrate how to soften the intense heat flowing from the plasma to the exhaust, we also showed in JET how we can get the plasma edge into a stable state thus preventing bursts of energy reaching the wall. Both techniques are intended to protect the integrity of the walls of future machines. This is the first time that we've ever been able to test those scenarios in a deuterium-tritium environment."

Over 300 scientists and engineers from EUROfusion—a consortium of researchers across Europe, contributed to these landmark experiments at the UK Atomic Energy Authority (UKAEA) site in Oxford, showcasing the unparalleled dedication and effectiveness of the international team at JET.



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The results solidify JET's pivotal role in advancing safe, low-carbon, and sustainable fusion energy.

UK Minister for Nuclear and Networks, Andrew Bowie, said, "JET's final fusion experiment is a fitting swansong after all the groundbreaking work that has gone into the project since 1983. We are closer to fusion energy than ever before thanks to the international team of scientists and engineers in Oxfordshire."

"The work doesn't stop here. Our Fusion Futures program has committed £650 million to invest in research and facilities, cementing the UK's position as a global fusion hub."

JET concluded its scientific operations at the end of December 2023.

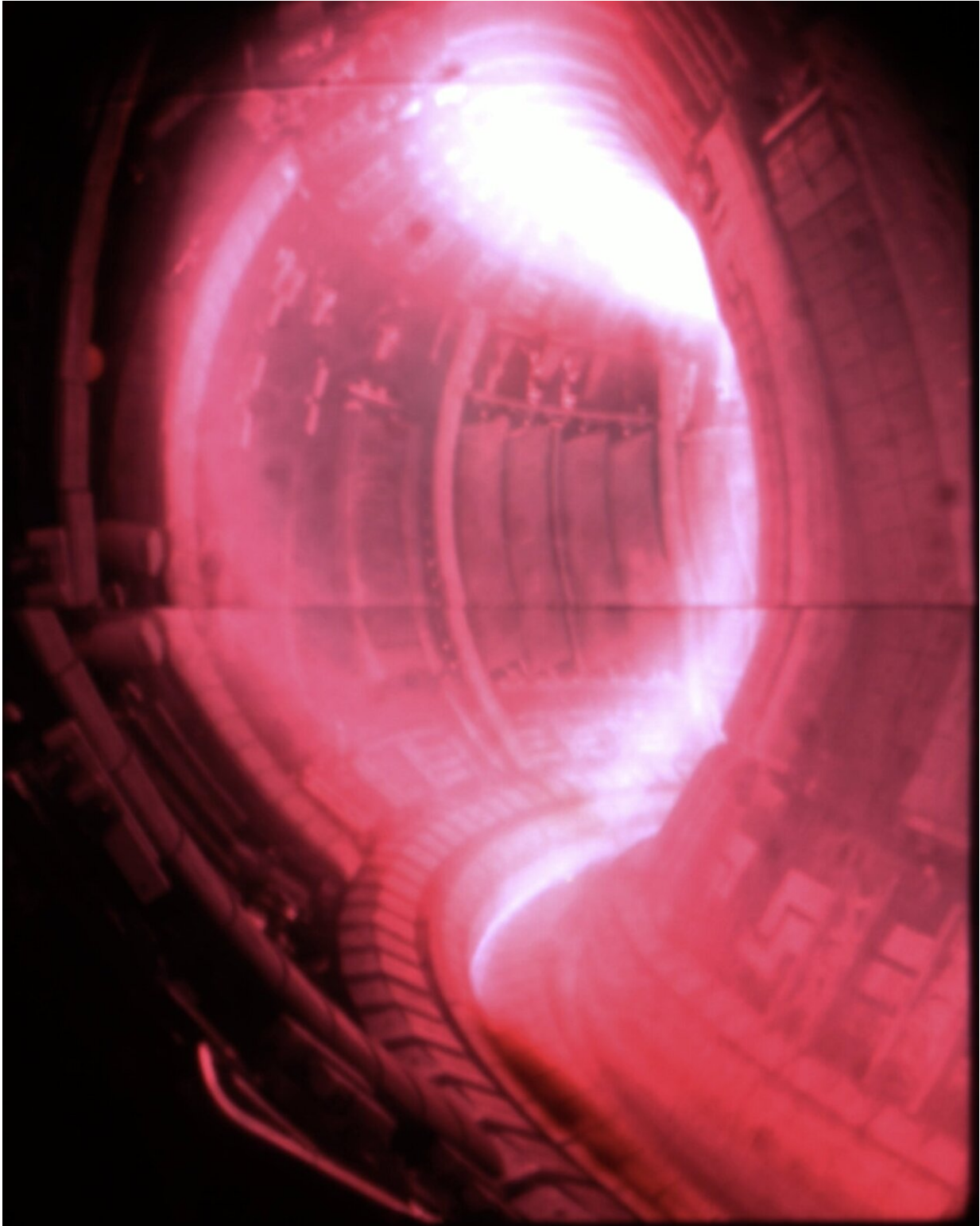
Professor Sir Ian Chapman, UKAEA CEO, said, "JET has operated as close to powerplant conditions as is possible with today's facilities, and its legacy will be pervasive in all future powerplants. It has a critical role in bringing us closer to a safe and sustainable future."

JET's research findings have critical implications not only for ITER—a fusion research mega-project being built in the south of France—but also for the UK's STEP prototype powerplant, Europe's demonstration powerplant, DEMO, and other global fusion projects, pursuing a future of safe, low-carbon, and sustainable energy.

Dr. Pietro Barabaschi, ITER Director-General, said, "Throughout its lifecycle, JET has been remarkably helpful as a precursor to ITER: in the testing of new materials, in the development of innovative new

components, and nowhere more than in the generation of scientific data from Deuterium-Tritium fusion."

"The results obtained here will directly and positively impact ITER, validating the way forward and enabling us to progress faster toward our performance goals. On a personal note, it has been for me a great privilege having myself been at JET for a few years. There I had the opportunity to learn from many exceptional people."



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JET has been instrumental in advancing fusion energy for over four decades, symbolizing international scientific collaboration, engineering excellence, and the commitment to harness the power of fusion energy—the same reactions that fuel the sun and stars.

JET demonstrated sustained fusion over five seconds at high power and set a world record in 2021. JET's first deuterium-tritium experiments took place in 1997.

As it transitions into the next phase of its life cycle for repurposing and decommissioning, a celebration in late February 2024 will honor its founding vision and the collaborative spirit that has driven its success.

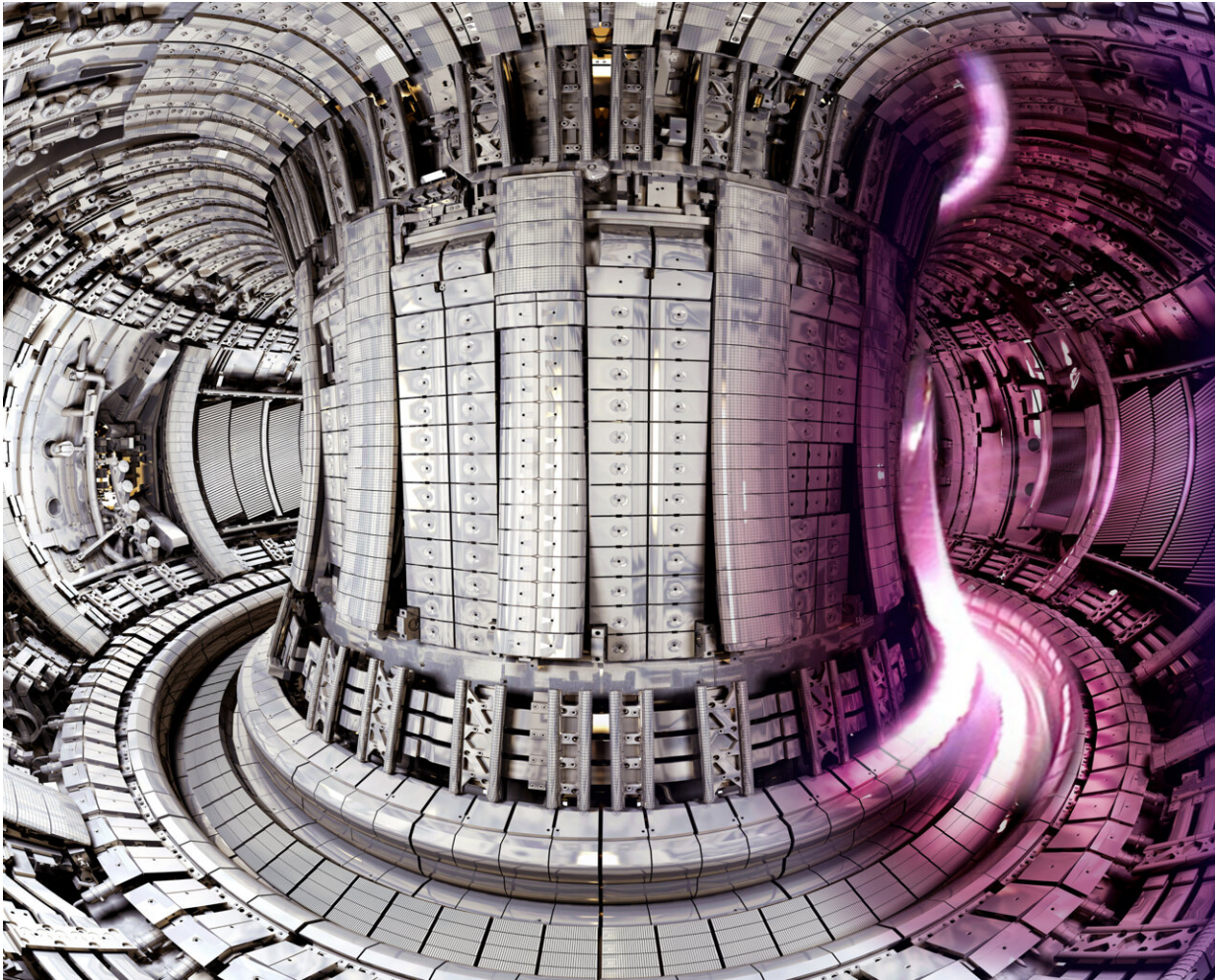
The achievements at JET, from the major scientific milestones to the setting of energy records, underscores the facility's enduring legacy in the evolution of fusion technology.

Its contributions to fusion science and engineering have played a crucial role in accelerating the development of fusion energy, which promises to be a safe, low carbon and sustainable part of the world's future energy supply.

Fusion energy's potential

Fusion, the process that powers stars like our sun, promises a clean baseload source of heat and electricity for the long term, using small amounts of fuel that can be sourced worldwide from inexpensive materials.

When a mix of two forms of hydrogen (deuterium and tritium) is heated to form a controlled plasma at [extreme temperatures](#)—10 times hotter than the core of the sun—they fuse together to create helium and release energy which can be harnessed to produce electricity.



Interior of the Joint European Torus (JET) tokamak experimental fusion machine with a photo of the plasma overlaid. Credit: United Kingdom Atomic Energy Authority, courtesy of EUROfusion

Deuterium and tritium are two heavier variants of ordinary hydrogen and together offer the highest reactivity of all fusion fuels. At a temperature of 150 million degrees Celsius, deuterium and tritium fuse together to form helium and release a tremendous amount of heat energy without any greenhouse contributions. Fusion is inherently safe in that it cannot start a run-away process and produces no long-lived waste.

There is more than one way of achieving fusion. Our approach is to hold the hot plasma using strong magnets in a ring-shaped machine called a "tokamak," and then to harness this heat to produce electricity in a similar way to existing power stations.

About the fusion energy fuel

Most approaches to creating commercial fusion favor the use of two hydrogen variants—deuterium and tritium. When deuterium and tritium fuse together they produce helium and vast amounts of energy—a reaction that will form the basis of future fusion powerplants.

Deuterium is plentiful and can be extracted from water. Tritium is a radioactive variant of hydrogen with a half-life of about 12 years. Tritium can be farmed from lithium.

About the final deuterium-tritium experiments (DTE3)

JET is the only tokamak fusion machine in operation capable of handling tritium fuel. The third round of experiments using deuterium and tritium fuel were conducted over seven weeks from 31 August to 14 October 2023. They focused on three areas—plasma science, materials science and neutronics.

JET's [fusion energy](#) record is a result of the advanced capability in operating deuterium-tritium plasmas. These experiments were primarily designed as the first-ever opportunity to demonstrate the feasibility of minimizing heat loads on the wall in a deuterium-tritium environment, crucial for ITER scenarios.

More information: To learn more about the scientific results of the JET DTE3 experiments visit: [Joint European Torus successfully tests new solutions for future fusion power plants.](#)

Provided by EUROfusion

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