IEA TECHNOLOGY COLLABORATION PROGRAMMES

The breadth and coverage of analytical expertise in the IEA Technology Collaboration Programmes (TCPs) are unique assets that underpin IEA efforts to support innovation for energy security, economic growth and environmental protection. The 38 TCPs operating today involve about 6 000 experts from government, industry and research organisations in more than 5

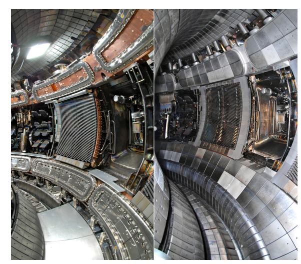
Tokamak Programmes (CTP TCP)

HIGHLIGHT

Reducing, avoiding and mitigating plasma instabilities

The CTP TCP carries out collaborative research activities on tokamak** fusion reactors and joint experiments to enhance scientific and technological understanding of these doughnut shaped devices for fusion power. Given the volatility of fusion plasma, identifying and testing systems to remedy plasma disruptions is crucial to advancing fusion power technology.

In-vessel coil devices designed to mitigate transient thermal energy losses in the ASDEX-Upgrade tokamak (Garching, Germany).*



Fusion energy could play a primary role in reducing GHG emissions while enhancing energy security, diversifying fuel sources, and providing large-scale electricity at stable production costs. Much fusion research focuses on maintaining the plasma in equilibrium and finding suitable materials to withstand the extreme temperatures. Co-ordinated experiments are needed to understand and master this complex science.

To date, tokamak fusion reactors are the most promising fusion confinement devices. The International Thermo-nuclear Experimental Reactor (ITER)***, the world's largest tokamak pilot reactor, is an international collaboration between seven parties. ITER is expected to produce approximately 500 MW of electricity from an input of 50 MW. Despite this potential, further research is needed to demonstrate the safety of this experimental reactor. The successful exploitation of ITER depends on developing reliable and effective strategies to predict, and work to avoid, ejections and disruptions in the plasma. When small amounts of the plasma are regularly ejected, or when the plasma loses density and it is disrupted, energy is deposited on the inner walls of the reactor. These deposits interact with further operations and damage the metallic surfaces.

For these reasons, the CTP TCP worked to characterise these ejections (edge localised modes) and disruptions and to explore solutions and to develop systems and methodologies to reduce them. Most participants have now equipped their respective devices with in-vessel coils designed to minimise the ejections. In addition, many devices are now equipped with dedicated exhaust valves designed to dissipate excess energy bursts before they can affect the chamber walls.

If these plasma control systems fail to stabilise the plasma, a disruption system must be activated. Two possible avenues for disruption systems were considered. The first was massive injection of gases such as neon or argon into the plasma. A second solution was to inject cork-sized pellets of frozen gas (mostly neon and deuterium) into the plasma. Both methods must be deployed very quickly to mitigate the disruption.

While experiments have demonstrated reliable mitigation of electromagnetic loads using gas injection, uncertainties remain. Consequently, the CTP TCP recommends developing a flexible disruption system that includes both massive gas injection and shattered pellets to ensure successful and safe operations. ITER will be equipped with ELM and disruption mitigation systems similar to those being developed and tested on current tokamaks. These and other findings are consolidated in the report, *Disruptions in ITER and Strategies for their Control and Mitigation*.

* Photos courtesy of Max Planck Institute for Plasma Physics

** The term *tokamak* is a transliteration of the Russian term for a toroidal chamber with magnetic coils (*toroidal'naya kamera v magnitnykh katushkakh*)

*** ITER is a large-scale scientific experiment that aims at demonstrating the technological and scientific feasibility of fusion energy by producing approximately 500 MW of fusion power from an input of 50 MW (Cadarache, France)

ACTIVITIES

- Confinement and transport
- Disruption and ELM mitigation
- Edge and pedestal physics
- Energetic particles
- Plasma control and scenario development
- Plasma diagnostics
- Plasma-wall interaction
- SOL and divertor physics

PARTICIPANTS

	IEA member countries	Partner countries	Reg./Int. orgs.
Contracting Parties	3	2	2
Sponsors	-	-	-

For more information: http://ctp.jet.efda.org/

1. Information or material of the IEA Technology Collaboration Programmes, or IEA TCPs (formally organised under the auspices of an Implementing Agreement), including information or material published on this website, does not necessarily represent the views or policies of the IEA Secretariat or of the IEA's individual Member countries. The IEA does not make any representation or warranty (express or implied) in respect of such information (including as to its completeness, accuracy or non-infringement) and shall not be held liable for any use of, or reliance on, such information.