The Field-Reversed Configuration: A promising path to aneutronic fusion

J. Romero

TAE Technologies, USA

The Field-Reversed Configuration (FRC) is a promising confinement concept for a fusion reactor due to its compact size, low rate of neutron emission, and high beta (where beta is the ratio of the plasma pressure to the magnetic pressure).

The C-2W device – a research facility built and operated by TAE Technologies Inc. – uses an NBI driven toroidal plasma current to generate a closed field configuration without externally applied toroidal fields. A mirror confined Scrape-Off-Layer (SOL) surrounds the closed field structure. This design boasts practical advantages, like a linear geometry for simplified construction and maintenance and the ability to control the FRC position and size using low power levels.

To improve the thermal properties of the plasma, the FRC size needs to be maximized and aspect ratio matched to the long confinement vessel. The external fields required to elongate the plasma work against the natural tendency of the plasma currents to contract it, resulting in an axially unstable behaviour that must be actively stabilized.

High frequency, low latency magnetic control is now routinely used in C-2W to shape and stabilize the plasma using multiple external magnetic coil actuators. The control algorithm is informed by Large Scale Bayesian analysis which fuses information from multiple diagnostics to obtain a consistent picture of the plasma state along with uncertainty measures.

This is a tremendous accomplishment in fusion energy research. FRC's – once believed to be operable only in pulsed mode – can now operate continuously, as required to reduce thermal stresses in a high-power density fusion reactor plasma core.

This talk will present the status of the plasma control system and automatic inference developments at TAE, illustrated with recent C-2W experimental results.