Contribution ID: **135** Type: **Poster**

Modeling separatrix splitting and magnetic footprints in TCABR

Wednesday, 17 July 2024 15:40 (1h 30m)

Plasma instabilities are still a concern when thermonuclear conditions are approached as they can impose severe constraints on the maximum achievable plasma performance. When operating in the so-called high confinement mode (H-mode) a very steep plasma pressure profile is formed in the plasma edge, which leads to repetitive instabilities known as edge localized modes (ELMs). The crash of these modes leads to high transient heat fluxes onto the divertor plates, significantly reducing the lifetime of it's components. Experiments have demonstrated that externally applied resonant magnetic perturbations (RMPs) can be used to control the plasma edge stability thus providing a way to trigger ELMs prematurely. When field lines from inside the perturbed plasma volume connect to the divertor targets, structures termed magnetic footprints appear on the plates, delimiting the spots over which most of the exhausted heat and particles are deposited. A significant upgrade of the Tokamak ʻa Chauffage Alfv´en Br´esilien (TCABR) is being designed to make it capable of creating a well controlled environment where the physics basis behind the effect of RMP fields on ELMs can be addressed. The core of this upgrade corresponds to the design and construction of an innovative set of 108 in-vessel ELM control coils, installed both on the high field side (HFS) and on the low field side (LFS). Modeling the magnetic field produced by these non-axisymmetric coils is a fundamental step for their design and, of course, their use during future experiments. In this project, to estimate the vacuum magnetic field produced by this set of coils in the plasma region, the geometry of the conductors of each coil is modeled using sufficiently small rectilinear segments of current. Subsequently, the magnetic field created by each segment is calculated using the Biot-Savart law. With both the geometry and the electric current of each coil being given, the perturbed magnetic field distribution inside the TCABR vacuum vessel can be calculated for various plasma scenarios, including the field spectra. Controlling the intersection of magnetic lobes with divertor target plates is also an important issue to maintain the integrity of the plasma facing components as it controls the levels of heat and particle deposition on the target plates surface. Therefore, the calculated perturbed magnetic field is also used to model the separatrix splitting, magnetic lobes and footprints for various plasma scenarios in TCABR.

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Session Classification: Poster Session

Track Classification: Special Session for Physics Topics