Engineering studies for an axisymmetric metallic divertor in Tore Supra

L. Doceul, C. Portafaix, J. Bucalossi, A. Saille, B. Bertrand, M. Lipa, M. Missirlian, G.Jiolat, F. Samaille

Association Euratom-CEA, IRFM, Cadarache, 13108 Saint-Paul-lez-Durance, France

Tore Supra has been designed to operate with technologies allowing long plasma duration (a few minutes), thanks to the use of superconducting magnets and high heat flux actively-cooled plasma facing components. Feedbacks of such components point out the high importance of operating in real plasma environment. Actively cooled tungsten plasma facing components will be used in the ITER divertor. In order to fully validate such a technology (industrial manufacturing, operation with long plasma duration), the implementation of a tungsten axisymmetric divertor in the tokamak Tore-Supra is studied. With this major upgrade Tore-Supra will be the only European tokamak able to address the problematic of long plasma discharges with a metallic divertor.

It is proposed to create an X point magnetic configuration in the upper and lower area of the vacuum vessel. To do so, two symmetric divertor coils will be installed inside the vacuum vessel. The coils will be constituted of a wiring of actively cooled copper conductors. The two winding pack being included inside two rigid stainless steel casing in order to sustain the electromagnetical loads.

The magnetic configuration allows sharing thermal loads between the two divertor targets. It is proposed to extract the maximum power in steady state at the lower X-point while a lower power extraction capability is foreseen at the upper X-point. This increases the system flexibility and leads to a global cost reduction.

The plasma facing components of the lower X- point targets are representative of the ITER divertor vertical targets (tungsten monobloc design) while the upper X- point targets are more representative of the first wall heat sink technology of ITER blanket modules (CuCrZr copper / stainless steel) with a tungsten coating.

The paper will describe:

- The mechanical design of this major component and its integration in the Tokamak,
- The electromagnetic and mechanical analysis including off-normal loads such as the electrodynamique forces in the coils and forces du to eddy and halo currents,
- The design and thermo mechanical analysis of the proposed plasma facing components,
- The manufacturing issues,
- The assembly simulations in Tore-Supra.