Contribution ID: **13** Type: **Oral (Plenary Session)**

Divertor and Exhaust Modelling in the Framework of a Systems Code for a Stellarator Power Plant

Tuesday 5 November 2019 11:50 (20 minutes)

The controlled particle and heat exhaust is one of the most challenging aspects towards the realisation of a commercial fusion power plant. However, despite this importance, it is difficult to extrapolate the expected divertor heat load for a future fusion power plant. In the tokamak community, credible models for the divertor heat load in DEMO have long been missing and still largely rely on empirical scalings, which were derived from a large database of tokamak experimental data. A number of very sophisticated codes exist, but require prohibitively large computing resources to cover a larger parameter space.
Consequently, it is important to develop tractable models at affordable computational cost to assess the divertor placement and heat loads for the next-generation of power generating fusion devices. It is essential to be able to predict the expected heat load in order to ascertain whether the concept is actually feasible given the material limitations. In other words, the divertor heat loads may limit the design space, posing a strict boundary condition that needs to be taken into account during the conceptual design phase and optimisation of next-step devices. For this procedure, usually a Systems Code is employed that models an entire fusion plant. In this work we concentrate on the divertor and exhaust scenario for the stellarator concept.
The advanced modular 5-periodic stellarator concept currently favoured in Europe features a so-called magnetic island divertor concept. In this concept, the inherent magnetic field structure with a low order rational rotational transform at the plasma boundary and low magnetic shear leads to a chain of resonant magnetic islands in the plasma edge region, which provides a structured layer between the confined core plasma and the target elements. The divertor target plates are placed such that they intercept the islands to efficiently control the energy and particle exhaust.
Before the start of the Wendelstein 7-X stellarator, a heuristic island divertor model was developed for the Systems Code PROCESS and used for power plant design studies of the stellarator concept. In the meantime W7-X has become operational and demonstrated a robust particle and heat exhaust handling using the island divertor concept. The most notable achievement has been the stable and fully detached plasma operation for 30 seconds, which is a favourable scenario for a stellarator power plant.
Based on these results, the original heuristic island divertor systems code model is reviewed and validated against W7-X experimental results. Further, based on the experimental results, a way forward is devised for the development of an improved tractable island divertor model suited for Systems Code and design applications. Ultimately, this work aims to enhance the fidelity and credibility of the conceptual design studies of next-step stellarators addressing one of the most challenging aspects of fusion development.

Country or International Organization

Germany

Author: WARMER, Felix (Max Planck Institute for Plasma Physics)

Presenter: WARMER, Felix (Max Planck Institute for Plasma Physics)

Session Classification: Stellarators Divertors

Track Classification: Divertors for DEMO and Reactors