Contribution ID: **24** Type: **Oral**

Heat Transport Widths and its Scaling in the W7-X Island Divertor

Thursday 30 October 2025 14:20 (20 minutes)

The stellarator concept offers a promising pathway toward achieving nuclear fusion as a scalable, carbon-free energy source. Wendelstein 7-X (W7-X), an optimized stellarator experiment, aims to provide a proof-of-concept for this approach [1]. W7-X employs the island divertor concept as its plasma exhaust solution, utilizing a chain of magnetic islands at the plasma boundary, intersected with toroidally discrete divertor targets [2].

With the goal of evaluating the power exhaust performance of the island divertor, this contribution focuses on heat transport in the complex and inherently three-dimensional scrape-off layer (SOL) of W7-X. Drawing inspiration from established approaches in tokamak research —such as the use of the Eich function [3] to parameterize divertor heat loads —we present a novel framework to characterize the transport that is responsible for the two-dimensional heat flux patterns observed on the W7-X island divertor. By leveraging the spatial correspondence between strike line structures and SOL footprints on the divertor, the power exhaust can be systematically decomposed into three transport channels associated with distinct topological regions of the island SOL. Each channel is characterized by a representative length scale (width), which reflects the interplay between parallel and cross-field transport. Notably, the average power-channel width Λ_W evaluated from the proposed scheme serves as a stellarator analogue to the well-known SOL heat flux width λ_q in tokamaks.

These width parameters provide qualitative insights into transport processes dictating the divertor heat loads, enabling a systematic study of underlying mechanisms and allowing for consistent investigations of scaling with operational parameters. The framework has thus been applied to the experimental data from multiple W7-X campaigns [4]. Resulting empirical scalings of SOL transport widths with relevant plasma and operational parameters are presented and compared to simplified models. Finally, we highlight future prospects for the methodology, including cross-device comparisons of SOL transport, informing numerical models for 3D SOL, and standalone stellarator divertor heat load predictions.

[1] M. Endler et al, Fusion Engineering and Design 167 (2021) 112381

[2] Y. Feng et al, Nuclear Fusion 46.8 (2006) 807

[3] T. Eich et al, Phys. Rev. Lett. 107 (2011) 215001

[4] Y. Gao et al, Nuclear Fusion 59.6 (2019) 066007

Speaker's title

Mr

Speaker's Affiliation

Max-Planck-Institut für Plasmaphysik, Greifswald

Member State or IGO

Germany

Author: Mr KHARWANDIKAR, Amit (Max Planck Institute for Plasma Physics)

Co-authors: NAUJOKS, Dirk (IPP Greifswald); REIMOLD, Felix (Max Planck Institute for Plasma Physics, Greifswald, Germany); Prof. SCHNEIDER, Ralf (Universität Greifswald); Dr GAO, Yu (Max-Planck-Institute for Plasma Physics, Greifswald, Germany); FENG, Yuhe (Max-Planck-Institute for Plasma Physics)

Presenter: Mr KHARWANDIKAR, Amit (Max Planck Institute for Plasma Physics)

Session Classification: Scrape-off-Layer and Divertor Physics

Track Classification: Scrape-off-Layer and Divertor Physics