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FTP/P1-02: Heat Flux and Design Calculations for the W7-X Divertor Scraper Element

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The W7-X stellarator is a high-performance optimized stellarator currently under construction in Greifswald, Germany. W7-X will operate under near steady-state conditions (˜30 minute pulses), with high input power (15-20MW, 8-10MW in first operational phase). The power and particle exhaust will be handled using an island divertor, in which last closed flux surface is defined by an island chain. New divertor components are being designed to protect the edges of the primary targets during the bootstrap current evolution in scenarios that deviate from the 'minimum bootstrap current' configurations. These new components will have peak heat fluxes ˜10-12 MW/m2, and will be constructed using CFC (carbon fiber composite) monoblocks of the same type that has been qualified for ITER.
The heat flux distribution to the plasma facing components is calculated from field line following in a 3D magnetic field that includes the plasma contribution. The magnetic field is determined from the VMEC [1] (3D equilibrium) and Extender [2] (fields outside the last closed flux surface) codes. The heat flux and strike patterns in the 9 reference W7-X operating configurations will be presented for various values of the total bootstrap current during its evolution. The calculated heat fluxes to the scraper element are used as an input to heat transfer calculations. Several quantities which guide the scraper design are calculated, e.g., CFC surface temperature, fluid temperature rise, and fluid pressure drop. The results of both the heat flux calculations and the heat transfer model are used in a coupled optimization procedure to develop the geometry of the scraper element. The latest divertor geometry will be presented, along with results from the optimization and analysis procedures.
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Country or International Organization of Primary Author

USA

Primary author: Mr LORE, Jeremy (ORNL)

Co-authors: Dr PEACOCK, Alan (IPP-Garching); Dr LUMSDAINE, Arnold (ORNL); MCGINNIS, Dean (ORNL); Dr BOSCARY, Jean (IPP-Garching); Dr HARRIS, Jeff (ORNL); Dr GEIGER, Joachim (IPP-Greifswald); Dr CANIK, John (ORNL); TIPTON, Joseph (University of Evansville); Dr ANDREEVA, Tamara (IPP-Greifswald)

Presenter: Mr LORE, Jeremy (ORNL)

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