Contribution ID: **470** Type: **not specified**

P4.134 Numerical design approaval of port liner and bellows protection

Thursday, 20 September 2018 11:00 (2 hours)

The world's largest modular stellarator, Wendelstein 7-X (W7-X), is in operation since 2015. Stepwise increase of operation parameters has its final goal in the demonstration of steady-state operation capabilities with pulses up to 30 minutes. Such pulses require a constant heating of the plasma due to losses by plasma-wall interactions, particle drift and radiation losses. The latter are assumed to occur with resulting loads of up to 5 kW·m-2 in average on the surfaces of the ports. Thus, a thermal shielding is required for the port walls, in order to keep the average wall temperature below 80 ℃. Otherwise, unsustainable heat radiation loads on the superconducting magnetic coil system of W7-X could emerge and cause a quench incident.
Due to gaps between port and first wall components, like graphite tiles and panels, the weld directly faces a small fraction of the plasma radiation, which subsequently requires protection. In the inner cavities of the ports, short length microwave stray radiation (ECRH) is the dominating radiation component. This renders usual protection measures, like shields throwing a shadow, for the thin walled bellows useless.
The paper describes the calculation of the relevant heat loads, based on a 1-way ray-tracing code [1] and the developed radiation-shielding concept for the port. The concept consists of a water-cooled port-liner, a passively cooled sheet metal gap-closure, attached to the liner and designed to protect the exposed welds and a copper bellows protection, blocking ECRH stray-radiation from sensitive bellows. Finally, the vital ability to serve as a steady-state capable shielding concept is demonstrated here.

[1] S. Bozhenkov, https://bitbucket.org/sboz/meshlib

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Session Classification: P4