Steady-state in vessel components for the Wendelstein 7-X stellarator

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The Wendelstein 7-X stellarator, presently under construction in Greifswald, Germany will be a "fully-optimized" stellarator device. The In Vessel components of W7-X are so designed to allow steady state operation with a Divertor designed to allow for 10MW/m^2 power loading. A steady-state divertor solution is required to demonstrate the reactor potential stellarators for DEMO and beyond.

The plasma vessel is further protected by a series of water cooled components designed and tested to allow for between 500 kW/ m^2 for the high loaded Baffle and 200kW/ m^2 for stainless steel quilted panels, the position depending on the proximity to the plasma. Behind the Divertor targets are cryo-pumps to aid the exhausting of the plasma and sweep/control coils that help to smooth any small differences in the plasma and also allow for sweeping of the strike point to spread the high heat loaded area. The technologies employed in these components are varied and complex. The components are designed to maximise the plasma volume therefore great care has been taken to position them as close to the plasma vessel wall as possible.

One key element component of the In Vessel components is the High Heat Flux Divertor which is located in 10 positions in the upper and lower sections of the plasma vessel. The 10 units are divided into 12 modules per unit and a total of 890 individual elements are used. The plasma facing surface of the elements is carbon fibre composite welded via a copper interface to the CuCrZr cooling structure.

This paper describes the basic principles, design elements, manufacturing and testing of the in-vessel components for the Wendelstein 7-X stellarator that will allow steady state operation with fusion relevant plasmas. It will outline the high accuracies required and how these will be achieved by the use of an inertially cooled Test Divertor to calibrate the actual plasma position during the first operation phase.