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Design and test of W7-X water-cooled Divertor Scraper

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For steady state operation up to 30 minutes pulse duration of the stellarator Wendelstein 7-X, an actively water-cooled divertor will replace the currently installed adiabatically loaded divertor designed for maximal 10 second plasma pulses. Heat load calculations taking into account the effect of bootstrap current have indicated the possible overloading of the ends of the divertor beyond their technological limit. The intention of the additional scraper is the interception of some of the plasma fluxes both upstream and downstream before they reach the divertor surface. To check the effect of the scraper on the divertor for long pulse operation, an adiabatically loaded scraper element will be installed during the phase of the short pulse operation.

Design activities including the manufacturing and testing of prototypes have been carried out to prepare a possible fabrication of the water-cooled scraper. One scraper is made of 24 identical plasma facing components (PFCs). A PFC is 247 mm long and 28 mm wide. It has 13 monoblocks made of CFC NB31 bonded by hot isostatic pressing onto a CuCrZr cooling tube equipped with a copper twisted tape. Due to pressure drop limitation the scraper is divided into 6 parts of 4 PFCs; each part has 4 PFCs hydraulically connected in series by 2 water boxes (inlet and outlet). Individual full-scale prototypes of PFCs have been successfully tested in the GLADIS facility up to 20 MW/m².

This paper discusses the challenges of the design and manufacture of the water box prototypes. The scraper and water boxes have to be integrated in a very limited available space and require a very compact design. Prototypes have been manufactured to select the best technology for the water boxes. The results of the successful HHF testing of a component made of 4 PFCs will be presented. The results of these activities have defined the technological basis for a possible fabrication of the water cooled scraper.

Eligible for student paper award?

No

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