DEVELOPMENT OF A THERMO-HYDRAULIC BYPASS LEAKAGE TEST METHOD FOR THE W7-X TARGET ELEMENT COOLING STRUCTURE

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After the high heat flux test campaign and examination of the WENDELSTEIN 7-X (W7-X) target element pre-series 3 a bypass in the CuCrZr cooling structure was identified as the major reason for the overheating of CFC tiles, which resulted in a defect by cracking of the CFC – AMC-Cu interlayer. The target element cooling structure is built from two half-shells, in both a half pipe is milled [1]. Post mortem analysis of these high heat flux tested components showed that a critical bypass had occurred, where the central blind-weld breaks, which normally connects the heat sink body and the cover lid together. A bypass leads to a slower cooling water velocity and this to a decreased heat transfer coefficient between cooling water and cooling tube wall.

To minimize the occurrence of bypasses two design changes have been implemented to the fabrication route. They should minimize the effect of bypass leakage inside the cooling structure, nevertheless the extreme influence of this effect on the cooling performance and life time of target elements gives the motivation to develop a practicable test method which ensures the hydraulic quality of the target element heat sink.

Based on the calculations presented here (Fig.1), it should be feasible to identify gaps with 75 µm width through pressure drop flow tests and thermal transient response tests. A test bed has been built up at IPP to do a proof of concept study with a hydraulic mock up. It is built from the same CuCrZr material as the target elements, and is similar in shape and weight but with a lid that can be opened for artificial gap manufacture. The study includes sensitivity analysis carried out during the pressure drop measurement, and the correlation between the thermal response functions to the artificial bypass gaps. The results of the measurements carried out with the new developed hydraulic test bed are presented and compared with the calculated results.

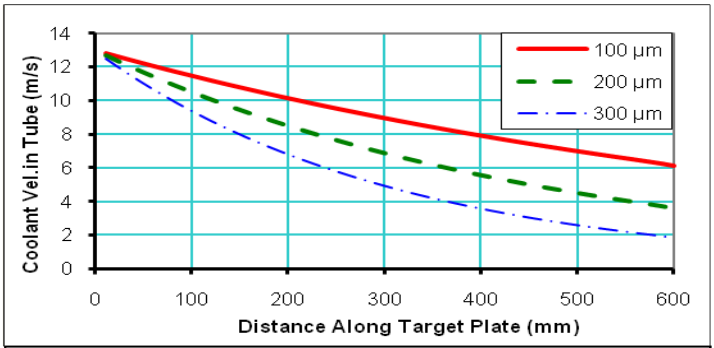

Fig1.) Estimated effect of gaps between cooling channels to water velocity

[1] J. Boscary et al., Fusion Engineering and Design 82 ,2007, 1634–1638
[2] H.Greuner et al., Fusion Engineering and Design, 84 ,2009, 848-852

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