DESIGN CHALLENGES OF THE ITER FIRST WALL EXPERIMENT 'POSITIFE' IN THE HFR, PETTEN

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The ITER first wall consists of a stainless steel backing plate with copper chrome zirconium (CuCrZr) heat sink and beryllium as plasma facing material. Due to the cyclic plasma operation of ITER, the first wall heats up and cools down in cycles, with a design lifetime of 30,000 cycles. The heating and cooling induces thermal stresses at the material interfaces due to the different thermal expansion coefficients. In addition to that, the neutron dose also affects the material properties. In the HFR in Petten, three mock-ups will be tested under these simultaneous irradiation and thermal fatigue conditions to assess the lifetime of the components, in addition to other experiments [1],[2]. A picture of a mock-up can be seen in figure 1. This experiment will be the first to combine the both the design lifetime for the irradiation dose and the number of cycles.

This paper focuses on the engineering challenges of designing a thermal fatigue experiment in an neutron environment. The aim of the experiment itself induces design problems, which demand a dedicated design approach of both the sample holder and the surrounding system. The methodology and solutions to the design problems are described in this paper.

Figure 1: Picture of one of the mock-ups

[1] Russel Eaton, Successful testing of First Wall Mock ups, ITER newsline 95, http://www.iter.org/newsline/Pages/95/1303.aspx, 2010

[2] N. Litunovskya, A. Gervash, P. Lorenzetto, I. Mazul and R. Melderc, In-pile testing of ITER first wall mock-ups at relevant thermal loading conditions, Journal of Nuclear Materials Volumes 386-388, 30 April 2009, Pages 979-982