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ITR/2-3: Technology R&D Activities for the ITER Full-tungsten Divertor

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The current ITER Baseline foresees the use of carbon fibre composite (CFC) as armour material in the high heat flux strike point regions and tungsten (W) elsewhere in the divertor for the initial non-active phase of operation with hydrogen and helium plasmas. This divertor would then be replaced with a full-W divertor for the nuclear phase with deuterium and deuterium-tritium plasmas. To reduce costs the ITER Organization (IO) has proposed to install a full-W divertor from start of operations and to implement a work programme to develop a full-W divertor design, qualify the corresponding fabrication technology and investigate critical physics and operational issues with support from the R&D fusion community.

An extensive R&D programme has been implemented over more than 15 years to develop fabrication technologies for the procurement of ITER divertor components. Significant effort has been devoted to the development of reliable armour/heat sink joining techniques such as Hot Isostatic Pressing (Europe), Hot Radial Pressing (Europe) or brazing (Japan, Russia). In this development programme, established for the CFC/W divertor variant, the design solution for W-armoured components was optimized for the divertor baffle and dome regions, namely for steady state operation conditions at heat flux values of typically 5 MW/m2 and for slow transient events at heat flux values up to 10 MW/m2.

A very positive outcome of this R&D work has been that some fabrication technologies mentioned above can achieve much higher performances, close to the expected slow transient conditions for the strike point region (20 MW/m2 for 10 s). To prepare for the procurement of a full-W divertor, a development work programme has been launched including in particular the manufacturing and high heat flux testing of small-scale mock-ups with improved monoblock geometries and full-W pre-qualification prototypes, and the manufacturing and testing of qualification full-size full-W vertical target prototypes. Further important R&D activities will study the behaviour of W-armoured components under combined normal (e.g. thermal fatigue) and off-normal heat loads (e.g. disruptions and ELMs) and the behaviour of recrystallized surfaces under combined plasma and thermal shock loading.

This paper will present the status of progress of this development work programme.

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