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ITR/P1-07: Validation of the RF Properties and Control of the ITER ICRF Antenna

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One ITER ICRF antenna consists of a close-packed array of 24 straps arranged in a 6 poloidal by 4 toroidal array. Three poloidally adjacent straps (a "triplet"of straps) are fed in parallel from one single feeding line through a 4-port junction. A shunt service stub is inserted on the feeding line inside the antenna. It has been optimized to provide a broad-band RF frequency response of the array. Load tolerance is achieved by feeding each pair of two poloidal triplets through a 3dB hybrid coupler. The array has to radiate 20MW of RF power (with a 45kV limit on the system) in quasi-CW operation for frequencies ranging from 40MHz to 55MHz and different toroidal phasings to provide a wave spectrum appropriate for both heating and current drive. Two identical ICRF antennas are foreseen on ITER.
In order to gain confidence in the design options the RF properties of the ITER ICRH antenna array are experimentally validated on reduced-scale mock-ups of part or of the whole antenna array. Experimental measurements allow to check the optimization of the antenna front-end geometry, to confirm the RF frequency response of the antenna array and hence the expected performance of the antenna for the different proposed phasings, to verify the impact of critical parameters as the vertical septum recess on the coupling properties of the antenna as well as on the mutual coupling terms and finally to test and validate the proposed grounding options to the vessel.
An overview of the experimental measurement results on the different mock-ups is given. Comparisons with simulations performed by various codes (Topica, CST MWS and ANTITER II) are given together with the expected performance on plasma deduced from measurements with dielectric load. The effect of limitations (voltage, current) on the maximum total radiated power is discussed. The importance of a good decoupling network and of grounding is emphasized.
Finally the control of the antenna wave spectrum and of the matching is performed by implementing a feedback control of the matching-decoupling system close to the one foreseen for ITER on a low-power reduced-scale mock-up of the whole ITER ICRH antenna array. It uses 23 feedback loops simultaneously operated. Control algorithms are developed and tested together with the stability of the system.
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