ANALYSIS OF DYNAMIC MATCHING NETWORKS FOR THE ICRF SYSTEM AT ASDEX UPGRADE

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The ICRF (Ion Cyclotron Range of Frequencies) system, used to heat the plasma of ASDEX Upgrade, consists of RF generators, coaxial transmission lines, matching networks and inductive loop antennas. The maximum power achievable by the generator is strongly depending on amplitude and phase of the voltage standing wave ratio (VSWR) seen by the generator. Hence, the matching of antenna input impedance to the generator output impedance is essential for the ICRF heating system. The coupling between the ICRF antennas and the plasma is subject to relatively fast variations (few ms). The changes are caused by continual modification of plasma conditions, as L-H mode transitions, gas puffing or the effects of ELMs. These variations change the impedance of the ICRF antennas. For optimal operation of the ICRF system, a continuous, and fast matching is thus necessary.

The present matching system at ASDEX Upgrade comprises two stub tuners connected in parallel to the main transmission line between generator and antenna array. The matching is realized before the plasma shot, by adjusting electrical length of the stubs and not adjusted during the shot. This kind of matching is static. The change of antenna impedance due the change of coupling conditions leads to a mismatch of the heating system. Under this condition, the reflected power significantly increases and the power transferred from the generator to antenna and consequently to the plasma decreases drastically. To improve the situation a fast matching system is needed, which varies the matching according to the change of the antenna impedance. Instead of varying the electrical lengths of stub tuners, which is slow, variable vacuum capacitors can be used to realize a fast matching system. Therewith a dynamic matching becomes possible, in tens of ms timescale.

For the analysis of matching networks a MATLAB/GUI (Graphical User Interface) based simulation tool has been developed. The program has a large flexibility, and can solve the matching calculations for different conditions of the system. The results are plotted in a Smith chart.

The paper describes a number of matching networks options, and compares at several VSWR the extension of the impedance range that can be matched using the dynamic option with respect to the static one. The static matching network comprises only the stub tuners with the transmission lines. The circuit for the dynamic system extends the static model with one or two variable vacuum capacitors. They are mounted in parallel to the main transmission line and the choice of different locations is compared. The matching circuit is analyzed at several working frequencies for ASDEX Upgrade. Based on this optimization, a new dynamic matching system for the ICRF at ASDEX Upgrade is proposed.