Coupling studies of the C3 Tore Supra LH multijunction

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The most recent LH launcher in Tore Supra, a multijunction dubbed C3, has been in use since 1999 and has been paramount in the most outstanding achievements of this machine (6 min pulse length with the current fully driven by LH wave). Yet, a few minor unexpected phenomena have been plaguing its coupling and thermal performances for some time now, as evidenced by measurements of the wave-plasma coupling as well as of the temperature increase in the launcher. Being made of 16 identical modules set up in two rows of eight – save for a difference in length stemming from the mouth's toroidal and poloidal shaping, each module is identically constructed with one input and 18 outputs distributed evenly in three rows of 6 waveguides each – the coupling coefficients were expected to be roughly identical. Yet, they have been determined experimentally and shown to differ more significantly from the values computed with the coupling code SWAN, for the (left and right) outermost modules. Moreover, the power reflection coefficients for these same modules have been ascertained to extend up to 20%, an unmistakable departure from the average value (for all the other modules) of 5%. What is more, measurements made with thermocouples installed in the launcher show that, during long pulse operation, the temperature increase is in flagrant contradiction with what was to be expected from the design solution implemented for the water cooling circuits of the launcher, which run along the top and bottom part of each module: the temperature increase in the middle row waveguides is less significant than in the upper and lower rows. This work attempts to shed some light into these matters by comparing experimentally derived data with theoretical simulations in which the scattering matrices are extracted from more accurate models of each module using the finite element code HFSS (taking into account its entire waveguide structure and the mode converter, in addition to the differences introduced in each module by the toroidal and poloidal shaping of the mouth), on the one hand, and use is made of a more recent 2D coupling code developed at Cadarache, ALOHA, which allows for the coupling to take place also between waveguides in different horizontal rows from the antenna side. Different plasma scenarios will be explored as well by allowing for a given density and density gradient to be assigned to each individual row.