Implementation and testing of a shape control system in RFX-mod Tokamak discharges

G.Marchiori[1], R. Cavazzana[1], A. Cenedese[2], C. Finotti[1], O. Kudlacek[1], G. Manduchi[1], L. Marrelli[1], P. Merlo[2], F. Villone[3], L. Zanotto[1]

[1]*Consorzio RFX, Associazione Euratom-ENEA sulla Fusione, Padova, Italy*

[2]*Department of Information Engineering, University of Padova, Italy*

[3]*Ass. Euratom/ENEA/CREATE, DIEI, Università di Cassino e del Lazio Meridionale, Italy*

In past years the Reversed Field Pinch RFX-mod has also been operated as a low current Tokamak to perform experiments of active control of MHD modes particularly harmful to a prospective reactor. The stabilization of m=2, n=1 mode has been achieved for 150 kA plasma currents in circular shape discharges. In order to test the system capability of stabilizing such modes in improved confinement regimes, the possibility of producing D-shaped plasma discharges has been explored. Once verified the compatibility with the available magnetic winding and power-supply system, preliminary experiments were carried out in open loop in 2011. A completely new plasma position and shape control system was designed and its performances tested both with a plasma response model including a 3D description of the passive structures and with the finite element 2D MHD equilibrium code MAXFEA. According to the simulation results, feedback control of the D-shape configuration was capable of meeting the design requirements. In the new experimental campaign in Tokamak configuration, a series of preliminary investigations were focused on the issue of the vertical instability growth rate predicted by the equilibrium code. Thanks to the fast power supplies, the task of assuring the configuration stability can be performed only by properly controlling the m=1, n=0 current component in the outer and inner array of the saddle coils making up the MHD active control system. The diffusion time of the magnetic field horizontal component produced by the m=1, n=0 current was estimated in vacuum shots to validate the parameters of the vertical stability control inner loop, designed on the basis of the finite element model. The algorithms to evaluate the plasma boundary distances from the first wall and the plasma equilibrium global parameters were also revised to allow their real time implementation. The shape control system, closed around the faster inner position loop, consists of both a regulator and an estimator cast in the form of dynamic systems, which have been implemented in MARTe framework. As a first step to assess its reliability and achievable accuracy, initial tests were carried out with the aim of controlling elongation and triangularity of the plasma discharges.