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P4.1095 Estimation of controllability region of unstable vertical plasma position and plasma separatrix multivariable reachability area of a spherical tokamak

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The paper deals with plasma controllability and reachability regions in the spherical tokamak Globus-M (Ioffe Inst.). Plasma magnetic control system [1] of Globus-M consists of 2 loops for plasma vertical Z and horizon R position control with thyristor current invertors [2], and 6 inner cascades for control of currents I_CS&PF (Fig.1) with thyristor multiphase rectifiers [1]. All these loops contain PID-controllers and two of them for plasma position control were adjusted by Quantitative Feedback Theory approach based on the Nichols chart analysis of an open loop linear model [3]. The linear plant model [1] has one unstable real pole because of plasma elongation in vertical direction, and the voltage on horizon field coil (HFC) is restricted. Therefore, the controllability region of vertical plasma displacement is restricted as well [4]. For plasma linear model of 40 order [1] this region was estimated by application of the maximum voltage of proper sign on the HFC to return Z back (Fig.2) [5] for Z(0). The value of this region namely ⊠ 0.15 m coincided with numerical calculation of the same region by the linear model. Upper and lower reachability region estimations of the plasma separatrix shape were obtained at the plasma diverter phase (Fig.3) for the multivariable and multicascade control system in Fig.1. There are no shapes beyond the upper estimation because of the given limits and there are any shapes inside the lower estimation. Values of these estimations are about 10^-3÷10^-2 m. They were obtained using matrix relations between inputs and outputs of the system in Fig.1 in steady-state regime at restrictions. For calculation of upper estimation the maximum allowable inputs with needed signs were applied and for calculation of lower estimation the maximum possible displacement of each shape projection P1-P6 available with all restrictions was reached.

[1] Mitrishkin Y.V., Prokhorov A.A., Korenev P.S., Patrov M.I. Fusion Eng. Design, v. 138, 2019, pp. 138-150.
[2] Kuznetsov E.A., Mitrishkin Y.V., Kartsev N.M. Fusion Engineering and Design, 2019.
[3] Garcia-Sanz M. Robust Control Engineering. Practical QFT solutions. Taylor & Francis Group, 2017.
[4] Mitrishkin Y.V. Plasma Devices and Operations, v.4, no 2, 1995, pp. 111-140.
[5] Humphreys D.A., et al. Nuclear Fusion, 2009; vol. 49.

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