Application of the free-boundary SIESTA MHD equilibrium code to bootstrap control scenarios in the W7-X stellarator

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SIESTA [1] is an MHD equilibrium code designed to perform fast and accurate calculations of ideal MHD equilibria for three-dimensional magnetic configurations. SIESTA is an iterative code that uses the solution previously obtained by the VMEC code [2] for the same problem to provide an Eulerian background coordinate system and an initial guess of the equilibrium solution. In contrast to VMEC, SIESTA does not assume closed magnetic surfaces. Thus, the final equilibrium solution can include magnetic islands and stochastic regions.

In its original implementation, the SIESTA code addressed only fixed-boundary problems. That is, the shape of the plasma edge, assumed to be a magnetic surface, was the same obtained by the VMEC code and it was kept fixed as the solution iteratively converges to equilibrium. This fixed boundary condition has somewhat restricted the possible applications of SIESTA in the past, limiting it to problems in which a possible variation of the plasma boundary was not of interest. To circumvent these limitations, SIESTA has been recently extended [3] being now able to deal with free-plasma-boundary problems, opening up the possibility of addressing situations in which the plasma boundary is perturbed either externally or internally. The computational domain of the new version of SIESTA can now be extended all the way to the vacuum vessel if desired. This is made possible by several techniques that extend the background coordinate system and provide suitable initial guess for the equilibrium solution over the extended volume. As an illustration of its new capabilities, SIESTA is applied in this contribution to the study of bootstrap control scenarios to avoid undesired distortions of the island chain that insulates the plasma edge from the divertor of the W7-X stellarator [4].

References

[1] S.P. Hirshman, R. Sanchez and C.R. Cook, Phys. Plasmas **18** 062504 (2011)

[2] S.P. Hirshman and JC Whitson, Phys. Fluids **26** 3553 (1983)

[3] H. Peraza-Rodriguez, J.M. Reynolds-Barredo, R. Sanchez, V. Tribaldos, J. Geiger, S.P. Hirshman and M. Cianciosa, Phys. Plasmas **24** 082516 2017)

[4] H. Peraza-Rodriguez, J.M. Reynolds-Barredo, R. Sanchez, V. Tribaldos and J. Geiger, Plasma Phys. Contr. Fus. **60**, 2018 (2018)