Towards a fully 3D MHD plasma-structures model: Coupling JOREK and CARIDDI

N. Isernia[1], N. Schwarz[2], F. J. Artola[3], S. Ventre[4], G. Rubinacci[1], M. Hoelzl[2], F. Villone[1]

[1] *Consorzio CREATE, DIETI, Universitá degli Studi di Napoli Federico II, IT*

[2] *Max Planck Institute for Plasma Physics, Garching, DE*

[3] *ITER Organization, Route de Vinon sur Verdon, 13067 St Paul Lez Durance Cedex, FR*

[4] *Consorzio CREATE, DIEI, Universitá degli Studi di Cassino e del Lazio Meridionale, IT*

Passive conductors represent an essential element of all existing tokamak devices, since eddy currents slow down Alfvénic instabilities to the electromagnetic time scale [1]. Shared currents between plasma and conductors, defined as *halo currents*, have also been routinely observed during *disruptions* of experiments [2]. The 3D features of conducting structures affect plasma vertical stability properties [3] and can be responsible for mode locking or breaking. Consequently, realistic macroscopic simulations of tokamak plasma dynamics require to capture the mutual interaction of a 3D plasma model with an accurate 3D model of conducting structures. However, complete 3D extended-MHD models generally use a simplified description of passive conductors (*e.g.* 2D or thin), and detailed 3D models of conductors are self-consistently coupled only to simplified MHD plasma models [4].

Here we illustrate a coupling scheme, based on the Virtual Casing principle, for the self-consistent integration of the 3D non-linear extended-MHD model of the JOREK code [5] with the fully 3D volumetric model of conducting structures in CARIDDI [6]. An equivalent current distribution, circulating at the MHD domain computational boundary, reproduces the same magnetic field as the plasma in the outer domain. The magnetic field produced by the equivalent currents is tested successfully. The coupling is illustrated both in the no-wall limit and with eddy currents.First test cases and benchmarks to JOREK-STARWALL [7] are shown. An outlook on the inclusion of halo currents in the coupling scheme and further developments is given.

References

[1] E. A. Lazarus et al., Nuclear Fusion **20**, 111 (1990)

[2] T. Hender et al., Nuclear Fusion **47**, 128 (2007)

[3] R. Albanese et al., Nuclear Fusion **44**, 999 (2004)

[4] F. Villone et al., Plasma Physics and Controlled Fusion **55**, 095008 (2013)

[5] M. Hoelzl et al., Nuclear Fusion **61**, 065001 (2021)

[6] R. Albanese and G. Rubinacci, IEE Proceedings A **135**, 457 (1988)

[7] M. Hoelzl et al., Journal of Physics: Conference Series **401**, 012010 (2012)