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Simulation of the ITER Toroidal Field Coil Case welding distortion using Finite Element Method

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The first European superconducting Winding Pack (WP) and the first set of Coil Cases (TFCC) for ITER are going to be delivered in 2017. The TFCC are steel structures which provide structural integrity to the WP, contribute to neutron shielding capacity, provide support to operating forces and offer interface connections with the rest of ITER machine. The TFCC assembly is formed by four main parts, two sectors with U-shaped section and two closure plates, which, after being welded together, enclose the WP. Each TFCC weights about 150 t and present wall thicknesses from 60 to 120 mm. The presence of distortions when welding such thick structures is particularly problematic in our components requiring tight tolerances and with several interfaces with other components of the tokamak. In order to compensate distortions, extra-material is present in the critical areas to allow post-welding machining. The amount of extra-material has to be optimized to reduce machining time and therefore cost of the components. So, the evaluation of the welding-caused-distortions is essential in order to confirm the extra-material strategy. In this scenario, a complete experimental and virtual campaign has been set up to predict and minimize the deformation of the TFCC during welding. First, welding coupons were welded in representative configurations. Then, this data was used to build a preliminary modelling approach, using ANSYS® software, which was then benchmarked against a 'blind test' coupon and three TFC-like mock-ups of 1 m long. Finally, a full FEM model is under construction using the previous lessons-learnt, to predict the deformation of the coil structures during the welding process. This paper describes the numerical and experimental activities carried out so far, being EnginSoft S.p.A the developer of FEM models, SIMIC S.p.A the responsible of welding processes and data acquisition, and Fusion for Energy the contractual and technical supervisor.

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