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SIMULATING THE REMOTE HANDLING OF THE BLANKET SEGMENTS IN DEMO FUSION REACTOR WITH THERMO-MECHANICAL MESHFREE MULTIBODY DYNAMICS

Daniel Iglesias[1] and Juan. C. García Orden[2] and A. Loving[1]

[1] EURATOM/Culham Centre for Fusion Energy, Culham Science Centre Abingdon OX14 3DB, UK, daniel.iglesias@ccfe.ac.uk, http://www.ccfe.ac.uk
[2] ETSI Caminos, Canales y Puertos, Universidad Politécnica de Madrid C/ Profesor Aranguren s/n, 28042 Madrid, Spain, juancarlos.garcia@upm.es, http://www.upm.es

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EDFA, as part of the Power Plant Physics and Technology programme, has been working on the pre-conceptual design of a Demonstration Power Plant (DEMO). As part of this programme, several options for the remote maintenance (RM) of the in-vessel components were assessed during the 2012 activities [1]. In 2013, these remote maintenance activities were further extended, providing an insight into the requirements, constraints and challenges for the design of the RM equipment.

The tokamak is divided in 16 sectors, each with one upper port, one equatorial port and a divertor port at the bottom (Figure 1). All the upper and divertor ports are used for the RM operations to avoid the use of in-vessel transporters. The blankets are designed to transform neutron kinetic energy into high-grade energy, and to breed enough tritium for making the reactor self-sustainable. The modules are arranged vertically inside of the vessel grouped in five multi-module segments (MMS) per sector.

A vertical maintenance crane (VMC) has been designed to handle the MMS. The VMC is inserted in the vessel through the upper port, moves each MMS using a mover with six degrees of freedom, and has the following top-level requirements:

- It must comply with the required kinematics while supporting the MMS weight and derived dynamic loads.
- The movement and safety checks should be automatized using simple movers and limit switches, as the environmental radiation is too high to use cameras.

- The risk of collisions is very high because of the small clearances and the large deformations expected.
- The MMS after their service life will be activated, with decay heat values as high as 30 kW. The temperatures produced by this heat may require active cooling on the RM equipment.

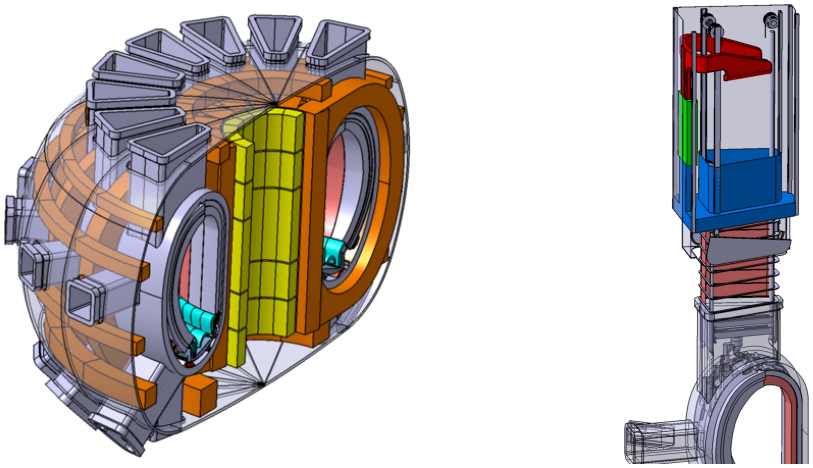

Figure 1: Sectioned DEMO tokamak conceptual model and vertical maintenance crane

Meshfree methods have been previously applied to nonlinear multibody dynamics in [2]. When compared to FEM, they've shown improved efficiency and robustness for capturing large strains with a reduced number of nodes. Also, a coupled form of the discretized equations was proposed in [3] for accurately modeling nonlinear volumetric thermal loads, similar to the decay heat envisaged for the MMS.

The present study shows a first approach to the simulation of the remote handling operation which takes into account the thermal and flexible behavior of the blanket segments and its implications on the remote handling equipment, in order to validate and improve its design.

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