IFERC Newsletter

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Status of DEMO Design Activity

Highlights on Plasma scenario development

The joint EU/JA activity, which addresses some aspects of plasma operation in the respective DEMO reactors (Task 1), has been focused in 2022/the beginning of 2023 on two main topics:

- Topic I: Optimum H&CD Mix
- Topic II: Runaway Electron and Charged Particle Loads

Concerning Topic I, the milestone defined in the Work Programme 2022 was related to the evaluation of the H&CD power for L-H transition considering the impurity effects in JA-DEMO. The JA side has completed a publication for the assessment of the required external heating power for the L-H transition in JA-DEMO as shown in Fig-1. Even with conservative assumptions on different aspects, such as impurity radiation by seeding Ar impurities, it is expected that 100 MW of external heating power is sufficient to ensure a robust L-H transition and pedestal formation as shown in Fig-1. This level of heating power is compatible with the required heating power for maintaining steady-state operation and is consistent with the technical constraints for the available number of ports for H&CD auxiliaries.

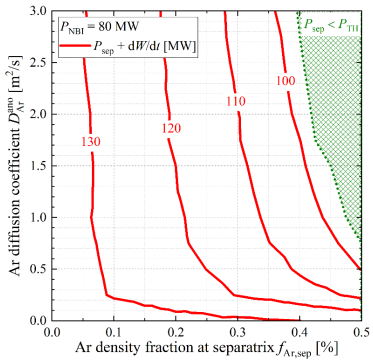

Fig-1: Contour of P_{sep} + dW/dt in (D_{Ar}^{ano}, f_{Ar}^{sep}) space

On EU side, focus has been given on the implementation of CREATE-NL controllers in the ASTRA/Simulink flight simulator, to account for kinetic (H&CD, mass injection) and magnetic (position and shape) control simultaneously. First applications of the new tool dealt with the definition of a strategy for the control of fusion power oscillation during flat-top. In 2023, the problem of plasma ramp-up will be tackled.

Concerning Topic II, the main milestone identified in the WP2022 was related to the identification of the Runaway Electron (RE) beam scenario with low-*n* MHD instability. The development of the workflow for evaluating the RE wall load has progressed. Vertical Displacement Event (VDE) simulations coupled with the RE generation model have been successfully implemented for both the JA-DEMO and EU-DEMO configurations as shown in Fig-2. Preliminary RE orbit-following simulations have been performed and visualized for low-q plasma-beam equilibrium touching the upper limiter of EU-DEMO. In the next FY, after setting detailed load conditions through discussions between JA and EU experts, the plan is to provide input from the INDEX code to the FLUKA code to evaluate the penetration of the RE beam into the sacrificial limiter. On the EU side, test cases with FLUKA for different RE energies, incidence angles and FW materials have been carried out. The first results of inter-code benchmarking of the charged particle loads between APPLE (JA) and PFCFLUX (EU) have also been obtained, showing reasonable agreement for the peak heat load and footprint on the upper limiter at the First Touch (FT) of the plasma during an upward VDE. The benchmark activity will be expanded to Thermal Quench (TQ) and Current Quench (CQ) in near future.

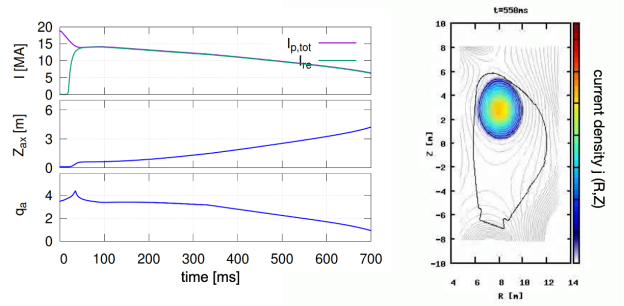

Fig-2: Example of VDE simulations coupled with RE generation model in EU DEMO configuration

(DEMO Design Task-1 TROs)