IFERC Newsletter

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International Fusion Energy Research Centre, Rokkasho, Aomori 039-3212, Japan

Status of DEMO Design Activity

Highlights on Plasma scenario development

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

- Topic I (Task 1-1): Optimum H&CD Mix
- Topic II (Task 1-2): Runaway Electron and Charged Particle Loads

In Task 1.1, JA evaluated the external heating power required for the L-H transition in JA DEMO by conducting parameter studies using the integrated modeling code TOPICS. An L-H transition model was developed, which determines the time evolution of pedestal pressure such that a power ratio, the net plasma loss power across the separatrix over the L-H threshold power, is maintained at a constant value during pedestal growth. The dependence of the required heating power on the plasma density, temperature, threshold power, impurity density fraction, and impurity transport coefficients was quantitatively clarified. One of examples is shown in Fig-1 below.

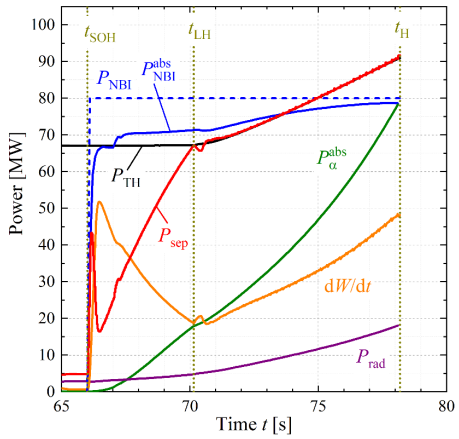

Fig-1: An example of JA power balance during L-H transition

Even if evaluated pessimistically, 100 MW of external heating power was sufficient to complete pedestal growth. This power is almost the same as the power required for steady-state operation and is installable in terms of ensuring the blanket space, i.e., the tritium breeding ratio. On EU-side, the development of the flight simulator with the inclusion of CREATE-NL shape and position controller has been completed. First applications concern the modelling of fusion power control during flat-top in presence of fluctuations. The H&CD actuators are studied in parallel with shape controllers (i.e. change in elongation). The next step is to perform a comparison of the respective results with the Japanese counterpart, with the purpose of sharing information on the chosen control strategies

In Task 1-2, the charged particle load evaluation code APPLE (JA) has been improved. Following the successful benchmark between CREATE (EU) and INDEX (JA), APPLE was modified to read the magnetic equilibrium obtained from INDEX, which enables us to calculate the charged particle loads during Vertical Displacement Event (VDE). The comparison to the previous results obtained by PFCFLUX (EU) for EU-DEMO model is ready to be done. For the Runaway Electron (RE) modelling, the workflow development has been progressed as planned. The VDE simulations coupled with the RE generation model have been successfully implemented using the INDEX code (see Fig-2). The initial results for evaluating the runaway electron flux to the first wall in JA-DEMO and EU-DEMO are expected in the first quarter of 2023. In parallel, on the EU-side, the code FLUKA has been employed to evaluate the penetration of the runaway beam in the materials (tungsten) under various assumptions in terms of RE energy and impact angle. The long term goal is to run FLUKA with the RE distribution input generated by APPLE/INDEX, to evaluate the effectiveness of the limiters in presence of RE under various conditions of underlying MHD stability.

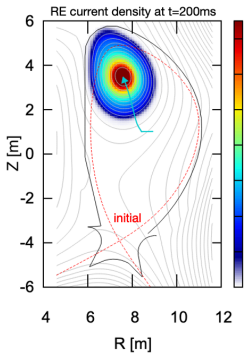

Fig-2: Example of RE current density and plasma movement during VDE

(DEMO Design Task-1 TROs)