IFERC Newsletter

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Collaboration with ITER

Collaboration of CSC with ITER in 2021

The Implementing Arrangement No.2 to the Cooperation Arrangement between BA Activities and the ITER Project was signed in Jun. 2021, for collaborative activities between ITER and IFERC. The first Work Programme 2021/2022 for IFERC activities was approved in Oct. 2021 by the Coordination Committee. Based on the Work Programme, collaborative activities between IFERC-CSC and ITER were implemented in 2021. The Work Programme includes:

- Participation in joint simulation projects, on the subjects defined by ITER as high priority: Modelling of disruptions in ITER, and ITER edge/SOL/divertor plasma simulations
- Participation of IO in HPC Follow-up Working Group.

Both activities started immediately after approval of the Work Programme. Regarding the Participation in joint simulations projects, ITER scientists joined two existing CSC simulation projects ("MHD" for disruption studies in ITER and "MISONIC" for ITER edge/SOL/divertor plasma simulations) while additional subjects were included. Resources for these projects were increased in JFRS-1 by reallocating unused resources assigned to other BA simulation projects. This allocation was concluded in Dec. 2021. Regarding the second activity, the ITER responsible person for the CSC collaboration has been invited and attends regularly the meetings of the HPC Follow-up Working Group. Hereafter, a summary of the simulation results obtained so far is described.

I. HOT VDE simulations in ITER

Since predictive simulations of tokamak disruptions are key to refine the ITER disruption budget, ITER unmitigated disruptions are being simulated with the 3D MHD code JOREK in the BA simulation project; MHD. More specifically, simulations on disruptions of the type "asymmetric hot VDEs" are performed in order to assess the maximum horizontal forces that are expected to act on the ITER vacuum vessel. A single simulation requires very long continuous runs (of the order of 4 to 6 months) with about 11 to 22 nodes. Although the simulations have not run long enough to study the asymmetric wall forces due to a short available period, the initial phases of the simulations already bring new insights on the physical processes taking place during hot VDEs in ITER. One of the main results obtained from this study is the confirmation that despite different assumptions (e.g. re-scaling of dissipative parameters and VDE direction), the thermal quench is triggered once the edge safety factor decreases to a value of 2. The plasma drifts vertically while keeping its current constant, which explains the decay of the safety factor (q_{95}) due to the reduction of the plasma size. When q_{95}~2, a resistive external kink mode (2/1 mode) becomes unstable, which leads to the stochastization of the magnetic field lines and the loss of thermal energy. Simulation research continues in 2022.

II. SOLP-ITER simulations of ITER

As part of the MISONIC project, the IO has begun running a number of SOLPS-ITER simulations of the ITER device. As a first step, the newest code version, v3.0.8, was installed and adapted to the JFRS-1 environment. The goal is to revisit the existing SOLPS4.3 database built in the early 2010s with three major improvements:

- updated the physics model, including Grad-Zhdanov closure of the fluid equations, solving for the electric potential, and more recent atomic data rates.
- updated wall contour, including the thicker blanket modules for improved neutron shielding in the central column, and a more representative equilibrium for ITER baseline operation.
- much more detailed description of the divertor structures, including moving the gas puffing location to its actual location, displacing the pumping surface to the entrance of the bottom port, and a proper accounting of neutral conductance paths.

After having set up a base case which includes all these improvements, a parameter scan is implemented to establish what the new pumping rate should be to obtain a similar throughput to the older SOLPS4.3 solution, with 5 values of the pumping surface albedo. However, because of the large change to the solution that the modifications above represent, this can only be assessed once this set of base cases scan has been re-converged. Simulation research continues in 2022.

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