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Development and Successful Operation of the Enhanced-Interlink System of Experiment Data and Numerical Simulation in LHD

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The enhanced-interlink system of experiment data and numerical simulation has been developed, and successfully operated routinely in LHD. This system consists of analyzed diagnostic data, real-time coordinate mapping, and I/O to numerical simulation. It has enabled automated data handling/transferring between experiment and numerical simulation, to extensively perform experiment analyses. It can be considered as one of prototypes for seamless data-centric approach for integrating experiment data and numerical simulation/modellings in fusion experiment.
In large-scale fusion experiments and future reactors, it is crucial to establish reliable data-centric system to perform data acquisition from many actuators/diagnostics, and to issue signals for controlling plasma operation possibly along with relevant numerical analyses. In LHD, in order to systematically handle various data acquired by different diagnostics, Analyzed Data Server was setup, and it has been functionally extended. Now it has been successfully coupled to numerical simulation, TASK3D-a.
Numerical simulations for toroidal plasmas usually employ density and temperature profiles described in averaged minor radius or flux functions. Therefore the conversion (so-called mapping) from real coordinates to flux coordinate (or reff) is required to establish inter-linkage between experiment data and numerical simulation. For this purpose, three-dimensional equilibrium database using VMEC was established. Based on this database, the equilibrium mapping system called TSMAP (Thomson Scattering MAPping) was developed. It searches for the best-fitted equilibrium so as to minimize the discrepancy between inward and outward side of an electron temperature profile measured by the Thomson scattering system. In order to calculate the profiles on the flux coordinate automatically, an automatic calculation system, AutoAna, was developed. It provides the necessary data for numerical simulations soon after the experiment data is available.
Utilizing this system, experimental analyses by numerical simulations have been extensively progressed. The author believe this data-centric approach for integrating experiment data and numerical simulation/modellings contribute to not only LHD but other plasma fusion projects including DEMO reactor in the future.

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