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SIMULATION SCIENCE FOR FUSION PLASMAS

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Abstract. The world fusion effort has recently entered a new age with the construction of ITER in Cadarache, France, which will be the first magnetic confinement fusion plasma experiment dominated by the self-heating of fusion reactions. In order to operate and control burning plasmas and future demo fusion reactors, an advanced ability for comprehensive computer simulations that are fully verified and validated against experimental data will be necessary. The ultimate goal is to develop the capability to predict reliably the behavior of plasmas in toroidal magnetic confinement devices on all relevant time and space scales. In addition to developing a sophisticated integrated simulation codes, directed advanced research in fusion physics, applied mathematics and computer science is envisaged.

In this talk we review the basic strategy and main research efforts at the Department of Simulation Science of the National Institute for Fusion Science (NIFS)- which is the Inter University Institute and the coordinating Center of Excellence for academic fusion research in Japan. We overview a simulation research at NIFS, in particular relation to experiments in the Large Helical Device (LHD), the worlds largest superconducting heliotron device, as a National Users facility (see Motojima et al. 2003). Our main goal is understanding and systemizing the rich hierarchy of physical mechanisms in fusion plasmas, supported by exploring a basic science of complexity of plasma as a highly nonlinear, non-equilibrium, open system. The aim is to establish a simulation science as a new interdisciplinary field by fostering collaborative research in utilizing the large-scale supercomputer simulators. A concept of the hierarchy-renormalized simulation modelling will be invoked en route toward the LHD numerical test reactor. Finally, a perspective role is given on the ITER Broad Approach program at Rokkasho Center, as an integrated part of ITER and Development of Fusion Energy Agreement.

References

Motojima, O. et al.: 2003, *Nuclear Fusion*, **43**, 1674.