Building a predictive modelling capability for ITER plasmas

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Simulation codes for predicting tokamak plasma evolution have been in use since the very late 1960's. The codes have been under constant development and reinvention but the aim for this type of codes have always remained invariant: a) to compare experimental results with theoretical models, b) support interpretative analysis of experiments and c) to extrapolate the results validated on present experiments to future Tokamaks. Hence, there is a very high level of maturity in the current code base but this is somewhat challenged both by the requirements of a burning plasma environment and domain specific developments in underlying theory and implementation of tools.

The advancement of theory into high end modelling codes has accelerated in the last two decades and the availability of HPC resources has extended the limit of physics understanding greatly in a number of areas. The computational cost of these codes is often prohibiting their use directly in predictive transport codes and there is now a need to readdress the traditional transport code to start address these issues.

Although rapid developments have occurred in recent years the progress is not uniform when applied to the full range of transport channels needed for burning plasma predictions. In some cases it is the underlying physics which is not sufficiently well established: anomalous transport is now very well described in the gradient region but there are issues both in the inner core region as well as the edge, and anomalous high-Z multiple charge state transport remains largely untested. On the other hand recent work on rotation has shown that the transport code infrastructures need to be revisited as well to, for example, properly take into account rotation effects and poloidally asymmetric flows.

Integrated Modelling for ITER presently involves the assessment of operating scenarios and plasma control strategies as well as the validation of comprehensive models against present facilities results. In view of supporting ITER operation, robust, computationally efficient and reliable physics modelling tools will be necessary, both for pulse validation and plasma control. A full level comprehensive prediction of ITER physics rapidly becomes expensive in terms of computing resources, the simulation framework also needs to allow use of HPC or distributed computing facilities. The European ITM Task Force and EUFORIA projects addressed the development of a framework and modular and extensible integrated modelling package offering for the above capabilities, building on a set of standard ontologies [4] and access tools. The framework and tools have inherited by the EUROfusion Code Development for Integrated Modelling work package (WPCD). The presentation will review the scientific needs and constraints on the modelling tools and will detail the current activities in the WPCD in relation to the European transport Solver (ETS) [5-6]. Current capabilities and the pathway to new features is outlined

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