IFERC Newsletter

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DEMO Design Activity

Joint Activity on Systems Code Benchmark

The phase-Two of the DEMO Design Activities under the Broader Approach (BA) started at the beginning of 2011 to begin a coordinated effort between Europe and Japan to quantify the key physics and technology prerequisites for a Demonstration Power Fusion Reactor (DEMO), to consolidate the knowledge base achieved so far and needed for the design of DEMO; to define design requirements, existing standards, design inputs, design rules including the physics basis for DEMO Design; to provide input to parallel and future R&D activities needed for DEMO; to address the remaining outstanding physics and engineering problems, and to conduct parameter studies for characteristic DEMO concepts.

The major emphasis of activities foreseen during 2011 and 2012 is on:
•Development and application of systems code, including review of physics and engineering input assumptions and explore different design options (e.g. inductive/steady state)
•Assessment of the problem of the power exhaust, which is perceived to be one of the most outstanding challenges in the design of DEMO and definition of the strategy on divertor R&D
•Assessment of the key design integration, reliability and maintainability issues for in-vessel components.

We described in this issue of the IFERC Newsletter the progress of activities on Systems codes. A systems studies code is a program that attempts to model an entire fusion power plant self-consistently subject to physics and technological limitations, and the results should therefore represent a realistic and achievable power plant – subject to the assumptions underlying the limitations. For example, the code could compare the effects of an improvement in plasma energy confinement on the final plant design, or show the consequences of having to limit heat transfer to the divertor if sufficiently high heat-flux materials are unavailable for an existing design. An intensive benchmarking exercise, both within the EU (comparing PROCESS, Helios, and the IPP code) and between the EU and Japan (comparing PROCESS and TPC/TOPPER), has identified (and subsequently updated) old physics models and clarified the assumptions underlying the systems codes. Fundamental differences in the way different codes solve the problem of identifying a final physically-consistent fusion reactor design mean that they may find different solutions for a given set of inputs, but it should be possible to reproduce the final operating point output from one code in another code. The benchmarking started out as a straightforward attempt to reproduce others' results but exploring variations in the solutions led to examination of nearly every underlying model within the codes and robust discussions about which models may be most suitable for modelling DEMO scenarios. Facilitating this work has seen members of the Japanese team visiting Garching and CCFE; IPP staff visiting CCFE and *vice versa*; an upcoming visit by CCFE staff to Rokkasho; as well as frequent videoconferences and exchanges of e-mails. The benchmarking exercise and associated documentation has undoubtedly already improved the codes and will strengthen confidence in their calculations. One ultimate aim is to produce a *DEMO Physics and Technology Guidelines* document, an expert summary of the best available models relevant to DEMO and recommendations for further improvements to codes where appropriate, and to implement these guidelines into a rigorously assessed systems code for exploration of different DEMO operating scenarios.