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Progress in the EU DEMO Research and Design Activity

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As part of the Roadmap to Fusion Electricity, Horizon 2020, Europe initiated a pre-conceptual design study of a Demonstration Fusion Reactor Concept (DEMO) a few years ago, which targets the generation of a few hundred MW of net electricity and the demonstration of a closed tritium fuel cycle in the 2050s.

The design and R&D approach adopted include some distinctive elements such as: 1) a strong philosophy of integrated design at an early stage to encourage a more 'systems thinking'culture and to bring major clarity to a number of critical design issues and overall integration challenges; 2) an improved understanding of system context as a foundation for informed plant design concept and technology development programmes; 3) a prudently modest extrapolation from the ITER physics and technology basis, in order to minimize programme/development risks and their associated mitigation costs; 4) multiple DEMO plant design architectures are studied in parallel (e.g. reactor configurations such as a double-null tokamak), as are major sub-systems or technologies for which there are particularly high technical risks or low maturity (e.g. the divertor, the breeding blanket, etc).

The progress of the EU DEMO design and R&D activities to date is described, with a focus on the areas that are believed to have a strong hand in defining the conceptual layout of the DEMO device, and drive its performance. Recently, a number of external and internal developments have occurred that challenge some of the assumptions underpinning the original schedule. This includes the delay of ITER construction and DT operations and a greater appreciation of the 'integration challenge'required to define a robust plant architecture. A reasonable extrapolation from ITER results is maintained, and a provisional, updated DEMO schedule is discussed.

The pulsed EU DEMO baseline design point continues to be the primary configuration studied (in particular for integration issues –many of which have broad applicability to other reactor designs); however a number of alternative reactor configurations are now also being studied in earnest. These include for example a double-null divertor machine, and a pulsed "flexi-DEMO"machine capable of transitioning to steady-state operation. Preliminary results of studies exploring the available design space and defining the main parameters and technical characteristics for these configurations are shown. The design strategy of the plasma-facing system is discussed, and the preliminary definition of a DEMO plant layout is presented, aimed at enabling further design integration studies as well as safety and cost analyses for the wider plant auxiliary systems.

Design and technology down-selection will be of vital importance on the path reaching a DEMO concept and it is critical that a robust decision-making framework is established in the years to come to support future decisions. Thoughts on such a framework are presented here, and on its application to the fusion R&D programme in the future to progressively narrow down sub-system technologies and reactor architecture options.

Eligible for student paper award?

No

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