Required and Achievable TBR for the European DEMO

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The Power Plant Physics and Technology (PPPT) programme of EUROfusion aims at the development of a DEMOnstration fusion power plant (DEMO) as central element of the European roadmap to fusion energy. DEMO is anticipated to deliver a substantial amount of electricity to the grid and operate with a closed tritium fuel cycle. Tritium self-sufficiency is a strict pre-condition for the operation of such a DEMO which is designed to produce a fusion power in the order of 2 GW. Thus a net Tritium Breeding Ratio (TBR) ≥ 1.0 is required, i. e. it must be assured that per D-T fusion reaction one triton, generated in the breeding blankets surrounding the plasma chamber, is finally available for injection into the plasma. This needs to be proven by appropriate neutronic calculations which provide estimates for the global TBR and are validated, as far as possible, against experiments. In effect, a global TBR with some additional margin in excess of unity must be demonstrated to account for uncertainties in the neutronic simulations for DEMO and the loss budget expected for the processing of the tritium in the fuel cycle. Another margin has to be added when considering DEMO to provide the start-up inventory for a follow-up power plant.

This work presents an up-to-date assessment of the TBR requirement for DEMO as deduced from neutronics considerations including uncertainties and limitations in the underlying design calculations, and resulting from advanced tritium fuel cycle concepts with a significantly reduced tritium loss budget and the demand to build-up a tritium start-up inventory. The TBR requirement is evaluated against the actual TBR performance which is achievable for DEMO based on latest results for the HCPB (Helium Cooled Pebble Bed) and WCLL (Water Cooled Lithium Lead) driver blankets.

Keywords: TBR, DEMO, neutronics, tritium, fuel cycle

Topic Category	Blanket Technology or Tritium Fuel Cycle
Presentation Preference	☒ Oral Presentation ☐ Poster Presentation