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Evolutions of EU DEMO reactor Magnet System design along the recent years and lessons learned for the future

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The DEMO reactor is expected to be the first application of fusion for electricity generation in the near future. In the DEMO power plant the management of magnet system is of central importance as being driver on many crucial aspects such as nominal power plant performance (toroidal field scales fusion power), overall investment budget (about 1/3 of the total construction cost), production efficiency (full power total availability heavily impacted by magnet off-normal events). Therefore a careful approach is requested for this kind of component to ensure a safe design compatible with a power plant production conditions, keeping a control on the factors prone to degrade the economic model (cost, risk). The derivation of those considerations into practical activities results in a constant attempt to lead in parallel extensive design activities and the mastering of upstream knowledge in magnet behavior. This enables to consolidate to the most extend crucial design choices (e.g. the operation temperature margin) by valorizing a maximum of breakthrough either in technological progresses or in knowledge of physic-related phenomena (e.g. instabilities in transient regimes).
In this purpose design activities on DEMO magnet system were continuously conducted in Europe, particularly evolving since 2011 in structured environments, always backed on the association of several laboratories. Since then, the actors underwent preparatory design phase and then the pre-conceptual design activity (CDA) phase, that led to evolutions of design in many aspects, from associated tools and methods to strategic considerations.
Along the 2011-2016 period DEMO magnet design were set for TF and CS systems but reinforced by ad-hoc tools (integrated and macroscopic mechanical design tools) developed to allow efficient pre-design of TF & CS coils. R&D also provided assessed values of effective strain that strongly consolidates future design to come. Finally cross-fertilization between codes (at system & magnet scales) ensured alignment across the top-bottom flow of magnet functional features (e.g. TF allocated radial build). The outcomes of those activities will be described in the present paper.

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