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Uncertainty analysis of an SST-2 fusion reactor design

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Systems codes are a powerful tool for designing the next generation of nuclear fusion reactors. By exploring a large design space in a single calculation, they can obtain highly optimised solutions. However, while a single design is informative, it does not give the whole picture. Often new designs will push boundaries, whether that involves scaling to new physical regimes or applying new technologies. All of this will introduce uncertainty which needs to be quantified to give a complete understanding of the performance of a proposed reactor. Uncertainty analysis can then inform about high impact areas, critical design aspects or simply confirm the robustness of the design.

The SST-2 reactor is a proposed medium sized device with low fusion gain (Q = 5) and capable of producing fusion power from 100 to 300 MW. Tritium breeding will be achieved by having breeding blankets only on the outboard side, while on the inboard side, shielding blankets will be placed due to the limited space available. The magnets will be superconducting in nature to achieve steady state operation. In this work, we are performing an uncertainty analysis of its latest published concept design (Srinivasan et al. 2016; Fusion Eng. Des., 112, 240). We initially use the systems code PROCESS to reproduce the SST-2 design originally obtained using another systems code, SPECTRE, highlighting and explaining the differences between the two. We then apply a Monte-Carlo based uncertainty quantification tool using PROCESS to explore its predicted performance and highlight high impact areas. By building a more comprehensive understanding of the implications of the uncertain parameters we can give better predictions to aid the development of the design.

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