The Paramak, automated parametric geometry construction for fusion reactor analysis

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Abstract

During the design process of fusion reactors it is desirable to rapidly prototype different design concepts and assess their suitability against a range of high level requirements. This helps to narrow the design window and scope out potential designs which can undergo further more detailed analysis. The Paramak in an opensource tool that aims to provide automated parameter driven 3D CAD models for fusion reactor components and fusion reactors. The geometry produced is compatible with analysis workflows and this allows iterative automated model building and analysis to help steer the design optimisation process. The Paramak is uses CadQuery and OCC to create the 3D CAD model. Neutronics analysis is just one possible use of the 3D CAD geometry and is demonstrated in this paper as to demonstrate a potential use. Conversion from CAD to neutronics model is automatically carried out using Trelis and DAGMC which allows simulation in neutronics codes such as OpenMC and MCNP. In this paper we demonstrates the use of the Paramak framework to create a few example reactor configurations including a spherical reactor, a regular large radius tokamak and a compact submersion tank reactor. The models are not exact reproductions of any of any particular designs but just reflective of different reactor designs that are available. Input parameters for the various reactors that the Paramak can generate generally fall into three categories which are continuous ranges such as blanket thickness, integer ranges such as number of toroidal field coils and categorical

parameters such as type of divertor. The design tool facilitates parameter studies where users can investigate the impact of input design

parameters on the reactor performance. The generation of output metrics from input parameters leads itself to the use of data science and machine learning approaches to steer the design.

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