Neutronics Analysis of HTS-ST

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Spherical tokamaks (STs) have the potential to provide a cost-effective approach to fusion power and as a neutron source for experimentation, as they hold the plasma in tighter magnetic fields; forming a more compact reactor requiring lower capital construction and material costs. However, due to the smaller physical size of the tokamak and the aspect ratio that characterises its geometry, there is a limited amount of inboard space in and around the centre column. The restricted space limits the size of the centre column and means that only a limited amount of shielding can be used to reduce the nuclear heating and damage levels experienced by superconducting coil-type ST's. Since the associated cryoplant in a power device would need to remove the power deposited in the central column, at what is expected to be a significant cost per kW, this aspect of the superconducting ST design is a key economic consideration.

The limited inboard space also restricts the tritium breeding blankets to the outboard. For a self-sustaining tritium supply, for the D-T fusion reaction, a tritium breeding ratio of >1.1 is required.

The radiation transport code MCNP (Monte Carlo N-Particle) and inventory code FISPACT have been used to perform neutronics analysis on a HTS-ST model based on the PPPL FNSF radial build and CAD model. This work draws on previous analysis, using simplified parameterised ST models, on the centre column with respect to the material composition and size of the centre column, shielding material and shielding thickness. Initial neutronics results will be presented.