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Three confinement systems - Spherical Tokamak, Advanced Tokamak and Stellarator: A comparison of key component cost elements

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Since the 1950's Next Step fusion devices and power plant studies have been developed for a number of magnetic confinement systems but an open question remains···can a magnetic fusion device be simplified to the point where it will be cost competitive and operate with high availability? Concept designs based on the advanced tokamak (AT), spherical tokamak (ST) and the quasi-axisymmetric stellarator (QAS) option have progressed in recent years through a series of PPPL studies with an underlying intent to improve the engineering feasibility of each, giving special attention to concepts that simplify the device configuration and improve maintenance features. For the spherical tokamak option, design details centered on a 3m Fusion Nuclear Science Facility concept that evolved to incorporate vertical maintenance, HTS magnets, a small inboard DCLL blanket and a liquid metal divertor. In collaboration with the K-DEMO and CFETR concept study teams the AT design has evolved to increase plasma component access within a vertical maintenance approach using enlarged TF coils incorporating a low and high field Nb3Sn winding pack that can provide a peak field of 16T. A recent PPPL stellarator study focused on simplifying the stellarator winding topology to improve access to in-vessel components; combining coil optimization with winding surfaces that incorporated geometry constraints specified by engineering. This study centered on a 1000 MW power plant design with a tokamak like vertical maintenance scheme that allows access to remove large segmented internal blanket sectors.
Results of these three confinement studies will be presented to highlight concepts that simplify each device configuration and improved their maintenance features. Scaling each option to a common 1000 MW net electric power plant mission allows comparisons to be made of key cost elements such as to major core component sizes, sizing of the test cell or external facilities needed for on-site construction or facilities to handle and store activated in-vessel components.

Eligible for student paper award?

No

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