FT/2-3 · Design Limits of WENDELSTEIN 7-X

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Abstract: WENDELSTEIN 7-X (W7-X) shall confirm the favourable plasma properties and the high density and beta limits of the helical advanced stellarator and demonstrate steady state operation. The magnetic configuration of W7-X is characterised by a set of 50 non-planar and 20 planar superconducting coils. The magnet system will be cooled to 3.3 K, manufactured and assembled to a precision of a few millimetres and maintain its symmetry during cool-down to cryogenic temperatures. Power supplies allow to adjust the magnetic field in the range of a few mT and safely dump the magnet energy in case of a quench. The plasma vessel gives maximum space for the plasma and is kept symmetrically w.r.t. the plasma by dedicated means. Steady state heating is achieved by 10 MW ECR. Energy and particles are controlled by a continuously working divertor. All plasma facing surfaces are covered by CFC, graphite and B4C. The status of construction is reviewed and details of construction are described.

FT/2-4 · Engineering Aspects of Compact Stellarators

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Abstract: Compact stellarators could combine the good confinement and high beta of a tokamak with the inherently steady-state, disruption-free characteristics of a stellarator. Two U.S. compact stellarator facilities are now in the conceptual design phase: the National Compact Stellarator Experiment, NCSX, and the Quasi-Poloidal Stellarator, QPS. NCSX has a major radius of 1.4 m and a toroidal field up to 2 T. The primary feature of NCSX is the set of modular coils that provide the basic magnetic configuration. These coils represent a major engineering challenge due to the complex shape, precise geometric accuracy and high current density of the windings. The winding geometry is too complex for conventional hollow copper conductor construction. Instead, the NCSX coils will be wound with flexible, multi-strand cable conductor that has been compacted to a 75% copper packing fraction. Inside the coil set and surrounding the plasma is a highly contoured vacuum vessel. The QPS device has a major radius of 0.9 m, a toroidal field of 1 T, and an aspect ratio of only 2.7. Instead of an internal vacuum vessel, the QPS modular coils will operate in a bell jar.

FT/2-5 · Objectives and Design of the JT-60 Superconducting Tokamak

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Abstract: The modification of JT-60U to a large and fully superconducting tokamak (JT-60SC) is proposed to demonstrate the high beta operation of the reactor relevant steady-state plasma and the applicability of the low activation ferritic steel characterized by a ferromagnetic property to plasma confinement devices. In order to improve economic and environmental suitability of tokamak fusion reactors, crucially important are the accomplishment of low circulating power operation in accord with a high pressure plasma and the establishment of utilization technology of low radio-activation materials to minimize the influence of radioactive waste to the environment. The JT-60SC device is designed to implement the steady-state research in a high performance plasma regime of a break-even class for a long duration ($\sim$100 s or longer) sufficiently exceeding a current diffusion time. Physics and engineering design of JT-60SC is presented to address the issues of high beta plasma control, steady state plasma control and divertor heat & particle control with high performance steady-state plasmas non-dimensionally similar to the future reactor plasma and surrounded by ferritic steel.