W7-X Progress

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The WENDELSTEIN 7-X stellarator (W7-X) is the next step device in the stellarator line of IPP and is presently under construction at the Greifswald branch institute. The experiment aims at demonstrating the steady state capability of a stellarator machine at reactor relevant parameters.

The main parameters of W7-X are: average major radius 5.5 m, average plasma radius 0.53 m, magnetic field on the plasma axis 3.0 T, total weight 725 t. An important feature of W7-X is the high geometrical accuracy of the magnetic field configuration; perturbations ($\Delta B/B$) with a periodicity different from the five-fold periodicity of the device should be kept below 10^{-4}. The magnetic system of the machine consists of 50 non planar and 20 planar superconducting coils supported by a central structure made of 10 sectors. The magnetic system is kept at 4K by liquid helium.

The superconducting coils are made by a conductor composed of 243 NbTi/Cu strands twisted to form a cable that is enclosed in an aluminium alloy jacket. The winding package is insulated by fibre glass epoxy resin and enclosed inside a stainless steel casing. To limit the ohmic heat production, electrical joints between superconductor cables with an electrical resistance below 1 nΩ at 4 K, were successfully developed. Conventional current leads appropriately designed are used to connect the seven groups of superconducting coils with the power supplies (20 kA-30 V each).

Critical components are the coil support elements connecting the coils to the central structure and the inter-coil support elements connecting the coils one to the other. These supports operate in high vacuum and at cryogenic temperature, withstand high loads and moments and allow the assembly of the machine with high accuracy.

Efficient thermal insulation of the superconducting coils is achieved by high vacuum and multilayer insulation. The complex shape of these thermal shields need the development of support panels based on a new technology: glass fibre epoxy resin reinforced with integrated Cu-mesh.

The plasma vessel is composed of 10 half-modules and is being constructed from stainless steel rings bent precisely to the shape and successively welded together to keep the vessel surface within tight tolerances.

The high thermal load from the plasma (up to 10 MW/m^2) is taken by a divertor made by Carbon Fibre Composite tiles brazed on water cooled CuCrZr alloy heat sinks.

A 10 MW ECRH system with CW-capability operation at 140 GHz is under construction to meet the scientific objective of W7-X. The microwave power is generated by 10 gyrotrons; a prototype was successfully developed and tested. The microwave power is focussed into the plasma through 10 synthetic diamond barrier windows and quasi-optical plug-in launchers.

Production of most of the W7-X components made significant progress: some planar and non planar coils have successfully tested, segments of plasma vessel were delivered at Greifswald and most of the tools required for the assembly are ready for use.

The paper will report the recent progress on W7-X with particular emphasis on the components where high-technology solutions have been applied.