

DESIGN AND TEST OF THE SUPPORT ELEMENTS OF THE W7-X MAGNET SYSTEM

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The Wendelstein 7-X (W7-X) stellarator is presently under construction and assembly in Greifswald, Germany. Its ultimate goal is to verify that such stellarator magnetic confinement concept is a viable option for a demonstration fusion power-plant. The “pentagonal” basic magnet system, capable to generate a magnetic field up to 3 Tesla at the magnetic axis, is composed of 50 non planar coils and 20 planar coils, which are connected to a central support ring. This magnet system is a complex mechanical structure which has to fulfill demanding requirements in terms of:

- accuracy of the magnetic field, where a millimetric precision in the coils position is needed, in order to keep at an acceptable level the ratio between the magnetic field error at the plasma boundary ΔB and the average magnetic field on the plasma axis B_0 .
- capability to take the operational loads, mainly coming from the electromagnetic forces generated by the currents in the coils, with acceptable deformations and stresses in the various elements of the magnet system (superconductors, coils casings, supports, ring).
- suitability of the manufacturing tolerances and assembly scheme, which must be optimized in conjunction with the design of the connections mentioned above.

Basically, such structure will have to sustain efficiently the electromagnetic (EM) forces, generated by the current flowing into the superconductors, by reacting at the various support elements that connect the coils between themselves and with the central support ring: reactive forces and moments being in the order of MN and hundreds of MN•mm, respectively. The support elements are a proper combination of contact sliding elements and welded boxes between the coils in the inner and outer side, respectively, and bolted connections between coils and central support ring in the inner side. They have been conceived and designed in such a way to react to the loads in a “balanced way,” while complying with the other requirements listed above. Given the unprecedented complexity of such mechanical scheme, a wide range of cross-linked development activities have been performed to support the design, including FE analyses, mechanical tests on mock-ups reproducing the way these supports work in cryogenic conditions under vacuum, and assembly trials, in order to finalize and validate the magnet system mechanical structure.

This paper gives an overview of the way the mechanical structure is conceived, of its key support elements, and of the results of the analyses and tests carried out so far.