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Design and development of the Wendelstein 7-X inter-coil supports: main results and critical issues

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The Wendelstein 7-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 superconducting magnet system, capable to generate an average magnetic field up to 3 Tesla at the magnetic axis, is basically composed of 50 non-planar and 20 planar coils, and of a central support structure (CSS) to which they are connected. This system is a complex mechanical structure which has to fulfil demanding requirements in terms of accuracy of the magnetic field, capability to take the operational loads, compliance with the manufacturing tolerances and assembly scheme, and interfaces.
The support elements of the magnet system have been conceived and designed in order to react to the loads in a “balanced way”, while complying with the other requirements mentioned above. The non planar coils are interconnected each-other by the Lateral Support Elements at the outer side, and by the Narrow support Elements and the Contact Elements at the inner side, while the Central Support Elements connect each coil to the CSS. Similarly, the planar coils are linked to the non planar coils by the Planar Support Elements, and to the CSS also by the Central Support Elements.
These supports, during stellarator operation, have to transmit forces and moments that are in the order of several MN and hundreds of MN•mm, respectively. Given the unprecedented complexity of this mechanical scheme, a wide and integrated programme of design, FE analyses, tests, and assembly trials has been undertaken, in order to develop and validate the design, and to optimize the mechanical response of the magnet system.
This paper gives an overview of the way this structure is conceived, of its key support elements, and of the results of the analyses and tests carried out so far.