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FTP/3-1: Technical Challenges in the Construction of the Steady-State Stellarator Wendelstein 7-X

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The “fully-optimized” stellarator Wendelstein 7-X stellarator, presently under construction in Greifswald, combines a quasi-isodynamic magnetic field configuration sustained by superconducting coils with a steady-state exhaust concept, steady-state heating at high power, and a size sufficient to reach reactor-relevant nT-values. It is the mission of the project to demonstrate the reactor potential of the optimized stellarator line.

For the development of a credible stellarator reactor concept, steady-state operation has to be demonstrated with fully integrated discharge scenarios at high heating power with a divertor providing suitable power and particle exhaust. The development of reactor-relevant operation regimes is the chief scientific goal of Wendelstein 7-X.

The subject of steady-state operation, however, is of more general interest, as this is also of great concern and interest for future tokamak devices. Consistent with the physics requirements of steady-state plasmas must be the engineering aspects of a steady-state fusion device. We discuss these issues for the design, manufacturing, and assembly of Wendelstein 7-X.

The major components of Wendelstein 7-X have been manufactured, tested and delivered: 70 super-conducting coils, 121 superconducting bus-bars for the 7 coil current circuits, about 1000 cryo pipes, 10 half-modules of the central support structure, the plasma vessel and outer vessel, and 254 ports. The main focus of the project has in recent years shifted to the assembly process and considerable progress has been achieved.

Although in the early phases of the Wendelstein 7-X construction several schedule delays have accumulated, there have been no major project delays for more than four years and completion of the device is foreseen for mid 2014. A summary of the technological challenges that have been faced in the project and solutions found are discussed in this paper. In addition the route towards completion, commissioning, and the first operation phase is presented.

Country or International Organization of Primary Author

Germany

Primary author: Mr BOSCH, Hans-Stephan (Germany)

Presenter: Mr BOSCH, Hans-Stephan (Germany)

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