stellarator news

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Wendelstein 7-X Update

Wendelstein 7-X (W7-X) is a superconducting modular stellarator that is under construction at the Max-Planck-Institut für Plasmaphysik in Greifswald, Germany. These items are taken from issue 5 of the Wendelstein 7-X newsletter (September 2010).

Status

Two modules are already in their final position on the machine base in the Torus Hall (Fig. 1). A third module was transfered there in August. Soon this module, too, will undergo final positioning. Work on the first module is concentrating on the difficult installation of about 50 ports. The ports provide access for the heating and diagnostics systems required for scientific measurements, and for cooling of in -vessel components.

Fig. 1. Two modules of W7-X on the machine base in the Torus Hall.

A number of work packages have been completed in recent weeks. Assembly of half-modules, where the coils were threaded onto the plasma vessel, has been completed. This workstation has been freed up for prepare the ports for assembly. Two further extremely challenging work packages were completed: all of the special coil slide bearings have been manufactured, and the serial production of helium piping is complete. Both required innovation and expertise to employ novel manufacturing techniques.

Bus bar systems for Wendelstein 7-X completed

At the heart of W7-X are 70 superconducting coils, which generate the stellarator's magnetic field. At the end of June, the team at the Forschungszentrum Jülich celebrated the successful development and construction of the bus bar system for Wendelstein 7-X. This milestone ensures that the magnetic field coils can be supplied with high currents.

The bus bar system provides electrical connections between the coils and to external power supplies. Ten coils of each type are connected in series and then to one current lead. The production was extremely complex, due to the three-dimensional design of the bus bars and the large forces that they must withstand. Components in the stellarator will move as much as a few centimetres and the bus bars have to absorb these streses. Furthermore, the bus bars are installed in cramped space. This all results in extremely high accuracy requirements for the design and assembly.

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Fig. 2. Preparation of the bus bars for assembly.

The bus bars (Fig. 2) are made from copper-niobium-titanium, the same material as the coils. Specially woven wires are placed in an aluminium jacket. Liquid helium will flow through the jacket to cool the wires down to 4 K (–269°C). Since the coils are designed to be switched off very quickly, the electrical insulation was tested to 13000 V. Such a high level of performance is achieved by using two layers of Kapton foil embedded in a fibreglass reinforced epoxy resin. On the surface, a conductive lacquer prevents buildup of static charge and helps to detect short circuits.

The comprehensive expertise and specialized equipment at the Forschungszentrum Jülich were utilized for the bus bar manufacture. A computer-controlled manufacturing line was specially built for the machining and bending of bus bars.

After the first bus bars were produced, they were checked on a 1:1 mock-up of a Wendelstein 7-X module. The first bus bars were installed on a real module in 2009 while the rest were still in production. Currently, four of the five modules are equipped with their bus systems, and preparation for the last module is in progress. In total, the Forschungszentrum Jülich has produced and delivered 140 bus bars up to 14 m long. In addition, 400 brackets and 700 clamps have been made to attach the bus bars to the modules, and 240 joints to connect the modules to the coils. Some of the pieces of bus bar and clamps are shown in Fig. 3.

After the bus bars were bent to shape with millimeter accuracy, special transport racks were used to deliver them to Greifswald to prevent any in-transit distortion. Prior to assembly the ends were cut and bent precisely, transition pieces were welded on, the ends were insulated electrically, and detector wires were mounted. For the final assembly the technicians used a technique learned from Jülich production: in Fig. 4, the bus bars hang from helium balloons as they are positioned delicately and precisely on the modules.

Fig. 3. Details of the bus bar assembly.

Fig. 4. Assembly of the bus bars using helium balloons to hold them suspended in air.

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