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# Challenges for the Wendelstein 7-X magnet systems during the next operation phase

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During the first operation phase OP1.1 of Wendelstein 7-X (W7-X) the magnet systems were not operated up to the maximum current. During the next operation phase OP1.2 the next step in the direction to a full current operation will be taken. Based on lessons learned during the first phase the necessary improvements have been worked out to deal with the challenges in OP1.2.
The superconducting magnet system consists of the two different coil types: the non planar coils (NPC) generate the main magnetic stellarator field, whereas the planar coils (PLC) generate additional fields to provide the experimental flexibility of the device. With respect to OP1.1 the NPC current in OP1.2 will be increased slightly, but will be doubled in the PLC. Also a reversal of the current direction in the PLC will be required. This affects the electrical, the thermo hydraulic and the mechanical behavior. Test during and after OP1.1 showed that it might be advantageous to reduce the electrical stress during fast discharges. Therefore the dump resistor of the magnet protection system was optimized. It is customized for the next operation phase, but reduces the fast discharge voltage significantly from 2.7 kV to 1.8 kV.
In order to avoid the risk of a quench the magnet system is be operated with a temperature margin of one K or more with respect to the critical temperature of the superconductor. A continuous comparison of the actual operation temperature with the maximum allowed temperature is being performed. In case of the safety margin being smaller than one K an automatic current ramp down should be initiated. During OP 1.1 a number of sensors did not work well which resulted in a blocking of the automatic function. In addition to check and repair of sensors and signal processing units the software was upgraded in a way that the operator is now able to exclude a sensor from the calculation also during operation.
The five trim coils are normal conducting coils mounted at the outer surface of the cryostat. They were operated during OP1.1 up to 1.1 kA which represents 2/3 of the maximum current. An important improvement resulted from the evaluation of one fast discharge of the superconducting magnet system. The trim coil power supplies detected an internal failure and switched off. This induced via the magnetic coupling a strong and fast voltage peak in the superconducting coils. The quench detection system interpreted this voltage as a sign of a quench and triggered a fast discharge of the superconducting system. For OP1.2 measures were studied and installed to minimize the cross link between the two coil systems.
The control coils are also normal conducting coils, but situated inside of the plasma vessel behind the divertor plates. These coils were commissioned for OP1.1, but not operated during the first plasma campaign. Nevertheless it turned out that the reliability of the power supplies needs to be improved, especially auxiliary systems like water cooling or driver boards of the inverter stages were sources of failures.

## Eligible for student paper award?

No

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