The superconducting magnets of the future

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The FRESCA2 cryostat before the insertion of the magnet. Credit: Sophia Bennett

The superconducting magnets of the future are under development and CERN is on the front line. To increase the energy of circular colliders, physicists are counting on ever more powerful magnets, capable of generating magnetic fields way beyond the 8 Tesla produced by the magnets in the Large Hadron Collider (LHC).

Magnets generating fields of almost 12 Tesla, based on a superconducting niobium-tin compound, are already being manufactured for the High-Luminosity LHC. But CERN and its partners have also started work on the next generation of magnets, which will need to be capable of generating fields of 16 Tesla and more, for the colliders of the future such as those under consideration in the FCC (Future Circular Collider) study. To achieve this goal, the performance of niobium-tin superconducting cable is being pushed to the limits.

One of the key steps in the programme is the development of a test station capable of testing the new cables in realistic conditions, i.e. in a strong magnetic field. Such a facility, in the form of a dipole magnet with a large aperture, has been set up at CERN. The magnet, known as FRESCA2, was developed as part of a collaboration between CERN and CEA-Saclay in the framework of the European EuCARD programme.

At the start of August, FRESCA2 reached an important milestone when it achieved its design magnetic field, generating 13.3 Tesla at the centre of a 10-centimetre aperture for 4 hours in a row – a first for a magnet with such a large aperture. By comparison, the current magnets in the LHC generate fields of around 8 Tesla at the centre of a 50-millimetre aperture. The development and performance of FRESCA2 were presented today at the EUCAS 2017 conference on superconductors and their applications.


FRESCA 2

The FRESCA2 magnet before the start of the tests. Credit: Maximilien Brice/CERN

Testing of the cables under the influence of a strong magnetic field is a vital step. "We not only need to test the maximum current that can be carried by the cable, but also all the effects of the magnetic field. The quality of the field must be perfect," explains Gijs De Rijk, deputy leader of the Magnets, Superconductors and Cryostats group at CERN. The precision with which the intensity of the magnetic field can be adjusted is an important feature for an accelerator. When the energy of the beams is increased, the intensity of the field that guides them must be increased gradually, without sudden spikes, or the beams could be lost. The fact that the magnets in the LHC can be adjusted with a great degree of precision, keeping their magnetic fields stable, is what allows the beams to circulate in the machine for hours at a time.

The two coils of FRESCA2 are formed from a superconducting cable made of niobium-tin. Their temperature is maintained at 2 degrees above absolute zero. The magnet they form is much larger than an LHC magner, measuring 1.5 metres in length and 1 metre in diameter. This allows the magnet to have a large aperture, measuring 10 centimetres, so that it can house the cables being tested, as well as sensors to observe their behaviour. FRESCA2 will also be used to test coils formed from high-temperature superconductors (an article on this subject will be published tomorrow).

FRESCA2 is being modified so that by the end of this year it will be able to generate an even stronger field. The station will then be ready to receive the samples to be tested.

Provided by CERN