High-Luminosity LHC: Electricity transmission reaches even higher intensities

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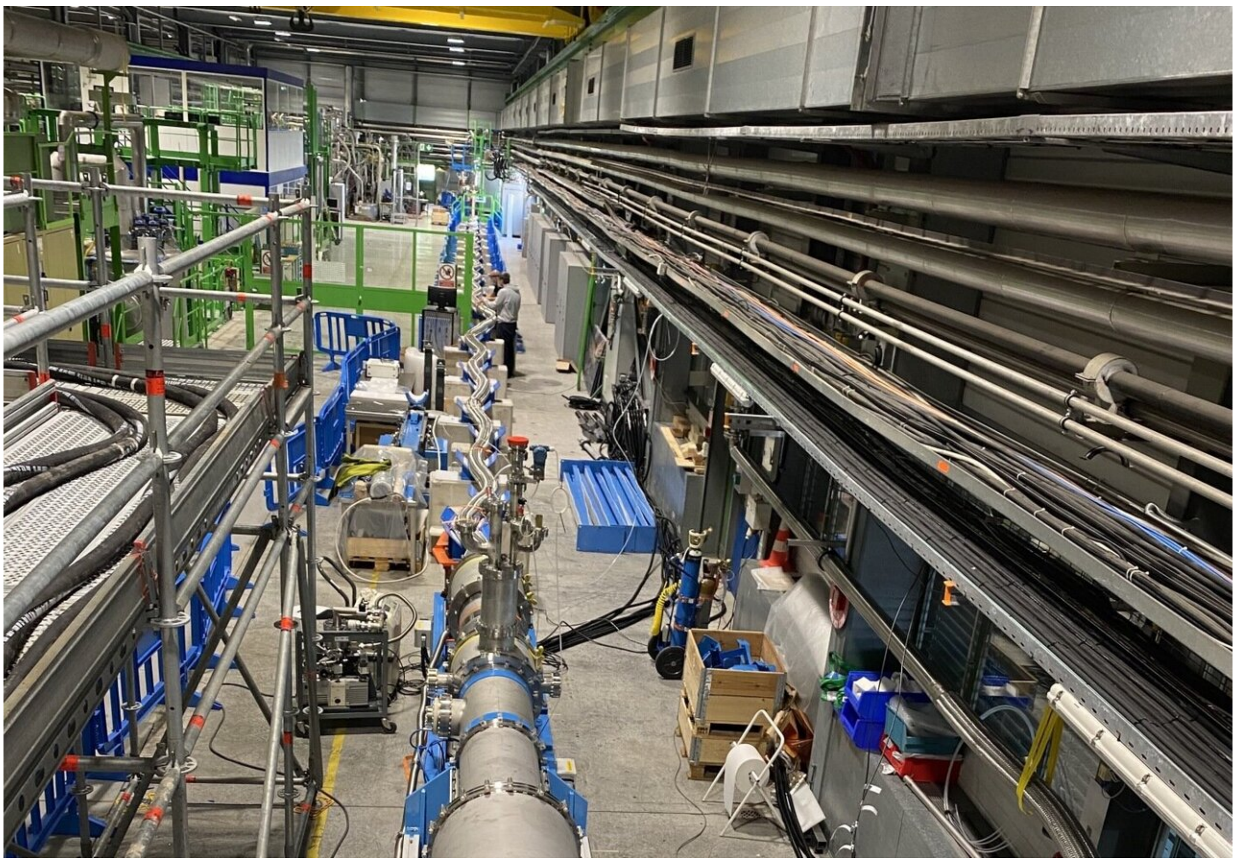

The innovative electrical transmission line, designed for the HL-LHC, has been undergoing tests since mid-June. Credit: CERN

Intensity is rising at CERN. In the superconducting equipment testing hall, an innovative transmission line has set a new record for the transport of electricity. The link, which is 60 meters long, has transported a total of 54,000 amperes (54 kA, or 27 kA in either direction). "It is the most powerful electrical transmission line built and operated to date," says Amalia Ballarino, the designer and project leader.

The line has been developed for the High-Luminosity LHC (HL-LHC), the accelerator that will succeed the Large Hadron Collider (LHC) and is scheduled to start up at the end of 2027. Links like this one will connect the HL-LHC's magnets to the power converters that supply them.

The secret to the new line's power can be summarized in one word: superconductivity.

The line is composed of cables made of magnesium diboride (MgB2), which is a superconductor and therefore presents no resistance to the flow of the current and can transmit much higher intensities than traditional non-superconducting cables. On this occasion, the line transmitted an intensity 25 times greater than could have been achieved with copper cables of a similar diameter. Magnesium diboride has the added benefit that it can be used at 25 kelvins (-248 °C), a higher temperature than is needed for conventional superconductors. This superconductor is more stable and requires less cryogenic power. The superconducting cables that make up the innovative line are inserted into a flexible cryostat, in which helium gas circulates.

The strands of magnesium diboride of which the cables are made were developed by industry, under CERN's supervision. The cable manufacturing process was designed at CERN, before industrial production began. As the strands of magnesium diboride are fragile, manufacturing the cables requires considerable expertise. The current is transmitted from the power supply at room temperature to the flexible link by ReBCO high-temperature superconducting (HTS) cables.

Last year, an initial prototype transmitted a 40 kA intensity over a distance of 60 meters. The link that is currently being tested is the forerunner of the final version that will be installed in the accelerator. It is composed of 19 cables that supply the various magnet circuits and could transmit intensities of up to 120 kA. "We started the power tests by connecting just four cables, two at 20 kA and two at 7 kA," explains Amalia Ballarino. New records are therefore expected to be set in the coming months.

This new type of electrical transmission line has applications far beyond the realm of fundamental research. Links like these, which can transfer vast amounts of current within a small diameter, could be used to deliver electricity in big cities, for example, or to connect renewable energy sources to populated areas.

Provided by CERN