# A novel electrical power transmission system

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Tests being carried out on the superconducting power line. From left to right: Julien Hurte, Jerome Fleiter, Alejandro Zurita and Amalia Ballarino, the project leader. Credit: CERN.

A novel superconducting transmission system , developed at CERN in the framework of the LHC High Luminosity upgrade (HL-LHC), has demonstrated its capability of efficiently transferring large currents at higher temperatures via innovative technology.

The system consists of a 60 m long flexible power line, transporting 40 kA from liquid helium temperature (–268.8 °C) up to 25 K (–248 °C) via magnesium-diboride ($MgB_2$) superconductor. High Temperature Superconducting ReBCO (Rare earth-Barium-Copper Oxide) material provides the electrical and thermal bridge up to 50 K (–223 °C), from where the current is conveniently transferred to room temperature. Cryogenic cooling is assured by a controlled flow of helium gas. Unprecedented technologies were validated in this new transmission system.

Below a certain temperature ($T_c$), superconducting materials carry current with no resistance. Magnesium diboride ($T_c$ ~39 K, i.e. –234 °C) and ReBCO ($T_c$ ~90 K, i.e. –183 °C) are respectively medium and high temperature superconductors, with operating temperatures exceeding those of

conventional Nb-Ti material ($T_c$ ~9 K, i.e. –264 °C). Their use in a transmission system enables safe cryogenic operation, well below $T_c$ to assure a generous temperature margin, and opens the path to cost-effective refrigeration, not requiring liquid helium.

The $MgB_2$ based superconducting system will feed current to the HL-LHC superconducting magnets. In its final version, it will transfer a total current of about 100 kA. It is planned to install several of these systems in the LHC underground areas in 2024. Recently performed tests confirm the feasibility of the innovative technology. The new transmission system can find application also as high-voltage, long-distance, transmission line replacing conventional systems, and companies around the world are using the work done at CERN to study this possibility. We see how accelerator development can pave the way to innovation benefiting society at large.