

# Commissioning of the cryogenic system of the HL-LHC Inner Triplet String test bench

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For the High Luminosity LHC (HL-LHC) project, the final focusing Inner Triplet (IT) superconducting magnets of the LHC will be replaced by a new 60 m-long set of higher performance Nb<sub>3</sub>Sn magnets that will operate at 1.9 K in pressurised He II. A test facility, the HL-LHC IT String, is currently being built to validate the collective behaviour of these new magnets and of the related systems. A dedicated cryogenic system was recently installed to provide the specific cryogenic functionalities required for the planned test program. The system includes a refrigerator with helium liquefaction capacity of around 25 g/s, a 100 m-long cryogenic multi-header distribution system, and a low-pressure pumping system equipped with a cold compressor with a capacity of 18 g/s at 10 mbar. This article reports on the first cooldown and commissioning of this cryogenic system in a standalone mode without magnets. The test program and a staged cooldown plan for the first cryogenic commissioning were defined with the goal to assess the functionality of the system, to determine its performance and to validate its individual components. The cryogenic commissioning was performed under conditions representative of the cooldown of the IT magnets in the future HL-LHC. Different cooldown modes were tested, and the performance of the system was evaluated for the conditions that are required for nominal operation at 1.9 K with heat loads up to 300 W. The pressure drop and heat loads on the cryogenic distribution system were measured at several temperature levels and compared to the expected design values. The presented results are demonstrating that the cryogenic system can provide the operating conditions required to accomplish the complete test program of the HL-LHC IT String test bench.

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