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Status of the cryogenic infrastructure upgrade for the High Luminosity LHC at CERN

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The High Luminosity LHC project is a major upgrade of the Large Hadron Collider that will provide a fivefold increase of the instantaneous collision rate and a tenfold increase of the integrated luminosity with respect to the LHC original design values for the ATLAS and CMS experiments.
To achieve the higher luminosity, the existing focusing magnets on each side of ATLAS and CMS experiments will be replaced with newly developed superconducting magnets operating in pressurized HeII at 1.9 K and new superconducting radiofrequency cavities modules ("crab-cavities"type) will be also installed on each side. The increased collision rate and beam current will generate a significantly larger heat load at 1.9 K that the current configuration, requiring new cryogenic infrastructures at Point 1 (P1) and Point 5 (P5) of LHC.
The upgraded cryogenic configuration requires two new helium cryogenic plants & their ancillary infrastructure at both P1 and P5, each with an equivalent capacity of about 14 kW at 4.5 K, including a capacity of about 3 kW at 1.9 K. The refrigerators will include a cold box located in a surface building that will provide 4.5 K supercritical helium, and a cold compressor box, required for 1.9 K operation, located in an underground cavern. The surface cold box will be connected to the underground cold compressor box with a vertical multi-header transfer line and the cold compressor box will also be connected to new cryogenic distribution lines feeding the LHC tunnel cryogenic equipment on both sides of the interaction points. This multi-header cryogenic line will interface with the cryogenic devices of the accelerator via flexible cryogenic jumpers at dedicated modules, which will also house the process control equipment like control valves and heat exchangers.
The main tenders for the refrigerators and the cryogenic distribution systems were adjudicated to industrial contractors in 2022. To anticipate all the possible activities before the next Long Shutdown 3 of the LHC (LS3, starting mid 2026 towards the objective to resume beams operation by mid 2030), these contracts are structured in phased stages of design and installation. The initial phases are currently under execution, with several equipment under construction and installation.
This presentation reports on the progress of the HL-LHC cryogenic infrastructure design, production and installation, and presents the schedule and preparatory activities for the installation foreseen for the Long Shutdown 3.

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