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# C4Or1B-02: Preliminary Conceptual Design of FCC-hh Cryo-Refrigerators: Air Liquide Study

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In the framework of a world-wide international collaboration, the FCC-hh, a 100 TeV hadron collider in a 100-km long tunnel, is proposed as a future circular collider beyond LHC at CERN offering the broadest discovery potential at the energy frontier.
For such high performance hadron collider, the cryogenic system has to distribute very large cooling capacities all along the 100-km tunnel for the superconducting magnets continuously cooled at 1.9 K and for the beam screens operated between 40 and 60 K. The required total cooling power will be produced in 10 refrigeration plants with a unit equivalent capacity of 100 kW at 4.5 K, up to 4 times larger than the present state-of-the-art. Half of the entropic refrigeration load is due to the synchrotron radiation produced by the high-energy proton beams and deposited on beam screens actively cooled around 50 K. This non-conventional thermal load distribution is an additional challenge for the FCC-hh cryogenic system. Furthermore the cryogenic system has also to cool down the cold mass of the FCC-hh machine in less than 20 days with controlled thermal gradients in the cryo-magnets and beam screens.
Based on preliminary design works from research institutes, an engineering study was performed with world-leader industries to assess a preliminary conceptual design for the FCC-hh cryoplants with industrial solutions and innovative technologies. The present paper recalls the FCC-hh cryogenic requirements and presents the main results of Air Liquide study confirming the novel precooling refrigeration option down to 40 K.

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