

**Beyond the Large Hadron Collider:
a First Look at Cryogenics for CERN Future Circular Colliders**

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Abstract – Following the first experimental discoveries at the Large Hadron Collider (LHC) and the recent update of the European strategy in particle physics, CERN has undertaken an international study of possible future circular colliders beyond the LHC. The study, conducted with the collaborative participation of interested institutes world-wide, considers several options for very high energy hadron-hadron, electron-positron and hadron-electron colliders to be installed in a quasi-circular underground tunnel in the Geneva basin, with a circumference of 80 km to 100 km. All these machines would make intensive use of advanced superconducting devices, i.e. high-field bending and focussing magnets and/or accelerating RF cavities, thus requiring large helium cryogenic systems operating at 4.5 K or below. Based on preliminary sets of parameters and layouts for the particle colliders under study, we discuss the main challenges of their cryogenic systems and present first estimates of the cryogenic refrigeration capacities required, with emphasis on the qualitative and quantitative steps to be accomplished with respect to the present state-of-the-art.

Keywords – Cryogenics, helium, particle accelerator, LHC, collider, CERN