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Cryogenic eficiency and sustainability aspects for particle accelerators & detectors

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Cryogenics is a key enabling technology for present and future particle accelerators and detectors, providing the conditions required for the operation of superconducting magnets, superconducting RF cavities, vacuum systems, and particle detection devices. However, extracting heat at very low temperatures requires large amounts of energy, often representing a major share of the total energy demands of the facilities. This article presents the main factors driving energy consumption, the status of the technology for a large spectrum of temperatures, and possible developments for improving the efficiency of cryogenic systems. It discusses the impact of cryogenic cooling configurations and the potential of new superconducting materials towards improved sustainability of future accelerators and particle detectors.

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