J-PARC Cryogenic Systems

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The science experimental facilities in J-PARC use various secondary particle beams such as neutrons, mesons, neutrinos, etc that produced in proton-nucleus reactions. The J-PARC has two large scale cryogenic systems for producing such secondary particles; a cryogenic hydrogen system for a spallation neutron source of a materials and life science experimental facility (MLF) and a cryogenic helium system for neutrino superconducting magnet beam line of neutrino experimental facility.

At the MLF, the material or biological structures are analyzed through cold neutron beam scattering experiments. The high-energy MeV-order neutrons, which are produced via a spallation reaction between 3-GeV protons and the mercury nucleus, are moderated to cold neutrons with less than eV-order energy by passing them through a supercritical hydrogen moderator. The cryogenic hydrogen system provides the supercritical hydrogen to the moderators with a pressure of 1.5 MPa and temperature lower than 20 K and removes the energy (nuclear heating), which is estimated to be 3.75 kW for a proton beam power of 1 MW.

At the Neutrino facility, the neutrino-oscillation experiment uses an artificial neutrino beam being directed towards the Super-Kamiokande detector located 295 km west of J-PARC. To produce such a neutrino beam, the primary proton beam is transported from the main synchrotron to a graphite target. The bending section of the beam line is a radius of 105 m and is composed of a superconducting magnet system with a dipole field of 2.6 T and quadrupole field of 19.6 T/m at the nominal current of 7345 A to transport 50 GeV protons.

We introduce the development and the current status of the J-PARC large-scale cryogenic systems.