Cryogenic system for BEPCII SRF cavity IR quadrupole and detector solenoid magnets

Jia L.X.[1] and Wang L.[2]

[1]Brookhaven National Laboratory, Upton, New York 11973, USA
[2]Institute of Cryogenics and Superconductivity Technology, Harbin Institute of Technology, Harbin 150001, CHINA

Beijing Electron-Positron Collider Upgrade (BEPCII) requires three types of superconducting facilities, including one pair of superconducting radio frequency (SRF) cavities, one pair of interaction region quadrupole magnets, and one detector solenoid magnet. The cryo-plant for BEPCII has a total cooling capacity of 1kW at 4.5K, which is composed of two separate helium refrigerators of 500 W each. The two refrigerators comprise the same gas storage and recovery system. The engineering design for the cryogenic systems, power leads, control dewars, subcooler, cryogenic valve boxes, cryogenic transfer-lines and cryogenic controls, is completed. The production of their subsystems is under way. This paper summarizes the progress in cryogenics of the BEPCII project.

INTRODUCTION

The cryogenic facilities of the BEPCII cryoplant are distributed over four areas; the first colliding hall, the second colliding hall, the compressor hall, and the gas tank farm (see Figure 1). The BESIII detector solenoid magnet and a pair of interaction region quadrupole magnets are located in the first colliding hall. The two SRF cavities are located in the second colliding hall. The two colliding halls are in a distance of 100 meters. To reduce the length of cryogenic transfer line and to meet the different loading requirements in two operation modes, colliding mode and the synchrotron radiation mode, two separate helium refrigerators of 500W each are used for the two colliding hall [1,2].

THE FIRST COLLIDING HALL

The layout of the cryogenic subsystem in the first colliding hall is shown in Figure 2. There are three superconducting facilities: the detector solenoid magnet with its valve box and two quadrupole magnets with a separated valve box. To provide cooling capacity to these facilities, a 500 W helium refrigerator (Linde TCF50) and a 1000 litter liquid helium control dewar are installed in the adjacent refrigerator building. The liquid helium produced by the refrigerator cold box is delivered to the subcooler that serves the control dewar. On the top of the subcooler is a cryogenic valve box that serves as a distributor to deliver subcooled helium to the valve boxes of the detector magnet and the two quadrupole magnets. The valve box for each magnet contains the power leads, cryogenic valves, relief valves, and pressure and temperature instrument ports. The connecting vacuum jacketed cryogenic transfer lines are of multiple types with tubes for helium and nitrogen. The multiple transfer line between quadrupole magnet and its valve box also contains the superconducting cables. The quench gas return lines and lead cooling gas

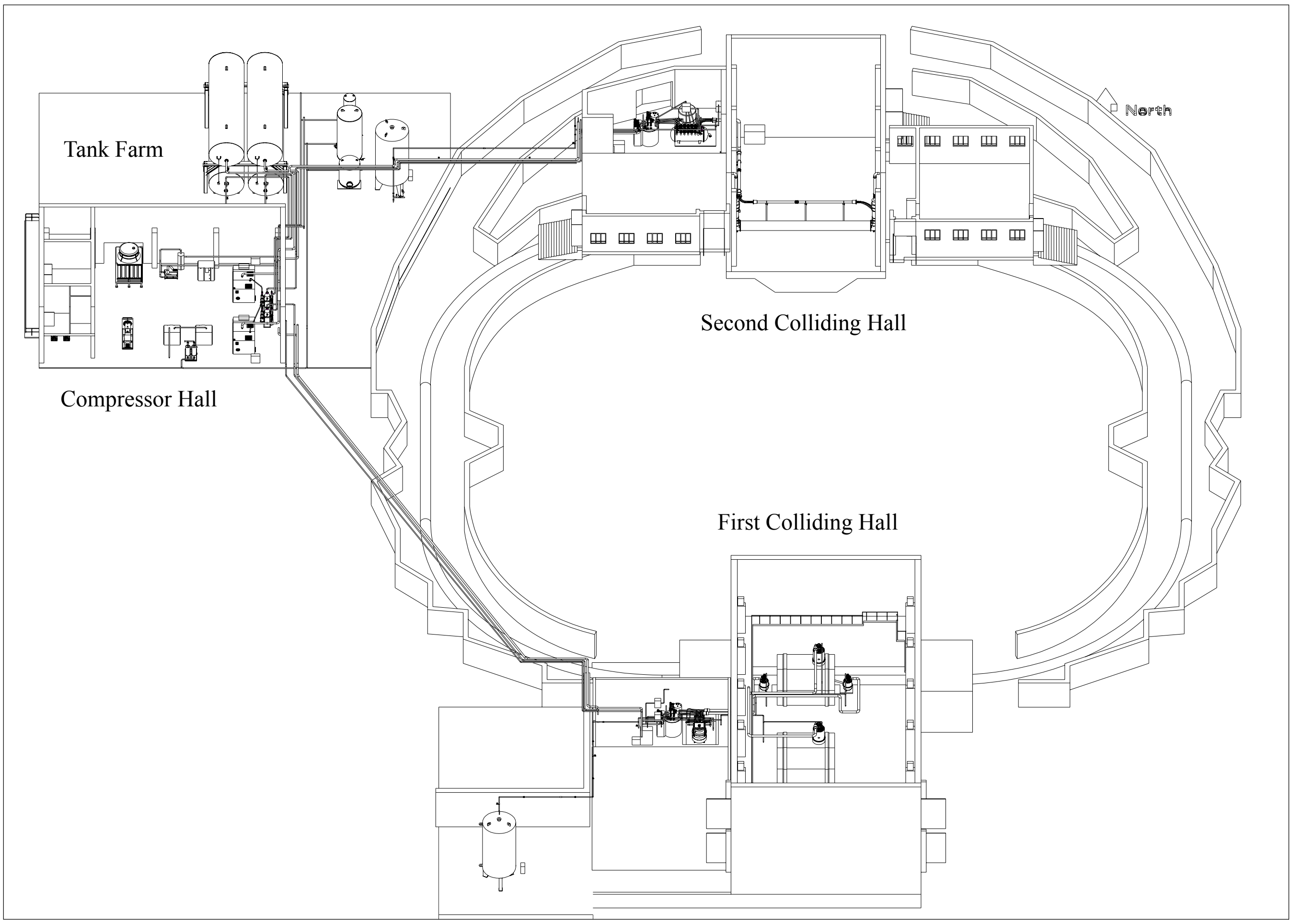

Figure 1 BEPCII ring and its cryogenic facilities

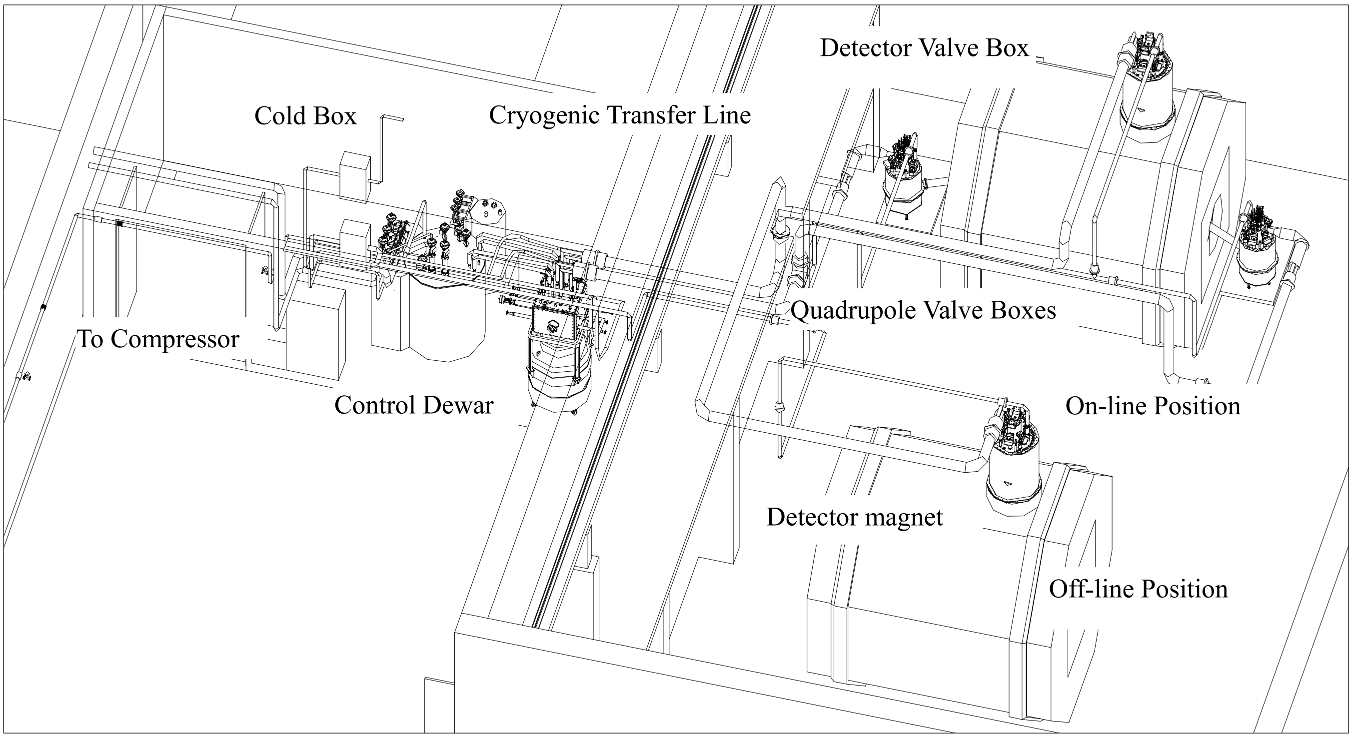

Figure 2 The first colliding hall and its cryogenic system

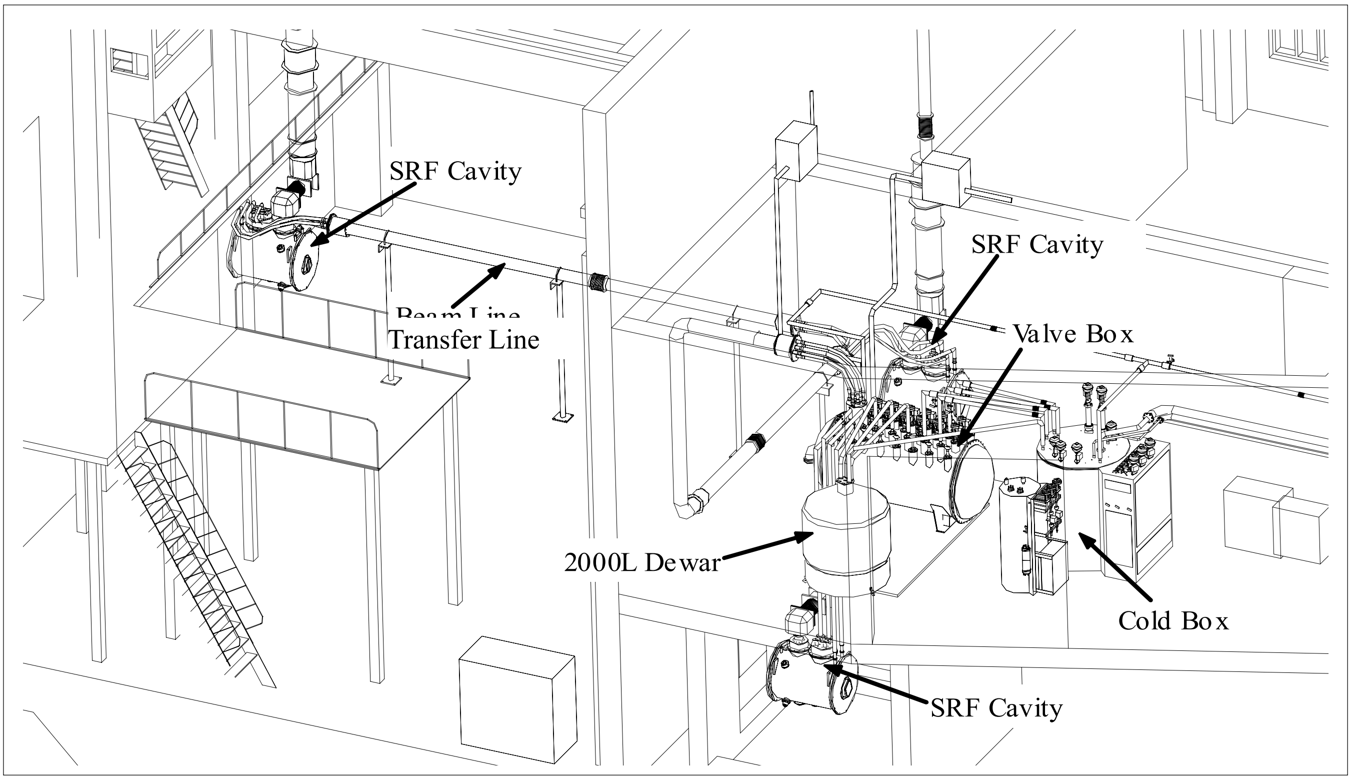

Figure 3 The second colliding hall and its cryogenic system

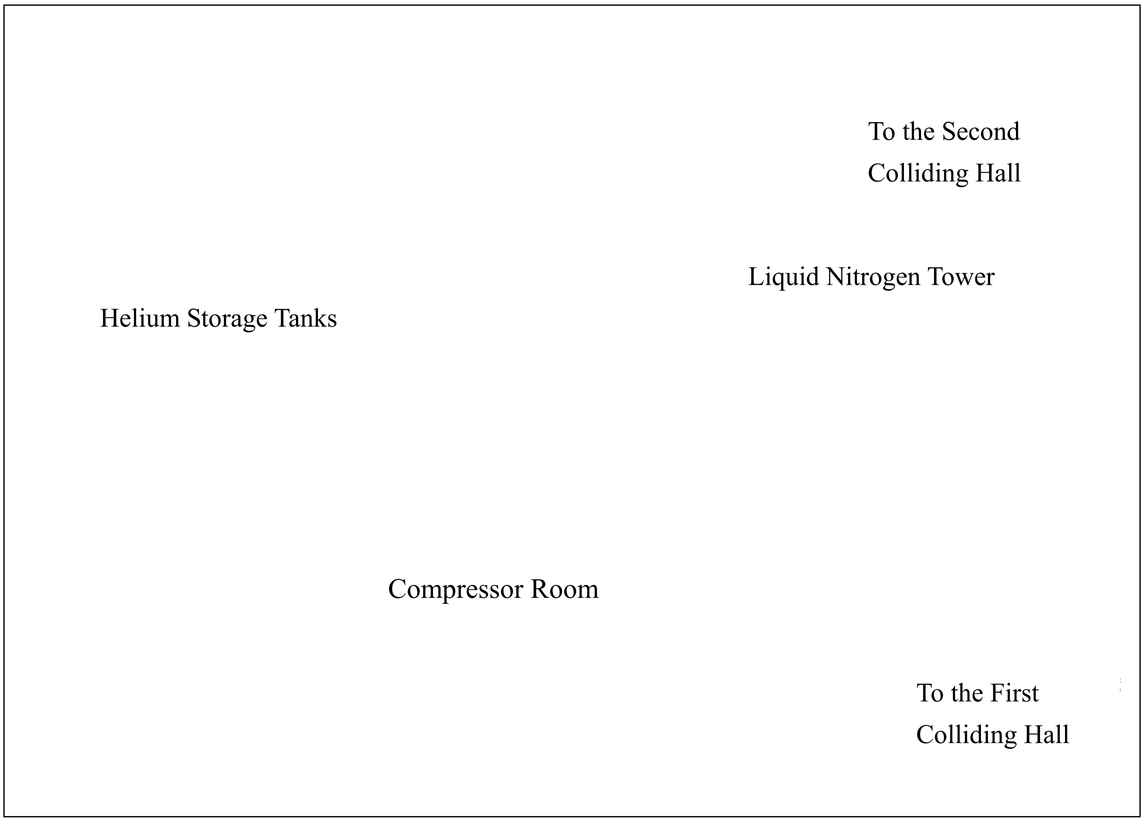

Figure 4 Compressor room and gas tank farm

return lines are directly connected to the compressor suction. The high pressure warm gas lines and low pressure warm gas line run from the cold box to remotely located compressor building. A liquid nitrogen tower for the refrigerator cold box and magnet heat shield is located just outside of the first colliding hall. The vacuum jacketed transfer lines for the detector solenoid magnet is designed to accommodate its off-line test positions as well as the in-line operation position. The vacuum separation barriers are arranged in various portions of the transfer lines that allows the quick reassemble and relocation of each cry modules.

THE SECOND COLLIDING HALL

The layout of the cryogenic subsystem in the second colliding hall is shown in Figure 3. Three superconducting RF cavities: two in-lined cavities and one off-line test cavity. In the refrigerator building adjacent to the second colliding hall, there are four major cryo equipments: the refrigerator cold box with the cooling capacity of 500W (Linde TCF50), the external cryogenic helium purifier, the 2000 litter liquid helium dewar, and the SRF distribution valve box. The 2000 litter dewar is used to maintain available liquid helium for each cavity for cool down and operation. Each cavity has a liquid volume of 300 litters. The main cryogenic valve box distributes liquid to three SRF cavities. The valve box is so designed that three cavities can be cold at the same time or anyone of three cavities can be cold when others are warm. This horizontal valve box contains all necessary cryogenic valves, relief valves, and pressure sensor ports. The multiple cryogenic transfer lines in the second colliding hall are designed with several vacuum barriers for operating and testing of these cavities.

THE COMPRESSOR HALL AND TANK FARM

The layout of the helium compressor hall and the helium gas tank farm is shown in Figure 4. The compressor hall is remotely located in a new building that is about 100 meters away from the first colliding hall and 70 meters away from the second colliding hall. Two compressors with separated oil removal, cooling water, and VFD systems are located in the compressor hall. Each compressor supports each cold box in the first and the second colliding halls. The piping for the two compressors is designed as to support individual cold box at different colliding hall and also to be the backup of each other. The compressor hall also contains the instrument air pumping system and the emergency electrical power generator. The cryogenic control room for the entire cryoplant is also located in the same building. Adjacent to the compressor hall is the tank farm in which there are four high pressure gas tanks, 130 m^3 each, one impurity helium gas tank, one instrument air tank, and one liquid nitrogen tower of 30 m^3 in capacity.

CONCLUSION

The engineering design work for the BEPCII cryogenic system is carried out in the framework of collaboration among three institutes: the Institute of High Energy Physics, the Institute of Cryogenics and Superconductivity Technology, and the Brookhaven National Laboratory. The design work started in March 2003 and basically completed in May 2004. The construction will be soon started as this report is presented. The mechanical fabrication of the cryogenic system is to be conducted in China with some imported components such as the refrigerators and cryogenic valves.

REFERENCES

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