Cryogenic Plant and Instrumentation Section

- Cryogenic Plant and Instrumentation section is responsible for installation, commissioning, operation and maintenance of helium refrigerators and liquid nitrogen delivery system.
- Presently, two helium refrigerators one of 250W @ 4.5K and other of 415 W @ 4.5K refrigeration capacity without liquid nitrogen pre-cooling are operational. They can provide required liquid helium for cooling the cryostat and cryopnel of the superconducting cyclotron and as well deliver liquid to the other experimental facilities. Both can be operated simultaneously with selection facility among three compressors each of 50 g/sec flow rate. The helium refrigerators follow modified Claude cycle and liquefaction is done in two isentropic expansions through warm and cold expanders and one isenthalpic expansion by Joule-Thompson valve.
- From the experience of the initial commissioning of the superconducting magnet system, a modification in control and tuning of smaller refrigerator was made resulting in 90W direct enhancement of refrigeration capacity.

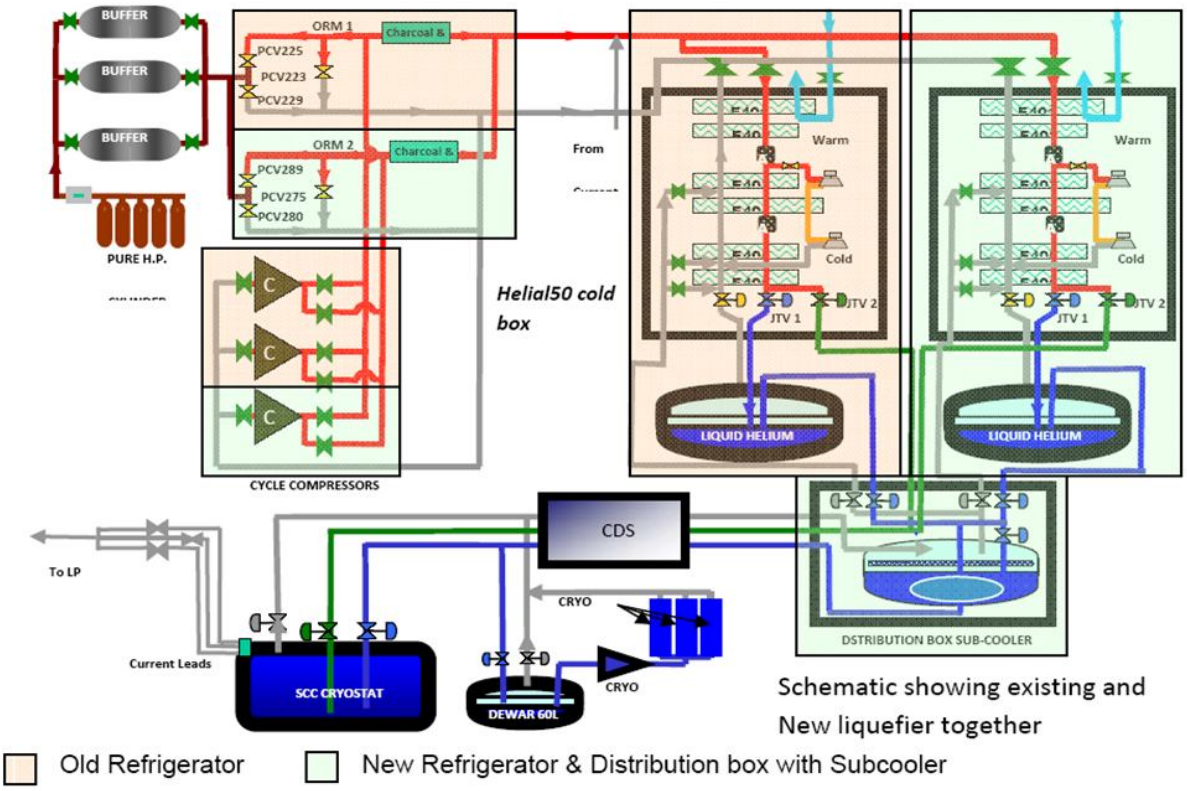

Figure 1 Schematic View of the total cryogenic system of VECC

- The cryogenic system operates in a closed-loop system in which total quantity of

helium gas should remain constant. A rigorous monitoring of total computed system gas is done to detect gas leak and to take preventive action immediately. A small amount of make-up pure gas required for the system is supplied by the buffer tanks maintained at the maximum pressure of 14 bar. Four buffer tanks are present, of which 20 m3 is generally kept for receiving gas after purification and two 60 m3 is connected with the system for make-up and one more 60 m3 is maintained at higher pressure and kept in isolation to meet emergency requirement.

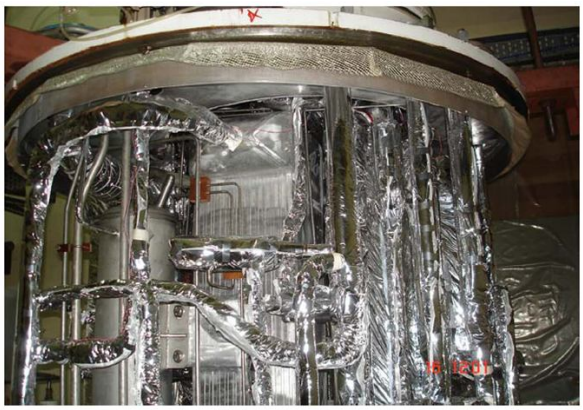

Figure 2: Internal view of the cold box of Helium Refrigerator 1

Figure 3 Buffer Tanks as storage of pure helium gas

- An impure helium gas system consisting gas bags, impure gas manifold, recovery compressors and liquid nitrogen based purifier, is also present for collection and purification of impure gas. Purification is made is batch process at the rate of 20 NM3/h at the extent of 6 hrs. Purifier for all modes of operations is made automatic with a check on total impurity from the online measurement of a multi-component detector.
- Liquid nitrogen delivery system comprises of four liquid nitrogen storage tanks of 2000 lit x 2, 12500 lit and 14500 lit. Liquid nitrogen is supplied by external agencies and consequently delivered by this section to superconducting cyclotron as well as experimental uses as and when required.
- Enormous and sophisticated mechanical systems were designed and developed in implementation of the above described set-up. In the XII th Plan, VECC has embarked upon a project on development of helium liquefier of capacity 50 l/h without liquid nitrogen precooling. The process design has been completed, based on which the components have been either designed or identified. Some of the components have already been procured and some are on the process of procurement. Oil removal system has already been developed and cold box design is under progress. Plate-fin Heat Exchangers, one of the major components of the liquefier, are to be tested before installation in the cold box. A conceptual design of

the test setup has already been completed. The progress of the project is satisfactory.

Figure 4 Three Quads for Impure bank

Figure 5 Liquid Nitrogen Tanks for storage and delivery of LN_2

Cryogenic Plant Instrumentation & Control

- Total cryogenic process is controlled by four programmable logic controller (PLC) of different make. The total system has been made fully automatic so that the operator only monitors and takes necessary actions in case of abnormal situations indicated by alarms. The user interface, data archiving and alarm system is based on Experimental Physics & Industrial Control System (EPICS).
- Cryogenic instruments like liquid nitrogen and liquid helium level sensors, cryogenic temperature transducer etc. were developed in house. The superconducting cyclotron magnet safety system, namely quench detection circuit, fast dump trigger circuit and lead drop monitoring circuit, was designed and developed in house by this group. A cryogenic set up, which can be used for calibrating temperature sensors, has been designed, developed and tested from 2.5 K to 300K.

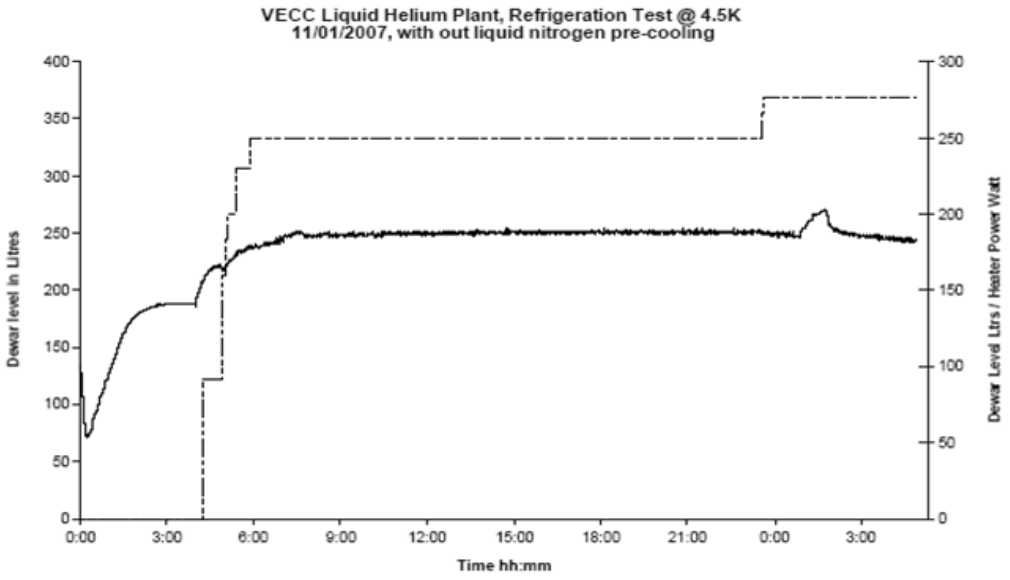

Figure 7- Test Result of First Helium Liquefier

- A moisture sensor for detecting water impurity in helium gas has already been developed in-house. The absorption cell of 50 cm length is illuminated by a near-infrared LASER source of 1877 nm. The absorption is measured using auto-Digital Gain Balancing technique, which can pursue very high sensitive detection. The measurement is successful for impurity level as low as 10 ppm in helium.

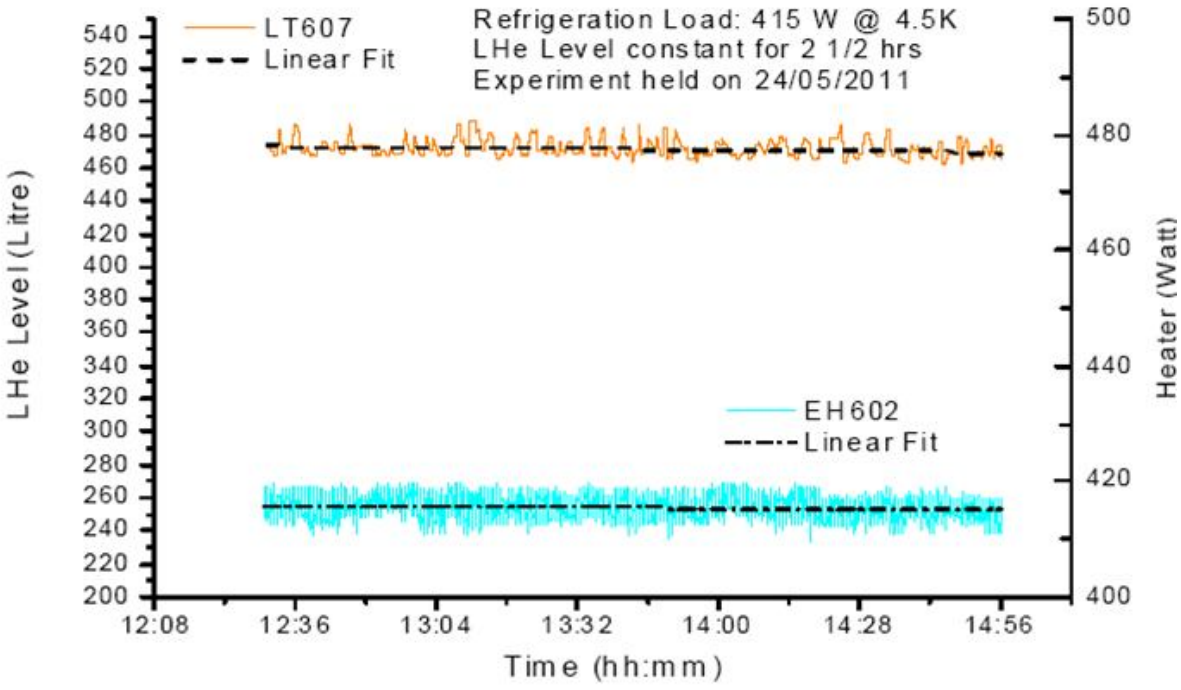

Figure 8 Test Result of Second Helium Liquefier