Abstract

The Advanced Rare Isotopes Laboratory (ARIEL) is a major expansion of the Isotope Separation and Acceleration (ISAC) facility at TRIUMF. A key part of the ARIEL project is a 10mA 50MeV continuous-wave superconducting radiofrequency (SRF) electron linear accelerator (e-linac). The 1.3Gf cm² SRF cavities are cooled by 2K liquid helium. E-line helium cryogenic system was designed to meet the ARIEL specifications [1]. The HELIAL LL helium liquefier by Air Liquides Advanced Technologies supplies 4K liquid helium (LHe) to cryomodules via LHe distribution system. The cryomodules have a top-loaded design [2].

The 4K – 2K temperature conversion is achieved by a counter flow heat exchanger and a JT-valve installed onboard of each cryomodule. The cryomodules have a top-loaded design. Another end of the heat exchanger is connected by non-insulated pipe to the tank of subatmospheric pumps which is connected by the normally insulated helium return line.

The installation of the e-linac cryogenic system components is in progress and presents the results of the acceptance tests and commissioning activities performed at TRIUMF since November 2013.

System Integration

Since the completion of the cryogenic test e-linac project team has accomplished a complex task of system integration which includes e-linac cryogenic system components limited to the injector cryomodule. The liquid helium supply and return lines were connected to the injector cryomodule. LN2 supply and distribution system was significantly upgraded. The vacuum-jacketed subatmospheric line was installed and installed on the room-vacuum wall. LN2 installation was done in the e-linac cryogenic system components limited to the injector cryomodule. The final step was to bring the cryomodules online and to connect them into the system to get the real e-linac cryo-system.

With all sub-systems device installation and readiness of the services such as cooling water, power, compressed air control, etc. the system was prepared to go through the rigorous routine of checks and commissioning tests. The operation of the e-linac cryogenic system was resumed in May to fit overall schedule.

References


First Cooldown and Commissioning

Finally after the end of the services installation and pre-commissioning tests were completed the pre-commissioning of the e-linac – 2K cryomodule test was performed. The pumping capacity of one subatmospheric pumping unit is sufficient to achieve stable 2K operation of injector CM with no RF load. The functional testing of individual subatmospheric components (pressure and liquid level regulation control loops) were repeated during few 4K – 2K tests. Control elements were tuned to achieve stable system automation response to RF power applied. Pulse RF mode and CM RF mode tests were started. Several low-power quench events were successfully recovered by cryo-system during RF conditioning. Injector CM SRF tests will be completed by the end of July 2014.

Summary

1. All major components of cryogenic system were specified, designed, procured and delivered to TRIUMF in time to suit e-linac delivery schedule.
2. The installation, integration, device and sub-system testing is proceeding according to the master plan. The acceptance test of the cryo-system that manufacturer fully satisfied design requirements for e-linac liquid helium refrigerator.
3. The injector cryomodule was successfully integrated into e-linac cryo-system. It went through all stages of the cooldown and thermalization, final alignment procedure and finally was brought to 4K.
4. The e-linac integration team is performing functional checks and commissioning of various subsystems. At the moment the sub-atmospheric and SRF systems are the subjects of underneath tests.

Figure 1. Recently completed the new building for TRIUMF’s ARIEL facility.
Figure 2. ARIEL e-Linac: Helium Cryoplant Acceptance Test
Figure 3. System Integration
Figure 4. Refrigeration capacity (constant LHe level in the dewar)
Figure 5. HELIAL LL cryostat and LHe distribution lines.
Figure 6. Supply and return stingers connecting Injector CM to LHe distribution system. Sub-atmospheric line to be connected next.
Figure 7. Refrigeration capacity (constant LHe level in the dewar)