Upgrading the Helium Cryogenic Plant at NSLS-II

Abstract:
The cryogenic system at NSLS-II is a closed loop helium system that consists of compressors, liquefier/refrigerator (Cold Box), manifold box, and a valve box. The system liquefies gaseous helium to a temperature of 4 K and delivers to the SC RF cavities by means of vacuum jacketed transfer lines. Beginning in 2017, the cryogenic system has undergone several upgrades, including the addition of a second valve box, a fourth buffer tank, an inline helium purifier and a Bonitron UPD System for our main compressors. In addition, the manufacturing of a second Cold Box and Dewar are underway and scheduled for a 2024 installation.

Helium Plant

The NSLS-II Liquid Helium Refrigeration/Liquefaction System construction began in 2012 and was commissioned in 2014. It consists of the following:

Liquefier/Refrigerator 890W
- 3 Gas bearing Turbines
- Dual 80K Adsorbers
- 5 Heat Exchangers

Compressors
- 2 250 kW Main Compressors
- 1 75 kW Recovery Compressor

Storage Tanks
- 3 horizontal tanks 30,000 gal each

Manifold Box
- 3 Distribution Ports
- 1 To Valve Box A
- 1 To Test Area

Valve Box
- 3 Distribution Ports
- 2 for 500 MHz Cavities
- 1 for 1500 MHz Cavity

Dewar 3,500 Liters
- 2 redundant level sensors
- 2 redundant 1,000-watt heaters

Transfer Lines
- ~128 feet of Vacuum Jacketed Multi-Channel Transfer Lines to Valve Box A and Cavaities

LHe Supply
- ~128 feet of LHe supply with isolation valves

Cold Gas Return
- 700 feet of VJP between Tank and Phase Separator

Additional Support

Cryo Controls Test Stand
- Used to validate new changes to existing PLC system
- Tests proposed upgrades
- Used to assist troubleshooting

Purifier

The cryogenic plant requires ultra-high purity helium (99.9995%) for operation. When it was noticed that impurities resulted in the decline of the cold box performance, it was determined in 2020 that a purifier was needed. Commissioned in April 2023

- In-Line
- Dual bed 80K Adsorbers
- Inlet Dryer
- Ambient Heater to dump LN2 out of the cryostat

Bonitron Capacitor UPD
- 480VAC
- 250kW (at 480VAC)
- Up to 2 seconds outage protection
- Ultracapacitor energy storage
- Seamless power transfer from electro utilities to Bonitron

Construction for Phase II of the cryogenic plant began in 2017 and was commissioned in 2021.

2nd Valve Box

With the fully built cryogenic plant, a 4th buffer tank was added to accommodate the required helium.

4th Storage Tank
- horizontal tank 30,000 gal

MC Transfer Lines
- ~40 meters of Vacuum Jacketed Multi-Channel Transfer Line to Valve Box B
- 3 MC Transfer Lines to Cavities

2nd Cold Box

The cryogenic plant has the highest Mean Time Between Failure (MTBF) but also has a long Mean Time To Repair (MTTR). Therefore, the construction of a 2nd Cold Box and Dewar began in 2023 and scheduled for installation in 2024.

Dewar 3,500 Liters
- 2 redundant level sensors
- 2 redundant 1,000-watt heaters

Platform
- Free standing
- Steel deck

Transfer Lines
- Coaxial Line from Cold Box to Dewar
- LHe supply from Dewars with isolation valves
- Cold gas return with isolation valves

2011 - 2014
National Synchrotron Light Source II

2023 - 2024

2017 - 2020

2021 - 2022