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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 liquifies 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

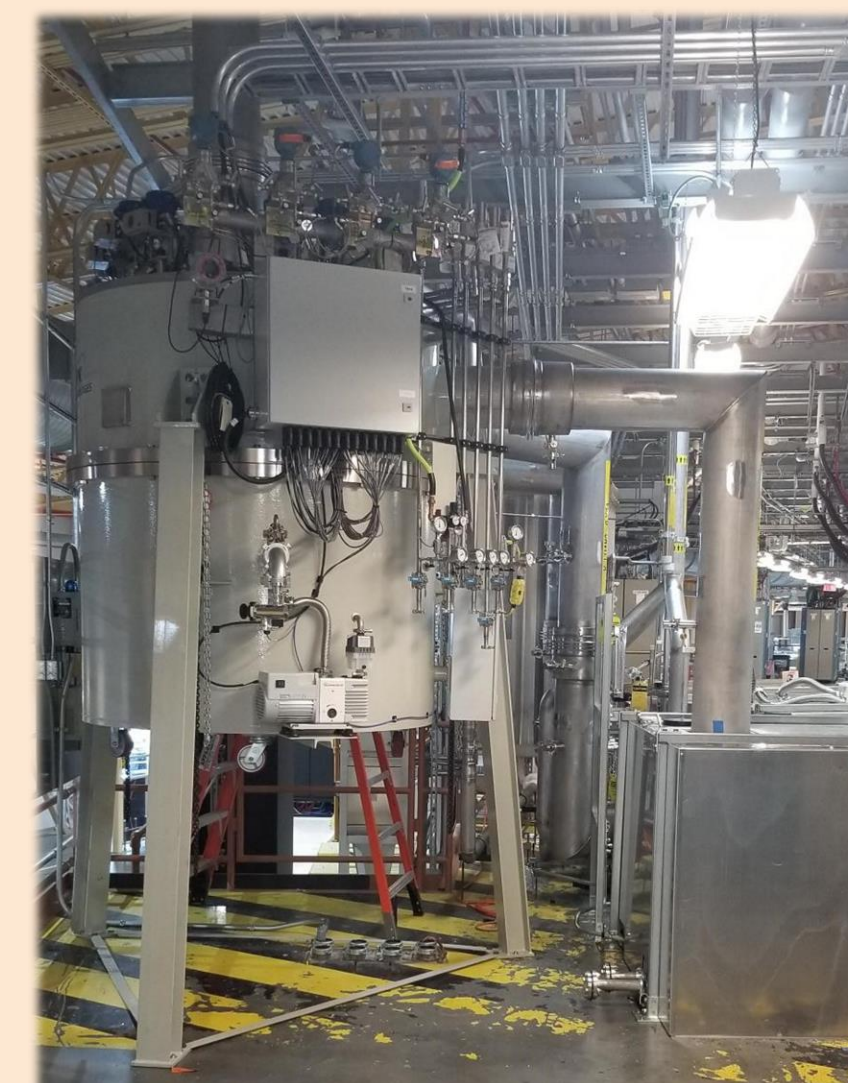


2nd Valve Box

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

2nd Valve Box

- 3 Distribution Ports
 - 2 for 500 MHz Cavities
 - 1 for 1500 MHz Cavity
- Ambient Heater



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

Purifier

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

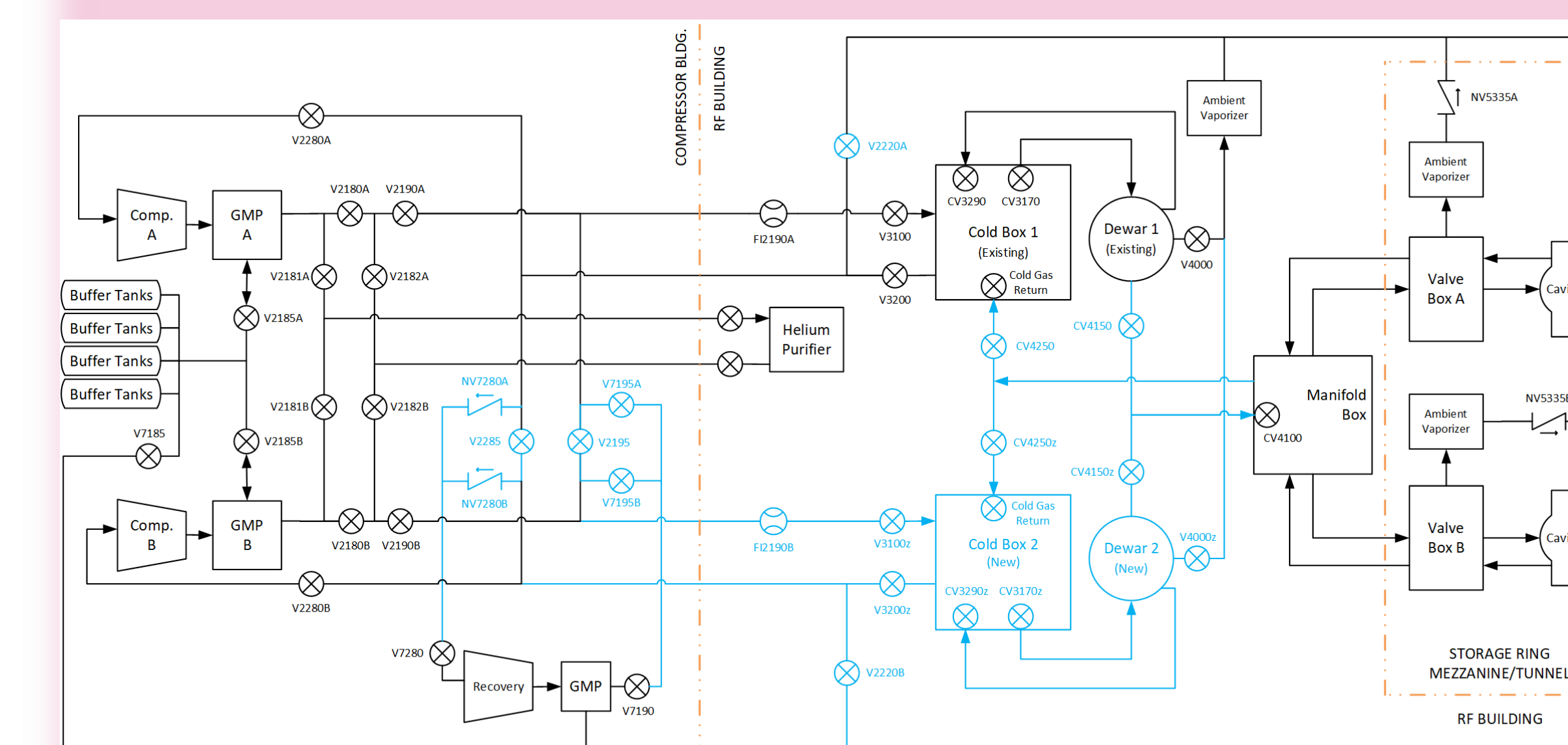
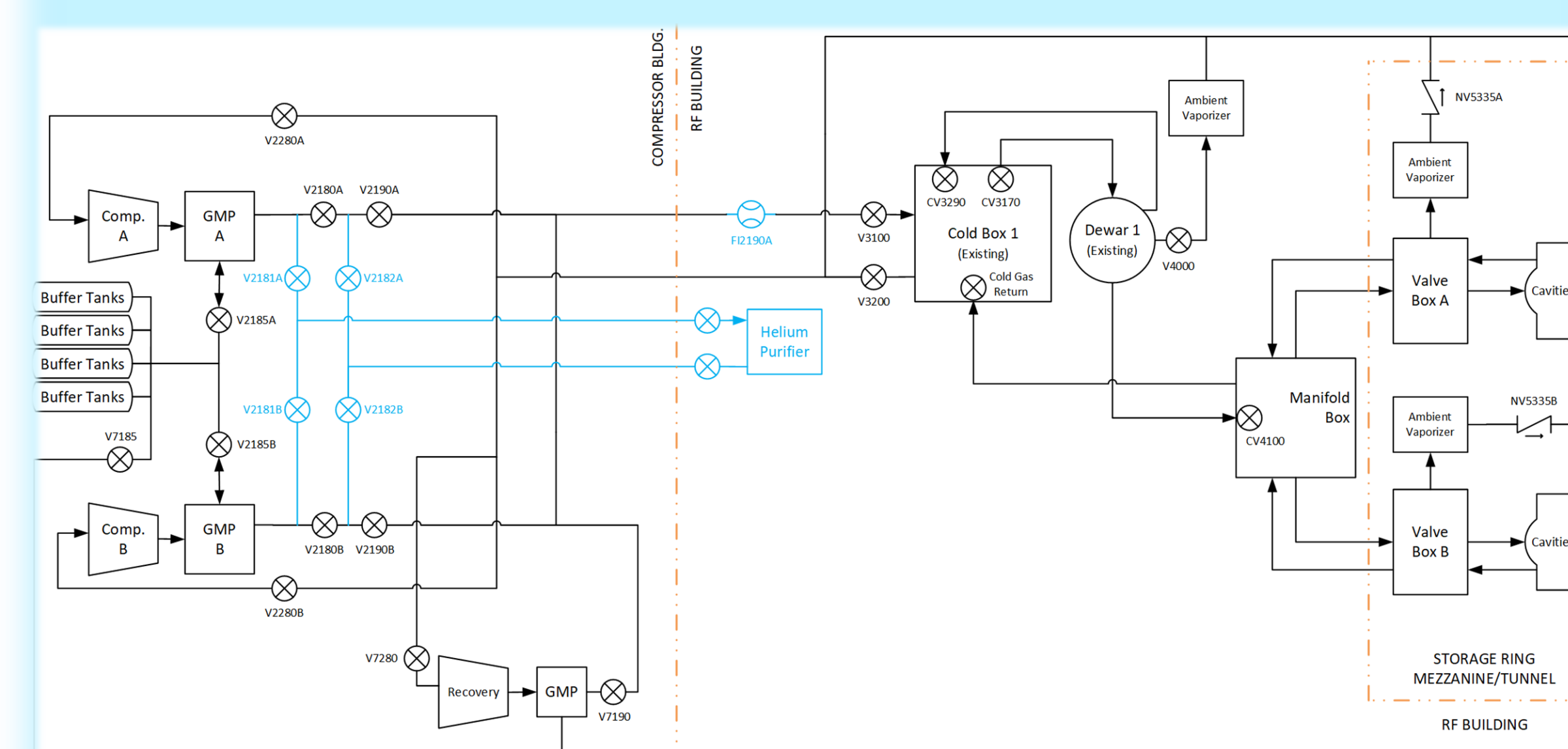
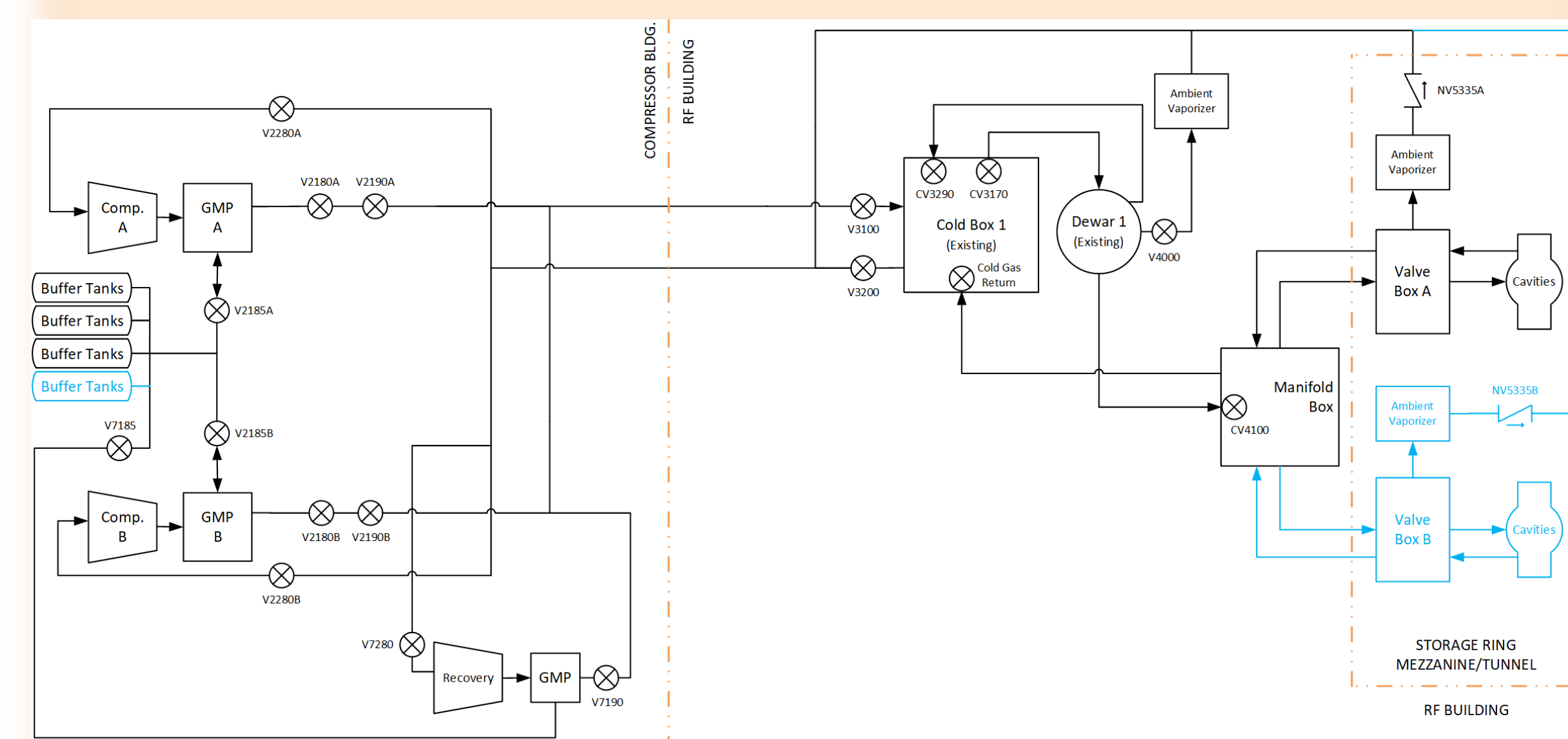
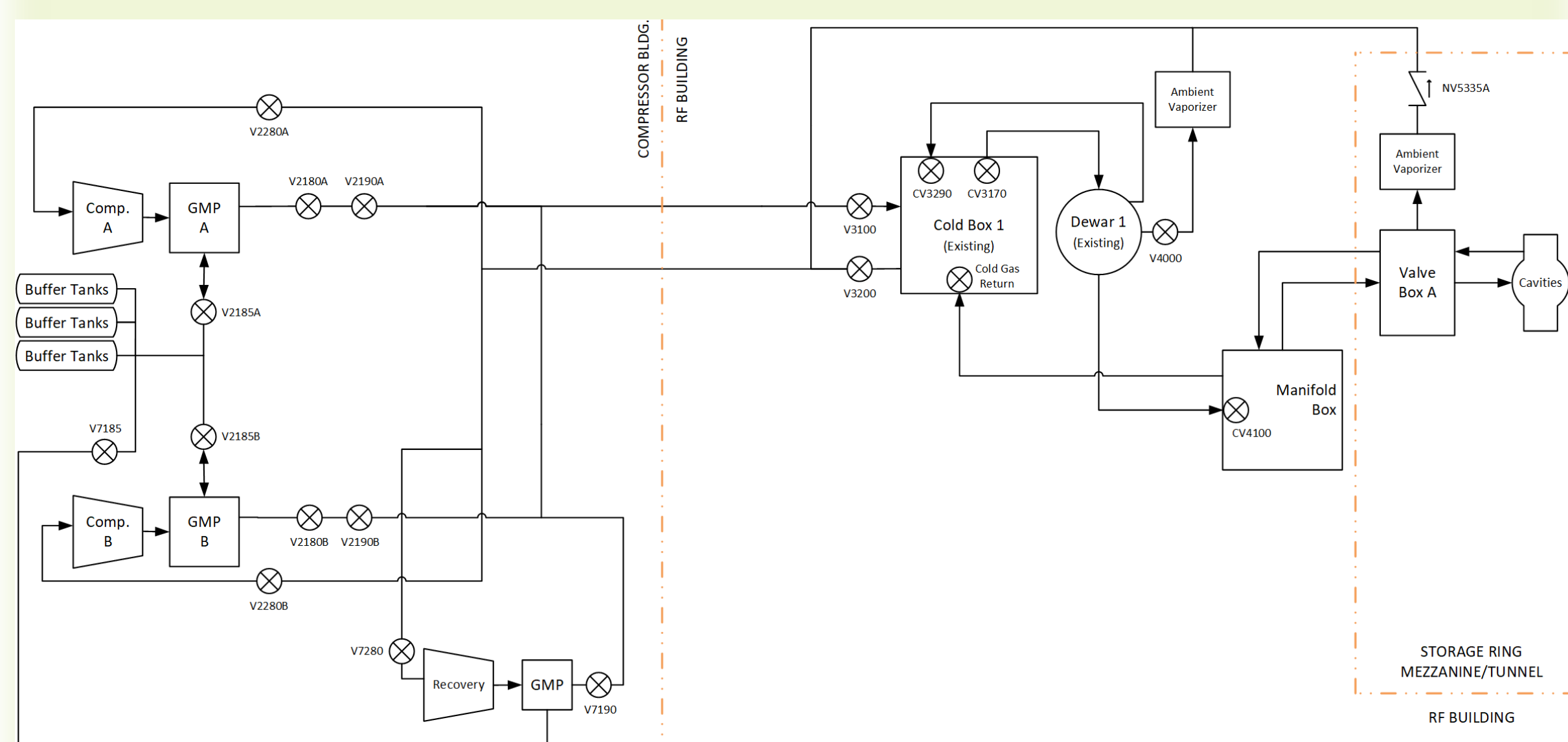
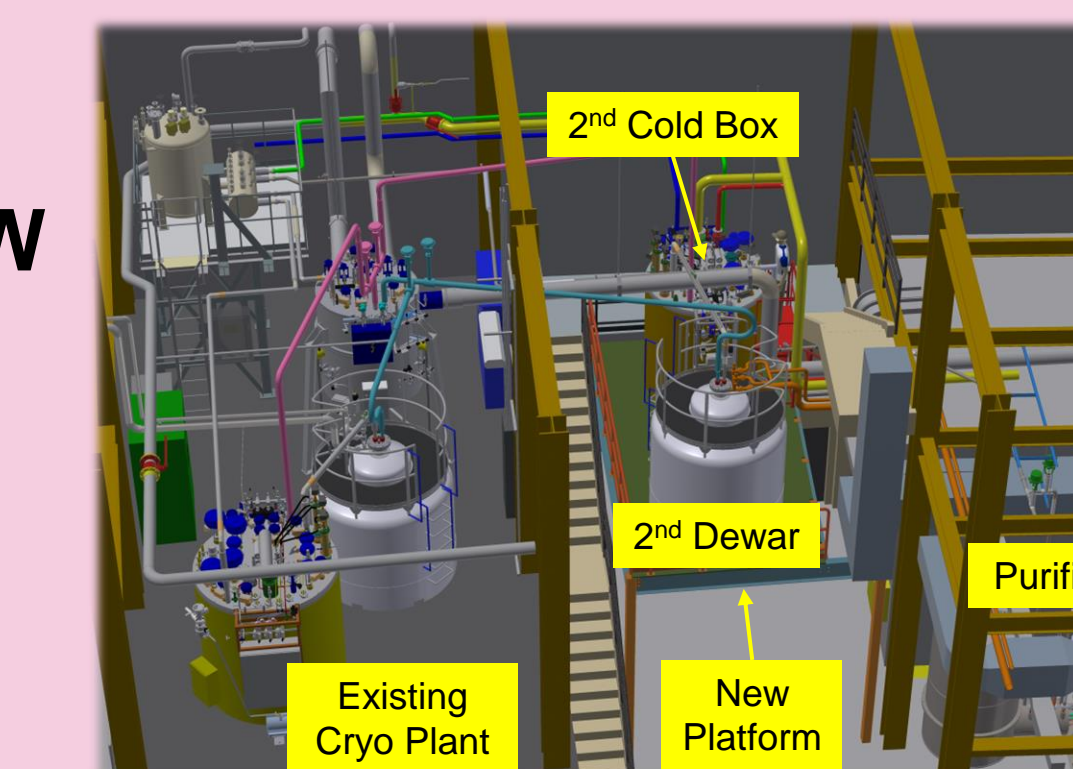


2nd Cold Box

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.

Liquefier/Refrigerator 890W

- 3 Gas bearing Turbines
- Dual 80K Adsorbers
- 5 Heat Exchangers



Manifold Box

- 3 Distribution Ports
 - 1 To Valve Box A
 - 1 To Valve Box B (Future)
 - 1 To Test Area

Valve Box

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

Dewar 3,500 Liters

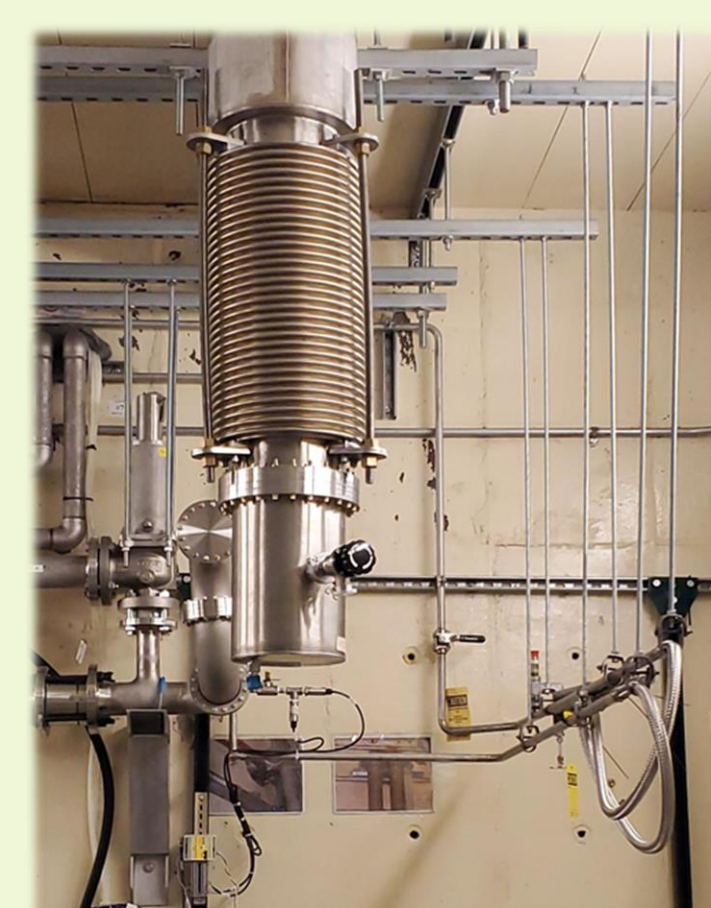
- 2 redundant level sensors
- 2 redundant 1,000-watt heaters

Transfer Lines

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

LN2 System

- 11,000-gal Vertical LN2 Tank
- 250 Liters Phase Separator
- ~ 700 feet of VJP between Tank and Phase Separator



MC Transfer Lines

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

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



Additional Support

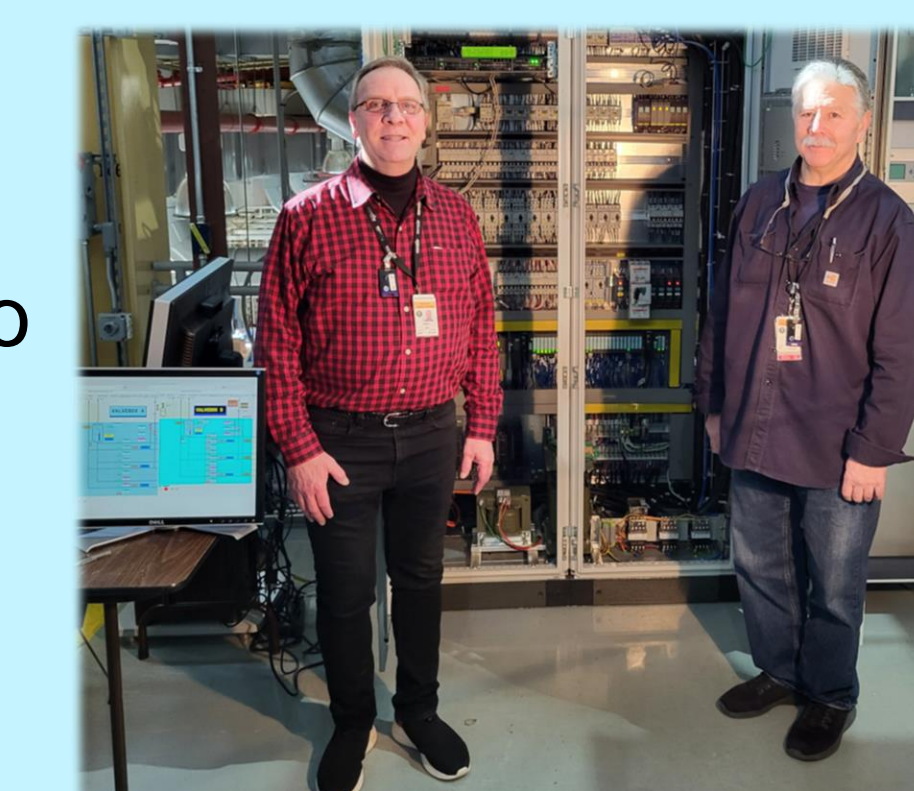


Bonitron Capacitor UPD

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

Cryo Controls Test Stand

- Used to validate new changes to existing PLC system
- Tests proposed upgrades
- Used to assist troubleshooting



Dewar 3,500 Liters

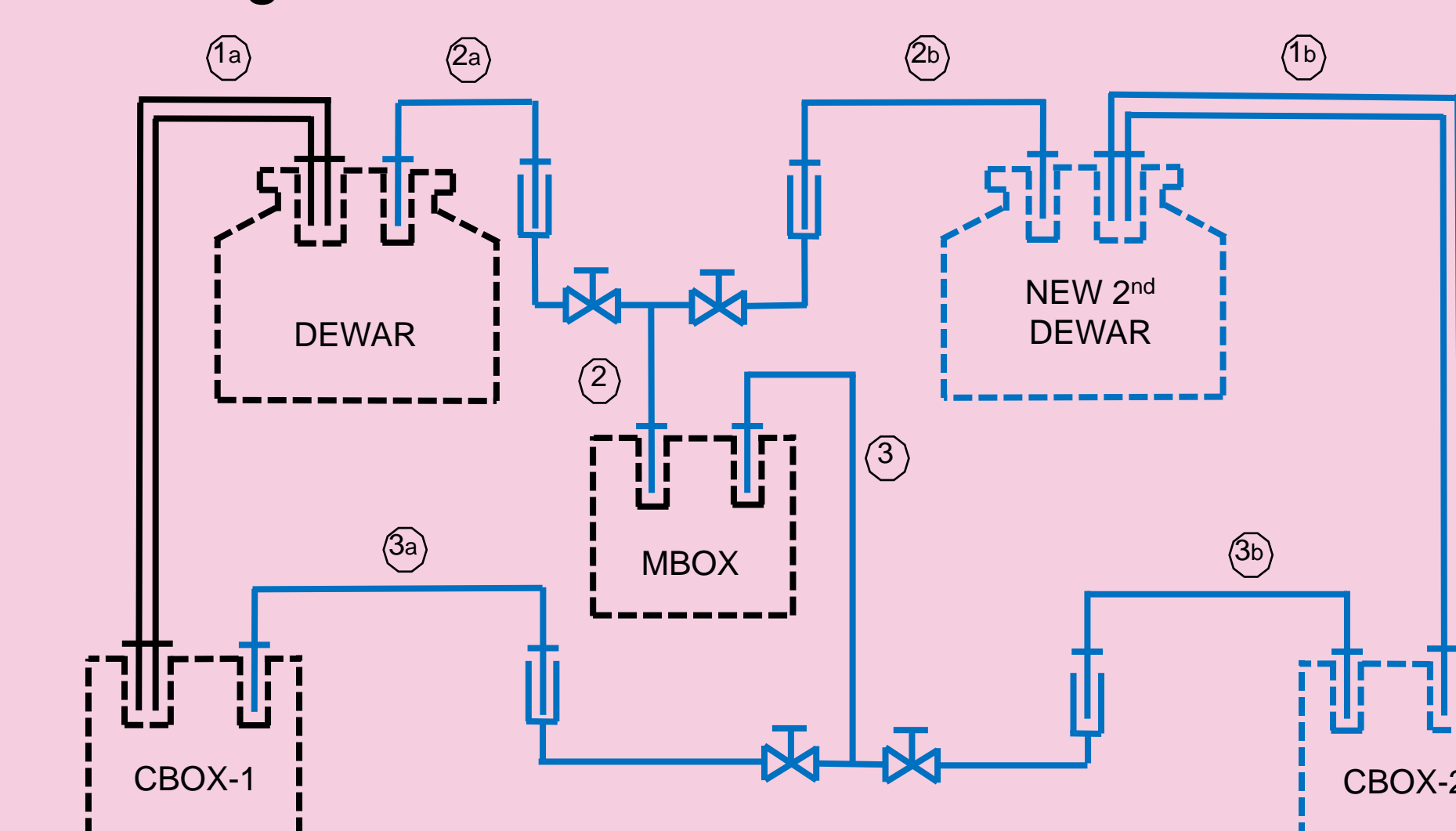
- 2 redundant level sensors
- 2 redundant 1,000-watt heaters

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

2017 - 2020

2021 - 2022

2023 - 2024