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Monitoring Helium Cryogen Usage with iFix Software at IB1 Test Facility

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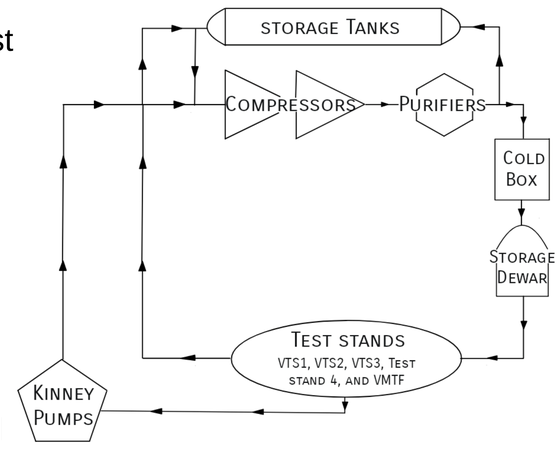
IB1 Testing Facility

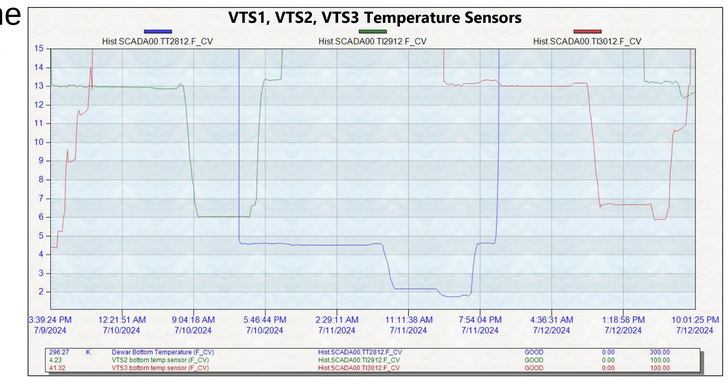
- 5 Superconducting Cavities and Magnet Test Stands
  - Vertical Test Stand 1(VTS1),
  - Vertical Test Stand 2(VTS2)
  - Vertical Test Stand 3(VTS3)
  - Vertical Magnet Test Facility (VMTF)
  - Test Stand 4 (TS4).
- These stands are used to test the thermal and superconducting capabilities of cavities and magnets and are connected to a closed loop system that strives to keep helium within the system minimizing the helium losses.
- The test stands require large volumes of liquid helium. The liquid helium that enters the test stand is monitored through a series of valves and controls to determine the start and stop for monitoring time.



Flow Diagram depicting closed loop system for IB1.

Cooldown and Warm-up of Test Stands

- All the VTSs are setup with the same configuration and valve functionality.
- To distinguish between each VTS there is a specific prefix assigned to each stand:
  - VTS1 - prefix 28
  - VTS2 - prefix 29
  - VTS3 - prefix 30

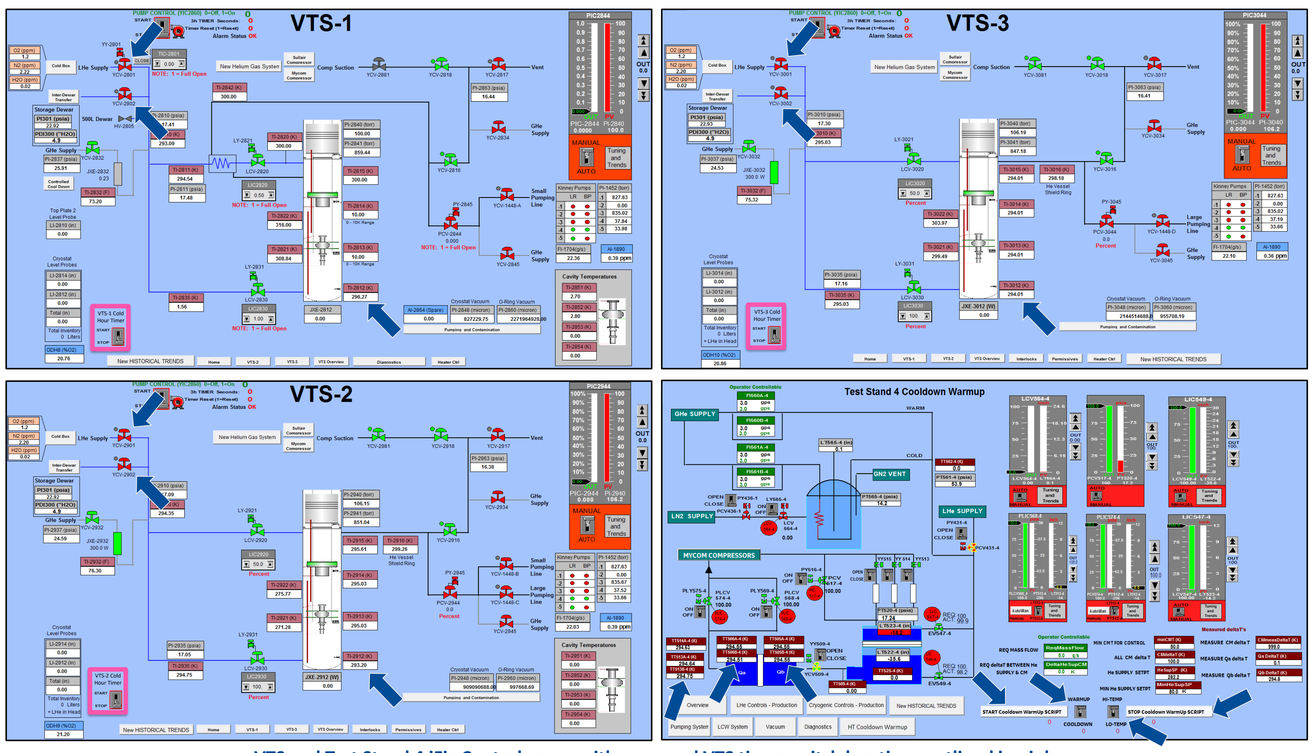


Graph showing temperature change over time in the VTS Dewar temperature probes

- Test Stand 4 is large and has two additional steps during testing, pre-cooling and pre-warming to monitor ΔT.
  - ΔT is incredibly important since it prevents a magnet from cracking from a large temperature distribution difference.
  - Pre-Cooling stage = bring the entire magnet from room temperature (294K) to 80K.
  - Pre-warming stage = slowly warm up the magnet from 80K to room temperature(294K).
- VMTF uses the same cool down and warm up procedure as the VTSs
  - Stands are cooled down with liquid helium to 5K
  - After 5K is achieved GHe is pumped out of the system creating a low-pressure environment making the stand colder to 2.1K or less (Superfluid State).
  - Stands are warmed up to 5K causing helium evaporation (see graph)

Monitoring Control Flow

- Monitoring cryogen control will require a new system to mark definitive starts and stops to a counter clock to be able to track time cryogen is used within the stand.
- The iFix Software contains all the controls available to control flow, temperature and supply of a test Dewar
- Using these controls a new system can be determined for tracking cold hours and monitoring cryogen usage within a system.
- Certain valves being turned on will signal the clock to begin.
- To end the clock these same valves can stop the clock
  - To ensure all cryogen has left the system at 5K at the bottom of test Dewar
- In some instances, a special procedure is used for cooldown and warmup – for this a button will be added to each control page that will be manual activated to count the cold hours
- The control pages to the left depict with arrows pointing the valves that will indicate start/stop of the cold hour clock and the temperature sensors that will be monitored to mark the end of cryogen presence in the test Dewars.



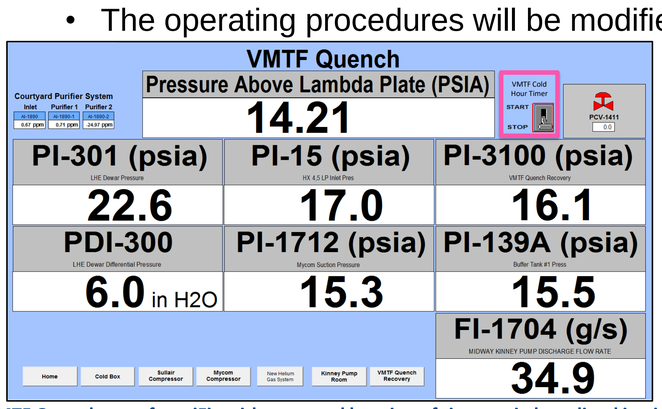
VTS and Test Stand 4 iFix Controls page with proposed VTS timer switch locations outlined in pink.

Discussion and Results

- The cost of helium continues to increase as the demand for the rare gas increases
- With growing costs in Helium IB1 and Fermilab need to better manage the Helium that is supplied and used within the various projects across our campus.
- Creating a better system to monitor cold hours will create more accurate User Fees, Helium usage and awareness of helium within the IB1 facility system.
- With the new system existing technology is used but optimized for performance

Old System New Problems

- VMTF has an old user interface and cannot track historical usage of valves.
  - New system must be developed just for VMTF to track cold hours
  - A button will be added to the VMTF iFix sensor readings page to count the cold hours
  - The operating procedures will be modified to include this additional steps for operators to press the button when cooldown begins, and warmup ends to mark the start and stop of cold hours.
    - VMTF's system will be less definitive but will be temporary
    - As the system is update new operational updates will improve cold hours counting.



VMTF Quench page from iFix with proposed location of timer switch outlined in pink.

- As the IB1 facility continues to grow and modify the list of signals and controls can be modified and updated
- Additionally with this system in place in future a similar system can be employed for nitrogen monitoring
  - Nitrogen is almost exclusively controlled manually at IB1 but could be a potential future project to add computer and remote controls for the systems.
- In future create and adding a coded script into the controls program iFix would automate the cold hour tracking process making it exponentially fast to export time and better calculate monetary assessments.

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