



U.S. DEPARTMENT OF  
**ENERGY**



# RICH Issues in December 2021

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# Problem #1 – Bad Pressure Transducer Value

- On December 11, 2021, reading from pressure transducer (PT) in air-cooling buffer tank jumped to -838 psi
- Initial impression was that PT had failed and should be replaced
  - Replacement scheduled for restricted access period on December 14
- RICH left operating with PT interlock disabled
  - If there was a problem with air-cooling system, the hardware interlock system would trip off on a low airflow interlock

# Solution #1

- PT was replaced with a spare, but -838 psi reading prevailed
- Concluded that channel 0 of module 5 (NI-9219 analog voltage input module) in N<sub>2</sub> Volume cRIO responsible had failed reading PT
  - The three other channels in module were working fine
- Replaced module
- Issue resolved
  - PT reading returned to expected value
  - Pressure interlock re-enabled
- [Logbook link](#)
  - JLab login required

# Follow-Up #1

- NI-9219 used was one reserved for RICH II, so a procurement request for a replacement module has been submitted
- Awaiting radiation survey of failed module to be able to move it to EEL for tests
- DSG's cRIO test station program will be set up to help in diagnostics
- NI will be contacted for repair/replacement

# Problem #2 – Electronic Panel cRIO Failure

- On December 12, 2021, all temperature and humidity data readings coming from channels of Electronic Panel (EP) cRIO froze
- RICH powered off until investigation completed and problem resolved
  - EP cRIO temperature sensors responsible for monitoring and interlocking on temperatures in the Electronic Panel

# Solution #2 – Part 1: Remote Debugging

- Issue remotely debugged first
- NI Distributed System Manager reported timeout errors for modules
- cRIO rebooted in attempt to reset module communication
- After reboot, new error occurred indicating that cRIO could not recognize any of the four modules installed in cRIO
  - Error not resolved after multiple reboots
- Modules and/or cRIO had to be replaced
  - Scheduled for restricted access period on December 14

# Solution #2 – Part 2: Hardware Swap

- Prior to access, spare cRIO with full set of spare modules prepared
  - Module 1: NI-9216 eight-channel RTD module
  - Module 2: NI-9216 eight-channel RTD module
  - Module 3: NI-9205 16-channel analog voltage input module
  - Module 4: NI-9485 eight-channel solid state relay module
  - Swap plan:
    - First: Replace only modules since error specified issue in modules
    - Second: Replace cRIO chassis
- Replacing all cRIO modules in chassis resolved issues
  - Interlock system back online
  - RICH turned back on
- [Logbook link](#)
  - JLab login required



# Follow Up #2

- All four modules surveyed, released, and moved to EEL
- Simple LabVIEW program developed for initial debugging
  - All channels could be read with no issues, but no sensors or voltage source were applied to channels
- DSG's cRIO test station program will be set up to help in diagnostics
- NI will be contacted for repair/replacement

# General Follow-Up

- Two cRIO system hardware failures occurred within two days
- This is not the first time hardware in one of RICH's hardware interlock cRIO systems randomly failed
- Previously, N<sub>2</sub> cRIO failed in March 2021
- Hall B systems with same series cRIO (cRIO-903X) have not had similar issues
  - FT, SVT, Torus, Solenoid
- Only difference in system is location in hall
  - RICH cRIOs are downstream relative to target
  - All others are upstream relative to target
- Could radiation effects from particles ejected by target in beam operations be damaging RICH cRIO components?
  - Discussing dosimeter options with RadCon

# Conclusion

- Two issues of cRIO component failure occurred recently
- Both issues resolved by replacing modules in cRIOs
  - RICH hardware interlock system is online and operational
- Diagnostic testing of failed modules to be performed
  - DSG cRIO test station will be used
  - National Instruments will be contacted for repairs/replacement
- Further investigation into cause of failure underway
  - Looking into radiation monitoring in racks with cRIOs