Cryo Instrumentation Deliverables

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Overall Cryo Responsibilities pTDR p(2-112)

- The responsibility for the system is split between ProtoDUNE-SP and CERN:
  - The ProtoDUNE-SP collaboration is responsible for all the devices that will be installed and cabled inside the cryostat, the sensors needed to monitor the cryostat and its content, and the specifications for the system.
  - CERN is responsible for the implementation of the control system elements outside the cryostat (hardware, firmware and software), including the high-voltage and low-voltage power supplies necessary for the detector operation.
- Depending on how one reads this, it appears that the collaboration is responsible for all sensors, whether inside or outside the Cryostat (?)

“Categories” of Cryo Instrumentation

- Devices primarily used by the Cryo system for basic control of Cryostat
  - Pressure Transducers
  - Various Temperature devices for Cryo operation
    - Monitoring cooldown of cryostat, various other uses
  - Level Monitors
  - Gas Analyzers during various phases of Cryostat operation
- Devices that can be used to check/verify CFD models of the Cryostat
  - Matching measurements at locations that we can place instrumentation helps build confidence that we have a reasonable idea what is going on in locations we can’t place sensors.
    - Also lends credence to future cryostat designs where we may not have capability to “fix problems”.
  - Includes Vertical Profile Temperature & Purity Monitors
- Overlap between two categories
  - PrMs monitoring LAr Purity in case of filtration issues,
- Devices to use in conjunction with HV
  - Level Monitors and interlocks to HV
  - Cameras to look for potential HV breakdown
  - Various other instrumentation that properly belong to the HV system directly and not covered here
    - Corona Monitors, Field Cage Current pickoffs…..

What are the “Deliverables” to the Slow Control?

- Analog voltages to be sampled. There are commercial hardware (“signal conditioning”) modules that already support most of these categories.
  - RTDs
  - Pressure Transducers
  - Level Gauges
  - Analog outputs from Digital Modules (e.g. Gas Analyzers)
- Numbers—connection via ethernet, serial, GPIB,…….
  - Purity Monitors
  - Digital Modules (e.g. Lakeshore 218 Temperature monitor)
  - Gas Analyzers
  - Oscilloscopes….are there “favorite” ones to choose?
- Data streams/raw data?
  - Video Camera
  - Raw PrM data, scope traces…....
  - Analysis via monitoring applications
- It would be useful to understand ASAP what our interfaces to the Slow Control are
  - It would be convenient to use already supported” hooks” (hardware & software) if possible.
  - Should see what the 3x1x1 (WA105) is doing.
  - If existing hooks are not there, who makes a new one?

Examples from FNAL LAPD/35t

- Purity Monitors have a local analysis in a PC—report numbers (lifetimes etc.) to Slow Control System)
- Precision RTDs/Spooler- connected to Lakeshore 218, temperature report to Slow Control is as digital numbers.
- Gas Analyzers fundamentally digital, but at FNAL, readout is via analogue voltages from back panel of module
  - Likewise our capacitive level monitors

Other Considerations

- Need to follow grounding rules
  - See DUNE DocDb 1953
- Where do our receiving electronics reside with respect to the Cryostat Ports?
- Slow Control is probably on Building Ground.
  - Some instrumentation most likely on Detector Ground
  - Need to provide ground isolation between instrumentation on Detector Ground

Rhetorical questions I have

Gas Analyzers

- From pTDR page (2-104)
  - A 50 m3 (69 tons of LAr capacity) vertical dewar will allow for receipt of LAr deliveries for the initial filling period. This liquid argon dewar serves also as a buffer volume to accept liquid argon during the fill period. An analyzer rack with instruments to check water, nitrogen, and oxygen content of the delivered LAr batches will also be located in the vicinity.
  - Are these the only analyzers that we will have, and are they capable of monitoring the sPhase Cryostat during the various phases of purging, recirculation, filling, and running?
    - Do we want “local” ones
  - Who supplies the analyzers above?

Purity Monitors

- What is being supplied by the PrM group?
  - PrM module, support hardware, electronics, software?
- How will this hook into Slow Controls?

Temperature Measurements

- Vertical Temperature Profile
  - What will be the readout method?
    - Local Processing Module
    - Or Slow Control RTD module
- Other Temperature Measurements
  - Membrane temperatures
    - Including RTD placed at height of LAr level.
  - RTD placed in (or near) exit of Filtered LAr return to cryostat?
    - This should be a precision readout