ELECTRICAL OVERVIEW AND SUBSYSTEMS

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OVERVIEW

• Overview
• Detector Controller
• Dewar Subsystems
• Data Communications
• Environmental Control
• Power Distribution
• Control System
• Housekeeping
ARCHITECTURE

- Basic architecture is the same as early concepts for the RSS-NIR instrument.
- Changes address the mass/size/volume issues, emergency power loss conditions, and future enhancements.
- Impact to the control software and spares was also considered.
- Significant implementation changes are:
  - Detector Controller
  - cRIO replacement of the PXI chassis
  - Motor Controller/Drivers
  - Thermal Control and Protected Power
  - 1-Wire System
  - Data Flow and Communications
DETECTOR CONTROLLER

- Significant hardware reduction by use of SIDECAR & JADE2 card.

Detector

SIDECAR

JADE2 Card

Isolated Power Supply

USB 2 to Fiber

USB 2 Cable

Ethernet

NDET Control Computer

USB 2 to Fiber

Fiber Optic Cable

USB 2 Cable

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RSS-NIR MTR
DEWAR SUBSYSTEMS

• Dewar subsystems based on small, low power devices.

Lake Shore Model 325
Dual Cryogenic Controller

Lake Shore Model 218
8-Channel Monitor

Varian 2 L/s
Ion Pump

Varian MicroVac
Ion Pump Controller

Varian Model 531
Vacuum Sensor

Varian Model 801
Vacuum Gage
DATA COMMUNICATIONS

Communication within RSS-NIR system can be broken down into several areas:

- Discrete signals interfacing directly to the cRIO or buffered and then to the cRIO.
- cRIO discrete RS-232 and RS-485 communications to individual COTS subsystems.
- cRIO RS-485 multi-drop communications to multiple COTS subsystems.
- cRIO 1-wire communications to multiple sensors.
- Fiber optic buffered ethernet connection between the cRIO and the local ethernet.
- PCON discrete RS-232 communications to individual COTS subsystems.
- PCON ethernet connection to the local ethernet.
- NDET and Detector subsystem connected via fiber optic buffered USB 2.0.
- NDET ethernet connection to the local ethernet.
- NDET data pipeline to facilities remote from the SALT site.
ENVIROMENTAL CONTROL

• Critical purpose is to prevent damage to the instrument from temperature and humidity excursions.
• Crucial components are crystalline optical elements, sensitive to rapid temperature changes.
• Air Lock environmental control for the change-out of filters.
  – Air Lock cycled from Pre-Dewar conditions to the local environment and back.
  – Cannot disturb the temperature or humidity in the Pre-Dewar.
  – No condensation of moisture on the filters when they are removed.
  – Prevent local air from entering the Pre-Dewar.
• Must handle longer power failures without damage to the instrument.
• Critical requirements of the environmental control system are:
  – Return the Pre-Dewar to ambient temperature in a controlled fashion.
  – Provide power long enough to control the temperature rate of rise.
POWER DISTRIBUTION

• RSS-NIR power distribution is a two-tier system, Normal, and Protected.

• Driven by two primary functions:
  – Normal Operations: RSS-NIR power to all of the elements.
  – Emergency Conditions: Only critical RSS-NIR thermal systems remain powered.

• Normal power from main grid power.

• Protected power from UPS or generator sources.
  – Begin after a short delay of 1 to 3 minutes after loss of main grid power.
  – Conditions the Dewar and the Pre-Dewar temperatures to prevent damage to optics.
POWER DISTRIBUTION

• Power distribution driven by two primary functions:
  – Normal Operations (main grid power):
    • RSS-NIR power to all of the instrument's subsystems.
  – Emergency Conditions (Protected Power):
    • Only critical RSS-NIR thermal subsystems remain powered.
    • Protected power from UPS or generator sources.
    • Thermal conditioning begins after a short delay of 1 to 3 minutes after loss of main grid power.
    • Conditions the Dewar and the Pre-Dewar temperatures to prevent damage to optics.
CONTROL SYSTEM - cRIO

- CompactRIO (cRIO) System from National Instruments
- 8-port chassis
- Built-in ethernet communications
- Programmable FPGA (Field Programmable Gate Array)
  - Program FPGA to perform hardware interlocks
- Extra ethernet port for easy addition of another chassis
- Rugged with a wide operating temperature range
- Interfaces with Labview easily
CONTROL SYSTEM – Piezo

- Piezo Stages
  - Z/Tip/Tilt
  - Long Travel Flexure Stage

- Piezo Drivers – Amplifier/Feedback Sensor/Communications for four channels

- 19” Rack
CONTROL SYSTEM – Motor Controllers

• Motor Controllers
  – ION Model 500
    • Configurable to any kind of motor (stepper, DC brush, or DC brushless)
    • Compact and powerful (500 watts)
    • Single 24 volt power
    • Configurable velocity, acceleration, jerk even on the fly
    • S-curve acceleration mode for smooth motion
    • RS-485 for daisy chaining controllers together
    • Encoder feedback for precise positioning
CONTROL SYSTEM - Motors

• **Motors**
  
  – **Ultramotion “The Digit” stepper motors**
    
    • Two sizes depending on load – NEMA 17 or NEMA 23
    • Configurable lead screw pitch
    • Custom stroke lengths available
    • Optical encoder
    • Power-off brake
CONTROL SYSTEM - Encoders

• Encoders
  – Netzer rotary and linear
    • Absolute position
    • High precision
    • High tolerance to temperature, shock, moisture, external electric fields
    • Requires special interface module

Rotary Encoder
Resolution 18 bits
Accuracy < ± 0.03°

Linear Encoder
Resolution 1µm
Accuracy < 15µm

Interface Module
CONTROL SYSTEM - Pneumatics

- Pneumatics
  - Bimba Metric Flat Cylinders
    - Stainless Steel
    - Custom bore size and stroke length
CONTROL SYSTEM - Switches

- Switches
  - Hall Effect – Allegro Microsystems A121x family
    - Solid State reliability
    - Voltage regulator built-in
    - Wide operating temperature range (-40 to 150 degrees C)
    - Designed for harsh environments
HOUSEKEEPING

• For the simpler sensors – 1-Wire system
  – Daisy chain the sensors
  – Four wire bus
  – Slow but efficient
  – Measure temperature, humidity, and position

• cRIO system I/O count (8 slots/controller)
  – Two 32-channel analog input
  – Two 32-channel digital input/output
  – Two 4-channel RS-232
  – One 4-channel RS-485
  – One spare slot
ENCLOSURE

- Majority of electronics are in a single enclosure.
- Only Etalon controller is remote at current time.
- Ron wants a legend - - -