Stobie NIR

## SALT RSS-NIR MID-TERM REVIEW MAY 20 & 21, 2009

#### ELECTRICAL OVERVIEW AND SUBSYSTEMS

ersity of WV

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#### **OVERVIEW**



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



#### ARCHITECTURE



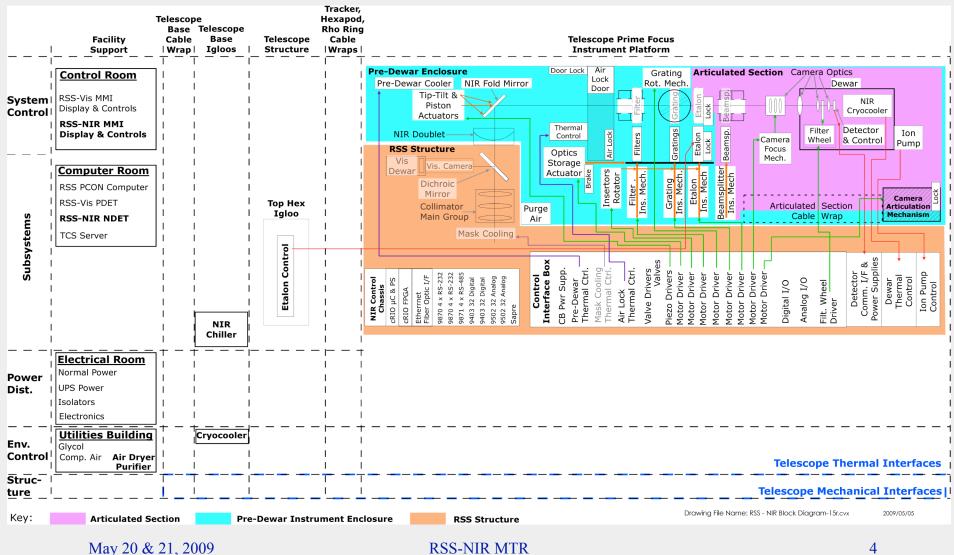
- Basic architecture is the same as early concepts for the RSS-NIR instrument.
- Changes address the mass/size/volume issues, emergency power loss conditions, and future enhancements.
- Impact to the control software and spares was also considered.
- Significant implementation changes are:
  - Detector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

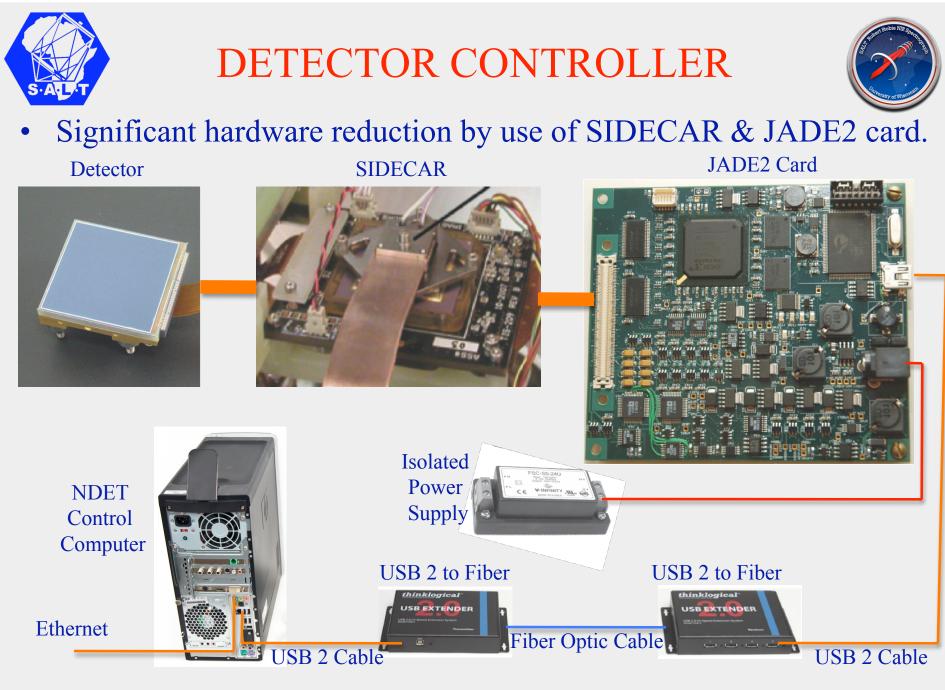


#### ARCHITECTURE



#### **RSS-NIR System Functional Block Diagram**





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#### 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 Model 531 Vacuum Sensor



Varian MicroVac Ion Pump Controller



Varian Model 801 Vacuum Gage



May 20 & 21, 2009



# 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.



#### **DATA COMMUNICATIONS**



**RSS-NIR Detector Data Flow Block Diagram** 

#### **RSS Structure Pre-Dewar Articulated Section** Dewar Detector, 2048 x 2048 Pixels NIR Control Interface Box (CIB) Optional Guide Mode (12 bit) Image Readout (16 bit) 2048 x 2048 Read = 0.26 to >10.5 sec 16 x 16 to 128 x 128 (Low level interfaces) @ 32 x 500 kHz = 262 ms Minimum @ 10 MHz = 25 µs to 1.7 ms (12 bit) @ 32 x 200 kHz = 0.655 sec. Nominal @ 5 MHz = 51 µs to 3.3 ms (12 bit) **Detector & Data Flow** Image Data **NIR Instrument** Control NCC SIDECAR (cRIO chassis) Image Transfer to JADE2 Card (16 bit) 2048 x 2048 Read @ 32 channels 500 kHz = 262 ms / Image 2048 x 2048 Read @ 32 channels x 16 bit x 500 kHz = 32 MB/sec Maximum NIR Instrument 2048 x 2048 Read @ 32 channels x 16 bit x 200 kHz = 12.8 MB/sec Nominal Ethernet Control **Ethernet to** Detector & Data Flow Control Image Data **Fiber Interface Detector Subsystem I/F** (JADE2 Card) Image Transfer to NDET Computer 0.29 sec/Image Minimum; 0.685 sec/ Image Nominal. Detector & Data Flow Control Fiber Optic USB 2 2048 x 2048 x 2 Bytes/0.29 sec = 29 MB/sec Max. Ethernet Image Data 2048 x 2048 x 2 Bytes/0.685 sec = 12.24 MB/sec Nominal **USB 2 to Fiber Interface** Fiber Optic SALT Computer/Control Rooms **Detector & Data Flow Control** USB 2 **NIR Instrument Control** Image Data Raw Image Data (16 bit) **USB 2 to Fiber Interface** 29 MB/sec Maximum Ethernet to 12.2 MB/sec Nominal 512 Fowler frames = 4.2 GBytes **Fiber Interface** Image and USB 2 Reduced Image Data **Optional Guide Data** Observation ≈25 MB/Image 15 MB/sec Max. @ 10 MHz Parameters NDET PCON SAMMI - SOMMI 7.5 MB/sec Nominal @ 5 MHz Users External External Key: Network Network Image Data Synchronization NIR Instrument Control Connection Connection & Statistical Data Fiber Copper NDET, SIDECAR & Detector Interface Interface Ethernet Control **SALT Internal Network Connection** File: Detector Data Flow-F.cvx 2009-04-28

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**RSS-NIR MTR** 

8



# ENVIRONMENTAL CONTROL



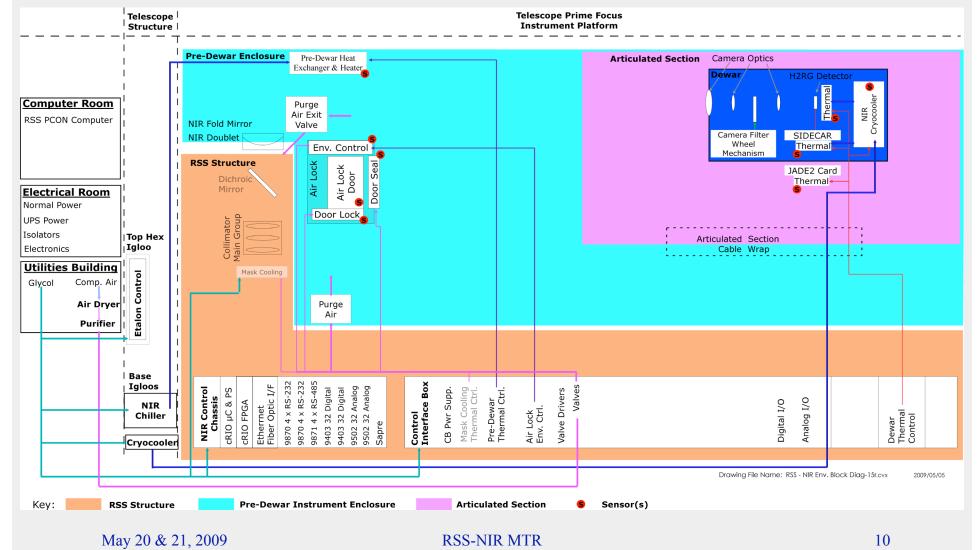
- Critical purpose is to prevent damage to the instrument from temperature and humidity excursions.
- Crucial components are crystalline optical elements, sensitive to rapid temperature changes.
- Air Lock environmental control for the change-out of filters.
  - Air Lock cycled from Pre-Dewar conditions 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.



#### ENVIRONMENTAL CONTROL



#### **RSS-NIR** Environmental Control Block Diagram





# 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



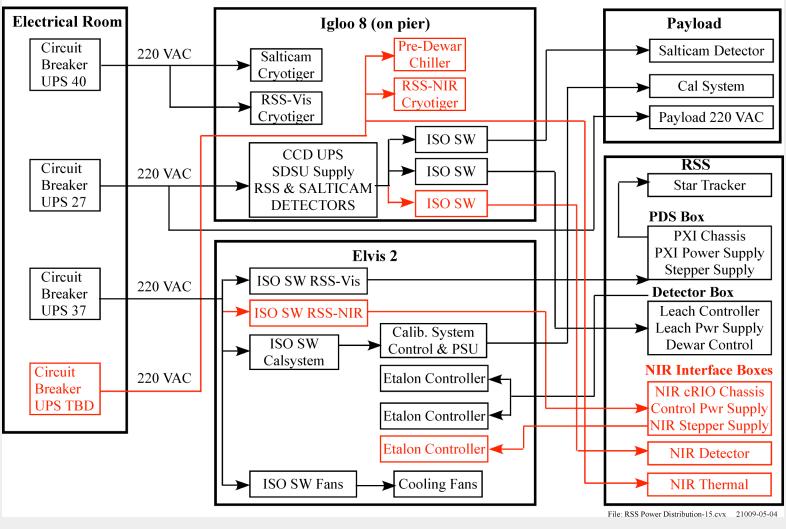
- Power distribution driven by two primary functions:
  - Normal Operations (main grid power):
    - RSS-NIR power to all of the instrument's subsystems.
  - Emergency Conditions (Protected Power):
    - Only critical RSS-NIR thermal subsystems remain powered.
    - Protected power from UPS or generator 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.



### POWER DISTRIBUTION



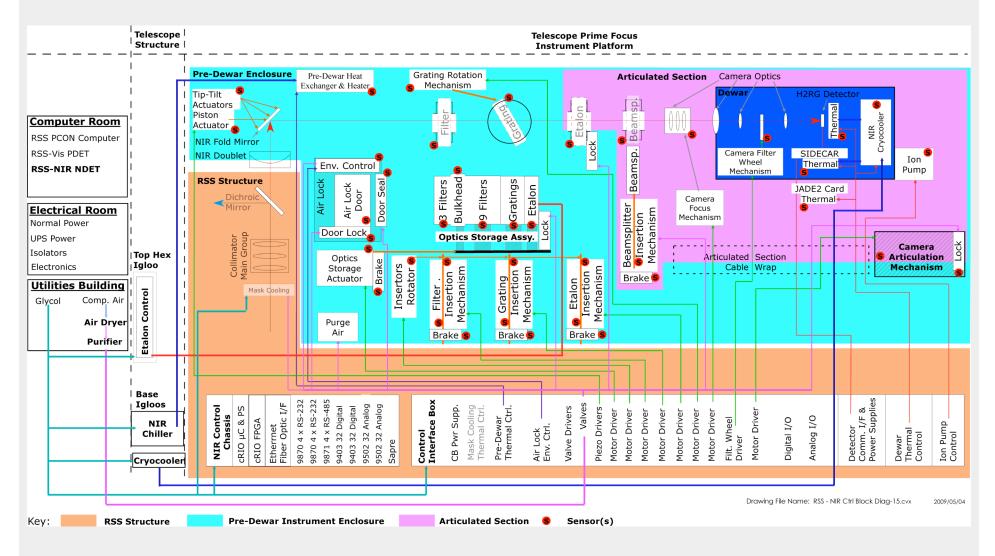
#### **RSS** Power Distribution Block Diagram





#### **CONTROL SYSTEM**





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- 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



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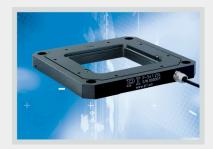




# CONTROL SYSTEM – Piezo



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



- Piezo Drivers Amplifier/Feedback Sensor/Communications for four channels
- 19" Rack









- 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

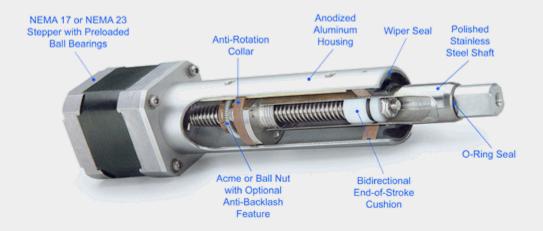




# **CONTROL SYSTEM - Motors**



- 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



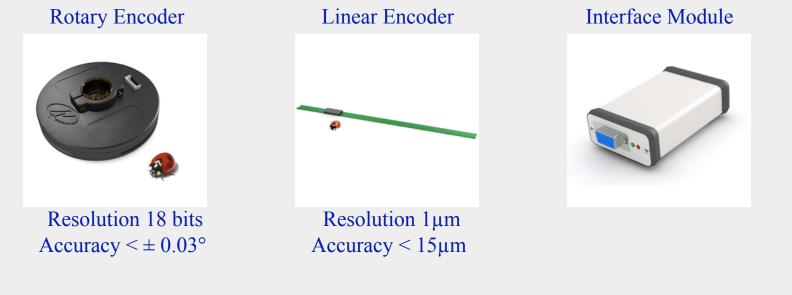


# **CONTROL SYSTEM - Encoders**



#### • Encoders

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





## **CONTROL SYSTEM - Pneumatics**



#### • Pneumatics

- Bimba Metric Flat Cylinders
  - Stainless Steel
  - Custom bore size and stroke length

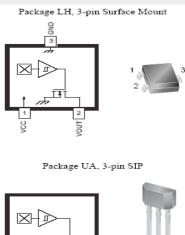


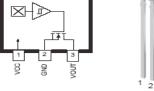


# **CONTROL SYSTEM - Switches**



- 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





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#### 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



23

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

