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

ELECTRICAL OVERVIEW AND SUBSYSTEMS

DON THIELMAN and PAUL SENDELBACH
UNIVERSITY OF WISCONSIN

OVERVIEW

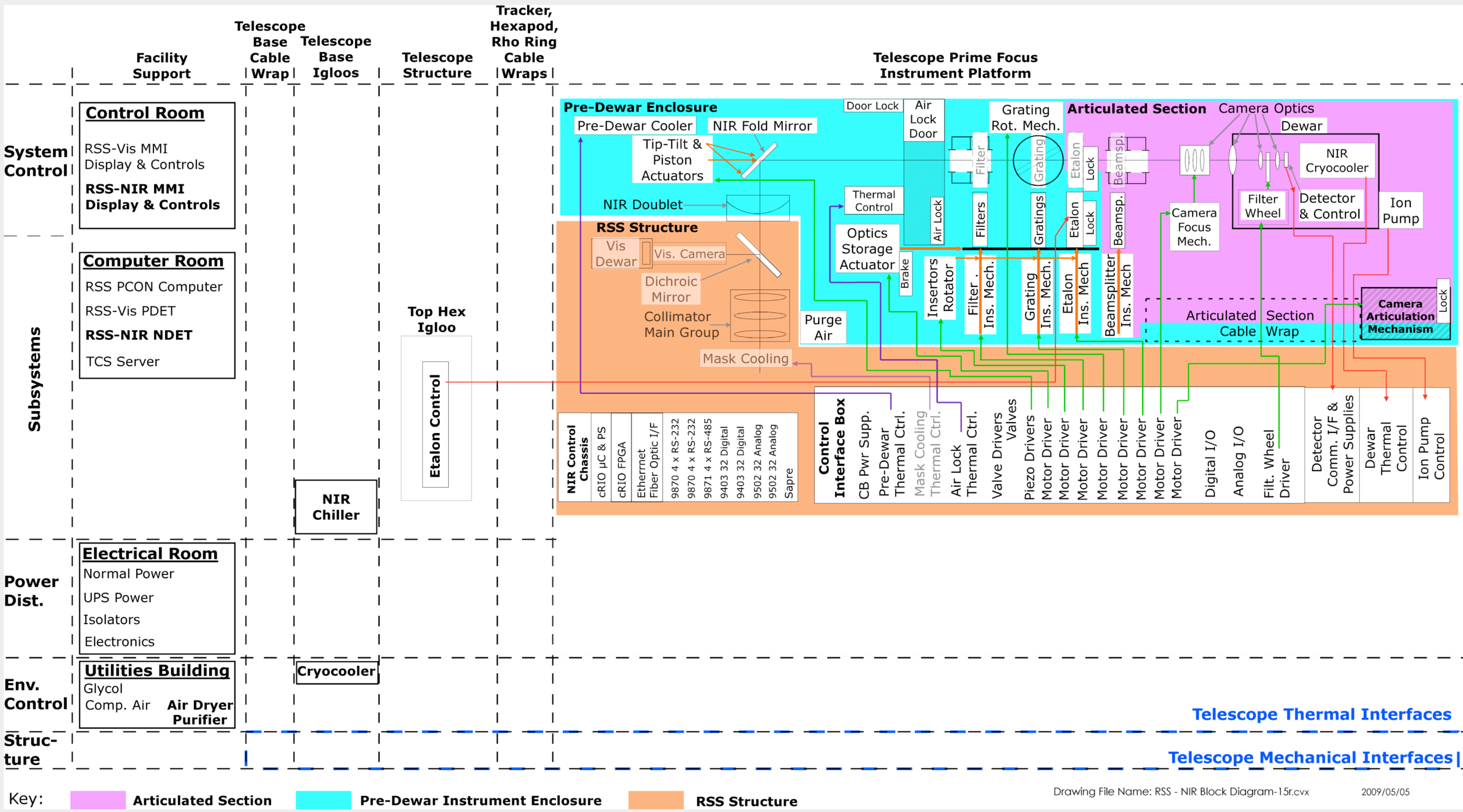
- Overview
- Detector Controller
- Dewar Subsystems
- Data Communications
- Environmental Control
- Power Distribution
- Control System
- Housekeeping

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

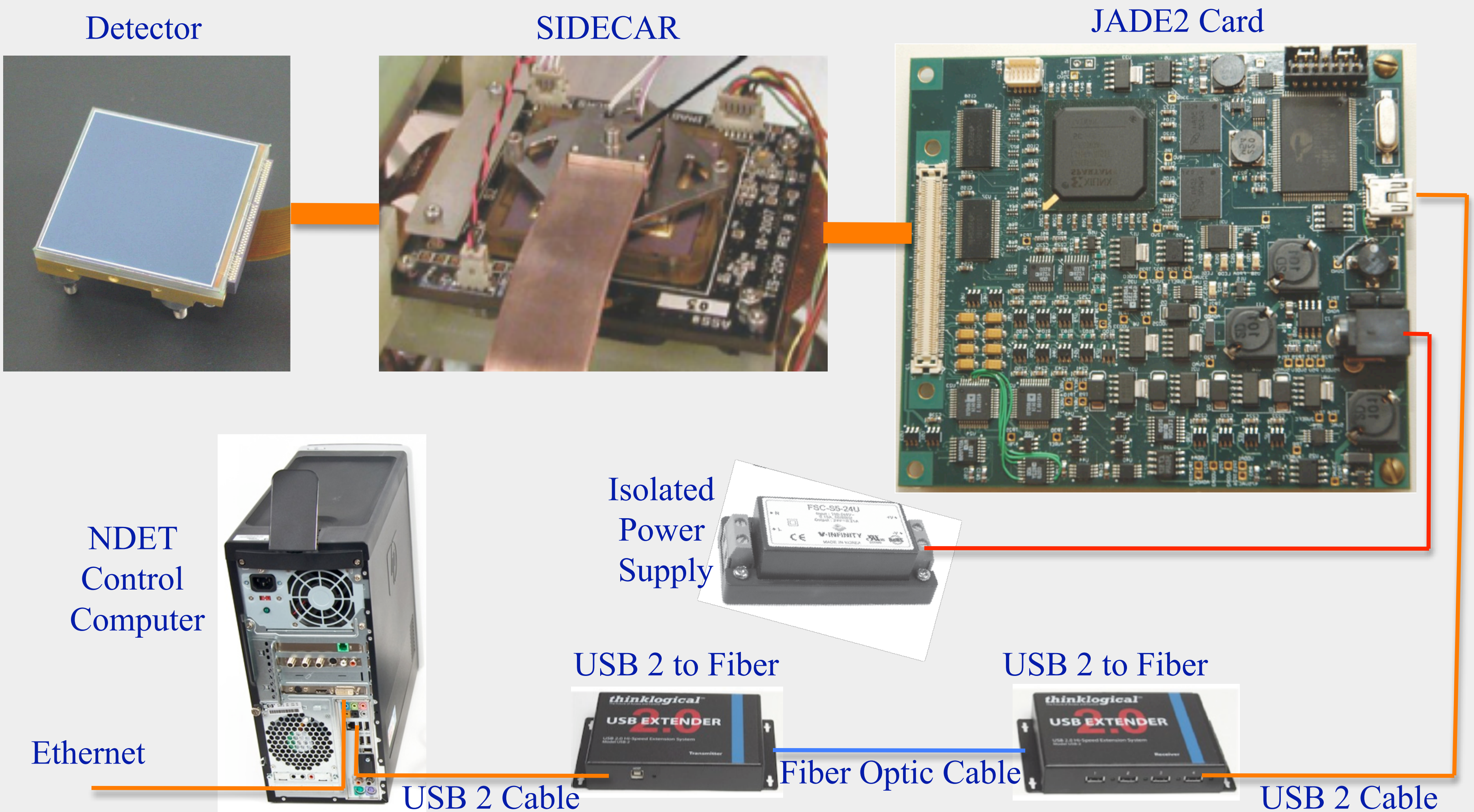
ARCHITECTURE

RSS-NIR System Functional Block Diagram



DETECTOR CONTROLLER

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



DEWAR SUBSYSTEMS

- Dewar subsystems based on small, low power devices.

Lake Shore Model 325
Dual Cryogenic Controller

Varian 2 L/s
Ion Pump

Varian Model 531
Vacuum Sensor

Lake Shore Model 218
8-Channel Monitor

Varian MicroVac
Ion Pump Controller

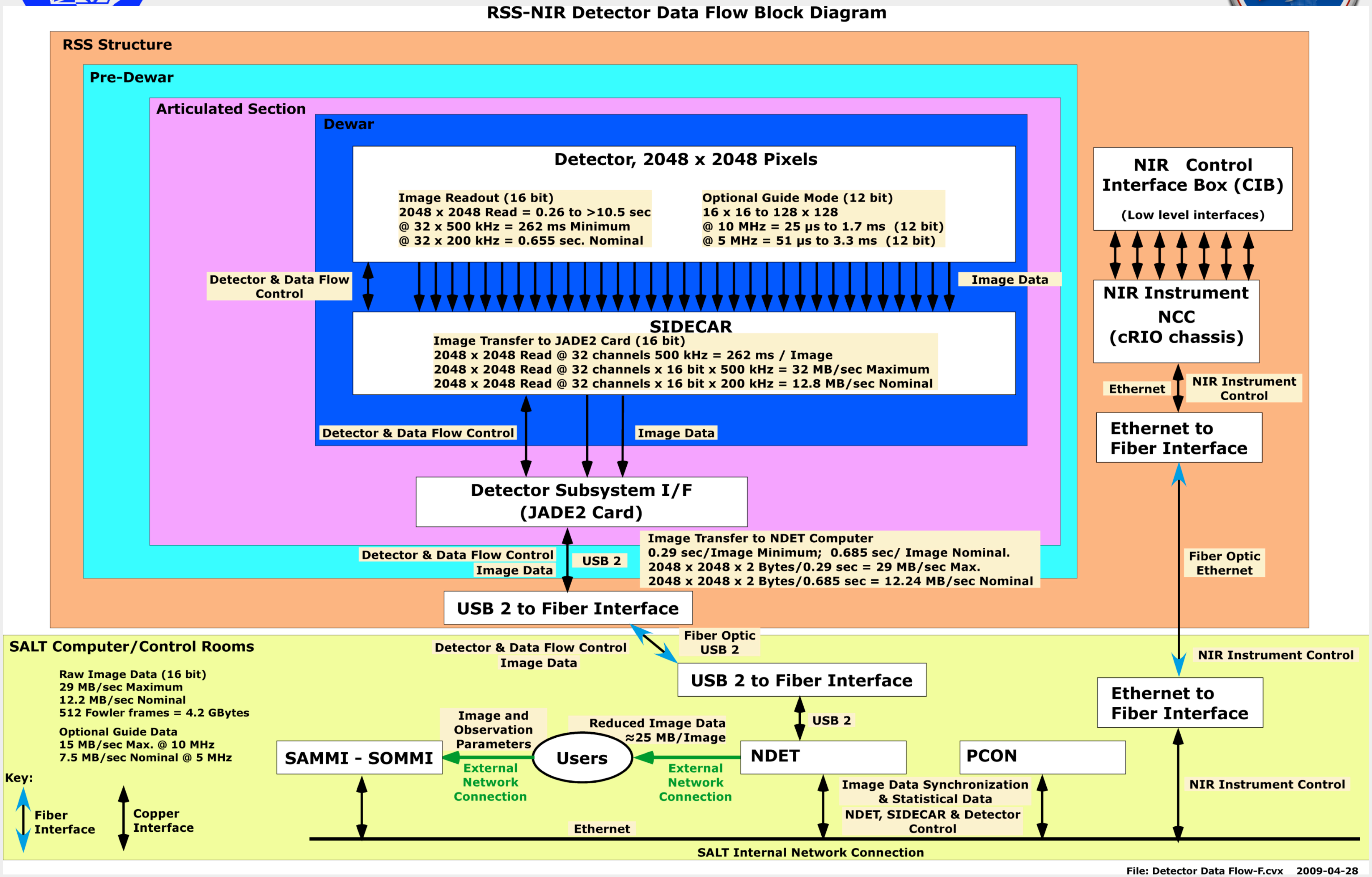
Varian Model 801
Vacuum Gage

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.

DATA COMMUNICATIONS

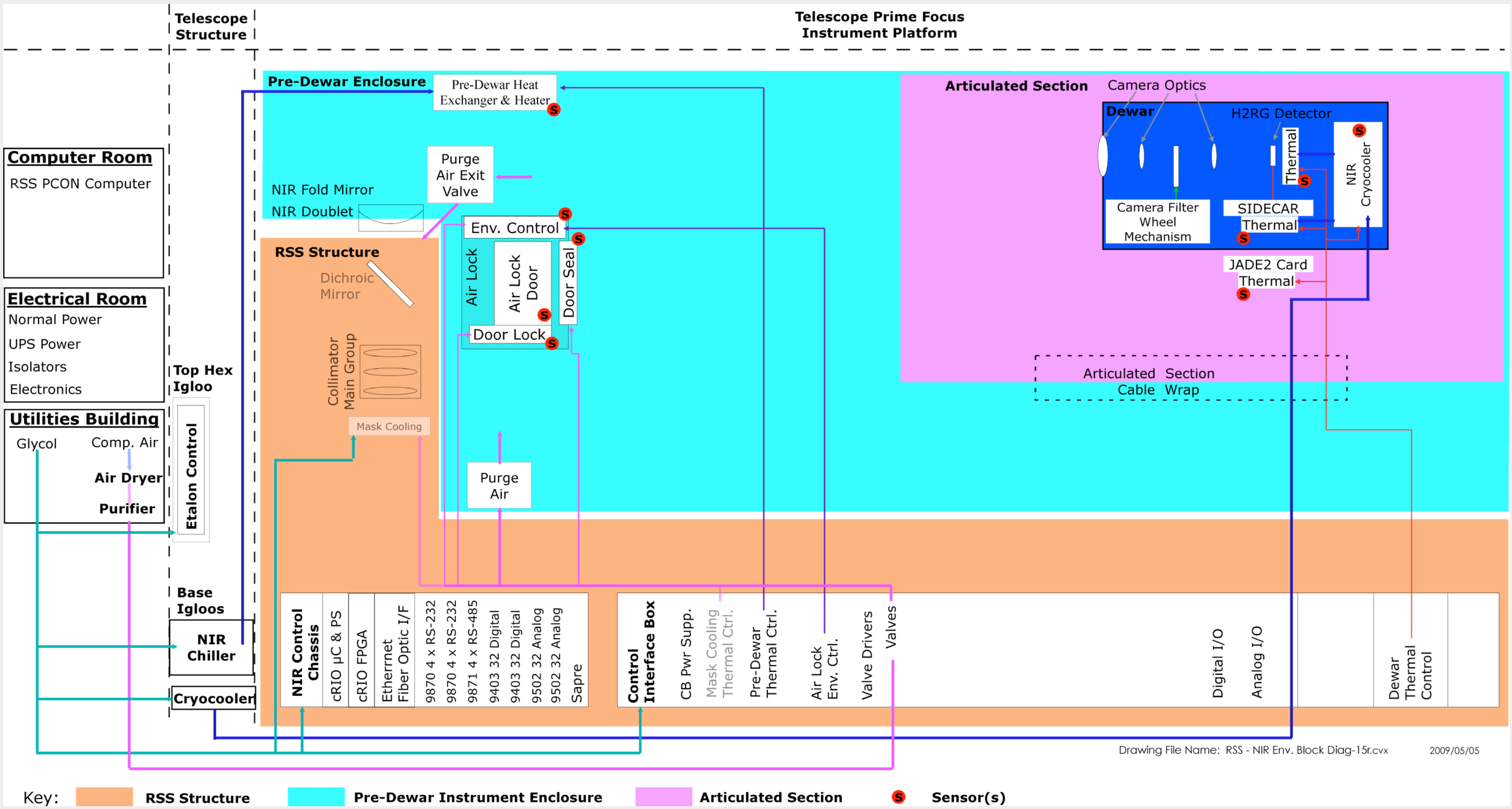


ENVIRONMENTAL CONTROL

- 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



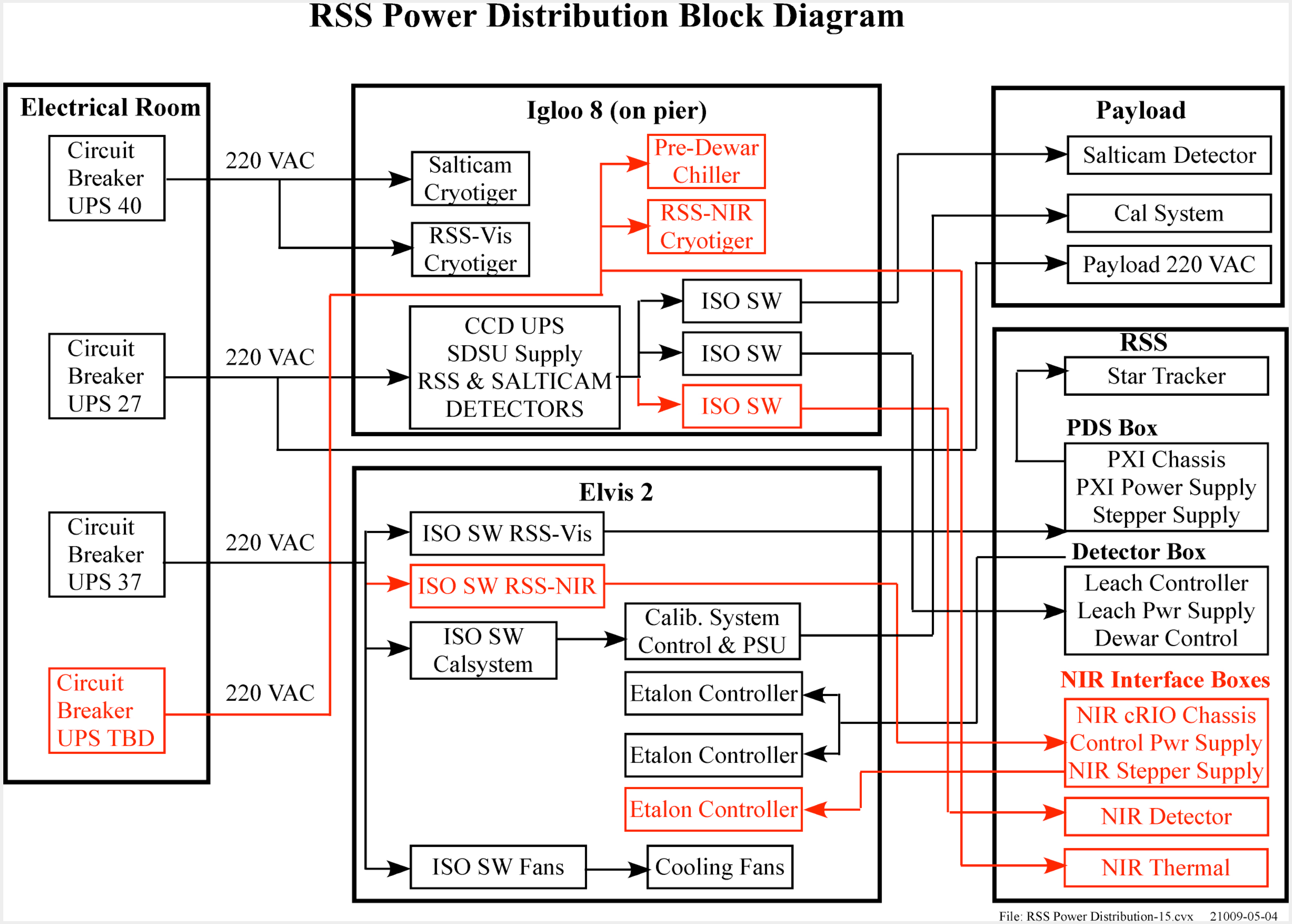
POWER DISTRIBUTION

- 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.

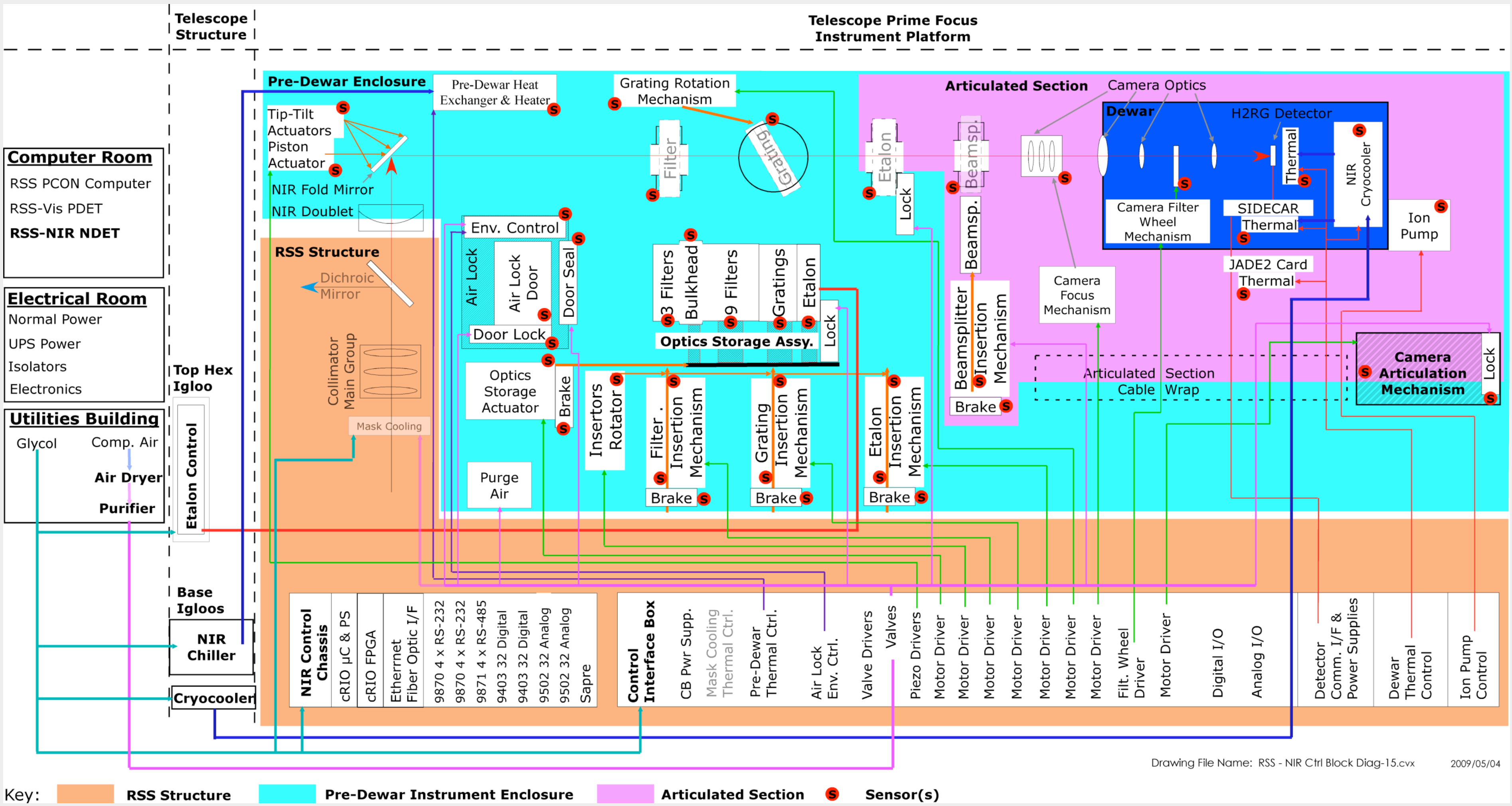
POWER DISTRIBUTION

- 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



CONTROL SYSTEM



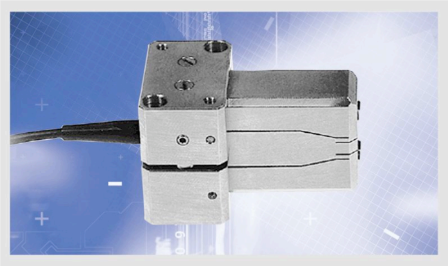
CONTROL SYSTEM - cRIO

- 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

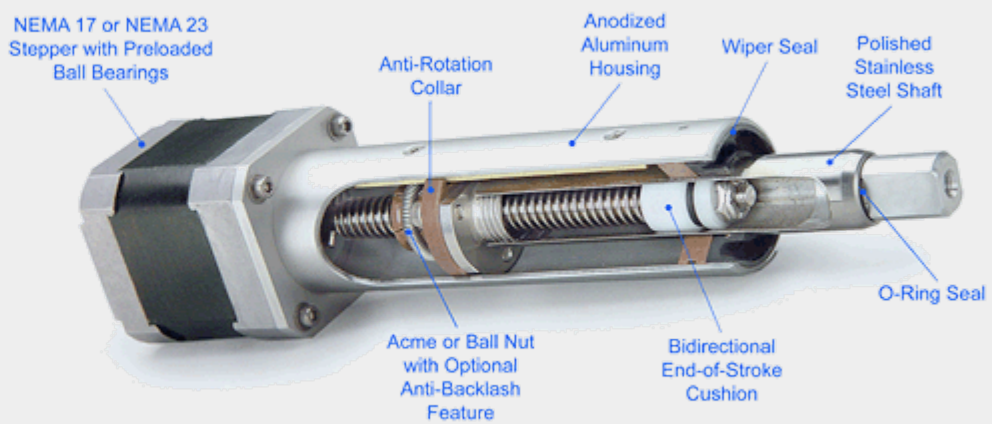


CONTROL SYSTEM – Motor Controllers

- 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

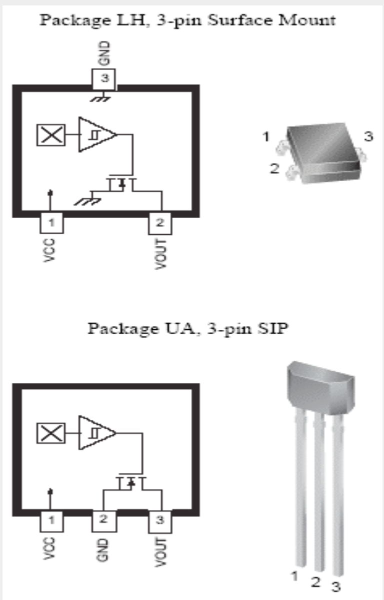
Interface Module

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 - - -