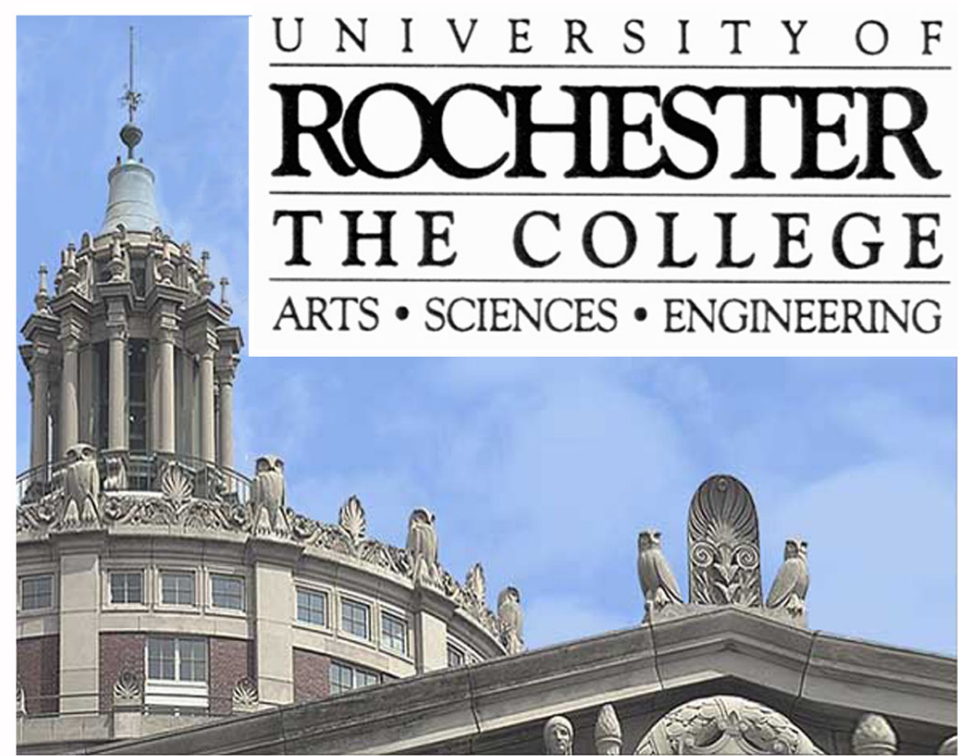


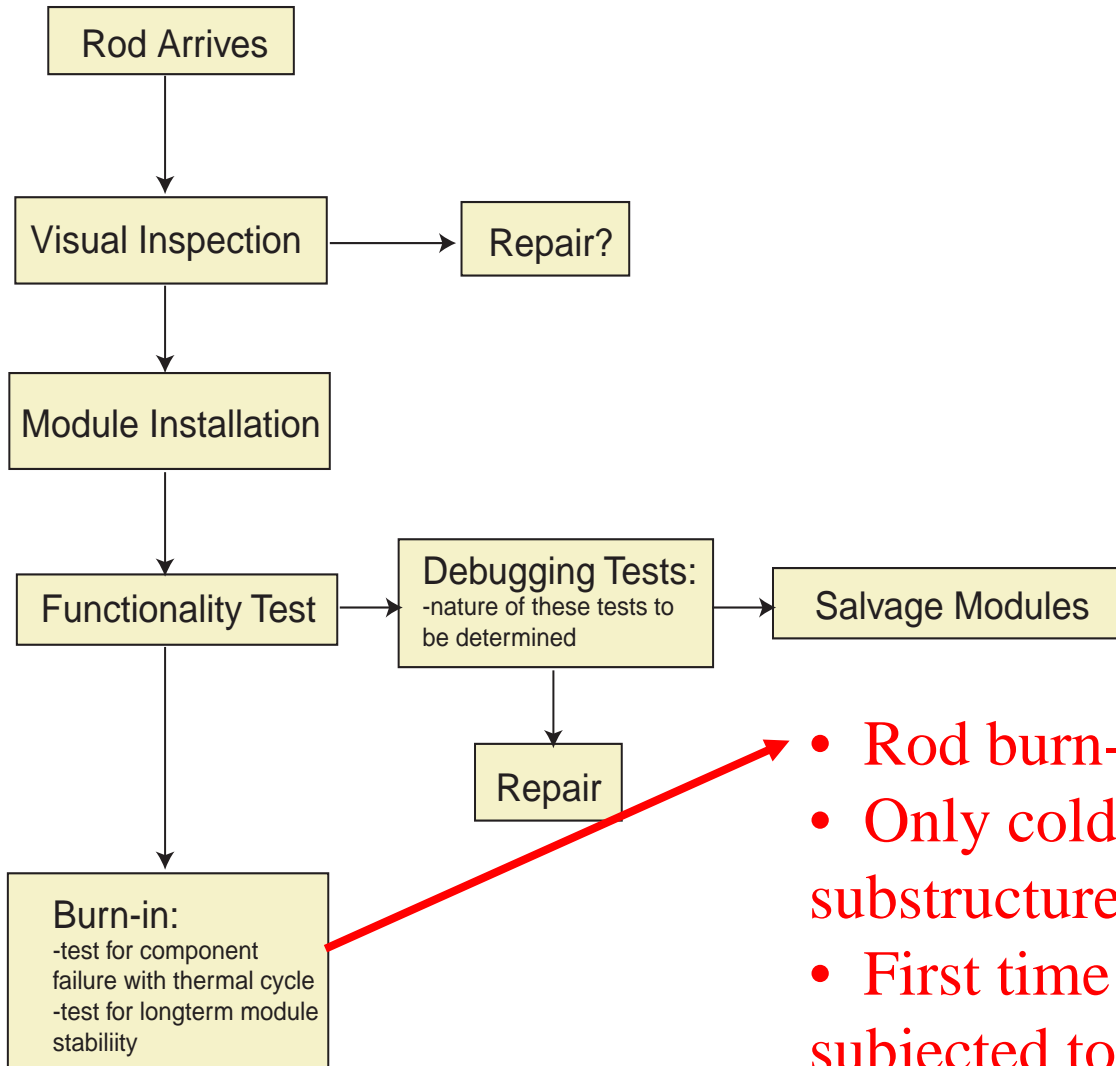
UNIVERSITY OF  
**ROCHESTER**  
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## **The U.S. Multi-Rod Burn-In Test-Stands**

Paul Tipton for Ricardo Eusebi, Andy Hocker, Tom Haelen, Eva Halkiadakis, University of Rochester, and the US TOB Collaboration

# Planned Rod Tests



- Rod burn-in very important.
- Only cold-test of entire rod substructure.
- First time every rod component is subjected to cold, long-term test.

# Burn-in Introduction

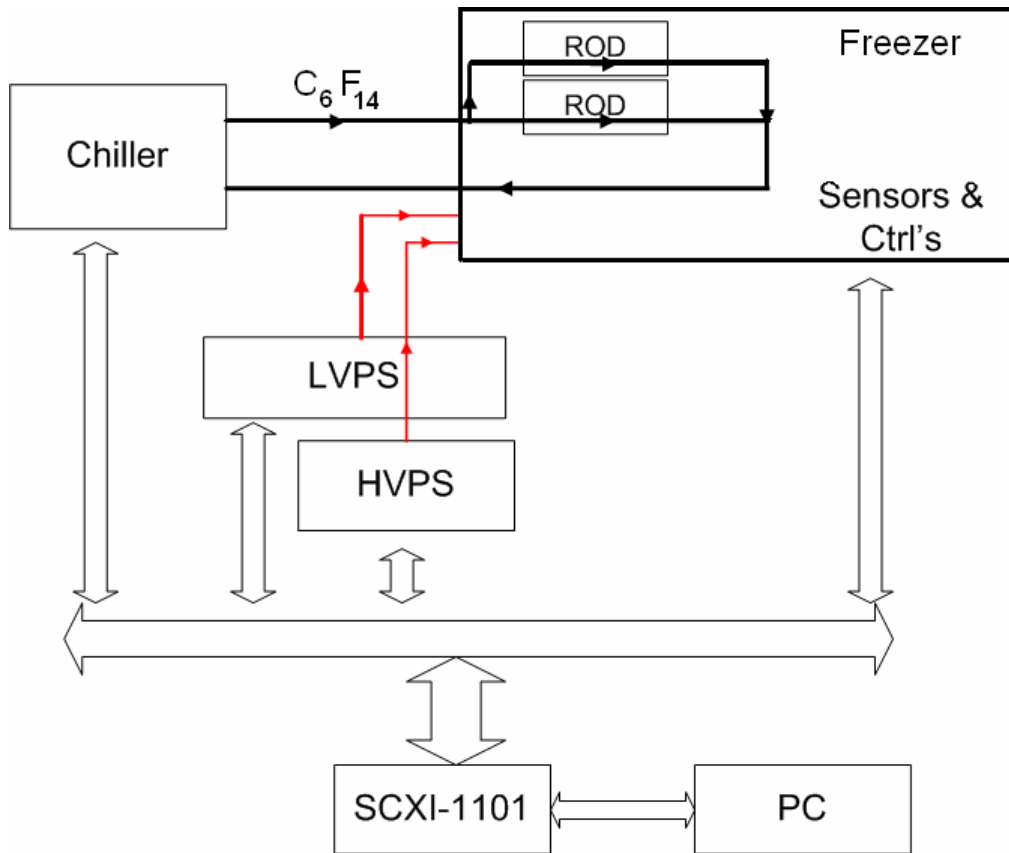
This Facility must provide:

- multi-day burn-in
- thermal-cycle capability between room temp and -20C
- At each of two production sites, FNAL and UCSB
- for up to 8 rods at a time per site
- While keeping rods safe and happy (dry, cool, dark, powered, biased)
- Ease of operation – by technicians

# Need:

- Rod Container
  - C<sub>6</sub>F<sub>14</sub> Chiller and pump
  - Flow and temperature control hardware and software +interface to Lt DAQ
  - Flow, pressure, temperature, and relative humidity monitoring and Interlocks
  - Dry air and vacuum
  - Cables and power supplies
  - Rod readout using multi-rod Lt software
- Prepared by Wim Beaumont and UCSB Group (Not discussed in this presentation)

# System Schematic Diagram

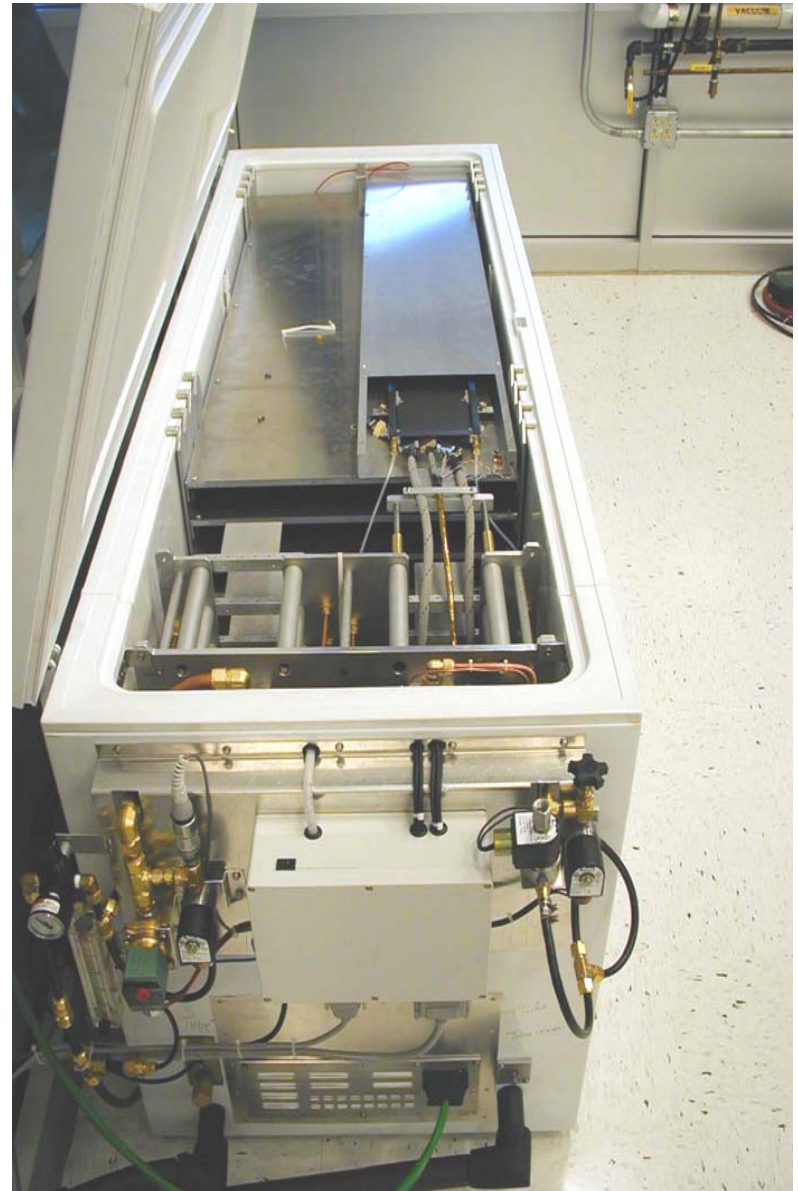


## PC through SCXI Chassis controls and monitors:

- Chiller and chiller temp
- Enables for the power supply
- $C_6F_{14}$  flow valves and flow sensors
- RH monitors
- Temperature
- Pressure
- Talks to Lt software through TCPIP

# Rod Container

- Modified commercial chest freezer provides light-tight insulated environment
- 4 removable shelves, each contain 2 rods
- Rods contained within their Aluminum transport boxes for protection and ease of insertion
- Dry air flow into each transport box

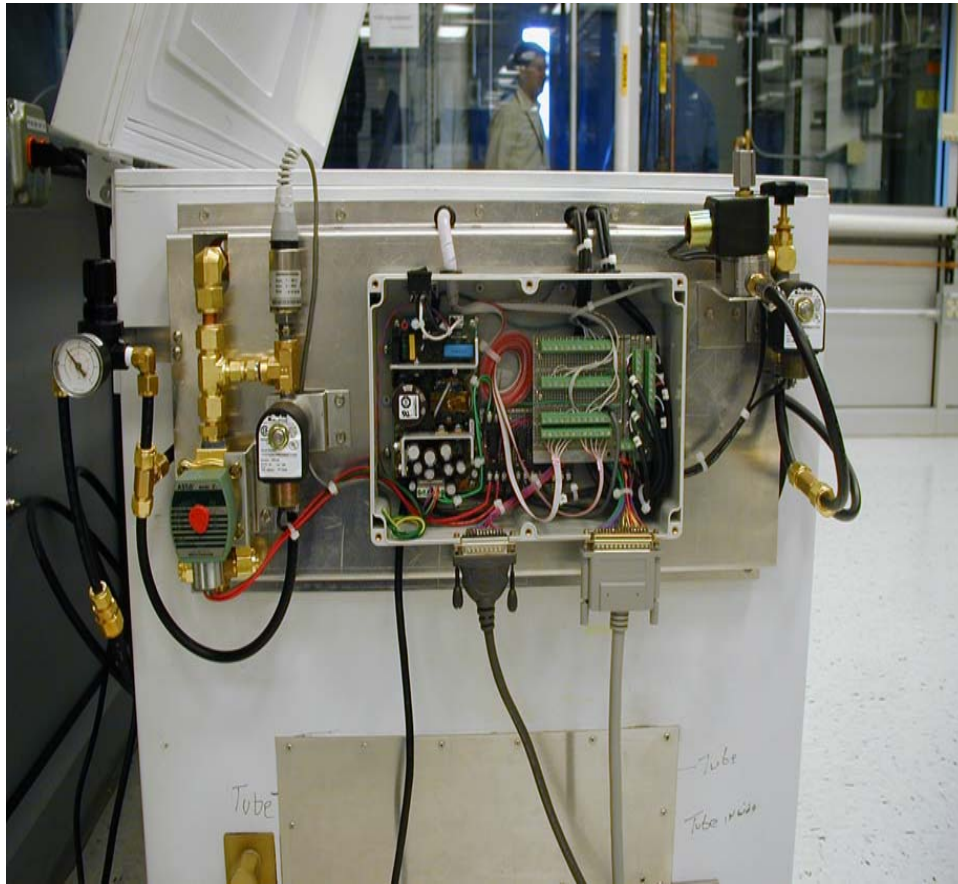


# C<sub>6</sub>F<sub>14</sub> Chiller

- Commercial chiller placed outside cleanrooms
- 350W at -25C cooling capacity
- 15LPM maximum flow rate
- Controlled through RS232 port with PC.
- Brings rod to -17C in 2 hours with help from freezer



# Multi-Rod Flow Control



- 4 computer-controlled valves:
  - 1 valve to control the  $C_6F_{14}$  flow
  - 1 valve to allow air in the input manifold
  - 2 valves allow air/vacuum in the output manifold

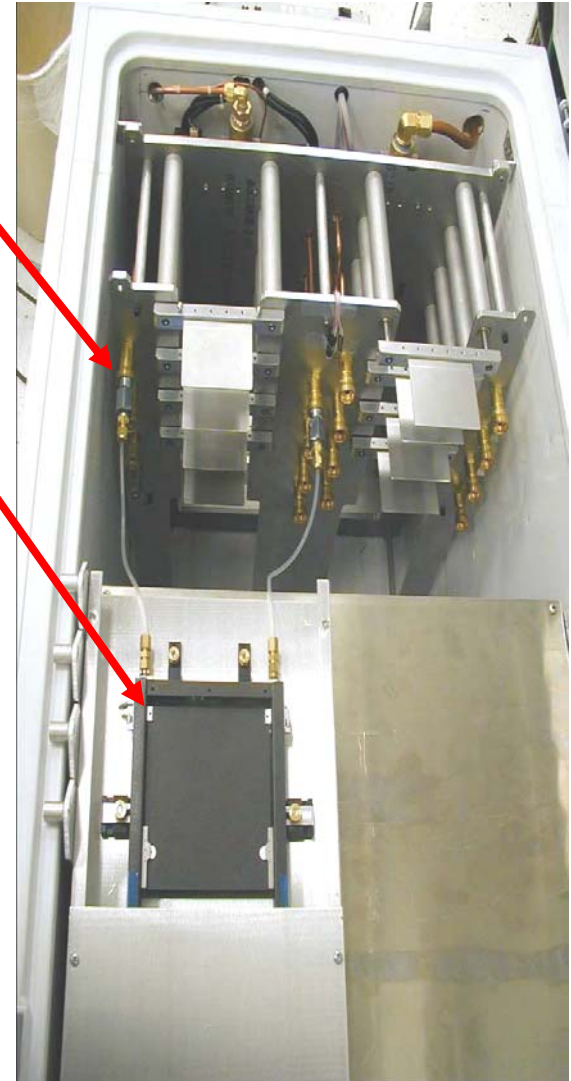
# $C_6F_{14}$ flow control

**Input and output manifolds allow constant pressure differential across variable number of rods**

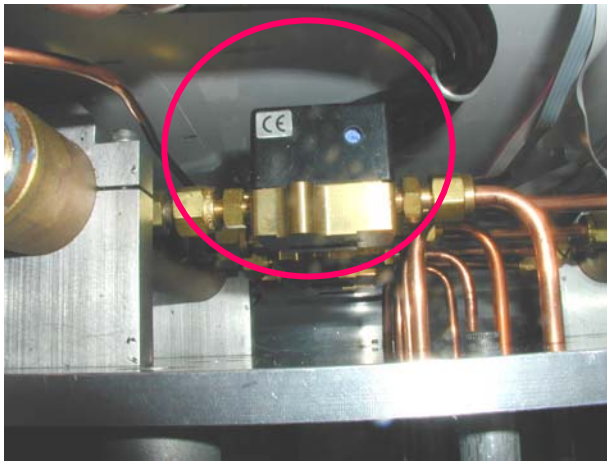


# Within the rod container

- Quick disconnects make installation easier
- Removable partial lid on transport box allows access without rod removal
- Automated test of rate-of-pressure drop after overpressure for leak detection at beginning
- Automated purge of  $C_6F_{14}$  at end



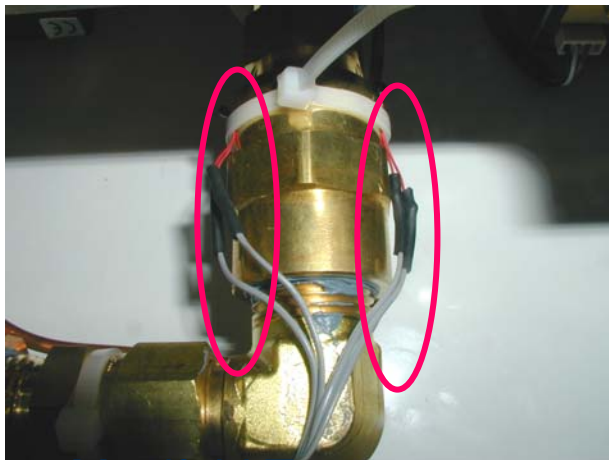
# Sensors within the Rod Container



Flow meters



Container RH & T



Manifold Temp.



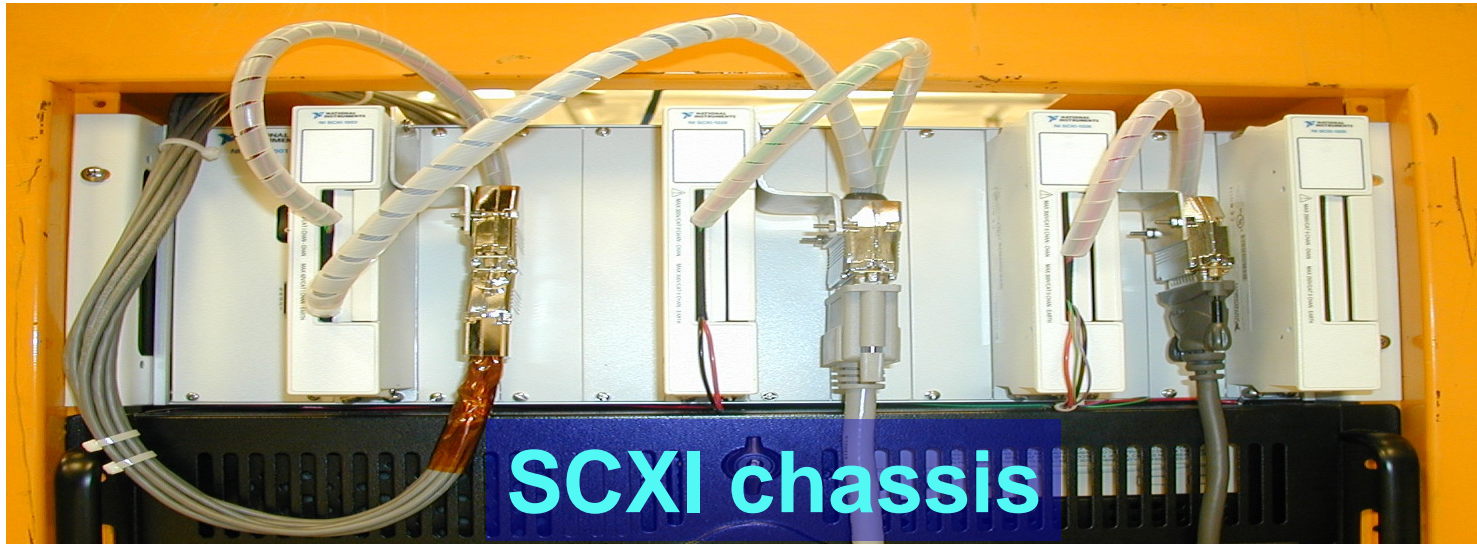
Proximity detectors

# Burn-in Electronics Rack Contains:

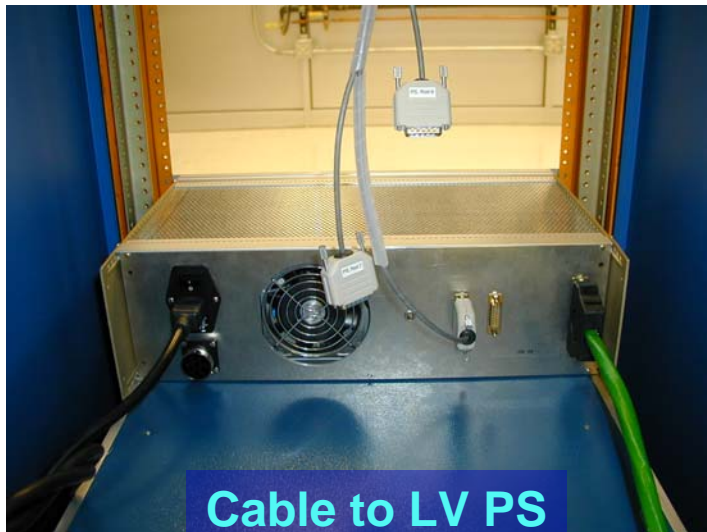


- SCXI-1101 chassis (National Instruments)
- Interlock & Ctrl PC.
- Has space for 9 LV PS's (8 Rod's+ 1 Control loop (CCUs))
- 2 HV CAEN PS's (40 channels each)
- 2 separated electrical lines.  
(allows Duccio supplies to be reset via the computer)
  - Line1: 8 LV PS (computer controlled)
  - Line2: SCXI,PC, HVPS and control LVPS

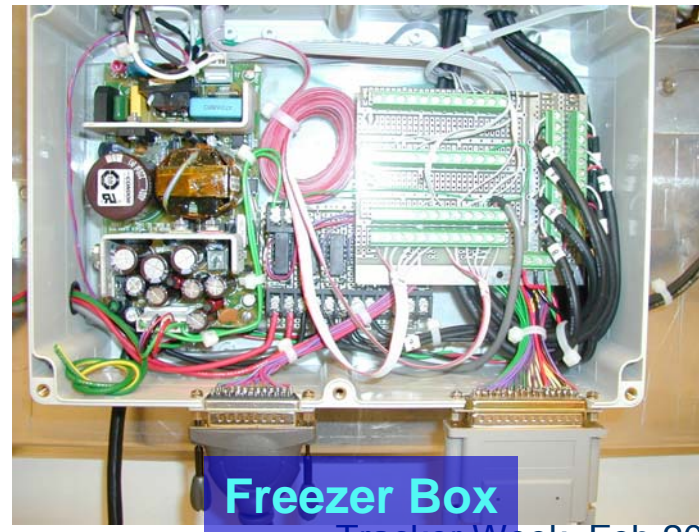
# Multi-Rod stand. Hardware : Cables



SCXI chassis



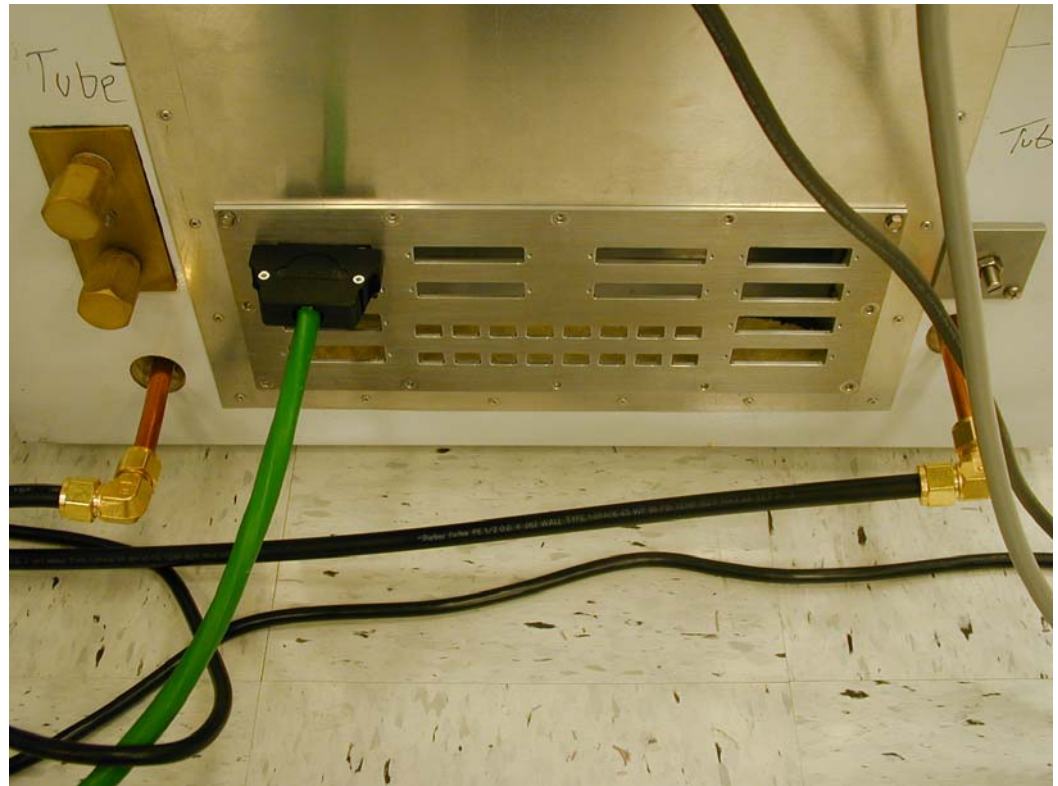
Cable to LV PS



Freezer Box

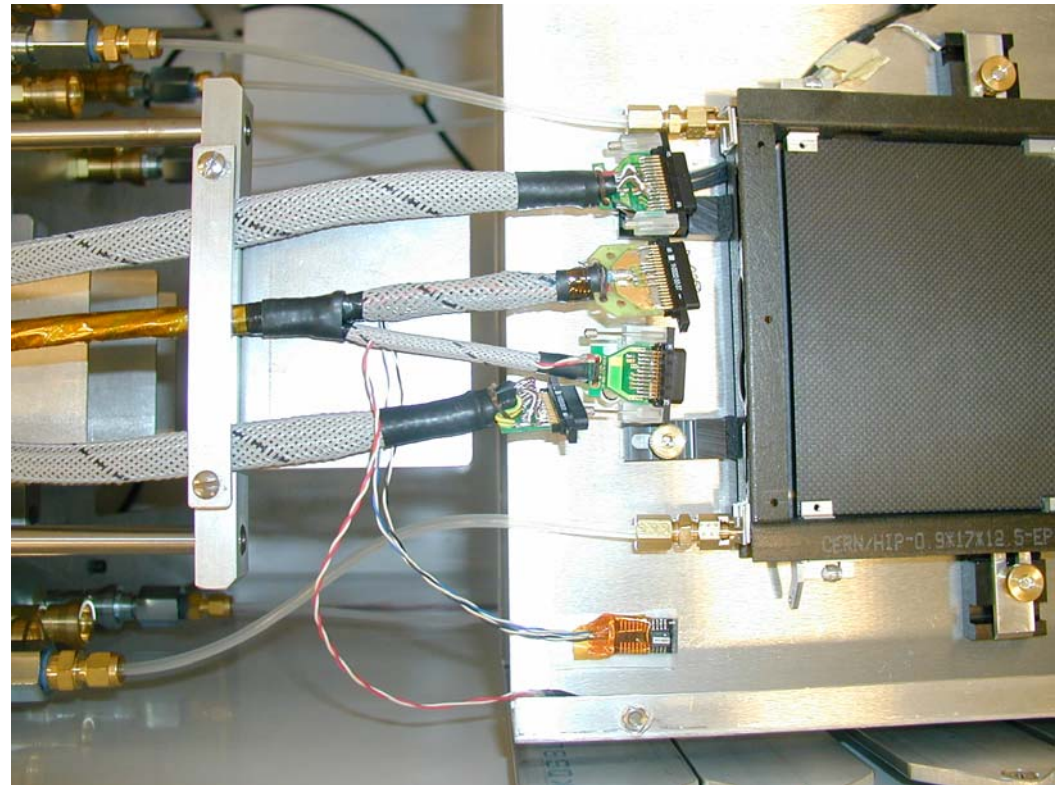
# MS and optical cable patch panel to rod container

Once all cables are present, a mold will allow us to fill the back of the patch panel with insulating foam



# Rod Cabling

**Sliding/retractable  
cable strain relief  
allows access to  
lowest rods during  
loading and unloading**



# Multi-Rod stand Location at Fermilab

- We have a new location in the Lab C south clean room.
- Enough space for all the different TOB-related activities.



# Multi-Rod Burn-in at ucsb

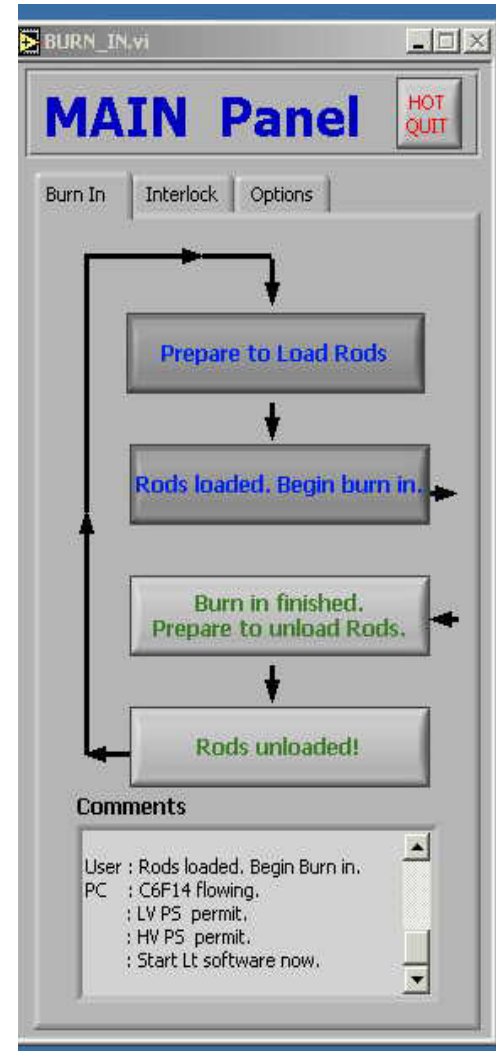
- 100m<sup>2</sup> devoted to assembly, testing, storage and shipping



# System Labview Software

## PC guides the user through the rod burn-in cycle

- Button “Prepare to Load Rods.”
  - When selected system self-checks counts rods,etc, then returns **Ready Rods Loaded.**
- Rods are then leak-checked and system enables
- Button “Prepare to burn in” when selected and completed
  - ⇒ **Interlock software enables PS**
  - ⇒ **User can start Lt software**
  - ⇒ **Lt software chooses rod temperature, labview responds**
- “Burn-in finished”.Button.
  - ⇒ **Drains rods, turns off interlocks**
- Rods are then ready to be removed



# Multi-Rod stand : Interlock Logic

- Power interlock

 **Kill LV+HV**

- $T_{\text{ROD}}$  and RH->Dewpoint
- Flow (each Rod and total)
- Chiller status
- Rod container dewpoint

- Cooling interlock

 **Stop coolant supply**

- Dew point of rods or manifolds
- Freezer open (not yet implemented)

# Display showing Status of Interlocks, Rods and chiller

The screenshot displays a LabVIEW interface with four main windows:

- MAIN Panel (BURN\_IN.vi):** Features a navigation menu with buttons for "Display sensor information", "Display ROD information", "Display INTERLOCK information", "SETTINGS", and "RESET Interlock". A "Heartbeat" indicator is shown as a green square.
- LimitsSET.vi (Settings):** A configuration window for limits. It contains three columns: "Maximum Temp Limits", "Minimum Flow Limits", and "T-Dew Point Min Separation". Each column has eight rows of numerical input fields. The "Maximum Temp Limits" column is set to 35, "Minimum Flow Limits" to 0.2, and "T-Dew Point Min Separation" to 5. "Save" and "Cancel" buttons are at the bottom.
- RodDisplay.vi:** A vertical stack of eight rod status panels, labeled "Rod" through "Rod 8". Each panel displays "Flow (l/min)", "Temp (C)", and "RH (%)".

Rod	Flow (l/min)	Temp (C)	RH (%)
Rod 1	0.31	6.7	-35.04
Rod 2	0	NaN	-166.53
Rod 3	0	NaN	0
Rod 4	0	NaN	0
Rod 5	0	NaN	0
Rod 6	0	NaN	0
Rod 7	0.49	NaN	0
Rod 8	0.47	NaN	0
- ServerChiller.vi:** A window for chiller control. It shows "Port: 6341", "Number of Connections: 0", and "Chiller ON" status. It also displays "Current Temperature: -27.7", "Status: 13", "Target Temperature: -20", and "Alarm Code: 320".

The Windows taskbar at the bottom shows the Start button, several icons, and the following taskbar buttons: "Messenger...", "LabVIEW", "Adquisition...", "Adquisition...", "ServerChill...", "BURN\_IN.vi", "RodDisplay.vi", and "LimitsSET.vi". The system clock shows "11:35 AM".

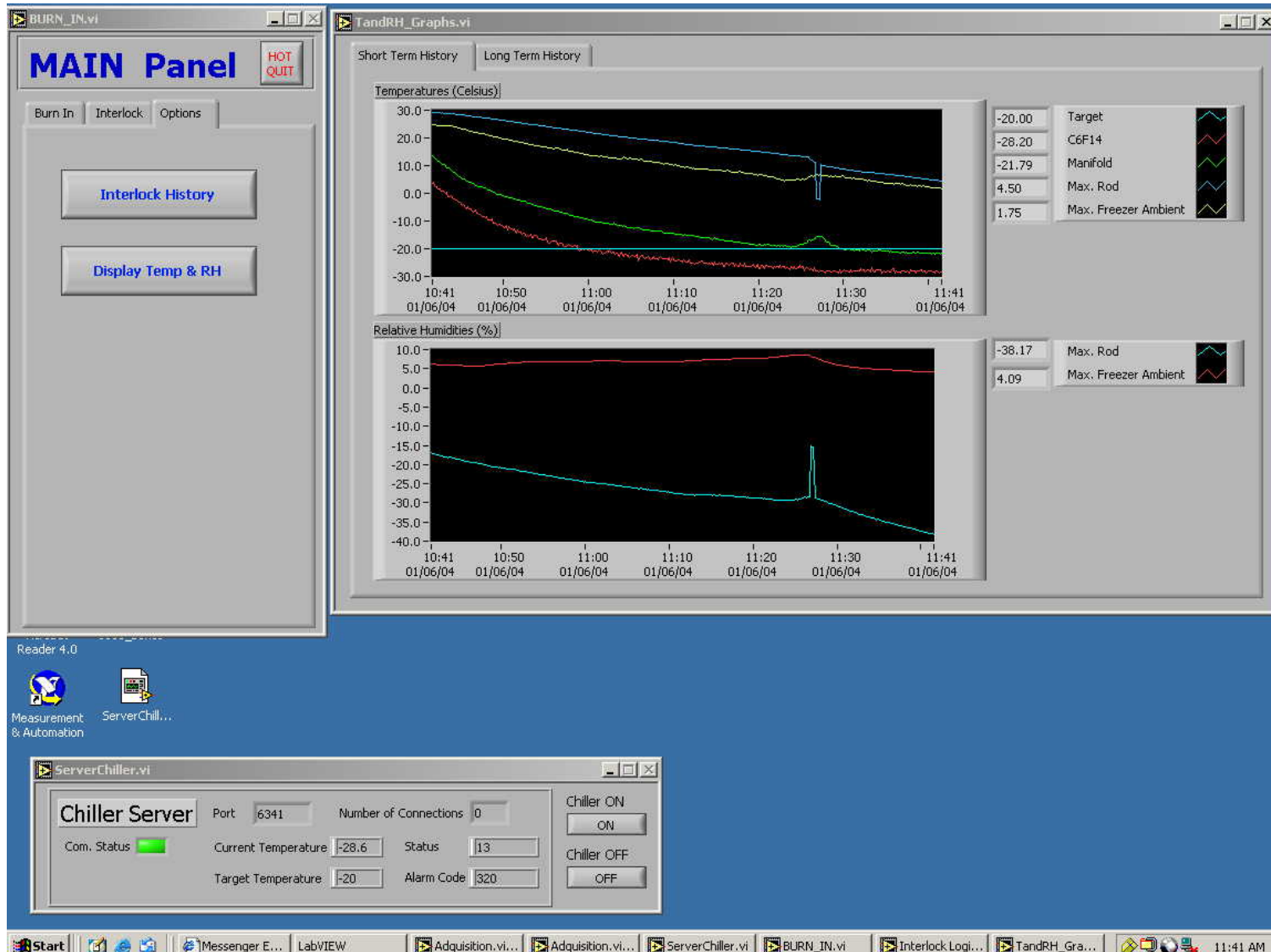
# Hardware and Interlock Debugging Tools

The screenshot displays a LabVIEW interface for hardware and interlock debugging, consisting of several interconnected windows:

- MAIN Panel (BURN\_IN.vi):** Features a navigation menu with buttons for "Burn In", "Interlock", and "Options". Below this is an "INTERLOCK PANEL" with buttons for "Display sensor information", "Display ROD information", "Display INTERLOCK information", "SETTINGS", and "RESET Interlock". A "Heartbeat" indicator is shown at the bottom.
- LimitsSET.vi (Settings):** A configuration window with three columns: "Maximum Temp Limits", "Minimum Flow Limits", and "T-Dew Point Min Separation". Each column contains a series of numeric input fields, many with "value" labels. "Save" and "Cancel" buttons are at the bottom.
- Interlock Logic.vi:** A logic monitoring window with three main sections:
  - Interlock Condition:** Shows "Current cooling Interlock" and "Latched cooling Interlock" (both green), and "Current power Interlock" and "Latched power Interlock" (both green).
  - Detailed current STATUS:** Lists "Device failures" with corresponding status indicators:
    - Freezer's P.S. Status: -12V (green), +5V (green), +12V (green), Chiller OK (green).
    - Freezer floating T's: T1 (green), T2 (green), RH1 (green), RH2 (green).
    - Cable from SCXI chassis to LV PS: 8 green indicators.
    - LV PS most likely off: 8 green indicators.
    - Cable from LV PS to Rod: 8 green indicators.
    - Rod Temp with floating sensor: 8 red indicators.
    - Rod Rel. H. with floating sensor: 4 red, 4 green indicators.
  - Logic & comparison:** Lists comparison rules with status indicators:
    - Manifold Temp against Dew Point: T1 (green), T2 (green).
    - Rod Temp against Proper limits: 8 green indicators.
    - Rod Flows against Proper limits: 4 red, 4 green indicators.
    - Rod Temp against Dew Point: 8 green indicators.
- ServerChiller.vi (Chiller Server):** A window showing server status:
  - Port: 6341, Number of Connections: 0
  - Com. Status: Green indicator
  - Current Temperature: -26.2, Status: 13
  - Target Temperature: -20, Alarm Code: 320

The Windows taskbar at the bottom shows the Start button and several open applications: Messenger E..., LabVIEW, Acquisition.vi..., ServerChiller.vi, BURN\_IN.vi, Interlock Logi..., LimitsSET.vi, and the system clock at 11:23 AM.

# Sample data during cool-down



# Conclusions

## To be Done

- The drain and setup of rods was performed with 1 rod and 7 bypass hoses (dummy rods). Need to test with 8 rods
- One chiller is flakey and is being fixed now
- The software needs some fine tuning (timing for draining time, leak check, etc)
- We await full complement of cables and power supplies

## Conclusions:

- The hardware and software are essentially completed.
- The commissioning of the burn-in stands is proceeding well, in advance or production ramp-up
- **We need experience**