Temperature Sensor Experiment

<u>University of Illinois</u>

Participating members:

D. Errede

Z. Conway

M. Haney

G. Qian

J. Crnkovic

D. Errede/UIUC

Absorber Group Meeting

5/17/2004

Purpose

Providing temperature information for cooling channel energy absorber undergoing testing in Mucool Test Area

Study properties of fiberoptic gauges at cryogenic temperatures.

History

Z. Conway, M. Haney, (D. Errede) got the experiment going, purchasing equipment, setting up cryostat, installing sensors.

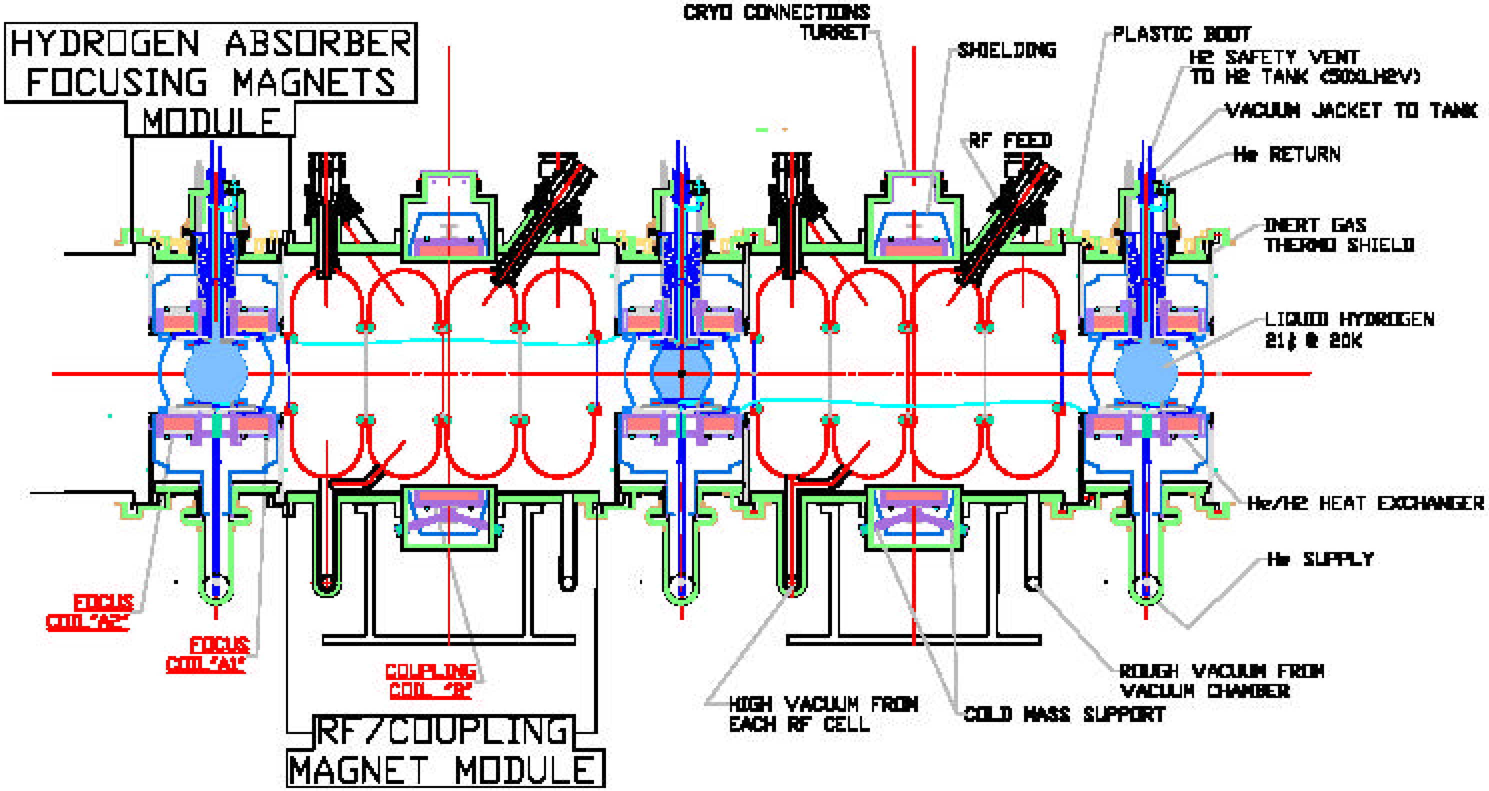
Zack wrote the daq for our test setup and absorber testing in situ.

Jason Crnkovic, D. Errede, M. Haney studied the systematic errors associated with the test setup.

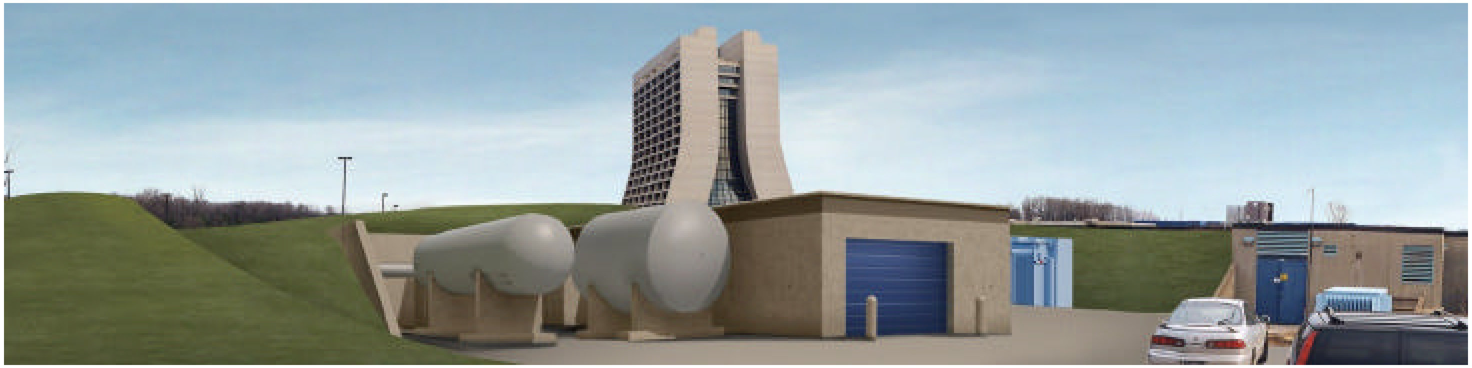
Gefei Qian has added some nice modifications to the daq and written a temperature conversion program whose algorithm looks better than Lakeshores.

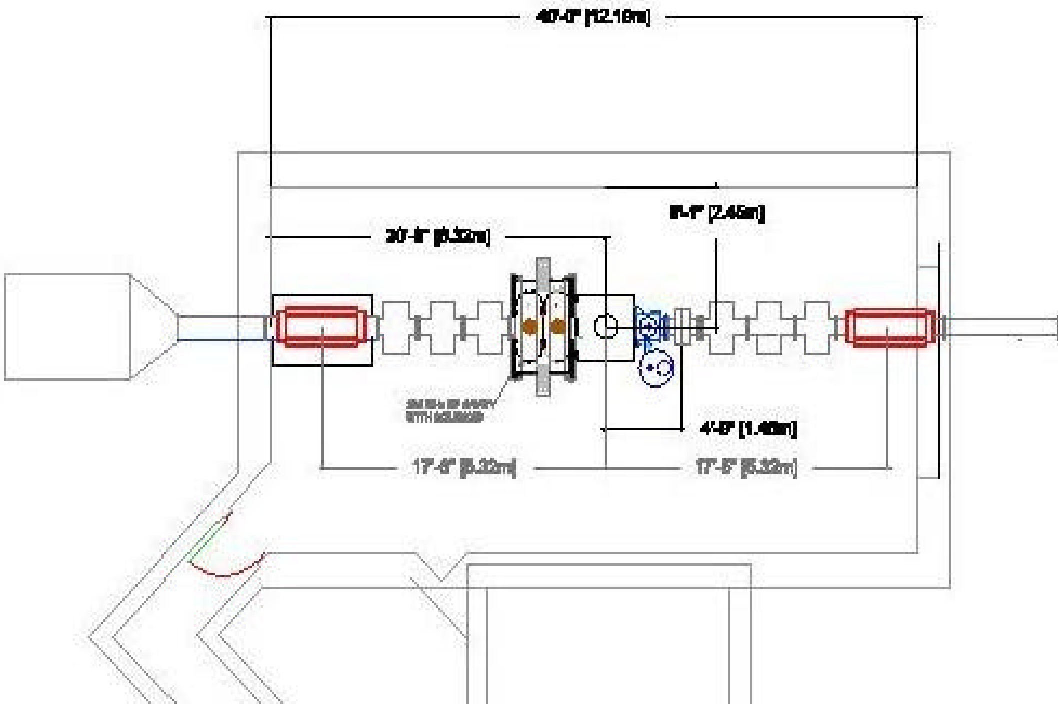
Cooling Channel Lattice Cell

Includes UIUC



New MUCOOL Test Facility





- Fill & test absorbers
- HP 201 MHz (& 805 MHz ?) Tests
- Integrate components into a unit
- Test in intense ionizing beam

Absorber Instrumentation

The absorber environment:

-The absorber will absorb 100-1000 Watts depending on beam intensity in cooling channel muon beam.

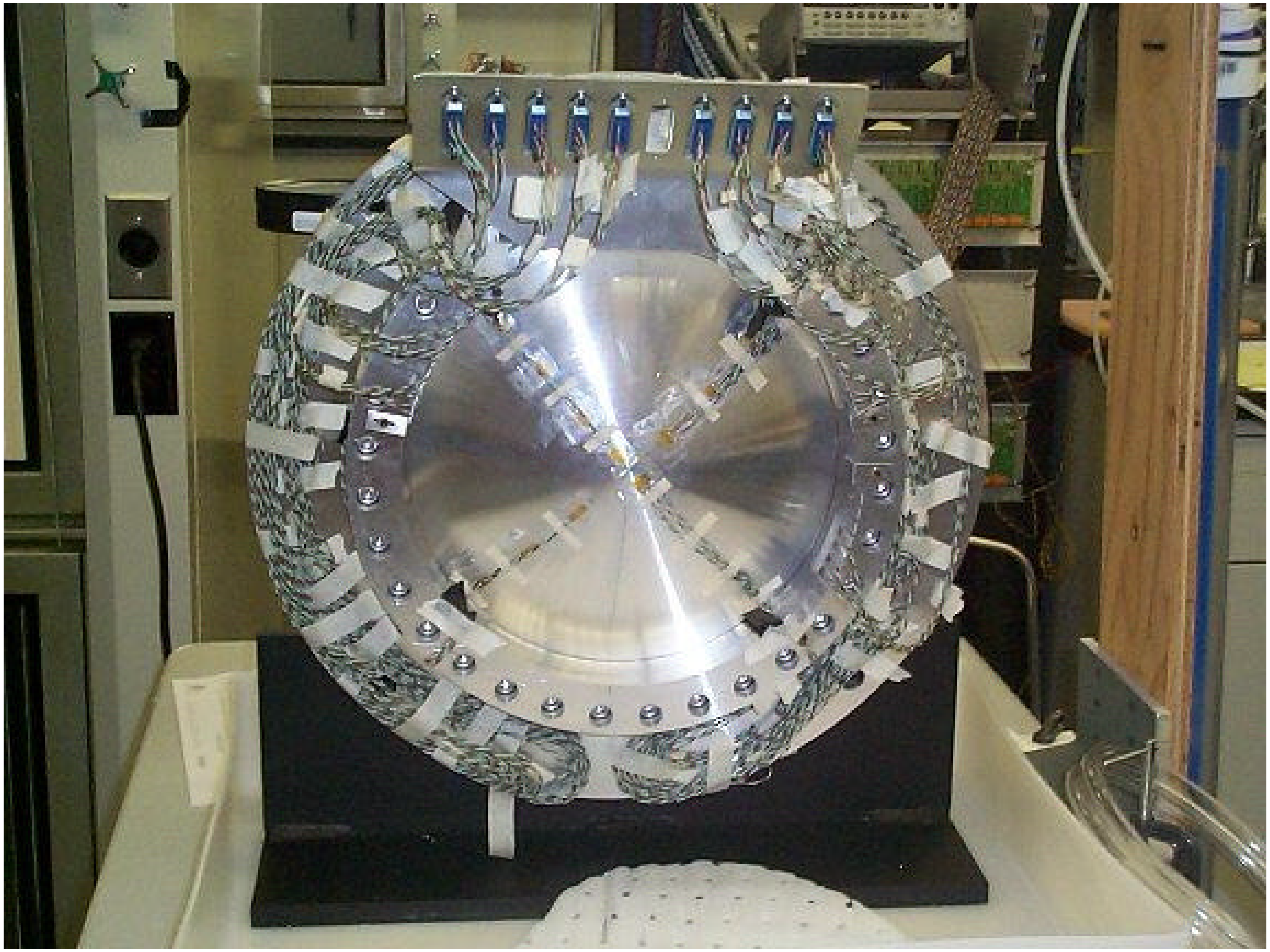
-The MTA will provide a 400 MeV proton beam of ~ 10^{12}-10^{13} protons/pulse @ 15 Hz to mimic the dE/dx deposition of a muon beam.

-The absorber sits inside a solenoid of 4 Tesla (~1.5 T at absorber in cooling channel design)

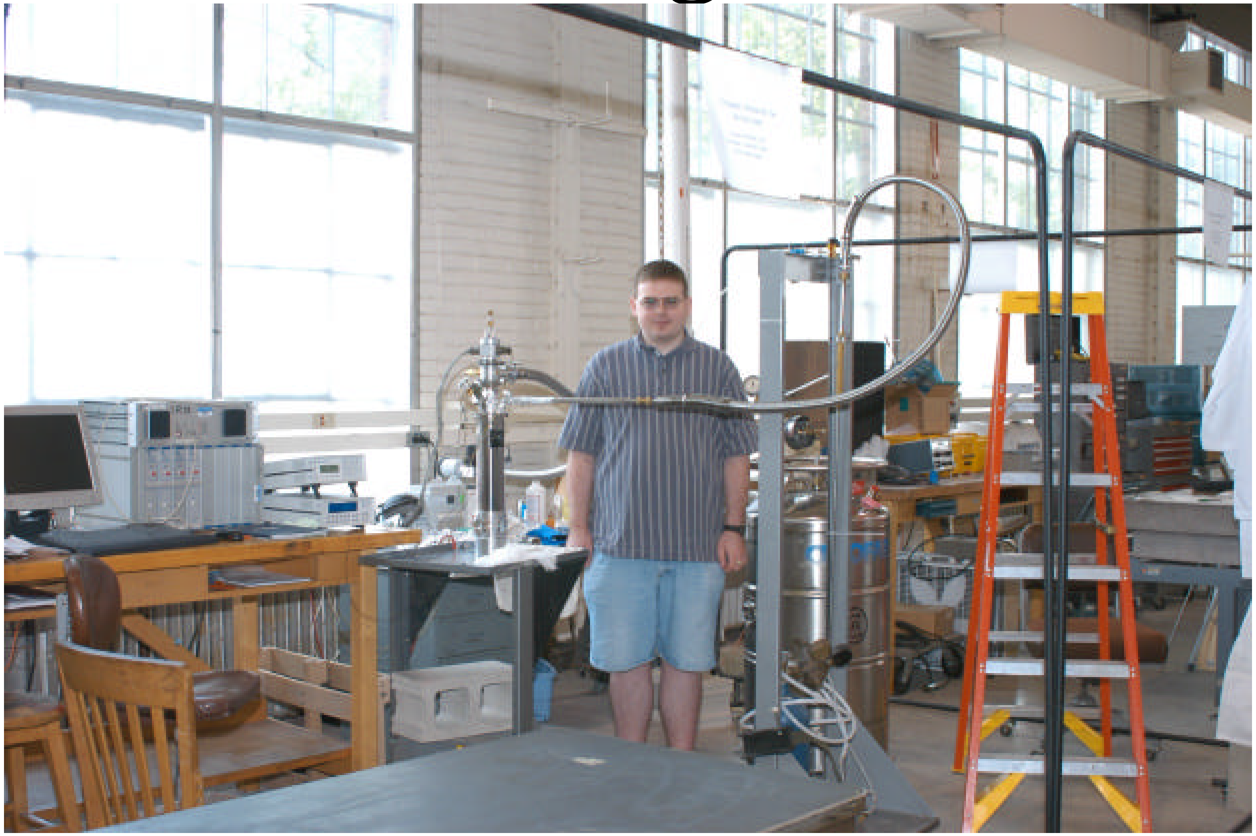
- The absorber is filled with liquid hydrogen thus operates at cryogenic temperature (14 –20K)

THUS the monitoring devices must be rad-hard, and able to operate in high magnetic fields and cryogenic temps.

Absorber Aluminum Window Pressure/Burst Testing



Cryogenic Testing of Temperature Gauges



Jason Crnkovic

2003 Summer REU Student at UIUC

8/8/2003

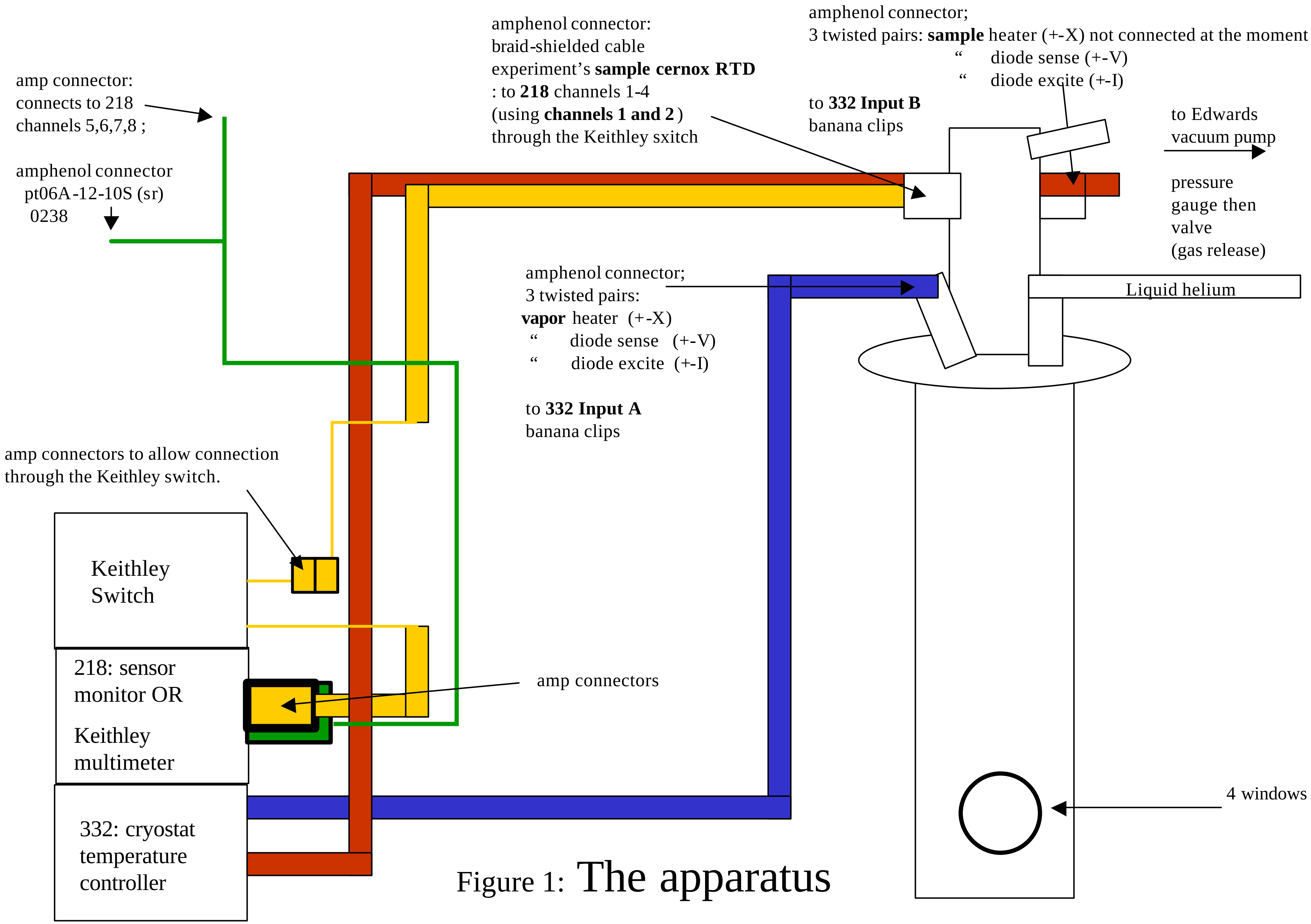
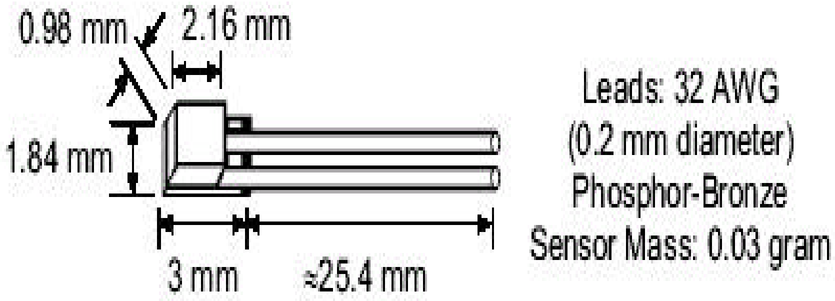


Figure 1: The apparatus

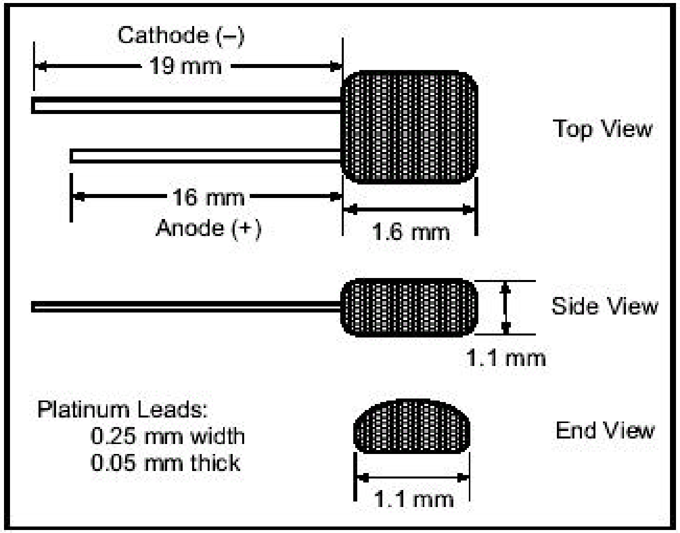
Sensors under consideration



Cernox

Diagram found at:

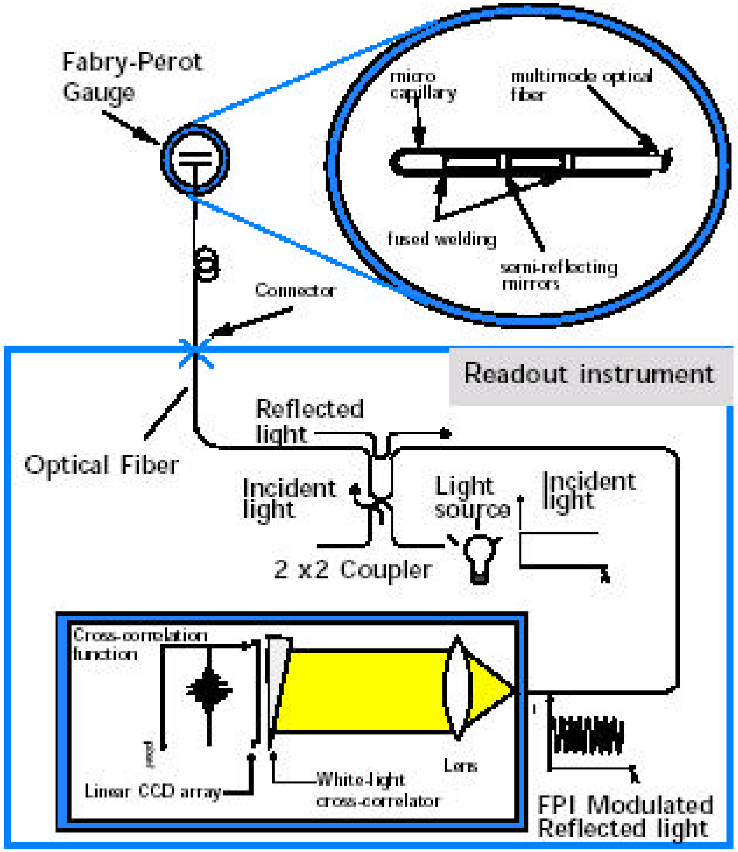
http://www.lakeshore.com/temp/sen/F017_00_00.pdf



Diode

Diagram found at:

http://www.lakeshore.com/temp/sen/F031_00_00.pdf

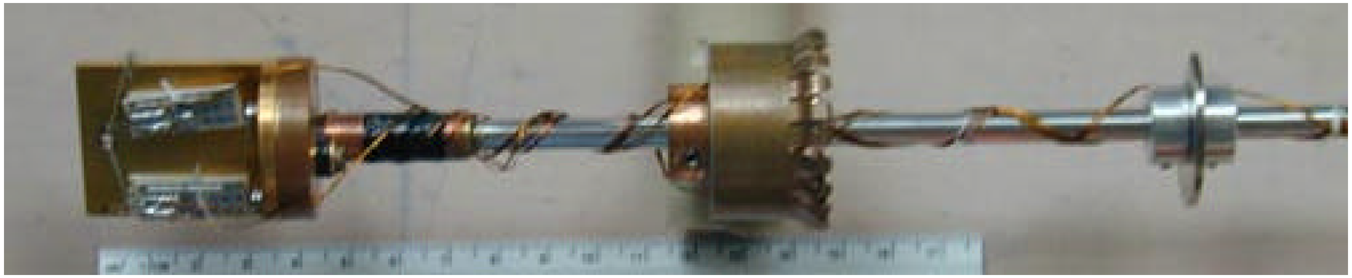


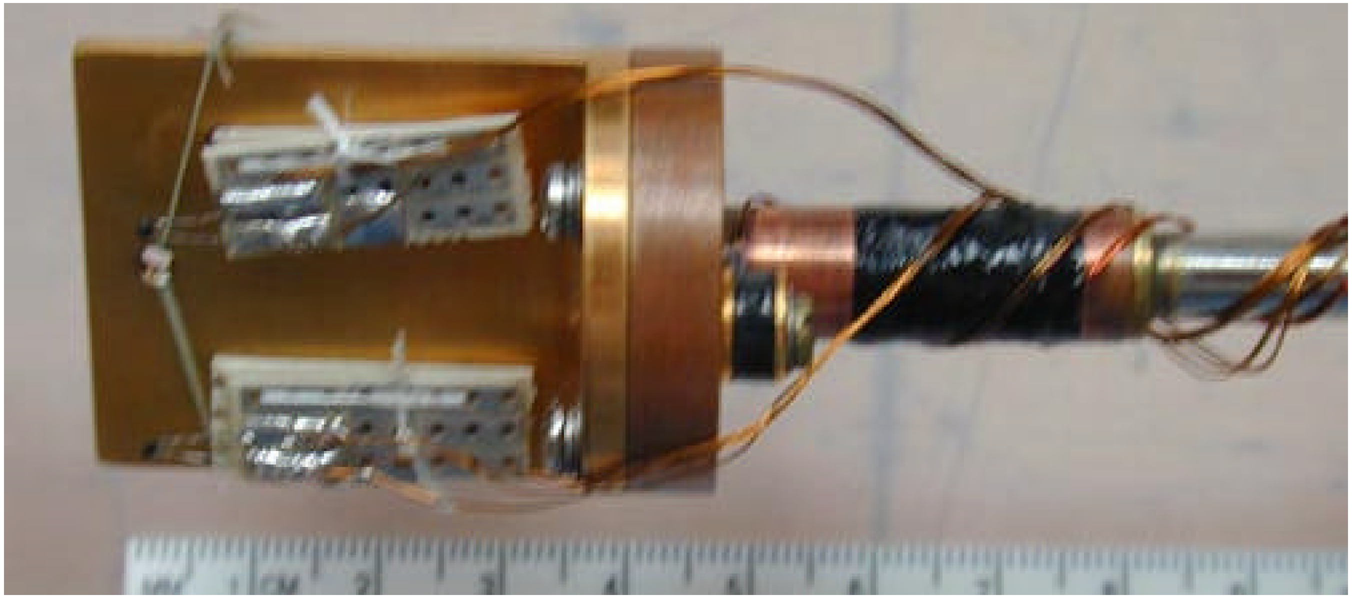
FISO Temperature Gauge

Diagram found at:

http://www.fiso.com/pdf.php?id=66

Temperature diode and resistive transducers
(experiment in Urbana)





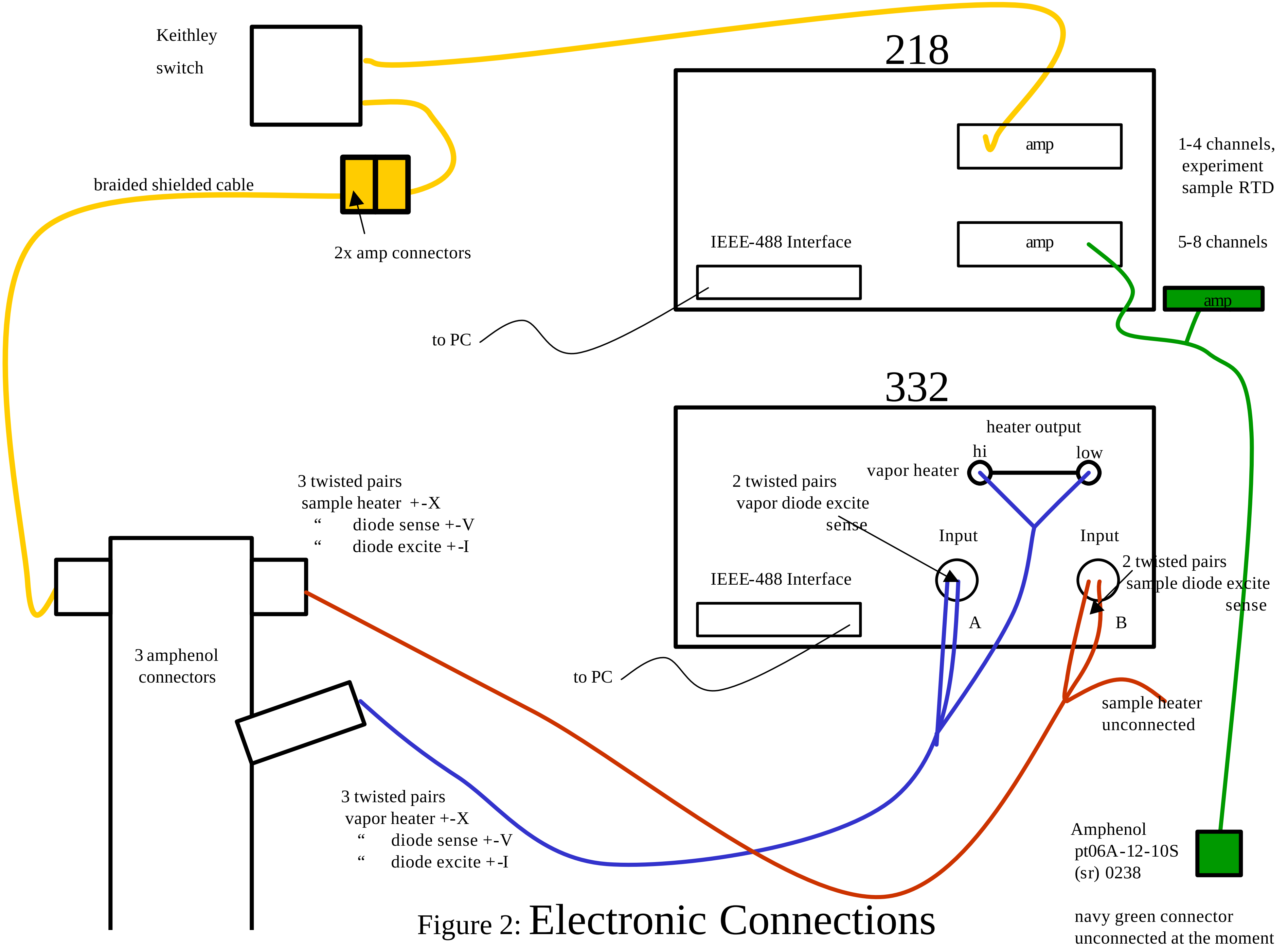
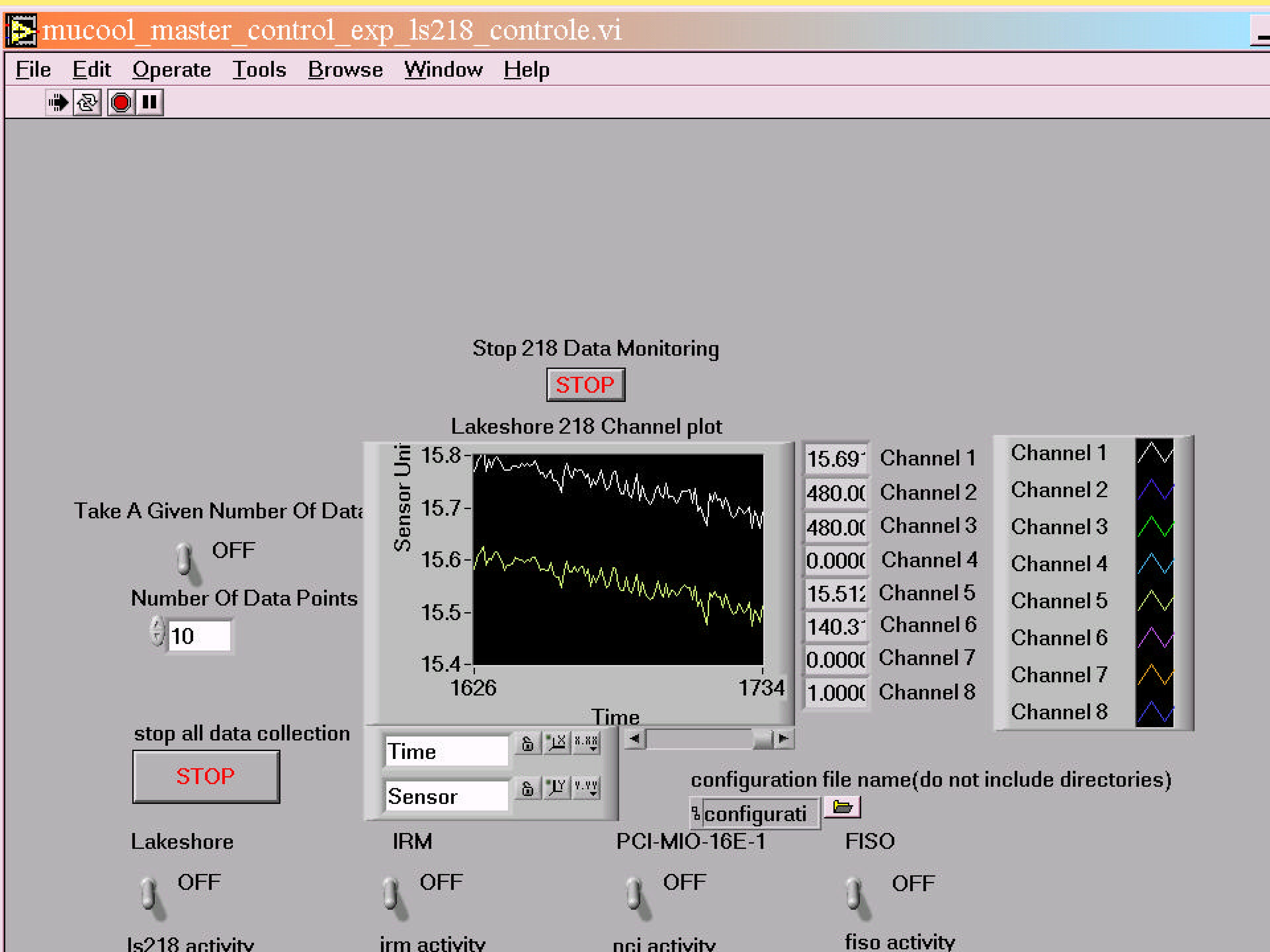


Figure 2: Electronic Connections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STOP
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Sensor Uni
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1626
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Time
Take A Given Number Of Data
OFF
Number Of Data Points
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15.69
480.00
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0.0000
15.512
140.31
0.0000
1.0000
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Channel 2
Channel 3
Channel 4
Channel 5
Channel 6
Channel 7
Channel 8
stop all data collection
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Time
Sensor
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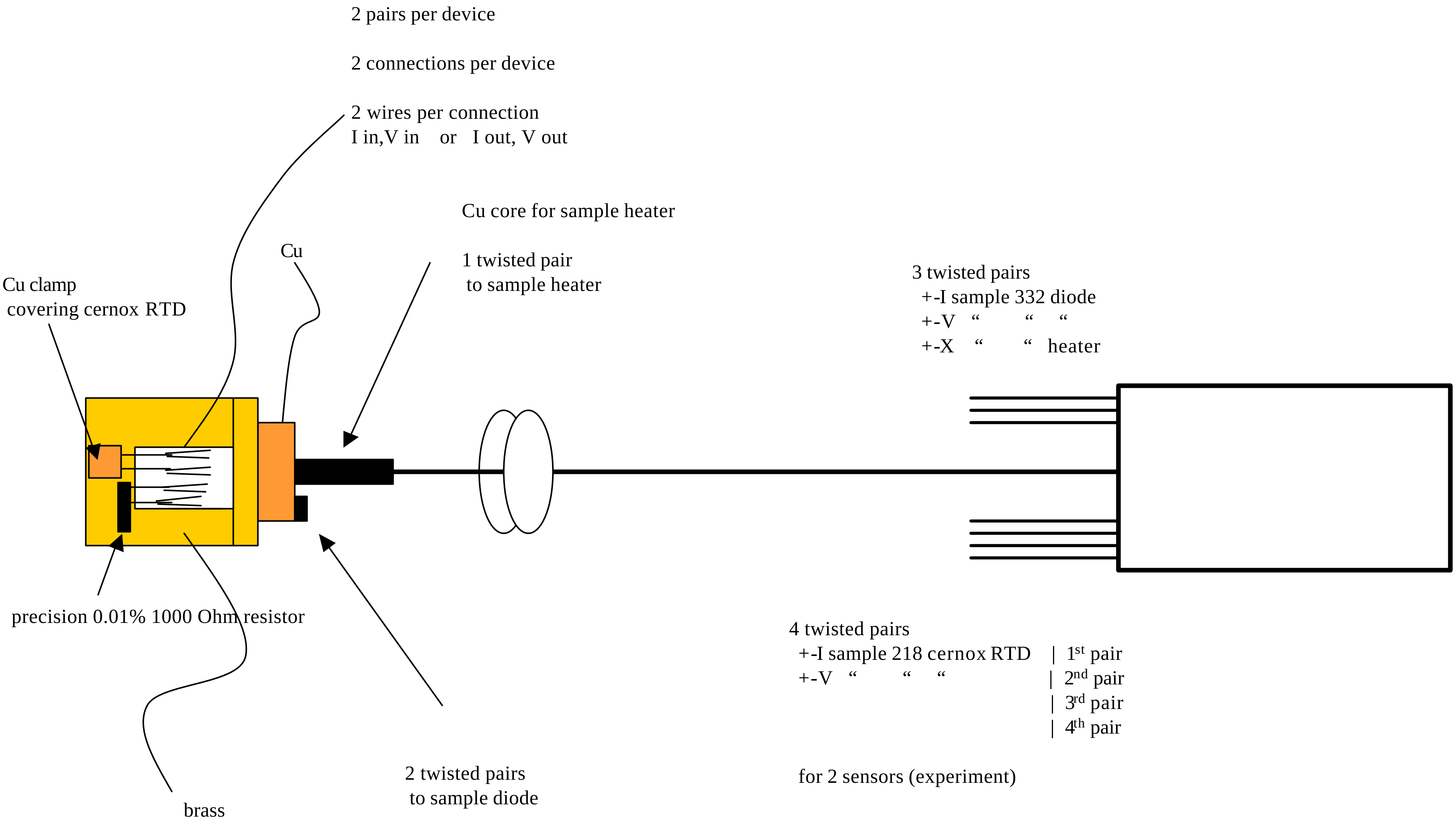
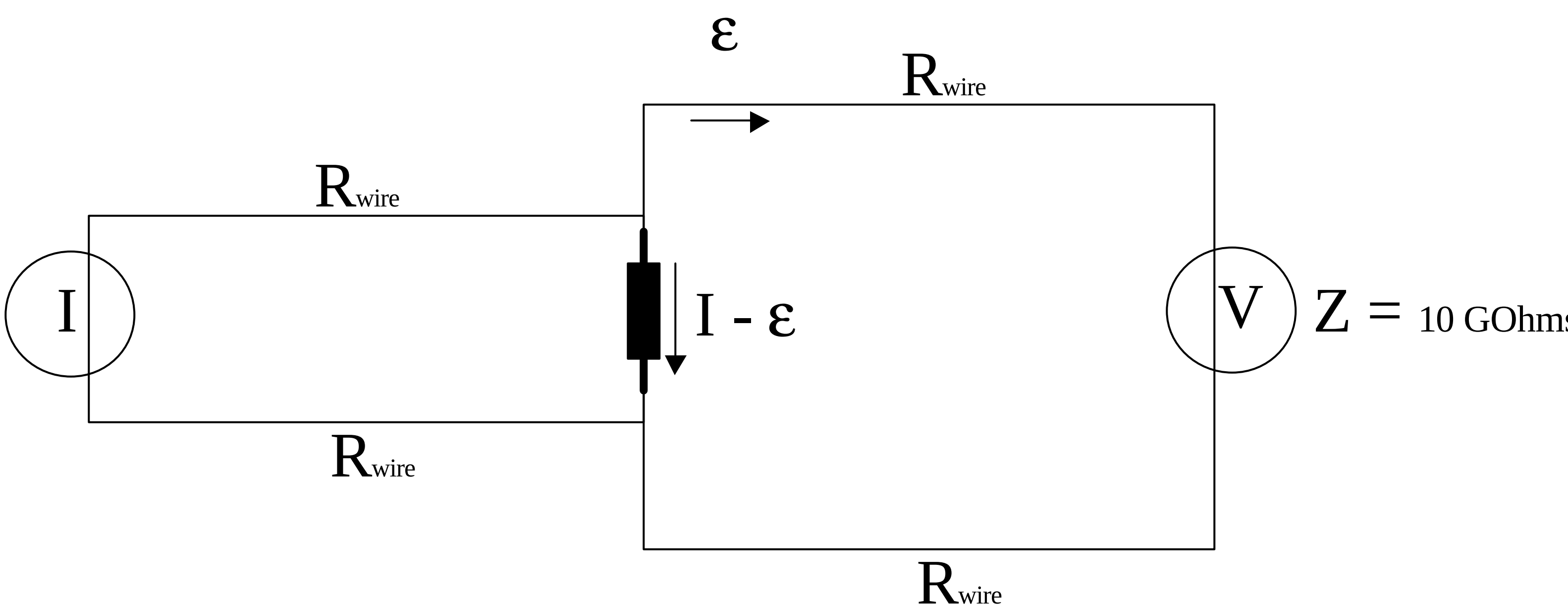


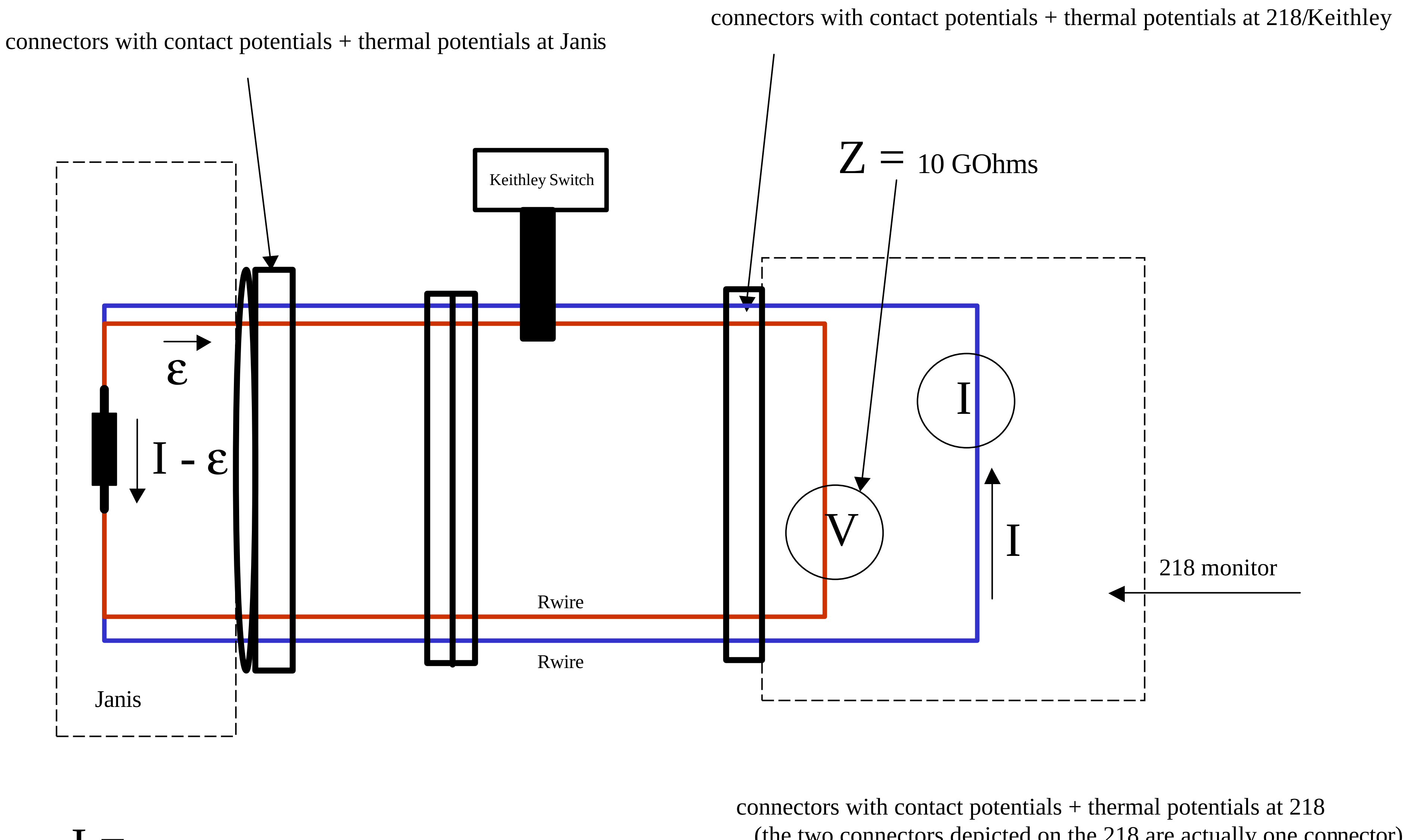
Figure 3: Sample Holder



$I =$ 10.0001 +- 0.0001 μAmps

$R_{wire} \sim$ 15 Ohms/m,   length/wire about ½ meter

Figure 4: Sensor Circuit Diagram



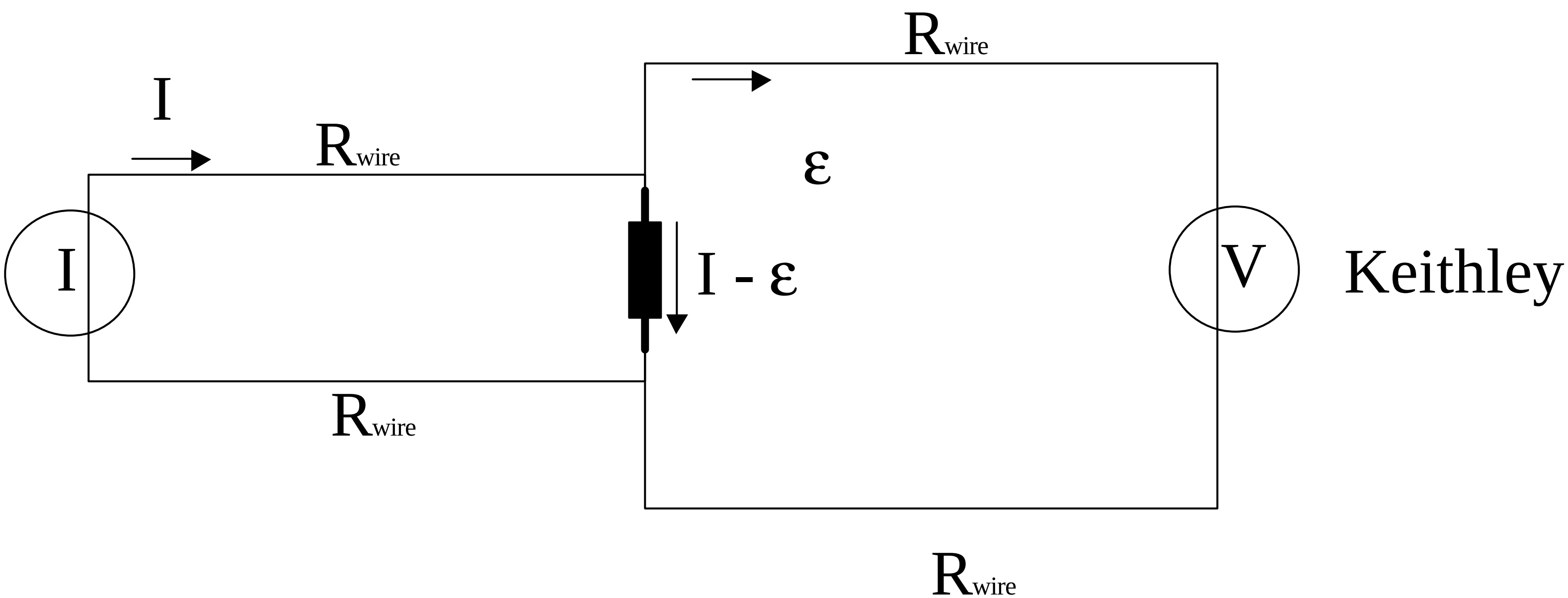
$I = 10.0001 \pm 0.0001\ \mu\text{Amps}$

$R_{wire} \sim 15$ Ohms/m, length/wire about ½ meter

Figure 5: Sensor Circuit Diagram

Test

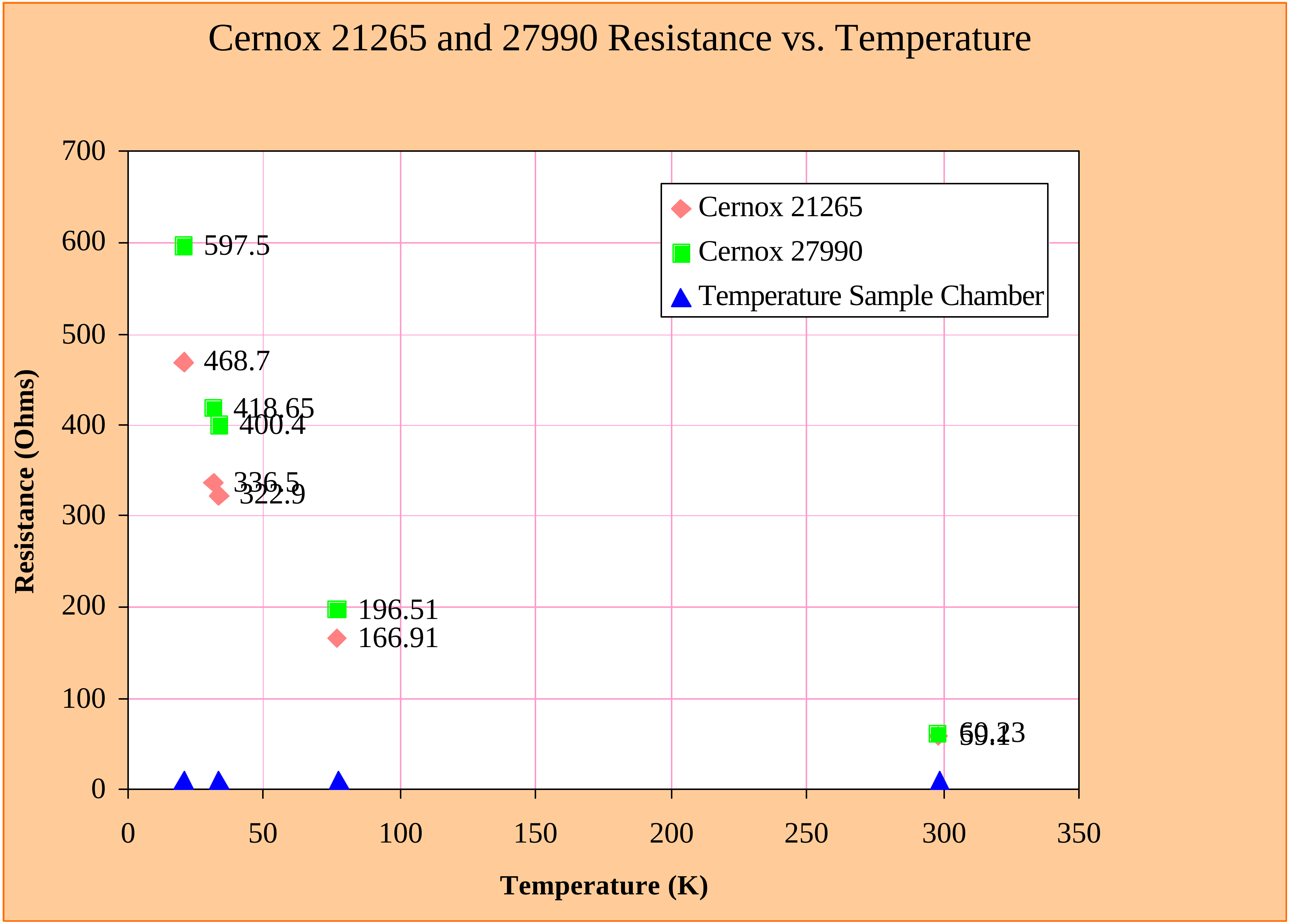
We examined the voltages and resistances of all loops in the circuit, both as 4 wire and 2-wire resistance measurements, with the sensors in and out of the circuit. We reversed the current through the loops to look for current-direction independent potentials.



The temperature dependent potentials increase with an increase in temperature.

No significant effects were found under stable temperature conditions.

Data from Teststand using Cernox RTDs



Status

The status of the commissioning of the Cernox is that the calibrated sensors work (+- 0.03K @ 20K) better than the specifications of our needs (+- 0.1K @ 20K).

The electronics (Lakeshore 218s) are not measuring resistances to within specifications (worse than 1% in the 100-1000 Ohm range). The Keithley multimeter (6 ½ digit precision, accurancy tested with high precision resistors; 100 & 1000 Ohms) that we bought demonstrates that the problem lies with the Lakeshore electronics.

One 218 has been sent back to Lakeshore for corrected calibration. All 218s demonstrate the same problem and will be sent back to Lakeshore.

The temperature sensor system is presently operational with the Keithleys and the simple daq provided by Keithley.

The Conway/Qian DAQ handles 218s, the IRM, the FISO fiber optic transducers, and the PCI-MIO-E16 ADC.

Conclusions

Recalibrate the 218s