



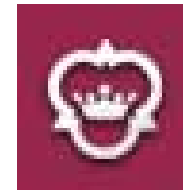
Physical Property Measurements of Glassy Metals

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Measuring Thermal Properties

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Data Processing

The Quantum Design Cryostat

- Temperature Range: 1.9K – 400K
- Pressure: 8.9×10^{-5} Torr
- Samples: Metglas, MoRuB



Thermal Transport - Theory

1. Generate Heat Pulse
2. Measure $\Delta T = T_{\text{hot}} - T_{\text{cold}}$
3. Estimate Corrections
4. Calculate Thermal Conductivity!

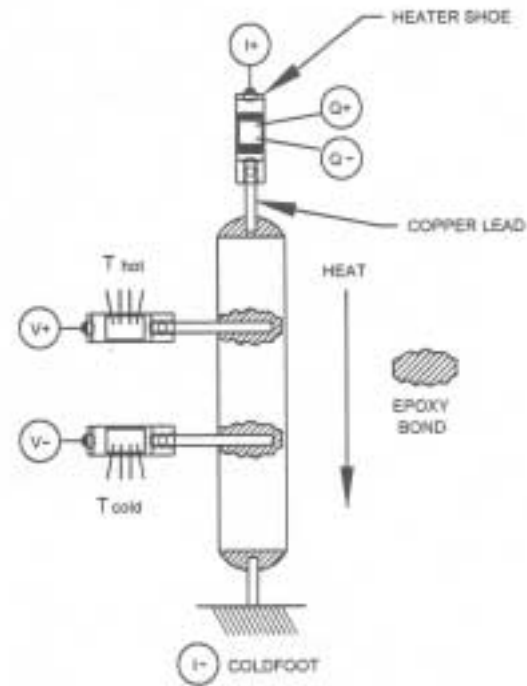
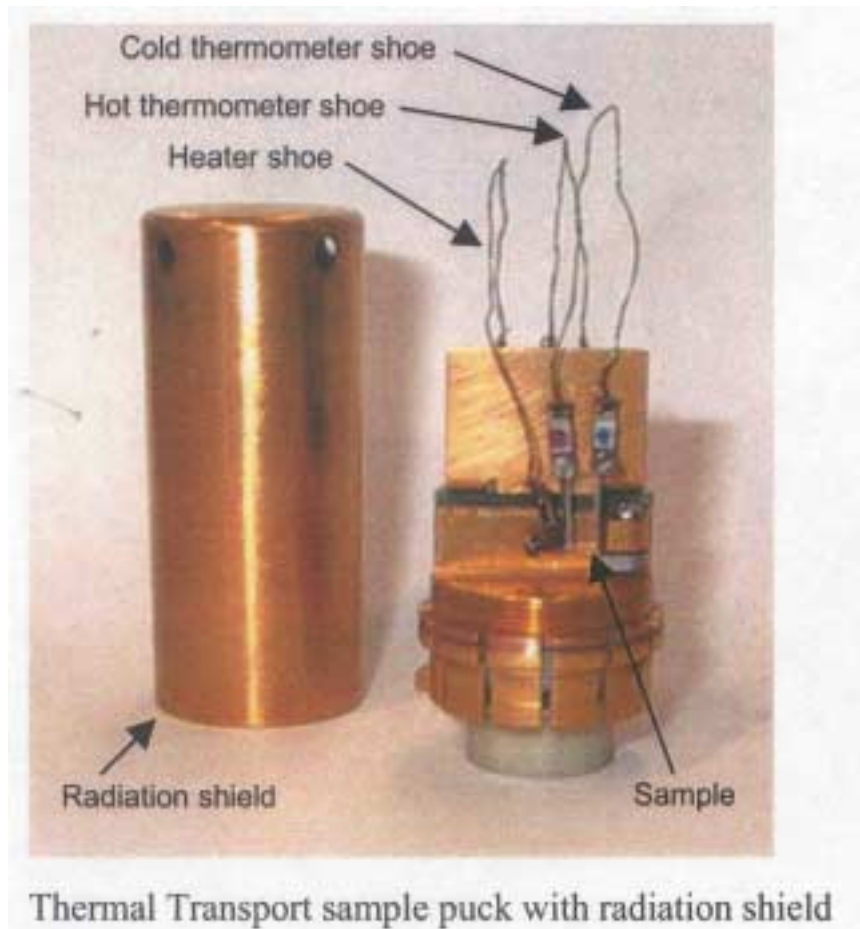


Figure 1-1. Thermal and Electrical Connections for an Idealized Sample

Thermal Transport - Hardware



The Cryostat – HiVac System

- HiVac Pressure: 9×10^{-5} Torr
- Many Problems!!
- Result: Quantum Design is Redesigning Cryopump

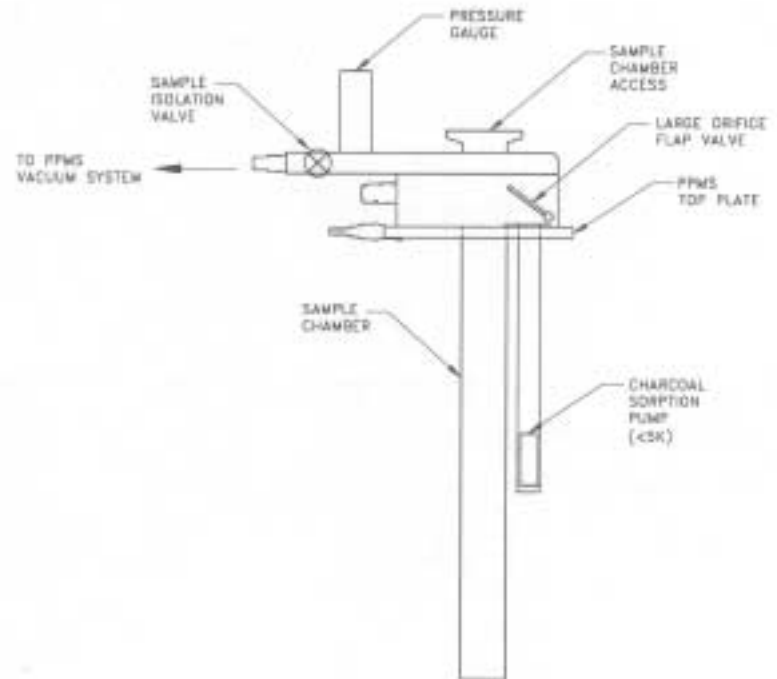
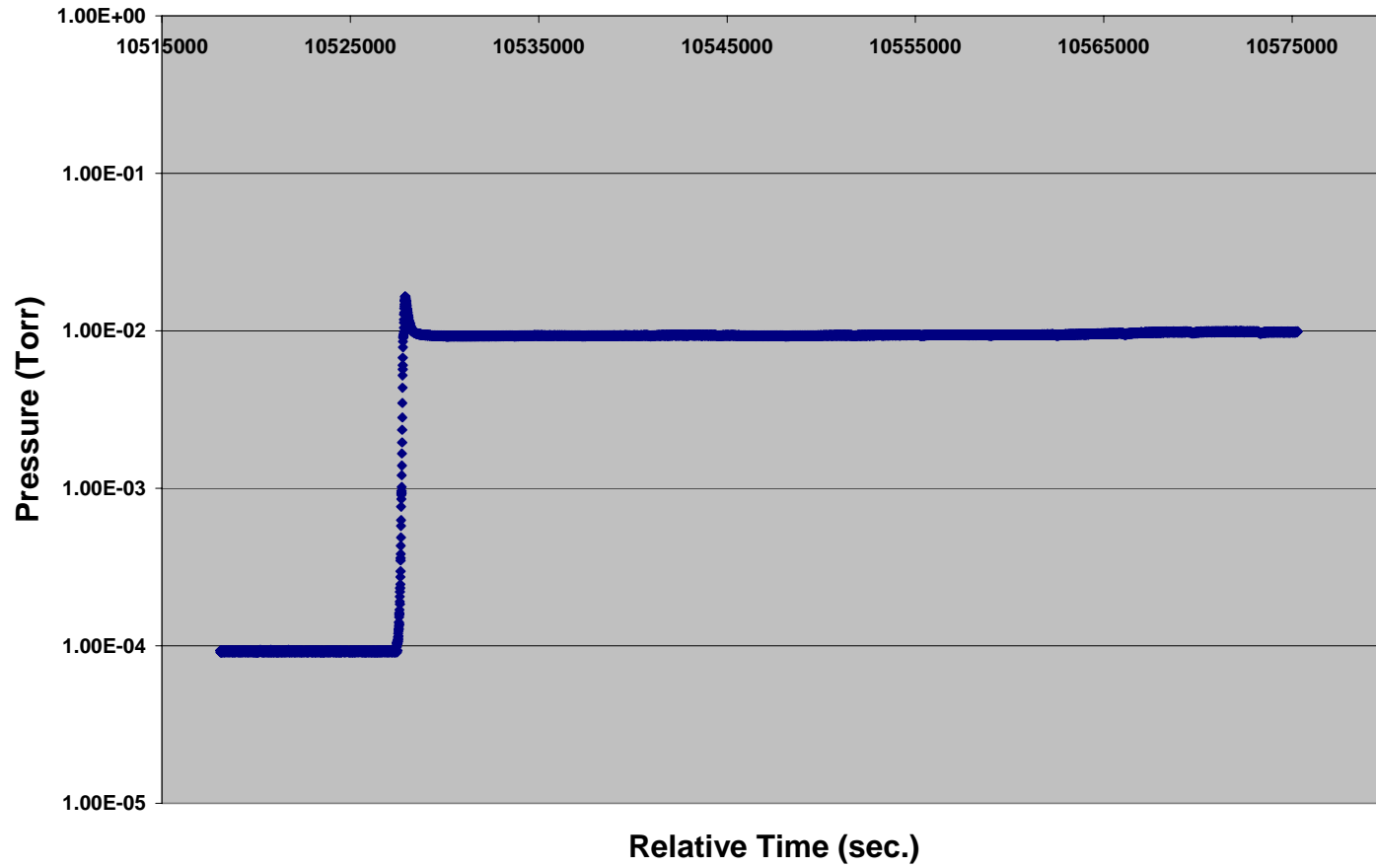
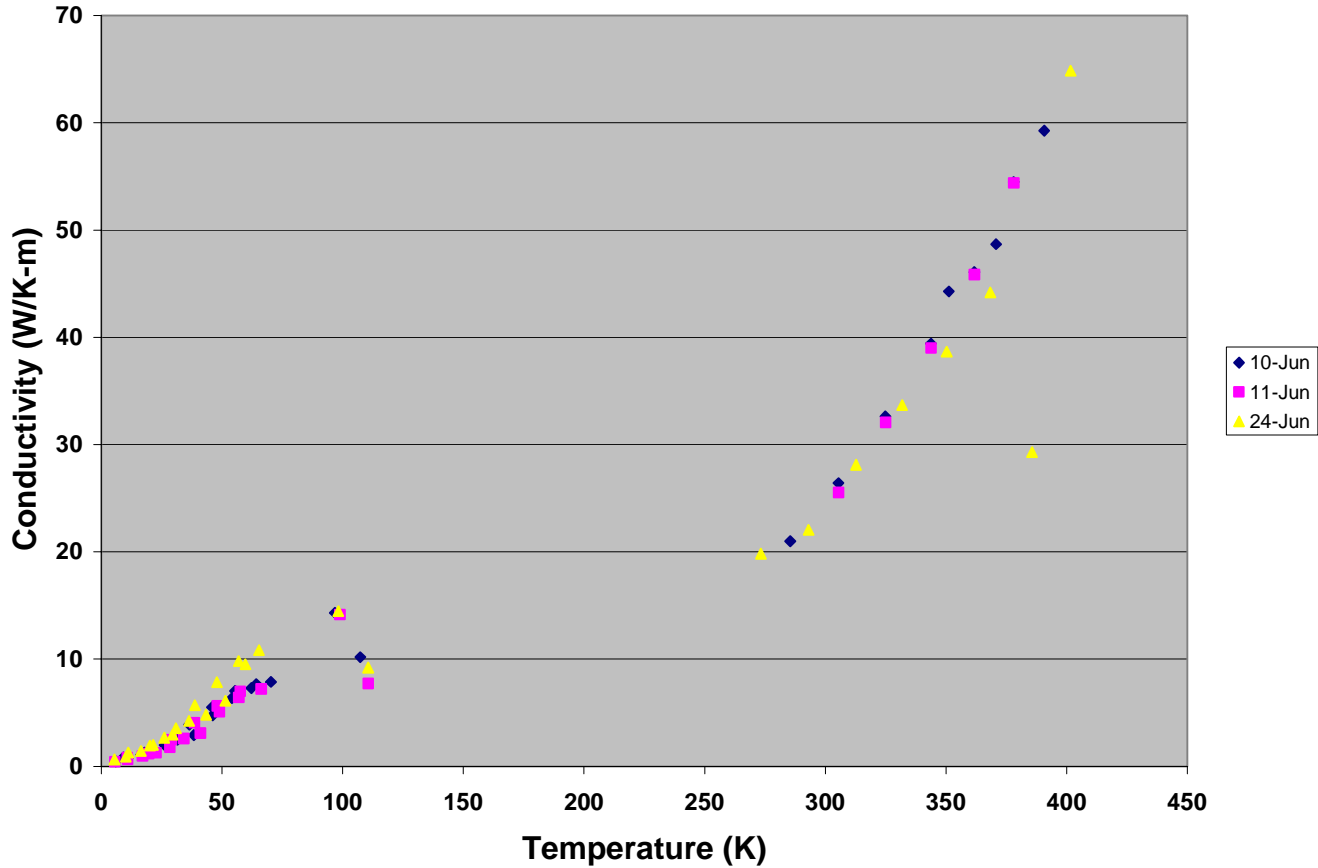


Figure 1-1. Cryopump Assembly

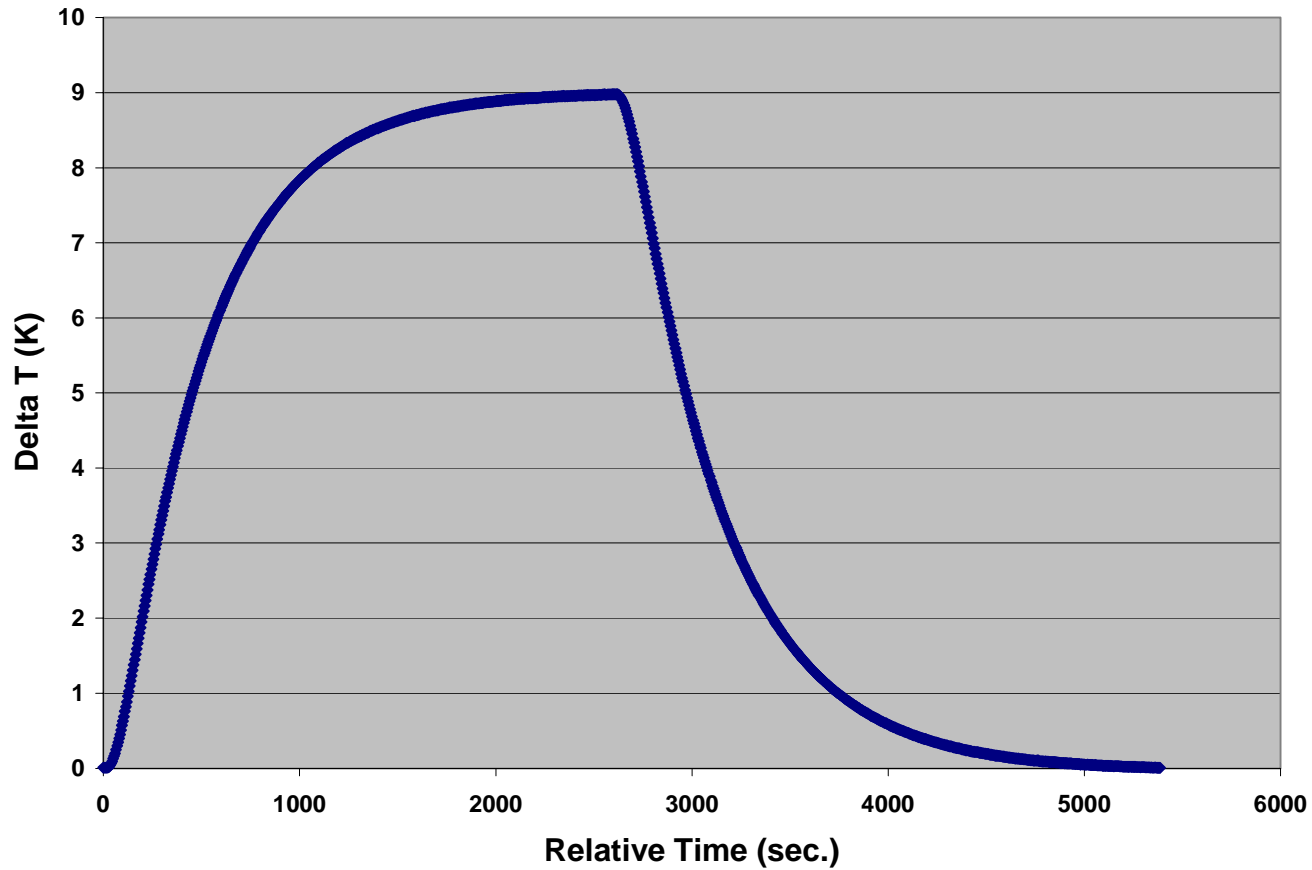
Cryopump Failure



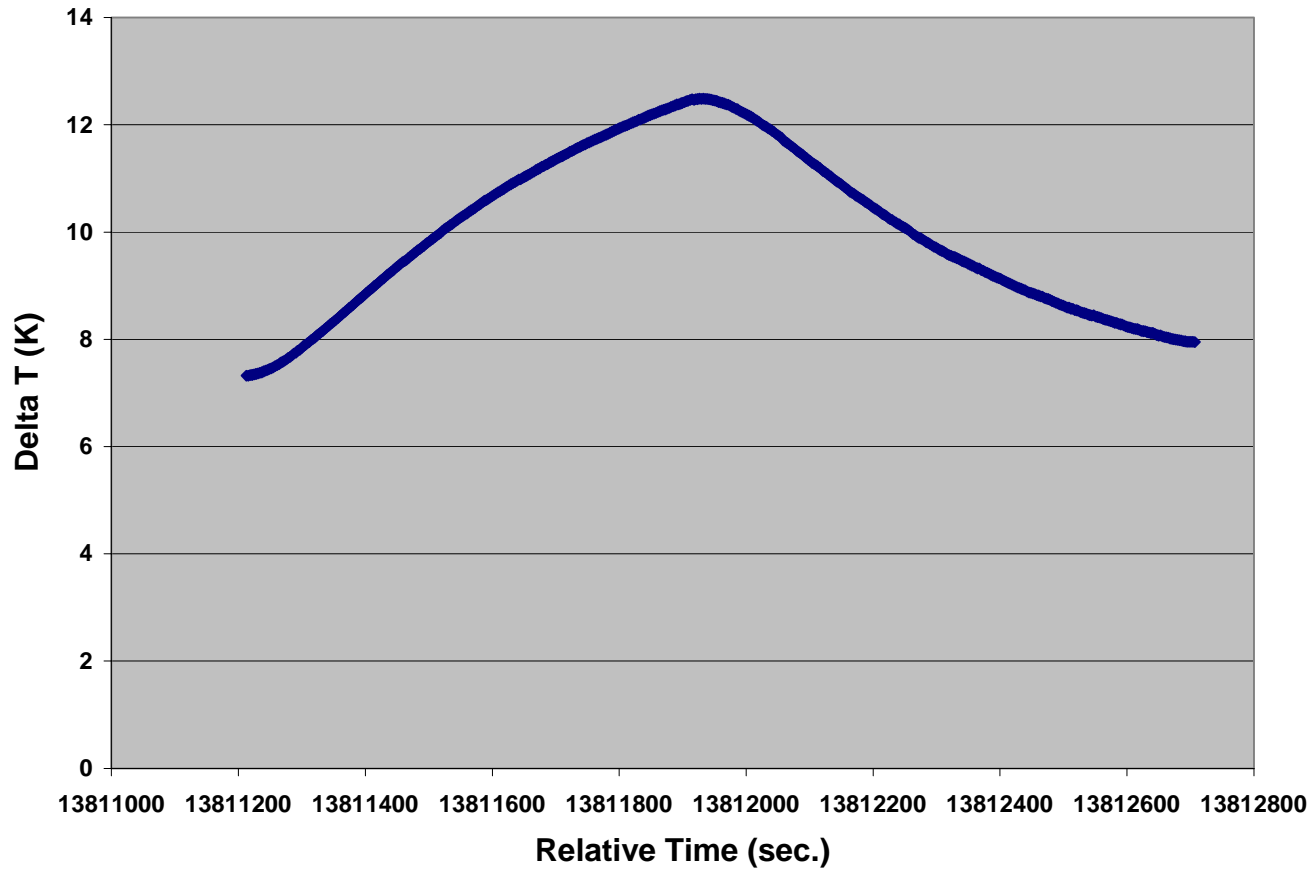
Continuous Measurement



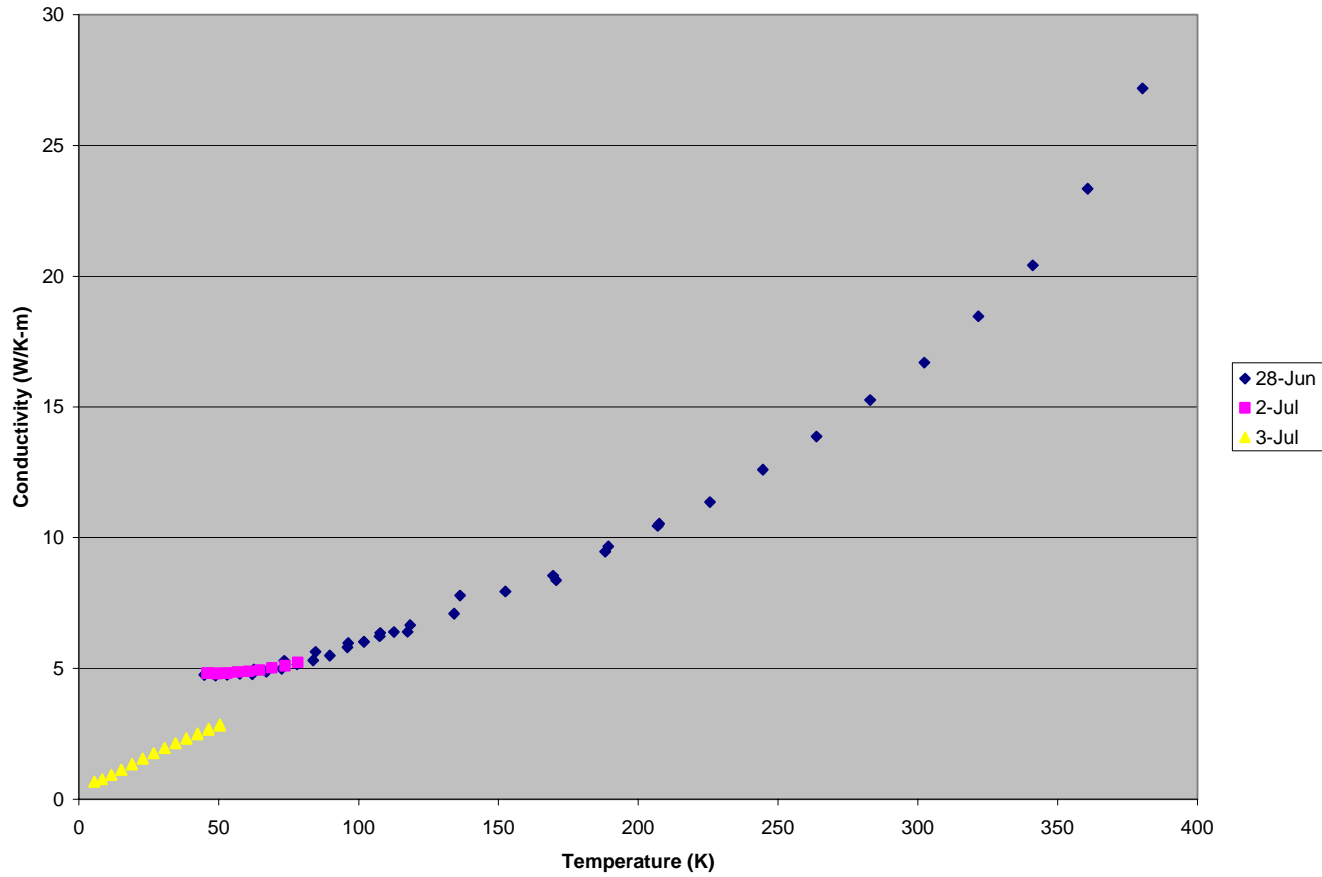
Ideal Data Acquisition



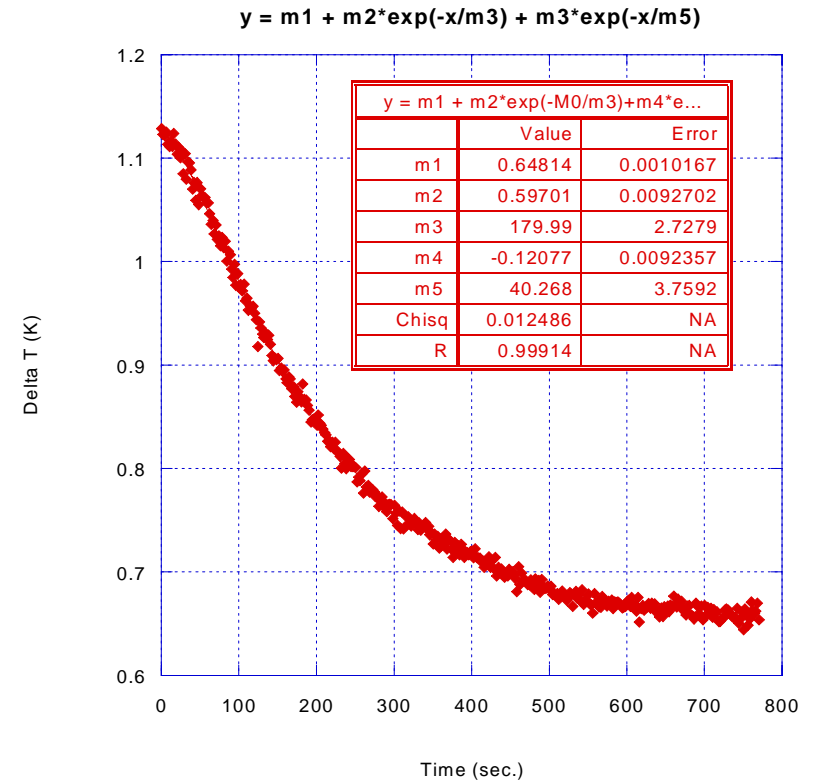
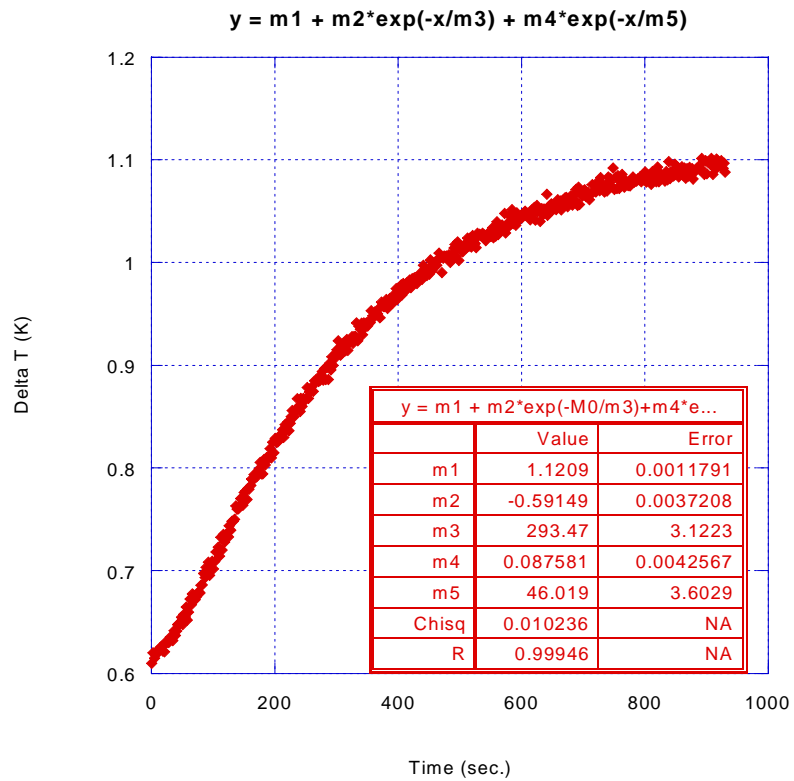
Poor Data Acquisition



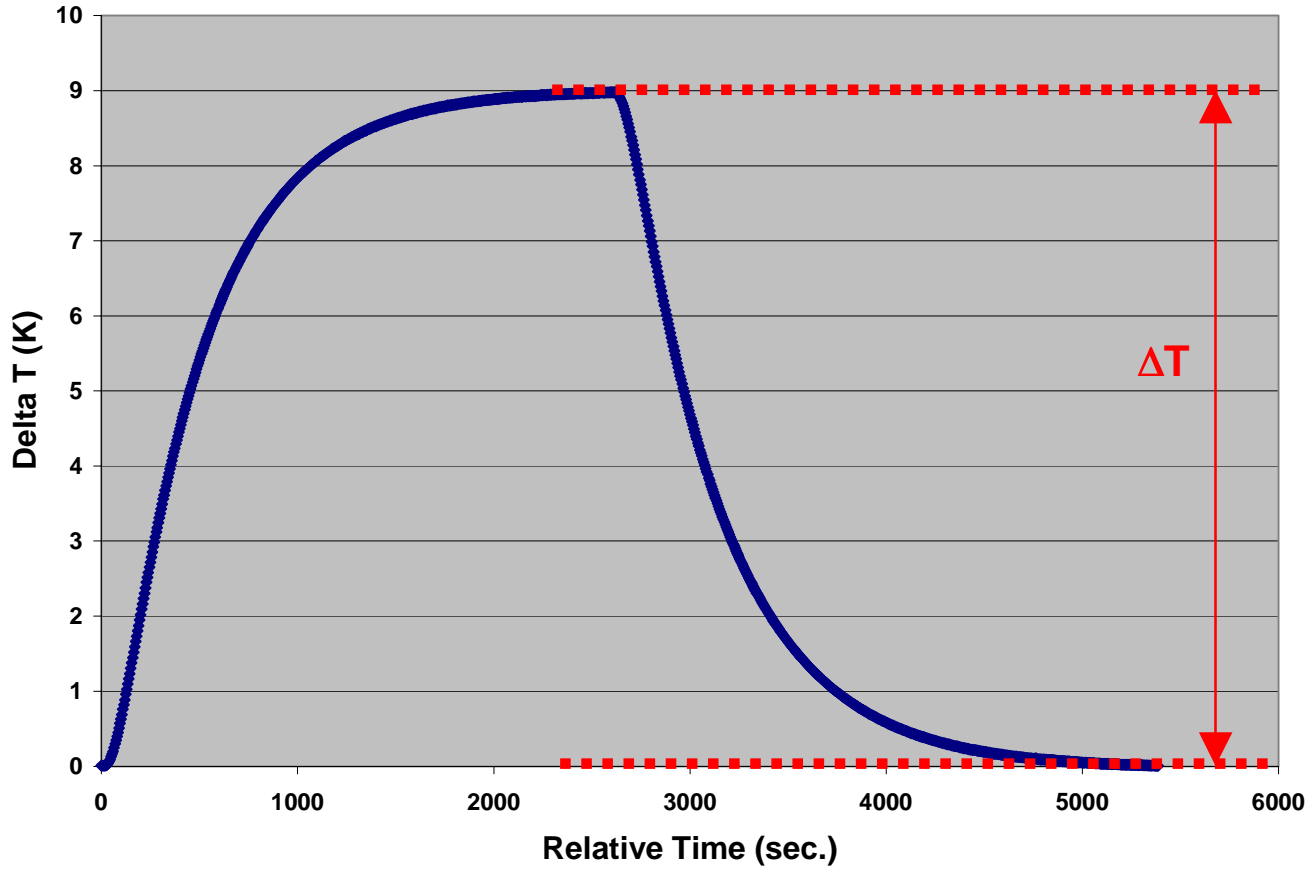
TTO – Stable Measurement



Data Processing



Data Processing



Thermal Transport Formulas

- Conductance
- $K = P/\Delta T$

- Conductivity
- $\kappa = [(P_{IN} - P_{RAD})/\Delta T - K_{WIRES}](L/A)$

- $P_{RAD} = \sigma\epsilon(S/2)(T_{HOT}^4 - T_{COLD}^4)$

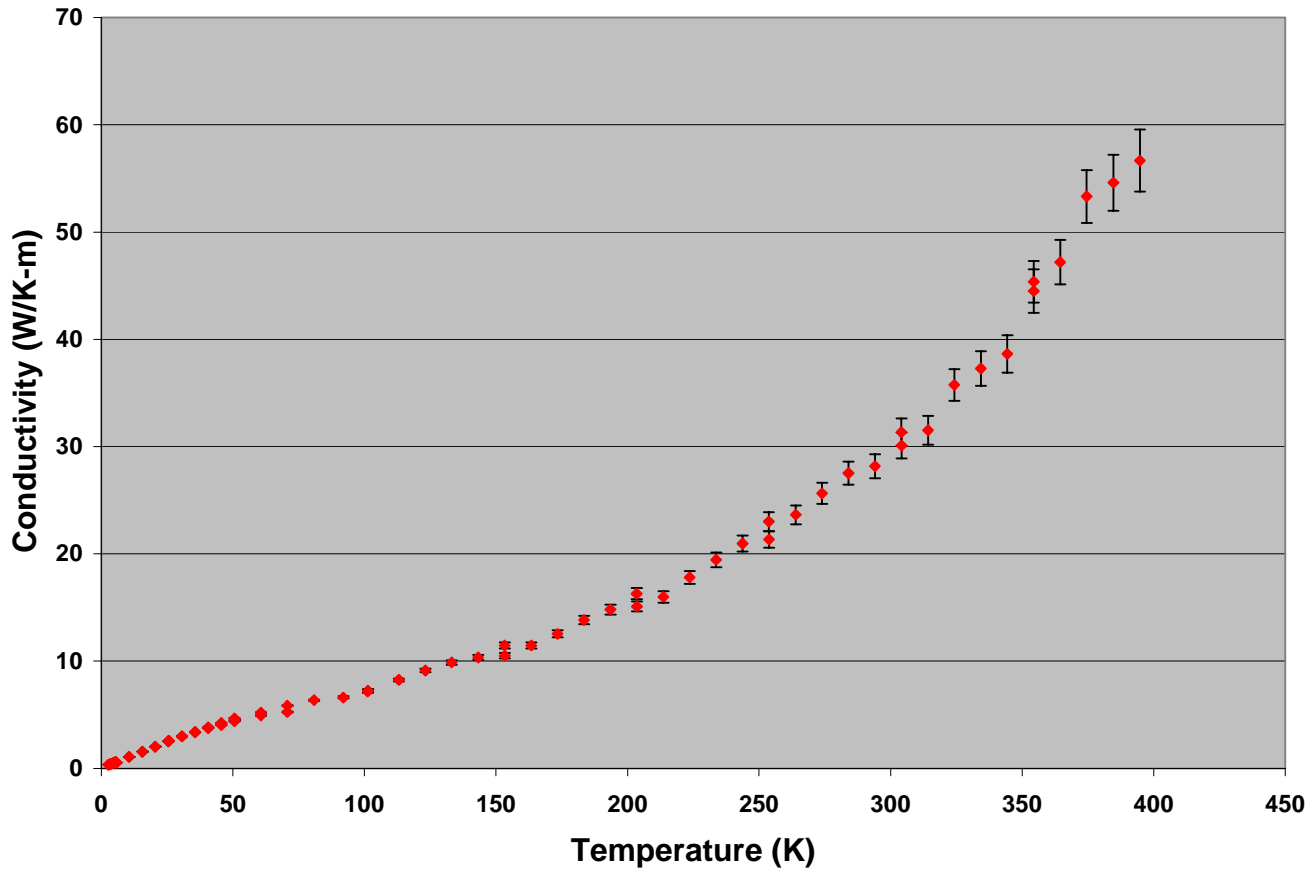
- K_{WIRES} is Measured Directly!



Measurement Adjustments

1. Stable Measurements
2. $\Delta T \sim 0.5\text{K} - 1.5\text{K}$
3. Measure Parasitic Conductance
4. Manual Data Processing

Thermal Conductivity



Heat Capacity - Theory

1. Generate Heat Pulse
2. Measure RC
3. Estimate Corrections
4. Calculate Heat Capacity!

- $\Delta T = T_{\infty} \exp[-t/R_8(C_P + C_G + C_S)]$

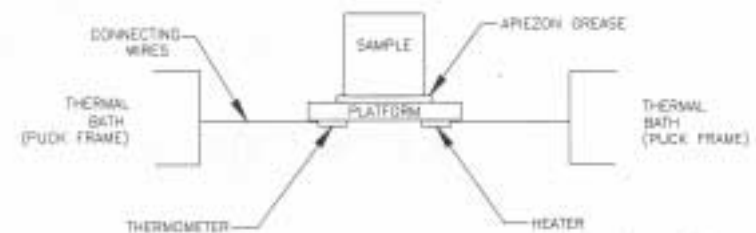
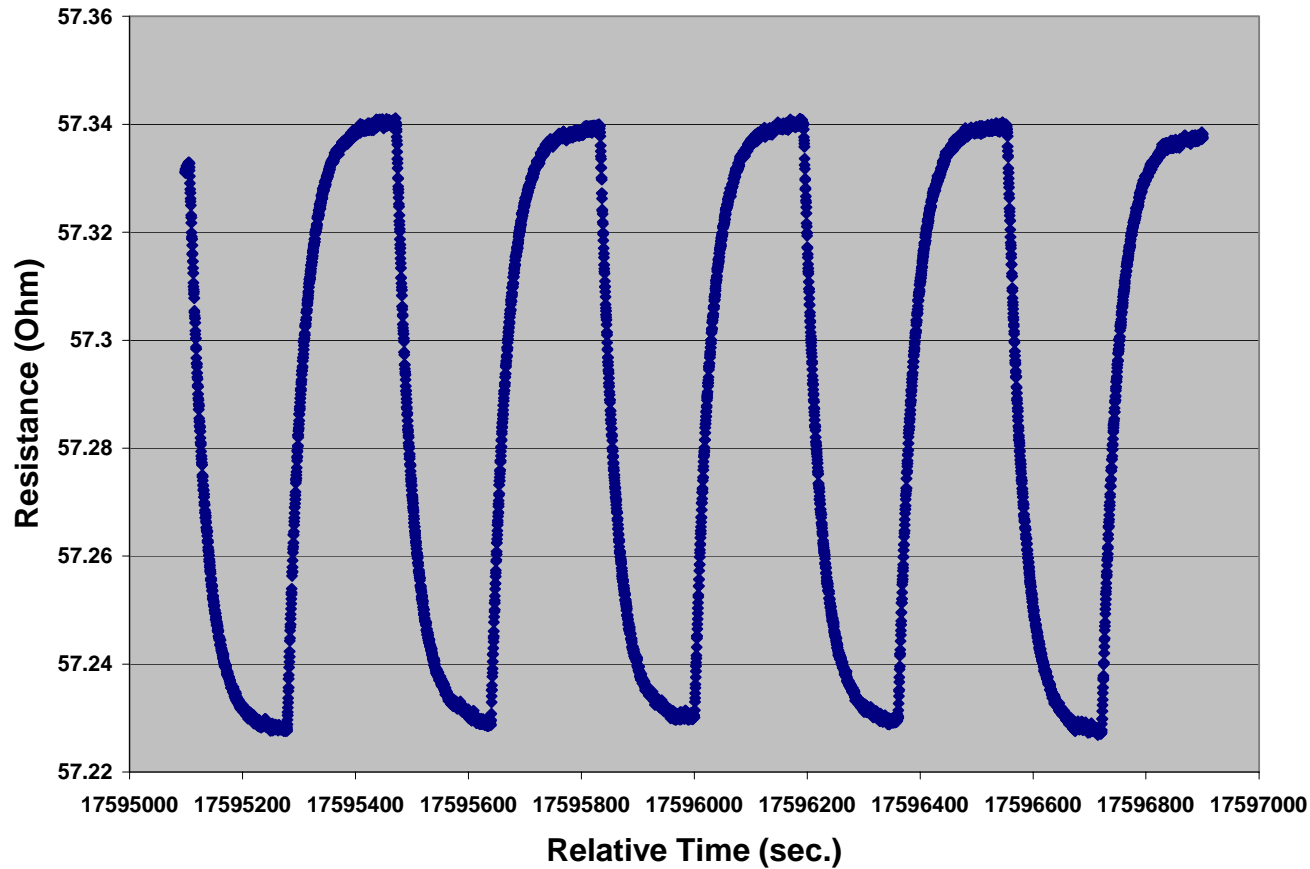


Figure 1-1. Thermal Connections to Sample and Sample Platform in PPMS Heat Capacity Option

Heat Capacity – Sample Data



Q Factor Measurement



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Thermal Properties / Undergraduate
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Creep Analysis / Undergraduate
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