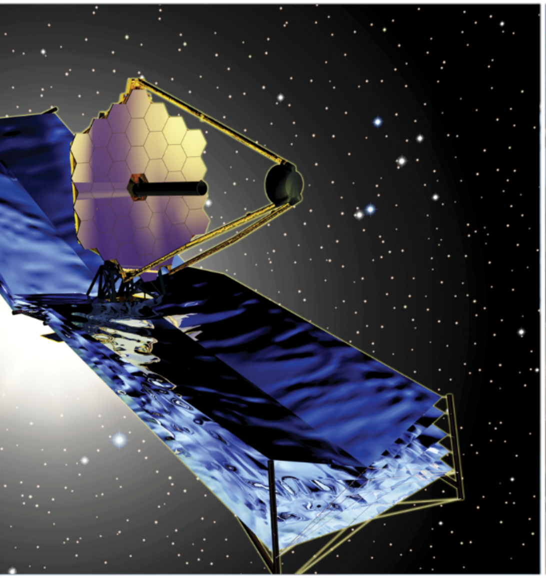
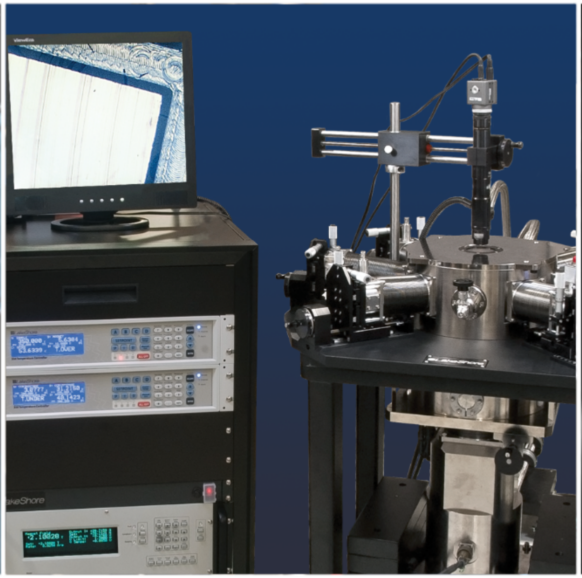
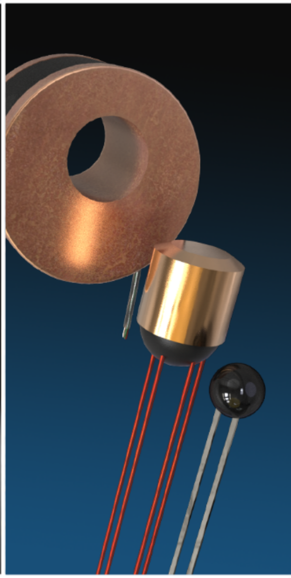
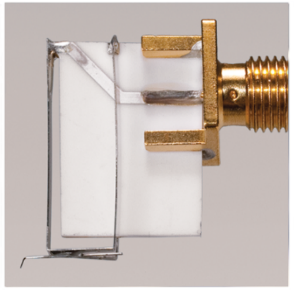
Lake Shore CRYOTRONICS









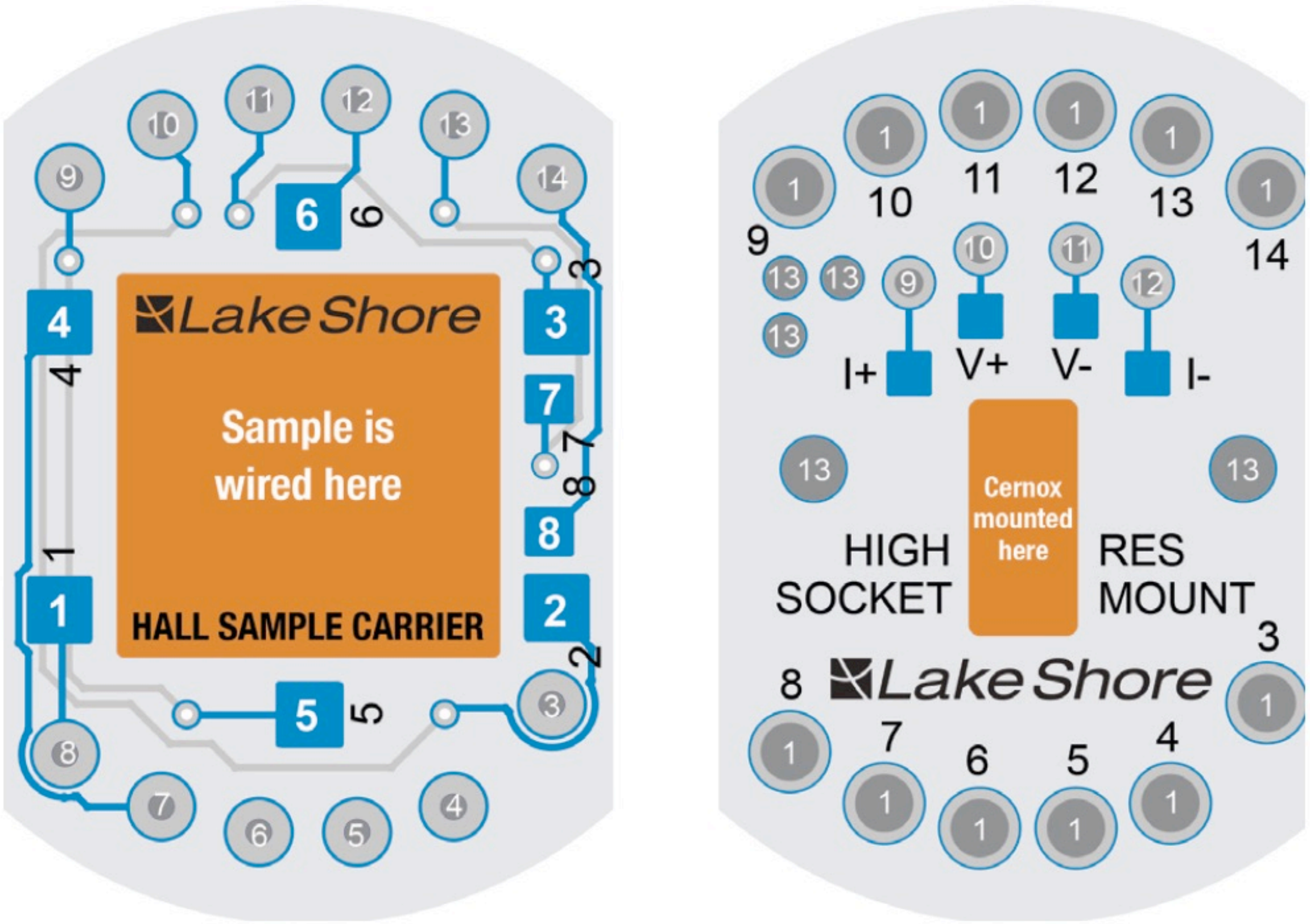
High Impedance Hall Measurements and the Fully Guarded Insert

Jeffrey Lindemuth

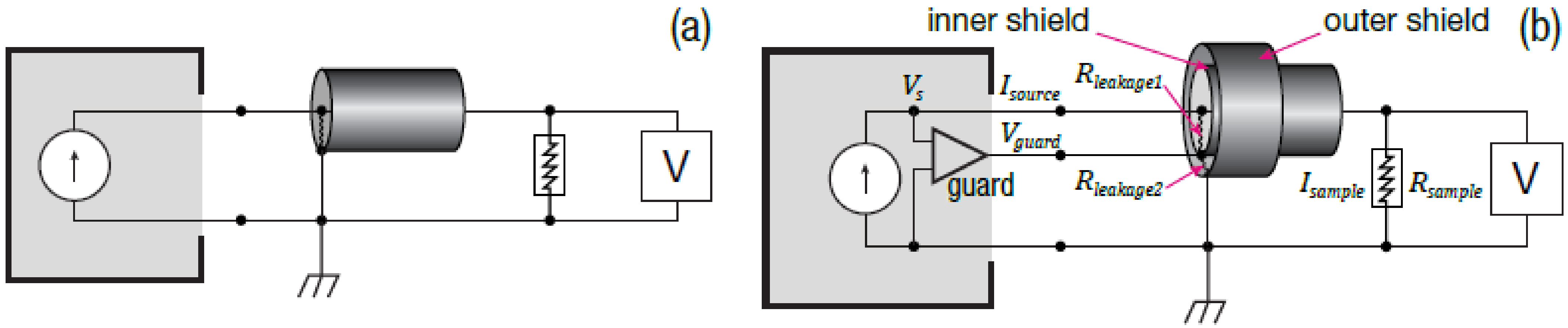
A Fully guarded insert for the PPMS

- Fully guarded from instrument to sample for low noise measurements
- Eight guarded connections
- M91-HR low-noise measurements and high resistance measurements up to 200 GΩ
- Electrically isolated common from the PPMS
- Samples mount to consumable Lake Shore sample carrier boards (also pin compatible with Quantum Design sample carrier boards)

Sample and Mounting and Cernox® sensor



What is a triax cable and why do I use it?



$$I_{source} = I_{leakage} + I_{sample}$$

$$= \frac{V_{meas}}{R_{leakage}} + \frac{V_{meas}}{R_{sample}}$$

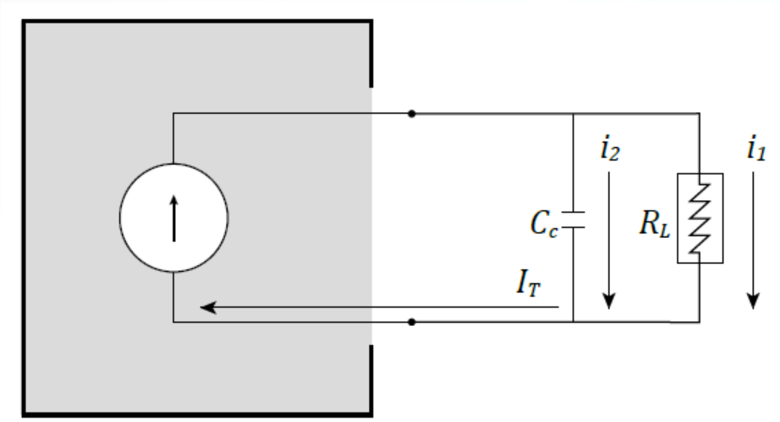
$$R_{meas} = \frac{V_{meas}}{I_{source}} = \frac{R_{sample} \cdot R_{leakage}}{R_{sample} + R_{leakage}}$$

$$V_{source} = V_{guard}, \text{ so } V_{R_{leakage1}} = 0 \text{ and } I_{leakage} = 0$$

$$I_{source} = I_{sample}$$

$$R_{meas} = \frac{V_{meas}}{I_{source}} = R_{sample}$$

Why reduce the capacitance?



$i_1 = I_T(1 - e^{-t/R_L C_c})$ $\quad$ $i_2 = I_T e^{-t/R_L C_c}$

Do not forget about current reversal

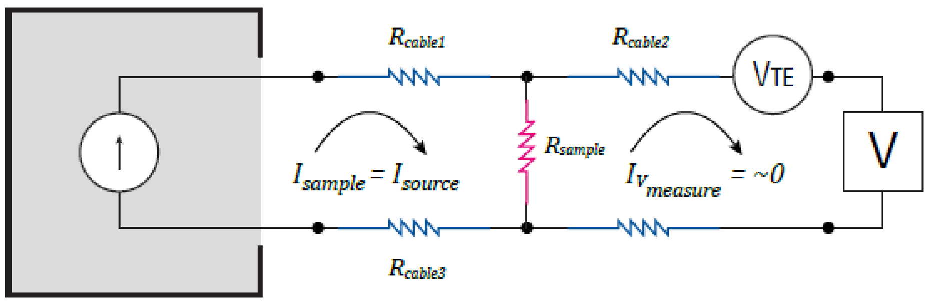


Figure 53 4-wire resistance measurement included cable resistance.

$$V_{cs} = I(R_{cable1} + R_{Sample} + R_{cable2})$$

$$V_{meas}(I_1) = I_1 R_{Sample} + V_{TE}$$

$$V_{meas}(I_2) = I_2 R_{Sample} + V_{TE}$$

$$R_{sample} = \frac{V_{meas}(I_1) - V_{meas}(I_2)}{I_1 - I_2}$$

For more best practice on low noise high resistance measurements download the Hall Measurement Handbook from the Lake Shore web site.

Example measurements

Semi-Insulating GaAs

Mobility	SE	CC	SE	Resistiviy	SE	Hall voltage	SE	type
cm²/(V·s)	cm²/(V·s)	$1/cm^2$	$1/cm^2$	ohm/sqr	ohm/sqr	volts	volts	
2.24E+03	4.76E-03	1.24E+06	2.64E+02	2.25E+09	1.26E+06	-1.80E-01	3.83E-05	n

Low mobility NiO

Mobility	SE	CC	SE	Resistiviy	SE	Hall voltage	SE	type
cm²/(V·s)	cm²/(V·s)	$1/cm^2$	$1/cm^2$	ohm/sqr	ohm/sqr	volts	volts	
0.0457	0.0039	1.66E+11	1.41E+10	8.22E+08		9.32E-04	7.91E-05	p