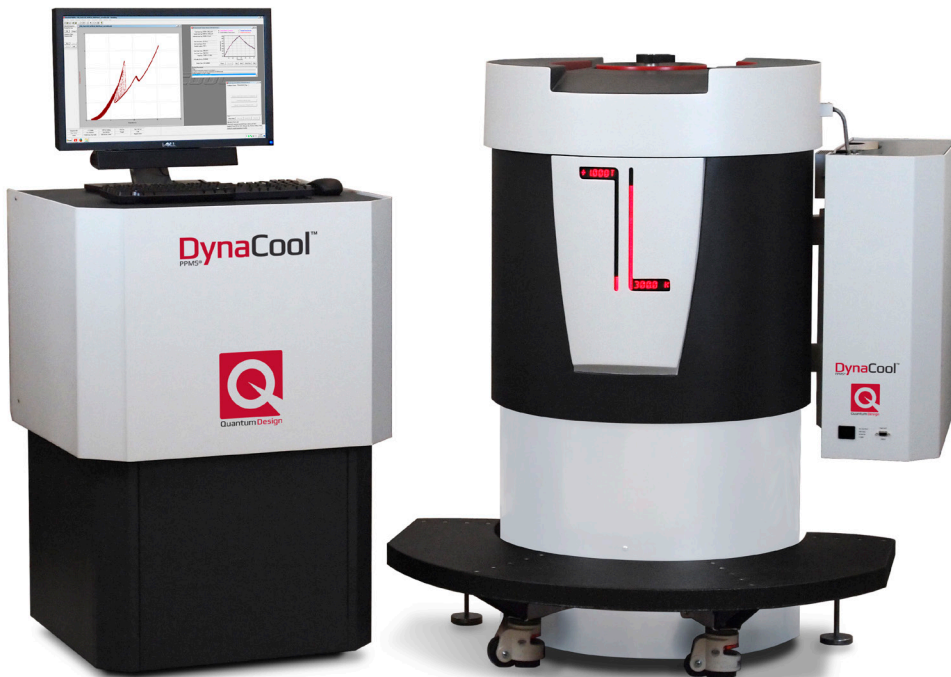


# FastHall™ Analysis Kits for Hall Measurement Integration with Quantum Design PPMS®

Measure**LINK**™



# Introduction

Cut your measurement time up to one half with the MeasureReady® M91 FastHall™ measurement controller. Measurements are so fast, time-dependent misalignment errors are eliminated using the patented FastHall™ measurement technique.

- FastHall eliminates the need for field reversal
- Up to 100× faster for low-mobility materials
- Lower mobilities can be measured using lower fields

Combine the measurement power of a FastHall Controller with Quantum Design's Physical Property Measurement System (PPMS). In partnership with Quantum Design, the M91 can now be seamlessly integrated with a PPMS measurement application. Two kits are available to easily integrate the M91 into a PPMS:

- Standard resistance: low-cost option that uses a Lake Shore feedthrough box to connect the M91 to the PPMS
- High resistance: low-noise, fully guarded Lake Shore insert



## M91 electrical measurement specifications

The M91 FastHall measurement controller integrates all the required source measure and signal switching capabilities to provide a complete start-to-finish Hall analysis.

### Resistance (R)

Standard: 10 mΩ to 10 MΩ source current

High resistance\*: Up to 200 GΩ source voltage

### Mobility (μ)

Mobility range: 10<sup>6</sup> cm<sup>2</sup>/(V s) to 0.001 cm<sup>2</sup>/(V s)

### Parameters

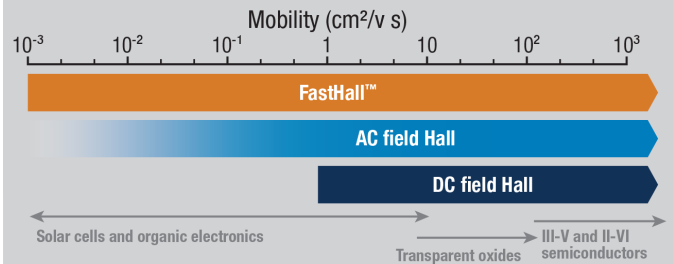
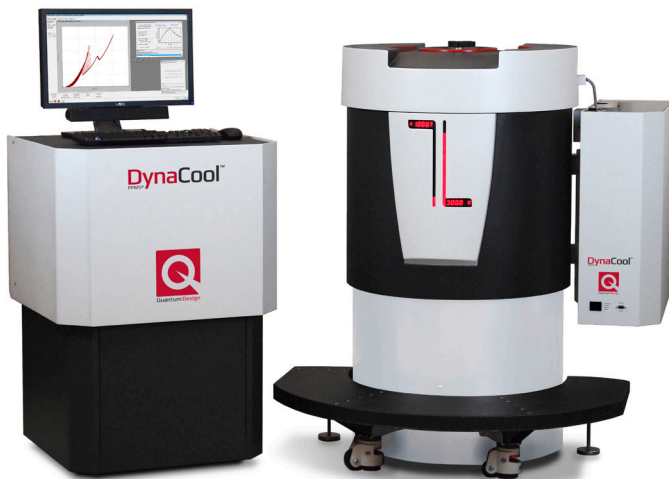
Current source range: 1 μA to 100 mA (lowest usable: 10 nA)

Current measurement range: 100 mA to 10 nA (lowest measurable: 1 pA)

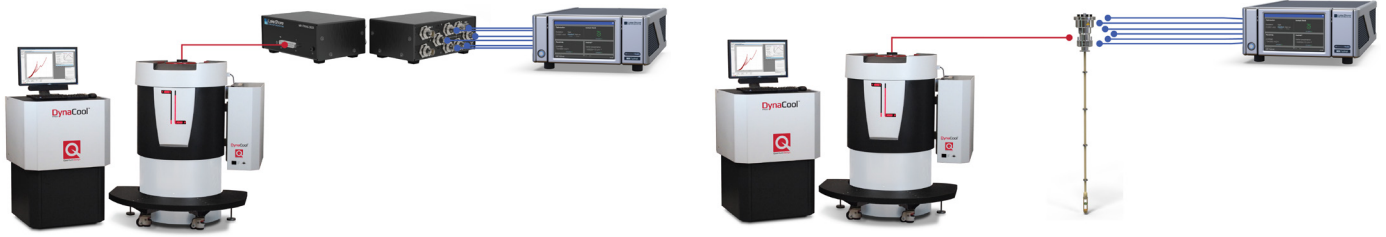
Voltage source range\*: 10 mV to 10 V

Voltage measurement range: 1 mV to 10 V

\* Only available with M91-HR (high resistance) model



## Connection kit comparison



Standard resistance  
up to 10 MΩ

High resistance  
up to 200 GΩ

Benefits	<p>Benefits with M91 integration:</p> <ul style="list-style-type: none"> <li>■ Cut measurement time up to one half with no field reversal needed</li> <li>■ Switching technique minimizes thermal drift</li> <li>■ Eliminates manual trial-and-error steps with optimized calculations</li> </ul>	<p>Additional benefits with M91 + Lake Shore insert:</p> <ul style="list-style-type: none"> <li>■ Fastest measurements with reduced settling times</li> <li>■ Best performance for low-noise, low-current measurements</li> <li>■ Fully guarded from instrument to sample</li> </ul>
Cost	\$	\$\$
Resistance range	10 mΩ to 10 MΩ	10 mΩ to 200 GΩ
Integration	M91/PPMS integration with feedthrough box	M91/PPMS integration with low noise, fully guarded insert
FastHall model	M91 (standard)	M91-HR (high resistance)
FastHall excitation	Current source	Current source, voltage source
Sample mounting	PPMS sample puck	Lake Shore sample board
Signal path	Standard twisted pair wiring	Fully guarded (internal coaxial) from instrument to sample
Mobility	10 <sup>6</sup> cm <sup>2</sup> /(V s) to 0.001 cm <sup>2</sup> /(V s)	
Sample types	Supports van der Pauw and Hall bar samples	
Temp sensor	Integrated Cernox <sup>®</sup> temperature sensor local to sample	
Control software	FastHall's MeasureLINK <sup>®</sup> software for Hall measurement control integrates easily with the PPMS MultiVu <sup>™</sup> application software	

# Standard resistance kit — PPMS/M91 integration via Lake Shore feedthrough box



Diagram 1: PPMS connected to the M91 via feedthrough box

## Features

- Low-cost option
- Compatible with Quantum Design PPMS puck
- M91 resistance measurements up to 10 MΩ

## Sample connections

The M91 supports both van der Pauw (4 connections) and Hall bar (6 connections) geometries. These samples should be wired to Quantum Design’s PPMS sample puck as shown in Diagram 2. When inserted into the PPMS, these sample connections are present on the LEMO connector on the side of the PPMS. The M91-TRIAX-DB25 feedthrough box enables these pins to connect to the M91. Six triaxial cables are included in the kit. Note: guarding is only up to the feedthrough box.

Gray LEMO (puck) pins	Fast-Hall triaxial
3 (CH 1, I+)	1
7 (CH 2, I+)	2
8 (CH 2, I-)	3
12 (CH 3, I-)	4
4 (CH 1, I-)	5
11 (CH 3, I+)	6
10 (CH 2, V-)	AUX 1
9 (CH 2, V+)	AUX 2
6 (CH 1, V-)	Measure common

Note:  
Internal jumper on measure common:  
Gray LEMO pin 6, puck CH 1, V-  
P1-user bridge D shield, pin 13

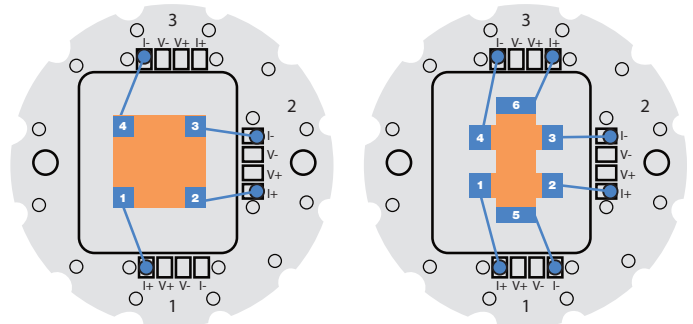


Diagram 2: Pinning for PPMS sample puck

# High resistance kit — PPMS/M91 integration via Lake Shore insert



Diagram 3: PPMS connected to the M91 with the Lake Shore insert

## Features

- Fully guarded from instrument to sample for ultra-low noise measurements
- M91-HR resistance measurements up to 200 GΩ
- Samples mount to consumable Lake Shore sample carrier boards (also pin compatible with Quantum Design sample carrier boards); 12 are included

## Specifications summary

Triaxial center conductor leakage current	<500 fA
Max current per pin	100 mA
Max voltage between any 2 pins and insert body	50 V
Operating temperature range	1.9 K to 400 K

## Sample connections

Diagram 3 generally shows how the PPMS/M91 connection is made via the insert (Diagram 4) supplied by Lake Shore.

The M91 supports both van der Pauw (4-connection) and Hall bar (6-connection) geometries. These samples are wired to the Lake Shore sample board (Diagram 5). The sample board then snaps into the sample insert board located on the probe (Diagram 6).

When the insert is loaded into the PPMS, these sample connections are fully guarded up to the M91 via triaxial cables (included in kit). The integrated Cernox® sensor connections go to the PPMS, enabling temperature readings directly through MultiVu. Diagram 7 shows a close up view at the working end of the insert.

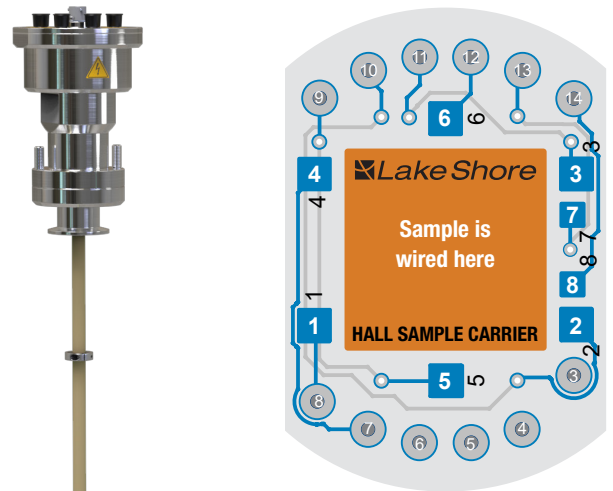


Diagram 5: Sample carrier board



Diagram 4: Lake Shore insert

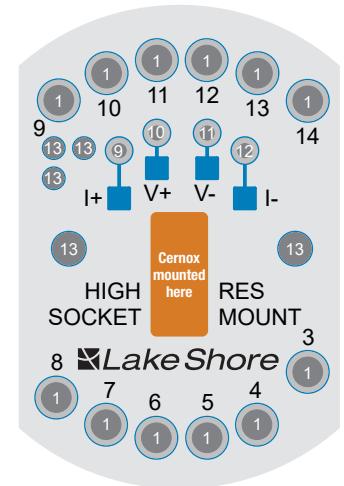


Diagram 6: Sample mount board

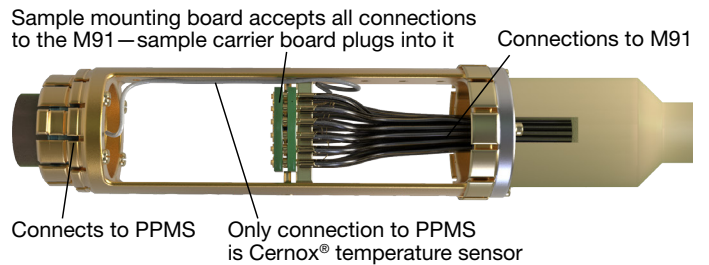
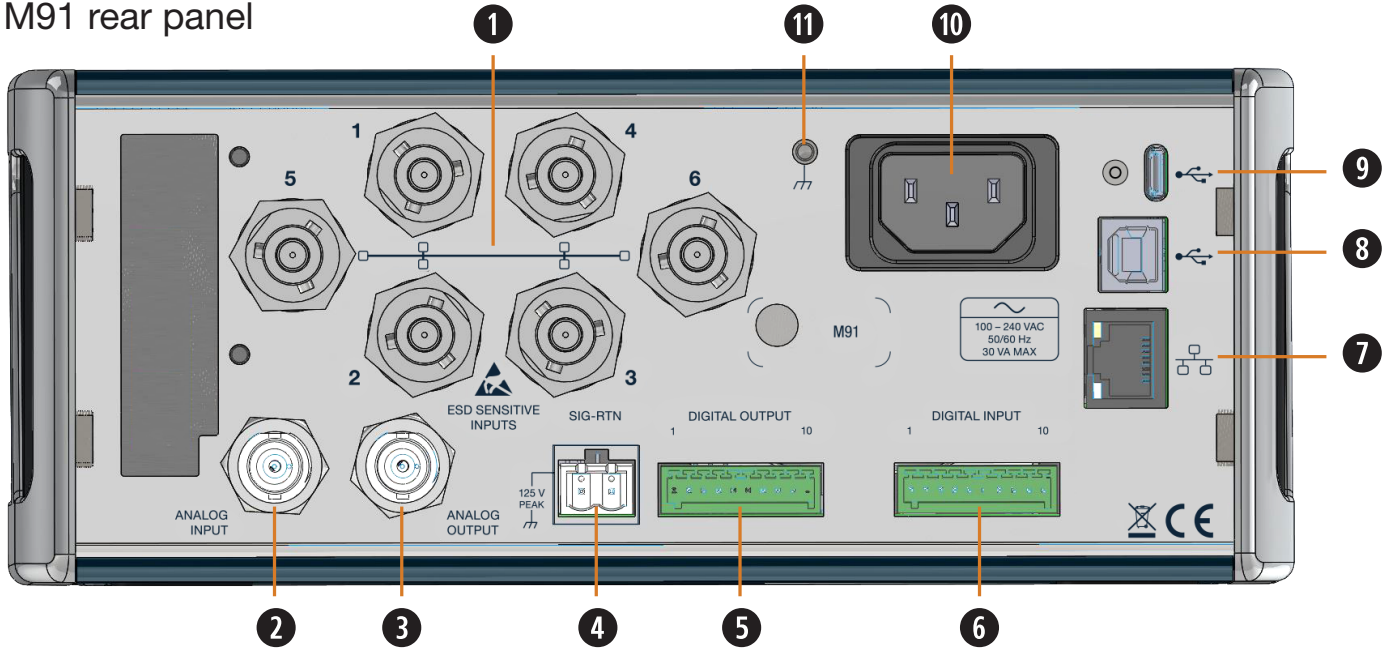


Diagram 7: Insert connections

# M91 rear panel

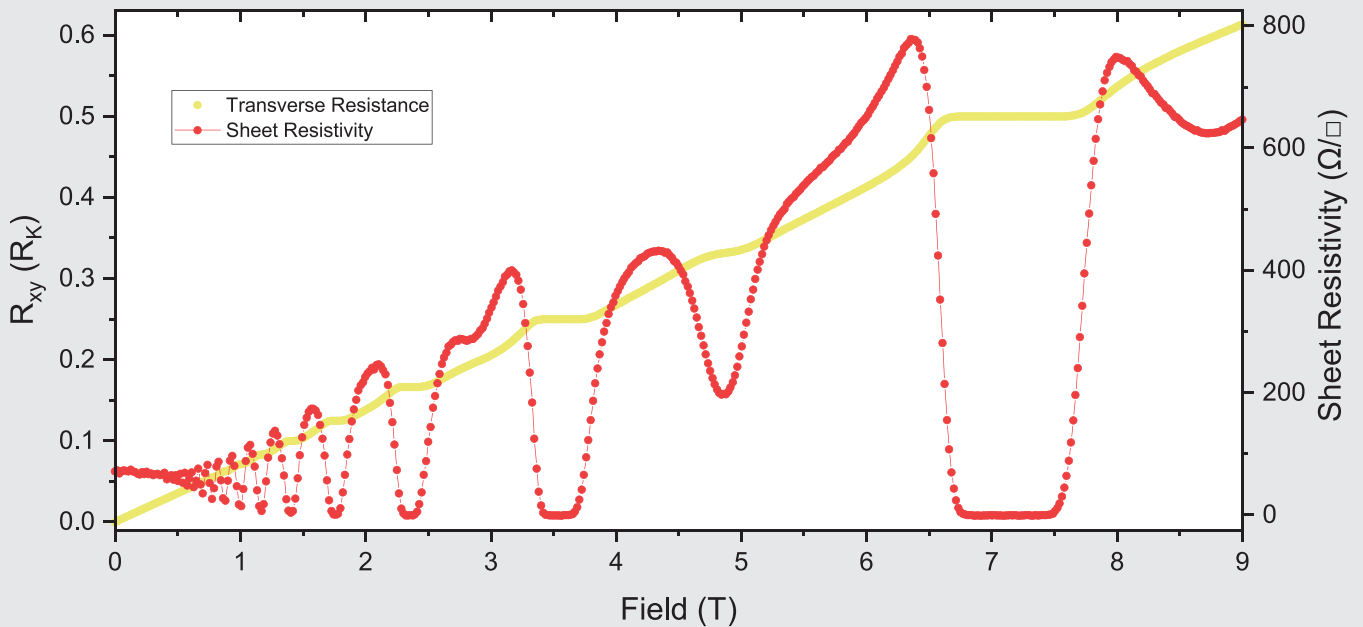


- ① Triaxial sample connectors
- ② Analog input
- ③ Analog output
- ④ Signal RTN
- ⑤ Digital output
- ⑥ Digital input
- ⑦ RJ-45 Ethernet interface
- ⑧ USB communications interface
- ⑨ USB thumb drive interface
- ⑩ Line input assembly
- ⑪ Chassis ground connection

Diagram 8: Back panel of M91 instrument

Field-dependent transverse and longitudinal transport measurements for a GaAs 2-D electron gas system at 2 K with 1  $\mu$ A sourced excitation current in the van der Pauw geometry. Plateaux in the transverse channel demonstrate the integer quantum Hall effect and correspond to where the Fermi level falls in an area of localized states between neighboring Landau levels.

Sample provided by Dr. M. Pendharkar, Chris Palmström Group, University of California Santa Barbara.





# MeasureLINK software

The M91's MeasureLINK™ software for Hall measurement control integrates easily with the PPMS MultiVu application software. MeasureLINK can be installed on the same PC with the MultiVu software or on a separate PC that is on the same network as the MultiVu PC.

Once installed, MeasureLINK:

- Provides a simple way to start and step through your measurement sequences, as well as chart, log, and organize the result
- Includes scripts for running Hall measurements and reporting the result
- Enables automated control of field and management of sample temperature
- Generates detailed reports including all the supporting intermediate data so you can readily confirm the integrity of the final results
- Allows for customization of measurement sequences for specific Hall research requirements (optional upgrade)

## Home screen

Three main functions:

- Sample setup
- Sequencing
- Scripting

## Sample setup screen

Associate sample information with a measurement sequence

Enter new sample information directly

Import sample information from previously-saved file

## Sequence screen

Build a sequence of steps that define the desired measurement protocol

Choose from:

## Measurement functions

- Built-in functions

## Control functions

- Go to field or temperature
- Loop field or temperature

## Custom measurements

- Modified or specialized routines, previously defined by scripts

## Script screen

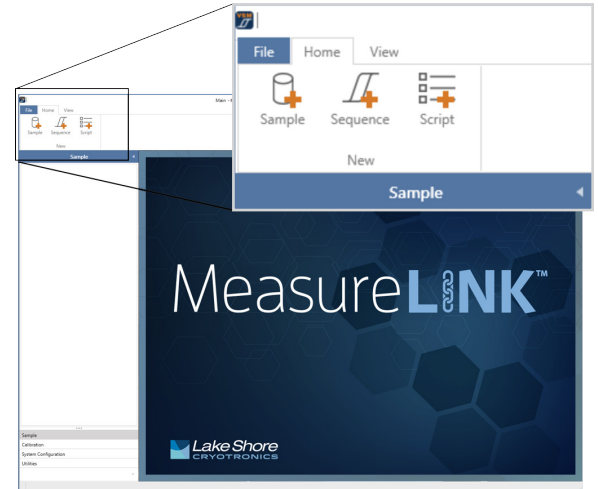
Extend your system functionality by creating custom scripts

- Implement nearly any measurement
- Integrate third-party instruments

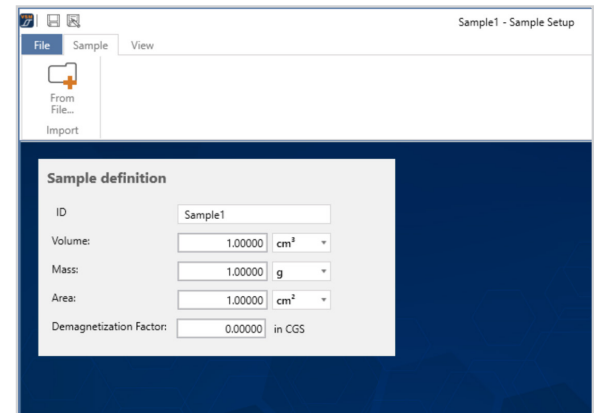
Modify existing scripts

Import other scripts

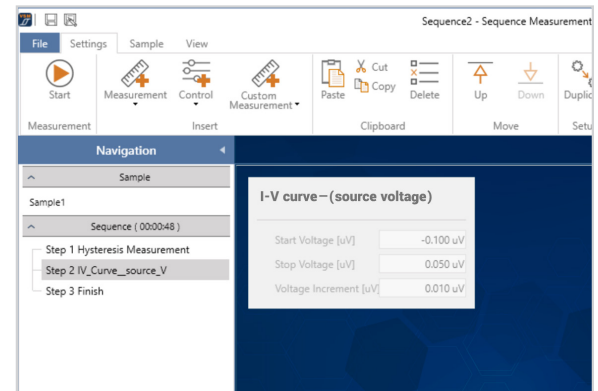
Simpler and faster than writing code



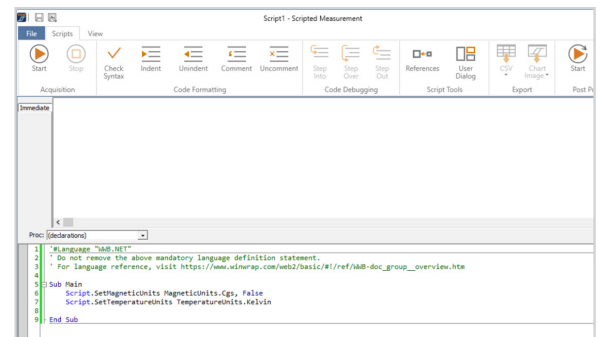
Home screen



Sample setup screen



Sequence screen



Script screen

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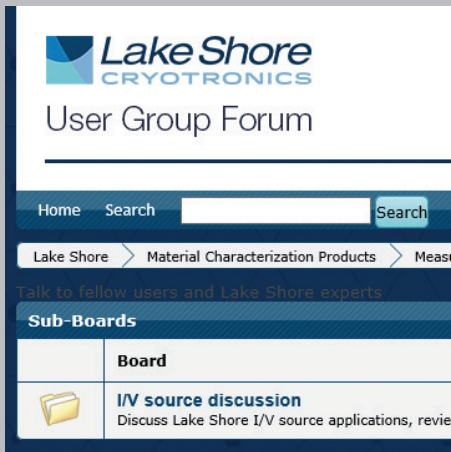
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### Questions? Answers?

Visit <http://forums.lakeshore.com/> and become part of the conversation!



The screenshot shows the Lake Shore Cryotronics User Group Forum interface. At the top left is the Lake Shore Cryotronics logo. Below it is the text "User Group Forum". A navigation bar includes "Home" and "Search" with a search input field and a "Search" button. A breadcrumb trail reads "Lake Shore > Material Characterization Products > Meas". Below this is the text "Talk to fellow users and Lake Shore experts". A "Sub-Boards" section is displayed as a table:

Sub-Boards	
	<b>Board</b>
	<b>I/V source discussion</b> Discuss Lake Shore I/V source applications, review