



# cryogenics

**material characterisation at low temperatures**

Introducing the new  
pinnacle of cryogenic  
nanopositioners

**Interview: Prof  
Jason Robinson**

**Quantum Design  
Opens First  
University Laboratory**

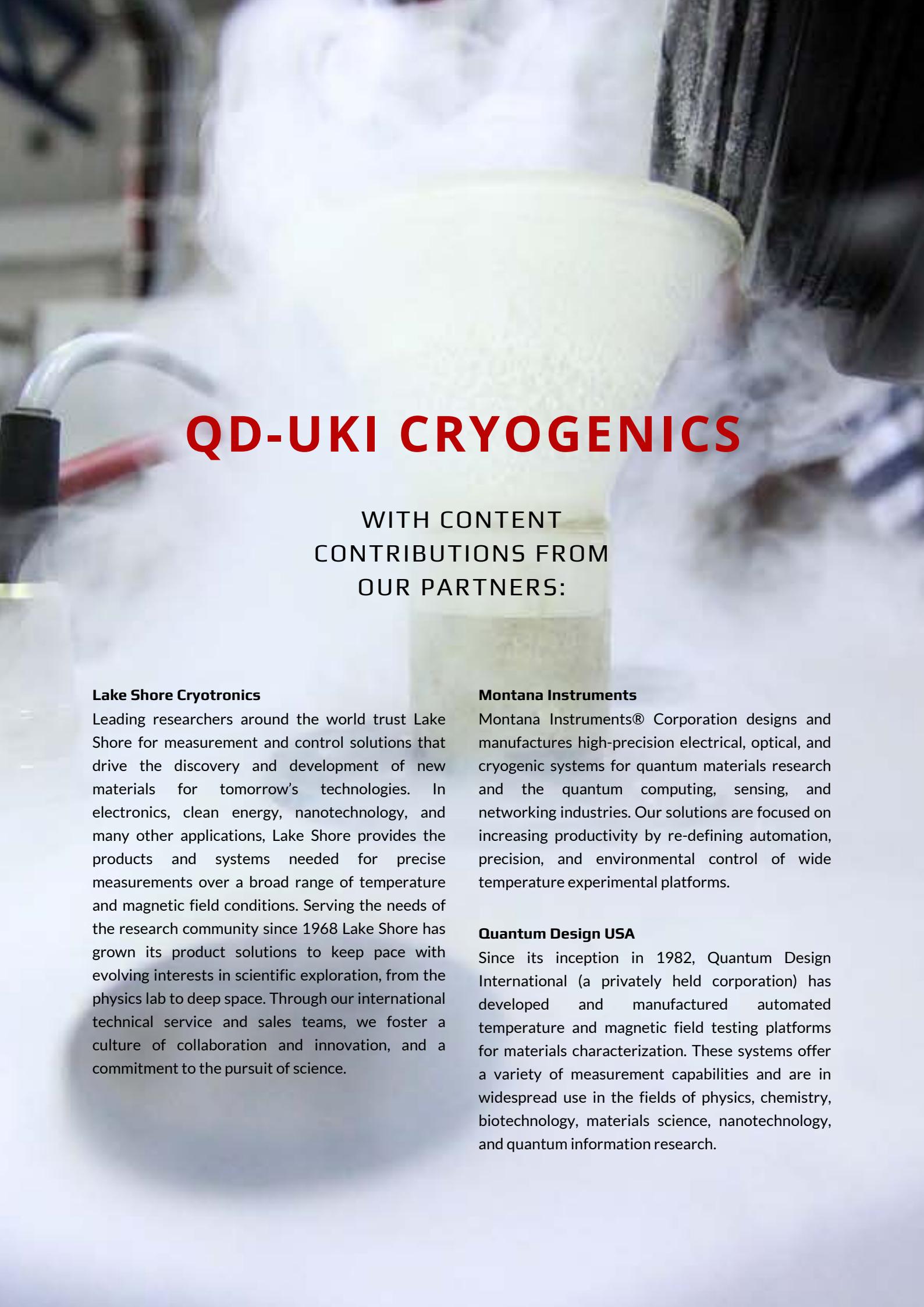
**MEET THE UK SERVICE &  
APPLICATIONS DEPARTMENT**

**RUN AN LHE CRYOSTAT  
WITHOUT THE LHE**

**NEW:  
CryoComplete**

**New Frontiers:  
Quantum Computing**

**OptiCool Used for  
Near-field Optical  
Microscopy For the  
First Time Ever**



# QD-UKI CRYOGENICS

WITH CONTENT  
CONTRIBUTIONS FROM  
OUR PARTNERS:

## **Lake Shore Cryotronics**

Leading researchers around the world trust Lake Shore for measurement and control solutions that drive the discovery and development of new materials for tomorrow's technologies. In electronics, clean energy, nanotechnology, and many other applications, Lake Shore provides the products and systems needed for precise measurements over a broad range of temperature and magnetic field conditions. Serving the needs of the research community since 1968 Lake Shore has grown its product solutions to keep pace with evolving interests in scientific exploration, from the physics lab to deep space. Through our international technical service and sales teams, we foster a culture of collaboration and innovation, and a commitment to the pursuit of science.

## **Montana Instruments**

Montana Instruments® Corporation designs and manufactures high-precision electrical, optical, and cryogenic systems for quantum materials research and the quantum computing, sensing, and networking industries. Our solutions are focused on increasing productivity by re-defining automation, precision, and environmental control of wide temperature experimental platforms.

## **Quantum Design USA**

Since its inception in 1982, Quantum Design International (a privately held corporation) has developed and manufactured automated temperature and magnetic field testing platforms for materials characterization. These systems offer a variety of measurement capabilities and are in widespread use in the fields of physics, chemistry, biotechnology, materials science, nanotechnology, and quantum information research.

# Contents

- 4 - Foreword
- 5 - Combine the Lake Shore M91 with the Quantum Design PPMS®
- 7 - Guarded insert for PPMS®
- 8 - NEW: CryoComplete from Lake Shore
- 11 - OptiCool News
- 12 - OptiCool Used for Near-Field Optical Microscopy for FIRST TIME EVER
- 13 - NEW: QD Teaching and Materials Discovery Laboratory
- 16 - Quantum Design: Educating Tomorrow's Researchers
- 19 - The New Pinnacle of Cryogenic Nanopositioners
- 22 - Meet the UK Service & Applications Department
- 23 - Kick Start Your Quantum Research
- 25 - New Frontiers: Quantum Computing
- 27 - Interview: Prof Jason Robinson
- 29 - Run an LHe Cryostat Without the LHe

# CRYOGENICS

A MAGAZINE FROM QUANTUM DESIGN UK AND IRELAND

## Highlights

### RUN AN LHE CRYOSTAT WITHOUT THE LHE

Introducing the new pinnacle of cryogenic nanopositioners

### INTERVIEW: PROF JASON ROBINSON

OptiCool Used for Near-field Optical Microscopy For the First Time Ever

New Frontiers: Quantum Computing

QUANTUM DESIGN OPENS FIRST UNIVERSITY LABORATORY



# FOREWORD

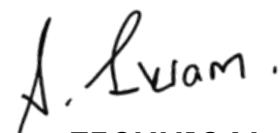
We at Quantum Design UK and Ireland (QDUKI) are delighted to present our second cryogenics magazine, featuring updates on new products, publications, and white papers related to our offerings.

Quantum Design is heavily involved in education and in this edition we explore various global initiatives from QD.

QDUKI has been deeply engaged in the field of Cryogenics, serving both as a manufacturer and a distributor of low-temperature instrumentation.

Our offerings include standout products like the unique MPMS3 and the widely acclaimed DynaCool. Moreover, we consistently expand our portfolio by providing materials characterisation solutions from other top-tier vendors.

We are confident that amongst our range of existing and brand new product offerings, will be the perfect solution to your current and upcoming research projects. Please do not hesitate to get in touch for an informal chat - we relish a scientific challenge.



Dr. S Ikram

**TECHNICAL DIRECTOR  
QUANTUM DESIGN UK AND IRELAND**

**DR. SHAYZ IKRAM**  
Technical Director



- QD Systems
- Lake Shore Cryostats

**DR. LUKE NICHOLLS**  
Technical Sales Manager



- Montana Instruments Shore Cryostats

**DR. JORDAN THOMPSON**  
Service Manager



- Quantum Design Products Installation, Service and Advice

**LIAM COLMAN**  
Field Service Engineer



- QD, Montana and Lake Shore Installation, Service and Advice

# Combine the measurement power of the Lake Shore M91, with the Quantum Design PPMS®



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

## 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

[DISCOVER THE M91 >](#)

## Lake Shore M91

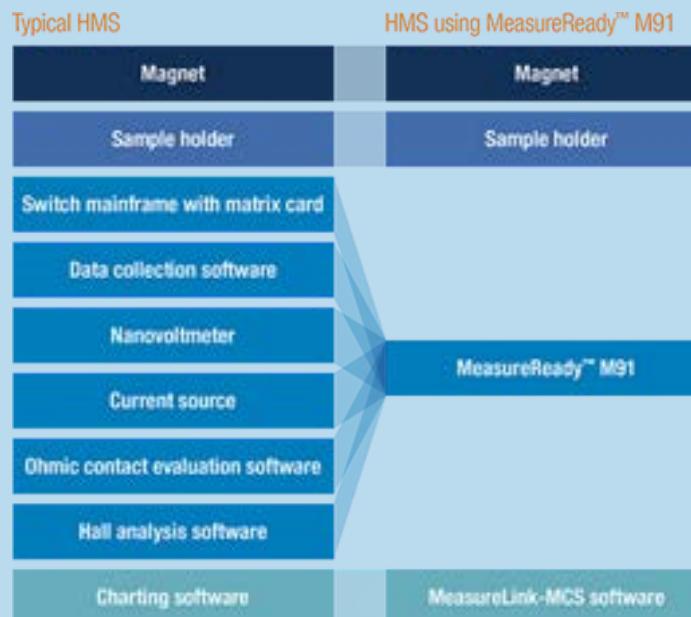


Executes a complete Hall measurement sequence:



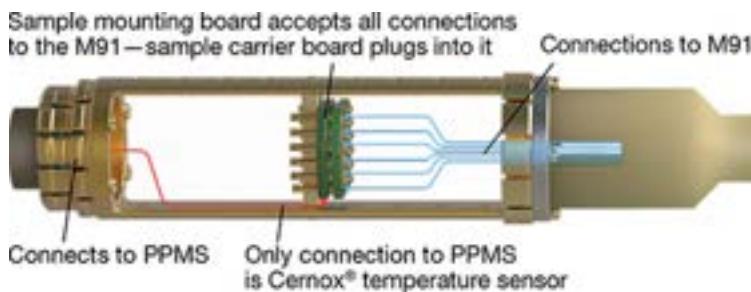
The M91 fundamentally changes the way the Hall effect is measured by eliminating the need to switch the polarity of the applied magnetic field during the measurement. This breakthrough results in faster and more precise measurements, especially when using high-field superconducting magnets or when measuring very low-mobility materials.

## Others' approach vs. the FastHall™ approach:



In collaboration with Quantum Design, Lake Shore has created a measurement kit to offer a complete Hall measurement solution. The M91 and Lake Shore's Hall insert can be seamlessly integrated into Quantum Design's PPMS. Plus, it is optimised for low noise and resistances up to 200 GΩ.

The diagram below is a close-up of the sample connections on the Hall insert. 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, which snaps inside the insert.



When the insert is loaded into the PPMS, these sample connections are fully guarded up to the M91 via triaxial cables (included in the kit). The integrated Cernox® sensor connections go to the PPMS, enabling temperature readings directly through MultiVu.

Samples mount to consumable Lake Shore sample carrier boards (also pin compatible with Quantum Design sample carrier boards); 12 are included in the kit.



NEW

## Guarded insert for PPMS®

The Lake Shore guarded insert can be used alone or with one of our PPMS Hall measurement packages that include the MeasureReady® M91 FastHall controller. Cut your measurement time up to one-half with the M91. Measurements are so fast that time-dependent misalignment errors are eliminated using the patented FastHall™ measurement technique.



### Features:

- Fastest measurement with reduced settling time
- Best performance for low-noise, low-current measurement
- Fully guarded from instrument to sample when used with the M91 FastHall™ controller

**Adding HMS capabilities to any research platform has never been easier.** If you'd like to learn more about the PPMS FastHall measurement packages, contact Shayz



### Get in touch

Contact our Technical Director: Dr. Shayz Ikram  
Telephone: (01372) 378822  
Email: [shayz@qd-uki.co.uk](mailto:shayz@qd-uki.co.uk)

# Spanning the cryogenic ecosystem



## CRYOCOMPLETE™ FROM LAKE SHORE CRYOTRONICS

Everything you need to make temperature-dependent, low-level electrical measurements from 77 K to 500 K



environment by  JANIS

With more than 55 years of experience in enabling scientific research with temperature sensors and instruments, Lake Shore's expanded mission on fully integrated research platforms provide customers with one source for all of the essential components in their system and the software to coordinate it all.

This leads to fewer variables, less uncertainty, and less setup time. The culmination of this is Lake Shore's new CryoComplete™ system, which provides everything you need to start making temperature-dependent, low-level electrical measurements.



[WWW.QD-UKI.CO.UK](http://WWW.QD-UKI.CO.UK)

**With CryoComplete™, you can start making cryogenic electrical measurements as soon as it lands in your lab.**

**From the simple-to-use, pour-fill LN2 Dewar to the prewritten I-V (resistance) measurement routines, CryoComplete produces results right out of the box.**

While easy to use, the system's performance doesn't disappoint. Its industry-leading measurement electronics promote low-level DC measurements and three full channels of lock-in AC capability—the keys to unlocking difficult measurements. Best of all, our cryogenic experts have designed CryoComplete from top to bottom, using cryogenic best practices, to deliver end-to-end system specifications.

#### PC with MeasureLINK™

A PC with MeasureLINK provides the user interface to control your cryogenic system. MeasureLINK enables a wide range of capabilities, including data charting, instrument control, and system monitoring with a cryostat-specific process view.

#### LN2 cryostat

The Environment by Janis VPF-100 sample in vacuum cryostat provides a variable-temperature sample environment from 77 K to 500 K. The pour-fill design allows quick and easy LN2 refills.

[MORE ABOUT CRYOCOMPLETE >](#)

#### Source + measure + lock-in

Run ultra-low-noise AC/DC measurements with the MeasureReady® M81-SSM synchronous source and measure system. In addition to the M81-SSM-4 instrument, it includes a BCS-10 balanced current source module and a VM-10 DC/AC/lock-in voltmeter module with a combined noise performance (differential) of 4.1 nV/√Hz

#### Temperature control

Control temperature within 50 mK with a Lake Shore Model 335 temperature controller, a Lake Shore precision-calibrated silicon diode, and a pre-wired heater. Advanced PID autotuning, pre-programmed sensor calibration, and default cryostat tuning enable fast setup and operation.



**To discuss the benefits that CryoComplete can bring to your lab, please get in touch with our Technical Director, Dr. Shayz Ikram by email or call (01372) 378822 today.**

BE SURE TO FILL  
IN WHICH  
AREAS INTEREST  
YOU AND WE'LL  
ONLY SEND  
INFO RELEVANT  
TO YOU

[www.qd-uki.co.uk](http://www.qd-uki.co.uk)

# NEVER MISS A THING

- case studies
- application notes
- webinars
- events
- workshop
- courses and more...

# FREE

## TEMPERATURE RESOURCES

Our partner Lake Shore Cryotronics has a wealth of educational resources to help you. As well as app notes and how-to guides, they also provide calibration services



[READ MORE >](#)

Compare sensor characteristics in our  
**TEMPERATURE SENSOR SELECTION GUIDE**

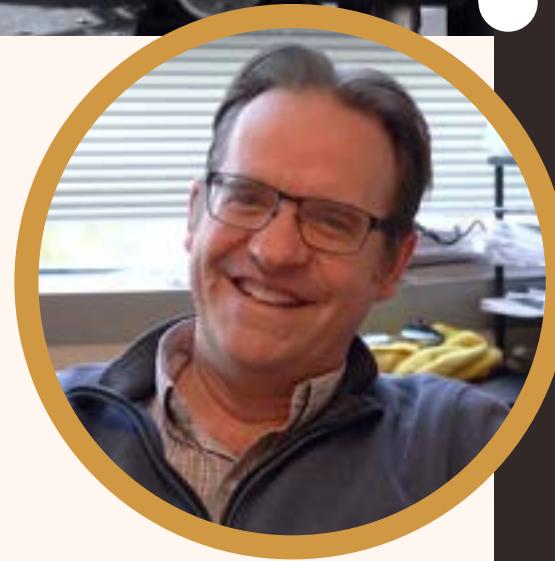




# OPTICOOL NEWS

## Quantum Design Receives New Patent for OptiCool

Quantum Design Receives New Patent for OptiCool! A patent entitled "A Low Vibration Cryocooled Cryostat" has been awarded by the US patent office to Quantum Design. The three inventors Dinesh Martien, Will Neils and Randy Black are pictured with the patent.



“

My area is condensed matter physics, and I use lasers to study the property of materials. I've had a great working relationship with Quantum Design. I started work with them incorporating the VersaLab into our undergraduate curriculum here. And so that VersaLab has been running for the better part of eight years.

So it's natural then that, having magnetic fields that this OptiCool opportunity arose. In terms of the research we've done in the OptiCool up to this point, has been primarily what we would call all-optical pump-probe spectroscopy; where we're bringing in different beams in the visible or infrared range. But a lot of my research over the years has been in the far infrared or terahertz. So I think that the OptiCool provides a really excellent opportunity to do novel far infrared spectroscopy on materials in a magnetic field environment.

The OptiCool has really nice optical access because the sorts of experiments we do, we have to bring in multiple optical beams to be able to excite a sample and then probe these dynamics in a time resolved fashion.

### The OptiCool by Quantum

**Design** is an optical cryostat using an innovative design that puts the sample volume in the heart of your optical environment. And one of our users has been the first person to ever attempt to use the OptiCool in a completely different way.

[DISCOVER THE OPTICOOL >](#)

The magnetic field allows us to tune the properties of the materials and then look at the dynamics of the materials that we're studying as a function of magnetic field and, of course, as a function of temperature. So just the ability to have these degrees of freedom when we're doing these dynamic studies of quasiparticles inside of solids, it's very powerful. The automation of the OptiCool really facilitates these measurements. We can take continuous data and really get high quality data, run overnight. We can get more data per unit time than we would be able to do if the software wasn't so easy to use.”



# OptiCool Used for Near-field Optical Microscopy For the First Time Ever

ONE OF THOSE USING THE OPTICOOL IN NEW AND INVENTIVE WAYS IS MENGKUN LIU, A FORMER STUDENT OF RICHARD AVERITT...

“ I work with near-field optical microscopy, an optical microscope that beats the diffraction limits so we can look at optical properties of materials at nanoscale. So this is actually a combination of optics and scanning probe microscopy. Rick Averitt my PhD advisor spoke very highly of the OptiCool and then I talked to many colleagues. They suggested that this might be possible for scanning probes. I needed a closed-cycle system which will be ultra stable, especially for the scanning probe.”

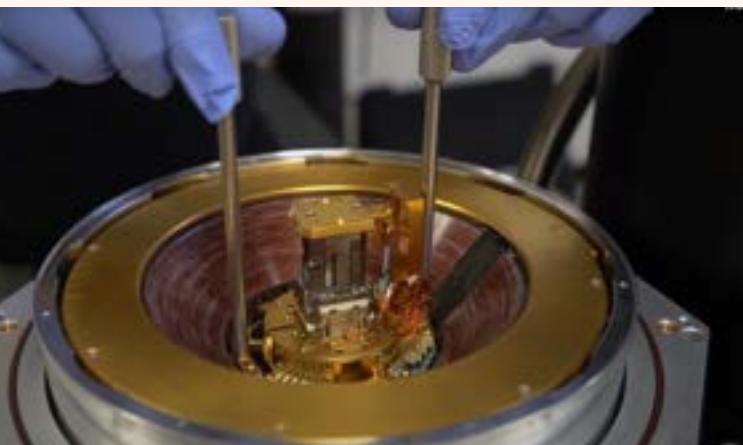
So I had my first OptiCool in 2020. That was for me, at that time, a little bit risky because no-one had done a scanning probe in an OptiCool. But we did it in 2021 and we liked it so much that we actually purchased another one in 2022!

**The OptiCool really is THE unique system that fits into my particular research.**

**This is actually a game-changer for us, because now we can use a helium-free system. Once you start to use this system it's really hard to go back to the open-cycle systems.**

The OptiCool has a total of eight windows and seven side windows. So we can choose whatever ports we want to send the light into. And we can set up a camera from the top so that we can see what's going on in our scanning probes. This is great for our alignment, for the optics. You can align your optics to the tip, through the top window, and then send infrared or terahertz light in from the side windows. And we are amazed by the stability at low temperature, when the cryo pumping is on. So we have ultra-stable AFM performance even at low temperature.

“There's basically no other products on the market, that I'm aware of, that can do this better than the OptiCool. Experts from different fields, from AFM groups or STM groups or from Optics groups, they're all very interested. I think the main feature that they find interesting is how open the system is and how big you can put this sample core in. We actually put two sample stages or piezo stages inside of the mechanism. I think most people are amazed by this fact – just how compact and big it is at the same time.”





# Quantum Design Teaching and Materials Discovery Laboratory

**Begun almost 10 years ago,** the main goal of Quantum Design's Education Initiative is to expand and innovate the teaching of hands-on, experimental physics in the undergraduate arena. Most often, undergraduate physics students are limited to learning theory in classrooms with laboratory experience, if any, limited in scope to only very simple experiments.

Quantum Design knows that the scientists of tomorrow begin as the physics students of today.



Therefore, the sooner those students become familiar with industry-standard equipment, the sooner their natural scientific curiosity and excitement can be awakened, and the more comfortable they can become with these tools.

*"Quantum Design is very passionate and committed to using innovation in undergraduate laboratory education. This is why, along with our industry partners and university collaborators, QDUSA has developed a teaching curriculum that can be used for this purpose."* Stefano Spagna, VP Strategy & Innovation, QDI.



In addition to providing undergraduate labs like this with instruments such as the PPMS VersaLab, Quantum Design and its Education Board of Advisors have worked together to create freely available experimental modules that can be used with the PPMS VersaLab. These modules lead students through various measurements (electrical, thermal, magnetic) so that they can become better familiar with basic materials research principles. They also provide ready-made coursework for educators who wish to incorporate these types of experiments in their lab classes.

*"Right now, it is an important time for undergraduate students to be exposed to Quantum Information Science because of how rapidly the quantum info industry is growing."* said Advisory Board member Dr. Justin Perron, "We're starting to see a lot more positions for undergraduate level scientists and engineers,

***... the industry is looking for a quantum competent, classically trained work force.***

**"What would happen if you could get a state of the art instrument that researchers around the world already use and put that in an instructional laboratory?"**

Stephen Tsui

Professor  
CSUSM

[DISCOVER THE VERSALAB >](#)

Lake Shore Cryotronics, a leading cryogenic temperature sensor and scientific instrument manufacturer based near Columbus, Ohio was excited to be part of the celebration and co-sponsored the event. They also provided demonstrations of some of their newest instruments (such as the M91 FastHall™ Measurement Controller and the M81 Synchronous Source Measure system), both of which are appropriate for undergraduate physics laboratories.

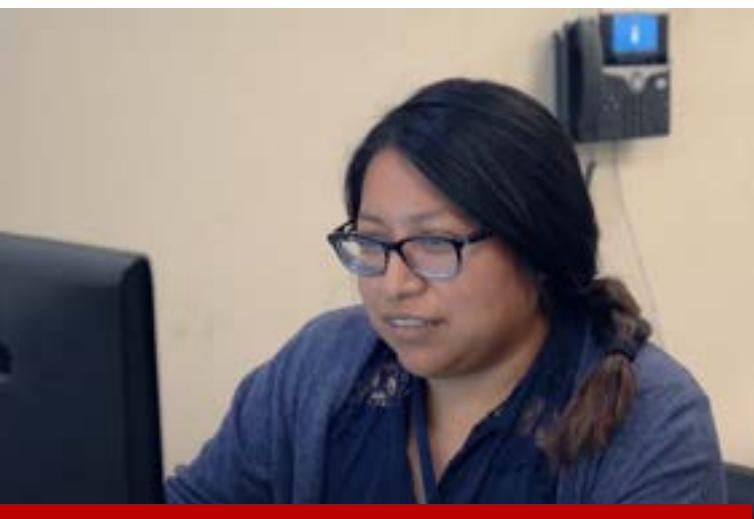


Perhaps Dr. Tsui said it best when he highlighted the importance of programs like this to the local community: "We serve our region. A little over half of the students we graduate are the first in their family to go to college, and roughly 80% of them stay in the region and join our local workforce. Programs like this are not only serving the students and our Physics Department, but also contributing locally to the welfare of our region. As one example, many of these students now work at Quantum Design, locally serving as engineers and other technical staff."

**"Using the VersaLab prepared me to not be intimidated using other laboratory equipment. I think it's important for undergrads to be exposed to this type of equipment."**

Josefa Gergorio, CSUSM Alumna and Final Test Engineer, Quantum Design).

Stefano Spagna says the Education Initiative is entering a new stage of expansion, "I am truly excited to see where we will go next and all the ways we can expand this essential program to expand and improve the teaching of experimental physics in undergraduate physics programs around the country, and even in other countries around the world."



# Quantum Design: Educating Tomorrow's Researchers



Since its inception in 1982, Quantum Design (QD) has developed and manufactured automated temperature and magnetic field testing platforms for materials characterisation.

These systems offer a variety of measurement capabilities and are in widespread use in the fields of physics, chemistry, materials science and nanotechnology. Quantum Design instruments are found in the world's leading research institutions, and have become the reference standard for a variety of magnetic and physical property measurements.

**QD INSTRUMENTS  
ARE CITED IN, AND  
PROVIDE THE DATA FOR,  
MORE SCIENTIFIC PUBLICATIONS  
THAN ANY OTHER INSTRUMENT  
IN THE FIELDS OF MAGNETICS  
AND MATERIALS  
CHARACTER-  
ISATION.**

Each year, literally  
hundreds of scientific  
publications, advancing the  
science of materials, use data  
generated from QD instruments.

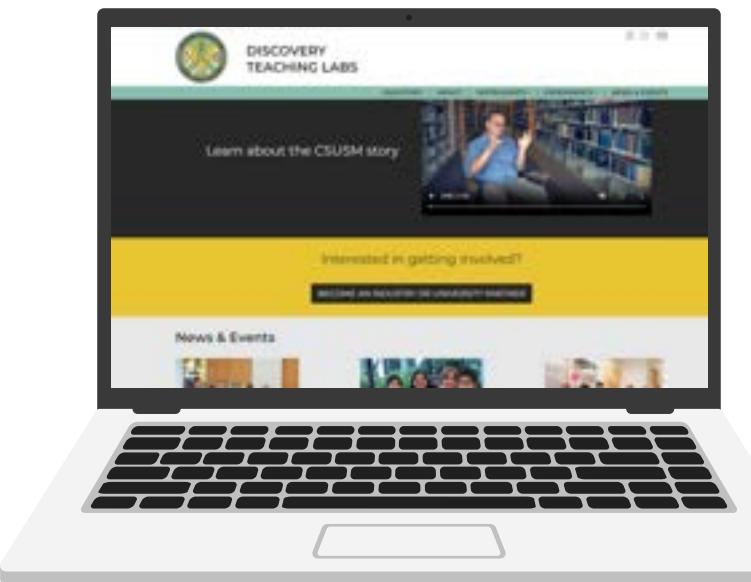
# Discovery Teaching Labs Website

## Connecting Students with Materials Research



Quantum Design believes in the importance of innovations for educating tomorrow's researchers, especially in the fields of condensed matter physics, chemistry and materials science. Our primary goal is to teach students how to preserve and foster their magical curiosity and to learn how to express it creatively.

The Quantum Design Education website is part of an initiative between QD USA and leading universities to develop a teaching curriculum of core research skills that exploits simple and "uncluttered" leading edge technology to inspire students to learn in new and more meaningful ways.



Its purpose is to encourage the development and sharing of measurement curricula using our wide range of measurement options available on the PPMS® VersaLab cryogenic platform. The teaching materials and sample experiments on the site are meant to provide advanced lab instructors and professors with ready-made curricula that can be the vehicle to bring students to the forefront of materials research.

**Discovery Teaching  
Labs Website**

***Utilising a new approach to cryocooler equipment design, VersaLab employs a new 4He-based temperature control system and gas flow technology that eliminates the need for liquid cryogens.***

With a temperature range of 50 – 400 K, this 3 Tesla platform is perfect for accomplishing many types of materials characterisation in a limited space. As with all Quantum Design instruments, VersaLab is a fully automated turnkey system with a user-friendly interface, and utilises technology developed for Quantum Design's popular Physical Property Measurement System (PPMS®). [Technical Service and Application Support](#) is available for the Quantum Design VersaLab



At QDUKI we are continually adding to our own support of universities and institutions, through resources, webinars and events such as the Material Property Measurement Workshops we hold. The most recent one being hosted at the University of Cambridge, specifically Royce@Cambridge...

The background of the page is a photograph of a mountain range. The peaks are covered in snow, and the sky above them is filled with soft, pastel-colored clouds, suggesting either sunrise or sunset. The overall atmosphere is serene and majestic.

Market-leading cryostats.  
Partners in the journey.  
Tried and trusted results.

MONTANA INSTRUMENTS IS THE PREMIER  
CRYOGENICS COMPANY ACCELERATING  
QUANTUM DISCOVERY

Since 2010, Montana Instruments has worked with hundreds of category pioneers to build configurable cryostats that are simple to set up and compatible with future system needs. Montana Instruments has produced 10 patents to-date for cryogenic technologies that free researchers to focus on science instead of just equipment.

# Introducing The Rook™ the new pinnacle of cryogenic nanopositioners

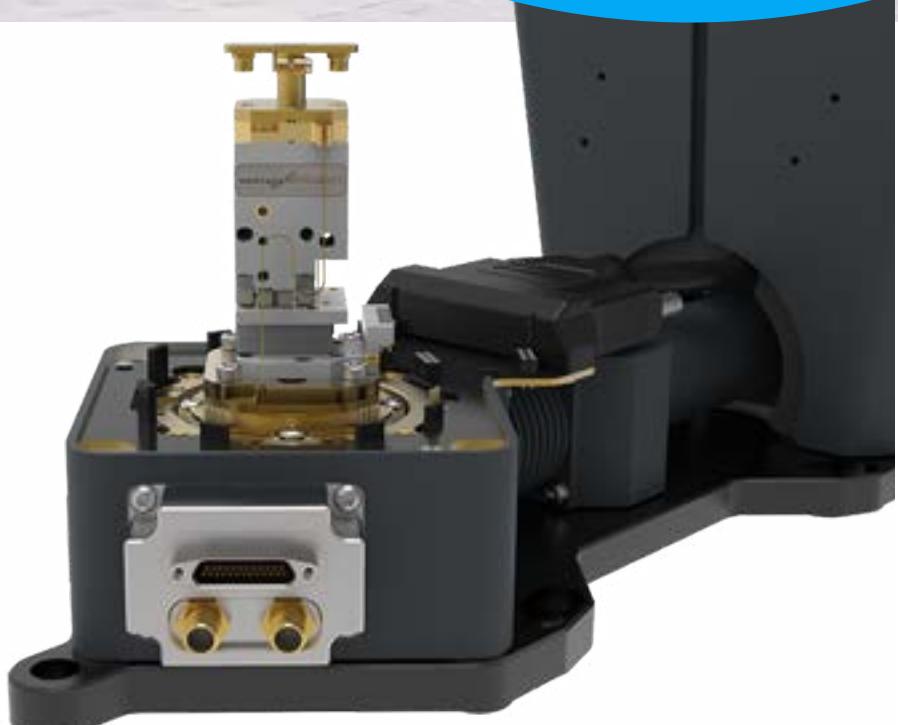
*"The Rook™ is a game changer  
in cryogenic nanopositioner  
technology. We're excited to  
make it available in our  
configurable cryostats."*

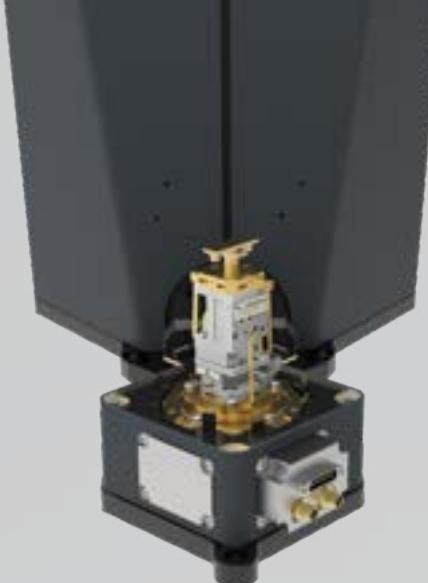
Mark Carroll, CEO,  
Montana Instrument

## The First Fully Integrated 3-Axis Cryogenic Nanopositioner

What makes The Rook™ stand out from the competition is that all performance specifications have been measured and validated at the top of the positioner in a 4 Kelvin vacuum environment while mounted in an operational 100 mm Cryostation® platform – the same conditions in which customers would typically use it.

The Rook™ is a 3-axis (XYZ) piezo-driven nanopositioning system constructed of ceramic and titanium.





## Features include:

- 3-axis design for optimal sample temperature and motion control
- Low vibrations
- Robust and reliable design
- Fully integrated plug-and-play control
- Galaxy software control, remote monitoring, and scripting
- Best-in-class thermal links

To distinguish even further, The Rook™ is the only positioning system available with bi-directional runout and multi-axis repeatability specified across the full travel range, which means this performance is achievable from anywhere within the motion envelope. With this performance and metrology comes the most complete and accurate expectation of a sample's three-dimensional motion of any cryogenic nanopositioner on the market today.

“Performance for The Rook is specified at the top of the 3-axis stack, providing the user with clear expectations of what is happening at the sample in terms of temperature, vibrations, and bi-directional run-out.”

Sal Guarnieri, Product Manager,  
Montana Instruments

### PERFORMANCE

Travel Range (XYZ mm)	<b>5 × 5 × 5 mm</b>
Sensor Resolution (Closed loop only)	<b>50 nm</b>
Multi-Axis Runout	<b>&lt;8.0 µm</b>
Bi-Directional 3-D Point Repeatability (Closed loop only)	<b>&lt;10 µm</b>
Uni-Directional 3-D Point Repeatability (Closed loop only)	<b>&lt;10 µm</b>
Payload <small>400 g possible with included preload springs; performance to specifications is not guaranteed when spring is in use</small>	<b>100 g</b>
Drive Velocity <small>Maximum</small>	<b>1.0 mm/sec</b>
Open Loop Mode Minimum Incremental Motion	<b>40 nm</b>
Closed Loop Mode Minimum Incremental Motion	<b>100 nm</b>
<b>GENERAL</b>	
Environmental Operating Range	<b>3.2K to 300K</b>
Vacuum Pressure Range	<b>1E-7 Torr to ambient</b>
Positioner Dimensions <small>Not including flex-link or stage wiring</small>	<b>24 × 24 × 51 mm (L × W × H)</b>
Multi-Stack Configuration <small>Limited by sample space</small>	<b>Up to 4x</b>
Drive Modes	<b>Open loop or closed loop</b>

All values are specified at 40K unless otherwise stated; all metrology completed with The Rook installed in an operational Montana Instruments 100-mm Cryostation

[DISCOVER THE ROOK >](#)



**Want to learn more  
about The Rook?**

Contact our Technical Sales Manager: Dr. Luke Nicholls  
Telephone: (01372) 378822  
Email: [luke@qd-uki.co.uk](mailto:luke@qd-uki.co.uk)

# Useful Links for QD Systems



**PHAROS** Digital Library  
QuantumDesign



Applications Team  
Notes and  
Downloads



Parts and  
Consumables



# Meet the UK Service & Applications Department

The UK Service Department offers fast front line local support to users within the UK and Ireland.



## Dr. Jordan Thompson, Service Engineer

Jordan received his PhD in 2016 from the University of Oxford on the topic of inelastic neutron scattering and heat capacity measurements on rare earth oxide materials at low temperatures and high magnetic fields. Jordan joined Quantum Design UK and Ireland in 2017, and his specialties lie in making Quantum Design equipment work for customers; through **installing new equipment**, **servicing** existing equipment, and advising customers on how to **optimise their experiments** to get the best possible results.

Already a customer? Please use the service email for any service issues  
[service@qd-uki.co.uk](mailto:service@qd-uki.co.uk)

We are backed by our extensive and experienced European Service Department, based in Darmstadt Germany, and by our US Service Department and Factory Engineers, based in the Quantum Design Headquarters in San Diego, California.

We offer helpful advice and can work with you to find individual solutions to your particular application.



## Liam Colman, Field Service Engineer

Liam graduated with a first-class master's degree in 2021 from the University of Lancaster, with a specialisation in low temperature helium physics. He operated their advanced wet dilution refrigerator at a base temperature of 2 mK to study quantum turbulence in superfluid He-3. Liam joined Quantum Design in January 2024 and is excited to help customers with any queries that may arise. He will be aiding customers with **installation** or **operation** of their systems to ensure their experiments run as smoothly as possible. Liam will specialise in dealing with **Montana Instruments**, but will also help with QD systems and Lake Shore Cryotronics products.

# Kick Start Your Quantum Research

[WWW.QD-UKI.CO.UK](http://WWW.QD-UKI.CO.UK)

If you would like assistance evaluating the various platforms and configuration options, contact us to talk directly with our Technical Sales Manager, Dr. Luke Nicholls...

Telephone: (01372) 378822  
Email: [luke@qd-uki.co.uk](mailto:luke@qd-uki.co.uk)

Montana Instruments offers solutions for multiple research applications, including cutting-edge techniques and breakthrough technology developments for a variety of colleges, universities, and research labs around the globe. Montana Instruments enables the quantum materials research community with state-of-the-art performance, high reliability, and user-friendly product line.

For those looking for a multi-functional platform, please ask us about the CryoAdvance range. System engineers will work with you to select or design a configuration (sample mounting, electrical & optical access, etc.) to fit your unique needs.



[DISCOVER THE CRYOADVANCE >](#)



If you are looking for large cryogenic sample configurations with space for multiple accessories, we suggest starting with one of the Montana Instruments Cryostation® platforms. System engineers will work with you to select or design a configuration (sample mounting, electrical & optical access, etc.) to fit your unique needs.

**SAY "YES" TO QUANTUM DISCOVERY, MADE POSSIBLE BY CRYOGENICS**



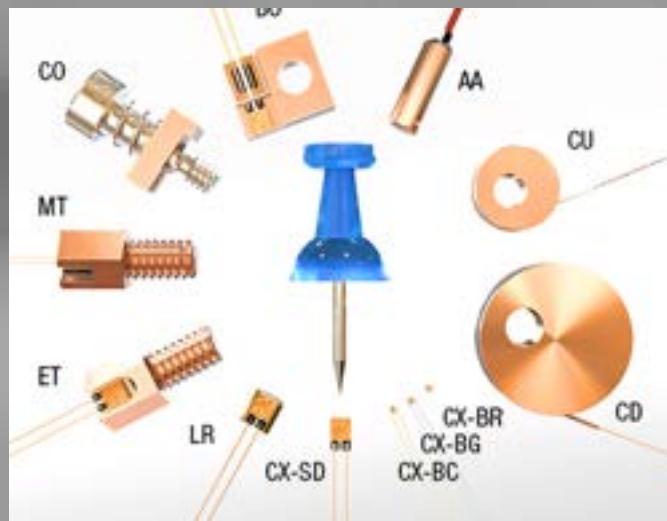
DR. ALEX S. CLARK, CENTRE FOR COLD MATTER, IMPERIAL COLLEGE LONDON

“

The Montana Cryostation lies at the heart of a number of experiments in my group. The Cryo-Optic add-on allows us to perform optical spectroscopy on single organic molecules at low temperature with excellent collected photon count rates from the in-vacuum high-NA objective. The system reaches a base temperature low enough to observe atomically-narrow resonances in these molecules, making them suitable for use in quantum technology.

The automated temperature control allows us to investigate the effects of phonon-induced dephasing with ease, while the integrated nano-positioning system and sample holder - designed in collaboration with Montana Instruments and QD-UK - is fully compatible with the nanophotonic devices we are investigating at low temperature. All of our experiments benefit from the low vibrations seen in the Montana Cryostation.

stable coupling to nanophotonic waveguides to diffraction-limited confocal microscopy. The support we have received from QD-UK has been excellent - they are easily contactable should issues arise and are very open to collaborative problem solving to expedite finding a solution. Having all of this in a closed-cycle system that does not require the purchase of expensive and increasingly rare liquid helium is the icing on the cake.”



## Cryogenic Sensors: Installation Techniques for Success

 [WATCH NOW](#)



## Probing Magnetodynamics at Nanosecond Timescales and Beyond

 [WATCH NOW](#)



## Cryogenics Probing Platforms and Materials and Device Development

 [WATCH NOW](#)

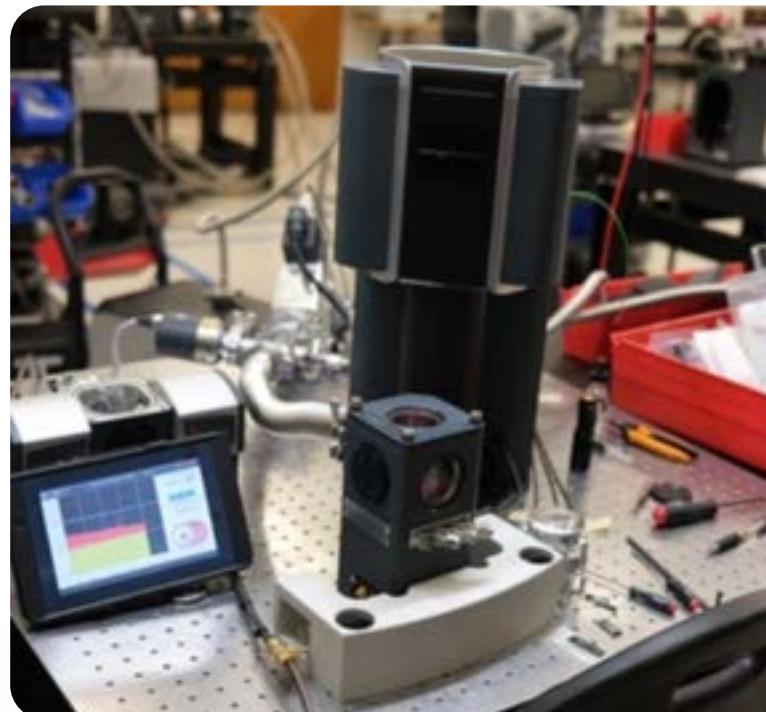
# WATCH CRYO WEBINARS

Don't miss out on the best webinars in the field of Cryogenics

# New Frontiers in Quantum Computing

Quantum computing promises to deliver major advances in a wide variety of fields including simulations of the natural world, virtual quantum experiments, quantum cryptography, data communication systems, and new pharmaceutical drug research and design.

These new and exciting research frontiers in quantum computing rely on two hallmarks of quantum physics: the superposition of states and quantum interference.



## FOUR APPROACHES

Montana Instruments has developed a line of cryogenic products to meet the needs of the quantum computing industry for research and development, production testing, and critical quantum computer infrastructure. There are multiple active architectures under consideration for the realisation of a scalable quantum computer. The most promising candidates are those utilising photonics, spin/quantum dots, superconducting circuits, and trapped ions.

- Photonics
- Spin/quantum dots
- Superconducting circuits
- Trapped ions

## CRYOGENICS FOR QUANTUM

Montana Instruments has overcome the cryogenic barriers to entry for ion trap, photonic, and superconducting circuit research and development. They've done this by helping alleviate the following common experimental challenges:

- Disruptions to the local sample environment such as mechanical vibrations can impart energy to the qubit states and destroy the quantum environment

- Trapped ion experiments require high vacuum conditions to reduce the number of molecular collisions with trapped ions
- Cryogenic conditions are required because thermal energy can excite vibrational motion that disrupts the quantum computing operations
- Thermal radiation can drive undesirable internal RF transitions in trapped ions or can raise a superconducting circuit above its critical temperature
- Power fluctuations in laser sources as well as RF power source instabilities perturb the QC system
- Fluctuating external magnetic fields can alter atomic transitions (Zeeman effect)

## KEYS TO QUANTUM CRYOGENICS

A high vacuum, low vibration, and stable cryogenic environment are required to prevent any unwanted excitation of the qubit state. Superior optical access (low working distance and high numerical aperture) for spatially resolved laser excitation and high collection efficiency fluorescent readout is also necessary for trapped ions and some spin/quantum dots.

### Low vibration

Low vibrations are key to preventing energy transfer to qubits and distortion of the quantum state.

### Stable, low temperature (<4 K)

Cryogenic environments minimise thermal excitation of qubits. <10 mK temperature stability is important to minimise thermal excitation.

### Low working distance

A low working distance objective with a high numerical aperture (0.9 NA, for example) provides a narrow excitation spot for individual trapped ions and provides high collection efficiency. The objective is temperature controlled to virtually eliminate drift. This eliminates the need for frequent realignment and maximises data collection time.

### Easy access to sample

Additional window ports may be used to laser ablate (generate the ions) or laser cool (prepare the quantum states). Our cryogenic systems can be configured with multiple side windows and a top window. In addition, the availability of larger sample spaces make it easy to address the sample from multiple incident angles.

[WWW.QD-UKI.CO.UK](http://WWW.QD-UKI.CO.UK)



[DISCOVER THE CRYOSTATION >](#)

### Electrical access

Many electrical feedthroughs may be required to either generate the RF trapping potential or operate the superconducting circuit. Montana's base panels can be used to add low frequency/DC wires in addition to coaxial wires for low loss and higher frequency signal (up to approximately 20 GHz). The sample space is kept uncluttered through the use of specially designed low thermal heat load cryogenic ribbon cables.

### High vacuum

Molecular and atomic collisions can excite qubits out of their quantum state or completely knock an ion out of the trap, destroying the quantum crystal. Montana's integrated charcoal cryo-pumps enable high vacuum operation for months at a time.



**Learn more about cryogenics for quantum.**

[Contact our Technical Sales Manager: Dr. Luke Nicholls](#)  
[Telephone: \(01372\) 378822](#)  
[Email: luke@qd-uki.co.uk](mailto:luke@qd-uki.co.uk)

# INTERVIEW

PROFESSOR JASON ROBINSON  
FIMMM, UNIVERSITY OF  
CAMBRIDGE CMP

The University of Cambridge Centre for Materials Physics (CMP) is a world-class research laboratory for advanced electronic materials synthesis, discovery, characterisation, and device development. It is not a group but a Centre and all equipment are owned by the Department of Materials Science & Metallurgy, and supported by expert Technicians and Facility Scientists associated with several groups or facilities in the Department.

***"WE WORK CLOSELY WITH GLOBAL ACADEMIC AND INDUSTRIAL LEADERS TO DEVELOP MATERIALS AND DEVICES FOR ENERGY EFFICIENT COMPUTING, ENERGY STORAGE, ENERGY GENERATION, AND ENERGY CONVERSION TECHNOLOGIES FOR A SUSTAINABLE FUTURE."***

Centre for Materials Physics (CMP)

Jason Robinson FIMMM has a Professorial Chair in Materials Physics at the University of Cambridge where he is a joint Head of the Department of Materials Science & Metallurgy, Director of the Quantum Materials & Devices Group, and co-director of the Centre for Materials Physics.

He has made major contributions to in the fields of spintronics, superconductivity, and quantum technologies, including the discovery of triplet Cooper pairs in hybrid superconductor/magnetic devices and helping to pioneer the field of superconducting spintronics.



The Centre is home to multiple open-access [Henry Royce National Facilities](#), one of which is the Royce Transport Magnetometer

The Royce Transport Magnetometer manages equipment for the characterisation of magnetic and electrical properties of materials and devices. All equipment is shared and owned by the Department of Materials Science & Metallurgy, and supported by expert Technical Staff associated with several groups across the Department and university, including the DMG, CMP, and the Maxwell Centre.



## Could you tell us a bit about which products you purchased from Quantum Design and why they were chosen?



[DISCOVER THE MPMS3 >](#)

**“A few years ago, Cambridge Royce bought the Quantum Design MPMS3 as it specifically enables sensitive measurements in magnetic research.”**

The Lake Shore Cryotronics 8600 series room temperature vibrating sample magnetometer was brought in to complement the MPMS. It offers a fast-turnaround, high-throughput magnetic data. The Facility needed kit that could fill the niche for room temperature experiments and optimise thin film research for academics and industry users.”

### How has this helped the user experience?

“The principal benefit of this second purchase was the increase in the turnover of samples and freeing up the MPMS. It was a case of half an hour, versus half a day. And there is then the option to transfer to the MPMS for further research. This has allowed us to streamline the process, matching up users with the right equipment.

“It’s been a game changer for industry led projects, without sacrificing sensitivity. As I manage both systems, it’s easy to be able to point users in the right direction, depending on the testing they want to carry out. Having both systems complement each other as well as provide different levels of results. The SQUID VSM is in a box, whereas the Lake Shore 8400 VSM is accessible. This enables us to attach wire samples easily.”

**“IT’S A CUSTOMISABLE ACADEMIC EXPERIENCE”**

Prof. Jason Robinson

[DISCOVER THE LAKE SHORE 8600 VSM >](#)



Further information:

[Royce Transport Magnetometer | Centre for Materials Physics \(cam.ac.uk\)](#)

[Quantum materials and devices group | \(cam.ac.uk\)](#)

# Run an LHe Cryostat Without the LHe

## The Problem

YOU WANT THE BENEFITS OF A LHE CRYOSTAT, BUT LHE IS EXPENSIVE AND DIFFICULT TO CONTINUOUSLY SOURCE

## The Solution

THE RGC BRINGS TOGETHER THE BEST OF BOTH WORLDS; THE LOW TEMPERATURES, SAMPLE THROUGHPUT, AND LOW VIBRATION OF LHE CRYOSTATS, WITHOUT THE ADDITIONAL COST OF LHE.

**Quantum Design UK and Ireland offers the Lake Shore Cryotronics Recirculating Gas Coolers – a cryogen-free solution that allows you to use an LHe cryostat without the LHe. It's ideal for low vibration, with excellent thermal performance.**



## What is a recirculating gas cooler?

A recirculating gas cooler is a cryocooler-based system that continuously recirculates helium in a closed loop, enabling a continuous-flow LHe cryostat to operate cryogen-free.

## How it Works

The RGC runs helium in a closed loop, making a continuous flow cryostat cryogen-free.

Helium gas is cooled and liquefied by the RGC's cryocooler, and travels to the cryostat through a flexible vacuum-insulated transfer line. LHe cools the sample. The RGC captures the evaporated gas through the transfer line and reliquefies it, continuously recirculating the helium.

## Ideal for Low Vibration

Commonly paired with a Lake Shore ST-500 cryostat, the combination is an ultra-stable cryogenic microscopy platform.

[READ MORE >](#)

Comparison	Closed-cycle cryostat	LHe cryostat	LHe cryostat + RGC
Cryogen consumption	✓ Cryogen-free	✗ Liquid helium	✓ Cryogen-free
Lifetime cost	✓ \$	✗ \$\$\$	✓ \$
Cooling power	✗ Lower cooling power	✓ Higher cooling power	✓ Higher cooling power
Low vibration	✗ Higher vibrations; cold head is part of system	✓ Low vibration; no cold head	✓ Low vibration; cold head is decoupled from system
Cold head warmup for sample change	✗ Warmup required	N/A	✓ No warmup required between sample changes
Test environment footprint	✗ Larger footprint in test environment	✓ Small and flexible to different mounting configurations in test environment	✓ Maintain small LHe cryostat; RGC is next to test environment



» **Temperature Products  
Brochure**

» **Cryogenics Instrumentation  
Brochure**

## SEND IN YOUR RESEARCH OR WHITE PAPERS

We'd love to share  
your findings

## SHARE YOUR APPLICATIONS

What have you been  
using systems for  
recently?

# HAVE YOUR SAY

BE INCLUDED IN THE NEXT EDITION



# cryogenics

Further reading:

[Material Characterisation](#)

[Cryogenics - Lake Shore](#)

[Cryogenics Range](#)

Produced by:

Quantum Design UK and Ireland  
Unit 1, Mole Business Park, Leatherhead, Surrey,  
KT22 7BA  
+44 (0)1372 378822  
[info@qd-uki.co.uk](mailto:info@qd-uki.co.uk)  
[www.qd-uki.co.uk](http://www.qd-uki.co.uk)

Follow us:



[WWW.QD-UKI.CO.UK](http://WWW.QD-UKI.CO.UK)