VersaLab: Leading Edge Materials Characterization for Your Undergraduate Research Program

Why use VersaLab for advanced labs?

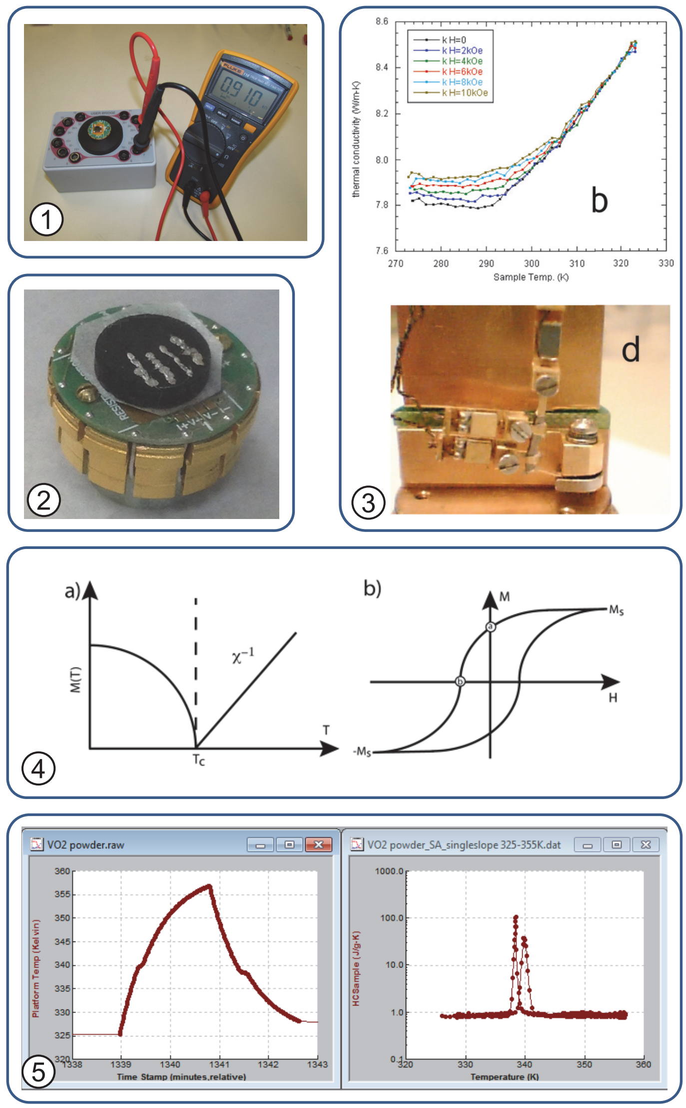
The VersaLab™ Physical Properties Measurement System (PPMS®) from Quantum Design provides a compact, cryogen-free temperature/field platform (50 K - 400 K / 3 tesla) which can host a variety of integrated measurements. These include DC and AC magnetometry, heat capacity, thermal transport and electronic transport, in addition to custom experiment possibilities. The VersaLab has minimal space and power requirements, and uses less than one standard cylinder of industrial grade helium gas per year.

Features of the PPMS VersaLab:

- Minimal infrastructure requirements:
  - Completely cryogen-free, uses less than one K type helium gas cylinder per year
  - Small 1 square meter footprint for entire system (cryostat with air-cooled compressor)
  - Electrical power requirement: single phase, 220 volts
- Research-quality instrument: See a partial list of journal publications produced using the VersaLab on page 3, or follow this link
- Centerpiece of upper division laboratory instruction: Free access to all educational modules available at **education.qdusa.com**
- Agile platform for demonstrations of thermodynamics, magnetism and transport which can greatly enhance lecture-based courses
- Open architecture allows users to directly monitor raw signals while the instrument remains robust and student-friendly
- Capable of providing turnkey measurement options of DC and AC magnetometry, heat capacity, thermal transport and electrical transport
- Switching between measurement options takes less than 5 minutes
- Training for students takes less than a day, so productive measurements can get underway quickly
- Automated operation from 50 – 400 K and +/- 3 tesla allows for unattended measurements
- Same functionality as our flagship PPMS platform at a lower cost; measurement options can be easily added on later
- Remote tech support and operation for both students and instructors

Educational Modules:

Training grounds for new researchers - Launchpads for original research

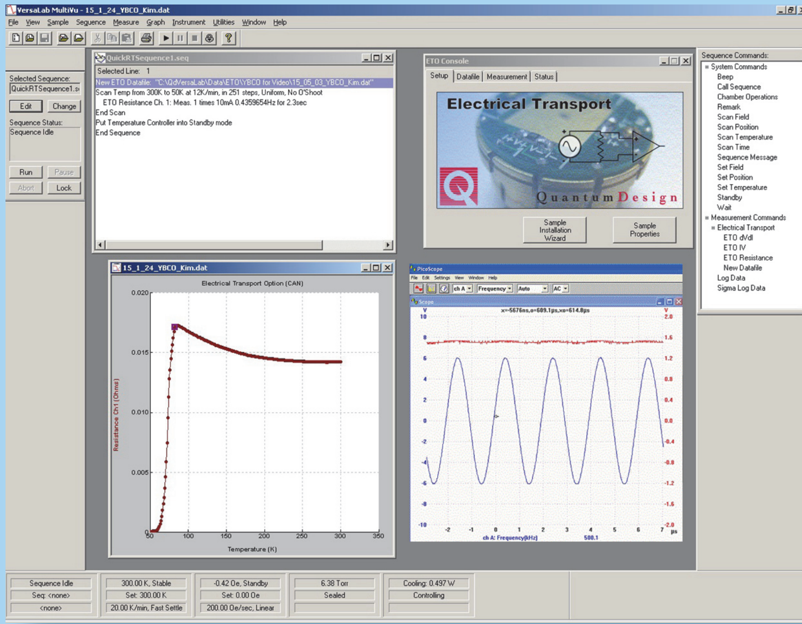


(1) Hall Effect in Germanium (2) YBCO Synthesis and Characterization
(3) Thermal Transport in Gadolinium (4) Magnetization of a paper-clip
(5) Metal-Insulator Transition in VO_2

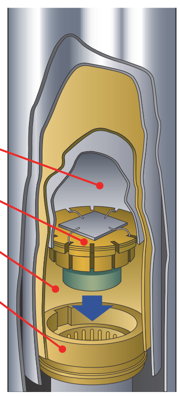
For information and curricula, visit: ***education.qdusa.com***

VersaLab: What Can It Do?

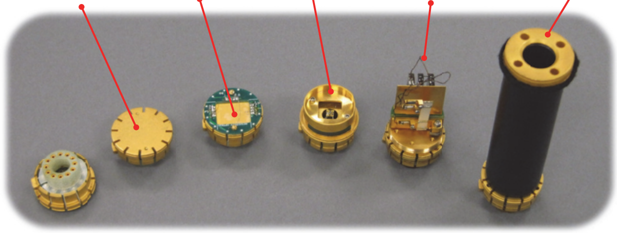
The VersaLab is a compact, automated, cryo-cooled materials characterization system, allowing stable temperature ranges of 50 - 400 K and magnetic fields up to 3 tesla. Samples are mounted to "pucks" that are easily inserted into the sample chamber. Many measurement routines are available through MultiVu, Quantum Design's Windows-based software, but custom experiments can also be carried out through a built-in Visual Basic scripting interface.



Screenshot of our custom MultiVu software used for system control, experiment design and data viewing. Also shown are oscilloscope traces of raw transport data taken using a PicoScope® USB oscilloscope.

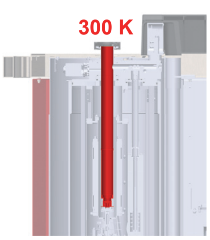


Cutaway showing the puck interfacing to the sample chamber experiment space.



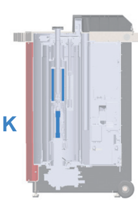
Examples of experiment pucks used in the VersaLab

How does it work?



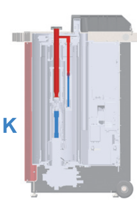
To introduce a new experiment, first warm the sample chamber to 300 K and vent with industrial grade He gas.

VersaLab is powered by a small Gifford-McMahon (G-M) cryocooler with a 1st stage at ~40 K and 2nd stage at 4 K. The 4 K stage has 0.1 watts of cooling power.



A 3 tesla superconducting magnet (Nb-Ti wire) is cooled by the 4 K stage using solid conduction through high conductivity copper.

A thermal switch connects the chamber to the 40 K stage and cools the bottom of the chamber to 50 K. The switch "closes" by using He gas conduction across a narrow gap.



If vacuum of $<10^{-4}$ torr ($<10^{-2}$ Pa) is needed in the sample chamber, it is evacuated using an activated charcoal-based cryopump which is cooled by the 4 K stage.

The complete system is shown here with the small variable speed compressor for the G-M cooler.
Lab requirements:
- 200 V / 16 A / single-phase
- Industrial grade He gas
- 1 m² of floor space

For information and curricula, visit: education.qdusa.com

A Sampling of Research Using the Quantum Design PPMS VersaLab

"Magnetism, electron transport and effect of disorder in CoFeCrAl"
P. Kharel, W. Zhang, R. Skomski, S. Valloppilly, Y. Huh, R. Fuglsby, S. Gilbert, and D. J. Sellmyer, *Journal of Physics D: Applied Physics*, **48**(24), 245002 (2015).

"Discontinuous reactions in melt-spun Cu–10 at. %Co alloys and their effect on magnetic anisotropy"
N.M. Suguihiro, Y. T. Xing, D. Haeussler, W. Jaeger, D. J. Smith, E. Baggio-Saitovitch, and I. G. Solorzano, *Journal of Material Science*, **49**(18), 6167-6179 (2014).

"Critical anomalous Hall behavior in Pt/Co/Pt trilayers grown on paper with perpendicular magnetic anisotropy"
W. Che, X. Xiao, N. Sun, Y. Zhang, R. Shan, Z. Zhu, *Applied Physics Letters*, **104**, 262404 (2014).

"Size and lone pair effects on the multiferroic properties of $Bi_{0.75}A_{0.25}FeO_{3-d}$ (A = Sr, Pb, and Ba) ceramics"
S. Hussain, K. Husanain, G. H. Jaffari, S. Faridi, F. Rehman, T. A. Abbas, and S. I. Shah, *Journal American Ceramic Society*, **96**(10), 3141-3148 (2013).

"Gate voltage induced phase transition in magnetite nanowires"
J. Gooth, R. Zierold, J. G. Gluschke,T. Boehnert, S. Edinger, S. Barth, and K. Nielsch, *Applied Physics Letters*, **102**, 073112 (2013).

"$Ni_{59.0}Mn_{23.5}In_{17.5}$ Heusler alloy as the core of glass-coated microwires: Magnetic properties and magnetocaloric effect"
V. Vega, L. González, J. García, W. O. Rosa, D. Serantes, V. M. Prida, G. Badini, R. Varga, J. J. Suñol, and B. Hernando, *Journal of Applied Physics*, **112**, 033905 (2012).

"Contributions of electron and phonon transport to the thermal conductivity of GdFeCo and TbFeCo amorphous rare-earth transition-metal alloys"
P. E. Hopkins, M. Ding, and J. Poon, *Journal of Applied Physics*, **111**, 103533 (2012).

"Structural, magnetic and dielectric properties of Fe-doped $BaTiO_3$ solids"
Z. Guo, L. Yang, H. Qui, X. Zhan, J. Yin, and L. Cao, *Modern Physics Letters B*, **26**(9), 120056 (2012).

"Complex itinerant ferromagnetism in noncentrosymmetric $Cr_{11}Ge_{19}$"
N. J. Ghimire, M. A. McGuire, D. S. Parker, B. C. Sales, J.-Q. Yan, V. Keppens, M. Koehler, R. M. Latture, and D. Mandrus, *Physical Review B*, **85**, 224405 (2012).

"The role of boron segregation in enhanced thermoelectric power factor of $CoSi_{1-x}Bx$ alloys"
H. Sun, D. T. Morelli, M. J. Kirkham, H. M. Meyer, and E. Lara-Curzio, *Journal of Applied Physics*, **110**, 123711 (2011).

For additional citations, see a more extensive list at education.qdusa.com