The Role of Electronics Shops

In a Research Environment

Blaise Thompson

University of Wisconsin–Madison

2024-04-10

What is a research electronics shop?

UW-Madison Department of Chemistry

three shops:

- machine
  - three full time staff
  - specialty focus on pump repair
- glass
  - two full time staff
- electronics
  - two full time staff
  - four student workers

UW-Madison Department of Chemistry

Electronics at UW-Madison Chemistry

- here for as long as anyone can remember
  - at least 50 years
- historically much larger group
  - more than seven full time staff, at peak
- construct, repair, assist

UW-Madison Department of Physics

Department of Physics

Research, teaching and outreach in Physics at UW–Madison

Electronics Shop

The Physics Electronics Shop does not sell parts to the public. We don't do repairs for the public.

3336 Chamberlin Hall
1150 University Ave.
Madison, WI 53706
Phone: (608) 262-0527

UW-Madison Physical Sciences Lab

Purdue Amy Facility

PURDUE UNIVERSITY | Department of Chemistry

Jonathan Amy Facility for Chemical Instrumentation

The Amy Instrumentation Facility (JAFCI) is dedicated to the fusion of engineering expertise with the quest for scientific knowledge to further research and instructional efforts in the Department of Chemistry and School of Chemical Engineering at Purdue University. Our team of scientists and engineers provide assistance in the design / construction of specialized instrumentation not commercially available along with repair / modification of commercial systems.

DEPARTMENT OF CHEMISTRY

Electronics Shop

The Electronics Shop (Bagley Hall room 74) supports graduate teaching activities and research.

All staff are skilled in design, development, construction, repair and maintenance of scientific apparatus and

Instrument Shop

For over 16 years the professional research Instrument Shop at the Department of Chemical and Biological Engineering has provided mechanical and electrical design and fabrication services at CU Boulder. The experienced staff provides solutions for instructional and research needs for any department or college at highly competitive rates. The Instrument Shop is collectively comprised of a machine shop and electronics shop, both of which are located in the basement level of the Jennie Smoly Caruthers Biotechnology Building.

In short, the shop's primary mission is to help the labs and researchers get the custom tools and instruments they need to successfully complete their projects, from problem to solution. Contact the shop staff with the details of your project.

Tools, components, and instruments

Instrument Shop Equipment and Products

Instrument Shop Staff

Dragan Mejic
Shop Manager, Instrument Maker / Fabricator
dragan.mejic@colorado.edu
(303) 735-5901

Deepak Dileepkumar
Electronics Engineer
deepak.dileepkumar@colorado.edu
(303) 492-8125

Dana Hauschulz
Electronics Engineer
dana.hauschulz@colorado.edu

University of Pittsburgh

University of Pittsburgh

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The DIETRICH School of Arts & Sciences

SHARED RESEARCH SUPPORT SERVICES

Electronics Shop

Electronics Shop

Electronics Shop Personnel

Work Request Form

Contact

David Emala

Indiana University Bloomington

THE COLLEGE OF ARTS + SCIENCES

Department of **Chemistry**

UNC | COLLEGE OF ARTS AND SCIENCES Chemistry

Electronics

Location

Room C249, Kenan Laboratories, second floor.

ASU Arizona State University
Core Facilities

Electronics

Electronics

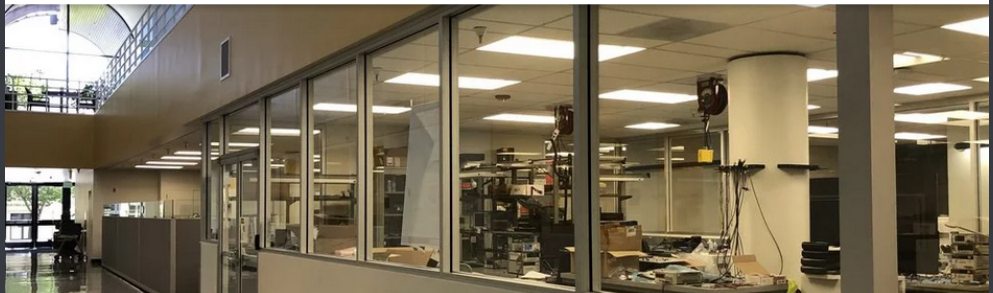
Stanford University

FOR ALL YOUR TOOL ENABLES, RESERVATIONS, AND PURCHASES:

NEMO: FEB 1 2024!

SNF Stanford Nanofabrication Facility

Menu



BROWN | Department of Chemistry

IN THIS SECTION

Electronics Shop

Custom electronics for research?

Electronics as Research

Electronics development has a key role to play in higher education & cutting-edge research.

- lowered cost
- greater reproducibility
- automation, high throughput
- creativity and niche application

frontiers in Plant Science

ORIGINAL RESEARCH
published: 10 July 2020
doi: 10.3389/fpls.2020.01015

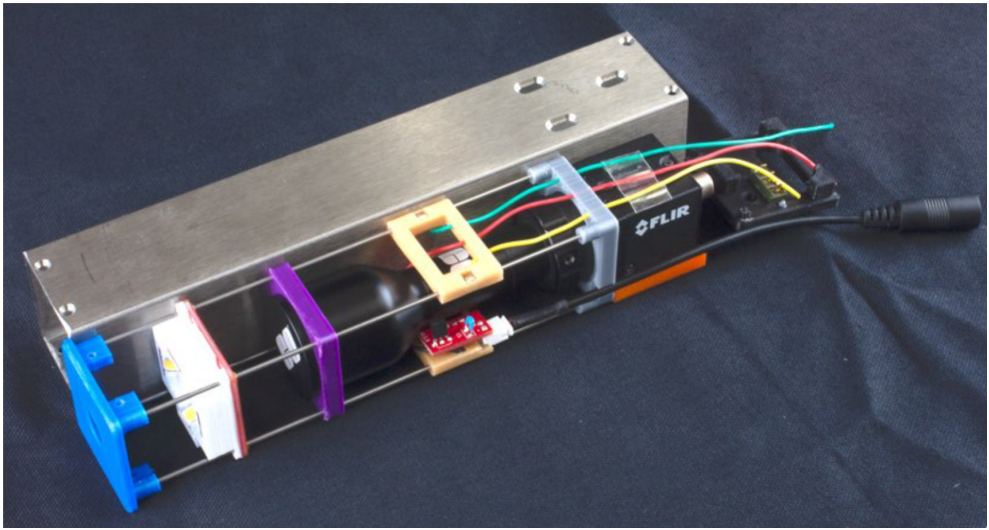
The XyloTron: Flexible, Open-Source, Image-Based Macroscopic Field Identification of Wood Products

Prabu Ravindran[1,2], Blaise J. Thompson[3], Richard K. Soares[1,2] and Alex C. Wiedenhoeft[1,2,4,5]*

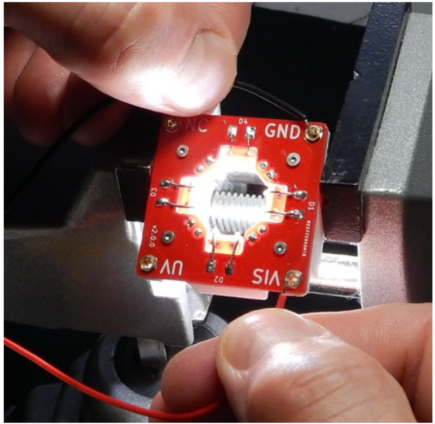
[1] Center for Wood Anatomy Research, USDA Forest Products Laboratory, Madison, WI, United States, [2] Department of Botany, University of Wisconsin, Madison, WI, United States, [3] Department of Chemistry, University of Wisconsin, Madison, WI, United States, [4] Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, United States, [5] Departamento de Ciências Biológicas (Botânica), Universidade Estadual Paulista, Botucatu, Brazil

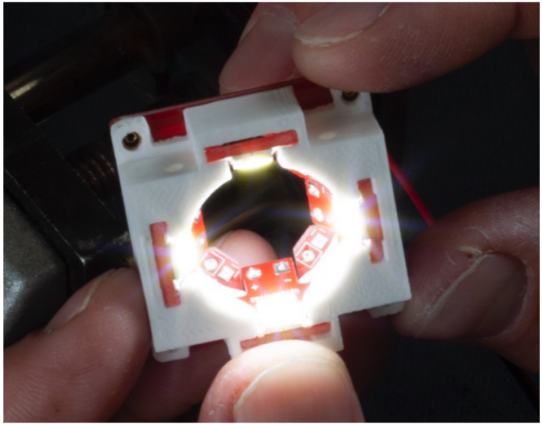
Forests, estimated to contain two thirds of the world's biodiversity, face existential threats due to illegal logging and land conversion. Efforts to combat illegal logging and to support sustainable value chains are hampered by a critical lack of affordable and scalable

XyloTron



XyloTron





XyloTron

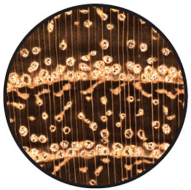
Wood position

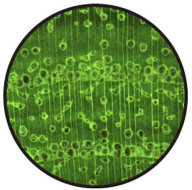
Charcoal position

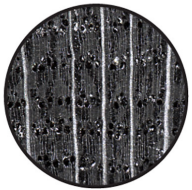
Visible light

UV light

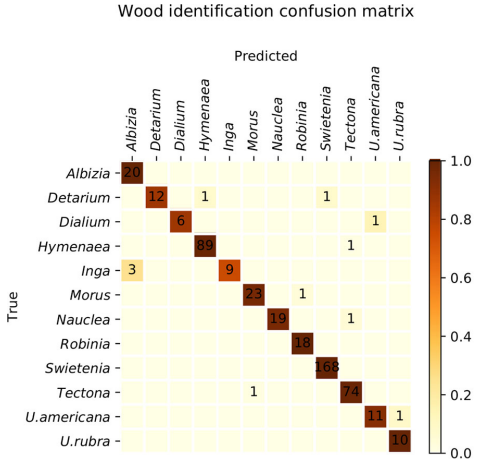
Visible light

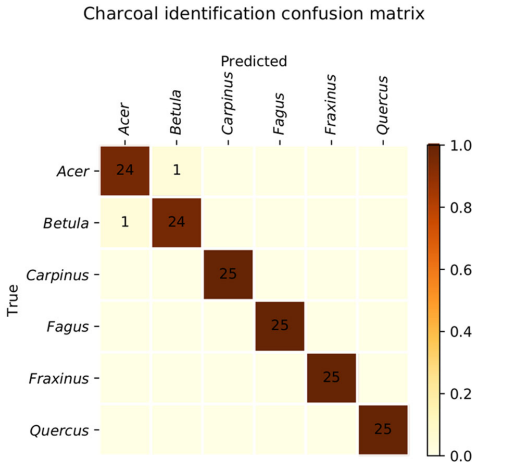






XyloTron


Wood identification confusion matrix
Predicted
True
Albizia
Detarium
Dialium
Hymenaea
Inga
Morus
Nauclea
Robinia
Swietenia
Tectona
U.americana
U.rubra
20
12 1 1
6 1
89 1
3 9
23 1
19 1
18
168
1 74
11 1
10
1.0
0.8
0.6
0.4
0.2
0.0


Charcoal identification confusion matrix
Predicted
True
Acer
Betula
Carpinus
Fagus
Fraxinus
Quercus
24 1
1 24
25
25
25
25
1.0
0.8
0.6
0.4
0.2
0.0

Review of Scientific Instruments ARTICLE scitation.org/journal/rsi

Multichannel gas-uptake/evolution reactor for monitoring liquid-phase chemical reactions

Cite as: Rev. Sci. Instrum. 92, 044103 (2021); doi: 10.1063/5.0043007
Submitted: 5 January 2021 • Accepted: 28 March 2021 •
Published Online: 15 April 2021

Chase A. Salazar, Blaise J. Thompson, Spring M. M. Knapp, Steven R. Myers, and Shannon S. Stahl[a)]

AFFILIATIONS

Department of Chemistry, University of Wisconsin-Madison, Madison, Wisconsin 53719, USA

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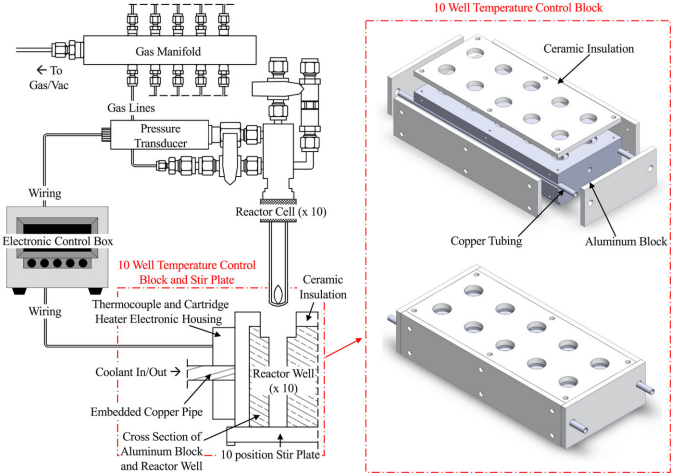
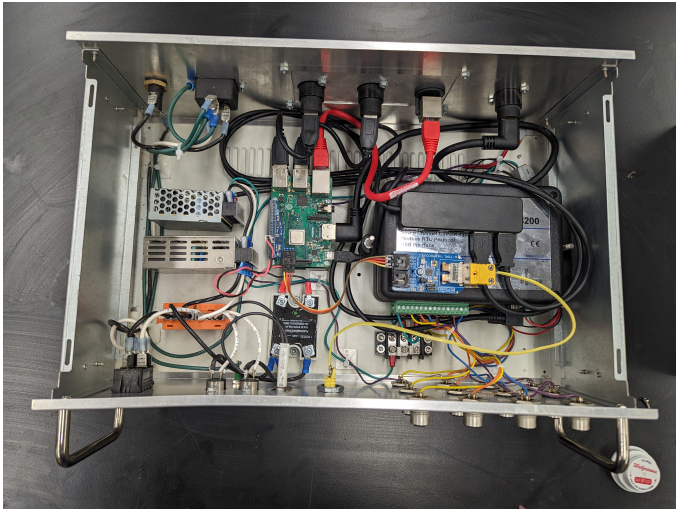
ABSTRACT

Gas Uptake


Gas Manifold
← To Gas/Vac
Gas Lines
Pressure Transducer
Wiring
Reactor Cell (x 10)
Electronic Control Box
10 Well Temperature Control Block and Stir Plate
Ceramic Insulation
Wiring
Thermocouple and Cartridge Heater Electronic Housing
Coolant In/Out →
Reactor Well (x 10)
Embedded Copper Pipe
Cross Section of Aluminum Block and Reactor Well
10 position Stir Plate
10 Well Temperature Control Block
Ceramic Insulation
Copper Tubing
Aluminum Block

Gas Uptake



OL Organic Letters
pubs.acs.org/OrgLett
Letter

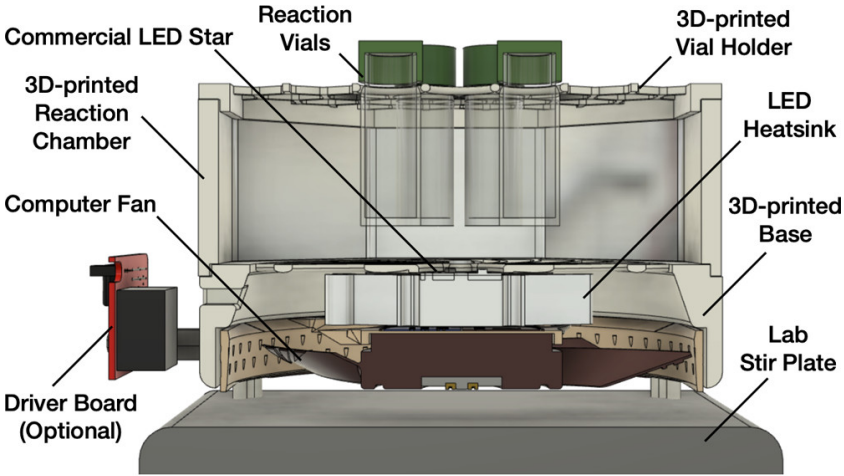
Versatile Open-Source Photoreactor Architecture for Photocatalysis Across the Visible Spectrum

Philip P. Lampkin, Blaise J. Thompson, and Samuel H. Gellman*

Cite This: *Org. Lett.* 2021, 23, 5277–5281
Read Online

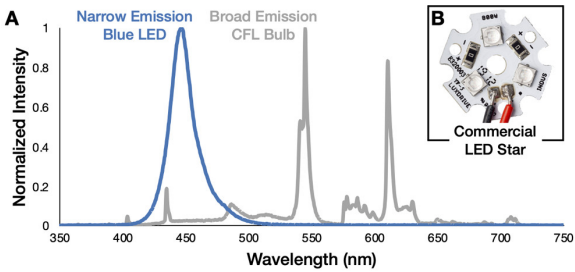
ABSTRACT: Adoption of commercial photoreactors as standards for photocatalysis research could be limited by high cost. We report the development of the Wisconsin Photoreactor Platform (WPP), an open-source photoreactor architecture potentially suitable for general adoption. The WPP integrates inexpensive commercial components and common high-intensity LEDs in a 3D-printed enclosure. Dimensions and features of WPP reactors can be readily varied and configurations easily reproduced. WPP performance is evaluated using literature transformations driven by light of disparate wavelengths.

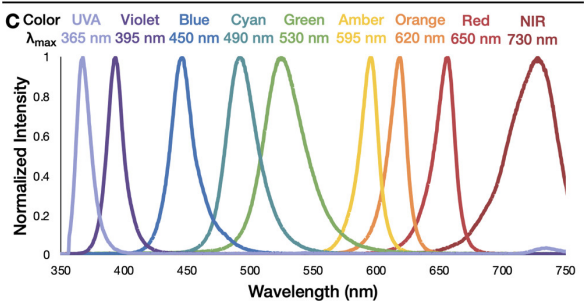
Photoreactor



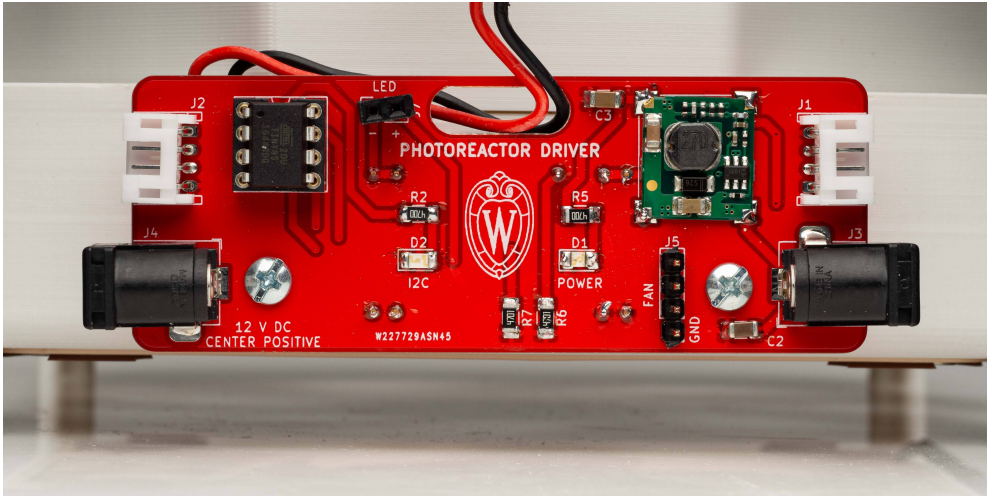
3D-Printing and Assembly Time: < 24 hours
Component Cost: < $100 **Open-source**

Photoreactor





Photoreactor



Photoreactor

Oscillator

ACS Partner Journal

Journal of the American Society for Mass Spectrometry

pubs.acs.org/jasms

Research Article

The Wisconsin Oscillator: A Low-Cost Circuit for Powering Ion Guides, Funnels, and Traps

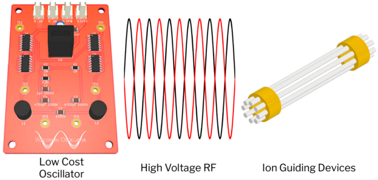
Steven J. Kregel,* Blaise J. Thompson, Gilbert M. Nathanson, and Timothy H. Bertram

Cite This: *J. Am. Soc. Mass Spectrom.* 2021, 32, 2821–2826

Read Online

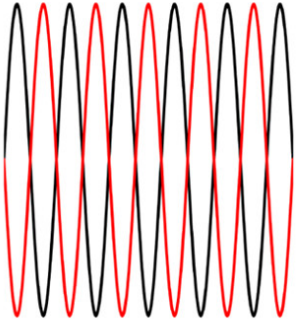
ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: In this work, we present the Wisconsin Oscillator, a small, inexpensive, low-power circuit for powering ion-guiding devices such as multipole ion guides, ion funnels, active ion-mobility devices, and non-mass-selective ion traps. The circuit can be constructed for under $30 and produces two antiphase RF waveforms of up to 250 V_{p-p} in the high kilohertz to low megahertz range while drawing less than 1 W of power. The output amplitude is determined by a 0–6.5 VDC drive voltage, and voltage amplification is achieved using a resonant LC circuit, negating the need for a large RF transformer. The Wisconsin Oscillator automatically oscillates with maximum amplitude at the resonant frequency defined by the onboard capacitors, inductors

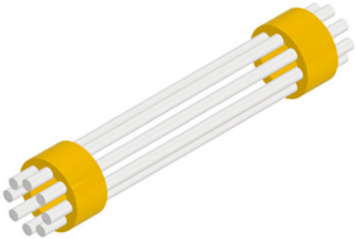


Oscillator

Low Cost Oscillator

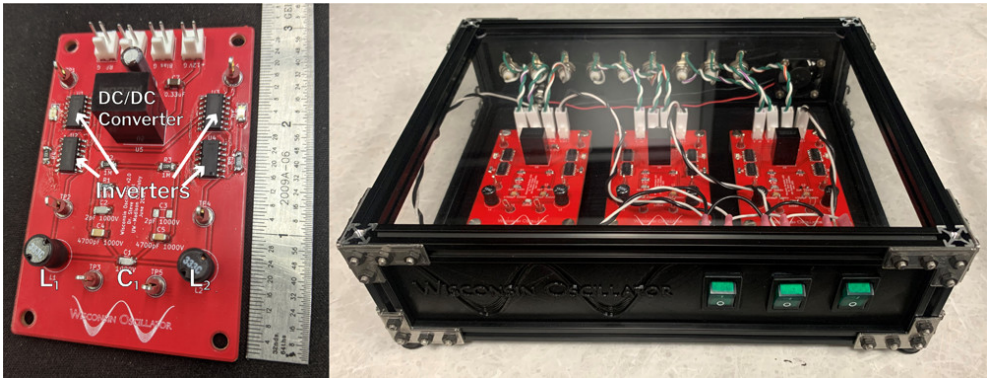


High Voltage RF



Ion Guiding Devices

Oscillator



Teaching

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

Chemistry 860: Selected Topics in Physical Chemistry

Instrument Design & Fabrication

Spring 2024

General Course Information

***Course Subject, Number and Title**
CHEM 860 — SELECTED TOPICS IN PHYSICAL CHEMISTRY

***Credits**
2 credits

Chemistry 728 **Electronics for Chemical Instrumentation** 3 credits
Spring 2024

Course URL: CANVAS

Dr. Rob McClain
office: 7446 Chemistry
e-mail: mcclain@chem.wisc.edu

office hours: By appointment
phone: 608-262-5615

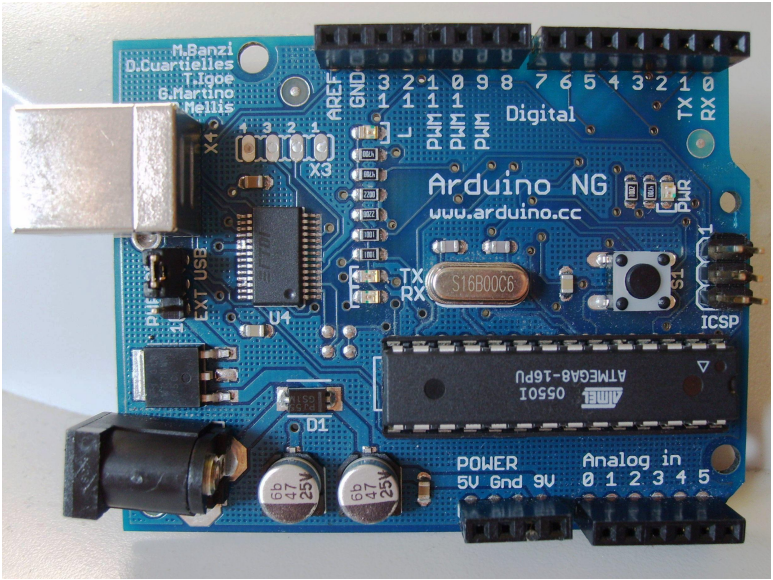
Dr. Blaise Thompson
office: S307 Chemistry
e-mail: blaise.thompson@wisc.edu

office hours: By appointment
phone: 608-263-2573

Pre-requisites: graduate standing

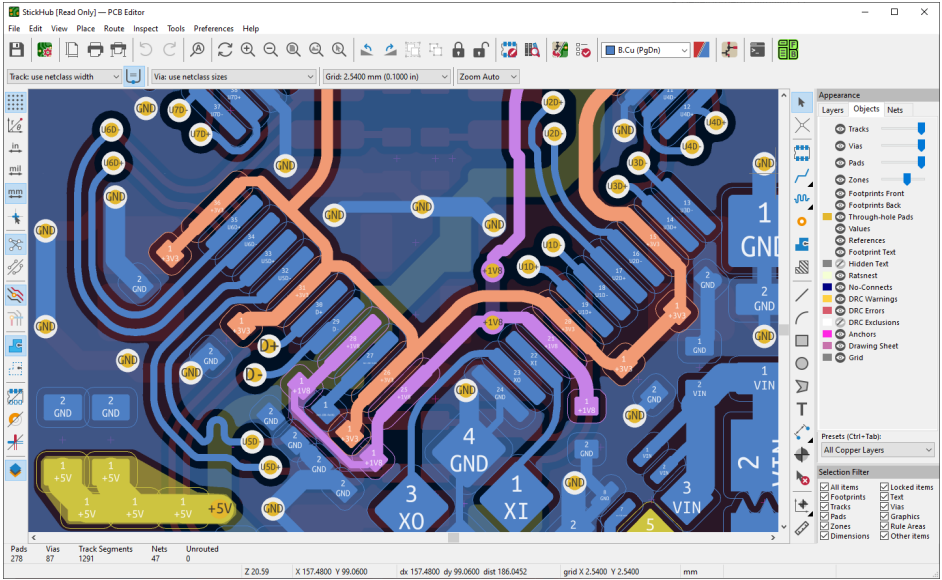
Workspace

Electronics: More Accessible than Ever

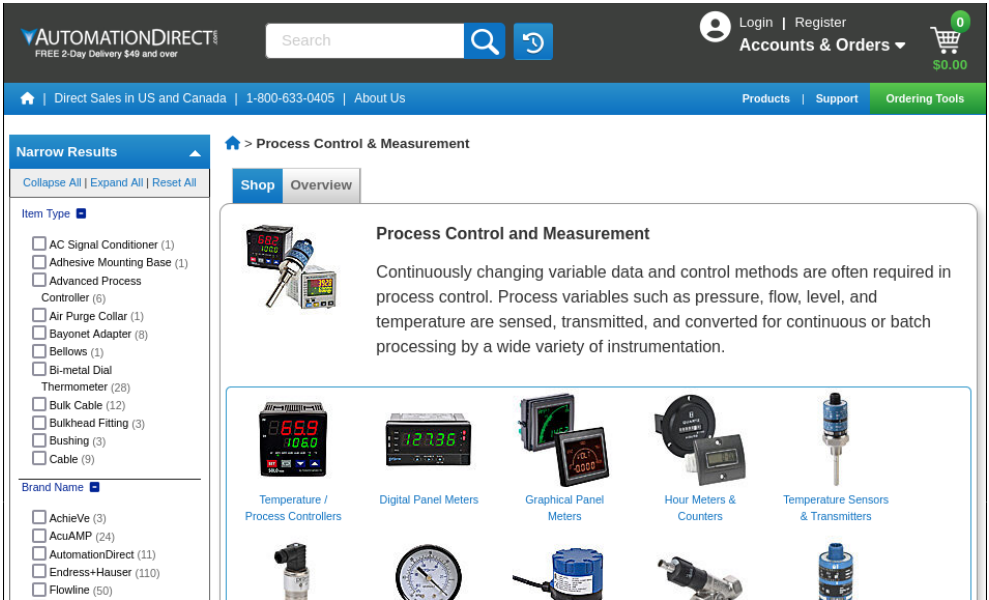


Electronics: More Accessible than Ever

Electronics: More Accessible than Ever



Electronics: More Accessible than Ever



PLOS BIOLOGY

ESSAY

Open hardware: From DIY trend to global transformation in access to laboratory equipment

Tobias Wenzel *

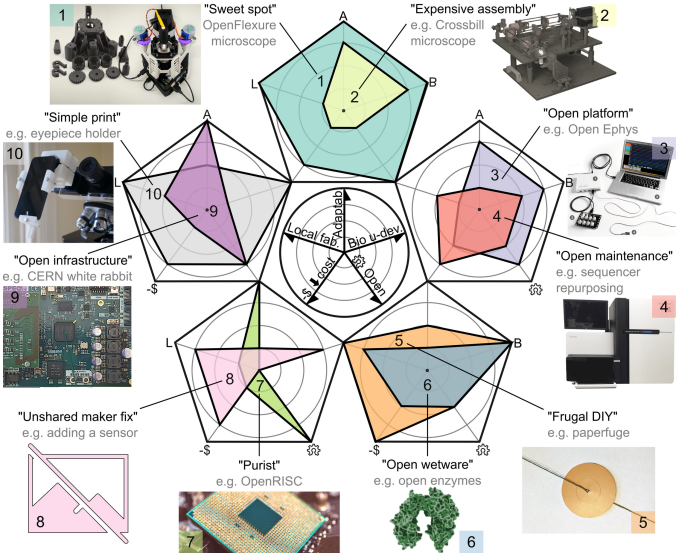
Institute for Biological and Medical Engineering, Schools of Engineering, Medicine and Biological Sciences, Pontificia Universidad Católica de Chile, Macul, Región Metropolitana, Chile

* tobias.wenzel@uc.cl

Abstract

Open hardware solutions are increasingly being chosen by researchers as a strategy to improve access to technology for cutting-edge biology research. The use of DIY technology is already widespread, particularly in countries with limited access to science funding, and is catalyzing the development of open-source technologies. Beyond financial accessibility, open hardware can be transformational for the access of laboratories to equipment by

Open Source Hardware



Repair and maintenance of research equipment.

Repair

One or two pieces of equipment per day.

About fifty research groups.

One employee...

Repair

Common research appliances

- hotplates
- stirplates
- shakers
- ovens
- rotovaps
- UV lamps
- sonicators
- balances
- chillers

Repair

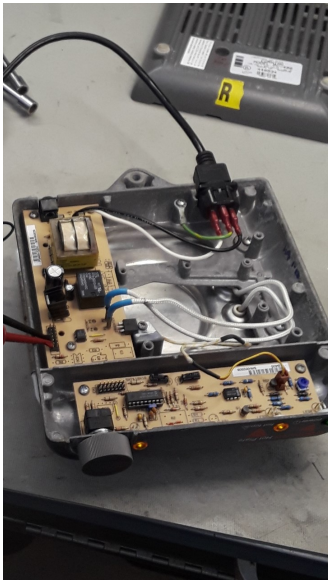
Cost savings

Irreplaceable

Operational continuity

Rotovap

Hotstir



Heating Elements

Amber Bartz

Amber Bartz
Chemistry Electronics Shop
afbartz@wisc.edu

Check out Amber's poster presentation:
What Researchers Should Know When Powering Lab Equipment

Electrical Safety

as Viewed from the Shop

Safety

Researchers utilize advanced electronics.
Researchers design and build custom instruments.
Researchers rely on in-house repair.

Let's think about safety implications!

Humility

I'm not a safety expert... talking at CSHEMA is a bit intimidating.

I'm glad you are dedicating a symposium to electrical safety.

I have no idea how to think about certification...

I hope we can work together.

Safety

Cutting-edge researchers will inevitably customize/create electronic circuits.

Hopefully, the electronics shop can be a place to do this work under professional supervision!

We don't have the time or the staff to look over every shoulder... ...instead, we try to convince researchers that they have a professional responsibility to care about electrical safety.

Safety

Two categories of electrical hazard:

- electrocution
- fire

Current Kills

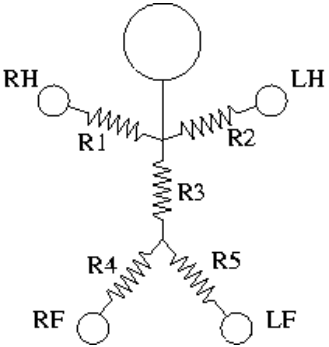
Relatively small amounts of current can be very dangerous!

- 1 mA - barely perceptible
- 16 mA - maximum current an average person can grasp and "let go"
- 20 mA - paralysis of respiratory muscles
- 100 mA - ventricular fibrillation threshold
- 2000 mA - cardiac standstill and internal organ damage
- 15000 mA - fuse / breaker opens circuit

A typical LED draws 20 mA.
Fuses and breakers will NOT protect you from death by electrocution!

WORKER DEATHS BY ELECTROCUTION
A Summary of NIOSH Surveillance and Investigative Findings
May 1998

Current and Voltage

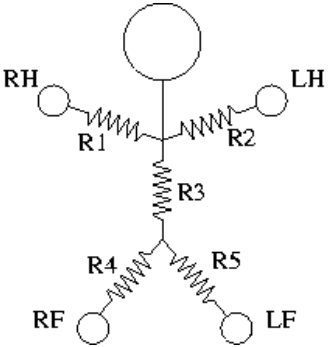


Current and voltage are related by Ohm's Law.

$$V = IR$$

Larger voltages drive more current through your body.

Current and Voltage

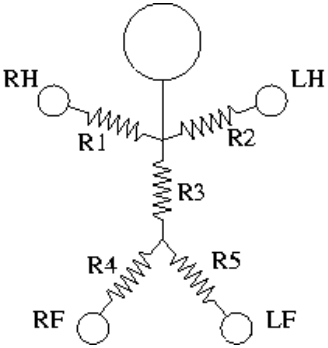


"Typical" resistance across the human body:
as low as 10kΩ. Solve for voltage driving 10 mA

$$V = 10\text{mA} \times 10\text{k}\Omega$$
$$V = 100\text{V}$$

Every device plugged into the wall is at least 120V.

Wet and Dry



Most resistance is at the skin.

Resistance decreases significantly if your skin is wet.

Typical Voltages

Treat anything above 30 V as an electrocution hazard.

- 5 V - USB power supply
- 120 V - typical lab appliance
- 120 V - typical vacuum roughing pump
- 50 to 200 V - gel electrophoresis
- 1000 V - piezoelectric actuators
- 1000 V - photomultipliler tubes
- 3000 V - electron / ion multipliers
- 15000 V - X-Ray sources

Typical Voltages

Voltage is not necessarily dangerous,

Know the current rating!

GFCI

Designed specifically for shock protection.

Ensure that no current is leaking out of circuit.
Sensitive to a few mA.

Will trip if used with large inductive loads (motors).

Prone to weaken over time—replaced every ten years.

Liquids and Shock Hazard

Avoid mixing water and electricity.

- Minimize the use of electrical equipment in cold rooms or other areas where condensation is likely. If equipment must be used in such areas, mount the equipment on a wall or vertical panel.
- If water or a chemical is spilled onto equipment, shut off power at the main switch or circuit breaker and unplug the equipment.

Electrical Fire

When an electrical circuit fails it can rapidly cause sparks and get very hot.

When combined with chemicals, this situation can become explosive.

Even low voltage circuits are capable of getting very hot.
Power is product of voltage and current.

Recommendations for Avoiding Electrical Fire

Ensure that circuits are not overloaded.

- Recognize which devices are drawing a lot of power.
  - Heaters, ovens
  - Pumps
  - Motors
- Be aware which devices share a circuit.
- Never use extension cords or power strips.

Recommendations for Avoiding Electrical Fire

Use good housekeeping.

- Do not crowd multiple appliances into small spaces.
- Regularly inspect power cords for damage.
- Keep appliances clean, free from chemical buildup.
- Dispose of broken appliances quickly.

Recommendations for Avoiding Electrical Fire

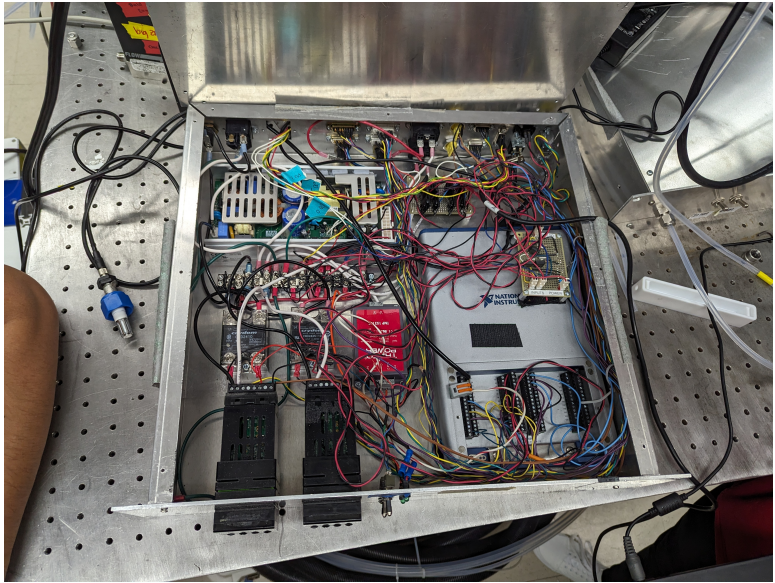
Protect against catastrophic failure.

- Ensure that devices have fuses and/or breakers.
- When designing heating systems, consider incorporating thermal fuses.
- Ground exposed metal.

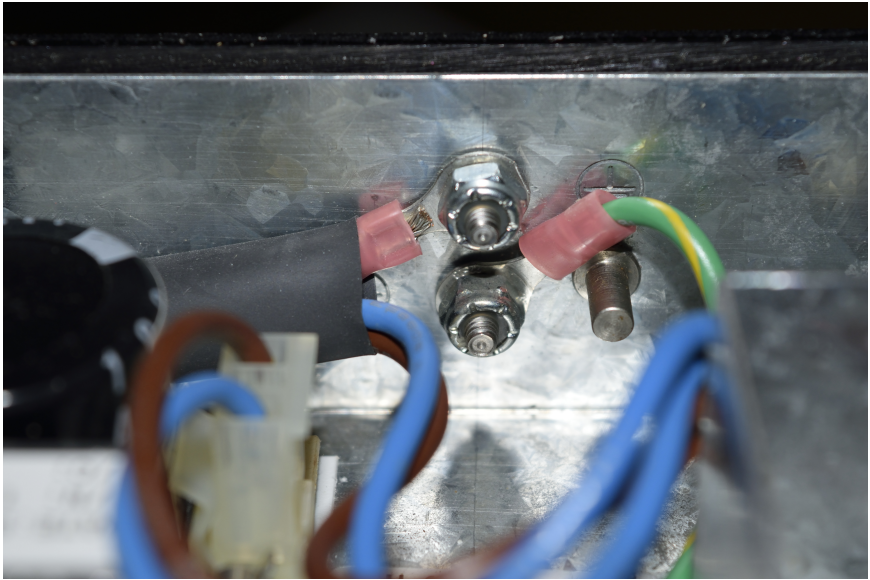
Examples

Some examples!

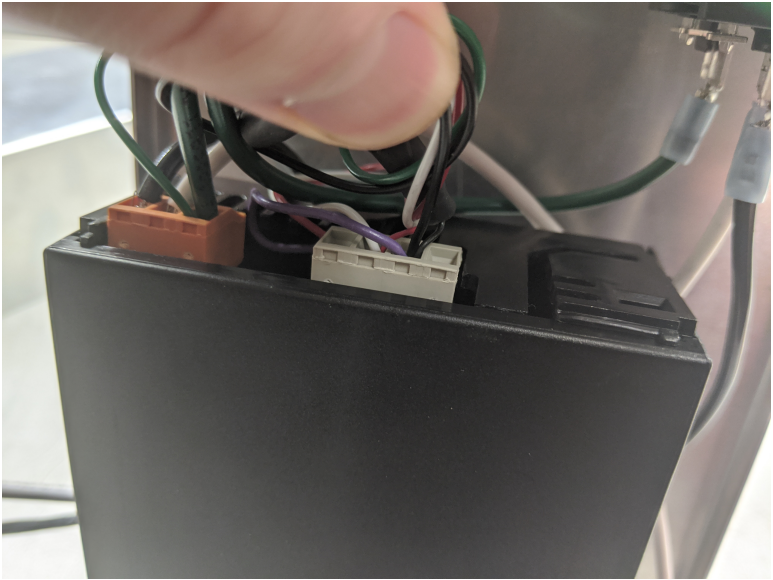
Wiring Mess



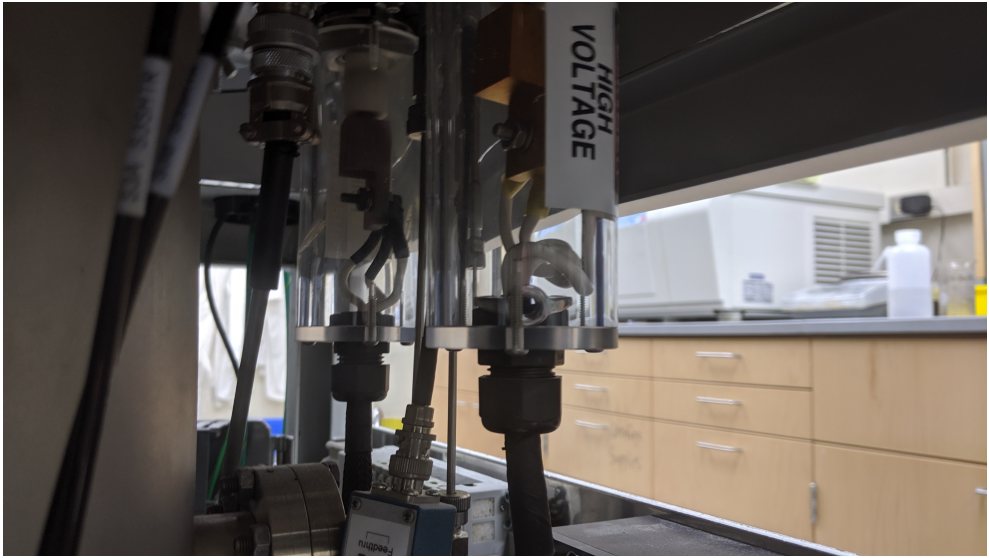
Chassis Ground



Electrocution Hazard



Electrocution Hazard



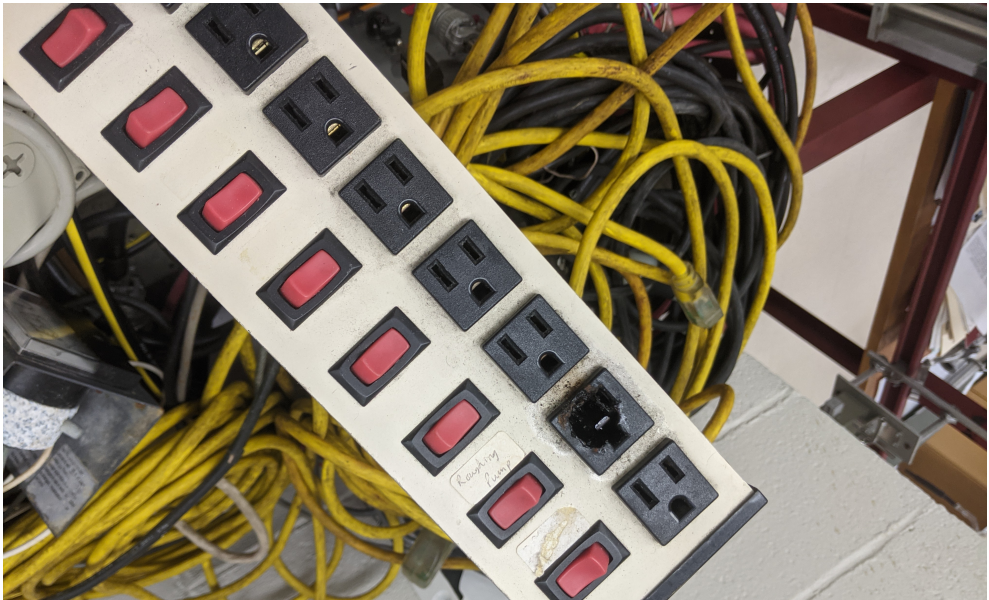
Electrocution Hazard

Fire Hazard

Cable Ratings

NEMA 5-15
120 V
Up to 15 amps, but many cables 10 amps!

Fire Hazard



Fire Hazard

Grounding, spark hazard.

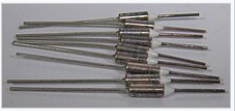
Thermal cutoff

From Wikipedia, the free encyclopedia

"Thermal protection" redirects here. For protection from external heat, see thermal insulation.

This article **needs additional citations for verification**. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.
Find sources: "Thermal cutoff" – news · newspapers · books · scholar · JSTOR *(May 2017)* *(Learn how and when to remove this template message)*

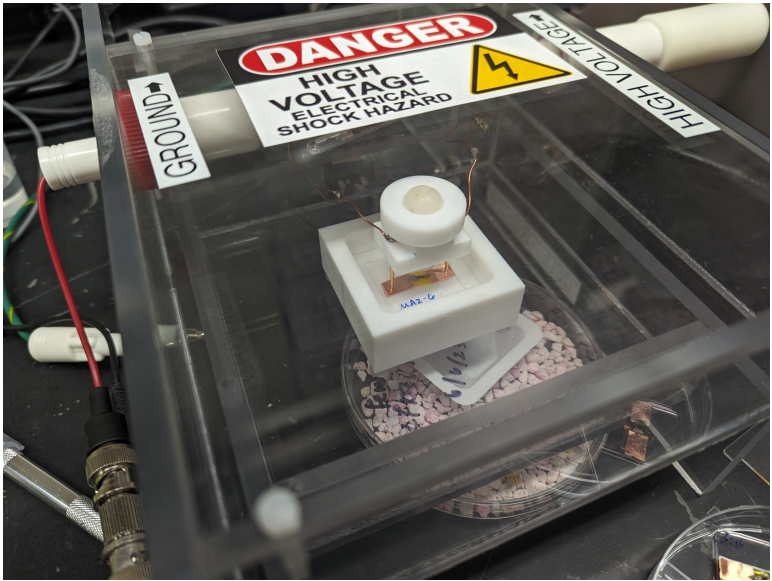
A **thermal cutoff** is an electrical safety device (either a thermal fuse or thermal switch) that interrupts electric current when heated to a specific temperature. These devices may be for one-time use (a thermal fuse), or may be reset manually or automatically (a thermal switch).


An assortment of thermal fuses

Thermal fuse [edit]

A **thermal fuse** is a cutoff which uses a one-time fusible link. Unlike a thermal switch which may automatically reset itself when the temperature drops, the thermal fuse is more like an

Interlocks


DANGER
HIGH VOLTAGE
ELECTRICAL SHOCK HAZARD
GROUND
HIGH VOLTAGE

Cable Ratings

BNC
500 V
Typically 1 Amp
Use SHV connectors for high voltage (!!!)

Interlocks


Panasonic
AZ7310CE
10A 250V
EN60947-5-1
AC-15
2A/250V~
Matsushita Electric Works, Ltd.
Panasonic
AZ7141CE
10A 250V AC
EN60947-5-1
AC-15
2A/250V~
Matsushita Electric Works, Ltd.
7021M
Made in Japan

Conclusion

Academic electronics shops contain staff working with researchers to best utilize electronic research equipment.

Shop staff are professionals who care about electrical safety.

Your institution might have a research electronics shop—consider reaching out!

Thank You

Blaise Thompson
Chemistry Electronics Shop
blaise.thompson@wisc.edu

Love to learn about research & electronics.
Let's chat!

Questions?