

# MONT Montana Nanotechnology Facility

*An NSF NNCI Node in the Northern Rocky Mountain Region*

NNCI Annual Conference 2022



David Dickensheets

October 21, 2022

[nano.montana.edu](http://nano.montana.edu)



# MONT Our Team



At this meeting...  
Andy Lingley  
MMF Facility Manager



Dave Mogk  
co-PD (ICAL, E&O)



Alison Harmon  
VP REDGE



Yves Idzerda  
Dean, CLS



Brett Gunnink  
Dean, COE

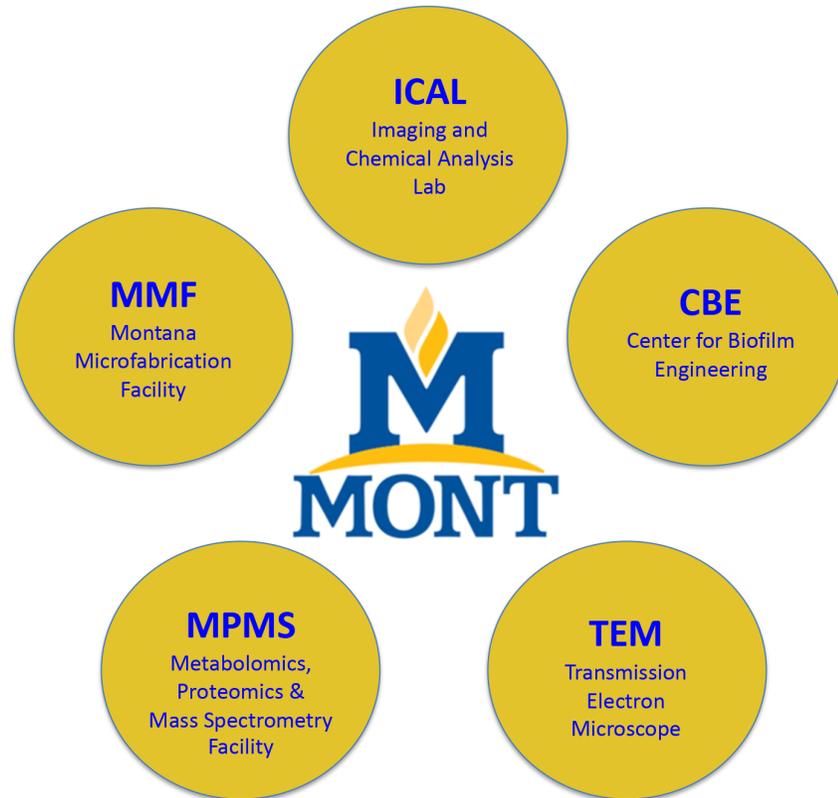


Sean Fox  
Education Specialist  
Carleton College  
Science Education Resource  
Center



# MONT Overview and Core Facilities

## Five Campus Facilities

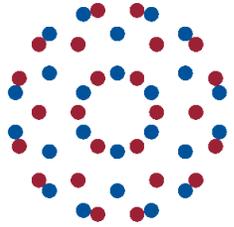


## Program Emphases

- **Optical MEMS and Nanosystems** – with local industrial collaborations
- **Biology, Earth and Environment, and Nanotechnology** – Biofilms and Microfluidics, bio-corrosion, nano in nature
- **Novel optical and high temperature materials**
- **2D Quantum Materials**
- **Nanoscale characterization** – SEM, nanoAuger, XPS, XRD, ToF-SIMS, AFM, TEM
- **Education and Outreach** emphasizing undergraduate research, K-12 students/teachers, web-based education

Prompt: What new program have you introduced recently?

# MONT: MonArk Quantum Foundry Updates



**MonArk  
Quantum Foundry**

A NATIONAL NETWORK OF 2D-QMaPs

[www.monarkfoundry.org](http://www.monarkfoundry.org)



**MONT**



MonArk collaborations with  
academia, industry, and national labs.

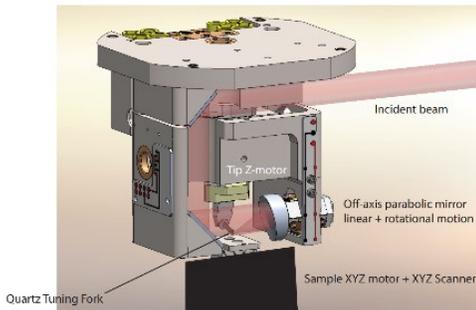


## MonArk Scientific Thrusts

- 2D quantum emitters & quantum interconnects
- 2D quantum dots and qubits.
- 2D nonlinear media
- 2D magnetism quantum spin liquids
- + more!

## MonArk Infrastructure Development

4 K nano-optics (MSU)

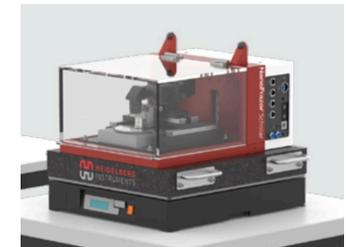
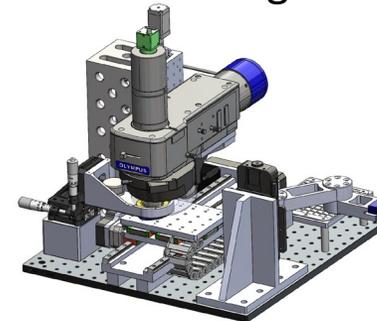


mK qubit  
characterization (UA)



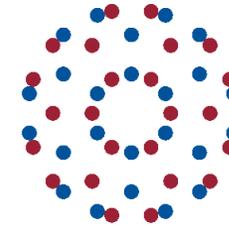
Automated 2D material exfoliation  
and device fabrication (MSU and UA)

Inert gas environment



# MONT: MonArk Quantum Foundry Updates

- 6 full-time staff; 10 graduate students
- Development of inert-atmosphere device processing:
  - 2D material exfoliation and stacking
  - nanolithography, etching, deposition, packaging, and in situ characterization
  - all in interconnected gloveboxes.
  - Pilot user interactions in 2023, welcoming external users in 2024
- Partnerships (so far) with 13 universities, 3 national labs + 1 international lab, and 6 companies
- collaboration with ExpandQISE NSF program at UA Pine Bluff (Arkansas HBCU)
- Anticipate extending 2D materials capabilities through NNCI network – not ready yet...



MonArk  
Quantum Foundry

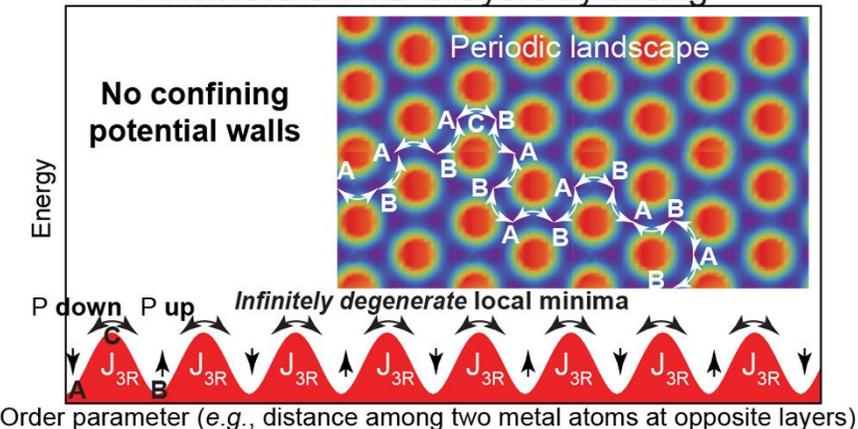
A NATIONAL NETWORK OF 2D-QMaPs



MonArk collaborations with  
academia, industry, and national labs.

NANO LETTERS

Paraelectric TMD bilayers by sliding



Juan M. Marmolejo-Tejada\*, Joseph E. Roll, Shiva Prasad Poudel, Salvador Barraza-Lopez\*, and Martín A. Mosquera\* DOI: (10.1021/acs.nanolett.2c03373)

# NEW! MONT Education and Outreach

## MONT Empower Scholars Program

The Empower Program is dedicated to the inclusion and success of underrepresented minorities and women in engineering and other fields of STEM

- Students receive a stipend and facility training costs are covered
- 11 total awards
- All students who receive a post-scholarship this was their first hands-on research in a lab and the experience was overall extremely positive.



Michael Espinal

Getting involved with undergraduate research has been pretty life-changing,” said Espinal, who grew up in Vacaville, California. “It has really opened a lot of doors for me.”

**Recipient 2021**  
the student.  
er reinforced  
EM in ICAL).

- Author on publication in *Materials* (2021).
- **Awarded an NSF Graduate Research Fellowship 2022.**

# New! Workforce Development

## Emerging Workforce Development Programs



- Working with local Gallatin College on certificate development.
- Considering Semiconductor Manufacturing certificate option within COE at MSU.
- Working with corporations like Micron, Intel, and others to develop a “reverse intern” program. Company pays undergrad to work in our facilities, then student goes on to work at the sponsoring company.
- Hiring undergraduates from the MSU Empower Program to work in MONT facilities, particularly the cleanroom (undergraduate education and expanding diversity).



# MONT: Measuring Economic and Commercial Impact

## External Users SBIR/STTR Awards 2021



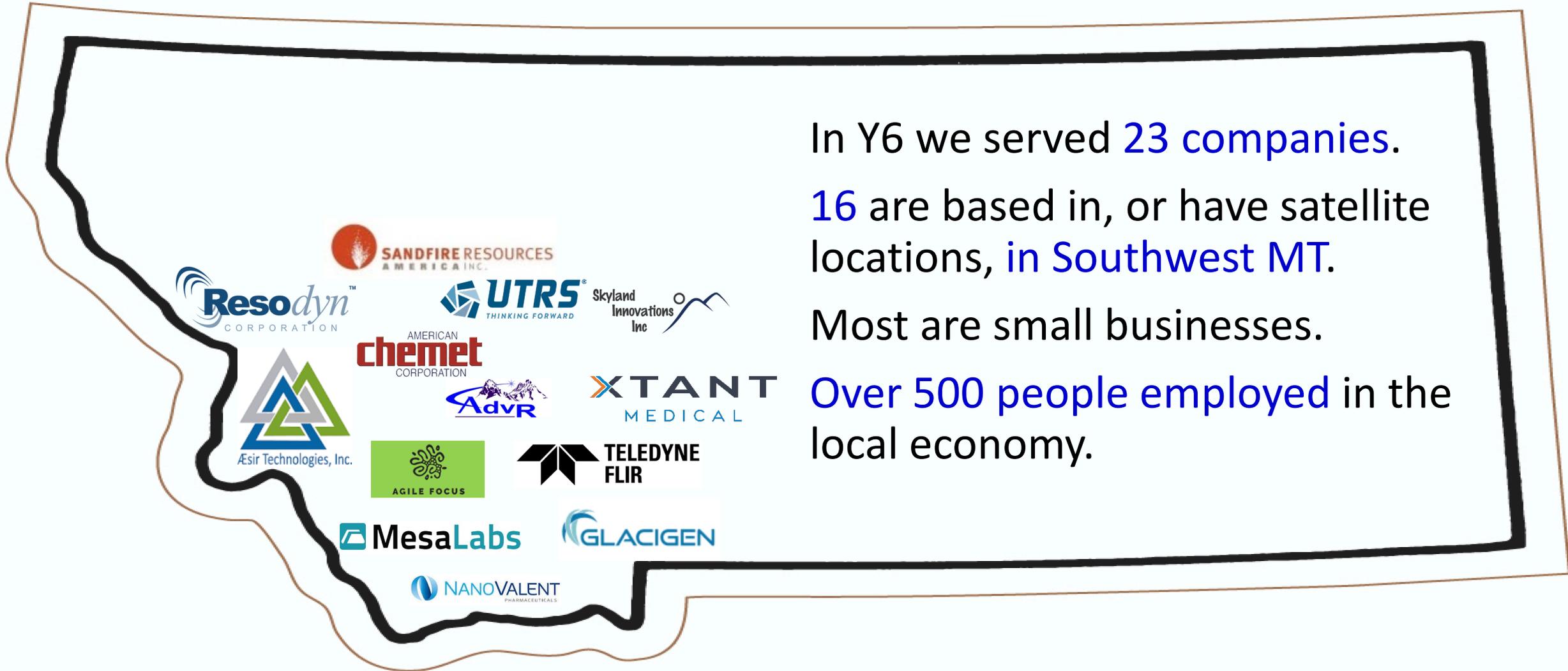
- AdvR, Bozeman, MT Phase II, STTR, DOD F20A-T003-0001, \$1.4M
- AdvR, Bozeman, MT Phase I, SBIR, DOE 255767, \$250K
- Agile Focus, Bozeman, MT, Phase I, SBIR, NSF 1951117, \$750K
- Resodyn, Butte, MT, Phase I, SBIR, DOD N172-141-0157, \$1M
- Resodyn, Butte, MT, Phase I, SBIR, DOD A202-101-0151, \$750K



Additional successes for our industrial users include **Nature's Fynd**, a food company growing sustainable protein from a microbe with origins in the geothermal springs of Yellowstone National Park, has raised \$350 million in a **Series C funding**.



# MONT: Regional Impact



In Y6 we served **23 companies**.

**16** are based in, or have satellite locations, **in Southwest MT.**

Most are small businesses.

**Over 500 people employed** in the local economy.

# MONT: Convergence of nanoES + Rules of Life

## MONT Fall 2022 Virtual Event

### The Convergence of Biology and Earth Sciences

Tuesday, November 1, 12–3 PM (Mountain Time), Online

Register by Monday, October 31, 2022

### Description

This virtual event explores the intersection between biology and geological sciences. The speakers will discuss how microbial communities interact with and shape their environment, and how we can use tools from nanoscience to better understand these interactions.

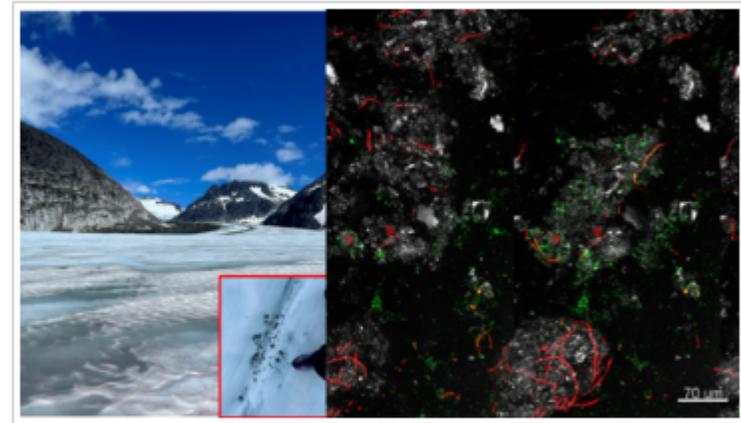
This event is open to all, but will be of particular interest to anyone curious about how nanoscale technologies can help us probe microbial communities in the environment. Participants across the geosciences, biological sciences, physics, and engineering are encouraged to attend!

### Goals and Objectives

- Provide examples of the interface between biology and the geosciences.
- Provide an interdisciplinary networking opportunity.
- Introduce participants to research, tools, and services that can be used to explore the interface between biology and geosciences.

[https://serc.carleton.edu/msu\\_nanotech/mont\\_fall2022/registration.html](https://serc.carleton.edu/msu_nanotech/mont_fall2022/registration.html)

In 10 days!!



Gilkey Glacier, Alaska. Inset showing cryoconite sediments on glacier surface and confocal microscopy image of biofilm on the sediment surface. Image credits: C. Foreman and H. Smith, Montana State University.



# Undergraduate Engagement

Why do we engage Undergraduates?

- "Workforce" development
- Inspire our creative and optimistic students to think about the future challenges and opportunities in nano

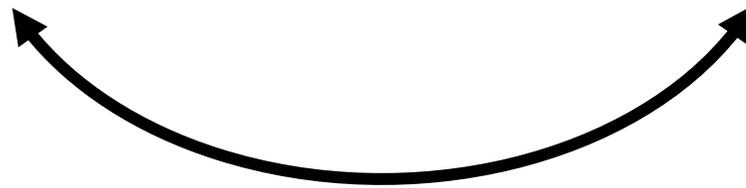
How do we engage them?

- Coursework (Facility hosts labs)
- UG Research Assistants (Working for PIs who are facility users)
- REU, EMPOWER, USP (also through local PIs)
- Facility Staff (UG become integral part of our facility staff)
- Outreach (Family Science Day, e.g.)

# Undergraduate Engagement

“Remote work drains staff resources”

Remote Work  $\neq$  Workforce Development



Use UG students on  
facility staff to do work  
for external users

Thank you!