MONT
Montana Nanotechnology Facility

An NSF NNCI Node in the Northern Rocky Mountain Region

David Dickensheets

NNCI Annual Meeting 2024

nano.montana.edu

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MONT Team

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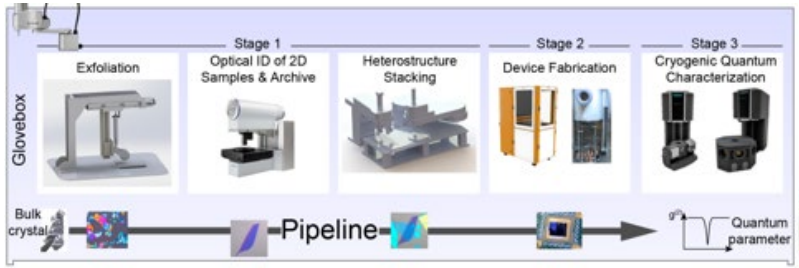
Key Capabilities



2D-QMIS
Quantum Materials Instrumentation Suite
MonArk Quantum Foundry

ICAL
Imaging and Chemical Analysis Lab

MMF
Montana Microfabrication Facility

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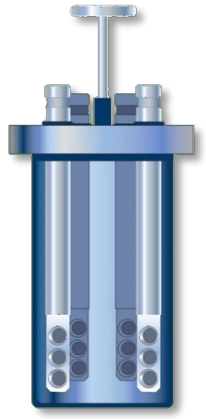
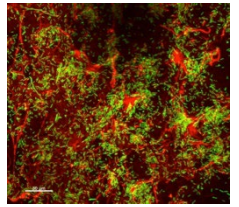
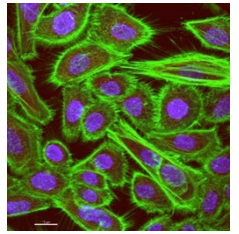
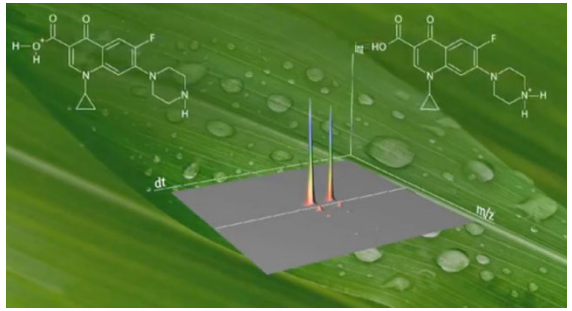
Shared-Use Facilities

CBE
Center for Biofilm Engineering



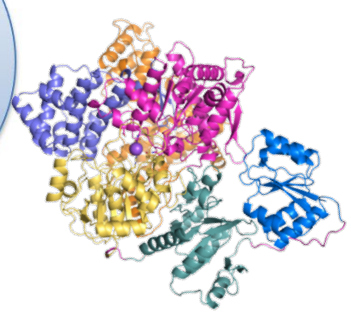






Mass Spec

Cryo-EM



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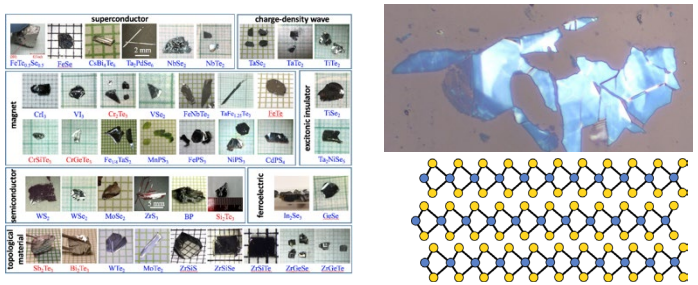
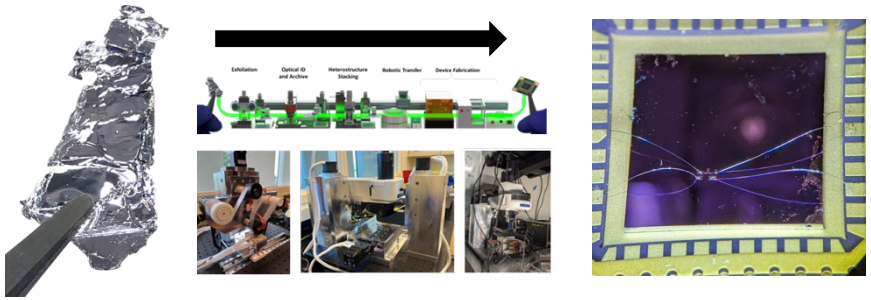
Newest Facility: MonArk Quantum Foundry

Introduction to 2D quantum materials research and the MonArk NSF Quantum Foundry



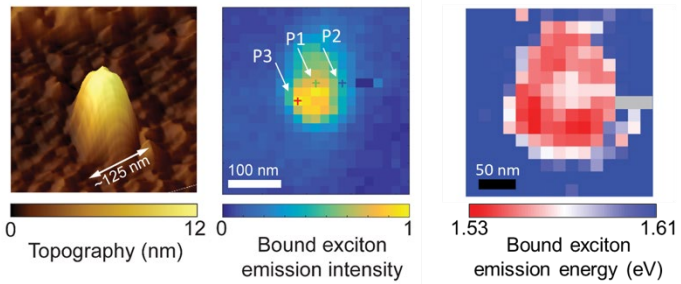
Many exciting opportunities in 2D quantum materials

2D Quantum Materials Pipeline :
accelerated 2D quantum materials research



MonArk 2D-QMaPs improve efficiency of 2D quantum materials research with robotic automation

Nano-optical studies of quantum emitter systems in 2D semiconductors



Nanoscale fabrication and characterization is essential for engineering and understanding 2D quantum materials

MonArk Quantum Foundry
A NATIONAL NETWORK OF 2D-QMaPs

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UNIVERSITY OF ARKANSAS

Sustainable Programs and Activities

Annual Meeting Topic for 2024:

- What are examples of programs and activities developed under NNCI that will be sustainable, independent of any continued NSF renewal funding, and what strategies or sources will be used to support them?

Sustainable Programs and Activities

- MONT Facilities will continue to serve Nano Users
  - Much enhanced compared to 9 years ago – an enduring impact of the NNCI award
    - Number of users has more than doubled in 9 years
    - Infrastructure investments > $20M
    - Expansion of capabilities includes 2D materials fabrication and characterization
  - Message: NNCI has had a profound and lasting effect on nanotechnology technical capacity at Montana State
  - Without NNCI funding, likely a reduction in staffing, with a negative impact on service to external users

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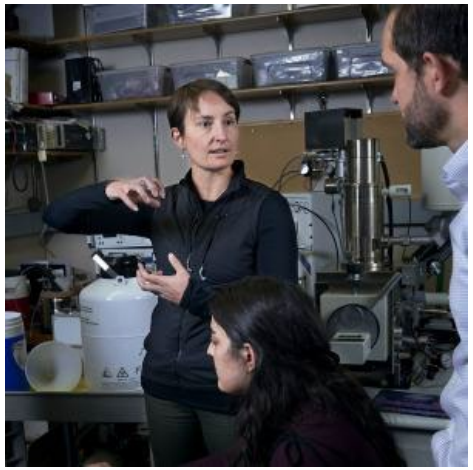
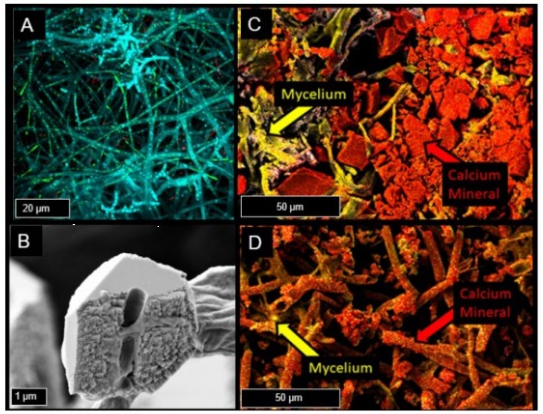
Sustainable: Positive Impact for our Users



MONT researchers Chelsea Heveran, Lewis Cox and graduate student Ghazal Vahidi in ICAL

Dr. Chelsea Heveran received **an NSF CAREER** award for a project called, “Osteocyte Regulation of Bone Tissue Fracture Resistance.” Heveran was the recipient of MONT User Grant that helped kick-start this line of inquiry in 2019.



Biomineralization of fungal scaffolds figure from proposal.

MONT co-PI Avci and MONT Users Awarded $3M NSF Grant: Manufacturing, repairing, and re-using biomineralized infrastructure materials through low-energy biological processes.

AAAS Science Advances Cover A thread spools out from a yarn ball, representing a genome of an RNA virus.

MONT Users Work Featured in AAAS Science Advances Cover Illustration. The work of Cryo-EM and TEM facility users Artem Nemudryi and Anna Nemudraia is illustrated on the cover of the September 2023 issue of Science Advances.

Amberly Guerrero, above.

Amanda Haab, below.

Two Undergraduate MONT Users Receive Goldwater Scholarships. Both undergraduate researchers are users of the ICAL facility. The Barry Goldwater Scholarship and Excellence in Education provides up to $7,500/year and is among the most prestigious available to undergraduates pursuing research careers in STEM.

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Sustainable Programs and Activities

- On-campus education will continue
  - Past 9 years has seen expanded service to UG Courses, teacher short courses, community college short courses, all likely to continue

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Sustainable Programs and Activities

Northwest Nano-Lab Alliance (NWNLA)

Joint effort between MONT / NNI

- Regional network, modeled after MINIC's NNLA
- Build relationships, solve common problems, and grow awareness of capabilities, needs, vendors, and NNCI resources
- Biennial meeting at UW or MSU

NWNLA will continue, but perhaps in a virtual format

NWNLA participating institutions

https://www.nano.uw.edu/nni/northwest-nanotechnology-laboratory-alliance/

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Workforce Development is Sustainable

Northwest University Semiconductor Network

- Micron Technology announced the formation of the Northwest University Semiconductor Network, a partnership created to develop the next generation of the semiconductor industry's workforce in June 2023. The new network is comprised of 13 founding-member universities across six states.

Micron and other industry partners supporting workforce development

- MONT received a $10k gift to develop and run a semiconductor short course and has been awarded another $35k gift for hiring student employees.
- Micron hires many MONT students and is excited about the quality and preparation of the students.
- Other companies are taking notice of this success and are considering similar student support.

Student Workforce

- **The MMF now employs 17 undergraduate students**, primarily supported by user fees. Student training focuses on both technical and professional development. These students also do an enormous amount of outreach: Shadow Day, STEAM Day, EconoQuest, Undergrad Research Fair, etc.

NanoCats

- The MMF student workforce created an official MSU student organization to connect students and companies in the semiconductor industry. During the Fall Career fair, the NanoCats organized info sessions with Micron, Applied Materials, and TEL. https://www.linkedin.com/groups/14385428/

Gallatin College

- The MMF runs a 3-evening hands-on introduction to semiconductor manufacturing for students in the Gallatin College Optics and Photonics program.

Impacted Programs and Activities

- On-campus single-day Outreach will continue, but…
  - Rural reach may be compromised: NNCI funds help pay to bus rural students to MSU for major outreach activities
  - Overnight activities, chartered trips, etc. likely go away
- MONT/EMPOWER Scholarships for URG in STEM take a hit
- User Grants (Kickstarter program) take a hit
- Online education partnership with SERC at Carleton College cannot be further expanded
- MONT contributions to NNCI Research Communities impacted

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Sustainability after NNCI

Take home message:

- NNCI has left an indelible, positive impact at MONT, with enduring enhanced capabilities and programs that will be sustained after the end of the funding
- NNCI also provides ongoing funding for programs that have little or no other means of support, and those programs will not be sustained

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Panel Topic #4

Panel Topic

How does MONT support translation of research to the commercial sector and what more could be done.

Fostering Translation of Research to Commercial Sector

- Spinning out companies with MSU students (and faculty)
- Workforce development – training students in nanotech
- Welcoming companies into the facilities for process development
  - Choices about methods of access
  - Consultation on critical needs for new capabilities
- Project initiation grants (kick-starter funding)
- Joint development of technology between Companies/Staff/Faculty/Students
- CHIPS Act major initiatives

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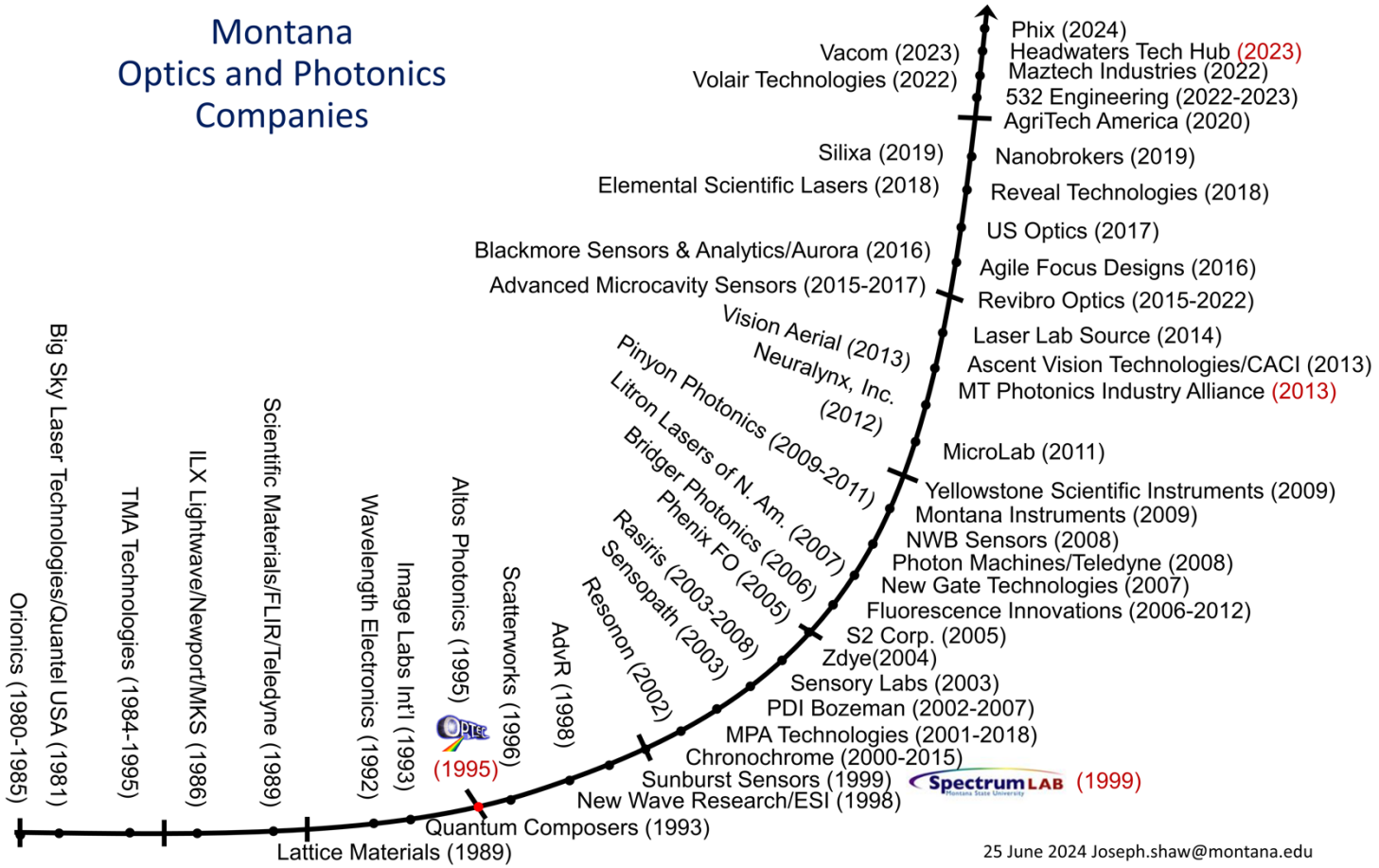
Spinning out Companies and Training the Workforce

A model: Montana Optics and Photonics Companies



- 9 of 12 companies founded in 1980s and 1990s started by MSU graduates (75%)
- MSU's Optical Technology Center started in early 1990s
- 29 of 51 companies founded by MSU students or faculty (57%)
- We expect to see a similar progression around nano/quantum
- All of these companies rely on MSU graduates as a primary source of employees

Workforce Development!

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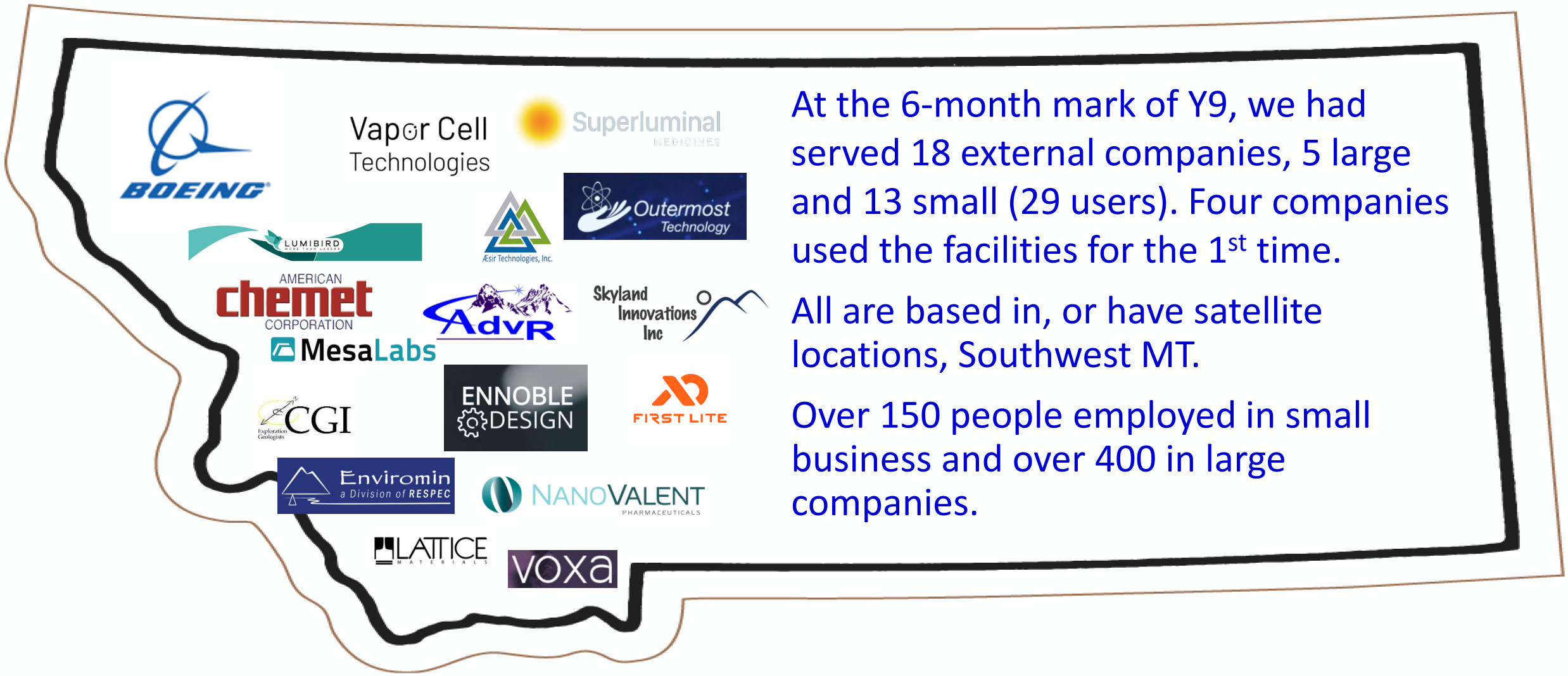
Welcoming companies into the labs



At the 6-month mark of Y9, we had served 18 external companies, 5 large and 13 small (29 users). Four companies used the facilities for the 1st time.

All are based in, or have satellite locations, Southwest MT.

Over 150 people employed in small business and over 400 in large companies.

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Partnering to win Federal grants

External Users SBIR/STTR Awards 2023

10 NEW Phase I and Phase II awards

- AdvR, Bozeman, MT Phase I, STTR, NASA 80NSSC23PB307, $150k
- AdvR, Bozeman, MT Phase I, SBIR, NASA, 80NSSC23PB306, $150k
- AdvR, Bozeman, MT Phase I, STTR, DOD, FA9451-23-P-0011, $150k
- AdvR, Bozeman, MT Phase I, SBIR, DOD, FA9451-23-P-A042, $150k
- Aesir Technologies, Bozeman, MT/ Joplin, Mo, Phase 1, SBIR, FA9422-23-C-0008, $1.7M
- Biosqueeze Inc, Butte, MT, Phase I, SBIR, DOD, FA8649-23-P-1021, $1.2M
- Quench Medical, St. Paul, MN, SBIR Phase I, NIH, R43HL165960-, $300k
- Quench Medical, St. Paul, MN, SBIR Phase II, NIH, R44CA277898, $31.2M
- Resodyn, Butte, MT Phase II, SBIR, DOD, SP4701-22-P-0057, $1.2M
- NWB Sensors, Bozeman, MT Phase I, SBIR, DOA, 2023-00786, $150k

AdvR

NWB Sensors, Inc.

QUENCH MEDICAL

Resodyn™ CORPORATION

BioSqueeze SEALED WELL

Æsir Technologies, Inc.

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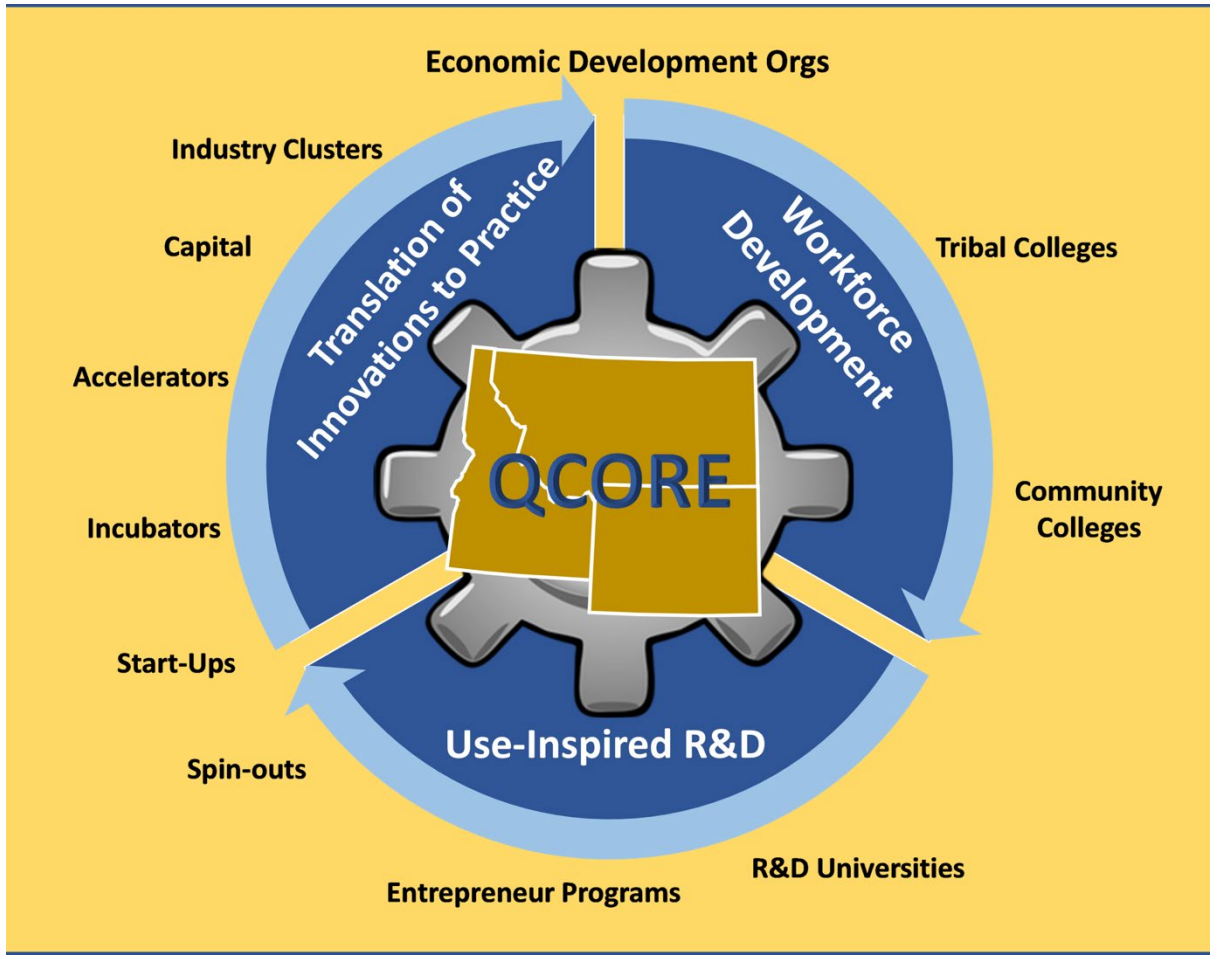
Federal Translation Initiatives: Quantum

NSF Engines

$1M Award in May 2023

Award includes collaborations with several MONT industrial users. (Montana Instruments, Teledyne FLIR, Cylynt, Quantel, AdvR, Wavelength Electronics, Micron, and Qubitekk)



DoD Investment: Quantum/Nano

AFRL
AIR FORCE RESEARCH LABORATORY

$26.7 M grant from the U.S. Air Force, MSU will establish The Applied Quantum Core Facility to advance quantum technology applications in cybersecurity, communications technology and national defense from concept and testing to market.

Applied Quantum Core Facility

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A Final Thought:

- MONT, strengthened by NSF NNCI investment, is the natural home for much of this expanded “Quantum” capacity
  - Infrastructure and technical staff
  - Well-developed user access
  - Track record of open access and commercial customers
- Applies equally well to all of the NNCI Sites

Quantum is Nano / Quantum needs Nano

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Thank you!

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