

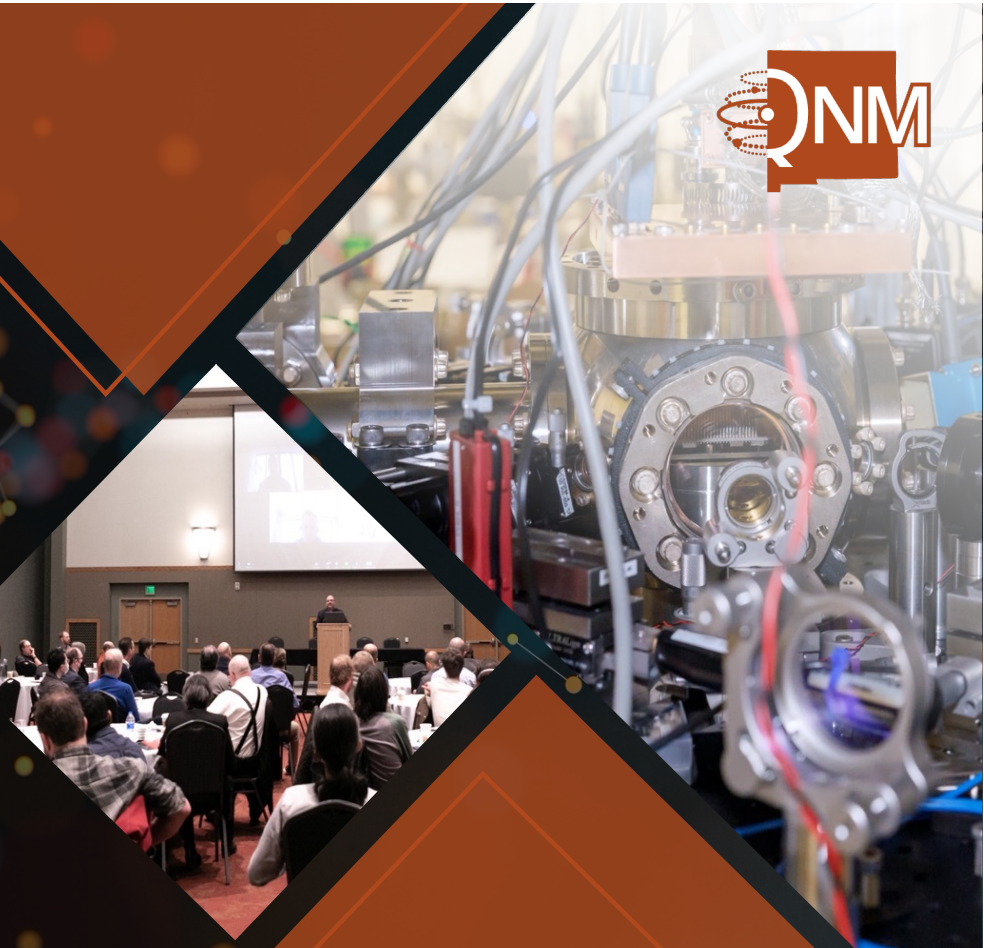
# QUANTUM NEW MEXICO

*New Mexico is a quantum state*

QNM Overview

**Presented By:** Rick Muller, Sandia National Labs  
Ivan Deutsch, University of New Mexico

July 2022



*Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.*



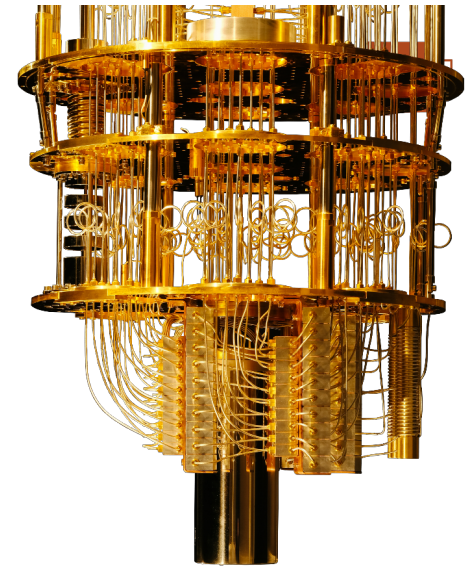
## Agenda

- Overview of **Quantum Opportunities**
- What is **Quantum New Mexico (QNM)**
- QNM's **Vision and Projects**
- QNM's **Future and Next Steps**

# Quantum 101

Quantum information science and technology (QIST) will allow us to solve new types of problems

- Quantum computers operate under the rules of quantum physics
- Nascent technology with the potential to solve previously unsolvable problems
  - Break **unbreakable** cryptography and solve unsolvable problems
  - Enable **provably** secure communications
  - Dramatically improve **sensing** and **detection**
- E.g., in September 2019, Google's Sycamore quantum computer performed a calculation in 200 seconds that a classical computer would require 10,000 years to solve

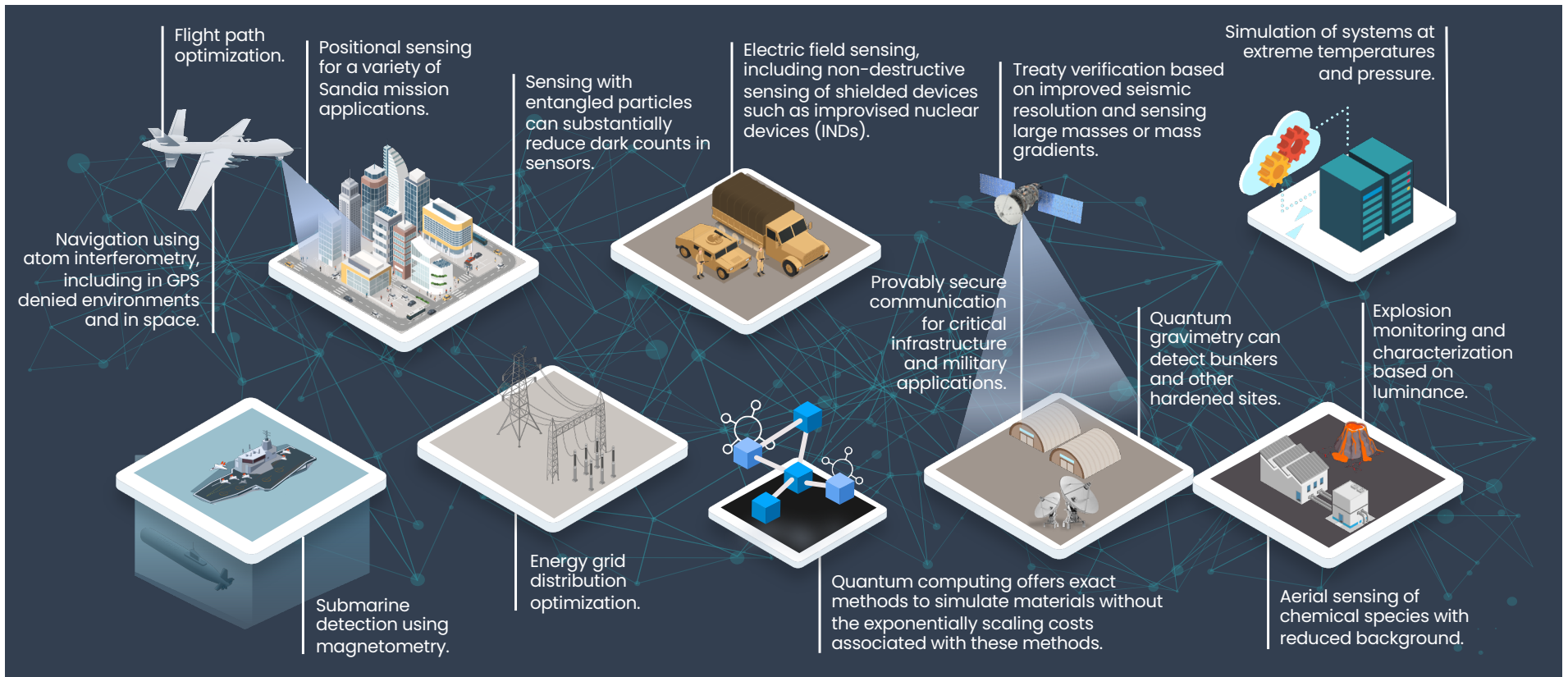


*"Many industries are currently working with quantum computing, including banking, capital markets, insurance, automotive, aerospace, and energy. In years to come, the breadth and depth of the industries leveraging quantum will continue to grow." – Dr. Robert Sutor, Chief Quantum Exponent, IBM Research*

# Potential Applications of QIST



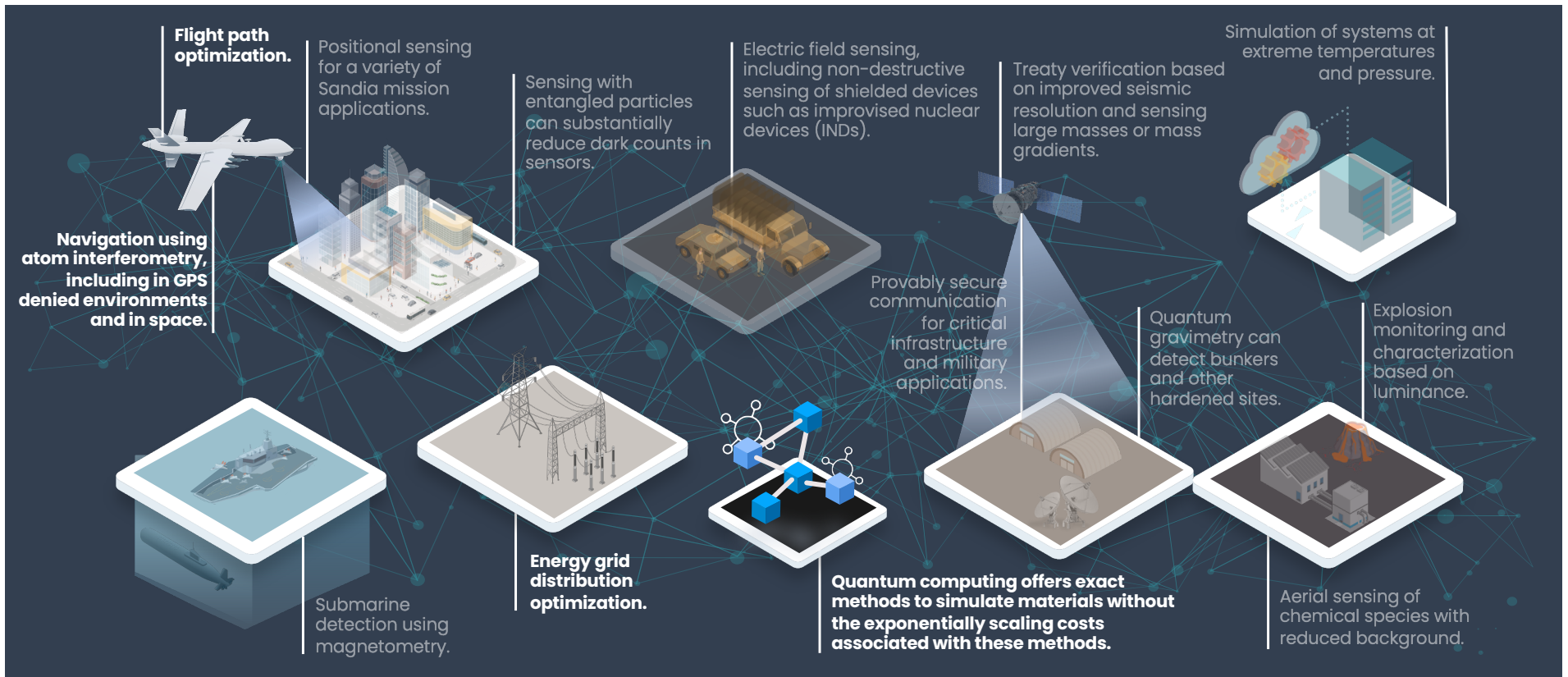
QIST has the potential to impact a broad set of sectors and applications



# Potential Applications of QIST



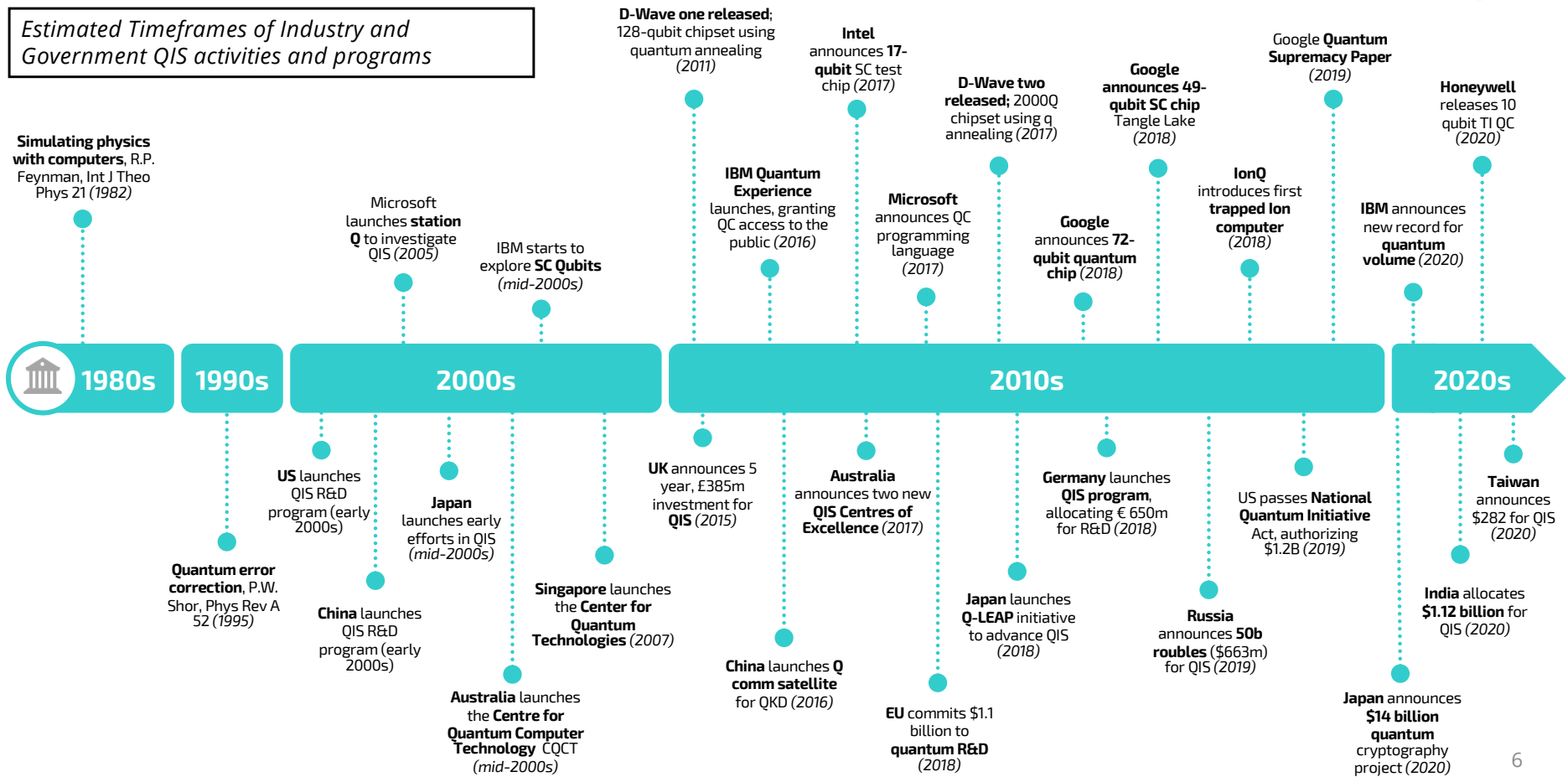
QIST has the potential to impact a broad set of sectors and applications



# INDUSTRY AND GOVERNMENT QIS TIMELINE



*Estimated Timeframes of Industry and Government QIS activities and programs*



# QIST is a National Strategic Priority



## National Quantum Initiative

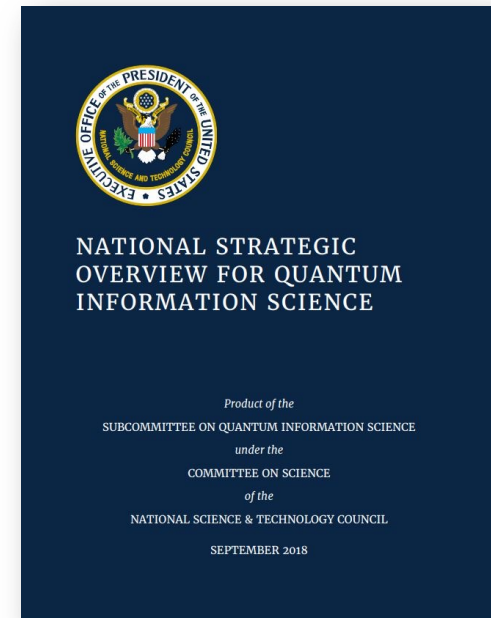
- Created all of government approach to sustain national and economic security. Established in late 2018, authorized \$1.15B in funding
- Currently funding 5 DOE NQISRCs, 5 NSF QLCI's, and QED-C efforts. SNL, LANL, and UNM are all engaged with these centers

## Government Agencies are continuing to support QIST

- Dept. of Energy Reaching a New Energy Sciences Workforce (RENEW)
- National Science Foundation Regional Innovation Engines (RIE)
- Economic Development Agency Build Back Better (BBB)

## Additional Legislation will Enable and Affect QIST in years to Come

- CHIPS (Creating Helpful Incentives to Produce Semiconductors) for America Act
- America COMPETES Act/ U.S. Innovation and Competition Act



# State Commitments to Advancing QIST



## California

- Exploring workforce development programs leveraging it's Employment Training Panel (ETP) to support job creation and retention in partnership with QIS industry.

## Colorado

- Approved tax credit program in 2021 for quantum manufacturing and encouraging the development of local quantum clusters.
- Strong partnership between national labs and academia supports JILA

## Illinois

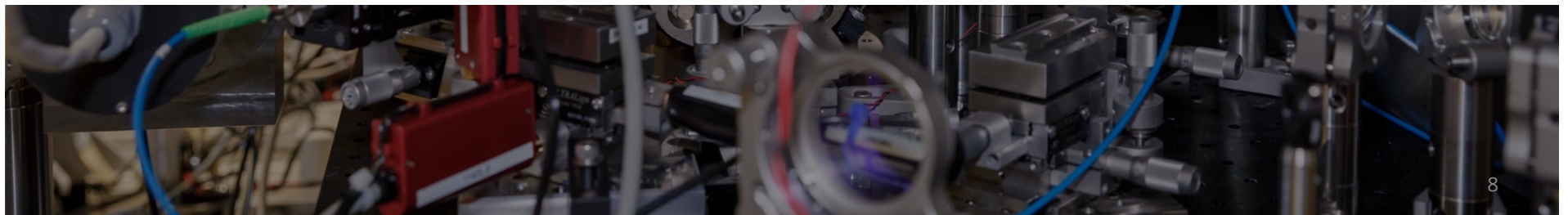
- Committed \$200M in 2019 for quantum research infrastructure for universities and national labs.
- Supporting efforts to create a local quantum cluster through the Chicago Quantum Exchange

## Maryland

- Creating partnership with national labs, academia, and state government partners to support emerging QIST innovations

## New York

- Creating partnership with national labs, academia, and state partners to support emerging QIST innovations



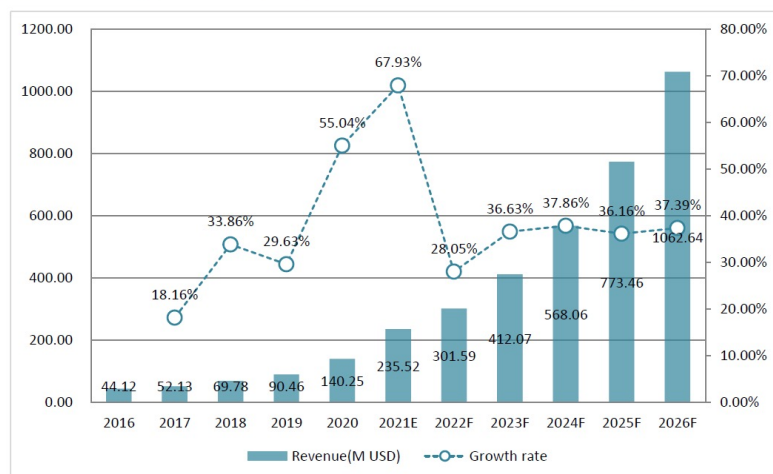


# QIST Market Projections

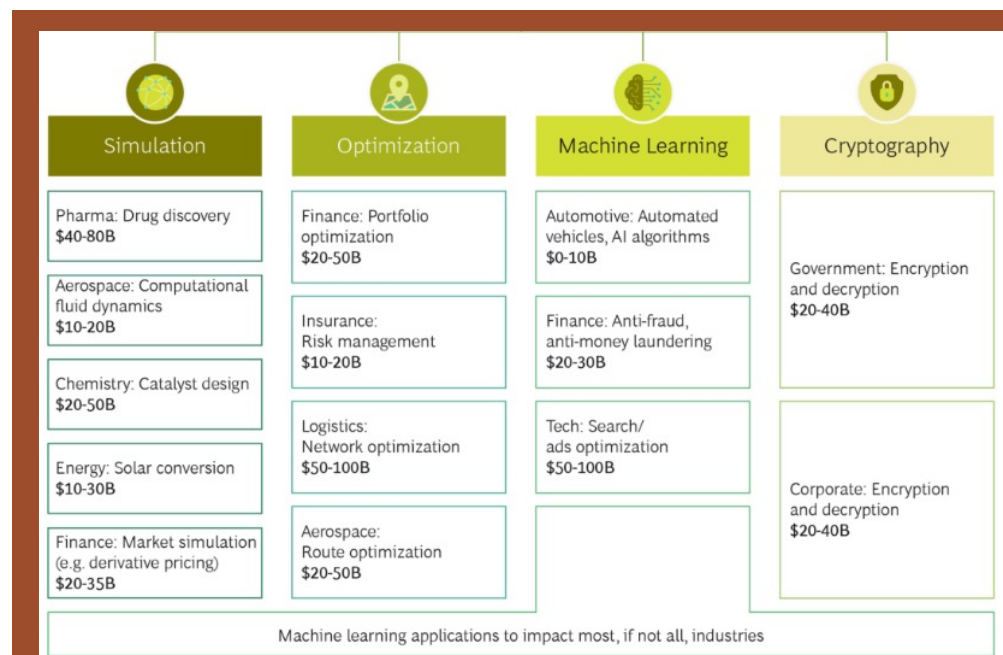


LP Information's Global Quantum Computing Market Growth projects significant growth in quantum computing over the next 5 years

Figure 5: Global Quantum Computing Market Size Growth Rate 2016-2026 (\$ millions)



Source: Secondary information and LP Information Research Team, 2021



**Boston Consulting Group (BCG) estimates that quantum computing could create value of \$450B to \$850B in the next 15-30 years. Value of \$5B - \$10B could start accruing as soon as the next 3-5 years.**

<https://www.bcg.com/publications/2021/building-quantum-advantage>

# Quantum industry is growing quickly



NM Institutions are engaged with industry partners across the entire QIST Ecosystem

## Large Cap



## Full Stack Startups



## QIS Software



## Enabling Technologies & Supply Chain

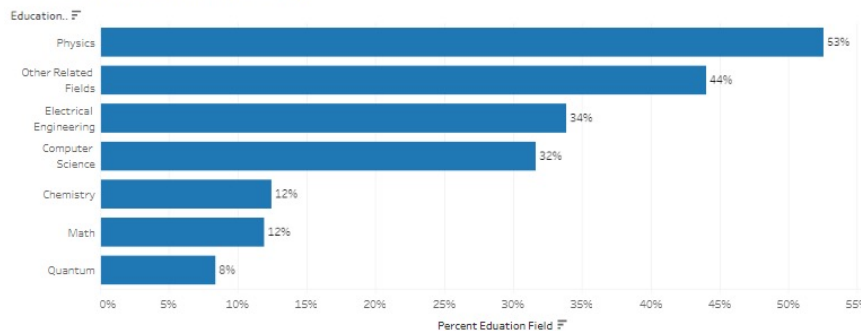


# Quantum Ready Workforce Needs

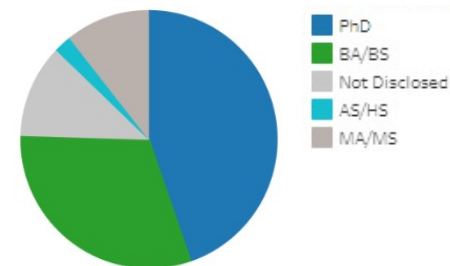
Demand for a quantum ready workforce is growing across the world

- Many federal programs are targeting capacity building and driving efforts to create a more equitable and inclusive workforce
- QIST is truly multidisciplinary, with opportunities for NM institutions to engage across all levels of education
  - Less than ½ of the job postings require a PhD
  - Working with universities and community colleges in NM to develop a quantum technician program
  - Engaging high school teachers and students through QCaMP

Education Field Overall Percentage



Minimum Education Requirements



Results from a quantum workforce hiring survey for the months of May 2021 – January of 2022. Data based on open job postings in the US sorted by keyword N=991.

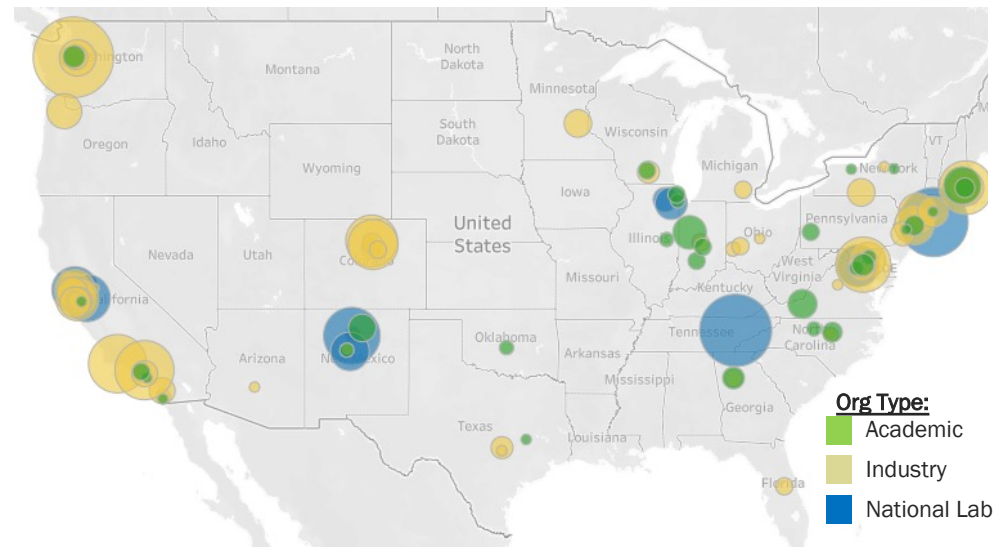


# Quantum Workforce Hiring Heatmap



QIS hiring across the US

- NM already has leadership in academia and national laboratories
- A catalyst is needed to spur QIS industry in New Mexico



*Building a quantum ready workforce will allow NM to continue serving as a leader in QIST on the national landscape.*



| QUANTUM NEW MEXICO >

# QNM Opportunity

---

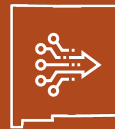


# Recap of QIST Opportunity



## Quantum Information Science And Technology (QIST)

- QISE promises to **revolutionize** computation, communication, and sensing
- National Quantum Initiative aims to ensure **U.S. leadership** in QISE
- Large potential impact on most sectors of our **economy**



## New Mexico has World Leading Capabilities in Quantum Technologies

- **Globally recognized expertise** across the full “quantum stack”
- QNM partners have the **talent needed** to translate quantum theory into transformational breakthroughs



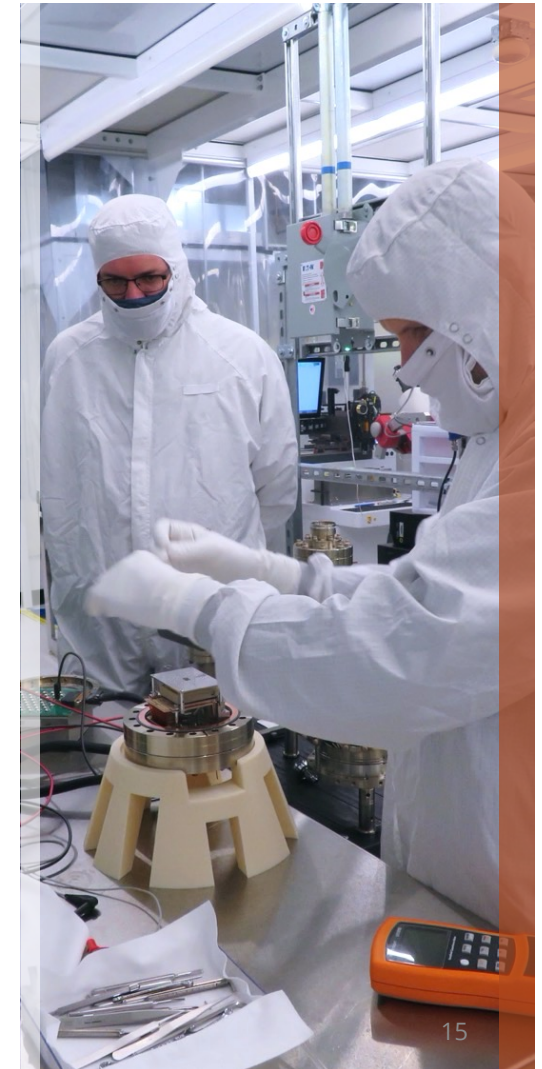
## QNM Coalition Opportunities

- Be both the **thought** and **commercialization leader** in quantum
- Expand **equitable access** to information and new technologies
- **Drive economic development** through workforce training, entrepreneurship, and strategic industry partnerships

# New Mexico has a long and storied history in QIST

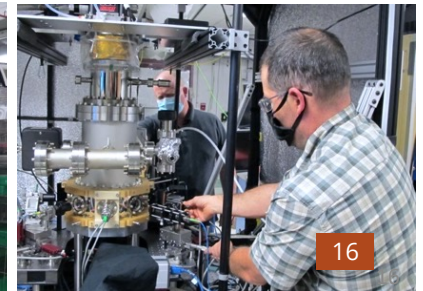
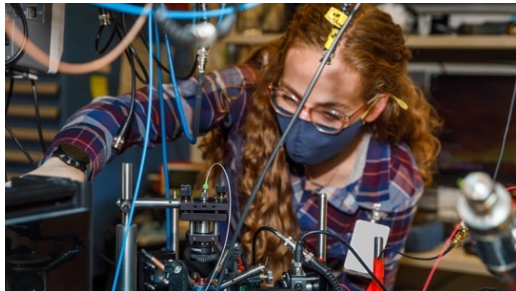
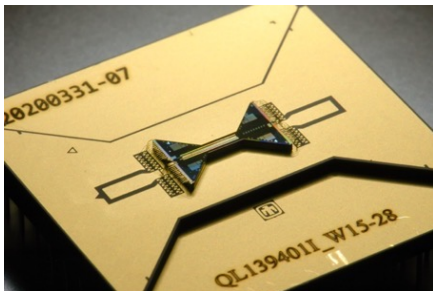
NM led the way in many areas of QIS from inception. The early efforts listed below helped build the strong QIST programs we see today

- University of New Mexico
  - 1992: Carl Caves Establishes the Information Physics Group
  - 2005: Center for Advanced Studies devoted to QIS.
  - 2009: The Center for Quantum Information and Control (CQuIC) was created, funded by the National Science Foundation.
- Sandia National Labs
  - 2004: First QIS presentation at Sandia on Microfabricated Ion Traps
  - 2008: Sandia launches QIST Grand Challenge LDRD project, the first of four quantum Grand Challenges that span quantum computing, sensing, and communication.
- Los Alamos National Labs
  - 2001: LANL formed QIST working group to develop a lab-wide QIST program
  - 2005: LANL established an Institutional Center called the Quantum Institute
- Each institution has built successful QIST programs that are thriving today



# Quantum New Mexico Institute (QNM-I)

- **Objective:** Develop a world-class research institute that builds on the historically strong SNL-UNM QIS foundation:
  - Expand research & development in QIST technologies
  - Support education, training, and workforce development
  - Foster the creation of multi-institution research centers
  - Build a stronger scientific foundation that integrates key aspects of QIS
  - Meet the nation's economic and national security goals in QIS
- **Why:** QNM Institute will raise our national profile
  - We are uniquely positioned to capitalize on upcoming federal and private investments in QIS. We have a common interest in remaining competitive in this field.

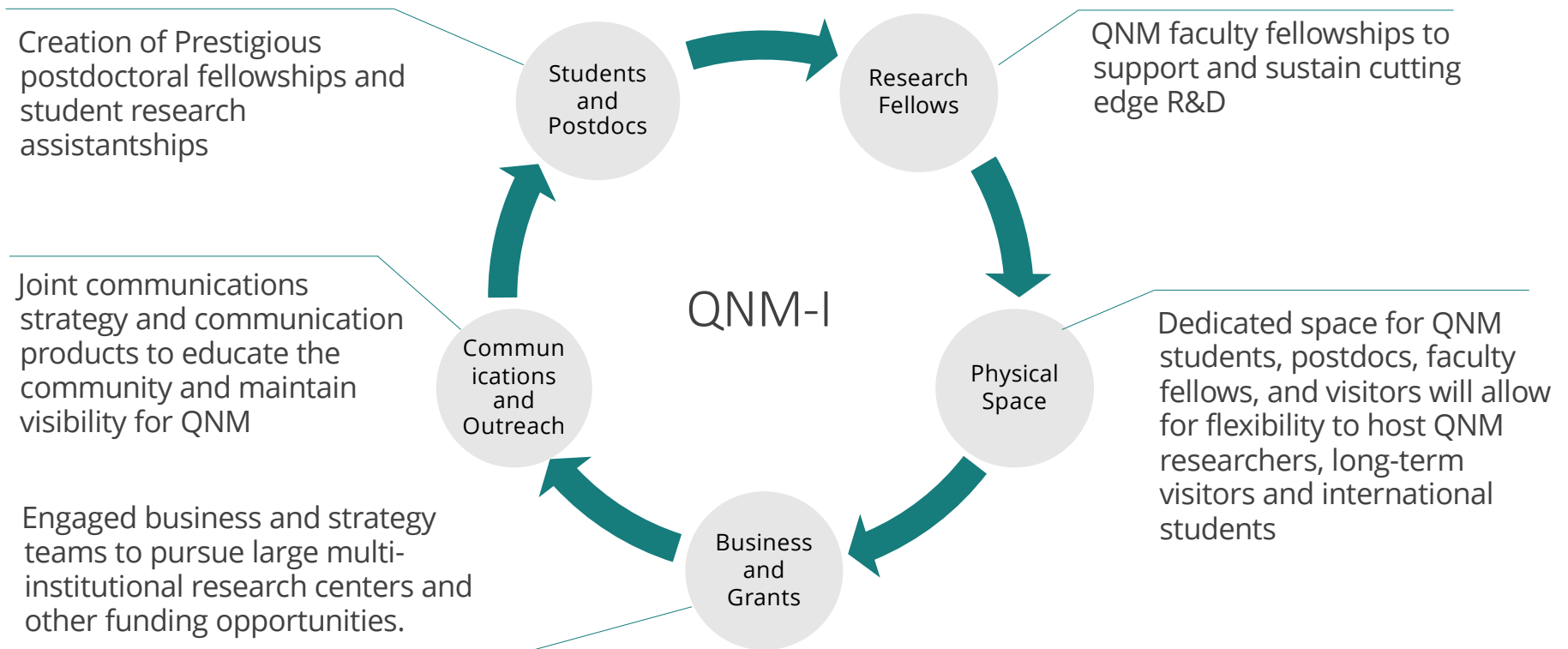




# QNM-I Elements to Success



Launched in March of 2022, QNM-I will play a key role in the broader Quantum Ecosystem



# Origins of the Quantum New Mexico Coalition



- The **Quantum New Mexico Coalition** (QNM-C) arose in response to the Economic Development Agency (EDA) Build Back Better funding opportunity
- Phase 1 proposal included partners from more than **30 institutions** spanning from NM's national labs, academia, industry, economic development groups, non-profits
- Proposal was not selected, but opportunities to **build on the partnership and momentum** have led to a desire to formalize QNM-C



# EDA Build Back Better Proposal

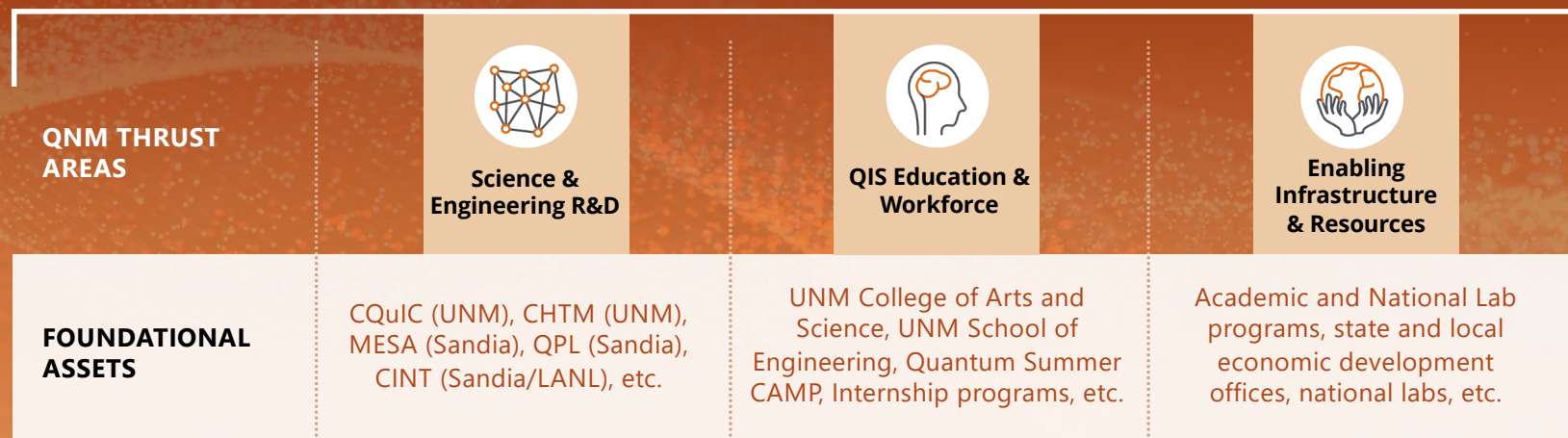
Support for QNM-C's BBB proposal was seen from across the state.



# What is the QNM Coalition now?



*Bringing stakeholders together to build the QIS Ecosystem in NM*



## Quantum New Mexico Coalition




*New Mexico is a Quantum State*

- Creates a world class quantum science collaborative technology hub in NM
- Will help build a diverse, equitable, accessible, and inclusive quantum ecosystem
- Focuses efforts across thrust areas spanning from Science and Engineering through Economic Development

# What is the QNM Coalition now?



*Bringing stakeholders together to build the QIS Ecosystem in NM*

QNM THRUST AREAS	 <b>Science &amp; Engineering R&amp;D</b>	 <b>QIS Education &amp; Workforce</b>	 <b>Enabling Infrastructure &amp; Resources</b>
<b>FOUNDATIONAL ASSETS</b>	CQuIC (UNM), CHTM (UNM), MESA (Sandia), QPL (Sandia), CINT (Sandia/LANL), etc.	UNM College of Arts and Science, UNM School of Engineering, Quantum Summer CAMP, Internship programs, etc.	Academic and National Lab programs, state and local economic development offices, national labs, etc.
<b>FOCUS AREAS</b>	<ul style="list-style-type: none"> <li>▪ Broaden basic and applied research programs</li> <li>▪ Support QNM partner R&amp;D priorities and strategies</li> <li>▪ Joint proposals</li> </ul>	<ul style="list-style-type: none"> <li>▪ Support growing QIS academic programs</li> <li>▪ Develop new QIS pathways across all education levels</li> <li>▪ Identify opportunities for Internships, fellowships, and apprenticeships</li> </ul>	<ul style="list-style-type: none"> <li>▪ Support QIS industry engagements</li> <li>▪ Establish unified economic development strategy</li> <li>▪ Create resource for QIS business &amp; policy coordination</li> <li>▪ Build QIS Infrastructure</li> </ul>



## What will we be doing the rest of the year?



### **QNM Technical Exchange Workshop** (June - July 2022)

- Learn about the areas of interest and expertise from researchers across the state



### **Quantum 101 Briefings** (June 2022 – July 2022)

- Help educate the broader community about QIS



### **Building the Next Generation Quantum Workforce** (July-August 2022)

- Identify current state of academic programs and discuss ways to strategically and collectively support QIS programs



### **Building a Regional Quantum Cluster** (September-October 2022)

- Identify practical ways to kickstart a quantum cluster in the state



## Getting involved

- **We would love to hear feedback on how to:**
  - Ensure QNM can build a **diverse and inclusive community**
  - Create a **sustainable program** that supports partners across the state
  - Better engage and **support QIS industry**
  - **Future directions** that you would like to see QNM explore
- **To get engaged or learn more about QNM, reach out to:**
  - **Rick Muller**, Sandia National Labs: [rmuller@sandia.gov](mailto:rmuller@sandia.gov)
  - **Ivan Deutsch**, University of New Mexico: [ideutsch@unm.edu](mailto:ideutsch@unm.edu)

A photograph of a conference room with an audience seated at tables, facing a speaker at a podium. The image is overlaid with a semi-transparent orange filter.

*QNM is in the early stages of establishment, and is looking for partners to help lead QNM-C efforts*



# QUANTUM NEW MEXICO

*New Mexico is a Quantum State*