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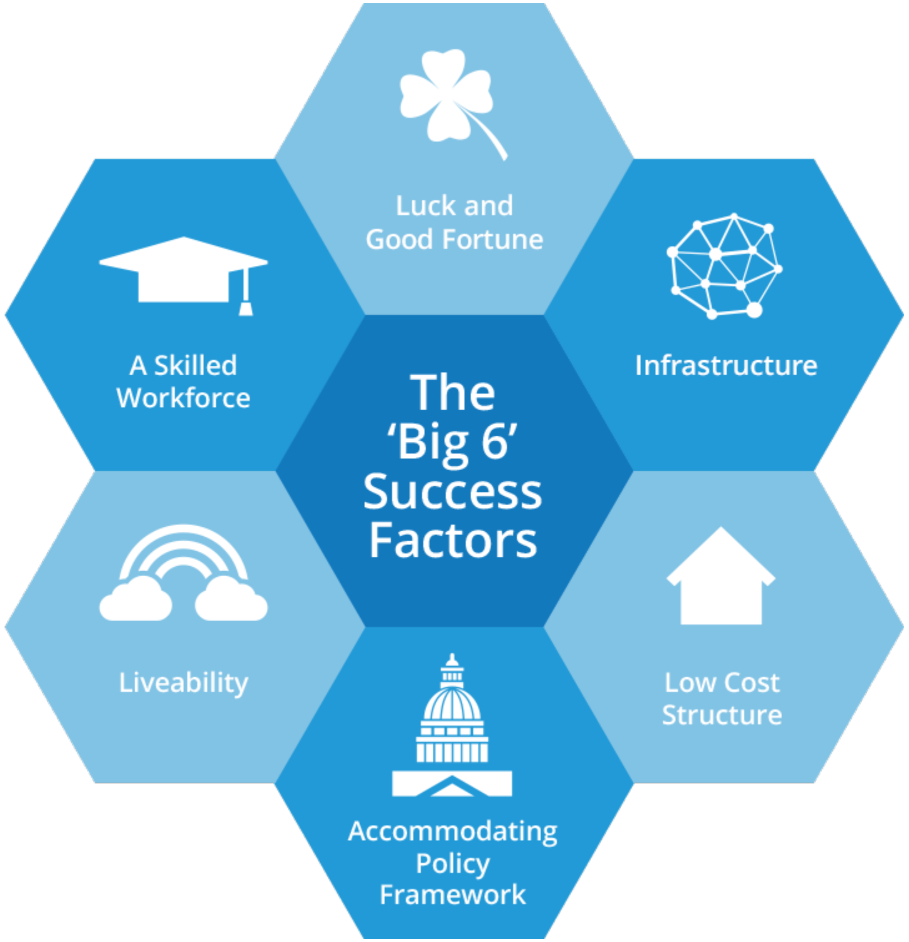
New Goals for US Science & Innovation Policy



- Goal: Put the USA in the lead developing the technologies that will shape the next century

- Strategy: Place based innovation that build these technologies <u>outside the usual "knowledge hubs"</u> (expand the geography of innovation)

Source: The Economist Intelligence Unit "Innovation Clusters: Understanding Life Cycles" http://destinationinnovation.economist.com/wp-content/uploads/sites/3/2015/12/ICUL.pdf

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New Federal Opportunities

- The Build Back Better Regional Challenge – $1B ***Active***
- The National Science Foundation's "Regional Innovation Engines" – $160M ***Active***
- Regional Clean Hydrogen Hubs authorized in the Infrastructure Investment and Jobs Act – $8B across 4 hubs ***Active***
- Regional Technology and Innovation Hubs authorized in the recently passed Chips and Science Act – $10B across an anticipated 20 hubs ***Expected 2023***

Source: The Economist Intelligence Unit "Innovation Clusters: Understanding Life Cycles" http://destinationinnovation.economist.com/wp-content/uploads/sites/3/2015/12/ICUL.pdf

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BIOTECH

MONTANA BIOSCIENCE ALLIANCE

628+

Montana Bio Companies

3rd

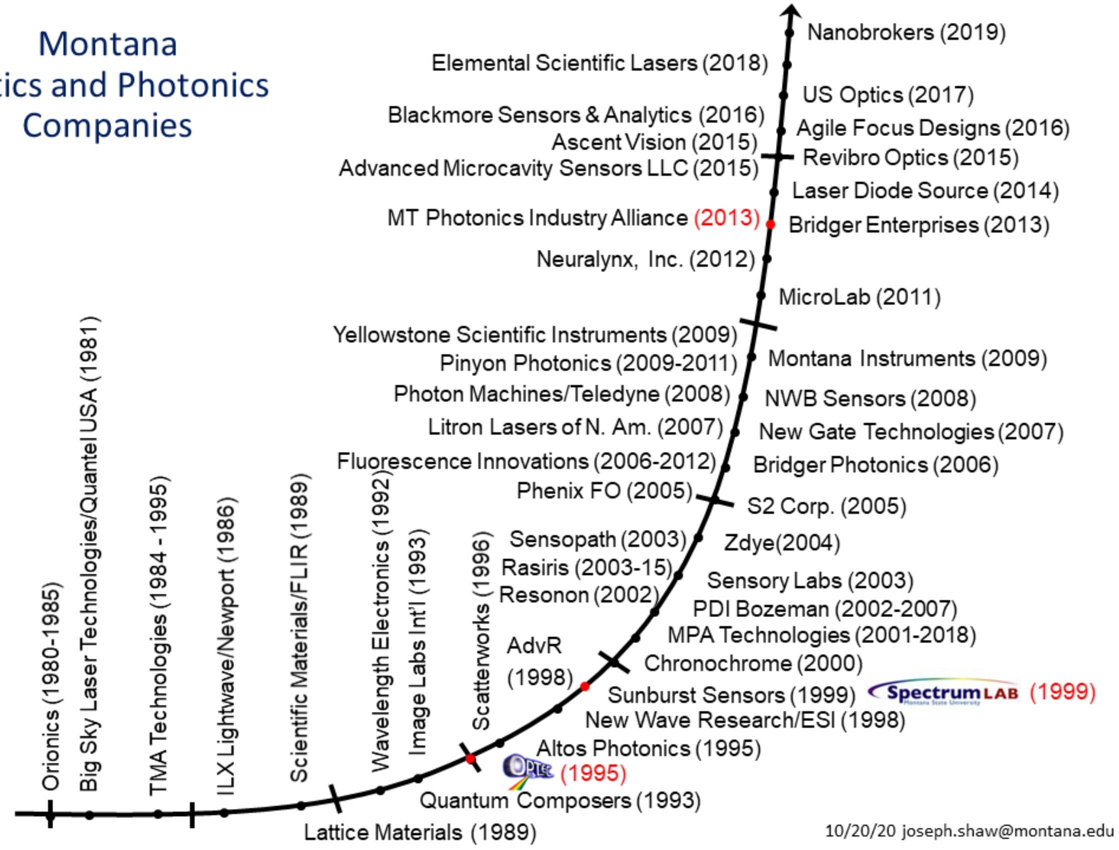
In the nation for growth in academic bioscience R&D, 2014-2019

1st

Highest success rate for NIH SBIR/STTR grants

OPTICS

Montana Optics and Photonics Companies



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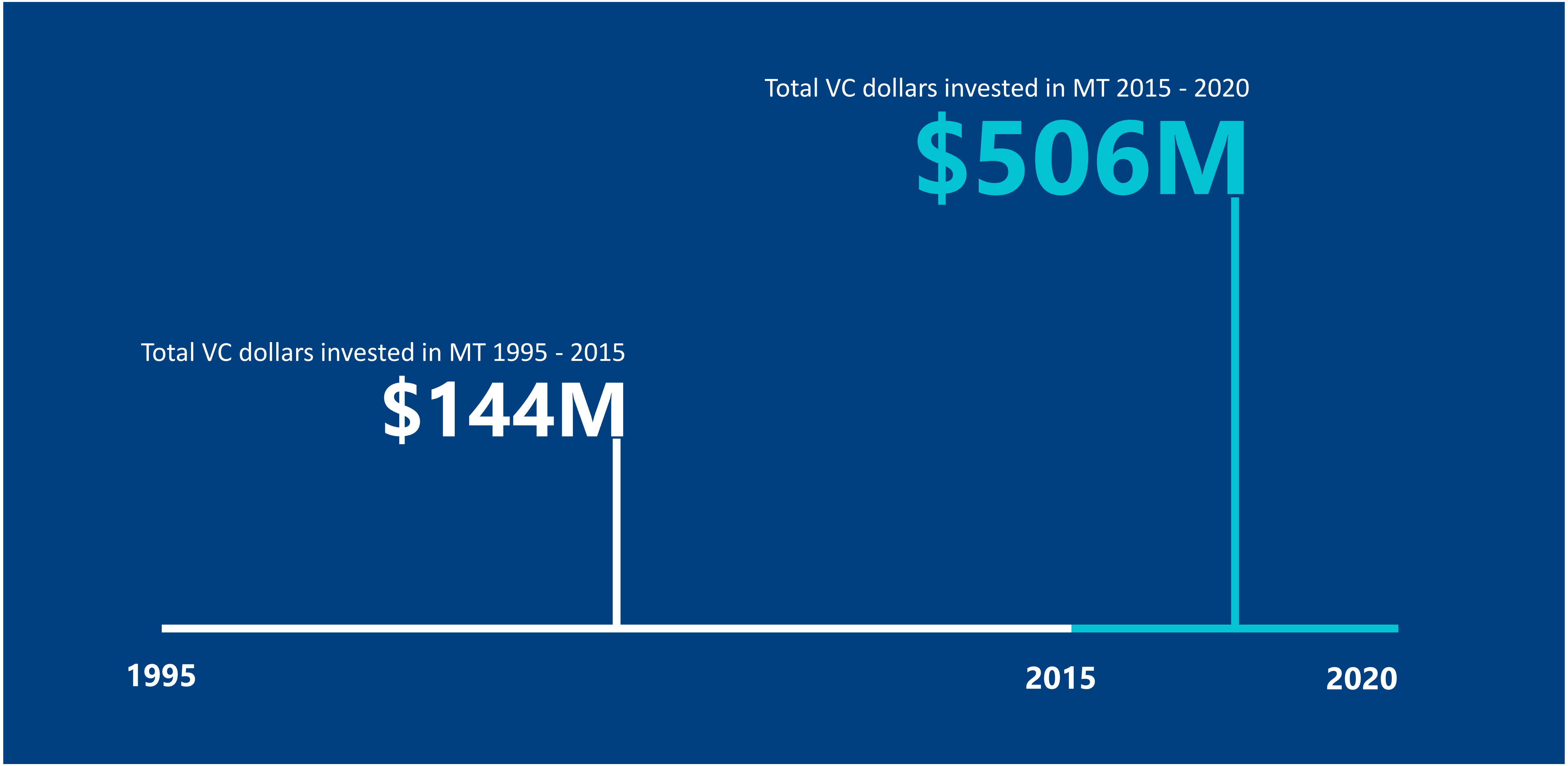

Source: NFC Capital

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Mountains and Plains University Innovation Alliance

The Mountains & Plains University Innovation Alliance is a partnership among thirteen research-focused universities to develop new innovation ecosystems and economic growth opportunities in the Idaho, Montana, North Dakota, South Dakota, and Wyoming region.

Alliance institutions will make use of each other's existing research, education and training programs, and public service expertise to boost their collective ability to attract and support the high technology industry in the region.

Partnership to date

- $65M in proposals in development for the NSF Regional Innovation Program
- Early coordination across state government for larger Regional Technology and Innovation Hub opportunity

Quantum Capacity, Operational Resilience and Equity Organizations

Economic Development Orgs

Industry Clusters

Capital

Accelerators

Incubators

Start-Ups

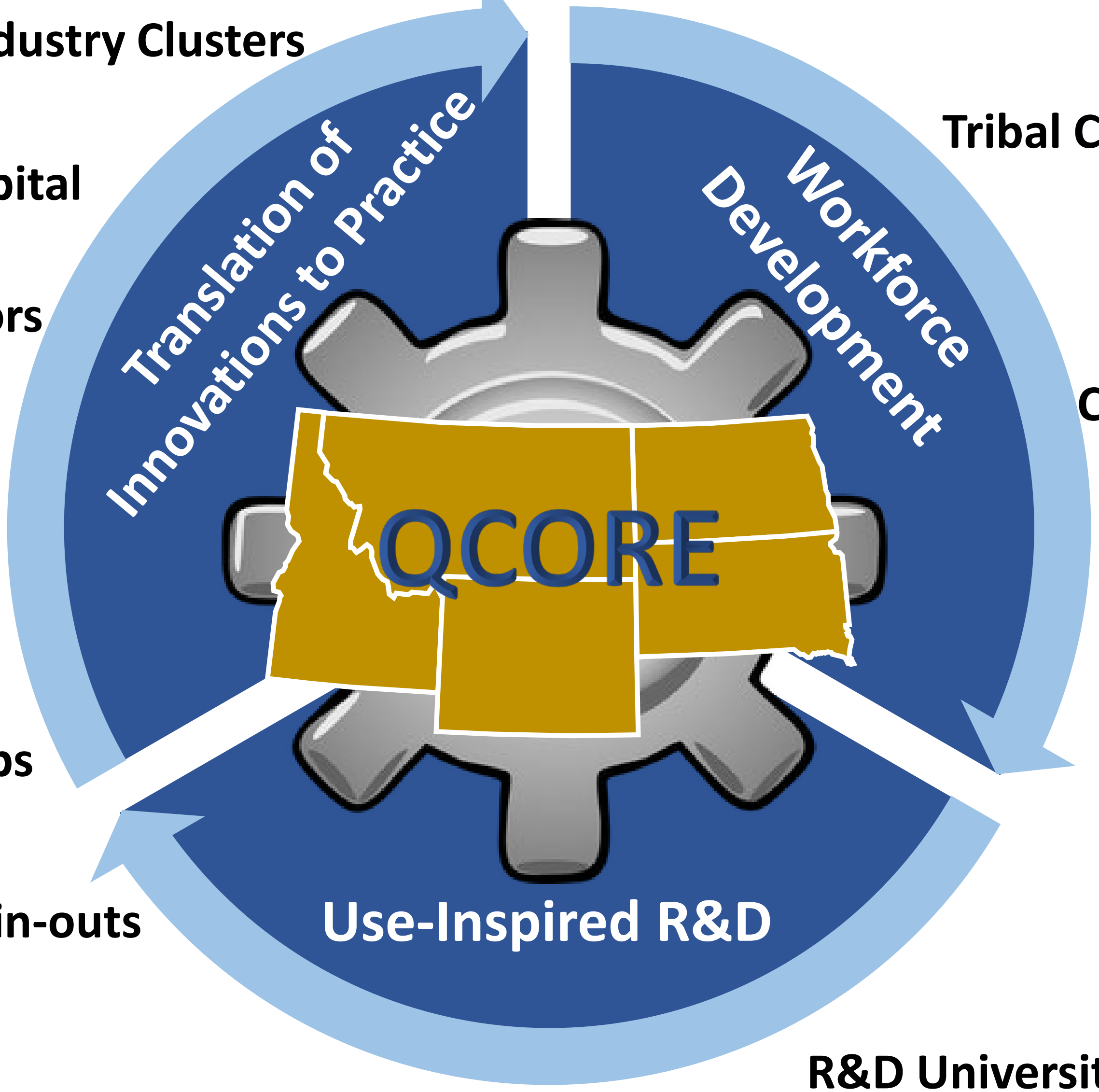
Spin-outs

Tribal Colleges

Community Colleges

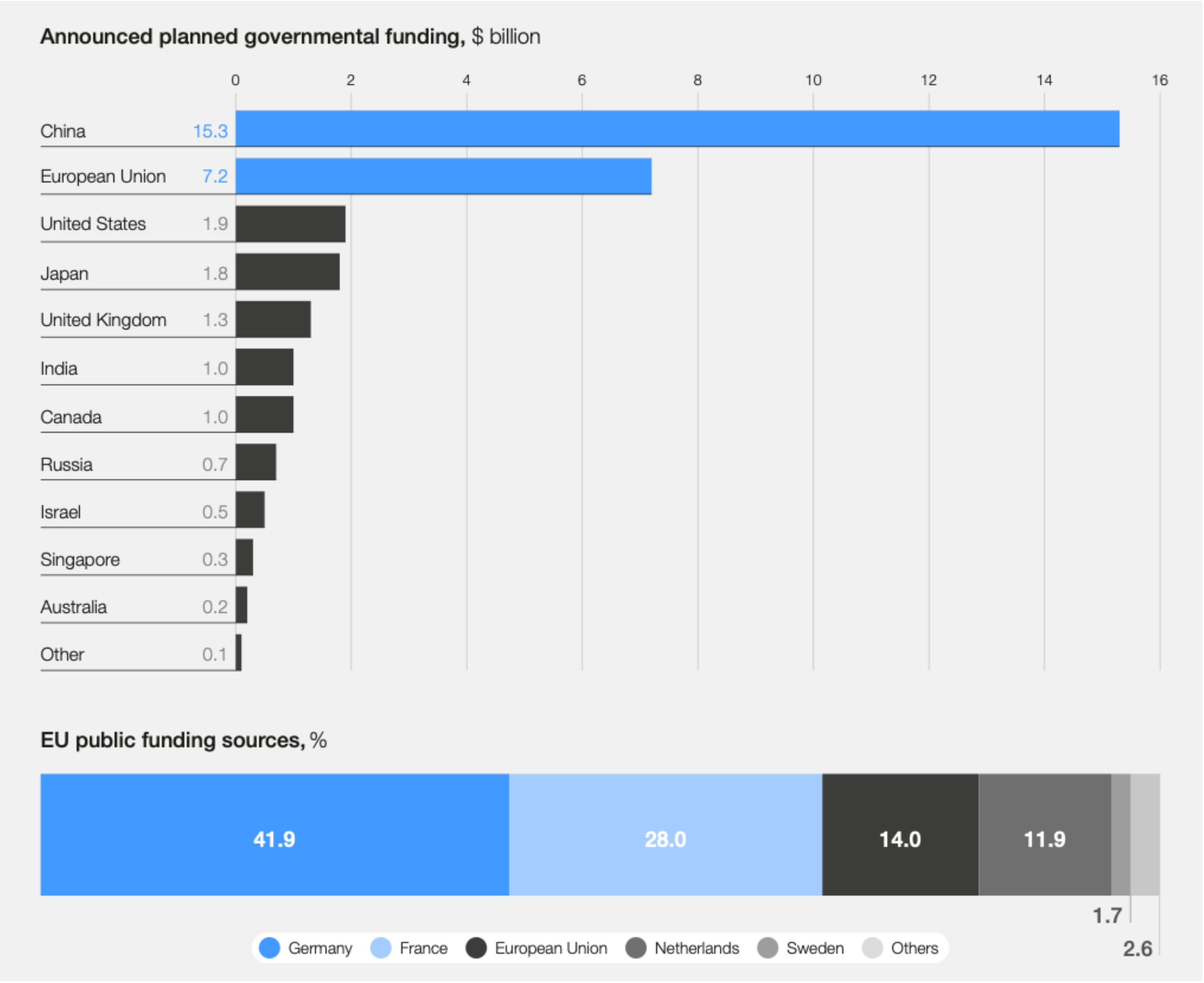
R&D Universities

Entrepreneur Programs



Why Quantum? It's Global Impact…

- **Total global investment is estimated at $35.5 billion**[1]
  - Public Investment > $30 billion
  - Private ~$5.5 billion
- U.S. investment is $1.9 billion
- China has committed $15 billion[2]
  - China has the most patents in quantum technology
- BCG estimates that quantum computing ***could create a value of $450B to $850B*** in the next 15-30 years[3]
  - $5B - $10b to users in the next 3-5 years
- 2021 private investments doubled compared to investments in 2020
- Private investment shifting from VC → IPOs

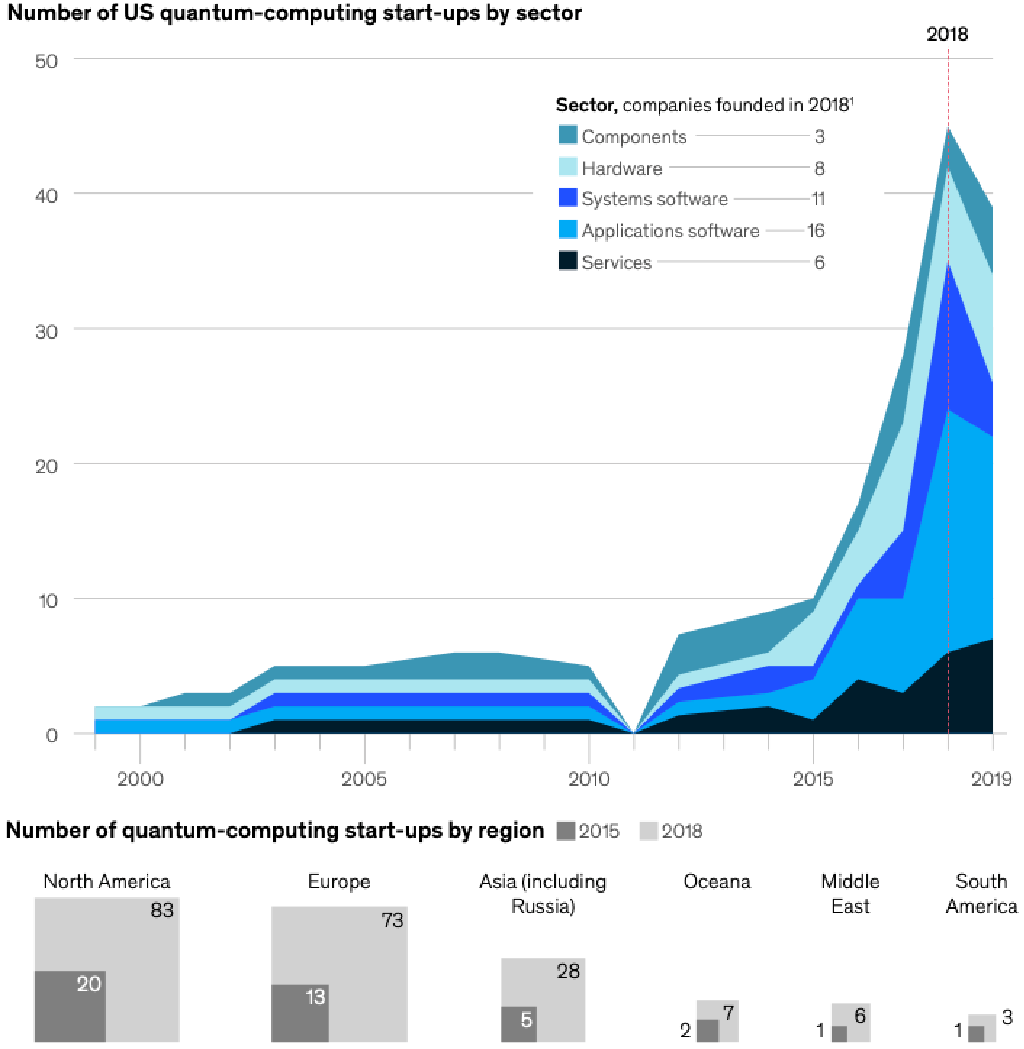


1: World Economic Forum. "State of Quantum Computing: Building a Quantum Economy," Insight Report, Sept. 2022
2: McKinsey & Company. "Quantum Technology Monitor," June 2022
3: Boston Consulting Group. "What Happens When 'If' Turns to 'When' in Quantum Computing?" July 2021

Why Quantum In the US?

- In 2019, the US established the National Quantum Initiative Act
  - Included founding the Quantum Economic Development Consortium (QED-C)
- June 2021, US passed US Innovation and Competition Act, authorizing $250B to invest in technology advancement, which included Quantum
- Cleveland Clinic, Univ. of Illinois Urbana-Champaign and Hartree Centre each entered into a "discovery acceleration" partnership with IBM, anchored by Quantum computing, that have attracted $1B in investment
- Four industries are estimated to be early beneficiaries (~$700B by 2035)[1]:
  - Pharmaceuticals
  - Chemicals
  - Automotive
  - Finance

The United States is home to the highest number of quantum-computing start-ups, with software seeing the highest level of global start-up growth.



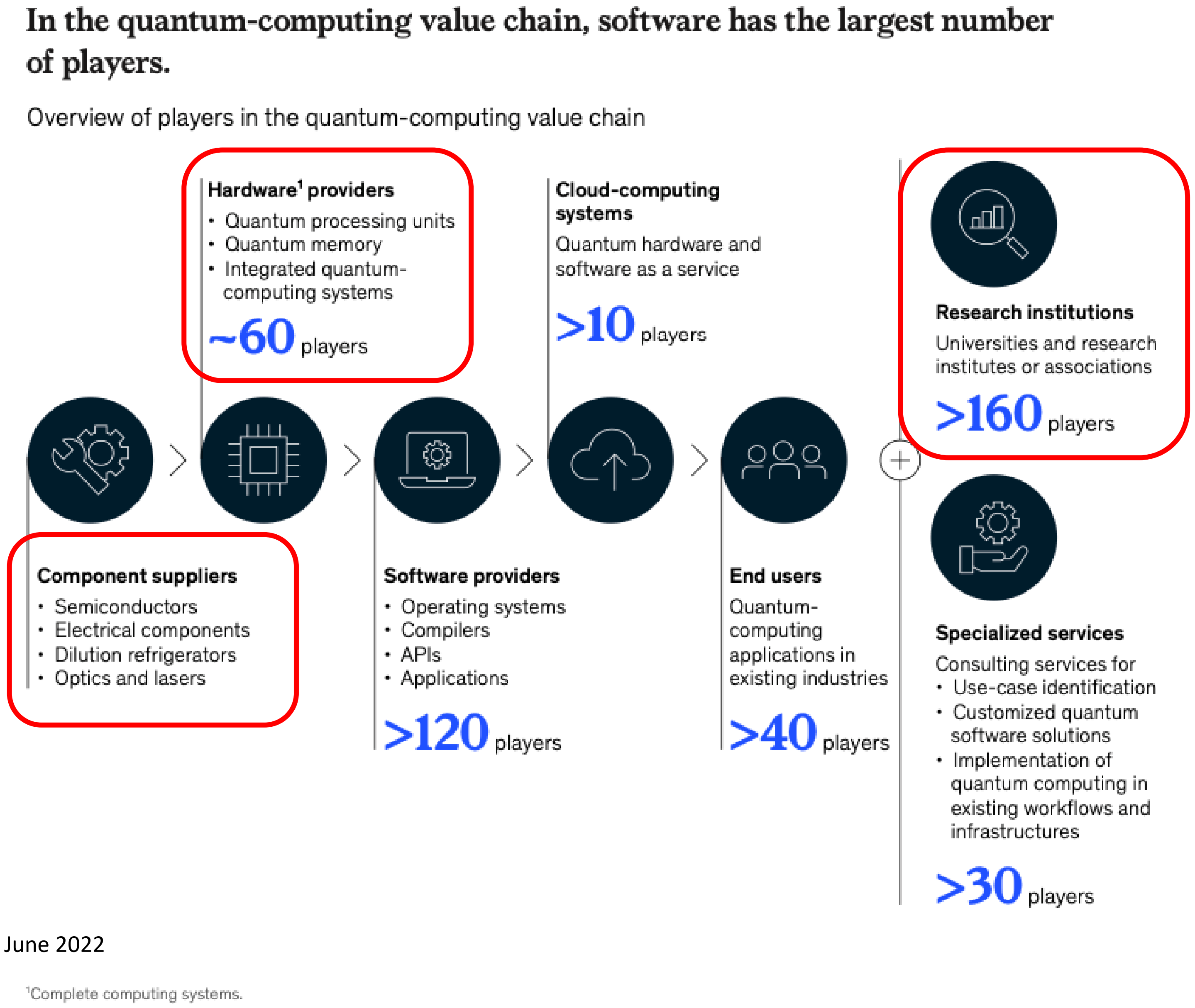
Note: Not exhaustive; commercial activity is opaque in some regions.
[1]Number only quoted until 2018, since start-ups with a later founding date may still be in stealth mode (ie, they have not disclosed their activity publicly.
Source: Capital IQ; Crunchbase; PitchBook; Quantum Computing Report; McKinsey analysis

MONTANA STATE UNIVERSITY | QUANTUM CORE

1: McKinsey & Company. "Quantum computing: An emerging ecosystem and industry use cases," Dec. 2021

- Our Quantum CORE believes MT is poised for advances in the Q-Supply chain focused on hardware and component suppliers

- Within the value chain, startup hardware companies (manufacturers of quantum computers) saw more than 70% of private investments*



*McKinsey & Company. "Quantum Technology Monitor," June 2022

Why Quantum In Montana?

An Occupational Analysis – MT vs US

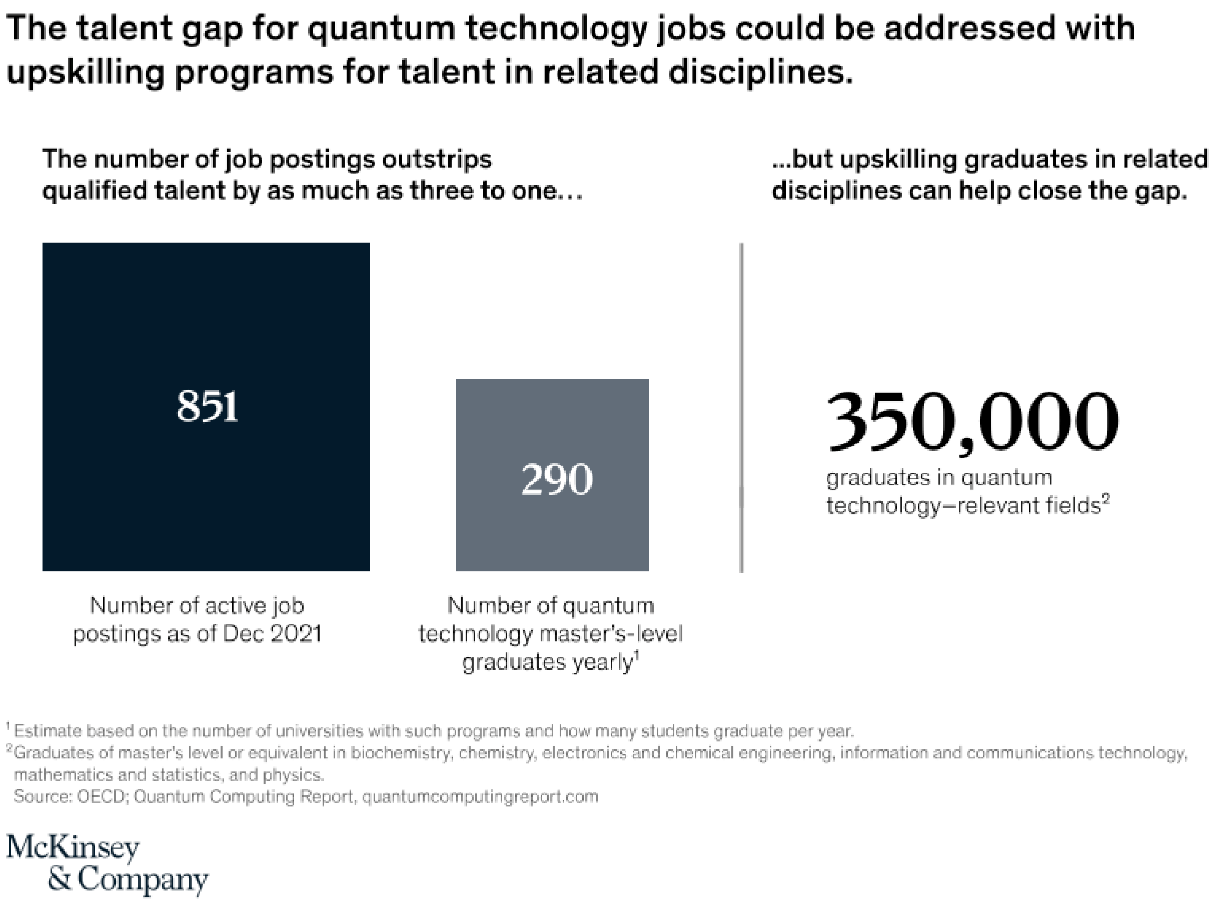
		Montana				Nation			
OCC CODE	Occupation Title	Total Employed	% of Total Jobs	Mean Hourly Wage	Mean Annual Wage	Total Employed	% of Total Jobs	Mean Hourly Wage	Mean Annual Wage
00-0000	All Occupations	470,230		$ 23.72	$ 49,340.00	140,886,310		$ 28.01	$ 58,260.00
11-000	Management Occupations	22,390	4.8%	$ 44.46	$ 92,480.00	8,909,910	6.3%	$ 59.31	$ 123,370.00
13-000	Business and Financial	25,000	5.3%	$ 32.99	$ 68,630.00	9,053,790	6.4%	$ 39.72	$ 82,610.00
15-000	Computer and Mathematical	8,800	1.9%	$ 34.20	$ 71,130.00	4,654,750	3.3%	$ 48.01	$ 99,860.00
17-000	Architecture and Engineering	8,230	1.8%	$ 36.00	$ 74,880.00	2,436,520	1.7%	$ 44.10	$ 91,740.00
19-000	Life, Physical, and Social Science	8,610	1.8%	$ 28.60	$ 59,500.00	1,273,640	0.9%	$ 38.81	$ 80,730.00
21-000	Community and Social Service	9,620	2.0%	$ 21.35	$ 44,400.00	2239680	1.6%	$ 25.94	$ 53,960.00
23-000	Legal	3,880	0.8%	$ 36.66	$ 76,240.00	1,178,140	0.8%	$ 54.38	$ 113,100.00
25-000	Educational Instruction and Library	27,970	5.9%	$ 24.55	$ 51,060.00	8,191,930	5.8%	$ 29.88	$ 62,140.00
27-000	Arts, Design, Entertainment, Sports, and Media	6,400	1.4%	$ 22.02	$ 45,790.00	1,815,290	1.3%	$ 31.78	$ 66,100.00
29-000	Healthcare Practitioners and Technical	29,890	6.4%	$ 43.70	$ 90,900.00	8,787,730	6.2%	$ 43.80	$ 91,100.00
31-000	Healthcare Support	19,020	4.0%	$ 15.62	$ 32,500.00	6,603,680	4.7%	$ 16.02	$ 33,330.00
33-000	Protective Service	8,010	1.7%	$ 25.08	$ 52,160.00	3,385,030	2.4%	$ 25.68	$ 53,420.00
35-000	Food Preparation and Serving Related	47,770	10.2%	$ 12.67	$ 26,350.00	11,201,480	8.0%	$ 14.16	$ 29,450.00
37-000	Building & Grounds, Cleaning & Maintenance	19,560	4.2%	$ 15.65	$ 32,550.00	4,108,810	2.9%	$ 16.23	$ 33,750.00
39-000	Personal Care and Service	10,200	2.2%	$ 14.72	$ 30,620.00	2,566,440	1.8%	$ 16.17	$ 33,620.00
41-000	Sales and Related	46,490	9.9%	$ 19.05	$ 39,630.00	13,256,290	9.4%	$ 22.15	$ 46,080.00
43-000	Office and Administrative Support	60,010	12.8%	$ 18.40	$ 38,280.00	18,299,380	13.0%	$ 20.88	$ 43,430.00
45-000	Farming, Fishing, and Forestry	1,890	0.4%	$ 19.24	$ 40,020.00	452490	0.3%	$ 16.70	$ 34,730.00
47-000	Construction and Extraction	30,290	6.4%	$ 25.83	$ 53,720.00	5848950	4.2%	$ 26.87	$ 55,900.00
49-000	Installation, Maintenance, and Repair	23,090	4.9%	$ 24.39	$ 50,720.00	5,574,410	4.0%	$ 25.66	$ 53,380.00
51-000	Production	17,220	3.7%	$ 21.33	$ 44,370.00	8,408,030	6.0%	$ 20.71	$ 43,070.00
53-000	Transportation and Material Moving	35,880	7.6%	$ 19.81	$ 41,200.00	12,639,920	9.0%	$ 19.88	$ 41,340.00

Source: U.S. Bureau of Labor and Statistics, Occupational and Employment Wage Statistics, May 2021

Quantum Workforce?

The Quantum Workforce needs support in 3 areas[1]:

1. **Workforce availability and development**
   - Q workforce will include quantum physicists, computer scientists, engineers, technicians, and people with business, sales and policy backgrounds
   - *Only 29 Universities worldwide offer Master's degrees in Quantum Technologies*[1,2]
   - U.S. leads the world in Master's programs in Quantum technologies (11 in the U.S.)[1,2]
2. **Policies and Regulations**
   - Access to quantum hardware
   - Ethics of the technology
   - Collaborations within industry, government, and academia
3. **Standardization**
   - Use of hardware, tools, etc.



1: World Economic Forum. "State of Quantum Computing: Building a Quantum Economy," Insight Report, Sept. 2022
2: McKinsey & Company. "Quantum computing funding remains strong, but talent gap raises concern," June 2022

Experience Growing Tech Innovation Cluster - Existing Foundation

1989
5 photonics-based companies

1992
4 MSU faculty receive grant for collaborative research with 3 companies

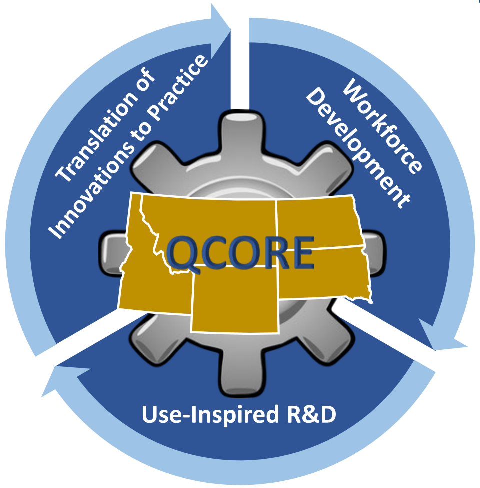
1995
OPTEC

Steady Growth of Photonics companies

2013
MPIA
Montana Photonics Industry Alliance

2022
35 companies employ over 800 people

Half spun out of MSU research
4th Largest Photonics Cluster
Largest per capita
Strongest in LIDAR



Existing QSC industry

- AdvR – PPKTP waveguides for photon pair generation
- Wavelength Electronics – Precision temperature control
- Montana Instruments – Low vibration cryostats
- Teledyne / FLIR – Rare earth crystalline photonic materials

Existing MSU Programs

- MSU – MonArk Quantum Foundry (1 of only 2 nation wide)
- AFRL quantum networking

Key Features of Planning Grant – Based on Lessons Learned

- Quantum Supply Chain gap analysis to identify regional opportunities
  - Includes non-quantum support components
- Engagement of institutions / programs shown in graphic
  - Includes identifying degree and certificate programs
- Discussions with tech sector businesses to understand what programs bring the most benefit and what is missing
- Study of successful tech-based innovation clusters in low population density regions. Can best practices be identified?
- Planning for test beds and core facilities to reduce capital costs for start-up companies' entry into field
- In multiple cases students transitioned with a technology to the private sector

Lessons: University – Industry Partnership Reduces Risk in the “Valley of Death”

Championship Shifts
- Industry input to research
- Entrepreneur short courses
- Local Industry Assoc.
- Business mentorship programs

Risk Mitigation Shifts
- Co-development with Univ.
- Univ Personnel transitioning with technology
- Gap funding programs
- Venture capital involvement

Resource Floor Shifts
- Use of testbeds
- Business Incubators
- Access to major instrumentation