Opportunities and Challenges in the Era of *CHIPS & Science*

Daniel Reed

dan.reed@utah.edu

Chair, U.S. National Science Board

National Science Board

Presidentially Appointed Board

- 24 members serving 6 year terms

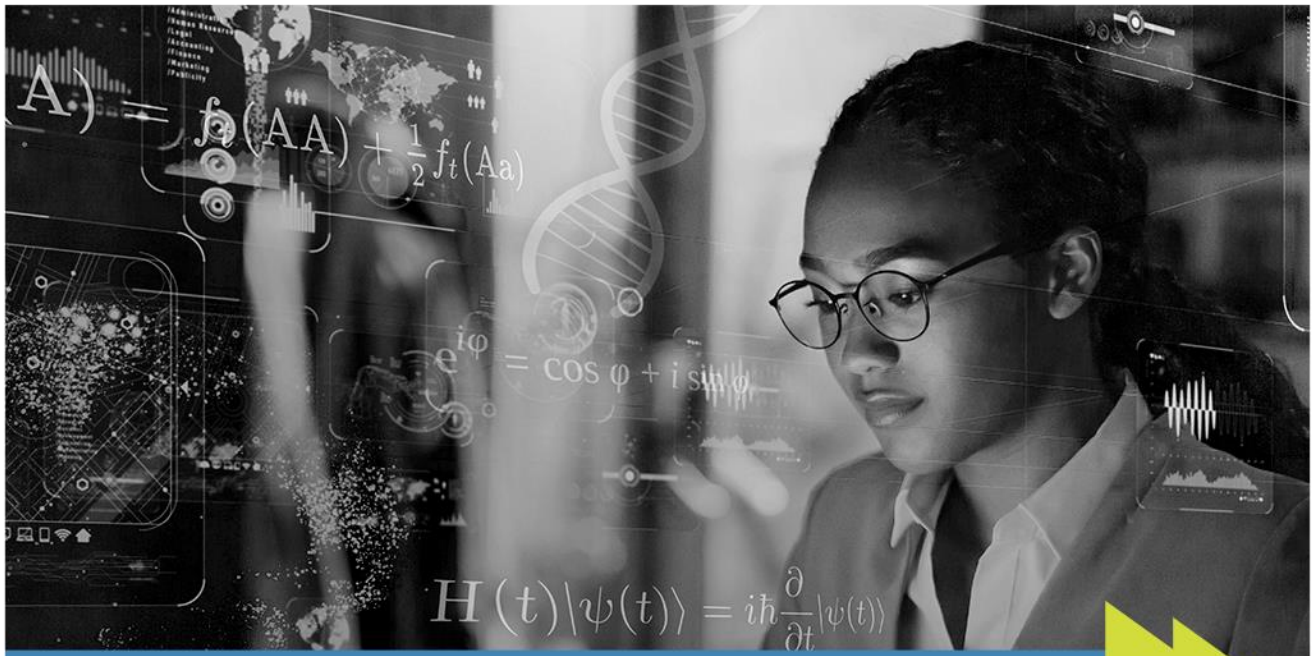
Advisers to the White House and Congress

- Publishes *Science & Engineering Indicators*
- Issues policy reports on S&E, STEM education, and workforce

Governing Board of NSF

- Establishes policies
- Identifies issues critical to NSF's future
- Approves strategic budget direction and major awards
- Provides oversight

NATIONAL SCIENCE BOARD



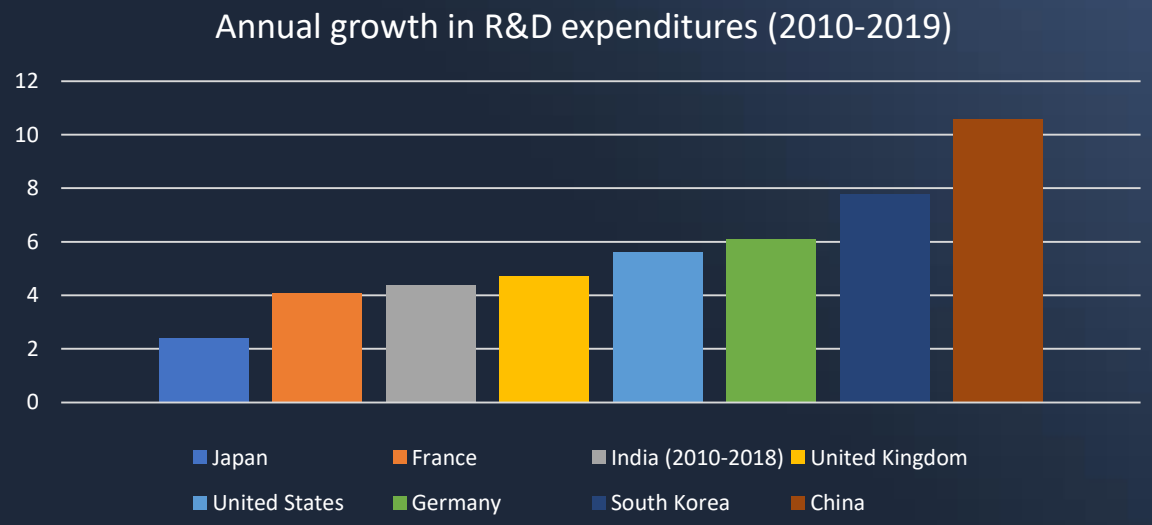
VISION 2030

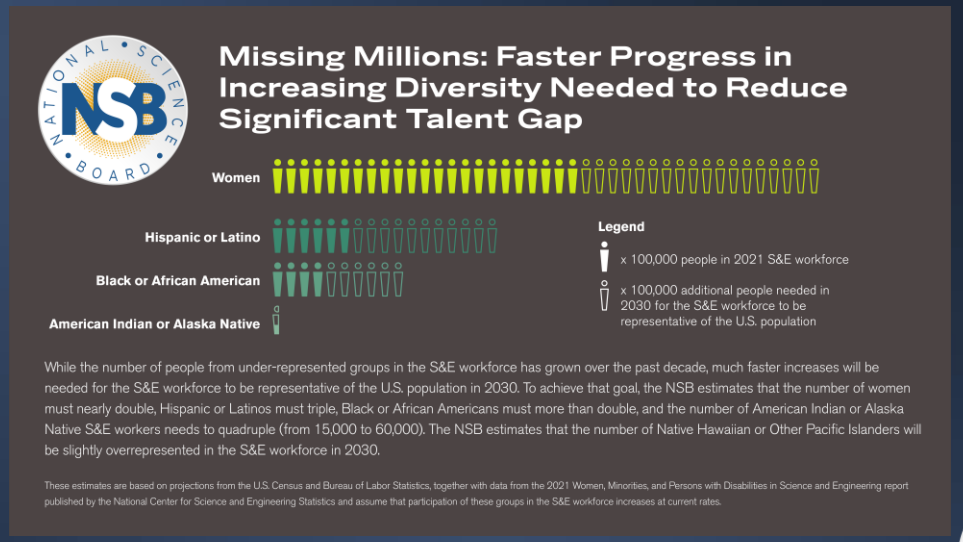
Source: https://www.nsf.gov/nsb/publications/2020/nsb202015.pdf

A Shifting Global Landscape

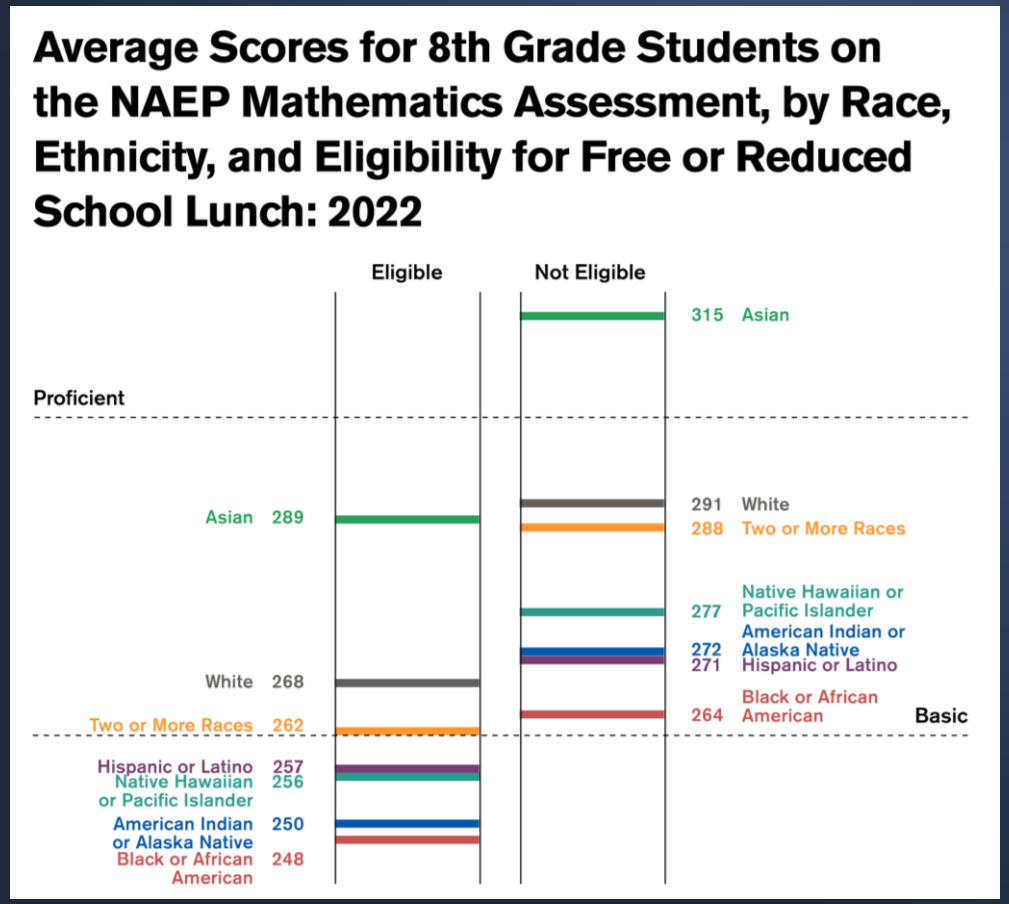
U.S. leadership in S&T is increasingly at risk

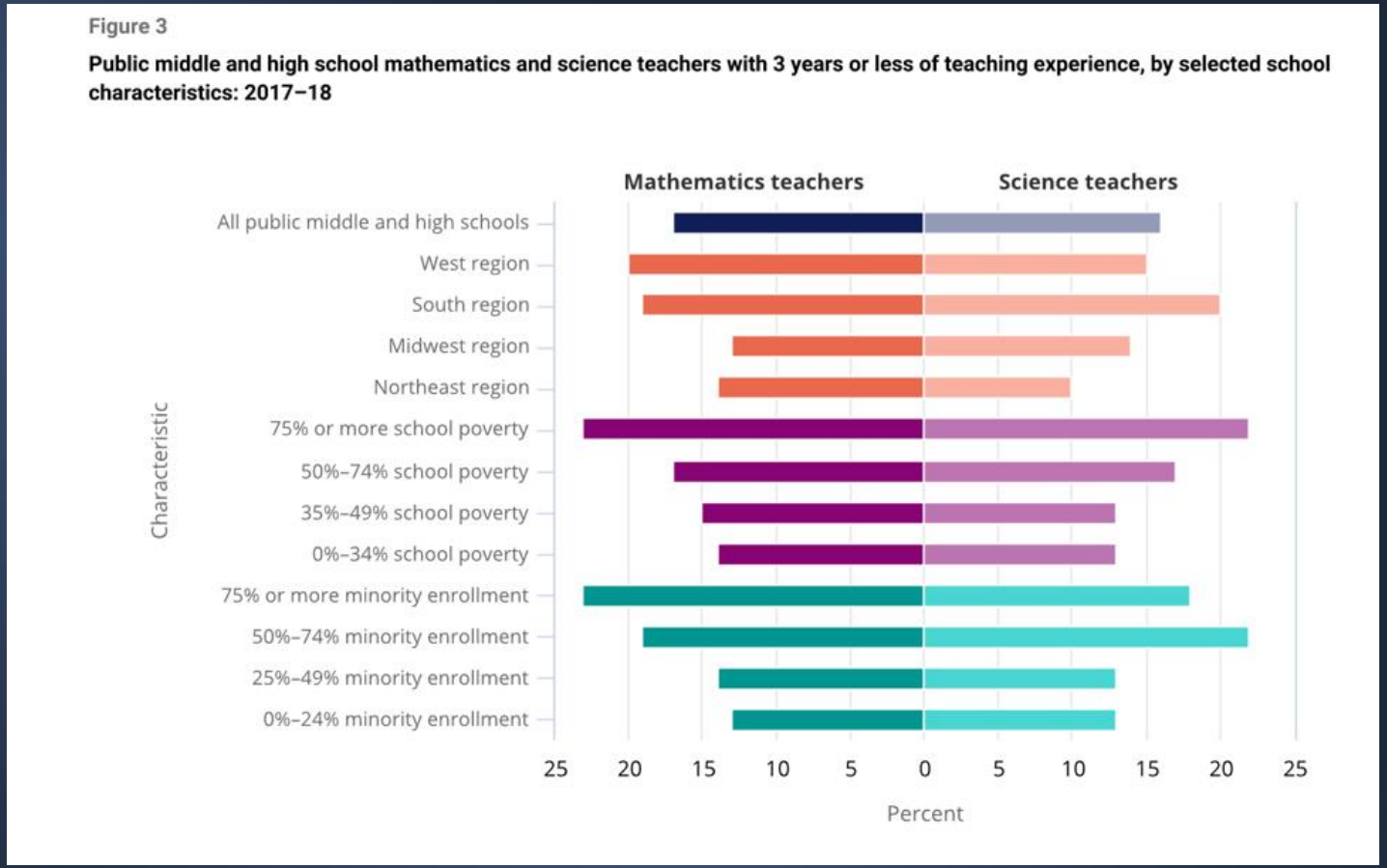
- The derivatives of change are not trending well
- Our domestic STEM workforce is too small and not representative
- Our immigration policies are limiting for international STEM talent
- U.S. R&D is too concentrated geographically





U.S. Educational Attainment and Poverty

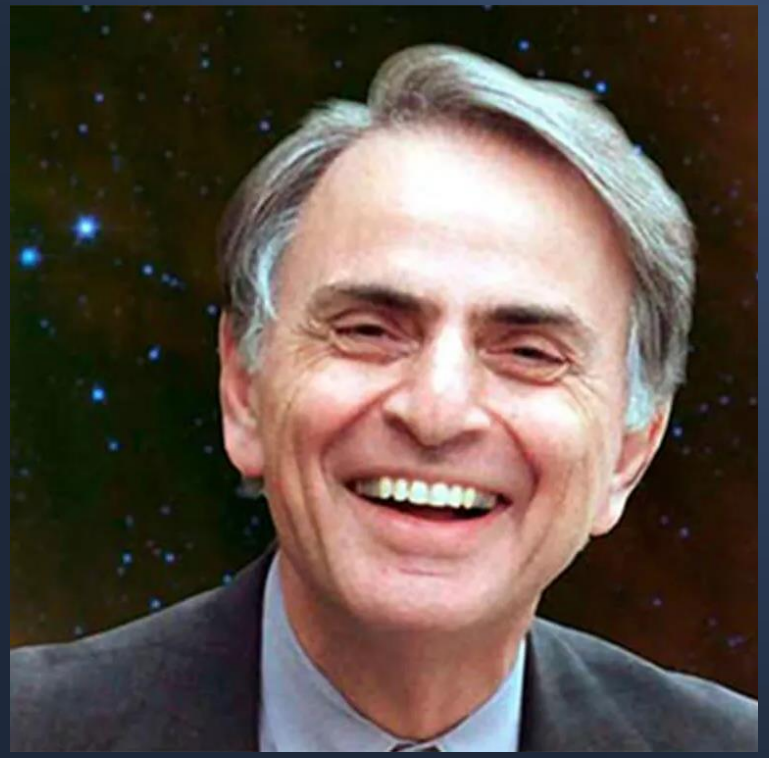




National Science Board

NSB and National Center for Science and Engineering Statistics (NCSES)
https://ncses.nsf.gov/indicators

The Joy of Science – Lost



Carl Sagan

My experience is, you go talk to kindergarten kids or first-grade kids, you find a class full of science enthusiasts. And they ask deep questions. “What is a dream, why do we have toes, why is the moon round, what is the birthday of the world, why is grass green?”

These are profound, important questions. They just bubble right out of them. You go talk to 12th grade students and there’s none of that. They’ve become leaden and incurious. **Something terrible has happened between kindergarten and 12th grade and it’s not just puberty.**

Foreign Born U.S. Science and Engineering Workforce

Substantial and Growing Proportion of the U.S. S&E Workforce is Foreign-Born

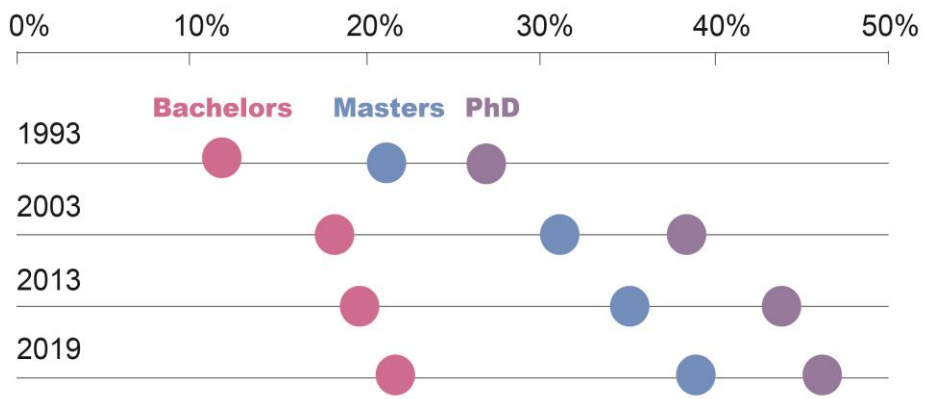


Figure 2, top: Share of foreign-born S&E workers by degree type (bachelor's, master's, and PhD).

Foreign-Born PhDs Across S&E Fields, 2019

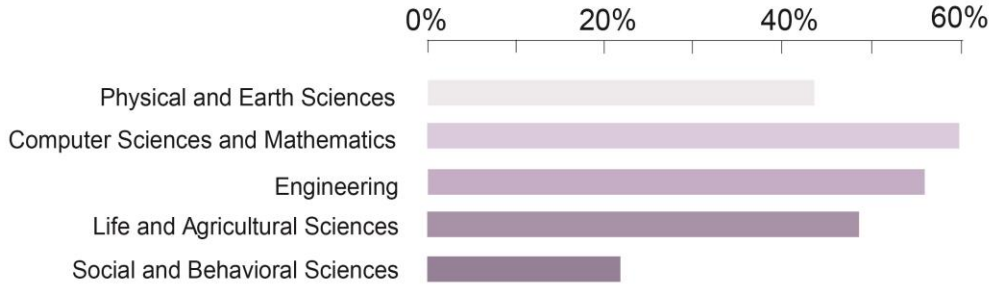
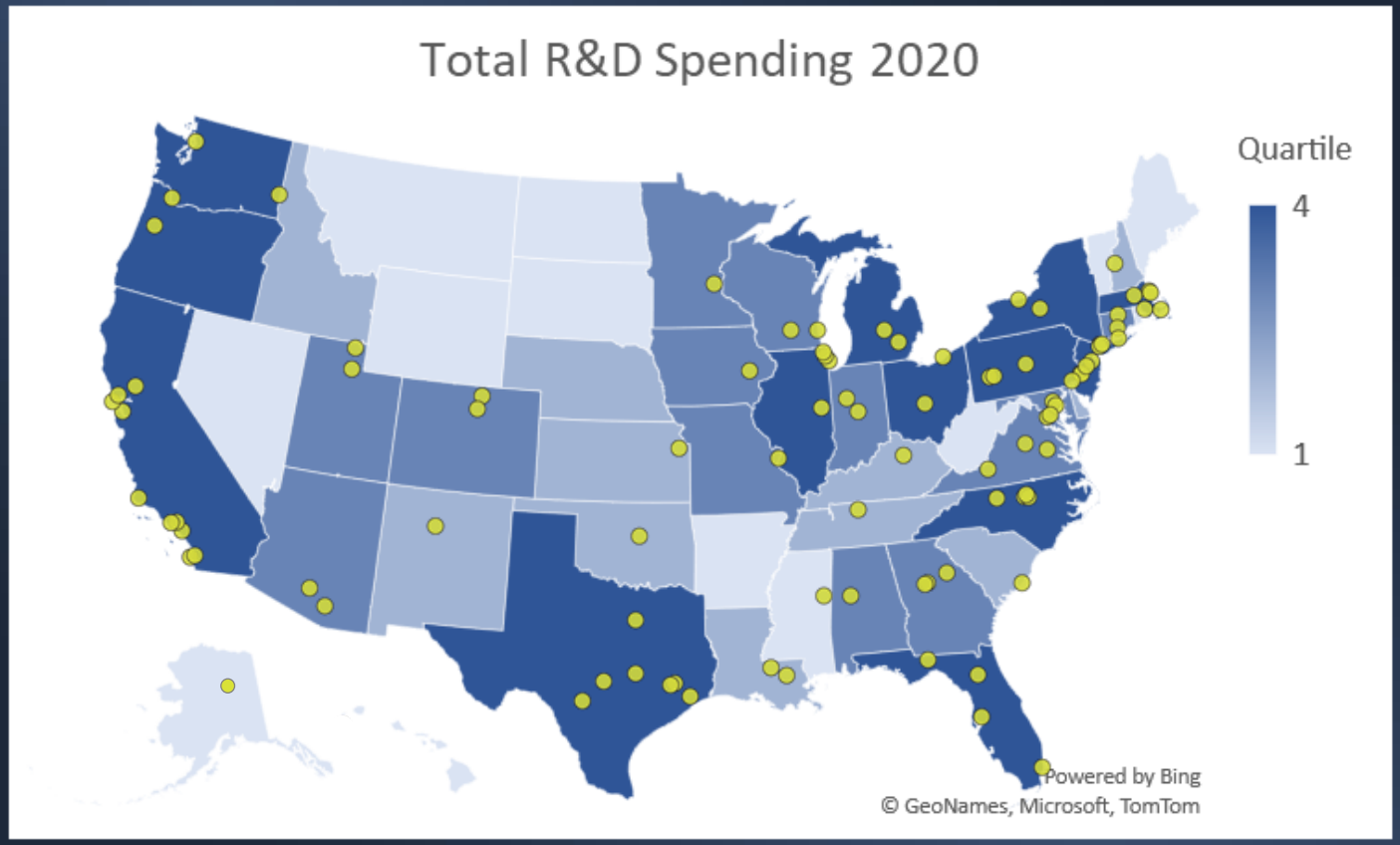


Figure 2, bottom: Percent of S&E workers holding a doctoral degree who are foreign-born, by field.

National Science Board

Source: NSB and National Center for Science and Engineering Statistics (NCSES) https://ncses.nsf.gov/indicators

Geography of U.S. R&D Spending

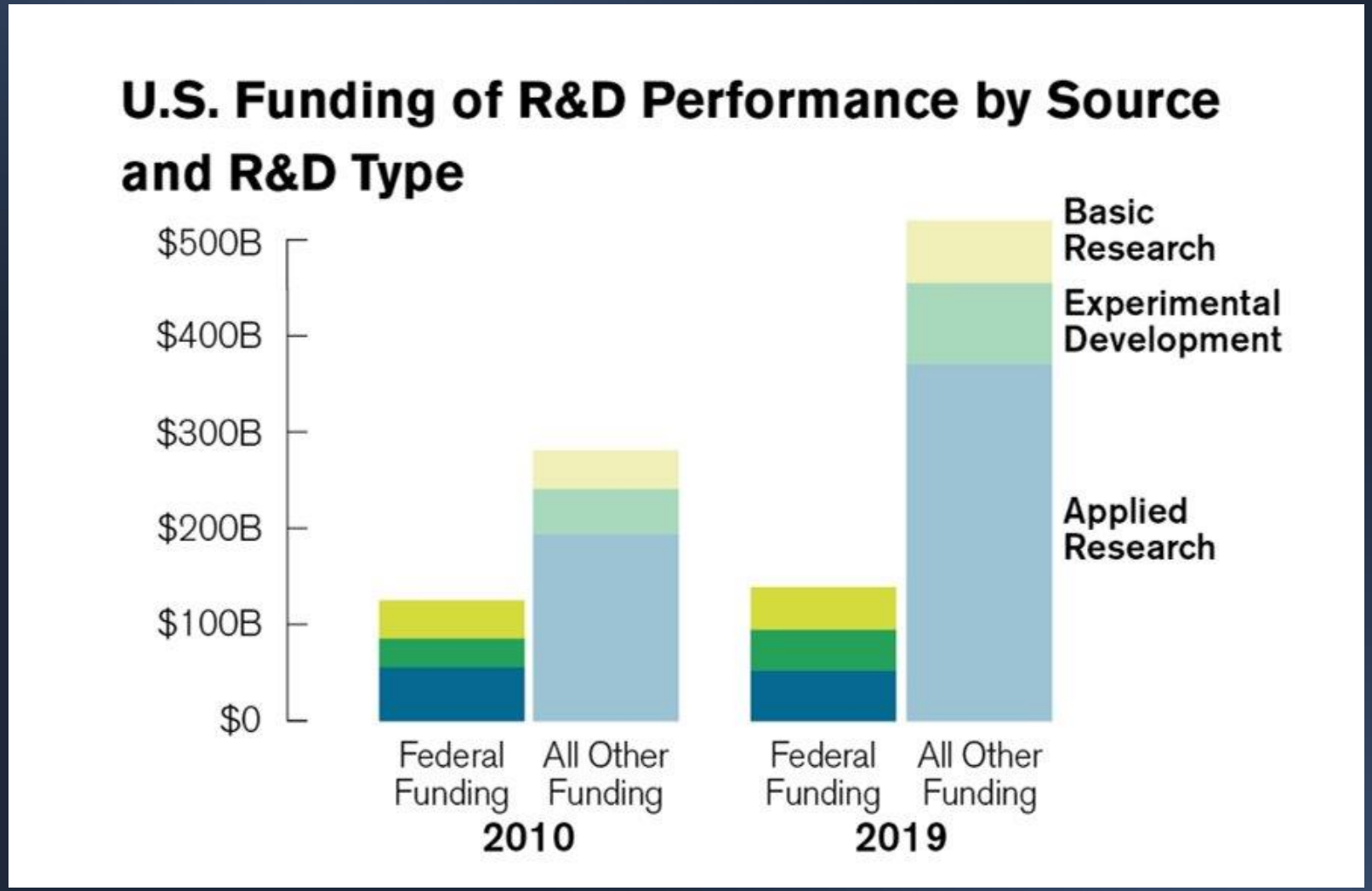


100 higher education institutions receiving the most federal R&D money

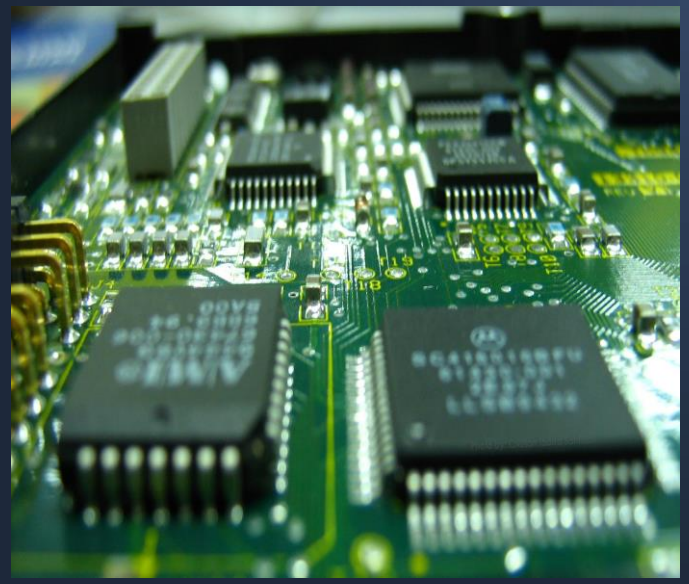
National Science Board

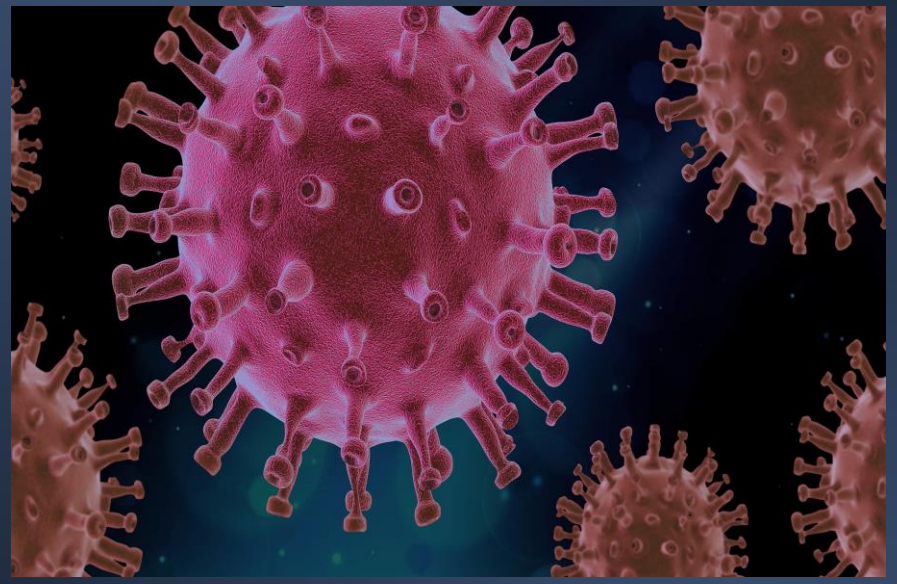
Source: Science & Engineering State Indicators

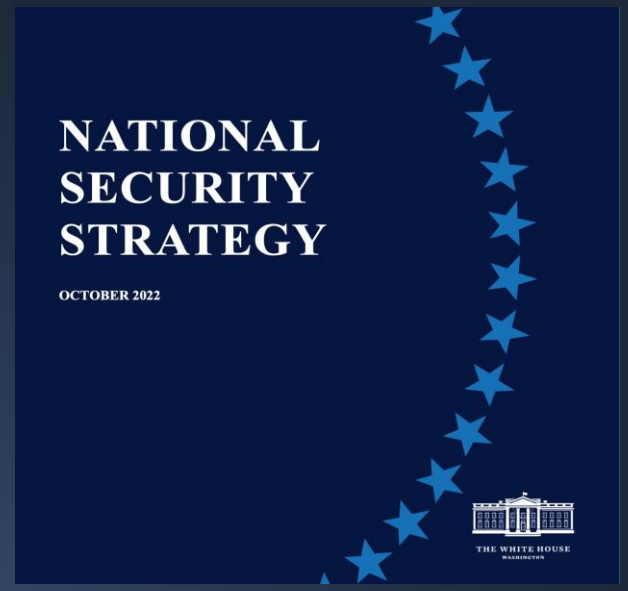
Federal Funding



Changing World Conditions



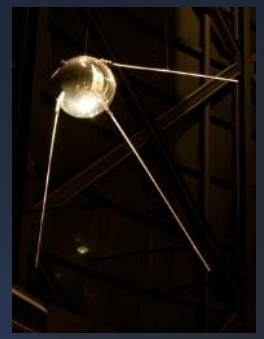




U.S. Universities: Punctuated Change

Nine “Colonial Colleges”

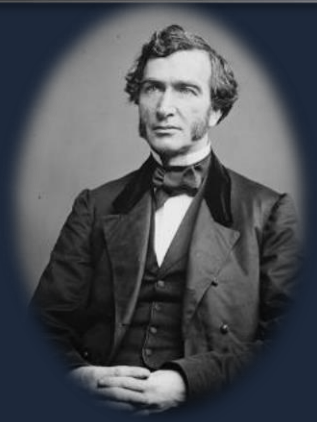
Servicemen's Readjustment Act of 1944 (GI Bill)



National Defense Education Act of 1958

Civil Rights Act of 1964

Quo Vadis?



Morrill Act of 1862 (Land-Grant Act)

Agricultural College Act of 1890 (HBCUs)

Smith-Lever Act of 1914 (Cooperative Extension)

1945-1950
Science: The Endless Frontier
Federal Research Programs

Higher Education Act of 1965

Title IX 1972

Research in a Changing World

- Urbanization
- Globalization
- Disintermediation
- Stratification
- Polarization
- Demographics

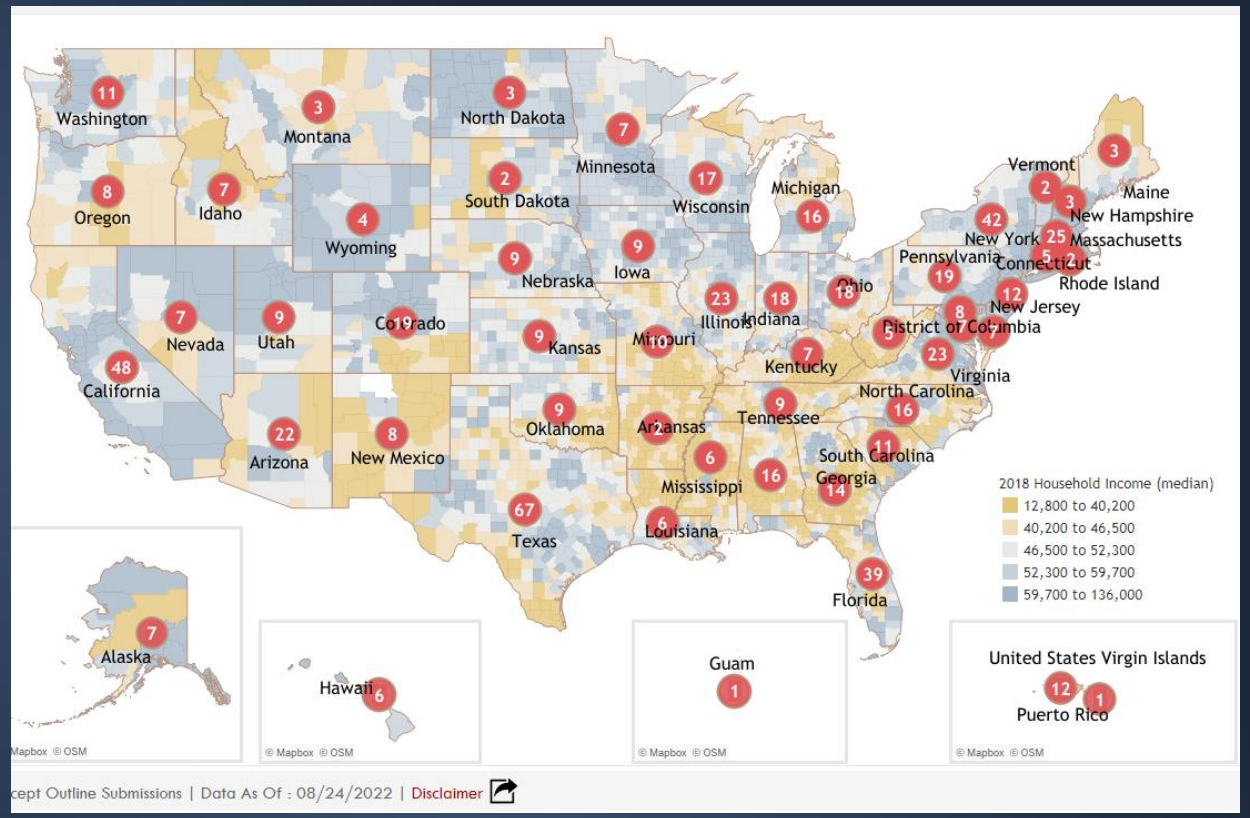
- Technology/AI
- Communication
- Biohealth
- Food and water
- Environment

CHIPS and Science Act

- Appropriates $52B for semiconductor manufacturing and R&D
- Authorizes DOUBLING of NSF's budget over five years
- Authorizes new NSF Technology, Innovation, and Partnerships (TIP) Directorate
  - Including Regional Innovation Engines (RIEs)
- Requires NSF to spend a larger percentage of funds on EPSCoR programs
- Calls for policy reforms and data collection to increase STEM diversity
- Institutes new research security provisions

NSF Regional Innovation Engines (RIE)

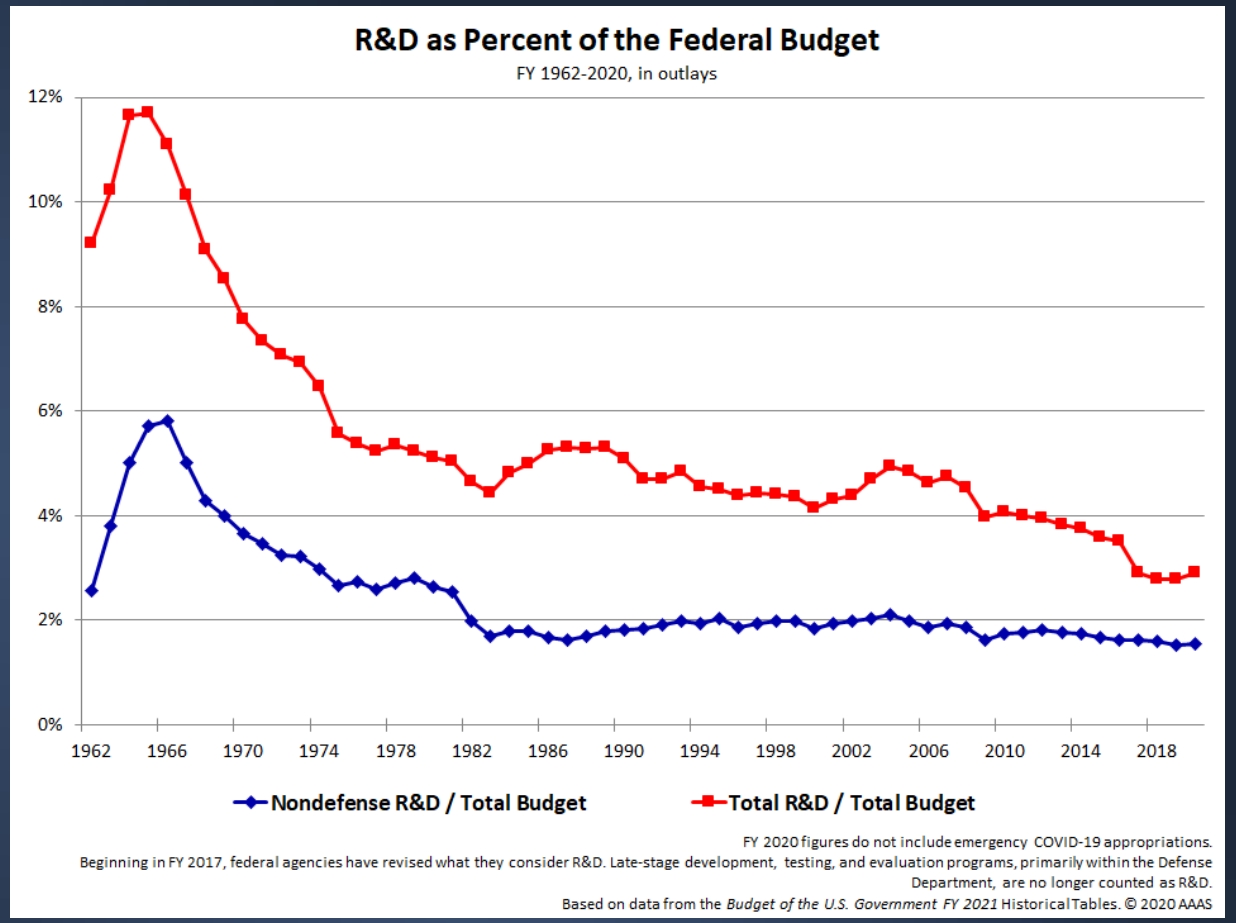
- Advance critical technologies
- Address national & societal challenges
- Foster partnerships across industry, academia, government, nonprofits, civil society, and communities of practice
- Promote and stimulate economic growth and job creation
- Spur regional innovation and talent



Research and Development Funding

How much should a nation spend on science? What kind of science? How much from private versus public sectors? Does demand for funding by potential science performers imply a shortage of funding or a surfeit of performers?

J. Marburger, “Wanted: Better Benchmarks," *Science*, 308:1087, 2005, https://doi.org/10.1126/science.1250055



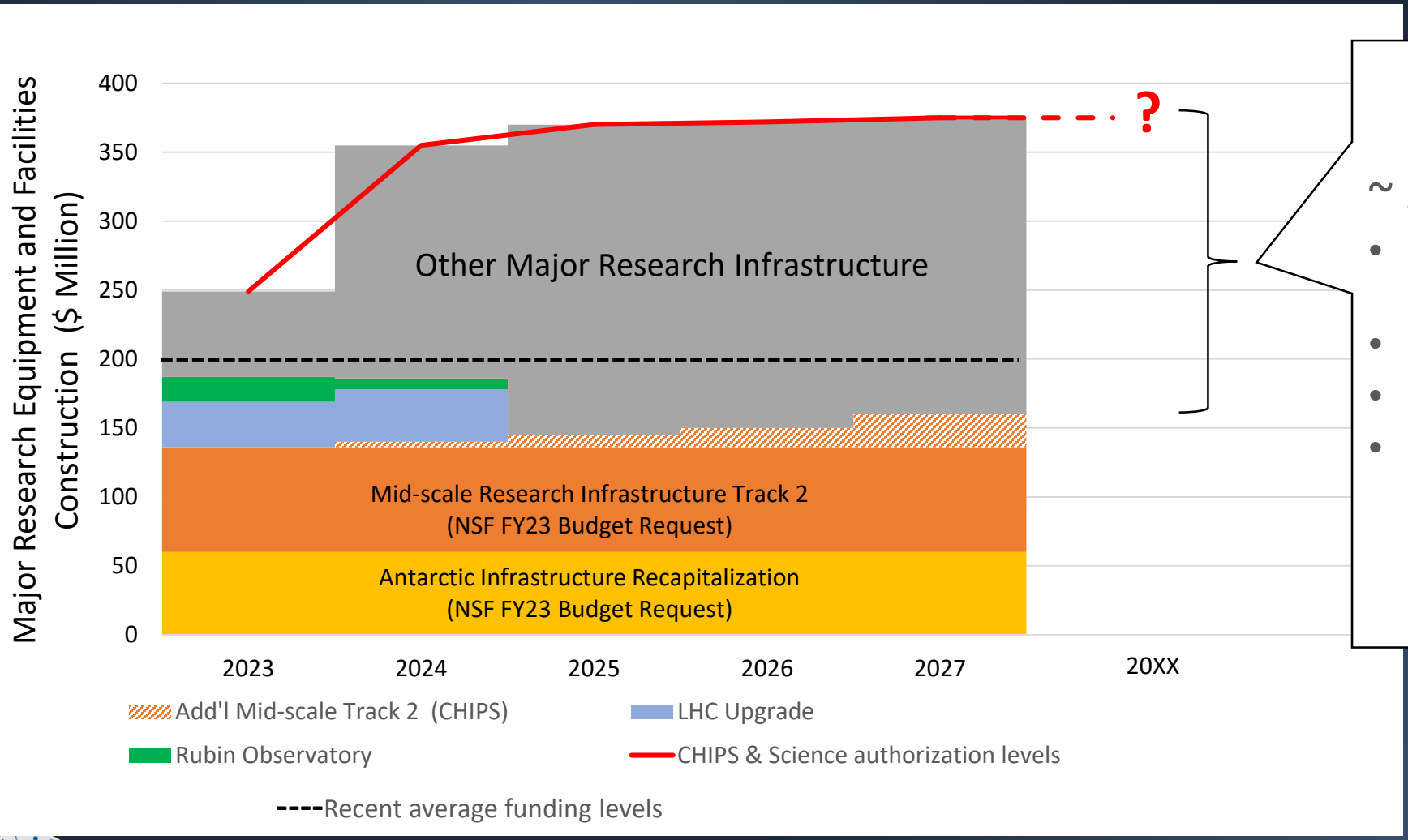
National Science Board

Source: American Association for the Advancement of Science (AAAS)

Looking Forward

- NSF and physical sciences budget doubling has been authorized before
  - Highlighting basic research alone has not yielded major NSF budget increases
  - The basic research story is absolutely necessary, but it is not sufficient
- We've got to move the needle on STEM education and workforce development
  - Both in numbers and in diversity
- We've got to expand the geography of innovation
- Difficult decisions are likely ahead for NSF on Major Research Infrastructure
  - Project demand exceeds *CHIPS & Science* MREFC authorization levels

Major Research Infrastructure



~ $200 million/year for e.g.,:

- Leadership-class computing
  (Approved for future budget inclusion)
- Antarctic Research Vessel
- ASTRO 2020
- Other major research infrastructure projects

Science Matters – Both as an End and as a Means

Science, by itself, provides no panacea for individual, social, and economic ills. It can be effective in the national welfare only as a member of a team, whether the conditions be peace or war. But without scientific progress no amount of achievement in other directions can insure our health, prosperity, and security as a nation in the modern world.

Science – The Endless Frontier

The Big Questions Don’t Change …

… but the approaches and answers do