

NSF Ideas for Future Investment The “Big Ideas” Summarized (Along with a Few Budget Comments)



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Directorate for Mathematical and Physical Sciences**

**High Energy Physics Advisory Panel
(HEPAP)**

December 1, 2016



The President's Request and Congressional "Marks"

**FY 2016
(Estimate)**

NSF \$ 7463 M

R&RA \$ 6034 M

**FY 2017
(Request)***

\$ 7564 M 1.3%

\$ 6425 M 0.8%



UNITED STATES
NATIONAL
SCIENCE
FOUNDATION

**FY 2017
BUDGET
REQUEST TO
CONGRESS**

	House	Senate
NSF	\$ 7406 M	\$ 7510 M
R&RA	\$ 6079 M	\$ 6034 M

***Excludes \$ 400 M requested
from "mandatory" account**



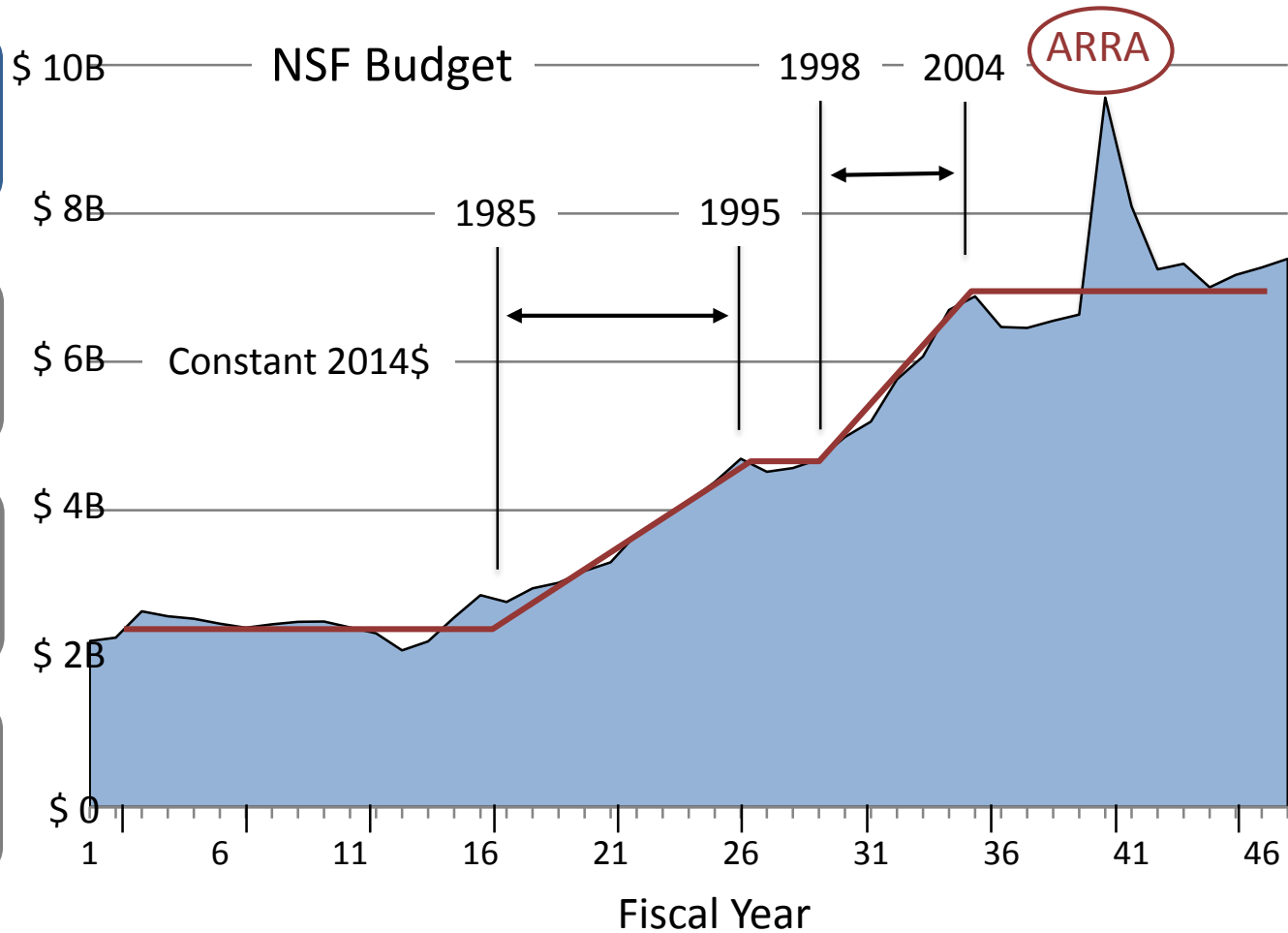
NSF by the Numbers FY 2016

NSF Budget
\$ 7.46 B

42 200
Research Proposals

9 200
Research Awards (22%)

140 000
Researchers



Mathematical and Physical Sciences

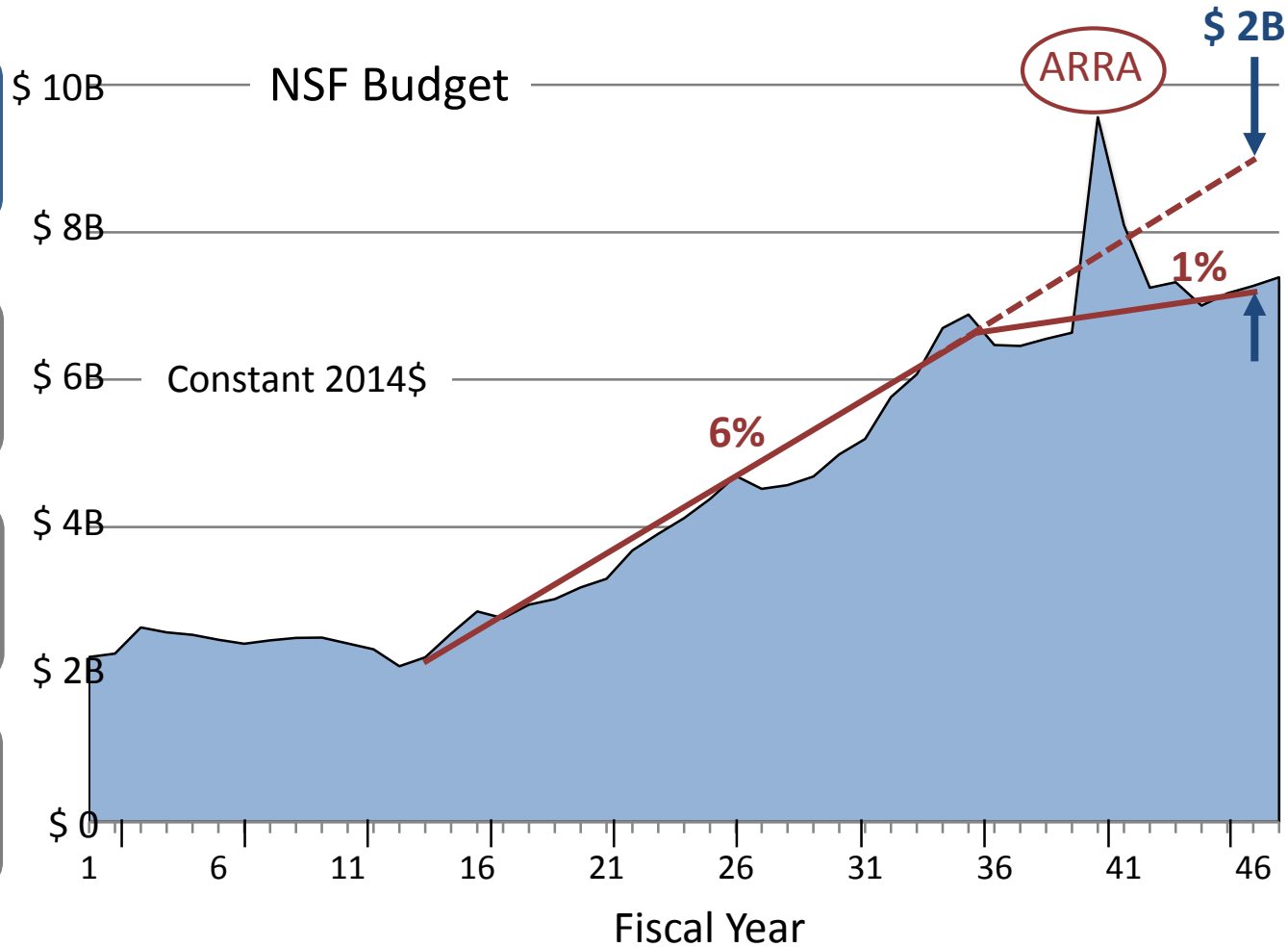
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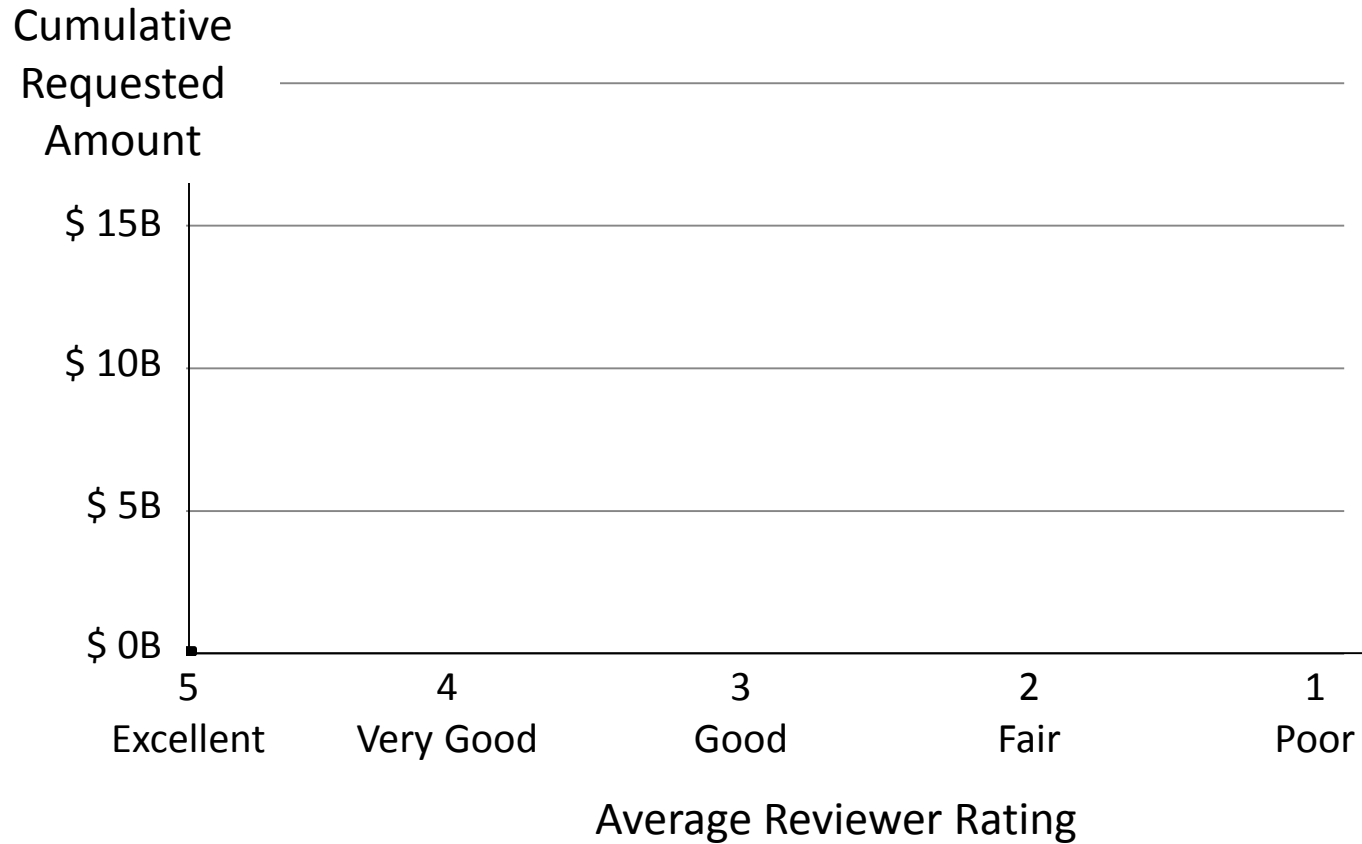
140 000
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Mathematical and Physical Sciences

Science Left on the Table

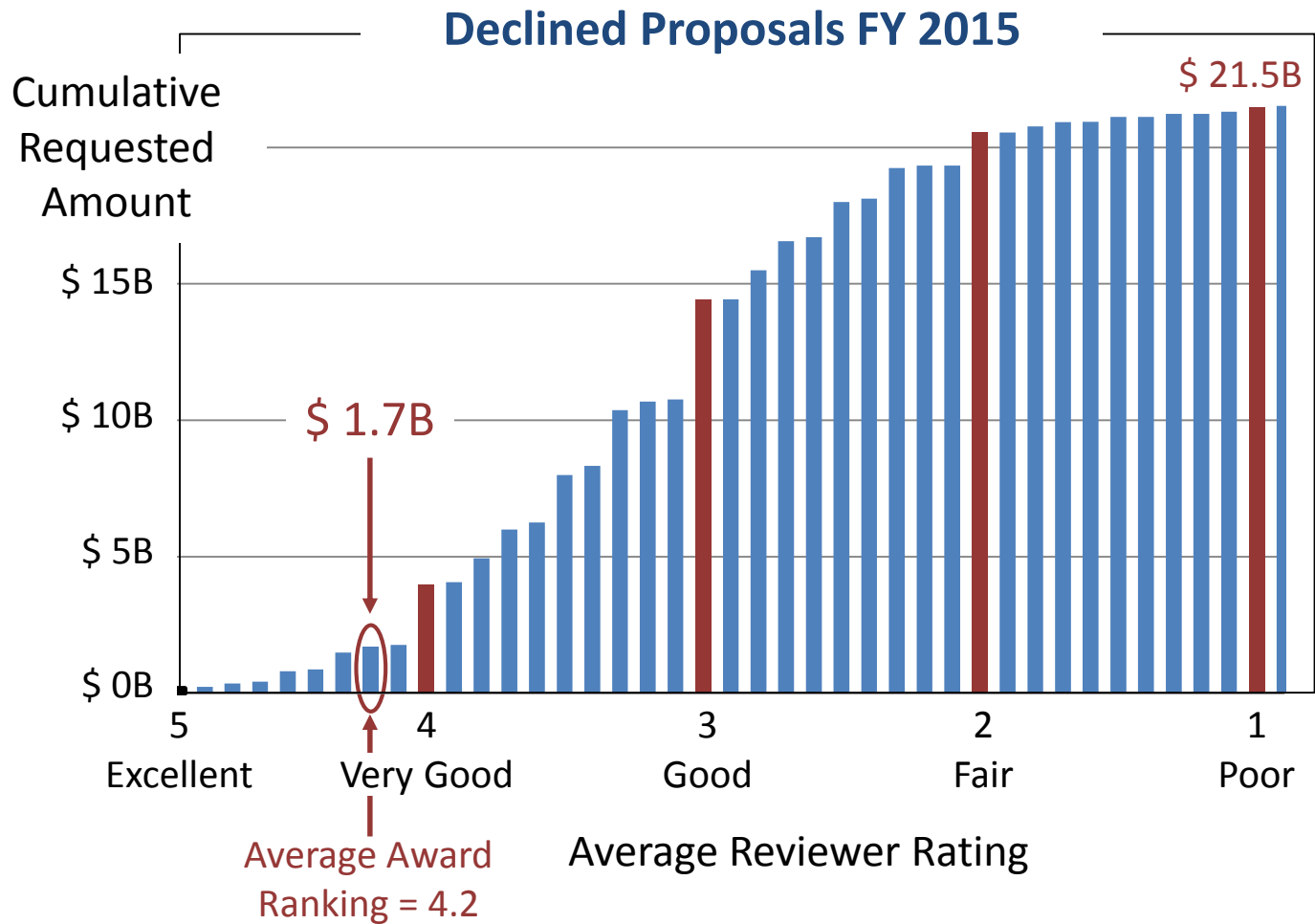
Declined Proposals FY 2015



Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2015



Science Left on the Table



Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2015



NSF Ideas for Future Investment - “Big Ideas”

SCIENCE POLICY

Science

MAY 12, 2016

NSF director unveils big ideas

Plan is aimed at the next president and Congress

“This comes at a time of transition,” she told the National Science Board, NSF’s oversight body, on 6 May. “So that makes it **a great opportunity for NSF to present a menu of the things it can do.**” And NSF’s current budget of \$7.46 billion is insufficient to tackle these questions, Córdova told *Science* after the meeting. “We can’t do any of these things without future investments. **So yes, we need an infusion of money.**”

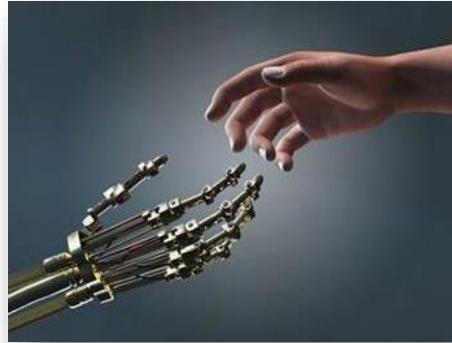


Research Ideas

Harnessing Data



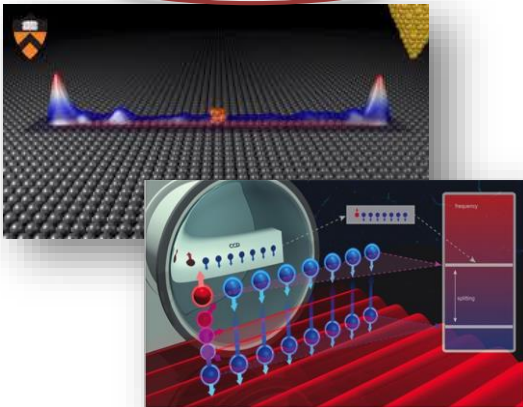
Human-Tech Frontier



Rules of Life



Quantum Leap



New Arctic

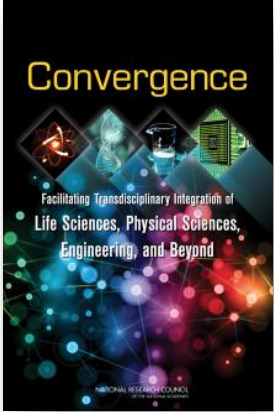


Windows on the Universe



Process Ideas

Convergence



Mid-scale



NSF 2050 Fund



INCLUDES



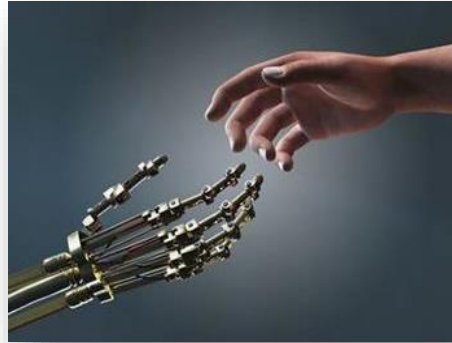
Mathematical and Physical Sciences

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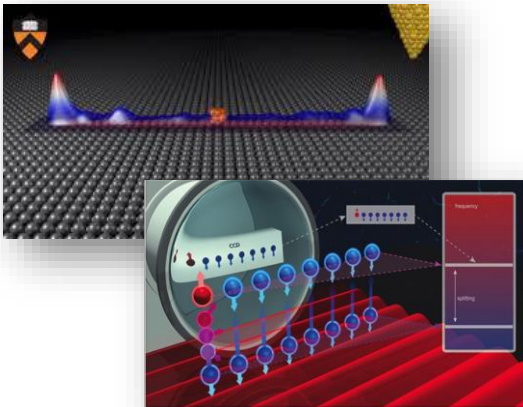
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Windows on the Universe



NSF Ideas for Future Investment - “Big Ideas”

Harnessing Data for 21st Century Science and Engineering



*“engage NSF’s research community in the pursuit of **fundamental research in data science and engineering**, the development of a cohesive, federated, national-scale approach to **research data infrastructure**, and the development of a **21st-century data-capable workforce**.”*



NSF Ideas for Future Investment - “Big Ideas”

Harnessing Data for 21st Century Science and Engineering



Fundamental research in mathematics, statistics, computer science

Fundamental research on data topics

Engagement of research domains

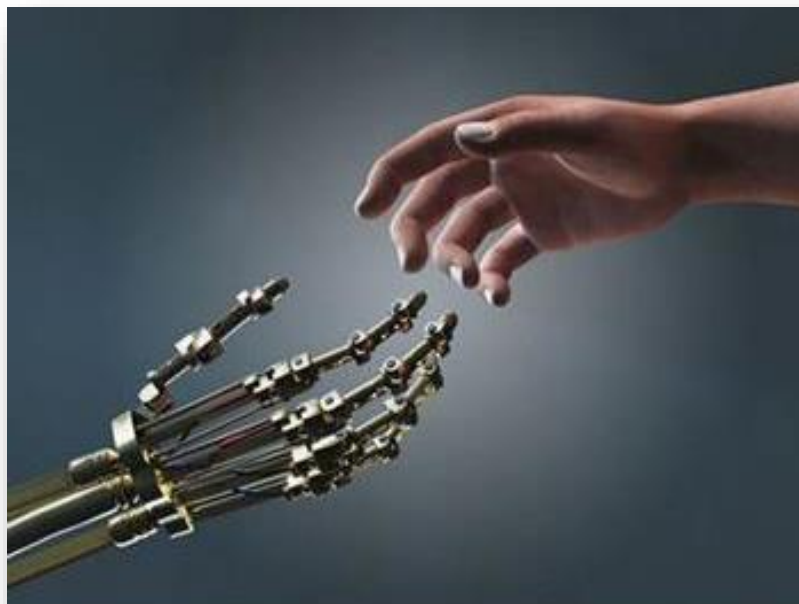
Robust, comprehensive, open, science-driven cyberinfrastructure ecosystem

Learning opportunities and pathways



NSF Ideas for Future Investment - “Big Ideas”

Shaping the New Human-Technology Frontier



*“catalyze the interdisciplinary science and engineering needed to shape that future and the **human centered engineered and social systems** that those technologies will enable .”*



NSF Ideas for Future Investment - “Big Ideas”

Understanding the Rules of Life: Predicting Phenotype



“How do living systems, from cells to organisms, get to be the way they are (the “phenotype”) through the complex interplay of the information contained in the genetic blue print (the “genotype”) and the environment .”

NSF Ideas for Future Investment - “Big Ideas”

Understanding the Rules of Life: Predicting Phenotype



Computational modeling and informatics

Understanding genetic, epigenetic, and environmental factors

Predicting behavior of living systems

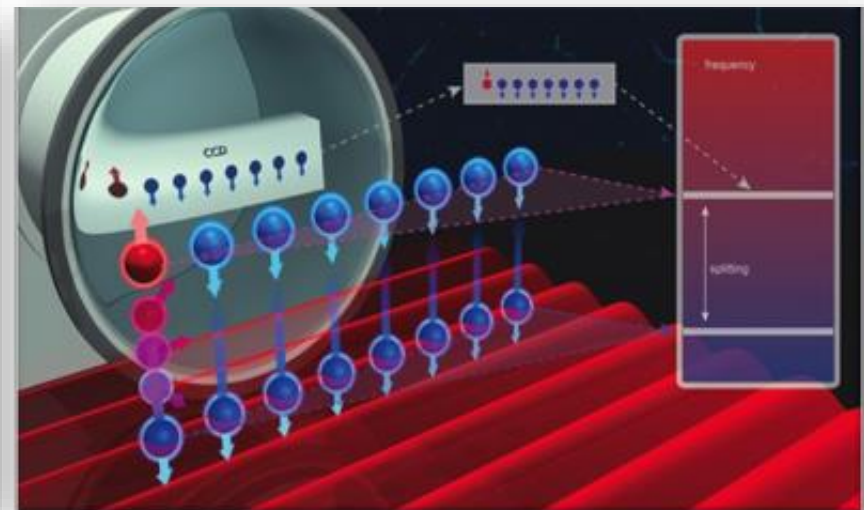
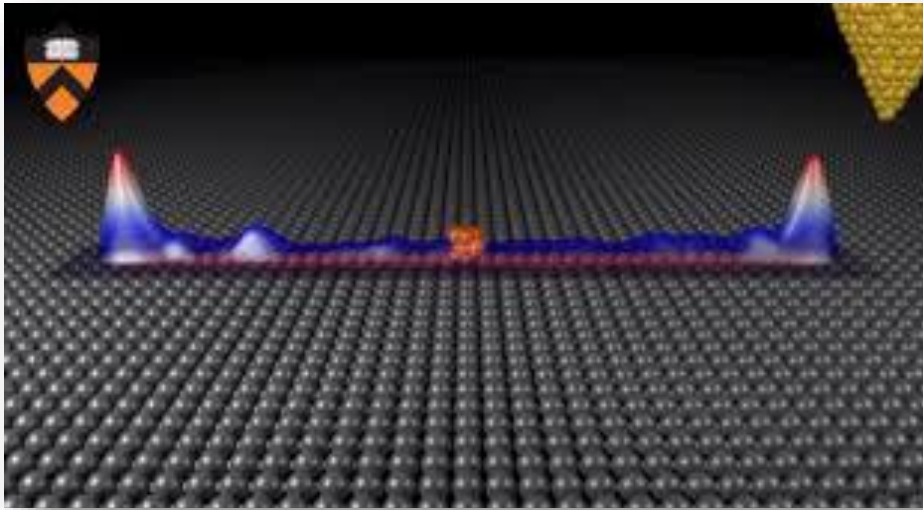
Influence of the symbiosis with microorganisms

Ability to synthesize cells and organisms from basic molecules



NSF Ideas for Future Investment - “Big Ideas”

The Quantum Leap: Leading the Next Quantum Revolution

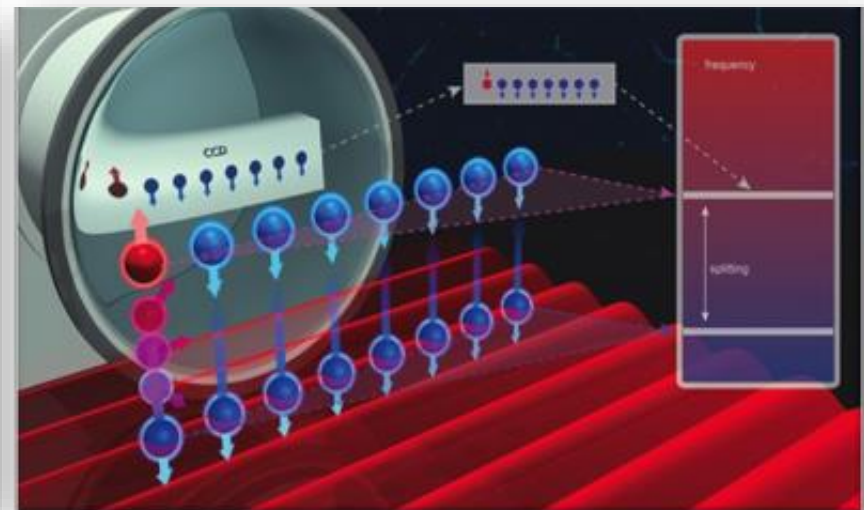
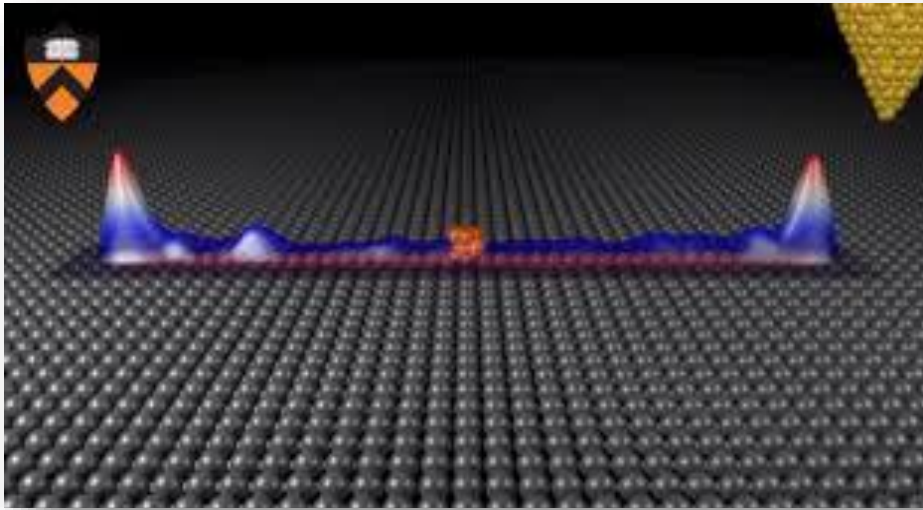


“a cross-NSF approach to identifying and supporting research that answers deep questions about quantum behavior and develops the means of accessing and manipulating quantum systems ... couple together experiment, computation, and theory to attack fundamental questions”



NSF Ideas for Future Investment - “Big Ideas”

The Quantum Leap: Leading the Next Quantum Revolution



Preparation and manipulation of complex or dynamic quantum states

Control light-matter interactions to create new quantum phenomena

Mathematical descriptions of emergent quantum behavior

Design and engineer systems to use quantum effects extensively



NSF Ideas for Future Investment - “Big Ideas”

Navigating the New Arctic



*“establish an observing network of mobile and fixed platforms and tools across the Arctic to document these rapid **biological, physical, chemical and social changes**, leveraging participation by other federal agencies”*



NSF Ideas for Future Investment - “Big Ideas”

Windows on the Universe: The Era of Multi-messenger Astrophysics



*“observe the universe and extreme events in it through three different windows – detection of **electromagnetic waves, particles, and gravitational waves** – to answer some of the most profound questions before humankind”*



NSF Ideas for Future Investment - “Big Ideas”

Windows on the Universe: The Era of Multi-messenger Astrophysics



How did the universe begin?

Why is the universe accelerating?

What is the unseen matter that constitutes much of the universe?

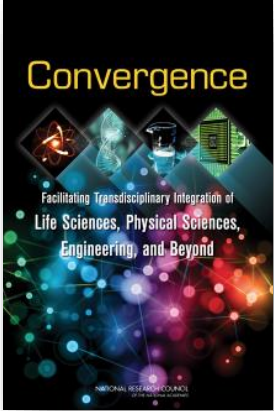
How does gravity work under the most extreme conditions?

What are the properties of the most exotic objects in the universe?



Process Ideas

Convergence



Mid-scale



NSF 2050 Fund

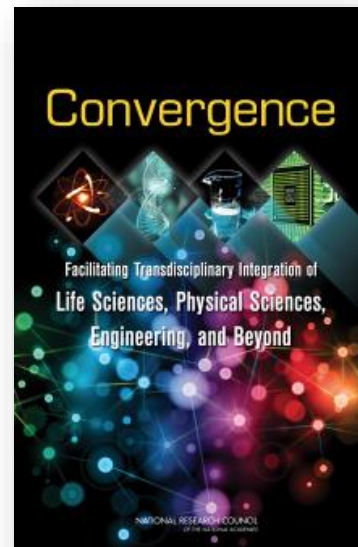


INCLUDES



NSF Ideas for Future Investment - “Big Ideas”

Growing Convergent Research at NSF



*“the convergence paradigm **augments a more traditional transdisciplinary** approach to research by framing challenging research questions at inception, and fostering the collaborations needed for successful inquiry”*

“motivated by intellectual opportunity or important society problems”



NSF Ideas for Future Investment - “Big Ideas”

Mid-scale Research Infrastructure



*“meet the need for **large, mid-scale research infrastructure** for science and engineering that is changing to*

- rely on cyberinfrastructure, broadly defined,*
- be diverse in space, cost, and implementation time, and*
- require dynamic and nimble responses to new challenges”*



NSF Ideas for Future Investment - “Big Ideas”

NSF 2050 The Integrative Foundational Fund



“a fund dedicated to identifying bold, long-term foundational research questions to set the stage for breakthrough science and engineering all the way to NSF’s Centennial in 2050”



NSF Ideas for Future Investment - “Big Ideas”

NSF INCLUDES: Enhancing Science and Engineering through Diversity



“NSF INCLUDES: ‘Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers’ invests in alliances using collective impact-style approaches ... to achieve inclusion in science and engineering, at scale, of people from traditionally underrepresented groups”

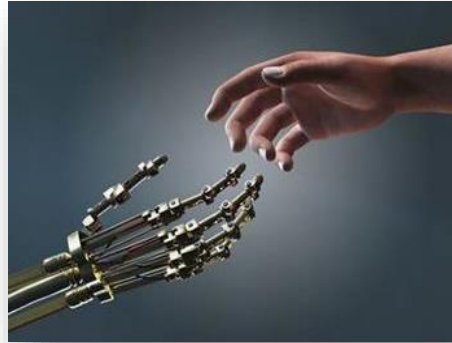


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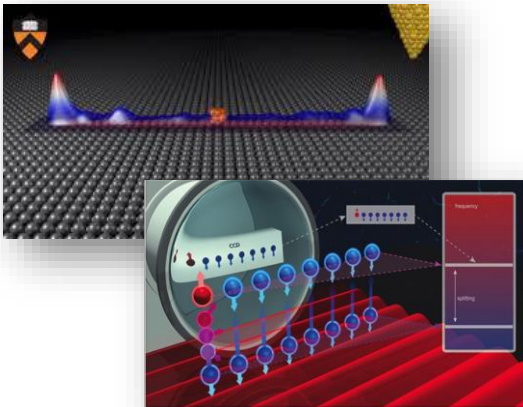
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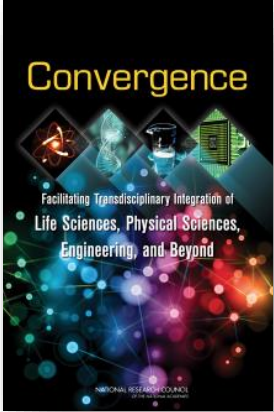


Windows on the Universe



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NSF 2050 Fund



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NSF Ideas for Future Investment - “Big Ideas”

Next Steps

**Working Groups to Plan for
FY 2017, FY 2018, and beyond - differing by topic**

- **Establish baseline of current investment**
- **Community input – workshops, ...**
- **New programs, new coordination, meta-programs, ...**

Thoughts and Comments

