



AFOSR Basic Research Strategy

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Integrity ★ Service ★ Excellence

Report Documentation Page

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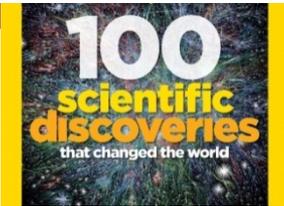
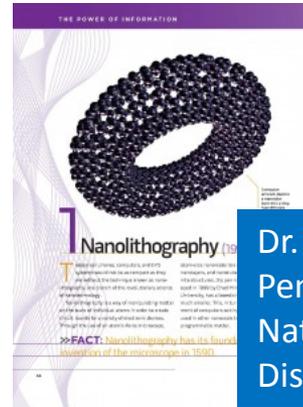
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Why the Air Force Invests in Basic Research



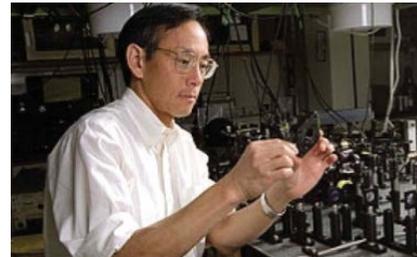
- To probe today's technology limits and ultimately lead to future technologies with DoD relevance
- Attract the most creative minds to fields of critical DoD interest
- Create a knowledgeable workforce in fields of critical DoD interest



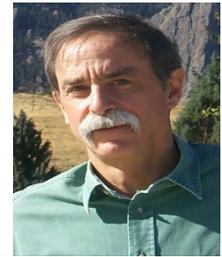
Dr. Chad Mirkin's research on Dip Pen Nanolithography was featured in National Geographic's '100 Scientific Discoveries That Changed the World'



AFOSR Sponsored 71 Nobel Laureates



1997 Nobel Prize in Physics - Steven Chu Secretary of Energy



2012 Nobel Prize in Physics Dr. David Wineland, Univ of Colorado/NIST



5 AFOSR PIs Received PECASE Awards in 2012

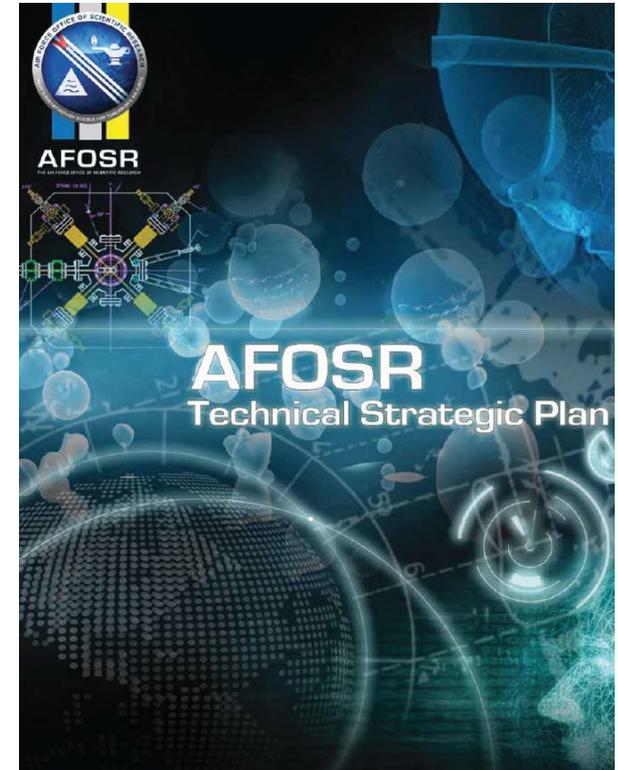
Dr. Matthew Squires, AFRL scientist, received an FY11 PECASE for his work in controlling laser cooled atoms



AFOSR Strategic Plan - 2009



- **Vision**
 - The U.S. Air Force dominates air, space, and cyber through revolutionary basic research
- **Mission**
 - Discover, shape, and champion basic science that profoundly impacts the future Air Force
- **Strategic goals**
 - ID breakthrough research opportunities – here & abroad
 - Foster revolutionary basic research for Air Force needs
 - Transition technologies to DoD and industry





AFOSR ≠ NSF



- **AFOSR mission**

- Discover, shape, and champion basic science that profoundly impacts the future Air Force



- **NSF mission**

- Promote the progress of science
- Advance the national health, prosperity, and welfare
- Secure the national defense
- Other purposes



AFOSR focuses on Air Force & DoD requirements



Examples of National Guidance



General



- Nuclear Deterrence Operations
 - Air Superiority
 - Space Superiority
 - Cyberspace Superiority
 - Command and Control
 - Global Integrated ISR
 - Global Precision Attack
 - Special Operations
 - Rapid Global Mobility
 - Personnel Recovery
 - Agile Combat Support
 - Building Partnerships
- AF Core Functions

S&T Areas

Cyber Vision 2025

Energy Horizons

United States Air Force Chief Scientist (AF/ST)

Report on **Technology Horizons**
A Vision for Air Force Science & Technology

OSD S&T Emphasis Areas

The Department has identified seven priorities:

- Defense Strategic Guidance
- Autonomy
- Counter Weapons of Mass Destruction
- Cyber Sciences
- Data-to-Decisions
- Electronic Warfare
- Engineered Resilient Systems
- Human Systems

Reviews

Report of the Defense Science Board Task Force on

Basic Research

January 2010

Office of the Chief Scientist
Air Acquisition
Washington, DC

Many new guidance documents since 2009





Factors Underlying AFOSR Investment Decisions



- **Search for transformational opportunities**
 - We take on informed “relevance” risk
- **Comprehensive search**
 - Relevance: across the spectrum of potential future AF requirements
 - Opportunity: throughout the world
- **Investment balance across technology areas**
- **What other agencies are funding**
 - Awareness, collaboration

AFOSR program officer autonomy a key component of our success



Updating Our Strategy



- **Motivation**

- Incorporation of updated guidance
- Restructuring to improve responsiveness to new technological areas

- **Steps taken**

- New dynamic organizational structure
- Corporate AFOSR approach to funding the Air Force Research Laboratory intramural program
- Basic Research Initiative to spur portfolio turnover

- **Written strategic plan is being updated**



New Organizational Structure



- **New structure (partial description)**
 - Integrated business office
 - Technical departments organized around common themes
 - Dynamic – number and focus of departments will change as research thrusts evolve
 - Department chairs are term positions
 - Integrated international program
 - Develop international portfolio considering the world as a whole, not Europe, Asia, etc., separately

New structure designed to improve AFOSR effectiveness



New AFOSR Departments



- **Dynamical Systems and Control – Dr. David Stargel**
 - Mathematics
 - Materials
 - Fluid dynamics
 - Structural mechanics
- **Quantum and Non-Equilibrium Processes – Dr. Pat Roach**
 - Fundamental quantum processes
 - Plasma physics and high-energy-density non-equilibrium processes
 - Optics and electromagnetics



New AFOSR Departments



- **Information, Decision, and Complex Networks – Dr. Bob Bonneau**
 - Data-driven modeling
 - Self-analyzing software & hardware network architectures
- **Complex Materials and Devices – Dr. Hugh DeLong**
 - Complex materials and structures
 - Complex electronics and fundamental quantum processes
 - Natural materials and systems research
- **Energy, Power and Propulsion Sciences – Dr. John Schmisser**
 - Energy extraction and storage
 - Energy conversion and utilization



Elements of the AFRL Intramural Program



- **AFRL intramural basic research (“lab task”) program**
 - AFRL technical directorates submit proposals to AFOSR through their chief scientist offices
 - AFOSR corporately selects proposals to be funded
- **Workforce development**
 - Centers of Excellence (7 Active/3 Pending)
 - Tie selected universities to TDs
 - International personnel exchanges (30)
 - Postdocs (80) & summer faculty (99) & students (22) at AFRL research sites

Promotes a healthy AFRL in-house basic research capability



Basic Research Initiative (BRI) Program



- **10% of AFOSR core funds each year dedicated to new basic research initiatives**
 - Program officers develop initiative proposals
 - Initiatives undergo internal and external review for relevance, excellence, and priority
 - Collaborations across disciplines and geographic boundaries encouraged
- **New research areas identified via a broad agency announcement**

Goal – ensure the ongoing relevance of the AFOSR portfolio



Basic Research Initiatives

FY14 (~\$20M)



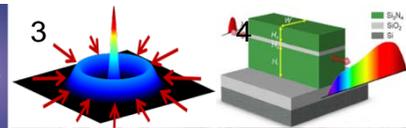
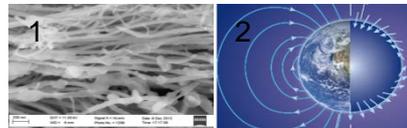
1. 2D Materials and Devices beyond Graphene: Grow, characterize and understand hetero-structures of different 2D materials with unique electronic, photonic, thermal and structural characteristics.

2. Bio-Sensing of Magnetic Fields: Initiates a basic research program to understand biological magnetic field sensation.

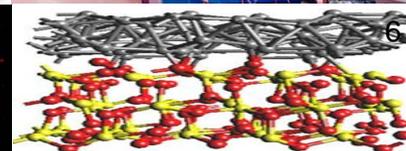
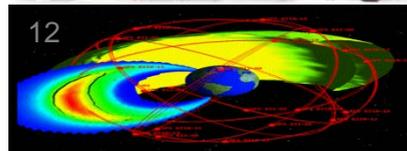
3. Development and Verification of Effective First Principles Modeling of Semiconductor Lasers under Non Equilibrium Operating Conditions: Support theory and measurements that are highly sensitive to detailed gain and index dynamics.

4. Laser-matter Interactions in the Relativistic Optics Regime: Explore and understand the rich variety of physical processes and potential new physics involved in the interactions of extreme light fields with matter.

13. Understanding the Psychological/Behavioral Effects of Advanced Weaponry: Understand the psychological/behavioral effects of current and future weaponry



12. Understanding the Interaction of Coronal Mass Ejections with the Solar-Terrestrial Environment: Determine ICME geoeffectiveness with a focus on the internal magnetic topology of ICMEs.



5. Lasers Physics for Scaling of Single Fibers to High Beam Quality and High-power: Address the fundamental science behind the development and the scaling of individual CW and pulsed optical fibers operating between 1 and 8 microns to high power.

6. Metal Dielectric Interface - Charge Transfer in Heterogeneous Media under Extreme Environments: Provide fully self-consistent and timedependent solutions for the electron density functions.

11. Theory-based Engineering of Biomolecular Circuits in Living Cells : Make synthetic biology a rational engineering discipline by creating a math and theory-based framework for modular design and fabrication.

10. Socio-Digital Influence: Result in novel theories of influence within the socio-digital landscape and in empirical studies that identify mechanisms for influence within different groups.

9. Plasma – Surface Interactions in Reactive Environments: Enable unique reaction conditions that permit novel and energy-efficient means of protecting or creating materials or utilizing energy for U.S. Air Force needs.

8. Perceptual and Social Cues in Human-like Robotic Interactions: Analyzes and develops the perceptual and social cues that drive trust perceptions and performance within human-robot interactions.

7. Nanoscale Building Blocks for Novel Materials: Develop a new paradigm for materials and molecular science in which new nanoscale building blocks and tailored bonds or linkers are utilized to create new materials.



Summary



- **Changes to the AFOSR strategy are being implemented**
 - BRI process, new departments, increased emphasis on AFRL intramural program
 - Includes incorporating new national guidance, evolved AFRL portfolio structure, and desire to integrate international portfolio across geographical boundaries
- **Written AFOSR strategic plan is being updated**
 - It is a living document, so updates will continue to be made