



Air Force Office of Scientific Research Overview

Nov 2011

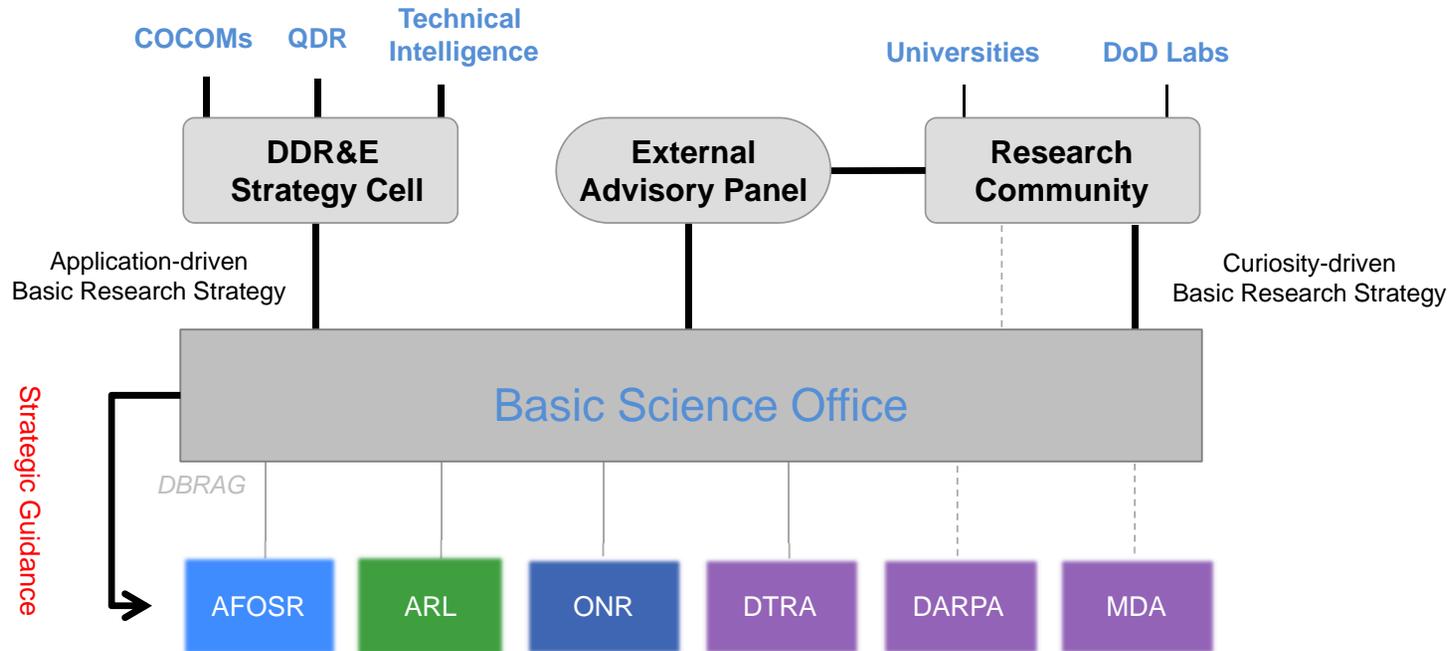
**Dr. Thomas Russell, SES
Director**

Air Force Office of Scientific Research

Approved for public release.



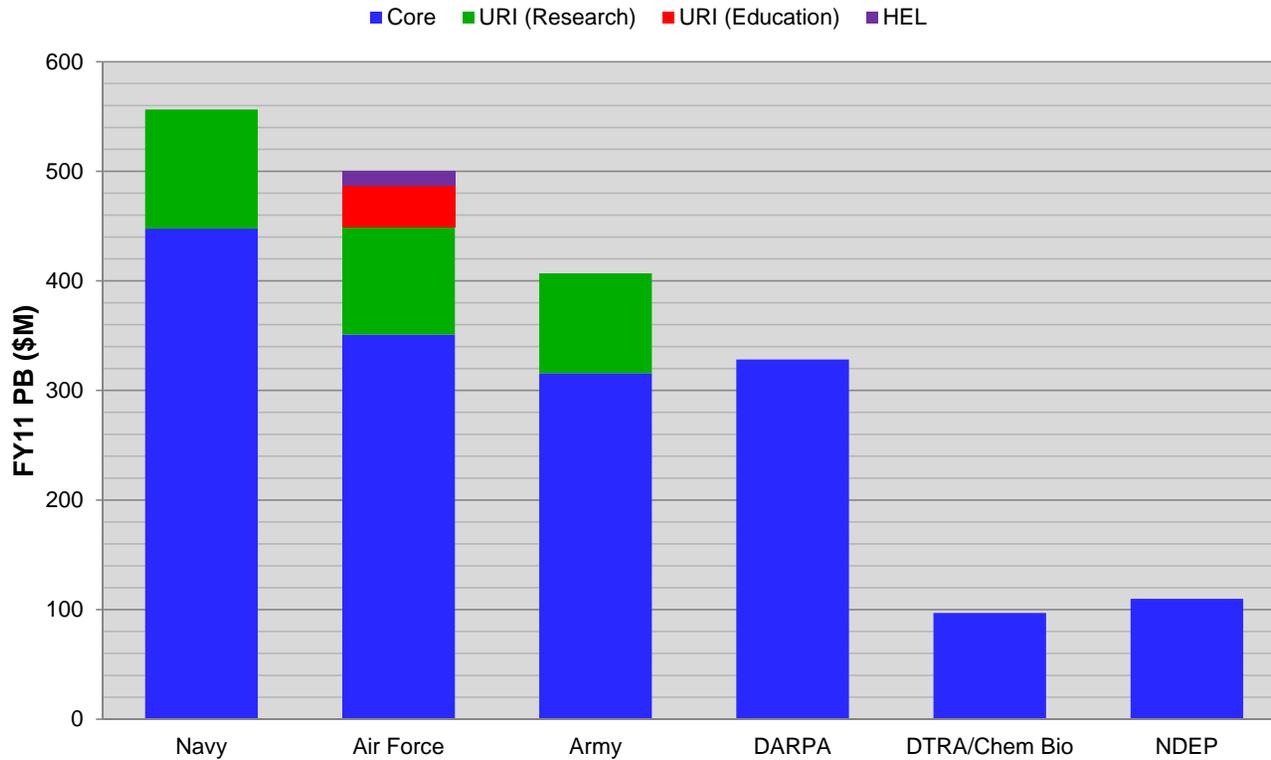
Strengthening Our Connections



- University visits and advisory panel → connections to the research community
- New Connections to the DDR&E Strategic Cell
- More directed guidance to the OXRs



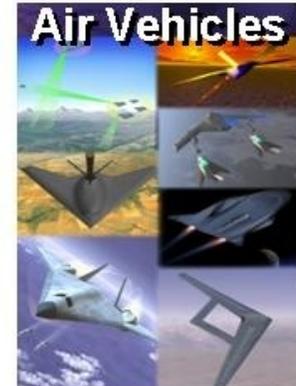
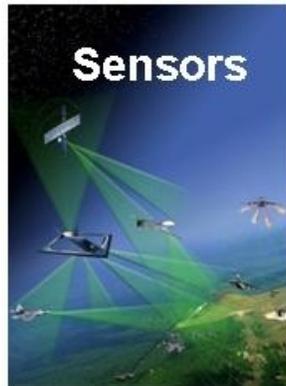
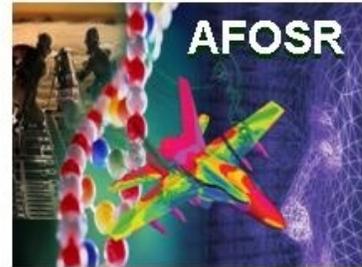
DoD Basic Research Enterprise



DoD Total FY11 Basic Research Budget Request = \$2.0B



Air Force Research Laboratory



The Air Force's Corporate Research and Development Laboratory



AFOSR Mission



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

- ID Breakthrough Research Opportunities – Here & Abroad
- Foster Revolutionary Basic Research for Air Force Needs
- Transition Technologies to DoD and Industry

TODAY'S BREAKTHROUGH SCIENCE FOR TOMORROW'S AIR FORCE

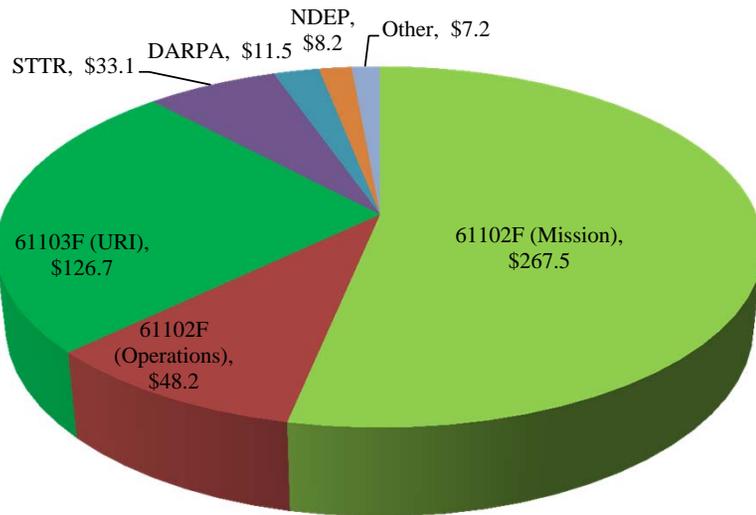


FY11 Funding Summary Total AFOSR TOA



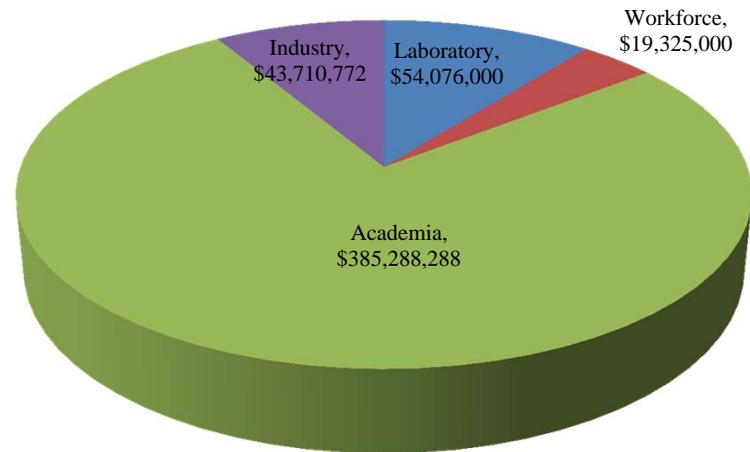
Program Element	FY2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
61102F	328,471	350,978	364,328	379,046	396,590	414,923	433,592	442,263
61103F	141,524	136,297	140,273	145,093	147,415	149,702	152,397	155,444

FY12 PBR



Sources of funding

TOA = \$502.4M*



Extramural & Intramural funds

Operating Expense = 9.6%

*HPC and AF Tax not included



Defense Research Sciences PE 61102F/61103F Shaping the Research Portfolio



Goals for AFOSR to strengthen the Air Force basic research program as defined in AF S&T Strategic Plan:

- **Provide scientific leadership** for the AF basic research enterprise
- **Attract the Nation's/World's best S&Es** to contribute to and lead AF/DoD research
- **Ensure the coherence and balance** of the AF basic research portfolio
- **Foster connections between** AFRL researchers and the National/International basic research community
- **Maximize the discovery potential** of the defense research business environment

*Focus on the Future AF with the ultimate goal to make
Today's AF and Tomorrow's AF Obsolete!*



Defense Research Sciences PE 61102F/61103F Shaping the Research Portfolio



Though a principal source of new scientific opportunities is bottom up from the scientific community through AFOSR PMs, we also consider the assessment of opportunities by AF and OSD

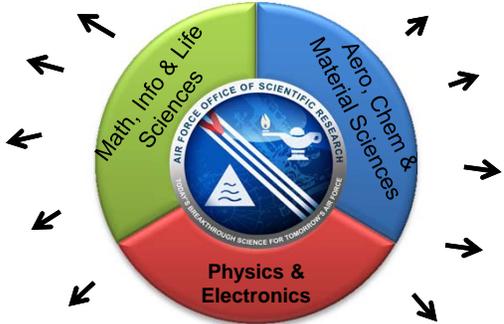
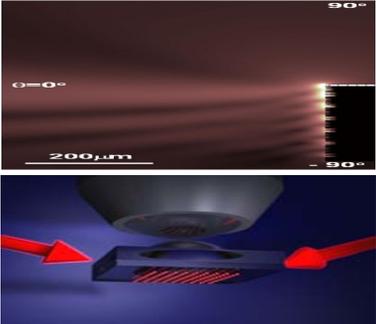
AF/ST “Technology Horizons”

Inherently Intrusion-Resistant Cyber Networks

Trusted Highly-Autonomous Decision-Making Systems

Hyper-Precision Air Delivery in Difficult Environments

Fractionated, Composable, Survivable Remote-Piloted Systems



Metamaterials and Plasmonics

Quantum Information Science

Cognitive Neuroscience

Nanoscience and Nanoengineering

Synthetic Biology

Computational Models of Human Behavior

ASD(R&E) “Six Disruptive Basic Research Areas”



Trends in AFOSR Emphasis in PE61102F and PE 61103F



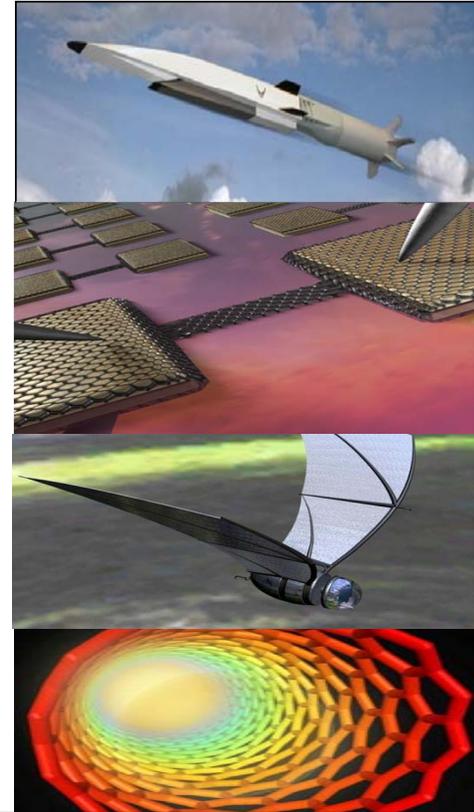
- Advanced Mathematics
- Hypersonics (Turbulence Control)
- Complex, Multi-Functional Materials
- High-Temperature Superconductivity
- Info Assurance and Network Sciences
- Micro Air Vehicles (Autonomy, Adaptive Aero)
- Interfacial Sciences (**Thermal Sciences**)
- **Counter-Directed Energy Weapons**
- Robust Decision-Making, Info Fusion
- **Socio-Cultural Modeling, Minerva**
- Quantum Information Sciences
- Space Situational Awareness
- fs-Laser Material Interactions
- Artificial Intelligence

OSD Priorities

BLUE = Tech Horizons

Grand Challenges

GREEN = Both





PE61102F/PE61103F FY 11 Budget Increases; Invest in AF “Technology Horizons” Research Areas



- SecDef Topic Enhancements

- Information Assurance
- Interacting Complex Networks
- Artificial Intelligence
- Socio-Cultural Modeling

- Materials and Processes Far from Equilibrium

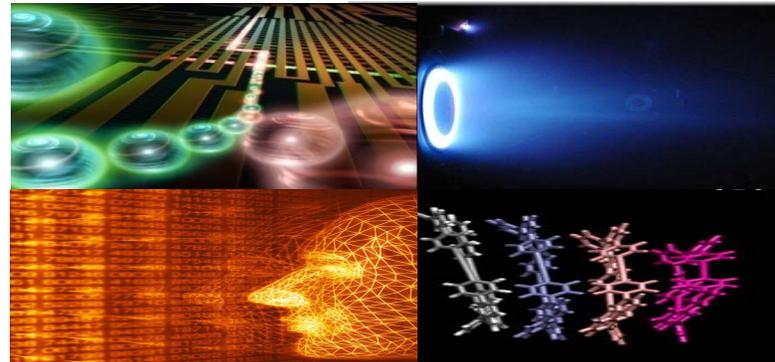
- Physics and Chemistry of Surfaces in Highly Stressed Environments
- Small Molecule Activation
- Extreme Optics

- Transformational Computing

- Neural Computing
- Bio-Inspired Distributed Control Sys.
- Beyond Moore’s Law Electronics
- Multiscale Modeling

Tech Horizons Grand Challenges

1. Inherently Intrusion-Resistant Cyber Networks
2. Trusted Highly-Autonomous Decision-Making Systems
3. Fractionated, Composable, Survivable Remote-Piloted Systems
4. Hyper-Precision Air Delivery in Difficult Environments





PE61102F and PE 61103F Investments; Disruptive Basic Research Areas



Metamaterials & Plasmonics:

Engineered design of basic properties and transport of energy/information in materials and structures. Amount: \$21.5M



Quantum Information:

Science: Manipulate and control nature down to the precision of a single quantum. Amount: \$15.5M



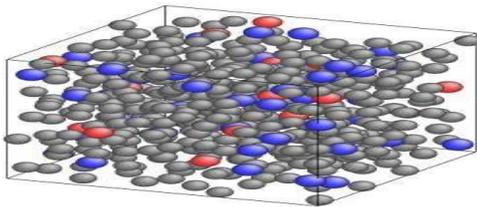
Cognitive Neuroscience:

More deeply understand and more fully exploit the fundamental mechanisms of the brain. Amount: \$4.8M



Nanoscience & Nano-Engr:

Advanced materials and manufacturing processes are built using control at the nanoscale. Amount: \$23.0M



Synthetic Biology:

The promise of engineered biology for a multitude of applications. Amount: \$0.2M



Computational Models of

Human Behavior: *A fundamental under-standing and predictive capability of human behavior dynamics. Amount: \$5.9M*



Basic Research (Ten Focus Areas)

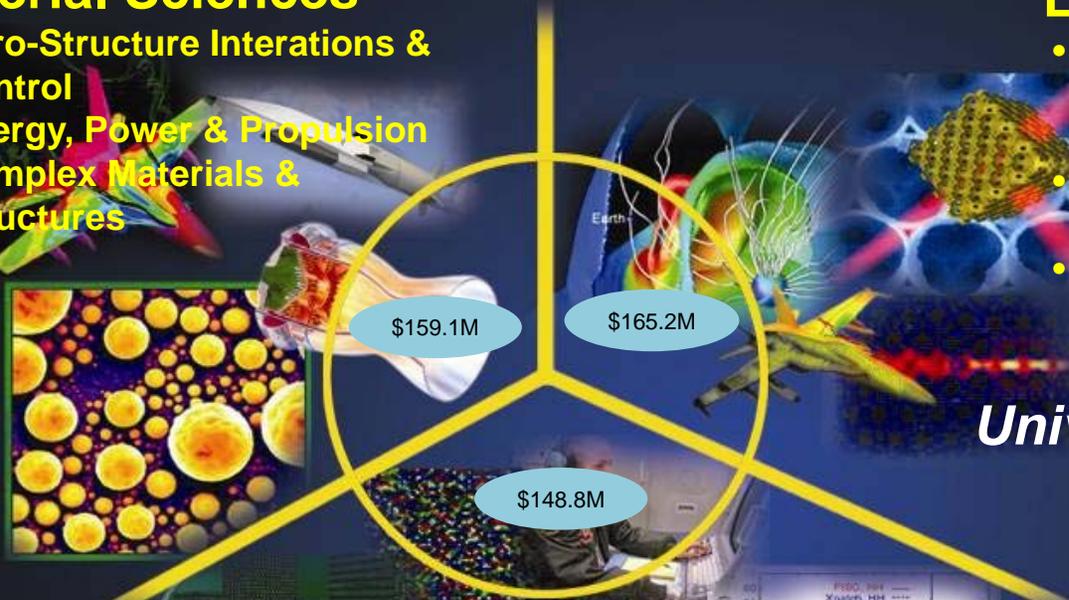
(FY11 - \$351M)

Aerospace, Chemical & Material Sciences

- Aero-Structure Interactions & Control
- Energy, Power & Propulsion
- Complex Materials & Structures

Physics & Electronics

- Complex Electronics & Fundamental Quantum Processes
- Plasma Physics & High Energy Density
- Optics, EM, Comm, Signals Processing



University Research Initiatives

(FY11 - \$136.3M)

Mathematics, Information & Life Sciences

- Info & Complex Networks
- Decision Making
- Dynamical Sys, Optimization & Control
- Natural Materials & Systems

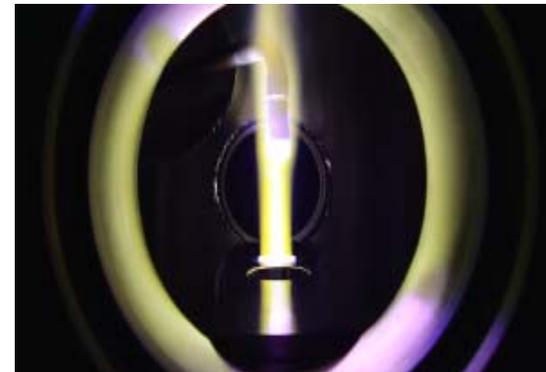




Aero-Structure Interactions and Control



- **Objective:** Characterization, modeling, and exploitation of interactions between unsteady aerodynamic flow fields and dynamic air vehicle structures.
- **Critical Subjects Include:**
 - Turbulence and laminar-turbulent transition
 - Flow control
 - Unsteady aerodynamics
 - Structural dynamics
 - Aero elasticity
- **Tech Horizons KTAs:**
 - **Autonomous Systems**
 - **High-Temperature Materials**
 - **Structural Modeling and Simulations**
 - **High Speed Turbines**
 - **Advanced Aerodynamic Configurations**



30 kW Inductively Coupled Plasma Facility
for High Temperature Material Testing

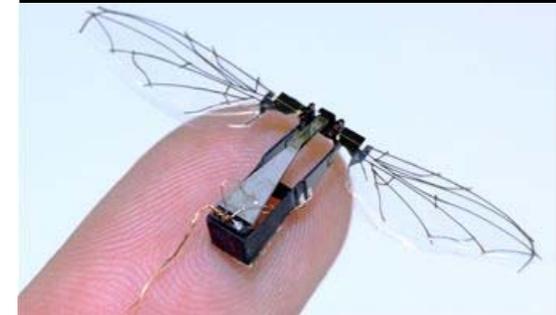
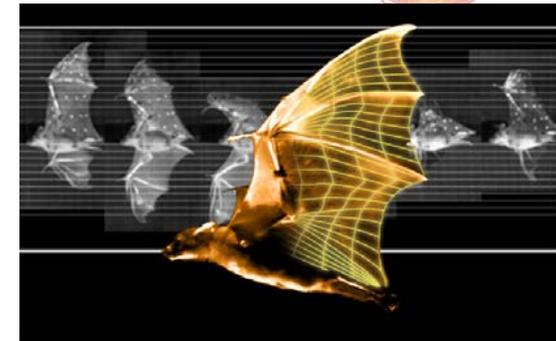
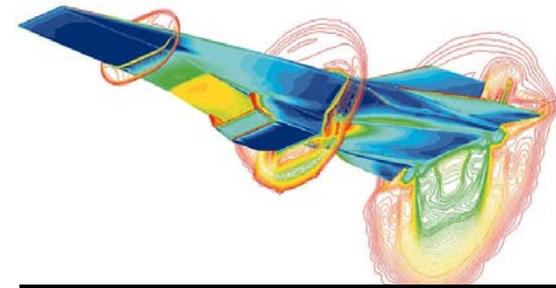
FY11	FY12	FY13	FY14	FY15	FY16	FY17
34.4	34.9	35.4	36.7	37.9	39.2	40.5



Aero Structure Interactions and Control



- **Hypersonics Research:** Model-free simulations of $>$ Mach 3 shock/turbulent boundary layer interactions provide physical insight for development of reduced order models.
- **Bio-Inspired MAVs:** Characterize aeromechanics and scalability of bat flight. Engineered maneuverable micro flight vehicles may incorporate flexible wing membranes as lifting surfaces.
- **Micro-Robotic Fly:** Research to understand how wing design can impact performance for an insect-size, flapping-wing vehicle for monitoring & exploration.

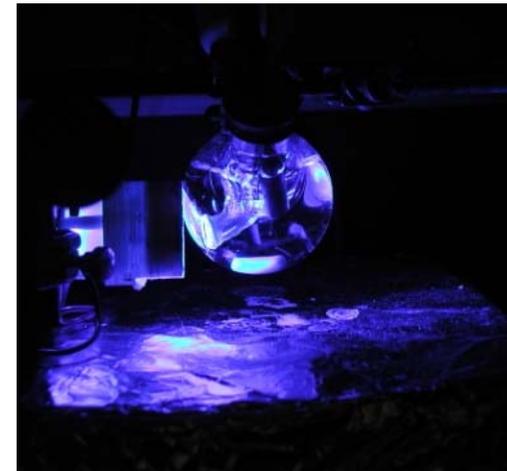




Energy, Power, and Propulsion



- **Objective:** Focus on the production, storage, and efficient utilization of energy.
- **Critical Subjects Include:**
 - Novel energetic materials
 - Combustion research
 - Thermal science
 - Novel propulsion methods
 - Catalysis chemistry
 - New ways in which energy can be produced/collected/stored/utilized
- **Tech Horizons KTAs:**
 - **Alternative Fuels**
 - **Spacecraft Propulsion**
 - **Energy Storage**
 - **Thermal Management Components**
 - **Hydrocarbon Boost Engine**



Blue light (465 nm) is used to convert CO₂ to alcohols with a substituted pyridine catalyst and a p-GaP electrode.

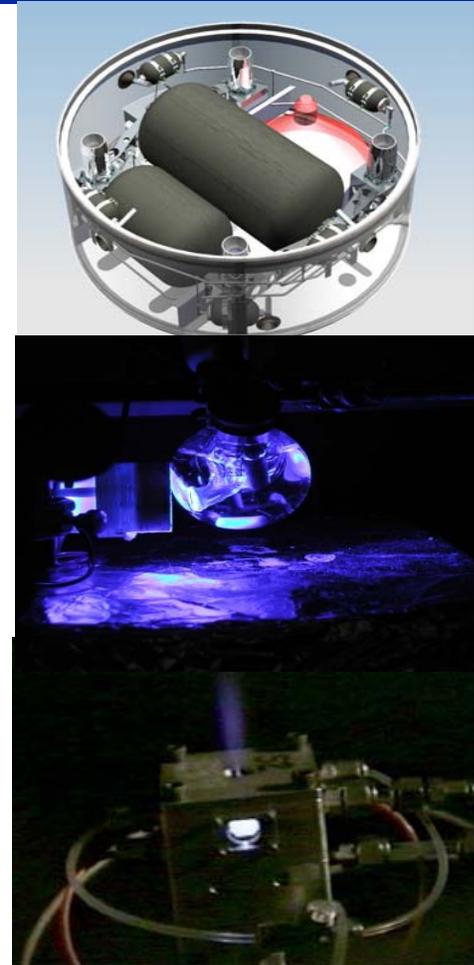
FY11	FY12	FY13	FY14	FY15	FY16	FY17
45.5	46.0	46.6	47.5	49.3	49.5	50.2



Energy, Power, and Propulsion



- **Ionic Liquid Propellants:** Ionic liquids are non-volatile, non-toxic, high density material system that can be tailored to alter properties. High-performance and reliable ignition enabling use as bipropellants.
- **Photoelectrochemical Conversion of Carbon Dioxide to Alcohols:** Blue light (465 nm) is used to convert CO_2 to alcohols with a substituted pyridine catalyst and a p-GaP electrode.
- **Miniaturized Electric Propulsion:** Developed thruster that operated off a microwave generator. It improves satellite endurance, maneuverability, fabrication and testing of a space flight ready microwave thrusters

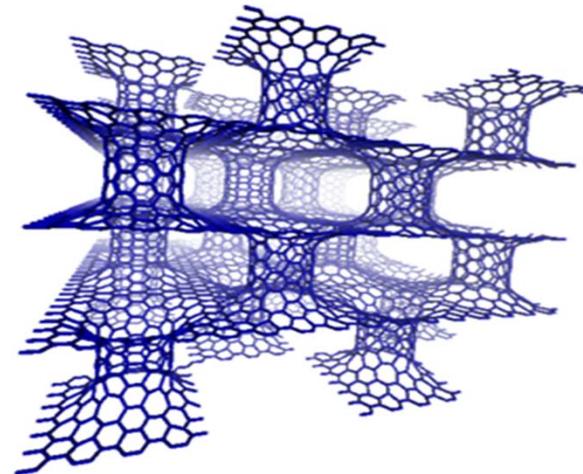




Complex Materials and Structures



- **Objective:** Future materials and structures that incorporate hierarchical design and functionality from the nanoscale through the mesoscale to effect functionality and/or performance characteristics to enhance the mission versatility of future air and space systems.
- **Critical Subjects Include:**
 - Materials with tunable properties
 - Adaptive morphing structures
 - Active materials with on-demand shape and phase change
 - Reconfigurable structures
- **Tech Horizons KTAs:**
 - **Nanomaterials**
 - **Directed Energy Protection**
 - **Light Weight Multi-functional Materials**
 - **Health Monitoring and Prognosis**



3D Pillared CNT/Graphene Nano Structure

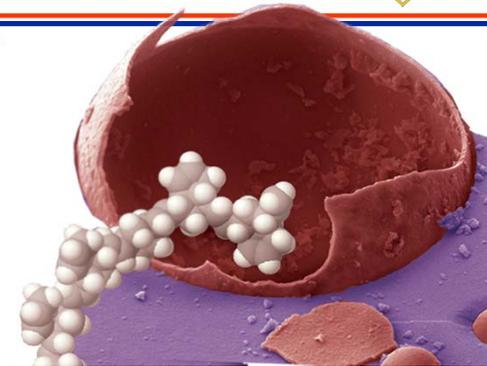
FY11	FY12	FY13	FY14	FY15	FY16	FY17
58.1	58.6	59.2	61.6	62.7	63.9	64.7



Complex Materials and Structures



- **Self-Healing Structures:** AFOSR led research has demonstrated the ability to engineer high efficiency self-healing polymeric composites. One result would be more durable & longer-lasting aircraft structures.
- **Morphing Aircraft Structures:** Establish “morphing” aerospace structures capable of altering their shape, functionality and mechanical properties for real-time conditions.
- **Nanotube Artificial Muscles:** Carbon nanotube artificial muscles can provide a hundred times the force generation capability of natural muscles and twice the rate capability.





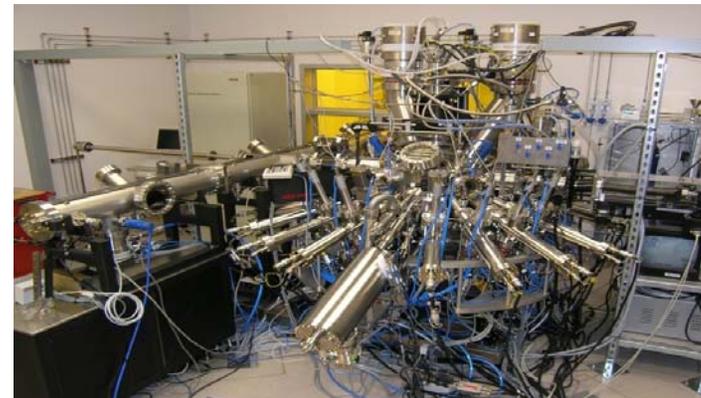
Complex Electronics and Fundamental Quantum Processes



- **Objective:** Pursue breakthroughs in information processing, secure communication, multi-modal sensing, computer memory, high speed communication and computing through exploration and understand of complex engineered materials and devices.

- **Critical Subjects Include:**

- Non-linear Optical Materials
- Optoelectronics and Nanophotonics
- Ultracold Atoms & Molecules
- Metamaterials & Graphene
- Dielectric and Magnetic Materials
- High Energy, Semiconductor and Ultrafast Lasers
- High temperature Superconductors
- Quantum Dots and Wells



Atomic-Layer Molecular Beam Epitaxy System

- **Tech Horizons KTAs:**
 - **Chip-scale Atomic Clocks**
 - **Laser Communications**
 - **Quantum Key Distribution**
 - **High Temperature Electronics**
 - **Signal Identification and Recognition**

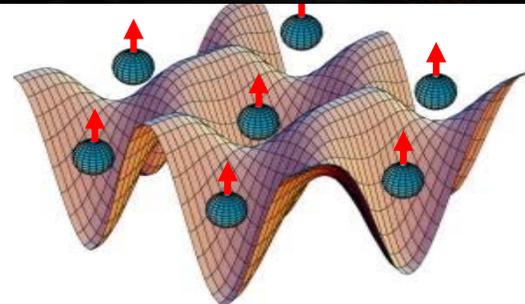
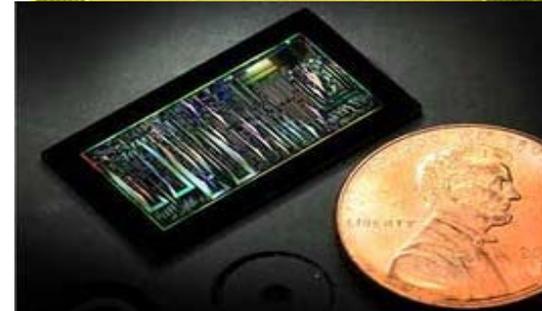
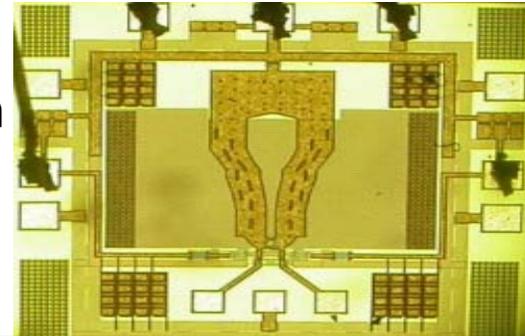
FY11	FY12	FY13	FY14	FY15	FY16	FY17
63.8	64.9	66.1	67.2	68.7	70.9	72.1



Complex Electronics and Fundamental Quantum Processes



- **Plasmonic Circuits:** New designs for passive components (inductor & resonator) in communication circuits and high-performance oscillators and tunable multi-spectral terahertz detector arrays.
- **Silicon Photonics:** Combining low-cost silicon chips with tiny lasers to send bits of data using light rather than pulses of electricity.
- **Ultracold Molecules:** Investigation of quantum computers or high-speed computers (>100 GHz clock speeds), which will improve crypto-analysis, microwave electronics and material sciences.

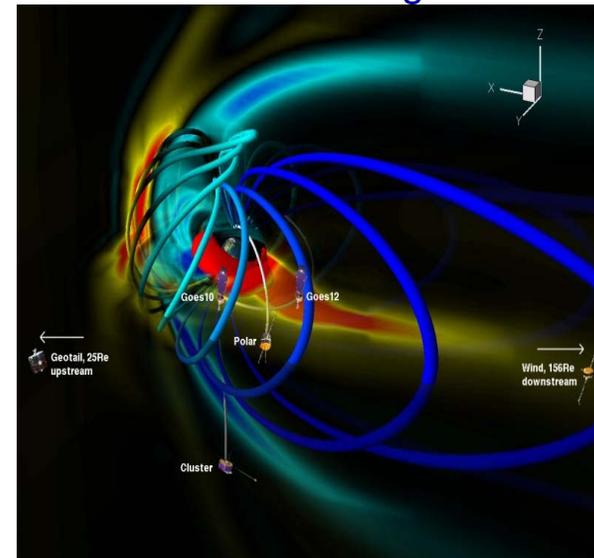




Plasmas and High Energy Density Nonequilibrium Processes



- **Objective:** Pursue understanding of fundamental plasma, non-linear electromagnetic phenomena, and the non-linear response of materials to high electric and magnetic fields.
- **Critical Subjects Include:**
 - Space weather
 - Plasma discharges & non-equilibrium chemistry/thermo
 - Plasma control of boundary layers in turbulent flow
 - RF propagation and RF-plasma interaction
 - High power beam-driven microwave devices
- **Tech Horizons KTAs:**
 - **Advanced RF Apertures**
 - **Directed Energy Effects**
 - **Radiation Hardened Electronics**
 - **High Power Microwaves**
 - **Orbital Environment Characterization**



The simulated heliosphere during the Halloween storms.

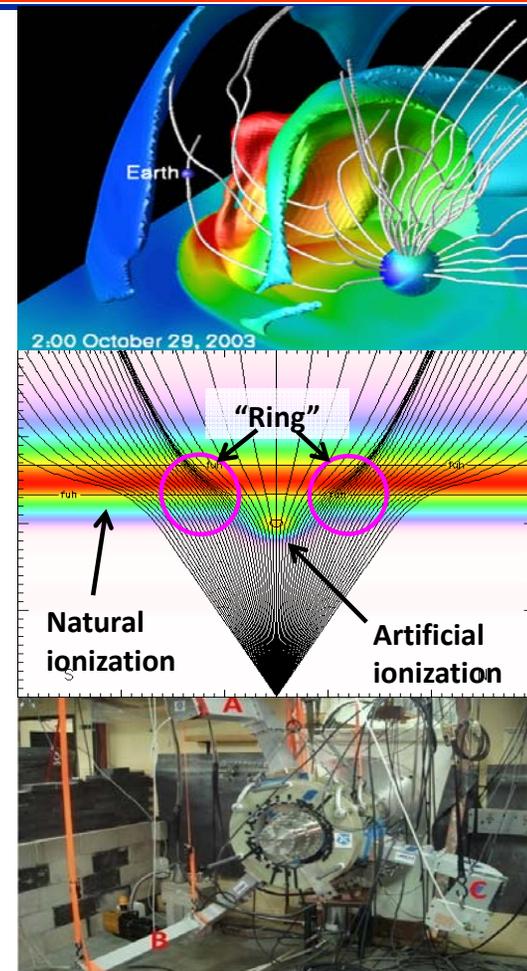
FY11	FY12	FY13	FY14	FY15	FY16	FY17
14.0	14.3	15.5	17.8	19.2	21.7	22.6



Plasma Physics & High Energy Density Non-Equilibrium Processes



- **Space Weather:** Important progress toward space weather forecast capability. Enables early warning to protect space assets. Minimize radio communications disruptions because of the effects on the ionosphere.
- **Artificial Ionization Layers:** The effect of energy input into ionosphere is researched at HAARP ionospheric heater in Alaska. The HF radiation to heat the ionosphere generated artificial layers.
- **Relativistic Magnetron:** To develop more compact magnetrons that operate at higher power and higher frequencies and those could be used to jam and defeat enemy electronics.

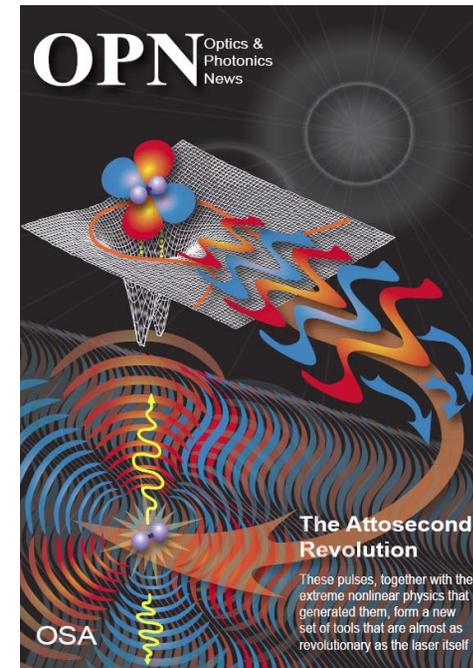




Optics, Electromagnetics, Communication, & Signal Processing



- **Objective:** Pursue understanding of complex electro-magnetic and electro-optical signals impacting space object imaging, secure reliable communication, on-demand sensing modalities, distributed multilayered sensing, automatic target recognition, and navigation.
- **Critical Subjects Include:**
 - Adaptive Optics and Optical Imaging
 - Laser Phenomenology
 - Precision Navigation and Timing
 - Sophisticated mathematics and algorithm development for extracting information from complex and/or sparse signals
- **Tech Horizons KTAs:**
 - **Secure RF Links**
 - **Semiconductor Lasers**
 - **Dynamic Spectrum Access**
 - **Integrated Sensing and Processing**
 - **Cold Atom Inertial Navigation System**



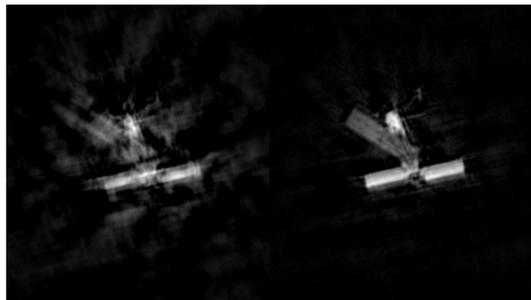
FY11	FY12	FY13	FY14	FY15	FY16	FY17
29.7	30.8	31.9	33.1	35.2	36.5	37.1



Optics, Electromagnetics, Communication & Signal Processing



- **Ghost Imaging:** A new phenomenon where the imaging system does not receive any light directly from the object, but rather from the illumination source
- **Aero-Optics:** Discovered relationship between spatial and temporal frequencies of distorted wavefront for a laser propagating through turbulent, variable-index flows.
- **Satellite Ground Observation:** Extraction of resolved images from fusion of optical images to aid in identification of objects in orbit.





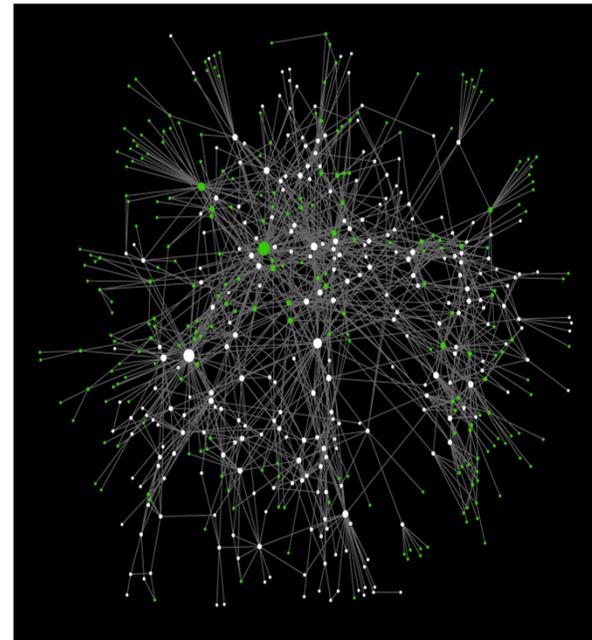
Information and Complex Networks



- **Objective:** Reliable and secure exchange of information and predictable operation of networks and systems.

- **Critical Subjects Include:**

- System and network performance prediction, design and analysis
- Predict and manage network failure comprehensively
- Information operations and security
- Integration of models of computation and cognition for the specification and design of complex human-machine systems



Network Map

- **Tech Horizons KTAs:**

- **Agile Networks**
- **Quantum Computing**
- **Complex Adaptive Systems**
- **Virtual Machine Architecture**
- **Information Fusion and Understanding**

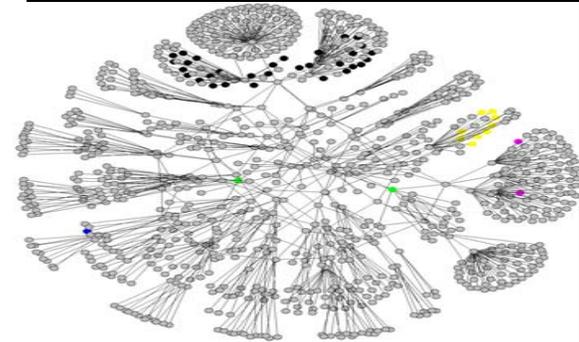
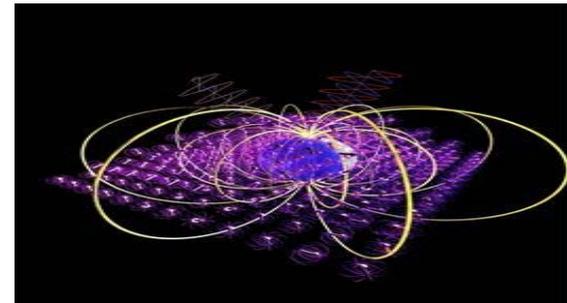
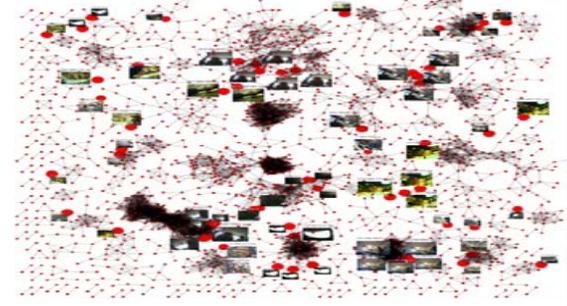
FY11	FY12	FY13	FY14	FY15	FY16	FY17
27.5	29.2	30.9	32.6	34.9	37.6	38.2



Information and Complex Networks



- **Dynamic Information System Verification:** Develop new mathematical algorithms for real time measurement, risk analysis, and statistical verification of large systems.
- **Enable New Information Architectures :** Develop mathematical measurement and estimation strategies to enable next generation of quantum network and computing semiconductors.
- **Guarantee Mission Critical Information Transaction:** Mathematical guarantees of performance for protocol, policy, and security using new coding, management, and online analysis methods.

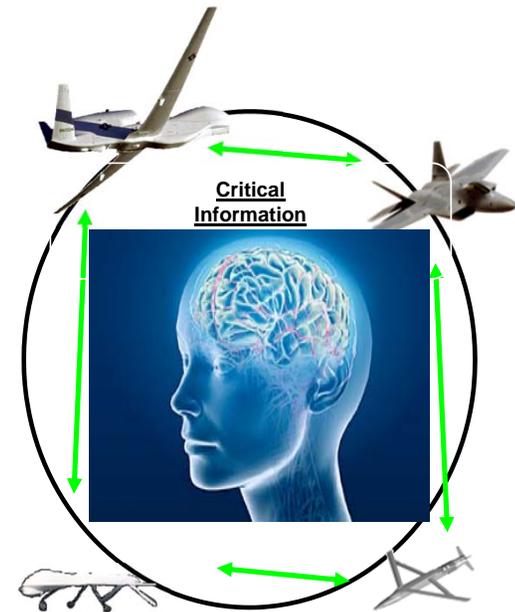




Decision Making



- Objective: Discovery of mathematical laws, foundational scientific principles, and new, reliable and robust algorithms, which underlie intelligent, mixed human-machine decision making.
- Critical Subjects Include:
 - Robust human-machine decision making
 - Socio-cultural modeling
 - Mathematical analysis and models of individual human cognition and collective behavior
- Tech Horizons KTAs:
 - Cognitive Modeling
 - Human-machine Interfaces
 - Autonomous Reasoning and Learning
 - Collaborative and Cooperative Control
 - Social, Cultural, Human Behavior Modeling



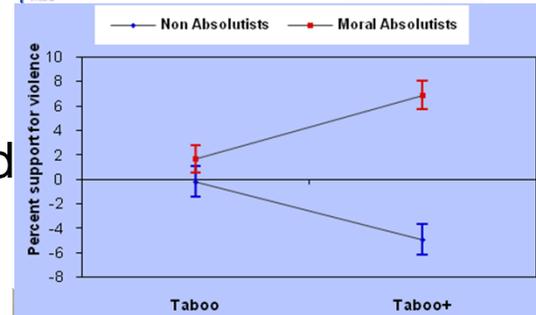
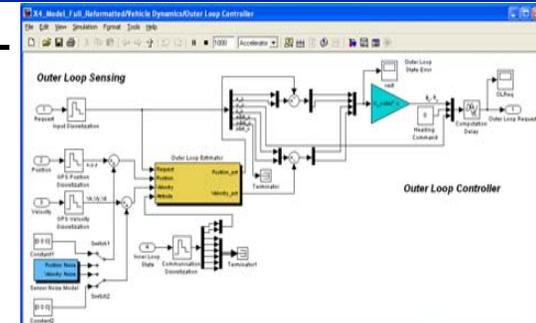
FY11	FY12	FY13	FY14	FY15	FY16	FY17
13.7	14.6	15.5	16.4	18.5	19.3	19.7



Decision Making



- **C2 Wind Tunnel:** Model integration uses meta-modeling - “model of the model” allows for creating model templates, allows for easier integration of diverse models. Successful demonstration at HQ 8AF of C2WT integrated with adversary modeling.
- **Sacred Values:** Adversarial reasoning about hypothetical peace agreement involving sacred values. Resistance to tradeoffs between the sacred and the secular.
- **Capturing Black Swans:** Develop new tools in probability and statistics for ranking risks, realistic prioritization to catastrophic events, making decisions under unpredictable conditions preceding an event.



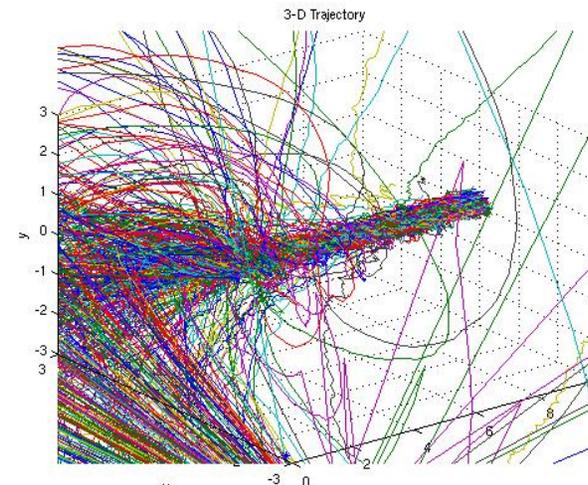
Axiom 1: $W : L_{\infty} \rightarrow R$ is linear and continuous.
 Axiom 2: $W : L_{\infty} \rightarrow R$ is sensitive to frequent events.
 Axiom 3: $W : L_{\infty} \rightarrow R$ is sensitive to rare events.



Dynamical Systems, Optimization, and Control



- **Objective:** To provide advances in in the science of autonomy including adaptive control for coordinating heterogeneous autonomous or semi-autonomous aerospace vehicles in uncertain, information rich, dynamically changing, adversarial, and networked environments.
- **Critical Subjects Include:**
 - Embedded optimization
 - Dynamical systems theory
 - Reliable scalable algorithms
 - Computational and discrete mathematics
 - Management of the effects of uncertainties
 - Robust adaptive control of complex systems
- **Tech Horizons KTAs:**
 - **Massive Analytics**
 - **Resilient Autonomy**
 - **Complex System Dynamics**
 - **Autonomous Mission Planning**
 - **Coupled Multi-Physics Simulations**



Simulation: 400 agents[†] converge to equilibrium under the Adaptive NCE Control Law

FY11	FY12	FY13	FY14	FY15	FY16	FY17
37.2	39.7	42.0	44.6	47.4	50.3	52.2

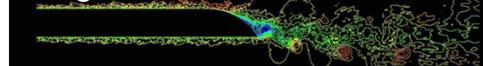


Dynamical Systems, Optimization, and Control

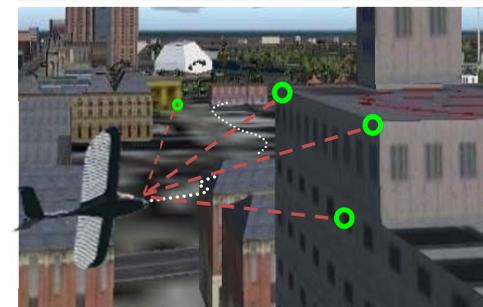
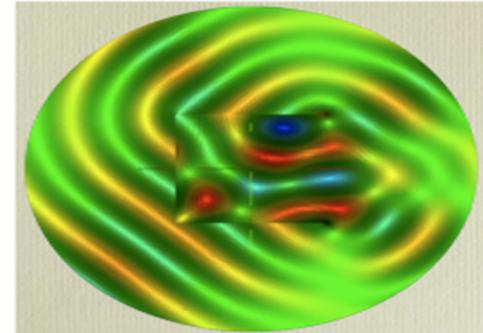
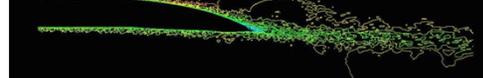


- **Meta Algorithms for Engineering Design:** Developed the MADS (Mesh Adaptive Direct Search) algorithm for solving challenging non-smooth optimization problems with 37% reduction in solution times.
- **Reduced Order Modeling for Wave Problems:** The potential for significant reductions in the required computational effort to solve the data-dome problem for general problems by using a reduced basis technique.
- **Vision-Based Control:** Developing vision-based guidance, navigation, and control algorithms for micro air vehicles (MAVs) to operate autonomously in urban environments.

Original airfoil



Optimized airfoil, 89% noise reduction

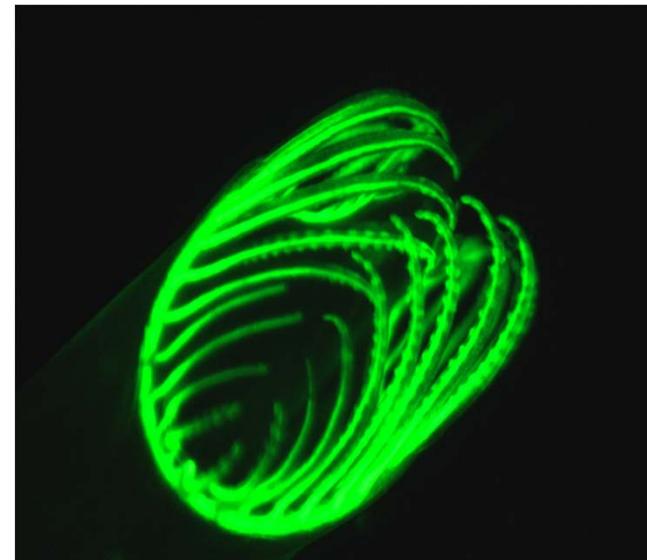




Natural Materials and Systems



- **Objective:** Studying, using, mimicking, or altering the novel ways that natural systems build exquisite materials and sensors that often outperform manmade versions and perform under extreme conditions.
- **Critical Subjects Include:**
 - Biomimetics of materials and flight
 - Sensors
 - Interfaces
 - Extremophiles
 - Bioenergy
- **Tech Horizons KTAs:**
 - **Alternative Fuels**
 - **Self-Healing Materials**
 - **RF and Electronic Materials**
 - **Optical and Infrared Materials**
 - **Advanced Light Weight Materials**



bfoGFP, a new family of fluorescent proteins from lancelet cephalochordate amphioxus

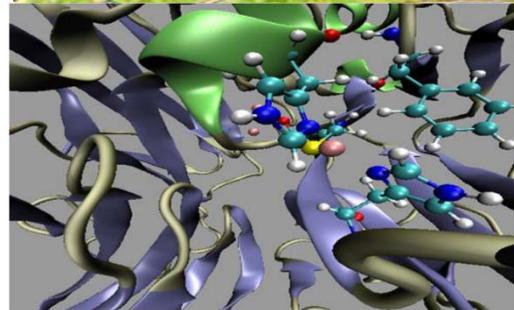
FY11	FY12	FY13	FY14	FY15	FY16	FY17
19.7	20.9	22.1	23.5	25.7	27.2	27.9



Natural Materials and Systems



- **Spider Silk Research:** Researchers have been created artificial spider silk that is stronger, flexible, and biodegradable. Silk has unusual mechanical & optical properties for thin film devices or to improve body armor.
- **Biofuels Research:** Investigating ways to produce large quantities of hydrogen gas using photosynthetic microbes, commonly known as algae and cyanobacteria.
- **Artificial Photosynthesis:** Discovered new method to split and store hydrogen and oxygen using solar energy. New method is cheap, efficient and easy to manufacture.





Innovation's Stealth Utility, Basic Research



Joint Precision Air Drop System

- **Warfighter Capability**
 - Using GPS and electro-mechanical steering actuators allows cargo bundles dropped from cargo planes to steer themselves to drop zones
 - JPADS able to airdrop up to 60,000 pounds of cargo

- **Enabling S&T**
 - AFOSR worked winds calculations, the on-board computational algorithms, and the GPS-guided controlled parafoil technologies
 - Natick provided system integration



In 1999, AFOSR joined with the U.S. Army to leverage efforts to improve precision air delivery capability and provided program funding.

Transition path



Other DoD organizations frequent transition partners



Innovation's Stealth Utility, Basic Research



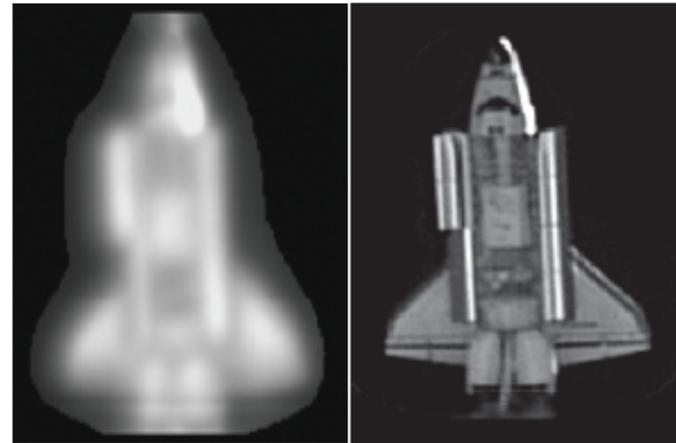
Image Enhancement for Space Situational Awareness

- **Warfighter Capability**

- Iterative image restoration algorithm estimates and removes atmospheric and system blurring from one or more frames of blurred imaged data to produce a single high-resolution picture.

- **Enabling S&T**

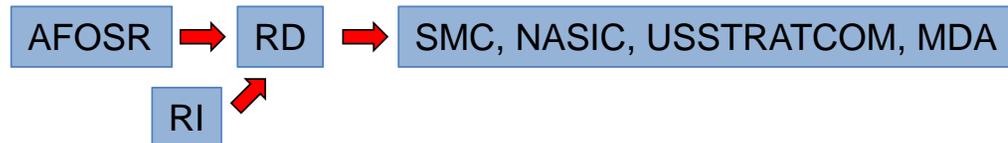
- Physically Constrained Iterative Deconvolution extracts most relevant information from multiple images by removing atmospheric and system blurring to produce a single high-resolution image.
- Optimized source code produced 30X speed-up



Raw data collected using an AMOS telescope

Physically Constrained Iterative De-convolution (PCID) Image

- **Transition path**



Same capability may benefit multiple customers



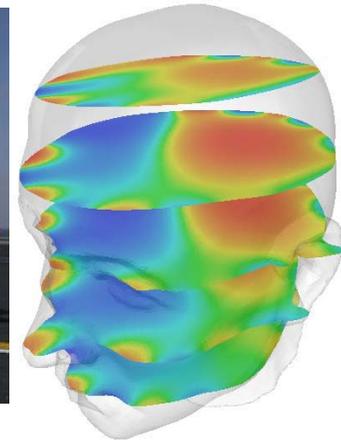
Innovation's Stealth Utility, Basic Research



Noise Attenuation (Achieved 50 dB Attenuation Goal of DTO HS-33)

• Warfighter Capability

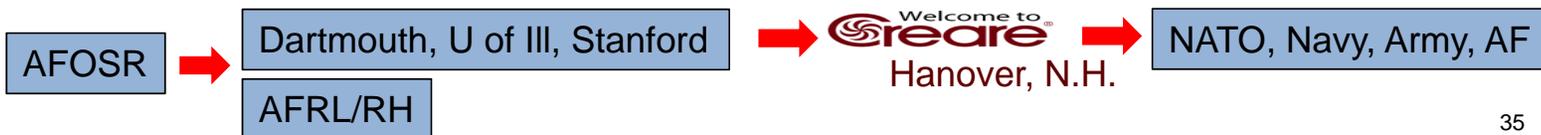
- Protect flight line operators and warfighters from noise induced hearing loss, fatigue and decrease errors associated with fatigue due to noise and vibrations.



• Enabling S&T

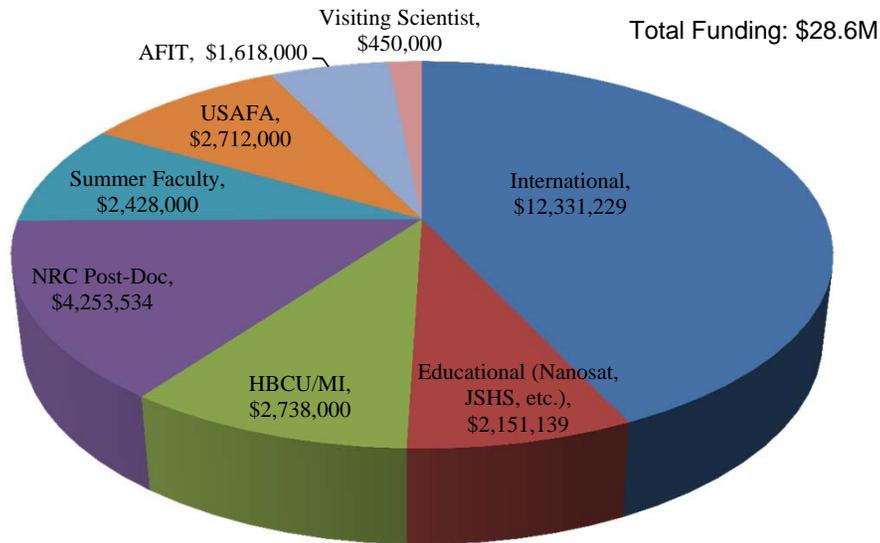
- Developed head and neck simulator that enabled attenuation of noise levels without exposure to human subjects. Coordinated STTR, 6.1, 6.2 efforts

- Developed a physiologically realistic, instrumented human head simulator
- Measured and model dynamics of middle ear transduction
- Developed new techniques for noise cancellation (active and passive)
- Instrumented Head Simulator enabled acoustic tests without risk to human listeners





Education and Outreach PE 61102F/61103F



ASSURE site at Fort Johnson, NY



USA Science & Engineering Festival, DC 2010

PE 61103F (NDSEG & ASSURE Total: \$45.6M)

- **National Defense Science and Engineering Graduate Fellowship (NDSEG) Program:** Supporting 590 PhD-track graduate students in DoD relevant fields
- **Awards to Stimulate and Support Undergraduate Research Experience (ASSURE):** Provides 550 undergraduates with research opportunities in S&E fields of DoD interest during summer months



AFOSR Supports University Individual Investigators



- **Goals**

- Provide revolutionary scientific breakthroughs to maintain military air, space, and information superiority
- Build collaborations between AFRL and universities

- **General Submission Process**

- Researchers submit white papers to AFOSR program managers
- Promising white papers lead to request for full proposals
- Proposals merit reviewed for *excellence* and *relevance*
- Individual grants awarded for up to 5-years in duration

- **Broad Agency Announcement (BAA) open at all times to innovative ideas <http://www.afosr.af.mil>**



Multidisciplinary University Research Initiative (MURI)



- **Achieve significant scientific advances**
 - Capture attention of top researchers
 - Build on results of individual-researcher grants
 - Encourage multidisciplinary collaboration
- **Up to \$1.5M/yr for five years**
- **Typically 8-10 research topics per Service**
 - Occasional joint topics
 - One or two awards per topic
- **Currently there are 61 AFOSR MURI Projects (FY05-09)**
 - 10 new projects in FY10



AFOSR Supports Tomorrow's S&Es for the Air Force



- **Presidential Early Career Award for Scientists & Engineers (PECASE)**

- Recognizes outstanding young researcher
- 5-year awards \$200K/year

- **Young Investigator Program (YIP)**

- Develops long-term relationships with junior PIs
- 127 awards since FY07; 43 awards planned in FY11



- **National Defense Science and Engineering Graduate Fellowship (NDSEG) Program**

- Supporting 590 PhD-track graduate students in DoD relevant fields

- **Awards to Stimulate and Support Undergraduate Research Experience (ASSURE)**

- Provides 550 undergraduates with research opportunities in S&E fields of DoD interest during summer months



AFOSR Supports Tomorrow's S&Es for the Air Force



- **NRC Resident Research Associates (Post-Doc Program)**
 - Offers postdoctoral and senior S&E opportunities to perform research at sponsoring TDs (50 Associates in the program)
- **Summer Faculty Fellowship Program (SFFP)**
 - Offers fellowships to faculty and students to conduct research at AFRL in the summer (96 Faculty & 22 Grad Students)
- **Defense University Research Instrumentation Program (DURIP)**
 - Provides specialized research equipment to U.S. universities
 - 48 awarded in FY10, median award \$200K
- **Small Business Technology Transfer (STTR) Program**
 - Provides up to \$850,000 for early-stage R&D directly to small companies working cooperatively with research institutions
 - FY10 : 112 Phase I & 41 Phase II projects ; \$40.2M total funds



National Security Science and Engineering Faculty Fellowships



NSSEFF
 NATIONAL SECURITY
 SCIENCE & ENGINEERING
 FACULTY FELLOWS
 PART OF THE NATIONAL DEFENSE
 EDUCATION PROGRAM

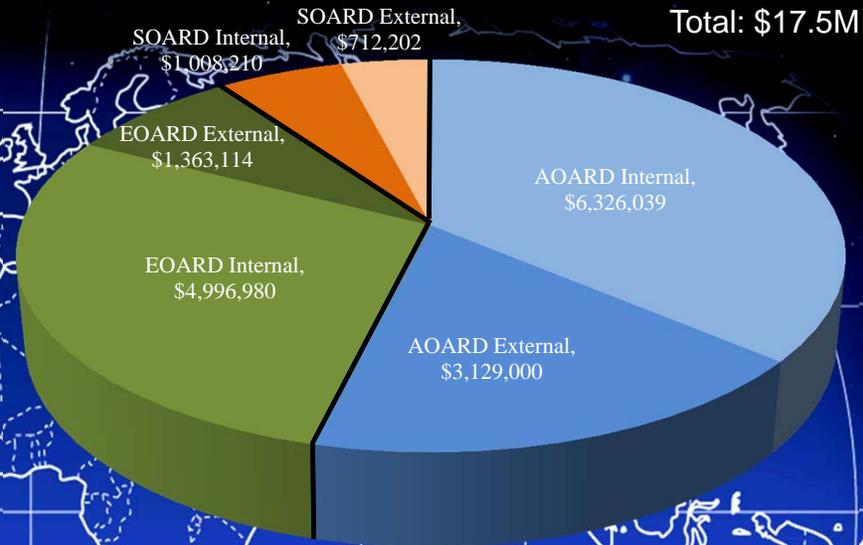
- DDR&E program, managed by AFOSR
- Objectives
 - Excellent unclassified basic research on topics of interest to DoD
 - Long-term relationships with outstanding faculty and students
 - Familiarity with DoD missions, technologies, and challenges
 - Cadre of technical experts for DoD advisory groups
- Award Information (Eleven awards in FY10)
 - Single-investigator awards up to \$850K/yr for up to 5 years
 - Open to faculty at US doctoral degree-granting institutions
 - US citizens and permanent residents are eligible to apply
- Application process (more info at <http://nsseff.ida.org/>)
 - Letter of intent to nominate from home institution
 - Formal nomination letter and white paper
 - Full proposal and oral presentation (by invitation only)



AFOSR International Enterprise



- **Building international goodwill**
- **Strengthening partnerships**
- **Avoiding technological surprise**
- **Accelerating S&T achievements and transitions to the US**



AOARD
ASIAN OFFICE OF AEROSPACE
RESEARCH AND DEVELOPMENT
Tokyo

EOARD
EUROPEAN OFFICE OF AEROSPACE
RESEARCH AND DEVELOPMENT
London

SOARD
SOUTHERN OFFICE OF AEROSPACE
RESEARCH AND DEVELOPMENT
Santiago

The Sun Never Sets on AFOSR



International Research Achievements



- **Agent-Based Computing in Distributed Adversarial Planning: Czech Tech Univ (EOARD)**

A decision-making process through which an agent constructs a sequence of actions (possibly consisting of a single action only) leading to the desirable goal state of the world in an adversarial situation.

- **Biomimetic Silicon Nanostructure: National Taiwan University, (AOARD)**

Created nanostructure (nanotip) surfaces which mimic moth eye and surpass its function in anti-reflection in that they absorb almost all incident light.

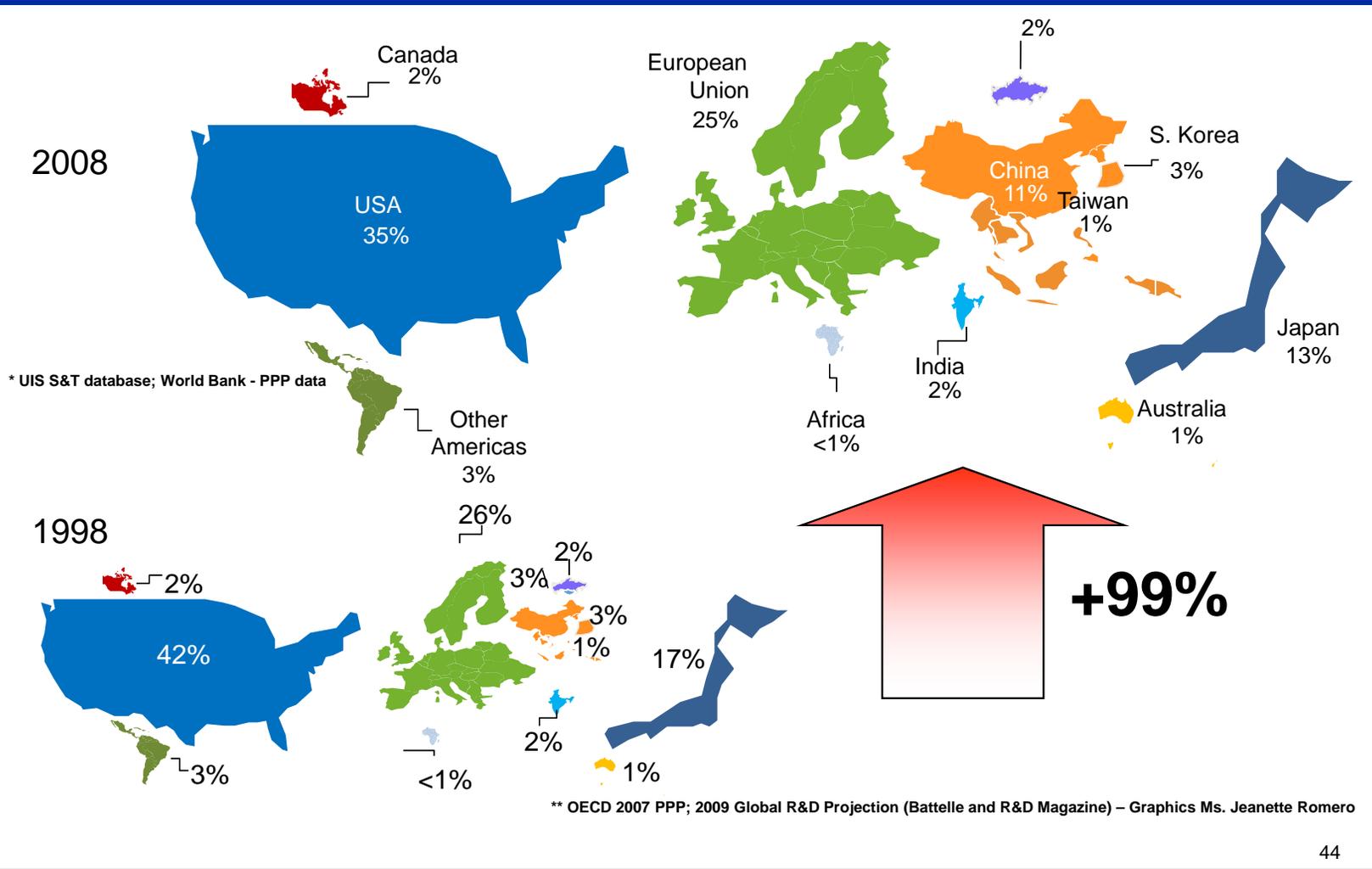
- **Laser-Induced Air Breakdown in Hypersonic Flow: Sao Jose dos Campos, Brazil (SOARD)**

Experimental study of hypersonic flow. Gearing up collaboration with Australian hypersonic project HIFIRE .





THREAT: US share of global R&D investment steadily decreasing (1998* to 2008**)





Summary



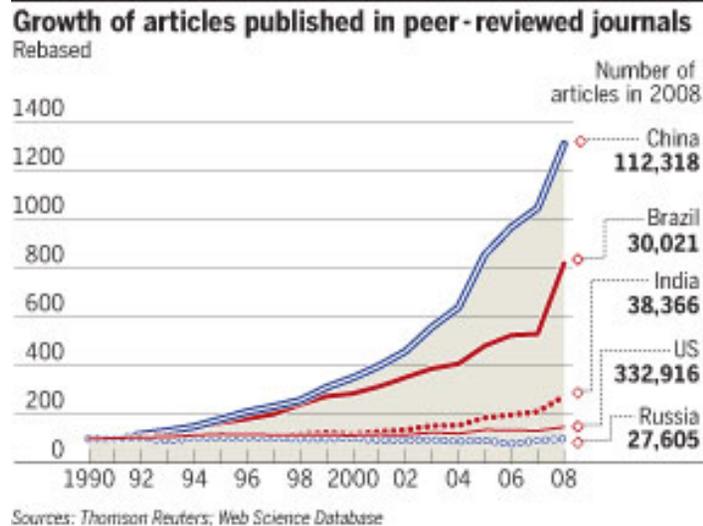
AFOSR continues to *discover, shape, and champion basic science that profoundly impacts the future Air Force*

- **Supporting world-class basic research**
- **Educating tomorrow's scientific leaders**
- **Providing meaningful transitions now**
- **Filling pipeline for future transitions**
- **Enhance mutual understanding of AFOSR and other organizations missions, roles, programs, priorities**
- **Ensure current investments are fully coordinated and opportunities for leveraging are exploited**

"There are those who say we can't afford to invest in science, that it's a luxury at a moment defined by necessities. I could not disagree more. Science is more essential for our prosperity, our security, and our health, and our way of life than it has ever been." – President Obama



China's Growth in S&T



China's "awe-inspiring" growth had put it in second place to the US – and if it continues on its trajectory it will be the largest producer of scientific knowledge by 2020. - Jonathan Adams, Thomson Reuters

- China has experienced the strongest growth in scientific research over the past three decades of any country
- China, India & Russia - research strengths tend to be in the physical sciences, chemistry and engineering
- Brazil – strength in life sciences, agriculture and environmental research, especially in biofuels research

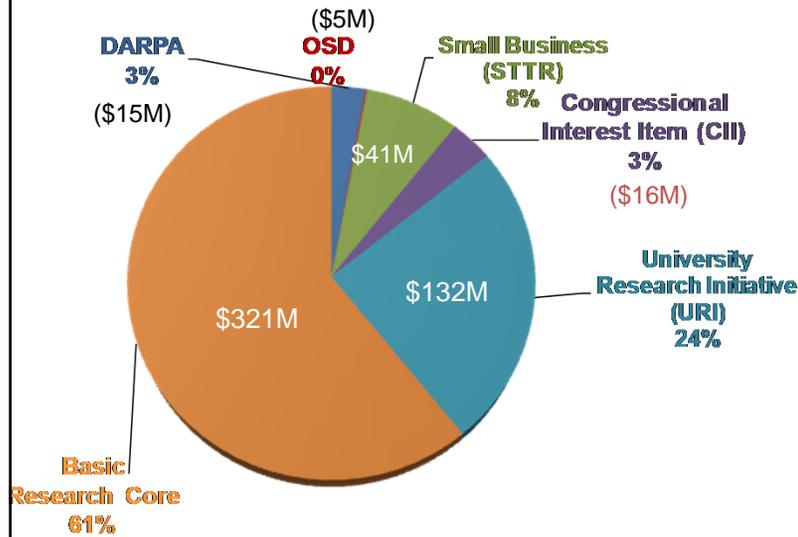


AFOSR FY10 Budget

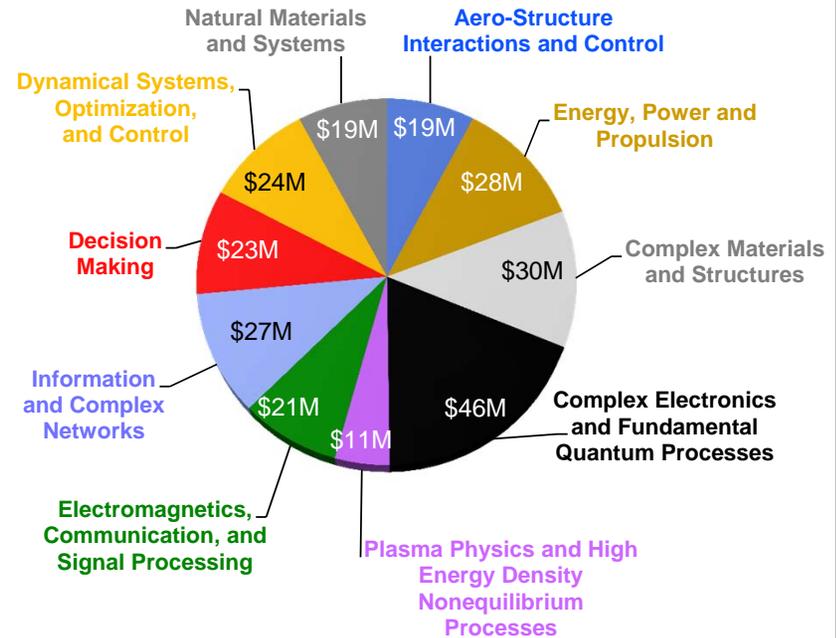


	FY05	FY06	FY07	FY08	FY09	FY10
PE61102F Core	\$217M	\$224M	\$250M	\$258M	\$310M	\$321M
PE61103F URI	\$116M	\$105M	\$108M	\$104M	\$126M	\$132M

President's Budget



Total Budget: \$528M



Research Focus Areas