Air Force Office of Scientific Research

AFOSR Overview

Oct 03

The Basic Research Manager for the Air Force

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AFOSR MISSION

AFOSR Orchestrates the Air Force Basic Research Program with Universities, Industry, Other Government Organizations, and the AFRL Technical Directorates (TDs)

Creating Revolutionary Scientific Breakthroughs for the Air Force

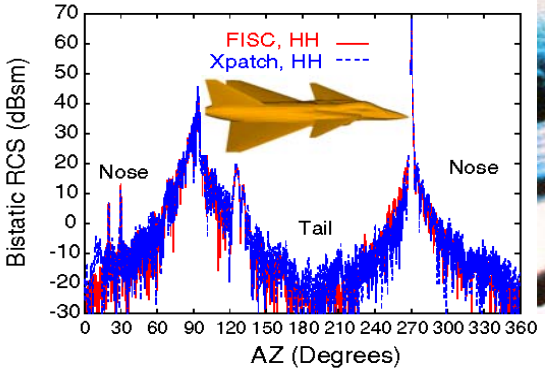
AFOSR

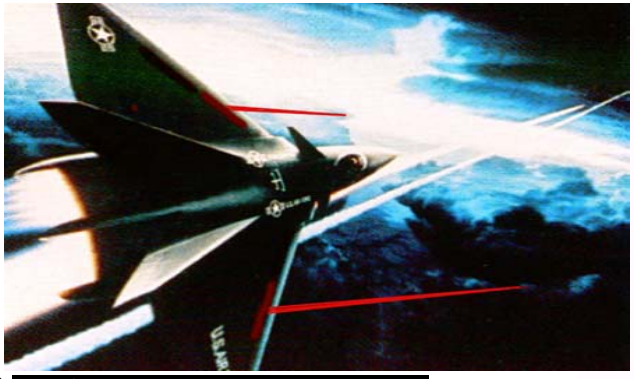
Organization

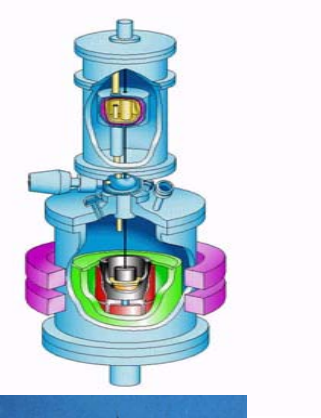
Investment Portfolio

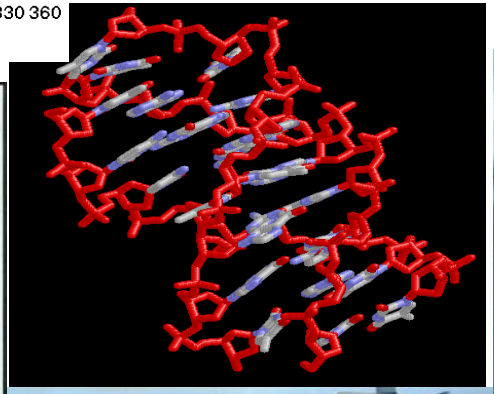
How we measure success

High Priority Areas / AF Long Term Challenges

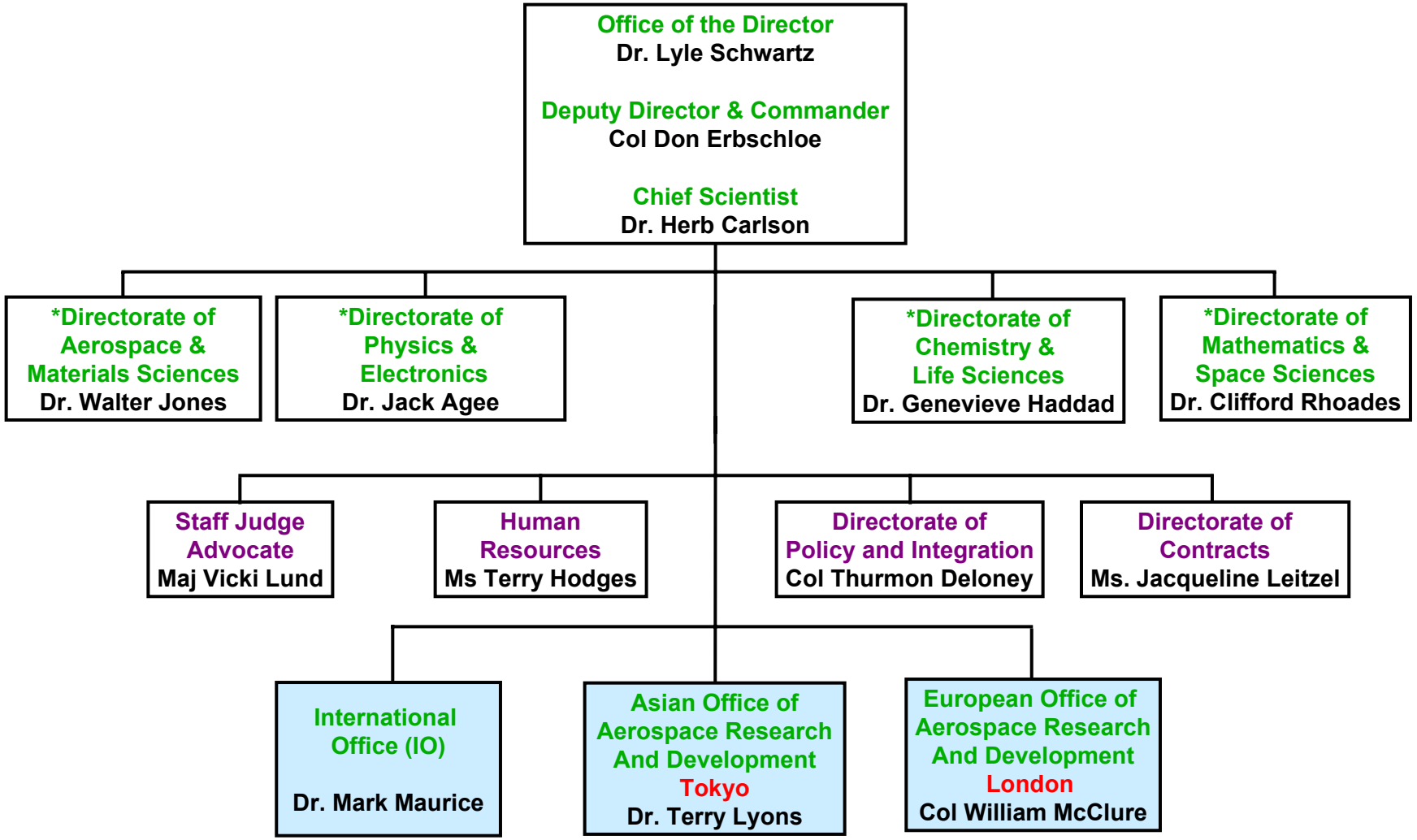








AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

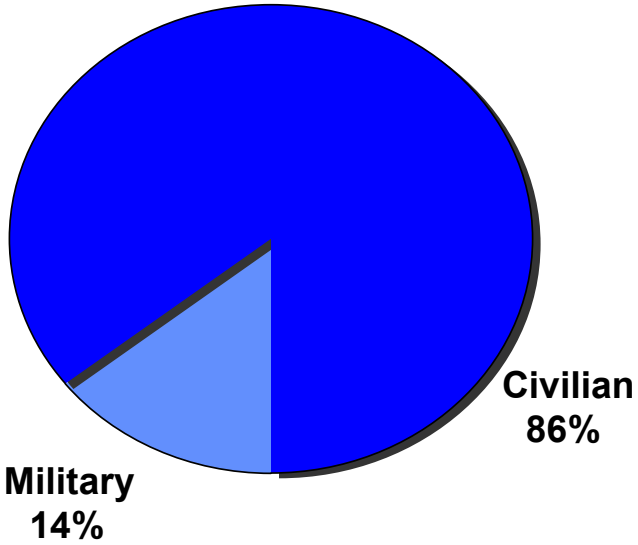


All Science Directorate Program Managers have PhDs

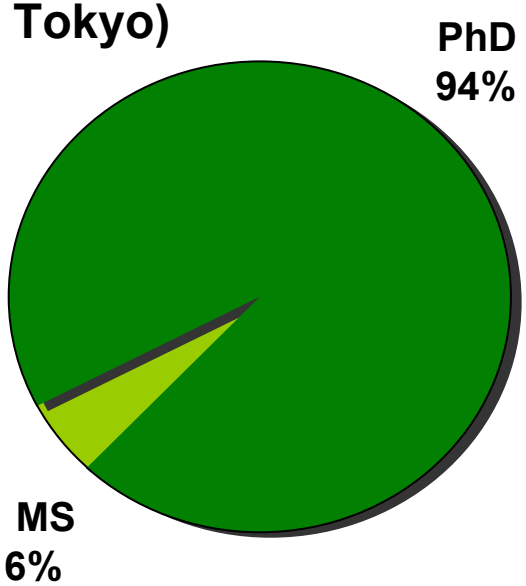
AFOSR
Personnel

Government - Civilian	111
IPAs	10
Government – Military	29
On-Site Contractors	60
Total	210

(Includes Offices in London, Tokyo)



AFOSR Personnel (210)



S&E (64)

As of July 03

AFOSR

Organization

Investment Portfolio

How we measure success

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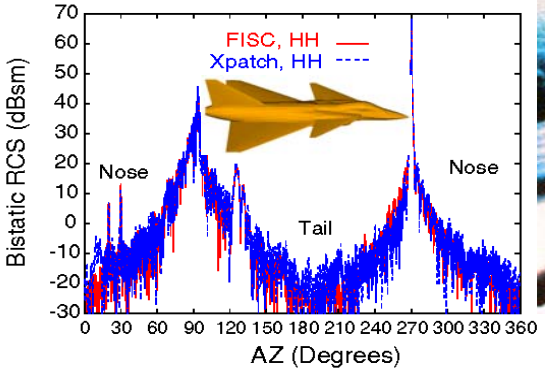
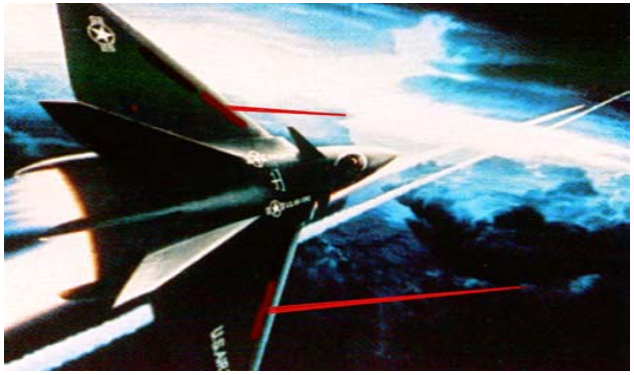
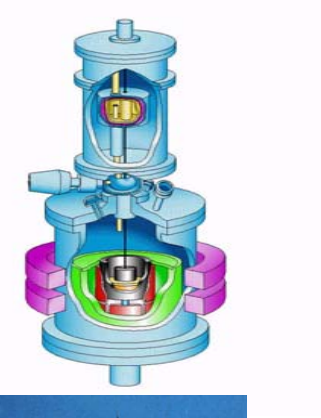
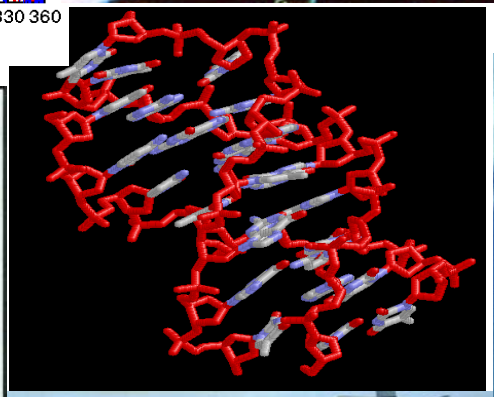
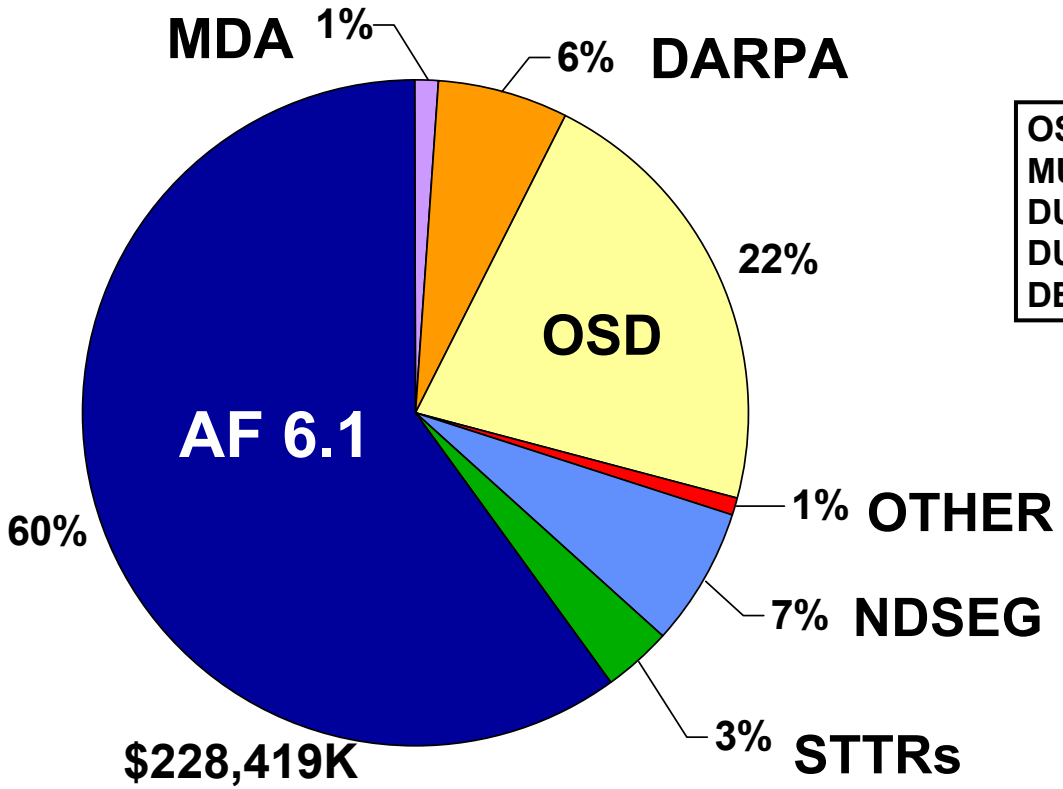








AFOSR
FY02 6.1 Funding Sources



OSD includes:
MURI
DURINT
DURIP
DEPSCOR

FY02 Appropriated: **$228,419K**

FY02 External Funding: **$191,572K**

Total AFOSR FY02: **$419,991K**

FY03 Appropriated: **$223,744K**

* Special Topic on Other Funds, 27 Aug 0830

AFOSR Funding Profile
(FY02)

~ 5000 Researchers

AFOSR Ballston

Air Force 6.1 Funding

$228 M

30%

AFRL Technology Directorates
219 Projects

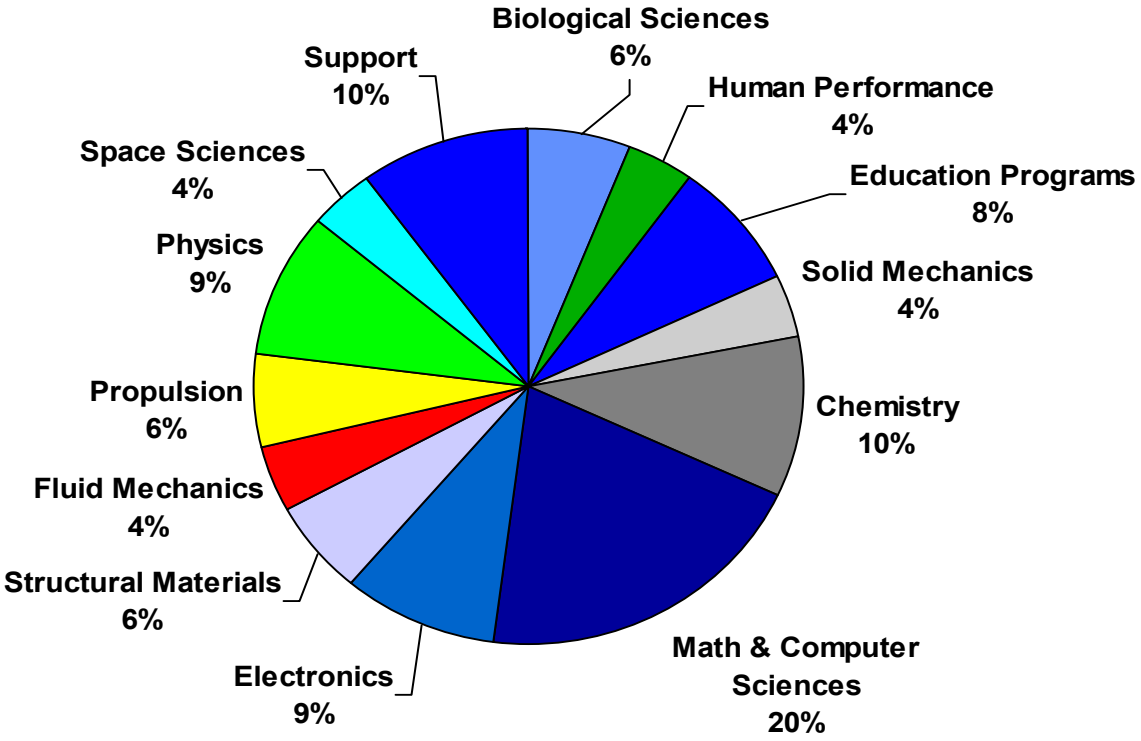
60%

191 Universities
1064 Grants

10%

Industry
181 Contracts

FY02 AFOSR 6.1 INVESTMENT BY DISCIPLINE

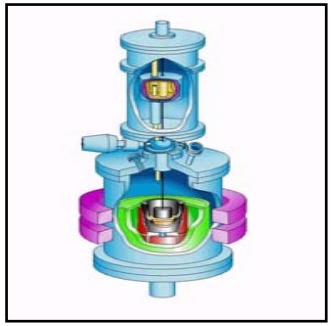


OFFICE OF SCIENTIFIC RESEARCH

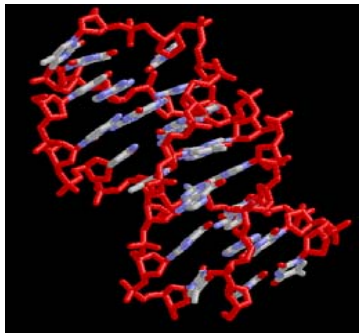
Technology Thrusts

Aerospace and Materials Sciences

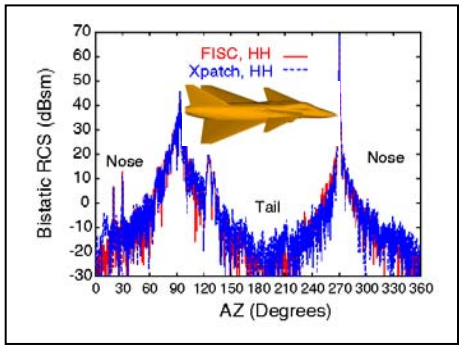
Physics and Electronics



Chemistry and Life Sciences



Mathematics and Space Sciences



Sub-thrusts

- Solid Mechanics and Structures
- Materials
- Fluid Mechanics
- Propulsion

- Physics
- Electronics

- Chemistry
- Bio Sciences
- Human Performance

- Mathematics
- Computer Sciences
- Space Sciences

Basic Research & Enabling Technologies

AEROSPACE AND MATERIALS SCIENCE

Technologies	Capability/Payoff
• High Cycle Fatigue	• Reduce engine fatigue
• Mechanics of Materials/Devices	• Extend Aerospace Vehicle Life
• Structural Mechanics	• Reduce aerospace vehicle weight and provide multifunctional space structures
• Metallic Materials	• Increase engine thrust to weight ratio
• Ceramic and Non-Metallic Materials	• Increase temperature limit and reduce weight
• Polymer Matrix Composites	• Expand flight envelope and enhance maneuverability
• Unsteady Aerodynamics and Hypersonics	• Reduce hypersonic drag
• Turbulence and Rotating Flows	• Improve engine performance & durability
• Space Power and Propulsion	• Provide low cost, more flexible space access
• Combustion and Diagnostics	• Streamline aircraft and rocket propulsion system design

PHYSICS AND ELECTRONICS

Technologies	Capability/Payoff
• Lasers and Optical Physics	• Processing speeds orders of magnitude faster than today
• Atomic and Molecular Physics	• Recovery of images through atmospheric turbulence
• Plasma Physics	• Greater radiation tolerance
• Space Electronics, Sensors and Propulsion	• 1000 times improvement in data storage
• Optoelectronic Information Processing	• Expanded transmission bandwidth
• Semiconductor Materials	• Real-time adaptive signal and image processing
• High Power Microwaves	• Electronic warfare and non-lethal effects

CHEMISTRY AND LIFE SCIENCES

Technologies	Capability/Payoff
• All-Nitrogen Propellants	• Energetic materials for propellants and explosives
• Theoretical Chemistry	• Ten times more powerful chemical lasers
• Polymer Chemistry •Adaptive Bio-Materials	• New class of highly functional light weight polymeric materials
• Biomimetic Interfaces	• Biomimetically enhanced sensors
•Bio-Response Profiling	• Safer new fuels, materials, lasers and non-lethal weapons
• Chronobiology and Neural Adaptation	• Strategies to reduce fatigue
• Complex Decision Modeling	• Faster, more accurate C2 performance
• Switchable, Tunable Optical Filters	• More efficient individual/team training
	• Prediction of adversary behavior
	• Versatile laser protection

MATHEMATICS AND SPACE SCIENCES

Technologies	Capability/Payoff
• Dynamics and Control	• Modeling of complex problems and systems
• Physical Mathematics and Applied Analysis	• Control of vibrations and shape of space structures
• Computational Mathematics	• Better vehicle performance and control
• Optimization and Discrete Mathematics	• New methods for target acquisition and recognition
• Systems, Software, and Reliability	• Detection avoidance
• Artificial Intelligence	• Timely management of information
• Space and Solar Physics	• Improved forecasting of the solar and space environment
• Electromagnetics	• Protect & enhance aerospace systems
• Multi-Spectral Imaging	• ID Targets Under Trees
• Upper Atmosphere Laser Beam Propagation	• ABL targeting through turbulence
• Information Fusion	• Command & control decision making

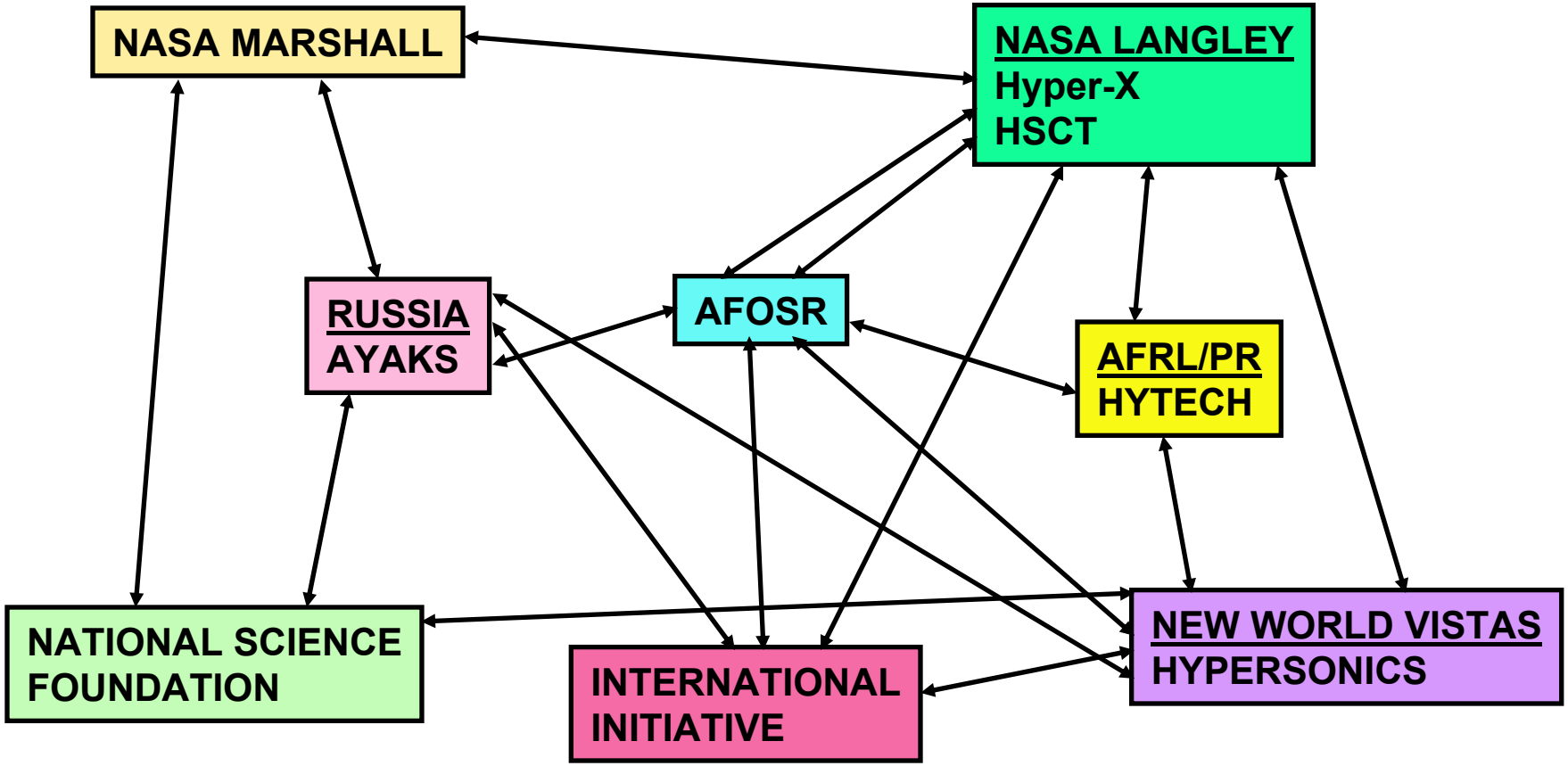
PARTNERSHIP STRATEGY

- **Building Partnerships with Excellence and Relevance**
  Enabled by Program Manager Authority
  - Between Several Disciplines -- fosters Innovation
  - Many Performers -- fosters Success & Quality
  - Between Users And Performers -- fosters Relevance
  - All Proposals -- Merit Reviewed

- **Open-ended Broad Area Agency Announcement (BAA)**
  - Open At All Times To Good Ideas
  - Program Managers Provide Focus

HIGH SPEED PROPULSION

INTER AGENCY COORDINATION



AFOSR INVESTMENT SUPPORTS THE AFRL TDS

	VA	DE	HE	IF	ML	MN	SN	PR	VS
AEROSPACE & MATERIALS SCIENCES									
Solid Mechanics	■	■			■	■		■	■
Materials	■				■	■		■	■
Fluid Mechanics	■	■			■			■	■
Propulsion		■			■	■		■	■
PHYSICS & ELECTRONICS									
Physics		■			■	■	■	■	■
Electronics		■			■		■	■	■
CHEMISTRY & LIFE SCIENCES									
Chemistry		■			■	■	■	■	■
Biological Sciences	■		■		■	■	■	■	
Human Performance			■			■		■	
MATHEMATICS & SPACE SCIENCES									
Math and Computer Sci.	■	■	■	■	■	■	■		■
Space Sciences		■		■					■
External Programs	■	■	■	■	■	■	■	■	■

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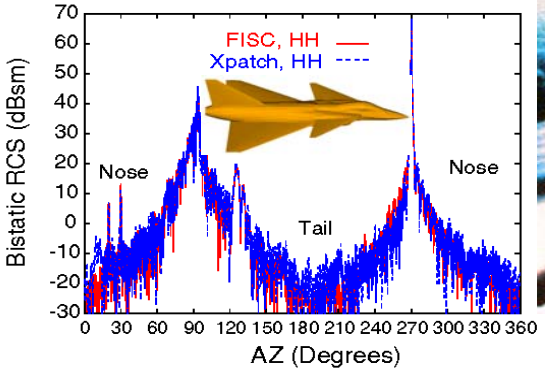
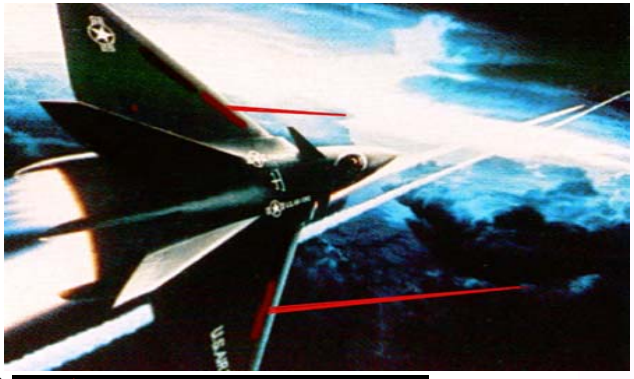
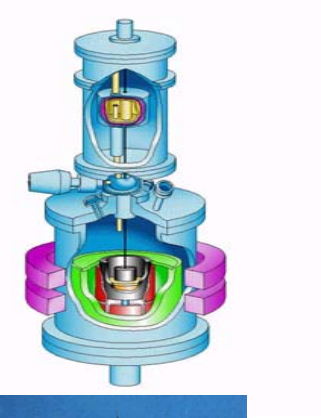
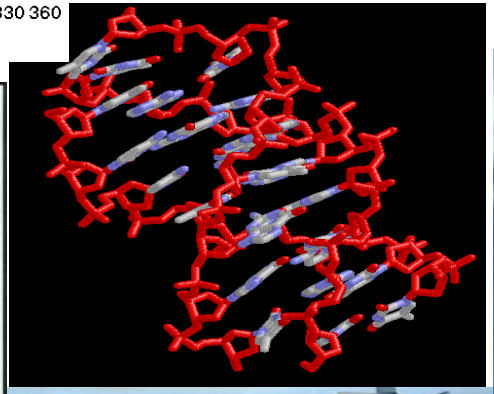


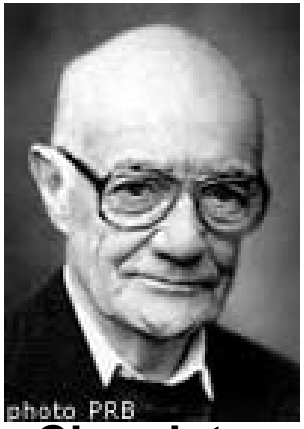






Recent AFOSR-Supported Nobel Laureates

PROF JOHN FENN
Virginia Commonwealth University



Chemistry
2002

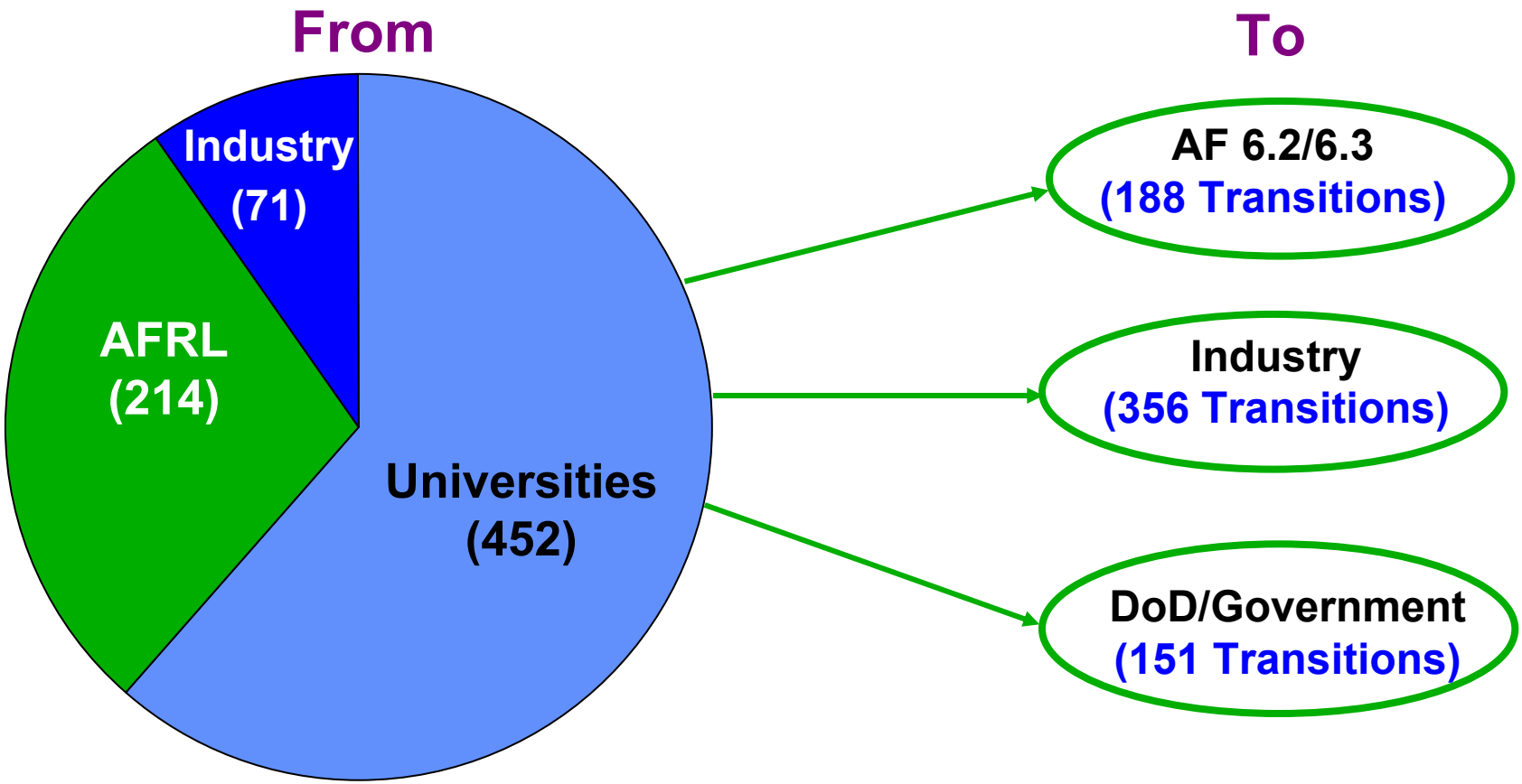
PROF DANIEL KAHNEMAN
Princeton University

Economics
2002

46 NOBEL PRIZES AWARDED TO LAUREATES WHO PERFORMED AFOSR-SPONSORED BASIC RESEARCH

BASIC RESEARCH TRANSITIONS
(FY02-FY03)

737 Documented Transitions
From 6.1 to 6.2 and Above



Sums of categories exceed fiscal year total due to more than one customer per transition

EXAMPLES OF BASIC RESEARCH CONTRIBUTIONS

- Self-Healing Polymer Composites
  - Provide Long Life for Structures & Materials for Air & Space
- Poly Nitrogen
  - High Density Energy Storage for Propulsion and/or Combustion
- Dip Pen Nanolithography
  - Reduces Weight of Electronic Components in Air and Space Craft
- Cold Plasma
  - Used for Protecting Spacecraft
- Tracking Algorithms
  - Improved Tracking of Moving Ground Targets

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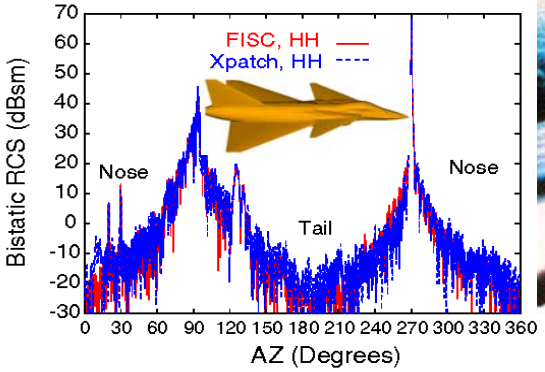
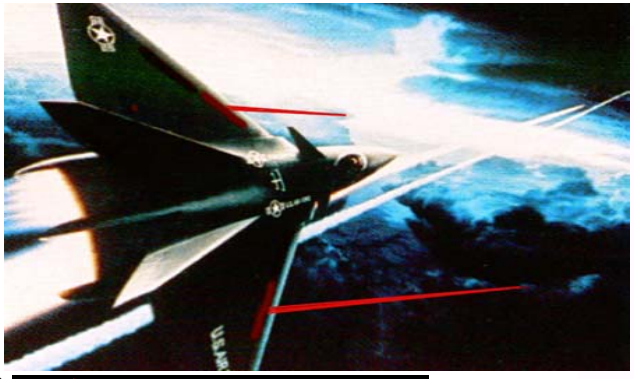
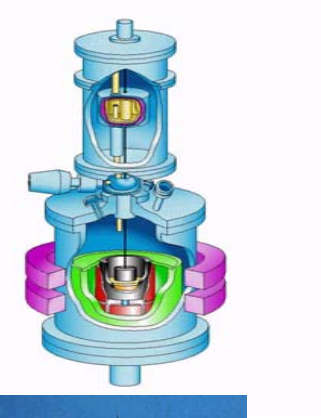
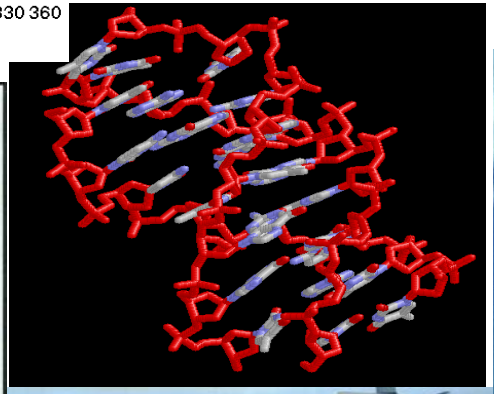








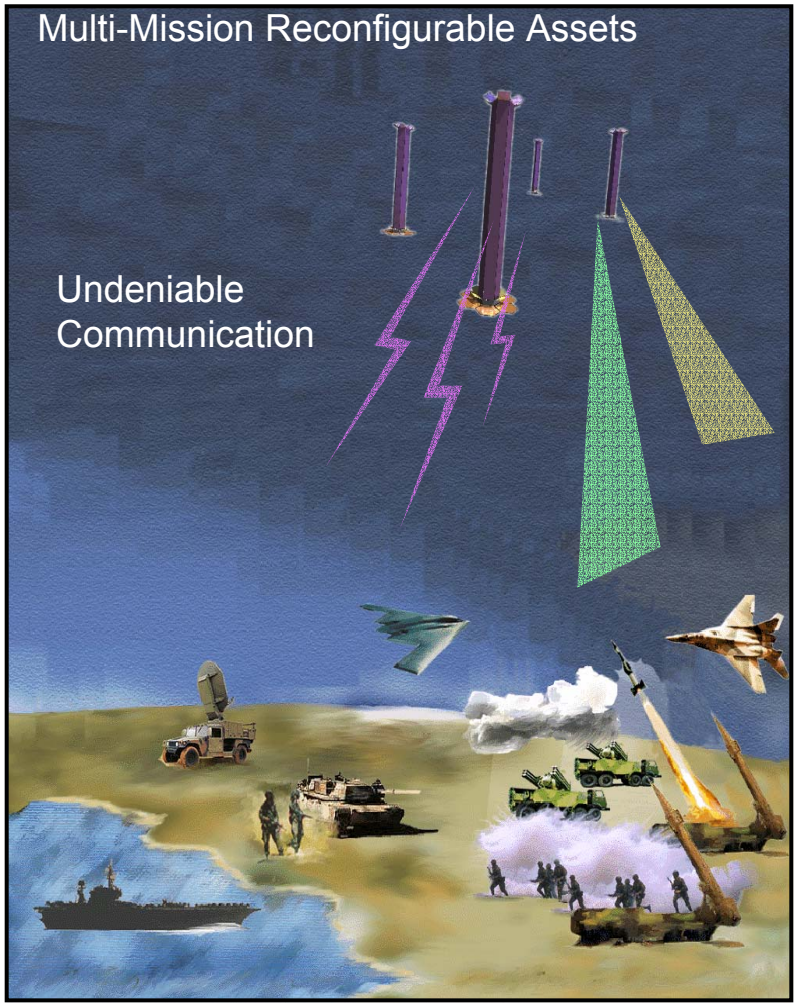
AFOSR THEMES

- Broad Interdisciplinary Areas Funded and Managed to Achieve Significant Progress
- Topics Generated by Program Managers; Prioritized by AFOSR and TDs
- Enhanced Funding of Themes via reprogramming or FY02 plus-up

Designated Themes

- Cooperative Control
- Plasma Dynamics
- Miniaturization Science for Space
- Biologically Inspired Concepts
- Type II Quantum Computation
- Materials Engineering

COOPERATIVE CONTROL



Objective

- Further develop theory of cooperative control systems

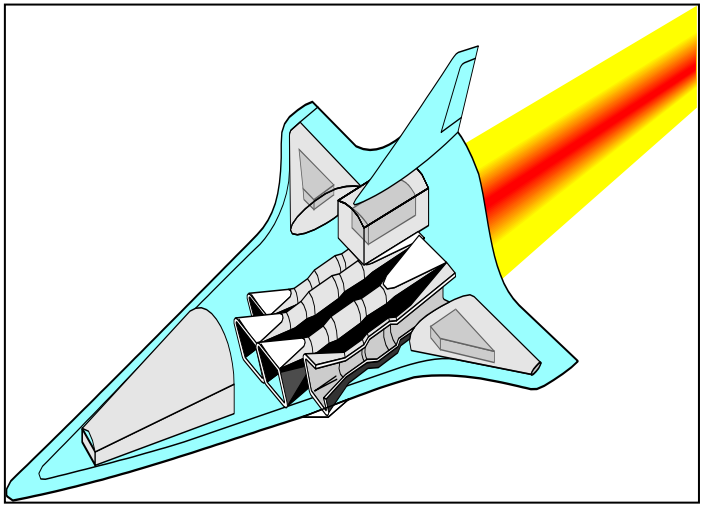
Approach

- Evaluate variety of revolutionary and evolutionary technologies
- Include applicable technologies into cooperative control systems

Payoff

- Autonomous swarms of UAVs
- Development of affordable “smart” weapons

PLASMA DYNAMICS



Objective

- Evaluate plasma flow physics
- Demonstrate plasma control effects

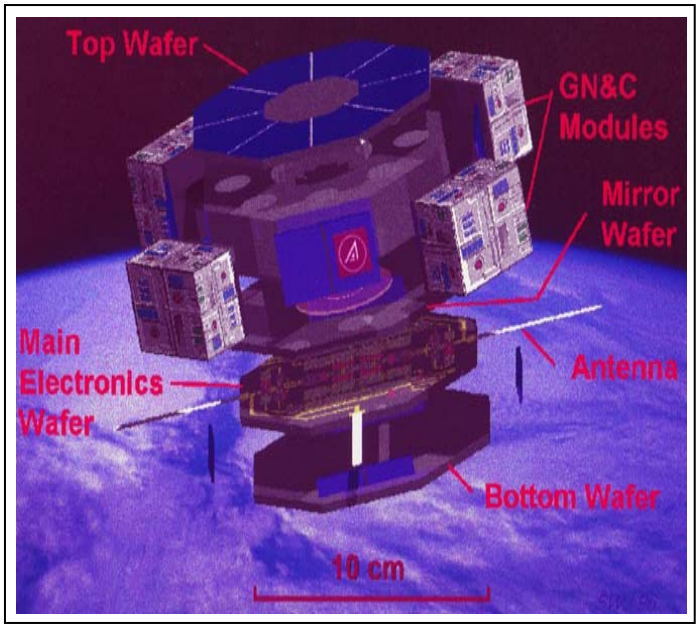
Approach

- Investigate plasma physics & chemistry
- Demonstrate plasma control effects
- Determine/improve efficiency of plasma generation

Payoff

- Reduce hypersonic vehicle drag & heating
- Novel flight control techniques
- Stable high speed combustion
- Alleviate sonic boom, reduce engine noise

MINIATURIZATION SCIENCE FOR SPACE



Objective

- Enable much lighter, more compact, microsatellite, nanosatellites & picosatellites

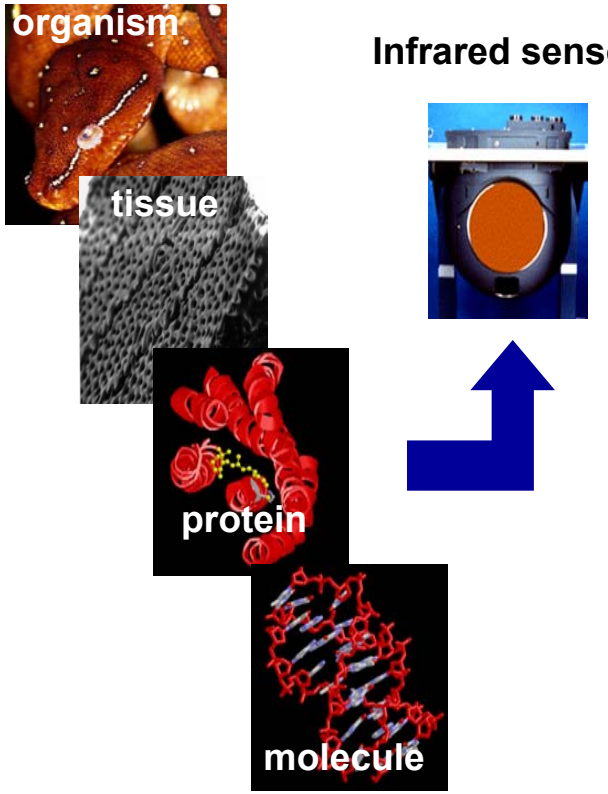
Approach

- Continue size/weight/power reduction efforts
- Conduct critical mass research
- Leverage investments of other agencies

Payoff

- Reduce satellite cost, weight, & size
- Improve access to space
- Increase mission flexibility

BIOLOGICALLY INSPIRED CONCEPTS



Objective

- Provide biologically inspired technology

Approach

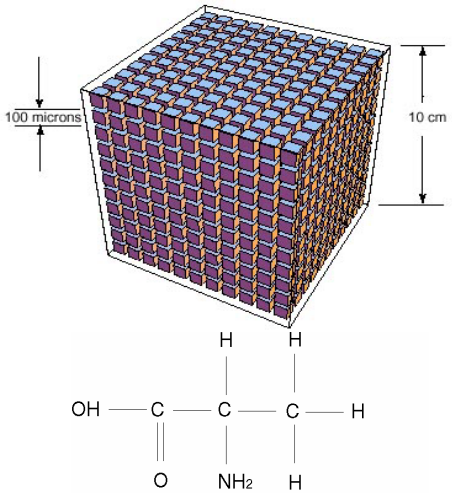
- Explore living systems down to molecular level (molecular biology is nanobiology)
- Develop chemical models & engineering concepts

Payoff

- Increase in IR sensitivity & detection
- Novel techniques for materials development
- Extreme miniaturization for guidance & control
- Develop analysis of complex nonlinear systems
- Highly efficient new polymers & composites
- Energy-dense compact power & nano-actuators

TYPE II QUANTUM COMPUTATION

Prototype QC using NMR



Objectives

- Develop near-term quantum computer implementations
- Develop algorithms to model physical systems
- Explore architectures to scale a large array of small quantum computers

Approach

- Implementation of a "type-II" quantum computer
- Explore both NMR & SQUID technology
- Implement & test quantum lattice-gas algorithms

Payoffs

- 10^6 faster atomic-level computing
- Fast solutions of complex fluid dynamics problems
- Extremely fast image reconstruction & signal processing

MATERIALS ENGINEERING FOR AFFORDABLE NEW SYSTEMS (MEANS)

Objective

- Exploit computational materials science and engineering to develop techniques for coupling models of material behavior
- MEANS enables materials design to be an integral part of the global design process

Approach

- Emphasize parallel design of components
- Develop computational approaches to minimize testing
- Establish applications-oriented performance objectives

Payoff

- Optimal utilization of materials and processes to produce affordable, reliable and durable products for military and civilian applications

AIR FORCE LONG TERM CHALLENGES

The six proposed Long Term Challenges are:

1. Finding and Tracking

Provide the decision maker target quality information from anywhere in real-time

2. Command and Control

Monitor, assess, plan, and direct aerospace operations anywhere from multiple locations in near-real time, across the spectrum of operations and command

3. Controlled Effects

Deliver the appropriate type & amount of energy on targets of military significance

4. Sanctuary

Protect our total force from natural and man-made hazards or threats

5. Rapid Aerospace

Respond as quickly as necessary to support peacetime operations or control crises

6. Effective Aerospace

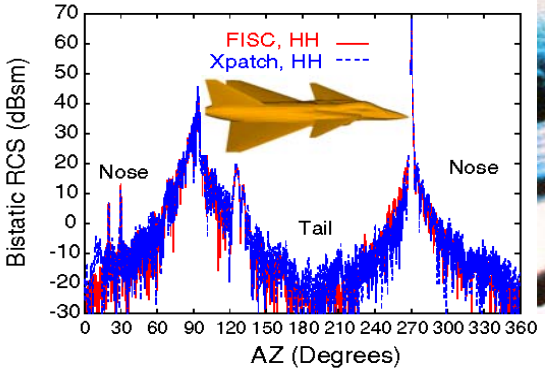
Sustain the flow of equipment, supplies, and force for as long as required

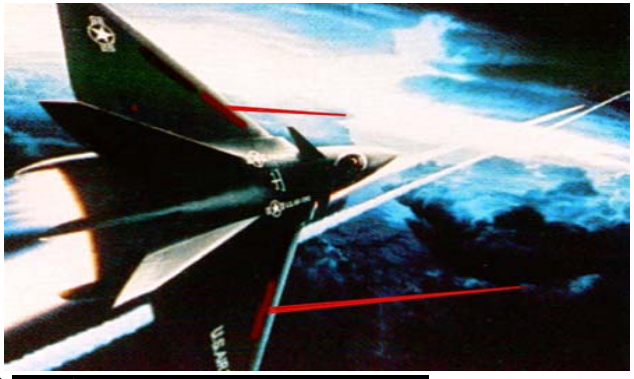
AFOSR INITIATIVES MAPPED TO LONG TERM CHALLENGES

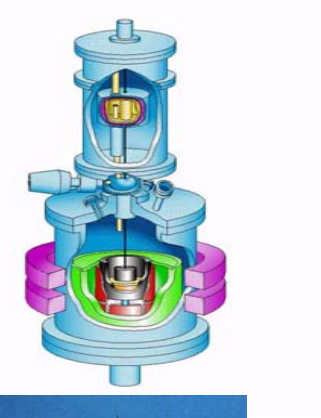
Long-Term Challenges	Cooperative Control	Quantum Computing	Bio-Inspired Concepts	Miniaturization Science for Space	Plasma Dynamics	Super Energetic Propellants	Materials Engineering
Finding and Tracking	■	■	■	■			■
Command and Control	■	■	■				
Controlled Effects	■	■	■			■	■
Sanctuary	■	■	■	■	■		■
Rapid Aerospace Response		■	■	■	■	■	■
Effective Aerospace Persistence	■	■	■	■	■	■	■

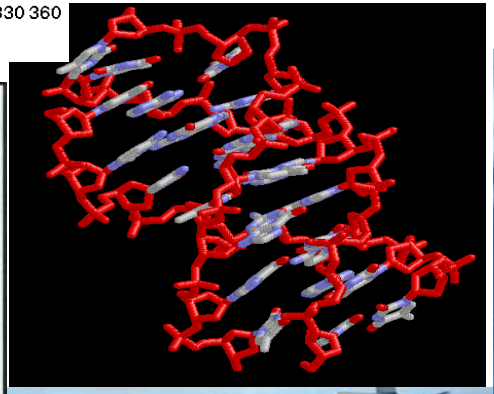
AFOSR

- Organization
- Investment Portfolio
- How we measure success
- High Priority Areas / AF Long Term Challenges
- Summary









SUMMARY

- **AFOSR Focuses the Scientific Community on Air Force Warfighter Needs**
- **AFOSR Researches Foundation Technologies for Critical Air Force Systems**
- **AFOSR Forges Transitions of Innovative Technologies**
- **AFOSR Earns its Reputation as "World-Class" through Early and Accurate Selection of Premiere Research Scientists**

Creating Revolutionary Scientific Breakthroughs for the Air Force