

Air Force Office of Scientific Research



18 February, 2005

*USAF/Taiwan Nanoscience Initiative
workshop – Honolulu, HI*

*The Basic Research
Manager for the Air Force*

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Division

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Welcome to Hawaii



- **The Hawaiian Islands were discovered by:**
 - **Blue Whales a very long time ago**
 - **Polynesian explorers a long time ago**
 - **By Captain Cook, RN in 1778**
 - **By Jack Agee in 1973**
- **We enjoy the Hawaiian traditions of Aloha – welcome to a beautiful and friendly place**
- **We are on Oahu, which throughout recorded history ha been the meeting place**
- **The future is bright! – Nanoscience is part of the reason**

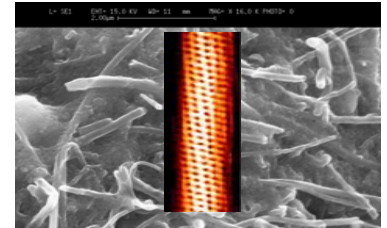


NANOTECHNOLOGY FOCUS AREAS AT AFOSR



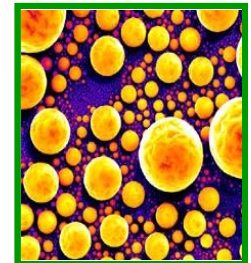
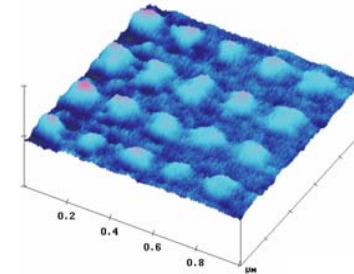
HIGH PERFORMANCE MATERIALS

- *high temperature*
- *high strength*
- *light weight*
- *smart*
- *multifunctional*



INFORMATION PROCESSING

- *nano-electronics/nano-magnetics*
- *nano-photonics & nano-optics*



ENERGETIC MATERIALS

COMPACT POWER GENERATION AND STORAGE

BIO-INSPIRED CONCEPTS

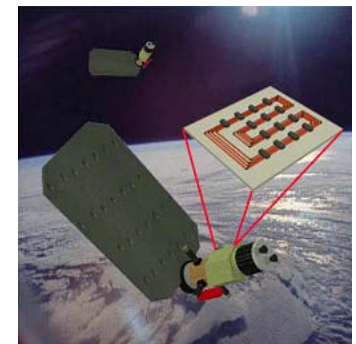
PREDICTIVE TOOLS

- *molecular dynamics*
- *quantum computing*

MATERIALS PROCESSING & FABRICATION

NANOPROBE TOOLS

SURFACE MODIFICATION

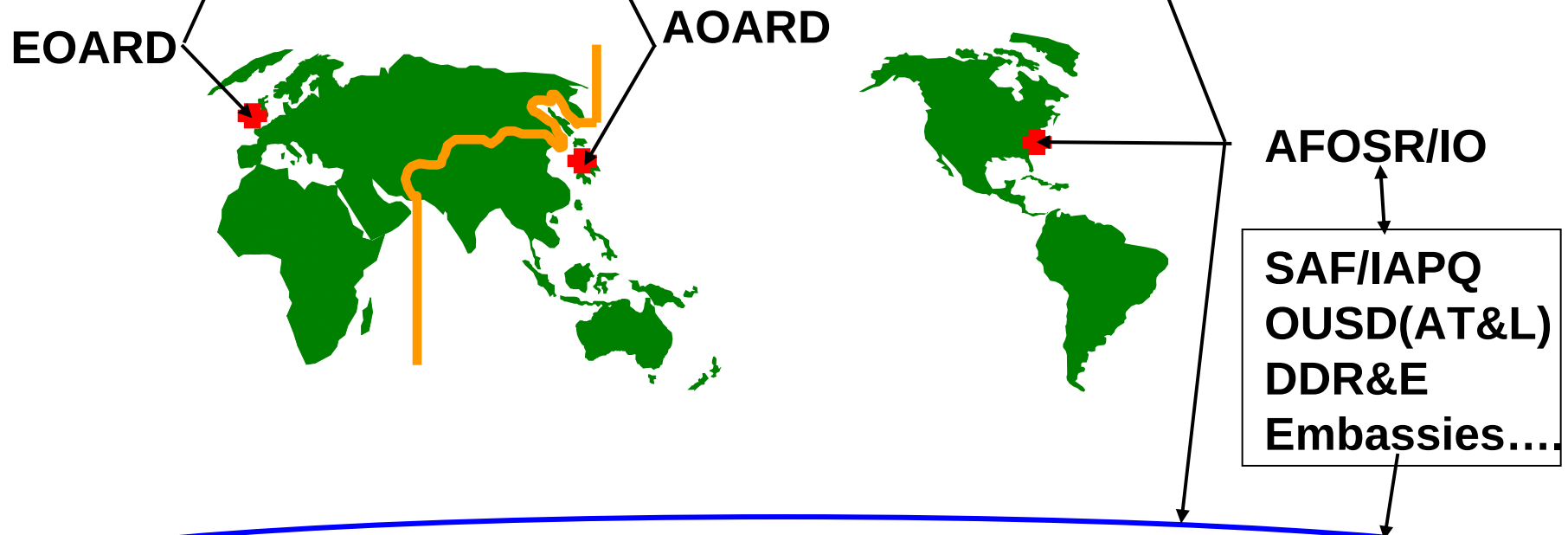




International Programs

Non-Government Interaction

Window-on-Science, Conference Support, Research Contracts

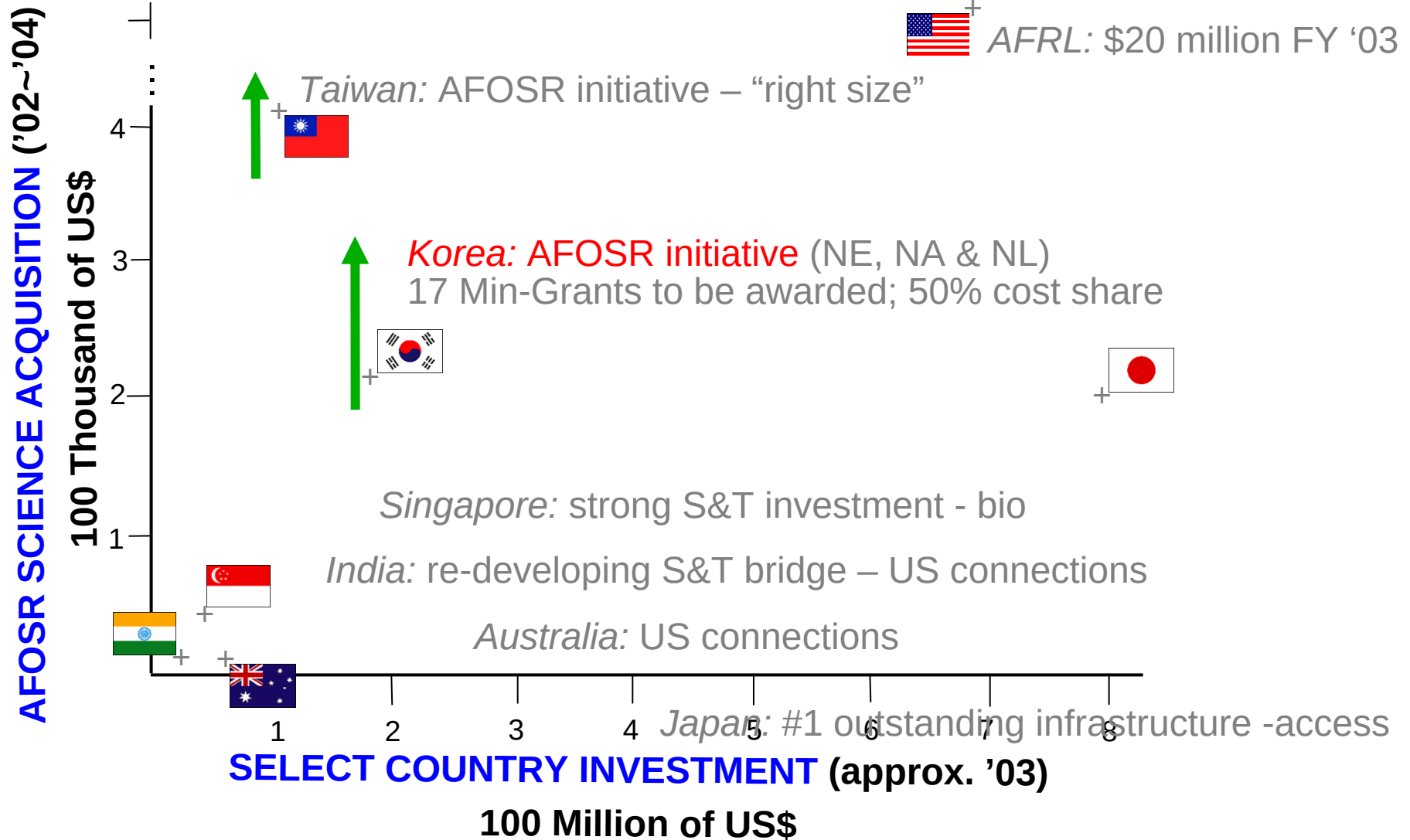


Information Exchange, Loans, Cooperative Projects, RTO, TTCP

Government-to-Government Cooperation



INVESTMENT IN NANOSCIENCE & MICROSYSTEMS



Ave. FY'03 international overhead: 13% Direct & indirect leverage: >>> \$ millions



Taiwan – AFOSR Nanoscience Initiative



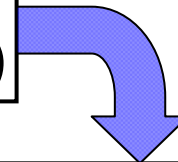
- Natural extension of common interest
- Founded in recognition of Taiwan's commitment to establishing itself as a world-class technical power in nanoscience and nanotechnology
- Primary goal: To establish mutually beneficial scientific interactions between researchers in Taiwan and AFRL scientists
 - Foster basic research innovation & interactions between scientists
 - Enhance future USAF capabilities through support of Air Force fundamental nanoscience research efforts



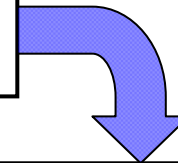
Taiwan/Air Force Program Concept



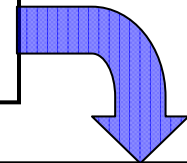
**AFOSR Requests
White Papers (2 pages)**



**AFRL & AFOSR Reviews
White Papers**



**Select / Make Request for
Full Proposal**



**Select Proposals and
Award Contracts**

Key Program Elements

- Visits and Joint Workshops
- Research Funding
- Sponsorship of In-Country Conferences

**Hold Periodic Joint
Technical Exchange
Meetings**



USAF – TW Joint Workshop, Maui, Feb 2004



Taiwan Participants Include



- National Science Council
- Academia Sinica
- Chung-Shan Institute of Science and Technology
- Industrial Technology Research Institute
- National Cheng Kung University
- National Chiao Tung University
- National Chung Cheng University
- National Taiwan University
- National Taiwan Normal University
- National Tsing Hua University





Closing Thoughts



- **The Air Force Office of Scientific Research works within the Air Force Research Laboratory to Enhance Scientific Research**
 - Among world class researchers
 - With Universities, Industry, Government Laboratories
- **Nano Science and Technology R&D a Major Contributor to Revolutionary System Capabilities**
- **Globalization of Research & Development is Key**
 - Asian Office of Research and Development, Tokyo
 - Benefits are win-win for the USAF and for our international partners



Back-Up Charts





Taiwan Projects in Materials Area



- 034017, *Investigation on Mechanical Properties of Nano-scale Thin Film*, Yeau-Ren Jeng, National Chung Cheng University
- 034021, *Diamond-Like Carbon (DLC) Nanocomposite Film Depositions and Characterizations*, Franklin Chau-Nan Hong, National Cheng Kung University
- 034040, *Growth and Characterization of Nanorods*, Jih-Jen Wu, National Cheng Kung University
- 034054, *The Relationship of Microscopic Material Characteristics & Physical Behavior of Quantum Dots*, Shan Torng, Chung-Shan Institute of Science & Technology
- 044026, *InGaN/GaN Quantum Dots --- Growth, Nano-structure Material Analysis, and Optical Characterization*, Chih-Chung Yang, National Taiwan University
- 044073, *Study of Laser Ablation for Generating Nano-Particles*, Jehnming Lin, National Chen Kung University
- 044074, *Dispersion and Reinforcement of Nanotubes in High Temperature Polymers for Ultrahigh Strength and Thermally Conductive Nanocomposites*, Arnold Chang-Mou Yang, National Tsing Hua University



Taiwan Projects in Devices Area (1)



- **024004, *THz Laser based On Ge/Si Heterostructures*, Hung Hsiang Cheng, National Taiwan University**
- **024046, *Polymer Based Field-Effect Transistors*, Ten-Chin Wen, National Cheng Kung University**
- **024052, *Blue Laser Gain Characteristics of InGaN Quantum Dots Embedded in InGaN Quantum Well Structures*, Chih-Chung Yang, National Taiwan University**
- **034019, *Integrated Field Emission Devices Based On Carbon Nanotubes and Related Nanostructures*, Li-Chyong Chen, National Taiwan University**
- **034020, *Study on Wide-Gap Gallium-Nitride Based Films and Their Quantum-dots Devices*, Huey-Liang Hwang, National Tsing Hua University**



Taiwan Projects in Devices Area (2)



- **044020, *THz laser based on Si*, Hung Hsiang Cheng, National Taiwan University**
- **044025, *Novel Organic Field Effect Transistors via Nano-Modification*, Ten-Chin Wen, National Cheng Kung University**
- **044070, *GaN/AlGaN Terahertz Quantum Cascade Laser*, Shing-Chung Wang, National Chiao Tung University**
- **044071, *Study on Wide-gap Gallium-nitride Films and Their Quantum dots Devices*, Huey-Liang Hwang, National Tsing Hua University**
- **044072, *Ge/SiGe Quantum Dot Detectors and Light Sources at Terahertz Frequencies*, Cheewee Liu, National Taiwan University**



Taiwan Projects in Bio-Nano, Energy



- **Bio-Nano**
 - 044008, *High resolution real time phase contrast radiology study of hydrodynamic in micrometer scale*, Maw-Kuen Wu, Academia Sinica
- **Energy**
 - 044023, *High Efficiency Photovoltaic Devices Fabricated from Self-Assemble Block Insulating-Conducting Copolymer Containing Semiconducting Nanoparticles*, Wei-Fang Su, National Taiwan University
 - 024048, *High Efficiency Photovoltaic Devices Fabricated from Self-Assemble Block Insulating-Conducting Copolymer Containing Semiconducting Nanoparticles*, Wei-Fang Su, National Taiwan University



Taiwan Projects in Foundational Areas



- **Self-Assembly (foundation)**
 - 034018, *Self-Assembly of Block Copolymer/Quantum Dot Nanocomposites for Optical Application*, Kung-Hwa Wei, National Chiao Tung University
 - 044069, *3D Photonic Crystals Build Up By Self-Organization Of Nanospheres*, Yu-Wen Chen, National Central University
- **Modeling and Simulation (foundation)**
 - 034039, *Fundamental study on quantum nanojets– structures, dynamics and energetic*, Huei-huang Chiu, National Cheng Kung University



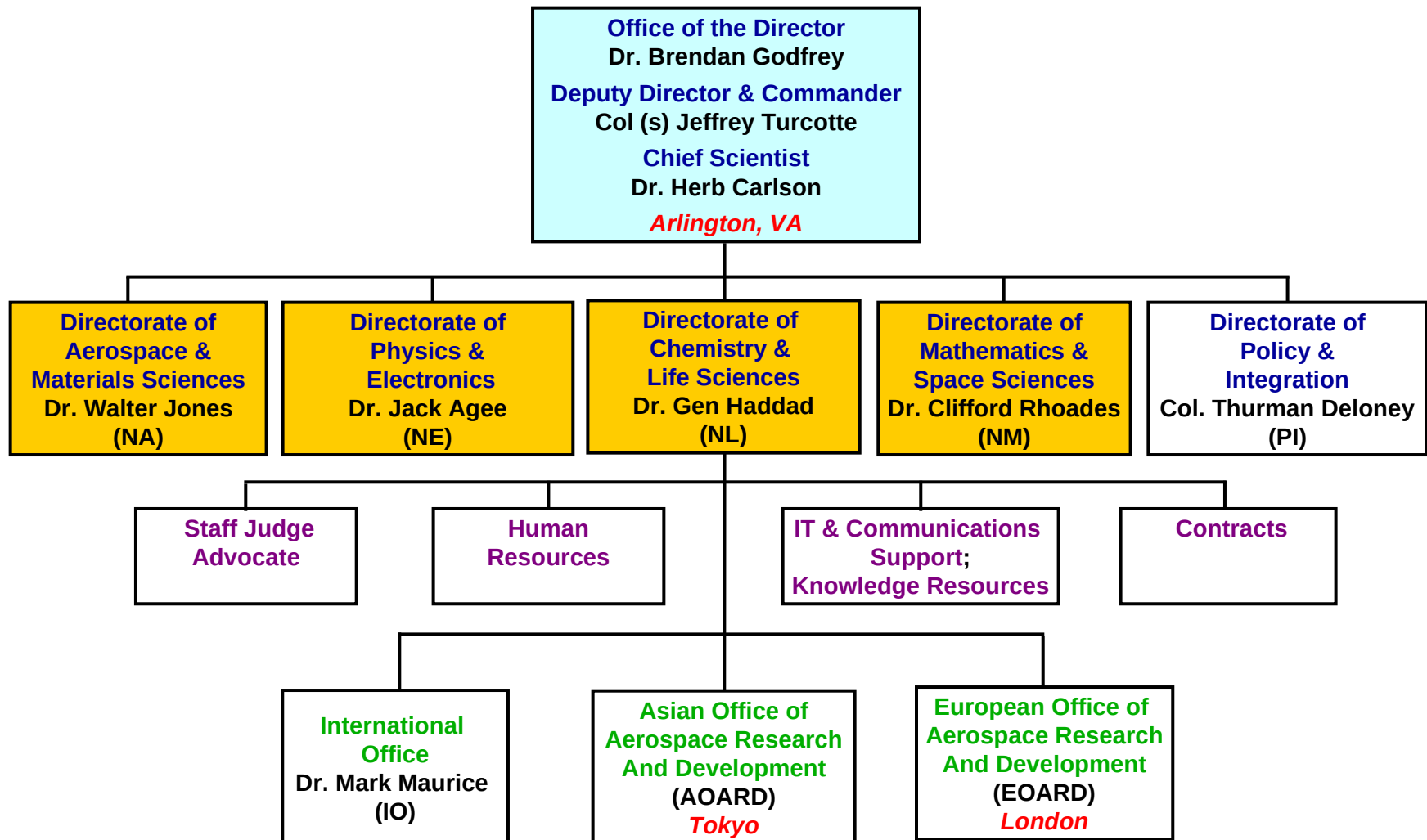
CSIST Nanoscience Contract



- **AFOSR Contract with CSIST Researcher**
 - **Relationship of Microscopic Material Characteristics & Physical Behavior of Quantum Dots**
 - **Dr. Shan Torng (CSIST)**
 - **Explore relationship between microscopic materials characteristics and physical behavior for self-organized InAs/GaAs quantum dots, including quantum effect and optical properties**

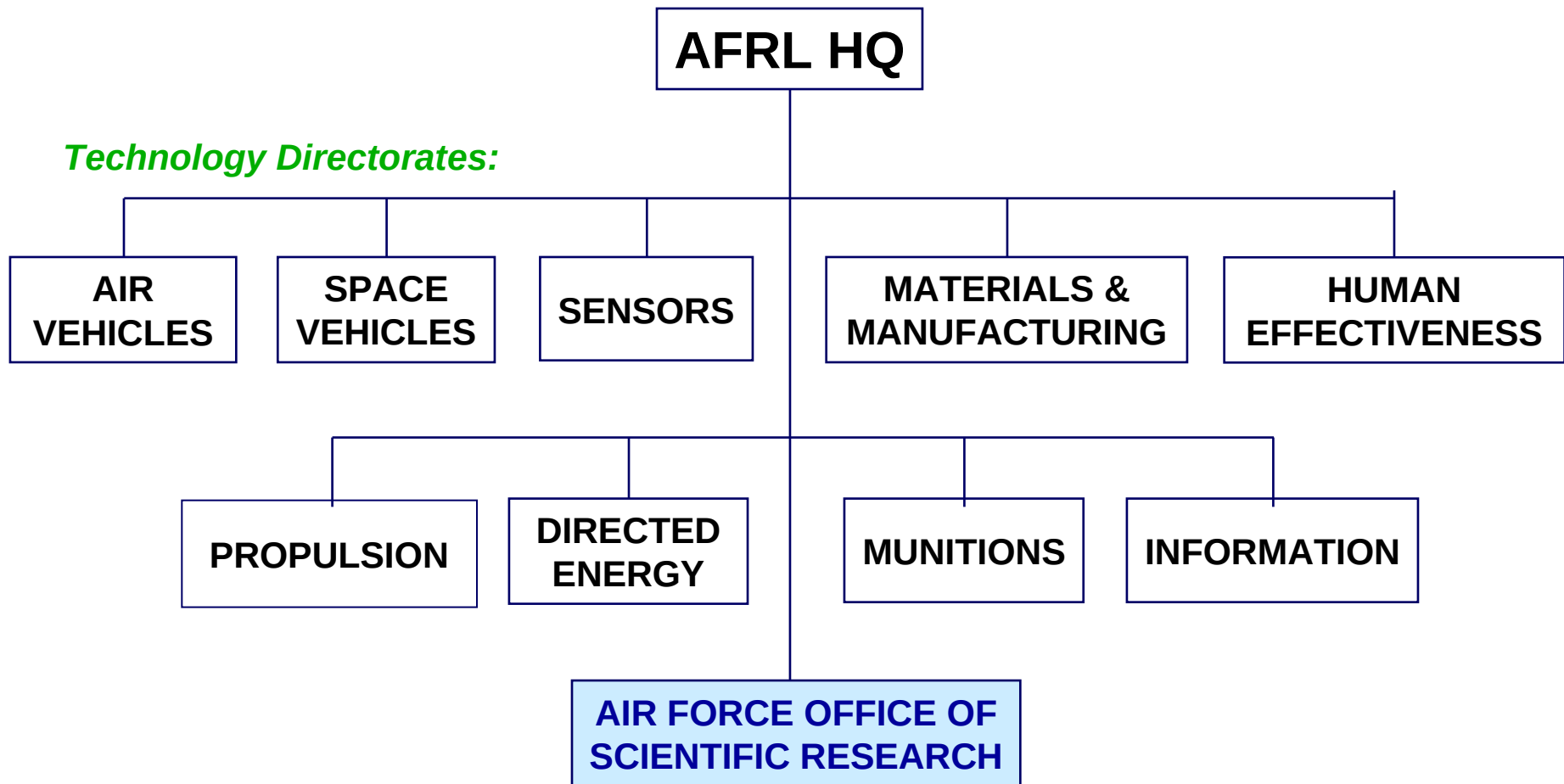


AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR)





AIR FORCE RESEARCH LAB (AFRL)



Sole Manager of AF Basic Research



AFOSR PROGRAMS WITH NANOTECHNOLOGY FOCUS



Program (Program Manager):

Semiconductor Materials (*Steiner*) <<

Optoelectronics/Nanophotonics (*Pomrenke*)

Quantum Electronic Solids (*Weinstock*)

Molecular Dynamics (*Berman*)

Surface & Interfacial Science (*Trulove*)

Polymers/Polymer Composites (*C. Lee*)

Ceramic & Nonmetallic Materials (*Fuller*)

Metallic Materials (*Hartley*)

Mechanics of Materials/Devices (*B. L. Lee*) <<

Biomimetics (*DeLong*)



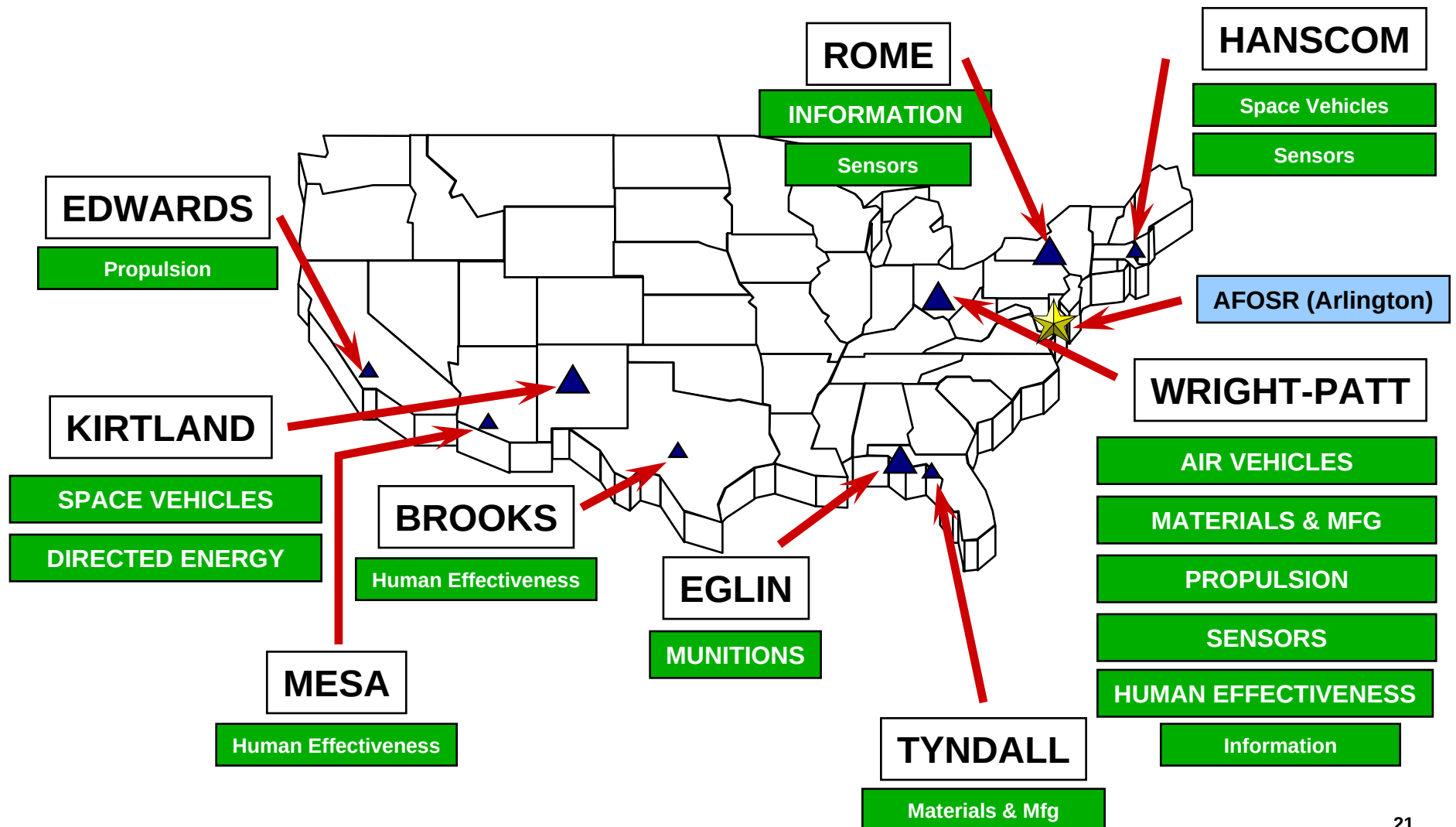
Overview of AFRL NST Interest



- **Materials Area**
 - 1. Tailorable Dielectrics
 - 2. Reconfigurable Optical Response
 - 3. Adaptive Structural Materials
 - 4. Thermal Control Materials
- **Energy Area**
 - 5. Energetics on the Nanoscale
 - 6. Nano-enhanced Power Technologies
- **Devices Area**
 - 7. Quantum Confined Optical Sensors
 - 8. Nanotechnology for RF
 - 9. Nano Signal Processors
- **Bio-Nano Area**
 - 10. Bio Interactions of Nanostructures
- **Cross-Cutting (foundations)**
 - 11. Self-assembly of Nanostructures
 - 12. Nano-Micro-Macro Interfaces
 - 13. Modeling And Simulation



AFRL RESEARCH SITES



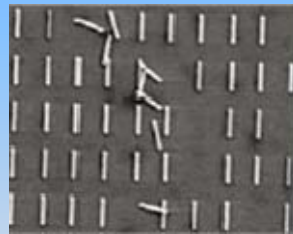


Nano Science & Technology Application



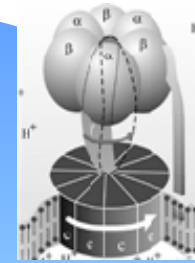
Generations

Fourth: Molecular
Third 3D
Second: Active
First: Passive



NanoTechnologies

NanoMachines
NanoDevices
NanoEngineering



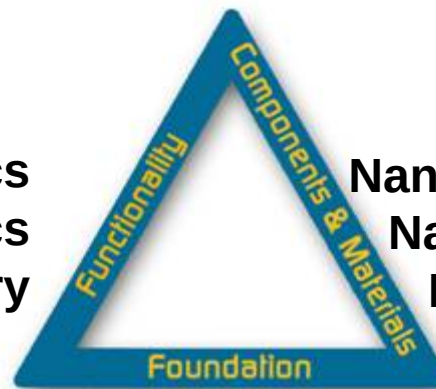
Nano-Enhanced Technologies

Coatings
Catalysts
Structures
Power
Generation



NanoScience

NanoElectronics
NanoMagnetics
NanoChemistry
NanoPhotonics



NanoStructures
NanoParticles
NanoComposites

NanoMetrology NanoFabrication
NanoAssembly Theory&Modeling



Nanoscience Initiative Chronology



- Oct 01: AFRL Introduction to TECRO
- Feb 02: High Level AFOSR Delegation to Taiwan, [incl. CSIST](#)
 - AFOSR Commander, Chief Scientist, Dir of Phys & Electronics
- Apr 02: AFRL-Taiwan Nanoscience Research Opportunities Seminar (Joint Workshop)
- Aug 02: Visit to Researchers & NSC by AFOSR, AOARD
- Sep 02: High Level Delegation Visit to Taiwan
 - Included AFOSR Director, AFRL Chief Technologist
- Aug 03: AOARD Visit to Researchers
- Nov 03: Visit to Universities, [CSIST](#), & NSC by AFOSR, AOARD
- Feb 04: Joint US Air Force/Taiwan Nanoscience Initiative Workshop, Maui HI

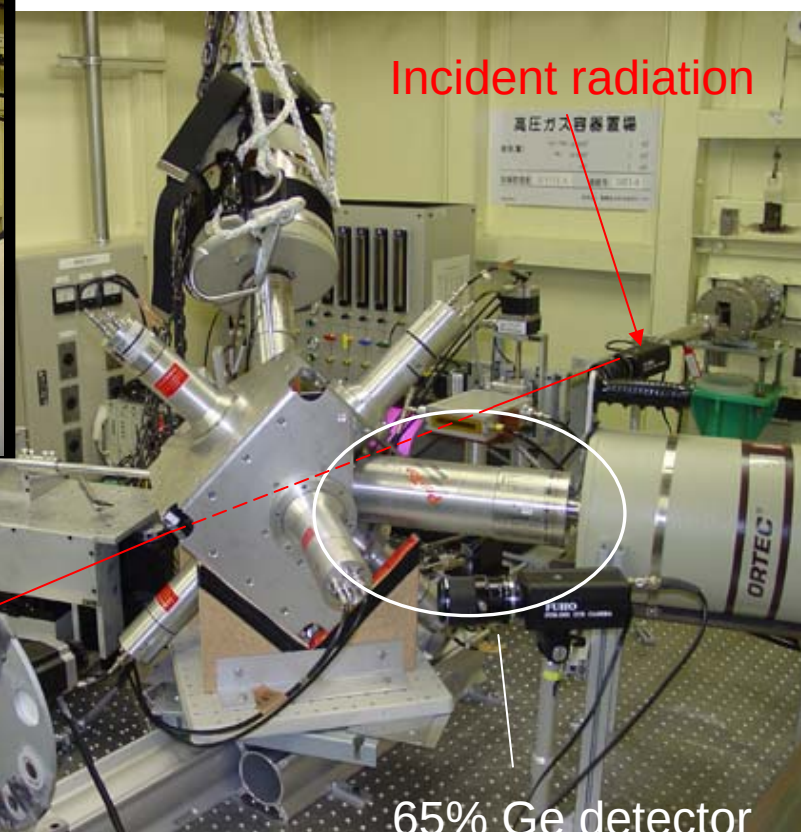
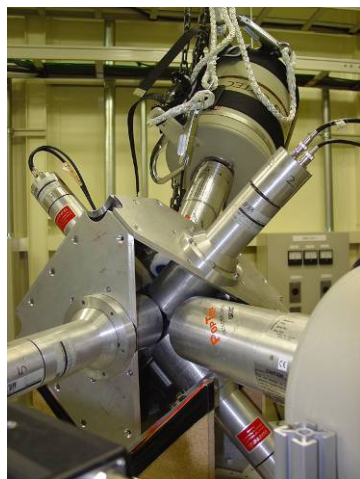
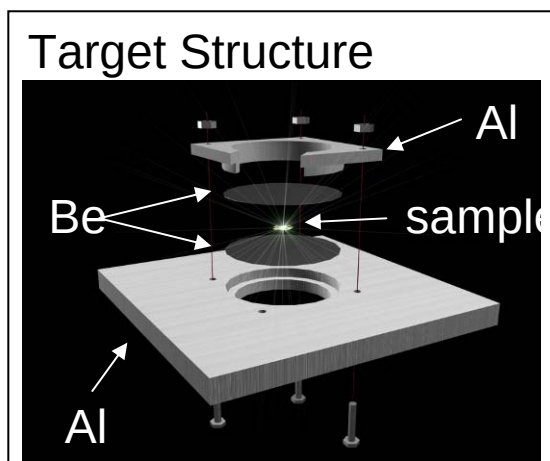


Taiwan Projects by Area



- **Materials**
 - 7 projects
- **Devices**
 - 10 projects
- **Bio-Nano**
 - 1 project
- **Energy**
 - 2 projects
- **Self-Assembly (foundation)**
 - 2 projects
- **Modeling and Simulation (foundation)**
 - 1 project

TYPICAL EXPERIMENTAL SETUP (YSU MINIBALL ARRAY)



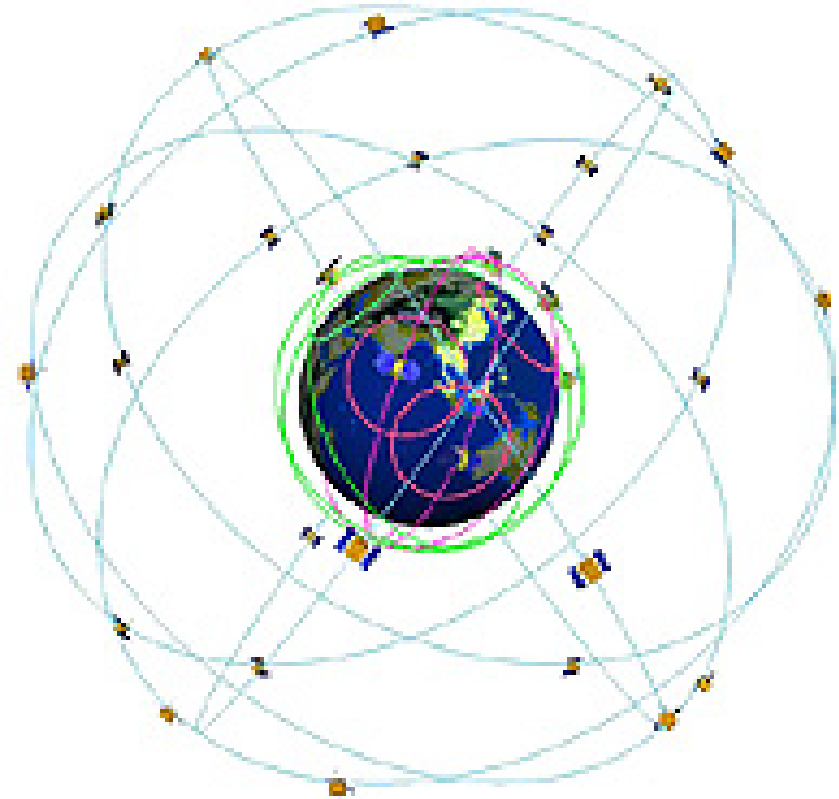
Target positioning arm



ROCSAT-3 Mission

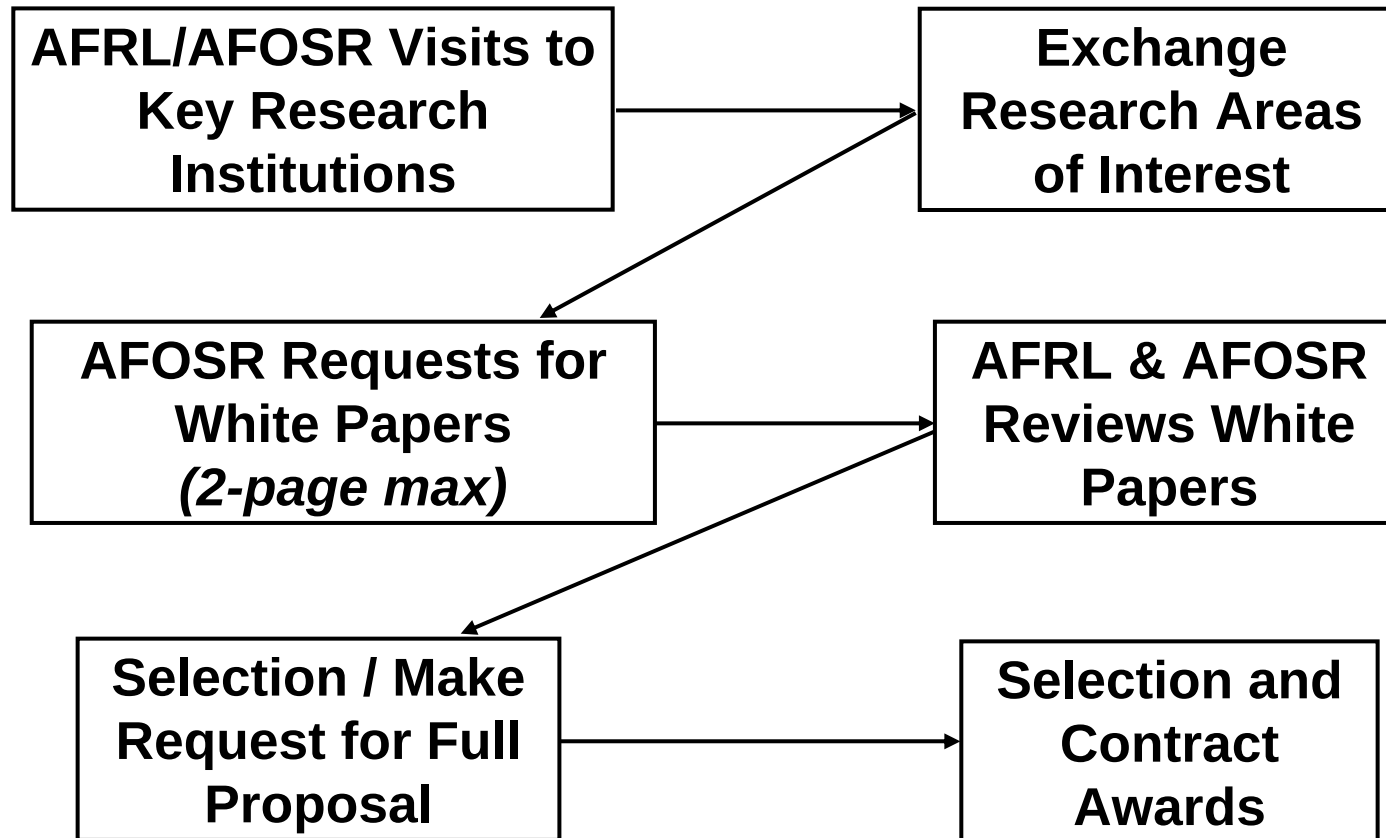


- The ROCSAT-3/COSMIC program is to launch and operate a constellation of 6 LEO micro-satellites comprised of an integrated spacecraft platform and three payloads
 - GPS occultation receiver
 - Tiny Ionosphere Photometer
 - Tri-Band Beacon Transmitter
- These micro-satellites will collect a large amount of atmospheric data for meteorological, climatic, ionospheric, and geodetic research as well as for weather forecasting and space weather monitoring





South Korea / Air Force Program



Hold Periodic Joint Technical Exchange Meetings



US - South Korea Collaboration



- **AFOSR Directors and Program Managers**
 - Manage investments in basic research
 - Have portfolios of research efforts
- **AFRL Technical Directorates and AFOSR**
 - Create / influence international projects
- **International Office**
 - Coordinate issues - cooperative efforts / MOUs
- **AOARD**
 - Make **Windows On Science** visits happen
 - Arrange for meetings
 - Put in place **Mini-Grants** in areas of mutual interest



Air Force Basic Research Program



- **The Nanoscience and Technology Program is Collaboratively Planned by AFOSR Program Managers and AFRL In-House Researchers**
- **The Basic Research Effort is Closely Coordinated with Applied Research and Demo Efforts**
- **NST Basic Research Leverages Extensive International Investments**

The South Korea – AFOSR Nanoscience Initiative is a Model for International Research