

Headquarters U.S. Air Force

Integrity - Service - Excellence

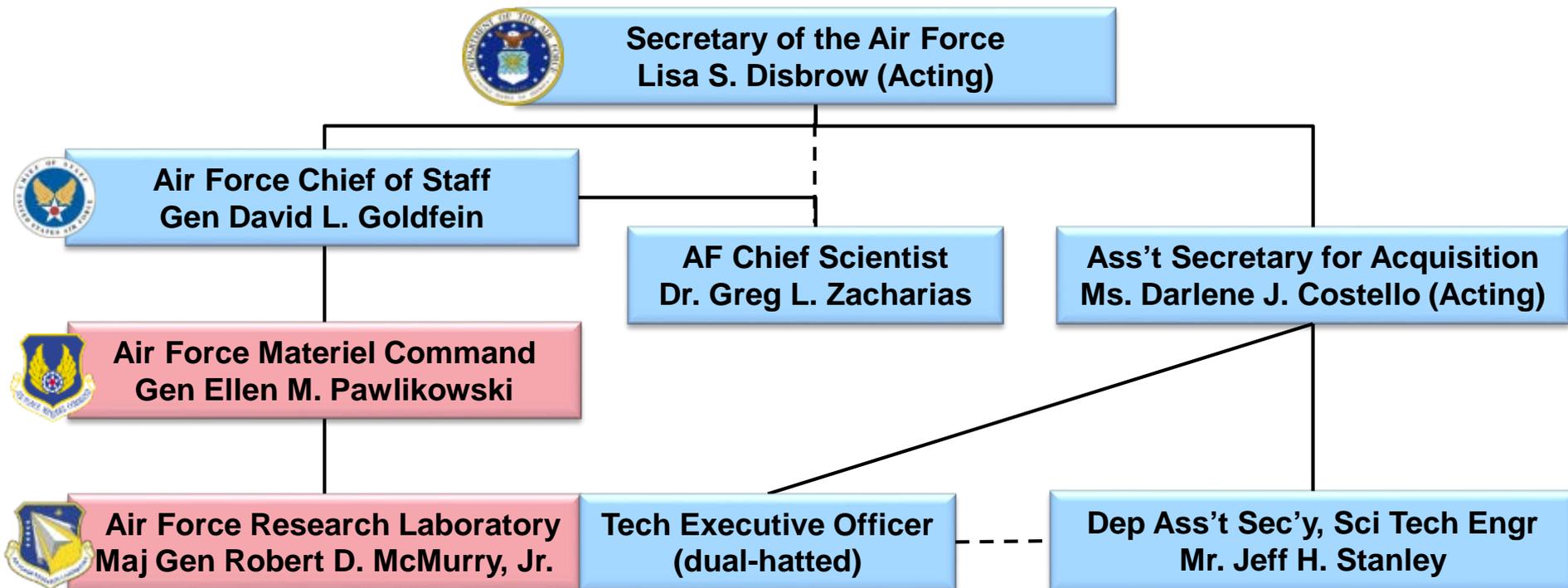
Air Force Science and Technology Program



Mr. Jack L. Blackhurst
Director, Plans and Programs Directorate
and Director Strategic Development
Planning and Experimentation Directorate
Air Force Research Laboratory



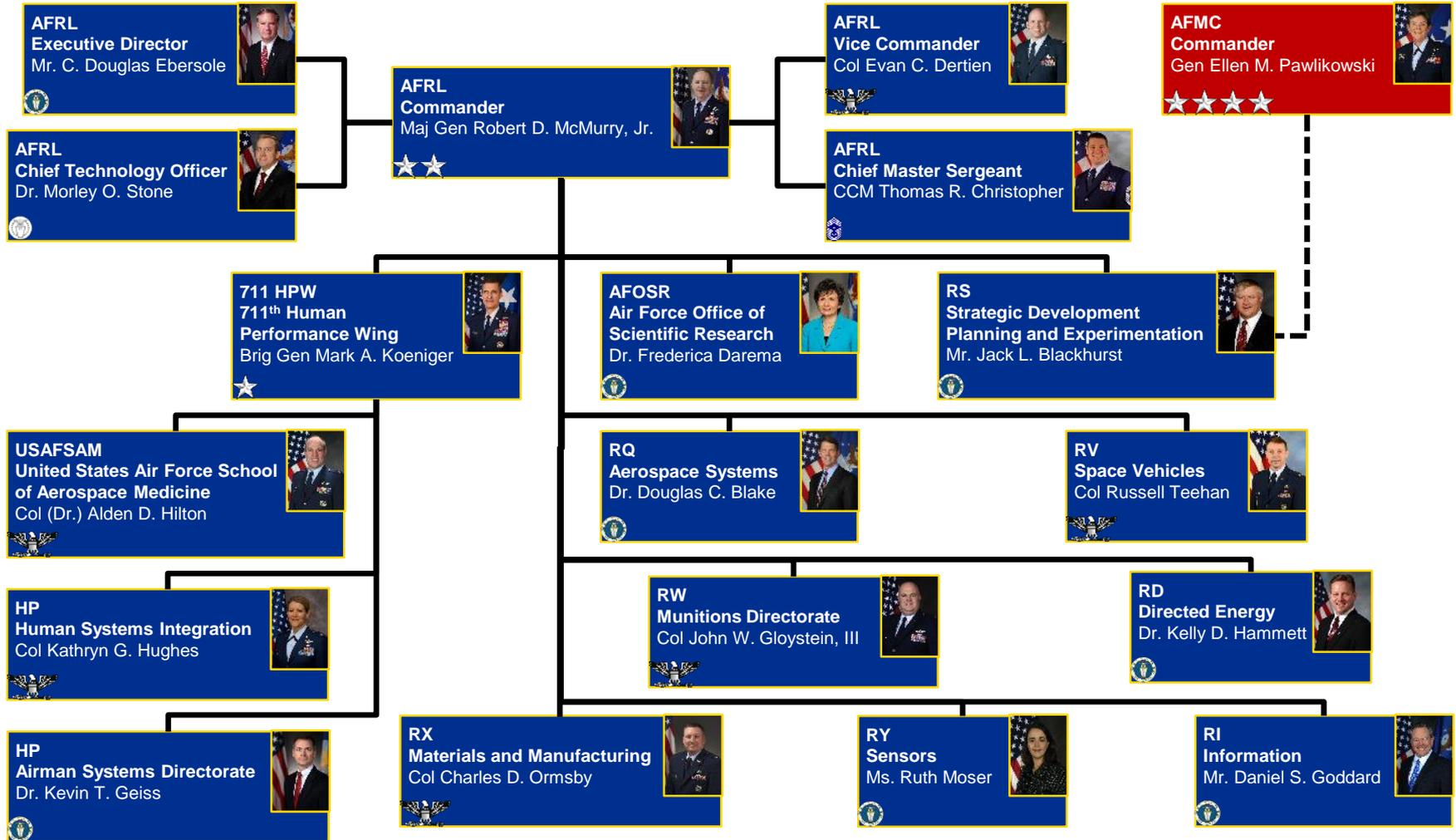
Air Force S&T Organization



- AFRL/CC under AFMC, dual-hatted as Technology Executive Officer to SAE
- SAF/AQR provides S&T guidance and oversight for SAE
- AF Chief Scientist under the CSAF advises SECAF and CSAF
- Scientific Advisory Board (SAB) reviews research quality and advises SECAF and CSAF on topics of interest

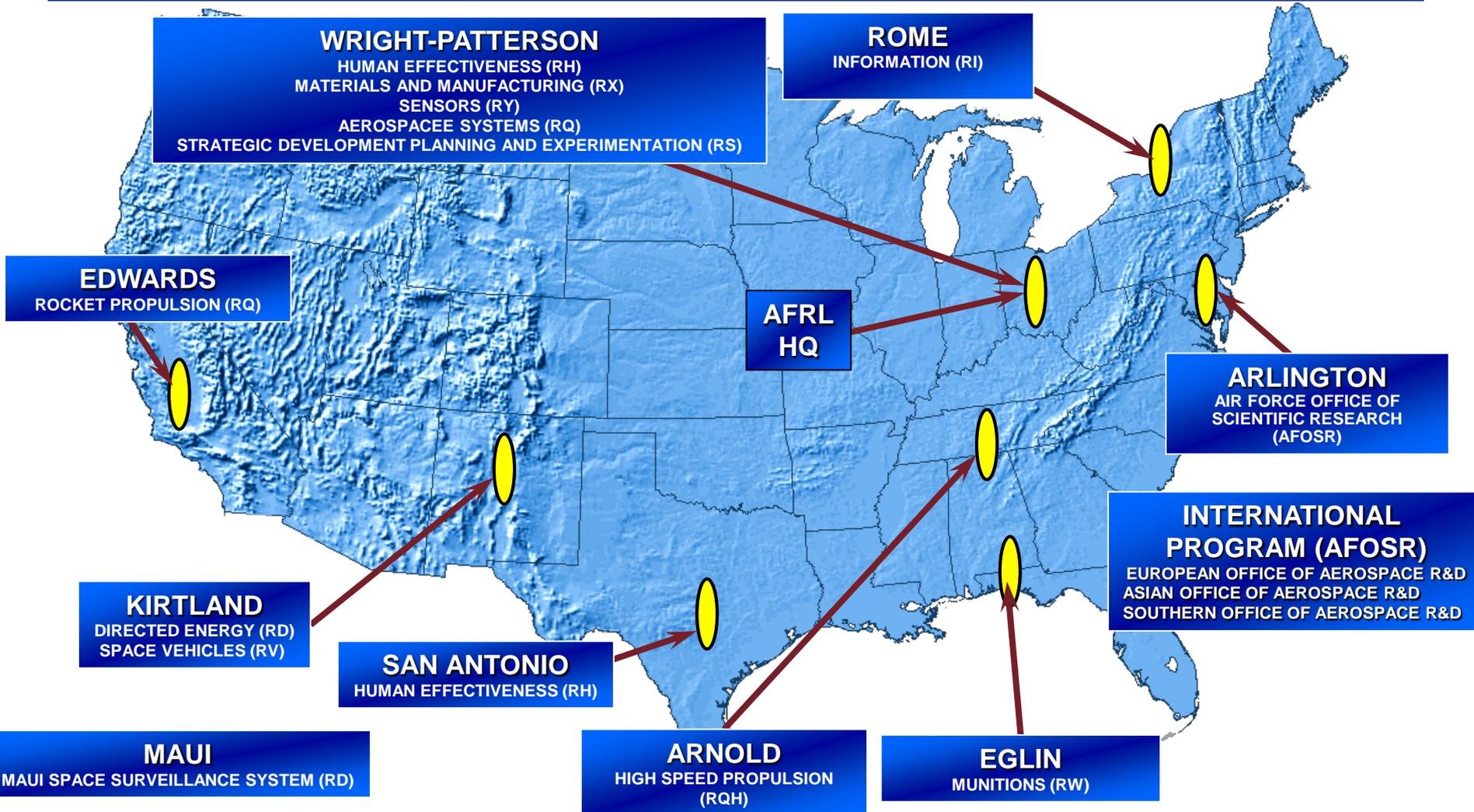


Air Force Research Laboratory





Major AFRL Facilities

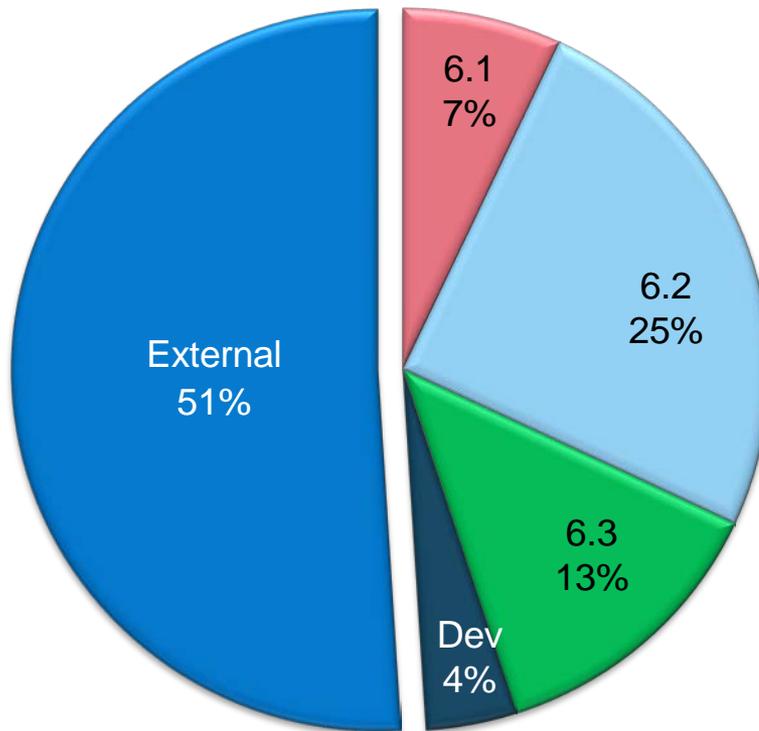


Breaking Barriers ... Since 1947

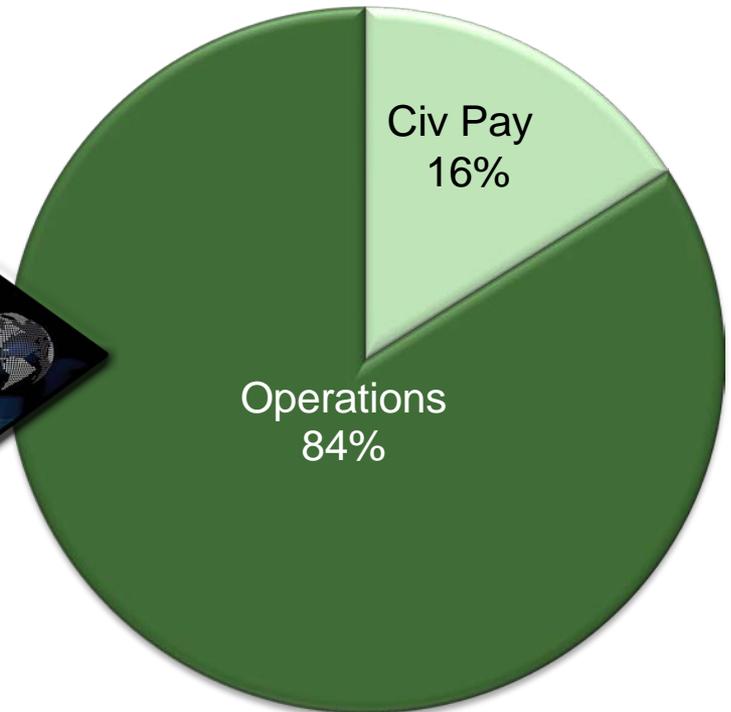


AFRL Funding FY16

All Sources: \$5.065B



Core Execution
(Total S&T \$2.422B)

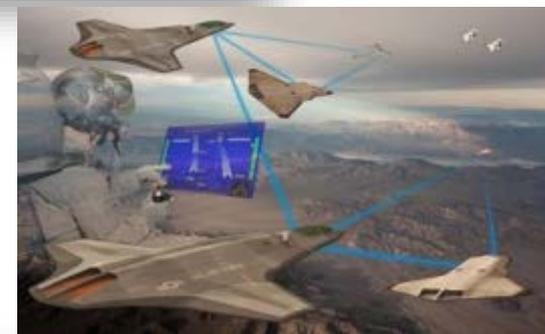


- (1) External funding includes all non-S&T funding
- (2) Devolved funding & SDP&E



Increased Emphasis

- **Small Advanced Capabilities Missile (SACM) Demonstration Effort**
- **Autonomy and Human Machine Teaming**
- **Self-Protect High Energy Laser Demonstrator (SHIELD) Advanced Technology Demonstration**





Revolutionary



Hypersonics



Directed Energy



Autonomy



Nano Technology



Unmanned Systems

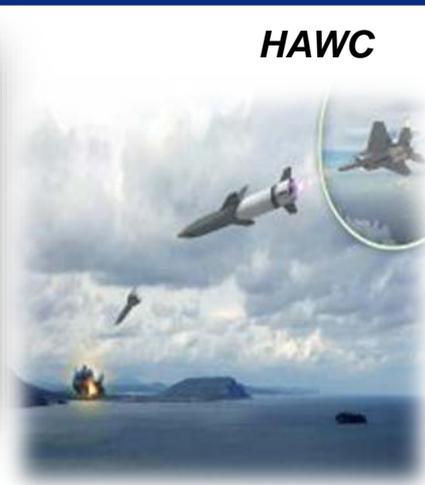
Technology to make and keep the fight unfair - Game Changers



High Speed Strike Weapon (HSSW)



TBG



HAWC

DESCRIPTION

- Flight demonstrate two air-launched weapon concepts with speeds of Mach 5 or greater in the 2019-2020 timeframe
 - Memorandum of Agreement signed by the AF and Defense Advanced Research Projects Agency (DARPA) in FY14 to fund two HSSW approaches
- Parallel Air Force technology risk reduction efforts critical for potential follow-on weapon

TECHNOLOGY

- Tactical Boost Glide (TBG) weapon - rocket boost and glide vehicle
- Hypersonic Air-breathing Weapon Concept (HAWC) - rocket boost, scramjet, airframe
- Technology challenges include aerodynamics, thermal and structural loads, materials, systems integration, aero-propulsion integration
- HSSW Technology Maturation - ordnance, propulsion, guidance, navigation, and materials & manufacturing technologies

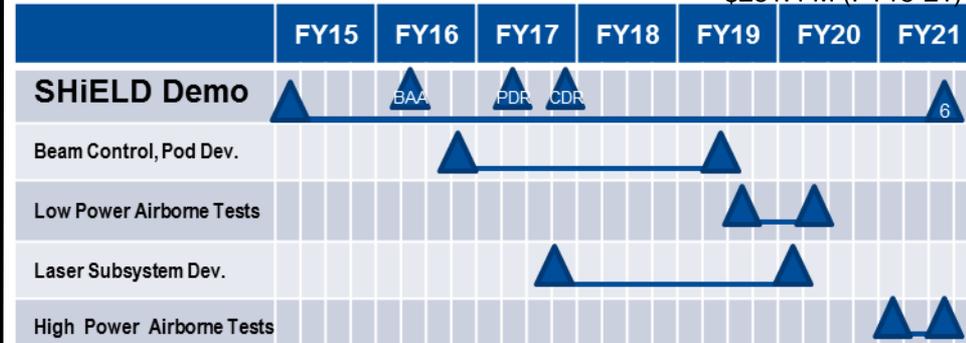
BENEFITS TO WARFIGHTER

- Increased lethality against broad target set with smaller tailored blast to max target coupling
- Decrease response time for engaging surface targets
- Prosecute time sensitive targets from safe standoff ranges
- Complete missions with fewer launch platforms
- Reduced mission cost and asset loss
- Increased weapon survivability & effectiveness



Self-Protect High Energy Laser Demonstrator (SHiELD)

\$281.4 M (FY15-21)



Description

- Integrate Laser Weapon System (LWS) into fighter fuel tank pod
- Airborne flight test of a beam control in a transonic/supersonic airspeeds & High-G flight
- Demos 50 kW-class power LWS in relevant flight environments for defeat of EO/IR based threats

Technology

- Packaged/ruggedized LWS within fighter size, weight and power (SWaP) constraints
- Aero optics mitigation at subsonic - supersonic airspeeds
- Agile, compact, large aperture flight qualified beam director
- Acquisition, Tracking, Pointing to defeat dynamic missile targets

Delivering

- Integrated LWS on legacy fighter to show self-protect from EO/IR air-air and ground-air threats
 - Demonstrate laser effectiveness in transonic environment
 - Characterize supersonic environment to strategize beam control advances
 - Flight qualified weapon system to explore next steps (component advancements, CONOPS, alternate platforms)
- Laser subsystems (Beam Control, power, cooling) scalable to higher power to increase range, number, target types engaged
- Multi-capable system for both defensive & offense use



High Power Joint Electromagnetic Non-Kinetic Strike (HIJENKS)



OBJECTIVE:

- Engage multiple challenging targets with a single weapon
- Prosecute targets previously restricted due to collateral damage concerns
- Conduct joint research and development with Navy for advanced HPM payload for Air Force and Navy applications.
- Live fire demonstration of a multi-mission/multi-target HPM payload integrated on an advanced airborne platform.

MILITARY RELEVANCE/OPERATIONAL IMPACT:

- Resolve operational issues with CHAMP
- Increase operational access/decrease cost exchange ratios
- Disrupt targets non-kinetically; reduce collateral damage while providing scalable effects.
- Disrupt land based C4I and CBRN facilities
- Disrupt left side of kill chain for shipboard C4I, sensors, and/or ECM
- Augment Electronic Warfare (EW) and/or cyber
- Engage multiple targets with a single weapon

Funding: FY17-FY21 USAF portion: \$100M

| Tasks | FY17 | FY18 | FY19 | FY20 | FY21 |
|------------------------------------|------|------|------|------|------|
| Requirements & Target Definition | ▲ | ▲ | | | |
| Technology Assessment | ▲ | ▲ | | | |
| Weapon and Target Effects Research | ▲ | | | | ▲ |
| Payload and Platform Development | ▲ | | ▲ | | |
| Hardware Integration | | ▲ | ▲ | ▲ | |
| System Testing and Evaluation | | | | ▲ | ▲ |
| Live Fire Demonstration | | | | | ▲ |

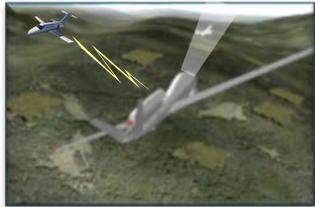


Roadmap: Autonomy

Autonomy S&T Challenges

- Trust
- Artificial Intelligence
- Cognitive & Computer Science
- Data Analytics
- Machine & Human Learning
- Reasoning Transfer btwn Domains
- Human Factors Engineering

Operating Safely & Efficiently



Air Collision Avoidance



Work-centered PED cell

Machine-Assisted Ops compressing the kill chain



Defensive systems ID threats and recommend actions beyond learned behavior



Intelligence analytic system fuzes INT data, cueing analyst of threats

Mission Continues thru A2/AD



Heterogeneous platforms negotiate & accomplish commander's intent & ROEs collectively

Precise PNT w/o GPS anywhere on earth

Today

2020

2030+

Facilitates Decisions at the Speed of Computing



U.S. AIR FORCE

Unmanned Systems

Systems of air systems yield operational agility

Now

0-5 Years

Next

5-15 Years

Future

10-25 Years

Dependence on autonomy →

Unmanned Teaming



Cooperative ISR

Cooperative Strike



Distributed, Cooperative SEAD



Manned + Unmanned Pairing



Off-Board Sensing

Def, Off Counter-Air

Air-to-Ground



Strategic Refueling

Tactical Refueling

AirLand



Manned Platform Replacement

Persistent ISR



Penetrating Strike

DE Strike



AirDrop





Gray Wolf Cruise Missile S&T Demo



DESCRIPTION

- Prototype flight demonstrations of low-cost subsonic cruise missiles that use;
 - Open architectures and modular design for rapid prototyping and spiral capability growth
 - Networked, collaborative behaviors to ensure mission success against enemy Integrated Air Defense Systems (IADS)
- Spiral demos of variant payloads (e.g., kinetic warheads, Electronic Attack, ISR) every 18 months

TECHNOLOGY

- Innovative manufacturing for low unit costs at low quantities and without long-lead timelines
- Low-cost, multi-function seekers and sensors
- Affordable and efficient small engines
- Robust networked collaborative (semi-autonomous) algorithms aligned with operator-defined CONOPs and Tactics/Techniques/Procedures
- Highly contested environment nav/comm suites
- Flexible/effective lethality in smaller form factors
- High-fidelity MS&A for op effectiveness studies

BENEFITS TO WARFIGHTER

- Affordable counter-IADs strike capability at range in highly-contested A2/AD environment
 - Range enhances launch platform survivability
 - Networked ops enhance missile navigation, survivability and target attack
- Low unit costs support affordable missile attrition and imposes high-cost adversary response
- Spiral experimentation framework provides rapid technology prototyping and provides multiple transition opportunities



Low Cost Attritable Aircraft Technology



LCAAT will enable a family of limited function, rapidly produced, low cost, attritable UAVs to augment manned systems and force a cost imposition on near peer adversaries

Amplifies Enduring Attributes Of Airpower

- Mass
- Responsiveness
- Range
- Flexibility
- Asymmetric force
- Increased risk tolerance



AFRL Weapons Truck LCAA Variant Concept

Challenge/Problem Space

- Rising costs of exquisite Air Force aircraft
“In the year 2054, the entire defense budget will purchase just one aircraft.” – Norman Augustine
- Permissive A2/AD environments



Foundational Knowledge and Planning

- Conduct ops analysis, vehicle design, lifecycle cost, industry engagement, manufacturing studies, and define technology needs
- Develop plan: reduce risks of LCAA objective systems

Technology, Capability Experimentation

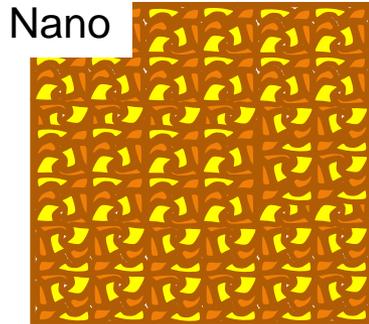
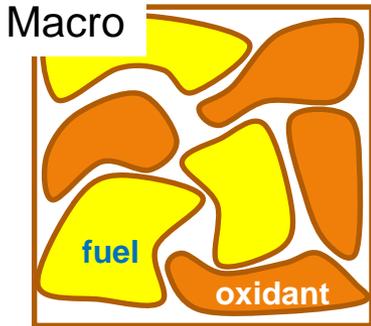
- Conduct a campaign of experiments to explore LCAAT, innovations and capabilities
- Validate cost and performance of key technologies
- Demo LCAAT in a capability context to the Warfighter



Roadmap: Nanotechnology Nano-Energetics for Weapons

NanoScience

Reaction ~ Surface Area



Today

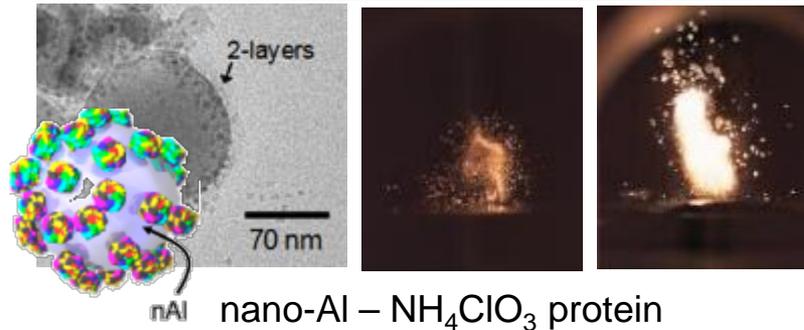
Safer & Lighter Systems



AlFA: nano-Al - fluoromethacrylate

2030

More Efficient Burn



Tomorrow Munitions

20-50% ↑ efficiency



Range

20% ↓ propellant volume



Readiness

Maximum Fuel T ↑20-40C



Delivering Precision Effects

Breaking Barriers ... Since 1947



Relevant



Agile Combat Support



Air Superiority



Space Superiority



Global Integrated ISR



Command and Control



Cyber Superiority



Rapid Global Mobility



Personnel Recovery



Nuclear Deterrence Operations



Global Precision Attack



Special Operations



Education and Training



Technology for near- and mid-term warfighter needs

Breaking Barriers ... Since 1947



Small Advanced Capabilities Missile (SACM) Demonstration



DESCRIPTION

- Develop and demonstrate various system and sub-system critical technologies to enable the next generation air dominance missile for the 2030 Air Superiority mission

TECHNOLOGY

- Advanced airframe design
- Improved solid rocket motor (Highly loaded grain)
- Synergistic control (combined aero, attitude control and thrust vectoring)
- Compressed carriage techniques
- High lethality, small size/weight ordnance
- Hyper-Agility
- Energy optimizing GN&C

BENEFITS TO WARFIGHTER

- High loadout for enhanced sortie effectiveness
- Increased maneuverability ensures higher single-shot Pk
- Dramatically improved high off bore sight for rear hemisphere kills
- Increased range
- Lower cost per kill



Manufacturing Technology Vision Applied to Air Force Priorities

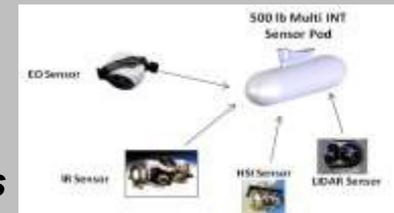
Next Generation Agile Manufacturing



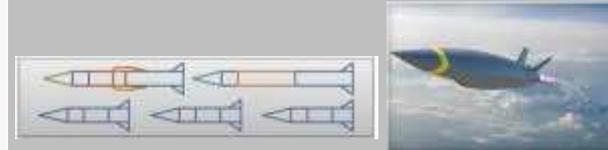
Select Applications Advanced Turbine Engines



ISR Open Systems



Weapons



F-35



Complex of the Future



Technology Efforts:

- Moving Manufacturing Left



- Cradle to Cradle Digital Thread



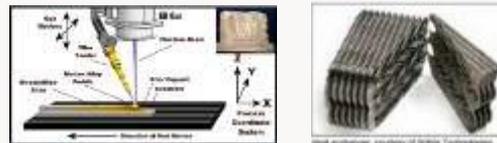
- Factory of the Future



- Responsive, Integrated Supply Base



Ex: Additive Manufacturing

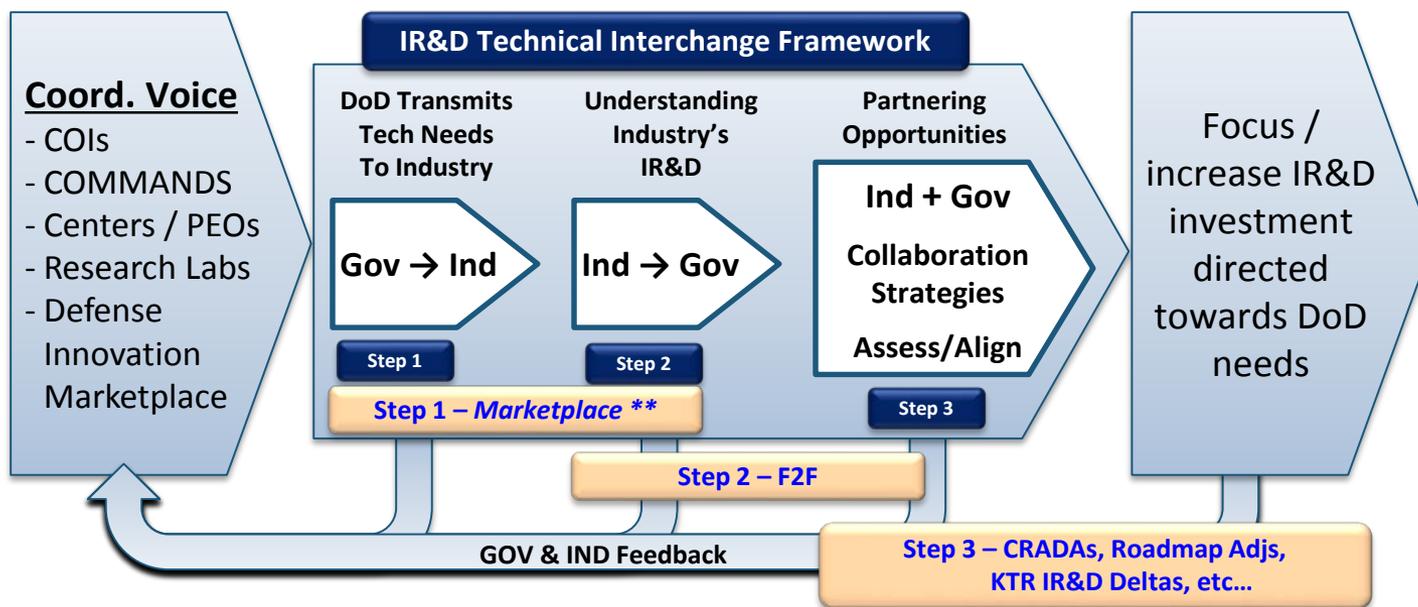


Ex: Digital Thread





IMPLEMENTATION IR&D INTERCHANGE FRAMEWORK





Upcoming AF IR&D Engagements

| Month | Meeting | Location |
|--------------|--|------------------------------|
| Jun | 2017 HS COI IR&D TIM | Washington DC |
| Aug | 2017 C4ISR & CyberSCF IR&D TIM | Rome NY |
| Sep | 2017 AFGSC NDO Innovation Summit | Barksdale AFB, LA |
| Dec | 2017 Space SCF IR&D TIM | TBD |
| Jan | 2018 Weapons COI IR&D TIM | TBD |
| Mar | 2018 Personnel Recovery SCF IR&D TIM | TBD |
| Apr | 2018 Advanced Electronics COI IR&D TIM | TBD |
| May | 2018 Nuclear Deterrence Operations SCF IR&D TIM | TBD |
| Jun | 2018 Autonomy COI IR&D TIM | TBD |
| Aug | 2018 Sensors COI IR&D TIM | TBD |
| Oct | 2018 Air Platforms COI IR&D TIM | TBD |



AFRL Commercialization and Innovation Toolbox



THE
COMMERCIALIZATION
ACADEMY



SMALL BUSINESS HUB
AT WRIGHT BROTHERS INSTITUTE



Defense Technology
Accelerator Group



WRIGHT BROTHERS INSTITUTE -
DOWNTOWN: AN AFRL PARTNERSHIP



Wright Brothers Institute



Breaking Barriers ... Since 1947



UNITED STATES AIR FORCE



INDUSTRIAL STRATEGY INITIATIVE
GAME CHANGER SYNTHESIS
MAKER-BEYOND
DATA LEGACY CYBER
CONNECTION
AGILE COMBAT
NEXT GENERATION
COMMERCIALIZATION
INNOVATION
SUSTAIN
EFFICIENT FUNDS
HIGH TECH CONTRACT
COMPOSITE
DEPLOY
RESEARCH TECHNOLOGY TRANSFER
PRODUCT VET
INTEGRATION
INTELLECTUAL PROPERTIES
BUSINESS PRACTICES

Small Business Programs



AIR FORCE RESEARCH LABORATORY SMALL BUSINESS DIRECTORATE
SMALL SOURCE | RIGHT VALUE | BIG PERFORMANCE



Connect with AFRL



SMALL BUSINESS HUB AT WRIGHT BROTHERS INSTITUTE

The Small Business Hub was created to link entrepreneurs, businesses, industry and governmental organizations in support of tech driven business growth, strengthening the Air Force industrial base and commercializing technologies for new market opportunities. It was established in 2014 as a dual effort by the Wright Brothers Institute (WBI) and the Air Force Research Lab (AFRL).

COLLIDERS

Free and open business events, known as *Colliders*, are hosted by the Small Business Hub to drive opportunity discovery and identify supporting resources. Attendance allows for engagement with fellow community members from business, government and academic circles.

Focused around technology, entrepreneurship, and business growth, there are four styles in the Collider Series, each of which offers a networking component. These include:

- **Information Series** - educational or learning sessions
- **Partnership Series** - networking, partnership opportunities, matchmaking, Q&A panels, and problem solving
- **Innovative Technology Series** - targets specific leading-edge research areas and technology needs
- **Regional Ecosystem Series** - cross-promotes events happening throughout the region

ONE-ON-ONES

While the Collider Project is a resource that enables connections to happen organically, the Small Business Hub also works to formally engage individuals and organizations through

Dayton, OH
 Founded Aug 7, 2014

Members: 703

Group reviews: 24

Upcoming Meetups: 11

Past Meetups: 124

Our calendar

Organizers:

Jim Masonbrink, Bill Harrison, Lee McFawn, Ryan Clarke, Ryan Holbooh

GET CONNECTED

▶ COLLIDER EVENTS ▶ SOCIAL MEDIA ▶ WEB SITES

AFRL SMALL BUSINESS HUB

WRIGHT BROTHERS INSTITUTE
 5000 SPRINGFIELD ST | SUITE 100 | PATTERSON ROOM
 WRIGHT POINT OFFICE PARK | DAYTON OHIO 45431

In 2014, the Small Business Hub was formed with the Air Force Research Laboratory to attract innovative small businesses to solve tough Air Force problems, strengthen the Air Force industrial base and to commercialize AFRL technologies. Three of the primary services provided are Colliders, One-on-Ones and Electronic tools.

Colliders are free and open business events that promote a networking and a social component for government, academia, and businesses to engage in topics focused around technology, entrepreneurship and business growth.

There are four styles in the Collider series: Information, Partnership, Innovative Technology and Regional Ecosystem.

Register for Collider event notifications at www.meetup.com/collider

One-on-Ones allow representatives from small businesses, industry, AFRL and other regional assets to interconnect organically and the needs and capabilities are needed and connect them to the right person or organization in the region.

Electronic tools provide 24 hour-a-day, seven days-a-week access to a toolkit that allows innovative small businesses to capture opportunities and build symbiotic relationships and partnerships with others in their ecosystems. (See back)

AIR FORCE | SMALL BUSINESS OPPORTUNITIES RESEARCH AND DEVELOPMENT

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www.facebook.com/afslbsttr
www.facebook.com/AirForce2

Twitter
 Small Business Hub @AFRLBIZHub
 Small Business Director @AFRLSBDirector
 Air Force SBIR/STTR @AF_SBIR_STTR

YouTube
www.youtube.com/channel/UCb3EQFNKopw5Fv0rAKT8g



DEFENSE INNOVATION MARKETPLACE

HOME BUSINESS OPPORTUNITIES COMMUNITIES OF INTEREST NEWS / EVENTS PAGES

Your Centralized Resource for R&D Market Research

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 IR&D Searchers

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WHAT'S NEW

Solicitations

- Navy E-Strike Data Collection Program Software Products
- Army RPT: Prioritizing Beliefs between using Automatic Floor Placement Methods
- Army Potential Solutions to Integrate the Identification of Trends in the Applications
- Air Force Capabilities for Cyber Mission Assurance
- Army HWS/ST/AN LMA based Region/Info
- Navy F&A Increment 3 Platform Integration
- Air Force Research and Development for Electro-Optical and Radio Frequency Sensor (EO/ROFP)

Strategic Documents

- Mobility Air Force Strategic Vision - 2010
- Army Posture Statement
- Air Force Strategic Master Plan

Events

- NSA C2X National Small Business Conference ** Sep 24
- AUSA Annual Meeting Conference ** Oct 12-14
- OSA 2015 Forecast to Industry ** Nov 2-11

Better Buying Power 3.0

CONNECTING INDUSTRY AND DOD

NEW BUSINESS OPPORTUNITIES

Have a solution to a DoD Technology need? Find links to:

- IRFA
- RFPs
- Procurements

TECHNOLOGY INTERCHANGE MEETINGS

TIIMs allow DoD and industry/academia to cooperate on R&D technology challenges.

- Aeronautical Enterprise (Oct. 16-22)
- Air Force Space Enterprise (Dec. 7-11)
- Cyberbase (Feb. 20-28)

DEFENSE INNOVATION INITIATIVE (DI)

The DI is an effort to identify and invest in innovation for the future.

- Defense Innovation Unit - Experimental (DIUx)
- Long-Range Research and Development Planning Program (LRORPP)

STRATEGIC DIRECTION

Where is the Department of Defense headed? Gain insight by linking to key DoD and Services information.

- Strategic Documents

SMALL BUSINESS RESOURCES

Small Business Resources can help your growing enterprise.

- Small Business Innovation Research (SBIR) program
- Rapid Innovation Fund

NEWS / EVENTS

What DoD news, events, or meetings do you need to know about?

- News
- Events
- Weekly SET Bulletin

CONNECTING INDUSTRY AND DOD

HOME IMAGE GALLERY AIR&S INNOVATION AIR IR&A USA 2015 ADDRESS/CONTACT INFO 161-752-4400 WEB FEED HOME INFO CONTACT US

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Development Planning

- **New Capability Development (CD) paradigm driving changes to AF Development Planning**
 - **Centralized planning of all DP activities in accordance with Capability Development Council governance**
 - **Seamless, multi-domain integration across the AF enterprise**
- **SDPE office working with CDC/CDWG to support CD**
 - **Partnered with LCMC, NWC and SMC for Development Planning and experimentation**
 - **Multi-domain analytics**
 - **Coordinated with M&S Tri-Chair governance**
 - **Partnered with HAF/A9 to assess CD effectiveness**
 - **Implement AS2030 Flight Plan**
 - **Support MDC2 ECCT Flight Plan development/implementation**



ECCTs and Experimentation

ECCT

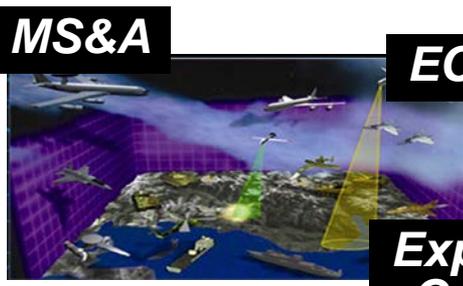
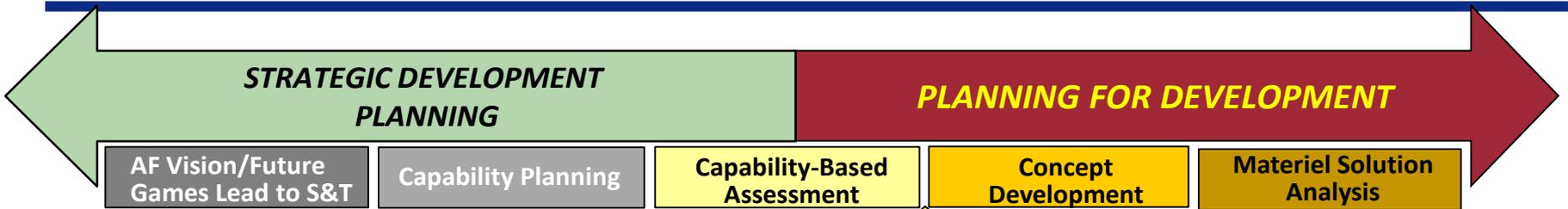
- **Focus on cross-cutting enterprise-wide mission areas**
- **Bring together users and operators from all Air Force domains and core functions, along with the requirements, acquisition and science and technology communities**
- **Develop defendable, achievable and affordable solutions**
- **Appointed by the HAF**

Experimentation

- **Explore and assess the operational value and technological feasibility of a new technology or concept**
- **Experimentation activities include workshops, wargaming, simulation, and field experimentation**
- **Build an evidence-based case for a capability development course of action**



Evolving Development Planning



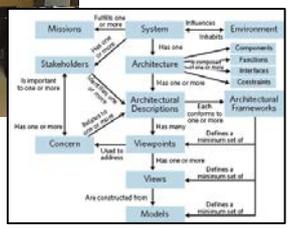
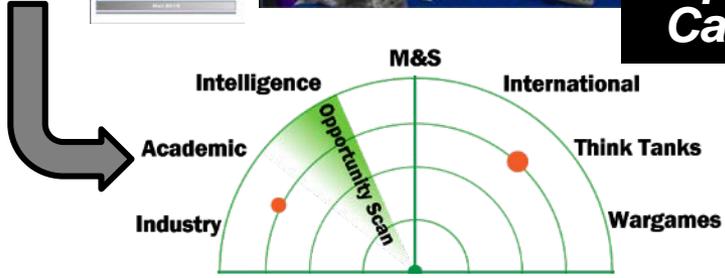
ECCTs

ICD MDD

Flight Plans

Experimental Campaigns

AoA CDD A



NEEDS/OPPORTUNITIES

INTEGRATED CAPABILITIES

Solutions Span DOTMLPF-P Spectrum

Breaking Barriers ... Since 1947



Current Experimentation Activities

Light Attack Experiment

- Explore COTS light attack aircraft capability to support prolonged operations in permissive environments for counter insurgency/terrorism operations
- Flight Experiments planned for summer 2017

Data To Decisions (D2D) Experiment

- Collect, aggregate, fuse, and distribute data across the multi-domain battlespace to enable and enhance mission effects chain closure
- Initial 2-year campaign (FY17-18) will establish COAs for follow-on experimentation and development

Defeat of Agile Intelligent Targets (DAIT) Experiment

- Defeating targets that change and adapt location and signature across multiple domains
- Developing CONOPS for phase 1 experimentation

Directed Energy Weapon (DEW)

- Explore DEW concepts to support joint battlespace operations
- DEW Flight Plan in coordination for CSAF/SECAF signature



Summary

- S&T portfolio aligned to Air Force Strategy and Core Function Support Plans
- Continue to emphasize technologies that are revolutionary, relevant and responsive
- Increased the use of experimentation and prototyping -- Leveraging partnerships with OSD and DARPA

