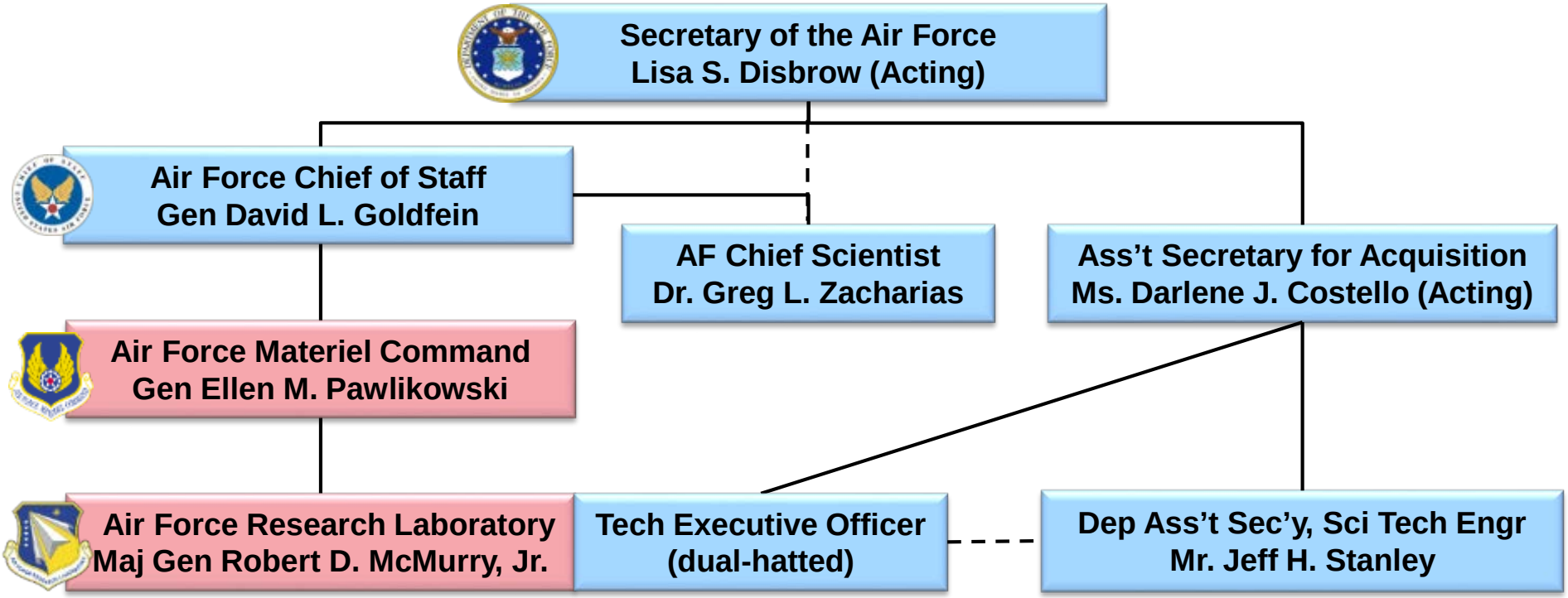
Headquarters U.S. Air Force

Integrity - Service - Excellence

Air Force Science and Technology Program

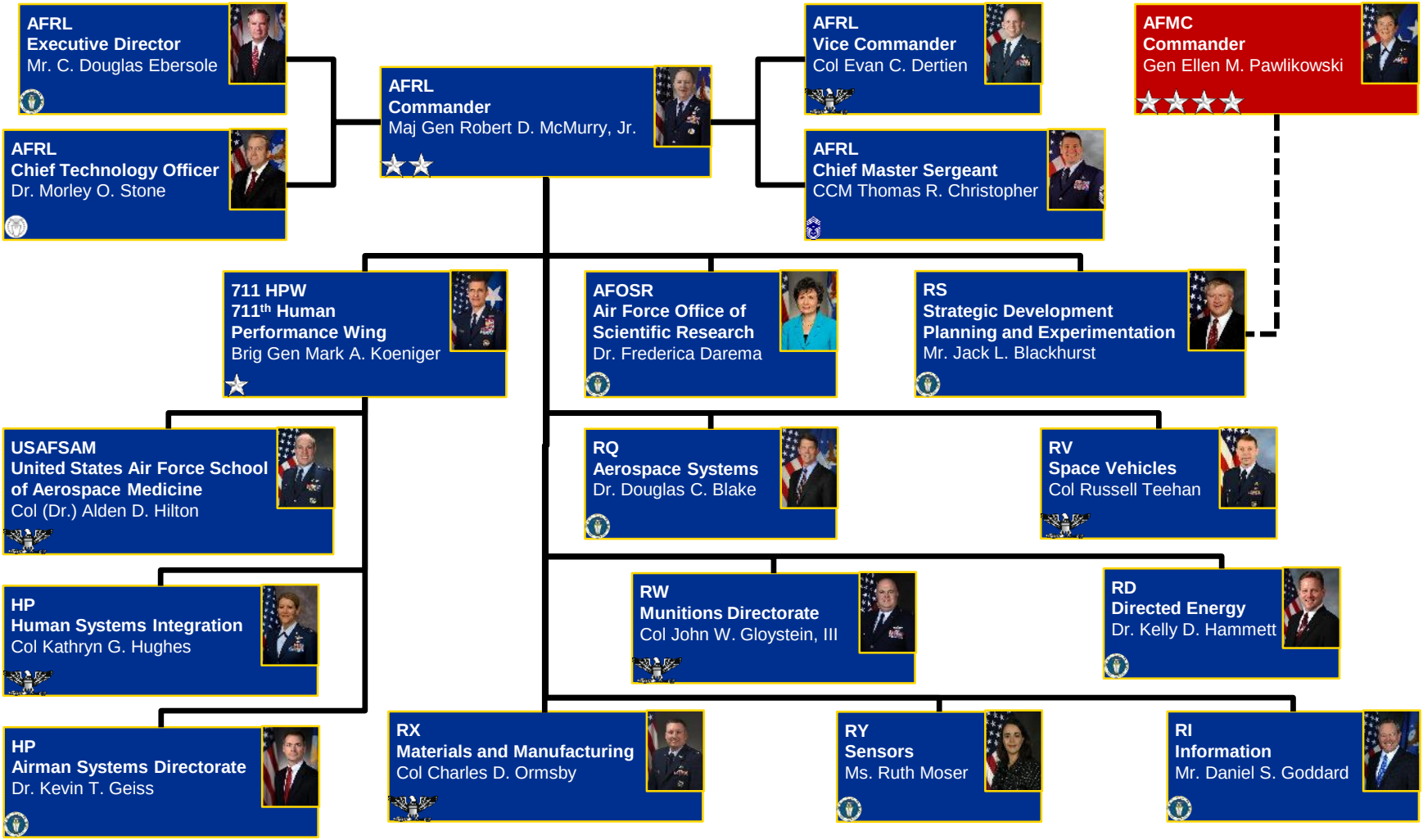
Mr. Jack L. Blackhurst
Director, Plans and Programs Directorate
and Director Strategic Development
Planning and Experimentation Directorate
Air Force Research Laboratory

Air Force S&T Organization

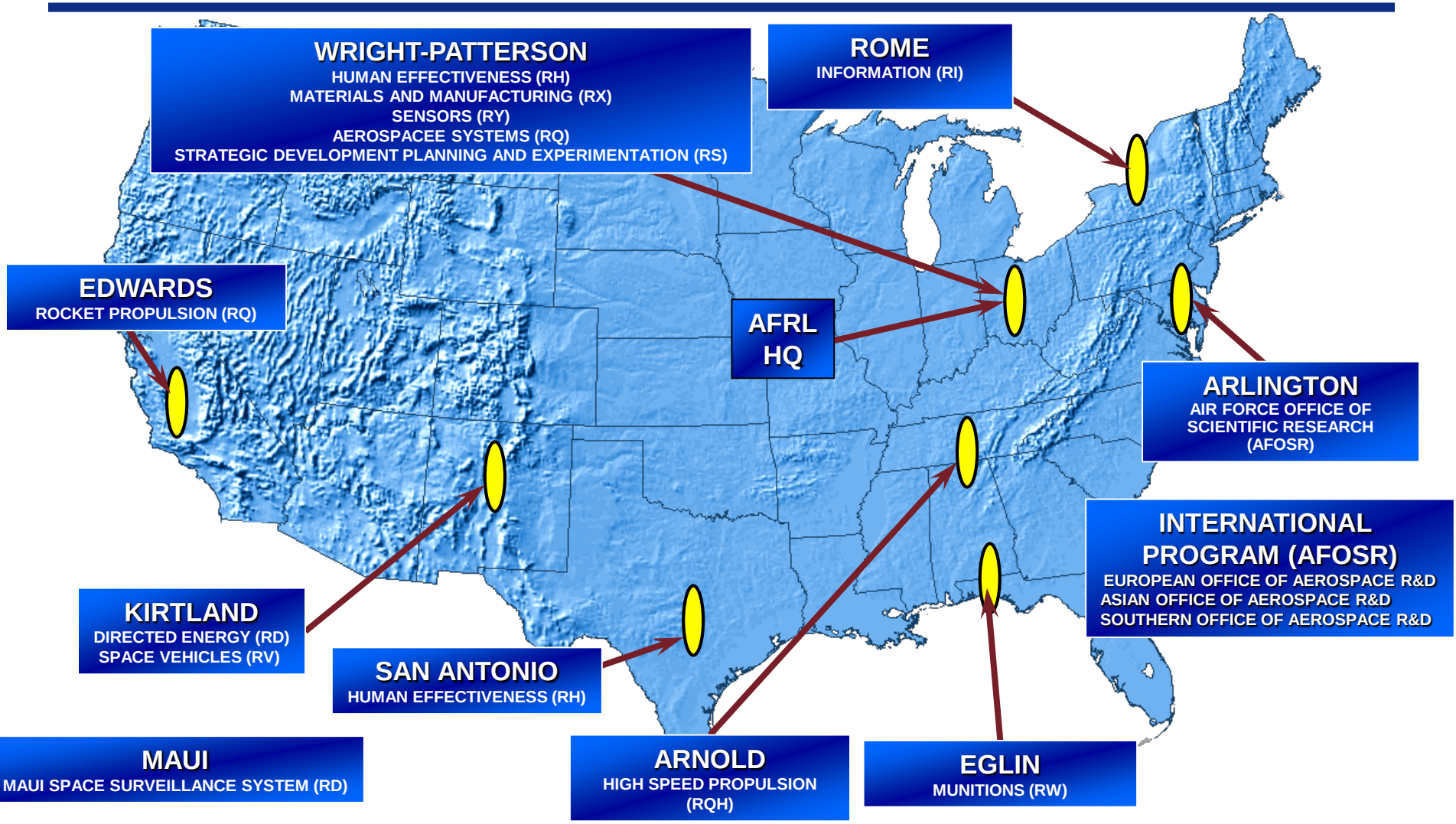


- AFRL/CC under AFMC, dual-hatted as Technology Executive Officer to SAE
- SAF/AQR provides S&T guidance and oversight for SAE
- AF Chief Scientist under the CSAF advises SECAF and CSAF
- Scientific Advisory Board (SAB) reviews research quality and advises SECAF and CSAF on topics of interest

Air Force Research Laboratory

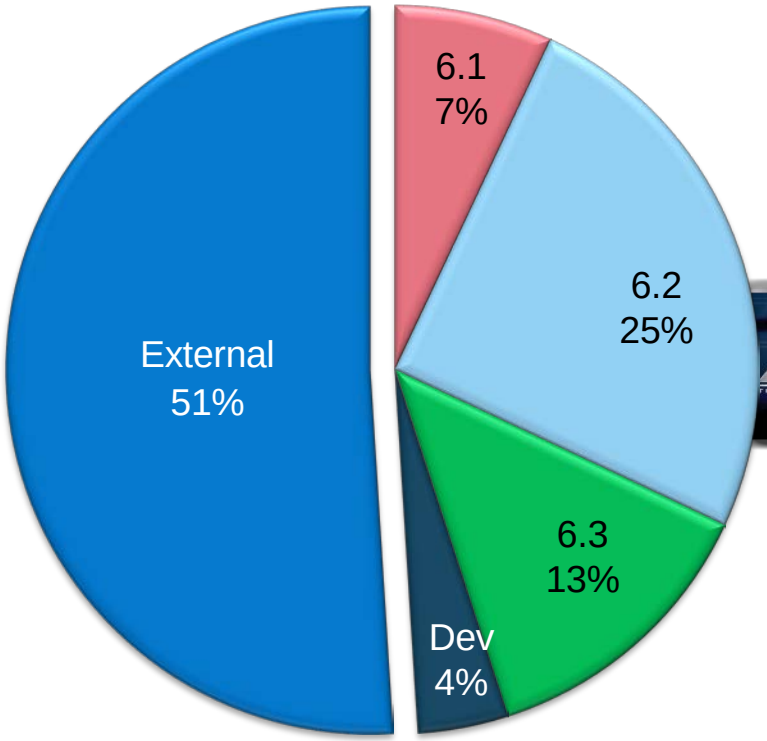


Major AFRL Facilities

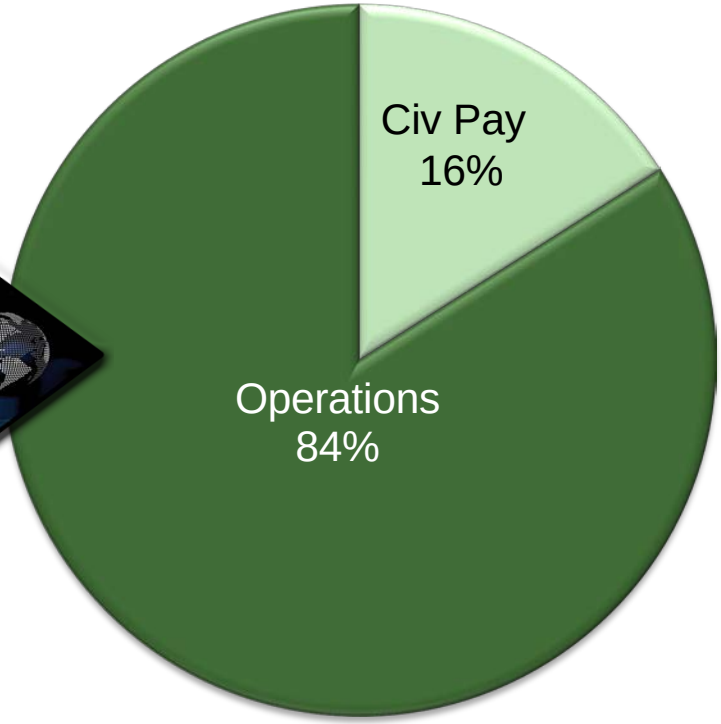


AFRL Funding FY16

All Sources: $5.065B



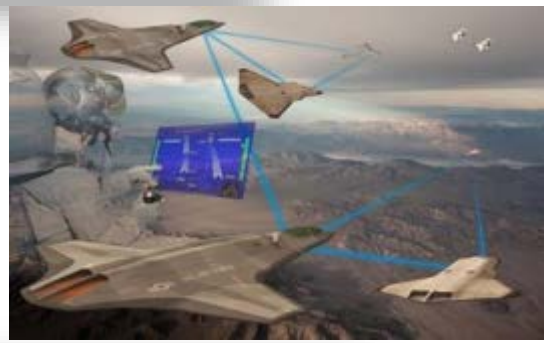
Core Execution (Total S&T $2.422B)



(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

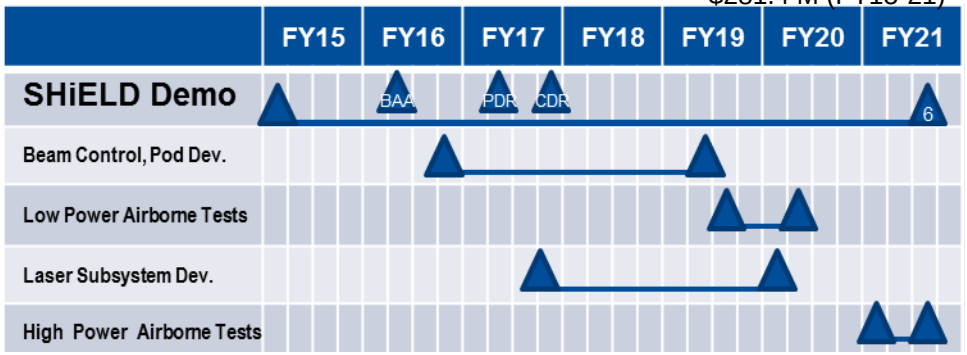
- Tactical Boost Glide (TBG) weapon - rocket boost and glide vehicle
- Hypersonic Air-breathing Weapon Concept (HAWC) - rocket boost, scramjet, airframe
- Technology challenges include aerodynamics, thermal and structural loads, materials, systems integration, aero-propulsion integration
- HSSW Technology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

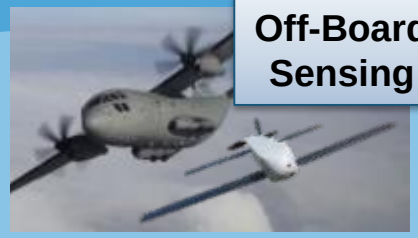
Unmanned Teaming

Cooperative ISR

Cooperative Strike

Distributed, Cooperative SEAD

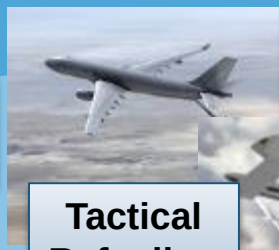
Manned + Unmanned Pairing



Off-Board Sensing

Air-to-Ground

Def, Off Counter-Air



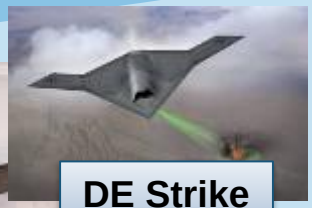
Tactical Refueling

Strategic Refueling

Manned Platform Replacement

Persistent ISR

Penetrating Strike



DE Strike

AirDrop

AirLand

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 <u>cost imposition</u> 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

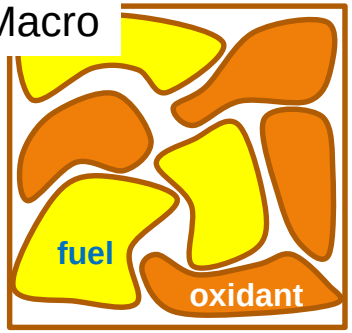
Roadmap: Nanotechnology

Nano-Energetics for Weapons

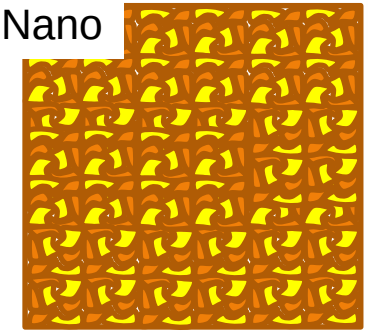
NanoScience

Reaction ~ Surface Area

Macro



Nano



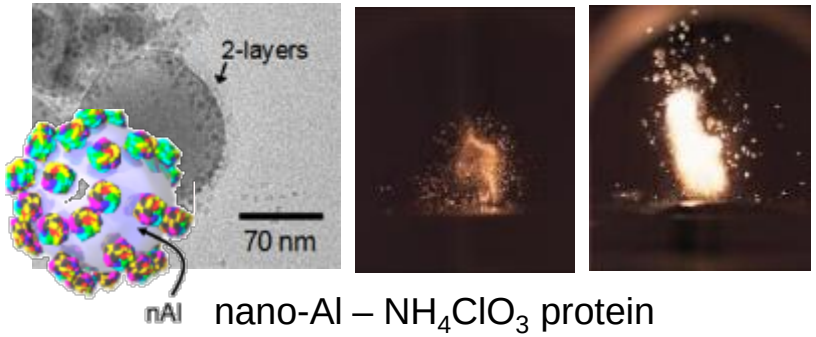
Today

Safer & Lighter Systems

AlFA: nano-Al - fluoromethacrylate

2030

More Efficient Burn



nano-Al – NH_4ClO_3 protein

Tomorrow

Munitions

20-50% ↑ efficiency

Range

20% ↓ propellant volume

Readiness

Maximum Fuel T ↑20-40C

Delivering Precision Effects

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

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

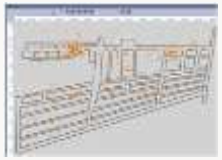
Manufacturing Technology Vision
Applied to Air Force Priorities

Next Generation Agile Manufacturing

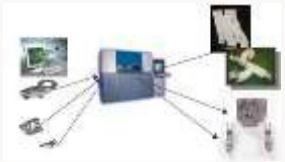
Technology Efforts:

- **Moving Manufacturing Left**

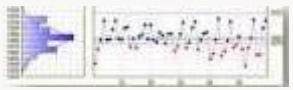

- **Cradle to Cradle Digital Thread**




- **Factory of the Future**




- **Responsive, Integrated Supply Base**

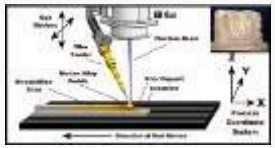
AFRL and Partners

Joint Defense ManTech Panel

ENERGY | Advanced Manufacturing Partnership

DARPA

Ex: Additive Manufacturing



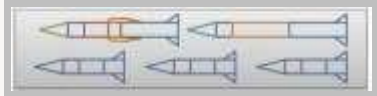

Ex: Digital Thread

Select Applications

Advanced Turbine Engines

ISR Open Systems

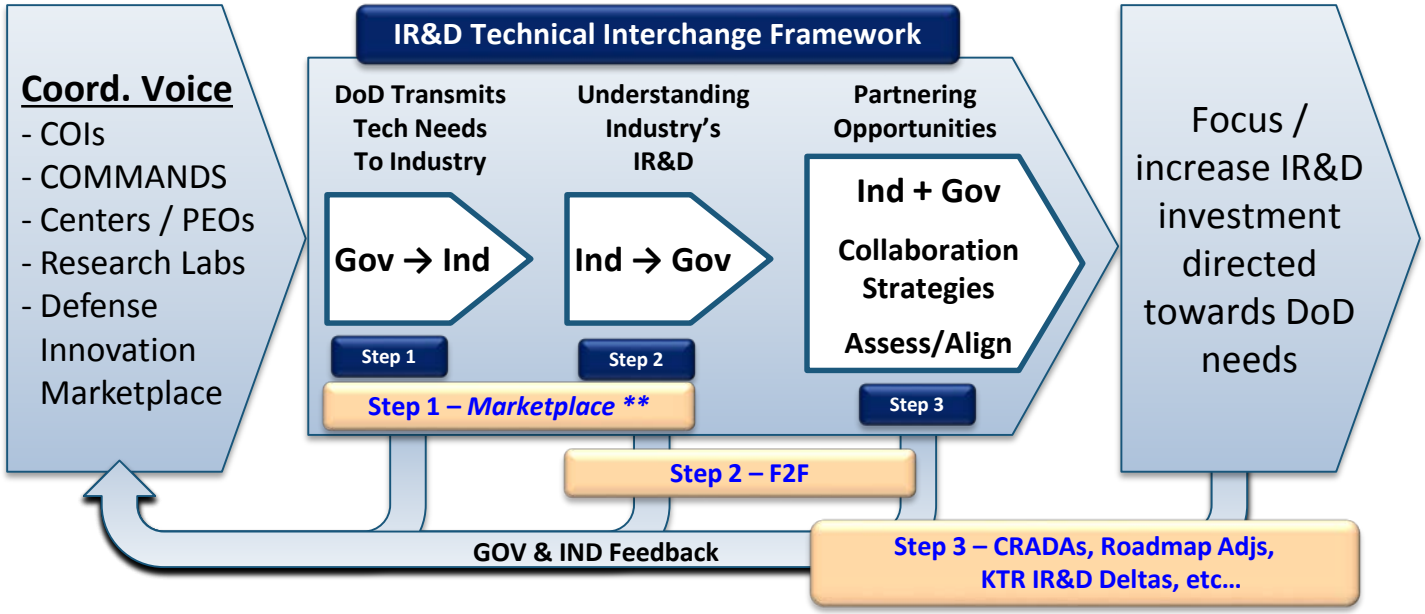
Weapons




F-35

Complex of the Future

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

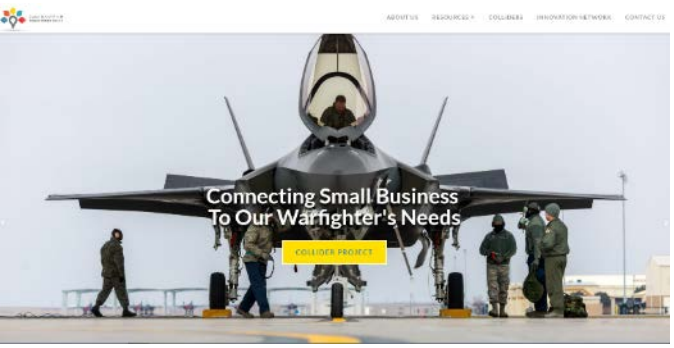
UNITED STATES AIR FORCE

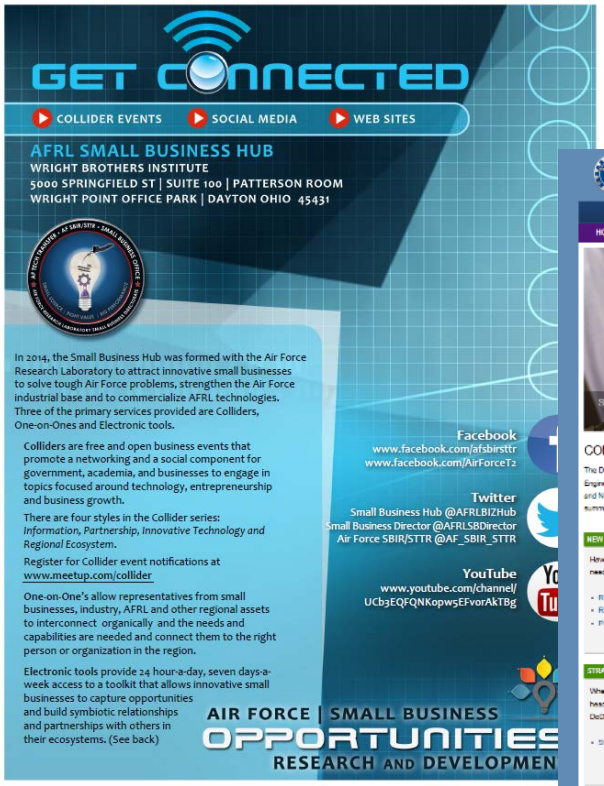
Small Business Programs

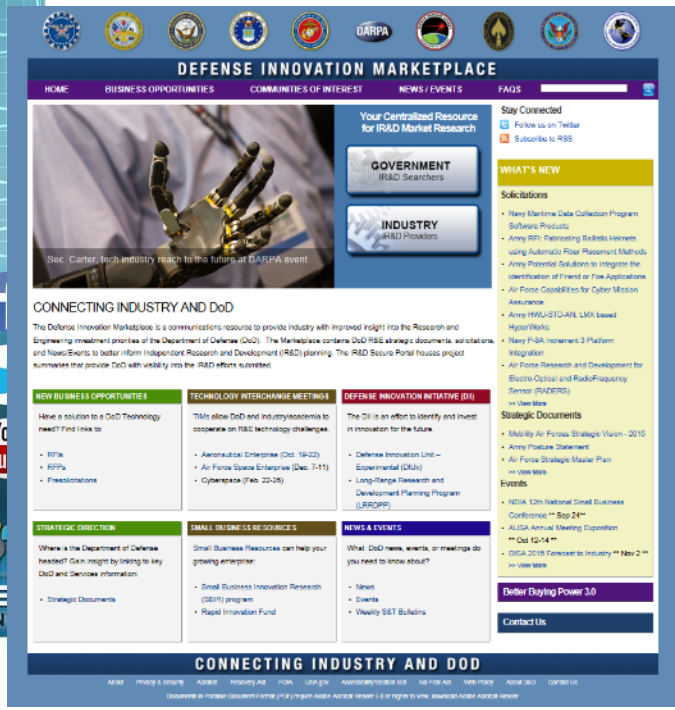
AIR FORCE RESEARCH LABORATORY SMALL BUSINESS DIRECTORATE

SMALL SOURCE | RIGHT VALUE | BIG PERFORMANCE

Connect with AFRL







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

STRATEGIC DEVELOPMENT PLANNING → **PLANNING FOR DEVELOPMENT**

AF Vision/Future Games Lead to S&T	Capability Planning	Capability-Based Assessment	Concept Development	Materiel Solution Analysis

MDD

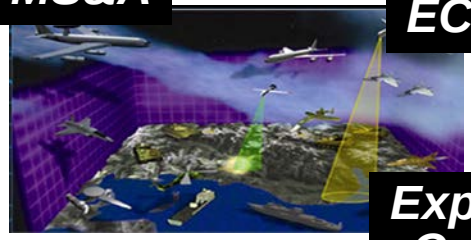
ICD

AoA

CDD

A

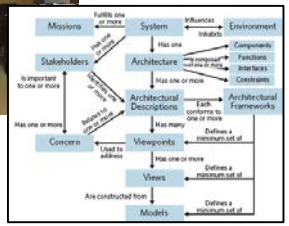
MS&A

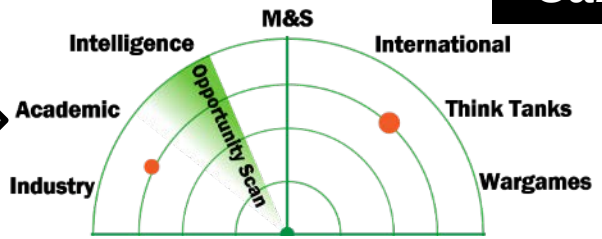


ECCTs

Flight Plans

Experimental Campaigns





NEEDS/OPPORTUNITIES → **INTEGRATED CAPABILITIES**

Solutions Span DOTMLPF-P Spectrum

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