Air Force S&T Organization

- **Secretary of the Air Force**
  - Lisa S. Disbrow (Acting)

- **Air Force Chief of Staff**
  - Gen David L. Goldfein

- **Air Force Materiel Command**
  - Gen Ellen M. Pawlikowski

- **Air Force Research Laboratory**
  - Maj Gen Robert D. McMurry, Jr.
  - Tech Executive Officer (dual-hatted)

- **Ass’t Secretary for Acquisition**
  - Ms. Darlene J. Costello (Acting)

- **Dep Ass’t Sec’y, Sci Tech Engr**
  - Mr. Jeff H. Stanley

- **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**
Major AFRL Facilities
AFRL Funding FY16

All Sources: $5.065B

- External: 51%
- Dev: 4%
- Operations: 25%
- 6.1: 7%
- 6.2: 13%

Core Execution (Total S&T $2.422B)

- Civ Pay: 16%
- Operations: 84%

(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)

### 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)

**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

**Funding**

$281.4 M (FY15-21)
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

<table>
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<th>Tasks</th>
<th>FY17</th>
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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

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

Facilitates Decisions at the Speed of Computing

Air Collision Avoidance
- Work-centered PED cell

Today 2020 2030+

Breaking Barriers ... Since 1947
Unmanned Systems

Systems of air systems yield operational agility

**Now**
5-15 Years

- Cooperative Teaming
- Off-Board Sensing
- Persistent ISR
- Maned + Unmanned Pairing
- Manned Platform Replacement
- Cooperative Strike
- Air-to-Ground Strike
- Penetrating Strike
- DE Strike

**Future**
10-25 Years

- Distributed, Cooperative SEAD
- Strategic Refueling
- Tactical Refueling
- AirLand
- AirDrop
- Def, Off Counter-Air
- Persistent ISR
**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

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

Fuel

Oxidant

Nano

Safer & Lighter Systems

More Efficient Burn

Today

AIFA: nano-Al - fluoromethacrylate

2030

NanoScience

Delivering Precision Effects

B r e a k i n g  B a r r i e r s  ...  S i n c e  1 9 4 7

Tomorrow

Munitions

20-50% ↑ efficiency

Range

20% ↓ propellant volume

Readiness

Maximum Fuel T ↑20-40C

deco2protonStructural

nano-Al – NH₄ClO₃ protein
Relevant Technology for near- and mid-term warfighter needs

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

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
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

Select Applications

Advanced Turbine Engines

ISR Open Systems

Weapons

F-35

Complex of the Future
IMPLEMENTATION
IR&D INTERCHANGE FRAMEWORK

Coord. Voice
- COIs
- COMMANDS
- Centers / PEOs
- Research Labs
- Defense Innovation Marketplace

IR&D Technical Interchange Framework

Step 1 – Marketplace **
DoD Transmits Tech Needs To Industry
Gov → Ind

Step 2 – F2F
Understanding Industry’s IR&D
Ind → Gov

Step 3 – CRADAs, Roadmap Adjs, KTR IR&D Deltas, etc...
Partnering Opportunities
Ind + Gov Collaboration Strategies
Assess/Align

Focus / increase IR&D investment directed towards DoD needs

GOV & IND Feedback
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<tr>
<th>Month</th>
<th>Meeting</th>
<th>Location</th>
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<td>Jun</td>
<td>2017 HS COI IR&amp;D TIM</td>
<td>Washington DC</td>
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<tr>
<td>Aug</td>
<td>2017 C4ISR &amp; CyberSCF IR&amp;D TIM</td>
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<tr>
<td>Sep</td>
<td>2017 AFGSC NDO Innovation Summit</td>
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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

<table>
<thead>
<tr>
<th>ECCT</th>
<th>Experimentation</th>
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<tr>
<td>Focus on cross-cutting enterprise-wide mission areas</td>
<td>Explore and assess the operational value and technological feasibility of a new technology or concept</td>
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<tr>
<td>Bring together users and operators from all Air Force domains and core functions, along with the requirements, acquisition and science and technology communities</td>
<td>Experimentation activities include workshops, wargaming, simulation, and field experimentation</td>
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<td>Develop defendable, achievable and affordable solutions</td>
<td>Build an evidence-based case for a capability development course of action</td>
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<td>Appointed by the HAF</td>
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*Breaking Barriers ... Since 1947*
Evolving Development Planning

NEEDS/OPPORTUNITIES

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