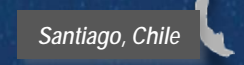




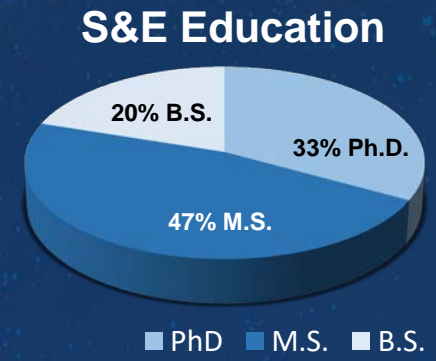
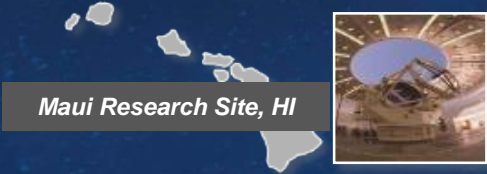
# AFRL Munitions Directorate Overview

DR. DAVID LAMBERT, CHIEF SCIENTIST  
MUNITIONS DIRECTORATE, 4 JUNE 2019

# A World-Wide Enterprise of Researchers



International Sites



	Employees	Civilian	Military
<b>Total</b>	5,827	79%	21%
<b>S&amp;Es</b>	3,455	80%	20%

# Core Technical Competencies (CTC)

## MATERIALS & MANUFACTURING



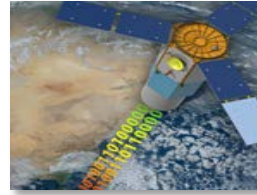
Structural Materials, Functional Materials, Manufacturing Technologies, Support for Operations

## HUMAN PERFORMANCE



Training, Decision-making, Bioeffects, Human Centered ISR

## SPACE VEHICLES



Advanced Space Resilience Technologies, Space Communication & Navigation Technologies, Space Awareness and Command & Control, Space Environment

## INFORMATION



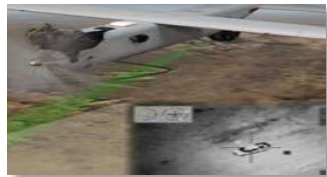
Autonomy, Command & Control, and Decision Support, Processing & Exploitation, Cyber Science Technology, Connectivity & Dissemination

## BASIC RESEARCH



Engineering & Information Sciences, Physical & Biological Sciences

## SENSORS



Spectrum Warfare, Trusted & Resilient Mission Systems, Multi-domain Sensing Autonomy, Enabling Devices & Components, Radio Frequency (RF) Sensing, Electronic Optic (EO) Sensing

## AEROSPACE SYSTEMS



Aerospace Vehicles, Control, Power & Thermal Management, High Speed Systems, Rocket Propulsion, Turbine Engines

## DIRECTED ENERGY



High Power Electromagnetics, Laser Systems, Ground-based Electro-optical /Infrared Space Situational Awareness

## MUNITIONS



Ordnance Sciences, Terminal Seeker Sciences, Munitions, Airframe, Guidance, Navigation & Control, Modeling & Simulation, Evaluation Sciences

## EXPERIMENTATION



Capability & Technology Prototyping



# Future Technologies - Big Bets



## QUANTUM INFORMATION SCIENCE

Harnesses certain laws of particle physics to dramatically improve the acquisition, transmission and processing of information.

Applications include computing, communication and sensing. Quantum can be used to teleport information, create secure communication networks, gather location data in GPS-denied environments and enhance supercomputing capabilities.



## ARTIFICIAL INTELLIGENCE / AUTONOMY

Facilitates the use of machine generated information by creating knowledge from observations gathered.

AI can provide expertly-planned courses of action, streamline business processes, enhance situational awareness and increase mission effectiveness. It could save time, money, manpower and lives.



## DIRECTED ENERGY WEAPONS

Strike critical targets at the speed of light and defeat attacks in an effective, affordable and expedient manner.

DEWs precisely engage targets with little to no collateral impacts or detectable disturbance. They can be integrated with aircraft, munitions or used on the ground.



## HYPERSONICS

Flying at five times the speed of sound, also known as Mach 5 or higher.

Hypersonic flight could enable the U.S. to conduct longer range military operations with shorter response times and enhanced effectiveness.

## AFRL Munitions Directorate

# Mission

**Lead** the discovery, development, integration,  
and transition of **affordable** weapons  
technology, enabling the warfighter to **win**  
**across all domains**

# Air Force 2030 S&T Strategy

## Three Objectives

1

### Develop and Deliver Transformational Strategic Capabilities

- Global Persistent Awareness
- Resilient Information Sharing
- Rapid, Effective Decision Making
- Complexity, Unpredictability & Mass
- Speed and Reach of Disruption ~~and~~ lethality

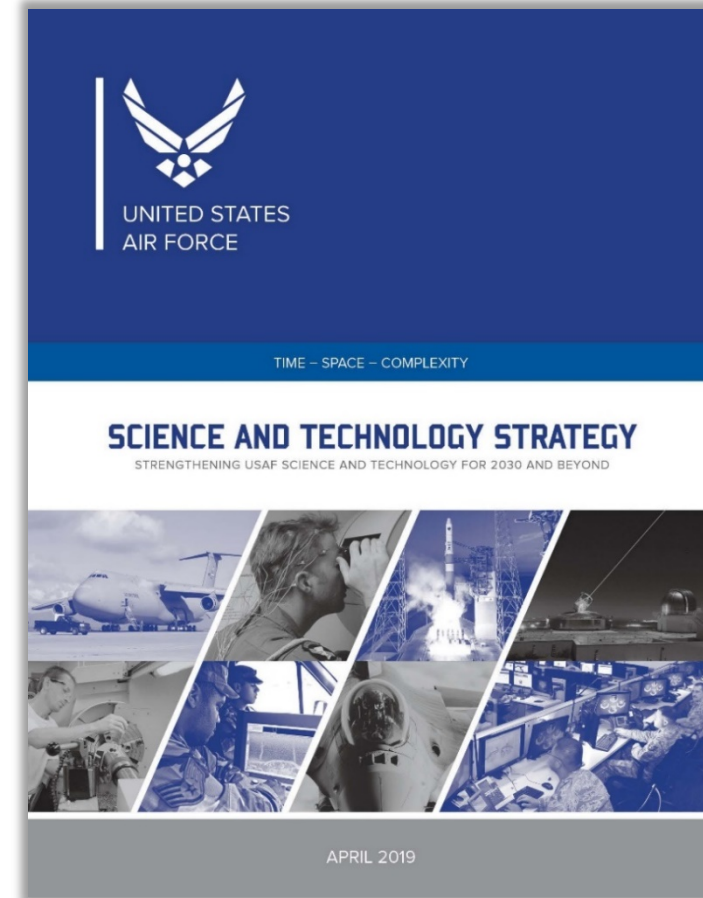
2

### Reform the Way Science & Technology is ~~Managed~~ Leveraged

3

### Deepen and Expand the Scientific and Technical Enterprise

- Engage and Support a Technical and Driven Workforce
- Drive Innovation Through Partnerships





# Tech Opportunities to Align to AF 2030 S&T Strategic Capabilities

Speed & Reach of Disruption and Lethality	Complexity, Unpredictability, & Mass	Global Persistent Awareness	Resilient Information Sharing	Rapid, Effective Decision Making
<ul style="list-style-type: none"> <li>• Hypersonic Weapons</li> <li>• Lowcost, networked cruise missiles <u>AND</u> <u>smart</u> munitions</li> <li>• Increased energy coupling / efficiency</li> <li>• Agility on the edge</li> </ul>	<ul style="list-style-type: none"> <li>• Collaborative autonomy and swarming</li> <li>• Lowcost air and space platforms</li> <li>• Agile digital and AM</li> <li>• Cooperative lethality</li> <li>• Nontraditional effects</li> <li>• Multifunctional / adaptive endgame</li> </ul>	<ul style="list-style-type: none"> <li>• Microelectronics, photonics, and materials</li> <li>• Distributed multimodal sensing</li> <li>• New sensing modalities</li> <li>• Servicebased functionality</li> </ul>	<ul style="list-style-type: none"> <li>• Alternative navigation methods</li> <li>• Mesh networking and topology management</li> <li>• Software defined, agile systems with realtime spectrum awareness</li> <li>• BDA / BDI</li> </ul>	<ul style="list-style-type: none"> <li>• Artificial Intelligence: machine learning and machinebased reasoning</li> <li>• Data fusion and visualization</li> <li>• Digital twin</li> <li>• Software Defined Radios</li> </ul>

Not All Inclusive Other Technologies Should be Considered

# Networked / Autonomy Technologies



## Complexity, Unpredictability, & Mass

Overwhelm & Confuse

Survivable

Stand-Off Capability

Low Cost / Cost-Imposing

Responsive / Flexible Attack

Cooperative

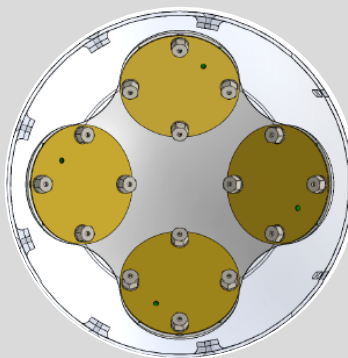
## Tech Enablers



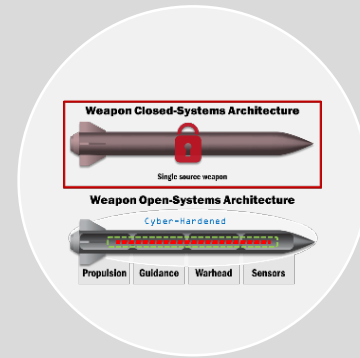
Low-Cost Engine Tech



Cooperative Algorithms & Autonomy Modules



Low-Cost DF Sensors, Nav, & Comms



Weapons Open Systems Architectures



Mission Planning Playbooks



# Hypersonic Weapons Technologies



## Speed & Reach of Disruption and Lethality

Engage Time Sensitive Targets

Provides Flexibility & Precision

Survivable

Enhanced Effectiveness

Stand-Off Capable

Sustain Technology Superiority

## Tech Enablers



Solid-rocket-motor technologies



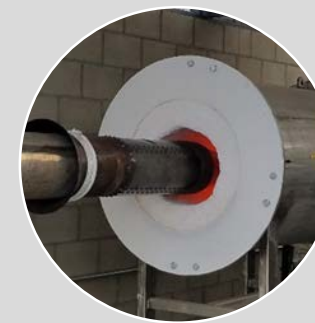
Ordnance technologies for smaller warheads



Advanced materials



Hydrocarbon scramjet-powered propulsion



Guidance, navigation, and control technologies



Affordable system designs and manufacturing approaches

# Air-to-Air Weapons Technologies



## Speed & Reach of Disruption and Lethality

Increase Load Out

Lower-Costs

Platform Persistence in Highly Contested Environments

Enhance Platform Survivability

Increase Weapon Lethality



### Tech Enablers



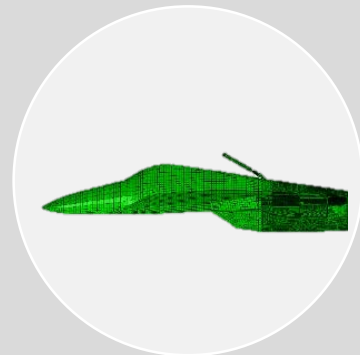
Highly Agile Airframes



Highly Efficient Solid Rocket Motors



Reduced Size, Highly-Lethal Warheads



Modeling & Simulation Tools to Evaluate Performance



Low-Cost Passive Seeker (MSDM)

# Precision Effects Technologies



Speed & Reach of Disruption and Lethality

Complexity, Unpredictability, & Mass

Reduce Collateral Damage

Optimizes Effect on Target

Control of Lethal Footprint

Improves Sortie Flexibility

Many Target Sets

Increase load outs

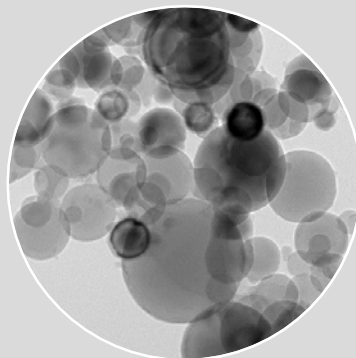
Tech Enablers



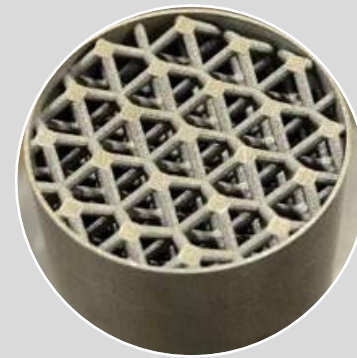
Precision Height of Burst Sensor



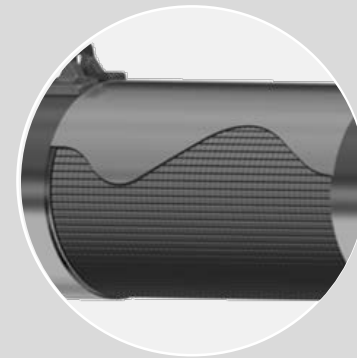
Distributed Embedded Fuze System



Advanced Energetics & Additive Manufacturing



Reactive Materials



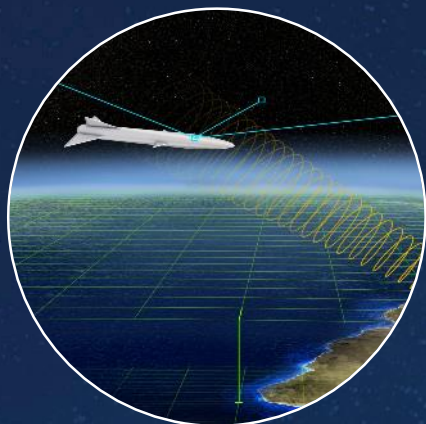
Fragmenting Warhead Cases



# Pervasive Technology Investments



3D Printing



Alternative Navigation Methods



Autonomy / Networked Systems



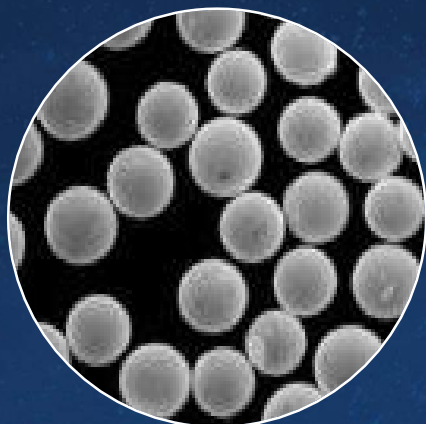
Selectable / Dialable Effects Tech



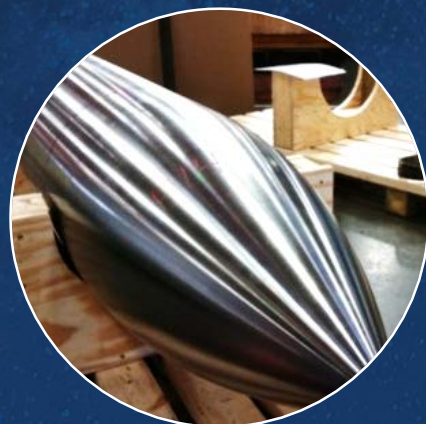
Modeling & Simulation



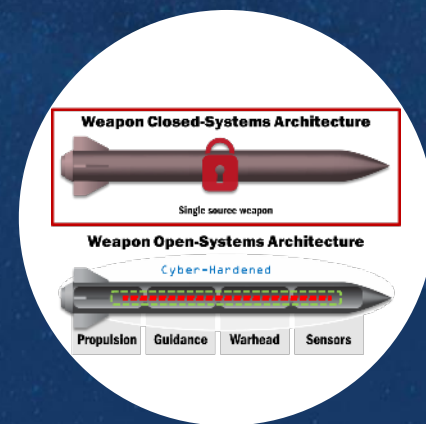
Advanced Seeker Technologies



Advanced Energetics



High Performance Weapon Materials



System Modularity & Software Defined Capability



Cyber Assurance

# How We've Changed Our Business

## Increasing Use of Defense Ordnance Technology Consortia (17+)



### Selectable Effects Munition (SEM)

- Agility
- Access to Necessary Materials
- Faster Timelines



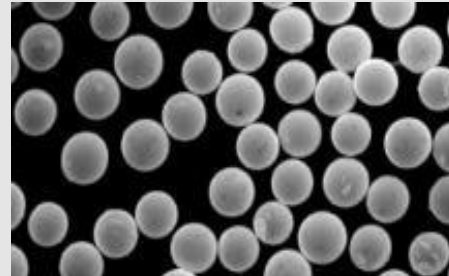
### Hypersonic Weapon Tech Maturation

- Synergy of hypersonics S&T
- Rapid access to expertise



### Counter Air Science & Technology (CAST)

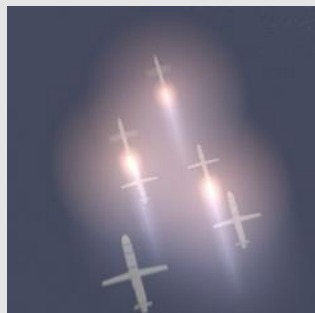
- Expedited Contract Award
- Obligate + Expenditure Rates
- Enhanced AFRL/RW Budget Reviews



### Advanced Energetics

- High-Temp Energetics for Hypersonics
- 3D Printing of Explosives
- Nanoenergetics

Increasing R&D Reviews and Information Exchange with Industry

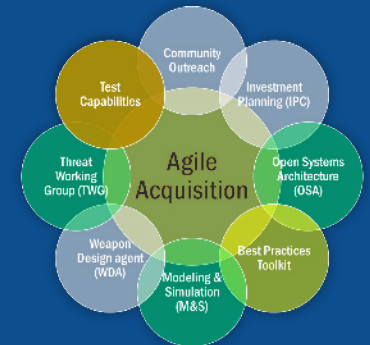


OTA to TDI to reduce cost of manufacturing Gray Wolf engine by half



Increasing Use of PIAs for Tech Sprints and Idea Harvesting

## Consortium with Team Eglin





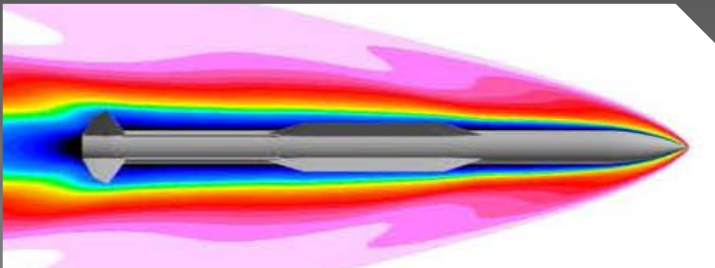
# Lots of Ways to Work With Us

## Open BAA

FY17 - FY22  
Not to Exceed  
**\$500M**  
Cumulative

**White Papers Welcome**

Check FedBizOpps  
FA8651-17-S-0003



## SBIR / STTR

177 Active  
SBIR/STTR  
**\$126M**

30 Active  
STMP  
**\$30M**

**New Topics as of Nov '18**

Check FedBizOpps  
<https://sbir.defensebusiness.org/>



## DOTC

18 Active  
Initiatives  
**>\$33M**

**New Topics as of Mar '19**

[http://www.nac-dotc.org/  
DOTC-18-01](http://www.nac-dotc.org/DOTC-18-01)





Questions?