Building the S&T Foundation for Agile Solutions

COL GARRY HAASE, DIRECTOR/COMMANDER
MUNITIONS DIRECTORATE, 7 NOVEMBER 2018
Our Mission

Leading the discovery, development and integration of affordable warfighting technologies for our air, space and cyberspace forces.

Who We Are

Experts in a wide range of fields

Lead

We are world leaders in science and technology.

What We Do

Explore, research and push the boundaries of technology

Discover

We are at the forefront of innovation.

Develop

We bridge the gap between research and application.

Why Our Work Matters

We provide the Air Force with the technology it needs to defend America.

When We Deliver

We identify future needs and advance technologies to support these capabilities.

Deliver

We provide superior technology to warfighters in a continuous manner.

As needs evolve and technologies change, AFRL delivers solutions to keep the fight unfair.
A World-Wide Enterprise of Researchers

AFRL Headquarters
711th Human Performance Wing
Materials & Manufacturing
Aerospace Systems
Sensors
Information

Edwards AFB, CA
Wright-Patterson AFB, OH
Kirtland AFB, NM
Arlington, VA
Rome Research Site, NY
AF Office of Scientific Research

Space Vehicles Directed Energy
Munitions
Information

Ft. Sam, TX
Eglin AFB, FL

Space
Directed Energy
Munitions

Maui Research Site, HI
Tokyo, Japan
London, UK
Santiago, Chile

Employees
Civilian
Military

Total
S&Es
6,254
3,611

International Sites

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AFRL Enterprise Focus Areas

AF Office of Scientific Research
- Aerospace, Chemical, & Materials Sciences
- Physics & Electronics
- Mathematics, Information, and bio-inspired sciences

Aerospace Systems
- Aerospace Vehicles
- Control, Power, & Thermal Management
- High Speed Systems
- Space & Missile Propulsion
- Turbine Engines

Directed Energy
- High Power Electromagnetics
- Laser Systems
- Directed Energy
- Electro-Optics for Space Superiority
- Weapons Modeling & Simulation

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

Materials and Manufacturing
- Structural Materials
- Functional Materials
- Manufacturing Technologies
- Support for Operations

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

Sensors
- Spectrum Warfare
- Layered Sensing Exploitation
- Enabling Devices & Components
- RF Sensing
- EO Sensing

Space Vehicles
- Space Electronics
- Space Remote Sensing
- Space Environment Impacts & Mitigation
- Space Experiments
- Space Platforms

Human Performance
- Training
- Decision Making
- Bioeffects
- Human-Centered ISR

The Air Force Research Laboratory

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AFRL S&T Business Overview

$5,211M Total Funds

AFRL Workforce

- Academia: $326M
- Small Business: $1,449M
- Industry: $4,069M
- In-House: $806M
- International Collaboration: $83M*

Basic Research

- Intellectual Property
- Technology Base
- Advanced Demonstrations
- Fielded Capabilities

Air Force: $2,608 M
External: $2,594 M

* In kind support

Investments:
- AFRL: $2,608 M
- Workforce: $5,211 M
- Total Funds: $8,821 M

$5,211M Total Funds

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Investment Categories

6.1 Basic Research
Science Knowledge
Greater knowledge or understanding fundamental aspects
Observable facts
Without specific applications toward processes or products in mind
New Science
$515 M FY19

6.2 Applied Research
Science to Technology
Applying knowledge or understanding to determine the means by which a recognized and specific need may be met
$1.3 B FY19

6.3 Advanced Technology Development
Capability Concepts
The development and integration of hardware for field experiments and tests
From Lab to Field
$811 M FY19
The Munitions Directorate
Turning Requirements Into Capabilities

WARFIGHTER NEEDS

Global Precision Attack

Core Research
(Core Technical Competencies)

Special Ops / CAS

Air Superiority

Munitions Airframe, Guidance, Navigation & Control (MAGNC)

• Weapon Airframe Science
• Guidance & Control
• Weapon Navigation

Modeling & Simulation Evaluation Sciences (MSEs)

• Virtual & Physical Environment M&S
• Applied Munition Systems Effects Sciences

Terminal Seeker Sciences (TSS)

• RF Seekers
• EO/IR Optical Seekers
• Information Exploitation
• Multi-Spectral / Multi-Aperture

Ordnance Sciences (OS)

• Energetic Effects and Energy Coupling
• Energetic Materials Form. & Processing
• Ordnance Material Science
• Fuzing for Functional Defeat of Hard Tgts
• Terminal Burst Point Control
• Advanced Initiation Sciences
• Fuze & Electronic Design
How We’ve Changed Our Business

Increasing Use of Defense Ordnance Technology Consortium – OTAs (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

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

Increasing Use of PIAs for Tech Sprints and Idea Harvesting

AFRL
THE AIR FORCE RESEARCH LABORATORY

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Team Eglin Consortium

Agile Acquisition

- Targets Consortium
- Potential
- Test Capabilities
- Community Outreach
- Investment Planning (IPC)
- Open Systems Architecture (OSA)
- Threat Working Group (TWG)
- Weapon Design agent (WDA)
- Modeling & Simulation (M&S)
- Best Practices Toolkit

EB
TW
AQ
AFRL
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 Late Nov ‘18
- Check FedBizOpps https://sbir.defensebusiness.org/

DOTC
- 17 Active Initiatives
- >$20M
- New Topics as of Mar ‘18
Labs and Spaces to Collaborate

Doolittle Institute
AMTC
Advanced Munitions Technology Complex

Open FY17

VHT
Variable Height Tower for Seeker Experimentation

Under Construction FY18

FEF/Soft Catch
Fuze Experimentation Facility

Under Construction FY18

TEC
Terminal Engagement Center

Under Construction FY18

KHSLS / KHILS 2.0
Kinetic Hardware in the Loop Simulator

Currently Re-Vitalizing

Hangar 421
Networked Weapons Lab

Under Construction FY18

VWaMS
Virtual Warfare Munitions Server

Hangar 421
Networked Weapons Lab

VWaMS
Virtual Warfare Munitions Server

Univ. of FL
REEF
Munitions Directorate Goals – Technologies to…

*Dominate* in a Complex, Multi-Domain Battlefield

*Overcome* Adversary Defenses

*Prosecute* Time-critical Targets

*Place* the Right Effect on Target

*Maintain* Technology Superiority – Speed to Field New Capabilities & Controlling Costs

*Increase* Magazine Depth
Technology Investments

- 3D Printing
- Alternative Navigation Methods
- Autonomy / Networked Systems
- Selectable / Dialable Effects
- Modeling & Simulation
- Advanced Seeker Technologies
- Advanced Energetics
- High Performance Weapon Materials
- System Modularity & Software Defined Capability
- Cyber Assurance
Providing Capability, Flexibility, and Scalability

Exquisite Single System
Highly Capable

- Intelligent Terminal Guidance Seekers/Sensors
- Networked Tech / Cyber Resilient Open Systems Architectures
- Advanced Materials / Manufacturing
- GPSNavigation and GPS-Denied Navigation Tech
- Efficient / Low-Cost Engine Technology
- Precision Height of Burst Sensor
- Advanced Energetics
- Selectable Effects Warhead
- Advanced Fuzing
- Optimized Airframe Design

Networked System of Systems
Highly Tailorable

- Technology A
- Technology B & C
- Technology A & D
- Technology C
- Technology D

Information Collection & Sharing

Balancing Capability, Complexity, & Cost

Highly Complex – Higher Cost – Exquisite – Lower Numbers
Less Complex – Lower Cost – Networked – Higher Numbers

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Big Bet – *Software Defined Weapon Capabilities*

**Challenge (example)**
- Identifying Targets
- Reaching Target
- Navigation
- Sensing
- Surviving Countermeasures
- Communicating

**Solution (example)**
- New Target Models
- New Behaviors
- New Cooperative Algorithms
- Improved EW
- Improved I.D. of Threats
- Enhanced Countermeasures
- Enhanced Communications

**Mission Planning**
- Weapon System in Combat
- Enhanced Weapon System Capability
- System Software Update

**Hardware-in-the-Loop / Software-in-the-Loop**
- Software Defined Weapon Capabilities
- Model-Based OT&E

**Combat Capability Through Near Real-Time System Performance Upgrades**
### Technology That Will Protect & Accelerate Tech Transitions

<table>
<thead>
<tr>
<th>Digital Design &amp; 3D Lab</th>
<th>Advanced M&amp;S – Live, Virtual Construct</th>
<th>Advanced HIL/SIL Labs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional design won’t outpace the enemy</td>
<td>“Space” to practice like we’ll fight</td>
<td>Hardware/software validation of new tech</td>
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<tr>
<th>High-Fidelity Digital Twins</th>
<th>Cybersecurity Lab</th>
<th>Weaponereing Lab</th>
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<td>Increased confidence in design</td>
<td>Securing $72B weapons portfolio</td>
<td>DoD authority for munitions effectiveness</td>
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**Faster Transition | Agnostic Industry Testing | Saves hundreds of millions in system costs | Enhanced decision making**
Planning for Future Capabilities

- **Contested Environments**
  Range – Navigation - Autonomy

- **Maximizing Internal Carriage**
  Increased Kinetic Effects

- **DE / KE / Cyber Battlefield**
  Integrated Effects

- **HDBTs Increasing**
  Asymmetric Tech - Autonomy

- **Scalable Effects / Alt Payloads**
  Placing the Right Effect on Target

- **Near Peer Tech Cycles**
  Hardware & Software Tech Refresh

- **Accelerated Kill Chains**
  Time to Target

- **Next Generation Labs**
  Develop the Future