



AFRL

SENSORS DIRECTORATE OVERVIEW

DR. MIKE EISMANN, CHIEF SCIENTIST
AFRL/RV, MAY 2024

AFRL Sensors Directorate

Mission

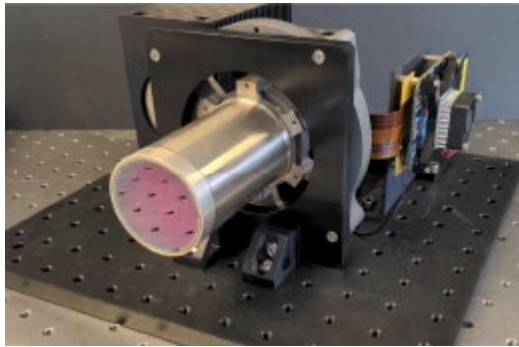
Lead the discovery and development of future capabilities providing integrated Intelligence, Surveillance, and Reconnaissance (ISR), combat identification, and spectrum warfare effects

Vision

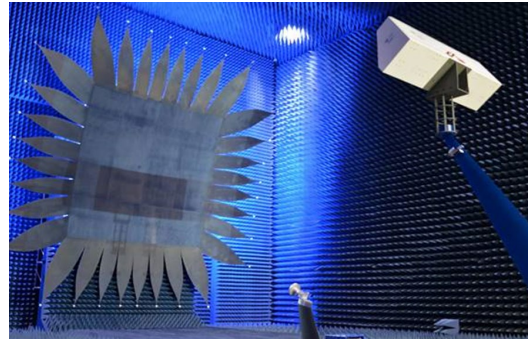
Enable ubiquitous situation awareness and spectrum dominance for Global Vigilance, Reach, and Power

Sensors Directorate Technology Areas

Electro-Optical and Infrared Sensing



Radio Frequency Sensing



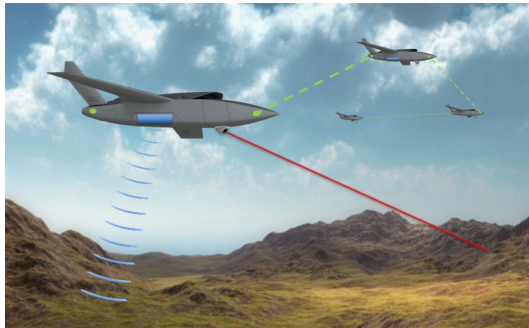
Electromagnetic Spectrum Warfare



Positioning, Navigation, and Timing



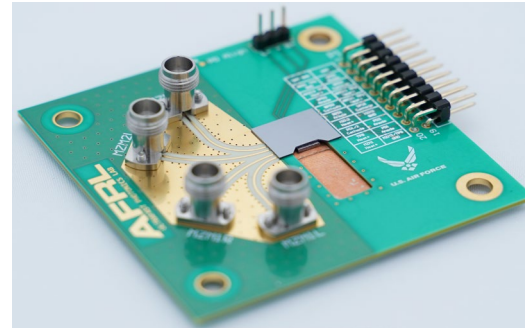
**Sensing
Autonomy**



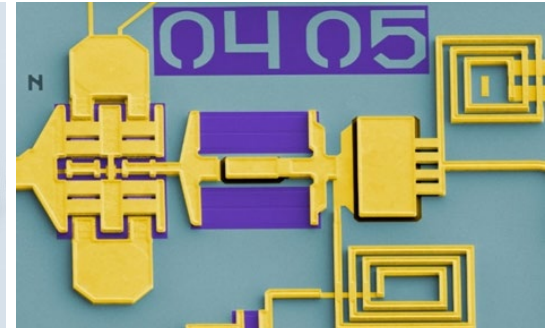
**Multi-Domain
Sense Making**



Photonics



Microelectronics





EO/IR Sensing

Mission: Develop disruptive EO/IR technology to enable surveillance and targeting of multi-domain threats in contested environments

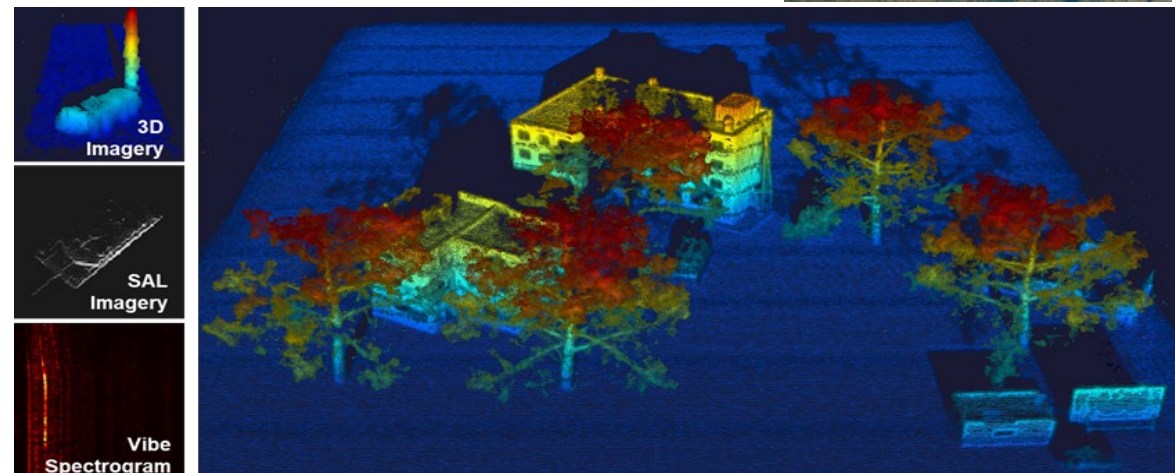
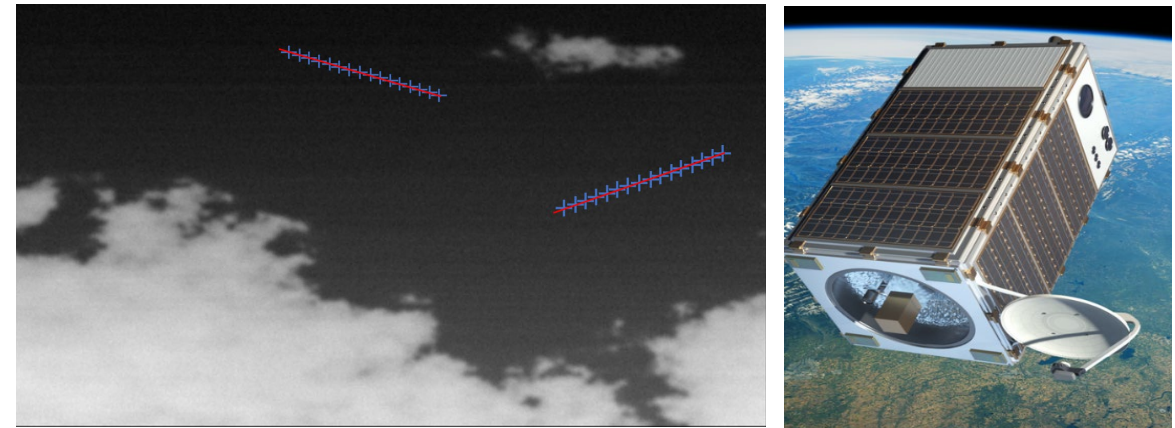
Scope: EO/IR technology for “sensing” and sensor-specific “sense making” functions to deliver real-time “data products”

Current Research Focus

- Extended range infrared search and track
- Multi-mode ladar technology; 3-D, SAL, vibrometry
- Space-based sensing concepts
- Event-based sensing
- Hyperspectral imaging

Technology Area Lead

Dr. Joseph Meola; joseph.meola.1@us.af.mil



Future Directions

- High-performance, low-cost ladar component technology
- Midwave infrared hyperspectral imaging technology



RF Sensing

Mission: Develop and enhance AF capabilities for all weather intelligence, surveillance, reconnaissance, and targeting in permissive, contested, and highly contested environments

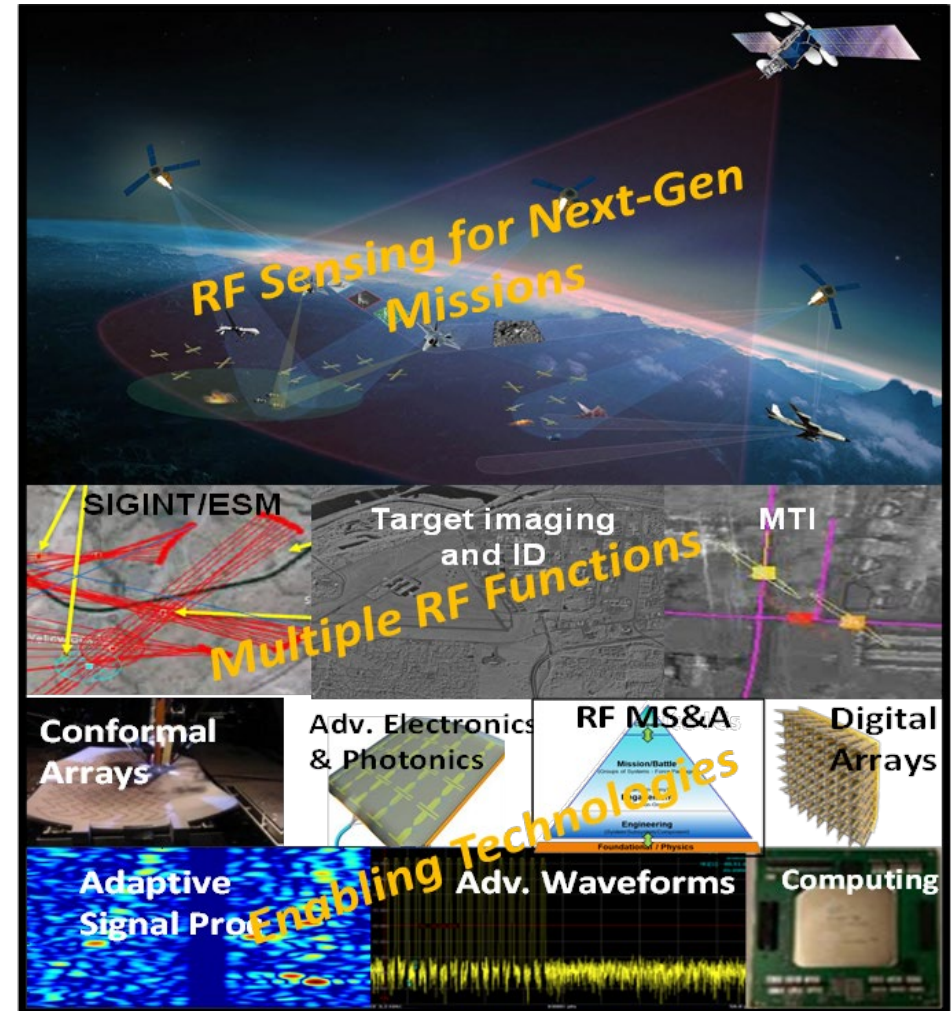
Scope: Pursue novel RF system concepts to persistently sense across RF spectrum. Detect, ID, track and maintain custody of high value targets.

Current Research Focus

- RF modeling, simulation and analysis
- Low-cost RF sensors
- Advanced multifunction digital arrays
- Distributed moving target indication
- RF targeting, imaging and identification

Technology Area Lead

Dr. Stephen Hary; stephen.hary@us.af.mil



Future Directions

- Distributed RF sensing tailored for future missions
- Mode development for digital beamforming radar



Electromagnetic Spectrum Warfare

Mission: Research, develop, and transition technologies that enable mission assurance in contested and denied environments against threats that exploit the electromagnetic spectrum (EMS)

Current Research Focus

- Systems engineering of capabilities to ensure dominance in contested EM environments
- Advanced sensing strategies to characterize adversary signals in a dense spectral environment
- Timely Electro-Optical (EO) countermeasure development to protect the warfighter
- Command and Control (C2) of assets to defeat advanced threats

Technology Area Lead

Mr. Ryan Sites; ryan.sites@us.af.mil



Future Directions

- New algorithms to parse and make sense of a dense EMS environment
- EW battle management: Data driven analytics to determine operational & tactical EW decisions
- High-Value Aerial Asset (HVAA) Protect: Dominance of RF and EO domains for survivable EMS operations



Positioning Navigation and Timing (PNT)

Mission: Enable the DAF (USAF & USSF) ISR and warfighting systems in contested environments through research, development, and transition of robust and resilient positioning, navigation, and timing (PNT) technology and capabilities

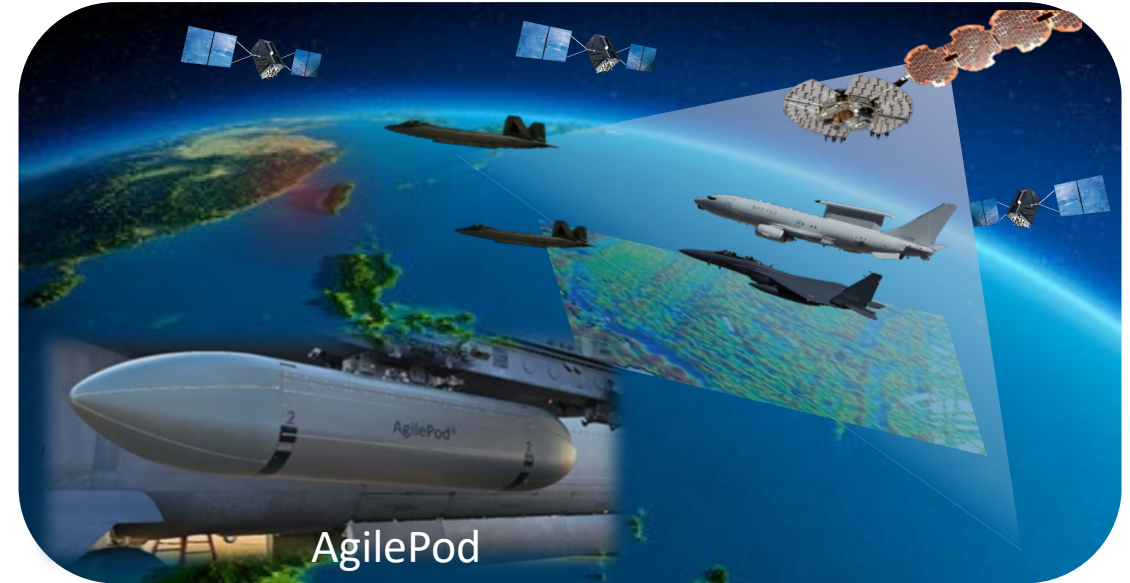
Scope: PNT technologies for airborne platforms enabling precision warfare and distributed ISR

Current Research Focus

- Robust & resilient multi-global navigation satellite system
- Resilient alternatives to GPS through Alt-PNT tech including Magnetic Nav
- Modular/Open PNT systems allowing for timely and affordable technology integration to pace threats

Technology Area Lead

Dr. John D. Elgin; john.elgin@us.af.mil



Future Directions

- Triage threat-driven gaps in PNT capabilities through the development and integration of GNSS and Alt-PNT tech
- Development of high TRL PNT tech transitioning to PNT PoRs
- R&D on alt-PNT, GNSS, and pLEO technologies to enable precision warfare and ISR in threat environments

Microelectronics

Mission: Transition RY microelectronics (ME) R&D to DAF RF sensor sub-systems that demand disruptive advances in size, weight and performance to win

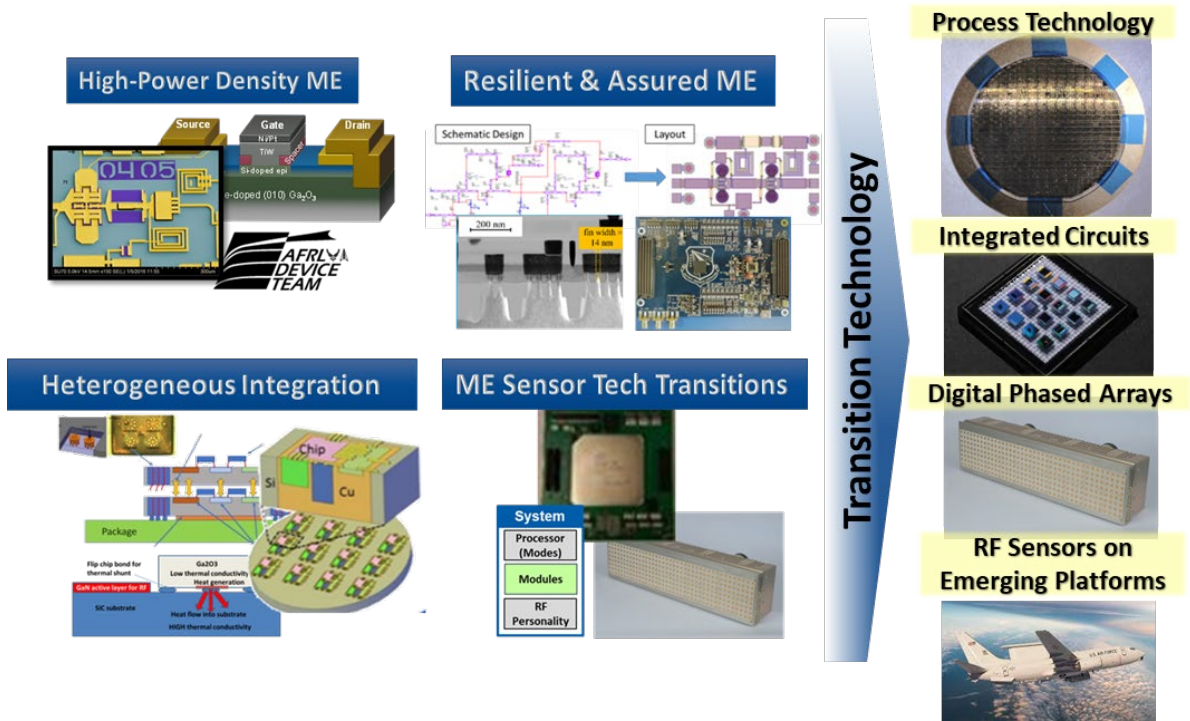
Scope: In-house device R&D, chip-agnostic integration, & securing ME within a digital engineering environment. Leverage national programs to accelerate transition of advanced ME prototypes for DAF warfighting domains

Current Research Focus

- ME devices with high-power density: GaN, Ga₂O₃
- Advanced integration and packaging of ME
- Securing and accelerating how we transition DAF ME from design phase to operational use
- Prototyping advanced ME in DAF sensor sub-systems to seed transition paths

Technology Area Lead

Dr. Kelson Chabak; kelson.chabak.1@us.af.mil



Future Directions

- Ultra-wide bandgap semiconductor device research
- Heterogeneous microelectronics/photronics integration
- Ultra-wideband RF microelectronics for autonomous collaborative platforms
- Microelectronics root of security

Photonics

Mission: Provide next-generation foundational research to identify, protect against, track and remove threats to the USAF

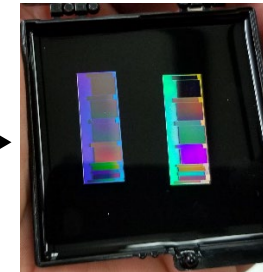
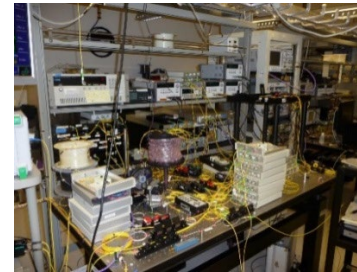
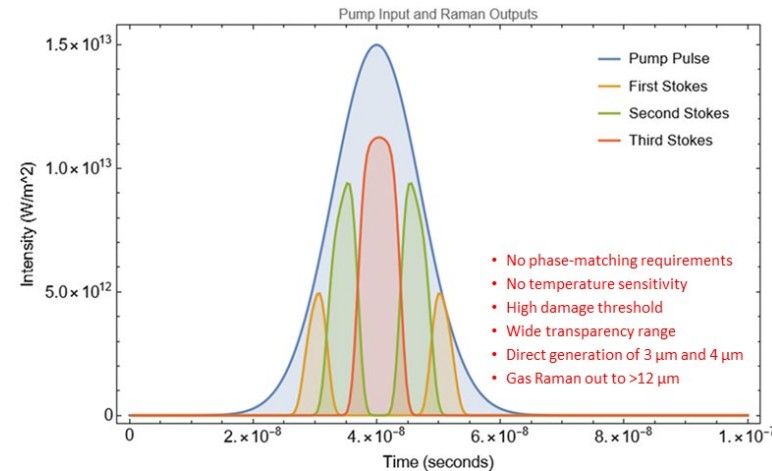
Scope: In-house research is focused on laser sources, FPAs and detectors, photonic integrated circuits, and photonic and quantum substructures

Current Research Focus

- Integration and Low CSWAP
- Photonics for Situational Awareness
- Photonic integration and packaging
- Enabling EMS Warfare
- LWIR FPA with enhanced quantum efficiency

Technology Area Lead

Dr. Emily Heckman; emily.heckman.1@us.af.mil



Future Directions

- Wideband 100 GHz microwave photonic sampler
- LIDAR sources and APD detectors at 2 μm
- Joule-class MIR/LWIR laser sources



Multi-Domain Sensemaking

Mission: Develop and transition militarily relevant AI/ML technology that fuses information from any source, reasons over the environment, and enables improved, timely, and executable battlespace decisions

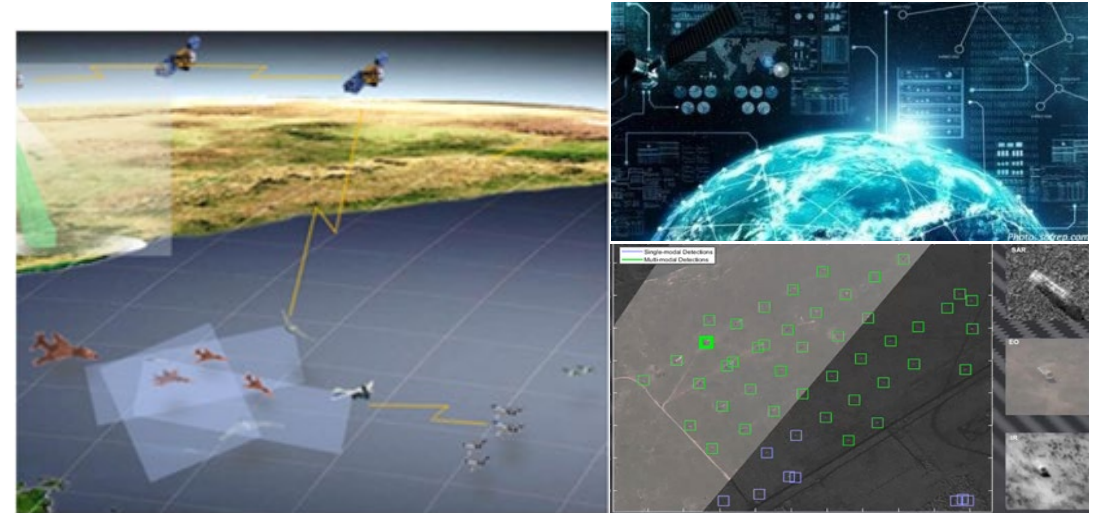
Scope: Sensemaking from multiple sensors (or single sensor, as needed), modalities, and domains applied at-the-edge, at forward operating units, and/or in reach-back cells

Current Research Focus

- AI/ML- and physics-based automatic target recognition (ATR) and fusion
- Behavioral models, target intent, & predictive analytics
- Detect and track at-the-edge
- Cognitive and distributed sensing

Technology Area Lead

Dr. Lori Mahoney; lori.mahoney.3@us.af.mil



Future Directions

- Maintain custody of targets by fusing ATR output with additional contextual information
- Multi-modal identification and geolocation to provide targeting quality information to the warfighter at range
- Autonomous, adaptive sensing control/feedback target ID capability by integrating fused identification and tracking



Sensing Autonomy

Mission: Empower sensing systems to prioritize, orchestrate, and actively direct the sensing apparatus for the satisfaction of mission directed goals

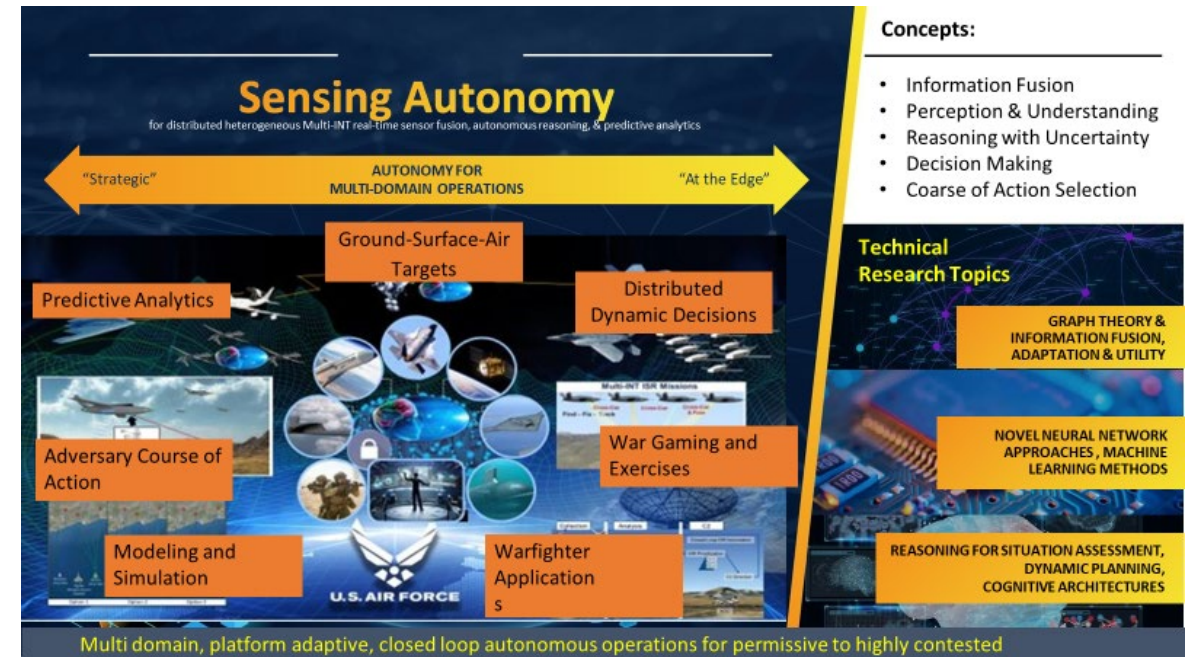
Scope: Novel sensing system architectures, trusted data acquisition, artificial intelligence, machine learning, enhanced computer processing, distributed network collaboration, and closed-loop exploitation algorithms

Current Research Focus

- Edge computing world models and prediction techniques
- Machine low-compute learning such as analogical learning, semantic pointers, and graph analytics
- Large Language models for text to model extraction
- Sensor payload mission planning and control
- Generative AI for courses of action development

Technology Area Lead

Mr. Todd Rovito; todd.rovito@us.af.mil



Future Directions

- Onboard tactical air sensor orchestration: offering higher fidelity tactical airborne sensor tasking and control from a web of large and small UAVs operating in a decentralized manner
- Generate adversary activity models automatically: using AI methods to discover and encode I&W predictors for generative predictive activity models

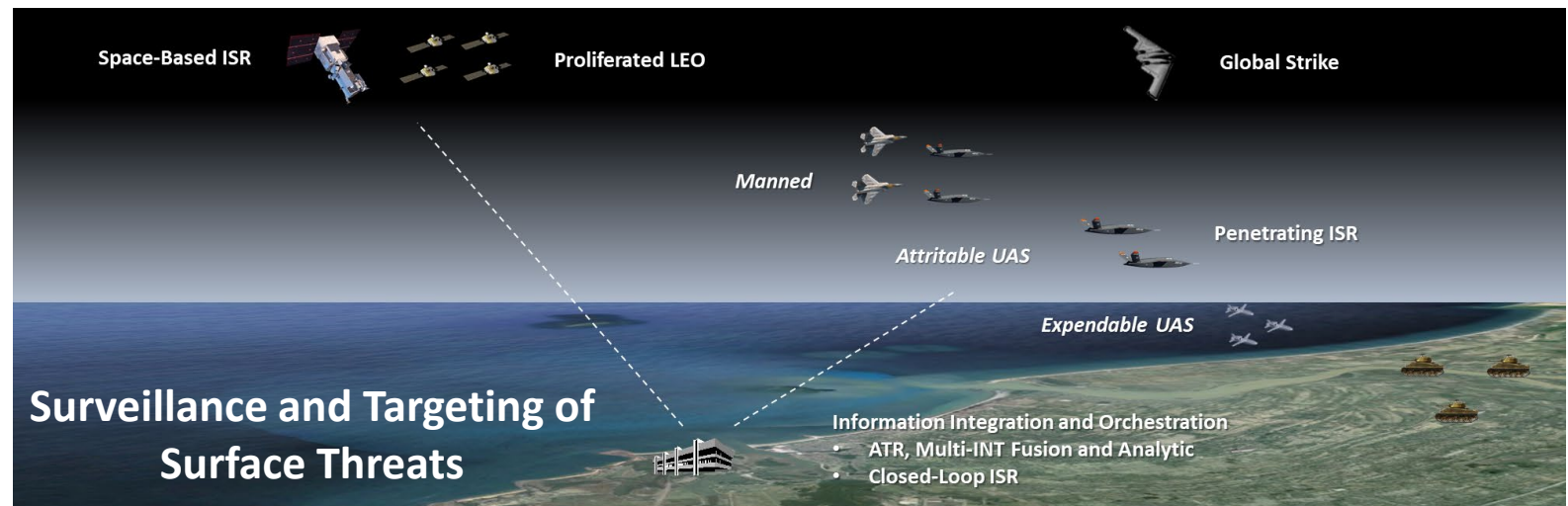
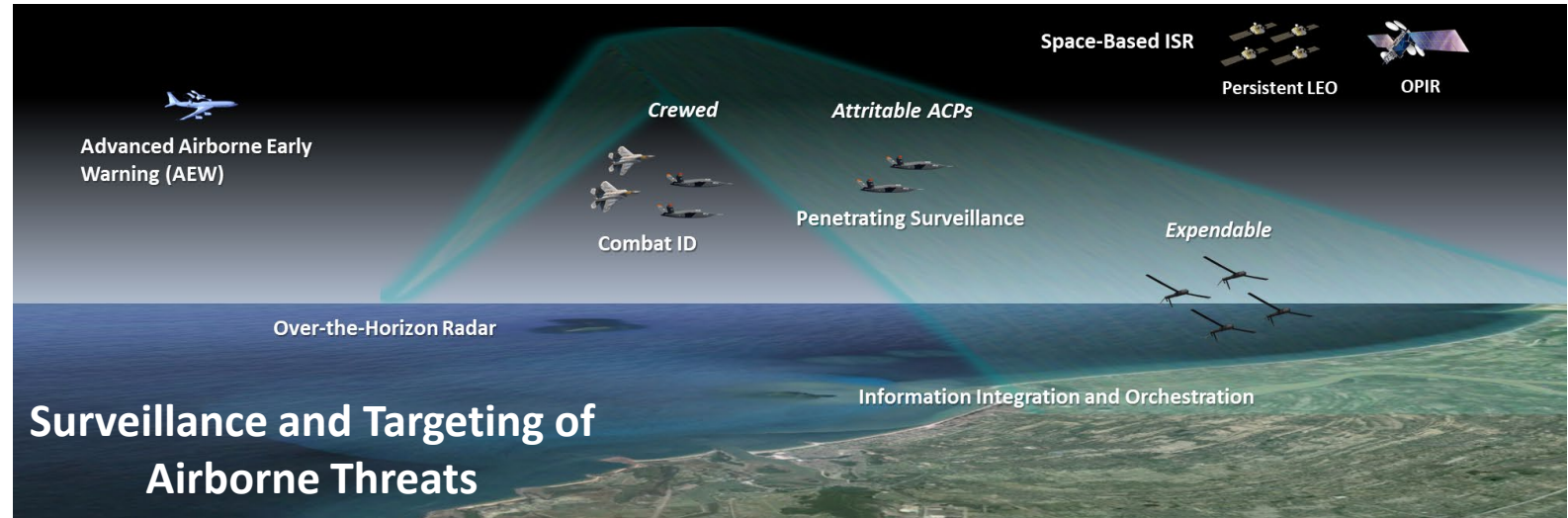
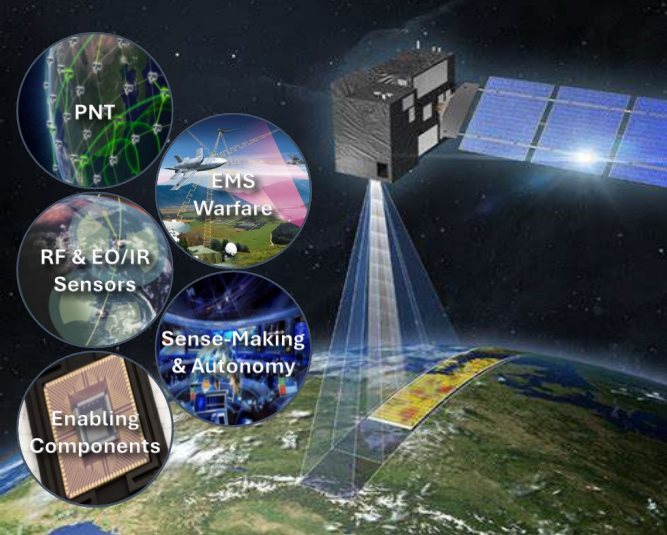
Cross-Disciplinary Capability Areas

SECAF

Operational Imperatives

- Space Order of Battle
- Operationally Focused ABMS
- **Moving Target Engagement**
- Tactical Air Dominance
- Resilient Basing
- Global Strike
- Readiness to Deploy and Fight

Sensing for Multi-Domain Effects





Sensors Directorate Leadership



CHIEF SCIENTIST
Dr. Mike Eismann, ST



DIRECTOR (Detailed)
Ms. Amanda Gentry



ACTING DIRECTOR
Col Rodrick Koch



RF Sensing Technology
Bill Baldygo, ST



Chief Engineer
Phil Maciejewski



Organizational Health & Development Officer
Dr. Erin Lunday



Positioning, Navigation, and Timing
Dr. Jeff Hebert, ST



Senior Strategist
Tim Poth



**Multi-Domain Sensing
Autonomy (RYA)**
Jason Williams



Integration & Operations (RYO)
Ben Lammers



Human Resources (RYH)
Pam Rodriguez-Roberson



EMS Warfare Technology
Marv Potts, ST



Contracting (RYKS)
Dave Searle



Aerospace Components & Subsystems (RYD)
Dr. Fred Arnold



Spectrum Warfare (RYW)
Dr. Mike Pochet



Security (RYS)
Matt Cameron



ATR and Sensor Fusion
Dr. Steven Rogers, ST



Multispectral Sensing & Detection (RYM)
Barry Karch



Capability Integration & Transition Support (RYZ)
Col Ryan Givens

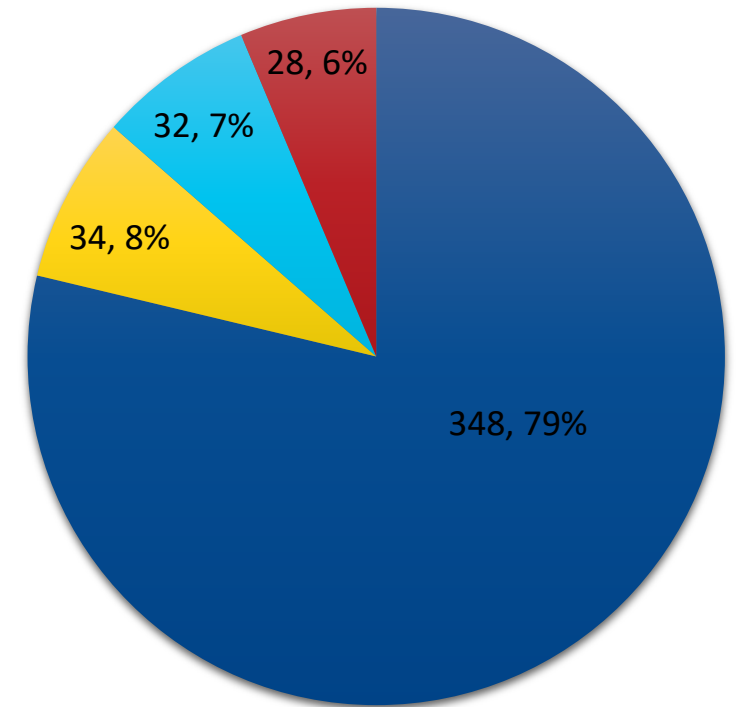
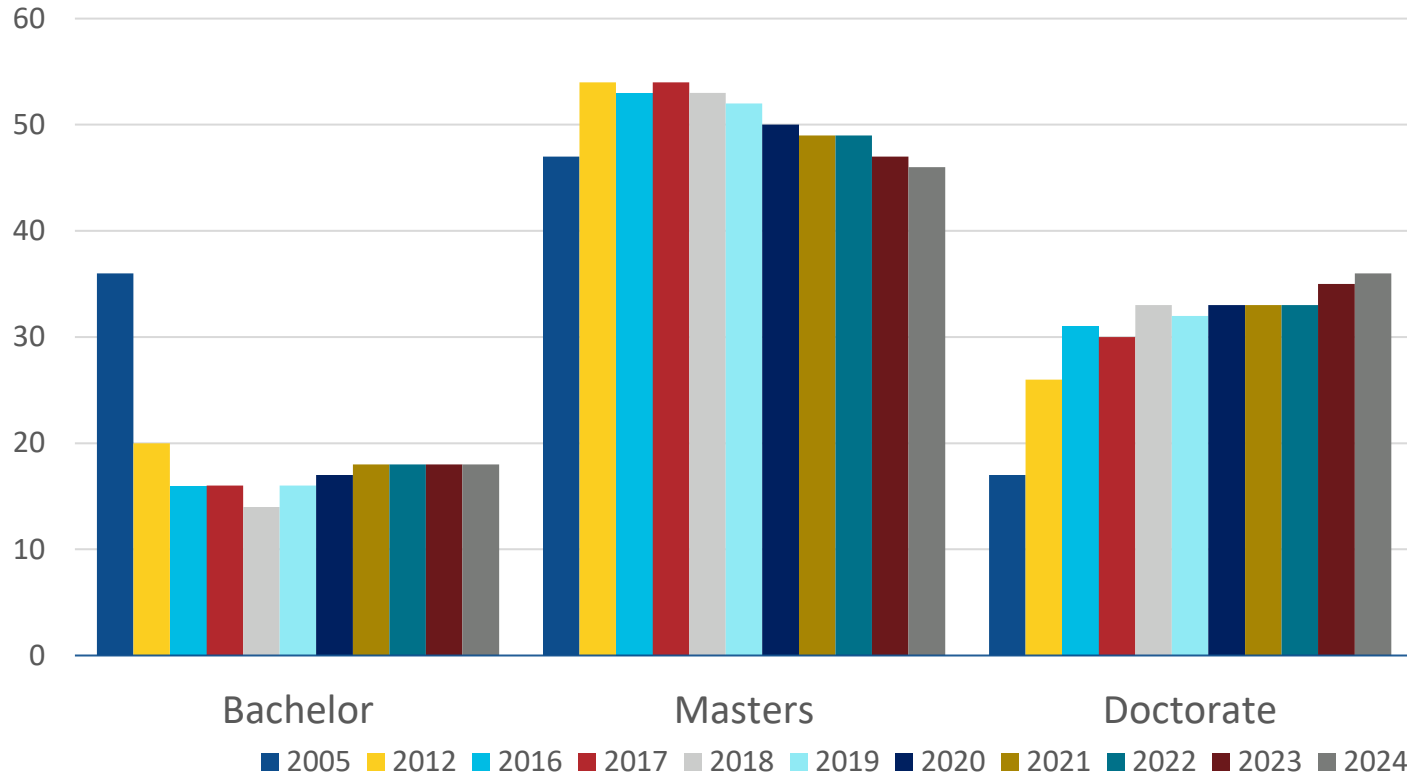


Sensors Financial Management (RYF)
Rob Schemmel



Sensors Directorate S&E Personnel

Percentage of S&Es



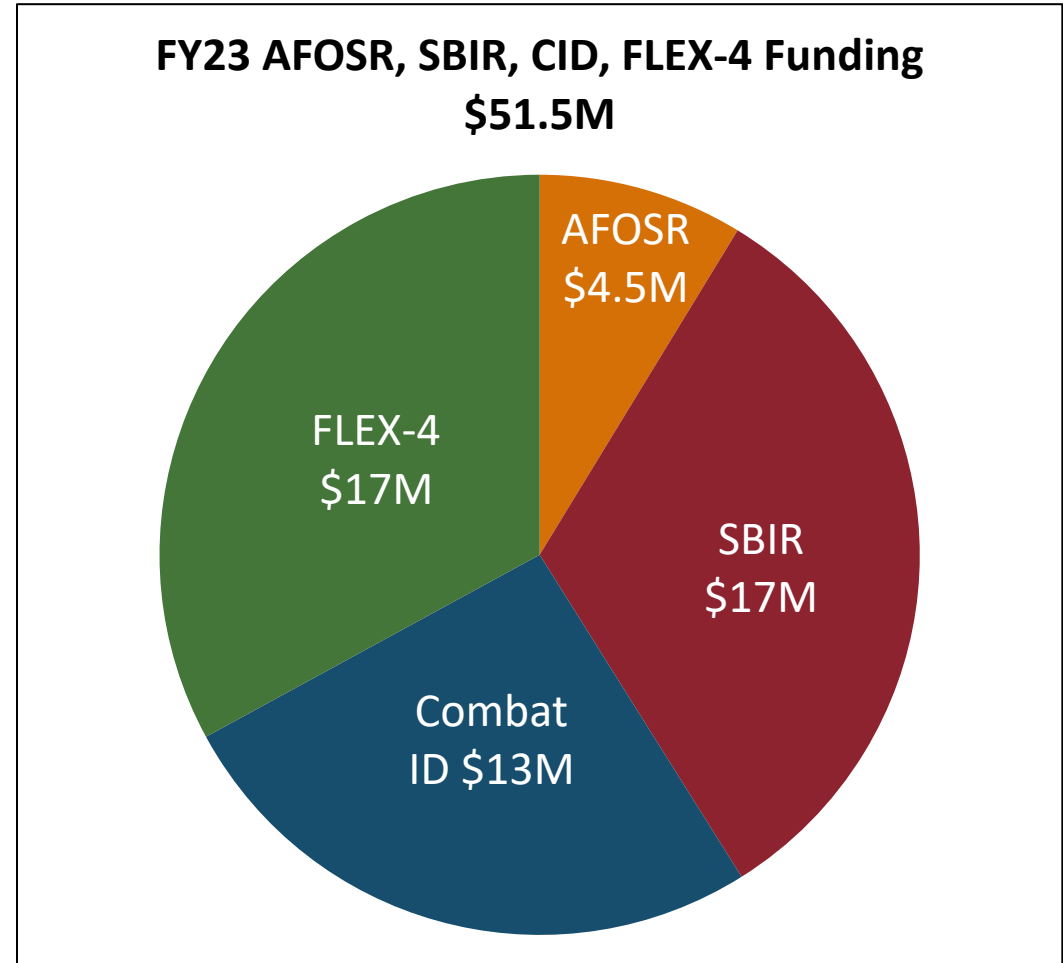
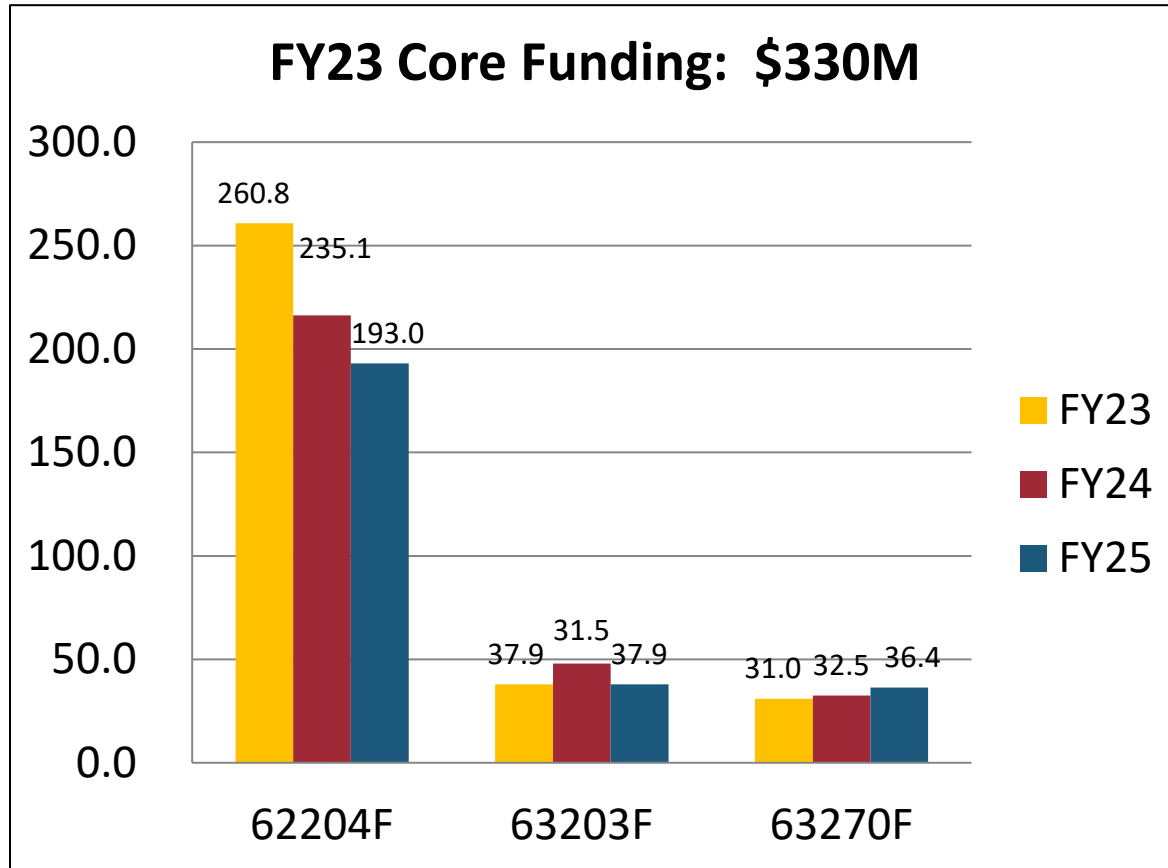
- Engineers
- Physics
- Others
- Computer Science

**Based on 442 S&Es assigned
(410 civ & 32 mil)**

Note: Does not include Students
Data as of 31 Jan 2024



RY Funds Execution



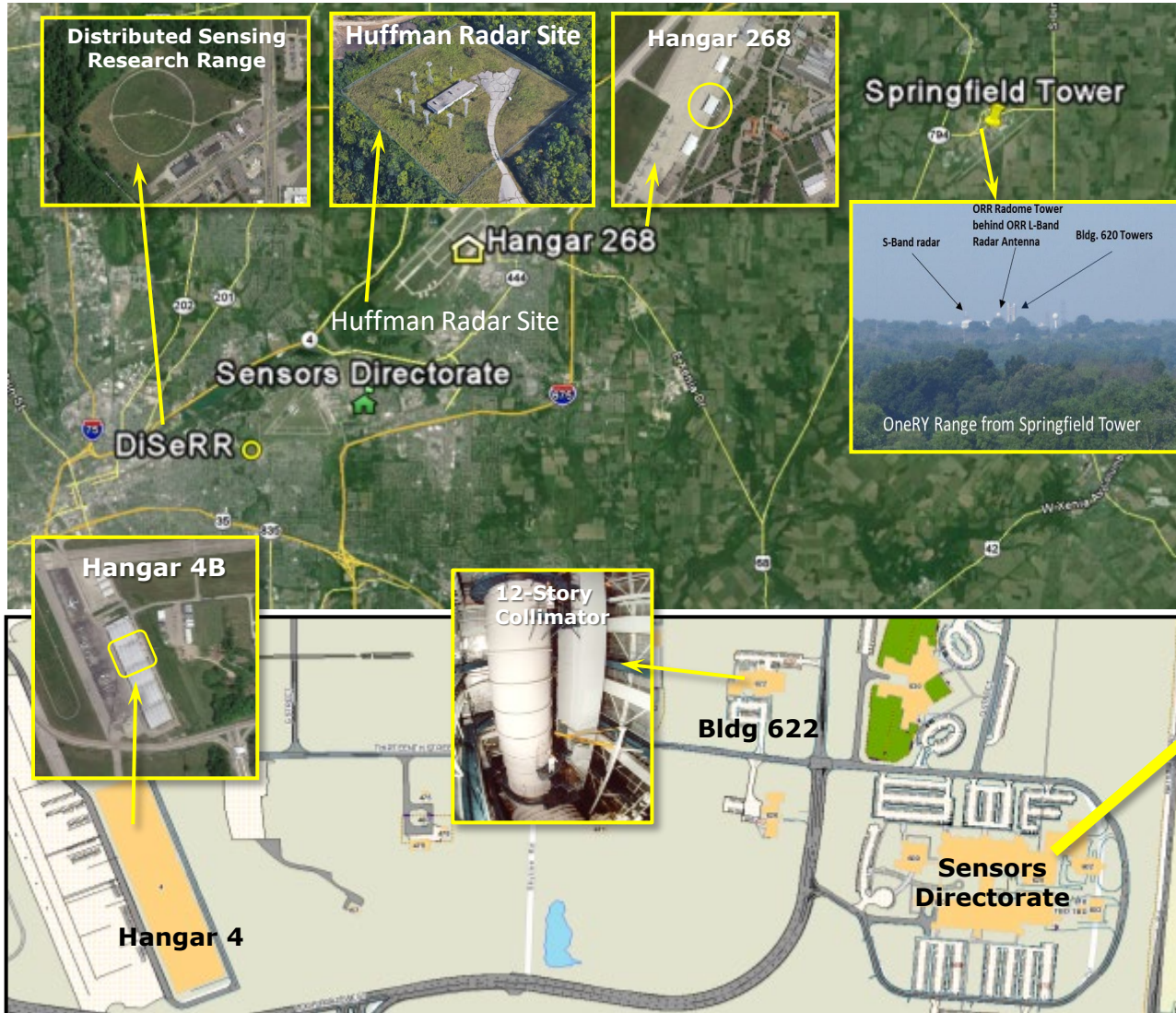
- FY23 amounts includes \$73.7M in Congressional Adds

FY23 funding from other collaborators: \$463M

Total FY23 funding executed: \$845M

Data as of 23 Feb 2024

Research Facilities



| | | |
|---|---|---|
|  |  |  |
| Radar Labs | Optics Labs | Digital Array Testbed |
|  |  |  |
| Outdoor Range | IDAL | Device Research Lab |
|  |  |  |
| RF EW Lab | ARC Lab | LID Range |
|  |  | |
| EO Electronic Warfare | Small UAV Lab | |

ARC = Advanced Recognition Capabilities
EW = electronic warfare
IDAL = Integrated Demonstration & Application Laboratory
LID = Laser IR Development
RF = radio frequency



Questions?