



Applied Neuroscience at the AFRL 711th Human Performance Wing

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14. ABSTRACT

One of the fundamental challenges facing designers of military aviation systems has always been how to integrate humans and machines into an effective system. The Air Force Research Laboratory's Decision Making Core Technology Competency (CTC) wrestles with one of the most challenging aspects of creating such integrated systems, namely the design of the interface between the human airman and the sophisticated and increasingly intelligent machinery with which he or she must coalesce in order to perform the mission. Historically, optimizing the human-machine interface required little more than increasing the compatibility of the machine's displays with the human sensory system and the machine's controls to human motor capabilities. But in environments in which the humans must function with machines processing greater and greater intelligent automation, working with larger and larger data bases of situational knowledge, and teaming with larger and more distributed teams of other airmen and non-human systems, the focus of human machine interface research must shift from relatively peripheral perceptual-motor issues to optimizing the interface between the airman's highest cognitive capabilities and the networked knowledge and intelligence provided with modern networked systems. To accomplish this, the traditional research to optimize the use human sensory systems as conduits of information and knowledge must be bolstered by research integrating humans with intelligent automation and exploiting understanding of higher cognition that can be provided by modern neuroscience. Executing this combination of essential human-machine interface research is the mission of the Decision Making CTC. The Applied Neuroscience component of the CTC is challenged to develop innovative neuroergonomic methodologies and integrated approaches to assess and classify individual and team operator functional state and provide adaptive mitigations to aid decision making effectiveness. Recent capability gains in the neuroergonomics field will be exploited to improve and sustain effective performance levels in small team environments. Current and planned research in this area will be discussed.

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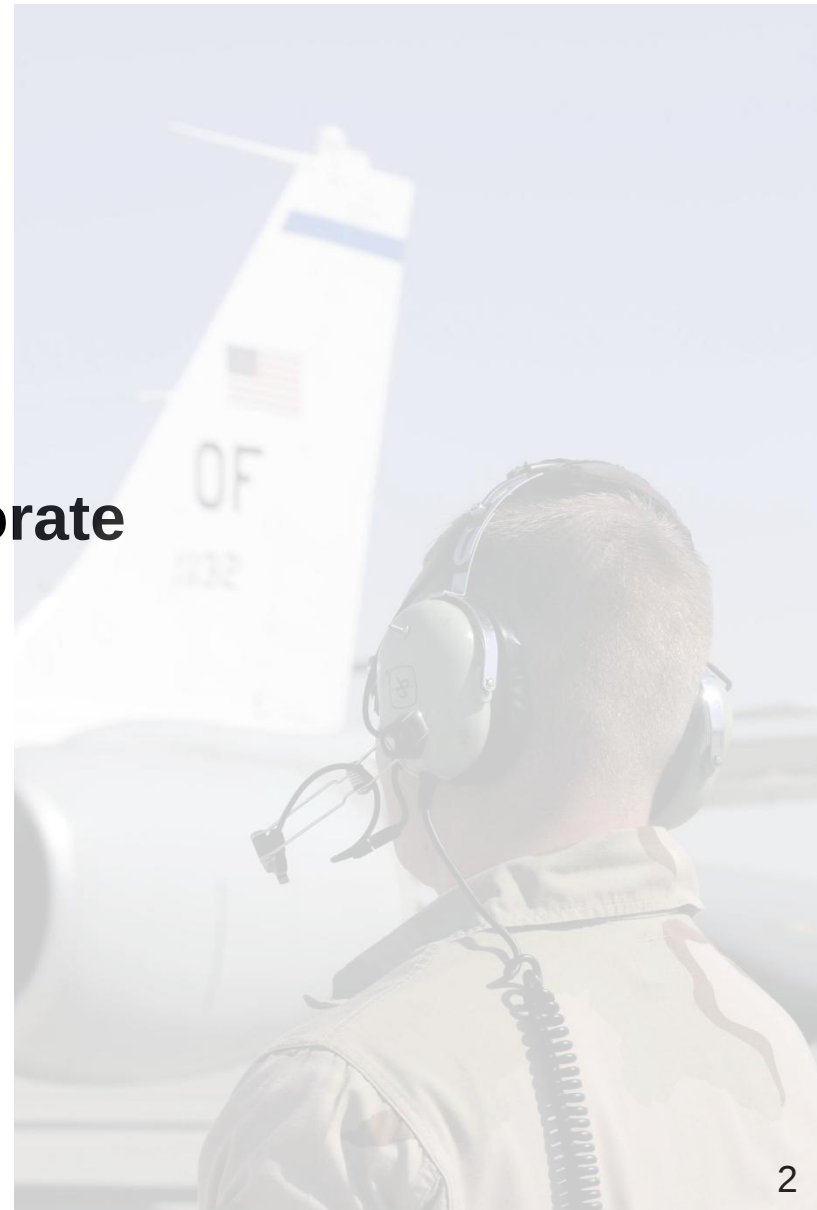
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RESPONSIBLE PERSON



711th Human Performance Wing Overview



- Vision and Mission
- Organization
- Mission Units
 - Human Effectiveness Directorate
- Applied Neuroscience





711th Human Performance Wing

Vision and Mission



**– The Human Performance Wing –
Supporting the Most Critical Air Force Resource**

Vision

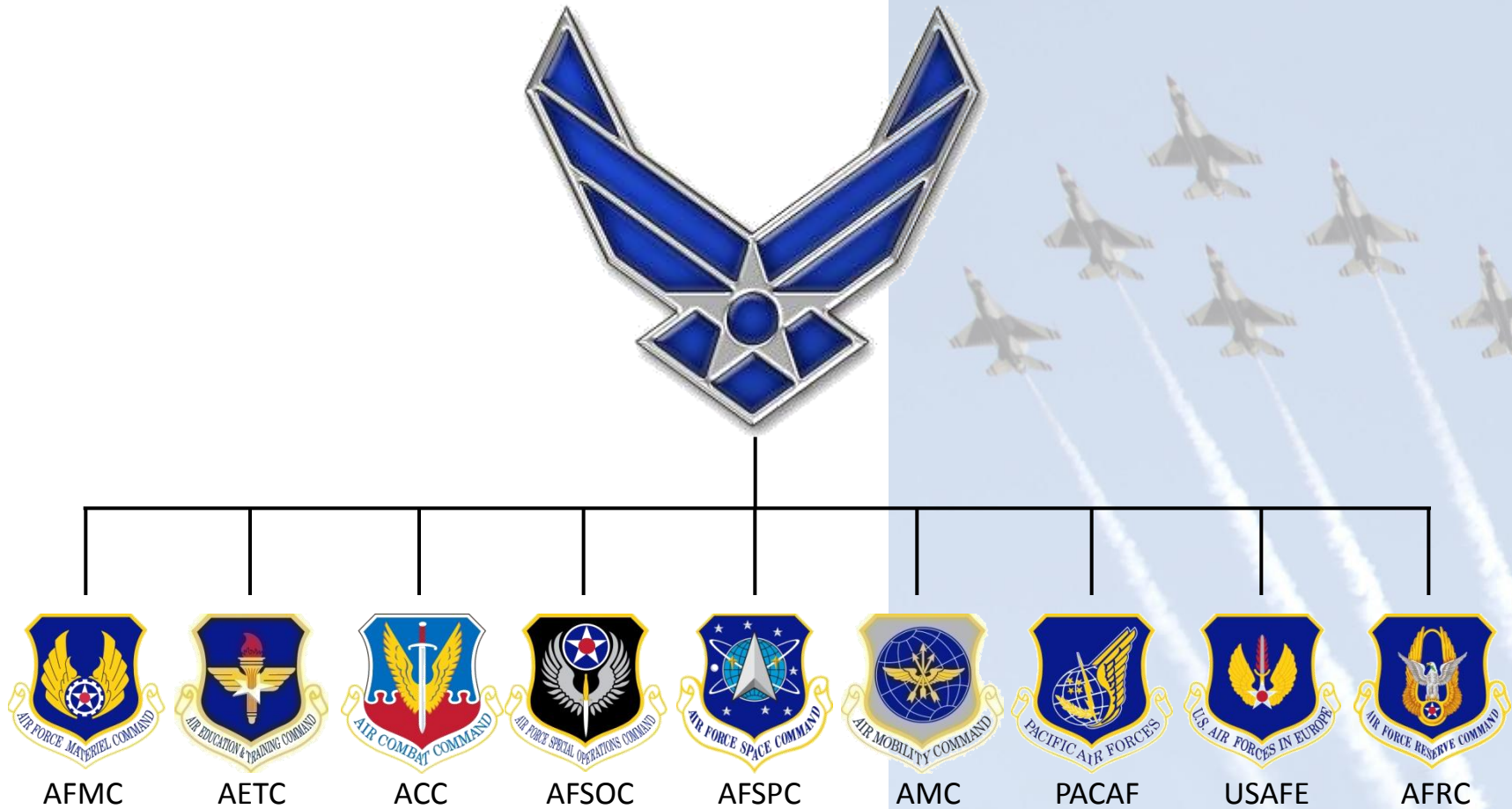
World Leader for Human Performance

Mission

**Advance Human Performance in Air, Space, and
Cyberspace through Research, Education, and
Consultation.**



USAF Major Commands





USAF Major Commands





Air Force Materiel Command





Air Force Materiel Command





AFRL Organization

S&T Directorates



AFOSR



Propulsion
(RZ)



Directed Energy
(RD)



Information
(RI)



Munitions
(RW)



Sensors
(RY)



Space Vehicles
(RV)



Materials &
Manufacturing (RX)



Air Vehicles
(RB)



Human Performance
Wing (HPW)



Human Effectiveness
Directorate (RH)

AFRL Organization

S&T Directorates



AFOSR



Propulsion
(RZ)



Directed Energy
(RD)



Information
(RI)



Human Performance
Wing (HPW)



Munitions
(RW)



Sensors
(RY)



Space Vehicles
(RV)



Materials &
Manufacturing (RX)



Air Vehicles
(RB)



Human Effectiveness
Directorate (RH)



711th Human Performance Wing



USAF School
of Aerospace Medicine
(USAFSAM)



Human Performance
Integration
Directorate
(711 HPW/HP)



Human Effectiveness
Directorate
(711 HPW/RH)



The Breadth & Integration of 711 HPW/RH



To
Societies



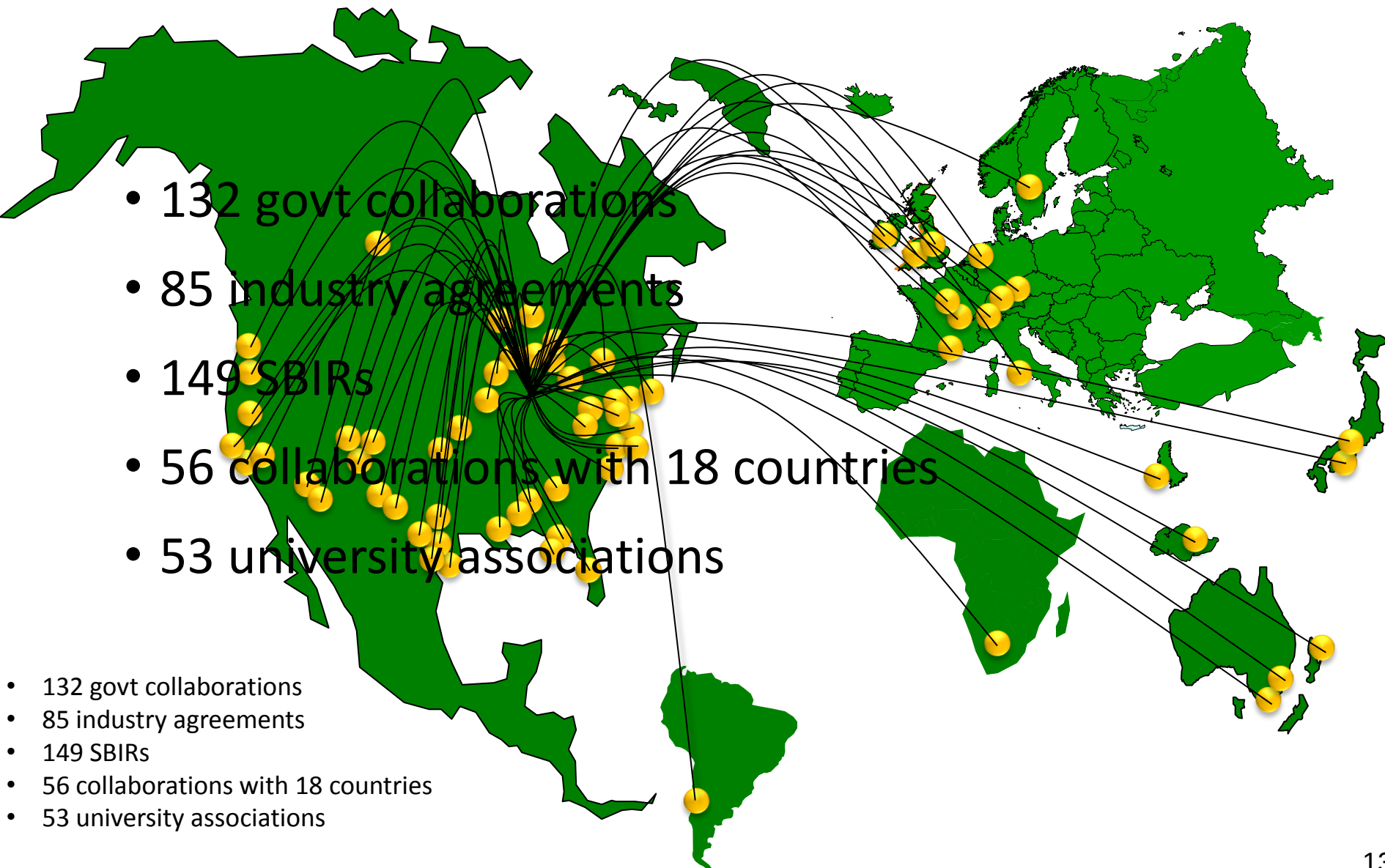
From
Molecules



Human Effectiveness Directorate Collaborations



- 132 govt collaborations
- 85 industry agreements
- 149 SBIRs
- 56 collaborations with 18 countries
- 53 university associations

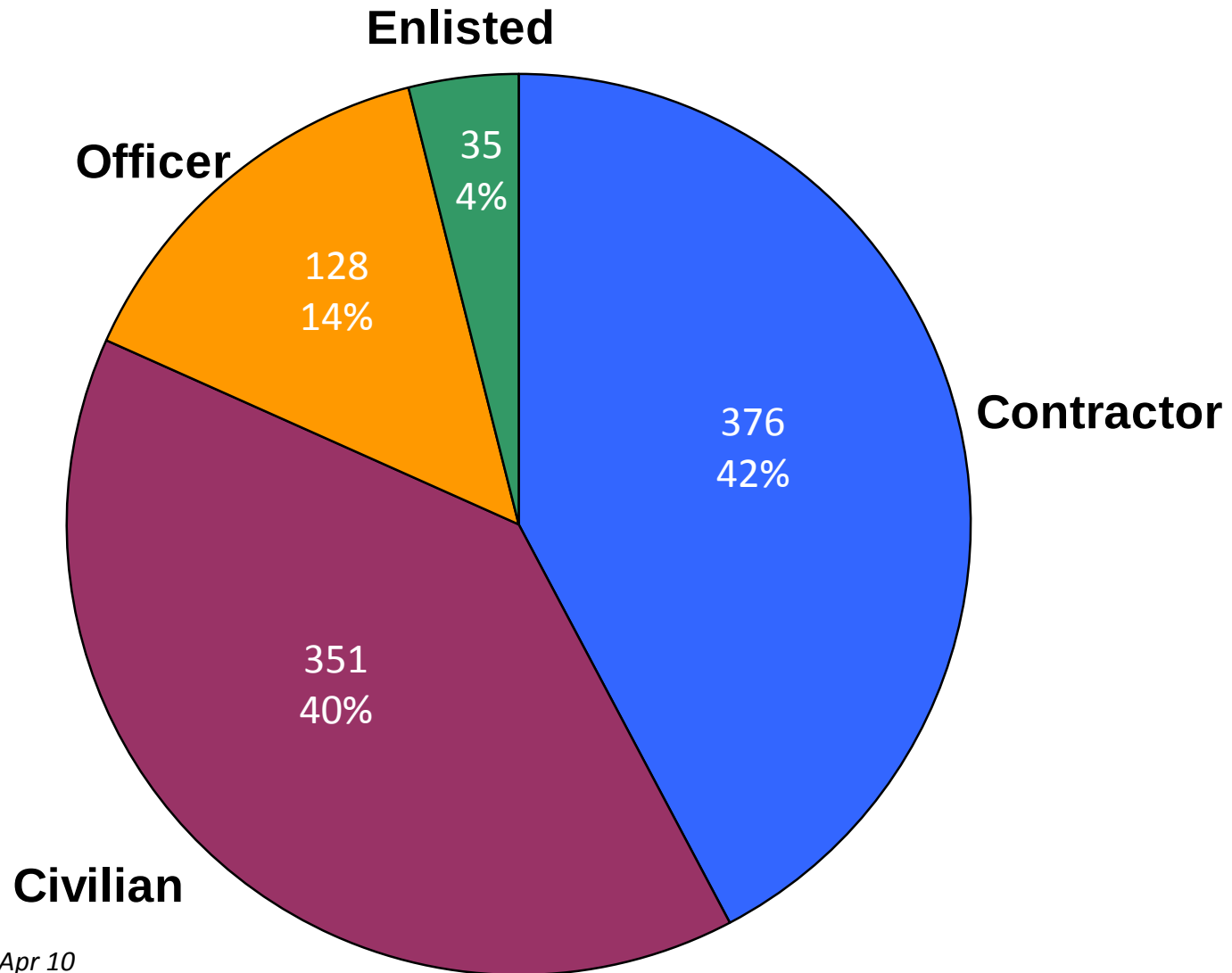


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- 53 university associations



Human Effectiveness Directorate

Total Workforce - 890

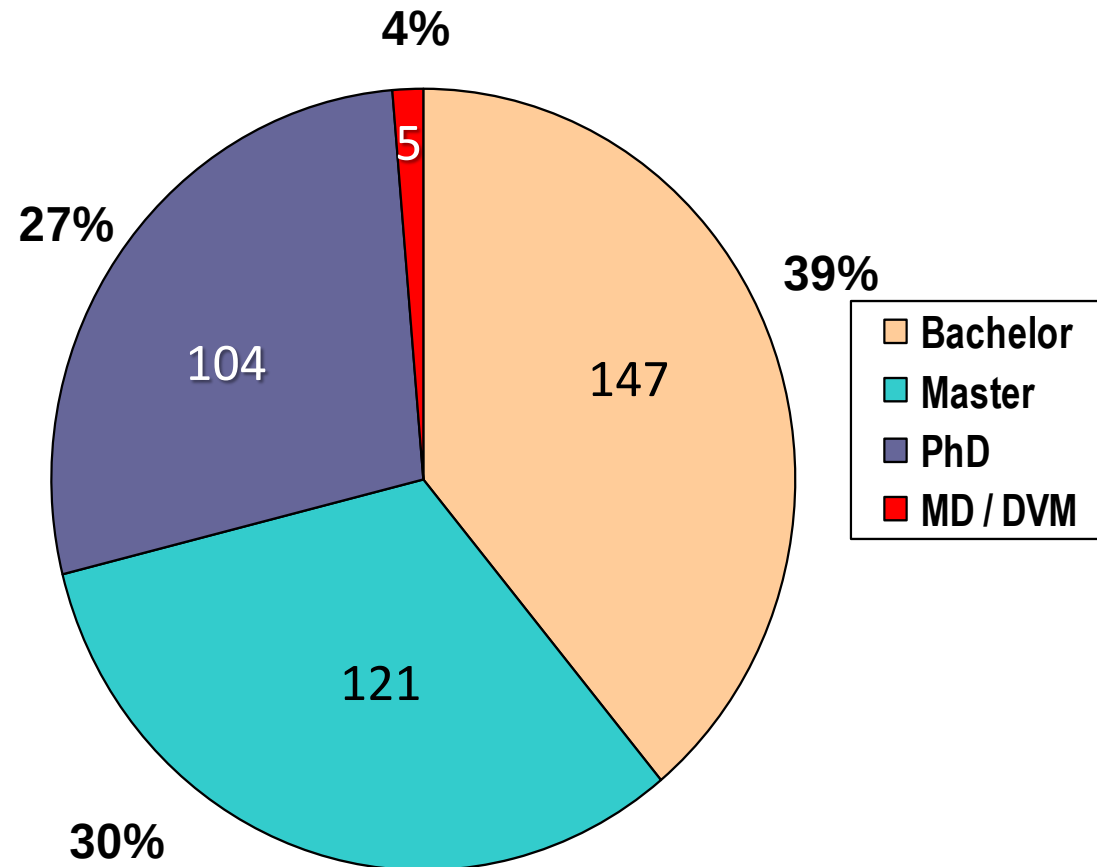


As of 22 Apr 10



Human Effectiveness Directorate

S&E Academic Levels – Govt Only



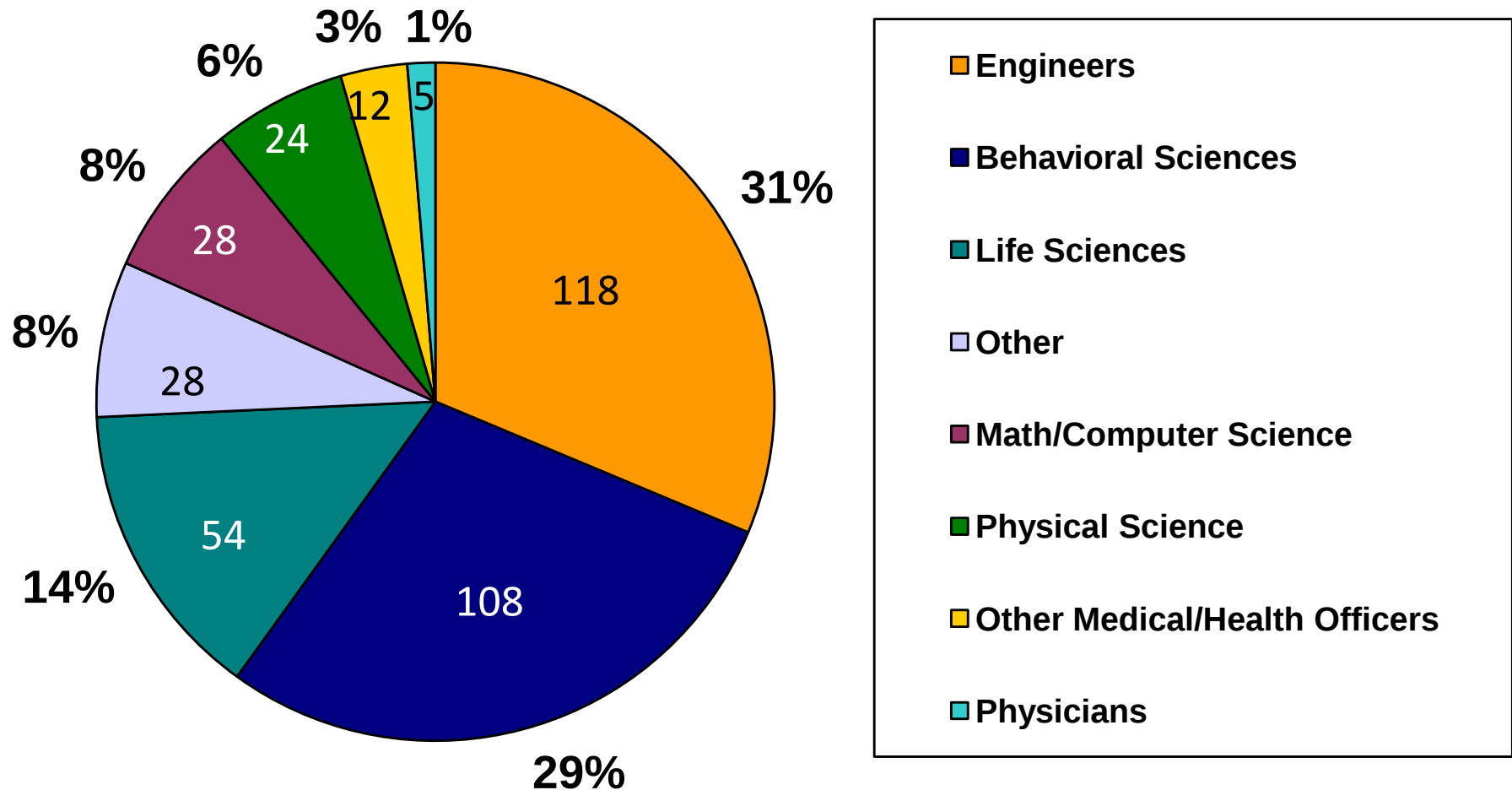
Assigned Govt S&E Workforce = 377

As of 22 Apr 10



Human Effectiveness Directorate

Science & Engineering Disciplines



As of 22 Apr 10



Human Effectiveness Directorate Core Technical Competencies (CTC)



Forecasting

Training

Decision Making

Performance

Four Core Technology Competencies (CTCs)
with 13 Sub-CTCs



Decision Making CTC



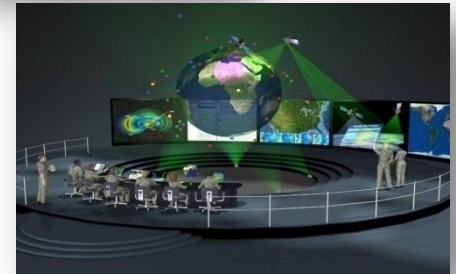
Battlespace Acoustics

Revolutionize auditory displays to maximize operator effectiveness in complex multisource environments



Battlespace Visualizations

Discover novel information presentation techniques to improve human decision making



Human Role in Semi-autonomous Systems

Understand and apply the fundamental underpinnings of human-automation interaction



Applied Neuroscience

An inter-disciplinary approach to examine the brain and behavior at work – from individuals to teams



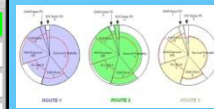
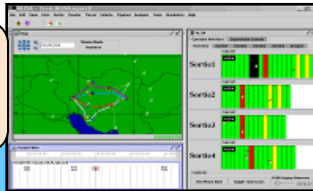


Role of Human in Autonomous Systems

Research Thrusts - Basic to Applied

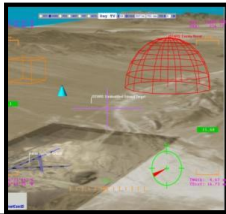


Human-automation interaction
(methods, visibility, attention, allocation)



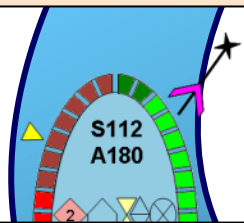
Integrated crew stations:
increased span of control

Multi-modal & 3D interfaces for
supervisory control



Interfaces tailored for future
capabilities & missions

Multi-UAV management
(glyphs, task switching, timeline)



Sensor inspection aids



Multi-platform control station
hardware/software framework



Applied Neuroscience Research



Focus the power and potential of neuroscience to improve human performance

- **Automatically assess, manage, and intuitively mitigate task overload**
- **Facilitate human/machine collaboration**





What are we trying to do?



- Study the brain and behavior at work
 - Neuroergonomics
- Inter-disciplinary approach: neural, behavioral, and computational
- One smaller piece of the very large world of neuroscience, with a real-world task focus
- Behavior and performance alone are simply not enough to push the state of the art



Why Neuroergonomics?



- **Huge body of neuroscientific research; vast majority is basic science and not application oriented**
- **Neuroergonomics is not an immediate concern for many neuroscientists**
- **Neuroergonomic research is application oriented, though not all is specific to Air Force interests**
- **External funding directed at integrative neuroergonomic research is limited**



Strategy



- **Conduct research with more complex, realistic tasks that aid in advancing the application of neuroscience**
 - **Basic research with simple tasks well-covered outside AFRL; continue to monitor and leverage**
- **Focus on integration of methods**
- **Utilize external collaborations to increase depth and breadth of neuroergonomics research**



Research Objectives

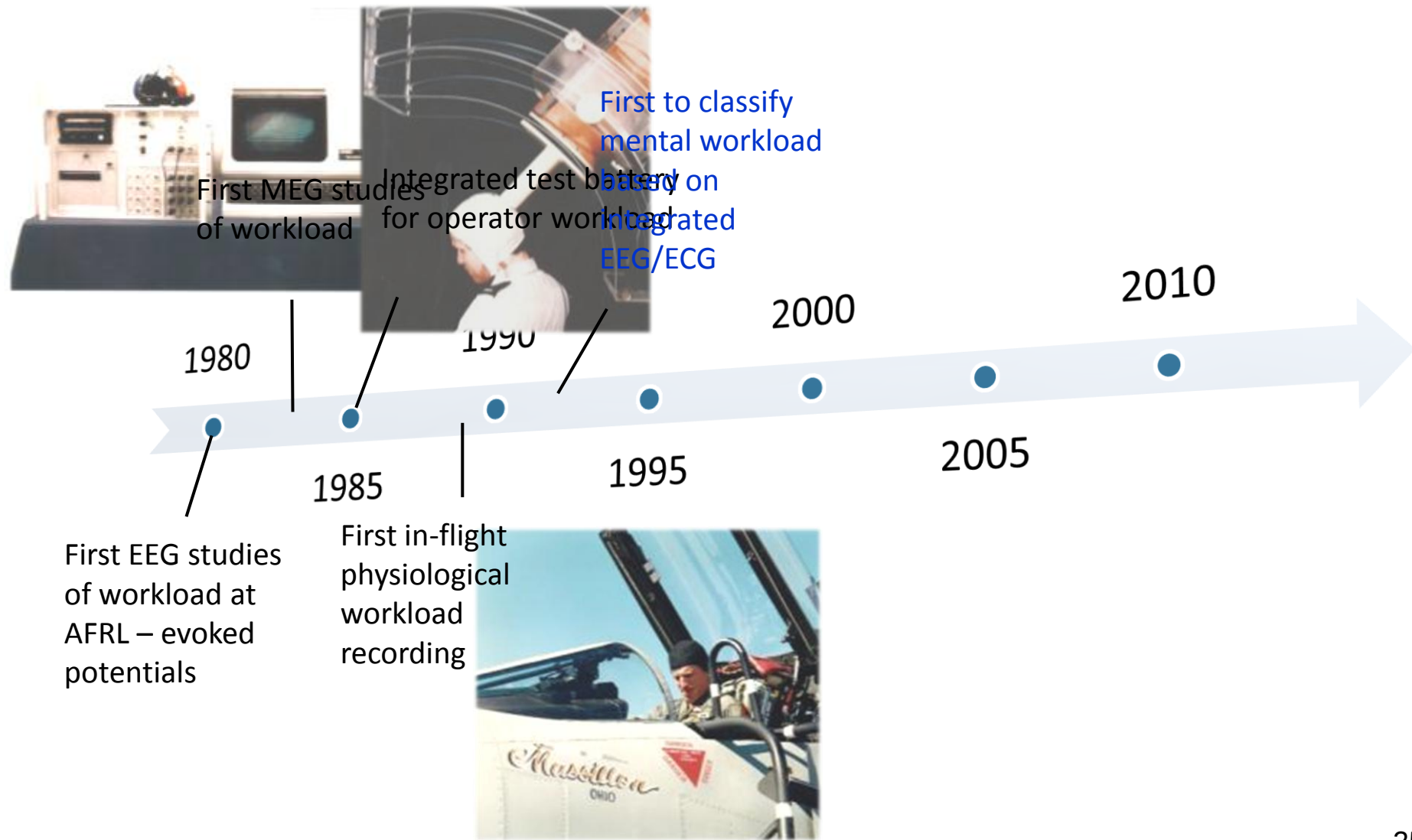


- **Provide a full spectrum of enhanced capabilities:**
 - Adaptive systems that monitor operator cognitive state and self-modify in real time
 - Materiel solutions optimized to meet human cognitive needs via neuroscience applied to test and evaluation
 - Support teaming and collaboration research performed by RHCPT





History of Applied Neuroscience Research



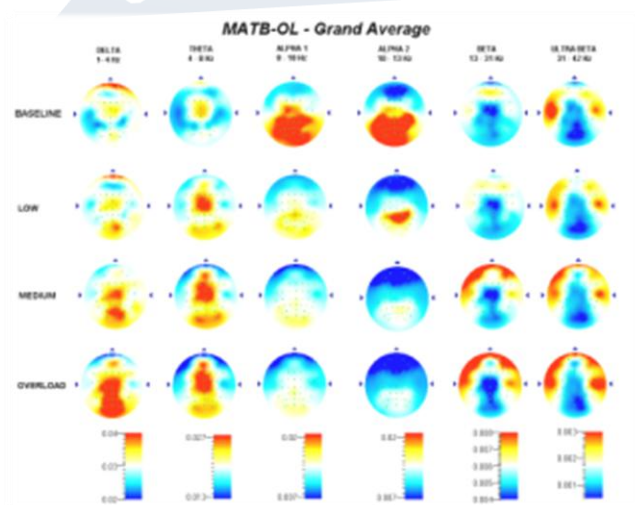
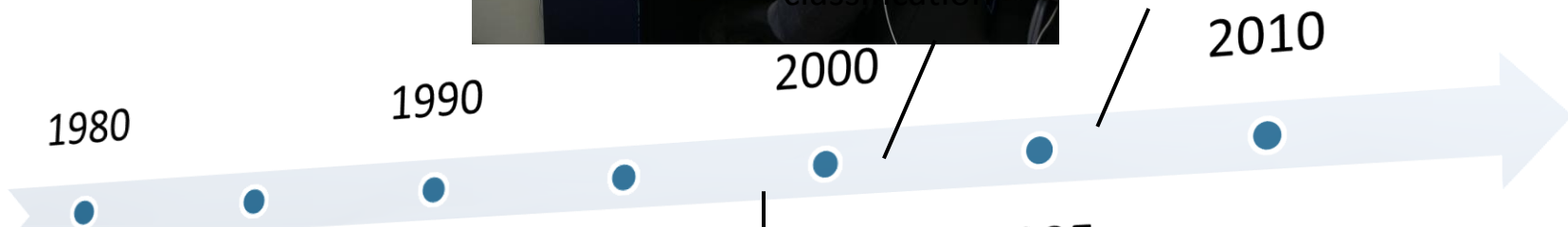


History of Applied Neuroscience Research



First successful real-time workload classification

Closed-loop adaptive aiding based on EEG/ECG



1995

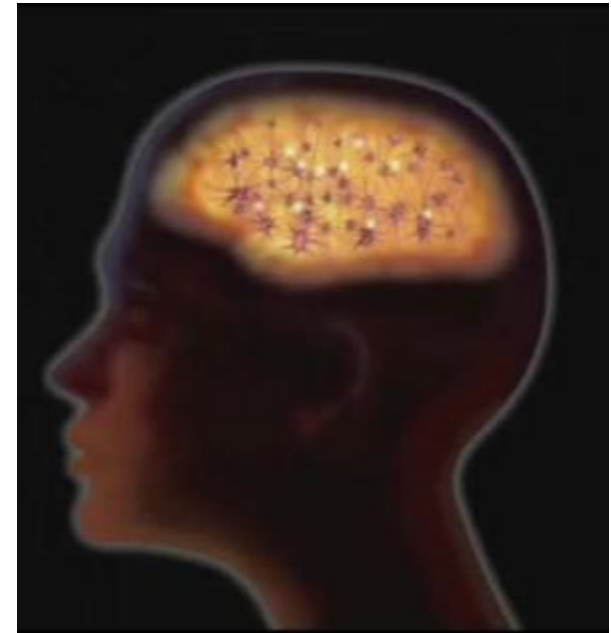
Measured EEG workload in complex tasks



Current Applied Neuroscience Research

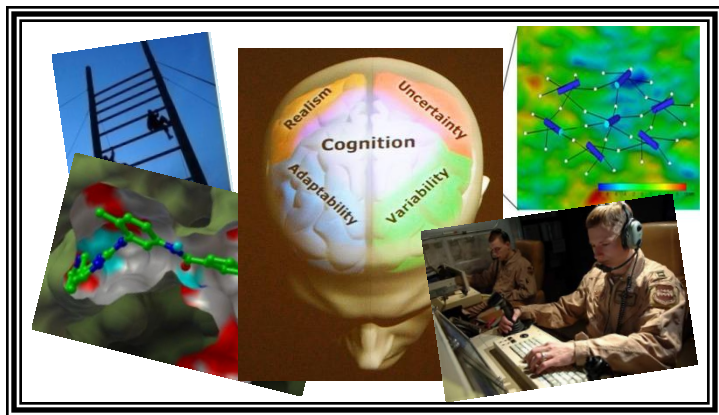


- **Mix of in-house and external collaborations**
 - Collaboration with ARL, NRL, IARPA, and numerous universities and businesses
- **In-house research takes full advantage of the many programs that provide student employees and interns**
- **Current projects include**
 - testing new sensors
 - evaluating applicability of academic paradigms
 - integrative research
 - extension to novel domains, such as teamwork and collaborative tools
 - Sensors/Mitigations





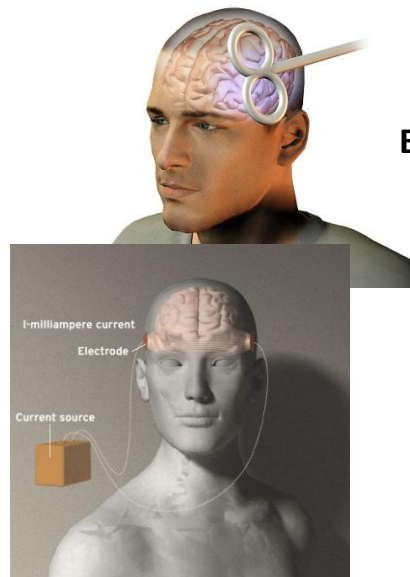
Diverse Programs in Cognitive Performance Optimization



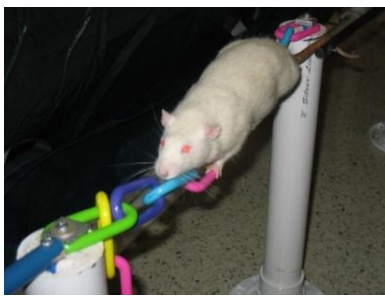
Molecular Mechanisms of Human Learning and Memory



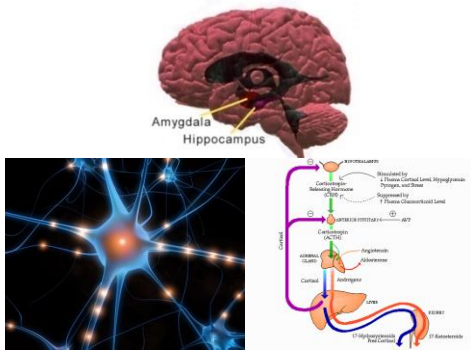
Agility-Based Physical Training Promotes Cognitive Performance



Non-Invasive Brain Stimulation to directly augment cognition and improve performance or accelerate learning



Enrichment strategies improve brain structure and response to stress



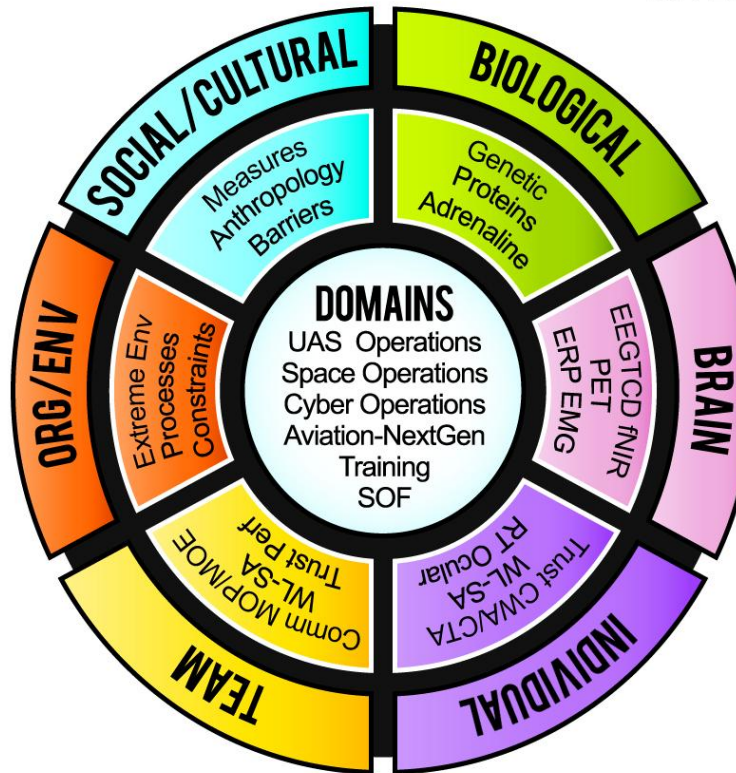
Markers of stress, inflammation and plasticity correspond with performance effects



HUMAN Approach

360° ANALYSIS

MODEL
GENERATION
& TESTING



CONVERGENCE

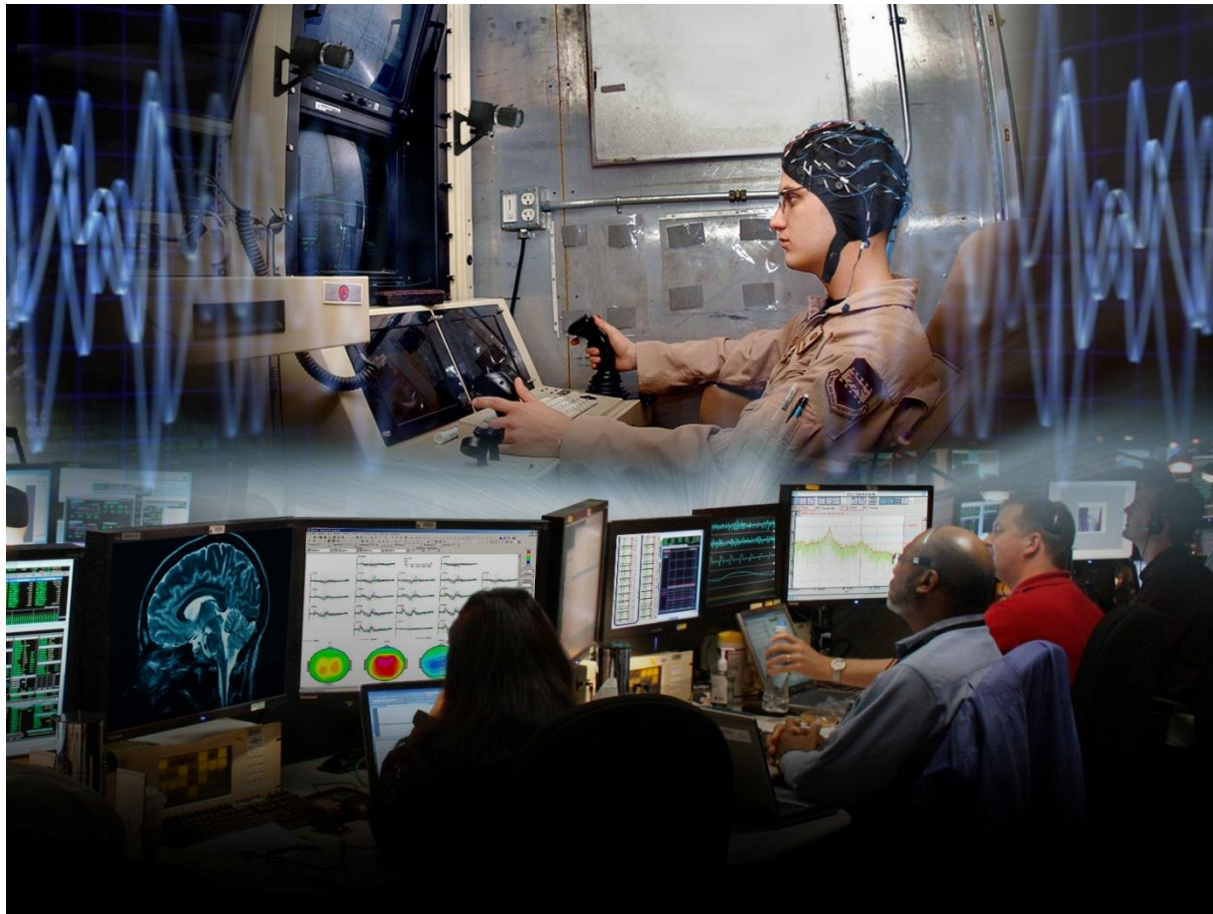
INTELLECTUAL
CAPITAL



Objectives



Where we are today





Objectives

Where we plan to be in 4 years



Human
Universal
Measurement and
Assessment
Network





Potential Future Work



- **Selection**
- **Adaptive Training**
- **Trust (interpersonal and human/machine)**
- **Cognitive Neurofeedback**



Human Effectiveness Directorate

Summary



- **Dedicated to supporting Air Force people and improving their performance**
- **Focused on our science and technology programs that address user capability needs**
- **Working closely with the technology users to meet their requirements**

“Unleashing the power of human performance through technology”

