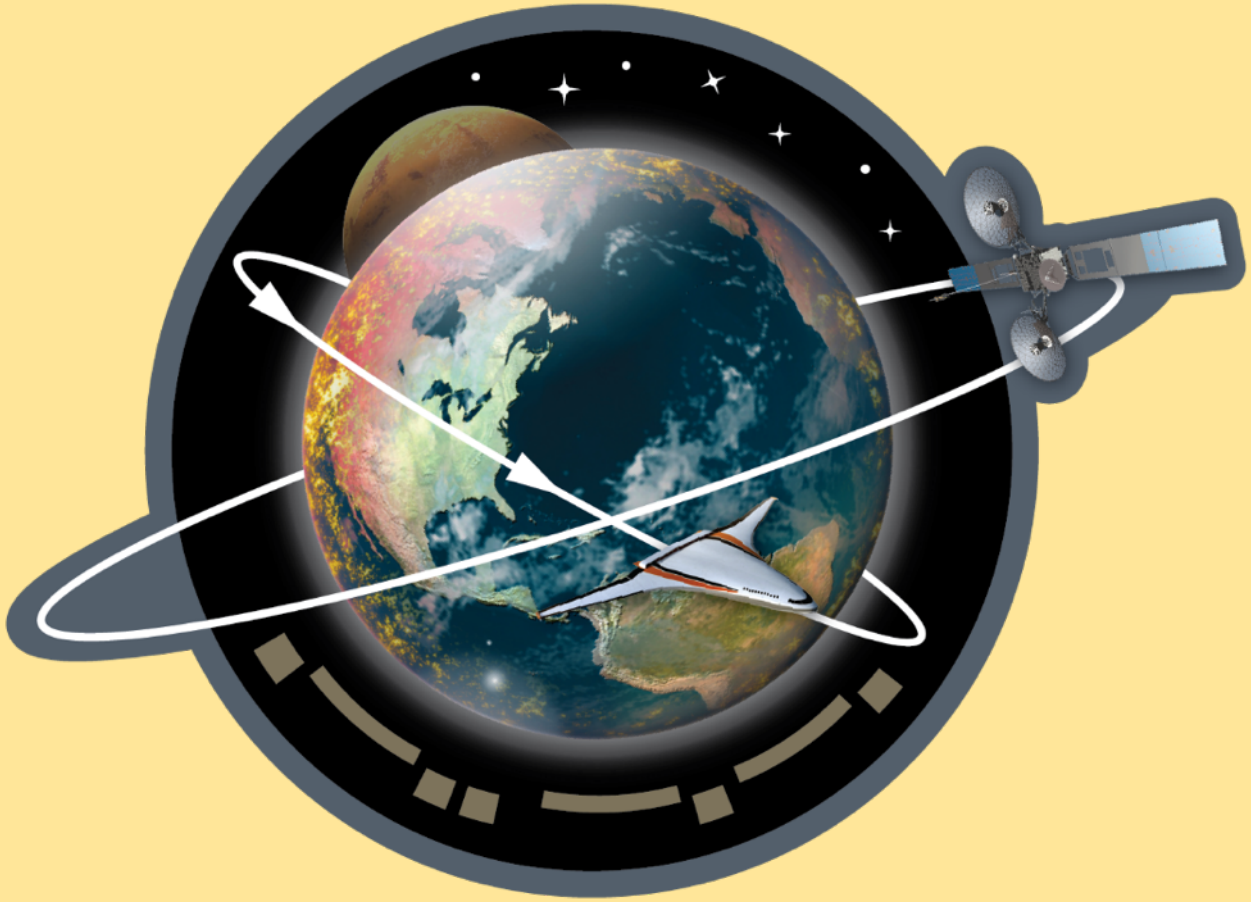


COMMUNICATIONS &
INTELLIGENT SYSTEMS DIVISION

NASA GLENN RESEARCH CENTER

Division Overview

Dawn C. Emerson

Chief, Communications and

Intelligent Systems Division

September 2020

The NASA John H. Glenn Research Center at Lewis Field

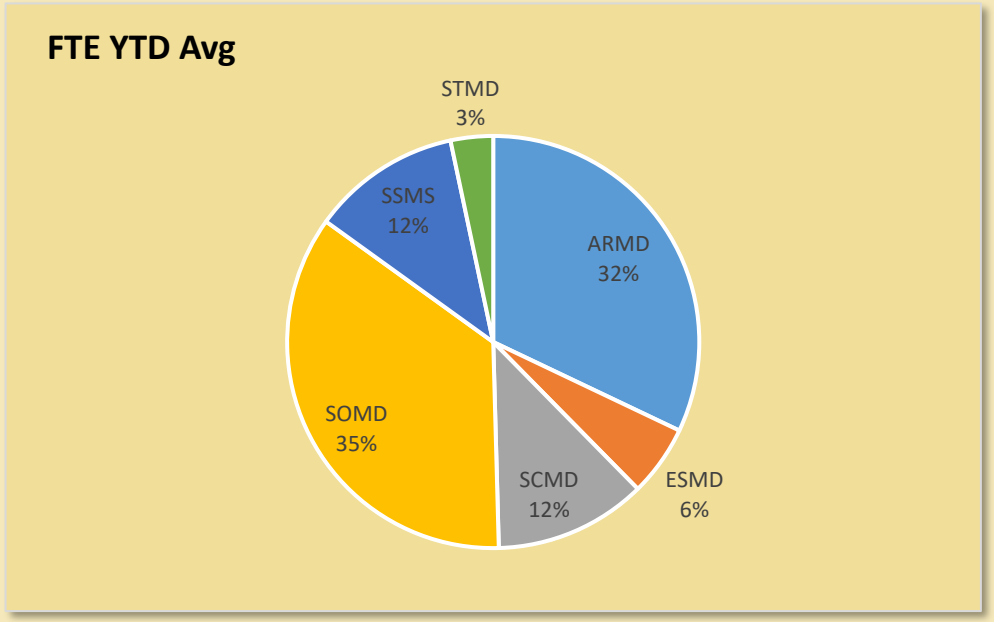
Lewis Field (Cleveland)
- 350 acres
- 1514 civil servants and 1,528 contractors
- 84 Pathways Interns (not included above)

Plum Brook Station (Sandusky)
- 6,500 acres
- 21 civil servants and 105 contractors

Communications and Intelligent Systems Division (LC)

- Our Mission: Perform and direct research and engineering in the competency fields of Advanced Communications and Intelligent Systems with emphasis on **advanced technologies, architecture definition and system development** for application in current and future aeronautics and space systems.
- Research and discipline engineering covers a broad range of technology readiness levels (TRL).

LC Support to NASA Mission Directorates



LC Competency Elements:

Space and Aeronautical Communications

Expertise:

- Architecture Definition & Analysis
- Network Research
- Signal Processing & Cognition
- Advanced High Frequency Components & Systems
- Optical Communications
- Communication System Integration & Test

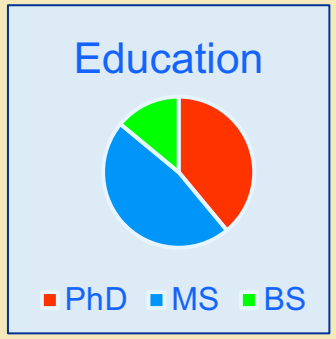
Intelligent Systems – Cross-Cutting Competencies

Expertise:

- Optics and Photonics
- Smart Sensor Systems
- Instrumentation- Electronic
- Controls- Dynamic System Modeling and Controls

Communications and Intelligent Systems Division (LC)

108 FTE (headcount 113)
+ 27 Summer Students
+ 2 Summer Faculty



Highly Trained Staff

Extensive Laboratories ~60

NEW Aerospace Communications Facility

Communications & Intelligent Systems Division (LC)
Division Chief: Dawn Emerson
Deputy Division Chief: Dr. Félix Miranda
Associate Division Chief: Denise Ponchak
Senior Technologist: Dr. Robert Romanofsky

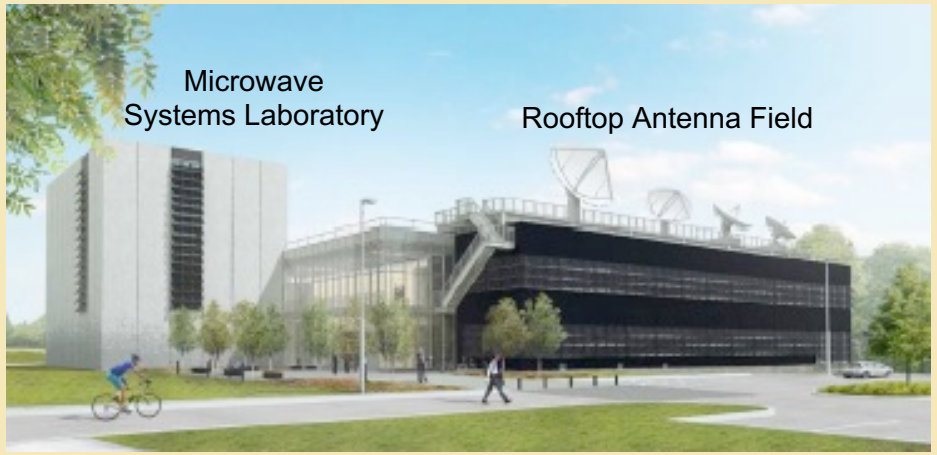
- **System Architectures and Analytical Studies Branch** — LCA / Richard Reinhart
- **Intelligent Control and Autonomy Branch** — LCC / Kevin Melcher
- **Secure Networks, Systems Integration and Test Branch** — LCN / Robert Jones
- **Cognitive Signal Processing Branch** — LCI / Gene Fujikawa
- **Advanced High Frequency Branch** — LCF / Dr. James Nessel
- **Optics and Photonics Branch** — LCP / Dr. Margaret Nazario
- **Smart Sensing and Electronics Systems Branch** — LCS / Diana Centeno-Gomez

Aerospace Communications Facility (ACF) - Overview

The **Aerospace Communications Facility (ACF)** at GRC is a ≥ LEED Silver 54,000 sq-ft R&D facility that consolidates and replaces over 40 aging and dispersed communications laboratories into one State-of-the-Art (SOA) building

Antenna Metrology Capabilities:

- *45' x 45' x 50' Near Filed Range*
- *Shielded Compact Antenna Range*
- *Frequency Range: up to 110GHz*
- *Antenna Size: up to ≈10 m in diameter*
- *Conductive Concrete and Absorber provides ≈150 dB attenuation – EMP compliant facility*



Architectural Engineering Firm (Ross-Barney, Chicago, Illinois)

ACF Design Completed: Spring 2019

Contract Award (Austin Co.): November 2019

Groundbreaking: March 4, 2020

Open for Business: Late Summer 2022

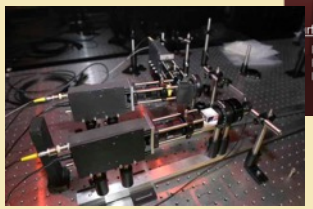
(schedule being revised due to COVID-19 impact)

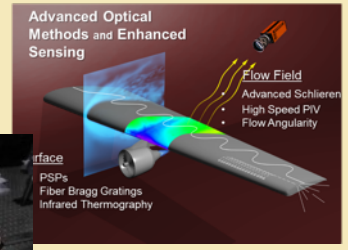
25 SOA Laboratories and Facilities will enable cutting edge R&D in core communications competencies

- *Advanced RF Technologies and Electromagnetic Systems*
- *Signal Processing and Cognitive Communications*
- *Optical/Quantum Communications (Vibration Isolated Lab)*
- *Network and Architecture Research*
- *Harsh Environment Communications Technologies*
- *Antenna Ranges, Antennas and GND Stations*
- *Systems Analysis, Emulation, Integration & Testing*
- ***M**ultiple **A**sset **T**estbed for **R**esearch in **I**nnovative **C**ommunications **S**ystems (MATRICS)*

Communications and Intelligent Systems Division (LC)

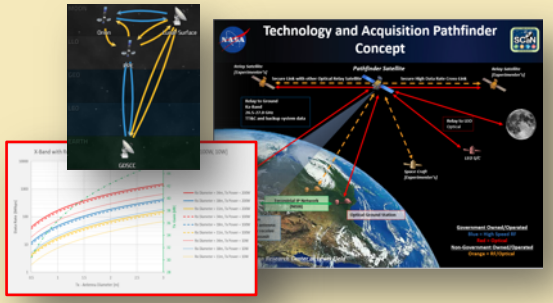
Optics and Photonics





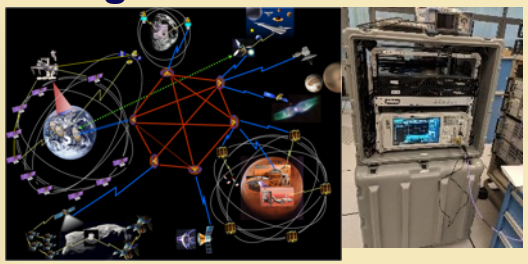
Optical Communications/Quantum Comm
Hyperspectral Imaging
Optical Instrumentation- Flow Diagnostics
Health Monitoring

Systems Architectures & Analytical Studies



Communications System Architectures
Analytical System Studies, Mod & Sim
Spectrum Analysis

Secure Networks, System Integration and Test Branch

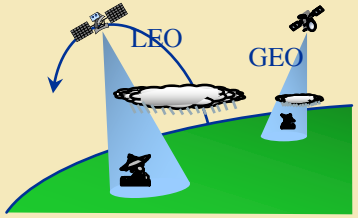


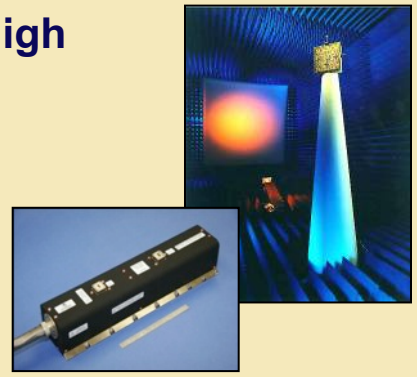
Network Research/Security
System Integration/Test/Demo

Intelligent Control and Autonomy

Intelligent Controls
Dynamic Modeling
Health Management

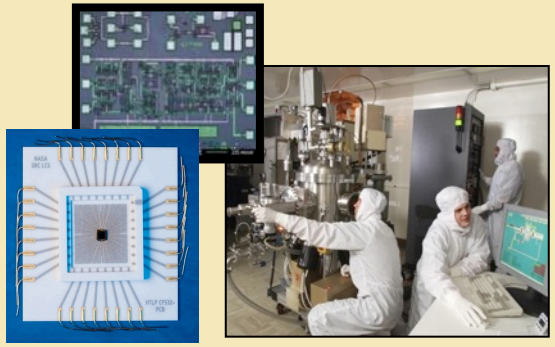
Advanced High Frequency





Antennas Design and Metrology
Propagation
RF Systems and Components
3-D Electromagnetic Modeling

Smart Sensing and Electronics Systems



Extreme Environment Sensors & Electronics
Electro-Optical Sensing
Thin Film Physical Sensors

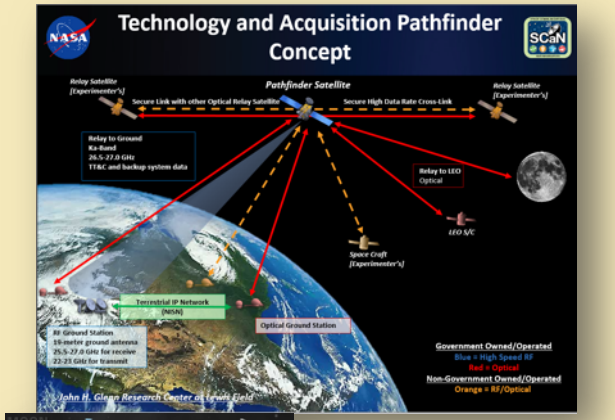
Cognitive Signal Processing

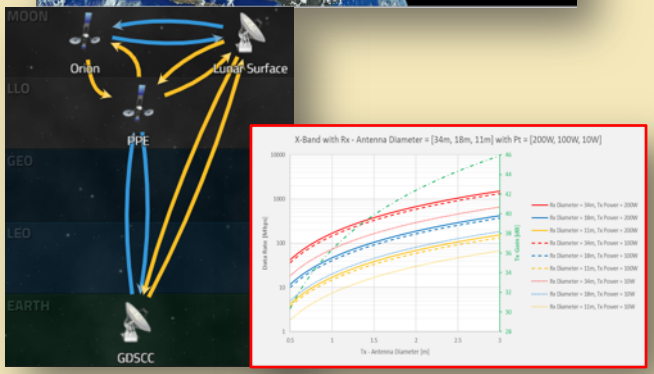
Radio Systems – SDRs,
Signal Processing and Cognition
Position, Navigation & Timing

System Architectures & Analytical Studies Branch (LCA)

Focus discipline areas include: System Architectures; Analytical System Studies; Modeling and Simulation at communication system level; and Spectrum Analysis

- Conducts research in communication systems engineering, development and analyses. Emphasizes and implements processes based on best engineering practices and experience.
- Executes system design processes through: stakeholder expectations definition, technical requirements definition, and architecture design solution definition through all life cycle phases of a communications project.
- Performs communications architecture conceptualization and communications system level analyses (including link budgets for both RF and Optical systems).
- Performs communications systems simulation and modeling analysis of communication architectures for Aeronautics and Space applications using STK, Opnet, Visualyse, and ACES and many specialized software models.
- Conducts communication system architecture evaluations and assessments, trade-off studies, propagation modeling, technology assessments, development of design requirements, and develops technology roadmaps and forecasts in support of Aeronautics and Space missions.
- Includes analytical support for spectrum-related issues to NASA missions, interference analysis, field analysis and technical surveys.



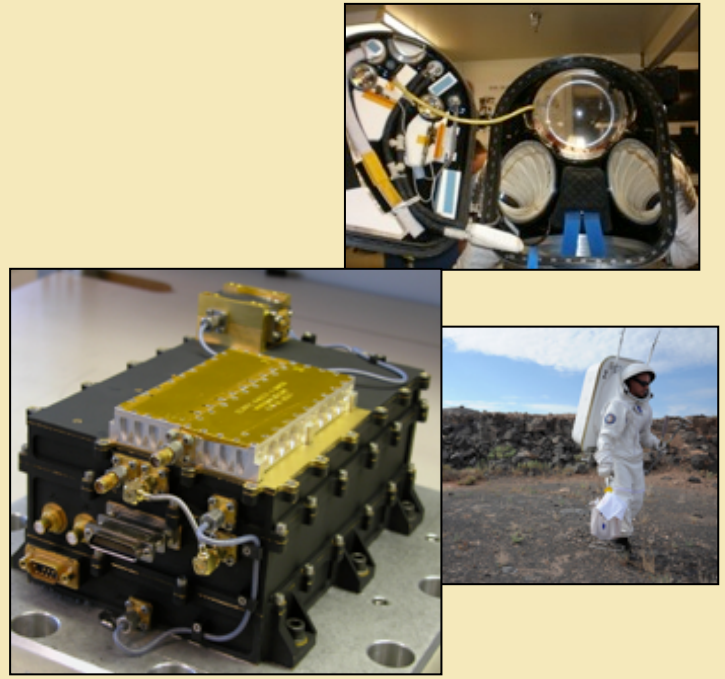


Communications System Architectures
Analytical System Studies, Mod & Sim
Spectrum Analysis

Cognitive Signal Processing Branch (LCI)

Focus discipline areas include: Cognitive Communications; Signal Processing; Software-Defined and Cognitive Radios; and Positioning, Navigation and Timing (PNT)

- Conducts research, technology development and engineering of cognitive signal processing methods and approaches, focusing on applications in cognitive and spectrum efficient communications systems for NASA's space and aeronautical applications.
- Focus areas include: software-defined and cognitive radios; waveform development; artificial intelligence (AI) and machine learning (ML) algorithms for communications; position, navigation and timing methods; spectrum and power efficient coding and modulation techniques; field programmable gate array (FPGA) reconfigurable devices to enable cognitive AI/ML algorithms.
- Develops and maintains open architectures for space-based software defined radios; develops platform-independent, portable waveforms; tests and evaluates digital communication methods for mobile, multi-user links; and performs engineering technology assessment.
- Provide proof-of-concept fabrication and experimental ground and/or flight testing.

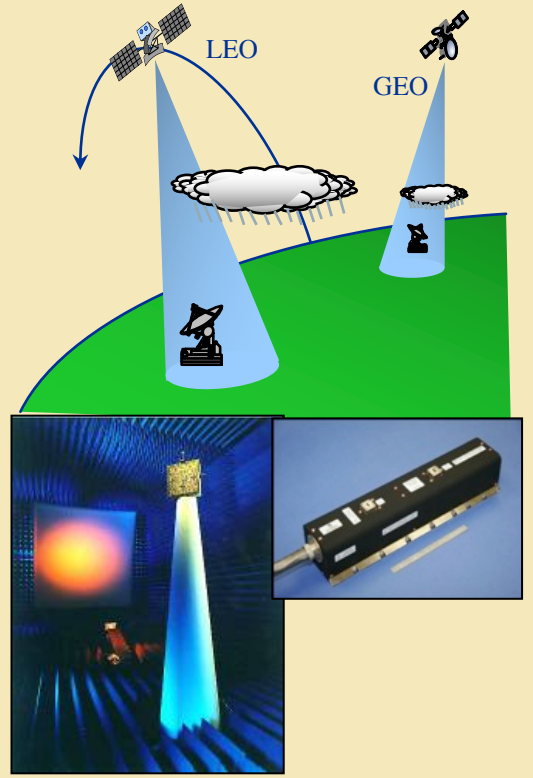


Radio Systems – SDRs,
Signal Processing and Cognition
Position, Navigation & Timing

Advanced High Frequency Branch (LCF)

Focused Discipline Areas Include: Radio Frequency (RF) Components & Systems; High Power Amplifiers; Advanced Antenna Technologies; Antenna Metrology; and Atmospheric Propagation

- Conducts research and development in the areas of Radio Frequency (RF) devices and circuits including antennas, RF systems and RF propagation for aerospace communications.
- Includes test and characterization of RF devices and subsystems such as solid state power amplifiers, power combiners, up/downconverters, and phased array technologies for communications and sensing applications at microwave, mm-wave and THz frequencies.
- Develops technologies and techniques in support of the next generation space and aeronautics communications architectures, such as phased arrays based on silicon RF integrated circuits (RFICs) and associated in-situ calibration techniques.
- Facilities include Planar and Cylindrical Near-Field and Far-Field Ranges, Multiple Asset Testbed for Research in Innovative Communications Systems (MATRICS), Microwave/Millimeter-Wave Device and Circuit Characterization Laboratory, RF Rapid Prototyping Laboratory, and RF Propagation Laboratory.
- Strong computational and device simulation and test/characterization capabilities are available in addition to microelectronics fabrication and processing facilities.

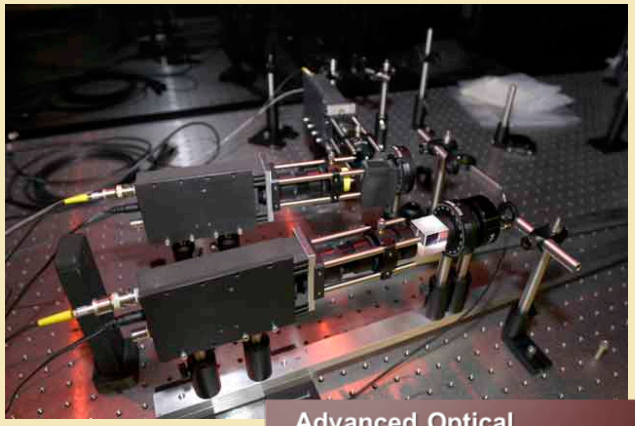


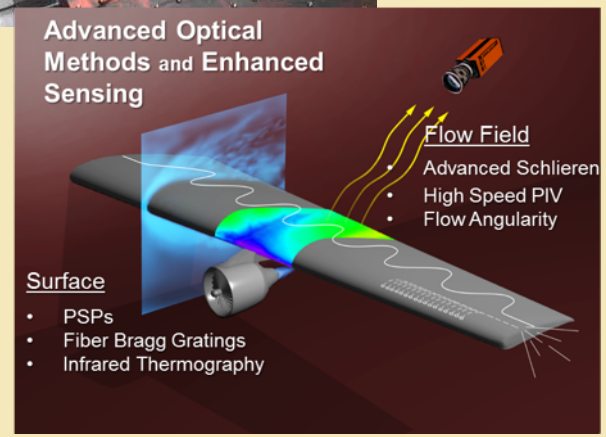
Antennas Design and Metrology
Propagation
RF Systems and Components
3-D Electromagnetic Modeling

Optics and Photonics Branch (LCP)

Focus disciplines Areas Include: Optical Communications; and Flow Diagnostics

- Conducts research and development in the areas of optical communications, optical instrumentation, and photonic devices.
- Innovates, develops, demonstrates, and transitions relevant new technologies to the aerospace community with emphasis on communications, propulsion and autonomous systems.
- Focus areas include: free-space optical and quantum communications for aeronautics and for near earth and deep space, optical flow and surface diagnostics instrumentation for aerospace subsonic through hypersonic propulsion, and photonics and opto-mechanical devices for intelligent and autonomous systems.
- Resulting data, measurements, and optics and photonics sub-systems lead to improved understanding of the fundamental physics, designs, model validation, intelligent and autonomous sub-systems, and safety of the aerospace systems for many of the core technologies at GRC and across NASA.



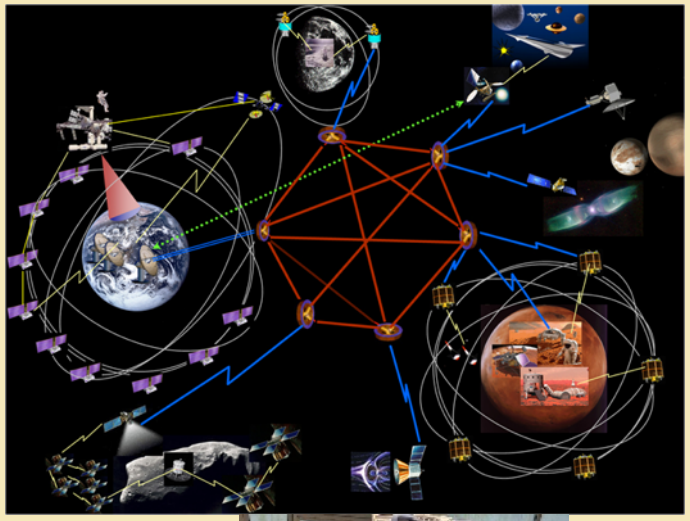


Optical Communications/Quantum Comm
Hyperspectral Imaging
Optical Instrumentation- Flow Diagnostics
Health Monitoring

Secure Networks, Systems Integration and Test Branch (LCN)

Focus Disciplines Areas Include: Protocol and Network Research and Development; Network Security; and Communications System Integration, Test, and Demonstration

- Conducts communications network research and preliminary concept studies by defining needs, feasibility, requirements, and functional system definitions.
- Conducts research and development of advanced communications network architectures, protocols, national and international technology and security standards, technology development and network-based applications.
- Particular emphasis on communication efficiency, quality-of-service, security and autonomy (including cognition) for mobile, ad hoc and challenged networks.
- Network research includes the development of network components, design of network layers, networked systems architectures and network testbeds to benchmark and evaluate networking protocols and security.
- Emphasis is on secure wireless mobility, protocol characterization and development, component development, requirements definition, standards and flight software and hardware component assessment.
- Major competencies include: conducting network level analyses, development of design requirements, development of network architectures, conducting trade studies, and the integration, test and verification of communication networks and systems.

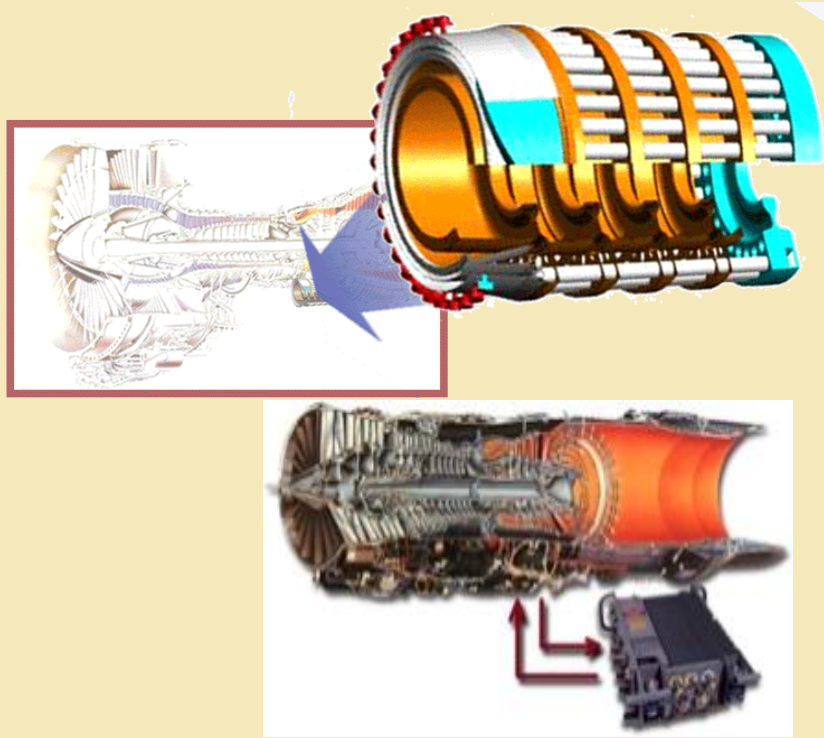


Network Research/Security
System Integration/Test/Demo

Intelligent Control and Autonomy Branch (LCC)

Focus disciplines Areas Include: Intelligent Control; Modeling and Simulation of Dynamic Systems; and System Health Management

- Conducts research and development of technologies to increase the level of intelligence and autonomy in complex aerospace systems with a strong focus on aero-space propulsion systems.
- Identifies, develops and demonstrates relevant new technologies and facilitates technology transition to the aerospace community.
- Technology areas include: dynamic modeling of complex systems and subsystems; intelligent control concepts; advanced system health management and diagnostics; and autonomous operation of aero-space vehicles.
- The goal of these efforts is to enhance the affordability, capability, efficiency, environmental compatibility, and safety of aerospace systems.
- Facilities include Flight Simulation laboratory, Control Hardware-in-the-Loop Simulation laboratory, Active Combustion Control laboratory, and Unsteady Combustion laboratory.

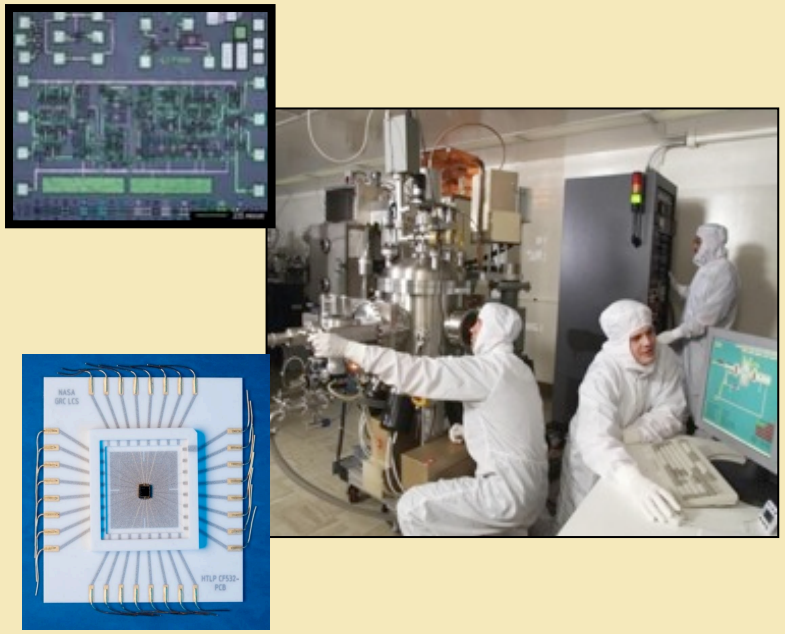


Intelligent Controls
Dynamic Modeling
Health Management

Smart Sensing and Electronics Systems Branch (LCS)

Focus disciplines Areas Include: Smart Sensors; Electro-Optical Sensing; and Extreme Environment Sensors and Electronics

- Conduct fundamental & applied research and development of adaptable sensing systems and instrumentation which incorporates electronics and other capabilities to enable integrated intelligent measurement systems for ongoing and future aerospace and space programs.
- Projects typically involve extreme environments including operation in or exposure to a wide range of temperatures, pressures, chemical/caustic environments or application requirements far beyond conventional instrumentation technology.
- Specific areas of work include thin film and photonic sensors for temperature, strain, heat flux and flow measurements; chemical species sensors for leak detection, emission, safety, human health, and environmental monitoring; silicon carbide electronic devices for signal conditioning and processing, sensors, power devices; mobile and remote sensing platforms; microelectromechanical systems (MEMS); and nanoelectromechanical systems (NEMS) based sensors and electronics.
- Facilities include crystal growth laboratories, sensor and device microfabrication clean rooms, rapid design prototyping, and labs for packaging, test, evaluation, and reliability studies of sensors and electronic devices.



Extreme Environment Sensors & Electronics
Electro-Optical Sensing
Thin Film Physical Sensors

Contact Information

Ms. Dawn Emerson, Chief, Communications and Intelligent Systems Division

216-433-8901

dawn.c.emerson@nasa.gov

Dr. Felix Miranda, Deputy Chief, Communications and Intelligent Systems Division

216-433-6589

felix.a.miranda@nasa.gov