Engineering and Technology Directorate

Overview

Felicia Jones
Director

December 21, 2018

NASA Goddard Space Flight Center
ETD Vision

The Engineering and Technology Directorate (ETD) provides multidisciplinary engineering expertise for the development of cutting-edge Science and Exploration Systems and technologies.

ETD’s talented and diverse workforce is committed to expanding today’s engineering boundaries through the application of emerging technologies to develop high performance, cost effective solutions to the most challenging problems in Science and Exploration. We will achieve this within our laboratories and those of our many valued present and future partners.
• A diverse, talented and highly educated workforce. Unique facilities and laboratories. All working as one to serve the Science and Exploration communities and making the Nation’s Vision for Space Exploration a reality.

  – ETD holds one third of the Center’s civil service population

  – ETD is the main source of the Senior Technical and Management pipeline

  – The success of NASA/GSFC Projects depends upon the technical competence and capability of ETD

  – ETD is the steward for engineering excellence and Engineering Technical Authority at GSFC
ETD Workforce Demographics

~1273 Employees
Data as of May 2017

**Skill Distribution**
- Engineer: 88%
- Professional Administrative: 4%
- Technician: 6%
- Clerical: 2%

**Gender**
- Male: 74%
- Female: 26%

**Education Level**
- Bachelors: 44%
- Masters: 32%
- Doctorate: 12%
- Associates: 2%
- No Degree: 10%

**Ethnicity**
- White: 69%
- African American: 10%
- Asian: 12%
- Hispanic: 7%
- Multiracial: 2%
- Native American: 0%

**Age Groupings**
- Average Age = 46.5
- Under 25: 4%
- 25-29: 8%
- 30-34: 10%
- 35-39: 10%
- 40-44: 8%
- 45-49: 12%
- 50-54: 17%
- 55-59: 19%
- 60-64: 8%
- 65 and over: 4%
Engineering and Technology Expertise

1. **End-to-end mission system design and implementation:**
   - Thermal Systems
   - Large Optical Systems
   - Environmental Testing
   - Flight Dynamics Analysis
   - Spacecraft Propulsion
   - Mechanical Structures/Mechanisms
   - Mission Systems Engineering & Implementation
   - Avionics Architecture & Implementation
   - RF & Optical Communication Systems
   - Command & Data Handling Systems
   - Power Systems & Electrical Systems
   - Ground Support Equipment Design & Implementation
   - Guidance, Navigation & Control Components & Systems
   - Flight & Ground Software Systems
   - Systems Integration, Test & Verification
   - Access to Space Carrier Systems
   - Ground Command & Control Systems
   - Mission Planning & Scheduling Systems
   - Data Processing, Analysis & Modeling Systems

2. **Engineering competencies in support of scientific instrumentation:**
   - Detector Systems
   - Optics, Lasers & Electro Optics
   - Cryogenics & Fluids Systems
   - Active/Passive Microwave Systems
   - Payload/Instrument Systems Engineering

3. **Cross-cutting engineering disciplines:**
   - Materials
   - Autonomy
   - Contamination Control
   - Electromechanical Systems
   - Wavefront Sensing & Control
   - Electronics Parts & Radiation
   - Data Management & Analysis
   - Microelectronics & Signal Processing
   - Machining/Fabrication Technologies
   - Network Systems & Technology
   - Computing Environments & Technologies
Engineering and Technology Directorate

ETD DIRECTORATE - Code 500
Director • Felicia Jones (6-6218)
Deputy Director • Juan Roman
Deputy Director for Tech Mgmt • George Jackson
Deputy for Planning & Business Mgmt • Karen Flynn
Assistant Dir. for Business Development • Carl Stahle
Assistant Director Engineering Ops • Barry Green
Assistant Dir. for Eng Safety & Compliance Mgmt • Dann Brown
Assistant Director for Wallops • Steve Nelson
Assistant Director for Workforce Strategies • Lori Simmons
Chief Technologist • Michael Johnson
Safety Manager • Frank Coleman

MECHANICAL SYSTEMS DIVISION
CODE 540
Chief • Jim Loughlin (6-7101)
Associate • Sharon Cooper
Associate • James Marsh

INSTRUMENT SYSTEMS & TECHNOLOGY DIVISION
CODE 550
Chief • Cynthia Simmons (6-7531)
Associate • Peter Maymon
Associate • Cathy Long
Associate • Anthony Sanders

ELECTRICAL ENGINEERING DIVISION
CODE 560
Chief • Art Azarbarzin (6-5118)
Associate • Beverly Settles
Associate • Vacant

SOFTWARE ENGINEERING DIVISION
CODE 580
Chief • Jerome Bennett (6-8623)
Associate • Chris Durachka
Associate • Leigh Forbes

MISSION ENGINEERING & SYSTEMS ANALYSIS DIVISION
CODE 590
Chief • Tupper Hyde (6-8496)
Associate • Lamar Dougherty
Associate • Eric Holmes

GSFC Chief Engineer • Steve Scott
ETD Senior Engineer • Tim Trenkle
NASA EEE Parts Manager • Jonny Pellish

*Acting
Mechanical Systems Division (MSD)
Code 540
MSD Mission

The Mechanical Systems Division (MSD) provides end-to-end multi-disciplinary mechanical and thermal systems capabilities and technology development to:

- Design, Analyze, Fabricate, Assemble, Integrate, Verify/Validate On Orbit, and Support

... advanced scientific instruments and support platforms for ground-based, suborbital, and orbital science and exploration missions

Discipline engineering support includes materials, structural analysis, mechanical design, thermal, electromechanical, contamination/coatings, manufacturing, and environmental testing and integration for both in-house flight hardware development and oversight for out-of-house developed instruments and missions
MSD Technology

MSD is aggressively pursuing the in-house development of several new technology thrusts that have significant potential to win new work and/or materially improve equipment performance in future Goddard missions.

Additive Manufacturing

- High Stiffness, Dimensionally Stable Optical Bench Metal Matrix Composite Core Material Sample
- 0.3m Telescope, all parts fabricated via Direct Metal Laser Sintering

Advanced Thermal Control Techniques

- Cryogenic Loop Heat Pipe for Large Area Cooling
- Nanolamination Multimaterials using Atomic Layer Deposition

Goddard Composite Materials Engineering Technology: Go-CoMET

Develop and Maintain the Most Current Standards in:
1. Design
2. Fabrication
3. Quality Control
4. Analysis
5. Test
6. Embedded Thermal Control
7. Embedded Sensors

SmallSat and CubeSat Development

- Dellingr CubeSat design, analysis, fabrication, test
- 12-month development cycle
- Goddard Modular SmallSat Architecture - Standard SmallSat spacecraft bus optimization to enable maximum capacity for various science instrument
MSD Facilities

Space Environment and Materials Testing at WFF

Materials and Mechanical Testing at Greenbelt

Manufacturing and Plating Labs

Spacecraft and Instrument Integration Facilities

Thermal Tech Lab

Contamination and Coatings Labs

Space Environment Test Capabilities
Instrument Systems & Technology Division (ISTD)
Code 550
ISTD Organization

INSTRUMENT SYSTEMS AND TECHNOLOGY DIVISION
CODE 550
Chief • Cynthia Simmons (x6-7531)
Associate Chief • Peter Maymon
Associate Chief • Cathy Long
Associate Chief • Anthony Sanders
Assistant Chief for Technology • Terence Dolron
Chief Engineer • Fernando Pellerano

OPTICS BRANCH
CODE 551
Head • Peter Maymon*
Associate • Felix Threat
Associate • Manuel Quijada
Associate • Catherine Marx
Associate • Len Seals
Associate • Ron Shiri
Associate • Ray Ohl

CRYOGENICS AND FLUIDS BRANCH
CODE 552
Head • Eric Silk
Associate • Hudson Delee
Associate • Xiaoyi Li

DETECTOR SYSTEMS BRANCH
CODE 553
Head • David Franz
Associate • Lantrang Nguyen
Associate • Kevin Denis
Associate • Manual Balvin
Associate • Kyle Gregory

LASERS AND ELECTRO-OPTICS BRANCH
CODE 554
Head • Mike Krainak
Associate • Elisavet Troupaki

MICROWAVE INSTRUMENT TECHNOLOGY BRANCH
CODE 555
Head • Diep Nguyen
Associate • Jared Lucey

*Acting
The Instrument Systems and Technology Division (ISTD) provides end-to-end multi-disciplinary instrument systems and technology development to:

- Design, Analyze, Fabricate, Assemble, Integrate, Verify/Validate On Orbit, and Support

... advanced scientific instruments for ground-based, suborbital, and orbital science and exploration missions

Discipline engineering support includes optical, cryogenics, lasers and electro-optics, detectors, and microwave leadership for both in-house flight hardware development and oversight for out-of-house developed instruments
Advanced Optical Systems
High precision cryogenic index of refraction measurements
Development and test of petal masks for coronography
High-speed Computational Optics

Cryogenic Systems
Astro-H Continuous Adiabatic Demagnetization Refrigerator
Long Term Cryopropellant Storage for Exploration

Laser Systems
ATLAS laser lifetest setup

Microwave Instruments
HIWRAP on Global Hawk

Detector Arrays
Kilopixel TES Array for SOFIA
QWIP Detectors for Landsat 9
ISTD Facilities

Facility to calibrate assembled optical systems

Cryogenic Test Facility

Laser and Electro-Optics Laboratory

Optical Coating Facility with 2m chamber

Detector Characterization Laboratory (DCL)

Detector Development Laboratory (DDL)

Microwave Instrument Development Lab
Electrical Engineering Division (EED)
Code 560
The Electrical Engineering Division (EED) provides end-to-end electrical systems capabilities & technology development to:

- Design, Analyze, Fabricate, Assemble, Integrate, Verify/Validate on Orbit, and Operate

... electrical/electronic components and systems in advanced scientific instruments and support platforms for ground-based, suborbital, and orbital science and exploration missions

Discipline engineering support includes electronics parts & packaging, fiber optics, photonics, command/data handling, power, end-to-end RF & optical communications, network ground hardware & systems, flight harnessing, microelectronics & signal processing, electrical systems, electromagnetic interference/compatibility, and systems integration and test for both in-house flight hardware development and oversight for out-of-house developed instruments and missions.
EED Technology

Targeted Capabilities

- Instrument Data Acquisition and Control
- Miniaturization
- Radiation Effects
- Avionics
- Communications

Technology Readiness

- Compressive Sensing Single-Pixel Camera
- System-On-a-Chip Instrument Processor
- Multi-Channel Digitizer ASIC
- Astro-H ADR Controller
- SMAP Radiometer Digital Electronics
- Additively Manufactured Electronics
- Radiation Hardened Mixed-Signal ASICs
- Radiation Risk Assessment Tool
- Modular Avionics Architectures
- Housekeeping System-On-a-Chip ASIC
- Memory Error Correction Coding
- Fiber Optic Assemblies
- Ka-Band Earth Shaped Antenna
- Low Cost Transceiver for Suborbital
- LRO Ka-Band Transmitter

NASA Goddard Space Flight Center - Engineering and Technology Directorate
EED Facilities

- Radiation Effects Test Facilities - Damage Van de Graff Test Chamber
- Microelectronics Assembly Laboratory
- Microwave Electronics Test and Assembly Laboratory
- Photonics Vibration Testing and Spectroscopy “Black” Laboratory
- Laser Polishing Facility For High Power Assemblies
- Photonics Assembly Laboratory
- Goddard Electromagnetic Anechoic Chamber (GEMAC)
Software Engineering Division (SED)  
Code 580
The Software Engineering Division (SED) provides end-to-end software systems solution, expertise, and software technologies to:

- Design, Develop/Build, Integrate, Simulate, Verify/Validate On Orbit, and Operate

... advanced scientific instruments and support platforms for ground-based, suborbital, and orbital science and exploration missions

Discipline engineering support includes spacecraft and instrument flight software, ground command and control systems, science and mission planning and scheduling systems, science data processing systems (including on-board/in-flight systems), and science data analysis and modeling systems for both in-house flight hardware development and oversight for out-of-house developed instruments and missions
The SpaceCube Family—SED is developing advanced on-board processing capabilities to meet the computational Science requirements of future missions (e.g., those including hyperspectral and SAR instruments). Capable to reconfigure and adapt on the fly, those capabilities will enable to produce data products on-board for direct downlink and to perform rapid detection and real-time reaction to Science and "first-responder" events.

Pi-Sat: A Low Cost Distributed Mission Test Bed—SED has prototyped ultra-low cost, preconfigured, easy to use development systems for Distributed Spacecraft Mission (DSM) flight software research and for CubeSat/SmallSat flight software research and development."
The Flight Software Technology Advancements Development and Test Lab is used to assemble, integrate, and test flight software technologies using simulators prior to proposing on future missions.

The Code 587 Science Data Processing Lab is used to assemble, integrate, and test SpaceCube avionics systems prior to delivering to customer.

Top left: Software engineers test their code on the SpaceCube platform that will control an ISS payload.
Bottom left: Electrical and mechanical engineers work on a SpaceCube data processing system bound for the International Space Station.

The ASIC SIDECAR Lab is used to develop and test software that will be used in conjunction with detectors on mission like JWST and TIRS.

The Code 587 Science Data Processing Lab is used to assemble, integrate, and test SpaceCube avionics systems prior to delivering to customer.

The Goddard Mission Services Evolution Center (GMSEC) provides mission enabling, cost/risk reduction solutions for current and future missions.

The Wallops Mission Planning Lab (MPL) is the mission analysis, design, visualization, and evaluation facility for sub-orbital and special orbital missions.
Mission Engineering & Systems Analysis (MESA) Division
Code 590
MESA Division Organization

MISSION ENGINEERING AND SYSTEMS ANALYSIS DIVISION
CODE 590
Chief • Tupper Hyde (x6-8496)
Associate Chief • Lamar Dougherty
Associate Chief • Eric Holmes
Assistant Chief for Technology • Jason Mitchell
Chief Engineer • Scott Glubke

ATTITUDE CONTROL SYSTEMS ENGINEERING BRANCH
CODE 591
Head • Jim O'Donnell
Associate • Paul Mason
Associate • Nikesha Davis

INSTRUMENT/PAYLOAD SYSTEMS ENGINEERING BRANCH
CODE 592
Head • Carmel Conaty
Associate • David Richardson
Associate • Wayne Roher
Associate • Mahmooda Sultana

NAVIGATION & MISSION DESIGN BRANCH
CODE 595
Head • Carl Adams
Associate • Daniel Solomon
Associate • Amanda Shelton
Associate • Neerav Shah

COMPONENT & HARDWARE SYSTEMS BRANCH
CODE 596
Head • Chuck Clagett
Associate • Bob Spagnuolo
Associate • Vacant
Associate • Vacant

PROPULSION BRANCH
CODE 597
Head • Andrew Maynard
Associate • Alison Rao
Associate • Kristen Brown

GN&C AND MISSION SYSTEMS ENGINEERING BRANCH
CODE 598
Head • Shannon Fitzpatrick
Associate • Brett Vincent

MISSION SYSTEMS ENGINEERING BRANCH
CODE 599
Head • Vacant
Associate • Kathy Jenkins
Associate • John Johnston
Associate • Dean Chai
Associate • Vacant

*Acting
The Mission Engineering and Systems Analysis Division (MESA) provides end-to-end mission systems engineering and guidance, navigation, and control capabilities and technology development to:

- Conceive, Design, Analyze, Implement, Verify/Validate On Orbit, and Support

... advanced scientific instruments and support platforms for ground-based, suborbital, and orbital science and exploration missions

Discipline engineering support includes attitude and orbit determination and control, spacecraft propulsion, trajectory design, mission architecture, and mission systems engineering for both in-house flight hardware development and oversight for out-of-house developed instruments and missions.
## MESA Technology

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<th>Targeted Capabilities</th>
<th>GN&amp;C Tools</th>
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<tbody>
<tr>
<td>Rendezvous, Capture and Landing</td>
<td>GN&amp;C Hardware</td>
</tr>
<tr>
<td>Propulsion</td>
<td></td>
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<tr>
<td>Space Systems and Integrated Mission Design</td>
<td></td>
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</tbody>
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- **GN&C Tools**: Precision Formation and Alignment, Orbit Determination Toolbox,
  Evolutionary Mission Trajectory Generator, GRSSLi LIDAR, Inter-Satellite Ranging/Comm,
  Satellite Servicing, Natural Feature Tracking, Pose Estimation.
- **GN&C Hardware**: GN&C Hardware, GN&C Tools.
- **Rendezvous, Capture and Landing**: Rendezvous, Capture and Landing.
- **Propulsion**: Propulsion.

### Technology Readiness

- **Mission Design Lab**: Mission Design Lab.
- **Formation Flying Test Bed**: Formation Flying Test Bed.
- **Model-Based Systems Engineering**: Model-Based Systems Engineering.

### Acronym Definitions

- **CCA**: Common Communications Adapter
- **TTA**: Time-Triggered Architecture
- **PnP**: Plug-and-Play
- **GMSEC**: GSFC Mission Services Evolution Center
- **CSI**: Computing Systems Integration (formerly C3I)
- **CFS/CFE**: Core Flight System/Executive

### Examples

- **GRSSLi LIDAR**: Multi-function StarTracker / AR&D Camera
- **GMAT**: Orbits Determination Toolbox
- **XNAV**: Precision Formation and Alignment
- **GPS Enhanced Onboard Navigation (GEONS)**: Evolutionary Mission Trajectory Generator
- **Demisable RWA**: Green Propulsion
- **Free-space Hi-Fi Simulation**: Electric & MEMS Micro-thrusters
- **Non-pyro Valves**: Mission Design Lab
- **Model-Based Systems Engineering**: Formation Flying Test Bed

**NASA Goddard Space Flight Center - Engineering and Technology Directorate**
MESA Division Facilities

- Formation Flying Testbed (FFTB)
- Flight Dynamics Facility (FDF)
- Propulsion System Final Assembly
- Flight Dynamics 3-D Immersive Visualization Environment
- Wallops Island Flight Facility