National Aeronautics and Space Administration

Marshall Space Flight Center
Avionics Design

Engineering Solutions for Space Science and Exploration


High Temp Vacuum Furnace


Inertial Navigation Development Lab


Flight Robotics Lab


X-Ray Optics Fabrication


Electronic Systems Development

Avionics Design provides in-depth engineering for the research, design, development, fabrication and evaluation of avionics systems such as electronic control systems, data systems, communication systems, flight instrumentation systems, inertial components for guidance navigation and control systems, flight instruments, imaging systems and high quality optics.

The avionics capability has existed at the Marshall Space Flight Center since its inception. Over time, the avionics design group has developed capabilities ranging from the design, development, and control of the avionics architecture in a system to the independent verification and validation of integrated systems after fabrication. The avionics design capability ranges from direct hands-on development and/or testing of hardware to performing insight into, and analytical integration of work performed by one or multiple prime contractors. In order to meet these areas of need, the avionics design group has developed a rich set of resources from state-of-the-art facilities and tools, and a wealth of subject matter experts.

The sensors, data systems, and control electronics cross-organizational capability performs research, design, and development of electronic circuits and systems, including instrumentation and signal conditioning, flight computers, audio systems, data busses, digital systems, field programmable gate arrays, and drive electronics for motors, valves, and other electrical actuators. Testing and evaluation is conducted in a variety of laboratories ranging from basic electronics, audio, and sensor characterization chambers (thermal, pressure, and humidity). These facilities provide the capability to support a variety of customers in the development of experiments to control instrumentation for propulsion elements on space vehicles. The closely related imaging team provides the ability to develop and test analog or digital imaging systems and components such as cameras, optics, recorders, and frame grabbers. The imaging team works closely with the optics team, which manufactures and tests mirrors, lenses, and optical systems.

The GN&C hardware & systems capability provides for the evaluation and selection of equipment such as inertial measurement units, sun sensors, star trackers, as well as specialized systems for automated rendezvous and capture. Laboratories include rate tables, star field simulators, the Flight Robotics Laboratory (FRL), and the Contact Dynamics Simulation Laboratory (CDSL). The FRL is a versatile test facility capable of performing both open and closed loop testing in either a digital or hardware-in-the loop mode. The CDSL was developed in response to the need to evaluate the Earth-orbit dynamic response of interfacing mechanisms such as latches and locks, allowing engineers to simulate how a docking or berthing mechanism would behave in Earth orbit.

The RF systems capability provides analyses for communication and range safety for launch vehicles and satellites. RF laboratories enable engineers to design, develop, test, and analyze components such as transmitters, receivers, transceivers, transponders, antenna systems, and feed networks. The RF team also has expertise with Global Positioning Satellite (GPS) systems, including a GPS simulator, which also supports the GN&C Hardware team.

The imaging and optics capability provides implementation and test of imaging and video systems for both spaceflight and ground hardware. It also provides expert knowledge and unique fabrication capabilities in the area of advanced optics, specializing in replicated x-ray optics.

Facilities/Laboratories

Facility	Task	Specifications
Flight Computer and Data System Laboratories	Development, testing, integration and verification of computer and data systems.	A variety of state-of-the-art commercial test equipment such as oscilloscopes, multi-meters, function generators, precision power supplies, etc. More specialized equipment allows the monitoring and testing of MIL-STD-1553 data buses, Ethernet, Versa Module Eurocard (VME) computer communication, and other industry standards. In addition, custom test equipment, such as breakout boxes, unit testers, and other special test fixtures are frequently developed for each project and used in the test process.
Design Simulation Laboratory	MSFC's state-of-the-art electronic design capability	Full logic simulation of hardware before prototype units are built thus minimizing cost and contributing to the affordability of space systems. The hardware modeling system allows complex device model development using the actual silicon for devices with up to 640 pins.
Control Electronics Development Laboratory	Provides MSFC with the capability to perform research, design, development and implementation of both microprocessor and discrete component based electronic control systems for space flight vehicles and experiments.	In-house programs include a wide variety of circuit designs, ranging from linear low-power amplifiers for precision control systems, to multiple-kilowatt switch-mode amplifiers for propellant flow and thrust vector control of ascent vehicles. Modern control techniques utilizing and adaptive controls are developed in this laboratory. Typical equipment comprising the laboratory includes dynamometers; an environmental chamber; a laminar flow bench; oscilloscopes; servo and logic analyzers; resistive, capacitive, and inductive meters; transistor curve tracers; precision voltage and current references; computers; and logic programmers.
Radio Frequency (RF) Laboratory	Provide NASA and MSFC with the capability to design, develop, test, and analyze RF communication systems and their component subsystems—such as transmitters, receivers, transceivers, transponders, antenna systems and feed networks. Provide sustaining engineering related to Range Safety, Communications and Tracking of launch and space vehicles	Typical measurement capabilities of the RF Laboratory include RF power and input sensitivity, modulation characteristics and bandwidth, RF power spectrum, scattering parameters, voltage standing wave ratio, antenna radiation patterns and characteristic impedance. Typical analysis capabilities include simulating dynamic link margin, antennas, and RF subsystem components. The RF Laboratory also provides the resources to investigate new methods of wireless instrumentation, RF signal processing, modulation and demodulation, and provides for RF analysis of communication subsystems
Audio Laboratory	Development and testing of flight audio subsystem designs.	1.) Acoustically isolated test chamber – Provides a high degree of sound isolation from the outside area for subjective evaluation of audio sound quality in the presence of controlled amounts of noise. 2.) Control Room – Supports testing in the audio chamber and serves as a general-purpose audio lab for bench testing of audio hardware and computer simulation of audio design concepts.
Flight Robotics Laboratory (FRL)	Provides a full-scale, integrated simulation capability to support the design, development, test, integration, validation, and operation of orbital space vehicles.	Centered around a 44 foot by 86 foot precision air bearing floor—the largest of its kind. Consists of: mobile solar simulator with 6 lights totaling 42 KVA air-bearing vehicles ranging in size from 200 lbs to 4,000 lbs—each with its own compressed air supply 8-Degree-of-Freedom (DOF) overhead gantry (the Dynamic Overhead Target Simulator or DOTS) provides an 800 lb payload capability for simulating relative motion with respect to a fixed target in the facility (motion envelope of 30' × 160' × 20') Used to simulate the docking conditions of an automated rendezvous and capture system (AR&C).
Inertial Navigation Sensors Development and Test and Navigation Components Development Laboratories	Provide the capability to analyze and evaluate inertial sensors and strapdown inertial navigation systems. Provide the capability to develop and evaluate navigation components for launch vehicles.	Three precision rate tables, recording instrumentation, and supporting test equipment. The rate tables are mounted on massive concrete pads designed to decouple the facility from building vibrations and to minimize ambient seismic noise. The rate tables precise information about rotation axes that can be tilted parallel to the earth's spin axis to remove the effects of the Earth's spin. These tables are used to evaluate rate sensors for bias, scale factor, scale factor linearity, bias stability, and other performance characteristics. Three-axis rate simulator, a high-fidelity Global Positioning System (GPS) simulator, a rooftop GPS antenna, a GPS base station, a 6-processor simulation computer, workstations, and a data display computer.
Image Research Laboratory	Three different facilities for the design, fabrication, and testing of imaging systems	Development and test of analog or digital imaging systems and components such as cameras, optics, recorders, or frame grabbers. Concepts, as well as systems, may be tested by using specialized electronic, recording, and spectral monitoring equipment. Design, breadboard, and test electronic circuits to build complete imaging systems.
Optical Fabrication Facility	World class facility for replicating and testing x-ray mirrors Processes bulk optical materials, cuts them to rough blanks, generates the required surface figure and grinds and polishes items to achieve the final figure and finish.	Custom built polishing machines that are capable of polishing X-ray mirror mandrels 40-500mm in diameter and 305-610mm in length to less than 8 arcsec in figure and less than 4 Angstrom roughness. Can accommodate smaller microscope X-ray mirror mandrels. Curve generators, spindle grinders/polishers, a Blanchard, an edger, and a 48 inch continuous polisher.
Optical Metrology Facility	Specializing in many aspects of dimensional measurement using precise optical and mechanical techniques	Surface figure measurement devices include: Zygo interferometers with 4, 12, 18, and 32 beams (32" has FlashPhase™ capability) Laser unequal path interferometer (LUPI) Bauer scanning profilometer Continental long trace profilometer (LTP) Continental vertical long trace profilometer (VLTP) (measure x-ray cylinders and shells up to 0.7-m long × 0.75-m diameter with an accuracy of 10-nm) Cranfield 1 meter profilometer, tallysurf and tallystep profilometers Grant micro-densitometer for measuring interferograms 1 meter collimator and a diffraction limited 16 inch Goertz collimator Zeiss coordinate measuring machine with .5m × .5m × 1m capability and 1 micron per point accuracy
Straylight Test Facility (SLTF)	Provides the capability to do vacuum testing of telescope baffle systems to demonstrate that they meet their performance requirements. Also used as an X-Ray test facility with 100 meter beam path. X-Ray test range is from soft to hard x-rays with mirror sizes up to 1 meter in diameter.	Consists of: 3m × 12m test volume for mirror 1.3m diameter by 82m long section 1.5m diameter by 10 isolatable section Pumped with cryopumps; 10^{-7} torr Measure telescope baffle rejection ratios over 15 orders of magnitude
Contact Dynamics Simulation Laboratory	Simulate how a docking or berthing mechanism would behave in earth orbit under a variety of conditions.	Can be used to determine the capture envelope of docking and berthing devices as well as reveal the stresses a device will experience once in space through the use of force and torque data recorded during a simulation.

For more information, please visit www.nasa.gov/centers/marshall/about/business.html

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George C. Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/marshall

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NP-2013-11-140-MSFC
G–28367s