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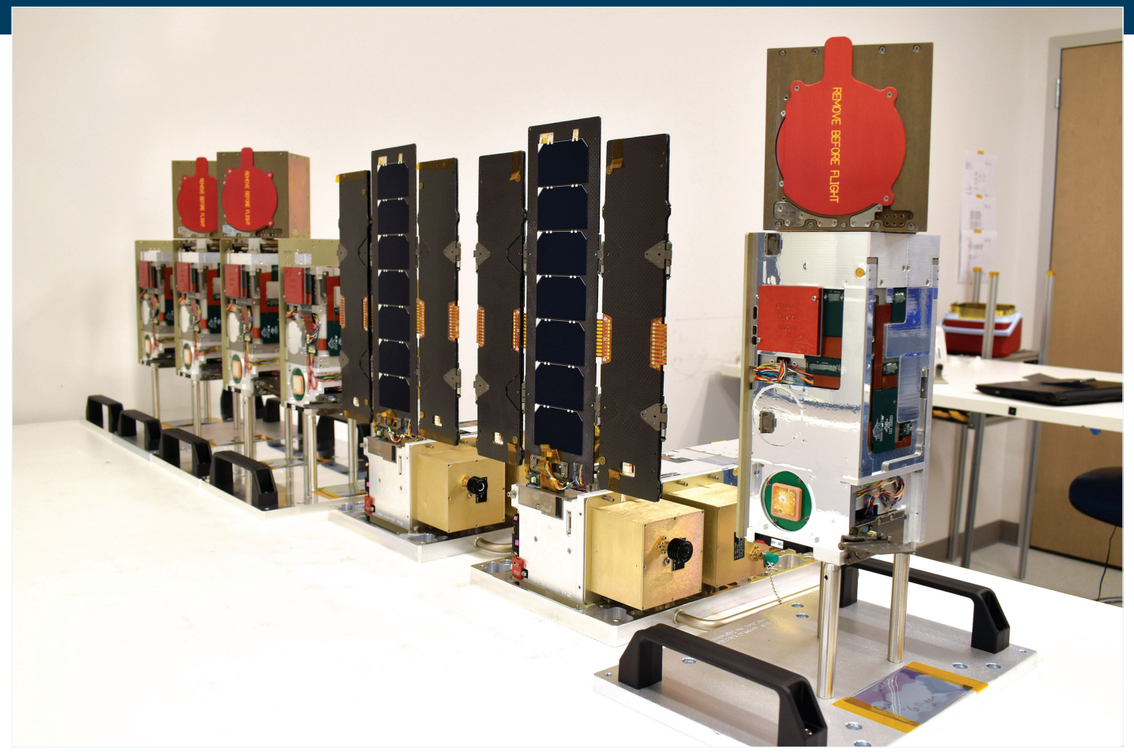
Engineering

Employing expertise in electrical, mechanical, structural, thermal, aeronautical, optical, and control systems engineering to build, integrate, and test prototype systems for application in space control, energy, communications, and autonomy



The TROPICS (Time-Resolved Observation of Precipitation structure and storm Intensity with a Constellation of Smallsats) constellation of 3U cubesats will provide rapid revisit passive microwave sounding in the 90–200-gigahertz frequency range for improved characterization and prediction of tropical storms.

Principal 2019 Accomplishments

- Lincoln Laboratory is making a significant investment in model-based engineering (MBE) as part of a digital transformation initiative to enable more efficient prototype system development. The first phase established a common database for information and fully digitized processes for design and fabrication using a product lifecycle management tool.
- The Laboratory developed a chamber to perform semiautomatic testing on full 200-millimeter wafers at temperatures below 5 Kelvin with magnetic flux density nulling less than 1 μTesla. The chamber supports research at the Microelectronics Laboratory on superconducting integrated circuits, which are a promising solution to ever-increasing high-performance computing demands.
- Flight system subassembly designs were completed for laser communication terminals that will fly on the International Space Station and the Orion space vehicle. Critical design reviews were held, and the designs were released for fabrication.
- TROPICS, the first ever CubeSat-enabled NASA science mission, was developed to provide tropical storm characterization for enhanced weather prediction. The Laboratory led the design, building, integration, and testing of six space vehicles for TROPICS.
- A ground-breaking optical design capability that allows freeform optical surfaces to be incorporated and optimized in optical system designs was developed. This capability has enabled considerable improvement in the optical performance of conventional systems and has enabled missions that were previously unachievable with conventional optical systems.
- The Laboratory demonstrated the operational readiness of three Army installations by developing and testing protocols to safely disconnect the installations from commercial electrical power systems to test backup power capabilities and interdependent missions and infrastructure for up to 12 hours. Army mission owners were able to identify unknown interdependencies between missions and other tenants, identify misconfigured backup systems, and test the deployment of forces during a prolonged power outage.

Future Outlook

The new Engineering Prototyping Facility will house engineering staff and fabrication, assembly, and test capabilities, and will replace aging facilities that are no longer adequate to support the wide range of Laboratory prototyping. Engineering staff will work with the Air Force on specifications for the building.

Research will continue on advancing the Laboratory's prototyping tools, including autonomy software for small satellite constellations, additively manufactured composite materials, propulsion systems for small satellites, advanced thermal management, new techniques to align complex optics, and unmanned air vehicle design and analysis tools.

Model-based systems engineering and integrated analysis capabilities will be incorporated into MBE as part of the digital transformation initiative.

Chickadee Sensor

The Chickadee prototype is a mid-wave infrared ultrawide field-of-view imaging sensor developed for use in a small satellite constellation. The sensor is the widest field-of-view optical system ever built at the Laboratory and has the widest known field of view of any infrared imaging system. It is the lowest f-number fisheye lens ever built, is the first imaging infrared system known to be aligned to single micron tolerances, and enables imaging performance over the ultrawide field of view in a very compact package. The Chickadee prototype has undergone initial environmental testing and will continue performance evaluation in 2020.