ICON

CCD Cameras/Payload Integration & Test

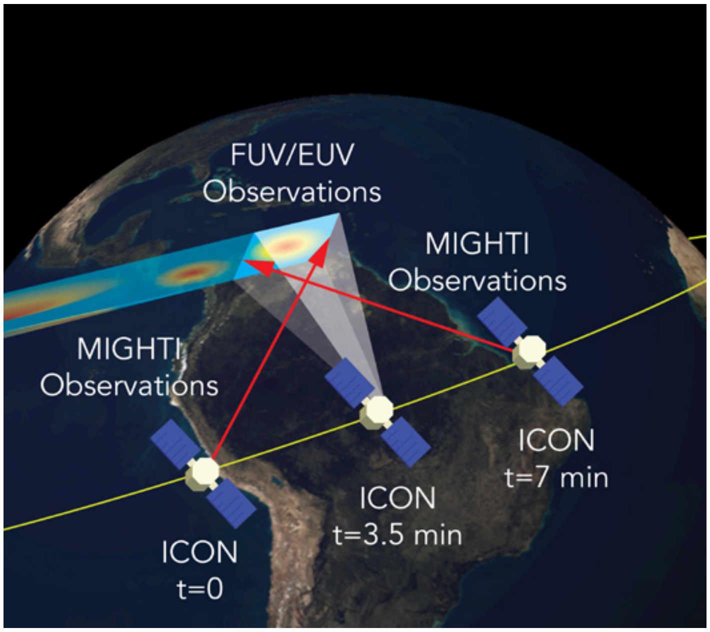
The purpose of NASA's Ionospheric Connection Explorer (ICON) mission is to explore how both terrestrial and space weather affect conditions in the ionosphere, the region of plasma forming the boundary between Earth and space. The ionosphere is energetically coupled to the thermosphere through collisions between ions, electrons, and neutral gas. These interactions often show extreme temporal and spatial variability, which can be disruptive to GPS and radio communications.

The ICON payload consists of four highly sensitive instruments: 1) the Michelson Interferometer for Global High-resolution Thermospheric Imaging (MIGHTI) to measure neutral winds and temperatures; 2) the Far Ultra-Violet Imaging Spectrograph (FUV) to measure daytime thermospheric and nighttime ionospheric density profiles; 3) the Extreme Ultra-Violet Imaging Spectrograph (EUV) to measure daytime ionospheric density profiles; and 4) the Ion Velocity Meter (IVM) to measure ion drift velocities, temperatures, and densities. The ICON mission is led by Principal Investigator Thomas Immel and the University of California, Berkeley. ICON was launched on October 10, 2019, from Cape Canaveral Air Force Station in Florida.

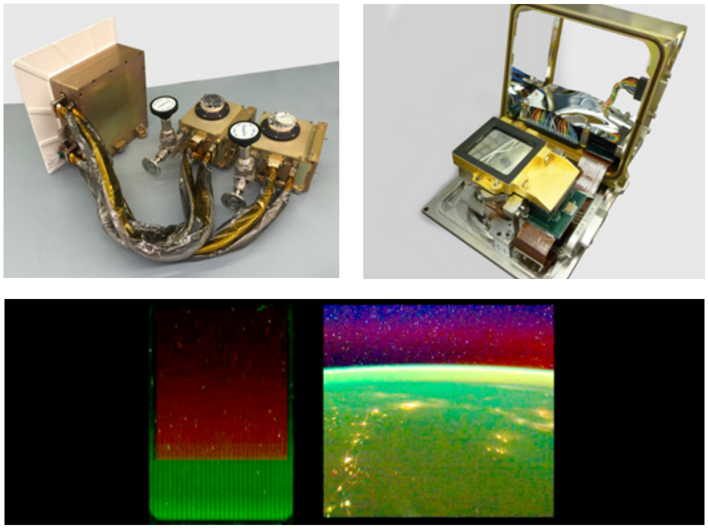
The Space Dynamics Laboratory (SDL) developed charge-coupled device (CCD) cameras for the MIGHTI and FUV instruments and led the payload integration and test (I&T) efforts. SDL has extensive experience flying space-qualified cameras, optical sensors, and electronics and brings this legacy of success in space to the ICON mission.

ICON PAYLOAD I&T	MIGHTI INSTRUMENT	FUV INSTRUMENT
Payload integration	Two synchronized cameras	Two cameras
Vibration testing	Camera electronics	Camera electronics
EMI/EMC testing	CCD TEC control electronics	Electronics board for turret control
Thermal vacuum testing		

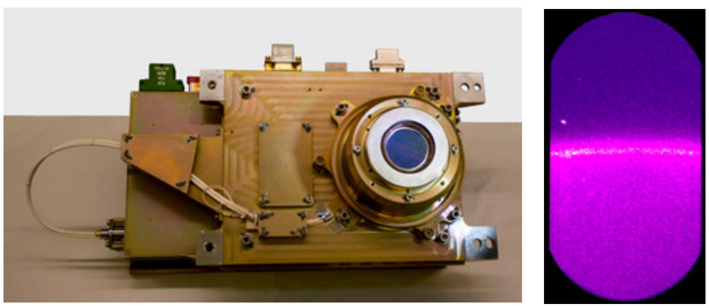
Image courtesy of NASA's Goddard Space Flight Center Conceptual Image Lab/B. Monroe.



SDL provided CCD camera systems for the MIGHTI and FUV instruments on ICON, which will make continuous limb-viewing observations of the ionosphere-thermosphere system. Image courtesy of UC Berkeley.



MIGHTI CCD camera assembly (top) and a rendering of MIGHTI data (bottom) showing how red and green oxygen airglow appear from the International Space Station. Data image courtesy of NASA/ICON/Christoph Englert/Joy Ng.



FUV CCD camera (left) and nitrogen emissions sample data captured on orbit (right). Data image courtesy of NASA/ICON/Harald Frey Thomas Bridman/Joy Ng.

ICON CCD CAMERAS

MIGHTI

SDL designed, fabricated, and tested the CCD cameras and control electronics for the MIGHTI instrument.

- 2048 x 2048 binnable CCD sensor
- Frame transfer, back-illuminated
- Synchronized camera systems
- Ultra-low system noise (10 e-)
- TEC-controlled

FUV

SDL designed, fabricated, and tested the CCD camera systems for the FUV instrument.

- 1024 x 1024 binnable, frame transfer CCD sensor
- UV converter for single photon detection at 136 & 155 nm
- Dual thermal zones to enable passive sensor cooling

ICON PAYLOAD INTEGRATION & TEST

SDL led the ICON payload I&T. SDL has extensive expertise in electro-optical testing, calibration, and characterization of diverse sensor systems, as well as the facilities necessary for integrating and testing complex payloads.

To reduce integration time, cost, and risk, the SDL team created a high-fidelity mockup of the ICON payload using 3D printed parts prior to hardware integration. The team performed several payload-level tests after integration, including vibration, thermal vacuum (both thermal balance and thermal cycling), and EMI/EMC testing. SDL also provided contamination control support and monitoring along with quality assurance support throughout the integration and testing.

ICON payload I&T at SDL facilities in North Logan, Utah.