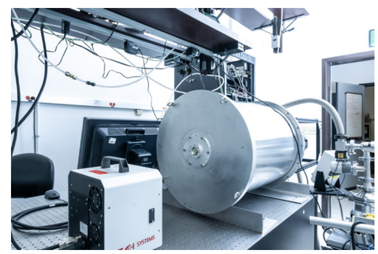
SENSOR TEST, EVALUATION, AND PROTOTYPING LAB

The Aerospace Corporation has decades of experience doing radiometric characterization testing of imaging arrays, known as focal plane arrays (FPAs), built for space applications, both scanning and staring types. The purpose of the Sensor Test, Evaluation, and Prototyping (STEP) Lab is to provide mission operations support from the early development phases of an electro-optical system procurement, build, integration, and test to on-orbit performance analysis, calibration, and anomaly resolution. The STEP Lab plays an integral role at every stage of a program lifecycle.



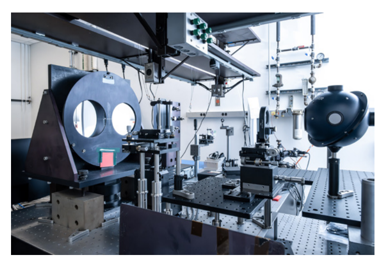
Thermal-Controlled (LN2) Vacuum Chamber.

Testing Capabilities and Features

The FPAs used in modern electro-optical space systems are now high resolution, large format, custom designed mixed-signal ASICs. These FPAs have strict power quality requirements, high-speed digital interfaces, and they can produce many terabytes of data in a single day of collection. Characterizing these highly capable devices requires a team of experts to come together to optimize the optical, mechanical, software/firmware and electrical hardware design.

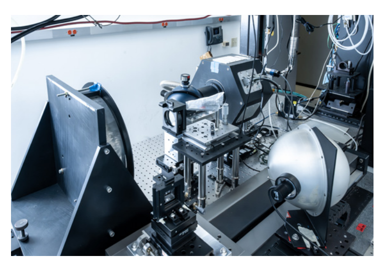
Custom Data Acquisition Systems.

The Aerospace Corporation has invested in upgrading the basic radiometric testing with automation to cut the time to provide customers with baseline radiometric performance data to weeks instead of months. Software processing tools have been standardized to provide consistent results across devices and programs. Hardware and software have been designed to be modular and repeatable, so that one test station can be used to test many devices over short periods of time with minimal changes and test station components are interchangeable. The STEP Lab has developed a flexible test bench to perform a wide range of characterization of high value FPAs for space applications. Features include:



Visible to LWIR Image Characterization Capabilities.

- Calibrated light sources: LEDs, halogen, blackbody, monochromator, FTIR (wavelength: 350 nm to 15 um)
- Custom designed dewars:
  - Transfer lines to use large storage tanks and enable long cooldowns
  - Operating temperature down to 26K
  - Up to 14” diameter cold space to accommodate large format sensors
- COTS-based, custom designed data acquisition system:
  - FPGA development board with high-speed transceivers for Gbps data links
  - PCIe interface to support high-speed data transfers to memory
  - Direct transfer to memory (128 GB) to store thousands of large format image frames in a single collection
- Custom designed software
  - Individual register/bit control with live display
  - Custom commanding sequences with frame-to-frame flexibility to perform test-like-



Scanning and staring array characterization capability.

you-fly operations
  - Power monitoring with fail-safes to ensure part safety
- Continuous lab monitoring
  - WatchDog software enables safe, continuous sensor operation for months (test-like-you-fly)
- Data analysis software
  - Python module to process large datasets on high performance computers with repeatable, dependable results

Standard test list with comparison of what Aerospace offers above and beyond what the manufacturer will typically deliver, including the use of the data for mission operations support:

Test	FPA Vendor Test Pack	Aerospace	Mission Support				Comments
			Performance Validation	Performance Modeling	Payload Requirement	ConOps	
Bit error rate (BER)	•	•	■				Verify data integrity
Commanding	•	•	■			■	Identify commanding sequences
Telemetry	•	•	■		■		Verify proper telemetry information
Power	•	•	■		■	■	Study power vs. operating parameters
Frame rate	•	•	■	■	■	■	Map available frame rates
Integration time	•	•	■	■		■	Verify proper, min, max integration times
ADC calibration	•	•	■	■		■	Characterize ADC non-linearity
Starvation/Saturation		•	■	■		■	Establish dynamic range
Readout Noise	•	•	■	■	■		Measure best noise performance
Dark noise	•	•	■	■			Measure noise performance in dark conditions
Dark current/offsets		•	■	■			Dark performance for modeling and calibration
Conversion gain		•	■	■			DN to ph conversion for radiometry
QE/Responsivity	•	•	■	■			DN to ph conversion for radiometry
NEI	•	•	■	■			Minimum detectable signal/target
Linearity	•	•	■	■		■	Linearity correction for higher fidelity
Reciprocity		•	■	■		■	Calibration, correlation between modes
Blinkers	•	•	■	■			Evaluate impact on false alarm
MTF		•	■	■			Inform on centroid accuracy (geolocation, etc)
Thermal drift		•			■	■	Stability of sensor-to-temperature variations
Bias drift		•			■	■	Stability of sensor-to-bias variations
Temporal cross talk		•	■			■	Impact of ghost images after bright events
Spatial cross talk		•	■				Impact of bright events on surrounding imagery
Windowing		•	■	■		■	Windowed modes impact on calibration/perf.
Aggregation		•	■	■		■	Aggregation modes impact on calibration/perf.
Extended cold testing		•				■	Sensor stability vs. time (noise, calibration)
Structured scene		•				■	Test as-you-fly
Moving spot		•					Test as-you-fly
Bias ripple injection		•			■		Performance impact of bias noise
Clock jitter		•			■		Performance impact of clock jitter
Uncharacterized operating modes		•	■	■		■	Explore uncharacterized operating modes
Radiation testing	AFRL		■	■	■	■	Performance degradation in space environment

Legend				
Legend	Performance Validation	Performance Modeling	Payload Requirement	ConOps

The Aerospace Corporation

The Aerospace Corporation is a leading architect for the nation's space programs, advancing capabilities that outpace threats to the country's national security while nurturing innovative technologies to further a new era of space commercialization and exploration. Aerospace's national workforce of more than 4,600 employees provides objective technical expertise and thought leadership to solve the hardest problems in space and assure mission success for space systems and space vehicles. For more information, visit www.aerospace.org.