Our Approach

Detector hardware development requires specialized facilities, equipment and processes. The 20,000 square foot manufacturing and test areas in the DTC include cleanrooms, test labs, microelectronics packaging, precision alignment and other process-intensive operations.

Packaging

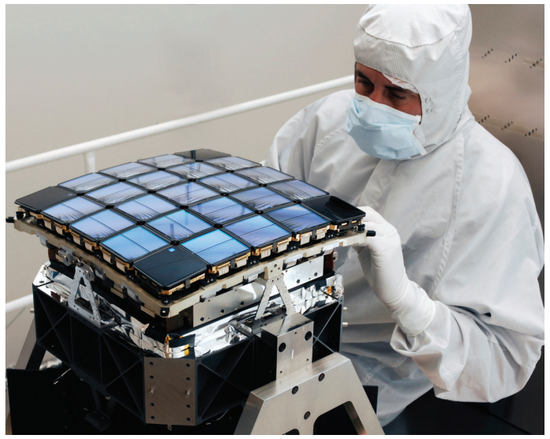
The FPA packaging area services include:

- Die attach / wire bonding
- Multiple die assembly onto a common focal plane
- Dewar fabrication and vacuum sealing technologies
- Thermal control hardware integration (TECs, thermal straps, cryocoolers)
- Precision optical alignment of detectors
- Precise integration of optical components (masks, filters, optics) with focal planes
- Assembly and vacuum processing of detector assemblies
- EMI/EMC mitigation

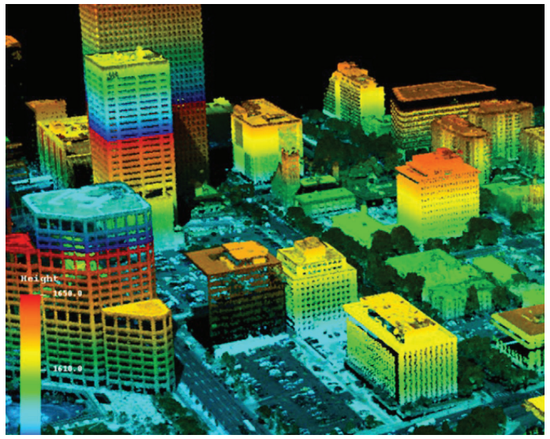
Testing

The DTC maintains several large vacuum chambers for cryogenic electro-optical performance testing of full focal plane heads and the focal plane electronics. Our optical characterization spans the X-ray to far-IR spectrum. We have established the necessary test capabilities to develop full systems starting with detector device characterization:

- DC and Warm Functional Test systems for incoming inspection and device characterization
- Signal path development to demonstrate detector function to mission requirements with flight-like interconnects, electronics and firmware
- Flexible electro-optic (EO) test sets capable of characterizing the performance of detectors
- Single and Dual Stage dewars for testing sensors at cryogenic temperatures
- Custom thermal-vacuum chambers for full focal plane subsystem test and thermal-cycling
- Specialized Test Equipment (STE) design, development, fabrication and certification
- Other services include Wafer probe, Burn in / Accelerated Life Testing (ALT) and Radiation Testing



Kepler Focal Plane Array (FPA)



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BAE SYSTEMS

Detector Technology

Advances in detector technology continue to transform imaging capabilities, enabling the next generation of defense, civil and commercial missions. BAE Systems has made significant investments in its Detector Technology Center (DTC) to develop innovative focal plane subsystem hardware for space and tactical applications.

The Hubble Space Telescope's near-infrared imaging camera took this image of Westerlund 2, a cluster of stars in the constellation Carina. Credit: STScI

BAE SYSTEMS

Overview

In 2004, BAE Systems, Space & Mission Systems established its Detector Technology Center (DTC) to deliver end-to-end focal plane capabilities to the country. This center integrates the necessary staff, technologies, facilities, equipment, processes and corporate learning to specialize in this key part of a science instrument. Detector experts have been recruited from across the U.S. to work in the DTC and bring execution excellence and efficiency to all our programs. This one-stop-shop ensures an instrument focal plane will perform to expectation.

We architect detectors for a broad range of instruments and systems. This includes staring imagers, scanning imagers, spectrometers, radiometers, imaging lidar, low-cost context cameras and star trackers.

The DTC has successfully executed dozens of programs:

- Detector subsystems for all instruments aboard the NASA Hubble Space Telescope
- The largest focal plane mosaic launched into space at that time for the NASA Kepler Space Telescope
- Cameras that captured images of Pluto and Mars by the NASA New Horizons and Mars Reconnaissance Orbiter missions, respectively
- Sensors on Solar Backscatter Ultraviolet Radiometer (SBUV/2), Ozone Mapping and Profiler Suite (OMPS), Landsat 8 and 9, and Geostationary Environment Monitoring Spectrometer (GEMS) — transforming earth and meteorological sciences

The focal plane subsystem incorporates the core imaging device with local camera hardware, custom interconnects and the focal plane electronics. By testing the detector early in the program lifecycle, we characterize the artifacts of each semiconductor device to inform flight electronics and mission operations. By testing the complete subsystem hardware with a consistent 'test-as-you-fly' best practice, we ensure that the hardware meets all requirements before integration with the payload.

We often tailor our involvement to partner with customers who have sophisticated focal plane capabilities of their own, in the form of review panels, system trade-offs and early architecture studies, special test campaigns or select hardware operations. At any given time, the DTC executes a blend of multiple flight programs, customer and BAE Systems-funded R&D programs.

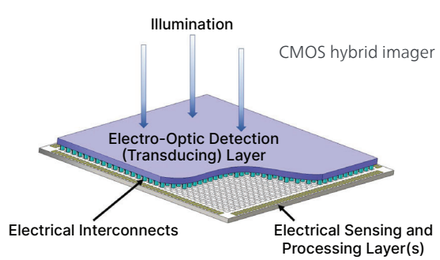
Enabling Capabilities

Detector Arrays and Devices

Photodetection technology has changed a lot over the past 30 years. We maintain expertise in heritage technologies and stay aligned with emergent product offerings of focal plane suppliers in the main detector families:

- Microchannel Plate (MCP) detectors
- Photomultiplier tubes (PMT)
- Charge Coupled Devices (CCD): frame transfer, interline, time delay and integration (TDI), back-illuminated and coupled to complementary metal-oxide semiconductor (CMOS) digital readouts
- Monolithic CMOS
- CMOS hybrid imagers — analog or digital
- Smart-pixel CMOS
- Event-based imagers
- Microbolometer arrays
- TeraHertz (THz) sensors

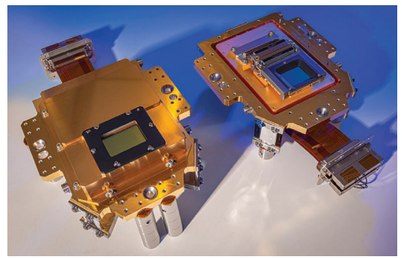
Many of our recent systems leverage emerging CMOS sensors. CMOS hybrid imagers allow you to separate the two functional tasks of a focal plane device: detection and electrical processing. The two-dimensional array of detector pixels transduces electromagnetic radiation into some electrical attribute. The electrical layer leverages ultra-large-scale integration gains in state-of-the-art silicon wafer processing. Since silicon is spectrally limited as a photodetector, the CMOS hybrid focuses the task of the silicon to the electrical work. The designer is free to tailor the detection layer to the specific electro-optic application. In current array designs, the processing layer is a read-out integrated circuit (ROIC) which senses the detected quantity at the interconnect and addresses its location. Future detector arrays will expand electrical processing by adding memory, graphics processing units (GPU), micro-sequencers, compression and fiber-optic communication in a single stacked silicon product.



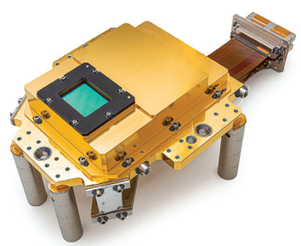
For the latest radiation-hard, all-digital CMOS sensors, we get hands-on experience operating these new devices as soon as they are available. We have the latest 8k x 8k format all-digital detectors running in our lab now. BAE Systems designs some of its detectors in-house and relies on its foundry partners to produce the wafers. We perform radiation testing on the devices to learn which foundry processing lines and device structures are suitable for space missions.

Focal Plane Assembly Hardware

The semiconductor detector device is the heart of a focal plane subsystem. For that hardware, we incorporate local optical components, stray light management, electrical interfaces, thermal control hardware and opto-mechanical alignment precision to create a camera or focal plane assembly (FPA) ready to install into a science instrument. The DTC produces the broadest range of packaged focal plane hardware in the country: cryogenic infrared (IR) staring arrays, long-life vacuum dewars, large mosaics, visible and IR scanning focal planes, star trackers, lidar sensors and low-cost chip-on-board visible imagers.



MethaneSat Focal Plane Array (FPA)



MethaneSat Focal Plane Array (FPA)

Focal Plane Electronics (FPE)

BAE Systems ensures mission success by developing all our focal plane electronics (FPE) in house with the detector hardware. We have a proven history of producing low-noise, analog electronics for flight CCDs and (analog) CMOS imaging chips.
We provide unique capabilities such as:

- Implementing fault tolerance
- Managing crosstalk and noise
- Guarding against EMI/EMC in flight FPE hardware
- Almost all our designs require cold focal planes including many cryogenic designs as cold as 40K. To span the thermal gap, BAE Systems also develops special cold electrical cabling.

In 2013, BAE Systems created its Reconfigurable Focal Plane Electronics (RFPE), capable of operating any all-digital focal plane. To date, BAE Systems has operated 16 unique digital focal plane products.

Many modern devices now incorporate digital ROICs. Digital ROICs require digital-only commanding; precise, stable input voltages; and a digital read-out to operate. These ROICs generate their own clocks and analog-to-digital conversion on-chip, which greatly reduces the complexity of the electronics.

The ability to locate the detector avionics meters away instead of inches away, makes instrument design more flexible. Each new project can take the basic RFPE hardware and update the firmware to operate its unique focal plane under mission conditions.

The BAE Systems RFPE is a low size, weight and power (SWaP) solution compatible with one or multiple digital focal planes or other sensors. The 3U VPX form factor is scalable to meet the requirements of the user while minimizing size and weight. The RFPE's flexibility and capability is showcased through an extensible architecture.

Reconfigurable Focal Plane Electronics (RFPE)