

Seam Sealing



Plasma Cleaning

Packaging Design and Development Services

- FPA packages for CCD and CMOS detectors
- Hermetically sealed and open FPAs
- Passive and actively cooled FPA packages utilizing TECs or cryocoolers designed and built by Ball
- Packages with integral optics and spectral filters
- Jitter suppression utilizing isolators and fast steering mirrors built by Ball
- Receiving inspection, testing and screening of device and critical sub-components

Packaging Fabrication and Assembly

- Fabrication of FPAs with individual or a mosaic of detectors
- Precision die attach, alignment and wirebonding
- FPA optical alignment and metrology with precision detector placement
 - Coordinate measuring machines located in a Class 5 cleanroom
 - Supports hardware up to 400 by 800 mm
 - Includes curved FPAs
 - Optical bonding and precision optical assemblies
- Precise integration of focal plane arrays with optical components including masks, filters, windows, lenses, mirrors, and beamsplitters
- Thermal control hardware integration (TECs, thermal straps, cryocoolers) and dewar fabrication
- Routine handling of highly ESD sensitive components
- Ultra clean processing including assembly and vacuum processing of detector assemblies
- Helium leak detection of ultra clean vacuum systems
- High-voltage conditioning
- UV or electron scrub of micro-channel plate detectors
- UV photocathode processing (CsI, KBr, Cs₂Te, RbTe, bi-alkali)
- Indium-solder processing
- Thin film metal deposition

FPA Electronics Services and Products

- Focal Plane Array Electronics design, development and verification in conjunction with the Electronics Product Center (EPC)
- Focal Plane Electronics architecture development
- FP Electronics circuit design and layout
 - Low-noise analog readouts
 - Designs for radiation environments
- Focal Plane Array Electronics prototyping

Focal Plane Subsystem Design and Development Services

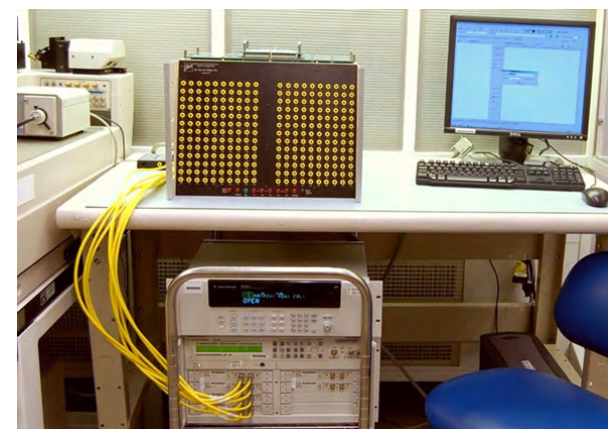
- Architecture development and specification
- Detailed modeling

Integration and Test Capabilities

- Integration of detectors with focal plane array electronics and verification with processing software
- Testing and Qualification
 - Thermal-vacuum
 - Vibration
 - Thermal Cycle
 - EMI

Additional Ball Support Available for Instrument, Science Payload, and Observatory Integration and Test

- Integration of FPA into instrument
- Environmental testing of instrument
- Instrument calibration
- Instrument/payload integration with telescope
- Observatory integration and test (with spacecraft bus)
- Launch preparations
- On-orbit commissioning
- Sustaining engineering during flight operations



Detector TECHNOLOGY CENTER



Ball Aerospace has integrated a wide range of detector resources into its Detector Technology Center (DTC) in Boulder, Colorado. This facility is dedicated to developing, fabricating, and testing custom detectors and focal plane array (FPA) systems for electro-optical instruments from the ultraviolet to the infrared.



**Ball Aerospace
& Technologies Corp.**

Detector Technology Center

The DTC produces a wide variety of FPA products including: packaged CMOS and CCD detectors, staring and pushbroom mosaic FPAs, and cryogenic IR imaging systems. The center offers customers a photons-to-bits detection solution with detector and focal plane experts in each of six sub-areas:

- Top-level Development
- Detailed Package Design
- Fabrication and Assembly
- Electronics
- Integration and Test
- Systems Engineering

Ball develops flight detectors, focal plane arrays and instruments for scientific and commercial missions using state-of-the-art technologies, processing techniques and facilities. We have the expertise to provide sensor solutions to match science needs from the UV to the IR. Recent missions include; Kepler, HiRISE, Deep Impact, the Hubble Space Telescope (seven science instruments), and Spitzer (two science instruments). Kepler has the largest focal plane array in space and HiRISE has the largest telescope outside of Earth's heliocentric orbit.

Ultraviolet:

- Thinned, back-illuminated, charge-coupled devices
- Microchannel plate (MCP) detectors with semi-transparent or opaque photocathodes

Visible:

- Conventional staring CCDs
- Time Delay Integration (TDI) CCDs
- Low-light-level CCDs
- Silicon-based CMOS

Near Infrared:

- HgCdTe-based CMOS

MIR:

- HgCdTe
- Arsenic-doped silicon (24 μm)

LWIR:

- Antimony-doped silicon (14 μm - 40 μm)
- Gallium-doped germanium (50 μm - 160 μm)

The DTC can provide support at any phase of development or production including: contracted technology development, studies and technology roadmaps for detector needs on future missions, mission concept development and proposals, contracted development of flight hardware, and flight hardware production.

The DTC contains production areas, clean rooms, vacuum bake out chambers, environmental test chambers, and facilities for the storage, preparation, and transportation of flight hardware.

The DTC was designed to assemble all detector resources into one area, as well as position them in a logical fabrication and test sequence to minimize the handling and transportation of critical and sensitive detector hardware during the manufacturing flow. This results in lower risk and more efficient operation with cost and schedule savings.

The DTC staff includes over 60 co-located, experienced engineers and technicians, twelve of whom hold Ph.D.s. It is run by a dedicated leadership team with an average of 18 years of aerospace and detector experience.

Facilities

- 14,600 sq. ft. center, co-located Offices and Labs
- Class 5 and 7 Clean Rooms (1804 sq. ft. and 1832 sq. ft.)
- ESD-safe Detector Assembly Workstations
- Securable areas for sensitive or classified hardware
- Segregated Engineering Development and Flight Production Facilities
- Ultra-high Vacuum Facilities for MCP Vacuum Tubes
- Wafer Probe Station
- Wafer Dicer and Washer
- Wire Bonders and Wire Bond Testers
- Mask Aligner/Photolithography
- Metal Deposition Systems and Plasma Etch
- Film Thickness Measurement Systems| (optical and stylus)
- X-Ray Fluorescence System
- Metal Finish
- Hermetic Seam Sealer
- Hybrid/MCM Soldering Stations
- Coordinate Measuring Machines
- Leak Detectors
- Vacuum Bake-out Chambers
- Five Clean-room Based Detector Test Stations
 - Two automated dc test systems capable of measurements on both CCD- and CMOS-based detectors and one dc wafer probe station
 - Three flexible EO test sets characterize the performance of detectors from low-noise scientific grade CCDs to high-speed HDTV detectors



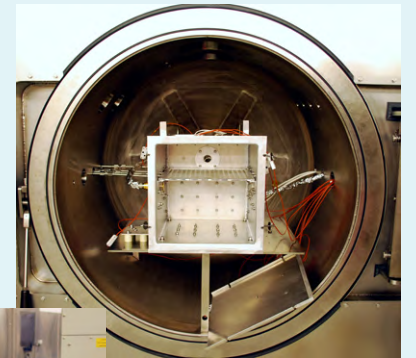
Wet Chemical
Clean Benches

DTC Products

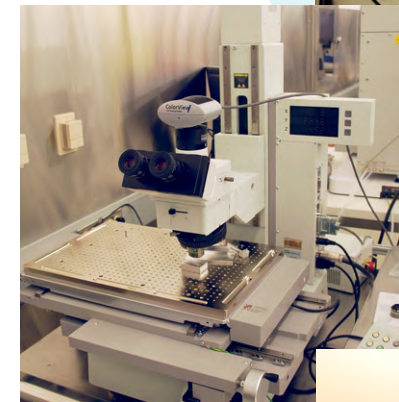
- Large Format FPAs utilizing CCD or CMOS Detectors
- Single Detector or Multi-chip Mosaic Staring FPAs
- Cryogenic IR Detector Systems
- Multi-chip Pushbroom and TDI FPAs
- Vacuum Tube Hybrid Sensors utilizing MCPs
- FPAs for Ground, Air and Space-based Scientific, Civil, Commercial, and Defense Systems
- FPAs for Tactical Defense Systems, in conjunction with the Ball Video Technology Group
- Sensors for Star Trackers
- Focal Plane Array Electronics
- Developmental Project and Study Reports

Detector Design and Development Services

- Detector Performance Modeling:
 - Design modeling
 - Performance Prediction
 - Performance Simulation
 - Radiation Effects Modeling
- Detector and Subsystem Definition and Specification
- CCD Design
- Detector Lot Characterization
 - Silicon Wafer Probing
 - SEM Testing
 - Wirebond Stress and Destructive Testing
 - Burn-in and Accelerated Life Testing
- Wafer and die level processing, test, and inspection including dicing, bonding, and cleaning
- Detector electronics design and production
 - PWAs and cabling
- Data acquisition for all detector types using modular portable test equipment
- Direct Current (dc) characterization:
 - Leakage current and identification of electrical opens and shorts
 - Diode continuity and breakdown tests
 - Gain and channel potential measurements
- Electro-Optical (EO) performance characterization from UV to LWIR:
 - Read noise and dark current
 - Quantum efficiency (QE) and spectral response
 - Gain, linearity, and full well capacity
 - MTF and spatial response
 - Charge Transfer Efficiency (CTE)
- Ball's Universal Hyperspectral Testbed (patent pending) with IR optics and Fabry-Perot
- Radiation hardness testing and qualification:
 - Pre- and post-radiation detector characterization
 - DDD and TID testing with gamma ray, proton, neutron and electron sources
 - Transient testing
 - Flash x-ray testing
 - SEU and SEL testing



Vacuum Baking



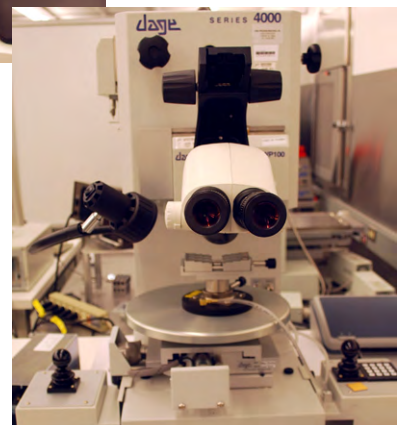
Microscopes



CMMs



Wedge Bonder



Wire Bond Tester