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AEDC Focal Plane Array Test Capability

R. A. Nicholson
and
C. L. Steele
Calspan Corporation/AEDC Operations

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JERE J. MATTY
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Deputy for Plans and Requirements

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13 ABSTRACT (Maximum 200 words)

The focal plane array test facility at AEDC provides complete radiometric characterization of detector arrays and hybrid arrays. Most testing is performed in the Focal Plane Characterization Chamber (FPCC), which provides a cold, low background environment for focal plane tests. An injection system on the chamber facilitates a high throughput rate and good economy of operation. Testing in the FPCC can involve either flooding the array with uniform blackbody radiation or focusing radiation on a single pixel. Focal plane voltage output and noise can be measured as functions of source irradiance, bias voltage, focal plane temperature, integration time, chopper frequency, and infrared background. Relative spectral response measurements are made in a test station involving a three-grating monochromator. Most critical performance parameters can be evaluated, including responsivity, noise equivalent input, dynamic range and linearity, radiometric stability, power consumption, recovery time, array uniformity, and crosstalk. In addition, a wide variety of data presentation formats is available.

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PREFACE

The work reported herein was performed by the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC). The work was performed by Calspan Corporation/AEDC Operations, operating contractor for the aerospace flight dynamics testing effort at AEDC, AFSC, Arnold Air Force Base, Tennessee, under AEDC Project Number DA85VK. The Air Force Project Manager was Mr. Jere Matty, AEDC/XRV. This report describes the work performed during the period from October 1987 through September 1990. The manuscript was submitted for publication on September 15, 1990.

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1.0 INTRODUCTION

A facility was developed at the Arnold Engineering Development Center (AEDC) to provide a complete radiometric characterization of focal plane arrays (FPAs). The facility provides the capability to test both detector and hybrid FPAs. The primary component of the AEDC test facility is the Focal Plane Characterization Chamber (FPCC). The FPCC provides a cryogenic, low background environment for the test focal plane. Focal plane testing in the FPCC includes flood source testing, during which the array is uniformly irradiated with IR radiation; and spot source testing, during which the target radiation is focused onto a single pixel or group of pixels. For flood source testing, no optical elements are required between the source output aperture and the array. During flood source testing, performance parameters such as power consumption, responsivity, noise equivalent input, dynamic range, radiometric stability, recovery time, and array uniformity can be assessed. Sufficient data are acquired to permit complete parametric characterization of the array. Crosstalk is evaluated during spot source testing. Spectral response testing is performed in a spectral response test station using a three-grating monochromator.

This report describes the AEDC focal plane test facility and documents the FPA test methodology. Inquiries for additional information or potential test activities should be directed to AEDC/DOCS, Arnold Air Force Base, TN 37389-5000 (615/454-7813).

2.0 TEST FACILITY DESCRIPTION

2.1 FOCAL PLANE CHARACTERIZATION CHAMBER

Most testing of hybrid and detector arrays is performed in the AEDC Focal Plane Characterization Chamber (FPCC). A photograph of the assembled chamber is presented in Fig. 1. The major hardware components in the FPCC are shown schematically in Fig. 2 and are described in the following sections.

2.1.1 Test Chamber

The FPCC is composed of two nested, concentric, right circular cylinders with axes aligned vertically. The outer shell of the chamber is a cylindrical, stainless steel spool section, enclosed by elliptical end bells, which provides the vacuum enclosure for the internal working volume. Two large cylindrical flange sections are welded to the chamber spool section. One flange section is used to mount and cool the focal plane dewar assembly; the other provides additional length for movement of the internal source package. The working volume of the chamber is enclosed within a gaseous helium-cooled, optically tight liner. A mechanical pump and a turbomolecular pump are used to evacuate the FPCC. In addition, cryo-pumping is provided when the internal liners are cooled to operating temperature. IR backgrounds as low as 10^9 photons/sec-cm^2 can be attained in the FPCC.

2.1.2 IR Sources

The infrared (IR) source package located inside the chamber liner is used for both flood source and spot source testing. A photograph of the source package installed in the FPCC is shown in Fig. 3. The source is mounted within a rectangular box that is cooled with gaseous helium (GHe) to a temperature less than 20 K. The IR source package consists of a heated cavity emitter, an aperture wheel, a diffuser wheel, an internal linear translation stage, a spectral filter wheel, a chopper assembly, and an IR background source. The source emitter is a reentrant conical cavity that can be operated at temperatures ranging from 200 to 500 K. Cavity temperature is measured using two platinum temperature sensors embedded in the cavity block. The source cavity output is projected through a hole located in the face plate of the source package. The aperture wheel, mounted directly in front of the cavity opening, contains a blank position and six apertures that provide a source irradiance dynamic range of approximately 400. A stepping motor drives the aperture wheel to various positions, and a rotary potentiometer measures aperture position. The seven-position diffuser wheel is used in conjunction with the spot source illumination system to reduce the spot intensity.

The source and its aperture wheel are mounted on a linear translation table. The translation table allows the source cavity to be driven in relation to the diffuser to provide additional control of the energy on the focal plane. The 12-position spectral filter wheel contains a set of bandpass filters that can be used to limit the spectral output from the source. Eight filters and an open hole position are provided in the filter wheel. A stepping motor and potentiometer are used to drive and indicate the position of the filter wheel.

A motor-driven chopper assembly is included in the source package to provide a modulated output. The chopper is a two-blade, rotating element that is located at the front of the source package. The chopper is used for source calibration and single-element or detector array testing. The two-blade chopper can be operated at frequencies ranging from 0 to 100 Hz. The frequency range can be extended by installing a chopper with a greater number of blades.

Calibration of the IR source was performed in the FPCC. A null calibration technique was used to compare the output of the test source to that of an AEDC standard source. The standard source is designated SIRS2, and the transfer detector is an IR Labs bolometer. The calibration of the SIRS2 source is traceable to the National Institute of Standards and Technology (NIST).

A second IR source, designated as the background source, is mounted on the front of the source package to allow background radiation that is independent of the target radiation to be imposed on the focal plane. The radiating element is a cylindrical slug of aluminum that can be heated to temperatures between 77 and 500 K. The cylinder is black-anodized to increase its surface emissivity to nominally 0.95. A shutter assembly permits the background source to be blocked when minimum background conditions are desired.

The source package is mounted on a three-axis drive system that allows it to be moved horizontally (X), vertically (Y), or toward or away from (Z) the test focal plane. Each translator stage is positioned using a stepping motor-driven, ball screw assembly. Position readouts are provided by rotary potentiometers. The Z-axis translator can position the source between 25 and 94 cm from the test focal plane. The combination of blackbody temperature, aperture selection, variable source distance, diffuser selection, and internal source position provides a source irradiance dynamic range from 10^{-14} to 10^{-5} W/cm^2.

Recovery time testing requires that a high-intensity radiation flash be imposed on the FPA. A laser diode that operates at a wavelength of 10 μm is used to provide flash intensities greater than 10^{16} ph/sec-cm^2. The laser diode is mounted on the support structure for the optical lens system described in Section 2.1.3.

2.1.3 Optical Systems

A demagnified image of the flood source aperture can be projected onto the test focal plane using the FPCC optical system. A photograph of the optics assembly installed in the FPCC is provided in Fig. 4. The optical package is mounted on a two-axis drive system that moves the optical system from the stowed flood source position into position for spot source testing. The imaging element is a refractive doublet that demagnifies the source aperture by a factor of five. The germanium lenses are antireflection coated at a design wavelength of 10.6 μm. The image point-spread function, plotted in Fig. 5, reveals that 83.8 percent of the energy falls within a spot 71 μm in diameter.

To provide spectral in-band measurements, a spectral filter carousel is mounted within the test dewar, near the focal plane. The internal surfaces of the filter carousel housing are black-anodized. The eight-position filter carousel contains three spectral bandpass filters. In addition, open hole positions are provided for making broadband measurements, and a blank position is included for low background measurements.

2.1.4 Modular Test Dewar

A Lakeshore Cryotronics, Inc., modular test dewar is used to mount and cool the test focal plane. A photograph of the test dewar is presented in Fig. 6. A sketch of the modular test dewar is provided in Fig. 7. The cooling mechanism is a two-stage heat exchanger. Both stages of the heat exchanger have electrical heaters and temperature sensors. Cooling of the heat exchanger is provided by liquid helium (LHe) from an external dewar. The test focal plane is mounted to a cold pedestal that is cooled from the first-stage heat exchanger. A photograph of a focal plane installed in the test dewar is presented in Fig. 8. Focal plane temperature can be maintained at any value between 4.5 and 300 K within ±0.1 K.

In addition to cooling the focal plane, the test dewar establishes electrical interface connections to instrumentation outside the vacuum environment. A test focal plane, which is mounted in a leadless chip carrier, is inserted into a chip socket that makes electrical contact to the chip through spring-loaded contacts. Leads on the chip socket are soldered to a fanout board that carries the electrical connections to a second set of spring contacts. These contacts are attached to a fanout board that brings the electrical connections to 100 coaxial wires located on the circumference of the dewar heat exchangers. External connections are made as required for the particular FPA being tested.

For testing in the FPCC, the modular test dewar is flange-mounted to the ambient-temperature chamber vacuum shell. A labyrinth interface baffle between the chamber liner and the test dewar cold cavity provides the optical seal necessary to obtain a low background environment for the test focal plane. A baffle tube is used to restrict the field-of-view of the focal plane detectors to a small area at the front of the source package.

A special vacuum cover can be installed on the test dewar to allow it to be used in a stand-alone configuration. The vacuum cover is cooled to provide a low IR background, while an internally mounted light emitting diode (LED) is used to flood the FPA with IR radiation. The LED can be electrically chopped or operated in a steady-state mode.

2.1.5 Injection System

An injection system is used to accommodate installation or removal of FPAs while the test chamber is maintained at cryogenic vacuum conditions. The major components of the injection system are shown in Fig. 2. To install a test article, the antechamber cap is bolted to the chamber so that it encloses the modular test dewar. The antechamber is evacuated to a pressure approximately equal to the pressure in the FPCC. The isolation valve is opened, and the test dewar is injected using the retraction mechanism. The antechamber can then be repressurized, and the cap can be removed to permit access to the focal plane electronics boxes. The opposite procedure is used to remove a test article.

2.2 SPECTRAL RESPONSE TEST STATION

The modular test dewar is also used as a principal component in the spectral response measurement station. In this configuration, a vacuum test cover with a KRS-5 window and a series of cold apertures is installed on the test dewar. A sketch of the test dewar assembly configured for spectral response testing is provided in Fig. 9. A radiation shield is installed to block radiation from the room temperature vacuum shell to the cold first-stage assembly. The shield has an opening in front to allow radiation into the dewar volume. An aperture stop assembly, which contains three pinhole apertures, extends from the test dewar to the opening in the radiation shield. The KRS-5 window in the vacuum cover provides transmission of approximately 70 percent of the incident radiation to the detector.

A schematic of the spectral response test configuration is shown in Fig. 10. A high-temperature (1,275 K) IR source provides input to a Jarrell-Ash Monospec 27 grating monochromator. The monochromator is a three-grating instrument with a spectral range from 2.2 to 32 μm; the gratings are mounted on a hand-operated turret assembly. A concave focusing mirror and a flat folding mirror image the source on the monochromator inlet slit. The input radiation is modulated by a rotary chopper that is mounted at the monochromator entrance. A set of six order-sorting filters is mounted in a wheel assembly positioned at the output slit. A collimating mirror produces a collimated beam of monochromatic IR energy, and a folding mirror directs the energy into the test dewar.

The monitor detector for the spectral response station is a pyroelectric element having a nominally flat spectral response. To duplicate the window used in the modular test dewar, a KRS-5 window is mounted in front of the reference detector. A flat folding mirror mounted on a translator is driven into the collimated beam to direct the monochromatic radiation onto the reference detector.

2.3 INSTRUMENTATION

2.3.1 Chamber Systems

Several instruments are used to monitor the chamber environment. Temperature sensors are mounted on various surfaces inside the cryogenic volume to monitor chamber cool-down and thermal conditions. An ionization gauge is used to measure chamber pressure. A mass spectrometer is available to provide a quantitative measure of the residual constituents in the FPCC while under vacuum. The output of the mass spectrometer is analyzed and displayed by a Dycor Model M200M Quadrupole Gas Analyzer. This system provides a real-time display of the spectrum of constituents found in the chamber environment. A monitor detector is used to measure background in the FPCC during test operations. The arsenic-doped silicon

(Si:As) monitor detector is mounted on the detector pedestal, near the focal plane. The output of the detector was characterized as a function of photon flux.

Temperatures of the target and background sources are set and maintained to within 0.01 K by Lakeshore Cryotronics, Inc., temperature controllers. Source temperatures are monitored using AEDC-designed and fabricated IR source monitor panels that display temperature sensor inputs and outputs. Another Lakeshore unit is used for controlling focal plane temperature at the required value.

Two Aerotech Unidex XI four-axis control units are used to drive the chamber systems. Each Unidex controller has an associated DC power supply and a four-channel stepping motor current limiter panel. One unit controls operation of the source aperture wheel, the diffuser wheel, the internal source drive, and the source package Z-axis drive. The other Unidex controller provides the capability to drive the source package and the optics assembly in the X and Y directions. The Unidex controllers can be used to operate the drive motors in run, jog, or index mode. The resolution of the source Z-drive is 0.0005 in./step; the resolution of the other source and optics drives is 0.00025 in./step. The drive motors can be operated in half-step or full-step mode; less than half-stepping capability is not available.

Chamber data parameters, which include source temperatures, wheel positions, source and optics translator positions, and chamber liner temperatures, are recorded using a 100-channel Fluke scanner and Fluke digital multimeter. Focal plane dewar temperatures are monitored using a second Fluke scanner and voltmeter.

2.3.2 Hybrid Focal Plane Operation

Each hybrid focal plane tested requires a unique set of both static and dynamic electrical input signals. The static signals are characterized by voltage and current values. The dynamic signals are characterized by current values and complicated timing relationships provided by the test article manufacturer in the form of Boolean logic equations or truth tables. All test article interface electronics are designed and built at AEDC. The interfaces are implemented using "smart" programmable logic devices (PLDs) to achieve the required flexibility. The system can acquire data at burst rates of 640 Mbits/sec.

A block diagram of the hardware required to operate and acquire data from hybrid focal planes is shown in Fig. 11. AEDC-developed power supply units, which contain six current sources and up to 24 voltage sources, provide the power required to operate the hybrid focal plane.

The system master clock, a Hewlett Packard 3325A frequency synthesizer, is used to produce the timing signal necessary for simultaneous control and data acquisition from a hybrid FPA. The output of the frequency synthesizer drives the FPA system timing sequencer (Fig. 12). Sequencer operation is controlled by microcode algorithms contained in an erasable, programmable, read-only memory (EPROM) chip. The timing logic and functionality of each of the 14 sequencer output lines can be redefined by selecting algorithms within the EPROM. The minimum time resolution of the sequencer logic is 65 nsec. The control sequence contained in the sequencer memory operates the FPA and the data acquisition hardware. The integration time is controlled by the memory clocking frequency and the control sequence length. Hybrid focal planes can be operated at integration times approaching 64 μsec. Algorithms also exist for clocking data from the array.

The AEDC-developed level translator, shown in Fig. 13, is required because of the wide variation in the logic levels required by different hybrid arrays. The level translator is used to condition all digital control signals supplied to the test articles. The output voltage rails can be set from -20 to 20 V. To minimize noise, the level translator also incorporates optoisolators on each logic input.

Hybrid FPAs are characterized by an internal (on-chip) multiplexer that sequentially connects the output of each detector in a given FPA column to a single interface pin. Hybrid FPAs typically have 4, 8, 10, 16, or 20 multiplexed analog signal outputs. The number of analog outputs is usually identical to the number of columns in the array. Each analog output from the FPA is amplified and buffered by two high-speed, low-noise pre-amplifiers. The pre-amplifiers are configured to apply a gain of 2 or 10.8 to the focal plane output signal without modifications; other gain values can be established if required. The pre-amplifiers also provide the capability to remove the offset voltage that may be associated with the FPA output by shifting the offset voltage to zero. The first amplification stage is located approximately 30 cm from the FPA. The first-stage amplifiers drive a short coaxial cable to the second-stage amplifiers, which are located near the analog-to-digital (A/D) converters. The A/D conversion is accomplished by two 12-bit, 1-MHz A/D converters (Fig. 14) that can be operated in a "ping-pong" or alternating mode for a maximum sampling speed of 2 MHz per channel. The digital samples are then optically isolated and transmitted in parallel to a data buffer. During noise measurement, the data system is switched into a high gain mode; in this configuration, the noise boards provide a theoretical gain of 13.

A Keithley programmable electrometer is used to measure the current in various lines associated with the hybrid focal plane. This instrument is used primarily for measuring detector current and when making power consumption measurements.

2.3.3 Detector Array Measurements

When single-element detectors or detector arrays are tested, the signal output of each detector element or series of elements is recorded using a Stanford Research System SR 510 lock-in amplifier. The reference signal for the lock-in amplifier is provided by a phototransistor, IR-emitter pair mounted so that it is modulated by the chopper. Noise data are recorded using a Hewlett-Packard 3582 spectrum analyzer that measures amplitude as a function of frequency. The lock-in amplifiers and spectrum analyzer are interfaced to the control computer through an IEEE-488 bus.

2.3.4 Spectral Response Test Station

For spectral response characterization, data are recorded using SR 510 lock-in amplifiers. A Lakeshore temperature controller is used to control the temperature of the spectral response station-high-temperature IR source. A Zenith 248 personal computer (PC) is used to control the drive of the monochromator gratings and to acquire, store, and reduce the spectral response data.

2.4 DATA ACQUISITION SYSTEM

The focal plane data acquisition system is a modular, multiprocessor-based, software-configurable unit designed to emphasize high performance and flexibility. A block diagram of the system used to acquire and record data from focal planes during FPCC testing is shown in Fig. 15. The data acquisition system can be logically divided into the four subsystems described in the following sections.

2.4.1 Control Computer

The control computer is a PC/386 system running MS-DOS. This computer serves as the primary user interface for focal plane testing in the FPCC. It is configured with 4 Mb of random access memory (RAM) and a math coprocessor. Mass data storage is provided by a 322-Mb hard disk, a 150-Mb tape system, a 3.5-in. floppy disk drive (1.44 Mb), and a 5.25-in. floppy drive (1.2 Mb). The control computer is interfaced to three independent processor subsystems: the housekeeping computer, the data acquisition and control system (DACS) computer, and the data reduction computer. The control computer performs sufficient data processing to generate a quick-look printout of results obtained during a single run.

The shell software integrates the control, data acquisition, and display capabilities into a single, user-friendly interface. The shell software provides a menu-driven user interface that controls the entire data acquisition sequence. The software provides an efficient, lowmaintenance approach to meeting changing software needs. The software code is written primarily in Microsoft QuickBASIC and uses Crescent Software's QuickPAK Professional subroutine package.

2.4.2 Chamber Housekeeping Computer

Two separate computer systems are used to provide monitoring of the FPCC housekeeping parameters. The chamber environment computer monitors chamber system temperatures and the locations of positioned systems within the chamber. The dewar environment computer monitors temperatures and voltages associated with the focal plane and the test dewar assembly. Both systems are Digital Equipment Corporation (DEC) large-scale integration (LSI) 11/73 computers running RT11 V5.4 and TSX-Plus V6.16 operating systems. Each computer is configured with 2 Mb of RAM. Mass storage for each computer is provided by a 1-Mb floppy disk.

Each housekeeping computer acquires data via an interface with its associated Fluke digital multimeter. The interfaces between the multimeters and the chamber and dewar environment computers are provided by IEEE-488 communication links. Dewar and chamber housekeeping information is continuously monitored, independently of the other data acquisition system components, and displayed on separate DEC VT220 displays. The chamber housekeeping computers are interfaced to the control computer through Ethernet connections.

2.4.3 Test Article Data Acquisition and Control System (DACS) Computer

The test article DACS (commonly referred to as the 20-channel system) controls all functions required to support hybrid focal plane operation and acquire FPA data. A block diagram of the test article DACS and the associated interfaces is shown in Fig. 16. The test article DACS is based upon a DEC LSI 11/73 computer running RT11 V5.4 and TSX-Plus V6.16 operating systems. It is configured with 4 Mb of RAM, a floating point processor, 12 serial input/output (I/O) lines, 32 parallel I/O lines, and an Ethernet local area network port. Mass storage is provided by a 70-Mb Winchester disk, a 60-Mb cartridge tape system, and two 1-Mb floppy disks.

The digital signal processor (DSP) architecture, shown in Fig. 17, permits simultaneous FPA data acquisition and processing, as well as transfer of the reduced data to the host computer. The DSP interfaces with the FPA data bus, the signal processor data bus, and the host computer bus. First-in/first-out memory devices (FIFO data buffers) provide isolation between the three data buses, allowing simultaneous operation.

Because standard parallel computer interfaces cannot accommodate the aggregate data rates of up to 40 megasamples/sec provided by the 20 dual A/Ds, a Q-bus compatible FIFO data buffer (Fig. 18) acts as a high-speed data sink to absorb the data from the A/D converters. The buffer, which contains four channels of 64K by 16-bit words (512 Kb total), accepts the input data at aggregate rates up to 5 megawords/sec. The data are then sent to the Q-bus in a FIFO mode at rates up to 500 kilowords/sec.

The DACS also serves as a host bus and power source for a two-dimensional (2-D) data display system. A high-speed image processing system resides in the backplane of the test article DACS. The image processing system gathers data directly from the test article DACS data bus and performs operations on the data using an internal, high-speed, bipolar arithmetic logic unit. The system generates the 2-D data display that provides test engineers and users with a real-time color display of the FPA signal voltages.

2.4.4 Data Reduction Computer

A DEC MicroVAX III computer, which uses a VMS operating system, is used to perform all final data reduction for runs made during focal plane testing in the FPCC. Data are transferred from the control computer to the data reduction computer via a 10-Mbit/sec Ethernet local area network. The MicroVAX computer is used to process the data files, perform necessary calculations, and generate tables and plots that present results necessary to describe focal plane performance. In addition to standard plot routines, the data reduction computer can develop a three-dimensional (3-D) graphics display of FPA performance. This display is generated using commercially developed graphics software running under DEC's VMS operating system.

3.0 TEST DESCRIPTION

Testing of FPAs is divided into three categories: flood source testing, spot source testing, and spectral response characterization. Flood source and spot source testing are performed in the FPCC. Both types of testing require that most of the test parameters be set manually. Data are acquired automatically under computer control. Runs to be made during a particular FPCC test and the test variable parameters corresponding to those runs are determined and arranged in the form of a test matrix prior to the start of testing. Each run is assigned a unique run number. Each focal plane test is assigned a one- or two-character series designation, which allows the same run numbers to be used for different tests and the data to be kept separate. Spectral response measurements are made with a monochromator assembly mounted on an optical table in an ambient environment.

3.1 FLOOD SOURCE TESTING

After all pretest preparations are completed, the FPCC is evacuated and cooled to test conditions. The focal plane is cooled to its operating temperature with LHe from a 500-ℓ dewar. For flood source testing, the optical lens system is moved to the stowed position (out of the focal plane field-of-view). The flood source configuration provides uniform IR radiation over the entire FPA. Slightly different techniques are used for performing flood source testing of hybrid arrays and detector arrays.

3.1.1 Hybrid Focal Plane Arrays

During flood source testing of hybrid arrays, initial measurements are made to determine the voltage setting that provides zero bias voltage. To determine the zero bias setting, the chopper in the source package is used to modulate the source output, and the focal plane voltage outputs are observed on an oscilloscope. The detector voltage is varied until there is no response on most pixels. Subsequent bias voltage settings are referenced to the zero value. Data are then acquired to determine the effective capacitance of the focal plane. Test runs are made at several target irradiances, and detector currents are measured with an electrometer and recorded manually. A plot of detector current versus output voltage is made. The slope of the straight line fitted through the data points is determined, and the effective capacitance is calculated.

Parameters varied during the course of hybrid array flood source testing include the IR power on the focal plane, the focal plane temperature, the detector bias voltage, and the integration time. The IR power on the focal plane is determined by the target temperature, the target aperture, and the distance between the source and the focal plane.

After all of the test parameters are set and verified, the command is given to the control computer to acquire data. The computer acquires data necessary to develop a general housekeeping record by reading specified Fluke channels. Next, a specified number of samples of detector voltage is obtained for each pixel by the 20-channel data acquisition system. The average and standard deviation of each set of samples are calculated and sent to the control computer. A similar process occurs for the noise data. Sufficient data are acquired and stored to permit various noise processing techniques, including subtracted double sampling (SDS) and correlated double sampling (CDS), to be used. After data from all pixels are received and stored, a posttest general housekeeping record is taken. A quick-look data tabulation is produced on the laser printer. The tabulation is examined, and if the data appear satisfactory, the data are permanently stored on disk. The conditions for the next run are established, and the data acquisition procedure is repeated until all runs have been completed.

For flood source testing of hybrid arrays, a measurement of the tare voltage is made for each set of test conditions. Tare runs are made with the source aperture blocked so that no target radiation is imposed on the focal plane. Information from these runs is used to correct the signal data for tare effects.

Several types of tests are performed under the category of flood source testing. The measurements that are necessary to calculate power consumption are made. Runs are made at nominal test conditions, from which performance parameters such as responsivity, noise equivalent input (NEI), and array uniformity can be assessed. Detector responsivity and noise are characterized as functions of the critical input parameters. A dynamic range test is conducted by varying the target irradiance. Other parameters that are evaluated by performing special tests include radiometric stability and recovery time. The specific tests performed during flood source testing are described in the following sections.

3.1.1.1 Power Consumption

Power consumption is simply a measure of the power required to operate the hybrid FPA. Power consumption measurements are made independently of all other test runs. The focal plane is cooled to operating temperature, and all power supplies are activated. Nominal test conditions are established. With no target radiation imposed on the focal plane, an electrometer is used to measure the voltages and currents in all applicable lines to the focal plane. The control computer is not required to acquire data for power consumption measurements. Currents and voltages are manually recorded on a test log sheet.

3.1.1.2 Runs at Nominal Test Conditions

For each focal plane test, a set of nominal test conditions is defined. Nominal conditions involve the specification of target flux, bias voltage, integration time, and FPA temperature. Generally, several sets of runs are made at nominal test conditions. Several performance parameters are evaluated from runs made at nominal test conditions.

The primary performance parameter evaluated from runs made at nominal conditions is the noise equivalent input (NEI). NEI is defined as the number of photons required to provide an output signal-to-noise ratio of one. Both signal and noise must be measured to determine NEI. NEI is measured with the FPCC configured in the flood source mode. Nominal test conditions are established, and the source output aperture that provides an output most closely matching the desired target photon flux is selected. The spectral filter carousel attached to the dewar or the spectral bandpass filter in the source package is used to select the filter position required to provide measurements within the desired bandpass segment. Signal and noise data are acquired using the standard data acquisition process. Data are acquired both with the aperture open and with the aperture blocked (minimum background).

3.1.1.3 Parametric Characterization

Performance of hybrid arrays is evaluated over a range of test parameter settings. Detector responsivity and noise are characterized as functions of radiant power, detector bias voltage, integration time, and focal plane temperature. For parametric characterization, one parameter is varied over a range of values while all other parameters are held constant.

3.1.1.4 Dynamic Range/Linearity

The relationship between output voltage and irradiance should be linear for an ideal detector. The dynamic range of a focal plane is the maximum output voltage divided by the minimum measurable output voltage, which is defined as the noise at the minimum background condition. To assess linearity and dynamic range, signal data are acquired over a range of target irradiances. The signal data are plotted versus irradiance, and a straight line is fitted through the data points. A band that contains values within a desired percentage about the fitted line is defined. The last point at which the voltage falls within the band is designated as the upper limit in the dynamic range calculation.

Dynamic range/linearity testing is performed with the FPCC in the flood source test configuration. The specified test conditions are established. First, the noise and the tare are measured with the source aperture blocked (minimum background condition). Next, the smallest source output aperture is selected. The irradiance is increased by moving to larger source apertures. The irradiance is increased further by increasing the source temperature and/or decreasing the distance between the source and the focal plane. For most arrays, sufficient irradiance variation is provided to allow evaluation of the full dynamic range.

3.1.1.5 Radiometric Stability

Radiometric stability is a measure of the change in response to a constant radiometric flux over a specified time interval. Radiometric stability testing is performed with the FPCC in the flood source test configuration. Nominal test conditions are established. Baseline signal data are acquired for all pixels in the FPA. All test conditions are held constant for the desired time interval, and the pixel output signals are measured again. The results from the two runs are compared to determine the percent change in output signal for each pixel.

3.1.1.6 Recovery Time

Recovery time is the period required for focal plane performance to return to normal after the focal plane has been exposed to a high-intensity flash that drives the detector output voltages into saturation. The recovery time test is conducted with the FPCC in the flood source test configuration. Nominal test conditions are established. With the source aperture set to a position that provides a reasonable output signal, baseline signal data are acquired for all pixels in the array. A flash sequence is initiated. The laser diode is activated to impose high-intensity monochromatic radiation on the array. After a specified interval during which the pixel outputs are saturated, the laser diode source is de-activated. At some specified interval after completion of the flash sequence, another set of signal data is acquired. The data from the two sets are compared to determine if the signals have returned to preflash values within the desired recovery time.

3.1.2 Detector Arrays

Testing of detector arrays is divided into three categories: AC signal, RMS noise, and current measurement versus bias voltage (load curve) testing. Parameters that can be varied during detector array testing include the IR power on the array, the focal plane temperature, the detector bias voltage, the chopper frequency, and the IR background. The IR background is controlled by the background source temperature and the distance between the source and the focal plane. During AC signal testing of detector arrays, the chopper in the source package is set to the desired operating frequency to provide a modulated output. The output voltage from each detector group to be tested is interfaced to a lock-in amplifier, with the chopper providing the reference signal. A phase adjustment is made to the lock-in amplifiers, and an appropriate range is selected. After all of the test parameters are set and verified, the command is given to the control computer to acquire data. The average of a specified number of samples of detector voltage is obtained from the lock-in amplifiers for each detector group. Outputs for all of the detector groups are recorded on a single run. Tare runs are made periodically during execution of the test matrix. Information from these runs is not used to correct the data for tare effects; the runs are made to verify that the chopper blade is not heating and generating an appreciable signal.

Responsivity variation with selected test parameters (IR power incident on the focal plane, FPA temperature, bias voltage, chopper frequency, and IR background) is determined by varying one parameter over a range of values while holding all other parameters constant. A controlled IR background is provided for selected test runs by setting the temperature of the background source to the desired value and opening the shutter in front of the background source.

To measure noise for detector arrays, the source chopper is in a stationary position. The output from one of the detector groups is interfaced to the spectrum analyzer. Noise voltages within a 15-Hz bandwidth are output from the spectrum analyzer. Values are obtained at 10-Hz intervals over a broad range of frequencies. After data are obtained from one detector, the output from the next detector group is connected to the spectrum analyzer. The measurement process is repeated until results are obtained for all detector groups. Noise data from all detector groups are stored in one data file.

For load curve testing, the source chopper is held stationary. The source aperture position is selected to provide the desired photon flux. The detector bias voltage is varied automatically in small increments, and values of detector current are recorded at each increment for each detector group. The load curve test is performed at several aperture positions to provide various photon flux values.

3.2 SPOT SOURCE TESTING

For most detector arrays, spot source positioning on the focal plane is impractical because only a few individual pixel outputs are available. Spot source testing cannot be performed on detector arrays if pixels adjacent to those being evaluated are not wired to the bonding pads. Thus, spot source testing is generally performed only on hybrid FPAs.

To prepare for spot source testing, the source package is driven to the lens object position using the source Z-axis translator, and the optics assembly is driven to a position between the source and the focal plane. The primary objective of spot source testing is to characterize the crosstalk that exists when a single pixel is illuminated. The intensity of the source must be greatly reduced for spot source testing. The amount of energy that can pass through to the focal plane is reduced by moving the diffuser wheel to a position containing a diffuser. An appropriate spectral bandpass filter is inserted to further reduce the spot intensity. The source cavity is positioned in the source housing until an acceptable detector signal is obtained.

A special display is available on the control terminal to aid in focusing and centering the spot image on a pixel. The display shows the signals on the pixel of interest and the surrounding pixels. Iterative position adjustments are made with the source X- and Y-axis drives to center the target image on a single pixel. The source package is also driven along the Z axis to establish the best focus condition. After the spot is focused and centered on the specified pixel, the data acquisition mode is entered, and data are acquired in the same manner as that described for flood source testing. Spot source testing is generally performed only for selected pixels; no attempt is made to acquire crosstalk data for all pixels in the array.

Crosstalk is the amount of signal present on an unilluminated pixel when a single pixel is illuminated. Crosstalk measured can be a result of optical or electrical effects. To measure crosstalk, the source energy is focused on a single pixel, and signal data are acquired for all pixels. Then, the source aperture is blocked, and a tare run is made. Results from these two data runs are used to determine the crosstalk present for each pixel.

If the spot image is larger than an individual pixel, the crosstalk measured is not purely electrical. One method of evaluating the optical contribution to crosstalk is to position the source image at the junction of a group of four pixels. With the source/optics assembly held fixed at the best focus position, iterative position adjustments are made with the other drive systems to obtain nearly equal output signals on a group of four adjacent pixels. Crosstalk runs are made when the final conditions are established. If optical contributions to the total crosstalk are significant, then the four-pixel technique can be used to provide a measure of electrical crosstalk.

3.3 SPECTRAL RESPONSE TESTING

Spectral response testing is typically performed on detector arrays or on sister chips of hybrid focal planes. For spectral response testing, the focal plane is mounted in the modular test dewar, and the radiation shield is installed. The assembly is mounted in the vacuum test cover on the spectral response test station. The focal plane is cooled to operating temperature with LHe.

For accurate test results, uniform background radiation is required on all detector elements. With the chopper not operating and the source output blocked, the relative DC signal for each of the detector elements (from the 300 K background radiation) is examined for consistency. The source output is unblocked, and the chopper is turned on and adjusted to a specific frequency. The source temperature is set to 1,275 K. The folding mirror translation table is driven into the optical path of the spectral response station to direct the energy onto the reference detector.

A scan is made with the reference detector prior to acquiring spectral response data for the array. Scans are made under computer control. To initiate the scan process, the first grating is inserted. The appropriate order-sorting filter is selected and controlled by the computer. The output of the detector is recorded on a lock-in amplifier at each wavelength increment. After the wavelength segment corresponding to the first grating is completely scanned, the next grating is manually inserted, and its spectral region is scanned. After all three segments are scanned, the folding mirror assembly is moved out of the optical path, and the source radiation is directed into the test dewar. A complete scan is made over the spectral range provided by all three gratings. The outputs from the detector element groups are recorded on lock-in amplifiers and stored in data files.

4.0 DATA REDUCTION

Evaluation of the performance of either hybrid or detector arrays requires that an accurate knowledge of the radiometric input to the device be available. The radiometric input is expressed as the radiant power incident on the FPA. To determine radiant power, the irradiance at the focal plane must be calculated. Power on each focal plane detector is determined by multiplying the source irradiance by the area of the detector. The irradiance (H) at the focal plane is given by the expression

$$H = (A_s \times N_s)/d^2 \quad (1)$$

where A_s is the source output aperture area, N_s the source radiance, and d the distance between the source output aperture and the FPA. The flood source is a cavity-type radiator that has an effective emissivity, as calculated using the method of Gouffe, greater than 0.99. Thus, the source emissivity is assumed to be unity. The source radiance (N_s) is determined by integrating Planck's expression for radiant emittance over the appropriate wavelength band. The integration is performed using Simpson's method, and the waveband is divided into 100 increments during the integration. The normalized spectral response or the spectral bandpass filter transmission characteristics are incorporated into the integral to provide a value of effective irradiance. The photon unit version of Planck's equation can be used to express the target irradiance in units of photon flux. Background source flux is also calculated using Planck's equation and is expressed in photon units.

Data reduction routines have been developed to calculate various performance parameters. Data reduction methods vary depending on whether the focal plane being tested is a hybrid focal plane or a detector array. Some of the methods used to evaluate the performance of both types of arrays are discussed in the following sections.

4.1 HYBRID FOCAL PLANE ARRAYS

The primary measured quantities for hybrid focal plane tests are the DC output voltage and the noise. From flood source test results, average values of output signal and root-mean-square (RMS) noise are determined for the focal plane. Calculated parameters for hybrid focal plane tests include detector current, power incident on the focal plane from the source, and detector responsivity. Crosstalk values are calculated from results obtained during spot source testing.

4.1.1 Power Consumption

The values of current and voltage that are manually recorded on the test log sheet are used to calculate power consumption. Measurements are made for all applicable lines into the focal plane. Power in each line is calculated as the product of the measured current and voltage values. Power consumption is calculated as the sum of the individual power terms. Power consumption is converted to a per-pixel value by dividing the total power by the total number of active pixels in the array.

4.1.2 Average Signal and Noise

For each pixel, a number of samples of signal voltage is acquired; an average voltage is calculated for each pixel. Corrected voltages are calculated as the difference between the average signal measured for each pixel and the corresponding tare value. The corrected signal values for all pixels are arranged in an array. The average and standard deviation (σ) of all pixels are calculated. Values that are outside $\pm 4.5\sigma$ of the mean are removed, and final average and standard deviation values are calculated. An identical method is used to process the noise measurement samples for each pixel.

4.1.3 Detector Current

In reporting focal plane performance, detector responsivity is usually expressed as the ratio of detector current to input power. The output of a hybrid focal plane, however, is measured in terms of a voltage at the output of its multiplexer. To calculate current from voltage, an effective capacitance is determined. To determine effective capacitance, measurements of the multiplexer output voltage and the average pixel current are made for several input flux values. A plot of detector current versus output voltage is developed. A straight line is fitted to the data points, and the slope of the line is determined. To obtain effective capacitance, the slope is multiplied by the integration time and divided by the total number of pixels in the array. The detector output current is calculated by multiplying the voltage output by the capacitance and dividing by the integration time.

4.1.4 Detector Responsivity

Responsivity is defined as the ratio of output to input. In defining focal plane performance, detector responsivity can be expressed in terms of voltage or current. In either case, responsivity is calculated by dividing the detector output (voltage or current) by the power incident on the detector from the flood source.

4.1.5 Noise Equivalent Input

The experimental expression used to calculate in-band NEI is

$$NEI = (V_n \times Q \times A_d \times t)/V_s \tag{2}$$

where V_n is the total noise, Q the in-band photon flux, A_d the detector area, t the integration time, and V_s the voltage difference. Peak NEI values can be determined for runs made with a broadband source output. In addition, an average in-band NEI value can be calculated for runs made with one of the spectral bandpass filters in place. For the in-band calculations, the spectral transmission characteristics of the bandpass filters are incorporated into the integral in Planck's expression for radiant emittance in photon units; the relative spectral response values are not included. For the minimum background condition, the noise value obtained with the aperture blocked is used in the NEI calculation. To calculate NEI at higher background values, the noise obtained with the source aperture open is used in the calculation.

4.1.6 Dynamic Range/Linearity

Dynamic range is defined as the maximum linear output voltage divided by the noise obtained with the minimum radiation background. For each pixel in the array, voltage difference is plotted versus source irradiance, and a straight line is fitted to the data points. The slope and intercept of the fitted line are used to calculate the characteristics of two lines defining a specified-percent linearity band around the fitted line. Each data point is examined to determine if its voltage falls within the band. The first data point that falls outside the band defines the upper limit of the dynamic range. The first two data points are not considered when determining the dynamic range. To calculate dynamic range, the voltage corresponding to the last point within the linearity band is divided by the minimum radiation background noise. Dynamic range is calculated and tabulated for every pixel.

4.1.7 Adjacent Pixel Uniformity

Adjacent pixel uniformity is evaluated by comparing the response of one pixel to that of its immediate neighbors. Voltage differences for all pixels are calculated by subtracting tare values from data run values. An algorithm that identifies bad pixels that might corrupt uniformity results for neighboring pixels is used to process the data for adjacent pixel uniformity. A final matrix denoting all pixels as good or bad is developed. If a pixel is denoted good, the ratio of the voltage difference for that pixel to the average of its good neighbors is calculated. If a pixel is designated bad, the voltage difference for that pixel is divided by its worst nonzero neighbor. All pixels in the array are examined for adjacent pixel uniformity; a tabulation that contains adjacent pixel uniformity ratios for each pixel is developed.

4.1.8 Subarray Uniformity

For uniformity purposes, a subarray is defined as one column of the FPA. Subarray uniformity is evaluated by computing the ratio of maximum to minimum voltage difference for a single column. Voltage differences are calculated for all pixels. For each column of the array, the pixels having the maximum and minimum voltage differences are identified, and the ratio of maximum to minimum voltage difference is calculated. The statistical information for each column, including the subarray uniformity ratio, is tabulated.

4.1.9 Crosstalk

The only data reduction performed on crosstalk data involves a percentage calculation. A signal run and a tare run are made at each set of conditions used for crosstalk testing. Corrected voltage values are determined by subtracting the values obtained during the tare run from the values obtained during the data run. The voltage difference for the pixel on which the spot is focused is the basis for the crosstalk calculations. The voltage differences from every other pixel are divided by this value, and the results are multiplied by 100 to convert to percent crosstalk.

4.2 DETECTOR ARRAYS

The primary measured quantity for AC signal detector array tests is the output voltage from each detector. Calculated parameters for detector array tests include detector current and detector responsivity. RMS noise is determined from a frequency distribution measured with a spectrum analyzer. Load curve results are tabulations of current versus bias voltage.

4.2.1 AC Signal

For detector arrays, the average output voltages from the lock-in amplifiers are recorded. Because the signals are AC values, it is not necessary to subtract a tare caused by the chamber radiation background. To calculate the responsivity in units of amps/watt, the current is calculated by dividing the output measured on the lock-in amplifier by the feedback resistance. A different feedback resistor is used with each transimpedance amplifier (TIA).

The calculation of responsivity for detector arrays is similar to the calculation for hybrid focal planes. Responsivity is the ratio of output current to input power. Because detector voltage is the RMS of the fundamental component of the square wave signal, the RMS of the fundamental component of the chopped source power is used to calculate detector responsivity. The power on the detector is the product of the RMS conversion factor, the source irradiance, and the detector area. For a square wave signal, the RMS conversion factor has a value of 0.45.

4.2.2 RMS Noise

Noise refers to the random electrical fluctuations generated in the detector circuit elements. The noise amplitude is the voltage output from the spectrum analyzer at 10-Hz intervals. The bandwidth of the measurements is 15 Hz. The volts-per-root-Hertz values are calculated at each frequency interval. The 60-Hz and higher-order harmonics are removed and replaced with the average of the data points on either side of the removed value. For example, to remove the amplitude at 60 Hz, the amplitudes at 50, 60, and 70 Hz are replaced with the average of the noise amplitudes at 40 and 80 Hz. To obtain the detector current noise, the voltage values are divided by the amplifier gain and the TIA feedback resistance. Total RMS noise and RMS noise with the 60-Hz harmonics removed are calculated from the spectral data. Noise-squared per Hertz is plotted as a function of frequency; RMS noise is the square root of the area under the resulting curve.

4.2.3 Load Curve

For load curve testing, the DC output voltage is recorded over a range of bias voltage settings. The output current is calculated by dividing the voltage by the feedback resistance. Tabulations and plots of current versus voltage are developed.

5.0 DATA PRESENTATION

Focal plane performance information that is derived from the data reduction routines can be presented in various formats. The most commonly used data presentation formats are briefly described in the following sections.

Tabulations can be generated that display voltage, noise, responsivity, and NEI information for all pixels in the array, as well as the results from statistical processing. A sample responsivity printout is shown in Fig. 19. The header record contains all pertinent test, operating, and test system conditions, as well as other essential information. The body of the printout lists the responsivity value for each FPA pixel. Results obtained from statistical processing of the data set are listed in the lower portion of the printout.

Summary tables that list values of performance parameters for all test runs can be produced. The summary tables are used to display either voltage, noise, or peak responsivity values for each run. An example of a responsivity summary for a hybrid array is provided in Fig. 20. The run number and date are provided in the first two columns of the summary. The pertinent source quantities are listed in the next three columns, and the focal plane operating conditions are shown in the next three columns. The values of peak responsivity are listed in the final column.

Trend plots showing the variation of voltage, noise, and responsivity with the various test parameters can be developed. Trend plots can be developed to show the variation in performance parameters with radiant power, bias voltage, FPA temperature, integration time, and chopper frequency. A sample responsivity versus power plot is shown in Fig. 21. The legend on the plot identifies the important parameters associated with the series of runs for which the data are plotted.

Linearity plots are developed by plotting the output voltage as a function of source irradiance for the dynamic range test runs. The straight line fitted to the data is plotted, and the linearity band around the fitted line is shown. A sample linearity plot is presented in Fig. 22. Points that fall outside the linearity band are marked with an "X." The last data point (excluding the first two) for which the signal fell within the linearity band is used to define the dynamic range. The curve fit analysis is performed, and the dynamic range is calculated and tabulated for every pixel. A sample dynamic range table is provided in Fig. 23.

Several methods are available to provide focal plane uniformity information. A color printout of the 2-D display, which shows color-coded voltages for all pixels, can be produced. A 3-D plot that shows output voltage as a function of pixel location for all focal plane pixels can be generated. The voltage of each pixel is represented as a point on the plot. Adjacent pixels, both rows and columns, are connected by line segments. The voltage value for a given pixel is represented as the point at which the line segments for a given column and row intersect. A sample 3-D plot is provided in Fig. 24.

A sample adjacent pixel uniformity table is shown in Fig. 25. On this printout, the pertinent run information is included in the header record. The body of the printout contains the uniformity ratio calculated for each pixel in the array, arranged according to pixel row and column location.

A sample subarray uniformity printout is presented in Fig. 26. The pertinent run information is presented in the header record. The statistical parameters for the pixels in each column of the array are provided in the body of the printout. The subarray uniformity for each column is represented by the maximum-to-minimum ratio. The final column of the printout lists the statistical results for the entire array.

To provide an indication of FPA uniformity, flooded voltage and noise data results can be expressed in terms of $\frac{1}{2}\sigma$ units. A voltage value that corresponds to $\frac{1}{2}\sigma$ unit values ranging from -9 to 9 is determined. A $\frac{1}{2}\sigma$-wide voltage band is established around each unit value. Each pixel is assigned the unit value corresponding to the band within which its voltage falls. Pixels that have voltage or noise values falling outside $\pm 4.5\sigma$ of the mean are designated as outliers. A sample printout showing the voltage and noise results in the standard deviation format is shown in Fig. 27.

Histograms can be produced to show the distribution of signal or noise values in the array. A sample histogram showing the distribution of signal values is shown in Fig. 28. The center bin is centered around the mean value for the array. The number of data points that fall within bins that are defined by the number of standard deviations away from the mean is plotted along the Y axis.

The crosstalk results are presented in a table that expresses the results in terms of percent of the maximum value. A sample crosstalk printout is given in Fig. 29. The pertinent run information is listed at the top of the printout. The maximum output signal is listed directly below the header record. The values listed for pixels in all rows and columns are actually 10 times the percent value.

6.0 CONCLUSIONS

The facilities developed at AEDC provide a highly versatile focal plane array test capability. The FPA test facility is capable of providing complete testing and evaluation of many types of focal planes. Both hybrid and detector arrays can be characterized. Data from hybrid arrays of up to 20 output channels can be recorded simultaneously at integration times approaching 64 μsec. Most critical FPA performance parameters can be evaluated, and a wide variety of data presentation formats is available.

The FPCC concept provides a number of inherent advantages in focal plane characterization. A low background radiation environment, similar to that which would be encountered in space, is provided by the FPCC. With all test components enclosed within an optically tight, cryogenic environment, the test article can be irradiated with a broadband IR source while maintaining independent control of background radiation.

For IR testing, the major uncertainty is associated with the radiation that is incident on the focal plane. During flood source testing in the FPCC, there are no optical elements such as IR windows or neutral density filters between the source output aperture and the FPA. Thus, it is not necessary to consider the spectral transmission characteristics of any optical elements in determining the radiation incident on the array. The chamber configuration is such that testing can be performed over a large dynamic range with relative ease. Radiometric flood source and spot source testing can be performed during a single test entry. The injection system makes possible a high throughput rate and good economy of operation. This system can be used to install and remove focal planes without disturbing test conditions, thus providing the capability to test many focal planes in a short period of time (nominally one per day). In addition to the FPCC capabilities, relative spectral response can be measured using a spectral response station involving a three-grating monochromator.

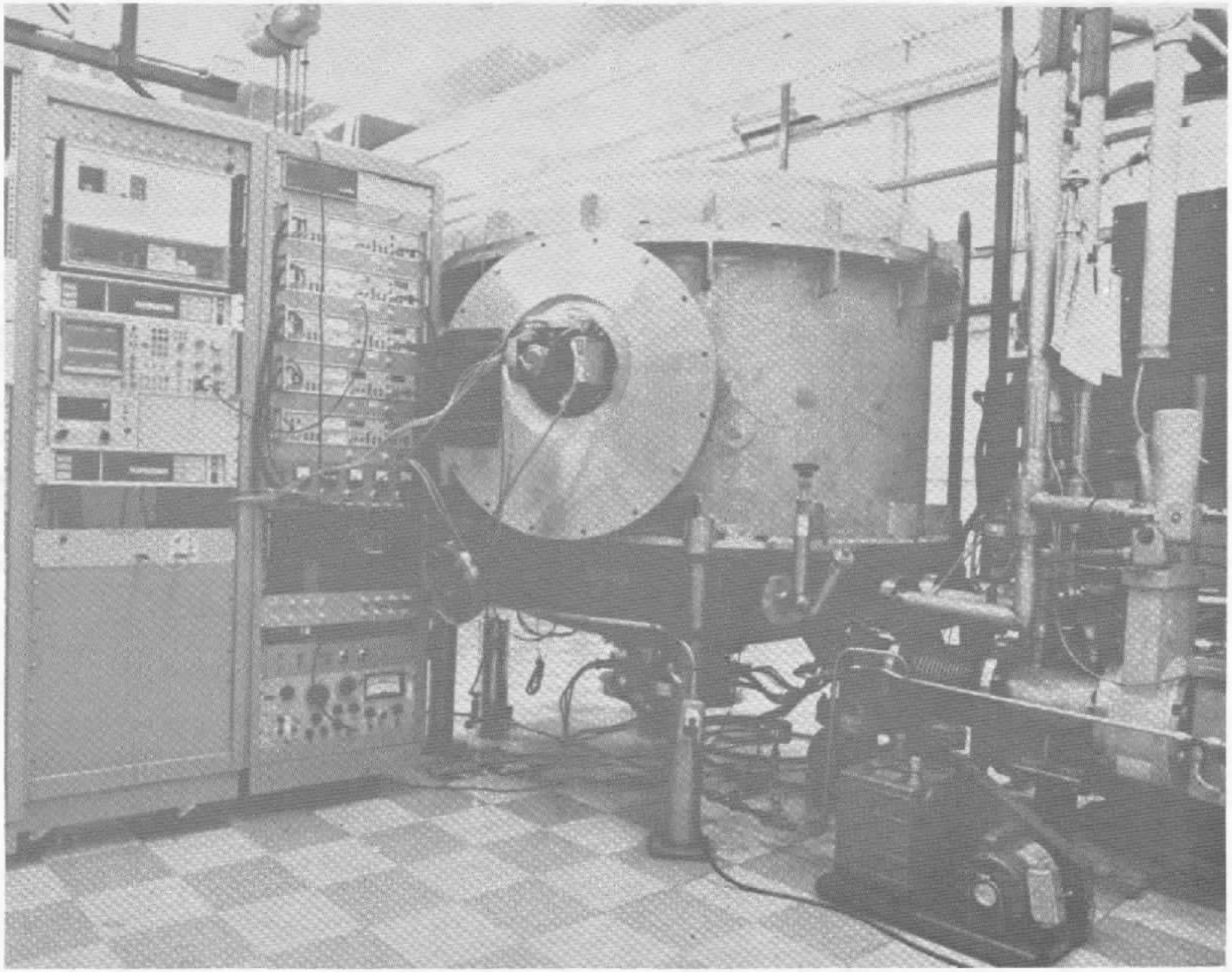

Figure 1. Focal Plane Characterization Chamber.

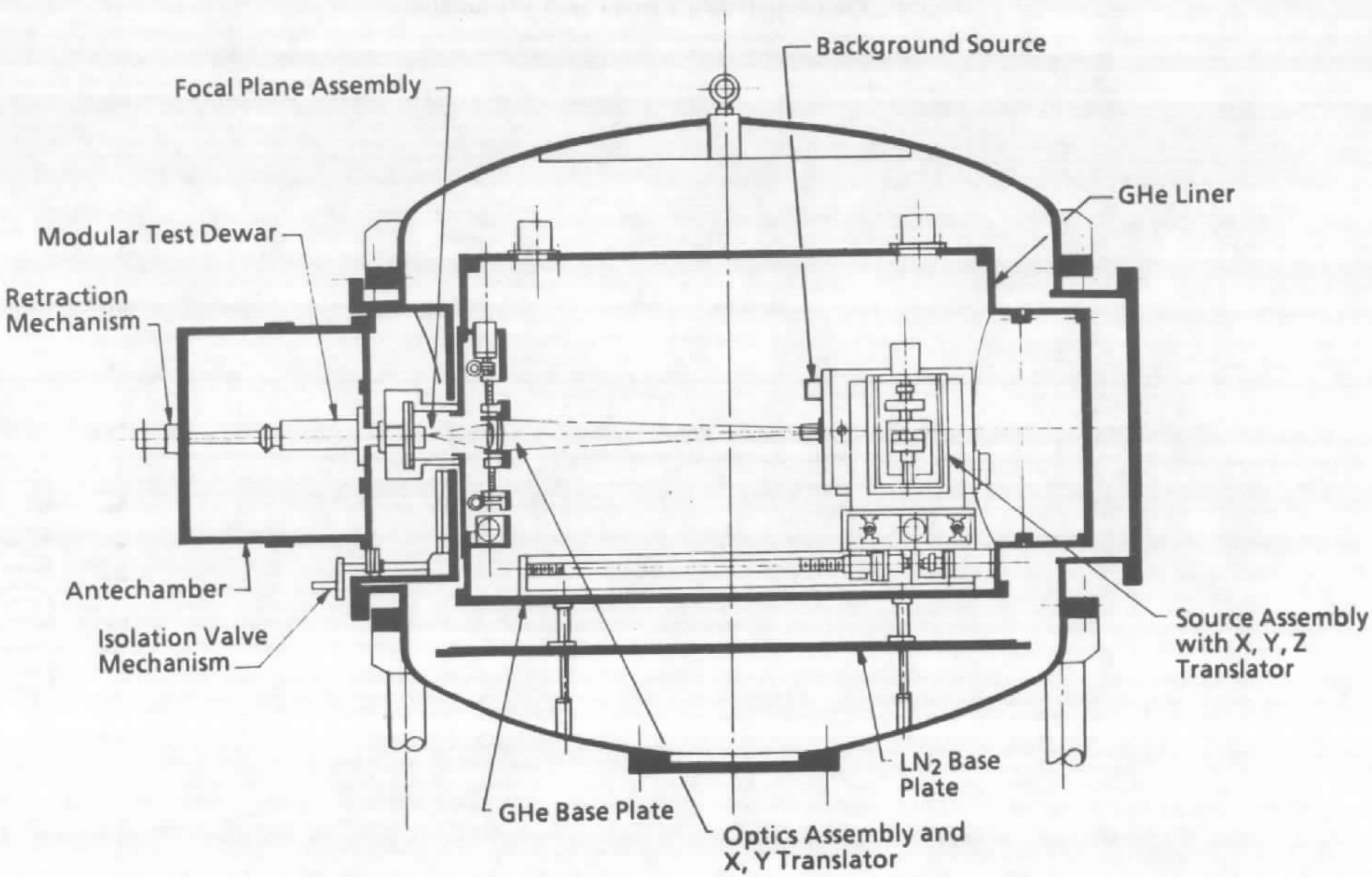

Figure 2. Focal Plane Characterization Chamber schematic.

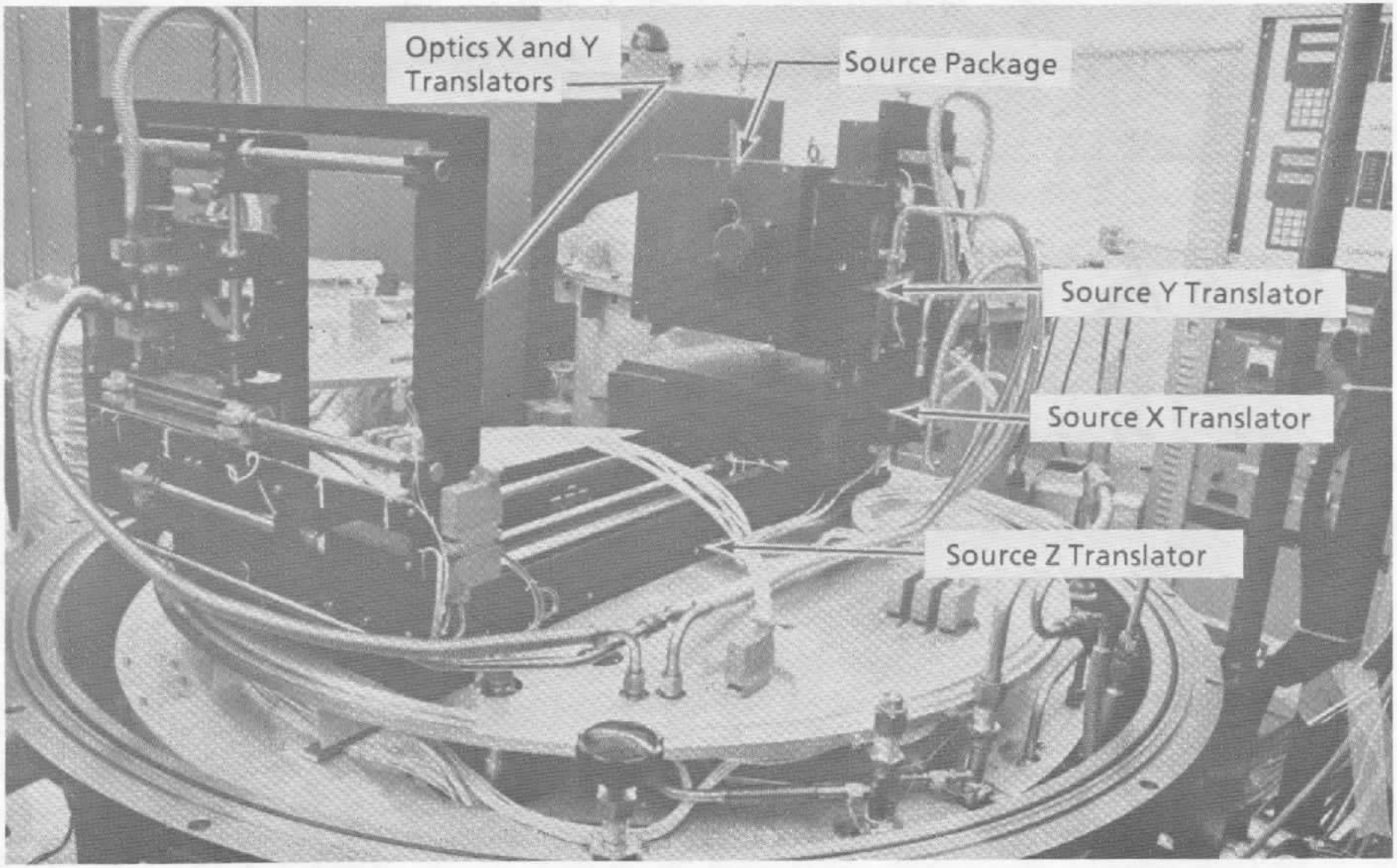

Figure 3. Source package installed in the FPCC.

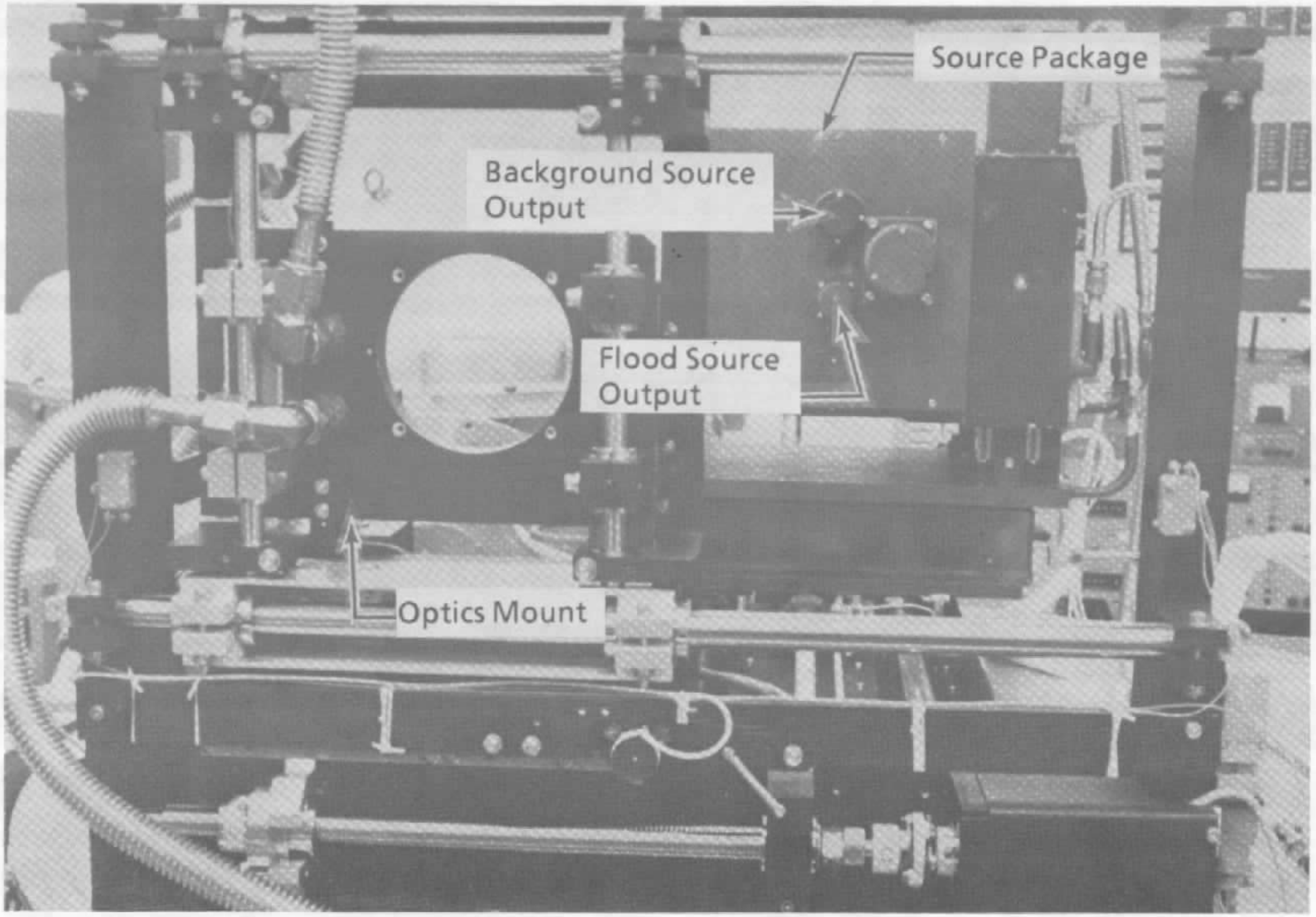

Figure 4. Optics assembly installed in the FPCC.

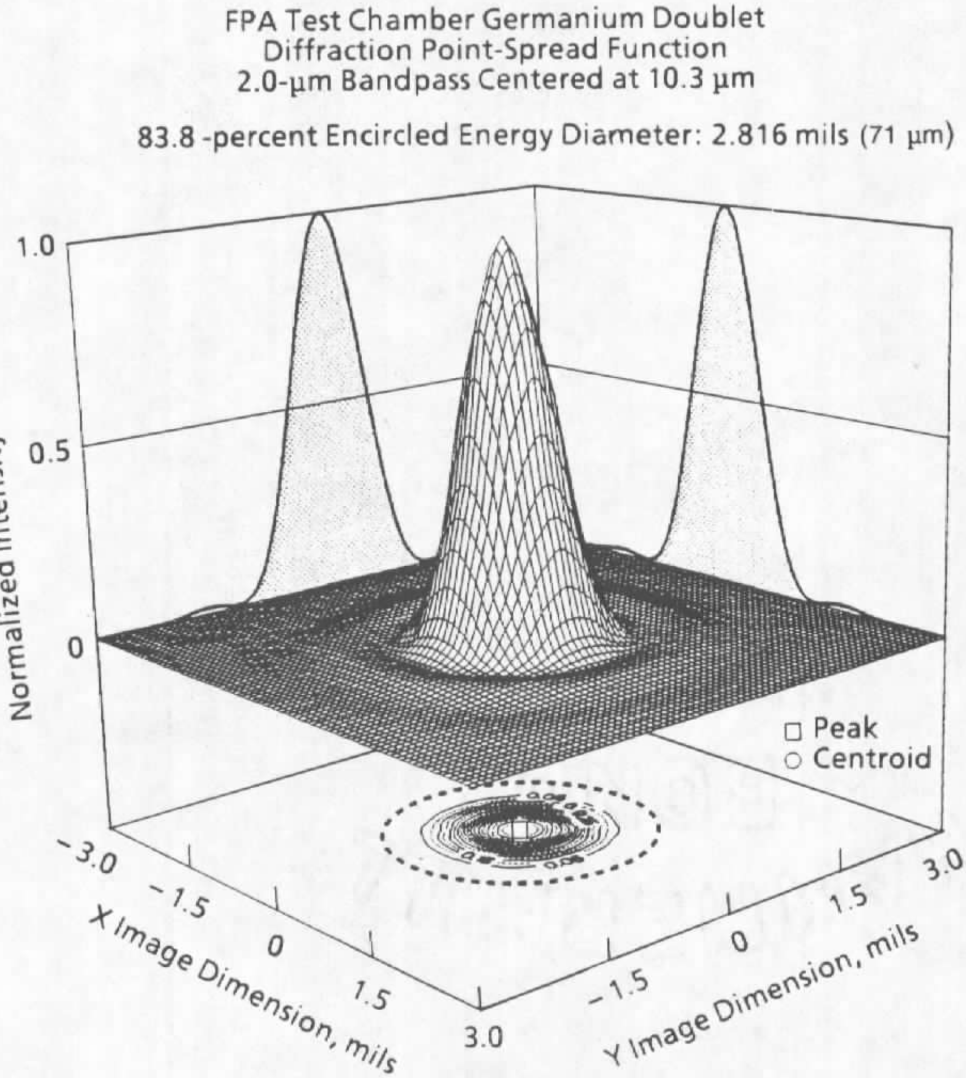

Figure 5. Image point-spread function.

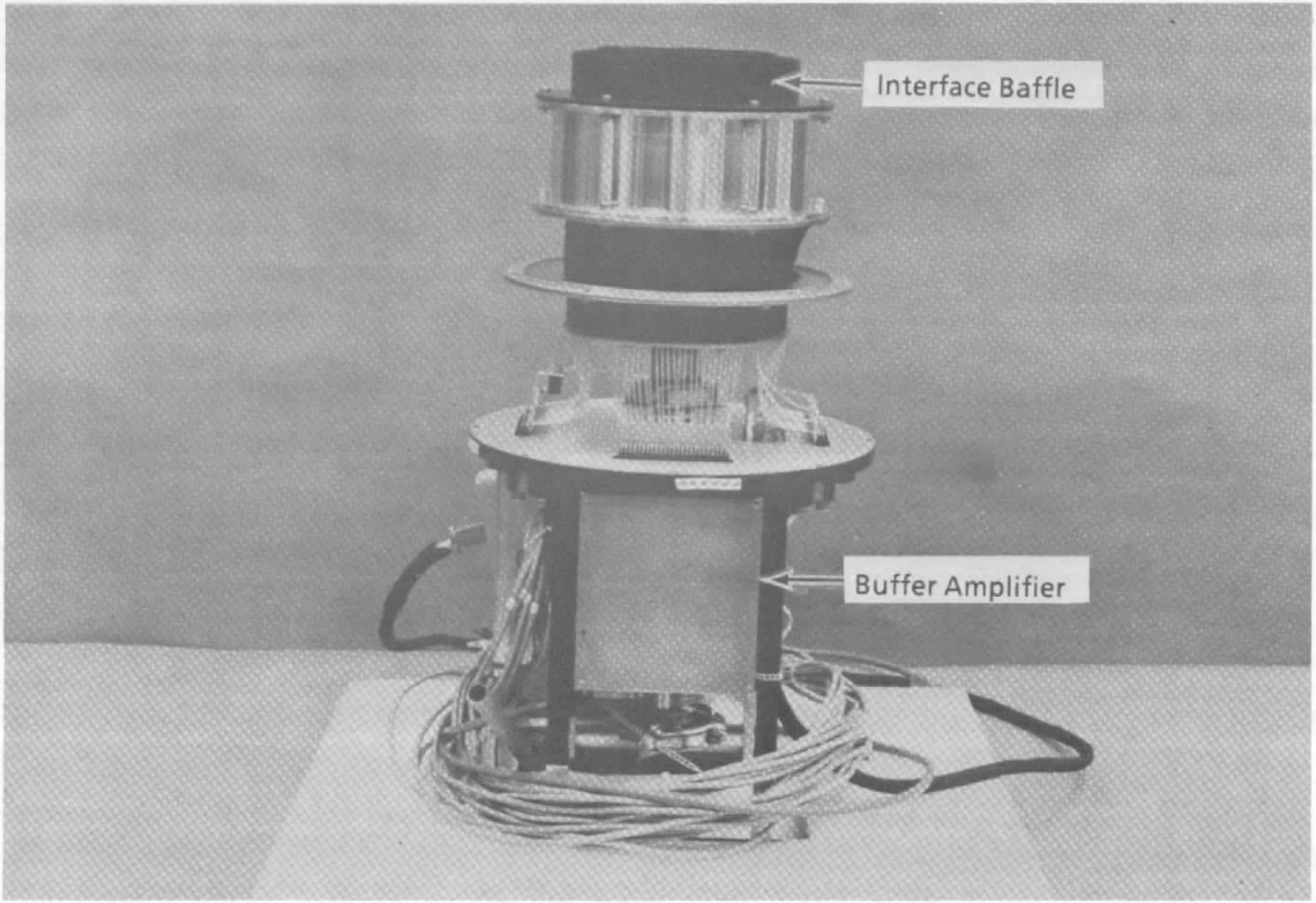

Figure 6. Modular test dewar.

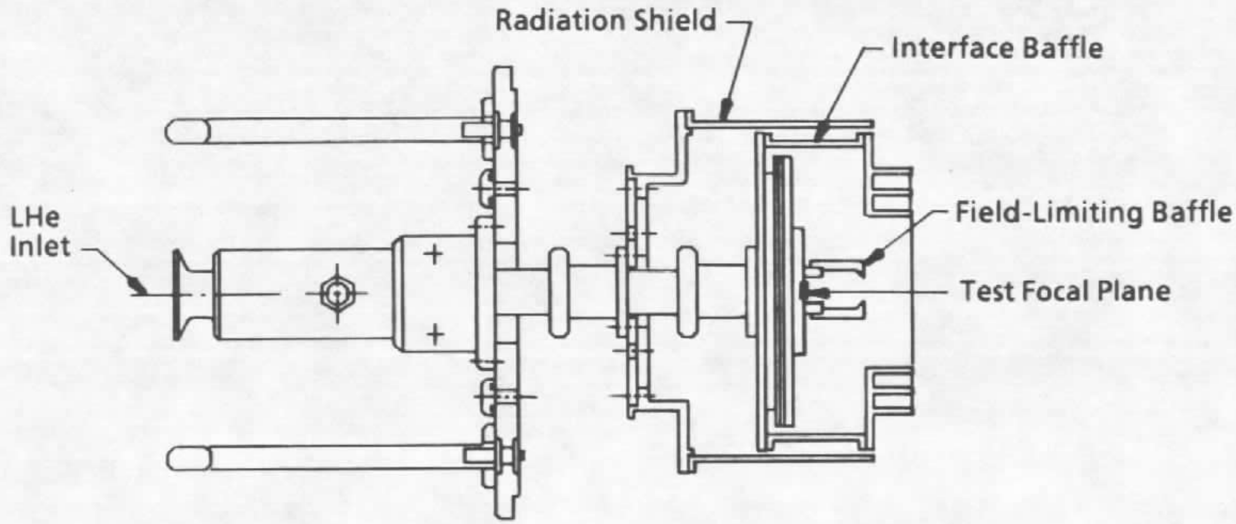

Figure 7. Modular test dewar sketch.

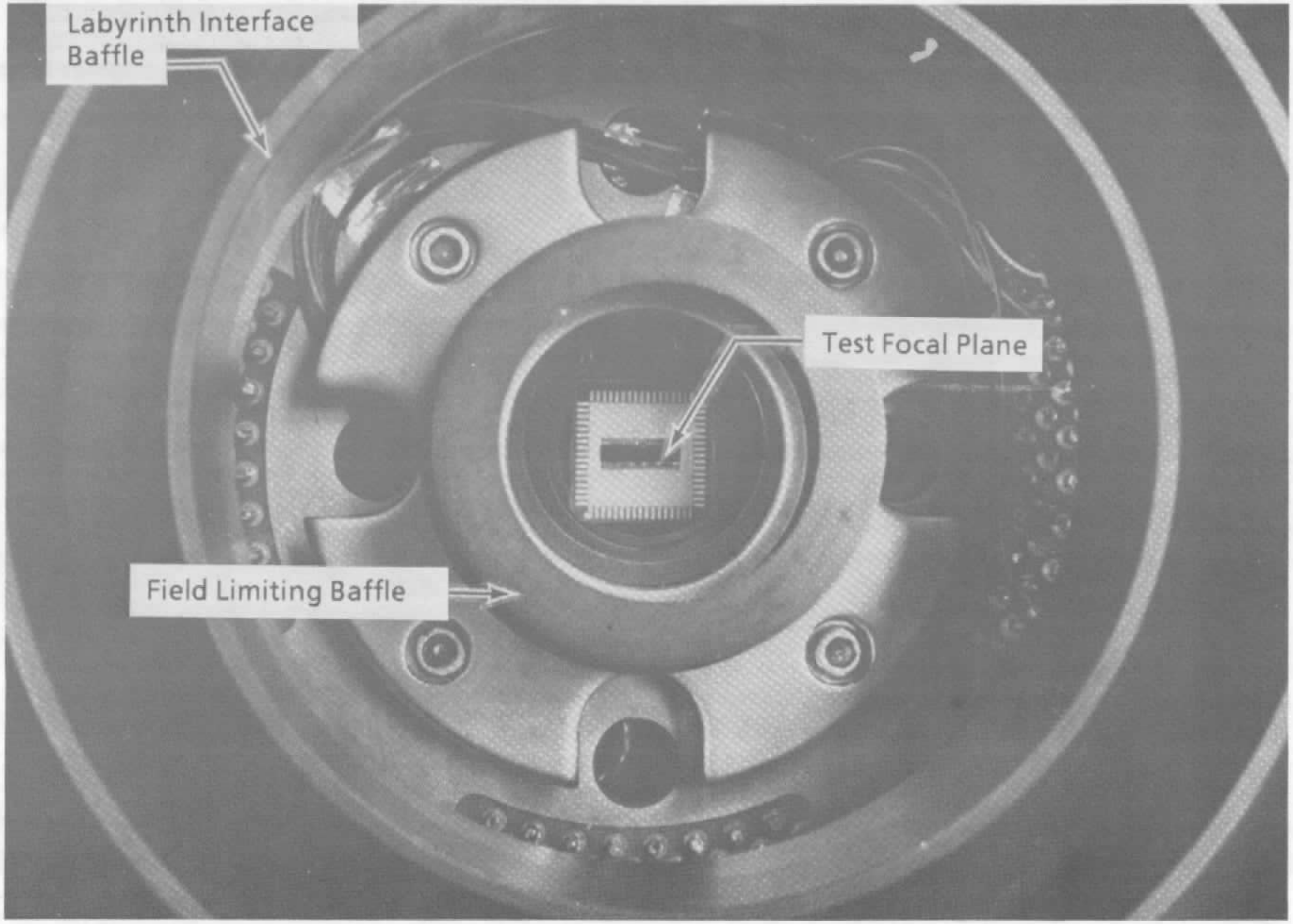

Figure 8. FPA installed in test dewar.

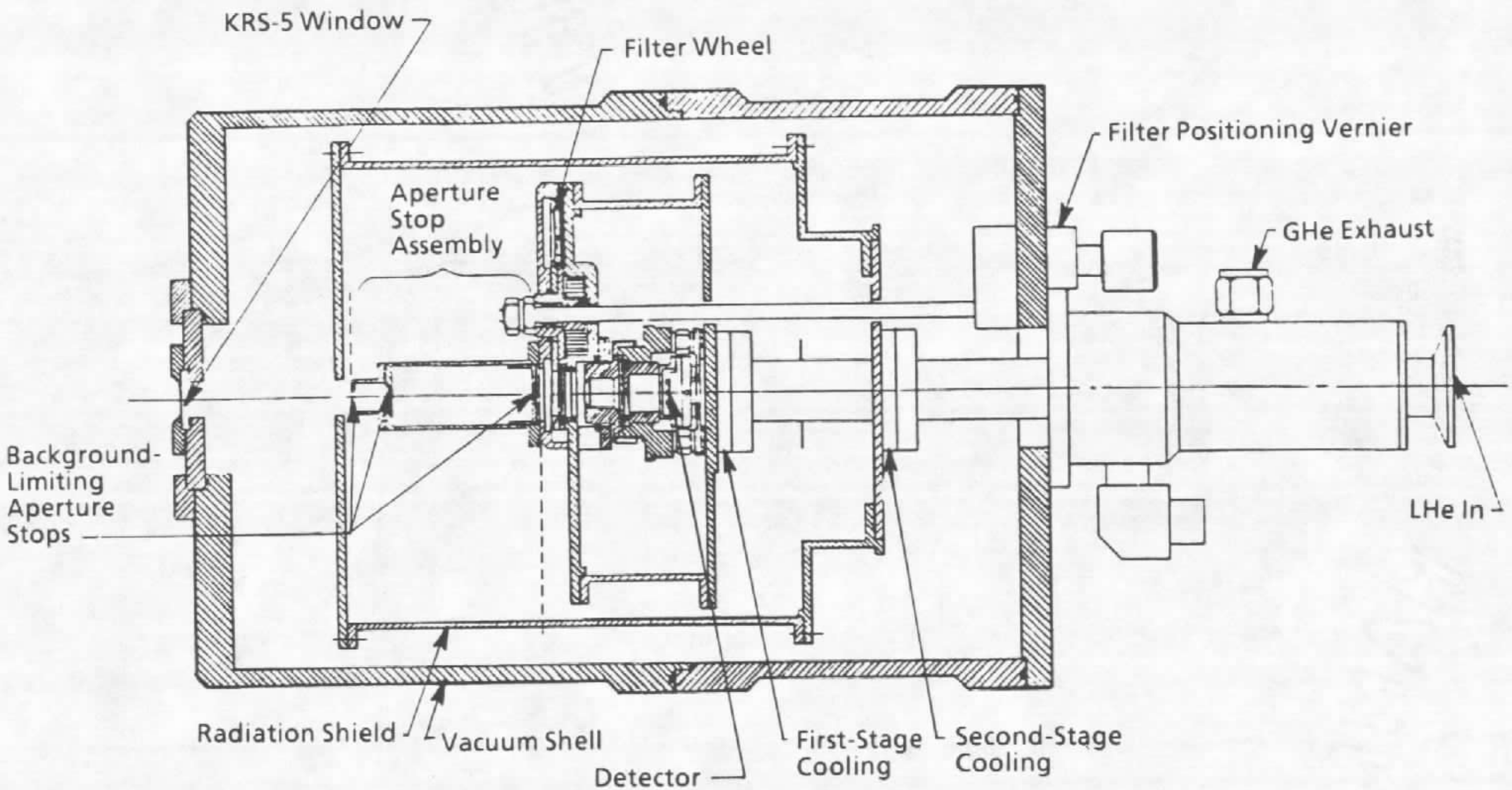

Figure 9. Test dewar configuration for spectral response testing.

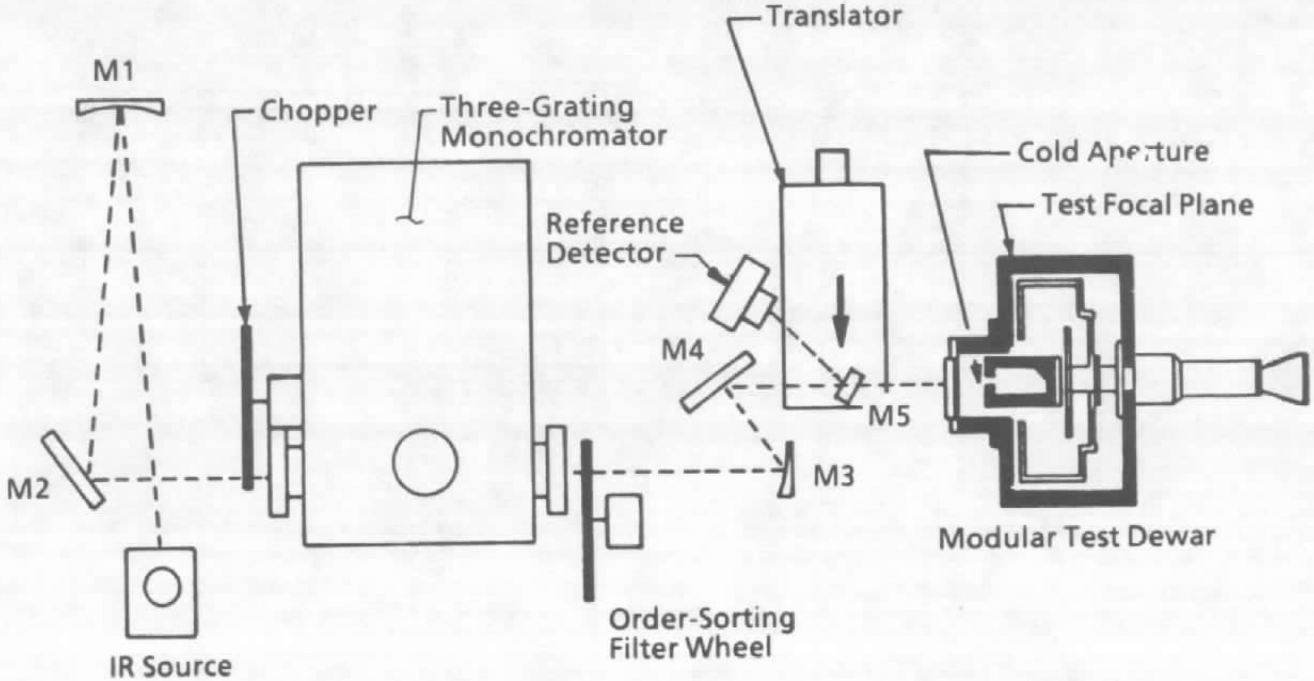

Figure 10. Spectral response test station.

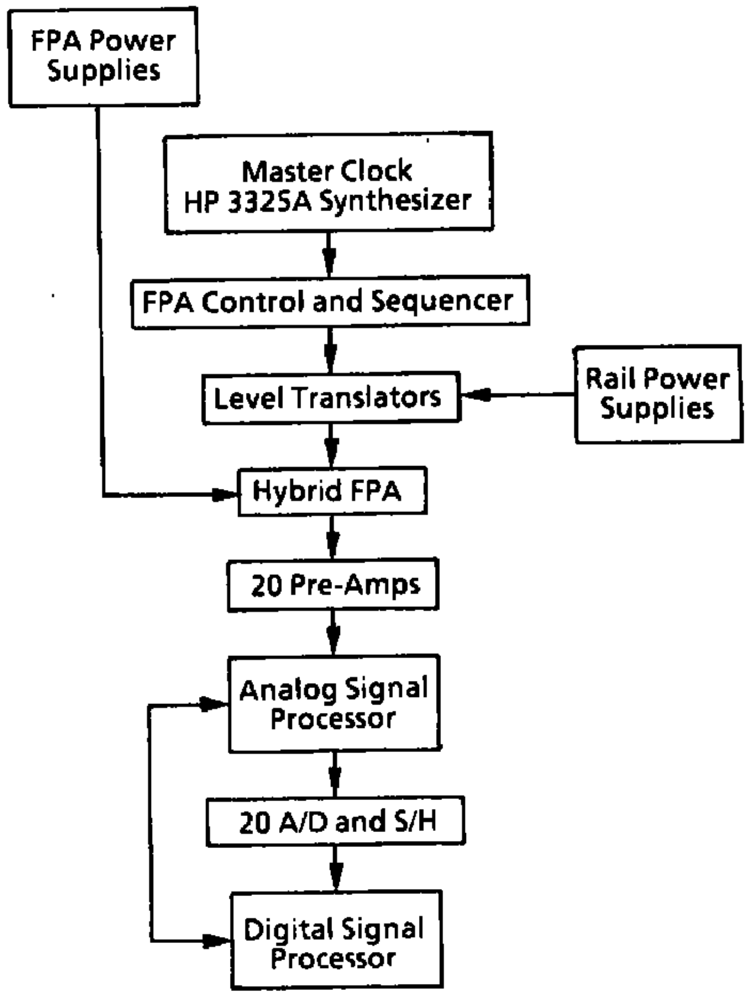

Figure 11. Hybrid focal plane test instrumentation.

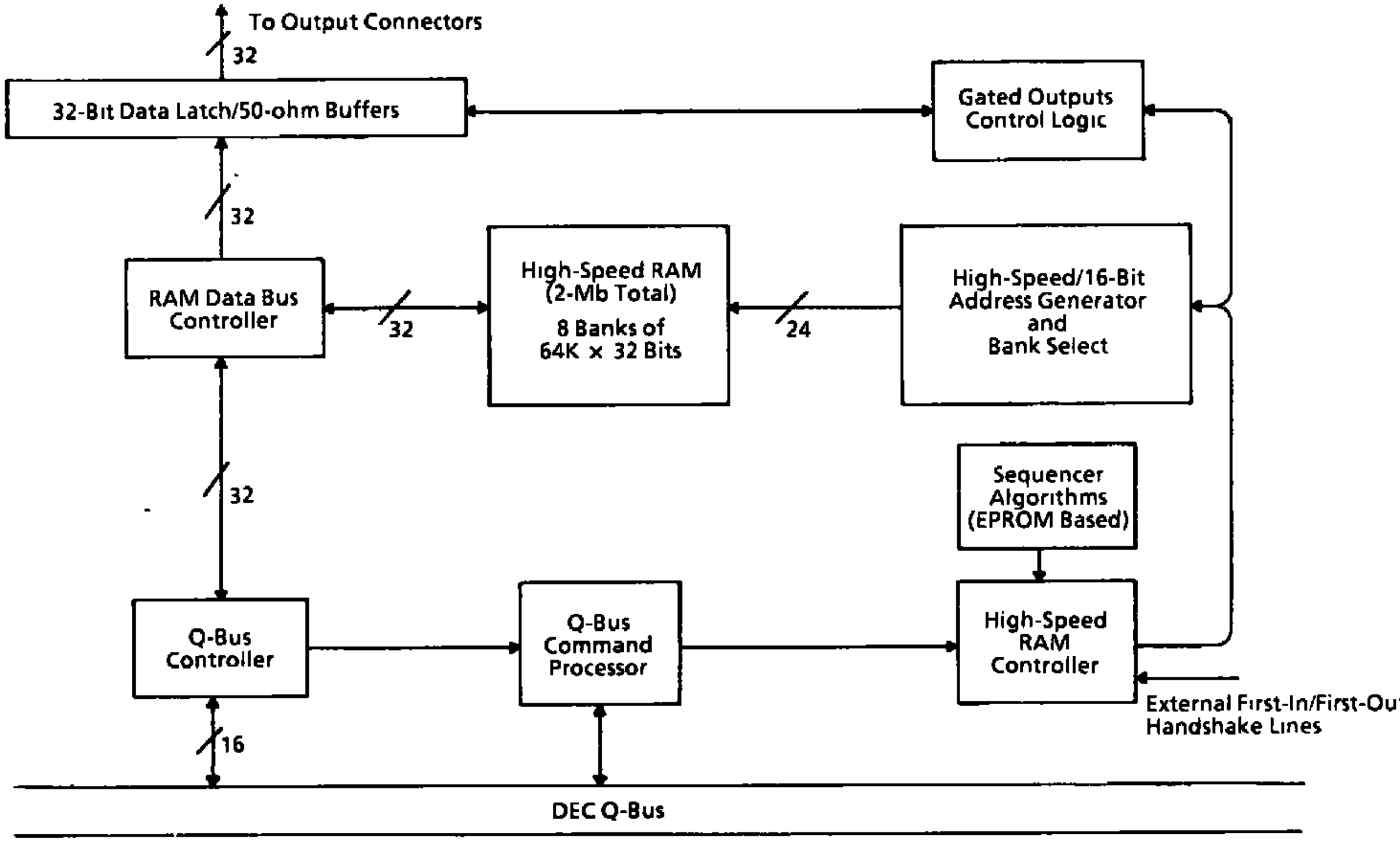

Figure 12. FPA system timing sequencer.

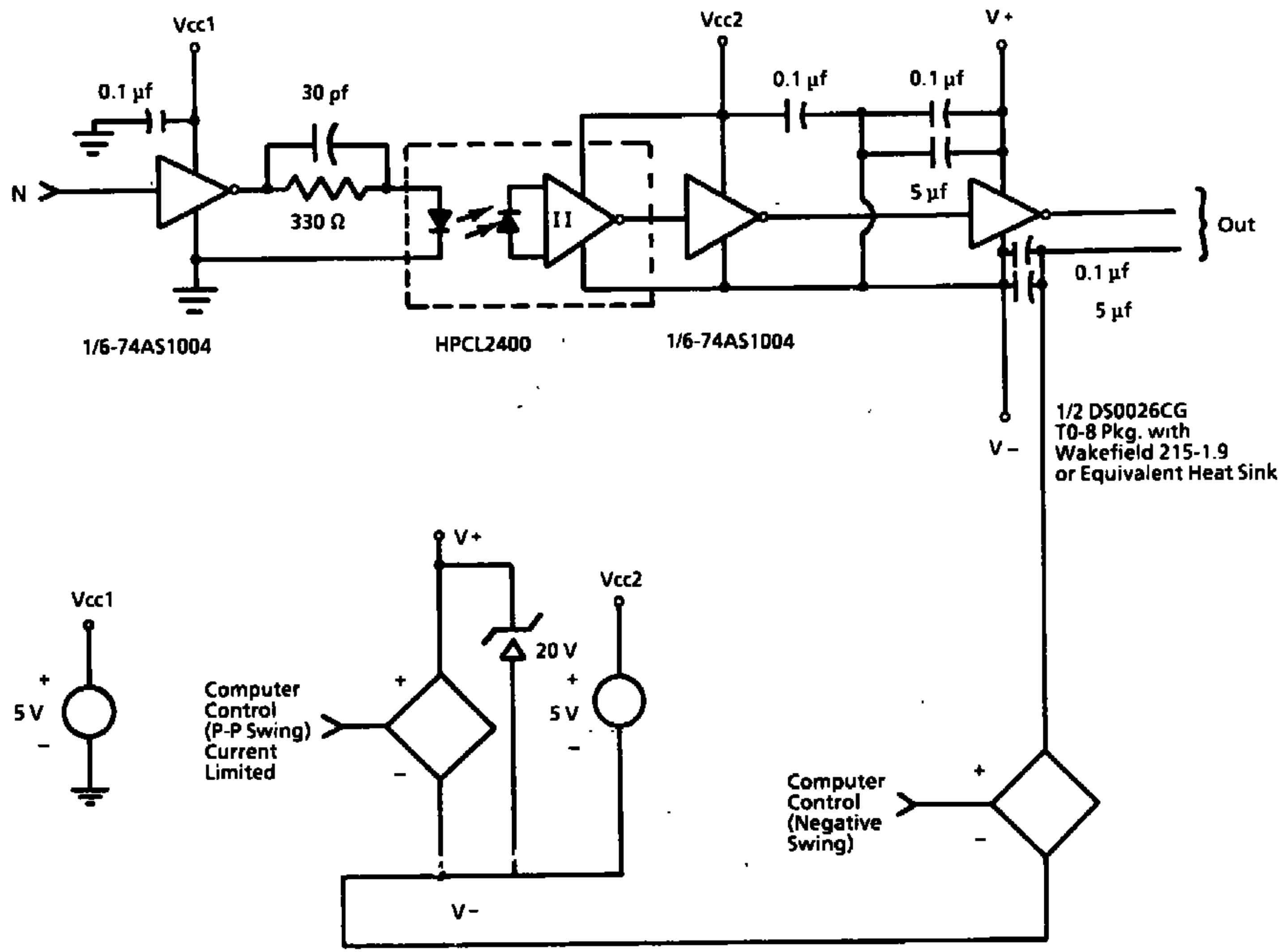

Figure 13. Level translator.

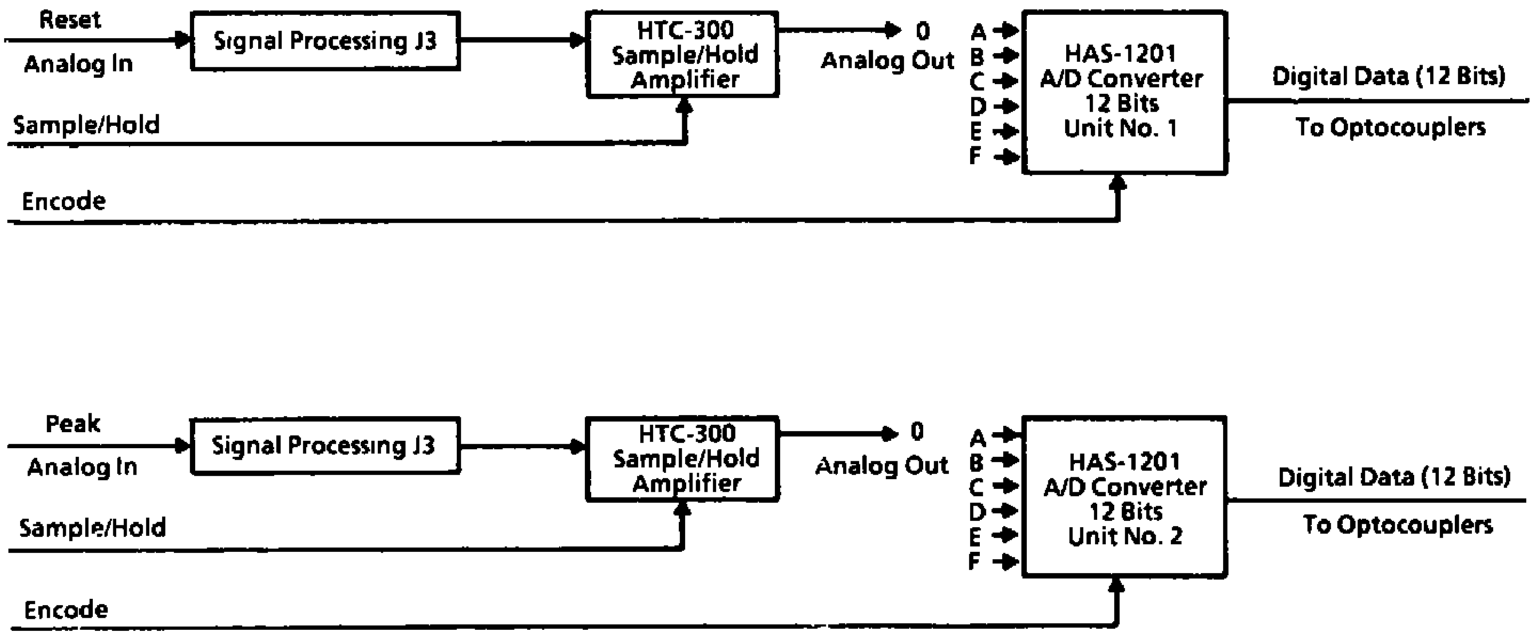

Figure 14. Analog-to-digital converters.

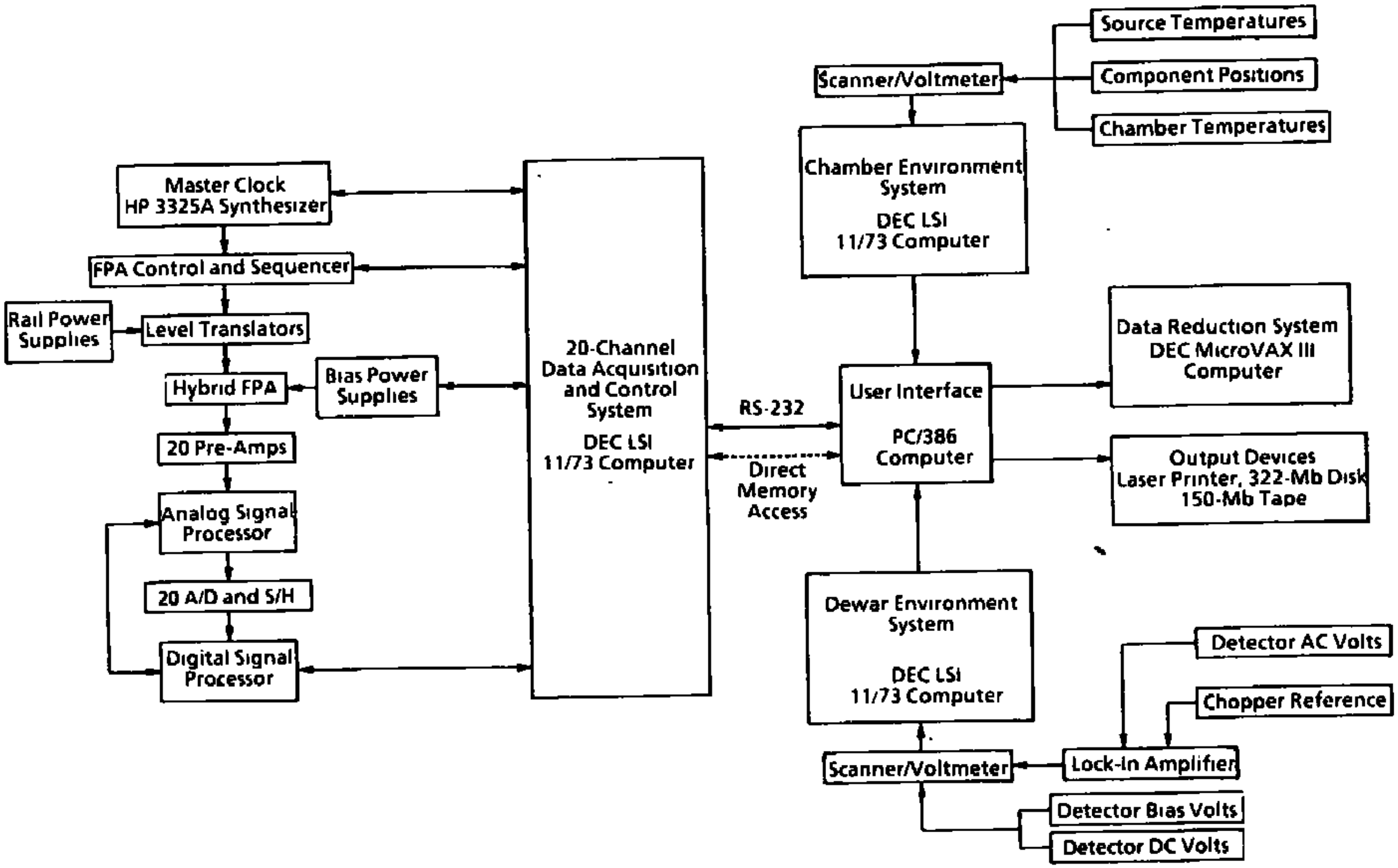

Figure 15. Instrumentation system block diagram.

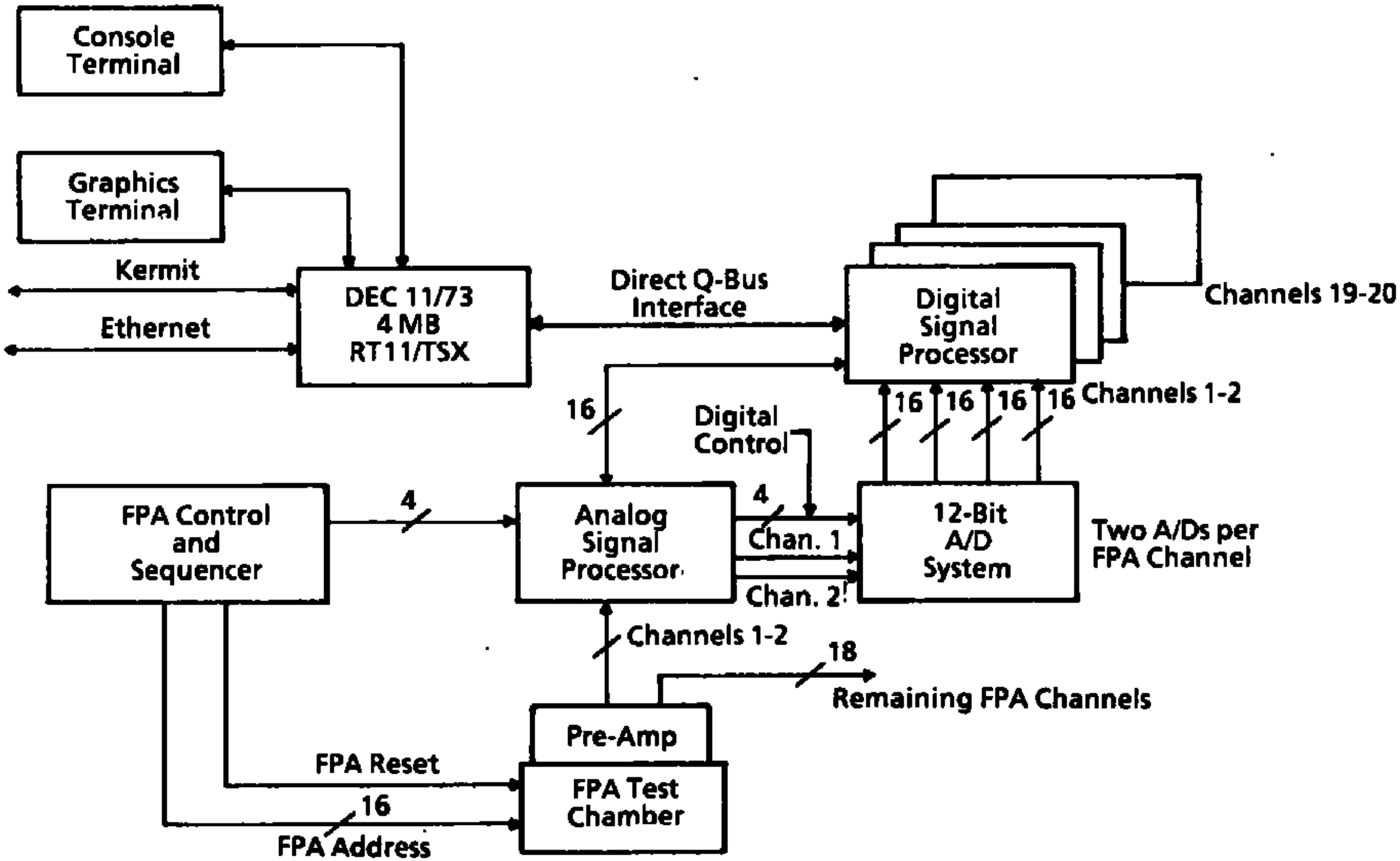

Figure 16. Test article data acquisition and control system.

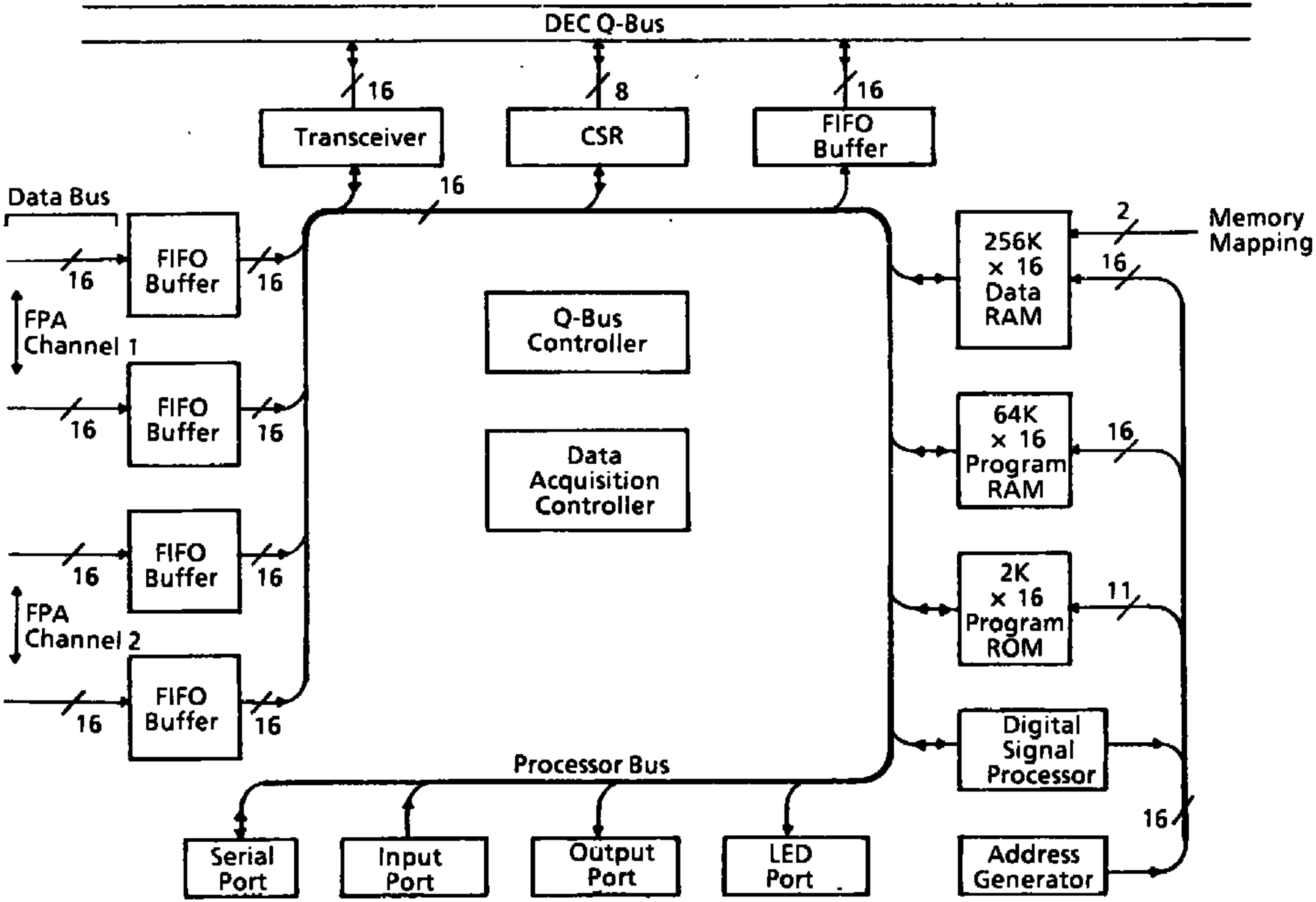

Figure 17. Digital signal processor architecture.

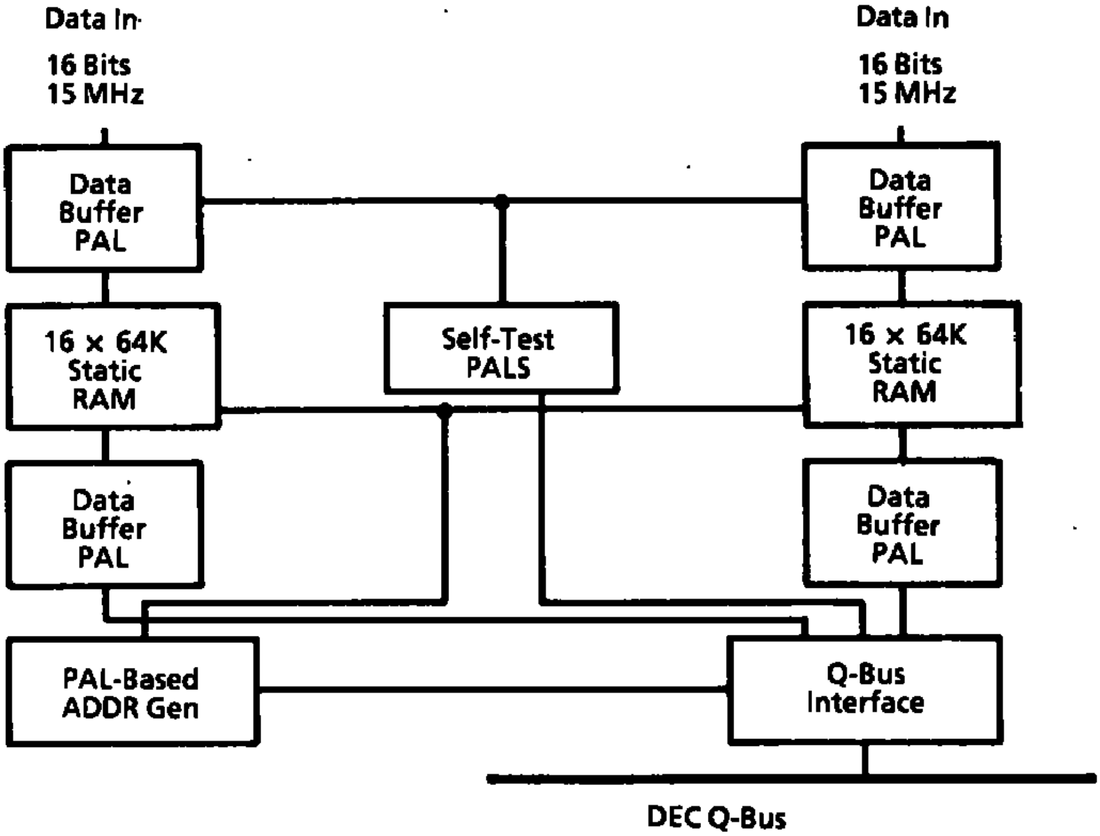

Figure 18. First-in/first-out data buffer.

Peak Responsivity
Run Number 1110

Device ID

AEDC FPCC Dewar # 5	Test Date	Test Time 14:17:28
Int Time 1.0000 msec	Vbias -1.665 V	FPA Temp 12.03
Blackbody Irradiance 1.457E-08 W/cm2	Blackbody Flux 1.534E+12 Ph/cm2-sec	Total Background Flux 3.0E+10 Ph/cm2-sec
Spectral Band B	Vdet -3.006 V	Vreset V
Peak Wavelength 22.4 um	Electrical Bandwidth 2.0 MHz	Effective Capacitance 0.040 pF
(Data Units - V/W x 1.E-10)		Date Reduced

Data:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	22.75	10.97	22.53	20.56	16.93	22.54	17.49	14.63	24.67	11.85	17.82	25.09	19.45	12.64	13.92	22.70	14.42	5.09	6.88	0.09
2	14.98	22.69	25.71	16.01	17.45	20.62	15.44	16.75	4.15	9.43	5.72	13.64	15.02	6.48	14.29	12.43	5.59	8.31	1.62	0.21
3	14.09	10.21	13.16	14.01	17.41	16.10	18.98	16.69	15.88	16.24	7.37	17.59	20.10	16.64	15.12	23.23	22.09	19.85	21.12	0.05
4	25.97	14.66	19.11	24.02	14.92	19.64	20.88	19.34	19.41	17.72	9.81	12.70	20.23	19.26	21.37	12.41	18.02	17.49	13.08	0.09
5	14.96	0.05	14.83	21.89	5.42	15.35	9.17	23.86	17.76	17.34	14.90	18.15	16.23	6.82	15.83	15.37	14.21	17.17	22.38	0.16
6	26.20	16.95	8.37	10.71	17.30	14.67	19.80	14.85	11.35	15.81	19.09	19.15	22.05	12.79	12.31	11.21	20.73	13.72	22.04	0.16
7	20.32	10.12	24.28	25.61	21.10	17.19	22.44	17.71	16.84	23.87	14.71	13.18	12.40	16.65	21.17	23.93	22.24	15.89	12.92	0.04
8	13.63	10.67	11.91	19.57	15.69	14.06	12.85	13.50	15.83	17.24	1.97	15.41	8.94	12.97	20.05	17.09	20.01	7.62	8.07	0.18
9	14.56	15.68	19.05	20.10	16.14	15.04	19.67	22.85	20.07	24.72	13.40	17.43	18.90	10.15	20.99	22.61	27.56	12.09	13.18	0.05
10	18.27	14.74	18.87	17.08	18.76	11.04	18.74	10.18	17.99	13.52	8.70	21.47	18.90	10.01	5.98	10.56	21.68	18.85	22.33	0.12
11	14.54	14.94	15.36	17.10	12.72	20.68	11.85	11.73	23.12	17.43	7.92	12.68	12.94	12.63	13.54	21.53	17.62	8.71	24.53	0.16
12	15.94	11.30	14.37	17.91	13.97	22.33	10.80	10.92	15.47	19.32	13.66	18.36	28.68	14.83	17.05	31.52	13.12	15.69	14.36	0.14
13	15.41	19.09	16.40	22.85	10.72	20.65	18.00	20.39	30.54	18.52	11.65	23.22	18.98	19.83	19.35	12.70	19.37	22.96	13.77	0.18
14	16.08	8.32	15.42	23.06	19.47	20.53	18.77	12.92	13.52	22.40	18.57	11.78	14.65	16.07	22.76	7.55	16.60	14.01	11.99	0.12
15	13.01	13.10	23.75	17.19	16.81	23.27	8.90	19.26	20.09	18.05	13.93	10.77	24.26	13.90	18.02	9.07	17.44	11.61	14.15	0.16
16	18.70	17.92	23.72	20.36	12.25	15.88	13.85	11.61	25.48	18.06	7.35	22.59	24.19	24.54	23.28	17.40	15.96	14.15	12.24	0.14
17	27.74	14.91	27.45	23.64	19.69	23.40	19.16	28.11	17.31	15.94	10.24	22.16	29.03	10.61	19.36	19.22	25.24	8.34	17.23	0.05
18	18.16	14.27	18.86	15.44	19.97	13.04	23.51	12.48	24.59	14.42	18.85	22.46	30.58	17.91	25.06	18.74	22.77	14.51	18.25	0.05
19	18.03	16.08	28.47	19.64	17.76	22.52	14.70	17.99	21.23	17.87	12.05	18.27	33.25	19.77	18.35	19.05	23.24	14.12	13.53	0.09
20	18.15	18.96	16.51	22.77	16.46	10.45	20.21	15.73	21.34	19.53	13.58	17.50	21.97	11.21	23.95	17.28	20.10	13.47	24.10	0.03
21	23.77	19.62	23.11	14.74	26.87	18.18	29.01	21.96	23.67	17.67	9.83	27.56	18.04	23.33	28.35	12.77	29.02	20.27	22.33	0.14
22	17.61	16.96	21.48	10.76	18.54	19.62	23.08	18.37	19.40	22.27	17.60	26.52	22.90	15.79	25.53	19.46	32.16	21.33	11.03	0.14
23	20.11	12.88	29.14	16.75	18.28	19.29	19.67	21.63	17.12	16.62	15.79	20.43	21.92	15.39	25.83	12.16	19.32	13.72	19.79	0.01
24	7.78	21.02	19.22	18.87	16.19	22.44	14.69	18.98	27.01	13.76	22.56	31.23	19.92	17.44	18.76	20.56	22.03	15.77	16.31	0.16
25	13.56	7.71	15.77	14.40	20.74	21.54	25.29	23.16	25.64	24.53	18.38	16.99	38.04	1.06	26.53	11.08	22.29	18.14	16.20	0.04
26	25.03	21.62	19.84	30.14	18.57	30.23	22.11	21.51	25.15	12.09	18.02	31.09	19.86	22.44	0.81	18.16	31.64	27.93	13.89	0.05
27	19.43	19.66	18.63	23.18	18.83	26.64	15.37	27.36	2.08	1.51	4.59	23.27	24.12	10.15	29.33	0.76	35.70	1.49	35.65	0.10
28	9.09	20.08	18.68	27.04	17.60	12.52	22.48	27.16	21.41	17.72	15.32	28.63	0.96	16.21	30.87	23.95	27.61	20.36	30.00	0.09
29	28.48	26.27	27.21	15.07	16.12	25.69	26.60	23.90	23.39	12.53	20.29	29.97	25.83	25.71	20.17	13.69	23.35	20.78	17.98	0.01
30	19.01	27.04	17.11	21.27	24.99	19.22	29.69	22.75	31.39	22.83	6.02	23.84	16.31	1.84	42.81	24.70	28.06	13.11	30.81	0.03
31	30.32	22.87	23.42	29.38	2.00	28.30	18.57	35.13	1.00	4.58	27.63	29.14	26.55	17.88	36.53	20.65	0.81	1.00	1.15	0.05
32	29.70	19.01	21.76	20.08	29.06	23.36	1.56	21.81	17.83	23.02	17.35	23.10	28.86	21.04	25.20	20.81	27.20	16.55	16.19	0.16
33	19.54	2.22	32.49	22.70	16.31	24.84	26.00	19.54	31.15	22.24	25.09	25.89	28.99	29.33	27.43	20.24	25.18	16.51	21.27	0.01
34	29.20	22.29	19.68	21.78	17.48	23.71	14.28	15.04	26.16	24.90	23.51	23.41	26.73	20.13	26.74	14.48	23.27	19.76	21.15	0.13
35	26.86	12.87	20.94	23.29	19.14	23.50	23.89	20.21	23.24	19.56	15.44	25.31	24.85	22.29	25.53	18.51	26.24	25.55	21.78	0.06
36	27.89	17.44	25.77	25.31	19.75	27.77	24.09	18.78	24.75	25.13	14.39	22.40	32.23	20.93	23.15	27.83	27.05	22.38	14.06	0.15
37	25.37	23.99	22.90	18.12	26.00	21.06	23.49	26.27	24.02	19.65	24.08	30.98	24.04	26.66	26.92	12.04	23.47	27.12	24.71	0.16
38	22.72	21.39	31.04	22.43	20.08	23.25	21.26	24.61	24.43	24.89	2.23	22.40	30.72	20.27	23.70	6.90	37.92	1.60	23.05	0.05
39	25.60	21.70	31.48	14.98	25.73	24.89	25.16	25.07	23.17	20.32	17.65	31.71	34.15	17.74	26.49	18.90	22.81	32.30	24.43	0.14
40	24.78	22.90	22.77	24.54	19.29	29.60	26.72	25.56	22.34	14.80	24.61	26.53	29.71	15.44	24.62	16.69	27.94	17.08	18.07	0.09
41	21.28	16.38	21.50	26.74	16.86	26.51	20.46	30.60	28.54	18.26	14.04	24.53	38.59	20.49	40.78	20.05	31.49	19.57	18.29	0.01
42	31.93	16.47	21.74	23.53	20.25	24.96	24.48	19.38	27.30	31.03	17.04	29.92	30.59	20.77	25.42	29.88	28.00	23.75	28.13	0.10
43	19.75	17.53	24.16	26.64	25.22	29.91	20.30	28.72	32.94	26.82	24.09	24.19	29.55	25.31	25.35	26.28	26.93	26.68	1.43	0.14
44	29.45	23.41	30.15	17.82	21.39	25.11	25.01	19.44	30.86	27.82	22.50	26.40	30.23	24.94	22.16	21.83	30.20	21.89	23.73	0.18
45	20.65	18.65	24.05	22.10	10.04	21.87	28.90	27.34	26.69	27.72	21.35	32.21	41.84	28.65	31.87	17.77	29.11	24.39	24.34	0.08
46	22.66	20.00	26.78	24.06	24.93	31.60	23.21	18.43	25.56	21.27	21.33	0.87	32.20	30.23	30.71	20.52	26.38	24.16	22.77	0.03
47	22.84	14.76	29.36	23.32	25.05	24.26	27.28	1.28	35.31	23.32	20.63	28.25	37.33	35.53	30.15	21.55	23.49	22.53	31.28	0.05
48	23.93	24.71	28.61	25.57	15.96	29.84	19.73	25.40	29.88	20.47	17.29	31.23	40.78	35.74	34.24	19.77	33.10	20.30	23.27	0.18
49	25.16	23.40	32.96	19.38	31.57	15.15	26.39	26.71	29.89	24.91	26.56	35.61	38.96	31.25	35.02	24.99	28.07	21.80	19.16	0.14
50	25.65	20.89	22.33	22.44	32.18	21.21	29.79	20.36	30.54	19.49	15.64	22.77	44.81	35.28	31.54	26.32	36.05	22.55	23.76	0.12
51	26.69	28.31	26.47	32.13	21.00	29.09	23.87	21.82	24.10	30.69	22.71	27.98	43.27	32.13	33.14	26.23	26.77	25.73	1.18	0.09
52	25.93	26.72	1.73	26.11	30.60	19.36	23.56	21.04	27.47	27.77	16.11	26.64	39.54	26.36	30.07	30.05	29.13	26.40	21.21	0.05
53	26.02	16.25	29.58	26.60	31.91	27.80	24.04	31.59	29.01	23.36	25.51	34.54	26.36	31.16	26.93	24.04	31.27	28.72	28.04	0.08
54	24.59	28.84	24.40	28.11	16.82	29.41	30.96	28.83	26.55	33.47	23.05	29.23	35.01	35.16	31.17	28.26	31.65	23.33	20.21	0.01
55	31.91	28.92	32.23	30.52	28.72	31.27	33.84	23.05	29.62	34.58	16.47	30.94	27.28	27.72	33.27	25.34	28.41	31.02	26.64	0.01
56	31.63	17.35	20.53	24.74	23.62	23.09	31.36	26.07	24.26	26.36	1.61	36.84	36.10	28.07	34.72	29.12	30.74	25.46	22.36	0.12
57	33.42	29.36	28.56	31.76	18.20	27.09	25.55	23.72	27.44	27.81	26.40	31.94	38.42	30.55	32.50	26.42	30.81	18.45	41.91	0.01
58	23.16	16.71	27.58	26.27	28.39	26.51	20.85	25.72	28.55	24.37	27.14	26.93	39.53	15.51	32.16	28.20	30.77	27.01	23.67	0.01
59	33.01	21.05	26.29	26.82	25.70	25.57	24.85	23.14	28.95	21.27	24.88	27.28	33.32	29.70	32.35	33.40	37.76	26.53	33.25	0.18
60	7.34	21.49	25.02	24.97	23.82	27.89	23.35	26.12	29.64	34.41	17.77	28.97	39.05	25.12	31.36	26.85	1.21	17.78	22.45	0.00
61	1.50	20.67	24.89	22.76	19.97	25.92	24.33	24.77	24.69	0.67	23.93	31.30	27.18	27.92	29.19	33.34	40.35	21.72	27.77	0.10
62	29.77	20.46	23.82	29.49	20.02	24.52	26.40	25.24	36.41	24.58	26.32	30.83	40.78	1.26	27.39	25.45	28.50	30.68	17.08	0.16
63	33.10	20.69	24.74	28.59	27.94	32.91	25.83	25.71	21.63	29.49	15.80	28.24	42.38	31.72	27.32	28.57	25.38	27.70	27.93	0.16
64	6.55	8.73	5.87	4.25	6.74	3.95	5.35	5.11	2.26	7.34	14.79	4.36	0.81	8.66	2.60	8.49	4.28	8.44	7.91	0.24

Summary:		
	Mean (with outliers)	20.32
	Mean (w/o outliers)	20.32
	Median	21.33
	Standard Deviation	8.73
	Minimum	0.00
	Maximum	44.81
	# Outliers	0

Figure 19. Sample responsivity printout.

Project: CE69 HYBRID RESPONSIVITY SUMMARY Page 1
Detector type: Si:As Print date:
FPA ID.:

RUN NO.	DATE	SOURCE TEMP. (K)	SOURCE IRRAD (w/cm2)	PHOTON FLUX (Ph/sec-cm2)	FPA TEMP (K)	FPA BIAS (Volts)	INT TIME (msec)	RESPONSIVITY (V/W)
100	6-28-1990	299.45	5.239E-10	5.517E+10	9.928	-2.074	1.000	4.491E+09
110	6-28-1990	299.45	2.205E-09	2.322E+11	9.924	-2.074	1.000	1.945E+10
120	6-28-1990	299.45	2.256E-07	2.375E+13	9.925	-2.074	1.000	3.768E+10
140	6-28-1990	299.44	5.630E-08	5.928E+12	9.914	-2.074	1.000	3.709E+10
150	6-28-1990	299.45	2.819E-08	2.968E+12	9.934	-2.074	1.000	3.531E+10
160	6-28-1990	299.45	1.458E-08	1.536E+12	9.932	-2.074	1.000	3.571E+10
300	6-29-1990	299.43	5.238E-10	5.515E+10	9.997	-1.664	1.000	2.538E+11
310	6-29-1990	299.43	2.205E-09	2.321E+11	10.011	-1.664	1.000	5.364E+10
320	6-29-1990	299.43	2.255E-07	2.374E+13	10.001	-1.664	1.000	2.712E+10
340	6-29-1990	299.42	5.629E-08	5.927E+12	10.020	-1.664	1.000	2.896E+10
350	6-29-1990	299.42	2.818E-08	2.967E+12	10.005	-1.664	1.000	2.707E+10
360	6-29-1990	299.43	1.458E-08	1.535E+12	9.997	-1.664	1.000	2.604E+10
400	6-29-1990	299.43	5.238E-10	5.515E+10	10.005	-1.664	1.000	1.452E+10
410	6-29-1990	299.42	2.204E-09	2.321E+11	9.989	-1.664	1.000	2.970E+10
420	6-29-1990	299.43	2.255E-07	2.374E+13	9.982	-1.664	1.000	5.294E+10
440	6-29-1990	299.42	5.629E-08	5.927E+12	9.979	-1.664	1.000	4.753E+10
450	6-29-1990	299.42	2.818E-08	2.967E+12	10.000	-1.664	1.000	5.514E+10
460	6-29-1990	299.41	1.458E-08	1.535E+12	10.003	-1.664	1.000	6.035E+10
600	6-30-1990	299.37	5.234E-10	5.511E+10	10.077	-1.667	1.000	9.493E+10
610	6-30-1990	299.37	2.203E-09	2.320E+11	10.079	-1.667	1.000	5.500E+10
620	6-30-1990	299.39	2.254E-07	2.373E+13	10.059	-1.667	1.000	2.670E+10
640	6-30-1990	299.38	5.626E-08	5.924E+12	10.085	-1.667	1.000	2.932E+10
650	6-30-1990	299.39	2.817E-08	2.966E+12	10.089	-1.668	1.000	2.590E+10
660	6-30-1990	299.38	1.457E-08	1.534E+12	10.079	-1.668	1.000	2.688E+10
700	6-30-1990	299.37	5.234E-10	5.511E+10	12.019	-1.669	1.000	5.734E+11
710	6-30-1990	299.38	2.203E-09	2.320E+11	12.030	-1.669	1.000	1.624E+11
720	6-30-1990	299.38	2.254E-07	2.373E+13	12.068	-1.669	1.000	2.971E+10
740	6-30-1990	299.39	5.626E-08	5.925E+12	12.003	-1.669	1.000	2.346E+10
750	6-30-1990	299.38	2.816E-08	2.965E+12	12.066	-1.665	1.000	3.005E+10
760	6-30-1990	299.37	1.457E-08	1.534E+12	12.052	-1.665	1.000	3.201E+10
800	6-30-1990	299.36	1.161E-09	1.222E+11	12.040	-1.665	1.000	2.315E+11
810	6-30-1990	299.37	4.886E-09	5.144E+11	12.043	-1.665	1.000	7.642E+10
820	6-30-1990	299.37	4.997E-07	5.262E+13	12.029	-1.665	1.000	2.582E+10
840	6-30-1990	299.37	1.248E-07	1.314E+13	12.034	-1.665	1.000	2.171E+10
850	6-30-1990	299.37	6.245E-08	6.576E+12	12.035	-1.665	1.000	3.045E+10
860	6-30-1990	299.35	3.231E-08	3.402E+12	12.069	-1.665	1.000	3.867E+10

Figure 20. Sample responsivity summary.

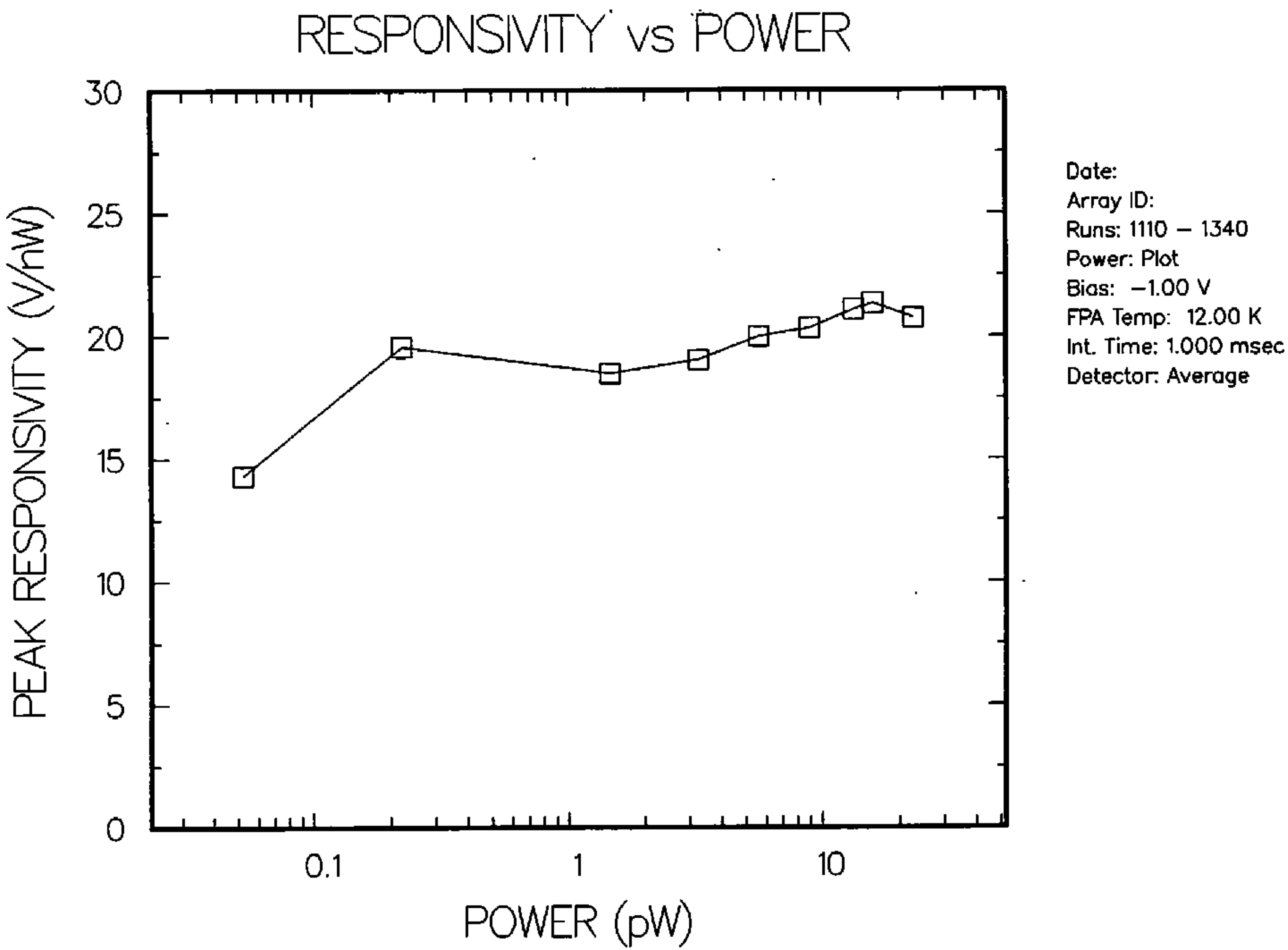

Figure 21. Sample trend plot — responsivity versus power.

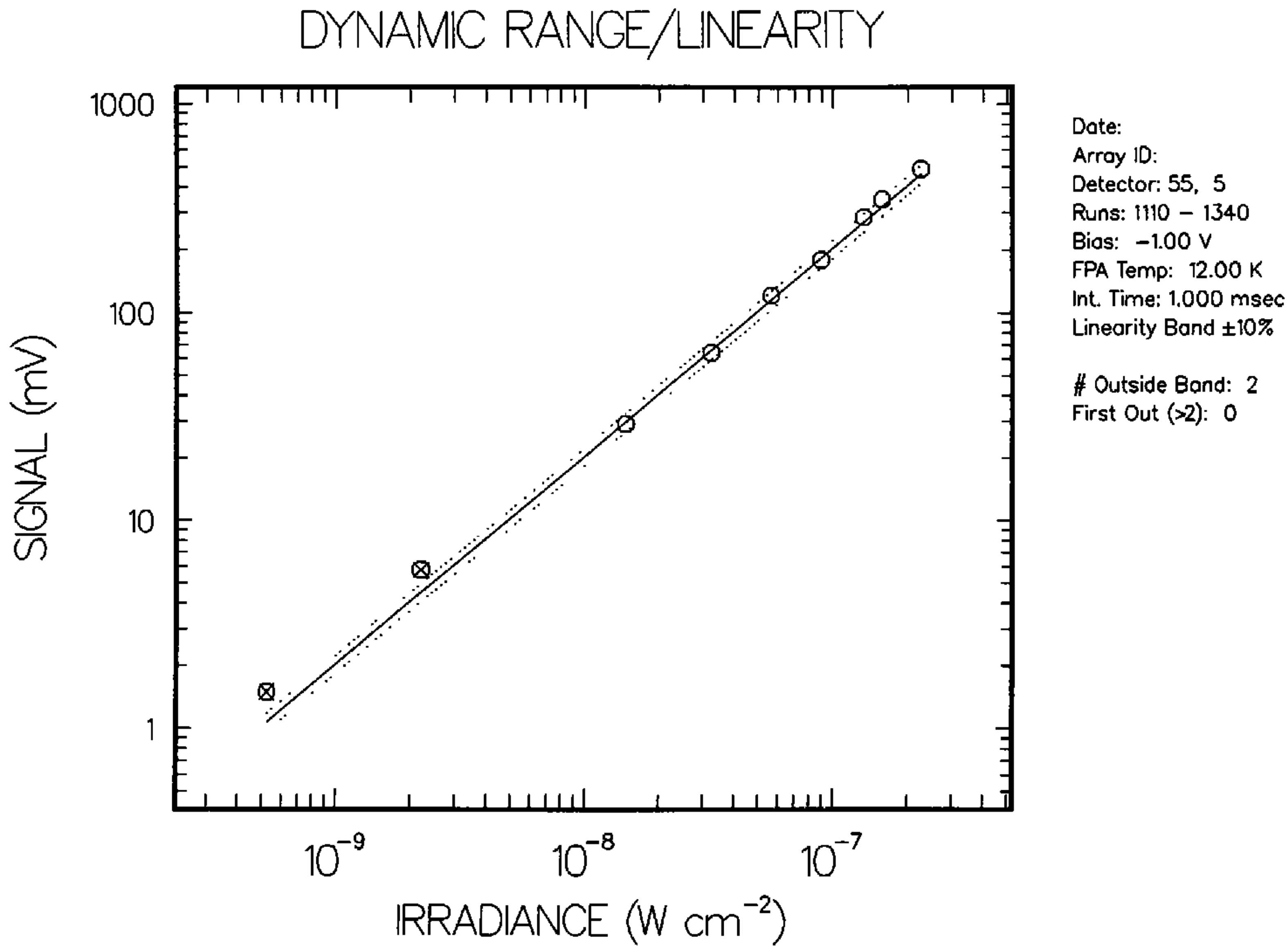

Figure 22. Sample linearity plot.

DYNAMIC RANGE TABLE

Run numbers: 4320–4440
Focal plane ID:
Array dimensions: 64 x 20

Run date:
Run time: 19:10:52
Date reduced:

Temperature: 12.01 degrees Kelvin
Bias: –1.998 Volts
Gain: 1.0
Integration time:

	COLUMN																			
ROW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	268	293	247	265	303	258	256	445	249	352	299	290	550	70	531	247	16	279	275	287
2	267	277	288	235	265	454	292	–101	256	301	242	282	528	2	507	257	230	290	17	269
3	58	256	216	270	263	316	9	12	222	298	239	430	554	348	532	470	257	282	188	307
4	244	291	288	227	288	229	419	459	*****	267	273	286	470	279	570	282	270	276	240	270
5	286	262	296	281	234	249	256	382	417	66	295	401	532	227	496	–119	246	278	394	270
6	289	269	267	245	283	370	304	369	243	219	284	321	466	–10	475	378	22	358	282	284
7	139	264	275	260	266	–18	294	380	238	223	274	305	278	352	503	–15	514	296	405	257
8	279	248	316	292	237	523	239	348	267	282	234	282	532	270	507	455	215	277	302	319
9	60	277	255	311	229	271	276	290	244	258	274	311	456	276	353	232	297	297	274	291
10	287	231	269	287	253	313	7	238	265	229	159	302	495	265	444	267	309	124	230	295
11	293	276	265	269	238	255	469	233	272	306	212	331	454	278	639	270	310	287	256	311
12	276	241	262	247	292	269	260	470	192	197	316	334	471	284	518	272	278	275	328	344
13	326	268	269	272	236	248	255	397	261	271	277	352	576	249	501	383	295	316	282	91
14	286	276	263	284	454	239	243	411	278	272	456	–14	503	407	446	431	288	284	382	568
15	510	261	137	444	525	406	254	375	623	490	8749	521	520	395	516	419	274	275	399	463
16	511	238	456	523	17	371	579	445	435	448	470	381	508	486	426	514	259	451	398	537
17	506	449	488	463	452	526	550	395	487	397	–21	564	406	414	508	368	443	404	353	408
18	548	538	534	480	487	405	0	54	444	485	215	413	503	442	485	429	441	505	365	443
19	438	406	503	543	475	407	457	450	498	596	–2	326	453	544	103	419	464	481	418	510
20	407	493	469	471	401	418	419	299	437	437	3498	497	554	390	501	372	476	410	366	508
21	483	157	488	545	588	371	485	297	392	399	386	380	514	488	490	488	416	424	344	434
22	716	495	23	428	563	379	408	47	365	363	6440	517	367	356	441	389	439	416	398	403
23	0	446	508	224	413	328	436	50	415	463	14423	247	452	341	491	462	443	431	371	–4
24	508	437	553	453	–8	448	488	42	461	451	526	684	521	73	372	395	468	428	451	–21
25	381	548	413	512	513	356	361	43	322	422	443	346	501	441	377	608	527	402	393	536
26	439	531	441	502	386	328	433	54	421	430	465	327	570	503	460	426	454	472	383	455
27	440	491	535	450	419	426	388	314	575	529	–3	491	445	99	440	394	517	432	338	481
28	423	414	507	507	438	411	23	48	2	358	146	444	453	398	458	450	482	505	343	423
29	479	481	223	264	431	376	395	42	270	524	468	434	442	398	541	414	124	–45	406	445
30	390	478	280	398	414	369	424	416	410	423	441	399	420	413	474	436	480	402	406	556
31	463	371	450	467	460	370	469	37	529	363	7678	417	502	429	310	368	671	521	385	442
32	446	437	442	411	422	406	394	51	427	465	275	556	435	15	449	485	–11	515	353	0
33	418	495	447	452	525	338	428	43	435	528	7070	398	305	–33	375	357	599	454	309	425
34	427	–22	428	466	423	339	31	48	633	477	450	477	527	700	490	391	541	437	79	478
35	572	562	–15	458	397	425	36	44	457	483	8256	416	475	379	518	33	493	495	366	402
36	443	550	344	436	600	409	426	43	5	508	455	390	427	357	432	389	559	485	310	482
37	518	577	358	405	430	438	526	54	360	412	5062	372	417	427	383	459	385	445	470	372
38	511	453	500	469	535	314	431	36	453	448	7259	525	492	399	453	465	533	369	343	385
39	511	332	381	198	472	63	516	45	473	414	449	440	455	365	562	457	461	379	352	407
40	477	528	426	559	508	434	416	402	395	429	8294	421	485	452	412	388	485	377	476	468
41	463	462	357	450	452	453	575	42	466	–39	7798	364	486	440	498	353	447	475	402	577
42	502	564	371	435	417	443	437	41	477	505	7293	524	630	391	476	434	454	428	377	428
43	497	423	192	517	418	372	466	46	403	451	446	425	521	439	471	420	458	470	359	408
44	30	590*	391	505	498	403	446	42	454	524	463	442	527	411	489	219	463	511	331	424
45	455	227	488*	555*	313	431	6	13	316	435	459	443	527	342	468	366	496	482	337	520
46	503	362	472	500	504	353	402	42	456	469	538	479	458	337	515	–17	369	375	433	383
47	413	162	408	571*	401	408	474	30	336	50	6754	492	497	376	465	572	431	411	348	402
48	422	242	208	431	446	407	470	32	306	231	7191	442	409	379	399	93	503	356	450	455
49	202	185	189	458	497	440	420	34	319	450	424	429	505	450	444	526	429	355	349	28
50	191	200	198	320	506*	43	578*	39	365	521	22	448	482	467	478	482	457	449	369	404
51	412	189	218	489	341	418	310	30	341	505	468	32	422	–3	441	404	338	356	424	0
52	191	192	189	175	297	366	334	32	296	469	429*	439	470	326	406	450	447	454	–15	665
53	168	194	210	504*	304	353	327	37	310	372	476	432	445	413	418	524	344	331	573	372
54	190	203	203	431	451	340	424	33	367	472	509	417	498	442	448	478	503	401	26	–2
55	173	187	182	504*	286	229	194	19	314	450	305	441	465	289	462	437	427	335	382	709
56	167	174	175	38	334	373	295	34	175	352	319	453	491	447	533	311	513	299	363	431
57	162	155	166	236	269	413	285	26	323	470	345	373	463	313	408	458	167	180	353	325
58	16	30	275	442*	17	228	156	31	262	7	293	366	485	385	188	434	314	363	291	458
59	18	166	291	157	1	488*	277	24	286	269	302	384	435	372	418	293	307	333	412	429
60	169	157	260	456*	258	183	265	28	131	166	262	197	475	351	451	383	338	218	28	9
61	149	26	146	358	19	432*	155	29	157	274	268	273	432	135	433	498	332	302	409	405
62	142	162	278	162	124	427	277	25	292	283	291	443	379	353	446	301	168	167	317	383
63	150	150	137	137	138	–22	249	30	146	269	256	442	487*	143	527	2	182	165	307	282
64	–33	–25	–25	–26	–47	–22	–39	–28	–33	–24	–297	–24	6	–29	9	–27	–41	–37	–18	–27

Figure 23. Sample dynamic range table.

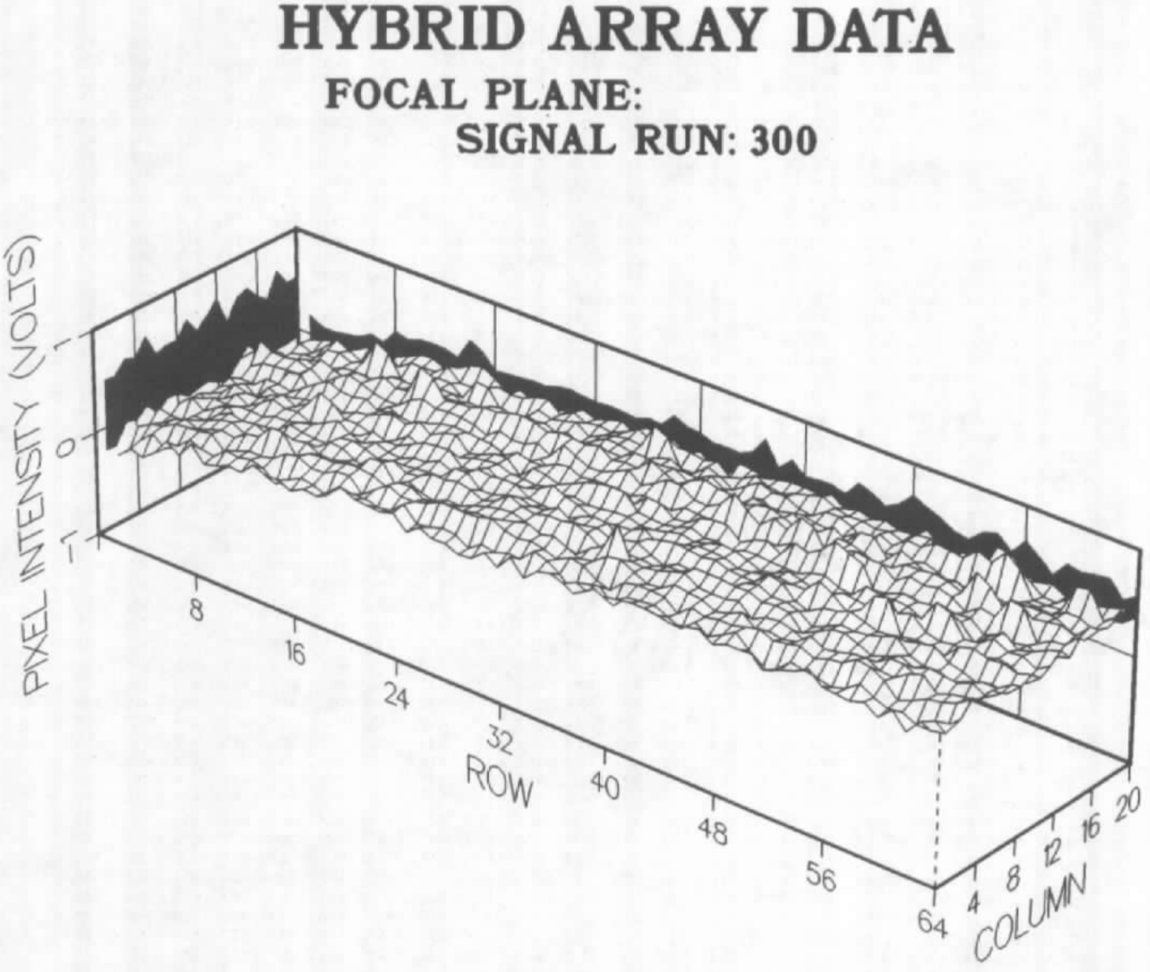

Figure 24. Sample three-dimensional plot.

ADJACENT PIXEL UNIFORMITY TABLE

Run number: 300 (TARE: 310)
Focal plane ID:
Array dimensions: 64 x 20

Run date:
Run time: 14:01:49
Date reduced:

Temperature: 12.01 degrees Kelvin
Bias: -0.998 Volts
Gain: 1.0
Integration time:

ROW	COLUMN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1.01	1.11	0.94	1.02	1.02	1.03	0.90	1.11	1.04	0.94	1.05	0.80	0.74	0.95	1.03	1.64	0.61	0.73	0.40	2.25
2	0.89	1.02	0.93	1.00	0.99	1.04	1.00	0.94	1.02	1.02	0.97	0.73	0.97	0.99	0.96	1.03	0.35	0.65	2.49	0.64
3	0.89	1.13	1.03	0.97	0.99	0.98	0.97	1.01	1.01	1.04	1.00	0.84	0.52	1.14	0.99	0.61	0.59	1.09	1.04	0.63
4	1.04	0.99	0.99	0.98	1.08	1.00	0.99	1.00	1.08	0.93	1.05	0.96	0.61	1.00	0.94	0.56	1.69	0.90	1.00	0.68
5	1.03	0.98	1.02	1.00	1.01	0.85	1.08	1.26	0.91	0.97	1.05	0.99	1.09	0.90	1.02	1.78	0.76	1.36	0.98	0.93
6	0.91	1.04	1.01	0.98	1.09	1.29	0.94	0.99	0.96	1.07	0.96	1.08	0.87	1.08	1.08	0.69	1.33	0.73	0.74	1.10
7	1.07	1.02	1.03	0.95	1.02	0.98	1.04	0.96	1.04	1.02	1.03	0.99	0.96	0.90	1.07	0.62	0.79	1.09	0.96	0.92
8	0.90	1.04	0.98	0.92	1.05	1.01	0.93	1.10	1.06	0.95	1.08	1.03	1.05	1.33	1.04	0.99	0.73	1.03	1.00	0.94
9	1.13	1.00	0.97	1.03	1.07	0.88	1.02	0.90	1.12	1.00	0.91	0.93	1.01	1.21	0.79	0.99	0.99	0.67	1.11	0.51
10	0.90	1.04	0.99	1.00	1.03	0.96	0.97	1.06	0.93	1.02	1.02	1.08	0.99	1.42	0.94	1.10	1.06	0.46	2.02	0.89
11	0.95	1.02	1.04	1.47	1.02	0.95	1.05	0.97	1.10	0.85	1.04	1.06	0.94	0.93	1.09	0.66	0.99	0.86	1.96	1.07
12	1.06	1.07	0.89	0.53	1.13	0.91	1.01	1.07	0.98	1.03	1.01	0.92	1.03	1.10	1.04	0.87	0.93	1.08	0.49	0.99
13	0.85	1.06	1.04	0.95	0.97	0.99	0.94	1.08	0.96	0.98	0.99	0.54	0.95	1.00	0.94	1.09	0.96	1.07	2.11	0.47
14	0.96	1.08	0.96	1.03	1.00	1.06	0.96	0.94	1.07	1.03	0.94	0.76	1.07	1.04	1.03	1.06	0.97	0.99	1.05	2.14
15	0.97	1.01	0.99	0.99	0.97	0.99	1.00	0.90	1.09	0.92	1.13	1.00	0.92	1.00	0.92	0.95	1.10	0.88	0.66	1.36
16	1.03	0.99	0.99	0.97	1.05	1.06	0.97	1.13	1.00	1.02	0.95	1.01	0.93	1.09	0.98	0.98	1.01	0.76	0.89	1.16
17	0.94	1.11	0.94	1.00	1.09	0.95	0.90	0.91	1.04	0.98	1.06	0.98	1.03	0.99	1.00	1.02	0.92	1.08	1.04	0.59
18	1.02	0.96	0.98	1.05	0.95	1.02	0.99	0.97	1.02	0.96	1.01	0.99	0.95	0.97	1.08	1.00	1.08	0.88	1.13	0.90
19	1.05	1.12	0.93	1.02	0.89	1.00	1.02	1.07	1.03	0.91	1.07	1.03	1.09	0.91	1.02	0.92	1.10	0.92	0.94	1.06
20	0.98	0.93	1.01	0.95	1.10	0.94	0.96	0.96	1.09	0.95	1.00	1.06	0.91	0.73	1.04	0.98	0.93	0.82	1.12	0.93
21	0.90	1.13	1.03	1.00	0.99	1.08	0.91	1.06	1.02	1.00	1.05	0.97	1.01	0.94	1.05	1.05	0.97	1.06	1.10	0.90
22	0.99	1.28	0.93	1.11	0.96	1.03	1.06	0.87	1.04	0.92	1.03	0.95	1.01	0.91	1.08	1.06	1.02	0.59	0.98	1.00
23	1.03	1.06	0.93	1.00	0.97	1.01	0.87	1.00	1.08	1.00	1.04	1.06	0.91	1.06	1.01	0.90	0.96	0.81	1.02	1.11
24	0.92	1.04	0.91	1.00	1.09	1.03	0.74	0.98	1.06	1.04	1.02	1.04	0.90	0.98	0.98	1.11	0.95	1.28	0.80	1.71
25	1.07	1.14	0.90	1.03	0.92	0.98	0.96	1.05	0.95	0.90	1.04	0.95	1.05	1.07	0.97	1.04	0.96	1.04	0.98	0.59
26	0.94	0.96	0.99	0.95	0.99	1.11	0.90	1.02	0.99	0.94	1.04	0.95	1.04	0.92	1.11	0.91	0.98	0.74	1.04	0.63
27	0.96	1.06	0.99	1.06	1.07	0.97	1.00	1.01	1.08	0.94	1.06	1.04	1.21	0.95	1.02	0.91	1.03	1.04	0.95	0.61
28	1.01	0.98	0.97	1.01	0.96	1.00	0.99	0.92	1.06	0.99	1.04	0.87	1.23	1.06	1.04	1.09	0.93	0.99	1.01	1.03
29	1.03	1.00	1.04	1.01	1.03	1.06	0.99	0.95	1.08	0.91	1.03	1.02	1.04	0.92	1.03	0.95	1.09	1.01	0.99	0.99
30	0.86	1.38	0.90	1.02	1.02	0.88	0.99	0.98	1.01	1.01	0.97	1.07	0.96	1.04	0.97	1.07	0.87	1.05	1.05	0.96
31	1.07	0.97	1.02	1.02	1.01	1.12	0.99	0.99	1.02	0.94	1.09	0.95	0.97	1.08	0.89	1.05	0.94	0.87	1.08	0.95
32	1.06	0.99	1.02	0.92	0.97	1.01	0.98	1.03	1.07	0.93	1.02	1.03	0.93	0.98	1.01	1.01	1.12	0.92	1.05	1.01
33	0.92	1.07	0.99	1.13	0.86	0.96	1.01	0.98	0.95	1.02	1.06	0.92	1.18	0.92	1.05	1.03	0.98	0.98	1.11	0.89
34	0.95	1.03	1.00	0.89	1.17	1.06	0.94	1.03	1.00	1.03	1.04	0.96	0.91	1.02	0.94	1.04	1.06	0.81	1.02	1.03
35	1.22	0.91	1.03	0.75	0.98	0.90	1.02	1.04	0.97	0.86	1.01	1.08	0.97	1.12	0.99	0.98	1.01	0.97	0.94	1.15
36	0.83	1.03	1.03	0.94	1.10	0.95	1.01	1.01	1.12	0.96	1.03	0.92	1.04	0.89	1.09	1.01	0.98	1.15	0.86	0.95
37	1.01	1.30	1.02	1.06	0.18	0.99	0.94	0.97	0.98	0.74	1.03	0.89	1.10	0.95	1.00	0.91	0.71	1.00	1.11	1.02
38	0.96	1.16	0.91	1.04	1.02	1.00	0.98	1.05	0.96	0.75	1.00	1.01	0.95	1.05	1.06	1.06	0.89	0.93	1.04	0.96
39	1.23	0.88	1.06	0.90	1.05	1.00	0.93	1.13	1.04	0.90	1.05	1.06	1.11	0.90	0.90	0.99	1.08	0.98	0.91	1.09
40	1.04	1.07	0.98	0.95	1.04	0.96	0.99	0.97	1.10	0.89	1.05	0.98	0.97	0.58	0.97	1.10	0.91	1.02	1.00	1.01
41	0.95	1.08	0.98	0.89	1.13	0.96	1.01	0.89	1.06	1.06	0.98	0.94	1.00	0.95	1.02	1.05	0.86	1.17	0.74	0.84
42	0.91	1.01	1.05	1.09	0.93	1.07	0.89	1.14	0.98	1.03	1.00	1.00	0.99	1.05	1.02	1.08	0.92	1.02	1.04	1.08
43	1.00	1.01	0.97	0.94	0.97	1.07	0.95	0.97	0.94	1.02	0.90	1.11	0.92	1.09	0.83	1.11	0.70	1.00	0.99	0.98
44	1.13	1.02	0.99	0.94	0.99	1.09	0.98	0.95	1.09	1.07	0.93	0.99	1.12	0.82	1.12	1.01	0.95	1.11	0.96	1.00
45	0.91	1.05	1.01	0.96	0.96	1.08	0.93	1.04	0.99	0.94	1.11	0.85	1.08	0.56	0.87	1.05	1.05	0.87	0.97	0.97
46	1.04	0.91	1.08	0.94	1.04	1.05	1.01	0.96	1.11	1.06	0.92	0.61	0.98	1.05	1.00	1.01	0.96	1.00	0.97	1.14
47	0.94	1.03	1.01	1.06	0.94	1.11	0.95	0.94	1.02	0.92	1.00	0.89	1.04	1.07	1.00	0.92	0.99	0.92	1.04	1.00
48	0.99	1.08	0.88	0.97	1.05	1.01	0.88	1.06	1.05	0.92	1.18	0.13	0.93	0.97	1.02	0.66	0.98	1.09	0.99	0.87
49	1.13	0.91	1.25	1.05	0.99	0.98	1.03	0.98	0.98	1.00	1.03	0.81	1.07	1.02	1.01	0.87	1.00	0.99	1.07	1.05
50	0.94	1.00	0.97	0.93	1.05	0.87	0.95	1.04	0.70	0.67	2.07	0.48	0.97	1.01	1.08	1.03	1.08	1.00	1.06	0.91
51	0.97	1.08	0.98	1.03	1.00	0.77	1.02	1.07	1.05	0.88	0.92	1.01	1.11	0.99	0.88	1.05	0.93	0.94	0.93	1.10
52	1.08	0.95	1.03	1.04	1.03	0.96	0.92	1.04	1.06	1.04	0.97	1.00	0.94	0.99	0.96	0.93	1.10	1.08	0.92	1.07
53	0.91	1.16	0.95	0.95	1.03	0.91	1.01	1.00	0.93	0.99	1.04	0.95	1.03	1.09	0.99	1.01	1.01	1.01	0.87	1.09
54	0.96	0.88	1.02	1.01	1.06	1.07	0.97	0.97	0.33	1.12	1.00	1.07	1.00	1.02	0.96	1.10	0.86	1.05	0.97	1.03
55	1.18	0.90	1.09	0.98	1.08	0.91	1.07	0.98	1.05	0.98	0.98	1.04	0.87	1.00	1.04	1.02	0.94	1.12	1.08	0.89
56	0.93	1.01	1.06	0.96	1.04	0.94	0.88	1.02	1.04	1.00	0.86	1.06	0.97	1.06	0.61	0.96	1.04	0.92	0.88	1.29
57	0.97	1.11	0.88	0.96	1.05	1.00	0.75	1.02	0.97	0.96	0.73	1.04	0.84	1.18	0.45	1.11	0.92	0.66	1.01	1.07
58	0.93	1.03	1.10	0.83	1.07	0.94	1.00	1.10	1.03	0.97	1.00	1.02	1.05	0.95	0.64	1.03	0.93	1.09	0.94	1.04
59	1.12	0.96	0.92	1.12	1.03	0.92	1.06	0.87	1.11	1.00	1.02	0.93	1.04	0.91	0.94	1.10	0.94	1.81	0.55	0.97
60	0.91	1.07	0.96	1.18	0.94	1.01	0.93	1.12	0.89	1.04	1.02	1.05	1.04	0.53	0.96	1.06	0.92	1.14	0.86	1.44
61	1.02	1.10	0.92	0.81	1.08	0.96	1.01	0.92	1.16	0.88	1.01	1.02	0.93	0.73	1.01	1.00	1.03	3.05	1.02	0.69
62	0.88	1.03	1.11	0.64	1.04	1.14	0.90	1.02	1.65	1.03	1.05	0.93	1.02	0.67	1.01	1.03	1.08	0.23	0.98	1.02
63	1.08	0.92	0.99	2.11	0.87	1.08	0.98	0.95	2.40	0.93	1.11	0.94	1.06	2.26	3.04	0.84	0.99	1.02	0.97	1.07
64	0.00	0.48	0.30	0.47	0.36	2.22	0.45	1.54	0.42	0.45	0.36	0.31	0.33	1.08	0.93	0.38	0.62	0.42	0.40	0.29

Figure 25. Sample adjacent pixel uniformity table.

Subarray Uniformity (DC Response Difference)
Run 330 Tare Run 320

Device ID:
AEDC FPCC Dewar # 5
Test Date
Test Time 13:49:34
Date Reduced
(Data Units - mv)

Blackbody Irradiance 1.459E-08 w/cm2
Integration Time
Bias Voltage -0.997 V
FPA Temperature 10.0 K

All Pixels Included

Column Number

	1	2	3	4	5	6	7	8	9	10
Mean	28.2	30.2	28.2	27.6	27.7	27.4	26.6	27.7	30.3	27.0
Median	28.0	29.9	27.9	27.6	27.5	27.9	26.4	27.9	30.7	27.3
Standard Deviation	4.5	3.8	3.9	3.9	3.8	3.1	3.1	3.2	3.5	3.7
Maximum	35.7	39.2	36.4	35.5	35.9	33.6	33.3	35.5	38.2	34.8
Minimum	0.2	14.6	8.3	8.8	9.5	17.6	12.2	15.5	14.2	11.2
Max/Min	209.8	2.7	4.4	4.0	3.8	1.9	2.7	2.3	2.7	3.1
Outliers	0	0	0	0	0	0	0	0	0	0

Column Number

	11	12	13	14	15	16	17	18	19	20	Array
Mean	26.8	26.8	27.1	25.4	25.0	25.2	24.2	22.3	23.3	19.7	26.3
Median	27.4	27.3	27.4	26.1	25.4	26.1	24.8	23.1	24.1	21.0	26.8
Standard Deviation	3.8	5.0	4.8	4.6	4.1	4.2	4.1	4.6	4.5	5.7	4.8
Maximum	32.4	34.8	41.1	38.3	33.7	32.3	30.6	29.8	30.1	28.1	41.1
Minimum	7.9	6.0	8.5	7.5	8.5	9.0	9.6	7.5	8.5	5.7	0.2
Max/Min	4.1	5.8	4.8	5.1	4.0	3.6	3.2	4.0	3.5	4.9	241.6
Outliers	0	0	0	0	0	0	0	0	0	0	0

Figure 26. Sample subarray uniformity printout.

FLOODED SIGNAL AND NOISE

```
Run number:  260 (Tare:  230)        Run date:                   Temperature: 100.27 degrees Kelvin
Focal plane ID:                      Run time: 13:28:45          Bias: -1.309 Volts
Array dimensions:  64 x  10          Date reduced:               Gain:
                                                                 Integration time:  0.305 msec
```

```
Signal power flux =  7.639E-08 W/cm2
Signal average = -5.688E-02 Volts
No. pixels in avg. =  635
Signal STD deviation =  3.755E-03 Volts
```

```
          COLUMN
ROW |   2   4   6   8  10
----+--------------------
   1|-3-2 2 4 0-1 3 1 0 2
   2|-4-2 0-2 1 1 1 3 1-1
   3| 0-3 1-1 2-1-1 3-1 2
   4|-1 0-2 1 0 2 2 1** 0
   5|-1-3-3-1-1 1-2 2-1 0
   6| 0 1-1 0-2 2 4 0-1-1
   7|-4-2-2-1-3 0 0 3 2 0
   8| 1 1-3-1 1 1 1 3 1-1
   9|**-3-1-1-2 0 0 1 1-1
  10| 1-1-1 2 4-1-3 3-1 0
  11|-1-2-2-3 2 1-3 3-2-1
  12| 1-5-2-2 2 0 2 2-1-1
  13| 1-1-2 0-3 3 3 3 0 0
  14|-2 1 2-5 2 2 1 2 0-2
  15|-3 2 0-1 1 1 0 4-1 3
  16|-3 1 1 4-1 1 3 2-1 1
  17| 1 4 3 0-2-1 2 0 2-1
  18| 1 1-1 1 0-1-1 1 1 1
  19|-2 0-1-1 0 0 1-1 3-2
  20|-1 1-1 1 3-1 3 2 1-1
  21| 0 0-4-1-2-1 1-2 3-1
  22|-1 1 1-2-3 2 0 0 2-4
  23|-3 3-1 2-2 1 3 3 3 1
  24| 1 2-1 2-4-1-2 1 2-2
  25| 1-1 0 2-5-2 3 3-1-1
  26| 1 4 1 0 3 0 2-1 2 0
  27|-1 1 3 0 0 2 0 1-1 0
  28|-1-2-1 1 2 1 2 1 4 0
  29|-3-1 0 1 1-1 0** 3 2
  30|-1 1 2 0 1 1 1 1-1 0
  31| 3 0 1 2 0-2 2 2 1 2
  32|-4 2 1 1-1 1 4-1-1-2
  33| 0 0 0-2 3 1 1 4-1 1
  34|-1 0 0-1 0 1 2 1 1-1
  35|-2 0-1 4-2 0 2 0 2-1
  36| 0-2-2-1 0 3 3 1 3 1
  37|-3 1-2 2-1 0 0-2 1-3
  38| 0 0 1 1-3 0 0 3-1 2
  39|-2 1 0 0 1 0 2 1 0 1
  40|-3 0-3 2 0-1 1 1 1 1
  41| 1 2 0-1 1 0 3 4 1 3
  42|-3-2 1-1 0 0 0 0 1-1
  43| 2-1 3 0-1 1 3**-2 0
  44|-3 0-4-2-1 1 1 0 1-2
  45|-1-1 1-4 2 1 4-1 1 1
  46|-1 0 0**-1 1-1 3-2 0
  47| 0-2 3 1 1-4 1 1-1 1
  48| 0 1 1-4-1-1 0 0 1 4
  49| 1 0-5-1-6 2-1-3-1 1
  50|-1-2 0-1 1-1 2 0-4-3
  51|-2 1 0 0**-2 1 4 3-1
  52|-2 0 0-3-1-4 0 0 2-2
  53|-3-2 3 0-1 1 3 1-1 0
  54|-3 2-6 1-2 0 0 4 0-1
  55| 0 0 0-3-1-3 1-1-1-2
  56| 0-1 2 2-1-2-4 0 1-1
  57|-4 0 1-2 0-1 2-2 0-1
  58| 1 0-2-5-2-1 0 3-3-2
  59|-4 0 0-2-5-1-4 1 2-1
  60|-5 2-1-1-1-1 1 0 2-3
  61|-8 0-2 4 0-2 0 1 2 0
  62|-6 0 1-1 2 0-5-1 3-2
  63|-3 2-1 1-2 3 2 0 1-2
  64| 0-2 0 0-1 1 0-2-2-1
```

1/2 SD Units	Volts	# Pix
-9	-0.074	0
-8	-0.072	1
-7	-0.070	0
-6	-0.068	3
-5	-0.066	8
-4	-0.064	16
-3	-0.063	33
-2	-0.061	67
-1	-0.059	123
0	-0.057	127
1	-0.055	129
2	-0.053	66
3	-0.051	44
4	-0.049	17
5	-0.047	0
6	-0.046	0
7	-0.044	0
8	-0.042	0
9	-0.040	0
**	BAD	6

```
Background Photon Flux =  1.724E+12 photons/sec-cm2
Noise average =  8.716E-04 Volts
No. pixels in avg.  635
Noise STD deviation =  7.328E-05 Volts
```

```
          COLUMN
ROW |   2   4   6   8  10
----+--------------------
   1|-1-1-2-2 1-2-1 1 2-4
   2|-1 0 0-1 0 1-1-2 1-2
   3| 0 2-2 3-1 0-1-1-1-2
   4|-1-1-1-1 1 3-1-1** 2
   5|-1-2-1 1 0-1-2 1-1-1
   6|-1 0-2-2 4 0 1 0 2 1
   7|-1 1-2 0 0 0 0 3-1-1
   8| 0-2-1 2 3 1-3 3-1-1
   9|** 0-3-2 0-1 1 0-2 1
  10| 0-4-1-2** 1-2 4 1-2
  11| 1 3-1 1** 2-1 2 0 1
  12|-3 2-3 0 1-1-2 3 0-1
  13| 2-2-2 2 3 1-1 5 3-2
  14| 0 0-2 0 0 1 0 2-1 3
  15| 1 0-3-2 1 1 0 4-3-1
  16|-1 2-1-4 2-2-1 2 0 1
  17|-2-2 0 0 1-2-2 0-3 0
  18| 1 0-1-1 1 1 2 0 3-1
  19|-1 0-2 2-1-1 0 3 0 2
  20|-1-1-1-1 0 1-1 1-1-2
  21| 2 3 0-2 3 1-2 1-2 0
  22| 0-1 2 0 1 1-1 5 2 1
  23|-2-1-3-3 3 4-2-1 0-1
  24| 0 0 0 1 2 1-1 2 2-1
  25|-2 0 1-2-1 2 1 1 2 1
  26| 4 1-3 2 2 1 0 4 1 0
  27| 2 1 0 2 1-2 1 0 1-1
  28| 1 1 0 2 0-1 1 2 1 0
  29| 1 1 0-2-1 0-1-8-2 0
  30| 0 0 1-1 0-1 0 0 1 1
  31| 0 4 0-2 2 0-2 0 1 0
  32|-1 0-3-2 2 4 1 2 1 2
  33|-1-2-1 1 2-3 2 1 2-1
  34|-3-2-1 2 1-1-1 2 0 1
  35| 4 0-3 0-2-2 3 0 0 1
  36| 2 1 1 0 0 0-1-1 2-3
  37| 1-2-3-2 2 0 1 4-1-1
  38| 1-1 0-1 7 2 2 3 0 0
  39| 0-1 0 1 1 0-1 2-1-3
  40|-1 0-1-2-2-2 0 2 4-3
  41|-2 0-1 3-1-2-3 2 3 0
  42|-2 3 0-3 3-2-3 4 0 0
  43| 0-3-2 0 1 1 0**-1-1
  44| 0-2 3 1-1-2-2 0 4-2
  45| 2 2 0 1-1 1-1 2 2 0
  46| 1 1 1** 0 0-2 0 1 0
  47| 2 0-1-1 1 2-1 0 1-1
  48| 1 0 0 0 1 2-2 1 1-2
  49| 1-3 0 1 4 2 2 3 1-1
  50| 0-2 3 1-1 0 0 3 3-2
  51| 1 0 1 3-4 1-1 1 0 1
  52| 2-1-1 0 1-3-3 5 2 3
  53| 0-1 0 0-4-3-2 1 4-1
  54| 2 3-2 1 3 1-1 3 2 1
  55|-2-1 1-1 2 1-1 3 0 2
  56|-1 0-2 1-1-1 0 2 0 0
  57|-3-3-2 0 3 2-1 1 1 0
  58| 1 0 0 0 0 0-2 2 1-1
  59|-1 1-3 0 0 4 0 1 2-1
  60| 2-2-1 1 2-1 1 1 3 3
  61| 3-3 1-1 1 0 2 3 2 0
  62| 1-1 0-1 1 4-2 4 0-1
  63|-1 4 0-2 1-3-1-3 6-2
  64|-8-7-7-7-3-5-6-5-6-6
```

1/2 SD Units	Volts	# Pix
-9	0.001	0
-8	0.001	2
-7	0.001	3
-6	0.001	3
-5	0.001	2
-4	0.001	5
-3	0.001	33
-2	0.001	77
-1	0.001	121
0	0.001	137
1	0.001	119
2	0.001	71
3	0.001	37
4	0.001	19
5	0.001	3
6	0.001	1
7	0.001	1
8	0.001	0
9	0.001	0
**	BAD	6

Figure 27. Sample standard deviation format printout.

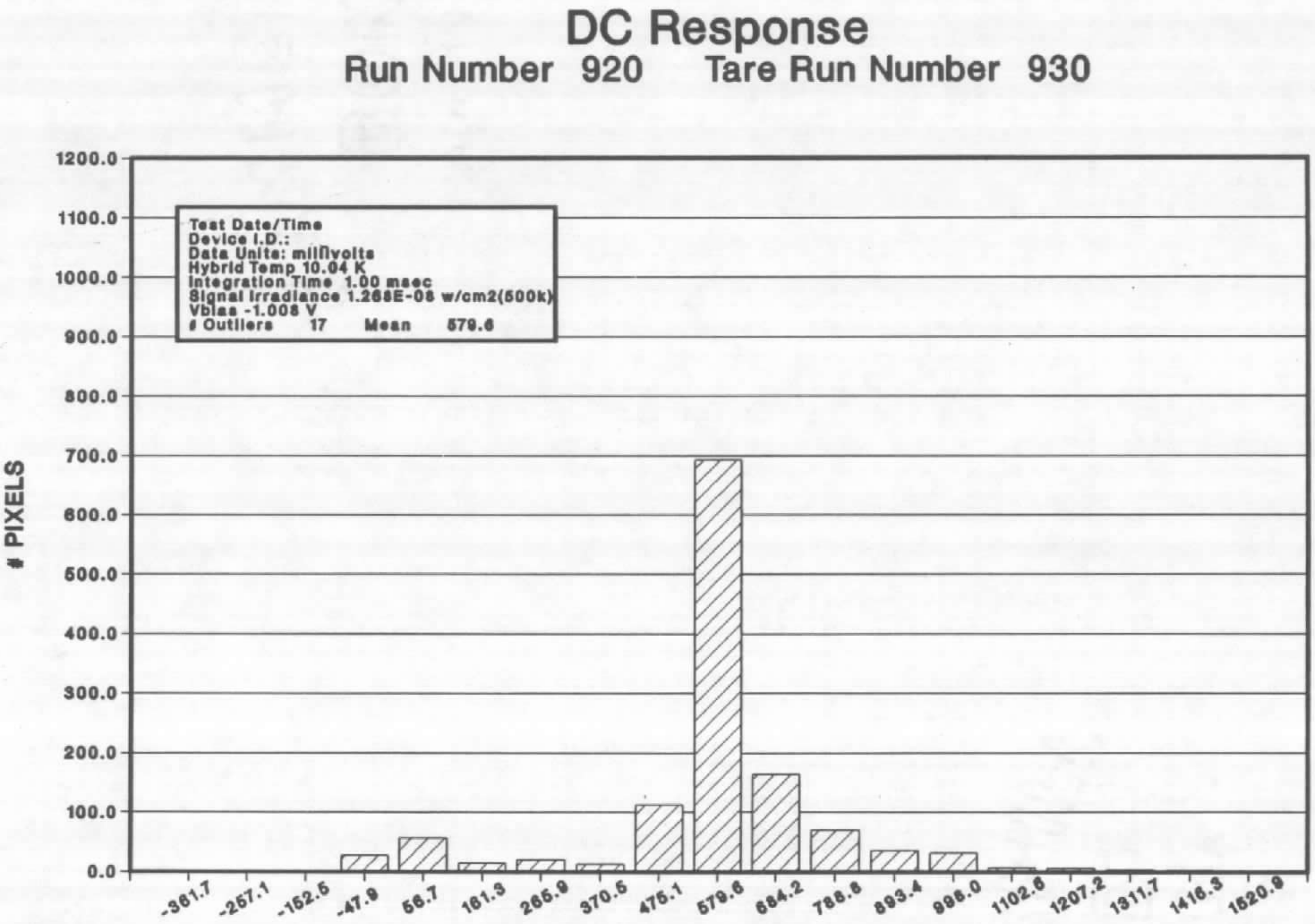

Figure 28. Sample histogram.

CROSSTALK

Run number: 2020 (TARE: 2030)
Focal plane ID:
Array dimensions: 64 x 20

Run date:
Run time: 18:41:42
Date reduced:

Temperature: 12.03 degrees Kelvin
Bias: -1.662 Volts
Gain: 1.0
Integration time:

(Detector values in percentage of maximum value * 10)
Maximum detector value: 1.065 volts

	COLUMN																			
ROW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	-9	-4	-2	0	3	0	-1	0	-2	0	-1	-1	0	0	0	0	-2	-2	0
2	0	-8	-1	0	0	0	-2	-1	1	1	0	-1	0	-2	0	0	-3	-1	-1	0
3	0	-6	0	0	0	0	-1	0	-1	0	0	0	-1	-1	0	-1	0	0	-3	1
4	0	-8	-2	0	0	0	0	0	-2	0	0	-1	0	0	-1	0	0	0	0	-1
5	0	-8	0	0	0	0	0	-1	0	0	0	-1	0	0	-1	0	-2	0	-1	1
6	-7	-8	0	-1	0	0	0	-1	-2	0	0	-1	0	-1	-1	0	0	-1	-1	0
7	0	-7	0	-2	0	0	-1	-1	0	0	0	-2	1	0	0	0	-2	-1	0	-4
8	0	-9	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	-2	0	0
9	-1	-8	0	0	0	0	-3	0	-1	0	-1	0	0	0	0	0	-1	0	-1	1
10	-1	-7	0	0	-1	0	-1	-1	-1	-1	0	0	0	0	0	0	0	0	0	-5
11	0	-6	-2	0	-1	0	-1	-1	1	0	-1	-1	0	-1	-1	-1	0	0	-1	-1
12	0	-6	0	-1	-1	0	-1	-1	0	0	0	0	0	0	0	-2	0	0	-1	0
13	0	-7	-1	0	-1	0	-2	-1	0	0	0	0	0	0	-1	-1	2	0	0	0
14	0	-7	0	-1	1	0	-1	-1	0	0	0	0	-1	0	0	0	0	0	-2	0
15	0	-7	-1	1	0	0	-1	-2	0	0	0	-1	0	-1	0	0	0	-1	-2	0
16	0	-7	-2	-1	0	0	0	0	-2	0	0	-1	0	1	0	1	0	0	-2	-8
17	0	-6	-1	-1	1	-2	-1	0	0	0	0	-1	0	-3	-2	-1	0	1	-2	-1
18	0	-6	0	-1	0	0	-3	-1	-1	-1	0	0	-1	-1	0	0	-2	0	0	0
19	0	-7	0	0	-1	-2	-2	-1	0	0	0	0	-1	-2	-1	-3	-1	0	0	-1
20	1	-6	0	-1	-1	0	-2	-1	0	0	0	-1	0	0	-1	-2	-1	-1	0	0
21	0	-4	0	0	0	-1	-1	0	0	1	1	0	0	0	0	-2	0	0	-1	-2
22	0	-7	0	2	0	0	-2	-1	0	0	0	0	1	0	0	0	-3	0	-1	0
23	-2	-6	0	0	-2	-1	0	0	0	-1	0	0	0	-3	0	-1	-2	-1	-1	-1
24	-1	-3	0	0	2	0	-1	-2	0	0	0	0	-1	0	0	0	0	0	-1	-2
25	-2	-5	0	0	0	-1	0	0	0	-2	-1	0	-3	0	0	-1	0	0	0	0
26	2	-2	2	1	0	1	0	-1	0	-1	-1	-1	0	1	0	-2	-1	-1	0	-2
27	9	4	11	7	4	1	-2	0	0	5	2	0	-2	-1	-3	-2	-2	-1	1	-9
28	108	173	152	28	7	1	0	0	-8	0	2	0	-2	-1	-1	4	0	0	0	-1
29	331	1000	348	28	9	3	0	0	-1	-2	0	0	0	0	-1	-1	0	0	0	-1
30	30	167	68	14	5	2	0	0	0	-1	1	0	-1	0	5	0	0	0	-2	-1
31	9	-19	12	12	3	2	-1	2	0	-1	2	0	-2	-1	-2	0	-1	0	-3	0
32	0	-33	2	2	2	2	2	0	-1	0	0	0	0	0	-2	0	-1	0	0	1
33	-1	-31	-2	-2	0	0	0	0	0	0	0	0	-1	-2	-1	0	-1	0	0	-1
34	-1	-21	-2	0	-2	-1	0	0	-1	-1	-1	0	-2	0	-1	-1	0	0	-1	1
35	-2	-19	-1	-1	0	0	-2	-2	-2	0	0	0	0	0	-1	0	0	0	0	0
36	-2	-18	-1	0	0	0	-1	0	-1	0	0	0	0	-1	0	-1	0	-1	0	0
37	-2	-17	-2	-1	0	0	0	-2	0	0	-1	0	0	1	-1	0	-2	-1	0	0
38	-2	-16	-2	-2	0	0	-3	0	-1	0	-5	0	-1	-1	0	0	2	-1	-2	-1
39	-2	-15	-2	-1	0	0	-2	-1	0	1	-1	0	-1	0	0	0	-1	-1	0	0
40	-2	-12	-3	-1	-1	0	-1	0	0	0	1	-3	0	-1	0	-1	0	0	0	0
41	-2	-15	-1	0	0	0	-2	-1	0	-1	0	0	-1	-2	0	-1	0	0	-1	0
42	-2	-14	-2	-1	0	-1	-1	-1	1	0	0	0	-2	0	0	-1	0	0	-1	0
43	-2	-15	-1	-2	0	0	-2	-1	-1	-1	0	0	0	0	0	0	-1	0	-1	0
44	-1	-14	-1	0	0	0	-1	0	0	0	-2	-1	-1	0	0	-1	0	0	0	0
45	-2	-12	-3	-2	0	-2	-1	0	0	-1	0	-3	-1	-1	-2	-1	-1	-1	0	-1
46	-2	-12	0	0	0	0	-1	-1	0	-2	1	-4	0	-1	0	1	0	-1	-1	-1
47	-1	-11	-2	-1	0	0	-2	0	-2	-1	0	0	-1	-2	0	-1	0	-1	0	0
48	-1	-11	-2	0	-1	-2	0	-1	-2	0	0	0	-1	0	0	0	-1	0	-1	0
49	-1	-13	-1	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	-1	0	-1
50	-1	-11	-1	0	0	0	-1	-4	0	1	-1	0	-1	-1	0	-1	-1	-1	0	-2
51	-3	-11	-2	0	-1	0	-1	-1	-1	0	0	-2	0	-1	-2	0	1	1	0	0
52	-2	-10	1	-3	0	-3	0	0	0	0	0	-1	0	0	0	1	0	0	-1	0
53	-2	-10	-3	-2	0	-1	-4	-2	-1	0	-1	-1	-1	0	0	0	0	-1	-1	0
54	-1	-11	-1	0	-3	0	-3	-3	0	-1	-1	0	-1	-2	-2	0	-1	0	0	-2
55	-1	-12	-2	-2	0	0	-2	-1	0	-1	-1	0	0	0	0	0	-3	0	-2	-1
56	0	-9	-2	0	-1	-1	0	-3	0	0	0	0	1	0	-2	0	0	0	0	0
57	-1	-12	-1	0	0	0	-2	-1	0	0	0	-1	0	-2	-2	0	0	0	0	0
58	-1	-9	0	-1	-1	0	-1	-1	-2	0	0	0	-1	0	0	-1	0	0	-1	-1
59	-1	-7	-1	-1	0	0	-1	-1	-1	-1	0	-1	0	-1	0	0	-2	0	0	0
60	-2	-9	-2	0	0	0	-1	0	0	0	0	-1	-1	0	0	0	-1	-1	1	0
61	7	-9	-1	0	-2	-2	-1	-2	0	0	0	0	0	0	-1	-1	-1	-1	0	-1
62	-1	-8	0	-1	0	0	-1	-2	-2	0	0	0	0	-8	-2	0	0	0	0	-1
63	-2	-11	-1	0	-1	-3	0	-1	0	-3	0	0	-2	-2	-1	-1	-2	-1	-1	-1
64	1	-8	-1	-1	-2	0	-2	0	-1	-1	-1	0	-2	0	-1	-1	-1	0	0	-1

Figure 29. Sample crosstalk printout.