GLAST LAT Flight Software Demonstration

SLAC Campus
Building 84, Central Lab Annex

July 30, 2004
Overview Presentation 10:00 AM (Room B-259)
Demonstrations 10:15 AM

1 Demonstration Overview

1.1 Agenda for the Demonstrations

The demonstration will take place in the Central Laboratory Annex (Building 84), Room B-101.

Demo Agenda Item	Presenter(s)
1. Overview of the Demonstration (in Group C Conference Room, Room B-259)	Eric Hansen
2. SIU Inter-task Communications Demo	Eric Hansen
3. Questions from Attendees	NA

Feel free to jot questions and comments down in the margins of this document or in the space provided on page 10.

1.2 Goals of the Demonstration

The July 2004 FSW Demonstration focuses on inter-task communications between real FSW tasks running on an SIU on the FSW Testbed. In May, the FSW Team demonstrated ITC using simple test-code tasks to receive ITC messages. This month, ITC is used to interconnect real FSW tasks through commands and telemetry -- in this case, it connects the CTDB (1553 communications) and LHK (Housekeeping) systems.

As in the June demonstration, the Spacecraft is represented by the Spacecraft Data Interface Simulator (SDIS), a Spacecraft simulator provided by Spectrum Astro, Inc. The LAT is represented by the FSW Testbed, which currently provides a large collection of flight-like data acquisition hardware, including a flight-like SIU, a complete GASU, PDU, and multiple TEMs.

1.3 Expected Outputs of the Demonstrations; Verification of Requirements

This section cites the expected outputs of each of the systems demonstrated today, and provides a space for the demonstration monitors to verify by signature that the demonstrations ran successfully.

Demo Agenda Item	Relevant FSW Requirements (SRS Version 3)	Expected Output of the Demonstration
SIU Inter-task Communications Demo	5.3.3.1, 5.3.3.4, 5.3.3.5, 5.3.3.6	For a full description of the outputs of the SIU Inter-task Communications Demo, see Section 1.3.1 starting on page 3. For the demonstration procedure and the demo's software and hardware context, see Section 2.1 on page 7, and Section 2.2 on page 8.

Demo Agenda Item	Relevant FSW Requirements (SRS Version 3)	Expected Output of the Demonstration
		Monitor Signature: _____

1.3.1 Output of the SIU Inter-task Communications Demo

The SIU Inter-task Communications demo produces two types of output, VxWorks (windSh) terminal output and AstroRT display output.

1.3.1.1 VxWorks Terminal Output

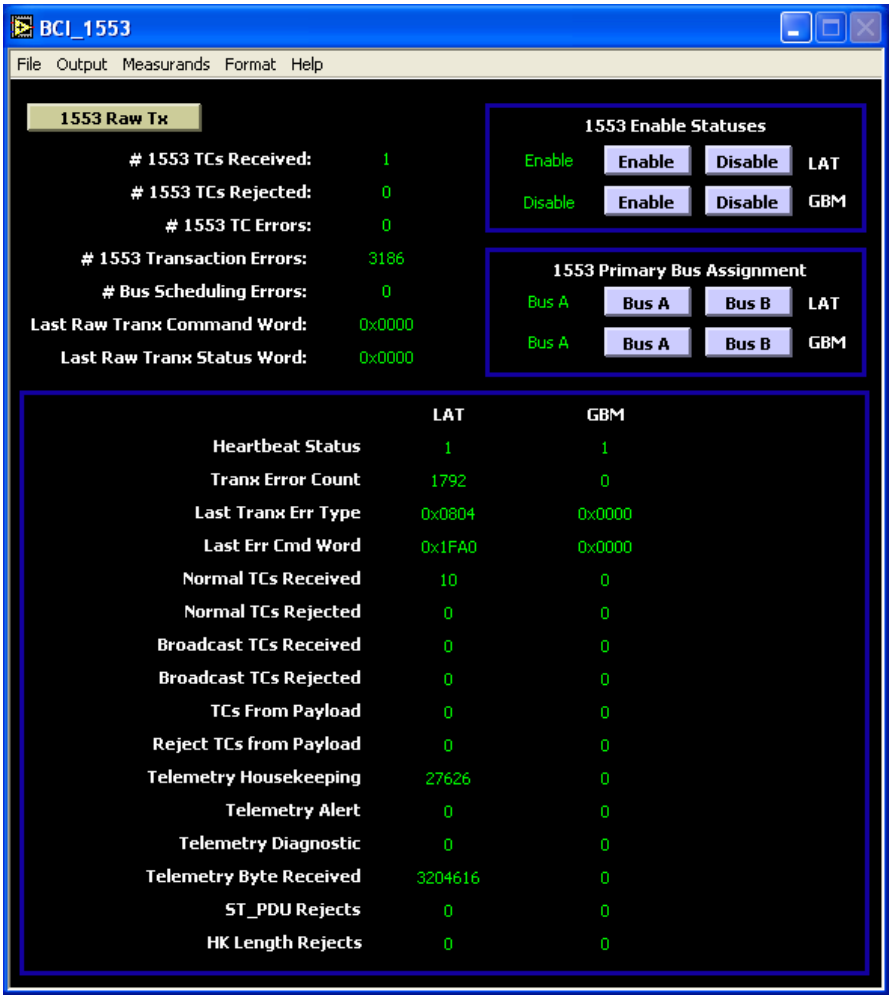
While the SIU boots and as the demonstrator runs VxWorks scripts at the VxWorks terminal to load FSW libraries, log messages are returned to the terminal window. The log messages from VxWorks are routine, and the boot status messages were demonstrated in April 2004; therefore, VxWorks terminal output is not reproduced here.

1.3.1.2 AstroRT Display Output

1.3.1.2.1 AstroRT Output

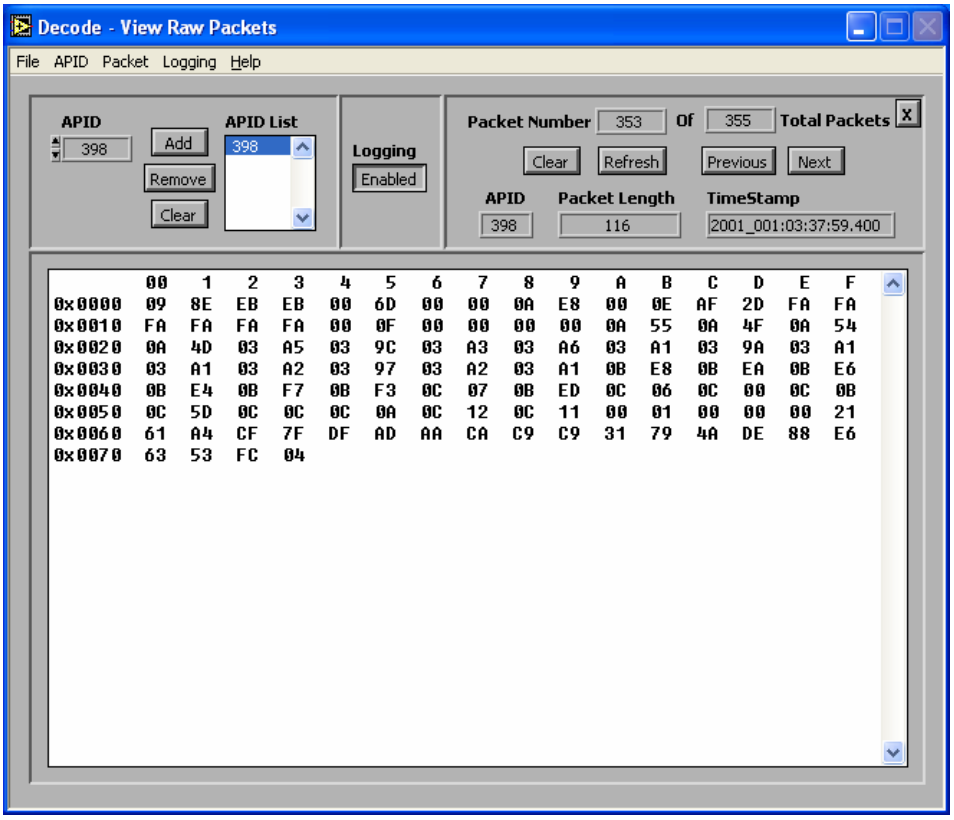
When 1553 communications between the SDIS and the LAT have been established, the demonstrator uses AstroRT to display the status of the 1553 communications link and to display the raw CCSDS packets containing housekeeping data. Examples of these two displays are shown in Figure 1 and Figure 2 below.

Figure 1: 1553 Performance and Status Monitor (AstroRT)



In Figure 1, note that the Telemetry Housekeeping and Telemetry Byte Received counts are reported (and incremented) as Housekeeping packets are delivered at 4 Hz over the 1553 interface.

Figure 2: Raw Housekeeping Telemetry Packet Viewer (AstroRT)



As shown in Figure 2, AstroRT is used to view the raw housekeeping packets (in hexadecimal format).

1.3.1.2.2 AstroRT Output

AstroRT is also used to display the actual Housekeeping data collected from the TEMs and PDU. Sequence and limit check plots (see Figure 3 below), and tabular views (see Figure 4 below) are used.

Figure 3: Housekeeping Data Displayed as a Sequence with Limit Indicators (AstroRT)

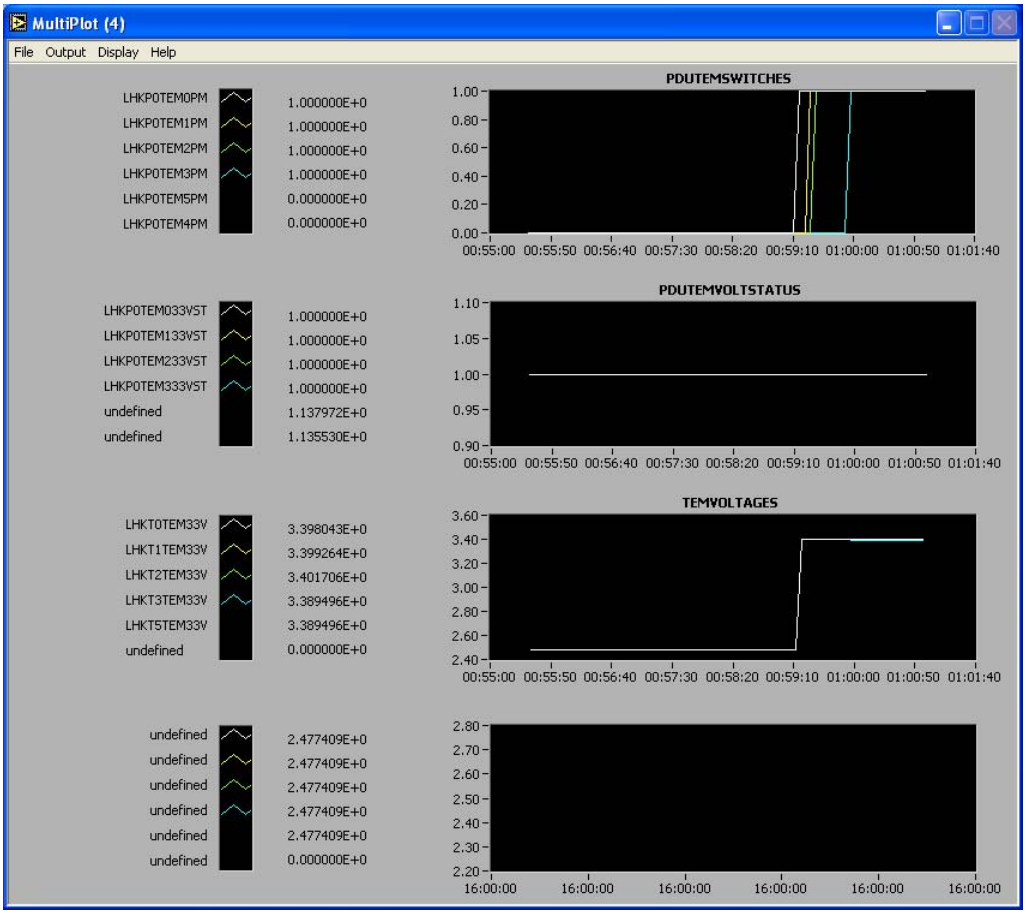
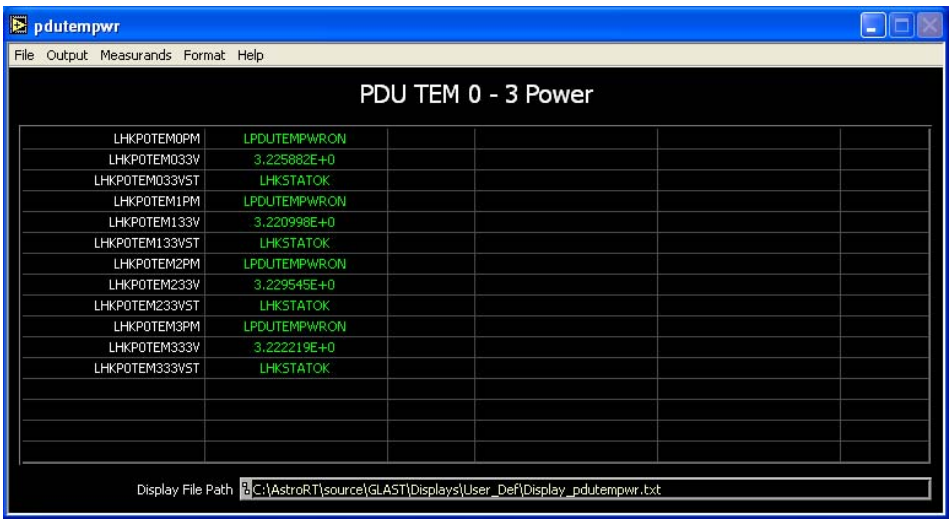


Figure 4: Housekeeping Data in Table View (AstroRT)

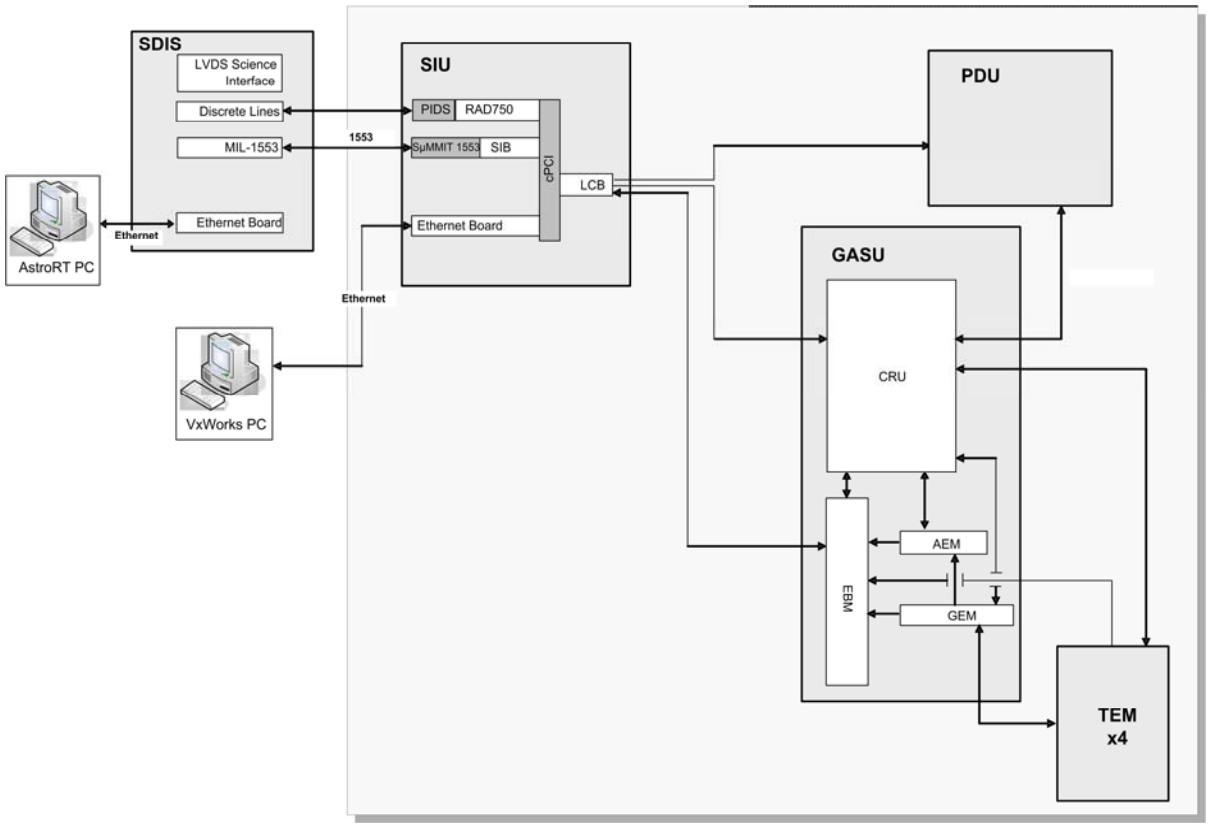


2 Demonstration Procedure

2.1 Overall Context of the Demonstration

The hardware configuration for today's demonstration is shown in Figure 5 below.

Figure 5: Testbed Configuration for Housekeeping Demo



2.1.1 Spacecraft Data Interface Simulator (SDIS)

The SDIS represents significant portions of the interface between the LAT and the Spacecraft. The SDIS comprises one side of the SC C&DH system with a 1553 bus, LVDS Science Interface, and Discrete monitors and controls.

A PC, connected to the SDIS via Ethernet, is used to control the Simulator. The PC runs Spectrum Astro's proprietary Spacecraft command and control package, AstroRT.

2.1.2 FSW Testbed

The FSW Testbed is configured as follows for the demonstration:

- A PC is connected via Ethernet to the SIU crate mounted on the Testbed. This PC is used to run the Tornado windSh, from which commands to load FSW and start the Housekeeping system are issued.
- The SIU crate mounted on the Testbed contains RAD750 processor, a 1553-capable compact PCI (cPCI) Spacecraft Interface Board (SIB), a cPCI LAT Communications Board, a serial line (not shown in Figure 5), and a Ramix Ethernet board.
- Flight Software preloaded on the SIU: the PBC (primary boot code) package and SBC (secondary boot code) are preburned into the RAD750 SUROM. Also loaded is a non-flight VxWorks image.
- The Testbed is configured with a complete GASU (EBM, AEM, CRU, and GEM), a PDU for power control, and 16 Tower Electronics Modules (4 are used in the demonstration).
- The following FSW software package constituents (production versions as of July 30, 2004) of are loaded onto the flight crate using the Tornado windSh and and Ethernet connection after the boot process is complete: /RAD750/librad750_reboot.o, /CMX/libcmx_asBuiltSpy.o, /PBS/libpbs.o, /MSG/libmsg_mt.o, /MSG/libmsg_print.o, /SIB/ libsib.o, /ZLIB/ libzlib_inflate.o, /FILE/libfile_hdr.o, CCSDS/libccsds_pkt.o, /CCSDS/libccsds_dump.o, /CCSDS/libccsds_swap.o, /CTDB/libsumt_rt_sib.o, /LCB/liblcbd.o, /LCB/libliox.o, /LCB/libt_adr.o, /DEM/libtem_reg.o, /DEM/libaem_reg.o, /DEM/ libltem_to.o, /DEM/liblaem_to.o, /DEM/libltem.o, /DEM/liblaem.o, /DEM/libstem.o, /DEM/libsaem.o, DAB/libdab_to.o, /DAB/libdab_reg.o, /DAB/libdab.o, /DAB/libscru.o, /DAB/libsgem.o, /DAB/libsebm.o, /DAB/libspdu.o, /DAB/liblcru.o, /DAB/liblgem.o, /DAB/liblebm.o, /DAB/liblpdu.o, /DUTIL/libstart.o, /ITC/libitc_dump.o, /ITC/libitc.o, /CTS/libctx_lcp_sumt.o, /CTS/libcts_lcp.o, /LHK/liblhk.o, /LHK/libLAT_sumt.o.

The first step in the demonstration session is to boot the flight crate through the primary boot stage, issue a command to the flight crate to continue to secondary boot, and wait while the flight crate finishes secondary boot. Then, the demonstrator loads demonstration-specific application software using the Tornado windSh over an Ethernet connection, as described above.

2.2 SIU Inter-task Communications Demonstration

The July demonstration, like earlier demonstrations, involves the Housekeeping system. However, this month, the Housekeeping system is connected to the CTDB (1553 communications) system through the ITC (Inter-task communications) task.

2.2.1 SIU ITC Demo Procedure

With the hardware and software configured and initialized as discussed above, the demonstration proceeds as follows:

- The PC controlling the SDIS is booted. LabView and AstroRT software is launched.
- The demonstrator powers up the Testbed using the main feed and SIU feed.
- After the SIU has completed primary boot, the demonstrator uses AstroRT to command the SIU to proceed to secondary boot.
- At the VxWorks terminal, the demonstrator sets up the demonstration:
    - Runs the **siu_sumt.vx** script to load the LHK package and all supporting flight software (see constituent list above).

  - Runs the **LAT_init()** command to initialize an LHK test application. This command starts low-level operating system and messaging services (PBS and MSG), initializes 1553 communications between the SIU and the SDIS via the SIB board, and initializes internal LAT (LATp) communications between the SIU and registers on the Testbed via the LCB board.
  - Runs the **LAT_start** command to launch the Housekeeping scheduler.
  - Executes the **addTEM** command 4 times to power on the 4 TEMs.

- The demonstrator moves to the SDIS control PC and, in turn, opens 4 AstroRT windows. Each window illustrates operation of the Housekeeping system: specifically, transmission of housekeeping packets via 1553 and the contents of those packets. These AstroRT application windows are shown in Section 1.3.1 on page 3.
- At the end of the demonstration, communications with the TEMs are shut down using the **removeTEM** command. The LHK test application is halted with **LAT_stop** and **LAT_exit**.

3 Demo Wrapup and Summary

The FSW Team thanks you for attending the demonstration and welcomes any questions about the software and hardware systems showcased. Comments or questions can be written in the following space.

4 Glossary

1553 – MIL-STD-1553B. Serial data bus specification; in particular, the serial data bus and data protocol implemented for the GLAST mission.

APID. CCSDS packet application identifier. A numerical code indicating the general type of data in a CCSDS packet.

Crate. Fond, generic term for development versions of Spacecraft Interface Units (SIUs) or Event-Processor Units (EPUs): custom-built, standalone on-board FSW processors and communications hardware units that control the LAT and communicate with the spacecraft (SIU), and process/filter instrument events (EPU). Crates are used for development purposes and will be replaced in the flight unit with single board computers with the same functionality.

GASU (Global-Trigger/ACD-EM/Signal-Distribution Unit). Portion of the FSW hardware suite that serves as the major hardware interface between data acquisition electronics on the LAT and other hardware and electronics that make up the FSW hardware package. The GASU contains the GEM, EBM, AEM, and CRU.

HKP. Real-time housekeeping telemetry data; telemetry data which relates to the health and safety of the LAT instrument.

LCB – The LAT Communications Board. A cPCI board that allows the internal components of the LAT to communicate with one another.

PID – Programmable Discrete. The RAD750 CPU board contains 32 channels of digital I/O. The primary boot code uses two channels configured as outputs.

PDU (Power Distribution Unit). Portion of the FSW hardware suite that manages power distribution from the spacecraft and monitors the health of other FSW hardware.

RTOS – Real Time Operating System. In particular the VxWorks 5.4 operating system used by the LAT.

SC – The GLAST Spacecraft. As built by Spectrum Astro. Refer to the GLAST LAT Instrument – Spacecraft Interface Control Document for the formal specifications of the SC as seen by the LAT.

SDIS – Spacecraft Data Interface Simulator. The SDIS represents significant portions of the interface between the LAT and the Spacecraft. The SDIS comprises one side of the SC C&DH system with a 1553 bus, LVDS Science Interface, and Discrete monitors and controls.

SDRAM. The RAD750 CPU board 128 MB of synchronous DRAM; the SDRAM serves as the RAD750 main memory.

SIB – Spacecraft Interface Board. The board in the SIU crates that contains the LAT 1553 remote terminal hardware.

SIU – Spacecraft Interface Unit. A type of single board computer (SBC) in the FSW hardware suite that acts as an interface between the spacecraft and the LAT.

SUROM – Startup ROM. 256 KB of EEPROM memory on the RAD750 CPU boards that holds the primary boot code; the SUROM is only programmable on the bench through the PPCI JTAG interface.

T&DF (Trigger and Dataflow System). Large LAT subsystem that provides gamma-ray identification, readout of the detector measurements, assembly of gamma-ray source location and energy measurements, and the streaming of data to the spacecraft. The T&DF subsystem contains the TKR, CAL, and ACD front-end electronics, Tower Electronics Modules (TEMs), ACD Electronics Modules (AEMs), Event Builder Module (EBM), Global Trigger (GLT), Global Trigger Electronics Module (GEM), and CPUs used for instrument configuration and data processing.

VxWorks. Computer operating system used on board the RAD750 processor.