Astronomical Data Analysis Software and Systems IV
ASP Conference Series, Vol. 77, 1995
R. A. Shaw, H. E. Payne, and J. J. E. Hayes, eds.

The Data Analysis System For The PDS Detector On-board the SAX Satellite

D. Dal Fiume, F. Frontera[1], L. Nicastro, M. Orlandini, and M. Trifoglio

CNR/TESRE, via Gobetti,101, I-40129 Bologna, Italy

1. Introduction

PDS is the high energy (15–300 keV) instrument on board the *SAX* satellite (Scarsi 1993). The launch is currently foreseen for the end of 1995. PDS is a telescope composed of a square array of four phoswich (NaI(Tl)/CsI(Na)) units for a total geometric area of 800 cm^2. The detector is surrounded by active shields (CsI(Na)) on the lateral sides and by a thin plastic scintillator on the front side. The field of view is limited to 1.4^o by means of graded hexagonal mechanical collimators (Ta–Sn–Cu).

The telescope is operated via an analog processor that analyses the analog signals coming from the various subsystems composing the telescope. The result of this analysis is then processed by two digital processors (PDS Intelligent Terminal, hereafter PDS IT): one dedicated to data acquisition from the analog processor, and the other dedicated to handle data transfer and communications with the On Board Data Handling (OBDH). More details on the detector and on its performances can be found in Frontera et al. (1991).

Tests on the detector electronics have already begun on the LABEN premises (Vimodrone). Tests on the integrated detector started in 1994 October, and calibrations are scheduled to begin soon after. In-flight deep calibrations and performance verification will take place in the first few months after commissioning of the satellite. In the operative phase, routine calibrations will be performed on a typical rate of one per day and long term history files, including some quantities relevant for calibrations and long term trend analysis, will be stored by Telespazio at SDC (Scientific Data Center located on the Telespazio premises in Rome). In the first part of the mission, a relevant part of these data must be processed timely by our group in order to produce the first set of calibration data usable by *SAX* PDS end-users. The production of publically available calibration data should be gradually taken over by SDC, during the operative life of the satellite.

In this report we describe the data collection, analysis and archival system in development at TeSRE to host the data of PDS.

[1]Also Dipartimento di Fisica Università di Ferrara, Ferrara, Italy.

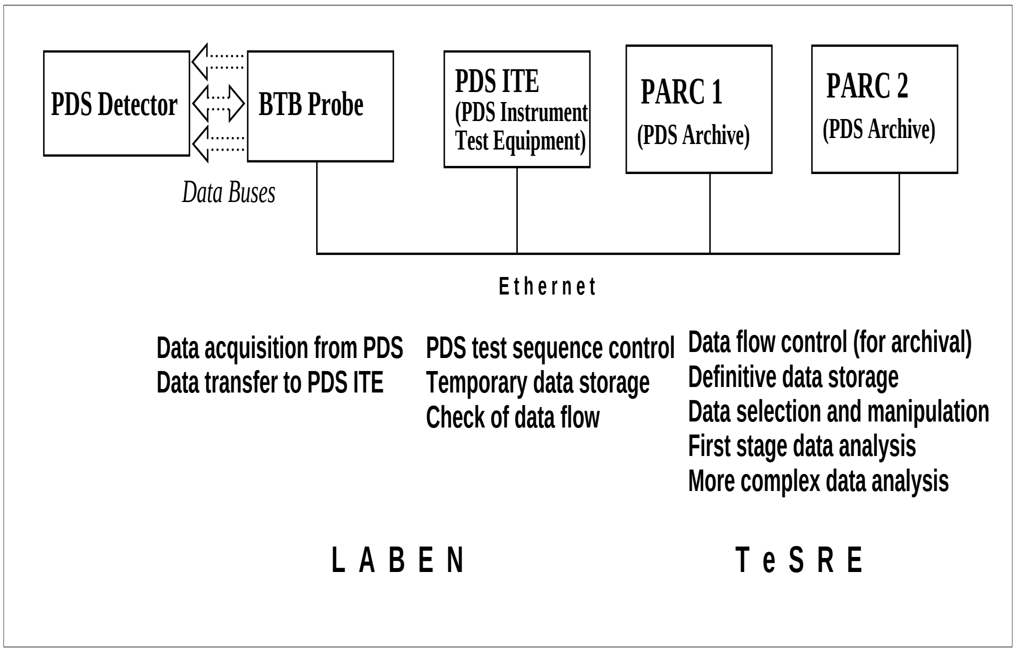

Figure 1. Block diagram of the data flow during the on-ground tests and calibrations.

2. Data Acquisition During Ground Tests and Calibrations

During the ground calibrations, data from PDS will be acquired using LABEN ITE (Instrument Test Equipment), a complex data acquisition system composed by a probe of the data bus on *SAX* (BTB probe) and a VAXstation.

Data comes from the PDS IT, which is composed of one analog processor and one digital processor. This latter is composed of two 80C86 microprocessors, on the *SAX* BUSes: the Response Bus (RB) and the Block Transfer Bus (BTB) (see Figure 1). The RB carries information on the health of the instrument (engineering HK, echos, responses to interrogations from IT to the central data handling system of *SAX*). The BTB transfers the scientific data in packets ready to be inserted in *SAX* telemetry. On *SAX* these buses connect all the ITs (one for each telescope) to the On Board Data Handling system (OBDH).

During the ground tests the RB and the BTB are probed by a dedicated instrument developed by LABEN called the bus probe. It retrieves output data from PDS coming on the RB and BTB and sends these data via TCP/IP to a VAXstation, where they are stored in files on hard disk. The LABEN ITE can control the data flow, with a dynamic display of the packets being transferred from PDS via bus probe. Data from LABEN ITE are then transferred to the PDS Data Analysis System, where the analysis and archiving are performed. These data are translated in native PDS format, exactly as they will be transmitted in *SAX* telemetry.

3. Data Acquisition, Event Handling, and Data Archiving

The front end to data coming from PDS is composed by some modules that: (1) reformat the input data, (2) handles events (as changes in the PDS configuration are made), (3) handles interprocess communication (as the scheduling of programs or information passes through the pipes), (4) archives the data in the PDS relational DataBase, and (5) allows for the display of data and performs data reductions/accumulations.

The **reformatter** is a module that transforms the data in PDS "native" format to the PDS data format of Final Observation Tapes (FOTs). This transformation will allow to have our archive data files with PDS packets in a single format for life of the PDS both pre-operational and operational. Actually, this reformatting is needed because the data distributed in FOTs are not a straight copy of telemetry data, but have undergone extensive reformatting, mainly consisting of the expansion of compressed data to an integer number of bytes. We will perform this reformatting, done during the operational phase at the Observation Control Center (OCC) operated by Telespazio, before archiving; recreating a data and file structure closely resembling that of the final data analysis of PDS. Prototypes of this reformatter were tested in 1994 October.

The **event handler** is a module that processes external events and notices, via message servers, the other applications running, of the type and effect of the noticed event. The event handler parses and analyzes the log-file produced by the "test sequence", a sequence of commands, macrocommands, actions, data produced by the LABEN ITE and that gives complete information on the operations performed on the PDS detector during the test session. The event handler is being developed.

The **message server** is a background process that handles requests to broadcast messages to the other running applications. The **process controller** is a deamon that handles inter-process communications and requests of process priorities. The message server and the process controller are now in prototype form and are being tested and completed.

4. The Insertion in the PDS Relational DataBase

The PDS Archival is based on the INGRES (t.m. of Ask Corporation) relational database. For each calibration record, we foresee archiving the following information: (1) the location of all the ancillary files related to a calibration, together with all the information needed by a user in order to analyze and reconstruct the calibration, (2) the results from the first level analysis (first processing of spectra and pseudo-images), and (3) the results from the second level analysis (PHA/ADC channel conversion, trend analysis, etc).

External tools to perform more sophisticated analysis can be used on data extracted from the database. The results of this analysis will be again archived in the database for further use. To this goal, we have built a Graphical User Interface (GUI) with Windows4GL scripts within the DataBase itself. The tasks that can be performed by means of the GUI are: (1) viewing database records, (2) creation, insertion and update database records (allowed only to authorized users—AU's), (3) the extraction of sets of records satisfying user conditions, (4) plotting one parameter vs. another (a correlation plot), and (5) fitting these correlation plots with linear, semilog or power law relations.

The View/Edit frame shows a list of all the records present in the database, that can be browsed with a scroll bar. For standard users, only the View and Close operations will be allowed. The Create and Edit tasks are accessible only for AUs. For AUs it is possible to perform three operations on the record: to insert the record in the database; to update the record, i.e., overwrite the record with the same ID Number, and delete the record.

Another operation possible from the View/Edit frame is the extraction of a subset of records that satisfy a search condition. The Selection frame allows the user to select particular values of the attributes and extract all the records in the database that satisfy the conditions imposed on the attributes. The subselections can be made in *cascade*. This means that the user can extract a subset from a subset, and so on, until the right sample is found.

By selecting the second task shown in the starting frame, we enter in the Plotting/Fitting frame. The user is asked to select the two attributes to be plotted, and to select the corresponding error columns, if present. The Fitting menu allows the user to access four kinds of fitting relations: linear, semilog (both in x and y), and log-log.

5. The Data Reduction and Display

IDL has been chosen as the graphical representation and manipulation tool for the *SAX* PDS data. We took advantage of the capability of IDL to build GUIs by writing user friendly, widget based, programs. In doing this, we assume that users have access to an X11 based System. IDL has seven basic widgets but several "compound widgets", and User Library routines that use the widgets are available. This allows most of the functionalities of our programs to be available just by "point and click".

Spectra, time series, and pseudo-images (counts vs. rise time vs. energy channel) are all accessible by a single, widget-based, program. The three types of data will have three different user interfaces with the relevant data shared using common blocks and temporary disk files. Default start-up settings are read-in from a user defined ASCII file. Other information exchange with the user uses both widget based windows and an IDL command window.

Thanks to the capability of IDL to spawn external processes via the `SPAWN` procedure, and to access external routines contained in sharable object libraries via the `CALL_EXTERNAL` function, once the data have been displayed, manipulated, and in some way selected, further analysis (e.g., model fitting) can be performed by invoking external tools. The results can then be returned to IDL for display and further processing.

References

Frontera, F., et al. 1991, Adv. Space Res., 11, 281

Scarsi, L. 1993, A&AS, 97, 371