CEDAR Requirements

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Prepared By: S. Béland -99
S. Béland, COS Software Engineer, CU/CASA

Reviewed By: Grant Blue 11-10-99
G. Blue, COS Softwar BATC Date

Approved By: Steve Penton 11-4-99
S. Penton, COS Software Scientist, CU/CASA Date

Approved By: John Andrews 11-8-99
J. Andrews, COS Experimen SA Date

Approved By: K. Brownsberger 11-5-99
K. Brownsberger, COS Sr. Software Scientist, CU/CASA Date

Center for Astrophysics & Space Astronomy
University of Colorado
Campus Box 593
Boulder, Colorado 80309

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1. SCOPE

1.1 IDENTIFICATION

This COS Evaluation and Data ARchive (CEDAR) Software Requirements Document is the top-level specification that establishes the requirements governing the development of the CEDAR GSE Software for the Cosmic Origins Spectrograph (COS) instrument. CEDAR is part of the Integration and Testing tools to be provided during the initial phases of the fabrication and integration of the multiple components making up COS. CEDAR is meant to provide a basic database interface to the data acquired during engineering tests and some simple tools to examine the data. An extensive set of data analysis tools specific to COS will be made available through the COS Data Analysis Software (CDAS) at a later time.

1.2 DOCUMENT OVERVIEW

This CEDAR Requirements Specification defines the requirements that have been levied upon CEDAR. The organization of this document is outlined below in a description of the contents of each of the ensuing sections.

Section 1 defines the scope of this document and introduces the concept of CEDAR.

Section 2 lists, by document number and title, documents that have been directly or indirectly referenced by this document.

Section 3 contains a glossary of document acronyms.

Section 4 presents a top-level functional, performance and interface overview for CEDAR.

Section 5 describes the CEDAR hardware and software environments.

Section 6 summarizes the list of requirements.

2. APPLICABLE DOCUMENTS

The following documentation relates to the CEDAR requirements as listed in this document. Unless a specific issue or revision is listed, the referenced documents will be of that issue or revision in effect on the date of release of this document.

2.1 COS RELATED DOCUMENTATION

STE-63	COS Contract End Item Specification
DM-01	COS SI Command Lists
DM-02	COS SI Engineering Data List
DM-03	COS DCE Flight Software Requirements Document
DM-03	COS DIB Flight Software Requirements Document
DM-03	COS MCE Flight Software Requirements Document
DM-03	COS NSSC-1 Flight Software Requirements Document
DM-05	COS SI Command Development Handbook
DM-06	COS SI Science Data Format
SCM-1050	HST COS Data Requirements Document
ST-ICD-26	SOGS to Space Telescope Project Data Base Interface Control Document
STR-43	Hubble Space Telescope (HST) Space Telescope Imaging Spectrograph (STIS) and Near Infrared Camera and Multi-Object Spectrometer (NICMOS) Performance Assurance Requirements (PAR)
STIS DM-03	STIS Flight Software Requirements Document
STIS DM-06	STIS SI Science Data Format
FUSE-JHU-0027	FUSE Science Data Processing Requirements
FUSE-JHU-0077	FUSE Science Data Processing to Science Archive
---	FUSE Science Data Archive Concept, v1.01

3. LIST OF ACRONYMS AND ABBREVIATIONS

BATC	Ball Aerospace & Technologies Corp.
CASA	Center for Astrophysics and Space Astronomy

CEDAR	COS Evaluation and Data Archive
CEI	Contract End Item
COS	Cosmic Origins Spectrograph
CSCI	Computer Software Configuration Item
DCE	Detector Control Electronics
DIB	Detector Interface Board
EDD	Engineering Diagnostic Data
EFS	Memory Dump File
FITS	Flexible Image Transport System
FUSE	Far Ultraviolet Spectroscopic Explorer
FUV	Far Ultra Violet
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface
HST	Hubble Space Telescope
ICD	Interface Control Document
IDL	Interactive Data Language
MAMA	Multi-Anode Microchannel Array
MCE	MAMA Control Electronics
MCP	Microchannel Plate
MHz	MegaHertz = 10^6 Hertz
NASA	National Aeronautics and Space Administration
NSSC-1	NASA Standard Spacecraft Computer Model 1
NUV	Near Ultra Violet
PHA	Pulse Height Amplitude
RCS	Revision Control System
SDF	Science Data Formatter
SDI	Science Data Image
SHP	Standard Header Packet
SI	Science Instrument
SMOV	Science Mission Orbital Verification
SRD	Software Requirements Document
STIS	Space Telescope Imaging Spectrograph
SW	Software

4. COS EVALUATION AND DATA ARCHIVE OVERVIEW

4.1 DATA INTERFACE DEFINITION

The data from the instrument shall be available to CEDAR as disk files accessible from the computer system on which the program is running. No provisions shall be made for CEDAR to communicate directly to COS via a live hardware connection. Support shall be provided to read the different data products generated by the instrument and the system as described below.

4.2 DATA PRODUCTS

CEDAR shall be able to read the "raw" data (copied to the archive), the FITS files that it generates and the database containing detailed information for each of these files. The raw data product is the data coming from the instrument control system. These consist of:

SDI: Science Data Image files
EFS: Memory Dump files
EDD: Engineering Diagnostic Data files
SHP: Standard Header Packet files

To display the information from the EDD files in a meaningful way, a Symbol Table is used. This table is an ASCII file which contains the name and the address (byte offset) in the EDD file of every field. The Symbol Table is an output product of the flight software build process. In addition to the symbol name, some of the values in the EDD file, corresponding to specific parameters, need to be converted into real units for clarity. The conversion factor for a specific field in the EDD file is found in either the TDFD or the EUDL file. These files are maintained by the project database group and are exported as a text report from this Database in a specific format. The TDFD format is documented in the ST-ICD 26 part 5. The EUDL format is documented in the ST-ICD 26 part 3.

These files are:

***.eud** - Science data header description file. The content of this file will change over time. CEDAR will need to keep track of the required and available versions.

***.tdf** - Telemetry data format description file. The content of this file will change over time. CEDAR will need to keep track of the required and available versions.

***.alg** - List of mnemonics corresponding to a list of addresses for an analog diagnostics dump. Once established, the content of this file should not change.

***.sdd** - List of mnemonics corresponding to list of addresses for a digital diagnostics dump. The content of this file will change over time. CEDAR will need to keep track of the required and available versions.

The version number for these different files will be implied in their names. CEDAR will have to determine from the raw data file, which version of these files it needs for correctly interpreting the data. If the required file isn't available, CEDAR will warn the user and present a file selection window so that an alternative file can be chosen (with the default file being the latest version).

The rules to identifying and naming the files are described next.

***.sdd** file: CEDAR will look for a file named cosboot.sdd when the diagnostic software mode is 0 (LQSWMODE=0, boot mode). For software mode 1 (operate mode), CEDAR will look for a file named cosMJMN.sdd where MJ is a 2 digit number for the Flight Software Major Revision Number (LQFSWMAJ) and where MN is a 2 digit number for the Flight Software Minor Revision Number (LQFSWMIN). The revision numbers are found in the data file header.

***.eud** file: CEDAR will extract the header version number from the data file from the field LQHDRVER. CEDAR will then look for an eudl file named 'eudlN.cos' where N is the version number previously obtained.

***.tdfd** file: CEDAR will extract the date information from the data file header from the field LQSTIME. CEDAR will then look for the latest tdfd file dated before the date previously obtained.
The date for the tdfd file is obtained from its name: tdfdMMDDYY.cos where MM is the 2 digit month number, where DD is the 2 digit day number, where YY is the 2 digit year number

cos.alg file: Since this file will always be the same, no version checking will be required.

All of those files are read directly by CEDAR in the format put out by the ACCESS Database report. It is the responsibility of the user to make sure that these files are available in the directory to which the environment variable CEDAR_REFERENCE_PATH points to. If CEDAR can not find the proper file, it will prompt the user for a different file to use and offering a reasonable default.

The FITS data generated by CEDAR shall contain all of the relevant information from any of these raw files. The exact nature of the FITS header keywords is under evaluation.

The SDI format still remains to be determined for COS. A good starting point would be the Science Data Format document for STIS (DM-006) for the NUV detector and the FUSE document for the FUV detector (FUSE-JHU-0027).
The SDI shall include for the FUV the following data types: Time Tagged, Histogram, Pulse Height Amplitude and STIM Pulse. For the NUV detector, the SDI shall include: Time Tagged and Histogram data types.

The memory dump files also include the Error Logs and Crash Dump formats.

CEDAR shall also be able to generate/create/update a database containing information on each of the files available to it. The access to the data files for analysis can either be through the database, directly from the raw data files or the FITS files.

The format of the FITS files generated for the FUV detector shall be similar to what FUSE generates (FUSE-JHU-0027). The format of the FITS file generated for the NUV detector shall be similar to what STIS puts out (STIS DM-006). Additional FITS keywords may be identified and added at a later time.

4.3 DATA FLOW DESCRIPTION

The CEDAR data flow is shown in the figure below.

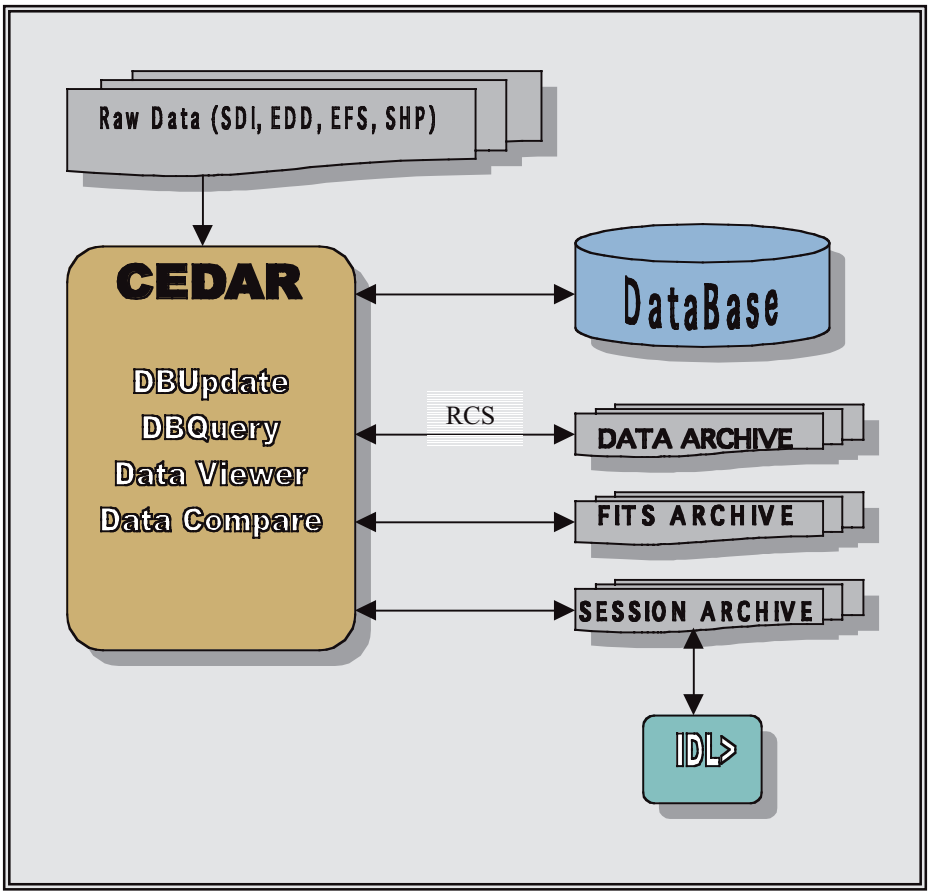


Figure 4.3-1 Data Flow Description

The program shall read the raw data as requested by the user and make a copy of it in the archive. A FITS file of the raw data shall also be produced. An entry in the database shall be made for each new FITS file created.

The user shall have the option to edit the header information for each of the raw or FITS files. To allow this, the archive shall be made using the Revision Control System (RCS). This way, a history of the changes made to a file during the course of its existence shall be recorded. It shall then be possible to regenerate any previous version of the file. This implies three copies for a single file: the archived version (with the RCS tags), the working version and a FITS copy. If disk space becomes an issue, it may be

desirable to have the archive copy also be the working copy for files which have not had any changes made to them.

The user shall have the opportunity to save the current session with all the relevant information as an IDL Save File. A saved session shall be able to be Restored at a later time.

The program shall generate the database from the initial raw data files. It shall also be able to regenerate the entire database from the archived data or from the list of FITS files in case the initial database gets corrupted or inaccurate.

4.4 DATABASE REQUIREMENTS

The CEDAR database shall contain information necessary to locate any raw or FITS file. All keywords contained in the raw and FITS files shall be stored in the database along with the pathnames of the corresponding files, the administrative and the comment fields. All keywords and administrative fields shall be searchable. The user shall be able to add raw and FITS files to the database but shall not be able to delete CEDAR database entries.

In addition, administrative tools shall be provided to recreate the database from either the raw or FITS archive, and to delete database entries. It is imagined that the database will be updated regularly, therefore the database fields will not be indexed. Database indexing would provide faster access, but would require the database to be unavailable during the re-indexing. With the limited number of expected databases files, we do not expect the database performance to be an issue. If the response of the database becomes an issue, we shall provide administrative tools to periodically index the CEDAR database.

The CEDAR database and all administrative tools shall be produced with IDL.

4.5 USER INTERFACE DESCRIPTION

The user interface shall be made up of an initial window which shall allow the user to access the available options:

Database:
- Entry
- Query/Reporting
- Edit
- Maintenance

Viewers:
- Detector Science
- Memory Dump
- ED Diagnostic

Tools:
- Data Compare/Analysis

IDL:
- Prompt
- Save Session
- Restore Session

Properties
Help
Quit

Figure 4.5-1 CEDAR Main Menu

4.5.1 DBEntry

The DBEntry option shall bring up its own window where the user can select the raw data files from a default directory or any other directory (see Figure 4.5-2). Once selected, these files shall be archived and a FITS file shall be generated for each one. A new entry in the database shall be made for each of those files.

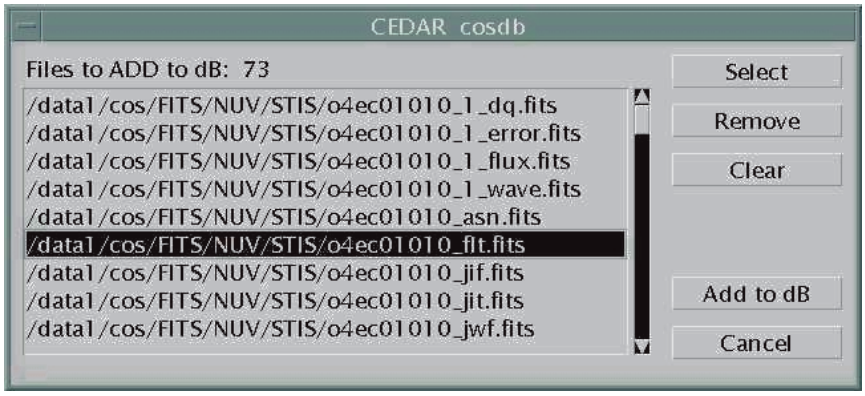


Figure 4.5-2 DBEntry Window

4.5.2 DBQuery

The DBQuery option shall bring up its own window where the user shall be able to browse and select files from the archive by searching the database for field values or ranges (see Figure 4.5-3). Once a file is selected the user will have the option to look at the details of the database entry or to open the file in one of the Data Viewer windows. The user shall have the option to save the results of the query in an ASCII file or print it in a predefined report format.

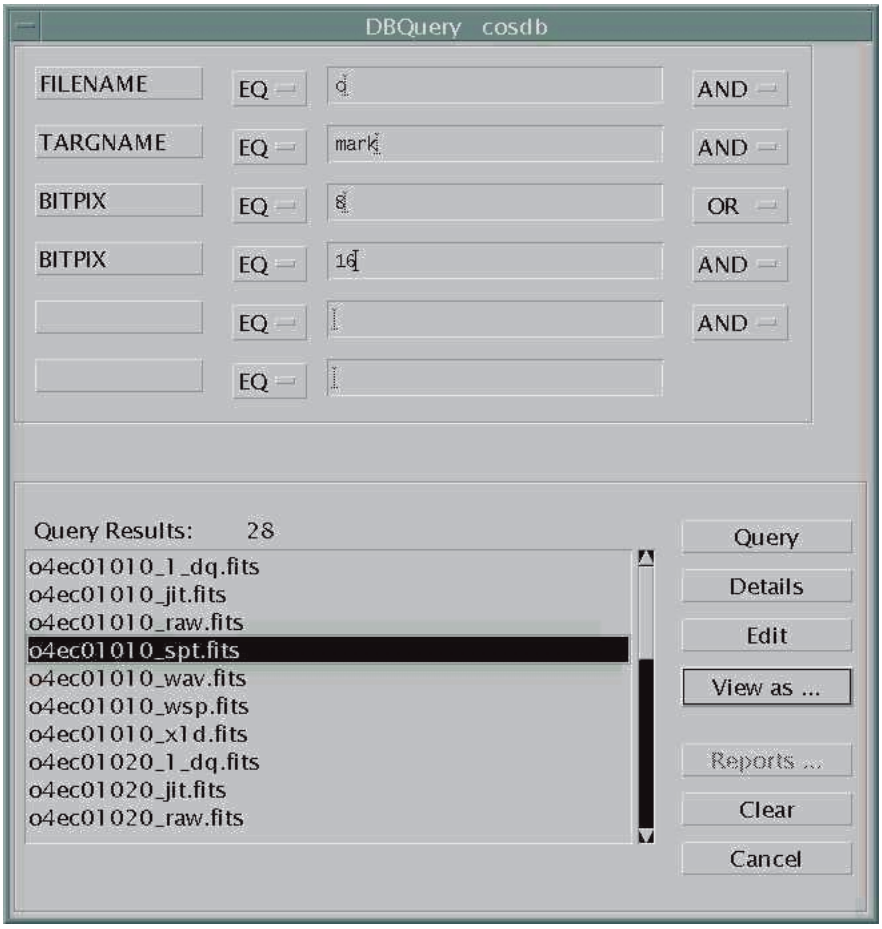


Figure 4.5-3 DBQuery Window

4.5.3 Data Viewer

The DataViewer window shall look different to the user depending on the type of data.

4.5.3.1 SDI Data Viewer

For SDI data, the window shall include an image display area for the full image at reduced resolution, a zoom window and a Region Of Interest window at full resolution. A combination of pull-down menus and buttons on the GUI shall allow the user to interact with the image (see Figure 4.5-4).

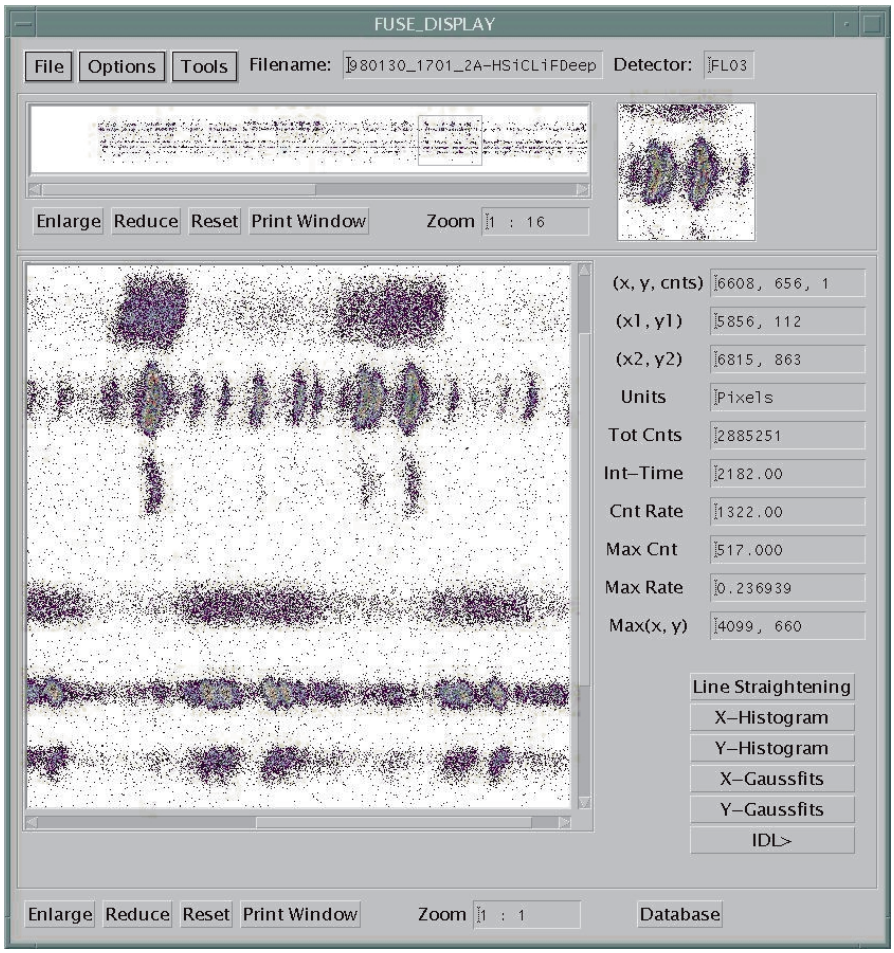


Figure 4.5-4 Data Viewer - Science Data

Once a file is displayed in the dataviewer, the user shall be presented with a number of initial image/data analysis tools to be performed on either the full image or the region of interest. These tools are described in Section 4.6.

4.5.3.2 Memory Dump Data Viewer

The Memory Dump Data Viewer will let the user view any file (raw, FITS, ASCII, etc.) in either hexadecimal, octal or decimal format. The user shall have the option to go to a specified offset in the file and search the file for a specific pattern (either ASCII, hex, octal , decimal). The viewer shall also be able to display the data with different byte spacing. This tool shall be of general purpose and be used as an IDL standalone application. Within the CEDAR environment, the viewer shall allow the user to read in an HST Science Data Stream file format and extract the relevant information from the HST data packets and only display that information. The Memory Dump Data Viewer shall be able to import the image part of a Science Data file format and display it as a 2D image according to user specified dimensions.

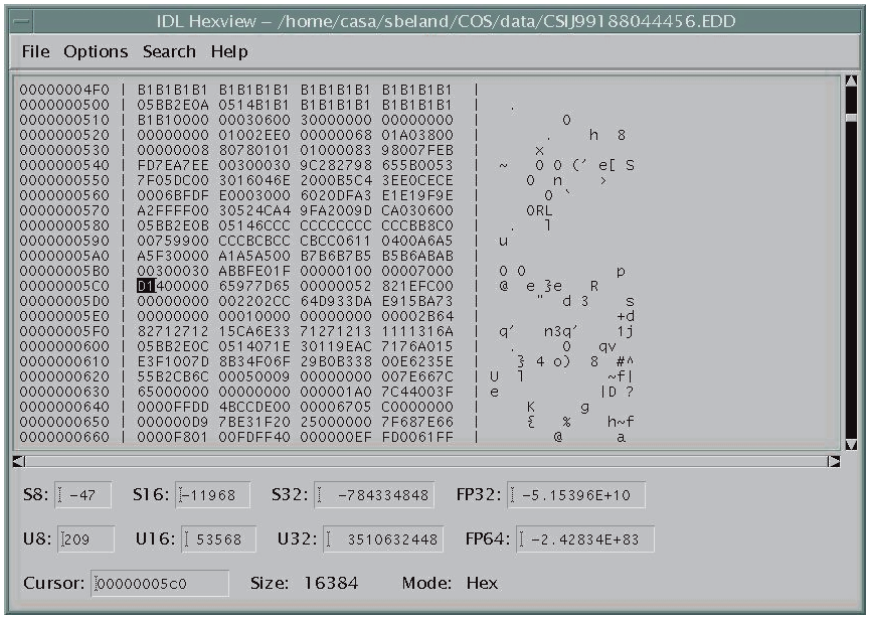


Figure 4.5-5 Data Viewer - Memory Dump as a HEX Display

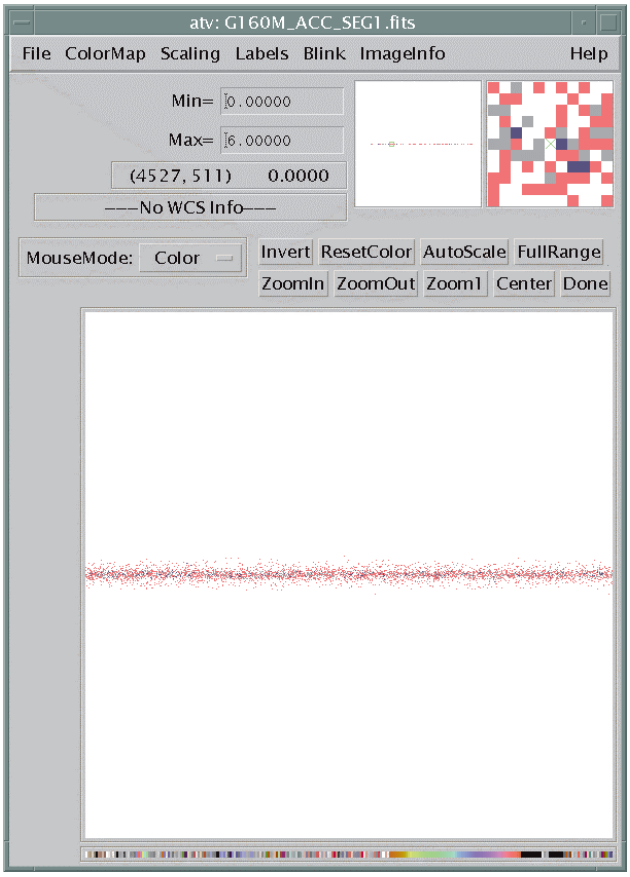
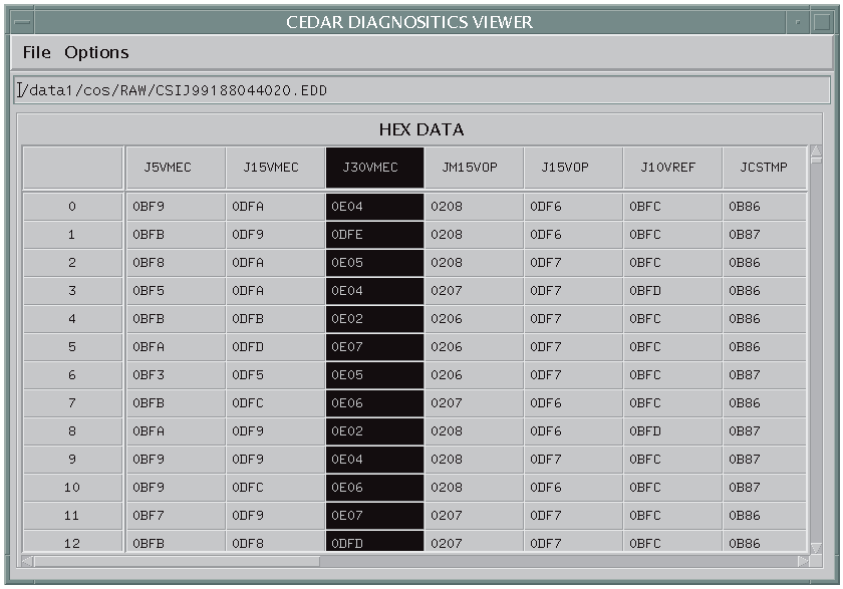


Figure 4.5-6 Data Viewer – Memory Dump as an Image

4.5.3.3 Diagnostic Data Viewer

For Diagnostic data, the data viewer shall read the field names and conversion factors from the Symbol Table and EUDL or TDFD files and display the Name/Value pairs in hexadecimal, decimal and converted values format in a window (see Figure 4.5-7 and Section 4.2). The diagnostic data viewer shall also display the header information for the file read in. The user shall be able to select a specific column, obtain a plot of that item and optionally get a hard copy of the plot (see figure 4.5-8). An option shall also be provided to save the data being displayed as tabular ASCII data which could easily be imported into other applications.



	J5VMEC	J15VMEC	J30VMEC	JM15VOP	J15VOP	J10VREF	JCSTMP
0	0BF9	0DFA	0E04	0208	0DF6	0BFC	0B86
1	0BFB	0DF9	0DFE	0208	0DF6	0BFC	0B87
2	0BF8	0DFA	0E05	0208	0DF7	0BFC	0B86
3	0BF5	0DFA	0E04	0207	0DF7	0BFD	0B86
4	0BFB	0DFB	0E02	0206	0DF7	0BFC	0B86
5	0BFA	0DFD	0E07	0206	0DF7	0BFC	0B86
6	0BF3	0DF5	0E05	0206	0DF7	0BFC	0B87
7	0BFB	0DFC	0E06	0207	0DF6	0BFC	0B86
8	0BFA	0DF9	0E02	0208	0DF6	0BFD	0B87
9	0BF9	0DF9	0E04	0208	0DF7	0BFC	0B87
10	0BF9	0DFC	0E06	0208	0DF6	0BFC	0B87
11	0BF7	0DF9	0E07	0207	0DF7	0BFC	0B86
12	0BFB	0DF8	0DFD	0207	0DF7	0BFC	0B86

Figure 4.5-7 DataViewer – Diagnostic Data

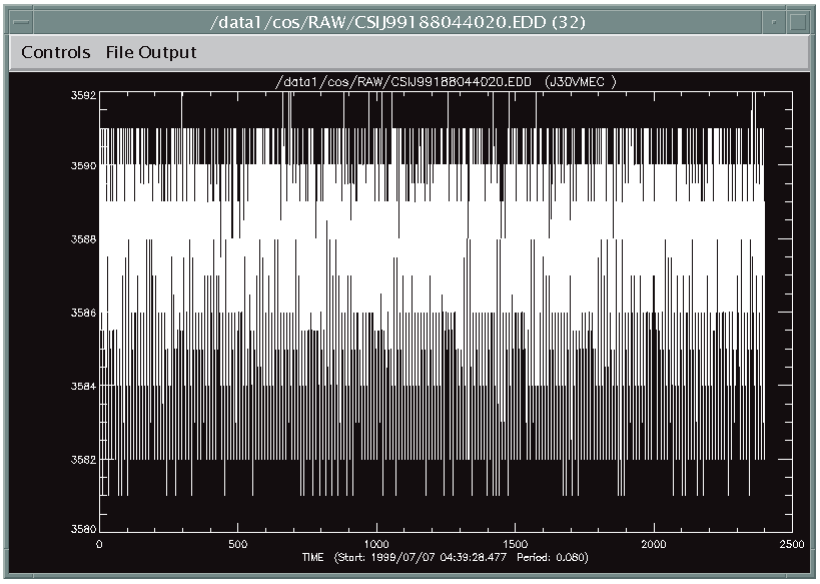


Figure 4.5-8 Data Viewer - Diagnostic Data – Column Plot

4.5.4 Data Compare

The Data Compare/Analysis tool shall provide the user with some basic operations to be performed on two images: exact match (byte by byte comparison), subtraction with the result being displayed as a 2D image with the corresponding statistics.

4.5.5 IDL Prompt

The user shall be provided with an IDL prompt to give access to all of IDL's commands. The data used by the program shall be made available to the user as IDL variables on which any IDL operations could be performed.

4.6 ANALYSIS TOOLS

The following data analysis tools for the SDI data shall be available to the user for either the full image or the region of interest:

Row/Column profile plots	Display one or the sum of many selected rows or columns as a 2D plot with pan/zoom and actual data value retrieval with mouse cursor
Contour/Surface plots	Display the whole image or the region of interest as a contour plot or a surface plot
Zoom/Pan	Allows the user to zoom in or out and pan around the displayed image
Color Adjust	Allows the user to change the color table and stretch used to display the data
Statistics	Calculate and display the statistics (minimum, maximum, mean, median, stdev) for the selected area
Histogram	Calculates and displays the histogram for the selected area with pan/zoom
Identify values within a range	Find and optionally identify the pixels in the image with values within a specified range
Hard Copy	Print a copy of the plot being displayed on the screen
Header Viewer/Editor	Display the content of the data header and allow changes to be made and saved in the archive and database

4.7 EXTERNAL TOOLS

CEDAR shall provide through the Main Menu or through the DBQuery tool, ways to call external programs. These programs are to be command line only, with no attached GUI. These programs will expect at least one command line parameter (usually the filename) which will be obtained by CEDAR and all other command line arguments will be set to their default values.

5. HARDWARE AND SOFTWARE ENVIRONMENTS

The following sections summarize the hardware and software environments where CEDAR shall reside and operate. Also listed are tools, such as compilers, that are part of the development environment.

5.1 HARDWARE ENVIRONMENT

The following items represent the minimum configuration for the hardware environment in which CEDAR shall reside and operate:

ITEM	DESCRIPTION	COMMENTS
Workstation	Sun Ultra 60	---
Monitor	21" Color Monitor	---
RAM	512MB	---
Disk Space	32GB	---
Graphics	24bit Color Depth	---
Operating System	Solaris 2.7	---

5.2 SOFTWARE ENVIRONMENT

The following software items are the software packages that together form the software environment in which CEDAR shall be developed and require for operation:

ITEM	DESCRIPTION	COMMENTS
IDL	Interactive Data Language	v5.2
Astron Libraries	IDL FITS and Database Routines	V5.0
CFITSIO	FITS I/O library in C	V2.033
gcc	gnu C ANSI standard compiler	V2.8.1

6. SUMMARY

6.1 REQUIREMENTS TABLE

No.	Section(s)	Description
1	5.1	Sun Ultra 60, 21” monitor, 512MB RAM , 32GB Disk
2	5.2	IDL, Astron Libraries, CFITSIO, gcc
3	4.1, 4.2	SDI, EFS, EDD, SHP, FITS data available to CEDAR as disk files
4	4.2	FITS keywords to include all relevant info from raw files
5	4.2, 4.3, 4.4	Searchable database of archived data with all keywords as fields and a comment field
6	4.3	Save / Restore a working session with data and current software parameters
7	4.4, 4.5	Add/Query/Edit/Print/View data from the database
8	4.5.3.1	SDI viewer to provide full view at reduced resolution, zoom/pan cursor value feedback
9	4.5.3.2	EFS viewer to display the data in hexadecimal format
10	4.5.3.3	EDD viewer to display Name/Value pairs with the help of the Symbol Table, EUDL and TDFD files
11	4.5.4	DataCompare tool to provide basic arithmetic/statistical functions (average, difference, mean, median, min, max, stdev)
12	4.5.5	IDL prompt
13	4.6	Row/Column profile plot of full image or region of interest with zoom and data value retrieval
14	4.6	Contour/Surface plot of full image or region of interest
15	4.6	Zoom/Pan of image displayed
16	4.6	Color adjustment tool
17	4.6	Data statistics on full image or region of interest (mean, median, min, max, stdev)
18	4.6	Histogram plot of full image or region of interest with pan/zoom
19	4.6	Identify/Mark on the display, data values within a selectable range
20	4.6	Hard copy of the many different plots/displays
21	4.6	Data header viewer/editor to allow viewing/editing/saving of header information