Chapter 2
HST File Formats

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STScI automatically processes and calibrates all the data received from HST. The suite of software programs that performs this processing—part of a system known as OPUS—is frequently called the *pipeline*, and its purpose is to provide data to observers and to the HST Data Archive in a form suitable for most scientific analyses. Pipeline processing assembles data received from HST into *datasets*, calibrates the data according to standard procedures described in the instrument sections of this handbook, and stores both calibrated and uncalibrated datasets in the Archive.

Before the 1997 servicing mission, HST data files passed through pipeline processing in Generic Edited Information Set (GEIS) format and then were stored in the Archive in Flexible Image Transport System (FITS) format, a machine-independent format that simplifies the distribution of data to many different platforms. Users of FOC, FOS, FGS, GHRS, HSP, WF/PC-1, and WFPC2 data currently need to convert FITS data files received from the Archive back into GEIS format before they can reduce them further. Recent developments have made the FITS format much more useful for data processing, and it is now the standard format for pipeline processing and subsequent reduction of STIS and NICMOS data. Observers using these new instruments *should not* convert their files to GEIS format.

This chapter describes these two HST file formats, first giving some historical perspective on the reasons why they were selected, then explaining the FITS and GEIS formats in more detail. STIS and NICMOS observers should pay particular attention to the section on FITS files, which shows how to identify and access the contents of these files and covers some important conventions regarding header keywords. Veteran observers with the other instruments will find little new in the section on GEIS files, but newcomers to the older HST instruments should consult the material on data groups and conversion from FITS to GEIS before proceeding to Chapter 3.

2.1 Historical Perspective

In the early 1980's, when GEIS was selected as the standard format for HST data files, it held several advantages over both FITS and the original IRAF format (OIF):

- GEIS allows floating-point data. The early incarnations of FITS accommodated only integer data, and this restriction to integers would have made data reduction and storage of calibrated data rather cumbersome.
- GEIS files can hold multiple images, each with associated parameters. This feature allowed the packaging of images from the four WF/PC-1 chips into a single unit, as well as the packaging of multiple FOS or GHRS readouts into single files. OIF files and early FITS files could contain only single images.
- GEIS data are stored in two parts, an ASCII header and a binary data file. The separation of these two pieces and the restriction of the header to ASCII made these headers easier to read and print in the days when computers were less powerful and tasks for reading header information were less numerous. OIF headers combine ASCII and binary information, and FITS headers come packaged with the data in a single file.

GEIS was also the standard format for archiving and distribution of HST data until September 1994, when the Space Telescope Data Archive and Distribution Service (ST-DADS) came online. This new system stores and distributes HST data files in machine-independent FITS format, but observers with FOC, FOS, FGS, GHRS, HSP, WF/PC-1, and WFPC2 still must convert their files to machine-dependent GEIS format as described on page 2-11 before using IRAF/STSDAS software (see Chapter 3) to reduce their data.

Since the selection of GEIS as HST's standard data format, FITS has added features that have dramatically increased its flexibility. In particular, FITS files can now contain multiple *image extensions*, each with its own header, size, and datatype, that allow multiple exposures to be packaged into the same file, along with associated error and data quality information. The FITS image kernel in IRAF version 2.11, released in August 1997, enables users to access FITS image extensions in ways similar to how they would access GEIS data groups.

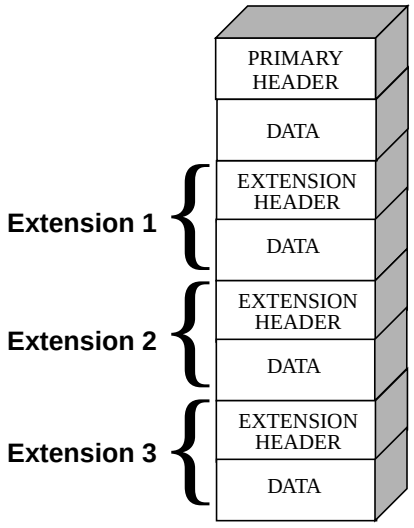
Because of these advantages, FITS was chosen as the standard reduction and analysis format for STIS and NICMOS. The STSDAS tasks written for these instruments expect FITS files as input and produce FITS files as output. *You cannot convert STIS and NICMOS files to GEIS format.* Observers using these instruments should therefore read the following section, which explains how to work with these new FITS files.

2.2 FITS File Format

Flexible Image Transport System (FITS) is a standard format for exchanging astronomical data between institutions, independent of the hardware platform and software environment. A data file in FITS format consists of a series of Header Data Units (HDUs), each containing two components: an ASCII text header and the binary data. The header contains a series of *header keywords* that describe the data in a particular HDU and the data component immediately follows the header.

The first header in a FITS file is known as the *primary header*, and any number of *extensions* can follow the primary HDU. The data unit following the primary header must contain either an image or no data at all, but each extension can contain one of several different data types, including images, binary tables, and ASCII text tables. The value of the XTENSION keyword in the extension's header identifies the type of data the extension contains. Figure 2.1 schematically illustrates the structure of a FITS file and its extensions.

Figure 2.1: FITS File Structure



The three-letter identifier (e.g., `d0h`) that follows the rootname of an HST data file (see Appendix B for more on HST file names) has often been called an "extension" in the past. However, because of the potential for confusion with FITS extensions, this handbook will refer to these three-letter identifiers as "suffixes."

2.2.1 Working with FITS Image Extensions

The FITS image kernel included in IRAF version 2.11 is designed to read and write the images in FITS extensions and their associated headers. Once IRAF has ingested a FITS image and its header, it treats the header-data pair like any other IRAF image. The following discussion describes how to specify the image extensions in FITS files that you would like to process with IRAF/STSDAS tasks and presumes that you are using IRAF 2.11 or higher. It covers how to:

- List a FITS file's extensions.
- Access data in particular FITS extensions.
- Inherit keywords from the primary header.
- Append new extensions to existing FITS files.

Retaining the `.fits` at the end of every FITS file name in your file specifications will ensure that IRAF both reads and writes these images in FITS format.

If you want to work with STIS and NICMOS data, you will need to upgrade to IRAF 2.11 or higher and STSDAS 2.0.

Generating a FITS File Listing

Once you have downloaded STIS or NICMOS FITS files from the Archive, you may want an inventory of their contents. To generate a listing of a FITS file's extensions, you can use the **catfits** task in the **tables** package. The following example illustrates the first thirteen lines generated by **catfits** from a NICMOS MULTIACCUM FITS file containing images only.

Figure 2.2: NICMOS MULTIACCUM Listing from catfits

```
tt> catfits n3t501c2r_raw.fits

EXT#  FITSNAME      FILENAME              EXTVE  DIMENS     BITPI OBJECT

0     n3t501c2r_raw n3t501c2r_raw.fits                      16    n3t501c2r_raw.f
1       IMAGE       SCI                   1      256x256    16    n3t501c2r_raw.f
2       IMAGE       ERR                   1                 -32
3       IMAGE       DQ                    1                 16
4       IMAGE       SAMP                  1                 16
5       IMAGE       TIME                  1                 -32
6       IMAGE       SCI                   2      256x256    16
7       IMAGE       ERR                   2                 -32
8       IMAGE       DQ                    2                 16
9       IMAGE       SAMP                  2                 16
10      IMAGE       TIME                  2                 -32
11      IMAGE       SCI                   3      256x256    16
12      IMAGE       ERR                   3                 -32
```

The first column of a **catfits** listing gives the extension numbers. Note that the primary HDU is labeled extension number zero. The second column lists the extension type, given by the keyword XTENSION (IMAGE = image, BINTABLE = binary table, TABLE = ASCII table). The third column lists the extension name, given by the keyword EXTNAME. In STIS and NICMOS image files, the EXTNAME values SCI, ERR, and DQ indicate science, error, and data quality images, respectively. NICMOS image files contain samples and exposure time images as well, with EXTNAME values SAMP and TIME.

Each STIS or NICMOS readout generates an image set or *imset*. STIS imsets comprise three images (SCI, ERR, DQ), while NICMOS imsets comprise five (SCI, ERR, DQ, SAMP, TIME). All images belonging to the same imset share the same integer value of the EXTVER keyword, given in the fourth column of a **catfits** listing. Several STSDAS tasks can work with entire imsets (see "Working with STIS and NICMOS Imsets" on page 3-12), but most operate on individual images. See the STIS and NICMOS Data Structures chapters for more information on the contents of imsets.

Accessing FITS Images

After you have identified which FITS image extension you wish to process, you can direct an IRAF/STSDAS task to access that extension using the following syntax:

`fitsfile.fits[`*extension number*`][`*keyword options*`][`*image section*`]`

Note that all the bracketed information is optional. However, the only time it is *valid* to provide only a file name without further specification is when the file is a simple FITS file that contains a single image in the primary HDU.

Designation of the extension number is the most basic method of access, but it is not necessary the most helpful. Referring to an extension's EXTNAME and EXTVER in the `[keyword options]` is often more convenient. If a number follows an EXTNAME, IRAF interprets the number as an EXTVER. For example, if extension number 6 holds the the science image belonging to the imset with EXTVER = 2, as in the **catfits** listing on the previous page, you can specify it in two equivalent ways:

```
fitsfile.fits[6]
fitsfile.fits[sci,2]
```

Designations giving an EXTNAME without an EXTVER refer to the first extension in the file with the specifed value of EXTNAME. For example, `fitsfile.fits[sci]` refers to the first science image extension in `fitsfile.fits`.

The syntax for designating image sections adheres to the IRAF standard, so in the current example the specifications

```
fitsfile.fits[6][100:199,100:299]
fitsfile.fits[sci,2][100:199,100:299]
```

both extract a 100 by 200 pixel subsection of the same science image in `fitsfile.fits`.

Header Keywords and Inheritance

STIS and NICMOS data files take advantage of an IRAF image kernel convention regarding the relationship of the primary header keywords to image extensions in the same file. In particular, IRAF allows image extensions to *inherit* keywords from the primary header under certain circumstances. When this inheritance takes place, the primary header keywords are practically indistinguishable from the extension header keywords. This feature circumvents the large scale duplication of keywords that share the same value for all extensions. The primary header keywords effectively become global keywords for all image extensions. The FITS standard does not cover or imply keyword inheritance, and while the idea itself is simple, its consequences are often complex and sometimes surprising to users.

Generally keyword inheritance is the default, and IRAF/STSDAS applications will join the primary and extension headers and treat them as one. For example, using **imheader** as follows on a FITS file will print the both the primary and extension header keywords to the screen:

```
cl> imheader fitsfile.fits[sci,2] long+ | page
```

Using **imcopy** on such an extension will combine the primary and extension headers in the output HDU, even if the output is going to an extension of another FITS file. Once IRAF has performed the act of inheriting the primary header keywords, it will normally turn the inheritance feature off in any output file it creates unless specifically told to do otherwise.

If you need to change the value of one of the global keywords inherited from the primary header, you must edit the primary header itself (i.e., “extension” [0]).

Keyword inheritance is not always desirable. For example, if you use **imcopy** to copy all the extensions of a FITS file to a separate output file, IRAF will write primary header keywords redundantly into each extension header. You can suppress keyword inheritance by using the NOINHERIT keyword in the file specification. For example:

```
im> imcopy fitsfile.fits[6][noinherit] outfile.fits
im> imcopy fitsfile.fits[sci,2,noinherit] outfile.fits
```

Both of the preceding commands will create an output file whose header contains only those keywords that were present in the original extension header. Note that the `noinherit` specification belongs bracketed with the EXTNAME and EXTVER keywords and not in a separate bracketed unit of its own.

Appending Image Extensions to FITS Files

IRAF/STSDAS tasks that produce FITS images as output can either create new FITS files or append new image extensions to existing FITS files. You may find the following examples useful if you plan to write scripts to reduce STIS or NICMOS data:

- If the specifed output file does not yet exist, a new output file is created containing only a primary HDU if no specification is appended to the output file name. For example, to copy the contents of the primary header of `fitsfile.fits` into the primary HDU of the FITS file `outfile.fits`, type the command:

```
cl> imcopy fitsfile.fits[0] outfile.fits
```

- If the specified output file already exists and you want to append a new extension to it, you need to include the APPEND option in the output file specification. The following command appends extension `[sci,2]` of `fitsfile.fits` onto the existing file `outfile.fits`, while retaining the original EXTNAME and EXTVER of the extension—the `noinherit` specification inhibits the copying of the primary header keywords from the input file into the output extension header:

```
cl> imcopy fitsfile.fits[sci,2,noinherit] \
>>> outfile.fits[append]
```

- If you want to change the EXTNAME or EXTVER of the appended extension, you can specify the new values of these keywords in the output extension, like this:

```
cl> imcopy fitsfile.fits[sci,2,noinherit] \
>>> outfile.fits[sci,3,append]
```

- For obvious reasons, it is not generally advisable for two file extensions in the same FITS file to share the same EXTNAME and EXTVER values. However, if you must append an extension to an output file already containing an extension with the same EXTNAME/EXTVER pair you can do so with the DUPNAME option:

```
cl> imcopy fitsfile.fits[7] \
>>> outfile.fits[append,dupname]
```

- If you need to replace an existing extension with a new output extension, you can use the OVERWRITE option as follows. Overwriting can cause a lengthy rewrite of the whole file to insert the new extension, if its size is not the same as the extension it replaces.

```
cl> imcopy fitsfile.fits[sci,2,noinherit] \
>>> outfile.fits[sci,2,overwrite]
```

2.2.2 Working with FITS Table Extensions

STIS and NICMOS use FITS tables in two basic ways. Both instruments produce association tables (see “Associations” on page B-4) listing the exposures that go into constructing a given association product. In addition, STIS provides certain spectra, calibration reference files, and time-tagged data in tabular form (see Chapter 20). Here we describe:

- How to access and read FITS table extensions.
- How to specify data arrays in FITS table cells.

This discussion assumes you are using STSDAS 2.0 or later. (The IRAF FITS kernel deals only with FITS images. The **tables** package installed with STSDAS handles FITS table extensions.)

Accessing FITS Tables

You can access data in FITS table extensions using the same tasks appropriate for any other STSDAS table, and the syntax for accessing a specific FITS table is similar to the syntax for accessing FITS images (see "Working with FITS Image Extensions" on page 2-4), with the following exceptions:

- The FITS table interface does not support header keyword inheritance.
- FITS tables cannot reside in the primary HDU of a FITS file. They must reside instead in a FITS table extension, in either ASCII form (XTENSION=TABLE) or binary form (XTENSION=BINTABLE).
- If the first extension in a FITS file is a TABLE or a BINTABLE, you can access it by typing the file name with no extension specifed. It is not sufficient for the table to be just the first BINTABLE or TABLE; *it must actually be the first extension*.

For example, running **catfits** on the NICMOS association table `n3tc01010_asn.fits` provides the following output:

```
fi> catfits n3tc01010_asn.fits

EXT#  FITSNAME      FILENAME              EXTVE ...
0     n3tc01010_asn N3TC01010_ASN.FITS ...
1       BINTABLE    ASN                   1 ...
```

Extension number 1 holds the association table, which has EXTNAME=ASN and EXTVER=1. You can use the **tprint** task in the STSDAS **tables** package to print the contents of this table, and the following commands are all equivalent:

```
tt> tprint n3tc01010_asn.fits
tt> tprint n3tc01010_asn.fits[1]
tt> tprint n3tc01010_asn.fits[asn,1]
```

STSDAS **tables** tasks can read both FITS TABLE and BINTABLE extensions, but they can write tabular results only as BINTABLE extensions. Tasks that write to a table in-place (i.e., **tedit**) can modify an existing FITS extension, and tasks that create a new table (i.e., **tcopy**) will create a new extension when writing to an existing FITS file. If the designated output file does not already exist, the task will create a new FITS file with the output table in the first extension. If the output file already exists, your task will append the new table to the end of the existing file; the APPEND option necessary for appending FITS image extensions is not required. As with FITS images, you can specify the EXTNAME and EXTVER of the ouput extension explicitly, if you want to assign them values different from those in the input HDU. You can also specify the OVERWRITE option if you want the output table to supplant an existing FITS extension. For example, you could type:

```
tt> tcopy n3tc01010_asn.fits outfile.fits[3][asn,2,overwrite]
```

This command would copy the table in the first extension of `n3tc01010_asn.fits` into the third extension of `outfile.fits`, while reassigning it the EXTNAME/EXTVER pair `[asn,2]` and overwriting the previous contents of the extension. Note that overwriting is the only time when it is valid to specify an extension, EXTNAME, and an EXTVER in the output specification.

Specifying Arrays in FITS Table Cells

A standard FITS table consists of columns and rows forming a two-dimensional grid of cells; however, each of these cells can contain a data array, effectively creating a table of higher dimensionality. Tables containing extracted STIS spectra (see “Tabular Storage of STIS Data” on page 20-5) take advantage of this feature. Each column of a STIS spectral table holds data values corresponding to a particular physical attribute, such as wavelength, net flux, or background flux. Each row contains data corresponding to one spectral order, and tables holding echelle spectra can contain many rows. Each cell of such a spectral table can contain a one-dimensional data array corresponding to the physical attribute and spectral order of the cell.

In order to analyze tabular spectral data with STSDAS tasks other than the **sgraph** task and the **igi** package, which have been appropriately modified, you will need to extract the desired arrays from the three-dimensional table. Two new IRAF tasks, named **tximage** and **txtable**, can be used to extract the table-cell arrays. Complementary tasks, named **tiimage** and **titable**, will insert arrays back into table cells. To specify the arrays which should be extracted from or inserted into the table cells, you will need to use the *selectors* syntax to specify the desired row and column. The general syntax for selecting a particular cell is:

`intable.fits[`*extension number*`][c:`*column_selector*`][r:`*row_selector*`]`

or

`intable.fits[`*keyword options*`][c:`*column_selector*`][r:`*row_selector*`]`

A *column selector* is a list of column patterns separated by commas. The column pattern is either a column name, a file name containing a list of column names, or a pattern using the IRAF pattern matching syntax. If you need a list of the column names, you can run the **tlcol** task (type `tlcol infile.fits`).

Rows are selected according to a *filter*. The filter is evaluated at each table row, and the row is selected if the filter is true. For example, if you specify:

```
infile.fits[3][c:WAVELENGTH,FLUX][r:SPORDER=(68:70)]
```

IRAF will extract data from the table stored in the third extension of the FITS file, `infile.fits`, specifically the data from the columns labelled WAVELENGTH and FLUX, and will restrict the extraction to the rows where the spectral order (SPORDER) is within the range 68–70, inclusive. Alternatively, if you specify:

```
infile.fits[sci,2][c:FLUX][r:row=(20:30)]
```

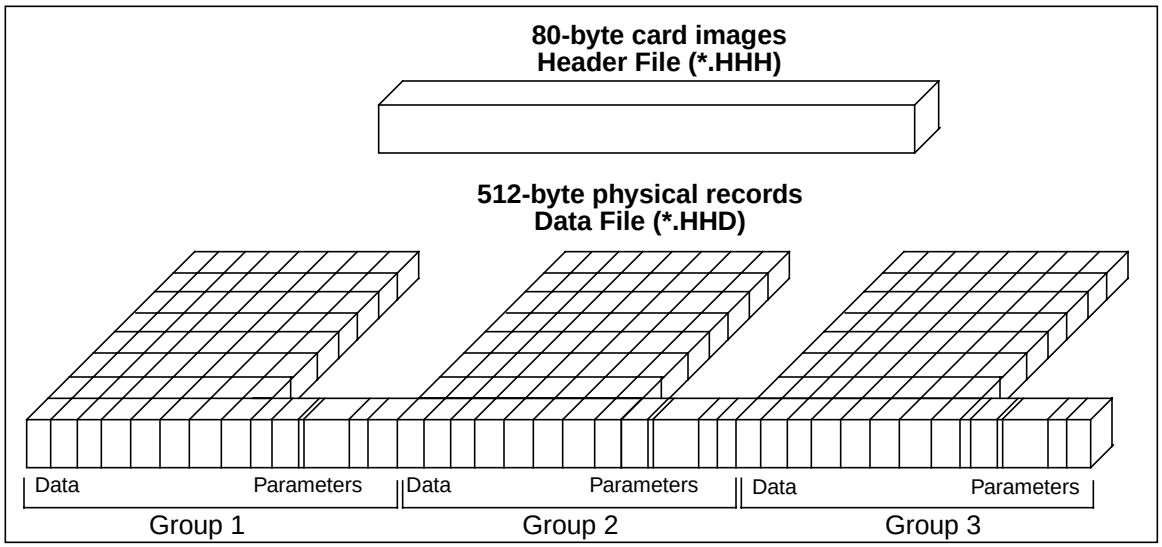
IRAF will obtain data from the table stored in the FITS file extension with an EXTNAME of SCI and EXTVER of 2. The data will come from the column FLUX and be restricted to the row numbers 20–30, inclusive. Eventually, all STSDAS and TABLES tasks will be able to use row and column selection.

2.3 GEIS File Format

The HST-specific Generic Edited Information Set (GEIS) format[1] is the standard format for reducing data from FOC, FOS, FGS, GHRS, HSP, WF/PC-1, and WFPC2. All HST images in GEIS format consist of two components: a *header file* and a separate *binary data file*, both of which should reside in the same directory. GEIS header files, whose suffixes end in "h" (e.g., `w0lo0105t.c1h`), consist entirely of ASCII text in fixed-length records of 80 bytes. These records contain header keywords that specify the properties of the image itself and the parameters used in executing the observation and processing the data. GEIS binary data files, whose suffixes end in "d" (e.g., `w0lo0105t.c1d`), contain one or more *groups* of binary data. Each group comprises a data array followed by an associated block of binary parameters called the Group Parameter Block (GPB). The sizes and datatypes of the data arrays and group parameters in each group of a GEIS file are identical. Figure 2.3 depicts the structure of a GEIS data file graphically.

The binary content of GEIS files is machine dependent. Copying GEIS files directly from one platform to another (e.g., from a VAX to a Sun) may result in unreadable data.

Figure 2.3: GEIS File Structure



1. GEIS files are also commonly referred to as STSDAS images.

2.3.1 Converting FITS to GEIS

The STScI archive stores and distributes datasets from FOC, FOS, FGS, GHRS, HSP, WF/PC-1, and WFPC2 in a special archival FITS format. *We highly recommend that users convert these datasets back into their native GEIS format before working with them.* Your data must be in GEIS format for you to use many of the STSDAS software tools developed specifically for analysis of these data. It is important to use the **strfits** task found in **stsdas.fitsio** or in **tables.fitsio** to perform the conversion from archival FITS format to the GEIS format because the data-processing pipeline employs a special convention for mapping GEIS files to FITS format. While other FITS readers may be able to read portions of the data correctly, they are unlikely to reconstruct the entire data file properly.

To recreate the original multigroup GEIS file using **strfits**, you must first type:

```
cl> set imtype=hhh
```

This command tells IRAF to write output files in GEIS format. You then need to set the **strfits** parameters `xdimtogf` and `oldirafname` both to "yes". For example, after you have set `imtype` = `hhh`, you can convert the FITS file `*_hhf.fits` into the GEIS format files `*.hhh` and `*.hhd` by typing:

```
cl> strfits *_hhf.fits iraf_fil="" xdim=yes oldiraf=yes
```

2.3.2 GEIS Data Groups

One of the original advantages of GEIS format noted in Section 2.1 was that it could accommodate multiple images within a single file. This feature is useful because a single HST observation often produces multiple images or spectra. For example, a single WF/PC-1 or WFPC2 exposure generates four simultaneous images, one for each CCD chip. Likewise, the FOS and GHRS obtain data in a time-resolved fashion so that a single FOS or GHRS dataset comprises many spectra—one corresponding to each readout. The data corresponding to each sub-image (for the WF/PC-1 or WFPC2) or each sub-integration (for the FOS or GHRS) are stored sequentially in the groups of a single GEIS binary data file. The header file corresponding to this data file contains the information that applies to the observation as a whole (i.e., to all the groups in the image), and the group-specific keyword information is stored in the group parameter block of each data group in the binary data file.

The *number* of groups produced by a given observation depends upon the instrument configuration, the observing mode, and the observing parameters. Table 2.1 lists the *contents* and the number of groups in the final calibrated image for the most commonly-used modes of each instrument.

2.3.3 Working with GEIS Files

This section briefly explains how to work with information in GEIS header and data files.

Table 2.1: Groups in Calibrated Images, by Instrument and Mode

Instrument	Mode	Number of Groups	Description
FGS	All	17	FGS data are not reduced with IRAF and STSDAS. Therefore, FGS groups have different meaning than for the other instruments.
FOC	All	1	All FOC images have only a single group.
FOS	ACCUM	*n*	Group *n* contains accumulated counts from groups (subintegrations) 1, 2, ... *n*. The last group is the full exposure.
	RAPID	*n*	Each group is an independent subintegration with exposure time given by group parameter EXPOSURE.
HSP	All	1	HSP datasets always have only a single group that represents either digital star (`.d0h`, `.c0h`), digital sky (`.d1h`, `.c1h`), analog star (`.d2h`, `.c2h`), or analog sky (`.d3h`, `.c3h`).
GHRS	ACCUM	*n*	Each group is an independent subintegration with exposure time given by group parameter EXPOSURE. If FP-SPLIT mode was used, the groups will be shifted in wavelength space. The independent subintegrations should be coadded prior to analysis.
	RAPID	*n*	Each group is a separate subintegration with exposure time given by group parameter EXPOSURE.
WF/PC-1	WF	4	Group *n* represents CCD chip *n*, e.g., group 1 is chip 1 (unless not all chips were used). Group parameter DETECTOR always gives chip used.
	PC	4	Group *n* is chip *n* + 4, e.g., group 1 is chip 5. If not all chips were used, see the DETECTOR parameter which always gives the chip used.
WFPC2	All	4	Planetary chip is group 1, detector 1. Wide Field chips are groups 2–4 for detectors 2–4. If all chips were not used, see the DETECTOR keyword.

GEIS Headers

Header keyword information relevant to each group of a GEIS file resides in two places, the header file itself and the parameter block associated with the group. Because GEIS header files are composed solely of ASCII text, they are easy to print using standard Unix or VMS text-handling facilities. However, the group parameters are stored in the binary data file. To access them you need to use a task such as **imheader**, as shown on page 2-13.

You can use the IRAF **hedit** task to edit the keywords in GEIS headers. While it it possible to edit GEIS header files using standard Unix and VMS text editors, you must maintain their standard 80-character line length. The **hedit** task automatically preserves this line length. If you need to add or delete group parameters, you can use the STSDAS **groupmod** task in the

stsdas.hst_calib.ctools package. The STSDAS **chcalpar** task, described in more detail in the Calibration chapters for each instrument, is useful for updating header keywords containing calibration switches and calibration reference files.

Always edit headers using tasks like **hedit**, **eheader**, and **chcalpar**. Editing headers with a standard text editor may corrupt the files by creating incorrect line lengths.

GEIS Data Files

Numerous IRAF/STSDAS tasks exist for working with GEIS images (see Chapter 3). Most of these tasks operate on only one image at a time, so you usually need to specify which group of a GEIS file is to be processed. If you do not specify a group, your task will choose the first group by default.

Specifying a Group

To specify a particular group in a GEIS file, append the desired group number in square brackets to the file name (e.g., `z2bd010ft.d0h[10]`). For example, to apply the **imarith** task to group 10 of a GEIS image, type the following:

```
cl> imarith indata.hhh[10] + 77.0 outdata.hhh
```

This command will add 77.0 to the data in group 10 of the file `indata.hhh`, and will write the output to a new single-group file called `outdata.hhh`. Any operation performed on a single group of a multigroup GEIS file results in an output file containing a single group.

Specifying an Image Section

If you wish to process only a portion of an image, you can specify the image section after the group specification in the following manner:

```
cl> imarith indata.hhh[2][100:199,200:399] * 32.0 outdata.hhh
```

This command extracts a 100 by 200 pixel subsection of the image in the second group of the file `indata.hhh`, multiplies this data by a factor of 32.0, and stores the result in a new output file, `outdata.hhh`, which is a 100 by 200 pixel single group GEIS file.

Printing Header Information

As discussed in the previous section, the task **imheader** extracts and prints information about the GEIS image. This task reports the image name, dimensions (including the number of groups), pixel type, and title of the image when it is run in default mode. For example:

```
cl> imhead indata.hhh
    indata.hhh[1/64][500][real]: INDATA[1/64]
```

The output line indicates that `indata.hhh` is a multigroup GEIS file which contains 64 groups of images, each consisting of a spectral array 500 pixels in length. The data type of the values is real (floating point). Note that since no group designation was provided, the task defaulted to the first group. To reveal more information regarding group 10, you can type:

```
cl> imhead indata.hhh[10] long+ | page
```

which will generate a long listing of both the ASCII header parameters in the `*.hhh` file and the specific GPB parameters for group 10 from the `*.hhd` file.

Other Group-Related Tasks

Currently, IRAF or STSDAS tasks cannot process all the groups in an input image and write the results to corresponding groups in an output image. However, there are several STSDAS tasks, particularly in the **toolbox.imgtools** and **hst_calib.ctools** packages, that simplify working with group format data. Please refer to the *STSDAS User's Guide* for more details about working with GEIS images.