Appendixes

Appendix A
IRAF Primer

In This Chapter...

The Image Reduction and Analysis Facility (IRAF), developed by the National Optical Astronomy Observatories (NOAO), forms the basis of the Space Telescope Science Data Analysis System (STSDAS). IRAF contains numerous packages of programs, called *tasks*, that perform a wide range of functions from reading data tapes to producing plots and images. Most astronomers will already be familiar with IRAF, but we provide this tutorial for HST observers who are beginners with IRAF. It includes information on:

- How to set up IRAF the first time you use the software.
- How to start and stop an IRAF session.
- Basic concepts, such as loading packages, setting parameters, etc.
- How to use the on-line help facility.

Additional information on IRAF, in particular *A Beginner's Guide to Using IRAF*, is available through the NOAO IRAF Home Page at:

`http://iraf.noao.edu`

A.1 Initiating IRAF

This section explains:

- How to set up your IRAF working environment.
- How to start and logout of the IRAF program.

We assume that your site has IRAF and STSDAS installed. If not, you must obtain and install the software. See "Getting IRAF and STSDAS" on page A-13 for details.

A.1.1 Setting Up IRAF

Before running IRAF for the first time you need to follow these three steps:

1. Create your IRAF root directory
2. Move to that directory and set the necessary environment variables or system logicals and symbols.
3. Run **mkiraf** to create a `login.cl` file and a `uparm` subdirectory

Users generally name their IRAF home directory `iraf` (also referred to as your IRAF *root* directory) and set it up in their account's root directory (i.e., the default directory that you are in when you log in to the system). The IRAF home directory doesn't need to be in your account's root directory, nor does it need to be called `iraf`, but you should *not* put it on a scratch disk that is periodically erased.

If you call your root IRAF directory "`iraf`", you can set up IRAF as follows:

Under Unix:

Can be placed in .login file

```
% mkdir iraf
% cd iraf
% setenv iraf /usr/stsci/iraf/
% source $iraf/unix/hlib/irafuser.csh
% mkiraf
```

The directory name is site-dependent—check with your system staff

Under VMS:

Can be placed in LOGIN.COM file

```
$ CREATE/DIR [.IRAF]
$ SET DEFAULT [.IRAF]
$ IRAF
$ MKIRAF
```

The **mkiraf** command initializes IRAF by creating a `login.cl` file and a subdirectory called `uparm`. After typing the **mkiraf** command, you will see the following:

```
% mkiraf
-- creating a new uparm directory
Terminal types: gterm=ttysw+graphics,vt640...
Enter terminal type:
```

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Enter the type of terminal or workstation you will most often use with IRAF. [1] Generic terminal types that will work for most users are:

- `vt100` for most terminals.
- `xtermjhs` for most workstations running under X-Windows.
- `xgterm` for sites that have installed X11 IRAF and IRAF v2.10.3 BETA or later.

You can change your terminal type at any time by typing `set term=`*new_type* during an IRAF session. You can also change your default type by editing the appropriate line in your `login.cl` file.

After you enter your terminal type, you will see the following output before getting your regular prompt:

```
A new LOGIN.CL file has been created in the current ...
You may wish to review and edit this file to change ...
```

The `login.cl` file is the *startup file* used by the IRAF command language (CL). It is similar to the `LOGIN.COM` file used by VMS or the `.login` file used by Unix. Whenever IRAF starts, it looks at the `login.cl` file. You can edit this file to customize your IRAF environment. In fact, you should look at it to make sure that everything in it is correct. In particular, there is a line starting with `set home =` that tells IRAF where to find your IRAF home directory. You should verify that this statement does, in fact, point to your IRAF directory. If you will be working with standard IRAF format images you should also insert a line saying `set imdir = "HDR$"`. The `imdir` setting is ignored when working with GEIS format images.

The `uparm` directory will contain your own copies of IRAF task parameters. This directory allows you to customize your IRAF environment by setting certain parameter values as defaults. Once you set up IRAF, you should rarely need to do it again, expect when updated version of IRAF are installed.

A.1.2 Starting and Stopping an IRAF Session

To start an IRAF session:

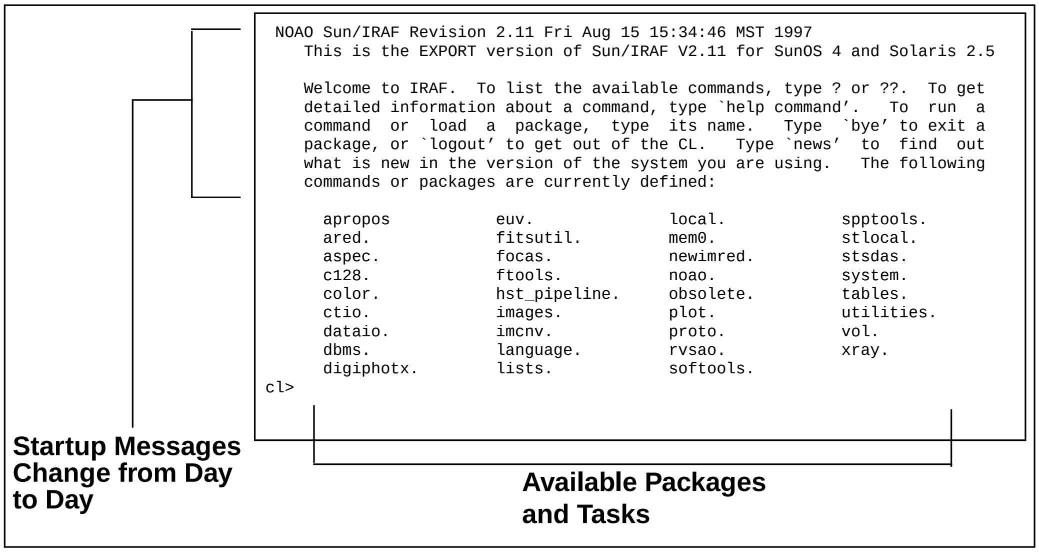
1. Move to your IRAF home directory.
2. Type `cl`.

---

1. Users at STScI should consult the *STScI Site Guide for IRAF and STSDAS*.

IRAF starts by displaying several lines of introductory text and then puts a prompt at the bottom of the screen. Figure A.1 is a sample IRAF startup screen.

Figure A.1: IRAF Startup Screen



To quit an IRAF session:

1. Type `logout`.

A.2 IRAF Basics

This section describes basic IRAF techniques such as:

- Loading packages (below).
- Running tasks and commands.
- Getting online help.
- Viewing and setting parameters (page A-8).
- Setting and using environment variables (page A-10).
- File management
- Troubleshooting

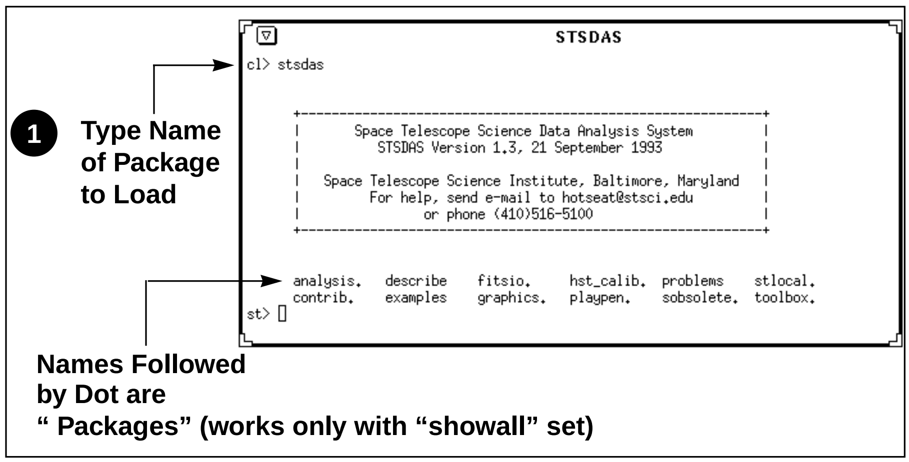
A.2.1 Loading Packages

In IRAF jargon, an application is called a *task* and logically related tasks are grouped together in a *package*. Before you can use a task, you must load the package containing that task. To load a package, type the name of the package.

The prompt will then change to the first two letters of the package name, and the screen will display the names of all the newly available tasks and subpackages. Even though the prompt has changed, previously loaded packages remain loaded, and all their tasks remain available.

Note that the standard way to specify a path through the IRAF package hierarchy to a task in a particular subpackage is to separate the package names with periods (e.g., **stsdas.hst_calib.foc.focgeom.newgeom**).

Figure A.2: Loading Packages



Some helpful commands for managing packages are:

- `?` - Lists tasks in the most recently-loaded package.
- `??` - Lists all tasks loaded, regardless of package.
- `package` - Lists names of all loaded packages.
- `bye` - Exits the current package.

A.2.2 Running Tasks

This section explains how to run tasks, background tasks, and system-level commands, and how to use piping and redirection.

Running a Task

The simplest way to run a task is to type its name or any unambiguous abbreviation of it. The task will then prompt you for the values of any required *parameters*, such as the names of input files. Alternatively, you can specify the values for the required *parameters* on the command line when you run the task. For example, if you want the task `imheader` to print header information on the file `myfile.hhh`, you can type

```
st> imhead myfile.hhh
```

IRAF does not require you to type the complete command name—only enough of it to make it unique. For example, **dir** is sufficient for **directory**.

Escaping System-Level Commands

To run an operating system-level command (i.e., Unix or VMS commands) from within the IRAF CL, precede the command with an exclamation point (!). This procedure is called *escaping* the command. For example:

`st> !`*system_command*

Piping and Redirection

You can run tasks in sequence if you desire, with the output of one task being used as the input for another. This procedure, called *piping*, and is done by separating commands with a vertical bar (|), using the following syntax:

`st>` *task1 filename* `|` *task2*

For example, if a particular task prints a large volume of textual output to the screen, you will often want to pipe it to `page`, which allows you to read the output one page at a time:

`st>` *task1 filename* `| page`

You can also redirect output from any task or command to a file by using the greater-than symbol (>) as follows:

`st>` *command* `>` *outputfile*

Background Tasks

To run a task as a background job, freeing your workstation window for other work, add an ampersand (&) to the end of the command line, like this:

`st>` *taskname* `&`

A.2.3 Getting Help

This section describes:

- How to use IRAF's on-line help facility.
- How to find a task that does what you want (page A-7).

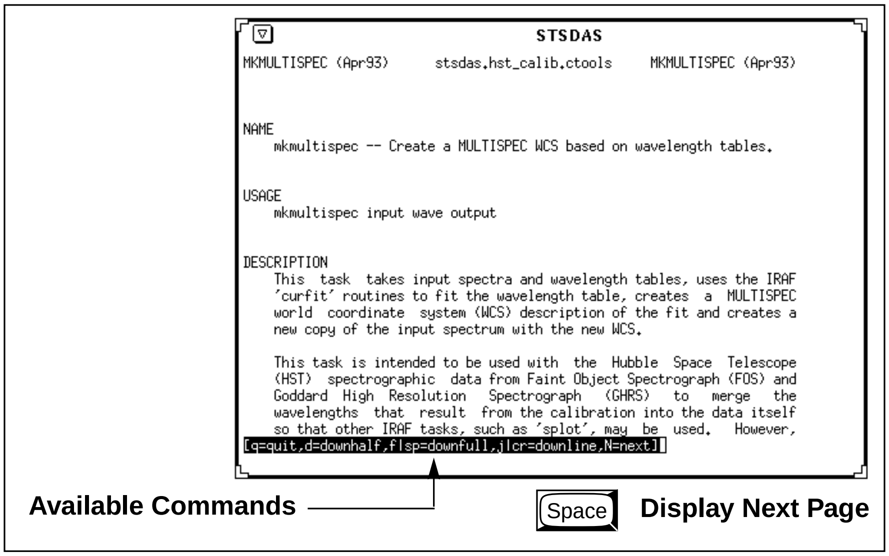
On-Line Help

You can get on-line help with any IRAF task or package by using the **help** command,[2] which takes as an argument the task or package name about which you want help. Wildcards are supported. For example, to display the on-line help for the STSDAS **mkmultispec** task, you would type:

```
fi> help mkmultispec
```

2. There is an optional *paging* front-end for help called **phelp**. For more information, type `help phelp` from within IRAF.

Figure A.3: Displaying On-line Help



Two STSDAS tasks that display only certain sections of the help file are also available:

- **examples** - Displays only the examples for a task.
- **describe** - Displays only the description of the task.

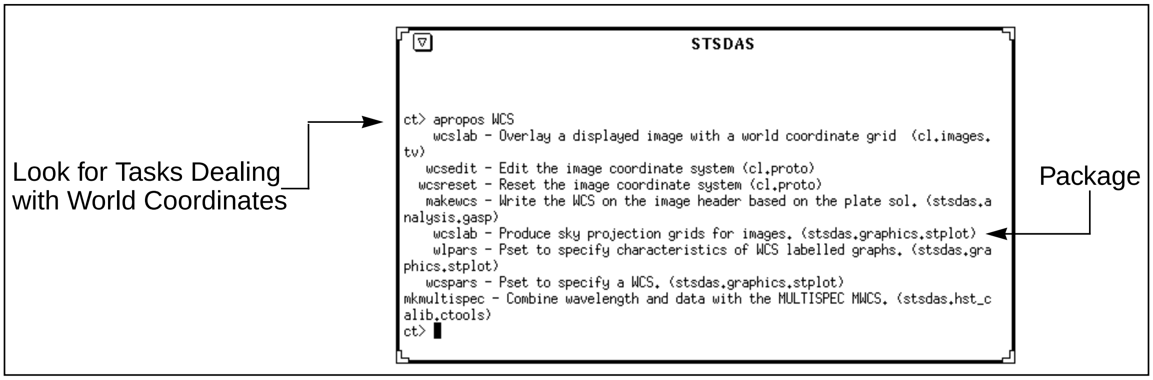
Typing `help` *package* will produce one-line descriptions of each task in the package.

Finding Tasks

There are several ways to find a task that does what you need:

- Use `help` *package* to search through the IRAF/STSDAS package structure.
- Use the **apropos** task as shown in Figure A.4 to search the online help database. This task looks through a list of IRAF and STSDAS package menus to find tasks that match a specified keyword. Note that the name of the package containing the task is shown in parentheses.
- Ask more experienced user, who can usually point you in the right direction.

Figure A.4: The **apropos** task Using apropos



A.2.4 Setting Parameters

Parameters specify the input information for IRAF tasks. They can be the names of input or output files, particular pixel numbers, keyword settings, or many other types of information that control the behavior of the task.

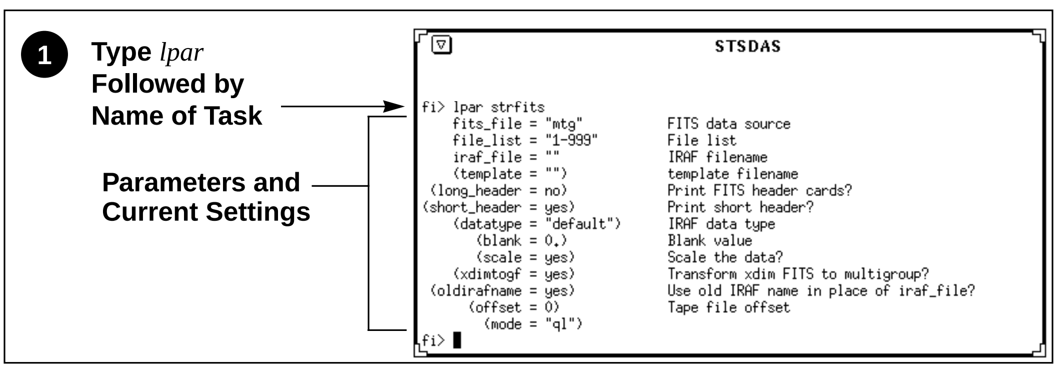
The two most useful commands for handling parameters are:

- **lparam** to display the current parameter settings (often abbreviated **lpar**).
- **eparam** to edit parameters (often abbreviated **epar**).

Viewing Parameters with lparam

The **lpar** command lists the current parameter settings for a given task (Figure A.5).

Figure A.5: Displaying Parameter Settings with lpar



Setting parameters with eparam

The **epar** command is an interactive parameter set editor. It displays all of the parameters and their current settings on the screen. You can move around the screen using the arrow keys (also called *cursor* keys) and type new settings for any parameters you wish to change. Figure A.6 shows a sample of the **epar** editor at work (invoked by typing `epar strfits`).

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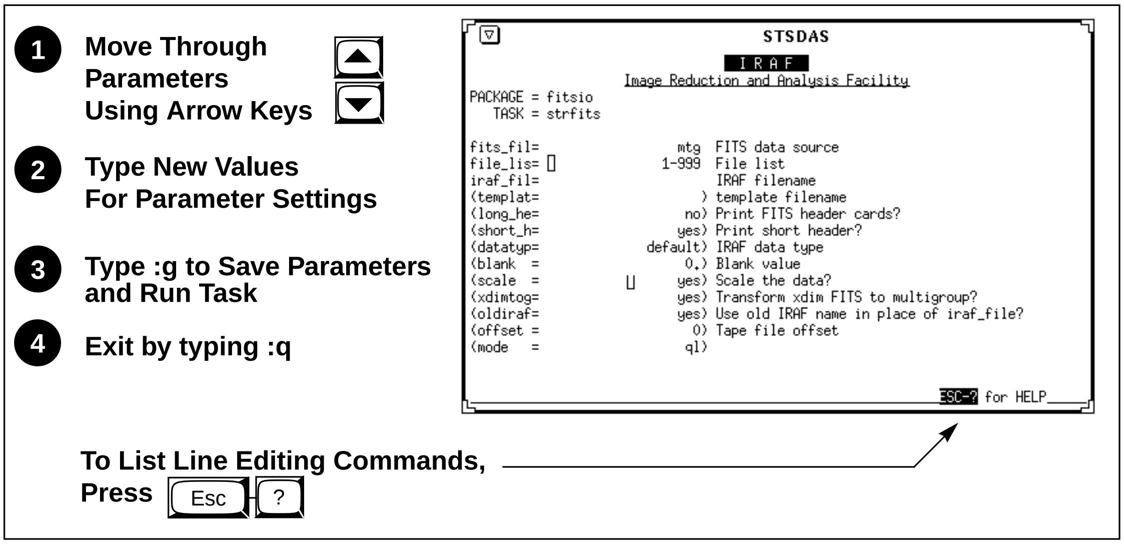
Figure A.6: Editing Parameters with epar



Parameter Data Types—What to Specify

Parameters are either *required* or *hidden*, and each parameter expects information of a certain *type*. Usually, the first parameter is required, and very often it expects a file name. Parameters are described in the online help for each task [include reference to help]. Hidden parameters, shown in parentheses in the online help and the **lpar** and **epar** listings, need not be specified at each execution because their default values frequently suffice.

Wise IRAF users will check the values of hidden parameters, as they often govern important aspects of a task's behavior.

If you specify the wrong type of information for a parameter, **epar** will usually display an error message saying something like "Parameter Value is Out of Range." The message is displayed when you move to another parameter or if you press Return. Table A.1 lists the different parameter types.

Table A.1: Parameter Data Types

Type	Description
`File Name`	Full name of the file. Wild card characters (* and ?) are often allowed. Some tasks allow you to use special features when specifying file names, including “@” lists, IRAF networking syntax, and image section or group syntax. (See “File Management” below).
`Integer`	Whole number. Often the task will specify minimum or maximum values (see the help pages).
`Real`	Floating point numbers, can be expressed in exponential notation. Often will have minimum and maximum values.
`Boolean`	Logical “yes” or “no” values.
`String`	Any characters. Sometimes file names are specified as string.
`Pset`	Parameter set.

Restoring Parameter Default Values

Occasionally, IRAF (or you) will get confused by your parameter values. To alleviate this confusion, you can restore the default parameters with the **unlearn** command. You can use **unlearn** on either a task or on an entire package.

The **unlearn** command generally will restore the parameters to reasonable values, a big help if you are no longer sure which parameter values you have changed in a complicated task.

A.2.5 Setting Environment Variables

IRAF uses *environment variables* to define which devices are used for certain operations. For example, your terminal type, default printer, and the disk and directory used for storing images are all defined through environment variables. Environment variables are set using the **set** command and are displayed using the **show** command. Table A.2 lists some of the environment variables that you might want to customize.

Table A.2: Environment Variables

Variable	Description	Example of Setting
`printer`	Default printer for text	`set printer = lp2`
`terminal`	Terminal type	`set term = xterm`
`stdplot`	Default printer for all graphics output	`set stdplot = ps2`
`stdimage`	Default terminal display setting for image output (most users will want this set to either imt512 or imt800)	`set stdimage = imt800`
`stdgraph`	Default graphics device	`set stdgraph = xterm`
`clobber`	Allow or prevent overwriting of files	`set clobber = yes`
`imtype`	Default image type for output images. “imh” is original IRAF format, “hhh” is STSDAS GEIS format.	`set imtype = “hhh”`

If you are working with GEIS files, you should set `imtype` to “`hhh`”. If you are working with STIS and NICMOS data in FITS files, you can set `imtype` to “`fits`”

You can set your environment variables automatically each time you login to IRAF by adding the appropriate commands to your `login.cl` file. Use your favorite text editor to specify each variable on its own line. The **show** command with no arguments prints the names and current values of all environment variables.

A.2.6 File Management

This section describes:

- File formats commonly used with STSDAS and IRAF.
- Specification of file names.
- Navigation through directories.

File Formats

IRAF recognizes a number of different file structures. Among them are the standard HST file formats known as GEIS and FITS (see Chapter 2), both of which differ from the original IRAF format (OIF). GEIS is closer to OIF, in that two files are *always* used together as a pair:

- A *header file*, which consists of descriptive information. IRAF header files are identified by the suffix `.imh`. GEIS header files are in ASCII text format and are identified by the suffix `.hhh` or another suffix ending in "`h`", such as `.c0h` or `.q1h`.
- A *binary data file*,[3] consisting of pixel information. IRAF data file names end with a `.pix` suffix. STSDAS data files end with an suffix of `.hhd` or another suffix that ends with "d", such as `.c0d` or `.q0d`.

STSDAS always expects both component files of a GEIS image to be kept together in the same directory. A single FITS file contains both the header information and the data.

When working with IRAF or STSDAS images, you need only specify the header file name—the tasks will automatically use the binary data file when necessary.

File Specification

Most tasks in IRAF and STSDAS operate on files and expect you to specify a file name for one or more parameters. Several types of special syntax can be used with certain tasks when specifying file names. These syntax features include:

- **Wild card characters**, often called *templates*, which are used to specify multiple files using pattern matching techniques. The wild cards are:
  - * Matches any number of characters, e.g.: `z*.c0h`
  - ? Matches any single character, e.g.: `z01x23x.c?h`

When using wildcards with image-processing tasks, be sure to exclude the binary pixel files by ending your file name specification with an "h", for example: `y*.??h`

- **List files**, often called *@-files*, which are ASCII file that contain lists of file names, one per line. If your task supports the list file feature, you would type the name of your list file, preceded by the "@" character. For example: `@files.txt`
- **Image section** specification. Tasks that work with image data will often let you specify that you want to work on only a small area of the image rather than the entire image. To extract a particular image section, specify each axis range in square brackets, for example: `image.hhh[10:200,20:200]`

3. The binary data file format is host-dependent and may require translation before it can be moved to a computer using a different architecture.

- **IRAF networking** specification. IRAF is capable of reading and writing files to and from remote systems on a network. This feature is often used with tasks in the **fitsio** and **convfile** packages, or with image display tasks. The *STSDAS Users Guide* and the online help (type `help networking`) describe how to enable this feature. To specify that you want to use the IRAF networking feature, type the remote host name followed by an exclamation point (!), followed by the file or device name. For example: `ra!mta`.

Directory Navigation

To navigate through directories, you can use the following commands:

- **path** or **pwd -** Lists the current working directory.
- **cd** *directory* - Move to the named directory.

A.2.7 Troubleshooting

There are a couple of easy things you can do to make sure that you don't have a simple memory or parameter conflict—common causes of problems.

- Look at the parameter settings and make sure that you have specified reasonable values for every parameter.
- When you run an IRAF task for the first time in a session, IRAF stores the executable file in its *process cache*. If IRAF appears not to be running your tasks properly, you may need to use the **flprcache** command to clear the process cache. To do this type: `flpr` Sometimes you will need to execute this command twice in succession.
- Occasionally, you may need to logout of the CL, restart IRAF, and try your command again.

If you still have a problem, contact the STScI Help Desk at `help@stsci.edu`

A.3 Getting IRAF and STSDAS

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Both IRAF and STSDAS are provided free of charge to the astronomical community. You must have IRAF to run STSDAS. Detailed information about installing and retrieving STSDAS is found in the *STSDAS Site Manager's Installation Guide and Reference*. If you have any problems getting and installing STSDAS, TABLES, or any other packages or data described in this handbook, please contact the Help Desk by sending e-mail to: `help@stsci.edu`.

A complete description of how to install the **synphot** data files is provided on page A-15.

A.3.1 Retrieving the IRAF and STSDAS Software

There are three ways to get the software:

- Use the World Wide Web.
- Use anonymous FTP.
- Request a tape.

World Wide Web

The STSDAS World Wide Web page:

`http://ra.stsci.edu/STSDAS.html`

provides links and instructions for downloading the appropriate files to your local system or to display the software directory, from which you can select the series of smaller files.

Anonymous FTP

- **IRAF**: `iraf.noao.edu` (140.252.1.1)
- **STSDAS**: `ftp.stsci.edu` (130.167.1.2)

There are two points to remember when using FTP to retrieve STSDAS:

- You must retrieve and install the TABLES package before STSDAS.
- You should retrieve the `README` file from the directory `/software/stsdas/v2.0` and read it to find out which files you should retrieve.

You must have IRAF installed on your system to install TABLES and STSDAS. When you retrieve STSDAS, you must also retrieve the TABLES package, and TABLES must be installed first.

Instructions for installing STSDAS are available in the `doc` subdirectory of the directory where you find STSDAS. The complete instructions for installing STSDAS, TABLES, and all of the supporting software and reference files (including instrument reference files and the **synphot** dataset) are found in the *STSDAS Site Manager's Installation Guide and Reference*.

Requesting Tapes

You can ask to have the software shipped to you on magnetic tape in a variety of formats. To do so, you will need to contact the Help Desk by sending e-mail to `help@stsci.edu`. The Help Desk staff will send you an ASCII text version of the STSDAS Software Request Form, which you can then complete and return via e-mail. The software can also be registered and requested using on-line forms available through World Wide Web at the following URL:

`http://ra.stsci.edu/RegistForm.html`

When you request the STSDAS software, you can also ask for the appropriate version of IRAF, which will be requested for you— simply check the appropriate box on the form under “Do You Already Have IRAF Installed?” If you prefer to request the IRAF software independent of STSDAS, you can do so by sending e-mail to: `iraf@iraf.noao.edu`

A.3.2 Getting the Synphot Database

This manual sometimes refers to the **synphot** dataset, which must be available in order to run tasks in the STSDAS **synphot** package. These data files are not included with the STSDAS software and must be retrieved independently. To do this, you need to retrieve a series of compressed tar files from the STScI FTP site (ftp.stsci.edu) in the directory `software/stsdas/refdata/synphot`. After uncompressing and extracting the tar files (see below), you need to unpack the FITS files as described below.

The synthetic photometry data are read in similar way as the instrument datasets, using the script `unpack.cl` provided in the top directory. This script is run within IRAF to convert data from FITS format into the format used by the **synphot** task. This script assumes you have the logical `crrefer` set up in your `extern.pkg` file (which is in the directory `$iraf/unix/hlib` (Unix) or `$iraf/vms/hlib` (VMS)) or have it set up in your session. You do this by placing the command below in `extern.pkg` or by typing it on the command line:

```
set crrefer = "/node/partition/stdata/synphot/"
```

Figure A.7 shows how to convert the files.

Figure A.7: Unpacking Synthetic Photometry Files

```
% cl
cl> cd /node/partition/stdata/synphot
cl> set crrefer = "/node/partition/stsdata/synphot/"
cl> task $unpack = unpack.cl
cl> tables
ta> fitsio
fi> unpack
```

Just in case...

The “$” is used because the task has no parameter file

Note that all three **synphot** files must be unloaded for the script to complete successfully.

A.3.3 Extracting the synphot Unix Tar Files

If you retrieved the **synphot** database as compressed tar files, you will need to copy them to an appropriate subdirectory and then expand and unpack the files. The tar and compress utilities that do this are are commonly available on most Unix systems, but are not standard in the VMS environment. The examples shown below reflect Unix usage. If you are on a VMS system, you should consult with your systems support staff regarding the availability and usage of these commands. To process the files on a Unix system:

1. Get the compressed tar file that you want, as described in previous sections.
2. Make an appropriate subdirectory using the `mkdir` command.
3. Pipe the compressed tar file through the `uncompress` and `tar` files to expand and unpack the file.

The following example shows how to do this. The example assumes that you are putting the files in a subdirectory under `/usr/iraf/stdata` (note that the name of your file here is assumed to be `XXX.tar.Z`).

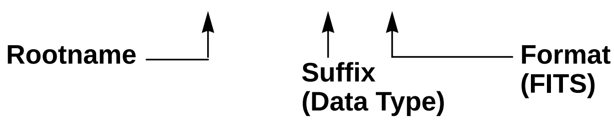
```
% pwd
/usr/iraf/stdata
% mkdir XXX
% mv XXX.tar.Z XXX/
% cd XXX
% cat XXX.tar.Z | uncompress | tar -xf -
```

Appendix B

HST File Names

This appendix describes the syntax of HST data file names, which encode a large amount of information about the files themselves. Datasets retrieved from the Archive as described in Chapter 1 consist of multiple files in FITS format, each with a name that looks like this:

```
ipppssoot_sfx.fits
```



- ***Rootname***: The first part of the file name (`ipppssoot`) is the *rootname* of the dataset to which the file belongs. All files belonging to a given dataset share the same rootname.
- ***Suffix***: The three-character second part of the name (`sfx`) is called the *suffix*, and it indicates the type of data the file contains.
- ***Format***: The identifier `.fits` indicates that this file is in FITS format.

For example, an FOC data file named `x3l80101t_d0f.fits` is a FITS file belong to the dataset with rootname `x3l80101t`, and its suffix `d0f` indicates that it contains raw science data.

In order to use IRAF/STSDAS tasks to work with data from instruments other than NICMOS and STIS, you will want to convert these FITS files into GEIS format. See page 2-11 for instructions on how to convert FITS files to GEIS files using **strfits**. Like FITS files, the names of GEIS files also derive from a file's rootname and suffix, and they look like this:

```
ipppssoot.sfx
```

Generally the suffixes of GEIS files end either in "`d`", indicating a binary data file, or "`h`", indicating an ASCII header file. The two GEIS files `x3l80101t_d0h` and `x3l80101t_d0d` together contain the same information as the single FITS file `x3l80101t_d0f.fits`.

The identifier referred to here as a “suffix” has often been called an “extension” in the past. However, the individual pieces of FITS files are also known as “extensions” (see “Working with FITS Image Extensions” on page 2-4). For clarity, this handbook will use the term “extension” when refering to a component of a FITS file and the term “suffix” when referring to the three character identifier in a filename.

Rootnames

Rootnames of HST data files follow the naming convention defined in Table B.1, which expands on the previous convention as follows: an initial “N” indicates a NICMOS exposure, an intial “O” indicates a STIS exposure, and the rootnames of files containing association products (see below) end in a number (0-8).

Table B.1: IPPPSSOOT Root File Names

Character	Meaning
I	Instrument used, will be one of: ***E*** - Engineering data ***F*** - Fine Guidance Sensors ***N*** - Near Infrared Camera and Multi-Object Spectrograph ***O*** - Space Telescope Imaging Spectrograph ***S*** - Engineering subset data ***T*** - Guide star position data ***U*** - Wide Field/Planetary Camera-2 ***V*** - High Speed Photometer ***W*** - Wide Field/Planetary Camera ***X*** - Faint Object Camera ***Y*** - Faint Object Spectrograph ***Z*** -Goddard High Resolution Spectrograph
PPP	Program ID; can be any combination of letters or numbers (46,656 combinations possible). There is a unique association between program ID and proposal ID.
SS	Observation set ID; any combination of letters or numbers (1,296 possible combinations).
OO	Observation ID; any combination of letters or numbers (1,296 possible combinations).
T	Source of transmission or association product number ***M*** - Merged real time and tape recorded ***N*** - Retransmitted merged real time and tape recorded ***O*** - Retransmitted real time (letter ‘O’) ***P*** - Retransmitted tape recorded ***R*** - Real time (not recorded) ***T*** - Tape recorded ***0*** - Primary association product (number zero) ***1-8*** - NICMOS background association product

Suffixes of Files Common to all Instruments

The three-character suffix of a data file (e.g., `d0h`) identifies the type of data that a file contains. Because the meanings of these suffixes change from instrument to instrument, please refer to the appropriate instrument-specific Data Structures chapter for their definitions. Several types of file suffixes are, however, common to all instruments.

OMS Files

Observatory Monitoring System (OMS) files, having suffixes `cm*` or `ji*`, contain Observation Logs describing how the HST spacecraft behaved during a given observation. OMS headers, which you can read with the IRAF task **imheader** (see "Working with GEIS Files" on page 2-11), are divided into groups of keywords that deal with particular topics such as SPACECRAFT DATA, BACKGROUND LIGHT, POINTING CONTROL DATA, and LINE OF SIGHT JITTER SUMMARY. The headers themselves provide short descriptions of each keyword.OMS tables and images record spacecraft pointing information as a function of time. For more information on OMS files, you can consult Appendix C or the STScI Observation Logs WWW pages at:

```
http://www.stsci.edu/ftp/instrument_news/Observatory/
obslog/OL_1.html
```

PDQ Files

The suffix `pdq` denotes Post Observation Summary and Data Quality Comment files—*PDQ files*—which contain predicted as well as actual observation parameters extracted from the standard header and science headers. These files may also contain comments on any obvious features in the spectrum or image, as noted in the OPUS data assessment, or automatically extracted information about problems or oddities encountered during the observation or data processing. These comments may include correction to the keywords automatically placed in the OMS files. The sample PDQ file on page 5-9 gives an example of such a correction.

OCX Files

The suffix `ocx` denotes Observer Comment Files—*OCX files*—which are produced by STScI personnel to document the results of real-time commanding or monitoring of the observation, along with keywords and comments. Prior to April 17, 1992, OCX files were not always archived separately and, in some cases, were prepended to the trailer file.

After early February 1995, OCX files were produced only when an observation was used to locate the target for an Interactive Target Acquisition. At this time, mission and spacecraft information were moved to the PDQ reports and the Observation Logs (OMS jitter image and jitter table).

Trailer Files

Trailer files (suffix `trl`) are FITS ASCII tables that log the processing of your data by the OPUS pipeline.

Note that trailer files are formatted with 132 columns.

Associations

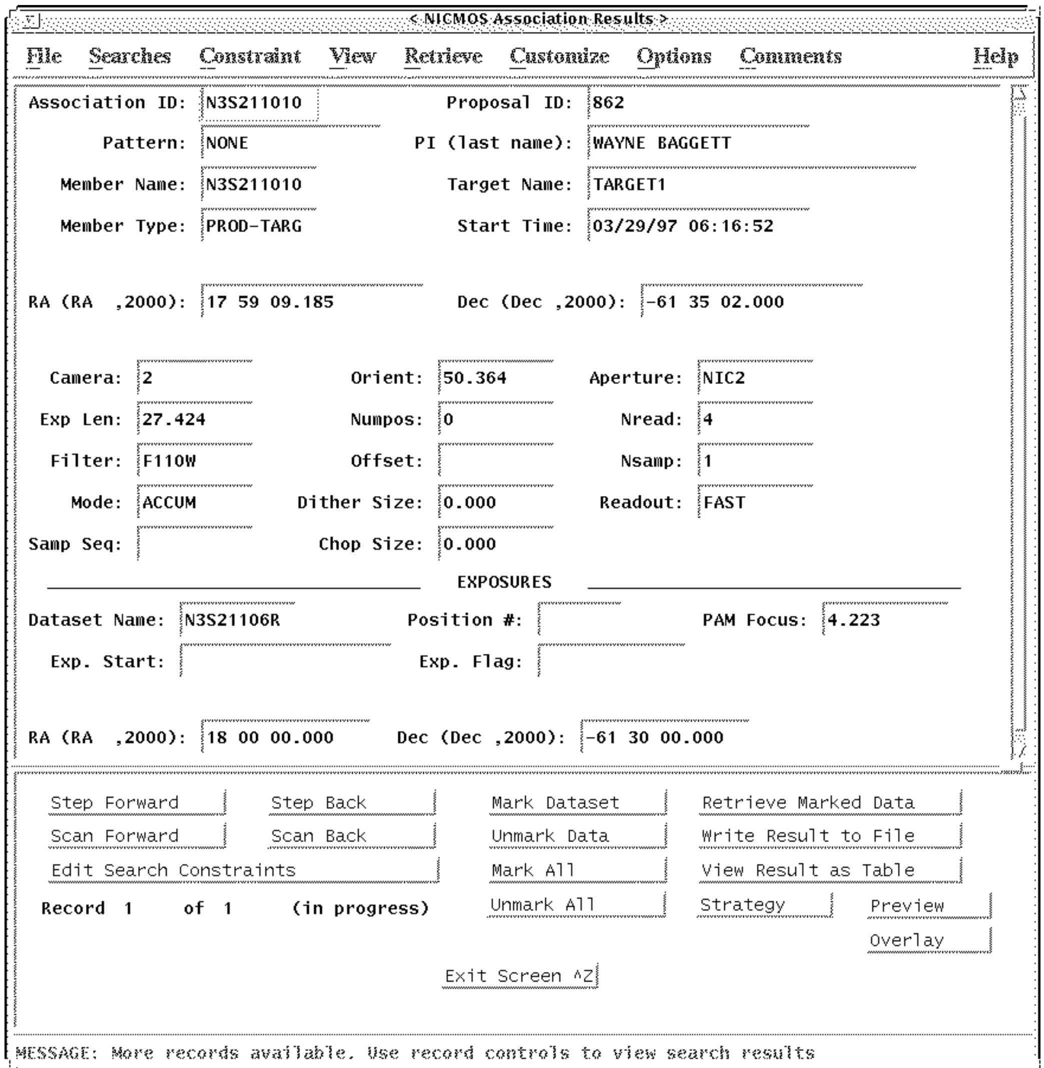
The STIS and NICMOS calibration pipelines sometimes produce single calibrated images from *associations* of many exposures. These associations allow HST pipeline processing to proceed further than it has in the past. For example, a NICMOS observer might specify a dithering pattern in a Phase II proposal. NICMOS would then take several exposures at offset positions, and the pipeline would combine them into a single mosaic. In this case, the original set of exposures constitutes the association, and the mosaic is the *association product*. Similarly, a STIS observer might specify a CR-SPLIT sequence in a Phase II proposal. STIS would gather several exposures at the same pointing, and the STIS pipeline would process this association of exposures into single image, free of cosmic rays, that would be the association product.

When you search the Archive with StarView for observations involving associations of exposures, your search will identify the final association product. The rootnames of association products always end in zero (see Table B.1 above.) If you request both Calibrated and Uncalibrated data from the Archive, you will receive both the association product and the exposures that went into making it. The corresponding association table, located in the file with suffix `asn` and the same rootname as the association product, lists the exposures belonging to the association. You can read this file using the STSDAS **tprint** or **tread** tasks (see "Tables" on page 3-2). The exposure IDs in the association table share the same `ipppss` sequence as the association rootname, followed by a base 36 number `nn` (`n` = 0-9,A-Z) that uniquely identifies each exposure, and a character `t` that denotes the data transmission mode (see Table B.1).

In practice, STIS and NICMOS store the exposures belonging to associations differently. The exposures belonging to a STIS association all reside in the same file, while the exposures belonging to a NICMOS association reside in separate datasets. See the relevant Data Structures chapters for more details.

Information on the exposures belonging to an association is also available through StarView (see Chapter 1). From the <Welcome> Screen, click on **[HST Instrument Searches]** to get the <HST Instruments> screen, and then click on the **[Associations]** button for the instrument of interest. You can then search for the various exposures belonging to an association by entering the rootname of the association in the Association ID field and clicking on **[Begin Search]** . An Association Results Screen will display the results of the search, which you can step though using the **[Step Forward]** button. Figure B.1 below gives an example of a NICMOS Association Results Screen. Note the differences between the association rootname and coordinates and those of the individual exposure.

Figure B.1: Association Results Screen from StarView



Appendix C
Observation Logs

In This Chapter...

This Appendix describes the *Observation Log Files*, also known as OMS or *jitter* files. These files record pointing, jitter, and other Pointing Control System (PCS) data taken during an HST observation. You can use them to assess the behavior of the HST spacecraft during your observation, and in particular, to evaluate the jitter of the spacecraft while it was taking data. Here we describe the contents and structure of the observation log files, how to retrieve them from the Archive, and how to work with the data they contain.

C.1 Observation Log Files

Observation log files associated with each HST dataset contain pointing and specialized engineering data taken during the observation. These data files are produced by the Observatory Monitoring System (OMS), an automated software system that interrogates the HST engineering telemetry and correlates the time-tagged engineering stream with HST's Science Mission Schedule (SMS), the seven-day command and event list that drives all spacecraft activities. This system reports the status of the instruments and observatory and flags discrepancies between planned and executed actions. OMS provides observers with information about guide star acquisition, pointing, and tracking that is not normally provided in the science headers.

The observation log files share the same rootname as the observation they are associated with, except for the final character, which for observation log files is always a "`j`" (see Appendix B for more on the names of HST data files). When

OMS was installed in October 1994, it initially generated files with the suffixes `cmh`, `cmj`, `cmi`, which contained header information, high time resolution pointing data, and three-second average pointing data, respectively (see Table C.1). OMS observation logs changed to the `jih`/`jid/jif` image format after August 1995, at which time the `cmi` table was renamed `jit` to keep the naming convention consistent. In the OMS version of August 1995, `cmj` tables were replaced with a jitter image, which is a two-dimensional histogram of jitter excursions during the observation. The suffixes of the GEIS jitter image are `jih` for the header and `jid` for the image data. The `jit` table accompanies the jitter image. The header file of the image replaces the `cmh` file but includes the same information with the addition of some image-related keywords.

A detailed description of the observation log files can be found on-line: `http://www.stsci.edu/ftp/instrument_news/Observatory/obslog/OL_1.html`

Table C.1: OMS Observation Log Files

Suffix	Contents
	October 1994 to August 1995
`cmh`	OMS header
`cmj`	High time resolution (IRAF table)
`cmi`	Three-second averages (IRAF table)
`_cmh.fits`	Archived FITS file of `cmh`
`_cmj.fits`	Archived FITS file of `cmj`
`_cmi.fits`	Archived FITS file of `cmi`
	August 1995 to February 1997
`jih/jid`	Two-dimensional histogram and header (GEIS)
`jit`	Three-second averages (IRAF table)[a]
`_jif.fits`	Archived FITS file which bundles the `jih/jid` files.
`_jit.fits`	Archived FITS file of `jit`.
	February 1997 onward
`_jif.fits`	Two-dimensional histogram (FITS)
`_jit.fits`	Three-second averages table (FITS)

a. After May 11, 1995, the `jit` tables for exposures shorter than 6 seconds contain higher-resolution, one-second average pointing data.

Pointing and tracking information prior to October 1994 is not routinely available. Interested observers with data from this epoch, can send E-mail to `help@stsci.edu`.

Observation Log File Contents (October 1994 version)

Observation logs created between October 1994 and August 1995 contain:

- *rootname*`j.cmh`: This ASCII header file contains the time interval, the rootname, averages of the pointing and spacecraft jitter, the guiding mode, guide star information, and alert or failure keywords. Figure C.1 shows a representative observation log header file.
- *rootname*`j.cmj`: This table presents the data at the highest time resolution for the telemetry mode in use. It contains the reconstructed pointing, guide star coordinates, derived jitter at the instrument aperture, and guiding-related flags. The intent is: (1) to provide high-time resolution jitter data for deconvolution or for assessing small aperture pointing stability, and (2) to display the slew and tracking anomaly flags with the highest resolution. Table C.2 lists the table column heading, units and a brief definition.
- *rootname*`j.cmi`: This table contains data that were averaged over three-second intervals. It includes the same information as the `.cmj` table and also includes orbital data (e.g., latitude, longitude, limb angle, magnetic field values, etc.) and instrument-specific items. It is best suited for a quick-look assessment of pointing stability and for studying trends in telescope or instrument performance with orbital environment. Table C.3 lists the table column heading, units and a brief definition.
- rootnamej_cmi`/j/h.fits`: The above three GEIS files are actually archived as FITS files. They may be worked with as such, or run through the STSDAS task **strfits**, to convert them.

Observation Log File Contents (August 1995 version)

The contents of observation log files created between August 1995 and February 1997 are as follows:

- *rootname*`j.jih`: This GEIS header file, the analog to the `cmh` file, contains the time interval, the rootname, averages of the pointing and spacecraft jitter, the guiding mode, guide star information, and alert or failure keywords. Figure C.2 shows a representative observation log header file.
- *rootname*`j.jid`: This GEIS image—a significant enhancement of the old `cmj` file—presents a two-dimensional histogram of the pointing fluctuations during the observation. You can display it to visualize the spacecraft stability during you observation, and is information for deconvolutions and PSF analyses.
- *rootname*`j.jit`: This table, the analog to the `cmi` table, contains data that were averaged over three-second intervals. Its content is identical (see Table C.3).

- *rootname*`j_jif.fits`: FITS file that is actually the de-archived product. This file can be converted to the `jih/jid` GEIS file via the **strftis** routine.
- *rootname*`j_jit.fits`: The de-archived FITS file corresponding to the `jit` IRAF table. It can be converted via **strfits**.

Observation Log File Contents (February 1997 version)

The contents of observation log files created since February 1997 are as follows:

- *rootname*`j_jif.fits`: The de-archived FITS file. Unlike the previous OMS epoch, this FITS file does not bundle a GEIS file and cannot be converted with **strfits**. This was done to more closely correlate the observation log files with the STIS and NICMOS FITS files with extensions and associations. OMS will normally put all associated observation logs into a single file, to correspond to the associated science exposures. However, if even one science exposure is orphaned (not associated) then an individual observation log FITS file will be produced for every exposure in that association. For a description of STIS and NICMOS association files, see Appendix B. All of the information contained in the old `cmh/jih` ASCII header is now available as keywords in the FITS files.
- *rootname*`j_jit.fits`: The FITS file containing the table information. The comments for the `_jif` file apply here as well.

Table C.2: Contents of `.cmj` Table

Parameter	Units	Description
`seconds`	seconds	Time since window start
`V2 dom`	arcseconds	Dominant FGS V2 coordinate
`V3 dom`	arcseconds	Dominant FGS V3 coordinate
`V2 roll`	arcseconds	Roll FGS V2 coordinate
`V3 roll`	arcseconds	Roll FGS V3 coordinate
`SI V2`	arcseconds	Jitter at aperture reference
`SI V3`	arcseconds	Jitter at aperture reference
`RA`	degrees	Right ascension of aperture reference
`DEC`	degrees	Declination of aperture reference
`Roll`	degrees	Angle between North and +V3
`DayNight`	0,1 flag	Day (0) or night (1)
`Recenter`	0,1 flag	Recentering status
`TakeData`	0,1 flag	Vehicle guiding status
`SlewFlag`	0,1 flag	Vehicle slewing status

Figure C.1: A Representative `.jih` or `.cmh` Header

```
------------------------------------------------------------------------------

SIMPLE  =                    F / data conforms to FITS standard               !
BITPIX  =                   32 / bits per data value                          !
DATATYPE= 'INTEGER*4         ' / datatype of the group array                  !
NAXIS   =                    2 / number of data axes                          !
NAXIS1  =                   64 / length of the 1st data axis                  !
NAXIS2  =                   64 / length of the 2nd data axis                  !
GROUPS  =                    T / image is in group format                     !
GCOUNT  =                    1 / number of groups                             !
PCOUNT  =                    0 / number of parameters                         !
PSIZE   =                    0 / bits in the parameter block                  !
OMS_VER = '16.2C             ' / OMS version used to process this observation
PROCTIME= '1994.133:06:24:18.35' / date-time OMS processed observation
                                 / date-times format (yyyy.ddd:hh:mm:ss.ss)

                               / IMAGE PARAMETERS
CRVAL1  =                  0.0 / right ascension of zero-jitter pixel (deg)
CRVAL2  =                  0.0 / declination of zero-jitter pixel (deg)
CRPIX1  =                   32 / x-coordinate of zero-jitter pixel
CRPIX2  =                   32 / y-coordinate of zero-jitter pixel
CTYPE1  = 'RA---TAN          ' / first coordinate type
CTYPE2  = 'DEC--TAN          ' / second coordinate type
CD1_1   =                  0.0 / partial of ra w.r.t. x (deg/pixel)
CD1_2   =                  0.0 / partial of ra w.r.t. y (deg/pixel)
CD2_1   =                  0.0 / partial of dec w.r.t. x (deg/pixel)
CD2_2   =                  0.0 / partial of dec w.r.t. y (deg/pixel)
COORDSYS= 'WFPC2             ' / image coordinate system
XPIXINC =                  2.0 / plate scale along x (mas per pixel)
YPIXINC =                  2.0 / plate scale along y (mas per pixel)
PARITY  =                   -1 / parity between V2V3 frame and image frame
BETA1   =               134.72 / angle from +V3 to image +x (toward +V2)
BETA2   =               224.72 / angle from +V3 to image +y (toward +V2)

                               / OBSERVATION DATA
PROPOSID=                05233 / PEP proposal identifier
PROGRMID= '288               ' / program id (base 36)
OBSET_ID= '02                ' / observation set id
OBSERVTN= '03                ' / observation number (base 36)
TARGNAME= 'NGC3379-PO        ' / proposer's target name
STARTIME= '1994.133:06:24:18.35' / predicted observation window start time
ENDTIME = '1994.133:06:39:18.35' / predicted observation window end time
SOGSID  = 'U2880203          ' / SOGS observation name                        !

                               / SCIENTIFIC INSTRUMENT DATA
CONFIG  = 'WFPC2             ' / proposed instrument configuration
PRIMARY = 'SINGLE            ' / single, parallel-primary, parallel-secondary
OPERATE = '1994.133:06:22:46.91' / predicted time instr. entered operate mode
TLMFORM = 'PN                ' / telemetry format
APERTURE= 'UWFALL            ' / aperture name
APER_V2 =                1.565 / V2 aperture position in vehicle frame (arcsec)
APER_V3 =                7.534 / V3 aperture position in vehicle frame (arcsec)

                               / SPACECRAFT DATA
ALTITUDE=               593.23 / average altitude during observation (km)
LOS_SUN =               106.08 / minimum line of sight to Sun (deg)
LOS_MOON=                77.11 / minimum line of sight to Moon (deg)
SHADOENT= '1994.133:05:11:29.00' / predicted Earth shadow last entry
SHADOEXT= '1994.133:05:42:45.00' / predicted Earth shadow last exit
LOS_SCV =                12.46 / minimum line of sight to S/C veloc. (deg)
LOS_LIMB=                 58.0 / average line of sight to Earth limb (deg)


                               / BACKGROUND LIGHT
ZODMOD  =                 22.3 / zodiacal light - model (V mag/arcsec2)
EARTHMOD=                 20.2 / peak Earth stray light - model (V mag/arcsec2)
MOONMOD =                 35.5 / moon stray light - model (V mag/arcsec2)
GALACTIC=                 -1.0 / diffuse galactic light - model (V mag/arcsec2)

                               / POINTING CONTROL DATA
GUIDECMD= 'FINE LOCK         ' / commanded guiding mode
GUIDEACT= 'FINE LOCK         ' / actual guiding mode at end of GS acquisition
GSD_ID  = '0084900235        ' / dominant guide star id
GSD_RA  =            161.70720 / dominant guide star RA (deg)
GSD_DEC =             12.45407 / dominant guide star DEC (deg)
```

Figure C.2: Representative .jih or .cmh Header

```
GSD_MAG =               12.867 / dominant guide star magnitude
GSR_ID  = '0085201189        ' / roll guide star id
GSR_RA  =            161.93314 / roll guide star RA (deg)
GSR_DEC =             12.78141 / roll guide star DEC (deg)
GSR_MAG =               12.977 / roll guide star magnitude
GSACQ   = '1994.133:06:31:02.92' / actual time of GS acquisition completion
PREDGSEP=             1420.775 / predicted guide star separation (arcsec)
ACTGSSEP=             1421.135 / actual guide star separation (arcsec)
GSSEPRMS=                  3.8 / RMS of guide star separation (milli-arcsec)
NLOSSES =                    0 / number of loss of lock events
LOCKLOSS=                  0.0 / total loss of lock time (sec)
NRECENT =                    0 / number of recentering events
RECENTR =                  0.0 / total recentering time (sec)

                               / LINE OF SIGHT JITTER SUMMARY
V2_RMS  =                  4.5 / V2 axis RMS (milli-arcsec)
V2_P2P  =                 51.6 / V2 axis peak to peak (milli-arcsec)
V3_RMS  =                 20.9 / V3 axis RMS (milli-arcsec)
V3_P2P  =                267.3 / V3 axis peak to peak (milli-arcsec)
RA_AVG  =            161.85226 / average RA (deg)
DEC_AVG =             12.58265 / average dec (deg)
ROLL_AVG=            293.01558 / average roll (deg)

                               / PROBLEM FLAGS, WARNINGS and STATUS MESSAGES
                               / (present only if problem exists)
ACQ2FAIL= '                 T' / target acquisition failure
GSFAIL  = 'DEGRADED          ' / guide star acquisition failure  (*1)
TAPEDROP= '                 T' / possible loss of science data
TLM_PROB= '                  ' / problem with the engineering telemetry
TM_GAP  =               404.60 / duration of missing telemetry (sec)
SLEWING = '                 T' / slewing occurred during this observation
TAKEDATA= '                 F' / take data flag NOT on throughout observation
SIPROBnn= '                  ' / problem with specified science instrument (*2)

END
-----------------------------------------------------------------------------

notes
*1 - GSFAIL appears only once in a single header file.
     The following table lists all current possible values for the GSFAIL
     keyword:
     -------------------------------------------------------------
     GSFAIL   |DEGRADED         | / guide star acquisition failure
              |IN PROGR         | / guide star acquisition failure
              |SSLEXP           | / guide star acquisition failure
              |SSLEXS           | / guide star acquisition failure
              |NOLOCK           | / guide star acquisition failure
              |                 |
              |SREXCS?          | / guide star acquisition failure
              |SREXCS1          | / guide star acquisition failure
              |SREXCS2          | / guide star acquisition failure
              |SREXCS3          | / guide star acquisition failure
              |                 |
              |SREXCP?          | / guide star acquisition failure
              |SREXCP1          | / guide star acquisition failure
              |SREXCP2          | / guide star acquisition failure
              |SREXCP3          | / guide star acquisition failure
              |                 |
              |UNKNOWN          | / guide star acquisition failure
              |VEHSAFE          | / guide star acquisition failure
     -------------------------------------------------------------

*2 - The SIPROBnn keywords appear in the header file with nn = 01 - 99.
     The following table lists all current possible values for the SIPROBnn
     keyword:
     -------------------------------------------------------------------------
     SIPROBnn |DCF_NUM unchanged| / This observation may not have been taken
              |FOS Safing!      | / This observation affected when FOS Safed!
              |HRS Safing!      | / This observation affected when HRS Safed!
              |WFII Safing!     | / This observation affected when WFII Safed!
              |FOC Safing!      | / This observation affected when FOC Safed!
              |Shut             | / FOS aperture door is not Open!
              |FAILED           | / FGS astrometry target acquisition failed
     -------------------------------------------------------------------------
```

APP / C

Table C.3: Contents of .jit or.cmiTable, Three-Second Averaging

Parameter	Units	Description
seconds	seconds	Time since window start
V2 dom	arcseconds	Dominant FGS V2 coordinate
V3 dom	arcseconds	Dominant FGS V3 coordinate
V2 roll	arcseconds	Roll FGS V2 coordinate
V3 roll	arcseconds	Roll FGS V3 coordinate
SI V2 AVG	arcseconds	Mean jitter in 3 seconds
SI V2 RMS	arcseconds	rms jitter in 3 seconds
SI V2 P2P	arcseconds	Peak jitter in 3 seconds
SI V3 AVG	arcseconds	Mean jitter in 3 seconds
SI V3 RMS	arcseconds	rms jitter in 3 seconds
SI V3 P2P	arcseconds	Peak jitter in 3 seconds
RA	degrees	Right ascension of aperture reference
DEC	degrees	Declination of aperture reference
Roll	degrees	Angle between North and +V3
LimbAng	degrees	Angle between earth limb and target
TermAng	degrees	Angle between terminator and target
LOS_Zenith	degrees	Angle between HST zenith and target
Latitude	degrees	HST subpoint latitude
Longitude	degrees	HST subpoint longitude
Mag V1,V2,V3	degrees	Magnetic field along V1, V2, V3
EarthMod	V Mag/arcsec^2	Model earth background light
SI_Specific	–	Special science instrument data
DayNight	0,1 flag	Day (0) or night (1)
Recenter	0,1 flag	Recentering status
TakeData	0,1 flag	Vehicle guiding status
SlewFlag	0,1 flag	Vehicle slewing status

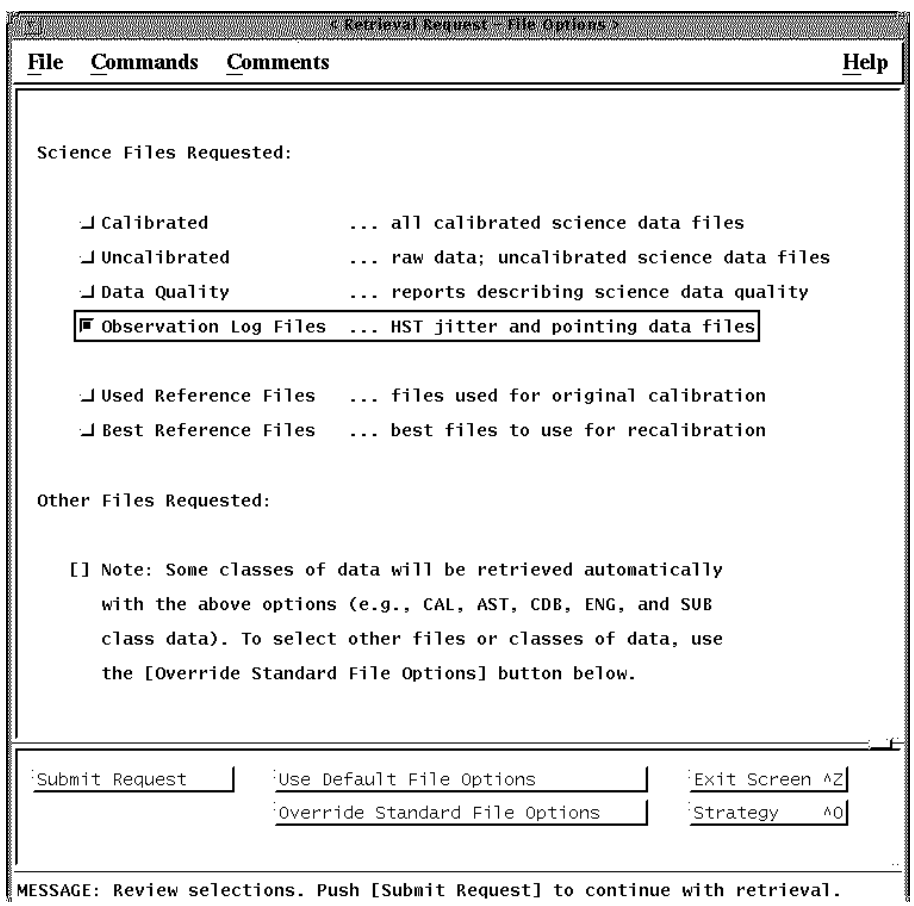
C.2 Retrieving Observation Logs

You can retrieve observation log files for data taken after October 20, 1994 from the HST Archive using StarView as described in Chapter 1. Unlike science data, which generally has a one-year proprietary period, observation log files become public as soon as they are archived.

The easiest way to get OMS files through StarView is to identify the observation of interest and proceed with your request as described in Chapter 1, until you reach the <Retrieval Request - File Options> screen, reproduced in Figure C.3. You can then check the Observation Log Files box, along with any other desired boxes, and continue with your request. StarView will then deliver the associated observation log files.

For observations logged between October 1994 to August 1995, you will be delivered the `cmi`, `cmj`, and `cmh` files in FITS form (e.g., `_cmi.fits`). Observations archived from August 1995 to February 1997 will return `_jif.fits` and `_jit.fits` files. These, and the earlier FITS files can be worked with as such, or converted to their GEIS counterparts via the STSDAS **strfits** task. However, as of February 1997, the `_jif.fits` and `_jit.fits` files are standard FITS files with extensions and cannot be converted to GEIS.

Figure C.3: Choosing Observation Log Files in StarView



C.3 Using Observation Logs

Here are some simple examples of what can be learned from the observation log files. Note that for FITS format observation logs, current versions of STSDAS tools will handle the files with extensions properly. Keywords can be viewed with tools such as **imheader** or **hedit**, and data viewed, plotted, or displayed using the same tasks one might have for the GEIS files. For more information on FITS file structures, see Chapter 2.

C.3.1 Guiding Mode

Unless requested, all observations will be scheduled with FINE LOCK guiding, which may be one or two guide stars (dominant and roll). The spacecraft may roll slightly during an observation if only one guide star is acquired. The amount of roll depends upon the gyro drift at the time of the observation, the location during an orbit, and the lever arm from the guide star to the center of the aperture.

There are three commanded guiding modes: FINE LOCK, FINE LOCK/GYRO, and GYRO. OMS header keywords GUIDECMD (commanded guiding mode) and GUIDEACT (actual guiding mode) will usually agree. If there was a problem, they won't agree and the GUIDEACT value will be the guiding method actually used during the exposure. If the acquisition of the second guide star fails, the spacecraft guidance, GUIDEACT, may drop from FINE LOCK to FINE LOCK/GYRO, or even to GYRO, which may result in a target rolling out of an aperture. Check the OMS header keywords to verify that there was no change in the requested guiding mode during the observation.

Until new flight software (version FSW 9.6) came online in September 1995, if the guide star acquisition failed, the guiding dropped to COARSE track. After September 1995, if the guide star acquisition failed, the tracking did not drop to COARSE track. Archival researchers may find older datasets that were obtained with COARSE track guiding.

The dominant and roll guide star keywords (GSD and GSR) in the OMS header can be checked to verify that two guide stars were used for guiding, or in the case of an acquisition failure, to identify the suspect guide star. The dominant and roll guide star keywords identify the stars that were scheduled to be used, and in the event of an acquisition failure, may not be the stars that were actually used. The following list of `cmh` keywords is an example of two star guiding.

```
GSD_ID  = '0853601369         ' / Dominant Guide Star ID
GSD_RA  =            102.42595 / Dominant Guide Star RA (deg)
GSD_DEC =            -53.41362 / Dominant Guide Star DEC (deg)
GSD_MAG =               11.251 / Dominant Guide Star Magnitude
GSR_ID  = '0853602072         ' / Roll Guide Star ID
GSR_RA  =            102.10903 / Roll Guide Star RA (deg)
GSR_DEC =            -53.77683 / Roll Guide Star DEC (deg)
GSR_MAG =               12.426 / Roll Guide Star Magnitude
```

If you suspect that a target has rolled out of the aperture during an exposure, you can quickly check the counts in each group of the raw science data. As an example, the following IRAF commands can be used to determine the counts in each group.

```
cl> grlist z2o4040dt.d0h 1-24 > groups.lis
cl> imstat @groups.lis
```

Some observations can span several orbits. If during a multiple orbit observation the guide star reacquisition fails, the observation may be terminated with possible loss of observing time, or switch to other less desirable guiding modes. The GSACQ keyword in the `cmh` header will state the time of the last successful guide star acquisition.

```
GSACQ   = '136:14:10:37.43    ' / Actual time of GS Acquisition Completion
```

C.3.2 Guide Star Acquisition Failure

The guide star acquisition at the start of the observation set could fail if the FGS fails to lock onto the guide star. The target may not be in the aperture, or maybe only a piece of an extended target is in the aperture. The jitter values will be increased because FINE LOCK was not used. The following list of `cmh` header keywords indicate that the guide star acquisition failed.

```
V3_RMS =                 19.3 / V3 Axis RMS (milli-arcsec)
V3_P2P  =                135.7 / V3 Axis peak to peak (milli-arcsec)
GSFAIL = '          DEGRADED' / Guide star acquisition failure!
```

The observation logs for all of the following observations in the observation set will have the "DEGRADED" guide star message. This is not a Loss of Lock situation but an actual failure to acquire the guide star in the desired guiding mode. For the example above, the guiding mode dropped from FINE LOCK to COARSE TRACK.

```
GUIDECMD= 'FINE LOCK          ' / Commanded Guiding mode
GUIDEACT= 'COARSE TRACK       ' / Actual Guiding mode at end of GS acquisition
```

If the observational dataset spans multiple orbits, the guide star will be re-acquired, but the guiding mode will not change from COARSE TRACK. In September 1995, the flight software was changed so that COARSE TRACK is no longer an option. The guiding mode drops from two guide star FINE LOCK to one guide star FINE LOCK , or to GYRO control.

C.3.3 Moving Targets and Spatial Scans

A type 51 slew is used to track moving targets (planets, satellites, asteroids, and comets). Observations are scheduled with FINE LOCK acquisition, i.e., with two or one guide stars. Usually, a guide star pair will stay within the pickle during the entire observation set, but if two guide stars are not available, a single guide star may be used, assuming the drift is small or the proposer says that the roll is not important for that particular observing program. An option during scheduling is to drop from FGS control to GYRO control when the guide stars move out of the FGS. Also, guide star handoffs (which are not a simple dropping of the guide stars to GYRO control) will affect the guiding and may be noticeable when the jitter ball is plotted.

The jitter statistics are accumulated at the start of the observation window. Moving targets and spatial scan motion will be seen in the jitter data and image. Therefore, the OMS header keywords V2_RMS and V3_RMS values (the root mean square of the jitter about the V2 and V3 axis) can be quite large for moving targets. Also, a special anomaly keyword (SLEWING) will be appended to the OMS header stating movement of the telescope during the observation. This is expected for observing moving targets. The following list of `.cmh` header keywords is an example of expected values while tracking a moving target.

```
                              / LINE OF SIGHT JITTER SUMMARY
V2_RMS  =                  3.2 / V2 Axis RMS (milli-arcsec)
V2_P2P   =                     17.3 / V2 Axis peak to peak
(milli-arcsec)
V3_RMS  =                 14.3 / V3 Axis RMS (milli-arcsec)
V3_P2P   =                     53.6 / V3 Axis peak to peak
(milli-arcsec)
RA_AVG  =            244.01757 / Average RA (deg)
DEC_AVG =            -20.63654 / Average DEC (deg)
ROLL_AVG=            280.52591 / Average Roll (deg)
SLEWING = '                  T' / Slewing occurred during this
observation
```

C.3.4 High Jitter

The spacecraft may shake during an observation, even though the guiding mode is FINE LOCK. This movement may be due to a micro-meteorite hit, jitter at a day-night transition, or for some other unknown reasons. The FGS is quite stable and will track a guide star even during substantial spacecraft motion. The target may move about in an aperture, but the FGS will continue to track guide stars and reposition the target into the aperture. For most observations, the movement about the aperture during a spacecraft excursion will be quite small, but sometimes, especially for observations with the spectrographs, the aperture may move enough that the measured flux for the target will be less than a previous group. Check the OMS header keywords (V2_RMS, V3_RMS) for the root mean square of the jitter about the V2 and V3 axis. The following list of `.cmh` header keywords is an example of typical guiding rms values.

```
                                / LINE OF SIGHT JITTER SUMMARY
V2_RMS  =                    2.6 / V2 Axis RMS (milli-arcsec)
V2_P2P   =                       23.8 / V2 Axis peak to peak
(milli-arcsec)
V3_RMS  =                    2.5 / V3 Axis RMS (milli-arcsec)
V3_P2P   =                       32.3 / V3 Axis peak to peak
(milli-arcsec)
```

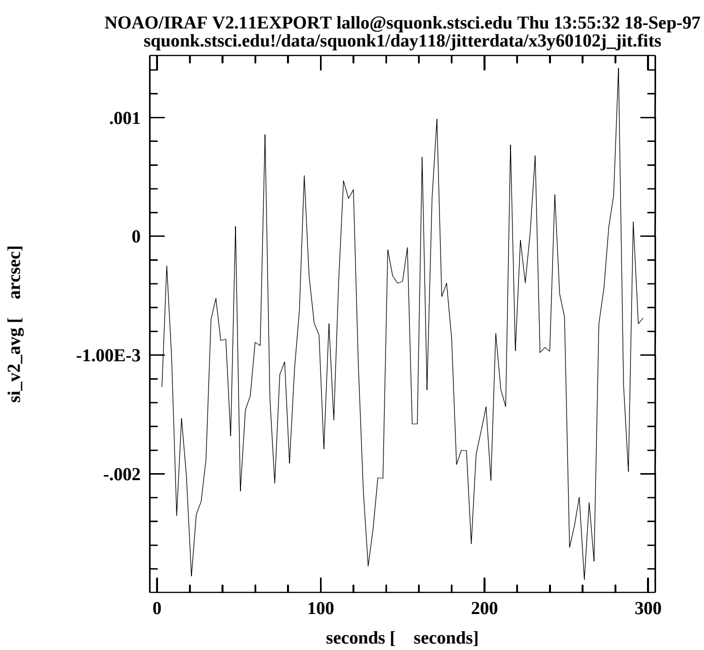
Recentering events occur when the spacecraft software decides that shaking is too severe to maintain lock. The FGS will release guide star control and within a few seconds reacquire the guide stars. It is assumed the guide stars are still within the FGS field of view. During the recentering time, INDEF will be written to the OMS table. Recentering events are tracked in the OMS header file.

Be careful when interpreting “Loss of Lock” and “Recentering” events that occur at the very beginning or at the end of the OMS window. The OMS window is larger than the observation window. These events might not affect the observation since the observation start time will occur after the guide stars are acquired (or re-acquired), and the observation stop time may occur before the “Loss of Lock” or “Recentering” event that occurred at the end of an OMS window.

The **sgraph** commend in the **stsdas.graphics.stplot** package will plot time vs. jitter along the direction of HST’s V2 axis (see Figure C.4):

```
cl> sgraph "x3y60102j_jit.fits seconds si_v2_avg"
```

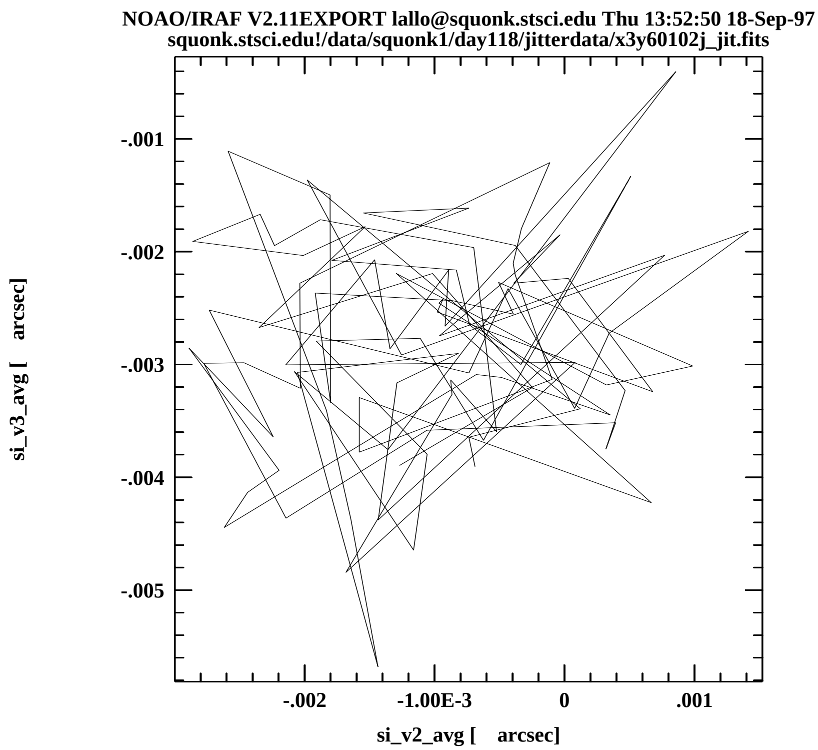
Figure C.4: Plotting Jitter Along V3 Axis



To get an idea of pointing stability, you can create a *jitter ball* by plotting jitter along the V2 axis vs. jitter along the V3 axis (see Figure C.5):

```
st> sgraph "x3660102j_jit.fits si_v2_avg si_v3_avg"
```

Figure C.5: Plotting V2 vs. V3 Jitter



The **tstatistics** task can be used to find the mean value of the `si_v3_avg` column—the amount of jitter (in arcseconds) in the direction of the V3. This value can be used to model jitter in a PSF. In this example, the mean jitter is ~3 mas, which is typical for post-servicing mission data:

Figure C.6: Averaging a Column with tstatistics

```
tt> tstat u26m0801j.cmi si_v3_avg
# u26m0801j.cmi  si_v3_avg
# nrows            mean       stddev       median           min         max
   11   -0.003006443888  0.00362533  -7.17163E-4  -0.00929515  0.00470988
```

Understanding and interpreting the meaning of the table columns and header keywords is critical to understanding the observation logs. Please read the available documentation and contact the STScI Help Desk (`help@stsci.edu`) if you have any questions about the files. Documentation is available via the WWW at: `http://www.stsci.edu/ftp/instrument_news/Observatory/obslog/OL_1.html`

APP / C

Appendix D:
Task Example Index

This index references examples and descriptions of IRAF/STSDAS tasks and some other software mentioned in this handbook.

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Appendix E
Resources on the Internet

This appendix lists locations of World Wide Web (WWW) sites and similar resources mentioned in this handbook. Resources are organized by topic, corresponding to the structure of this handbook.

Resource	**Location**
General Resources	
STScI Web Site	URL: http://www.stsci.edu
STScI Help Desk	E-mail: help@stsci.edu
HST Keyword Dictionary	URL: http://archive.stsci.edu/keyword
Archive Resources	
Hubble Data Archive	URL: http://archive.stsci.edu/
ST-ECF Archive Site	URL: http://archive.eso.org/
CADC Web Site	URL: http://cadc.dao.nrc.ca/
StarView Software	URL: http://archive.stsci.edu/starview.html
Archive User Registration Form	URL: http://archive.stsci.edu/registration.html
Archive Help	Email: archive@stsci.edu
Archive FTP Site	FTP: archive.stsci.edu
Software Resources	
STSDAS Page	URL: http://ra.stsci.edu/STSDAS.html
IRAF Page	URL: http://iraf.noao.edu/
SAOimage and SAOtng	FTP: sao-ftp.harvard.edu
TinyTim	URL: http://scivax.stsci.edu/~krist/tinytim.html

Resource	Location
FOC Resources	
FOC Page	URL: http://www.stsci.edu/ftp/instrument_news/FOC/topfoc.html
Instrument Science Reports	URL: http://www.stsci.edu/ftp/instrument_news/FOC/foc_bib.html
Instrument Handbook	URL: http://www.stsci.edu/ftp/instrument_news/FOC/foc_handbook.html
FOCSIM Exposure Simulator	URL: http://www.stsci.edu/ftp/instrument_news/FOC/Foc_tools/focsim/ focsim.html
FGS Resources	
FGS Page	URL: http://www.stsci.edu/ftp/instrument_news/fgs/html/TOPfgs.html
Instrument Science Reports	URL: http://www.stsci.edu/ftp/instrument_news/fgs/html/fgs_isr.html
Instrument Handbook	URL (PostScript): http://www.stsci.edu/ftp/instrument_news/fgs/html/ fgshbv6book.frame.ps
STANs	URL: http://www.stsci.edu/ftp/instrument_news/fgs/html/fgs_stans.html
NICMOS Resources	
NICMOS Page	URL: http://www.stsci.edu/ftp/instrument_news/NICMOS/topnicmos.html
Instrument Science Reports	URL: http://www.stsci.edu/ftp/instrument_news/NICMOS/ nicmos_doc_isr.html
Instrument Handbook	URL: http://www.stsci.edu/ftp/instrument_news/NICMOS/ nicmos_doc_handb.html
STANs	URL: http://www.stsci.edu/ftp/instrument_news/NICMOS/ nicmos_doc_stan.html
calnicc Software	URL: http://ecf.hq.eso.org/nicmos/calnicc/calnicc.html
NICMOSLook Software	URL: http://ecf.hq.eso.org/nicmos/nicmoslook
STIS Resources	
STIS Page	URL: http://www.stsci.edu/ftp/instrument_news/STIS/topstis.html
Instrument Science Reports	URL: http://www.stsci.edu/ftp/instrument_news/STIS/isrs/ stisisr_index.html
Instrument Handbook	URL: http://www.stsci.edu/ftp/instrument_news/STIS/ihb/stis_ihb_v1.html
STANs	URL: http://www.stsci.edu/ftp/instrument_news/STIS/documents/stan/ stan_index.html
WFPC2 Resources	
WFPC2 Page	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/wfpc2_top.html
Instrument Science Reports	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/wfpc2_bib.html
Instrument Handbook	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/Wfpc2_hand/ wfpc2_handbook.html

Resource	Location
WFPC2 Resources (Continued)	
STANs	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/wfpc2_stan.html
WFPC2 History Memo	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/Wfpc2_memos/wfpc2_history.html
Warm Pixel Tables	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/wfpc2_warmpix.html
Exposure Time Calculator	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/Wfpc2_etc/wfpc2-etc.html
CTE Report	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/Wfpc2_cte/ctetop.html
WFPC2 Polarization Calibration Tool	URL: http://www.stsci.edu/ftp/instrument_news/WFPC2/Wfpc2_pol/wfpc2-pol2.html
Dithering/Drizzle Software	URL: http://www.stsci.edu/~fruchter/dither/
Additional Resources	
OMS Information	URL: http://www.stsci.edu/ftp/instrument_news/Observatory/taps.html
Science Instrument Aperture File	URL: http://www.stsci.edu/ftp/instrument_news/Observatory/siaf.html
Calibration Data Base	URL: http://www.stsci.edu/ftp/instrument_news/Observatory/cdbs/cdbs.html
HST Proposal Info	URL: http://presto.stsci.edu/public/propinfo.html

Glossary

The following terms and acronyms are used in this manual.

A/D or ADC: Analog to digital converter.

AEDP: Astrometry and Engineering Data Processing.

CADC: Canadian Astronomical Data Center.

CCD: Charge-coupled device. Solid-state, light detecting device.

CDBS: Calibration Data Base. System for maintaining reference files and tables used to calibrate HST observational datasets.

C&DH: Control and Data Handling.

CL: Command language. The IRAF system-level prompt.

COSTAR: Corrective Optics Space Telescope Axial Replacement.

CTE: Charge transfer efficiency.

CVC: Current to voltage converter. Used with HSP.

DADS: Data Archive and Distribution System.

DAT: Digital audio tape.

DC: Dark current.

DMF: Data Management Facility. Used for archiving HST data.

DN: Digital number.

DQ: Data quality.

DQE: Detector quantum efficiency.

DQF: Data quality file.

EBS: Electron Bombarded Silicon.

EED: Extracted engineering data.

ESA: European Space Agency.

FDA: Field Divider Assembly (NICMOS).

FES: Fine error signal (used with FGS).

FFT: Fast Fourier transform.

FGE: Fine Guidance Electronics. (Used with FGS).

FGS: Fine Guidance Sensors.

FITS: Flexible Image Transport System. A generic IEEE- and NASA-defined standard used for storing image data.

FOC: Faint Object Camera.

FOM: Field Offset Mechanism.

FOS: Faint Object Spectrograph.

FOV: Field of view.

FTP: File Transfer Protocol. Basic tool used to retrieve files from a remote system. Ask your system manager for information about using FTP.

FWHM: Full width at half maximum.

GCI: Geocentric inertial.

GEIS: Generic Edited Information Set. The multigroup format used by STSDAS for storing HST image data.

GHRS: Goddard High-Resolution Spectrograph.

GIF: Graphic Interchange Format. Data format developed by CompuServe for storing and transporting image data. Supported by Mosaic and xv for use over Internet.

GIM: Geomagnetically-induced motion problem. Formerly a correction in the FOS calibration pipeline, now applied on the spacecraft.

GO: General Observer.

Gopher: Hypertext-oriented software developed at University of Minnesota for retrieving information through the Internet.

GPB: Group parameter block.

GSC: Guide Star Catalog.

GTI: Good time interval.

GTO: Guaranteed Time Observer.

HDU: Header Data Unit.

HSP: High-Speed Photometer.

HST: Hubble Space Telescope.

HTML: Hypertext Markup Language.

Hz: Hertz. Cycle per second.

ICD: Interface control document. Defines data structures used between software or systems to ensure compatibility.

ICF: Intrinsic correlation function.

IDL: Interactive Data Language.

IDT: Investigation Development Team.

IFOV: Instantaneous field of view.

IFT: Inverse Fourier transform.

IGI: Interactive Graphics Interpreter. Graphics program in STSDAS.

imset: Image set (STIS and NICMOS).

IPPPSSOOT: HST file naming convention to uniquely identify files (described in Appendix B).

IR: Infrared.

IRAF: Image Reduction and Analysis System. The system on which STSDAS is built.

IUE: International Ultraviolet Explorer.

JPL: Jet Propulsion Laboratory, located at California Institute of Technology in Pasadena. Home of WF/PC team.

K: Degree Kelvin.

LOS: Line of sight.

LSA: Large science aperture. One of two apertures on GHRS.

LVPS: Low-voltage power supply.

mas: Milliarcsecond.

MEM: Maximum Entropy Method. Algorithm for restoring images.

MIE: MAMA Interface Electronics.

MIF: Multiple Initial and Final (readouts, NICMOS).

MJD: Modified Julian date.

MOSS: Moving Object Support System.

ND: Neutral density.

NICMOS: Near Infrared Camera and Multi-Object Spectrometer.

NOAO: National Optical Astronomy Observatories.

OCX: Observer comments file from OSS. Contains updated mission information obtained when the observation is taken.

OFAD: Optical field angle distortion.

OIF: Old IRAF (data format).

OMS: Observatory Monitoring System.

OPUS: OSS and PODPS Unified Systems.

OTA: Optical telescope assembly.

OV: Orbital verification. Process of checking out equipment on HST.

PC: Planetary Camera; part of WF/PC.

PCS: Pointing Control System.

PDA: Photon Detector Assembly (in FOC).

PDB: Project Data Base.

PDQ: PODPS data Quality file. Contains predicted and actual observation parameters.

PI: Principal investigator.

pipe: To use the output from one task or program as the input to another task or program. The output of a STSDAS or IRAF task can be piped to another task.

PMT: Photomultiplier tube.

pset: Parameter set (IRAF).

PSF: Point spread function.

RA: Right ascension.

R-L: Richardson-Lucy. Algorithm for restoring images.

rms: Root mean square.

RSDP: Routine Science Data Processing. The basic calibration (pipeline) system used for processing all HST observation datasets.

RTB: Return-to-brightest. Target acquisition mode for GHRS.

SAA: South Atlantic Anomaly.

SDF: Science Data Formatter.

SHL: Science header line.

SHP: Standard header packet. File containing spacecraft information from time of observation.

SM97: 1997 Servicing Mission.

SMOV: Servicing Mission Orbital Verification.

S/N: Signal-to-noise ratio.

SOGS: Science Operations Ground System.

SSA: Small science aperture. One of two apertures on GHRS; the other is LSA.

ST-ECF: Space Telescope European Coordinating Facility.

STAN: Space Telescope Analysis Newsletter.

STARCAT: System used for retrieving archived HST data. To be replaced by StarView in 1994.

STEIS: Space Telescope Electronic Information System. The anonymous FTP host from which information, software, documentation, and other resources pertaining to the HST can be obtained.

STIS: Space Telescope Imaging Spectrograph.

STL: Science trailer line.

STScI: Space Telescope Science Institute.

STSDAS: Space Telescope Science Data Analysis System. The complete suite of data analysis and calibration routines used to process HST data.

SV: Science verification. Process of taking observations that can be used for HST instrument calibration.

TEC: Thermal electric cooler. Part of WF/PC.

TF: Transfer function.

TFMRP: Transfer Function Mode Reduction Package. Used with respect to FGS.

TIFF: Tagged Image File Format. Method of storing images, usually from a scanner.

TIM: Telescope Image Modeling. Software used to generate PSF.

UDL: Unique data log. File containing instrument command settings.

URL: Uniform resource locator. Address for WWW.

UT: Universal time.

UV: Ultraviolet.

VPU: Video processing unit.

WAIS: Wide-Area Information Server. Method of locating information on a network using indexes to files.

WCS: World Coordinate System.

WFC: Wide Field Camera. One of the two cameras in WF/PC.

WF/PC: Wide Field/Planetary Camera.

WFPC2: Wide Field Planetary Camera-2. Replacement for WF/PC installed during first servicing mission of December 1993.

world coordinates (WC): The coordinate system naturally applying to the data, pixels or wavelength, for example.

WWW: World Wide Web. Hypertext-oriented method for finding and retrieving information over the Internet.

ZD: Zenith distance.

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