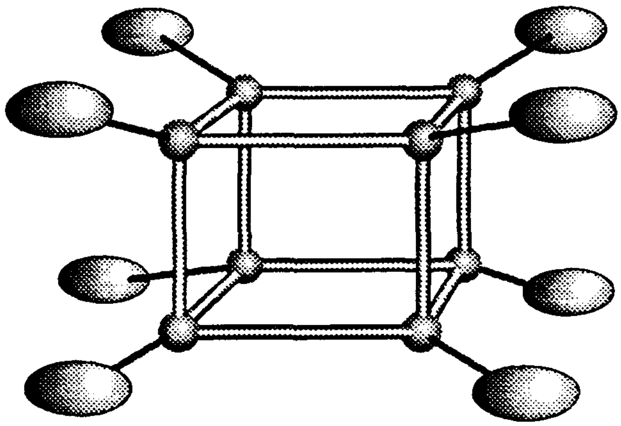
AD-A242 178

212100-22-T



HYPERCUBE IMAGE FORMATION PROCESSOR

HIFP V1.0 USER'S GUIDE

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The HIFP User's Guide describes the theory of operation and use of the HIFP (Hypercube Image Formation Processor) Version 1.0. The HIFP is a collection of five individual applications: ReadTape Application, Analysis, Image Formation Processor Application, Quality Control Application, and Refocus Module Application. The user's guide covers the general theory of operation, an example of all the steps needed to form an image, a detailed description of each of the applications, and describes how to install the HIFP on the user's computer system.

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1.0 OVERVIEW

This document describes the theory of operation and use of the HIFP (Hypercube Image Formation Processor) Version 1.0. The processor described is based on the VAX N1 image formation processor and has been rehosted onto a Hypercube. It is a collection of five individual applications.

The Hypercube Image Formation Processor applications names are as follows:

ReadTape - Tape Input Application (H)
ANA - Analysis Application (H)
IFP - Image Formation Processor Application (H)
QC - Quality Control Application (S)
RFM - Refocus Module Application (H)

All applications marked with an (H) will run on the i860 Hypercube from the SRM (or from the Sun using rlogin) and the applications marked with an (S) will run from the Unix shell of a Sun4 or equivalent workstation. This collection of HIFP applications, along with the Intel provided TAR and FTP programs, allow the user to perform the following functions:

Retrieve phase history and aux data from an 8mm tape
Select data for processing
Form high resolution SAR radar images from phase history
Check the quality of images
Refocus images at the user 's direction
Archive image and processing information on 8mm tape

1.1 DOCUMENT ORGANIZATION

This document is organized into the following sections: Section 2.0 discusses the general theory of operation, Section 3.0 is a example of all the steps needed to form an image (showing all user inputs), Section 4.0 provides a detailed description of each of the applications, Section 5.0 outlines the hardware and software configuration requires to use the HIFP applications and Section 6.0 describes how to install the HIFP on the user's computer system.

This document is available both as hardcopy and in an ASCII text version found in the on-line help feature in the QC Application. The hardcopy version of the document has several figures; whereas, the on-line help feature does not currently support figures and can only make references to the figures.

For more information on the theory of operations, see the Workstation Image Formation Processor User Interface, Scheduler and Communications CDR briefing material (19 Dec 90) or the Hypercube Image Formation Processor CDR briefing material (18 Dec 90). Although these documents are slightly out of date and refer to an integrated Application, much of the information is still useful. Additional information about the N1 radar parameters and capabilities can be found in the ERIM report titled "System Design and Implementation of the N1 Ground Image Formation Processor" (Oct 1989). Additional information on interpretation of SAR radar impulse response plots and general image quality measures can be found in the extracts from the Synthetic Aperture Radar Technology and Applications short course notebook included with the delivery.

1.2 LIST OF ACRONYMS

.aux	Extension for aux data file
.ci	Extension for complex image file
.cih	Extension for HOF complex image file
.clog	Extension for data collection log file
.cshrc	Unix shell setup file
.detci	Extension for detected image file
.detcih	Extension for HOF detected image file
.hdr	Extension for header file
.hmg	Extension for Horizontal IPR magnitude plot file
.hph	Extension for Horizontal IPR phase plot file
.nexec	Extension for ANA input parameter file
.phs	Extension for raw phase history file
.sum	Extension for quality control summary file
.vmg	Extension for Vertical IPR magnitude plot file
.vph	Extension for Vertical IPR phase plot file
ANA	Analysis Application
ARIES	Facility used to write 8mm phase history archive tapes
CDR	Critical Design Review
CFS	Hypercube concurrent file system
CIO	Ethernet card for the Hypercube
cp	Unix/nsh copy program
cube	An allocation of part or all of the Hypercube processors
DMR	Data Modification and Reformatting Facility
emacs	Unix text file editor
family_name	The first 7 characters of an image name (i.e., n0001a2)
fft	Fast Fourier Transform
FTP	Unix file transfer program
getcube	SRM command to allocate a cube on the Hypercube
HBASE	Unix variable defining the location of the HIFP directory
HIFP	Hypercube Image Formation Processor
HOF	Higher Order Focus
i860	Type of node processor in the Hypercube
IDA	Image Display Area in QC Application
IFP	Image Formation Processor Application
image_name	The family_name with 2 two digit number (i.e., n0001a201)
IOP	Input Output Processor for the Hypercube
IPR	Impulse Response

ipsc	Intel Parallel Super Computer
killcube	SRM command to kill a program running on a cube
LinLog	Algorithm to compress image data into a byte sized pixel
motif	Widget set for X11
N1	The name for the data collection system
nfs	Network file system
nsh	Hypercube node shell
OSF	Open Software Foundation
pathname	The Unix directory path (does not include the filename)
pgcc	Sun version of Intel i860 C cross compiler
pgf77	Sun version of Intel i860 Fortran cross compiler
QC	Quality Control Application
QC_doc	Quality Control Application help file
QC_RSRC	Quality Control Application window resource file
QCDOCPATH	Unix variable defining the location of the QC help file
RCS	Revision control system
ReadTape	Tape Input Application
rebootcube	SRM command to restart the Hypercube operating system
relcube	SRM command to deallocate a cube on the Hypercube
RFM	ReFocus Module Application
rlogin	Unix program to remotely login to another system
rst0	SCSI 1/4 inch cartridge tape device name
rst1	SCSI 8mm tape device name
SAR	Synthetic Aperture Radar
setenv	Unix shell command to set shell variables
srm	System Resource Manager
sun	Workstation from Sun computer
tapemode	Hypercube program to set 8mm tape driver parameters
TAR	Unix program for writing backup tapes
usr	User directory of a Unix workstation
VAX	Computer from Digital Equipment Corp
waitcube	SRM command to wait for a cube program to complete
wifp	Workstation Image Formation Processor
WriteTape	Application for writing 8mm phase history archive tapes
X11	A network based window system for workstations
XAPPLRESDIR	Unix variable defining the location of the QC res file
xgraph	Unix program to display graphs under X11 windows
xterm	Unix program to start a second window under X11 windows
zcat	Unix program to read a compressed file

1.3 DOCUMENT CONVENTIONS

Throughout this document, the following conventions will be used: 1) all user input is shown in double quotes and bold, 2) a <cr> symbol is shown where a carriage return should be used, 3) computer input and output is shown in Monaco type face, and 4) a line with a semicolon preceding it is a comment added to make the example more informative.

The following symbols are used for showing user input prompts from the various computer systems/programs/windows:

sun% = the Unix shell prompt from a Sun
sun1% = the Unix shell prompt from a Sun, window number 1
sun2% = the Unix shell prompt from a Sun, window number 2
sol% = the Unix shell prompt from a Solbourne
QC_main% = the Unix shell prompt from a the QC main window
IPR_screen% = the Unix shell prompt from a the QC IPR window
srm% = the Unix shell prompt from the system resource manager
nsh% = the prompt from the Hypercube node shell

In the text, the following program or path names may be shown in capital letters for clarity: ANA, IFP, RFM, FTP, QC, CFS, and TAR. On the Unix systems these commands are always executed with lower case letters.

1.4 FUTURE DIRECTIONS

Future versions of the HIFP applications could include some of the following enhancements:

(1) Minor modifications to IFP and RFM to reduce the execution time by 30-60%.

(2) Minor modifications to IFP and RFM to support image sizes other than 1950x1950.

(3) *Some additions* to the QC Application to preform most of the data transfer from the CFS in more automated fashion. The new QC Application would request only small portions of the .ci or .cih image directly from the Hypercube. This would eliminate the requirement for the user to manually FTP the .ci or .cih images.

(4) Some additions to the IFP and RFM Applications to write copies of the .detci or .detcih images to the Sun using NFS. This would eliminate the requirement for the user to manually FTP the .detci or .detcih images.

(5) Many additions to all applications and the the integration of the scheduler code into a single package. This would eliminate the requirement for the user to manually FTP images. This option would also schedule the Hypercube processes.

1.5 HYPERCUBE RELIABILITY

With the Hypercube used on this program, we experienced many operating system and hardware anomalies that occasionally caused problems. This document was written for an experienced Hypercube user that understands when the Hypercube hangs or crashes and can to recover from these events (typically by rebooting the Hypercube). The user should also be aware that a CFS failure can cause the loss of all data on the CFS disks. It appears that the number of unexplainable errors increases with an increasing number of concurrent users. See Intel customer support and Hypercube documentation for more information.

2.0 HIFP THEORY OF OPERATION

This section discusses the general operations of the HIFP applications and provides the reader with the overall architecture of the HIFP applications and the machines that execute them. Section 3.0 provides a concrete example of operations.

2.1 OPERATIONS TO FORM AN IMAGE

There are four computer systems needed to run the HIFP applications, namely, the Hypercube i860 tower, the Hypercube SRM (System Resource Manager), the CIO Ethernet IOP (I/O Processor) and a Sun4 or equivalent. The Hypercube tower performs nearly all aspects of the Image formation and data input and output. The CIO Ethernet IOP (hereafter called the FTP server) provides support for high speed file transfer from the CFS to the Sun. The SRM provides Hypercube cube allocation, application loading and reset functions. The Sun workstation and display provide the user interface for the display and verification of image quality. The Hypercube, SRM and FTP server must be connected with TCP/IP Ethernet. (See Figure 2.1)

To reduce the time associated with moving data from the Hypercube to the Sun, most of the data is stored and processed by the Hypercube and the CFS. The are two exceptions: the nexec file needed by ANA and the .ci, .detci, .cih, .detcih and .hdr files needed by QC.

The raw phase history will be transcribed using the DMR facility and converted into a Unix readable format by the ARIES facility. The data is then written to 8mm tape in a special format allowing the Hypercube to seek within the tape and determine the size and content of all relevant files for future processing. These 8mm tapes are shipped to the Hypercube facility performing the processing. Data enters the HIFP CFS from the Hypercube 8mm tape transport by execution of the ReadTape Application.

Once the phase history, aux and ancillary data is read into the Hypercube CFS, a nexec file must be edited to provide the proper parameters for ANA to build files needed to process an image. This nexec file can be edited on the Sun4 providing that the Sun4 and the SRM have NFS (Network File System) installed. The format of this file is described in the ANA documentation included in Section 4.0.

With the nexec file completely edited, the user runs ANA to generate files for image formation. ANA runs on the Hypercube and writes the parameter files to the Hypercube's CFS. After ANA completes processing these files, the user runs IFP to form the SAR image. IFP will read in files from the CFS and process the image requested. The image (.ci) and it's LinLog detected version (.detci) are written onto the CFS.

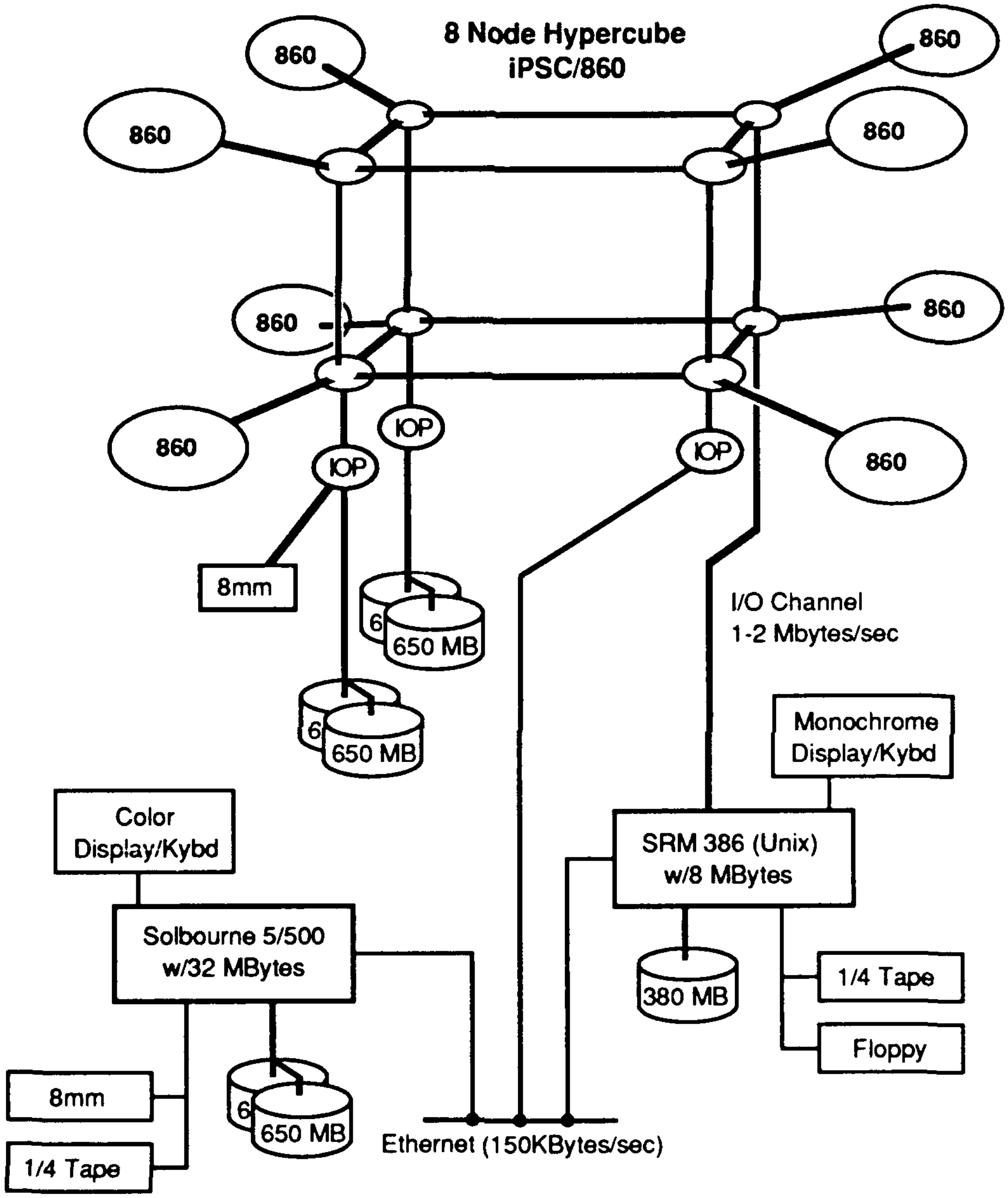

Figure 2.1 - HIFP Processor Configuration

The user then must move the .hdr, .ci and .detci from the CFS to the Sun by using NFS and nsh (the Hypercube shell) or FTP via the FTP server. The FTP server is currently the fastest method. This will take about 10 minutes due to the large size of the files. Once the files are moved, QC can be started on the Sun to display the LinLog detected image (.detci). Any IPR plots selected in QC will use the full precision complex float image (.ci). After interacting with QC, the user may either write the approved images to tape using the Intel provided TAR facility or perform refocusing on the image using RFM.

If required, RFM is executed on the Hypercube by applying the user-selected HOF correction from QC to the complex float image (.ci). RFM writes two new images to the CFS: the HOF image (.cih) and it's LinLog detected version (.detcih). Again, the user must move the cih and .detcih from the CFS to the Sun by using NFS and nsh (the Hypercube shell) or FTP via the FTP server. These should be moved to the same area that the .hdr, .ci and .detci files were stored. Then the user runs QC again to determine if image quality is now acceptable. The QC program allows the user to view the both the .detci and detcih images and generate IPR plots on both the .ci and .cih images. The user is only allowed to choose RFM parameters from the .ci image.

2.2 HIFP APPLICATION I/O SUMMARY

The following is a summary of input/output characteristics of the HIFP applications (also see Figure 2.2):

ReadTape Application:
- Gets input parameters interactively from user
- Reads radar phase history data from the 8mm tape
- Creates and Writes to files:
  - <family_name>.aux - Aux data file
  - <family_name>.phs - Phase history file
  - <family_name>.clog - Text file with the raw data collection log
  - <family_name>.sum - Text file with the quality control summary

ANA Application:
- Hypercube load command line arguments:
  - <cfs-image-path>
  - <image_name>
  - <nfs/cfs-nexec-path>
- Reads from files:
  - <image_name>.nexec* - User edited parameter file
  - <family_name>.aux - Aux data file
  - j0304512.con - Polar interpolation filter file
- Creates and Writes to the file:
  - <image_name>.ant - Amplitude correction data file
  - <image_name>.hdr* - Text file with processing params

IFP Application:
- Hypercube load command line arguments:
  - <cfs-image-path>

<image_name>

Reads from files:

<family_name>.aux - Aux data file
<family_name>.phs - Phase history file
<image_name>.ant - Amplitude correction data file
j0304512.con - Polar interpolation filter file
rtocxflt.fil - Real to complex filter filename
n07mar89.cor - Range phase error correction vector filename
n1filter.fil - N1 receiver IF filter

Reads and Modifies the following file:

<image_name>.hdr* - Text file with processing params

Creates and Writes to files:

<image_name>.ci* - Complex real SAR image
<image_name>.detci* - Lin-Log detected SAR image

RFM Application:

Hypercube load command line arguments:

<cfs-image-path>
<image_name>
<x-loc> - from the QC Application
<y-loc> - from the QC Application

Reads from files:

<image_name>.ci* - Complex real SAR image

Reads and Modifies the following file:

<image_name>.hdr* - Text file with processing params

Creates and Writes to files:

<image_name>.hdr* - Text file with updated params
<image_name>.cih* - HOF Complex real SAR image
<image_name>.detcih* - HOF Lin-Log detected SAR image

QC Application:

Unix command line arguments:

<image-path> - Path on the Sun to find the data files
<image_name> -
<x-size>
<y-size>

Reads from files:

<image_name>.hdr* - Text file with processing params
<image_name>.ci* - Complex real SAR image
<image_name>.detci* - Lin-Log detected SAR image
<image_name>.cih* - HOF Complex real SAR image
<image_name>.detcih* - HOF Lin-Log detected SAR image

Outputs the following data to the user:

RFM refocus target <x-loc>, <y-loc>

Optionally Creates and Writes to files:

IPR plot data files <image_name>.vmg and <image_name>.hmg

Note: All files with a * by their name are treated as SECRET for N1 data because they contain the values of the radar parameters or data that can lead to the determination of the system resolution.

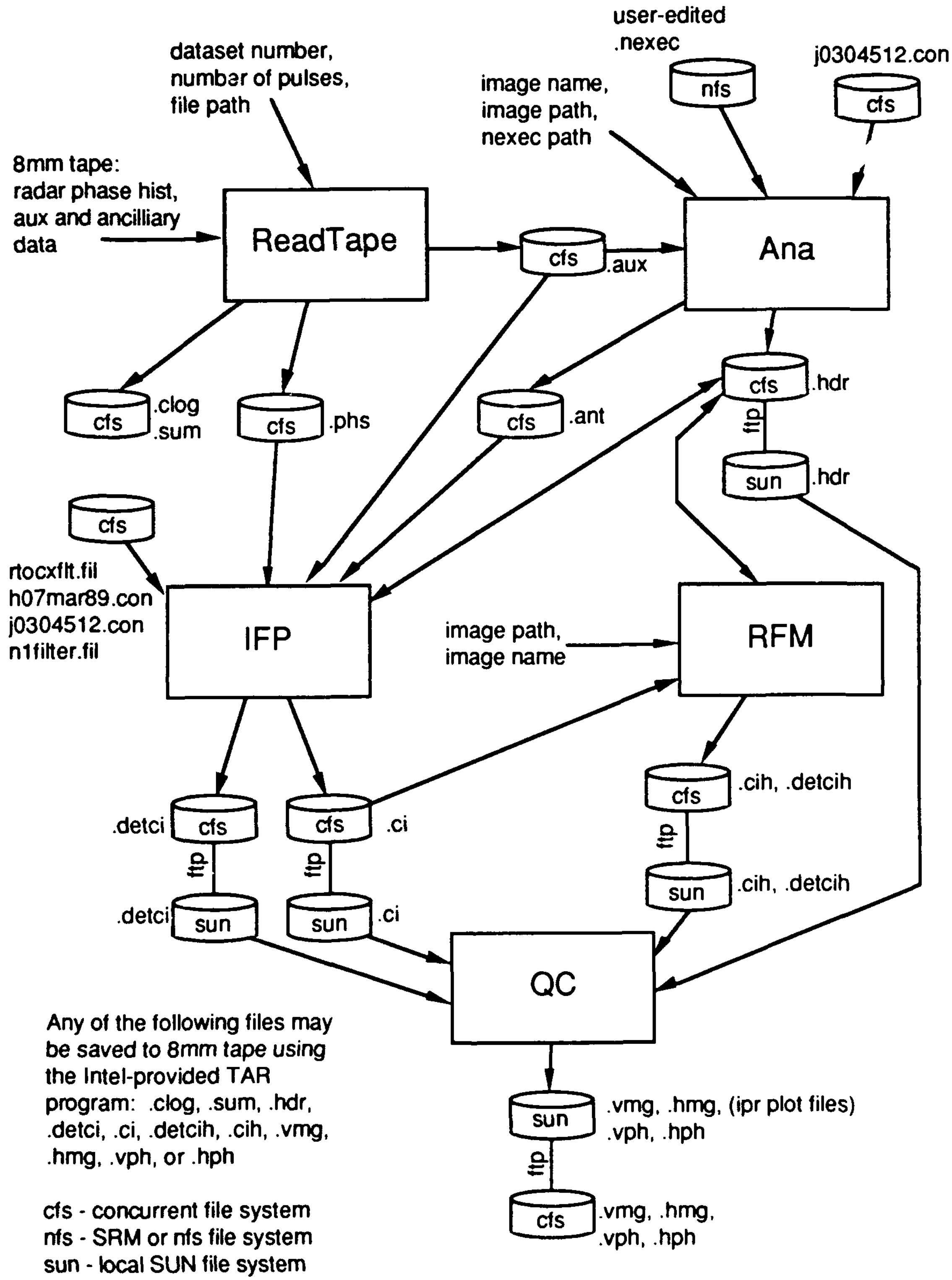

Figure 2.2 - HIFP Data Flow Diagram

3.0 HOW TO FORM AN IMAGE - AN EXAMPLE RUN

This section will describe an example of how to form an image from the initial step of reading the phase history from tape to the final step of archiving the image and ancillary file to tape. The section is intended to be an example that pulls together the more detailed information from Section 4.0; therefore, this section only covers the basics. It is best to read Sections 1.0 and 2.0 before reading this section. The example can be executed on the Hypercube and Sun as you read the text. For more information, refer to the detailed discussion of each application included in Section 4.0.

3.1 SUMMARY OF STEPS

A quick summary of the steps needed to form an image is as follows:

(0) Set up Unix environment and copy executables to convenient locations (this step is only done once per user).

(1) Log onto the Sun console and open an additional X-terminal window. In the second window, rlogin to the SRM.

(2) In the SRM window, load the ReadTape Application and get the radar phase history data (.aux, .clog, .sum, .phs files). This requires a cube of at least one i860 node (4 nodes are acceptable - only node zero runs the application). If the cube has just been rebooted, you must execute step 12.

(3) Edit a file (called the "nexec" file) on the Sun or SRM, describing the image formation parameters needed to form the image.

(4) In the SRM window, load the ANA Application to produce the image header file (.hdr). This requires a cube of at least one i860 node (4 nodes are acceptable - only node zero runs the application).

(5) In the SRM window, load the IFP Application to form the complex and detected image files (.ci and .detci). This requires a cube of exactly four i860 nodes.

(6) In the Sun window, execute the standard Unix FTP Application; connect to the Hypercube FTP server IOP and get the header, complex and detected image files (.hdr, .ci and .detci).

(7) In the Sun window invoke the QC Application to display the detected image file and produce IPR plots. If the image meets the IPR specifications, go tc step 11, otherwise record the best <x-loc> and <y-loc> reported by the HOF button.

(8) In the SRM window, load the RFM Application to form the higher-order focused complex and detected image files (.cih and .detcih). This requires a cube of exactly four i860 nodes.

(9) In the Sun window, execute the standard Unix FTP Application; connect to the Hypercube FTP server IOP and get the higher order focused complex and detected image files (.cih and .detcih).

(10) Go to step 7

(11) In the SRM window, write image data (.hdr, .ci or .cih, .clog, .sum, optional IPR plots) to the 8mm tape for storage or distribution using the Intel-provided /usr/i860/ipsc/bin/tar Application. This requires a cube of exactly one i860 node.

(12) In the SRM window, setup the tape mode to allow variable length records using the Intel-provided /usr/i860/ipsc/bin/tapemode Application. This requires a cube of exactly one i860 node.

3.2 THE EXAMPLE RUN

The following example run assumes that the cube was just rebooted.

```
;;; Step 0 - Move executables to your user directory on srm
sun1%   "rlogin SRM <cr>"
srm%    "cp /nfs/sun/usr/u/hifp/exe/HycReadTape  .  <cr>"
srm%    "cp /nfs/sun/usr/u/hifp/exe/ana  .  <cr>"
srm%    "cp /nfs/sun/usr/u/hifp/exe/ifp  .  <cr>"
srm%    "cp /nfs/sun/usr/u/hifp/exe/rfm  .  <cr>"
srm%    "getcube -ctemp -t4 <cr>"
srm%    "nsh <cr>"
;;  start the node shell to copy the filter files to the cube CFS
nsh%    "cd /cfs  <cr>"
nsh%    "mkdir sa  <cr>"
nsh%    "cd /cfs/sa  <cr>"
;;  copy the filter files to the cube CFS - This is required only
;;  once for each working directory on the cube
nsh%    "cp /nfs/sun/usr/u/hifp/exe/j0304512.con  .   <cr>"
nsh%    "cp /nfs/sun/usr/u/hifp/exe/n07mar89.cor  .   <cr>"
nsh%    "cp /nfs/sun/usr/u/hifp/exe/n1antpat.fil  .   <cr>"
nsh%    "cp /nfs/sun/usr/u/hifp/exe/n1filter.fil  .   <cr>"
nsh%    "cp /nfs/sun/usr/u/hifp/exe/rtocxflt.fil  .   <cr>"
nsh%    "exit <cr>"
srm%    "logout <cr>"
sun1%   "emacs .cshrc"
;;  Add the following lines to your .cshrc file:
```

```
"setenv XAPPLRESDIR /usr/u/hifp/exe/ <cr>"
"setenv QCDOCPATH   /usr/u/hifp/exe/ <cr>"
"setenv PATH $PATH\:/usr/u/hifp/exe/ <cr>"
"setenv HBASE       /usr/u <cr>"
sun1%

;;; Step 1 - Start up a processing session
sun1%  "xterm & <cr>"                ;; start another window
sun1%
sun2%  "rlogin SRM <cr>"
srm%

;;; Step 12 - Set 8mm tape to variable record mode
srm%  "getcube -ctemp -t1 <cr>"
;; got a cube for the tapemode
srm%  "/usr/i860/ipsc/bin/tapemode -b0 /dev/tape <cr>"
Some error from OS              ;; tapemode can fail the first time
srm%  "/usr/i860/ipsc/bin/tapemode -b0 /dev/tape <cr>"
srm%                            ;; tapemode worked
srm%  "relcube <cr>"

;;; Step 2 - Read phase history data from the 8mm tape
srm%  "getcube -chifp -t4 <cr>"
;; got a 4 node cube for the ReadTape, ANA, IFP, and RFM
;; Note: to redirect all cube output into a file use the
;;       following "getcube -chifp -t4 > logfilename <cr>"
;;       This is counter productive for the HycReadTape Application
;;       but may be useful for the ANA, IFP, and RFM Applications
srm%  "load HycReadTape; waitcube <cr>"
;;  this is the ONLY srm command that REQUIRES the waitcube
;;
Please input the device pathname to be used: "/cfs/tape <cr>"

Verifying that the tape is a phase history archive, please
hold...Verification complete

Would you like to view the data format headers of all the data sets?
(yes) or (no)?  [n]: "n <cr>"

Now enter the data set you wish to be at.
Data Set Number: "3 <cr>"

Please enter the pathname where this set should be placed.
Pathname: "/cfs/sa <cr>"

How many Phase History pulses would you like?
Number of pulses: "<cr>"

Retrieving Rawc log file...OK
Retrieving Quality control data file...OK
Retrieving Aux data...OK
Retrieving Phase History data...OK

Now enter the data set you wish to be at.
Data Set Number: "<cr>"
srm%
;;   The following files are now in the /cfs/sa directory
;;                  n0001v1.clog
```

```
;;                  n0001v1.sum
;;                  n0001v1.aux
;;                  n0001v1.phs

;;; Step 3 - Edit nexec file
sun1%   "cp $HBASE/hifp/exe/UNCLASS.nexec
                 /nfs/mydir/n0001v101.nexec <cr>"
sun1%   "emacs /nfs/mydir/n0001v101.nexec"
;; change parameters as needed (see the detailed ANA Section 4.2)
sun1%

;;; Step 4 - Run analysis on the data
srm%   "load ana /cfs/sa n0001v101 /nfs/mydir; waitcube <cr>"
;;    where   n0001v101 - image name
;;            /nsh/mydir - the full nfs path to the nexec file
;;            /cfs/sa - the full pathname to be used for the CFS
;;    ANA generates the header file (takes about 1 minutes)
srm%

;;; Step 5 - Run the image formation processor on the data
srm%   "load ifp /cfs/sa n0001v101; waitcube <cr>"
;;    where   n0001v101 - image name
;;            /cfs/sa - the full pathname to be used for the CFS
;;    IFP generates the image files: .ci, .detci (takes about 12 minutes)
srm%

;;; Step 6 - FTP the data files to the Sun
sun1%   "ftp cubeiop <cr>"
;;  Where cubeiop is the hostname for the cube's FTP server
username [user]: "<cr>"
password required: "mypass  <cr>"
ftp>   "cd /cfs/sa <cr>"
ftp>   "get n0001v101.hdr <cr>"
ftp>   "binary <cr>"
ftp>   "get n0001v101.ci  <cr>"
ftp>   "get n0001v101.detci  <cr>"
ftp>   "bye <cr>"
sun1%
;; getting the .ci file will take up to 3-10 minutes

;;; Step 7 - Run QC on the Sun
sun1%   "qc n0001v101  .  1950 1950 <cr>"
;;   Look at the image and determine if it meets specifications.  Lets
;;   say that this one does not.  Push HOF button: the program will
;;   provide the user with a <x-loc> <y-loc>: (135, 1132). These numbers
;;   should be recorded for use with the refocus step to follow.
;;   See the QC Section 4.5 for detailed instructions
sun1%

;;; Step 8 - Run the image formation processor on the data
srm%   "load rfm n0001v101 /cfs/sa 135 1132; waitcube <cr>"
;;    where   n0001v101 - image name
;;            /cfs/sa - the full pathname to be used for the CFS
;;            135 1132 - the high order focus parameters
;;    RFM generates the HOF files: .cih, .detcih (takes about 1 minutes)
srm%

;;; Step 9 - FTP the HOF data files to the Sun
```

```
sun1%  "ftp cubeiop <cr>"
;;  Where cubeiop is the hostname for the cube's FTP server
username [user]: "<cr>"
password required: "mypass  <cr>"
ftp>  "cd /cfs/sa <cr>"
ftp>  "binary <cr>"
ftp>  "get n0001v101.cih <cr>"
ftp>  "get n0001v101.detcih <cr>"
ftp>  "bye <cr>"
sun1%
;; getting the .cih file will take up to 3-10 minutes

;;; Step 7 (again) - Run QC on the Sun
sun1%  "qc n0001v101  .  1950 1950 <cr>"
;;  Look at the cih image and determine if it meets specifications.
;;  See the QC Section 4.5 for detailed instructions
sun1%

;;; Step 11 - TAR data to 8mm tape
srm%  "getcube -ctemp -t1 <cr>"
;; got a cube for the tapemode
srm%  "/usr/i860/ipsc/bin/tar cvf /dev/tape   \
           /cfs/sa/n0001v101.clog  \"
           /cfs/sa/n0001v101.sum  \"
           /cfs/sa/n0001v101.hdr  \"
           /cfs/sa/n0001v101.cih  \"
           /cfs/sa/n0001v101.detcih  <cr>"
;;  the TAR command takes the files from the /cfs/sa dir and
;;  writes them to 8mm tape.  See Intel documentation for more info
srm%  "relcube <cr>"
```

4.0 DETAILED DESCRIPTION OF APPLICATIONS

Each of the five applications is discussed in detail in a separate subsection. In this section, no attempt was made to describe the interactions between applications. Section 3.0 describes how to run the applications end-to-end.

4.1 READTAPE APPLICATION USER'S GUIDE

4.1.1 ReadTape Overview

ReadTape is a program running under Intel Hypercube which retrieves N1 Phase History Sets from an 8mm cassette tape. The tape was written by the corresponding WriteTape program which archived the N1 data onto the 8mm cassette tape.

The program is called HycReadTape and is invoked on the System Resource Manager as follows:

```
srm%   "load HycReadTape; waitcube   <cr>"
```

NOTE: The Hypercube has a default block size of 1024 bytes for magnetic tape drives. This must be changed to a variable block size by one of two commands. If you wish to change the tapemode in the node shell, issue the following command:

```
srm%   "getcube -ctemp -t4   <cr>"
srm%   "nsh  <cr>"
nsh%   "tapemode -b0 /cfs/tape   <cr>"
;;  the tape mode command may have to be repeated if you get an
;;  error on the first try  (Some operating system error)
nsh%   "exit  <cr>"
srm%   "relcube   <cr>"
```

On directly from the SRM, issue the following command.

```
srm%   "getcube -ctemp -t1   <cr>"
srm%   "load /usr/i860/ipsc/bin/tapemode -b0 /cfs/tape   <cr>"
;;  the tape mode command may have to be repeated if you get an
;;  error on the first try  (Some operating system error)
srm%   "relcube   <cr>"
```

4.1.2 Tape Format

Each HIFP phase history archive tape consists of one tape header file followed by up to 30 phase history sets. Each phase history set contains 5 files. The first file, the data format header, contains the information necessary to read the tape and create the other 4 files. The four remaining files consist of the raw data collection log, a quality control summary, an auxiliary data file, and the phase history file.

4.1.3 Program Execution

ReadTape prompts for the information it needs. An example listing of application execution is shown in Section 4.1.4.

The basic sequence is as follows:
(1) Ask for device name
(2) Verify that the tape is an N1 Phase History archive
(3) Ask if user desires to see the data format header of each set
(4) Ask for Data Set Number (<cr> to exit)
(5) Ask for Pathname
(6) Ask for the Number of Phase History Pulses
(7) Loop back to (4)

A detailed explanation of each step follows:

(1) Input device name: The device name is the name that the system connects to the 8mm tape drive being used. The example device name '/cfs/tape' is typically used on the Hypercube if there is only one tape drive on the system.

(2) Verify operation: If there is no tape in the tape drive, the device will wait until a tape is inserted. If the tape in the tape drive is not a phase history archive, the program will display an error message that the tape was not the proper type and exit.

(3) Input print data set flag: A positive response allows the user to view all of the data format headers. The data format headers are interspersed throughout the tape therefore this action requires the scanning of the entire tape. This may take 5 or more minutes per data set.

(4) Input Data Set Number: The data set number is the sequential number indicating where the phase history set is located on the tape. Data set numbers begin with zero for the first phase history set. You may request any valid data set at any time. If you request a data set prior to the one that was last retrieved, the tape will rewind and then fast forward to the proper set. If you request a data set after the current set, the tape will fast forward to the proper location. The program requires an integer value to be typed in.

(5) Input Pathname: The Pathname is the desired location of the retrieved data files. The most likely path would be in the concurrent file system with an example pathname being /cfs/sa.

(6) Input Number of Pulses: The number of phase history pulses is the number of pulses starting from the beginning of the phase history data. A phase history may contain as many as 400,000 pulses, but as few as 6000 pulses are necessary to create an image (depending on the geometry of the target). The phase history data must begin at the first pulse because the ANA Application currently does not support scanning a phase history that does not begin with the first pulse. In the worst case, to create an image with data that includes the final 6000 pulses of the phase history, the entire phase history would have to be written to disk to allow the HIFP applications to operate correctly.

4.1.4 Examples

The following is an example run with a tape containing 4 data sets.

```
srm%   "load HycReadTape; waitcube   <cr>"
Please input the device pathname to be used: "/cfs/tape  <cr>"

Verifying that the tape is a phase history archive, please
hold...Verification complete
Tape Header Buffer follows...

!Phase_History_Archive
160                                      !Bytes remaining in header
 9 May 1991                              !Date
ARIES::VAX/VMS mua0:                     !Written by
4                                        !Number of Data Sets

Would you like to view the data format headers of all the data sets?
CAUTION: This requires scanning the entire
tape and may take up to 5 minutes per set.
(yes) or (no)?  [n]: "n  <cr>"

Now enter the data set you wish to be at.
Data Set Numbers begin with 0 being the first set.
A return with no data exits the program.
Data Set Number: "3  <cr>"

Please enter the pathname where this set should be placed.
A period makes the current directory the location of the data files.
A return with no input exits the program.
Pathname: "/cfs/testing  <cr>"

How many Phase History pulses would you like?
The pulses will begin at the first pulse.
Number of pulses: "6000  <cr>"

Please hold while data set is located on the tape...Data set located.
Data Format information follows...
```

```
RAWC
n0001v1.rawc
ASCII
1536       1536       1         0          0
N1QC
n0001v100.qc
ASCII
3584       3584       1         0          0
AUXD
n0001v100.aux
FAI                                                  !Filtered Aux
80         64000      137000    0          384       90         0
PHD
n0001v1.phs
PHI                                                  !Phase History
4096       61440      8000      12000      0

Extension conversions in Effect:
      00.aux   ->   .aux
     .rawc     ->   .clog
      00.qc     ->   .sum

The entire data set transfer with 6000 pulses will take approximately 3
minute(s).

Retrieving Rawc log file...OK
Retrieving Quality control data file...OK
Retrieving Aux data...OK
Retrieving Phase History data...OK

Now enter the data set you wish to be at.
Data Set Numbers begin with 0 being the first set.
A return with no data exits the program.
Data Set Number: "<cr>"
srm%
```

4.1.5 ReadTape Error Explanations

Following is a list of common errors encountered when running the ReadTape Application. Possible causes and corrections are shown for each error.

Invalid device name.

The device path specified is the wrong name.
Check with the system administrator for the proper device path name.

Program seems to be hanging.

Tapemode may not have been run.
The tape drive may be inactive.
The tape drive may not have a tape inserted.
Execute tapemode or check tape drive to insure a tape has been inserted.

No such file or directory.

The path you specified to place data in does not exist.
Make the proper directories or re-name the path.

4.2 ANA APPLICATION USER'S GUIDE

4.2.1 ANA Application Overview

The primary function of analysis is to create a header file which will be used by the IFP (Image Formation Processor) and RFM (Refocus Module). The header file contains all the parameters needed for the other processes. The header file is classified SECRET. The header file contains information which can be used to determine the resolution of the N1 radar.

4.2.2 ANA Application Execution

Analysis is a stand-alone process that requires information entered on a command line and information contained in a processing parameter file. This file is referred to as the ".nexec" file. The ".nexec" file is classified as SECRET. This file contains the input parameters requested by the user and some needed radar parameters. The ".nexec" file contains information which can be used to determine the resolution of the N1 radar.

Several things must be done before a process can begin. The ".nexec" file must be created. This file is an ASCII file with a list of operating parameters. The common practice is to copy an old ".nexec" file to the new file with the desired image name. This file is then edited using emacs, vi or any other suitable editor. Only a few parameters are normally changed such as the family name depression and squint angle, etc. These parameters are determined from the ".sum" and ".clog" ASCII files that are brought in with the phase history data. The ".nexec" file may reside anywhere on the workstation or Hypercube. The operator may find it more convenient to leave the file on the workstation. The raw phase history and auxiliary data must also be loaded on to the Hypercube disk before analysis can run. See Section 4.2.5 for details of editing the nexec file.

After all the above has been completed, analysis can be run with the following command line:

nexec <cfs-path> <image-name> <batch-path>

The cfs-path will tell the process where to find the phase history and aux data. The image-name is the unique name given by the user. The batch-path will tell the process where to find the ".nexec" parameter file. The batch-path may be the same as the cfs-path. The following is an example of an analysis command line:

```
srm%  "getcube -ctemp -t1  <cr>"
srm%  "load ana /cfs/hifp/sa n0000a101 /usr/u/username   <CR>"
;;  ANA runs on one i860 cube until complete
;;  ANA will run on a 4 node cube - only node 0 will be used
srm%  "relcube  <cr>"
```

At the completion of the execution of the analysis Application, a header file will be created at the cfs-path. To view the header file, FTP may be used to retrieve this file to the Sun workstation.

4.2.3 ANA Error Explanations

Analysis will quit and write out an error number if the error is detected. The following is a list of numbers errors and there definitions which may be encountered while running ANA:

Number	Definition	Label
1028	Aux File attach error	ERR_ATTACH_AUX_FILE
1029	Aux File read error	ERR_READ_AUX_FILE
1030	Aux Data unaccessable	CANT_ACCESS_AUX_DATA
1031	Aux File detach error	ERR_DETACH_AUX_FILE
1032	Bad Seq2 number	BAD_SEQ2_NUM
1033	NCCCFAN Error, unable to find angle	ERR_NCCCFAN_ANGLE
1034	Illumination Patch size error	BAD_ILLUM_PATCH_SIZE
1035	Improper Family Name	BAD_FAMILY_NAME
1036	Error Reading Nexec File	ERR_READ_NEXEC_FILE
1037	Improper Nexec filename	BAD_NEXEC_FNAME
1038	Not Enough Data to process at squint	INSUF_SQUINT_DATA
1039	Error reading PI Filter	ERR_READ_PI_FILT
1040	Error reading Antenna filter	ERR_READ_ANTENNA_FILT
1041	Antenna Pol not H or V	ANTEN_POL_NOT_H_OR_V
1042	Invalid FFT size	BAD_FFT_SIZE
1043	Image size invalid	BAD_IMG_SIZE
1044	Warning - Questionable SXR,SYR,SZR values	WARN_SXYZ
1045	Bad Squint angle	BAD_SQUINT

The following is a list of several other errors which may be encountered while running ANA:

Load Error - File Not Found
    The executable file may not be in present working directory.
    Check permission of working directory and the executable.
    Move to correct directory or the executable into present directory.

Bad CWRITE Number
    File you are writing to may be write protected.
    Change protection on the files.

READ Error
    File you are trying to read from may be protected.
    Check protection on the files.

File Not Found
    May not be specifying the correct CFS dir on load command.
    Make sure all files are in the CFS directory.

Cube Not Attached
Did not allocate a cube, see getcube

Lifeline Not Responding
Must reboot Hypercube (rebootcube at SRM prompt).

Invalid Node Configuration
4 node cube is only supported.

Also, if the Hypercube seems to be "hanging" it is a good idea to type

(1) killcube
(2) relcube
(3) rebootcube
(4) load ifp <cfs-path> <image-name>

4.2.4 ANA Security Concerns

The nexec input file and the header file created by Analysis are classified SECRET due to its resolution as well as the certain radar parameters which can be used to determine the resolution.

4.2.5 Editing a Nexec File

The nexec file must be edited and properly renamed to allow Analysis and the other application of the HIFP to run correctly.

4.2.5.1 File Naming Conventions

The first seven characters of the nexec file name comprise the phase history 'family-name'. It must be exactly the same as the phase history name that was read from the 8mm tape. The family name is determined from the transcription process performed in the DMR. The next two characters should be a unique two digit code, starting from 01, that identifies the image number. Each new unique image formed by the processor from this phase history family is assigned the next consecutive two digit number. These numbers should be carefully documented if any tracking or control of image processing is to be made. The final six characters of the nexec file name must be '.nexec', the extension for all nexec files. Note: if the nexec file is located on the SRM, the SRM will truncate the 'c' from the name.

Example file names for family 'n0001a1':

Data from 8mm tape:
n0001a1.phs - Phase history filename
n0001a1.aux - Aux filename
n0001a1.clog - Data collection log filename
n0001a1.sum - Quality control summary filename

First image produced from n0001a1 (no HOF required)

n0001a101.nexec - First image nexec filename
n0001a101.hdr - Image Header filename
n0001a101.ci - Complex image filename
n0001a101.detci - LinLog encoded byte magnitude filename

Second image produced from n0001a1 (HOF was required)

n0001a102.nexec - First image nexec filename
n0001a102.hdr - Image Header filename
n0001a102.cih - Complex image (HOF) filename
n0001a102.detcih - LinLog encoded byte magnitude (HOF) filename

4.2.5.2 Nexec Fields that May Require Editing

The only fields from the SECRET.nexec file that require editing are the 'Family name', 'date', 'ground look angle', 'tape drive or file', and the 'depression angle'. Editing other fields in the nexec file is not recommended and may lead to poor image formation, misleading results or program execution failures. The 'Family name' and 'tape drive or file' are taken from the phase history filename created from the 8mm tape. The 'date' field is the date of processing.

The 'ground look angle' and the 'depression angle' are taken from the .sum file. The depression angle needs any number between the BETAMN and BETAMX number found in the sum file. This number only aids Analysis in starting the aux file search and does not have to be exact. The 'ground look angle' is the squint angle that the image will be processed around. The value of this number is determined by the requirements of the user; however, it must be between the ISTHETG or FSTHETG values but can not be closer than about 1.5 degrees to either the ISTHETG or FSTHETG. The following is an example extract from a sum file:

```
ISTHETG    87.089706    <INITIAL SQUINT ANGLE (DEG)>
FSTHETG    92.902222    <FINAL SQUINT ANGLE (DEG)>
BETAMN     44.949886    MINIMUM DEPRESSION ANGLE (DEG)>
BETAMX     44.961204    MAXIMUM DEPRESSION ANGLE (DEG)>
```

For this example, the edited fields in the nexec file could be as follows:

```
n0001a1             Family name
19-JUN-91           date [DD-MMM-YY]
90.0                ground look angle [xxx.xxx deg]
n0001a1.phs         tape drive or file
44.9                depression angle
```

If the user desires to process the image in 2x mode, simply double of the values for the 'azimuth resolution' and 'range resolution' fields that are included in the distributed SECRET.nexec file.

Two other fields that can be edited are the 'scene center X position' and 'scene center Y position'. If the user desires to shift the center of the scene, enter the number of feet in x and y that the center should be shifted. The sign of the numbers depend on the geometry and should be consistent with the sign of the x and y values from in the .sum file.

4.2.5.3 Classified Nexec File Differences

The only fields that differ in the classified version of the nexec file are the 'azimuth resolution', 'range resolution', 'swath time select number', 'chirp rate select number', and 'radar starting frequency'. Examine the SECRET.nexec file included on the classified tape included with the HIFP distribution. Note: for 2x mode, the 'azimuth resolution' and 'range resolution' fields are simply the double of the values for the 1x mode values.

4.2.5.4 Example Unclassified Nexec File

The following is a complete list of an unclassified nexec file. Only the fields noted in Section 4.3.5.2 (shown with the *) should be changed.

```
n0000a1            * Family name
30-MAY-91          * date [DD-MMM-YY]
90.0               * ground look angle [xxx.xxx deg]
1                    number of tape drives mounted
n0000a1.phs        * tape drive or file
TP00RP00             pulse code
7.0                * azimuth resolution
7.0                * range resolution
1300                 azimuth scene size
1300                 range scene size
37.7               * depression angle
30.0                 Taylor weighting side lobe level
4                    Taylor weighting NBAR
7.0                  maximum search range for autofocus
4                    quadratic autofocus iterations
32                   maximum number of autofocus range bins
nlantpat.fil         antenna filter file
nlfilter.fil         filter response file
rtocxflt.fil         real to complex filter
n07mar89.cor         RCVR phase correction.
j0304512.con         polar interpolation filter
10                   polar interpolation filter extent
0                    polar interp. table number samples
 75                  polar interp. filter trim factor
2                    operation mode 0-low res., 1-survey, 2-full
.5                   relative aperture center
6.0                  max amount of illumination deviation correction
VV                   antenna polarization VV HH VH HV
1                    autofocus type
.75                  polar interp. sinc filter BW ratio
2                    polar interp. filter weighting SW
100.0                polar interp. filter gain
0.0                  lever arm projection x (ft.)
0.0                  lever arm projection y (ft.)
0.0                  lever arm projection z (ft.)
128                  amplitude correction array size; range
128                  amplitude correction array size; azimuth
8                    amplitude correction upsamp. filter extent
```

1	amplitude correction upsamp. filter type
0	generate annulus plots 1-do plot, 0-don't plot
0	process and display low res image 1-do,0-don't
0	use HRC to display image 1-do, 0-don't
0	invoke arcive routine 1-do , 0-don't
1.5	sample density in range
1.5	sample density in azimuth
90.0	starting ground squint angle
90.0	ending ground squint angle
0.0	increment for ground squint angle
0.0	scene center X position
0.0	scene center Y position
0.0	scene center Z position
1	first usable video sample number
4095	last usable video sample number
0.000000471	IF filter delay
40000000.0	IF filter bandwidth
1.19	excess aperture factor (KA)
1.13	excess aperture factor (KR)
490.0	swath time select number
30000000.0	WFG reference frequency
90.0	chirp rate select number
2100000000.0	radar starting frequency
45000000.0	sampling frequency
983210400.0	speed of light

4.3 IFP APPLICATION USER'S GUIDE

4.3.1 IFP Application Overview

The Image Formation Processor (IFP) takes raw phase history data and creates an image through a series of complex operations. The raw phase history is collected with the ERIM Data Collection System which collects only spotlight-mode SAR data. The system uses linear FM pulses that are transmitted at a fixed rate. The received echos are then deramped (partially compressed) and digitized. The digitized radar returns (video data) and the auxiliary data are recorded onboard the aircraft and later transcribed to workstation-compatible media on the ground. The data is then read from the tape media and stored in the .phs and .aux files. Radar and other processing parameters required by the IFP are stored in the .hdr file. The auxiliary data relates the radar platform's instantaneous position and attitude with respect to the Motion Compensation Point. The operations used to create an image are summarized below:

(1) Real-to-Complex Conversion
(2) Low Pass Filter
(3) Range Phase Error Correction
(4) Motion Compensation
(5) Projection from 3-D to 2-D Format
(6) Polar Interpolation
    (a) Range Interpolation/Resampling
    (b) Azimuth Interpolation/Resampling
(7) Taylor Weighting
(8) Range FFT's
(9) Quadratic Autofocus
(10) Azimuth FFT's
(11) Amplitude Correction
(12) Scaling/LinLog Encoding

The real-to-complex process takes a pulse containing real samples and converts them to complex samples. The low pass filtering operation is performed to filter out unwanted signals. Range phase error correction is performed to compensate for the waveguide dispersion and other deterministic phase errors in the radar. The same correction vector is applied to each pulse. Motion compensation corrects the phase of each pulse to obtain the coherence which is needed to generate high quality imagery.

The next two operations are collectively called polar formatting. These two operations compensate for image degradation that results from stationary targets moving through multiple resolution cells during formation of the synthetic aperture. The first operation takes a motion-compensated pulse in its data collection plane (3-D) and projects it into the processor space (2-D). The next operation can be thought of as a two-step process in which the unevenly-spaced phase history samples are resampled onto a rectangular grid of equal sample spacing via a two-dimensional separable FIR filter. First, samples within a range record are resampled to have equal spacing. These intermediate outputs are then resampled to have equal spacing in azimuth. Upon completion, the polar-formatted phase history has been reformatted to the desired rectangular coordinate grid.

After polar formatting, Taylor weighting is applied to the phase history to control impulse response sidelobe levels. Range FFT's are then used to transform each range record individually into the image domain. The autofocus module is then used to estimate and remove any azimuth quadratic phase errors present in the polar interpolated phase history. This produces a more focused image. The azimuth FFT is then used to transform the data in azimuth into the image domain. Now that an image is formed, the amplitude correction function is used to compensate for known, deterministic amplitude deviations in the complex output image. The amplitude compensations include corrections for the antenna pattern, the range power falloff, and the polar interpolation filter response. Finally, the complex image is scaled and the detected image is LinLog encoded to optimize the target/clutter contrast in an 8-bit image product (the .detci file). Two files are created, the .ci and .detci files, and the header file is modified to reflect the results of the processed image.

The data processed by the IFP is kept in memory until a particular portion needs to be output to disk. Presently, the detected image, the complex image, and the header file are the only files written to disk. The header file is in readable ASCII format, while the others are written to disk in a SUN readable format.

4.3.2 IFP Application Execution

In order to invoke the IFP, the user must be logged on the SRM and type:

```
srm%  getcube -t4
srm%  load ifp <cfs-path> <image-name>
```

ifp - the executable which drives the image formation processor
<cfs-path> - directory where the required files reside
<image-name> - image name without an extension

Several conditions must be met prior to running IFP:

(1) IFP operates on a 4 node cube only.
(2) Input files (filter files, raw phase history, header file, and aux data file) reside in the same <cfs-path> directory.
(3) Output products (complex, detected images, and the revised header file) will be written into the same CFS directory.
(4) Analysis must be run on <image-name> before IFP is run to create the .hdr file.

Using the IFP command line arguments, several filenames are created that will be used for creating the output files. The filenames are formed by concatenating the <cfs-path> with the image or family name. The family name is formed by parsing the last two characters of the image name. Once the pathname for each of the respective filenames has been determined, they are placed into a common block. The following is a list of the input and output filenames used by the IFP Application which reside in the common block:

phname - raw phase history filename (.phs)
auxname - aux data filename (.aux)
ciname - complex image filename (.ci)
detname - detected image filename (.detci)
rhdrname - header filename (.hdr)
piphname - polar interpolated phase history filename (.pi)

The following filters are provided with the software and should reside in the same CFS directory as all the other files. These filters are installed initially in the $HBASE/hifp/exe directory and should be copied to the working directory on the CFS.

rtocxname - real to complex filter filename (rtocxflt.fil)
wfgname - range phase error correction vector filename (n07mar89.cor)
piname - polar interpolation filter filename (j0304512.con)
n1name - n1 receiver IF filter (n1filter.fil)

4.3.3 IFP Error Explanations

The following is a list of typical errors which may be encountered while running IFP:

Load Error - File Not Found
The executable file "ifp" may not be in present working directory.
Check permission of working directory and the executable.
Move to correct directory or move the executable into present directory.

Bad CWRITE Number
File you are writing to may be write protected.
Change protection on the files.

READ Error
File you are trying to read from may be protected.
Check protection on the files.

File Not Found
May not be specifying the correct directory on load command.
Make sure all files are in the CFS directory.

Cube Not Attached
Did not allocate a cube, see getcube.

Lifeline Not Responding
Must reboot Hypercube (rebootcube at SRM prompt).

Invalid Node Configuration
4 node cube configuration is only supported.

Also, if the Hypercube seems to be "hanging" it is a good idea to type

(1) killcube
(2) relcube
(3) rebootcube
(4) load ifp <cfs-path> <image-name>

4.3.4 IFP Image Output Specifications/Limitations

The follow are the supported specifications or limitations for the IFP.

The output image size is always 1950x1950 pixels.
The processor supports both 1x or 2x modes.
The processor supports scene center shifts.
Output sample spacing may differ by up to 4 parts in 2030 from the ARIES IFP. (i.e., 0.197% - this would be noticeable only on very large images)
Uses quadratic autofocus.
1x mode images take 19-23 minutes to form on 4 nodes.
2x mode images take 13-15 minutes to form on 4 nodes.
Two 4 nodes cubes can be operated simultaneously.
On average two 4 nodes cubes can form an image every 7-12 minutes
Amplitude compensations: the antenna pattern, the range power falloff, and the polar interploation filter response.

4.3.5 IFP Security Concerns

Files created by the image formation processor (the header file, detected image, and complex image) are classified SECRET due to the resolution as well as the certain radar parameters which can be used to determine the resolution.

4.4 RFM APPLICATION USER'S GUIDE

4.4.1 RFM Application Overview

The Refocus Module (RFM) is a stand-alone program which is used to correct for higher-order phase errors which quadratic auto-focus was not able to remove. The RFM process works by creating a phase error correction vector from a reference point scatterer in the image. RFM is an interactive process, requiring the user to input the x and y image coordinates of the point target that had been selected as the reference point. This reference point is selected when running the QC program. The reference point scatterer must be a single point return and isolated from other strong scatterers by at least 40 pixels. The focus the whole image, reference target should be stationary. A moving target has a unique phase that would focus the moving target while inadvertently blurring rest of the image.

The higher-order focused image is created from the complex image. The complex image is first read into the RFM program. The image is then corner-turned to prepare it for an inverse Fourier transform in the azimuth direction. The phase error correction vector is computed from the azimuth data that is extracted about the given x and y coordinates. The azimuth data is then inverse transformed, multiplied by the phase correction vector then forward transformed back to the image domain. This operation is repeated for all the azimuth lines. Finally the image is corner-turned back to it's original state and written to disk files with the .cih and .detcih extensions.. A complex and detected image will be created by RFM.

4.4.2 RFM Application Execution

To invoke the RFM, the user must be logged into the SRM and must type the following:

```
srm%   "getcube -t4  <cr>"
srm%   "load rfm <cfs-path> <image-name> <x> <y>   <cr>"
```

rfm - The executable which drives the image formation processor
<cfs-path> - directory name where the required files reside
<image-name> - image name without extension
<x> - The first coordinate value given by QC of the reference
<y> - The second coordinate value given by QC of the reference

Several conditions must be met prior to running RFM:

(1) The RFM operates on a four node cube allocation only.

(2) The Input files(filters, header, complex image) must reside in the directory specified by <cfs-path>.

(3) The IFP process must be run first.

All output products (header, detected and complex image) will be written into the same directory specified by <cfs-path>. The header file will be updated with any new processing results and parameters changed in RFM.

4.4.3 RFM Errors Explanations

The following is a list of typical errors which may be encountered while running the RFM program:

Load Error - File Not Found
 The executable file may not be in the current working directory.
 Check permission of the working directory and executable file.

Bad CWRITE Number
 You may be attempting to write to a protected file.

READ Error
 File attempting to read is protected.

File Not Found
 Command line may not contain the correct CFS path.
 IFP process has not been run on this image name.

Cube Not Attached
 Did not allocate a four-node cube.

Lifeline Not Responding
 Hypercube system fault, reboot cube from SRM.

Invalid Node Configuration
 Only four-node configuration supported.

Blurred .detcih Image
 The x and y coordinates were reversed.
 Point reference target was actually multiple scatterers.
 Point reference target was non-stationary.
 Point reference target had low signal-to-noise ratio.

4.4.4 RFM Image Specifications

The image sizes are 1950x1950
Corrects for Azimuth miss-focus only
Can operate on any resolution
The process take 5-7 minutes on 4 nodes

4.4.5 RFM Security Concerns

Files created by the RFM process (Header file, detected image, and complex image) are classified SECRET due to the resolution as well as certain radar parameters which can be used to determine the resolution.

4.5 QUALITY CONTROL APPLICATION USER'S GUIDE

The Quality Control (QC) Application is used to verify image quality and to optionally allow the operator to determine higher-order focus (HOF) parameters. This application runs on a Sun with an eight-bit color display.

The QC Application will:

- display LinLog detected images
- demagnify large images
- allow zooming on demagnified images
- allow viewing of a SAR image from IFP
- allow viewing of a SAR image from RFM
- allow viewing of SAR images in color and greyscale modes
- create IPR plots for both the IFP and RFM images
- determine the parameters used for higher-order focus for RFM
- save the IPR plots

QC reads and displays LinLog detected images. While the image is being displayed, the user can change the contrast of the image to make it easier to view. All image data displayed by QC is from the LinLog encoded detected image files. These LinLog images are detected and compressed versions of the complex images. The QC display system is only intended to support the control of quality of output from the IFP and RFM Applications. The scaling and log encoding operations needed to create the LinLog image may render the image displayed by QC *unsuitable for image* exploitation. The .ci and .cih files contain the original complex image data.

QC demagnifies images that are too large to fit into the Image Display Area so the user is able to view them in their entirety. QC also informs the user what demagnification factor was used. QC can zoom in on a portion of a demagnified image and display that portion with normal magnification.

QC allows the user to change back and forth between the IFP and RFM versions of the image when both versions are present. QC does this so the user can see what effects higher-order focus had on the image.

QC allows the user to switch between viewing SAR images in color mode and greyscale mode.

QC generates impulse response (IPR) plots which are used in analyzing the quality of the image. These IPR plots can be done for IFP and RFM images. The IPR plots use the complex floating point output (.ci and .cih files) from the IFP and RFM application.

QC determines the refocusing parameters for each set of IPR plots that were generated with a IFP image.

QC saves the IPR plots in files which are compatible with other graphing programs, such as "xgraph", so they can be viewed at a later time or printed.

4.5.1 Getting Started with Quality Control

4.5.1.1 Running QC

To start QC, the name of the application, "qc", should be entered on the Unix command line, along with the name of the path where the image can be found, the name of the image (without extensions), the number of lines in the image, and the number of elements in the image (the last two inputs are optional). Simply typing "qc" at the command line will show the user what information needs to be entered, as shown below:

```
qc <image_path> <image_name> [<nl> <ne>]
```

where:

<image_path> name of the path where the file to be viewed is stored. (Note: if you want the current directory, use ".")

<image_name> name of the image to be viewed - (do not add the file extension)

<nl> number of lines in the image Default: 1950

<ne> number of elements in the image Default: 1950

When QC is initially invoked, an outline of the QC main screen pops up. By pressing the left mouse button, the user can place the QC main screen anywhere on the display screen. After the QC main screen is in place, the program automatically loads the image.

4.5.1.2 Setup Required for QC

Three environmental variables must be set before QC can be invoked for the first time during a processing session.

(1) The display device that the user is working on must be specified. This option is usually set when a user logs onto a display device. If it has not been set, the following error message occurs:

"Error: Can't Open display"

This error usually occurs when either the user attempts to run on a non-X windows device or the user remotely logs in from one system to another. If the first case occurs, running on a non-X windows device, there is nothing that can be done to fix this problem except to move to a terminal that supports X Windows. The second case can easily be handled by entering the following command:

```
setenv DISPLAY <display name>
```

where <display name> is the display name being used.

(i.e. setenv DISPLAY hostname:0.0)

(2) Before using QC, the user must also set the application resource directory to the directory where the QC resource file, QC_RSRC, is located. To set this, the user should type:

setenv XAPPLRESDIR <resource path>

where <resource path> is the path where QC_RSRC is stored. The QC_RSRC file is typically put in the same directory that QC resides. If the resource directory is not set at some point before QC is run, the QC main screen will look distorted and QC will not work properly. The user may wish to add the setenv command to the .cshrc file.

(3) In order to use the help facility available with QC, the path to the help document must be specified. The user can do this by typing the following command:

setenv QCDOCPATH <path>

where <path> is the path where QC_doc is located. If this environment variable is not set, QC looks for QC_doc in the user's current path. If QC_doc is not found, an "error opening file" message is displayed to the user and the help screen will not appear. This command may also be set in the user's .cshrc file.

4.5.1.3 Files Used by QC

The user must make sure that the files needed for a QC session are present in the directory specified by <image_path>. The user is notified if certain files are not found. If either the complex or the detected version of an image file is not present, QC treats that image as if it were not there.

QC initially displays the RFM image if it is found. If no RFM image is found, QC displays only the IFP image. If neither of these two images are present, the user is notified that no image was found and QC terminates. (If this happens, the user may want to check the path that was entered and the filename given to make sure that they were correct).

If an RFM image was found but the IFP version of that image was not found, QC informs the user that the IFP image could not be located. In this case, QC will function as it normally would, except that the user will not be able to switch back and forth between the RFM and IFP images and will not be able to select the parameters for RFM.

Note: If the RFM or IFP files get overwritten with new data while QC is running, the detected images shown will be from the original files (until the user switches between the RFM and IFP images), but the complex data used for the IPR plots will be from the new files.

QC also looks for a header file. Data from this file is used to calculate the oversampling factors for the IPR plots. If the header file is not found, QC tells the user that it could not be found and uses 1.5 as the default oversampling factor. QC assumes that the necessary files it will be using have the following extensions: (Currently, there is no way to override these default extensions.)

header file for image -> <image_name>.hdr
IFP complex -> <image_name>.ci
IFP detected -> <image_name>.detci
RFM complex -> <image_name>.cih
RFM detected -> <image_name>.detcih

4.5.1.4 Quality Control Example

The following section is an example of the output from a QC session. All of the commands in this section are preceded by a description of where they occur. For example, any commands preceded by "Unix>" are entered on the Unix command line. Any commands preceded by either "QC_main>" or "IPR_screen>" are actions that are taken on a particular screen, usually by moving the cursor or pressing a mouse button.

```
sun%  "setenv DISPLAY hostname:0.0"
sun%  "setenv XAPPLRESDIR /var/u/hifp/exe/"
sun%  "setenv QCDOCPATH /var/u/hifp/exe/"
sun%  "ls mydata/imgset"
img3.ci          img3.detci       img3.hdr
img3.cih         img3.detcih

sun%  "qc"
Usage: qc <image_path> <image_name> [nl] [ne]

     image_path :   name of path where file is located
     image_name:    name of file to be viewed (without extensions)
     nl:            number of lines in image
                          [defaults to 1950]
     ne:            number of elements in image
                          [defaults to 1950]

sun%  "qc mydata/imgset img3 1950 1950"

;;  The QC main screen comes up and img3.detcih is displayed in Image
;;  Display Area. The image is identified as "img3.cih" in the title
;;  bar.  At this point, the following buttons are active: Demagnified
;;  Image .CI, Subset Region, Contrast, and Exit. Because a demagnified
;;  image is being displayed, the area locator is entirely grey .  The
;;  labels under the image have the following information in them: Upper
;;  Left Corner = (1,1), Image Size = (1950,1950), and Magnification
;;  Ratio = 1:3

QC_main%  "Move the slider in the contrast bar up and down two
or three times"

;;  After the slider is moved, the cursor will change into a watch.
;;  When it changes back to an arrow, the user will be able to see a
;;  difference in the contrast of the image.

QC_main%  "Press the 'Subset Region' button"
```

;; The following message is displayed in the message area: "To select
;; an area, click at a point on the image"

QC_main% **"Move the cursor over the image and press one of the mouse buttons"**

;; Notice that before a mouse button is pressed, the cursor is in the
;; shape of a crosshair.

;; After the button has been pressed, the message box displays the
;; "Retrieving Region" message, and the cursor turns into a watch.

;; After the new region is displayed, the following buttons are active:
;; Demagnified Image .CI, Demagnified Image .CIH, IPR Plots, Contrast,
;; Select Color and Exit. The area locator now has a small grey box in
;; a larger white box. The grey box indicates where on the image the
;; portion being viewed from. The upper left corner label has also
;; changed to reflect its new value, and the magnification ratio is
;; now 1:1.

QC_main% **"Press the 'IPR Plots' button"**

;; The following message is displayed: "Place crosshair over center of
;; IPR area".

QC_main% **"Move the cursor to some point on the image and press a mouse button"**

;; The message "Doing IPR Plots" is displayed, and the cursor changes
;; to a watch. After about six to twelve seconds, the outline of a
;; second window shows up on the screen.

IPR_screen% **"Press a mouse button to place the new window on the screen"**

;; The new screen will be blank for about ten seconds and then the
;; information on the screen will be visible. Notice that the name of
;; the image that this set of data came from is in the title bar. Also
;; note that since these plots were done on a RFM image, the HOF button
;; is inactive.

IPR_screen% **"Press the 'Save Plots' button"**

;; A dialog box comes up asking the user to enter a filename. Notice
;; that if the cursor is moved out of the dialog box, the cursor
;; changes into the dialog warning cursor.

IPR_screen% **"Press 'OK' or 'Cancel' to get rid of the dialog box"**

IPR_screen% **"Press the 'Select Plots' button"**

;; A list comes down under this button. Because there is only one IPR
;; plot screen currently displayed, the only item listed here is the QC
;; main screen.

IPR_screen% **"Select the 'QC main' screen option"**

;; The QC main screen is now the top screen.

QC_main% **"Press the 'Demagnified Image .CI' button"**

;; A message, "Reloading Image", is displayed. After the demagnified
;; image is loaded, the file extension in the title bar is changed to
;; ".ci" to reflect the fact that the IFP image is being viewed. The
;; buttons now available are: Demagnified Image .CIH, Subset Region,
;; Select Plots, Contrast, and Exit.

QC_main% **"Press 'Subset Region' and choose and area the same way you did for the RFM image."**

QC_main% **"After the image comes up, press the 'IPR Plots' button and choose a point on the image to do IPR plots at."**

;; The process is the same as before. A few of the features on this
;; IPR plots screen will be slightly different than the one we just did
;; since this is an IFP image: the "HOF" button is active on this
;; screen and the title bar contains the name of the IFP image, not the
;; RFM image.

IPR_screen% **"Press the 'HOF' button"**

;; A dialog box appears showing the peak coordinates for the IPR plots.
;; The user must write these coordinates down if this is the point to
;; use for refocusing with the RFM application.

IPR_screen% **"When finished retrieving these parameters, press 'OK'."**

IPR_screen% **"Go back to the QC main screen"**

QC_main% **"Press the 'Select Plots' button"**

;; Notice that there are two items listed under this button, one for
;; each of the IPR plot screens that were created. Also notice that
;; the user can tell just by looking at the list which screen is
;; associated with the IFP image and which one is associated with the
;; RFM image.

QC_main% **"Move the slider in the contrast bar up or down."**

;; Notice that not only does the contrast in the Image Display Area
;; change, but the contrast of the images on the IPR Plots screens also
;; change.

QC_main% **"Press the 'Select Greyscale' button"**

;; Notice that the image in the Image Display Area, as well as the
;; images on the IPR plot screens, change from color to greyscale mode.
;; Also notice that the button that was just pressed, now reads "Select
;; Color".

QC_main% **"Go back to the IPR plot screen that was done on the RFM image"**

```
IPR_screen%   "Press the 'Dismiss' button"

;;  That screen goes away.

IPR_screen%   "Go to the QC main screen"

QC_main%   "Press the 'Exit' button"

;;  A dialog pops up asking the user if this is really the option
;;  wanted.

QC_main%   "Press the 'OK' button"

;;  The QC main screen as well the the remaining IPR plot screen both
;;  disappear.

sun%

;;  Now "RFM" can be run using the coordinates recorded from the HOF
;;  dialog box.
```

4.5.2 Quality Control Application Overview

QC is made up of two different screens: the QC main screen and the IPR plots screen. (See Figures 4.1 and 4.2). This section explains what the general purpose is for both of these screens. It describes what they are used for as well as what information they contain. Four different cursors are used throughout QC to indicate to the user what state QC is in at any particular time. These cursors and their meaning are also described. To help the user gain a better understanding of what the IPR plots are and how they are formed, IPR plots are described as well.

4.5.2.1 QC Main Screen

The QC main screen is used for viewing LinLog detected images, switching back and forth between RFM and IFP images, generating IPR plots, and communicating to the user what QC is doing and what needs to be done by the user.

Options available while viewing an image include changing its contrast, switching between the RFM and IFP image, changing from greyscale to color mode, and for images which have been demagnified, viewing a portion of the image at normal magnification.

This screen is made up of five general areas:

- Title Bar : gives the application name and the image name
- Image Display Area: area where image is displayed
- Message Area: area where messages are displayed
- Image Indicator Box: a box that indicates what part of the image is being displayed
- Button Area: area where all of the buttons are located

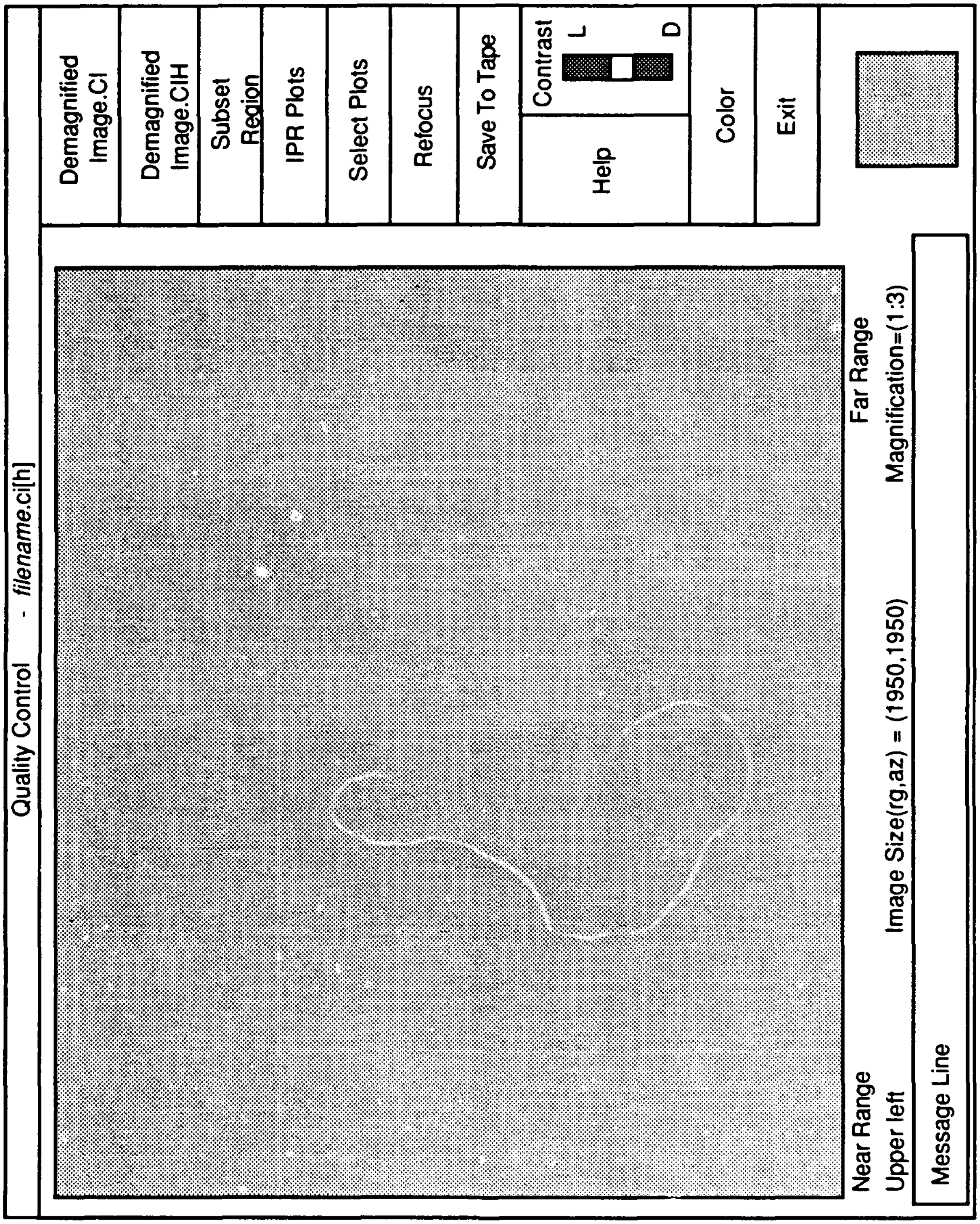

Figure 4.1 - QC Main Screen Layout

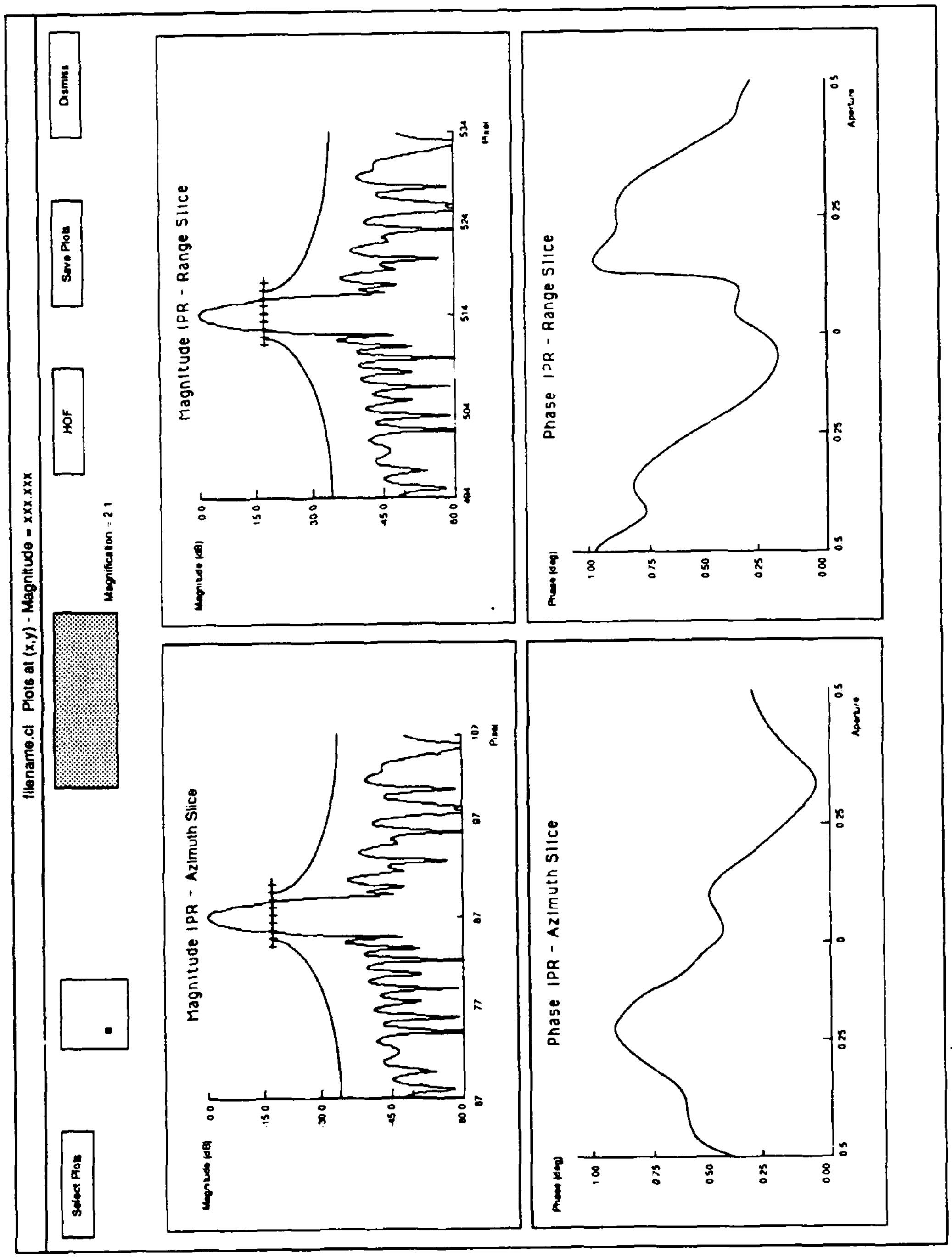

Figure 4.2 - QC IPR Screen Layout

4.5.2.2 IPR Plots Screen

An IPR Plot Screen is created after the user requests to make an IPR plot by choosing the "IPR Plots" button on the QC main screen and then selecting a spot on the image.

This screen displays the four IPR plots, allows the user to save these plots to an ASCII file, tells the user what coordinates to use for refocusing, shows the user where these IPR plots were done on the image, and allows the user to get rid of the screen.

This screen is made up of four general areas:

- Title Bar: displays the name of the image that the data for the plots was taken from as well as the magnitude and location of the pixel with the highest magnitude.
- Graphs: displays magnitude and phase plots in the range and azimuth directions
- Button Area: area where buttons are located
- Area Location Boxes: a box showing the location on the image where the IPR plots were generated and a picture of the image around the point the IPR plots were done

4.5.2.3 Cursors

The cursor is the pointer that moves around the screen in relation to mouse movement. *There are four different* cursor styles used in QC.

The arrow cursor is the most frequently used cursor in QC. When the cursor is in the shape of an arrow, the program is running normally and the user can use the cursor to press buttons and move screens.

The watch cursor is used to indicate that the program is waiting for something to finish processing. This is used while waiting for the IPR Plots screen to come up or while waiting for an image to be loaded. QC will not accept commands while the watch cursor is displayed. Repeatedly clicking the mouse while the watch cursor is displayed can lead to undesirable results or program crashes.

The crosshair cursor is used when the user is supposed to select a point on the image. As soon as the cursor is moved out of the Image Display Area, it is changed back to an arrow. Pressing any one of the mouse buttons while the crosshair is on the image picks a point on that image. If the cursor is within 20 pixels of any of the edges of the image, a message will pop up telling the user that a selection cannot be made that close to the edge of the image, and the user will have to chose another point on the image.

The warning dialog cursor, which looks like a circle with a line through it, is used when QC is waiting for the user to dismiss a pop up dialog box. This cursor indicates to the user that there is some importance to the dialog box that was brought up and that this dialog box has to be dealt with before doing anything else in QC. If one of the mouse buttons is pressed while the cursor is outside of the dialog box, the only response will be a beep.

4.5.2.4 IPR Plots

4.5.2.4.1 IPR Plot Overview

Image impulse response (IPR) plots are used to determine if higher-order focusing (HOF) is necessary on an image that has not been through HOF and to determine if HOF was successful. If HOF is needed, it gives the user the coordinates of the point where HOF should be done.

4.5.2.4.2 How It Works

When the user selects the point on the complex image where the IPR plots are to be measured, the pixel around that point with the largest magnitude is located. Range and azimuth slices, with a size of 40 pixels each, are taken though that point. Each range and azimuth slice produces a magnitude and phase IPR plot.

The magnitude IPR plots depict the image slice after it has been upsampled, normalized and log encoded.

The phase IPR plots are calculated by taking the upsampled version of the image slice, transforming it back into the phase history domain, calculating the phase angles of each complex sample, and then removing the linear and bias components to estimate the high-order phase errors.

4.5.2.5 Time Estimates

At various times during the execution of QC, the user will have to wait for certain actions to be performed. It is during these times that the cursor will change into a watch. A list of the average times for a 1950 by 1950 image are listed below. (Note: These times were measured while the system load was low. The time needed for each operation may vary depending the system load and the size of the image.)

Switching between IFP and RFM images: 15.4 sec
Subsetting a region of an image: 6.8 sec
Switching between the subset region and the demagnified image: 7.5 sec
Changing the contrast of image: 6.0 sec
Switching between color and greyscale : 4.0 sec
IPR Plots: 21.1 sec

4.5.3 Quality Control Main Screen Features

The QC main screen is the primary screen used in QC and it is made up of five different sections. This section describes each of these screen sections and explains it's purpose. It also describes the function of each of the buttons on the QC main screen.

4.5.3.1 Title Bar

The title bar is the part of the window which the user can use to move the window on the display screen. The name of the image being used is identified here. If both the IFP and RFM images are present, the title bar will indicate which one is being viewed by showing the image name with either the .ci or .cih extension.

4.5.3.2 Image Display Area (IDA)

The IDA accounts for most of the space on the QC screen. It is the area where the detected LinLog image is displayed. Any image that has a size of 650 by 650 pixels or less can be displayed in this area with a normal magnification. If the image is larger than 650 by 650 pixels, then it is demagnified the nearest size that will fit into the space.

Directly under the image, two labels indicate the far range and the near range of the image. *The airplane is always on the left* of the screen. Between the near and far range labels, the image is identified as a LinLog encoded byte magnitude image.

At the bottom of the IDA are three labels that give information about the image being displayed. The first label displays the image coordinates of upper left corner of the image. The middle label displays the size of the image. The last label displays the magnification ratio of the image.

4.5.3.3 Message Area

The box at the bottom of the QC screen is the Message Area. In this box, messages are displayed communicating to the user what QC is doing at various times during execution. Messages prompting the user to perform some action are also posted here.

Examples include messages telling the user that an image is being loaded and messages asking the user to pick an area on the image where the data for the IPR plots will extracted.

4.5.3.4 Image Indicator Box

This box, located under the buttons, is used to show which portion of the image is currently being displayed. The box itself represents the actual image size and the shaded area represents the portion of the image being displayed.

If the demagnified image is being displayed, the entire box is shaded in. If the user is looking at a region of the image that has been subsetted, then the area where that region is located on the image is shaded in on the box.

4.5.3.5 Button Area

There are ten buttons and a scroll bar in the Button Area. When a button is shaded out, it is inactive and cannot be used. Some of the buttons are inactive all of the time while others switch states. Pressing any of the active buttons will perform a specific operation. The purpose of each button is described below.

4.5.3.5.1 "Demagnified Image .CI"

When this button is pressed, the LinLog detected image that is associated with the IFP file is displayed in the Image Display Area. If the image is larger than 650 by 650 pixels, it is demagnified to an appropriate size.

This button is active when both the .ci and .cih files present but the .cih file is being displayed. It is also active when only the .ci file is present, but the user is lookinq at a subsetted region of it.

This button is inactive whenever the .ci file is being displayed, or if there is a .cih file but no .ci file exists.

4.5.3.5.2 "Demagnified Image .CIH"

When this button is pressed, the LinLog detected image associated with the .cih file is displayed in the Image Display Area. If it is larger than 650 by 650 pixels, it is demagnified to an appropriate size.

This button is active only when a .cih file is present but is not being displayed.

4.5.3.5.3 "Subset Region"

When this button is pressed, a message is displayed in the Message Area asking the user to pick a spot on the image to subset. At this point, if the mouse is placed anywhere over the image, the cursor is changed into a crosshair. When the user presses the left mouse button, the region of the image centered around that point will be displayed in the Image Display Area with a normal magnification. The size of the area that is subsetted will be the largest portion of the image that will fit into the IDA (up to 650x650).

The button is inactive when the detected image is less than 650 by 650 pixels.

4.5.3.5.4 "IPR Plots"

When this button is pressed, a message is displayed in the Message Area asking the user to choose the center point where the IPR plot data will be extracted. After the left mouse button has been pressed, QC finds the pixel with the greatest magnitude in the area 40 by 40 pixels around the point that the user chose. QC extracts a 40-pixel slice of data in both the range and azimuth directions, centered around the point with the highest magnitude, and creates IPR plots for that data. When all of the information needed for the IPR Plots screen is ready, the outline of the screen appears and the user can place the screen by pressing the first mouse button.

The IPR Plots button is inactive whenever the current image being displayed does not have a one-to-one magnification. It is also inactive if more than ten IPR plot screens are present.

Note: If QC is run from a directory where the user does not have read and write privileges, a segmentation fauit may occur. This is because the data from these plots is put in a temporary file, and if the user does not have write access, there will be no data to put in the graphs.

4.5.3.5.5 "Select Plots"

When this button is pressed, a cascade menu drops down from this button. Each option in the cascade menu corresponds to an IPR plot screen. The screens are identified by its location, its magnitude, and the extension of the complex file to indicate whether or not is was from the RFM image. When one of these options is selected, that screen is made the topmost window on the display terminal.

This button is only active when there are IPR plots screens present.

4.5.3.5.6 "Reprocess" and "Save To Tape"

Inactive in the current QC Application.

4.5.3.5.7 "Help"

When the help button is pressed, a text window appears. This screen contains the information that is in this document. The user can browse through this information by moving the scroll bars up or down.

4.5.3.5.8 "Contrast"

The user can change the contrast of the detected LinLog image being displayed by changing the position of the slider in the scroll bar. Moving it up lightens the image. Moving it down darkens the image. This option also changes the contrast of the images on all of the IPR plot screens.

The contrast bar actually controls both the contrast and the bias of the LinLog detected image to provide a more viewable image without the necessity for two controls.

The position of the slider can be changed three different ways. Clicking on the slider and then dragging it to the correct contrast value is one way of moving it. In this case, the contrast of the image does not change until the slider has been released. Clicking in the scroll bar either above or below the slider will move the slider several notches up or down. Pressing the arrows on the scroll bar will also move the slider, but it only moves a very short distance. In these last two cases, the contrast is changed each time one of the mouse buttons is pressed.

Warning: Do not keep clicking in the scroll bar!! After each "click" the contrast is updated and continuous clicks will have no effect until QC finishes changing the contrast of the image.

4.5.3.5.9 "Select Color/Select Greyscale"

When this button is pressed, the image is toggled from either greyscale to color mode or color to greyscale mode. The label on this button is the name of the mode that the image will be displayed in when the button is pressed. For instance, if the image is currently in greyscale mode, the label will read "Select Color". The colors are mapped from brightest to darkest using white, yellow, green, blue, and black where white represents the brightest pixel and black represents the darkest pixel.

4.5.3.5.10 "Exit"

When this button is pressed, a dialog box pops up asking the user to make sure that this is the option desired. If "OK" is chosen, the QC main screen along with any remaining graph screens, are deleted and the program quits. If "Cancel" is pressed, the user can continue to work with the current image.

4.5.4 IPR Plot Screen Features

The IPR Plot Screen is a secondary screen created by QC. It displays the IPR plots associated with a particular area on the image. There can be up to ten different instances of this screen up at any time. There are five main areas on the IPR Plot Screen. This section describes what information is contained in each of these areas as well as what functions the buttons provide.

4.5.4.1 Title Bar

The name of the image that the data for the IPR plots was taken is indicated in the title bar. The magnitude and coordinates of the point that the IPR plots were centered around is also displayed.

4.5.4.2 Buttons

4.5.4.2.1 "Select Plots"

This button is very similar to the "Select Plots" button on the QC main screen. When it is pressed, a cascade menu comes down from the button. This menu lists the QC main screen as well as any other IPR plot screens that are currently present. The plot screens are identified by their coordinates, magnitude and an indicator as to whether or not the IPR plot was done on a RFM image. For example:

"Plots at(305,92)-Magnitude=781.88319 (.ci)"
"Plots at(77,884)-Magnitude=569.55731 (.cih)"

When one of these options is selected, that screen is made the topmost window on the display terminal.

4.5.4.2.2 "HOF"

When this button is pressed, a small dialog box pops up. It contains a message with the coordinates to be used for higher-order focusing. These coordinates must be recorded by the user if they are going to be used with "RFM" for refocusing the image.

Pressing the "OK" button removes this dialog box. The user will not be able to resume normal control of QC until the "OK" button is pressed.

This button is only active when the IPR plots were done on a IFP image.

4.5.4.2.3 "Save Plots"

This button is used to save the data from the IPR plots into ASCII files. The format of these files is such that there is one set of x and y coordinates per line in the file for each point on the graph. The coordinates are floating point numbers written in ASCII format. For example, the following few lines are from one of these files:

```
217.000000  -47.431206
217.039062  -47.444622
217.078125  -47.409115
```

This format is compatible with some common graphing programs such as "xgraph".

When this button is pressed, a dialog box pops up, prompting the user to enter a filename. When a filename is entered and "OK" is pressed, QC saves each of the graphs in a separate file with the given filename and a specific extension. If "Cancel" is pressed, none of the files are saved.

The files are saved with the following extensions:

Magnitude IPR plot - azimuth: <filename>.vmg
Magnitude IPR plot - range: <filename>.hmg
Phase IPR plot - azimuth: <filename>.vph
Phase IPR plot - range: <filename>.hph

4.5.4.2.4 "Dismiss"

When this button is pressed, the IPR plot screen that it was on goes away.

4.5.4.3 Area Location Boxes

There are two boxes on the plot screen which the user can use to determine where the IPR plots were done on the image. These boxes are both located at the top of the plot screen.

The box that is next to the "Select Plots" button shows where the data from these plots came from in relation to the whole image.

The rectangular region next to the above box shows what the data looks like in the area around the point where the plots were taken. This data is displayed with a 2:1 magnification. (Note: changing the contrast bar on the QC main screen also changes the contrast of this portion of the image)

4.5.4.4 Graphs

Four graphs make up the rest of the screen. These graphs are the magnitude and phase IPR plots.

4.5.4.4.1 Magnitude IPR plots

These graphs are plotted as magnitude (dB) vs. pixel. The y-axis values range from 0dB tc -60dB. The x-axis indicates the pixel values for the input slice of data.

A line is drawn in the center of the graph to measure the size of the main lobe. This line, drawn at -18dB, uses the same scale as the x-axis, but it has one pixel tick marks on it instead of the ten-pixel tick marks that are on the x-axis. Specification lines, starting at -18dB, are also drawn on both sides of the graph.

4.5.4.4.2 Phase IPR plots

These graphs are plotted as phase (degrees) vs. aperture. The x-axis always varies from -0.5 to 0.5.

4.5.5 Quality Control Error Message Explanations

4.5.5.1 Fatal Errors

"Error: Can't open display"

This is an X-windows message. It occurs when the user has not set the display using the "setenv DISPLAY <display_name>" command. If this error occurs, execution of QC will be terminated.

"Error: Resource file not found -- Please set XAPPLRESDIR"

This message indicates to the user that the resource file QC_RSRC was not found. Without QC_RSRC, the items on the QC screens will not be properly initialized. The user must set the XAPPLRESDIR environment variable so that QC will run.

4.5.5.2 Non-Fatal Errors

"No complex (.ci) file found"

This error message will occur if either the .ci or the .detci is not present when QC is invoked. QC will run normally, except for the fact that the user will not be able to view the IFP image.

"No header (.hdr) file found"

This error message will occur if the header file for the current image is not found. The header file must have the extension .hdr. If the header file is not found, QC will use a default value of 1.5 for the oversampling factor while making the IPR plots.

"No complex (.ci) or header (.hdr) file found"

This message means that both the IFP and the header file were not found when QC was invoked. QC will still operate without these files.

"Error Opening Image File"

This message occurs when QC is unsuccessful in trying to access an image file. The can occur when QC is switching between the RFM and IFP images, subsetting a portion of an image, getting complex data for IPR plots or trying to access the Help document. If this error occurs, the operation that caused the error will not be performed.

"Error opening IPR plot data file"

This message occurs of there was a problem opening the IPR plot data file. If this error occurs, the IPR plot screen will appear, but the graphs will be empty. This error usually occurs when the user does not have read or write access to the directory in which QC was invoked.

"Cannot select an area next to the border"

This message gets displayed in the message box at the bottom of the screen when the user is choosing a point on the image to do either subsetting or IPR plots.The user must choose another point on the image before the operation can be completed.

"Error Opening Image File"

This message occurs when QC is unsuccessful in trying to access an image file. It can occur when QC is switching between the RFM and IFP images, subsetting a portion of an image, getting complex data for IPR plots or trying to access the Help document.

5.0 REQUIRED CONFIGURATION

This section discusses the required configuration and software version numbers needed to successfully compile and run the HIFP applications.

5.1 MINIMUM EQUIPMENT CONFIGURATION

The minimum equipment configuration is as follows:

4-node Hypercube
- w/1.2GBytes CFS (Concurrent File System) disk subsystem
- w/Exabyte 8200 8mm tape transport
- w/SRM (System Resource Manager) for the Hypercube
- w/CIO Ethernet Interface (with FTP support)

Sun4 (or equivalent)
- w/16Mbytes main memory (32MBytes is better)
- w/2-300 MBytes of free disk space available (more is better)
- w/Color or Grayscale monitor with display area of 800x800 pixels.

While it is possible to use the HIFP applications without the CIO Ethernet product and NFS, it is not advised and will not be discussed. The following additions to the configuration are assumed for all discussions in this document:

Ethernet connections between the Sun, SRM and CIO Ethernet
NFS installed on both the Sun and SRM

The Ethernet connection from the Sun to the SRM allows NFS to be used to share many files between the two machines. In addition, one of the node application programs (ANA) will read a file located on the Sun using NFS. The CIO Ethernet connection from Intel provides a FTP (File Transfer Protocol) daemon that will support FTP connections from the Sun. The FTP connection provides the fastest way to move files from the CFS to the Sun. This connection will be used to move complex and detected images from the Hypercube CFS to the Sun for Quality Control.

5.2 ADDITIONAL SOFTWARE

The following additional system software must be installed on the Sun prior to building and installing the software:

RCS (revision control system)
pgcc and pgf77 compilers
MIT X11 Release 4
OSF Motif User Interface Revision 1.1

5.3 SYSTEM SOFTWARE

The following is a complete detailed list of the system software and version numbers needed to successfully install the HIFP applications:

Sun4/Solbourne 550 software:

Sun SunOS Operating System 4.1.1
(or Solbourne BSD UNIX)
Operating System 4.0D
RCS Revision Control System 1.13
MIT X11 User Interface Release 4
Sun/Solbourne C Language Compiler Revision 4.0D
OSF Motif User Interface Revision 1.1
Intel pgf77 Compiler V1.0
Intel pgcc Compiler V1.0

Intel Hypercube software:

Intel IPSC/2/860 Revision 3.2
Intel IPSC/2 System Software Revision 3.2
Intel IPSC/2/860 Extension Software Revision 3.2
Intel IPSC/860 Fortran Compiler Revision 1.0
Intel IPSC/860 C Compiler Revision 1.0
Intel IPSC/2/860 PLOG Update Revision 3.2
Intel IPSC/860 CCOM860 Update Revision 3.2
Intel IPSC/860 Software Update 1 Revision 3.2

Intel SRM software:

Intel UNIX System V/386 R3.2 V2.1
Intel 3.2.1 XMIT 1 Diskproc
Intel TCP/IP Revision 3.0
Intel Ethernet Drivers Revision 3.0
Intel NFS Revision 3.2.4

5.4 ADDITIONAL INFORMATION

The information in this section is provided to allow the user to obtain selected software packages for the Sun.

5.4.1 RCS - Revision Control System

RCS source can be downloaded from anonymous FTP from gatekeeper.dec.com (16.1.0.2). The most current version of the RCS source is located in the pub/GNU area and it is called 'rcs-5.5.tar.Z'. Once downloaded it must then be decompressed with zcat and unpacked using TAR. Finally, follow the directions found in the TAR file and install RCS on your system.

Here is a log showing how to get the RCS source:

```
hostname> "ftp gatekeeper.dec.com <cr>"
Connected to gatekeeper.dec.com.
220 gatekeeper.dec.com FTP server (Version 5.64 Sun Mar 31 13:37:27 PST
1991) ready.
Name (gatekeeper.dec.com:sos): "anonymous <cr>"
331 Guest login ok, send ident as password.
Password:
230 Guest login ok, access restrictions apply.

ftp> "cd pub/GNU <cr>"
250 CWD command successful.

ftp> "ls <cr>"
200 PORT command successful.
150 Opening ASCII mode data connection for file list.
  <<stuff deleted>>
rcs-5.5.tar.Z                        <--- current RCS TAR file
  <<stuff deleted>>
226 Transfer complete.
2159 bytes received in 2.8 seconds (0.76 Kbytes/s)

ftp> "get rcs-5.5.tar.Z <cr>"
200 PORT command successful.
150 Opening ASCII mode data connection for rcs-5.5.tar.Z (239113 bytes).
226 Transfer complete.
local: rcs-5.5.tar.Z remote: rcs-5.5.tar.Z
240376 bytes received in 65 seconds (3.6 Kbytes/s)
ftp> "bye <cr>"
221 Goodbye.
```

5.4.2 Sources for Other Sun System Software

pgcc and pgf77 node cross compilers:

Shipped with the Hypercube S/W

For MIT X11 Release 4, write to:

Software Center
Technology Licensing Office
Massachusetts Institute of Technology
Room E32-300
77 Massachusetts Avenue
Cambridge, MA 02139

For OSF Motif User Interface Revision 1.1, write to:

Open Software Foundation
11 Cambridge Center
Cambridge, MA 02142
(617) 621-8700

If an already-configured X11/Motif system is prefered, write to:

Integrated Computer Solutions
163 Harvard Street
Cambridge, MA 02139
(617) 547-0510

6.0 HIFP INSTALLATION GUIDE

Installation of the HIFP applications has been automated by the use of Unix makefiles. Before installing any HIFP software on your system, check to see if your system meets all the requirements of Section 5.0. The following tapes are included with the version 1.0 HIFP distribution:

(1) Unclassified source code (Unix TAR format)
(2) Classified acceptance test nexec files (Unix TAR format)
(3) Unclassified phase history acceptance test tapes (HIFP ReadTape format)

The automatic installation system has been setup to either make the HIFP applications in the main HIFP directories or in a temporary directory. The following installation instructions assume that the install will be performed in a temporary directory. This method is easier to clean up when complete. The installation system traverses all the HIFP directories and invokes all other makefiles to build each application. See Section 4.1 for information on how to read the phase history acceptance tapes.

The following is the sequence of commands needed for the user install the HIFP applications:

(1) Load HIFP source code onto the users Sun system (Tape #1):

```
sun%  "cd /usr/u  <cr>"
sun%  "tar xvf /dev/rst0  <cr>"
;;  the TAR command create a hifp directory structure with
;;  source and makefiles as follows:
;;    hifp                          - HIFP Root Directory
;;    hifp/RCS                      - RCS Controlled Source Code
;;    hifp/exe                      - Holds the Executables
;;    hifp/sun                      - All Sun executable Source Code
;;    hifp/sun/qc                   - Quality Control Application
;;    hifp/sun/qc/RCS               - RCS Controlled Source Code
;;    hifp/hycube/ana               - Analysis Application
;;    hifp/hycube/ana/RCS           - RCS Controlled Source Code
;;    hifp/hycube/ifp               - Image Formation Application
;;    hifp/hycube/ifp/RCS           - RCS Controlled Source Code
;;    hifp/hycube/ifp/phfg          - Polar Formatter Code
;;    hifp/hycube/ifp/phfg/RCS      - RCS Controlled Source Code
;;    hifp/hycube/ifp/fig           - Image Formation Code
;;    hifp/hycube/ifp/fig/RCS       - RCS Controlled Source Code
;;    hifp/hycube/rfm               - Higher Order Focus Application
;;    hifp/hycube/rfm/RCS           - RCS Controlled Source Code
;;    hifp/hycube/tape_io           - ReadTape Application
;;    hifp/hycube/tape_io/RCS       - RCS Controlled Source Code
```

(2) Make all executables on Sun system:

```
sun%  "cd /usr/u/usrdir  <cr>"
sun%  "mkdir tempinstall  <cr>"
sun%  "cd tempinstall  <cr>"
sun%  "setenv HBASE /usr/u  <cr>"
;;  HBASE defines for the makefiles where the hifp directory can be
found
sun%  "co $HBASE/hifp/RCS/makefile,v  <cr>"
;;  rcs checkout of the main installation makefile
;;  the ,v at the end of the makefile name is very important
sun%  "make install  <cr>"
;;  make install will checkout, compile, link and
;;  move all HIFP executables to $(HBASE)/hifp/exe as follows:
;;  installation will take about 9 minutes on a Sun 4
sun%  "ls -gl $HBASE/hifp/exe  <cr>"
total 2922
-rwxrwxr-x  1 usr     hifp        170374 Jun 17 21:15 HycReadTape
-rw-rw-r--  1 usr     hifp         11756 Jun 17 20:58 QC_RSRC
-rw-rw-r--  1 usr     hifp         41464 Jun 17 20:58 QC_doc
-rw-rw-r--  1 usr     hifp          3106 Jun 17 21:15 UNCLASS.nexec
-rwxrwxr-x  1 usr     hifp        568079 Jun 17 21:01 ana
-rwxrwxr-x  1 usr     hifp        656886 Jun 17 21:09 ifp
-rw-rw-r--  1 usr     hifp         20492 Jun 17 21:15 j0304512.con
-rw-rw-r--  1 usr     hifp          8204 Jun 17 21:15 n07mar89.cor
-rw-rw-r--  1 usr     hifp           668 Jun 17 21:15 nlantpat.fil
-rw-rw-r--  1 usr     hifp           188 Jun 17 21:15 nlfilter.fil
-rwxrwxr-x  1 usr     hifp        876544 Jun 17 20:59 qc
-rwxrwxr-x  1 usr     hifp        565280 Jun 17 21:14 rfm
-rw-rw-r--  1 usr     hifp           128 Jun 17 21:15 rtocxflt.fil
;;
;;     HycReadTape      - ReadTape Application for the Hypercube
;;     QC_RSRC          - Window resource file for qc
;;     QC_doc           - Quality Control Help file
;;     UNCLASS.nexec    - Example unclassified nexec file
;;     ana              - Analysis Application
;;     ifp              - Image Formation Application
;;     j0304512.con     - Filter file for CFS
;;     n07mar89.cor     - Filter file for CFS
;;     nlantpat.fil     - Filter file for CFS
;;     nlfilter.fil     - Filter file for CFS
;;     qc               - Quality Control Application
;;     rfm              - Refocus Application
;;     rtocxflt.fil     - Filter file for CFS
;;
sun%  "cd ..  <cr>"
sun%  "rm -rf tempinstall  <cr>"
;;  Once the install is verified, you can delete the tempinstall
;;  directories without worry - the code is still in the hifp RCS
```

(3) Load classified nexec files Sun system (Tape #3):

```
sun%  "cd /usr/u/user  <cr>"
sun%  "tar xvf /dev/rst0  <cr>"
;;  the TAR command create a directory called "classified"
;;  with several classified nexec files
```

The makefile based install system depends on the following: 1) the setenv HBASE is defined as the directory that the HIFP directories is located, 2) X11 libraries (X11 and Xt) are located in /usr/lib, 3) Motif library (Xm) is located in /usr/lib, 4) X11 and Motif include files are located in /usr/include, and 5) the setenv PATH contains the paths to the cc, pgcc, pgf77 and RCS related applications.

If the users computer system configuration differs from the above assumptions, the user can edit the makefiles. The following makefiles could be effected:

hifp/RCS/makefile
hifp/sun/qc/RCS/makefile
hifp/hycube/ana/RCS/makefile
hifp/hycube/ifp/RCS/makefile
hifp/hycube/ifp/phfg/RCS/makefile
hifp/hycube/ifp/fig/RCS/makefile
hifp/hycube/rfm/RCS/makefile
hifp/hycube/tape_io/RCS/makefile

For more information, the user can consult the following sources: 1) Unix man pages for make, cc, rcsinfo, rcs, co, ci, or X, 2) Intel documentation on pgcc and pgf77 compilers.