

HDI operations manual

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Introduction

In October, 2013, the main instrument for the WIYN 0.9-m telescope was switched from the imaging camera called S2KB to a new camera called the **Half Degree Imager** (or **HDI** for short). The two cameras are similar in many ways, but differ in two main respects:

- the new camera covers more sky (about twice the area)
- the new camera reads out more rapidly (between 3 and 12 times more quickly, depending on the number of amplifiers used)

HDI is built around the [e2V 231-84 CCD chip](#); specifically, a 231-84-1-142 deep depletion chip, serial number 20110426, with astronomy process and a broadband anti-reflective coating (thanks to Alice Reinheimer of e2V for this information). You can look at a [quick comparison of the properties of S2KB and HDI](#) to get an idea for the differences between them.

The properties of HDI are roughly shown below. Look in the Technical Notes for more information.

mode	readout time	gain (e-/ADU)	readnoise (e-)
4-amp	9 sec	1.3	7-8
1-amp	35 sec	1.3	7.3

You can find descriptions of technical tests of HDI in a series of Technical Notes. If you have material to contribute to this archive, please contact Michael Richmond.

- [HDI Technical Notes](#)

Basic web interface

The most direct way to operate HDI is to use a web browser to connect to a simple command-line interface. Go to

- <http://hdserver.kpno.noao.edu:20501> is the full URL
- <http://hdserver:20501> should work for computers in the WIYN 0.9-m control room

Your browser should display a bunch of text in a variety of colors, something like this:

```

FITS images for c6584t0453d are ready.
Total expose script time: 1001.42 seconds
Total readsav script time: 9.94 seconds
Exposure 6 of 15.
FITS images for c6585t0001d are ready.
Total expose script time: 1001.46 seconds
Total readsav script time: 9.98 seconds
Exposure 7 of 15.
FITS images for c6585t0002d are ready.
ndi has detached from the session.
Total expose script time: 1001.80 seconds
Total readsav script time: 10.01 seconds
Exposure 8 of 15.
FITS images for c6585t0003d are ready.
Total expose script time: 1001.41 seconds
Total readsav script time: 10.01 seconds
Exposure 9 of 15.
FITS images for c6585t0004d are ready.
ndi has started a clone window.
Total expose script time: 1001.59 seconds
Total readsav script time: 9.93 seconds
Exposure 10 of 15.
FITS images for c6585t0005d are ready.
Total expose script time: 1001.69 seconds
Total readsav script time: 10.01 seconds
Exposure 11 of 15.
FITS images for c6585t0006d are ready.
Total expose script time: 1001.49 seconds
Total readsav script time: 9.91 seconds
Exposure 12 of 15.
FITS images for c6585t0007d are ready.
ndi has started a clone window.
ndi has started a clone window.
ndi has started a clone window.
ndi has started a clone window.
ndi has detached from the session.
Unrecognized escape sequence: `04B'
file c6585t0008d  etype DARK  etime 1000  filt  long stretch of darks

file c6585t0007d median background level = 16 e-, noise = 5.5
stargrasp9056: x.199 up 87790s|cpu 43C|board 32C|pre 99C|dev0 -170C|dev1 -115C|1.00E-5Torr|malloc 3200k|stack 1k|free 175461k|

```

Most of the screen contains a mixture of green and yellow text: these are messages printed by the camera controller as it goes through the steps of reading out the chip, saving the data to disk, and so forth. Down at the bottom of the screen, the text in the grey background provides status information on the condition of HDI: next to **dev1** is the temperature of the CCD, for example. The single line of text with a blue background shows the current image information: in this case, the most recent file had type **DARK** and an exposure time of **1000** seconds.

Near the bottom of the screen, between the grey CCD status information and the blue image information, is a single blank line. In this space, the user can type commands. One can use the up-arrow and down-arrow keys to recall past commands quickly, and the left-arrow and right-arrow keys to move the cursor within a line of text.

One of the most important commands is **help**. In response, the system will list all the commands:

```

Sat 23:07:08 > help
Sat 23:07:08 *---[ Commands ]-----*
Sat 23:07:08 help          : Display this help text
Sat 23:07:08 termhelp         : Display info on operating the terminal console window
Sat 23:07:08 debug on/off       : Toggle debug output (also requires verbose for displaying)
Sat 23:07:08 verbose on/off    : Toggle displaying of verbose messages
Sat 23:07:08 say [message]     : Chat with other users ([message] gets broadcast)
Sat 23:07:08 abort (or ^C)    : Attempt to interrupt a running command
Sat 23:07:08 cancel (or ^G)   : Cancel queued but not yet executing commands
Sat 23:07:08 shutdown         : Exit and shut down the Virtual Machine
Sat 23:07:08 *---[ Detector Commands ]-----*
Sat 23:07:08 stage2          : Load operational code ("stage 2") onto controller.
Sat 23:07:08 pon            : Apply detector high voltages ("Power ON")
Sat 23:07:08 pof            : Turn off detector voltages.
Sat 23:07:08 comment <string> : Set the CMMTOBS keyword in the FITS (sticky).
Sat 23:07:08 keep 3day|perm|... : Select between various retention periods for FITS files.
Sat 23:07:08 etime <seconds>  : Set integration time for OBJECT, DARK, LED, and XRAY.
Sat 23:07:08 etype o|d|b|x   : Select OBJECT, DARK, BIAS, XRAY, LED.
Sat 23:07:08 clean <niter>    : Clean all detectors (5 times, by default).
Sat 23:07:08 expose          : Time an exposure (shutter activates if etype=OBJECT).
Sat 23:07:08 go <niter>       : Equivalent to "clean; expose; eadout; save".
Sat 23:07:08 *---[ Experimental Commands ]-----*
Sat 23:07:08 ref on          : Turn on 4-output mode with a reference channel subtraction.
Sat 23:07:08 pon            : Go back to not using the reference subtraction.
Sat 23:07:08 oneamp ur       : Temporary mode for "Upper Right" amplifier only.
Sat 23:07:08 oneamp ul       : "Upper Left" amplifier mode (image display incorrect)
Sat 23:07:08 oneamp lr       : "Lower Right" amplifier mode (image display incorrect)
Sat 23:07:08 oneamp ll       : "Lower Left" amplifier mode (image display incorrect)
Sat 23:07:08 *---[ Communications Ports ]-----*
Sat 23:07:08 19501          : Use clicmd -n hdserver:19501... to send scripted commands.
Sat 23:07:08 20501          : Use HTTP browser client to access text console here.
Sat 23:07:08 *---*
Sat 23:07:08 Note 1: "ref on" only works with 4-output mode at the moment.
Sat 23:07:08 Note 2: "clicmd -n hdserver:19501 <command> [<args>...]" is the syntax.
Sat 23:07:08 Note 3: Get source for clicmd from http://www.stargrasp.org/wiki/Graspsw

```

Observers will typically need only a few of these commands.

Starting up and shutting down

pon

Power on the camera. Start it up in 4-amplifier mode.

pof

Turn power off.

Switching amplifier modes

oneamp ur

switch to 1-amp readout, using the amplifier in the upper-right corner of the chip.

pof ; pon

switch back to 4-amp readout

Setting image properties

observer

set the contents of **OBSERVER** keyword in the FITS header. Usage is like this: `observer Richmond`

object

set the contents of **OBJECT** keyword in the FITS header. Usage is like this: `object NGC 4567`

etime

set the exposure time, and the **EXPTIME** keyword in the FITS header. Type the desired exposure time in seconds after the word "etime", like this: `etime 30`

etype

set the exposure type and the **OBSTYPE** keyword in the FITS header. Type the desired exposure type after the word "etype", like this: `etype o`

The choices are

- o **o** for OBJECT
- o **f** for FLAT
- o **b** for BIAS
- o **d** for DARK

comment

set the contents of the "comment" field, shown in the HDI datastore window and set in the FITS header as **CMMTOBS**

Taking an exposure (or series of exposures)

go

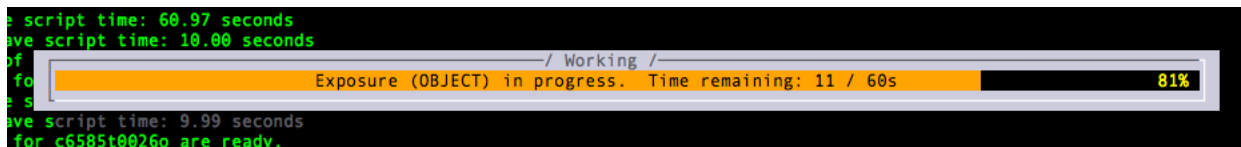
perform the steps necessary to take a typical image. If the user adds a number as an argument, that number of images will be taken in succession. For example, `go 12` will take 12 successive exposures with identical exposure times. The chip will be cleaned only before the first image in the sequence.

Please do **not** issue the "shutdown" command. If you do, you will leave the camera in a frozen state from which the only solution is manual intervention by people who are off-site. Don't do it.

Taking an exposure

When the user types **go** to take an exposure, the camera will go through a series of steps: cleaning the CCD, opening the shutter, waiting for the desired time, closing the shutter, reading out the CCD, saving the image on the HDI data archive.

During these procedures, a window will pop up in the web command display.



This window will show the progress of each task as it executes. During this time, the user will be unable to type new commands.

In order to abort an exposure or sequence of exposures, the user can type "Control-C" (hold Control key, type "c" at the same time). When the user issues this command, the current image will continue to count down to the end of its exposure time, but will not read out; any future images in a sequence will not be taken. After an abort, the camera may print error messages; if so, follow [the steps described in Troubleshooting](#) to recover.

Images are assigned names with a format like

`c6584t0023o00.fits`

in which

'c'	is always the first letter
'6584'	are final 4 digits of Julian Date at UT = 00:00
't'	follows the Julian Date

```
'0023'      is a four-digit index of images taken this day
'o'         encodes "type" of image:  'b' = bias
                                           'd' = dark
                                           'o' = object (also for flats)
'00'        always follows the "type"
'.fits'     is the file extension
```

Each image is placed into a separate directory in the data archive. The name of the directory is the same as the first 11 characters of the image's file name. Thus, the image in the example above,

```
file c6584t0023o00.fits is in directory c6584t0023o
-----
```

One can access an image in the data archive by its URL; in our example above, we would go to

- <http://hdiserver.kpno.noao.edu/ds/hdi/c6584t0023o/c6584t0023o00.fits>

After all exposure tasks have completed, the user can look at the image and download it. To do so, he should switch to the [web image browser and quick display](#) and click on the date string to refresh the list of images. In the example below, the date string is **20131020**, in bold white font.

Web image browser and quick display

All the images taken by HDI are automatically saved in a computer dedicated to the camera, which serves as a data archive. The user can access images in this archive through a web browser.

- <http://hdiserver.kpno.noao.edu/ds/hdi/>
- <http://hdiserver/ds/hdi/> should work for computers in the WIYN 0.9-m control room

The browser should show a display like this:

ds / hdi , on 20131019

Goto:
Date, TJD or fileset

[Text Version]

Show UT Date:

20131012
20131013
20131014
20131017
20131018
20131019
20131020
20131021
20131022
20131023 ...
20131028(latest)

Show toffset.log overheads

c6584t0245o	06:31:20Z	OBJECT	2013	3.0	?	1.09	Moon with V and Halpha
c6584t0246o	06:33:22Z	OBJECT	0.00 0.00 2013	3.0	?	1.09	Moon with V and Halpha
c6584t0247o	06:35:21Z	OBJECT	0.00 0.00 2013	3.0	?	1.09	Moon with V and Halpha
c6584t0248o	06:37:21Z	OBJECT	0.00 0.00 2013	3.0	?	1.09	Moon with V and Halpha
c6584t0249o	06:39:21Z	OBJECT	0.00 0.00 2013	3.0	?	1.08	Moon with V and Halpha
c6584t0250o	06:41:21Z	OBJECT	0.00 0.00 2013	3.0	?	1.08	Moon with V and Halpha
c6584t0251o	06:43:25Z	OBJECT	0.00 0.00 2013	3.0	?	1.08	Moon with V and Halpha
c6584t0252o	06:45:22Z	OBJECT	0.00 0.00 2013	3.0	?	1.08	Moon with V and Halpha
c6584t0253o	06:47:21Z	OBJECT	0.00 0.00 2013	3.0	?	1.08	Moon with V and Halpha
c6584t0254o	06:49:21Z	OBJECT	0.00 0.00 2013	3.0	?	1.08	Moon with V and Halpha
c6584t0255o	06:51:21Z	OBJECT	0.00 0.00 2013	3.0	?	1.08	Moon with V and Halpha
c6584t0256o	06:53:20Z	OBJECT	0.00 0.00 2013	3.0	?	1.07	Moon with V and Halpha
c6584t0257o	06:55:21Z	OBJECT	0.00 0.00 2013	3.0	?	1.07	Moon with V and Halpha
c6584t0258o	16:54:22Z	OBJECT	0.00 0.00 2013	5.0	?	1.59	flat field test
c6584t0259o	16:55:51Z	OBJECT	0.00 0.00 2013	5.0	?	1.59	flat field test
c6584t0260o	16:57:13Z	OBJECT	0.00 0.00 2013	5.0	?	1.59	flat field test
c6584t0261o	16:57:29Z	OBJECT	0.00 0.00 2013	5.0	?	1.59	flat field test

c6584t0245o 3 sec OBJECT

16249e- sky or bg

The basic structure of this display is threefold:

dataset at the top

In the example above, you can see that the dataset being displayed include images taken on **20131019** = UT 2013 Oct 19. In smaller text is a list of all recent datasets. Clicking on any one of the items will switch to the dataset for the given date.

Clicking on the current date string (**20131019** in the example above) will refresh the list. It's a good idea to do this regularly in order to see the latest images.

list of images on the left

In the example above, there are eight images. A small amount of information about each image is displayed in this list. The "comment" area will contain whatever the user has provided using the **comment** command.

The very first column, **filesetID**, is the name of a directory holding information on each image. Clicking on this column will take the user to another web page -- see [the discussion below](#).

quick-look JPEG on the right

In the example above, the image **c6584t0245o**, is being shown. The camera controller converts each image into JPEG format for quick-look purposes. Images are displayed with a rainbow colormap to highlight faint details.

At the bottom of the JPEG image, a single line of text provides some information on statistics of the image. The median value is listed with text like this:

16249 e- sky or bg

Even though this text states "e-", the units of this value are ADU, not electrons.

If one clicks on the **filesetID** column of the data archive browser, one will be taken to a web page like the following:

hdiserver.kpno.noao.edu/ds/hdi/c6584t0037o/

ds / hdi / c6584t0037o , on 20131019

30.0s OBJECT @ 2013-10-19T02:05:22Z, "focus 32600" [\[Text Version\]](#)

Other Filesets: [c6584t0032o](#) [c6584t0033o](#) [c6584t0034o](#) [c6584t0035o](#) [c6584t0036o](#) [c6584t0037o](#) [c6584t0038o](#) [c6584t0039o](#) [c6584t0040o](#) [c6584t0041o](#)

fileID	bytes	md5sum	chip
c6584t0037o00.fits	35527680	72da9e3dce6668c6679a6677679a25b4	ota00

c6584t0037o 30 sec OBJECT focus 32600

One sees again the same three-part display:

- dataset at the top
- image link at the left
- JPEG picture at the right

This time, the image link contains the full file name of a FITS image: in the example above, **c6584t0037o00.fits** . If the user clicks on this link, a window will pop up asking if the user would like to

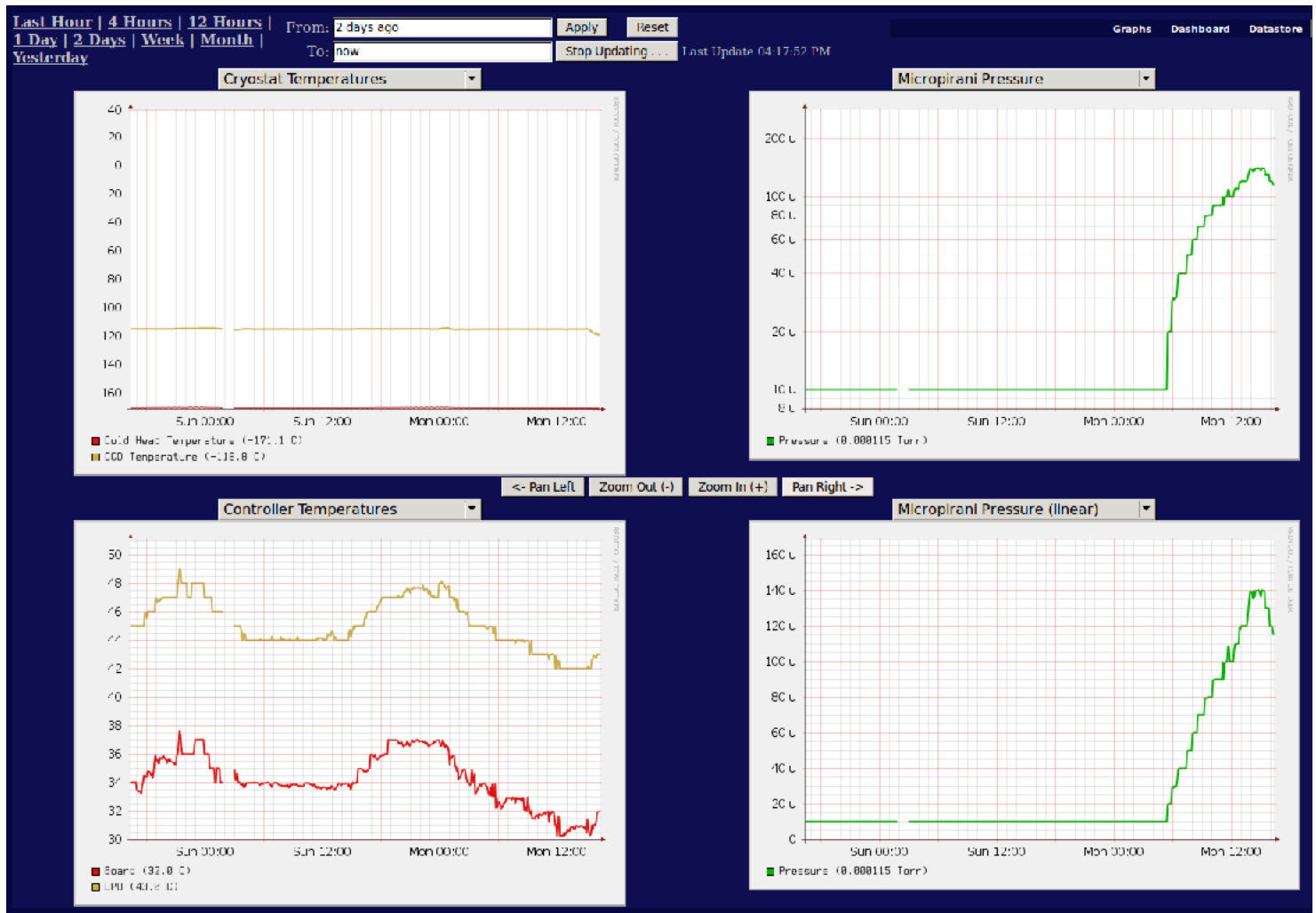
- open the image with the DS9 image display program. Note that by default, the image will appear in a non-standard orientation: North up and East to the right.
- or
- save the image to disk on emerald. By default, the image will be saved in the directory `/home/36inch/Downloads/`

Note that all raw HDI files are not simple FITS images, but are instead multi-extension FITS files (MEFs). Working with MEFs is a bit more complicated than with simple FITS images. It might help to read [the NOAO guide to working with mosaic CCD data](#).

Web status graphs

A few of the properties of HDI are logged continuously and displayed on a set of graphs. The user can see these graphs by clicking on the word **Graphs** in the upper-right corner of any of the HDI web pages.

Below is an example of these graphs; click on the image for a full-sized version.



The four graphs show

- cryostat temperatures (these should be below -100 C)
- pressure inside the camera (log scale)
- controller temperatures (these should be above 0 C)
- pressure inside the camera (linear scale)

The pressure values on the y-axis are in torr. Any values below 500 micro-torr are probably not very precise -- don't worry if you see spikes or dips, as long as their values remain below 500 micro-torr.

Saving your images to emerald

By default, all HDI images are stored on a dedicated computer which is connected directly to HDI. It is that computer which serves the images and other information via the web interface described above.

Most observers will need to copy the data from this datastore to the computer **emerald** in order to examine it in detail, and in order to transfer it to their home institution or a laptop. There are two ways to do this.

1. [As described above](#), if one clicks on the filesetID of an image in the browser quick-look display, one can download a copy of the image to the "/home/36inch/Downloads" directory on **emerald**. This is easy to do for an image or two, but not the best way to deal with many tens or hundreds of images.
2. One can use the [automatic scripts](#) described below to transfer a large number of files at once, or automatically copy each new image as it is acquired.

As-You-Go: Copying images as they are acquired ...

Let's look at the script which automatically copies images from the HDI datastore to **emerald** on the fly. In order to use this script, follow these directions BEFORE you begin to operate HDI:

- open a terminal window on **emerald**
- in this window, type the command

```
bash
```


which will start an instance of the Bourne-again shell and set the \$PATH to include a number of special directories.

- run the command

```
hdi_follow.pl    savedir=DIR
```

where DIR is the full path name of the directory on **emerald** into which you want your images to be copied; full path name means that the directory's name must begin with a "/" (slash) character. **We recommend very strongly that you specify a directory under /data/data1/.**

For example, you might create a directory /data/data1/oct23_2013 and then type

```
hdi_follow.pl    savedir=/data/data1/oct23_2013
```

After you run the command, the script will watch for *NEW* images to be taken by HDI; it will ignore all pre-existing images. As new images appear, they will be copied to emerald and to the NOAO backup archive. You should see a running list of new images which have been copied, something like this:

```
% hdi_follow.pl savedir=/data/data1/mwr_oct29_2013/
to stop this script, type 'Control-C' or kill the window
in which the script is running.
copied c6594t0038d00.fits ... (Cntl-C to quit)
copied c6594t0039d00.fits ... (Cntl-C to quit)
```

Let this process continue to run while you take images. Just leave the window alone and open other windows to do all your work.

- When you are finished with HDI, terminate the script by placing the cursor in the window and typing *Control-C*. That is, hold down the *Control* key and then press the *C* key at the same time. This should end the copying process.

All-In-A-Bunch: Copying a bunch of images all at once

If you have NOT been copying files as they are acquired, then you can use a different script: this one will transfer a bunch all at once from the HDI datastore to a single directory on emerald. It will also run the NOAO postproc command, which saves the image in a big NOAO-wide data archive.

- open a terminal window on **emerald**
- in this window, type the command

```
bash
```

which will start an instance of the Bourne-again shell and set the \$PATH to include a number of special directories.

- in this window, use the Unix *cd* command to go to the directory into which you wish the images to be copied. If the directory doesn't exist, create it, then go into it.
- run one of the following commands

```
hdi_grab.pl    YYYY-MM-DD  HH:MM:SS
```

or

```
hdi_grab_set.pl    YYYY-MM-DD  HH:MM:SS  YYYY-MM-DD  HH:MM:SS
```

where the first YYYY-MM-DD specifies the UT date of the earliest image you want to copy, and the first HH:MM:SS is the UT time of the earliest image you want to copy. For example, you might type

```
hdi_grab.pl    2013-10-30  02:20:00
```

in order to copy all images taken more recently than UT 2013 Oct 30 02:20:00.

The second form of the command, with two sets of dates and times, will copy all the images which were created between the given dates. Thus,

```
hdi_grab_set.pl    2013-10-30  02:20:00  2013-11-01  12:00:00
```

in order to copy all images taken between a starting time of UT 2013 Oct 30 02:20:00 and an ending time of UT 2013 Nov 01 12:00:00.

This command will copy ALL images within the given time frame to the current directory.

Converting HDI images to simple 16-bit integer FITS files

HDI saves raw images in FITS files, but they aren't the simplest type of FITS files. Every raw HDI image consists of a header unit, and then at least one extension:

- if 1-amp readout mode: 1 extension unit, to hold all 4096x4112 pixels
- if 4-amp readout mode: 4 extension units, each holding 2048x2056 pixels

Some image processing packages will properly handle complex FITS files, but others will not; moreover, properly displaying all the data in a multi-amp image can be a little tricky, as the orientation of the data may change from amplifier to amplifier.

If you would like to create simplified FITS images for quick-look purposes during your run, you may use the scripts described below. The first one, *fitsconv.csh*, is "safe" - it will not modify data values at all -- but limited: it only works on images read through a single amplifier. The subsequent ones will divide all pixel values by 2, but can be used on either 1-amp or 4-amp images.

fitsconv.csh: for 1-amp only

This routine supplied by Douglas Arion of Carthage College in Nov, 2016. Thanks!

This script is designed to work on a set of raw HDI images at all once. To use it,

1. create a directory and 'cd' into the directory
2. place all raw HDI images into this directory
3. copy the *fitsconv.csh* script into this directory:

```
cp ~/Carthage/fitsconv.csh .
```

4. run the script

```
./fitsconv.csh
```

The script will create a new subdirectory called `Converted` and place converted, simple FITS images into this subdirectory. The converted images will have the same names as the original raw images. The raw images will not be modified.

hdi_to_simple: for 1-amp or 4-amp images

The data values in the simplified images created by the following scripts will be modified from their raw values. Don't use them for science unless you really know what you are doing.

The first step is to start the Bourne Shell, and then type a single command:

```
bash
```

followed by

```
heainit
```

which will set up a number of environment variables so that the scripts below will run properly. This may change your current directory, so it may be necessary to **cd** back to your previous directory before you continue. Also, the changes made to your environment library variables by **heainit** may cause other programs to fail to run properly. You should probably use this shell only for image-conversion work, and use other terminal shells for your other work.

hdi_1amp_to_simple.pl

This script will convert a 1-amp HDI image into a simple 16-bit integer FITS image, in which the header and data sit within a single unit. All pixel values will be divided by 2, so the original range of 0 - 65535 turns into 0 - 32767. To run the program, type

```
hdi_1amp_to_simple.pl    c6584t0023o00.fits
```

The original image will remain unmodified, and a new file will be created with a similar name: the final three characters of the original name (**o00** in the example above) will be converted to the string **"_1"**, to indicate that the multi-HDU original FITS file has been turned into a simple 1-HDU equivalent. In the example above, the output file will be

```
c6584t0023o00.fits    --->    c6584t0023_1.fits
```

You may provide a name with a wildcard character as an argument in order to convert many images with a single command, like so:

```
hdi_1amp_to_simple.pl    c6584*00.fits
```

hdi_4amp_to_simple.pl

This script will convert a 4-amp HDI image into a simple 16-bit integer FITS image, in which the header and data sit within a single unit. A number of operations are performed:

1. All pixel values will be divided by 2, so the original range of 0 - 65535 turns into 0 - 32767.
2. Each quadrant's overscan region will be scanned, and the mean value will be subtracted from all pixels in the quadrant.
3. After which, all overscan pixels are stripped from the image.
4. Quadrants are rotated so that pixels in the final, simple, image have the proper orientation.

To run the program, type

```
hdi_4amp_to_simple.pl    c6584t0023o00.fits
```

The original image will remain unmodified, and a new file will be created with a similar name: the final three characters of the original name (**o00** in the example above) will be converted to the string **"_mos"**, to indicate that the multi-HDU original FITS file has been turned into a simple 1-HDU "mosaic" equivalent. In the example above, the output file will be

```
c6584t0023o00.fits    --->    c6584t0023_mos.fits
```


You may provide a name with a wildcard character as an argument in order to convert many images with a single command, like so:

```
hdi_4amp_to_simple.pl c6584*00.fits
```

Known 'features' (aka annoyances)

HDI is still not a mature instrument. Some of the software is in a state of flux. Experienced observers who have used S2KB may note the following (as of Jan 22, 2014):

- some FITS keywords are not set automatically by HDI. Specifically, the following are NOT set in the header:

`FILTER`

However, keywords `FILTER1` and `FILTER2` are set to the numerical values of the filterwheel positions. For example, if filterwheel 1 is in position 3, `FILTER1` = '103', and if filterwheel 2 is in position 4, `FILTER2` = '204'.

New version vmhdi-1.0 fixes some earlier keyword issues. The following keywords are now set properly in the FITS header: OBJECT, OBSERVER, MJD-OBS, DATE-OBS.

- There is no special focus routine which automatically changes the focus position of the telescope, or which waits for the user to do so, so that images of stars at multiple focus positions appear on a single frame.

Ron Probst provides the following suggestion:

- Decide what to do: e.g. 32200-32400 by steps of 50, so 5 exposures
- Set focus to starting point. Set jog to desired step size.
- Set "etime" to 10 sec and write appropriate "comment"
- Do "go 5" to take a series of 5, with only one cleaning cycle at start.
- As first exposure is reading out, jog focus to next value for second exposure.
- Repeat through series of 5 (in this case) exposures.
- Transfer images to emerald and examine with imexam.

We have created a tool which will help you to pick the best focus value from a set of images WHICH YOU HAVE ALREADY TAKEN; for example, following Ron Probst's steps 1-6 above. Please read

- [HDI Technical Note 16: A routine for determining a good focus position](#)

- There is no means yet to bin the pixels, or to read out a sub-frame of the entire image.
- When images are displayed via DS9, quadrant 1 is flipped so North is up, East to the right. This may be true of other quadrants as well.

Earlier problems with quick-look JPEG in HDI's browser have been fixed: the orientation is now North up, East left.

- When one uses IRAF and DS9 to display raw HDI images, by default only a portion of the image will be shown. If one opens a 4-amp image, only the upper-right quadrant will appear. One can specify the other quadrants using the terminology `image.fits[2]` to see the second quadrant, `image.fits[3]` to see the third quadrant, and so forth. One can load all 4 quadrants simultaneously via

```
ds9 -multiframe image.fits
```

Alternatively, if one has already started DS9, one can use the DS9 window's GUI to load and display a 4-amp image as follows: *File -> Open as -> Mosaic IRAF*, then select the desired image.

Images read via a single amplifier suffer from a different annoyance: by default, only the central portion of the image is displayed. One can display the entire image by appending `[xy00]` to the end of an image name, thus: `image.fits[xy00]`.

- Light-struck images created in single-readout mode show a low-level artificial feature: the rows running across the middle of the chip (rows 2057 and 2058 out of 4112) exhibit a "two-tone stripe." One row is slightly lower than the average value, and the other is slightly higher. The feature does not appear in bias or dark frames.
-

How to shut down the camera

Shutting down the camera should NOT be an ordinary action. The only situations which require it are

- if you are about to remove the camera from the telescope for maintenance
- if a lightning storm is coming, and you need to perform a lightning shutdown of the entire observatory

In case you are facing one of these situations, here's the procedure:

1. issue a command to turn off the CCD voltages first:

```
pof
```

2. now you can remove power from the electronics safely via:

```
power stargrasp off
```

If possible, before turning the power off to the computer *hdserver*, contact Peter Onaka's team (who built HDI) and ask them **to stop the software (virtual machines) on *hdserver***. You can send E-mail to Sidik Isani at isani at ifa dot hawaii dot edu. If there's no time, because a storm is coming, then just follow the shutdown procedures and hope for the best. It's possible that when re-starting after an emergency shutdown, the computer *hdserver* may not initialize properly, which may cause HDI not to work. The solution is to contact Peter Onaka's team and wait for them to fix the problem.

Errors and troubleshooting

These are known failure modes of HDI, and the procedures to recover from each.

1. communications failure with HDI controller

- symptoms: messages like the following:

```
Network connection failed for command `etyp object': error: receive-select timed out
Failed to connect to controller: error: connect failed (errno 113)
```

- treatment: type the following into the browser command window:

```
pof
```

Wait for 30 seconds, and check to see if the camera now responds to commands. If so, you are finished with the procedure, and can go back to regular operations.

If the camera is still not responding, then it is necessary to do the following -- which will recover camera control, **but also cause images to have an excess of signal spread over the active area for over an hour**. Type

```
power stargrasp cycle
```

followed by

```
stage2
```

Several lines of warning messages may appear at this point. That's okay. After they finish, type

```
pon
```

It is a good idea to take 2-4 bias images at this point, as the first images acquired after recovering communications may be somewhat corrupt.

```
etyp b
go 3
```

Moreover, images taken for the next hour or two will show an excess of charge in the active area, above the levels in the overscan columns. This excess will decrease exponentially with a timescale of order one hour, so for broadband images with high background levels, it may not cause any big problem. If your images have very low background levels, you may find it difficult to analyze these images properly.

Flatfield lamp and exposure guide

After HDI was returned to KPNO in late 2014, measurements indicate that the response to light may be non-linear above roughly 30,000 counts per pixel. See [HDI Tech Note 8](#) for the details.

We recommend flatfield exposures with mean values less than 30,000 counts.

You can read a chronological list of flatfield exposure times at

- [HDI flatfield exposure records](#)

The table below shows only the most recent reported values.

The most recent measurements were made by RIT students Ashley Frank, Natasha Nigam, and Shane Guernsey in Jan, 2020. Some older measurements are present as well.

Jan 2020

Filter	Lamp setting	Exptime (sec)	Mean counts
U	High 100%	45	21,000
B	High 54%	10	20,000
V	Low 100%	9	19,000
R	Low 100%	5	19,000
I	Low 100%	5	19,000
6580	High 70%	8	23,000
6620	High 50%	12	23,000
6660	High 70%	7	23,000
6700	High 50%	12	25,000
Stromgren b	High 70%	19	23,000
Stromgren H-Beta wide	High 70%	19	21,000
Gunn Z	Low 100%	15	25,000
V plus 6620	High 100%	100	15,000

Thanks to Douglas and Follette for the Gunn Z value, added 6/20/2016
