SHARP Observing Instructions

14 June 2014

NOTE: Nightly start-up and end-of-night shut-down instructions for SHARP are given in the SHARC quick-start guide, at:
`http://cso.caltech.edu/wiki/cso/instruments/sharcii/quickstart`

1 Entering new sources in the UIP catalog

Source coordinates for SHARP are stored in a file called "sharp.cat" which is kept on kilauea at the following location:

- sharc/.uip/cat

For details, consult section 3.1 of the following link:
`http://www.cso.caltech.edu/uip/User_Guide.html`

2 Data processing - basics

During the observations you will want to establish your best pointing and focus, and inspect your science data. You will do all such data processing on the "quick look" desktop for sharc which can be accessed as follows:
`csovnc.pl -C -l sharc sharc.ql`
This is the desktop of kilauea (user sharc). The first thing you should do on this desktop (if it has not already been done) is:
`su sharp`
If you are physically on the mountaintop, it may be easier to use puuoo and ssh into kilauea from there:
`ssh -X sharp@kilauea`.

Polarimetry files produced during data processing are stored in various different subdirectories of `~sharp/Runs/YYYYMMMM/process/`, where YYYYMMMM changes from run to run, e.g. June-July 2014 = 2014June. Each science target gets its own subdirectory, so when you start a new science target you should create a subdirectory for it. All commands for processing and inspecting your science data, such as `dointeg` and `dorawplot`, will be invoked from this subdirectory.

Meanwhile, all focus and pointing data files are kept in `~sharp/Runs/2013Nov/calibs/pointing/`. All commands for processing your focus and pointing data, such as `dosweep`, are invoked from this directory.

3 Spreadsheet logbook

- The spreadsheet logbook is for recording the details of the observations
- The spreadsheet logbook is kept on kilauea/puuoo. It should be an ".ods" file in `~sharp/Runs/YYYYMMM`
- Open the spreadsheet logbook through the sharc.ql VNC desktop described above, by typing "ooffice" at the command line
- At the start of a run, we copy a spreadsheet logbook from a previous SHARP run
- Old spreadsheet logbooks are useful and are kept on the "run by run" section of the SHARP teamsite
- At the end of each night of observing, be sure to e-mail the spreadsheet logbook to the remote SHARP expert who is "on call" that night

4 Things to do periodically throughout the night

- check that the HWP temperature is in the range of 10 C - 21 C, by accessing the HWP temperature controller's webcam and reading its display. If the HWP temperature is outside of this range, you must shut down. This webcam can be viewed by logging into kilauea (i.e., ssh -X sharp@kilauea.caltech.edu) and then typing:
  `vncviewer 128.171.86.206`
- keep an eye on the DSOS to make sure all boxes are white.
- save the spreadsheet logbook
- keep an eye on the Zenith Angle (see below). For ZA $<$ 10 (sometimes 20) there can be tracking problems, and for ZA $>$ 60 the signal-to-noise is bad.

5 Focusing and pointing: sweep-mode

For all focusing and pointing, we use "sweep-mode".

5.1 Choosing focus and pointing calibrators

These should be chosen ahead of time, in consulation with the SHARP team, but in case new ones are needed, two things that are useful are the spreadsheet logbooks from previous runs (described above) and the orrery. The orrery should already be running in the uip VNC desktop. If not, start one by typing 'orrery &' in a terminal.

All fixed calibrators have names that start with CAL_ so you can type **UIP**> verify CAL_* to see all of them

Jupiter's moons Callisto and Ganymede can be good calibrators if they are far away from the planet. You can check the current positions of the moons here:
`http://www.skyandtelescope.com/observing/objects/javascript/jupiter#`
Another alternative site for this info is here:
`http://pds-rings.seti.org/tools/tracker2_jup.html`

5.2 How to focus

The proper focus should be established early in the night before beginning your polarimetry observations, but not until the dome has been open for at least an hour and the DSOS is fully running. For optimum performance you may want to check the focus several times per night.

Focusing is accomplished by acquiring sweep-mode data (see section 5.4) and then analyzing it (see section 5.5), for several different values of the "focus offset". Your goal is to mimimize the FWHM and maximize the amplitude (if tau is stable), while optimizing the appearance (roundness). Record all these things in the spreadsheet logbook. The focus offset should be changed in steps of 0.1. The value of the focus offset can be read on the UIP screen ("FOC OFFS"). To change the focus offset to a value of "0.2" enter this command:

- **UIP**> focus /offset 0.2

Make sure that you see the image degradation at both the positive and negative extremes of the range of focus offset values that you test. The file `focus_image.jpg`, located on kilauea at `~sharp/giles_temp`, shows how the image will degrade when you are out of focus. You can view this by using the linux command "display".

Finally, note that you should maintain good pointing (see next section) while focusing.

5.3 How to point

During polarimetry observations you should do a pointing check every two hours, and also after any large telescope moves (> 60 degrees). The goal is to find the correct pointing offsets, FAZO and FZAO, via analysis of sweep-mode data files (see section 5.5), and then update these using "uip", as follows:

- **UIP**> fazo -101
- **UIP**> fzao -12

Note that the pointing offsets FAZO and FZAO are displayed on the UIP screen. The units are arcsec.

5.4 How to acquire sweep-mode data

- start the sweep:
  UIP> sweep 30 20 /y 20 14.142 /alt
  (this is "s5", a scan that should work for most purposes)
- stop the chopper:
  UIP> sec /stop
- go to the new source, e.g.
  UIP> planet uranus
  UIP> observe cal_crl2688
  UIP> planet callisto
- Make sure that the chopper offset on the UIP display is zero. This is called "CHOP AZO" and is toward the left side of the UIP screen.
  - If the chopper offset is not zero, type **UIP**> azo /chop 0
  - If this doesn't work, try **UIP**> observe
- set the integration time in the irc client "sharc controls" window: 180 sec is typical
- level the hardware before starting a new exposure

  For Jupiter, Saturn or Mars, you should move just off the source before leveling:
  UIP> azo 300 (offset by 300 arcseconds)
  UIP> azo 0 (get back on source)
- Push "Start" on the "Sharc Controls" window of the IRC

5.5 How to analyze sweep-mode data

From the "pointing" directory, type:

```
dosweep NNNNN
```

This will yield a source image and also fitting information such as the FWHM and the FAZO and FZAO pointing offsets.

- If the source source looks reasonable but the fit seems bad (e.g., the FWHM is unreasonably large) then try this command: `dosweep NNNNN --xy XX YY`, where XX and YY are FITS image pixel numbers for the peak, estimated from the source image you just produced in the first run of `dosweep`.
- You can get help on usage and options for the `dosweep` python script by typing `dosweep -h`.

6 Polarimetry observations: chop-nod mode

For all polarimetry observations, we use "chop-nod" mode.

6.1 Turn off the sweep

UIP> SWEEP /STOP

6.2 Start the chopper

UIP> SEC 300 0.925925925 4 4
or:
UIP> SEC /restart *# restart the chopper with the last tuning*

Replace 300 with the desired chopper throw in arcseconds. You must wait until the secondary finishes tuning. To determine when it is finished, type **UIP**> sec, and if the last three lines of the output are all `yes`, then you are good to go.

6.3 Move to new target

UIP> observe source_name

6.4 Acquire polarimetry data in chop-nod mode

Usually you will be doing a "coarse dither". In this case, before starting an observation you must set some parameters by clicking on the folder icon "Observing Procedures" in the "IRC Instrument Remote Control" window.

- Set the dither offsets to what the science PI wants (the default is -20, -20, 40, 40).
- Set the chopper throw so it matches that measured by `dointeg` for the previous dither, or to the nominal chopper throw for the case of the initial dither of the night. The use of `dointeg` is described below.
- Update the zenith angle (read it from the UIP screen).
- Do the hardware level.

Once you have done all this, push "Run" on the "IRC Instrument Remote Control" window.

IMPORTANT: make sure that the chopper offset is changing back and forth between positive and negative values while observing. The chopper offsets are called "CHOP AZO" and are displayed toward the left side of the UIP screen.

6.5 Process the polarimetry files using dointeg

The script `dointeg` (located in `~sharp/bin`) converts a raw SHARC data file into a FITS I, Q, and U image file. Only the "I" (total intensity) image is discussed here. This program also outputs the chopper throw so that you can update the "Coarse Dither" parameters in the "IRC Instrument Remote Control" window as described above.

To call `dointeg`, you must be in the directory `~sharp/Runs/YYYYMMM/process/SOURCENAME` where SOURCENAME is the subdirectory of process that corresponds to your source. The syntax for this script is:

```
dointeg NNNNN
```

where NNNNN is the last five digits of the file number. This will output file NNNNN_int.fits that you can examine with a fits viewer like ds9.

Note that `dointeg` is a python script with many options to process files with troublesome HWP angles, EDAS information, or chopper issues. To get help on the script and its various options, type `dointeg -h`.

6.6 Monitor the HWP angles

From the usual subdirectory (see previous section), call `dorawplot`:

```
dorawplot NNNNN
```

where NNNNN is the last five digits of the file number.

Verify that the "staircase" pattern for the HWP_ANGLE can be seen, with steps at 50, 72.5, 95, and 117.5 degrees.

By default, `dorawplot` will plot the EDAS_STATUS and HWP_ANGLE for an input file. However, many other variables can also be plotted. To get help on `dorawplot` and its various options, type `dorawplot -h`.

6.7 Monitor the integration lengths and the chopper efficiency

The lines of text that are printed when you run dointeg contain information that you should examine:

- The length of each left integration and each right integration should be 18-19, but typically the first left of the first HWP angle has a length of ~ 14. If it drops below 11-12, see "SHARP troubleshooting": `http://lennon.astro.northwestern.edu/SHARP/troubleshoot.pdf`
- Keep an eye on the chopper efficiency. Ideally it should be $> 35\%$ for a $5'$ chop, and $> 50\%$ for shorter chops. But in actuality the efficiencies can often drop to half of these values.

6.8 Verify the signal from your source

You should be able to see your source in the fits file that is created by `dointeg`. This provides an important sanity check that all is going well with the observations. However, there are some conditions under which you may not be able to see your source even if things are working:

- the source has less than 10 Jy per beam
- the tau is higher than 0.08
- there is very bad "sky noise" (in this case you will see large temporal fluctuations in the false color "bolometer array" window)

For more details on data analysis, see "Rough, Mountaintop Analysis" available at:
`http://lennon.astro.northwestern.edu/SHARP/analysis.html`