CIMA Setup and Observing Cookbook for GALFA

Marko Krčo, Snežana Stanimirović, Carl Heiles,
Jae-Joon Lee, Joshua Goldston, Jagadheep Pandian, Tim Robishaw, Yvonne Tang

September 14, 2004

Disclaimer: CIMA is changing; this works today but may not tomorrow! Note that there are some redundancies in the current version and some features are not yet implemented. This and CIMA are works in progress. The numbers and values in this document are specific to the GALFA precursor observations and may not necessarily be suited to everyone's needs.

1 CIMA startup and setup

1. A couple of things to check before starting: (1) ALFA cover must have been removed; (2) if you need to rotate the feed, the motor must be switched on (this is also done on the platform!). If the power have failed on the platform, the "reset button" on the motor may have to be pushed; if someone switches the motor on, he/she probably should hit the reset button too, before coming down, just in case. If you have any doubts, look for ALFA rotation using the dome video monitors (you should be able to see it move). Also, the operator may need to turn on ALFA in software from the control room. (Someday, all this will be automated.)

2. Log into OBSERVER2 as "dtusr" (password taped to the monitor).

3. Start CIMA by clicking with the right button of the mouse on the background, and choosing "cima online GUI" from the menu. Several windows will pop up: Identify New User (orange), AO Observer Display (black), CIMA Observer's Interface[1] (orange), and a couple of others (white background, with red or blue writing) that you will not use. CIMA Observer's Interface is the main window and should always be open. The buttons therein open new windows, which allow you to control the telescope.

4. Identify New User

   (a) Observer(s). This entry is placed in the FITS header for each record. It is also used in the return address in case, during your observations, you decide to email the RFI or CIMA groups with a comment (using the E-mail Comment button).

   (b) Proposal Number. This is important. Your settings and log files will be saved (if you decide to do so) in the corresponding project directory, which for us is /share/obs4/usr/aNNNN/.

   (c) Select "Line" observing mode.

5. Once you select the observing mode, a new window will pop up (choose receiver). Select ALFA. You may also choose to disable quick Tsys[2]. Click on "Select Receiver Now" and you can dismiss this window.

6. At this point you may choose to load a saved configuration file by choosing "Load/Save State" from the CIMA Observer's Interface. This can set many of the parameters.

[1] fig.1

[2] At the moment this doesn't seem to actually do anything with ALFA however. Either way it would take a long time to do with 7 receivers

Figure 1: CIMA Observer's Interface window

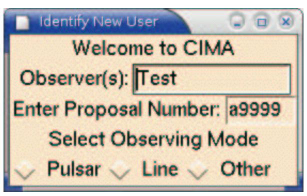

Figure 2: Identify New User window

7. Click on "Receiver IF/LO Control" and then "New Improved IFLO Setup". This will bring up the New Improved IFLO Control window where you may set your rest frequency and bandwidths. Once finished click on "Apply this Setup", and after checking your rest frequency and bandwidth you may dismiss this window.

8. To set up the WAPPs click on "Backend Control" from the CIMA Observer's Interface. This brings up the Backend Control window. There is no need to use this window to set anything up, instead you should click on the "Alpha Backend Control" button to bring up the WAPP ALFA window. Here you may set your WAPP Configuration and your cals. [**To be clarified by Jeff: do we need to set cals here or this could be done though our observing procedure?**] Click on "Configure WAPP ALFA" and wait for confirmation in the AO Observer Display window. You may then click on "Adjust Power". You should then check in the Backend Control window that all four WAPPs are active[3] and that there is power to all four of them as well.

9. You may click on "Pointing Control" on the CIMA Observer's Interface window to select a source. You should also make sure that the ALFA rotation angle is set to 0[4]. It is also a good idea to check and make sure that beam 0 is the center by highlighting the beam 0 button[5]. At this point you're essentially done with the general setup. You can click on the "Catalog" button in the Pointing window to load sources from your own catalog.

[3]Denoted by the green squares

[4]Unless you have a specific reason to use a different angle of course

[5]At present it is not clear whether the telescope will default to using the center beam so it is good to set this yourself

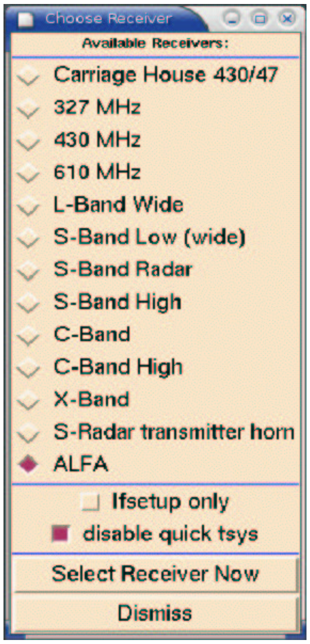

Figure 3: Select Receiver window

2 Spectral Line Observing modes (GALFA specific)

Once you have completed the general setup, you may click on the "Spectral Line Observing" button in the CIMA Observer Interface window. This will bring up the AO Spectral Line Observer's Widget Window where you may select your observing mode from the pull-down menu.

2.1 Cross/Spider Scans (ALFA Cross Map)

When you choose 'ALFA Cross Map' from the 'Spectral Line Observing' window this will bring up all input parameters you need. These are: Cal=hcal, Cal Secs=5, Beams=9, Secs=60, Az Size=329.06, ZA Size=384.005, Rotation Angle=0. Don't change these parameters. Choose between 'Cross' and 'Spider' map, choose ALFA beams you want to do, and also set 'IF/LO Control' to BW=100 Mz, Sky Frequency=1420.405; also choose Configuration=2 chan, 3-level on the 'WAPP ALFA' window. **Note: We would prefer to run Spider scans in full Stokes mode,**

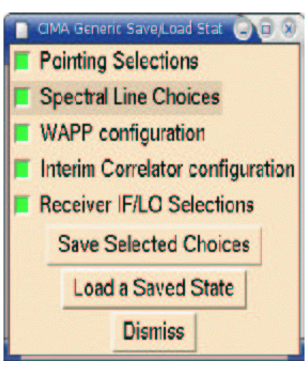

Figure 4: Load/Save State window

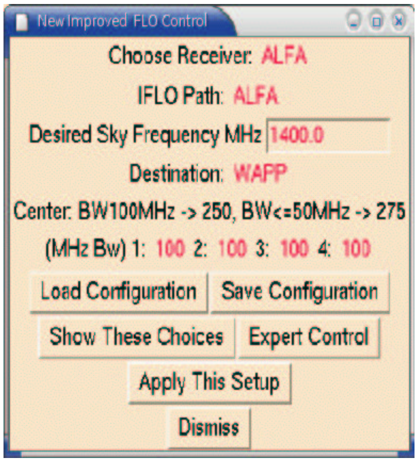

Figure 5: New Improved IFLO Setup window

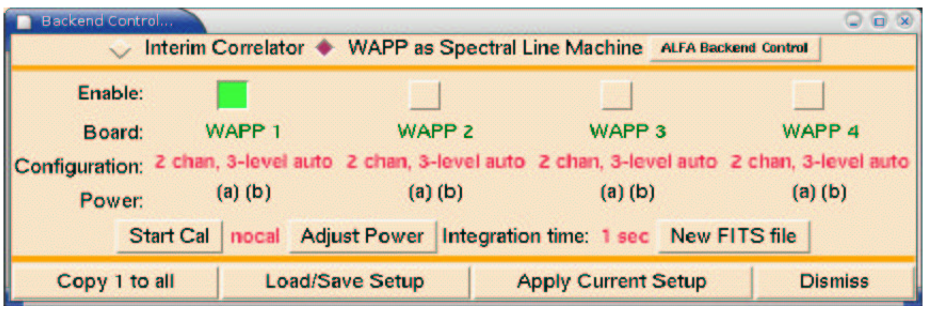

Figure 6: Backend Control window

that is ‘3-level, polarization’ configuration. However this mode does not work right now.

2.2 Smart Frequency Switching (SFS)

Current saved setup ‘$test_a1943\_sfs.gui$’ will bring up all input parameters you need. This means: “2 chan, 3-level auto” and BW=100 MHz. Make sure to apply these setup by pressing appropriate buttons. Frequencies are set to: 1420.405, 1421.205, 1420.805, 1420.605, 1428.405 and 1412.405. Step time per frequency is 5 sec, Cal type is ‘hcal’. Get to your source first (this is not actually important, you can also be anywhere on the sky, it’s nice to be close to your source though). Run SFS with BW=100 MHz for 3 loops, then change to BW=6.25 MHz for the next 3 loops. The procedure fires cal and steps through all frequencies, then turns off the cal and goes through all frequencies again.

2.3 Basketweave Scanning

Selecting Basketweave scan from the mode pull-down menu will bring up the Basketweave Scanning window. The following is a brief explanation of each parameter:
Before you start make sure ALFA Rotation Angle is set to 0 on the ‘Pointing Control’ window. An example setup is ‘*BW_a1943_mbm40.gui*’. In the ‘New Improved IFLO Control’ BW=6.25, Sky Frequency is set on HI line. In the ‘WAPP ALFA’ window, Configuration is ‘2-chan, 9-level auto’.

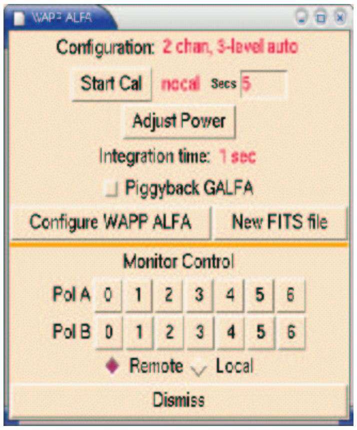

Figure 7: WAPP ALFA window

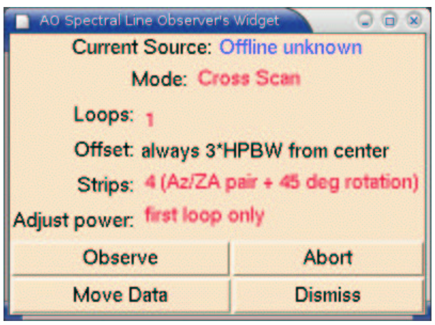

Figure 8: AO Spectral Line Observer's Widget

Start RA hhmmss has to be the same as the Start LST[6].

Start Dec ddmmss It is very important to give here the lower Dec for you map. This is = Source Dec - Dec Len/2.

Start LST hhmmss This is set based on our estimated LST times that will produce maps with equal beam spacings. These start times are calculated in advance. You should choose the LST time far enough ahead of your current time to give the telescope enough time to slew to the position. When you hit observe the telescope will head towards the reference position and it will wait until the LST time you entered to start.

RA rate asec/sec Specifies the R.A. slew rate of the telescope. Right now we use 15 asec/ses for fixed azimuth.

cycles The number of cycles to do. Each cycle consists of one sweep up and one sweep down + Cals before each sweep. Once you are happy with the setup put here 20 or 30 cicles for a large scan.

Sweep Time (secs) The number of seconds in which to do each sweep. At the moment this is set to 60 sec.

Declination Len (ddd.dd) How many degrees in declination to cover in each sweep, during our Sep run we have used 1.5 degrees.

Turn Around (secs) Specifies how much time to leave at the end of each sweep for the telescope to stop and turn around and take cals (if any). Though we don't fully understand the effects of what happens if this number is too low at the moment, you should leave at least 16 seconds if you are doing 3 second cals. It has been noticed

[6]since we want azimuth=180(or 360)

however that when the turn around time is too short the telescope can't keep up and offsets are introduced in the edges of the maps.

Num Cals How many cals to do per sweep. During our Sep run we had this set to 1.

Cal When A pull down menu for when to perform the cals, we use 'top and bottom of each'.

Cal Secs Seconds per cal, we use 3 secs.

Cal Type A pull down menu for the cal type, use 'hcal'.

Doppler Correct To be implemented.

Doppler Update To be implemented.

Lastly you need to set up the coordinate information. The coordinates you enter here refer to the starting location of the first sweep. Everything afterwards is offset from this point. You may enter your declination as desired, however the LST start time and start R.A. are a little more complicated. Since you want to keep the telescope at an azimuth near 360 degrees[7] your LST and R.A. should be the same.
Note: Once the telescope completes all the cycles it has been assigned it will return to the original starting R.A. and Dec. Since this may be quite far away in some cases you should try to continue your next set of scans before the telescope has had time to move too far.
Note: Pay careful attention to the timings in general with Basketweave Scanning just to make sure the telescope is doing what you want it to do. There are not many error traps in the software yet.
Note: dec len. = sweep time $\times$ 1.5degree/min is required to get a equal spacing between beam trajectory[8]. The angular difference in R.A. between up(or down) scans is given by scan rate $\times$ 2(sweap time+turn around time) and you have to choose appropriate sweap time by considering how you will cover this gap in remaing day (each scan will sweep up R.A range of 12 arcmin).
Note: If you get warning messages saying that the telescope is scanning while not on source, you can ignore them. For the moment this happens at every turn around since the telescope is indeed taking cals while it is not on source.

3 Additional Notes and Things To Keep Track Of

1. **Filekeeping**

   (a) All the data from an observation is stored in a single fits file, unless the file gets too large. Currently there is a limit of 2 GBy on any individual fits file. The observer should receive warnings in the AO Observer Display window before this limit is reached, however this has not yet been observed. If a file does get too large a new fits file will be opened automatically. This may cause problems if it happens in the middle of a scan so it is a good idea to periodically check the size of the current fits file and start a new fits file when needed[9]. The "New FITS File" button is available from a few displays including the WAPP ALFA window.

   (b) The fits files are all stored in the /share/pserverf.sda3/wappdata/ directory. Typing "ls -l *.[project code].*" in the fits directory will list all the files related to a particular project code.

   (c) A log file is created containing all the text from the executive window (which includes all the messages from AO Observer Display). This file is located at /share/obs4/usr/[project code]/[project code].cimalog

   (d) In order to access your fits files in IDL you must first close them by starting a new fits file.

2. **General and errors**

[7] A one degree error seems to be fine for now
[8] This depends on the declination but it will not much differ for the source near the plane
[9] Note that at the moment you lose 3 seconds of data each time you close the fits file and start a new one

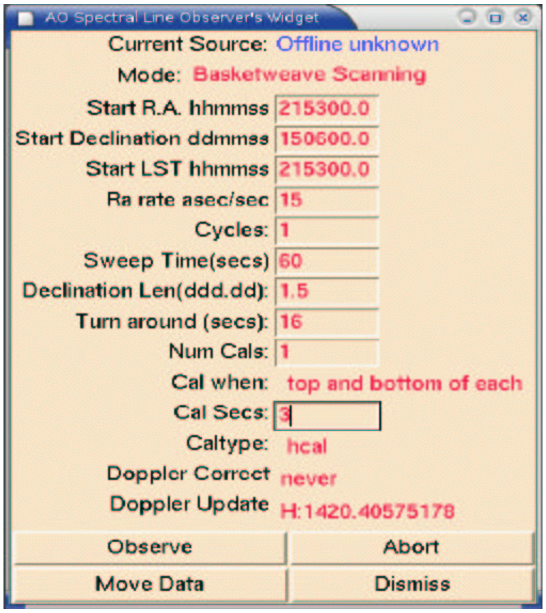

Figure 9: Basketweave Scanning window

(a) Is WAPPDATA confused? On a few occasions, after hitting "Observe" to start the integration, we had a series of warnings (on the AO Observer Display window): "WAPPDATA is confused". If this happens, open the User Preferences window, and type "socksend WAPPDATA FLUSH" on the "Send to GUI" line. Hit the "Send to GUI" button. If the "WAPPDATA is confused" state persists, exit CIMA and start again, this time choosing "Pulsar Observing" in the CIMA Observer's Interface. Click on the "More" button, then on "Restart all WAPPs".

(b) At the moment Full stokes mode ('3 lvl, polarizations) does not work. You will receive repeated "WAPPDATA is confused" messages if you try.

(c) This document is based on a similar document from the EALFA group. That document may be accessed from a web site maintained by Barbara Catinella[10].

4 Some Notes on Data Reduction

Basics on how to plot positions:

Note: There are known issues about the difference between the timestamp of the WAPP data and the actual time the data is taken. Hence, the positions derived from the timestamp in the fits file will have some errors in them.

At the observatory server, the fits files are stored in /share/pserverf.sda3/wappdata/. The fits files are named as wapp.yyyymmdd.projid.nnnn.fits. Here, yyyy is the year, mm is the month, dd is the day, projid is the project id (example a1943) and nnnn is the number. The number starts from 0000 for the first file written after midnight (AST). Phil Perillat has written a set of IDL routines that read the fits files into structures similar to those created when reading the interim correlator data.

At present, only the position (in the sky) of the central beam are written in the header of the fits file. This will hopefully change in future. Also, it turns out that the azimuth (az) and zenith angle (za) written to the header are

[10] http://www.astro.cornell.edu/ galaxy/alfacima_instr.htm.

more reliable than the actual positions in the sky. This is apparently because the program writes the required RA and declination to the header, and not the actual position on the sky. Hence, the way to plot positions of the scans is to read in the az, za and julian date values from the header, and then computing the position of the beams. Phil has written a procedure in IDL that can compute the position of all 7 ALFA beams if the az, za, julian date and rotation angle are known.

The IDL commands to calculate the positions of the scans are given below:

```
IDL> @phil
IDL> @wasinit2
```

The first batch file initializes paths for where the IDL procedures are. The second batch file runs a set of procedures relevant to analyzing WAPP spectral line data.

```
IDL> path = '/share/pserverf.sda3/wappdata/'
IDL> file = 'wapp.20040904.a1943.0009.fits'
IDL> print, wasopen(path+file, desc)
IDL> waslist, desc
```

If the data is moved from the NAIC server to some other place, the path should be modified accordingly. The function wasopen opens the fits file and assigns the pointer desc to the file. It returns 1 if the file was opened successfully. The procedure waslist lists the contents of the file. It shows the scan number, number of records in each scan number and the mode in which the data in the scan was taken. It also gives you error messages when a scan is incomplete or has other problems with it.

```
IDL> startscan = 424862279L
IDL> print, posscan(desc, startscan)
IDL> nrecs = 60
IDL> print, corgetm(desc, nrecs, b)
```

The function posscan moves the file pointer to the desired scan number (in this example, scan number 424862279). nrecs indicates the number of records to be read. The function corgetm then reads the records to the structure b. The structure b contains all the header information and the actual data. The az, za, julian date and rotation angle are derived from the b structure as follows:

```
IDL> az = b.b1.h.std.azttd*1d-4
IDL> za = b.b1.h.std.grttd*1d-4
IDL> tm=b.b1.h.std.postmms*.001
IDL> scan=b[0].b1.h.std.scannumber
IDL> daynum=scan/100000L mod 1000L
IDL> yr=scan/100000000L + 2000L
IDL> daynum=tm/86400D + daynum       ; put on the seconds
IDL> jdenc =daynotojul(daynum,yr+lonarr(npnts),gmtoffhr=4D) ;julian day enc
IDL> jdData=b.b1.hf.mjd_obs + 2400000.5D + .5D/86400D       ;julian day data
IDL> rotangl=b[0].b1.hf.alfa_ang
```

The az and za angles are stored to ten thousandths of a degree at b.b1.h.std.azttd and b.b1.h.std.grttd respectively (which is why they are multiplied by 10^{-4} to get the actual angle in degrees). tm is the time in milliseconds from midnight AST when the record was written. The next set of commands derive the year and day number from the scan number and derive the julian date from these. The rotation angle is stored in b.b1.hf.alfa_ang. Note that this is stored for each record, and since we need only one number, we use b[0].b1.hf.alfa_ang. Once these numbers are computed, the beam positions in the sky are calculated through

```
IDL> alfabmpos,az,za,jdData,rahr,decdeg ,rotangl=rotangl
```

Calculating positions for all scans for a source:
At present, one has to input all the different sets of scans in different files manually. Tim Robishaw has written an IDL procedure that I have subsequently modified to simplify this process. The idea is to have a procedure that will take an array of filenames, startscans and stopscans, and then carry out the above procedure for computing the beam positions for each file. An example for the source mbm40 is given below. Phil has a program arch_getalfa that can read in these scans automatically, but I have not used it yet.

```
IDL> path = '/share/pserverf.sda3/wappdata/'
IDL>
IDL> filenm = ['wapp.20040904.a1943.0009.fits', $
IDL> 'wapp.20040904.a1943.0010.fits', $
IDL> 'wapp.20040905.a1943.0007.fits']
IDL>
IDL> startscan = [424862279L, $
IDL> 424863520L, $
IDL> 424962753L]
IDL>
IDL> stopscan = [424863271L, $
IDL> 424865743L, $
IDL> 424965048L]
IDL>
IDL> wapp_pos, path+filenm, startscan, stopscan, ra, dec
```

The procedure wapp_pos can be found in the naic network /home/jpandian/galfa/.

Note: The procedure wapp_pos calculates the number of records to be read as the difference between the startscan and stopscan. However, scan numbers are related to the timestamp and not record number, as a typical scan number is ydddttttt and y is the year (4 for 2004), ddd is the day since the beginning of the year and ttttt is the number of seconds from midnight AST. Hence, the number of records calculated is more than the actual number in the scan. This will lead to problems if there are other scans unrelated to the source of interest.

Phil has written a procedure wasalfacmpradec to do many of the computations indicated above automatically. I have not used it yet, but once I check that everything works, will add an update to this document. The same applies to Phil's arch_getalfa procedure.