4 After your Observations

4.1 Archiving Your Data

There are several means for you to obtain a copy of your data once you have finished your observations. The following subsections will describe these methods in detail.

You are requested to make a copy of your data as soon as possible after the observations.

4.1.1 Optical Disk

You can back up your data to DVD. Each DVD holds 4400 MB, and the files from CABB are never allowed to grow larger than this size.

To make a DVD copy of your data, perform the following steps:

- wait until your observations are finished - you do not want the backup process to try to copy an open data file
- if necessary, open the EXPORTS GUI on FURIOUS
- click on the "Update" button to ensure that the list of available files is the most recent
- select the files you want to copy by clicking on them, while ensuring that the total size of the selected files remains less than 4400 MB.
- select the actions you want performed by clicking on the appropriate buttons on the `Exports` display; see the web page
  `http://www.narrabri.atnf.csiro.au/software/utility/user/export/exports.html`
  for further information
- push the GO button
- your data should be copied within a few minutes
- at the end of the backup, a directory of the backup and CD cover will be printed to the HP colour printer in the observer's area

4.1.2 Portable Storage

Since CABB data is very large, it will be more convenient to take your files away on a portable hard drive than on multiple DVDs. To get your files onto your portable drive, you may use any of the PCs in the observer's area by following the steps:

- log in to the computer using your ATNF username and password
- plug your portable hard drive into the USB port on the computer
  - USB is the only supported interface for portable hard drives
- wait for a couple of minutes while the hard drive gets mounted automatically by the computer. The drive should be mounted at `/media/usb`n, where n is the partition number (numbered from 0). You can use the command `df |grep media` to check whether it has mounted.
  - the only supported filesystem types are ext2/3 and FAT32
- Transfer your files across from the local archive:
  - change directory to your portable hard drive. For example:
    `cd /media/usb0`
  - and then execute the command:
    `cp /DATA/ARCHIVE_1/ATCA/archive/*.CX167 .`
    to copy all project CX167 data.

The local archive should keep up to three months of data. For older data files, you should go to the Online Archive (page 58).

4.1.3 Laptop

You can also copy your data to your laptop in a similar fashion to that described in Portable Storage (page 57). When your laptop is plugged in to a pink cable, you may access NELLE, so you can copy your data with the command:

```
scp username@nelle:/DATA/ARCHIVE_1/ATCA/archive/*.CX167 .
```

which would copy all project CX167 data, and where `username` is your ATNF username.

4.1.4 Online Archive

Your CABB data will appear on the Australia Telescope Online Archive (ATOA, http://atoa.atnf.csiro.au) within a few days to a few weeks after the end of your observations. Using the OPAL account you used to submit your successful proposal, you will have access to your data. Full instructions for how to use the archive interface are available on the website.

4.1.5 Remote Copy

If you are unable to get your data from the ATOA as soon as you would like, then you may get it directly from the disk on KAPUTAR that buffers the data.

To do this, you must set up an SSH tunnel from your local machine to KAPUTAR via the ATNF gateway machine VENICE. This can be set up with the command:

```
ssh -L 12345:kaputar:22 username@venice.atnf.csiro.au
```

where `username` is your ATNF username. This will log you into VENICE and set up the SSH tunnel. To copy data from KAPUTAR you should go to another terminal and do something like:

```
scp -P 12345 username@localhost:/DATA/ARCHIVE_1/ATCA/archive/2010-06-24_1342.C999 .
```

4.2 Report Your Experiences

After your observations, please provide us with feedback by completing the online Observer's Questionnaire at http://www.narrabri.atnf.csiro.au/feedback. The feedback you give provides us with a way of measuring the success or failure of Compact Array operations, and allows us to identify areas that need attention.

If you have used the mm systems during your observations, please also complete the "mm Observing Report", which can be found on the same webpage as the Observer's Questionnaire.

Feel free also to leave comments on our website! And to seek advice from our expert users, please visit the ATCA Forum website (http://atcaforum.freeforums.org), where you can start or participate in a conversation about your experiences with the ATCA.

4.3 Data Analysis

This section will describe how to get started on reducing CABB data using the MIRIAD software suite. More information can be found in the MIRIAD manual (http://www.atnf.csiro.au/computing/software/miriad). The manual's cookbook should be read by all users before starting their first data reduction. This section will explain how reduction differs for CABB data. The MIRIAD manual has been updated to incorporate information on CABB data reduction, but work continues on improving it.

4.3.1 Updating MIRIAD

The MIRIAD reduction suite is undergoing numerous changes to ensure it continues to be capable of reducing data from the ATCA. Most of the recent changes it has undergone relate to CABB processing. Most importantly, it now deals with the much larger memory requirements of CABB data processing during calibration and visualisation. However it is still being actively upgraded.

It is therefore important that before beginning your data reduction that you obtain the very latest MIRIAD distribution, as new features may have been implemented that will make your reduction easier or more successful, or may solve an issue that you were experiencing with an older version of MIRIAD.

To get the latest MIRIAD distribution, please follow the instructions here: ftp://ftp.atnf.csiro.au/pub/software/miriad/INSTALL.html.

It is also important to report any problems you may have with your reduction to the MIRIAD maintenance team so that any issues can be resolved. If you experience any problems, please use the MIRBUG routine, or send an email describing your problem to miriad@atnf.csiro.au. If you don't think your problem is related to a bug, but you need advice on how best to proceed with your reduction, please ask for help using the ATCA Forum (http://atcaforum.freeforums.org). ATCA and ATNF staff routinely check the forum and answer questions from the community, making the forum a good place to start to look for answers as well.

4.3.2 Loading Data

Data files from CABB are much larger than those generated by the old correlator, so it is recommended that you process them on a machine with plenty of physical memory (RAM). If you rely on virtual memory to work with CABB data files, then you will experience very poor performance.

To load CABB data, you will use the ATLOD task. The inputs to this task should, in general, be the same as for pre-CABB data. However there are two options that should be used for all CABB data to make subsequent reduction more pleasant. These two options are `birdie` and `rfiflag`.

The `birdie` option was always recommended for pre-CABB data, but for a different reason. For CABB data, a number of channels are affected by self-generated interference from the 640 MHz CABB clock, and the `birdie` option flags these channels during load. It also flags out 100 channels on each band edge and the unusable parts of the spectrum in the old, separate 20cm and 13cm bands. These unusable parts are due to the fact that these receivers did not respond to all frequencies across the 2 GHz bandwidth of CABB. This option still works for pre-CABB data as expected.

The `rfiflag` option can be used now to automatically flag out frequency bands that are known to be heavily affected by RFI. This option is most useful in the 16cm band, where the ATCA receivers are routinely affected by strong RFI. It is completely safe to use at any band however, and should be included in the default list of options when you use ATLOD. The file it uses to determine the flagging it performs can be customised to include extra flagging (or less flagging) if so desired. By default, this file (called `rfiflag.txt`) can be found in the directory `cat` in the MIRIAD tree. To customise it, copy it to your reduction directory, insert or remove more frequency ranges to flag, and then load your data with ATLOD.

Note that the `rfiflag` option will have no effect if the `birdie` option is not also specified.

Another useful ATLOD option is `xycorr`. This corrects the measured XY phase of the ATCA, and can be safely included at all bands for CABB data.

By default, CABB records the autocorrelations from each of the antenna that are being used, which may not be useful if all you are interested in is the cross-correlations required to make an image. Having the autocorrelations present during the reduction does no harm to any of the MIRIAD routines, but may become confusing and/or annoying when trying to examine the data. You can make ATLOD flag these data by using the `noauto` option.

The other ATLOD options are usually frequency dependent. Examples of ATLOD use are given below for all ATCA bands.

16cm band

```
Task:   atlod
in        = *.C007
out       = c007.uv
ifsel     = 1
restfreq =
options   = birdie,xycorr,rfiflag,noauto
```

```
nfiles   =
nscans   =
```

For these bands, if you used identical centre frequencies in both IFs, you need only extract 1 IF as both IFs will contain identical data, and keeping both may lead to confusion later on.

6cm, 3cm bands

```
Task:   atlod
in       = *.C007
out      = c007.uv
ifsel    =
restfreq =
options  = birdie,xycorr,rfiflag,noauto
nfiles   =
nscans   =
```

If you chose to use the same centre frequency for both IFs then you should extract only 1 IF using the `ifsel` parameter as described above.

15mm, 7mm bands

```
Task:   atlod
in       = *.C007
out      = c007.uv
ifsel    =
restfreq =
options  = birdie,xycorr,rfiflag,opcorr,noauto
nfiles   =
nscans   =
```

At these mm bands, you should include the `opcorr` option to correct for atmospheric opacity.

3mm band

```
Task:   atlod
in       = *.C007
out      = c007.uv
ifsel    =
restfreq =
options  = birdie,xycorr,rfiflag,noauto
nfiles   =
nscans   =
```

4.3.3 Correcting mm data

For higher frequency data, the ATFIX routine may be required to apply corrections to the antenna positions and system temperature measurements.

During a baseline reconfiguration at the ATCA, staff perform a baseline calibration (to determine precisely where each antenna is) at 5 GHz and 17 GHz. During normal observing, the solution determined at 5 GHz is applied on-line, and is usually very good. However, for mm data, you may wish to use more precise antenna positions obtained from the 17 GHz baseline calibration. This may aid in phase referencing experiments.

The ATFIX routine can "fix" the positions of the ATCA antennas based on the solution file that is made available by the ATCA staff at http://www.narrabri.atnf.csiro.au/observing/antpos/. The high-frequency baseline solutions are not routinely computed for each reconfiguration, so if you'd like to have one, please contact ATCA staff with your request.

The task ATFIX is also highly recommended for reduction of 3mm data. During an observation at 3mm, the system temperature is determined using the paddle during a so-called "paddle scan". These scans are usually tens of minutes apart, during which time the system temperature recorded by the correlator does not change. To make MIRIAD interpolate the system temperature between the paddle scans, use ATFIX with default parameters:

```
Task:   atfix
vis      = 3mm_data.uv
select   =
out      = 3mm_data_fixed.uv
dantpos  =
tsyscal  =
options  =
array    =
```

4.3.4 Splitting the dataset

After loading the data into a MIRIAD dataset, it is usually most convenient to split this into many datasets, each containing an individual source at a single central frequency. This is done using the UVSPLIT task.

At its simplest, it can be run with only the `vis` parameter set to the parent dataset:

```
Task:   uvsplit
vis      = c007.uv
select   =
options  =
maxwidth =
```

The `select` keyword can be used to split out only certain sources, or to effectively flag out certain antenna. Read about the `select` keyword here: http://www.atnf.csiro.au/computing/software/miriad/doc/select.html.

There are two `options` that are useful here. Specify the `mosaic` option if you are splitting a dataset that contains a mosaic observation, and specify the `clobber` option if you want to overwrite any previously split-out datasets in the current directory.

The `maxwidth` parameter is new to the CABB era, and allows you to break up the 2 GHz CABB bandwidth into smaller chunks. This will be most useful at lower frequencies where 2 GHz represents a large fractional bandwidth. At such frequencies, calibration and imaging is far more challenging than at higher frequencies. The bandwidth specified here should be specified in GHz. For example, to mimic the maximum bandwidth available from the old correlator, you could specify `maxwidth=0.128` here.

4.3.5 Flagging

In most cases, if the `birdie` and `rfiflag` options are given to ATLOD, the data will be mostly free from RFI at this point. However, you should always examine your data with the UVPLT and UVSPEC tasks to make sure.

Using UVPLT, examining amplitude and phase versus time is a good way to find time ranges that have been affected by RFI. Ensure that you specify `options=nofqav` to prevent UVPLT from averaging your data over frequency before plotting. Any RFI present in your observations will probably be restricted to only a few channels, and these channels can be identified by using UVSPEC.

To flag this data, you can use the following tasks.

UVFLAG — Use the `select` and `line` keywords to select the bad data and set `flagval=flag` to flag the data as bad. UVFLAG can be used to flag any set of bad data, but can be tediously repetitive.

BLFLAG — This task can replicate many of the plots that UVPLT generates, which may allow you to directly select the outliers representing bad data. However BLFLAG will always average your data over frequency before plotting, meaning that it may be impossible to do most flagging with this task.

PGFLAG — This new task replaces the old TVFLAG task that no longer works on displays with more than an 8-bit colour depth. PGFLAG displays data as a channel-time waterfall plot and allows direct selection of ranges of bad data and flexible flagging options.

MIRFLAG Based on PIEFLAG, this new automatic flagging routine is not yet distributed with the main MIRIAD package. It is very useful however at excising obviously bad data quickly and without user interaction. Details of how to obtain and run MIRFLAG can be found on the ATCA Forum site at http://atcaforum.freeforums.org/flagging-with-mirflag-t13.html.

4.3.6 Calibration

The calibration strategy for ATCA data has been refined for the CABB era, to ensure accurate calibration of wide bandwidths. This strategy also has the benefit of being applicable to the vast majority of ATCA data with little alteration. It is described best in the MIRIAD cookbook at http://www.atnf.csiro.au/computing/software/miriad/userguide/node95.html.

To summarise, you should use MFCAL on your bandpass calibrator, and transfer the bandpass solution to your flux and phase calibrators. This is followed by a GPCAL on your primary flux calibrator and phase calibrators (unless your flux calibrator is a planet, in which case drop the GPCAL on it). After this you must scale your phase calibrators to the proper flux scale using GPBOOT (or if your flux calibrator is a planet, scale its flux to the phase calibrator's to prepare for the next step). Now use MFBOOT to set the proper flux scale if your flux calibrator is a planet, otherwise it corrects the bandpass slope over a wide bandwidth; this crucial parameter was not accounted for in previous calibration strategies, since the effect was not very important with the bandwidth of the old correlator. Finally copy your phase calibrations to your target sources using GPCOPY.

After calibration, you should examine your solutions using GPPLT, UVPLT and CLOSURE at the very least. Calibration and flagging should be done in an iterative fashion until you are satisfied that your calibration solutions are of excellent quality.

4.3.7 Imaging

Imaging of CABB data can be performed in exactly the same way as pre-CABB data, however you may get better results with a slightly different method.

For high-frequency observations, where a bandwidth of 2 GHz does not represent a very large fraction of the sky frequency, then the imaging strategy used for pre-CABB data will most likely be adequate. For lower frequencies the multi-frequency strategies are more likely to produce good results. In particular, the use of the MFCLEAN task should be considered. Read the excellent description of why MFCLEAN is necessary (http://www.atnf.csiro.au/computing/software/miriad/userguide/node110.html) to see if you will need to proceed with this strategy.

If you don't need MFCLEAN then you should proceed with the usual INVERT, CLEAN and RESTOR method of creating an image, and combine this with SELFCAL or GPSCAL if appropriate. In this case, nothing should be different from pre-CABB reduction.

If you do need MFCLEAN then the inputs to INVERT will need to be slightly different as well. Firstly, both the `mfs` and `sdb` options will need to be passed to INVERT. MFCLEAN also requires that the beam be three times the size of the region being cleaned, which cannot be achieved using a simple option, but rather requires that you set the `imsize` parameter to be three times the size of the ATCA primary beam (if you plan to clean the entire primary beam region). You should therefore set `cell` and `imsize` together to produce the appropriate dirty map. You may use MIRIAD to get a rough idea of these numbers by running through the reduction without MFCLEAN and use RESTOR's estimate of the synthesised beamsize.

Example inputs to INVERT are shown below for a theoretical observation at 5.5 GHz for 12 hours in a 6km configuration.

```
Task:   invert
vis      = obs.uv
map      = obs.map
beam     = obs.beam
imsize   = 1887,949
cell     = 0.83,1.65
```

```
offset   =
fwhm     =
sup      =
robust   = 0.5
line     =
ref      =
select   =
stokes   = i
options  = mfs,sdb
mode     =
slop     =
```

This will create an image that is 26.1 arcmins on each side, and assumes a synthesised beamsize of 2.48 by 4.95 arcsec.

The inputs to MFCLEAN might then be:

```
Task:   mfclean
map      = obs.map
beam     = obs.beam
model    =
out      = obs.clean
gain     =
cutoff   =
niters   =
region   = relcenter,boxes(-314,-158,314,158)
minpatch =
speed    =
mode     =
log      =
```

Here we are selecting the central third of the image (the primary beam area) with the `region` keyword. This also satisfies the MFCLEAN requirement that a guard band be present around the region being cleaned. The other parameters are very similar to those of CLEAN and should be set as usual to prevent over-cleaning.

After MFCLEAN has run, RESTOR should be used in the normal way to produce the cleaned image. SELFCAL can also be used in the usual fashion in this process.

4.4 Publishing Results

4.4.1 ATNF Acknowledgements

Observers are requested to acknowledge the ATNF in any publications resulting from the use of the ATNF as follows:

> The Australia Telescope is funded by the Commonwealth of Australia for operation as a National Facility managed by CSIRO.

Where possible, authors are requested to include one of the terms "ATNF" or "Australia Telescope" in the Abstract of their papers. This is to facilitate electronic searches for publications that include ATNF data.