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A newsletter for users of the NRAO
Astronomical Image Processing System

Written by a cast of *AIPS*

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General developments in *AIPS*

AIPSLetter publication

We have decided to discontinue paper copies of the *AIPSLetter* other than for libraries and NRAO staff. The *AIPSLetter* will be available in PostScript and pdf forms as always from the web site listed above. It will be announced in the NRAO e-News mailing and on the bananas list server.

Current and future releases

We have formal *AIPS* releases on an annual basis. While all architectures can do a full installation from the source files, Linux (32- and 64-bit), Solaris, and MacIntosh OS/X (PPC and Intel) systems may install binary versions of recent releases. The last, frozen release is called `31DEC10` while `31DEC11` remains under active development. You may fetch and install a copy of these versions at any time using *anonymous* `ftp` for source-only copies and `rsync` for binary copies. This *AIPSLetter* is intended to advise you of improvements to date in `31DEC11`. Having fetched `31DEC11`, you may update your installation whenever you want by running the so-called "Midnight Job" (MNJ) which copies and compiles the code selectively based on the changes and compilations we have done. The MNJ will also update sites that have done a binary installation. There is a guide to the install script and an *AIPS* Manager FAQ page on the *AIPS* web site.

The MNJ serves up *AIPS* incrementally using the Unix tool `cvs` running with anonymous ftp. The binary MNJ also uses the tool `rsync` as does the binary installation. Linux sites will almost certainly have `cvs` installed; other sites may have installed it along with other GNU tools. Secondary MNJs will still be possible using `ssh` or `rcp` or NFS as with previous releases. We have found that `cvs` works very well, although it has one quirk. If a site modifies a file locally, but in an *AIPS*-standard directory, `cvs` will detect the modification and attempt to reconcile the local version with the NRAO-supplied version. This usually produces a file that will not compile or run as intended.

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Improvements of interest in 31DEC11

We expect to continue publishing the *AIPSLetter* approximately every six months along with the annual releases. Henceforth, this publication will be primarily electronic. There have been several significant changes in 31DEC11 in the last six months. Some of these were in the nature of bug fixes which were applied to 31DEC10 before and after it was frozen. If you are running 31DEC10, be sure that it is up to date to sometime this year (a MNJ after June 8 would be best). New tasks in 31DEC11 include REWGT to scale data weights by subarray and/or IF, ACLIP to do clip operations on auto-correlation data, RLCAL to solve for right minus left phase differences as a function of time when good source models are available, SY2TY to make TY tables from SysPower tables, SYCOP to copy good SY table IFs to bad ones, QUOUT and QUFIX to determine right-left calibrations from well-calibrated images, RFLAG to flag data based on rmses measured over short time intervals and on deviations from the average spectrally, IM2CC to convert model images into Clean components attached to suitable image facets, and AFARS to extract useful parametric images from the Faraday Rotation synthesis (FARS) output image cubes. The new verb HUEWEDGE draws a step wedge in two dimensions on the TV and even labels it to match a TVHUEINT display. The OBIT programs BDFIn and BDFList have been made accessible to *AIPS* users through "verbs" BDF2AIPS and BDFLIST. These replace earlier stand-alone, question-and-answer scripts. This worked so well that further "verbs" OBITMAP, OBITIMAG, OBITSCAL, and OBITPEEL have been written to make available increasingly complex portions of the OBIT program Imager. A new pipeline procedure named DOOSRO has been written to reduce EVLA data taken with less difficult observing parameters ("Open shared risk"). A service program to list assigned user numbers called USERNO was re-created.

31DEC09 contains a significant change in the format of the antenna files, which will cause older releases to do wrong things to data touched by 31DEC09 and later releases. 31DEC08 contains major changes to the display software. Older versions may use the 31DEC08 display (XAS), but 31DEC08 code may not use older versions of XAS. Magnetic tape logical unit numbers changed with 31DEC04. You are encouraged to use a relatively recent version of *AIPS*, whilst those with EVLA data to reduce must get the latest release.

Lion

Apple has announced a new major revision of OS X called Lion (10.7). The VAO in Socorro has made a new, beautifully equipped iMac available to us for testing. It was found to install and run the existing MACINT load modules with no difficulty. We then tried using the latest Intel compiler (12.0.4 dated 20110503) with the x86_64 architecture. This version ran a little bit faster than the 32-bit version, but not enough faster to justify making a new MAC64 "architecture" with a new NRAO computer to support it.

EVLA UV-data calibration and handling

A great many changes have been stimulated by the commissioning effort now underway with the new EVLA WIDAR correlator. A new appendix (E) to the *CookBook* has been written to describe EVLA data reduction. It has been available on the web and is now incorporated into the *AIPS* release. Note that this document is a work in progress and it will of necessity evolve with time.

RFLAG

RFI is frequently characterized by rapid variability in both time and frequency. RFLAG looks for this and flags the data accordingly. Using a floating buffer in time (usually just 3 or 5 integrations), it measures the rms over time in each channel individually. If the rms exceeds a cutoff, the channel is flagged over that time range. RFLAG also finds the mean and rms of the real and imaginary parts of the visibility over the channels in each spectral window at each time. The task uses "robust" methods which exclude outliers while finding the "real" mean and rms. Any channel that deviates by more than N times the rms will also be flagged. To assist in setting the time cutoff and the value of N, RFLAG will plot the histograms of values of the time rms and the spectral deviations instead of writing a flag table. RFLAG flags spectral channels individually, while FLAGR deletes whole spectral windows depending on trends in the average and rms of the spectral channels.

Polarization and right minus left matters

RLDLY finds the difference in delay between right and left polarizations. This can be large even if little or no delay correction is needed for the parallel-hand data. Bugs were fixed that caused the answers to be compromised especially when dividing the IFs into halves to get one AC and one BD delay. It was changed to copy and correct the CL table that it applied to the data rather than the highest CL version. It was changed to get correct phase offsets for each IF, so that phases will remain continuous across the full band.

After correcting the right minus left delay, one can solve for antenna polarization using PCAL. The model computation in PCAL was found to be in error for Clean component models of Q and U and was corrected. Unfortunately, since PCAL does not solve for a right minus left phase difference but the data contain this difference, the use of a fixed model for the calibrator in PCAL cannot work.

After PCAL, the D-terms are applied to the data from a source of known polarization position angle and the remaining right minus left phases are found and corrected. RLDIF is the main task for this and it had to be fixed to change the spectral-line D-term file (PD) and the continuum mode tables (SU, AN, CL) properly. RLDIF can now read a text file with the Q and U spectrum in order to do its calibration. RLDIF had incorrect position angles for known sources 3C48, 3C138, and 3C147. Handling of blanked solutions and smoothing was also improved.

RLDIF can be instructed to correct the relevant *AIPS* tables in either continuum or spectral modes. It can also, in continuum mode only, leave the corrections to be run later in CLCOR. That task corrects the antenna table (D-term solutions) and CL table and now also corrects the source table Q and U values.

RLDIF assumes that the right minus left phase difference is constant with time. At high precision, this is often not the case. A new task RLCAL was written to compare visibility data with models of Q and U to determine and correct this phase difference as a function of time. It should be possible to feed this back into the original data set to improve the polarization and RLDIF solutions and therefore the new set of images.

Dynamic scheduling of observations means that the user cannot count on having observations of the best polarization calibration sources in every data set. Two new tasks were written to assist the user desperately trying to calibrate the data anyway. QUOUT prepares a text file of Q and U for a calibration source from another, well-calibrated data set or from a Q/U image cube. RLDIF can read this file to allow this previously unknown calibration source to be used. The new task QUFIX assumes that the user has a well-calibrated Q/U image cube from one day and a second Q/U image cube from a day lacking the polarization angle calibrator. Comparing the position angles over areas in the two cubes at each spectral channel, the task determines and applies the right-minus left correction.

OBIT in *AIPS*

The software package known as OBIT, written by Bill Cotton, offers capabilities not available elsewhere. Two stand-alone procedures have been available to translate data from the Science Data Model/Binary Data Format file tree into *AIPS* for those users who have OBIT available. These question-and-answer scripts, with requirements on the users' setup, have been replaced with AIPS verbs. The adverb values are prepared in the usual way inside AIPS and the functions invoked by entering the verb names BDFLIST and BDF2AIPS. They invoke OBIT programs and leave log files in the user's home area. The DOWAIT adverb is very useful here, causing AIPS to display the output from the OBIT programs as it occurs and returning control of the AIPS window to the user only when the process has finished.

EVLA SysPower table

The units of the EVLA SysPower table were examined and changed on February 24. They were a Psum and Pdif *divided* by a "gain" normally recorded as having value 512. In fact, this was a fiction with the real gain involving other factors as well. Beginning February 24, the Psum and Pdif are the true values *times* a gain (as advertised) and the true gain is recorded. TYAPL was changed to use the new scaling for observations beginning February 24 and to use the former scaling for older data. TYAPL was also changed to offer the option of scaling the visibilities but leaving the weights untouched. In computing weights, it now uses the INTTIM random parameter when available as the integration time and ignores the incoming data weights.

Those incoming data weights can include channel averaging, which TYAPL already includes from the channel width in the header, causing the resulting weights to be in error if the incoming weights are used. SPLAT was corrected to insure that the INTTIM values would be correct.

TYSMO, which prepares SY tables for TYAPL, now uses Tsys rather than Tsys/Tcal for clipping and applies a flag table optionally to the SY and TY data as they are read. Blanking of all parameters in the SY table when any one is bad is now handled properly.

Two new tasks were written to allow manipulation of SY tables. SYCOP averages SY table values from "good" IFs and replaces the values in "bad" IFs with them. RFI can cause bad SY values in heavily affected frequency ranges. For experimentation purposes, SY2TY was written to translate SY tables into TY tables for use by tasks that only understand the latter.

Miscellaneous EVLA-driven matters

DOOSRO is a new RUN file which enables a pipeline to reduce EVLA data taken in forms not too much larger than the old VLA.

REWAY now has the option to use the INTTIM random parameter rather than the incoming weights or 1.0. The output weights do not seem to change much with this option.

NOIFS had a significant error in scaling the *uvw*'s causing a scale change in the images corresponding to half of an IF bandwidth.

SOUSP can update the fluxes in the SU table with the fit spectral-index curve under control of a DOCONFRM option.

UVFLG now has QUAL and CALCODE to modify the sources it uses. Assumptions about how to recognize missing antennas were corrected.

UVFND now has adverbs QUAL, CALCODE, ANTENNAS, and BASELINE to modify which data are examined.

VLANT does work for EVLA data as well as VLA data, using different tables and coordinate conventions. The help file used to discourage EVLA users.

More general *uv*-data matters

CALIB was given a NORMALIZ adverb to control how the amplitude gains are normalized. Choices are a global normalization or separate normalizations over subarray, over subarray and IF, or over subarray, IF, and polarization. The average gain modulus can be either the mean of the median. CALIB was changed to make output data sets consistent with AIPS structures even when the input files are not entirely normal. It was also given DOAPPLY to control whether the SN table is applied to the data to write out a single-source calibrated data set. The counting of failed solutions was upgraded to separate all polarizations, IFs, and antennas with no data from those that failed for other, more interesting, reasons.

Many more simultaneous flags can now be handled. The normal limit was raised from 6000 to 30000 and the special UVCOP limit was raised from 120000 to 200000.

Stokes selection was not taken into account in copying tables. If a task selected only LL polarization, the RR values from the CL and SN tables would have been applied to it. All table copying now takes the Stokes selection into account.

FRING did not test for failure to get all the pseudo-array memory it needs and so wandered into the weeds in some large cases. The exhaustive search method had an error which caused the answers to be correct only for the first IF.

Index tables are automatically created and filled by many tasks as they copy *uv* data. The method was changed to use the index table of the input file as a guide for the scan break times for the output file. This lets the initial scan structure (if known as with BDF2AIPS) to be preserved. An error when dealing with multiple subarrays was corrected.

FLAGR can do robust rather than simple averaging on the spectra which will alter what is flagged. A combination of `RFLAG` and `FLAGR` should be very powerful.

REWGT is a new task to scale data weights with factors depending on subarray or IF.

TIORD now tests for baseline numbering order as well as time order.

DBCON now appends `SY` tables and will append all versions of tables found in the inputs to corresponding versions in the output. `CALCODE` is now used to distinguish sources. An index table is made, but it ignores those in the input files.

OOP tasks processing *uv* data could write things to the wrong files if there was a file of the same output name on the disk with a higher sequence number than that of the current output.

3C138 model for X-band had a position error of 0.25 arc seconds.

Multi source files are those with a `SOURCE` random parameter. Tasks that confused the presence of a source table as a sure indicator of a multi-source file were corrected.

APCAL now allows the `ANTENNAS` adverb to convey a list of antennas to be omitted in the usual way. Previous usage allowed only one omitted antenna and was very non-standard.

SPLAT was corrected to use all 16 characters of the source names and to support source de-selection properly in the SOURCES adverb.

UVCOP was changed to apply flags to copied `SY` tables (it already did `TY` and `SN`) and corrected to use all characters of the source name. You now have to tell *not* to flag tables should you desire that action.

SETJY will now issue messages when the current standard calibrator flux differs by more than 3% from the previous standards. Spectral index is reported more clearly in both the messages and the history file.

PRTUV uses the index table when possible to speed up finding the beginning of the desired data.

Imaging

AIPS imaging task `IMAGR` received only a little attentions in the last six months. The formula for `FACTOR` used with multi-scale imaging was changed to a more stable one. When doing baseline-length time averaging on the fly, `IMAGR` had an error addressing multiple spectral channels in a bandwidth synthesis. In order to speed the search for the next facet, `IMAGR` actually images multiple facets each time with the number controlled by the size of the work file and limited by user parameter `IMAGRPRM(18)`. This has been found to slow the task down after reaching the stage in which all facets are similar in their peak values. Therefore, `IMAGR` was changed to reduce the number of simultaneously imaged facets as the Clean progresses, but to raise that number again if it encounters difficulties in finding the next facet to Clean.

The OBIT software system written and maintained by Bill Cotton at NRAO in Charlottesville contains a variety of interesting programs besides the SDM/BDF reading tasks mentioned above. Perhaps of greatest interest is the program `Imager` which images a full field of view with options for outlying sources, multi-scale Clean, self-calibration, and even peeling. In addition to a variety of algorithmic enhancements, `Imager` can run with multiple threads allowing significant performance advantages over *AIPS*' single-thread programs. `AIPS` now offers four verbs `OBITMAP`, `OBITIMAG`, `OBITSCAL`, and `OBITPEEL` which expose increasingly complicated interfaces to `Imager`. All of them prepare a "run" file in the user's `$HOME` area and then order `ObitTalk` to execute the run file, writing a log file in the `$HOME` area. If `DOWAIT=2`, `AIPS` will wait for `Imager` to finish and then display the messages under control of `DOCRT`. With `DOWAIT = 1`, which is recommended, `AIPS` will display the log file messages as they are generated and resume when `Imager` is finished. Note that this is a powerful and complex program and is not maintained by the *AIPS* Group. It requires that the OBIT package be installed and maintained at your site. This should not be difficult.

Display

HUEWEDGE is a new verb to display a wedge in two dimensions suitable for accompanying a hue-intensity display (such as total hydrogen controls intensity and velocity controls color). The double wedge can be labeled in both axes.

PRTAB was given an option to limit the display to those rows that match (or not match) a specified value in a specified column.

POSSM was changed to use the correct frequencies when applying shifts to the visibilities, to determine the desired Stokes before setting pointers for plotting auto-correlations, to select the desired Stokes for tables and plot all valid data even if one of the Stokes is fully blanked. `FACTOR` got an additional meaning suppress connecting lines when > 100.

OFMGET was changed to allow it to get only one of the colors of an OFM, rather than all three.

LWPLA used an incorrect `'LG'` transfer function; the correct one is much better and matches that used elsewhere.

TVROAM was enhanced to initialize the look-up-tables of all channels to match those of a specified channel and to allow modification of all LUTs during roaming (on button `A`).

SNPLT was changed to read the table to be plotted in order to determine how many records are used for each antenna. It then allocates enough memory dynamically to plot even the largest `SY` tables. A `DOSCAN` option was added to plot marks at scan boundaries as defined by the index table.

FRPLT was changed to allow more times, to determine sensible defaults for start and stop times, to initialize all line drawings to avoid plotting from a non-data point, to handle missing data sensibly rather than over-plotting, to label x axes correctly when plotting more than one IF and/or polarization, to do time binning carefully rather than assuming exact times, to use `FACTOR` to control the plotting of symbols and/or connecting lines, and to display antenna numbers as well as names on each plot panel.

Image analysis

FARS

`FARS` is an experimental task written by Leonia Kogan to perform "Faraday rotation synthesis" on a group of Q and U polarization images taken over a range of frequencies. It performs a Fourier transform at each spatial coordinate of the set of λ^2. It can then do a one-dimensional Clean along this axis. The final output is a cube over rotation measure and two spatial axes of the real part and a second cube of the imaginary part of this operation. A variety of minor improvements were made to `FARS` over the last six months, allowing full Cleaned output, supporting `BLC/TRC` properly, computing frequencies from the `FQ` table or header as appropriate, and so on.

To simplify this operation, a new task `AFARS` was written. It writes out an image at each spatial coordinate of the rotation measure at which the maximum amplitude occurs. It also writes an image of that maximum amplitude or of the phase at that position.

Further simplification is provided by a new `RUN` file `DOFARS`. This procedure runs `RSPEC` (see below), transposes both Q and U cubes with `TRANS`, runs `FARS`, and then transposes the output cubes, leaving both zxy and xyz cubes behind.

Other analysis changes

RSPEC was changed to offer the option to output a signal-to-noise image rather than plotting/writing the spectrum of noise. To support `FARS`, the option to write a text file of normalized weights as a function of channel was added.

IMFIT, `JMFIT` and `SAD` were changed to use the actual Clean beam for the particular channel and to display results in Jy/headerbeam and Jy/actualbeam.

IM2CC is a new task to convert a model image (Jy/pixel) over a wide area into multiple facets with Clean component files. This should make it easier to use models generated with other software systems in *AIPS* tasks such as `CALIB`.

General

RMS computations are found generally to be quite demanding and `DOUBLE PRECISION` is now used in all such computations within *AIPS*.

CookBook chapter 4 was updated to reflect the revisions in `TVFLG`. Appendix E changed to describe `PCAL` and `RLDIF` more correctly, to describe the use of Tsys in `SY` tables, and the flagging of tables in `SNEDT` and `TYSMO`.

USERNO is a re-created program to process user number lists into an interesting format for printing.

ZMI2.C file size error messages needed additional format control for 64-bit computers.

Patch Distribution for `31DEC10`

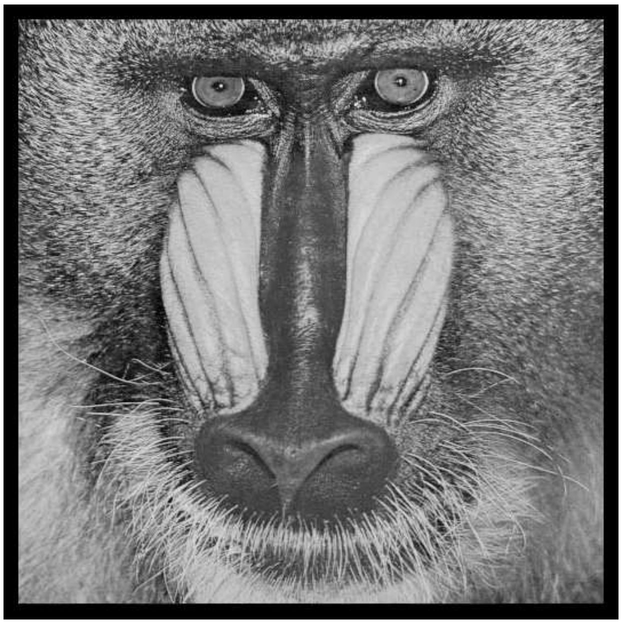
Important bug fixes and selected improvements in `31DEC10` can be downloaded via the Web beginning at:

`http://www.aoc.nrao.edu/aips/patch.html`

Alternatively one can use *anonymous* `ftp` to the NRAO server `ftp.aoc.nrao.edu`. Documentation about patches to a release is placed on this site at `pub/software/aips/`*release-name* and the code is placed in suitable sub-directories below this. As bugs in `31DEC11` are found, they are simply corrected since `31DEC11` remains under development. Corrections and additions are made with a midnight job rather than with manual patches. Since we now have many binary installations, the patch system has changed. We now actually patch the master version of `31DEC10`, which means that a MNJ run on `31DEC10` after the patch will fetch the corrected code and/or binaries rather than failing. Also, installations of `31DEC10` after the patch date will contain the corrected code.

The `31DEC10` release has had a number of important patches:

1. `UVCOP` used only 12 of the 16 characters of the `SOURCE` adverbs. *2011-01-18*
2. `DBCON` was vulnerable to errors in table headers causing absurd disk file size expansions. *2011-01-18*
3. `FRING` got wrong answers from the exhaustive search method for IFS higher than 1. *2011-01-21*
4. OOP-based *uv* tasks could write to the wrong output file. *2011-01-21*
5. `CALIB` failed to build the output header correctly for non-standard single-source data sets. *2011-01-24*
6. `RLDIF` did not handle one source, continuum corrections properly. *2011-01-24*
7. `SWAPR` ignore autocorrelation data. *2011-01-24*
8. `SNPLT` did not handle PC table phases correctly. *2011-03-23*
9. `IMAGR` did not average multi-channel data correctly when doing on-the-fly baseline-length time averaging. *2011-04-15*
10. `NX` tables were written incorrectly when there were multiple subarrays. *2011-04-25*
11. `IMEAN` did not write the text file output correctly. *2011-06-08*
12. `NOIFS` did not scale the UVW's correctly *2011-06-14*
13. `CVEL` did not die on fatal errors such as missing bandpasses *2011-06-23*
14. `FITLD` and friends did not read table header character-valued keywords correctly *2011-06-24*



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