AIPSLETTER

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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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Happy 35th birthday *AIPS*

AIPSLetter publication

We have discontinued 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. New issues will be announced in the NRAO eNews 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 `31DEC13` while `31DEC14` 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 `31DEC14`. Having fetched `31DEC14`, 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. Use a copy of the task and its help file in a private disk area instead.

Improvements of interest in 31DEC14

We expect to continue publishing the $\mathcal{AIPSL}etter$ approximately every six months, but the publication is now primarily electronic. There have been several significant changes in 31DEC14 in the last six months. Some of these were in the nature of bug fixes which were applied to 31DEC13 before and after it was frozen. If you are running 31DEC13, be sure that it is up to date; pay attention to the patches and run a MNJ any time a patch relevant to you appears. New tasks in 31DEC14 include BPWAY to determine spectral channel-dependent uv data weights, DBAPP to append multiple uv data sets at once, CENTR to change the frequency reference pixel to the center of the spectrum, HUINT to adjust hue-intensity images interactively and then save the result as image files, and MODSP to compute model images of spectral lines. A set of RUN files, under the general name TDEPEND, was created to assist with imaging a time-dependent source. The cube model-fitting tasks XGAUS, RMFIT, and ZEMAN were given significant attention and a new $\mathcal{AIPS}$ Memo was written to document their usage.

Coming attractions include a completely overhauled VLB data-reduction pipeline. Amy Mioduszewski has re-written the RUN file VLBAPIPE, re-naming it VLBARUN, and is now giving it final testing.

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. You are encouraged to use a relatively recent version of $\mathcal{AIPS}$, whilst those with EVLA data to reduce should get release 31DEC13 or, preferably, the latest release.

UV-data

BPWAY is a new task to determine relative weights for spectral channels based on an RFLAG-like rms computation (over time). It can do weight spectra averaged over one scan or over one source at a time.

DBAPP is a new task to append one or more similar uv data sets. It is not as capable as DBCON but can do multiple data sets at once.

CENTR is a new task to change the frequency reference pixel to the actual center channel of each spectrum.

FQCENTER is a new adverb in numerous tasks to change the frequency reference channel to the center of each band ($N_{\rm chan} + 1$). This requires re-scaling all (u, v, w) values and correcting values in both the FQ and SU tables.

RLDLY was changed to average over all possible reference antennas when REFANT = 0.

PCAL was corrected for an error affecting data sets with axes in non-standard order. It was changed to handle no data found situations with more grace and to make use of previous solutions an option rather than a requirement.

DOPOL applying the orientation-ellipticity mode of PCAL was made to function properly. Unfortunately, the solutions from PCAL are not as good as they should be.

BPASS was corrected to use no spectral index when multiple sources have been averaged together (SOLINT=-1 with multiple sources) but to apply a correction when only one source was averaged.

DOBAND modes 2 and 4 apply the nearest-neighbor bandpass solution to the data. The correction arrays were not initialized correctly at the beginning and after any long breaks in the data.

REWAY was corrected to handle very short scans without dying and to write out data records only when they contain some valid data.

CLIP was given new options to flag parallel-hand polarizations when cross-hand polarizations are clipped and to flag all polarizations when any one polarization is clipped.

SPLAT was changed to "tidy up" the calibration table as well as the source table. Otherwise, the `CL` table could contain sources no longer in the `SU` table. The output frequency, when averaging spectral windows with `BIF` > 1, was corrected. The task was also changed to defend itself from bad input values when doing spectral averaging.

UVFND was given the `DOSCALE` option to normalize the amplitudes by the fluxes in the source table, including optionally the spectral index. Channel averaging was corrected.

CLCAL was corrected for a bug which caused re-referencing of phases to fail and for a bug in time smoothing affecting very short scans.

SETJY was corrected for bugs in the velocity computations in `OPTYPE = ' '` and `'SPEC'` modes.

SNP2D was tested to calibrate wide-band phase using a single spectral line. Converting input `SN` table phases into both a delay and an IF-dependent phase appears to provide an excellent adjustment after the standard calibrations have been applied.

SPECR was given the option to use simple interpolation methods rather than the FFT method, but the FFT is still recommended in most cases.

RLCAL was corrected to do time averaging properly, to stop dividing Q and U models by the I polarization flux, and to pay attention to all adverbs before dividing by a model.

TI2HA and `HA2TI` were given the `REFANT` option to control the antenna to which the hour angle refers. Previously it was the lower numbered antenna in each pair which made for confusion in sort order.

FITLD was changed to save the data file when an error occurs in reading "trailing" records in the FITS file. Problems finding the desired records in the `MC` and `IM` table were also fixed.

APCAL was given the option of looping over all subarrays. It was changed to handle flagged table records without getting upset, to understand that subarray 0 means all, and to handle duplicate records in `GC` tables properly.

PCCOR was changed to handle magic blank values in the input tables properly.

SNSMO was corrected in numerous ways to handle rates properly in Hz at the correct IF frequency, rather than handling them rather casually in the basic units (sec/sec).

Display

A new task `HUINT` has been written. Its goal is to do the same display as the `TVHUEINT` verb, but then to save the image as displayed in rather arbitrary units and, optionally, to save an image of the hue-intensity step wedge as well. The results may then be plotted in tasks such as `KNTR` with the full flexibility allowed by `LWPLA` and its PostScript output. The task `TVHUI` attempts to write out the image with real image units, suitably scaled, and is caught up in the now obsolete need to replicate true color in a non-true color environment. The results from the new task appear more pleasing than those from this older one. Until now, if one wanted to capture a `TVHUEINT` display, one had to use a screen capture tool (such as `import`) and could not modify anything about the plot afterwards.

BLSUM now offers the option of weighting the spectral sums with the values of the blotch image. This should be good for recombination lines with total intensity as the blotch. The task also now offers the option of making real plot files instead of printer plots.

SNPLT now offers the option of plotting amplitude gains as $1/g(t)^2$ called `POWR` and $-20\log(g)$ as `PODB` to display the antenna-based power. Several aspects of rate plotting were changed to use correct frequencies in scaling from sec/sec to mHz.

POSSM was given improved labeling for parallel- versus cross-hand and auto- versus cross-correlations.

VPLOT now allows all x-axis types when plotting amplitude and phase in the same plot.

PRTAB was changed to use enough digits when an exponential format had to be used in a floating-format display. It also now handles extra long character strings appropriately.

LISTR was corrected to use `FACTOR` properly in phase, elevation, and parallactic angle displays. Additional information on `FACTOR` was added to the help file — it can be confusing. Some display overflows were previously not shown as such.

CURVALUE was given adverbs to control which graphics plane is used for its display and which memory plane is used for the image data to be displayed.

Slice labeling was corrected for a variety of issues including special code for when the slice is along an axis and code to encourage the use of the full display area.

Coordinate labeling was adjusted to be more flexible in dealing with the new, all-sky types of coordinates.

Imaging

`IMAGR` was given several new options. If `OBOXFILE` is set simply to an environment variable, *e.g.*, `MYAREA:`, then an output box file named in a unique way will be written to that directory. Adverb `LTYPE` specifies the type of labeling to be added to any image display on the TV. These displays can also plot "stars" which are specified by up to 100 `S` cards in the `BOXFILE`. More important, perhaps, was the addition of the concept of "UNClean" boxes, namely rectangular or circular areas within which no Clean components are allowed (at least in the facet for which the UNClean box has been specified). This concept has been used profitably in the `OBIT` package to add special facets with bright sources carefully centered upon a pixel. Users may use the concept this way, but its introduction to *AIPS* was required for the time-dependent imaging procedures described next. UNClean boxes are supported interactively in the image display if at least one was specified in the input `BOXFILE`.

A general help file and a `RUN` file, both called `TDEPEND`, have been written to suggest a sequence to image a source which varies during the course of a synthesis observation. In general, the assumption is that one has a variable source (*i.e.*, a star) in the midst of a larger field containing other sources which do not vary. Each time interval is imaged with a number of facets including a special facet just for the star and an UNClean box around the star in any other facet in which it occurs. `UVSUB` is then used to remove the star from the *uv* data of the time interval and all intervals of star-free data are concatenated. The combined data are then used to image the full field including self-cal and editing as needed. The process may then be iterated to make better images of the star in each interval, a *uv* file more free of the star, and then further imaging of the full field. Eventually, the final calibration and flag tables may be applied to the star-only data in intervals and time-dependent images made. `TDEPEND` has not been used "in anger" as yet, so your editor is very interested in any experiences you may have with this.

Image analysis

`XGAUS`, `RMFIT`, `ZEMAN`, modeling

The analysis of image cubes in polarization, spectral line, and Zeeman splitting received considerable attention in the last six months. There is a new *AIPS* Memo number 118 to describe the use of the presently available tasks. The abstract for this Memo appears later in this *AIPSLetter*. A new image modeling task `MODSP` was written. It can add models to existing image cubes (I and V or RR and LL) or create new ones. Each model object is a spectral line with specified frequency and spatial structure and separate RR and LL fluxes.

The three cube fitting tasks received several improvements in common. All three will now display, in the "edit" phase, small images expanded by pixel replication. This means that `TVZOOM`, which affects the menus as well as the image, is far less necessary. All three tasks now offer the option of using TV menus in the fitting stages, rather than communicating extensively in the terminal window. All three also use the adverb

RMSLIMIT to specify when a fit has failed, changing the task from automatic fitting back into interactive modes.

XGAUS and RMFIT now indicate a component which is not to be fit by an X off the left side of the spectrum plot. They both are prepared to fit larger menus and titles when there are a large number of components and/or the character size is increased (via CHARMULT). They both offer a DO FIT menu option after the user has entered a guess by the HAND option, treating the user's guess not as the answer but just an initial guess to be refined if possible. XGAUS even allows the user to specify that certain parameters are to be held fixed during the fit that immediately follows the HAND entry.

XGAUS was corrected to require that the *average* of three consecutive spectral points be above the cutoff for fitting. This is what is expected by ZEMAN and it is important that both tasks do the same thing. XGAUS was given another scheme to make its initial guesses which turns out to be successful in many cases. It also had bugs preventing the writing out of the residual image. The plot of the initial guess in ZEMAN was changed to be at the data points, rather than on a fine and regular grid. The latter made the plot look like a step function for no good reason.

RMFIT was changed to fit for a rotation measure "thickness" using any one of three models for the thickness (slab, Gaussian, exponential). Such thickness accounts for much of the loss of polarization brightness at low frequencies. MODIM was changed to be able to model such thicknesses.

Other analysis changes

FARS did not do the convolution by the restoring function properly, making the answers from Cleaning incorrect. This was fixed while simplifying the code for legibility and performance.

IMFIT, JMFIT, and MAXFIT again had trouble with negatives. The tasks ran into problems fitting baselines in regions less than zero and failed to report all the values they found. MAXFIT was given the adverb DOINVERS to allow it to fit a maximum or a minimum and was corrected to do these in regions of negative brightness.

DSKEW had a bug affecting the correction of images with any apparent rotation, especially those with a large rotation angle.

AIPS Memo 117 was changed to describe the meaning of the (x, y) coordinates in the Clean Components file correctly.

General

TGET file has changed format to include the adverb names and their types and lengths. This allows TGET and VGET to remark on changes in the INPUTS since the corresponding TPUT (or GO) and VPUT and to avoid messing up adverb values following the changes. The old format TGET files will still be used if the task or verb is not found in the new format file. TGINDEX will list the contents of both format files, listing only the most recent occurrence of each task.

DISKU was changed to have the DOALL adverb control the smallest size catalog entry to be listed in detail and the format of that listing was made much more useful. This enables users to find their largest data files when it becomes time to clear some disk space.

CookBook was brought up to date in April and later converted to use Palatino fonts rather than Computer Modern fonts. This *AIPSLetter* also uses these more elegant fonts. Appendix L on reducing EVLA low frequency data was contributed by Minnie Mao.

On-line help information in interactive tasks involving menus is provided by special help files, *e.g.*, HLPXGAUS. The parsing of these files was changed to allow certain string substitutions for increased clarity, namely "<n>" has the current value of n substituted.

Maximum image size was increased to 131072 to match the maximum number of spectral channels. FFTs of this size are then supported, but will be expensive. Square arrays of this size are too large for Fortran compilers by a factor of more than 32.

Patch Distribution for 31DEC13

Important bug fixes and selected improvements in 31DEC13 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 31DEC14 are found, they are simply corrected since 31DEC14 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 31DEC13, which means that a MNJ run on 31DEC13 after the patch will fetch the corrected code and/or binaries rather than failing. Also, installations of 31DEC13 after the patch date will contain the corrected code.

The 31DEC13 release has had a number of important patches:

1. BPASS failed to apply a spectral index correction when SOLINT=-1 even when there was only one calibration source. *2014-01-14*
2. LISTR failed to read source information while printing "gains". *2014-01-14*
3. DOOSRO run file had a typo in its first line. *2014-01-27*
4. UVFND in averaging channels used the real part as both the real and imaginary parts. *2014-02-07*
5. DOBAND modes 2 and 4 had an initialization problem. *2014-02-09*
6. DOOSRO had a POPS language error *2014-02-10*
7. KNTR and PCNTR had minor issues which blocked display of true-color images. *2014-02-11*
8. PCCOR did not handle blanked values from the PC table cable-cal measurements *2014-02-11*
9. FITLD had trouble finding the correct records for MC and IM tables. *2014-03-11*
10. DSKEW did bad things when the input image had a non-zero value of rotation. *2014-03-17*
11. CLCAL failed to re-reference the SN tables when requested. *2014-03-19*
12. SNP2D needed clarification of BCHAN and BIF and to write reference channel phases as well as delays. *2014-03-27*
13. TIORD had a bad format. *2014-02-31*
14. XGAUS and RMFIT called the function routine incorrectly numerous times, mostly with remarkably benign results. *2014-04-02*
15. PRTAB could abort when string data were very long. *2014-04-02*
16. LISTR did not show the correct scaling for angles in the GAIN listing. *2014-04-11*
17. TVFLG and SPFLG interpreted flagged rows in the flag command table as a serious error in a couple of places. *2014-05-29*
18. DTSUM omitted the highest numbered antenna from its matrix list if it did not have autocorrelation records. *2014-06-13*
19. CALIB in phase-only solutions could return amplitude gains other than 1.0 when only 2 baselines occurred in an interval. *2014-06-27*

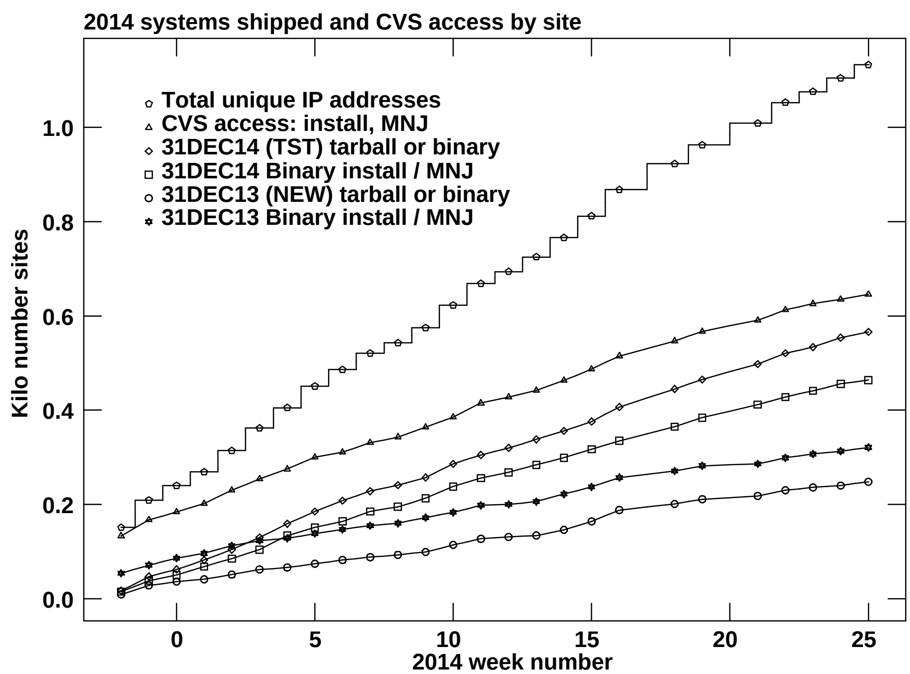
Recent *AIPS* Memoranda

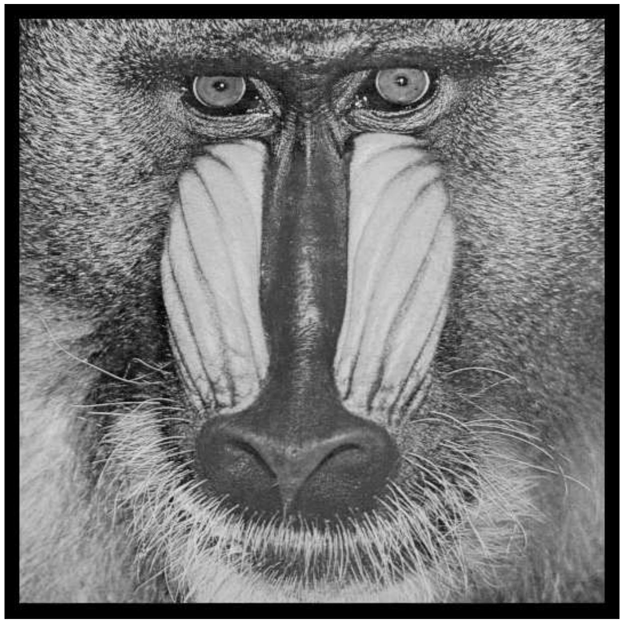
All *AIPS* Memoranda are available from the *AIPS* home page. *AIPS* Memo 117 describing *AIPS*' usage of the FITS format was modified slightly in the first part of 2014.

118 **Modeling Spectral Cubes in *AIPS***
Eric W. Greisen, NRAO
June 19, 2014
AIPS has done Gaussian fitting along the x-axis of image cubes with task `XGAUS` since the 1980s. That task has recently been overhauled to be much easier to use and much more capable. In like fashion, new tasks `ZEMAN` and `RMFIT` have been developed. The former fits the standard leakage and scaling terms for Stokes V cubes, including a new option to do this for each of the Gaussians found by `XGAUS`. The latter fits polarization models to Stokes Q and U cubes, using the output of Faraday Rotation Measure Synthesis (*AIPS* task `FARS`) to assist with initial guesses. The models can contain multiple components each with a polarization flux, angle, rotation measure, and rotation measure "thickness." The present memo will describe the functions of these tasks in some detail with numerous graphical examples. This memo also discusses a number of tasks which make visibility and image model files.

AIPS Distribution

We are now able to log apparent MNJ accesses and downloads of the tar balls. We count these by unique IP address. Since some systems assign the same computer different IP addresses at different times, this will be a bit of an over-estimate of actual sites/computers. However, a single IP address is often used to provide *AIPS* to a number of computers, so these numbers are probably an under-estimate of the number of computers running current versions of *AIPS*. In 2014, there have been a total of 646 IP addresses so far that have accessed the NRAO cvs master. Each of these has at least installed *AIPS* and 257 appear to have run the MNJ on `31DEC14` at least occasionally. During 2014 more than 248 IP addresses have downloaded the frozen form of `31DEC13`, while more than 566 IP addresses have downloaded `31DEC14`. The binary version was accessed for installation or MNJs by 321 sites in `31DEC13` and 464 sites in `31DEC14`. A total of 1105 different IP addresses have appeared in one of our transaction log files. Some of these numbers are a bit higher than those of 2013 at a comparable date, while the `cvs` number is curiously low.





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