

A I P S L E T T E R

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A newsletter for users of the NRAO
Astronomical Image Processing System

Written by a cast of *AIPS*

Edited by

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General developments in *AIPS*

Reduction of JVLA and ALMA data in *AIPS*

This *AIPS Letter* and those from 2010 through 2012 contain numerous improvements to *AIPS* that enable full calibration of modern VLA data and most imaging operations as well. The one exception is the wide-band (bandwidth synthesis) deconvolution algorithm (“MSMFS”) being developed in *CASA* by Urvashi Rao Venkata, for which there is no comparable function in *AIPS*. Calibrated *uv* data may be ported from *AIPS* in “UVFITS” format for use in that program. ALMA data may also be reduced in *AIPS*, although the package is not fully qualified to calibrate data from linearly-polarized feeds. See Appendix E of the *AIPS* Cookbook, available via the *AIPS* web site, for details.

AIPS Letter publication

We have discontinued paper copies of the *AIPS Letter* other than for libraries and NRAO staff. The *AIPS Letter* will be available in PostScript and pdf forms as always from the web site listed above. It 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 31DEC12 while 31DEC13 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 *AIPS Letter* is intended to advise you of improvements to date in 31DEC13. Having fetched 31DEC13, 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.

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Improvements of interest in 31DEC13

We expect to continue publishing the *AIPS Letter* approximately every six months. Henceforth, this publication will be primarily electronic. There have been several significant changes in 31DEC13 in the last six months. Some of these were in the nature of bug fixes which were applied to 31DEC12 before and after it was frozen. If you are running 31DEC12, 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 31DEC13 include RMFIT to fit polarization models to Q/U cubes interactively, DSKEW to remove coordinate skew from input (usually optical) images, FTFLG to edit *uv* data interactively in a frequency-time display with all baselines averaged, CLVLB to apply calibration to correct VLBI data for phase-stopping positions away from the pointing position, VLAMP to determine system temperature calibration for the phased VLA in VLBI observations, and PCVEL to include planetary velocities when correcting *uv* data spectra to be centered on a line at the source. The interactive Gaussian-fitting task XGAUS was overhauled to become a much more usable tool to fit large spectral cubes. The handling of more global coordinate types was expanded and brought up to more modern standards to handle images, primarily optical, now being brought into *AIPS*. A fifth name group (IN5NAME, *et al.*) was added with new verbs GET5NAME, M5CAT, U5CAT, IM5HEAD, and Q5HEADER to support it.

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 *AIPS*, whilst those with VLA data to reduce should get the latest release.

UV-data

Calibration application

Calibration application subroutines, shared by all tasks with DOCAL as an adverb, were found to have numerous difficulties. Simple corrections included making various in-memory calibration arrays be structured to include auto-correlations as well as cross-correlations. Prior to that, DOCAL on data which included auto-correlations would fail miserably. Then it was found that bandpass calibration was done only for channels BCHAN through ECHAN even when more channels would be needed to do frequency smoothing after the bandpass was applied (SMOOTH(1) > 4).

The CL table is supposed to have records at the very start and end of each scan for each subarray as well as at regular intervals in between. If this is in fact the case, then the two CL table records to be applied to any datum are easily found and unambiguously correct for the source observed at that time. However, CL tables can lose correspondence with the data file in a variety of ways. The most damaging is through the task CLCAL which can create a new CL table omitting sources, times, antennas, and more. The intention of this omission is to build up a new CL table piece-by-piece with different inputs until a new and complete table results. That often fails however. To reduce the frequency of this failure, the default OPCODE in CLCAL was made 'CALP' which passes all CL table information including that which is not selected for change in the current execution.

The CL table contains corrections that are specific to the source for which the record is intended. These include amplitude corrections for antenna elevation gain dependence and atmospheric opacity and phase corrections for antenna and source location, for clock errors, for affects due to the atmosphere and ionosphere,

and more. It is therefore an error to use a CL table record from one source for data from another source. Unfortunately, when the CL table was not in pristine condition, the software quite happily did this. It was changed to use only records for the current source, a change that exposed numerous inadequacies in the way the required CL data records are found. It is believed that these have now been found and corrected. However, pathological CL tables may still cause difficulties. Be sure to run the midnight job on 31DEC13 regularly — or whenever you encounter difficulties applying calibration.

INDXR was corrected for two ways in which it was able to write more than one CL table record for each antenna at indistinguishable times. Scans consisting of a single record would trigger this as would scans microscopically longer than an integer times the CL table interval.

Polarization calibration also had its issues. Oddly, PCAL had at least 5 separate declarations of the maximum number of calibration sources, with three quite different values. They all now agree on one upper limit (50). DOPOL true with a spectral-channel dependent solution using a polarization model other than the default ('APPR') would run without complaint, but produce nothing but zero for output. The bottom-level routines for these polarization models were all prepared to work correctly for spectral solutions, but a higher level routine refused to call them except for non-spectral solutions. That has been fixed and tested.

VLA Calibration

SETJY has received a variety of significant modifications. It was changed to ignore some of the adverbs on some of the OPTYPEs. Previously, unintended changes could suddenly appear in the source table. A new collection of primary calibration source fluxes was added which includes time dependence for sources 3C48, 3C138, and 3C147. An additional model of source fluxes at low frequencies, due to Anna Scaife and George Heald, was also added. It is the default for data taken at frequencies < 500 MHz. BPASS was also changed to use the new, time-dependent spectral indices for the primary calibration sources.

S-band models at 2141, 2663, 3047, 3463, and 3847 MHz for 3C48, 3C138, 3C147, 3C196, 3C286, and 3C295 were made available. The 3463 MHz ones were made the default S-band ones. Note that these images are based on one A-array data set only and we expect to improve on these models at a later time.

TYAPL was corrected to examine the validity only of the parameters it needs to use. Previously, it would flag post-gain calibrations when the values of Pdif and/or Psum appeared bad. It was given the option to review all the SY data to decide which antennas, polarizations, and IFs have an excessive amount of obviously bad calibration values. With this option, the “bad” correlations are passed through without application of the SY data while those data are applied to all other correlations. CALIB should be able to correct for the omitted SY calibration and it certainly beats deleting the affected data.

SYCOP is used to correct IFs that have bad values in the SY table due to RFI and the like. It was given additional OPTYPEs to control which data are averaged and which replaced.

VLBI Calibration

FRING was changed to run much faster in some cases. The useless division by source fluxes from the SU was dropped. Model division must be done in some cases, but a simple division by flux has no affect on the task other than to waste time. When FRING is told to determine no rates (DPARM(9) > 1) and to use no solution sub-intervals (SOLSUB = 0), the data are now averaged on the fly rather than after reading them all separately into memory. This saves a lot of memory in many cases and saves compute time. FRING was corrected to flag multi-band delay when it solves for it, but finds too low a S/N and blanks the individual IF solutions. The routine at the start of FRING that examines the data to find an integration time was improved to return errors and appropriate messages when no data are found or other basic dataset errors arise.

The new task VLAMP was written to use the VLA SY table to write an ANTAB file for the phased VLA. It sums up the system temperatures of the antennas suitably weighted by calibration amplitudes from the CL table to provide the amplitude calibration needed for VLBI arrays which include the phased VLA.

The new task CLVLB was written to correct CL-table amplitudes for any difference in antenna pointing and phase-stopping positions. In VLBI observations, which have minuscule fields of view, this can be done in the uv plane, while such corrections must be done in the image plane for interferometers with larger fields

of view. The DiFX software correlator is now capable of using numerous phase stopping positions while correlating a VLBI observation. Data from each of these phase-stopping positions are written to separate data files so that software such as *AIPS* will not be confused by multiple sources observed simultaneously. CLVLB attempts to model beam squint for each antenna as well as changes in the primary beam size above and beyond those which are simply a linear function of frequency. Initial attempts with this task provided encouraging results, but left a good bit to be desired. As a consequence, debug options have been left in to display solutions in selected ways and to choose two different approaches to the handling of the angles involved (the one we believe to be correct and the one that seems to give better answers).

Editing

TVFLG and SPFLG received some useful attention over the past six months. The most important change was the addition of a new, large dynamic-memory method to prepare the work files. The old method of writing the same row of multiple output planes at the same time worked well on older disk systems, but does not perform well with modern disk systems. It is now better to read the input file more times if necessary and to write the output file one plane at a time. With large memory usage, it is often possible to reduce the number of passes through the input data while still writing the grid file one plane at a time. Both tasks now have the DOCENTER option to control the positioning of the data plot with respect to the menu. This often helps reduce or avoid the overlap of the two. Both tasks also needed the X-axis labeling to be corrected for plots that have so many baselines or spectral channels that only every n 'th value can be displayed. SPFLG now also has the option to smooth the data in frequency after the grid file has been filled with interactive control over the degree of smoothing.

FTFLG is a new task based on SPFLG. Like the latter, it displays the data with frequency changing along the horizontal axis and time on the vertical axis. Unlike SPFLG, the data from all baselines are averaged together; only the different Stokes are kept separate. Mostly this task is intended as a quick way to examine the data for wide-spread RFI. It does have most of the display and flagging options of SPFLG, but, of course, flags all baselines in every flag it generates.

SNEDT and EDITA were given the ability to edit based on multi-band delay values recorded in SN and CL tables. Flags generated using multi-band delay, of course, must flag all IFs. RFLAG has a new DOSCALE option which instructs it to find flux scales for each IF and baseline in an attempt to bring them all up to the same scale. When RFLAG is required before CALIB can be run, this option provides a near uniform scaling for the cutoff levels.

Miscellaneous *uv*-data matters

FITLD was changed to honor DIGICOR for all array names rather than just those labeled VLBA. This requires a CQ table in order to apply some of the corrections. Since many files do not have this, FITLD was changed to be forgiving about the lack. Handling of S0 tables was corrected to make a buffer large enough for a significant number of IFs and to fix a bad error message.

TIORD now also checks baseline codes for correctness and has the new PRTLIMIT adverb to limit the number of messages printed for the various types of errors in *uv*-data files that it can detect.

SPLAT now honors OUTNAME even when writing multiple single-source output files. In that mode, OUTSEQ is honored for the first output file and then set to 0 (highest +1) for all others.

UVFIX was given the INVERS adverb to control the version of the CL or F0 table read for Doppler offsets. It now checks that file to see if there are any non-zero values and, if not, skips reading the file further. The reading of these files was improved in numerous ways to improve the extraction of the Doppler values.

PCVEL is a new task that reads a text file providing a sequence of planetary velocities. It adds these, with various options, to the corrections for the Earth's motions to shift the visibility spectra so that a selected channel represents a selected velocity with respect to the planet.

SPECR was corrected to avoid losing the data sort order and to handle the fact that the FQ table had a format change some time ago.

BPASS was corrected to avoid creating apparent overlaps between scans which could cause very short integrations to be used in bandpass solutions.

Display

UVPRT offers the option to display real and imaginary instead of amplitude and phase and the option to apply an additional scaling to the visibilities. It now prints as many channels as will fit on the line and displays the actual frequency of the first channel being displayed.

SNPLT now offers the option to display multiple data types in separate panels at the same time each with its own plot range. Thus one could set `NPLOTS=3` and plot `PDIF`, `PSUM`, and `PSYS` from the `SY` table with one antenna per page. The task now offers azimuth as an optional horizontal axis.

POSSM now offers the option to smooth the plotted data over frequency after the plot has been averaged. This speeds up frequency smoothing a lot, although it will give somewhat different results than doing it one record at a time when the data have lots of channel-dependent flagging. The task was fixed to recognize Stokes “formal I”, to access the calibration data more efficiently, and to handle the upper plot scaling and labeling more correctly.

UVPLT and **WIPER** were given frequency and spectral channel number as additional available axes.

PRTAB was corrected to handle really big numbers in floating-point format and to allow non-integer comparison numbers for integer-valued columns.

Tick mark computation and labeling were corrected for excessive round-offs that led to offsets in the plotted coordinates. Edge issues, especially with difficult coordinate systems (see below), were also addressed.

Imaging

Image coordinates

The IAU FITS Working Group has endorsed a World Coordinate Systems agreement which came along many years after *AIPS* required solutions to the problem¹. Part I of the agreement² is a generalization of the *AIPS* methods which adds the possibility of a skew in the coordinates. While *AIPS* has always allowed a rotation, it still does not support skew generally. However, fits to image coordinates in optical astronomy often find a slight skew which is dutifully recorded by IRAF and other packages in the FITS files which reach *AIPS*. `IMLOD` and `FITLD` report this when they cannot convert the FITS header into something that will be understood fully in *AIPS*. A new task `DSKEW` has now been written to re-grid such images to remove the skew recorded in the `CDi,j` FITS keywords saved by `IMLOD` and `FITLD` in the *AIPS* history file. The new task uses much of the machinery of `OHGEO` with only the coordinate translation portion replaced. As such, it will handle blanked pixels congenially.

AIPS does not and will not handle the full generality of the IAU agreements. That has been considered carefully and found to be an enormous amount of work for little general benefit. Nonetheless, some of the second part of the agreement on celestial coordinates³ appears moderately often in images that *AIPS* users need for comparison with their radio data. *AIPS* has been revised to handle some of the more global coordinate systems in a manner incorporating much of the more commonly used generality. Coordinate systems previously known to *AIPS* (Sanson-Flamsteed previously called global-sinusoidal, Mercator, and Hammer-Aitoff) were revised and new ones (Plate-Caree, Molweide, and Parabolic) were added. The old *AIPS* mathematics worked correctly as long as the latitude reference pixel had a value of zero. The big change arises when the latitude reference value is not zero. In the new agreement, the “native” coordinate system of the projection has by definition reference longitude and latitude equal to zero, but the celestial coordinates become oblique when the reference celestial latitude is not zero. This is illustrated in Figure 1.

¹Greisen, *AIPS* Memos 27 (1983), 46 (1986)

²Greisen & Calabretta, 2002, A&A, 395, 1061

³Calabretta & Greisen, 2002, A&A, 395, 1076

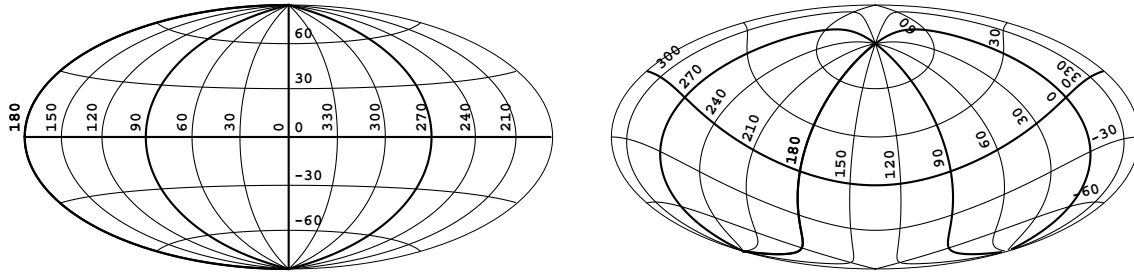


Figure 1: Displays of the celestial sphere in Hammer-Aitoff projection. At left, the reference longitude and latitude are 0, 0 while at right they are 135, 30 degrees.

IMAGR

The main imaging and deconvolution task, **IMAGR** received a number of bug fixes in this half year, with one new option. That option allows the user to specify in the **BOXFILE** ranges of facet numbers to be entirely ignored in the cleaning steps. The expected usage is to ignore the more extended scales in the outer facets, but any facet may be so specified. This specification can be absolute or allow a facet to be turned on interactively after it has been ignored in earlier cycles.

Bug fixes include a slight difference in the formulæ for memory requirements between the “planning” stage and the execution stage which was able to cause the task to shoot itself in the foot. The output header values for pointing (“observed”) position were sometimes set to zero due to zeros from the data acquisition tasks; the phase stopping coordinate is a better guess in that case. If the **BOXFILE** defines a facet more than once, an error is now raised. When **IMAGR** is told to use a specific work file whose contents are not currently good ($\text{ALLOKAY} \leq 1.5$), the task deletes the file and recreates it to insure that its structure fits current needs. If the user has accidentally specified some file in **IN2NAME** *et al.*, this may result in unhappiness when a non-work *uv* data set or image gets deleted. **IMAGR** was changed to try to avoid this, when it can. If the purported work file is in fact an image, a compressed *uv* data set, or a *uv* data set with more than one Stokes value, **IMAGR** will quit with an error condition. Unfortunately, uncompressed *uv* data with one Stokes looks just like an **IMAGR** work file and cannot be protected.

Image analysis

XGAUS and RMFIT

XGAUS was substantially overhauled. In the new version, the task starts by building and initializing a table with the fitting results with one row for each pixel within BLC to TRC. It then begins an interactive session trying to fit the Gaussian model to every **YINC**’th and **ZINC**’th pixel. Initial guesses are based on the previous fit and, for each new row, the left-most fit in the previous row. If things are going well, the user may turn off interactivity to allow the task to find initial guesses and fits by itself. Interactivity will turn back on automatically if a bad answer is found. After this pass through the data, **XGAUS** will then go through the data doing interactive fits at very pixel that has not already been fit. The results of the fitting are stored in the table as soon as they are determined. This means that the user may elect at any time to exit the task and resume the fitting at the next convenient time. The task may also be restarted with a higher number of Gaussians to be fit and/or a lower flux cutoff level for the fitting.

After all pixels above specified cutoff levels have been fit, **XGAUS** goes into a menu-driven “editing” mode. The primary purpose at this stage is to try to improve upon, or flag, the fits at those pixels where the fit appears less than desirable. There are three methods for doing this. The first is to establish the parameter values (S/N in peak, peak residual, center values, width values, and error in widths) which constitute desirable values. There are operations to review all fit pixels to see if they meet these criteria and, if not, to flag the pixel or to try a new interactive fit on that pixel. The second method is to make a list of suspect pixels and then to flag or re-fit those pixels. The pixel numbers may be entered by hand or by pointing at them while

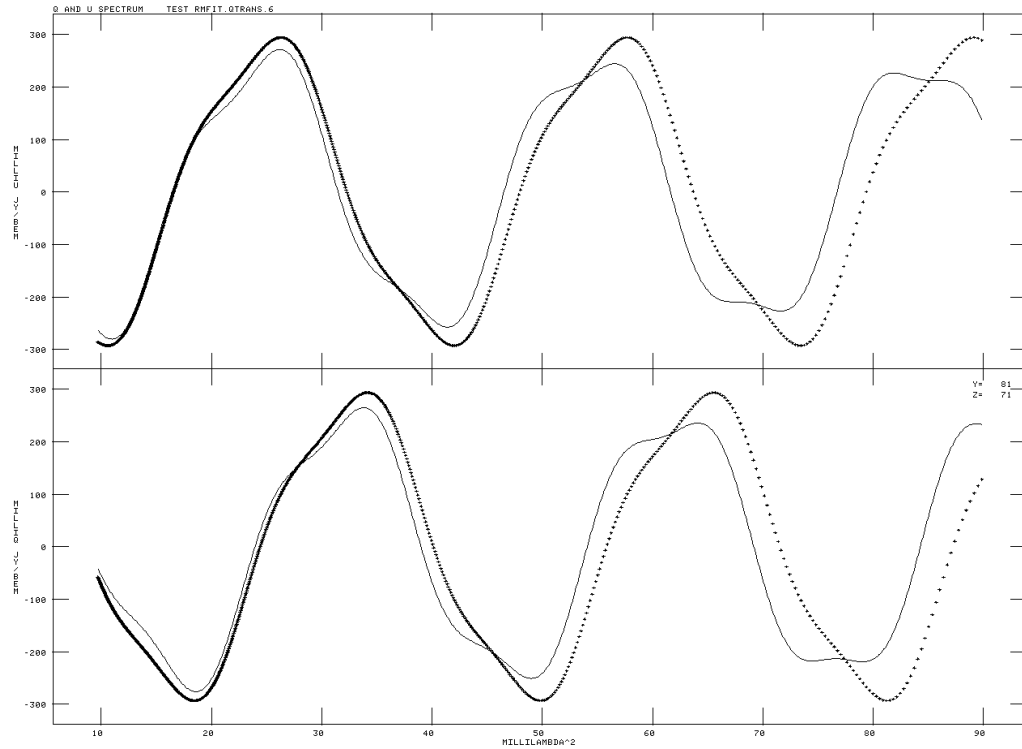


Figure 2: Result of RMFIT at one pixel in a model image with two components. The solid line is the guess based on the FARS output rotation-measures at this pixel; the dots are both the data and the fit, which are indistinguishable at this high S/N.

looking at images of the fit results. The third editing method is a swap of the results between components n and m since the fitting task may confuse which component number goes with those from previous pixels. The swap may be done on the pixel list or on an area marked with a TV blotch function like that used in the AIPS verb TVSTAT. This editing phase will display images of the fit results including the “flux” (integral of the Gaussian in frequency) and their errors. While looking at the image, you may engage in many of the familiar image display functions to adjust the transfer function, color, and zoom as well as examine pixel values with a CURVALUE-like function. It is that last function that allows you to add pixels to the list most easily.

When the user really believes that the results are as good as can be, the task can be told to write out images of the residuals and of each parameter and its uncertainty.

RMFIT is a new task based on the overhauled XGAUS. It follows the sequence of functions described above, but fits the data with the model

$$Q(i) = \sum_{j=1}^n P_j \cos(2\theta_j + 2RM_j \lambda^2(i))$$

$$U(i) = \sum_{j=1}^n P_j \sin(2\theta_j + 2RM_j \lambda^2(i)),$$

where i is the spectral channel. RMFIT will attempt to fit n polarization components of total polarization P_j , intrinsic polarization angle θ_j and rotation measure RM_j . The output of the Faraday rotation measure synthesis task FARS is used to provide the data from which initial guesses are found, while the fit is done to transposed image cubes of the Q and U Stokes parameters. During fitting, the FARS results are displayed as amplitude and phase versus rotation measure to allow selecting the initial guess. Then the spectra of Q and U are displayed with the initial guess and the fit in different colors. After the user accepts the result, the task repeats the process on the next pixel.

RMFIT is still in the early development phase. It also differs from **XGAUS** in that it allows the spectral data to be weighted, with weights provided either by an external text file or by fitting the rms, by robust means, of each spectral channel in the Q and U images. The model may become more complicated. Adding an optional fit for spectral index is one obvious improvement. That will force P_j to be the polarization at some fiducial frequency (1 GHz is widely used in *AIPS*) rather than being the polarization at $\lambda = 0$. More complex models, such as thick polarized emitters, may require more advanced mathematical fitting methods. The fitting code currently used is the modified Levenberg-Marquardt algorithm used by **IMFIT** and **XGAUS**, among others, in *AIPS*. It is fast and converges well if the initial guess is not too bad. An example fit to one pixel of a model image is shown in Figure 2.

Other analysis changes

IMFIT, **JMFIT**, and **MAXFIT** now return the new adverb **FSHIFT** which provides a net shift parameter to be used to force the particular component to land exactly on a cell.

FQUBE was given a new option to control whether a fully blanked input image plane is written to the output image. It also checks that each input image plane has a corresponding **CG** table (Clean Gaussian) entry before allowing it to be written to the output image.

COMB attempts to scale the input images so that they are in units of Jansky per the *same* beam. This caused issues which have been corrected in 'POLC' with noise values in **BPARM** and with images not in Jansky/beam.

IRING was changed to include column labels and a column of uncertainties in the output text file. It was corrected to use double-precision floats for its counters. Single-precision runs out of sensitivity on large images (*e.g.*, 7000 x 7000).

FARS was corrected to blank the output, computing nothing, for those pixels which were completely blanked on input. Previously it did something with such rows, producing microscopic output values which were almost, but not quite zero.

AFARS was corrected to handle its input headers more carefully; it tried to read more image planes than were present.

General

SETMAXAP was changed to allow the user to request up to 12288 Mega-bytes in 64-bit computers. This is 1536 mega-words in the pseudo-AP since it is now implemented in double precision.

IN5NAME, **IN5CLASS**, **IN5SEQ**, and **IN5DISK** are new adverbs to describe a fifth input data file (required by **RMFIT**). New verbs **GET5NAME**, **M5CAT**, **U5CAT**, **IM5HEAD**, and **Q5HEADER** support this fifth name set.

Patch Distribution for 31DEC12

Important bug fixes and selected improvements in 31DEC12 can be downloaded via the Web beginning at:

<http://www.aoc.nrao.edu/aips/patch.html>

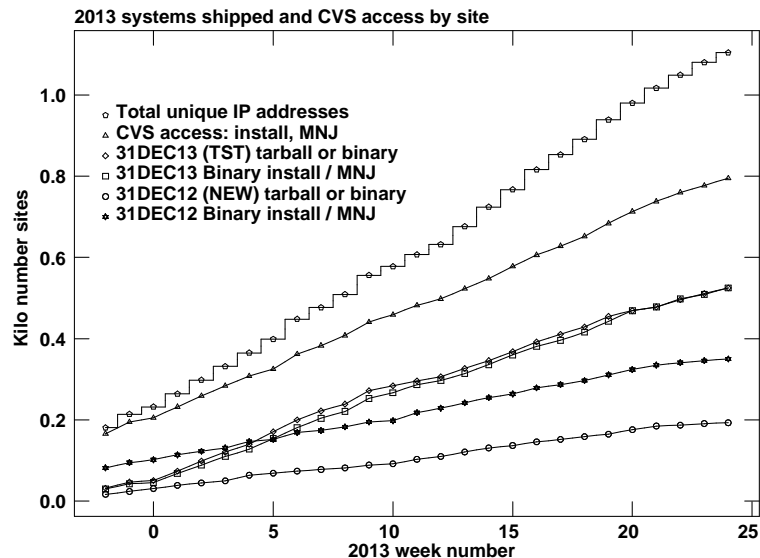
Alternatively one can use *anonymous ftp* to the NRAO server **ftp.aoc.nrao.edu**. Documentation about patches to a release is placed on this site at **pub/software/aips/release-name** and the code is placed in suitable sub-directories below this. As bugs in 31DEC13 are found, they are simply corrected since 31DEC13 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 31DEC12, which means that a MNJ run on 31DEC12 after the patch will fetch the corrected code and/or binaries rather than failing. Also, installations of 31DEC12 after the patch date will contain the corrected code.

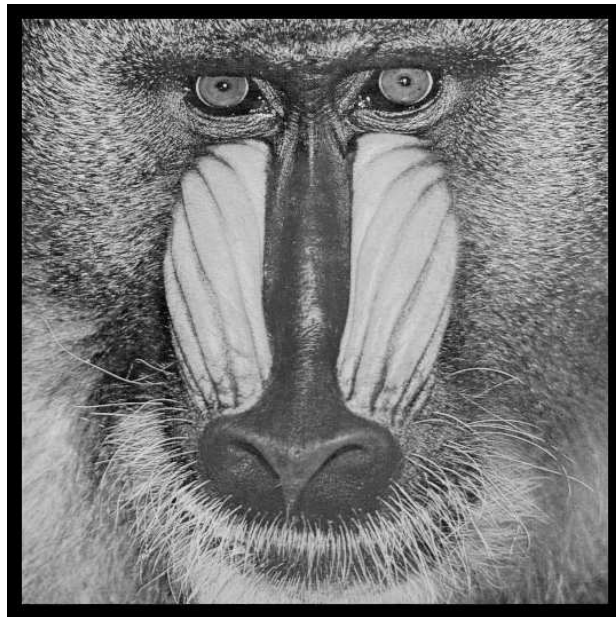
The 31DEC12 release has had a number of important patches:

1. Bandpass calibration was not applied to enough channels to support frequency smoothing afterward. 2013-01-16
2. Tick increments were computed with an erroneous round-off parameter leading some tick marks to be plotted at offset values. 2013-01-29
3. POSSM had a variety of irritating bugs. 2013-02-05
4. FITLD turned off DIGICOR corrections when the array name was not VLBA. 2013-02-05
5. FITLD, after correction 4, failed if it could not make a CQ table. 2013-02-18
6. CL2HF aborted because of an internal name conflict 2013-02-19
7. PRTAB had a format issue with large F formats (NDIG $i=0$). 2013-03-01
8. COMB did not do POLC correctly when using constant noise values 2013-04-04
9. AFARS had a header bug causing it to try to write too much 2013-04-05
10. FITLD could get the EQUINOX wrong in the SU table with FITS-IDI input 2013-04-11
11. COMB messed up scaling when combining two images with one of them not JY/BEAM 2013-05-03
12. FITLD had a bad warning message, causing aborts on some machines. 2013-05-21
13. BPASS rounded times outward for each scan by too much 2013-06-17
14. SETJY used Perley 2010 coefficients but reported Perley 2013 coefficients 2013-06-26

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 2013, there have been a total of 795 IP addresses so far that have accessed the NRAO cvs master. Each of these has at least installed AIPS and 265 appear to have run the MNJ on 31DEC13 at least occasionally. During 2013 more than 193 IP addresses have downloaded the frozen form of 31DEC12, while more than 525 IP addresses have downloaded 31DEC13. The binary version was accessed for installation or MNJs by 350 sites in 31DEC12 and 525 sites in 31DEC13. A total of 1104 different IP addresses have appeared in one of our transaction log files. Some of these numbers are a bit lower than those of 2012 at a comparable date, while the total is noticeably higher.

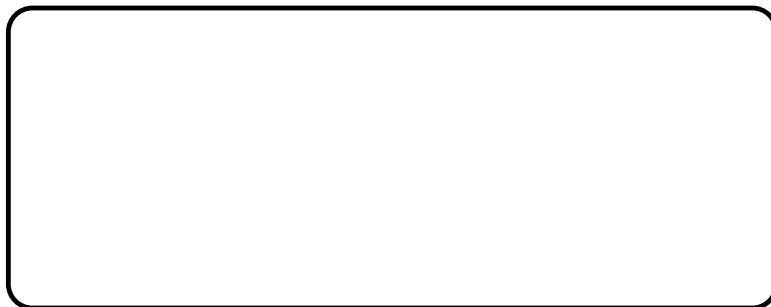




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General developments in *AIPS*

Reduction of EVLA and ALMA data in *AIPS*

This *AIPS Letter* and those beginning in 2010 documents numerous improvements to *AIPS* that enable full calibration of Jansky VLA data and most imaging operations as well. The one exception is the wide-band (bandwidth synthesis) deconvolution algorithm (“MSMFS”) being developed in *CASA* by Urvashi Rao Venkata, for which there is no comparable function in *AIPS*. Calibrated *uv* data may be exported from *AIPS* in “UVFITS” format for use in that program. ALMA data may also be reduced in *AIPS*, although the package is not fully qualified to calibrate data from linearly-polarized feeds. See Appendix E of the *AIPS Cookbook*, available via the *AIPS* web site, for details.

AIPS Letter publication

We have discontinued paper copies of the *AIPS Letter* other than for libraries and NRAO staff. The *AIPS Letter* will be available in PostScript and pdf forms as always from the web site listed above and will be shipped with all distributions of *AIPS*. It will be announced on the bananas and mnj list servers and, usually, in the NRAO e-News mailing.

Current and future releases

We have formal *AIPS* releases on an annual basis. We recommend a full binary installation method for both the frozen and development versions for MacIntosh OS/X (PPC and Intel chips), Solaris, and Linux (32- and 64-bit) systems, but all architectures can do a full installation from the source files. If you develop *AIPS* code locally *or have system managers that forbid the use of rsync or cvs*, you will need to do a source-level installation. The current release is called 31DEC13 and is now “frozen.” If you took a development copy of this version at some earlier date, you should use the “Midnight Job” (MNJ) to bring it up to date. You need to run a MNJ only once in 2013 to convert your copy of 31DEC13 into the frozen version. However, when patches to 31DEC13 are announced, you may apply them with the MNJ. This *AIPS Letter* is intended to advise you of corrections and improvements in this release.

We have begun a new version, called 31DEC14, which is now under development by the *AIPS* Group. You may fetch and install a complete copy of this version at any time. Having fetched 31DEC14, you may update your installation whenever you want by running the MNJ. This uses *cvs*, *rsync*, and/or transaction files to copy all changed text files and then to copy the binary files or to compile the code selectively based

on the code changes and compilations we have done. We expect users to take their source-only or binary version of 31DEC14 *AIPS* over the Internet (via *anonymous* ftp). Both versions require you to copy the installation procedure `install.pl` via ftp; the source-only version also requires you to ftp the 115-Mbyte 31DEC14.tar.gz compressed tar file. 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 new name for the task or put a copy of the task and its help file in a private disk area instead.

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Installing a new version

If compiling locally, new releases must be installed from the tar ball for that release. If using the binary installation, a full new installation must also be done with `rsync`. The `cvs` system used in the MNJ requires this. When installing a new *AIPS* release in a system that already has a previous release, we recommend that `install.pl` be used and that the previous release be left in place, at least until the new installation has been verified. If you do this, then you will not have to re-edit the disk, printer, and tape lists and can simply skip all those pages in the `install.pl` menus. The old `$HOME/.AIPSRC` file may be left in place, but it will need to be edited. The lines giving the `DOWNLOADED` and `UNPACKED` parameters should be cleared and the `CCOMOPT` line should be changed to point to the current release rather than the previous one. If you have made a special version of `do.daily.host`, you should preserve it under a new name and restore it after the install. If you have an odd set of *AIPS* versions, the `$AIPS_ROOT/AIPSPATH.*SH` files may need to be edited after the install to set the desired versions.

31DEC09 contains a change in the format of antenna files. Previous releases will not understand the antenna coordinates for arrays that were traditionally left-handed (VLBI primarily). The format change occurs automatically when any 31DEC09 or later antenna-file specific code reads the file, after which older releases will have difficulties. Note that the only version which we patch for major errors is 31DEC13; even 31DEC12 is no longer changed.

Preview of coming attractions

The 31DEC14 release already contains a few changes that we decided were a bit risky or not needed in 31DEC13. `APCAL` will now loop over subarray. The format of the `TGET/TPUT` file was changed to incorporate the names, sizes, and types of the adverbs present in the file. Subsequent `TGETs` will change the values of these adverbs and report any differences between the `TGET` file and the current `INPUTS` file. This will prevent adverb values from being messed up by a `TGET` when there are new adverbs in the `INPUTS` file. `RLDLY` has the option to average solutions over all possible reference antennas rather than depending on just one. A new appendix to the *CookBook* has been completed. It is a simplified guide to EVLA P-band data reduction in *AIPS*. The EVLA and VLBA data reduction pipeline procedures have been brought up to date. After some more testing, they will be released in 31DEC14. `BLSUM` will soon have the ability to make real plot files in addition to, or instead of, its printer plots.

Improvements of interest to users in 31DEC13

We expect to continue publishing the *AIPSLetter* every six months along with the annual releases. There are several new tasks released in the last six months. New tasks in the last six months include **BPWGT** to use the bandpass table to estimate channel-dependent weights, **HA2TI** to convert data sets with hour angle as the “time” into true times, **SNP2D** to convert a single-channel phase calibration into a delay suitable for wide bandwidths, **ALVAR** to estimate the Allen variance of visibility phases, **REIFS** to convert a data set into multiple IFs allowing the new IFs to include data from more than one input IF, **BDAPL** to apply a BD table found by **BLCHN** to another data set, **ZEMAN** to fit Zeeman splitting models to image cubes with interactivity, and **SPMOD** to add spectral-line models to a *uv*-data set. See below for more details.

In the first six months of 31DEC13 the new tasks were **RMFIT** to fit polarization models to Q/U cubes interactively, **DSKEW** to remove coordinate skew from input (usually optical) images, **FTFLG** to edit *uv* data interactively in a frequency-time display with all baselines averaged, **CLVLB** to apply calibration to correct VLBI data for phase-stopping positions away from the pointing position, **VLAMP** to determine system temperature calibration for the phased VLA in VLBI observations, and **PCVEL** to include planetary velocities when correcting *uv* data spectra to be centered on a line at the source. The interactive Gaussian-fitting task **XGAUS** was overhauled to become a much more usable tool to fit large spectral cubes. The handling of more global coordinate types was expanded and brought up to more modern standards to handle images, primarily optical, now being brought into *AIPS*. A fifth name group (**IN5NAME**, *et al.*) was added with new verbs **GET5NAME**, **M5CAT**, **U5CAT**, **IM5HEAD**, and **Q5HEADER** to support it.

Normally, bugs which appear in an *AIPS* TST version and then are fixed in that same version before its release get little or no discussion in the *AIPSLetter*. Since a rather large number of sites now install the TST version of *AIPS* during its development, this is somewhat of an oversight. We urge you to run the “Midnight Job” at least once after 31DEC13 is frozen to bring it up to date and to fix all bugs of this sort. We urge active sites to use the MNJ and, when something odd occurs, to examine **CHANGE.DOC** using the cgi tool available from the *AIPS* documentation web page (<http://www.aips.nrao.edu/aipsdoc.html>). Please do not hesitate to e-mail daip@nrao.edu with any questions or suspicions that there are problems.

UV data

Primary calibration source spectra

Task **SETJY** is provided with the best possible fluxes and spectral shapes available. These parameters are provided by Rick Perley and Bryan Butler. In 2013, **SETJY** was given time-dependent fluxes for 3C48, 3C138, and 3C147, low frequency fluxes from Anna Scaife and George Heald, and spectra for the stable sources 3C123, 3C196, and 3C295. **SETJY** was also given a new option **VANT** to compute the velocity of each source at its first scan, like **VCAL** but with respect to a specified antenna rather than the center of the Earth. Bugs affecting the velocity computation were fixed.

Tasks **BPASS** and **CPASS** need to know source spectral index in order to correct the bandpass functions to a spectral index of zero. Both tasks were given knowledge of all spectral energy distributions known to **SETJY**. **BPASS** was corrected to allow separate spectral indexes for each calibration source and to fit the fluxes in the **SU** table for any calibration source not in the list of known sources. **BPASS** was also corrected for an error in separating closely-spaced scans.

BPWGT is a new task to set the weights of data based on the values in the bandpass table. Various functions of the bandpass values are allowed.

HA2TI is a new task to convert hour angles back to legitimate times in a data set which had been through **TI2HA**. This allows data from multiple days to be run through **STUFFR** and then converted back for use by tasks that require real times (such as **UVFIX**, **CASA**).

SNP2D is a new task to convert the phase calibration found in one IF at one channel (*e.g.*, at a maser line at the phase center) into a delay suitable for application to a wide bandwidth.

SPLIT and **SPLAT** ran into trouble when a source was found to have no data. The error messages have been improved and history card counters reset. **SPLAT** copies only those flag tables with a version greater than the one being applied (when making a multi-source output file.)

UVFND now offers the **NCHAV** option so that tests are performed on a channel average rather than a noisier single-channel value.

LISTR can now list P_{sum} and P_{dif} from **SY** tables with **OPTYPE** 'GAIN'.

ALVAR is a new task to compute the Allen variance of complex visibilities in several ways. It prints the answers as a function of baseline and IF which may be used to evaluate the performance of the telescope.

TYAPL was changed to give “skipped” antennas (due to bad values in the **SY** table and the **CUTOFF** adverb) values equal to the average of those antennas which were not skipped. While not perfect, this will put the data weights on a similar basis.

RFLAG was given two more options to flag whole baselines in any spectral window that has fluxes exceeding the new parameters (**FARM(15)** and **FARM(16)**).

REIFS is a new task to divide a data set into multiple IFs. The new IFs can include data from more than one input IF which allows the task to retain IF-dependent values from the input tables.

SPFLG was given double-precision counters to avoid overflows, was changed to handle missing sources in the source table, and was fixed to label sub-images correctly. **DPARM(4) = 2** is a new option to divide not only by the source flux (as a function of IF) but also to determine a spectral index and use it to determine the flux to be divided into each channel.

UVPLT was given the **DOSCALE** option to divide the plotted fluxes by those in the source table, including optionally a spectral index also found from the source table values. Thus the plot is of normalized flux.

CLIP was given the **DOSCALE** option to divide the tested fluxes by those in the source table, including optionally a spectral index also found from the source table values. Thus the clipping is based on normalized flux and so might apply to multiple sources.

BLCHN was changed to correct the answers for the calibration source spectral index. The “known” sources have spectral indexes available, unknown sources will find the spectral index from the source table, or the user may specify a spectral index (and curvature). The correction may be turned off if desired.

BDAPL is a new task to apply a BD table found by **BLCHN** to another data set (*i.e.*, not the one input to **BLCHN**).

USUBA was changed to write subarray value 0 into those tables for which the new subarray values are not readily determined. Only tables with subarray, source, time, *and* antenna columns will get the newly determined subarray numbers. All tasks should understand that subarray 0 means all subarrays.

Imaging

SUBIM was given a **ZINC** option to allow selecting every n^{th} plane. The option to determine the average, minimum, or maximum over the $\text{XINC} \times \text{YINC} \times \text{ZINC}$ voxel was retained. Errors in the old implementation of this option were corrected.

TRANS messed things up badly when swapping rows with a row reversal. The task usually died from writing off the end of the file. The matter has been fixed.

IMAGR was corrected to compute the average included frequency correctly. Previously it assumed that the frequencies were in a monotonic and regular sequence.

TVMOVIE can be replicated in an animated gif for use in talks. Information about how to do this was added to the help file.

Analysis

Interactive analysis of spectral cubes

The previous *AIPSLetter* reported on the overhaul of **XGAUS** to make a truly useful, interactive task to fit Gaussians to spectral-line cubes. It also reported the creation of a task to fit rotation measures to cubes of Stokes Q and U. Tests of **RMFIT** show that it correctly resolves RM components which are totally blended in Faraday rotation measure synthesis methods. These tasks received considerable effort over the last six months as well. The most notable changes are to allow **XGAUS** to fit up to 8 Gaussians at every pixel, to allow both tasks cubes up to 8192 pixels on the x axis, and, optionally, to fit spectral index in **RMFIT**. Both tasks were changed to display the image step wedge more clearly (including a line drawn around the image), to handle the setting of blotch regions with more forgiveness for user error, to display and manage images larger than the TV display, to display the fit results and errors more completely, to try additional methods for finding the next initial guess, to solve for the fit even when a parameter or component is not fit, and to allow restarts on smaller regions interior to the region used initially. **RMFIT** was changed to function without a total-intensity input image, to allow the user to set the Q and U display ranges, and to record more things in the RM table including the rms of the fit evaluated with and without weighting. **XGAUS** was changed to drop a number of adverbs that are no longer useful in the overhauled task.

A new task, based on **XGAUS** has now been written. It is called **ZEMAN** and solves at each spectrum the equation $V(c) = AI(c) + 0.5BdI(c)/dc$ where $V(c)$ is the Stokes V cube at channel c and $I(c)$ is the total intensity spectrum. The task also offers the option of using the XG table produced by **XGAUS** and solving $V(c) = AI(c) + 0.5 \sum [B_i dG_i(c)/dc]$, where G_i is the i 'th Gaussian component. **ZEMAN** has much of the same structure as **XGAUS** and **RMFIT** although the fit is linear and not as difficult as the Gaussian and rotation measure ones. In the end, **ZEMAN** will produce images of A and B or B_i . The Gaussian model for **ZEMAN** has been found correct answers in data of poor spatial resolution (in which 2 lines overlap spatially) when compared to the same region observed earlier with good spatial resolution.

Other analysis

SPMOD is a new task that adds a model to an existing uv -data set. The model is of spectral lines of specified spatial type, position, and extent and frequency position and Gaussian width. Up to 9999 components may be specified.

SAD, **IMFIT**, and **JMFIT** were corrected to return positive error bars even when the component peak flux is negative.

SLFIT was changed to scale with the slice minimum and maximum rather than those of the image as a whole. Changed to use double precision to deal with extreme images.

FARS was corrected to use buffers large enough for the images in allowed.

General and system matters

RUN files may now contain **RUN** commands, up to a nesting level of 20. The “verb” **COMPRESS** uses **RUN** and so counts as one of the 20.

install.pl was changed to drop the dependence on certain Perl “packages” which are not always available.

Unix sockets have predictable names which are used by *AIPS* but this now fails on Mac systems. The start-up procedures were changed to skip the test on the display name on Macs. This does interfere with the option to have one computer display on multiple computers, but Macs are not usually used in that way.

Tables may have flagged rows, since this option is directly available to the user. All table routines should return flagged rows to the calling routine with a negative error code to indicate the flagging. Numerous table routines that did other things were corrected. Calling routines should deal with flagged rows appropriately (skip them usually).

Patch Distribution for 31DEC12

Because of the extensive use of binary installations, we now patch the master copy of the most recently frozen version. Older versions are not corrected even for egregious errors. Thus, 31DEC12 was patched during 2013 and 31DEC13 will be patched as needed during 2014. Your copy of them may be corrected simply by running a Midnight Job. Information about patches and the code may be found using links from the main *AIPS* web page or by *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. Patches to older releases are kept here as well, but they will require local compilation.

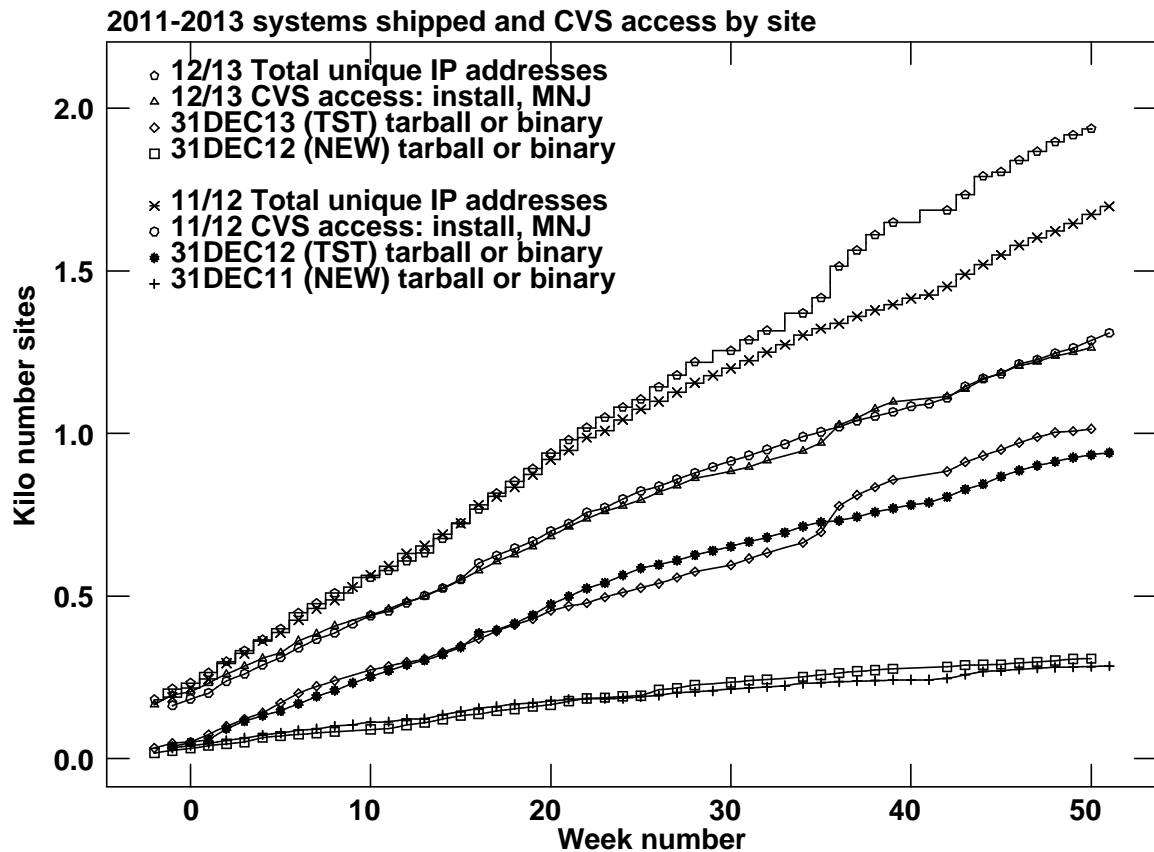
The 31DEC12 release is no longer available for installation and will no longer receive patches even for egregious errors. It had a number of important patches during 2012. They are

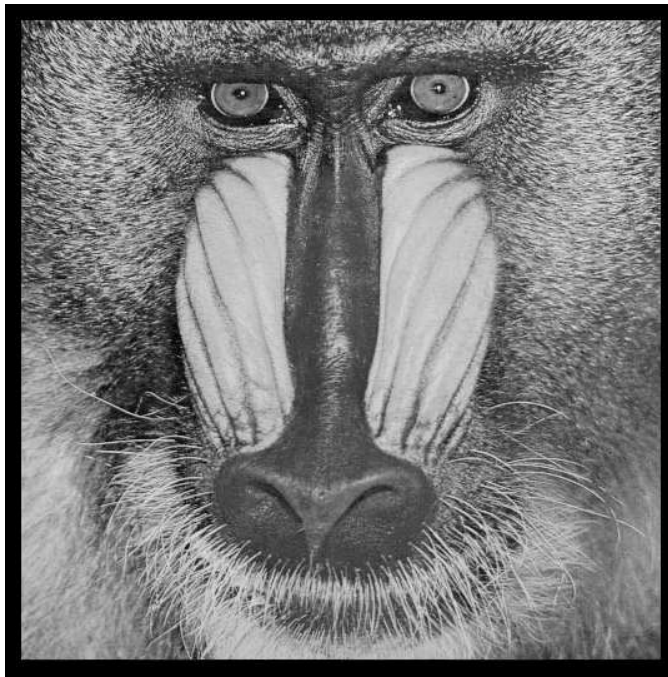
1. Bandpass calibration was not applied to enough channels to support frequency smoothing afterward. *2013-01-16*
2. Tick increments were computed with an erroneous round-off parameter leading some tick marks to be plotted at offset values. *2013-01-29*
3. POSSM had a variety of irritating bugs. *2013-02-05*
4. FITLD turned off DIGICOR corrections when the array name was not VLBA. *2013-02-05*
5. FITLD, after correction 4, failed if it could not make a CQ table. *2013-02-18*
6. CL2HF aborted because of an internal name conflict. *2013-02-19*
7. PRTAB had a format issue with large F formats ($\text{NDIG} \leq 0$). *2013-03-01*
8. COMB did not do POLC correctly when using constant noise values. *2013-04-04*
9. AFARS had a header bug causing it to try to write too much. *2013-04-05*
10. FITLD could get the EQUINOX wrong in the SU table with FITS-IDI input. *2013-04-11*
11. COMB messed up scaling when combining two images with one of them not JY/BEAM. *2013-05-03*
12. FITLD had a bad warning message, causing aborts on some machines. *2013-05-21*
13. BPASS rounded times outward for each scan by too much. *2013-06-17*
14. SETJY used Perley 2010 coefficients but reported Perley 2013 coefficients. *2013-06-26*
15. IMAGR computed the actual average frequency wrongly. *2013-07-03*
16. IMFIT and JMFIT could return negative error bars when the object was negative. *2013-07-07*
17. TRANS messed up when reversing the order of an axis it was also swapping. *2013-07-17*
18. PRTAB had formatting issues with large tables with many blanked values. *2013-07-25*
19. SU table access was incorrect in some routines including widely used ones. *2013-07-29*
20. SPFLG had a gridding counter which could overflow with modern data sets. *2013-08-16*
21. PRTAB had formatting issues with required E formats in F-format modes. *2013-08-23*
22. SETJY and CVEL were affected by a bad variable in setting the Doppler velocity and the former omitted the system velocity when setting source velocities. *2013-10-21*
23. ISPEC on an image with an FQID axis could fail. *2013-10-24*

AIPS Distribution

From the NRAO system logs, we count apparent MNJ accesses, downloads of the tar balls, and `rsync` accesses by unique IP address. Since DSL and some university and other connections may be assigned different IP addresses at different times, this will be a bit of an over-estimate of actual sites. However, a single IP address is often used to provide *AIPS* to a number of computers, so these numbers are at the same time an under-estimate of the number of computers running current versions of *AIPS*. In 2013, a total of 307 different IP addresses downloaded the frozen form of 31DEC12 and 1013 IP addresses downloaded 31DEC13 in tarball or binary form. Fully 1264 IP addresses accessed the NRAO cvs master. Each of these has at least installed some version of *AIPS* and 365 appear to have run the MNJ at least occasionally. The total number of unique IP addresses in these three lists was 1937. The table below shows these numbers as a function of year since we began recording them. The attached figure shows the cumulative number of unique sites, cvs access sites, and download sites known to us as a function of week in 2013. The numbers for 2012 are also plotted and show an increase in 2013 in all numbers except those for cvs, perhaps due in part to a VLBI workshop which used *AIPS*.

year	TST name	NEW name	TST	NEW	TST binary	NEW binary	cvs	Total unique
2004	31DEC04	31DEC03	808	196			797	1276
2005	31DEC05	31DEC04	832	246	299	48	982	1460
2006	31DEC06	31DEC05	806	191	402	94	1050	1398
2007	31DEC07	31DEC06	965	277	669	161	1385	1811
2008	31DEC08	31DEC07	1058	246	986	303	1667	2107
2009	31DEC09	31DEC08	1228	307	1082	478	1855	2399
2010	31DEC10	31DEC09	1228	307	1203	477	1914	2416
2011	31DEC11	31DEC10	1105	270	1064	424	1747	2228
2012	31DEC12	31DEC11	940	284	1028	396	1309	1698
2013	31DEC13	31DEC12	1014	307	990	443	1264	1937





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