# AIPSLETTER

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A newsletter for users of the NRAO
*A*stronomical *I*mage *P*rocessing *S*ystem

Written by a cast of *AIPS*

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# Happy 36th 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 `31DEC14` while `31DEC15` 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 `31DEC15`. Having fetched `31DEC15`, 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 31DEC15

We expect to continue publishing the *AIPSLetter* approximately every six months, but the publication is now primarily electronic. There have been several significant changes in 31DEC15 in the last six months. Some of these were in the nature of bug fixes which were applied to 31DEC14 before and after it was frozen. If you are running 31DEC14, 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 31DEC15 include SNFIT to fit Gaussians to drift-scan gain solutions, UVFRE to re-grid visibility data in frequency space to match a second data set, HOLOG to transform and analyze holography data, PANEL to convert HOLOG output to panel adjustment tables, STACK to combine multiple images without regard for coordinates, and TVHLD to display and save histogram-equalized versions of images. New verb TVLAYOUT also assists in displaying holography results and new procedure DOVLAMP assists in converting EVLA SysPower data to gains for VLB usage.

31DEC14 contains a change to the "standard" random parameters in *uv* data and adds columns to the SN table. Note, however, that the random parameters written to FITS files have not been changed. Older releases of *AIPS* cannot handle the new *internal uv* format and might be confused by the SN table as well. 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. You are encouraged to use a relatively recent version of *AIPS*, whilst those with EVLA data to reduce should get release 31DEC14 or, preferably, the latest release.

## UV-data

### Dispersion and fringe fitting

Wide-band observations, particularly those at low frequencies, are affected by ionospheric dispersion (phases change linearly with wavelength) as well as delay errors (phases change linearly with frequency). The calibration (CL) table has contained dispersion columns, used by TECOR, for a long time. The current release was changed to have dispersion columns also in the solution (SN) table. CLCAL was also changed to smooth and apply dispersions from the SN to the CL table. It was corrected to do the advertised smoothing of the multi-band delay as well.

SNSMO was changed to smooth, clip, and re-reference dispersions as well as other SN-table data. SNSMO was also changed to handle phases more carefully, keeping track of groups of IFs so that the phase relationship between IFs in a group is not lost when delays are smoothed. A new SMOTYPE = 'VLDE' is used to request this improved smoothing method.

If there is dispersion, then the single-band delays found by FRING will depend on frequency even if the real delay is actually the same for all bands. The single-band delays may then be converted to a single multi-band delay plus a dispersion by a relatively simple least-squares routine. OPTYPE = 'DISP' was added to MBDLY to perform this computation on SN tables computed as single-band delays by FRING and KRING. An option was also added to FRING to perform this same computation following the fit for single-band delays. FRING was also corrected to handle cases in which the spectral increment is of opposite sign in different IFs (*e.g.*, ALMA).

The alternative fringe-fitting task KRING contains a least-squares routine designed, among other things, to solve for a multi-band delay plus dispersion. This routine was adjusted and the output into the SN table corrected to produce correct phases, delays, and dispersions. These corrections affect the output substantially even when not solving for dispersion. Code was added to average the data over time when not solving for rates. This produces a great improvement in the run time. The task was also changed to work for single-source files as well as multi-source. Unfortunately, the least-squares routine can return wrong answers some of the time. Why it does so remains under investigation, so care should be exercised in using KRING outputs. The task does offer the only routine to use all the phases when solving for dispersion; MBDLY and FRING only use the single-band delays to find dispersion.

### PIPEAIPS

The RUN file procedure DOOSRO (formerly called VLARUN) has been renamed PIPEAIPS. When given the expected format of data, PIPEAIPS will take most connected element interferometer data and calibrate them according to known standard procedures. Optionally it will make images automatically and provide some means of quality control. It handles both continuum and spectral line data flexibly as well as a wide range of observational setups. Polarization calibration however is not built in since that currently requires much hands-on massaging.

Like any pipeline, PIPEAIPS will only do what it is designed to do. The anticipated typical use of PIPEAIPS is to calibrate data from the VLA, but also ALMA, ATCA, WSRT, etc. in a first pass to provide feedback on bad data: This can be done blindly, without any prior flagging if desired. After (additional) flagging, the procedure can be (re)run with imaging switched on. The resulting data can be inspected, the pipeline can be rerun, and/or the calibrated data can be re-imaged with the final imaging parameters.

As an example, most of the old VLA continuum data in the archive was imaged in a single run of (then) VLARUN, *i.e.*, without additional flagging or self-calibration. These data sets and their images, which constitute the NRAO VLA Archive Survey (NVAS), are publicly available from the NRAO data archive or more directly via `https://archive.nrao.edu/nvas` and are a great resource for a quick look or as starting point for further imaging (*e.g.*, by combining multiple of these calibrated data sets on the same source in the same frequency band).

For inquiries or help with PIPEAIPS, please contact `lsjouwer@nrao.edu` or `daip@nrao.edu`.

### Other matters

**UV** data inside *AIPS* now have random parameters ANTENNA1, ANTENNA2, and SUBARRAY rather than the BASELINE parameter that combined all three. All *AIPS* tasks can handle either of these forms and the FITS writers FITTP and FITAB will continue to write data out using the BASELINE form when possible. The new format allows for more than 255 antennas, as planned for some of the array designs now being considered.

**Calibration** routines required several bug fixes. The routine that fetched the next gain solution used a time increment of 0.4 seconds which is way too long when data are at intervals of 0.1 seconds. The computation of wavelengths for polarization and dispersion calibration assumed a frequency reference pixel of 1.0 rather than using the actual value, which is now usually at the center of each band. Dispersions were applied to the data only when both dispersion values were non-zero, thereby leaving out all baselines to the reference antenna. There was also a bug in the I/O initialization routine which only mattered if the data file on disk was exactly the minimum size required.

**BPASS** did not use left-handed antenna coordinates in shifting VLBI data, making bandpass solutions for high frequency, narrow channel data incorrect. The low-level routines were changed to use right-handed coordinates (like the rest of *AIPS*) and the bandpass application routines were changed accordingly.

**Sorting** of data in the OOP routines (such as IMAGR) uses the pseudo-AP, but the communication between low-level routines was badly flawed. Sorting with OOSRT and inside IMAGR has now been fixed, but must not have been used much previously.

**FITLD** was changed to set the RDATE table keyword to the user-specified reference date (if any) including setting the GST at midnight and dealing with date offsets in computing the source apparent positions. The handling of DIGICOR was changed, to tell the truth about what the task is doing and to allow non-VLBA correlators to get the corrections.

**UVSUB** now offers the option to divide cross-hand polarization data by the parallel-hand model using OPCODE = 'DIV4'.

**MORIF** was given the option to combine IFs as well as to sub-divide them.

**UVFRE** is a new task to re-grid the frequency structure of one data set (as best one can) to match that of another data set.

**UVIMG** was re-written to grid on any user-selected axes with channel averaging and increments and including multiple IFs. It can grid the data with a variety of gridding functions or output the count of samples instead. The output may be an interpolated or a convolved image.

**SOUSP** was given the option of correcting a range of SN table versions if the new fluxes replace the previous fluxes in the source table.

**DOVLAMP** is a new RUN-file procedure to produce amplitude calibration for phased-VLA data used in VLBI.

**CLCOR** was changed to allow the 'EOPS' operation to request day offset 0, which is useful when the first scans occur just before midnight.

**TECOR** was changed to use values from the JPL files at time 0 hours rather than the data at time 24 hours of the previous day. The two are not the same and the 0 hours one is likely to have been computed with additional information.

**SNFIT** is a new task to fit a primary-beam model to SN tables generated for a source that moves through the primary beam (*e.g.*, drift or driven scans).

**TVFLG,** SPFLG, and FTFLG were corrected to prevent them from trying to load too much data when switching from one of multiple "pieces" back to a single (time-averaged) piece.

**LISTR** will now list autocorrelation data in 'LIST' with an extra factor of 0.01 in the scaling, when DOACOR is true.

## Holography and other analysis

The analysis of holography data was given attention. Two tasks, kept by Rick Perley, were brought into AIPS and adjusted to simplify inputs and meet plot standards. HOLOG is a simplified version of HOLGR to read the output of UVHOL and do FFTs to make images. Ten different types of image may be obtained including regridded amplitude and phase, regridding weights, amplitude and phase of the antenna illumination, amplitude and phase of the point-spread function, focus model phase corrections, surface deviations, and interpolated antenna power pattern. Then PANEL takes the illumination amplitude as a mask and the surface deviations as the image to make plots of the raw data, adjustment image, and residual image and tables of the adjustments to be applied at each panel corner. Verb TVLAYOUT was written to overlay the panel layout on images from HOLOG loaded to the TV and tasks KNTR and GREYS were given enhanced capability to overlay the panel layout on their plots.

**STACK** is a new task to do image "stacking" in which small images of selected positions are added to see if an object below the noise level of any one image will appear. Basically, it just does a weighted average (or median) of a set of images from a cube or a range of sequence numbers.

**MCUBE,** FQUBE and STUFFER were changed to deal with missing sequence numbers between INSEQ and IN2SEQ without quitting.

**OMFIT** now quotes uncertainties $\sqrt{2}$ less than before. The new values match uncertainties found by other means more closely.

**UVFIT** now says whether it converged or not.

## Display

**TVHLD** is a new task to replace the old tasks TVHXF and TVHLD, both of which required well-equipped IIS Model 70 display devices. It loads an image on the TV with "histogram equalization." An interactive menu is used to control the intensity range of the equalization and to select various functions to be performed on the normal histogram before it is used to do the equalization. Some of these functions enhance the higher levels of the image relative to the lower levels more than others. The usual image display/enhancement options are also offered. When done, the equalized image may be written to a cataloged image file or the task may exit without writing an image.

**TVMOVIE** was given the option DOALL to allow the movie to run over the planes of more than one axis. Since UVIMG can now write cubes with both a frequency and an IF axis of more than one pixel, this option became advisable.

## Imaging

IMAGR no longer returns control to the user when DOTV is true. This allows it to check with the user when a requested TVBOX would wipe out more than one previously existing box. If OBOXFILE is blank at the start, the task now creates a temporary file in the user's home area. This temporary file, or a user-specified one, may be replaced later with a TELL operation. IMAGR was also corrected to avoid, but also handle, a situation in which the dynamic memory allocated is inadequate for the number of channels or facets in a pass of gridded subtraction. A bug in IMAGR's baseline-length time averaging was also corrected. Previous usage of that option could have been severley compromised.

SCIMGF and SCMAP were changed to support image labeling including "stars," the more general OBOXFILE usage described above, and to check with the user whenever TVBOX would delete more than one pre-existing box.

## General

The Max OS/X operating system, in version 10.10 called "yosemite," changed the standard directory /tmp into /private/tmp. Changes to the START_AIPS and START_TVSERVERS scripts as well as to start-up code in XAS itself were required to handle this so that the simple command aips would again bring up the TV as expected. The background of characters written to grey-scale TV planes now remains black when the image plane is enhanced.

The *POPS* language processor would occasionally produce a strange result when strings were being concatenated in procedures. A wrong pointer was returned to the concatenation subroutine. The bug was fixed by ignoring this pointer. The data were already stored in memory and did not need to be stored a second time in the same place.

Task MOVE has been changed to use large I/O buffers, reducing the I/O count and achieving a substantial improvement in performance on some I/O systems. A factor of 10 in real time was obtained on a Lustre system; local Linux systems had much less improvement in real time but had a substantial reduction in cpu time.

A nuber of sites have tried to compile *AIPS* using relatively modern versions of gfortran and gcc and have encountered difficulties. We have found that the default gfortran included with RedHat 6 Linux (version 4.4.7) does seem to work although the default version of the debugger (gdb version 7.2) does not play well with that version. Later versions of gfortran produce code in which (at least) Fortran text-file I/O and optimised pseudo-AP code fail.

# Recent *AIPS* Memoranda

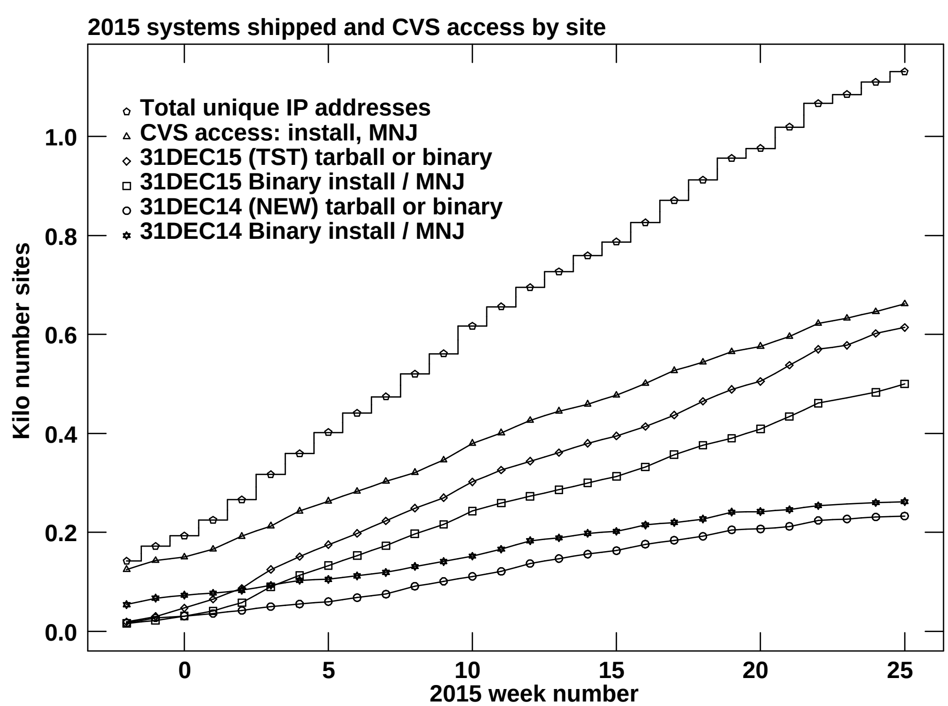
All *AIPS* Memoranda are available from the *AIPS* home page. *AIPS* Memo 117 describing *AIPS'* usage of the FITS format was modified in 2015 for changes to the UV and SN table formats.

**117** *AIPS* **FITS File Format**
Eric W. Greisen, NRAO
April 24, 2015, revision
*AIPS* has been writing images and *uv* data in FITS-format files for a very long time. While these files have been used widely in the community, there is a perception that a detailed document in still required. This memo is an attempt to meet that perception. *AIPS* FITS files for *uv* are conventions layered upon the standard FITS format to assist in the interchange of data recorded by interferometric telescopes, particularly by radio telescopes such as the EVLA and VLBA.

The Memo was revised for changes to the `SU` table (`RAOBS` and `DECOBS` columns), the `FQ` table (`BANDCODE` column), the `AN` table (clarification of coordinate systems), clarifications of when source tables and columns or random parameters are required, the `CC` table (clarify meaning of `DELTAX` and `DELTAY`), the *uv* data format (possible addition of `SUBARRAY`, `ANTENNA1` and `ANTENNA2` random parameters), and the `SN` table (addition of `DISP` and `DDISP` columns).

# *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 2015, there have been a total of 662 IP addresses so far that have accessed the NRAO cvs master. Each of these has at least installed *AIPS* and 229 appear to have run the MNJ on `31DEC15` at least occasionally. During 2015 more than 233 IP addresses have downloaded the frozen form of `31DEC14`, while more than 614 IP addresses have downloaded `31DEC15`. The binary version was accessed for installation or MNJs by 262 sites in `31DEC14` and 500 sites in `31DEC15`. A total of 1131 different IP addresses have appeared in one of our transaction log files. The `31DEC15` numbers are rather higher than last year; the others are about the same as last year at this time.



# Patch Distribution for 31DEC14

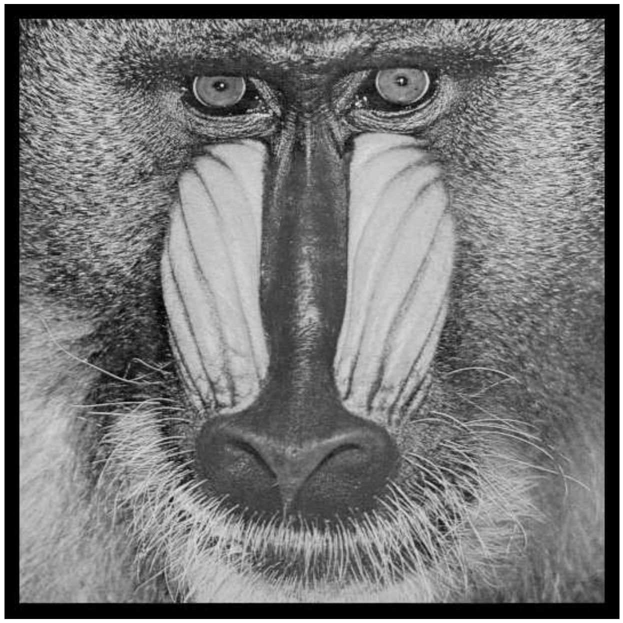
Important bug fixes and selected improvements in 31DEC14 can be downloaded via the Web beginning at:

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 31DEC15 are found, they are simply corrected since 31DEC15 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 31DEC14, which means that a MNJ run on 31DEC14 after the patch will fetch the corrected code and/or binaries rather than failing. Also, installations of 31DEC14 after the patch date will contain the corrected code.

The 31DEC14 release has had a number of important patches:

1. DOFARS procedure and inputs retained adverbs no longer used by FARS. *2015-01-02*
2. RMFIT failed to copy the FQ table to the output residual images. *2015-01-13*
3. FTFLG messed up antenna numbers in the output FG table when a single antenna or baseline was used. *2015-01-16*
4. VLBATECR had trouble around the end of the year deciding what files needed to be downloaded. *2015-01-19*
5. VLBARUN requires convert to make the html output files. Added tests and a control on DOTV. *2015-01-19*
6. BPASS had an array and history writing code which could not handle more than 32 antennas. *2015-01-20*
7. MORIF messed up bandpass and other spectral tables. *2015-01-29*
8. TYSMO did not apply clipping unless median-window filtering was also requested. *2015-02-11*
9. BPASS did not understand that low-level VLB routines expected left-handed antenna coordinates. *2015-02-21*
10. UV data disk I/O had an issue if the full file fit into the first of the two buffers and the disk file was exactly the right size! *2015-04-24*
11. START_AIPS, START_TVSERVERS needed a grammar change to support Mac yosemite systems. *2015-04-24*
12. Basic calibration subroutines mis-computed the channel wavelengths and did not always do the dispersion correction. *2015-05-19*
13. XAS needed a change to support Mac yosemite systems and also to write black character backgrounds. *2015-05-20*
14. KRING help file adverb list did not match that of the Fortran. *2015-06-17*
15. IMAGR did not do the baseline-based time averaging properly for the last samples written to the work file. *2015-06-22*



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