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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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General developments in *AIPS*

Reduction of VLB, VLA and ALMA data in *AIPS*

AIPS continues to be the main software system for the reduction of VLBI data from the VLBA and other telescopes. Since 2010, there have been numerous improvements to *AIPS* that enable full calibration of data from the Karl G. Jansky VLA 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.

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 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 (Intel chips only), and Linux (32- and 64-bit) systems, but all architectures can do a full installation from the source files. There are also binary versions available for `31DEC17` for Solaris and Mac PPC chip architectures. 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 `31DEC17` 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 2018 to convert your copy of `31DEC17` into the frozen version. However, when patches to `31DEC17` are announced in 2018, you may apply them with the MNJ. This *AIPSLetter* is intended to advise you of corrections and improvements in this release.

We have begun a new version, called `31DEC18`, 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 31DEC18, 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 31DEC18 *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 135-Mbyte 31DEC18.tar.gz compressed tar file. Binary installations use only rsync, while locally compiled versions also use cvs. 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. 31DEC15 and later versions contain improvements to the code which should make local compilation more reliable. If using the binary installation, a full new installation must also be done with rsync. 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. The file $SYSLOCAL/UPDCONFIG also needs to be edited to correct your e-mail address(es).

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. 31DEC15 contains a change in the headers of *uv* data sets which will not be understood by previous versions. Note that the only version which we will patch for major errors is 31DEC17; even 31DEC16 will no longer be changed.

Improvements of interest to users in 31DEC17

In the latter half of 2017, new tasks appeared including FGSPW to flag whole spectral windows on a scan, baseline, and polarization basis when the scalar average amplitudes are excessive. New tasks for handling large pulse-cal tables include PCAVG to average pulse-cal tables over time, PCRMS to flag a pulse-cal table automatically based on various statistics, and PCHIS to plot histograms generated by PCRMS. The calibration of linearly-polarized feeds has been partially addressed although there is much room for improvement. New tasks in the first half of 2017 include ELFIT to fit polynomials to selected data from tables, SYSOL to calibrate Solar data sets using the SysPower table, DFTIM to make an image of visibility data at a celestial coordinate as a function of time and frequency, AGAUS to fit Gaussians to absorption-line image cubes, ZAMAN to fit Zeeman splitting models to absorption line image cubes, and MODAB to prepare models for the Gaussian fitting tasks.

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 `31DEC17` 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 contact us via the NRAO help desk (`https://help.nrao.edu`) or via e-mail `daip@nrao.edu` with any questions or suspicions that there are problems.

VLBI matters

Pulse-cal tables

The DiFX correlator is now capable of providing pulse-cal tones at every MHz. These complex data are written into text files archived in full at the correlator site and may be written in the FITS-IDI output files. Since these data have very high signal-to-noise ratio, they should be used wherever possible to assist with calibration. During the past 6 months, `PCLOD` was changed to get the start date from the data once rather than from the pulse-cal input and to offer the option of keeping or ignoring data outside of uv-data scans. `PCFLG` was changed to handle large input tables, to manage the sort order carefully to avoid excessive sorting, to handle only times in the specified time range, and to display times including day number correctly even when there are no values in the current display. `PCAVG` is a new task to average pulse-cal tables over time. `PCFIT` was given a new option to suppress excessive jumps in delay and the sign of the value written to the `SN` table was switched. `PCPLT` was changed to honor `XYRATIO` and `ANTENNAS` and to do horizontal axis labeling for any number of panels. `PCRMS` is a new task intended to auto-edit pulse-cal tables. This task looks for individual channels that stick out too much from their neighbors and for times where spectral windows deviate excessively from the average and rms of that spectral window, polarization, and antenna. `PCRMS` does a surprisingly good job, but, if you want to examine the data, `PCRMS` has the option of writing a text file containing the IF-average amplitude and its rms for every time in the table. The new task `PCHIS` can read this file and plot histograms and statistics. The format of the file is rather general, so `PCHIS` may well have other uses. The `SN` table written by `PCFIT` has been shown to correct many, but not all, delay jumps found in real data sets.

Miscellaneous

VLBAUTIL was changed to update the URL for the EOP file.

VLBARUN was changed to avoid some `BLEW TEMP C` failures.

ANTAB occasioned a change to allow 2560-character input lines in *AIPS*' version of `KEYIN` and a more extensive explanation of allowed input formats.

APCAL was given very much larger buffers to handle data sets with numerous spectral windows.

KRING was changed to write zeros rather than magic blanks for multi-band delay and dispersion when a polarization is flagged. The calibration routines flagged all polarizations on the magic blanks.

USUBA was changed to allow more sources and entries up to the limits imposed by compilers.

UV data: Miscellaneous

Low-level routines in the calibration package were changed to allow correct conversion of linear polarization data into full Stokes. This requires more widespread maintenance of the current parallactic angle. `PCAL` still cannot handle a linear-polarization model but works well on unpolarized calibrators at P-band. The correction for the X-Y phase difference is not available at this time, so full calibration of linear polarization still does not work in *AIPS*.

FGSPW is a new task designed to find and flag spectral windows that have been over-run by RFI. It does a scalar-amplitude average of all spectral channels in each scan and, for those baselines, polarizations, and spectral windows that exceed a user-set cutoff, flags the data in that scan. It is a fast way to start the editing of RFI-riddled data, before using SPFLG or RFLAG.

SY table format changed and required some tasks to handle the tables differently and TYAPL to change its internal version of the SY-table flagging routine.

Antenna file opening and reformatting required changes to avoid leaving open files on errors, to specify enough keywords for data sets with 30 or more spectral windows, and to handle CASA's decision to honor only a portion of the new format.

WIPER was corrected to position displays properly on zoomed images.

TVFLG and similar tasks were corrected to handle time labels correctly including day number and to switch to fully blanked displays when no data are found for the selected image. Label information became incorrect when the old, valid data remained on the display. They were also changed to support STOKES = 'IQU' and 'IQUV'.

UVMOD was changed to allow comment lines and negative flux components in the input text file.

UVHOL was corrected to handle unwanted data at the end of a print group and to allow a choice of whether the parallactic angle correction is applied or not on DOPOL > 0.

HOLOG was changed to allow the option to compute the images from user-supplied parameters rather than the data and to simulate the effect of reference pointing. It was changed to allow the specification of the frequency used to control the sampling and to request real and imaginary images rather than amplitude and phase.

Analysis: Miscellaneous

RMFIT was corrected to handle blotch drawing on pixel-replicated images when switching solutions between components and the units of the Q0 and U0 output images were corrected. The option to display total polarization and polarization angle instead of Q and U was added. Fitting is done in Q and U always. The initial guess algorithm was substantially improved.

FARS was changed to write the one-dimensional RMTF (RM beam) as slice files, one each for real, imaginary, amplitude, and phase.

FQUBE was changed to use the FQ planes in the current image and not to complain about FQ values in the table which are not present in the image. This allows SUBIM to be used on an FQ axis with the result being fed back into FQUBE.

TVSPC acquired the options to label the images and to do a CURVALUE display for any of the up to four displayed images and plots.

Imaging and Display: Miscellaneous

IMAGR added OVRSWTCH, FGAUSS, and IMAGRPRM(11) to the supported TELL adverbs. Multi-scale Clean requires OVERLAP ≥ 2, so the code was changed to force this.

RSPEC was changed to use BLC and TRC in the normal way with DOINVER controlling whether the statistics are done inside or outside the window.

WETHR was corrected to use the correct table-file format and to decide whether the TIME column is double precision correctly. An option to connect the plotted points was added.

PCNTR was changed to allow, with a warning, the drawing of polarization vectors on images lacking a proper celestial coordinate pair of axes.

General

Major difficulties arose over the last year or so with the LNX64 binary version of *AIPS*. Beginning with Fedora 25, tasks started to produce NaNs ("not-a-number") in seemingly random but repeatable places in the output. IMAGR was particularly affected, but other tasks were as well. Gradually other operating systems, more modern than those used at NRAO, began to see the same problem. Thinking that the very old version of the Intel compiler which we were using might be at fault, we installed the latest Intel compiler (version 18.0.0, dated 20170811). All continued to work well on NRAO computers, but the new version failed on those computers on which the old versionhad failed. The new failures occurred at even earlier points than the NaNs. Therefore, the binary version of *AIPS* for LNX64 is now computed with gfortran and gcc version 6.3. This seems to work more or less everywhere. During the test on the latest Intel compiler, *AIPS* code was corrected for "over-stated" EQUIVALENCE statements and incorrect E$w.d$ format codes.

ABORTASK was given the NUMTELL adverb to allow aborting tasks running under other POPS numbers.

WAITTASK was given the NUMTELL adverb to allow waiting on tasks running under other POPS numbers.

RUN was corrected to avoid using magic text-file logical unit numbers so that verbs executed under nested RUNs would have normal access to those LUNs.

CookBook was updated for changes noted above.

Recent *AIPS* Memoranda

All *AIPS* Memoranda are available from the *AIPS* home page. *AIPS* Memo 117 was modified to describe the added columns in the SY and CD tables for Solar data. Memo 120 was modified for new options in TVSPC. Memo 118 was modified for new options in RMFIT. *AIPS* Memo 123 was written to describe the usage of the new, large pulse-cal tables in VLBI.

117 ***AIPS* FITS File Format**
Eric W. Greisen, NRAO
June 19, 2017 (revised)
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.

118 **Modeling Spectral Cubes in *AIPS***
Eric W. Greisen, NRAO
November 20, 2017 (revised)
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. A revision of this memo discusses changes made for the 31DEC15 release and two new tasks to plot spectra with model fits and a number of tasks which make visibility and image model files. The November 2017 revision includes new display options in RMFIT.

120 Exploring Image Cubes in AIPS
Eric W. Greisen, NRAO
July 22, 2017 (revised)
AIPS has recently acquired powerful tasks to fit models to the spectral axis of image cubes. These tasks are easier to run if the user is already familiar with the general structure of the data cube. A new task TVSPC has been written to assist in acquiring this familiarity. This task provides an exploration tool within the AIPS environment, rather than requiring users to export their cubes to one or more of the many excellent visualization tools now available. In the 31DEC17 version an additional data cube may be displayed one plane at a time.

123 New Pulse-cal Capabilities for VLBI in AIPS
Eric W. Greisen, NRAO
October 30, 2017
The DiFX correlator has acquired the capability of measuring and recording large numbers of pulse-cal tones, typically at intervals of 1 MHz through each spectral window. These pulse-cal tones have very high signal-to-noise, but show a roll-off at the edges of each spectral window and usually have one or more single channels which have amplitude and residual phase differing significantly from the average for the spectral window. AIPS has acquired the ability to deal with these data including new tasks to display and edit them and to derive calibration from them.

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 2017, a total of 408 different IP addresses downloaded the frozen form of 31DEC16 and 874 IP addresses downloaded 31DEC17 in tarball or binary form. Fully 644 IP addresses accessed the NRAO cvs master. Each of these has at least installed some version of AIPS, but with the change to the MNJ we are unable even to guess how many sites have run the MNJ. The total number of unique IP addresses in these three lists was 1383. The table below shows these numbers as a function of year since we began recording them. The usual plot of numbers versus time, which we omit, shows that 2016 and 2017 were very similar.

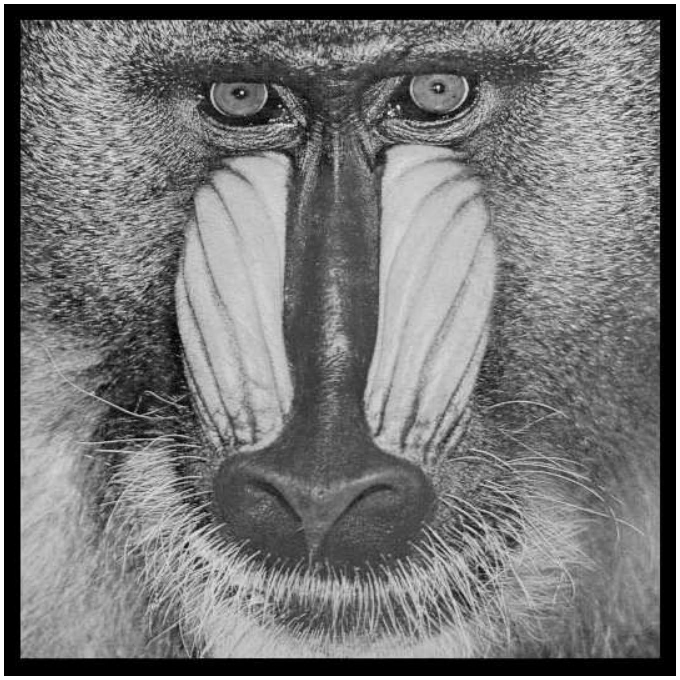
year	TST name	NEW name	TST	NEW	TST binary	NEW binary	cvs	Total unique
2004	31DEC04	31DEC03	808	196			797	1276
2005	31DEC05	31DEC04	832	246	299	48	982	1460
2006	31DEC06	31DEC05	806	191	402	94	1050	1398
2007	31DEC07	31DEC06	965	277	669	161	1385	1811
2008	31DEC08	31DEC07	1058	246	986	303	1667	2107
2009	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
2014	31DEC14	31DEC13	1045	333	848	431	1023	1843
2015	31DEC15	31DEC14	1104	309	1001	350	1070	1817
2016	31DEC16	31DEC15	878	222	788	372	761	1330
2017	31DEC17	31DEC16	874	408	768	386	644	1383

Patch Distribution for 31DEC16

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, 31DEC16 was patched during 2017 and 31DEC17 will be patched as needed during 2018. 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 31DEC16 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 2017. They are

1. POSSM would not label correlation functions in seconds *2017-01-04.*
2. ATLOD would not open disk files properly. *2017-01-06.*
3. CCRES did not honor blanked pixels. *2017-01-12.*
4. DFTPL did not use the correct frequencies when BIF > 1. *2017-01-31.*
5. DBCON scaled uvw wrongly when combining data sets of different frequencies. *2017-02-24.*
6. DFTPL did not address data correctly when the input had more than one Stokes. *2017-02-28.*
7. BPASS did not normalize linear polarization bandpasses correctly for normalization type 1. *2017-03-08.*
8. Automatic spectral index determination from the SU table had problems when one or more IFs had no flux value. *2017-03-21.*
9. UVMOD did not handle frequencies correctly with spectral index *2017-03-21.*
10. SPIXR did not label the output images with the frequency for which they were determined (1 GHz). *2017-03-31.*
11. PCAL miscomputed the flux at 1 GHz for known sources at low frequency *2017-06-06.*
12. SQASH mishandled BLC, TRC *2017-06-21.*
13. UVLSF copied tables twice to the output continuum data set. *2017-06-30.*
14. SCMAP and SCIMG messed up the self-cal step when the number of IFs was not the same as the number of polarizations. *2017-07-03.*
15. PCAL left a file open when an IF had no data in spectral mode, causing failure on the next IF. *2017-07-11.*



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