

# 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

Eric W. Greisen

National Radio Astronomy Observatory

P.O. Box O, Socorro, NM 87801-0387

575-835-7236; Fax 575-835-7027

[daip@nrao.edu](mailto:daip@nrao.edu)

<http://www.aips.nrao.edu/>

## Happy 41<sup>st</sup> birthday *AIPS* and FITS, COVID-19

The FITS format was devised in a meeting at the VLA site on March 27 and 28, 1979. Don Wells (then of NOAO) and Eric Greisen (still of NRAO) were the primary authors while Barry Clark and other NRAO staff members provided valuable suggestions. The FITS format, enhanced by later extensions, is still in wide spread use in astronomy and is the envy of other scientific fields. Then the FITS format colored the design of the *AIPS* internal formats. The *AIPS* project was begun officially on July 1, 1979 and has stood the test of time remarkably well.

Due to the outbreak of the COVID-19 pandemic, the NRAO went to “infectious disease operating status” on March 16, 2020. Telescope operations (other than ALMA) continued with a skeleton support staff. The rest of us were expected to work as best we could from home. On June 8 we began the first steps to return to the new normal. Primarily, this means that those employees who could not do their jobs properly from home have returned to work with numerous safety precautions. Those of us who can work from home will continue to do so indefinitely.

This status means that your editor does find times when he would like interesting things to do. If you find any problems with *AIPS* or have any suggestions for new or improved functions, please do not hesitate to e-mail me.

### *AIPS*Letter publication

We have discontinued paper copies of the *AIPS*Letter entirely, at least for this issue. The *AIPS*Letter 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 and mnj 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), and MacIntosh OS/X (Intel) systems may install binary versions of recent releases. Binary versions for Solaris and MacIntosh (PPC) are available for the 31DEC17 release but not for later releases. The last, “frozen” release is called 31DEC19 while 31DEC20 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 31DEC20. Having fetched 31DEC20, 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 for binary versions of *AIPS* now uses solely the tool `rsync` as does the initial installation. For locally compiled (“text”) installations, the Unix tool `cvs` running with anonymous ftp is used for the MNJ. Linux sites will almost certainly have `cvs` installed; but other sites may have to install it from the web. 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. For local versions, use a copy of the task and its help file in a private disk area instead.

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## Improvements of interest in 31DEC20

We expect to continue publishing the *AIPS Letter* approximately every six months, but the publication is now primarily electronic. There have been several significant changes in 31DEC20 in the last six months. Some of these were in the nature of bug fixes which were applied to 31DEC19 before and after it was frozen. If you are running 31DEC19, 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. There are six new tasks in 31DEC20. They are `UVRMS` to compute statistics on a time series of selected averaged visibility data, `SPRMS` to plot the spectra of mean and standard deviation of selected visibility data, `MOD3D` to convert a set of facets’ Clean Component files into a single “3-dimensional” CC table, `PDPLT` to plot polarization D-term spectra from multiple antennas and/or data sets, `DENAN` to report and remove NaNs from data sets, `MTARS` to compute rotation measure models for input to `TARS` (the test task for `FARS`), and `RMTFC` to plot the convolution of the complex rotation measure transfer function with various RM thickness models. Further enhancements to rotation-measure analysis and another task to print `SY` table data are on the near horizon.

31DEC20 contains a change to the TV display program `XAS` that makes it incompatible with previous releases when characters are displayed. 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 recent VLA data to reduce should get release 31DEC19 or, preferably, the latest release.

## UV-data

### RLDLY

A serious error was found that has been in the code since March 2015! If the visibility data were described with the “new” random parameters `ANTENNA1`, `ANTENNA2`, and `SUBARRAY` rather than the older compound `BASELINE`, then the only data used in the solution were those in which the reference antenna was the higher numbered. Thus reference antenna 1 would never have data. Since `RLDLY` can combine data from all baselines to the reference antenna, this bug caused it to omit anywhere from all to none of the desired data depending on the reference antenna number. `RLDLY` worked fine for any old format data sets, but, by now, they are no longer common.

## UVFIX

The differential aberration correction requires the comparison of the apparent position of the source to the apparent position of a point 10 asec North. Since we treat the apparent position as fixed during the run (it actually isn't), we need to do this comparison only once at the same time that we compute the source apparent position. In 31DEC18 and previous, this was done but only for the first source (with the result used for all sources). In 31DEC19 and 31DEC20, the comparison was recomputed every time a source changed which put a time change in the offset position but not the reference position. This made the correction a (false) function of time. Furthermore, when the input file was in B1950, the EPOCH variable did not stay at 2000 for this comparison. This could make the aberration correction a factor of 200 rather than 0.99992! All these issues have been corrected with the aberration correction now a function of source but not time (except for planets).

## Calibration models

Some model images of the standard calibration sources with Clean Component tables are shipped with AIPS. Rick Perley has, however, a very large set of such models for more sources and with better frequency discrimination. Access to these, from Rick's web sites, has been added. Verb CALDIR will list them and CALRD will load them into your data catalog.

Models for known sources scale the source-table fluxes by the flux found within a central circle, ignoring Clean components outside. That circle was too small and has been increased a bit. New sources, suitable for calibration at low frequencies, were added to this algorithm (3C123, 3C196, 3C295, and 3C380).

Models at low frequency require making images over a rather wide field. In AIPS this is done with multiple overlapping facets. If one has all the facets and their "2-dimensional" CC tables, the modeling routines use the facet coordinates to compute a correct model for the data. Shipping a large number of facets is however prohibitive. Therefore a new task MOD3D was written. It does the conversion of the "2-D" tables into the "3-D" form needed by the modeling code and then writes a "3-dimensional" CC table. All AIPS use of these tables was modified to handle the multiple formats that now arise.

## Miscellaneous

**CLCOR** got confused on `OPCODE = 'EOPS'` when the input CT table had multiple nearly identical entries. This arises when FITLD concatenates multiple data sets. A simple fix allows this identical groups case to work along with the more complex cases with non-identical groups.

**The** header for visibility data now keeps track of the application of calibration (DOCAL, DOBAND, and DOPOL). This information will be displayed by IMHEADER and is used to decide if warnings about a lack of polarization calibration are appropriate.

**CLIP** now reports the fraction of data flagged for each IF and polarization. The counts of flagged cross-hand polarizations were corrected.

**EDITR** and other interactive editing tasks were changed to allow the user to enter only those values needed rather than requiring the maximum number of values at all times.

**BPEDT** was given the option to set the initial plot ranges when starting up.

**ELINT** was given the options to color the symbols by source, to plot all the data (not just that time range used to in the fitting), and to control the plot range.

**DENAN** is a new task to replace NaNs (if any) in a data set with zeros.

**EVAUV** was corrected to take into account changes made to lower level Q routines last year.

**UVHOL** was given the option to fit the peak and the sidelobes on each side and then to display the fit values and their ratio.

**PRTSY** was changed to sort both new and old format SY tables correctly.

## VLBI

**APCAL** now appends new solutions to a pre-existing SN table rather than replacing such tables. A new **PLOT\_OPCODE** is available to plot the model in **TRECVR** and **TAUO** with no model fitting.

**DELZN** was changed to pass its reference date to **CLCOR** in case the reference date of the data set is different.

## Display and analysis

### XAS and new tasks

The TV server program was changed to allow an intensity value when writing characters to the display. This enables the use of color in standard plot characters through a new subroutine (**G3CHAR**). The new task **PDPLT** uses this capability. It over-plots spectra of polarization D terms from multiple antennas and up to four different data sets. Color is used to distinguish antennas and data sets and a plot label shows the colors used for each antenna. **PDPLT** is being used to study the polarization characteristics of the VLA's receivers.

New task **UVRMS** averages selected visibility data in a sequence of time intervals. It then conducts a statistical analysis of the time sequence, printing mean, standard deviation, median, first and third quartiles, median absolute deviation, maximum, minimum, and more. In order to determine whether these statistics are valid, the task offers the option to plot a histogram of the data and to plot the values as a function of time. A companion task **SPRMS** has also been written. It does a similar average to that in **UVRMS** but keeps spectral channels and IFs separate. It then makes spectral plots of the mean and standard deviation.

### XGAUS and friends

**XGAUS**, **ZEMAN**, **RMFIT**, **AGAUS** and **ZAMAN** received a variety of mostly minor improvements. In the edit window, which appears after the initial fitting of the models to the spectra, the type and extrema of any displayed image are shown in the header to the menu. That menu now includes an option to **RESET WINDOW** to change the image display to its maximum extent and the option **LABEL WEDGE?** to turn on/off intensity labeling of the step wedge. In model fitting, the initial guess is now limited to those components that were fit in the previous spectrum. This saves work constantly telling the task not to fit one or more components when that is appropriate. This is particularly important in **ZEMAN** when using the Gaussian model. Numerous other minor bugs and features were addressed. The new menu appearance was documented in revised versions of *AIPS* Memos 118 and 122.

### Miscellaneous

**KNTR** and **PCNTR** now have the adverb **PVPLT** to request a plot of a polarization vector within a box located in one of the corners. The length of this vector in Jy/beam appears in one of the plot label lines.

**EXTLIST** lists the contents of extension files in some detail. It was updated for changes in some plot tasks and to add tasks that were missing including the new plot tasks.

**PLGET** is a verb that will get the adverbs used to make a particular plot file. It was updated for missing and new tasks and changes in older ones.

**CLPLT** and **CAPLT** were corrected to work when there is only one sample. They now include the model when setting the default plot range.

**TARPL** was changed to plot the input files to **TARS** as well as the output files.

**MTARS** is a new task similar to **MODIM** to compute models of polarization in a form suitable for input to **TARS**, the Faraday rotation measure synthesis test task.

**RMTEFC** is a new task to convolve the (complex) rotation measure transfer function with various simple models of RM thickness.

## General

**Compilation** procedures were changed to avoid an issue that prevented the compilation of XAS during installation.

**fix\_aips\_elcap** was renamed and `install.pl` changed since Mac users often thought that the fix applied only to the El Capitan (10.11) version of the operating system. It applies to all versions  $\geq 10.11$ .

**Help** files were written for adverbs that lacked same. Further improvements to adverb help files are in progress.

**CookBook** updates were made for the new calibration models and new tasks as well as other changes described above.

## Patch Distribution for 31DEC19

Important bug fixes and selected improvements in 31DEC19 can be downloaded via the MNJ or from 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 31DEC20 are found, they are simply corrected since 31DEC20 remains under development. Corrections and additions are made with a midnight job rather than with manual patches. Because of the many binary installations, we now actually patch the master version of 31DEC19, meaning that a MNJ run on 31DEC19 after the patch will fetch the corrected code and/or binaries rather than failing. Also, installations of 31DEC19 after the patch date will contain the corrected code. The 31DEC19 release has had a number of patches:

1. BPASS had a bad call sequence causing aborts. 2020-01-22
2. FACSET did not include all the flux of standard calibration source models. 2020-01-27
3. UVFIX did not compute the aberration correction properly, especially when converting from B1950 to J2000. 2020-02-28
4. EVAUV did not compute the DFT subtraction model correctly, aborting due to a call sequence error. 2020-03-02
5. RENUMBER aborted if the catalog file required expansion. 2020-03-03
6. CLIP over counted cross-hand flags when cross-hands are flagged because of parallel hands. 2020-03-25
7. CLPLT, CAPLT died when trying to self-scale plots with only one point. 2020-04-07
8. VLBAUTIL had an error when trying to use curl to fetch the EOP file. 2020-04-21
9. VLBARUN had 2 errors when trying DOPLLOT=2 to make a very large number of plots. 2020-05-07
10. RLDLY had an error when selecting data. 2020-06-10
11. PRTSY sorted on the wrong column when OPCODE was set. 2020-06-12
12. CLCOR got confused on EOPS when the CT table had multiple nearly identical entries. 2020-06-19
13. OMFIT had 3 FORMAT statements that were improper when writing to character string variables. 2020-06-29

## Recent *AIPS* Memoranda

All *AIPS* Memoranda are available from the *AIPS* home page. *AIPS* Memo 117 was revised to describe changes to the Clean Components table, Memos 118 and 122 were revised to show new interactive options in the edit stage of operation.

### 117 *AIPS* FITS File Format

Eric W. Greisen, NRAO

March 12, 2020 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 is 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

May 6, 2020 revision

*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*.

### 122 Modeling Absorption-line Cubes in *AIPS*

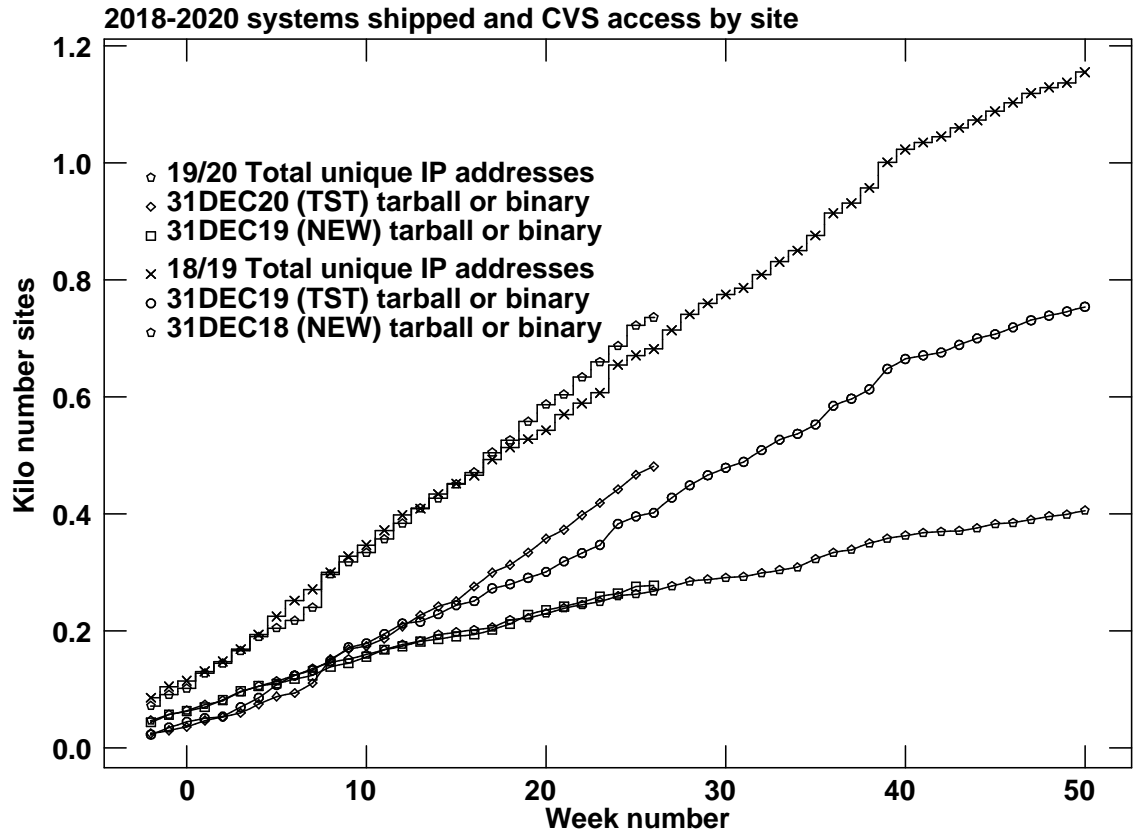
Eric W. Greisen, NRAO

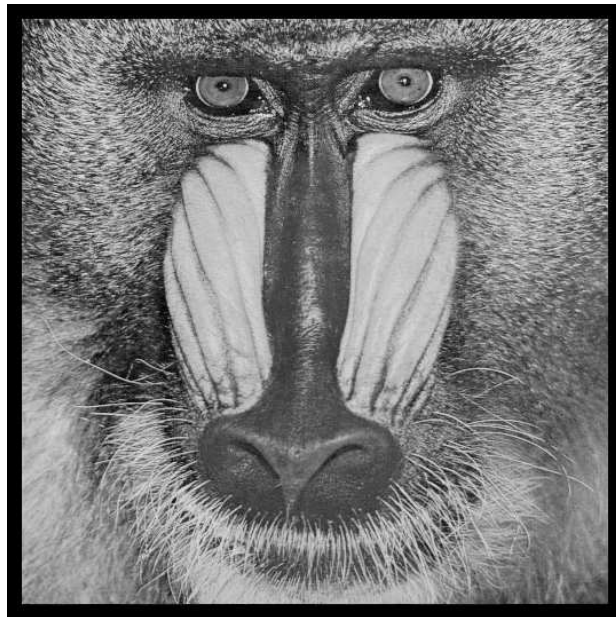
May 6, 2020 revision

*AIPS* does Gaussian fitting of spectral lines with recently-overhauled task *XGAUS* and can fit V polarization image cubes for Zeeman-splitting with the relatively new task *ZEMAN*. Both of these tasks are designed for emission spectra in which the noise is not a function of spectral channel. In absorption, however, the noise in optical depth becomes high when the optical depth is high. Therefore, new tasks *AGAUS* and *ZAMAN* have been written to provide similar functions but with mathematics suitable for absorption lines. This memo describes the new tasks in some detail and includes a description of a new, simplified modeling task *MODAB* which may also be useful. That task has shown that the results of these four tasks are biased by the presence of the Zeeman splitting and need modest correction if they are meant to describe the actual pre-splitting line widths and magnetic field.

## 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*. So far in 2020 more than 278 IP addresses have downloaded the frozen form of 31DEC19, while more than 481 IP addresses have downloaded 31DEC20. A total of 736 different IP addresses have appeared in one of our transaction log files. These numbers are noticeably higher than those of last year at this time.



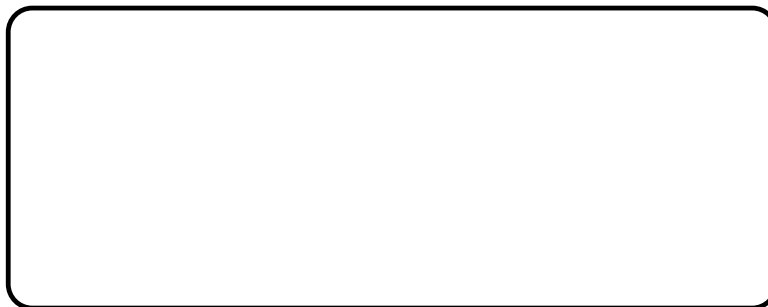


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National Radio Astronomy Observatory  
Post Office Box O  
Socorro, NM 87801-0387  
USA





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## General developments in *AIPS*

### Help desk, COVID-19

Users of the NRAO Science help desk, will notice a changed appearance. We are using new software to manage helpdesk tickets, but we hope to continue to provide help to our users as we have done. Use <https://help.nrao.edu>, the same as before.

Due to the outbreak of the COVID-19 pandemic, the NRAO went to “infectious disease operating status” on March 16, 2020. Telescope operations (other than ALMA) continued with a skeleton support staff. On June 8 we began the first steps to return to the new normal. Primarily, this means that those employees who could not do their jobs properly from home have returned to work with numerous safety precautions. Telescope operations have continued and we have even managed VLA re-configurations safely. Those of us who can work from home will continue to do so indefinitely.

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### 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 no longer binary versions available 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 31DEC20 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 2021 to convert your copy of 31DEC20 into the frozen version. However, when patches to 31DEC20

are announced in 2021, 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 31DEC21, 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 31DEC21, 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 31DEC21 *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 175-Mbyte 31DEC21.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. 31DEC20 contains a change to the XAS TV server which will cause problems with older versions. Note that the only version which we will patch for major errors is 31DEC20; even 31DEC19 will no longer be changed.

## Improvements of interest to users in 31DEC20

In the latter half of 2020, new tasks appeared including `FTARS` to do Q/U fitting of TARS Faraday rotation data, `SYPR` to print the contents of SysPower SY tables in detail, `MASKS` to make a mask image from an *AIPS* boxfile for input to CASA, `OFUDG` to process a UV data file applying a user-created algorithm to the data (FUDGE without calibration), `FIXFR` to reorder the frequencies in the spectral and IF axes to be in one direction, `BPEPL` to plot bandpass functions with multiple times over-plotted, `ACIMG` to make a frequency-time image from auto-correlation *uv* data, `RIRMS` to find the mean and rms of the real and imaginary parts

of visibility data as a function of time and baseline, and **CDFIX** to repair catalog file headers that have been corrupted in the keyword records. A new verb called **TV2COLOR** implements a 2-color scheme for the *AIPS* TV display. A new **RUN** file called **CXIMAGR** implements an experimental complex imaging process. In the first six months of the year new tasks appeared including **UVRMS** to compute statistics on a time series of selected averaged visibility data, **SPRMS** to plot the spectra of mean and standard deviation of selected visibility data, **MOD3D** to convert a set of facet Clean Component files into a single “3-dimensional” **CC** table, **PDPLT** to plot polarization D-term spectra from multiple antennas and/or data sets, **DENAN** to report and remove NaNs from data sets, **MTARS** to compute rotation measure models for input to **TARS** (the test task for **FARS**), and **RMTCF** to plot the convolution of the complex rotation measure transfer function with various RM thickness models.

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 *AIPS Letter*. 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 31DEC20 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](mailto:daip@nrao.edu) with any questions or suspicions that there are problems.

## VLBI matters

The VLB data reduction pipeline **VLBARUN** continued to get attention in the reporting period. Since significant bad data can make **BPASS** find erroneous solutions, the option to run **CLIP** before the **BPASS** step was added. **CLIP** is, optionally, run either just before **BPASS** or just before the long **FRING** step. The option to clip bad rates and then smooth the rates was added. It is done on the output of **FRING**. An option to self-calibrate all of the calibration sources before the final **SPLIT** was added. This option makes Clean images of each calibration source and then runs **FRING** one source at a time with the resulting models.

The procedures for automatically downloading EOP (Earth orientation) and TEC (Total electron content) data from NASA have changed. The procedures in **RUN** files **VLBAUTIL** and **VLAUTIL** were revised to use the new method of download (with **curl**) and the new upper part of the web address. The previous download methods and addresses were discontinued by NASA on November 1, 2020.

**FITLD** had two significant bugs corrected. The scaling of auto-correlation data from the old VLBA correlator was wrong by a factor of order  $10^6$  due to the new weight scaling. The value of **DIGICOR** was damaged for non-VLBA data, causing the correction to be omitted for any included files after the first.

**ACIMG** is a new task to grid auto-correlation data making an image with frequency and time on the  $x$  and  $y$  axes, respectively. It should be helpful in examining data sets for RFI. See the color figure at the end of this section.

## Imaging and Display

A scheme for imaging data in a fully complex fashion has been implemented. The new **RUN** file **CXIMAGR** implements the full process. **UVMG** was changed to allow uniform weighting with **ROBUST** prior to the convolution to the grid. The option to suppress the use of the Hermitian property was added as was the option to make a “beam” image with all the same weighting and convolution options. **FFT** was given new **OPCODEs** to make images from the complex  $uv$  plane images produced by **UVMG**. **CXCLN** required only minor changes to honor the input reference pixels and to actually honor the option to write a residual image rather than the restored Clean image. **CCMRG** and **PRTCC** were changed to handle complex Clean Component (**CX**) files as well as the usual **CC** files. The **RUN** file procedure **CXIMAGR** then runs **UVMG** to make real, imaginary, and beam  $uv$ -plane images. It **FFT**s them to make map-plane images. It rescales those so that the peak of the beam is one. Then it renames them as if they were **Q** and **U** images so that **CXCLN** can, optionally, Clean them. This scheme works rather well but, I suspect, is inferior to the normal imaging done by **IMAGR**.

**UVPLT** was given a new axis type “baseline” which plots the data at baseline  $i-j$  and also at  $j-i$ . It can be very helpful in finding questionable data. **IMSIZE** was added to allow control of the grid size used.

**ISPEC** and **RPSEC** were changed to allow numerous circular and rectangular windows with **NBOXES** and **CLBOX**, both of which may be set interactively with **TVBOX**.

**MASKS** is a new task to make a mask image from *AIPS*’ boxes in a **BOXFILE**. CASA requires a mask image rather than the list of circular and rectangular boxes used by *AIPS*.

**TV2COLOR** is a new verb to implement an interactive, two-color only TV enhancement. It should be useful for images having interesting negative as well as positive values such as images of Q and U polarization, residual images, or images of the deflection of the dish surface from ideal.

**TVLABEL** was corrected to preserve the data needed to plot the Clean beam.

## UV data

**RIRMS** is a new task to compute the mean and rms of the real and imaginary parts of the visibilities over short time intervals as a function of time and baseline. It prints a matrix of the mean and rms of these for all antennas. It then can plot the time series or the histograms for selected baselines.

**SYPRT** is a new task to print the contents of the SysPower (**SY**) tables in glorious detail.

**BPEPL** is a new task to plot bandpass values with multiple times on the same plot. This is like the plots in **BPEDT** but can make plot files. It uses a grid in memory to compute the plot efficiently.

**EDITA** and **EDITR**, **BPEDT**, **SNEDT**, and **PCEDT** were changed to allow use of an in-core dynamic memory to compute each plot before displaying it on the TV. In complex cases, this will speed up the operation significantly.

**FIXFR** is a new task to re-order spectral windows and spectral channels so that the frequency all goes in one direction. The VLA can produce spectral windows in seemingly arbitrary order.

**VLANT** was enhanced with **DETIME** to limit how long after an observation one allows corrections to be made.

**Calibration** tasks now emit a message to say to what parameters calibration is being, and is not being, applied.

## Analysis

**FTARS** is a new task to fit Q/U values to the input spectrum supplied to the rotation-measure synthesis study task **TARS**. It uses the algorithms of **RMFIT** with the input and output files of **TARS** to fit a complex rotation measure and polarization model to the data.

**HOLOG** had the math for reference pointed observations improved including a new option for the slope. The default magnification was changed to 13 which is correct for the VLA. The **OFFSET** equal to the distance from the prime focus and the bottom of the sub-reflector was added as an option with 0.522 meters (VLA value) as the default. The tilt parameters are now in degrees and the Cassegrain offsets may be included in the model.

**UVHOL** was changed to be more tolerant of small offsets from pure horizontal and vertical scans.

**IMFIT** and **JMFIT** now allow a 40000 pixel window.

## General

**Help** files for adverbs were systematically updated to reference all verbs, tasks, and procedures using the adverb.

**CookBook** was updated on October 21 to account for numerous changes to help files and to mention new tasks and other changes.

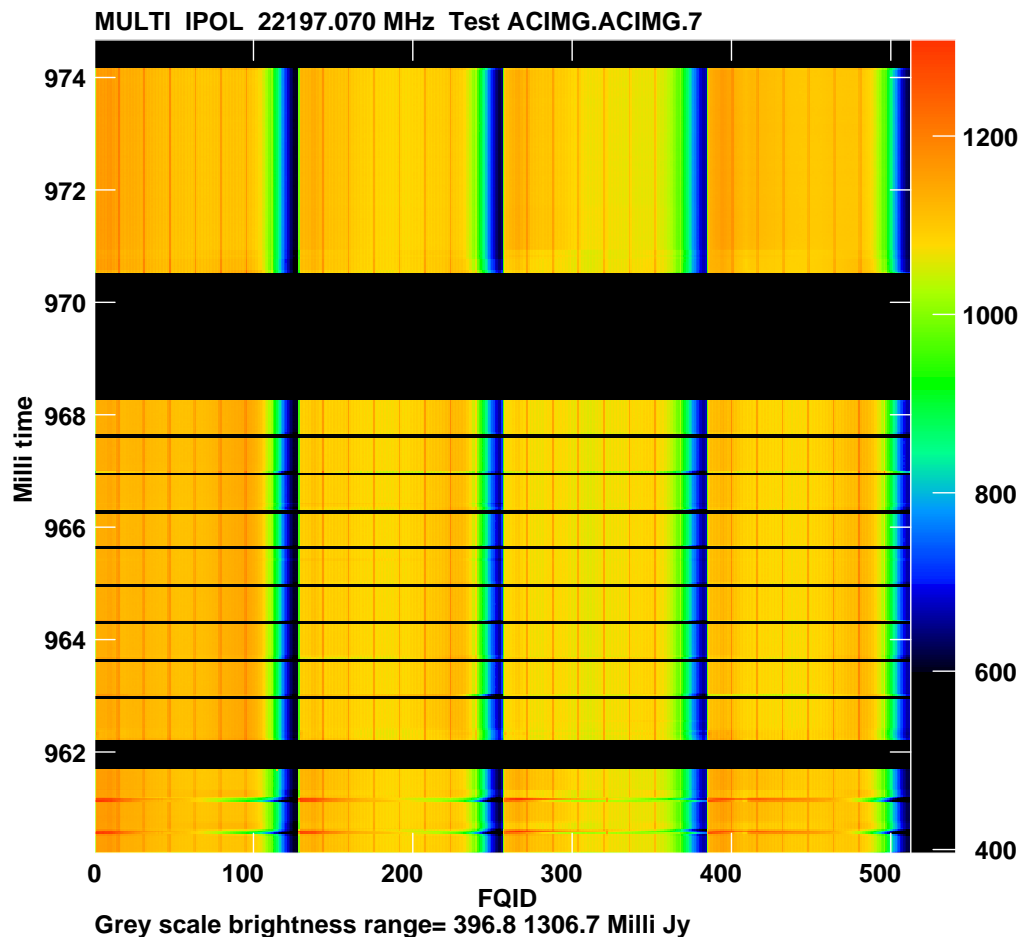
**EXTLIST** and **PLGET** were updated to account for changes to existing plot tasks and for the new ones.

**AIPSPATH** scripts were changed to put *AIPS* directories at the end of \$PATH and \$LD\_LIBRARY\_PATH variables. Because Mac OS X does not differentiate on case when executing procedures, new procedure names **AIPP**, **AIFC**, and **AILINK** were created to replace the now-conflicted names for pre-processing, compiling, and linking *AIPS* Fortran.

**OFUDG** is a “new” paraform task to process a *uv* data set through a user-created algorithm without the complication of all the calibration adverbs.

**CDFIX** is a new stand-alone program to repair catalog header files which have had the keyword section (records 2 and perhaps up) damaged.

**RedHat 6** is no longer supported. All Linux binaries are now computed on a RedHat 7 system. Mac OS binaries are now computed on a 10.15 system but with an option that should allow systems as old as 10.10 to use the load modules.

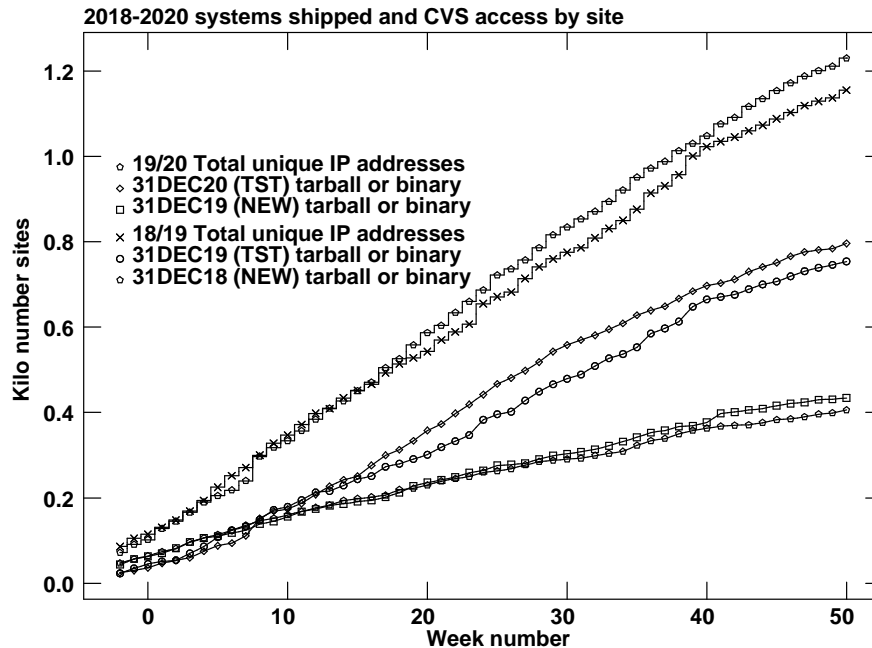


Example of output from ACIMG. The  $x$  axis is FQID (frequency ID number) because the channel increments over all 4 spectral windows is not entirely regular. The time axis is labeled in days.

## *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 2020, a total of 434 different IP addresses downloaded the frozen form of 31DEC19 and 796 IP addresses downloaded 31DEC20 in tarball or binary form. With the change to the MNJ (rsync only) we are unable even to guess how many sites have run the MNJ. The total number of unique IP addresses in these five lists was 1230. The table below shows these numbers as a function of year since we began recording them. The plot of numbers versus time shows that 2020 exceeded 2019, perhaps from people installing *AIPS* to run from home.

year	TST name	NEW name	TST	NEW	TST binary	NEW binary	Total unique
2004	31DEC04	31DEC03	808	196			1276
2005	31DEC05	31DEC04	832	246	299	48	1460
2006	31DEC06	31DEC05	806	191	402	94	1398
2007	31DEC07	31DEC06	965	277	669	161	1811
2008	31DEC08	31DEC07	1058	246	986	303	2107
2009	31DEC09	31DEC08	1228	307	1082	478	2399
2010	31DEC10	31DEC09	1228	307	1203	477	2416
2011	31DEC11	31DEC10	1105	270	1064	424	2228
2012	31DEC12	31DEC11	940	284	1028	396	1698
2013	31DEC13	31DEC12	1014	307	990	443	1937
2014	31DEC14	31DEC13	1045	333	848	431	1843
2015	31DEC15	31DEC14	1104	309	1001	350	1817
2016	31DEC16	31DEC15	878	222	788	372	1330
2017	31DEC17	31DEC16	874	408	768	386	1383
2018	31DEC18	31DEC17	684	368	603	343	1099
2019	31DEC19	31DEC18	754	406	686	388	1155
2020	31DEC20	31DEC19	796	434	750	470	1230

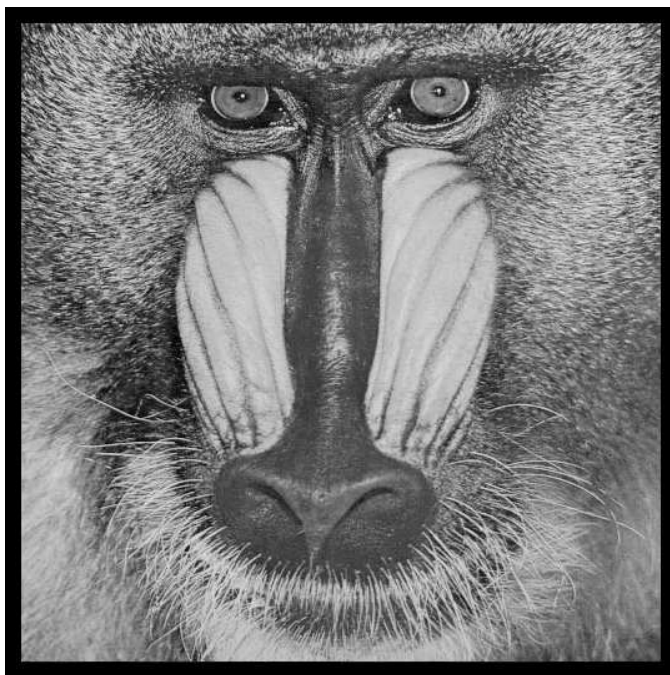


## Patch Distribution for 31DEC19

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, 31DEC19 was patched during 2020 and 31DEC20 will be patched as needed during 2021. 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 31DEC19 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 2020. They are

1. BPASS had a bad call sequence causing aborts. *2020-01-22*
2. FACSET did not include all the flux of standard calibration source models. *2020-01-27*
3. UVFIX did not compute the aberration correction properly, especially when converting from B1950 to J2000. *2020-02-28*
4. EVAUV did not compute the DFT subtraction model correctly, aborting due to a call sequence error. *2020-03-02*
5. RENUMBER aborted if the catalog file required expansion. *2020-03-03*
6. CLIP over counted cross-hand flags when cross-hands are flagged because of parallel hands. *2020-03-25*
7. CLPLT, CAPLT died when trying to self-scale plots with only one point. *2020-04-07*
8. VLBAUTIL had an error when trying to use curl to fetch the EOP file. *2020-04-21*
9. VLBARUN had 2 errors when trying DOPL0T=2 to make a very large number of plots. *2020-05-07*
10. RLDLY had an error when selecting data. *2020-06-10*
11. PRYSY sorted on the wrong column when OPCODE was set. *2020-06-12*
12. CLCOR got confused on EOPS when the CT table had multiple nearly identical entries. *2020-06-19*
13. OMFIT had 3 FORMAT statements that were improper when writing to character string variables. *2020-06-29*
14. VLBAUTIL was changed for changes in the location and access of the data files needed by VLBAEOPS and VLBATECR. *2020-07-22*
15. IMEAN and TVLABEL needed minor fixes. *2020-07-29*
16. FITLD had a bad scaling for auto-correlations from the old VLBA hardware correlator. *2020-09-02*
17. FITLD messed up DIGICOR for non-VLBA data for all files after the first. *2020-12-21*



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*AIPSLETTER*  
National Radio Astronomy Observatory  
Post Office Box O  
Socorro, NM 87801-0387  
USA

