A I P S L E T T E R

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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*

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`
`https://www.aips.nrao.edu/`

Happy 46$^{\rm th}$ birthday *AIPS* and FITS

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 the 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. The FITS format then 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.

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 `daip@nrao.edu`. Do note that the *AIPS* web site has become a secure (`https:`) web site.

AIPSLetter publication

We have discontinued paper copies of the *AIPSLetter* entirely. 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 and MNJ list server. Readers are encouraged to subscribe to one of these low volume mail lists at `https://listmgr.nrao.edu/mailman/listinfo`.

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 (64-bit only), and MacIntosh OS/X (Intel and ARM) systems may install binary versions of recent releases. The last "slushy" release is called `31DEC24`. It gets occasional bug fixes until changes in operating system versions force it to be frozen. `31DEC25` 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 `31DEC25`. Having fetched `31DEC25`, 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 ("source") installations, the Unix tool `cvs` running with anonymous ftp was used for the MNJ. That has been replaced with `rsync` to download any changed text files. The only installations to still use `cvs` are the four machines inside the Socorro Array Operations Center. Do not modify *AIPS* text files (*e.g.*, Fortran tasks) in the standard locations since `rsync` will over-write them. For local versions, use a copy of the task and its help file in a private disk area instead.

`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. You are encouraged to use a relatively recent version of *AIPS*, whilst those with recent VLA data to reduce should get release `31DEC24` or, preferably, the latest development release.

The Linux binary version of *AIPS* is maintained by a computer running RedHat 8 with 64-bit load modules. The 32-bit Linux binary release was frozen in June 2024 and there is no `31DEC25` 32-bit binary release. The `MACINT` binary version is maintained by an old Intel Mac mini and will be maintained until that machine dies. It cannot be replaced. The `MACARM` binary version is supported by an M1 Mac mini that will have its operating system updated later this year. At that time the `31DEC24` release will be frozen with no more bug fixes so that that version will not be affected by the OS upgrade.

Improvements of interest in `31DEC25`

We expect to continue publishing the *AIPSLetter* approximately every six months, but the publication is now primarily electronic. There are six new user tasks, 2 new verbs, and four new service programs in `31DEC25`. The new tasks are `SYHIS` to analyze the contents of SysPower (`SY`) tables, `IM2TX` to write one-dimensional text files from image data, `TX2IM` to create one-dimensional image files from text files, `LISPX` to compute spectral indexes from one-dimensional text files, `SPXMD` to add spectral index models to image cubes, and `OFMPL` to display on the TV all available OFM tables. The new verbs are `OFMCOLOR` to choose from 30 pseudo color tables for the current TV image and `OFMSTRCH` to modify the TV pseudo color table. The new service programs, used mainly by your editor, are `COLOR` to translate publicly available color tables into OFM files, `ADVHLP` and `ADVCHK` to be used by new script `ADVCHK` to make sure that all verbs, task, and procedures are listed in the adverb help files used by them, and `ADVCNT` to check line lengths in all help files.

Display

The *AIPS* "TV" display (`XAS`) has a rather complex internal structure which was initially suggested by the old IIS Model 70 that we used in the early days. With the advent of modern computers, we have increased the dimensions of `XAS` considerably. There are 16 memory planes, loaded with images scaled from 0 to 8191. Each enabled memory is passed through a lookup table, called the LUT, in each of the three colors. The LUT translates the inputs to the range 0 to 2045. At that point all outputs of the LUT are summed and put into another three color look up table called the OFM (output function memory). This translates the 0 to potentially 32735 sum into 0 to 255. For simplicity, *AIPS* normally uses LUTs that are the same in all three colors to do black-and-white enhancement *e.g.*, with the verb `TVTRANSF`. Also for simplicity, *AIPS* normally uses the OFM to add pseudo coloring in the range 0 to 2045 with the same coloring applied to all memory planes. The output from the OFM is in the range 0 to 255 which is all that the actual terminal screen can handle. A gamma correction is applied via the OFM since the response of the terminal is non linear. The verb `TVHUEINT` is the exception to this simplicity. It uses the LUT in three colors to take the log of the input images and the OFM to take the exponential of the sums, effectively multiplying the images through color filters.

AIPS supports the concept of OFM text files which list the values of potential OFM pseudo colorings. There are a number of verbs starting with `OFM` which allow the user to fetch, modify, and save the OFM. Verbs `OFMGET` and `OFMSAVE` were changed to pseudo-verbs, allowing the immediate argument (the name) to be typed without enclosing quite marks, Verbs `OFMADJUS` and `OFMTWEAK` were corrected to work sensibly in the range 0 to 2045. In `31DEC25`, we have added a large number of OFM tables derived from publicly available data using the new service program `COLOR`. To illustrate these tables, plus all previously available tables and any created by the user, a new task called `OFMPL` was developed. It has three display screens, one that shows up to 4 step wedges, one that plots the red, green, and blue functions, and one that shows an image with a selected pseudo coloring. The menu in all three screens lists every available OFM table in multiple columns. A new verb was created called `OFMCOLOR` which allows the user to try out numerous of these new tables; each of buttons A, B, and C can select 10 different OFMs and the verb will list the names of each OFM selected. It is hoped that one or more of these will let the user bring out the desired information in the image. A new verb `OFMSTRCH` lets the user stretch the OFM function to the left and right. That operation is also in `OFMCOLOR`.

The option `OFMCOLOR` has been added to numerous interactive tasks along with `TVPHLAME` when not already present. This includes `XGAUS`, `AGAUS`, `RMFIT. ZEMAN. ZAMAN`, `TVFLG`, `SPFLG`, `FTFLG`, `UFLAG`, `TVSPC`, and `TVIEW`. Numerous *AIPS* Memos were revised to illustrate their new menus. `TVIEW` was revised to display either a reference image or spectra with a menu option to switch between them. Windows applied to one of the displays now apply to all appropriately.

AIPS reserves the value zero in all lookup tables for magic blank pixels in the image. `TVLOAD` offers the option of interpolating the input image with `TXINC` and/or `TYINC` less than zero. That interpolation was corrected to honor the zeros strictly rather than allowing zero to be interpolated with non-blanked pixel values.

XPLOT was changed to do plotting in the normal way as well as n the previous plot methods.

SYPRT was corrected to handle looping over IFs, polarizations, and data types.

POSSM did not separate IFs correctly when they were not in a complete and regular sequence.

UV data

`SPFLG`, `FTFLG`, and `TVFLG` have received considerable attention also. They were fixed to record output flags correctly when doing clip operations in a sub window. The displays were correct but the output flags were not. Pseudo coloring `TVPHLAME` and `OFMCOLOR` were added. The waterfall plots were given the option to zoom via interpolation in both axes when the TV display is large enough to allow it. `TVFLG` also has that option but only in the time (y) axis since interpolating between baselines is meaningless. These `ALLOW X Y ZOOM ?` options complicated the clearing of flagged data, but the problems with it were solved. Clip operations now only apply to the voxel being clipped. Options to flag additional IFs, channels, baselines, *et al.* are ignored. `TVFIDDLE` was replaced by `TVZOOM` since `TVTRANSF` is better for black-and-white enhancement. A long overdue *AIPS* Memo 127 was written to describe these tasks in detail.

`SYHIS` is a new task that attempts to auto edit the SysPower (`SY`) table while providing a large amount of diagnostic information. It first measures and plots `SY` histograms. It then clips the `SY` data and runs a median window filter through the values. It compares the data to the MW filtered values and generates new histograms which it can plot and evaluate statistically. It can then clip based on the MW difference. Finally it can run a general smooth operation through the `SY` values and replace the clipped points or all points with the smoothed values. This is `TYSMO` but with smarts and the ability to use different values for each IF, polarization, and antenna. It should be regarded as experimental.

The adverb `DOBAND` was added to numerous procedures in `VLBAUTIL`. Then `DOBAND` and new adverb `BPSOLINT` were added to `VLBARUN` to allow time-dependent bandpass solutions. `VLBARUN` was also changed to plot bandpass solutions separately for each time in the `BP` table. `VLBARUN` was also given the `IN2NAME` *et al.* adverbs and `NMAPS` to allow a source model to be used in bandpass solutions.

LISTR did not check solution weights in the GAIN mode to make sure the data are valid.

NOIFS had an error in frequency computation causing the output to have one too many channels with the reference channel being one too high.

TECOR was provided with a new model of the Earth's magnetic field. IGRF14 is an updated version of IGRF13 released because we have aged another 5 years.

VLAMP and DOVLAMP were changed to handle wide-band EVLA data by selecting those IFs that are needed with the VLBA data.

Analysis

Spectral index computations received attention with TVSPX getting several new options. These included CLEAR LIST and CHAR MULT in the main menu, IMSTAT in the image menu, and CHAN RANGE, RESET CHANS, and QUIT in the redo menu. A new task LISPX is similar to TVSPX but takes its input from a one-dimensional text file which can contain a third data column to give the uncertainty. It writes an output text file that can be used as an input text file to the task. New task SPXMD was written to add models containing spectral index to new or existing image cubes. These tasks are described in the new *AIPS* Memo 126. PLOTR was given the option to read a third data column and plot it as error bars.

One dimensional text files containing spectra (or other data types) can now be read into *AIPS* as one dimensional images using new task TX2IM. The new task IM2TX reverses this process, making text files that can be read by PLOTR, LISPX, and other *AIPS* or non-*AIPS* programs.

The spectral model fitting tasks XGAUS, AGAUS, ZEMAN, ZAMAN, and RMFIT have been modified significantly. In the edit stage, they were given the OFMCOLOR option and an option to add a blotch region to the pixel list for later flagging or re-fitting. The REDO ALL and REDO LIST operations only do pixels that are bright enough. AGAUS now resets the optical depth spectrum array for each pixel to guarantee the correct spectrum when setting an initial guess. Commands are now given only with TV menus; the awkward option to type on the terminal for basic fitting was dropped. When fitting spectra in the edit stage, *i.e.*, when doing REDO ALL or REDO LIST, an additional option to flag channels is offered both before and after a fit is attempted (except for RMFIT). That option has its own menu and allows the user to flag and unflag ranges of channels interactively. The flagged and unflagged data are plotted in different colors. During the initial fitting, one can choose to turn off the TV to let the task try fitting pixels more quickly. When it gets in trouble, it will turn TV interaction back on, often dropping directly into setting a new guess. XGAUS, AGAUS, and RMFIT were changed so that the plot is in a different color when setting a new guess, thereby making it obvious that this mode has been entered. *AIPS* Memos 118 and 122 have been revised for all of these changes.

Imaging

SETFC can recommend image sizes and cell spacings. It also can make a list of overlapping facets on an hexagonal pattern. An option to generate that pattern in a rotated fashion was added. This may produce a better pattern of facets than the default. Use CHKFC and FLATN to evaluate. The TV display of images in IMAGR, SCIMG and SCMAP was enhanced with a labeled step wedge on the right hand side. It is displayed whenever the image is labeled (abs(LTYPE)$\geq$ 3).

DFTIM and DFTPL were given the adverbs ANTENNAS and BASELINE to limit the data included. Adverb OPTYPE was added to allow the tasks to image data types other than the DFT (which is the real part of the visibility after the shift). DFTIM only was given additional OPTYPEs to measure the difference between the current data value and an average of the surrounding points.

General

The documentation provided with *AIPS* has been systematically maintained as well. The new service program ADVCNT was written to check for long lines in all help files. A new service script ADVCHK was written, using new service programs ADVHLP and ADVCHK, to examine all help files to insure that all adverb help files report all verbs, tasks, and procedures that use them. A great many help files were edited as a result. Pre-existing service programs were used to update the ABOUT files and TAB-completion file. The *CookBook* was updated systematically in February and May.

AIPS plot (PL) and slice (SL) files have complex formats that do not lend themselves to FITS tables. Nonetheless, in order to allow *AIPS* users to back up these files and recover them at a later time, FITTP and FITAB were changed to write them as FITS tables. Each 1024-byte record is written as a row in this pseudo table format which is then read back by FITLD, IMLOD, and UVLOD. These "tables" are expected to be meaningless to other software systems, but do allow users to retain these potentially valuable extension files.

The verb PLGET allows a user to recover the adverbs used to make a plot file and the format of plot files was changed in 2023 to allow this verb to work mostly even if the adverbs to a plot task have changed. The verb EXTLIST tries to display information about extension files, especially plot files. Both verbs were updated for changes in plot tasks again this year.

Recent Memoranda

All *AIPS* Memoranda are available from the *AIPS* home page. Memo 126 is a new memo describing spectral index fitting in *AIPS*. Memo 127 is a new memo describing the first interactive flagging tasks in *AIPS* including the latest modifications. Memos 120, 121, and 124 have been updated to describe added display options in interactive tasks. Memos 118 and 122 have been revised to describe the changes in Gaussian, Zeeman and rotation measure fitting tasks. Memo 117 was updated to describe the slice files now written to FITS.

126 **Spectral index fitting in *AIPS***
Eric W. Greisen, NRAO
April 24, 2025
AIPS has had the task SPIXR to fit the spectral index of image cubes since 2005. Beginning in the 31DEC24 release, a new interactive task called TVSPX became available. It does the same fitting as SPIXR but then allows the user to examine the results and to try to improve upon them. This Memo will describe the usage of this new task.

127 **Interactive flagging in *AIPS***
Eric W. Greisen, NRAO
June 12, 2025
The first truly interactive task in *AIPS* was TVFLG, introduced in the late 1980s. It enabled interactive editing primarily of continuum data. A similar task suited to spectral line data sets appeared in January 1990. This task, SPFLG, has recently undergone some useful changes suggesting that this family of editing tasks should be described in a memo.

117 ***AIPS* FITS File Format**
Eric W. Greisen, NRAO
June 24, 2025 revision, adding slice files in FITS

118 **Modeling Spectral Cubes in *AIPS***
Eric W. Greisen, NRAO
July 2025 revision, describing XGAUS, ZEMAN, and RMFIT

120 **Exploring Image Cubes in *AIPS***
Eric W. Greisen, NRAO
April 20, 2025 revision, describing TVSPC

121 **Editing on a *uv* grid in *AIPS***
Eric W. Greisen, NRAO
April 30, 2025 revision, describing `UFLAG`

122 **Modeling Absorption-line Cubes in *AIPS***
Eric W. Greisen, NRAO
July 1, 2025 revision, describing `AGAUS` and `ZAMAN`

124 **Further Exploration of Image Cubes in *AIPS***
Eric W. Greisen, NRAO
April 22, 2025 revision, describing `TVIEW`

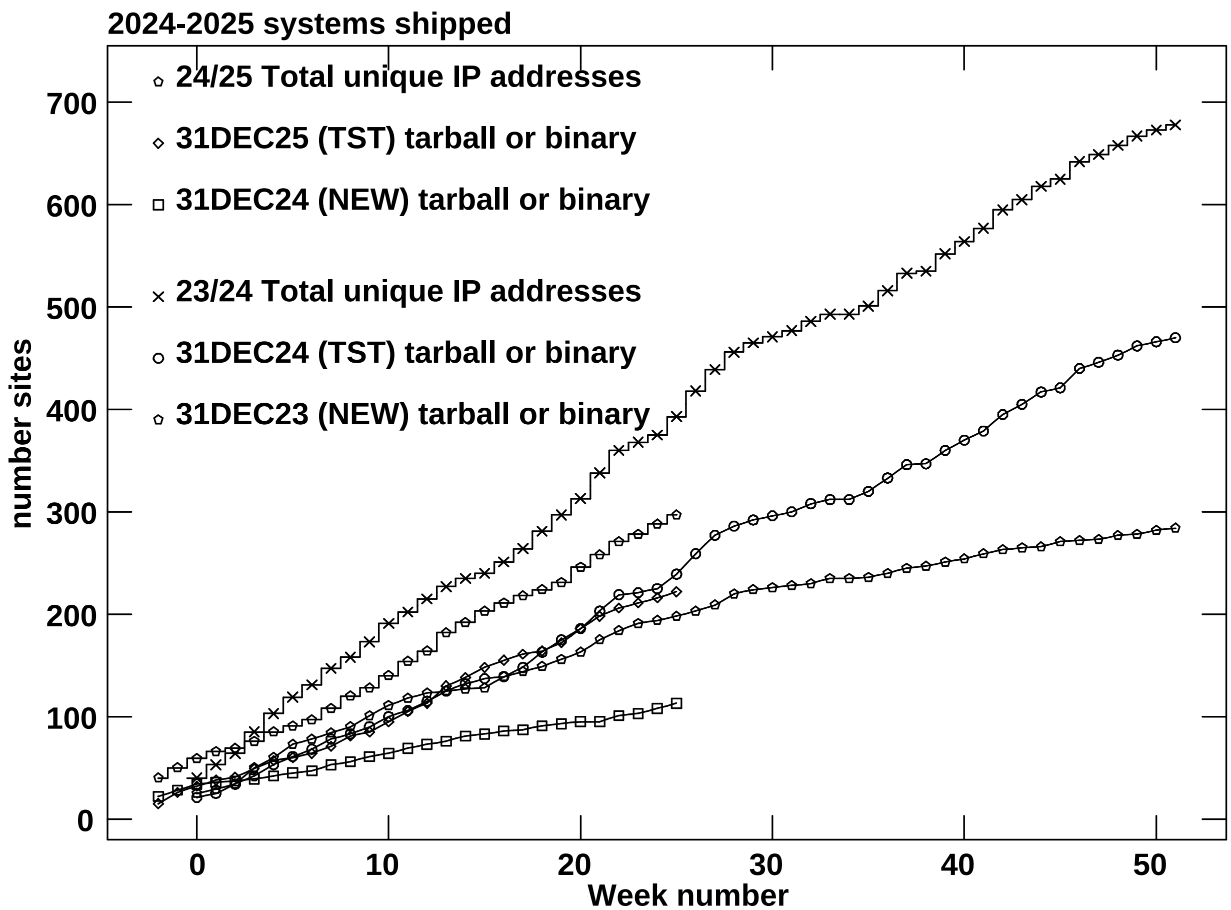
Patch Distribution for 31DEC24

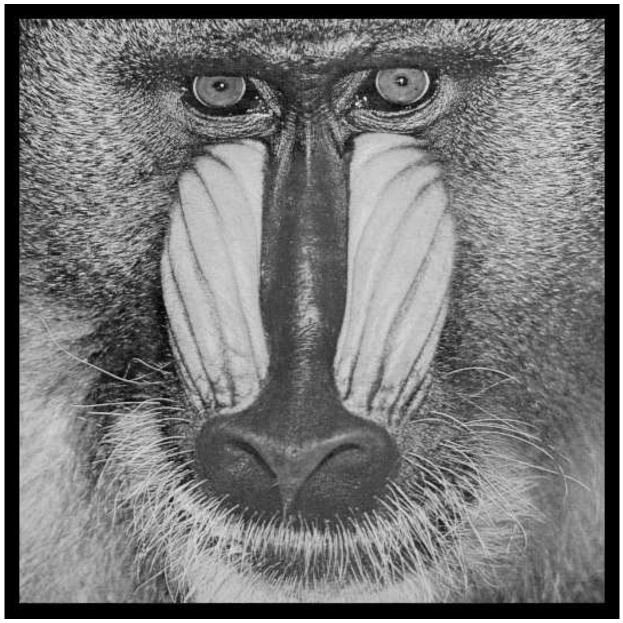
Normally, this section lists the patches that have been released for `31DEC24`. This was based on the assumption that users would want to download individual files to compile them locally. However, the "Midnight Job" (`$HOME/do_daily.`*hostname*) will do this for you on locally-compiled installations. It will also do a proper update for binary installations. Therefore there is no reason to continue the old procedure. Major bug corrections will be moved to `31DEC24` as they occur and users should use the MNJ on occasion on both the `NEW` and `TST` versions of *AIPS*. The `31DEC24` release has had a number of these "patches":

1. `TVSPX` was given new options and corrected for handling zoom and large images. *2025-01-23*
2. `QBEAM` was corrected for number of adverbs and its handling of `CUTOFF`. *2025-01-28*
3. `AU8A` (`EXTLIST` verb) was corrected for its handling of 30-value adverbs in `PLOTR`. *2025-01-28*
4. `TECOR` was changed to issue a warning about leaving the reliable model behind (date > 2025.0) only once. *2025-01-19*
5. `TEPLT` was changed to use finer plot range limits on `DIFF`. *2025-01-19*
6. `ZACTV9.C` had a C error preventing compilation on the latest compilers. *2025-01-19*
7. `FITTP` and `FITAB` were changed to write Slice (`SL`) files as pseudo-FITS tables. `FITLD`, `UVLOD`, and `IMLOD` were changed to read them back in. *2025-03-06*
8. `SYPRT` was corrected to handle page size limitations and to loop over IFs, polarizations, and data types properly. *2025-13-11*
9. `POSSM` had issues with frequency labeling when the IFs were not all contiguous. *2025-03-12*
10. `PLRFI`, `VBRFI`, `VLBRF` did not make plot files properly with more than one subplot per page. *2025-03-18*
11. `PRTSY` did not sort the `SY` table correctly. *2025-03-19*
12. `SGDESTR` left a file open, blocking many functions in `AIPS`. *2025-03-19*
13. `FITAB` and `FITTP` attempted to write the history file as a table making an error message. *2025-03-26*
14. New OFMs have been added for use in `OFMGET`. *2025-04-03*
15. `SPFLG`, `FTFLG` wrote incorrect flags to the flag table when doing clip in sub-images. *2025-04-23*
16. `NOIFS` output one too many channels and set the reference channel one too high. *2025-05-05*
17. `LISTR` did not handle arrays with more than 50 antennas well. Fixed both `LIST` and `MATX` listings. *2025-05-07*
18. `BPEDT` did not check times when deleting `BP` table records. *2025-06-23*

AIPS Distribution

We log apparent MNJ accesses and downloads of the tar balls and binary installations. 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 2025 more than 217 IP addresses have downloaded the now slushy form of `31DEC24`, while more than 223 IP addresses have downloaded `31DEC25`. A total of 297 different IP addresses have appeared in one of our transaction log files. These numbers are rather less than those of last year at this time although the numbers for `TST` are fairly close.





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