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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 43rd 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. 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.

There is less to say about Covid-19 these days. In-person access to NRAO facilities is now limited to those who are fully vaccinated with at least one booster shot. Mask use inside is determined on a weekly basis and varies from none, to suggested, to required. There is still a lot more work done from home and all meetings have a virtual component.

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.

AIPSLetter publication

We have discontinued paper copies of the *AIPSLetter* entirely, at least for this issue. 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.

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 **and ARM**) systems may install binary versions of recent releases. Binary versions for Solaris and MacIntosh (PPC) are no longer available. The last, "frozen" release is called `31DEC21` while `31DEC22` 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 `31DEC22`. Having fetched `31DEC22`, 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 is used for the MNJ. Linux sites will almost certainly have `cvs` installed; but other sites may have to install it from the web. 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 31DEC22

We expect to continue publishing the *AIPSLetter* approximately every six months, but the publication is now primarily electronic. The most significant change, so far, in `31DEC22` has been the addition of a release for the new Apple ARM chips. That required a very large number of changes to the software, with, one hopes, no changes to the outputs of that software. Closure phase and amplitude received attention, resulting in two new tasks called `EVACL` to look at closure statistics in continuum data and `CLOSE` to compute and plot closure statistics as functions of spectral channel. The RFI study software for the VLBA received attention as well. A new task, `VLBRF` was written to evaluate the median and rms over uncalibrated autocorrelation data. Numerous bug fixes and minor improvements have also been made.

`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 `31DEC21` or, preferably, the latest development release.

Mac ARM port

Apple has stopped using chips manufactured by Intel and started using their own "ARM" chips. NRAO purchased a Mac mini with this new architecture that has been used to enable an *AIPS* port to a "`MACARM''` architecture. Since this chip is so new, we were forced to use a very recent version of `gfortran` (11.0.0) and `gcc` (clang 13.0.0) to compile the code. These versions turn out to be rather more fussy about some older Fortran (and C) constructs and apparent code discrepancies (that actually were handled carefully) than were older compiler versions.

In 2018, the Fortran conventions were changed to outlaw three previously legal constructs. Two of these were deprecated in *AIPS* conventions, but were present in some of the code. The most pernicious was the "arithmetic IF" statement, *e.g.*,

```
IF (A-B) 100 110 120
```

where the code branches to 100 if `A < B`, to 110 if `A = B`, and 120 if `A > B`. Early Fortran math routines used this a lot in code that was almost unreadable. It remained in clones of `FUDGE` and in sort routines mostly. The other construct deprecated by *AIPS* was ending a `DO` loop with an executable statement, *e.g.*,

```
        DO 100 I = 1,23
100        A(I) = B*I*I + C*I + D
```

`DO` loops must now end with either `END DO` or, in *AIPS*, `CONTINUE`. The third construct, widely used in *AIPS*, was the use of a single `CONTINUE` statement to end multiple `DO` loops, *e.g.*,

```
          DO 100 J2 = 1,N2
          DO 100 J1 = 1,N1
             A(J1,J2) = FUNC(J1,J2)
   100    CONTINUE
```

This does create some confusion as to which DO loop is accessed with a GO TO 100 statement among other issues. The compiler was willing to let us use these constructs, but they were all corrected to avoid future issues.

Causing far more work, however, was the fact that the new compiler regarded apparent inconsistencies in call sequences as hard errors. Working only within the given Fortran file, the compiler would discover that certain call arguments would differ in type and/or number from one call to another. Fortran actually only passes addresses and so does not care about type or number so long as the calling and called routine know how to handle the types and array dimensions (or don't care in the case of passed work buffers). However, modern **gfortran** insists that apparent mismatches are errors rather than merely warnings (if that). In a few cases, the mismatches were in fact actual errors. But most forced the creation of EQUIVALENCEs and additional movement of data. In some cases, declaring a variable to be an "array" of (1) "solved" the number mismatch. The OOP code libraries were the most affected. For example, the simple line

```
          CALL CLNGET (NAME, 'CHANNEL', TYPE, IDIM, CHANN, CDUMMY, IERR)
```

had to be changed to

```
          CALL CLNGET (NAME, 'CHANNEL', TYPE, IDIM, DDUM, CDUMMY, IERR)
          CHANN = IDUM(1)
```

where IDUM, LDUM, RDUM, and DDUM are EQUIVALENCEd arrays large enough for the maximum parameter values. The TYPE and IDIM variables already specified the variable type and array dimensions. For example, this issue caused the large file QCLEAN.FOR, which does the Clean object for IMAGR and other tasks, to have 695 old lines of code removed and 1016 lines added.

The actual port from Intel to ARM was very easy. The operating system seems not to have changed significantly. The installation script and numerous system control files needed MACARM to be added. The Z routines were simply copied from Intel with a slight change to identify the architecture. The result was a system that runs the Y2K large test in 31 seconds (*AIPS* mark 1290)! The Intel load modules, using Apple's Rosetta capability, run the test in 40 seconds (*AIPS* mark 1000), which is already pretty spectacular. Such high speeds suggested a change to the internal parameter which scales wait times in various places within *AIPS*. The default value was raised from 20 to 500 and SETPAR, where one can set the computer's *AIPS* mark, had limits and formats changed to handle these large numbers.

Visibility closure

The "closure" phase and amplitude are functions of the visibility defined by

$$\begin{aligned} \Phi_{123} &= \phi_{12} - \phi_{13} + \phi_{23} \\ A_{1234} &= \log((a_{12}a_{34})/(a_{13}a_{24})) \end{aligned}$$

where Φ_{abc} is the closure phase for the three antennas a, b, c, A_{abcd} is the closure amplitude for the four antennas a, b, c, d, ϕ_{ab} is the visibility phase on baseline ab, and a_{ab} is the amplitude on baseline ab. So long as the instrumental complex gains are antenna based, these parameters are independent of those gains. In this case, the closure parameters differ from zero solely due to source structure (plus any non-closing noise). For this reason, early VLBI observations made extensive use of closure in model fitting. With the advent of the VLBA, however, closure has become less necessary. Nonetheless, closure can be useful in examining the quality of source models. The statistics of closure are also used to evaluate the use of sources as calibrators, *i.e.*, point sources for which closure should be zero[1]

AIPS has had, for a long time, two tasks, CLPLT and CAPLT, which plot individual closure triangles and quadrangles as functions of time. These tasks can also plot the same parameter for a source model. The tasks were cleaned up and control over the number of points in the model was added. New task EVACL evaluates closure statistics over all selected triangles and quadrangles, reporting the rms as a function of IF

[1] Xu, M.H., Anderson, J.M., Heinkelmann, R., Lunz, S., Schuh, H., Wang, G.L., 2019, "Structure Effects for 3417 Celestial Reference Frame Radio Sources," ApJ Supp., **242**, 5.

and the 3 different weighting schemes used in the Xu paper. This computation was also added to EVAUV, being done on the model divided data set (without the subtraction of 1.0). To evaluate the failure of closure as a function of spectral channel, another new task CLOSE was written. The noise in spectral image cubes often reflects this closure statistic.

Miscellaneous

The RFI evaluation procedures for the VLBA were given the DOCALIB option to control whether the standard calibrations are found and applied to the output autocorrelation data before the statistical computations. It is suggested that RFI may be complicating the system temperatures and bandpass functions, which would make the uncalibrated autocorrelations possibly more useful in evaluating RFI.. A new task, appropriate to uncalibrated autocorrelation spectra was added. VLBRF evaluates the median autocorrelation and rms (via median absolute deviation) as functions of spectral channel. It makes the same output text file and plots as the previous VBRFI task. Procedures VLBAWIDE and VLBARFI offer the choice of statistical task (and DOCALIB).

RFLAG was given the option to write out the newly flagged data set with a very large flagging work area. The writing of single-channel flags when too much of that channel was flagged was corrected to work on single-source files and to write fewer flag records.

APCLN and other tasks were corrected for a problem reading model images.

Polarization calibration had a bug that could over-write visibility data following a blanked channel. If the last channel was blanked, the u of the next visibility sample was zeroed.

SNPLT was revised to allow re-referencing independent of the choice of the X axis parameter. Previously it only worked for a time axis.

POSSM was corrected to plot all polarizations when NPLOTS was zero and APARM(9) was 2 or 3. An abort when the data included more than 50 antennas was corrected. The display of IF numbers was changed for greater visibility.

PCEDT was changed to initialize the delay-phase residuals at the start. The previous requirement to do this with a menu item was confusing.

XAS was changed to not use shared memory on both Mac architectures. The severe limitation imposed on Macs for the size of shared memory has been causing installation problems.

CookBook was updated along with other documentation.

Progress messages have been added to a variety of tasks.

TRUEP was corrected to solve for absolute polarization.

dave

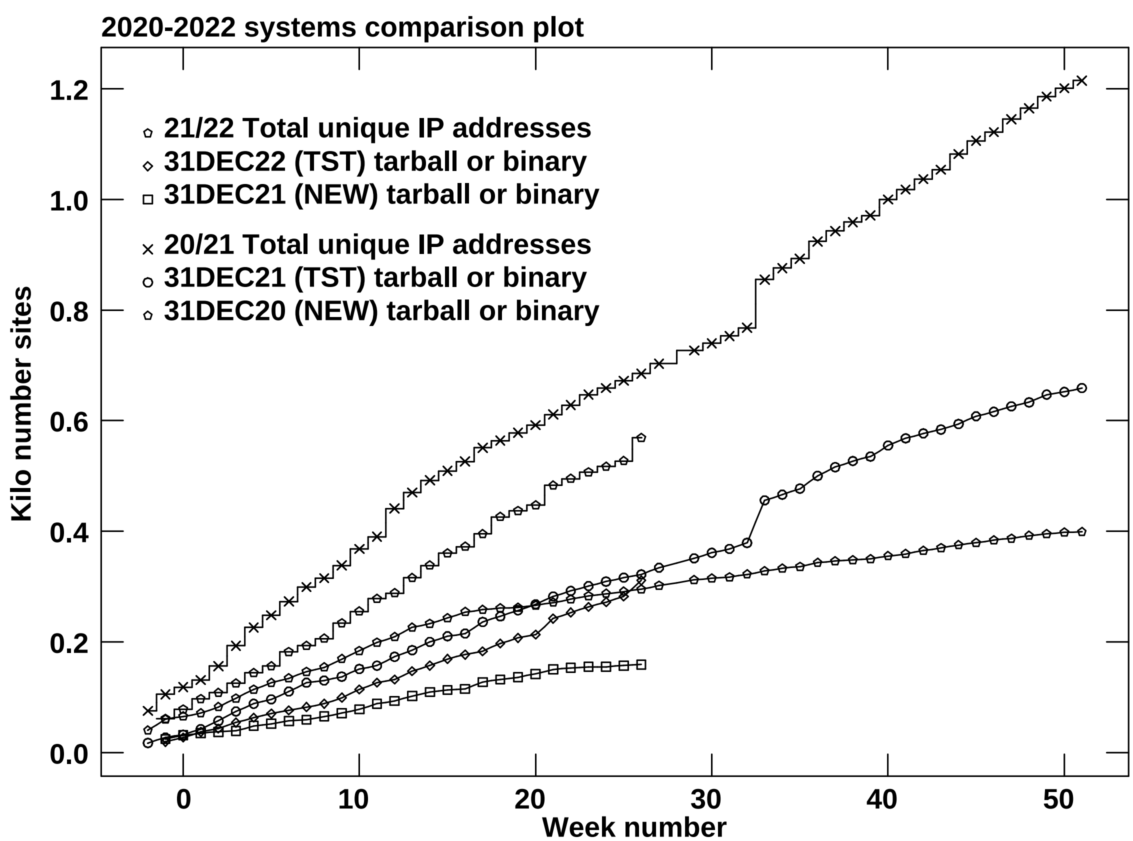
The computer named dave has been used for many years to support the main *AIPS* code repository including the cvs (code versioning system) that allows us to access older versions of any module. It turns out that the repository sat on a disk local to dave and was never backed up! Fortunately, dave has been very reliable, although it is now so old that it can run only RedHat 5. The repository has been moved to a file server machine and is now regularly backed up. The compilation procedures had to be changed to write to the transaction files even though they are not on a local disk. It was found that readline, used by AIPS to allow in-line editing, was based on a 2005 version of READLINE.SHR for the Linux versions. That was changed to use a dynamic library instead. Our Mac systems come with a static library (libreadline.a) which we use.

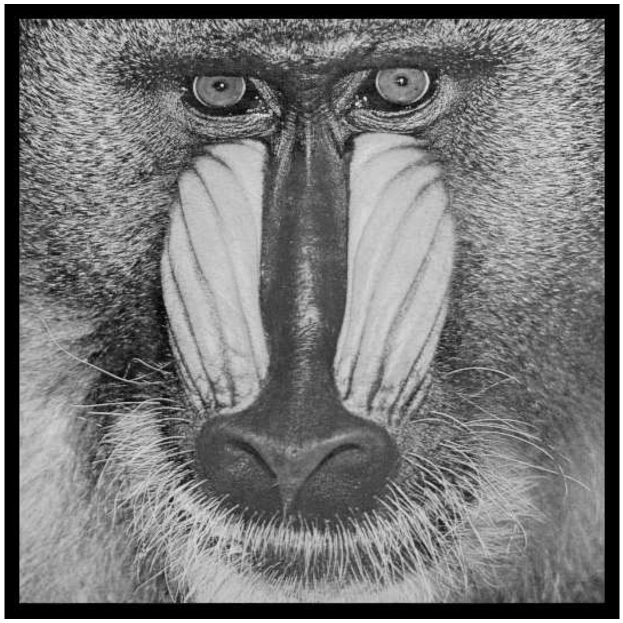
Patch Distribution for 31DEC21

Normally, this section lists the patches that have been released for `31DEC21`. 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 `31DEC21` as they occur and users should use the MNJ on occasion on both the `NEW` and `TST` versions of *AIPS*. Note that a number of bug fixes were moved to `31DEC21` on June 27, 2022.

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*. Our counting of apparent MNJs (not shown on the plot below) failed for a number of weeks due to a partly incomplete switch from dave. So far in 2022 more than 159 IP addresses have downloaded the slushy form of `31DEC21`, while more than 311 IP addresses have downloaded `31DEC22`. A total of 569 different IP addresses have appeared in one of our transaction log files. These numbers are lower than those of last year at this time, although the `TST` version is catching up.





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