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*

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AIPSLETTER Number, Personnel Changes

This AIPSLETTER is the second of two letters in volume XII of the series. The letter for the `15APR92` release of *AIPS* was erroneously labeled volume X, number 1.

Gustaaf van Moorsel has rejoined the *AIPS* group, this time stationed in Socorro, NM. His considerable experience will be a great help in providing user support and on-the-spot debugging at the AOC.

Darrell Schiebel has joined NRAO in Charlottesville to work on the *AIPS*++ project.

Ger van Diepen is visiting Charlottesville for one year from Dwingeloo also to work on the *AIPS*++ project.

15OCT92 Available

The `15OCT92` version of *AIPS* is now available. It contains significant improvements in "television" displays for workstations and in various tasks of particular interest to the VLBI community. These improvements will be described in some detail below.

The last VMS machine directly accessible to the NRAO *AIPS* group has now been dismantled. This means that we cannot write a VMS-`BACKUP`-format release tape. VMS users can get the code via `ftp` in Unix compressed `tar` format or, by special arrangement, in plain text. Tapes in the Unix compressed `tar` format are available in several shapes (half-inch reels, DATs, Exabytes). A "compressed-FITS-text" format could be made available on tape if there is sufficient demand. The program to read such a tape was never fully developed for VMS, however. It lacks one easy and two less easy Z routines for VMS. We could write the remaining code, but we have no way to test it. Nonetheless, we will attempt this route if our users seem to need it.

So far as we know, *AIPS* will still work on FPS array processors. However, we will no longer support those devices, and may develop code using Q routines that have no FPS version.

We had hoped to offer support for several additional flavors of Unix in this release. That hope will now have to be placed on the next release. Of particular urgency is Sun's shift to the Bell-UNIX-based operating system they call Solaris. Hewlett Packard (HP-UX) and Silicon Graphics versions are also anticipated. Both of these will require assistance from non-NRAO sites.

Calibration Improvements in 15OCT92

Changes to Calibration Tables and Time Systems

In the `15OCT92` release there were significant changes made to the contents of the calibration tables and to the time system used for *uv* data. These changes were driven by the needs of the VLBA and result in smaller sizes for CL tables.

While forward compatibility is not a problem, these changes have resulted in some incompatibility between `15OCT92` (and later) versions of *AIPS* with previous releases. Due to a bug in the older software, the new CL tables cannot be applied in systems older than `15APR92`. New CL tables can be applied by older versions if a patch is made to `$APLSUB/CLREFM.FOR` (see the Patch Distribution article below). Alternatively, VLA data can be recalibrated in older systems by deleting the new-format CL and SN tables and creating a new, old-format CL table using `INDXR`. The final `CALIB` and `CLCAL` (and `CLCOR` for polarization data) steps of the calibration need to be repeated. Your editing and determination of secondary calibrator fluxes (FG and SU files) are not affected by these changes.

The CL and SN tables were changed to include a multi-band delay column for each polarization. This multi-band delay is not a part of the residual calibration but is kept for model accountability. Also, the phase for each IF was changed to be at the reference channel for that IF rather than at the over-all reference frequency. This means that this phase is no longer a function of the single band delay.

The system temperature values were removed from the CL table. Separate TY tables have been implemented to contain system-temperature information.

The model accountability in the CL table has been changed. The geometric portion of the model delay is given as a time series polynomial (column `GEODLY`) and columns `GEOPHA` and `GEORAT` have been removed. There is a single atmospheric group delay and first time derivative per antenna/time (`ATMOS` and `DATMOS`). Each polarization has a separate clock epoch and rate error (`CLOCK`*n*, `DCLOCK`*n*). Each polarization also has a dispersive term (`DISP`*n* and `DDISP`*n*) which is the phase delay at a wavelength of 1 meter and scaled as wavelength squared.

The time system associated with *AIPS* time labels for *uv* data was simply assumed to be IAT. Our new scheme will allow any time system with a fixed offset from UTC. This offset is carried in the AN table along with a character string label specifying the time system.

VLBI Polarization Calibration and Imaging

The `15OCT92` release contains a number of enhancements to the VLBI polarization calibration and imaging capabilities of *AIPS*. *AIPS* Memo Number 79 describes several techniques for polarization calibration and suggests a method of calibration and imaging of VLBI polarimetric data.

A procedure called `CROSSPOL` was implemented to simplify the calibration of the cross-polarized delay and IF-peculiar right-minus-left (R–L) phase difference. This procedure is defined by entering `RUN CROSSPOL`, and it has both inputs and explain documentation. The end result of the procedure is an SN table containing the appropriate cross-polarized delay and phase corrections to be applied to a CL table.

`CROSSPOL` begins by copying a user-selected subset of his/her data, usually a single baseline observation of one or more strong calibrator sources. A parallel-hand fringe fit is run on this subset to correct the R and L delays and phases. Then, the R and L polarizations are swapped for one of the antennas using task `SWPOL` and `FRING` is run again to determine cross-polarized single- and multi-band delays (and any IF-dependent peculiar R-L phase differences). Finally task `POLSN` munges the output of this last `FRING`, producing an SN table which is copied back to the original data (where it can be applied using `CLCAL`.

Imaging of data with asymmetric coverage (some data samples with one, but not both, cross-polarizations) is supported in this release. Procedure `CXPOLN` simplifies the process, using a combination of the new task `UVPOL` and the old familiar `MX` to produce complex dirty images and beams. New task `CXCLN` will then do a complex Högbom CLEAN deconvolution of the Q and U images. This procedure is defined by entering `RUN CXPOLN`, and it has both inputs and explain documentation.

VLBI data input

A number of changes as well as bug fixes were made to MK3IN, our task to read Haystack-format MkIII VLBI correlator tapes. MK3IN now offers the option to split upper and lower sidebands into separate IFs. In order to support this, the maximum number of IFs allowed in *AIPS* was raised to 28. MK3IN now shifts all frequency channels by one-half of a frequency cell to avoid the zero frequency and no channels are automatically blanked. This produces 8 frequency channels for double-sideband data. AIPS verb TELL can now be used to terminate MK3IN gracefully.

Data editing

The baseline-oriented interactive editing task IBLED was substantially rewritten to be considerably faster and to handle the flag command table, more than one polarization, multiple frames in the data, the master file, workstation windows, and numerous other matters correctly. It now also offers the option to flag on "decorrelation", defined as the ratio of the vector- to the scalar-averaged amplitudes, and on the ratio of any 2 IFs present in the data. It also offers the one- versus all-source option for each flag prepared and will also determine a "best" time interval by default. TVFLG and SPFLG were also changed to pick up some of the better changes to IBLED, including on-line help for all menu items, cataloging even temporary master files, more flexible and correct handling of Stokes flag masks, and more efficient application of flagging to single-source files. SPFLG was given a new menu option to show the next baseline.

Total electron content data for FARAD

The *AIPS* task FARAD, which corrects for ionospheric Faraday rotation requires total electron content data for the period of observation. These data are distributed with *AIPS* in the directory with the logical name $AIPSIONS. The data files follow the naming convention TEC*s.yy* where *s* is a station code and *yy* is the last two digits of the year. Currently data are only available from Boulder (station code B), the closest ionosonde to the VLA, and are complete up to May 1992.

The data are also available from baboon.cv.nrao.edu by anonymous ftp (from area pub/aips/TEXT/IONS). We will announce the availability of new ionospheric data on bananas and the alt.sci.astro.aips newsgroup as soon as we receive updates from Boulder.

Additional Improvements in 15OCT92

TV servers and programs

Almost all TV applications verbs and tasks were changed to take full advantage of the new asynchronous capabilities of XAS (see below). As a result, displays change less smoothly, but much faster. Verbs GREAD and GWRITE were added to allow users to read and set the colors of the TV graphics overlay planes. Two new tasks were created to allow nearly full color displays even on workstations (see *AIPS* Memo Number 82 for additional details). One of these, TVHUI, does a TV display, with optional output file, in which one image controls intensity, a second image controls hue, and a third, optional, image controls saturation. All levels of a single TV memory are used and the results are surprisingly good (at least without the saturation image) on workstations with only about 200 levels. This task should be used with spectral-line moment images, continuum polarization images, and numerous other possibilities. The second task is called TVRGB and is used to display independent red, green, and blue images using a single TV memory. A "median-cut" algorithm is used in the histogram of the images colors to optimize use of the limited number of levels available on the TV. This task can be used to display "true-color" images and outputs from TVHUI and RGBMP, or to compare images such as comparing optical and radio images of a source or even the same image with significantly different scalings. Both tasks offer a menu of interactive enhancement and display options.

A number of changes have been made in the 15OCT92 version of the *AIPS* television driver XAS, resulting in considerably improved performance. First, the DISPLAY variable was changed from *host*:0 to simply :0, where possible. This should prompt the X server to use Unix sockets rather than Internet sockets, with some improvement in performance. Second, the "blit" of the image from XAS's memory to the display was changed to be as large as possible on each display update. Previously, only a row at a time was blitted when the image was zoomed and/or contained graphics overlays. Third, the XAS memory was changed to use, optionally, the X extension called "shared memory." This greatly improves blit speed after an initial overhead to synchronize the memories. Fourth, the application code was provided with the option to ask XAS to delay updating the display until instructed to do so. This allows multiple graphics planes to be turned on with a single screen update, a full image to be loaded with a single blit to the display rather than one blit per row, multiple line segments of a plot to be drawn with a single blit to the display rather than very many small blits, and so forth. This option, implemented with subroutine YHOLD, is dangerous in that it requires considerable care on the part of the application programmer to make certain the the display is brought up to date whenever required. As some protection against programmer error, subroutine TVCLOS forces synchronization. Also the new XAS allows the user to set (via his or her .Xdefaults file) a maximum number of commands to be done asynchronously before XAS itself forces an update of the screen.

The older television drivers, XVSS and SSS, were changed to allow the YHOLD command and SSS even supports it. A bug in the screen addressing for all three drivers was corrected. This caused too many pixels to be sent to the display frequently, but no serious error. The output buffer in XAS, which was too small to support reading a full image row of the TV, was increased. The new XAS was changed to allow users to set the maximum image intensity used. This allows one to choose between high dynamic range (up to 237 levels) and the distraction caused by using different workstation color tables when the cursor is inside and outside the *AIPS* TV window. The XAS help file was also improved.

Tape programs

The performance of Berkeley sockets over Ethernet connections depends critically on the size of the data blocks being transmitted. If they are too small (requiring many connections) or too large (requiring subdivision into multiple segments), then the throughput is reduced by factors of two or more. For the 15OCT92 version, we changed the remote tape open and I/O routines to raise the assigned buffer sizes to the maximum size we could ever need (29000 bytes). This was the simplest of several solutions to give optimal performance, *i.e.*, performance equal to that for directly-connected tape devices. See *AIPS* Memo Number 80 for details.

A number of other changes were made to tape programs. FITTP was given the ability to write out the extra keywords now recorded with *AIPS* image and *uv* headers. A special form is used so that *AIPS* FITS readers (FITLD, IMLOD, UVLOD) can now read the parameters and put them back into the *AIPS* headers' keywords. A "new" tape operation was created to allow FITTP to write anywhere on a tape. Previously, at least on Exabytes, it was restricted to writing either at the beginning of tape or at the end-of-information. BAKLD and BAKTP were made to work better and to work on IBMs. Several minor inadequacies were corrected in FILLM. Serious bugs in writing the frequency into the antenna file and in setting the final file size were corrected. In addition, support for "on-line" uses of FILLM and for AIPS' SHOW and TELL verbs was added. Additionally, the procedure which starts the remote tape dæmons was made more powerful, the tape Z routines were given more explanatory error messages, bugs reading labeled tapes were corrected, and mounting of remote tapes on Convexes was made somewhat more reliable.

New programs for optical data

Several new tasks were added to 15OCT92 *AIPS* primarily to assist in the reduction of optical data. New task STFND uses a threshold-area algorithm for finding stars. New task GSCAT reads the STScI Guide Star tapes to find stars in the neighborhood of a specified coordinate. New task GSTAR converts the files created by GSCAT to *AIPS* ST tables to be used for plotting, for locating optical counterparts, and/or for transforming celestial and image coordinates. New task STRAN attempts to identify stars on optical images automatically using the list of stars in an ST file. Also, the median-window-filter task, MWFLT, was improved to do either a high- or a low-pass filtering.

Miscellaneous changes

Other corrections and improvements made to $\mathcal{AIPS}$ for the `15OCT92` release include:

ACFIT Added the option to write the baseline-corrected, total-power spectra to an output file.

CLCOR Added option to correct blanked phases using any valid ones with specified relationships between the IFs.

DBCON Changed to correct the u, v, w to reference channel one, allowing correct imaging of multi-channel continuum data which are first `SPLIT` and then `DBCON`ed. Also fixed to handle more channels and/or IFs.

HYB New procedure to simplify "hybrid mapping" using `CALIB` and `MX` with user editing of the CC file and a contour plot.

LISTR Corrected bug that caused the wrong columns to be printed when examining tables, corrected bugs handling times in tables and multi-band delays, and changed it to examine the full data set to determine the scaling for `GAIN` listings.

LWPLA Changed to produce Postscript suitable for encapsulating and to offer additional user controls over plot orientation, fonts, and the like. Corrected handling of vectors that go partly off the page in all plot programs. The error was serious only for `LWPLA` apparently.

POSSM Corrected its handling of flagged data and of times, changed it to plot a line at 0 in phase, real, and imaginary plots, changed it to use the full TV screen when `DOTV` is true, and to be properly interactive when doing multiple plots to the TV. Corrected the `EXTLIST` display of `POSSM` plot files as well.

UVCOP Corrected the handling of the reference frequency in the antennas files.

UVPRT New task to print *uv* data in the format of `PRTUV`, but with application of all standard calibrations and a special mode for holography data.

VBPLT Corrected to use data from the desired subarray and CC file, to apply baseline-dependent calibrations, and to show the CC file used.

Miscellaneous changes for programmers

Several rather technical but useful changes were made to this release which are primarily of interest to programmers.

ZACTV9 Rewrote the task activation to use POSIX standards, to create the task as a grandchild process thereby avoiding the accumulation of zombie processes, and to avoid creating link files in load-module areas when tasks are not being debugged.

ZABOR2 Took advantage of the change to `ZACTV9` to allow tasks being run in the presence of the debugger to trap exceptions normally unless they are being run in debug mode and to allow all tasks to trap floating-point exceptions.

COMLNK Changed compilation procedures to use list files to determine which programs should be optimized at which levels on which hosts.

TSKHLP New subroutine to allow run-time help information from inside tasks read from files named `$HLPFIL/HLP`*taskname*`.HLP` and displayed with `MSGWRT`.

APLNOT Cleaned up this area deleting unused subroutines which caused unresolved external reference messages to appear when linking with shared libraries. Also changed several tasks to provide the large buffers in the tasks rather than declaring them in the subroutines where they are actually needed. Large buffers declared in subroutines appear in all load modules, whether they are used or not, when shared libraries are used. Some large buffers and a few unavoidable unresolved references still remain.

TEXT The *AIPS* text areas containing ionospheric data, TV OFM tables, and publications (`COOKBOOK`, AIPSLETTERs, *AIPS* Memos, old `CHANGE.DOC` files) will be included on the release tape this time. They were inadvertently omitted in recent years.

Patch Distribution

Since *AIPS* is now released only semi-annually, we have developed a method of distributing important bug fixes and improvements via *anonymous* `ftp` on the NRAO Cpu `baboon` (192.33.115.103). Documentation about patches to a release is placed in the anonymous-ftp area `pub/aips/`*release-name* and the code is placed in suitable subdirectories below this. Reports of significant bugs in `15APR92` *AIPS* have been relatively few; however, the documentation file `pub/aips/15APR91/README.15APR92` mentions the following items:

INSTEP1 This initial installation procedure could clobber existing files if restarted.

START_AIPS `AIPS` start-up script failed when there is only one printer at a site or when there is a numeric digit in the host name of a TV server.

ZVTP*.C `$APLBERK` versions of remote tape open and I/O routines altered for significantly better performance.

MX Spectral-line data with poor phase calibration may fail to converge in cleaning due to an error in the test for divergence.

XTRAN Raised the size of the images and the number of stars that can be used to transform an (optical) image to standard coordinates.

Note that we do not revise the original `15APR92` tape or `tar` files for these patches. No matter when you received your `15APR92` tape, you must fetch and install these patches if you require them. See the `15APR92` AIPSLETTER for an example of how to fetch and apply a patch.

One more patch has been added to the `15APR91` area in addition to those listed in the previous AIPSLETTER. This is

SPLIT An error in `$APLNOT/CLREFM.FOR` prevented modern CL tables from being used by older versions.

As bugs to `15OCT92` are found, the patches will be placed in the `ftp` area for `15OCT92`.

VLBI Summer School Announced

The NRAO will hold a summer school in Socorro, NM June 23–30, 1993. Continuing the series of NRAO summer schools, this school will emphasize VLBI theory and techniques. In particular, we wish to provide students and other future users with an opportunity to become familiar with the capabilities and user aspects of the VLBA. The program will include lectures and demonstrations by NRAO staff members and by several invited speakers from the VLBI community.

If you are interested in attending the summer school you should contact Terry Romero at:

NRAO Summer School on VLBI Techniques
National Radio Astronomy Observatory
P. O. Box 0
Socorro, NM 87801

or

email: tromero@nrao.edu
fax: (505) 835-7027

Improved Tape Support Planned

We are planning to put greater support for a variety of tape devices into the *AIPS* tape Z routines. We would very much like to hear from all sites using tape devices on workstations except those using ordinary Exabytes with standard SCSI controller. Please let us know the manufacturer, model, controller, software driver, and any changes you have had to make to the *AIPS* Z routines for your tape devices. Please address your comments to eallen at the addresses in the masthead. He will forward them appropriately.

Latest *AIPS* Memos

Below is a list of the latest *AIPS* Memos.

MEMO	DATE	TITLE and AUTHOR
*76	91/11/27	Summary of *AIPS* Continuum UV-data Calibration, from VLA Archive Tape to UV FITS Tape (supersedes memo 68) Glen Langston, NRAO
77	92/09/03	Summary of DDT Accuracy Results Ernest Allen & Glen Langston, NRAO
78	92/06/01	Object-Oriented Programming in AIPS Fortran W. D. Cotton, NRAO
79	92/06/09	Polarization Calibration of VLBI Data W. D. Cotton, NRAO
80	92/06/30	Remote Tapes in AIPS Eric W. Greisen, NRAO
81	92/08/26	Tape and TV Performance in AIPS Eric W. Greisen, NRAO
82	92/09/24	Replacing the Convexes — New Color Algorithms in AIPS Eric W. Greisen, NRAO

To order, use an *AIPS* order form or e-mail your request to aipsmail@nrao.edu. Memos can also be gotten via anonymous `ftp`, except for figures which may be missing in those denoted by an asterisk.

To use `ftp` to retrieve the memos:

1. `ftp baboon.cv.nrao.edu` or 192.33.115.103
2. Login under user name anonymous and use your e-mail address as a password.
3. `cd pub/aips/TEXT/PUBL`
4. Read `AAAREADME` for more information.
5. Read `AIPSMEMO.LIST` for a full list of *AIPS* Memos.

AIPS Memos from Number 69 through 82 are present in this area as well as a few of the earlier ones. All are avaiable in paper form from Ernie Allen at the addresses in the masthead. Note that the anonymous ftp areas for memos, the `COOKBOOK`, and other text files have been changed to parallel the areas in the main *AIPS* directory tree.

Computing at the NRAO

The computing environment at the NRAO, both in Charlottesville and in Socorro, has been changing fairly rapidly. All of the old VAX 780s with their FPS array processors have been dismantled and carted away. The Convex C-1 computers will be phased out soon. We anticipate that the Charlottesville C-1 and one of the two C-1s at the AOC will be turned off around January 1, 1993. The other C-1 will be operated for some period of time without a maintenance contract, perhaps up to six months. This will affect $\mathcal{AIPS}$ users since we will no longer have a Convex cpu to test Convex-specific matters, we will no longer have any hardware TV devices (*e.g.*, IIS Models 70 and IVAS), and we will be operating with rather fewer half-inch tape drives.

To replace the Convexes, NRAO has recently purchased five IBM RS/6000 Model 560 workstations, each with 64 Mbytes of memory, an Exabyte tape, and 3 Gbytes of local disk. One of these is in Charlottesville and the other four are at the AOC. These workstations achieved a rating of 2.56 $\mathcal{AIPS}$marks, where a Convex C-1 achives about 1.0. $\mathcal{AIPS}$marks are based on the total time to run the large `DDT` test, as 5000 divided by this total time in seconds minus 60% of the real time of `ASCAL`. In addition, the NRAO has bought one large workstation for data visualization for each site. These are also IBM RS/6000 Model 560s, but equipped with a Model 7235 POWERgraphics GTO subsystem plus 256 Mbytes of memory and 3 Gbytes of local disk. Both are supplied with the AVS data visualization software package.

The "basic" workstations are already in routine use for data reduction with $\mathcal{AIPS}$ and other software. However, we are still trying to decide how best to use the visualization stations. To discuss this, we are holding a meeting October 19–20 involving people from both sites and from at least one non-NRAO site (University of Illinois).

We have also purchased a significant number of new tape devices, primarily Exabytes and DATs. In Charlottesville, there are now six tape devices on the IBM RS/6000 Model 530 called `lemur`, two each of half-inch, Exabyte, and DAT types. These replace the six half-inch drives of the VAX and Convex. A public Sun is also equipped with both an Exabyte and a DAT drive. At the VLA site, a Sun has been purchased to copy half-inch data tapes from the on-line system to Exabyte tapes for export from the site. The full VLA archive is being copied from (old) half-inch tapes to Exabytes. The AOC anticipates having three half-inch drives on Sun workstations for this project and for reading half-inch tapes generally. And all of the public workstations at the AOC have an Exabyte drive and many will also have a DAT drive. These replace the eight high-speed half-inch drives currently on the AOC Convexes.

All of the IBM workstations in Charlottesville (3) and the AOC (6) plus one Sun IPX in Charlottesville and seven Sun IPX's at the AOC are for public, but assigned, use. All public workstations have an Exabyte tape drive and 2 or more Gbytes of local disk. Visitors should call John Spargo at the AOC and Jim Condon in Charlottesville well in advance ($\geq$ 2 weeks) to arrange for use of these workstations.

At the VLA site, there is now a Sun workstation called `miranda` for visiting observers. A near-real-time version of `FILLM` is available to fill data into $\mathcal{AIPS}$ as it arrives. An Exabyte tape drive is also available on `miranda` to export data in FITS format for further reduction at the AOC or elsewhere. To sign up for `miranda` and reserve disk space (data files will have a lifetime of three days unless other advance arrangements are made), contact George Martin at the AOC at least one working day before the observing run.

And a Brag

On May 6, 1992, the VLBA Correlator obtained its first astronomical fringes using the W3(OH) masers at 18-cm wavelength. Within 12 hours, these data were read into $\mathcal{AIPS}$ 2000 miles away. The data were promptly sorted and plots produced of both the visibility functions and the spectra. `AIPS`' verbs even allowed the few minor rough spots in this data transfer to be covered over so that correctly annotated plots were produced.