PIPELINE USER'S MANUAL

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0. INTRODUCTION

The PIPELINE is a system of hardware and software designed for fast mapping of large amounts of visibility data and efficient cleaning of maps. The system is nearly fully developed and its power is available to alleviate present bottlenecks in the DEC-10 system and in AIPS. This manual describes the present capabilities and suggests how the PIPELINE can be used optimally for various observational projects. Please report any inaccuracies and errors in the manual to Ed Fomalont x247 at the VLA.

The manual is organized as follows:

This brief manual is meant to give an overview of the PIPELINE and its use. Detailed documentation for running the specific programs can be found in the PIPELINE Reference Manual (PRM) in the yellow binder, in the Observer's Reference Manual (ORM), and through the usual on-line documentation of INPUTS and HELP. A detailed description of the PIPELINE system can be obtained in PIPELINE SYSTEM REVIEW, Version 7, May 15, 1984, available from Ina Cole and in the PRM.

Because the PIPELINE system is still being developed and debugged, it is important to the VLA staff if you report all problems, suggestions and inconveniences as soon as possible. Use the software trouble report forms for minor problems and contact someone knowledgeable for major problems (Bob Duquet, Ed Fomalont, Jacqueline van Gorkom, Bob Payne, Don Retallack).

PIPELINE maintainence will occur once a week, generally on Wednesday between 0900 and 1600. The schedule is posted and no user jobs will be accepted and those still running may be terminated. In addition each day between 0900 and 1100 may be preempted for PIPELINE system use.

1. WHAT THE PIPELINE CAN DO

There are three ways in which the PIPELINE can be used effectively.

1. Mapping and cleaning visibility data on the PIPELINE
2. Mapping and cleaning visibility data on the DEC-10
3. Writing calibrated visibility data onto tape

1.1 Mapping and Cleaning a PIPELINE Visibility Data Base:

The data volume associated with large continuum projects and even moderately-sized spectral line projects are now too large for the DEC-10 to handle adequately. Disk space is tight, computer power too modest and the I/O traffic too dense. An alternative procedure is to put all of the visibility data directly into the PIPELINE (using the program DBFILL) and to put only the calibrator data into the DEC-10 (using the program FILLER with special options). This filling will normally be done by the telescope operators and details are given in Section 4; however, you should check with the operations department well before your run to talk over details of the filling of your data.

Using the standard DEC-10 software, the calibration parameters and most of the flagging can be obtained from the calibrator data in the DEC-10. This calibration and flagging information is then sent from the DEC-10, via the DBNAME.INX and DBNAME.GAI files, to the PIPELINE where mapping and cleaning are done (programs GRIDER and CLNMAP), or where the calibrated data is written on tape (program UVFITS). In this manner much of the load on the DEC-10 is alleviated while still using its basic editing and calibrating capabilities.

For spectral line data bases containing more than about 2,000,000 visibility points (visibility samples x channels) or large continuum data bases, writing only the calibrator data in the DEC-10 and all of the data in the PIPELINE should be considered. The limitations, at the present time are:

1) Data flagging can only be done over scan intervals for any set of antenna-IF's. Flagging of specific correlators or spectral line channels or flagging over arbitrary time ranges which include only part of a scan are not yet possible. Thus, to edit out an interference spike over a selected time range during a scan, the entire scan must be flagged. However, scans can be made sufficiently short during the observations so that this limitation is not severe. In setting up your OBSERV file, you should try to keep scans short so that you will not have to flag a lot of good data along with a few bad points. In addition the mapping and UVFITS programs contain a 'clip' option which will flag any data whose visibility amplitude falls outside of a specified range; these uvclip options have not yet been extensively tested.

2) Much of the flagging of source visibility data in the PIPELINE can be inferred from analysis of the calibrator visibility data in the DEC-10. Global flags (i.e. antenna 17-IF A was bad over the entire run) can be ascertained but intermittent problems (interference) and low level problems, too weak to be seen in the calibrators, can be missed.

3) The necessary display software for visibility data in the PIPELINE for determining and flagging bad source data is still limited. Baseline versus time displays (see Section 4D) can be produced and displayed from which bad data can be recognized or a clipping level determine.

These flagging limitations are not unduly severe for many spectral line projects and continuum projects associated with weak sources. Experience has shown that under normal VLA behavior very little detailed flagging is necessary unless very high dynamic range is desired from the data. The removal of large, spurious signals, is important and the clipping algorithm in UVFITS and GRIDER should suffice. However, modest interference, cross-talk and shadowing between the antennas in the C and D-configuration may be a problem.

A decided advantage to putting the source visibility data into the PIPELINE is 1) that mapping is much faster because the data does not have to be transferred from the DEC-10 over a relatively slow link, 2) the sorting of the visibility data is avoided, 3) the necessary disk space is more readily available and 4) for continuum data you can map the AC and BD IF's together.

Before deciding how best to use the PIPELINE, discuss your observation and mapping requirements with a VLA-PIPELINE expert (Ed Fomalont is first choice). Although this manual will be kept up-to-date, changes in the status of the PIPELINE may seriously affect your decision to use some or all aspects of the PIPELINE.

1.2 Mapping and Cleaning a DEC-10 Visibility Data Base:

After calibration and editing of visibility data in the DEC-10, the PIPELINE can be used to produce maps (program GRIDER) and then to clean these maps (program CLNMAP). The advantages to using the PIPELINE mapping and cleaning compared with using AIPS are:

1) The maps can be made directly from the DEC-10 with no tape transport necessary.

2) A set of maps from a spectral line data base can be made very conveniently with one program execution.

3) The maps can then be cleaned in the PIPELINE or written on a FITS-format tape for further analysis in AIPS or elsewhere.

4) Continuum maps must be made separately for the AC and BD IF's. Only if the data resides in the PIPELINE can maps of all four IF's be made together. This is a substantial saving of time for snap-shot programs. The frequency difference should not be more than 200 MHz, however.

Some disadvantages are:

1) PIPELINE maps are not as thoroughly tested as AIPS generated maps.

2) More complete display, analysis and editing software is available in AIPS. Most maps generated by the PIPELINE will probably need further analysis and display in AIPS.

3) Self-calibration, more extensive mapping and deconvolution methods are only available using AIPS.

Even if AIPS will be used for all further processing of the calibrated visibility data from the DEC-10, by first making a few representative maps using the PIPELINE, the general quality of the data can be checked.

1.3 Alternative Path of Writing Calibrated Visibility Data onto Tape:

The simplest use of the PIPELINE provides an alternative method of writing calibrated and edited visibility data on tape for subsequent use in AIPS or other systems outside of NRAO. This program, UVFITS, is much faster and more convenient for spectral line visibility data than EXPVIS, the DEC-10 program to write visibility data onto tape. Details of the use of UVFITS are given in Section 5. In this mode of operation the PIPELINE is used as a temporary storage area for the visibility data between the DEC-10 and tape.

2. A GUIDE TO THE PIPELINE HARDWARE

The PIPELINE consists three PDP11-series computers, twelve disk drives, three array processors, three tape drives, several display devices and it is all connected to the DEC-10 and to the MODCOMPS by data links. A complete description is given in the PIPELINE SYSTEM REVIEW document which is available from Ina Cole and is in the PIPELINE MANUAL (ORM volume 2). The location of some of the PIPELINE pieces is shown in Figure 1. The PIPELINE contains four major subsystems:

1) SORTER: This visiblity data part of the PIPELINE contains one PDP 11-70 computer, 2 Gbytes of disk capacity, one array processor. Data is read into SORTER from tape using the program DBFILL or directly from the MODCOMP using FILLER on-line.

2) GRIDER: This part of the PIPELINE contains one PDP 11-70 computer, 2 Gbytes of disk capacity, two array processors and a special purpose transpose memory for speeding-up Fourier transforms. The mapping and cleaning tasks are resident in the GRIDER part of the PIPELINE.

3) DISPLY: The display part of the PIPELINE contains a PDP 11-44 computer, 1 Gbyte of disk capacity, an IIS TV display, a DICOMED film recorder and two plotters.

4) WORKER: An additional PDP11-70 computer which is intended for program development and as a gateway to the outside world for SORTER and GRIDER.

There is one tape drive connected to each of the four parts of the PIPELINE. Their location is shown in Figure 1.

If everything is working normally, all commands to the PIPELINE, which do not need the display hardware, can and should be entered on any terminal connected to the DEC-10. The commands will then be sent to the appropriate PIPELINE system. In the DISPLY system you have to go to a DISPLY terminal in order to run a program. Programs which must be run from a PIPELINE terminal will be noted in the manual and described in Appendix A.

3. HOW TO USE THE PIPELINE

Most PIPELINE programs, which do not need the DISPLAY features, can be accessed from the DEC-10. Some programs are resident in the DEC-10 and are accessed by

<R program>

Others reside in SORTER or GRIDER in the PIPELINE and are accessed from the DEC-10 by typing

<R PIPELN(program)>

Those in DISPLY can only be run from a display terminal (Device 1 in Figure 1) by typing

<RUN program>

The type of program call that is necessary is given in Table 1.

If you encounter any problems with R PIPELN, you may have to run the program directly from a terminal connected directly to the PIPELINE. Three programs in GRIDER (FITS, CLNMAP and LINSUB) must be run directly from a PIPELINE terminal. Instructions are given in Appendix A. Please contact any of the following for help: Bob Duquet, Ed Fomalont, Jacqueline van Gorkom, Bob Payne or Don Retallack.

Display software in DISPLY is normally accessed from a terminal in the display room (old IMPS room) in the front right side of the main computer room. See Section 7 for instructions in using the DISPLY part of the PIPELINE.

A complete listing of all software available in the PIPELINE is given in Table 1.

4. VISIBILITY FILLING, EDITING AND CALIBRATION

4.1 How to read visibility data into the DEC-10 or the PIPELINE:

If you wish to put all of your visibility data into the DEC-10, run FILLER from the MODCOMP tape in the usual manner. This is normally done by the telescope operators just after your run.

If you wish to put your visibility data into the PIPELINE, two steps of filling are necessary. First, you must put your calibrator observations into the DEC-10 by running FILLER from the MODCOMP tapes. This can be done by the operators after your run is finished or done while the observations are in progress. Check with the VLA operator for advice well before your run. You can use a longer averaging time for the calibrator data than you might use for the source data. Be sure to include all data in the DEC-10 which will be used as a calibrator. The FILLER program only takes sources with a character in the CALCODE column of the observing file. To include other sources, you must place a character in that column when compiling your observing file. Some comments for running FILLER are:

a. Mount tape on a DEC-10 drive in the usual way.
b. Skip 1 file to go past a header file.
c. Then type <R FILLER>, then type <INP>.
d. Set subarray number and retype <INP>.
e. Fill in appropriate information.
f. Now type <WIZARD YES>, then type <INP>
g. Now type <PBOX NO>, then <PIPELINE YES>
h. Then type <GO>

Only visibility data for sources with a non-blank calcode in the observing file will be read into the DEC-10. Gain and Index records for <u>all</u> sources will be included.

Secondly, all of the visibility data must be read from the same MODCOMP tape into the PIPELINE using the task DBFILL. The MODCOMP tape must be mounted on the sorter tape drive (Device 8, Figure 1)--WITHOUT A TAPE RING. Then go to any convenient DEC-10 terminal and type

<R PIPELN(DBFILL)>

some comments are:

a. Type <HELP PACK> to see a listing of the available space on the disks. <PACK *> will choose the one with the most space. However, it is much safer to explicitly specify the disk device; egs. <PACK P01:>. In this way data from more than one MODCOMP tape will be put into the same file.
   About 20×10^6 visibility points will fit on a disk pack.
b. DBFILL must be run interactively so your terminal will be tied up.

In the PIPELINE the data is organized differently than that in the DEC-10. Each source-frequency is put in a separate file and sorted in rough decreasing order of the absolute value of the east/west projected spacing. For spectral line visibilities each set of 8 channels are put into one file.

If you slightly change frequency during a spectral line observation in order to compensate for the earth's motion (Doppler tracking), all data for a source will be merged into one file if the frequency change is less than 0.001 * (observing frequency). Otherwise, a separate source entry will be made for each source-frequency entry.

It takes about 2 hours of time to fill one full MODCOMP tape which contains about 3,000,000 visibility points. To continue with DBFILL, rewind and dismount the first tape, mount the next tape and then type <GO>. To skip a file on a MODCOMP tape, set <TAPEMOTION NOREWIND>, then <GO>. This will read through the first file very quickly. Make sure the other parameters are set so that no data will be copied onto the disk. On the beginning of the next execution the tape is at file 2. Repeat if necessary.

4.2 Utility program DBUTIL for data bases:

The listing of you catalog of visibility data sets as well as other utility functions, can be obtained by typing

```
<R PIPELN(DBUTIL)>
<user number>
```

and then following directions. DBUTIL does not use the standard commands but follows a menu-type user interface. You can delete any data files, delete all of you data files, and list the data in a very crude form.

4.3 Calibration of visibility data in the DEC-10:

If all of the visibility data resides in the DEC-10, calibrate and edit your continuum or spectral line data base in the normal manner. No special considerations are necessary at this stage of reductions in order to use the PIPELINE for generating UVFITS tape of calibrated and edited visibility data or to make maps (GRIDER) from the data.

4.4 Calibration of visibility data in the PIPELINE:

If the visibility data resides in the PIPELINE and the calibration data also resides in the DEC-10, calibration of your continuum or spectral line data set is still done in the normal manner using the calibrator data in the DEC-10. Remember to include all necessary calibrator data, including pass-band calibrators by, inserting a non-blank calcode for the source in your observing file. The entries in the index and gain files (DBNAME.INX and DBNAME.GAI) still contain the appropriate entries for the source observations. Only the visibility data (DBNAME.VIS or Vnn) of the sources are not in the DEC-10. Normally, the PIPELINE data base will contain all of the visibility data, sources as well as calibrators.

During the calibration process, you will undoubtedly need to flag some of the calibrator data. At the present time the PIPELINE only can interpret flags over an entire scan for any set of antenna-IF pairs. No individual spectral channels can be flagged. Thus, all flagging using the DEC-10 programs FLAGER and SHADOW must set the parameter

```
<FLAGLOCATION INX>
```

No flagging of individual correlators or parts of a scan can be done. If you insert a time range in FLAGER which attempts to flag only part of a scan, an error message will be returned if INX flaglocation was specified. Flagging of individual visibility records will be ignored by the PIPELINE.

When flagging calibrator data, remember to extend the flagging times to cover the time ranges appropriate for the source visibility data which is in the PIPELINE.

In the compact arrays, C and D, shadowing of one antenna by another may cause problems. Data from such shadowed antennas can be flagged using the DEC-10 program SHADOW, which allows the user to specify the amount of shadowing allowable. For Pipeline data, SHADOW should be used (rather than GTBCOR with the SHADOWCORR option) because SHADOW will flag on a scan basis and GTBCOR will not.

There is a clip option, when running UVFITS to generate a tape with calibrated and edited visibility data, or when running GRIDER to make maps, which will automatically flag very discordant visibility amplitude values for the data in the PIPELINE. The data is only flagged as it is read in to make a map or UVFITS tape and the flags set using this option only appear on the output (i.e. the map or UVFITS tape); they are not put into the database. This option may flag most of the source data which cannot be flagged from the DEC-10 using only the calibrator data.

4.5 Using BT maps as an aid to editing:

For visibility data resident on the DEC-10 or the PIPELINE, a new PIPELINE task is available for generating displays of visibility data. The BT map is an image with the ordinate as baseline pair and the abscissa as time. The display can be generated by typing

```
<R BTMAP>
```

in the DEC-10. On execution the visibility data is put on a grid of 351 (if all antennas are specified) by 256, 512 or 1024 time bins, depending on the ratio of time range to bin time. This 'map' can then be displayed in DISPLY as described in Section 7. Bad data can be easily recognized and software is now under development to use this display as a basis of further editing of visibility data in the DEC-10 or the PIPELINE. With suitable color contour display of the BT map you can determine a good clip level to use when running GRIDER or UVFITS. At the present time use the DISPLY programs CURVAL and TVVAL and write down the baseline pair (or antenna) and time of the bad data. Then flag the appropriate data using FLAGER in the DEC-10 with the above limitations.

5. WRITING AND DELETING VISIBILITY DATA (UVFITS)

5.1 Using UVFITS:

Visibility data on the DEC-10 or the PIPELINE can be written onto tape by typing,

```
<R PIPELN(UVFITS)>
```

on the DEC-10. If the data is in the PIPELINE, UVFITS will transfer the appropriate DEC-10 files to the PIPELINE, apply the calibration and flagging, and write the data on tape. If the data is on the DEC-10, UVFITS will first apply the calibration and flagging and then transfer the data to the PIPELINE in a temporary file which is then written on tape. The data can then be read into AIPS for further processing.

For spectral line data bases in the DEC-10, this route is much more efficient than using SPECTR and EXPVIS in the DEC-10. For continuum data bases the UVFITS route, while not much faster than using EXPVIS, will write the DEC-10 history files on tape and the data can be written on 6250 bpi tapes (at present the drives do not work reliably at this density).

For continuum data which resides in the PIPELINE, both the AC and BD IF's will be placed in the one file by DBFILL and can be written on tape in one file. If the data resides in the DEC-10, the AC and BD IF's must be written in separate files.

The tape must, of course, be first mounted on the tape drive labelled SUBSYSTEM:SORTER (Device 8, Figure 1). A complete description of UVFITS is given in the PIPELINE Reference Manual. Some comments on running UVFITS are:

a. PASSBAND must be set to the name of the passband file if you have a passband file and want to apply it. The passband name must include the user ppn but not the passband file extension; eg. PASNAM[14,pn]. If you don't want to apply it or have no passband, then give PASSBAND NONE.
b. USER-ID must be specified.
c. Visibility type is equal to the number of channels in the data base; eg. 128, not 7 for 2^7.
d. SOURCE must be set to a single source name. A special option for continuum data on the DEC-10 or PIPELINE will permit the writing of all sources on tape by typing <SOURCE (*)>. You MUST include the () parentheses around the *. Giving SOURCE (*) will not work for spectral line data.
e. <GO TAPE> will begin execution after proper keywords have been set.
f. For all spectral line data in the DEC-10 or in the PIPELINE, fill in DBNAME only. DB2NAME should be set to <NONE>.
g. DBNAME must be specified in its entirety, eg. DBNAME[14,xxx]. DB2NAME is only used for continuum data resident on the PIPELINE. DBNAME contains the AC data base; DB2NAME contains the BD data base. For all other applications DB2NAME should be NONE. For continuum data on the DEC-10 you must run UVFITS twice, first with DBNAME as the AC data base and then with DBNAME as the BD data base.

The spectral line visibility data is organized in files of eight channels on the disk; channels 0-7, 8-15, etc. When generating a UVFITS tape, the sets of eight channels are written into one file. Because channel 0, the 'continuum' channel is special, it will be put in a

separate file when channel 0 is among the channels specified in the keyword CHANNELS. This continuum channel will also be included in the file which contains channels 0-7, but it should not be used since its frequency will be incorrect. Use the special file automatically generated by UVFITS.

About 1,000,000 visibility points can fit on a 2400-ft tape at 1600 bpi density; 3,000,000 points will fit at density 6250 bpi if it is working. DBUTIL gives the number of visibility points in Pipeline databases so use those number as a guide to how mauch data will fit onto a tape. It takes about 80 minutes to write this amount of data onto tape. If the data is sent from the DEC-10, it takes an additional 100 minutes to transfer the data to the PIPELINE. You cannot put data on more than one tape; UVFITS will give unpredictible results it you try to write more data than will fit onto one tape. Hence, you MUST limit each UVFITS execution within the above tape capacity guidelines.

You should get a summary of your UVFITS tape by rewinding it, taking out the tape ring, remounting it and then use the option <GO INDEX> in UVFITS. Other, more detailed tape summaries are available in UVFITS. You can get a hard-copy of this index under the outfile name. However, you have to go a PIPELINE terminal in order to do this. See instructions in Appendix A.

To delete PIPELINE visibility data which has been sent from the DEC-10 in the mapping or UVFITS process, type

<R PROBE>

find the request sequence number M which generated the data transfer and then type

<SEQ M>
<GO KILL>

to delete the data set. Data sent from the DEC-10 to the PIPELINE for UVFITS is deleted automatically. Data which has been read into the PIPELINE directly from the MODCOMP or by using DBFILL, can be deleted by typing

<R PIPELN (DBUTIL)>

Next type in your user number and get a listing of the files in your catalog. If you wish to delete all of you data files, type <X> for expunge. If you wish to delete one entry, type the data base (db) catalog number, and then <D>. If you are deleting one file of 8 spectral channels, the program will ask you if you wish to delete all of the spectral channels associated with the source.

Backing-up data on the PIPELINE is not needed since visibility files are never changed. They can be reread into the PIPELINE using DBFILL. The DEC-10 files, including calibrator visibilities, should be backed up in the normal manner. The associated DEC-10 files should be backed up using the DEC-10 utility program R BACKUP.

5.2 Taking the data to AIPS:

When taking a UVFITS tape to AIPS, the data is organized in the following manner:

a. Continuum data from the DEC-10: The AC IF's and the BD IF's are placed in two separate files. They can be concatenated in AIPS if desired; then sorted and mapped.
b. Continuum data from the PIPELINE: In running UVFITS you have the choice of keeping the AC and BD IF's separate or putting them into one file. If they are put together, AIPS can load and sort the data more quickly. In AIPS mapping/cleaning the program MX will permit you to map the AC and BD IF's together if desired. The AIPS selfcalibration task ASCAL cannot handle this two frequency data in one pass presently.
c. Spectral line data from the DEC-10 or the PIPELINE: UVFITS will put the visibility data in groups of 8 channels per file. The continuum channel (Channel 0) will be put in a separate file.

Users of UVFITS tapes made with the VLA PIPELINE system may have to install the latest version of AIPS in order to produce correct results; earlier version of AIPS (before the March 15, 1984 version) have had some problems with VLA PIPELINE UVFITS tapes.

6. MAKING MAPS

6.1 Using the program GRIDER:

From any DEC-10 terminal type
<R GRIDER>

Use the inputs and help on-line documentation. Use the PIPELINE Reference Manual for more details. A few hints are:

a. DB2NAME used for BD data base if you want your AC and BD data bases to be mapped together. This option will only work if the visibility data is in the PIPELINE. For DEC-10 visibility data or spectral line data set <DB2NAME NONE>.
b. PASSFILE is the name of the pass band file. You must specify the ppn but not the file extension; eg. PASNAM[14,pn].
c. SUBSOURCE is the name of the file containing a list of point sources to be subtracted from the visibility data before griding and mapping. The clean components list is generated by CLNMAP and can be copied into the DEC-10 as described in Section 9. The file can be edited but do not change the format of the file. There is a limit of 1000 components which can be subtracted.
d. Do not exit from GRIDER until you have submitted all of the jobs associated with one data base on the DEC-10. It takes a while to transmit the data to the PIPELINE so you should transfer all mapping requests before exiting GRIDER.
e. The maps will have the following designation; X.Y.Z where
X = keyword NAME assigned in GRIDER.

Y = CLASS given by ABC where
A=M if map, B if beam.
B=Stoke's parameter (I,Q,U,V,F,A,C,B,D)
C=Frequency band (20cm=L, 6cm=6, 2cm=2, 1cm=K, 90cm=P)
Z = Version number. Each map in turn will be given the lowest version number to differentiate among them.

f. For spectral line maps the channel number can be used to specify a map. Run CATLST in order to list the channel number of any map. Examples in using X.Y.Z and channel number for designating a map will be given elsewhere.

If you send a large data base from the DEC-10 for mapping, it will take about 20 minutes to transfer about 1,000,000 visibility data points. If you wish to remap this data, it is possible to do so without again sending the data base from the DEC-10. Contact Bob Payne for details.

6.2 Typical mapping times:

A large spectral line data base - 80,000 visibility points x 128 channels takes about 2 hours to transfer data from the DEC-10 to the PIPELINE and then an additional 2 hours to sort the data. This time is saved if the data is written into the PIPELINE. The entire set of 64 512 x 512 maps takes 5 hours to produce. Small continuum data bases of 100,000 visibility points take 2 min to transfer data and 3 minutes to make a 512x512 map.

6.3 Map-related information:

To check on the progress of your mapping request type,

```
<R PROBE>
<GO LIST>
```

to determine the state of the computer. PROBE will let you know if the data is being transmitted or if the map is being made. To delete a mapping request before execution, get the job sequence number, M, from <GO LIST> then type

```
<SEQ M>
<GO KILL>
```

When your maps are completed, the index record can be listed by typing

```
<R CATLST>
<GO LIST>          to see your entire catalog
<GO INDEX n>       to see the index of map n in catalog
<GO DELETE n:m>    to delete maps n through m in catalog
```

If your mapping request involves a lot of data; for example, making <40 1024x1024 maps, or sending over <5,000,000 visibility points from the DEC-10, check the availability of disk space before sending your request. This is done by typing

```
<R PROBE>
```

from any DEC-10 terminal. The available space for maps or visibility data sent from the DEC-10 is given. A full disk of 450,000 blocks

contains about 40 1024x1024 maps or 150 512x512 maps. If there are disk space problems, check with Ina Cole.

6.4 Mapping strategies:

Do not blindly make your entire set of spectral line maps after you have calibrated the data. Choose a few selected channels and map them first. You will probably want to include channel 0 which contains the 'continuum' map which includes the inner 75% of the total observing bandwidth. Make at least one beam pattern. Some questions to ask are:

a. Is the map grid separation okay? The pixel intensities one cell away from the beam center should not be less than about 50%. Is the field of view sufficiently large?
b. For sources not limited by dynamic range, is the rms noise in the continuum and channel maps reasonable? Are there artifacts which might be caused by interference or large spurious points?
c. Is the map weighting reasonable? Natural weighting may enhance undesired large-scale features too much. Uniform weighting may decrease the signal to noise too much.
d. You can display the difference between two maps in the DISPLY system (see the following section). In order to subtract out any continuum, will this simple map difference work or must you subtract a continuum model from the visibility data before mapping? See section 8 on cleaning for details.
e. Do you want to average channels before mapping?
f. Try to limit the number of maps made in one execution if the maps are larger than 256 on a side. There may not be enough disk space.

7. DISPLAYING MAPS

Maps can be displayed conveniently on the DISPLY system which is in the front right of the computer room. Since the DISPLY is only a one-user system, you should reserve time on the sign-up sheet on the wall to the left of the door.

The simplest way to display the maps is as follows:

a. Go the the Display room (old IMPS room)
b. You will use the ADDS terminal on the right side of the room
c. If you see a prompt > you are in monitor mode. If the IMPS program is running, exit from IMPS to get back into monitor level.
d. Type <@[300,20]EXP>
   to initialize everything. Wait for @EOF - takes about 30 seconds.

7.1 Listing the map catalog:

To search your catalog to see your map listing, type
<RUN CATLST>

and follow directions. The delete option of CATLST does not work in the DISPLY version. To delete a map, you must run CATLST from the DEC-10.

7.2 Loading an image on the TV:

To display a map on the CONRAC TV screen on the right, type
<RUN TVLOD>

and follow directions. Both CATLST and TVLOD use the standard commands with inputs and help. For these and other tasks the pack name should be DO1:. There are two TV channels available. Differences and sums of the channels can be made using the TV. Other parameters are described using the documentation on-line or in the PIPELINE reference manual.

7.3 TV display modifications:

To change some of the image display characteristics, type
<RUN TVDIS>

Use the data tablet and the menu display on the VT11 to provide the display alterations.

7.4 Reading map values under a cursor:

To position cursor on the TV, type
<RUN CURVAL>

The location and intensity under the cursor will be reported; for baseline-time images it reports time and antenna pair (physical ID's) for the baseline. CURVAL reads the pixel value from the disk map.

7.5 Reading TV values under a cursor:

To position cursor on the TV, type
<RUN TVVAL>

TVVAL is similar to CURVAL except that it reads the pixel value directly from the TV and has limited 8-bit precision. Point the cursor to the wedge to get value read-outs of the wedge function.

7.6 Running CLNMAP and setting cleaning windows:

To submit a clean request which allows interactive box specifications, type
<RUN CLNMAP>

The clean box can be specified on the TV if the dirty map is being displayed. Otherwise this program is identical to R PIPELN(CLNMAP) from the DEC-10 (see Section 8). To set windows for n cleaning boxes (maximum n is 5) type
<BOX n !>
Move cursor to the desired bottom left corner
of box 1.

Touch any key on the VT11 terminal
Move cursor to the desired top right corner
of box 1.
Press light pen twice to confirm box.
Repeat for next cleaning boxes. Up to 5 can be set.

7.7 Multi-tasking in DISPLY:

Multi-tasking in DISPLY is possible. For example, while TVLOD is putting a map on the TV, you can run TVDIS or CATLST. In fact, it is often useful to keep TVDIS running while you do other things, although this does slow down the system. However, concurrent running of CURVAL and TVDIS is not possible. When in doubt, run one task at a time until you get used to the system.

7.8 IMPS software package:

The old IMPS display package is still available although it will be phased out. It does contain programs which might be of use to PIPELINE users (rms calculation over a map, contour plotting). To access the IMPS package, type

<@[300,20]IMPS>

Before you can display any PIPELINE maps, they must be transferred to the DISPLY disk. This is done by typing

<RUN GETMAP>

and following directions. It takes about 4 minutes to transfer a 512x512 map using the data link between GRIDER and DISPLY. To transfer many large maps, use FITS to transport the maps by tape. You can then use the IMPS software package which includes contouring, subimaging and many other useful functions. When you are finished using IMPS, please type

<@[300,20]EXP>

8. WRITING MAPS (NFITS) and DELETING THE MAPS

When you are satisfied with the dirty and/or clean maps produced by the PIPELINE, you should write the maps to a FITS tape and delete the associated visibility data which remains in the PIPELINE. To write your maps, type from any DEC-10 terminal

<R PIPELN(NFITS)>

(The old program FITS should not be used!).

Go to the Telex tape drive in the back part of the DEC-10 room, near the PIPELINE terminals (tape drive will have a label with SUBSYSTEM:GRIDER) and mount a tape with the ring in. Make sure the unit is on-line and the correct tape density has been designated. Tape density 6250 BPI works somewhat unreliably.

At the present time R PIPELN does not interact well with tasks which are resident in GRIDER. These tasks are NFITS, CLNMAP and LINSUB. You will have to go to a PIPELINE terminal in order to run them. Instructions are given in Appendix A.

Fill in the standard commands and run the program. You will probably want first a hardcopy of your map catalog which can be obtained by running CATLST from the DEC-10. It is usually most convenient to select maps by RECORD number range. At 1600 BPI density about 15 1024x1024 maps or 62 512x512 maps (16-bit integer pixel values which is the default) will fit on a 2400-ft reel. The execution time to fill a tape with maps at 1600 bpi is only about 10 minutes. There is no capability of writing map on more than one tape, so limit the number of maps for each execution using the above guidelines.

To check the tape after execution, rewind and take out the tape ring. Run NFITS with the GO INDEX option. You can get a hard copy of this index by following the directions in Appendix A. The file will be printed from the DEC-10.

Maps may be deleted by typing in the DEC-10

```
<R CATLST>
<GO DELETE n:m>
```

where n:m specify the range of catalog entries to be deleted.

9. CLEANING MAPS

9.1 Using the program CLNMAP:

From any DEC-10 terminal type

```
<R PIPELN(CLNMAP)>
```

If R PIPELN does not work properly, go to a PIPELINE terminal in order to access CLNMAP. See instructions in Appendix A. You can also run CLNMAP from a DISPLY terminal and set the cleaning windows interactively.

Set the standard commands in the usual way. The keywords in CLNMAP are somewhat different than the cleaning program in MAKMAP (the old DEC-10 program), which will be phased out, and somewhat similar to APCLN in AIPS. See the PIPELINE reference manual for further details. Additional changes are anticipated over the next six months. Some particular comments are:

a. BOX: Generally use INNER QUARTER or set up to five cleaning windows using the interactive CLNMAP in DISPLY.
b. FLUX LIMIT 0 is recommended. Use MAXITER to terminate clean.
c. OUTNAME is the name of the CLEAN map. The class is defaulted to XXXCLN where XXX is the class of the dirty map.
d. PATCH, SFACTOR and SPIKE should normally be set to 64, 0, 0. See EXPLAIN APCLN in AIPS for more details.
e. CLASS, NAME, VERSION contain three parts. They are the dirty map, dirty beam and components file attributes. The components file is only needed if RESTART YES.
f. CHANNEL. Set channel number of dirty map(s). Use * for continuum. You can use the implied looping for CHANNEL The channel number is not equal to the version number.

g. RECORD-NUMBER You can access a set of dirty maps by setting the proper range for the record number. You can only use one beam for the clean looping.

9.2 Cleaning a set of maps:

Cleaning a set of maps with one execution is possible, although the syntax is tricky. A typical example to clean a set of 8 dirty maps (SGRA.MIL.* from channel 0 to 7--the version number is irrelevant) using one beam pattern (SGRA.BIL.1) for all the maps is:

```
<OUTNAME SGRA>
<CHAN 0 7 1>
<NAME      SGRA   SGRA   *>
<CLASS     MIL    BIL    *>
<VERSION   *      1      *>
<RECORD    *>
```

Time estimates are similar to those in AIPS.

The CLNMAP request can also be submitted from DISPLY. This allows the interactive specification of clean boxes if the dirty map is displayed on the TV. See Section 7 for details.

9.3 Using clean components:

After submitting CLNMAP, use PROBE on the DEC-10 to check on the status of the job. CATLST will show you the map in your catalog when the cleaning is completed. To inspect the clean components file use CATLST in the following way:

```
<R CATLST>
<INMACHINE GRIDER>
<GO LIST>          and find the catalog number n of the map
<TYPE CMP>
<CMPSTEP m>        Step m components after component m
<GO LIST n>        where n is the catalog number
```

To copy the components file to the DEC-10, where it can then be accessed by GRIDER as a source list for subtraction in the visibility data, type

```
<CMPSTEP m>        Make m>total number of components
<OUTFILE DSK:X.CCC[14,51]>
                   File to store components
<GO COPY n>        Copy into DEC-10
```

This file can be edited in the DEC-10 using the standard text editor SOS. When writing a clean map onto tape, the clean components are <u>not</u> written.

10. OTHER PIPELINE PROGRAMS

10.1 Subtracting the continuum map from a set of line maps:

To facilitate cleaning and analysis of spectral line maps, there is a PIPELINE program which will subtract (or add) a specified continuum map from a set of line maps and write the set of difference maps into the

PIPELINE disk for further cleaning and processing. The difference maps should only be made if

DF/F < 0.1 P/R

where F is the center frequency of the channels, DF is the frequency range of the channels, P is the map size in arcsec and R is the resolution in arcsec. Otherwise a model of the continuum visibility function will have to be subtracted from the channel visibility functions before mapping. This can be done by mapping and cleaning the continuum visibility and then running GRIDER with the SUBSOURCES option, described in Section 8.

To use this task type

<R PIPELN(LINSUB)>

If R PIPELN does not work, go to a PIPELINE terminal and follow the directions given in Appendix A. The input keywords are straight-forward. The first column designates the set of line maps, the second the continuum map. A sample set-up follows:

```
<CHANNELS *>
<CLASS MI2 MI2>              for 2cm data
<NAME 3C219 3C219>
<OUTNAME 3C219S>             Use different name for output
<PACK D01: D01: D01:>        Use this pack
<USER-ID 51>
<VERSION * 1>                Subtract 3C219.MI2.1 from all
                             maps 3C219.MI2.*
<GO SUB>
```

If you want to iterate on channel number and not version number, type

```
<CHANNELS from 1 to 32 step 2>
<VERSION * 1>
```

with the other keywords the same.

11. REASONS TO NOT USE THE PIPELINE

As discussed in Sections 1 and 4, the flagging limitations of visibility data resident on the PIPELINE may force you to put all of your data on the DEC-10. However, if all of the bad data is not flagged, AIPS does have some flagging capabilities which can subsequently find and flag this data. Also, the tasks GRIDER and UVFITS contain a 'clip' option which can be used to flag all visibility amplitudes outside of a specified range.

If self-calibration is needed, then the AIPS system must be used for mapping and cleaning, as well as self-calibration. The PIPELINE can, of course, be used as a first pass in order to determine the quality of the map and the need of self-calibration. In the future when the PIPELINE and AIPS can communicate with each other, the self-calibration step will be done with AIPS while the mapping and cleaning can be done in the PIPELINE.

If your data base spans a time longer than 24 hours, the PIPELINE may produce non-optimum maps when using uniform weighting because of its gridding procedure. Please contact any of the VLA-PIPELINE experts to discuss this problem with you.

12. WHEN THINGS GO WRONG

12.1 DEC-10 to PIPELINE link problems:

Before using the PIPELINE or when you suspect that the link is broken, type <NET> on the DEC-10 to obtain the network status: the network nodes that must be present are VLA10, DN2011, SORTER, GRIDER, WORKER and DISPLY. If the network is down, check the computer maintainance schedule; the PIPELINE is not available to users ALL day on maintenance days - jobs may bomb or be killed by maintenance personnel. If the computers are not being maintained and there is a problem with communication between machines, contact Don Retallack.

12.2 Diskspace:

You can check diskspace by typing
<R PROBE>

It will list the available disk space for maps in units of 512x512 images; the available disk space for visibility data which can be sent from the DEC-10. Each 512x512 map requires 2000 blocks of disk space. To check the available disk space for visibility data which can be stored in the PIPELINE, run DBFILL and type <HELP PACK> or <PACK ?>. Each 1,000,000 visibility data points require about 20,000 blocks of disk space. If you need disk space, check with Ina Cole.

12.3 R PIPELN hangups:

If there is no response after several minutes, the DEC-10 may be very busy so wait another few minutes. If there is still no response, DO NOT TYPE CNTRL C. Instead type (CNTRL SHIFT ~) to get back to the DEC-10.

There are occasional problems with the link between the DEC-10 and the PIPELINE so do not despair if PIPELN hangs up occasionally. Try it again. Type <NET> to make sure the link is up.

12.4 DISPLY problems:

If a program is DISPLY should die in the middle of execution, you should type

<@[300,20]EXP>

to reinitialize the TV display and the image catalog.

12.5 Aborting a PIPELINE job:

If you are running a PIPELINE job from the DEC-10 via R PIPELN and wish to abort the job, type

<CNTRL SHIFT ~ CNTRL SHIFT ~> <CR>

DO NOT TYPE <CNTRL C CNTRL C>

This will put you back at the DEC-10 monitor level and abort the PIPELINE job. If you run the job again and you get an error return that the program is still active, you will have to get help from Bob Duquet, Ed Fomalont, Jacqueline van Gorkom, Bob Payne or Don Retallack.

12.6 Communication of Problems:

Because the PIPELINE system is still being developed and debugged, it is helpful to the VLA staff if you report all problems and suggestions as soon as possible. Please use the software trouble report forms. Help in using the PIPELINE and optimum strategies to follow can be given by Ed Fomalont. Hardware and software bugs should be documented on the bug report sheets and major problems should be reported to the appropriate person listed in the Emergency Call-out on Computer System memo posted nearly everywhere. During off-hours the array operator will guide you in the proper procedure to follow.

APPENDIX A. USING THE PIPELINE TERMINALS

A.1 Running tasks NFIT, CLNMAP and LINSUB:

There are several PIPELINE terminals located at the VLA. They should only be used when explicitly suggested in this manual. It is best to use a terminal which is connected to WORKER and then to connect to SORTER, GRIDER or DISPLAY.

The best terminal to use is located in room 211 on the second floor of the control building. It is the ADDS terminal next to the pen plotter. Position the switch on the left to WORKER in order to connect with WORKER. A second WORKER terminal is located in the computer room (device 11 in Figure 1). This terminal is within sight of the tape drives so it may be more convenient for some tasks. To run NFITS, CLNMAP or LINSUB at the terminal type the following:

```
<BYE>
<BYE>                   to log off.  Disregard any messages
<LOGON>                 to log into worker
Account or name: <USER>
Password: <USER>        This will not echo on the screen
                        after some salutory comments,
                  wait for the > prompt, then type
<RMT GRIDER>            to get into GRIDER
<DCL SET CLI DCL>       to set DCL language
<SET DEF 300,20>        to set proper UIC
<RUN NFITS>
*<INPUTS>               wait for the * prompt before typing
   ...
   ...                  fill in keywords, etc.
<EXIT>                  Exit program after execution
<BYE>                   to log off GRIDER
<BYE>                   to log off WORKER
```

These terminals have extended privileges and you can easily disrupt the whole PIPELINE system if you 'fool around'. Please contact any PIPELINE person if the above recipe does not work or if you have any questions.

A.2 Printing output from PIPELINE:

To print a file on the DEC-10 which has been generated by UVFITS or NFITS; such as index listings, type the following:

```
<BYE>
<BYE>                   to log off.  Disregard any messages
<LOGON>                 to log into worker
Account or name: <USER>
Password: <USER>        This will not echo on the screen
                        after some salutory comments type
<RMT GRIDER>            to get into GRIDER for NFITS index
    or
<RMT SORTER>            to get into SORTER for UVFITS index
<DCL SET CLI DCL>       to set DCL language
```

<SET DEF 300,20>	to set proper UIC
<PIP filename/SP>	to send file to DEC-10 printer
<BYE>	to log off GRIDER or SORTER
<BYE>	to log off WORKER

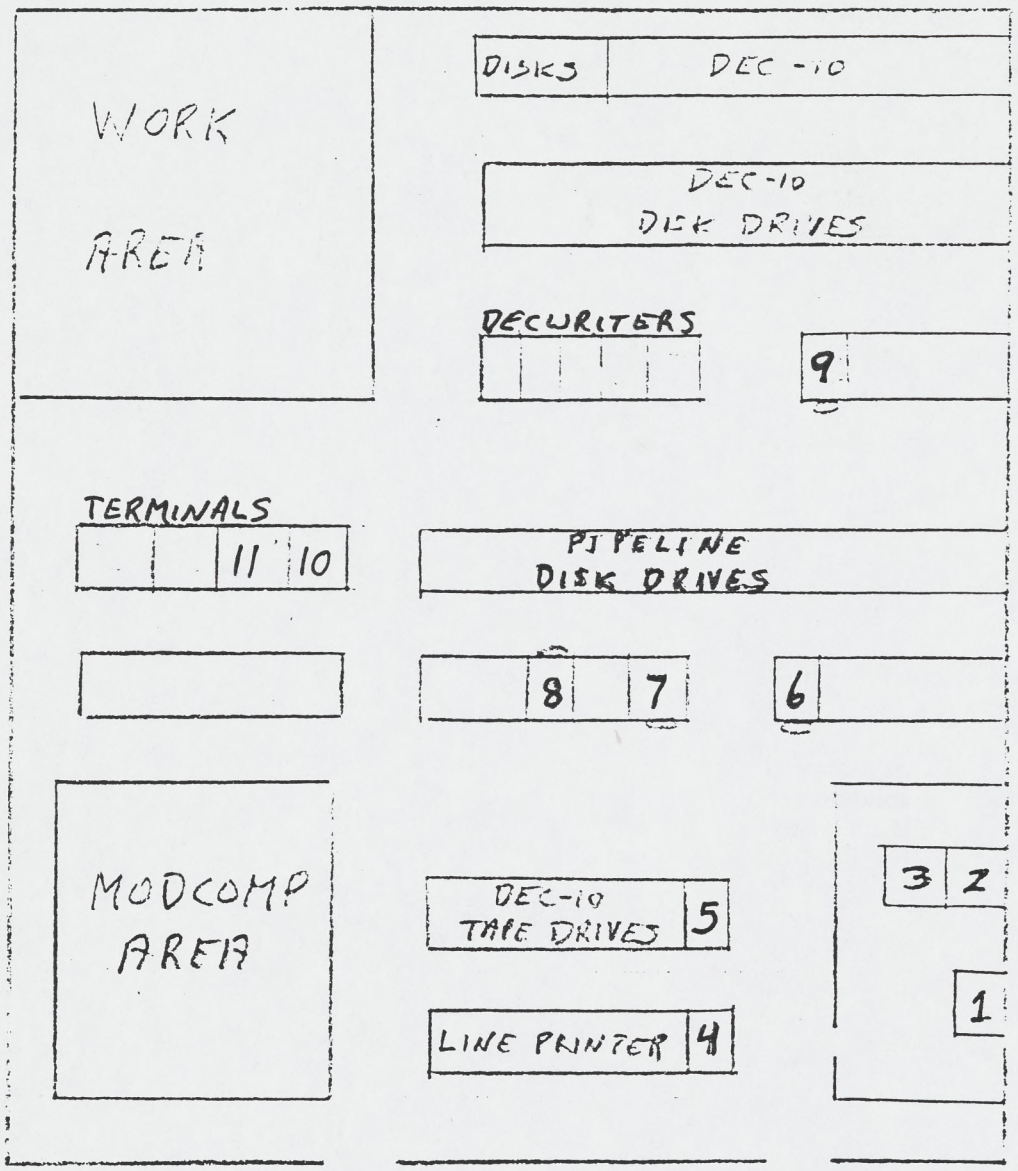
PIPELINE SOFTWARE

MARCH 23, 1984

PROGRAM	Description of Task	Doc *	Status
UV TASKS (IN SORTER)			
R FILLER	Fill all visibility data directly from MODCOMP to PIPELINE and all calibrator data directly into the DEC-10. See G. Hunt or D. Retallack to use this option.	PRM	Not working
R FILLER	Fill all calibrator visibility data from a MODCOMP tape to the DEC-10. Use WIZARD option. Operators may help with this.	PRM	Working
R PIPELN(DBFILL)	Fill all visibility data from a MODCOMP tape to the PIPELINE	PRM	Working
R PIPELN(DBUTIL)	List visibility data files in the PIPELINE	PRM	Working
R PIPELN(DBUTIL)	Delete visibility data files in the PIPELINE	PRM	Working
R BTMAP	Make Baseline-time maps of DEC-10 or PIPELINE visibility data.	PRM	Working
R PIPELN(UVFITS)	Write PIPELINE or DEC-10 visibility data onto tape.	PRM	Working
R PROBE	List status of PIPELINE jobs. Use <GO> option.	PRM	Working
R PROBE	Delete visibility data in PIPELINE sent from DEC-10. Use <KILL> option.	PRM	Working
R PIPELN(DBUTIL)	Delete visibility data written directly in PIPELINE.	PRM	Working
R BACKUP	Save DEC-10 files on tape.	ORM	Working
MAPPING TASKS (IN GRIDER)			
R GRIDER	Make maps from DEC-10 or PIPELINE data base	PRM	Working
R BTMAP	Make Baseline-time maps of DEC-10 or PIPELINE visibility data.	PRM	Working
R CATLST	List map files in PIPELINE. Use <GO LIST> command.	PRM	Working
R CATLST	List map index of map file in PIPELINE. Use <GO INDEX> command	PRM	Working
R CATLST	Delete map files from the PIPIELINE. Use <GO DELETE> command	PRM	Working
R CATLST	Copy map files from PIPELINE to DEC-10. Use <GO COPY> command	PRM	Working
R PIPELN(NFITS)	Write PIPELINE maps onto tape.	PRM	Working
R PIPELN(LINSUB)	Subtract continuum from set of line maps	on-line	Working?
CLEANING TASKS (IN GRIDER)			
R PIPELN(CLNMAP)	Initiate cleaning of map in PIPELINE	PRM	Working
R CATLST	List clean components. Use <COPY CMP> command.	PRM	Working
DISPLAY TASKS (Run from Display room terminal only)			
RUN CATLST	List map files in PIPELINE. Use <GO LIST> command.	on-line	Working
RUN CATLST	List map index of map file in PIPELINE. Use <GO INDEX> command.	on-line	Working
RUN TVLOD	Load PIPELINE map onto TV display.	on-line	Working
RUN TVDIS	Modify TV display. Use VT11 terminal for menu style functions.	on-line	Working
RUN CURVAL	Position cursor on TV; report pixel intensity and location.	on-line	Working
RUN TVVAL	Position cursor on TV; report TV pixel intensity and location.	on-line	Working
RUN CLNMAP	Initiate cleaning of map in PIPELINE. Set cleaning window interactively if dirty map is on TV display.	on-line	Working

* DOC: Where to find additional documentation. ORM=Observer's Reference Manual. PRM=Pipeline Reference Manual.
Status: Working means relatively bug-free. Working? means still some problems.

PIPELINE GUIDE TO THE COMPUTER ROOM



1. TERMINAL FOR DISPLAY
2. TV FOR DISPLAY
3. VT11 FOR DISPLAY
4. VERSATEC
5. DICOMED
6. TAPE DRIVE FOR DISPLY
7. " " FOR WORKER
8. " " FOR SORTER
9. " " FOR GRIDER
10. DEC-10 TERMINAL
11. WORKER TERMINAL