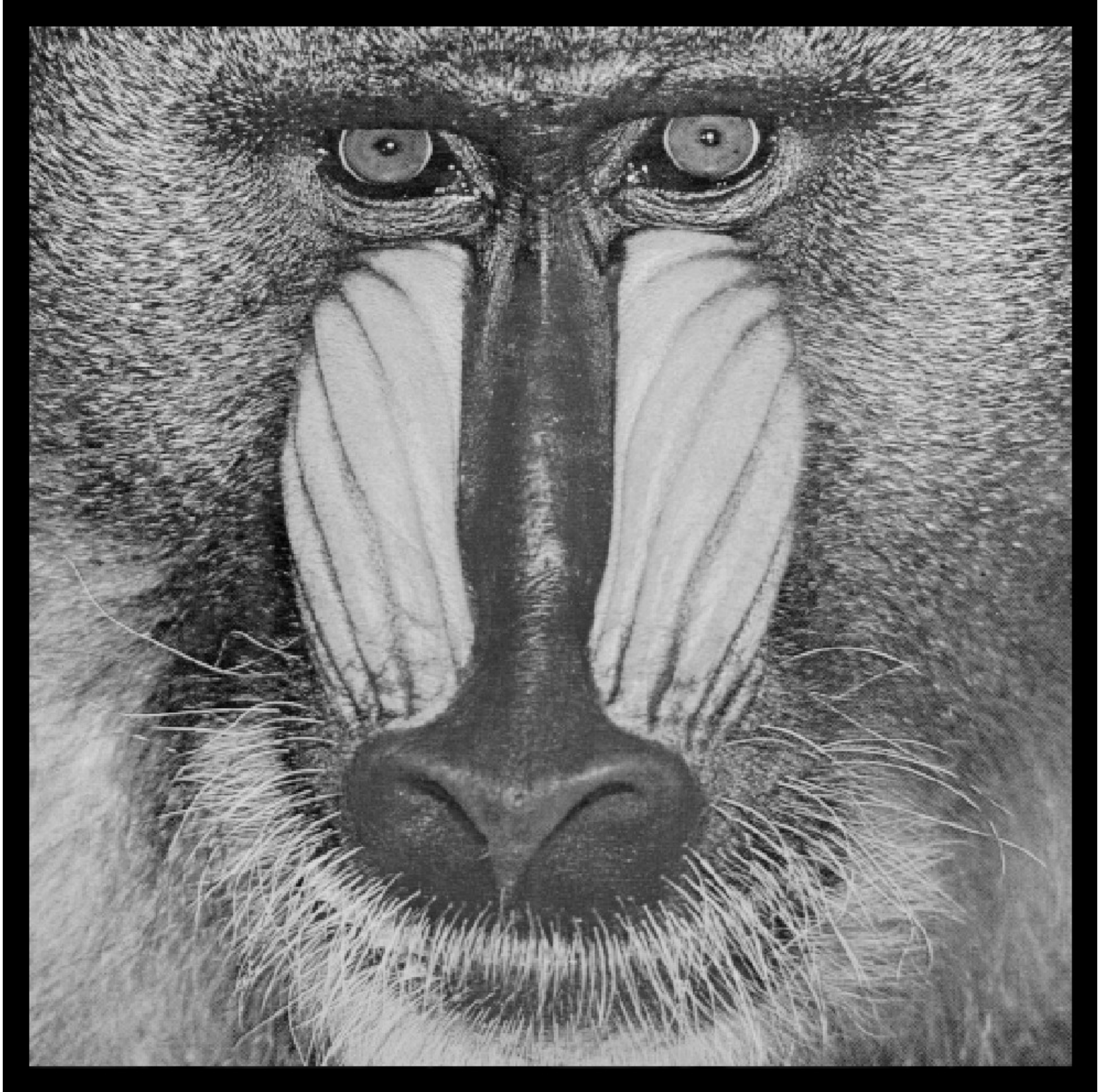


The AIPS Cookbook

VERSION FOR 31-DEC-2006 AIPS

Most recently changed on 2006/06/09

AIPS

???

What is AIPS?

http://www.aoc.nrao.edu/aips/

This document was most recently updated at $Date: 2002/09/05 15:24:51 $ (UT).

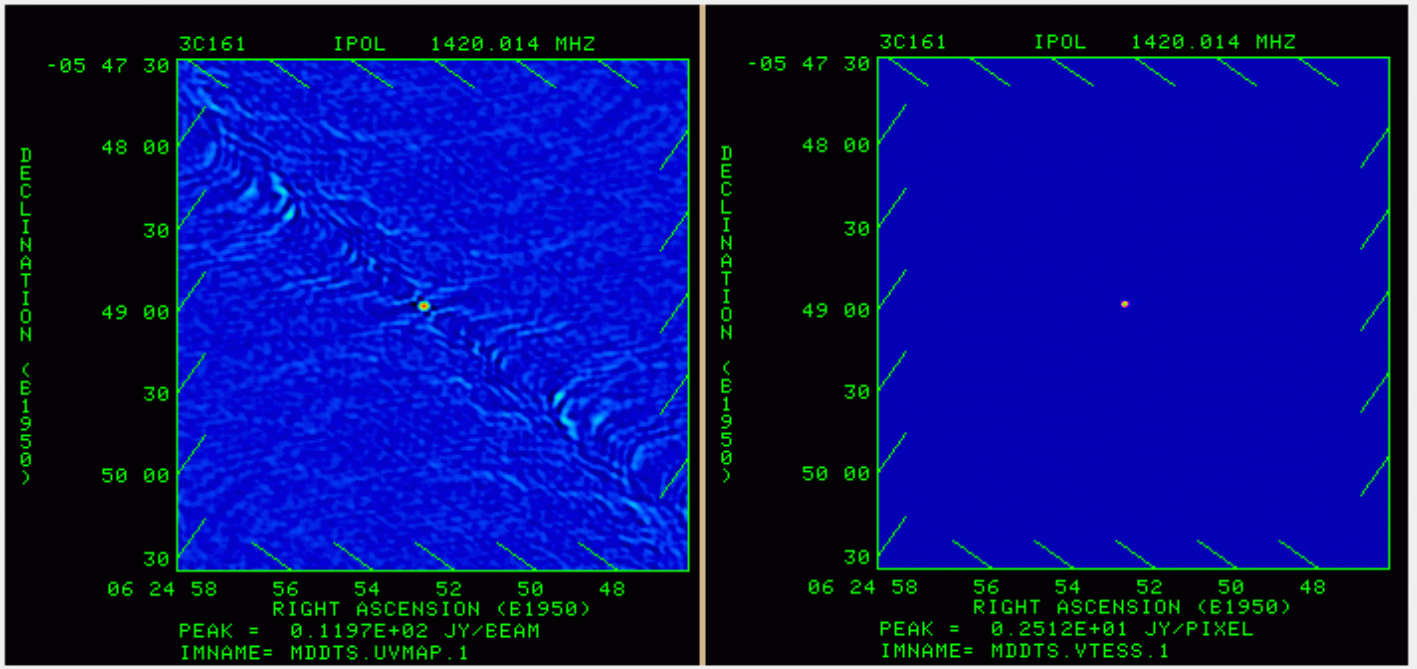
The *Astronomical Image Processing System* is a software package for calibration, data analysis, image display, plotting, and a variety of ancillary tasks on Astronomical Data. It comes from the National Radio Astronomy Observatory. It is primarily for Radio Astronomy. There is a Usenet newsgroup `alt.sci.astro.aips` that deals with AIPS issues and has occasional interesting announcements. There is a FAQ (answers to Frequently Asked Questions) for this newsgroup too.

A memo dating from 1994 provides a nice Summary of the NRAO AIPS Project (PostScript, 655773 bytes). An older AIPS memo describing the AIPS Software System (PostScript, 190706 bytes) can also be retrieved. The latter contains an interesting schematic diagram of the overall AIPS structure.

If you want to retrieve AIPS, it should be available via anonymous ftp. If that's not an option, and you are serious about using it for research or educational purposes, you can order it on-line.

Show me with pictures!

Ok. On the left is a raw image. On the right is the processed image.



Any questions? :-)

Some AIPS History I

- Design began in 1979 in Charlottesville for the VLA
- Design criteria of the software
  - Transportable (space and time)
  - Software needs to be general and flexible
  - Interactive
  - Efficient with computer resources
  - User friendly and powerful
  - Multiple interactive users and batch-like usage
  - Well documented, uniformity in coding standards

Some AIPS History II

- Designed initially on Modcomp computers with floating point array processor and special television display
- Next DEC VAX 11/780 with AP and TV
- FORTRAN66 (std. not well defined ! → portability)
- Early AIPS ran on Modcomps, VAXes, UNIX, IBM, Cray
- People involved: Eric Greisen, Bill Cotton, and others
- At present 1 to 2 people support AIPS
- Is now FORTRAN77 + system dependent routines in C
- Some (Bourne) shell scripts and PERL (installation)

Structure of AIPS I

- FITS development influenced AIPS data structures
  - AIPS header binary representation of the FITS header
  - Disk structure:
    - Header file
    - Image or UV-data file
    - Extension files (tables, plot files, history)
- AIPS main program: aips
  - User interaction, input from RUN files (text)
  - POPS command interpreter
- TASKS (large number of) started by aips

FITS

Flexible Image Transport System

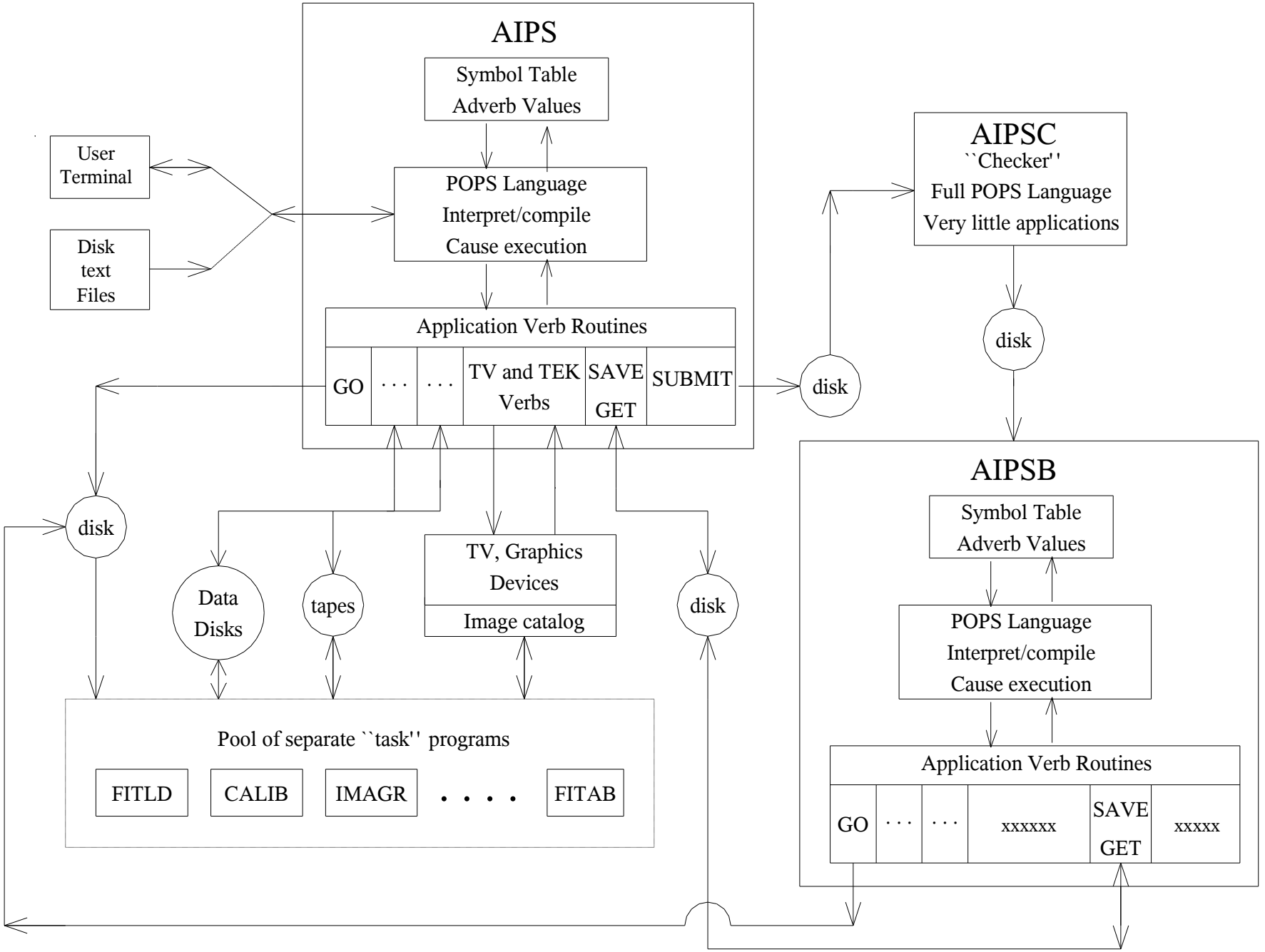
http://en.wikipedia.org/wiki/FITS

http://fits.gsfc.nasa.gov/

- Multi-dimensional arrays: 1D spectra, 2D images, 3D+ data cubes
- Tables containing rows and columns of information
- Header keywords provide descriptive information about the data (human readable) (80 character fixed-length strings)

AIPS structure II

- Communication via the `aips` program
  - Language is POPS
  - Interactive or via text file
- Define values of ADVERBS
  - Adverbs are in common to all tasks !
- Use VERBS (built into `aips`)
- Execute TASKS asynchronously/synchronously
  - Task parameters (adverbs) defined in “Help file”
  - Note: tasks can be created or modified without modification of `aips`


AIPS
Symbol Table
Adverb Values
User
Terminal
Disk
text
Files
POPS Language
Interpret/compile
Cause execution
Application Verb Routines
GO
. . .
. . .
TV and TEK
Verbs
SAVE
GET
SUBMIT
disk
AIPSC
``Checker''
Full POPS Language
Very little applications
disk
AIPSB
Symbol Table
Adverb Values
POPS Language
Interpret/compile
Cause execution
Application Verb Routines
GO
. . .
. . .
xxxxxx
SAVE
GET
xxxxx
disk
Data
Disks
tapes
TV, Graphics
Devices
Image catalog
disk
Pool of separate ``task'' programs
FITLD
CALIB
IMAGR
. . . .
FITAB

AIPS windows

- Console window for input/output to/from AIPS
- TV output/input
  - Original TV output is now via emulators
- Line graphics
  - Emulation of Tektronix Terminal via xterm
- Messages in Message Window

AIPS data files

- UV-data
  - Multi source files
    - Raw data from correlators
    - needs: SU table
    - All calibration info in CL table
  - Single source files
    - usually after SPLIT and averaging
    - Usually calibrated data, no CL table
- Map files

More on AIPS

- AIPS Versions
  - tst (31DEC07, might get updated via midnite job)
  - new (31DEC06, stable)
  - old
- AIPS extensively uses environment variables
  - Defined through LOGIN.SH/LOGIN.CSH
  - and $CDTST, $CDNEW for compiling etc.

$AIPS_ROOT

- In $AIPS_ROOT the most important files/directories are:
  - `31DEC07 LOGIN.SH HOSTS.LIST DA00 RUN TEXT`
- In 31DEC07 the most important files are:
  - `AIPS APL QY Y HELP LINUX Q RUN SYSTEM`
- They all branch further down
  - Source files `xxxxx.FOR, xxxxx.C`
  - At the lowest level are system dependent routines
  - Files with extension .HLP in the HELP directory
  - .EXE files in `LINUX/LOAD`

AIPS' virtual operating system

For portability reasons a “virtual device interface” for file handling implemented

- AIPS catalog
  - “flat” file system, organised in “disks”
  - Can reorder, rename and delete catalog entries
  - User ID (on disk in extended HEX)
  - AIPS data “disk” can be shared

```
AIPS 1: Catalog on disk  1
AIPS 1:  Cat Usid Mapname      Class   Seq  Pt     Last access      Stat
AIPS 1:    1  333 TEST        .UVSRT .    1 UV 24-MAY-2007 11:39:27 WRIT
AIPS 1:    2  333 TEST        .UVSRT .    2 UV 24-MAY-2007 11:40:40 WRIT
```

AIPS “disks” and “files”

- AIPS “disk” is a directory on a disk (file system) (defined in e.g. in `~/.dadevs` or `$NET0/DADEVS.LIST`)
- AIPS “file” are a bunch of files in that directory

```
-rw-rw-r-- 1 alef aips   10240 2006-08-02 14:40 AND005001.07O;
-rw-rw-r-- 1 alef aips    2048 2006-08-02 14:40 CBD005001.07O;
-rw-rw-r-- 1 alef aips    8192 2006-08-02 14:40 FQD005001.07O;
-rw-rw-r-- 1 alef aips  125952 2006-08-02 14:40 HID005001.07O;
-rw-rw-r-- 1 alef aips 4498432 2006-08-02 14:40 UVD005001.07O;

-rw-rw-r-- 1 alef aips   21504 2007-03-07 12:41 CAD000000.07O;
```

```
-rw-rw-r-- 1 alef aips    10240 2006-03-03 15:12 AND004001.07O;
-rw-rw-r-- 1 alef aips     2048 2006-08-31 16:53 CBD004001.07O;
-rw-rw-r-- 1 alef aips 28727296 2006-03-03 15:12 CLD004001.07O;
-rw-rw-r-- 1 alef aips 28727296 2006-03-03 15:15 CLD004002.07O;
-rw-rw-r-- 1 alef aips    29696 2006-08-31 16:49 FGD004001.07O;
-rw-rw-r-- 1 alef aips     8192 2006-03-03 15:12 FQD004001.07O;
-rw-rw-r-- 1 alef aips   172032 2006-03-14 15:24 GCD004001.07O;
-rw-rw-r-- 1 alef aips  7936000 2006-03-03 15:12 HFD004001.07O;
-rw-rw-r-- 1 alef aips    95232 2006-08-31 16:53 HID004001.07O;
-rw-rw-r-- 1 alef aips    15360 2006-03-03 15:12 NXD004001.07O;
-rw-rw-r-- 1 alef aips    84992 2006-03-15 13:25 PLD004001.07O;
-rw-rw-r-- 1 alef aips   361472 2006-03-14 09:32 SND004001.07O;
-rw-rw-r-- 1 alef aips     9216 2006-03-03 15:12 SUD004001.07O;
-rw-rw-r-- 1 alef aips   107520 2006-03-14 15:24 TYD004001.07O;
-rw-rw-r-- 1 alef aips 59023360 2006-03-03 15:15 UVD004001.07O;
```

The desired end product is the final calibration or CL-table !!

```
-rw-rw-r-- 1 alef aips    2048 2000-12-12 12:12 CBD02C001.07O;
-rw-rw-r-- 1 alef aips   16384 2000-12-12 12:12 CCD02C001.07O;
-rw-rw-r-- 1 alef aips   74752 2000-12-12 12:12 HID02C001.07O;
-rw-rw-r-- 1 alef aips 1048576 2000-12-12 12:12 MAD02C001.07O;
```

Summary

- AIPS holds data in files with tables
- AIPS “files” are organised in AIPS “disks”
- The directory of each “disk” can be listed, etc.
- Calibration of UV data is not applied to the data but accumulated in CL tables
- Solutions of calibration programs are written to SN-tables
- SN-tables are written into CL-tables (CLCAL)

AIPS start-up sequence

- `AIPS_ROOT=/homes/AIPS; export AIPS_ROOT`

or

- `SETENV AIPS_ROOT /homes/AIPS`

- `. $AIPS_ROOT/LOGIN.SH`

or

- `SOURCE $AIPS_ROOT/LOGIN.CSH`

AIPS start-up sequence

- `AIPS_MSG_EXE_FLAG='-sb -sl 900 -e'; export AIPS_MSG_EXE_FLAG`
- `setenv ME /aux/vlb045/alef/aips`
- `setenv  AIPS_TEK_EMULATOR none`
- `setenv AIPSREMOTE "ssh -n"`

AIPS start-up sequence

- `AIPS_MSG_EXE_FLAG='-sb -sl 900 -e'; export AIPS_MSG_EXE_FLAG`
- `setenv ME /aux/vlb045/alef/aips`
- `setenv  AIPS_TEK_EMULATOR none`
- `setenv AIPSREMOTE "ssh -n"`

Now let's do it !

- `aips [tst] [tv={my computer|local}]`
  - MANPATH=$AIPS_ROOT/31DEC07/SYSTEM/UNIX:...
  - man aips

AIPS for beginners I

- Start-up messages
- help, explain, apropos, about
- Define adverbs, save and get adverbs, inputs
- Messages
- AIPS directory
- “getn” files, clrstat, zap, recat
- List headers of UV and MAP files
- Look at a typical tables

AIPS for beginners II

- Multi and single source UV-files
- AIPS history
- tput, tget
- tvlod
- possm
- vplot
- snplt
- Tapes (DAT), external disk files

AIPS for beginners III

- Read FITS data into AIPS with FITLD
- Write data out with FITAB or FITTP

Tips and tricks

- Define your own AIPS “disks” for projects
- Use different AIPS IDs for different projects
- Don't use disks for writing (scratch) over NFS
- More than 1 physical disk helps (e.g. sorting)
- READ THE COOKBOOK!!!

AIPS tables I

- **AN** Antenna table. Contains a list of the antenna names and station coordinates. Also contains instrumental polarization terms.
- AT Antenna characteristics table. Contains additional information about antenna properties, including some time variable quantities.
- BL Baseline offset table. Contains non-closing baseline-dependent phase and amplitude errors as determined by BLCAL.
- BS Baseline solution table. Contains baseline delay, rate and phase solutions as determined by BLING
- **CL Calibration table. Version 1 contains, amongst other things, the default calibration parameters for the amplitude (usually unity), phase, and single-band delay (usually zero) for each source for each IF as a function of time. It also contains polynomial coefficients allowing the correlator delay and phase models to be recomputed. As calibration proceeds, higher versions of this table are created which incorporate more and more calibration effects into the phase, delay, and amplitude entries.**
- CQ Correlator parameter frequency table. Contains VLBA correlation parameters for each AIPS IF, and activates VLBA delay decorrelation corrections.
-

AIPS tables II

CT CALC table. Contains the input parameters passed to CALC to generate the polynomials recorded in the IM table.

FG Flag table. Contains information used to delete selected portions of the data.

FQ Frequency table. Contains information about the IF frequencies, channel spacings, bandwidths, etc.

GC Gain Calibration table. Contains the expected zenith gain and gain-elevation curve for each antenna. It is used for amplitude calibration.

HF Haystack FRNGE table. Contains information generated from the \AIPS\ tables that can be exported to the CALC and SOLVE package.

IM Interferometer model table. Contains the actual polynomial coefficients which the VLBA correlator used to calculate the geometrical model. Unlike the coefficients in the CL table, these have not been re-interpolated onto the CL time grid, but have time stamps corresponding to the times at which the correlator computed the geometrical model.

MC Model Components table. Contains the various components of the geometric model used in the VLBA correlator to generate the IM table.

NX Index File. Contains information about the time, source, sub-array and location within the data file of each observation or “scan”. It is used by some AIPS tasks in accessing the main data file and subsidiary tables.

OB Spacecraft Orbit table. Contains information about the positions and velocities used by the correlator for an orbiting antenna.

AIPS tables III

PC Phase-calibration table. Contains phases within each IF computed from the injected phase calibration signals. It is used to determine the phase offsets and single-band delays for each IF channel.

SN Solution table. Contains antenna delay, rate, phase, and amplitude corrections solved for by CALIB and FRING and other tasks.

SU Source table. Contains a list of the sources found within the multi-source file, including information on source positions and flux density.

TY System temperature table. Contains the system temperature as a function of time for each antenna and IF channel. It is used for amplitude calibration.

VT VLBA Tape table. Contains tape playback statistics for use mainly by the VLBA correlator group.

WX Weather table. Contains weather-related information for each station.

You need to do something special

- You could write your own AIPS task
  - FORTRAN is easy, but AIPS FORTRAN ?!
  - Read the documentation: GOING AIPS I & II
  - Start from an existing program !
  - Use one of the template programs
- Use ParselTongue
  - It allows you to run AIPS tasks and access AIPS headers and AIPS extension tables from Python http://www.radionet-eu.org/rnwiki/ParselTongue

Additional recipies

3.11.2 Cream of banana soup

1. Cook 1 quart green banana pulp, 1 1/2 quarts chicken stock, 1 small celery stalk, 1/2 onion, 1 carrot, 1 small bay leaf, 5 peppercorns, and salt to taste together for about 30 minutes until the mixture thickens.
2. Strain over 1/4 cup flour and 1/4 cup butter which have been combined as for a white sauce. Cook until thickened.
3. Just before serving, add 2 cups cream or milk and heat.
4. Serve with a slice of lemon on each plate as a garnish.