

# **How to run a VLBI observation with the 40m radiotelescope**

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Informe Técnico IT-OAN 2009-7

## Revision history

Version	Date	Author	Updates
1.0	18-03-2009	P. de Vicente	First version
1.1	27-10-2009	P. de Vicente	Added new sections

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## 1. Introduction

This report is a handbook to run a VLBI observation with the 40m OAN's radiotelescope. Three types of VLBI observations are possible: geodetic VLBI, astronomy VLBI and eVLBI. The two first types are performed using disk packs. The latter does not use disk packs and currently, at the time this report is written, is only used for astronomy observations.

## 2. Brief description of the system components.

Most of the devices necessary in a VLBI observation are at the 40m tower: in the control room (see figure 1), in the backends room (see figure 2), in the maser room, at the receiver cabin and in the servo cabin.

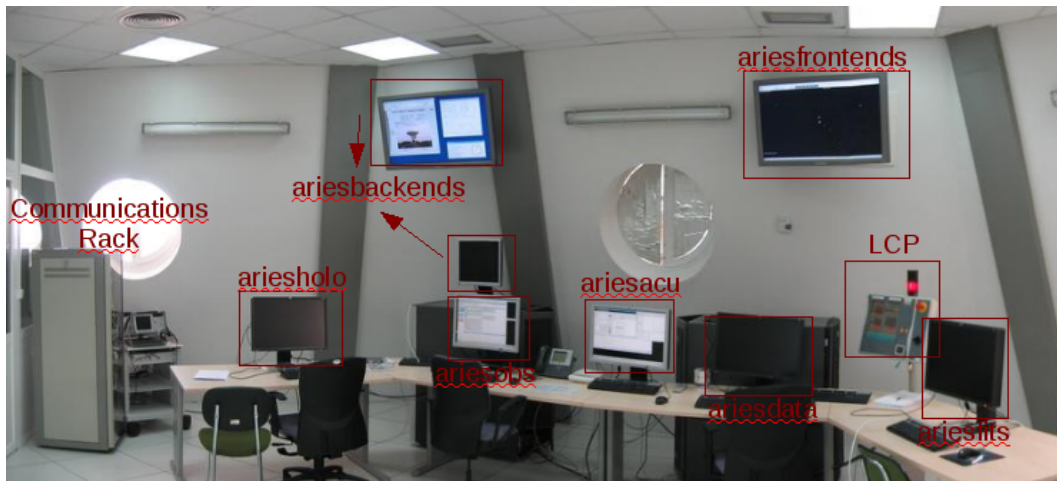


Figura 1: Control room. Equipment used is tagged in the photograph

The following hosts and devices are necessary for the system to work correctly:

- The Antenna Control Unit (ACU). Location: servo cabin inside the rack in front of the stairs. Usually it is on and running. The ACU may be stopped or off in rare occasions, mainly during some special maintenance period. If it were not running please contact PdV, CA, RB or LB. The status of the ACU may be quickly checked by looking at the LCP.
- Hydrogen maser. Location: maser room. The maser room should remain closed and not visited by anybody except maintenance personnel. The maser status can be tracked at the web page: <http://hercules.oan.es/cay/40m/maser/> where it is possible to see the comparison with the GPS and the room temperature as a function of time.

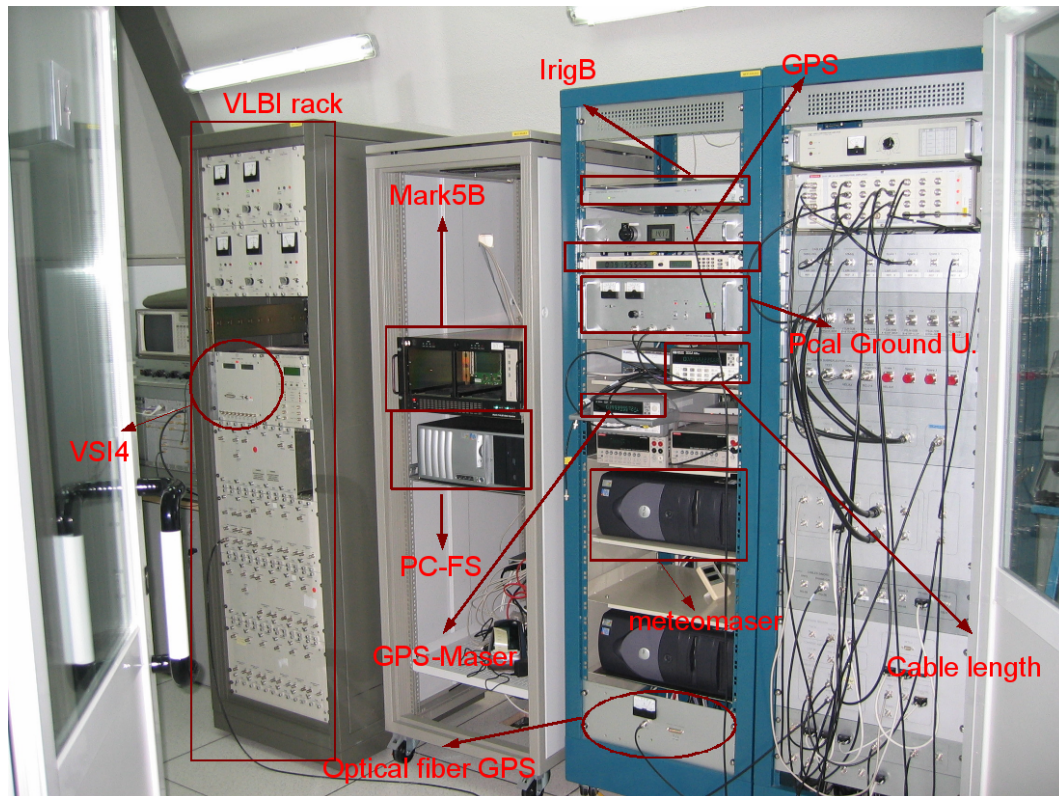


Figura 2: Backends room. Equipment used for VLBI is tagged in the photograph



Figura 3: Hydrogen Maser

## 2.1. Backends Room

- Truetime GPS receiver. Location: backends room. This receiver gets the GPS signal from an antenna located at the weather station tower. The optical signal is monitored with a voltmeter on one of the racks at the backends room (see IT-OAN-2007-03). The GPS receiver big LCD panel should show the current UTC date and time and the smaller panel the tracking mode and the satellite identifiers being tracked. During normal operation, mode is TIME - 3D and 6 satellites are simultaneously visible. If the GPS were not working correctly, check in the voltmeter that there is optical power from the fiber. Power should be around 26 and the green led at the right should be on.
- `meteomaser.oan.es`. Location: backends room. This computer gets information from the weather station and from an HP counter which compares 1 PPS from the GPS terminal and 1 PPS from a generator driven by the maser. It is always on and running. There are a couple of daemons which read these values and store them in two databases respectively. The weather data are transferred via an optical fiber using two serial to optical fiber converters, one at each end of the cable. The converter at the antenna is located in the communications rack in the control room. A serial cable communicates this device with one of the serial ports of this computer. The counter comparison is read via a GPIB card installed in the PC. Further details are described elsewhere in a different OAN internal report.
- `esquizo.oan.es`. Location: backends room. This computer is the control computer for the VLBI equipment. Report IT-OAN-2009-xx (de Vicente 2009) describes in detail the system installation.
- IRIG-B distributor. Location: backends room. Should be on.
- VLBI terminal. Location: backends room. It should be on. The only visible indicators are some LEDs on the VSI4 panel and the voltmeters from the power supplies.
- Mark5B. Location: Backends room. It should be on. During standard VLBI observations at least one disk pack should be in. There are three rows of LEDs on the Mark5B front face. One row in the lower part of the device and two on top of each bank. Their status is described in section 3.4.1.
- Phase Cal Station Unit. Location: backends room. It should be on. The equipment should be in remote mode.
- HP Counter model 2131 to measure the cable. Location: backends room. The cable counter monitors cable length variations. Usually it shows a number close to 0.025 seconds. We will describe further this counter and the cable length monitor. It is used only in geodetic VLBI observations.
- Quartzlock distributor. Location: backends room. It should be on. Alarm LEDs (red) are usually on although these behaviour is not the standard one.

- HP distributor. Location: backends room. It should be on.
- Aries servers. Location: control room. These are 7 computers which are used for the 40m control system, four of them are inside the rack at the left, and three of them inside the right rack. All of them should be on. In next sections we describe their role.

The backend room should be at a stable temperature. The temperature usually oscillates 1 degree peak to peak at most. Values for the last 24 hours and the last week are visible at <http://hercules.oan.es/cay/40m/backends/>.

## 2.2. Control room

The control room is located at the first level of the 40m tower, in front of the elevator. It has three glass doors: two of them to enter into two backends rooms, and a third one to get in and out of the control room. In front of the entrance door there is an U shape table, close to the eastern wall of the room but separated from it 1.5 meters. The communication rack is located at the left, close to the backends room glass wall.

Behind the table there are two racks 1 meter high which hold 7 computers used for the control of the 40m radiotelescope. The left rack houses the following servers: `ariesholo`, `ariesobs`, `ariesfrontends` and `ariesacu`. The rack on the right: `ariesdata`, `ariesfrontends` and `ariesfits`. All computers are labelled with a paper tag on their front and their names give an indication of their role.

All monitors in the control room are connected to a different computer using high quality DVI cables.

Two of these monitors are 42 inches TV screens which protrude from the wall. These are connected to `ariesbackends` (left side) and `ariesfrontends` (right side) respectively. The left one usually shows a live image of the 40m radiotelescope taken from a webcam at the main office building behind a glass window. Its location is towards the southeast referred to the 40m telescope. Its image is shown inside a Firefox (iceweasel) browser. The controls in the browser allow to move the camera and to focus the image. The image may be defocused early every morning since the low visibility during the night may trigger autofocus and focus on reflections generated on the glass at the office location where the camera is. This camera, an Axis 2130 model, is rather old and the CCD is not sensitive enough to provide images of the antenna at night. To open a connection to the camera use: `eyel.oan.es`. Username and password may be provided by PdV, RB or LB. It might be necessary to reload the page if the image is frozen.

There is a monitor below the previous one and on top of the left rack, also connected to `ariesbackends`. This monitor shows a number of graphical clients which display the antenna, receivers, and weather status. In the future more clients may be shown on this screen. The antenna status shows the antenna observing mode, the source being tracked (or the last tracked source if the antenna is stopped), the azimuth and elevation errors and the start and stop scan times in UTC and LST.

The upper right TV screen shows an image of the sky using KStars and the telescope HPBW represented as 3 yellow concentric circles on top of that. The sky should show some optical images and a catalog of radiosources drawn as green dots. The size of the green dots is somehow proportional to the source flux but unrelated to the dots which represent optical sources.



The Local Control Panel (LCP), in the right hand side of the control room is supported by a metallic mast and has a read beacon on top of it. It has got a direct connection to the ACU and shows the status of the main drives, subreflector and M3 mirror, as well as the type of connection (remote or local) to the Antenna Control Unit, and the wind speed. This panel is very useful to know if the antenna is tracking, slewing, stowing, or at any other status, its position and if any errors are present. During observations and in most of the rest of cases the LCP should show in the connection type field: REM. REM means that the ACU is remotely commanded. It may also be in local mode: LCP, as in figure 4.

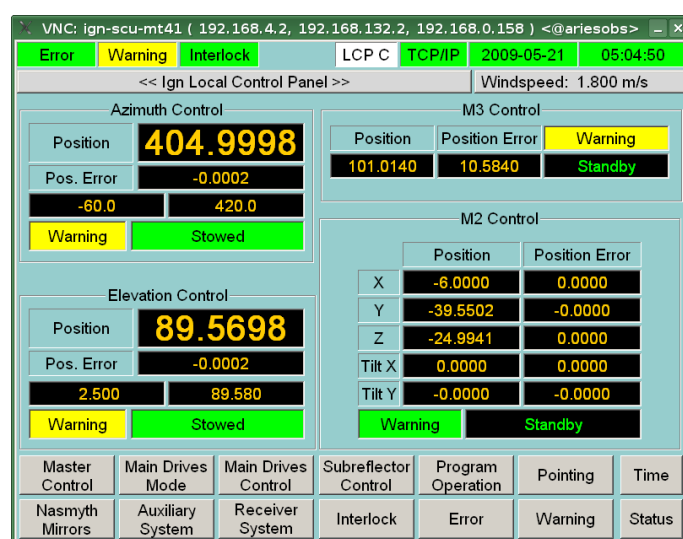


Figura 4: LCP panel display. During remote operations the box on the top and to the left of TCP/IP should show REM. In this image it shows LCP C

The left monitor on the U table is connected to `ariesholo` and it is usually used to open a remote session to the Field System PC and to the Mark5B. The next monitor to the right, just in front of the left rack, is connected to `ariesobs` and is usually used to command the antenna in single dish mode. The aries line command interface should be run from here. Next monitor to the right, between both racks, is connected to `ariesacu`. This one runs the ACS infrastructure which manages all processes necessary to control the radiotelescope.

The two monitors at the right side of the table and at both sides of the LCP panel, are seldom used during observations and, hence, observers may use them for their personal purposes. The rightmost monitor has been used in NME and eVLBI sessions for Skype chats but Skype chats should run from now on in the `ariesholo` monitor since this allows to easily cut and paste text from the FS session.

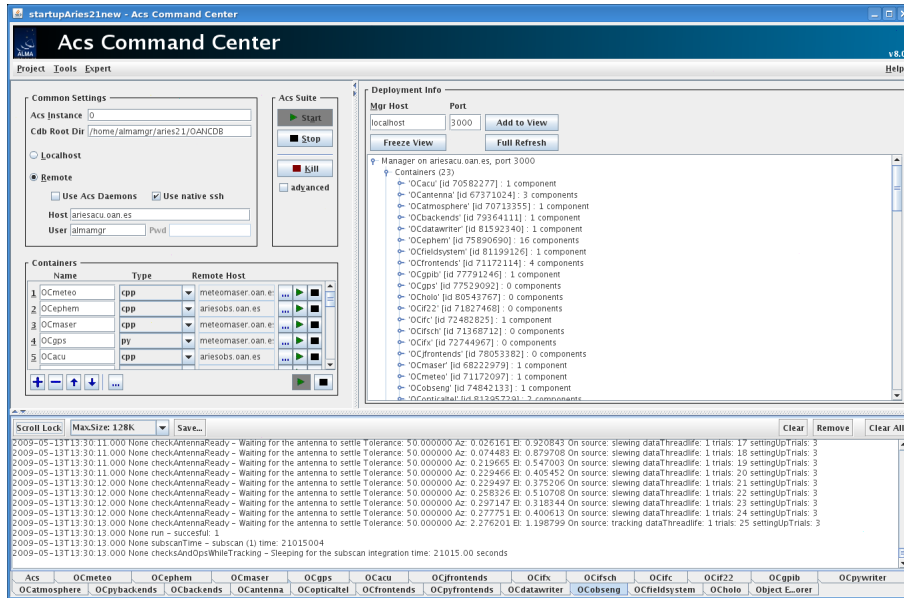


Figura 5: ACS command center during normal operation

### 3. Preparing the telescope for observations

#### 3.1. Starting up the ACS infrastructure

The `ariesacu` monitor, located in the center, is used for the control system infrastructure, that is the ACS (Alma Common Software) manager, services, and containers. All of them are controlled from a Java application called the ACS commandcenter. Usually observers will find this system up and running. The "acscommandcenter" during normal operations is displayed on image 5. The application is divided in 3 areas:

1. Upper left area: The upper window contains the controls to start and stop the ACS service.
2. Upper left area: The lower window contains the control to start and stop the containers.
3. Upper right area: The window contains a list of active containers, components and clients.
4. Lower area: The window is composed of tab logs, one per active container.

When the system is up, the most useful windows are the right window and the lower window. The right window contains a tree view with active containers which allows to open each container and see the list of components that run under this container. If the container tree is not opened, a number at the right indicates the number of active components started by that container. The number of active containers during normal observations at the time of this report is 20. The lower window contains tab logs, each with information used for debugging purposes which are extremely useful for spotting problems. Each tab is related to a container. If one container is managing more than one component all components pour their messages in the same parent container log window.

In case the ACS were stopped we describe the steps to start it up:

- Start the “acscommandcenter” from a konsole at ariesacu. Just type:

```
acscommandcenter
```

- Start the manager and services. This is achieved by clicking on the “play” button in the ACS window. See image 6. When the services start, a new tab log is created and the log is displayed inside. The messages should contain no error.
- Open the “Aries21” project. Click on *Project*, and open file: `/home/almamgr/aries21/startupAries21new`. This project contains the list of containers to be started by the Command center. When the project is opened, a list of containers is displayed in the containers window, each in their boxes. See target 1 on image 7.
- Start the containers. This is achieved by clicking on the green play button which will remain carved (see 2 on image 7). Containers are started in order from top to bottom. Each time a container is started, a new window pops up, the container appears in the right window and a new tab log is created in the lower window. Then the popup window is closed again

Containers are sorted according to their dependencies and started from top to bottom. The upper ones do not depend on any third component, while the lower ones depend on the first ones. Furthermore, some components require that the third components they depend on, are started some time in advance. After starting containers some components will be automatically booted: 1 component in the OCacu, 3 components in the OCfrontends, 1 component in the OCweather, and 2 components in the OCOpticaltel.

Containers should **never** be stopped except by software staff or following their indication. It is possible to stop individual containers but one should take into account that this operation stops all its components and may affect components managed by other containers and clients.

### 3.2. Starting up monitor clients

We have already mentioned that some clients should be started up in `ariesbackends`. These clients are helpful for the observer since they provide useful and live information on the antenna and current scan. Most of the clients can be launched by a generic application called `clients`. We recommend starting:

- Antenna monitor
- Weather monitor
- Frontend monitor

To start up `clients` open a konsole in `ariesbackends` and type in the command line interface:

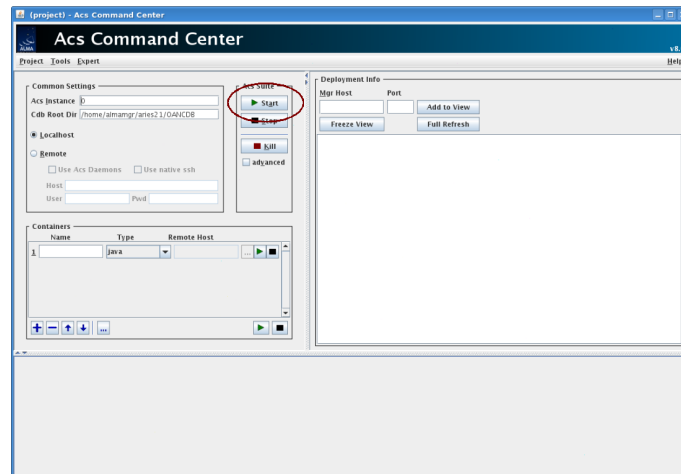


Figura 6: To start the ACS click on the surrounded button

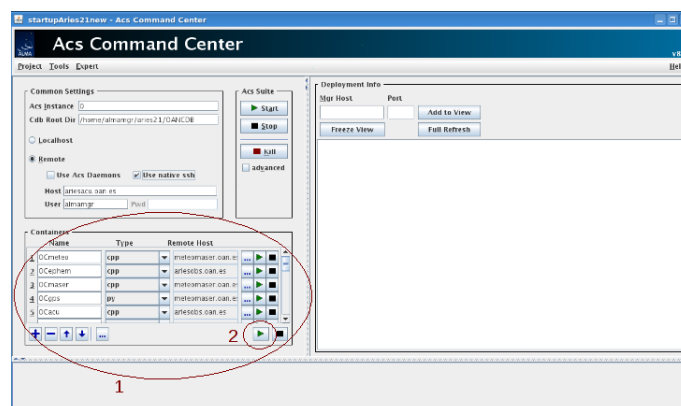


Figura 7: Once the aries21 project is opened, boxes with containers in area 1 are populated. To start all containers, not simultaneously but in order from top to bottom, click in area 2

clients

A window with two panels and two horizontal arrows in opposite directions will pop up. Choose the applications you need to start and press the horizontal arrow that points to the right. The application name will be included in the right window. When all required applications are in the right window, press button `start`.



Figure 8: Snapshot of the standard desktop in the ariesbackends monitor

In `ariesfrontend` start Kstars. This is easily done from the K menu button at the bottom left of the desktop. Kstars is in Educational Applications -> Science - KStars. Once it has started, type the following command from a konsole:

```
kstarsAntenna.py
```

and focus on the Kstars window again. Kstars will automatically display the antenna HPBW as three concentric yellow circles and the sky at the background. It is possible to zoom in and out using the mouse wheel or `ctrl+` and `ctrl-`. Check that the local time matches the UTC time at the aries computers. If not, KStars will display an apparent pointing error. In any case take into account that there is a jerky behaviour while refreshing the HPBW on the KStars sky. This effect is due to the refresh time on the antenna status message. There is also an additional pointing error caused by the fact that KStars does not allow for the DUT1 correction.

### 3.3. Starting up the aries program

Whenever the telescope is to be used, a session with the command line interface should be started at the `ariesobs` monitor. If you are starting the control from scratch, the LCP panel should show the antenna in stow position, both in azimuth and elevation axis, and the mode should be LCP. To start the command line interface, called `aries`, just type at `ariesobs` from within a konsole window:

```
aries
```

This will trigger all processes that prepare the antenna for observations. A normal startup may take from 30 seconds to 2 or 3 minutes. Differences come from the current antenna status. If the ACS infrastructure was already running, the boot time will be shorter. If the stow pins are already out, the antenna will boot faster. This program should never be started while an observation is taking place, because the motors are stopped and reset. During booting and previous to activating the motors, the beacon on top of the LCP metallic mast will light in red for some seconds and will generate a loud signal. Both the light and sound will extinguish after 6 seconds.

Once the startup process finishes one will get the following text on the screen. Two questions require the operator to enter two identifying letters for the observer and the operator.

```
ariesobs almamgr:~/aries21/Catalogs 560 > aries
This step will delay several seconds ....
Initializing required components....
Startup sequence for the antenna ....
Setting tolerance to 8'' (HPBW = 70''). You may change it manually
Setting tolerance to 8'' (HPBW = 70''). You may change it manually
Setting tolerance to 24'' (HPBW = 240'' = 6'). You may change it manually
This receiver only works at a fixed central observing frequency of 8415 MHz
Setting tolerance to 24'' (HPBW = 230''). You may change it manually
Setting tolerance to 24'' (HPBW = 230''). You may change it manually
Setting tolerance to 80'' (HPBW = 700'' = 12'). You may change it manually
This receiver only works at a fixed central observing frequency of 2285 MHz
Setting tolerance to 50'' (HPBW = 500'' = 8'). You may change it manually
Equatorial offsets cannot be used with a horizontal source. Resetting reference offsets
Reference position: 0 0 arcsecs
Re-setting focus offsets to 0.0
Pointing corrections due to focus are: 0.0 0.0
(focus) Final pointing corrections are: 0.0 0.0
Re-setting accumulated pcorr CA (Az) offset to 0.0 arcsec.
Re-setting accumulated pcorr IE (El) offset to 0.0 arcsec.
```

Welcome to the ARIES Command Line Interface v1.64 2009-05-06. (c) MPIfR, OAN  
Type help(aries) to get help. Hit CTRL-D to quit.

Project ID N-00.C-0001-2009

Operator ID (NN) ? PV

Observer ID (NN) ? PV

```
M1:      stopped. Current position: 97.20722, 57.30607
M2:      tracking. Current position: -0.00 0.00 0.00 0.00 -0.00 Errors: -0.00
        El Table offset position: -6.00 -7.45 -21.15 0.00 0.00
M2PS:    standby. Current position: 4.48037 Error: 0.00000
M3POS:    stopped. Current position: 122.72752 Error: 0.03244
M3R:      slewing. Current position: 89.91424 Error: 0.08576
M4A:      standby. Current position: -0.92655 Error: 0.00000
M4B:      slewing. Current position: 0.90490 Error: 0.00000
```

Once the antenna has booted a prompt `aries21` in green will appear on the screen. Usually this program is opened and left running during regular VLBI sessions since it may be very useful to control the antenna at any moment.

### 3.4. Starting up the Mark5B software and the Field System

The Mark5B is the device, it is a computer, that records VLBI data in a disk or transfers the data through Internet. Its work is controlled by one of two server programs which are described in the next section. The Field System is the software that runs in the VLBI PC. This software manages the VLBI acquisition rack, runs a prepared observation and commands the antenna and receivers. Obviously it also communicates with the Mark5B recorder where it sends the data in the form of a VSI stream. Usually it is best to start the Mark5B software prior to starting up the Field System.

#### 3.4.1. Starting the Mark5B server

The Mark5B is a computer with specialized boards that manage the flow of data from the VSI input to the disk packs and the Ethernet port. It requires two linux kernel modules and a software server application (of the same sort as daemons) which runs in the background. The Field System communicates with the Mark5B via sockets to that program server.

There are two server programs for the Mark5B: `dimino` and `jivemark5a`. `dimino` has been developed at Haystack and it is used in standard VLBI observations, where the data is stored in disk packs, however at the time of this report this server cannot transfer data in real time through the ethernet port. `jivemark5a` is a server program developed at JIVE and only works for eVLBI, that is to transfer data from the VSI input to the Ethernet port. `dimino` is managed remotely from the field system or from a local program called `tstdimino`. `jivemark5a` is controlled from JIVE and there is no available connection to the Field System. These programs are incompatible and cannot run simultaneously. Before starting one it is necessary to stop previously the other one.

To start `dimino`, open a ssh session from the `ariesholo` konsole, log into the Mark5B and run:

```
ssh -X -l oper mark5b
dimino -m0 -f1 &
```

We include here the log we will get after starting `dimino`.

```
[1] 2669
oper@mark5b[10]%
dimino DEBUG: msglev set to 0
dimino DEBUG: form1 set to 1
dimino DEBUG: mei 3, namep[mei] dimino
dimino DEBUG: XLRDeviceFind() OK
dimino DEBUG: Trying to XLROpen() ...
dimino errors() ERROR: XLR error 148 Drive module is not ready
dimino DEBUG: XLROpen() OK
dimino Initize() DEBUG: Active, first is TRUE
dimino Initize() DEBUG: Searching for Mark-5 board
dimino Initize() DEBUG: tag 0x80863590
dimino Initize() DEBUG: tag 0x80863591
dimino Initize() DEBUG: tag 0x80863594
dimino Initize() DEBUG: tag 0x80863595
dimino Initize() DEBUG: tag 0x80863597
```

```

dimino Initize() DEBUG: tag 0x80863598
dimino Initize() DEBUG: tag 0x80863599
dimino Initize() DEBUG: tag 0x808624d2
dimino Initize() DEBUG: tag 0x808624d4
dimino Initize() DEBUG: tag 0x808624d7
dimino Initize() DEBUG: tag 0x808624dd
dimino Initize() DEBUG: tag 0x8086244e
dimino Initize() DEBUG: tag 0x808624d0
dimino Initize() DEBUG: tag 0x808624db
dimino Initize() DEBUG: tag 0x808624d1
dimino Initize() DEBUG: tag 0x808624d3
dimino Initize() DEBUG: tag 0x80860329
dimino Initize() DEBUG: tag 0x80860326
dimino Initize() DEBUG: tag 0x8086032a
dimino Initize() DEBUG: tag 0x80860327
dimino Initize() DEBUG: tag 0x10b52046
dimino Initize() DEBUG: tag 0x11ab4361
dimino Initize() DEBUG: tag 0x80861076
dimino Initize() DEBUG: tag 0x10b59030
dimino Initize() DEBUG: 0x730 0x10b59030 0xc1 0xfebdb00 0xec01 0xfeba0000 0 0 0 0 0x80
dimino Initize() DEBUG: found 2, off0 0xfebdb00, off1 0xec00, off2 0xfeba0000, siz0 0x
dimino Initize() DEBUG: IOB offs 0xfeba0000, offp 0xec00
dimino Initize() DEBUG: Found Mark-5B board
dimino Initize() DEBUG: iob 2, II 0
dimino SIOLong5B() DEBUG: Wrote 0622222222 | 0x6492492 to I/O 0x54
dimino Initize() DEBUG: IOB wrote 0622222222 | 0x6492492 to I/O 0x54
dimino RIOLong5B() DEBUG: Read 000000101 | 0x41 from I/O 0x4c
dimino Initize() DEBUG: IOB read 0x41 from I/O 0x4c
dimino SIOLong5B() DEBUG: Wrote 000000101 | 0x41 to I/O 0x4c
dimino Initize() DEBUG: IOB wrote 0x41 to I/O 0x4c
dimino Initize() DEBUG: Trying to open(/dev/mem)
dimino Initize() DEBUG: open() OK, trying to mmap() 4273602560
dimino Initize() DEBUG: OK so far
dimino Initize() DEBUG: IOB buf1[7] 0x5b92
dimino Initize() DEBUG: We seem to have a DIM, idr 0x12, odr 0x5b92
dimino Initize() DEBUG: selpp 3, selcgclk 0, inter set to 2
dimino Initize() DEBUG: Not cold start, bsm 0xffffffff
dimino freq5B() DEBUG: Initial K 4, J 0, freq 32.000000 MHz, parm 0
dimino freq5B() DEBUG: parm 0, freq 32.000000, freq2 32.000000 MHz, k 4
dimino freq5B() DEBUG: DPhase 0x51eb851f 1374389535
dimino freq5B() DEBUG: Frequency set to 32.000000 MHz
dimino freq5B() DEBUG: Frequency 32.000000 MHz, K 4, J 0
dimino Initize() DEBUG: J 0, K 4
dimino freq5B() DEBUG: Initial K 4, J 0, freq 32.000000 MHz, parm 0
dimino freq5B() DEBUG: parm 0, freq 32.000000, freq2 32.000000 MHz, k 4
dimino freq5B() DEBUG: Frequency is already set to 32.000000 MHz
dimino freq5B() DEBUG: Frequency 32.000000 MHz, K 4, J 0
dimino Initize() DEBUG: DIM freq5B(), dxm 1
dimino Initize() DEBUG: DIM starting indDIMDOM(), inter 0x2
dimino Initize() DEBUG: DIM intDIMDOM() thread started
dimino Initize() DEBUG: Normal end, mei 3, iob 2, dxm 1
dimino inBoard() WARNING: Mark5B under construction
dimino inBoard(GET) DEBUG:

```



```

    ib->K 4, ib->J 0, ib->selpp 3, ib->selcgclk 0,
    ib->tvgsel 0, ib->seltvcnt 0, ib->gocom 0,
    ib->tvr_mask 0xffffffff, ib->bsm 0xffffffff, ib->userword 0xbead,
    ib->dimcasc 0, ib->envsiout 0, ib->ii 0,
    ib->ss 0, ib->hw2 0, ib->hw3 0
dimino freq5B() DEBUG: Initial K 4, J 0, freq 32.000000 MHz, parm 2
dimino freq5B() DEBUG: parm 2, freq 32.000000, freq2 32.000000 MHz, k 4
dimino freq5B() DEBUG: DPhase 0x51eb851f 1374389535
dimino freq5B() DEBUG: Frequency set to 32.000000 MHz
dimino intDIMDOM() DEBUG: Initializing
dimino inBoard() DEBUG: Set DIM parameters, tvo 0.000000, FPDP II 0, ii 0
dimino inBoard() DEBUG: Set DIM parameters, iob 2, tvo 0.000000, II 0, ii 0
dimino DEBUG: BoardType PCI-816VXF2, SerialNum 8182, NumDrives 0,
    NumBuses 0, TotalCapacity 0 * 4096 bytes,
    MaxBandwidth 0, PciBus 0x3, PciSlot 0x1, NumExtPorts 2
dimino inBoard() ERROR: XLRSetDBMode() returned error
dimino inBoard() DEBUG: tvg 5, FPDP II 0, ii 0
dimino inBoard() WARNING: Mark5B under construction
dimino inBoard(SET) DEBUG:
    ib->K 4, ib->J 0, ib->selpp 3, ib->selcgclk 0,
    ib->tvgsel 0, ib->seltvcnt 0, ib->gocom 0,
    ib->tvr_mask 0xffffffff, ib->bsm 0xffffffff, ib->userword 0xbead,
    ib->dimcasc 0, ib->envsiout 0, ib->ii 0,
    ib->ss 0, ib->hw2 0, ib->hw3 0
dimino intDIMDOM() DEBUG: Starting DIM ld->intr 0, ld->inter 1
dimino inBoard() DEBUG: Set DIM parameters, tvo 0.000000, FPDP II 0, ii 0
dimino inBoard() DEBUG: Set DIM parameters, iob 2, tvo 0.000000, II 0, ii 0
dimino inBoard() ERROR: XLRSetDBMode() returned error
dimino inBoard() DEBUG: tvg 5, FPDP II 0, ii 0
dimino inBoard() WARNING: Mark5B under construction
dimino inBoard(SET) DEBUG:
    ib->K 4, ib->J 0, ib->selpp 3, ib->selcgclk 0,
    ib->tvgsel 0, ib->seltvcnt 0, ib->gocom 0,
    ib->tvr_mask 0xffffffff, ib->bsm 0xffffffff, ib->userword 0xbead,
    ib->dimcasc 0, ib->envsiout 0, ib->ii 0,
    ib->ss 0, ib->hw2 0, ib->hw3 0
dimino outBoard() WARNING: Mark5B under construction
dimino DEBUG: Set bmode TRUE, abmode FALSE
dimino DEBUG: SystemReady, NOT BootmonReady, NOT Recording, NOT Playing,
    NOT RecordActive[0], NOT RecordActive[1],
    NOT RecordActive[2], NOT RecordActive[3],
    NOT ReadActive[0], NOT ReadActive[1],
    NOT ReadActive[2], NOT ReadActive[3],
    NOT FifoActive, NOT DriveFail,
    NOT SysError, NOT Booting, NOT FifoFull,
    NOT Overflow[0], NOT Overflow[1], NOT Overflow[2], NOT Overflow[3],
dimino DEBUG: ApiVersion 10.07, ApiDateCode Dec 10 2008, FirmwareVersion 12.06,
    FirmDateCode Dec 09 2008, MonitorVersion 6.02, XbarVersion 3.23,
    AtaVersion 1.05, UAtaVersion 0.00, DriverVersion 921
dimino DEBUG: BaseRange 16777216
dimino DEBUG: dfifo FALSE
dimino DEBUG: Calling CheckBanks(), bank 3
dimino DEBUG: On return from CheckBanks(), bank 2, nscans 0

```

```

dimino DEBUG: Setting defaults to outBoard() and inBoard()
dimino outBoard() WARNING: Mark5B under construction
dimino inBoard() DEBUG: Set DIM parameters, tvo 0.000000, FPDP II 0, ii 0
dimino inBoard() DEBUG: Set DIM parameters, iob 2, tvo 0.000000, II 0, ii 0
dimino inBoard() ERROR: XLRSetDBMode() returned error
dimino inBoard() DEBUG: tvg 5, FPDP II 0, ii 0
dimino inBoard() WARNING: Mark5B under construction
dimino inBoard(SET) DEBUG:
    ib->K 4, ib->J 0, ib->selpp 3, ib->selcgclk 0,
    ib->tvgssel 0, ib->seltvcnt 0, ib->gocom 0,
    ib->tvr_mask 0xffffffff, ib->bsm 0xffffffff, ib->userword 0xbead,
    ib->dimcasc 0, ib->envsiout 0, ib->ii 0,
    ib->ss 0, ib->hw2 0, ib->hw3 0
dimino mksock() DEBUG: sock 8, datahh 0,
    rcvbuf 87380, rcvlowat 1, sndbuf 16384,
    sndlowat 1, socbuf 131072, nbuf 8
dimino mksock() DEBUG: m5drive tcp port is 2620
dimino intDIMDOM() DEBUG: Initialized at UT 1242982127.999952 seconds,
    inter 1, kount 0, tvs 1242982125, (-)tvo -0.000048
dimino Ready. End with Enddim, please

```

```

no DEBUG: BaseRange 16777216
dimino DEBUG: dfifo FALSE
dimino DEBUG: Calling CheckBanks(), bank 3
dimino CheckBanks() DEBUG: New bank 0, was 3
dimino checkDisks() DEBUG: Found disk in Bus 0 Master,
    Model ST3750640NS
    Serial 5QD53NGE,
    Revision 3.AEG ,
    Capacity 1465127023 * 512 bytes
    SMARTState OK
dimino checkDisks() DEBUG: Found disk in Bus 0 Slave,
    Model ST3750640NS
    Serial 5QD5251K,
    Revision 3.AEG ,
    Capacity 1465127023 * 512 bytes
    SMARTState OK
dimino checkDisks() DEBUG: Found disk in Bus 1 Master,
    Model ST3750640NS
    Serial 5QD51DSL,
    Revision 3.AEG ,
    Capacity 1465127023 * 512 bytes
    SMARTState OK
dimino checkDisks() DEBUG: Found disk in Bus 1 Slave,
    Model ST3750640NS
    Serial 5QD53MQQ,
    Revision 3.AEG ,
    Capacity 1465127023 * 512 bytes
    SMARTState OK
dimino checkDisks() DEBUG: Found disk in Bus 2 Master,
    Model ST3750640NS

```

```

Serial          5QD4F54Q,
Revision 3.AEG  ,
Capacity 1465127023 * 512 bytes
SMARTState OK
dimino checkDisks() DEBUG: Found disk in Bus 2 Slave,
Model ST3750640NS
Serial          5QD53AY0,
Revision 3.AEG  ,
Capacity 1465127023 * 512 bytes
SMARTState OK
dimino checkDisks() DEBUG: Found disk in Bus 3 Master,
Model ST3750640NS
Serial          5QD4WTJR,
Revision 3.AEG  ,
Capacity 1465127023 * 512 bytes
SMARTState OK
dimino checkDisks() DEBUG: Found disk in Bus 3 Slave,
Model ST3750640NS
Serial          5QD52VPV,
Revision 3.AEG  ,
Capacity 1465127023 * 512 bytes
SMARTState OK
dimino checkDisks() DEBUG: Found 8 SS disks; OK
dimino checkDisks() DEBUG: SS directory Length 0,
AppendLength 0, NOT Full
dimino checkDisks() DEBUG: Set fill pattern OK
dimino checkDisks() DEBUG: XLRSetOption() drive statistics OK
dimino checkDisks() DEBUG: XLRSetDriveStats() OK
dimino checkDisks() DEBUG: Normal end
dimino CheckBanks() DEBUG: Calling ReadDir()
dimino ReadDir() DEBUG: Trying to XLRGetUserDirLength()
dimino ReadDir() DEBUG: Trying to XLRGetUserDir()
dimino ReadDir() DEBUG: XLRGetUserDir() returned normally
dimino ReadDir() DEBUG: User directory checks OK
dimino ReadDir() DEBUG: Directory read OK, nscans 0, recpnt 0
Directory copied to /var/dir/Mark5A OK
dimino ReadDir() DEBUG: write() wrote file /var/dir/StreamStor1Erased: Success
dimino ReadDir() DEBUG: Normal end

```

**LEDS:** Locked, Power and Ready on the Mark5B front side on both banks will light while the server starts. If there is a disk pack in the bank, LEDS on the disk pack will light up for one second from top to bottom and will remain off after the check.

If LED Ready (in the Mark5B horizontal row) is blinking after the Mark5B check, it means that the disk pack is not ready and should be reset by issuing the following instruction from the Field System:

```

> mk5=protect=off
> mk5=reset=erase

```

This instruction will erase all files in the disk pack and reset the disks.

Abnormal startup of dimino should spot a serious problem with the SDK version or the firmware version.

To start `jivemark5a` type

```
ssh -X -l oper mark5b
/opt/jivemark5a -m0
```

After starting `jivemark5a` the Mark5B will be checked. As, in the previous case, the LEDS will light up as a test procedure. If we are interested in getting full debug information parameter “m” should be followed by a 2. For example:

```
/opt/jivemark5a -m2
```

### 3.4.2. Starting the Field System

Since the Field System opens a socket connection to the Mark5B, it is highly recommended to start the Mark5B software prior to starting the Field System. Failure to do so will generate an error.

In order to activate the communication between the Field System and the antenna, an instance of the FieldSystem component should be initiated from the object explorer at `ariesacu`. To open an object explorer client, click on `Tools` at the ACS command center and select `Object Explorer`. Then navigate until you find `FielSystem`. Open the tree view and double click on the instance name: `FIELDSYSTEM`. The name should be highlighted in blue and you should get no error and no message.

From the `ariesholo` monitor a number of remote ssh sessions to `esquizo` should be opened. In order to avoid cluttering the desktop it is advisable to tag each tab with a sensible name like `FS-Log`, `esquizo` or `mark5b`. At least one session to the Mark5B and three sessions to the Field System PC should be opened.

At the `FS-Log` tab open an ssh client to `esquizo` and start the Field System:

```
ssh -X -l oper esquizo
password: xxxxxx
> fs
```

The konsole window from which the FS was commanded will transform to the log window and two additional windows will pop up: a white one for errors and a black one, whose name is `oprin` which holds the FS command line interface. This window can be resized, and placed below the FS log window. It usually allows for 10 lines approximately. When the Field System starts, the antenna will run the boot sequence; hence motors will be reset and activated some seconds later and therefore it is very important not to try to use the antenna before it is fully ready.

Important: If the FS PC were powerdown, start it **and** select kernel *2.6.18 etch and half*. Failure to do so will cause the FS not to work correctly since digi multiboard serial drivers will not be loaded and the serial communication to the VLBI terminal will fail. GPIB kernel module will also be loaded successfully.

Below we list frequent errors displayed when starting the Field System:

- `dimino` Mark5B server was not started. The error log will show the following messages:

```

ERROR un 115 Operation now in progress
ERROR m5 -23 mk5cn: socket open error from getsockopt()
ERROR un 115 Operation now in progress
ERROR m5 -23 mk5cn: socket open error from getsockopt()
ERROR un 115 Operation now in progress
ERROR m5 -23 mk5cn: socket open error from getsockopt()
ERROR un 115 Operation now in progress
ERROR m5 -23 mk5cn: socket open error from getsockopt()
#setcl#time/0,0,0000,000,00,00,00.00,0.000,0.000,$$$$$$$$$$$$
#setcl#model/old,1230472253,0,0,-5.399,50.674,computer,0,no_sync,0,$$$$$$$$$$$$
ERROR sc -10 setcl: failed too many times, couldn't check formatter time
ERROR sc -14 setcl: Computer time not synced to NTP
ERROR sc -22 setcl: Mark 5B clock source is wrong, correct manually.

```

To correct this error start `dimino` in the Mark5B as explained before.

- Synchronization problems between the FS clock, the computer clock and the Mark5B. Different error messages may arise here but typical ones are:

```

ERROR sc -13 setcl: formatter to FS time difference 0.5 seconds or greater

```

To correct this error read section 5.5

### 3.5. Starting up a Skype session

Skype sessions are started for NMEs (Network Monitoring Experiments) and eVLBI sessions. Username is `yebes40m`, and the password the same as the oper account for the FS PC. JIVE creates a chat for each experiment run and invites all telescope operators to the chat. Other experts may join the chat to help with potential problems. Chats are saved in the skype log file. Some participants will appear in green and others in grey. The former ones are people who authorize `yebes40m`, to chat with them. The grey ones have not authorized `yebes40m` yet.

## 4. Downloading, setting up and running a schedule

### 4.1. Downloading a schedule

Schedules are downloaded from two different sources depending if the observation is a geodetic or an astronomy one.

#### 4.1.1. Geodetic observations

Schedules for geodetic experiments can be downloaded from:

<http://ivscc.gsfc.nasa.gov/program/operafiles.html>

If there are last minute modifications they should be get using an FTP server:

```
cd /usr2/oper/scheds
ncftp3 -u user -p password ivscc.gsfc.nasa.gov
cd schedule_updates
get euro97.skd
get euro97.txt
get euro97.chg
```

User and password are not included in the public version of this report but they are available in the internal OAN wiki.

#### **4.1.2. Astronomy observations**

Schedule, logs and other related information for astronomy are stored in this host: `vlbeer.ira.cnr.it`, where a passive FTP server runs. To retrieve a schedule follow these steps:

```
cd /usr2/oper/scheds
ncftp3 -u user -p password vlbeer.ira.cnr.it
cd vlbi_arch
```

User and password are not included in the public version of this report but they are available in the internal OAN wiki.

Afterwards go to the correct directory, whose name is composed of month plus year and get the required files. It is advisable to download several files using the same command line:

```
cd may09
get rb002.skd rb002.key rb002.sum rb002.oms
```

## **4.2. Preparing a schedule**

All schedules are prepared locally running `drudg` on the downloaded sked files and the same steps apply to standard astronomy, eVLBI astronomy and geodetic observations.

Here we reproduce an example of running `drudg` for a geodetic experiment. By default, `drudg` looks for the sked file at directory `/usr2/oper/sched`. The program will show the number of observing sources and scans, and the stations, with a two letter code, that take part in the observation. After, it requests the station code and once entered it will show the equipment at that station. In our case this is a VLBA5 (VLBA + VSI4) and a Mark5B. If this is correct there is no need to modify the equipment. At the end `drudg` offers several possibilities for that station.

Usually 3 options should be selected, in this order:

- Create the procedure (proc) file: option number 12
- Create the schedule (snap) file: option number 3
- Print the observation summary: option number 5

Below we include a typical log:

```

drudg euro99.skd
RDCTL02 - Reading system control file /usr2/control/skedf.ctl
  DRUDG: Experiment Preparation Drudge Work (NRV & JMGipson 2008Oct08)
Version:  9.10.04
Opening file /usr2/oper/scheds/euro99.skd for schedule euro99.skd
EURO99
$SKED
$SOURCES
$STATIONS
$CODES
$HEAD
OBS_SORT00 - Sorting scans by time.
This is a geodetic schedule.
This is a standard non-Vex schedule file.
# of sources:          100
# of stations:         9
# of frequency codes:  1
# of scans:            349
Stations:
Bd (BADARY  ) Sm (CRIMEA  ) 6a (DSS65A  ) Eb (EFLSBERG) Mc (MEDICINA)
Mh (METSCHOV) On (ONSALA60) Wz (WETTZEHL) Ys (YEBES40M)

Output for which station (type a code,  :: or q to quit, = for all) ? Ys
WARNING! Using equipment from control file:
  Replacing rack VLBA4      by VLBA5
  Replacing rec1 VLBA4      by Mark5B
  Replacing rec2 none       by none

Equipment at YEBES40M:
  Rack: VLBA5   Recorder 1: Mark5B   Recorder 2: none

Select DRUDG option for schedule /usr2/oper/scheds/euro99.skd at YEBES40M
1 = Print the schedule          7 = Re-specify stations
2 = Make antenna pointing file  8 = Get a new schedule file
3 = Make SNAP file (.SNP)       9 = Change output destination, format
4 = Print complete .SNP file    10 = Shift the .SKD file
5 = Print summary of .SNP file  11 = Show/set equipment type
                                12 = Make procedures (.PRC)

51 = Print notes file (.TXT)
20 = Make fake lvex
0  = Done with DRUDG

```

The schedule file will be written at directory `/usr/scheds/`, and the procedure file at directory `/usr2/proc/`. At the OAN we usually store the `.skd` files on several folders with the monthyear code at directory `/usr2/oper/scheds` to avoid cluttering the account.

By the time of this report the procedure file requires manual editing at each line where command `lo=lox` appears. `x` may take any value among `a`, `b`, `c`, `d`. It is necessary to add a new line specifying the IF name of that LO. An example is shown below:

```

lo=loa,7650.00,usb,rcp,1
newlo=a
lo=lob,1530.00,usb,rcp,1
newlo=b

```

These instructions indicate the association between the VLBI equipment IFs and the LO frequency and the new command will guarantee that the correct frequency is commanded to the receivers at the 40m radiotelescope. It is also convenient to add instruction `tpicd=no,2000` immediately before `tpicd` appears:

```
tpicd=no,2000
tpicd
```

The previous modifications may be done by running a local script instead of editing the file by hand. This is very handy during an EVN session where there may be several files to be edited. For example:

```
cd /usr2/proc
add_newlo.py rb002ys.prc
```

#### 4.2.1. eVLBI schedule adjustment

By the time of this report schedules for eVLBI observations require to remove some references to Mark5 commands since the server program being run at the Mark5 is `jivemark5a` instead of `dimino`. In order to remove these references the procedure and the schedule file need to be parsed and corrected by a script file which performs this task:

```
cd /usr2/sched
mk5_del.pl rb002ys.snp
cd /usr2/proc
mk5_del.pl rb002ys.prc
```

This removal helps to decrease the number of log errors at the Field System log since `jivemark5a` is not prepared to communicate with the Field System, and any command sent by the latter is not understood and generates an error line. A solution is being thought by the FS developer to avoid using this script.

#### 4.2.2. Printing the observation summary

The observation summary is printed to the default printer at the 40m control room. The summary has got a header with information on the experiment and is composed of several columns with information on the scans. Below is an example of which we only reproduce a part:

```
Schedule file:  es060bys.snp          Page   1
Station:        YEBES40M (Ys) (Y)    Session:      ES060B
Tape motion:    ADAPTIVE (gap= 10) Recorder type:  DISK
Rack:           VLBA5
Recorder 1:     Mark5B                Early start:   0 sec
Recorder 2:     none                  Late stop:     0 sec
Mode 1 Setup proc(s): setup01        IFD proc: ifd01
Mode 2 Setup proc(s): setup02        IFD proc: ifd02
```

```
Times are in the format hh:mm:ss
Scan   = scan_name command in .snp file
Line#  = line number in .snp file where this scan starts
```



Dur = time interval of on-source data (Start Data to Stop Data) in mmm:ss  
 Gbyte = Gigabytes at start of scan  
 Record Usage: XXX or Rec1=start recorder 1, Rec2=start recorder 2  
 \*=parity check, @=no tape motion

Scan	Line#	Source	Az	El	Cable	Start Record	Start Data	Stop Data	Stop Record	Dur	Gbyte	Record
date = 2009JUN 1 DOY = 152												
No0001	7	3C286	178	80		21:00:00	21:00:00	21:05:00	21:05:00	5:00	.0	Mode 2
No0002	24	3C286	185	80		21:06:00	21:06:00	21:11:00	21:11:00	5:00	1.2	*
No0003	41	3C345	76	56		21:12:00	21:13:10	21:17:00	: :	3:50	2.7	*
No0004		3C345	77	57		: :	21:17:15	21:22:00	21:22:00	4:45	3.7	
No0005	70	3C345	77	58		21:23:00	21:23:00	21:33:00	21:33:00	10:00	4.8	*
No0006	87	J1825-07	112	13		21:34:00	21:34:02	21:37:45	: :	3:43	7.2	*
No0007		G21.57	114	11		: :	21:38:03	21:41:00	: :	2:57	8.2	
No0008		J1825-07	114	14		: :	21:41:18	21:42:45	: :	1:27	9.0	
No0009		G24.33	112	13		: :	21:43:02	21:46:00	21:46:00	2:58	9.4	
No0010	136	J1825-07	115	15		21:47:00	21:47:00	21:48:45	: :	1:45	10.1	*
No0011		G24.51A	113	14		: :	21:49:02	21:52:00	: :	2:58	10.6	
No0012		J1825-07	116	16		: :	21:52:17	21:53:45	: :	1:28	11.3	
No0013		G24.51B	114	15		: :	21:54:02	21:57:00	21:57:00	2:58	11.8	
No0014	183	J1825-07	117	17		21:58:00	21:58:00	21:59:45	: :	1:45	12.5	*
No0015		G24.79	115	16		: :	22:00:02	22:03:00	: :	2:58	13.0	
No0016		J1825-07	118	18		: :	22:03:17	22:04:45	: :	1:28	13.7	
No0017		G24.85	116	17		: :	22:05:02	22:08:00	22:08:00	2:58	14.2	
No0018	230	J1825-07	119	19		22:09:00	22:09:00	22:10:45	22:10:45	1:45	14.9	*
No0019	247	3C345	82	67		22:14:39	22:14:39	22:24:39	22:24:39	10:00	15.3	*
No0020	264	J1825-07	122	22		22:25:39	22:25:42	22:27:24	: :	1:42	17.7	*
Total 113.6 Gbytes												
Total number of scans: 172												

Columns contain information on the number of the scan, the line in the sched file at which the scan is started, the source, az and elevation of the antenna, if the antenna should do a clock wise or counter clock wise movement to arrive at its target, the start time for recording and for taking data, and the stop time for taking data and recording, the duration of the scan, the used disk space since the beginning of the experiment and the mode. This information is very important and useful during the observations.

The disk space allows to estimate when the disk pack changes are expected. The column with the line number allows to execute a schedule at any time and do it safely so that the equipment setup is properly commanded, regardless the schedule is not started from the beginning. In a next section we explain how this is achieved.

## 5. Checking disks, signals and levels

### 5.1. Checking disks

Disk packs should be prepared previous to the observation. Before a session the disk packs should be taken out of their boxes and their covers should be unscrewed and removed. The screws and the covers should be stored inside the card box and the disk packs placed on top of the boxes ready to be handled. All boxes should be placed in the backends room close to the VLBI equipment. Disk packs may be new or may come from the correlator.

### 5.1.1. New disk packs

If disk packs are new they should be given an identifier and several labels should be stucked on them.

- To assign an identifier, insert the disk pack in the bank and enter, for example, the following commands:

```
> mk5=protect=off
> mk5=vsan=OAN+0013
> mk5=vsan?
/mk5/!vsan? 0 : OAN+0013/4000/1024 : OK
```

The previous command, assigns label OAN+0013 to the active disk pack. Usually at the OAN we use labels with + for SATA disks, and - for PATA disks. Number starting from 100 on, are reserved for geodetic disk packs, and those below for astronomy packs. The system will generate the label plus to extra fields: the size in Mb (in the previous example 4000) and the maximum data allowed rate (in the previous example 1024 Mb/s).

- Usually new disk packs, if bought already mounted, do not require conditioning. If they were mounted in house they need conditioning. This is described below.
- A green and white rectangular correlator label should be stucked on the front of the disk pack. It has two areas: one for the experiment label, and one for the correlator library and a green dot which allows to stick a red dot indicating the disk is recorded. This label is specially designed to be able to easily remove the labels.
- Labels for the disk packs are produced using a special script which uses linux application, `xfig`. The current script allows to print labels for two disk packs in the same sheet of paper. The `xfig` template has been modified locally to fit in the stickers at the OAN. The stickers are from APLI, Ref: 01264, sized A4, ready for laser printers and allow to use two labels half A4 size. To generate the labels run:

```
cd /usr2/oper/dila
./dila OAN+0013/4000/1024 OAN+0014/4000/1024
```

This will produce an image with two bar code labels and one condition log table. The three labels should be separated with scissors.

- The smaller bar code label should be stucked on one side of the pack close the rear side.
- The larger bar code should be stucked on the front, at the right side of the handle. Since there is a small space there, the sticker should be cut to fit in that space.
- The conditioning label is stucked on one side of the disk pack, taking care that it does not cover the holes there.

### 5.1.2. Old disk packs

Old disk packs from the correlator usually need conditioning. Correlators usually keep the old files recorded in the disk and they place an orange/yellow sticker that informs the operators that the disk should be removed or conditioned. This operation requires a lot of time and if there are several disk packs to be conditioned the operation should be performed **several days before** the experiments. To condition a disk pack first stop dimino and then condition it:

```
Enddim
SSERase -m0 -c1
```

As with `dimino` it accepts two parameters:

- `-m` followed by the message level. Higher is more verbose. Values between -1 to 3 are allowed.
- `-c` followed by a 0 (FALSE) or 1 (TRUE).

If both keys were turned the two disk packs will be conditioned. Take into account that conditioning a disk pack may take a lot of time. The time required depends on the disk size and disk brand. Belowe we include conditioning times, as provided by Dan Symthe from Haystack Observatory by the time of this report. Conditionining erases data and makes a cycle of writing and reading to detect possible faults in the disks. This information is updated here: <ftp://web.haystack.mit.edu/pub/mark5/Conditioning.txt>

```

        average
GB minutes Mb/s
-----
8*120=960    152 2H32M 1684 with Mark 5A or B
8*120=960    116 1H56M 2200 with Mark 5B+
16*120      278 4H38M 1842 Western Digital with Mark 5A or B

8*164.7=1317  205 3H25M 1711 Hitachi with Mark 5A or B

8*185.2=1482 230 3H40M 1744 Hitachi with Mark 5A or B
16*185.2    430 7H10M 1838 Hitachi with Mark 5A or B

8*200=1600 260 4H20M 1641 Western Digital with Mark 5A or B
8*200=1600 187 3H07M 2276 Western Digital with Mark 5B+
16*200     465 7H45M 1835 Western Digital with Mark 5A or B

8*250=2000 306 5H06M 1700 Hitachi, WD with Mark 5A or B
8*250=2000 209 3H29M 2550 with Mark 5B+
16*250     580 9H40M 1839 Hitachi with Mark 5A or B
16*250     210 3H30M 5100 with Mark 5B+

8*300=2400 370 6H10M 1730 with Mark 5A or B
8*300=2400 230 3H50M 2755 with Mark 5B+
16*300     695 11H35M 1843 with Mark 5A or B
16*300     230 3H50M 5510 with Mark 5B+ (44 MB/s/drive)
```

```

8*320=2560 385 6H25M 1744 Western Digital with Mark 5A or B
8*320=2560 250 4H10M 2733 W-D with Mark 5B+ (43 MB/s/drive)
16*320      742      12H22M      1840 Estimated with Mark 5A or B

8*400=3200 484 8H04M 1744 Hitachi with Mark 5A or B
8*400=3200 300 5H00M 2800 with Mark 5B+
16*400      925      15H25M      1844 Seagate with Mark 5A or B
16*400      300      5H00M      5600 Seagate with Mark 5B+

8*500=4000 383      6H23M 2787 with Mark 5B+
16*500      1163      19H23M      1840 Estimated with Mark 5A or B
16*500      390      6H30M      5475 Seagate with Mark 5B+

8*750=6000 924      15H24M 1730 Estimated with Mark 5A or B
8*750=6000 577      9H37M 2770 With Mark 5B+
16*750      1744      29H04M      1840 Estimated with Mark 5A or B
16*750      580      9H40M      5500 With Mark 5B+

8*1000=8000 771      12H51M 2768 Seagate with Mark 5B+

```

In case there is not time to condition all disk packs, disk packs must be erased before the observations. This is done from the FS issuing the following instructions:

```

mk5=protect=off
mk5=reset=erase

```

### 5.1.3. Inserting disk packs

Standard astronomy and geodetic observations require inserting a disk pack in one of the disk banks. The first option should be bank A, but it is possible to use bank B. Usually it is advisable to insert a second disk in the other bank, but if the observation is not followed by another observation and does not require more space than provided by the first disk pack it is not necessary to insert the second one.

The disk should be pushed gently inside the bank. The lever on the disk pack front should be opened (in a horizontal position). Once the disk pack stops against the bottom, push gently while helping the lever go from the open position to the close position. Once the disk is completely inserted the lever should be fully closed (vertical).

It is important not to “activate” the disk pack if the Mark5B is recording in the other bank. To activate the disk bank the key should be turned clockwise from a vertical position to a horizontal one (90 degrees). Once the key is turned and if `dimino` is running in the Mark5B, LEDs “Locked” and “Ready” on top of the bank will light green. After some seconds ( $\sim 20$ ) the leds in a row in the disk pack will flash for a moment while the system checks the disks. The disks will be checked from top to bottom. If the checks were correct, the “Ready” LED will light steadily in green. The “Selected” LED will light in red only if the disk bank is selected.

In case the “Ready” LED flashes intermitently the disk requires being erased previous to being used. If the disk pack already contains data, do not erase it.

To erase the disk pack, the following commands should be written from the FS:

```

> mk5=protect=off
> mk5=reset=erase

```

It is important to avoid inserting in bank A a disk pack partially recorded in bank B. This should be visible because a disk pack that has been recorded should get a red point on the front and a label written by hand with letter identifying the bank in which it was recorded.

## 5.2. Checking signals and levels

IF cables should be connected to the corresponding VLBI terminal IFs in the backends room. 4 IF entries are possible. The patching is done in the rightmost rack. The patching is done according to the instructions in the “lo” line that we mentioned previously. For example the following instructions indicate that IF A should be connected to right circular polarization from the a receiver whose LO is at 21550 MHz and whose signal is in the upper side band, and IF C is connected to that same receiver but left circular polarization.

```
lo=loa,21550.00,usb,rcp,off
lo=loc,21550.00,usb,lcp,off
```

IF levels are automatically setup via software once an observation and the procedure file has been commanded. However this is not possible for the 22 GHz receiver since it is only manually controlled. In the case of the 22 GHz receiver, attenuation for both circular polarizations is kept fixed. To be sure that the correct attenuation has been commanded, one should use the procedure file for the experiment and check the IF levels by running:

```
> ifdab
> ifdcd
```

A typical correct log is included below:

```
ifdab/0,0,nor,nor,1,22705,5301,511,1pps
ifdcd/0,0,nor,nor,1,29140,141,512,1pps
```

Refer to the snap manual for information on this command. The level is the 6th parameter shown previously.

IF levels should be checked at two elevations: 15 and 70 degrees, with the vertex opened and using the IF detectors. Correct levels are between 7000 and 30000. These numbers are in arbitrary units and it is important to take into account that 65000 indicates that the detectors are saturated. IF attenuations for each receiver are already set to provide correct levels for operation. If the measured levels were wrong, this is an indication of something not working correctly (vertex closed, wrong patching, receiver fault, interferences, broken cables, ....). In that case please contact the author of the report or a receiver engineer.

BBCs can adjust their gain automatically under certain limits. Levels should be around 16000 (in arbitrary units). It is advisable that attenuation is close to 0. To check BBC status run:

```
> bread
```

Levels for all BBCs will be displayed. Take into account that there may be no signal in some IFs and hence BBCs connected to those IFs will display their maximum gain (11.99) and a low level count.

Below we include a typical correct log for the first 4 BBCs:

```
bbc01/784.49,a,16,16,1,agc, 4.26, 4.01,lock,16104,16198,570,1pps
bbc02/784.49,c,16,16,1,agc, 2.82, 3.02,lock,16244,16104,565,1pps
bbc03/816.49,a,16,16,1,agc, 6.63, 7.47,lock,16331,16309,574,1pps
bbc04/816.49,c,16,16,1,agc, 3.84, 3.11,lock,16232,16000,572,1pps
```

The attenuation at the upper side band and the lower band are the two values after the “agc” field respectively and the level count are the two field values following param “lock”.

If a BBC does not acknowledge or it is not locked or the 1 pps is not present then it should be taken out and replaced by another one not being used in the experiment. This is possible in astronomy observations since it is usual to only use 8 BBCs.

If we are running a geodetic observation, replace the non working BBC by the spare one (in the backends room tools cabinet). If the spare one does not work, place the broken BBC in position 6. If more BBCs were broken positions they should be placed at, are: 11, 7 and 2

To check that the noise diode works properly enter the following command:

```
> calon
```

The levels in the IFs should increase slightly. It is also possible to check the levels using the BBCs detectors, but in this case the autogain will correct the attenuation. Hence it is better to compare attenuations values with the cal diode on and off. To switch the noise diode off:

```
> caloff
```

### 5.3. Geodetic observations. The cable cal

Geodetic observations require to calibrate the phase change due to temperature variations along the IF cable and the 5 MHz reference signal. This is done with a cable cal system which runs while the observation takes place. This system has to be calibrated before each geodetic observation. The procedure is described here:

- Fetch the calibration cable with the 1.76 ns label attached to it in the backends tools cabinet. It is 20 cm long approximately.
- Execute `faseinit` in the Field System. This will load the required configuration at the counter.
- Measure the value by entering command `fase`. To get the value in seconds the number must be divided by  $2 \cdot 10^5$ .
- Unplug the cable at connector “Out To Ant” in the OAY-15 module, insert the calibration cable at that connector on one end and to the unplugged cable at the other end. That is, the new cable will be 20 cm longer than before. Module (OAY-15) must be in remote mode and off.
- Measure again the value by entering command `fase`. To get the value in seconds the number must be divided by  $2 \cdot 10^5$ .

- The cable delay is obtained by the following formula:

$$\text{CableDelay} = \frac{\text{ReadingWithCable} - \text{ReadingWithoutCable}}{4 \cdot 10^5}$$

The 4 in the denominator is to take into account that the signal travels twice through the inserted cable.

- Typical values are:

$$\text{CableDelay} = \frac{0,02621848629 - 0,02553445514}{4 \cdot 10^5} = 1,76 \text{ ns}$$

- Return the cable to its place.
- The computed value should be filled in the READY form which is mentioned further in the report.

## 5.4. Mark5B status

Mark5B should be checked before its usage. LEDs on the lower front panel provide very useful information. The correct status is as follows: LEDs MOD, VAL and FLO should light steady green. LED 1 PPS should blink in green with a periodicity of 1 second. LED TVR should be in red or off. LED ERR should be off.

If LED 1 PPS is blinking in red or it is off, it means that the Mark5B requires resyncing with an external PPS. The PPS is provided by the VSI module. It is important that the VSI is set in geo or vlba mode, since these two modes sync with the external PPS. The tvg mode uses an internal 1 PPS. For example to use the vlba mode and sync to the external 1 PPS enter from the FS:

```
vsi=vlba
mk5=dot_set=:force
mk5=dot?
```

If LED TVR is in red, the Mark5B is in TVG mode (or has recently been) and at least one byte from the "Test Vector Pattern" has not been detected (since the last reset). It is possible to switch it off by deactivating the TVG mode. However this should be investigated since the cable connector may require to be replugged. To switch off the TVR mode, run, from the FS:

```
mk5=tvtr=0
mk5=dot_set=:force
```

If this fails additional tests should be passed. These are described in report IT-OAN-2007/xx.

If LED ERR is in red it means that the Mark5B has not recorded any data on the disk pack since the last power up, or after a TVG test. The LED should go off when the recording starts.

If the LED READY in the disk pack is blinking, it is advisable to reset the disks. This operation erases all files, so this operation should not be performed if we need to keep data in the disks.

## 5.5. Time

Check the computer date and time at the FS PC and at the Mark5B. This is achieved by entering:

```
ntpdate -q hora.oan.es
```

The offset should be lower than 0.01 second. A typical correct entry is:

```
esquizo:/usr2/oper/:> ntpdate -q hora.oan.es
server 193.146.252.15, stratum 1, offset 0.002357, delay 0.02611
23 Jul 13:58:19 ntpdate[8492]: adjust time server 193.146.252.15 offset 0.002357 sec
```

If there is a large offset, then the computer needs to be resynchronized. This requires to stop the NTP daemon, synchronize with ntpdate and restart the NTP daemon again. This is only possible from the root account.

```
/etc/init.d/ntp stop
ntpdate hora.oan.es
/etc/init.d/ntp start
```

After restarting ntp one can check that computer is correctly running synchronized to NTP by issuing the following command. A typical response is displayed below:

```
ntpq -c peers
```

remote	refid	st	t	when	poll	reach	delay	offset	jitter
*hora.oan.es	.GPS.	1	u	4	64	17	0.521	0.838	0.217

Some time should be allowed after starting the NTP daemon before checking the NTP peers with ntpq. A delay of 2 minutes should be necessary. If the remote peer has got a "\*" in front of the name it indicates that peer is being in use. Other code letters may indicate an incorrect working of the NTP servers. For example 'x' or '+'. In order to know their meaning see <http://www.eecis.udel.edu/mills/ntp/html/decode.html#peer>.

To check that the FS clock is synchronized to UTC, utility fmset should be started from a session at the FS computer. This utility will show the Mark5B time, the FS time and the computer time. Ideally all should match, but sometimes this is not the case. At the right side of each time there is column indicating the synchronization origin like "rate model", "computer synced" or "NTP synch'd". The FS keeps its time by counting tics from the kernel and using a model for the computer PC clock. The longer the time interval the more accurate the model is. It is possible that the FS uses NTP from the computer if the time is reliable.

The Mark5B time is seldom incorrect, while it is more frequent that the FS time is incorrect. This can be easily checked by comparing with a clock synced to NTP.

- If the Mark5B is not in time, it can be set to the FS time by using fmset. Several options are possible, pressing: "-", "+" to decrement or increment a second, or "s" to completely synchronize the Mark5B.



- If the FS is not in time and the Mark5B is, it is possible to apply an offset to the FS so that it synchronizes with the formatter. From inside the FS try:

```
sy=run setcl offset &
```

- If the FS is not in time but the FS computer is, and it is synchronized to NTP according to `fmset` then it is a good idea to set the FS to the FS computer time. This is achieved by issuing the following command in the FS:

```
sy=run setcl computer &
```

- If both the FS time and the FS computer are not in time, then stop `fmset` and synchronize the FS computer as explained above by using `ntpdate`. Wait for a couple of minutes and open `fmset` again. Mark5B time and the FS computer should match and the latter should state: "NTP synch'd". If so, close `fmset` and set the FS time to the FS computer as explained in the previous item.

For a detailed explanation about time keeping in the FS and how to solve problems please read `/usr2/fs/misc/fstime.txt`

## 6. Checking the pointing, the system temperature, and SEFD

Previous to a VLBI observation two basic operations should be performed: pointing and on-off observations to check amplitude calibration, SEFD and system temperature. In order to correctly accomplish these operations, the FS should be started first. The antenna will boot and set all parameters (for example, focus and pointing corrections) to its default values. Then the ARIES antenna command interface should be started later. A new boot will be executed. If pointing corrections are applied from the ARIES shell, these corrections will be taken into account by the FS.

### 6.1. Pointing

Pointing is done from the ARIES shell. The sequence of commands is described below. The example uses the 22 GHz receiver connected to the single channel continuum detector OAY-14 to calibrate and make a pointing scan on 3C273:

```
source("J1229+020")
frontends('het22l')
het22l.line("VLBI22L")
het22l.backends("oay14")
oay14.setIntegrationTime(1.0)
reference(-600,0,0,1,'arcsec','abs')
calibrate()
calresults(30)
point(600,'arcsec',60,'otf',10,'no','-x',1)
```

Command `calibrate()` calibrates the amplitude of the signal, by using a noise diode and measuring the voltage on and off the source. `calresults(30)` displays the system temperature and efficiency of the antenna, by supplying the source flux in Jy (30 in this case) as a parameter. Finally `point()` launches a pointing scan.

The data are written on FITS files and appended to a 40m CLASS file in `ariesfits:/home/almamgr/data/PROJECTID`, where `PROJECTID` is the identification of the project. The pointing drifts should be analysed with CLASS and the pointing offsets applied to the antenna with the same value and sign as obtained from the analysis. Below we include an example, where pointing offsets determined from CLASS are 10'' and 40'' respectively.

```
pcorr(10,40, 'rel')
```

The applied pointing offsets will be kept during the VLBI observations if the FS client is not closed and started again. If the latter were the case, the absolute pointing offsets should be loaded from the ARIES shell once the FS has booted the antenna:

```
pcorr(10,40, 'abs')
```

## 6.2. On-Off observations

After checking and correcting the pointing a series of on-off measurements should be performed to check  $T_{\text{sys}}$  and SEFD. These measurements rely on the flux of the sources listed in control file `/usr2/control/flux.ct1`.

A typical on-off observation at 22 GHz is performed from the FS client as we list below:

```
proc=point
cal22wide
3c273b
onoff
```

Procedures `cal22wide` and `3c273b` belong to the `proc` library and configure the BBC frequencies, IFs, LOs and do the correct patching. `3c273b` commands the antenna to be on source 3C273. `onoff` commands an onoff cycle, which includes switching on and off the noise diode at two different antenna positions: on the source and off the source. The antenna movements can be seen in KStars and the voltage changes can be monitored at the object explorer (see de Vicente 2007). Logs are stored on special files, which in the case of the 22 GHz observations is called `cal22ys.log`. The FS computes  $T_{\text{sys}}$  from the four previous voltages, and the SEFD from the  $T_{\text{cal}}$  and the fluxes included at the FS control files. Hence it is very important to keep the latter values updated.

Typical results displayed are included below:

	source	Az	El	De	I	P	Center	Comp	Tsys	SEFD	Tcal(j)	Tcal(r)
2009.061.13:20:13.94#onoff#												
2009.061.13:20:13.94#onoff#VAL	3c84	70.5	50.6	1u	1	r	22264.99	1.0079	42.78	269.0	24.007	1.82
2009.061.13:20:13.94#onoff#VAL	3c84	70.5	50.6	2u	3	l	22264.99	1.0193	43.96	275.3	25.688	1.81
2009.061.13:20:13.94#onoff#VAL	3c84	70.5	50.6	3u	1	r	22284.99	1.0254	44.33	271.6	21.090	1.77
2009.061.13:20:13.94#onoff#VAL	3c84	70.5	50.6	4u	3	l	22284.99	1.0186	49.42	272.8	24.151	1.60
2009.061.13:20:13.94#onoff#VAL	3c84	70.5	50.6	5u	1	r	22308.99	1.0154	36.95	282.0	23.558	2.21
2009.061.13:20:13.94#onoff#VAL	3c84	70.5	50.6	6u	3	l	22308.99	1.0108	48.29	278.1	25.212	1.66
2009.061.13:20:13.94#onoff#VAL	3c84	70.5	50.6	7u	1	r	22334.99	1.0261	40.22	270.2	19.302	1.94

```

2009.061.13:20:13.94#onoff#VAL 3c84      70.5 50.6 8u 3 1 22334.99 1.0196 48.73 276.2 21.524 1.64
2009.061.13:20:13.94#onoff#VAL 3c84      70.5 50.6 ia 1 r 22300.00 1.0185 37.36 282.7 23.910 2.19
2009.061.13:20:13.94#onoff#VAL 3c84      70.5 50.6 ic 3 1 22300.00 1.0043 41.32 309.6 27.564 2.17
2009.061.13:20:13.94#onoff#      source Az El De I P Center Comp Tsys SEFD Tcal(j) Tcal(r)

```

They are organized in columns: source name, Az and El, detector used and IF connected to that detector, polarization, central frequency in the sky, system temperature, SEFD, Tcal in Jy and suggested correction for Tcal assuming the efficiency and K/y relation given in the rxg control file is correct.

### 6.3. Notes on the system temperature

- S band is plagued with interferences and hence system temperature is high and random.
- When observing in C band assure yourself that the MITEQ downconverter used for holographic measurements and placed at the primary focus is set to 12750 MHz. If not it may cause interferences and erratic and high system temperatures at 6 GHz.
- When observing at X band in extended mode, an interference from inside the same receiver is always present. This causes a high system temperature with the IF wide band detectors which saturates them. However  $T_{\text{sys}}$  for each BBC is correct because the interference is filtered out.
- The 22 GHz receiver IF generates an interference at X band. Hence all X band observations should be performed with the 22 GHz IF off.

## 7. Running the schedule

It is advisable to **start the FS** immediately before an observation. This guarantees that the antenna will be placed in a state ready for observations. If it were so, it is absolutely necessary to give enough time for the antenna to complete the booting process. This can be checked in the ACS command center window, in the OCantenna tab. A line with `boot process finished` will be displayed. The boot process may delay from 20-30 seconds to a couple of minutes depending on the previous status of the antenna. Only, once the boot process is finished, should the schedule be started.

The schedule is started by issuing at the oprin window the following instruction. Below is an example:

```
> schedule=es060bys,#1
```

The first parameter indicates the name of the SNAP file at `/usr2/sched/` without the extension. The second parameter indicates the line at which the schedule will start. Usually this line is 1, but in case the schedule had to be halted and restarted later, this number should be the next available line in the future that is indicated in the observation summary. The schedule will be read by the Field System and stored in memory. This means that, if by any means

the schedule file (the `.snp` file at `/usr2/sched/`) where modified, modifications will not be applied unless this instruction is repeated after the modification.

The schedule will halt and the FS will pop up a window reminding the operator to wait for the antenna to boot. Once the operator has checked that the boot process has completed, the operator should click on “continue” to resume the schedule.

Once the schedule is launched, if `dimino` is running at the Mark5B, it is necessary to issue a second command to reestablish the communication with the mark5B:

```
mk5relink
```

Errors will be displayed at the ERRORS window. The observer should pay attention to those. Some may be rather benign, but they may spot a problem in the system. Successful observations may display a WARNING: ONSOURCE status is slewing. If the antenna has not reached the source on time it may be due to a wrong computed slew time. This seldom happens but it is easily checked by looking at KStars, and verifying that the circle representing the HPBW moves towards the source. After some time a log like the following should appear in the log:

```
flagr/antenna,acquired
```

It also may be possible that the antenna stopped in which case the cause had to be investigated.

VLBI observations follow a regular pattern which can be easily seen in the schedule file (`.snp` file). The section we display below corresponds to a scan. Before and after there are other scans with a similar pattern:

```
....
scan_name=No0003,n09c2,Ys,210,570
source=4C39.25,092703.01,390220.9,2000.0,
checkmk5
setup01
!2009.162.12:10:20
preob
!2009.162.12:10:30
disk_pos
disk_record=on
disk_record
data_valid=on
midob
!2009.162.12:14:00
data_valid=off
disk_pos
postob
....
```

Observations may differ slightly from this one, but they follow the same regular pattern

- `source` commands a new source. The antenna moves towards the source and the frontends are set according to the expected values (IF attenuations and LO frequencies).

- `checkmk5` checks that the previous recorded scan was successfully written (correct dates and low parity errors)
- `setup01` This is usually a macro which sets the LOs and the IF patching, the BBCs to be used, the channels association, the gain measurement period and the Mark5b mask to be used. There may be more than one setup on one experiment.
- `preob.` This is a collection of instructions to be executed before recording. That depends on each station and they are defined at `/usr2/proc/station.prc`. In Yebes case it checks if the antenna is on source and triggers a system temperature measurement.
- `disk_pos.` Requests the byte pointer position in the disk.
- `disk_record=on.` Starts recording.
- `disk_record.` Checks the recording status.
- `data_valid=on.` States data are valid from now on, and triggers checking if the antenna is on source and continuous gain measurement.
- `midob.` This is a collection of instructions to be executed while recording. That depends on each station and they are defined at `/usr2/proc/station.prc`. In Yebes case, it checks if the antenna is on source, asks for the weather status, gps formatter comparison, IF levels and BBC status
- `data_valid=off.` Stops checking if the antenna is on source, and continuous gain measurement.
- `disk_pos.` Requests the byte pointer position in the disk. It should have increased since last time.
- `postob.` This is a collection of instructions to be executed after recording. That depends on each station and they are defined at `/usr2/proc/station.prc`.

Scans written in the disk may be seen by entering the following command at the Mark5B oper account.

```
DirList
```

A list like the one below, with start and stop byte pointer positions should appear:

```
nscans 25, n 24, recpnt 1961148825600, plapnt 1871918284800, playRate 0.000 MHz
n' scan name                start byte      end byte
----
```

1	ep064h_ys_no0111	0	114871500800
2	ep064h_ys_no0117	114871500800	229871206400
3	ep064h_ys_no0123	229871206400	341024768000
4	eg040d_ys_no0001	341024768000	384229785600
5	eg040d_ys_no0003	384229785600	469742387200
6	eg040d_ys_no0007	469742387200	555126784000

7	eg040d_ys_no0011	555126784000	640639385600
8	eg040d_ys_no0015	640639385600	695382835200
9	eg040d_ys_no0018	695382835200	762305740800
10	eg040d_ys_no0019	762305740800	804100505600
11	eg040d_ys_no0021	804100505600	890895155200
12	eg040d_ys_no0025	890895155200	977689804800
13	eg040d_ys_no0029	977689804800	1064356249600
14	eg040d_ys_no0033	1064356249600	1120381747200
15	eg040d_ys_no0036	1120381747200	1161535488000
16	eg040d_ys_no0038	1161535488000	1250894233600
17	eg040d_ys_no0042	1250894233600	1340252979200
18	eg040d_ys_no0046	1340252979200	1429611724800
19	eg040d_ys_no0050	1429611724800	1518970470400
20	eg040d_ys_no0054	1518970470400	1562175488000
21	eg040d_ys_no0056	1562175488000	1603970252800
22	eg040d_ys_no0058	1603970252800	1693328998400
23	eg040d_ys_no0062	1693328998400	1782559539200
24	eg040d_ys_no0066	1782559539200	1871918284800
25	eg040d_ys_no0070	1871918284800	1961148825600

The list will increase during the observation.

## 7.1. Standard Geodetic VLBI

Before starting a geodetic VLBI schedule the operator should send a message stating the antenna is ready. This is done by using a graphical interface form called “Ready”. To start this form, graphical interface *fsvue* should be started. Ready can be triggered from menu entry *Execute ->FS\_ready\_Form*

This form requires to enter the session name, the name of the first source and start time, comparison between gps and formatter and weather status. The latter values can be obtained by entering commands:

```
fs> gps-fmout
fs> wx
```

Sky conditions should be entered, as well as cable difference whose measurement has been described before. Last section is devoted to fill SEFD at X and S band for a given source. In order to get this value an onoff observation should be performed before the experiment.

All fields need to be filled, if not the Ready form will complain and will not complete. Once this form is completed a message is sent to *ivs-ops@ivscg.gsfc.nasa.gov* with the supplied information.

Once the schedule is started, the operator should send a second message informing about that. As previously this is accomplished filling the graphical interface “Start”. This only requires to fill the experiment name, name of the first observed source and the time at which this is done.

As in the previous case a message will be sent to *ivs-ops@ivscg.gsfc.nasa.gov* with this information.

## 7.2. Checking the schedule runs properly

While the observation is running the operator should check the following items are working correctly:

- IF and BBC levels are correct and within the correct values. BBCs should show 1 PPS and lock status.
- Weather parameters are correct. If the wind is too high ( $> 15$  m/s) the antenna should be stopped.
- The time difference between the GPS and the formatter should be a very small value (below  $10^{-6}$  seconds), and should not change much with time. If the value suddenly changes, this may be indicative of an error with the maser or the GPS.
- System temperatures should be within the expected values. Take into account that these values depend on the antenna elevation. Table 1 summarizes typical system temperature values.
- In the case of standard astronomy and geodetic observations the disks should record when it is scheduled. This can be checked by looking at the LEDS on the disk packs. They should show activity while recording.
- The antenna should slew between sources and be on the commanded source.

Frequency	$T_{\text{sys}}$
22150 MHz	50 K
8800 MHz	70 K
5900 MHz	100 K
4900 MHz	110 K
2300 MHz	180 K

Cuadro 1: *Typical system temperatures at the 40m when doing VLBI experiments*

## 7.3. Status client for occasional users

A Java client has been developed (Barbas, Bolaño & de Vicente, 2009) to help occasional users monitor the experiment log in real time. The client continuously reads the log and displays updated information on the screen on different boxes. When there is a fault which may compromise the observation the related box is depicted in red to grab the user attention. The detailed information is displayed when the user focus on the window and hovers the mouse on the selected box. If a given device shows an incorrect value, which does not affect the observation, the box is displayed in yellow. The client also shows the system temperature for all continuum

detectors: BBCs (both bands) and IFs. It is possible to deselect some of them to get a clearer view of the values.

To start the client, run from a konsole window in the FS PC the client passing the whole path of the log file as argument. For example:

```
fslogclient /usr2/log/n09k3ys.log
```

Below we include a snapshot of the client by the time the second version of this report was printed. The client may be modified in the future to meet new requirements or changes in the VLBI equipment.

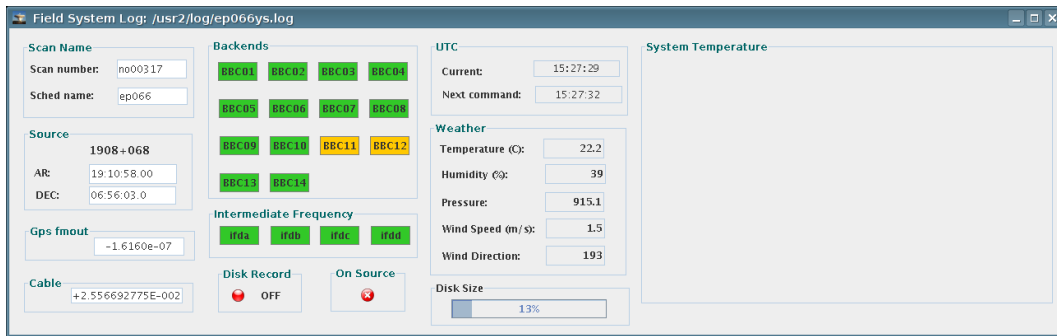


Figura 9: FS log client

## 7.4. Disk pack changes

Astronomy observations usually require disk pack changes. The FS handles automatically this change. It is very important to have a client that displays the disk pack free space and estimates the time at which the disk pack will change. The percentage of disk usage is displayed in the client described in the previous section. The time estimate is provided by a FS utility which is started by running:

```
xterm -name monit5 -e monit5
```

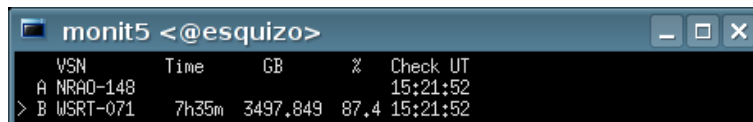


Figura 10: FS disk packs monitor client

When the disk pack is changed a new black window with green borders pops up and warns the user to replace the exhausted disk pack by a new one. It is convenient to exchange it when there is a time gap greater than 1 minute in which the Mark5B does not record in any disk pack. Meanwhile the popup window should be left opened and the schedule goes on.



Let us assume disk recording has stopped for a short time and the window is blinking. The observer should turn the key counterclockwise to a vertical position and extract the disk pack gently by using the lever and pulling the handle. Once the disk pack is out, a new one should be inserted. If there is still a gap larger than 40 seconds in which the disks will not record, the key should be turned clockwise to a horizontal position. The Mark5B will delay 20-30 seconds in setting up the new disk. It is very important that meanwhile the Mark5B does not receive a request to record in any of its disk packs. This new disk will not be the active one. It will only become the selected one when the other fills up. Once this is accomplished the observer should click on “Continue” in the popup window, which will close.

Note: It is important not to command:

```
mk5=bank_switch=on
```

since this instruction may interfere with the FS changing disk packs. In fact `bank_switch` should be off.

## 7.5. Checking fringes online: FTPing data chunks

NME (Network Monitoring Experiments) are observations scheduled at the beginning of a new frequency section during standard astronomy observations. Their role is to look for fringes online. Data are written on disk, and small selected intervals (4 to 10 seconds of data) are transferred to the correlator for fringes. The schedule extracts an interval of the data and writes it on the disk and sends the file via FTP to the correlator. JIVE prepares a page where the fringe results are displayed. Usually they can be found at: [http://www.evlbi.org/tog/ftp\\_fringes/](http://www.evlbi.org/tog/ftp_fringes/) followed by the name of the experiment in uppercase.

This page lists those scans that have been transferred via Internet. Each scan summarizes the results of the correlation between one antenna and the reference antenna. Usually correlated amplitude and phase versus time, plus SNR, are displayed for each channel. Autocorrelation is also displayed on a graphical window.

## 7.6. eVLBI fringes

eVLBI astronomy fringes can be checked at

<http://www.jive.nl/correlator/statusmonitoring/dsm.html>. This page offers information on the current scan. Results are displayed in the bottom table. Detailed information is available clicking on the elements that appear in the table. As in the previous section, fringes are checked between a reference antenna and the rest.

## 7.7. Remote observing

The ARIES control system allows to remotely control the telescope and the Field System schedule is also prepared for non attended observations. Human intervention for VLBI observations is only required for exchanging disk packs. However fringe search experiments should always be run in local mode and at the control room.

In order to remotely control a VLBI observation it is crucial to understand that any Internet disruption may compromise the observation. In order to avoid the failure of VLBI observations under these circumstances, the FS should always be started from the control room.

Any command to the FS should be run by using `inject_snap` FS utility at the FS computer once an “ssh” to that host has been opened. If several schedules are to be run remotely the FS should not be closed after each of them. This requires commenting two instructions in procedure `sched_end` at the station procedure library. Users should avoid doing this and only the author of this report or somebody from the software management team should proceed as below. To comment these two instructions use `pfmed`:

```
pfmed
pf,station
vi,sched_end
ex
```

and the following lines should be commented by prepending a quotation mark:

```
"sy=fs.prompt "please click on continue once the antenna is fully stowed"
"terminate
```

The file is saved by using standard “vi” commands.

Before running the schedule the antenna should be boot. This is accomplished by running:

```
inject_snap antenna=boot
```

The antenna may require several minutes to boot. It is very important to check that the antenna has fully boot before issuing any other command. This may be seen by looking at the last `OCantenna` container log file at “ariesobs”. To check for that file list them sorted in reverse time. For example:

```
ls -lrt /home/almamgr/.acs/commandcenter/acsStartContainer_OCantenna_*
tail -f /home/almamgr/.acs/commandcenter/acsStartContainer_OCantenna_2009-10-30_07.43.57
```

A line like the following should appear:

```
None boot - oanAntenna.boot() boot process finished
```

To start a schedule remotely run from the shell:

```
inject_snap schedule=es062ays,#1
inject-snap mk5relink
```

To monitor the FS log output use linux utility `tail` in real time. For example:

```
tail -f /usr2/log/es062ays
```

The antenna should be monitored with the client described in section 3.2.

## 7.8. Finishing the schedule

The last instruction of a schedule is `sched_end`. This instruction stops the antenna, waits for 3 seconds, switches off the phase cal, waits for 1 second and sends the antenna to stow position (the first stow position). Once `sched_end` is executed, a confirmation window will pop up stating that the operator should click on button “Continue” once the antenna is fully stowed in both axis. This may be checked by looking at the LCP. Azimuth and elevation axis should display: STOWED on top of a green background. Once the button is clicked, the FS should terminate. If the previous fails it is very important that, once the antenna is stopped, the FS is terminated.

## 8. After an observation

### 8.1. eVLBI

No special tasks have to be fulfilled for eVLBI. Once the observation has finished and JIVE has closed the connection, `/opt/jivemark5a` may be stopped by issuing a CTRL-C. It is advisable to start `dimino` afterwards.

### 8.2. Standard Astronomy VLBI

- Fill the feedback forms at the EVN web page <http://www.evlbi.org/session/feedback.html>. All remarkable incidents should be included here.
- Transfer the experiment log file to `ftp://vlbeer.ira.cnr.it/vlbi_arch` (selecting the current month plus year). For example:

```
ncftpput -v -u evn -p morevlbeer! vlbeer.ira.cnr.it vlbi_arch/mar09 n09k1ys.log
```

- Print the labels and attach them to the disk pack using a plastic badge with a hole. Each experiment label should be inserted inside the plastic badge. The plastic badge can be attached to the handle using a plastified short wire that also attaches to the plastic badge. If the disk pack only contains one experiment the plastic badge should not be used and the label should be stucked on, in its the place on the green sticker at the front. To print the labels execute, for example:

```
drudg n09k1ys.log OAN+0005
```

To get the name of the disk pack, run from the FS oprin shell:

```
mk5=vsn?
```

If the log file contains the entered label, the sticker will be printed at the dymo printer in the backends room, if not it will generate an error. The printer has some teeth that allow to cut the sticker cleanly.

- Send the disk packs to the correlator. The OAN wiki contains some documents with correlator addresses and proforma invoices. These papers should be printed on the control room printer. The proforma invoice should be signed and the addresses stuck to the disk pack card box.
- Fill track with information from the parcel service.

### 8.3. Standard Geodetic VLBI

The steps to be followed are similar to those in the standard astronomy observations. Here we repeat them for completeness:

- The operator should send a message reporting the end of the observation. This is accomplished filling the graphical form “Stop”. This form requires the session name and comments. In order for the form to work correctly it is necessary to add at least information on one source, scan start time and explanation of problem. If there was no problem during the observation fill in the box, “none” should be inserted here.

It is also required to fill the disk inventory. All boxes have to be filled. Those disks that not match the size should be filled with 0. The disk that matches the one used should be filled with the disk pack label.

- The log file should be uploaded to this FTP server: `ftp://cddisa.gsfc.nasa.gov`, for example:

```
ncftp3 -u ivsincoming cddisa.gsfc.nasa.gov
put euro97ys.log
```

The password may be found in the wiki.

- Print the label and stick it, in its the place on the green sticker at the front. To print the labels execute, for example:

```
drudg euro97ys.log OAN+0105
```

If the log file contains the entered label, the sticker will be printed at the dymo printer in the backends room. The printer has some teeth that allow to cut the sticker cleanly.

- Send the disk packs to the correlator
- Fill track with information from the parcel service shipper. The form is available at web server: `magnolia.nrao.edu/track`. The username and password are available at Yebe's wiki. A “make shipment” choice should be selected. The station field should be left empty and the correlator field filled with the correct information. A new page will appear. The shipper should be “EXPRES”, that in Spain is SEUR. The large window should be filled with two lines: the name of the experiment, and the disk pack VSN (for example OAN+0101). It is very important to notice one should not use O for OAN, but 0.

Once the list is completed click on button “Submit Shipment”.

Notice that before sending a disk pack, it has to be received at Yebes. Even if the disk pack is a new one and has never been received from a correlator.

## 9. Possible problems while observing

- High system temperatures. System temperature is the most important parameter to check while observing, since it is a very powerful tool to diagnose problems. High values may arise from different causes.

If  $T_{\text{sys}}$  ( $>200$  K) are seen check the vertex is opened by typing at the ARIES shell:

```
vertex()
```

If it is closed, open it:

```
openVertex()
```

High  $T_{\text{sys}}$  in several channels may be due to interference. This is usually unavoidable. In any case check the lights in the receiver cabin are off.

An increase in  $T_{\text{sys}}$  in all channels may also point to bad weather or low elevation at frequencies higher than 22 GHz.

High  $T_{\text{sys}}$  may also due to problems in the cryostats. Please check page: <http://hercules.oan.es/c> to see if the cryostats are working correctly.

- One of the most common problems appears when the FS and the mark5B do not run with the same absolute time. This is easily spotted by looking at the log or at the ERROR window:

```
2009.148.19:37:07.63?ERROR sc -13 setcl: formatter to FS time difference 0.5 secon
```

Use fmset to correct the time and to match Mark5B and FS time.

- Strong wind. If the wind speed were larger than 15 m/s the antenna should be stowed. This is achieved by issuing the following commands at the FS client:

```
halt
antenna=stop
antenna=stow
```

- Disk pack changes. This should not cause any problem if time intervals are respected. If this time is not respected, that is, if the key were turned while trying to record on another disk pack or in the same disk pack, the data may be incorrectly written and the memory pointer lost. If the system warns about a faulty disk pack, the schedule should be halted, and a new disk pack should be inserted in the bank.

```
halt
antenna=stop
```

A It is possible to keep the antenna tracking the previous source or stop it (as in the previous example) while the disk packs are replaced in the Mark5B. Once the disk packs are properly inserted see next item for instructions on how to resume the observation. Take into account that in this case there is no need to unstow or activate the antenna, only run the schedule on the correct line.

If the damage is more severe, it may be necessary to stop `Dimino` or even restart the Mark5B. Both cases have already been explained in this same report.

- Resuming an aborted observation. If an observation had to be aborted and the antenna has been stowed, to resume an observation the FS should be restarted. In this way we assure that the whole boot procedure is executed.

If the antenna were in standby, it is only necessary to activate it:

```
halt
antenna=activate
```

If the antenna were stopped but it is already active, there is no need to command it.

Once the antenna is ready, the schedule should be restarted from the correct line. The correct line is chosen from the printed schedule (column 2) by looking at the current time and estimating the time needed by the system (antenna and VLBI equipment) to reach the source and to setup the receiver and VLBI devices. For example, if we use the schedule in section 4.2.2, and the current time were 21:42, the schedule should be started on line 136, which starts recording at 21:47 allowing 5 minutes to boot the antenna, setup the equipment and slew until the antenna is on source. Below we list the commands needed. `relink` assures that the connection between the FS and the Mark5B is renewed.

```
schedule=es060bys,#136
mk5relink
```

To estimate the required time to be ready, the following times should be considered: rough boot time  $\simeq 30$  seconds, rough equipment setup  $\simeq 10$  seconds, slewing speed is 1 deg/s in both axis.

Once the antenna is on the source it is necessary to apply the pointing offsets from the ARIES shell if needed.

- Wrong time interval for extracting data for autotyping. This error may be associated to the Mark5B firmware, and driver versions. It is not easily solved and hence we do not describe here a solution. The problem would only affect scans which are partially extracted and sent to the correlator via FTP to check for fringes in real time.

## 10. Implemented antenna commands

The current FS version running at the Observatorio Astronómico Nacional has got several commands to control the antenna. We list them here as a reference:

- `antenna=boot`. This command boots the antenna. It unstows it, activates all motors, opens the vertex and loads the pointing model and refraction correction. Manual pointing corrections are set to 0.
- `antenna=stow`. This command unloads the pointing model, refraction correction, and manual pointing corrections, closes the vertex, stops the antenna and stows it to its closest stow position. It is the opposite of the previous command.
- `antenna=unstow`. This command unstows the antenna, but does not open the vertex.
- `antenna=stop`. This command stops the antenna. All motors are kept active and pointing corrections remain loaded. This should be used to cancel an observation and prior to using next command.
- `antenna=standby`. This command deactivates the main motors, azimuth and elevation. Pointing corrections remain loaded. To reactivate them use next command. This command should be used if the antenna needs to be stopped for security reasons.
- `antenna=activate`. This command activates the main motors, azimuth and elevation. It should be used after `unstow` or `standby`.

## Referencias

- [1] . Barbas, R. Bolaño & P. de Vicente. "Field System Log File Reader". IT-OAN-2009-8