Chapter 6

OBST: Telescope Control/Observing Program

6.1 Overview

The following is a verbal "block diagram" of the software and hardware at the HHT.

The photon acquisition system at the HHT consists of the telescope, the chopping subreflector, the various receivers and bolometers, the Krupp Servo Control Unit (SCU), the Building Drive system, the CAMAC electronics, Kronen (a VAX 4000/200 computer), Frankenheim (a VAXStation 4000/VLC), Drumbeat (a VME based Motorola 68000, a PC-on-a-VME card, 21 V-to-F converters, and three blanking generators), two PC's used to control the receivers, three acousto-optical spectrometers, and three filterbanks. A Status-And-Monitor (SAM) bus distributes synchronization and status signals between the Computer Room, the Control Room, and the two Receiver Rooms.

The telescope drive is controlled by the SCU which in turn receives (speed) commands from the CAMAC electronics via two microprocessors in a CAMAC crate. The CAMAC electronics also control the chopping and translating subreflector (except that the clock pulses which drive the chopping itself are generated in another VME crate). And CAMAC controllers are used to read out the three AOS's. The building is slaved to the antenna. The position difference is measured with an LVDT, and the building servo will normally keep the misalignment to less than 0.5 degree.

Drumbeat serves as the continuum back end. Voltages from the bolometers and from total-power detectors on the SIS receivers are routed to V-to-F converters whose outputs are counted with counters read by the 68000. The VME based PC reads out the data via shared memory and ultimately sends it to Kronen via ethernet.

Kronen gets access to the CAMAC crates and their electronics via a CAMAC highway driver which interfaces directly to its Q-bus. The control system software is run in Kronen and consists of several programs using common memory and VMS event flags to coordinate activities:

CONTROL - Reads the Control Rack switches (and controls their lamps). Based on these switches (and optionally event flags from **OBST**), it sends event flags to the other programs in order to control their actions.

FAHREN - Calculates the desired azimuth and elevation of the antenna based upon the observing procedure and coordinates specified and the current sidereal time (which it calculates from the Universal time read from a GPS clock). The azimuth and elevation required as well as their velocity and acceleration are then sent four times a second to the two CAMAC micros which contain the azimuth and elevation servo, respectively. The antenna positions, tabulated at 6 ms intervals, are read from the micros four times a second and stored in shared memory.

BEORGA - Collects the data from the various backends and writes them in shared memory for storage on disk. The data is either obtained via CAMAC (the AOS's) or ethernet (Drumbeat).

FEORGA - Calculates the sky frequency for the spectral line receivers and the synthesizer settings required to tune to this frequency. This is sent to the front end PC's via RS-232 so that they can set the synthesizers and, for the 345 GHz receiver, tune the Gunn oscillator.

MTWRITE - Collects the data from BEORGA and the antenna positions from FAHREN and writes them on disk.

OBST - Takes observing commands from the astronomer and converts these to OBSINP commands (the original user interface which is embedded inside the **OBST** program). These commands specify which observing procedure to use and how to configure the backends, the receivers, the subreflector, ...

OBSERVE - Monitors the progress of the observations and sends the appropriate commands to the two on-line reduction software packages. It also retrieves the results of focus and pointing observations for **OBST** so that they can be used to update the antenna and subreflector positions. Converts the raw data format to that required by the Toolbox software.

CHEF - Converts the raw spectral line data and continuum drift scans into **CLASS** format. Analyses the POINTING, ZFOCUS, XFOCUS, and SKYDIP observations.

TOOLBOX - Continuum and spectral line reduction package from Effelsberg. Online analysis of continuum observations. (Formerly used for POINTING, ZFOCUS, and XFOCUS. Being phased out.)

Frankenheim is a VAXStation which is used for data analysis and to display in windows, output from some of the programs running on Kronen: **OBST**, OBSERVE, BEORGA, FEORGA.

6.2 Introduction

OBST is the scion of the esteemed OBS$_E$ software and is designed to be familiar to users of both the Effelsberg 100-m and the IRAM 30-m MRT (OBS). The credit for the OBS$_E$ development is cited in the appropriate 100-m and 30-m manuals.

OBST serves as a friendly user interface to the **OBSINP** software which passes information (such as antenna positions, rates, integration times, frontends/backends) to an active option field which is subsequently read by the drive program. **OBST** commands are parsed by the **SIC** command interpreter to execute a **SIC** command file. This command procedure prepares the particular **OBSINP** commands and sends them to **OBSINP** by means of the verb, SENDOBS.

6.3 Entering and Exiting OBST

In the control room, the computer labeled 'Frankenheim' is reserved for the observers. The observer should log into the terminal as 'OBS' This initiates several processes necessary for observing as well as setting up a directory area for the incoming data, under [SMT.INI], where INI are the observer's initials prompted for during log-in.

Several windows will be generated:

1. `KRONEN` → A work window on KRONEN.
2. `OBST` → The **OBST** user interface.
3. `OBSERVE` → Program which handles the information flow between **OBSINP** and **OBST**.
4. `CHEF` → This program is for the calibration and preliminary reduction of data scans. Type 'CHEF' in this window.
5. `GREG` → A window for GREG. Type 'GREG' to start.
6. `ONDIS` → Initiates the on-line **TOOLBOX** (CONT and SPEC) and **CHEF** (**GreG**) displays. Displays are on hachenburger.
7. `BEORGA` → This is the BackEnd ORGAnizer program.
8. `FEORGA` → FrontEnd ORGAnizer program.

6.3.1 Starting OBST

The DECTERM window labeled **OBST** should have already started the program running. It will then prompt you for a user name (accepts 4 letters) and a project name (accepts 6 letters).

If for some reason this does not occur, then you can open a DECTERM using the 'Applications' menu on the SESSION MANAGER. To keep your windows organized, use the 'OPTIONS' menu on the DECTERM window and select 'WINDOW'; this allows you to alter the name of both the window and the icon to 'OBST'.

Simply typing **OBST** will initiate the software (loads all commands and starts **OBSINP** as part of itself) and prompt as mentioned above. The initial **OBST** screen looks as follows:

```
PID: exampl        Obs:  jpm      SOURCE  : none
LAM/BET 00:00:00.00 (s)   00 00 00.0 (")    Basis System 14
Catalogs: SYS$SMT:[SMT.CAT]STANDARD.CATSYS$SMT:[SMT.CAT]LINE.CAT

FRQ_Cont: 230.0                          USB
CONT RX:  T                  T integ(s):  **        T cycle(ms):  16
              FIT RESULTS :   None      None              None
NULA,C*,NULE,FCZ,FCX    0.00     -90.20     -5.00      -1.10  -0.14
              HPBW AZ/EL        None       None
LANG: CLAS                              COMM:  START OBST


         Waiting for scan     3787
        3787 discarded
Idling / No active program
         Waiting for scan     3787
```

with a prompt of:

OBST>

6.3.2 Saving/Restoring Parameters and Symbols

For later use, **OBST** allows you to save your own default parameters and symbols in a **SIC** command file. This is achieved using the SAVE command, as follows:
OBST> SAVE <filename> /SYMBOLSONLY

- <filename> A complete filename can be specified; if no directory tree is specified, the current directory is used; If nothing is given, the information is stored in LAST.PRO in the current directory.
- `SYMBOLSONLY` Only the observer-specified symbols from the symbol table (see the **SIC** manual) are saved in the file <filename>. Default parameters are not saved. This allows a record of your own abbreviations to be kept.

If you want to reload these parameters, use either the RESTORE command or the "@" command procedure of **SIC**, i.e. "@<Save File Name>" followed by the command "@TEL$OBS:RESTORE". Note that doing "@<Save File Name>" alone *is not equivalent* to RESTORE <Save File Name>.
RESTORE is invoked as follows:
OBST> RESTORE <filename>

- <filename> Restores the observer-defined symbols and parameters from a file with the name <filename>

If you do not specify a filename, your default filename is used. At start-up, this will be LAST.PRO in the default directory. After restoring the values, **OBST** will continue from where you last saved it.

The SAVE and RESTORE commands have been modified to allow the observer to do a complete RESTORE, so that it should not be necessary to execute certain OBST commands to complete the process. Notify an FOT if you find a problem. NOTE: Parameters entered directly into **OBSINP** can neither be SAVED or RESTORED.

6.3.3 Entering DCL Command Level/Entering OBSINP

The **SIC** command,
OBST> dcl
allows you to spawn to DCL (the DEC Command Language); you can return to **OBST** by typing:
$$> quit
Similarly, you can enter the **OBSINP** environment with:
OBST> obs
and return with:
quit
(Note: there is no prompt while within **OBSINP**. For information on **OBSINP** see the **OBSINP** guide.)

6.3.4 Exiting OBST

OBST> exit
will leave **OBST** . **OBST** will then prompt you on whether you wish to SAVE your default values (Y/N); or you can <CNTRL-Z> to leave **OBST** without inquiry.

6.4 General Rules

OBST executes just a single command at a time. After finishing that command, the program issues an 'OBST>' prompt and waits for the next command.

OBST uses the **SIC** command interpreter to scan and parse the command line. Therefore, the **SIC** command syntax has to be followed when entering **OBST** commands. All features of **SIC** such as command-line editing, defining loops, command procedures or symbol definitions are available through **SIC** and are not a particular feature of **OBST** (as supplied with the 94VMS release of the Grenoble software).

6.4.1 OBST : The Command Line

Every **OBST** command line has the following syntax:

OBST> COMMAND <arg1> ... <argn>/OPTION <arg1> ... <argm>/OPTION ...

An executable command in **OBST** is called a VERB, an option in the **SIC** syntax is called an ADVERB, and the arguments of each are called parameters and are used to set values needed by command (VERB).

Rules for OBST command lines:

a) A VERB can be abbreviated as long as the characters entered define it unambiguously amoung all possible VERBS and **SIC** commands. If insufficient characters are typed, **SIC** informs you of the possible choices and the line can be edited in **SIC** via the keypad.

b) ADVERBS can be abbreviated as long as the characters define them unambiguously in the context of the VERB. The order of the ADVERBS is arbitrary, and they are defined by their names.

c) Parameters belonging to either a VERB or an ADVERB have to be separated. If blanks are part of a single parameter, this parameter has to be enclosed in double quotes ("), or else a new parameter will be considered to start at the blank. The sequence of occurrence determines the parameter sequence p1...etc. An asterisk "*" can be used as a place holder for a parameter in the sequence, the value of which does not have to be modified. You can type more or less parameters than specified for the VERB or ADVERB. Surplus parameters are discarded by **OBST** , while fewer parameters may cause branches in **OBST** depending on the VERB or ADVERB. For example:

- OBST> CORRECTIONS F -will only update the azimuth pointing correction.
- OBST> CORRECTIONS F F -will only update the azimuth and elevation pointing corrections.
- OBST> CORR * F -will only update the elevation pointing correction, while the azimuth pointing correction is unchanged.

6.4.2 OBST : Making an Observation

Automatic Observing Mode

By pressing the AUTO button, the LOAD command can be issued by commands from the observer's terminal, rather than repeatedly hitting the LOAD button in the console rack.

The automatic mode is activated or resumed after an observation has been started manually by hitting LOAD. A light in the AUTO button on the control desk indicates that the automatic mode is engaged and the observing program can be started from **OBST** .

To set the AUTO button:

a) Start an observation with an appropriate VERB (like POINTING).

b) After **OBST** answers with "waiting for end of previous scan" and "Try the load button", press the LOAD button.

c) Then press the AUTO button.

The OBSERVE Process

A high priority task, called OBSERVE, inspects the state and progress of the drive program. Whenever new procedures begin, it sends command lines to the off-line data reduction packages in much the same way as the user does for later reduction. In this process the raw data are converted into the preferred data structures of the reduction programs which is convenient for further data analysis. For calibration observations, **CHEF** automatically returns the calibration results which can be used for pointing and focusing through **OBST** commands. OBSERVE displays the progress of the current observation on one of the screen sections available to **OBST** . **OBST** interprets the actual observing states whenever it is requested to start a new observation.

The OBST WAIT state

The astronomical drive program can only execute one observation at a time. It internally uses a single passive option field. **OBST** has to coordinate the user commands with the drive program. Especially in the case of executing sequences of observing commands through **SIC** command files the observations have to be serialized. The coordination occurs in a synchronization state, called WAIT. The verb WAIT is only used inside the command procedures that start the observations, but should not be used in routine observations.

6.4.3 OBST : Setting up an Observation - The GO command

The GO command is designed to let the observer go to a source and set up the observation without actually starting an observation. This allows the observer to update the frequency, adjust the tuning, or other tasks without starting an actual observation.

- **OBST**> GO - the telescope will load the source, receiver, frequency information and go to the source position. No actual scan will be taken.

6.4.4 Cancelling an Observation

Two commands allow the observer to cancel the current observation, KILL and CANCEL.

If you are at the OBST> prompt level and no observation is in progress, there will be a delete event flag set, but there will be no influence on the drive program. OBSERVE however will react to the delete flag with a message.

If you are at the OBST> prompt level and an observation is in progress, KILL and CANCEL stop the observation immediately, CANCEL S (a parameter starting with an S) will finish the current subscan and then cancel the observation. Only with CANCEL S the subscan will finish normally and the data will be available to the reduction packages.

If you are in the WAIT state and do not see the **OBST** prompt, either executing a **SIC** observing program command or having sent the next observing command and **OBST** is in the wait state, you have to send a <CTRL–C> to get out of the wait state. Then you can send KILL, CANCEL or CANCEL S. All three will cancel the current observation, the first two immediately, the other after completion of the current subscan. In all cases a pause is generated by **SIC** and a prompt of **OBST** with a numerical level occurs. Typing a C (for continue) lets you continue the loop, typing Q (for quit) until the regular prompt occurs lets you terminate the loop and return control to your next command or verb. Your input after the pause determines actually whether you continue or terminate.

KILL stops the observation.

In contrast, CANCEL allows you to continue with the next observing command.

During **SIC**-Loops, CANCEL stops a (previous) scan, but allows you to continue the loop with the next scan, while KILL terminates the loop and sets an error flag. The observer can then leave the loop with QUIT. (If one is within nested loops, several QUITs might be necessary).

If CANCEL occurs due to an error condition detected by the drive program, or by the intervention of the operator, the reaction of the wait state of **OBST** is the same as if a CANCEL had been typed.

Almost all VERBS need ADVERBS to set values or select options. Each ADVERB is related to at least one VERB, while some ADVERBS relate to more than one VERB.

6.4.5 OBST : Parameters

The STANDARD, CURRENT, and DEFAULT Parameter Values

For every parameter, **OBST** keeps 3 values:

a) The system default STANDARD value, which is loaded at program start up. If one wants to use the system default values as the new defaults, the command STANDARD can be used.

   i) STANDARD followed by a full ADVERB name just sets the parameters for that ADVERB.

   ii) STANDARD followed by the full name of a VERB preceded by a $ will set just the relevant parameters for those options connected with the VERB (like the observing mode, <c_mode>, for the command POINTING).

   iii) STANDARD followed by just the full name of a VERB will set all ADVERB parameters (including those for $VERB) related to the VERB.

b) A user-specified DEFAULT. At program start up, the default is set to the system standard. With the command SET_DEFAULT, a new default value can be entered by the observer. When the parameters are SAVEd, all default parameters are written to the save file. With the command RESTORE (or the **SIC** command @), these default values are reloaded.
   NOTE: The SET_DEFAULT command requires enough characters that a unique minimum match is granted, either for the name of the ADVERB to be given, or for just a VERB's parameters that a $-sign is placed in front of the VERB name. If the minimum match is ambiguous, all possible candidates are listed, and the input should be repeated with sufficient number of characters in the name.

c) If nonmandatory parameters (like source names) are specified in the command line for a VERB or ADVERB, these parameters are used as CURRENT values for just that execution of the VERB. For all other parameters, the defaults are used.

   It might be advantageous to execute a VERB with current values, and at the same time transfer the current values to the default values. In this case append the **OBST** VERB with /DEFAULT.

EXAMPLES :

Assuming the system default scan length for pointing is 200 arcsec:

OBST> POINTING	will scan for 200 arcsec.
OBST> SET_DEFAULT LENGTH_PT 210	will set the default to 210 arcsec.
OBST> POINTING	will now scan for 210 arcsec.
OBST> POINTING/LEN 190	will scan for 190 arcsec.
OBST> POINTING	will scan for 210 arcsec, since the default is adopted.
OBST> POINT/LEN 190/DEF	will scan for 190 arcsec and set the default.
OBST> POINTING	will scan for 190 arcsec, the new default is used.
OBST> STANDARD LENGTH_PT	will reset the default to 200 arcsec.

SHOW_CURR <VERB> or <ADVERB>

This VERB lists current and default values of VERBS or ADVERBS for the most-recent execution of the VERB. This can be useful for interrogating the receiver configuration, (see below).

NOTE: The SHOW_CURRENT command requires enough characters that a unique minimum match is granted, either for the name of the ADVERB or VERB to be given, or for just a VERB's parameters that a $-sign is placed in front of the VERB name. If the minimum match is ambiguous, all possible candidates are listed, and the input should be repeated with sufficient number of characters in the name.

Receiver Set-up (Frontend and Backend)

VERBS that will initiate observing programs automatically in **OBST** set the frontend/backend configuration for the execution of the program. These VERBS have unique names and the choice of continuum or spectral line setup is performed automatically.

The parameters of the frontend set–ups are specified with C_MODE and L_MODE, and the parameters for the backends by DRUMBEAT and BACKEND. The most-recent use of C_MODE sets the current values for continuum observations, while the use of L_MODE does the same for line observations. The SHOW_CURRENT command permits you to see what values are currently being used. If just one parameter should be changed for the next observing sequence, C_MODE or L_MODE has to be used for this change.

EXAMPLE :

OBST> C_MODE/PHASES_C 2

This sets the DRUMBEAT backend to record the data in two different phases.

IMPORTANT:

If you use the verbs SET_DEFAULT or STANDARD on C_MODE, L_MODE, DRUMBEAT, BE_FE or BACKEND, or use the verbs C_MODE, L_MODE, DRUMBEAT, BE_FE or BACKEND itself, the current values for that setup command are overwritten. Especially if you specify one adverb's parameter at a time, previously entered current values for all the other adverbs are reset (unlike at the IRAM 30m-MRT OBS). If the current values should be retained from now on, use the /DEFAULT option, which transfers the current parameters to the default values.

Special ADVERBS

There are adverbs that have no reference to or from a verb. One can list their related parameters with the SHOW command followed by the adverbs name. If one uses the SET_DEFAULT command with the one of these adverbs name (and provide some parameters), a **SIC** command file is executed which either updates parameters of other adverbs or parameters in the passive option field. The default values of some of the adverbs are SAVEd and the appropriate action is re-executed in RESTORE.

These adverbs are used for passing parameters that do not relate to a specific observing command, like the change of an operator or an update of manual input for the ambient temperature or pressure.

- SET_DEFAULT OBSERVER <observer> <project–ID>
  four characters are used for observer's names and six for the project identification

EXAMPLE:

SET_DEFAULT OBSERVER * PROJCT
changes the project identification to PROJCT, starting with the next observation

- SET_DEFAULT WEATHER <temperature> <pressure> <humidity>

The observer can enter values for temperature, pressure and humidity for the calculation of the refractive index. In this case he can update the values individually by typing * for the ones that do not change

EXAMPLES:

SET_DEFAULT WEATHER 20.0 960 80
uses 20 degrees centigrade, 960 hPa and 80 percent humidity for the calculation of the refraction in the pointing model.

SET_DEFAULT WEATHER * * 70
now uses 20 degrees centigrade, 960 hPa and 70 percent humidity for the calculation of the refraction in the pointing model.

A different application of these separate adverbs arises in the attempt to make the commands compatible with the standard IRAM OBS commands. There, the commands for PSWITCH and PRASTER (and CONOFF) use the same definition of the reference positions. Similarly FSWITCH and FRASTER should have the same definition of the frequency switching parameters. In order to transfer these parameters to all relevant verbs with one command, we have defined two special adverbs, REF_POS and REF_FRQ.

- SET_DEFAULT REF_POS <ref_long> <ref_lat> <ref_sys> <ref_orig>

For a definition of the parameters see the CONOFF, PRASTER and PSWITCH description of section 6.8.10. The SET REF_POS command sets the default values for all three procedures, current values used in a command will overwrite the default values for the one execution of the observing command.

EXAMPLES:

SET_DEFAULT REF_POS 200 -20 LAM ORIGIN
will select an OFF (the reference) position shifted by 200" / cos(latitude) and -20" of the origin as defined by the source longitude and latitude.

PRASTER
will set up the observation with this reference position.

PRASTER * * * NO
will set up the observation with a reference relative to the raster position. The value for <ref_orig> is a current value and used only in this observation

PRASTER or also a CONOFF
will set up the observation relative to the source position again.

SET_DEFAULT REF_FRQ <delta_f> <switch_mode>
For a definition of the frequency switching parameters see the FRASTER and FSWITCH description of section 6.8.10. The SET REF_FRQ command sets the default values for both procedures, current values used in a command will overwrite the default values for the one execution of the observing command.

6.4.6 OBST: Screen Layout

OBST uses the DEC screen management facilities and distributes information for you on five "virtual" displays.

The display is refreshed automatically at the start of an observing command. With the command

OBST> REFRESH

you can redisplay the current content of the virtual displays, whenever it has become disturbed.

OBST> REFRESH CLEAR

will result in a redisplay of display 1 and 5, but clear all information on the other virtual displays.

Display 1 (top) shows the parameters like the source name and position, the observing frequency, the observing command that is selected (or being executed) and the integration or scanning times for an individual subscan. It shows the pointing and focus fit values from the last calibration measurements.

Display 2 is used by OBSERVE and shows you the progress of the observation. Idle means no observing program is loaded. This is the message that is displayed at the start of OBSERVE by the operator. When you send an observation command, you see the message Waiting for SCAN. Once the first subscan is started OBSERVE reports about the start and end of each individual subscan and possible on-line fits to the data. It also displays when a scan is cancelled by either an error, by the operator or by a KILL or a CANCEL **OBST** command.

Display 3 (middle right) is used during the starting of an observing program. **OBST** might have to wait for the end of the previous observation. Then it loads a program and waits until it has started successfully. Messages about the changes in this particular synchronization state are displayed for your information.

Display 4 uses some 10 lines in the middle of your screen. It is used for error messages when you set up procedures with undefined or out of range parameters, it is also used to display the parameters on your request (SHOW_CURRENT). You can also display how your command is expanded into OBSINP primitives by the **SIC** symbol PROTOCOL and suppress it by NOPROTOCOL.

Display 5 is the scrolling region of a few lines with the **OBST** prompt. This section is also used when you use the recall features of the **SIC** interpreter.

NOTE: If you refresh the screen while a scan is still in progress, and have prepared already a new observation, some of the parameters (source name, source position) refer to the next observation.

6.4.7 HELP and Error Recovery

a) If the prompt is **OBST**> and you have forgotten the name of a VERB, or what a VERB does, type,

OBST> HELP
to see a list of **OBST** and **SIC** commands.

OBST> HELP OBST\
gives you a one-line explanation for all VERBS and some general explanations in OBST.

OBST> HELP <verb>
gives you the **OBST** command line for the VERB with all its related ADVERBS and some additional information.

OBST> HELP <verb> /<adverb>
gives further information about the ADVERB. For example:

OBST. HELP C_MODE

```
    Defines parameters for the C (ontinuum) observing mode

        C_MODE       [<configuration>]
     [/PHASES_C <nr_of_phases>]
                              [/RECEIVER_C <rx_nr>]
     [/CYCLETIME_C <phase_t> <blank_t>]
     [/FREQUENCY_C <freq> [unit]  <sideband>]
     [/BACKEND_C <backend_ID>]

Examples:
  C_MODE T /FREQ 230. Ghz
    Set the total-power configuration for continuum to the latest
    default values and a new default frequency of 230. GHz.

  C_MODE B
    Set the backend up for beam-switched observations.

Warning:
```

```
    The parameters set by this command become the new default values.

Additional information available:
<configuration>:      /PHASES_C  /RECEIVER_C          /CYCLETIME_C
/FREQUENCY_C          /BACKEND_C /SWITCHES_C
```

OBST> SHOW_CURRENT <verb or adverb>
is to be used should you just want to see which parameters are being used currently. You have to give enough characters for the name of the VERB or ADVERB that a minimum match is unambiguously. In case of too few characters all possible candidates are listed, so you can repeat the input with a sufficient number of characters. For example, 'SHOW POI':

```
              Current                        Default
 $POINTING    TOT                            TOT
 LENGTH_PT    180                            180
 TIME_PT      30                             30
 SUB_PT       4                              4
              ONE_COORD                      ONE_COORD
ORIENTATION  ELEVATION                      ELEVATION

 $PRASTER     2700                           2700
      0                              0
      BASIS                          BASIS
      ORIG                           ORIG
 MAPSIZE      480                            480
              10                             10
      360                            360
      10                             10
      AZM                            AZM
 TIME_L       30                             30
              30                             30
 ON_OFFS      1                              1
              NO                             NO
```

b) If you receive the reverse-video prompt while executing a command procedure:

During the execution of a VERB, or one of your own observing procedures, an erroneous command line can occur. The program then returns with a reverse-video prompt containing the level number, e.g. **OBST_3**>. If you cannot correct the problem and continue using the SIC CONTINUE command, then erase the incorrect line after the prompt and enter QUIT. Repeat QUIT until you get the normal video

OBST> prompt and correct the procedure by editing (using a SIC DCL command to go to DCL), or replace the incorrect parameter.

c) Inside a FOR loop, after CANCELling or KILLing an observation:

In the start up, **OBST** receives a **SIC** error recovery ON ERROR PAUSE. In the case of a fault occurring, this command returns control to you as the interactive user, when you are executing a command procedure. KILL or an operator intervention during the execution of an observation (no **OBST**> prompt) will set the error flag, and **SIC** prompts with its current execution level, e.g. **OBST_4**>. Input QUITs until you reach the regular **OBST**> prompt. If you wish to complete the execution of the loop, enter CONTINUE for the loop to continue the execution with the next command in the loop. CANCEL will terminate the current observation, but will continue the command procedure, as will KILL followed by CONTINUE.

d) If there is no **OBST**> prompt:

If there is no prompt, you are most probably in the WAIT state, the command has to wait until the previous observation is finished. Look at the messages in the upper right part of the display. In the upper left part OBSERVE informs which subscan is currently executed. If you want to cancel the current observation, you have to enter a <CTRL–C> and then type either KILL, CANCEL or CANCEL S. If you don't type one of these 3 commands, the current observation will continue, but the next one does not start until you repeat the command.

Section 6.9 contains a full list of VERBS and their related ADVERBS.

6.5 Catalogs

Two types of catalogs can be used by **OBST**:

a) The source catalog which contains the basis system, source positions, and velocities.

   The search key is the source name, and the first match is extracted. The source catalog is used by the SOURCE command.

b) The line catalog which contains the rest frequencies of spectral lines.

   The search key is the name of the spectral line. In contrast to OBS at the 30-m MRT, all characters of the line name have to be given. The line frequency is extracted by the LINE command.

Both catalogs have the default file extension .CAT. Default catalogs are loaded at start up. If the item of interest is to be extracted from a different catalog by either of the commands SOURCE or LINE, the appropriate command should be accompanied by the adverb CATALOG. If a new catalog is to be used as the subsequent default, type,

OBST> SET_DEFAULT CATALOG_C <source-catalog filename>
or

OBST> SET_DEFAULT CATALOG_L <line-catalog filename>

respectively.

6.5.1 The Source Catalog

The command SOURCE transfers the source and catalog names to the OBSINP SOUR command. There, the source catalog is scanned sequentially for the first matching source name. In general, the source name, the basis system, the longitude, latitude and source velocity are extracted from the catalog.

Rules for the SOURCE Catalog:

1. At the start of the catalog, two sets of parameters are defined:

   COMMON - those items that every source has in common (such as a common coordinate system (like 1950 RA, DEC).
   These items must be defined at this point.

   INDIVIDUAL - the items that will be unique to each source.
   examples include: source name (SNAM), longitude (SLAM - source lambda), and latitude (SBET - source beta).
   Just the variables are named at this point.

2. Information after an "!" is a comment.
   If a "*" starts a line, it is also considered a comment line.

3. The minimum parameters that have to be defined in either COMMON or in the individual source listings are:

   SNAM - source name

   SBAS - source basis coordinate system (see Table 6.1)

   SLAM - source longitude

   SBET - source latitude

   velocity - The observer provides both the velocity and the velocity reference frame.

4. Source name:
   Format: "snam= XXXXXXXX" where the name can contain the characters A-Z, a-z, +, -, _, and 0-9.

5. Source basis coordinate system:
   Format: "sbas X" where X is a number from Table 6.1.

   T0 is the present time when the take-over into the active field occurs. The standard equinox (1950.0) need only be given in cases B=2 and B=6. The last column states whether the coordinate system is right handed (R) or left handed (L). Pointing corrections are always applied unless one is using B=10.

   NOTE: Usually the SDH window will display coordinates in J1950.0 RA, DEC. It is possible to have OBST display the coordinates in J2000.0 coordinates.

   To switch to J2000.0
   ```
   OBST> OBSINP SDH1 EQ(2000)
   ```

   To switch to J1950.0
   ```
   OBST> OBSINP SDH1 EQ(1950)
   ```

   The available basis systems are in Table 6.1.

6. Source longitude:
   Format: "slam= XX XX XX.Xs" where XX XX XX.Xs is the longitude (for example RA) expressed in appropiate units.

7. Source latitude:
   Format: "sbet= XX XX XX.XX" or "sbet=-XX XX XX" where "XX XX XX.XX" ("-XX XX XX") is the latitude (for example Dec) expressed in appropiate units.

Table 6.1: Basis Coordinates for Source Catalogs

B	Basis Coordinates	Description
-1	RA, Dec (J2000)	Mean equatorial
0	l^{II}, b^{II}	Galactic
1	RA, Dec (J1950)	Mean equatorial
2	RA, Dec (EQ)	Mean equatorial
3	RA, Dec (T0)	Mean equatorial
4	RA, Dec	Apparent equat.
5	H, Dec	Apparent Ha, Dec.
6	Lam, Bet (EQ)	Mean Ecliptic
7	Lam, Bet (T0)	Mean Ecliptic
8	Lam, Bet	Mean Ecliptic
9	Lam, Bet	Apparent Ecliptic
10	A, a	Azimuth,Elv.

8. Source velocities:
   They are provided in [km/sec], which is used for correcting the observing frequency during an observation (if the frequency is not used in fixed mode).
   The current velocity frames include:

   VHEL: relative to the movement of the sun.

   VLSR: relative to the movement of the local standard of rest.

   VBAR: relative to the movement of the baricenter of the earth-moon system.

   ZRED: relative to the movement of that redshift.

   Example: VLSR=50.0

9. One source per line. Each parameter is separated by a ";".
   If you need to continue a source to another line, use the continuation character "-" at the end of the line.

10. You can also include other information, provided you specify it as a comment or include a variable in the INDIVIDUAL or COMMON statements. See 6.7.2 for an example.

An example of the format for the catalog is:

```
*
INDIVIDUAL: SNAM SLAM SBET
COMMON: SBAS 1; VHEL= 0.0;
!
snam= 0003+38          ; slam= 00 03 22.3s ; sbet= 38 03 33; !    0.74 Jy.
snam= 0007+106         ; slam= 00 07 56.7s ; sbet= 10 41 48; !    0.57 Jy.
snam= 0048-09          ; slam= 00 48 09.98s; sbet=-09 45 24.25; ! 0.53 Jy.
```

The coordinate system is common to all 3 sources. All 3 sources have a VHEL (helocentric velocity) equal to 0.0 km/sec. The 'SBAS 1' indicates that the slam (source lambda) and sbet (source beta) coordinates are RA and DEC for epoch 1950.0. The observer has added a comment about the expected flux.

Due to the fact that the source is found through a sequential search, we advise you not to use too large a catalog, but to extract a reduced source list from a large catalog, and use this as the default catalog during your observing session.

When you have generated your catalog, ftp to frankenheim and place it in the [OBS.initials] directory.

6.5.2 The Line Catalog

If just a line name is present in the command LINE, the line catalog is searched for a perfect match between the name in the command and the name in the catalog. Then the frequency, possibly the side band, and perhaps a fixed frequency indicator are taken from the line catalog. A sample catalog can be found in SYS$SMT:[SMT.CAT]LINEFREQ.CAT.

Rules for the line catalog:

NOTE: The rules for the line catalog differ from those for the source catalog.

1. Information has to be on a single line. Letters are converted to UPPER CASE, as are the letters of the name in the LINE command.
2. The line name has to be the first item of the line, but it can be preceded by blanks or a <TAB>. The frequency must be separated by a blank or a <TAB>.
3. THz, GHz (default), MHz and kHz are recognized after the frequency, as are USB and LSB and the combination FIX. The sequence is irrelevant.
4. The rest of the line can be used for comments. These should be preceded by an exclamation mark (!).
5. EXAMPLES :

```
CO(2-1)        230.537990   GHz LSB
13CO(2-1)      220.398686   GHz LSB
C17O(2-1)      224.714368   GHz LSB
C18O(2-1)      219.560360   GHz LSB
CO(3-2)        345.795975   GHZ LSB
```

6.5.3 List of Current Catalogs at the SMTO

The primary catalogs for the SMTO are:

SYS$SMT:[SMT.CAT]SMTCONT.CAT → Standard continuum pointing source list. Derived from IRAM pointing list. Useful for POINT.

SYS$SMT:[SMT.CAT]SMTLINE.CAT → Standard spectral line source list. Derived from IRAM pointing source list. Useful for Checking Lines.

SYS$SMT:[SMT.CAT]LPOINT.CAT → Standard spectral line pointing source list. Useful for LPOINT, LWPOINT. Derived from the Loup Catalog of Evolved Stars.

SYS$SMT:[SMT.CAT]LINEFREQ.CAT → Standard spectral line frequency list.

NOTE: A shortcut to writing out the "SYS$SMT:[SMT.CAT]" string every time is to use "CAT:" in its place.

i.e. OBST> SOURCE W3OH /CAT CAT:SMTCONT.CAT

instead of OBST> SOURCE W3OH /CAT SYS$SMT:[SMT.CAT]SMTCONT.CAT

Currently, there are converted versions of the SMTCONT.CAT source list which can be used to plot visibility charts using ASTRO:

SMTCONT_G1JY_0-12.SOU → Sources from SMTCONT.CAT which have fluxes greater than 1 Jy and have RA between 0 and 12.

SMTCONT_G1JY_12-24.SOU → Sources from SMTCONT.CAT which have fluxes greater than 1 Jy and have RA between 12 and 24.

SMTCONT_L1JY_0-12.SOU → Sources from SMTCONT.CAT which have fluxes less than 1 Jy and have RA between 0 and 12.

SMTCONT_L1JY_12-12.SOU → Sources from SMTCONT.CAT which have fluxes less than 1 Jy and have RA between 12 and 24.

6.5.4 Getting your catalog to the SMTO

The easiest way to get your catalog to the SMTO is to ftp it from your home computer after your arrival at the site. However, remember to bring a tarred copy in case the link is down!

You can place it in your "FDATA:[OBS.yourinitials]" directory. It can also be placed in the "SYS$SMT:[OBS.CAT]" directory by one of the Friends of the Telescope.

You can then invoke the catalog through

OBST> SET_DEF CATALOG_C FDATA:[OBS.initials]MYCAT.CAT
for the source catalog MYCAT.CAT

or through the SOURCE COMMAND

OBST> SOURCE mysource /CAT FDATA:[OBS.initials]MYCAT.CAT

You can do similar things with your own line catalogs.
(remember that you use CATALOG_L for line catalogs).

A special program (cconv) has been installed that allows you to easily creat XEPHEM format files from your HHT-format catalogs. See AppendixA.1.1 for details on how to use cconv on either the VMS (kronen, frankenheim) or UNIX (hannen) systems.

6.5.5 Source positions for Solar System Objects

The nice thing about objects in the solar system is that they move around in fun orbits. However, this means that we need a different procedure for dealing with the SOURCE command. Rather than supply a catalog which lists the moving object at different times, we use an EMPHERIS file. These files provide the information that OBST will need to calculate the orbit of the object, and hence its position and velocity relative to the telescope.

Planets

Note that for the planets, moon, and sun, you just have to say:

OBST> SOURCE VENUS and off you go to Venus

P.S.—-Don't you dare point at the Sun!

Comets, Asteroids, and Alien Spacecraft

For comets and asteriods, you have to supply the orbital elements and use a special form of the SOURCE command.

The elements must in a file which is the name you wish to use. Furthermore, the file must have the extension .BOD and it must be located in the directory "SYS$SMT:[SMT.ASTRO]". (This is also where our USNO elements are kept-in case you were dying to know!).

The source is then called via the source command:

OBST> SOURCE BODY NAME

where the word BODY tells OBST that you are loading a moving object. "NAME" is the name of the source *and it matches the file name in "SYS$SMT:[SMT.ASTRO]".*

EXAMPLE:

Consider the comet Hale-Bopp. We would name the file "HALEBOPP.BOD"and place it in "SYS$SMT:[SMT.ASTRO]". We would invoke it with the command:

OBST> SOURCE BODY HALEBOPP

This procedure applies to comets, asteroids, and large alien space craft with well defined orbital elements.

Sample Empherides

An example orbital element file for a comet is below:

```
245082.6019  = 1998/02/28.1019 = T           | Here be comments
235.2580     = Long. of Asc. Node            | if you wish!
172.4971     = Arg. of Perihelion
162.4858     = Inclination
  0.9766606  = Perihelion Distance (AU)
  0.905516   = Eccentricity
2000.0       = J2000 = Elements Equinox
```

A slightly different format can be used in cases of better empherides.

```
2450539.638112d0 ! = 1997/04/ 1.138044 = T    | Here be comments!
282.4707898d0    ! = Long. of Asc. Node
130.5901353d0    ! = Arg. of Perihel
 89.4296941d0    ! = Inclination
  0.9141300d0    ! = Perihelion Distance
  0.9951123d0    ! = J2000 = Elements equinox
```

The d0 refers to Double Precision.

The orbital element information can be found in the Minor Planets Circulars (MPCs), IAU Circulars, or on the web.

Two web addresses of interest are:

```
http://encke.jpl.nasa.gov    - Comet Observation Homepage
      (COOL SITE!)

http://cfa-www.harvard.edu/iau/Epheremides/index.html
```

There is also a nice web page which contains the Epheremides in XEPHEM format (as well as for other popular programs).

```
http://cfa-www.harvard.edu/iau/Ephemerides/SoftwareEls.html
```

6.6 Set-Up VERBS

The set-up VERBS are used to set up the frontend and backend configurations for data acquisition during an observation. **OBST** currently holds two set-ups in parallel, one for continuum, and one for spectral-line observations. Both set-ups remain stored until changed explicitly by one of the VERBS described in this chapter. Once set, either the continuum or line setup is automatically selected by the VERB that initiates an observation or calibration measurement.

The verbs covered here include:

RX	- set up the receiver(s)
LINE	- set up the line frequency
BE_FE	- attaches the backend to the appropiate frontend
BACKEND	- setup the desired backends (replaces the old AOS command)
AOS	- (defunct - see BACKEND command)
DRUMBEAT	- modifies DRUMBEAT
WOBBLE	- set wobbler parameters (mostly used to change wobble throw)
C_MODE	- set up for continuum mode
L_MODE	- set up for line mode
FESET	- set the frequency synthesizer information

6.6.1 RX

OBST> RX <receiver name> [<receiver name #2>] /DEFAULT
/OBS_MODE <mode>
/PT_MODEL <receiver name>

RX performs a broad set-up of variables based on the receiver type, name and observing mode. For example, the receiver and it's location will dictate which pointing model is used, how FESET is setup, which drumbeat channels to read, etc... The RX command also sets up the Harmonic and Multiiplier for the Gunn for each receiver (via the FESET command). Finally, the RX command specifies the positions of the RF switches in order to route the Synthesizer #1 to the required receiver and the receiver IF's to the MPIfR IF Switch Box (see below). Currently, only the SIS230 and SIS490 receivers may be used simultaneously. When the SIS345 receiver is used, only one frontend area is used. The two channels of the 345, A and B, are associated with the same frontend, Frontend #1.

The command has been substantially simplified, with the information about the backends now being specified by the BE_FE command (which connects the appropiate backend to the desired frontend).

RX <receiver name> [<receiver name #2>]

The RX command can take up to two parameters: the name of Frontend#1's receiver and the name of Frontend #2's receiver.

For example: "OBST> RX SIS230 SIS490".

If you wish to change Frontend #2 only, use a "*" for Frontend #1. To change only Frontend #1, either omit the Receiver #2 name or use a "*" for it.

The naming convention for bolometers is "B" followed by a 3-letter designation of the wavelength (e.g. 1.3 mm is 130, 0.87 is 087, etc), followed by a 2-letter designation for the number of bolometer channels. The 1.3 mm channel of the 4-color (4 channel) bolometer is B130C4, the 0.87 mm channel of the 4-color is B087C4, etc... For the single channel bolometers, there is an additional 1-letter designation for the flange (or side) of the receiver cabin (L for left, R for right). For example the 0.87 mm 1 channel bolometer mounted on the right flange is: B087C1R. (Single channel bolometers are offline.) See Chapter 3.2.

For the 19-channel boloarray, the name is 19CHAN. See Chapter 4.

For the SIS receivers, the naming convention is simply "SIS" followed by a 3-letter designation for the center or characteristic frequency, e.g. SIS230, SIS345, SIS490, etc... See Chapter 3.3

Current Receivers include:
SIS230, SIS345, SIS490, B130C4, B087C4, B045C4, and B035C4.

ADVERBS:

- OBS_MODE <mode> - The observing mode.
  "C" for continuum mode
  "L" for spectral line mode

"H" for holography mode (staff use only)

- PT_MODEL <receiver name> - Specifies which of the two frontends' in use will be used to define the pointing constants. Use the normal receiver name for the receiver desired. The name should be one of the active receiver names defined in the command (or by a previous RX command). If only one frontend is active, it should be that receiver name. If the receiver name stored in PT_MODEL is *not* one of the currently active frontends, the value of PT_MODEL is set to the value in the first frontend. Once a scan is started, the name of the receiver used for the pointing offsets is stored in a SIC character variable, MOD_NAME.

  If you wish to see which pointing model is currently defined, use the command:
  RX /PT_MODEL ?

- DEFAULT - set the receiver(s) as defaults.

See the BE_FE command and the discussion of the IF switching box (Chapter 5.5.1) for gory details on backend/frontend options.

6.6.2 LINE

OBST> LINE <name> <frq> [<unit>] <band> /DEFAULT
/CATALOG_L <catalog_name>
/RECEIVER <1> or <2>
/MODE <mode>

The LINE command is used to specify the line name and frequency. (It should no longer be necessary to specify these separately for the L_MODE and C_MODE commands.) When specifying the rest frequency, one should use the /RECEIVER adverb to specify which frontend area, 1 or 2, is to be modified. As usual, if /RECEIVER is omitted, the default value is assumed.

Temporarily, one can only verify what the LINE and FESET parameters are in effect for a particular Frontend by doing SHOW FE1 or SHOW FE2 in OBSINP.

LINE allows the user to enter center frequencies from a line catalog directly into C_MODE, L_MODE. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <name> the line name is mandatory !

  If the line name is the only parameter for the VERB, the line catalog is searched for the first entry which matches that name exactly. Then the frequency, and possibly the side band, is extracted and sent to the ADVERB selected via the /MODE.

  If additional parameters are entered for the VERB, it is assumed to be the direct input of the frequency with a possible unit, side-band and fix indicator. These values are sent as typed to the ADVERB selected by the /MODE.

  The line name of an observation is transferred to the **CLASS** data reduction package. This holds for names entered with a MODE that sets FREQUENCY_L.

ADVERBS:

- CATALOG_L allows you to declare a line-catalog name for just that call. Otherwise, the default catalog is scanned.

- RECEIVER specifies which of the two currently connected FRONTENDs you wish to set.

  EXAMPLES:

  LINE CO(2-1) /RECEIVER 1 - Sets the First RX to the CO(2-1) freq.

  LINE CO(4-3) /RECEIVER 2 - Sets the Second RX to the CO(4-3) freq.

- MODE determines where the frequency input should go. This option is now not necessary, since the LINE command will update both L_MODE and C_MODE.

  If the current value of mode is starting with a letter other than L or C the input extracted goes to both the line observing frequency FREQUENCY_L of L_MODE and the continuum observing frequency FREQUENCY_C of C_MODE. If you want to set them differently set the MODE adverb accordingly.

<mode> = L : The frequency input goes to FREQUENCY_L of the line mode, L_MODE, only.

<mode> = C : The frequency input goes to FREQUENCY_C of the continuum mode, C_MODE, only.

EXAMPLES :

LINE CO(2-1)/MODE CONT

will extract the 230.53799 GHz from the line catalog and store it in FREQUENCY_C for continuum observations.

LINE TEST 230.53799 USB

will set the spectral-line center frequency to 230.53799.

- DEFAULT - set parameters as the defaults.

6.6.3 BE_FE

OBST> BE_FE <backend_id> <frontend> [<frontend>] /DEFAULT

where <backend> is the backend name or number, and <frontend> is the frontend number. In order of backend numbers 1-8, the backend names are: DRUM, HOLO, AOSA, AOSB, AOSC, NASA, FBS, and CHIRP. (AOSA and AOSB are 1 GHz wide AOS with about 900 kHz resolution, AOSC is a 250 MHz wide AOS with about 400 kHz resolution.) The second <frontend> is used only if the <backend> can be connected to two Frontends simultaneously. (This is currently only possible for DRUM.)

In the case of the SIS345 receiver, there are two channels, A and B. For this receiver, the frontend should be specified 1A or 1B as appropriate. This scheme is adopted to allow two channel receivers (like the SIS345) to have separate T_{rec}'s, etc... without having to define two separate front end Raw Data sections filled with the same information. Instead of referring simply to the frontend number, one can append a letter to distinguish between the two channels. 1A is the first channel of Frontend #1 and 1B is the second channel of Frontend #2. (if the letter is omitted, A is assumed.

When using the SIS345 receiver, if one forgets to specify the letter A or B on the frontend number in the BE_FE command, the data headers will indicate that the backend(s) were connected to channel A. Since the computer cannot yet control the MPIfR IF Switch Box, the data will be unaffected.

Repeat BE_FE for each Backend whose associated Frontend is to be changed. (Note that the old scheme of specifying the Frontend by the /RECEIVER adverb no longer works.)

BE_FE will display the frontend end that each backend is assigned. To see what values BE_FE has assigned to each backend, simply type BE_FE without any parameters.

Examples:

SIS230 alone:

RX SIS230
LINE CO(2-1)/RECEIVER 1
BE_FE DRUM 1
BE_FE AOSA 1
BE_FE AOSB 1
BE_FE AOSC 1
BE_FE FBS 1
BACKEND AOSA AOSB AOSC FBS

(A POINTING command will automatically connect DRUM and temporarily disconnect the spectrometers.)

SIS345 alone. AOSA & FBS -> channel A, AOSB & AOSC -> channel B. Process the pointing data for the second channel on line.

RX SIS345 LINE CO(3-2)/RECEIVER 1
BE_FE DRUM 1
BE_FE AOSA 1A
BE_FE AOSB 1B
BE_FE AOSC 1B
BE_FE FBS 1A
BACKEND AOSA AOSB AOSC FBS
DISPL_CHAN 3

(Drumbeat always gets both channels A and B.)

SIS490 alone:

RX * SIS490
LINE CO(4-3)/RECEIVER 2
BE_FE DRUM 2
BE_FE AOSA 2
BE_FE AOSB 2
BE_FE AOSC 2
BE_FE FBS 2
BACKEND AOSA AOSB AOSC FBS

(If you didn't mind changing the name of the Frontend #1 receiver, you could have specified a name instead of the "*". Whether or not a frontend is actually used depends upon whether it is specified for any of the active backends.)

SIS230 and SIS490. AOSA & FBS -> SIS230, AOSB & AOSC -> SIS490. Pointing offsets for SIS490. Process SIS490 pointing data on line:

RX SIS230 SIS490/PT_MODEL SIS490
LINE CO(2-1)/RECEIVER 1
LINE CO(4-3)/RECEIVER 2
BE_FE DRUM 1 2
BE_FE AOSA 1
BE_FE AOSB 2
BE_FE AOSC 2
BE_FE FBS 1
BACKEND AOSA AOSB AOSC FBS
DISPL_CHAN 3

Display the current frontends that each backend is assigned:

BE_FE
The frontend that each backend is assigned to is then listed.

ADVERBS

- DEFAULT - set as the defaults

6.6.4 BACKEND

OBST> BACKEND <backend_id> /DEFAULT

Defines which backends are active. Up to 8 BACKENDSs may be specified at one time. These will remain active till the verb is used again. If the /DEFAULT adverb is used, the parameters are transferred to the default values.

Currently, the appropiate numbers for the <backend_id<¿ are summarized in Table 5.1. In order of backend numbers 1-8, the backend names are: DRUM, HOLO, AOSA, AOSB, AOSC, NASA, FBS, and CHIRP. (AOSA and AOSB are 1 GHz wide AOS with about 900 kHz resolution, AOSC is a 250 MHz wide AOS with about 400 kHz resolution.)

Example: BACKEND 3 4 5 7

This will enable BACKENDs 3, 4, 5, and 7 for data taking.

Example: BACKEND AOSA AOSB AOSC FBS

This will enable BACKENDs AOSA, AOSB, AOSC, and the FBS for data taking. (i.e. the same backends as the previous example!).

BACKEND replaces the old AOS command.
Note that the naming of the AOSs is slightly different than before:

AOS 3→AOSA or backend 3
AOS 4→AOSB or backend 4
AOS 5→AOSC or backend 5

6.6.5 AOS

OBST> AOS <backend_id> /DEFAULT

Replaced by the BACKEND command since not all backends are AOSs.

6.6.6 DRUMBEAT

OBST> DRUMBEAT /DEFAULT
/CHANNELS_C <number_of>
/PREINTEG_C <hardint> <softint> <Dumps>
/SEL_CHOPPER <chopmode>
/BOLOGAIN <attenuation>
/BANDWIDTH_C <not_implemented>

DRUMBEAT sets up the parameters for the continuum backend selected by C_MODE. Currently C_MODE automatically executes DRUMBEAT. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

ADVERBS:

- CHANNELS_C is number of backend channels to be used.
- PREINTEG_C
  <hardint> sets the number of integrations averaged in the counter hardware. <softint> sets the number of cycles that are averaged by the 68000 before being transferred to the DRUMBEAT PC, i.e. number of basic cycles per dump. <dumps> sets the number of averages (hardint*softint cycles) that are accumulated before sending them to the VAX which then attaches time and position information (DAPs) and then writes them to disk.
- SEL_CHOPPER sets the chopping technique (and synchronization signal) for DRUMBEAT to use. The current options are 'S' for the sky-chopper, useful only on the right flange of the telescope, 'W' for the wobbling secondary, and "H" or "C" for the hot/cold load. The specifics of the wobbling secondary are setup with the "WOBBLE" verb.
- BOLOGAIN reflects attenuation level on the V-F converter, 1 being the lowest, and 9 being the highest.

  Note: The toggle switch on the V-F converter must be set to 'external' for computer control. A small LED light will display the current value of the BOLOGAIN parameter. This is the standard position.
- BANDWIDTH_C Not yet implemented.
- **EXAMPLE :**

  OBST> DRUMBEAT /SEL_CHOPPER W /BOLOGAIN 5

  This sets the synchronization signal to the wobbling secondary and sets the attenuation to 5.

6.6.7 WOBBLE

OBST> WOBBLE <Y(enable) or N(disable)> /DEFAULT
/W_POS <wobble position 1><wobble position 2>...<wobble position n>
/W_NUM <number of wobble positions>
/W_BEAM <beam position 1> <beam position 2>

WOBBLE enables the wobbling secondary and sets the parameters for the wobbling cycle. Currently frequency control of the wobble is maintained by a frequency generator in the leftmost CAMAC rack.

- < Y(enable) or N(disable)> Enable or disable the wobbling motion during an observation.

ADVERBS:

- W_NUM: This sets the number of different positions or phases in a wobbling cycle. The maximum number is 16, while the most commonly used setting is 2 for a dual-beam observation. Note: currently this parameter is limited to 8 settings.

- W_POS: These values set the different angular positions for each phase. For example, setting '/W_POS -60 60', sets phase 1 to -60" off and phase 2 to +60" off center. The maximum extent currently available is approximately 150" offset in each direction (+/- azimuth). We recommend, if possible, using smaller throws (+/-60" or +/-100" arcseconds)

- W_BEAM: This pair of values designates the pointing correction to be made for a wobbled observation. It makes the correction based on the average of the values. For example, 'W_BEAM 2 2' will make a pointing correction compensate for the offset of phase 2; in the above example, this means it will apply a 60" offset such that the phase 2 position is at the zero position. This is the standard setup.

EXAMPLE:
OBST> WOBBLE Y /W_NUM 2 /W_POS -60 60 /W_BEAM 2 2
This will enable the wobbler for a 2-phase wobble with a symmetric chop of -60" to +60". It sets the second phase (the +60" position) as the zero-position or center; this is the standard setup prior to making a POINTING observation.

NOTE: As if this VERB wasn't complicated enough, there is the added complication of being able to reverse the phase order using a hardware switch near DRUMBEAT. Usually there is no reason for the observer to mess with that-so be careful up there!

6.6.8 C_MODE

```
OBST> C_MODE  <c_l>                          /DEFAULT
              /BACKEND_C <backend id>
              /PHASES_C <nr_of_phases>
              /RECEIVER_C <rx_nr>
              /FREQUENCY_C <GHz> <side>
              /CYCLETIME_C <t> <blank>
```

C_MODE sets up the frontend-specific part of the receiver for continuum observations and selects the backend. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <c_mode> : The observing mode, which takes one of 2 possibilities: T or B where T = Total-power and B = Beam-switched mode

  NOTE: The observing mode can be changed by every VERB executing a continuum observation.

ADVERBS:

- BACKEND_C sets the name of the continuum backend. Currently only the 80-channel digital backend (DRUMBEAT) can be used. (There is a "HOLO" mode for use by staff during HOLOGRAPHY runs.
- PHASES_C is the number of receiver switch phases; typically 1. For PHASES_C 1: DRUMBEAT subtracts phase 1 from phase 2 before sending to the VAX. For PHASES_C 2: The analysis software (**CHEF**) does the subtraction.
- RECEIVER_C is Frontend number to be connected. Currently frontend 1 is initialized by the operator and is selected automatically.
- FREQUENCY_C sets the center frequency and the side-band for continuum observations. See the verb LINE if the frequency is to be extracted from a catalog.
- CYCLETIME_C sets the phase time (in msec) and the blanking time (in units of 10 μsec) for the pulse generator within the Frontend control unit. Typical values are 16 40. ***NOT IMPLEMENTED***

6.6.9 L_MODE

OBST> L_MODE <l_mode> /DEFAULT
/BACKEND_L <backend_id>
/PHASES_L <number>
/RECEIVER_L <rx_nr>
/FREQUENCY_L <SCF> <side>
/CYCLETIME_L <t> <blank>

- < l_mode> : The observing mode, which takes one of 3 possibilities: T, L, or F
  T = Total-power, L= Load-switched mode,
  and F = Frequency-switched (***NOT IMPLEMENTED***).

  L_MODE sets up the frontend-specific part of the receiver for spectral-line observations and selects the backend. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

  NOTE: The observing mode can be changed by every VERB executing a line observation.

ADVERBS:

- BACKEND_L sets the name of the line backend. Currently only the AOS backend can be used.
- PHASES_L Number of receiver switch phases.
- RECEIVER_L Frontend number to be connected. Currently only frontend 1 can be selected.
- FREQUENCY_L Sets the center frequency and the side-band for line observations. See the command LINE if the frequency is to be extracted from a catalog.
- CYCLETIME_L This sets the phase time (in msec) and the blanking time (in units of 10 μsec) for the pulse generator within the Frontend control unit. ***NOT IMPLEMENTED***

6.6.10 FESET

OBST> FESET /DEFAULT
/HARM <harmonic value>
/MULT <Gunn mult. value>
/IF <IF frequency>
/PL <PL frequency>

FESET sets up the frontend parameters for a line observation with Doppler tracking. It selects the harmonic used, the Gunn multiplier value, the sideband and the IF frequency.

The synthesizer formula used is:

Sky_freq = (HP_synthesizer*HAR1 + PLL)*MUL1 +/- SIF1

where HAR1 is the OBSINP harmonic value (default 9), MUL1 is the OBSINP Gunn multiplier (default 4), SIF1 is the OBSINP IF frequency (default 1500 MHz), and the phase lock loop reference frequency is PLL. The +/- is chosen by the sideband setting in OBSINP (SID1 U or SID1 L). Sky_freq is automatically calculated by CONTROL based upon the rest frequency (OBSINP's SCF1) and is displayed on the SDH screen ("SKY_F").

ADVERBS:

- HARM - The harmonic value.
- MULT - The Gunn multiplier value.
- IF - The IF frequency in MHz.
- PL - The PL frequency in MHz

EXAMPLE:

OBST> FESET /HARM 9 /MULT 4 /IF 1500

This sets the harmonic value to 9, the Gunn multiplier value to 4, and the IF frequency to 1.5 GHz. These values are used by FEORGA to calculate the values needed for PLL and HP_synthesizer. It adjusts both because the PLL synthesizer has higher frequency resolution than the HP synthesizer (10 Hz vs 1, 2, or 3 KHz) and has a smaller multiplier. PLL is restricted to the range CPL1 +- RPL1 (OBSINP variables; defaults 105 +- 10 MHz). The value of HP_synthesizer is only changed when PLL would fall outside this range. When HP_synthesizer is changed it is set to a value which would center PLL in its range. If RPL1 is set to zero, PLL will be kept nearly equal to CPL1. (It will still be adjusted slightly in order to more accurately produce Sky_freq given the coarser settings of the HP.) The PLL synthesizer can be tuned from 90 to 120 MHz.

FEORGA calculates a new synthesizer setting at the beginning of each subscan. It will do so even if only the bolometer is being used for the observations. Since there is no feed back from the HP synthesizer, one can power it off without FEORGA noticing. However, should HOST4 (the receiver roomPC) fail to accept the commands, FEORGA may abort the observation. To prevent this, turn off the FE button on the control panel.

6.7 Calibration VERBS

For accurate, reliable measurements, the correct pointing of the antenna has to be determined and updated from time to time. Also, the state of the atmosphere and the sensitivity of the receivers have to be monitored. The results of these measurements are used to calibrate the observations made during an observing session. For calibration purposes, VERBS have been developed that execute standard procedures for pointing, focusing and skydips, and the on-line data-processing facilities will evaluate the results from these immediately after finishing the measurements. Should you wish to do so, you can revise the pointing and focus adjustments using the results of the calibration procedures.

The verbs included here are:

POINTING	- continuum pointing
LPOINT	- line pointing (position switching)
LWPOINT	- line pointing (wobble switching)
GPOINT	- continuum pointing (seldom used)
ZFOCUS	- check zfocus
XFOCUS	- check xfocus
CORRECTIONS	- apply corrections (pointing and/or focus)
DARK	- take a dark for all active backends
CALIBRATION	- calibration scan (sky-hot-cold or sky-hot)
SKYDIP	- do a skydip

6.7.1 POINTING

OBST> POINTING <c_mode> /DEFAULT
/LENGTH_PT <arcsec>
/TIME_PT <time(s)>
/SUB_PT <nsub_total> <by_2>
/ORIENTATION <direction (L, B, A, E)> <only>
/APPEND

POINTING performs back-and-forth cross scans in latitude and longitude/cos(latitude) centered on the object selected by the SOURCE command. To determine the apparent center of the source, a Gaussian is fitted to the data after baseline removal. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

NOTE: The results can only be applied to update the pointing corrections if the cross scans are made in azimuth/elevation (see the /ORIENTATION option).

- <c_mode> is the continuum observing mode (this is transferred to C_MODE), where T = Total-power and B = Beam-switched.

ADVERBS:

- LENGTH_PT is the real-angle length of the arm(s) of the cross in arcsec. For point sources, 3 to 4 half power beamwidths is a good choice. As a rule of thumb at the SMT, $25 \times \lambda_{mm}$ yields the HPBW in arcsec.

- TIME_PT is the scanning time in sec for an individual subscan along an arm.

  NOTE: If you check the set up in OBSINP, remember that the velocity is converted into angular units/min.

- SUB_PT The first parameter, <nsub_total>, is the number of subscans in the observation. Since all subscans will scan in both positive and negative directions (to minimize the effects of time constants and hysteresis), use multiples of 4 if both orientations are selected, otherwise 2. Remainders are truncated.

  If the second parameter, <by_2>, is BY_2 (only the B is tested for), the scanning coordinate is changed after each 2 subscans (one back and one forth). Otherwise, half of the subscans (<nsub_total> /2) are performed in the first coordinate of ORIENTATION, followed by the other half in the other coordinate (if <only> is not specified in ORIENTATION).

  NOTE: This is different from the 30-m MRT, where two subscans along the first, followed by two subscans along the second, coordinate are repeated.

- ORIENTATION This ADVERB has 2 parameters. The first, <direction (L, B, A, E)>, determines the coordinate system, while the second, <only>, dictates which of the coordinates is to be used for the first subscan. Only the first character of <direction (L, B, A, E)> is tested, the following values being legal,

E = Relative AZ/EL, starting with elevation
A = Relative AZ/EL, starting with azimuth
B = Scan in LAM/BET of the SOURCE basis system, starting with latitude BET
L = Scan in LAM/BET of the SOURCE basis system, starting with longitude LAM.

The first character of the second parameter is tested. If this is an O for ONLY, the subscans can be made in just the starting coordinate selected by <direction (L, B, A, E)>. In all other cases normal cross scans are executed.

- APPEND Causes the ONLINE CHEF to add this POINTING observation to that of the scan(s) immediately proceeding. If you then use CORR F F, then the result of the two scans is appended to the POINTING.LOG as a single scan. This option is recommended to use when repeating a weak source. You will get more signal to noise on the pointing fit as a result.

EXAMPLE:
OBST> POINT/LEN 200/TIM 30/ORI AZIM NO/SUB 12
This will first make 6 subscans of 200 arcsec at a rate of 400 arcsec/min in azimuth with OAZM * in effect, followed by 6 subscans in elevation with the same length and velocity.

6.7.2 LPOINT

OBST> LPOINT <ref_long> <ref_lat> <ref_system> <ref_origin> /DEFAULT
/LENGTH_PT <arcsec>
/TIME_LPT <T_{on}time(s)> <T_{off}time(s)>
/ON_OFFS <n on per offs> <f:on first>
/NUMBER_LPT <number of points along an arm>
/SUB_LPT <number of total repeats> <by_2>
/ORIENTATION <direction (L, B, A, E)> <only>

LPOINT performs a cross with a given number of points per arm, using spectral line observations(PSWITCH). It does the observations using a single off position, as defined by the observer.

- <ref_long> <ref_lat> <ref_system> <ref_origin>

  These 4 parameters set up the relative position for the reference measurement (the OFF). Values typed in the LPOINT command are current values, used for the observation. To set defaults, use the SET_DEFAULT REF_POS command. For details, see section 6.8.10. The <ref_long> and <ref_lat> are given in arcseconds.

ADVERBS:

- LENGTH_LPT is the real-angle length of the arm(s) of the cross in arcsec. For point sources, 3 to 4 half power beamwidths is a good choice. As a rule of thumb at the HHT, 25 $\times\lambda_{mm}$ yields the HPBW in arcsec.

- TIME_LPT is the integration time for an individual subscan along an arm. You can specify the on and off times separately.

- ON_OFFS is the number of ons taken per off observation. 3 ON's per OFF is recommended under good weather conditions. /ON 2 or /ON 1 otherwise.

- SUB_LPT is the number of times you repeat each portion of the cross. If you add BY_2, then the scanning coordinate is changed after 2 subscans.

- ORIENTATION This ADVERB has 2 parameters.

  The first, <direction (L, B, A, E)>, determines the coordinate system, while the second, <only>, dictates which of the coordinates is to be used for the first subscan. Only the first character of <direction (L, B, A, E)> is tested, the following values being legal,

  E = Relative AZ/EL, starting with elevation
  A = Relative AZ/EL, starting with azimuth
  B = Scan in LAM/BET of the SOURCE basis system, starting with latitude BET
  L = Scan in LAM/BET of the SOURCE basis system, starting with longitude LAM.

  The first character of the second parameter is tested. If this is an O for ONLY, the subscans can be made in just the starting coordinate selected by <direction (L, B, A, E)>. In all other cases normal cross scans are executed.

EXAMPLE:

OBST> LPOINT -500 0 /NUM 3 /TIME 15 15 /LEN 50 /ON 3

Will observe 3 points on each arm spaced by 25 arcseconds with a reference point at (-500", 0"). The integration time per point is 15 seconds. The /ON 3 qualifier tells LPOINT to observe 3 ON's per OFF.

CHEF NOTES:

The LPOINT observation is reduced and displayed in the online display (CHEF). It subtracts a baseline of order 1 off all spectra and calculates the line area. It needs specific velocity windows to do that. Those windows are specified in the catalog using the OBSINP commands VLOW, VHIG, WLOW, WHIG.

VLOW and VHIG define a window for the baseline calculation (like SET MODE X in CLASS). This is necessary because of edge effects (e.g the isolator in the SIS230). The second pair (WLOW, WHIG) defines a line window for the area calculation (like SET WINDOW in CLASS). The Loup catalogs found in the [SMT.CAT] area already contain those velocities. If you want to use your own catalog, you must provide those parameters. A typical line in the catalog would be:

SNAM=o CET; SLAM=02 16 49.11S; SBET=-03 12 22.4; -

VLSR=+47; VLOW=-14; VHIG=108; WLOW=36; WHIG=58;

Note the dash at the end of the first line. This is the continuation character. The head of that catalog section must contain the extra parameters:

COMMON: SBAS=1

INDIVIDUAL: SNAM SLAM SBET VLSR VLOW VHIG WLOW WHIG

CHEF writes those velocity windows in the CLASS spectrum header so that they can later be used for the fit. The online CHEF mails the fit results to OBST where they can be used with CORRECTION F F, etc... like a continuum pointing. The LPOINT command in CHEF does the fitting and mailing. It can be used offline for later analysis as well (e.g. using baselines of different order or different velocity intervals).

The CHEF syntax is:

LPOINT <Scan Number> [[[[[<Base Order—*>]

<VLOW—*>] <VHIG—*>] <WLOW—*>] <WHIG—*>]

The scan number must be given, the other parameters are optional. A "*" tells LPOINT to take the velocities from the header and to take a baseline of order 1. LPOINT expects the line pointing spectra in the current input file opened by FILE IN in CHEF.

6.7.3 LWPOINT

```
OBST> LWPOINT <ref_long>                          /DEFAULT
              /LENGTH_LPT <arcsec>
              /TIME_LWPT <Time per point (in seconds)
              /NUMBER_LWPT <number of points along an arm>
              /SUB_LWPT <number of total repeats> <by_2>
              /NOOFFSET
              /ORIENTATION <direction (L, B, A, E)> <only>
```

LWPOINT performs a cross with a given number of points per arm, using spectral line observations (WSWITCH).

- <ref_long> The wobble throw (in arcseconds). It will be compared against the current wobbler settings and a warning issued if the two do not match.

ADVERBS:

- LENGTH_LPT is the real-angle length of the arm(s) of the cross in arcsec. For point sources, 3 to 4 half power beamwidths is a good choice. As a rule of thumb at the HHT, 25 $\times \lambda_{mm}$ yields the HPBW in arcsec.
- TIME_LWPT is the integration time for an individual subscan along an arm.
- SUB_LWPT is the number of times you repeat each portion of the cross. If you add BY_2, then the scanning coordinate is changed after 2 subscans.
- NOOFFSET By default, the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.
- ORIENTATION This ADVERB has 2 parameters.

  The first, <direction (L, B, A, E)>, determines the coordinate system, while the second, <only>, dictates which of the coordinates is to be used for the first subscan. Only the first character of <direction (L, B, A, E)> is tested, the following values being legal,

  E = Relative AZ/EL, starting with elevation
  A = Relative AZ/EL, starting with azimuth
  B = Scan in LAM/BET of the SOURCE basis system, starting with latitude BET
  L = Scan in LAM/BET of the SOURCE basis system, starting with longitude LAM.

  The first character of the second parameter is tested. If this is an O for ONLY, the subscans can be made in just the starting coordinate selected by <direction (L, B, A, E)>. In all other cases normal cross scans are executed.

EXAMPLE:

OBST> LWPOINT -120 /NUM 5 /TIME 15 15 /LEN 60

Will observe 5 points on each arm spaced by 60 arcseconds (at -30, -15, 0, 15, and +30" per arm). The wobblerthrow is at (-120"). This would correspond to a wobble position of (-60",+60"). The integration time per point is 15 seconds.

CHEF NOTES:

The LPOINT observation is reduced and displayed in the online display (CHEF). It subtracts a baseline of order 1 off all spectra and calculates the line area. It needs specific velocity windows to do that. Those windows are specified in the catalog using the OBSINP commands VLOW, VHIG, WLOW, WHIG.

See LPOINT for details on CHEF use.

6.7.4 GPOINT

```
OBST> GPOINT <c_mode>                                  /DEFAULT
                /LENGTH_GPT <arm length in arcsec>
                /TIME_GPT <time per arm>
                /SUBSCAN <n_total> [by 2]
                /ORIENTATION <scanning dir> [ONLY]
                /NUMBER_GPT <number of points per arm>
```

GPOINT sets parameters for a continuum grid point.

- <c_mode> : The observing mode, which takes one of 2 possibilities: T or B where T = Total-power and B = Beam-switched mode

  NOTE: The observing mode can be changed by every VERB executing a continuum observation.

ADVERBS:

- LENGTH_GPT sets the scan-length <arm_length> for both directions of the cross in seconds of arc.

- TIME_GPT The duration <time_par_arm> of the one subscan with length <arm_length> in seconds.

- SUBSCAN selects the number of subscans for the pointing cross-scan (for both arms of the cross), where the highest even number is taken. If BY_2 is commanded, every two subscans (forth and back) the direction within the cross is changed (makes sense only if <n_total> is greater than 4). If the adverb /ORIENTATION is given with ONLY, <n_total> subscans are done in the <scanning dir> - coordinate only (no cross).

- ORIENTATION sets the scanning direction. If the parameter ONLY is set, the direction orthogonal to scanning dir will not be done. If ONLY is not present, <scanning dir> defines the starting scan direction (LAM, BET, AZM, ELV).

- NUMBER_GPT sets the number of points per arm.

6.7.5 ZFOCUS

OBST> ZFOCUS<c_mode> /DEFAULT
/NWAV_FCZ <#>
/TIME_FC <Time(s)>
/STEP_FC <no_of_steps>

ZFOCUS performs a series of on-source measurements where the axial focus displacement (FCZ) is stepped back and forth symmetrically about the hitherto best value. A parabola is fitted to the averaged values in order to determine the optimum focus. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <c_mode> is the continuum observing mode (this is transferred to C_MODE), where T = Total-power and B = Beam-switched.

ADVERBS:

- NWAV_FCZ Sets the number of wavelengths for focus travel during the measurement. <#> in [multiple wavelengths].
- TIME_FC Integration time in sec per ON-source measurement.
- STEP_FC Number of steps in each direction. If an even number is used, there will be no measurement at the best-guess value. A value of 3 measures at positions of –LENGTH/2, the best-guess position and +LENGTH/2, and back again.

EXAMPLES:

- **OBST**> ZFOCUS
  This will do a ZFOCUS using the default values.
- **OBST**> ZFOCUS /NWAV_FCZ 1 /TIM 15
  This will give 15 sec integration at -0.65 mm offset, 0 mm offset, +0.65 mm offset, +0.65 mm offset, 0 mm offset, and -0.65 mm offset for 230 GHz.

6.7.6 XFOCUS

OBST> XFOCUS<c_mode> /DEFAULT
/NWAV_FCX <#>
/TIME_FC <Time(s)>
/STEP_FC <no_of_steps>

XFOCUS performs a series of on-source measurements where the vertical focus displacement (FCX) is stepped back and forth symmetrically about the hitherto best value. A parabola is fitted to the averaged values in order to determine the optimum focus. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <c_mode> is the continuum observing mode (this is transferred to C_MODE), where T = Total-power and B = Beam-switched.

ADVERBS:

- NWAV_FCX Sets the number of wavelengths for focus travel during the measurement. <#> in [multiple wavelengths].
- TIME_FC Integration time in sec per ON-source measurement.
- STEP_FC Number of steps in each direction. If an even number is used, there will be no measurement at the best-guess value. A value of 3 measures at positions of –LENGTH/2, the best-guess position and +LENGTH/2, and back again.

EXAMPLES:

- **OBST**> XFOCUS
  This will do a XFOCUS using the default parameters.
- **OBST**> XFOCUS /NWAV_FCX 1 /TIM 15
  This will give 15 sec integration at -0.65 mm offset, 0 mm offset, +0.65 mm offset, +0.65 mm offset, 0 mm offset, and -0.65 mm offset for 230 GHz.

6.7.7 CORRECTIONS

OBST> CORRECTIONS <col*> <nule> <sfcz> <sfcx> /NULA

This VERB allows you to use the results of a calibration measurement to update the antenna correction constants. After a POINTING measurement, the pointing in azimuth and elevation can be improved via the results of Gaussian fits to the measurements. After a ZFOCUS or XFOCUS measurement, the precise symmetry of displacements along the axial-focus direction can be improved via the results of a parabolic fit.

All corrections are parameters of the command, the first parameter being the azimuth correction, the second being the elevation correction, the third being the zfocus correction, and the fourth being the xfocus correction.

For each parameter of CORRECTIONS, there are three possibilities:

a) * = no change in the relevant coordinate.

b) F = the result of the fit is to be the correction applied. The displacement computed from the fit is added to the pre-fit value, and thus applying a given correction several times without a new measurement will always result in the same corrected value.

c) Any number can be entered in units of arcsec (azimuth and elevation) or mm (focus). The appropriate correction will be set to that value.

ADVERB:

- NULA If this ADVERB is present, <az> is used to update the zero-point correction in azimuth. In the common case, with NULA absent, <az> is used to update the azimuth collimation (COL*).

  NOTE: If F is used for <az>, and NULA is present, the result of the fit is added to the pre-fit zero-point correction. Otherwise, the result is added to the pre-fit collimation correction (COL*).

EXAMPLES:

CORR F F	updates the azimuth, elevation corrections (NULE, COL*).
CORR * * –1.5	updates the zfocus to –1.5 mm.
CORR * F	uses the Gaussian-fit result to update the elevation pointing.
CORR –210/NULA	sets the zero correction in azimuth (NULA) to –210 arcsec.

NOTE: A transfer of the results of gaussian fits to longitude and latitude is only possible after POINTING with the ORIENTATION set to either azimuth or elevation. Repeated entries of CORR without new measurements will always yield the same corrections. If the fit was not successful, but the correction is requested, an error in the **SIC** command procedure occurs and has to be resolved by entering Q.

Results obtained from the command CROSS are not accepted, even though the procedure might set up identical scanning parameters.

WARNING: Unlike most commands, CORRECTIONS takes effect immediately. It should never be done during an observation.

6.7.8 DARK

OBST> DARK TIME_LM < *timeofdark* > /DEFAULT

DARK performs a dark integration of the specified time TIME_LM on all of the AOS that were specified with the AOS command. It sets all parameters and takes a DARK scan, and then resets the parameters back for a normal scan. The DARK is then stored, where subsequent observations recall it and use it for calibration purposes.

6.7.9 CALIBRATION

OBST> CALIBRATION <reflong> <reflat> <refsystem> /DEFAULT
/CALMODE <cal_mode>
/TIME_LM <Ton> <Toff>
/NOOFFSET
/TREC < T_{rec1}> [< T_{rec2}>]

CALIBRATION performs a spectral line calibration scan (SKY-HOT-COLD). The SKY-HOT loads are taken automatically. Currently, the observer must take the COLD manually. When the COLD is required, the observer should go upstairs and insert the COLD load. Then, he/she can press the CALIB button and the COLD load will be measured automatically.

The ONDIS window will display the calculated T_{cal}, T_{sys}, and T_{rec}. ONLINE CHEF is set up to display the passbands for SKY-HOT-COLD. (or SKY-HOT if you only do a SKY-HOT load, i.e. a TREC command). A COLD calibration is recommended after retuning and then every couple of hours to check the receiver temperature. In between, one can use the fully automatic Sky-Hot or TREC mode which uses the receiver temperature(s) previously determined with a COLD calibration (/TREC SAME [SAME]) or manually supplied values (/TREC <T_{rec1}> [<T_{rec2}>]). Almost always, the observer should choose /TREC SAME.

The staff currently recommends that cold/hot/sky loads be relatively short (say 5-15 seconds) since the cold load will warm up during the observation.

- <reflong> <reflat> <refsystem>: Specify the longitude, latitude, and coordinate system of the reference position (e.g. AZ for az/el, LAM for lam/bet, etc) used for the SKY observation.

ADVERBS:

- CALMODE : Sets the calibration mode (C = COLD, T=TREC)

- TIME_LM : Sets the amount of time spent on the different phases of the calibration scan.

- NOOFFSET: The field center is identical to the object selected by the SOURCE command, no offsets are applied. This has to be repeated each time the offsets should be suppressed.
- TREC: The observer can supply up to two T_{rec} for use with TREC CALMODE. If the observer wishes to use the last T_{rec} from a COLD calibration, then the observer can type SAME

EXAMPLES:

OBST> CALIBRATION 900 0 AZ /CAL COLD /TIME_LM 30 30

This will move to the offset position of 15' in azimuth and performs a calibration scan of 30 seconds for each phase of a SKY-HOT-COLD calibration (S-H-C).

OBST> CALIBRATION 600 0 AZ /CAL TREC /TIME_LM 5 5 /TREC SAME

This will move to the offset position of 10' in azimuth and performs a calibration scan of 5 seconds for each phase of a SKY-HOT (TREC) calibration (S-H). The T_{rec} will be kept the same as the result of the last COLD calibration.

6.7.10 SKYDIP

OBST> SKYDIP <azm_in_deg> /DEFAULT
/AIRMASS <amax> <amin>
/NUMBER_SKY <np>

SKYDIP will make calibration measurements of the atmosphere by measuring the total power at equally spaced airmasses, i.e. equal intervals of sec(zenith distance). The integration time is always 15 sec. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values. The default azimuth is the current antenna position.

If using a SIS receiver rather than a bolometer, the SKYDIP program has been modified to expect a hot load (done automatically) and a cold load (done manually) at the end of the SKYDIP. These are written as two additional subscans (done at two more airmasses-even though the airmass have no importance for the hot-sky/cold-sky subscans.) The two extra subscans are taken to help simplify the SKYDIP data reduction.

For a bolometer, only the requested number of airmasses are done.

- <azm_in_deg> Azimuth (in deg) at which the dip is to be made.

ADVERBS:

- AIRMASS This ADVERB has two parameters, these being the maximum and minimum airmasses for the measurement. Use values in the range 1.05 (EL $\approx 72°$) $\leq$ airmass $\leq$ 7.0 (EL $\approx 8°$).
- NUMBER_SKY Number of samples, starting at an airmass of amin, and finishing at amax, with constant steps in air mass.

EXAMPLES:

- **OBST**> SKYDIP

  Takes a SKYDIP at current azimuth (if possible due to sun) with current parameters. Note that typically, we do 6 airmasses starting at 1.05, ending at 3.0

- **OBST**> SKYDIP 235.25 /NUM 4/AIR 3 1.5

  This will measure at airmasses of 1.5 (EL $\approx$ 42), 2.0 (EL $\approx 30.0°$), 2.5 (EL $\approx 23.6°$) and 3 (EL $\approx 19.5°$) for 15 sec each for an azimuth of 235.25°.

Note: presently no automatic evaluation of a skydip measurement is implemented. See Chapter 2.8 for an example of how to reduce your skydip data currently.

6.8 Observational Procedures

In this section, we focus on the commands that acquire data. These commands include both continuum and spectral line observations, single positions and maps:

SOURCE	- Identify the Source
SET_DEFAULT OFFSETS	- set offsets for the ON position(s)
GO	- Go to source, set up everything for the scan. Just don't take data.

Single Observations:

CROSS	- back and forth cross scans-similar to POINTING
CONOFF	- Continuum observation with a reference OFF position.
CTRACK	- Continuum ON-source measurement
PSWITCH	- Position Switching for line observations
WSWITCH	- Beam switching for line observations
NOTE:	- Currently Frequency switching is not available

Maps and Rasters:

START	- Starts the actual observation for the last entered MAP or RASTER
CMAP	- Continuum Scanned Raster map
PRASTER	- Position switching point-raster line observation (one position at a time)
WRASTER	- Beam switching point-raster line observation (one position at a time)
CRASTER	- Continuum point-raster map observation
ST_ONLINE	- Use ONSINP but with on-line display of the accumulated data.

Observations are set up in **OBST** by using the SOURCE command to specify either the center, or the pole, of a spherical coordinate system. The astronomically-defined longitude is called LAM, and the latitude BET, in the SOUrce coordinate system, while the current HORizontal coordinates of an object are called AZM and ELV.

All observing procedures are specified relative to an object in either the SOU or HOR system. In the first of these, all relative angles are always treated as true angles (i.e longitudinal offsets are divided by the cosine of the related latitude) and given in arcsec.

All observing procedures (except the calibration procedures POINTING, ZFOCUS, XFOCUS and SKYDIP) are specified at a point relative to the object selected by the SOURCE command. This position is called the field center, even though it might be offset from the object selected by the SOURCE command. Either specific points are tracked for a given integration time, or the telescope is scanned in one coordinate for a given distance at a constant rate, (calculated from the travel time), and a raster of scans built up by incrementing the non-scanning coordinate.

Observations that need only the center position, and possibly one reference (or OFF) position are CTRACK, CONOFF for continuum observations and PSWITCH, LONOFF, and FSWITCH for spectral-line observations. For continuum cross scans through an object, the command CROSS is used. All these VERBS set up the relevant observing procedure, and initiate it.

The observing procedures that record data on more than one point, and possibly for a whole area around a source, are called RASTER for point-by-point integrations, and MAP when scanning at a constant rate in a defined scanning coordinate, updating the non-scanning coordinate to produce a scanned raster. CMAP and CRASTER set up such continuum observations, while PRASTER, and FRASTER are used to produce spectral-line raster maps.

The relative positions for all MAP and RASTER-like observations are all set up the same way, by giving a size and a resolution for longitude and latitude (VERB /MAPSIZE). In the case of the scanning coordinate of MAPs, the resolution is not used.

All RASTER and MAP commands set up the observing program, but do not start automatically. The command START has to be used to send the load command to the control program. In this way, the parameters for a long observing program can be inspected before the start, or a large map can be observed in sections, always with the same map definition, but starting at a later subscan. START always starts or repeats the last correct raster or map.

6.8.1 SOURCE

OBST> SOURCE <name> /DEFAULT
/CATALOG_C <cat_name>
/VELOCITY <vel> <frame>

From the catalog <cat_name>, this VERB selects information such as longitude and latitude, catalog epoch, and a velocity for spectral-line work for the source called <name>, The VELOCITY option can be used to overwrite the catalog information if a spectral line should be centered at a different velocity. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

Typing SOURCE resets any field center offsets to zero.

- <name> A source name is mandatory as it is used as the search key.

  NOTE: the first entry that matches the characters typed is extracted, (see section 6.5) Longitude, latitude and a position angle can be given in a variety of astronomical coordinate systems, and in general a standard epoch and catalog positions are used. When an object within the solar system is selected (the first three letters of its name are tested), the coordinate system is centered on that object, and its coordinates are (0,0). For more information see the OBSINP Manual.

ADVERBS:

- CATALOG_C <cat_name>

  If the option CATALOG_C is present, then the catalog with the name <cat_name> is used to find the source for just the present execution of the command SOURCE. At the next invocation of SOURCE, the default catalog is reverted to, or the option CATALOG_C has to be entered afresh (or recalled with the **SIC** edit arrows).

  Directories other than the current one have to be explicitly typed in if the catalog is in a different directory.

  EXAMPLE:

  OBST> SOURCE ALFORI/CATA SYS$SMT:[SMT.CAT]STAR

  This will extract the epoch (1950) coordinates for Betelgeuse.

- VELOCITY <km/sec or zred> <velocity_frame>

  The velocity extracted from the catalog (should the catalog contain any) will be overwritten by the value specified. If /VEL is not present, such overwriting will not occur.

  The first parameter is the numerical value of a velocity. Units of KM or M can be given, with the default being km/sec.

  The second parameter specifies the velocity frame. The first, or first two, characters are tested. If this parameter is missing, the default value is used. For this parameter,

H or VH = heliocentric,
B or VB = barycentric,
L or VL = LSR (i.e. with respect to the local standard of rest), and,
Z = redshift, implying that the first parameter is the numerical redshift.

EXAMPLES:

OBST> SET_DEFAULT VELOCITY * VBAR
OBST> SOURCE name/VEL 20 will yield V(barycentric) = 20 km/sec
OBST> SOURCE name/VEL 20 HEL will yield V(heliocentric) = 20 km/sec.

NOTE: If you require a source not contained in any source catalog, you should use the OBSINP commands (e.g. OBSINP SLAM ...). See the OBSINP manual for more information.

6.8.2 SET_DEFAULT OFFSETS - defining the Field center

OBST> SET_DEFAULT OFFSETS <off_lon> <off_lat> < ofc2> <off_sys>

The astronomical coordinate system and longitude and latitude of the object of interest is defined by the SOURCE command.

Any observation (except a calibration procedure) is shifted with SET_DEFAULT OFFSETS, either in the same coordinate system or in another. This command has to be entered before the observing command. The shift of the field center can be suppressed by adding /NOOFFSET to the observing command.

Typing the SOURCE command will reset the offsets to zero again.

- <off_lon> and <off_lat> are offsets in true angle in longitude and latitude with respect to the position selected by the SOURCE command. The basis system for the offset coordinates is defined by <off_sys>. The observation is centered around this field center.

- <ofcz> is an additional offset to the axial focus in mm.

- <off_sys>

  The coordinate system for the offsets can be specified either in the source coordinate system and epoch of the catalog (possibly rotated if a descriptive system is used), or in the horizontal system of AZ/EL. The first two characters of <off_sys> are tested to define the observing system, as follows,

  For (SO)urce, (BA)sis, (LA)mbda or (BE)ta, the OBSINP commands OLAM and OBET are used to calculate the offset position, while for (HO)rizontal, (AZ)imuth or (EL)evation, the OBSINP commands OAZM and OELV are used.

  EXAMPLE:

  OBST> SET OFFSETS 200 –400 0 LAM

  Typed prior to the observing commands, this will offset the field center by 200 arcsec/cos(BET) in LAM and by –400 arcsec in BET. No offset to the radial focus position will be applied.

OBST> <observing procedure> /NOOFFSET

For all observing procedures the switch NOOFFSET can be used to suppress the shifting of the field center from the position selected by the SOURCE command.

- without /NOOFFSET

  The field center is shifted from the object selected by the SOURCE command by the parameters as given in SET OFFSETS. This is the default.

- with /NOOFFSET

  The field center is identical to the object selected by the SOURCE command, no offsets are applied. This option has to be repeated every time the offsets should be suppressed.

EXAMPLE:

OBST> CROSS

Executes cross scans, with an offset of –200 arcsec/cos(latitude) in longitude and by 400 arcsec in latitude with respect to the object selected by the SOURCE command. No offset to the radial focus position will be applied.

OBST> CROSS/NOOFFSET

Executes cross scans through the object selected by the SOURCE command (like POINTING).

6.8.3 GO

OBST> GO

This simple command acts like an observation command (such as PSWITCH) by sending the telescope to the source, causing all observation critical parameters to be updates. However-it does not take a scan.

This is equivalent to typing an observation command, and then pressing the WAIT button, except that you do not have to cancel the command.

It allows the observer to adjust tunings on the receivers, verify parameters, and fun stuff like that without actually having to "waste" a scan.

6.8.4 CROSS

OBST> CROSS <c_mode> /DEFAULT
/LENGTH_PT <arcsec>
/TIME_PT <time(s)>
/SUB_PT <nsub_total> <by_2>
/ORIENTATION <direction (L, B, A, E)> <only>
/NOOFFSET

CROSS performs back-and-forth cross scans in latitude and longitude/cos(latitude) centered on the field center as selected by the choice of the offsets. It is very similar to the POINTING command, it uses the same adverbs. To determine the apparent center of the source, a Gaussian is fitted to the data after baseline removal. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

NOTE: No update of the pointing corrections through CORRECTIONS is possible if the procedure CROSS is used. You have to interpret the results of the fits yourself.

- <c_mode> is the continuum observing mode (this is transferred to C_MODE), where T = Total-power and B = Beam-switched.

ADVERBS:

- LENGTH_PT is the real-angle length of the arm(s) of the cross in arcsec. For point sources, 3 to 4 half power beamwidths is a good choice. As a rule of thumb at the SMTO, $25 \times \lambda_{cm}$ yields the HPBW in arcsec.

- TIME_PT is the scanning time in sec for an individual subscan along an arm.

  NOTE: If you check the set up in OBSINP, remember that the velocity is converted into angle/min.

- SUB_PT The first parameter, <nsub_total>, is the number of subscans in the observation.

  Unlike pointing there is the possibility to execute the arms only once. This allows quick searches. In this case the first parameter has to be 2 for a full cross and 1 for ORIENTATION * ONLY. If the parameter is larger, all subscans will scan in both positive and negative directions (to minimize the effects of time constants and hysteresis). In this case use multiples of 4 if both orientations are selected, otherwise 2. Remainders are truncated.

  If the second parameter, <by_2>, is BY_2 (only the B is tested for), the scanning coordinate is changed after each 2 subscans (one back and one forth). Otherwise, half of the subscans (<nsub_total> /2) are performed in the first coordinate of ORIENTATION, followed by the other half in the other coordinate (if <only> is not specified in ORIENTATION).

- ORIENTATION This ADVERB has 2 parameters. The first, <direction (L, B, A, E)>, determines the coordinate system, while the second, <only>, dictates which of the coordinates is to be used for the first subscan. Only the first character of <direction (L, B, A, E)> is tested, the following values being legal,

  E = Relative AZ/EL, starting with elevation
  A = Relative AZ/EL, starting with azimuth
  B = Scan in LAM/BET of the basis system, starting with latitude BET
  L = Scan in LAM/BET of the basis system, starting with longitude LAM.

  The first character of the second parameter is tested. If this is an O for ONLY, the subscans can be made in just the starting coordinate selected by <direction (L, B, A, E)>. In all other cases normal cross scans are executed.

- NOOFFSET By default the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.

EXAMPLE:
OBST> CROSS/LEN 200/TIM 30/ORI AZIM NO /SUB 12
This will first make 6 subscans of 200 arcsec at a rate of 400 arcsec/min in azimuth with OAZM * in effect, followed by 6 subscans in elevation with the same length and velocity.

6.8.5 CONOFF

OBST> CONOFF <ref_long> <ref_lat> <ref_system> <ref_orig> /DEFAULT
/TIME_CM <T_on> <T_off>
/SUBSCAN <n_repeats> <f: On_first>
/CMODE <c_mode>
/NOOFFSET

CONOFF will set up and start a continuum observation with a reference (OFF) position as specified by its own three parameters and for a given integration time on each position. The whole procedure can be repeated, and begun with an ON-source measurement. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <ref_long> <ref_lat> <ref_sys> <ref_orig>
  These 4 parameter set up the relative position for the reference measurement (the OFF). Values typed in the CONOFF command are current values, used for that observation. To set defaults use the SET_DEFAULT REF_POS command. For details see section 6.8.10

ADVERBS:

- TIME_CM <T_on> <T_off>

  Integration time in sec. These parameters can be different for ON-position measurements and OFF (reference) measurements. If only one parameter is given explicitly to the ADVERB, both parameters are set equal.

  <u>NOTE:</u> the observation does not finish exactly at the time given, but rather when the next complete backend cycle has been accumulated. For example, if the data transfer interval for the backend were set to 3 sec, a value of 35 sec in this ADVERB would cause an integration of 36 sec.

  EXAMPLE:

  Default 30 60

/TIME_CM 40 *	This yields 40 sec for the ON, and 60 sec for the OFF (REF). However,
/TIME_CM 40	yields 40 sec for both (Only one parameter is entered).

- SUBSCAN <n_repeats> <f: On_first>

  The ON-OFF cycle is repeated <n_repeats> times. If the second parameter starts with an F, the ON-OFF cycle will be started with the ON phase. Otherwise the OFF (reference) position will be measured first.

- CMODE <c_mode>

  <c_mode> selects the observing mode. There are two possibilities; T, B.

  T = Total-power, B = Beam-switched.

  <c_mode> can be set by other observing commands (e.g. POINTING B).

- NOOFFSET By default the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.

6.8.6 CTRACK

OBST> CTRACK <c_mode> /DEFAULT
/TIME_CM <sec>
/NOOFFSET

CTRACK executes just a continuum ON-source measurement in the selected continuum observing mode for TIME_CM sec. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <c_mode> This selects the observing mode. There are two possibilities; T, B.

  T = Total-power, B = Beam-switched.

  <c_mode> can be set by other observing commands (e.g. POINTING B).

ADVERB:

- TIME_CM Integration time in sec.

  <u>NOTE:</u> after expiration of the specified time, the next complete backend cycle finishes the observation.

- NOOFFSET By default the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.

6.8.7 PSWITCH

OBST> PSWITCH <ref_long> <ref_lat> <ref_sys> <ref_orig> /DEFAULT
/TIME_LM <T_on> <T_off>
/SUBSCAN <n_repeats> <f: On_first>
/NOOFFSET

PSWITCH will set up and start a position-switched line observation in total-power mode, with a reference (OFF) position as specified by the VERB's own three parameters, and for a given integration time on each position. The whole procedure can be repeated, and begun with an ON- or an OFF-source measurement. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <ref_long> <ref_lat> <ref_sys> <ref_orig>
  These 4 parameter set up the relative position for the reference measurement (the OFF). Values typed in the PSWITCH command are current values, used for that observation. To set defaults use the SET_DEFAULT REF_POS command. For details see section 6.8.10

ADVERBS:

- TIME_LM <T_on> <T_off>

  Integration time in sec. These parameters can be different for ON-position measurements and OFF (reference) measurements. If only one parameter is given explicitly to the ADVERB, both parameters are set equal.

  NOTE: the observation does not finish exactly at the time given, but rather when the next complete backend cycle has been accumulated. For example, if the data transfer interval for the AOS were set to 30 sec, a value of 35 sec in this ADVERB would cause an integration of 60 sec.

  EXAMPLE:

  Default 30 60

  /TIME_LM 40 * yields a 40-sec ON, and a 60-sec OFF (REF), while,
  /TIME_LM 40 yields 40 sec for both ON and OFF.

- SUBSCAN <n_repeats> <f: On_first>

  The ON-OFF cycle is repeated <n_repeats> times. If the second parameter starts with an F, an ON-OFF cycle will be started with the ON phase first. Otherwise the OFF (reference) position will be measured first.

- NOOFFSET By default the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.

6.8.8 WSWITCH

OBST> WSWITCH<reflong> /DEFAULT
/TIME_LM <Ton> <Toff>
/WFRQ <wobble frequency>
/SUBSCAN <nrepeats> <f:on first>

WSWITCH performs a beam switching for line observations. The parameters describe the beam throw.

- <reflong> Position offset in true angles in longitude for the reference position. Unit is arcseconds.

ADVERBS:

- TIME_LM Integration time in seconds. The integration time for the "on" position and the reference position may be set differently. If <Ton> is given ony, then OBST assumes that <Ton>=<Tref>.
- WFRQ The wobble frequency-this must be set correctly since the AOS command sets up several parameters based on this. Currently, the wobble frequency must be determined manually.
- SUBSCAN The REF/ON cycle is repeated <nrepeat> times. If the second parameter stats with an "F" the "On" position will be measured first.

EXAMPLE:

WSWITCH -120 /sub 5 : This yields a beam switched observation for a wobble command of "wob /w_p -60 60" and will take 5 pairs of data.

6.8.9 RASTERS and MAPS (General)

Currently, observations of a complete area around the field center can be executed as either a point raster or as a scanned raster (or map). In the first case, individual points of the area are tracked for the specified integration time. In the second case, one coordinate is scanned along at a constant rate, the other being kept constant for each subscan, but incremented between subscans.

All point-raster observations are called RASTERs in this version of **OBST**. Observations of scanned rasters are called MAPs.

The size of a MAP or a RASTER is specified by the same option called MAPSIZE. MAPSIZE has 5 parameters:

- /MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>

  <lon> gives the length (in arcsec) of the coverage in the longitudinal coordinate. The longitude coverage will be between ±0.5×lon, always in true angle, i.e the <lon> value is divided by cos(latitude).

  <res_lon> is the resolution in longitude in arcsec (this is not used for scanned rasters). However, NEVER set this value to 0. In a RASTER, or if longitude will be the fixed coordinate, <res_lon> will set the step size.

  <lat> and <res_lat> determine the size and resolution (increment) in latitude. These should always be given in arcsec along a great circle.

  <obs_sys> determines the first coordinate to be updated in a point raster, or the coordinate that will be scanned along, as follows,

  LAM will step or scan along the source longitude,
  BET will step or scan along the source latitude,
  AZM will step or scan along azimuth, and,
  ELV will step or scan along elevation.

  EXAMPLES for RASTERs:

  /MAPSIZE 1000 100 800 90 LAM

  This will observe a region from –500 to +500 arcsec in 11 steps along the source longitude and then change the relative source latitude. The latitude range starts from –400 arcsec and will go in 10 step to +400 arcsec. Since 9 increments of 90 arcsec would exceed the 800 arcsec size in latitude, the interval is changed to 88.88 arcsec. One can look at the values to be used by SHOW MAPSIZE, where the current values stored are those used for the observation. If MAPSIZE is used in a MAP command, the velocity is calculated from the given distance in that coordinate, divided by the time given in the /TIME option. In the above case, it would divide 1000 by the time in sec. If just one line of a raster or map is to be observed, then the distance in the orthogonal coordinate should be set to 0.

A MAP or RASTER can be shifted with SET_DEFAULT OFFSETS, either in the same coordinate system or in another. (See section 6.8.2)

All MAP and RASTER observations are only set up by the VERBs, but have to be started with a START command.

6.8.10 References (OFF)

Reference position

For ON–OFF measurements (CONOFF, CRASTER, PSWITCH, PRASTER), the reference position (OFF) relative to the ON position is specified by offsets in longitude/cos(latitude) and latitude. Furthermore the coordinate system in which the offsets should be applied and which ON position should be used has to be specified. These four parameters define the reference position:

- <ref_long> <ref_lat> (in arcseconds) The measurement on the reference position will be taken at a position offset in true angle in longitude (i.e. longitude/cos(latitude)) (parameter 1) and latitude (parameter 2). Units are always arcsec. For parameters not specified, the default values will be used.

- <ref_sys> (2 characters are tested)

  The reference system can be specified either in the source coordinate system and epoch of the catalog (possibly rotated if a descriptive system is used), or in the horizontal system of AZ/EL. Fixed celestial offsets would be preferred in congested areas, horizontal offsets if the airmass should remain constant from ON to OFF (or in beam-switched mode). The first two characters of <ref_sys> are tested to define the observing system, as follows,

  For (SO)urce, (BA)sis, (LA)mbda or (BE)ta, the OBSINP commands RLAM and RBET are used to define the reference position, while for (HO)rizontal, (AZ)imuth or (EL)evation, the OBSINP commands RAZM and RELV are used.

- <ref_origin> (1 character, tested for O)

O	: The reference OFF is relative to the position selected by the SOURCE command. NOTE: The focus offsets of SET_DEFAULT OFFSETS are applied.
else	: The reference OFF is relative to the current ON position of the map or raster, i.e the next ON (<on first = NO>) or previous ON (<on first = FIRST>)

EXAMPLE **OBST**> PSWITCH 200 –30 BAS ORIGIN

will yield a reference position of 200/cos(BET) arcsec in LAM and –30 arcsec in BET relative to the position defined by the SOURCE command

OBST> PSWITCH * * HOR NO

will use the default longitude and latitude offsets, and add them to the azimuth and elevation of the field center (OFFSETS included), which is the only ON position in a PSWITCH observation.

In order to transfer these parameters to all relevant verbs with one command, we have defined a special adverb, REF_POS.

SET_DEFAULT REF_POS <ref_long> <ref_lat> <ref_sys> <ref_orig>

The SET REF_POS command sets the default values for all relevant procedures, current values used in a command will overwrite the default values for the one execution of the observing command.

EXAMPLES:
OBST> SET_DEFAULT REF_POS 200 -20 LAM ORIGIN

will select an OFF position shifted by 200"/cos(latitude) and -20" of the origin as defined by the source longitude and latitude.

OBST> PRASTER

will set up the observation with this reference position.

OBST> PRASTER * * * NO

will set up the observation with a reference relative to the raster position.

OBST> PRASTER

will set up the observation with the default selection again (relative to the position as defined by the SOURCE command).

6.8.11 START

OBST> START <nsub_start>

This VERB starts the actual observation of the last successfully entered MAP or RASTER VERB, i.e a VERB that has produced no error in OBSINP when its command procedure was interpreted. If START is executed after SET_DEFAULT commands or calibration procedures, the last correctly entered MAP or RASTER VERB is reexecuted automatically using the newly set default values and repeating the current value in the MAP or RASTER VERB.

- <nsub_start> Using this option, you can repeat part of the map, starting at a later subscan.

  NOTE: Reference measurements count as subscans too.

6.8.12 CMAP

OBST> CMAP <c_mode> /DEFAULT
/TIME_CM <time>
/MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>
/SUB_CM <n_sub> <alt>
/NOOFFSET

This VERB will set up a continuum scanned-raster map according to the rules of MAPSIZE, in the continuum observing mode <c_mode>. The observation has to be started with a START command. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <c_mode> selects the observing mode. There are four possibilities; T, B, L, C.

  T = Total-power, B = Beam-switched, L = Load-switched, C = Correlation Mode.

  <c_mode> can be set by other observing commands (e.g. POINTING).

ADVERBS:

- SUB_CM This sets the number of repeats of a raster line before incrementing the orthogonal coordinate. If the second parameter is ALT, the scanning coordinate will reverse from one subscan to the next (independent of n_sub).
- NOOFFSET By default the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.
- MAPSIZE , see Section 6.8.9.
- TIME_CM, see Section 6.8.10.

6.8.13 CRASTER

```
OBST> CRASTER <ref_long> <ref_lat> <ref_sys> <ref_orig>     /DEFAULT
              /MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>
              /TIME_CM < T_on> <T_off>
              /ON_OFFS <n_ons_per_off> <f: On_first>
              /CMODE <c_mode>
              /REFERENCE
              /NOOFFSET
```

This VERB will set up a continuum point-raster map in the continuum-observing mode <c_mode>. The observation has to be started with a START command. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

- <ref_long> <ref_lat> <ref_sys> <ref_orig>
  These 4 parameter set up the relative position for the reference measurement (the OFF). Values typed in the CRASTER command are current values, used for that observation. To set defaults use the SET_DEFAULT REF_POS command. For details see section 6.8.10

  NOTE: If /REFERENCE is not specified, no measurement of a reference position will be made.

ADVERBS:

- MAPSIZE - see Section 6.8.9

- TIME_CM <T_on> <T_off>

  Integration time in sec. These parameters can be different for ON-position measurements and OFF (reference) measurements. If only the first parameter is given in the input line, the reference time is calculated to be <T_on> ×SQRT(<n_ons_per_off>).

  NOTE: the observation does not finish exactly at the time given, but rather when the next complete backend cycle has been accumulated. For example, if the data transfer interval for the backend were set to 3 sec, a value of 35 sec in this ADVERB would cause an integration of 36 sec.

  EXAMPLE:

  Default TIME_CM 30 60
  Default ON_OFFS 3

/TIME 40 *	yields a 40-sec ON, and a 60-sec OFF (REF),
/TIME 40	yields a 40-sec ON, and a 69-sec OFF,
/TIME *	yields a 30-sec ON, and a 52-sec OFF.

- ON_OFFS <n_ons_per_off> <f: On_first>

  The ON-REF cycle contains <n_ons_per_off>. If the second parameter starts with an F, an ON-REF cycle will be started with the ON phase first. Otherwise the REF (OFF) position will be measured first.

- CMODE <c_mode>

  <c_mode> selects the observing mode. There are four possibilities; T, B, L, C.

  T = Total-power, B = Beam-switched, L = Load-switched. C= Correlation.

  <c_mode> can be set by other observing commands (e.g. POINTING B).

- REFERENCE Defines whether a reference position will be observed.

- NOOFFSET By default the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.

6.8.14 PRASTER

OBST> PRASTER <ref_long> <ref_lat> <ref_sys> <ref_orig> /DEFAULT
/TIME_LM <T_on> <T_off>
/ON_OFFS <n_ons_per_off> <f: On_first>
/MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>
/NOOFFSET

PRASTER will set up for a point-raster line observation in total-power mode, with a reference position specified by its own three parameters, and given integration times for ON and REF (OFF) positions. The whole procedure can be begun with an ON-source measurement first. The observation has to be started with a START command. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

PRASTER will produce a spectral-line point-raster map according to the rules of MAPSIZE, in the total-power REF-ON observing mode.

- <ref_long> <ref_lat> <ref_sys> <ref_orig>
  These 4 parameter set up the relative position for the reference measurement (the OFF). Values typed in the PRASTER command are current values, used for that observation. To set defaults use the SET_DEFAULT REF_POS command. For details see section 6.8.10

ADVERBS:

- TIME_LM <T_on> <T_off>

  Integration time in sec. These parameters can be different for ON-position measurements and OFF (REF) measurements. If only the first parameter is given in the input line, the reference time is calculated to be <T_on> ×SQRT(<n_ons_per_off>).

  NOTE: the observation does not finish exactly at the time given, but rather when the next complete backend cycle has been accumulated. For example, if the data transfer interval for the AOS were set to 30 sec, a value of 35 sec in this ADVERB would cause an integration of 60 sec.

  EXAMPLE:

  Default TIME_LM 30 60
  Default ON_OFFS 3

/TIME 40 *	yields a 40-sec ON, and a 60-sec OFF (REF),
/TIME 40	yields a 40-sec ON, and a 69-sec OFF,
/TIME *	yields a 30-sec ON, and a 52-sec OFF.

- ON_OFFS <n_ons_per_off> <f: On_first>

  The ON-REF cycle contains <n_ons_per_off>. If the second parameter starts with an F, an ON-REF cycle will be started with the ON phase first. Otherwise the REF (OFF) position will be measured first.

- NOOFFSET By default the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.

- MAPSIZE, see Section 6.8.9

6.8.15 WRASTER

OBST> WRASTER<ref_long> /DEFAULT
/TIME_LM <T_on> <T_off>
/WFRQ <wobble frequency>
/SUBSCAN <n repeats> <f: ON First>
/MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>
/NOOFFSET

Beam switching for line observations. The parameters describe the total beam throw. The whole procedure can be begun with an ON-source measurement first. The observation has to be started with a START command. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters into the default values.

WRASTER will produce a spectral-line point-raster map according to the rules of MAPSIZE.

The WOBBLE command must have been executed prior to this. (example: WOB /W_POS -60 120)

- <ref_long>
  Sets up the total beam throw. Values typed in the PRASTER command are current values, used for that observation.

ADVERBS:

- MAPSIZE - see Section 6.8.9
- TIME_LM <T_on> <T_off>

  Integration time in sec. These parameters can be different for ON-position measurements and OFF (REF) measurements. If only the first parameter is given in the input line, the reference time is calculated to be <T_on> ×SQRT(<n_ons_per_off>).

  NOTE: the observation does not finish exactly at the time given, but rather when the next complete backend cycle has been accumulated. For example, if the data transfer interval for the AOS were set to 30 sec, a value of 35 sec in this ADVERB would cause an integration of 60 sec.

  EXAMPLE:

  Default TIME_LM 30 60
  Default ON_OFFS 3

/TIME 40 *	yields a 40-sec ON, and a 60-sec OFF (REF),
/TIME 40	yields a 40-sec ON, and a 69-sec OFF,
/TIME *	yields a 30-sec ON, and a 52-sec OFF.

- /WFRQ <wobble frequency>

  Wobble Frequency.

- /SUBSCAN <number of repeats> <f: On_first>

  Number of subscans. If the second parameter starts with an F, an ON-OFF cycle will be started with the ON phase first. Otherwise the REF position will be measured first.

- NOOFFSET By default the field center is offset by the parameters of SET OFFSETS. If /NOOFFSET is part of the observing command, the field center is the unshifted object selected by the SOURCE command.

6.8.16 ST_ONLINE

OBST> ST_ONLINE <obs_proc> <nsub_start> /DEFAULT

- <obs_proc> <nsub_start> To permit you to use regular OBSINP command procedures from **OBST**, but with the on-line display of the accumulated data (which is achieved through **OBST**), the command ST_ONLINE will start the observation and treat the on-line display as if the observation had been set up by **OBST**. To achieve this, exit from OBSINP by QUIT and enter for the parameter <obs_proc> whichever of the **OBST** observing procedures comes closest to your observation. Thus, for any continuum map enter CMAP; for a continuum point raster enter CRASTER; for scans through a source enter POINTING; etc. As with the command START, you can begin at a later subscan in your procedure using <nsub_start>. If parameters are entered as current values, they remain active until the verb is entered again, unless the /DEFAULT adverb is used to transfer the parameters (the procedure and possibly the starting number of subscans) into the default values.

EXAMPLE:
OBST> OBSINP READ MYFILE.OBS
Reads your OBSINP command file MYFILE.OBS to set up a measurement, which we will suppose to be a continuum map.
OBST> ST_ONLINE CMAP
Starts the map from within **OBST** and informs the data-processing program that the observational procedure is a continuum map.

6.9 List of all VERBS and associated ADVERBS

6.9.1 SET-UP VERBS

The most critical commands are:

RX <receiver name> [<receiver name>] /DEFAULT
/OBS_MODE <mode>
/PT_MODE <receiver name>
LINE <name> <frq> [<unit>] <band> /DEFAULT
/CATALOG_L <catalog_name>
/MODE <obsmode>
BE_FE <backend_id> <frontend> [<frontend>] /DEFAULT
BACKEND <backend> [<backend> <backend>...] /DEFAULT
AOS <backend_id> - Defunct, replaced by BACKEND command.

If you have to do further modifications of key setup parameters:

DRUMBEAT /DEFAULT
/CHANNELS_C <no_of>
/PREINTEG_C <intcycles> <cycles/DAP>
/BANDWIDTH_C <?>
WOBBLE <Y(enable)/N(disable)>/DEFAULT
/W_POS <position_1> <position_2> ...
/W_NUM <Number of wobbler positions>
/W_BEAM <beam position 1> <beam position 2>
C_MODE <c_mode> /DEFAULT
/BACKEND_C <backend_id>
/PHASES_C <nr_of_phases>
/RECEIVER_C <rx_no>
/CYCLETIME_C <t> <blank>
/FREQUENCY_C <GHz> <side>
/SWITCHES_C <static1> <static2> <switch_no_for_CAL>
L_MODE <l_mode> /DEFAULT
/BACKEND_L <backend_id>
/PHASES_L <number>
/RECEIVER_L <rx_no>
/CYCLETIME_LM <t> <blank>
/FREQUENCY_L <SCF> <side>
/SWITCHES_L <static1> <static2> <switch_no_of_CAL> <NB>
FESET
/HARM <harmonic value>
/MULT <Gunn multiplier value>
/IF <IF frequency>

6.9.2 CALIBRATION PROCEDURES

POINTING <c_mode> /DEFAULT
/LENGTH_PT <arcsec>
/TIME_PT <time(s)>
/SUB_PT <nsub_total> <by_2>
/ORIENTATION <direction(L, B, A, E)> <only>
LPOINT <ref_long> <ref_lat> <ref_system> <ref_origin> /DEFAULT
/LENGTH_PT <arcsec>
/TIME_LPT <T$_{on}$time(s)> <T$_{off}$time(s)>
/ON_OFFS <n on per offs> <f:on first>
/NUMBER_LPT <number of points along an arm>
/SUB_LPT <number of total repeats> <by_2>
/ORIENTATION <direction (L, B, A, E)> <only>
LWPOINT <ref_long> /DEFAULT
/LENGTH_LPT <arcsec>
/TIME_LWPT <Time per point (in seconds)
/NUMBER_LWPT <number of points along an arm>
/SUB_LWPT <number of total repeats> <by_2>
/NOOFFSET
/ORIENTATION <direction (L, B, A, E)> <only>
GPOINT <c_mode> /DEFAULT
/LENGTH_GPT <arm_length> /TIME_GPT <time per arm>
/SUBSCAN <ntotal> [BY 2] /ORIENTATION <scanning dir> [ONLY]
/NUMBER_GPT < number of points per arm >
ZFOCUS <c_mode> /DEFAULT
/NWAV_FCZ <#>
/TIME_FC <Time(s)>
/STEP_FC <number_of_step>
XFOCUS <c_mode> /DEFAULT
/NWAV_FCX <#>
/TIME_FC <Time(s)>
/STEP_FC <number_of_step>
SKYDIP <azm_in_deg> /DEFAULT
/AIRMASS <amax, amin>/NUMBER_SKY <np>
CORRECTIONS <az> <nule> <sfc2> /DEFAULT
/NULA
DARK </TIME_LM integration time>/DEFAULT
CALIBRATION <reflong> <reflat> <refsystem>
/CALMODE <calibration mode>
/TIME_LM <Time on> <Time off>

6.9.3 OBSERVATION PROCEDURES

SOURCE <name> /DEFAULT
    /CATALOG_C <cat_name>/VELOCITY <vel> <frame>
SET_DEFAULT OFFSETS <off_lon> <off_lat> <ofc2> <off_sys>
GO
CROSS <c_mode> /DEFAULT
    /LENGTH_PT <arcsec> /TIME_PT <time(s)>
SUB_PT <nsub_total> <by_2>
    /ORIENTATION <direction(L, B, A, E)> <only>
    /NOOFFSET
CONOFF <ref_long> <ref_lat> <ref_sys> <ref_orig> /DEFAULT
    /TIME_CM <T_on> <T_off>
    /CMODE <obs_mode>
    /SUBSCAN <n_repeats> <f: On_first>
    /NOOFFSET
CTRACK <obs_mode> /DEFAULT
    /TIME_CM <sec>
    /NOOFFSET
PSWITCH <ref_long> <ref_lat> <ref_sys> <ref_orig> /DEFAULT
    /TIME_LM <T_on> <T_off>
    /SUBSCAN <n_repeats> <f: On_first>
    /NOOFFSET
WSWITCH <reflong> /DEFAULT
    /TIME_LM <T_on> <T_off>
    /WFRQ <wobble frequency>
    /SUBSCAN <n_repeats> <f: On_first>

6.9.4 MAPPING: OFFSETS and START

START <nsub_start>

CMAP <c_mode> /DEFAULT
- /TIME_CM <time>
- /MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>
- /SUB_CM <n_sub> <alt>
- /NOOFFSET

CRASTER <ref_long> <ref_lat> <ref_sys> <ref_orig> /DEFAULT
- /TIME_CM <T_on> <T_off>
- /ON_OFFS <n_ons_per_off> <f: On_first>
- /CMODE <c_mode>
- /MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>
- /REFERENCE
- /NOOFFSET

PRASTER <ref_long> <ref_lat> <ref_sys> <ref_orig> /DEFAULT
- /TIME_LM <T_on> <T_off>
- /ON_OFFS <n_ons_per_off> <f: On_first>
- /MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>
- /NOOFFSET

WRASTER <ref_long> /DEFAULT
- /TIME_LM <T_on> <T_off>
- /WFRQ <wobble frequency>
- /SUBSCAN <nrepeats> < f:On First>
- /MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys>
- /NOOFFSET

ST_ONLINE <obs_procedure> <n_sub> /DEFAULT

6.9.5 AUXILIARY VERBS

CANCEL [S]
KILL
SAVE <filename> /SYMBOLSONLY
RESTORE <filename> (= @<filename> followed by @TEL$OBS:RESTORE)
SHOW_CURR <VERB or ADVERB name>
STANDARD <VERB or ADVERB name>
OBSINP [<command>] Enter OBSINP [or send command]
REFRESH [C]
WAIT
SENDOBS
SET_DEFAULT <VERB or ADVERB name>
SET_DEFAULT **OBSERVER** <observer_name> <project_ID>
SET_DEFAULT **WEATHER** <temp> <press> <humidity>
SET_DEFAULT **REF_POS** <ref_long> <ref_lat> <ref_sys> <ref_orig>

6.10 List of SIC commands:

@<file>	execute a command macro <file>
BREAK	terminates loop execution
CONTINUE	Resumes macro or loop execution
DCL	Executes VAX VMS command
DEFINE type	Defines **SIC** variables of type
DELETE	Deletes Variables or symbols
EDIT	Edit stack
EDIT <file>	Edit <file>
ELSE	Part of IF THEN ELSE ENDIF conditional structure
ENDIF	Part of IF THEN ELSE ENDIF conditional structure
EXAMINE	list of all variables
EXAMINE <var>	content of the variable <var> is displayed
EXIT	Exits from program
FOR	FOR - NEXT loop
HELP	
IF	start conditional structure
LET	assigns a value to a (defined) variable
NEXT	end of a FOR loop
ON ERROR	changes the error recovery
PAUSE	Break point in a loop or macro
QUIT	aborts an execution
RECALL	recalls a line from the stack
RETURN	terminates procedure execution
SAY “text”	Output a text or ’<var>
SYMBOL	defines, list and delete symbols
TYPE	lists the stack
TYPE <file>	lists the <file>

By Dirk Muders