Chapter 1

OBST: Telescope Control/Observing Program

1.1 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, and three acousto-optical spectrometers. 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. On-line 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.

1.2 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.

1.3 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' (passwd: suckphoton). 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.

1.3.1 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>

1.3.2 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**. 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.

NOTE: Parameters entered directly into **OBSINP** can neither be SAVED or RESTORED.

1.3.3 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.)

1.3.4 Exiting OBST

OBST> exit

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

1.4 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).

1.4.1 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

1.4.2 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 at the console desk.

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.

1.4.3 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.

1.4.4 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 AOS. 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.

EXAMPLES :

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 or AOS, or use the verbs C_MODE, L_MODE, DRUMBEAT or AOS 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 0.8.10. 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 0.8.10. 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.

1.4.5 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.

1.4.6 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 their 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.

The Appendix contains a full list of VERBS and their related ADVERBS.

In the index a reference to commands is entered in capital letters, a reference to general definitions is entered in regular letters.

1.5 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.

1.5.1 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.

A sample catalog may be found in SYS$SMT:[SMT.CAT]SMTCONT.CAT.

An example of the format for the catalog is:

h

Table 1.1: 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.

```
*
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.
```

Where the 'SBAS 1' indicates that the slam (source lambda) and sbet (source beta) coordinates are RA and DEC for epoch 1950.0. Information after the exclaimation point is a comment.

The available basis systems are:

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. **NEED TO ADD STATEMENT HOW TO MODIFY EPOCH**. 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.

Due to the 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.

1.5.2 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.

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

Rules for the line catalog:

a) 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.

b) 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>.

c) THz, GHz (default), MHz and kHz are recognized after the frequency, as are USB and LSB and the combination FIX. The sequence is irrelevant.

d) The rest of the line can be used for comments. These should be preceded by an exclamation mark (!).

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
```

1.5.3 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.

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

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

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.

1.5.4 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.

1.6 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 set up is automatically selected by the VERB that initiates an observation or calibration measurement.

1.6.1 RX

OBST> RX /R_NAME
/OBS_MODE

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.

ADVERBS:

- R_NAME The receiver name. 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. 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. The 1.3 mm channel of the 4-color (4 channel) bolometer is B130C4

  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.

- OBS_MODE The observing mode. Either "C" for continuum or "L" for spectral line.

1.6.2 C_MODE

OBST> C_MODE <c_l>

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

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 can be used.
- 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 Frontend number to be connected. Currently frontend 1 is initialized by the operator and is selected automatically.
- CYCLETIME_C 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. Typical values are 16 40. *NOT IMPLEMENTED*
- 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.

1.6.3 DRUMBEAT

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

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 The 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, and 'W' for the wobbling secondary. The specifics of the wobbling secondary are setup with the "WOBBLE" verb.

- BOLOGAIN The 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.

EXAMPLE :

OBST> DRUMBEAT /SEL_CHOPPER W /BOLOGAIN 5

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

- BANDWIDTH_C Not yet implemented.

1.6.4 WOBBLE

OBST> WOBBLE<Y(enable) or N(disable)>
/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 170" offset in each direction (+/- azimuth).
  W_BEAM NEEDS TO BE REFINED!

- 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.

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. Be careful up there!

1.6.5 L_MODE

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

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

  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.
- 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*
- 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.

1.6.6 AOS

OBST> AOS <backend_id> /DEFAULT

Connects the specified backend with the frontend (defined by the command L_mode. 1, 2 or 3 AOSs 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 **??**.

Example: AOS 3 4

This will enable AOSs 3 and 4 for data taking.

1.6.7 LINE

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

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.

- MODE determines where the frequency input should go.

  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.

1.6.8 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 even do so 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 room PC) fail to accept the commands, FEORGA may abort the observation. To prevent this, turn off the FE button on the control desk.

1.7 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.

1.7.1 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.

1.7.2 GPOINT

OBST> GPOINT <c_mode>
/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.

1.7.3 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.

EXAMPLE:
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.

1.7.4 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.

EXAMPLE:
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.

1.7.5 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.

- <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.

EXAMPLE:
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.

1.7.6 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, and the third being the focus 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:

OBST> CORR * * –1.5	updates the zfocus to –1.5 mm.
OBST> CORR * F	uses the Gaussian-fit result to update the elevation pointing.
OBST> 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.

1.7.7 DARK

OBST> DARK TIME_LM < *timeofdark* >

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.

1.7.8 CALIBRATION

OBST> CALIBRATION <reflong> <reflat> <refsystem>
/CALMODE <_mode>
/TIME_LM <Ton> <Toff>

CALIBRATION performs a spectral line calibration scan (SKY-HOT-COLD). Currently, it requires the use of the WAIT button to separate the different phases.

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

EXAMPLE:

OBST> CALIBRATION 600 0 AZ /CALMODE C /TIME_LM 5 5

This will move to the offset position of 10' in azimuth and performs a calibration scan of 5 seconds for each phase of a cold calibration (S-H-C). Currently, the WAIT button must be pressed to halt between steps of the calibration.

1.8 Observational Procedures

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.

1.8.1 Field center

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.

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

- <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).

1.8.2 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.

- <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 0.5) 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.

  EXAMPLE:

  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.

1.8.3 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.

1.8.4 PSWITCH (or LONOFF)

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 0.8.10

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.

1.8.5 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.

1.8.6 FSWITCH *NOT IMPLEMENTED*

OBST> FSWITCH <delta_f> <switch_mode> /DEFAULT
/TIME_LM <sec> /NOOFFSET

FSWITCH executes an ON-source line observation in frequency-switched 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. Note: NOT CURRENTLY IMPLEMENTED.

- <delta_f> <switch_mode>
  These two parameter set up the frequencies for signal and reference measurements. Values entered with FSWITCH are current values, which override the defaults for that observation. To set defaults use the SET_DEFAULT REF_FRQ command. For details see Chapter 0.8.10

ADVERB:

- TIME_LM This defines the integration time for the measurement in sec.

  NOTE: After expiration of the integration time, the observation will stop when the next full backend cycle is complete.

- 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.

1.8.7 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 0.8.10

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.

  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 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.

1.8.8 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.

  NOTE: 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.

1.8.9 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 $\pm 0.5 \times$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 0.8.1)

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

1.8.10 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).

1.8.11 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.

  T = Total-power, B = Beam-switched, L = Load-switched. Load-switched mode is not implemented yet.

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

ADVERBS:
(For those of MAPSIZE and TIME_CM, see Sections 0.8.9 and 0.8.10 respectively)

- 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.

1.8.12 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 0.8.10

ADVERBS:
(For details of MAPSIZE see Section 0.8.9)

- 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.

- 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.

1.8.13 WRASTER

OBST> PRASTER <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:
(For details of MAPSIZE see Section 0.8.9)

- 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.

1.8.14 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 0.8.10

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

ADVERBS:
(For details of MAPSIZE see Section 0.8.9)

- 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,

  T = Total-power, B = Beam-switched, L = Load-switched. Load-switched mode is not implemented yet.

  <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.

1.8.15 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.

1.8.16 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.

1.9 List of all VERBS and associated ADVERBS

1.9.1 SET-UP VERBS

RX /R_NAME
/OBS_MODE
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>
DRUMBEAT /DEFAULT
/CHANNELS_C <no_of> /PREINTEG_C <intcycles> <cycles/DAP>
/BANDWIDTH_C <?>
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>
AOS <backend_id>
LINE <name> <frq> [<unit>] <band> /DEFAULT
/CATALOG_L <catalog_name> /MODE <obsmode>
WOBBLE <Y(enable)/N(disable)>
/W_POS <position_1> <position_2> ...
/W_NUM <Number of wobbler positions>
/W_BEAM <beam position 1> <beam position 2>
FESET /HARM <harmonic value>
/MULT <Gunn multiplier value>
/IF <IF frequency>

1.9.2 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>
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>
/NULA

DARK </TIME_LM integration time>
CALIBRATION <reflong> <reflat> <refsystem>
/CALMODE <calibration mode>
/TIME_LM <Time on> <Time off>

1.9.3 OBSERVATION PROCEDURES

SET_DEFAULT OFFSETS <off_lon> <off_lat> <ofc2> <off_sys>
SOURCE <name> /DEFAULT
/CATALOG_C <cat_name>/VELOCITY <vel> <frame>
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>
FSWITCH <delta_f> <switch_mode> /DEFAULT
/TIME_LM <sec> /NOOFFSET *NOT IMPLEMENTED*

1.9.4 MAPPING: OFFSETS and START

START <nsub_start>
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
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

FRASTER <delta_f> <switch_mode> /DEFAULT
/MAPSIZE <lon> <res_lon> <lat> <res_lat> <obs_sys> /TIME_LM <sec>
/NOOFFSET
ST_ONLINE <obs_procedure> <n_sub> /DEFAULT

1.9.5 AUXILIARY VERBS

CANCEL [S]
KILL
SAVE <filename> /SYMBOLSONLY
RESTORE <filename> (= @<filename>)
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>
SET_DEFAULT **REF_FRQ** <delta_f> <switch_mode> *NOT IMPLEMENTED*

1.10 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>