CLIC
Continuum and Line Interferometer Calibration

R. Lucas[1] and F. Gueth[1]

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(1) Institut de Radio Astronomie Millimétrique
300 Rue de la Piscine
F-38406 Saint Martin d'Hères

Warning: The on–line help (cf. section 8) is now up–to–date. We still need to update sections 1 to 7.

This document describes the calibration software for the IRAM Plateau de Bure Interferometer.

Related information is available in:

- IRAM Plateau de Bure Interferometer: Users Guide
- IRAM Plateau de Bure Interferometer: Foreign Commands
- IRAM Plateau de Bure Interferometer: Trouble Shooting Guide
- IRAM Plateau de Bure Interferometer: Frequency Setup
- IRAM Plateau de Bure Interferometer: Atmospheric Calibration
- GreG, Grenoble Graphic
- GILDAS, Grenoble Image and Line Data Analysis System

Contents

1 Introduction

This document gives a description of the CLIC software, developed to calibrate the data taken with the IRAM millimeter-wave interferometer on Plateau de Bure. CLIC stands for "Continuum and Line Interferometer Calibration". The way the data must be calibrated is very much dependent on the acquisition procedures and the backend hardware. For that reason it was felt easier to develop a dedicated program that to try to use an existing package such as AIPS. The situation is different for mapping software, for which our needs are certainly covered by the capabilities of AIPS. Thus a gateway from CLIC calibrated visibility files into the AIPS world is provided.

We outline now the different steps in data calibration. The (complex) visibility W measured on the baseline from antenna i to antenna j at frequency channel k is related to the true object visibility V_{ij} by

$$W_{ijk} = g_i(t)g_j^*(t)b_{ijk}(t)V_{ij}(u_k(t), v_k(t)) + noiseterm \quad (1)$$

where $u_k(t)$ and $v_k(t)$ are the spatial frequencies corresponding to baseline ij at time t and frequency k, and we assume the object has a flat spectrum. Calibrating the data is computing the complex "calibration curves" $g_i(t)$ and $b_{ijk}(t)$. For the relatively narrow bandpass of millimeter astronomy, $u_k(t)$ and $v_k(t)$ are almost independent of the frequency channel k (even the sideband separation is only 3 % of the observing frequency).

$b_{ijk}(t)$ is the bandpass of the detection system, and is usually almost constant with time. It can be formally decomposed in a product of RF bandpass, caused by receivers and cables and usually with weak dependence on frequency, and IF bandpass, caused by the backend (spectral and continuum correlators at Bure).

For the $g_i(t)$, we must separate the calibration of amplitude and phases since amplitude and phase errors have very different origins. The amplitude corrections is related to several effects: atmospheric absorption, receiver gain, antenna gain (affected by pointing errors, defocussing, surface status and systematic elevation effects), and correlation losses due to phase noise. Phase errors may come from delay errors, baseline errors, or a slow drift in atmospheric or receiver phases.

- *Amplitude calibration*: Atmospheric absorption and receiver gain are derived in the same way as for single dish data, the correction factors being determined from "chopper wheel calibrations" being performed at regular intervals (typically 10–15 minutes). This in the same time corrects for the amplitude passband (except for antenna chromatism effects). The atmospheric model calculations are done on-line to help monitoring data quality, and applied to the data. However, the calibration parameters are stored in the headers as well as the overall amplitude factor applied. In this way, the model calculations can always be repeated at any stage in the data reduction process, with the possibility of correcting wrong atmospheric parameters.

- *IF Passband Calibration*: Phase errors introduced in the backend are measured by connecting all correlator inputs to the same source of white noise (a noise generator in the IF). Ideally all outputs should give 100% correlated signals. The phases then are the channel-to-channel phase errors. Normally this operation should be done every time the spectral correlator setup is changed. It is actually done as often as the amplitude calibration, since it can be done during antenna motion from one source to the next, and since it provides a good means to trace down hardware problems in the backend.

- *Phase Calibration* is necessary to correct the raw visibilities for instrumental and atmospheric short–term phase fluctuations. This is done by repeatedly observing a nearby point source for which the measured phases should be zero if delays are correctly tracked. The phase closure relations may also be used. If the calibrator is very close to the source, this will also correct to first order baseline errors.

  The visibilities amplitudes measured on the calibration source, if strong enough, give an estimate of the additional amplitude corrections introduced by pointing and focussing inaccuracies and atmospheric phase jitter. They are commonly used to calibrate the source amplitude relatively to the flux of the phase calibrator, thus eliminating to first order the decorrelation effect due to the atmospheric phase fluctuations.

- *RF Passband Calibration*: Ideally the phase calibration should be done separately for each receiver channel (but calibrators are not strong enough). However if one assumes that phase fluctuations are not frequency–dependent one may calibrate the relative phases of the channels on a strong source, before or after the observations. Actually only the RF passband needs observing a source in the sky for this, since the passband of the correlators may be calibrated in autocorrelation mode on a noise source (see above). RF passband calibration may be necessary only for broad band spectra or objects where a high channel to channel dynamic range is needed.

Amplitude calibration and IF passband calibration have now been moved into the acquisition software. They are however described in section 4.1. Instrumental phase and RF passband calibrations might need more user intervention, depending on the data quality, and are described later, after a section dedicated to the data display capabilities of CLIC. Finally some specific operations, such as baseline calibration, are explained.

2 The Commands

CLIC commands may be separated into several groups, as shown in the following table:

Group of commands	*Section of this manual*	*Commands*
General purpose	all	`SAVE, SET, SHOW`
Data retrieval	3.1	`COMPRESS, DUMP, DROP, FILE, FIND, FLAG, MARK, MASK, HEADER, IGNORE, LIST, MASK, NEW_DATA, TABLE, WRITE`
Data display	3.2	`CURSOR, PLOT, RESIDUALS`
Calibration	4.1, 4.3	`SOLVE, ATMOSPHERE, STORE`

3 Data Access

3.1 Data Storage and Retrieval

Visibility data and header information are stored on files in a format which is a simple extension of the one used by the single dish CLASS program. The file organisation is exactly the same as in CLASS; except for some additional index entries, specific to interferometric data. Observation headers are also organised in sections, most of which are interferometer-specific. However, the

length of the data section may vary, depending on the number of data records written sequentially. Each data record contains a short data header with the values of some fast varying parameters such as time, U and V coordinates, source direction vector, ...

The Input and Output files are selected by the `FILE` command (syntax: as in CLASS).

Most commands deal with all observations in the Current Index. The Current Index is filled by means of the command `FIND`. Selection criteria are mostly identical to the ones in CLASS, with some additions such as Hour Angle or Calibration Status. Commands `DROP` and `IGNORE` have the same meaning as in CLASS. Commands such as `GET` and `WRITE` are provided for test purposes only.

Depending on whether the input and output files are identical or not commands which output data will either modify data in place, or write new versions of the data observations. Command `COMPRESS`, is normally used to time-compress data. To simply transfer data from one file to another, the command `COPY` should be preferred.

Finally command `TABLE` outputs a UV Data Table suitable for use in mapping programs (either GILDAS tasks, or AIPS tasks after format conversion by GFITS).

3.2 Data Display

The CLIC program includes the one dimensional part of GREG (SIC language GREG1). All graphic display is done internally via GREG commands or subroutines. So we refer to the GREG documentation for commands like `DEVICE`, `HARDCOPY`, ... which must be issued to obtain a graphic display. [1]

The CLIC display may do two kinds of plotting: time-like or spectral-like. By default, the time-like mode is selected (`SET MODE TIME`). In this mode, two quantities are plotted one against each other, in one or several GREG boxe Both quantities are time functions, such as time itself, or hour angle, or amplitude (or phase) in a selected channel.

In spectral-like mode (`SET MODE SPEC`), the quantity in abs is a spectral coordinate, such as channel number, frequency or velocity. The ordinate is then amplitude or phase. Switching between time mode and spectral mode is done automatically by the `SET X` and `SET Y` commands.

3.2.1 Time-like plots

The defaults plot settings are the following:

```
SET MODE TIME
SET X TIME
SET Y AMPLITUDE PHASE /LIMITS 0 * -180 180
SET ASPECT_RATIO 2.0 AUTO
SET SUBBANDS C01 TO C06
SET BANDS LOWER
SET BASELINES 12 13 23 14 24 34
SET AVERAGING NONE
SET PHASES DEGREES JUMPY
SET PLOT POINTS
```

[1] Note that since `SET` and `SHOW` are commands in both CLIC and GREG, we have predefined a few symbols in CLIC so that, e.g. `SET` will execute CLIC\SET . You will have to type `GREG1\SET` to execute a GREG `SET` command. But `HELP SET` will be ambiguous; type `HELP CLIC\SET` to get information about the CLIC `SET` command.

Thus the PLOT command will produce six plots in six GREG boxes; one for amplitude versus time and one for phase versus time, for the three baselines linking the three first antennas. The data plotted will be the average of the 6 continuum channels (C01 to C06) for the upper side band. No time averaging will be done (one point plotted for each data point recorded), the phase will be in degrees with no 360 degrees jumps.

The SET X and SET Y commands are needed to choose the variables to be plotted. In time-like mode the variables may be the components of the visibilities (amplitude, phase, real part or imaginary part), or the baselines coordinates U, V, RADIUS or ANGLE (the rectangular or polar coordinates of the baseline vector in the plane perpendicular to the source direction). Other variables are time (in hours of Universal Time), scan number, source direction (HOUR_ANGLE and DECLINATION), or delays (see the internal help or section 8 for a complete description).

The SET BANDS command will select the side bands plotted. Several side bands may be plotted simultaneously. Side bands may obviously be UPPER or LOWER, or AVERAGE, where the weighted average of both side bands will be used to compute the components of the visibilities if any are to be plotted, or RATIO, in which case the (unweighted) ratio USB/LSB will be used. The weights for averaging the side bands are entered by the SET AVERAGING command.

The SET SUBBANDS command is used to specify the sub-bands to be used. Sub-bands are referred to by their mnemonics C01, ..., C06, for the continuum sub-bands, L01, ..., L06 for the line sub-bands. In CLIC, L01 refers to the first available line subband, L02 to the second one, and so on. They correspond to the bands selected in the SPECTRAL command in OBS. Several continuum sub-bands may be averaged together by specifying a range (e.g. C01 TO C05, or C01 AND C04, or C01 AND C03 TO C06, the latter just excluding C02).

For line sub-bands all the channels are averaged together, except if the /WINDOW option is used. For instance:

```
SET SUBBAND L01 /WINDOW 30 45
```

will average visibilities in channels 30 to 45 of the first line sub-band. However the edge channels (with lower signal–to–noise ratio, due to anti–aliasing filters in the correlators) may be left out, by using e.g. SET DROP 0.1 to leave out 10% of the bandwidth at each edge of each spectral subband (the default is only 5%). The central channels, possibly affected by the Gibbs phenomenon in case of scontinuum signal in the image subband, are left out by using command SET GIBBS number, number is the number of channels left out

The SET BASELINES command obviously selects the baselines for which data is to be plotted. Baselines are named 12, 13, 23, (14, 24, 34, ...). Note that the numbers here refers the ordinal numbers of the antennas that where connected at the time of the observations. If only two antennas were connected, only one baseline will be in the data, and it will be referred to as "12", even though the antennas you used are labelled "2" and "3" in black paint, and were at this time connected to correlator inputs "1" and "3"! However this hardware information is recorded in the header, for possible needs.

A SET ANTENNA command is also available. It is used to plot antenna-related parameters (such as TSYS, Elevation, ...) or with autocorrelation data (SET Y AUTO). It may also be used (in time-like mode only) with correlation data: in that case,

- amplitude A_i for each antenna is computed from ratios of baseline amplitudes A_{jk} in the following way:
  $A_i = \frac{A_{ij} A_{ik}}{A_{jk}}$
  (averaged over possible antennas j and k, different of i and of each other). This actually is a measurement of the gain of antenna i, if a point source is observed. It is a convenient way of displaying pointing and focussing data, but three antennas at least are needed.

- antenna phases are computed by using the closure relations (the phases of all antennas are computed by a least square fit, assuming that antenna 1 has a phase of zero).

The SET AVERAGING command deals with the way data is averaged. Data may be time-averaged by the PLOT command; SET AVERAGING TIME t will specify the averaging time, while SET AVERAGING SCAN will force averaging observation by observation, and SET AVERAGING NONE will turn off time averaging. The normal method is to average complex visibilities (SET AVERAGING METHOD VECTOR, the default), while an alternate method is to average separately amplitude and phases (SET AVERAGING METHOD SCALAR).

Side band averaging, and sub-band averaging are always done in vector method. The weights for side band averaging are specified by the commands SET AVERAGING UPPER baseline amplitude phase and SET AVERAGING LOWER baseline amplitude phase. These weights should be determined from the data, using plots of both amplitude and phase of the side band ratios.

The plotting may be done either with GREG symbols (SET PLOT POINTS, the default), or with lines connecting the points (SET PLOT LINES), with histograms (SET PLOT HISTOGRAM), or with error bars (in the case of visibilities only; type SET PLOT BARS).

Finally the command SET ASPECT_RATIO selects a default x/y aspect ratio in the cases when several boxes will be plotted. The boxes will be positioned on the screen to approach this ratio as much as possible (SET ASPECT_RATIO value AUTO), or will exactly reflect the demanded aspect ratio (SET ASPECT_RATIO value EXACT).

After a plot has been obtained, coordinates of special points may be obtained interactively by command CURSOR, which calls the interactive graphic cursor. Striking almost any key will give the user coordinates of the cursor, while "E" is used as usual to exit the cursor mode; "K" will delete the selected data point from the current plot (useful to avoid this point in SOLVE PHASE); you may also IGNORE or TAG scans in a given range to a given quality: type N to open a new range, and I or T to close it (if using T you will be prompted for the quality in the range 0-9). Finally "F" may be used in the same manner as "T" to interactively flag bad data points in the data (see section 4.6.2)

After the PLOT command, the abscissae and ordinates of the plotted data points are kept in two two-dimensional SIC arrays named X_DATA and Y_DATA, where the first index is the data point counter (1 to N_DATA) and the second index is the box number. Thus the data are available for more specific plots or mathematical operations using the possibilities of SIC and GREG.

3.2.2 Spectral-like plots

In spectral-like mode (SET MODE SPECTRAL), the only X variables allowed are Channel number, IF frequency, RF rest frequency, and Velocity, while Y variables are the components of the visibilities, or autocorrelations (SET Y AUTO). SET ANTENNA may be used, but only with autocorrelations. Some SET keywords have a different meaning:
SET SUBBAND: here groups linked be the keyword TO indicate concatenation rather than averaging. For instance SET SUBBAND C01 TO C06 will form a single broad band spectrum with the 6 continuum sub-band visibilities; or SET SUBBAND L01 TO L02 will concatenate the first two line sub-bands to form a single spectrum, plotted in a single box.
SET AVERAGING TIME or SCAN or NONE has no meaning; all data in the current index is averaged to form a single spectrum in any case.

Use of SET DROP and SET GIBBS is the same as in time mode, but their effect here is more obvious on the plots since the channels are plotted individually.

4 Data Calibration Steps

4.1 Real Time Calibration

Under this denomination we group a certain number of calibration operations that need to be done on the visibilities, and on autocorrelation data. These calibration steps are performed by the data acquisition processes (`CORREL` and `RDI`) running on the control computer, `BURE01::`. It is nevertheless useful to briefly describe these operations here. They are:

- *Clipping correction of line correlator data* (the clipping correction for the continuum correlator is performed in real time on the control computer). For this we use the approximation of Kulkarni and Heiles (*Astron.J.***85**, 10, 1413) for correlation data, and a numeric integration using cubic splines for auto correlation data.
- *Fourier transform of autocorrelation data*
- *Fourier transform and sideband separation of correlation data*
- *Correction of phases for delay rounding errors*
- *Reduction of atmospheric calibrations*, using an atmospheric model and recorded atmospheric parameters. A calibration constant (T_{CAL}) is determined, as well as the gains in each channel for each antenna.
- *Reduction of the IF Passband calibration scans.*
- *Amplitude calibration of correlation data* using the last available autocorrelation data, and system temperatures from atmospheric calibrations
- *Calculation of velocity scales* for each sub-band and side band.

The atmospheric calibration may be re-computed off-line by using the command `ATMOSPHERE`. The atmospheric calibration is normally performed according to parameters given in real time in OBS. Each antenna may be set in one of three calibration modes: `FILE`, `AUTO`, or `TREC`. `FILE` mode (the default) just means that the mode used will be the one given in OBS for the corresponding antenna. Any antenna in `TREC` mode is first used to determine a value of the water content. If more than one is available, an average is made. Then the resulting water content is used for the antennas in `AUTO`, for which a value of Trec is then determined.

Note that the command `ATMOSPHERE` may be run several times on the same data. The mode for some antennas may be forced in CLIC with commands `SET ATMOSPHERE TREC temp /ANTENNA i`, or `SET ATMOSPHERE AUTO water /ANTENNA i`. This may be useful if, by chance, the amplitude calibration parameters were not set to the correct values in OBS by the observer. Incorrect calibration parameters may be updated by command `MODIFY HEADER`.

4.2 A First Look at the Data

Before processing to actually calibrate the data, it is useful to evaluate the data quality. Actually this should be done on the site, as soon as possible after the data has been taken, to take the appropriate action (such as re-observing the source in the current interferometer configuration). We list here the simplest checks to be done on the data (these checks do not require knowledge of the astronomic aims of the observing program):

Plot the system temperature and water vapor content versus time (or versus elevation). Use `SET ANTENNA 1 2 3 4`, `SET Y TSYS WATER`. `TSYS` should have a reasonable dependence on elevation, while `WATER` (the zenith opacity) will reflect any strong variation of atmospheric opacity with time.

Plot the total power output versus time. Use Use `SET ANTENNA 1 2 3 4`, `SET Y TOTAL`. It should display a reasonable elevation dependence.

Plot the calibrator amplitude and phase versus time The phase calibrators are selected from the data set by the command `SET TYPE PHASE`. Both amplitude and phase should ideally be constants.

The amplitude (in kelvins) should be in principle the same as observed in single-dish observations. Check for pointing or focussing problems if the amplitude suddenly drops in baselines connected to one antenna. Check the calibration parameters if the amplitude as a clear dependence on elevation.

If the phase has a sinusoidal dependence on hour-angle, the baseline parameters may be incorrect.

Plot the calibrator amplitude and phase versus IF-frequency. These curves should be relatively flat, since the IF pass-band has been removed during real time calibration. No systematic slope should appear in the phase of the calibrator, if the delay offsets have been measured with sufficient accuracy. If some strange effect is seen in the correlator data (very low amplitude, very strong slope in the phases), you should check the IF passband calibrations.

Plot the IF-passband calibrations (if anything seems wrong with the correlator). These calibrations consist of two observations, an autocorrelation and a correlation.

With `SET Y AMPLITUDE PHASE, SET X I_F` and `SET BASELINE 12 13 23 14 24 34`, you will get the correlation (normalised by the autocorrelation). Amplitudes should be very close to 1., except for possibly the edge channels of each subband. Phases show a systematic slope, varying from one correlator unit to another.

With `SET Y AUTOCORR, SET X I_F` and `SET ANTENNA 1 2 3 4`, you will get the autocorrelation spectrum for each correlator entry. The passbands should be rather smooth.

Bad channels should show up as strong oscillations in either plot.

4.3 Phase Calibration

4.3.1 Determining the calibration curve

The first operation is to select in the current index the calibrator observations performed during the time period when calibration is needed, and to plot the visibilities after having selected the baselines, side bands and/or subbands needed. This is done via `SET BASELINES`, `SET BANDS`, `SET SUBBANDS` commands. Time should be specified as X axis and Phase as Y axis (in `SET MODE TIME`, of course). `SET PHASE CONTINUOUS` should also be specified, otherwise fitting a smooth curve will be difficult.

Then a calibration curve is determined by command `SOLVE PHASE`. By default this command will fit a cubic spline into each measured phase or amplitude. With option `/PLOT`, the curve will be plotted with the data points. The calibration curve is then in memory.

The time interval between knots of the cubic splines is available as a parameter through the `SET STEP` command. Its default value is 3 hours. Additional knots may be introduced with the option `/BREAK`, to match discontinuities or angular points.

Alternatively, with option `/POLYNOMIAL`, a polynomial fit will be made. The degree of the polynomial is automatically chosen, using the statistical errors bars for each data point.

4.3.2 Storing the Phase Calibration Curves

The next step is to store this curve (if satisfactory) in the headers of the observations to be calibrated. This is done after loading those observations into the current index, by the `STORE PHASE` command. Before doing this, you must have selected an output file. This may either be the same as the input file (the headers will then be modified in place), or a new file.

CLIC will not apply the calibration to the data itself before it is processed Calibrated data may be examined however with the `PLOT` command; to do this you have to enter the command `SET PHASE RELATIVE` . This will be switched back to `ABSOLUTE` if you try to use `SOLVE PHASE` on calibrated data.

4.4 Amplitude Calibration

Phases being angles are naturally defined in radians (or degrees). For the amplitude two units might be of interest : flux densities (in Jansky) or brightness temperatures (in Kelvin). In principle, after atmospheric amplitude calibration have been applied, the amplitude naturally comes out in brightness temperature scale, which can be converted just knowing the primary beam size into flux density. However, unavoidable effects such as short term atmospheric phase fluctuations add extra degradations to the amplitude scale.

Accordingly, it is often necessary to refer the amplitude scale to a primary (or secondary) calibrator of known flux density. To summarize, amplitude may be displayed in 3 different modes and 2 units, with the following factor :

Unit \ *Mode*	`ABSOLUTE`	`RELATIVE`	`SCALED`
`KELVIN`	1	$A_{ij}(t)$	$1/S$
`JANSKY`	$\sqrt{F_i * F_j}$	$A_{ij}(t)/\sqrt{F_i * F_j}$	$1/S$

where the F_i are the efficiencies of antenna in Jy/K, A_{ij} is the amplitude calibration factor (in K/Jy) and S the source flux in Jy.

Calibrating the amplitude usually implies determining both the F_i and A_{ij} functions.

4.4.1 Solving for fluxes

The first step is usually to determine the efficiencies of antenna from sources of known flux. To do that, the `SOLVE FLUX` command forces `SET AMPLITUDE SCALED`. It uses all sources of known flux from the current index to compute the (time averaged) values of the efficiencies F_i. The fluxes of other sources in the current index can then be determined using from the efficiencies. Sources of known flux are specified using the `SET FLUX` command. The sources should have been observed sufficiently closely in time to avoid any variation of the A_{ij} values. Also, good flux determination requires pointing errors to be similar on those sources.

The fluxes (measured or manually entered by `SET FLUX`) can be written to the output file using the `STORE FLUX` command.

4.4.2 Determining the calibration curve

The first operation is to select in the current index the calibrator observations performed during the time period when calibration is needed, and to plot the visibilities after having selected the baselines, side bands and/or subbands needed. This is done via `SET BASELINES`, `SET BANDS`, `SET SUBBANDS` commands. Time should be specified as X axis and amplitude as Y axis (in `SET MODE TIME`, of course).

Then a calibration curve is determined by command `SOLVE AMPLITUDE`. It forces `SET AMPLITUDE ABSOLUTE KELVIN` to determine the calibration curve $A_{ij}(t)$ which is then in memory.

For the type of curve (splines, breaks, polynomials), `SOLVE AMPLITUDE` behaves as the the `SOLVE PHASE` command applies.

4.4.3 Storing the Amplitude Calibration Curves

The next step is to store this curve (if satisfactory) in the headers of the observations to be calibrated. This is done after loading those observations into the current index, by the `STORE AMPLITUDE` command.

CLIC will not apply the calibration to the data itself before it is processed for mapping. Calibrated data may be examined however with the `PLOT` command; using the `SET AMPLITUDE RELATIVE [JANSKY|KELVIN]` command

4.5 RF Passband Calibration

The IF part of the passband shape should have been calibrated out either on-line or by the `SPECTRUM` command. However the RF part remains and must be calibrated using radio sources.

4.5.1 Determining the passband curves

The first operation is to select in the current index the calibrator observations performed during the time period when calibration is needed, and to plot the visibilities after having selected the baselines, side bands and/or subbands needed. This is done via `SET BASELINES`, `SET BANDS`, `SET SUBBANDS` commands. Channel number should be specified as X axis and Phase and/or amplitude as Y axis, `SET MODE SPEC`. You should preferrably use `SET PHASE CONTINUOUS`, since 2π jumps may occur in the passband shape. Then a calibration curve is determined by command `SOLVE RF_PASSBAND`. This command will fit a polynomial into each measured phase or amplitude, for each line subband. For the line subbands the polynomial is by default of degree 0 for amplitude and 1 for phase data. Higher degrees may be specified as arguments to the `SOLVE RF_PASSBAND` command. For the continuum, the ten values are simply stored and will be used as calibration data.

With option `/PLOT`, the curve will be plotted with the data points. The calibration curve is then in memory. These `PLOT` and `SOLVE` operations will have to be done in several steps, if many subbands are used. The curve for each subband and sideband is kept in memory, so that a single `STORE` command is needed.

4.5.2 Storing the passband curves

The next step is to store this curve (if satisfactory) in the headers of the observations to be calibrated. This is done after loading those observations into the current index, by the `STORE RF_PASSBAND` command. Before doing this, you must have selected an output file. This may either be the same as the input file (the headers will then be modified in place), or a new file.

As for instrumental calibration, CLIC will not actually apply the calibration the data before it is processed for mapping. Calibrated data may be examined however with the PLOT command; to do this you have to enter the command SET RF_PASSBAND ON . This will be switched back to OFF if you try to use SOLVE RF_PASSBAND on calibrated data.

4.6 Editing the Data

In some (rare) cases the calibration will reveal unpleasant results: the weather was very bad indeed, or something did not work properly. Thus you may consider modifying some header parameters, or even delete some data points. The parameters in the headers (and even the data itself) are all accessible as **SIC** variables. Selection of data records for further use is done by a set of flags in the header of each data record.

4.6.1 Variables

A **SIC** variable may be associated with nearly every header parameter. Variables are normally not enabled; a whole group of variables may be enabled, by means of command VARIABLES. For instance:
VARIABLES ATMOS ON
will turn on all variables concerning atmospheric parameters. Use HELP VARIABLES to consult the list of variables and groups of variables. To examine the content of variables, the observation, and one of the associated may be read in with command GET /RECORD.

The edition of the data headers is done is a more powerful way by command MODIFY HEADER. This command will perform a loop on the current index, loading each header in turn; for each it will execute a procedure MODIFY.CLIC, that you should provide (you may give it another name, and enter it as a second argument to command MODIFY). This procedure may contain **SIC** commands (such as EXAMINE, LET, SAY ...), or some CLIC commands like HEADER, DUMP ... Its execution must end with the special command GO, otherwise the loop will be aborted. The command GO WRITE will ensure that the modified header is rewritten to disk.

For instance, assume the flux for 3C84 was entered incorrectly as 100 Jy, during an observing session (you do not recall when exactly). The correct flux was 12 Jy. Your MODIFY.CLIC might look like:

```
IF FLUX.NE.12 THEN
    LET FLUX = 12
    SAY "Flux updated, scan " 'SCAN'
    GO WRITE
ELSE
    GO
ENDIF
```

You will have to execute the following commands:

```
FIND
VARIABLE POSITION ON            ! this is the group for FLUX
VARIABLE GENERAL ON             ! this is the group for SCAN
MODIFY HEADER
```

Note that in the above example, the same result could be obtained more simply by:
SET FLUX 3C84 12.

```
STORE FLUX
```

Command MODIFY DATA works in the same way, but it will successively load all the data records of each observation, and execute (by default) the procedure DATA.CLIC. The range of this command may however be restricted with options /AFTER date time and /BEFORE date time, where 'date' is a usual date chain (jj-mmm-yyyy), and 'time' the time in hours (sexagesimal notation in understood).

4.6.2 Flags

Each record contains one flag word by antenna, and one flag word by baseline. There may ultimately 32 flags in each word. As for now, both antenna and baseline flag words may contain one flag by subband (named C01 to C06, and L01 to L06; in addition, the antenna flag words may contain flags LOCK, TSYS, POINTING, SHADOW, and DATA, while the baseline flagwords may contain flag DATA.

For instance, if subband flag C02 is present in baseline 23, subband C02 will be ignored for further processing of baseline 23 (in particular, it will be absent from plots). If present in antenna 1, baselines 12 and 13 will be affected. Other flags such as LOCK, TSYS, POINTING, SHADOW, and DATA will affect all subbands of the relevant baselines. Flags should normally be set by the real time system, or the real time calibration step in CLIC.

You may wish to use that data anyway, by masking them (command MASK). For instance use MASK C02 /BASELINE 23 if you feel that this subband was usable, but do not be surprised by the results !

You may also want to suppress temporarily some data channels from plots or from output tables, without modifying the data file itself. This is done by command MARK. Marked data channels will be ignored just as if they were flagged in the data.

On the opposite, you might have to flag some data yourself. There are several ways of doing this:

- using the command STORE FLAG which will flag all the records of all the scans in the current index. For instance

  ```
  FIND /SCAN 5436
  STORE FLAG DATA /BASELINE 12
  ```

  will flag baseline 12 for the whole duration of scan 5436. This is the best way to flag one or more complete scans.

- using command MODIFY DATA, with a procedure DATA.CLIC containing the command FLAG. For instance, assume that you want to discard all data where the total power on antenna 2 is lower than some threshold, say 10. You will create a procedure DATA.CLIC:

  ```
  IF DH_TOTAL[2].LT.10. THEN
      FLAG DATA /ANTENNA  2
      GO WRITE
  ELSE
      GO
  ENDIF
  ```

Do not forget to enable variables of group `DATA_HEADER`, before typing `MODIFY DATA`.

- interactively, after a `GET /RECORD`, use the `FLAG` command to set or reset a flag for this specific record. The `UPDATE` command will write back the flagged data to the file.
- interactively, with command `CURSOR`. Assume you have plotted amplitude versus time (with no averaging), you should have one point for each record. Then you can select a range of records in X coordinate: point the cursor to the first point you want to flag, type N (for New range), then go to the last point, type F (for Flag). You will be prompted for the name of the flag to set. This flag will be set for the baseline, or antenna, corresponding to the box you are pointing to with the cursor.

You may get a status of the flags in the data og the current index by issuing command `LIST /FLAG`.

5 Calibrating the Interferometer

New instrumental constants have to be measured each time the antennas have been moved: delays, antenna coordinates, pointing constants. We describe here the reduction procedures to be used.

5.1 Delay determination

The delay parameters are determined by taking a correlation on a strong source (the strongest available in the sky), and by measuring the variation of phase as `SOLVE DELAY /PLOT`
is available to measure the delays. The phase should be plotted as a function of IF frequency, over the broadest band available (the correlator should be set up to analyse the 100-600 MHz band by juxtaposition of several 160 MHz subbands). `SOLVE DELAY /PLOT`, applied to baseline 12, will output the delay to be applied to antenna 1. If the delay is too large, increase the range of search by using the option `/SEARCH range` (by default the search range is between -100 and +100 nanoseconds).

5.2 Baseline Calibration

We examine here the way to determine the baseline vectors from calibration observations done for instance after an antenna move. Assume the relevant observations are gathered into the current index. One should make a plot of phase versus both Hour Angle and Declination (`SET X HOUR_ANGLE DECLINATION` and `SET Y PHASE`, for each sideband separately.

The command `SOLVE BASELINE` will then do a least square fit and output the baseline vectors. A linear method is used which works only if the starting values (that is the baselines values in the header) are within half a wavelength in any direction of the true values. Different starting values may be given with the `/OFFSET baseline dx dy dz` option. In that case the phases are first corrected for the given baseline offsets before the fit.

A blind search within a given range may be done. For this enter the option `/SEARCH range` where range is in meters. All offsets within the given range (in three directions, stepping by half a wavelength) are tried, and the best rms value is kept. A blind search in a 0.01 meter range will take about 4 seconds on the microVAX 3400. This the default if only `SOLVE BASELINE /SEARCH` is given. Rms values on the range 10-20 degrees are expected, if the data was scan averaged, and observing conditions were acceptable.

The program gives for each baseline two series of offsets, and the fitted baseline for record. The first offsets given (`dx, dy, dy`) are relative to the baseline coordinates used while observing, while the second set of offsets (`DX, DY, DZ`) are relative to the "standard values" of the antenna positions. After all available baselines have been fitted, the command `PRINT BASELINE` will produce a command procedure `CLIC-BASELINE.OBS`. This command procedure may be used in OBS, in the `CONFIGURE` mode, to update the antenna position offsets.

If `SET ANTENNA 2 3` has been used instead of `SET BASELINE`, then the antenna position offsets of antennas 2 and 3 are directly determined (the position offset of antenna 1 are by definition zero, like antenna phases for this antenna in the `SET ANTENNA` mode. This mode is preferable since baseline closured is ensured.

Residuals may be examined by entering `RESIDUALS BASELINE`; phases should be independent of hour angle and declination.

Phase data can later modified in previous data to reflect this baseline change (if a previous value proved to be wrong) with `MODIFY BASELINE FITTED`.

If `SET X HOUR DECL TIME` is specified, then plots of phase as a function of time are obtained; `RESIDUALS BASELINE` will also display the variation with time of the residuals. This is useful to detect a time drift of the phases, especially during long observations (to be avoided in any case!). These drifts may be fitted simultaneously with the option `/POLYNOMIAL degree`. In that case a time polynomial (degree up to 3) is added to the fitted phase function.

5.3 Reduction of Pointing and Focussing Scans

This is done by `SOLVE POINTING` and `SOLVE FOCUS` commands.

These commands will scan the current index for the specific data, and fit the data for each antenna. The results may be kept in a data file (Text format): use the option `/OUTPUT filename NEW` or `/OUTPUT filename APPEND` for this.

- for `SOLVE POINTING`, the measured pointing errors in the file may be used to replace the collimations in OBS (command `CORRECTIONS`, first two arguments), or the data file be used as a whole to solve for pointing coefficients with the program **POINT** (see the specific documentation on pointing).
- for `SOLVE FOCUS`, the measured error is to be *added* to the foc correction in OBS (command `CORRECTIONS`, third argument).

In both cases, option `/PLOT` will produce a graphic display of each fitted curve.

5.4 Reduction of Skydip Scans

This is done by `SOLVE SKYDIP`.

These commands will scan the current index for the specific data, and fit the data for each antenna. The data may be used to solve for the forward efficiency and the water vapor content (default), or to solve for the receiver temperatures and the water vapor contents. Note that at the frequencies currently used, the results for the water content are not very reliable, since the dominant absorption around 90 GHz is oxygen in good weather conditions.

6 A Few Receipes

We give here a few commonly used sequence of commands, to be used as examples.

6.1 Finding the best delay offsets

```
FILE IN INTER_DATA:01-dec-1992 ! load the current data file
SET SUBBANDS L01 to L04        ! use all subbands, which
                               ! should be have close to equal phase offsets.
                               ! delay is more accurately determined.
SET BAND LOWER                 ! select lower side band for instance
SET Y PHASE                    !
SET X I_FREQ                   ! Intermediate frequency  as X axis
SET SCAN 1234                  ! or SET NUMBER n
FIND                           !
SOLVE DELAY /PLOT
```

The optimum delay is actually the differential delay between first and last antennas of the baseline in question. It should be entered in the data file for the first antenna, or its opposite entered in the data file for the second antenna (or possibly shared between them along these lines). Be careful to determine the delay with enough precision, in order not to introduce a slope in the phases (1 nanosecond produces 0.5 turn in the 500 MHz passband).

6.2 Baseline determination

6.2.1 a rough, simple way

Here we just plot the data of lower sideband.

```
!
FILE I INTER_DATA:01-dec-1992
SET SCAN 2393 2440               ! select data by scan number
SET PROCEDURE CORR               ! discard AUTOs and possible other scans
FIND
PLOT                             ! giving it a glance does not hurt ...
SET ANTENNA 2 3                  ! use antenna mode
SET SUBBANDS C01 TO C06          ! should be OK
SET BANDS UPPER LOWER            ! side bands separately
SET PHASE JUMPY                  ! best for baseline solving
SET Y PHASE                      ! amplitude not needed
SET X HOUR_ANGLE DECLINATION
PLOT                             ! phases should be displayed
SOLVE BAS/SEARCH                 ! should normally be enough.
                                 ! ...wait a few seconds ...
PAUSE                            ! keep a log of the results !
                                 ! (both side bands should agree)
PRINT BASELINE                   ! to have the results in a OBS procedure
RESIDUALS BASELINE               ! phases should be flat.
```

6.2.2 more sophisticated

In this we first process the data into a secondary file, perform a RF passband calibration to be able to average continuum subbands and sidebands more accurately, and solve for the baseline with a search loop.

```
!
FILE I INTER_DATA:01-dec-1992         !  Load the raw data
SET SCAN 2393 2440                    ! select data by scan number
SET PROCEDURE CORR                    ! only correlations
FIND
LIST                                  ! as a check
FILE O W00-N15-E23 NEW                ! open a secondary data file
COMPRESS 60                           ! compress to 1 minute,
                                      ! (this saves plotting time)
!
! Select the compressed data file and do passband calibration on 3c273
!
FILE BOTH W00-N15-E23                 ! reopen for both input and output
FIND
PLOT                                  ! giving it a glance does not hurt ...
SET SOURCE 3C273                      ! the strongest souce
SET MODE SPEC                         ! actually not needed
SET X I_F                             !
SET PHASE CONTINUOUS                  !
SET RF FREQUENCY                      ! use frequency dependent mode
SET Y AMPLITUDE  PHASE
SET SUBBANDS L01 TO L06
FIND
LIST
SET BANDS UPPER                       ! do upper side band fist
SOLVE RF_PASSBAND 5 10 /PLOT          ! degrees as actually needed ...
SET BANDS LOWER                       ! Then lower side band
SOLVE RF_PASSBAND 5 10 /PLOT
SET SOURCE *                          ! come back to all sources
FIND
STORE RF_PASSBAND                     ! in place, in the data headers
!
! Now solve for baseline, using average of subbands 1 to 6
!
SET RF_PASSBAND ON  FR                ! from now on, plot calibrated data
SET MODE TIME                         ! switch back to time mode
SET SUBBANDS C01 TO C06               ! now subbands may be averaged
SET PHASE JUMPY                       ! best for baseline solving
SET Y PHASE                           ! amplitude not needed
SET X HOUR_ANGLE DECLINATION
SET BANDS AVERAGE                     ! double side band
PLOT                                  ! phases should be displayed
SOLVE BAS/SEARCH                      ! should normally be enough.
                                      ! ...wait a few seconds ...
PRINT BASELINE
PAUSE                                 ! keep a log of the results !
RESIDUALS BASELINE                    ! phases should be flat.
```

7 Producing Images

Images may be produced either by AIPS or GILDAS. The first step in any direction is to produce a UV Data Table from calibrated data. This is done with CLIC command `TABLE`.

7.1 Creating a UV Table

You will have first to select which band and subbands are to be used, with command `SET SELECTION`. The format is

```
SET SELECTION key band subbands
```

'`key`' may be `LINE` or `CONTINUUM`; use `CONTINUUM` to obtain a table with a single channel, and `LINE` to obtain a table with multi-channel data. '`band`' may be `USB, LSB,` or `DSB` (the latter is allowed for continuum mode only, and produces two records: one for each sideband). Finally '`SUBBANDS`' is a group of subbands, like `C01 to C06` or `L01 to L02`, to be averaged in continuum mode, and concatenated in line mode (overlapping spectral bands will cause a resampling to occur).

The table itself will be a file in the Gildas Data Format, of dimensions $[3N_C + 7, N_V]$, for N_C channels and N_V visibilities. The $3N_C$ lines contain:

1. U in meters
2. V in meters
3. W in meters
4. Observation date (integer CLASS day number)
5. Time in seconds since above date
6. Number of start antenna
7. First frequency point (real part)
8. First frequency point (imaginary part)
9. First frequency point (weight)
10. Same for second frequency point, and so on

The data weights are controlled by command `SET WEIGHTS`. `SET WEIGHT TSYS ON` will turn on weighting by $1/T_{SYS}^2$, and `SET WEIGHT CALIBRATION ON` will turn on weighting by $1/F_{CAL}^2$, where F_{CAL} is the amplitude instrumental calibration factor (if amplitudes are relative). Both weighting factors may be applied simultaneously. If both factors are `OFF`, data is weighted proportionally to observing time.

Do not forget to `SET PHASE RELATIVE`, `SET RF ON`, and `SET AMPLITUDE RELATIVE` before you invoke command `TABLE`, otherwise you will tabulate uncalibrated data. The command `TABLE` itself should contain the name of the table:
`TABLE Name Status [/RESAMPLE nc ref val res code]`
where 'Status' is `NEW` to create a new table or `OLD` to extend an existing one (default). The default and recommended file extension for the UV Table is `.UVT`.

Option `/RESAMPLE` resamples the spectrum to a different velocity or frequency resolution, or to select a part of the spectrum only; see internal help for details.

7.2 Going AIPS

You should first convert your table into UVFITS format. This is done by the program GFITS. To invoke in, type GFITS under VMS. The commands are:

```
SET STYLE UVFITS        ! Select type of FITS format
IMAGE name.uvt          ! Define input table
FILE OUT name.uvfits    ! Define output FITS file
WRITE                   ! Write FITS file
EXIT
```

The output file 'name.uvfits' will be accepted by AIPS task UVLOD (use INFILE name.uvfits). You may also produce a UVFITS file on tape for further reduction at any site running AIPS.

Another possibly is the task GILDAS_FITS available in GILDAS (using the programs VECTOR, GRAPHIC, or OVERLAY), with command RUN GILDAS_FITS/EDIT. The initialisation file will be

```
! GILDAS_FITS: Gildas to Disk FITS translator
!          (items)                              (user answers)
TASK\FILE "Input Gildas File" IN$               name.uvt
TASK\FILE "Output FITS file" FITS$              name.uvfits
TASK\INTEGER "Number of bits" NBIT$             16 ! or 32 or -16 or -32
TASK\CHARACTER "Style of FITS file" STYLE$      UVFITS
TASK\GO
```

7.3 Mapping facilities in GILDAS

- The UV Table should first be sorted by task UVSORT, to obtain a UV Sorted Table.
- From the UV Sorted Table, task DFT produces images by Direct Fourier Transform, a simple way, but slow and only practical for continuum images.
- Task UVMAP produces images by gridding and Fast Fourier Transform of a UV Sorted Table.
- Task CLEAN is available for deconvolution with several variants of the CLEAN algorithm.

See the GILDAS documentation for further details.

8 CLIC Language Internal Help

We give here a *fac simile* of the internal HELP file for CLIC. Please consult the internal help itself, which is normally kept up to date.

8.1 Language

```
                        CLIC\ Command Language Summary

                Continuum and Line Interferometric Calibration

ATMOSPHERE      : Perform atmospheric calibration.
COMPRESS        : Compress data.
COPY            : Copy data.
CURSOR          : Call the interactive graphic cursor.
DROP            : Take a scan out of the current index.
DUMP            : List some informations on the R spectrum.
FILE            : Define the input/output files.
FIND            : Search the input file for observations.
FITS            : Write out spectra in FITS format (e.g. for CLASS).
FLAG            : Flag data.
GET             : Read a scan in the input file.
HEADER          : Display some header information.
IGNORE          : Ignore scans from the input file.
LIST            : List header information about an ensemble of scans.
MARK            : Force data to be treated as if flagged.
MASK            : Cause some flags to be ignored.
MINMAX          : compute extremal amplitudes in data
MODIFY          : Edit and change the scan header (and data).
MONITOR         : Process data for total power phase correction parameters.
NEW_DATA        : Wait until new data present in input file.
PLOT            : Plot data according to display options.
PRINT           : Produces an output text file (PRINT BASELINE).
RESIDUALS       : Plot residuals from last SOLVE operation.
SET             : Enter a value for a parameter.
SG_TABLE        : Create a UV data Table for mapping purposes.
SHOW            : Show current value for a parameter.
SOLVE           : Solve for calibration functions.
STORE           : Store calibration functions.
TABLE           : Create a UV data Table for mapping purposes.
TAG             : Change the quality of scans in the output file.
VARIABLES       : Enable/disable CLIC variables
WVR             : Process data for WVR phase correction parameters.
```

8.1.1 Language INFO

```
     *** THIS HELP IS NOT UPTODATE ***

  Main modifications to CLIC since the MAR99 version:
[24-sep-1999] FIND /RECEIVER is now available
[24-sep-1999]  FIND  will  not be case sensitive for Source names and Line
  names.

     Main modifications to CLIC since the JUL98 version:
[29-jan-1999] SET X TCHOP, TCOLD, TCUGSBIN, TDEWAR1,  ...,  TDEWAR3:  Plot
  some temperatures recorded in the receiver cabin.

[13-jan-1999]  SET  PHASE ATM /ANT i j : The phase correction can be vali-
  dated independently  for the different antennas.

[24-Nov-1998] SET X GROUNDS, EMISSION, AIRSS: new items to plot.

[16-oct-1998] SET SCAN, FIND/SCAN: now accept a more general scan list  s1
  s2 s3 s4 ...

     Main modifications to CLIC since the APR98 version:
[19-may-1998]  MODIFY FOCUS: to correct the phases according to the actual
  focus
    position used (should be used only on data prior to November 1996,
    or April 1998 for the few projects using HIGH lock).

[28-apr-1998] SET SELECTION CONT /WINDOW * is now allowed  to  reset  fre-
  quency windows in the building of continuum tables from line subbands.

[28-apr-1998]  LIST/SHORT  will  now  log  the  scan  numbers  is an array
  S_GROUP[2,N_GROUP]

[25-apr-1998] LIST /OFFSET will give the list of position offsets  in  the
  current index (useful for a mosaic session).

  Main modifications to CLIC since the NOV97 version:
[16-feb-1998]  STORE  CORRECTION  AUTO [tmin] : tmin is now accessible (in
  minutes)

[30-jan-1998] SOLVE FLUX now gives the decorrelation  factor  relative  to
  the efficiencies logged in the scan headers.

[24-nov-1997]  SOLVE  FIVE  [/PLOT]  now  possible for five point pointing
  scans.  SOLVE TOTAL/PRINT available.

  Main modifications to CLIC since the APR97 version:
[08-oct-1997] FILE /DIRECTORY: Open a window to edit interactively the raw
  data file directories.
```

[03-sep-1997] SET AMPLITUDE UNSCALED: to reset the SET AMPLITUDE SCALED state (if needed).

[26-aug-1997] SET Y ATMLIDITY: plots the validity of the phase correction (values 0 or 1) as stored by STORE CORRECTION

[26-aug-1997] SOLVE GAIN SCAN to solve gain scan by scan (instead of averaging all scans)

[21-aug-1997] SET Y WIND_AVERAGE, WIND_DIR_AV, WIND_TOP, WIND_DIR_TOP: plots the wind variables (average, direction of average, maximum, direction of maximum)

[17-aug-1997] After a FIND the scans are now time ordered even across the 9999/0001 scan numbering boundary.

[17-aug-1997] STORE CORRECTION SELF works like AUTO, but the phase correction valitity is based on the amplitude of each scan, whether or not it is a phase calibrator.

[27-jul-1997] GET n /HEADER to access the header vatiables of a given observation without acessing the data itself (i.e. the header file only is needed).

[25-jul-1997] SET OBSERVED n1 n2 : use integer representation of dates made possible

[22-jul-1997] variable SHORTLE available after FILE IN : contains the file name without directory or extension.

[04-jun-1997] TABLE /RESAMPLE nchan rchan value inc V|F The syntax of /RESAMPLE has
been changed for compatibility with CLASS: One may now enter the velocity or frequency offset at the reference channel.

[22-may-1997] FILE /WINDOW Open data files via a file browser of the windowing system.

[20-may-1997] SET PHASE ATMOSPHERE NOFILE bypasses the effect of STORE CORRECTION.

[20-may-1997] It is now HIGHLY RECOMMENDED to use the extension ".hpb" when creating header files for calibration.

[20-may-1997] FILE RAW [project] [date] [/WINDOW] This command may be used to open raw data files residing in the directories IPB_DATA:, IPB_DA-

TA1:, IPB_DATA2:, ... assuming they have kept teir original names jj-mmm-yyy-pppp.ipb, (with date and project name), and to create header files for calibration.

Main modifications to CLIC since the DEC96 version:

[07-apr-1997] FITS [name] FITS will now create a fits file (named name-l0i) with each selected line subband.

[04-apr-1997] SET SELECTION LINE DSB This is now allowed in LINE mode, and means that the side band will be automatically selected when the TABLE command is issued, to match the desired frequency range.

[03-mar-1997] SOLVE FLUX [NOREFERENCE] Use the default efficiencies rather than a reference source to set the flux scale.

[03-mar-1997] SOLVE FLUX [BEST n] Average the results of the n antennas giving the highest fluxes to compute the source flux.

[12-feb-1997] COPY HEADERS|DATA [[NO]BASE] [[NO]]ANTENNA 1st argument is now mandatory; second and/or third select which calibration section is created.

[08-jan-1997] STORE CORRECTION GOOD|BAD|AUTO Store, in the header of each scan, whether the atmospheric phase correction will be applied when SET PHASE ATMOSPHERE is used.

Main modifications to CLIC since the NOV95 version:

[29-nov-1996] SET WRITE DATA|NODATA now renamed to SET COPY DATA|NODATA.

[12-nov-1996] STORE QUALITY qual ; change the data quality in the current index (equivalent to a loop of TAG commands).

[12-nov-1996] LIST /VARIABLE variables /FORMAT formats : lists the header variables for scans in the current index; may also be used with /SHORT.

[04-nov-1996] SOLVE POINT, SOLVE FOCUS, SOLVE GAIN, SOLVE DELAY now have an option /PRINT to write an OBS procedure in directory INTER_OBS:

[17-oct-1996] SOLVE HOLOGRAPHY [FREE r1 r2..] : some panel rings may be released from the paraboloid fit.

SET Y AZ_ERR and EL_ERR ; AZ_PH and EL_PH : plot pointing errors, and horizontal coordinates of the phase tracking center.

[04-jun-1996]

SET Y AZ_ERR and EL_ERR ; AZ_PH and EL_PH : plot pointing errors, and horizontal coordinates of the phase tracking center.

[27-may-1996]
MODIFY ANTENNA|BASELINE /OFFSET 89|96 The argument to /OFFSET is mandatory, and selects either the old (89) or the new (96) standard station coordinates.

[14-may-1996]
ATMOSPHERE now checks the efficiencies on phase calibrators, assuming the flux in the header is correct.

[10-may-1996]
- FIND /SOURCE s1 s2 .. sn is now supported. - FIND /SCAN n1 n2 will now loop across 9999/0000 if n1 > n2.

[29-apr-1996]
- CLIC is now dimensioned for FIVE antennas.

[29-apr-1996]
- SET X|Y PARAL_ANGLE:
The parallactic angle can be plotted.

[14-apr-1996]
- SET COPY DATA|NODATA:
A new data access mode. See HELP SET COPY.
- SET BASELINES ALL, SET ANTENNAS ALL:
Use all the baselines, in the data by default. See HELP SET BASELINES,
- SET SUBBANDS ALL, SET SUBBANDS LINE, SET SUBBANDS CONT:
Use all the subbands in the data, switch between line and continuum subbands.
- SET PHASE EXTERNAL|INTERNAL and STORE PHASE /RECEIVER:
A new mode to use the other receiver as a phase reference for phase calibration. See HELP SET PHASE, HELP SOLVE PHASE. See also STORE PHASE.

[07-mar-1996]
- Command PHASE CONTINUOUS:
to recover from a real time problem due to jumps of the LO2.

[07-feb-1996]
- Command MODIFY AXES:
to correct for non intersection of the azimut and elevation axes. See HELP MODIFY AXES. SOLVE BASELINE has also been modified to solve for this parameter using elevation as an X axis.

[17-jan-1996]

```
- Command MODIFY BUG 1:
   to correct for a calibration bug affecting data between 11-nov-1995 and
  09-jan-1996.

[20-dec-1995]
- Command  PLOT /NOFRAME pen
   used to overlay a plot with the previous one, using a different  color.

[28-nov-1995]
- SET PROJECT resets the RF mode to OFF.

      Main modifications to CLIC since the JAN95 version:

[09-nov-1995]
- Implementation of the atmospheric correction.
   See command MONITOR, and SET PHASE ATMOSPHERE.

[08-sep-1995]
- Command SET SORT RECEIVER|SCAN

[25-jun-1995]
- Command SET TIME_ORIGIN

[08-jun-1995]
- command SET UV_RANGE:
   data will not be plotted ouside of this range.
```

8.2 ATMOSPHERE

```
      CLIC\ATMOSPHERE [DETECTOR|CORRELATOR] [/NOWRITE]

  *** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

  Recompute  the  atmospheric (transparency) calibration from the data and
  the informations provided by the SET ATMOSPHERE command.  All  scans  in
  the current index are processed:


    -  Atmospheric  calibration scans (CALI): compute calibration tempera-
    ture Tcal, using either the total power DETECTORs or  the  continuum
    CORRELATOR to measure the atmospheric emission. Default is DETECTOR.
    The data on the atmospheric monitor (the 1.3 mm) receiver will  also
    be  used to compute the phase correction factors (see also the MONI-
    TOR command).
```

- Apply the new model to the subsequent observations and write (update) the recalibrated data if option /NOWRITE is not present. This is done until a new calibration is found.

8.3 COMPRESS

CLIC\COMPRESS timemax uvmax

*** THIS HELP IS NOT UPTODATE ***

Compress data in the current index by averaging successive records in individual scans. 'timemax' is the maximum averaging time in seconds. Data with baseline orientation differing by more 'uvmax' in meters in the UV plane are not averaged, as well as data flagged differently.

Defaults for timemax and uvmax are 60 seconds and 7.5 meters respectively. An output file must have been opened to receive the compressed data.

Use command COPY rather than COMPRESS to copy the whole current index to a new file.

For data taken after September 1992 (new correlator), the command will only compress the temporal data (data header and continuum subbands), since the spectral data is already compressed to 1 record per scan.

8.4 COPY

CLIC\COPY HEADERS|[NO]DATA [[NO]BASE] [[NO]ANTENNA]

Copy the content of the current index to the ouput file. The first argument is mandatory and controls whether the data section is actually written in the output file or not.

COPY DATA selects the old mode, in which the data as well as the headers are copied in the output file.

COPY HEADERS selects the RECOMMENDED mode in which only the headers are copied in the output file. In this new so-called "header file", the data sections are not written but replaced by pointers to the original file. This way, the data file, originally written at Plateau de Bure, is later only used in a read-only mode. All further calibrations are stored in the (much smaller) header file. It is HIGHLY RECOMMENDED to use the extension ".hpb" for the new file containing the headers.

```
Example:
!
! Original file is "14-apr-1996-f081.ipb".
! Create a header file:
!
file in 14-apr-1996-f081.ipb
find
file out f081-b2.hpb new
copy headers
!
! Now open the f081-b2.hpb for input/output
!
file both f081-b2
find
solve phase /plot
store phase
!
! ... and so on as usual
!
```

When the header file is opened for input, CLIC will look for the data sections in the original (read-only) data file. The original data file may be kept locally or reside in any directory, which is pointed to by one of the logical names "IPB_DATA:", "IPB_DATA1:" to "IPB_DATA9:". The original file name MUST BE UNCHANGED, apart from the extension.

Most commands are available in this mode, even commands that affect data amplitudes phases such as ATMOSPHERE, MODIFY BASELINE or MODIFY DELAY. The phase factors are kept in the headers and applied only when the data will be later read again.

There need not be a one to one correspondence between the original ".ipb" file contents and the ".hpb" header file. The header file may refer to only part of the scans in the .ipb file (e.g. omit the IFPB or POINT scans), and it may refer to several .ipb files (e.g. data from two consecutive days).

Arguments [NO]BASE and [NO]ANTENNA control whether respectively the baseline and antenna-based calibration sections are written in the header file. Antenna-based calibration is now the default and omitting the baseline-based sections saves a lot of space. Do not forget to use COPY HEADERS BASE if you foresee you will need baseline-based calibration.

8.5 CURSOR

```
CLIC\CURSOR [mode]
```

Call the interactive cursor, if available on your graphic terminal. This enables you to measure point coordinates and perform some data editing on the result of a PLOT command.

After pressing any key, one of the data points is selected according to the argument 'mode'. In mode D the closest data point from the cursor is selected; in mode X (the default) the data point with closest X coordinate is selected; in mode Y the data point with closest Y coordinate is selected.

The following actions are possible:

- Press any key to get the coordinates of the selected point.

- Press 'H' to display some header information of the selected scan (as with LIST command).

- Press 'K' to delete the selected point from the current plot buffers (type PLOT SAME to replot the buffers). This may be very useful to remove corrupted points from the buffers e.g. before fitting calibration curves.

- Press 'N' to initiate a new range for Ignore, Tag, and Flag (see below). This works only with time-like plots, and is to be used preferrably with coordinates that are monotonous functions of time (scan number, observation number, time, ...)

- Press 'I' to ignore all scans in the current range (initiated by 'N'). This is equivalent to typing the IGNORE command for the same scans.

- Press 'T' to tag all scans in the current range (initiated by 'N'). This is equivalent to typing the TAG command for the same scans. You will be prompted for a quality code in the range 0 to 9 (see TAG command). The quality codes are stored in the output file, which must be equal to the input file.

- Press 'F' to flag all records in the current range (initiated by 'N'). You will be prompted for a list of flags (see FLAG command). These flags will affect the baseline or antenna corresponding to the box you are pointing at. They will be stored in the output file, which must be equal to the input file.

- Press 'E' to exit the cursor mode.

8.6 DROP

```
CLIC\DROP observation [version]
```

Remove an observation from the current index. The version number must be specified if it is not the last in the input file, even if it is the last in the current index. The observation will be ignored until the next FIND command. See also the IGNORE command.

8.7 DUMP

```
CLIC\DUMP arguments [/PLOT]
```

A debugging command that lists a certain number of informations on the last read observation.

- DUMP HEADER argument: lists a certain number of informations about the observation header. Argument may be ALL, HEADER, GENERAL, POSITION, INTERFEROMETER, FREQUENCY, ATMOSPHERE, MONITOR, CONTINNUM, LINE (with optional argument 'iband', dump only subband 'iband'), SCANNING, IC (Instrumental calibration), AIC (Antenna-based Instrumental calibration), PC (RF Passband calibration), APC (Antenna-based RF Passband calibration), DD (Data Descriptor), WVR (Water Vapor radiometer), PHASES.

- DUMP DATA: lists the data associated parameters.

- DUMP FILE: lists information about the input and output files.

- DUMP INDEX: lists information about the current index.

- DUMP VIRTUAL: gives the virtual memory and paging file quotas.

- DUMP SIZE: gives the values of a number of key variables that define the size of the problem.

- DUMP CONTINUUM: dumps the continuum data.

- DUMP LINE c1 c2: dumps the spectral data from channel c1 to c2. DUMP LINE c1 c2 /PLOT will plot the spectral data amplitude as a function of channel number.

DUMP DATA, DUMP CONTINUUM and DUMP LINE will return the phase-corrected or uncorrected data, depending on the last SET PHASE ATM or SET PHASE NOATM command issued.

8.8 FILE

```
CLIC\FILE [type] [name] [NEW] [/WINDOW]
```

Selects the input and output files.

```
FILE IN Name            defines the input file.
FILE OUT Name [NEW]     defines the output file, and
                        initializes it if NEW is precised.
FILE BOTH Name          selects the same file for input and output.
```

The default filename extension is ".hpb". With FILE IN, the extension ".ipb" is also checked. This behaviour can be changed using the command SET EXTENSION. The character variable SHORT_FILE is available after a FILE IN: it contains the file name without directory or extension. With option /WINDOW (if the windowing system is active), a panel window is created and the file name may be selected via a file browser ('Name' is then used as a filter). Pressing GO will then open the file.

```
CLIC\FILE RAW [project] [date] [/WINDOW] [/DIRECTORY]
```

FILE RAW [Project] [Date] will select the first file residing in the directories IPB_DATA:, IPB_DATA1:, ..., IPB_DATA9:, which matches the optionally given project name and date, following the standard name convention used at Plateau de Bure (jj-mmm-yyyy-proj.ipb, or YMJJPROJ.IPB for CDROMs). The names of all the NFILE files matching the project name and date are put in character array DATAFILE[NFILE] (the integer variable NFILE is also defined).

FILE RAW [Project] [Date] /WINDOW (if the windowing system is active) will create a panel window with a menu to select one of the available files, and two action buttons, one for opening the file, the other for creating a header file for calibration.

FILE RAW /DIRECTORY (if the windowing system is active) creates a panel window with a menu to edit the list of raw data file directories (logical names IPB_DATA:, IPB_DATA1:, ...)

8.9 FIND

```
CLIC\FIND [APPEND] [NEW_DATA] [/LINE lname] [/NUMBER n1 n2]
[/SCAN s1 s2 [s3 s4 ...]] [/OFFSET o1 o2] [/PROCEDURE proc1 [...]]
[/QUALITY q] [/SOURCE s1 s2 ... sn] [/TELESCOPE tel] [/TYPE type]
[/RECEIVER number]
```

FIND performs a search in the input file to build a new index, according to selection criteria defined by the SET command. These criteria can be

listed with the SHOW CRITERIA command. They may be temporarily modified by the following options :

```
/LINE lname          search by line name
/NUMBER n1 n2        search for the specified range of obs. numbers
/SCAN s1 s2 [s3 s4]  search for the specified range(s) of scan numbers
/OFFSET o1 p2        search for these offsets
/PROCEDURE p1 .. pn  search by procedure name(s)
/QUALITY q           search for the data of quality better than q
/SOURCE s1 ... sn    search by source name
/TELESCOPE tel       search for the specified telescope name
/TYPE type           search by source type
/RECEIVER number     search by receiver number
```

FIND /SCAN s1 s2 [s3 s4 ..] will loop across the 9999/0001 border if s1 (s3) is larger than s2 (s4). Using several source names in FIND /SOURCE is now supported. Source name and Line name matching is not case sensitive.

The current index is ordered by scan number or receiver number depending on the last command SET SORT issued. However the scan ordering is done modulo 9999 (i.e. the time order is respected if the 9999/0001 transition occurs in the current index).

FIND by default overwrites the current index. Found observations may be appended to the current index by specifying the argument APPEND; an index compression occurs to avoid duplication of scans in the index.

FIND does not return an error if the index is empty, but the variable FOUND is set to 0. FOUND is always set to the number of observations in the index. The command IGNORE can be used to declare a list of observations to be ignored by the FIND command.

Argument NEW_DATA can be used to wait until new data is present in the input file. This possibility is intended for sites where data acquisition is done in CLIC format (Plateau de Bure) to use CLIC as an automated quick look facility. The behaviour is similar to that of command NEW_DATA, but all selection criteria are considered and no switching to a new observation type occurs.

8.9.1 FIND /POLAR

```
CLIC\FIND /POLAR argum
```

Find scan corresponding to a given state, where X and I indicate cross and direct switches for (physical) antenna i. Possible choices are: XXXXXX IIIIII XIXIXI IIXXII IXXIIX XXIIII XIIXIX IIIIXX IXIXXI

8.10 FITS

```
CLIC\FITS name
```

Create for each selected line subband a FITS file containing the spectral data. The fits file names are e.g. name-l01.fits, name-l02.fits, name-l03.fits (one fits file is created for each subband), if one has specified SET SUBBAND L01 L02 L03.

For autocorrelation data, the data from all antennas are averaged. For correlation data, the complex data from all baselines are averaged and the real part of the resulting visibility is used.

This command allows to easily write out spectra from point-like sources to be further analyzed in CLASS. Reading the data in CLASS and writing them in a CLASS-format file can be done with a procedure like:

```
FILE OUT myfile NEW
FITS READ name-l01.fits
WRITE next_obs
FITS READ name-l02.fits
WRITE next_obs
etc..
```

8.11 FLAG

```
CLIC\FLAG f1 f2 ... [/ANTENNA a1 [...]] [/BASELINE b1 [...]]
[/RESET]
```

Flag the current record (obtained by GET /RECORD) with flags f1 f2 ...

Flags may be relative to antennas or baselines. One of the options /ANTENNA or /BASELINE, with lists of antenna numbers or baseline names as arguments, must therefore be given. /ANTENNA ALL will flag all antennas, /BASELINE ALL will flag all baselines. These are the default.

Supported flag names are:

- C01 to C08 for bad individual continuum correlator subbands
- L01 to L08 for bad individual spectral correlator subbands
- DATA for bad data
- TSYS for too high system temperature (antenna based only)
- LOCK for out of lock local oscillator (antenna based only)
- POINTING for poor pointing (antenna based only)

- SHADOW for antenna being shadowed by another antenna (ant. based only)
- SATURATION for too high total power on a particular antenna
- TIME for time discontinuity
- DOPPLER for doppler discontinuity
- REDU for data reduction

Use option /RESET to suppress flags that were accidentally set.

FLAG with no argument lists the flags of the current record.

This command may be used in a MODIFY DATA or MODIFY RECORD loop, to flag data. If more than one record is to be flagged, command STORE FLAG is HIGHLY RECOMMENDED.

8.12 GET

CLIC\GET [n|FIRST|NEXT] [/RECORD r] [/HEADER] [/ATM]

GET loads the observation number n. If n is absent, the previous (last read) observation is recovered. If instead of a number the keyword "FIRST" is given, the first observation of the current index is loaded. With "NEXT", the next observation in the current index is loaded.

If option /RECORD is present, only record r is loaded. Otherwise, the average record is loaded; it contain by default the uncorrected data unless option /ATM is present, in which case the phase-corrected record is loaded if it exists.

If option /HEADER is present, only the scan header is read. No data record is accessed. This command does not access the data file if only the header file is available.

8.13 HEADER

CLIC\HEADER

Displays some header information on the current observation.

General information line
Observation number
Scan number
Project Id
Source name
Source type (Object or Phase calibrator)
Procedure name
Interferometer configuration

```
    Date of observation
    UT of observation
    Hour angle

Position information line
    RA or L : right ascension or longitude (or azimuth)
    DEC or B : declination or latitude (or elevation)
    Epoch if equatorial coordinates are used
    Offsets in current units
    Type of coordinate (Eq, Ga, Ho)
    Flux of the source

Quality information line
    Quality code
    Flag
    Receiver number
    Number of dump
    Azimuth
    Elevation

Spectral line information line
    Line name
    Rest frequency
    Sideband
    Doppler correction
    Source velocity

Correlator information, for each subband
    Logical name
    Width (MHz)
    Central IF (MHz)
    Physical unit
    Quarter [for new receivers only]
    Polarization [for new receivers only]
    Narrow-band correlator input [for new receivers only]

Interferometer status, for each antenna
    Antenna number
    Station
    Azimuth, Elevation, Focus corrections
    Receiver temperature (K)
    Image rejection (dB)
    Water (mm)
    System temperature (Tsys)
```

8.14 IGNORE

```
CLIC\IGNORE list_of_observations
```

This command can be used to declare the specified list of Observations (from the input file) to be ignored in all FIND operations. They effectively become invisible to CLIC (except in a LIST IN command), until a FILE IN command is typed again. The input file is not physically modified however. The list of observation can be given using the same format as with a FOR command (e.g. n1 n2 n3 TO n4 BY n5 n6 TO n7).

8.15 LIST

```
CLIC\LIST [key] [/SHORT] [/BRIEF] [/LONG] [/OUTPUT file]
[/PROJECT] [/SOURCE] [/VARIABLE var_list [/FORMAT format_list]]
[/OFFSET] [/FLAG]
```

This command lists header information of an ensemble of observations. LIST is used for a quick look to observation headers, in a more or less detailed format. 'Key' specifies the file to be listed: IN or OUT; if 'Key' is not present, the current index (as determined by the last FIND command) is listed. The list will be ordered by scan numbers or by receiver number, depending on the command SET SORT SCAN|RECEIVER. For each observation, a medium-sized format is used by default. This can be modified using the options:

LIST /BRIEF

Brief format (observation numbers and version numbers only).

LIST /LONG

Long format (not allowed for the output file). Several lines can be listed for each scan, that can be selected using the SET FORMAT command.

LIST /SHORT

Gives only one line for a set of scans with same parameters; IFPB and CALI are not listed. The first and last scan of each group are logged in array S_GROUP[2,N_GROUP], N_GROUP is the number of groups.

The output of the LIST command can be written in an output file instead of the terminal using the "/OUTPUT File" option. LIST can also be used to to list a number of specific parameters:

LIST /FLAG

List data flags for current index.

LIST /PROJECT

List the observing projects in the current index. The number of differents offset positions is in variable N_OFFPOS, the offsets are in array OFFPOS[2,N_OFFPOS].

LIST /SOURCE

List the observed sources in the current index. The number of different source is in variable N_SOURCE, the source names in character array C_SOURCE[N_SOURCE].

LIST /OFFSET

List the observed position offsets for the current index.

LIST /VARIABLE var_list

List the value of the header variables given in var_list. These variables must have been defined by command VARIABLE. If "/FORMAT format_list" is also given, each variable in the list is printed according to the associated format item. The format items must match the variable types. With option /SHORT, a line is printed only if at least one of the variables has changed, and is preceded by the corresponding scan number range.

Example: LIST /VARIABLE FREQUENCY IFCEN[2] /FORMAT f10.3 f6.3 /SHORT gives the sky rest frequency and the central IF frequency of subband L02, as a function of scan numbers. These variables must have been previoulsy defined using VARIABLE RF and VARIABLE LINE.

8.16 MARK

CLIC\MARK f1 f2 ... [/ANTENNA i][/BASELINE ij] [/RESET]

*** THIS HELP IS NOT UPTODATE ***

Set the antenna or baseline mark words.

To decide whether data should be used, CLIC uses the logical OR of the data flag words with the corresponding mark words. Thus data from some subbands may be [temporarily] ignored even if unflagged. Flags may be relative to antennas or baselines. /ANTENNA or /BASELINE must be

given, with antenna numbers or baseline names as arguments. Several antennas and baselines may be given simultaneously. Use /ANTENNA ALL or /BASELINE ALL for all antennas or all baselines.

Flag names f1 f2 ... are alphanumeric codes. Valid codes are subband names (C01 to C10, L01 to L06), DATA, POINTING, SHADOW, TSYS, SATURATION and LOCK and REDU

Use option /RESET to reset flags that were accidentally set in the mark words.

MARK with no arguments (just options) will list the MARK words currently in use.

8.17 MASK

```
CLIC\MASK f1 f2 ... [/ANTENNA i1 [...]] [/BASELINE b1 [...]]
[/RESET]
```

This commant causes some flags to be ignored by setting the antenna or baseline "mask" words. Data flagged will normally not be processed by calibration commands. However flags set in the corresponding mask word will be ignored, causing data to be processed anyway. Flags may be relative to antennas or baselines. One of the options /ANTENNA or /BASELINE must therefore be given, with antenna numbers or baseline names as arguments.

Supported flag names are:

- C01 to C08 for bad individual continuum correlator subbands
- L01 to L08 for bad individual spectral correlator subbands
- DATA for bad data
- TSYS for too high system temperature (antenna based only)
- LOCK for out of lock local oscillator (antenna based only)
- POINTING for poor pointing (antenna based only)
- SHADOW for antenna being shadowed by another antenna (ant. based only)
- SATURATION for too high total power on a particular antenna
- TIME for time discontinuity
- DOPPLER for doppler discontinuity
- REDU for data reduction

Use option /RESET to remove flags from the mask works.

MASK with no arguments will list the mask words currently in use.

8.18 MINMAX

CLIC\MINMAX

This command is used to compute extremal amplitudes on the current observation (loaded e.g. with GET). It processes all continuum and line data, USB and LSB. Results for the continuum subbands are stored in variables C_MAXAMP_U, C_MINAMP_U, C_MAXAMP_L, C_MINAMP_L, and results for the line subbanbds in variables L_*.

This command may be used in a MODIFY DATA or MODIFY RECORD loop, to search for bad data.

8.19 MONITOR

CLIC\MONITOR delta_time

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

This command is used to prepare the atmospheric phase correction based on the total power monitor (normally done at 1.3 mm). It process all scans in the current index and performs two operations.

First, it processes the calibration scans to compute the correction factors. i.e. the change of path length for a given change in emission temperature of the atmosphere at the atmospheric monitor frequency (normally 1.3 mm, i.e. using Receiver 2 data). These correction factors are then written in subsequent scans, until a new calibration is found.

Second, the scans in the current index are grouped in intervals of maximum duration 'delta_time' (in seconds); source changes will also be used to separate intervals. In each interval a straight line is fitted in the variation of atmospheric emission as a function of time; this line will be the reference value for the atmospheric correction, i.e. the correction at time t is proportional to the difference between the atmospheric emission at time t and the reference at time t. This scheme is used to avoid contaminating the correction with total power drifts of non-atmospheric origin (changes in receiver noise and gain, and changes in ground noise).

MONITOR 0 will use for each scan the average of the atmospheric emission as the reference value. This will cause the correction to average to zero in one scan: the average phase is not changed, only the coherence is restored leading to an improved amplitude (this is what is done in the correlator at the Plateau de Bure to compute the scan-averaged spectral and continuum quantities).

8.20 MODIFY

```
CLIC\MODIFY Item [Values...]
```

This is a command to change some parameters relevant to data acquisition, such as baseline values, time, position of phase center, delay, etc. MODIFY applies to the current index. An output file must be opened (it may be equal to the input file).

Note the special behaviour of MODIFY HEADER, MODIFY DATA, and MODIFY RECORD, which execute an external script to modify the data and/or the header, hence giving to the user a large flexibility in the possible changes.

The MODIFY command is to be used with great caution, as it can directly affect the data. There's no telling what can happen if this command is wrongly used. So please consult an expert before any action.

8.20.1 MODIFY ANTENNA

```
CLIC\MODIFY ANTENNA a1 x1 y1 z1 [a2 x2 y2 z2 ...] [/OFFSET 89|96]
CLIC\MODIFY ANTENNA FITTED
```

Modify the vector coordinates for antenna a1 to be: x1, y1, z1 (meters), and the phases accordingly. Keyword FITTED will load the antenna coordinates the most recenty found by the SOLVE BASELINE command.

Use option /OFFSET 96 to enter antenna coordinates offsets instead (i.e. offsets from the new (1996) standard antenna positions in STATION.DAT). For the old procedures use /OFFSET 89.

8.20.2 MODIFY AXES_OFFSET

```
CLIC\MODIFY AXES_OFFSET a1 x1 [a2 x2 ...]
```

Correct the phases for the offset of the elevation axis with respect to the azimuth axis. This effect, if different for different antennas, causes a phase offset proportional to frequency and to the cosine of elevation. a1 is the antenna number, x1 the offset between axes in meters. The actual values should be at most 1 mm, and may be measured using the command SOLVE BASELINE, using SET X ELEVATION in addition to Hour angle and declination.

8.20.3 MODIFY BASELINE

```
CLIC\MODIFY BASELINE b1 x1 y1 z1 [b2 x2 y2 z2 ...] [/OFFSET 89|96]
```

CLIC\MODIFY BASELINE FITTED

Modify the vector coordinates for baseline b1 to be: x1, y1, z1 (meters), and the phases accordingly. Keyword FITTED will load the baseline coordinates the most recenty found by the SOLVE BASELINE command.

Use option /OFFSET 96 to enter baseline coordinates offsets instead (i.e. offsets from the new (1996) standard antenna positions in STATION.DAT). For old procedures, referring to the old (1989) station values, use /OFFSET 89 instead.

8.20.4 MODIFY BUG

CLIC\MODIFY BUG number

This command is reserved for the correction of nasty bugs in the data acquisition. The number is used for identification.

Current accepted values:

1 Affecting data taken between 11-nov-1995 and 09-jan-1996. Bug in RDI found by S.Guilloteau. The continuum data was erroneously calibrated in the real-time aquisition. As result, the continuum data did not agree with the average of the spectral data. For instance plotting data with "set sub C02 L02" as a function of time gives different results for C02 and L02. The result would affect line intensities if, as is usually the case, the amplitude calibration is done with the continuum subbands.

Correction: the current index should contain both atmosphere calibrations and correlation data; the data file should be open for both input and output. This command should not affect data taken before 11-nov-1995 and after 09-jan-1996; be careful for the last day since the hour is not checked, and RDI was corrected at 3pm.

2 No other bug so far!

8.20.5 MODIFY CABLE

CLIC\MODIFY CABLE arguments

Modify the cable phase.

MODIFY CABLE a1 a2 a3 a4 a5 a6 corrects for a permutation of the cables to the phasemeters. Phasemeters 1 2 3 4 5 6 are assumed to be connected

to the antennas a1 a2 a3 a4 a5 a6.

MODIFY CABLE CONTINUOUS corrects the cable phases to be continuous (should use only the correlations, without LOCK flag, for which the phases have a meaning).

MODIFY CABLE FACTOR f asssume the phase correction applied has to be multiplied by f (replaces the old MODIFY CABL2).

8.20.6 MODIFY DELAY

CLIC\MODIFY DELAY a1 d1 [a2 d2 ...] [/OFFSET]

Modify the delay for antenna a1 to be d1 (nanoseconds), and recompute the phases accordingly.

Use option /OFFSET to enter delay changes with respect to the previous values.

8.20.7 MODIFY DOPPLER

CLIC\MODIFY DOPPLER

Computes the Doppler velocity correction, in case it was not taken into account at the time of observing. The LO2 frequency in the header is assumed to be the frequency actually used. A warning is issued if the LO1 frequency in the header is not coherent with the LO2 frequency (which means the phase tracking might be in error, since it uses that LO1 frequency).

The frequencies and line names introduced by SET FREQUENCY are used to define the velocity scales for each subband/sideband.

8.20.8 MODIFY FLUX

CLIC\MODIFY FLUX value

Modify the flux of the source as stored in the header. In SET AMPLITUDE SCALED mode, the amplitude will be divided by this number before plotting.

8.20.9 MODIFY FOCUS

CLIC\MODIFY FOCUS [antenna1 value1 antenna2 value2 ...]

Correct the phases for the offsets in focus, introduced to optimize efficiency. antenna1 is the antenna number, value1 the focus offset in mm, and so on. The phases are normally corrected in real time since 1996-nov-29. Between 1996-may-29 and 1996-nov-29, the focus corrections were logged in the data files. Before 1996-may-29 they are only in the log-obs files. Between 1996-nov-29 and 1998-apr-02, the correction had wrong sign for the few projects using HIGH LOCK.

So use MODIFY FOCUS with NO arguments for data more recent that 1996-nov-29: this should correct the HIGH LOCK problem. Between 1996-may-29 and 1996-nov-29, MODIFY FOCUS with no arguments will use the focus offsets in the header and apply the corresponding phase offsets.

For older data you may now search for the focus changes in the log files to apply the phase corrections before calibration; or use jumps in the phase calibration (SOLVE PHASE /BREAK) just as you had done before.

8.20.10 MODIFY FREQUENCIES

CLIC\MODIFY FREQUENCIES

The frequencies and line names introduced by SET FREQUENCY are used to re-define the velocity scales for each subband/sideband. By default, the frequency and line name entered in OBS for at data aquisition on the Plateau de Bure is used for all sidebands and subbands.

8.20.11 MODIFY PHASE_SIGN

CLIC\MODIFY PHASE_SIGN

Change the sign of all phases of the data in the current index. This command is intended for recovering data taken in a preliminary status of the new correlator software.

8.20.12 MODIFY POSITION

CLIC\MODIFY POSITION EQ Epoch R.A. Dec.

Modify the source (phase center) position. This precesses the phases accordingly. Note that this cannot change the antenna pointing center. Typical use of this command is to correct positions of inaccurate phase calibrators.

8.20.13 MODIFY REFERENCE

```
CLIC\MODIFY REFERENCE UPPER|LOWER r1 r2 ...
```

The reference channels in the available line subbands are changed to the new values. Use with caution: this command is actually changing the frequency and velocity scale of your data.

8.20.14 MODIFY SCALE

```
CLIC\MODIFY SCALE amplitude phase
```

Multiply all data in the current index by this (complex) scale factor. To be used in case of emergency only!.

8.20.15 MODIFY TELESCOPE

```
CLIC\MODIFY TELESCOPE
```

Compute the telescope name (i.e. the configuration name) according to the new rules.

8.20.16 MODIFY TIME

```
CLIC\MODIFY TIME dut1
```

Modify the time constant DUT1 (in seconds) and recompute the phases accordingly. For very high accuracy astrometry, DUT1 may need to be adjusted afterwards to correct for irregularities for the earth rotation. The "a priori" estimates may be wrong. Another case is the leap seconds, if they are introduced asynchronously with the DUT1 constant...

8.20.17 MODIFY VELOCITY

```
CLIC\MODIFY VELOCITY New_vel
```

The source velocity is changed to New_vel. Use with caution: this command is actually changing the frequency and velocity scale of your data.

8.20.18 MODIFY HEADER

```
CLIC\MODIFY HEADER procedure
```

This is a general command to edit the header of the scans in the current index.. CLIC enters a loop in which all the headers are read succes-

sively. For each header the procedure 'procedure' (default extension ".clic") is executed. This procedure may only contain the following commands : DUMP, HEADER, GO, or any SIC command that acts on variables. Especially, variables defined by the VARIABLE command can be modified...

The command GO [WRITE] must end the procedure. With GO WRITE, the scan header will be updated; with only GO, the scan header is not updated and CLIC loads the next scan header in the current index. If no GO command in encountered in the procedure, the loop is aborted. If a PAUSE command is found in the procedure, the PAUSE is executed, but the prompt changes to "MODIFY>". The same commands as above may then be executed from the keyboard; "QUIT ALL" may be used to abort the loop.

8.20.19 MODIFY DATA

CLIC\MODIFY DATA procedure [/BEFORE date] [/AFTER date] [/ATM]

This is a general command to edit the data headers of the scans in the current index. CLIC enters a loop in which for all scans in the current index, the data header of the average record is read. For each scan the procedure 'procedure' (default extension ".clic") is executed. This procedure may only contain the following commands : DUMP, HEADER, FLAG, MINMAX, GO, or any SIC command that acts on variables. Especially, variables defined by the VARIABLE command can be modified...

The command GO [WRITE] must end the procedure. With GO WRITE, the data record will be updated; with only GO, the data record is not updated and CLIC loads the next record from the current index. If no GO command in excountered in the procedure, the loop is aborted. If a PAUSE command is found in the procedure, the PAUSE is executed, but the prompt changes to "MODIFY>". The same commands as above may then be executed from the keyboard; "QUIT ALL" may be used to abort the loop.

The options /BEFORE and /AFTER allows to select data depending on their observing dates.

If present, the /ATM option allows to modify the data header of the phase corrected average record (will work only if such record is present in the data, so only on cross-correlations: CROSS, FLUX, POINT, GAIN ...)

8.20.20 MODIFY RECORD

CLIC\MODIFY RECORD procedure [/RECORD idump] [/BEFORE date] [/AFTER date]

This is a general command to edit the data headers of the scans in the current index. CLIC enters a loop in which all the data header of all records of all scans in the current index are read successively. In the case the option "/RECORD idump" is used, only the record number idump is read. For each record the procedure 'procedure' (default extension ".clic") is executed. This procedure may only contain the following commands : DUMP, HEADER, FLAG, MINMAX, GO, or any SIC command that acts on variables. Especially, variables defined by the VARIABLE command can be modified...

The command GO [WRITE] must end the procedure. With GO WRITE, the data record will be updated; with only GO, the data record is not updated and CLIC loads the next record from the current index. If no GO command in excountered in the procedure, the loop is aborted. If a PAUSE command is found in the procedure, the PAUSE is executed, but the prompt changes to "MODIFY>". The same commands as above may then be executed from the keyboard; "QUIT ALL" may be used to abort the loop.

The options /BEFORE and /AFTER allows to select data depending on their observing dates.

8.21 NEW_DATA

```
CLIC\NEW_DATA [time] [tries]
```

Waits until new data has been written to the input file, then makes a new index from all new data. The type of observation can be changed by this command, but the index will contain only observations of one type. Selection criteria defined by command SET are ignored.

This command can be used to make a quick look or analysis of data produced by a real time acquisition system (Plateau de Bure). Caution: only two programs should access the input file simultaneously, one for writing the other for reading.

The first argument is the time interval between two consecutive inspections of the file index; the second is the allowed number of unsuccessful attempts to find new data in the file. The defaults are 10 seconds and 12 tries (two-minute timeout).

8.22 PLOT

```
CLIC\PLOT keyword [/IDENTIFY [COLOUR]] [/NOFRAME [pen]] [/NODRAW]
[/RECORD list_of_records] [/RESET] [/APPEND] [/PHYSICAL]
```

Plot data from the current index according to options selected by the

CLIC\SET command.

PLOT [ALL]

Erases the screen and plots all data in the current index (default).

PLOT FIRST

Erases the screen and plots data from the first observation in the current index.

PLOT NEXT

Plots data from the next observation in the current index. Does not clear the screen before plotting.

PLOT number

Plots data from the observation of the given number (must be in the current index). Does not clear the screen before plotting.

PLOT SAME

Plots again the last plotted buffers (with possibly new options, such as line type, limits, ...).

PLOT /NOFRAME [Pen]

Does not erase the screen, and plots data in the present boxes, optionally with a new pen. This is very useful for comparing data. It can also be used in conjunction with PLOT /APPEND.

PLOT /NODRAW

Does not produce the plot but read all data and update the X and Y buffers. This is very useful to e.g. modify these buffers in SIC before actual plotting (with PLOT SAME).

PLOT /RECORD list_of_records

Plots only some records for the observation(s). "list_of_records" is of the format n1 to n2 n3 n4 to n5, as with the SIC\FOR command.

PLOT /IDENTIFY [COLOR]

Plots a different GREG symbol for each source (if SET PLOT POINT is currently active). Using optional argument COLOR will produce points

also differing by color.

PLOT /PHYSICAL

Plot labels use physical antenna number rather than logical numbers.

PLOT /RESET

Reset the time origin (and, by consequence, the time-dependent amplitude and phase calibration curves) before plotting.

PLOT /APPEND

Does not reset the previous buffers before reading data and plotting. This may be used at the Plateau de Bure for incrementally plotting new data just after it is written on disk.

After the plot, the arrays X_VALUE and Y_VALUE contain the values of the points that have been displayed. N_BOXES is the number of boxes that have been plotted.

8.23 PRINT

CLIC\PRINT Item

Prepares a procedure for further use.

PRINT BASELINE

Prepares a procedure to be used in OBS to enter the most recently fitted baseline parameters (SOLVE BASELINE command). This procedure also contains (but commented out) the CLIC\MODIFY command to edit previous data to the same fitted baseline parameters.

PRINT DELAY

Prepares a procedure to be used in OBS to enter the most recently fitted delay parameters (SOLVE DELAY command).

PRINT FLUXES

Prepares a procedure to be used in CLIC to re-enter the most recently determined source fluxes (SOLVE FLUX command).

8.24 RESIDUALS

CLIC\RESIDUALS item

Clear the graphic screen and plot the residuals from last SOLVE command. "item" can only be "BASELINE" up to now.

8.25 SAVE

CLIC\SAVE name

[STILL UNIMPLEMENTED]

SAVE creates a procedure file of name "name.clic", containing all the current parameters of the program. This file may be executed at any time using the @ command : just type "@ name" after the CLIC> prompt, or pass "@ name" as a parameter when invoking CLIC (by typing "CLIC @ name"). This file is composed of standard CLIC commands, and may be edited with any text editor.

8.26 SET

CLIC\SET Keyword [Value1 [Value2 [...]]] [/DEFAULT]

This command is used to specify a value for a parameter used by CLIC. These values may be temporarily overridden by the options of some commands (e.g. FIND).

Each "SET Keyword" command has an equivalent "SHOW Keyword" command that display the current status. SET /DEFAULT restores all default values.

8.26.1 SET AMPLITUDE

CLIC\SET AMPLITUDE [ABSOLUTE|RELATIVE] [SCALED|UNSCALED]
[KELVIN|JANSKY] [ANTENNA|BASELINE]

This command controls which scaling factor is applied to the data for plotting and writing in the output table, in subsequent PLOT and TABLE commands:

- ABSOLUTE means that the relative amplitude calibration is not applied.

- RELATIVE means that the relative amplitude calibration, as determined with SOLVE AMPLITUDE, and stored with STORE AMPLITUDE, is applied.

- SCALED means that the absolute amplitude is divided by the source flux; SCALED is only used for the command SOLVE AMPLITUDE.

- KELVIN|JANSKY indicates the unit in which the amplitude are displayed: either Kelvins (in main-beam brightness temperature) or Janskys.

SET AMPLITUDE ABSOLUTE forces SET AMPLITUDE KELVIN since the uncalibrated data are measured in Kelvins. With SET AMPLITUDE RELATIVE, the amplitudes are in Janskys, since a calibrator of known flux has been used for reference. If the default is overridden (SET AMPLITUDE ABSOLUTE JANSKY or SET AMPLITUDE RELATIVE KELVIN), conversion factors (=antenna efficiencies) are taken from the scan headers; these factors may be determined by SOLVE FLUX and stored by STORE FLUX.

SET AMPLITUDE ANTENNA|BASELINE switches between Antenna-based and Baseline-based amplitude calibrations. This switch will be active for SOLVE AMPLITUDE (calibration curve determination), STORE AMPLITUDE (calibration curve storing operation), and SET AMPLITUDE RELATIVE (application). Both baseline-based and antenna-based calibration curves may be stored alongside in the data header, independently of each other. Using SET AMPLITUDE ANTENNA is recommended.

8.26.2 SET ANGLE

```
CLIC\SET ANGLE unit
```

Specify the angle unit for offsets. May be R[adian], D[egree], M[inute of arc], S[econd of arc]. Default is SECOND. The ANGLE unit is also used to display Continuum drifts.

8.26.3 SET ANTENNAS

```
CLIC\SET ANTENNAS [a1 a2 ...]
CLIC\SET ANTENNAS ALL
```

Selects the antennas for which data will be displayed by command PLOT. This command is exclusive with commands SET BASELINES and SET TRIANGLES.

Parameters which may be displayed in this antenna-mode are obvious antenna-based parameters such as cable phase, LO-phase and rate, ... With SET Y AMPLITUDE and when more than 3 antennas are available in the data, antenna amplitude is computed by averaging all possible "triangular ratios" of baseline amplitudes. With SET Y PHASE a phase is attributed to each antenna by setting the phase of antenna 1 to zero, and making use

of closure relations for other antennas (least square fit). This is useful for fitting baselines for instance (it enables one to determine directly antenna position offsets).

SET ANTENNA with no arguments selects all antennas present in the baselines previously in use. SET ANTENNA ALL will select all the antennas available in the first scan of the current index, for each command accessing the data (e.g. PLOT). This is the default.

Note that SET ANTENNA also allows to select the antenna to be processed by the SOLVE HOLOGRAPHY command (if several antennas are selected, the first one in the list is processed).

8.26.4 SET APC

CLIC\SET APC status

*** THIS COMMAND IS OBSOLETE ***

8.26.5 SET AVERAGING

CLIC\SET AVERAGING mode

Selects time averaging of data plotted (the data in the file is unaffected). 'mode' may be :

- NONE : all data points are plotted.
- SCAN : the scan-averaged data is used and only one point is thus plotted per scan.
- TIME dt : data is averaged in time intervals of length dt (seconds). Data of consecutive scans is NOT averaged together.
- METHOD VECTOR : complex visibilities are averaged as complex numbers.
- METHOD SCALAR : amplitude and phases of visibilities are averaged separately.

This command obviously does not affect the spectral data. See also SET BINNING for another way of averaging data.

8.26.6 SET ASPECT_RATIO

CLIC\SET ASPECT_RATIO value [AUTO|EXACT]

Choose a default aspect ratio (x_size/y_size) for boxes plotted by command PLOT. If several boxes must be plotted (depending on subbands, baselines, or sidebands selected), the plot page will be partitioned in order to:

- AUTO mode: approach this aspect ratio for each box while filling the whole page.

- EXACT mode: use this aspect ratio for each box (part of the plot page will be left blank).

The default is 2.0 AUTO.

8.26.7 SET ATMOSPHERE

CLIC\SET ATMOSPHERE Argument Value /ANTENNA a1 [a2 ...]

Selects the way atmospheric calibration is done by command ATMOSPHERE, Argument may be FILE, AUTO, TREC, or MANUAL. This will affect the antennas given in argument to the option /ANTENNA (/ANTENNA ALL selects all antennas). Argument may also be NEW, 2009, 2003, OLD, 1985, to switch between atmospheric model versions or INTERPOLATE to use tabulated atmospheric model (defined to be GAG_ATMOSPHERE) ; option /ANTENNA is not required in that case.

- In FILE mode the actual mode is taken from the data header, as given in the OBS program.

- In TREC mode the receiver temperature is assumed known, to set the scale of measured sky temperature and optical depth, and determine the system noise temperature. The receiver temperature is taken from the data header, as given in OBS. It may be forced to a different value by giving it as second argument 'value', or by the SET TREC command.

- In AUTO mode the water wapor content is assumed known; it is determined from the antennas in TREC mode, if any, or taken from the data header, or forced to the value given in the second argument 'value', or by the SET WATER command.

These parameters, together with the wheather station data, are used to compute the system noise temperature for each antenna. In MANUAL mode, no model atmosphere is used, but the values of optical depths and atmospheric temperatures stored in the data.

- OLD or 1985 (the default) select the old ATM model, in use at IRAM

since circa 1985.

- 2003 select the 2003 version of the ATM model,developed by Juan Pardo in ISM in Madrid. For this, the new ATM library must be available. If not the old ATM will be used.

- NEW or 2009 select the 2009 ATM model,developed by Juan Pardo in ISM in Madrid. For this, the ATM library must be available. If not the old ATM will be used.

- INTERPOLATE will use a tabulated file produced by ASTRO\ATMOSPHERE MAKE. This option should not be used, as the use of tabulated file is only used to speed up calculations at Bure.

8.26.8 SET BANDS

```
CLIC\SET BANDS b1 b2 ...
```

Selects the sidebands for which data will be displayed by command PLOT. Valid codes are "UPPER" or "USB", "LOWER" or "LSB", "AVERAGE" or "DSB", "DIFFERENCE", and "RATIO".

In "AVERAGE", "DIFFERENCE" or "RATIO" modes, the sidebands visibilities are corrected before combination for their relative phases, as determined by the RF bandpass calibration. If no RF bandpass calibration is available (i.e. stored with the data), the relative phases are obtained by averaging the continuum subbands (which is useless if no continuum emission is detected).

8.26.9 SET BASELINES

```
CLIC\SET BASELINES [b1 b2 ...]
CLIC\SET BASELINES ALL
```

Selects the baselines for which data will be displayed by command PLOT. Valid codes are pairs of antennas, e.g. "12", "13", "23", etc... This command is exclusive with commands SET ANTENNAS and SET TRIANGLES.

SET BASELINE with no argument selects all baselines connecting the antennas previously in use. SET BASELINE ALL will select all the baselines available in the first scan of the current index, for each command accessing the data (e.g. PLOT). This is the default.

8.26.10 SET BINNING

```
CLIC\SET BINNING size [position]
CLIC\SET BINNING OFF
```

Selects data averaging in bins of the parameter in the X coordinate array. Bins are defined by the size of intervals, and the position of one of the intervals (in units of the X coordinate; default is 0). SET BINNING OFF will turn this mode off. Note that this averaging in bins occurs AFTER the averaging selected by SET AVERAGING.

SET BINNING is particularly useful for averaging spectra along the frequency axis and for plotting data as a function of UV coordinates.

A command SET X used to change the X units will automatically reset the binning OFF.

8.26.11 SET BPC

```
CLIC\SET BPC status
```

FIND will select observations according to the status of RF Bandpass Calibration (BPC). 'status' may be YES to select observations already calibrated, NO to select still uncalibrated observations, * to disregard this selection criterion. This command is very seldom used.

8.26.12 SET CLOSURE

```
CLIC\SET CLOSURE b1 w1 b2 w2 ...
```

*** THIS COMMAND IS OBSOLETE ***

Select weights to be used for each baseline when computing the closure relations (this is done by a least squares resolution of an overdetermined system, in antenna mode). You may wish to give more weight to the shorter baselines. Default weights are equal.

8.26.13 SET CRITERIA

```
CLIC\SET CRITERIA /DEFAULT
```

Reset all the search criteria for command FIND to their default values (all the observations in the file will be found). Use SHOW CRITERIA to list the current criteria.

SET /DEFAULT will set default values for all parameters (not only selec-

tion criteria).

8.26.14 SET DATA

CLIC\SET DATA np nb

Extend the size of the plot buffers to contain nb boxes of np points each.

8.26.15 SET DEFAULT

CLIC\SET DEFAULT (or SET /DEFAULT)

Reset all the SET parameters to their default values.

8.26.16 SET DROP

CLIC\SET DROP low high

Give the fraction of the passband to be left out at the low-frequency and at the high frequency ends of each spectral correlator subband. This is used by further PLOT and TABLE commands. The default is 5% of the bandwidth at both ends.

8.26.17 SET ERRORS

CLIC\SET ERROR NOISE|ATMOSPHERE

*** THIS HELP IS NOT UPTODATE ***

Controls the way the error bars for phase plots in time mode are computed.
- with NOISE the errors are computed according to the system noise only; this is the default.
- with ATMOSPHERE the rms phase fluctuations as measured when compressing the data, are included in the error bars.

8.26.18 SET EXTENSION

CLIC\SET EXTENSION string

Use 'string' as the list of the default extensions for the FILE IN command. The default is ".hpb .ipb" (in this order).

Not all extensions are accepted by CLIC: other possible values are ".ipb-raw", ".ipb-comp", ".ipb-cal", ".ipb-data".

8.26.19 SET FLUX

CLIC\SET FLUX name value [frequency] [date] [/RESET]

Enters 'value' as the flux (in Janskys) of source 'name'.

The flux of one or several reference sources must be given to CLIC as an input to command SOLVE FLUX (which derives the antenna efficiencies and the fluxes of the other objects). If the flux of a source is entered by SET FLUX, this source will be a reference source. After "SET FLUX name *", source 'name' will not be a reference source any more. Its flux may then be re-determined by a subsequent SOLVE FLUX command.

Use command SHOW FLUX to list the fluxes known to the current CLIC session. The reference sources are listed with a "FIXED" keyword (their flux is fixed), while the flux determined by SOLVE FLUX are listed as "FREE".

One may optionally enter a frequency (in GHz) and a date (jj-mmm-yyyy). The frequencies and dates are checked in that case by SOLVE FLUX and STORE FLUX. Matching is within 1 GHz for frequencies and 1 week for dates.

If /RESET is given, all entries with the given source name are deleted from the flux list. SET FLUX ALL /RESET will empty the flux list.

8.26.20 SET FORMAT

CLIC\SET FORMAT Keyword [ON] [OFF]

Set the format of the header information listed with the LIST /LONG command. Each keyword indicate whether certain informations are to be written (ON) or not (OFF). If all Keyword are ON, then the same list of information as with the command HEADER is obtained.

General information line (always written)
- Observation number
- Scan number
- Project Id
- Source name
- Source type
- Procedure name
- Interferometer configuration

```
    Date of observation
    UT of observation
    Hour angle

Position information line  (keyword POSITION)
    RA or L : right ascension or longitude (or azimuth)
    DEC or B : declination or latitude (or elevation)
    Epoch if equatorial coordinates are used
    Offsets in current units
    Type of coordinate (Eq, Ga, Ho)
    Flux of the source

Quality information line (keyword QUALITY)
    Quality code
    Flag
    Receiver number
    Number of dump
    Azimuth
    Elevation

Spectral line information line (keyword STATUS)
    Line name
    Rest frequency
    Sideband
    Doppler correction
    Source velocity
    Quarter [for new receivers only]
    Polarization [for new receivers only]
    Narrow-band correlator input [for new receivers only]

Correlator information, for each subband (keyword SPECTRAL)
    Logical name
    Width (MHz)
    Central IF (MHz)
    Physical unit

Interferometer status, for each antenna (keyword INTERFERO)
    Antenna number
    Station

Pointing & Focus correction, for each antenna (keywrod POINTING)
    Azimuth correction
    Elevation correction
    Focus correction

Calibration information, for each antenna (keyword CALIBRATION)
    Receiver temperature (K)
```

```
Image rejection (dB)
Water (mm)
System temperature (Tsys)
```

8.26.21 SET FREQUENCY

```
CLIC\SET FREQUENCY subband sideband name freq
CLIC\SET FREQUENCY ALL name freq
```

Select the line name and frequency to be used to define the velocity scale, for the given sub-band and sideband, by the commands MODIFY FREQUENCY and MODIFY DOPPLER.

subbands; 'sideband' must be either USB or LSB; 'name' is a (max. 12 character) mnemonic for the line name; 'freq' is the rest frequency in MHz. If the line name is '*', then the default frequency entered prior to the observation will be used to compute the velocity scale for the corresponding subband.

"SET FREQUENCY ALL" will fill in the given frequency for all subbands.

8.26.22 SET GAIN_IMAGE

```
CLIC\SET GAIN_IMAGE value /ANTENNA i|ALL
```

Give the value of the relative gain for the receiver image side band, to be used by the command ATMOSPHERE. Use * instead of the value to force the use of the numbers stored in the file.

8.26.23 SET GAIN_METHOD

```
CLIC\SET GAIN_METHOD OLD|NEW
```

Selects the method used to compute antenna-based gains from baselines-based measured quantities. Default is OLD (older but more robust method).

OLD method: 'gain' for a antenna i is computed from three baselines (Gi = Gij.Gik/Gjk). All possible "triangular ratios" including the antenna i are computed and averaged (for the phase, only triangles including the reference antenna are considered).

NEW method: 'ALMA' like method. Solves the linear system of equations (for the amplitudes, solves the logarithms).

8.26.24 SET GIBBS

CLIC\SET GIBBS number

Give the number of channels to be masked on each side of the central frequency, for the correlator subbands which are obtained by juxtaposition of both sidebands of a common local oscillator. Due to the Gibbs effect, a few channels are corrupted by a contribution of the image sideband of the first local oscillator, which may contain signal if the source has continuum emission. This is the case for the 320 MHz bands at the Plateau de Bure correlator, as well as the 160 and 80 MHz bands in some modes.

The GIBBS number is used by further PLOT and TABLE commands. The default is 0, which is relevant for line sources with no continuum emission.

8.26.25 SET HOUR_ANGLE

CLIC\SET HOUR_ANGLE begin end

FIND will select all observations with hour angles in the specified range (in hours). Default is * * (no selection by Hour Angle).

8.26.26 SET IC

CLIC\SET IC status

FIND will select observations according to the status of Instrumental (Phase+Amplitude) Calibration (IC). 'status' may be YES to select observations already calibrated, NO to select still uncalibrated observations, * to disregard this selection criterion. This command is very seldom used.

8.26.27 SET LEVEL

CLIC\SET LEVEL number

Set the threshold severity level (0-8) for messages to be output on the terminal. The default value is 4.

With SET LEVEL 1, all messages will be displayed. With SET LEVEL 8, only key messages will be displayed (this is useful during pipeline processing).

8.26.28 SET LINE

```
CLIC\SET LINE name
```

FIND will select all observations according to the specified line name (not case sensitive). Default is *. A syntax like NAM* can be used to find observations with line names beginning by NAM.

8.26.29 SET MODE

```
CLIC\SET MODE type
```

*** THIS COMMAND IS OBSOLETE ***

Selects which kind of data are displayed. "type" stands for TIME or SPECTRAL. In TIME mode, the underlying parameter is time, i.e. two time-dependent parameters are plotted one against each other, for instance phase versus time, or amplitude versus hour-angle. In SPECTRAL mode, the underlying parameter is frequency, for instance amplitude versus velocity.

This command is now obsolete. Please just select the parameters to be plotted using the SET X and SET Y commands.

8.26.30 SET NARROWINPUT

```
CLIC\SET NARROWINPUT 0|1|2
```

Selects the narrow-band correlator input.

8.26.31 SET NUMBER

```
CLIC\SET NUMBER n1 n2
```

FIND will select all Observations with numbers between n1 and n2. Default is * *.

8.26.32 SET OBSERVED

```
CLIC\SET OBSERVED d1 d2
```

FIND will select all observations with observing dates between d1 and d2. Default is * *.

d1 and d2 are normally in explicit form (jj-mmm-yyyy) but internal day

numbers are also accepted, i.e. something like SET OBSERVED 'DOBS-1' internal format and is available after the command VARIABLE GENERAL ON has been issued).

8.26.33 SET OFFSETS

```
CLIC\SET OFFSETS o1 o2
```

FIND will select all observations with offsets o1 and o2. Default is * *. This is very useful in case of mosaic osbervations, in order to select a specific field (and e.g. create a UV table). See also SET RANGE.

8.26.34 SET PHASE

```
CLIC\SET PHASE [ABSOLUTE|RELATIVE] [ANTENNA|BASELINE]
[INTERNAL|EXTERNAL] [ATMOSPHERE|NOATMOSPHERE] [FILE|NOFILE]
[WVR|NOWVR] [TOTAL|NOTOTAL]
[DEGREES|RADIANS] [JUMPY|CONTINUOUS]
```

CLIC\SET PHASE ABSOLUTE|RELATIVE

This command decides whether the phase calibration is applied or not to the data for plotting and writing the final UV table, in subsequent PLOT and TABLE commands. ABSOLUTE means do not use the phase calibration determined by the SOLVE PHASE command, RELATIVE means apply it.

CLIC\SET PHASE INTERNAL|EXTERNAL

Switch between two modes of phase calibration.

INTERNAL is the standard mode. In EXTERNAL mode the calibration curve from another receiver may be used (as stored by STORE PHASE /RECEIVER r); on the top of this a second order calibration curve may be determined (using SOLVE PHASE) and stored as usual. This does not erase any INTERNAL calibration curve previously stored.

For example, using receiver 2:

SET PHASE INTERNAL RELATIVE: use the phase curve determined from Rec. 2 only

SET PHASE EXTERNAL ABSOLUTE: use the phase curve from Rec. 1 only, as stored with STORE PHASE /RECEIVER 1

SET PHASE EXTERNAL RELATIVE: use the phase curve from Rec 2, deter-

mined on top of the phase curve Rec. 1, by using SOLVE PHASE and STORE PHASE with SET PHASE EXTERNAL in effect.

SET PHASE INTERNAL is recommended for Receiver 1, SET PHASE EXTERNAL for Receiver 2.

CLIC\SET PHASE ANTENNA|BASELINE

Switch between Antenna-based and Baseline-based phase calibrations. This switch will be active for SOLVE PHASE (calibration curve determination), STORE PHASE (calibration curve storing operation), and SET PHASE RELATIVE (application). Both baseline-based and antenna-based calibration curves may be stored alongside in the data header, independently of each other. SET PHASE ANTENNA is recommended.

CLIC\SET PHASE ATMOSPHERE|NOATMOSPHERE

Force CLIC to use or not the real-time atmospheric phase correction. The atmospheric phase correction is based on monitoring the atmosphere water vapor emission using either the total power measured by the 1.3 mm receivers or the 22 GHz water vapor radiometers. It is applied in real-time to each dump before computing the scan-averaged quantities (spectra and continuum); these are further corrected for the average atmospheric phase, hence leading to phases essentially not modified, but to improved amplitudes (correction of the decorrelation). This phase-corrected scan-averaged dump will be used by CLIC after SET PHASE ATM has been issued.

The phase correction will NOT be used if it has been declared invalid for a given scan, using the command STORE CORRECTION, except if SET PHASE NOFILE is in effect. See these commands.

Note that the continuum 1 sec dumps are not corrected in real-time, and are therefore not affected by the SET PHASE ATM command. To avoid any confusion, SET PHASE ATM forces SET AVER SCAN.

CLIC\SET PHASE FILE|NOFILE

Turn ON of OFF the effect of the STORE CORRECTION command.

If SET PHASE ATMOSPHERE FILE, the information on the validity of the phase correction declared by STORE CORRECTION will be used, and the phase correction will thsu be done only on scans validated by STORE CORRECTION.

If SET PHASE ATMOSPHERE NOFILE, this information will be bypassed, and the phase correction will be done for all scans.

CLIC\SET PHASE WVR|NOWVR

Switch ON or OFF the off-line atmospheric phase correction based on the WVR data. All data (individual as well as scan-averaged dumps) are affected. It is necessary to have run the WVR command before. SET PHASE WVR forces SET PHASE NOTOTAL.

CLIC\SET PHASE TOTAL|NOTOTAL

Switch ON or OFF the off-line atmospheric phase correction based on the 1.3 mm total power monitoring. All data (individual as well as scan-averaged dumps) are affected. It is necessary to have run the MONITOR command before. SET PHASE TOTAL forces SET PHASE NOWVR.

CLIC\SET PHASE DEGREE|RADIANS

Select the unit in which the phases are plotted.

CLIC\SET PHASE JUMPY|CONTINUOUS n

Selects the way phases are determined. With argument JUMPY no attempt is made to suppress 2pi jumps: the determination is always [-pi,pi]. With argument "CONTINUOUS n", the phase jumps are limited to +/- pi, that is the phase is always chosen in the range [previous-pi,previous+pi], n being the number of points averaged together to estimate the 'previous' phase (default is 1, higher values are to be used in noisy cases).

8.26.35 SET PLANET

CLIC\SET PLANET *|PRIMARY|FILE [filename]

Planet model to be used by the SOLVE FLUX command.

* = default (elliptical disc)

PRIMARY = same with primary beam attenuation

FILE filename : use data in file filename

8.26.36 SET PLOT

CLIC\SET PLOT type

Selects the way the data are displayed. "type" stands for LINE, POINTS, HISTOGRAM, or BARS. With POINTS, the current GreG marker, as defined by the GREG\SET MARKER command, is used. With BARS (valid only for the visibility data, i.e. amplitude, phase, real, or imaginary), 1-sigma error bars are drawn.

8.26.37 SET POLARIZATION

CLIC\SET POLARIZATION NO|HOR|VER|BOTH|EACH

Selects the polarization of the new receivers. HOR and VER refers to the two polarization channels (but the 'horizontal' or 'vertical' definition is arbitrary). BOTH means that both polarization must be used and averaged when applicable (eg time variation of the phase or amplitude). EACH will plot H and V polarization separately but at the same time (e.g. useful to SOLVE DELAY).

SET POLARIZATION NO makes CLIC forget anything about polarization. This is the mode to use to reduce data from the old receivers (<2007).

8.26.38 SET PROCEDURE

CLIC\SET PROCEDURE proc

FIND will select observations done under procedure 'proc'. Known procedures are: CORRELATION, AUTOCORR, GAIN, DELAY, FOCUS, POINTING, CALIBRATE, IFPB, ONOFF, HOLOGRAPHY, FIVE_POINT, PSEUDO_CONT, FLUX, STABILITY, CWVR, VLBI, VLBG.

SET PROCEDURE * will disable procedure as a selection criterion.

8.26.39 SET PROJECT

CLIC\SET PROJECT projId

FIND will select observations done for the observing project projId. SET PROJECT * will disable project number as a selection criterion.

8.26.40 SET QUALITY

CLIC\SET QUALITY Q

FIND will select only observations of quality better than Q (i.e. less than Q). When originally written, unless the real time acquisition system detected a severe problem, all observations have quality 0, a priori

the best. The quality flag of an observation can be changed using the TAG command. See HELP TAG for the recommended quality scale.

8.26.41 SET RANGE

CLIC\SET RANGE West East South North

FIND will select all observations with offsets in the specified range. Default is * * * *. See also SET OFFSET command.

8.26.42 SET RECEIVER

CLIC\SET RECEIVER number

Use the receiver number as a selection criterion. With the OLD receiver system at Plateau de Bure (<2007), Receiver 1 is the 3 mm receiver, while Receiver 2 is the 1.3 mm receiver. With the NEW receiver system (>2007), 4 receiver bands are available:

- receiver band 1: 80-117 GHz (3mm band) -- AVAILABLE

- receiver band 2: 129-174 GHz (2mm band)

- receiver band 3: 200-257 GHz (1.3mm band) -- AVAILABLE

- receiver band 4: 277-371 GHz (1mm band)

The default is SET RECEIVER * : observations with all receivers will be selected.

For OLD receiver data, SET RECEIVER 1 does automatically a SET PHASE INTERNAL, while SET RECEIVER 2 does SET PHASE EXTERNAL. See the SET PHASE command help. For NEW receiver data, SET PHASE INTERNAL is the default for all bands.

8.26.43 SET RECORD

CLIC\SET RECORD list

Will force all further PLOT commands to use only the records as given in the list (e.g. r1 r2 r3 to r4 by r5 ...). Very seldom needed. Use SET RECORD 1 to 1000000 to reset it.

8.26.44 SET REDUCED

```
CLIC\SET REDUCED d1 d2
```

FIND will select all observations with reduction dates between d1 and d2 (format jj-mmm-yyyy). Default is * *.

8.26.45 SET REFERENCE

```
CLIC\SET REFERENCE antenna_number
```

Enter the logical number of the antenna used as reference for antenna-based calibrations (both RF passband and phase calibrations). The phase for this antenna is set to zero. Default is Antenna 1.

8.26.46 SET RF_PASSBAND

```
CLIC\SET RF_PASSBAND [ON|OFF] [CHANNEL|FREQUENCY]
[FILE|MEMORY] [ANTENNA|BASELINE]
```

This command controls the behaviour of CLIC regarding the RF passband calibration.

SET RF_PASSBAND ON|OFF

Switch ON or OFF the application of RF passband calibration curve in plotting the data. The RF passband calibration curve is computed by SOLVE RF_PASSBAND and stored with the data by STORE RF_PASSBAND. Subsequent PLOT commands will use or not this curve according to the status of SET RF_PASSBAND ON|OFF.

SET RF_PASSBAND CHANNEL|FREQUENCY

Use either the channel dependent passband curves or the frequency dependent passband curve. The channel-dependent passband curves must be determined separately for each subband, while the frequency-dependent passband curve is determined by using SOLVE RF_PASSBAND on all subbands together (Note: this will not work for data taken before July 14th 1990). SET RF_PASSBAND FREQUENCY is recommended.

SET RF_PASSBAND MEMORY|FILE

Use either the passband curves just determined by SOLVE RF_PASSBAND, and still present in the program memory, or the passband curves previously stored in the data headers of the input file by a command STORE RF_PASSBAND.

SET RF_PASSBAND ANTENNA|BASELINE

Switch between Antenna-based and Baseline-based RF passband calibrations. This switch will be active for SOLVE RF_PASSBAND (passband determination), STORE RF_PASSBAND (passband storing operation), and SET RF_PASSBAND ON (fpassband application). Both baseline-based and antenna-based calibration curves may be stored alongside in the data header, independently of each other. SET RF_PASSBAND ANTENNA is recommended.

8.26.47 SET SCAN

CLIC\SET SCAN s1 s2 [s3 s4 ...]

FIND will select all observations with Scan numbers between s1 and s2, or s3 and s4... The Scan number, attributed by the on-line acquisition system may be different from the Observation number which is used by CLIC to refer to the Observations. Default is * *.

8.26.48 SET SELECTION

CLIC\SET SELECTION mode band subband-list [FREQUENCY freqout]
[/WINDOW fmin fmax [fmin2 fmax2 ...]]

Choose the type of data selection to be done by command TABLE (to create an output UV table).

- The first argument 'mode' is CONTINUUM or LINE, to prepare single channel or multiple channel maps.

- The second argument is the sideband to be used: UPPER (or USB), LOWER (or LSB), AVERAGE (or DSB), AUTO or SSB. DSB may be used in conjunction with CONTINUUM: in this case, two separate visibility points are written, one for each sideband. DSB used in conjunction with LINE means that the side band will be selected to match the desired frequency range (as given in the command TABLE), thus allowing to mix in the same table data from USB and LSB, if different frequency setups have been used in different configurations. AUTO will determine for each narrow input whether the receiver tuning is DSB or SSB and accordingly select DSB (write a visibility for each sideband) or the signal sideband if SSB. SSB will write one visibility for the signal side band (automatically determined). This last two options are useful for continuum only. For LINE, they will just select the matching side band as does DSB.

- The third argument is a subband list.In CONTINUUM mode, subbands are averaged, in spectral mode they are combined to produce a single spectrum. The subband list is given with the same syntax as in the SET SUBBAND command, e.g. "n1 to n3" or "n1 to n3 and n5".

Example: SET SELECTION CONTINUUM USB C01 AND C03 AND C05 selects continuum data, USB, and the subbands C01, C03, and C05.

Arguments "FREQUENCY freqout" are used only for CONTINUUM tables. They define the frequency (in MHz) used for mapping purposes. U and V (for each side band in DSB mode) will be scaled to this frequency. This is intended to combine maps obtained in continuum at slightly different frequencies. The default for freqout is the actual observing frequency , or the frequency used for previous data if data is appended to a previously existing table by the TABLE command.

Option /WINDOW is used to avoid spectral lines when producing a continuum table from spectral correlator data. The first two rest frequencies (in MHz) give the first frequency window in which data is to be used, the next two give the second frequency window, etc....

8.26.49 SET SOURCE

CLIC\SET SOURCE name1 name2 ... namen

FIND will select all scans according to the specified source names (matching is not case-sensitive). Up to 10 source names can be given. Syntax like NAM* can be used to find all observations with source name beginning by NAM. Default is *.

8.26.50 SET SORT

CLIC\SET SORT RECEIVER|SCAN

The output of LIST and LIST /SHORT may be sorted primarily be receiver number or scan number. Use SET SORT to switch between the two modes. Default is RECEIVER mode.

8.26.51 SET SPECTRUM

CLIC\SET SPECTRUM ON|OFF

*** THIS COMMAND IS OBSOLETE ***

8.26.52 SET STEP

```
CLIC\SET STEP t_step
```

Select the time interval parameter to be used by the SOLVE PHASE and SOLVE AMPLITUDE command (time interval between knots of the cubic spline functions). Value is in hours (default 3 hours).

8.26.53 SET SUBBANDS

```
CLIC\SET SUBBANDS n1 n2 ...  [/WINDOW f1 l1 f2 l2 ...]
CLIC\SET SUBBANDS LINE|CONT
CLIC\SET SUBBANDS ALL
CLIC\SET SUBBANDS EACH
CLIC\SET SUBBANDS HOR|VER
CLIC\SET SUBBANDS Q1|Q2|Q3|Q4
CLIC\SET SUBBANDS NBC1|NBC2
```

Selects the subbands for which data will be displayed by command PLOT. Valid codes are continuum subbands numbers (C01, C02, ... C08) or line subbands numbers (L01, L02, ... L08). These are logical numbers, so one should select e.g. L01 to L04 if four correlator units were used, independentely from the physical units actually used. This is a classical trap, especially with the old receiver system (<2007): if e.g. units 1 to 5 were used on Receiver 1 and units 6 to 8 on Receiver 2, the corresponding subbands will be L01 to L05 for the Receiver 1 scan, and L01 to L03 for the Receiver 2 scan.

Subbands may be grouped by typing e.g. "SET SUBBANDS n1 to n2 and n3 n4". Here, two quantities will be plotted. The first one is either the average of subbands n1 to n2 and n3 (in time mode), or the concatenation of spectral data from subbands n1 to n2 and n3 (in spectral mode). The second quantity plotted is subband n4.

SET SUBBANDS LINE|CONT will switch all subbands to their line/continuum counterpart, e.g. L01 to L04 will be changed to C01 to C04 by SET SUBBBANDS CONT. Done by SET X I_F

A number of usefule shortenings are available:

- SET SUBBANDS ALL will automatically select all the subbands in the first scan of the current index, for each command accessing the data. The subbands are concatenated (equivalent to e.g. SET SUBBANDS L01 to L06).

- SET SUBBANDS EACH will automatically select all the subbands in the first scan of the current index, for each command accessing the da-

ta. The subband are NOT concatenated (equivalent to e.g. SET SUBBANDS L01 L02 L03 L04 L05 L06).

- SET SUBBANDS HOR|VER will automatically select (in the first scan of the current index) the subbands connected to the horizontal or vertical polarization channel (if any). The subbands are concatenated.

- SET SUBBANDS Q1|Q2|Q3|Q4 will automatically select (in the first scan of the current index) the subbands connected to the selected quarter (if any). The subbands are concatenated.

- SET SUBBANDS NBC1|NBC2 will automatically select (in the first scan of the current index) the subbands connected to the selected narrowband correlator input (if any). The subbands are concatenated.

CLIC\SET SUBBANDS n1 n2 ... /WINDOW first1 last1 first2 last2 ...

The /WINDOW option select the first and last channels to be used for the LINE subbands. There should be one couple of parameter for each group of subbands.

In spectral mode, the window limits may be used to restrict the plot to a certain range, e.g.
SET SUBBANDS L01 TO L02 /WINDOW 10 64

will avoid plotting channels 1 to 9 of each of the two subbands L01 and L02 (which are here combined to a single spectrum). This may be useful to flag meaningless channels at the low-frequency and at the high frequency ends of each spectral correlator. Note: this is now done automatically, see SET DROP command.

In time mode, the window limits select the data to be integrated to compute a single point.For example
SET SUBBANDS L01 L02 /WINDOW 1 10 1 10 will plot data integrated from the first ten channels of the first line subband, as a first quantity, and data integrated from the first 10 channels of the second line subband, as a second quantity.

Note: if you want to use both continuum and line subbands, in the same plot page, you should include dummy arguments in the /WINDOW option for the continuum spectra:
SET SUBBANDS C01 to C10 L01 to L02 /WINDOW 0 0 2 64 (two arguments are needed for each resulting spectrum).

8.26.54 SET TELESCOPE

```
CLIC\SET TELESCOPE name
```

FIND will select all scans according to the specified telescope (i.e. interferometer configuration) name. Default is *. Syntax like NAM* can be used to find all observations with telescope name beginning by NAM.

8.26.55 SET TIME_ORIGIN

```
CLIC\SET TIME_ORIGIN  *|date
```

*** THIS HELP IS NOT UPTODATE ***

Specify the time origin for the abscissa in time plots. This is normally the day for which the first data is plotted, and time is displayed in hours since that day. This day is reset by using PLOT /RESET.

"SET TIME_ORIGIN date" forces the time origin to the specified day (e.g. 01-AUG-2004). "SET TIME_ORIGIN *" resets the default (automatic) behaviour.

8.26.56 SET TOTAL_POWER

```
CLIC\SET TOTAL_POWER raw|physical
```

For new receivers, switch between total power as measured by the correlator (raw) in units of (sigma/v)^2 and "physical" temperature scale (in K).

8.26.57 SET TREC

```
CLIC\SET TREC value /ANTENNA i|ALL
```

Give the value of the receiver temperature, to be used by the command ATMOSPHERE. Use * instead of the value to force the use of the numbers stored in the file.

8.26.58 SET TRIANGLE

```
CLIC\SET TRIANGLE t1 t2 ...
```

*** THIS HELP IS NOT UPTODATE ***

Selects the triangle products for which data will be displayed by com-

mand PLOT. Valid triangles are codes as e.g. "123" or "345". This command is exclusive with commands SET BASELINES and SET ANTENNAS.

This command will be effective only if the triangle products have been computed and stored in the data by commands SPECTRUM/TRIANGLE or COMPRESS/TRIANGLE. In that case the triangle products will have been averaged by these commands; since the phase of the triangle products are closure quantities, the amplitude of the average should not be affected by atmospheric decorrelation.

8.26.59 SET TYPE

CLIC\SET TYPE par

FIND will select observations of specified type 'par'. This may be OBJECT, PHASE (i.e. calibrators), or RF (i.e. RF passband calibrator; this is obsolete). Use argument "*" to disable selection by source type.

8.26.60 SET UV_RANGE

CLIC\SET UV_RANGE UVmin UVmax

This command will force all further PLOT commands to use only the points that are within this range in the UV plane, i.e. those for which UVmin < sqrt(U**2+V**2) < UVmax.

8.26.61 SET VIRTUAL

CLIC\SET VIRTUAL

*** THIS COMMAND IS OBSOLETE ***

8.26.62 SET WATER

CLIC\SET WATER value

Give the value of the water vapor content (in mm), to be used by the command ATMOSPHERE. Use * instead of the value to force the use of the numbers stored in the file.

8.26.63 SET WEIGHTS

CLIC\SET WEIGHTS [TSYS ON|OFF] [CALIBRATION ON|OFF]

Selects the way the weights written in the output file by the command TABLE are computed.

Weights are always proportional to observing time.

With TSYS ON, data is also weighted by 1/TSYS**2, where TSYS is the equivalent system temperature (the geometrical mean of system temperature of both antennas, for a given baseline). With TSYS OFF, this weight factor is turned off.

With CALIBRATION ON, data is also weighted by 1/CAL**2, where CAL is the amplitude instrumental calibration factor (if any). If no amplitude instrumental calibration function is applied (absolute amplitude), this weighting should have no effect. With CALIBRATION OFF, weights are not affected by amplitude calibration.

Default is TSYS ON and CALIBRATION ON, which results in weights equal to 1/sigma^2, where sigma is the thermal noise in the data.

8.26.64 SET X

```
CLIC\SET X param1 [param2 ...] [/LIMITS min1 max1 [min2 max2 ...]]
```

Choose the parameters to be plotted along X-axes by command PLOT.

Parameters valid in both TIME mode and SPECTRAL mode:

AMPLITUDE, PHASE, REAL, or IMAGINARY: referring to the visibility in the subband(s), sideband(s), baseline(s) (or antenna(s)) selected by SET SUBBANDS, SET BANDS, SET BASELINES or SET ANTENNAS commands. Only correlation scans will be plotted, not autocorrelations.

AUTOCORR. : the autocorrelation power measured in the subband(s), antenna(s) selected by SET SUBBANDS, and SET ANTENNAS commands. Only autocorrelation scans will be plotted, (including calibration scans), not correlations.

Parameters valid in SPECTRAL mode only:

CHANNEL : channel number in the correlator (use ony this one if Fourier Transform has not been made).

VELOCITY : normally with respect to LSR.

I_FREQUENCY : the frequency in the second IF (around 350 MHz).

SKY_FREQUENCY : the sky frequency. This should be the line rest fre-

quency if the velocity is correct.

Parameters valid in TIME mode only:

U_COORD, V_COORD, RADIUS, ANGLE: referring to cartesian, or polar coordinates, in the (U,V) plane, of the baseline(s) selected by command SET BASELINES.

TIME: universal time (in hours, origin determined by the first plot made, may be reset by PLOT /RESET).

SCAN: the scan number

NUMBER: the observation number.

RECORD: the record number (1 to the number of plotted points).

HOUR_ANGLE

DECLINATION

RMS_PHASE: the r.m.s. of the phase of the average of the non-flagged subbands of the continuum correlator, in current phase units (degrees or radians). This r.m.s. phase is computed during the data compression.

RMS_AMPLITUDE: the r.m.s. of the amplitude of the average of the non-flagged subbands of the continuum correlator, in current amplitude units (kelvins or janskys). This r.m.s. amplitude is computed during the data compression.

DELAY: as specified for specified baseline (differential, A1-A2 for baseline 12), or for the specified antenna(s).

LO_RATE: as specified for specified baseline (differential, as DELAY), or for the specified antenna(s).

LO_PHASE: as used for specified baseline (differential, as DELAY), or for the specified antenna(s).

CABLE_PHASE: as measured for specified baseline (differential, as DELAY), or for the specified antenna(s).

GAMME: the current range (1 or 2) of the cable phasemeter.

TOTAL_POWER: the total power measured for the given antenna(s), as measured by the connected detectors.

LAMBDA, BETA, or FOCUS: the scanning coordinates for pointing and focussing scans (arc seconds, or millimeters), for the specified antenna, or the moving antenna if the given baseline (if only one is moving).

AZ_CORR: the azimuth collimation correction in arc seconds.

EL_CORR: the elevation collimation correction in arc seconds.

FOC_CORR: the Z focus correction in millimeters.

T00 ... T04 : general test parameters (in data headers)

T10 ... T14 : test parameters (antenna based) (in data headers)

TREC: receiver temperature for the given antenna(s).

TSYS : Equivalent system temperature for the given baseline (Geometrical mean of Tsys for both antennas), or for the given antenna(s).

PAMB, TAMB, HUMIDITY: measured atmospheric parameters.

WIND_AVERAGE, WIND_DIROthe wind direction in degrees, for 5 min. averages and maxima..

QUALITY: The observation quality as set with commands TAG or CURSOR.

AZIMUTH, ELEVATION: Start azimuth and elevation for each scan.

AZ_ERR, EL_ERR: The tracking errors in arc seconds.

AZ_PH, EL_PH: The azimuth and elevation for each record (as used for phase tracking).

PARAL_ANGLE: Parallactic angle (angle between the vertical direction and the meridian plane)

WATER: Water content of atmosphere (as set by the programmer, or measured with given antenna).

ATM_EMISSION: From the output of the atmospheric monitor (normally the 1.3mm receiver). This is the measured radiation temperature of the atmosphere, in Kelvins of Rayleigh-Jeans equivalent radiation temperature.

ATM_POWER: This is the output of the atmospheric monitor (normally the 1.3mm receiver). It is the actual counts that appear on the monitors during observations.

ATM_REFERENCE: The atmospheric emission used as a reference for the phase correction. This is computed by the command MONITOR. The phase correction will be proportional to the difference between the output of the atmospheric monitor and this reference value.

ATM_PHASE: The computed atmospheric phase correction.

ATM_UNCORRPH: The phase uncorrected from atmosphere.

ATM_CORRPH: The phase corrected from atmosphere.

ATM_VALIDITY: 0 or 1 whether the phase correction has been declared valid or not.

CAL_PHASE: The phase instrumental calibration curve.

CAL_AMPLI: The amplitude instrumental calibration curve.

AIR_MASS: The number of air masses (1/sin(elev))

GROUND_EMIS: The ground emission in K (calibrated total power, with sky emission subtracted).

EMISSION: The total power detected in emission in K (ground + sky)

TDEWAR1, TDEWAR2, TDEWAR3: The temperatures in the 3-stage cryogenerators.

TCABIN, TCHOP, TCOLD: The temperatures of the receiver cabin, of the ambient load, and the equivalent temperature of the cold load.

WVRTAMB, WVRTPEL: The temperature of the water vapor radiometer (WVR) ambient load and peltier cooler.

WVRTCAL1, WVRTCAL2, WVRTCAL3 : The channel gains for the 3 frequency bands.

WVRREF1, WVRREF2, WVRREF3 : The average counts on reference observation

WVRAVER1, WVRAVER2, WVRAVER3 : The average counts on current observa-

```
  tion

WVRAMB1, WVRAMB2, WVRAMB3 : The average counts on  last  ambient  mea-
  surement

WVRTREC1, WVRTREC2, WVRTREC3 : The receiver temperatures

WVRFEFF1, WVRFEFF2, WVRFEFF3 : The coupling factors to sky

WVRMODE : The calibration mode

WVRH2O, WVRPATH : The precipitable water vapor and corresponding path-
  length

WVRTSYS1, WVRTSYS2, WVRTSYS3 : The system temperatures

WVRDPATH1, WVRDPATH1, WVRDPATH3 : The Kelvin to water vapor pathlength
  (model)

WVRFPATH1, WVRFPATH2, WVRFPATH3 : The Kelvin to water vapor pathlength
  (empirical)

WVRLIQ1, WVRLIQ2, WVRLIQ3 : The Kelvin to liquid water emission

WVRDCLOUD1, WVRDCLOUD2, WVRDCLOUD3 : The Kelvin to liquid water  path-
  length (model)

WVRTATM : The temperature of atmosphere

WVRQUAL : The  quality code

DH_WVR1, DH_WVR2, DH_WVR3 : counts of each WVR channel

DH_WVRSTAT :  status word

WVR_PHA_M : The WVR phase value (model)

WVR_PHA_E : The WVR phase value (empirical)

WVR_PHA_C : The WVR phase value due to Cloud (Model)

tatm_s,  tatm_i  : The temperature of the atmosphere in the signal and
  image band

REFC1, REFC2, REFC2: refraction coefficients.

REFRACTION: refraction correction.
```

The available parameters are the same as with the SET Y command. Default is SET X TIME.

The /LIMITS option is used to specify fixed limits, e.g.: "SET X TIME /LIMITS t1 t2" where t1 and t2 are the time limits to be used in this example. The codes "*" and "=" may be used. "*" means that the limits are automatically adjusted to the data, separately in each box; "=" means that common limits to all boxes are computed.

For time-like plots, the defaults are "/LIMITS * * ". For frequency-like plots, the defaults are "/LIMITS = =".

8.26.65 SET Y

CLIC\SET Y param1 [param2 ...] [/LIMITS min1 max1 [min2 max2 ...]]

Choose the parameter to be plotted along Y-axes by command PLOT.

Parameters valid in both TIME mode and SPECTRAL mode:

AMPLITUDE, PHASE, REAL, or IMAGINARY: referring to the visibility in the subband(s), sideband(s), baseline(s) (or antenna(s)) selected by SET SUBBANDS, SET BANDS, SET BASELINES or SET ANTENNAS commands. Only correlation scans will be plotted, not autocorrelations.

AUTOCORR. : the autocorrelation power measured in the subband(s), antenna(s) selected by SET SUBBANDS, and SET ANTENNAS commands. Only autocorrelation scans will be plotted, (including calibration scans), not correlations.

Parameters valid in SPECTRAL mode only:

CHANNEL : channel number in the correlator (use ony this one if Fourier Transform has not been made).

VELOCITY : normally with respect to LSR.

I_FREQUENCY : the frequency in the second IF (around 350 MHz).

SKY_FREQUENCY : the sky frequency. This should be the line rest frequency if the velocity is correct.

Parameters valid in TIME mode only:

U_COORD, V_COORD, RADIUS, ANGLE: referring to cartesian, or polar coordinates, in the (U,V) plane, of the baseline(s) selected by command SET BASELINES.

TIME: universal time (in hours, origin determined by the first plot made, may be reset by PLOT /RESET).

SCAN: the scan number

NUMBER: the observation number.

RECORD: the record number (1 to the number of plotted points).

HOUR_ANGLE

DECLINATION

RMS_PHASE: the r.m.s. of the phase of the average of the non-flagged subbands of the continuum correlator, in current phase units (degrees or radians). This r.m.s. phase is computed during the data compression.

RMS_AMPLITUDE: the r.m.s. of the amplitude of the average of the non-flagged subbands of the continuum correlator, in current amplitude units (kelvins or janskys). This r.m.s. amplitude is computed during the data compression.

DELAY: as specified for specified baseline (differential, A1-A2 for baseline 12), or for the specified antenna(s).

LO_RATE: as specified for specified baseline (differential, as DELAY), or for the specified antenna(s).

LO_PHASE: as used for specified baseline (differential, as DELAY), or for the specified antenna(s).

CABLE_PHASE: as measured for specified baseline (differential, as DELAY), or for the specified antenna(s).

GAMME: the current range (1 or 2) of the cable phasemeter.

TOTAL_POWER: the total power measured for the given antenna(s), as measured by the connected detectors.

LAMBDA, BETA, or FOCUS: the scanning coordinates for pointing and focussing scans (arc seconds, or millimeters), for the specified antenna, or the moving antenna if the given baseline (if only one

is moving).

AZ_CORR: the azimuth collimation correction in arc seconds.

EL_CORR: the elevation collimation correction in arc seconds.

FOC_CORR: the Z focus correction in millimeters.

T00 ... T04 : general test parameters (in data headers)

T10 ... T14 : test parameters (antenna based) (in data headers)

TREC: receiver temperature for the given antenna(s).

TSYS : Equivalent system temperature for the given baseline (Geometrical mean of Tsys for both antennas), or for the given antenna(s).

PAMB, TAMB, HUMIDITY: measured atmospheric parameters.

WIND_AVERAGE, WIND_DIR0the wind direction in degrees, for 5 min. averages and maxima..

QUALITY: The observation quality as set with commands TAG or CURSOR.

AZIMUTH, ELEVATION: Start azimuth and elevation for each scan.

AZ_ERR, EL_ERR: The tracking errors in arc seconds.

AZ_PH, EL_PH: The azimuth and elevation for each record (as used for phase tracking).

PARAL_ANGLE: Parallactic angle (angle between the vertical direction and the meridian plane)

WATER: Water content of atmosphere (as set by the programmer, or measured with given antenna).

ATM_EMISSION: From the output of the atmospheric monitor (normally the 1.3mm receiver). This is the measured radiation temperature of the atmosphere, in Kelvins of Rayleigh-Jeans equivalent radiation temperature.

ATM_POWER: This is the output of the atmospheric monitor (normally the 1.3mm receiver). It is the actual counts that appear on the monitors during observations.

ATM_REFERENCE: The atmospheric emission used as a reference for the phase correction. This is computed by the command MONITOR. The phase correction will be proportional to the difference between the output of the atmospheric monitor and this reference value.

ATM_PHASE: The computed atmospheric phase correction.

ATM_UNCORRPH: The phase uncorrected from atmosphere.

ATM_CORRPH: The phase corrected from atmosphere.

ATM_VALIDITY: 0 or 1 whether the phase correction has been declared valid or not.

CAL_PHASE: The phase instrumental calibration curve.

CAL_AMPLI: The amplitude instrumental calibration curve.

AIR_MASS: The number of air masses (1/sin(elev))

GROUND_EMIS: The ground emission in K (calibrated total power, with sky emission subtracted).

EMISSION: The total power detected in emission in K (ground + sky)

TDEWAR1, TDEWAR2, TDEWAR3: The temperatures in the 3-stage cryogenerators.

TCABIN, TCHOP, TCOLD: The temperatures of the receiver cabin, of the ambient load, and the equivalent temperature of the cold load.

WVRTAMB, WVRTPEL: The temperature of the water vapor radiometer (WVR) ambient load and peltier cooler.

WVRTCAL1, WVRTCAL2, WVRTCAL3 : The channel gains for the 3 frequency bands.

WVRREF1, WVRREF2, WVRREF3 : The average counts on reference observation

WVRAVER1, WVRAVER2, WVRAVER3 : The average counts on current observation

WVRAMB1, WVRAMB2, WVRAMB3 : The average counts on last ambient measurement

WVRTREC1, WVRTREC2, WVRTREC3 : The receiver temperatures

WVRFEFF1, WVRFEFF2, WVRFEFF3 : The coupling factors to sky

WVRMODE : The calibration mode

WVRH2O, WVRPATH : The precipitable water vapor and corresponding path-length

WVRTSYS1, WVRTSYS2, WVRTSYS3 : The system temperatures

WVRDPATH1, WVRDPATH1, WVRDPATH3 : The Kelvin to water vapor pathlength (model)

WVRFPATH1, WVRFPATH2, WVRFPATH3 : The Kelvin to water vapor pathlength (empirical)

WVRLIQ1, WVRLIQ2, WVRLIQ3 : The Kelvin to liquid water emission

WVRDCLOUD1, WVRDCLOUD2, WVRDCLOUD3 : The Kelvin to liquid water pathlength (model)

WVRTATM : The temperature of atmosphere

WVRQUAL : The quality code

DH_WVR1, DH_WVR2, DH_WVR3 : counts of each WVR channel

DH_WVRSTAT : status word

WVR_PHA_M : The WVR phase value (model)

WVR_PHA_E : The WVR phase value (empirical)

WVR_PHA_C : The WVR phase value due to Cloud (Model)

tatm_s, tatm_i : The temperature of the atmosphere in the signal and image band

REFC1, REFC2, REFC2: refraction coefficients.

REFRACTION: refraction correction.

The available parameters are the same as with the SET Y command. Default is SET Y AMPLITUDE PHASE.

The /LIMITS option is used to specify fixed limits, e.g.: "SET Y AMPLITUDE /LIMITS a1 a2" where a1 and a2 are the amplitude limits to be used in this example. The codes "*" and "=" may be used. "*" means that the limits are automatically adjusted to the data, separately in each box; "=" means that common limits to all boxes are computed.

Default limits are provided for AMPLITUDE and PHASE only: 0 * * * if SET PHASE CONTINUOUS is effective, 0 * -180 180 if SET PHASE JUMPY DEGREE (with corresponding values if SET PHASE RADIANS).

8.27 SHOW

CLIC\SHOW Argument

Display the parameters defined by SET. Each "SET Argument" command has an equivalent "SHOW Argument".

In addtion, "SHOW ALL" will display all parameters specified by SET. "SHOW CRITERIA" will display only selection criteria for the command FIND, "SHOW DISPLAY" will give only the parameters relevant to command PLOT, and "SHOW GENERAL" will give the rest of the parameters.

8.28 SOLVE

CLIC\SOLVE Item

This is a command to determine interferometer parameters from measured data. SOLVE is processing the current index.

8.28.1 SOLVE AMPLITUDE

CLIC\SOLVE AMPLITUDE [/PLOT] [/BREAK kind time [kind time ...]
[/POLYNOMIAL [degree]] [/WEIGHT]

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

This command fits a mathematical function into the measured amplitude of the sources in the current index (presumably calibrators). This data must have been selected and plotted in axes : SET X TIME and SET Y AMPLITUDE for the baselines and bands of interest, specified by the corresponding SET commands. The calibration function is kept in memory. Command STORE AMPLITUDE should be used next to store this function in the header of source observations, after a change in the index to select the appropriate scans.

SOLVE AMPLITUDE internally and temporarily resets SET AMPLITUDE to SCALED.

In antenna mode (selected by SET AMPLITUDE ANTENNA), the averaged phase and amplitude closures are computed, as well as their standard deviations. The phase closures should be close to zero, while the amplitude closures should be close to 100%. Strong deviations of amplitude closures from 100% are an indication of amplitude loss on long baselines, due to phase decorrelation during the time averaging. The fit then shows strong systematic errors; if this occurs, baseline based calibration of the amplitudes might be preferred.

Option /PLOT will plot the fitted curve over the data.

Fitted curves may be of two kinds:

- Cubic splines (the default). By default knots are regularly spaced with an interval between knots set by the SET STEP command. Additional knots may be introduced with the option "/BREAK kind time [kind time ...]" which introduces a break at abscissa 'time'; 'kind' is an integer in the range 0-3; 0 means that a discontinuity will be present, 1 that the first derivative will be discontinuous, and so on. Several breaks may be introduced. The program will detect an error if too many breaks are introduced, compared to the density of data points.

- Polynomial curves may be used instead. For this the option is: /POLYNOMIAL [degree] indicating the degree of the polynomial (default 0).

Normally the data points are all assigned the same weight for the fit. With option /WEIGHT, the data points are weighted according to their errors.

8.28.2 SOLVE BASELINE

```
CLIC\SOLVE BASELINE [/OFFSET b1 dx1 dy1 dz1 b2  ...]
[/SEARCH range] [/POLYNOMIAL degree]
```

This uses a linear method to determine baselines. The baselines to be determined must have been selected by the SET BASELINE command, and the data plotted; plot axes must have been previously selected by : SET X HOUR_ANGLE DECLINATION and SET Y PHASE. With SET ANTENNA in action the antenna position offsets are directly fitted to the antenna phases, ensuring baseline closure.

The fitting should work only if the starting values are within half a

wavelength in any direction of the true values. Use option /OFFSET to correct the phases for an offset (dx1,dy1,dz1) in baseline b1 before fitting. This is needed if the baseline was wrong by more than half a wavelength. Offsets are to be given in meters.

The results are given as offsets in meters to be added to the baseline used for data acquisition (which may be read by SIC\EXAMINE BASELINE). The total fitted baseline is also given in meters, as well as the rms of the residuals in phase units. Two sets of offsets are given: the first set (dx, dy, dz) are the offsets with respect to the antenna positions actually used, while the secoond set (DX, DY, DZ) are with respect to the standard antenna coordinates (the default values in OBS).

The /SEARCH option enables an automatic search with starting offsets scanning a 3-d box in dx, dy, dz, by steps of half a wavelength in the three directions. The argument range is in meters (scanning is from -range/2 to +range/2, default -0.005 to 0.005). Only the solution with the minimum rms is kept.

With option /POLYNOMIAL degree, and if SET X TIME is used in addition of HOUR_ANGLE and DECLINATION, a polynomial function of time is included in the phase function being fitted. The degree may range from 0 (the default) to 3. In that case command RESIDUALS will also plot the residuals as a function of time.

Use command RESIDUALS BASELINE to display the fit residuals (phase should be constant). Use later command PRINT BASELINE to create a procedure file (named CLIC-BASELINE.OBS) containing the antenna position offsets. This procedure file may be executed by the observing program OBS on the control computer bure01.

If one specify elevation as an additional X variable (e.g. SET X HOUR_ANGLE DECLINATION TIME ELEVATION), then an additional parameter is fitted: the offsets between elevation and azimuth axes (or rather the differences between antennas). These differing offsets result in a phase effect proportional to the cosine of elevation. In antenna mode, these offsets are given for each antenna in meters. In baseline mode, only differences are computed. To further correct for this effect use the command MODIFY AXES.

8.28.3 SOLVE DELAY

CLIC\SOLVE DELAY [/SEARCH range interval] [/PLOT] [/PRINT]

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

This uses a linear method to determine delays. The baselines to be determined must have been selected by the SET BASELINE (or SET ANTENNA) command, and the data plotted; plot axes must have been previously selected by :SET X I_FREQUENCY and SET Y PHASE.

The /SEARCH option enables an automatic search with starting offsets from -range/2 to +range/2 by steps of given interval. The default range is 200 nanoseconds, with interval of 1 nanosecond.

With SET ANTENNA in action the antenna delays are directly fitted to the antenna phases, ensuring delay closure.

The results are given in nanoseconds. Use option /PRINT or command PRINT DELAY to create a procedure file (INTER_OBS:clic-delay.obs) containing the fitted antenna delays. This procedure file may be executed by the observing program OBS on the control computer bure01.

With option /PLOT, the fitted phases will be plotted over the data.

8.28.4 SOLVE FLUX

CLIC\SOLVE FLUX [NOREFERENCE] [BEST n] [REAL] [/RESET]

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Calculate the fluxes of the sources in the current index or the antenna efficiencies (Jansky to Kelvin) if the source flux is known. The command can also be used to bootstrap source fluxes from a known source.

It should be used before computing any amplitude calibration, on an index covering a reasonably short time interval to avoid possible efficiency variations.

The commands should be used in the following way:

- The command SET FLUX is used to define the flux of one, or several of the sources in the current index for which the flux is known. Frequencies and dates may be specified.

- Then the command SOLVE FLUX will use the sources of known flux (optionally with matching frequencies and dates) to determine the efficiencies for all antennas. SOLVE FLUX now gives the decorrelation factor relative to the efficiencies logged in the scan headers (assumed to be the standard single-dish efficiencies).

- SOLVE FLUX then uses these antenna efficiences to compute the fluxes of all other sources. IF the keyword "BEST n" is present, the n an-

tennas giving the highest fluxes will be used for averaging (n is 1 to the number of available antennas). Default is n=3.

- The command SHOW FLUX will give the current flux list. The reference sources are listed with a "FIXED" keyword, while the fluxes determined by SOLVE FLUX are listed as "FREE".

- SOLVE FLUX /RESET can be used to reset the flux list (i.e. remove from the list all sources whose flux is not fixed) before processing.

- The command PRINT FLUX will create a procedure that may be used later to reload these fluxes in CLIC, if needed.

- The command PRINT FLUX will create a procedure that may be used later to reload these fluxes in CLIC, if needed.

- The command STORE FLUX will store the fluxes and efficiencies in the headers of the observations in the current index.

If no reference sources are available, the keyword NOREFERENCE should be given, and the default efficiencies stored in the data header will be used (step 2 in the above list is bypassed).

The keyword REAL forces SOLVE FLUX to use the real part of the visibilities instead of the amplitude to derive the antenna efficiencies and source fluxes. This is only for test purposes and must not be used without asking an expert.

8.28.5 SOLVE FIVE

```
CLIC\SOLVE FIVE [beam] [/PLOT] [/PRINT]
[/OUTPUT filename [NEW|APPEND] [FLUX] [TPOINT]]
```

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Find pointing corrections from FIVE point scans. All five-point scans in the current index are processed by a gaussian fit. Its width can be fixed if the argument 'beam' is given (in arcsec). All continuum subbands and both side bands are averaged. The fits may be displayed with option /PLOT.

The presence of option /PRINT produces a procedure file (INTER_OBS:pointing.obs), to be used in OBS for introducing the fitted pointing offset.

The results may also be written on an output ASCII file if /OUTPUT is

given. The file is given extension .lis by default; a new file is opened except if APPEND is given as a second argument of option /OUTPUT. The file is by default in a format suitable for the determination of a pointing model (program POINT at BURE). The presence of optional argument FLUX changes the output format for the determination of relative fluxes (by ASTRO). With argument TPOINT, the output is written in a format suitable for processing by the TPOINT program.

8.28.6 SOLVE FOCUS

```
CLIC\SOLVE FOCUS [/PLOT] [/COMPRESS timex] [/PRINT]
[/OUTPUT filename [NEW]] [/TOTAL] [/FIX par1 [value] ...]
```

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Find focus corrections from a FOCUS scan using a parabolic fit. All focus scans in the current index are processed. All continuum subbands and both side bands are averaged. SET AVERAGE METHOD SCALAR is recommended. The fits may be displayed with option /PLOT.

The option /COMPRESS may be used to average data in a given time interval before processing, to improve the signal-to-noise ratio. Default is 4 seconds.

The presence of option /PRINT produces a procedure file (INTER_OBS:focus.obs), to be used in OBS for introducing the fitted focus offset. With option /OUTPUT, results of the fit, together with elevation and azimuth, are written in an output ASCII file, for further examination.

****** ATF CORNER ******

With option /TOTAL, SOLVE FOCUS uses the total power to solve for axial focus errors. In that case, option /FIX may be used to fix one parameter. Possible parameters are:

```
FOCUS: the axial focus error (mm)
PEAK: the peak amplitude, in total power units
WIDTH: the HPW of focus curve (mm)
ZERO: the off-source zero level, in total power units
```

With /TOTAL, /COMPRESS does the ON-OFF combination if in beam switching mode. In that case ZERO is preferrably fixed to zero (e.g. SOLVE FOCUS /TOTAL /COMPRESS /PLOT /FIX ZERO 0).

8.28.7 SOLVE GAIN

```
CLIC\SOLVE GAIN [SCAN] [/PRINT]
```

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Compute the receiver gain ratio (Image Side Band over Signal Side Band) from correlation data on a continuum source. Compute also the LO1 and LO3 phases that should be used in real time to have zero phases in both side bands.

The data from all the scans in the current index are averaged except if optional argument SCAN is given, in which case the gain ratios are computed for each scan.

Option /PRINT produces a procedure INTER_OBS:gain.obs to set the gains (and phases) in OBS.

8.28.8 SOLVE HOLOGRAPHY

```
CLIC\SOLVE HOLOGRAPHY [NPOINTS npix] [FREE r1 r2 ...]
[MODES nmodes] [ITER niter gain] [MASK npanels p1 p2 p3 ...]
[BASELINES b1 b2 b3 ... ]
[DISTANCE dist] [DIAMETER diam] [DEFOCUS df]
[TEST testFile] [FRESNEL] [ASTIGMATISM]
[/PLOT [AMP amin amax astep] [PHA pmin pmax pstep]
[ERRORS emin emax estep]  [NUMBER]] [/OFFSET x y z]
```

This command computes an antenna surface map from a set of holography measurements. The set of scans (procedure HOLO) should have first been calibrated in phase, amplitude and RF passband relative to interspaced correlation scans in the direction of the source. The map will be computed from the first band and subband sets chosen with commands SET BAND and SET SUBBAND. SET BAND AVERAGE is recommended for continuum measurements; only continuum subbands should be used. For line measurements, the continuum width of one of the correlator units should match the actual line width for better sensitivity. The antenna to be studied should be selected by command SET ANTENNA i. Data from the baselines linking this antenna (scanned) to other (fixed) available antennas are averaged.

SOLVING FOR ANTENNA PARAMETERS

The amplitude and phase maps are obtained by FFT of the observed beam map. The maps will be square (npix by npix pixels). The default for npix

is 64, it should be greater than the number of observed holography scans (usually 16 or 32).

After FFT a gaussian illumination function is fitted in the amplitudes, giving the offset from the center (in meters) and the edge taper (in dB). If /PLOT is given, the amplitude map will be displayed (in decibels), from -15 to 0 dB, with contours in steps of 3db (these may be changed using "/PLOT AMP amin, amax and astep").

A least square fit is used to correct the phases from a remaining phase offset, pointing errors, and focus offsets. The panel rings following the keyword FREE are not used for this fit. If /PLOT is given, the antenna normal surface errors will be shown, in micrometers, from -500 to 500 mum, with contours in steps of 100 mum (these may be changed using "/PLOT ERRORS emin, emax and estep"). If /PLOT PHASE is given, the residual phase map will be plotted instead of surface errors, in radians from -pi to pi, with contours in steps of 0.2 radian. If this map shows remaining 2*pi discontinuities, or if focus offsets larger that 1mm are found, you should try using option /OFFSET to correct the phases for an offset (x,y,z in meters) in the focus coordinates, before fitting. This should lead to better rms values.

The rms values for the phase and the normal surface errors (in radians and micrometers) are given, both with and without amplitude weighting. The contribution of the illumination amplitude distribution and of the observed phase errors to the antenna efficiency are given.

A gildas image file of the results is kept (e.g. "jj-mmm-yyyy-an1.map"), in which plane 3 in the amplitude in dB, plane 4 the raw phases and plane 2 the residual phase in radians (plane 1 contains the fitted amplitude, i.e. a Gaussian).

SOLVING FOR PANEL DISPLACEMENTS

Finally, if "PLOT MODE nmodes" is entered with nmodes larger than 0, a listing of panels displacements is computed. This uses the parameter nmodes which is the number of modes used for each panel: 1 is the translation mode only (normal to the antenna surface); 3 (the usual setting) adds both tilt modes, radial and tangential, but no panel deformation; 4 adds a torsion mode and 5 a motion of the panel center relative to its edges (there are only 5 screws for each panel, thus only 5 possible modes).

The results of this computation is written in a file "panels-an1.dat" (or similar name for other antennas). In this file, a line for each panel is printed. The first two numbers are the panel numbers, followed by

up to five screw settings (three only for the inner ring). All screw settings are equal if nmodes was set to 1, only one number is then printed.

The fit is obtained iteratively: the panel orthogonal deformation modes are computed from the aperture phase, then the phase change that these deformations would have caused is computed (by doing a FFT to the beam map, doing a cut-off at the observed map size, followed by a FFT back to the aperture plane), and subtracted from the aperture phase; second order panel deformations are computed from these residuals, and so on. The number of iterations niter and a gain to this iterative procedure may be specified (ITER niter gain); their default values are 5 and 1.0 . Use ITER 0 for no iterative procedure at all. At each step the phase residual rms and the rms of panel deformations fitted are given (weighted by the fitted amplitude illumination and counted perpendicularly to the surface).

Variables containing antenna parameters are available:
- -TAPER_X, TAPER_Y: illumination tapers.
- -OFFSET_X, OFFSET_Y: illumination offsets.
- -RMS_PHA_U, RMS_PHA_W: phase r.m.s (unweigthed or weighted by illumination).
- -ETA, ETA_230, ETA_345: aperture efficiency at observing frequency, 230 and 345 GHz.
- -JYKEL, JYKEL_230, JYKEL_345: antenna efficiency at observing frequency, 230 and 345 GHz.
- -HOLO_FOCUS: focus position.
- -HOLO_RMS: surface r.m.s. (unweighted or weighted by illumination).
- -HOLO_RING: rings r.m.s

SOLVE HOLOGRAPHY options

SOLVE HOLOGRAPHY NPOINTS npix

Gives the number of pixels of the amplitude and phase maps. Default is 64.

SOLVE HOLOGRAPHY MODE nmodes

Force CLIC to compute the panel displacements (see above). nmodes is 1 to 5.

SOLVE HOLOGRAPHY ITER niter gain

Select the number of iteration and gain to be used for the panel displacement determination (see above). Does make sense only if used in conjonction with the MODES keyword.

SOLVE HOLOGRAPHY BASELINES b1 b2 b3 ...

By default, all baselines connecting the antenna to be studied (selected by SET ANTENNA) to a fixed antenna are used. The keyword BASELINES allows to specifically select the baselines to be used.

SOLVE HOLOGRAPHY MASK npanels p1 p2 p3 ...

SOLVE HOLOGRAPHY FREE r1 r2 ...

Indicates the ring NOT to be used for paraboloid fit.

SOLVE HOLOGRAPHY ASTIGMATISM NOFOCUS NOXYFOCUS FOCUS

SOLVE HOLOGRAPHY POINTING FUDGE CHEAT DEFOCUS df DIAMETER

SOLVE HOLOGRAPHY TEST testFile

Use a test beam file instead of real data from the CLIC data file.

SOLVE HOLOGRAPHY DISTANCE dist

Gives distance of the source, in meters. Not relevant for astronomical sources, of course. Any distance larger than than 1000 km (which is the default) forces the FRESNEL approximation.

SOLVE HOLOGRAPHY FRESNEL

Use Fresnel approximation (use only the Fourier transform, neglect the additional terms in the complex exponential argument). This is the default mode for long distance (e.g. astronomical) sources, but must be indicated if a DISTANCE has been entered.

SOLVE HOLOGRAPHY /OFFSET x y z

SOLVE HOLOGRAPHY /PLOT [AMP amin amax astep] [PHA pmin pmax pstep] [ERRORS emin emax estep] [NUMBER]

With /PLOT, SOLVE HOLOGRAPHY will plots the results: two maps are displayed, which by default are the amplitude illumination pattern (default plot limits are -15dB to 0dB by step of 3dB) and the antenna normal surface errors (from -500 to 500 mum, with contours in steps of 100 mum). The min., max., and steps can be changed with "/PLOT AMP amin amax astep" and "/PLOT ERRORS emin emax estep". With "/PLOT PHASE", the phase residuals are plotted instead of the surface errors. Default are from -pi to +pi by step of 0.2 radians.

If NUMBER is given as a /PLOT argument, the panels numbers are drawn.

8.28.9 SOLVE PHASE

CLIC\SOLVE PHASE [/PLOT] [/BREAK kind time [kind time ...]]
[/POLYNOMIAL degree] [/WEIGHT]

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

This will fit a mathematical function into the measured phases of the sources in the current index (presumably calibrators). This data must have been selected and plotted in axes : SET X TIME and SET Y PHASE for the baselines and bands of interest, specified by the corresponding SET commands. Phases should be continuous (SET PHASE CONTINUOUS). The calibration function is kept in memory. Command STORE should be used next to store this function in the header of source observations, after a change in the index to select the appropriate scans.

SOLVE PHASE internally and temporarily resets SET PHASE to ABSOLUTE. The INTERNAL|EXTERNAL mode is kept to allow determining a phase curve on top of an external receiver reference.

In antenna mode (selected by SET AMPLITUDE ANTENNA), the averaged phase and amplitude closures are computed, as well as their standard deviations. The phase closures should be close to zero, while the amplitude closures should be close to 100%.

Option /PLOT will plot the fitted curve over the data.

Fitted curves may be of two kinds:

- Cubic splines (the default). By default knots are regularly spaced with an interval between knots set by the SET STEP command. Additional knots may be introduced with the option "/BREAK kind time [kind time ...]" which introduces a break at abscissa 'time'; 'kind' is an integer in the range 0-3; 0 means that a discontinuity will be present, 1 that the first derivative will be discontinuous,

and so on. Several breaks may be introduced. The program will detect an error if too many breaks are introduced, compared to the density of data points.
- Polynomial curves may be used instead. For this the option is: /POLYNOMIAL [degree] indicating the degree of the polynomial (default 0).

Normally the data points are all assigned the same weight for the fit. With option /WEIGHT, the data points are weighted according to their errors.

8.28.10 SOLVE POINTING

```
CLIC\SOLVE POINTING [beam] [/PLOT] [/COMPRESS [timex]] [/PRINT]
[/OUTPUT filename [NEW|APPEND] [FLUX] [TPOINT]]
[/TOTAL] [/FIX param1 [value1] param2 [value2] ... ]
```

Find pointing corrections from POINTING scans. All pointing scans in the current index are processed by a gaussian fit. Its width can be fixed if the argument 'beam' is given (in arcsec). All continuum subbands and both side bands are averaged. SET AVERAGE METHOD SCALAR is recommended. The fits may be displayed with option /PLOT.

The option /COMPRESS may be used to average data in a given time interval before processing, to improve the signal-to-noise ratio. Default is 4 seconds.

The presence of option /PRINT produces a procedure file (INTER_OBS:pointing.obs), to be used in OBS for introducing the fitted pointing offset.

The results may also be written on an output ASCII file if /OUTPUT is given. The file is given extension .lis by default; a new file is opened except if APPEND is given as a second argument of option /OUTPUT. The file is by default in a format suitable for the determination of a pointing model (program POINT at BURE). The presence of optional argument FLUX changes the output format for the determination of relative fluxes (by ASTRO). With argument TPOINT, the output is written in a format suitable for processing by the TPOINT program.

****** ATF CORNER ******

With option /TOTAL, SOLVE POINTING uses the total power to solve for pointing errors. In that case, option /FIX may be used to fix one parameter. Possible parameters are:

AZ: the azimuth collimation error (arc sec.)

```
    EL: the elevation collimation error (arc sec.)
    PEAK: the peak amplitude, in total power units
    WIDTH: the HPBW (arc sec.)
    ZERO: the off-source zero level, in total power units
```

With /TOTAL, /COMPRESS does the ON-OFF combination if in beam switching mode. In that case ZERO is preferrably fixed to zero (e.g. SOLVE POINTING /TOTAL /COMPRESS /PLOT /FIX ZERO 0).

8.28.11 SOLVE RF_PASSBAND

```
CLIC\SOLVE RF_PASSBAND [da] [dp] [/PLOT]
```

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Solve for passband calibration curves, by fitting it to the amplitudes and phases. The current index should contain calibration observations of strong continuum sources (RF passband calibrator). The behaviour of this command depends on the current mode of RF passband calibration (Frequency or Channel).

- For frequency-dependent RF passabnd calibration (SET RF_PASSBAND FREQUENCY, recommended): the resolution is normally done using all the spectral subbands plotted together, as a function of intermediate frequency. It should be done separately for upper and lower side bands. A single frequency-dependent polynomial is fitted, a high degree might be necessary for the phase, if band edges are used (up to 20 is feasible).

- For channel dependent RF passband calibration (SET RF_PASSBAND CHANNEL)

  (i) For continuum, the data itself is directly stored as calibration values (this gives a channel-dependent passband curve). In addition a polynomial is fitted and optionally plotted (this gives a frequency-dependent passband curve).

  (ii) For spectral subbands, polynomials are fitted and optionally plotted, as a channel-dependent passband curve.

The degrees for polynomials are 'da' for amplitude, 'dp' for phase (defaults 0 and 1). Command STORE should be used next to store the fitted function in the header of source observations. Both channel dependent and frequency dependent curves can be stored; Use command SET RF_PASSBAND FREQUENCY|CHANNEL to apply one or the other.

Option /PLOT will plot the polynomial fits over the data.

8.28.12 SOLVE SKYDIP

```
CLIC\SOLVE SKYDIP [TREC|EFF] [/PLOT]
```

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Compute receiver temperature TREC or antenna forward efficiency EFF from skydip scan. Default is EFF. All skydip scans in the current index are solved. A graphic display of the solution can be plotted using the /PLOT option. "SET Y TOTAL" must have been entered before solving the skydip, to force the software to use the total power measurements (otherwise, autocorrelations will be used).

The resulting receiver temperatures and forwad efficiencies are available in the variables T_REC and FORWARD_EFF, providing the command "VARIABLE ATMOSPHERE ON" has been issued.

8.28.13 SOLVE TOTAL

```
CLIC\SOLVE TOTAL [beam] [/PLOT] [/COMPRESS timex] [/PRINT]
[/OUTPUT filename [NEW|APPEND] [FLUX] [TPOINT]]
```

Find pointing corrections from POINTING scans, but using the total power from each antenna. All pointing scans in the current index are processed by a gaussian fit. The fits may be displayed with option /PLOT.

The option /COMPRESS may be used to average data in a given time interval before processing, to improve the signal-to-noise ratio. Default is 4 seconds. *** option temporarily disabled ***

The presence of option /PRINT produces a procedure file (INTER_OBS:pointing.obs), to be used in OBS for introducing the fitted pointing offset.

The results may also be written on an output ASCII file if /OUTPUT is given. The file is given extension .lis by default; a new file is opened except if APPEND is given as a second argument of option /OUTPUT. The file is by default in a format suitable for the determination of a pointing model (program POINT at BURE). The presence of optional argument FLUX changes the output format for the determination of relative fluxes (by ASTRO). With argument TPOINT, the output is written in a format suitable for processing by the TPOINT program.

8.29 STORE

CLIC\STORE Keyword

Writes calibration (or edition) data in the output file. All scans in the current index are processed.

8.29.1 STORE AMPLITUDE

CLIC\STORE AMPLITUDE [/BAND code] [/SELF]

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Store the amplitude calibration determined by the last SOLVE AMPLITUDE.

One calibration curve is stored for each sideband. With option "/BAND code", one may use the calibration curve determined with one of the sidebands (‘code’ is UPPER or USB, LOWER or LSB, or AVERAGE or DSB), to calibrate both sidebands.

With option "/SELF", the calibration stored will not be the calibration curve (as determined from the last SOLVE AMPLITUDE command) but, for each scan, the visibility corresponding to the first subband set (eg., SET SUB L01 to L03 ...); data from each side band will be used to calibrate the same side band. This provide a simple, easy way to self-calibrate data taken on strong continuum sources (quasars).

STORE AMPLITUDE and STORE PHASE can be performed simultaneously using STORE AMPLITUDE PHASE [/BAND code] [/SELF] [/RECEIVER irec] (the /RECEIVER option has no meaning for amplitudes).

8.29.2 STORE CORRECTION

CLIC\STORE CORRECTION [GOOD|BAD|AUTO|SELF [tmin]] [/RECEIVER irec] [/ANTENNA a1 ...] /FRACTION fraction

Store in the header of each scan (of the current index) the information whether the atmospheric phase correction is or not declared valid, and should be actually applied when SET PHASE ATM is selected. This is an antenna-based flag.

- GOOD: the atmospheric phase correction is to be used.

- BAD: the atmospheric phase correction is not to be used.

- AUTO [tmin]: that information is determined on the phase calibrators (type PHASE), by comparing the scan-averaged amplitudes with and

without the correction. This information is then propagated to the neighbouring source observations (type OBJECT), in a +- tmin minutes time window. 'tmin' defaults to 15 minutes.

- SELF: that information is determined on the source, whatever its type may be, by comparing its amplitude with and without the correction. This will produce random result if the source has no continuum emission.

- STORE CORRECTION /RECEIVER irec: the validity of the correction from Receiver 'irec' is used (useful to transfer the correction validity from one frequency to the other).

With option /ANTENNA a1 a2 ..., only the specified antennas are considered. The correction validity for other antennas is not modified.

With option /FRACTION fraction, fraction of amplitude will replace the noise in estimating if uncorrected is better than corrected.

8.29.3 STORE FLAG

```
CLIC\STORE FLAG f1 f2 ...  [/ANTENNA a1 a2 ...   ]
[/BASELINE b1 b2 ...] [/RESET]
```

Flag all data in the current index according to the parameters and option specified.

Supported flag names are:

- C01 to C08 for bad individual continuum correlator subbands
- L01 to L08 for bad individual spectral correlator subbands
- DATA for bad data
- TSYS for too high system temperature (antenna based only)
- LOCK for out of lock local oscillator (antenna based only)
- POINTING for poor pointing (antenna based only)
- SHADOW for antenna being shadowed by another antenna (ant. based only)
- SATURATION for too high total power on a particular antenna
- TIME for time discontinuity
- DOPPLER for doppler discontinuity
- REDU for data reduction

Use option /RESET to suppress flags that were accidentally set.

"STORE FLAG" is equivalent to "MODIFY DATA proc.clic", where the "proc.clic" procedure contains:

```
FLAG f1 f2 ... [/ANTENNA a1 a2 ...] [/BASELINE b1 b2 ...] [/RESET]
GO WRITE
```

but it is simpler and faster. All the data records will be flagged.

8.29.4 STORE FLUX

CLIC\STORE FLUX

Store the source fluxes and antenna efficiencies determined from a previous SOLVE FLUX command. Source names, frequencies (within 1GHz) and dates (within a week) must match. See the SOLVE FLUX and SET FLUX commands.

8.29.5 STORE PHASE

CLIC\STORE PHASE [/BAND code] [/SELF] [/RECEIVER irec]

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Store the phase calibration determined by the last SOLVE PHASE command.

One calibration curve is stored for each sideband. With option "/BAND code", one may use the calibration curve determined with one of the sidebands (‘code’ is UPPER or USB, LOWER or LSB, or AVERAGE or DSB), to calibrate both sidebands.

With option "/SELF", the calibration stored will not be the calibration curve (as determined from the last SOLVE PHASE command) but, for each scan, the visibility corresponding to the first subband set (eg., SET SUB L01 to L03 ...); data from each side band will be used to calibrate the same side band. This provide a simple, easy way to self-calibrate data taken on strong continuum sources (quasars).

With option "/RECEIVER irec", the calibration curves solved using data from receiver "irec" will be stored in parallel with any other calibration curve. This phase curve will be selected by giving SET PHASE EXTERNAL (see this command). In practice, this is used for Receiver 2 data, for which the calibration curve determined with Receiver 1 is stored. /BAND may be used in conjunction with /RECEIVER.

STORE PHASE and STORE AMPLITUDE can be performed simultaneously using STORE AMPLITUDE PHASE [/BAND code] [/SELF] [/RECEIVER irec] (the /RECEIVER option has no meaning for amplitudes).

8.29.6 STORE QUALITY

CLIC\STORE QUALITY code

Store the data quality to be used as a selection criterion. All the scans in the current index are tagged. Code may be an integer in the range 0-9, or directly the corresponding quality word:

0 Unknown
1 Excellent
2 Good
3 Fair
4 Average
5 Poor
6 Bad
7 Awful
8 Worst
9 Deleted

8.29.7 STORE RF_PASSBAND

```
CLIC\STORE RF_PASSBAND
```

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

Store the RF passband calibration curves. Channel dependent and frequency dependent curves will be simultaneously stored if available. Caution: RF passbands should be stored only for consistent spectral correlator configurations.

8.30 SG_TABLE

```
CLIC\SG_TABLE Name [OLD|NEW]
[/RESAMPLE nc ref val inc code shape width]  [/FFT]
[/FREQUENCY name rest-freq] [/DROP  n1 n2]
[/NOCHECK [SOURCE|POINTING|PHASE|EPOCH]]
[/ADD Item[s]]
[/POLARIZATION SPLIT|AVERAGE|JOINT]
```

Prepare a UV Table, in spectral line mode only, but with added flexibility to store more information compared with the TABLE command. Polarization is handled in 3 possible ways, the default being AVERAGE.

Option /POLARIZATION and /ADD control the details of the polarization handling and of the extra information written.

See Command TABLE for the other options.

8.30.1 SG_TABLE /POLARIZATION

```
SPLIT:         A different visibility for each polarization
AVERAGE: averaged polarizations before writing
JOINT:   All channels Polar 1, then All channels polar 2 in visibility
```

8.30.2 SG_TABLE /ADD

```
CLIC\SG_TABLE Name [OLD|NEW] /ADD Item [Item [...]]
```

Add some more information columns. Possible items are

U V W DATE TIME IANT JANT
which are in principle already present in elements 1 to 7 of the visibilities.

L_PHASE_OFF M_PHASE_OFF X_POINT_OFF Y_POINT_OFF
which indicate the Phase and Pointing offsets (e.g. for mosaics)

ELEVATION HOUR_ANGLE PARA_ANGLE
which can be useful for full polarization measurements

SCAN ON_TIME WEIGHT
for bookkeeping

X_POINT_IANT Y_POINT_IANT X_POINT_JANT Y_POINTJANT
the antenna pointing errors (used mostly for simulations...)

RA DEC FREQUENCY
the Source coordinates and Observing frequency (in Real*8, used for multisource UV tables, still very experimental)

STOKES is also a recognized item, but it is handled by the /POLARIZATION option

8.31 TABLE

```
CLIC\TABLE Name [OLD|NEW] [/COMPRESS tmax uvmax]
[/RESAMPLE nc ref val inc code shape width] [/FFT]
[/FREQUENCY name rest-freq] [/DROP n1 n2]
[/NOCHECK [SOURCE|POINTING|PHASE|EPOCH]]
```

This command will create an UV data Table from the current index. is not given, the most recently created table will be extended. Next argu-

ment may be OLD (default value if not specified) to extend and existing table, or NEW to create a new table.

The bands and subbands used must have been given by the command SET SELECTION. The weighting mode can be modified by the command SET WEIGHTS.

TABLE /RESAMPLE nc ref val inc code [shape width /FFT]

Option /RESAMPLE enables to resample data on a new spectral grid (for line data). 'nc' is the output number of channels, 'ref' the reference channel, 'val' the value of velocity or frequency offset (with respect to the rest frequency) at the reference channel, 'inc' the resolution, 'code' is "V" if the value 'val' and the resolution 'inc' are in velocity units, "F" for frequency units.

The reference channel thus corresponds to the given 'val' velocity, or to the offset 'val' in MHz from the rest frequency present in the header or modified by option /FREQUENCY.

Resampling is done by default through linear interpolation of input channel data. Resampling may also be done (using option /FFT) in Fourier space by cut-off or extrapolation (by zeroes) of the Fourier components, after deconvolution by the channel response of the correlator (due to on-line apodization), and followed by reconvolution to produce frequency channels of the given 'shape' and 'width'. Allowed shapes are:

TBox = a box in delay space (unapodized correlator)
Ppar = a parabola in delay space (apodized correlator) (the default)
FBox = a box in frequency space (square filter)
FTri = a triangle in frequency space (Hanning smoothed square filter)

The width is the channel width in units of channel separation (default 1).

Option /FFT is not recommended when joining together several subbands to produce a single spectrum, with a limited number of broad channels. In those cases using the FFT could produce a spectrum with "holes" at the points between subbands with limited overlap.

TABLE /FREQUENCY name rest-freq

Option /FREQUENCY is used to redefine the rest frequency (in MHz) and line name for the output table. The velocity scale is computed accordingly. This rest frequency will correspond to the reference channel in option RESAMPLE.

TABLE /NOCHECK [SOURCE|POINTING|PHASE|EPOCH]

When processing each scan, CLIC checks whether a number of position parameters are consistent with those defined in the table header. Option /NOCHECK allows to switch off this checking. Arguments can be given to switch off only part of the parameters (SOURCE name, POINTING direction, PHASE center, EPOCH of coordinates). This option is intended for building tables with inconsistent parameters (typical exemple is a different source name...). It is potentially dangerous and is to be used with caution.

TABLE /DROP n1 n2 --- THIS OPTION IS OBSOLETE

Option /DROP enables to drop the first 'n1' and last 'n2' channels in each subband of the OLD spectral correlator. For the NEW spectral correlator (data taken since summer 1992), it is replaced by the commands SET GIBBS and SET DROP.

TABLE /COMPRESS tmax uvmax

Option /COMPRESS is used to compress the data before writing the table. This works like the COMPRESS command, but no intermediate file is written. Very seldom used.

8.31.1 TABLE UVTABLE

UV Table format

A UV table is a file in the Gildas Data Format, of dimension 2. Each column corresponds to a visibility data point. Lines contain respectively:

1. U in meters
2. V in meters
3. W in meters
4. Observation date (integer CLIC Day Number)
5. Time in seconds since above date
6. Number of start antenna
7. Number of end antenna
8. First frequency point (real part)
9. First frequency point (imaginary part)
10. First frequency point (weight)
11. Same for second frequency point, and so on.

See the SET WEIGHT command to select the weighting mode . The first dimension is then the 3 * Nchan + 7, for Nchan frequency channels. The second dimension is the number of UV points measured.

8.32 TAG

```
CLIC\TAG Quality_Code List_of_Observations
```

Attributes a quality to a given list of Observations. Quality_Code is an integer in the range 0-9, and the recommended quality scale is

```
0 Unknown
1 Excellent
2 Good
3 Fair
4 Average
5 Poor
6 Bad
7 Awful
8 Worst
9 Deleted
```

The operation is immediate and occurs in the OUTPUT file for all versions of all Observations specified in the list. If no list is given, the R memory is attributed the specified quality. A FIND operation will only select Observations of quality better than (i.e. less or equal to) the quality specified by the SET QUALITY command, or in the /QUALITY option.

8.33 VARIABLES

```
CLIC\VARIABLES group ON|OFF
```

*** THIS HELP HAS NOT BEEN UPDATED FOR THE NGRX ***

This command is used to create/delete CLIC variables corresponding to header information. Several groups of variables are available, corresponding to sections in the scan headers.

```
READ_WRITE     Input/Output file information (Global)
GENERAL        General information (Scan based)
POSITION       Source related information (Scan based)
CONFIG         Array configuration related information (Scan based)
RF_SETUP       Receiver related information (Scan based)
CONTINUUM      Continuum correlator related information (Scan based)
LINE           Spectral correlator related information (Scan based)
SCANNING       Special scanning information (Record based)
ATMOSPHERE     Atm. calibration parameters and results (Scan based)
MONITOR        Total power monitor information (Scan based)
```

```
WVR             Water Vapor Radiometer information (Scan based)
DESCRIPTOR      Data descriptor information (Scan based)
DATA_HEADER     Data header information (Record based)
DATA_RECORD     Data values (Record based)
```

Scan- or record-based variables refer to the last scan or record that has been read (explicitely by GET/RECORD, or implicitely by PLOT or other commands).

8.33.1 VARIABLES READ_WRITE

```
CLIC\VARIABLES READ_WRITE ON|OFF
```

Input/Output file information (Global).

```
IN_FILE          Name if input file
OUT_FILE         Name of output file
INBLOC           Block of observation in input file
IDATA            Address od data section in input observation
INSEC            Number of sections in header
INEXT            Next available block in input file
ONEXT            Next available block in output file
IXNUM            Index number of current observation in input file
ISEC [INSEC]     Header sections
ILEN [INSEC]     Length of header section (words)
IADD [INSEC]     Addresses of header sections (words)
IXNEXT           Next available entry in input file index
OXNEXT           Next available entry in output file index
CXNEXT           Next available entry in current index
INWORD           Number of words in current observation
IDATAL           Length (words) of data section
MODIFY           (Logical) data is open for modify
SHARE            (Logical) Output file is shared
IX_NUM   [ ]     Observation numbers in input file index
IX_BLOC  [ ]     Blocks numbers of observations in input file
OX_NUM   [ ]     Observation numbers in output file index
OX_BLOC  [ ]     Blocks numbers of observations in output file
```

The following additional variables are defined by the command FIND:

```
FOUND            Number of observations in current index
CX_NUM   [ ]     Observation numbers in current index
CX_BLOC  [ ]     Blocks numbers of observations in current index
```

8.33.2 VARIABLES GENERAL

```
CLIC\VARIABLES GENERAL ON|OFF
```

General information (Scan based).

TELESCOPE	Telescope name
RECEIVER	Receiver number
CONFIGURATION	Interferometer configuration
NUMBER	Observation number
VERSION	Observation version number
DOBS	Day of observation (internal format)
DATE_OBSERVED	Day of observation (in clear)
DRED	Day of last reduction (internal format)
DATE_REDUCED	Day of last reduction (in clear)
DATATYPE	Type of observation (4 for interferometer data)
IQUAL	Quality of observation (0-9)
QUALITY	Quality of observation (Excellent, ... Awful)
SCAN	Scan number
UTOBS	Time of observation (radians!)
TIME_OBSERVED	Time of observation (hh:mm:ss.ss)
LSTOBS	Sidereal time of observation (radians)
AZIMUTH	Azimuth of source direction (radians)
ELEVATION	Elevation of observation (radians)
TIME	Integration time (minutes)
PROJECT	Project name
PROC	Procedure used (internal format)
PROCEDURE	Procedure used (in clear)
TYPE_OFF	Type of offsets

8.33.3 VARIABLES POSITION

```
CLIC\VARIABLES POSITION ON|OFF
```

Source related information (Scan based).

SOURCE	Source name
LAMBDA	Source longitude-like coordinate (radians)
BETA	Source latitude-like coordinate (radians)
OFF_LAMBDA	Offset in lambda (radians)
OFF_BETA	Offset in beta (radians)
EPOCH	Epoch of coordinates (if equatorial)
PROJECTION	Projection used for offsets
FOCUS	Focus position used
FLUX	Source flux (Jy) for calibrators
TYPE_COORD	Type of coordinates

8.33.4 VARIABLES CONFIG

```
CLIC\VARIABLES CONFIG ON|OFF
```

Array configuration related information (Scan based).

NANT		Number of antennas
NBAS		Number of baselines
HOUR_ANGLE		Hour angle of observation (hours)
STATION	[NANT]	Positions of antennas
PHYS_ANT	[NANT]	Antenna physical numbers
CORR_INPUT	[NANT]	Correlator input connected for each antenna
START_ANTENNA	[NBAS]	First antenna of baseline
END_ANTENNA	[NBAS]	Second antenna of baseline
BASELINE	[3,NBAS]	Coordinates of baselines (meters)
ANTENNA	[3,NANT]	Coordinates of antennas (meters)
AXES_OFFSET	[NANT]	Offsets of El axis from Az axes (meters)
PHLO1	[NANT]	LO1 phase
PHLO3	[NANT]	LO3 phase

8.33.5 VARIABLES RF_SETUP

```
CLIC\VARIABLES RF_SETUP ON|OFF
```

Receiver related information (Scan based).

LINE	Line name (in OBS)
FREQUENCY	Rest Frequency (in OBS) (MHz)
ISB	Side band (1:upper, 2:lower)
LOCK	Lock
FLO1	Frequency of First LO (MHz)
FLO2	Frequency of Second LO (MHz)
FIF1	First intermediate frequency (MHz)
VELOCITY	Velocity entered in OBS (km/s)
TYPE_VEL	Velocity type
DOPPLER	Doppler correction factor (v/c)

8.33.6 VARIABLES CONTINUUM

```
CLIC\VARIABLES CONTINUUM ON|OFF
```

Continuum correlator related information (Scan based).

N_SIDEBANDS	Number of present sidebands
N_SUB_BANDS	Number of continuum sub-bands
NCDAT	Total number of channels (sidebands x subbands)
CRCH [2]	Reference channel for sideband

```
CVOFF [2]        Velocity for sideband
CVRES [2]        Velocity resolution
CRFOFF [2]       Rest frequency (MHz)
CRFRES [2]       Frequency resolution
CNAM_U           Line name for Upper side band
CNAM_L           Line name for Lower side band
CFCEN [10]       Center frequency for subband (MHz)
CFWID [10]       Width of subband (MHz)
```

8.33.7 VARIABLES LINE

```
CLIC\VARIABLES LINE ON|OFF
```

Spectral correlator related information (Scan based).

```
N_LINE_BANDS             Number of line subbands
FOURIER                  (Logical) FFT done, data in frequency space
TOTAL_CHANNELS           Total number of line channels
N_CHANNELS     [NSUBB]   Number of channels in subband
FIRST_CHANNEL  [NSUBB]   First channel in subband
LFCEN          [NSUBB]   LO3 frequency (channel 1)
LFRES          [NSUBB]   Frequency resolution (signed)
REF_CHANNEL  [2,NSUBB]   Reference channel for spectrum
F_RESOLUTION [2,NSUBB]   Frequency resolution
F_OFFSET     [2,NSUBB]   Rest frequency in reference channel
V_RESOLUTION [2,NSUBB]   Velocity resolution
V_OFFSET     [2,NSUBB]   Velocity in reference channel
R_LILEVU  [NSUBB,NANT]   Sampling levels (USB)
R_LILEVL  [NSUBB,NANT]   Sampling levels (LSB)
PHSELECT  [NANT,NSUBB]   Real-time atm. correction (1: TP, 2:WVR)
```

8.33.8 VARIABLES SCANNING

```
CLIC\VARIABLES SCANNING ON|OFF
```

Special scanning information (Record based). This is for Pointing, Focus, Holography, ...

```
SCAN_TYPE        Type of special scan (1 focus 2,3 point 4,5 calibr)
MOBIL   [NANT]   Antennas in motion (logical)
COLL_AZ [NANT]   Collimation in azimuth (arc sec)
COLL_EL [NANT]   Collimation in elevation (arc sec)
COR_FOC [NANT]   The Z focus correction in mm
```

8.33.9 VARIABLES ATMOSPHERE

```
CLIC\VARIABLES ATMOSPHERE ON|OFF
```

Atmospheric calibration parameters and results (Scan based).

PRESSURE		Pressure in hectopascals (zero alt.)
AMBIANT_T		Outside temperature (K)
ALTITUDE		Altitude in kilometers
HUMIDITY		Humidity in %
WATER	[NANT]	Water content (mm)
TAU_S	[NANT]	Optical depth in signal side band
TATM_S	[NANT]	Temperature of atmosphere in signal side band
TAU_I	[NANT]	Optical depth in image side band
TATM_I	[NANT]	Temperature of atmosphere in image side band
BEAM_EFF	[NANT]	Beam efficiency
FORWARD_EFF	[NANT]	Forward efficiency
T_CHOPPER	[NANT]	Temperature of ambiant load (K)
T_COLD	[NANT]	Temperature of cold load (K)
T_REC	[NANT]	Receiver temperature (K)
GAIN_IMAGE	[NANT]	Gain ratio image/signal
CHOPPER_COUNTS	[NANT]	Measured counts on ambiant load
COLD_COUNTS	[NANT]	Measured counts on cold load
SKY_COUNTS	[NANT]	Measured counts on sky
T_SYS_S	[NANT]	System temperature (signal band)
T_SYS_I	[NANT]	System temperature (image band)
CHOPPER_EFF	[NANT]	Chopper efficiency
CAL_MODE	[NANT]	Calibration reduction mode
JY_TO_KEL	[NANT]	Jansky to Kelvin conversion factor
T_CABIN	[NANT]	Temperature in cabin (K)
T_DEWAR	[3,NANT]	Temperatures in dewar (K)

8.33.10 VARIABLES MONITOR

```
CLIC\VARIABLES MONITOR ON|OFF
```

Total power monitor information (Scan based).

NREC_MON	
FRS_MON	
FRI_MON	
MAGIC_MON	
WATER_MON	[NANT]
TAU_S_MON	[NANT]
TAU_I_MON	[NANT]
TATM_S_MON	[NANT]
TATM_I_MON	[NANT]

```
FORWARD_EFF_MON [NANT]
T_CHOPPER_MON   [NANT]
T_COLD_MON      [NANT]
T_REC_MON       [NANT]
GAIN_IMAGE_MON  [NANT]
CHOP_COUNTS_MON [NANT]
SKY_COUNTS_MON  [NANT]
COLD_COUNTS_MON [NANT]
T_SYS_MON       [NANT]
CAL_MODE_MON    [NANT]
PATH_MON        [NANT]
TEM_MON         [NANT]
DPATH_MON       [NANT]
OK_MON          [NANT]
```

8.33.11 VARIABLES WVR

```
CLIC\VARIABLES WVR ON|OFF
```

Water Vapor Radiometer information (Scan based).

```
WVRNCH          [NANT]   Number of channels (=3; 0 if no WVR)
WVRFREQ  [WVRNCH,NANT]   Central frequencies (MHz)
WVRBW    [WVRNCH,NANT]   Bandwidths (MHz)
WVRTAMB         [NANT]   Temp ambient load (K)
WVRTPEL         [NANT]   Temp Peltier cooler (K)
WVRTCAL         [NANT]   Calibration temperature (K)
WVRREF   [WVRNCH,NANT]   Average counts on reference observation
WVRAVER  [WVRNCH,NANT]   Average counts on current observation
WVRAMB   [WVRNCH,NANT]   Average counts on last ambient measurement
WVRTREC  [WVRNCH,NANT]   Receiver temperatures (K)
WVRLABTREC [WVRNCH,NANT]
WVRLABTCAL [WVRNCH,NANT]
WVRLABTDIO [WVRNCH,NANT]
WVRFEFF  [WVRNCH,NANT]   Coupling factor
WVRMODE         [NANT]   Calibration mode
WVRH2O          [NANT]   Precipitable water vapor (mm)
WVRPATH         [NANT]   Water vapor pathlength (mum)
WVRTSYS  [WVRNCH,NANT]   System temperature (K)
WVRDPATH [WVRNCH,NANT]   K to H2O vap. pathlength (model, mum/K)
WVRFPATH [WVRNCH,NANT]   K to H2O vap. pathlength (empirical, mum/K)
WVRLIQ   [WVRNCH,NANT]   K to H2O liquid emission (K/K)
WVRDCLOUD[WVRNCH,NANT]   K to H2O liquid pathlength (mum/K)
WVRTATM         [NANT]   Temperature of atmosphere (K)
WVRQUAL         [NANT]   Quality code
```

8.33.12 VARIABLES DESCRIPTOR

```
CLIC\VARIABLES DESCRIPTOR ON|OFF
```

Data descriptor information (Scan based).

N_DUMPS	Number of records
HEADER_LENGTH	Length of data header (words)
CONT_LENGTH	Length of continuum data (words)
LINE_LENGTH	Length of line data (words)

8.33.13 VARIABLES DATA_HEADER

```
CLIC\VARIABLES DATA_HEADER ON|OFF
```

Data header information (Record based).

DH_DUMP		Record number
DH_OBS		Date of observation (in internal format)
DH_DATE		Date of observation (in clear)
DH_INTEG		Integration time in seconds
DH_SVEC[3]		EQ coordinates of source direction
DH_AFLAG	[NANT]	Antenna flag word
DH_TOTAL	[NANT]	Total power
DH_DELCON	[NANT]	Delay used for continuum correlator (ns)
DH_DELLIN	[NANT]	Delay used for line correlator (ns)
DH_DELAYC	[NANT]	Computed delay (ns)
DH_DELAY	[NANT]	Delay offset (ns)
DH_PHASEC	[NANT]	Computed LO1 phase
DH_PHASE	[NANT]	LO1 Phase offset
DH_RATE	[NANT]	Computed fringe rate
DH_CABLE	[NANT]	Phase of IF cable (at LO2 frequency)
DH_OFFFOC	[NANT]	Focus offset (mm)
DH_OFFLAM	[NANT]	Azimuth offset (arc sec) in pointing scans
DH_OFFBET	[NANT]	Elevation offset (arc sec) in pointing scans
DH_UVM	[2,NBAS]	U and V for baseline (meters)
DH_RMSPE	[2,NANT]	AZ and EL pointing errors rms *arc sec.)
DH_UTC		UT Time (sec)
DH_TIME		UT Time (hh:mm:ss.ss)
DH_ATFAC	[2,NANT]	Atm. calibration factor [sideband,ant] (K)
DH_BFLAG	[NBAS]	Baseline Flag word
DH_INFAC	[2,2,NBAS]	Instrumental factor [real/imag,upp/low,base]
DH_WVR	[WVRNCH,NANT]	Counts of each WVR channel
DH_WVRSTAT	[NANT]	WVR status word
DH_TEST0	[10]	
DH_TEST1	[5,NANT]	
DH_GAMME	[NANT]	

```
DH_RMSPHA [2,NBAS]
DH_RMSAMP [2,NBAS]
AMPFAC_L [2,2,NBAS]
AMPFAC_U [2,2,NBAS]
```

8.33.14 VARIABLES DATA_RECORD

```
CLIC\VARIABLES DATA_RECORD ON|OFF
```

Data values (Record based).

```
DATA_C [CONT_LENGTH]     Continuum data
DATA_L [LINE_LENGTH]     Line data
```

The following additional variables are computed by command MINMAX:

```
C_AMPMAX_U [NBAS]        Maximum amplitude, continuum, USB
L_AMPMAX_U [NBAS]        Maximum amplitude, line, USB
C_AMPMAX_L [NBAS]        Maximum amplitude, continuum, LSB
L_AMPMAX_L [NBAS]        Maximum amplitude, line, LSB
C_AMPMIN_U [NBAS]        Minimum amplitude, continuum, USB
L_AMPMIN_U [NBAS]        Minimum amplitude, line, USB
C_AMPMIN_L [NBAS]        Minimum amplitude, continuum, LSB
L_AMPMIN_L [NBAS]        Minimum amplitude, line, LSB
```

8.34 WVR

```
CLIC\WVR [/CMODE wvrmode wvrcpol] [/NOWRITE]
```

*** THIS HELP IS NOT UPTODATE ***

This command is used to prepare the atmospheric phase correction based on the 22 GHz Water Vapor Radiometers (WVR). It process all scans in the current index and performs two operations.

First, it processes the WVR calibration scans (CWVR) to compute receiver and calibration temperatures of each radiometer. Option /CMODE is used to specify the WVR calibration mode: the 'wvrmode' parameter can be equal to:

- TR_GE: Trec + gain external
- LAB
- TREC
- DIODE
- NOCAL: no calibration, for test purposes only

```
The second argument of /CMODE is 'wvrcpol' which gives the degree of the
poynomial fit removed from the data.  Default value are: wvrmode = TREC,
and wvrcpol = 0.
```

9 TIFITS Language Internal Help

We give here a *fac simile* of the internal HELP file for the tifits language. Please consult the internal help itself, which is normally kept up to date.

9.1 Language

```
                                    TIFITS\ Command Language Summary

                        ALMATI-FITS to/from native CLIC format converter

    READ            : Read FITS file(s) and write converted output
                      on ipb file
    WRITE           : Convert current index from ipb into FITS file(s)
```

9.2 READ

```
    TIFITS\READ name

Convert  the input ALMA-TI Fits file to native CLIC format. Observations
are read in sequence from the Fits file and are written in the CLIC out-
put  file  (should  have  been opened and/or initialized by command FILE
OUT).

'name' is the name of the input file to which '.fits' is  added  if  not
present.
```

9.3 WRITE

```
    TIFITS\WRITE [file] [/DATA] [/NOCAL] [/HOLO] [/ANTENNA] [/TELESCOPE]

Write  data  into a new Fits file in ALMATI Fits format. All data in the
current index (initialized by the last command FIND) is converted.  This
command  and  many of the options were actually designed to prepare test
data.

'file'

is  the output file name. The extension ".fits" is added if not present.
The file will be split if more than 950  table  extensions  are  needed;
this  is  to  enable using the CFITSIO library and optimize file reading
```

performance. In that case the fits files are named ‘file’-01.fits, ‘file’-02.fits, ...

/DATA

forces the writing of binary table extensions (ALMATI-CORRDATA, ALMATI-AUTODATA, ALMATI-HOLODATA). Otherwise only ALMATI-DATAPAR, ALMATI-CALIBR, ALMATI-GAIN, ALMATI-PASSBAND are written.

/NOCAL

disables the writing of atmospheric calibration data (e.g. system temperatures, water contents,...).

/HOLO ant ref

generates test ALMATI-HOLODATA tables, based on actual holography data from Plateau de Bure. ‘ant’ is the antenna that was scanned and ‘ref’ points to the reference antenna (i.e. the data from the baseline from ‘ref’ to ‘ant’ will be used).

/ANTENNA ant1 ant2 ant3 ... antn

selects a subset of antennas (subarray) which is only used.

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