AT.39.2/013

Intelligent AT Fault Diagnosis System
Users' Manual

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1 Introduction

Faulty analyses the AT monitor points (approximately one thousand per antenna), astronomical data, and various environmental variables (weather data, the primary monitor rack) to try to determine if there is anything awry with the array.

If so, it produces a fault report, which may be sent to the observing computer *NOEL* and used to alert the observer, or may be left until discovered by an engineer, depending on its severity. The User Interface notifies the user of all faults, but the interface may not be running or the user may not be attending it. However every fault is written to a disk file in the FAULTS: directory where it may be examined at any time. See section 7. The current file is closed and a new one opened every midnight.

The process DOCTOR that diagnoses faults is one of several processes running in the background. Other processes produce detailed LOGs of selected monitor point data one item per minute or a general ARCHIVE of all the monitor points, one characterization every half hour. This robust statistical characterization is described in section 5 in more detail. These background processes are active regardless of whether the User Interface is running or even if any user is logged in.

The *Faulty* User Interface (FUI) is the primary means by which the user can examine the state of the array. There are six graphics viewports which may display up to twenty-four time histories of monitor data. In each viewport the user can select either six hours of detailed data, one item per minute, or one week of characterized data, one item per half hour. An item indicates both the value of the monitor point and its range in a way described in section 4. Hardcopies of particularly interesting plots may be produced. See section 6.

You can also plot histograms of the data you select and get a statistical characterization of them. And you can plot scatter diagrams of the data from two viewports and calculate the regression of one on the other.

2 Getting Started

The Interface is usually left running on *DELPHI*, the VAXstation located next to the primary monitor rack just outside the door of the control room.

These generic names refer to four specific monitor points (two for class 4). If a name has no prefix, it has no generic name. (Note: in perverse cases, the prefix may appear inside the name, as in SAMP A1 TEMP.

Points may be selected in three ways. The easiest is to use the point/module selection menu under antennas 4 and 5. Repeatedly clicking on the header, will cycle through the four options: - points - - errors - - values - and - probe -. To select a point, make sure the header says - points -. Then click on the subsystem in the list below. A list of modules within that subsystem will appear. Without letting up the mouse button, drag the pointer to the desired module and then to the right until a list of points appears. Drag the cursor to the point and release the button. The point should appear in the text input box in the upper left.

You may also type the name of the point in the text box. It always receives keyboard input and the standard keyboard and mouse editing commands apply—linefeed, (F13) for example, will delete the word to the left of the input pointer (the vertical bar). You can type either the generic name, the specific name, or the old PNTDEFA 8-character name.

The subsystem/module/points menu contains all generic names and all unprefixed specific names. Selecting the generic name will allow you to see all (or any) of the four points it references. (Yes, two for class 4.) See selecting an IF channel, below.

If a block diagram appears as a result of a fault, clicking on any oval that contains the name of a monitor point, will select it.

3.2 selecting an antenna

Antennas may be selected and deselected, but unless they are applied to the viewports they have no affect on the viewport displays.

Any antenna may be applied to any viewport by clicking on the antenna icon and then clicking on the viewport's select box. (The select box will either contain the word *select* or the name of a previously selected monitor point.) The number of the antenna assigned to a viewport appears within the viewport's select box at the left edge. If more than one antenna is selected, nothing will happen: in this case, deselect the extraneous antennas by clicking on them and try again. A selected antenna appears white, a deselected antenna appears ghostly.

An antenna may be deselected and another one selected in one elegant motion: Press the mouse button while the pointer is on a selected antenna, drag the cursor to the unselected one, and release the button.

If the box to the left of the antennas reads *All*, clicking on it will select all antennas; if it reads *None*, clicking on it will *de*select them all. We describe now why this could be useful:

Some distributions of antennas over viewports are so often desired that they have accelerators:

- To apply antennas 1 through 6 to viewports 1 through 6 (top to bottom), click on the *All* box under the *Apply* box. (If the box is presently labelled *None*, click twice.) This will select all the antennas *and* apply them to the viewports.
- To apply a single antenna to every viewport, select the antenna and click on *Apply*.
- To apply two antennas to all viewports select any two and click on *Apply*. The first will be applied to the first three viewports and the second, to the bottom three. We presume that three different monitor points will be chosen for viewports 1 and 4, 2 and 5, and 3 and 6.
- Similarly three antennas can be applied to the first two ports, the second two, and the last two. Select three antennas and *Apply*.
- four and five antennas may be applied sequentially to the first four or five viewports, leaving the remaining ones unaffected. Select and *Apply*.

3.3 selecting an IF channel

The time histories of all selected specific monitor points will appear in their viewports without the need for specifying a channel

If the screen is dark, move the mouse and the screen will blossom into living color. If you see a login screen instead, login as FAULTY with password TOWERS (or wake up a guru and ask for the password.) *Faulty* should come up automatically after 1 minute. If not, get a DCL window and type, `resume`.

The interface display occupies the entire screen. To use other X-windows in the same session, iconify *Faulty* by clicking on the small box with a dot in it to the right of the title bar and to the left of the square. You may want to do this to read FAULT reports, plot data from the LOG files, examine the ARCHIVE files, or to run CAMON, or some other utility.

To restore the FUI display, locate the icon labelled *main* and double click on it. (Click twice within 250 milliseconds.)

You can exit from the interface by clicking on the red exit box in the lower right corner, but normally the interface is left running.

The FUI is a mouse only affair so that it is equally friendly to good and bad typists. Once the interface is displayed you can put the keyboard away.

3 Selections

Some output is available without selecting anything.

- The Local time and date (AEST) and the UT time and date are displayed in the title bar. The times are derived from Delphi system time and, at this writing, drift with respect to astronomical time.
- Each antenna is displayed in one of three states: observing, stowed, or isolated. As these are not mutually exclusive, isolated has priority.
- The stations on which the antennas sit are shown under the icon of each antenna.
- The reference antenna, if it is one of the six in the Compact Array, is indicated in its icon.
- The name of the program (image) that is running in the process that has control of each antenna is shown above the antenna icon. This is usually CAOBS, but could be A_TEST, LO_TEST, VLOBS, or somesuch.
- The observing frequencies are shown in the boxes above and below the icons for the conversion chains. If the second frequency is not being used it is shown as zero.
- The current cycle number is shown in its own box. This is not very useful, but if it is not incrementing every integration cycle then data are not coming in.

To display a time history of some monitor point in one of the viewports, a point and an antenna must be selected and applied to that viewport. In addition, if a *generic* monitor point has been applied, at least one IF channel must be selected.

3.1 selecting a monitor point

The names of monitor points are of two sorts: generic and specific. If a monitor point name has a prefix, its *specific* name is its whole name, including the prefix and its *generic* name is its name without the prefix. Prefixes are of four classes:

class 1 prefixes are the set {A1, B1 A2, B2}. They are used throughout the array.

class 2 prefixes are {CA, CB, XA, XB} and are used in the CX receiver.

class 3 prefixes are {LA, LB, SA, SB} and are used in the LS receiver.

class 4 prefixes are {1L, 2L} and are used in the 2-GHz and 7-GHz local oscillators.

complementary to A1 is that for B2; B1 is complementary to A2; etc.) Thus for normally distributed values, the plots show a thin band in one colour surrounded by a complementary band about three or four times as wide. Uniformly distributed data show a broad band with a thin complementary fringe. Erratic data will show a thin band with a broad (usually asymmetric) envelope. Half hours with a few outlying points will show a tall complementary spike. These histories do not move. If a half hour elapses while viewing a weekly history it must be reselected to view the new rightmost pair of lines.

4.3 marking and the cursor

The mouse pointer can be used inside a viewport to specify features and regions of the display for special treatment. It has two functions according to the state of the **mark** toggle.

If **mark** is *not* selected, the cursor returns the user coordinates of the point under the tip of the arrow when the mouse button was pressed. The values are printed in white at the position of the pointer when the mouse button is released. This is to allow you to stack several positions for easy comparison and to move the output away from graphical congestion. Moreover, without this feature the viewport would clip the printout for points near the right edge. For 6-hour graphs, the first number is of the form */hh:mm*, where *hh* and *mm* are hours and minutes before *now*. For 1-week graphs, the first number is of the form */d hh*, where *d* and *hh* are days and hours before *now*. The second number is the ordinate, in the units shown within the **select** box.

If **mark** *is* selected, the cursor is used to mark vertical lines on the plots which can be used to delimit a region of time over which to apply the statistical analysis functions discussed in section 5 or over which to select values to use for rescaling the vertical axis. The mouse button is pressed, the pointer dragged, and the button released. The region delimited lies (inclusively) between the two markers that appear at the press and release positions. If the press and release positions coincide, the region delimited lies between the marker and *now* (the right hand edge). If **mark** is toggled on, but no markers are selected, the delimited region is the whole time axis. Markers on a 6-hour plot move with the data. If the left marker falls off the left edge, **marking** is turned off. Markers on a 1-week plot are independent of those on the 6-hour plot. Four markers are stored, although only one pair can be seen at a time.

4.4 tying marks

The cursor can be used to mark several viewports simultaneously (over the same region, naturally). Click on the red tie toggles at the junction of two viewports to form a chain of tied viewports. Marking any viewport will also mark all viewports in the chain except those with their **mark** toggle off or those displaying a different (6-hour/1-week) time axis. The **tie** toggles are also used to tie viewports together for printing. (See section 6 below.)

4.5 display options

What you see in a viewport can be modified by a variety of display options.
The last section described selecting the number of IF channels for display, each in its own colour.

To the right of each viewport are toggle buttons which implement the following further functions:

expand rescales the vertical axis (always with 10% overrange) using the highest and lowest data over the marked interval (or the whole time axis, if **marking** is off) and over all IF channels currently selected. Toggling **expand** off reverts to the scale determined by the upper and lower limits.

6 hours/1 week selects the 6-hour or the 1-week display. The label will disappear, indicating that *Faulty* is working– reading the archive files for the 1-week data may take a while.

mark allows marking as described above. It also enables drawing the median and quartile positions on the histogram display described below in section 5

grid draw a grid of vertical lines. On a 6-hour plot the lines mark the hours (00 minutes AEST) and move with the data. On a 1-week plot, they mark midnights AEST

5 Analysis

The statistical analysis functions are chosen from the green box above the viewports. The data to which they are applied are the whole time axis if **mark** is off, otherwise the data within the **mark**ed region. The **high/ave/low/hi-lo** data selector in the blue box to the left of the green function box is used to further specify the data to be analysed. If ***high*** or ***low*** is selected, the high or low data within the selected region are used. If *ave* is selected for 6-hour data, the averages of the high and low values over each minute are used. If *ave* is selected for 1-week data, the medians of those thirty averages are analysed. If *hi-lo* is selected the range of the data is analysed.

To apply an analysis function to the data in a viewport, click on a function button and then click on the viewport's **select** box. To deselect a function, click on it again, or select a different function. The following functions are available:

stats types a robust statistical characterization for each IF channel selected. A characterization is six numbers:

range the maximum minus the minimum of the data,

median the median of the data,

width the third quartile minus the first quartile of the data,

trend a number between -1 and +1, indicating the direction and trend of the data. Briefly, the data are divided into a first and later half. If every datum in the later half is larger than its corresponding datum in the first half, the trend is +1, if there are as many negative as positive differences, the trend is 0, etc.

intermittancy a two part quantity: 1) the number of times the given monitor point dropped below its *lower* limit or increased from below to above its lower limit, and 2) the number of times it transited across its *upper* limit.

N the number of values analysed.

For the time being the display appears in a DCL window behind *Faulty*Raise it to the top by moving *Faulty* aside just a bit and clicking on the border of the DCL window.

hist Draws a histogram of the data for each IF channel selected in the colour of that channel. If **grid** is on it also draws the three quartiles on the histogram as vertical green lines.

y Selects the vertical axis for a scatter diagram, which it displays if **x** has been selected. The viewport that supplies the vertical axis is indicated next to the label *y*. See **x**.

x Selects the horizontal axis for a scatter diagram, which it displays if **y** has been selected. The viewport which supplies the horizontal axis is indicated next to the label *x*.

Two regression lines are fit to the data:

1. The grey line minimizes the sqared distances from the data to the line. The correlation coefficient, slope (with uncertainty), and rms residual (in the units of the vertical axis and as a percentage of the vertical range) are shown in white on the left.
2. The blue line minimizes the absolute distances from the data to the line. The slope and the average absolute deviation are shown in blue on the right. This fit is often more robust (insensitive to outliers) than the least squares fit.

6 Hardcopying

To print one viewport, select the **print** function and click on the viewport's select box. The plots come equipped with axes and labels and a heading giving the time at which the plot was made. The current (perhaps expanded) vertical scale is used. If more than one IF channel was plotted, an attempt to separate the graphs is made by printing the prefix for each channel outside the right edge

of the plot at the height of the last plotted line for that channel. More exciting is to print several viewports together on one sheet. Tie the viewports together by toggling the red tie buttons between viewports, select the **print function**, and click on the **select box** of the highest tied viewport you wish to print. Six-hour plots and 1-week plots can be mixed (as you would wish), each given its own time axis. Hardcopies are automatically sent to the Laser Printer. A typical printout is included as the last page of this manual.

7 Examining Errors, Points, Faults, Archives and Logs

7.1 Errors and points

To see those points in any module that are currently out-of-range, click on the header of the subsystem/module menu until it says - **errors** -. Then select a module from a subsystem. Points that are out-of-range high are shown as $+$, those out-of-range low as $-$.

To see data about a particular monitor point, including its scale and offset, its upper and lower limits, and its current value for all antennas, select - **probe** - in the header of the subsystem/module/points menu and select the desired point.

For the time being the two displays above appear in the DCL window behind the interface. Move the interface window slightly right or up, and click on the border of the DCL window in the lower left to raise it to the top of the window stack. Or iconify the interface, then the DCL window, then de-iconify them in the same order. The output window will appear on top.

7.2 Fault reports, Archives, and Logs

The files written by the Diagnostic, Archiving, and Logging detached processes are, for the time being, accessed from Fileview. You can read Fault reports, plot or examine the logged data, or examine the archived data.

First iconify the Interface. Then locate a FileView window: if the window is open, its title bar will begin, FileView - DELPHI:: . . . . Alternatively, if it's in an iconified state its label will begin DELPHI:: . . . . When all else fails, open FileView as an Application of the Session Manager.

Choose the **Views** menu and select one of the four views in CAPITALS; that is, either ARCHIVE, FAULTS, or LOGS. (You should not need to use POINTS.)

Now select the files you wish to examine. Select a single file by clicking on it. Select contiguous files by dragging the pointer. Select noncontiguous files by clicking on each while holding down the <Ctrl> key on the keyboard. (Sorry, you'll have to retrieve the keyboard, but you'll need that to drive the examination programs anyway.)

These programs are traversed by answering a hierarchy of questions. Repeating <cr> often enough floats you to the highest level from which the next one exits the program. If more than one file has been selected, exiting the program does not exit the window but starts the program anew on the next file. The file currently being examined and its order in your list of selected files appears in the title bar of the window that will appear with the first pass. After the last pass, the order counter will be replaced with the word *Done*. Then you can click on the **Stop Task** box at the bottom of the window to exit finally.

From the **Faulty** menu, you can select

Report to read (and print) fault reports for the days selected,

Errors to run the error routine described above that displays the current out-of-range points in any module.

Probe to display data about a single monitor point.

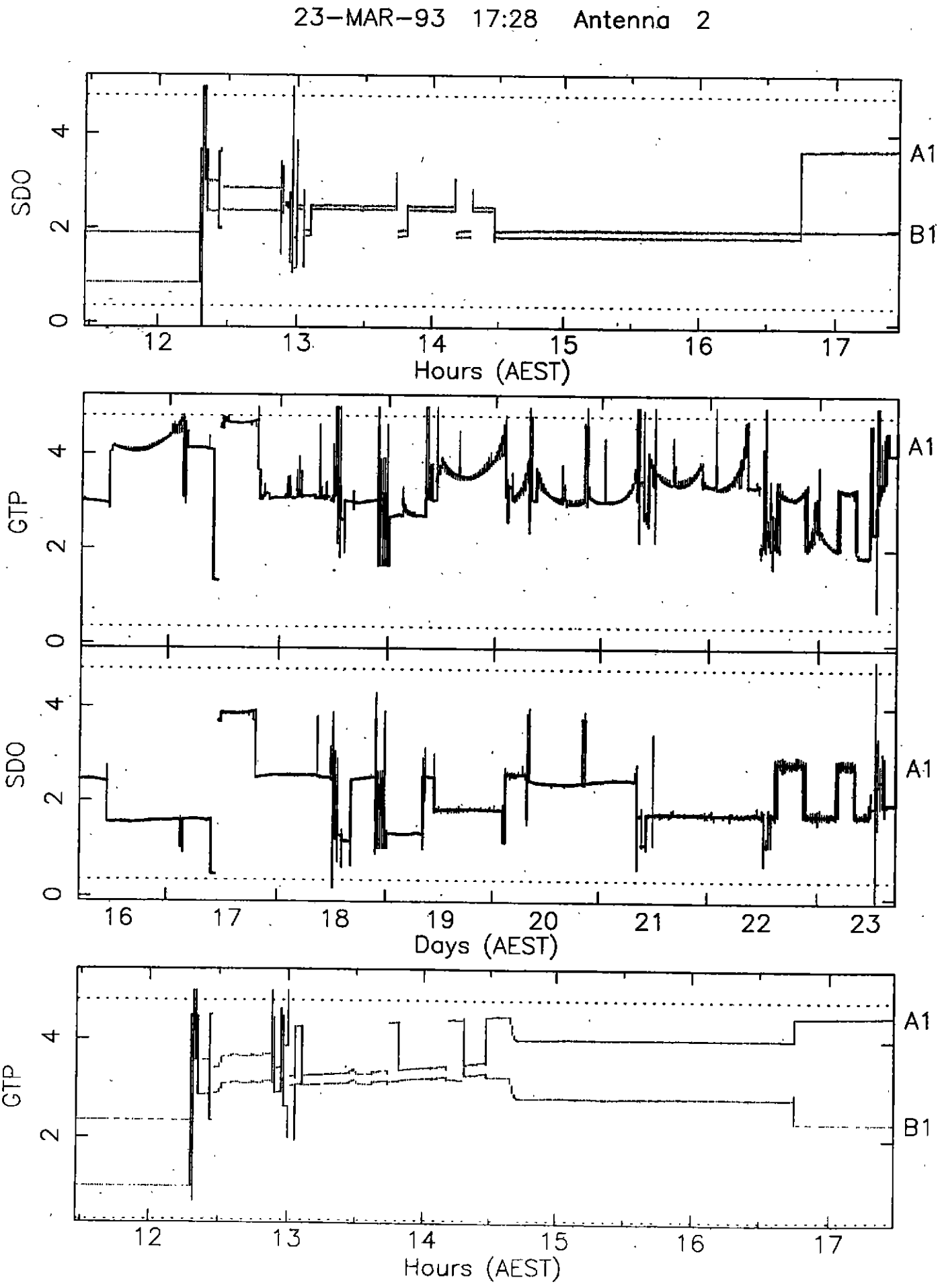
Peek to examine the data in archive or log files, or

Plot to call up a *PGPLOT* window to plot (and print) logged data

You can also run any program in a DCL window. The most useful may be **camon** which continually updates the data for a page of points. Enable input into the window by clicking the cursor in the window and type the name of the program at the prompt.

The graphical package ARCHEOLOGIST will plot archive files, but must be run from *LEON*. The most recent 2 or 3 months of data are kept on disk, but the rest are on DAT tapes that are stored in the compactus in the computer room. Only *LEON* has access to the DAT tape reader. From a terminal logged into *LEON*, type, **excavate**, and answer the questions. Data from the half-hour characterizations for any point for all antennas can be plotted on one sheet over any window of time back to 14 January 93, when archiving in this form began. Plots may be previewed by selecting *\X11* as an output device or sent to the printer by choosing *\VPS*

Have fun.


23-MAR-93 17:28 Antenna 2
SDO
GTP
SDO
GTP
A1
B1
A1
A1
A1
B1
0
2
4
12
13
14
15
16
17
Hours (AEST)
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Days (AEST)
12
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17
Hours (AEST)