Datasheet: Sleepscore 7.06

Overview

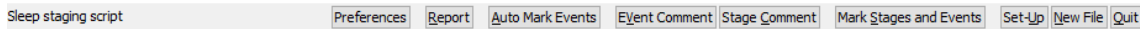This script allows you to perform the following tasks:

- Subdivide a polygraph in a Spike2 time view into epochs of the desired duration.

- Inspect the data and assign time ranges (one or more epochs) to user-defined categories, usually, sleep stages. The epochs are shown in a ‗States‖ channel with the different sleep stages represented by a colour code. States are assigned under mouse control using ‗drag and drop‖ methods.

- Mark the time ranges of user-defined ‗episodes‖ such as apneas and arousals using the mouse.

- Display plots of power in user-defined spectral bands next to selected EEG channels.

- Display banded power spectra of selected EEG channels for the current epoch.

- Show a table of power in bands for the current epoch.

- Generate a report suitable for further analysis with spreadsheet software.

Software requirements

This script requires Spike2 version 8.03 or higher.

User guide

When you first run the script, a toolbar with 9 buttons appears. You can control the script by clicking on the buttons with the mouse or by pressing the associated hotkeys.

| Sleep staging script | Preferences | Report | Auto Mark Events | EVent Comment | Stage Comment | Mark Stages and Events | Set-Up | New File | Quit |

You can work on the currently open time view or click on New File and browse to a suitable data file. Any previously open time view will close before a new one opens. You will be warned if there is any unsaved data in the file that is about to close. If a data file is open, then the Set Up button will be enabled.

Next, click on Set-Up. In the dialog that opens, you select the Epoch and Events marker channels. These will be new TextMark channels first time around, but you can also select pre-existing epoch and event channels in order to review and edit them. You can also set the epoch duration and time range to analyze, You can set the time range by any combination of dragging cursors in the data view, pressing buttons to fetch or shift the cursors or by typing the required times in the dialog.

There are also 4 check boxes.

The first check box allows you to select the sleep stages to use or define your own. The second check box allows you to define the type of Events you want to mark. Check the third box to display sleep stages as a hypnogram as well as colour coded states. Check box 4 to set up and display power spectra of selected epochs. If you leave the Stage and Event boxes unchecked, default values will be used or the ones used last time the script was run. You can preview the current default settings for sleep stages and Events by clicking on the Show Stages or Show Events buttons.

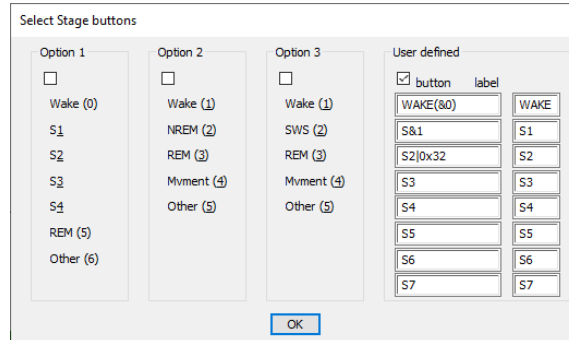For demonstration purposes, check all the boxes.
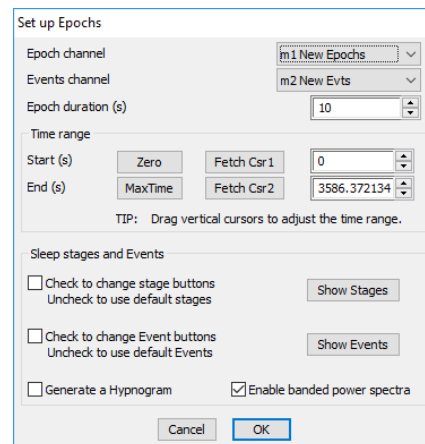
Before clicking on OK, move the dialog to your preferred position on the screen by dragging its title bar. The dialog position when you click on OK will become the new default setting. The same applies to all the other dialogs in this script.

Stage selection

At this point, the new epoch channel is displayed, with each epoch initially labeled *"U"* for un-staged. The *Select Stages* dialog opens. Here, you select the set of staging buttons that is most appropriate for your study by checking a box. Your selection will become the default the next time you run the script.

Four options are available. Three are preset to various combinations of sleep stages (hotkeys underlined). The fourth allows you to define your own buttons.
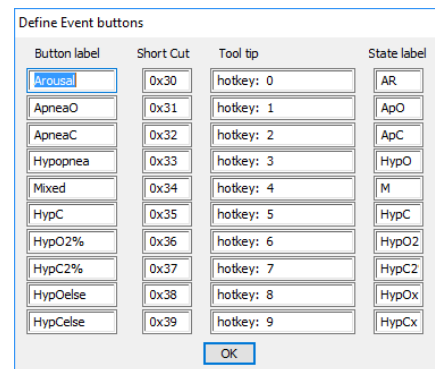
To do this, check the ÷user-definedø box and then enter your preferred titles for staging buttons and labels for the epochs in the selection boxes. Add *&* to a button label to make the following character a hotkey. Alternatively, use the õ|ö character followed by a key code. For example, the code *0x31* sets the character õ1ö on the keyboard as the hotkey for the button. See the Spike 2 online help under *ToolbarSet()* for further information on key codes. Do not use: H, ↑,↓, ←, →, or Enter as hotkeys. They are already in use. You can define up to eight stage buttons. If you donøt need so many buttons, simply leave the lower selection boxes blank.

Select Events

The next dialog allows you to define up to ten Event buttons. For each Event type you must enter:

- a label for the button that you will press to choose an event type
- a key code for the keyboard short cut for that button (see the online Help for *ToolbarSet()* for a list of key codes).
- A tool tip, that is, the text that appears when you move the mouse pointer over the button. It is a good idea to enter a reminder of the hotkey for that button. However, you can enter other information if you wish.
- A *state* label. This text is a label that appears at the start of each Event.
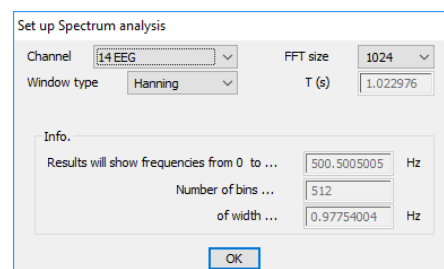
If you need less than ten Event types then leave the lower sections blank. Note that the Event and Sleep stage buttons are shown together in the same control panel. Therefore, you must use different hotkeys for Events and sleep stages to avoid ambiguity.

Power spectra

If the power spectrum option was selected in the main *Set up* dialog then several dialogs will appear for you to set it up. In the first one, select an EEG waveform channel from the list. You can generate power spectra of multiple channels by choosing ÷Selectedø from the list. Then hold down *Ctrl* and click on the channel numbers of the EEG channels to analyze. You are only allowed to choose combinations of channels that were sampled at the same rate.

Next choose the type of windowing to use on the power spectra. The *Hanning* window is probably the most appropriate. Now select the FFT size. As you change the FFT size, the other items in the dialog will update automatically, telling you the minimum length of data required to create the power spectra (Ts), the frequency range, number of bins and the bin width. You should choose an FFT size that gives a bin width of 1Hz or less in order to get well defined EEG bands. You can find further information on power spectra in the Spike2 online help. The FFT size and window selections will become the defaults, thus speeding the set-up process for standardized analysis of other files. Press OK when ready.

Power in Bands

EEG signals are usually subdivide into 4 contiguous power bands:

- *Delta*: less than 4 Hz
- *Theta*: 4 ó 8Hz
- *Alpha*: 8 ó 14 Hz
- *Beta*: greater than 14 Hz.

In this dialog, you define the frequency bands. Use the spinner arrows to adjust position of the band margins in increments of one bin. It is recommended that you exclude the first bin from the *Delta* band. This prevents artifacts caused by a DC offset in the EEG data from distorting the *Delta* power band. The minimum width of a band is one bin. The band margins that you select will be stored for future use. The next time you run the script the default bands will be as close as possible to the previous values within the limits imposed by the current bin width.

Check the upper checkbox to display power spectra with per cent of total power in all bands as the Y-axis. Leave the box unchecked to display actual power in bands.

Check the lower box to generate trend plots of power in bands (*not* per cent of total power) in the data file. You can select which trend plots to show in the next dialog. They are shown in Virtual channels with the same frequency and time resolution as the power spectra for individual epochs. Total power within all bands combined and Theta : Delta ratio are shown as separate channels. *Delta*, *Theta*, *Alpha* and *Beta* channels are shown overdrawn adjacent to the EEG channel that they are based on. The traces are colour-coded as *Delta* green; *Theta*: blue; *Alpha*: red; *Beta*: orange. You can view the trend plots on separate y-axes by clicking on the channel numbers in turn and dragging vertically until the mouse pointer is between channels before dropping them. There is an option to apply smoothing channel processes to the trend plots to reduce their õspikinessö and make it easier to visualise longer term trends.

Most of the facilities of Spike2 remain available while the script is running. This is a good time to use some of these tools to adjust the display to show the data you are interested in to best effect. For example, you can adjust the size of each window by dragging the borders with the mouse. You can also hide any channels in the view that wonøt be helpful in assigning stages in order to increase the area available to useful channels. Simply, click the right mouse button on the data area of the time view and select *Show/Hide* channels from the context menu. You can further adjust the amount of space occupied by each channel by holding down the Shift key and dragging the margin between adjacent channels
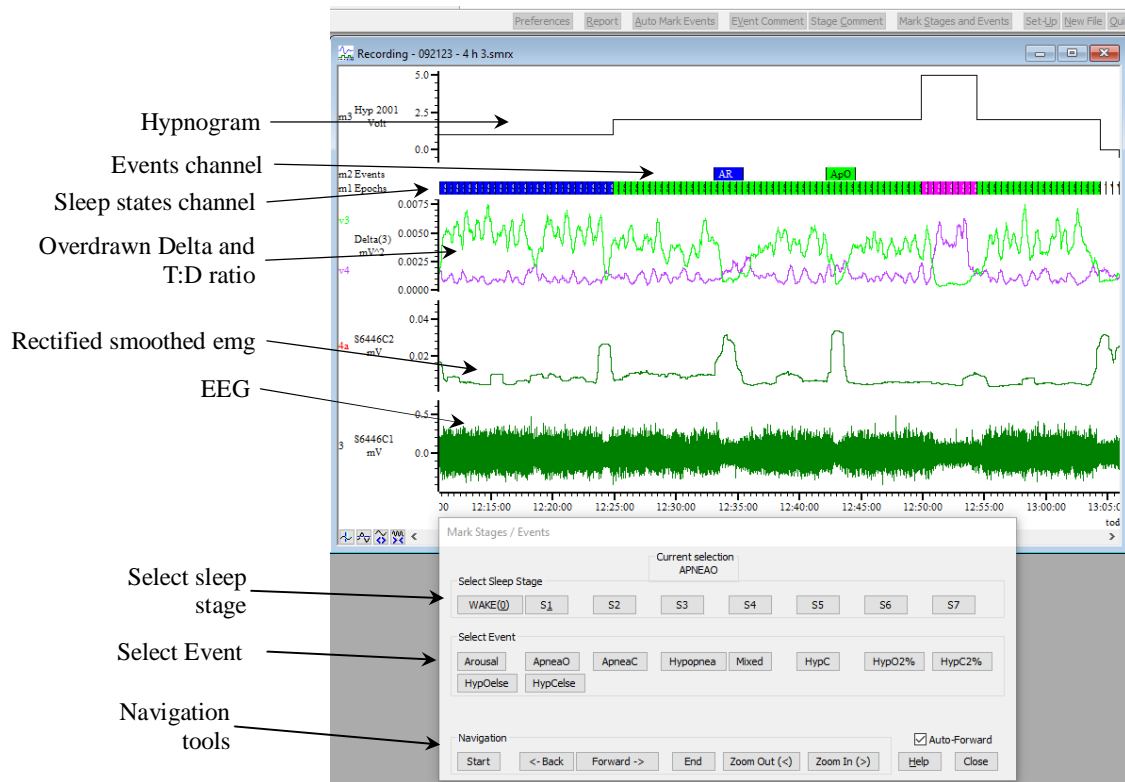
Preferences

Review the *Preferences* before scoring data for the first time. The *Preferences* dialog allows you to set the preferred overlap between successive time ranges when you advance page by page through the file. If you prefer to view one or two epochs at a time, then you might set the overlap between pages to zero, so that each page of data shows an exact number of epochs, always starting at the same relative screen position.

If you prefer to view more epochs (say 10) in less detail so that you can quickly assign multiple consecutive epochs to the same state, then you may wish to set an overlap (say 10%) between successive pages so that some previously staged epochs are visible.
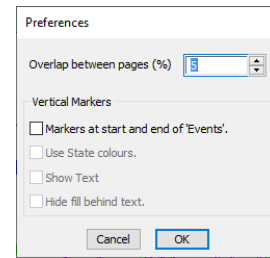
There is also an option to set up vertical markers at the start and end of Events. The default (no boxes checked) is simply a horizontal coloured bar in the *Events* channel. If you check the first box, then a *cursor-like* vertical marker is added at the start and end of each event. Other check boxes allow you to customize the vertical markers by using Event colours or showing the Event label on each vertical mark

Sleep scoring and Event marking

Hypnogram

Events channel

Sleep states channel

Overdrawn Delta and
T:D ratio

Rectified smoothed emg
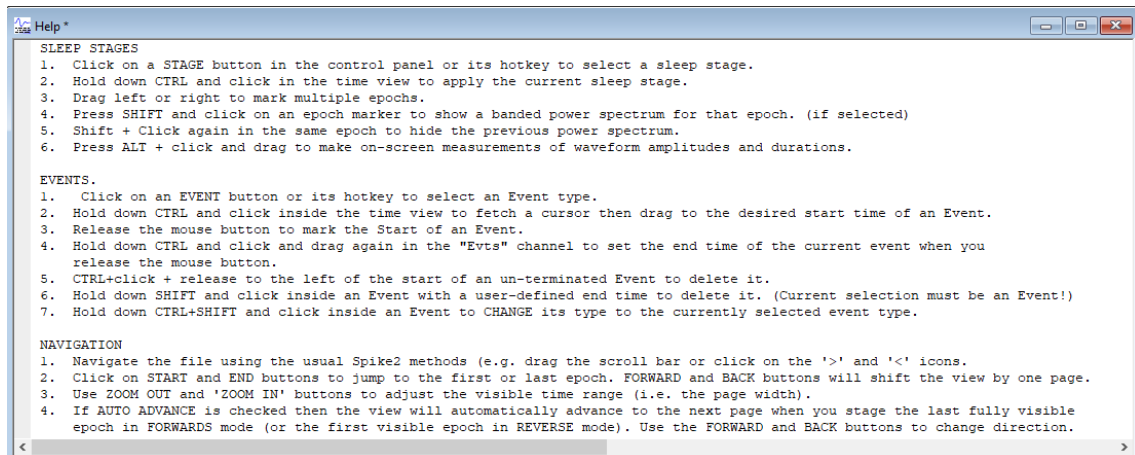
EEG

Select sleep
stage

Select Event

Navigation
tools

Click on Mark Stages and Events. The control panel will appear. You can move it to a convenient position by dragging its title bar.

You can modify this using the scroll bar and / or the *Zoom in* / *Zoom out* buttons in the dialog. You are now ready to mark sleep stages by clicking and dragging with the mouse.

Help

Click on Help to display this guide to using the *drag and drop* interface. Click again to hide it.

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SLEEP STAGES
1.  Click on a STAGE button in the control panel or its hotkey to select a sleep stage.
2.  Hold down CTRL and click in the time view to apply the current sleep stage.
3.  Drag left or right to mark multiple epochs.
4.  Press SHIFT and click on an epoch marker to show a banded power spectrum for that epoch. (if selected)
5.  Shift + Click again in the same epoch to hide the previous power spectrum.
6.  Press ALT + click and drag to make on-screen measurements of waveform amplitudes and durations.

EVENTS.
1.   Click on an EVENT button or its hotkey to select an Event type.
2.  Hold down CTRL and click inside the time view to fetch a cursor then drag to the desired start time of an Event.
3.  Release the mouse button to mark the Start of an Event.
4.  Hold down CTRL and click and drag again in the "Evts" channel to set the end time of the current event when you
    release the mouse button.
5.  CTRL+click + release to the left of the start of an un-terminated Event to delete it.
6.  Hold down SHIFT and click inside an Event with a user-defined end time to delete it. (Current selection must be an Event!)
7.  Hold down CTRL+SHIFT and click inside an Event to CHANGE its type to the currently selected event type.

NAVIGATION
1.  Navigate the file using the usual Spike2 methods (e.g. drag the scroll bar or click on the '>' and '<' icons.
2.  Click on START and END buttons to jump to the first or last epoch. FORWARD and BACK buttons will shift the view by one page.
3.  Use ZOOM OUT and 'ZOOM IN' buttons to adjust the visible time range (i.e. the page width).
4.  If AUTO ADVANCE is checked then the view will automatically advance to the next page when you stage the last fully visible
    epoch in FORWARDS mode (or the first visible epoch in REVERSE mode). Use the FORWARD and BACK buttons to change direction.
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Following these instructions, click on a button in the control panel or its keyboard shortcut to select a sleep state. Now hold down *Ctrl* and click with the left mouse button inside the time view. The epoch where you clicked will be assigned (i.e. labeled and colour-coded) to the current sleep stage. Drag to

the right or left while holding down *Ctrl* and the left mouse button to assign adjacent epochs. Note that if you drag the mouse quickly over a long time range, there is a possibility that not all of the intervening epochs will be marked until you release the mouse button.

If a hypnogram channel was selected in the *Set up* dialog (or a hypnogram channel already existed, then it will update at the same time as the colour-coded epoch channel. In the hypnogram channel, a level is assigned to each sleep state. Unclassified epochs are at - 0.5. The levels 1, 2, 3 etc. are linked to the sleep state buttons in order from left to right in the control panel.

Display Power spectra

If you selected this option in the *Set up* dialogs then you can display the power spectra of a selected epoch in a result view and as a table by holding down the *Shift* key and clicking in an epoch with the left mouse button. The selected epoch will be marked by cursors. The spectral bands are shown with the same colour code as the traces in the power in band trend plots (if selected). The power spectrum will update whenever you press *Shift* and click on a different epoch. Press *Shift* and click a second time on an epoch to hide the power spectrum.
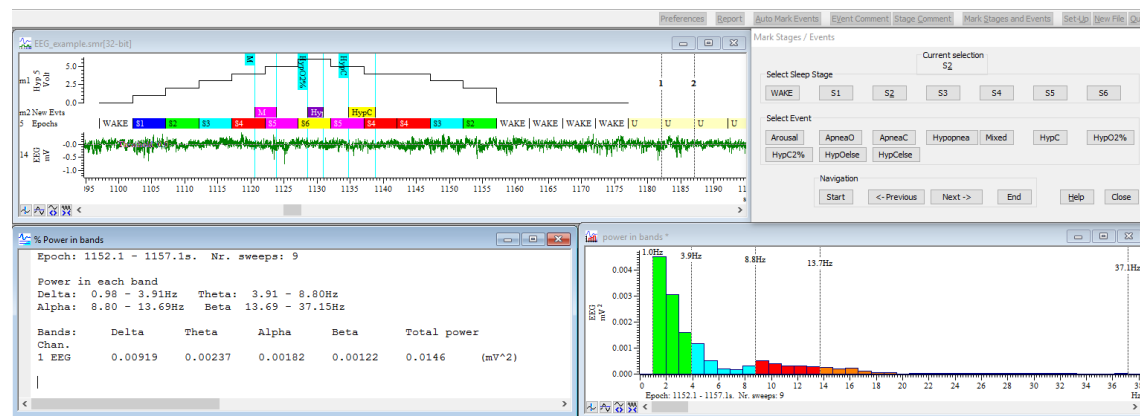
Manual Event Marking

To add an Event marker, select the required event type via its dialog button. Next, hold down *Ctrl* and click with the left mouse button in the data window. A cursor will appear at that position. While holding the mouse key down, drag to the onset time of the Event and release the mouse button to insert the Event. Provisionally, the Event will appear as a coloured state that extends to the end of the file or until the onset of a pre-existing event. Hold down *Ctrl* and click again with the left mouse button and drag the cursor to the required position of the end of the event. The event will be terminated when you release the mouse button. The Preferences button provides an option to add vertical markers at the start and end of Events as shown above. Further options for customizing Vertical markers are available via the Spike2 *View* drop-down menu.

You are not allowed to have overlapping event markers. The system will try to behave sensibly if you attempt it. For example, if you try to start an Event within an existing Event then the existing event will be truncated, that is, it will be terminated just before the new start point. If you try to insert the end of a new Event inside an existing event, then the new event takes precedence and the previous event will be deleted. If you try to terminate a new Event before its start time then the new Event will be deleted. You can also delete a pre-existing event by holding down *Shift* and clicking inside the unwanted event.

You can re-assign an existing Event to a new type while leaving its position and duration unchanged by selecting the new Event type from the control panel and hold down *Ctrl+Shift* and click in the Event to modify.
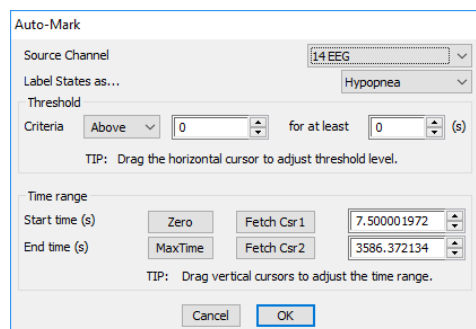
Navigation

The Next and Previous buttons or their shortcuts (   ) scroll the view one page forward or back. There will be an overlap between consecutive pages if this was selected in the Preferences.

Start and End buttons (hotkeys   and) shift the display to the beginning and end of the time range selected in the *Setup* dialog. The x-axis scroll bar and zoom in/out tools remain available for adjusting the time range. However, dragging the mouse to the right or left-hand edge of the view does not cause scrolling Thus, you cannot assign stages to epochs that you have not inspected, inadvertently.

Press Close to close the dialog and return to the main toolbar when you have finished adding events and sleep stages.

Auto-Mark Events

This button gives you the option to mark all of the time ranges during which a waveform channel, oxygen saturation (SaO_2) for example, falls below a specified threshold level. A *Set up* dialog opens when you click on the button and the ranges are marked when you click on OK. A horizontal cursor shows the threshold level that you chose. The minimum duration item in the dialog is intended to exclude brief excursions of the trace below threshold caused by noise. The *Label State As* item allows you to set the label and colour to match one of the manual Event marker buttons on the toolbar. You should perform automatic Event marking *before* adding events manually to the same Event channel.
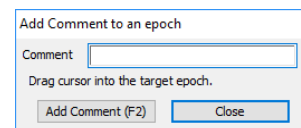
Alternatively, create a separate Events channel for adding events automatically at the *Set up* stage.

Stage Comment.

You can add a comment to any sleep stage by clicking this button on the main toolbar. Drag *Cursor (1)* into the relevant epoch and enter a note in the dialog that opens. The note will be displayed in the coloured bar when you hit OK. If the comment is unreadable because the displayed epoch width is too narrow, you can view it in a *Tip* box by positioning the mouse pointer over the relevant epoch. Comments are printed in the report. Thus you can store the result of any measurements you make for later analysis. For example, you might want to make a note here of oxygen saturation levels based on measurements from an SaO_2 channel made with a horizontal cursor
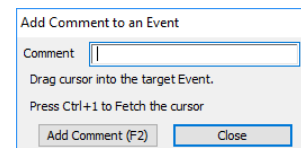
EVent Comment

Similarly, you can add more text to an event via the Event Comment button on the main script toolbar. Enter the comment in the dialog, drag *Cursor 1* into the target event and click on the Add Comment button or its shortcut F2. You can add comments to multiple events in this way. Any comments that you add will appear in the report. Click on Close to return control to the main script toolbar.

Report

Click here to generate a table of results for further analysis with a spreadsheet. You can print a report of new or previously analysed data. In the set- up dialog, you can choose the Epoch and Event channels, and the time range. Check boxes allow you to customize the scope of the report. All On and All Off buttons provide a quick way to check or un-check all of the checkboxes.

Summary of Events. This generates a table of start / end times and durations for each event type in turn together with summary statistics such as mean duration and its standard deviation.

Summary of sleep stages. óa table showing the number of epochs of each sleep stage in the time range together with total time and percent time in each sleep state.

Sequence of sleep states. This table shows the sequence in which different sleep stages occurred together with the start time, duration and epoch count of each episode. The results are printed in blocks of 1 hour duration.

Sequence of events. Check this box for a listing of the sequence of events, their onset and end times and their durations.

Epoch by epoch times. This generates a listing of every epoch in time order together with any comments that were added using the stage comments button. A further checkbox allows you to extend this listing to include Events.

Power in bands. Click here to print an epoch by epoch listing of the banded power of each epoch.

Percent total power in bands. Checking this box prints banded power as a percentage of total power in each epoch.

You can save the report to disk as a text file using the *Save As* option on the Spike 2 *File* menu. This text file will be stored in a format that can be easily imported into spreadsheet software for further analysis. After saving the report, click the *Close* or *Minimize* box on the Report window or press the Report button again to hide the report and return to the data file.

Quit   Click here to close the script.