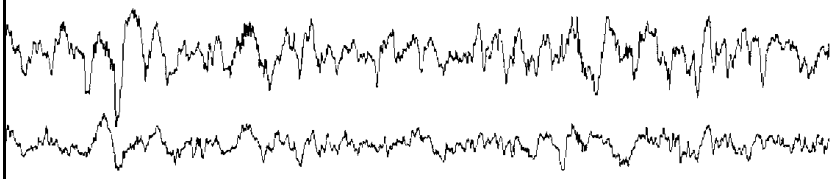
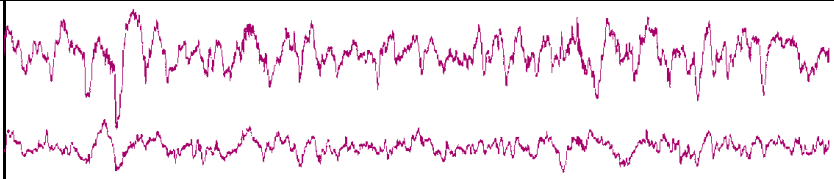
Sleep Analysis with Actiwave™

The ultra-miniature size of the **Actiwave** family of wave recorders makes them a practical, unobtrusive alternative for monitoring sleep. Weighing 10g or less, the Actiwave can be adhered to the skin with little risk of detaching. With a thickness of 8mm, they can be placed in a convenient location on the body without creating discomfort.

EEG waveforms from the Actiwave compare favorably with waveforms collected by the Siesta polysomnograph (PSG) recorder from Compumedics[1].

Recording Instrument	EEG of Stage 4 Sleep	Signal Reference
Siesta by Compumedics		C3-A2 O1-A2
Actiwave by CamNtech		C3-A2 O1-A2

The Actiwave family includes ECG/EEG Recorders with 1, 2, or 4 channels and EMG Recorders with 2 channels. The researcher can select the sampling rate from 32 Hz to 1024Hz and the resolution from 8 to 10 bits. Recording times for 128Hz, 8 bit resolution range from 36hrs (1 channel) to 13hrs (4 channels).

The Actiwave Cardio records ECG waveforms, and 3-axes of acceleration. The 3-axis accelerometer records the frequency and intensity of the subject's activity as well as their orientation. The researcher can select from 32 Hz to 1024Hz sampling rate for the ECG waveform and from 32 Hz to 128Hz for the acceleration waveform. With a sampling rate of 128Hz for ECG, 32Hz for the activity and 8 bits resolution, the Cardio can record up to 31 hours of ECG data.

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How does it work?

The Actiwave monitors have 1mm diameter pins to which slip-on leads are attached. CamNtech supplies two styles of leads. One lead set has touch-proof contacts on one end and 4mm female snap contacts on the other end. The second lead set has custom 1mm female sockets on one end and spring-loaded clip contacts on the other end. Either lead set will attach directly to any ECG, EEG, or EMG electrodes that have 4mm male snap contacts.

The Cardio attaches to the chest using standard ECG electrodes with 4mm male snap connectors. An internal accelerometer measures 3-axis acceleration as well as position.

Physiological signals are passed from the electrodes through the leads to an on-board amplifier. A miniature, efficient microcontroller digitises the amplified physiological signal, and stores the digitised waveform in non-volatile flash memory. At the end of the recording session, the leads are disconnected from the Actiwave recorder (the Cardio lead remains connected) and the recorder is connected to a dock. The Actiwave software transfers data from the recorder to the PC via the dock and USB cable.

Actiwave data is stored on the PC in European Data Format (EDF+) files. There are several open source EDF+ viewers available for download from the internet (eg. Polyman, EDF Browser) that will allow you to view the Actiwave files. Most viewers will display multiple channels with correlated time stamps so the researcher can observe simultaneous events in the different physiological parameters.

For example, the following diagram shows data collected from a sleeping individual experiencing periodic limb movement disorder. The waveforms recorded are ECG, and XYZ acceleration and orientation collected by an Actiwave Cardio on the chest and EMG collected by Actiwave EMG on the leg. The heart rate and annotations are derived by the Actiwave software. One can easily see the time correlation between the leg movements and the increase in heart rate. It is also evident that the leg movement was not caused by a change in the body position, as the XYZ orientation did not change.

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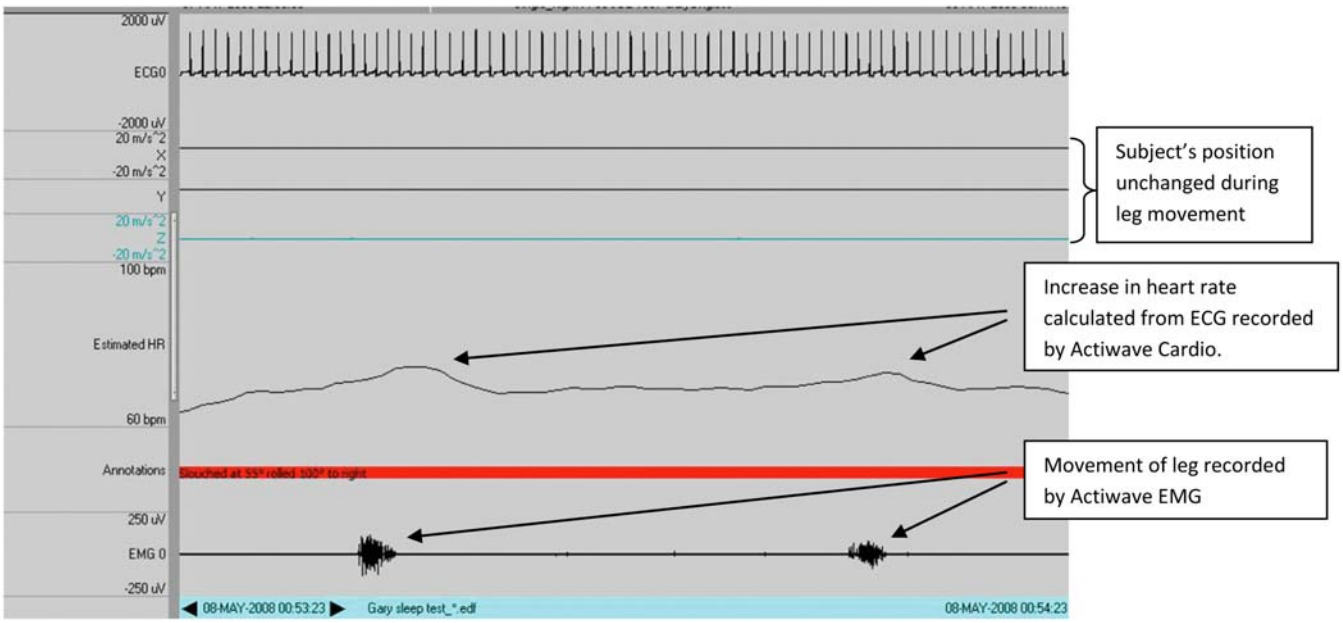

Key to waveforms:

ECG0: ECG recorded by Actiwave Cardio

X: Side-to-side acceleration and position recorded by Actiwave Cardio

Y: Up-Down acceleration and position recorded by Actiwave Cardio

Z: Front-to-Back acceleration and position recorded by Actiwave Cardio

Estimated HR: Heart Rate calculated from ECG waveform by Actiwave software

Annotations: Text interpretation of XYZ orientation information

EMG 0: EMG recorded by Actiwave EMG

Actiwave Advantages

- Extremely small, light-weight recording devices. The single-channel EEG/ECG wave recorder has dimensions of only 18.5mm x 27mm x 8.5mm and weighs a mere 4.8g.
- User selectable sampling rates from 32Hz to 1024Hz and resolution of 8, 9, or 10 bits.
- Record over 24 hours of data with 128Hz sampling rate and 8 bits resolution on ECG/EEG recorders with 1 and 2 channels, EMG Recorders with 2 channels, and Actiwave Cardio.
- Data recorded in standard EDF+ files for easy import into a wide variety of analysis programs.

Additional Information

See our website at www.camntech.com for more information regarding these products.

References

1 Evans, T., (2008), CamNtech report on Actiwave Sleep Trial carried out by the University of Surrey.

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