A telemedicine solution based on a piezoelectric movement sensor for the long-term monitoring of sleep disorder patients

Joonas Paalasmaa
Beddit.com Ltd, Espoo, Finland;
Department of Computer Science,
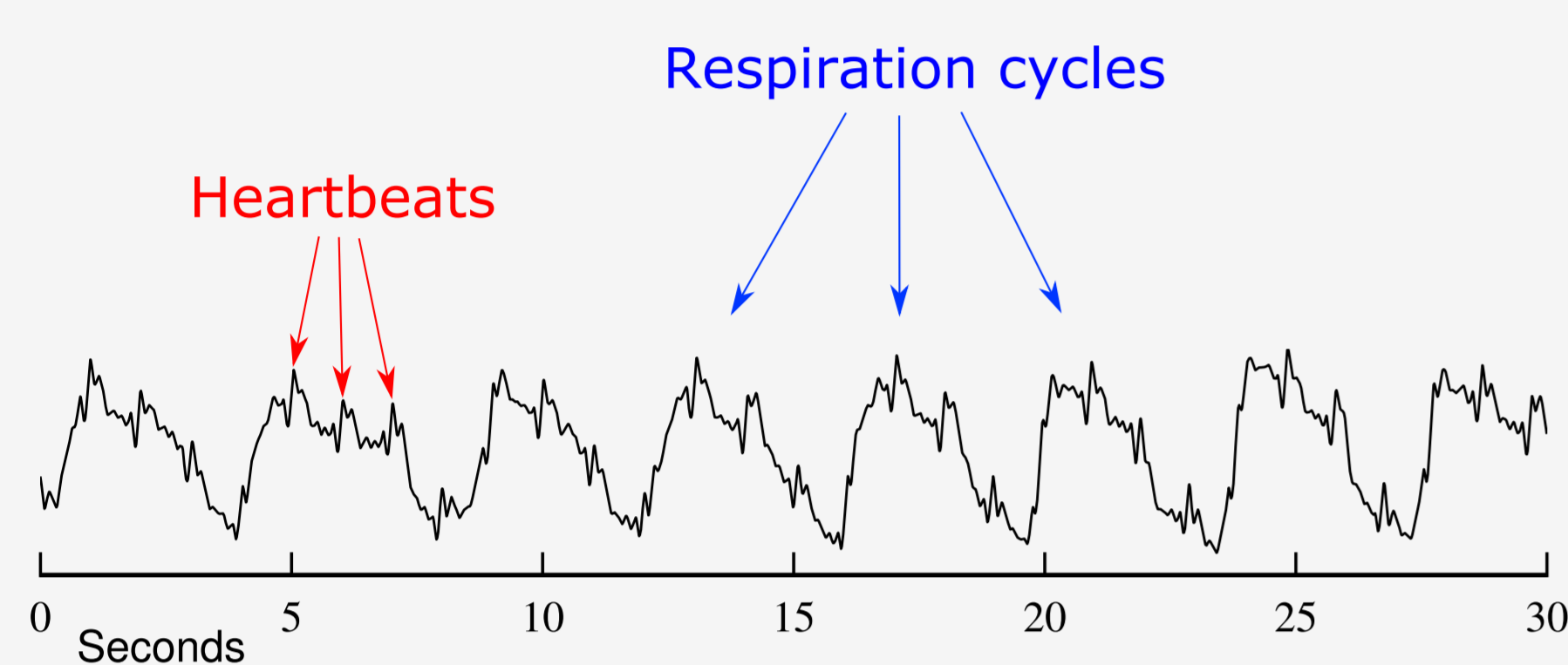University of Helsinki, Helsinki, Finland

Markku Partinen
Helsinki Sleep Clinic, Vitalmed Research Center;
Department of Clinical Neurosciences, Helsinki
University Central Hospital
Helsinki, Finland

Sensor with web gateway

A thin piezoelectric sensor (4 by 70 cm) is placed under the mattress
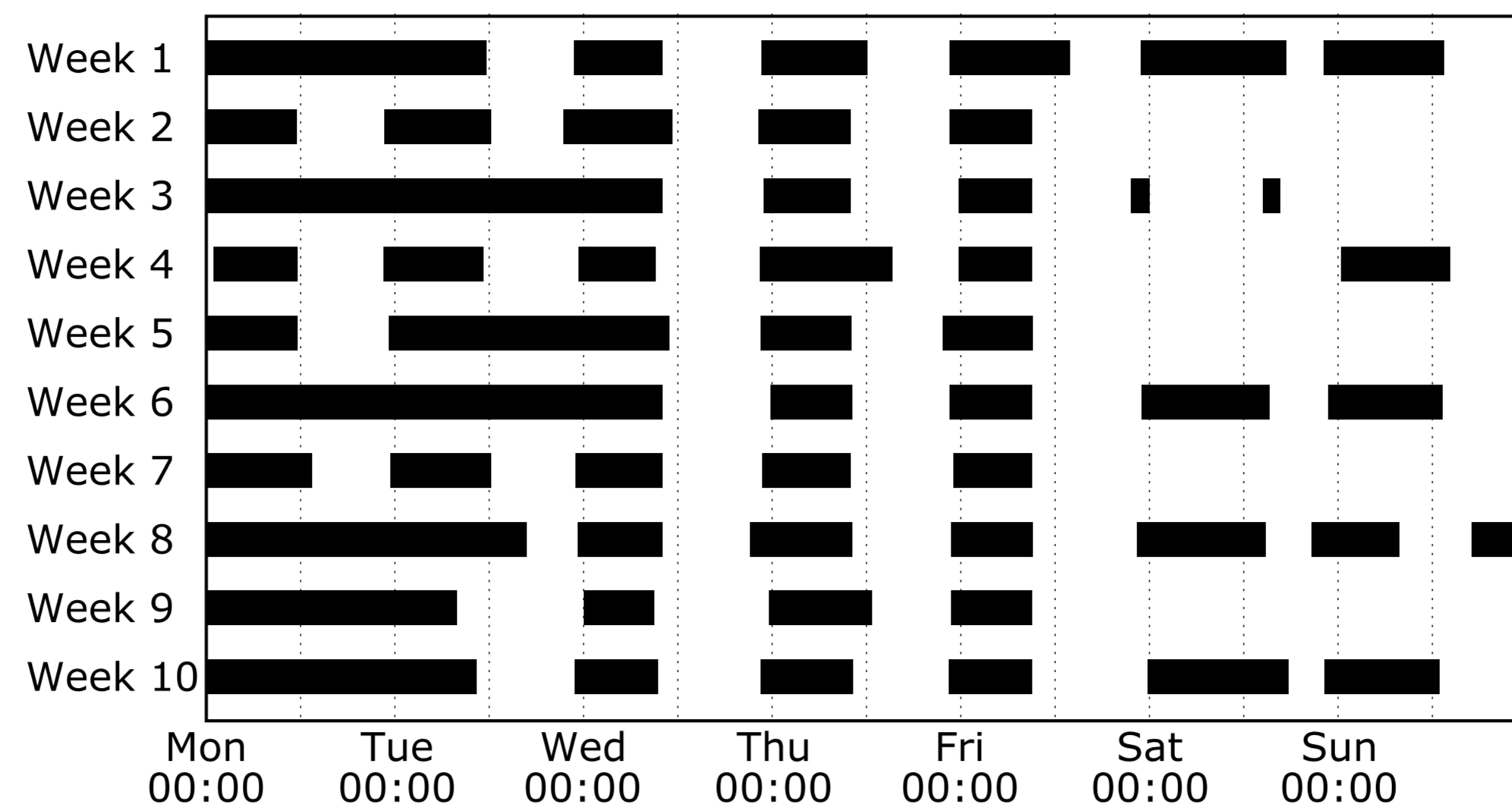

The measured signal consists of respiration and heartbeat waveforms, as well as deflections caused by movements

The sensor's signal, along with temperature, noise level and brightness, are sent to a web application with an Internet gateway

Automatic analysis

The signal is automatically analyzed at the web application. Movements, heart rate and respiration rate as well as sleep are analyzed.

Web app for viewing signals

The sleep specialist has access to the measurements in a web application.

Screening of common sleep disorders

Circadian rthythm sleep disorders
Problems with circadian rthythm can be investigated by measuring the patient for weeks or months. The sleep specialist has a long-term view to the patient's measurements in the web application, where abnormalities can be spotted.
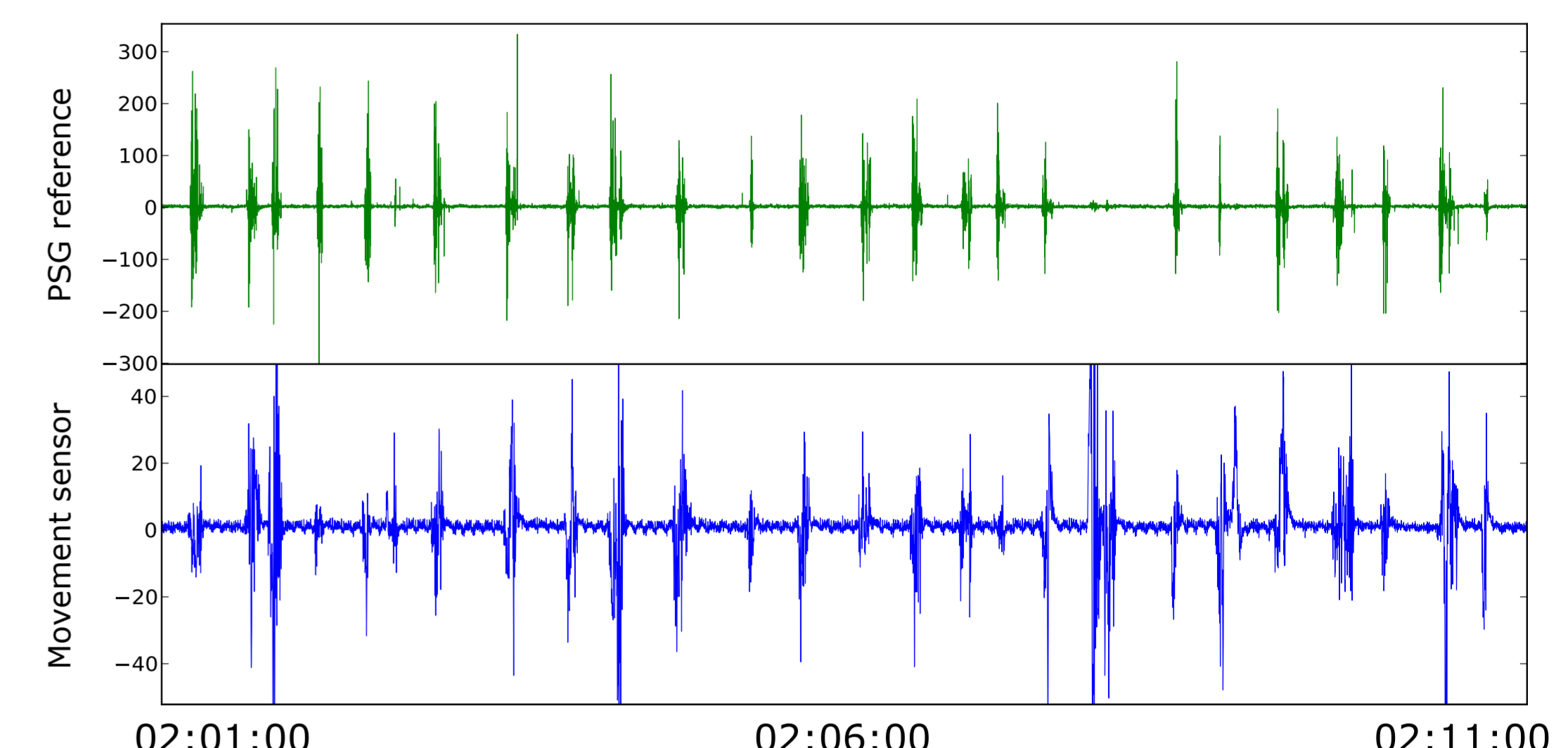
Periodic limb movement syndrome
The movement sensor can measure the patients's limb movements sensitively. The sleep specialist does not need to go through the whole signal manually, as regions of movement are highlighted automatically for closer inspection.
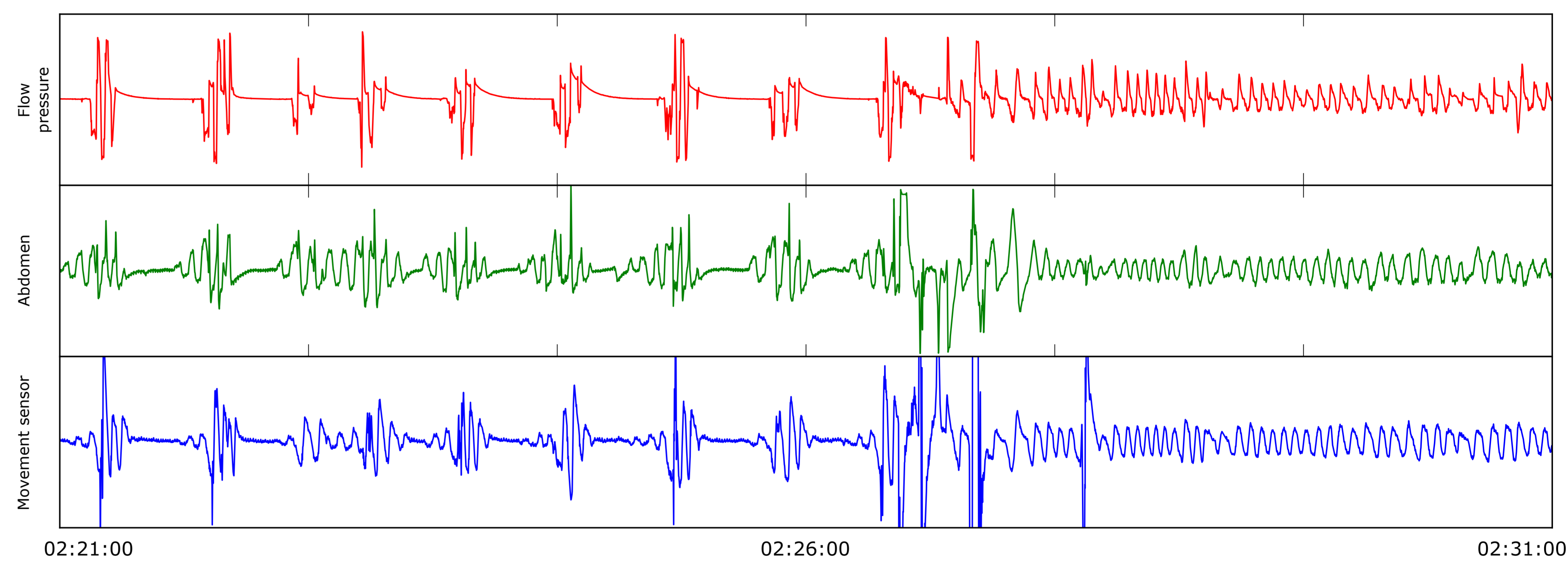

Sleep-related disordered breathing
A preliminary assesment of sleep-related respiratory problems can be done by inspecting the signal. The low-frequency component of the signal is very similar to the abdominal respiration effort signal in PSG. The sleep specialist inspects the signal in around 10-minute segments to detect abnormal breathing patters. Regions with suspected respiratory problems are highlighted, so it is typically not necessary to go throught the whole measurement in detail. The final classification of the disorder typically requires a PSG measurement, with oximetry and measurement of airflow.

Ubobtrusive long-term tracking of sleep
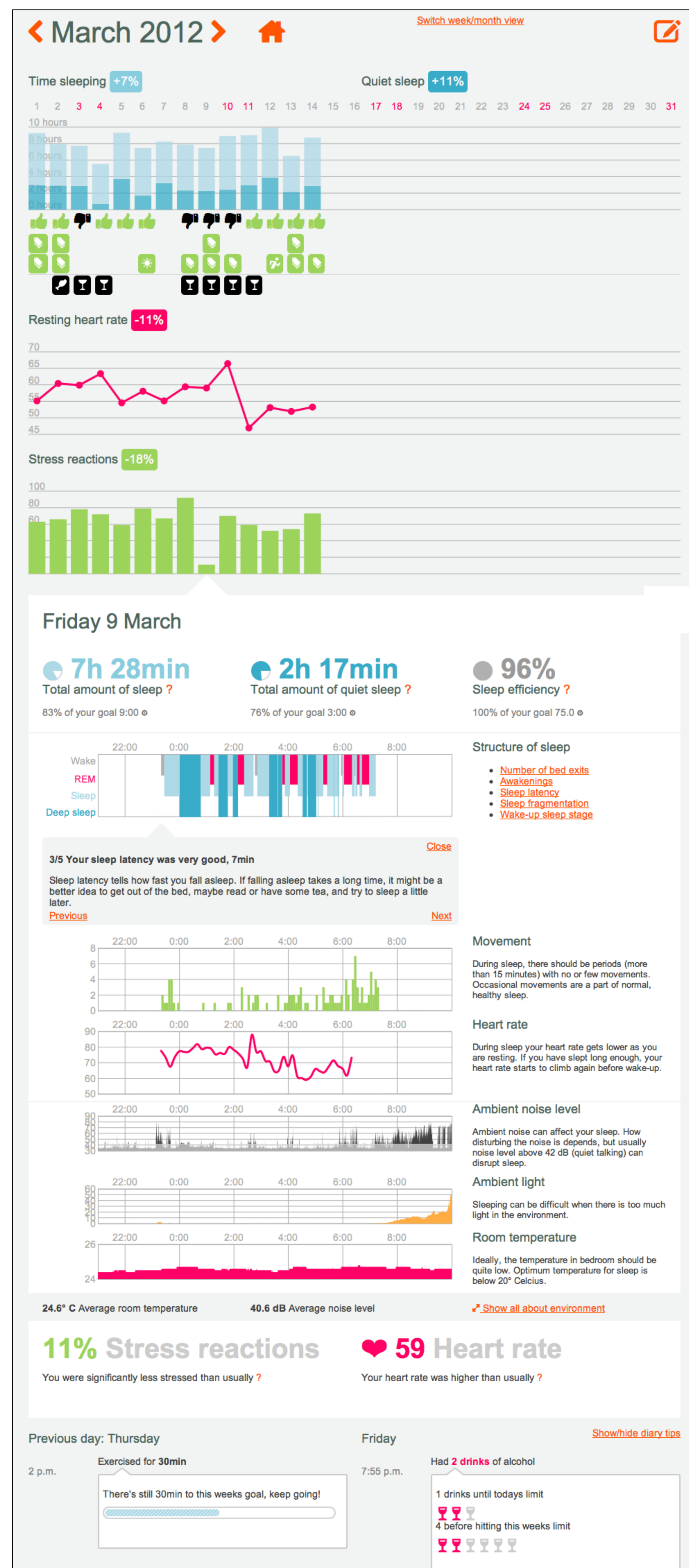
Fast track to sleep disorder diagnosis
The measurement is affordable and can be prescribed in primary care if sleeping problems are suspected. The patient sets up the sensor independently and is measured for a month. After that, the sleep medicine specialist can reach the diagnosis faster, as an overview of the sleeping problem is already provided by the measurement.

Rarely occurring symptoms
Some disorders such as problematic hypersomnias occur only infrequently and in the normal sleeping environment. In those cases, a long-term measurement is set up for the patient. The sleep specialist analyzes the measurements about every week, and the measurement is continued until the symptoms have occurred sufficiently many times.

Follow-up after treatment
The effectiveness of treatment can be conveniently followed up with the system. Ideally, the patient is measured some time before diagnosis and several months after treatment, so it can be confirmed that the treatments are effective and that the symptoms do not recur. This applies to the treatment of various disorders, such as SRDB, insomnia and PLMS.
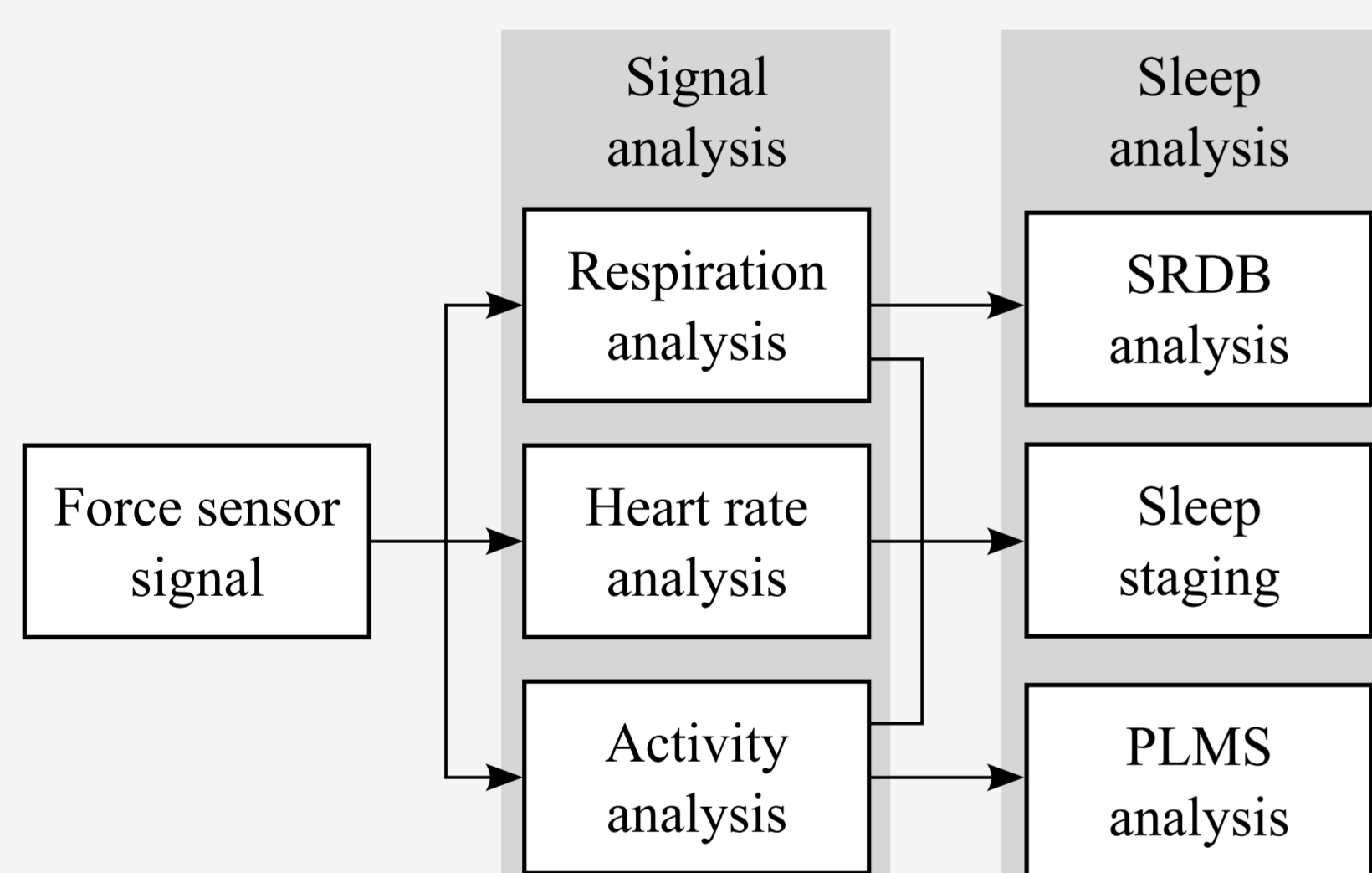
Cognitive behavioral therapy
The effectiveness of CBT can be enhanced by providing an objective assesment of the patient's sleep, alongside a traditional sleep diary. During therapy, the measurements can be accessed both by the therapeutist and the patient. After the therapy period, measurement should be continued so that the recurrence of the problems can be detected rapidly.
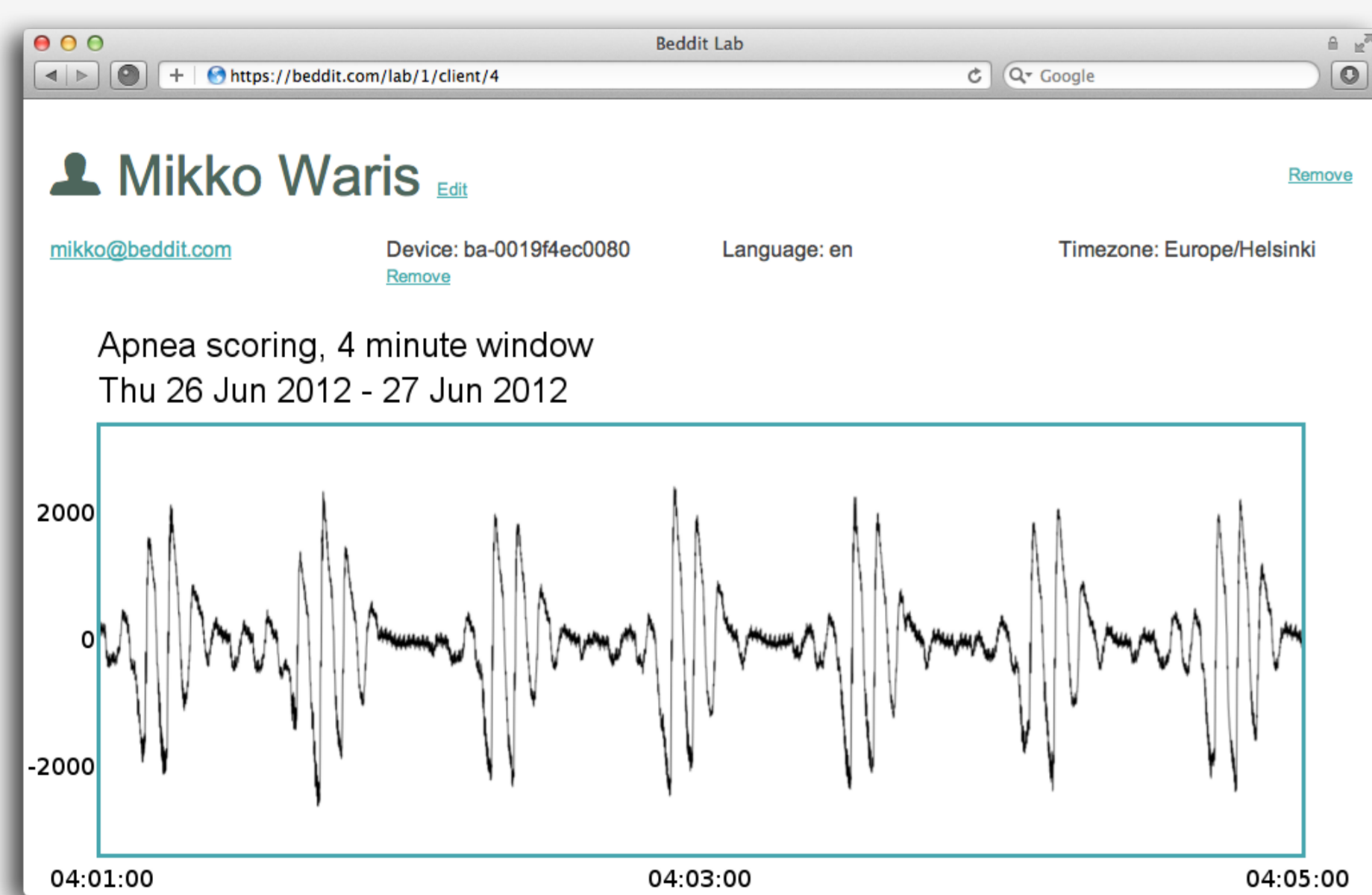
Geriatric care
The system is particularly suitable for measuring the quality of sleep in geriatric care, because no wearable sensors are needed, and because extensive measurement periods are affordable. In addition to quantifying sleeping problems, it can be detected if the patient is in bed or absent from bed at abnormal times, which is common with dementia.

We are looking for new collaborators here at ESRS'12!
joonas.paalasmaa@beddit.com +358 505 820 100