

Research projects to support clinical medicine

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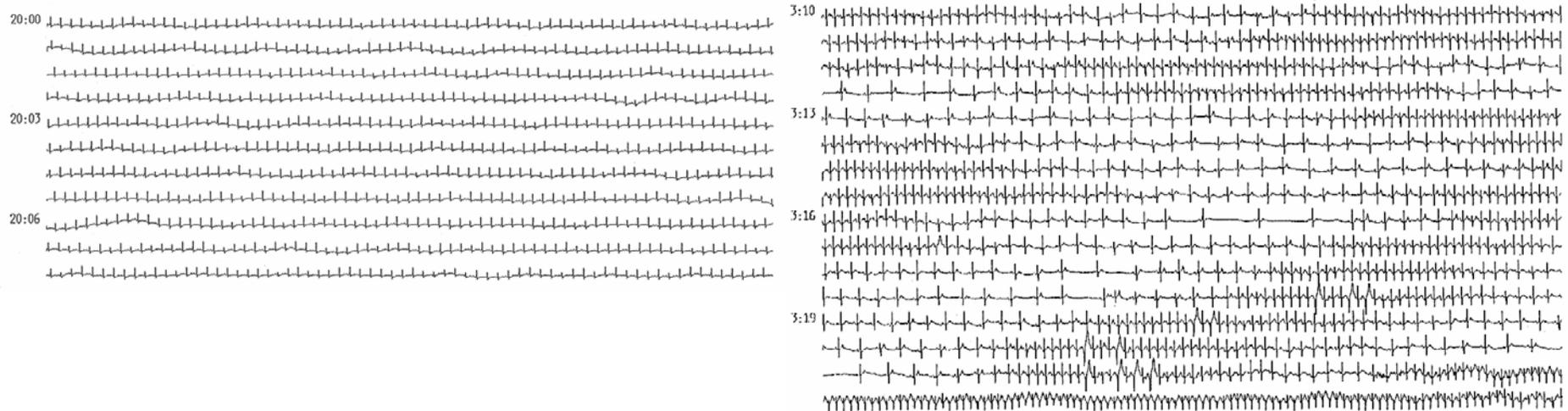
Motivation for clinical studies

- GRID applications to process of extensive data sets:
multi parameter, and highly sampled biosignals
Example sleep laboratory with EEG, EOG, EMG, ECG, respiration
- GRID applications to process distributed data sets:
Phenotyping for specific disorders on the basis of characteristic biosignals. Examples are obstructive sleep apnea, periodic limb movement syndrome, Insomnia
- GRID application to process data using standardized data formats:
A standard data format for digital neurophysiological biosignals is available and supported since 1992 (the EDF file format).

GRID scenarios

- Analysis of ECG (electrocardiogram) → algorithms are developed, implementation in a GRID setting is under development.
- Analysis of EMG (electromyogram, diagnosis of limb movement disorders during sleep) → algorithms under development.
- Analysis of respiratory air flow (diagnosis of sleep related breathing disorders) → algorithm development has started, implementation in GRID setting is under development.
- Analysis of EEG (electroencephalogram) to calculate sleep stages → planned validation, algorithms under development and in testing phase.
- Data protection for data transmission and evaluation inside the local intranet of the university hospital Gießen and Marburg GmbH, site Marburg

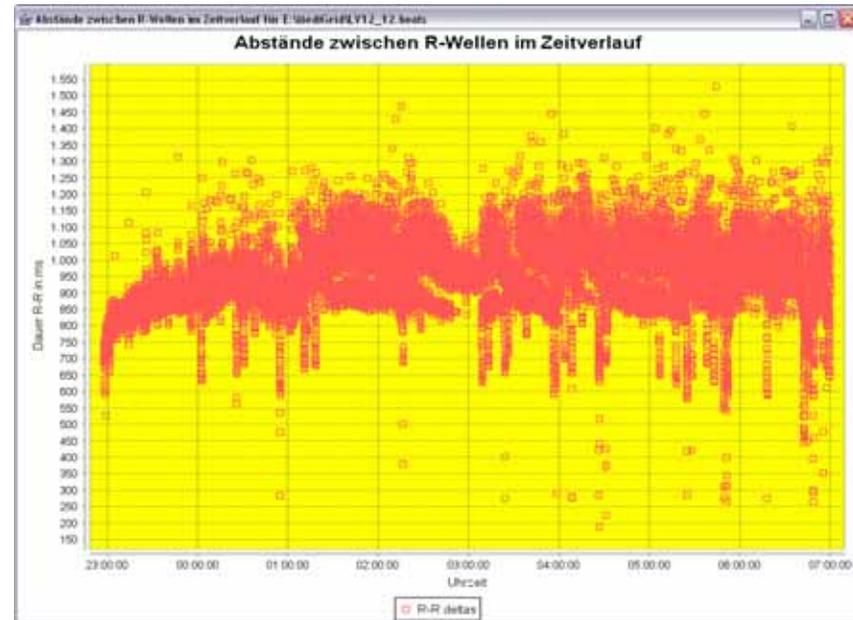
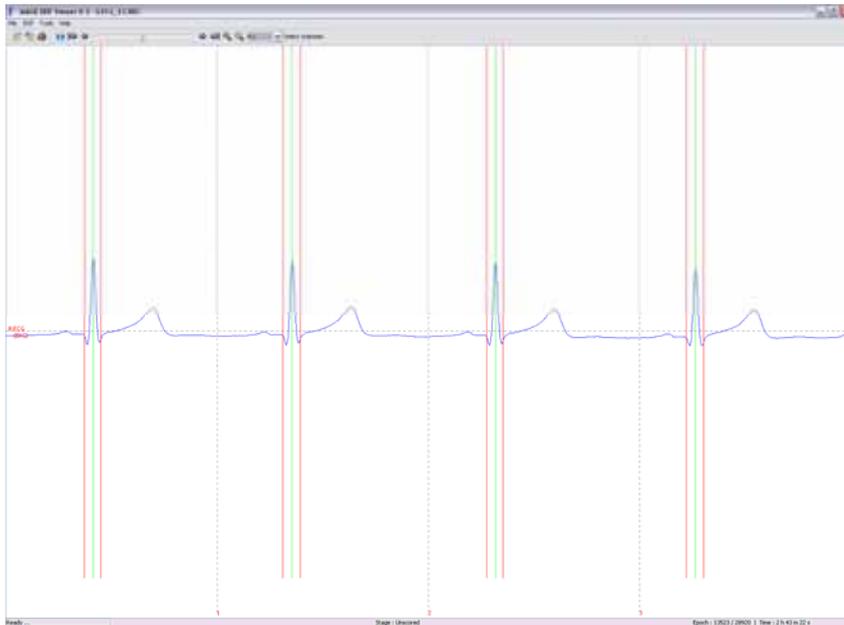
ECG of a normal subject and a patient with sleep apnea



Heart rate variability shows cyclical variations with sleep apnea, actually with each respiratory event.

Penzel T et al. IEEE Trans. Biomed. Eng. 50: 1143-1151 (2003)
Stein PK et al. J. Cardiovasc. Electrophysiol. 14: 467-473 (2003)
DeChazal P et al. Physiol. Meas. 25: 967-983 (2004)

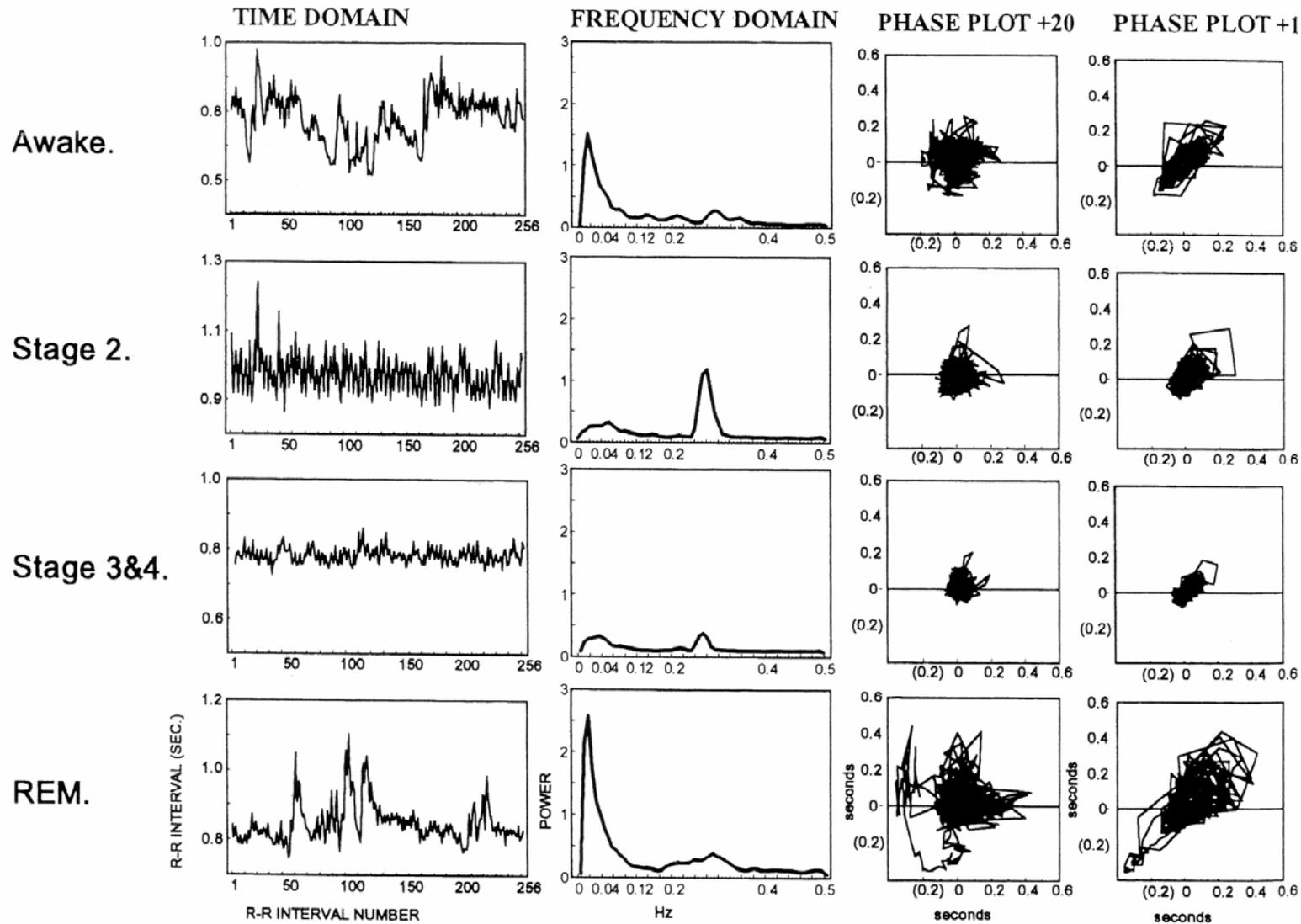
GRID based ECG analysis



Analysis of ECG (electrocardiogram) → algorithm development using a GRID toolkit is finished

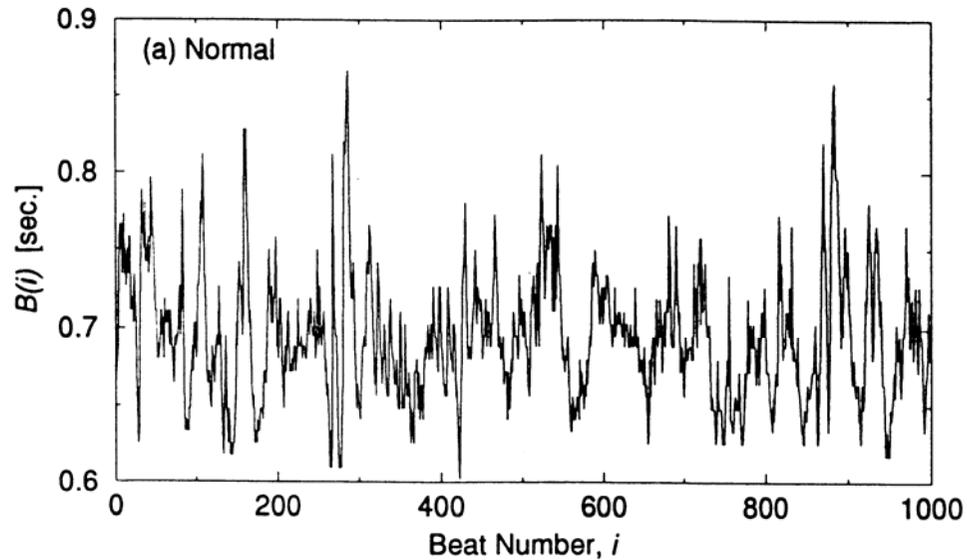
Tests in a GRID environment will follow after setting this in a hospital

Analysis of heart rate variability



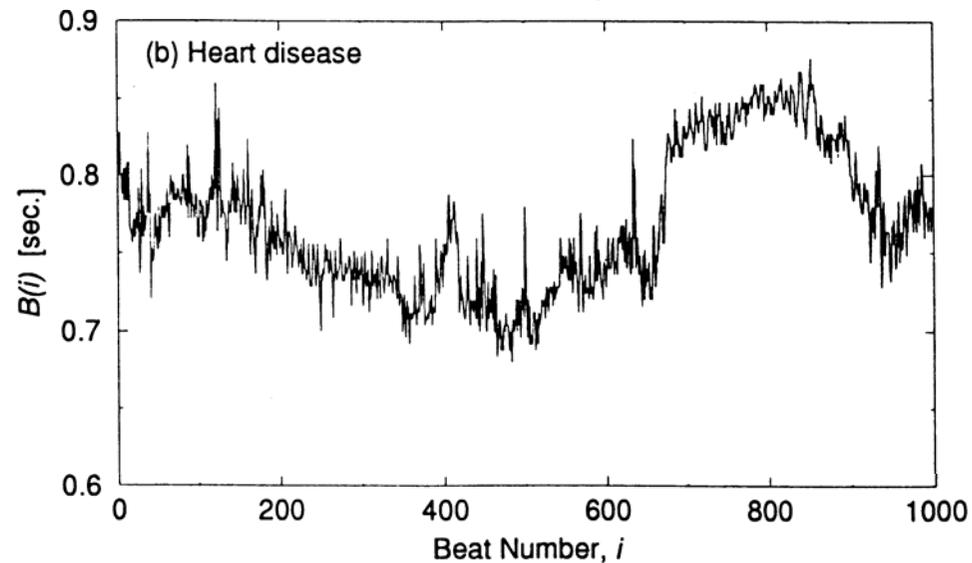
Vaughn BV et al. Heart period variability in sleep. *Electroencephal. Clin Neurophysiol.* 94: 155-162 (1995)

Heart rate variability



Heart rate variability as a sequence of R-R intervals

(a) in healthy volunteers and



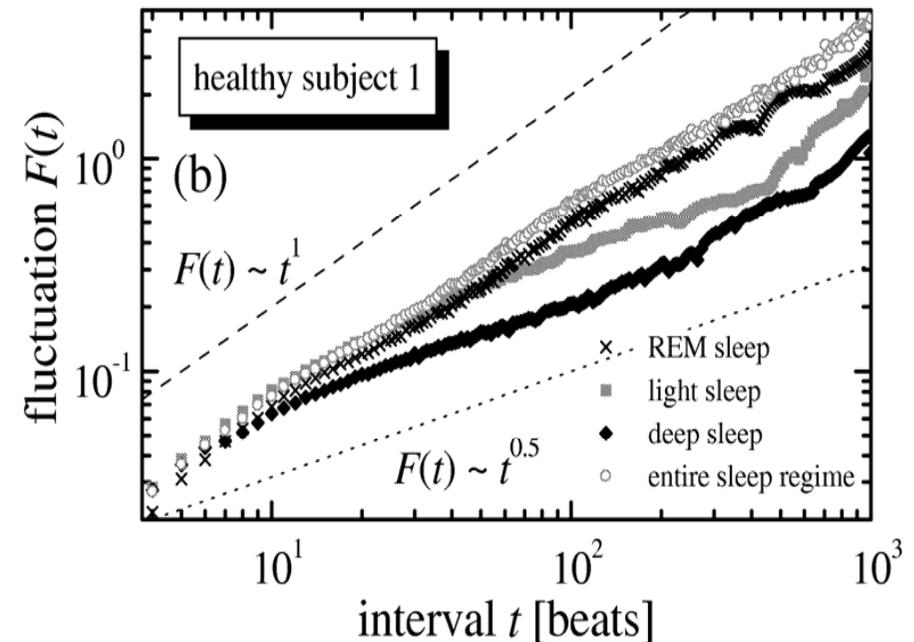
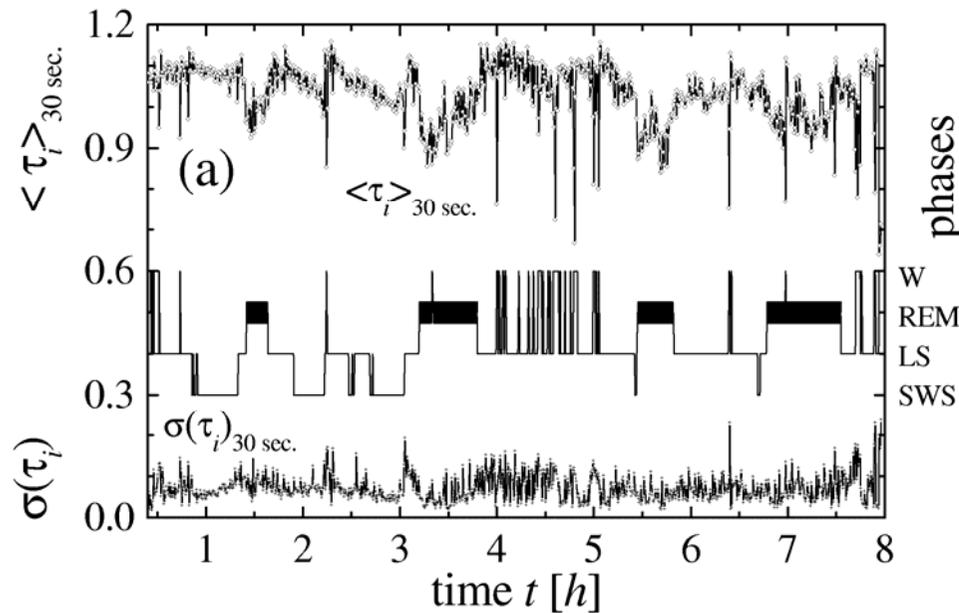
(b) in patients with cardiac failure

Peng CK, Goldberger A et al. Chaos 1995; 5: 82-87

DFA applied to heart rate during sleep

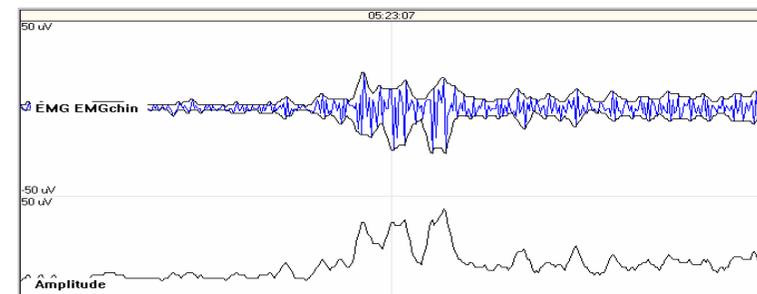
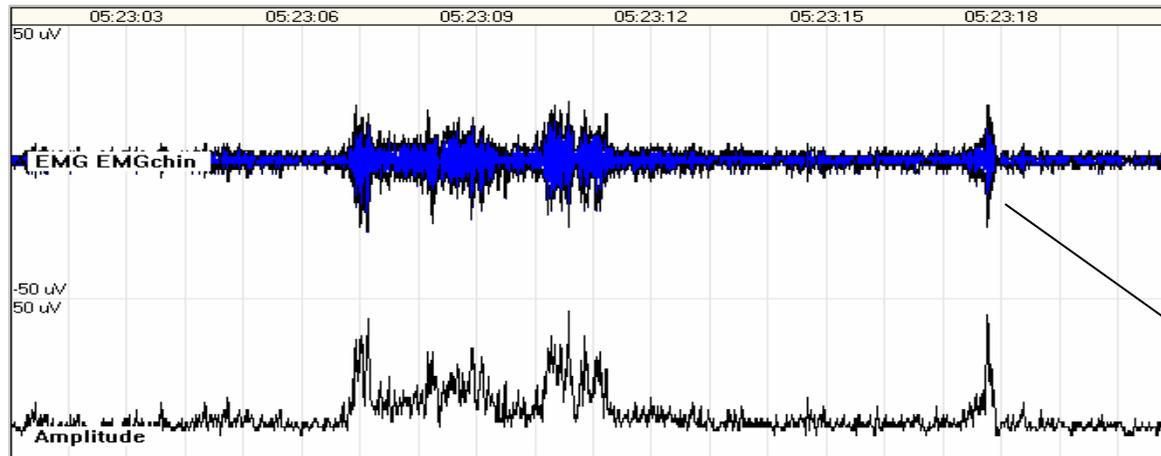
Detrended fluctuation analysis applied to heart rate during sleep

- possible to distinguish sleep stages
- algorithm works in normals and patients with sleep disorders
- different scaling behavior in deep sleep and REM sleep



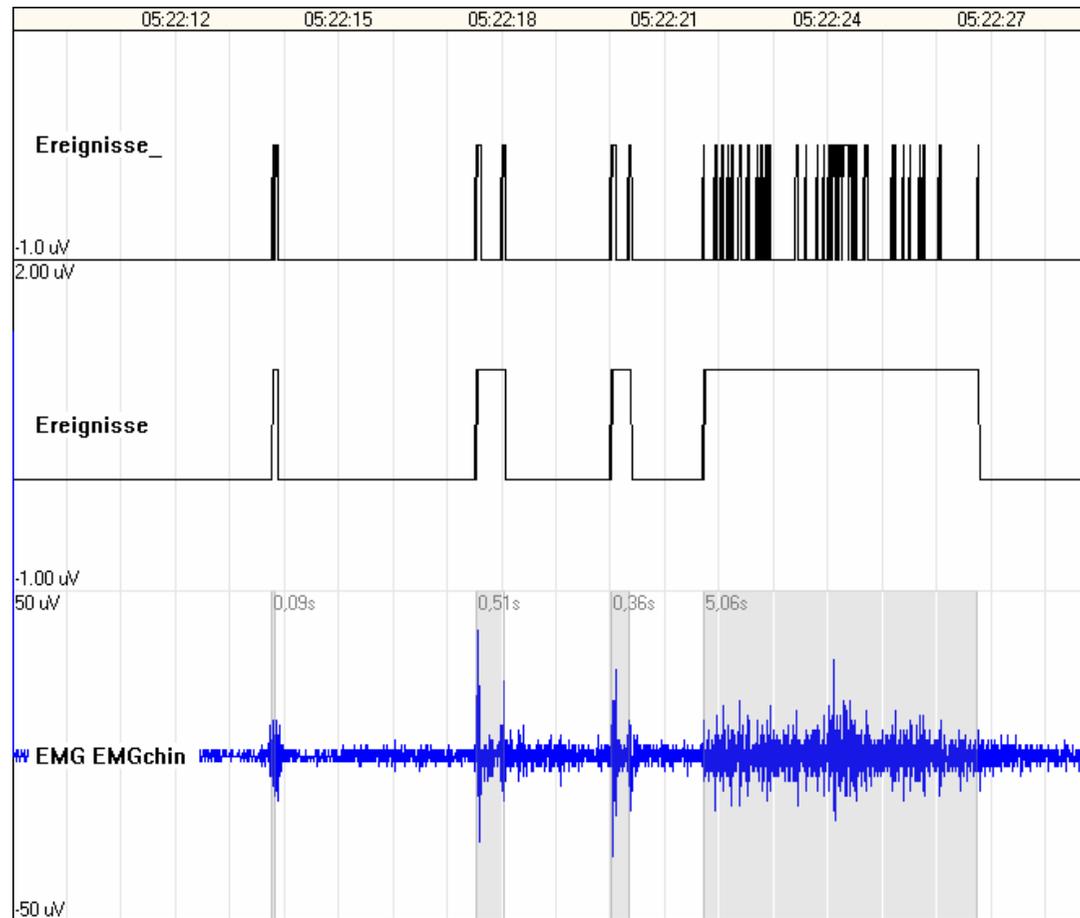
Bunde et al. Physical Review Letters 85; 2000

GRID based EMG analysis



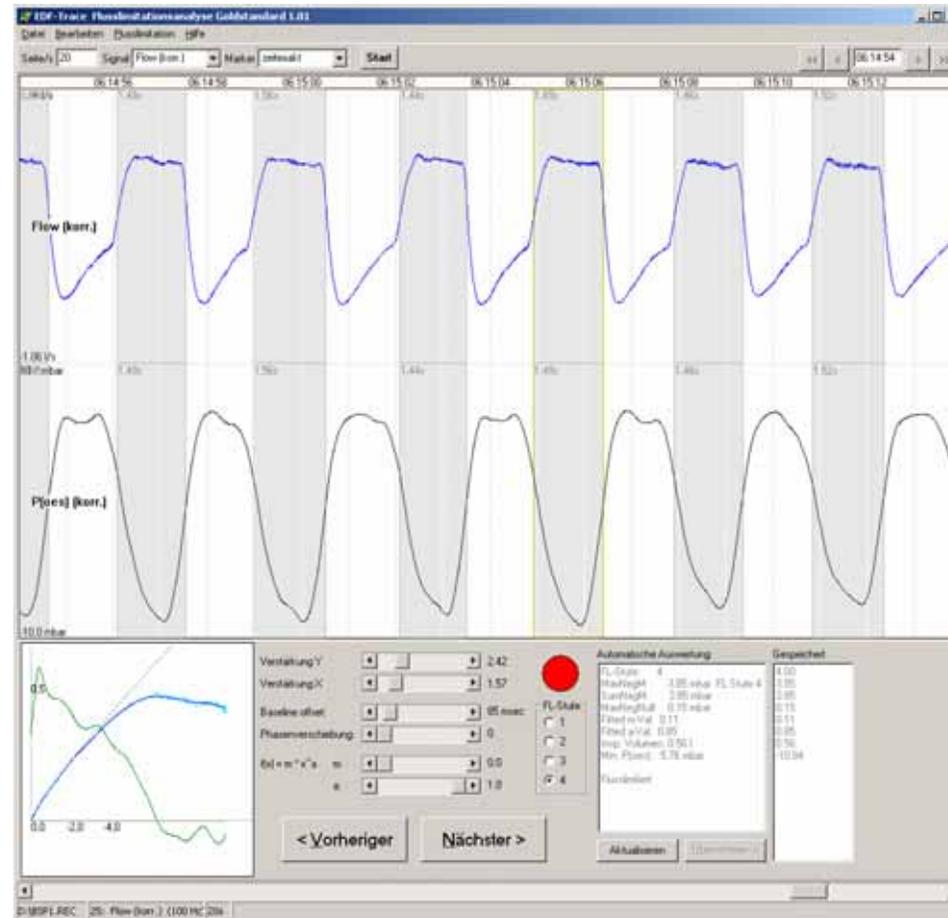
Calculation of upper and lower envelope of the EMG in order to determine amplitude and thus muscle activity.

GRID based EMG analysis



Evaluation of the EMG amplitude in temporal sequence:
if activation episodes are separated by less then 1 second they
are taken together as one activity.

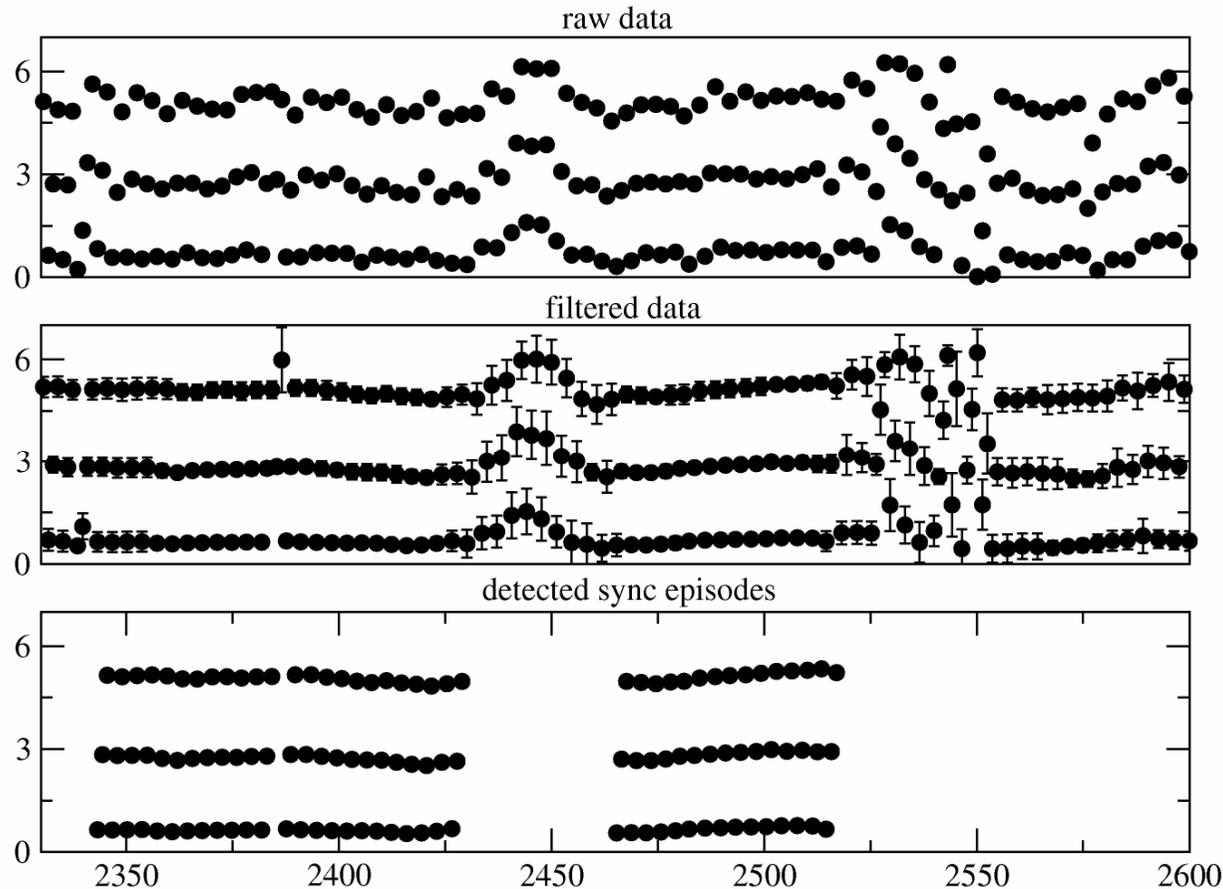
GRID based analysis of respiration



Computer based recognition of breaths, recognition and classification of flow limitation based on respiratory flow.

Synchronisation between respiration and heart beat

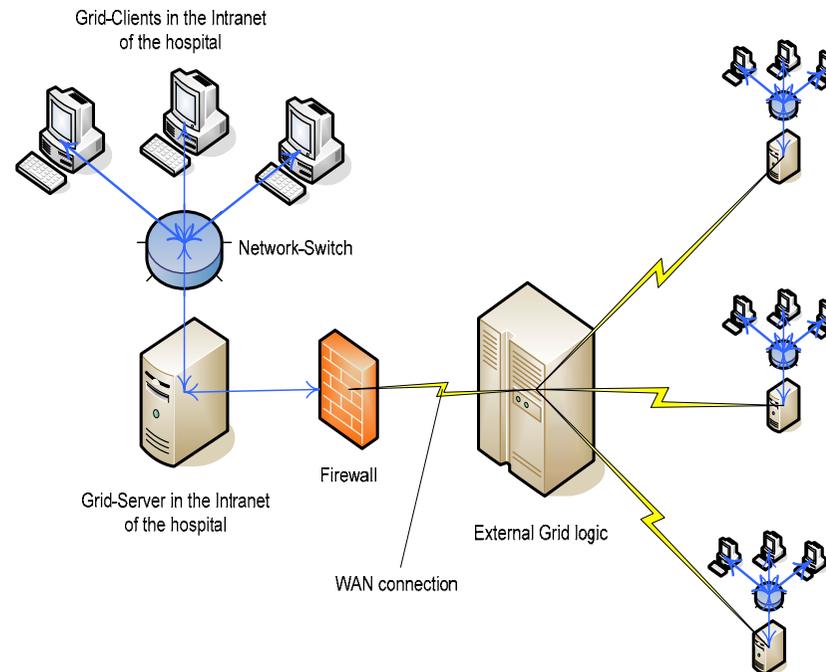
Example for multi-parameter analysis of biosignals: respiration, ECG, sleep stages



Bartsch R, Kantelhardt JW, Penzel Havlin S. Phys. Rev. Letters 2007

Data protection and data security

Medigrd clinical studies: rules for data protection and data security following hospital guidelines of the University hospital Gießen and Marburg



A GRID within the hospital must be set up separately.
The communication with other GRID networks must be done through a firewall using an additional data communication server or using an external GRID logic.

Enhanced Security

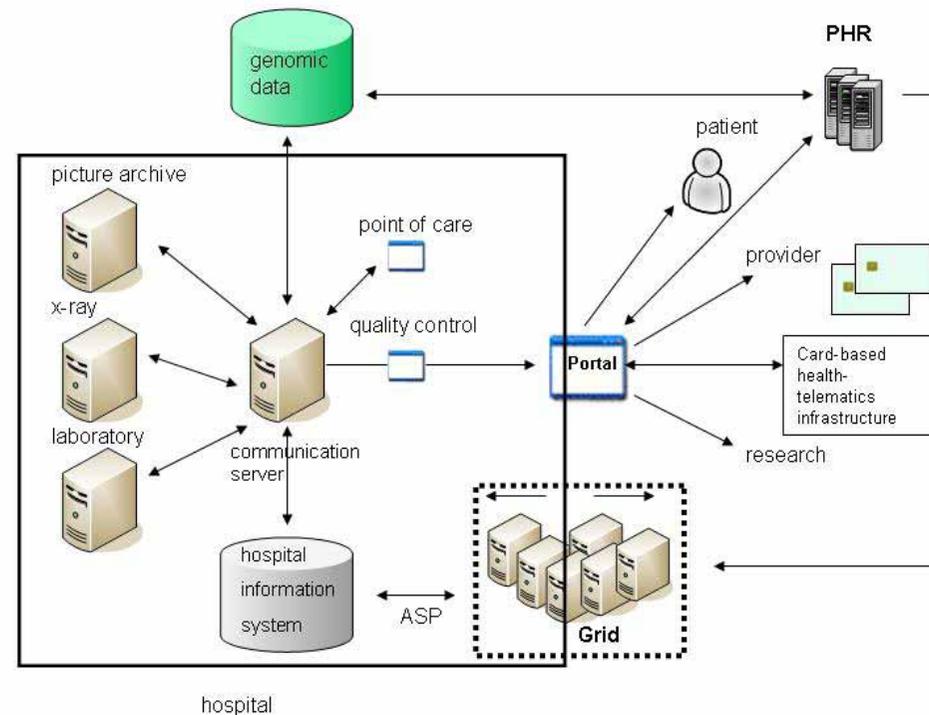
For the use of Grid applications in a context beyond hospitals, for instance a clinical study or a PHR Enhanced Security Structure must be presented, in which:

- audit ability,
- traceability,
- access rights and access control,
- confidentiality,
- trust and trust delegation and
- safety

can be accomplished.

The opening of clinical Grids for research and health care compellingly presupposes Enhanced Security in this form.

Grid for clinical research and health care



In the future information from the hospital can be transferred into care and research via a personal health record (PHR) or rather processes with Grid resources and Grid methods. Today's procedures of using X.509-certificates will be replaced by the German health telematics infrastructure.

Summary

- Biological signal analysis of extensive time series
- Linkage of different time series for complex analyses
- Data Protection and Data Security must be considered
- Grid can be opened for health care under certain conditions
- Implementation of Enhanced Security is compellingly necessarily
- research and health care are able to use Grid resources and algorithms or rather methods via secure procedures
- Patients use PHR also in the background of used Grid technology, which is safe, through access control steered in document level