NEW SENSOR DEVELOPMENT FOR THE DETECTION OF SLEEPINESS IN THE WORK AND TRAFFIC ENVIRONMENT AND SLEEP LABORATORIES

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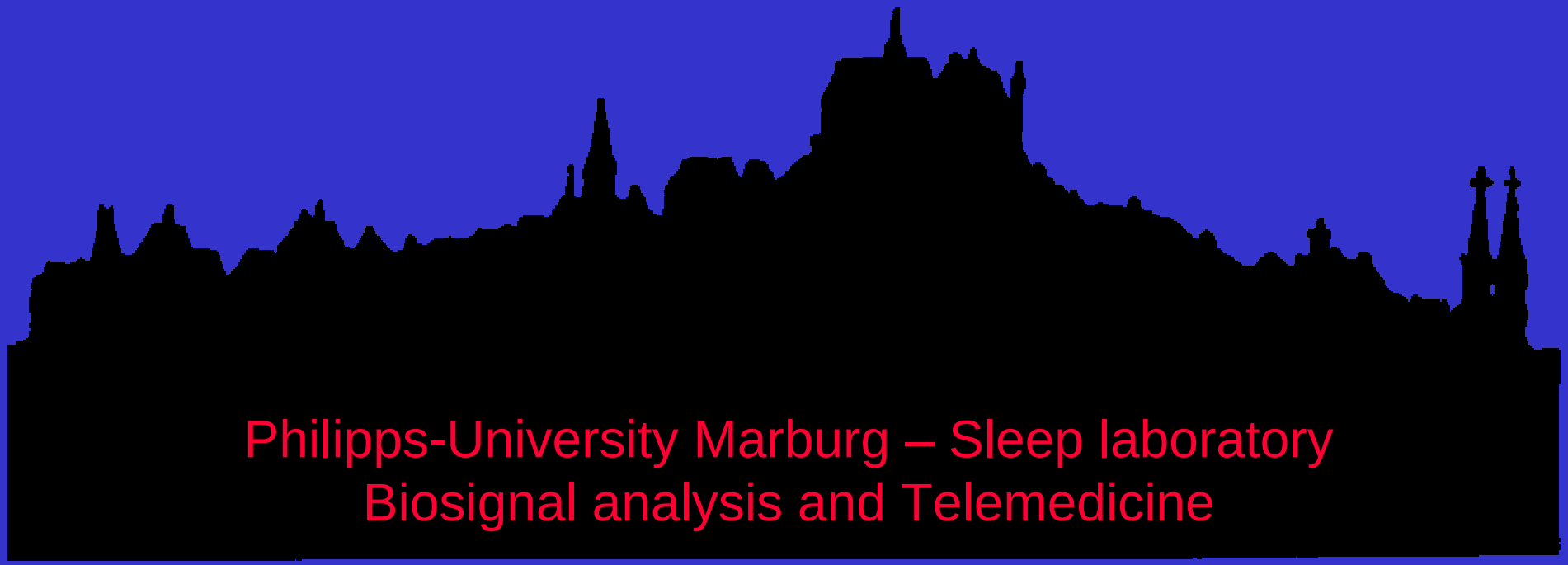


Philipps-University Marburg – Sleep laboratory
Biosignal analysis and Telemedicine

AIMS of SENSATION

The SENSATION Integrated Project (EU 6th FP, 2004-2007) ***aims*** at promoting the health, safety and quality of life of people by reducing relevant accidents and thus the impact on environment through the ***application of novel micro and nano sensors*** and signal processing ***for physiological state monitoring***.

The focus of the work is brain activity, specifically ***sleep and wakefulness states and their boundaries, stress, inattention and hypovigilance states.***

Objectives are hypovigilance detection, prediction and management as well as diagnosis, treatment and remote monitoring of sleep disorders.

Transport accidents

- About 40% of fatal car accidents on US highways are fatigue-related, whereas sleep-related accidents count for as many as 240,000 motor-vehicle accidents in the US annually.
- 31% of fatal truck crashes are caused by drivers' fatigue.
- According to NASA Aviation Safety Reporting System, approximately 21% of the aviation incidents are fatigue-related.
- The US Coast Guard Research identified that 16% of critical vessel casualties and 33% of personnel injury casualties occurring in US coastal waters were fatigue-related.
- Three fatigue-related train crashes were reported within four months in year 2000 in the New Zealand, whereas the sleep-deprived condition of a freight train personnel was the cause of a head-on collision between two freight trains in January 1998 in the US.

Non-transport accidents

- Most nuclear accidents (Chernobyl, Three-mile Island and several US islands) have clear fatigue-related causes (Mitler et al 1988).
- Among other accidents the Bhopal chemical disaster, the Challenger explosion and the Exxon Valdez grounding are considered fatigue-related (Mitler et al 1988).
- Disturbed sleep and shift work predict prospective fatal accidents (Akerstedt et al 2002).
- Reduced sleep length (and increased) increase prospective overall mortality twofold regardless of diagnoses (Kripke et al 2001).
- Night work in industry is associated with 43% increase in accidents in the automotive industry (Smith et al 1994).
- Night work in process industry is associated with accidental sleep at work (Torsvall et al 1989).
- Accidents in anaesthesia are often related to fatigue / drowsiness.

Medical sleep wake disorders

Prevalence

- As much as 20% of the general population suffers to some degree from sleep disorders.

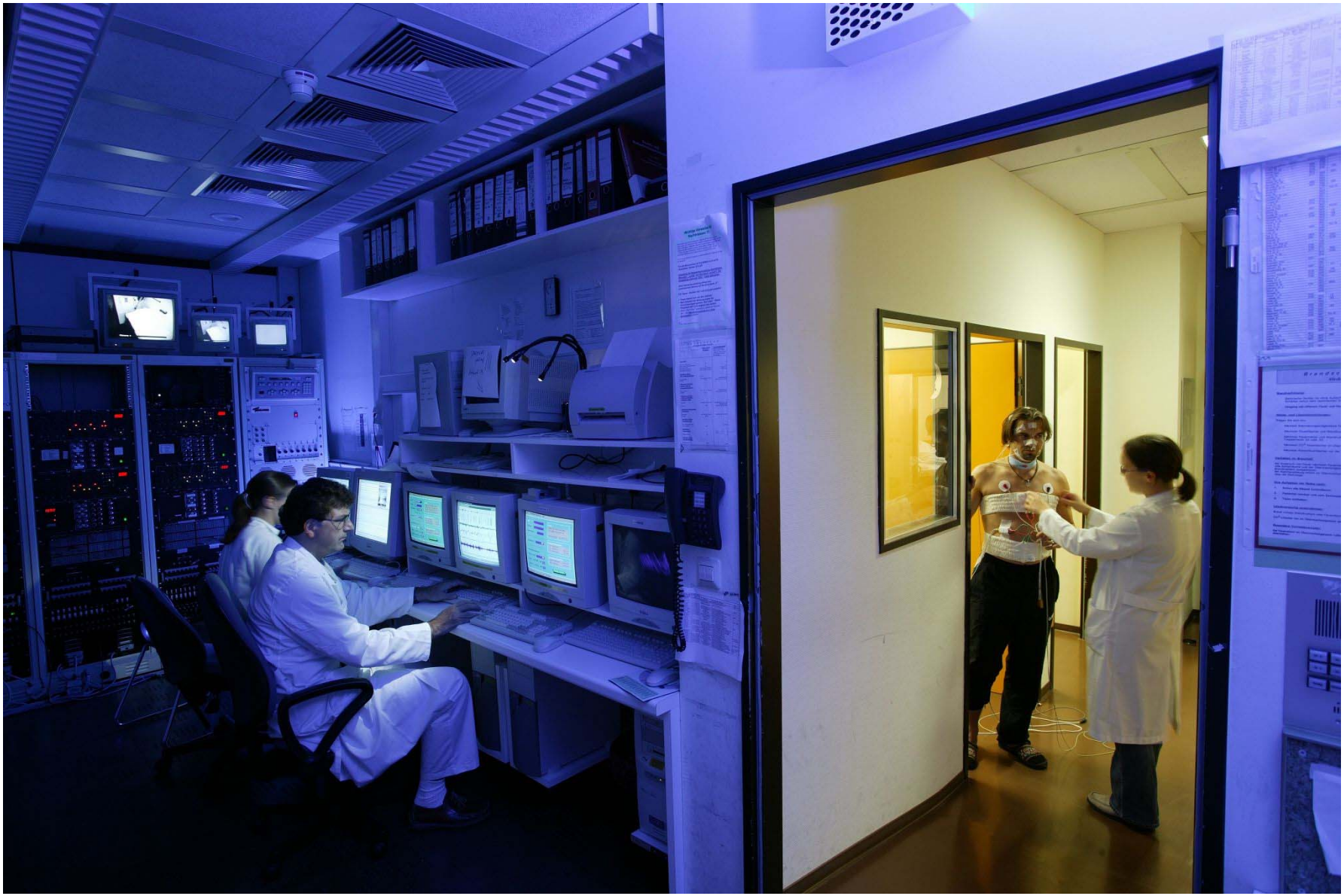
Symptoms

- Patients with sleep disorders suffer from non-restorative sleep.
- Excessive daytime sleepiness
- Disorders of initiating and maintaining sleep

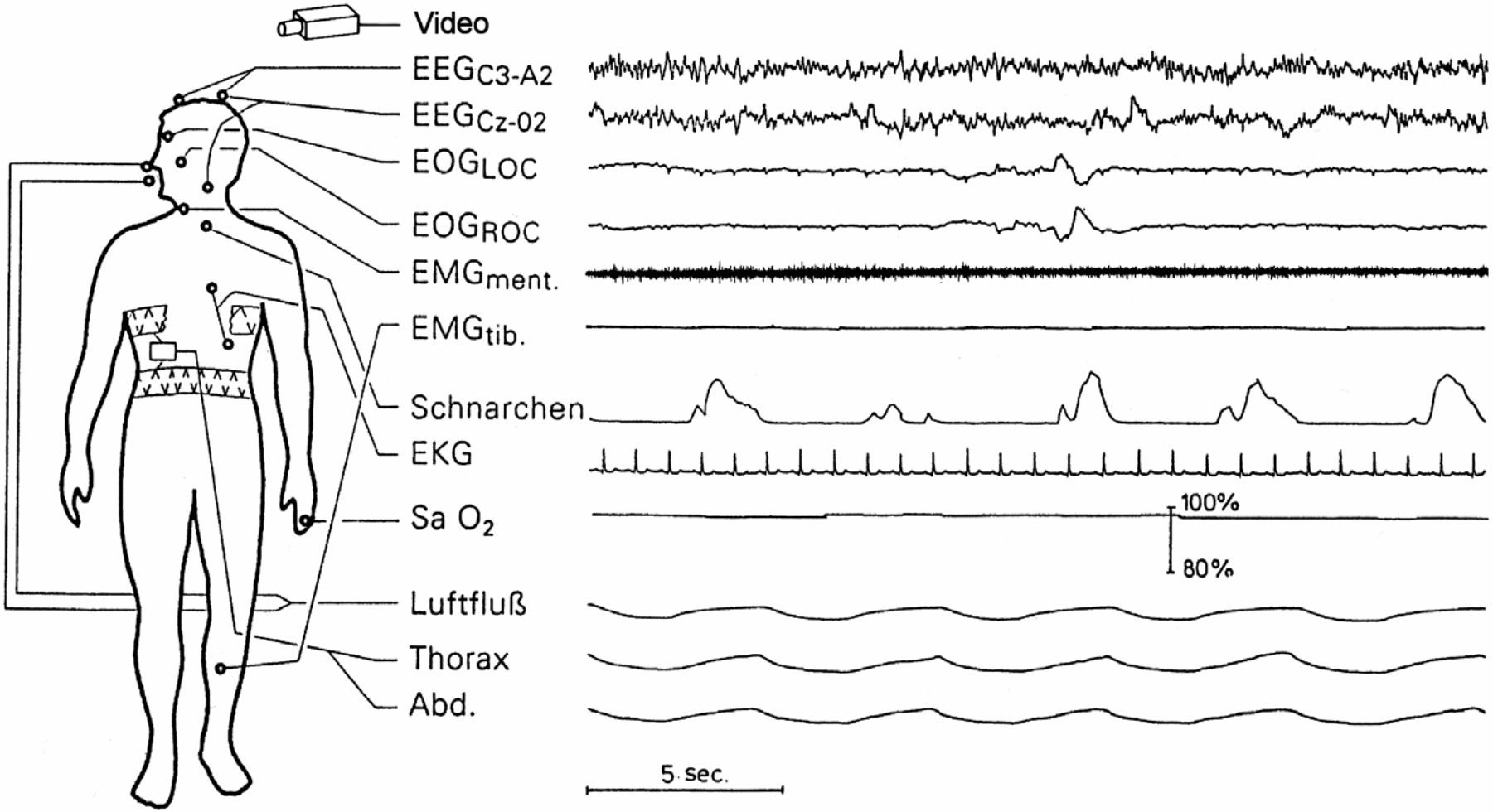
Sleep disorders of major importance:

- Insomnia
- Sleep apnea
- Restless legs syndrome
- Narcolepsy

Sleep laboratory supervision



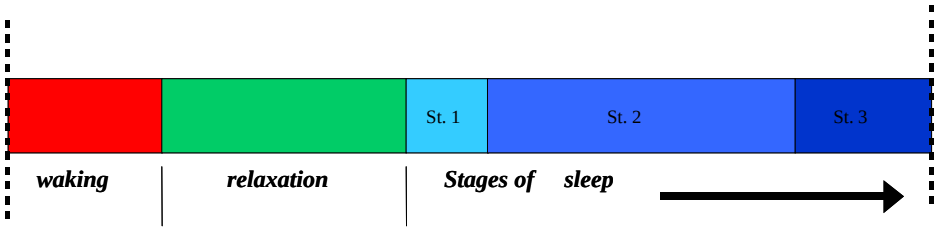
Cardiorespiratory polysomnography

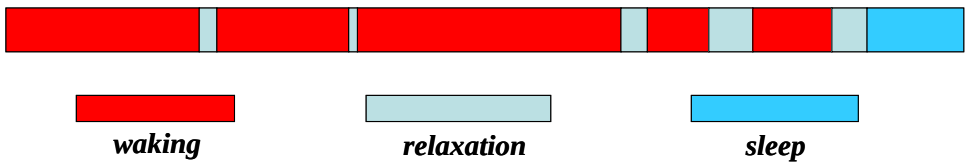


Cardiorespiratory polysomnography

Definition of Sleep Wake processes

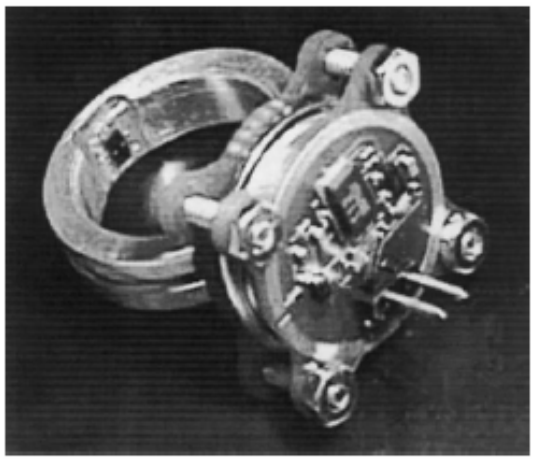
- Definition of sleep / wakefulness and their transition states, as well as stress, inattention and emotional states.
- Modelling of sleep stages and sensors specifications.





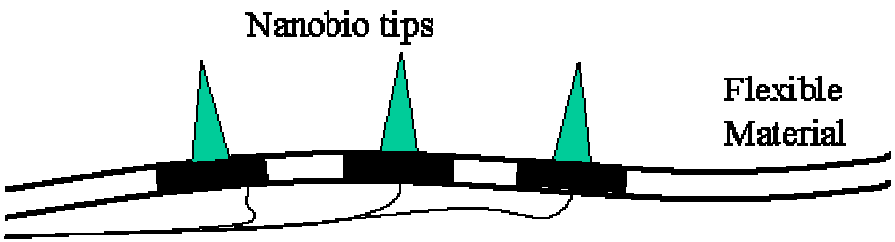
Small wearable sensors

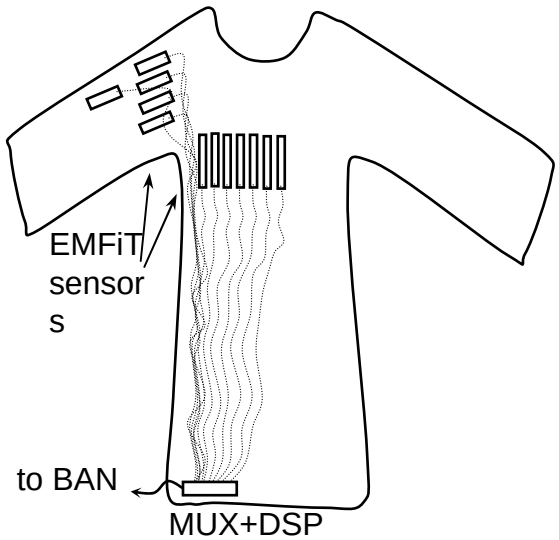
Development of eyelid and skin micro and nano sensors for respiration and skin conductivity measurements (autonomic functions).

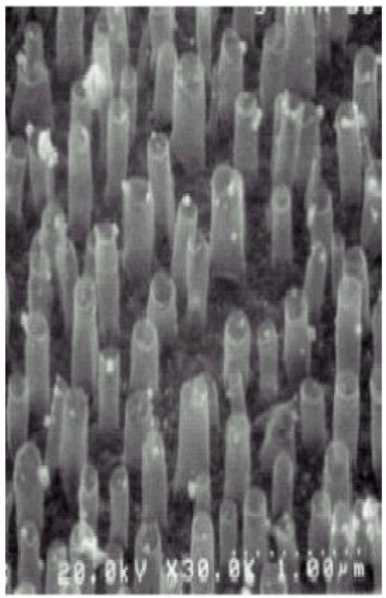


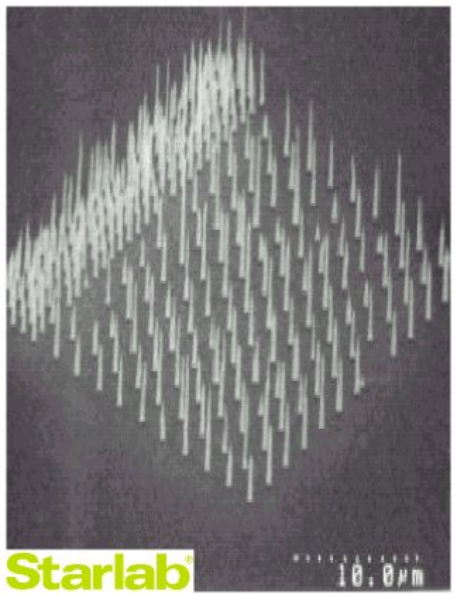
Nanotechnology improves sensors

Development of wearable micro and nano sensors, on the wrist, textile, bed, pillow blanket and ear, for physiological and activity measurements.



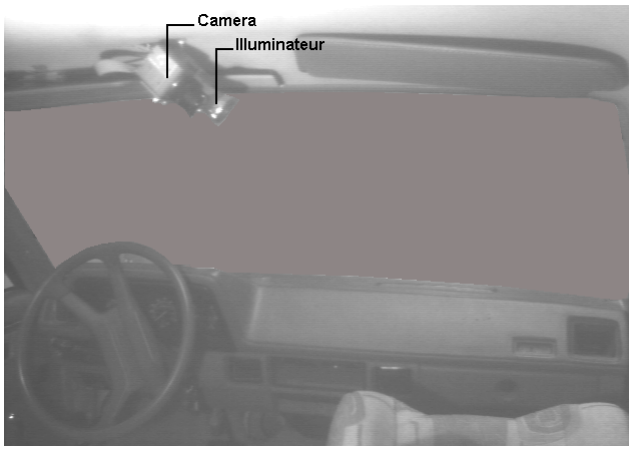


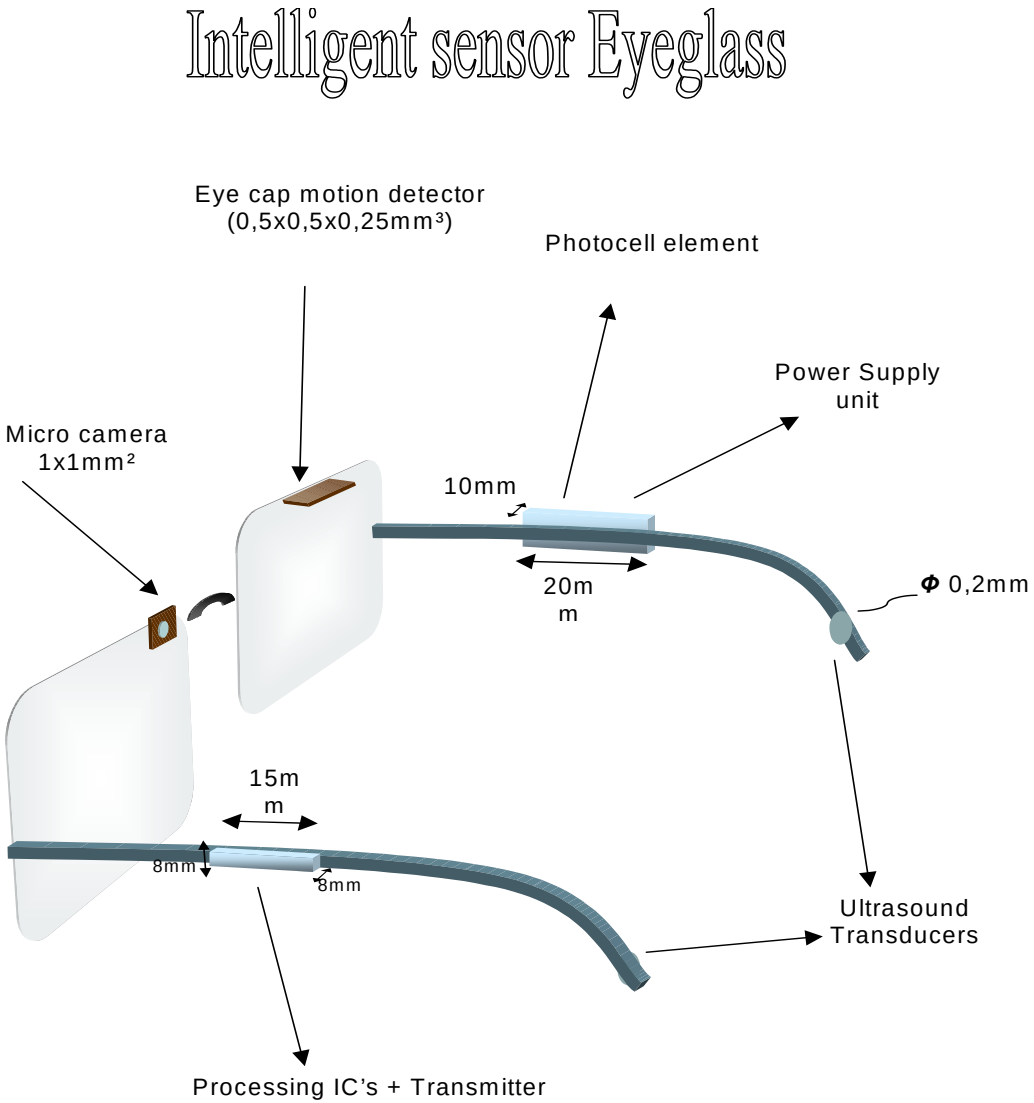




New microtechnology sensing devices

Development of camera-based micro sensors for of EOG and motility parameters.

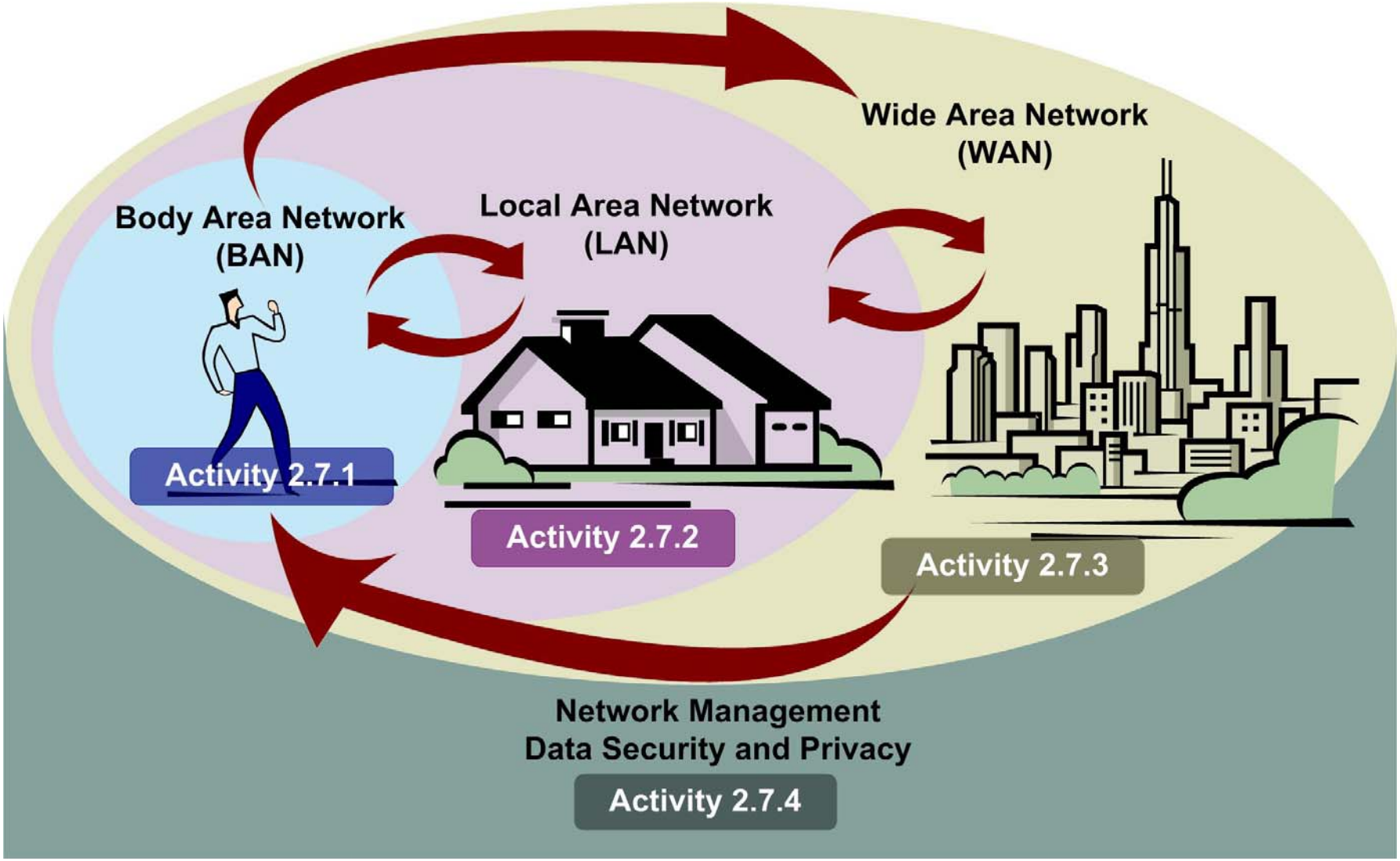




Using existing technology for sleepiness detection

Development of posture (seat, foil-based) and capacitive micro sensors

The Network scenario



Network from BAN to WAN for sleep / wake monitoring

Sleepiness at the traffic environment

Development of innovative systems for hypo-vigilance detection and real-time prediction.

Sleepiness at work

Development of new and individualised sleep management systems and sleep quality improvement schemes.

http: www.sensation-eu.org

Conclusion

- Sleepiness at work and in transport is a major risk for accidents
- Sleep disorders of multiple causes have a high prevalence. Particularly the disorders of hypersomnia and insomnia
- Monitoring of sleep / wakefulness at remote conditions can reduce risks and improve health by early diagnosis
- The use of nanotechnology improves sensor technology
- Networking of existing sensing equipment can be used to monitor activity patterns and sleep wakefulness problems