Group of Medical Signals
Department of Medical Signals

ISI ASCR Institute of Scientific Instruments AS CR, v. v. i.

THEMATIC RESEARCH FOCUS

Research area
– Non-invasive cardiology
– Scalp and intracerebral neurology
– Medical signal processing
– Medical acquisition systems
– Experimental devices – ECG monitors, amplifiers, whole body plethysmography
– Testing and verification of new diagnostics procedures

Excellence
Analysis and statistical evaluation of EEG recordings from deep brain structures, circulation control and hemodynamics, cardio electrophysiology

Mission
Development of new measurement techniques and analytical procedures for brain activity mapping and treatment of epileptic patients. Diagnostic procedures for non-invasive, cheap, comfortable and early diagnosis of cardiovascular system diseases.

DEVELOPED TECHNOLOGIES

Content of research
– Research based on the interpretation of experimental repeated stimulations related to description of brain structure connectivity
– Experimental research in cardiology leading to the interpretation of pathological patterns and couplings in ECG signals
– Development of new methods for dynamic description of hemodynamic parameter coupling during different excitations and states

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Multi-channel whole-body impedance cardio-plethysmograph system ISI MBM

Main capabilities

Basic research

– Deep brain structure cross-connectivity, description of involvement of brain structures in decision-making processes
– Experimental procedures related to the description of basic heart electrophysiology behaviour during different excitations
– Genetically dependent coupling between heart rate and ventricular repolarisation

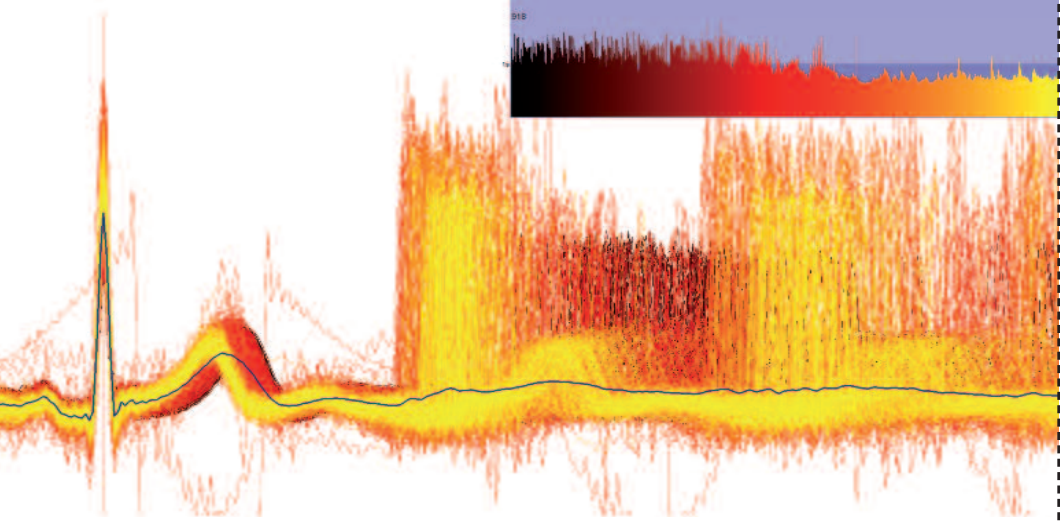
Applied research

– Deep brain structure epileptic foci detection and localization
– High frequency EEG identification, detection of pathological deep brain EEG oscillations
– Non-invasive diagnostics of heart and cardiovascular diseases

Blood circulation control measurement, experimental laboratory located in St. Anne's University Hospital, Brno

Fields of research results application

– Neurology in general
– Epileptic patient treatment
– Dementia diseases
– Cardiology in general
– Heart failure, arrhythmia, heart attack, ischemic disease
– Blood vessel stiffness and properties of blood circulation
– Cardiac output and heart efficiency
– Non-invasive preventive cardiology



ECG signal during rest and exercise

KEY RESEARCH EQUIPMENT

- Data acquisition systems for neuro-cardio electrophysiology – ISI PAS II.
- Data acquisition software and software for signal visualisation and pre-processing – ScopeWin, EEGVisual
- Multi-channel whole-body impedance cardiograph-plethysmograph system – ISI MBM
- Experimental syringe mixing pump for ultrasound contrast agents – ISI MSP
- Microneurography amplifier – ISI FARIO
- Experimental 12 lead electrocardiographs – ISI ECG 12
- Detector of vagus nerve stimulation – ISI VAG 1
- Respiration control device – ISI RECO 2
- Strain gauge plethysmograph – ISI SGP

Detector of vagus nerve stimulation ISI VAG 1

ACHIEVEMENTS

New methodology for description of dynamic properties of heart repolarisation

- Halámek, J.; Couderc, JP.; Jurák, P.; Vondra, V.; Zareba, W.; Viščor, I.; Leinveber, P.; *Measure of the QT–RR Dynamic Coupling in Patients with the Long QT Syndrome.* Ann Noninvasive Electrocardiol, 17(4), (2012), p. 323–330
- Halámek, J.; Jurák, P.; Bunch, T.; Lipoldová, J.; Novák, M.; Vondra, V.; Leinveber, P.; Plachý, M.; Kára, T.; Villa, M.; Fráňa, P.; Souček, M.; Somers, V.; Asirvatham, S.; *Use of a novel transfer function to reduce repolarization interval hysteresis.* J Interv Card Electrophysiol, 29, (2010), p. 23–32

European patent

- Halámek, J.; Jurák, P.; *Method of Ventricular Repolarization Analysis.* Institute of Scientific Instruments, Academy of Sciences of the Czech Republic, PCT/IB2008/002198, priority 30. 5. 2007, granted 15. 2. 2012

Detection and analysis of ECG parameters and blood circulation

- Lanfranchi, P. A.; Ackerman, M. J.; Kára, T.; Shamsuzzaman, A. S.; Wolk, R.; Jurák, P.; Amin, R.; Somers, V. K.; *Gene-specific paradoxical QT responses during rapid eye movement sleep in women with congenital long QT syndrome.* Heart Rhythm, 7, n. 8, (2010), p. 1067–1074
- Lanfranchi, P. A.; Gosselin, N.; Kára, T.; Jurák, P. et al.; *Menopause, hormone replacement and RR and QT modulation during sleep.* Sleep Medicine, Vol. 6, Issue 6, (2005), p. 561–566
- Halámek J.; Kára T.; Jurák P. et al.; *Variability of phase shift between blood pressure and heart rate fluctuations – A marker of short-term circulation control.* Circulation, Vol.108, Issue 3, (2003), p. 292–297

Respiration control and stimulation

Interictal high-frequency oscillations indicating seizure onset zone

– Brázdil, M.; Halámek, J.; Jurák, P.; Daniel, P.; Kuba, R.; Chrastina, J.; Novák, Z.; Rektor, I.; *Interictal high-frequency oscillations indicate seizure onset zone in patients with focal cortical dysplasia.* Epilepsy Research, 90, 1–2, (2010), p. 28–32

Deep brain structure cognitive, memory and emotion properties

– Bočková, M.; Chládek, J.; Šímová, L.; Jurák, P.; Halámek, J.; Rektor, I.; *Oscillatory changes in cognitive networks activated during a three-stimulus visual paradigm.* An intracerebral study. Clinical Neurophysiology, in press

– Štillová, K.; Jurák, P.; Chládek, J.; Halámek, J.; Telecká, S.; Rektor, I.; *The Posterior Medial Cortex is Involved in Visual but not in Verbal Memory Encoding Processing.* An Intraceribral Recording Study, Intracerebral Recording Study, J Neural Transm, (2012), DOI 10.1007/s00702-012-0890-z, in press

– Bočková, M.; Chládek, J.; Jurák, P.; Halámek, J.; Baláž, M.; Rektor, I.; *Involvement of the subthalamic nucleus and globus pallidus internus in attention.* Journal of Neural Transmission, (2011), 118, n. 8, p. 1235–1245

– Brázdil M.; Roman R.; Urbánek T.; Chládek J.; Spok D.; Mareček R.; Mikl M.; Jurák P.; Halámek J.; Daniel P.; Rektor I.; *Neural correlates of affective picture processing – A depth ERP study*. NEUROIMAGE, Vol. 47, Issue 1, p. 376–383

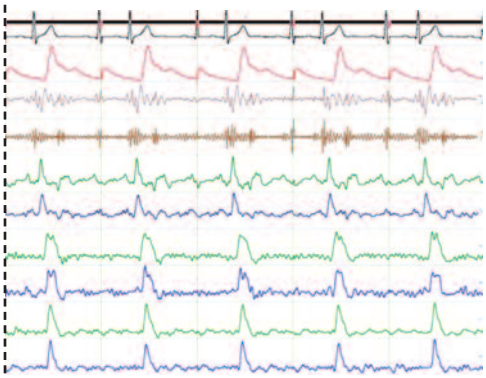
MAIN COLLABORATING PARTNERS

Collaboration with academic partners

St. Anne's University Hospital (Brno, CZ)
University Hospital (Brno, CZ)
Mayo Clinic (Rochester, MN, USA)
Masaryk University (Brno, CZ)
International Clinical Research Center (Brno, CZ)
Central European Institute of Technology (Brno, CZ)
University of Rochester Medical Center (Rochester, NY, USA)
Université de la Méditerranée, (Marseille, France)
University of Veterinary and Pharmaceutical Sciences (Brno, CZ)
Universita degli Studi di Milano (Milano, Italy)
Université de Montréal (Montreal, Canada)
Medical University of Gdansk (Gdansk, Poland)

Collaboration with companies

M&I, s.r.o. (Praha, CZ)
Unimedis, s.r.o. (Praha, CZ)



Multi-Channel Impedance Cardiography, ECG, blood pressure, heart sounds

EXPECTATIONS

Offers

– Sharing experience with experimental medical device design and construction
– Offering experience with experimental protocols design, data acquisition and processing
– Providing a professional background for the implementation of medical experimental measurement in cardiology and neurology
– Partnership in international projects
– Custom manufacturing of medical devices

Requirements

We welcome collaboration with academic partners especially from human health area as well as medical companies in the fields of cardiology and neurology.