RESEARCH, DEVELOPMENT AND SCIENTIFIC ACTIVITIES OF THE DEPARTMENT OF ELECTROMAGNETIC AND BIOMEDICAL ENGINEERING
Content

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Important milestones

- 2000 – accreditation of study program „Biomedical Engineering“ at FE ŽU – development of R&D activities in this area, 
- 2002 – bilateral **cooperation with IIU Corp.**, Tokyo, Japan – development of R&D activities in the area of non-destructive testing of materials, 
- VEGA projects:
  - 1/2053/05: Design and optimization of electromagnetic and acoustic methods and means of material non-destructive testing
    - **Duration:** 01/2005 – 12/2007
    - **Project supervisor:** prof. Ing. Klára Čápová, PhD.
    - **Project members:** prof. Ing. Ivo Čáp, CSc., Ing. Daniela Gombárka, PhD., Ing. Ladislav Janoušek, PhD., Ing. Dagmar Faktorová, PhD., Ing. Vilibalda Darmová, PhD., Ing. Mariana Beňová, Ing. Lenka Markovičová, PhD., Ing. Tomáš Marek, Ing. Milan Smetana
  - 1/0308/08: Innovative approach to material failures monitoring and evaluation by electromagnetic methods
    - **Duration:** 01/2008 – 12/2010
    - **Project supervisor:** prof. Ing. Klára Čápová, PhD.
    - **Project members:** prof. Ing. Ivo Čáp, CSc., doc. Ing. Ladislav Janoušek, PhD., Ing. Daniela Gombárka, PhD., Ing. Mariana Beňová, PhD., Ing. Zuzana Pšenáková, PhD., Ing. Milan Smetana, PhD., Ing. Tatiana Strapáčová, PhD.
Objectives of R&D activities

- Electromagnetic field and its interactions with various environments and objects;
- Research and development of methods and means for the non-destructive evaluation of materials including biomaterials;
- Biomedical sensors and their applications;
- Signal processing in biomedical applications;
- Modelling and simulations of dynamical biological systems especially for use in medical diagnostics;
- Influences of the electromagnetic field on living organisms.
**Devices for non-destructive evaluation**

**Phase-array eddy-current instrument**

**Olympus ECA**: harmonic excitation, 32 channels with internal multiplexor, 20Hz - 6MHz frequency range, bandwidth 8Hz-5kHz/1 coil, 40MHz digitizing rate, 16 bit resolution

**Eddy-current probes**

**X-Y-Z positioning system**

**Velmex**: step motors, 1.1μm resolution, independent motor drives, PC controlled, max. displacement speed 1cm/s

**Single-channel eddy-current instrument**

**Rohmann B300**: harmonic excitation, frequency range 10Hz - 10MHz, single channel, gain up to 60dB, max. output voltage 15V<sub>pp</sub>

**Ultrasound device with EMAT transducer**

**EMAT DIO1000**: pulsed excitation, frequency range 0.5MHz - 30MHz, output voltage 100V - 400V, repetition rate up to 20kHz
Experimental instruments

Arbitrary waveform generator

Agilent 33521A: frequency range 0Hz - 30MHz, USB connection, 1 channel, 250MS/s

Wide-band power amplifier

Krohn-Hite 7500: frequency range 0Hz - 1MHz, output power 75W, max. output voltage 200V_{pp}

Multifunctional measurement card

NI ELVIS II: multicomponent measurement system, USB connection, interfaced with LabVIEW, PC card for signal acquisition: 32-I/O channels, resolution 16bits/channel, max. 250MS/s

Lock-in amplifier

Signal Recovery 7280: frequency range 0Hz - 2MHz, two independent channels, dual harmonic mode, sensitivity 1nV/1pA
Special equipments and software

- Human head phantom
- Incubator for studying effects of electromagnetic field on biological structures
- Photoplethysmograph
- Magnetic field flux-gate sensors
- Software for electromagnetic field simulations

**OPERA 2D, 3D:**
- static, stationary, quasi-stationary electromagnetic field,
- rotational and linear motion,
- coupled problems—electromagnetic field and thermal field,
- linear and non-linear systems,
- steady-state and transient states,
- optimization of electromagnetic systems.
International research projects

- A-0930-RT-GC: HElicopter fuselage Crack MoniToring and prognosis through on-board sensOR network (HECTOR)
  - **Duration:** 12/2009 – 12/2011
  - **Coordinator:** prof. Marco Giglio (Politechnica di Milano)
  - **Supervisor for ŽU:** doc. Ing. Róbert Hudec, PhD. (DTM)
  - **Members – DEBE:** prof. Ing. Ivo Čáp, CSc., doc. Ing. Ladislav Janoušek, PhD., Ing. Milan Smetana, PhD.

The project is financed by the European Defence Agency – EDA and co-financed by the Ministry of Defence of the Slovak republic.
National research projects

APVV-0194-07: Research on methods for enhancing information rate of signals in quantitative non-destructive evaluation of conductive materials
- Duration: 09/2008 – 06/2011
- Project supervisor: doc. Ing. Ladislav Janoušek, PhD.

APVV-0349-10: Towards electromagnetic induction based methods to meet their true potential in non-destructive monitoring of conductive structures
- Duration: 05/2011 – 10/2014
- Project supervisor: doc. Ing. Ladislav Janoušek, PhD.
- DTM: doc. Ing. Róbert Hudec, PhD., Ing. Miroslav Benčo, PhD., Ing. Peter Kortič, PhD., Ing. Peter Lukáč
National research projects VEGA

- 1/0927/11: Research of new approaches to monitoring and evaluation of biomaterials using electromagnetic methods
  - **Duration:** 01/2011 – 12/2013
  - **Project supervisor:** prof. Ing. Klára Čápová, PhD.
  - **Members – DEBE:**
    - prof. Ing. Ivo Čáp, CSc., doc. Ing. Ladislav Janoušek, PhD.
    - Ing. Branko Babušiak, PhD.
    - Ing. Mariana Beňová, PhD.
    - Ing. Michal Gála, PhD.
    - Ing. Daniela Gombárska, PhD.
    - Ing. Milan Smetana, PhD.
    - Ing. Tatiana Strapáčová, PhD.
    - Ing. Mária Michniaková

- 1/0765/11: Research on application possibilities of eddy currents non-harmonic excitation in quantitative non-destructive evaluation of conductive materials
  - **Duration:** 01/2011 – 12/2013
  - **Project supervisor:** doc. Ing. Ladislav Janoušek, PhD.
  - **Members – DEBE:**
    - prof. Ing. Klára Čápová, PhD.
    - prof. Ing. Ivo Čáp, CSc.
    - Ing. Branko Babušiak, PhD.
    - Ing. Mariana Beňová, PhD.
    - Ing. Michal Gála, PhD.
    - Ing. Daniela Gombárska, PhD.
    - Ing. Milan Smetana, PhD.
    - Ing. Tatiana Strapáčová, PhD.
    - Ing. Mária Michniaková

Faculty of Electrical Engineering
National research projects

VEGA

**1/0038/09: Regulation of excitability and respiratory motor output under coughing and other reflexes of reflexes from breathing system in anaesthetized cats and rabbits**

- **Duration:** 01/2009 – 12/2011
- **Project supervisor:** prof. MUDr. Ján Jakuš, DrSc. (JMF CU in Martin)
- **Members – DEBE:** prof. Ing. Ivo Čáp, CSc.

**1/0470/09: Research of topologies and control of power electronic excitation system with single-phase HF input and two-phase orthogonal output in two-phase SM/AM electric motors**

- **Duration:** 01/2009 – 12/2011
- **Project supervisor:** prof. Ing. Branislav Dobrucký, PhD. (DME)
- **Members – DEBE:** Ing. Mariana Beňová, PhD.
National research projects

- **26220220134: Research of technologies and products for intelligent and technical textiles (VY-INTECH-TEX)**
  - **Contractor:** VÚTCH-CHEMITEX, spol. s r.o., Žilina
  - **Duration:** 01/2011 – 12/2014
  - **Project manager at ŽU:** Ing. Michal Gála, PhD.
  - **Members – DEBE:** doc. Ing. Ladislav Janoušek, PhD., Ing. Branko Babušiak, PhD., Ing. Milan Smetana, PhD.

- **26220220407: Competence center for research and development of diagnostic methods and therapy in oncology**
  - **Contractor:** Comenius University in Bratislava, Jessenius Medical Faculty in Martine
  - **Duration:** 09/2011 – 12/2014
  - **Project manager at ŽU:** Ing. Martin Čapka, PhD. (DCIS)
  - **Members – DEBE:** Ing. Branko Babušiak, PhD., Ing. Michal Gála, PhD., Ing. Roman Radil
National research projects

- **26220220121: Modification and verification of surgical tools**
  - **Contractor:** University of Žilina, Žilina
  - **Duration:** 12/2010 – 12/2013
  - **Project manager:** prof. Ing. Radomila Konečná, PhD. (DME FME)
  - **Members – DEBE:** doc. Ing. Ladislav Janoušek, PhD., Ing. Milan Smetana, PhD.

- **26220120003: Centre of excellence of power electronic systems and materials for their components**
  - **Contractor:** University of Žilina, Žilina
  - **Duration:** 05/2009 – 10/2011
  - **Project manager:** prof. Ing. Pavol Špánik, PhD. (DME)
  - **Members – DEBE:** doc. Ing. Ladislav Janoušek, PhD.

- **26220120046: Centre of excellence of power electronic systems and materials for their components II**
  - **Contractor:** University of Žilina, Žilina
  - **Duration:** 04/2010 – 03/2013
  - **Project manager:** prof. Ing. Pavol Špánik, PhD. (DME)
  - **Members – DEBE:** doc. Ing. Ladislav Janoušek, PhD.
PhD students

- **Dissertation theses in last five years:**
  - SMETANA Milan: *Interaction of electromagnetic field with conductive structure and influence of excitation type on material inhomogeneities evaluation*, Faculty of Electrical Engineering, University of Žilina, 2009.

- **Current dissertation theses:**
  - MICHNIAKOVÁ Mária: *Non-harmonic excitation of eddy currents in non-destructive evaluation of conductive materials*. – 2nd year
  - RADIL Roman: *Analysis of non-thermal effects of low-frequency electromagnetic field on select biological structures*. – 2nd year
  - MAŤKOVÁ Viera: *Electromagnetic methods for evaluation of biomaterials – signal detection optimization*. – 1st year
Significant outputs

- **Patents (3):**

- **Current contents publications in the last five years (9):**
Significant outputs

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Publications in journals indexed in a world-wide databases within the last five years (18):

Significant outputs

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Significant outputs

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Significant outputs

- Papers in proceedings of the world conference published in prestigious foreign publisher within the last five years (7):
Significant outputs

- Articles published in the special issue of the journal Communications 1/2011 oriented to biomedical engineering:
R&D services offered by the department

- numerical simulations of electromagnetic field (static, stationary and quasi-stationary field, rotational and linear motion - 2D and 3D);
- solution of coupled problems – electromagnetic field and thermal field using numerical tools;
- design and optimization of selected low-frequency electromagnetic systems;
- non-destructive evaluation of conductive materials using selected electromagnetic methods;
- solution of various problems in the area of biomedical engineering.
Demand

- Processing and signal analysis in non-destructive evaluation of materials;
- Hardware realization and construction of designed electrical devices;
- Laboratory equipments for educational purposes and practical exercises in subjects Theory of Electrical Engineering I, II and Sensors for Biomedical Engineering
Interconnection between R&D activities and educational process

- LPP-0076-07: Searching and education of talented students at primary and secondary schools in science by means of talents’ competitions
  - **Duration:** 01/2008 – 12/2012
  - **Project supervisor:** prof. Ing. Ivo Čáp, CSc.
  - **Members:** RNDr. Jozef Kúdelčik, PhD. (DF), RNDr. Žubomír Mucha (FEI TU Košice)

Significant outputs:

- Numerous national meetings and trainings of young physicists/physics olympics participants,
- Organization of Czech-Slovak scientific conference „Tutoring of talented students in physics at primary and secondary schools “ at the occasion of the 50th anniversary of Physics olympics in Slovak republic and Science and technology week in Slovakia, 27.-28.11.2009, Žilina
- 2 gold, 5 silver and 7 bronze medals in IPhO (2008-2011),
- 2 gold, 5 silver and 1 bronze medal in EUSO (2008-2011),
- **publication of four books:**
Interconnection between R&D activities and educational process

- 26110230005: Flexible and attractive study at the University of Žilina for the labour market’s requirements and for the knowledge society
  - Contractor: University of Žilina, Žilina
  - Duration: 05/2009 – 07/2012
  - Project manager: PhDr. Renáta Švarcová (rector’s office)

Planned outputs:
- Creation of complex pedagogical documentation and new study programmes:
  - BME: 2 new subjects – Introduction to biomedical engineering and Image analysis in medicine (IAM), 5 updated subjects – Signal processing in medicine (SPM), Information systems in medicine (ISM), Wave processes in BME (WPM), Sensors and measurement methods in BME (SMM), Basics of ecology (BEK);
  - TE: 3 updated subjects – Theory of electrical engineering I, II, III;
  - Teaching in English language: Theory of electrical engineering I, II, III and Wave processes
- Use of virtual laboratories in the educational process of subjects Theory of electrical engineering I, II
Interconnection between R&D activities and educational process

- FP7 SIS-CT-2010-244749: European Science and Technology in Action Building Links with Industry, Schools and Home (ESTABLISH) - CSA
  - Duration: 01/2010 – 12/2012
  - Coordinator: Eilish McLoughlin (Dublin City University)

- Construction of laboratory for practical exercises of subjects:
  - Theory of electrical engineering I, II
  - Sensors in biomedical engineering
THANK YOU FOR YOUR ATTENTION