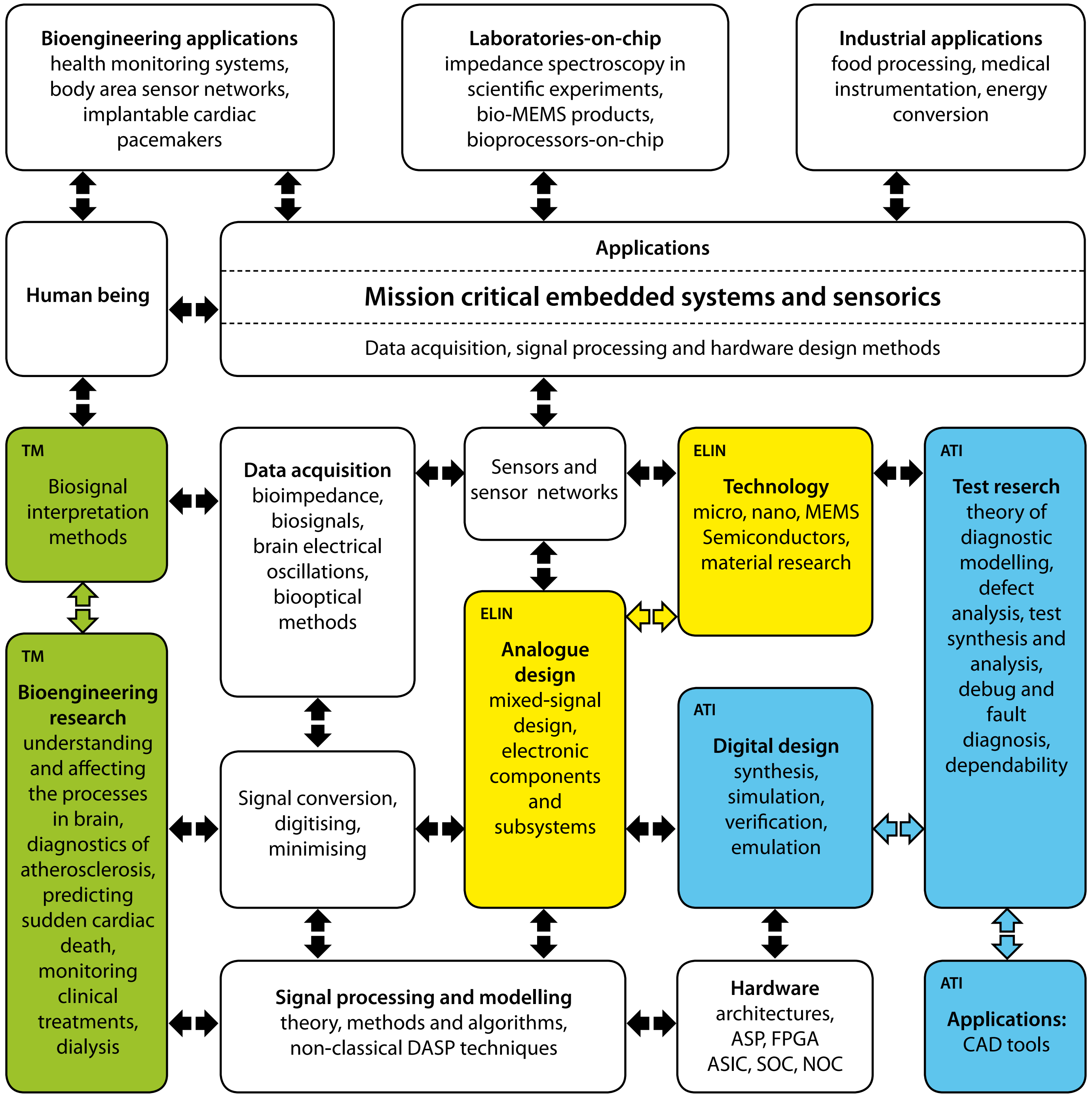
RESEARCH OBJECTIVES AND INTERDISCIPLINARY COOPERATION OF CEBE



Head of the centre:
Prof. Raimund Ubar
Department of Computer Engineering
Tallinn University of Technology
Raja 15, 12618 Tallinn, Estonia
www.cebe.ttu.ee

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti tuleviku heaks

CEBE | Centre for Integrated Electronic Systems and Biomedical Engineering

CEBE | Centre for Integrated Electronic Systems and Biomedical Engineering

Centre for Integrated Electronic Systems and Biomedical Engineering – CEBE

Centre for Integrated Electronic Systems and Biomedical Engineering - CEBE – is one out of seven Estonian centers of research excellence. It is based on research cooperation of three departments from Tallinn University of Technology:

- **Department of Computer Engineering (ATI)**
- **Department of Electronics (ELIN)**
- **Technomedicum (TM)**

MISSION

The mission of CEBE is to carry out fundamental and strategic interdisciplinary R&D in the fields of electronic components, systems, computer and biomedical engineering by a collaborating consortium with applications in medicine, semiconductor and information technologies.

GOALS

Interdisciplinary research in bio-, electronic and computer engineering. Most importantly in sensing and interpretation of bio-signals, developing of new efficient methods for signal processing, meeting the challenges in the field of design and test of reliable embedded systems.
The ultimate goal is to achieve synergy from composing the emerging knowledge of nanotechnologies, biomedical sensorics, novel signalprocessing methods, new design and test paradigms based on SoC/NoC technology and advanced design for dependability methods to come up with flexible solutions for real-time and mobile reliable embedded systems.

COOPERATION

CEBE is cooperating in Estonia with ELIKO, Artec Group, Smartimplant, Cybernetica AS, Elcoteq, National Semiconductor Eesti, Clifton AS, JR Medical, AS LDI, LDIAMON AS, Emros OÜ, Tensiotrace OÜ, Girf OÜ, AB Medical Teeninduse OÜ, 2 clinics, 4 Estonian hospitals.
Internationally CEBE cooperates with several world leading industrial companies like St. Jude Medical, Boston Scientific, National Semiconductor, TDI Inc, Göpel Electronic, STMicroelectronics, AerieLogic, TransEda and others.

SCIENTIFIC POTENTIAL

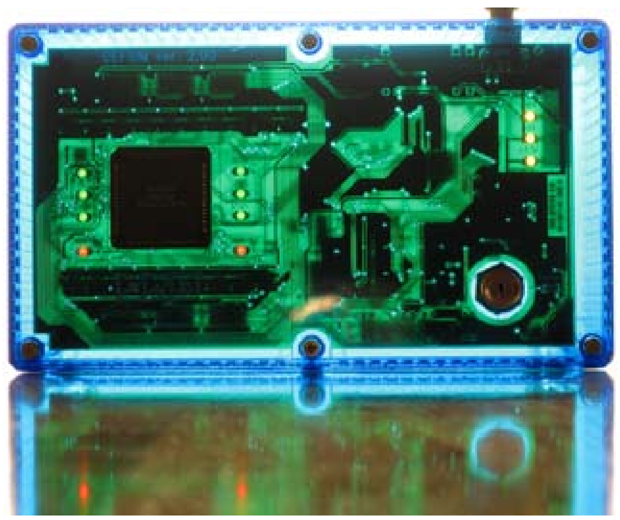
CEBE includes ca 80 researchers, of what ca 40 are senior staff members and the rest are PhD students. During the last 5 years scientists of CEBE have been involved in 14 projects within EU FP5-FP7 and other international programs, which has led to a widespread cooperation with leading research teams of EU and worldwide.
More than 120 joint papers with researchers from 15 countries have been co-authored. CEBE researchers are behind 2 high-tech start-ups and are holding 25 patents.

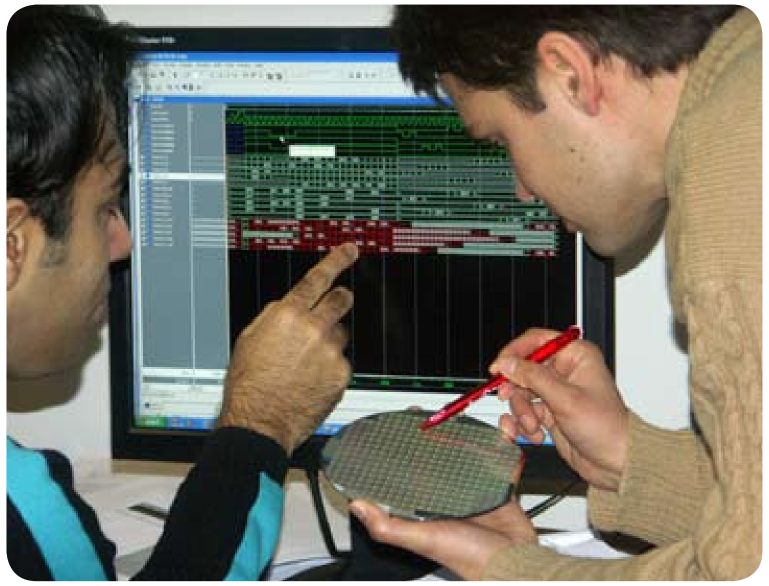
DESIGN AND TEST OF DEPENDABLE ELECTRONIC SYSTEMS

The main objective is research in design and test of embedded digital systems including modeling and synthesis, verification and debug, test generation and simulation, self-test, diagnosis, and fault tolerance.
The primary objective is to find suitable integrated methodologies to cope with the complexity in developing reliable applications out of non-reliable circuits, to reduce time-to-market and to ensure high quality and reliability of embedded systems by developing new methods for design and test.
It includes design methods of heterogeneous electronic systems, improved efficiency of simulation and verification, diagnostic modeling and test generation based on Decision Diagrams theory, hierarchical functional test generation and defect analysis methods, and fault tolerance methods for new emerging systems architectures.
Prototype tools will be created to prove the correctness of concepts and hypotheses and to evaluate new solutions.

MIXED-SIGNAL DESIGN AND SIGNAL PROCESSING

The research is focused on mixed signal (analogue/digital) specific processors which will make a revolution in development of implantable and wearable biomedical technology where the energy supply problems have to be solved effectively, e.g. using human body heat and other energy harvesting methods.
Another research objective is BioMEMS, the next generation of biomedical devices requiring novel, function specific, and ultra low power signal processing methods and means with reduced complexity.
Impedance spectroscopy will become an effective sensoric tool for getting the biological and physiological information from living matter.
Reducing of digital complexity will depend mainly on the processing algorithms, whereas the methods and algorithms for joint time-frequency analysis will determine greatly the success of embedded signal processing.
The main research topics are: methods for signal and data acquisition, signal processing methods and tools, development of reconfigurable processor architectures, and impedance spectroscopy with applications in bio- and medical technology.





SEMICONDUCTOR MATERIALS AND NANOTECHNOLOGIES

New metallization technologies together with wide-bandgap semiconductor materials will introduce semiconductor devices with strongly improved electrical characteristics for applications in energy conversion and distributing.
Our goal is to develop theoretical basis and finding practical solutions for a wide bandgap anisotropic hetero-polytypic interface inside the SiC (specific heterojunctions) for creating solutions to design new power HEMT devices with much higher speed characteristics than those of traditional MOS transistors.
Investigations of nanotechnological interfaces between organic/biological and semiconductor or metal bodies is our aim to find the methods for design of reliable BioMEMS.
The main research topics are: investigations on semiconductor metallization technologies, theoretical basis of hetero-polytypic interfaces, and nanotechnological compatibility of interfaces.

BIOMEDICAL ENGINEERING

The common feature of the research is application of bioengineering and modern signal analysis to different biosignals in order to improve existing and develop new non-invasive methods within medical technology.
Currently, an active worldwide scientific work is directed to understand and affect the processes in the brain, to monitor blood pressure and heart-vascular diseases, to study potentially dangerous myocardial arrhythmogenic behaviour, and to monitor end stage renal disease patient treatment quality.
The EEG/ERP/EP analysis, linear (spectral, correlation, etc) and nonlinear (entropy, length distribution of low variability periods, etc) and ICA signal processing methods are utilised.
Theoretical models are used for planning of experiments and interpretation of the results.
The main research topics are: brain research, diagnostics of cardiovascular diseases, sudden cardiac death prediction, and bio-optical monitoring.

CEBE | Centre for Integrated Electronic Systems and Biomedical Engineering