

## Institute of Biomedical and Neural Engineering: Application Form

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### 1. Name and place of the CI

- a. Name of CI in Icelandic:
- b. Name of CI in English: **Institute of Biomedical and Neural Engineering (BNE)**
- c. Anchor(s) name: School of Science and Engineering
- d. Home site of CI (URL):

### 2. Director of the CI

- a. Name and position: Paolo Gargiulo, Assistant Professor
- b. Link to directors CV: <http://www.ru.is/haskolinn/starfsfolk/paolo>

### 3. Members of the CI (Name and position)

- a. Research Faculty (at least 3):
  1. Bjarni Vilhjálmur Halldórsson (BVH), Associate Professor
  2. Brynjar Karlsson (BK), Associate Professor
  3. Ceon Ramon (CR), Professor
  4. Haraldur Auðunsson (HA), Associate Professor
  5. Magnús Kjartan Gíslason (MKG), Assistant Professor
  6. Karl Ægir Karlsson (KÆK), Associate Professor
  7. Ólafur Eysteinn Sigurjónsson (OES), Assistant Professor
  8. Þórður Helgason (ÞH), Associate Professor
  9. Kamilla Rún Jóhannsdóttir (KRJ), Assistant Professor
  10. Jón Guðnason (JG), Assistant Professor
- b. Research students:
  1. Þröstur Peturson (ÞP), Msc student
  2. Benedikt Magnusson (BM), Msc student
  3. Ahmad Diab (AD) PhD, student
  4. Ásgeir Alexandersson (ÁA), MSc student
  5. Jón Ingi Sveinbjörsson (JIS), PhD student
  6. Guðný Anna Árnadóttir (GAÁ), MSc student
  7. Lilja Níelsdóttir (LN), MSc student
  8. Oddný Björgvinsdóttir (OB), MSc student
  9. Sandra Mjöll Jónsdóttir-Buch (SMJB), PhD student
  10. Kristbjörg Gunnarsdóttir (KB), MSc student
  11. Ramona Lieder (RL), Post Doc
  12. Dröfn Svanbjörnsdóttir, (DS)
  13. Jóna Sigrún Sigurðardóttir, (JSS)
- c. Support personnel:
- d. External collaborators:
  1. Halldór Jónsson jr (HJj), Professor (Medical Faculty HI)

2. Sigurður Brynjólfsson (SB), Professor (Engineering Faculty HI)
3. Gissur Örlygsson (GÖ), PhD (Innovation Centre NMI)
4. Bernhard O Pálsson (BOP), Professor (UCSD)
5. Már Másson (MM), Professor (Medical faculty HI)
6. Guðbjörg Kristín Ludvigsdóttir, (GKL) Landspítali, Rehabilitation Hospital
7. Hannes Petersen, (HP) Professor (Medical faculty HI)

#### 4. Memorandum to the RU Research Council : Details of the governance structure of the CI and details on how major decisions will be made in the CI:

##### 4.1 Introduction

The core group of the BNE institute are faculty members committed to scientific activities in the field of Biomedical and Neural Engineering. The establishment of the BNE institute aims to strengthen research synergies between members and to create core facilities for research and development. The BNE holds the ambition to become the reference for Biomedical Engineering research in Iceland.

##### 4.2 Description of BNE core member research

**Brynjar Karlsson** is an Associate Professor of Biomedical Engineering and leads the EHG-group at the SSE. He has been involved in developing engineering tools for application in obstetrics for over 20 year. For the first 10 years his main research interest involved using ultrasound techniques principally for fetal monitoring and for the last 10 years he has concentrated on the interpretation of the EHG in predicting pre-term labour. He has directed various research projects including two 3 year project grants from the Icelandic Research fund and various smaller projects. He was a work package leader in the ERASysBio+ project BioModUE\_PTL. He also has extensive managerial experience in academia. He has in the past served as Dean for the Faculty of Health Sciences in the Technical University of Iceland, Director for Graduate studies and for Research Development in the SSE. Dr. Karlsson obtained his PhD in Physics from the Université Francois Rabelais in Tours, France in 1996 and his Habilitation à Diriger des Recherches from The Université de Technologie de Compiègne in 2012.

**Magnús K. Gíslason** is an Assistant Professor of Biomedical Engineering. His research interest are focussed on biomechanics and biomechanical modelling in conjunction with finite element analysis. In recent years he has published on the finite element modelling of the wrist and on the risk fracture of the osteoporotic bone. He earned his PhD from the University of Strathclyde in Glasgow in 2008 and has since then been lecturing at the Department of Biomedical Engineering and at the Department of Mechanical and Aerospace Engineering, before joining Reykjavik University in 2013. He is a member of the European and International Society of Biomechanics.

**Ceon Ramon** obtained his B.E.(Hons.) Degree in Electrical Engineering from the Indian Institute of Science, Bangalore in 1966. Graduate studies and a Ph.D. degree in

Electrical Engineering with specializations in lasers and quantum optics were done at the University of Utah, Salt Lake City by 1973. He has worked on the computer modeling of the electrical activity of human heart and brain since 1980s. For the past 20 years, his research efforts have been largely involved with neuroscience and the developmental genesis of the human EEG. He is currently involved in developing new technologies for noninvasive localization of epileptogenic zones in the brain and also the electrical stimulation of the brain, to treat epilepsy and stroke. To date, he has published more than 170 papers in the peer reviewed scientific journals. For the past 35 years, Ceon has also held faculty appointments at the University of Utah, State University of New York, Stony Brook and at the University of Washington. Presently, he is an Affiliate Professor of Electrical Engineering at the University of Washington and a Professor of Biomedical Engineering at Reykjavik University, Iceland. He is also associated with Pacific Northwest Center for Neural Engineering and the Integrated Brain Imaging Center at the University of Washington.

**Bjarni V. Halldórsson** is an Associate Professor of Biomedical Engineering. His research focuses on algorithmic problems arising in bioinformatics, particularly focused on DNA sequence analysis, as well as statistical genetics. He received his PhD from Carnegie Mellon University in 2001 in Algorithms, Combinatorics and Optimization. He has been an associated professor at RU since 2006, where he is now in a part time position. Since his PhD graduation he has worked for biotech companies, Celera genomics, Applied Biosystems, Expeda and deCODE genetics. He is currently a research scientist at deCODE genetics where he leads a group developing algorithm and software for DNA sequence analysis and in associating DNA markers to diseases and traits in the central nervous system. He has published over 80 publications in bioinformatics, algorithms and statistical genetics. He is currently supervising two MS and one PhD students in collaboration with local biotech companies, deCODE genetics and Expeda.

**Haraldur Auðunsson** is an associate professor in the School of Science and Engineering at Reykjavik University. Haraldur received his PhD from Oregon State University in 1989. Haraldur has been involved with radiography in academia since 1996, and has worked on applications of x-ray for several years, both in medical imaging as well as in industry outside the medical field. Two MS students have graduated under his supervision and he is currently supervising one MS student.

**Jón Guðnason** is an assistant professor at the School of Science and Engineering at Reykjavik University. He has a track record in the study of the voice production system and has developed novel features that have improved speaker recognition systems. He completed a Ph.D. degree with the Communications and Signal Processing Group, Imperial College, London, U.K in 2007. His thesis was on speaker recognition systems using voice source information. In 2008-2009 he was a Visiting Scholar at LabROSA, Columbia University, New York. He has been a member of the academic staff at the School of Science and Engineering, Reykjavik University since 2009. His current projects include *Almannarómur*: Speech recognition for Icelandic, Instruction recognition in air-traffic control, and Cognitive workload monitoring in air-traffic control.

**Kamilla Rún Jóhannsdóttir** is an Assistant Professor of Psychology. Her research focuses on cognitive mechanisms in basic and applied environments. Current research projects include measuring biological markers such as speech signals and physiological processes in order to monitor workload and diagnose depression (in

cooperation with Dr. Jón Guðnason). Other projects include examining the impact of stress and workload on working memory and executive attention, based on behavioural as well as physiological measures. Dr. Jóhannsdóttir received her Ph.D. in Cognitive Science from Carleton University, Ottawa, Canada in 2004. Following her graduation, Dr. Jóhannsdóttir held a position as a Visiting Research Scientist at the *Advanced Cognitive Engineering* (ACE) lab at Carleton University. She has extensive experience in research on cognitive mechanisms/processes.

**Karl Ægir Karlsson** is an associate professor of biomedical engineering at the school of science and engineering at Reykjavik University. Karl is the author of 24 published peer-reviewed articles. Almost all of Karl's career has been focused on understanding the neural underpinnings of sleep and wakefulness Karl has been a PI at the RU NEUROLAB since 2006 (see: [www.karlstofa.is](http://www.karlstofa.is)), a founding member and chairman of the Icelandic Society for Neuroscience, BMC, founding member of ZFNordic and EuBioFishMed (which is a new zebrafish organization that springs out of COST action (BM 0804)). Since 2009 Karl has also managed 3Z (see: [www.3z.is](http://www.3z.is)) a pharmaceutical start-up capitalizing on technology developed in the lab en route to understand sleep in zebrafish.

**Olafur E. Sigurjonsson** is an assistant professor at the school of science and engineering at the Reykjavik University. In addition Olafur is heads the department of research and development at the Blood bank landspítali University Hospital, is the laboratory director for cellular therapy at the Blood bank and clinical assistant professor at the department of medicine, University of Iceland. Olafur received his PhD from the University of Oslo in 2006. For this thesis, he was awarded the "H.M. Kongens gullmedalje" by king Haakon V of Norway in 2007. Olafur has over 25 peer reviewed publications that have been cited more than 400 times. Olafur has graduated 1 PhD student and several MSc. Students. The Sigurjonsson laboratory focuses on developing clinical grade methods for expansion and differentiation of stem cells and development of tissue engineering strategies for bone and cartilage defects. The lab runs the only clinical cell therapy service in the country, harvesting, processing and storage of hematopoietic stem cells that are used as an autologous support method in patients undergoing strong chemotherapy for myelomas, lymphomas etc (ISO9001:2000 certified). In addition Olafur heads the Blood banks pursuit on developing methods to increase the quality of blood storage using systems biology approach. Olafur is a management committee member of COST actions 1005 (NAMABIO) and 1301 (MPNS) as well as he sits on the board of Scandinavian society for biomaterials (secretary)

**Paolo Gargiulo** is an Assistant Professor of Biomedical Engineering. He has been active in the field of Clinical Engineering and medical Image processing and 3-D modeling for surgical planning. He studied at TU Wien and finished his PhD in 2008. He has published over 30 papers on peer reviewed international journals and chapters in academic books. He is currently member of EU-COST project called Namabio ([www.namabio.eu/members/paolo-gargiulo](http://www.namabio.eu/members/paolo-gargiulo)) consultant of MedEl ([www.medel.com](http://www.medel.com)) cooperating with Össur ([www.ossur.is](http://www.ossur.is)) for the assessment of total hip arthroplasty, with Cornell University (US) in Larynx Pacemaker development and with Washington University (US) in Brain Modeling project.

**Pórður Helgason** is an associate professor in the School of Science and Engineering at Reykjavik University and an engineer at the Landspítali University Hospital. His research field is in electrical stimulation, techniques and application where he has been

active for over 25 years. He has published over 10 articles in peer reviewed international journals, over 40 conference articles in peer reviewed conferences proceedings and 4 chapters in professional books. He has got over 50 research and development grants from Icelandic, Nordic and European funds. He has ongoing projects with some leading Icelandic companies: Marel on bone detection, Össur on EMG, Star Oddi on heart monitoring, Kine on development on wireless bio signal measurement units. He is founding member on three companies and has worked with several other Icelandic and foreign medical engineering companies. He is a chairman of the board of the Icelandic Society of Biomedical Engineering, founding member of International Functional Electrical Stimulation Society (IFESS), a substitute member of The Scientific Board of Landspítali – University Hospital, member of The Educational Board of Icelandic Society for Chartered Engineers. Dr. Helgason obtained a CS degree in electrical engineering from University of Iceland, Dipl.-Ing. and Dr.-Ing. in biomedical engineering from Universität Fredriciana zu Karlsruhe in Germany, 1982, 1985 and 1990 respectively.

### 4.3 Governance of the Biomedical and Neural Engineering Institute

#### 4.3.1 Anchor and Members

The Anchor of the **Biomedical and Neural Engineering (BNE)** will be the School of Science and Engineering. The BNE Institute will be a structure of type A (not self-financed). The BNE Institute has as core members 11 faculty members from the Biomedical Engineering Department, Department of Psychology and the School of Science and Engineering. Other members are students involved in research, postdoctoral specialists and external collaborators. The students will be Master, PhD and post doctoral students who contribute to the research projects.

#### 4.3.2 Meetings and decisions

The major decisions will be made by the consensus (majority) of the core members. Such decisions may concern the allocated space for students and facilities, joint research projects, joint applications, etc. The BNE members will meet once a month and discuss, ideas, applications, research results or any other interesting scientific material. During these meetings each member will be informed about the recent activity of the other members and about recent publications of the Institute. The recent results may also be presented as public talks for other scientists or students. As a rule Master or PhD theses will be presented in the Institute's meetings prior to the final public presentation, as a rehearsal exercise.

#### 4.3.3 Finances

The centre will have an account within the financial system of Reykjavik University. The director of the BNE Institute has the procuration.

#### 4.3.4 Director

The core members proposed Paolo Gargiulo as future Director of the BNE Institute. He will propose the short term objectives and organize the monthly meetings and the annual reports.

#### **4.3.5 Revision of the governance**

The governance rules will possibly be revised or updated once a year, depending on the evolution of the Institute or other factors. New rules will be adopted with the majority consensus of the core members.

## **5. A plan for common research activity envisaged by the members of the CI for the next three years:**

### **5.1 Plan for common research within the next three years**

The BNE institute has three major directions for research and development activities within the next three years (2014-2016):

- 1 – Biomedical engineering technologies and optimization of clinical processes
- 2 – Modeling and simulation of neurological functions
- 3 – Tissue Engineering and biomaterial science
- 4 – The use of biological markers for classification and diagnoses purposes

The research carried out the BNE Institute within the next three years will be on several subjects from the main directions and will be done in close cooperation by faculty members and their students. Considering the present work in progress (involving at least 2 core members), the BNE institute will act as umbrella for the following on-going projects:

- Clinical evaluation score for Total Hip Arthroplasty planning and post-operative assessment (PG), (MKG), (þP), (BM), (HJj), (GKL)
- 3D segmented model of head for modelling electrical activity of brain (CR), (PG)
- Monitoring Extracellular Matrix Mineralization Processes in Biological Scaffolds using Bioreactors, X-ray  $\mu$ CT Technology and 3-D Modeling Methods (OES, PG, GÖ)
- Modeling and measuring the electrical activity of the uterus with the aim of predicting preterm labor (BK), (AD), (ÁA)
- Epilepsy localization, memory and language studies with 256 channel scalp EEG and 64 channel ECoG data (CR and PG)
- Time-series analysis of EEG data (CR and PG)
- Modeling and analysis of muscle artifacts in human EEG data (CR and PG)
- EEG phase synchronization and phase transition studies with application to epilepsy and cognition (CR and PG)
- Building bone using tissue engineering approach (OES, GÖ, PG)
- Strategies for coating titanium implant with chitosan strategies (OES, GÖ, MKG, MM)
- Increasing the quality of blood storage using a systems biology approach (OES, BOP)
- Developing methods for GMP culture of stem cells (OES, SMJB)
- Novel methods of high-throughput drug screening using zebrafish as an animal model; this is an multifaceted project that involves basic research on the biology

and pharmacological effects on zebrafish as well as development and implementation of novel hardware and software (KÆK)

- Use of X-ray and other imaging modalities analogs used in medical imaging applied in industry, especially in fish processing and biology. (HA, KÆK)
- Development of simple system to monitor physical activity and endurance during normal outdoor activities using simple off the shelf devices. (HA)
- Mathematical modelling of finger movement restoration with electrical stimulation (ÞH, CR, AÓ)
- Neuroprosthesis development for finger movement restoration (ÞH, HS)
- Use of CT and MRI to monitor tissue changes in man and fish (ÞH, HA...)
- Use of Ultrasound Current Source Density Imaging for monitoring denervated muscles and nerve sprouting (ÞH, AÓ, BG)
- Measuring various physiological signals (e.g. EEG, EMG, heart rate, blood pressure) in order to classify and later monitor and diagnose, workload, stress, and various emotional states. (JG, KRJ).

A more detailed plan for 2015 and 2016 will depend on the evolution of the present research and will be made at the end of the previous years. It is an ambition of the institute to increase the cooperation within the BNE members therefore we aim to involve more BNE members in the above project list.

## 5.2 Facilities for research and development

The BNE members will apply to equipment fund in order to build a technological park to support research and development activities. Follow a proposed list of equipment which the members would like to apply for. The priority for the equipment will be decided by the BNE core members in the 1<sup>st</sup> BNE meeting.

- X-ray imaging equipment with digital high resolution sensor, which can be used for CT experiments.
- Equipment for monitoring biosignals outdoors.
- 256-channel EEG system (also planned to be used for high resolution measurements of uterine electrical activity.)
- 3D printer
- Scanning electron microscopy
- Atomic force microscopy
- Software for mathematical modelling
- Software and hardware for electronic design and prototyping
- Live signs measurement lab (Faraday room) for EEG, EMG, ECG and others
- Motion analysis lab built in synergy with sport science

## 6. A plan for the financing of the activity of the CI for the next three years and a budget for the first year of operation:

### 6.1 Financial plan for the next three years

The major financial resources will consist of research grants. The present grants which will be still active within the next three years are:

- Clinical evaluation score for Total Hip Arthroplasty planning and post-operative assessment (Landspítali research fund and Erasmus funds (PG 2013-2014).
- Use of EPD methods for coating of titanium implants using chitosan derivatives. Bioactivity of bone development (Landspítali research fund) (OES, GO 2013-2014)
- Development and construction of a bioreactor system for bone development and non-invasive methods for analysis of bone development development (Landspítali research fund) (OES, PG 2013-2014)
- Effect of lysates from expired platelet concentrates on expansion, differentiation and immunomodulation of embryonic stem cell derived mesenchymal stem cells development (Landspítali research fund) (OES 2013-2014)
- Chitosan derivatives in increasing the bioactivity of titanium implants (AVS fund) (OES, MM 2013-2014)
- Fiskað eftir svefnlyfjum framtíðarinnar (Tæknipróunarsjóður **131828-0611** KÆK)
- The behavioural and electrophysiological effects of Kcna and bHLH knock-down on sleep in zebrafish (Rannsóknasjóður **130751-051** KÆK)

The faculty members will constantly send grant applications to Icelandic, European or other foreign funds.

## 7. Submission date of application:

Reykjavik 23/10/2013

## 8. Signature of the director of the CI:

