TTÜ KÜBERNEETIKA INSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2012

1. Instituudi struktuur

TTÜ Küberneetika Instituut, Institute of Cybernetics at Tallinn University of Technology
Instituudi direktor Andrus Salupere

- Juhtimissüsteemide osakond, Control Systems Department, Jüri,Vain
- Foneetika ja kõnetehnoloogia laboratoorium, Laboratory of Phonetics and Speech Technology, Einar Meister
- Mehaanika ja rakendusmatemaatika osakond, Mechanics and Applied Mathematics Department, Jüri Engelbrecht
- Fotoelastsuse laboratoorium, Laboratory of Photoelasticity, Hillar Aben
- Lainetuse dünaamika laboratoorium, Wave Engineering Laboratory, Tarmo Soomere
- Süsteemibioloogia laboratoorium, Laboratory of Systems Biology, Marko Vendelin
- Tarkvara osakond, Software Department, Ahto Kalja
- Raamatukogu, Library, Marje Tamm

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

2.1, 2.2 Struktuuriüksuse koosseisu kuuluvate uurimisgruppide teadustöö kirjeldus, aruandeaastal saadud tähtsamad teadustulemused ja olulisemad publikatsioonid

MAIN LINES OF RESEARCH

NONLINEAR DYNAMICS

Nonlinear Dynamics group deals with (i) nonlinear wave motion in solids; (ii) soft matter physics; (iii) photoelasticity. Attention is on hierarchical behaviour of microstructured solids under dynamical impact and corresponding inverse problems; solitons and solitary waves; turbulent mixing; processes with power laws; nonlinear photoelastic tomography.

Main results in 2012:

- It is shown that the concept of dual internal variables can provide hyperbolic governing equations for processes in the microscale of microstructured materials concerning also temperature fluctuations which can be treated as microtemperature.
- The accuracy of wave models for microstructured solids is analysed in case of different internal structures for a large of material parameters and wavelengths.
- The novel methods for measuring the orientation of fibres short fibre reinforced concrete are proposed and applied.
- An analysis of phase plots and parametric plots is carried out in order to enchance accuracy of NDT for functionally graded materials.

- The mechanism for anomalously fast nucleation of droplets is explained by highly inhomogeneous and intermittent widening of the droplet-size distribution spectra.
- Using the concept of finite-time compressibility, the patch formation efficiency is explained in compressible flows (analysis of the surface velocity field in the Gulf of Finland).
- A multivariable method for determining scaling exponents (developed earlier at CENS) is used to analyse the classical percolation problems.

SELECTED PUBLICATIONS

1. Aben, H.; Errapart, A. (2012). Photoelastic tomography with linear and non-linear algorithms. Experimental Mechanics, 52(8), 1179 - 1193.
2. Berezovski, Mihhail; Berezovski, Arkadi (2012). On the stability of a microstructure model. Computational Materials Science, 52(1), 193 - 196
3. Engelbrecht, J.; Salupere, A. (2012). Soliton ensembles and solitonic structures. Applicable Analysis, 91(2), 237 - 250.
4. Ravasoo, A. (2012). Interaction of bursts as a detector of material inhomogeneity. ACTA Acustica United with Acustica, 98(6), 864 - 869.
5. Tamm, Kert; Salupere, Andrus (2012). On the propagation of 1D solitary waves in Mindlin-type microstructured solids. Mathematics and Computers in Simulation, 82(7), 1308 - 1320.

CONTACT: Prof, Jüri Engelbrecht, e-mail: je@ioc.ee

WAVE ENGINEERING

Wave Engineering group has competence in nonlinear wave theory and modelling of fluids with the focus on applications in the marine and coastal environments. Attention is to wave excitation and propagation over the sea surface; impact of waves in coastal regions; unified framework for wave-driven phenomena.

Main results in 2012:

- The basic features of the wave climate in the South-Western Baltic Sea are established based on the second longest instrumentally recorded wave time series in the Baltic Sea at the Darss Sill in 1991-2010.
- The preventive technique for the optimisation of fairways based on environmental considerations has been expanded to cover the south-western Baltic Sea and the Kattegat.
- A catalogue of rogue wave accidents reported in mass media during 2006{2010 has been created.

SELECTED PUBLICATIONS

1. Didenkulova, I.; Pelinovsky, E. (2012). Nonlinear wave effects at the non-reflecting beach. Nonlinear Processes in Geophysics, 19(1), 1 - 8. (http://dx.doi.org/10.1007/s00024-012-0510-8).
2. Kurkina, O.E.; Kurkin, A.A.; Ruvinskaja, E.A.; Pelinovsky, E.N.; Soomere, T. (2012). Dynamics of solitons in a nonintegrable version of the modified Korteweg-de Vries equation. JETP Letters, 95(2), 91 - 95.
3. Lu, Xi; Soomere, Tarmo; Stanev, Emil V.; Murawski, Jens (2012). Identification of the environmentally safe fairway in the South-Western Baltic Sea and Kattegat. Ocean Dynamics, 62(6), 815 - 829.

4. Pelinovsky, E.N.; Rodin, A.A. (2012). Transformation of a strongly nonlinear wave in a shallow-water basin. Izvestiya Atmospheric and Oceanic Physics, 48(3), 343 - 349.
5. Soomere, T.; Weisse, R; Behrens, A. (2012). Wave climatology in the Arkona Basin, the Baltic Sea. Ocean Science, 8(2), 287 - 300

CONTACT: Prof Tarmo Soomere, e-mail: soomere@cs.ioc.ee

SYSTEMS BIOLOGY

Systems Biology group is focused on unravelling the intricacies behind regulation of intracellular processes in cardiac muscle cells. Efforts are mostly concentrated on studying regulatory mechanisms of metabolic processes in the heart, expanding our knowledge of cardiac energetics and contractile function, and shedding light on novel aspects of excitation-contraction coupling in rat, trout and mouse hearts. Both experimental and computational approaches are applied in investigating these topics.

Main results in 2012

An efficient and accurate method for determining sarcomere lengths of cardiomyocyte has been developed and implemented in open-source software.

It has been shown that the dynamic method provides a measure of total flux, and not net flux as presumed previously, making the fluxes predicted from both methods consistent.

Results obtained from experiments indicate that diffusion of a smaller molecule (1127 MW fluorescently labeled ATTO633-ATP) is restricted more than that of a larger one (10,000 MW Alexa647-dextran), when comparing diffusion in cardiomyocytes to that in solution. The presence of periodic intracellular barriers has been suggested.

An integrated method to quantify calcium fluxes in cardiac excitation-contraction coupling has been developed which can be applied to all species including genetically modifiable mice and zebrafish to study the cardiac functional phenotype under a range of physiological conditions.

SELECTED PUBLICATIONS

1. Illaste, Ardo; Laasmaa, Martin; Peterson, Pearu; Vendelin, Marko (2012). Analysis of molecular movement reveals latticelike obstructions to diffusion in heart muscle cells. Biophysical Journal, 102(4), 739 - 748.
2. Karo, Jaanus; Peterson, Pearu; Vendelin, Marko (2012). Molecular dynamics simulations of creatine kinase and adenine nucleotide translocase in mitochondrial membrane patch. The Journal of Biological Chemistry, 287(10), 7467 - 7476
3. Schryer, David W.; Peterson, Pearu; Illaste, Ardo; Vendelin, Marko (2012). Sensitivity Analysis of Flux Determination in Heart by H(2) (18)O -provided Labeling Using a Dynamic Isotopologue Model of Energy Transfer Pathways. PLoS Computational Biology, 8(12), e1002795, 1 - 15.

CONTACT: Dr Marko Vendelin, e-mail: markov@sysbio.ioc.ee

NONLINEAR CONTROL THEORY

Nonlinear Control Theory group has competence in dynamical control systems on time scales. Attention is focused on novel algebraic methods and symbolic software tools for solving funda-

mental problems for nonlinear control systems towards unification of discrete- and continuous-time control.

Main results in 2012

- The simple necessary and sufficient conditions, allowing to transform the nonlinear discrete-time control system into the extended observer form, were provided. The solvability conditions are formulated in terms of certain partial derivatives and due to the matrix representation they can be checked almost by direct inspection.
- The application of Neural Networks based Additive Nonlinear Auto Regressive eXogenous (NN-ANARX) models as a computational tool of the supervision system for therapeutic exercises was proposed.

SELECTED PUBLICATIONS

1. Belikov, Juri; Kotta, Ülle; Tõnso, Maris (2012). State-space realization of nonlinear control systems: unification and extension via pseudo-linear algebra. Kybernetika, 48(6), 1100 - 1113
2. Halás, Miroslav; Kotta, Ülle (2012). A transfer function approach to the realisation problem of nonlinear systems. International Journal of Control, 85(3), 320 - 331.
3. Kaldmäe, Arvo; Kotta, Ülle (2012). Disturbance decoupling of multi-input multi-output discrete-time nonlinear systems by static measurement feedback . Proceedings of the Estonian Academy of Sciences, 61(2), 77 - 88.
4. Kotta, Ülle; Tõnso, Maris (2012). Realization of discrete-time nonlinear input-output equations: polynomial approach. Automatica, 48(2), 255 - 262.
5. Mullari, T., Kotta, Ü., Bartosiewicz, Z., Pawluszewicz, E. The concepts of Lie derivative for discrete-time systems. - Proceedings of the Estonian Academy of Sciences, 61(4), 253 – 265

CONTACT: DSc Ülle Kotta, e-mail: kotta@ioc.ee

SOFTWARE SCIENCE

The software department conducts research into language and automata theory, programming languages and software engineering.

Main results in 2012:
Language and automata theory:

- The quotient complexity of atoms of regular languages was studied and the exact upper bounds were found for this complexity..
- Symmetric difference nondeterministic finite automata (SD-NFAs) were studied and the class of those SD-NFAs whose determinization yields the minimal deterministic automaton was characterized.
- Bartholdi's results stating that certain properties of cellular automata hold if and only if the group of space translations is amenable were extended; it was shown to which extent these properties fail in the non-amenable case.
- The theory about analogs to Noether's theorem for discrete dynamical systems was advanced by studying the question of what corresponds to the quantity of momentum in the discrete case.
- A certified generic translator of regular expressions into nondeterministic finite automata and a certified generic CYK parser of context-free grammars in Chomsky normal form were written.

Programming languages:

- Explicit constructions were provided for the cofree directed container, the product of two strict directed containers; the concepts of a distributive law between two directed containers and a compatible composition were developed; it was shown that distributive laws and compatible compositions are in a bijection.
- The different variations that the linear temporal logic operator "almost always" obtains in constructive logic were identified and their interrelationships determined.
- For the categorical semantics of functional reactive programming, structures and axioms were identified that model linearity of time and causality.
- A sequent calculus was developed for classical call-by-need lambda calculus.
- A big-step coinductive semantics for concurrency was developed that accounts also for diverging behaviors.
- A compilation scheme from concurrency to delimited continuations was proved correct and implemented.

Software engineering:

- A new method for composing e-government services was developed where the service model is a weighted directed graph automatically generated from SAWSDL descriptions, domain ontologies and QoS characteristics of services.
- The navigation behavior of the anonymous web user in the university information system was modelled.
- Multi-pole models were constructed for electro-hydraulic servo-systems and simulated.
- A new solution was developed for securing customers' email commmunications in e-commerce.
- A security analysis of the Node.js platform was performed.

SELECTED PUBLICATIONS

1. D. Ahman, J. Chapman, T. Uustalu (2012). When is a container a comonad? In: L. Birkedal, ed., Proc. of 15th Int. Conf. on Foundations of Software Science and Computation Structures, FoSSaCS 2012 (Tallinn, March 2012), v. 7213 of Lect. Notes in Comput. Sci., pp. 74-88. Springer.
2. M. Bezem, K. Nakata, T. Uustalu (2012). On streams that are finitely red. Log. Methods in Comput. Sci., v. 8, n. 4, article 4.
3. S. Capobianco, T. Toffoli (2012). Conserved quantities in discrete dynamics: what can be recovered from Noether's theorem, how, and why? Nat. Comput., v. 11, n. 4, pp. 565-577.
4. R. Maigre, P. Grigorenko, H.-M. Haav, A. Kalja (2012). A semantic method of automatic composition of e-government services. In: A. Caplinskas, G. Dzemyda, A. Lupeikiene, O. Vasilecas, eds., Databases and Information Systems VII, v. 249 Frontiers of Artificial Intelligence, pp. 204-217. IOS Press.
5. A. Ojamaa, K. Düüna (2012). Security assessment of Node.js platform. In V. Venkatakrishnan, D. Goswami, eds., Proc. of 8th Int. Conf. on Information Systems Security, ICISS 2012 (Guwahati, Dec. 2012), v. 7671 of Lect. Notes in Comput. Sci., pp. 35-43. Springer.

CONTACT: Dr. Tarmo Uustalu, tarmo@cs.ioc.ee

SPEECH TECHNOLOGY

Laboratory of Phonetics and Speech Technology is focused on experimental studies of Estonian phonetics and research and development of methods and prototypes for Estonian speech recognition.

Main results in 2012:

- Open and extendable speech recognition application architecture was implemented and used for building mobile applications with speech-based user interfaces; new methods for unsupervised vocabulary and speech style adaptation were proposed.
- The methods for jointly learning morphological segmentations and syntactic roles of words, and the dependencies between these two tasks were studied, the best-performing method was found through simulation experiments.
- Corpus-based study on prosodic characteristics of lexical boundaries in Estonian revealed that prosodic cues provide useful information for word boundary detection in continuous speech.
- New results on cross-language comparison of Estonian and Finnish plosives and on the perceptual role of microduration of vowels have been reported.

SELECTED PUBLICATIONS

1. Alumäe, Tanel; Kaljurand, Kaarel (2012). Maximum entropy language model adaption for mobile speech input. In: Interspeech 2012 : Spoken Language Processing and Biomedicine, 13th Annual Conference of the International Speech Communication Association, September 9-13, 2012, Portland, Oregon: Portland: International Speech Communication Association, 2012, [1 - 4].
2. Sirts, Kairit; Alumäe, Tanel (2012). A hierarchical Dirichlet process model for joint part-of-speech and morphology induction. In: NAACL HLT 2012 : The 2012 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies, Proceedings of the Conference, June 3-8, 2012, Montréal, Canada: June 4-6, Montreal, Canada. Stroudsburg, PA: Association for Computational Linguistics, 2012, 407 - 416.
3. Nemoto, Rena; Adda-Decker, Martine. Prosodic patterns of Estonian words: a corpus-based description using spontaneous speech. Human Language Technologies. The Baltic Perspective : Proceedings of the Fifth International Conference Baltic HLT 2012, Amsterdam: IOS Press. Frontiers in Artificial Intelligence and Applications 247, 286 - 239.
4. Suomi, Kari; Meister, Einar (2012). A preliminary comparison of Estonian and Finnish plosives. Linguistica Uralica, 48(3), 187 - 193.
5. Werner, Stefan; Meister, Einar (2012). Microduration in Finnish and Estonian vowels revisited: methodological musings. Linguistica Uralica, 48(3), 180 - 186.

CONTACT: Dr Einar Meister, e-mail: einar@ioc.ee

APPLIED MATHEMATICS

Applied mathematics group is focused on fast methods for solving integral equations, inverse problems to determine properities of complex materials and multi-objective and convex optimisation.

Main results in 2012:

- Convergence and superconvergence of collocation method for some classes of perturbations of standard weakly singular Volterra and Fredholm integral equations were proved.

- An evolution equation for the 2d motion of microstructure was deduced and the wave-propagation simulated. Uniqueness for an inverse problem for 1d model of microstructure with multiple scales using harmonic waves was proved.
- Based on the wave solution in exponentially graded materials an algorithm has been developed to determine material inhomogeneous properties.
- Using hiearchical approach multi-objective optimization problems problems are reduced to smaller and simpler subproblems which thereafter were solved as harmonized ones. For finding values of coordination parameters Gauss-Newton type methods were studied.

SELECTED PUBLICATIONS

1. Sertakov, Ivan; Janno, Jaan (2012). Periodic waves in microstructured solids and inverse problems . Mathematical Modelling and Analysis, 17(5), 599 - 617.
2. Leibak, Alar; Šeletski, Anna; Vaarmann, Otu (2012). On multi-level approach to the generation of Pareto points for complex systems. In:VI International Conference"Parallel Computing and Control Problems", October 24-26, Moscow, Russia, vol.2, pp.11-20
3. Riismaa, Tiit (2012). Description and optimization of the structure of horizontally homogeneous parallel and distributed processing systems. - In: The 11th International Conference on Modeling and Applied Simulation (MAS 2012): September 19-21 2012, Vienna, Austria / Eds. M. Affenzeller [et al.]. Genova : DIME University of Genoa, 2012, 224-228.

CONTACT: Prof Jaan Janno, e-mail: janno@ioc.ee

2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustustest.

2.4 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

Tanel Alumäe
International Speech Communication Association (ISCA) - liige

Jüri Engelbrecht
ICSU Peaassamblee liige
Euromech liige
ERAWATCH nõukoja liige
RP7 „Peoples Programme“ nõukoja liige
ERA-NET Complexity juhtkomitee liige
Academia Europea, liige
World Academy of Arts and Sciences liige
Bulgaaria Teaduste Akadeemia välisliige
Budapesti Tehnikaülikooli audoktor (Dr. h.c.)
Ungari Teaduste Akadeemia, auliige
Göteborgi Kuningliku Teadus- ja Kunstiühingu välisliige
Lissaboni Teaduste Akadeemia liige
Läti Teaduste Akadeemia, välisliige
Euroopa Teaduste ja Kunstide Akadeemia liige
Accademia Peloritana dei Pericolanti, välisliige

Hele-Mai Haav
Baltic Journal of Modern Computing- toimetuskollegiumi liige

Proceedings of Riga Technical University - toimetuskolleegiumi liige
European Coordinating Committee for Artificial Intelligence (ECCAI) liige ja Eesti koordinaator

Jaan Janno
Abstract and Applied Analysis - toimetuskolleegiumi liige
Mathematical Modelling and Analysis – toimetuskolleegiumi liige
The Open Acoustics Journal - toimetuskolleegiumi liige
Baltimaade ülikoolide konverentsivõrgustiku MMA liige

Jaan Kalda
Advisory Board of the International Physics Olympiads – liige
International Jury of the World Physics Olympiad – liige
European Academy of Sciences and Arts – liige

Ahto Kalja
Baltic Journal of Modern Computing- toimetuskollegiumi liige

Einar Meister
International Speech Communication Association (ISCA) - liige

Lya Meister
International Speech Communication Association (ISCA) - liige

Sven Nõmm
Rahvusvaheline Automaatjuhtimise Föderatsiooni (IFAC) Eesti rahvusliku komitee kontaktisik
IFAC Technical committee "Human - Machine Systems" - liige.

Jaan Penjam
EL 7. Raamkava IST programmi programmkomitee Eesti delegatsiooni ekspert
ACM – Association for Computing Machinery – liige

Ewald Quak
Journal of Mathematics in Industry, Springer, toimetuskolleegiumi liige
EL RP7 programmi „People“ Marie Curie Industry-Academia Partnerships and Pathways (IAPP) taotlusi hindava paneeli aseesimees

Arvi Ravasoo
Euroopa Mehaanikaühingu Euromech liige
Euroopa Eksperimentaalmehaanika Alalise Komitee liige

Andrus Salupere
IUTAM (International Union of Theoretical and Applied Mechanics) peaassamblee liige
Eesti Rahvusliku Mehaanika Komitee esimees
Euroopa Mehaanikaühingu Euromech liige

Tarmo Soomere
Euroopa Teadusfondi Merekomitee aseesimees
Journal of Marine Systems toimetuskolleegiumi liige
Boreal Environment Research toimetuskolleegiumi liige
Oceanologia toimetuskolleegiumi liige
Euroopa Geoteaduste Liidu liige
Euroopa Akadeemiate Nõuandva Kogu Keskkonnapaneeli liige

Enn Tõugu
IEEE liige
IEEE Computer Society, liige
Academia Europea, liige
Computing and Informatics /Slovac Acad Sci) toimetuskolleegiumi liige
Knowledge Based Systems (Elsevier) toimetuskolleegiumi liige

Tarmo Uustalu
International Federation for Information Processing (IFIP), WG 2.1 „Algorithmic Languages and Calculi“ liige
Journal of Universal Computer Science toimetuskolleegiumi liige
Association for Computing Machinery (ACM), liige
European Association for Programming Languages and Systems (EAPLS) liige
European Association for Logic, Language and Informationn (FoLLI) liige
European Association for Computer Science Logic (EACSL) liige
European Association for Theoretical Computer Science (EATCS) liige
Interest Group in Pure and Applied Logic (IGPL) liige
Formal Methods Europe (FME) liige

Otu Vaarmann
The European Working Group *Multiple Criteria Decision Aiding*, liige
The European Working Group *Financial modelling*, liige
Töörühma EUROPT – The Continuos Optimization (Associaton of European Operations Research Societies) liige

2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

Küberneetika Instituudi peamisteks finantseerimise allikateks 2012. aastal olid:

Riigieelarve	1 191 877 eurot
Teadusfond	135 790 eurot
Riigi finantseeritavad fondid ja sihtasutused	1 351 540 eurot
Välismaised finantseerimisallikad	276 477 eurot
Ettevõtted	27 003 eurot

2.6 Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

2.7 Instituudi teadus- ja arendustegevuse teemade ja projektide nimetused *(Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel)*

- Haridus- ja Teadusministeerium

– sihtfinantseeritavad teemad:
SF0140077s08, Mittelineaarne dünaamika ja komplekssüsteemid, Engelbrecht Jüri (2008 – 2013)

SF0140083s08, Mittelineaarsed, puuduliku informatsiooniga ja keeruka struktuuriga matemaatilised mudelid, Kangro Inga (2008 – 2013)

SF0140017s08, Keerukate mittelineaarsete juhtimissüsteemide süntees, Kotta Ülle (2008 – 2013)

SF0140007s11, Lainetuse dünaamika ja rannikutehnika, Soomere Tarmo (2011 – 2016)

SF0140007s12, Usaldusväärsed tarkvara- ja inimkeeletehnoloogiad, Uustalu Tarmo (2012 – 2014)

– baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):

– riiklikud programmid:
EKT17, Audiovisuaalse kõnesünteesi prototüüp, Meister Einar (2011-2014)

EKT3, Kõne- ja multimodaalsed korpused, Meister Einar (2011-2014)

EKT18, Kõnetuvastus, Alumäe Tanel (2011-2014)

- Teiste ministeeriumide poolt rahastatavad riiklikud programmid:

- SA Eesti Teadusfond/Eesti Teadusagentuur

– grandid:
ETF8787, Arvutialgebra meetodid juhtimissüsteemides, Tõnso Maris (2011 – 2014).

ETF8365, Inimliigutuste tuvastamine ja modelleerimene, Nõmm Sven (2010 – 2013).

ETF8870, Lained ohufaktorina Eesti rannavetes, Didenkulova Irina (2011 – 2014).

ETF9125, Läänemere idaranniku reaktsioon lainekliima muutustele, Soomere Tarmo (2012 – 2015).

ETF9475, Matemaatilised struktuurid programmeerimiskeeltes, Uustalu Tarmo (2012 – 2015).

ETF8702, Multimastaapne deformatsioonilainete analüüs mikrostruktuuriga materjalides, Berezovski Arkadi (2011 – 2014).

ETF8041, Na+ /Ca2+ -vahetaja roll vikerforelli kardiomüotsüütide elektromehaaniline sidestus ja energeetika, Birkedal Nielsen Rikke (2009 – 2012).

ETF9398, Paralleeltarkvara kontrollitavad garantiid, Nakata Keiko (2012 – 2015).

ETF7728, Pöördülesanded keerukate omadustega materjalide identifitseerimisel, Janno Jaan (2009 – 2012).

ETF8972, Reaktiivsete hapniku vormide ja kaltsiumisignaalide vastastikune sõltuvus südamepuudulikkuse algstaadiumis, Ramay Hena (2011 – 2014).

ETF9219, Sertifitseeritud tarkvara sertifitseeritud kontrollimine, Chapman James (2012 – 2015).

ETF8658, Solitonilised struktuurid mitteintegreeruvates süsteemides ja diskreetne spektraalanalüüs, Salupere Andrus (2011 – 2014).

ETF7909, Turbulentse segunemise roll komplekssüsteemides toimuvate protsesside dünaamikas, Kalda Jaan (2009 – 2012).

– ühisgrandid välisriigiga:

– järeldoktorite grandid (SA ETF ja Mobilitas):

MJD30, Ramay Hena, Systematic examination of arrhythmogenic calcium release in cardiac myocytes (24.08.2009 - 23.07.2013)

MJD80, Karo Jaanus, The theoretical study of mitochondrial energetic metabolism (1.09.2010 - 31.08.2013)

MJD270, Nikolkina Irina, Ekstreemsete lainetuse tingimuste ja sündmuste statistika Eesti rannavetes (1.02.2012 - 31.01.2014)

– tippteadlase grandid (Mobilitas):
MTT63,Torsvik Tomas, Numerical particle tracking modeling for inhomogeneous turbulent water basins (1.08.2011 - 31.07.2015)

- Ettevõtluse Arendamise SA

– eeluuringud:
– arendustoetused:

- SA Archimedesega sõlmitud lepingud

– infrastruktuur (nn „mini-infra“, „asutuse infra“):
AP007, Lainetuse dünaamika ja rannikutehnika, Soomere Tarmo (1.01.2011 - 31.12.2012)

Teekaardi objekt
EKRK, Eesti Keeleressursside keskus, Einar Meister (1.10.2011 - 31.12.2015)

– Eesti tippkeskused:
EXCS, Arvutiteaduse tippkeskus, Tarmo Uustalu (7.07.2008 - 31.08.2015)

TK124 ,Mittelineaarsete protsesside analüüsi keskus, Jüri Engelbrecht (1.01.2011 - 31.12.2015)

– riiklikud programmid:
KESTA, Teaduspõhiste prognooside väljatöötamine ja riskide kvantifitseerimine kiireks ja täpseks ohule reageerimiseks Eesti maismaa, veekogude, ranniku ja õhustiku kontekstis –TERIKVANT, Tarmo Soomere (1.01.2012 - 31.12.2014):

Osalemine projektis „NanoCom – Nanogeomeetria ja struktuurne põimumine kõrgete talitusomadustega keraamika-baasil nanokomposiitide disainimisel ja prototüüpimisel (NanoCom)“ (Arkadi Berezovski, Jaan Kalda).

Osalemine projektis „Smart Composites – Design and Manufacturing“ (Andrus Salupere, Jaan Janno, Ivan Sertakov).

– muud T&A lepingud:

- SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:

- Siseriiklikud lepingud:

LN09, Kõnetuvastuse uuring, Einar Meister

LN10, Tüvekontuuri servaga laudadest puitpõrandate optimeerimine, Jaan Penjam (15.03.2010 - 31.12.2012)

LO11, Tuulikuparkide mõju hindamine seireradaritele, Vahur Kotkas (2009-)

LO12, Kohtuekspertiis, Ahto Kalja

- EL Raamprogrammi projektid:

HATS, Highly Adaptive and Trustworthy Software Using Formal Models - HATS, Tarmo Uustalu (1.05.2010 - 28.02.2013)

- Välisriiklikud lepingud:

EN05, Südamelihase rakkude adeniinnukleotiidide kompartmentatsiooni struktuursete ja funktsionaalsete aspektide analüüs, Marko Vendelin (1.08.2007 - 31.07.2012)

ESTwave, Mesoskoopilise pideva keskkonna füüsika õpetuslikuid, teaduslikud ja tehnoloogilised aspektid lainete uurimisel keerukate omadustega materjalides, Heiko Herrmann (1.04.2009 - 31.03.2012)

2.8 Struktuuriüksuse töötajate poolt avaldatud eelretsenseeritavad teaduspublikatsioonid *(ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1).*

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2.9 Struktuuriüksuses kaitstud doktoriväitekirjade loetelu *(NB! struktuuriüksus lisab struktuuriüksuse töötaja juhendamisel mujal kaitstud doktoriväitekirjade loetelu)*

Ardo Illaste, TTÜ Küberneetika Instituut
Teema: *Analysis of Molecular Movements in Cardiac Myocytes* (Molekulaarsete liikumiste analüüs südamelihasrakkudes)
Juhendaja: vanemteadur Marko Vendelin
Kaitses: 23.02.2012
Omistatud kraad: filosoofiadoktor (rakendusmehaanika)

David Schryer, TTÜ Küberneetika Instituut
Teema: *Metabolic Flux Analysis of Compartmentalized Systems Using Dynamic Isotopologue Modeling* (Isotopoloogilise modelleerimise rakendamine heterogeensete bioloogiliste süsteemide ainevahetusvoo analüüsis)
Juhendajad: vanemteadur Marko Vendelin, vanemteadur Pearu Peterson ja prof Toomas Paalme
Kaitses: 12.04.2012
Omistatud kraad: filosoofiadoktor (rakendusmehaanika)

Andrei Errapart, TTÜ Küberneetika Instituut
Teema: *Photoelastic Tomography in Linear and Non-Linear Approximation*
(Fotoelastsustomograafia lineaarses ja mittelineaarses lähenduses)
Juhendaja: juhtivteadur Hillar Aben
Kaitses: 25.05.2012
Omistatud kraad: filosoofiadoktor (rakendusmehaanika)

Oxana Kurkina, TTÜ Küberneetika Instituut
Teema: *Nonlinear Dynamics of Internal Gravity Waves in Shallow Seas* (Siselainete mittelineaarne dünaamika madala vee lähenduses)
Juhendajad: prof Tarmo Soomere ja prof Efim Pelinovsky
Kaitses: 24.09.2012
Omistatud kraad: filosoofiadoktor (ehitus ja keskkonnatehnika)

2.10 Struktuuriüksuses järeldoktorina T&A-s osalenud isikute loetelu *(ETIS-e kaudu esitatud taotluste alusel)*

Ramay Hena, Systematic examination of arrhythmogenic calcium release in cardiac myocytes (24.08.2009 - 23.07.2013)

Karo Jaanus, The theoretical study of mitochondrial energetic metabolism (1.09.2010 - 31.08.2013)

Nikolkina Irina, Ekstreemsete lainetuse tingimuste ja sündmuste statistika Eesti rannavetes (1.02.2012 - 31.01.2014)

2.11 Struktuuriüksuses loodud tööstusomandi loetelu

3. Struktuuriüksuse infrastruktuuri uuendamise loetelu

Arvutid ja IT vahendid	
Arvuti Fujitsu Celsius,	2190
Serverikomplekt HP ProLiant DL	21690
Server-mälupank HP proLIANT dl180G6 CTO	4900
Graafikaarvuti Tigma	5717
Arvutid ja IT vahendid kokku	*37197*
Seadmed	
Valgusmikroskoop Primo Star HAL B-117	2370
Autonoomne hoovusemõõtja (2 tk)	34632
Lainete uhtekõrguse mõõtur	4407
Magnetiline 6DOF jälgija	3470
Seadmed kokku	*45059*
Infrastruktuuri uuendamine kokku	82736