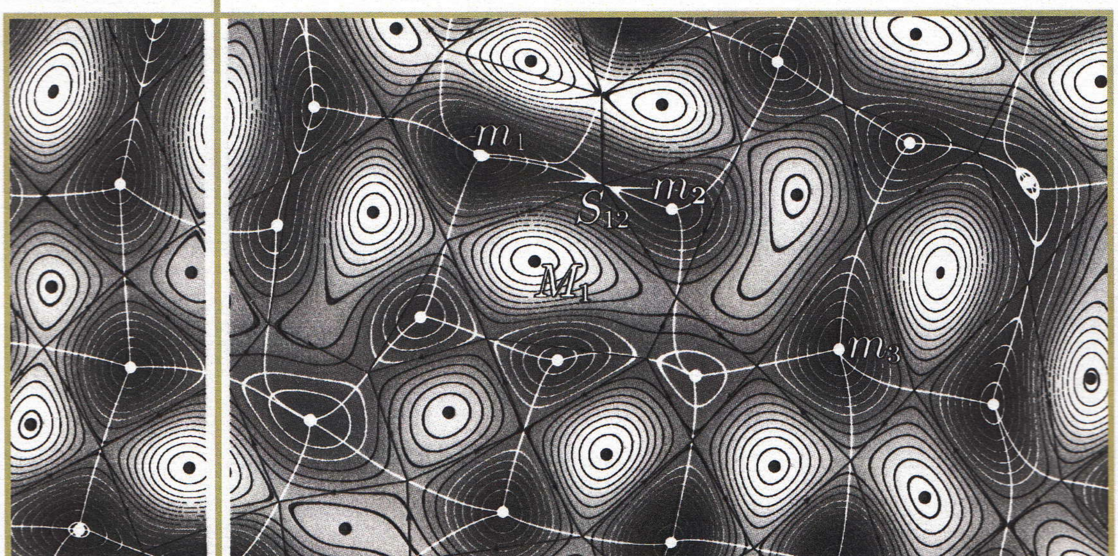
CENS

CENTRE FOR NONLINEAR STUDIES



2014 ANNUAL REPORT

Tallinn

Institute of Cybernetics at Tallinn University of Technology
Institute of Physics, University of Tartu

Eesti tuleviku heaks

Euroopa Liit
Euroopa
Regionaalarengu Fond

CENS

Centre for Nonlinear Studies

Estonian Centre of Excellence in Research

Annual Report

2014 Tallinn

Contents

Abstract

This Report gives a brief overview on activities of CENS in 2014. From August 2011, CENS is an Estonian Centre of Excellence in Research, supported by the European Regional Fund. Described are research highlights of 2014 and more detailed results summarised by research groups: (i) nonlinear dynamics: waves in solids, inverse problems, photoelasticity, fractality and econophysics; (ii) wave engineering: waves on sea and coastal engineering; (iii) systems biology: cell energetics; (iv) optics: light pulses; (v) nonlinear control theory: algorithms and software.

The full records of published papers, reports, conference talks, teaching activities, promotions, etc are included together with list of science-popular articles and public talks. The Annex includes some additional information on activities of CENS.

Keywords: nonlinear dynamics, soft matter physics, microstructured solids, solitons, acoustodiagnostics, photoelasticity, cell energetics, water waves, extreme waves, coastal engineering, differential equations, control theory, wave optics and localised waves.

Sisukord

Lühikokkuvõte

Aruanne sisaldab ülevaadet CENSi (Mittelineaarsete Protsesside Analüüsi Keskuse) tegevusest 2014.a. Alates augustist 2011, on CENS Eesti teaduse tippkeskus, millega kaasneb toetus Euroopa Regionaalarengu Fondilt. Esitatud on ülevaade parimatest tulemustest 2014 a ja põhitulemused uurimisgruppide kaupa: (i) mittelineaarne dünaamika: lained tahkistes, pöördülesanded, fotoelastsus, fraktaalsus ja ökonofüüsika; (ii) lainetuse dünaamika: lained veepinnal ja rannikutehnika; (iii) süsteemibioloogia: rakuenergeetika; (iv) optika: lokaliseeritud valguslained; (v) juhtimissüsteemid: teooria, algoritmid ja tarkvara.

On esitatud publikatsioonide, konverentsiettekannete, seminaride ja õppekursuste jm. nimekirjad, samuti populaarteaduslike artiklite ja esinemiste nimekirjad. Lisas on täiendav informatsioon.

Võtmesõnad:
mittelineaarne dünaamika, pehmisefüüsika, mikrostruktuuriga materjalid, solitonid, akustodiagnostika, fotoelastsus, rakuenergeetika, pinnalained, hiidlained, rannikutehnika, diferentsiaalvõrrandid, juhtimisteooria, laineoptika, lokaliseeritud lained.

1. Introduction

The underlying idea for founding Centre for Nonlinear Studies (CENS) in 1999 was to bring together the scientific potential of Estonia engaged in interdisciplinary studies of complex nonlinear processes. The essential milestones of CENS are the following. In 2002–2007, CENS was included into the first Estonian National Programme for Centres of Excellence in Research. The results from this period are described in "CENS Highlights 2003–2007". In 2009, CENS was awarded with the title "Centre of Excellence in Research of Tallinn University of Technology for years 2009–2011. In 2011, CENS was included into the second Estonian National Programme for Centres of Excellence in Research (2011–2015). The Annual Reports (http://cens.ioc.ee) describe the results and activities of CENS in detail.

This Report covers, like the previous ones, all the results and activities of CENS in 2014. Section 2 is a short summary on the structure of CENS and on highlights in 2014. In Section 3, current research results in 2014 are described in more detail. Next sections describe funding (Section 4), publications, conferences, etc (Section 5) and other additional activities of CENS (Section 6). Finally, in Section 7, conclusions and perspectives are presented. The Annex includes some additional materials.

2. Overview on CENS and highlights in 2014

CENS is the Estonian hub of competence, research and training into nonlinear phenomena – the intrinsic component of real world that brings in universal phenomena (solitons, coherence, chaos, hierarchies, self-emergence, etc) which need specific tools for their analysis and control. As before, CENS includes four research groups from the Institute of Cybernetics (IoC) at Tallinn University of Technology (TUT) and one group from the University of Tartu (UT). In 2014, the structure of the IoC was simplified and instead of the two-level system of Departments and Laboratories the one-level system of only Laboratories was introduced. In this structure, new Heads (PI's) of two laboratories were elected by the Council of the IoC. The structure of CENS remains the same with some changes of PI's:

Nonlinear Dynamics (IoC at TUT) — Prof J.Kalda;
together with the *Laboratory of Photoelasticity* — Dr J. Anton;

Wave Engineering (IoC at TUT) — Prof T.Soomere;

Systems Biology (IoC at TUT) — Dr M.Vendelin;

Optics (UT) — Prof P.Saari;

Nonlinear Control Theory (IoC at TUT) — Dr Ü.Kotta.

The Head of CENS is Prof J.Engelbrecht.

The competences of research groups are described in previous reports and not repeated here. Synergy and added value is created by the analysis of universal nonlinear phenomena: mathematical models and methods of analysis; interaction of waves and fields in a wide range of scales, solitons, solitary waves and localized waves: emerging features; nonlinear feedback, irreversibility; control over physical phenomena, etc. Such studies are in the forefront of science, more specifically, in studies of complex systems. CENS has personnel of 64, of whom 22 are PhD Students (see Annex 1).

Highlights of research in 2014

Nonlinear Dynamics

- A novel mathematical model for waves in thermoelastic microstructured materials is derived which describes simultaneously the effects of microdeformation and microtemperature.
- A twodimensional evolution equation is constructed for describing ultrasound in microstructured materials.
- A profound mismatch between experimental results regarding the behaviour of tracers in real (time-correlated) flows, and the existing theoretical results for tracers in ideal Kraichnan flows (delta-correlated in time) has been explained theoretically.
- A scaling law has been derived for the yield of binary reactions in turbulent flows when reagents are injected from point sources.
- The exact analytical description compared with the numerics of the nonlinear interaction of counter-propagating waves near specimen boundaries due to reflection.
- For the first time the stresses in a prince Rupert drop (PRD) have been experimentally determined with integrated photoelasticity. These results explain the strange behaviour of PRD's.

Wave Engineering

- The Carrier–Greenspan transform for wave run-up on a plane beach is generalised for inclined channels of arbitrary cross-section.
- Nonlinear effects are most strongly pronounced for the run-up of a solitary wave of depression.
- A measure of finite-time compressibility of flow fields is developed that accounts for time correlations of realistic flows and is capable to quantify the ability of clustering of passive tracers on the sea surface.
- The locations for spontaneous formation of surface patches are established for the Gulf of Finland through the analysis of time correlations of the convergence field and the Lagrangian transport.
- The wave energy resource theoretically and practically available in a semi-sheltered shelf sea of moderate depth and with highly intermittent wave climate has been quantified on the example of the Baltic Sea.
- The options for using an ensemble of projections to evaluate return periods of extreme water levels are established for selected locations of the Estonian coast.

Systems Biology

- We have demonstrated that in oxidative muscle, such as a heart, some ATPases are tightly coupled to glycolysis and do not use ATP provided by mitochondria.
- On the basis of our data, we suggest that at least part of the diffusion restriction at the mitochondrial outer membrane level is not by the membrane itself, but due to the close physical association between the sarcoplasmic reticulum and mitochondria.

Optics

- The optics group as the whole Institute of Physics of the University of Tartu moved into the new building. The conditions to carry out experimental research in the fields of physical, non-linear and ultrafast optics became much better from now on (see the panoramic picture).

Nonlinear Control Theory

- Using the nonlinear realization theory, necessary and sufficient conditions were provided for linear parameter-varying input-output equations to be transformable into a state-space form with static dependence on the so-called scheduling parameter.
- The observable space of the nonlinear system was studied using the time scale formalism. This allows to formulate the conjecture about the possible non-integrability of the observable space in the discrete-time case.

Applications

- Glass quality control equipment supplied to glass industry.
- Software A.C.T.I.V.E. for the visualization environments.

3. Current results 2014

3.1 Laboratory of Nonlinear Dynamics (IoC)

3.1.1 Dynamics of materials

Waves in microstructured solids, general theory.
Prediction of the thermoelastic behaviour of microstructured thermoelastic materials suggests a more general description of thermal processes in addition to the generalized continuum description extending the conventional continuum mechanics for incorporating intrinsic microstructural effects. Double dual internal variables are introduced in order to couple inertial microstructural effects like microdeformation and diffusive microstructural effects like microtemperature (temperature fluctuation due to microstructure). The full coupled system of governing equations provides a complete extension of the classical thermoelasticity theory onto the case of microstructured solids. Elaborated for the 1D case, this system includes the balance of momentum, the balance of energy (a parabolic equation in terms of temperature), and two hyperbolic evolution equations – one for the microdeformation and one for the microtemperature. These evolution equations are not coupled directly but both of them are coupled with the balance of momentum. The balance of energy (the heat conduction equation) is affected only by the microstructure field because of the nondissipative microdeformation. To the best of knowledge of the authors, this is the first attempt to describe the effects of microdeformation and microtemperature simultaneously within one mathematical model (A.Berezovski, J.Engelbrecht, P.Ván).

For the same problem, a detailed analysis was carried for linking the results to other models. The entropy production was calculated, and thermodynamic forces and fluxes were identified. A quadratic free energy and linear conductivity relations closed the system of equations. The final evolution equations in a nondissipative case are equivalent of those for micromorphic continua; therefore, the thermodynamic method gave a dissipative extension of the original Mindlin theory (P.Ván, A.Berezovski, C.Papenfuss).

The concept of wave hierarchies in the Whitham's sense is generalized to hierarchies of second order wave operators. Based on Mindlin's model of microstructured solids, the scaling procedure is described and the corresponding hierarchical equation derived which includes two wave operators. It is shown that waves in the Cosserat' medium are described by a similar hierarchical equation. These results are generalized to a multiscale case (a scale within a scale) and to nonlinear media. It is shown also how to construct hierarchies for waves in elastic ferroelectrics. The results obtained by Scott for hierarchies in termoelasticity are presented in the similar framework. To complete the analysis of hierarchies, the cases with first order wave operators are also briefly described (J.Engelbrecht, A.Salupere).

Waves in microstructured solids, numerics.
A comparison of Finite Element Method, Isogeometric Analysis, and Finite Volume Method in numerical simulation of one-dimensional elastic wave propagation problems with stress discontinuities is performed. The special attention is paid to accuracy of tested numerical methods and the appearance of spurious oscillations and dissipation effects occurring close to theoretical sharp wavefronts. Finite Element Method and Finite Volume Method are widely accepted as numerical methods used for numerical solution of hyperbolic (wave-like) problems. Isogeomet-

ric Analysis, the spline variant of Finite Element Method, is a modern strategy for numerical solution of partial differential equations. This method is based on splines as shape functions in Finite Element Method content. In Isogeometric Analysis and Finite Element Method, the Newmark method, the central difference method, the generalized-α method and the Park method are employed as time integrators. All the tested numerical strategies are applied for elastic wave propagation in a bar. At the end, main advantages and disadvantages of the numerical methods in wave propagation are summed up (A.Berezovski, R.Kolman, J.Blažek, J.Kopačka, D.Gabriel, J.Plešek).

Numerical simulation of elastic wave diffraction at embedded gratings.
The invention of metamaterials with exotic properties that are unavailable in nature and the state-of-the-art fabrication tools demands a more accurate prediction of wave propagation in structured solids. Any substructure suggests a discontinuity in properties of the structured material. Diffraction of elastic waves at discontinuities results in the dynamic stress concentration. Compared to acoustic and electromagnetic scattering, the elasticity problem is more complicated because of the coexistence of compressional and shear waves that propagate at different speeds.

Numerical simulation of elastic wave propagation is based on the solution of equations of linear elasticity. Specifically, we consider the propagation of an initially harmonic plane elastic wave in a 2-D medium with a rigid grating. The sketch of the problem is shown in (Fig. 1) left. Due to the schematization, no scale is shown at axes. The grating is colored by the red color. The size of rigid inclusions and the distance between them are the same. The plane wave is excited at the boundary as it is indicated by arrow.

The numerical simulation of elastic wave propagation through a grating in a homogeneous medium shows the characteristic Talbot self-imaging effect (Fig. 1) right.

The size of the imaging and patterns can be controlled by changing the periodicity of grating and wavelength, respectively. It provides a novel route to modulate elastic wave distributions in solids with inclusions. Time dependent simulation suggests a long-distance elastic-wave-based interconnection in solids. Computations performed show the applicability of the proposed algorithm to simulate the complicated Talbot diffraction of wave propagation in two dimensions with high accuracy. This method not only demonstrate the capacity for understanding of the elastic wave Talbot effect with temporal resolution, but also opens a new way to understand dynamic effects, which are vital for tailoring artificial mechanical properties of materials to meet future needs (A.Berezovski, J.Engelbrecht, M.Berezovski, W.-X.Tang, W.Wan).

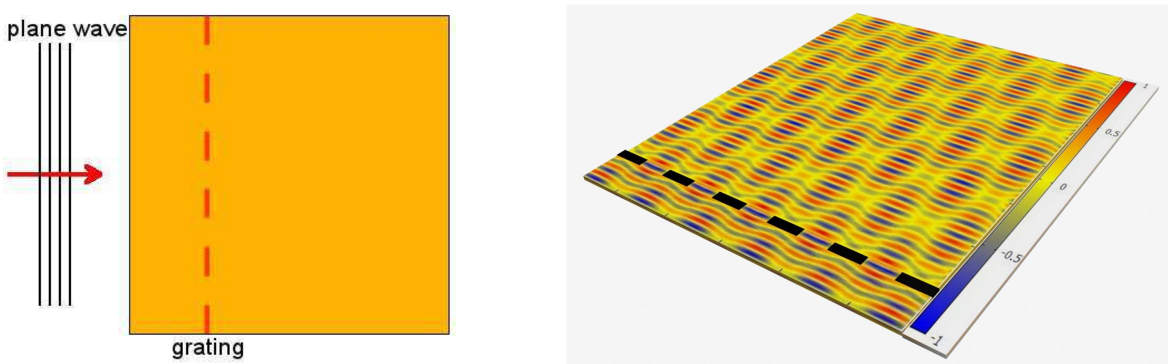


Figure 1: Geometry of the problem (left). Stress field pattern at 1040 time steps for the grating placed between 70 and 80 space steps (right).

Crack propagation.
Numerical simulation of crack propagation under conditions of 3-point bending test is performed in order to estimate the bridging effect of the reinforcement of Al_2O_3 by fibers covered by graphene layer. The time-dependent explicit finite-volume scheme was applied for computations

of the crack growth. The J-integral criterion for crack growth was used and the velocity of the crack was calculated by using the dependence on the driving force at the crack tip. It is demonstrated that crack grows discretely due to relaxation of the driving force at the crack tip after each growing step. The bridging effect is estimated by the comparison of time histories of J-integral values computed for both cases with and without fiber reinforcement. It is shown that the reinforcement leads to the increase in the toughness, which indicates the bridging effect. J-integral values were calibrated using experimental data of the fracture toughness for Al_2O_3 matrix reinforced by Al_2O_3 fibers covered by graphene layer obtained by indentation measurement in the framework of this project. It appears that the toughness of the fiber-reinforced ceramics depends on the strength of the interface between matrix and fibers in a nonlinear manner (A.Berezovski).
Remark: This result is obtained within the Estonian Programme 3.2.1101.12-0010 "NanoCom – Nano-geometry and entanglement for design and prototyping of ceramic-based high-performance nanocomposites".

Solitons and solitary waves.
The formation of solitons in a microstructured continuum, modelled by a hierarchical Korteweg-de Vries equation, is studied. The model equation is integrated numerically making use of the discrete Fourier-based pseudospectral method under different initial conditions. While the earlier results described the emergence of solitary waves from localized initial conditions then in this study the attention is on cnoidal initial conditions and the emergence of possible hidden solitons. It is shown that the number of hidden solitons depends on the energy of an initial condition and the total number of emerging solitons (A.Salupere, M.Lints, J.Engelbrecht).

The two-dimensional evolution equation is derived for the description of waves in microstructured solids using the Mindlin-type model. The result is the Zabolotskaya-Khokhlov-type 2D evolution equation which takes into account nonlinearity of macro- and microstructure, dispersion caused by the existence of the microstructure and diffractional expansion. The 2D equation is integrated numerically under localized (solitary wave type) initial conditions by the FFT-based pseudospectral method. Analysis of results demonstrates that such an asymptotic equation is able to grasp all essential effects including asymmetry of a pulse caused by the nonlinearity at the microscale. The results can be used in the NDT of microstructured materials in order to model wave beams generated by ultrasonic transducers (I.Sertakov, J.Engelbrecht, J.Janno).

Inverse problems.
The nonlinear interaction of tone bursts in functionally graded materials with strongly variable properties is studied. The mathematical model is derived on the basis of the five constant nonlinear theory of elasticity in the 1D setting and the problem is solved numerically for an exponentially graded material. The influence of the material properties variation on the evolution of bursts profiles is traced on the boundaries of samples. A special case of the bursts interaction by which oscillations evoked by the counter-propagating bursts disappear in the homogeneous material is proposed as a reference case for the nondestructive material characterization. The deviation from this special case caused by inhomogeneity in material properties is analyzed by parametric plots. Obtained results may be used by qualitative non-destructive determination of the inhomogeneity in material properties (A.Ravasoo).

Acoustodiagnostics of inhomogeneous solids.
A comparative study of ultrasonic nonlinear wave propagation with free-boundary reflections was carried out. In this study numerical solution for the longitudinal wave process in homogeneous nonlinear elastic material was compared with the analytical solution gained by the perturbation method. The reason of comparing numerical solutions with analytical ones is to clarify how well the perturbation method quantitatively coincides with the numerical solution (A.Braunbrück).

Nonlinear phenomena of the sound generation in piano.
The main goal is the experimental measurement of the piano string motion by application of the high-speed line scan camera, and investigation of nonlinear wave propagation in microstructured wool felt. A novel high accuracy experimental equipment for acoustical measurements of vibrating objects has been designed and built. This set-up consists of a high frame rate line scan camera and a custom-built optical lens system. The optical tube is designed to capture maximum amount of light, as well as to provide sufficient magnification. The experimental set-up gives possibility to perform accurate non-invasive measurements of vibration of various parts of musical instruments, such as the strings, bridges, necks, etc. The set-up has been calibrated and successfully used to capture the piano and bass guitar string motion. A robust method of the vibration data extraction from the recorded video file is developed.

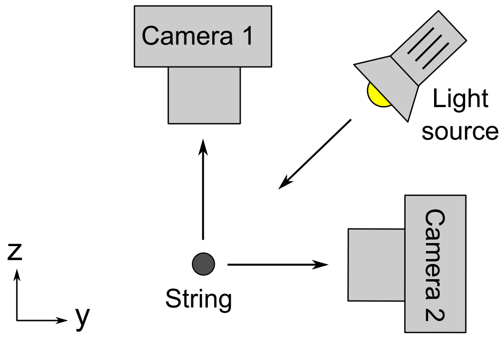


Figure 2: Two camera measurement set-up. Arrows indicate the direction of light propagation.

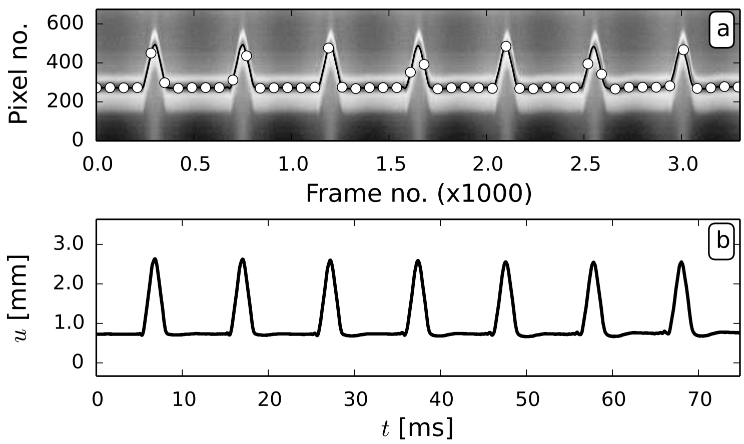


Figure 3: Vibration of a bass guitar G string, with a triangular initial condition. a) The recorded image; b) The corresponding extracted and calibrated string displacement.

On the basis of the experimental data of the behaviour of piano hammers study the one-dimensional constitutive equation of the wool felt material is proposed. This equation enables deriving a nonlinear partial differential equation of motion with third order terms, which takes into account the elastic and hereditary properties of a microstructured felt. This equation of motion is used to study pulse evolution and propagation in the one-dimensional case. The thorough analysis both of the linear and nonlinear problems is presented. The physical dimensionless parameters are established and their importance in describing the dispersion effects is discussed. It is shown that both normal and anomalous dispersion types can exist in the wool felt material. The dispersion analysis shows also that for the certain ranges of physical parameters negative group velocity appears. The initial value problem is considered and the analysis of the numerical solution describing the nonlinear strain wave evolution is provided.

It is shown that a smooth pulse and without discontinuity on its front propagates with the constant speed up to the moment when the accumulation of nonlinear effects results in the eventual wave breaking. After that moment, a shock wave will be formed, and the velocity of the shock wave starts to depend on the value of the amplitude of the jump discontinuity across the wave front. It is verified that the velocity of the shock wave is greater than the velocity of sound in a linear medium (A.Stulov, D.Kartofelev, M.Mustonen).

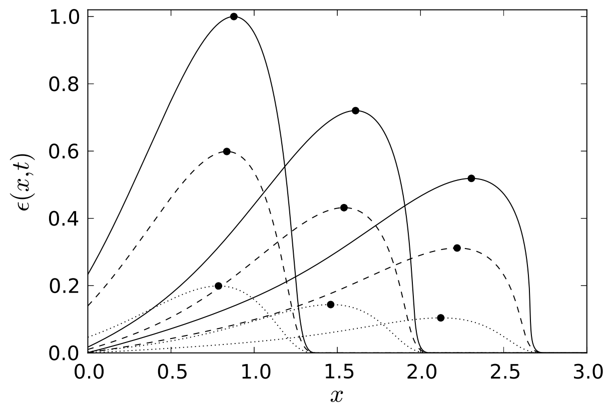


Figure 4: Nonlinear evolution of a pulse for three sequential time moments, and different initial amplitudes. Bullets show the position of a pulse maximum.

Phenomenological and numerical modelling of short fibre reinforced cementitious composites.

A constitutive model for short fibre reinforced cementitious composites was presented. This model is based on the St. Venant-Kirchhoff model, which is a special case of a hyperelastic material. This model is refined to include the fibre orientation distribution. Numerical FEM simulations with the developed constitutive model and fracture simulations using the discrete element method are presented. The outcomes of these numerical methods demonstrate how important it is to monitor and further to control the fibre orientation distribution during the manufacturing process. As the manufacturing process might involve casting, as, e.g., in the case of steel fibre reinforced concrete, an outlook on simulations of the manufacturing process in order to predict and to control the fibre orientation distribution is given (H.Herrmann, M.Eik, J.Puttonen (Aalto), V.Berg (Kassel)).

An orthotropic material model for steel fibre reinforced concrete based on the orientation distribution of fibres.

The anisotropic properties of SFRC are caused by the orientation distribution of fibres. The constitutive relation is developed for one meso-volume element of SFRC as a combination of isotropic and orthotropic St. Venant-Kirchhoff material models, which are applied to concrete matrix and to steel fibres, respectively. The alignment tensors and orientation distribution function adopted from the mesoscopic continuum theory are utilised to identify the material meso-symmetry axes and to asses the contribution of fibres in the symmetry axes. While assessing the orthotropic meso-elasticity for fibres, the elasticity of an individual fibre in its local coordinates is transformed into the material meso-symmetry axes and weighted with the orientation distribution function of fibres. The advantage of the material model developed for SFRC is that it uses complete orientation information of fibres (two angles in spherical coordinates) and utilises tensor quantities complying with material objectivity (H.Herrmann, E.Eik, J.Puttonen (Aalto)).

A.C.T.I.V.E.: A Scalable Superellipsoid-based CFD Visualization for Virtual and Desktop Environments.
A flexible software (A.C.T.I.V.E.) able to visualize the superellipsoidal glyphs describing the orientation of short fibres during the dynamic process of casting a short fibre reinforced composite in a container has been developed, see Fig. 5. The software is designed to run on the VRUI framework and it features an optional face-tracking to grant a more natural interaction also on standard non-3D displays. Due to its flexibility it can be used on a wide range of environments, from desktop computer to multi-screen CAVE-like systems (H.Herrmann, E.Pastorelli, M.Padilla (TU Berlin)).

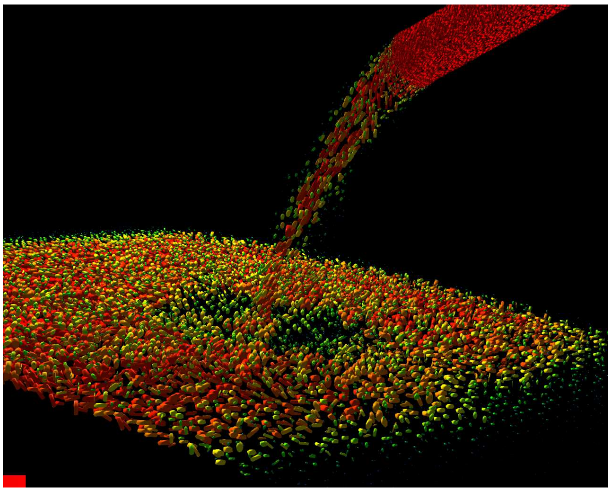


Figure 5: Casting of SFRC simulated with OpenFOAM and visualized using A.C.T.I.V.E.

Virtual reality visualization for photogrammetric 3d reconstructions of cultural heritage.
The design of a self-build general-purpose Virtual Reality environment is reviewed, which presents all relevant features of a full-size CAVE-like system, yet at a fraction of the financial and space requirements. Further, the application of this system to the development of a virtual museum is presented. The objects in the museum are models, reconstructed via photogrammetry from a set of pictures. For this process cost-free software is used. The presentation of the 3D models in the Virtual Environment is done using BlenderCAVE, a multi-screen extension of the Blender game engine. The main contributions of are the discussion of the design choices for a small and low-budget but feature-rich virtual reality environment and the application of the system for cultural heritage. In this area tools for creation of 3D models and their presentation in a VR environment are presented (H.Herrmann, E.Pastorelli).

Virtual Reality Visualization for Short Fibre Orientation Analysis.
The beneficial contribution of visual feedback in the development of an algorithm for the automatized analysis of fibre orientations in short fibre reinforced composites was investigated. Of special interest was steel fibre reinforced concrete (SFRC), a multi-disciplinary research area involving material sciences, physics and civil engineering. More in detail, it is explained how scientific visualization techniques, employed on a Virtual Reality environment, contribute to the understanding of the SFRC properties, both for research and educational aims. Furthermore, the analysis algorithm to obtain fibre orientation distributions from noisy tomography scans is developed and presented, Fig. 6 (H.Herrmann, E.Pastorelli).

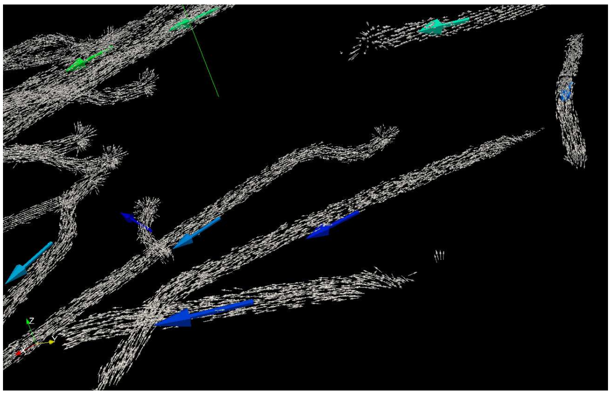


Figure 6: Fibre orientation analysis with self-developed software

Software Development:
A.C.T.I.V.E.: – A scalable tool for Virtual Reality visualization of superellipsoid-based glyphs depicting the orientation equation of SFRC fibres during a CFD casting simulation. The software uses VRUI as framework and is therefore equally suitable for desktop or VR systems. This software would have not been possible without the gratefully acknowledged contribution of M.Padilla and M.Krause.

FibreCT: – A cross platform tool for the automated filtering and analysis of fibre orientations in SFRC x-ray tomographies (H.Herrmann, M.Eik, J.Puttonen (Aalto University)).

3.1.2 Fractality and econophysics.

General aspects of fractality.
Our scaling laws for the intersections of moving fractal sets have been generalized to the case when the fractal sets evolve in time. The evolution of the fractal sets is described by a dispersion law: the frequency is assumed to be a power law of the wavelength. The fluctuations of the intersection size are described by the Hurst exponent H. We derived expression relating the exponent H to the fractal dimensions of the fractal sets, and the exponent of the dispersion law. Analytical results are in a good agreement with numerical simulations, and are applicable to the reflection of electromagnetic waves from turbulent sea surfaces (J.Kalda, I.Mandre).

Turbulent mixing
Finite-time Lyapunov exponents (FTLE), together with their variance have been expressed for isotropic homogeneous chaotic two-dimensional compressible and incompressible flows with finite correlation time in terms of the velocity gradient tensor statistics. In particular, it has been shown that these exponents depend not only on the dimensionality and compressibility of the flow, but also on the velocity gradient tensor determinant statistics. In Fig. 7, the Lyapunov dimension of the tracer field is plotted against the compressibility of the flow; blue dots are calculated according to our theory for different determinant values; black solid curve corresponds to the ideal flows (delta-correlated in time), blue thin line — to our theoretical results, averaged over an ensemble of flows; red dots — to the experimental study of Boffetta et al 2014 (PRL 96, 134501). This result represents a breakthrough in the understanding of the role of time correlations for turbulent mixing.

Chemical reaction rate of binary reactions have been studied when the reagents are injected into a turbulent fluid from point sources. It has been shown analytically that the reaction yield is a power law of the distance between the injection points, and the scaling law exponent is expressed in terms of the dimensionality of the flow, and the Kubo number (the correlation time of the flow). This theoretical finding has been subject to experimental and numerical verification.

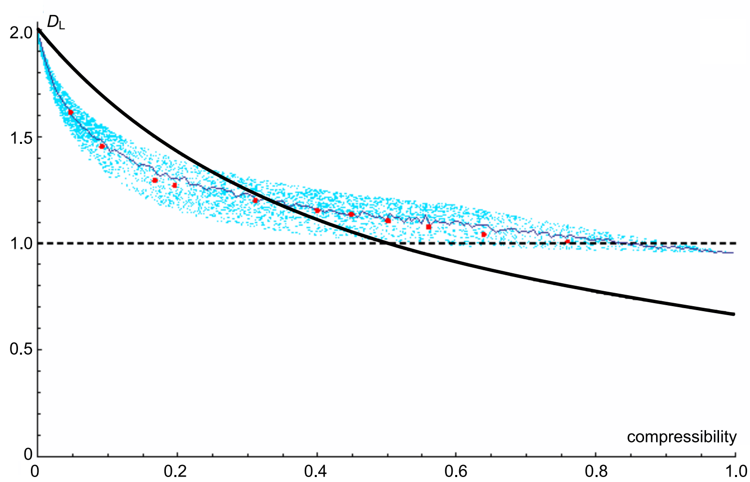


Figure 7:

Experimental verification is based on the studies by M.Kree at the IRPHE laboratory, University of Marseille. To this end, correlation coefficient of two different tracer concentrations has been calculated for the experimental data, for the simulation data based on sine flows, see Fig. 8, and compared with the theoretical results. In (Fig. 8), two different dye stripes have been evolved in a sine flow for seven flow periods; panels (a) and (b) correspond to different Peclet' numbers. These results have a series of direct applications in chemical industry (J.Kalda, M.Kree et al.).

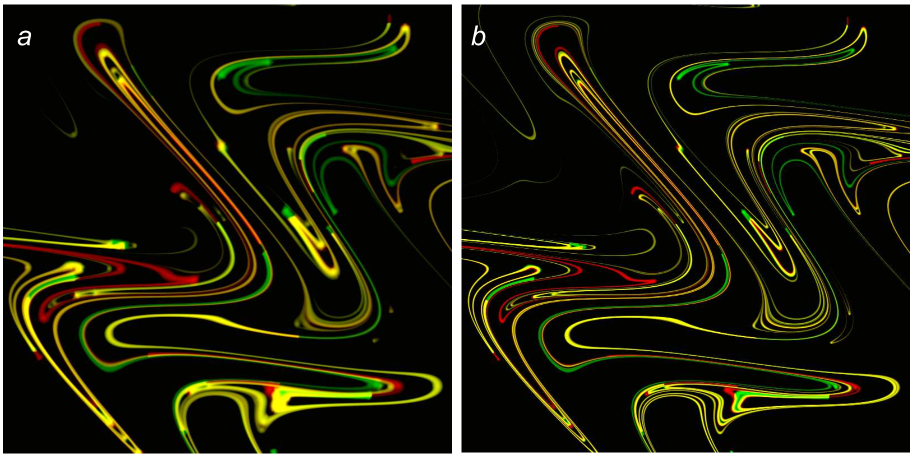


Figure 8: .

Based on ray tracing approach, light propagation in inhomogeneous media with fluctuating coefficient of refraction has been interpreted as a chaotic mixing of the wavefront in the 6-dimensional phase space where the spatial coordinates are complemented by the respective wave vector components. According to ray tracing, the evolution of wave vectors follows Hamiltonian dynamics and hence, according to the Liouville's theorem, the mixing of wave front takes place in an incompressible flow field. This approach has been used to show that the brightest light speckles in inhomogeneous media follow a power law intensity distribution, and to derive the relevant scaling exponents. These results are important for understanding the wave propagation in inhomogeneous media, and for optical imaging in strongly turbulent atmosphere (J.Kalda et al.).

Random walks of oriented particles on fractals.

Random walks of point particles on fractals exhibit subdiffusive behavior, where the anomalous diffusion exponent is smaller than one, and the corresponding random walk dimension is larger than two. This is due to the limited space available in fractal structures. Here, we endow the particles with an orientation and analyze their dynamics on fractal structures. In particular, we focus on the dynamical consequences of the interactions between the local surrounding fractal structure and the particle orientation, which are modeled using an appropriate move class. These interactions can lead to particles becoming temporarily or permanently stuck in parts of the structure. A surprising finding is that the random walk dimension is not affected by the orientation while the diffusion constant shows a variety of interesting and surprising features. (H.Herrmann, R.Haber, J.Prehl, K.H.Hoffmann (TU Chemnitz)).

Economic decision making.
The complex systems are discussed in the context of economic and business policy and decisions making. The motivation for such studies is that social systems are typically chaotic, nonlinear and/or non-equilibrium. In addition, it is assumed that the rapid change in global consumer behaviour is underway that further increases the complexity in business and management. For policy making under complexity, following principles are offered: openness and international competition, tolerance and variety of ideas, self-reliability and low dependence on external help. Several applications are elaborated in more detail. The first application demonstrates that small economies have good prospects to gain from the global processes underway, if they can demonstrate production flexibility, reliable business ethics and good risk management. The second application elaborates on and discusses the opportunities and challenges in decision making under complexity from macro and micro economic perspective. Here the balance between short term noise and long term chaos whose attractor included customers, shareholders and employees must be found. Two applications are related to debt and risk management (R.Kitt).

3.1.3 Laboratory of Photoelasticity

Stress measurement in prince Rupert drops (PRD).
Strange behavior of PRD's has been considered as the biggest mystery of the 17th century science. PRD's are made by letting a small piece of molten glass to drop into cold water. As a result, a half-spherical piece of glass is formed, supplied with a long thin tail. The solid spherical part of the PRD is highly strong and bears blows of a hammer without cracking. At the same time, cutting the thin tail of the PRD leads to explosive demolishing of the PRD. Although the process of fracture of a PRD has been filmed at the Purdue University, no information about the residual stresses in a PRD has been available until today.

In cooperation with the Purdue University and the Cambridge University, the Laboratory of Photoelasticity started the project of measuring stresses in the PRD.

The PRD was made at the Cambridge University. Fig. 9 shows fringe pattern of the PRD in the circular polariscope. The diameter of the PRD in its most thick part was 7 mm. Dark spot in the centre of Fig. 9 shows a void, which is formed by high tensile stresses in the central part of the drop during the cooling.

Stresses in the PRD were measured using integrated photoelasticity. The polariscope AP-07 (GlasStress Ltd) with the software Glasstress 9.0 was used. Fig. 10 shows stress plots in the tail and in the middle section of the drop. Fig. 10 shows that near the external surface of the drop there is a layer of about 0.7 mm thickness with very high compressive stresses. That explains the resistance of the drop to the blows of a hammer.

In the middle part of the tail very high tensile stresses are present. Cutting the tail, as soon as the cut reaches the middle part, the tensile stresses initiate an explosive cracking of the middle part of the PRD and that leads to explosive cracking of all the PRD.

Thus the residual stresses explain the strange behaviour of PRD's.

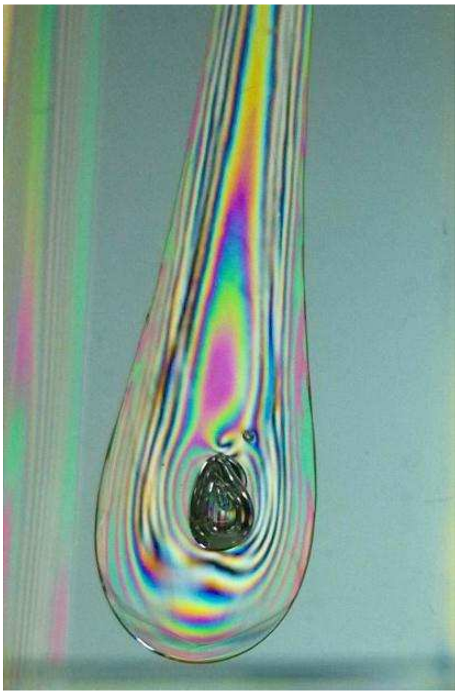


Figure 9: Fringe pattern of the PRD in a circular polariscope.

Comparison of the surface stress and edge stress in chemically tempered glass plates. It has been established both by mathematical modelling and experimentally (H.Aben, D.Lochegnies, Y.Chen, J.Anton, M.Paemurru, M.Õis) that in thermally tempered glass panels the surface stress and the edge stress are practically equal to each other. It is of interest to investigate whether similar phenomenon exists in chemically tempered glass plates. This problem was investigated together with the Institute of Physics of the University of Tartu (Prof. J.Kikas, S.Hödeman).

At the Institute of Physics, 7 glass plates of the size 20x40x3 mm of Lithium Alumino Silicate glass were chemically tempered for a time from 1 to 24 hours. After chemical tempering the edge stress in the plates was measured with the polariscope AP-07 and the surface stress with the scattered light polariscope SCALP-05 at the Laboratory of Photoelasticity of the Institute of Cybernetics.

Preliminary conclusion on the basis of these measurement is that there is a correlation between the surface stress and edge stress. As a rule, the edge stress is somewhat (about 10%) bigger than the surface stress. Additional experiments are needed to establish a reliable relationship between the surface stress and edge stress in the case of chemical tempering.

Light bending in high resistance glasses

In order to increase the resistance of glass products, thermal or chemical tempering is used with the aim to create highly compressive stresses on surfaces to inhibit crack development and growth. As the glass technology develops, the stresses are getting higher, reaching over 1000 MPa compression in case of chemical tempering of display glasses. Such high stresses itself and the chemical process to create that high stresses, alter the refraction index distribution in glass enough to considerably bend the light rays going through the glass. Currently, the polariscopes for stress measurement assume straight light path, which in some cases yields to unusable measurement results. A project is started with the Institute of Physics of the University of Tartu and GlasStress Ltd to find a solution to use actual light path in calculations, enabling

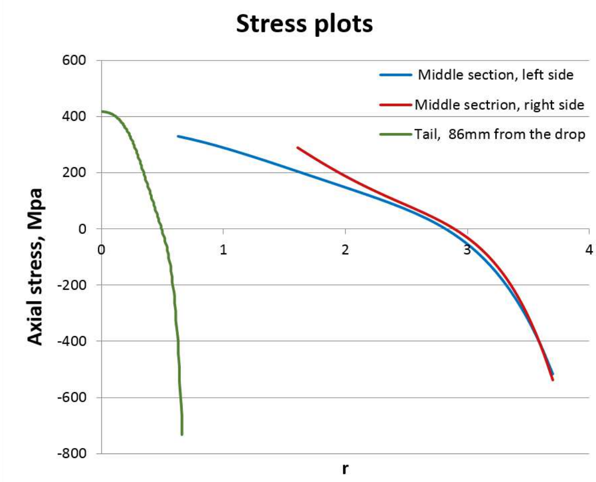


Figure 10: Stress plots in various parts of the PRD.

to measure very highly stressed glasses.

GlasStress Ltd
GlasStress Ltd supplies glass quality control equipment to glass companies in automotive (VW, Peugeot), container (ARC International, Bormioli-Rocco, Coca-Cola, Emhart), display glass (Samsung, Apple, Corning), lighting (Philips, Osram) etc. industries. 41 polariscopes were delivered in 2014, close to 200 polariscopes have been delivered in total (H.Aben, at al.).

3.2 Laboratory of Wave Engineering (IoC)

General theory.
An exact analytical solution of the nonlinear shallow water theory for wave run-up in inclined channels is presented. This solution, found using a hodograph-type transform, generalizes the well-known Carrier–Greenspan transform for wave run-up on a plane beach to channels of arbitrary cross-section. The nonlinear shallow water equations are reduced to a single 1D linear wave equation and all physical variables can be expressed via purely algebraic formulas (I.Didenkulova in cooperation with A.Rybkin, University of Alaska Fairbanks, and E.Pelinovsky, Institute of Applied Physics RAS, Nizhny Novgorod).

Nonlinear deformation of long solitary waves of elevation over a composite bottom topography (a plane sloping beach transforms into a region of constant depth) results in an increase in the wave steepness and leads to a significant increase in the run-up height. However, nonlinear effects are most strongly pronounced for the run-up of a wave of depression. The run-up height of waves of depression increases with their steepness and can exceed the amplitude of the incident wave (I.Didenkulova, E.Pelinovsky, O.Didenkulov, Nizhny Novgorod State Technical University).

It is demonstrated that certain combinations of linear edge wave components may lead to durable changes in the thickness of the surfactant film, equivalently, in the concentration of various substances (debris, litter) floating on the water surface. Such changes are caused by high-amplitude transient elevations that resemble rogue waves and occur during dispersive focusing of wave fields with a continuous spectrum. This process can be treated as an intrinsic mechanism of production of patches in the surface layer by linear edge waves (E.Averbukh, O.Kurkina, T.Soomere, A.Kurkin, Nizhny Novgorod State Technical University).

Decadal scale pycnocline variations in the Baltic Sea are shown to affect background conditions for internal waves (O.Kurkina, T.Soomere in cooperation with A.Kurkin, A.Rybin and

D.Tyugin, Nizhny Novgorod State Technical University). Properties of run-up of large storm waves on Estonian coasts are specified based on field measurements (A.Rodin, I.Didenkulova, I.Nikolkina) and run-up characteristics of solitary waves are parameterized in the bay of parabolic cross-section (I.Didenkulova, in cooperation with O.Didenkulov and E.Pelinovsky, Nizhny Novgorod State Technical University). The dependence of run-up height on the roughness elements of the sloping bottom is quantified (A.Rodin, I.Didenkulova in cooperation with P.Denissenko and J.Pearson). Possibilities for the generation of a tsunami in a large scale wave flume and long wave propagation, shoaling and run-up in nearshore areas are analysed (I.Didenkulova in cooperation with S.Schimmels, V.Sriram, H.Fernandez, A.Sergeeva, N.Goseberg). Dynamics of long waves in the marine coastal zone involving effects of wave breaking is studied in the framework of Riemann (simple) waves (A.Rodin in cooperation with E.Pelinovsky, Institute of Applied Physics RAS, Nizhny Novgorod).

Lagrangian transport.
To quantify the effects of flow compressibility of a 2D velocity field on the transport of substances floating on the sea surface overlying 3D circulation, a modified measure of finite-time compressibility is developed that accounts for time correlations of realistic flows and is directly related to the ability of clustering of passive tracers on the sea surface. This measure is evaluated based on precomputed 3D velocity fields and various methods for the tracking of Lagrangian trajectories. It characterizes the possibilities for spontaneous formation of surface patches with high concentrations of contaminants through time correlations of the convergence field and the Lagrangian transport. Spatial distributions of this measure reveal extensive seasonal variations, with the most persistent areas of high finite-time compressibility in the windy season. The spatial distribution of the areas in which the values of finite-time flow compressibility of surface velocity fields exceed the threshold for clustering of floats (equivalently, spontaneous patch formation) is established for the Gulf of Finland, the Baltic Sea. These areas are located predominantly in the southern and eastern nearshore of the gulf in regions of frequent downwelling but also in certain offshore areas (A.Giudici, T.Soomere, J.Kalda).

A method for preventive reduction of environmental risks that are transported by surface currents and wind impact to the coasts is generalised to the entire Baltic Sea. This method is based on characterizing systematically the damaging potential of the offshore areas in terms of potential transport to vulnerable regions of an oil spill or other pollution that has occurred in a particular area. The resulting maps of probabilities of pollution to be transported to the nearshore and the time it takes for the pollution to reach the nearshore are used to design environmentally optimized fairways for the Gulf of Finland, Baltic Proper, and south-western Baltic Sea (T.Soomere in cooperation with the BalticWay consortium).

The spatial pattern of hits to the nearshore by tracers originating in a major fairway in the Gulf of Finland and transported by surface currents is established based on Lagrangian trajectories of water parcels reconstructed using the TRACMASS model from 3D velocity fields for 1987–1996. The probabilities for a hit to different parts of the nearshore and the ability of different sections of the fairway to serve as starting points of tracers have extensive seasonal variability. The potential of the fairway to impact the nearshore is roughly inversely proportional to its distance from the nearest coast. The most probable starting points of tracers and the most frequently hit nearshore areas are established (B.Viikmäe, T.Soomere). Statistical properties of surface currents and current-driven transport are established for the Gulf of Finland using data from surface drifters (T.Torsvik, J.Kalda).

Wave and wind climatology.
The analysis of decadal changes to the average and extreme wave properties in the Baltic Sea is performed based on the wave hindcast for the entire Baltic Sea 1970–2007 using the wave model WAM and adjusted geostrophic winds under the assumption of no ice cover. The overall average wave activity in the entire basin has limited variations. The local wave properties reveal strong decadal-scale signal in many parts of this water body. The typical time interval between episodes of high or low annual average significant wave height is 10–12 years. The analogous interval between episodes of high and low 99%-iles of wave heights is about 5 years. Changes to the wave properties in different sea areas may be completely different in different decades (T.Soomere, A.Räämet).

Abrupt changes in large-scale wind patterns over the Gulf of Finland are highlighted using properties of air flow derived from classical measurements of surface-level winds during 1981–2010. The direction of the average air flow does not always coincide with the direction of the most frequent winds. A significant increase in the air flow speed occurred in January 1988 and a comparable decrease in January 1994–1996. The identified shifts may be associated with a major change in the geostrophic air flow over the southern Baltic Sea in 1988. These events do not become evident in the average wind speed (T.Soomere in cooperation with S.Keevallik, Marine Systems Institute).

A clear signal of wave climate change is extracted from the analysis of temporal changes in the wave set-up height in the vicinity of Tallinn Bay and Muuga Bay (K.Pindsoo, T.Soomere). The basic properties of the wave climate in the Gulf of Riga have been established based on visual wave observations at Ruhnu and Sõrve (M.Org, M.Eelsalu, T.Soomere). First results of a multidecadal ensemble hindcast of wave fields in the Baltic Sea show that the reliability of wind fields from different simulations substantially varies in different regions of the Baltic Sea (I.Nikolkina, T.Soomere, A.Räämet).

Coastal processes and other applications.
Alongshore variations in sediment transport along the eastern Baltic Sea coast are established using long-term (1970–2007) simulations of the nearshore wave climate and the Coastal Engineering Research Centre (CERC) wave energy flux model. The transport rates are the largest along the Sambian Peninsula and in the north-western part of the Latvian coast. The mostly counter-clockwise net transport contains several divergence and convergence points and associated local reversals. A divergence point at the Akmenrags Cape divides the sedimentary system in question into two almost completely separated compartments. Cyclic relocation of a highly persistent convergence point over the entire Curonian Spit suggests that this landform is in almost perfect dynamical equilibrium in the contemporary wave climate. The qualitative pattern of wave-driven alongshore sediment transport is almost invariant with respect to model setup and sediment properties (T.Soomere, M.Viška).

Based on high-accuracy tracking of single painted sediment clasts with a diameter of 1–10 cm it was established that sediments accumulated on the shoreline of the Baltic Sea moved up to 3 m/hour along the shore and approximately 350 m during three months. Calm periods can be more influential in places where regular vessel-generated waves wash the shores. As vessel-generated waves often approach from a different angle than natural waves, they can cause notable erosion during the periods when natural waves are weak or absent (M.Eelsalu, K.Pindsoo, with many co-authors). Vessel-generated waves may dominate sediment transport on the south-western coast of the Island of Aegna during the entire relatively calm season (April–October) (K.Pindsoo, M.Eelsalu, T.Soomere, in cooperation with H.Tõnisson). It is demonstrated that combined airborne and terrestrial laser scanning is a proper method to monitor coastal processes (M.Eelsalu, T.Soomere in cooperation with K.Julge, E.Grünthal, S.Märdla (Talvik), A.Ellmann from Dept. of Road Engineering TUT and H.Tõnisson, Institute of Ecology, Tallinn University).

The wave energy resource theoretically and practically available in a semi-sheltered shelf sea of moderate depth and with relatively severe but highly intermittent wave climate has been quantified on the example of the Baltic Sea. The wave properties are reconstructed numerically and the wave energy resources evaluated for 1970–2007 using finite-depth dispersion relation in the nearshore. The average wave energy flux is about 1.5 kW/m (at selected locations up to 2.55 kW/m) in the eastern Baltic Proper but much smaller, about 0.7 kW/m, in the interior of the Gulf of Finland and the Gulf of Riga. The total theoretical wave energy resource is about 1.5 GW but the existing and proposed marine protected areas limit it down to 840 MW. The production of grid energy is complicated because of extremely high intermittency and strong seasonal variation of the wave properties (T.Soomere, M.Eelsalu).

The options for using an ensemble of projections to evaluate return periods of extreme water levels are analysed for selected locations of the Estonian coast. The ensembles are constructed by means of fitting block maxima extracted from numerical simulations and observed time series with three statistical distributions of extreme values. For coastal segments where the observations represent the offshore water level well, the errors of single projections are randomly distributed and the median of the ensemble provides a sensible projection. For locations where the observed water level involves local effects (e.g. wave set-up) the block maxima are split into clearly separated populations. The resulting ensemble consists of two distinct clusters, the difference between which can be interpreted as a measure of the impact of local features on the water level observations (M.Eelsalu, T.Soomere, K.Pindsoo in cooperation with P.Lagemaa, Marine Systems Institute). The possibilities for polynomial approximation of the isotherms (the dependence of the pressure, exerted by the film, on the concentration of the substance per unit area) of films of surface active substances in marine environment are explored based on samples from the nearshore of the Black Sea and the coasts of the USA. The constant term and the coefficients of this polynomial have a reasonable scatter but the standard deviations of the coefficients at the quadratic and the cubic term exceed the relevant average values by two orders of magnitude. It is thus not possible to approximate the isotherms of surface active films using one universal polynomial function. Cumulative distributions of the coefficients of the cubic approximation are provided for the use in probabilistic express models of properties of surface films in the marine environment (E.Averbukh, T.Soomere in cooperation with T.G.Talipova and A.A.Kurkin, Nizhny Novgorod State Technical University).

3.3 Laboratory of Systems Biology (IoC)

Coupling of ATPases to glycolysis.

The heart relies on accurate regulation of mitochondrial energy supply to match energy demand. The main regulators are Ca(2+) and feedback of ADP and Pi. Regulation via feedback has intrigued for decades. First, the heart exhibits a remarkable metabolic stability. Second, diffusion of ADP and other molecules is restricted specifically in heart and red muscle, where a fast feedback is needed the most. To explain the regulation by feedback, compartmentalization must be taken into account. Experiments and theoretical approaches suggest that cardiomyocyte energetic compartmentalization is elaborate with barriers obstructing diffusion in the cytosol and at the level of the mitochondrial outer membrane (MOM). A recent study suggests the barriers are organized in a lattice with dimensions in agreement with those of intracellular structures. Here, we discuss the possible location of these barriers. The more plausible scenario includes a barrier at the level of MOM. Much research has focused on how the permeability of MOM itself is regulated, and the importance of the creatine kinase system to facilitate energetic communication. We hypothesize that at least part of the diffusion restriction at the MOM level is not by MOM itself, but due to the close physical association between the sarcoplasmic reticulum (SR) and mitochondria. This will explain why animals with a disabled creatine kinase system exhibit rather mild phenotype modifications. Mitochondria are hubs of energetics, but also ROS production and signaling. The close association between SR and mitochondria may form a diffusion barrier to ADP added outside a permeabilized cardiomyocyte (Fig. 11). But in vivo, it is the structural basis for the mitochondrial-SR coupling that is crucial for the regulation of mitochondrial Ca(2+)–transients to regulate energetics, and for avoiding Ca(2+)-overload and irreversible opening of the mitochondrial permeability transition pore (R.Birkedal, M.Laasmaa, M.Vendelin).

The effective integrated organization of processes in cardiac cells is achieved, in part, by the functional compartmentation of energy transfer processes. Earlier, using permeabilized cardiomyocytes, we demonstrated the existence of tight coupling between some of cardiomyocyte ATPases and glycolysis in rat. In this work, we studied contribution of two membrane ATPases and whether they are coupled to glycolysis–sarcoplasmic reticulum Ca(2+) ATPase (SERCA) and plasmalemma Na+/K+-ATPase (NKA). While SERCA activity was minor in this preparation in the absence of calcium, major role of NKA was revealed accounting to 30% of the total ATPase activity which demonstrates that permeabilized cell preparation can be used to study this pump. To elucidate the contribution of NKA in the pool of ATPases, a series of kinetic measurements was performed in cells where NKA had been inhibited by 2 mM ouabain. In these cells, we recorded: ADP- and ATP-kinetics of respiration, competition for ADP between mitochondria and pyruvate kinase (PK), ADP-kinetics of endogenous PK, and ATP-kinetics of total ATPases. The experimental data was analyzed using a series of mathematical models with varying compartmentation levels. The results show that NKA is tightly coupled to glycolysis with undetectable flux of ATP between mitochondria and NKA. Such tight coupling of NKA to PK is in line with its increased importance in the pathological states of the heart when the substrate preference shifts to glucose (M.Sepp, N.Sokolova, S.Jugai, M.Mandel, P.Peterson, M.Vendelin).

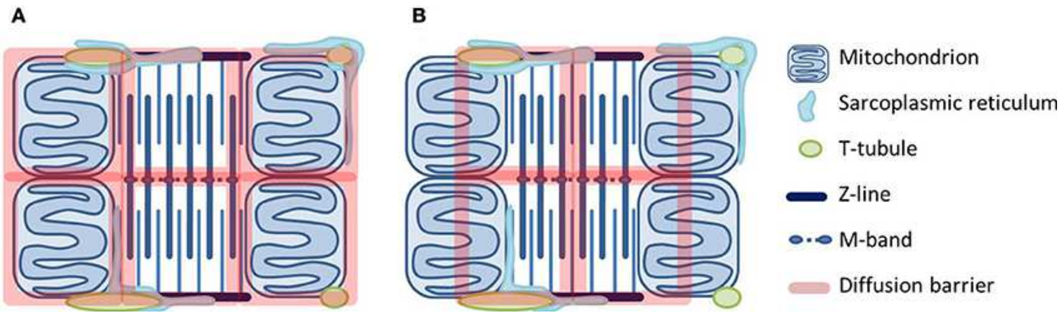


Figure 11: Two scenarios for how diffusional barriers may be organized in cardiomyocytes. The schematic drawings are scaled according to Birkedal et al. (2006), Hayashi et al. (2009) and show mitochondria, t-tubules and sarcoplasmic reticulum (SR) around a sarcomere. The diffusional barriers are drawn to scale according to Illaste et al. (2012) and superimposed. In (A) the barriers are in agreement with the cell structures, but seem to separate mitochondria and myosin ATPases. In (B) mitochondria are grouped together with ATPases, but this scenario is difficult to explain in structural terms (M.Vendelin, et al.).

3.4 Optics group (UT)

Particle accelerators are used in a variety of applications from fundamental physics to cancer treatment to medical imaging and material analysis. Today the technology mainly uses radio frequency radiation for acceleration and thus the accelerators are relatively big and expensive. With the advent of chirped pulse amplification, sufficient energy for particle acceleration is available at the optical spectral range, which has wavelengths of about 6 orders of magnitude smaller. Localized pulses, which have been actively studied for the last 3 decades, provide a natural candidate for a method of optical particle acceleration since their group velocity can be tuned to the electron velocity. We undertook a study of the feasibility of accelerating particles with nondiffracting optical pulses. The following tasks were fulfilled: (i) a program for simulating the one-dimensional movement of relativistic particles in an external field was written; (ii) the behaviour and acceleration mechanisms of an electron in an subluminal localized wave mode and self-imaging pulse were analyzed; (iii) it was verified that energy radiated by the particle is negligible; (iv) was shown that it is possible to achieve acceleration of a few percent of the initial momentum.

It was suggested that the acceleration is due to a ponderomotive effect as the accelerated electron bounces elastically from the field. The acceleration is most efficient with paraxial fields and wide spectra. There was no difference in acceleration between a single wave mode and the self-imaging field if the other parameters were kept constant (A.Remm, H.Valtna-Lukner).

3.5 Laboratory of Nonlinear Control Theory (IoC)

Comparison of linear parameter-varying and nonlinear system theory: A realization problem.
The nonlinear realization theory was utilized to address the problem of transforming linear parameter-varying input-output (LPV-IO) equations into a state-space form with static dependence on the so-called scheduling parameter. Necessary and sufficient solvability conditions were given, and three additional subclasses of LPV-IO equations were suggested that are guaranteed to have a realization of the considered type (J.Belikov, Ü.Kotta, M.Tõnso).

Disturbance decoupling by measurement feedback.
The problem of disturbance decoupling was addressed for multi-input multi-output discrete-time nonlinear systems. A sufficient conditions were derived to solve the problem by dynamic measurement feedback, i.e. the feedback that depends on measurable outputs only. The proposed solution to the disturbance decoupling problem is based on the input-output linearization, which is used to linearize certain functions (A.Kaldmäe, Ü.Kotta).

Observable space of the nonlinear control system.
The observability property of the nonlinear system, defined on a homogeneous time scale, was studied. The observability condition was provided through the notion of the observable space. Moreover, the observability filtration and observability indices were defined and the decomposition of the system into observable/unobservable subsystems was considered. Moreover, studying the integrability of the observable space, it was conjectured that the observable space is, in general, integrable, except for a few possible values graininess function where these values correspond to the sampling frequencies at which the state transition map of the sampled system is not reversible (V.Kaparin, Ü.Kotta).

Note that, in general, the observable space related to the concept of single-experiment observability of discrete-time nonlinear systems cannot always be locally spanned by exact one-forms whose integrals would define the observable state coordinates. It has been proved that for the special sub class of reversible polynomial systems, the observable space is integrable like in the continuous-time case (Ü.Kotta).

Algebraic approach for analysis and control of a water tank system.
The modern nonlinear control theory provides various powerful frameworks. Unfortunately, the majority of them are still either out of sight of the industry or too complex to be implemented. The possibilities of the algebraic framework of differential forms was explored to be used in real applications on the basis of a water tank system (see Figure 12). The tutorial paper was written to present and explain the key points of an algebraic framework of differential forms. Together with *Mathematica* based software package NLControl it forms a powerful basis toward the employment in control of various complex processes. The application was illustrated on the basis of the simple laboratory model of three serially connected water tanks. Analysis of different configurations was provided, accompanied by experimental results from the real plant (J.Belikov, Ü.Kotta).

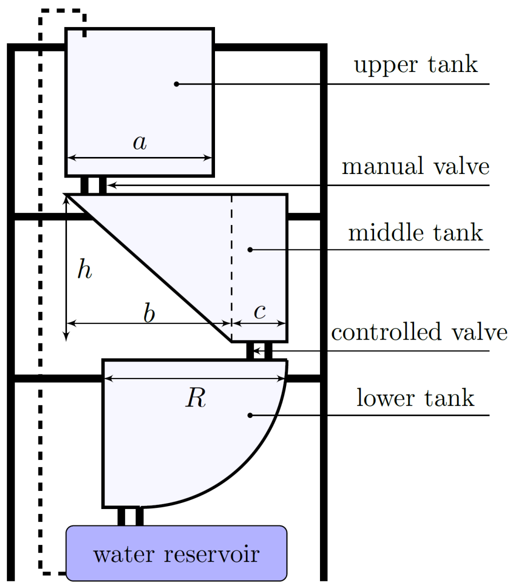


Figure 12: Model of the multi-tank sytem.

Linearization by input-output injections on homogeneous time scales.
The problem of linearization by input-output (i/o) injections was addressed for nonlinear single-input single-output systems, defined on a homogeneous time scale. The conditions were derived for the existence of a state transformation, bringing state equations into the observer form, which is linear up to some nonlinear input- and output-dependent functions, called i/o injections. These conditions are based on differential one-forms, associated with the i/o equation of the system (V.Kaparin, Ü.Kotta).

Transformation of nonlinear state equations into the observer form: necessary and sufficient conditions in terms of one-forms.
Necessary and sufficient conditions were given for the existence of state and output transformations, that bring single-input single-output nonlinear state equations into the observer form. The conditions were formulated in terms of an unknown single-variable output dependent function and differential one-forms, directly computable from an input-output equation, corresponding to the state equations. An algorithm for transformation of the state equations into the observer form was developed. Moreover, considering the special case of third-order systems, it was shown how the main result can be employed to obtain simpler conditions, independent from the unknown function (V.Kaparin, Ü.Kotta).

Combined steering feedback control of sampled data control system.
The steering feedback control was studied for sampled data control system. The starting point was a nonlinear system described by a system of explicit ordinary differential equations. With the help of the implicit Euler method, the continuous-time system was converted to a time discretized one. Because the starting point for trajectory planning and its stabilization was the Brunovsky normal form, the linearization of the discretized system was necessary and in this purpose a new method in terms of vector fields was developed to check the linearizability and to compute the corresponding coordinate transformation. The design of the steering and feedback control lov linear system was performed analogously to the continuous-time case. The developed theory was also applied to some physical systems like a hydraulic press, whereby the efficiency of the developed method was shown by numerous numerical simulations (T.Mullari).

Robust Hurwitz stability of polynomials via reduced Routh parameters.
A problem of inner convex approximation of a stability domain was studied for continuous-time linear control systems. First, the reduced Routh parameters of polynomials were defined and the necessary and sufficient Hurwitz stability conditions were obtained. Second, a one-to-one mapping between reduced Routh parameters and polynomial coefficients was derived. Third, constructive procedures for generating stable cones and polytopes of polynomials in polynomial coefficient space were developed. The main idea is based on a construction of so-called Routh rays (stable half-lines) starting from a given stable point (see Figure 13). These lines serve as edges for the corresponding Routh subcones that form a polyhedral Routh cone inside the stability domain (Ü.Nurges, J.Belikov).

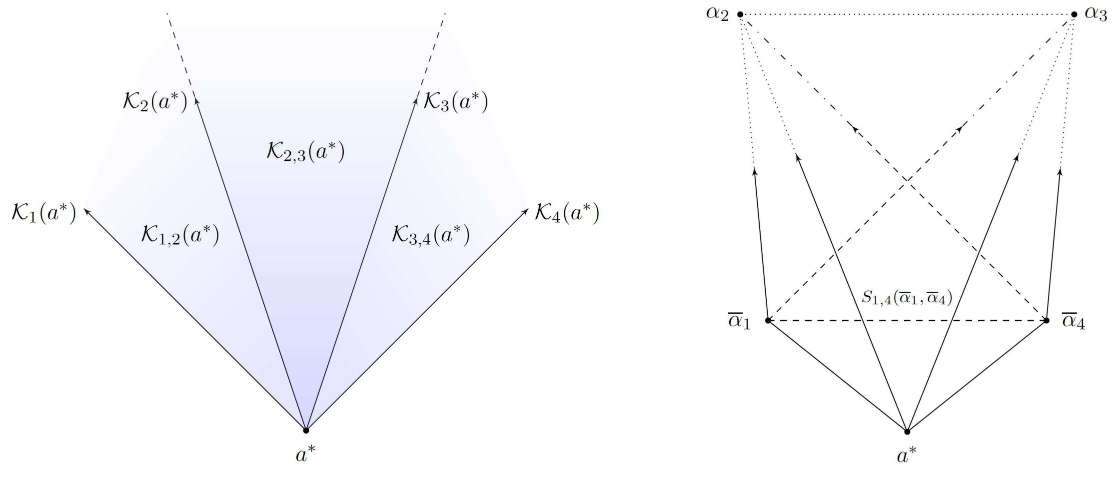


Figure 13: Left: Routh cones and frontal Routh subcones. Right: Inner approximation of a stability domain by the truncated polyhedral Routh cone $\overline{K}^4_{1,4}(a^*)$.

Networked automation systems.
Networked automation systems (NAS) are prototypical examples of complex real-time systems in industries. Response time of NAS is in the order of milliseconds and needs to be verified during the design phase for building dependable NAS. This investigation proposes a workflow and methodology for verifying the response time of NAS using timed model-checking. In order to verify the timing performance, first the timing requirements and properties needs to be known for different components in NAS. The timing requirements are known from applications and time-sheet, whereas timing properties need to be estimated. Timing properties of NAS components are affected by the network architecture and the inter-connection among the components. The timing properties in NAS components are modeled as jitter. To estimate the timing imperfections in NAS, the jitter has been classified based on the source of jitter as hardware, software and

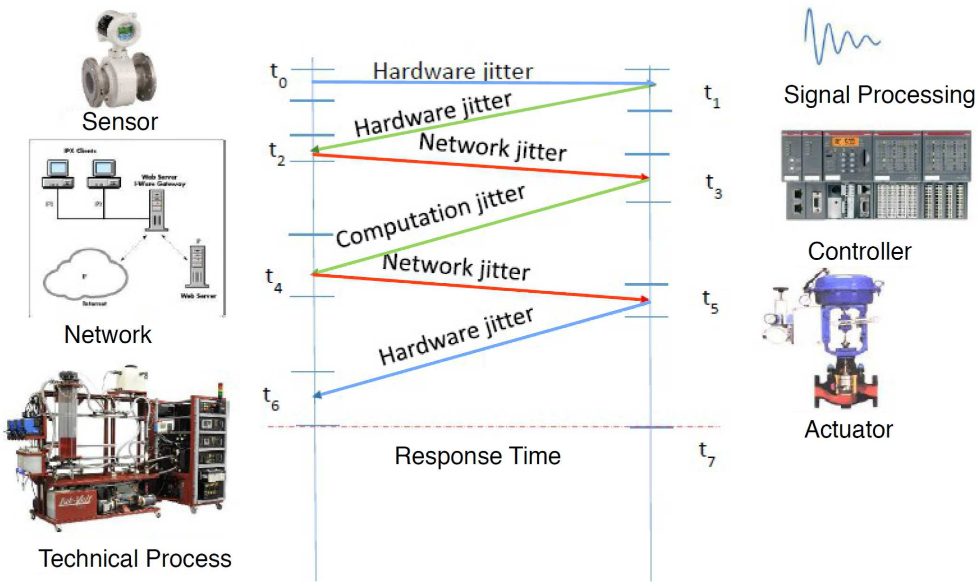


Figure 14: Temporal relations in response time

network jitter. The jitter occurrence has been modeled to be constant, deterministic and time-varying depending on their behaviour. For these models to be useful in verification, bounds of jitter have been obtained. Experiments and software tools such as Wireshark, Integrated Automation Builder, and RSlogix task monitor are used. In our approach, the jitter bounds and the model are used to develop the time-chain which is a component model capturing the architecture and timing imperfections in NAS (Fig. 14). Later, simulations on technical process are used to obtain insights of the technical process and the operating conditions. Further, the simulation outputs have been used for model abstraction to build formal model of the process. For the models to be used in model checking, the timing constraints need to be defined with jitter bounds. We have used model patterns with timing wrapper to generate the formal model of the jitter. The composed model of the technical process along with timing specifications have been validated in UPPAAL timed model checker for verifying the response time of the NAS. The methodology outlined is captured as a workflow that can be used to verify the RT in NAS. The verification methodology has been illustrated using extensive experiments on an industrial steam boiler in a process industry. The proposed workflow gives a framework to design dependable NAS wherein the response time is verified already during design phase in contrast to the current practice where verification is done after deployment. As for future work, the approach is planned to be extended for engineering broader class of industrial automation systems (J.Vain).

3.6 Research within international programmes

3.6.1 FP7 Marie Curie International Research Staff Exchange Scheme (PIRSES-GA-2011-295164-EUMLS) EU-Ukrainian Mathematicians for Life Sciences (EUMLS), http://www.math.uni-luebeck.de/EUMLS/ (1.4.2012 – 31.3.2016), led by Universität zu Lübeck (Germany). Participating scientist: E.Quak.

3.6.2 Estonian-Polish joint research project "Algebraic methods in nonlinear control" 2013–2015 under the agreement on scientific cooperation between the Estonian Academy of Sciences and the Polish Academy of Sciences (Estonian project coordinator: Ü.Kotta).

3.6.3 Estonian-Bulgarian joint research project under the agreement on scientific cooperation between the Bulgarian Academy of Sciences and the Estonian Academy of Sciences "Tsunamis in Inland Seas (Black and Baltic Seas)" 2012 – 2014 (Estonian project coordinator: I.Didenkulova).

3.4.4 FP7 European Commission Funded Collaborative Research Project Hydralab IV, Joint Research Activities, Grant HyIV-FZK-03 "Long wave dynamics and statistics of the shoreline motion: influence of the asymmetry and nonlinearity of incoming waves", 2010 – 2014 (Project coordinator: I. Didenkulova).

3.6.5 Tempus SESREMO project "Strengthening education in space-based remote sensing for monitoring of eco systems in Israel, Azerbaijan, Kazakhstan" (543720-TEMPUS-1-2013-1-DE-TEMPUS-JPCR, 01.11.2013 – 31.10.2016), led by Technische Universität Berlin (Germany); partners: University of Twente (The Netherlands); Tallinn University of Technology (Estonia); Engineering, Consulting and Management Office (Germany); National Aviation Academy (Azerbaijan); Sumgait State University (Azerbaijan); Baku State University (Azerbaijan); Tel-Aviv University (Israel); Israel Institute of Technology (Israel); Jerusalem College of Engineering (Israel); Al-Farabi Kazakh National University (Kazakhstan); L.N.Gumilev Eurasian National University (Kazakhstan); Korkyt Ata Kyzylorda State University (Kazakhstan); Centre for Remote Sensing and GIS "TERRA" (Kazakhstan); U.Sultangazin Space Research Institute (Kazakhstan); EkoSfera "Social-Ecological Center" (Azerbaijan); Ministry of Education & Science of the Republic of Kazahkstan; Israeli Space Agency at Ministry of Science; Ministry of Education of the Republic of Azerbaijan; Ministry of Environmental Protection of Israel; Participating Scientists: I.Didenkulova, T.Torsvik, T.Soomere, A.Rodin.

3.6.6 Estonian-Polish joint research project "Algebraic methods in nonlinear control" 2013 – 2015 under the agreement on scientific cooperation between the Estonian Academy of Sciences and the Polish Academy of Sciences (Estonian project coordinator: Ü.Kotta).

3.6.7 Estonian-France joint research on "Computer algebra, symbolic computation and automatic control" within G.F.Parrot programme (Estonian project coordinator: M.Tõnso).

4. Funding

4.1 Target funding through the Ministry of Education and Research

1. Block grant SF0140007s11 “Wave dynamics for coastal engineering” (2011–2016), PI: T.Soomere.

4.2 Funding through the Archimedes Foundation

1. Funding from the programme ”Estonian Centres of Excellence in Research”

4.3 Estonia Research Agency (formerly Estonian Science Foundation) grants

1. P.Saari, Personal Research Funding PUT 369 ”Search for new types of nondiffractive accelerating light pulses and their applications” (2014–2017).
2. A.Berezovski, Personal Research Funding PUT 434 ”Wave energy redistribution in solids with microstructure” (2014–2017).
3. M.Tõnso, Personal Research Funding grant PUT481, ”Modelling of control systems: theory, algorithms, software” (2014–2017).
4. P.Piksarv, ”Shaping light for advanced light sheet microscopy” for 2-year postdoctoral work in St.-Andrews University, Scotland.
5. A.Salupere, grant 8658, ”Solitonic structures in nonintegrable systems and discrete spectral analysis” (2011–2014).
6. A.Berezovski, grant 8702, ”Multiscale simulation of high strain rate dynamics in microstructured materials” (2011–2014).
7. M.Tõnso, grant 8787, ”Computer algebra methods in control” (2011–2014).
8. I.Didenkulova, grant 8870, ”Wave induced hazards in Estonian coastal waters” (2011–2014).
9. T.Soomere, grant 9125, ”Quantification the reaction of the eastern Baltic Sea coast to changing wave conditions” (2012–2015).

4.4 International grants

1. The project ”Computer Algebra, Symbolic Computation, and Automatic Control” (CASCAC) within G.F.PARROT programme – a bilateral research and technology programme between France and Estonia (2013–2014). Estonian PI – M.Tõnso.
2. SEREIN – Modernization of Postgraduate Studies on Security and Resilience for Human and Industry Related Domains. TEMPUS IV project EACEA N0 35/2012 – J.Vain.
3. Wellcome Trust International Senior Research Fellowship (2007–01.02.2014) – M.Vendelin.
4. MOBILITAS Top Researcher Grant MTT63 “Numerical particle tracking modeling for inhomogeneous turbulent water basins” (2011–2015) – T.Torsvik.

5. MOBILITAS post-doctoral grant MJD270 “Statistics of extreme wave conditions and events for Estonian coastal waters” (2012–2014) – I.Nikolkina.

6. Post doctoral scholarship from Max Planck Institute for the Science of Light. September 2013 – September 2014 with full work load and Sept. 2014 – Sept. 2015 with reduced work load, in Erlangen, Germany – H.Lukner.

7. TEMPUS project “Strengthening Education in Space-based REMOte sensing for monitoring of ecosystems in Israel, Azerbaijan, Kazakhstan”(SESREMO, 20 partners), 543720-TEMPUS-1-2013-1-DE-TEMPUS-JPCR (2013–2016) – I.Didenkulova, T.Soomere.

4.5 Additional funding (State Programmes)

1. Grant “Science-based forecast and quantification of risks to properly and timely react to hazards impacting Estonian mainland, air space, water bodies and coasts” TERIKVANT of the Environmental protection and technology programme KESTA (2012–2014) from the Estonian Research Council in the framework of supporting R&D in environmental technology (SFOS 3.2.0802.11–0043) – T.Soomere.

2. Smart composites-design and manufacturing (SCDM) (2012–2014) – A.Salupere, A.Braunbrück, J.Janno.

3. NanoCom – Nanogeometry and structural entanglement for design of nanocomposites based on ceramics. (2012–2014) – J.Kalda, A.Berezovski.

4.6 Supportive grants (travel, etc)

1. I.Didenkulova. Grant HyIV-FZK-03 ”Long wave dynamics and statistics of the shoreline motion: influence of the asymmetry and nonlinearity of incoming waves” (Hydralab IV, Joint Research Activities, within the FP7 European Commission Funded Collaborative Research Project), 2010–2014.

2. H.Herrmann. HITSA travel grant for attending SALENTO AVR 2014 (The First International Conference on Augmented and Virtual Reality), Lecce, Italy. 17–20 September, 2014.

3. D.Kartofelev. Kristjan Jaak scholarship for attending the 7th Forum Acusticum 2014, Krakow, Poland, 6–13 Sept. 2014.

4. D.Kartofelev. Archimedes Foundation DoRa T6 grant for attending International Symposium on Musical Acoustics (ISMA 14), Le Mans, Prantsusmaa, July 7–12, 2014.

5. M.Mustonen. Archimedes Foundation DoRa T8 for attending International Symposium on Musical Acoustics (ISMA 14), Le Mans, Prantsusmaa, July 7–12, 2014.

6. M.Lints. DoRa 8 grant for attending 11th European Conference on Non-Destructive Testing, Czech Republic, Praha, October 6–10, 2014.

7. M.Lints. DoRa 8 grant for attending workshop ”Solitary Waves in Non-Destructive Testing”, Blois, France, March 24–28, 2014.

8. J.Belikov. IT Academy travel grant for attending the 19th IFAC World Congress, Cape Town, South Africa, 24–29 August, 2014.

9. K.Halturina. Bourse du gouvernement Français (French government scholarship) to join the DISCO project of INRIA Saclay – Île-de-France, 1 February – 30 April, 2014.

10. A.Kaldmäe. EIFFEL grant for studing in Ecole Centrale de Nantes, France, 14 October, 2013 – 13 July, 2014.

11. A.Kaldmäe. Doctoral School in Information and Communication Technology (IKTDK) grant for attending the 21st International Symposium on Mathematical Theory of Networks and Systems, Groningen, The Netherlands, 7–11 July, 2014.

12. A.Kaldmäe. IT Academy travel grant for attending the 19th IFAC World Congress, Cape Town, South Africa, 24–29 August, 2014.

4.7 Total income of CENS in 2011 – 2014(Euros)

Source	**2011**	**2012**	**2013**	**2014**
Targeted financing (TF)[1]	610660	613780	484790	23519
ERA (former ESF) grants[2]	187414	132662	70976	63133
External project funding*[3]	526698	508405	554454	353801
EU Structural Funds[4]	29656	314000	295926	843358
Grand total	**1354428**	**1568847**	**1406146**	**1283511**

Remarks:

* EU Structural Funds excluded.

1 Targeted financing is used to support evaluated R&D research topics (both basic and applied) from State budget through the Ministry of Education and Research.

2 ERA (ESF) grants are available to individuals as well as research groups who have to undergo a research project financing competition (this programme is closing).

3 External project funding – R&D grants from and contracts with various Estonian and foreign institutions (Wellcome Trust, Humboldt Foundation, Marie Curie actions, etc).

4 EU Structural Funds for supporting R&D activities implemented through the Archimedes Foundation (Implementation Agency of Structural Support), programme for Centres of Excellence in Research.

5. Publicity of Results

5.1 Publications

5.1.1 Books, theses

1. J.Engelbrecht. Mõtteraamat (Essays on science) Tallinn, 2014, 271 lk, in Estonian.
2. A.Salupere, G.A.Maugin (eds.). IUTAM Symposium on Complexity of Nonlinear Waves, 8–12 Sept., 2014. Book of Abstracts, IoC at TUT, Tallinn, 2014.
3. M.Ioannides, E.Quak (eds.). 3D Research Challenges in Cultural Heritage. A Roadmap in Digital Heritage Preservation. Lecture Notes in Computer Science, 8355, 2014, Springer, Berlin, Heidelberg, 142 pp.
4. D.Kartofelev. Nonlinear Sound Generation Mechanisms in Musical Acoustics. PhD thesis, TUT Press, Tallinn, 2014, 110 pp.
5. B.Viikmäe. Optimising fairways in the Gulf of Finland using patterns of surface currents. PhD thesis, TUT Press, Tallinn, 2014, 196 pp.
6. M.Viška. Sediment Transport Patterns Along the Eastern Coasts of the Baltic Sea. PhD thesis, TUT Press, Tallinn 2013, 2014, 155 pp.
7. N.Delpeche-Ellmann. Circulation Patterns in the Gulf of Finland Applied to Environmental Management of Marine Protected Areas. PhD thesis, TUT Press, Tallinn, 2014, 143 pp.
8. A.Rodin, E.Pelinovsky. Dynamics of long waves in the marine coastal zone involving effects of wave breaking. Nizhny Novgorod State Technical University n.a. R.E.Alekseev, Institute of Applied Physics, Russian Academy of Sciences, IoC at TUT, Nizhny Novgorod 2014 (in Russian).

5.1.2 Papers (refereed)

Laboratory of Nonlinear Dynamics

1. J.Engelbrecht, A.Salupere. Scaling and hierarchies of wave motion in solids. ZAMM, 2014, 94, 9, 775–783.
2. A.Berezovski, J.Engelbrecht, P.Ván. Weakly nonlocal thermoelasticity for microstructured solids: microdeformation and microtemperature. Arch. Appl. Mech., 2014, 84, 9–11, 1249–1261.
3. A.Salupere, M.Lints, J.Engelbrecht. On solitons in media modelled by the hierarchical KdV equation. Arch. Appl. Mech., 2014, 84, 9–11, 1583–1593.
4. A.Berezovski, J.Engelbrecht, M.Berezovski. Numerical simulation of elastic wave diffraction at embedded gratings. In: A.Eriksson, G.Tibert (eds.), Proc. 27th Nordic Seminar on Computational Mechanics, NSCM-27, 2014, 113–116.
5. I.Sertakov, J.Engelbrecht, J.Janno. Modelling 2D wave motion in microstructured solids. Mech. Res. Comm., 2014, 56, 42–49.
6. R.Kitt. Economic decision making: application of the theory of complex systems. In: S.Banerjee et al (eds.), Chaos Theory in Politics. Understanding Complex Systems. Springer, Dordrecht, 2014, 51–73.

7. A.Ravasoo. Interaction of bursts in exponentially graded materials characterized by parametric plots. Wave Motion, 2014, 52, 5, 758–767.

8. P.Ván, A.Berezovski and C.Papenfuss. Thermodynamic approach to generalized solid mechanics. Continuum Mechanics and Thermodynamics, 2014, 26, 403–420.

9. A.Berezovski, Wen-Xin Tang, Weishi Wan. Elastic wave Talbot effect in solids with inclusions. Mechanics Research Communications, 2014, 60, 21–26.

10. A.Berezovski, R.Kolman, J.Blažek, J.Kopačka, D.Gabriel, J.Plešek. Comparative study of finite element method, isogeometric analysis, and finite volume method in elastic wave propagation of stress discontinuities. Proceedings of the 11th European Conference on Non-Destructive Testing, Prague, Czech Republic, October 6–10, 2014, CD-ROM, 8 pp. www.ndt.net/search.

11. P.Ván, A.Berezovski and C.Papenfuss. Erratum to: Thermodynamic approach to generalized continua. Continuum Mechanics and Thermodynamics, 2014, 26, 3, 421–422.

12. D.Kartofelev, A.Stulov. Propagation of deformation waves in wool felt. Acta Mechanica, 2014, 225(11), 3103–3113.

13. A.Stulov, D.Kartofelev. Vibration of strings with nonlinear supports. Applied Acoustics, 2014, 76, 223–229.

14. M.P.Vilà, I.A.Kubilay, D.Kartofelev, M.Mustonen, A.Stulov, V.Välimäki. High-speed line-camera measurements of a vibrating string. Proc. Baltic-Nordic Acoustic Meeting BNAM 2014, Tallinn, Estonia, 2–4 June, 2014, 1–8.

15. D.Kartofelev, M.Mustonen, A.Stulov, V. Välimäki. Application of high-speed line scan camera for string vibration measurements. Proc. Intern. Symp. Musical Acoustics ISMA 2014, Le Mans, France, 7–12 July, 2014, 1–5.

16. M.Mustonen, D.Kartofelev, A.Stulov, V.Välimäki. Experimental verification of pickup nonlinearity. Proc. Intern. Symp. Musical Acoustics ISMA 2014, Le Mans, France, 7–12 July, 2014, 1–5.

17. D.Kartofelev, A.Stulov. Wave propagation and attenuation in wool felt. Proc. 7th Forum Acusticum 2014, Kraków, Poland, 7–12 September, 2014, 1–6.

18. M.Mustonen, D.Kartofelev, A.Stulov, V.Välimäki. Application of high-speed line scan camera for acoustic measurements of vibrating objects. Proc. 7th Forum Acusticum 2014, Kraków, Poland, 7–12 September, 2014, 1–6.

19. A.Braunbrück. Determination of inhomogeneous properties of materials by analysis of ultrasonic wave motion. Acta Acust. united Ac., 100, 2014, 259–265.

20. R.Haber, J.Prehl, K.H.Hoffmann, and H.Herrmann. Random walks of oriented particles on fractals. J. Physics A: Mathematical and Theoretical, 47, (15), 2014.

21. H.Herrmann, M.Eik, V.Berg, and J.Puttonen. Phenomenological and numerical modelling of short fibre reinforced cementitious composites. Meccanica, 2014, 49, (8), 1985–2000.

22. H.Herrmann, E.Pastorelli. Virtual reality visualization for photogrammetric 3d reconstructions of cultural heritage. In: L.T. De Paolis and A.Mongelli, (eds.), Augmented and Virtual Reality, Lecture Notes in Computer Science, Springer Intern. Publ., 2014, pp. 283–295.

23. H.Herrmann, M.Padilla, and E.Pastorelli. A.C.T.I.V.E.: A Scalable Superellipsoid-based CFD Visualization for Virtual and Desktop Environments. In: J.Perret, V.Basso, Fr.Ferrise, K.Helin, V.Lepetit, J.Ritchie, Chr.Runde, M. van der Voort, and G.Zachmann, (eds.), EuroVR 2014 – Conf. and Exhibition of the European Association of Virtual and Augmented Reality. The Eurographics Association, 2014.

24. J.Kalda, T.Soomere, A.Giudici. On the finite-time compressibility of the surface currents in the Gulf of Finland, the Baltic Sea. J. Marine Systems, 2014, 129, 56–65.

25. T.Torsvik, J.Kalda. Analysis of surface current properties in the Gulf of Finland using data from surface drifters. In: 2014 IEEE/OES Baltic Intern. Symp., 26–29 May 2014, Tallinn, Estonia, IEEE, 2014, 1–9.

Laboratory of Photoelasticity

26. H.Aben, J.Anton, A.Errapart. Photoelasticity for the measurement of thermal residual stresses in glass. In: Encyclopedia of Thermal Stresses, R.B.Hetnarski (ed.), Springer, 2014.

27. H.Aben. Stress measurement in tubes made easy. Glass Worldwide, 2014, No. 52, 68.

28. H.Aben, D.Lochegnies, Y.Chen, J.Anton, M.Paemurru, M.Õis. A new approach to edge stress measurement in tempered glass panels. Exp. Mech., online October 2014, DOI 10.1007/s 11340-014-9950-7.

29. H.Aben, D.Lochegnies, Y.Chen, J.Anton, M.Paemurru, M.Õis. A new approach to edge stress measurement in tempered glass panels. In: Proc. Intern. Conf. Glasstec "Engineered Transparency". TU Darmstadt, TU Dresden, Messes Düsseldorf, 2014, 241–248.

30. H.Aben, A.Errapart, J.Anton. Measuring residual stresses in homogeneous and composite glass materials using photoelastic techniques. In: Residual Stresses in Composite Materials. M.M.Shokrieh (ed.), Oxford, Woodhead, 2014, Ch. 6, 152–172.

Laboratory of Systems Biology

31. M.Sepp, N.Sokolova, S.Jugai, M.Mandel, P.Peterson, M.Vendelin. Tight Coupling of Na+/K+-ATPase with Glycolysis Demonstrated in Permeabilized Rat Cardiomyocytes. PLoS ONE, 2014, 9(6), e99413. doi:10.1371/journal.pone.0099413

32. R.Birkedal, M.Laasmaa, M.Vendelin. The location of energetic compartments affects energetic communication in cardiomyocytes. Frontiers in Physiology, 2014, 5, 376.

Laboratory of Wave Engineering

33. E.Averbukh, O.Kurkina, A.Kurkin, T.Soomere. Edge-wave-driven durable variations in the thickness of the surfactant film and concentration of surface floats. Phys. Lett. A, 2014, 378, 1–2, 53–58.

34. T.Soomere, A.Räämet. Decadal changes in the Baltic Sea wave heights. J. Marine Systems, 2014, 129, 86–95.

35. T.Soomere, M.Viška. Simulated sediment transport along the eastern coast of the Baltic Sea. J. Marine Systems, 2014, 129, 96–105.

36. B.Viikmäe, T.Soomere. Spatial pattern of hits to the nearshore from a major marine highway in the Gulf of Finland. J. Marine Systems, 2014, 129, 106–117.

37. T.Soomere, K.Döös, A.Lehmann, H.E.M.Meier, J.Murawski, K.Myrberg, E.Stanev E. The potential of current- and wind-driven transport for environmental management of the Baltic Sea. Ambio, 2014, 43, 94–104.

38. H.Tõnisson, Ü.Suursaar, A.Kont, K.Orviku, R.Rivis, R.Szava-Kovats, K.Vilumaa, T.Aarna, M.Eelsalu, K.Pindsoo, V.Palginõmm, U.Ratas. Field experiments with different fractions of painted sediments to study material transport in three coastal sites in Estonia. J. Coastal Res., Special Issue, 2014, 70, 229–234.

39. A.Rybkin, E.Pelinovsky, I.Didenkulova. Nonlinear wave run-up in bays of arbitrary cross-section: generalization of the Carrier–Greenspan approach. J. Fluid Mech., 2014, 748, 416–432.

40. T.Soomere, M.Eelsalu. On the wave energy potential along the eastern Baltic Sea coast. Renew. Energy, 2014, 71, 221–233.

41. I.I.Didenkulova, E.N.Pelinovsky, O.I.Didenkulov. Run-up of long solitary waves of different polarities on a plane beach. Izvestiya RAS. Physics of the Atmosphere and Ocean, 2014, 50, 5, 532–538.

42. M.Eelsalu, T.Soomere, K.Pindsoo, P.Lagemaa. Ensemble approach for projections of return periods of extreme water levels in Estonian waters. Cont. Shelf Res., 2014, 91, 201–210.

43. E.Averbukh, T.G.Talipova, A.A.Kurkin, T.Soomere. Statistical characteristics of coefficients of a cubic approximation of isotherms of surface active substance films. Proc. Estonian Acad. Sci., 2014, 63, 4, 417–427.

44. S.Keevallik, T.Soomere. Regime shifts in the surface-level average air flow over the Gulf of Finland during 1981–2010. Proc. Estonian Acad. Sci., 2014, 63, 4, 428–437.

45. A.Giudici, T.Soomere. Finite-time compressibility as an agent of frequent spontaneous patch formation in the surface layer: a case study for the Gulf of Finland, the Baltic Sea. Mar. Pollut. Bull., 2014, 89, 1–2, 239–249.

46. O.I.Didenkulov, I.I.Didenkulova, E.N.Pelinovsky. Parameterization of the characteristics of runup of single waves in the bay with parabolic cross-section. In: Proc. 24th Scientific and Practical Conf. "COGRAPH 2014", 16–17 April 2014, Nizhny Novgorod, 2014, 170 – 175 (in Russian).

47. K.Pindsoo, T.Soomere. Signal of wave climate change reflected by wave set-up height. In: 2nd Intern. Conf. Climate Change – The environmental and socio-economic response in the Southern Baltic region, Szczecin, Poland, 12–15 May 2014, Conf. Proc., Witkowski A., Harff J., Reckermann M.,(eds.), Intern. Baltic Earth Secretariat Publ. 2. Helmholtz-Zentrum Geesthacht, Germany, 2014, 67–68.

48. M.Eelsalu, T.Soomere. On spatio-temporal variations of the wave energy potential along the eastern Baltic Sea coast. In: 2nd Intern. Conf. Climate Change – The environmental and socio-economic response in the Southern Baltic region, Szczecin, Poland, 12–15 May 2014, Conf. Proc., Witkowski A., Harff J., Reckermann M., (eds.), Intern. Baltic Earth Secretariat Publ. 2. Helmholtz-Zentrum Geesthacht, Germany, 2014, 81–82.

49. A.Giudici, T.Soomere. Highly persisting patch formation areas in the Gulf of Finland, the Baltic Sea. In: 2nd Intern. Conf. on Climate Change – The environmental and socio-economic response in the Southern Baltic region, Szczecin, Poland, 12–15 May 2014, Conf. Proc., Witkowski A., Harff J., Reckermann M., (eds.), Intern. Baltic Earth Secretariat Publ. 2. Helmholtz-Zentrum Geesthacht, Germany, 2014, 84–85.

50. M.Viška, T.Soomere. On sensitivity of wave-driven alongshore sediment transport patterns with respect to model setup and sediment properties. In: 2nd Intern. Conf. Climate Change – The environmental and socio-economic response in the Southern Baltic region, Szczecin, Poland, 12–15 May 2014, Conf. Proc., Witkowski A., Harff J., Reckermann M., (eds.), Intern. Baltic Earth Secretariat Publ. 2. Helmholtz-Zentrum Geesthacht, Germany, 2014, 94–95.

51. A.Giudici, T.Soomere. Measuring finite time compressibility from large simulated datasets: towards identification of areas of spontaneous patch formation in the Gulf of Finland. In: Databases and Information Systems. Proc. the 11th Intern. Baltic Conf., Baltic DB&IS 2014, 8–11 June, Tallinn, Estonia. Haav H.-M., Kalja A., Robal T. (eds.), Tallinn: TUT Press, 2014, 441–446.

52. M.Eelsalu, M.Org, T.Soomere. Visually observed wave climate in the Gulf of Riga. In: 6th IEEE/OES Baltic Symp. Measuring and Modeling of Multi-Scale Interactions in the Marine Environment, May 26–29, Tallinn Estonia. IEEE Conf. Publ., 2014, 10 pp.

53. K.Pindsoo, M.Eelsalu, T.Soomere, H.Tõnisson. An estimate of the impact of vessel wakes on coastal processes: a case study for Aegna, Estonia. In: 6th IEEE/OES Baltic Symp. Measuring and Modeling of Multi-Scale Interactions in the Marine Environment, May 26–29, Tallinn Estonia. IEEE Conf. Publ., 2014, 9 pp.

54. I.Nikolkina, T.Soomere, A.Räämet. Multidecadal ensemble hindcast of wave fields in the Baltic Sea. In: 6th IEEE/OES Baltic Symp. Measuring and Modeling of Multi-Scale Interactions in the Marine Environment, May 26–29, Tallinn Estonia. IEEE Conf. Publ., 2014.

55. K.Julge, M.Eelsalu, E.Grünthal, S.Talvik, A.Ellmann, T.Soomere, H.Tõnisson. Combining airborne and terrestrial laser scanning to monitor coastal processes. In: 6th IEEE/OES Baltic Symp. Measuring and Modeling of Multi-Scale Interactions in the Marine Environment, May 26–29, Tallinn Estonia. IEEE Conf. Publ., 2014, 10 pp.

56. O.Kurkina, A.Kurkin, T.Soomere, A.Rybin, D.Tyugin. Pycnocline variations in the Baltic Sea affect background conditions for internal waves. In: 6th IEEE/OES Baltic Symp. Measuring and Modeling of Multi-Scale Interactions in the Marine Environment, May 26–29, Tallinn Estonia. IEEE Conf. Publ., 2014, 1–8.

57. A.Rodin, I.Didenkulova, I.Nikolkina. Run-up of large storm waves on Estonian coasts of the Baltic Sea. In: 6th IEEE/OES Baltic Symp. Measuring and Modeling of Multi-Scale Interactions in the Marine Environment, May 26–29, Tallinn Estonia. IEEE Conf. Publ., 2014, 5 pp.

58. P.Denissenko, J.Pearson, A.Rodin, I.Didenkulova. Long waves climbing the slopes of different roughness: run-up height and the load on individual roughness elements. Proc. the HYDRALAB IV Joint User Meeting, Lisbon, July 2014. TA-FZK-03, 6 pp.

59. S.Schimmels, V.Sriram, I.Didenkulova, H.Fernandez. On the generation of tsunami in a large scale wave flume. Proc. 34th Intern. Conf. Coastal Engin., Seoul, Korea, 15–20 June 2014, 10 pp.

60. V.Sriram, I.Didenkulova, S.Schimmels, A.Sergeeva, N.Goseberg. Long wave propagation, shoaling and run-up in nearshore areas. Proc. 34th Intern. Conf. Coastal Engin., Seoul, Korea, 15–20 June 2014, 8 pp.

Together with Laboratory of Nonlinear Dynamics:

J.Kalda, T.Soomere, A.Giudici. On the finite-time compressibility of the surface currents in the Gulf of Finland, the Baltic Sea. J. Marine Systems, 2014, 129, 56–65 (see N24).

T.Torsvik, J.Kalda. Analysis of surface current properties in the Gulf of Finland using data from surface drifters. In: 6th IEEE/OES Baltic Symp. Measuring and Modeling of Multi-Scale Interactions in the Marine Environment, May 26–29, Tallinn Estonia. IEEE Conf. Publ., 2014, 9 pp. (see N 25).

Laboratory of Nonlinear Control theory

61. J.Belikov, Ü.Kotta, M.Tõnso. Adjoint polynomial formulas for nonlinear state-space realization. IEEE Trans. Autom. Contr., 2014, 59(1), 256–261.

62. J.Belikov, Ü.Kotta, M.Tõnso. Comparison of LPV and nonlinear system theory: a realization problem. Syst. & Contr. Lett., 2014, 64, 72–78.

63. J.Belikov, E.Petlenkov. Model based control of a water tank system. In: IFAC 2014; The 19th IFAC World Congress, 24–29 August, 2014, Cape Town, South Africa. E.Boje, X.Xia (eds.), Cape Town: IFAC, 2014, 10838–10843.

64. J.Belikov, Ü.Kotta, M.Tõnso, Z.Bartosiewicz, M.Wyrwas. Dynamic feedback linearization of nonlinear control systems on homogeneous time scale. In: MSC 2014: The 2014 IEEE Multi-Conference on Systems and Control, 8–10 October, 2014, Nice/Antibes, France. Antibes: IEEE, CSS, 2014, 947–952.

65. E.Brezhniev, V.Kharchenko, J.Vain. Cyber security of smart substations with critical load via cyber diversity: strategies and assessment. In: EWDTS 2014: 12th IEEE East-West Design & Test Symposium, Kiev, Ukraine, 26–29 September, 2014. IEEE, 2014.

66. M.Ciulkin, V.Kaparin, Ü.Kotta, E.Pawłuszewicz. Linearization by input-output injections on homogeneous time scales. Proc. Estonian Acad. Sci., 2014, 63(4), 387–397.

67. A.Kaldmäe, Ü.Kotta. Input-output linearization of discrete-time systems by dynamic output feedback. European J. Contr., 2014, 20(2), 73–78.

68. A.Kaldmäe, Ü.Kotta. Input-output decoupling of discrete-time nonlinear systems by measurement feedback. In: MTNS 2014: 21st Intern. Symp. Mathematical Theory of Networks and Systems, 7–11 July, 2014, Groningen, The Netherlands. Groningen: University of Groningen, 2014, 311–316.

69. A.Kaldmäe, Ü.Kotta. Disturbance decoupling by measurement feedback. In: IFAC 2014: The 19th IFAC World Congress, 24–29 August, 2014, Cape Town, South Africa. E.Boje, X.Xia (eds.), Cape Town: IFAC, 2014, 7735–7740.

70. A.Kaldmäe, Ü.Kotta, A.Shumsky, A.Zhirabok. Disturbance decoupling for nonlinear systems by measurement feedback: sensor location. In: IFAC 2014: The 19th IFAC World Congress, 24–29 August, 2014, Cape Town, South Africa. E.Boje, X.Xia (eds.), Cape Town: IFAC, 2014, 7729–7734.

71. V.Kaparin, Ü.Kotta, M.Wyrwas. Observable space of the nonlinear control system on a homogeneous time scale. Proc. Estonian Acad. Sci., 2014, 63(1), 11–25.

72. V.Kharchenko, O.Illiashenko, A.Boyarchuk, C.Phillips, J.Vain, M.Krispin. FPGA-based critical computing: TEMPUS and FP7 projects issues. In: EWME 2014: 10th European Workshop on Microelectronics Education, 14–16 May, 2014, Tallinn, Estonia. Tallinn: IEEE, 2014, 74–79.

73. Ü.Kotta, M.Tõnso, Y.Kawano. Polynomial accessibility condition for the multi-input multi-output nonlinear control system. Proc. Estonian Acad. Sci., 2014, 63(2), 136–150.

74. P.Lump, J.Ernits, J.Vain. Towards better specifications for software outsourcing. In: Baltic DB&IS 2014: 11th Intern. Baltic Conf. Databases and Information Systems, 8–11 June, 2014, Tallinn, Estonia. H.-M.Haav, A.Kalja, T.Robal (eds.), Tallinn: TUT Press, 2014, 453–458.

75. T.Mullari, K.Schlacher. Geometric control for a nonlinear sampled data system. In: MTNS 2014: 21st Intern. Symp. Mathematical Theory of Networks and Systems, 7–11 July, 2014, Groningen, The Netherlands. Groningen: University of Groningen, 2014, 54–61.

76. Ü.Nurges, I.Artemchuk, J.Belikov, Generation of stable polytopes of Hurwitz polynomials via Routh parameters. In: CDC 2014: IEEE 53rd Annual Conf. Decision and Control, 15–17 December, 2014, Los Angeles, CA, USA, 2014, 2390–2395.

77. S.Srinivasan, S.Ramaswamy, J.Vain. Verifying response times in networked automation systems using jitter bounds. In: ISSRE 2014: The 25th IEEE Intern. Symp. Software Reliability Engineering, 3–6 November 3-6, 2014, Naples, Italy. IEEE, 2014.

78. A.Tepljakov, E.Petlenkov, J.Belikov. Embedded system implementation of digital fractional filter approximations for control applications. In: MIXDES 2014: The 21st Intern. Conf. Mixed Design of Integrated Circuits and Systems, 19–21 June, 2014 Lublin, Poland. A.Napieralski (ed.), Lublin: IEEE, 2014, 441–445.

79. A.Tepljakov, E.Petlenkov, J.Belikov. Gain and order scheduled fractional-order PID control of fluid level in a multi-tank system. In: ICFDA 2014: Intern. Conf. Fractional Differentiation and its Applications, 23–25 June, 2014, Catania, Italy. Catania: IEEE, 2014, 1–6.

80. A.Tepljakov, E.Petlenkov, J.Belikov. Closed-loop identification of fractional-order models using FOMCON toolbox for MATLAB. In: BEC 2014: The 14th Biennial Baltic Electronics Conf., 6–8 October, 2014, Tallinn, Estiona. Tallinn: IEEE, 2014, 213–216.

81. A.Tepljakov, E.Petlenkov, J.Belikov. Fractional-order digital filter approximation method for embedded control applications. Int. J. of Microelectronics and Computer Sci. 2014, 5(2), 54–60.

82. A.Tepljakov, E.Petlenkov, J.Belikov, E.A.Gonzalez. Design of retuning fractional PID controllers for a closed-loop magnetic levitation control system. In: ICARCV 2014: The 13th Intern. Conf. Control, Automation, Robotics and Vision, 10–12 December, 2014, Singapore 1345–1350.

83. D.Truscan, J.Vain, M.Koskinen. Combining aspect-orientation and UPPAAL timed automata. In: The 9th Intern. Conf. Software Paradigm Trends, 29–31 August, 2014, Vienna, Austria. A.Holzinger, J.Cardoso, J.Cordeiro, M. van Sinderen, S.Mellor (eds.), SciTePress, 2014, 159–164.

84. J.Vain, A.Anier, E.Halling. Provably correct test development for timed systems. In: Baltic DB&IS 2014: Selected papers from 11th Intern. Baltic Conf. Databases and Information Systems, 8–11 June, 2014, Tallinn, Estonia. H.-M.Haav, A.Kalja, T.Robal (eds.), Amsterdam: IOS Press, 289–302.

85. J.Vain, H.Sarapuu. Towards context-sensitive dialogue with robot companion. In: BEC 2014: The 14th Biennial Baltic Electronics Conf, 6–8 October, 2014, Tallinn, Estonia. Tallinn: IEEE, 2014, 205–208.

86. V.Vansovitš, E.Petlenkov, K.Vassiljeva, A.Tepljakov, J.Belikov. Application of MPC to industrial water boiler control system in district heat plant. In: ICARCV 2014: The 13th Intern Conf. Control Automation Robotics and Vision, 10–12 December, 2014, Singapore, 1609–1614.

87. K.Vassiljeva, J.Belikov, E.Petlenkov. Application of genetic algorithms to neural networks based control of a liquid level tank system. In: IJCNN 2014: Intern. Joint Conf. Neural Networks, 6–11 July, 2014, Beijing, China. Piscataway, NJ: IEEE, 2014, 2525–2530.

88. A.N.Zhirabok, Ü.Kotta, A.E.Shumsky. Accommodation to defects in the discrete dynamic systems. Automation and Remote Control, 2014, 75(6), 997–1009.

UT Optics Group

89. P.Piksarv, A.Valdmann, H.Valtna-Lukner, P.Saari. Ultrabroadband Airy light bullets. J. Physics: Conf. Series, 2014, 497, 012003.

90. A.Valdmann, P.Piksarv, H.Valtna-Lukner, P.Saari. Ultra-broadband dispersing and nondispersing Airy pulses. Antennas and Propagation Society Intern. Symp. (APSURSI), 2014 IEEE.

91. A.Valdmann, P.Piksarv, H.Valtna-Lukner, P.Saari. Realization of laterally nondispersing ultrabroadband Airy pulses. Optics Letters, 2014, 39, 1877.

92. P.Piksarv, A.Valdmann, H.Valtna-Lukner, P.Saari. Ultrabroadband Airy light bullets. Laser Phys. 2014, 24, 085301.

5.2 Other publications

5.2.1 Research Reports

1.	Mech 308/14	Selected bibliography on waves in microstrucured solids.
2.	Mech 309/14	J.Engelbrecht. Complexity in engineering and natural sciences.
3.	Mech 310/14	Inverse problems. Arvi Ravasoo in memoriam (materials of a seminar).
4.	Report	T.Soomere, M.Eelsalu, K-Pindsoo. Rannasetete bilanss Miiduranna sadamast Tallinna Vanasadamani (The budget of coastal sediments from Miiduranna Harbour to Tallinn Old Harbour).

5.2.2 Lecture Notes

SECREMO and Tempus courses: T.Soomere:

1.	12/2014	Environmental Mathematic Modelling for Wave Dynamics.
2.	13/2014	Coastal Processes and Environmental Management.

5.2.3 Submitted papers

1. M.Berezovski, A.Berezovski, and J.Engelbrecht. Numerical simulation of one-dimensional microstructure dynamics. Int. J. Structural Stability and Dynamics (submitted).

2. J.Engelbrecht, A.Berezovski. Reflections on mathematical models of deformation waves in elastic microstructured solids. Math. Mech. of Complex Systems (accepted).

3. J.Engelbrecht, K.Tamm, T.Peets. On mathematical modelling of solitary pulses in cylindrical biomembranes. Biomech. Model. in Mechanobiology (accepted).

4. J.Engelbrecht, M.Kutser. Legacy of Nikolai Alumäe: theory of shells. Proc. Estonian Acad. Sci. (accepted).

5. J.Engelbrecht. Complexity in engineering and natural sciences, Proc. Estonian Acad. Sci, Special issue of the IUTAM Symp on Complexity of Nonlinear Waves (submitted).

6. A.Salupere. On hidden solitons in KdV related systems. Mathematics and Computers in Simulation (in press).

7. M.Lints, A.Salupere, S.Dos Santos. Simulation of solitary wave propagation in carbon fibre reinforced polymer. Proc. Estonian Acad. Sci. (submitted).

8. A.Berezovski. Nonlinear dispersive wave equations for microstructured solids. Proc. Estonian Acad. Sci. (submitted).

9. A.Berezovski, I.Giorgio, A.Della Corte. Interfaces in micromorphic materials: wave transmission and reflection with numerical simulations. Mathematics and Mechanics of Solids (submitted).

10. A.Berezovski. Nonlinear dispersive wave equations for microstructured solids. Proc. Estonian Acad. Sci. (submitted)

11. A.Berezovski, I.Giorgio, A.Della Corte. Interfaces in micromorphic materials: wave transmission and reflection with numerical simulations. Mathematics and Mechanics of Solids (submitted).

12. A.Stulov, D.Kartofelev. Wave propagation and dispersion in microstructured wool felt (submitted).

13. A.Stulov, V.Erofeev. Shock wave propagation in nonlinear microstructured wool felt (submitted).
14. E.Pastorelli, H,Herrmann. Virtual reality visualization for short fibre orientation analysis, 2014. BEC 2014 (accepted).
15. T.Peets. Internal scales and dispersive properties of microstructured materials. Mathematics and Computers in Simulation (accepted).
16. K.Tamm, T.Peets. On solitary waves in case of amplitude-dependent nonlinearity. Chaos, Solitons & Fractals (submitted).
17. T.Peets, K.Tamm. On mechanical aspects of nerve pulse propagation and Boussinesq paradigm. Proceedings of the Estonian Academy of Sciences (submitted).
18. J.Kalda, S.Ainsaar. On the effect of finite-time correlations on the turbulent mixing in smooth chaotic compressible velocity fields (accepted).
19. J.Kalda, V.Mate. Seagull competition: difficult problems, easy answers (under revision).
20. J.Kalda, M.Kree. Implications of the theory of turbulent mixing for wave propagation in media with fluctuating coefficient of refraction (submitted).
21. J.Kalda, S.Ainsaar, M.Kree. The role of time correlations for turbulent mixing of tracers (submitted).
22. J.Belikov. Controllability of switched linear systems on time scales. In: ECC'15: The 14th annual European Control Conf., 15–17 July, 2015, Linz, Austria (submitted).
23. J.Belikov, Ü.Kotta, M.Tõnso. Realization of nonlinear MIMO system on homogeneous time scale. European J. Contr. (accepted).
24. J.Belikov and E.Petlenkov. NN-SANARX model based control of a multi tank liquid-level systems. Int. J. of Computational Intelligence Syst. (to be published in 2015).
25. A.Kaldmäe, C.H.Moog. Disturbance decoupling of time-delay systems. Asian J. Contr. (accepted).
26. A.Kaldmäe, C.Califano, C.H.Moog. Integrability for nonlinear time-delay systems. IEEE Trans. Autom. Contr. (submitted).
27. A.Kaldmäe, Ü.Kotta, B.Jiang, A.Shumsky, A.Zhirabok. Faulty plant reconfiguration based on disturbance decoupling methods. Asian J. Contr. (submitted).
28. A.Kaldmäe, Ü.Kotta, A.Shumsky, A.Zhirabok. Measurement feedback disturbance decoupling in discrete-event systems. Int. J. of Robust and Nonlinear Contr., (accepted).
29. V.Kaparin, Ü.Kotta. Transformation of nonlinear state equations into the observer form: necessary and sufficient conditions in terms of one-forms. Kybernetika (accepted).
30. Y.Kawano, Ü.Kotta. On integrability of observable space for discrete-time polynomial control systems. IEEE Trans. Autom. Contr. (accepted).
31. Ü.Nurges, I.Artemchuk, J.Belikov. On stable cones of polynomials via reduced Routh parameters. Syst. & Contr. Lett. (submitted).
32. Ü.Nurges, S.Avanessov. Fixed-order stabilising controller design by a mixed randomised/deterministic method. Int. J. Contr. (accepted).

33. A.Tepljakov, E.A.Gonzalez, E.Petlenkov, J.Belikov, C.A.Monje, I.Petráš. Incorporation of fractional-order dynamics into an existing PI/PID DC motor control loop. IEEE Trans. Autom. Contr. (submitted).

34. A.Tepljakov, E.Petlenkov, J.Belikov. FOPID controller tuning for fractional FOPDT plants subject to design specifications in the frequency domain. In: ECC'15: The 14th annual European Control Conf., 15–17 July, 2015, Linz, Austria (submitted).

35. T.Soomere, M.Eelsalu, A.Kurkin, A.Rybin. Separation of the Baltic Sea water level into daily and multi-weekly components. Continental Shelf Research (submitted).

36. O.E.Kurkina, A.A.Kurkin, E.A.Rouvinskaya, T.Soomere. Propagation regimes of interfacial solitary waves in a three-layer fluid. Nonlinear Processes in Geophysics (submitted).

37. T.Soomere, N.Delpeche-Ellmann, T.Torsvik, B.Viikmäe. Towards a new generation of techniques for the environmental management of maritime activities. Culshaw M.G. et al. (eds.), Environmental security of the European cross-border energy supply infrastructure, NATO Science for Peace and Security Series C: Environmental Security (accepted).

38. I.Bagdanavičiutė, L.Kelpšaitė, T.Soomere. Multi-criteria evaluation approach to coastal vulnerability index development in micro-tidal low-lying areas. Ocean & Coastal Management (accepted).

39. K.E.Parnell, T.Soomere, L.Zaggia, A.Rodin, G.Lorenzetti, J.Rapaglia, G.M.Scarpa. Ship-induced solitary Riemann waves of depression in Venice Lagoon. Physics Letters A (accepted).

40. B.Hünicke, T.Soomere, K.Skovgaard Madsen, M.Johansson, Ü.Suursaar, E.Zorita. Sea level and wind waves. The BACC II Book, Springer (submitted).

41. T.Soomere, S.R.Bishop, M.Viška, Andrus Räämet. An abrupt change in winds that may radically affect the coasts and deep sections of the Baltic Sea. Climate Research (accepted).

42. T.Torsvik, T.Soomere, I.Didenkulova, A.Sheremet. Identification of ship wake structures by a time-frequency method. Fluid Mechanics (accepted).

5.2.4 Popular science

1. J.Engelbrecht. Üks küsimus tippkeskusest (A question – what are centres of excellence in research?). Horisont, 2014, No 1, p4.

2. J.Engelbrecht. Matemaatika õhtuõpik – arvustus (Mathematics for evening reading). Akadeemia, 2014, No 3, 539–541.

3. J.Engelbrecht. Komplekssüsteemid meis ja meie ümber (Complex systems with us and in us). Horisont 2014, No 2, 28–36.

4. P.Saari. Public lecture on the Day of Photonics: Optics & Photonics in the Technology of the 21^{st} century. 2014, Oct. 21., Tartu.

5. H.Lukner. Performed as judge in European's best education TV show (according to EBU, 2012) Rakett 69 4^{th} season broadcasted in national TV in spring 2014, and participated on shooting of 5th season.

6. H.Lukner. Introduced Rakett 69 and popularized physics in Nõo Gymnasium, Tamme Gymnasium (Tartu) and Võru Kreutzwald's Gymnasium in September.

7. A.Valdmann. Participated in educational project ”Tudeng füüsikatundi” by giving 8 lectures in Estonian high schools highlighting the role of photonics in modern high-speed telecommunication.
8. B.Viikmäe. Laevateede optimeerimine Soome lahel pinnahoovuste mustrite põhjal (Fairway optimization in the Gulf of Finland based on patterns of surface currents). Meremees (The Mariner), 2/2014 (in Estonian).
9. M.Eelsalu, A.Ellmann, K.Julge, S.Märdla, T.Soomere. Rannaprotsesside anatoomia laserskaneerimise skalpelliga (Anatomy of coastal processes analysed by laser scanning). Kaugseire Eestis 2014, 2014, 47–58 (in Estonian).
10. T.Soomere. Kõigil on teadusest kasu (Everybody benefits from science). Postimees–Arvamus. Kultuur, 273(7264), 22.11.2014, 5 (in Estonian).
11. T.Soomere. Teaduse populariseerimisest (The meaning of science popularisation). Horisont, 6/2014, 4 (in Estonian).
12. T.Soomere. Merelt lähtuvate ohtude kvantifitseerimine ja minimeerimine Läänemere ranniku kontekstis (Quantification and minimization of marine coastal hazards in the Baltic Sea). Tallinna Tehnikaülikooli Aastaraamat 2013 (Yearbook of Tallinn University of Technology 2013). TTÜ Kirjastus, 2014, 170–190 (in Estonian).
13. T.Soomere. Keskkonnahoidliku merekasutuse matemaatika rakendusi Läänemere rannikute kaitseks (Applications of environmentally friendly mathematics for the protection of the Baltic Sea coasts). Tallinna Tehnikaülikooli Aastaraamat 2013 (Yearbook of Tallinn University of Technology 2013). TTÜ Kirjastus, 2014, 216–227 (in Estonian).

5.2.5 Other papers / Science policy

1. J.Engelbrecht. Akadeemiatest ja paradigmadest (On academies and paradigms). Akadeemia, 2014, No 4, 723–732 – in Estonian.
2. J.Järv, J.Engelbrecht, T.Soomere. Towards a tighter symbiosis of natural sciences and engineering. Proc. Estonian Acad. Sci., 2014 63, 1, p 1.
3. J.Engelbrecht. Mõtisklusi akadeemiast (Thoughts on the Estonian Academy of Sciences). Sirp, 2014, 28.nov.
4. J.Engelbrecht. Networks, mobility and young researchers. In Proc. Int. Conf. ”Transition to a new Society”, M.Djurovic (ed.), Montenegrin Academy of Sciences, Podgorica 2014, 573–576.
5. J.Kalda. Study guide: Available online,
   Electrical circuits: $http : //www.ioc.ee/\ kalda/ipho/e - circuits.pdf$,
   Problems of kinematics: $http : //www.ioc.ee/\ kalda/ipho/e - circuits.pdf$,
   Problems of mechanics: $http : //www.ioc.ee/\ kalda/ipho/meh_ENG.pdf$,
   also in Indonesian: $http : //www.ioc.ee/\ kalda/ipho/mechanics_Indonesian.pdf$.
6. T.Soomere. Pöördepunkt Eesti teaduses: uurimisprogrammide klastrist projektiteaduseks (Inflection point in Estonian science: from a cluster of research programmes to project-based science). Sirp, 24/25(3494/3495), 20.06.2014, 42–43 (in Estonian).
7. T.Soomere. Katse liigitada sädelemist (How to categorize sparkling science: a comment to the 75th birthday of J. Engelbrecht), Sirp, 29(3499), 25.07.2014, 29–30 (in Estonian).

8. T.Soomere. Teaduse järelkasv teadusreformi järellainetuses (Young scientists in the wake of changes in the science financing system). Sirp, 33(3503), 22.08.2014, 34–35 (in Estonian).

9. T.Soomere. Diagnoos: teadlane (Diagnosis: a scientist). Tallinna Tehnikaülikooli Aastaraamat 2013 (Yearbook of Tallinn University of Technology 2013). TTÜ Kirjastus, 2014, 22–30 (in Estonian).

10. J.Undusk, T.Soomere. Truudus Eestile. Globaliseeruvas maailmas (Loyalty to Estonia in the globalized world). Sirp, 50(3520), 19.12.2014, 2–5 (in Estonian).

5.3 Conferences

1. Euromech 563 "Generalized continua and their application to the design of composites and metamaterials", Cisterna di Latina, Italy, 17–21 March, 2014.
   A.Berezovski. Inertial and thermal effects in the internal variable description of microstructure.
   J.Engelbrecht. On solitary pulses in cylindrical biomembranes.

2. IDEAS 2014: "Investigating Dynamics in Engineering and Applied Science 2014", Budapest, Hungary, 3–5 July, 2014.
   J.Engelbrecht. Nonlinear waves in biological systems.

3. IUTAM Symposium "Complexity of Nonlinear Waves", Tallinn, Estonia, 8–12 September, 2014.
   General Sessions:
   A.Salupere. On formation and propagation of solitonic structures.
   J.Engelbrecht. Complexity in engineering and natural sciences.
   T.Soomere. Change in waves and winds that may lead to an ecological deadzone in the deep Baltic.
   J.Kalda. Implications of the theory of turbulent mixing for wave propagation in media with fluctuating coefficient of refraction.
   A.Berezovski. Nonlinear dispersive wave equations for microstructured solids.
   A.Stulov and V.I Erofeev. Shock wave propagation in nonlinear microstructured wool felt.
   T.Torsvik, I.Didenkulova, A.Rodin, H.Herrmann, E.Quak. Ship wake deformation in the surf zone analyzed by use of a time-frequency method.
   O.Didenkulov, I.Didenkulova, E.Pelinovsky. Parameterization of run-up characteristics of bell-shaped tsunami waves in a bay of parabolic cross-section.
   T.Peets, K.Tamm, M.Sepp. On mechanical aspects of nerve pulse propagation and Boussinesq paradigm.
   A.Rybin, T.Soomere, A.Kurkin, O.Kurkina, and D.Tyugin. Long-term variability of internal wave climate in the Baltic Sea.
   A.Stulov, V.I.Erofeev. Shock wave propagation in nonlinear microstructured wool felt.
   J.Janno, I.Sertakov, A.Šeletski. Reconstruction of parameters of nonlinear dispersive media by means of travelling waves.

   Student's Session:
   M.Lints, A.Salupere, S.dos Santos. On simulation of wave propagation in layered solids.
   B.Viikmäe, T.Soomere, T.Torsvik. Modelling wave-driven impacts on the spatial pattern of current-driven hits to the nearshore.
   M.Eelsalu, K.Julge, E.Grünthal, A.Ellmann, T.Soomere. Laser scanning reveals detailed spatial structure of sandy beaches.

K.Pindsoo, T.Soomere. Wave set-up climatology in the city of Tallinn, Estonia.
M.Viska, T.Soomere. Structural stability of eastern Baltic Sea coast under simulated wave-driven alongshore sediment transport.
N.Delpeche-Ellmann, T.Soomere. Using current-driven patterns in the surface layer of the Gulf of Finland to predict the marine protected areas most at risk of pollution.
A.Giudici, T.Soomere. Finite-time compressibility as a measure of likelihood of spontaneous patch formation in the Gulf of Finland.
A.Rodin, T.Soomere. Deformation of long large-amplitude waves in finite-depth fluid.

4. 27rd Nordic Seminar on Computational Mechanics NSCM-27, Stockholm, 22–24 October, 2014.
A.Berezovski, J.Engelbrecht, M.Berezovski: Numerical simulation of elastic wave diffraction at embedded gratings.

5. 11th European Conference on Non-Destructive Testing, Prague, Czech Republic, 6–10 October, 2014.
A.Berezovski, R.Kolman, J. Blažek, J.Kopačka, D.Gabriel, J. Plešek: Comparative study of finite element method, isogeometric analysis, and finite volume method in elastic wave propagation of stress discontinuities.
M.Lints, A.Salupere, S.Dos Santos. Simulation of Nonlinear Time Reversal wave propagation in carbon fibre reinforced polymer.
S.Dos Santos, Z.Dvořáková, M.Lints, V.Kus, A.Salupere, Z.Prevorovsky. Acoustic wave focusing in complex media using Nonlinear Time Reversal coded signal processing.
A.Salupere, M.Lints, M.Ratas. On detection of hidden solitons in solitonic systems

6. 2014 MRS Fall Meeting & Exhibit, Boston, Massachusetts, November 30 – December 5, 2014.
M.Berezovski, A.Berezovski: Numerical Simulation of Wave Propagation in Dynamic Materials.

7. Baltic-Nordic Acoustic Meeting BNAM 2014, Tallinn, Estonia, 2–4 June, 2014.
M.P.Vilà, I.A.Kubilay, D.Kartofelev, M.Mustonen, A.Stulov, V.Välimäki. High-speed line-camera measurements of a vibrating string.

8. International Symposium on Musical Acoustics ISMA 2014, Le Mans, France, 7–12 July, 2014.
D.Kartofelev, M.Mustonen, A.Stulov, V.Välimäki. Application of high-speed line scan camera for string vibration measurements. M.Mustonen, D.Kartofelev, A.Stulov, V.Välimäki. Experimental verification of pickup nonlinearity.

9. 7th Forum Acusticum 2014, Kraków, Poland, 7–12 September, 2014.
D.Kartofelev, A.Stulov. Wave propagation and attenuation in wool felt. M.Mustonen, D.Kartofelev, A.Stulov, V.Välimäki. Application of high-speed line scan camera for acoustic measurements of vibrating objects.

10. The 4th Finnish-Estonian Mathematics Colloquium & Finnish Mathematical Days, Helsinki, Finland, 09–10 January 2014.
T.Soomere. Changing wave climate in the Baltic Sea.
A.Braunbrück. Evaluation of functionally graded material properties by longitudinal wave motion.

11. First International Conference Augmented and Virtual Reality, AVR 2014, Lecce, Italy, September 17–20, 2014.
H.Herrmann, E.Pastorelli. Virtual reality visualization for photogrammetric 3D reconstructions of cultural heritage.

12. Joint Virtual Reality Conferences EuroVR 2014. Bremen, December 8–10, 2014.
H.Herrmann, M.Padilla, E.Pastorelli. A.c.t.i.v.e.: A scalable superellipsoid-based cfd visualization for virtual and desktop environments.

13. 14th Biennial Conference on Electronics and Embedded Systems. Tallinn, Estonia, October 6–8, 2014.
E.Pastorelli, H.Herrmann. Virtual reality visualization for short fibre orientation analysis.

14. 8th Annual Conference of the Information and Telecommunication Doctoral School. Rakvere, Estonia, December 5–6, 2014.
E.Pastorelli, H.Herrmann. Complex materials analysis and visualization through virtual reality environments.

15. Joint Meeting of the Federation of European Physiological Societies and the Hungarian Physiological Society, Budapest, 27–30 August, 2014.
M.Vendelin. Diffusion obstacles shape the environment surrounding mitochondria in heart.

16. International Conference at Glasstec, Düsseldorf, 21–22 October, 2014.
J.Anton presented the paper: H.Aben, D.Lochegnies, Y.Chen, J.Anton, M.Paemurru, M.Õis. A new approach to edge stress measurement in tempered glass panels.

17. 12th European Society of Glass Conference, Parma, 21–25 September, 2014.
H.Aben, J.Anton, M.Paemurru, M.Õis. Modern photoelastic technology for residual stress measurement in glass.

18. IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, Memphis, Tennessee, USA, July 6–11, 2014.
A.Valdmann, P.Piksarv, H.Valtna-Lukner, and P.Saari. Ultra-broadband dispersing and nondispersing Airy pulses.

19. Seminar: "40 years of spectral hole burning", Tartu, August 26, 2014.
P.Saari. Spectral hole burning in time domain.

20. Fourth Finnish-Estonian Mathematics Colloquium and Finnish Mathematical Days (FINEST MATH 2014), Helsinki, Finland, 8–10 January, 2014.
J.Belikov. Polynomial methods for nonlinear control systems (invited talk).

21. International seminar "Algebra and its applications", Änkküla, Estonia, 25–27 April, 2014.
Ü.Kotta. Polynomial tools for discrete-time nonlinear control systems.

22. 7th Dependable Systems, Services and Technologies conference (DESSERT 2014), Kiev, Ukraine, 16–18 May, 2014.
J.Vain. Provably correct online testing of timed systems (keynote speech).

23. The 11th International Baltic Conference on Databases and Information Systems (Baltic DB&IS 2014), Tallinn, Estonia, 8–11 June, 2014.
J.Vain. Probably Correct Test Development for Timed Systems.

24. The 21st International Symposium on Mathematical Theory of Networks and Systems (MTNS 2014), Groningen, The Netherlands, 7–11 July, 2014.
A.Kaldmäe, Ü.Kotta. Input-output decoupling of discrete-time nonlinear systems by measurement feedback.
T.Mullari. Geometric control for a nonlinear sampled data system.

25. The 19th IFAC World Congress (IFAC 2014), Cape Town, South Africa, 24–29 August, 2014.
J.Belikov, E.Petlenkov. Model based control of a water tank system.
A.Kaldmäe, Ü.Kotta. Disturbance decoupling by measurement feedback.
A.Kaldmäe, Ü.Kotta, A.Shumsky, A.Zhirabok. Disturbance decoupling for nonlinear systems by measurement feedback: sensor location.

26. 14th Biennial Baltic Electronics Conference (BEC 2014), Tallinn, Estonia, 6–8 October, 2014.
J.Vain. Towards context-sensitive dialogue with robot companion.

27. The 2014 IEEE Multi-Conference on Systems and Control (MSC 2014), Antibes, France, 8–10 October, 2014.
J.Belikov, Ü.Kotta, M.Tõnso, Z.Bartosiewicz, M.Wyrwas. Dynamic feedback linearization of nonlinear control systems on homogenous time scale.

28. Scientific conference and kick-off meeting of the Tempus project SESREMO "Strengthening Education in Space-based REMOte sensing for monitoring of eco-systems in Israel, Azerbaijan, Kazakhstan", 27–29 January 2014.
I.Didenkulova, T.Soomere. Contribution of the Institute of Cybernetics.

29. The Baltic Earth Workshop on Natural hazards and extreme events in the Baltic Sea region, Helsinki, Finland, 30–31 January 2014.
M.Eelsalu, K.Pindsoo and M.Org. Trends in long-term components and rapid variations in the water level: a case study for Tallinn Bay.
M.Eelsalu, P.Lagemaa, K.Pindsoo, T.Soomere. Evaluation of extreme water levels and their return periods near Tallinn using ensemble approach.

30. COST conference "The Predictive Power of Marine Science in a Changing Climate". Sopot, Poland, 07–08 April 2014.
M.Viška participated.

31. Conference on Wave Interaction (WIN-2014), Johannes Kepler Universität, Linz, Austria, 23–26 April 2014.
I.Didenkulova. Rogue waves in the basin of intermediate depth and in the coastal zone: observations and field data.

32. EGU General Assembly, Vienna, Austria, 27–02 May 2014.
I.Didenkulova, A.Rodin. Nonlinear dynamics of the coastal zone with applications to marine hazards.
A.Zaytsev. Assessment of Tsunami Inundation map for Bulgarian coasts of in the Black Sea.
A.Rodin, I.Didenkulova. Shallow water freak waves: the case of Tallinn Bay the Baltic Sea (poster presentations).
I.Didenkulova, P.Denissenko, A.Rodin, J.Pearson. Experimental study of the runup of long nonlinear regular and irregular waves (poster presentations).
I.Didenkulova, E.Pelinovsky. Travelling Long Waves in Water Channels of Variable Cross Section (poster presentations).
I.Didenkulova was a convener and the chair in two sessions: NH5.1 "Tsunami" and NH5.3 Nonlinear Dynamics of the Coastal Zone.

33. 2nd International Conference Climate Change – The environmental and socio-economic response in the southern Baltic region. Szczecin, Poland, 12–15 May 2014.
A.Giudici, T.Soomere. Highly persisting patch formation areas in the Gulf of Finland, the

Baltic Sea.
M.Eelsalu, T.Soomere. On spatio-temporal variations of the wave energy potential along the eastern Baltic Sea coast.
K.Pindsoo, T.Soomere. Signal of wave climate change reflected by wave set-up height.)
M.Viška, T.Soomere. On sensitivity of wave-driven alongshore sediment transport patterns with respect to model setup and sediment properties.

34. JONSMOD 2014 conference. Belgian Institute of Natural Sciences, Brussels, Belgium, 12–14 May 2014.
T.Torsvik, J.Kalda, B.Viikmäe. Eddy diffusivity in the Gulf of Finland based on drifter data and numerical modelling.

35. 11th International Baltic Conference on DB&IS (Data Bases and Information Systems, 09–11 June 2014.
A.Giudici, T.Soomere. Measuring Finite Time Compressibility from Large Simulated Datasets: Towards Identification of Areas of Spontaneous Patch Formation in the Gulf of Finland.

36. 6th International Workshop on Modeling the Ocean. IWMO 2014, Halifax, Canada, 24–27 June 2014.
B.Viikmäe, T.Soomere, T.Torsvik. Optimising fairways in the Gulf of Finland using patterns of surface currents.

37. International conference MEME'2014 "Mathematics and Engineering in Marine and Earth Problems". Aveiro, Portugal, 22–25 July 2014.
T.Soomere. Towards smart use of currents for environmental management of maritime activities.
A.Giudici, T.Soomere. Quantification of spontaneous patch generation in marine surface layer.
K.Pindsoo, T.Soomere, M.Eelsalu, H.Tõnisson. Vessel wakes effectively transport gravel, cobbles and pebbles.
M.Eelsalu, K.Julge, E.Grünthal, S.Talvik, A.Ellmann, T.Soomere, H.Tõnisson. Combined laser scanning to monitor coastal processes.
A.Rodin. Peculiarities of long wave transformation waves in nonlinear hyperbolic systems (shallow-water framework).
K.Pindsoo, T.Soomere. Changing wave set-up climate in the urban area of Tallinn, Estonia.
M.Eelsalu, T.Soomere. Intermittency of the wave energy flux in the eastern Baltic Sea.
B.Viikmäe, T.Soomere, T.Torsvik. Optimizing fairways in the Gulf of Finland using patterns of surface currents.

38. Conference "Population, risks and environment". Estonian Academy of Sciences, Tallinn, 17 September 2014.
T.Soomere. Marine-induced risks at Estonian coasts.

39. Meeting "20 years of VASAB 2010" and at the 8th VASAB Conference of Ministers Responsible for Spatial Planning and Development of the Baltic Sea Region in Tallinn, 25 – 26 September 2014.
B.Viikmäe. BalticWay project consortium materials (poster).

40. Conference of Estonian Remote Sensing Days 2014 with an oral presentation. 22 October 2014.
M.Eelsalu. Laser scanning anatomy of beach processes (in Estonian).

41. 10th Baltic Earth–Gulf of Finland Year 2014 Modelling Workshop, Finnish Environment Institute. SYKE, Helsinki, 24–25 November 2014.
T.Soomere, M.Eelsalu, K.Pindsoo. Major natural hazards in the Gulf of Finland.
M.Eelsalu, K.Julge, T.Soomere, E.Grünthal. Quantification of the evolution of a small beach applying laser scanning technology (poster).
K.Pindsoo, M.Eelsalu, T.Soomere. Quantification of the impact of vessel wakes on the transport of coarse sediments (poster).

42. CIESM International Scientific Forum-2014 "Advances and Gaps in Black Sea / Mediterranean Sea Oceanography" in Sochi, Russia, 30 November–03 December 2014.
I.Didenkulova. Monster waves in Russian waters.

5.4 Seminars

5.4.1 Tallinn Seminars on Mechanics (CENS 2013)

1. 13.1.2014, J.Kalda: Superdiffusion and structure functions of passive tracers in 2D quasistationary Gaussian flows.
2. 20.1.2014, L.Ilison: BIG DATA, what it is and how it is used for solving Business Problems.
3. 7.2.2014, A.Berezovski: Why the optical branch of dispersion curve is important for microstructure models?
4. 10.2.2014, I.Didenkulova: Long wave dynamics in the coastal zone with application to marine induced hazards.
5. 17.2.2014, S.Ainsaar (Univ. of Tartu): On the effect of time correlations of surface flows on the Lagrangian dynamics of passive tracers.
6. 21.2.2014, A.Berezovski: Fermi-Pasta-Ulam, Korteweg-de Vries, Spectral analysis.
7. 7.3.2014, A.Berezovski: Lattice vibration and wave dispersion.
8. 10.3.2014, J.Kübarsepp, I.Hussainova (TUT Faculty of Chemical and Materials Technology): Current Trends in Materials Engineering.
9. 31.3.2014, M.Eik: Orientation of short steel fibres in concrete: measuring and modelling.
10. 2.4.2014, H.Altenbach (Magdeburg University, Germany): Plates and shells.
11. 7.4.2014, J.Kalda: Yield of Binary Reactions in Turbulent Flows.
12. 14.4.2014, A.Rodin: From Riemann waves to planetary (Rossby and topographic) waves: how the background rotation, Earth's shape and bathymetry modify the long wave motion.
13. 28.4.2014, T.Torsvik: Data analysis of surface drifter data.
14. 5.5.2014, D.Kartofelev: Application of high-speed line scan camera for acoustic measurements of vibrating objects.
15. 13.5.2014, I.Didenkulova: Field experiment at Norderney, North, Sea: Wave statistics and its run-up on a beach.
16. 20.5.2014, G.Csernák (Budapest University of Technology and Economics): Small scale chaotic vibrations of digitally controlled systems.

17. 2.6.2014, A.Braunbrück, A.Ravasoo: Nonlinear reflection at the free boundary – analytical and numerical study.

18. 18.8.2014, D.Kartofelev: Nonlinear Sound Generation Mechanisms in Musical Acoustics.

19. 13.10.2014, N.Delpeche-Ellmann: Numerical simulation of average Eulerian and Lagrangian transport in the marine surface layer.

20. 20.10.2014, Arvi Ravasoo in memoriam: J.Engelbrecht: Inverse problems and studies by Arvi Ravasoo, J.Janno: Recent results of inverse problems research group, A.Braunbrück: Nonlinear propagation of a harmonic burst – comparing numerics with analytics.

21. 27.10.2014, I.Mandre: Intersections of spatial-temporal fractal sets – Kolmogorov wave dynamics.

22. 3.11.2014, N.Delpeche-Ellmann: Implications of general, deepwater and surface circulation of the Baltic Sea on the management of marine protected areas.

23. 10.11.2014, K.Tamm, T.Peets: Propagation of action potentials and mechanical waves in axons.

24. 17.11.2014, H.Hinrikus: EEG and brain models.

25. 1.12.2014, H.Herrmann, E.Pastorelli: Overview and a practical demonstration of the 3D visualization system.

26. 15.12.2014, M.Eik: Bond between steel fibres and concrete.

5.4.1.1 Seminars of the Wave Engineering Group

1. 07.01.2014. General discussion, reporting.

2. 21.01.2014. General discussion, reporting. Tomas Torsvik "About using wavelab-wiki and updated wavelab server tools".

3. 04.02.2014. Maris Eelsalu "Evaluation of extreme water levels and their return periods near Tallinn using ensemble approach" and Katri Pindsoo "Trends in long-term components and rapid variations in the water level: a case study for Tallinn Bay".

4. 18.02.2014. Artem Rodin "Influence of breaking effect of the transformation and run-up of long waves on the shore".

5. 25.02.2014. Bert Viikmäe "Optimising Fairways in the Gulf of Finland Using Patterns of Surface Currents".

6. 11.03.2014. General discussion.

7. 17.03.2014. Tomas Torsvik "Modelling mixing and transport in lakes, harbors and estuaries".

8. 25.03.2014. Reporting of the work in process.

9. 01.04.2014. General discussion, reporting.

10. 22.04.2014. Bert Viikmäe, Maris Eelsalu and Katri Pindsoo made short overview of their work to the artists in the frames of the event "Maikellukese päevad" (in Estonian).

11. 06.05.2014. Andrea Giudici "Highly persisting patch formation areas in the Gulf of Finland, the Baltic Sea", Maris Eelsalu "On spatio-temporal variations of the wave energy potential along the eastern Baltic Sea coast", Maija Viška "On sensitivity of wave-driven alongshore sediment transport patterns with respect to model setup and sediment properties" and Katri Pindsoo "Signal of wave climate change reflected by wave set-up height".
12. 20.05.2014. General discussion, reporting.
13. 26.05.2014. Maris Eelsalu "Visually observed wave climate in the Gulf of Riga" and "Combining airborne and terrestrial laser scanning to monitor coastal processes", Katri Pindsoo "An estimate of the impact of vessel wakes on coastal processes: a case study for Aegna, Estonia", Maija Viška "Variations of wave-driven sediment flux along the eastern Baltic Sea reflecting the choice of wind data".
14. 03.06.2014. Kevin Parnell, presentation (overview of his recent work).
15. 15.07.2014. Maris Eelsalu "Combined laser scanning to monitor coastal processes", Katri Pindsoo "Vessel wakes effectively transport gravel, cobbles and pebbles".
16. 05.08.2014. General discussion, reporting and planning.
17. 26.08.2014. General discussion, overview of work done in the summer.
18. 04.09.2014. Maris Eelsalu "Laser scanning reveals detailed spatial structure of sandy beaches", Katri Pindsoo "Wave set-up climatology in the city of Tallinn, Estonia", Artem Rodin "Deformation of long large-amplitude waves in finite-depth fluid", Maija Viška "Structural stability of eastern Baltic Sea coast under simulated wave-driven alongshore transport".
19. 16.09.2014. Maija Viška "Sediment transport patterns along the eastern coasts of the Baltic Sea".
20. 23.09.2014. Katri Pindsoo, Maris Eelsalu and Andrea Giudici gave short overview of their work. Discussion with prof. Jan Harff from Univeristy of Szczecin.
21. 30.09.2014. General discussion.
22. 21.10.2014. General discussion, reporting.
23. 04.12.2014. Nicole Delpeche-Ellmann "Circulation Patterns in the Gulf of Finland Applied to Environmental Management of Marine Protected Areas"

5.4.1.2 Seminars Nonlinear Control Group

1. 20.2.2014, T.Mullari: Discrete control of a system, linearizable by continuous-time feedback, along the desired trajectory.
2. 10.4.2014, T.Mullari: Discrete control of a nonlinear continuous-time system along the trajectory.
3. 24.4.2014, Prof. Ewa Pawłuszewicz (Bialystok University of Technology, Poland): Applications of functional universes in control theory.
4. 5,7,10.11.2014, Dr Claude Moog (Institut de Recherche en Communications et en Cybernétique de Nantes (IRCCyN), France): Nonlinear time-delay control systems.

5. 11.12.2014, Monika Ciulkin (Bialystok University of Technology, Poland): Input-output linearization by dynamic output feedback on homogeneous time scale.

5.4.1.3 Seminars of Optics Group

1. 21.03.2014 A.Valdmann. Curvilinearly propagating light bullets, Estonian Physics Days, Tartu.

5.4.2 Lectures and seminars outside CENS

1. J.Engelbrecht. Funding of Centres of Excellence. The Conference on Research Funding in Estonia, 14 Febr., 2014, Tartu.
2. J.Engelbrecht. Networks, mobility and young researchers. International Conference "Transition to a New Society" 20–22 March, 2014, Podgorica, Montenegro.
3. J.Engelbrecht. Overview on CENS. Academy of Sciences of Turin, Class of Phys., Math., and Nat. Sciences, 08 April, 2014, Turin, Italy.
4. J.Engelbrecht. International science organizations in Europe. Academy seminar on international cooperation, 19 May, 2014, Tallinn.
5. J.Engelbrecht. Estonian research structure and funding perspectives. Oxford-Cambridge Club meeting, 10 July, 2014, Tallinn.
6. J.Engelbrecht. Mathematics and time. Summer School "Timeless time", 22–24 Aug., 2014, Käsmu, Estonia.
7. J.Engelbrecht. Drivers and barriers in education. WAAS International Conference on New Paradigms, 05–08 Nov., 2014, Almaty, Kazakhstan.
8. A.Salupere. Nonlinear waves in solids – overview of studies carried out in CENS, INSA Centre Val de Loire, 25 March 2014.
9. M.Lints. Simulations of soliton formation and propagation in complex systems. INSA Centre Val de Loire, 25 March 2014.
10. A.Berezovski, M.Berezovski. Stress field distortion by crack propagation in 3-point bending test. March, 24, NanoCom seminar, Tartu.
11. H.Herrmann. Short Fibre Composites and Virtual Reality, Division of Virtual Product Development, TU Chemnitz, 17 December, 2014.
12. J.Vain. Specific Objectives of Security and Resilience Curricula in Ukraine. TEMPUS SEREIN meeting in City University London, UK, 19, 20 June, 2014.
13. Ü.Kotta. Lecture on Institute of Cybernetics and Tallinn University of Technology. Far Eastern Federal University, Vladivostok, Russia, 17 September, 2014.
14. Ü.Kotta. Lecture on Institute of Cybernetics and Tallinn University of Technology. Bialystok University of Technology, Białystok, Poland, 15 October, 2014.
15. Ü.Kotta. Research in the Control Laboratory of Institute of Cybernetics. Bialystok University of Technology, Białystok, Poland, 22 October, 2014.

16. Ü.Kotta. Algebraic methods of differential one-forms in the study of nonlinear control systems – advantages and disadvantages. Seminar at Johannes Kepler University of Linz, Linz, Austria, 18 November, 2014.

17. Ü.Kotta. Non-integrable observable space and realization via postcompensator. Seminar at Johannes Kepler University of Linz, Linz, Austria, 20 November, 2014.

18. R.Birkedal. How to understand heart? Talk in Sütevaka Gymnasium (Pärnu) within the Researcher's Night Programme, 26 September, 2014.

19. M.Vendelin. Rhythms in heart and brain. Öökulli Akadeemia, Eesti Loodusmuuseum (Owl's Academy, Estonian Museum of Natural History), 06 November, 2014.

20. T.Soomere. Baltic Sea waves in the middle of changes. The 3rd Sparkling Seminar on marine science, limnology and coastal engineering, the Estonian Marine Institute at Tartu University, 04 February, 2014.

21. K.Parnell. Why ship generated wakes matter. Consiglio Nazionale delle Ricerche institute – INSEAN (The Italian Ship Model Basin), 24 March, 2014.

22. K.Parnell. Climate change, coastal processes and communities on reef islands. Consiglio Nazionale delle Ricerche – Istituto de Scienze Marine (CNR-ISMAR), Venice, Italy, 03 April, 2014.

23. T.Soomere. On the possibilities to protect the coastal zone of the Kakumäe Peninsula. Maintenance and security of beaches. Estonian Society of Municipal Engineering, Tallinn, Estonia, 24 April, 2014.

24. K.Parnell. Why ship generated wakes matter. Consiglio Nazionale delle Ricerche – Istituto de Scienze Marine. CNR-ISMAR, Venice, Italy, 28 April, 2014.

25. T.Soomere. Dialogue of waves and coasts. Days of the Estonian Academy of Sciences in Saaremaa. Kuressaare Adults Gymnasium, 22–23 May, 2014.

26. T.Soomere. The art of waves. Maikellukese Päevad 2014 (Science as inspiration for artists), Kanuti Gild, Tallinn, 24 May, 2014.

27. B.Viikmäe. Technology of preventive optimisation of fairways. Maikellukese Päevad 2014 (Science as inspiration for artists), Kanuti Gild, Tallinn, 24 May, 2014.

28. T.Soomere. Dialogue of coasts and waves. Summer University, Tapurla, Juminda, 14 June, 2014.

29. T.Soomere. Slow dialogue of sea and land. Summer school. Käsmu, Estonia, 22–24 August, 2014.

30. T.Torsvik. Master Class lecture: Preventive Methods for Coastal Protection. Tempus project SESREMO, Baku State University, Baku, Azerbaijan, 06–07 October, 2014.

31. T.Soomere. The coasts of Estonia and the Baltic Sea under joint pressure of nature and mankind. (Eesti ja Läänemere rannikud looduse ja inimeste surve all). Seminar of gymnasium teachers in the framework of the UNESCO Baltic Sea project, Pärnu, Centre of Environmental Education (in Estonian), 23 October, 2014.

32. T.Soomere. The partnership of GIS and coastal science. (GIS rannikuteaduse partnerina.) Conference on the occasion on the GIS Days, Estonian National Library (in Estonian), 19 November, 2014.

33. T.Soomere. The coasts of the Gulf of Finland under joint pressure of nature and mankind. (Soome lahe rannikud looduse ja inimeste surve all). Seminar Days of Estonians in Foreign Countries, Tallinn University of Technology (in Estonian), 29 November, 2014.

34. T.Soomere. The coastal zone under impact of high water level and large waves. (Rannavöönd kõrge vee ja suurte lainete surve all). Committee on Environmental Protection of the City Council of Tallinn (in Estonian), 01 December, 2014.

35. T.Soomere. The partnership of the Academy of Science and the Society of Engineers: from the past to the future. (Akadeemia ja inseneeria partnerlus: ühine vaade minevikku ja tulevikku). General Assembly of the Estonian Society of Engineers (Estonian Academy of Sciences, Tallinn), 12 December, 2014.

36. T.Soomere. The timeless values of Academia on the landscape of science. (*Academia* ajaülesed väärtused muutuval teadusmaastikul). 58th scientific conference "The days of Kreutzwald" (Estonian Literature Museum, Tartu) (in Estonian), 16–17 December, 2014.

37. P.Saari. "Teaduse rahastamise reformist, nähtuna suurima ülikooli suure instituudi seest, toetudes TÜ FI ja ETAGi statistilisele andmestikule ning AFO kolleegide arvamustele" (On science reform from the viewpoint of a large institute of the largest University) at science policy conference, 2014, Tartu, Omicum.

5.5 Meetings and events

5.5.1. Meetings and events in CENS

IUTAM symposium "Complexity of Nonlinear Waves", 8–12 September, 2014. The symposium was focused on nonlinear problems related to wave propagation in solids and fluids. Researchers from 25 countries gave 47 oral and 11 poster presentations. Presentations from CENS are listed in Section 5.3. The Symposium was dedicated to 75 anniversary of Prof. Jüri Engelbrecht, the Head of CENS.

Intense day on Marine Research, 3 March, 2014.

1. Presentations to this event organised by the Wave Engineering Laboratory were given by Prof. Urmas Lips "Recent marine research in the Marine Systems Institute" (Marine Systems Institute at Tallinn University of Technology), Prof. Kristofer Döös "The coupled ocean-atmosphere hydrothermohaline circulation" (Department of Meteorology, Stockholm University, Sweden), Dr. Bjørn Ådlandsvik "NorKyst800 and the Norwegian Current Information System" (Department of Institute of Marine Research and Bjerknes Centre for Climate Research, Bergen, Norway) and Prof. Pentti Kujala "Challenges of Arctic operations and related research" (School of Engineering, Aalto University, Espoo, Finland).

Intense day on coastal science, 22 September, 2014.

1. Prof. Dr. Jan Harff "River-mouth systems – zones of interference between terrestrial, marine and anthropogenic impacts" (Institute of Marine and Coastal Sciences, University of Szczecin, Poland & Leibniz-Institute for Baltic Sea Research, Warnemünde, Germany).

2. Dr. Daria Ryabchuk "Coastal systems of the eastern Gulf of Finland: Holocene development and recent dynamics" (A.P.Karpinsky Russian Geological Research Institute (VSEGEI), Russia, St.Petersburg).

3. Dr. Albertas Bitinas "Geology of the Curonian Spit" (Marine Science and Technology Center & Department of Geophysical Sciences, Faculty of Natural Sciences and Mathematics, Klaipėda University, Lithuania).

Intense day on Marine Science, 8 December, 2014.

1. Presentations to this event organised by the Wave Engineering Laboratory and held in the Estonian Academy of Sciences were given by Dr. habil. Joachim Dippner "Quo vadis, Baltic Sea" (Leibniz-Institute for Baltic Sea Research, Warnemünde, Germany), Dr. Kai Myrberg "The Gulf of Finland Year: marine science for the benefit of all" of us (Finnish Environment Institute SYKE, Helsinki, Finland; Vice-President of ICES) and Dr. Vladimir Ryabchenko "Modeling the variability of marine ecosystem in the Canary upwelling system" (Saint Petersburg Branch, P.P.Shirshov Institute of Oceanology, Russian Academy of Sciences).

Annual Seminar of the Institute of Cybernetics, Jäneda, 8–9 December, 2014.

1. M.Laasmaa. Calcium Fluxes in Heart Cells.
2. R.Birkedal. Getting to the heart of the matter: Do we need creatine for energy transfer?
3. T.Mullari. Geometric control for a nonlinear sampled data system.
4. A.Kaldmäe. Integrability conditions for nonlinear time-delay control systems.
5. J.Engelbrecht. On interdisciplinarity.
6. H.Herrmann. Short Fibre Composites and Virtual Reality.
7. D.Kartofelev. Kymographic imaging of vibrating strings.
8. R.Kitt. Economic decision-making: an application of complex systems
9. T.Torsvik. Recent developments in data analysis of surface current measurements.
10. A.Rodin. Ship-induced solitary Riemann waves of depression in Venice Lagoon.
11. K.Pindsoo. Quantification of the impact of vessel wakes on the transport of coarse sediment.
12. M.Eelsalu. Intermittency of the wave energy flux in the eastern Baltic Sea.

Arvi Ravasoo – in memoriam, CENS seminar, 20 October, 2014

1. J.Engelbrecht. Inverse problems and studies by Arvi Ravasoo (1939–2014).
2. J.Janno. Recent results of inverse problems research group
3. A.Braunbrück and A.Ravasoo. Nonlinear propagation of a harmonic burst – comparing the numerics with analytics.

The 14th Tallinn Glass Stress Summer School, 29–30 May, 2014, was organized Laboratory of Photoelasticity together with the company GlasStress Ltd. The number of participants was 8, from Austria, United Kingdom, Germany, Denmark and Estonia.

The 4th Sparkling Seminar on marine science, limnology and coastal engineering, 5 May, 2014, was organised jointly by the Wave Engineering Laboratory and the Commission on Marine Sciences of the Estonian Academy of Sciences and hosted by the Ministry of the Environment. The keynote lecture “Invasion of the alien species: fight with inevitability or hope exists?” was given by Henn Ojaveer (Estonian Marine Institute).

6. Research and teaching activities

6.1 International cooperation

Nonlinear Dynamics Group:

- Estonian-Hungarian Joint Research Project for 2013–2015 on ”Thermal and mechanical phenomena in media with multiscale microstructure,” within Estonian Academy of Sciences and Hungarian Academy of Sciences (A.Berezovski, J.Engelbrecht).
- Estonian-Czech Joint Research Project for 2015–2017 on ”Advanced numerical modelling of dynamic processes in solids,” within Estonian Academy of Sciences and the Academy of Sciences of the Czech Republic (A.Berezovski, J.Engelbrecht, A.Salupere, K.Tamm). This project is supported by the MoU (2012–2014) between the Institute of Thermodynamics of the AS CZ and CENS, Institute of Cybernetics at Tallinn UT.
- Agreement of scientific cooperation (2014–2016) on ”Micro-macro-interactions in microstructured media” between the Institute for Mechanics, Otto-von-Guericke-University Magdeburg and CENS, Institute of Cybernetics at Tallinn UT.
- Agreement of scientific cooperation (2014–2016) on ”Influence of microstructure on dynamic material response” between the International Research Center for Mathematics & Mechanics of Complex Systems (Cisterna di Latina, Italy) and CENS, Institute of Cybernetics at Tallinn UT.
- MoU on research (2013–2015) on ”Waves in elastically non-linear solids, shock waves and numerical methods” between Worcester Polytechnic Institute (USA) and CENS, Institute of Cybernetics at Tallinn UT.
- Agreement of scientific cooperation (2013–2015) on ”Dynamics of nonlinear and strongly inhomogeneous materials” between Blekinge Institute of Technology (Sweden) and CENS, Institute of Cybernetics at Tallinn UT.
- Agreement of scientific cooperation (2013–2015) on ”Crack propagation and damage description” between Tampere University of Technology (Finland) and CENS, Institute of Cybernetics at Tallinn UT.
- Agreement of scientific cooperation (2012–2015) on ”Nonlinear wave propagation in complex media” between PRES Centre Val de Loire University (France) and CENS, Institute of Cybernetics at Tallinn UT.
- Mutual cooperation between the Department of Signal Processing and Acoustics (Aalto University, School of Electrical Engineering, Espoo, Finland) and the Institute of Cybernetics at Tallinn University of Technology.

Nonlinear Control Group:

- A.Kaldmäe. Joint PhD studies with Ecole Centrale de Nantes, France.
- Collaboration with French scientists A.Quadrat (INRIA Saclay – Île-de-France) and T.Cluzeau (University of Limoges) within the framework of G. F. PARROT programme.
- Collaboration with (1) Slovak University of Technology: Dr. Miroslav Halás, (2) Institut de Recherche en Communications et en Cybernétique de Nantes (IRCCyN): Prof. Claude H. Moog, (3) Far Eastern Federal University: Prof. Alexey N. Zhirabok, (4) Osaka Unimersity: Dr. Yu Kawano. Collaboration includes joint publications, exchange visits, seminars for graduate students.
- Collaboration with Åbo Akademi University, Aalborg University, Kharkov University of Avionics, Technical University of Denmark, University of Sannio.

Laboratory of Wave Engineering:

- 17 March – 30 April 2014, K.Parnell and L.Ischenko (usually based in James Cook University (JCU), Australia) renewed a long association with the Wave Engineering Laboratory for five months. Between March and May they have been based in Venice, working with scientists from the Consiglio Nazionale delle Ricerche – Istituto de Scienze Marine (CNR-ISMAR) researching waves generated by large cruise ships in the Lido Channel and by cargo ships in the Industrial Channel, and developing collaborations between IOC, ISMAR and JCU. During this time, field experiments were undertaken showing that the cruise boats produced minimal wake-wave impacts, but there were significant effects in the smaller industrial channel. Seminars were presented at ISMAR ('Why ship generated wakes matter' and 'Climate change, coastal processes and communities on reef islands') and at another Consiglio Nazionale delle Ricerche institute – INSEAN (The Italian Ship Model Basin) which operates a number of vessel tow tank and other vessel testing facilities ('Why ship generated wakes matter').

6.2 Teaching activities

6.2.1 Courses:

1. J.Engelbrecht – courses in TUT (MSc level):
   – Mathematical modelling (assistant T.Peets);
   – Nonlinear Dynamics and Chaos (assistant D.Kartofelev).
2. A.Salupere – courses in TUT:
   – Fundamentals of Elasticity;
   – Continuum Mechanics;
   – Theory of Elasticity;
   – Seminars and Special Seminars for MSc and PhD students.
3. J.Kalda, M.Kree:
   – Training of the Estonian team of the International Physics Olympiad.
4. A.Braunbrück – courses in TUT:
   – Technical Mechanics I;
   – Technical Mechanics II;
   – Statics;
   – Dynamics.

5. H.Herrmann – courses in TUT:
   Special Topics in Scientific Visualization, ITI8910, Spring, Autumn 2014;
   Simulation of new Materials, in Institute of Physics, TU Chemnitz, Winter 2014/2015.

6. P.Peterson – courses in TUT:
   – EMR9740 Scientific programming with Python.

7. J.Belikov – courses in TUT:
   – ISS0010 System Theory (BSc)
   – ISS0031 Modeling and Identification (MSc)

8. J.Vain – courses in TUT:
   – ITI0021, Logic Programming (BSc)
   – ITI8531, Software Synthesis and Verification (MSc)
   – IXX9601, IXX9602, IXX9603, Doctoral seminar "Formal methods in model-based testing and verification" (PhD)

9. T.Mullari – courses in TUT:
   – YFR0030, Physics (BSc / MSc)

10. M.Viška – Short course in TUT:
    – Risk and uncertainty assesment

11. A.Räämet – courses in TUT:
    – Structural Mechanics.

12. The Wave Engineering Laboratory team organised an international training event in the framework of Tempus SESREMO project jointly with the Klaipėda University (01–14.11.2014). The event focused on three new curricula:

    - Preventive methods for coastal environmental protection;
    - Environmental Mathematic Modelling for wave dynamics;
    - Coastal processes and environmental management.

    1 and 14 November: discussions on the curriculum Preventive methods for coastal environmental protection (Tallinn, Institute of Cybernetics, I.Didenkulova, T.Torsvik).
    2–13 November: Training event in Klaipėda, sample lectures (4 academic lecture hours each) on the curricula *Environmental Mathematic Modelling for wave dynamics* and *Coastal processes and environmental management* (T.Soomere, assisted by A.Rodin):

    The theoretical material was linked to practical demonstrations (L.Kelpšaitė, T.Mingelaitė, E.Valaitis):

    - full day of field work dedicated to naturally developing sandy beaches in different locations of the Curonian Spit (UNESCO World Heritage) and examples of sustainable management of the coastal zone (groins, stabilisation of sand masses, handling of the problem of cormorants);
    - half-day visit to a beach near Klaipėda (with sighting of a recently discovered ship wreck from 19th century in an area suffering from intense erosion) and to Palanga Beach that has been subject of considerable anthropogenic interventions.

Courses in University of Tartu:

13. P.Saari:
– Quantum mechanics;
– Advanced quantum mechanics.

14. H.Lukner:
- Physics and technology, lectures on optics.

15. P.Piksarv:
– Practical course in physics III – Optics.

16. A.Valdmann:
– Seminars on optical properties of matter.

6.2.2. Participation in other events, transfer of knowledge:

1. J.Kalda, M.Kree – participation at the 45th International Physics Olympiad (July 2014, Astana, Kazakhstan).

2. J.Kalda – participation at the 15th Asian Physics Olympiad (May 2014, Singapore).

3. J.Kalda, M.Kree – training of the Estonian and Finnish teams of the International Physics Olympiad – June 2014.

4. J.Kalda – training of the Saudi Arabian team of the International Physics Olympiad (lectures in KAUST University in February and May 2014), and Brazilian team of the International Physics Olympiad (lectures in Sao Paulo, June 2014).

5. J.Kalda – Academic Advisor of the Saudi Arabian team of the International Physics Olympiad.

6. J.Kalda – member of the Syllabus Committee of the International Physics Olympiad; the new Syllabus was accepted in July 2014 at the 45th International Physics Olympiad in Astana.

7. J.Belikov – participation in module ”Introduction to Geometric Nonlinear Control Theory and Applications” (Prof. W.Respondek). HYCON-EECI Graduate School on Control, Istanbul, Turkey, 28 April – 2 May, 2014.

8. Ü.Kotta – lecture course for graduate students ”Polynomial methods in the study of nonlinear systems” in Far Eastern Federal University, Vladivostok, Russia, 15–24 September, 2014.

9. Ü.Kotta – lecture courses for graduate students ”Algebraic methods in nonlinear control” and ”Mathematica-based software NLControl and its webservice” in Bialystok University of Technology, Białystok, Poland, 1–31 October, 2014.

10. T.Soomere – the first opponent of the PhD thesis ”Modelling of coastal morphogenesis – past and future projection (examples from the southern Baltic Sea)” by Junjie Deng (University of Szczecin, Poland), 12 April, 2014.

11. M.Eelsalu and K.Pindsoo participated in the event Maikellukese Päevad 2014 (Science as inspiration for artists), Tallinn, 10 May, 2014.

12. T.Soomere – the official opponent of the PhD thesis "Sea level changes on the Finnish coast and their relationship to atmospheric factors" by Milla M. Johansson (University of Helsingi, Finland), 04 June, 2014.

13. I.Didenkulova and T.Torsvik – attended a coordination meeting for the Tempus project SESREMO, organized by Baku State University in Baku, Azerbaijan. As part of the meeting, T.Torsvik gave a Master Class lecture "Preventive Methods for Coastal Protection", 06–07 October, 2014.

14. I.Didenkulova – official opponent of the Cand. Phys. Math. Sci (equivalent to PhD) thesis of Igor Medvedev "Spectrum of Baltic Sea water level oscillations in the period range from hours to years" (P.P.Shirshov Institute of Oceanology, Moscow), 25 November, 2014.

15. I.Didenkulova – official opponent of the PhD thesis "Experimental work related to tsunami research, conducted in 2D small scale and 3D large scale facilities" by Erika Kristina Lindstrøm (University of Oslo, Norway), 10 December, 2014.

16. M.Vendelin – official opponent of the PhD thesis of Hannes Hettling, Free University Amsterdam, 12 June, 2014.

6.3. Visiting fellows

For shorter period

1. Dr. Peter Ván: Research Institute of Particle and Nuclear Physics, Budapest, Hungary, September 7–21, 2014.

2. Dr. Radek Kolman, Dr. Jiří Plešek, Institute of Thermomechanics, Academy of Sciences of Czech Republic, Prague, Czech Republic, September 7–13, 2014.

3. Marcel Padilla, TU Berlin, Germany, 20 June – 20 September 2014 (DAAD-Rise internship).

4. Michael Krause, RWTH Aachen, Germany, 25 August – 05 September 2014 (DAAD-Rise internship).

5. Liis Harjo, TUT, 14 June – 7 August 2014 (IT Akadeemia internship).

6. Prof. Ewa Pawłuszewicz, Bialystok University of Technology, Białystok, Poland, 22–29 April, 2014.

7. Dr. Alban Quadrat, INRIA Saclay – Île-de-France, Paris, France, 20–24 October and 8–12 December, 2014.

8. Dr. Thomas Cluzeau, University of Limoges, Limoges, France, 20–24 October and 8–12 December, 2014.

9. Dr. Yu Kawano, Kyoto University, Kyoto, Japan, 3–14 November, 2014.

10. Prof. Claude H.Moog, Institut de Recherche en Communications et en Cybernétique de Nantes (IRCCyN), Nantes, France, 4–11 November, 2014.

11. Dr. Luca Zaggia (National Research Council of Italy: Institute of Marine Science (CNR-ISMAR)), to discuss the results of field campaing on ship wake measurements in Venice Lagoon and to draft further joint research plan, July 2014.

12. Prof. Dr. Andrey Kurkin and Dr. Oksana Kurkina (Department of Applied Mathematics, Nizhny Novgorod State Technical University n.a. R.E.Alekseeva), for longer research stay targeted at the analysis of changes in the propagation regime of internal waves in the Baltic Sea, 16 July–15 August 2014.

13. Prof. Pentti Kujala (School of Engineering, Aalto University, Finland), Dr. Bjørn Ådland svik (Institute of Marine Research and Bjerknes Centre for Climate Research, Bergen, Norway) and Prof. Kristofer Döös (Department of Meteorology, University of Stockholm), to participate in the Intense Day on Marine Research and in the defence of the PhD thesis of Bert Viikmäe (03 March 2014). Prof. Kujala and dr. Ådlandsvik were opponents of this thesis, 02–04 March 2014.

14. Prof. Dr. Jan Harff (Institute of Marine and Coastal Sciences, University of Szczecin, Poland and Leibniz-Institute for Baltic Sea Research, Warnemünde, Germany), Dr. Albertas Bitinas (Marine Science and Technology Center, Klaipėda University, Lithuania) and Dr. Dariya Ryabchuk (A.P.Karpinsky Russian Geological Research Institute (VSEGEI), Russia, St.Petersburg), to participate in the Intense Day on Coastal Science and in the defence of the PhD thesis of Maija Viška (22 September 2014). Prof. Harff and dr. Bitinas were opponents of this thesis, 21–23 September 2014.

15. Privatdozent Dr. habil. Joachim W. Dippner (Leibniz-Institute for Baltic Sea Research, Warnemünde, Germany), DSc Vladimir A. Ryabchenko (Saint Petersburg Branch, P.P.Shirshov Institute of Oceanology, Russian Academy of Sciences, Saint Petersburg, Russia) and Dr. Kai Myrberg (Finnish Environment Institute SYKE), to participate in the Intense Day on Marine Science and in the defence of the PhD thesis of Nicole Delpeche-Ellmann (08 December 2014). Prof. Dippner and dr. Ryabchenko were opponents of this thesis, 07–09 December 2014.

16. Prof. Dr. Andrey Kurkin and Dr. Oksana Kurkina (Department of Applied Mathematics, Nizhny Novgorod State Technical University n.a. R.E.Alekseeva), to finish the joint manuscript "Propagation regimes of interfacial solitary waves in a three-layer fluid" and to discuss cooperation plans for 2015, 14–20 December 2014.

For longer periods

1. E.Pastorelli, Italy (PhD student, DoRa support).

2. G.Psistakis, Krete, Greece, (ERASMUS internship), 1 September 2013 – 31 March 2014.

3. M.Ciulkin, PhD student of Bialystok University of Technology, 15 September – 13 December, 2014, Activity 5 of the ESF DoRa programme visiting PhD student under supervision of Ü.Kotta and V.Kaparin.

4. K.Parnell, L.Ischenko (usually based in James Cook University, Australia) worked in the Wave Engineering Laboratory in March–July 2014.

5. Tiziano Modica, Lucia Favosi – MSc students from Catania University, Italy.

6.4 Graduate studies

Nonlinear Dynamics:
Promoted:

1. PhD:

M.Eik.	Short fibre orientation phenomenon in concrete composites: measuring and theoretical modelling (supervisor H.Herrmann).
D.Kartofelev.	Nonlinear Sound Generation Mechanisms in Musical Acoustics (supervisor A.Stulov).

2. MSc:

M.Mustonen	Magnetic Pickup Nonlinearity (supervisor A.Stulov, co-supervisor D.Kartofelev)

In progress:

1. PhD:

M.Lints.	Application of solitary waves for nonlinear medical imaging and non destructive testing of materials (supervisors A.Salupere, S.Dos Santos (France)).
E.Pastorelli.	3D virtual reality visualization techniques for microstructured materials and virtual reality systems improvements (supervisors H.Herrmann, J.Engelbrecht).
S.C.Azizabadi.	Nonlinear dynamics of solids: energy transport in deformed crystal lattice and defects formation (supervisors V.Hižnjakov, J.Kalda).
S.Ainsaar.	Stochastic transport in two- and three-dimensional structures (supervisors J.Kalda, Teet Örd).
M.Heidelberg.	Transfer processes in fluctuating media (supervisors J.Kalda, T.Örd).
J.Jõgi.	Semiempirical modeling of structure and functional properties relationships of micro- and nanostructured materials (supervisors J.Kalda, A.Romanov, A.Lõhmus).
St.Rendon De La Torre	From theory to application: econophysics and finances (supervisor J.Kalda)
I.Mandre.	Percolation phenomena in complex systems (supervisor J.Kalda).

Laboratory of Systems Biology:
In progress:

1. PhD:

J.Branovets.	Structural and energetic modifications in cardiomyocytes from mice with modified creatine kinase system (supervisor R.Birkedal).
N.Jepihhina.	Heterogeneity of energetic parameters in cardiomyocytes (supervisor M.Vendelin).
M.Kalda.	Mechanoenergetics of a single cardiomyocyte (supervisors M.Vendelin, P.Peterson).
M.Laasmaa.	Studies of the relationship between excitation-contraction coupling and energetics on trout cardiomyocytes (supervisors P.Peterson, R.Birkedal).

P.Simson.	Localization of diffusion restrictions in cardiomyocytes (supervisors P.Peterson, M.Vendelin).
N.Karro.	Energetics and contractility in heart of rainbow trout (supervisor R.Birkedal).
M.Mandel.	Bioenergetics of mitochondrial dynamics in neurons (supervisors A.Kaasik, M.Vendelin).

2. MSc:

M.Poroson.	Deconvolution of fluorescence microscopy images (supervisors M.Laasmaa and P.Peterson).

Laboratory of Wave Engineering:
Promoted:

1. PhD:

B.Viikmäe.	Optimizing Fairways in the Baltic Sea Using Patterns of Surface Currents (supervisor T.Soomere).
M.Viška.	Evolution and forecast of open sedimentary coasts in the Baltic Sea conditions (supervisor T.Soomere).
N.Delpeche-Ellmann.	Using improved understanding of the circulation pattern in the Gulf of Finland to minimize coastal pollution (supervisor T.Soomere).

In progress:

1. PhD:

A.Rodin.	Evolution, runup and breaking of strongly nonlinear sea waves in the nearshore (supervisors I.Didenkulova and T.Soomere).
A.Giudici.	Quantification and visualisation of current-induced risk of coastal pollution (supervisor T.Soomere).
M.Eelsalu.	Quantification of the reaction of Estonian beaches to changing wave loads (supervisors T.Soomere and A.Ellmann).
K.Pindsoo.	Quantification of wave-driven hazards at the Estonian beaches (supervisor T.Soomere).
O.Kovaleva.	Development of the coastal zone of the Eastern Gulf of Finland in Holocene (supervisor T.Soomere).

2. MSc:
   M.Org.

Control Systems Department:
Promoted:

1. MSc:

K.Halturina.	Computer algebra tools for feedback linearization and computation of flat outputs (supervisors M.Tõnso, A.Quadrat).
E.Till.	ICT Risk Assessment of Smart Electricity Meters (supervisor J.Vain).
D.Pal.	Model Based Conformance Testing of Reactive Systems (supervisor J.Vain).

In progress:

2. PhD:

A.Kaldmäe.	Advanced design of nonlinear discrete-time and delayed systems (supervisors Ü.Kotta and C.H.Moog).
S.Avanessov.	Robust adaptive output controller (co-supervisor Ü.Nurges).
A.Anier.	Motion recognition via abstract interpretation (supervisor J.Vain).
D.Pal.	Model-based test generation for distributed systems (supervisor J.Vain).
J.Guin.	An expert system to find court cases based on similarities (supervisor J.Vain).
J.Irve.	Feature Detection and Tracking for Medical (supervisor J.Vain).
E.Halling.	Distributed intelligent control of cooperative robotic systems (supervisor J.Vain).
G.Kanter.	Cognitive context-aware planning in autonomous robot systems (supervisor J.Vain).
P.Lump.	Quality assurance of safety critical software systems using quantitative methods (supervisor J.Vain).
A.Tepljakov.	Fractional-order calculus based identification and control of complex dynamic systems (co-supervisor J.Belikov).

Optics group:
Promoted:

1. BSc:

A.Remm.	The feasibility of charged particle acceleration with optical non-diffracting pulses.

In progress:

2. PhD
A.Valdmann.

6.5 Distinctions and awards

Fellows:

1. T.Soomere: elected the President of the Estonian Academy of Sciences.
2. T.Soomere: received the state decoration III class Order of the White Star.
3. R.Kitt: Chairman of the Board; Head of Swedbank Estonian Branch.
4. B.Viikmäe: Post-doc scholarship of the Estonian Academy of Sciences.
5. I.Didenkulova: awarded National L'Oreal-UNESCO award "For Women in Science". Award ceremony took place in the Pushkin State Museum of Fine Arts and Hotel Baltschug-Kempinski in Moscow, Russia.
6. M.Eik: H.Laul post-doc scholarship awarded by AS Nordecon.
7. P.Saari: Honoured Citizen of Tartu.
8. J.Belikov: Academician Boris Tamm's honorary scholarship.

Students:

1. K.Halturina: 2nd award in the student research competition of Tallinn University for the master thesis "Computation of Flat Outputs for Nonlinear Control Systems with Mathematica" (supervisors M.Tõnso and Alban Quadrat, Institut National de Recherche en Informatique et en utomatique).

2. B.Viikmäe: received the 3rd prize at doctoral level in natural sciences and technology area at State Student Research Paper Competition of 2014.

3. A.Giudici: received the best students' presentation award at the 2nd International Conference Climate Change – The environmental and socio-economic response in the southern Baltic region (Szczecin, Poland).

6.6 Other activities

6.6.1 Participation on programme committees, reviewing papers:

1. A.Salupere, J.Engelbrecht, T.Soomere, A.Berezovski, T.Peets, K.Tamm, M.Lints, K.Pindsoo, M.Eelsalu, T.Kosmatšova: members of the Local Organising Committee of the IUTAM Symposium on Complexity of Nonlinear Waves, Tallinn, 8–12 Sept., 2014

2. A.Salupere: reviewer for Physica D; Chaos, Solitons & Fractals; Applied Physics Letters.

3. A.Salupere: chairman of the International Scientific Committee of the IUTAM Symposium on Complexity of Nonlinear Waves, Tallinn, 8–12 Sept., 2014.

4. J.Kalda: reviewer for Phys. Rev. Lett., Phys. Rev. E, Proc. Estonian Sci.

5. A.Berezovski: reviewer for Mathematics and Mechanics of Solids, Intern. J. Non-Linear Mechanics, Archive of Applied Mechanics, Communications in Applied and Industrial Mathematics, J. Vibration and Control, ZAMM – Zeitschrift fuer Angewandte Mathematik und Mechanik, Journal of Physics and Chemistry of Solids.

6. A.Stulov: INTAS, ERA. NET RUS and Shota Rustaveli NSF – evaluator of grant applications.

7. H.Herrmann: reviewer for Nondestructive Testing and Evaluation, ZAMM, J. Non-Equilibrium Thermodynamics.

8. P.Saari: International Program Committee of the symposium Laser Physics.

9. P.Saari, P.Piksarv, H.Lukner: reviewers for Optics Letters, Optics Communications, Optics Express, Journal of Optics.

10. J.Belikov: committee member the 22nd Mediterranean Conference on Control & Automation 2014 (MED'14).

11. Ü.Kotta: associate technical editor IFAC World Congress 2014. International Conference on Cognitive Computing and Information Processing (CCIP – 2015), 3–4 March, 2015, Noida, India.

12. J.Vain: The 11th International Conference on Integrated Formal Methods (iFM), 9–11 September, 2014, Bertinoro, Italy. 26th Nordic Workshop on Programming Theory (NWPT '14), 29–31 October, 2014 – Halmstad, Sweden. International Conference on Cognitive Computing and Information Processing (CCIP – 2015), 3–4 March, 2015, Noida, India. 14th Biennial Baltic Electronics Conference (BEC 2014), 6–8 October, 2014, Tallinn, Estonia.

13. T.Soomere: member of the steering committee of the Baltic Sea Science Congress.
14. T.Soomere: member of the scientific council of the Laboratory of Multiphase Flows at TUT.
15. T.Soomere: member of the commission on science of the TUT Council.

6.6.2. Participation in journal editorial boards:

1. Applied and Computational Mechanics: A.Berezovski, J.Engelbrecht.
2. Journal of Theoretical and Applied Mechanics: J.Engelbrecht.
3. Applied Mechanics: J.Engelbrecht.
4. Continuum Mechanics and Thermodynamics: A.Berezovski.
5. Journal of Laser Physics: P.Saari.
6. Acta Mechanica et Automatica: Ü.Kotta.
7. Journal of Logical and Algebraic Methods in Programming. Elsevier Special issue for 25th Nordic Workshop on Programming Theory (NWPT'13), Tallinn, Estonia, 20–22 November 2013: J.Vain (guest editor).
8. Proceedings of the Estonian Academy of Sciences: T.Soomere; J.Engelbrecht, Ü.Kotta (co-editors).
9. Estonian Journal of Earth Sciences: T.Soomere (co-editor).
10. Journal of Marine Systems: T.Soomere.
11. Oceanologia: T.Soomere.
12. Boreal Environment Research: T.Soomere.
13. Fundamental and Applied Hydrophysics: T.Soomere.
14. Natural Hazards and Earth System Sciences: I.Didenkulova.
15. Journal of Ocean Engineering and Marine Energy: I.Didenkulova.
16. The Scientific World Journal: I.Didenkulova.

6.6.3. Participation in professional organizations:

1. IUTAM General Assembly: A.Salupere – member.
2. Nordic Association for Computational Mechanics: A.Berezovski – member of executive committee.
3. EUROMECH – European Mechanics Society: A.Berezovski, J.Engelbrecht, A.Salupere, K.Tamm, A.Ravasoo – members.
4. ISIMM – The International Society for the Interaction of Mechanics and Mathematics: A.Berezovski, J.Engelbrecht – members.
5. Materials Research Society: A.Berezovski – member.
6. Optical Society of America (OSA): P.Saari – senior member.

7. Estonian Physical Society: P.Saari, H.Lukner, J.Kalda – members.
8. European Academy of Sciences: P.Saari, J.Engelbrecht, T.Soomere – members.
9. IFAC technical committee for nonlinear control systems: Ü.Kotta – member.
10. IEEE TC-CACSD Action Group on Polynomial Methods for Control System Design: Ü.Kotta – chair.
11. Estonian Society of System Engineers: J.Belikov – member.
12. European Geosciences Union: I.Didenkulova – scientific officer of Sea hazard devision.
13. International Tsunami Comission: I.Didenkulova – member, Estonian representative.
14. European Marine Board: T.Soomere – Estonian representative and vice-chair.
15. Marine Board of the Estonian Academy of Sciences: T.Soomere – chair.
16. EASAC Environmental Steering Panel: T.Soomere – Estonian representative.
17. EC evaluation of Integrated Project proposals for the ICT Call 7: E.Quak.
18. EC evaluation of the call for Marie Curie Industry Academia Fellowships and Pathways: E.Quak.

6.6.4 Estonian public bodies:

1. The Academic Council of the State President – P.Saari, R.Kitt.
2. The Board of the Estonian Academy of Sciences – T.Soomere (president), P.Saari, J.Engelbrecht.
3. The Council of the Tallinn University of Technology – A.Salupere.
4. The Board of Trustees of the Tallinn University of Technology – R.Kitt.
5. The Council of the University of Tartu – P.Saari.

6.6.5 Science and Politics:

1. A.Salupere participated in the IUTAM General Assembly meeting (Lyngby, Denmark), 16–20 Aug., 2014.
2. J.Vain, member of the IT Faculty Board, TUT.
3. A.Giudici and M.Viška participated in the Opening Ceremony of the Gulf of Finland Year 2014, Presentation of Gulf of Finland Year Research and speech of President of the Republic of Finland Sauli Niinistö, 21.01.2014.
4. T.Soomere participated in the ExCom meeting of the European Marine Board in Brussels, Belgium, 30.01.2014.
5. T.Soomere participated in the spring meeting of the European Academies Scientific Advisory Council Environment Steering Panel (Brussels, Belgium), 27.03.2014.
6. T.Soomere participated in the ExCom meeting (13.05) and spring plenary meeting of the European Marine Board (Brest, 14–15.05), and visited the research group of M.Olagnon in IFREMER, Brest, 13–15.05.2014.

7. T.Soomere participated in the seminar-workshop Estonian science in international organisations with a presentation "Estonian membership in the European Marine Board" (Tallinn, Estonian Academy of Sciences), 19.05.2014.

8. T.Soomere participated in the joint workshop of the Working Group on Marine Sustainability of the European Academies Scientific Advisory Council (EASAC) and the Institute for Environment and Sustainability, Joint Research Centre of the European Commission (Ispra, Italy), 01–03.07.2014.

9. T.Soomere participated in the European Marine Board ExCom meeting and in the drafting meeting of Rome Declaration for the EurOCEAN 2014 conference (Brussels, Belgium), 05.09.2014.

10. T.Soomere participated in the autumn meeting of the European Academies Science Advisory Council's Environment Steering Panel in Brussels, 24–25.09.2014.

11. T.Soomere participated in the European marine science policy conference EurOCEAN2014 (Rome, Italy) in the discussion panel Addressing complex seas and oceans challenges: how can we cross the disciplines more effectively and as the member of the drafting team of Rome Declaration. According to Maire Geoghegan-Quinn, EU Commissioner for Research, Innovation and Science: "EurOCEAN is considered as a top science conference in Europe which delivers concrete messages to science and policy. These are instrumental in strengthening the knowledge base for Europe and developing common priorities in the area of marine sciences" (June 2013), 07–09.10.2014.

12. T.Soomere participated in the European Marine Board autumn plenary meeting (Rome, Italy), 09–10.10.2014.

13. M.Eelsalu and K.Pindsoo participated in Sustainable Development Forum 2014 (Tallinn, Estonia), 28.10.2014.

14. T.Soomere presented an address about the major tasks of the Estonian Academy of Science and about the role of science in valuing the culture to the vision conference Where is the value of culture (Mis on kultuuri väärtus), Haapsalu, 21–22.11.2014.

15. M.Eelsalu and K.Pindsoo participated in Gulf of Finland Year 2014 workshop (SYKE, Helsinki), 26–27.11.2014.

6.6.6. Media reflections

Book exhibitions

1. J.Engelbrecht 75 – Book Exhibition in Tallinn UT, July–August, 2014.

2. H.Aben 85 – Book Exhibition in Tallinn UT, November–December, 2014.

Media outreach

1. H.Lukner, an article in daily newspaper Tartu Postimees and in online version of Postimees "Rakett 69 võistlejad selguvad oktoobris", from 16^{th} of September, introduces TV series Rakett 69.

2. J.Vain, interview at the opening workshop of TUT Center for Cyber Security and Digital Forensics (Estonian Radio 5).

3. 11 January 2014, a longer comment of T.Soomere to the Marine Hour (Kuku Raadio) about advances in the research into the Baltic Sea wave climate.

4. 09 March 2014, Bert Viikmäe gave an interview to the state radio channel "Vikerraadio" in the popular science program "Labor" on fairway optimisation in the Gulf of Finland.
5. 27 March 2014, a longer discussion of T.Soomere and M.Raidal about the status and perspectives of financing of scientific research in Estonia; an 1-hour broadcast in the series Kukkuv Õun of the leading radio channel Kuku Raadio.
6. 14 June 2014, a longer comment by T.Soomere to the Marine Hour (Kuku Raadio) about wind wave energy potential in the Baltic Sea and the possibilities of its use along Estonian coasts.
7. 14 June 2014, a longer comment by T.Soomere and M.Eelsalu to the broadcast Labor (state radio channel Vikerraadio) about the possibilities of using wind wave energy at Estonian coasts.
8. 22 August 2014, a comment by T.Soomere to the national radio and TV about potential environmental impact of the construction of a LNG terminal at the coast of the Gulf of Finland and underwater gas pipeline across this gulf, and about possibilities of minimising of their environmental impact.
9. 23 August 2014, Ü.Priks, A rolling stone becomes singing sand (Veerevast kivist saab lõpuks laulev liiv), Sakala (newspaper of Viljandi County, Estonia), 23.08.2014, 9; based on comments by T.Soomere about the origin of beach sand and functioning of sandy beaches.
10. 10 October 2014, M.Maidla, Mart Ustav and Tarmo Soomere – the candidates for the President of the Estonian Academy of Sciences A rolling stone becomes singing sand (Eesti Teaduste Akadeemia presidendiks kandideerivad Mart Ustav ja Tarmo Soomere) Sirp, 10.10.2014, nr. 40 (3540), 35–37 (in Estonian).
11. 12 October 2014, it is time to increase visibility of the Estonian Academy of Sciences (On aeg Teaduste Akadeemia nähtavuse suurendamiseks), interview with T.Soomere Postimees Online, 12.10.2014, (in Estonian).
12. 15 October 2014, Soomere wishes to build tighter connections of the Academy with society (Soomere tahab parandada Teaduste Akadeemia suhtlust ühiskonnaga), interview with T.Soomere Postimees Online, 15.10.2014, (in Estonian).
13. 15 October 2014, Live-on-air interview of T.Soomere to the major news program Aktuaalne Kaamera in the occasion of election to the President of the Estonian Academy of Sciences, Estonian national TV channel, 15.10.2014 (in Estonian).
14. 16 October 2014, Live-on-air interview of T.Soomere to the morning talk-show Terevisioon about the role of the Estonian Academy of Sciences in society, Estonian national TV channel, 16.10.2014 (in Estonian).
15. 16 October 2014, T.Randlo, Estonian science system will lose many jobs, says the new president of the Estonian Academy of Sciences (Teaduste Akadeemia uus juht: Eesti teadust ootab ees sadade või isegi tuhandete inimeste koondamine), interview with T.Soomere, Postimees Online, 16.10.2014, (in Estonian).
16. 17 October 2014, R.Aljas, Soomere prefers tighter contacts of scientists and society (Soomere eelistab inimlikku teaduskeelt), Päevaleht, 17.10.2014, nr. 201, 6–7 (in Estonian).

17. 17 October 2014, a longer interview of with T.Soomere in the occasion of election to the President of the Estonian Academy of Sciences, Estonian national radio channel Vikerraadio, broadcast The person of the week (in Estonian).

18. 17 October 2014, Live-on-air interview of with T.Soomere in the occasion of election to the President of the Estonian Academy of Sciences, City of Tallinn TV channel (in Estonian).

19. 18 October 2014, N.Korv, 1+1 is not always 2, an editorial comment in the occasion of election of T.Soomere to the President of the Estonian Academy of Sciences Postimees, 18.10.2014, nr. 243(7234), 3 (in Estonian).

20. 19 October 2014, An selection of interviews with colleagues of T.Soomere (J.Engelbrecht, M.Eelsalu, K.Pindsoo) to the major news program Aktuaalne Kaamera in the occasion of election to the President of the Estonian Academy of Sciences, Estonian national TV channel, 19.10.2014 (in Estonian).

21. 20 October 2014, A.Olesk, Visible or invisible (Nähtav või nähtamatu), an editorial comment in the occasion of election of T.Soomere to the President of the Estonian Academy of Sciences, Postimees, 20.10.2014, nr. 244(7235), 2 (in Estonian).

22. 23 October 2014, A.Lõhmus, 10 unexpected questions to the smartest (10 ootamatut küsimust targimale), an interview with T.Soomere, Maaleht, 23.10.2014, nr. 43(1411), 6–7 (in Estonian).

23. 23 October 2014, a longer Live-on-air interview of T.Soomere in the prime-time talk-show Kahekõne (The Dialogue), Estonian national TV channel, 23.10.2014 (in Estonian).

24. 29 October 2014, V.Veski, Tarmo Soomere: Only many scientists from various fields working together can solve the puzzles of our world (Tarmo Soomere: Erinevate valdkondade teadlased suudavad maailmapusle kokku panna), an interview with T.Soomere, Raplamaa Sõnumid, 29.10.2014, nr. 44(2845), 4–5 (in Estonian).

25. 29 October 2014, an interview with T.Soomere in the occasion 75-th birthday of Toomas Paul, Estonian national radio channel Vikerraadio (in Estonian).

26. 6 November 2014, Soomere: Estonian science can expect a wave of redundancies, The Baltic Times, 06.11–03.12.2014, vol. 11(852), 2.

27. 1 December 2014, a longer interview with academicians M.Lopp, M.Kalm and T.Soomere to the series of broadcasts about science Kukkuv Õun of Kuku Raadio about perspectives of science in Estonia and the role of the Estonian Academy of Sciences (in Estonian).

28. 14 December 2014, a longer interview with J.Engelbrecht to Kukkuv Õun about the Estonian Academy of Sciences (in Estonian).

29. 23 December 2014, a longer interview with T.Soomere to the major Russian-language radio channel Raadio 4 in the series of broadcasts *Tomorrow starts today* about achievements of marine science in Estonia (in Russian).

7. Summary

The research results in 2014 (see above, especially the Highlights) show explicitly that CENS is progressing according to the ideas of interdisciplinarity and complexity. The infrastructure for the Optics Group (UT) was considerably improved. The time consuming public procurement to build up new fluorescence microscopy device for the Laboratory of Systems Biology is on the way.

In general terms, complexity of physical processes leads to interesting phenomena, let them be the emergence of patches on the surface layer of the sea, emergence of solitary waves in microstructured solids, properties of fractal structures, interaction of macro- and microeconomies, coupling effects of glycolysis, etc. These all are the examples where "hidden" connectivity (interactions) influences outcome.

As far as the next year will be the last within this Programme of Centres of Excellence, the plans are made how to summarize the results, as for the scientific community as well as for the larger public. In addition to a flyer on CENS (see Annex) we plan to publish two overviews, one in Estonian (for general public), another one in English with highlights over 2011–2015. CENS has always stressed the need to have a broad views not only in research but also in the research policy. Such an attitude has surely prepared the background for a special event for CENS which has brought again a distinguished position to a member of the IoC and presently CENS in 2014. Following Nikolai Alumäe, the Vice-President of the Estonian Academy of Sciences (EAS) in 1964–1977 and Jüri Engelbrecht, the President of the EAS in 1994–2004 and Vice-President of the EAS in 2004–2014, Tarmo Soomere was elected to become the President of the EAS for 2014–2019. His numerous science policy articles and interviews in 2014 (see the list of publications and media outreach above) witness his sharp mind and readiness to lead this distinguished organisation in our fast developing world.

The IUTAM Symposium "Complexity of Nonlinear Waves" (Sept., 2014) brought the leading specialists over all world to Tallinn. Characteristically to CENS, the communities of Solid Mechanics and Fluid Dynamics were invited to discuss the problems together. It allowed to share the ideas and cross the borders between different fields. Interaction of nonlinearity with accompanying effects such as changing properties of media together with interaction of various fields shed further light to understanding and forecast of physical phenomena. The Proceedings will be published in a special issue of the Proceedings of the Estonian Academy of Sciences in 2015.

Next year, a special conference on CENS ideas, results and further activities will be held in September, 2015 together with the members of the International Advisory Board of CENS.

Annex

1. The staff of research teams.
2. Abstracts.
3. CENS 2011 – 2015.
4. IUTAM Poster.
5. Visualization course for students.
6. Cover of J. Physics A, 47, 15, 2014.

Annex 1: The staff of research teams in CENS in 2014:

Head of CENS: Jüri Engelbrecht, DSc.

Nonlinear dynamics

Head of team: Jaan Kalda, PhD.
Leading scientist: Hillar Aben, DSc, Jüri Engelbrecht, DSc.
Senior researchers: Johan Anton, PhD; Arkadi Berezovski, PhD; Heiko Herrmann, PhD; Jaan Kalda, PhD; Arvi Ravasoo, PhD; Andrus Salupere, PhD; Anatoli Stulov, PhD.
Researchers: Mihhail Berezovski, PhD; Marika Eik, PhD; Dmitry Kartofelev, PhD; Robert Kitt, PhD; Tanel Peets, PhD; Kert Tamm PhD; Mihkel Kree, MSc.
PhD students: Siim Ainsaar, Mihkel Heidelberg, Jakob Jõgi, Martin Lints, Indrek Mandre, Emiliano Pastorelli, Stephanie Rendon.
Other: Kristi Juske, Tatjana Kosmatšova, Mati Kutser PhD, Pilvi Veeber.

Wave engineering

Head of team: Tarmo Soomere, DMath.
Senior researchers: Irina Didenkulova, DSc; Ewald Quak, PhD; Tomas Torsvik, PhD.
Researchers: Nicole Delpeche-Ellmann, PhD; Irina Nikolkina, PhD; Andrus Räämet, PhD; Bert Viikmäe, PhD; Maija Viška, PhD.
PhD students: Andrea Giudici, Maris Eelsalu, Olga Kovaleva, Katri Pindsoo, Artem Rodin.
Other: Marika Org, Peeter Keres.

Systems biology

Head of team: Marko Vendelin, PhD.
Senior researchers: Rikke Birkedal Nielsen, PhD; Pearu Peterson, PhD; Hena Ramay, PhD.
Researchers: Ardo Illaste, PhD; David Schryer, PhD.
PhD students: Jelena Branovets, Natalja Jepihhina, Svetlana Jugai, Mari Kalda, Niina Karro, Martin Laasmaa, Päivo Simson, Merle Mandel.

Optics

Head of team: Peeter Saari, DSc.
Researchers: Heli Valtna-Lukner, PhD; Peeter Piksarv, PhD.
PhD students: Andreas Valdmann.
Other: Agu Anijalg.

Nonlinear control theory

Head of team: Ülle Kotta, DSc.
Senior researchers: Ülo Nurges, PhD; Maris Tõnso, PhD; Jüri Vain, PhD; Tanel Mullari, PhD.
Researchers: Jüri Belikov, PhD; Vadim Kaparin, PhD.
PhD students: Arvo Kaldmäe.
PhD students in TUT: Aivo Anier, Sergei Avanesov, Jaagup Irve.
Other: Kristina Halturina.

As a rule PhD students have part-time positions.

Annex 2: Abstracts

1. T.Torsvik, J.Kalda. Analysis of surface current properties in the Gulf of Finland using data from surface drifters. In: Measuring and Modeling of Multi-Scale Interactions in the Marine Environment. IEEE/OES Baltic Symp. 2014, 26–29 May, 2014, Tallinn, Estonia, Book of Abstracts, 2014, 125.

2. J.Engelbrecht. Complexity in engineering and natural sciences. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., eds. IoC, TUT, 2014, 47–48.

3. J.Kalda. Implications of the theory of turbulent mixing for wave propagation in media with fluctuating coefficient of refraction. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 63–64.

4. A.Berezovski. Nonlinear dispersive wave equations for microstructured solids. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 23–24.

5. J.Janno, I.Sertakov, A.Šeletski. Reconstruction of parameters of nonlinear dispersive media by means of travelling waves. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 61–62.

6. T.Peets, K.Tamm, M.Sepp. On mechanical aspects of nerve pulse propagation and Boussinesq paradigm. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 87–88.

7. A.Ravasoo. Nonlinear waves for characterization of materials with smoothly changing properties. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 97–98.

8. A.Salupere. On formation and propagation of solitonic structures. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 103–104.

9. A.Braunbrück. Evaluation of functionally graded material properties by longitudinal wave motion. In: Book of Abstracts, FinEst Math 2014, Helsinki 9–10 January, 2014, p. 24.

10. A.Salupere. On formation and propagation of solitonic structures. In: IUTAM Symp. Complexity of Nonlinear Waves : 8–12 September, Tallinn 2014, Book of Abstracts. A.Salupere, G.A.Maugin (eds.), Tallinn. IoC at TUT, 2014, 103–104.

11. T.Soomere. Changing wave climate in the Baltic Sea. 4th Finnish-Estonian Mathematics Colloquium and Finnish Mathematical Days, University of Helsinki. Book of Abstracts. University of Helsinki, Faculty of Science, January 9–10, 2014, 7–8.

12. I.Didenkulova. Nonlinear dynamics of the coastal zone with applications to marine hazards. Geophysical Research Abstracts, 2014, 16, EGU2014–817.

13. I.Didenkulova, E.Pelinovsky. Travelling long waves in water channels of variable cross section. Geophysical Research Abstracts, 2014, 16, EGU2014–1313.

14. A.Rodin, I.Didenkulova. Shallow water freak waves: the case of Tallinn Bay the Baltic Sea. Geophysical Research Abstracts, 2014, 16, EGU2014–7042.

15. A.Zaytsev, I.Didenkulova, B.Ranguelov, E.Pelinovsky, A.Yalciner. Assessment of Tsunami inundation map for Bulgarian coasts of in the Black Sea. Geophysical Research Abstracts, 2014, 16, EGU2014–11400.

16. A.Rodin. Influence of wave breaking effects on wave transformation and run-up on the beach. Geophysical Research Abstracts, 2014, 16, EGU2014–14319.

17. I.Didenkulova, P.Denissenko, A.Rodin, J.Pearson. Experimental study of the runup of long nonlinear regular and irregular waves. Geophysical Research Abstracts, 2014, 16, EGU2014–16403.

18. I.I.Didenkulova, A.A.Rodin. Transformation and runup of large-amplitude waves induced by fast ferries. In: Proc. 20th Intern. Scientific and Technical Conf. "Information Systems and Technologies (IST 2014)", 18 April 2014, Nizhny Novgorod, 2014, 374 (in Russian).

19. O.I.Didenkulov, I.I.Didenkulova, E.N.Pelinovsky. Runup of different bell-shaped pulses on the coast with parabolic cross-section. In: Proc. XIII Intern. Scientific Conf. "The Future of Technical Science", 23 May 2014, Nizhny Novgorod, 2014, 478 (in Russian).

20. A.A.Rodin, I.I.Didenkulova Transformation and runup of waves induced by fast ferries in the coastal zone of the Baltic Sea. In: Proc. XIII Intern. Scientific Conf. "The Future of Technical Science", 23 May 2014, Nizhny Novgorod, 2014, 486–487 (in Russian).

21. B.Viikmäe, T.Torsvik. Analysis of the lifetime of eddy structures. In: Measuring and Modeling of Multi-Scale Interactions in the Marine Environment: IEEE/OES Baltic Symposium 2014, May 26–29 2014, Tallinn, Estonia, Book of Abstracts. IoC, TUT, 2014, 136.

22. I.Nikolkina, T.Soomere, A.Räämet. Multidecadal ensemble hindcast of wave fields in the Baltic Sea. In: 6th IEEE/OES Baltic Intern. Symp., 26–29 May 2014, Tallinn, Estonia, Book of Abstracts, 2014, 88.

23. M.Viška, T.Soomere, I.Nikolkina, A.Räämet. Variations of wave-driven sediment flux along the eastern Baltic Sea reflecting the choice of wind data. In: 6th IEEE/OES Baltic Intern. Symp., 26–29 May 2014, Tallinn, Estonia, Book of Abstracts, 2014, 135.

24. V.Sriram, I.Didenkulova, S.Schimmels, H.Fernandez. 2014. On the generation of tsunami in a large scale wave flume. Abstracts of 34th Intern. Conf. Coastal Eng., Seoul, Korea, 15–20 June 2014, E104.

25. S.Schimmels, I.Didenkulova, V.Sriram, N.Goseberg. 2014. Tsunami propagation and run-up in nearshore areas. Abstracts of 34th Intern. Conf. Coastal Engin., Seoul, Korea, 15–20 June 2014, E155.

26. B.Viikmäe, T.Soomere, T.Torsvik. 2014. Optimising fairways in the Gulf of Finland using patterns of surface currents. In: Agenda and Abstracts: 6th Intern. Workshop on Modeling the Ocean, Halifax, Canada, 23–27 June 2014. Halifax, Canada, Dalhousie Univ., 2014, 45.

27. T.Soomere. Towards smart use of currents for environmental management of maritime activities. In: Math. Eng. in Marine and Earth Problems, 22–25 July 2014, Aveiro, Portugal. Book of Abstracts, 2014, 34–35.

28. A.Giudici, T.Soomere. Quantification of spontaneous patch generation in marine surface layer. In: Math. Eng. in Marine and Earth Problems, 22–25 July 2014, Aveiro, Portugal. Book of Abstracts, 2014, 56–57.

29. K.Pindsoo, T.Soomere, M.Eelsalu, H.Tõnisson. Vessel wakes effectively transport gravel, cobbles and pebbles. In: Math. Eng. in Marine and Earth Problems, 22–25 July 2014, Aveiro, Portugal. Book of Abstracts, 2014, 103–105.

30. M.Eelsalu, K.Julge, E.Grünthal, S.Talvik, A.Ellmann, T.Soomere, H.Tõnisson. Combined laser scanning to monitor coastal processes. In: Math. Eng. in Marine and Earth Problems, 22–25 July 2014, Aveiro, Portugal. Book of Abstracts, 2014, 106–108.

31. A.Rodin. Peculiarities of long wave transformation waves in nonlinear hyperbolic systems (shallow-water framework). In: Math. Eng. in Marine and Earth Problems, 22–25 July 2014, Aveiro, Portugal. Book of Abstracts, 2014, 109–111.

32. K.Pindsoo, T.Soomere. Changing wave set-up climate in the urban area of Tallinn, Estonia. In: Math. and Eng. in Marine and Earth Problems, 22–25 July 2014, Aveiro, Portugal. Book of Abstracts, 2014, 130–132.

33. M.Eelsalu, T.Soomere. Intermittency of the wave energy flux in the eastern Baltic Sea. In: Math. and Eng. in Marine and Earth Problems, 22–25 July 2014, Aveiro, Portugal. Book of Abstracts, 2014, 133–135.

34. B.Viikmäe B, T.Soomere, T.Torsvik. Optimizing fairways in the Gulf of Finland using patterns of surface currents. In: Math. and Eng. in Marine and Earth Problems, 22–25 July 2014, Aveiro, Portugal. Book of Abstracts, 2014, 184–185.

35. N.Delpeche-Ellmann, T.Soomere. Using current-driven patterns in the surface layer of the Gulf of Finland to predict the Marine Protected Areas at risk of pollution. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 35–36.

36. O.Didenkulov, I.Didenkulova, E.Pelinovsky. Parameterization of run-up characteristics of bell-shaped tsunami waves in a bay of parabolic cross-section. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 39–40.

37. M.Eelsalu, K.Julge, E.Grünthal, A.Ellmann, T.Soomere. Laser scanning reveals detailed spatial structure of sandy beaches. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 45–46.

38. A.Giudici, T.Soomere. Finite-Time Compressibility as a measure of likelihood of spontaneous patch formation in the Gulf of Finland. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 55–56.

39. O.Kurkina, T.Soomere, A.Kurkin, A.Rybin, D.Tyugin. Long-term variability of internal wave climate in the Baltic Sea. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 69–70.

40. K.Pindsoo, T.Soomere. Wave set-up climatology in the city of Tallinn, Estonia. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A.,(eds.), IoC, TUT, 2014, 91–92.

41. A.Rodin, E.Pelinovsky. Deformation of long large-amplitude waves in finite-depth fluid. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 99–100.

42. T.Soomere. Change in waves and winds that may lead to an ecological deadzone in the deep Baltic. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 115–116.

43. T.Talipova, K.Terletska, O.Kurkina. Breathers of the internal waves. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 121.

44. T.Torsvik, H.Herrmann, I.Didenkulova, A.Rodin, E.Quak. Analysis of ship wake structures by use of time-frequency methods. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 125–126.

45. B.Viikmäe, T.Soomere, T.Torsvik. Modelling wave-driven impacts on the spatial pattern of current-driven hits to the nearshore. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 135–136.

46. M.Viška, T.Soomere. Structural stability of eastern Baltic Sea coast under simulated wave-driven alongshore transport. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 137–138.

47. T.Torsvik, H.Herrmann, I.Didenkulova, A.Rodin,Ewald Quak. Ship wake deformation in the surf zone analyzed by use of a time-frequency methods. In: IUTAM Symp. Complexity of Nonlinear Waves 8–12 September, Tallinn 2014. Book of Abstracts, Salupere A., Maugin G.A., (eds.), IoC, TUT, 2014, 125–126.

48. T.Soomere. Major natural hazards in the Gulf of Finland. In: Baltic Earth – Gulf of Finland Year 2014 Modelling Workshop "Modelling as a tool to ensure sustainable development of the Gulf of Finland–Baltic Sea ecosystem". Finnish Environment Institute SYKE, Helsinki, 24–25 November 2014. Programme, Abstracts, Participants. Intern. Baltic Earth Secretariat Publ., Helmholtz-Zentrum Geesthacht, 2014, 7–8.

49. M.Eelsalu, K.Julge, T.Soomere, E.Grünthal. Quantification of the evolution of a small beach applying laser scanning technology. In: ibid, 10.

50. K.Pindsoo, M.Eelsalu, T.Soomere. Quantification of the impact of vessel wakes on the transport of coarse sediment. In: ibid, 16.

51. T.Soomere. Academia ajaülesed väärtused muutuval teadusmaastikul. In: 58. Kreutzwaldi päevade teaduslik konverents "Eesti perekond: traditsioon ja fiktsioon", 16–17 detsember 2014 Tartu. Teesid. Eesti Kirjandusmuuseumi Teaduskirjastus, 2014, 3–4 (in Estonian).

52. T.Torsvik, J.Kalda. Analysis of surface current properties in the Gulf of Finland using data from surface drifters. In: Measuring and a Modeling of Multi-Scale Interactions in the Marine Environment: IEEE/OES Baltic Symp. 2014, May 26–29 2014, Tallinn, Estonia, Book of Abstracts. TUT, 2014, 125.

Founded in 1999, the idea of CENS was to bring under one umbrella the scientific potential of Estonia in interdisciplinary studies of

COMPLEX NONLINEAR PROCESSES

Centre for Nonlinear Studies
Institute of Cybernetics at Tallinn University of Technology
(IoC at TUT)
Akadeemia 21
12618 Tallinn Estonia
http://cens.ioc.ee

HISTORY

2002-2007
Estonian Centre of Excellence in Research (The First National Programme)

2009-2011
Centre of Excellence in Research of Tallinn University of Technology

2011-2015
Estonian Centre of Excellence in Research (The Second National Programme)

WORKING GROUPS

Four from the IoC at TUT and one from the University of Tartu (UT):

NONLINEAR DYNAMICS, IoC at TUT
Prof. J.Engelbrecht (je@ioc.ee), Head of CENS

WAVE ENGINEERING, IoC at TUT
Prof. T.Soomere (tarmo.soomere@cs.ioc.ee)

SYSTEMS BIOLOGY, IoC at TUT
Dr. M.Vendelin (markov@sysbio.ioc.ee)

OPTICS, UT
Prof. P.Saari (peeter.saari@ut.ee)

NONLINEAR CONTROL THEORY
Dr. Ü.Kotta (kotta@ioc.ee)

KEYWORDS

COMPLEXITY
NONLINEAR DYNAMICS
SOFT MATTER PHYSICS
MICROSTRUCTURED SOLIDS
SOLITONS
WATER WAVES
EXTREME WAVES
COASTAL ENGINEERING
ACOUSTODIAGNOSTICS
PHOTOELASTICITY
CELL ENERGETICS
DIFFERENTIAL EQUATIONS
CONTROL THEORY
WAVE OPTICS
LOCALISED WAVES

MAIN COOPERATION PARTNERS

Paris 6, Turin, Worcester (US), Budapest, South Maine (US), Prague, Blekinge (Sweden), Val de Loire (France), Cisterna di Latina (Italy), Nantes, Valenciennes (France), Aalto (Finland), etc.

INTERNATIONAL ADVISORY BOARD

Prof. F.Allgöver (Stuttgart)
Prof. S.Bishop (London)
Prof. R.Grimshaw (Loughborough)
Dr. R.Grunwald (Berlin)
Prof. G.Holzapfel (Graz)
Prof. G.A.Maugin (Paris)
Prof. F.Pastrone (Turin)
Prof. G.Stepan (Budapest)

CENS 2011-2015

SOME INTERNATIONAL PROGRAMMES AND GRANTS

ESF NATEMIS
FP6 WIND-Chime
FP6 SEAMOCS
MC ToK CENS-CMA
Complexity-NET
Marie Curie
Wellcome Trust
A.v.Humboldt Foundation
COST
Global Systems Dynamics and Policies
MOBILITAS
TEMPUS
Bonus+, ...

ESTONIAN PROGRAMMES

NanoCom
Smart Composites

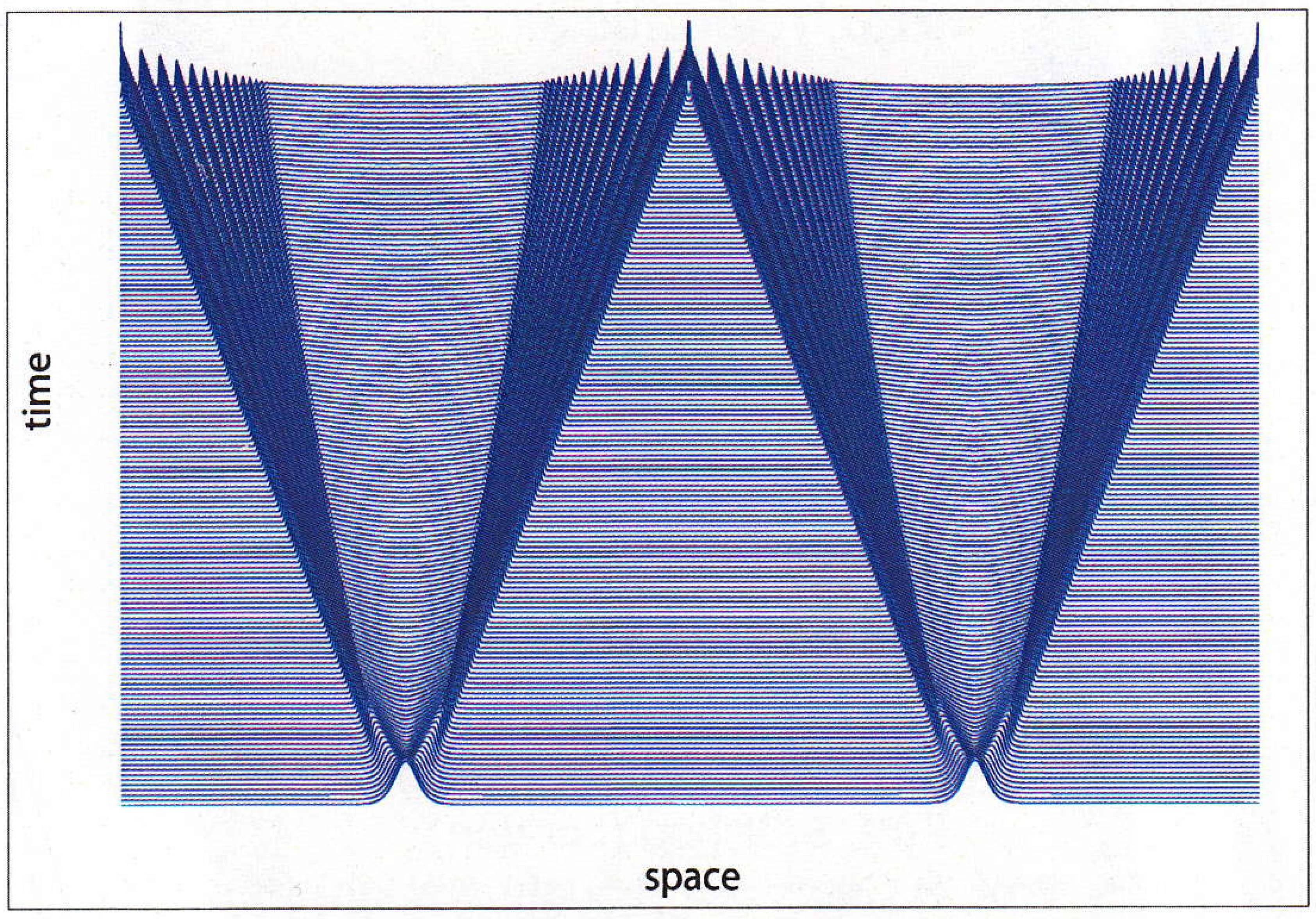
European Union
Regional Development Fund
Investing in your future

NONLINEAR DYNAMICS

INTERACTION OF WAVES, FIELDS AND STRUCTURES

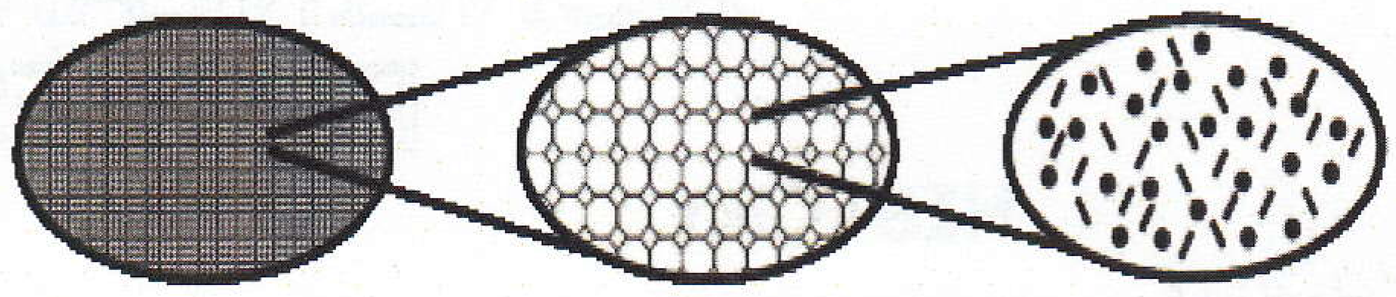
Waves in microstructured solids – formalism of dual internal variables describing microdeformation and microtemperature

Soliton formation in Boussinesq-type models

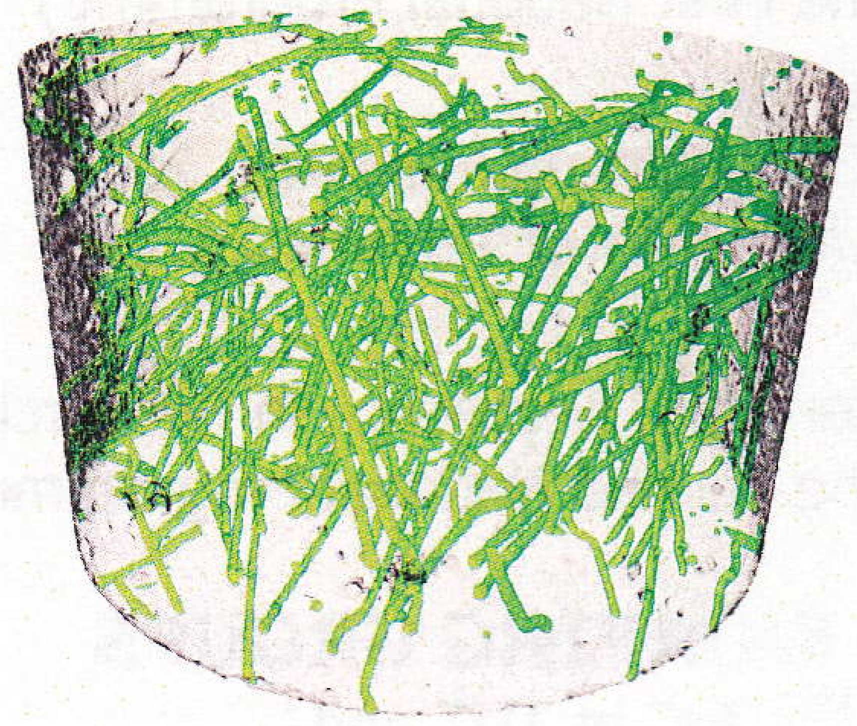


Scheme of soliton trains

Models



Scheme of multiscale microstructures



Fibre reinforced concrete

PHOTOELASTICITY

Novel technology of integrated photoelasticity and applications
International Glass Stress Summer Schools

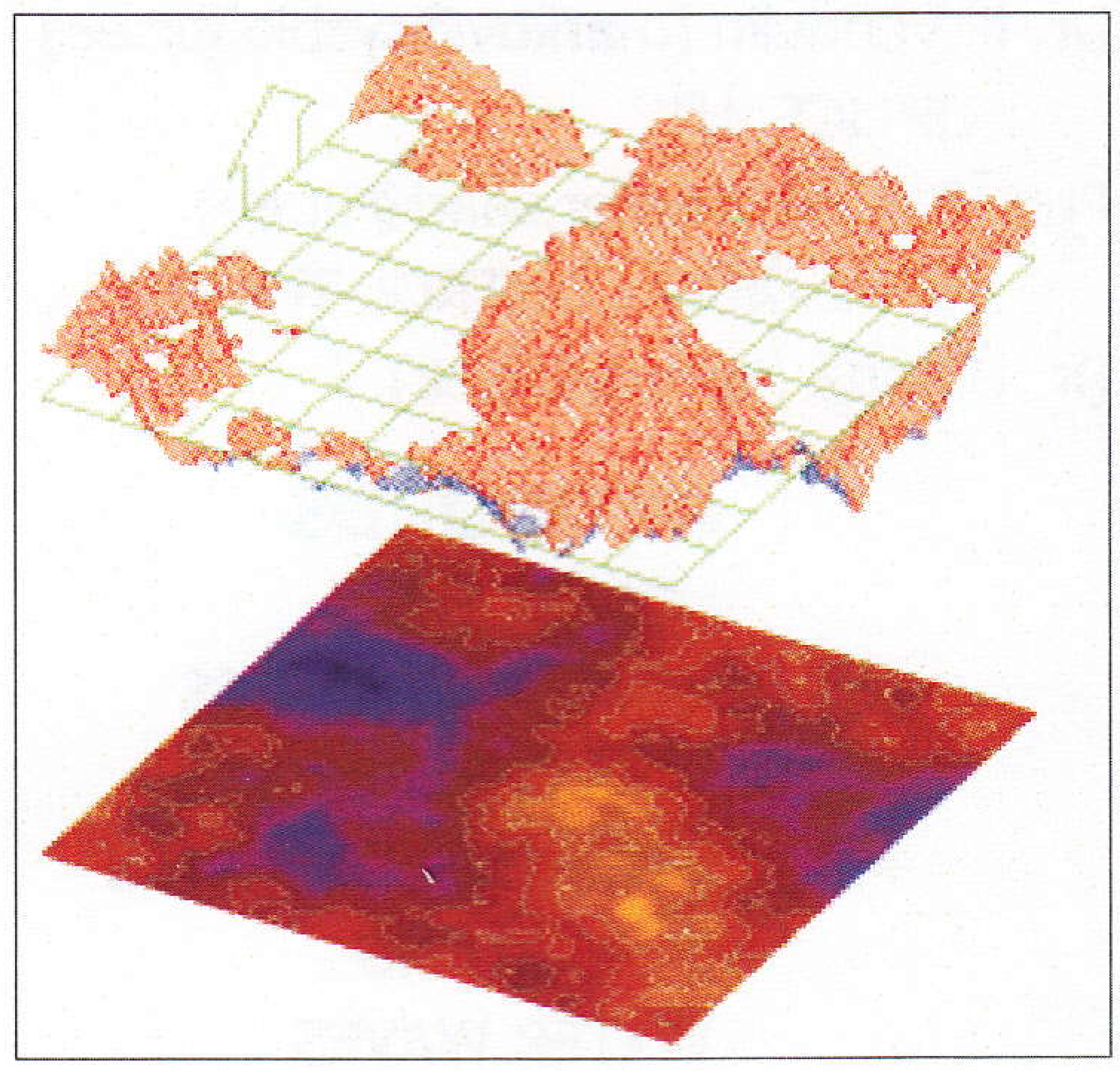
Scattered light polariscope SCALP

TURBULENT MIXING, FRACTALITY, PERCOLATION AND SCALING EXPONENTS

The stochastic triplet-map model of turbulent mixing is extended to describe the passive tracers in compressible flow (patchiness)

Scaling exponents determined for various processes

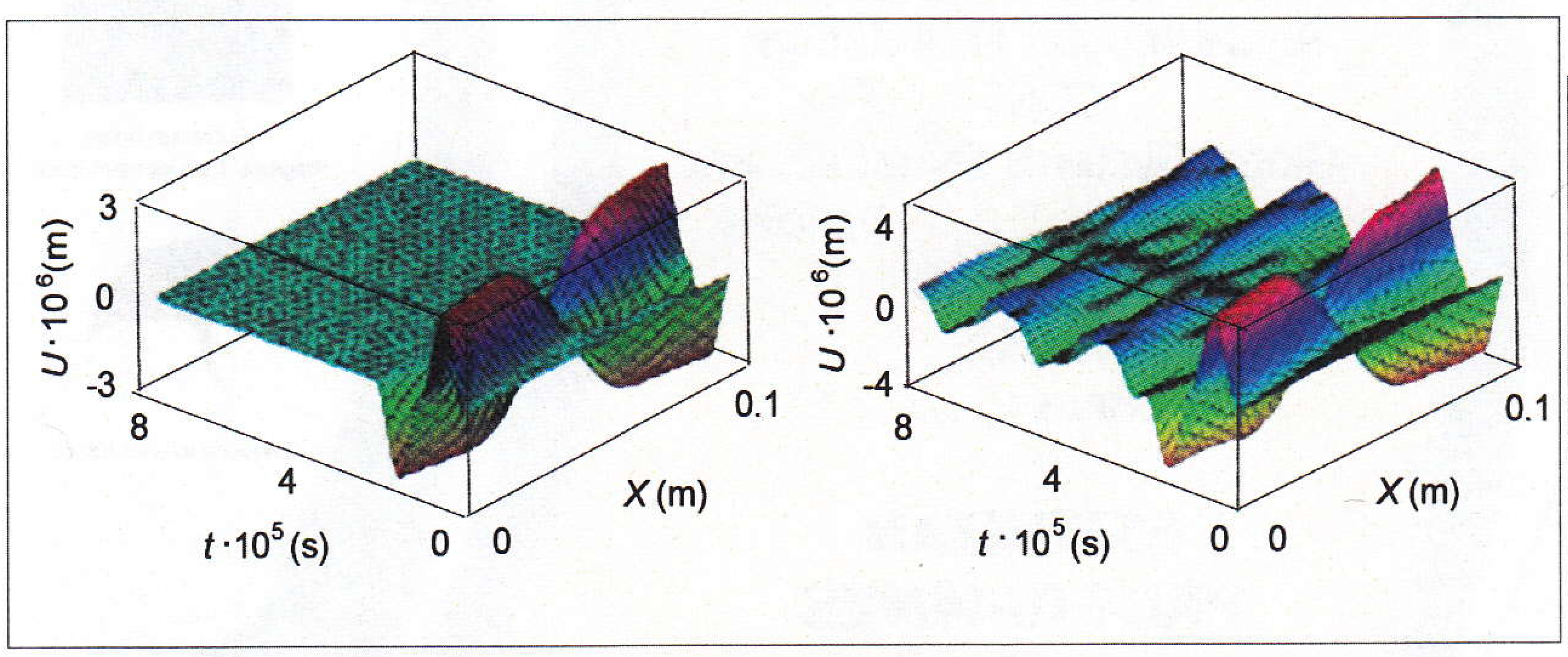
Complex systems in econophysics explained



Interaction of fractal sets

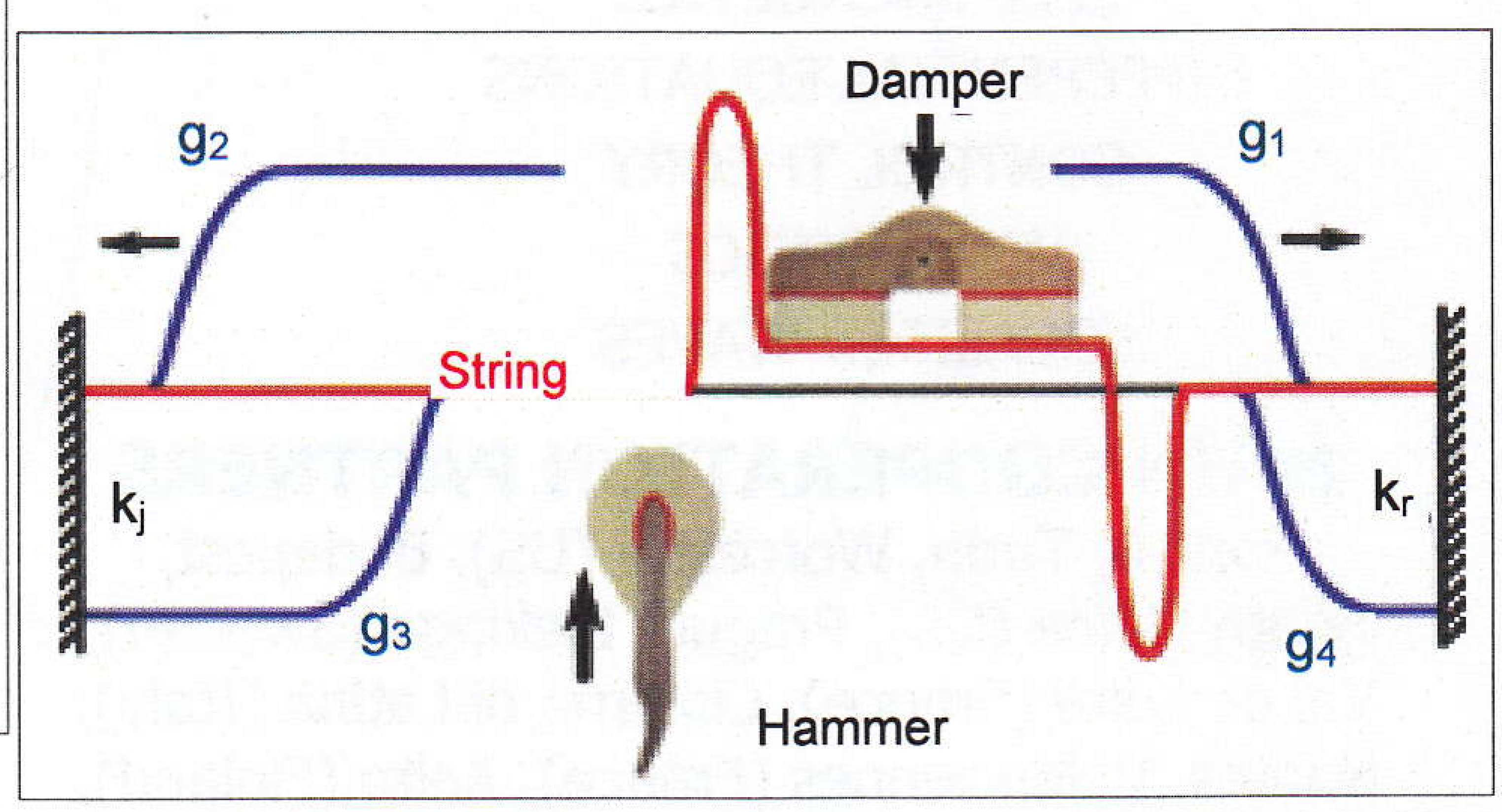
ACOUSTODIAGNOSTICS

Novel NDT methods based on interaction of waves and on deformation of solitary waves in microstructured solids



Interaction of bursts in homogeneous (left) and inhomogeneous materials (right)

SOUND GENERATION



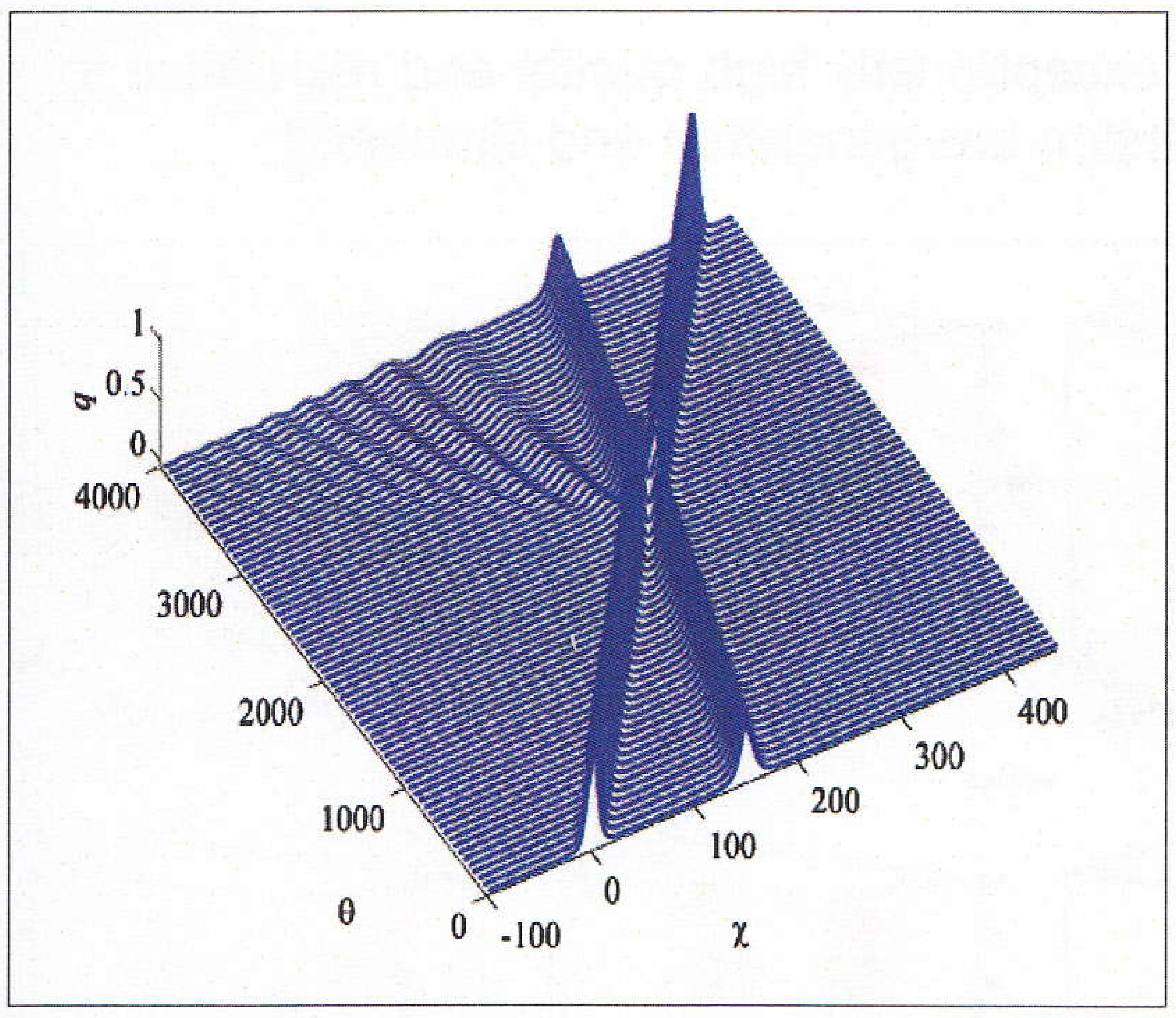
Waves in a string generated by a piano hammer

WAVE ENGINEERING

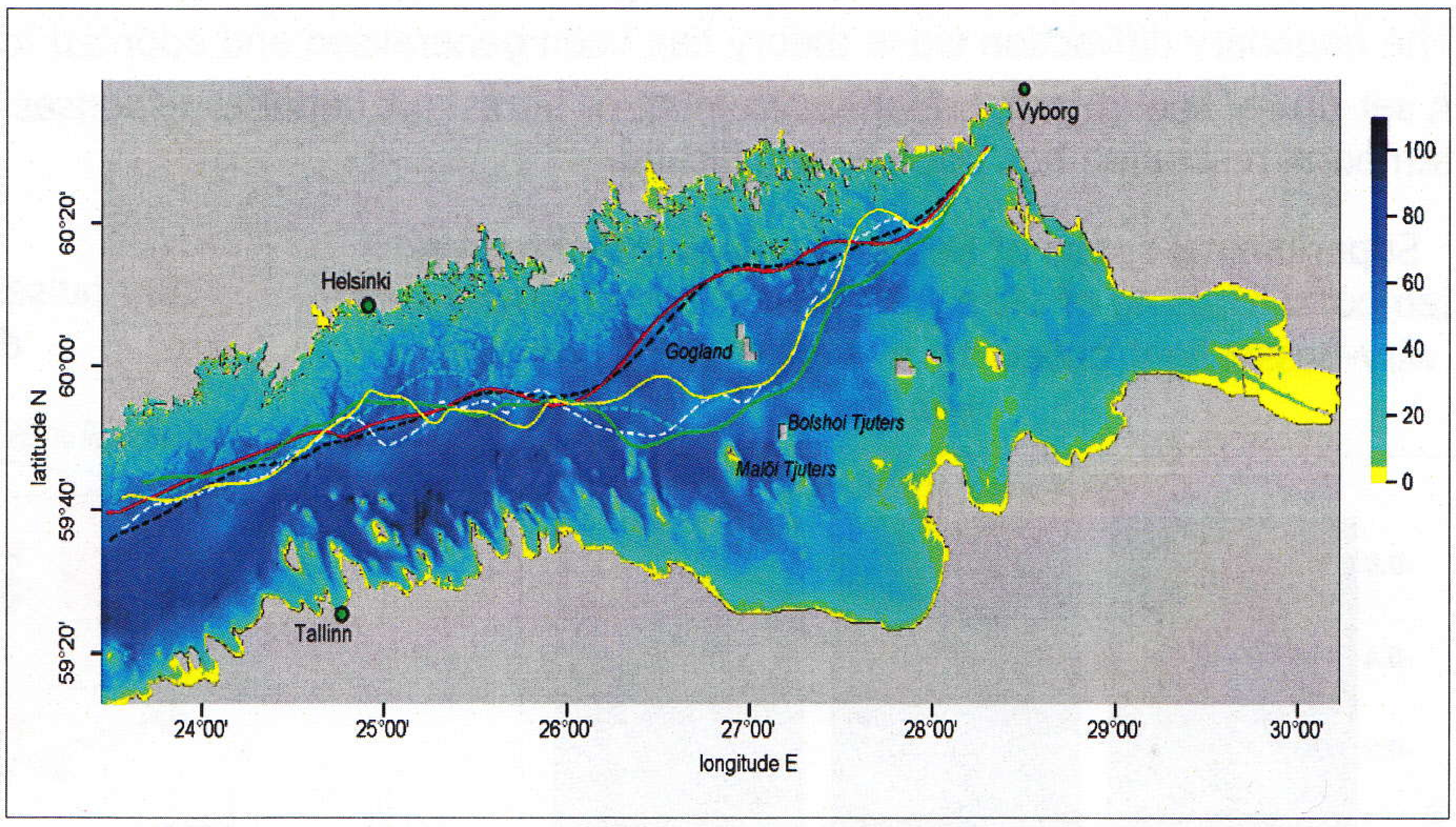
WAVES ON SEA, WAVE CLIMATE, COASTAL ENGINEERING

Determination of unusual convex beach profiles under joint impact of short wind waves and groups of long ship waves

A higher-order (2+4) Korteweg-de Vries-type model derived for interfacial waves in a symmetric three-layer fluid



Shape and interaction of solitary waves



Enviironmentally optimised fairways in the Gulf of Finland

Novel preventive technique for the optimisation of fairways based on environmental considerations

Wave climate of the eastern Baltic Sea and its spatio-temporal variations quantified back to the 1940s

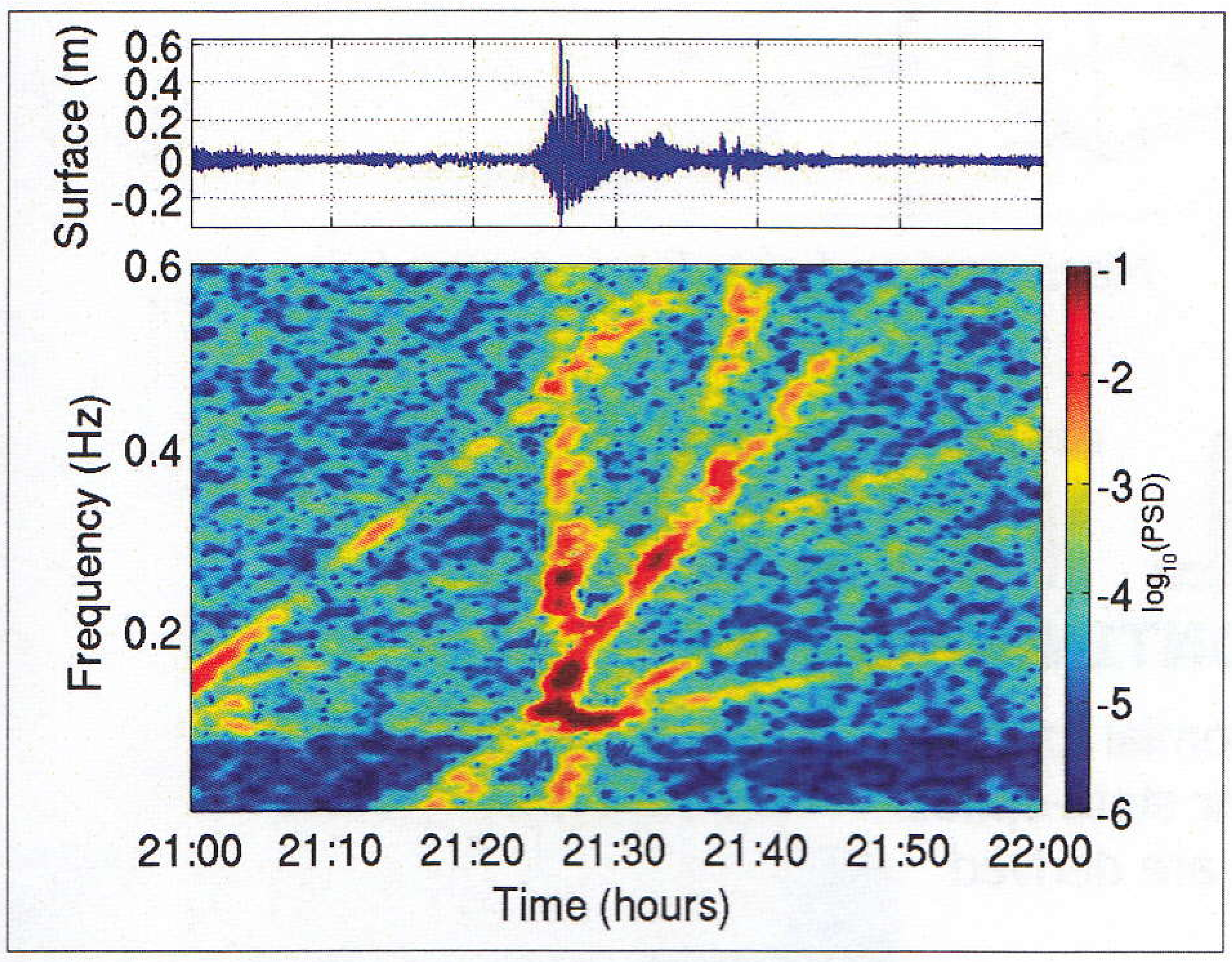
An exact analytical solution of the nonlinear shallow water theory for wave run-up in inclined channels of arbitrary cross-section derived

Analytical theory of tsunami generation extended to the case of narrow bays and channels of various geometry

Quantification of wave-driven coastal hazards: run-up, set-up, shallow-water rogue waves

Qualitative patterns of wave-driven sediment transport along the eastern Baltic Sea established

Novel mechanism of spontaneous patch formation on sea surface explained



Spectrogram of the wake of Tallink Star at the island of Aegna (June, 2008)

SYSTEMS BIOLOGY

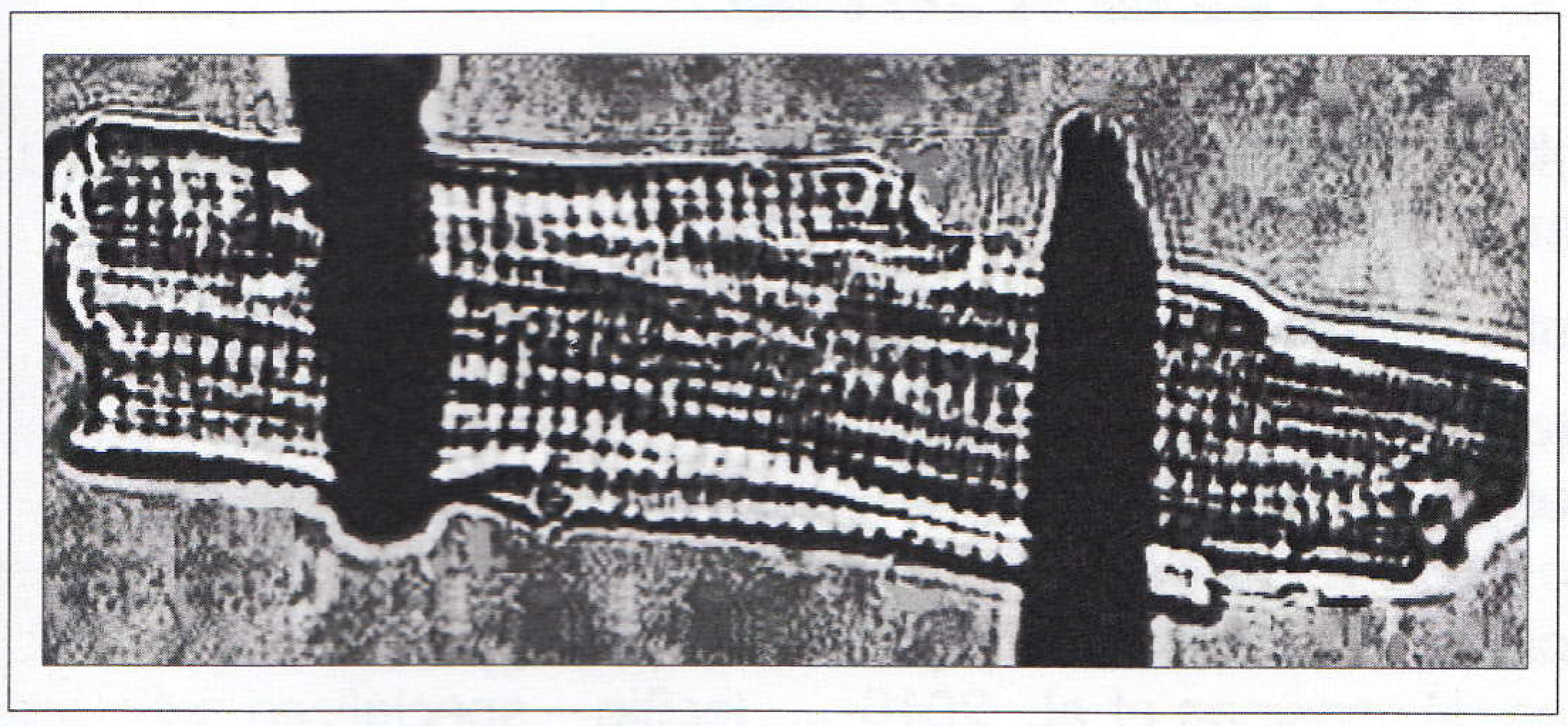
CELL ENERGETICS, DIFFUSION, MUSCLE CONTRACTION

Analysis of lattice-like obstructions to diffusion in heart muscle cells

Molecular dynamics simulation of creatine kinase and adenine nucleotide translocase in mitochondrial membrane patch

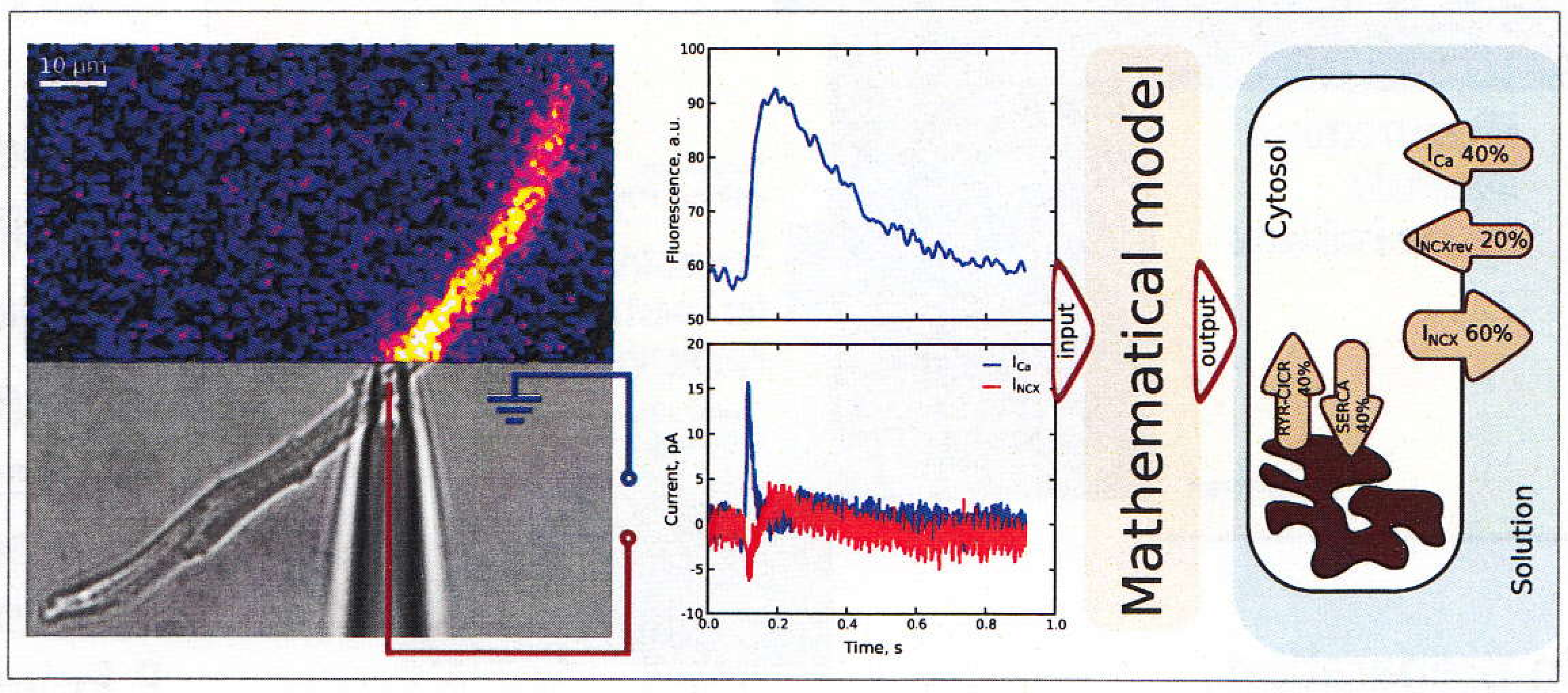
An open-source package for deconvolution of confocal microscopy images is developed

A cross-bridge model for mechanoenergetics of actomyosin interaction



Blow-up: a heart cell

An integrated method to quantify calcium fluxes in cardiac excitation-contraction coupling



Ca^{2+} fluxes in cardiac excitation-contraction coupling

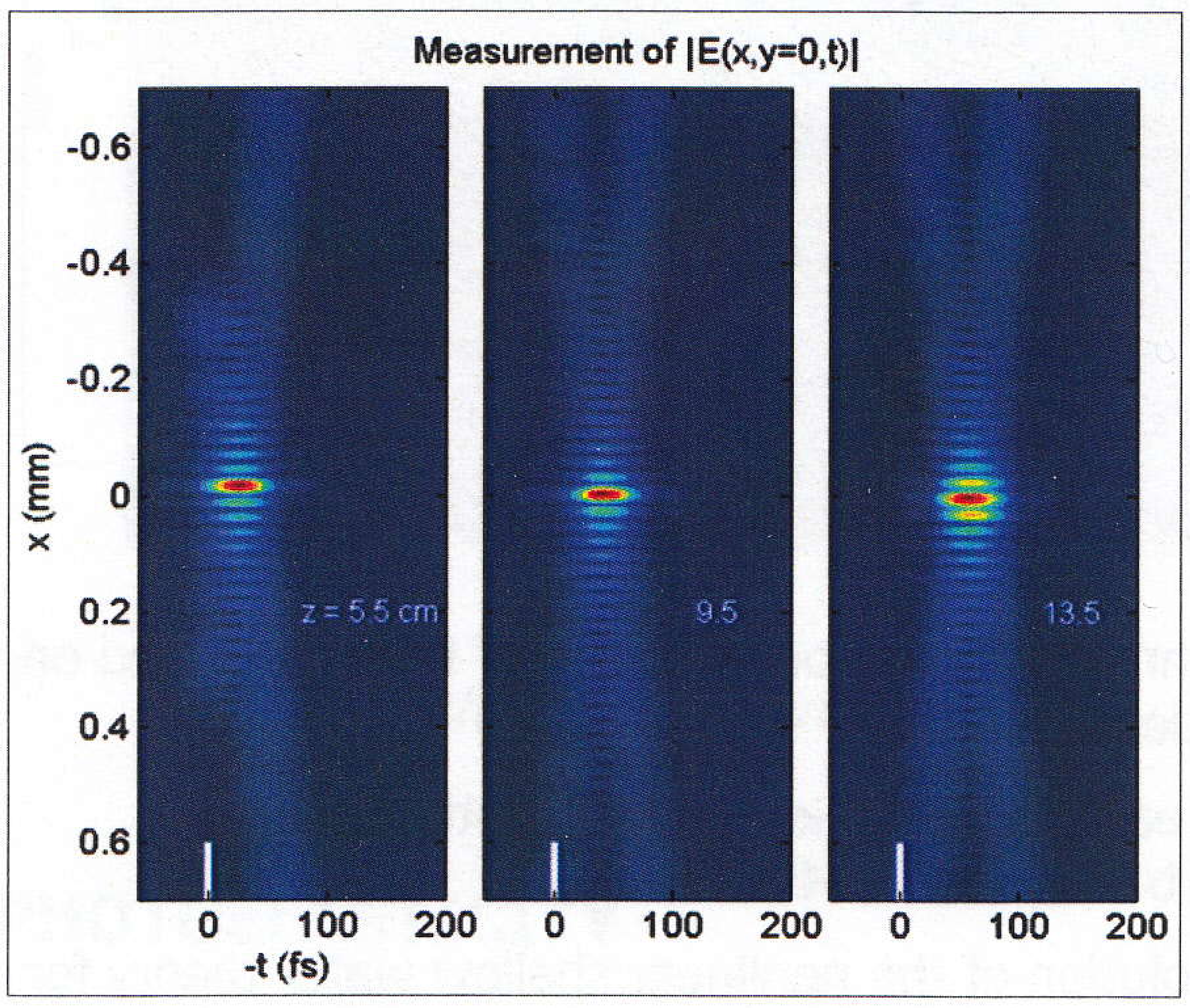
OPTICS

FORMATION OF LOCALISED PULSES, SPECTROSCOPY

The boundary diffraction wave theory has been generalised and adopted for Gaussian pulses

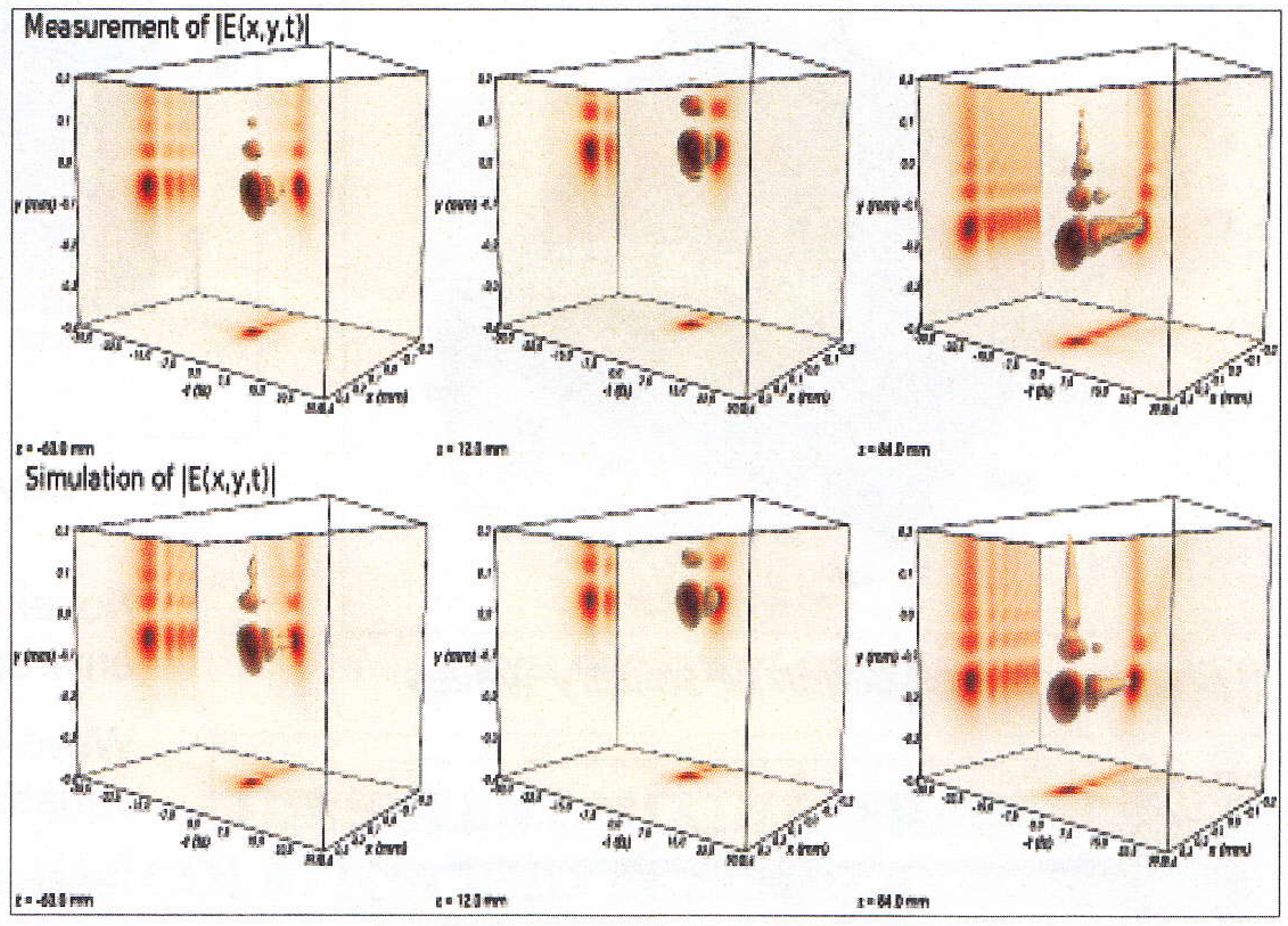
A set-up for spatio-temporal measurement of ultrashort impulse responses with up to 5-femtosecond temporal resolution has been accomplished

Superluminal speed of Bessel-X pulses measured and temporal focusing of ultrashort pulsed Bessel beams into Airy-Bessel light bullets by a circular diffraction grating verified



Measured superluminal Bessel-X pulses

Airy pulses of exceptionally high quality and resistance to dispersion are generated and simulated



Measured and simulated Airy pulses

NONLINEAR CONTROL THEORY

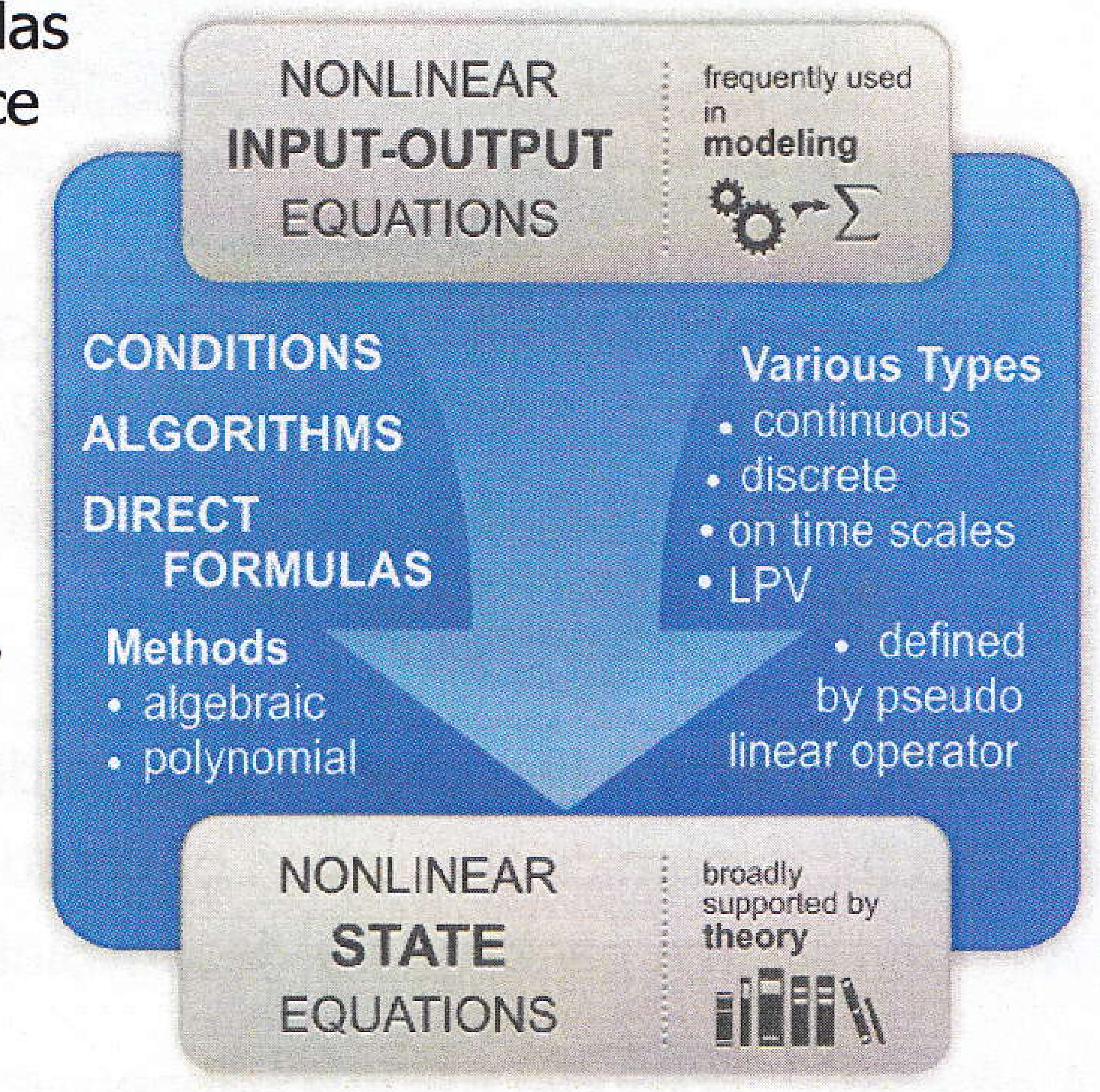
ALGORITHMS FOR CONTROL WITH DISCRETE AND CONTINUOUS TIME

The reduction and realization problems have been solved for nonlinear control systems applying the theory of non-commutative polynomials

The conditions allowing to transform the nonlinear discrete-time control system into the extended observer form were established

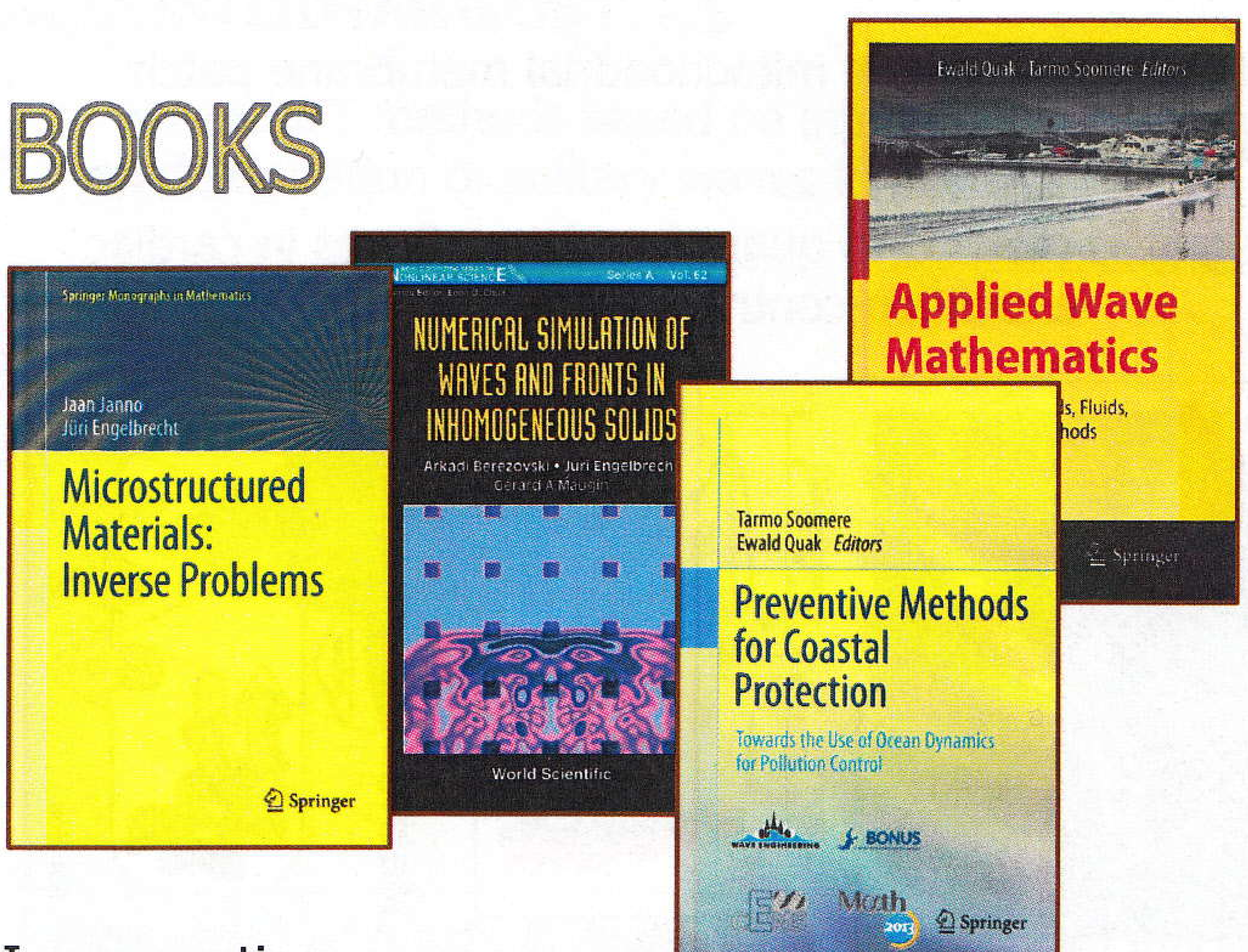
Algorithms for feedback disturbance decoupling in discrete-time nonlinear systems are derived

Adjoint polynomial formulas for non-linear state-space realization are derived



Realization problem

BOOKS



In preparation

J.Engelbrecht, Questions about Elastic Waves, Springer

SOME APPLICATIONS

- The photoelastic scattered light polariscope SCALP designed and applied
- A semi-immerse 3D visualisation system designed and installed
- Software from Systems Biology:

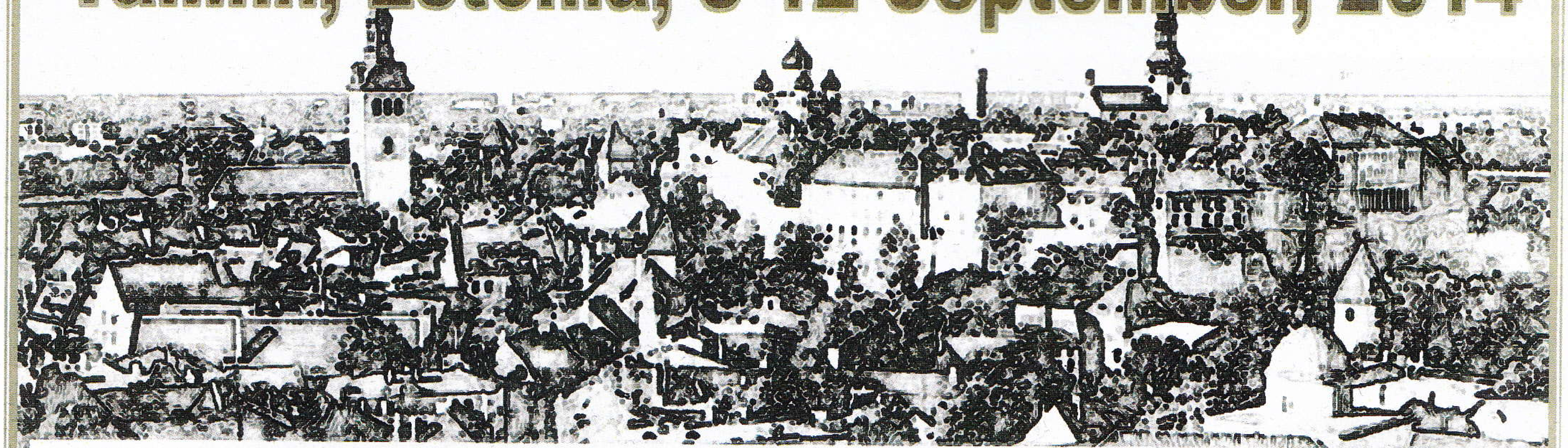
P.Peterson et al., 2002. SciPy (www.scipy.org)

P.Peterson, 1999. F2Py (www.f2py.org)

P.Peterson et al., 2005. NumPy (www.numpy.org)

P.Peterson, M.Laasmaa et al., 2010-... .iocBio – specialized software (iocbio.googlecode.com)

Tallinn, Estonia, 8-12 September, 2014



Complexity of Nonlinear Waves

Chairman: A. Salupere; Co-Chairman: G.A. Maugin

Wave motion is the key mechanism of interest to many fields of science, such as mechanics, acoustics, seismology, oceanography, coastal and offshore engineering, electromagnetism, etc. Despite an extreme variety of physical appearances of wave phenomena, different disciplines share many mathematical models and numerical methods.

Our purpose is to foster research into different aspects of nonlinear wave phenomena – the theoretical, the computational and the applied – through promoting the transfer of competence over the existing borders of classical research disciplines. The synergy of many fields will serve as final goal.

IUTAM SYMPOSIUM 2014

We focus on essentially nonlinear problems where complicated original mathematical models are derived, innovative ideas are applied for computing, and novel applications are intensively created in a number of research fields. Interaction of nonlinearity with accompanying effects such as changing properties of the medium sheds further light to understanding and forecast of physical phenomena. The Symposium will provide a forum for presentation and discussion of innovative complex models and methods including computer based simulation of dynamical processes in mechanics.

The main organiser of the Symposium is the Centre of Nonlinear Studies (CENS) at Institute of Cybernetics, where the complexity of wave fields in solids and fluids has been one of the focal issues for a long period (a previous IUTAM Symposium in 1982).

CENS

Hosting Institution:

Institute of Cybernetics at Tallinn University of Technology, Estonia

IUTAM International Union of Theoretical and Applied Mechanics

TALLINNA TEHNIKAÜLIKOOL
TALLINN UNIVERSITY OF TECHNOLOGY

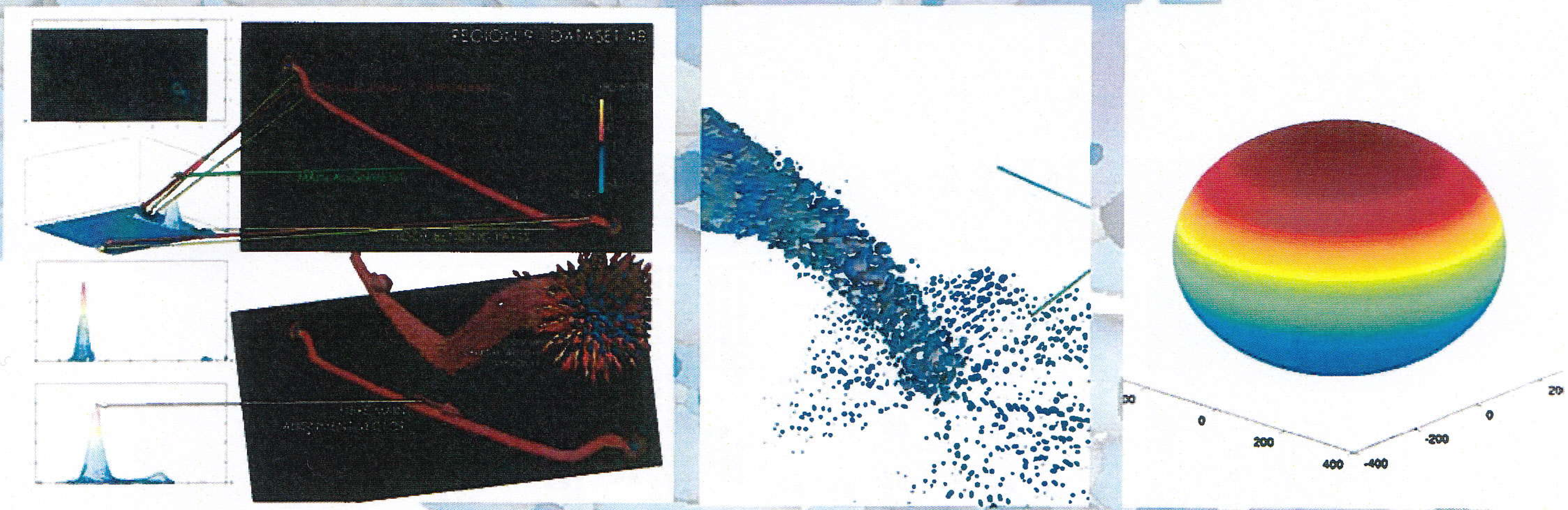
TTÜ KÜBERNEETIKA INSTITUUT
Institute of Cybernetics at TUT

CENS

TALLINNA TEHNIKAÜLIKOOL
TALLINN UNIVERSITY OF TECHNOLOGY

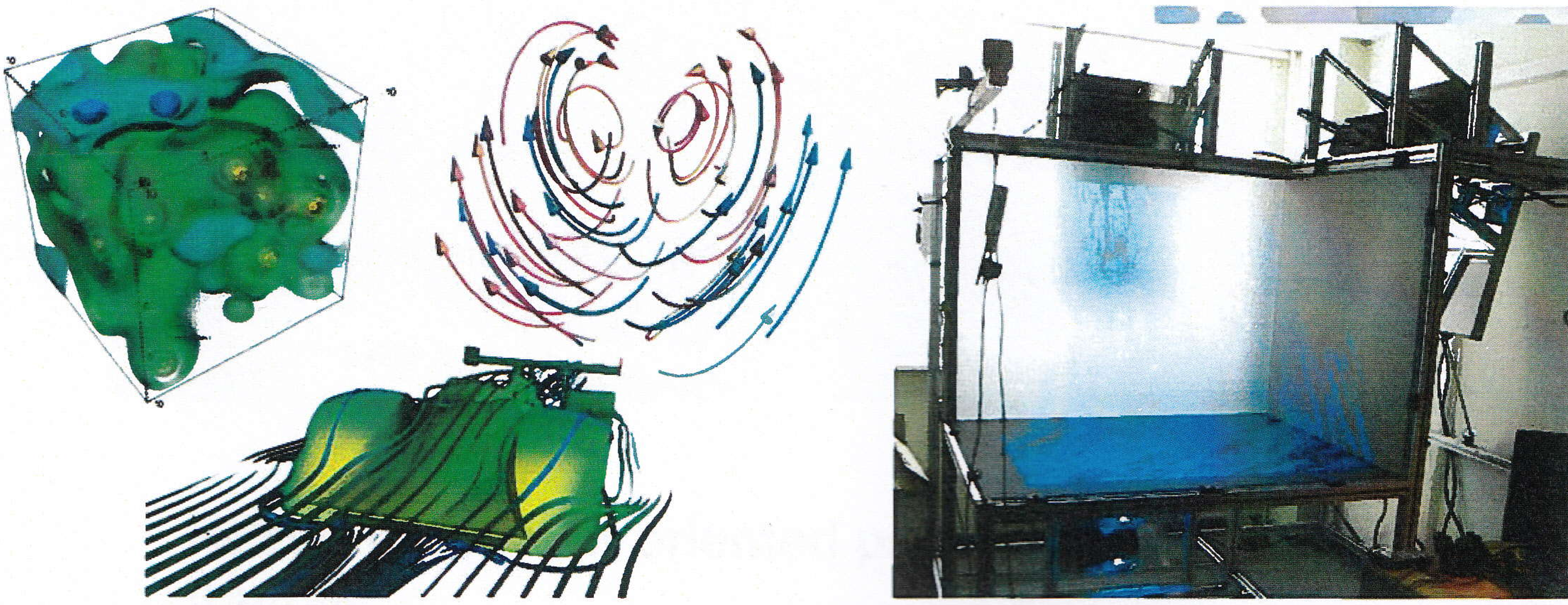
ITI8910 - Special Topics in Scientific Visualization

VisPar Visualization Group. Laboratory of Nonlinear Dynamics



Faculty of Information Technology, Department of Computer Science
Teaching language : English
Lecturer : Heiko Herrmann
Teaching semester : Autumn - Spring
Course volume ECP : 6.00

This project-based course will allow the student to investigate a wide range of special topics in Scientific Visualization and Visualization Infrastructure Engineering (e.g. stereoscopic visualization of scalar volume data, flow fields, tensor fields, mathematical surfaces) with the aim of representing special properties of the simulation or material (e.g. by using thresholding or glyphs, tracking of the user to generate the correct point of view, configuration of visualization infrastructure components (multi-screen user-tracked environments))

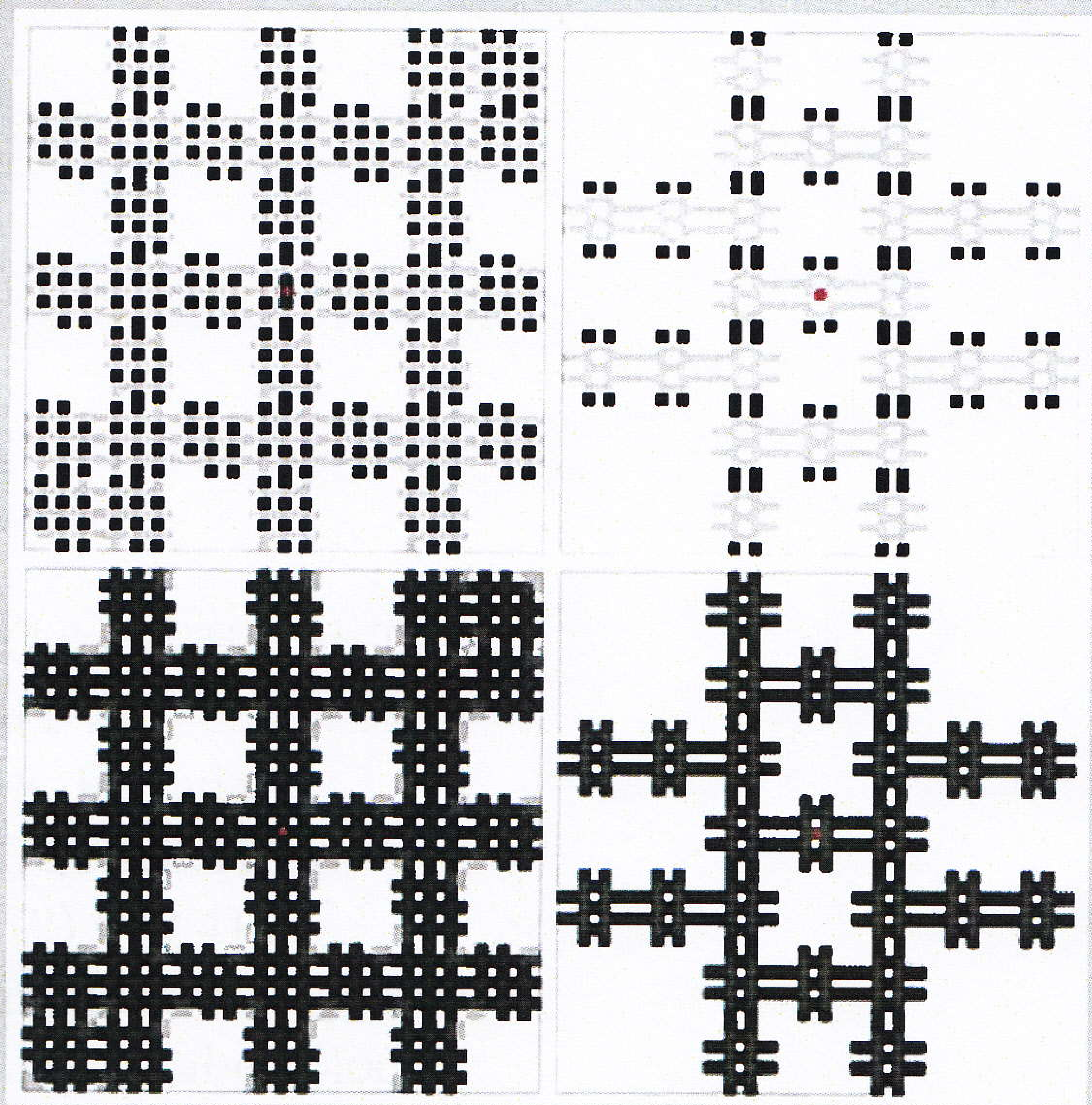


Heiko Herrmann, PhD, hh@cens.ioc.ee, +372 620 4228
Emiliano Pastorelli, MSc, pastorelli@cens.ioc.ee

ISSN 1751-8113

Journal of Physics A
Mathematical and Theoretical

Volume 47 Number 15 18 April 2014



iopscience.org/jphysa

IOP Publishing

Random walks of oriented particles on fractals

René Haber[1], Janett Prehl[1], Karl Heinz Hoffmann[1]
and Heiko Herrmann[2]

CENS

Institute of Cybernetics at TUT
Akadeemia tee 21
Tallinn 12618, Estonia
Phone: (+372) 620 4150
Fax: (+372) 620 4151
Prof. J. Engelbrecht, je@ioc.ee
Prof. H. Aben, aben@ioc.ee
Prof. T. Soomere, soomere@cs.ioc.ee
Prof. J. Kalda, kalda@cs.ioc.ee
Dr. M. Vendelin, markov@sysbio.ioc.ee
Dr. Ü. Kotta, kotta@ioc.ee
Prof. P. Saari, peeter.saari@ut.ee

Internet: http://cens.ioc.ee

CENTRE FOR NONLINEAR STUDIES
Institute of Cybernetics at Tallinn University of Technology
Akadeemia 21
12618 Tallinn
ESTONIA

Phone: +372 620 4160
Fax: +372 620 4151
E-mail: je@ioc.ee
Web-site: http://cens.ioc.ee