

CEMIS

Centre for Measurement and Information Systems

CEMIS Annual Report 2014

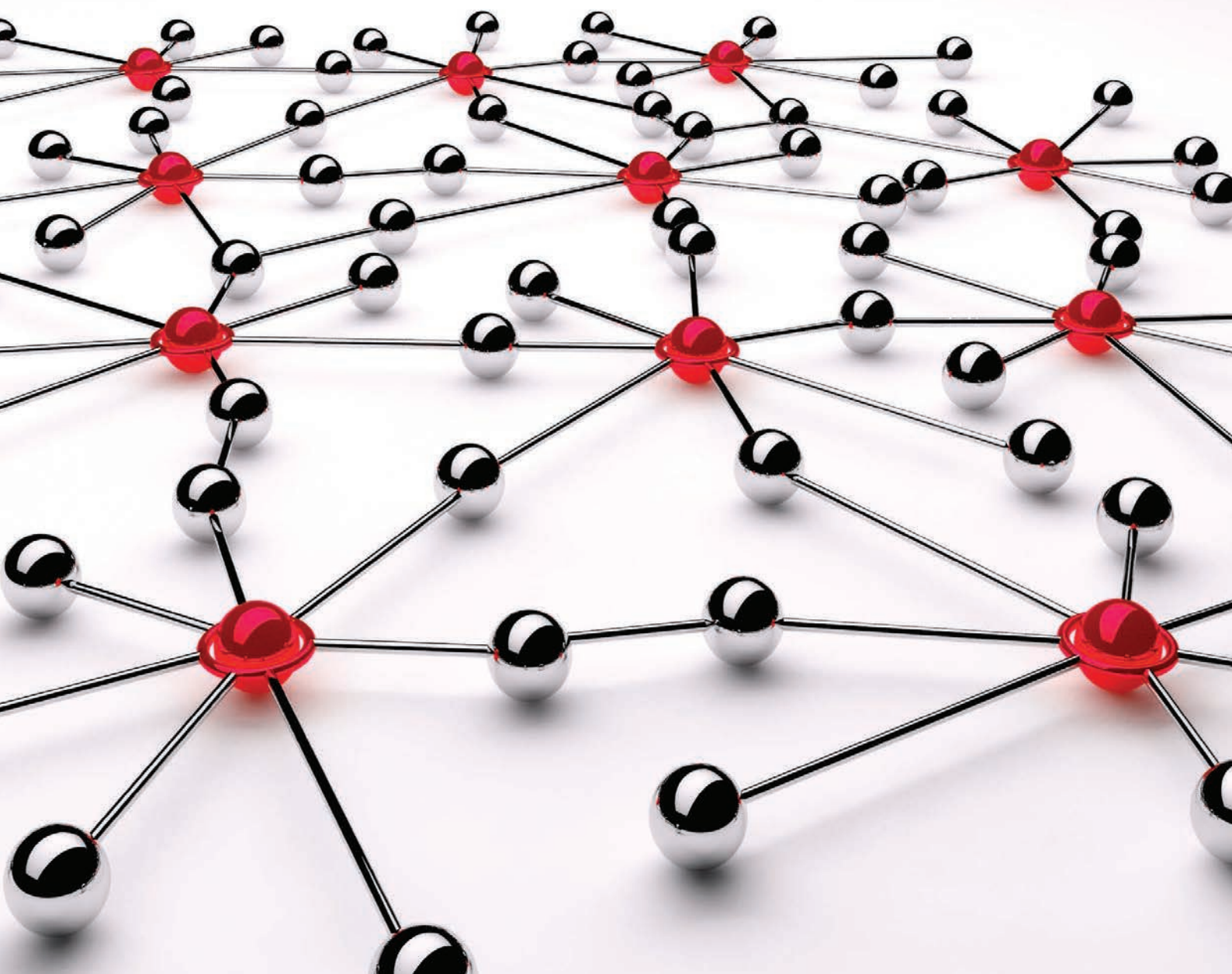


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Chairpersons' Review

The Finnish education and research system, which mainly operates with public funding, has been renewed. However, the global economic situation and abrupt changes in society continue to challenge education, research, development and innovation activities conducted in higher education. Moreover, it may not be possible to conduct future operations profitably using existing structures and operational models. Yet at the very moment it was established, CEMIS freed itself from commonly used operational models.

The CEMIS model seamlessly joins the measurement and information systems expertise of a university of applied sciences, two universities and two sector research institutes together. This has resulted in a cooperation structure where the strengths of the organisations with different basic tasks and duties form a basis for productivity and influential cooperation. For Kainuu, CEMIS is at the core of the region's vitally important innovation system.

Cooperation produces results for the CEMIS members that are visible in result indicators with the amount of state funding allocated to them.

CEMIS' cross-disciplinary cooperation, crossing organisational and sectorial boundaries, enables existing resources to serve the region's development needs effectively. In the view of the Ministry of Education and Culture, CEMIS, with its annually increasing productivity and regional impact, is an excellent example of a fearless and open-minded operational model. The strength of CEMIS lies in self-confidence and the confidence bestowed to its activities.

As the world changes, so must CEMIS change. In Kainuu, it has been possible to combine regional development targets and the universities' and research institutes' productivity targets successfully. As resources decrease and competition steps up, there will be an increasing need for dialogue between the most important stakeholders to reinforce a common understanding and commitment. If anywhere, this is possible in Kainuu!



*Jouko Niinimäki
Rector
University of Oulu*



*Turo Kilpeläinen
President
Kajaani University of Applied
Sciences*

Our work continues, together and in cooperation!



Introduction

Founded in 2010, the CEMIS (Centre for Measurement and Information Systems) is a two-university (Universities of Oulu and Jyväskylä), two research institute (MIKES Centre for Metrology and Accreditation, and VTT Technical Research Centre of Finland) and Kajaani University of Applied Sciences' (KAMK) joint contract based metrology and information systems research and education centre. CEMIS consists of the Oulu University Metrology Research Unit, KAMK's Information Systems Unit, MIKES' and VTT's Kajaani facilities and the metrology development functions of Jyväskylä University's Vuokatti Sports Technology Unit's metrology development operations. From 2014 CEMIS' operations also included KAMK's Mechanical and Mining Engineering competence area. VTT and MIKES merged at the beginning of 2015 to form Technical Research Centre VTT Oy which has research teams in Kajaani specialising in industrial metrology and the industrial internet of things.

The above mentioned four higher education and research organisations, the City of Kajaani and the Municipality of Sotkamo are committed to CEMIS' operations. CEMIS is one of the innovation hubs of Oulu University and the only one of its kind outside Oulu. In Kainuu, Oulu University has focused its technological research and development activities in CEMIS.

CEMIS is Kajaani University of Applied Sciences' most important form of university and research institute cooperation and a central focus of development. For University of Jyväskylä, MIKES and VTT, CEMIS is a form of regional cooperation. Figure 1. presents the organisational structure of CEMIS.

CEMIS focuses on the development of measurement and information systems expertise within nationally significant application areas such as mining, bio-economy, environmental monitoring, sports and wellbeing, and game and simulator technologies.

CEMIS aims to be a desired international partner in developing measurement and information systems technology. It is intended that this hub of expertise and innovation located in Kainuu, will create internationally significant expertise, new technology and business with the aid of research and development services based on extensive cooperation and higher education.

CEMIS produces top-class specialists, new technology and new business for companies and research institutes which develop and use measurement and information systems by offering research and development services and university education in an innovative and international environment.



Figure 1. Structure of CEMIS - The Centre for Measurement and Information Systems

CEMIS offers students with an interest in working in specialist posts, a motivating educational environment and an innovative and international working environment to researchers and experts who wish to develop and progress in their careers.

CEMIS intends to increase the attraction, competitiveness and impact of its members' measurement and information systems research and education activities. In order to achieve this, CEMIS has set quantitative productivity targets for R&D, education and innovation both for the centre itself and individually for the organisations involved.

The main resource used in starting CEMIS' operations has been the CEMIS Development Programme which defines actions for the coordination of operations, cooperation between the parties and how the work is shared, the use of joint resources and for increasing visibility. A second two-year development programme with an annual budget of two million euros and mainly funded by the East Finland ESF (European Social Fund) and ERDF (European Regional Development Fund) programmes and the Kainuu Development Fund, began at the beginning of 2013.

CEMIS' total funding is over 10 million euros per year and it consists of the organisations' own funding, regional development funding (as in the CEMIS Development Programme) and competed external funding. CEMIS employs almost 110 measurement and information system experts.

Director's Review

CEMIS' total funding for 2014 was slightly more than 10 million euros. There were approx. 110 measurement and information system specialists based in CEMIS in 2014.

Risto Oikari, director, CEMIS

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CEMIS was established almost five years ago on September 17th, 2010. It was in full operation from the beginning of 2011. Thus 2014 was CEMIS' fourth year of operations. Year 2014 was marked by a continuing weak global economy, changes in CEMIS' parent organisations, rapid development of international cooperation, continued systematic operational development within the CEMIS Development Programme and the preparation of a new development programme.

CEMIS' operations have progressed as planned. The basis CEMIS' operations has been the strong commitment of all five organisations (in the future four organisations with the merging of VTT and MIKES), from the top management level onwards, a jointly compiled and approved action plan and a shared, extensive development programme. CEMIS' specific strength lies in the practical cooperation conducted by two independent universities according to their own profiles, a university of applied sciences and two research institutes.

CEMIS' members are satisfied with the centre's operations, results and their impact. Jointly implemented activities such as the Strategy and

Management Group, the activities of the field of focus teams of experts, cooperation within R&D, project coordination, joint marketing and communication, development of business operations, cooperation in prototype implementation, and the development of shared facilities and environments as well as education cooperation have, to a large extent, progressed as planned.

The operations of the Metrology Research Unit of Oulu University, CEMIS-Oulu, was re-organised into two research teams which correspond well to CEMIS' fields of focus. The teams are specialists in cleantech and wellbeing. CEMIS-Oulu started two new international projects. TEKES allocated funding for two new technology commercialisation projects.

Within KAMK's Information Systems competence area, a new Smart Systems degree was developed. The Mechanical and Mining Engineering competence area became very much involved in CEMIS' operations. The popularity of education offered by KAMK remained at the record levels achieved in the previous year.

University of Jyväskylä started a new Master's programme in Sports Technology and project preparation aiming at strategic cooperation with VTT.

MIKES' Kajaani unit has achieved its targets with considerably almost a third of its income coming from paid services and employing eight people. The weak economic climate of 2014 decreased the demand amongst companies for its services. An international force measurement standard conference was organised at MIKES and it was also asked to coordinate international key comparison measurements. This was an excellent indication of the international recognition already enjoyed by MIKES. MIKES as a part of "new" VTT will continue to operate actively in the international metrology community, and as an active actor in the development of applied industrial metrology, and as a competitive producer of calibration services.

VTT continued to produce promising results generated by the development of impulse radar technology and commenced new initiatives with FIMECC, the Finnish Metals and Engineering Competence Cluster and the Forum for Intelligent Machines, FIMA, a company network specialising in machine construction. VTT underwent preparations to become a limited liability company and for MIKES to be merged with VTT. As a result,

the functions of the Kajaani Unit were concentrated in the Renforsin Ranta Business Area and a research team specialising in cloud services was integrated into an Industrial Internet of Things research team which will be lead from Kajaani.

The IT Centre for Science, CSC has had a data-centre unit in Kajaani since 2012. CEMIS started actions leading to more intensive cooperation with CSC with the aim of commencing international project cooperation and to negotiate CSC becoming a part of CEMIS.

The measurement of CEMIS' impact is primarily based on new commercially viable technology and how many companies have been set up as a result of CEMIS' activities. In 2014, CEMIS **developed 2 commercially viable inventions and established 4 new companies.**

There are approx. 20 technology development projects financed by national and international public funding and business funding continually in progress in CEMIS. New technology development projects are being continually prepared in cooperation with Finnish and international partners and companies. In 2014 over 60 project proposals were prepared and **almost 50 different projects** were implemented as well as direct commissions from client companies. The subjects of the projects

The Minister of the Environment (in the centre) Ville Niinistö, accompanies CEMIS to Brazil on an exports promotion trip





comprehensively covered CEMIS' fields of focus including the development of measurements in bio-economy, mining process management and environmental monitoring measurements, the development of measurement and information systems for vehicles and work machines, the development of game and simulator solutions and sports and wellbeing measurements. Over 300 companies were involved in CEMIS' projects and used its services. When operations started, 5 % of the Centre's 10 million euro annual budget was from partner companies. In 2011 the proportion of business funding had increased to 7.4 % and in 2014 it reached 8.7 %. The Centre has set a target of growing the proportion of business funding to more than 11% by 2017.

The implementation and development of metrology and information systems education has been a part of CEMIS' activities. Within CEMIS, education leading to a Bachelor's degree in Business Administration, a Bachelor's degree in Engineering and a Master's degree in Engineering in the Information Systems competence area was delivered, as well as education leading to a Master's and Doctoral degree in Sports Sciences in the Department of Sports Science of University of Jyväskylä in Vuokatti. Education at Kajaani University of Applied Sciences was developed particularly in the Smart Systems degree. A course in metrology and preparation

for education leading to a vocational qualification in measuring and calibration was implemented with AIKOPA – Adult and Continuing Education.

CEMIS is part of the metrology and information systems scientific community. It produces relevant scientific knowledge and participates in scientific activities within the field. In 2014, a total of **18 international, peer-reviewed and 22 conference publications** were produced in CEMIS. In addition, **1 doctoral thesis, 10 university Master's theses and 18 higher AMK theses and 102 Bachelor of Engineering and Bachelor of Business Administration theses** were produced in CEMIS.

In 2014 CEMIS' overall funding was just over **10 million euros**. There were approx. **113 (person work years)** of metrology and information system experts in CEMIS in 2014.

CEMIS has had projects in three strategic centres for science, technology and innovations (SHOK) Cleen Oy, FIBIC Oy and FIMECC Oy.

CEMIS has started or continued cooperation with several foreign research institutes, universities and companies, in e.g. Brazil, South Korea, Thailand, Spain, Poland, Romania, Italy, Austria, France, Great Britain, Germany and Chile.



Presentation of CEMIS' operations at a high level Finnish-Brazilian seminar in Rio de Janeiro.



*The rector of University of Oulu, **Lauri Lajunen's** (on the right) period in office ended at the end of 2014. As Chairman of the CEMIS Strategy Group, Lauri Lajunen played a significant role in starting up and steering CEMIS' operations.*

CEMIS' qualitative aims are to strengthen attraction, competitiveness and impact. Kajaani has retained its position as a metrological hub of expertise and strengthened its position as a game industry education and start-up business centre. Vuokatti has developed as an international centre of skiing training, coaching and research. Companies in Kainuu and elsewhere in Finland have gained new experts, as well as the technology and services they need to develop their business operations.

Risto Oikari, director, CEMIS



The CEMIS Development Programme

CEMIS' operations were to a large extent, developed in the CEMIS Development Programme which began in 2011. The second 2-year funding period started at the beginning of 2013. The aim of the development programme is to ensure that the qualitative aims of the centre are achieved – to increase the attraction, competitiveness and impact of metrological and information systems research and education. The CEMIS Development Programme 2013 – 2014 was divided into six action packages. They enabled the centre's operations by ensuring resources for key persons, the implementation of joint technology development projects in technology and application fields central to developing the business of local companies, the

development of the centre's joint operations in the implementation of device solutions, the marketing and dissemination of the programme's outcomes and promoting the commercial use of the results of centre's research and development projects.

The total finance volume of the two-year development programme (1.1.2013 – 31.12.2014) was 4.0 million euros. The main funding bodies were the Regional Council of Kainuu and Kainuu ELY-Centre (Centre for Economic Development, Employment and Transport). The programme was partly funded by the East and North Finland ERDF and ESF. The programme's structure and funding is described in Figures 2 and 3.

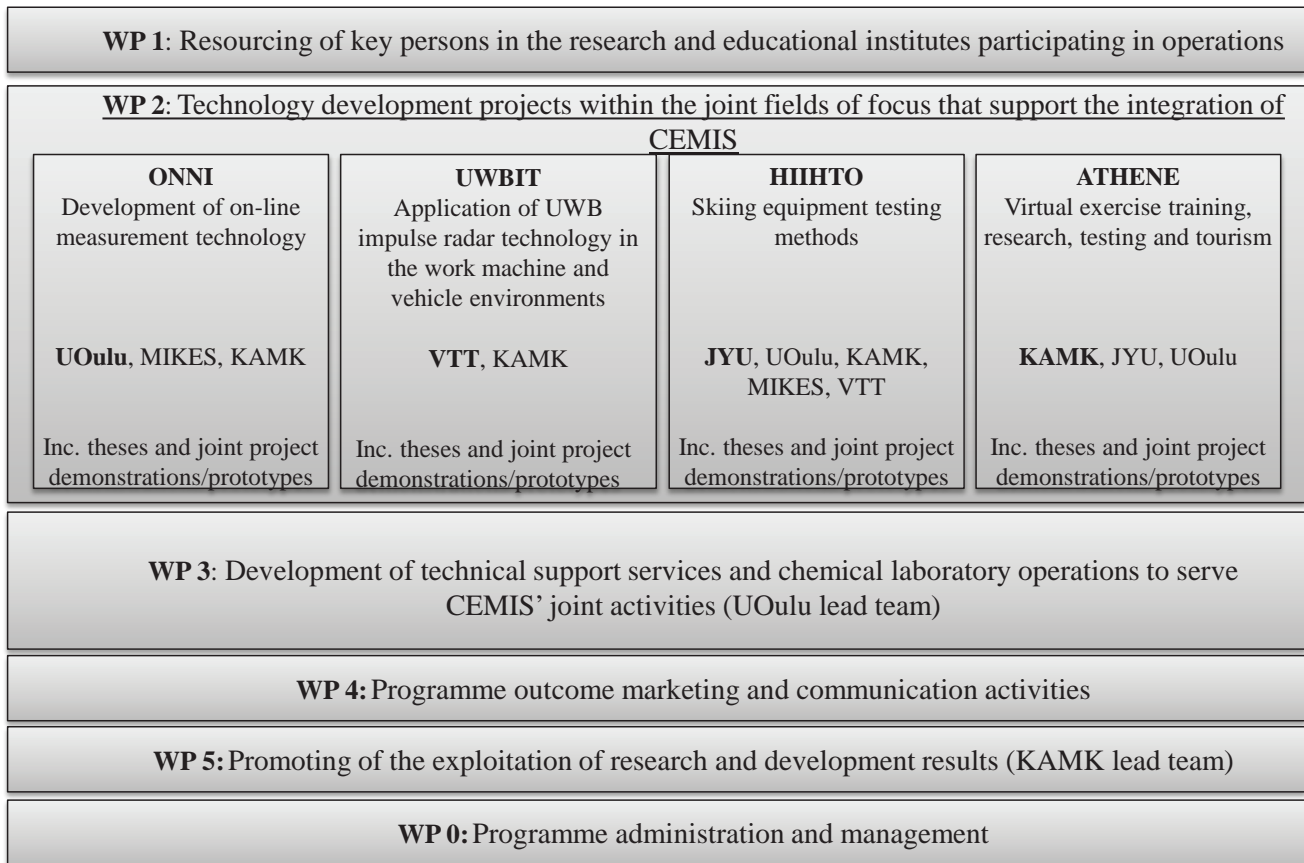


Figure 2. Work Packages implemented in the CEMIS development programme

The CEMIS Development Programme is a success: Raised external project funding of 8 million euros, more than 10 new technologies and 6 new companies

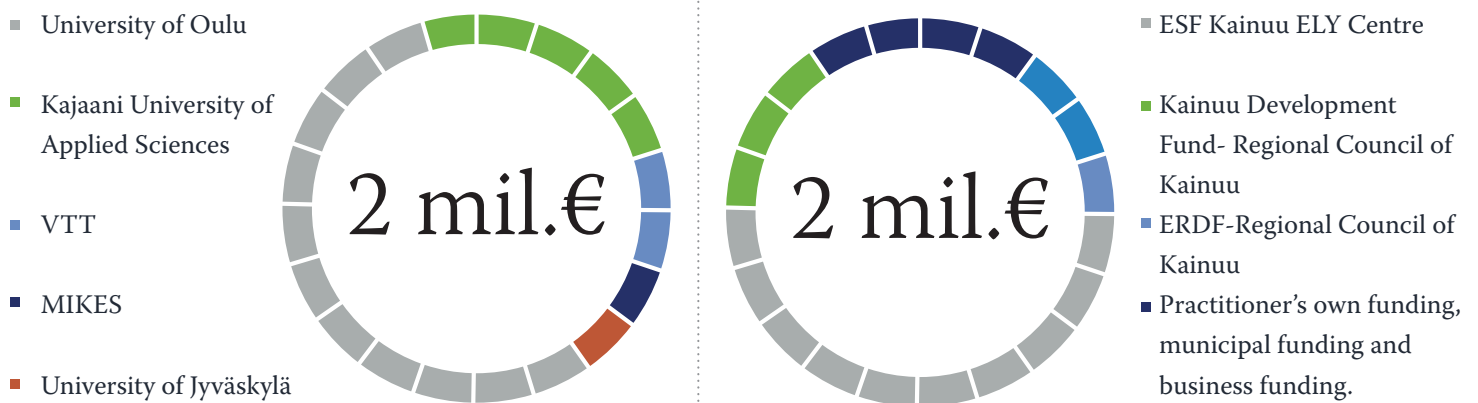


Figure 3. CEMIS development programme's funding distribution by partners and funding sources



Work package 1:

Resourcing of key persons for the research and education organisations participating in CEMIS' operations

The objective is to ensure that CEMIS and each participating research and education organisation achieves their productivity targets. To enable this the programme has provided resources to employ key persons in each organisation in CEMIS: Research Team Managers for University of Oulu, a Project Manager and Development Manager for the Kajaani University of Applied Sciences project, a Project Coordinator for University of Jyväskylä, a Unit Manager for the MIKES unit and a Unit Manager for the VTT unit. All of the above work part-time in the programme. They were responsible for their research team's operations in the development programme, for publishing the results of the development programme, coordinating the project activities of their research teams, marketing the results of their research teams' activities, cooperation, national and international research cooperation, preparing and developing projects and paid services to be implemented with competitive research funding.

Results:

The Metrology Research Unit of University of Oulu, CEMIS-Oulu: Preparation for approx. 50 projects resulting in **4 internationally, 11 nationally** funded and 4 regionally funded projects (total 5.4 million euros), several service commissions, 23 publications, the expansion of international cooperation and participation in the operations of the national and international scientific community

active in the sector.

Kajaani University of Applied Sciences: Preparation for approx. 20 projects resulting in **2 nationally funded** and 2 regionally funded projects. Two publications. Development of international cooperation particularly in the game and simulator fields as well as vibration measurements.

Jyväskylä University: Preparation for almost 10 projects resulting in 3 regionally funded projects. Participation in a book and one conference publication. Development of service operations as part of the HIIHTO project. International cooperation mainly with the international Paralympics Committee, Salzburg University and Freiburg University. Arrangements for an international skiing congress.

MIKES: Preparation for approx. 10 projects resulting in **1 internationally, 1 nationally funded** and 1 regionally funded projects. MIKES services produced to the sum of 500 000 euros during 2013-2014. One publication. Cooperation with the National Metrology Institute of Germany PTB, the National Metrology Institute of Sweden SP and Tampere University of Technology in the development of a flow measurements environment.

VTT: Preparation for approx. 10 projects resulting in **5 nationally funded** projects. Three conference presentations. Cooperation with the Irish and South-Koreans.

The outcome of WP 1 of the CEMIS Development Programme's operations was a **project base worth 8 million euros of which well over half are funded by international and national sources of finance.**



Work package 2:

Joint research projects supporting the integration of CEMIS.

Joint research and development projects on the following topics were conducted by two or several of CEMIS' members:

1. ONNI: On-line Measurement Technology Development
2. UWBIT: application of UWB (Ultra Wide Band) impulse radar in the work machine and vehicle environment.
3. HIIHTO: Equipment testing methods in skiing
4. ATHENE: Virtual training, research, testing and tourism environment

ONNI: On-line Measurement Technology Development

In the On-line measurement technology development (ONNI) project, new measurement technology and methods were developed for the on-line measurement needs of liquid samples. The aim was to develop online measurement methods to determine the physical and chemical properties of liquid samples and measurement systems and a testing environment for the measurement needs of liquid biofuels, mining process waters and other process liquids and sludge. The project was implemented by CEMIS-Oulu, MIKES and KAMK.

The work packages and main outcomes of the project were:

WP1: Solutions to improve the reliability of optical

measurement devices

A report was compiled on the monitoring of dirt accumulation on optical sensors and a measurement device for studying the accumulation of dirt on measuring devices was assembled. The features of this device are more advanced than the features of equivalent commercial devices. The flow profile of MIKES' liquid flows test device and other factors affecting measurement uncertainty were determined.

WP2: Characterisation of liquid organic compounds

An optical multi-parameter measurement method was developed to determine sugar and total carbon content from liquid organic compounds. The measurement uncertainty of the developed method has been determined by MIKES. The planning of a technology commercialisation project was begun. Capillary electrophoresis analysis for various types of industrial samples was developed. The functionality of on-line capillary electrophoresis equipment (ONCE) was tested successfully with industrial samples in the laboratory and in the field. An application for continued funding for ONCE technology application development was made.

WP3: Continuous optical measurement of changes in water

The functionality of continuous, real time NIR and UV-VIS measuring equipment has been demonstrated successfully in mine production process monitoring and in a municipal waste water treatment plant by measuring e.g. sulphide, carbonate and total phosphorus content.

WP4: New sensor solutions and technologies

The gas chromatography mass spectrometry method (GC-MSD) was tested in the analysis of mining samples. A biosensor to analyse respiratory air was developed. A laboratory method for identifying bacteria was developed using samples from a foreign partner (University of Toronto). The development of a biosensor to identify bacteria has begun. The identification of D vitamins in food samples was tested.

WP 5: Measuring small concentrations of metal with electrochemical and optical technologies

Methods of measuring small concentrations of zinc and nickel in mining environment waters have been developed. A zinc sensor based on a gold-bonded electrode and a nickel sensor based on impedance spectroscopy and a nickel sensor based on a bismuth coated electrode, have been implemented. The sensors have been tested using laboratory and industrial samples. The measurement uncertainty of the sensors has been determined by MIKES and KAMK has established their vibration tolerance.

In summary, the outcomes of the ONNI project were

- Five new measurement methods for three of which demonstration equipment was set up
- A comprehensive study of MIKES liquid flow equipment features
- 4 scientific publications
- 3 new cooperation projects started with companies

In addition the project prepared one commercialisation of r&d results project plan and several

new cooperation projects with companies. The project also produced more close cooperation as planned between CEMIS members, particularly CEMIS-Oulu and MIKES and strengthened CEMIS expertise in one of its most important areas of competence (online liquid flow measurements) and in important areas of application of the future (mining industry and biofuel production).

Application of impulse radar in the work machine and vehicle environment

In this project the applications of impulse radar (UWB) in work machine and vehicle environments were examined. UWB impulse radar is a radar technology using microwave frequency range and pulsed signal configuration. The aim was to examine and apply impulse radar technology to work machines, industry and sports and exercise. The focuses were: detecting human beings in challenging work machine and industrial environments, identifying foreign or oversized objects amongst materials on conveyors and measuring an athlete in motion.

During the project

- a report on UWB impulse radar technology literature was compiled
- the capacity of UWB impulse radar technology using simulations in different applications was surveyed
- laboratory measurements of the operational capacity of impulse radar technology were conducted in different applications
- a test platform for demonstrations was planned and set up



- algorithms for 1) detecting a person next to a massive metal object 2) for measuring the profile of crushed rock 3) for detecting a foreign object amongst crushed rock or wood chips, have been developed
- demonstrations were carried out
 - of detecting a person next to a massive metal object (work machine)
 - measuring the profile of crushed rock on a conveyor
 - detecting a foreign object amongst crushed rock/wood chips
- the algorithms were expanded to suit a dynamic environment
- field measurements of crushed rock profile and detecting foreign objects from a conveyor were implemented
- started impulse radar planning in an embedded environment
- presented outcomes at the RadarCon2014 conference in the USA and a part of the outcomes were reported in David Davidowski's thesis
- The final report: Impulse Radar technology in industrial Applications, VTT Research Reports VTT-R-00220-15 was compiled
- project planning for the application of the developed technology started with companies

HIHHTO: Equipment testing methods in skiing

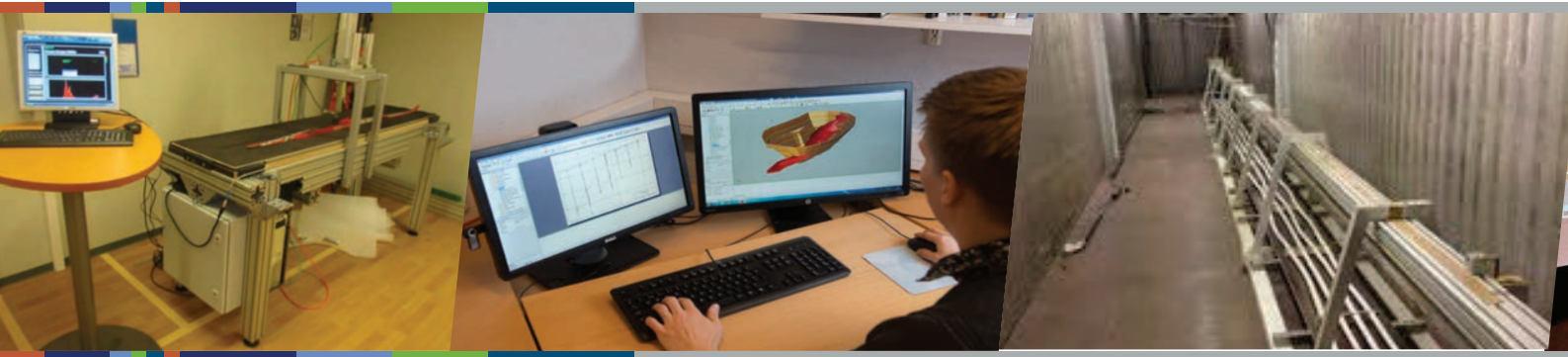
The aim of the Equipment Testing Methods in Skiing project was to implement unique winter sports, more specifically a ski sports coaching, testing and research cluster in Vuokatti. The listed objectives of the project were **1.** to develop low temperature laboratory operations for ski sports equipment testing as well as to search for applied research opportunities with partners in cooperation, **2.** to develop methods for measuring the features of skis (how conditions affect ski features and how the skis function) to improve the reliability of force measurement systems of the Sports Technology Unit, **3.** to continue snow related research, e.g. to detect water in snow and chemicals used on ski tracks, **4.** to further develop the skiing measurement module prototype developed in the CEMIS Development Programme's (2011-2012) LIIKE project **5.** to further develop the L-lactate and cortisol sensor, and **6.** coordination. The project was implemented jointly by University of Jyväskylä, University of Oulu, KAMK, MIKES and VTT.

The actions and major outcomes of the project were

WP1: Start-up of low-temperature testing laboratory and ski testing

The aim of the low-temperature testing laboratory was to enable repeatable and reliable research on the impact of conditions on equipment and athletic performance and for other research on the impacts of cold or damp (e.g. needs of the sports equipment industry). The laboratory contains cooling systems for ski track snow and indoor air with an adjustment range of +0 ... -20 degrees Celsius. A ski tester has been installed in the laboratory for which more reliable force measurement equipment and more user friendly software than earlier was developed.





WP2: Snow research, imaging methods

A method of characterising ski track snow has been developed. A new method and field-ready demonstration equipment for determining the properties of falling snow have been developed (SAKU). An advanced version of rain imaging equipment sends a measurement signal (holograms) for analysis to one server device, which automatically interprets the results. The rain drops and different crystalline snow flake structures can then be separated and measured using the snow flake and rain images. Small particles (pollen) have also been measured. From the images it is possible to detect e.g. different deposits and structures in the structure of flakes from different layers of cloud and to separate rain drops and snow from each other reliably, as well as small particles of solids. The functionality of the rain imaging equipment has been demonstrated in field tests with the Finnish Meteorological Institute. The equipment has also awakened interest among snow researchers and related companies. Cooperation has been carried out with the Meteorological Institute, University of Helsinki, Colorado University in the US and a few companies.

WP3: Further development of skiing measurement module

A more advanced version of the earlier wireless measuring system for skiing research (HIIHTO-card) has been implemented. With the HIIHTO card it is possible to measure ski and pole forces, EMG (muscle activeness), air pressure and location data (GPS). The system was demonstrated at the 2014 winter Olympics arena in Sochi and during at the 2015 ski WC arena in Falun. The HIIHTO card has also been used to record and save ski

track profiles and for bringing them into a virtual environment.

WP4: Further development of the L-lactate sensor, analysis and validation of results

Sensors for the non-invasive measurement of cortisol levels (saliva sample) and of lactate levels (sweat sample) were developed. Using the lactate sensor it is possible to measure diluted saliva and sweat samples quickly and reliably. Lactate concentrations detected with the sensor match concentrations measured using capillary electrophoresis reference analysis. During the project it was observed that lactate levels vary in different parts of the body and the levels seem to depend on physical load. Cooperation with a sensor company was started during the project to further develop the lactate sensor.

ATHENE: Virtual exercise training, research, testing and tourism environment

The aim of the ATHENE Project was to create a concept (ATHENE-concept) for developing new types of virtual exercising environments and to use the concept to implement 2 – 3 pilot environments. New virtual environments increase the attraction of using gym equipment and the pleasure derived from exercise. In addition, the ATHENE-concept included a new innovation for virtual tourism and created opportunities for developing and starting up new business ventures. The pilot environments were implemented based on the needs of the Kainuu region, especially Vuokatti.

The project was implemented jointly by KAMK, University of Jyväskylä and University of Oulu.



The project resulted in the creation of a versatile virtual environment, Athene which combines the world of video games and exercise in a creative manner.

The main elements of the virtual fitness and training environment are:

- Several environments and a developed route editor which enables the effective creation of virtual environments.
- Movement based control (Kinect) and user interface
- Device solution (ACD card) to connect fitness devices and other external devices to the virtual environment.

The concept was piloted at the Orienteering WC in Vuokatti and during the Lost in Kajaani event, athlete testing, in gyms, in an activity park and during rehabilitation together with a Japanese partner university and at other events. The implementation of the second pilot began with the aim of creating a keep-fit environment. In April 2014 the Athene concept was awarded the prize for second best innovation in the **FIBO exhibition's innovation Awards 2014** competition, held in Germany. The project has been widely mentioned in the general media (newspapers and periodicals, TV) and 1 conference publication and 2 peer assessed articles have been compiled. Extensive national and international cooperation took place in the project (e.g. with Sendai University, Japan, Medica Medizintechnik GmbH, Germany and Woodway, USA). The implementation of the project was supported by the Tekes funded by

the Athene+ project which was prepared during this project. The commercial rights of the project results were transferred to a spin-off company of KAMK operating in the sector.

Work Package 3:

Development of technical support services and chemical laboratory operations to serve CEMIS' joint activities

CEMIS aims to streamline the technical support services and chemical laboratory services so that by 2015 all the services can be produced centrally. The main aim was to assemble the technical support services and the chemical laboratory for University of Oulu and set up a device development coordination team serving all of CEMIS' members.

Actions and results:

Development of laboratory functions: In the Development Programme, the plans for shared laboratory functions and facilities for the Kajaani and Sotkamo based research groups of CEMIS-Oulu were carried out in line with the university's plan to concentrate the operations of CEMIS-Oulu in Kajaani Technology Park. During the project, new devices for CEMIS-Oulu were purchased such as a CNC work centre for assembling mechanical devices and a Screenprinter to manufacture sensors. The plan was also implemented and a cooperation agreement to implement the technical support and chemistry laboratory for the needs of the whole CEMIS organisation was compiled.

Support of joint projects: 9 pieces of demonstration equipment used in the ONNI, HIIHTO



and ATHENE joint projects were set up as well as chemistry laboratory services linked to development work.

Work Package 4:

Programme outcome marketing and communication activities

The outcomes of the programme were marketed and disseminated with the Development Programme. The main actions were the updating of CEMIS' joint marketing and communication plan, updating the CEMIS website and creating printed CEMIS brochures for the mining, bioenergy, exercise and wellbeing fields. CEMIS organised 7 seminars and actively attended at least 17 events. Numerous visits were also arranged and CEMIS was present in the media over 70 times. CEMIS' operators produced approx. 100 scientific publications and conference publications in 2013-2014.

Work Package 5:

Promoting the exploitation of research and development results

The main impact target of the CEMIS Development Programme is to create new companies and business and to commercialise development output.

The following actions were implemented to develop business:

- The joint business development team of all five CEMIS members started its work
- Market, competitor and technology surveys for approx. 20 projects were compiled
- Surveys of flow measurement calibration marketing and European calibration business. Also two business impact analyses were planned and conducted as separate commissions.
- CEMIS-Oulu mentoring clinic operations were implemented
- Six regionally funded development projects for service operations were prepared and started up
- Three new Tekes funded research result commercialisation projects were prepared and started up
- Two publications were compiled
- International cooperation was created with 20 different organisations in more than 10 different countries

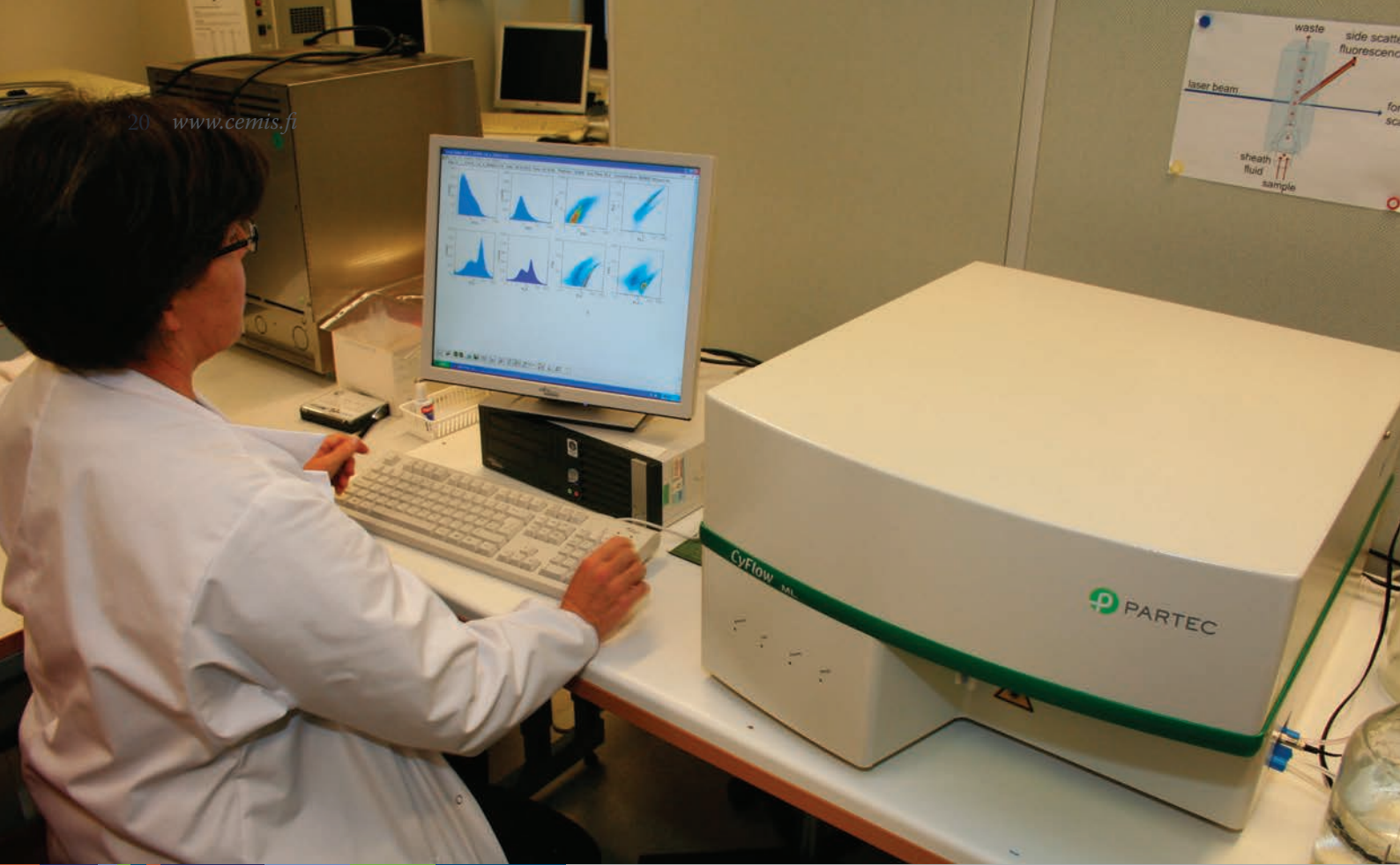


The CEMIS Development Programme is a success: Raised external project funding of 8 million euros, more than 20 international and national projects and 6 new companies

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As a summary of the CEMIS Development Programme 2013-2014 results it can be stated that

- The activities of the key persons (8) resourced by the programme were profitable. As a result **5 new internationally and 19 nationally funded projects** were created. The total financial volume of the projects is **more than 8 million euros**, mainly from international and national sources of funding. The amount of international funded projects increased by 50 % and **the volume of business funding increased by almost 30 %**.
- The joint projects have generated results as planned. **11 new technological solutions** were generated in the joint projects. New projects to be financed with competitive research funding based on the technologies developed in the joint projects have been prepared and are being planned. There is clear commercial interest in the technologies developed in the projects. Concrete cooperation between CEMIS operators was strengthened in the jointly implemented projects.
- Technical support and the chemical laboratory have supported the implementation of the joint projects. The unification of CEMIS-Oulu's technical support and chemical laboratory functions was completed successfully. **CEMIS' joint technical support and chemistry laboratory model** was planned and a cooperation agreement was compiled.
- CEMIS' national and international reputation is growing continuously. CEMIS has been asked to present the CEMIS model and its results at several events. **Media visibility has been good** (over 70 mentions).
- Business development and the commercialisation of research output are progressing and have attracted an increasing amount of interest. The main focus was in international, TEKES commercialisation (TuTLi) and business cooperation projects. International cooperation and cooperation with companies has been generated. Competitive external **funding has been obtained for commercialising three new technologies**.
- As a result of the operations **six new companies** were generated and **seven technologies** were commercialised.



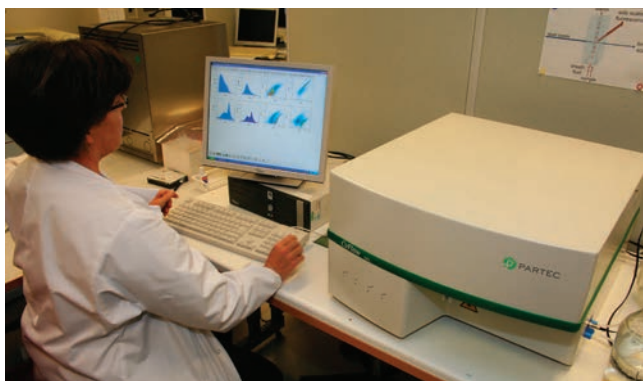
The Operations of University of Oulu

CEMIS-Oulu was formed in 2014 from three research groups: analytical chemistry and bioanalytics, optical spectroscopy and visualising measurements and is located in Kajaani, Sotkamo and in Vuokatti in terms of project activities. Sotkamo's operations moved to Kajaani in August and the new laboratory was inaugurated on the 10th September. At the beginning of September, the unit formed a two research team model: cleantech and wellbeing/health. The main focus of research is bioeconomy and application areas in 2014 were process and environmental applications (especially in mining), well-being applications, the renewable forest industry and bioenergy.

A fixed-term professorship in optical imaging technology continued in 2014 and was financed jointly by Oulu optoelectronics laboratory projects and Kajaani's unit project funding. There were post-graduate degree students in both research teams.

2014 saw the continuation and strengthening of CEMIS' (Centre for Measurement and Information Systems) operations. New CEMIS Development Programme projects started in 2013. Other organisations in CEMIS are the University of Jyväskylä, the Centre for Metrology and Accreditation (MIKES), VTT Technical Research Centre of Finland Kajaani and Kajaani University of Applied Sciences. The CEMIS Development Programme has further united the region's expertise and strengthened cooperation between the Universities of Oulu (CEMIS-Oulu) and Jyväskylä, as well as cooperation between University of Oulu and MIKES by Tekes and regionally financed projects. The Director, Vesa Virtanen, has participated in the work of the CEMIS Strategy and Management Groups. University of Oulu's unit is clearly the largest operator in the CEMIS Development Programme.

CEMIS-Oulu is involved in the national photonics research network Photonics Finland. In 2014



5 international projects, 12 Tekes projects and 15 other projects

cooperation with the Oulu Innovation Alliance was strengthened, in particular with its Centre of Health and Technology (CHT), the Centre for Environment and Energy (CEE) and PrintoCent. CEMIS-Oulu was involved in 12 Tekes-funded projects:

1. **Cleen/MMEA programme** (TEKES): development of online sensor contamination control and assessing the applicability of biosensors.
2. **Pulpvision**: development of imaging and machine vision systems for use in the manufacture of paper and pulp. (ended)
3. **RAIKU**: (TEKES TuTLi, linked with Green Mining Programme): Real time and cost-effective particle-size control from excavation to product. (ended)
4. **MEAN**: (TEKES TuTLi, linked with Water Programme): Mercury-free automatic online metal analyser
5. **SMARCTIC**: (TEKES small strategic opening): Road map for smart arctic expertise (2012 – 2014)
6. **LST-VISION**: (TEKES small strategic opening): New approach to analysing and visualising complex data, started at beginning of 2012-2015
7. **SEWEB**: (TEKES small strategic opening): Sensors and social web
8. **MINEFILTR**: (linked with TEKES Green Mining Programme) Developing the drainage and measurement of mining sludge (ended)
9. **BEST** (FIBIC-CLEEN SHOKs, TEKES):

Future sustainable bioenergy solutions

10. **BIO-In** (TEKES TUTLI), development of a biosensor to detect and analyse insulin
11. **Premium** (TEKES TUTLI), real-time smart control of process liquid metal concentrations
12. **Water-M** (ITEA2/TEKES), development of a smart water management system

CEMIS-Oulu participated in the energy and environment strategic centre for science, technology and innovation (CLEEN SHOK) Measurement, Monitoring and Environmental Assessment (MMEA) research programme and in CLEEN's Finnish Bioeconomy strategic centre for science, technology and innovation (FIBIC SHOK) in the joint BEST project.

In addition to the CEMIS Development Programme and TEKES projects, CEMIS-Oulu had 15 other ongoing projects. There was extensive cooperation with companies in the Kainuu region and nationally.

Methods of monitoring and identifying compounds containing sulphur in mining environments were developed in the national **SULKA** project. Geopolymer and mineral based binding agents and adsorbent materials are being studied and developed in the **GeoMaterials** project in cooperation with Kajaani University of Applied Sciences.

The Innovative High-Value Products from Biomass Raw Materials project **Biohiva** continued and is



now networked with Oulujärvi Leader and businesses. The creation of a service research concept for the identification and profiling of bacteria to produce new information for the adjustment of industrial processes to enhance production is ongoing in the **BAKOTUS** project in which mining, energy, renewable forestry and food companies are partners. The aim of the project is to develop profiling methods for the identification of bacteria in the forest and paper industry, mining, the food industry and the bioenergy industry.

CEMIS-Oulu participated in promoting Vuokatti in the **Testikatti** project, which is developing wellbeing, testing and sports services enhanced by analytics. The project will strengthen Vuokatti's competitiveness in sports and wellbeing tourism and will create new cooperation networks between companies, research institutes and other organisations. The project partners are e.g. The Finnish Olympic Committee, University of Jyväskylä, KIHU and Vuokatti Sports Academy.

The unit was also involved in the **Biovesi** project, in which the measurement of viscous liquid and biofuel samples is being developed for the benefit of MIKES' Kajaani site.

The Kainuu Higher Education Strategy **KICK-OFF** project began at the end of 2013. The project is

being implemented by the partner universities of the Kajaani University Consortium (Oulu, Lapland, East Finland and Jyväskylä) and Kajaani University of Applied Sciences. The Kainuu Higher Education Strategy (KKKS) is based on Kainuu's development needs and it will promote systematic inter-university cooperation in Kainuu, examine the role of higher education in supporting long-term development in Kainuu and intertwine the activities of the universities' main campuses in the development of Kainuu.

CEMIS-Oulu also implemented the mobile motion platform (**LILA**) project in which continuous and autonomous sensors for air and water measurements were set up at mobile device platforms and demonstrated. Additionally, ideas for how to use various operational and cooperation models for environmental applications were generated.

The unit conducted research cooperation with the Ministry of Agriculture and Forestry connected with cost-effective berry and vegetable cultivation. There was also cooperation within the fields of bioreactor operations and products. The actions of the **KAVERI** project aimed to decrease the nutrient and solids load caused by agriculture in waterways. The main objective of the preliminary survey project (**ENeuvonta**) was

Technology solutions for business needs





to conduct a survey of multichannel, optical fibre and mobile network based e advisory services to serve entrepreneurs in the fields of agriculture, food production and forestry.

The unit participated in five international projects: in the European Meteorological Research Programme, **EMRP**, with two projects; in the first, foreign researchers assessed the validity of quality monitoring outcomes and in the second project laboratory moisture analysis devices based on new technologies (NMR microwave and x-ray technology) are being investigated and their performance compared to the traditional standard of the oven drying method. CEMIS-Oulu is also in the PEOPLE part of the EU FP7 programme's ITN network project **EUROMBR** which has 12 partners in 8 countries. The project is developing expertise in microbioreactors and it provided resources for one foreign doctoral thesis employee. The unit is participating in the EU-N EIP, the Entrepreneurship and Innovation Programme's Eco-Innovation part, the **Envimon** project, in which industrial metal emissions monitoring in environment waters is being studied.

CEMIS-Oulu was also involved as a metrology developer in the EU EUREKA cluster ITEA 2 programme's **WATER-M** project, which aims to alter water management operating systems and services. Several companies and research institutes from Finland, France and Turkey are participating in the project. The aim is to ensure safe water for domestic uses in all situations. Finland's part of the project is financed by TEKES in 2014 – 2016. The European Commission's Directorate-General for Health and Consumers organised a research application in August 2014: Healthy diet: early years and aging population. CEMIS-Oulu's project proposal Nutritional research on the non-invasive screening and diagnosis of malnutrition in elderly persons (**NURSE**) was selected for funding. An agreement was signed with the Commission in December 2014 and the project started at the beginning of 2015 and will continue until the end of June 2016.

Strong international cooperation

The number of international researcher exchanges was 36 person months as planned. There was active international cooperation with more than 10 research institutions e.g. in Italy, Russia, the USA and Great Britain. The number of scientific articles produced was good: 9 referenced international scientific articles and 20 conference and other publications or presentations. The unit's employees participated in international and national evaluation tasks (scientific magazines, and assessment of international project applications). There were two notifications of inventions.

The unit's new structure facilitated the more efficient shared use of equipment and research environments. Its budget was approx. 3.8 million euros and it accumulated 49 person work years.



The Operations of Kajaani University of Applied Sciences

2014 was CEMIS' fourth year of operations. From the beginning of 2014 KAMK has operated as a limited company, officially known as Kajaani University of Applied Sciences Oy.

CEMIS' operations have continued according to the CEMIS cooperation agreement in the Information Systems competence area. The Mechanical and Mining Engineering competence area joined operations at the beginning of 2014.

New teaching curriculum “Smart Systems” in the Information Systems competence area

The actions within the Information Systems competence area in 2014 have been the renewal of the “vehicle information systems” curriculum towards “smart systems” as a part of the Information and Communication Engineering degree. The new degree curriculum leading to a Bachelor's degree qualification will be included for the first time in the 2015 joint application. The aim of the updated curriculum is to increase attraction and to renew teaching to fulfil new business requirements. The plan is to provide education in software and elec-

tronics not only for vehicles applications, but also in industry, sports and exercise and health and wellbeing. The content of the education enables graduates to be involved in industrial user interface, cloud service and sensor applications development. The previously developed “**game technology**” specialisation will continue as a second option for students to develop their competence towards gaining a university of applied sciences engineering degree at Kajaani University of Applied Sciences.

Extensive project operations continued within the Information Systems competence area focusing on datacentre, simulator, virtual and game competence –serious games and gamification development in cooperation with businesses. The staff of the competence area prepared project proposals throughout the year for regional and competitive national and international calls. **The total financial project volume of the Information Systems competence area was approx. 1.3 million euros.** As part of the CEMIS development programme 2013-2014 KAMK was involved in implementing the ATHENE project, which creatively combines virtualisation, game-like features and keep fit, the

skiing equipment testing methods development project, HIIHTO, and the UWBIT project, which is applying impulse radar technologies in industry and work machine environments. As well as these projects, device testing support was given to the online measurement technology development project (ONNI). Additionally, Tekes funded projects **Pelitys** and **Athene+** were implemented alongside several other research and development projects financed with regional or KAMK's own development funds. Teaching and RDI operations have been more strongly integrated into new learning environments developed in TEKES projects, e.g. in the Software and Operating System Testing courses.

“Athene, the mobile simulation environment”, which was created as a result of development work implemented partly with ESF and ERDF financing and partly with national TEKES funds, received significant recognition in 2014: it was awarded the title of second best innovation at the international trade show for fitness, wellness and health FiBO in spring 2014. International partnerships were strengthened in the Information Systems competence area within the KAMK university network, to which Howest University College of West Flanders, (Belgium), the University of Skövde, (Sweden) and Heilbronn University (Germany) belong. The network has identified expertise in the field of games and vehicle information systems in line with the commonly shared international profiles of the above universities. The network is aiming to make a joint international project application in 2015.

Our position as a leading educator in the field of games was strengthened when the Ministry of Education and Culture allocated 20 new temporary study places for 2014 and 2015 in order to deal with the bottleneck of applicants. Therefore the total number of KAMK study places in this field rose to 80 from previous years.

The number of **applicants with KAMK as their first choice university remained at record levels seen in 2013**, with a total of 378 applicants (2013, 382). An increasing amount of interest in the Data

Center option was also observed in the Business Information Technology degree. Most of the applicants were from outside of Kainuu.

The Data Center and the field of games also achieved national visibility during the Kajaani NGS and Helsinki NDBS events, which attracted several hundreds of game oriented participants. In 2014, **58 AMK Bachelor's degrees and 17 higher AMK degrees** were completed in the Information Systems competence area. 14 students participated in an international exchange and 19 international students came to Kajaani. Teachers and specialists in the competence area conducted 25 visits abroad lasting more than five days and 8 persons came to KAMK from abroad. 11 publications were compiled for various journals. In particular there was extensive media coverage of the outcomes of simulator development in 2014.

Mechanical and Mining Engineering a part of CEMIS' operations in KAMK

Since 2014, CEMIS' operations have also included the Mechanical and Mining Engineering competence area. It consists of the Mechanical, Construction and Civil Engineering degrees and related RDI activities.

The development of mining competence has already been a major part of KAMK's operations and RDI for several years. In cooperation with the University of Lapland, KAMK's working life and strategic partner, KAMK has planned a mining specialisation option for studies leading to an engineering degree to be jointly delivered in line with the profiles of the universities involved. This cooperation was viewed as worthy of an award by Finland's association for the technology industry, Teknologiateollisuus ry for the joint development of work based and university teaching in the promotion of engineering expertise.

In 2014, within research and development there were ongoing projects funded by TEKES, ESF, ERDF, industry, the Ministry of Education and Culture and KAMK itself. **The total financial volume of projects in Mechanical and Mining**



Engineering for 2014 was 0.5 million euros. Various CEMIS members and other research institutes and universities were involved in the projects. KAMK's contribution and development of expertise in geopolymers research and applications (the **Geomaterialit** – geomaterials project) can be viewed as an important addition to CEMIS KAMK's profile in 2014. This applied research, which began in 2013, has been excellently received in companies and promises interesting and international research opportunities for the future. The TEKES Green Mining programme succeeded from KAMK's perspective. KAMK participated in two funded projects in cooperation with e.g. CEMIS members and institutes of the University of Oulu. Cooperation with the Oulu Mining School has also been noticed and has advanced KAMK's international RDI and Business opportunities.

As a part of international cooperation, a delegation from KAMK visited Chile and Brazil to create new university and research institute partnerships as the basis of international project operations and specialist and student exchanges. **In 2014, KAMK ratified inter-university agreements with Santa Maria University in Chile and the Instituto Federal Brasília in Brazil.** Via CEMIS, KAMK participated in several domestic and international trade fairs related to the field, such as FinnMateria in Jyväskylä and Toronto's big annual mining event, PDAC. CEMIS' joint marketing materials were used at various events to promote the shared volume of expertise offered by the education and research centre.



In 2014, 44 AMK Bachelor's degrees were completed in the Mechanical and Mining Engineering competence area. The personnel of the competence area produced 11 publications for various journals.

The CEMIS Business Development Team (CBD) continued productive operations in 2014

Operations to promote the commercial use of research outcomes, to the benefit of all the members in CEMIS, continued successfully at the lead of the Business Development Team in 2014. This team of specialists, coordinated by a senior business R&D lecturer, has supported project preparation by carrying out market and business potential surveys. International cooperation networks have systematically been extended into growing market areas such as South America, which has generated interest, particularly in the field of mining.

Thanks to new networking visits, the international network has grown, thus advancing international project preparations. Business expertise has also been increased by participating in selected training programmes in Finland and abroad. In 2014, the CBD team was involved in the preparation of 10 projects and in promoting the commercialisation of outcomes of joint projects and the service business. As a result of the above activities, one new research outcome commercialisation project began, one previously started commercialisation project was implemented and two new commercialisation projects were prepared.



The Operations of VTT Technical Research Centre of Finland

VTT's Kajaani site is continuing to focus on deepening its local expertise in already commenced subject fields. These are impulse radar technology, deepened in CEMIS' UWBIT and the previously begun Ultra Wide Band (UWB) technology based on the IEEE 802.15.4 2011 standard.

Impulse radar technology has been studied in CEMIS' two-year UWBIT project where the target of research has been to detect people and other objects in the vicinity of various types of working machinery. The most important aspect of the project is that detection is carried out without an active sensor using primary radar. The project was expanded to include measuring material on a conveyor, such as crushed ore and wood chips.

UWB technology research and development continued in the PUOMI2020 project commissioned by the Forum for Intelligent Machines (FIMA), in which UWB position detection and data transfer

combined with Tampere University of Technology's MEMS based positioning forms the sensor set-up. It is intended that this type of sensor set-up will define the position of the head of a boom in various phases of movement ultimately allowing the boom to be controlled automatically.

Staff

The number of staff at VTT Kajaani changed drastically in 2014. At the start of the year there were six employees: 4 VTT researchers, 1 exchange researcher from abroad and 1 thesis employee. In the summer the number of staff decreased first to 4 and then to 3. At the end of the year there were 3 employees because VTT announced that the Kajaani site would be closed down. However, this did not happen because MIKES merged with VTT in the New Year enabling VTT's Kajaani site to remain.



VTT is a genuine forerunner in international technology development

Projects

In 2014 VTT Kajaani focussed on developing expertise in impulse radar, CEMIS UWBIT, UWB Puomi2020. Due to a lack of resources, some the development work conducted in these projects had to be moved to other locations in Oulu, Tampere and Espoo.

The **EU PRESTEGE** project, which had been prepared and ordered in the previous year, started but the team was moved to Tampere due to the lack of resources. FIMECC's **FAMOUS** project was finalised and its reports were completed during the spring.

An impulse radar technology research and development project was prepared and commissioned for FIMECC's extensive **S-Step** project. This project forms about a third of the work conducted by the team in Kajaani during the next four years.

International cooperation

VTT Kajaani continued to participate in the preparation of international projects. **Awesome**, **Awesome-Bit**, **LivornoOnFire** and **Modern2020** are project frameworks undergoing preparation with international consortiums. **Awesome-Bit**, prepared with Cemis-Oulu, is still awaiting a decision and **Modern2020**, a project linked to the final storage of radioactive waste, has been ordered. **Modern2020** is based, to a large extent, on the results of the Tekes funded **VAMMA** project conducted by the team in the past.

During 2014, there was one thesis student from Germany and one exchange researcher from South Korea at VTT Kajaani.

A presentation on impulse radar research delivered at the RadarCon 2014 conference generated an invitation to the conference to present progress made in the area.

Outlook for 2014 - 2015

VTT's work will continue in Kajaani with the merger of VTT and MIKES. Although our team in Kajaani is down to just one researcher, impulse radar and UWB technology research will continue in Kajaani in three separate projects.

As from the beginning of 2015, VTT will be one organisation amongst others involved in CEMIS' operations, i.e. MIKES and VTT separate agreements will be combined into one. Due to VTT's location based streamlining decisions, it will certainly be necessary to implement Kajaani based projects in other Industrial IoT team locations. Nevertheless, it is hoped that actively searching for joint projects in cooperation with local companies and research institutes will also bring new project volume to VTT Oy in Kajaani in the near future.



Centre for Metrology and Accreditation MIKES' Operations

MIKES Kajaani site has operated for just over three years in purpose-built facilities in the Renfors Riverbank Business Area. **MIKES' most important tasks are the maintenance of national measurement standards, the offering of traceability services to various organisations and participating in national and international research.** National force, torque, large mass (50 kg ... 2000 kg) and water liquid flow measurement standards are situated at MIKES Kajaani, which is also involved in metrology clubs and is responsible for force and liquid flow clubs.

MIKES' operations progressed as expected within traceability services and research operations. The most important target within traceability services for 2014 was being accepted to the CMC (Calibration and Measurement Capabilities) tables maintained by BIPM (International Bureau of Weights and Measures). These tables show the internationally approved levels of uncertainty for measurement

standards of different national measurement standard laboratories and contracted laboratories. A part of the project applications were submitted and some are still ongoing.

A significant meeting was also held in Kajaani. 10.–12.11.2014 an international team of specialists with worldwide responsibility for the accuracy of force and torque measurements visited Kajaani. This team is the International Bureau of Weights and Measures, BIPM's Mass Committee's working group which is responsible for the development of the aforementioned quantities and for cooperation with national metrology institutes. The group represents the best expertise available in this field. During 2014, **10 employees**, of whom 8 were full-time, **worked at MIKES** Kajaani. Most of the employees were recruited from the Kajaani area. All vacant posts have attracted several tens of good applicants. Additionally, the development work conducted at MIKES Kajaani has also pro-



vided work in the region's companies and research institutes.

Petri Koponen, Ph.D., is the Manager of the MIKES Kajaani site. Koponen previously worked as a researcher in Oulu University's CEMIS-Oulu unit and Joensuu University. **Aimo Pusa**, who was the previous Manager and responsible for establishing MIKES' office in Kajaani continued to work as a full-time expert until the end of 2011 and then part-time undertaking specialist tasks.

MIKES Kajaani has provided the opportunity for students from the region's educational establishments to accomplish practical training and engineering theses. The laboratory has also provided summer work for young people in the region.

MIKES Kajaani has actively participated in **EURAMET's** TC meetings with its own expert areas. It cooperates actively with the **German Metrology Institute PTB** in the traceability of force, torque and water flow and conducts significant cooperation with the Tampere University of technology in the development of liquid water measurement standards.

MIKES has actively participated in the joint projects of the CEMIS Development Programme. These were: the online measurement technology

development project, **ONNI**, and a ski equipment testing methods project, **HIHHTO**.

MIKES prepared and received funding or has produced service research during 2010-2014 for seven different projects (**Painevesi, LUMO, Analytical Photonics, Cleen/MMEA, TARRA, NICK** and **EMRP Force, BEST** and **Biovesi, EMPIR Torque**). In the business operational environment development projects (**PAINEVESI** and **BIOVESI**) funded to a large extent by the Centre for Economic Development, Transport and the Environment, MIKES started to develop a national liquid flow measurement standard in Kajaani and has significantly expanded MIKES Kajaani's operational opportunities. During 2010-2014, MIKES also continued in the energy and environment strategic centre for science, technology and innovation **CLEEN Oy's** MMEA programme (Measurements, monitoring and environmental assessment) developing e.g. measurement quality control. In the **TARRA** project, MIKES developed work machine vibration control systems in cooperation with Kajaani University of Applied Sciences, University of Jyväskylä and the Finnish Institute of Occupational Health. MIKES contributed to the **NICK** project funded via the **TEKES' Green Mining Programme** by providing a research service.

MIKES' **BEST** project contribution will be in providing a research service related to the uncertainty of humidity measurements. The EMRP (European Metrology Research Programme) Force is one of 37 EMRP projects currently ongoing in MIKES. The aim of the EMRP is to integrate European metrology research into the implementation of common goals. In the EMRP Force project MIKES Kajaani is studying and developing together with 10 other national metrology institutes, new calibration methods and researching the behaviour of force sensors' mechanical relay parts and the impacts of divergent forces and moments of deflection caused by their behaviour and which affect measurement in "build up" systems. The aim is to examine the relationship between the time used to take a measurement and strain-causing load to better understand the relationship between load and time in different types of force sensors. A new EU project will start in the summer of 2015, EMPIR Torque. This project will examine how torque measurement traceability can be implemented in a measurement area of more than 1MNm.

The functions of MIKES Kajaani have been actively presented at EURAMET meetings. An article on water flow calibration services was published in *Automaatioväylä* on 6/2011 and on all of MIKES Kajaani's operations in *Ohutlevy* 2/2012. In addition the Kajaani unit and its operations have been promoted regularly in MIKES' own publications, *Tiimalasi* and *TopFive*. Four pieces of writing on MIKES Kajaani's operations were published in local newspapers. Towards the end of the year an article on MIKES' time services was published. News concerning MIKES Kajaani has also been evident in social media (FB).

During its first four years of operation MIKES Kajaani has had more than 300 customers of whom over 95 % were from outside Kainuu. There have been more foreign than local customers, thus Kajaani as a location has not prevented demand.



*Director General of MIKES, **Timo Hirvi**, who played a central role in the founding of CEMIS and MIKES' Kajaani site, retired as from 1.1.2015*



The Operations of University of Jyväskylä

The Head of the Sports Technology Unit is Professor Vesa Linnamo. 12 persons were employed by the unit in 2014, a professor, two senior teachers, four project researchers, two planners, a laboratory engineer, a project coordinator and a project secretary.

In 2014, nine Masters in Sports Technology graduated from Vuokatti. A total of **52 Masters** had graduated by the end of the year. **Jarmo Piirainen**, Master of Sports Technology, defended his **doctoral thesis in Biomechanics "Neuromuscular function and balance control in young and elderly subjects: effects of explosive strength training"** in an event organized in Vuokatti on 7.6. 2014. He was the second doctoral student to have graduated from Vuokatti. The subjects of two other doctoral studies are linked with skate style cross-country skiing techniques and force production. Both doctoral theses are being completed in cooperation with Salzburg University.

Since the start of operations at the unit, sports technology graduates have found employment in about 60 places of work, of which approx. half are located in Kainuu. In 2014 a total of 10 graduates found employment. The students have set up **7 companies**. There has been cooperation with about 30 companies 20 education and research organisations.

Doctoral thesis and 9 Master's theses

In 2014, the unit participated in three different research or development projects: The joint projects 2013 – 2014 of the CEMIS Development Programme HIIHTO and Athene (Kainuu ELY Center, ESF), Export of Sports Expertise project - **LIIVI** (Kainuu ELY Center, ERDF), Active life and work - **ALIWO** (Kainuu ELY Center, ESF). CEMIS' activities continued from the beginning



of the year in the development programme in cooperation between University of Jyväskylä, University of Oulu's CEMIS-Oulu unit, Kajaani University of Applied Sciences, MIKES and VTT. The CEMIS Development Programme has provided resources mainly for a laboratory engineer and project coordinator in the Vuokatti unit. The CEMIS Development Programme's HIIHTO project coordinated by Vuokatti Sport Technology Unit focused on developing methods of snow research, equipment testing (cross-country skiing) by setting up a cold testing laboratory, and the development of a sports performance measurement card and non-invasive measurements (measuring lactate from sweat using a biosensor). Others involved in this project were: University of Oulu's CEMIS-Oulu, Kajaani University of Applied Sciences, MIKES and VTT. The aim of the **LIIVI** project is to create international cooperation opportunities to attract winter sports athletes to train and be coached in Vuokatti. The project involved representatives of the Jyväskylä unit visiting South Korea in 2014 as part of a delegation led by the Prime Minister of Finland, **Alexander Stubb** with the aim of setting up a cooperation agreement between national skiing association of Finland and Korea or the Olympic Committees of both countries. The aim of the **ALIWO** project is to develop using extensive cooperation networks, preventive occupational wellbeing operations and services in line with demand and taking into account future challenges. The **ALIWO** project recruited 40 managers, working in the Kainuu area, for the purposes of the study and who participated in extensive health and nutrition surveys

throughout the year.

2014 was a significant year for disabled skiing

Accompanying the Prime Minister in South Korea

research which University of Jyväskylä implemented with the universities of Freiburg, Salzburg, Torino and Leuven and the Paralympic Committee. Measurement periods lasting several weeks took place in Vuokatti throughout the year. The ultimate aim of the research was to develop testing methods for determining sit skiers' midriff impairment using a dynamic balance test. The research included an extensive selection of different variables from balance and muscle activeness measurements to movement analysis. The dynamic balance device used in the research was based on many years of development which started as a part of Jarmo Piirainen's (Doctor of Sports Technology) doctoral research in 2005. International cooperation expanded with a visit by an Italian researcher from Torino Technical University, **Valeria Rosso** who worked in Vuokatti in disabled skiing research from October to December and whose visit will continue until the end of February 2015.

The units international scientific publications were as follows in 2014: 3 referenced original scientific articles (6 more articles were reviewed), 1 doctoral thesis, 4 invited lectures (2 of them delivered abroad) and 5 congress abstracts.

International cooperation

CEMIS has an extensive and continually expanding international cooperation network consisting of universities, research institutes and companies. The most significant international partners are, amongst others:



- ◎ *Mid-Sweden University, Sweden*
- ◎ *Salzburg University, Austria*
- ◎ *Tübingen University, Germany*
- ◎ *Freiburg University, Germany*
- ◎ *Leuven University, Belgium*
- ◎ *Torino University, Italy*
- ◎ *International Paralympic Committee*

- ◎ *Howest University College, Belgium*
- ◎ *Rangsit University, Thailand*
- ◎ *Xi'An University, China*
- ◎ *Nanyang University, Singapore*
- ◎ *Moscow Technical University STANKIN, Russia*
- ◎ *PTB, Germany*
- ◎ *Cranfield University, UK*



- ◎ *Tor Vergata –University of Rome, Italy*
- ◎ *Florence University, Italy*
- ◎ *“Petru Poni” Institute of Macromolecule Chemistry, Romania*
- ◎ *DTI – Technical Institute of Denmark, Denmark*
- ◎ *St. Petersburg State University, Russia*

- ◎ *Institute of Photonics and Electronics, Czech Republic*
- ◎ *Minas Gerais University, Brazil*
- ◎ *InMetro, Brazil*
- ◎ *Federico Santa Maria University, Chile*



Publications

In 2014, CEMIS produced a total of 18 international peer reviewed scientific publications, 22 professional and conference publications. Additionally, one Doctoral thesis, 10 Master of Engineering and Master's theses, 17 higher university of applied sciences degree theses, and 102 Bachelor of Engineering and Bachelor of Business Administration theses were produced in CEMIS.

Doctoral thesis:

Piirainen, J. 2014 *Neuromuscular function and balance control in young and elderly subjects*, University of Jyväskylä

Diploma and Masters theses:

Yrjölä K., *Use of arms - influence to human balance during perturbation*

Lappi T., *Effect of sitting position on muscle activation and force generation in simulated sit-ski double poling and on balance perturbation test*

Pohjola M., *Analysing effectiveness of force application in ski skating using force and motion capture data - a model to support research and coaching*

Leino O., *Plyometrisen harjoittelun vaikutukset hyppysuoritukseen ja harjoituksen aiheuttamiin fysiologisiin vasteisiin nuorilla ja ikääntyneillä naisilla*

Rautio T., *Peruskoulutuskauden vaikutukset hermolihaskäytännön toimintaan ylikuormittuneilla varusmiehillä ja varusmiehillä, jotka eivät kärsi ylikuormittumisesta*

Piirala M., *HIT – harjoittelun vaikutus maastopyöräilijöiden suorituskykyyn ja hermo-lihaskäytännön toimintaan*

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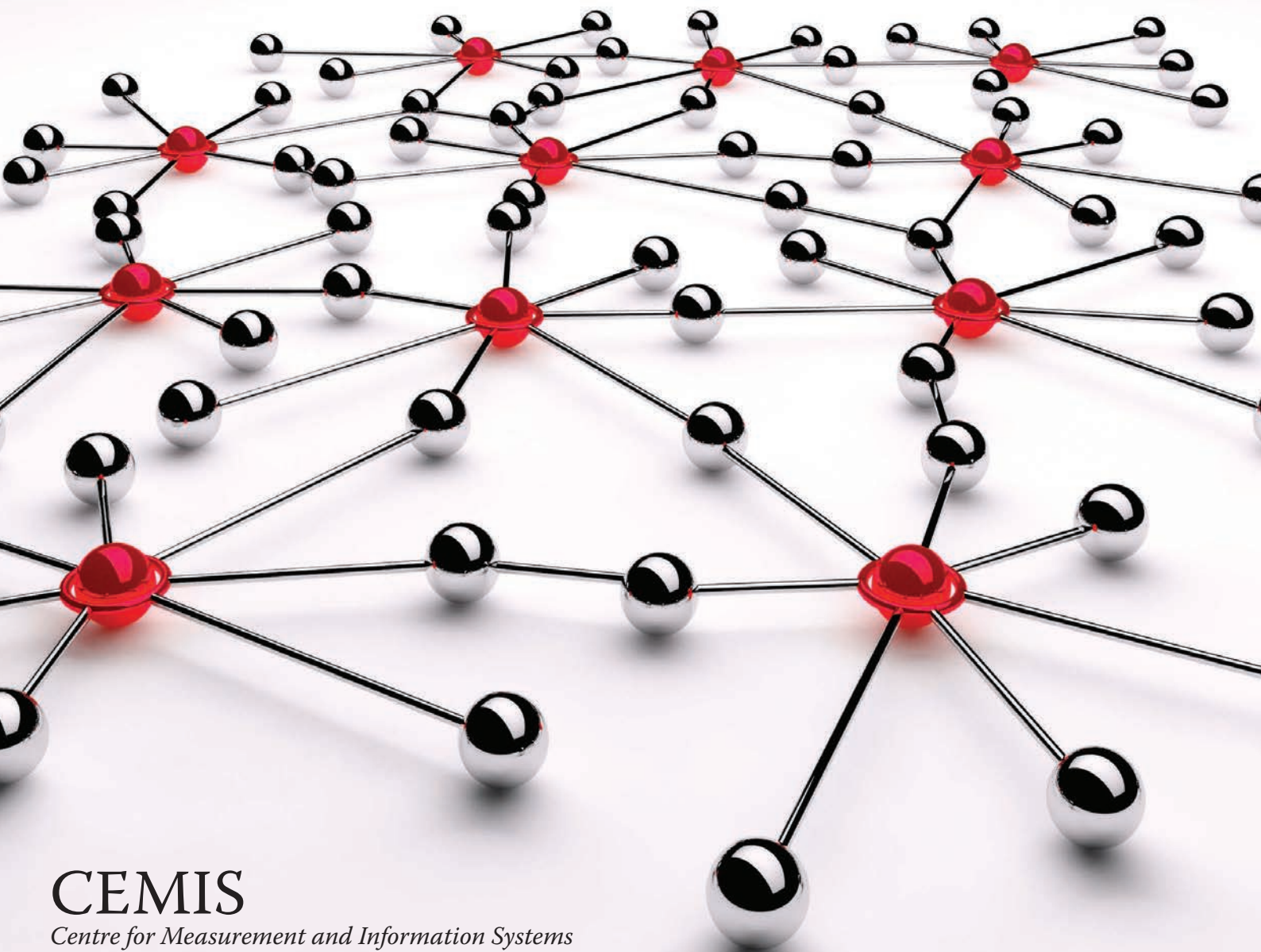
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