

CEMIS

Centre for Measurement and Information Systems

ANNUAL REPORT 2013

Content

<i>Chairpersons' Review</i>	1
<i>Introduction</i>	2
<i>Director's Review</i>	4
<i>CEMIS Development Programme</i>	8
<i>The operations of Oulu University</i>	16
<i>The operations of Kajaani University of Applied Sciences</i>	20
<i>The operations of VTT Technology Research Centre of Finland</i>	24
<i>The operations of MIKES Centre for Metrology and Accreditation</i>	26
<i>The operations of Jyväskylä University</i>	28
<i>International cooperation</i>	30
<i>Publications</i>	31
<i>Contact Information</i>	33

Editors: Risto Oikari and CEMIS-Management Group

Graphic design: Irna Imamovic-Tokalic

Translation: Kaisa Enticknap-Seppänen,

Images: Pekka Agarth, Kajaani UAS, University of Oulu, University of Jyväskylä, VTT, MIKES, Ponsse.

Cover photo: FreeImages.com

Printing: Painotalo Seiska Oy

CEMIS 2014



Chairpersons' Review

The rapid progression of globalisation and the strong development of technology are changing business and organisational environments at incredible speed causing the population to concentrate and increasing competition in all sections of society. This trend is forcing companies as well as training and research organisations to concentrate on their own strengths and restructure.

The key companies and organisations in Kainuu have demonstrated their ability to perceive future opportunities and grab them. It has been possible to renew procedures and structures to achieve new goals. An excellent example of this is CEMIS, in which at university level, measurement and information systems research, training and innovation activities have been collected to operate under one umbrella organisation.

The strength of the CEMIS model is the cooperation conducted by independent universities, a university of applied sciences and research institutes within their own areas of expertise.

According to different impact indicators, the results of CEMIS during its first years of operation have been excellent. Its share of international funding has increased more than tenfold, national funding fivefold and business funding has grown by over 50%. CEMIS' research and development projects have also made an impact: 9 new companies have been created and 16 technologies commercialised. We have CEMIS' whole staff to thank for this!

CEMIS demonstrates how open-minded co-operation of university of applied sciences, two universities and two state research institutes can produce genuine added value for the region and parent organisation. The objectives of higher education, business and regional policy have been successfully united in CEMIS. Each organisation brings its own expertise to the activities enabling a

strong and extensive competence base in selected areas. CEMIS is a model of cooperation between universities, universities of applied sciences and research institutes which hopefully will also develop elsewhere in Finland.

Overall, the core of CEMIS' cooperation is a powerful shared willingness to deal with future challenges together. Each organisation has its own role and all of them are strongly committed to the cooperation. Clear objectives have been set for CEMIS' activities. According to various indicators, the implemented structural reforms have hastened the achievement of such objectives. We believe that CEMIS has a powerful and profitable future although the austerity of the state economy will undeniably be visible in its operations.

CEMIS is being systematically developed into a creative training and research environment offering university students an excellent setting in which they are able to complete their theses and different types of research and development projects. Our fundamental aim is to integrate final year students into the business and commercial life of Kainuu thus safeguarding the availability of competent employees. This work requires all of our efforts.

Our work continues, together and in cooperation!

Lauri Lajunen
Rector

University of Oulu

Turo Kilpeläinen
President

Kajaani University of Applied Sciences

Introduction

CEMIS (Centre for Measurement and Information Systems), founded in 2010, is a joint centre of two universities (Universities of Oulu and Jyväskylä), two research institutes (MIKES Centre for Metrology and Accreditation, and VTT Technical Research Centre of Finland) and Kajaani University of Applied Sciences' that is dedicated to training and research in measurement and information systems. CEMIS consists of the Oulu University Metrology Research Unit, Kajaani -UAS' Information Systems Unit, MIKES' and VTT's Kajaani facilities and the metrology development functions of Jyväskylä University's Vuokatti Sports Technology Unit. The centre intends to increase the attraction, competitiveness and impact of the parties' measurement and information systems research and development activities.

The above mentioned organisations as well as 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. Oulu University has concentrated its technological research and development activities in Kainuu within CEMIS. CEMIS is Kajaani University of Applied Sciences' most important form of university and research institute cooperation and focus of development.

Where Jyväskylä University, MIKES and VTT are concerned, 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 applied fields of national importance such as the mining, renewable chemical and mechanical forest industries, vehicle information systems, sports and wellbeing, and game and simulation technology.

Located in Kainuu, this hub of expertise and innovation is aiming to create internationally significant expertise, new technology and business with the aid of research and development services based on extensive cooperation and university education.

CEMIS produces top class experts, new technology and new business for companies developing and using measurement and information systems by offering research and development services and university education in an innovative and international environment.

The centre offers students aiming to work as experts a motivating educational environment and an innovative and international working environment to researchers and experts who wish to develop themselves.

In order to achieve its aims CEMIS has set quantitative targets for R&D, education and innovation operations 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, used of joint resources and to increase visibility.

CEMIS' goal is to be an internationally desired partner for R&D and training in measurement and information systems

A two-year development programme with an annual budget of over two million euros and mainly funded by the East Finland ESF and ERDF programmes and the Kainuu Development Fund, began at the beginning of 2011.

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.

Measurement and information systems are the spearheads of technological expertise in the Kajaani area. Two universities in CEMIS (Oulu and Jyväskylä University), two research institutes (MIKES and VTT) and Kajaani UAS offer measurement and information systems research and education.

Measurepolis Development Oy, owned by the City of Kajaani specialising in the development of metrology and information system business operations also works in this field as well as 15 companies with similar expertise.



UNIVERSITY OF JYVÄSKYLÄ

Figure 1. The structure of CEMIS – the Centre for Measurement and Information Systems

Director's Review

CEMIS was established three and a half years ago on September 17th, 2010. It was in full operation from the beginning of 2011. Therefore 2013 was CEMIS' third year of operations. During 2013 CEMIS' activities became established and were promoted in national and international events as well as being systematically developed particularly within the CEMIS Development Programme which started the second year of its two-year period of activity at the beginning of 2013. In addition preparation of the CEMIS Action Plan for coming years began, taking into account possible changes in the operational environment, the objectives of the organisations involved and organisational structures.

CEMIS' operations have progressed as planned. The basis for the centre's operations has been the strong commitment shown by the five organisations involved including management, a jointly compiled and approved action plan and a shared, extensive development programme. CEMIS' specific strength lies in practical cooperation conducted by two independent universities working in their own profiles, a university of applied sciences and two research institutes.

In 2013 CEMIS' overall funding was just under 10 million euros and CEMIS employed around 100 metrology and information system experts

The parent organization of CEMIS is satisfied with its operations, results and impact of the results achieved so far. The forms of 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 and shared facilities and environments as well as education cooperation have, to a large extent, progressed as planned.

The Metrology Research Unit of Oulu University in CEMIS-Oulu started two new international projects and business funding grew despite the current challenging economic situation. CEMIS-OULU commercialised one technology it has developed for Finnish companies and was granted TEKES funding for a third commercialisation project.

There were a record number of projects in KUAS's Information Systems competence area funded by TEKES. KUAS's service business operations and business funding for projects doubled from the previous year.



Risto Oikari, Director, CEMIS

The attraction of education offered by KUAS broke a new record once again.

University of Jyväskylä secured operations in Vuokatti for the next five years and began systematic development for the export of their expertise to South Korea in preparation for the 2018 Olympic Games.

MIKES' Kajaani facility has achieved its targets. Considerably more than half of its income was produced by service business and MIKES already employs eight people. The first international audit of measurement capability was conducted at MIKES Kajaani.

VTT achieved extremely promising results with the development of new measurement technology within the CEMIS Development Programme. VTT experienced extensive restructuring resulting in the expansion of duties of the manager of the Kajaani office to three other districts.

The measurement of CEMIS' impact is based primarily on new commercially viable technology and how many companies have been set up as a result of CEMIS' activities. In 2013, CEMIS developed 5 commercially viable inventions and established two companies.

There are approximately 20 technology development projects financed by the public sector and private enterprises continually in progress in CEMIS. New technology development projects are being continually prepared in cooperation with Finnish and international partners and companies.

5 commercialised inventions were developed in CEMIS and 2 new companies were founded

In 2013 over 70 project proposals were prepared and almost 50 different projects were implemented as well as direct commissions from client companies. The subjects of the projects comprehensively covered CEMIS' fields of focus including the development of measuring for the renewable chemical forest industry (in particular the production of liquid biofuels and biochemical), and for mining process management and environmental impact monitoring, the development of measurement and information systems for vehicles and work machines, the development of game and simulator solutions and sports and wellbeing measuring. 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 2013 it reached 10%. The Centre's has set a target of growing the proportion of business funding to 13% within five years.

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 Jyväskylä University in Vuokatti, and education leading to a Master's degree in Food Biotechnology in the Metrology Research Unit of Oulu University within CEMIS-OULU. Education development continued at Kajaani University of Applied Sciences in the fields of game and simulation technology and datacenters. Additionally, preparation aiming to re-direct the Information Systems degree began and supplementary training in metrology was planned in cooperation 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 2013, a total of 24 international, peer-assessed and 32 conference publications were produced in CEMIS. In addition, 1 doctoral thesis, 10 university Masters theses and 9 higher UAS theses and 37 Bachelor of Engineering and Bachelor of Business Administration theses were produced in CEMIS.

In 2013 CEMIS' overall funding was just under 10 million euros. There were approximately 99 (person work years) metrology and information system experts in CEMIS in 2013.

CEMIS has participated in the implementation of two national competence cluster programmes, Forest Industry Future and Intelligent Machines. CEMIS has had projects in three strategic centres of science and technology; Cleen Oy, FIBIC Oy and FIMECC Oy. CEMIS' experts have actively participated in the activities of national advisory committees such as the Advisory Committee for Metrology whose members are named by the government, and in Photonics Finland that is a national network of Finnish photonics companies and research institutes.

CEMIS has started or continued cooperation with several foreign research institutes, universities and companies, e.g. in **Canada, Russia, China, South Korea, Thailand, Spain, Poland, Romania, Italy, Austria, Switzerland, Great Britain, Czech Republic, Germany and Chile.**

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, technology and services they need in order to develop their business operations.

To summarise CEMIS' quantitative results from 2013, CEMIS:

- further increased the proportion of direct funding from private enterprises
- increased the proportion of international R&D funding by 50%
- succeeded in retaining its proportion of national R&D funding despite tighter competition
- exceeded set targets in the number of first choice applicants for study places, scientific publications, commercialised technologies and established companies based on R&D
- maintained a good number of accomplished theses (doctoral theses, university Masters theses and engineering and business administration Bachelor's degree theses)



Risto Oikari, Director



Outlook 2014-2015

CEMIS' operations will continue in 2014-2015 as set out in the updated Action Plan. All 5 organisations in CEMIS are strongly committed to its operations. During 2014 a development programme will be prepared to take CEMIS through to the end of 2017.

CEMIS' vision is to be an attractive international partner in cooperation in developing new metrological and information systems expertise. 2014 and 2015 will work towards this vision by producing and presenting CEMIS' new outcomes nationally and internationally.

A significant focus of development in KUAS is to redirect activities within the Vehicle Information Systems field of focus to better serve companies and the needs of CEMIS' other operators. 2014 will also see the strengthening of KUAS's activities within CEMIS when mining becomes a part of CEMIS' operations in line with CEMIS' updated Action Plan. The main actions are to profile and strengthen mining R&D activities. In addition the development of game-like solutions for the wellbeing, health and tourism field will continue in KUAS as well as international technology business development actions.

The Sports Technology Masters and Doctoral programmes will continue in the Department of Biology and Physical Activity of Jyväskylä University and the Food Biomechanics Masters programme will continue at Oulu University. 2014 will also see continued cooperation in developing AIKOPA's (Adult and Continuing Education) supplementary education linked to metrology.

The most significant proportion of CEMIS' operations will continue to focus on research and development. New technology development projects are continually being prepared and implemented in cooperation with companies at a regional, national and international level within CEMIS. Companies also benefit from direct commissions.

Several changes affecting CEMIS' operations and operational environment will continue. The global recession, a weak national economy, problems with municipal funding, the decrease in regional development funds and the start of the new EU programme period will create challenges in the basic funding of CEMIS' organisations and decrease the amount of national and EU funding for tender.

***CEMIS is preparing a new,
comprehensive development
programme for years 2015-2017***

The current global recession also increases uncertainty in companies as regards developing new technologies and products which in turn will threaten the amount of funding and direct commissions CEMIS receives from companies. Nevertheless, CEMIS is certain that demand for the expertise it has developed will continue within specific applied fields such as mining, bioenergy and biofuels production, environmental monitoring, sports

and wellbeing and games and simulators. Considerable growth is apparent in these fields despite the recession.

The biggest decisions concerning the restructuring of universities, university of applied sciences and research institutes have been made for the time being. For CEMIS the most significant change is the merging of MIKES and VTT, leading to even closer cooperation between them within CEMIS although due to their differing profiles their functions and administrations will continue to be separate.

CEMIS has succeeded in extending its funding base as planned and in gaining an increasing amount from international and national sources of finance. Yet CEMIS' activities will continue to require a significant amount of regional funding and sufficient basic funding for its member organisations in addition to national, international and business funding that is subject to severe competition.



CEMIS Development Programme

CEMIS' operations were to a large extent, developed in the CEMIS Development Programme which began in 2011. The second year of its 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 is divided into six action packages. They will enable 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 technical device planning and prototyping, the marketing and dissemination of the programme's outcomes and promoting the commercial use of the results of centre's research and development projects.

Business development will be promoted in the CEMIS Development Programme by creating new technology based on the needs of companies looking to renew their operations and by creating new business through students and researchers. The programme supports the development needs of about 20 partner companies within CEMIS' areas of focus, i.e. measurement and information systems companies and companies that apply and use such technologies, operating in Kainuu. The programme will focus on application fields that are clearly experiencing growth globally such as mining, bioenergy and the production of biofuels, environmental monitoring, sports and wellbeing and game and simulators. The aim of the programme is to significantly increase the competitiveness and impact of CEMIS' operations.

*The goal is to establish 4 new companies
and commercialize 6 technologies*

It is intended that 4 new companies established by students or researchers and 6 new commercialised technologies will be created during the development programme (2013-2014). In addition the aim is to grow the proportion of competed national and international research and private funding and to increase the number of international partners in cooperation. The aim of the programme is also to produce competent employees for companies by offering thesis topics.

The total finance volume of the two-year development programme (1.1.2013 – 31.12.2014) is 4.0 million euros. The main funding bodies are the Regional Council of Kainuu and the ELY-Centre (Centre for Economic Development, Employment and Transport). The remaining programme funding consists of the programme implementers' own funding, municipal and private funding. The programme's structure and funding is described in Figures 2. and 3.

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 targets. To enable this the programme has provided resources to employ key persons in each organisation.

Oulu University:

Persons in charge of the three research groups in the Metrology Research Unit CEMIS-OULU:

1. **Optical spectroscopy (Research Manager)**
2. **Analytical Chemistry and Bioanalytics (Research Manager) and**
3. **Imaging Measurements (Professor)**

The task of the appointed persons is to be responsible for the operations of the above research groups, publish the outcomes of the development programme, to coordinate the project activities of the research groups, to market the groups' activities, cooperation, national and international research cooperation, the preparation and development of projects to be implemented with competed for research funding and paid service operations. The manager of the optical spectroscopy research group acts as a project manager on behalf of the CEMIS-Oulu and as the coordinator of the expert group of measurement technology. The manager of the analytical chemistry and bioanalytics research group is also in charge of the joint project of the CEMIS development programme, **ONNI**.

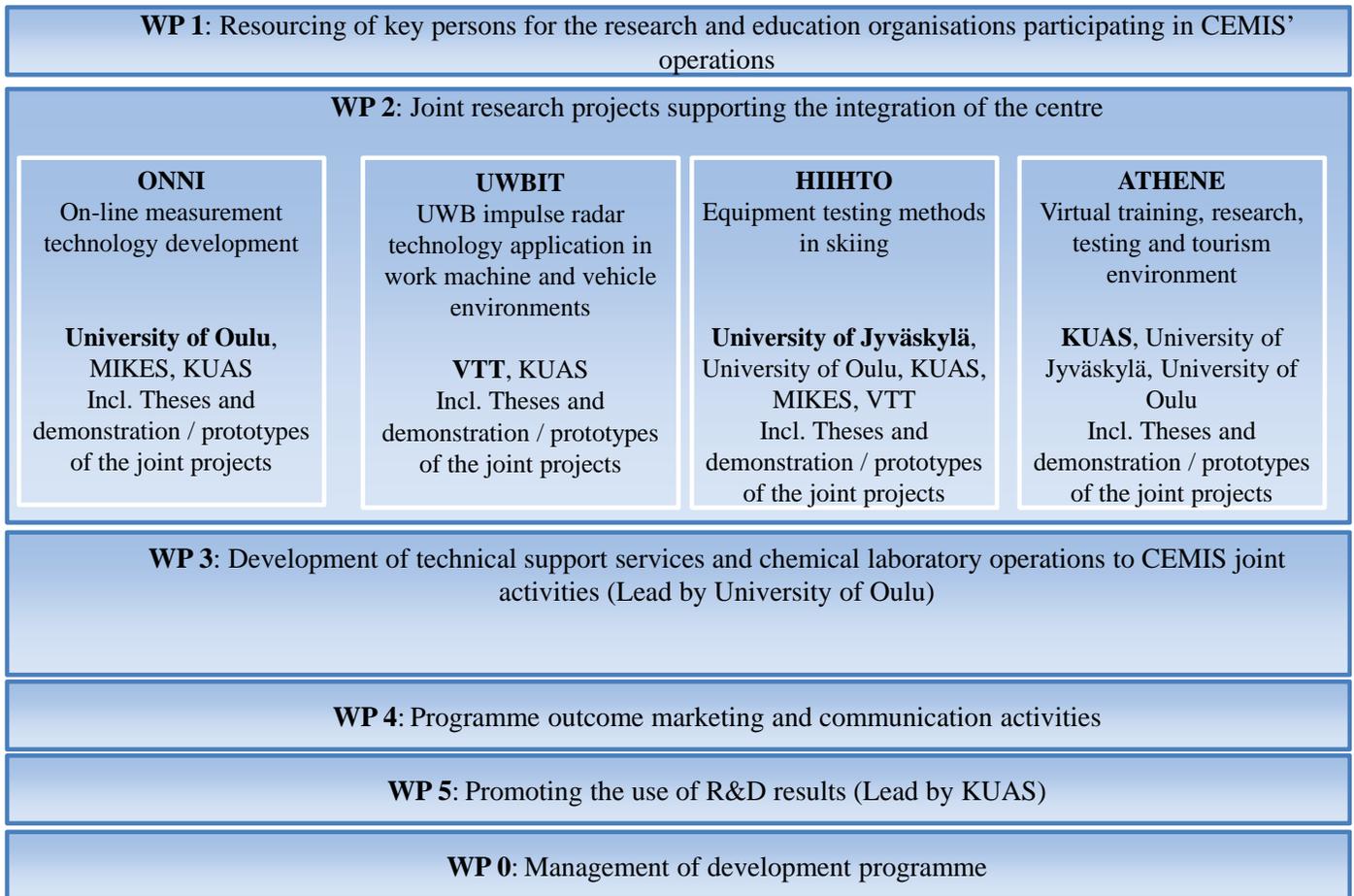
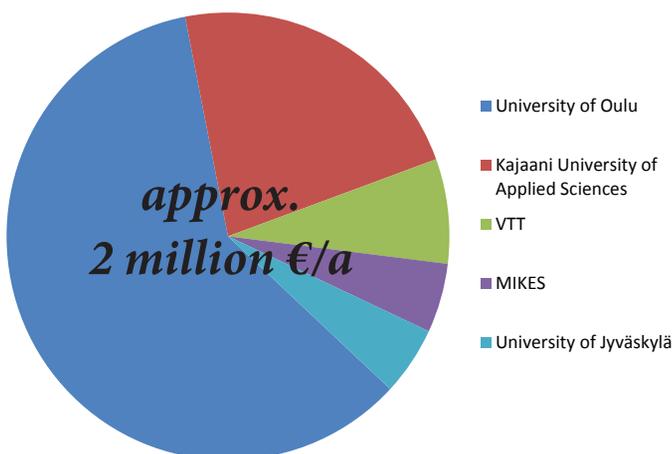


Figure 2. Work Packages implemented in the development programme

Distribution of programme funding for CEMIS partners



Funding structure of the programme

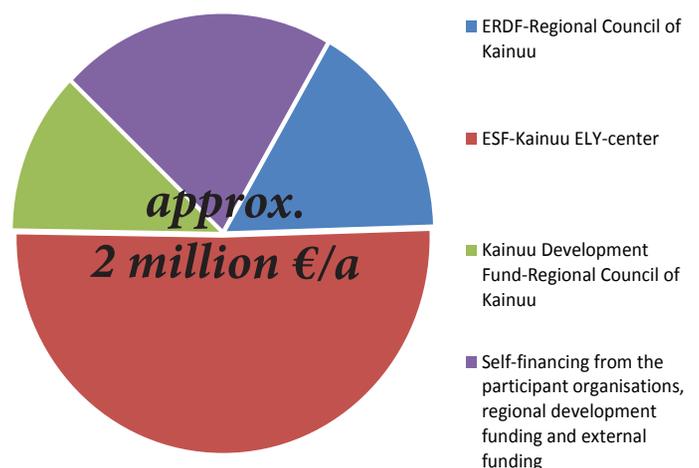


Figure 3. CEMIS development programme's funding distribution by partners and funding sources.

Jyväskylä University:

Sports Technology Measurement Project Coordinator: The Project Coordinator is in charge of the operations of Jyväskylä University within the Development Programme, coordinating the unit's research projects and preparing new jointly funded projects. The Project Coordinator is also in charge of the **HIIHTO** joint project and works as a representative of Jyväskylä University within R&D outcome commercialisation activities (**WP5**).

MIKES:

Manager of MIKES' Kajaani site: The manager is responsible for the operations of MIKES within the development programme, the planning of jointly funded projects at the MIKES' Kajaani site and for technical and scientific guidance in the development of online liquid flow measuring in cooperation with companies and CEMIS' other research units, and national and international research partners. The Manager also works as a representative of MIKES within R&D outcome commercialisation activities (**WP5**).

Kajaani University of Applied Sciences:

Project Manager and Development Manager: The Project Manager is responsible for KUAS's operations within the Development Programme and publishing the outcomes of the programme, and participating in the preparation of service business activities and projects funded with competitive R&D funding. The Project Manager is also in charge of the joint project, **ATHENE**. The Development Manager is responsible for publishing the outcomes of the development programme, coordinating project activities within KUAS's Information Systems competence area, marketing the competence area, cooperation development, developing national international research cooperation, preparing and developing paid service operations and projects implemented with competitive research funding.

VTT:

Site Manager: The Site Manager is responsible for VTT's project within the Development Programme as a Project Manager and publishing the VTT's results within the Development Programme. The Manager's responsibilities also include developing cooperation and preparing paid service activities and projects implemented with competitive research funding. The Manager also acts as the Vehicle Information Systems Expert Group Coordinator and is in charge of the joint project **UWBIT** while working as a representative of VTT within R&D outcome commercialisation activities (**WP5**).

Outcomes:

CEMIS-OULU: Increased external funding (including growth in the service business operations), approximately 5 projects using national funding from TEKES, development of international cooperation networks and participation in the FP7 general programme applications, 2 international projects and 14 scientific publications.

In the CEMIS development

programme the key persons produced

3 international and 9 national

projects and over 20 publications

Jyväskylä University: Development of international cooperation networks, one new development project and 2 scientific publications.

MIKES: Increased external funding (including growth in the service business operations), internal approval of measurement capability (force, torque and mass), development of international cooperation in liquid flow measurements and one TEKES project.

KUAS: Increased external funding (including growth in the service business operations), one new TEKES project and several projects funded by the Ministry of Education and Culture and two scientific articles.

VTT: One international cooperation project and one TEKES project. Two theses and two conference publications.

Work Package 2:

Joint research projects support the integration of the centre

Within the programme, joint research and development projects involving two or more of CEMIS' organisations are being implemented concerning the following topics:

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 are being 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 is being implemented by CEMIS-OULU, MIKES AND KUAS.

The work packages of the project are:

- WP 1:** Solutions to improve the reliability of optical measurement devices
- WP 2:** Characterisation of liquid organic compounds
- WP 3:** Continuous optical measurements of changes of water composition
- WP 4:** New sensor solutions and technologies
- WP 5:** Measuring small concentrations of metal with electrochemical and optical technologies

Outcomes:

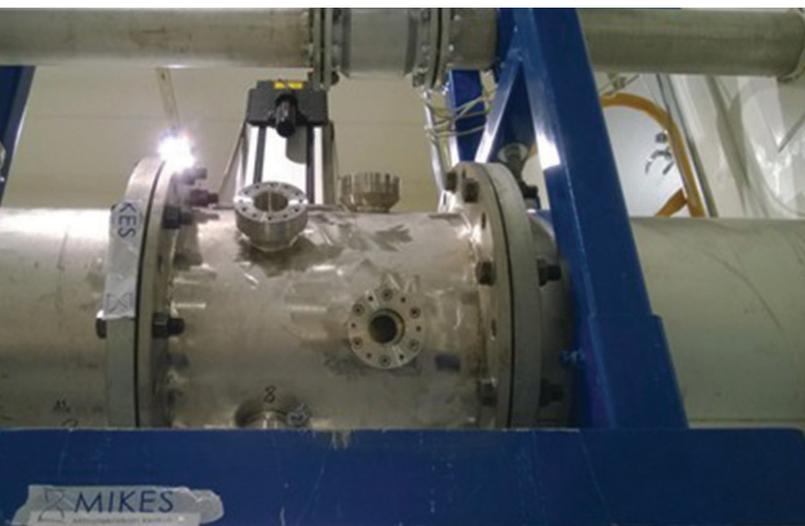
WP 1: A report has been compiled on the monitoring of dirt accumulation on optical sensors and a measurement set-up for studying the accumulation of dirt on measuring devices. The flow profile of MIKES' liquid flows test device has been determined as well as other factors affecting measurement uncertainty with the device.

WP 2: An optical multi-parameter measurement method has been developed to determine sugar and total carbon content from liquid organic compounds from bio refinery products. The measurement uncertainty of the developed method has been determined by MIKES. The planning of a technology commercialisation project has begun. Capillary electrophoresis analysis for various types of industrial samples has been developed. On-line capillary electrophoresis equipment (ONCE) has been developed and its functionality successfully tested with industrial samples. An application for continued funding for ONCE technology application development has been made.

WP 3: Continuous, real time NIR measuring equipment has been developed and testing has begun in mine production process monitoring.

WP 4: The gas chromatography mass spectrometry method (GC-MSD) has been tested in the analysis of mining samples. A biosensor to analyse respiratory air has been developed. A laboratory method for identifying bacteria has been developed using samples from a foreign partner (Toronto University). The development of a biosensor to identify bacteria has begun.

WP 5: Methods of measuring small concentrations of zinc and nickel in mining environment waters have been



developed. A zinc sensor based on a gold-wire electrode and a nickel sensor based on impedance spectroscopy, 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 KUAS has established their vibration tolerance.

UWBIT: application of UWB (Ultra Wide Band) impulse radar in the work machine and vehicle environment

*In this project the applications of impulse radar (UWB) in work machine and vehicle environments is examined. UWB impulse radar (hereafter **UWBIT**) is a radar technology using the UWB frequency rate and configurations, which has been studied to some extent for military use and in medicine. One application of **UWBIT** to be studied is work safety. An example could be a drill operator who gets too close to the rotating blades of a drill. Also, it will also be studied whether **UWBIT** would be suitable for mapping the shapes of different types of walls (mines) and for sports performance monitoring and for monitoring the heart rate and breathing of people during physical exercise.*

The reasons for the above research are the features of **UWBIT** technology: low power consumption, it is not affected by traditional radio signals, nor does it interfere with traditional radio transmissions and its assumed low-cost (will be verified during the project) and simplicity compared to other possible methods. The project is being implemented jointly by VTT and KUAS.

The project actions are:

1. Study of UWB impulse radar technology literature (2013)
2. Testing of UWB impulse radar technology on a testing platform and simulation of selected applications (2013).
3. Defining the capacity of UWB impulse radar technology using simulations in selected application environments (2013)
4. The demonstration of UWB impulse radar technology in a selected field of application (2013)
5. The designing of a UWB impulse radar prototype and its implementation in 1-2 selected applications (2014)
6. Prototype testing in the laboratory and field and comparison of results with simulation outcomes (2014).

Outcomes:

A report on UWB impulse radar technology literature, simulation in selected targets of use, device platform used in demonstrations has been implemented, measurement algorithms for observing a person next to a massive metal object, measuring the profile of crushed rock and detecting a foreign object amongst crushed rock or wood chips, have been compiled and the aforementioned

demonstrations have been carried out.

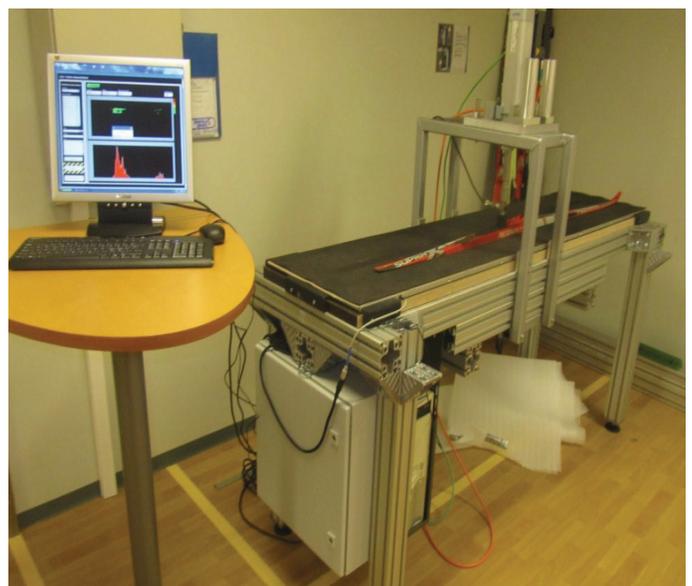
HIHITO: Equipment testing methods in skiing

*The aim of the **Equipment Testing Methods in Skiing** project is:*

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) **LIKE** project.*
5. *To further develop the L-lactate and cortisol sensor sensor*
6. *Coordination.*

The project further supports the aim of developing a unique winter sports (in particular, skiing) coaching, testing and research cluster in Vuokatti. An internationally unique research environment has been constructed in the Vuokatti including a ski tunnel containing a 20-metre long force plate sensor enabling the measurement of horizontal and vertical forces during skiing under both skis and poles. A ski-motion device has also been installed in the ski tunnel which simulates the natural production of force enabling the study of ski slide and grip properties.

The low-temperature testing laboratory enables the implementation of repeatable and reliable research concerning 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). Skiing related snow research and





biomechanical and physiological measurements that can be increasingly easily conducted with athletes are currently arousing a great deal of interest amongst those who work with top athletes. The results of such studies and methods can also be applied in the future to the needs of those who exercise actively. The top class ski environment developing as a result of the project will be used to develop new technologies and products for the benefit of companies and partners in cooperation, as well as for those completing Master's theses in CEMIS' member organisations. The scheme will be implemented jointly by Jyväskylä University, Oulu University, KUAS, MIKES and VTT in cooperation.

We are developing Vuokatti into a unique winter sports' coaching, testing and research concentration

Outcomes:

The low-temperature laboratory has been designed and the procurement of equipment has begun. Ski track snow water content measurement methods have been tested. A method of characterising ski track snow has been developed. A method of determining the properties of falling snow has been developed and cooperation aiming to demonstrate and commercialise this technology in cooperation with the Finnish Meteorological Institute has begun. A wireless measuring system for skiing research has been implemented and it was demonstrated in Sochi. A sensor for the non-invasive measurement of cortisol levels (saliva sample) and of lactate levels (sweat sample) has been developed.

ATHENE: Virtual training, research, testing and tourism environment

The aim of the ATHENE Project is 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 includes a new innovation for virtual tourism and creates opportunities for developing and starting up new business ventures. The pilot environments are implemented based on the needs of the Kainuu region, especially Vuokatti and they will support tourism and other business in the area.

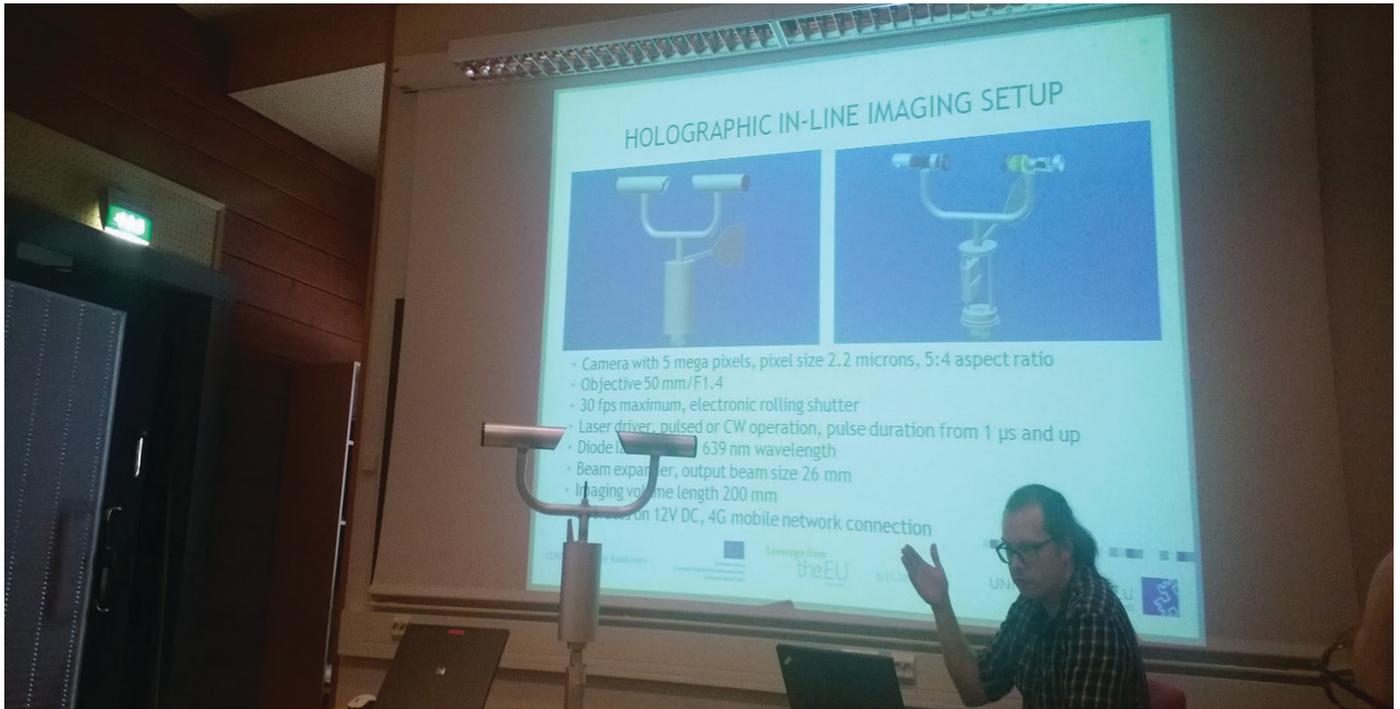
The project is being implemented jointly by KUAS, Jyväskylä University and Oulu University in four stages:

Stage 1 (1.1.2013–15.7.2013): A training environment will be developed and demonstrated as an orienteering environment 6.7.- 14.7.2013 at the Orienteering WC in Vuokatti, (www.woc2013.fi). A business analysis of the virtual training environment will be compiled to establish its business potential in different applications.

Stage 2 (15.7.2013–31.12.2013): Development of the training environment will continue e.g. by increasing the environment's versatility. The environment will be piloted as a fitness application and research will begin.

Stage 3 and Stage 4 (1.1.-2014–30.6.2014 and 1.7.-2014–31.12.2014): Development of the environment will continue with new applications, adding supplementary features and usability, finalising the ongoing research, marketing the environment in different contexts. The environment will be piloted in one new application, application projects will be prepared and actions to commercialise the environment will begin.





Outcomes:

An orienteering simulator was developed for the first demonstration. It consists of a treadmill, a 3D screen solution (3 projectors and CAVE screen), control by moving head and hands and a virtual orienteering environment, in this case based on Kajaani. The simulator was demonstrated at the Orienteering WC in Vuokatti and at the Lost in Kajaani event. The implementation of the second pilot began with the aim of creating a keep-fit environment. In addition to the treadmill, an exercise bike application was developed for the simulator. Video material was also developed at the same time.

During the third pilot, fitness testing has been developed using an environment based on the ascent to the top of Vuokatti hill. In connection with the above pilot project, fitness testing design has begun in cooperation with Jyväskylä University.

The planning of a motion platform that can simulate changes in hill gradient (going up and down hill) has also begun. Planning of the fourth pilot aiming to test the suitability of the **ATHENE** environment for use in rehabilitation has begun.

The **ATHENE** environment has achieved national and international visibility.

TEKES provided funding for the continued development and commercialisation of the **ATHENE** project.

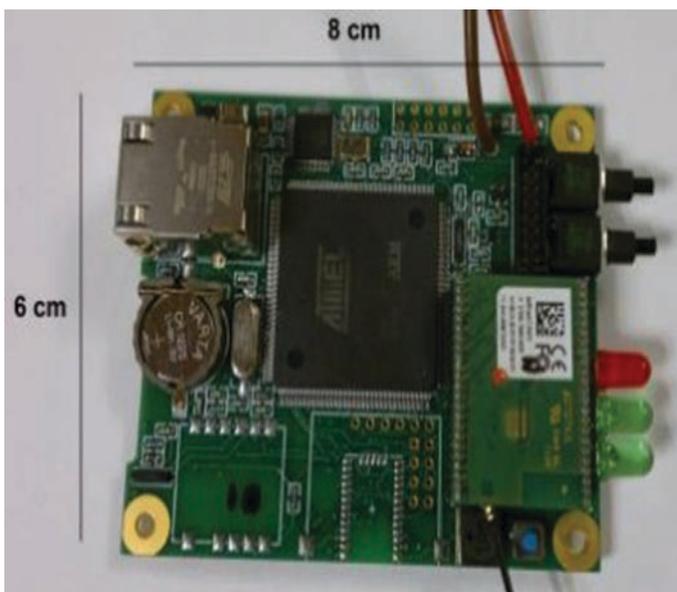
Work Package 3:

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

CEMIS aims to streamline the production of technical support services and chemical laboratory services so that by 2015 all these services can be produced centrally. Oulu University will assemble the technical support services and the chemical laboratory and cooperation between all the organisations in CEMIS will be increased within technical support (includes, e.g. mechanical and electrical engineering planning and prototype manufacture) by setting up a coordinating team lead by the CEMIS-OULU laboratory engineer.

Actions and results:

Development of laboratory functions: 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. The laboratory equipment was also maintained and planning to implement technical support and chemical laboratory operations for the whole of CEMIS began.



Support of joint projects: 9 pieces of equipment used in demonstrations in the **ONNI**, **HIIHTO** and **ATHENE** joint projects were designed as well as laboratory services were 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 key actions were the updating of CEMIS' joint marketing and communication plan, updating the CEMIS website and creating printed CEMIS brochures for the mining and bioenergy fields. CEMIS organised three seminars and attended at least 16 events. Numerous visits were also arranged and CEMIS was present in the media over 70 times. CEMIS' operators produced 56 scientific publications and conference publications in 2013.

*CEMIS was present at 20 events and
60 publications*

Work Package 5:

Promoting the use of research and development results

The central impact target of the CEMIS Development Programme is to create new companies and business and to commercialise development output. This will be done using existing structures and operators. The main service providers are the experts within the Business and Innovations competence area of KUAS and the Research and Innovation Service Units of the universities and research institutes in CEMIS.

The following actions will be implemented to develop business:

- Update and development of CEMIS technological road map
- Market, competitor and technology surveys
- Business impact analyses of measurement and information systems investments
- Technology commercialisation and supporting commercialisation training for research and development staff
- Creation of international technology and business cooperation relations
- Development of service operations

Results:

The operations of business development and research outcome commercialisation became more systematic and better resourced to serve the needs of all of CEMIS'

activities.

- Business surveys linked to the preparation of approximately 10 projects have been carried out
- Two surveys of the business impacts of measurement technology have been conducted and the compilation of two new surveys as paid commissions has begun
- 1 TEKES-funded TuTLi (New Knowledge and Business from Research Ideas) project started and 5 regional development fund financed projects aiming at commercialisation or the development of service business operations began. Also, commercialisation activities took place within 3 earlier TEKES TuTLi projects and in one EU project and in one project implemented as a business commission.
- The commercialisation of 5 (objective 3) technologies developed in CEMIS
- 2 (objective 2) new companies established by students and research and development staff
- Two scientific publications
- About ten new international contacts with whom joint project proposals have been compiled

Summary of the CEMIS Development Programme results for 2013:

- *The activities of the key persons (8) resourced by the programme were profitable. They have been active in planning new national, international and company-based projects.*
- *The joint projects have generated results as planned. New projects to be financed with external 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 has been strengthened in the jointly implemented projects.*
- *Technical support and the chemical laboratory have supported the implementation of the joint projects. Planning for a shared technical support and chemical laboratory model in CEMIS and closer cooperation is underway under the leadership of the laboratory engineer of CEMIS-OULU.*
- *CEMIS' national and international reputation is growing continuously. CEMIS has been asked to present the CEMIS operational 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 is in international, TEKES TuTLi and business cooperation projects. International cooperation and in companies has been generated. Competitive external funding has been obtained for commercialising developed technologies.*

The Operations of Oulu University

Unit of Measurement Technology, CEMIS-OULU

CEMIS-OULU was formed in 2013 from three research groups: analytical chemistry and bioanalytics, optical spectroscopy and image-based measurements. Project activities are located in Kajaani, Sotkamo and Vuokatti.

The unit's new structure facilitated the more efficient shared use of equipment and research environments.

In 2013, the main focus of research is bioeconomics and its applied fields in 2013 were mining, process and environmental applications, well-being applications, the renewable forest industry (forest cluster) and bioenergy.

The image-based measurement group, being Professor-lead, has the special task of participating in teaching by producing theses in CEMIS Oulu. Throughout its history (Measurement and Sensor Laboratory and CEMIS OULU), it has produced many MSc (technology/ engineering) graduates and their MSc theses as well as post-graduate students aiming for a doctoral qualification supporting the economy of Kainuu. The temporary professorship continued in 2013 and is financed partly by CEMIS' start-up funds from the Ministry of Education and Culture and by project financing. There are also post-graduate students in other research groups.

***CEMIS-Oulu is running 3
international, 15 TEKES and 10
other technology development
projects***

The Food Biotechnology Master's Degree project continued in Sotkamo in cooperation with the University of East Finland. The project was granted an extension to the end of 2013. There are a total of 30 students of whom 18 will graduate by the end of 2013.

2013 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 combined the region's expertise and strengthened cooperation between the Universities of Oulu and Jyväskylä (CEMIS-Oulu), as well as cooperation between Oulu University and MIKES. Cooperation between Jyväskylä University and MIKES has also been reinforced by TEKES and regionally financed projects.

The Director, Vesa Virtanen, has participated in the work of the CEMIS Strategy and Management Groups. Oulu University'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 2013 cooperation with the Oulu Innovation Alliance strengthened, in particular with its Centre of Health and Technology and PrintoCent.

CEMIS-Oulu is involved in 15 TEKES-funded projects:

1. **RACE** (Tekes Water Programme): development of methods for measuring toxic compounds for the chemical process industry (ended)
 2. **Cleen/MMEA** programme: development of sensor contamination control and assessing the applicability of biosensors.
 3. **Nutrisense 2**: Development of biosensor for nutrigenomics (ended)
 4. **Pulpvision**: development of imaging and machine vision systems for use in the manufacture of paper and pulp.
 5. **NONIT**: Laser measurement technology for examining the functionality of biomembranes (ended)
 6. **LUMO**: Development of liquid monitoring with new optical methods (ended)
 7. **NICK**: (TEKES Green Mining Programme): Development of low nickel content measurements for the mining industry.
 8. **RAIKU**: (TEKES TuTLi, linked with Green Mining Programme): Real time and cost-effective particle-size control from excavation to product.
 9. **MEAN**: (TEKES TuTLi, linked with Water Programme): Mercury-free automatic online metal analyser
 10. **SMARCTIC**: (TEKES minor strategic opening): Road map for smart arctic expertise (2012 – 2014)
 11. **LST-VISION**: (TEKES minor strategic opening): New approach to analysing and visualising complex data, started at beginning of 2013
 12. **SEWEB**: (TEKES minor strategic opening): Sensors and social web
 13. **MINEFILTR**: (linked with Green Mining Programme) Developing the drainage and measurement of mining sludge
 14. **COACHTECH**: Versatile sports performance feedback system
 15. **BEST**: Future sustainable bioenergy solutions
- CEMIS-Oulu has 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 and FIBIC's (Finnish bioeconomy strategic centre for science, technology and innovation) joint project, **BEST**.

In addition to the CEMIS Development Programme and TEKES projects, CEMIS-Oulu has 10 other ongoing projects:

Methods of monitoring and identifying compounds containing sulphur in mining environments were developed in the national **SULKA** project.

Expert services for cell-cultivation and antimicrobial research were continued in the **MIKROSOLU** project. Cooperation with business was strong nationally and in Kainuu.

The Innovative High-Value Products from Biomass Raw Materials project **Biohiva** continued and is now networked with OulujärviLeader and businesses.

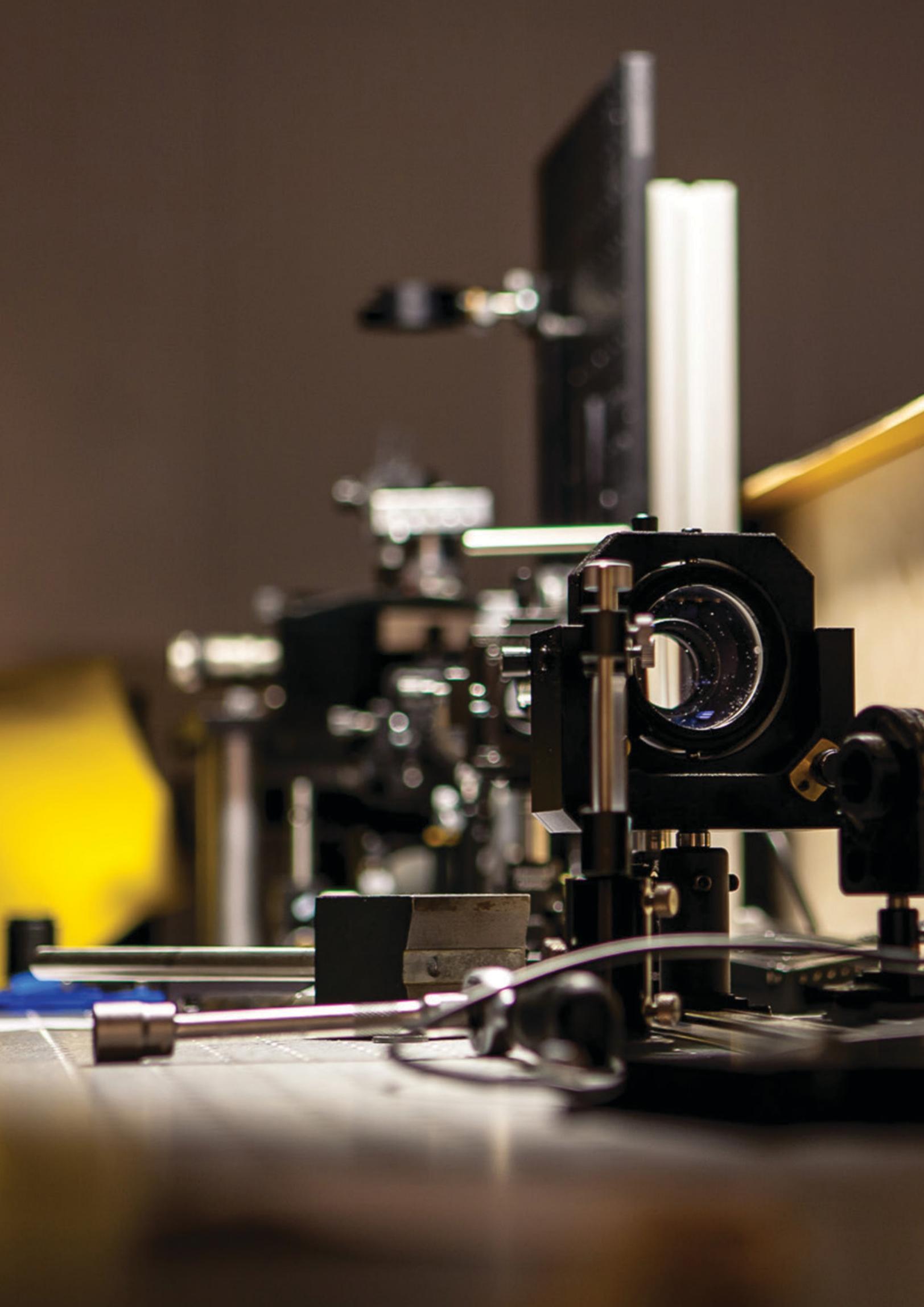
The creation of a service research concept for the identification and profiling of bacteria to produce new information for the adjustment of industrial processes to enhance production began in the form of the **BAKOTUS** project in which mining, energy, renewable forestry and food companies are partners.

CEMIS-Oulu is involved in development of Vuokatti's **Testikatti** project which is developing wellbeing, testing and sports services enhanced by analytics. The project partners are e.g. The Finnish Olympic Committee, Jyväskylä University, KIHU and Vuokatti Sports Academy.

It is also involved in the **BioVesi** project, in which the measurement of viscous liquid and biofuel samples is being developed in order for the benefit of MIKES' Kajaani site.

A **KICK-OFF** project of the Kainuu Strategy for Higher Education and Research Units began at the end of the year. 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 **KICK-OFF** project 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 has a mobile motion platform (**LILA**) project to implement and demonstrate continuous and autonomous mobile device platforms with sensors for air and water measurements. It has also 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 aim to decrease waterway solids load caused by agriculture.

There were three ongoing international projects. The Unit continued to coordinate the bioenergy theme programme to develop rural Kainuu when it was transferred from the Lönnrot Institute. The cross-provincial **Wenet Centre** project has been integrated into the implementation of the bioenergy theme programme. The aim the **Wenet Centre** project is to promote export amongst bioenergy companies. The international **Robinwood plus** project (Interreg IV C programme) promotes the versatile use of forests e.g. through bioenergy.

CEMIS-Oulu is also involved in the European Metrology Research Programme developing the commercialisation of future data transfer technologies. It 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.

3 new inventions and 30 scientific publications

The amount of international researcher exchanges increased as planned to 40 person months. There was active cooperation with more than 10 research institutions e.g. in Italy, Russia, the USA and the UK. The number of scientific articles produced was good: 14 referenced international scientific articles and 18 conference publications. The unit's employees participated in international and national assessment tasks (scientific magazines, preliminary reading of doctoral theses, and assessment of international project applications). There were three notifications of inventions. In conjunction with the Green Mining annual seminar CEMIS-Oulu arranged an international seminar as part of the **NICK** project (2 Professors from the University of Cranfield were guest speakers) in Helsinki together with TEKES and the Ministry of the Economy and Employment.

Its budget was approximately 4.0 million euros and it accumulated 46.2 person work years.

Outlook for 2014-2015

The unit will continue to focus its research taking into account CEMIS' policies and the Kainuu Strategy for Higher Education and Research Units. Its main areas of application will be cleantech and wellbeing/health. CEMIS-Oulu aims to improve the scientific quality of research and strengthen its international profile.



The Operations of Kajaani University of Applied Sciences

CEMIS' operations within Kajaani University of Applied Sciences have focussed upon the development of the Information Systems competence area, as stipulated in the CEMIS co-determination agreement. Within this competence area efforts have been made to reinforce education and RDI activities. Mechanical and Mining Engineering is also a powerful area of education and it has succeeded in related RDI activities, e.g. within TEKES programmes. 2013 saw discussion of whether this area of education would be further included in CEMIS' operations from the beginning of 2014. CEMIS' targets will also include mechanical and mining engineering.

The main education related actions have been to develop international cooperation within the Information Systems competence area and to develop Game Industry education within both the Business Information Technology degree and Information Technology degree. In addition virtual, game and simulator expertise has been used in the integration of education and RDI e.g. by developing new courses in authentic RDI environments (game testing). Practical training and these related cooperation also continued within CEMIS within the partner universities, research institutes and companies. As regards RDI,

Mechanical engineering and mining technology as a part of CEMIS

CEMIS has been active in preparing and implementing projects, developing technological expertise for the purposes of cooperation and built regional, national and international networks within the Information Systems competence area. Various forms of cooperation with other organisations have begun such as jointly implemented projects, student exchanges (international and domestic), jointly compiled project proposals for different financing bodies and the tightening and strengthening of joint activities. New joint projects implemented with competitive external funding have also begun within the Mechanical and Mining Engineering competence area.

Datacenter education and RDI strengthened significantly in 2013. Cooperation with CSC and Herman IT located in the Renfors Riverside area has progressed well. New courses were also offered to develop expertise in ecologically efficient datacenters in the area.

Game development programme had more than 4,5 applicants for every student place of open studentship

The attraction nationally of Games was good. In the 2013 joint application process there were 97 applicants for 40 study place (in 2012, 80 applicants for 40 study places). Similarly 245 persons applied for the 40 study places in Business Information Technology Degree (in 2012, 268 applicants for 40 study places). The number of applicants increased and significantly, many of them were not from Kainuu. As cohorts become smaller, it is becoming increasingly critical to attract applicants from all over Finland.

The aim of the **ATHENE** project in the CEMIS Development Programme is to create a training research, testing and tourism environment employing virtualisation and game-like features. It combines the previous expertise in simulator education and RDI, research equipment and environments of the organisations involved (KUAS, Oulu University and Jyväskylä University). This succeeded with the relocation of the CEMIS Simulation Centre into facilities in the Vimpelinlaakso campus and subsequent development operations. The staff of the centre have been fully involved in developing innovation activities in the field e.g. by successfully applying for TEKES funded projects. Expertise and project output was also visibly present during the Orienteering WC in Vuokatti. Kajaani UAS has participated in the implementation of the CEMIS Development Programme in the online measurement technology development project (**ONNI**), an impulse radar application project (**UWBIT**) and a ski equipment testing methods project (**HIIHTO**). KUAS's task in these projects has been to plan and implement measurement modules and software or to participate in the testing of developed measuring devices.

A record number of TEKES projects

As a part of CEMIS operations the **TEKES** projects **TARRA**, **Pelitys**, **WintEVE**, **DEVICO**, **MineFiltr** and **ATHENE+** were implemented at KUAS:

The projects developed new measurement and testing methods to evaluate and limit exposure to vibration in work machines (**TARRA**), game testing and business (**Pelitys**), a production integrated condition based maintenance model for the mining industry (**DEVICO**), methods of measuring the level in drainage in mineral materials (**MineFiltr**), winter testing technology for electric vehicles (**WintEVE**) and the mobile environment of the future (**ATHENE+**). KUAS also prepared project proposals for national (mainly TEKES) and international project applications. Operations in the Datacenter and

Game Kajaani UAS have been developed with KUAS's own development funds.

The Datacenter started testing in relation to certificates required in the systematic maintenance of information systems. There is growing demand nationally for courses leading to certification and Kajaani University of Applied Sciences is offering certification testing to students, companies and partners.

Cooperation with companies has been conducted extensively in the above mentioned projects and in several commissions carried out in vehicle information systems (e.g. testing services); simulators (e.g. motion device testing). In Mechanical and Mining Engineering the selling of services to mining companies has begun. For this purpose, testing and analytics infrastructure has been assembled in the campus area in cooperation with CEMIS operators and Kainuun Etu Oy. Many visitors from domestic companies and educational institutions are now familiar with Kajaani University of Applied Sciences thanks to such projects.

New type of simulator development in CEMIS

The most significant international visitors have been from Howest University College of West Flanders, Belgium and the University of Skövde, Sweden and the Northern Game Summit – organised for the second time. A development project started for the development of international cooperation with selected partners.

Good contacts have enabled the participation of KUAS students in various game competitions bringing positive visibility on a wider scale. At the beginning of 2013 KUAS students won the international Bafta competition in England.

11 students from the Business Information Technology and Information Technology degree programmes participated in an international exchange. There were 22 international exchange students in the Information Systems competence area at Kajaani University of Applied Sciences in 2013. 37 theses connected to UAS degrees were completed in 2013 in the Information Systems area and 9 Master's theses. In 2013 KUAS had seven professional magazine and conference publications within the Information Systems competence area.

In 2013 Kajaani University of Applied Sciences continued activities in the Älykkäät koneet (Smart machines) centre of expertise programme together with Measurepolis Development Oy.

In addition to Information Systems, the operations of CEMIS have had a significant impact on the activities of other competence areas in KUAS.



***CEMIS Business Development
supports all CEMIS partners in
facilitating commercialisation of
research results***

Promotional activities concerning the commercial use of research outcomes supporting all CEMIS operators are being implemented with the support of experts and students of the Business and Innovations competence area and the CEMIS Business Development model. KUAS's R&D Senior Lecturer is responsible for such activities and is integrating an international team of experts into the university community and developing technology based business requirements in Kainuu companies.

These activities were developed in 2013 using KUAS development funding. It is intended that the Cemis business development model will provide new project openings. Project applications were submitted to financing bodies, also for EU Framework Programme 7, during 2013. The model enables the strengthening of the role of KUAS in CEMIS' technology based business development tasks. CEMIS' business development operations have been

implemented with CEMIS development programme funding.

The Mechanical and Mining Engineering competence area has been operating in close cooperation with CEMIS. In addition to ongoing ESF and TEKES Green Mining programme projects, a **geopolymer and geomaterial based binding and adsorbent materials** project was prepared and started-up in 2013. The project will develop business needs based measurement solutions and study diversifying the uses of binding agents in e.g. in the concrete industry in cooperation with CEMIS-Oulu. Kainuun Etu Oy is also involved in the project. The project supports the further development of the Aqua Minerals pilot factory's operations in Paltamo.

CEMIS-based cooperation has been conducted with the Healthcare competence area concerning serious games and in particular, developing health games as well as the project application preparation in cooperation with various funding instruments. In the Activity Tourism competence area project planning under the theme of games and tourism has begun and will involve cooperation with Karelia University of Applied Sciences.

KUAS staff implements CEMIS' management, general administration and administration of the development programme. Experts from the university of applied sciences are involved in leading CEMIS, marketing

and communication, project administration planning and in development programme project management. Kainuu Strategy for Higher Education and Research Units **KICK-OFF** project, which began in 2013, aims to develop the impact and project work in selected fields of the Kajaani University Consortium partner in the Kainuu region. All of the partners in the consortium are participating: Lapland, East-Finland, Oulu and Jyväskylä University.

Outlook for 2014 - 2015

The challenges in the economy and in technology companies will be evident in the acquisition of own funding for projects. The new programme period Horizon 2020 will nevertheless provide opportunities for KUAS's project work within selected fields of focus and international cooperation expertise and partnership management will continue to be emphasised. Changes in local funding instruments and the partial transfer of decision-making as a result of internal streamlining mean more extensive and wider inter-regional interaction will be required.

The planning of expertise needed in the future conducted by the project based on the Kainuu Strategy for Higher Education and Research Units (Kajaani University Consortium) which aims to develop Kainuu and the region's business and commerce provides opportunities for making effective use of all that what the universities in the region have to offer. Our aim is partner-specific profiled cooperation supporting region's targets.



The Operations of VTT Technology Research Centre of Finland

VTT's Kajaani site continued technology development activities and widening its expertise as in previous years. VTT's field of focus remains working and heavy machinery though the researched technologies can also be used in other sectors of industry. At the beginning of 2013 within the CEMIS Development Programme, VTT started in the **UWBIT** (ERDF_IRWO in VTT's project base) research project which saw the successful start of impulse radar technology development. The original aim of the project was to detect people close to moving machinery and prevent possible accidents. The technology can also be used to prevent collisions with solid obstacles and other machines moving in the area. The project will also examine whether this technology can be used for visualising the profile of crushed rock or chips on a conveyor. Outside the project, the suitability of the technology for monitoring heart rate or breathing has also been explored.

Staff

In 2013 VTT employed five of its own staff in Kajaani, one exchange researcher and one domestic and one international person completing these. Two of these persons are committed to the **UWBIT** project and their task is to develop algorithms for impulse radar applications. One person has continued in UWB software component development. The exchange researcher is working on the application of IEEE80215.4MAC implementation, developed by VTT Kajaani, in practical measurements. One of our trainees has conducted accuracy analyses of UWB positioning and developed calibration methods for ad hoc positioning networks and the other has focused on the monitoring of bodily functions, respiration and hear rate using impulse radar.

Projects

In addition to the ongoing **UWBIT** project, VTT Kajaani is involved in the metal and machine construction strategic centre for science, technology and innovation, FIMECC's Future Semi-Autonomous Machines for Safe and Efficient Worksites (**FAMOUS**) project, the South Korean KIAT programme funded Professional Mobile Communication, Localization and Sensing in Hazardous Environment (**ProComSen**) project, the EU COST programme funded Wireles Networks in Mobile (**WiNeMo**) project

and a couple of VTT's internal projects. Towards the end of 2013 preparation began of the EUROSTARS project, **PRESTEGE** and it subsequently received a positive funding decision. Another project prepared for application purposes was the **eWeter** project within TEKES' from research to business, in cooperation with KUAS and MIKES. This application was not awarded funding, however. Autumn saw the start of preparation for a Forum for Intelligent Machines association, FIMA's **Puomi2020** project application which also lead to a positive funding decision. The **Pommisoni** project has been prepared in cooperation with Oulu University (Oulu) and Exéns Development and apparently it will receive funding.

VTT has actively worked in cooperation with businesses, both in Kainuu and other areas. Businesses have participated in the implementation and funding of all the aforementioned projects.





Field of focus is on working machines and heavy machinery

International Cooperation

VTT Kajaani has participated in the preparation of several international projects, either with CEMIS partners or with VTT's other units.

ProComSen project, funded by Korean local funding agency (KIAT), ended in the summer. A partner in the project was a Korean company, TranSono, whose main product is software based environmental noise reduction.

2013 saw the preparation of the EUROSTARS project **PRESTEGE**, with two UK partner companies specialising in energy harvesting material technology and Fimator Oy from Kouvola. The project was awarded funding towards the end of 2013. The **UWBIT** project produced a presentation of impulse radar which was accepted and will be presented in the spring 2014 at the RadarCon 2014 conference in the USA. Within the (**WiNeMo**) project, VTT Kajaani participated in the writing of a book concerning the project's outcomes in cooperation with **WiNeMo**'s international consortium.

Outlook for 2014-2015

VTT's operations will continue with research in Kajaani within its main research areas, UWB technology and energy harvesting. 2014 will see the continuation of impulse radar research operations.

VTT is intending to continue with extending its operations in Kajaani by employing more staff though only within the scope enabled by its projects. However, in VTT's new organisation, Kajaani is a part of a research team extending to three other cities. Thus increases in staff in Kajaani cannot be justified if there is not full employment of the research team in other districts.

The merging of VTT's and MIKES' operations will also have as yet unforeseen impacts on VTT's outlook for coming years.

Other challenges are the lack of interest of local companies in research and how to attract persons with expertise to Kajaani.



The Operations of MIKES Centre for Metrology and Accreditation

MIKES Kajaani site has operated for just over three years purpose-built facilities in the Renforsin ranta Business Park. 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 and liquid flow measurement standards are situated at MIKES Kajaani, which is also involved in in so called metrology club (expert group in metrology consisting of MIKES's staff members and experts from industry and other stakeholders) and is responsible for force and liquid flow clubs.

MIKES' operations progressed as expected within traceability services and research operations. The most important target for 2014 is to have the measurement standards maintained in MIKES Kajaani accepted to the CMC(Calibration and Measurement Capabilities) tables which show the internationally approved levels of uncertainty for measurement standards of different national measurement standard laboratories and designated institutes.

During 2013, 10 employees, of whom 8 were full-time, worked at MIKES Kajaani. Most of the employees have been recruited from the Kajaani area. All vacant posts have attracted several tens of applicants. Additionally,

the development work conducted at MIKES Kajaani has also provided 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 from the beginning of 2012.

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



MIKES Kajaani has provided the opportunity for students mainly 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 quantity areas. It cooperates actively with the German Metrology Institute PTB in the traceability of force, torque and liquid flow and with Tampere University of Technology in the development of liquid flow measurement standards.

MIKES has actively participated in the joint projects of the CEMIS Development Programme. These are: the online measurement technology development project (**ONNI**), and a ski equipment testing methods project (**HIHHTO**).

MIKES prepared and received funding 9/2010-2013 for six projects (**Painevesi**, **LUMO**, **Analytical Photonics**, **Cleen/MMEA**, **TARRA**, **NICK** and **EMRP Force**, **BEST** and **BioVesi**). 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 expanded MIKES Kajaani's operational opportunities. During 2010-2013, MIKES also continued in energy and environment strategic centre for science, technology and innovation CLEEN Oy's MMEA programme (Measurements, monitoring and environmental assessment) developing measurement quality control. In the **TARRA** project, MIKES developed vibration control systems in cooperation with Kajaani University of Applied Sciences, Jyväskylä University and the Finnish Institute of Occupational Health. MIKES is contributing 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. 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.

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

Outlook for 2014-2015

The outlook for 2014 is positive. Operations in CEMIS' joint projects will be reinforced within metrology. MIKES' aim is to bring its expertise in measurement reliability control to the projects. Income from calibration activities will grow significantly with liquid flow calibration.

The objective is that MIKES Kajaani will be one of the leading force and torque measurement standard laboratories in Europe. The high quality of the laboratory's work will be maintained by participating in international research and comparative measurement projects and by implementing research projects. In addition MIKES aims to get at least one TEKES funded project and one EMRP project off the ground during 2014.

The Operations of Jyväskylä University

The Sports Technology Unit

Jyväskylä University's Department of Biology of Physical Activity has delivered Masters training in Sports Technology since 2004 and Doctoral studies since 2005 in Vuokatti when work started as an ESF-funded project, in cooperation with the Municipality of Sotkamo. Continued operations at Vuokatti's Sports Technology Unit for the years 2014-2018 were ensured in September 2013 when the University of Jyväskylä and the Municipality of Sotkamo signed an agreement to fund its activities. The Head of the Sports Technology Unit is **Professor Vesa Linnamo**. 11 persons were employed by the unit in 2013, a Professor, three senior teachers, a laboratory engineer, two project researchers, a project secretary, a project coordinator and two persons in charge of research.

In 2013, seven Masters in Sports Technology graduated in Vuokatti. A total of 43 Masters had graduated by the end of the year. The subjects of those completing their doctoral studies are aging and balance control, and cross-country skiing. By 2013 one Doctoral had defended a thesis concerning the physical strain of soldiers. A balance control related thesis was sent for preliminary checking in December 2013. The unit's international scientific publications in 2013 were: 6 scientific referenced original articles, 5 books or chapters in books, 7 invited lectures (2 abroad), and 9 congress abstracts. To celebrate Jyväskylä University's 150th anniversary the Sports Technology and Top Sports Success by Cooperation - science and top sports meet in Vuokatti at a seminar that took place at Vuokatti Sports Institute on 5.9.2013.

CEMIS' activities continued from the beginning of the year in the form of a new development programme which will continue in 2014 which will see the strengthening of cooperation between Jyväskylä University, Oulu University'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. In 2013 the unit set up or participated in eight different research or development projects: The joint projects of the CEMIS Development Programmes **HIIHTO** and **ATHENE** (ESF), Coaching Feedback Systems and Sport Technology Developments - **CoachTech** (Tekes-ERDF), Export of Sports Expertise project - **LIIVI** (ERDF), Active life and work - **ALIWO** (ESF), Evaluating and

Limiting Exposure to Vibration - **TARRA** (TEKES) and **Biomechanics of skiing with and without rifle** project (International Biathlon Union's Research Fund).

In the **Coachtech** project coordinated by Vuokatti Sport Technology Unit a coaching feedback system prototype that can be used in different sports was developed. The aim of the system is the synchronous evaluation of performance based on e.g. video, force, acceleration and/or speed. Other partners involved in the project were CEMIS-Oulu of Oulu University, Vuokatti Sports Institute and the Research Institute for Olympic Sports (KIHU). The Vuokatti Unit is also coordinated the CEMIS joint project **HIIHTO** which focused on snow research, equipment testing (cross-country skiing), 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: Oulu University'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 first contender for cooperation is South Korea. In the **ALIWO** project set-up by the unit preventive occupational wellbeing operations and services are being developed in line with demand and taking into account future challenges. In the **TARRA** project, Jyväskylä University studied the effects





of exposure to vibration and poor posture while driving and working using biomechanical methods in the form of a Sport Sciences Master's thesis. Others involved in the project were Kajaani University of Applied Sciences, Oulu University's CEMIS-Oulu, MIKES and Kuopio Occupational Health Institute.

First Ph.D dissertation and 40 M.Sc's.

Vuokatti Ski Tunnel, Testing Station and the laboratory facilities of the Vuokatti Unit were used for several different research needs during the previous year. Close international cooperation continued within skiing research (biathlon and skiing with disabilities) with the universities of Salzburg and Tübingen. Biathlon research focused on skate skiing techniques with and without a rifle. Measurements were conducted on a group consisting of female and male Finnish national team-level biathletes in April 2013. A research project aiming to develop competition classes in disabled skiing (sit skiing) started in Vuokatti in summer 2013 and will continue until 2014. The aforementioned research was conducted in cooperation with the **Coachtech** project and the International Paralympic Committee. Cooperation with Salzburg University also included supervision of a doctoral thesis concerning the biomechanics of skiing.

Overall international cooperation occurred as follows: **Mid-Sweden University** (cross-country skiing research), **Osaka University** (alpine and cross-country skiing research), **Salzburg University** (cross-country and disabled skiing research) and **Tübingen University** (cross-country and disabled skiing research) and the International Paralympic Committee (disabled skiing research). A German researcher from Tübingen University, **Doctor Walter Rapp** worked at Vuokatti for a total of 0.2 person work years. His research topic was the developing

competition classes in sit skiing. In addition, a research group from Salzburg University, led by **Professor Stefan Lindinger** visited Vuokatti for several weeks for the measurement periods in biathlon research and for the purpose of doctoral thesis supervision. **Professor Jin Hae Kim** of Korea visited Vuokatti at the start of the winter to plan cooperation and subsequently four Korean cross-country skiers attended a one-month camp in Vuokatti.

Outlook for 2014–2015

The Sports Technology Master's degree is seeking new students via an application period lasting until April 2014. The new students (15) will begin their studies in Vuokatti in the autumn. In addition to the Master's degree, project activities will continue to form a significant part of the unit's operations and efforts will be increased in EU applications. In 2014 two EU project applications will be submitted and in 2015 the target is for at least one application. The unit will organise the "3rd International Congress on Science and Nordic Skiing" in Vuokatti on 2.–5.6.2015 together with Salzburg University and Vuokatti Sports Institute.

International cooperation

CEMIS has an expansive and continually expanding and deepening international cooperation network consisting of universities, research institutions and companies. Below are some of the most significant cooperation partners:

- *Ljubljana University, Slovenia*
- *Maastricht University, Netherlands*
- *Mid-Sweden University, Sweden*
- *Osaka University, Japan*
- *Potsdam University, Germany*
- *Salzburg University, Austria*
- *Tübingen University, Germany*
- *Akdeniz University, Turkey*
- *Howest University, Belgium*
- *Rangsit University, Thailand*
- *Xi'An University, China*
- *Nanyang Polytechnic, Singapore*
- *Yongsan university, Korea*
- *University of Toronto, Canada*
- *Silesian University Of Technology, Poland*
- *Moscow Technical University STANKIN, Russia*
- *PTB, Germany*
- *Cranfield University, Great Britain*
- *University of Rome, Tor Vergata, Italy*
- *“Petru Poni” Institute of Macromolecular Chemistry, Romania*
- *Danish Technology Institute, Denmark*
- *University of Athens, Greece*
- *St. Petersburg State University of Information Technologies, Russia*
- *Hokkai-Gakuen University, Japan*
- *University of Murora, Japan*
- *Institute of Photonics and Electronics, Czech Republic*
- *University Cambridge, Great Britain*
- *University of Liverpool, Great Britain*

Publications

In 2013 CEMIS produced 24 international scientific, peer reviewed publications and 32 professional and conference publications. Additionally CEMIS produced one doctoral thesis, 10 university Masters and Diploma theses, 9 university of applied sciences Masters theses and 37 Bachelor theses in engineering and business administration.

Doctoral theses:

Haapalainen, M. *Dielectrophoretic mobility of a spherical particle in 2D hyperbolic quadrupole electrode geometry*, University of Oulu, 2013

Diploma and Masters theses:

Rimpiläinen A., *Formation of international entrepreneurial opportunities within a network*

Helin T., *Menetelmät marjamehujen sokeripitoisuuden kasvattamiseksi (in Finnish)*

Jylänki P., *Nelipistevyötuennan vaikutus ylävartalon lihasaktiivisuuteen, selkälihasten refleksivasteeseen ja lihasväsymykseen työkonenäyttelyssä (in Finnish)*

Väliranta H., *Keskivartalon voiman ja tasapainon vaikutus kaarreluisteluun juniorikiekkoilijoilla (in Finnish)*

Halonen J., *Tasatyönnön biomekaniikan vertailu lumella hiihdon ja tasatyöntöergometrin välillä: ylävartalon aerobisen kapasiteetin testin kehittäminen (in Finnish)*

Karppi M., *Akuutin pitkäaikaisen istumisen vaikutukset hermo-lihasjärjestelmän toimintaan lentopalloilijoilla (in Finnish)*

Nieminen V-M., *Suksen pito- ja luisto-ominaisuuksien muutoksen vaikutus voimantuottoon ja lihasaktiivisuuteen maksimaalisessa pitkäkestoisessa hiihtosuorituksessa perinteisellä hiihtotavalla (in Finnish)*

Äyrämö S., *Neuromuscular fatigue after short-term maximal run in child, youth, and athletes*

Haataja A., *UWB-paikannusjärjestelmän automaattinen kalibrointi (in Finnish)*

Dawidowski D., *Impulse Radar in monitoring human signs of lide*

Scientific publications:

Räty J., Niskanen I., Peiponen K-E., *Use of light dispersion for monitoring particle purity*, Sensors & Actuators B, Chemical, *188*, 1183-1186, 2013

Nieminen S., Heikkinen J., Räty J., *Laser transillumination imaging for determining wood defects and grain angle*, Measurement Science & Technology 24, 125401, 2013 (in Finnish)

Niskanen I., Räty J., Peiponen K-E., *Determination of the refractive index of microparticles by utilizing light dispersion properties of the particle and an immersion liquid*, Talanta 115, 68-73, 2013

Kaikkonen V., Ekimov D., Mäkyne A., *A holographic in-line imaging system for meteorological applications*, accepted for publication on October 27th in the IEEE Transactions on Instrumentation and Measurement journal, 2013

Juttula H., Kananen T., Mäkyne A., *Instrument for measurement of optical parameters of turbid media by using diffuse reflectance of laser with oblique incidence angle*, accepted for publication on December 7th in the IEEE Transactions on Instrumentation and Measurement journal, 2013

Rissanen R., Niskanen I., Räty J., Kyrrönen P., Peiponen K-E., *Optical multi-sensor for simultaneous measurement*

of absorbance, turbidity and luorescence of a liquid, (accepted, Optical Review 9/2013)

Ohtonen O., Lindinger S., Linnamo V., *Effects of gliding properties of cross-country skis on the force production during skating technique in elite cross-country skiers*. International Journal of Sports Science and Coaching, 2013

Nieminen M., Piirainen J., Salmi JA., Linnamo V., *Effects of neuromuscular function and split step on reaction speed in simulated tennis response*. Eur J Sports Sci. <http://dx.doi.org/10.1080/17461391.2013.785598>, 2013

Ohtonen O., Lindinger S., Linnamo V., *Validation of portable 2D force binding systems for cross-country skiing*. Sports Engineering, 16(4): 281-296, 2013

Inkinen V., Häyrynen M., Linnamo V., *Technical and tactical analysis of women's volleyball*. Biomedical Human Kinetics. 5: 43-50, 2013

Piirainen J., Linnamo V., Cronin N., Avela J., *Age-related neuromuscular function and dynamic balance control during slow and fast balance perturbations*. Neurophysiol. doi:10.1152/jn.00476, 2013

Linnamo V. *Liikuntateknologia tukee talviurheilun valmennusta*. Liikunta & Tiede, 6: 68-71, 2013 (in Finnish)

Ruotsalainen K., Rantaharju T., Partanen A., Romppainen P., *Wireless System for the Continuous Observation of Whole-body Vibration in Heavy Machinery*. IEEE Instrumentation & Measurement Magazine - ISSN 1094-6969, - ss. 26-32., 2013

Järvilehto T., Nurkkala V-M, Koskela K., Kalermo J., *Anticipation, neural function and mastering driving*. Kirjassa: Driver behaviour and training, Volume VI. ISBN 9781472414694 (hbk), 2013

Al Natsheh A., Gbadegeshin S.A., Rimpiläinen A., Mainela T., *Technology Based-Entrepreneurship: Measurement Technology Perspective*, Interdisciplinary Journal of Research in Business, 2013

Al Natsheh A., Gbadegeshin S.A., Rimpiläinen A., Imamovic-Tokalic I., Zambrano A., *How the Firm networks affect the foundation and development of NTBF: Empirical evidence on the Propositions of Hite and Hesterly*. International Journal of Management Excellence, 2013

Sesay A- M., Micheli L., Tervo P., Palleschi G., Virtanen V., *Development of a competitive immunoassay for the determination of cortisol in human saliva* - Analytical Biochemistry, 434, 308-314, 2013

Ollikkala A., Kananen T., Mäkynen A., Holappa M., *Camera-based Curvature Measurement of a Large Incandescent Object*, Proceedings of SPIE , 8788, 2013

Pesonen M., Honkavaara M., Kämäräinen H., Tolonen T., Jaakkola M., Virtanen V., Huuskonen A., *Effect of concentrate level and rapeseed meal supplementation on performance, carcass characteristics, meat quality and valuable cuts of Hereford and Charolais bulls offered grass silage-barley-based rations* – Agricultural and food science, 22, 151-167, 2013

Kallio T., Kallio J., Jaakkola M., Mäki M., Kilpeläinen P., Virtanen V., *Urolithins display both antioxidant and pro-oxidant activities depending on assay system and conditions* - Journal of Agricultural and Food Chemistry, 61, 10720-10729, 2013

Ekimov D., Mäkynen A., *Web service for digital holographic video processing* - Proc. SPIE 8776, Holography: Advances and Modern Trends III, Proceedings of SPIE, 8776, 87760F, 2013

Juttula H.J., Mäkynen A., *Monte Carlo simulation of spatial reflectance pattern of translucent material with subsurface structure* - SPIE Optics + Optoelectronics 2013, Optical Sensors, Proceedings of SPIE , 8774, 87741R, 2013

Ollikkala A., Kananen T., Holappa M., Harvala T., Torppa E., Mäkynen A., *A single camera system for camber measurement in hot strip rolling*, Proceedings of 9th International Rolling Conference, Associazione Italiana Di Metallurgia (AIM), June 10 -- 12, Venice, Italy, ISBN 978-8-8852-9895-8, 2013

Juttula H., Kananen T., Mäkynen A., *Instrument for measurement of optical parameters of turbid media by using diffuse reflectance of laser with oblique incidence angle*, provisionally accepted for publication in IEEE Transactions on Instrumentation and Measurement journal, 2013

Contact Information



CEMIS

Centre for Measurement and Information Systems
 PL 21 (Kuntokatu 5) | 87101 KAJAANI
 Director Risto Oikari | Tel. 044 710 1410
 e-mail: risto.oikari@cemis.fi
www.cemis.fi



Business Development and International Connections
 PL 52 (Kuntokatu 5) | 87101 KAJAANI
 Ph.D., Senior Business Advisor Anas Al Natsheh | Tel. 044 7101 228
 e-mail: anas.alnatsheh@cemis.fi
www.cemis.fi



Kajaani University of Applied Sciences, Information Systems Competence Area
 PL 52 (Kuntokatu 5, Taito 1) | 87101 KAJAANI
 Head of School of Engineering Jari Kähkönen | Tel. 044 7101 303
 e-mail: jari.kahkonen@kamk.fi
www.kamk.fi



Oulu University Metrology Unit, CEMIS-OULU
 Kehräämöntie 7 | 87400 KAJAANI
 Director, Professor Vesa Virtanen | Tel. 040 839 7023
 e-mail: vesa.virtanen@oulu.fi
www.cemis.oulu.fi



Jyväskylä University, Sports Technology Unit
 Kidekuja 2 | 88610 VUOKATTI
 Professor Vesa Linnamo | Tel. 040 504 4800
 e-mail: vesa.linnamo@jyu.fi
www.jyu.fi



MIKES Kajaani Site
 Tehdaskatu 15, Puristamo 9P19 | 87100 KAJAANI
 Group Manager Petri Koponen | Tel. 029 505 4453
 e-mail: petri.koponen@mikes.fi
www.mikes.fi



VTT Kajaani Site
 Kehräämöntie 7 | 87400 KAJAANI
 Site Manager Timo Lehikoinen | Tel. 020 722 2221
 e-mail: timo.lehikoinen@vtt.fi
www.vtt.fi

CEMIS

Centre for Measurement and Information Systems



*Your success is our real
measure.*



CEMIS
Centre for Measurement and Information Systems
PL 52 (Kuntokatu 5)
FI-87101 Kajaani, FINLAND

CEMIS
Centre for Measurement and Information Systems

Leverage from
the EU
2007-2013

