

CEMIS Annual Report 2016



Table of Contents

<i>Chairman 's Review</i>	3
<i>Introduction</i>	4
<i>Director's Review</i>	6
<i>The CEMIS Development Programme</i>	9
<i>The Operations of University of Oulu</i>	19
<i>The Operations of Kajaani University of Applied Sciences</i>	22
<i>The Operations of VTT</i>	29
<i>The Operations of University of Jyväskylä</i>	29
<i>The Operations of CSC</i>	31
<i>Publications</i>	32
<i>Contact Information</i>	34

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Chairman's review

CEMIS has established itself as a key innovation actor within the measurement and information systems sector in Kainuu. CEMIS' operations provide effective support to the regeneration, development and internationalisation of the Kainuu region. Its efficient regional development work is also visible in the results of CEMIS' parent organisations. Thus, CEMIS is a genuine regional development hub that combines many development targets stipulated in national policy.

Nationally, the cooperation conducted by CEMIS is exceptional. The universities and research organisations in Kainuu operating in the measurement and information systems sector all belong under the same CEMIS umbrella. This regional cooperation is supported by CEMIS' wide international cooperation network which, as the next step in development, will be harnessed to further benefit Kainuu's commercial and business sector.

From the perspective of RDI, CEMIS includes all the elements of higher education level innovation activity. CEMIS is able to serve the needs of businesses and the economy by meeting and implementing academic and practical as well as a combination of both development requirements.

The significance of growing networks will continue to increase. The cooperation practised by CEMIS has indicated that it would not be possible to provide an equivalent service to business and commerce

with individual public organisations not collaborating on this scale. This voluntary combining of structures and operations as well as its conspicuous results, provide CEMIS with a genuine advantage in growing its national and international impact, compared to many other organisations.

CEMIS' strength lies in it being a forerunner in terms of its results and operations. As society changes, organisations must continuously assess their activity. Flexible organisational structures and operational models make it possible to implement sensible action. Sudden social change challenges traditional organisations and how they work in manifold ways. However, CEMIS has everything in place to pave the way towards a constantly variable future amidst critical periods of change.

2016 saw the start of a development process in CEMIS' leadership, when Risto Oikari, who has led operations since CEMIS began, decided to transfer to the post of senior lecturer at KAMK. The chairmen would like to warmly thank Risto Oikari for his work in getting CEMIS off the ground and into its current working condition. CEMIS' new director, Mikko Kerttula could not be better positioned to begin steering CEMIS towards future opportunities.



Matti Sarén
Vice Rector for Cooperation Affairs
University of Oulu



Turo Kilpeläinen
President
Kajaani University of Applied Sciences

Introduction

Founded in 2010, the CEMIS (Centre for Measurement and Information Systems) is a two-university (Universities of Oulu and Jyväskylä), two research and service institutes (VTT Technical Research Centre of Finland and CSC- the Finnish IT Centre for Science) and Kajaani University of Applied Sciences' joint contract based measurement and information systems research and education centre.

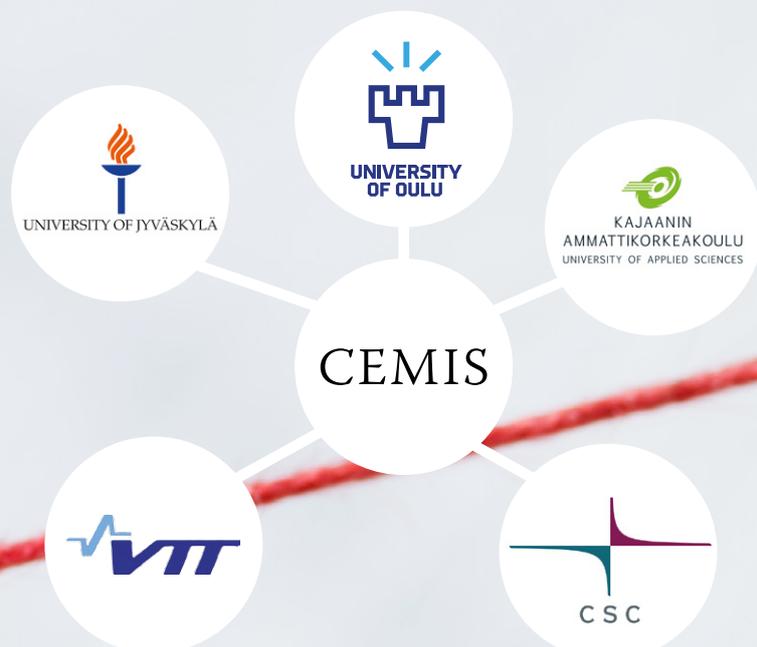
CEMIS consists of the University of Oulu's Measurement Technology Unit (MITY), the School of Information Systems and the School of Engineering (Mechanical and Mining Engineering) of the Kajaani University of Applied Sciences, VTT's Kajaani facilities and the metrology development functions of Jyväskylä University's Sports Technology Unit. In September 2016, CSC's Kajaani office also joined CEMIS.

The above mentioned five practitioners together with the City of Kajaani and the Municipality of Sotkamo are committed to CEMIS' operations. CEMIS updated its joint collaboration agreement in 2016, to take into account organisational changes and to welcome CSC to CEMIS. CEMIS is one of the innovation hubs of the University of

Oulu and the only one of its kind outside Oulu. In Kainuu, Oulu University has focused its technological research and development activities in CEMIS. CEMIS is Kajaani University of Applied Sciences' most important form of university and research institute cooperation and a central focus of development. For the University of Jyväskylä, CSC and VTT, CEMIS is a form of regional cooperation.

CEMIS updated its operational plan in 2016. CEMIS' key value is reliability. CEMIS' practitioners want to be reliable partners in cooperation and generate results for their organisations, each other, regions, customers and other partners in cooperation. CEMIS guarantees also that the metrological solutions developed by CEMIS and their measurements, can be trusted.

The Structure of CEMIS – Centre for Measurement and Information Systems



CEMIS' technological focuses in education, research and innovations are

1 On-line measurement solutions for the process industry, in particular for the bioeconomy, mining and environmental monitoring (Cleantech)

2 Measurement and testing solutions for sports, wellbeing and healthcare applications using sensor, game and simulation solutions (Sports and Wellbeing)

3 The development of international technology business operations based on CEMIS' technological expertise and cooperation partner companies (International Technology Business)

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

CEMIS produces leading specialists, new technology and new business for companies and research institutes which develop and use measurement and information systems by offering research and development services and university education in an innovative and international environment. CEMIS offers students with an interest

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

CEMIS intends to increase the attraction, competitiveness and impact of its practitioners' measurement and information systems research and education activities.

In order to achieve this, CEMIS has set quantitative productivity targets for R&D, education and innovation, for the centre itself and individually for each organisations involved.

The main tool used in starting CEMIS' operations has been the CEMIS Development Programme which defines actions for the coordination of operations, cooperation between the parties and how the work is shared, the use of joint resources and for increasing visibility.

The start of 2015 saw the start of the third two-year development programme in a row. The programme is mainly funded by the East Finland ESF and ERDF programmes with a yearly budget of 1.6 million euros. The overall budget of CEMIS is more than 10 million euros consisting of the parties' own funding, regional development funds (such as the CEMIS development programme) and tendered external funding. CEMIS employs almost 110 measurement and information systems experts.



Director's review

CEMIS was established more than six years ago on 17.09.2010. It has been in full operation from the beginning of 2011. Thus 2016 was CEMIS' sixth year in operation. 2016 was marked by a nascent enlivening of the global and national economy, less opportunity to apply for national R&D funding, the continued rapid development of international cooperation in CEMIS and one new member joining CEMIS.

In autumn 2016, the Finnish IT Centre for Science CSC joined. Due to these significant changes in the operational environment and among CEMIS' partner organisations, CEMIS also updated its strategy and plan of operations as well as the CEMIS Collaboration Agreement.

CEMIS' main forms of collaboration: the strategy group and management group, cooperation in R&D activities, coordinating project activities, joint marketing and communication, business

development, cooperation in prototype implementation, developing jointly used facilities and environments as well as cooperation within education, continued.

CEMIS develops its operations according to set targets. The targets concern development in education, R&D, and innovation activities. The same amount of people was involved in achieving the results as before, approx. 110 persons.



CEMIS changed director at the beginning of 2017.

CEMIS in numbers

In 2016, CEMIS began its third two-year development program which was also implemented in 2016. The content, activities and achieved results are described later on in this annual report.

CEMIS' publishing activities grew resulting 30 referenced, scientific publications and 36 conference publications. One Doctoral degree, Four Master's degrees, six university of applied sciences Master's degrees and 88 university of applied sciences Bachelor's degrees were accomplished in CEMIS in 2016.

2016 saw a record number of national project funding 2.35 million euros. There were 6 international projects which received 400 000 euros of funding in 2016. Regional funding (Regional Council of Kainuu or ELY Centre for Economic Development, Transport and the Environment) amounted to 2.4 million euros. The projects develop, among others, VTT's metrological standards, machine positioning solutions, metal concentration analyses from waterways, bioethanol production analysis solutions, biogasification solutions with the Sotkamo Unit of the Natural Resources Centre, biosensors for healthcare, the use of natural raw materials for the cosmetics and food industries, athlete testing and coaching, biathlon analyses, para-skiing measurements, simulators for the mining industry and driving instruction, and game and simulation education.

CEMIS' impact is primarily measured according to new commercially viable technology and how many companies have been set up as a result of CEMIS' activities. In 2016, one commercially used invention was developed and two new companies were set up.

The operations of **the Measurement Technology Unit of the University of Oulu**, MITY, continued to experience strong growth in the acquisition of tendered R&D funding and particularly in the volume of acquired national funding. The amount of national funding doubled compared to the previous year.

KAMK's new strategy and organisation started its operations from the beginning of 2016. The development of education relevant to CEMIS' operations: smart systems, the game and simulation field and the technology business, continued. KAMK also reinforced its activities in the preparation of national and international projects and the development of the international technology business. KAMK's national R&D funds also increased significantly. In addition, there were significant developments in business funding largely due to strengthened service operations.

The University of Jyväskylä produced a record number of publications and two new companies founded by students began their operations.

With the organisational changes in **VTT**, all operations in Kajaani again returned to CEMIS. Eight people work in two different research groups in Kajaani. MIKES has operated as part of VTT since the beginning of 2015. This work produced results. VTT's business funding grew significantly and international and national funding levels remained good as in the previous year.

New member **CSC** started its operations well in CEMIS. The central aim in CSC's strategy is to strengthen data analytics expertise. Its Kajaani office plays a significant role in promoting measurement

2
New companies

1
commercially used invention

2.35
million euros
for national project funding

6
international projects,
which received

400,000
euros of funding in 2016

30
referenced, scientific publications

36
conference publications

CEMIS in numbers

data analytics and machine learning. CSC recruited its first employee in Kajaani to develop this expertise and began cooperation project planning with companies.

In 2016, the Centre's total amount of funding was 11.5 million euros (+ 18%) divided as follows: international funding 0.4 million euros (-13%), national funding 2.35 million euros (+147%), business funding 0.86 million euros (+13%), regional funding 2.4 million euros (-6%) and own funding 5.4 million euros (+23%). By 2018, the centre aims to grow its international funding to 1.1 million euros, national funding to 1.6 million euros and business funding to 1.2 million euros.

CEMIS' qualitative objectives in 2016 were to reinforce its attractiveness, competitiveness and impact. Kajaani has retained its position as a metrology expertise hub and it has strengthened its position as a centre of game education and new business. Vuokatti has developed as an international ski sports training, coaching, and research hub. Businesses in both Kainuu and elsewhere in Finland have acquired new experts, technology and the services that they need to develop their business operations. Here in CEMIS, we are happy and proud of these achievements.

In line with CEMIS' updated strategy, CEMIS will continue as a research and education hub specialising in measurement and information systems. In addition to the Universities of Oulu and Jyväskylä, Kajaani University of Applied Sciences, and VTT, CSC will also operate within CEMIS. In the future as at present, CEMIS's task will be to provide companies and research establishments that develop and apply measurement and information systems, with top specialists in the field and new technology by offering research and development services as well as higher education, in an innovative and international environment. The central aims outlined in the updated strategy are to create new technology business and to significantly increase international R&D cooperation and funding. CEMIS has three areas of focus: 1) online measurement solutions for the process industry, particularly in bio-economics, mining, and environmental monitoring (Cleantech), 2) measurement and testing solutions for sports, wellbeing and healthcare applications using sensor solutions, and game and simulator solutions (Sports and Wellbeing) and 3) the development of international technology business based on CEMIS technological expertise and in cooperation with business partners (International Technology Business).

I had the honour of planning and establishing CEMIS and leading it for the first six and a half years of its operations. It is now time for me to move on and find new challenges. It is also time to welcome CEMIS' new director, Mikko Kerttula, D.Eng. to take charge of CEMIS and its development in the coming years. As this review shows, CEMIS is fit and ready to take on the challenges of the future.

Risto Oikari
Director, CEMIS

Centre's total amount of funding

11.5 million euros +18%

international funding

0.4 million euros -13%

national funding

2.35 million euros +147%

business funding

0.86 million euros +13%

regional funding

2.4 million euros -6%

own funding

5.4 million euros +23%

CEMIS Development Program

To a large extent, CEMIS' operations were developed in the CEMIS Development Programme which began in 2011. The third 2-year funding period of the program started at the beginning of 2015.

The aim of the development program is to ensure that the qualitative aims of the centre are achieved – **to increase the attractiveness, competitiveness and impact** of measurement and information systems research and education.

The quantitative objectives of the program were

- to increase the percentage of nationally competitive funding by 40%,
- double the amount of international funding,
- increase business funding by 20%,
- increase the number of international partners,
- almost double the number of theses and
- to create 8 new companies while
- commercializing at least 12 new technologies developed in CEMIS.

The program implemented joint technology development projects in engineering and application fields central to developing local business operations, develops measurement and information systems education, and joint operations in device solution implementation. It also implements the program's marketing and communication functions and promotes the commercial use of the results of centre's research and development projects. The two-year program was mainly be implemented with funding from the East and North Finland ERDF program and a supplementary three-year project funded by the ESF. The total budget of the program was approx. 3.4 million euros. The program was divided into three development packages: the development of education, the development of technology, and the development of service operations. The operations of the program were divided into five parallel sub-projects.

1) Measurement Technology Development, Demonstration and Commercialisation (MiKeDeKa) project implemented by the University of Oulu

The aim of the project was to develop, demonstrate and commercialise measurement technology using previously developed technologies on which measurement systems will be built; also to produce research outcomes and services that can be rapidly applied by the region's businesses and new companies. The key themes of the project's activity were environmental issues such as reducing carbon emissions, industrial emissions and water monitoring. Among other technologies, real time measuring technologies based on electrochemistry and optics were being developed for the aforementioned purposes. The work of the project involved extensive testing of the technologies and methods in the customers' applications. The project's resources were also targeted at the LIPAT project, coordinated by the University of Jyväskylä, in developing measurement methods for health and

wellbeing applications that specifically serve the development of the Vuokatti area, as a sports and tourism environment. The University of Oulu's Measurement technology unit MITY and VTT MIKES Metrology's new approach in the project was the integration of process and phenomena simulation into measurements.

The budget was 2 109 000 euros and the main funding body was the Regional Council of Kainuu (ERDF).

2) Sports and Wellbeing Technologies Service Business Development (LIPAT) implemented by the University of Jyväskylä

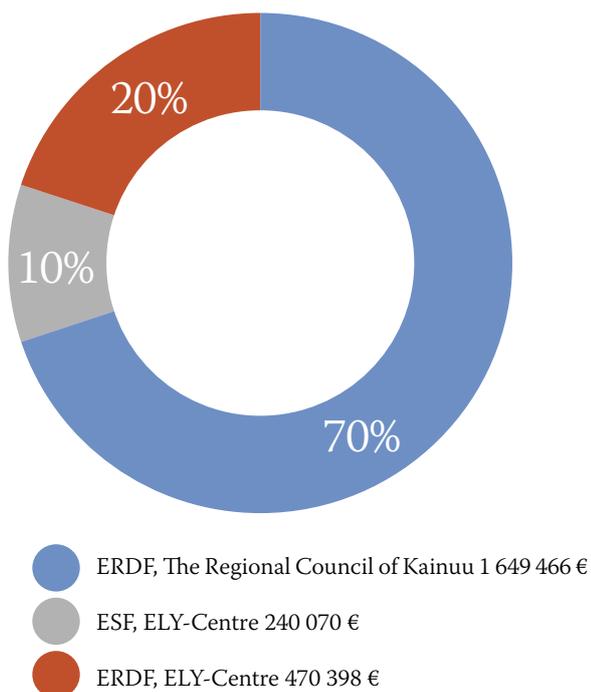
The aim of the project was to start commercial athlete and sports equipment testing activities or to develop existing services in Vuokatti. The project actions were specifically linked to setting up and using a virtual training environment in the Vuokatti Sport Testing Center and to developing the skiing equipment testing methods of the University of Jyväskylä. In the CEMIS 2015-2016 Program's ongoing sub-projects, the University of Oulu's Measurement Technology Unit, Kajaani University of Applied Sciences, and VTT MIKES Metrology were developing 1) non-invasive methods of monitoring physiological stress, strain and recovery using saliva or sweat samples, 2) improving and developing the reliability and repeatability of skiing equipment testing methods, and 3) developing technologies for athlete and fitness testing in virtual environments. A world-class skiing environment and previously developed technologies from well-being to world-class sport will be used to develop new products and services for companies. The objective of the project was to survey the commercial potential and test both athlete and equipment testing methods and wellbeing measurement technologies taking into account the needs of new and potential customers of the services. The CEMIS 2015-2016 program will improve the conditions and measurement methods of Vuokatti skiing research, coaching and testing with a view to commercial use in the future.

The budget was 164 000 euros and the main funding body was the Centre for Economic Development, Transport and the Environment (ELY-keskus).

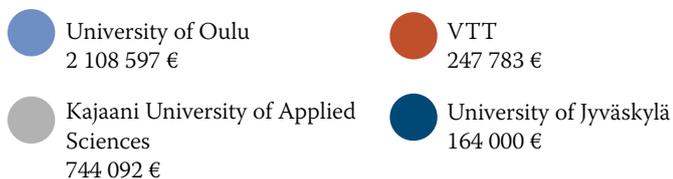
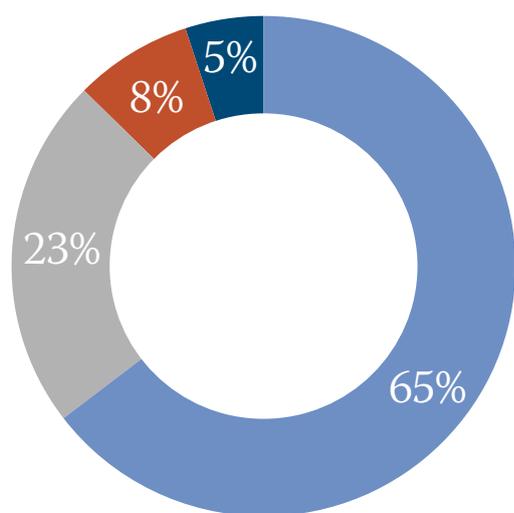
3) Simulator and Game Expertise Application in Teaching implemented by Kajaani University of Applied Sciences

This project consists of four development packages. In the first, the potential of game and simulation environments will be harnessed across disciplines for teaching purposes (Mechanical and Construction Engineering, Sports, Wellbeing, Business and Datacentre). The second action package focuses on developing

Breakdown of CEMIS' development programme funding by actor and funding source.



ELY-Centre: The Centre for Economic Development, Transport and the Environment



the content of the Smart Systems curriculum which will replace the current Vehicle Information Systems curriculum. The third development package focuses on making more effective use of serious game ideas in teaching. It is intended that an operational model will be created with which serious game ideas from companies and communities will create a project learning platform. The fourth package of the project will extend the already solid range of game education available in Kajaani to Master's level courses.

The estimated budget is 464 000 euros and the main funding body is the Centre for Economic Development, Transport and the Environment (ELY-keskus) (ERDF). The project will last for three years, until the end of 2017.

4) Technology Transfer Services Development and Demonstration, implemented by Kajaani University of Applied Sciences

The project had three objectives, the common denominator of these being to improve business conditions and operations by developing and focusing KAMK's service provision. The first aim of the project was to create new companies, as well as generating new business for existing companies. This was planned to be done by ensuring that CEMIS' expertise and services are used more effectively within the business sector by developing KAMK's operational and service model in order to be able to systematically analyse and predict the needs of businesses and transfer expertise to them. In addition, the companies' international cooperation and business operations, as well as CEMIS service business were planned to be developed. According to the plan, service business conditions were improved by developing a testing service concept that combines simulators and virtual environments. The concept was planned to be piloted in Vuokatti in cooperation with the University of Jyväskylä. The second part of improving conditions for service business operations involved promoting KAMK's device development activities together with CEMIS and other actors. The aim was to strengthen CEMIS's own joint device development team which can offer extensive services to both CEMIS' stakeholders and actors and partners in cooperation: companies, communities and research institutes.

The budget was 423 000 euros and the main funding body was the Centre for Economic Development, Transport and the Environment (ELY-keskus) (ERDF).

5) Development of a Monitoring Platform Based on Flow Modelling, UWB And Impulse Technology implemented by VTT

The VTT CEMIS program's project was strongly integrated into the projects of CEMIS's other partners. VTT's aim was to develop liquid flow modelling expertise required in the more cost-efficient development and reliability assessment of measurement methods developed by CEMIS, in the development and reliability assessment of VTT MIKES Metrology's own liquid flow testing and calibration equipment, and in the R&D projects of local companies. VTT is participating in the University of Oulu's MiKeDeKa project by offering modelling expertise and implementing reliability assessment of the measurement methods developed during the project. VTT was also participating in the University of Jyväskylä's Lipat project by advancing the reliability of skiing equipment testing systems under development. In addition, VTT continued its earlier work in developing the application of impulse radar based on ultra-wide band

The main aim of the long-term field tests involving companies is to develop cost-efficient and robust equipment for industrial process flow monitoring and to accelerate the commercialization of this technology.

technology for measuring material moisture content and perceiving humans.

The budget was 248 000 euros and the main funding body was the Regional Council of Kainuu (ERDF).

The five aforementioned projects were implementing the program's four 'focus of development' packages:

- 1) the cleantec process industry's online measurements
- 2) sports and wellbeing service business development
- 3) simulator and game expertise application in teaching and
- 4) development and demonstration of technology transfer services.

Actions implemented in 2016 and achieved results:

Cleantec process industry's online measurements

Accurate and precise, rapid and reliable liquid flow measurements provide important information for process control and environmental monitoring purposes. Renewable energy production and modern bio-refinery processes produce sugar and organic compounds, among other products. These industries need new methods of measuring such products real-time and continuously, to extract information on how these processes are functioning and make them more cost-efficient. Ever-stricter environmental permits have also created the need to develop real-time methods and devices to monitor industrial emissions. Depending on the situation, the damage to waterways caused by industrial emissions can be economic (process interruption/shutdown), health-related (heavy metal content of drinking water), ecological (contaminated waterways) or image-related (trust). The Cleantec subproject of the CEMIS 2015-2016 programme was developing real-time measurements based on previously developed technologies to meet the needs above and these solutions were piloted in industrial environments. A new perspective had been brought to development with phenomena and processes modelling conducted by MITY and VTT MIKES Metrology in cooperation.

The actions of the Cleantec project were divided into five work packages:

- 1) Modelling expertise to support flow measurements and real-time measuring
- 2) Optical and chemical measurements in order to meet the measurement needs of renewable forestry and the mining industry
- 3) Customer application technology and method testing
- 4) New sensor solutions and technologies
- 5) Impulse radar technology to monitor material flows

Modelling expertise was reinforced to support flow measuring and real-time measurements

In the project, VTT MIKES Metrology grew its modelling expertise in cooperation with MITY. MITY continued the use of COMSOL software utilizing the assistance of experts in the field and practical webinars. The development focus shifted to practical demonstrations and studying the dynamics of liquid fluid flows. Simulations were created during the year 2016 based on issues raised by companies in the Kainuu region and MITY has tried to find solutions to them by utilising modelling. So-called open-source modelling programs were studied and their potential in modelling and simulation were investigated. One scientific article manuscript concerning the results was written.

VTT MIKES Metrology continued to develop its own expertise in modelling. The focus was on increasing the use of open source software and on accumulating knowledge in computational fluid dynamics (CFD). VTT's internal resources had also been utilized to increase knowledge by participating in a variety of courses.

Computational fluid dynamics is a powerful and affordable tool to study industrial liquid flow processes. CFD provides information on local process conditions and thus the development of new process instruments can be accelerated. CFD has been utilized in the development of liquid flow calibration instruments in VTT MIKES Metrology, at the Kajaani unit. Such modelling also aims to find solutions to optimize industrial process parameters. Optimal conditions reduce the use of resources and bring a better yield and thus decrease emissions in the environment by reducing the carbon footprint.

Optical and chemical measurements were developed and tested for the measurement needs of renewable forestry and the mining industry

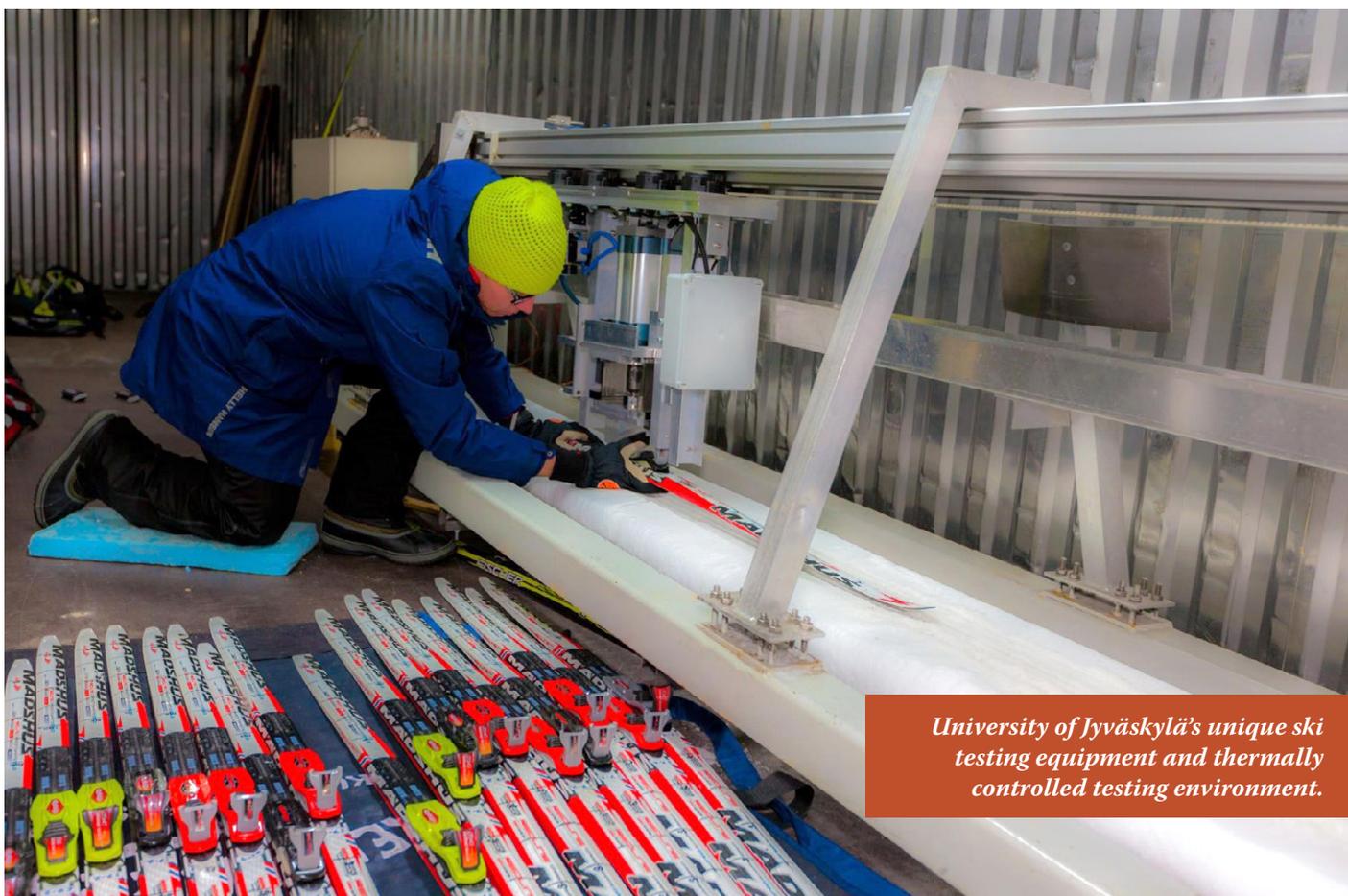
During 2016, Capillary Electrophoresis (CE) was used in a variety of ways in the analytics of various process samples in the MiKeDeKa project:

- 1) industrial sample analytics to assess online measurement applications
- 2) to develop new services for the analysis needs of companies to better understand and control processes
- 3) as the laboratory's internal reference in the development of optical and sensor based methods
- 4) in research cooperation to develop new, more ecological and efficient process methods, e.g., for the use of otherwise unused forest industry side flows and biomasses in the production of bio-ethanol, among other products.

The CE studies have focused on developing methods for the analytes that cannot currently be measured on-line, such as sugars, acids, metals and sulphate. The CE device was tested in a field test on a mining company site where Industrial discharge water was measured real-time and sulphate concentrations were monitored. The instruments provided measurements every three hours over a period of one month and the results were compared to samples taken manually and analysed in the laboratory by traditional methods. The results were very promising and there was very little interference in the data set consisting of 204 CE measurements (just one or two cases of interference), which was an excellent result.

At the end of the year, another field test was conducted in a biorefinery. It was not yet possible to attach automated sampling to the production line and thus the CE device was operated manually off-line. However, the device was located next to the process and samples were measured continually every three hours. During a period of approximately one week, over 80 samples were measured and analysed in addition to background matrix tests. The results were again promising and in the future, this technology will provide a convenient tool for quick and easy sensitive process monitoring and adjustment bringing savings, especially during the process start-up phase or when changes are needed.

The development of a real-time process monitoring instrument based on NIR spectroscopy continued and the focus shifted to field



University of Jyväskylä's unique ski testing equipment and thermally controlled testing environment.



Ski technology testing environment equipped with a real-time analysis and feedback system developed by the University of Jyväskylä.



The Finnish Ski and Biathlon Associations as well as the Olympic Committee have had an important role in developing Nordic ski sports equipment testing services in Vuokatti.

tests in the paper, pulp, and mining industry. The main aim of the tests was to evaluate the robustness of the instrument in harsh process conditions and to test cleaning procedures. The first field tests were conducted in summer 2016 in the mining industry and the second three-month field testing period was occurred in a pulp and paper plant in autumn 2016. The results were encouraging and the participating companies were satisfied. The main aim of the long-term field tests involving companies is to develop cost-efficient and robust equipment for industrial process flow monitoring and to accelerate the commercialization of this technology.

Development of new sensor solutions and technologies

Industrial measurement and development needs continually arise. Within this work package, new technology or methods development opportunities were rapidly investigated to respond to these needs.

During 2016 a new turbidity measurement device was assembled and tested in a real industrial environment. A novel solution, based on a reference reflectance meter, was created to determine the solubility of medicinal materials. The rapid analysis of microbes has been further developed for mining and biorefinery processes. The electrochemical determination of zinc from environmental discharge waters was studied and new electrode materials and expertise were developed by combining existing technology and new material solutions.

Impulse radar technology for material flows monitoring

In the project, VTT continued the development and application of ultra-wideband impulse technology in material moisture measuring. Impulse radar technology enables continual non-contact moisture measuring. In addition, the use of impulse radar technology to detect humans and the thickness of materials was tested. Software based on an embedded system was developed to control the radar and process the data it produces.

During the project, height measurement using impulse radar in a 3D UWB positioning system was also implemented. The system was used in an indoor positioning competition organised by Microsoft. A short publication on integrating the UWB positioning system with impulse radar technology: UWB Localization complemented by Impulse Radar, Microsoft Indoor Localization Competition, IPSN 2016, was produced.

Sports and wellbeing service business development

Athlete tests

The aim of actions related to athlete testing is to develop ever faster methods of testing athletic performance and to accelerate the analysis of results. In the project, MITY focus lies in developing non-invasive methods of monitoring physiological stress, strain and recovery, based on saliva or sweat samples and KAMK's focus was on developing virtual training environment.

Non-invasive tests

As a part of the work conducted by the University of Oulu, the development of technology required for non-invasive testing progressed enabling the transfer of health and wellbeing monitoring measurements to field conditions. The Universities of Oulu and Jyväskylä, KAMK, VTT MIKES Metrology and CSC prepared a Tekes ERDF project application in which the University of Oulu aims to

develop a biosensor measurement reading device for several markers analysed from saliva samples.

Virtual environment for athlete testing

The first version of the virtual environment with a treadmill to be tested by athletes was made for the Vuokatti Sport Testing Center in May. The University of Jyväskylä ensured that the virtual world (Athene, CSE Entertainment Oy), matched the treadmill's gradient and speed controls, while the treadmill's speed data was brought to the virtual environment with KAMK's Jetson environment, that was adopted for use during the project. The virtual environment was piloted in a Sports Sciences Master's thesis, which compared skiing performance in the virtual environment and real terrain (on snow) in terms of economy and compatibility. The route consisted of the skiing sprint track used in the Vuokatti Finnish Cup Race. The Master's thesis was also linked to the KAMK Serious Gaming Research Lab TEKES ERDF project. The research was presented to the press and at an international ski congress in Austria. The development of the virtual environment as a part of athlete testing was so successful that it should continue. The future will see simulation environments based on video imaging.

HIIHTO wireless server measurement card

The aim of the wireless measurement card was to enable synchronised data collection—force, muscle activity, GPS, air pressure—outside the laboratory environment. The card design also took durability in cold conditions into account. KAMK was in charge of developing the card which was tested in laboratory conditions at the end of the project but not with athletes. However, the University of Jyväskylä piloted the LIIKE measurement card that preceded the HIIHTO card, for the first time with athletes as a part of the previously mentioned virtual training research. There is demand for the wireless HIIHTO card particularly in skiing research.

Equipment testing

Equipment testing actions concentrated on applying and testing the air and the ski track snow cooling systems of the cold testing laboratory and the start of ski testing with a new ski test version in cooperation with the Finnish Ski Association. As regards the pole tester, the project focused on improving function and features based on user experiences recorded in earlier surveys. Within the work package, VTT MIKES was responsible for evaluating the reliability of measurements of the ski and ski pole testers.

Service testing

The most commercialisation potential of the methods selected for the project was displayed by the Coachtech system in athlete testing and the ski and ski pole testers, described later. The methods were included in the new Nordic skiing athlete and equipment testing service price list, which was compiled jointly by the University of Jyväskylä, Vuokatti Sport Institute, and Vuokatti Sport Testing Center. A presentation of the new services was also compiled for international distribution and it was delivered in conjunction with other ongoing projects (Kainuun Etu Oy, Vuokatti Sport Institute) in Japan and China. The University of Jyväskylä presented the project in national seminars. Ideas for new services for the future were also generated, such as a cross-country skiing technique clinic for keep-fit skiers, in cooperation with the Vuokatti Sport Institute. In the future, the potential uses of the virtual environment will include preparing

Game solutions for enlivening nursing learning situations, service design and presenting the physical changes of the aging process will be completed in 2017.

athletes for important national or international competitions and the main users of this service will be the national Nordic ski sports teams of Finland.

New specific tests for cross-country skiers, “Wassberg” and double poling technique as well as the maximum oxygen uptake while roller skiing were tested on customers at the Vuokatti Sport Testing Center during the autumn. The tests utilised a web-based coaching feedback system known as CoachTech, developed by the University of Jyväskylä, which combines a video image with sensor data. The system had already been installed to the testing station, earlier in the project. The developer of Coachtech and testing center’s staff were involved in conducting new skiing tests.

During 2016, the reliability and functionality of the pole strength sensors, an essential part of the Coachtech ski sports test, were improved in cooperation with VTT MIKES Metrology. The idea of using Coachtech alongside sports applications as a sports technology testing platform became stronger as the year progressed. In order to promote the idea, a TEKES Challenge Finland application was made in cooperation with the Tampere University of Technology. The project did not receive funding but business cooperation with several parties commenced, including Exiops and Coach4Pro, who jointly

developed the skiing technique application “Skiiot” on top of the measurement module. In this case, Coachtech acted as a validation method for assessing skiing cycle length.

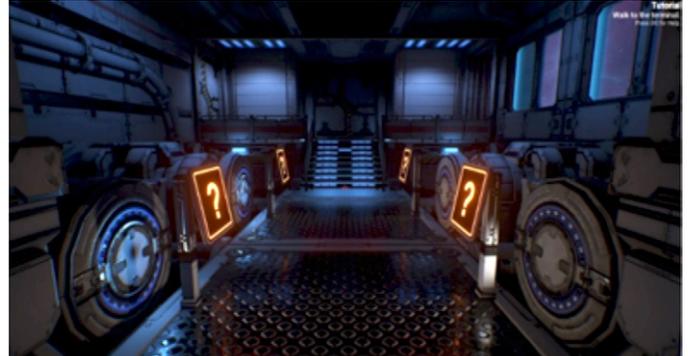
The Finnish Ski and Biathlon Associations as well as the Olympic Committee have had an important role in developing Nordic ski sports equipment testing services in Vuokatti. This enabled the sharing of information through the national teams to equipment manufacturers and international teams. The Finnish national teams have formed as a permanent practice to have their race gear tested with the ski tester, i.e. pairing good skis, in Vuokatti before the start of the season or important competitions. In addition to teams, equipment manufacturers are also still seen as ski testing service beneficiaries although the service has not been as popular among them as hoped. This is partly due to the fact that during 2015-2016, a new cold test laboratory and ski tester version were tested and adopted for use. For the ski pole testing year was more active. In March 2016 the Finnish Broadcasting Company YLE ordered a comparative ski pole survey from Jyväskylä University, in which the durability and force transmission capacity of 12 different ski pole brands were compared. The study and its results were also presented in the media. The equipment manufacturer, E-Sports Group (EXEL) regularly ordered tests during 2015-2016 for its ski pole prototypes.

Virtual hospital environment implemented by KAMK.





Game-like learning environments implemented by KAMK.



Ski pole manufacturers are seen as the most obvious customer group for this service.

Simulator and Game Expertise Application in Teaching

In contrast to the other projects in the CEMIS program period 2015-2016, the SIMPPELI project lasts three years. It is being implemented with ESF funding from the North Ostrobothnia Centre for Economic Development, Transport and the Environment (ELY).

The second year of the project saw the continued search for teaching applications that could benefit from the manifold simulation and game expertise available in the School of Information Systems. Cooperation between the serious games team in the School of Information Systems, teachers from six different disciplines, and student groups produced a total of three educational game or environment prototypes. Their themes were safety assessment in the home of an elderly person, information retrieval and literacy as well as customer service in tourism.

Game solutions for enlivening nursing learning situations, service design and presenting the physical changes of the aging process will be completed in 2017. In addition to these, three new teaching related game solutions will be selected for the final year of implementation, 2017. Thus, the project should produce a total of nine teacher generated game-like applications piloted during actual courses. This work package has promoted deeper interdisciplinary cooperation, increased the teaching staff's awareness of serious game expertise in the School of Information Systems and enriched course content. In general, the teachers and students felt that cooperation with the game team was enjoyable and rewarding.

The Smart Systems curriculum was reinforced by developing contents for the courses: Smart Technologies, Exercise and Gamification, and Smart Environments. During 2016, the business sector expressed increasing interest in Smart Systems education with a pleasing number of company representatives visiting KAMK to present their operations to students and to discuss their future competence needs with members of the teaching staff. The companies' message

concerning teaching content was clear: development has progressed in the right direction during the last two years and is currently up to date. As regards curriculum development, advanced professional training in the use of technologies and related teaching methods was acquired for teaching staff. The interest of KAMK's stakeholders towards serious game applications remained stable in 2016, and consequently suitable commissions for student projects were regularly received. The employer feedback for the student projects was mainly positive, indicating that the administrative practices and processes for SIMPPELI's student projects, work. The expansion of Master's studies in games began with planning a web-based course on a distributed game development project. It will first be piloted with KAMK game students and then with a wider target group as part of summer game studies. The SIMPPELI project has progressed according to its original schedule and will continue with all its work packages in 2017.

Technology Transfer Services Development and Demonstration (TEPA)

As during its first year, in 2016 the business development part of the TEPA project focused strongly on internationalisation, expanding cooperation networks, improving growth opportunities for SMEs and promoting the commercialisation of technologies generated previously in CEMIS. In November-December CEMIS and four partner companies (Aquaminerals Finland Oy, Meoline Oy, Prometec Tools Oy, W-Rix Oy) participated in the international Cleantech trade fair, Pollutec that took place in Lyon, France. The companies and CEMIS' representatives not only gained contacts leading to further activity but were also able to gain an overall view of the current technological offerings, competitive situation and state of the markets in this sector.

The aim of the visits abroad in the project was to build networks in growing market areas central to CEMIS' focal business sectors, particularly in the Middle East and Latin America. The networking destinations were Chile, Qatar and Saudi Arabia. In order to increase the impact of these actions, comprehensive technology market surveys were conducted in the regions mentioned above. In addition, our

CEMIS regularly organises seminars for its stakeholders.



representatives participated in six international partnership seminars and roughly the same amount of national conferences or networking events. During 2016, national contact networks were strengthened by cooperation negotiations involving approx. 30 companies.

As a result of the above-mentioned visits and participating in events, new partners in cooperation were found among research institutes as well as companies. The networking actions started up new project preparations with the aim of connecting the technological expertise of CEMIS and Finnish SMEs with international project consortiums. The key themes of the project preparation were measurement technologies, serious games, water purification solutions and the circular economy. The most significant planning and preparation contributions focused on the following projects:

- H2020 SC5-Raw Materials: ReMAIX project: the selective recovery of high value materials
- H2020 SPIRE: SofiLoop project: development of closed water circulation for the textile and metal industry
- SC1-PM-07-2017: ELMSY project: improving the life management skills of young people using health games, wearable technologies and expertise available in the health sector
- H2020-SPIRE-9: High5P project: optimisation of powder processing using continuous process measurements and piloting
- H2020-SFS-30: Agroloop project: operational models and technologies for the use of biogasification and for the recovery of nutrients from agricultural waste and drainage
- H2020-SC5: REGALISCAN project: development of new methods of recovering selected valuable metals from poor and complex ores, industrial waste and beneficiation side-flows
- Eranet Bioenergy application: BIOFEGG project: developing and piloting biogasification, biogas purification, continuous biogas quality monitoring and various biogas applications
- Interreg Baltic Sea Region: REFLEX project: automatic water monitoring solutions, impact monitoring and decision making processes
- Interreg Baltic Sea Region: IBCOLL project: The acceleration of multinational innovation processes and the promotion of internationalisation opportunities of SMES (soft landing services promotion)
- EMPIR Environment: application submitted during the first round, at the lead of SYKE, subject: Quality control of water quality monitoring methods
- NPA: Digital Service Tray project: Development and duplication of a digital wellbeing service selection tray
- Tekes: LOCADE project: application of inductive and UWB technology in localisation and data transfer in challenging conditions

In the project, the CEMIS Business Development team set up a service model and concept of operations for gathering and expertise and experiences from RDI projects. This model and concept aims to serve companies in surveying and analysing technology development needs and new business opportunities and to support CEMIS is the commercialisation of research results. The service model consists of:

- 1) Project preparation support: market analyses and forecasts and market entry strategies
- 2) Technology business development: market potential, IPR,

competitor, and technology surveys, business model development and start-up financing options search

- 3) Identification of international business opportunities and supporting internationalisation
- 4) Service business development

The TEPA project also systemised and commercialised KAMK's solid virtual environment expertise and serious game knowledge to a minor extent. To make the service business more efficient, the serious game development service model will be supplemented not only in other projects but also as a part of KAMK's own operations. The service model structure was completed in 2016. The development actions implemented in different instances on behalf of game development service sales are clearly visible in the statistics: sales volume in euros tripled compared to the year 2015.

The implementation of the athlete testing concept continued with the addition of automation and new features to the athlete testing and training environments. The actions of this theme were closely bound to the objectives of the LIPAT project conducted by Jyväskylä University. The desired integration of RouteGen software, used in the automatic generation of virtual sports routes, into the athlete testing concept, was not fully achieved. The most significant challenge was the inaccuracy of the generated routes and thus the need to adjust them manually. Also, the software tool cannot operate as an independent simulator since it needs a separate programme to run the routes, e.g. in treadmill training. Due to the aforementioned issues, it was not fully possible to seamlessly integrate the software into the athlete testing concept.

The other theme of athlete testing involved methods and environments for the rapid production of 2D route profiles and for the automatic control of the treadmill. The so called Jetson system developed in the project, automatically creates a 2D route profile with GPS and air pressure information, and controls the angle of the treadmill by matching it to the route profile and adaptively adjusts the speed of the treadmill based on the athlete's location. During the project, a functioning prototype of this system was produced. After the project, development of the system will continue by improving its usability, user interface view and the functioning of the adaptive speed adjustment. In 2016, the HIIHTO portable wireless server measurement system was finalised and ready for use. Due to problems that arose during development, it has not been possible to utilise all of functionalities in the system as widely as had been hoped.

As a result of the project, Vuokatti's athlete testing services gained a portable athlete measurement system (HIIHTO card) for use in field conditions and a system prototype for creating a 2D route profile and the controlling a treadmill automatically. In addition, a short presentation and marketing video of Vuokatti's athlete and sports equipment testing service offerings, was made. In order to make CEMIS' joint equipment development activities more efficient, concrete cooperation was carried out, namely by offering MITY KAMK's electronics design expertise. To streamline operations, KAMK and MITY made a two-way agreement concerning the joint use of facilities, equipment and staff. The device development cooperation process follows the practices and terms agreed in the previous CEMIS development programme.



The Operations of University of Oulu

The Unit of Measurement Technology changed its acronym to MITY in the final months of 2016. The unit was formed in 2016 by combining two research groups: Cleantech and health and wellbeing. The unit was based in Kajaani but also conducted project activities in Vuokatti.

In 2016, the main application areas of the unit's research were: bioeconomy (renewable forest industry, bioenergy, and utilization of forest biomass), Cleantech (process and environmental applications, especially mining) and health and wellbeing applications (development of biosensors, nutrition, and the development of the Vuokatti area).

A fixed-term professorship in optical imaging technology continued in 2016 and was jointly financed by Oulu optoelectronics laboratory projects and project funding from the Kajaani Unit. There were post-graduate degree students in both research teams.

2016 saw the continuation and strengthening of CEMIS (Centre for Measurement and Information Systems) operations.

The aim of the *MiKeDeKa* project is to utilize existing technologies to build new measurement devices and to produce new services and research results. These outcomes could be used by local companies and start-ups in the near future. A special area of research was environmental issues for example, low-carbon technologies, industrial emissions and water monitoring. For this purpose, real-time measurement technologies based on electrochemistry and optics have been developed and applied. This includes long-term customer application testing. The resources of the project are also used in the *LIPAT* project coordinated by the University of Jyväskylä, in which new measurement technologies are being developed for the health and wellbeing sector, in particular to support the development of sports and tourism locations in the Vuokatti area. A new collaboration between MITY and VTT MIKES Metrology involves integrating process and phenomena simulation into measurements.

Other organizations in CEMIS are the University of Jyväskylä, VTT Technical Research Centre of Finland Kajaani (including VTT MIKES Metrology, formerly MIKES), and the CSC IT Center for Science, as well as Kajaani University of Applied Sciences. The CEMIS Development Program has further united the region's expertise and strengthened cooperation between the Universities of Oulu (MITY) and Jyväskylä, as well as cooperation between the University of Oulu and VTT through TEKES and regionally financed projects. The Director, *Vesa Virtanen*, has participated in the work of the CEMIS Strategy and Management Groups. The University of Oulu unit is clearly the largest operator in the CEMIS Development Programme. MITY is involved in the national photonics research network Photonics Finland. In 2016 cooperation with the Oulu Innovation Alliance was strengthened, in particular with its Centre of Health and Technology (CHT) and the Centre for Environment and Energy (CEE).

CEMIS-Oulu was involved in 10 TEKES-funded projects.

1. *LST-VISION*: (TEKES small strategic opening): New approach to analysing and visualising complex data, 2012-2016 (ended)
2. *BEST* (FIBIC-CLEEN SHOKs, TEKES): Future sustainable bioenergy solutions
3. *BIO-In* (TEKES TUTLI): development of a biosensor to detect and analyse insulin
4. *Premium* (TEKES TUTLI): real-time smart control of process liquid metal concentrations
5. *MPA* (TEKES TUTLI): Bioethanol production optimization; versatile process analyser
6. *SME-MET IMCEE*: Innovative metallurgical cooperation for environmental efficiency
7. *WATER-M*: Unified Intelligent WATER Management
8. *PULLU* (TEKES TUTLI): Refining high value compounds of lingonberry for the global market
9. *Personalised medicine, ICT and biosensor diagnostics to support nutrition monitoring and changes in eating habits* (TEKES Challenge Finland)
10. *ICEMET* (TEKES TUTLI): Icing condition management in wind energy production

The Unit of Measurement Technology was also involved as a measurement method developer in the EU EUREKA cluster ITEA 2 programme's *WATER-M* project, which aims to alter water management operating systems and services. Several companies and research institutes from Finland, France and Turkey are participating in the project. The aim is to ensure safe water for domestic uses in all circumstances. Finland's part of the project is financed by TEKES in 2014 – 2017. MITY is coordinating the operations of Oulu University in this project.

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

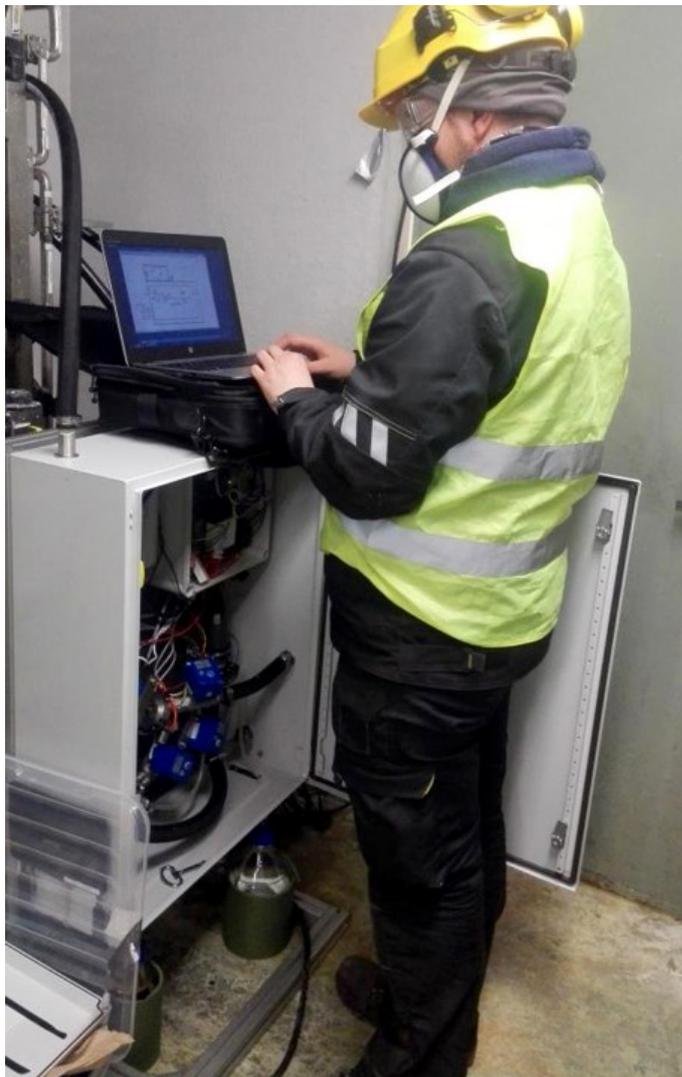
The Kajaani Lab project aims to create a laboratory learning environment where personnel can develop their knowledge. It will also enable the laboratory to increase the number of specialists and increase the scope and quality of its research services. The utilization of infrastructure will also be enhanced by personnel training. The project also enhances knowledge of health technology, how to produce sensor surfaces with different printing techniques, and sensor surface materials and reading devices. Furthermore, the capability to use new simulation tools is one of the aims. The training also provides personnel with new biotechnical tools and better capabilities to utilize and optimize pilots and proof-of-concept tasks. During and after this project, MITY can better support the development projects



Researchers of the University of Oulu, Measurement Technology Unit (MITU) set up a company in 2016, to commercialize a measuring instrument they had developed.



In the CEMIS programme, the University of Oulu, Measurement Technology Unit (MITU) developed an automatic measuring instrument for the real-time monitoring of industrial processes.



The aim of the MiKeDeKa project is to utilize existing technologies to build new measurement devices and to produce new services and research results. These outcomes could be used by local companies and start-ups in the near future.

and competitiveness of micro enterprises and SMEs. The project supports the start-up and development of bio-refinery, bioenergy and mining industry ventures in Kainuu.

The aim of the project *Development of Coaching at the Vuokatti-Ruka Sports Academy* is to build a simple and robust system for monitoring the enhancement of physical strain, development and technique. Also, the required testing blocks and evaluation feedback for the aforementioned solution are being developed for endurance sports athletes in Vuokatti and for athletes of alpine sports in Ruka, as well as tools for their coaches to support their work. The project involves collaboration between the University of Jyväskylä and Vuokatti-Ruka.

The POTIS - Potato Waste to Valuable Products project aims to promote sustainable valorisation of potato side streams produced in Northern Ostrobothnia via the development and assessment of potential product pathways based on their main component fractions. The project is implemented by the University of Oulu and Natural Resources Institute Finland in cooperation with companies in the value chain.

The Management and Rehabilitation of Surface Water Bodies Receiving Mine Waters (*KaiHali*) project, aims to develop expertise and business opportunities in the management of mine water discharge to surface waters. The project develops the prediction and modelling of mine water mixing and dilution and the resulting ecological and stratification effects in recipient surface waters. In addition, the project addresses the accumulation of load into aquatic sediments, the resulting changes in sediment geochemistry, and the increased cost efficiency of sediment survey methodology. In this context, the utilization of an autonomous measurement vessel (ROV) is evaluated. The project is promoted by the Finnish Environment Institute (coordinator), Geological Survey of Finland, Kajaani University of Applied Sciences and MITY.

JaMit project - Modelling oil spreading with CFD connected to oil and low metal (Ni, Hg) measurements in mines and harbours. This project involves collaboration with the Environmental and the Chemical Engineering group (ECE) of the University of Oulu and the Lappia Vocational College.

MITY is also involved in the *Vesien hallinta kaivoksessa (Water control in mine)* training scheme coordinated by AIKOPA Adult and Continuing Education, aimed at public officers and companies.

In the project, "*Smart Specialisation to be utilised by Companies*", the aim is to support local companies in their development projects and improve competitiveness by enhancing their productivity, innovation and R&D activities.

The personnel of MITY is also working in the *Kainuu Climate* Project, which aims at reducing greenhouse emissions in Kainuu by 25% by 2020 by including climate protection in the standard operating procedures of companies and municipalities. Companies and municipalities are given advice and training in the means to reduce greenhouse emissions. The project will increase the ability of companies to conduct climate-responsible business, which can be used to improve company image.

The "Analytical Services and Profitability of Biogas Production in the Kainuu Region (*BITES 1 and BITES 2*)" projects are being jointly implemented by MITY and Kajaani University of Applied Sciences. Biogas production is complex and is not based on any particular process technology but a combination of many. Thus, process management and output quality in biogas process plants is challenging. Currently,

there are not enough real-time measurement methods for process monitoring and optimization. The aim is to increase biogas processing in regional farms by surveying new raw material supplies, developing improved process optimization, and creating developed service models to commercialise biogas. A technological and economical profitability study will also be implemented.

The "Development of the Quality and Safety of Natural Products" (*PALKO 1*) project is being carried out by MITY and Kainuu Vocational College (KAO). In this project, new methods are developed and information is created for improving the quality and safety of natural products used especially in cosmetic compounds. Selected quality control parameters are based on the tightened legislation for cosmetic compounds. This safety data is required before enterprises can release their products onto the market.

The PAJU project, funded by Oulujärvi Leader, is a small study carried out by MITY, in which the Kainuu Forest Centre is participating as a consultant. The aim of the project is to investigate the utilization of young trees (willow, alder and birch) as a raw material for valuable compounds.

MITY participated in four international projects: the European Meteorological Research Programme, *EMRP*, with a project in which laboratory moisture analysis devices based on new technologies (NMR microwave and x-ray technology) are being investigated and their performance compared to the traditional standard of the oven drying method. MITY 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 micro-bioreactors and it provided resources for one foreign doctoral thesis employee. MITY is participating in the EU-N EIP, the Entrepreneurship and Innovation Programme's Eco-Innovation part, with the *Envimon* project, in which industrial metal emissions monitoring in environment waters, is being studied.

The European Commission's Directorate General for Health and Consumers organised a research application in August 2014: Healthy diet: early years and aging population. MITY's project proposal Nutritional research on the non-invasive screening and diagnosis of malnutrition in elderly persons (*NURSE*) was selected for funding. An agreement was signed with the Commission in December 2014 and the project started at the beginning of 2015 and continued until the end of June 2016. The project involved collaboration with the Jokioinen unit of Natural Resources Institute, Finland.

The number of international researcher exchanges was 42 person months as planned. There was active international cooperation with more than 10 research institutions e.g. in Italy, Denmark, Russia, the USA and Great Britain. The number of scientific articles produced was relatively good: 9 referenced international scientific articles and 11 conference and other publications or presentations. The unit's employees participated in international and national evaluation tasks (scientific magazines, pre-evaluator of Ph.D. thesis, and assessment of international project applications). There were five notifications of an invention and one commercialized invention.

The unit's budget was approx. 3.2 million euros. It had 50 employees during the year 2016 and it accumulated up to 41 person work years. 11 persons with a Ph.D. diploma (25% of the person work years) were engaged.

The Operations of Kajaani University of Applied Science

At the start of 2016, KAMK made significant changes to its organisational structure and continued to implement the vision of the KAMK'24 strategy, to be the smartest university in Finland in 2024.

Within the Information Systems competence area, the strategic actions were targeted at the game and measurement applications area of expertise and within Mechanical and Mining Engineering, at the production systems area of expertise. Both areas of expertise are in line with CEMIS' focus areas and thus they will strongly support the collaborative work of CEMIS in the future.

School of Information Systems – expertise in sensors to cloud

Information Systems is Kajaani University of Applied Sciences' unit consisting of approx. 60 teachers and project employees as well as 440 students, which trains information and communication technology degree students (Bachelors of Business Administration) and information technology engineers (Bachelors of Engineering). There are three subject groups: games and game technology (Games), Data centers (DC) and Smart Systems. Even according to international indicators (attractiveness, study performance, impact, projects), Information Systems is succeeding. A special attention has been attracted by the game students who have succeeded in a variety of competitions. This success has built the positive reputation of the unit. The key figures of the unit in 2016 include 53 university of applied sciences bachelor's degrees, five master's degrees, nine publications and external RDI funding totalling approx. 800 000 euros.

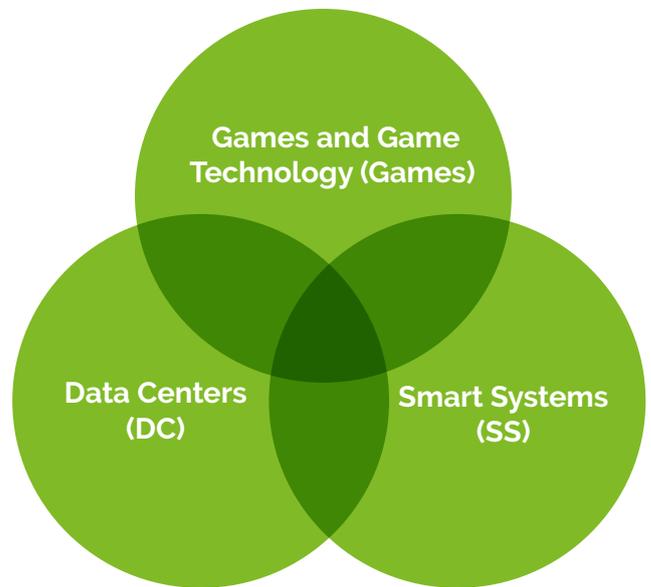
Information Systems continued its solid work of previous years on the project front. Funding was provided by the ESE, ERDF, TEKES and ERASMUS+. National projects were e.g. *SIMPPELI* and *TEPA*, that are part of the CEMIS programme, Segabu (ESF), SGRL (TEKES), Ministry of Education and Culture –funded projects *10-polku* (10 Paths) and *Digital Services Development*, *KALPAT* (ERDF), *Virtual Coach* (TEKES ERDF) and *Rural Agree* (Erasmus+). CEMIS practitioners, universities, colleges and companies were involved in these projects. This active cooperation with different bodies successfully describes the success in implementing regional development and cooperation with working life. The central development themes of the projects conducted by the School of Information Systems were serious games and game-like applications, education, technological solutions for sports and exercise and laboratory services. Members of staff from Information Systems also participated in preparing international projects (H2020, Erasmus+, Interreg BSR) based on the above themes.

The international expertise of the unit grew in 2016. This expertise is indicated by the following challenging projects and events: the international Northern Game Summit was organised for the fifth time in Kajaani: There were more than 1000 participants, from a total of 12 countries. Information Systems was invited to join the Erasmus+ Rural Agree project to take charge of serious game development. Information Systems was also involved in promoting exports on behalf of several local companies and took part in exports promotion trips to Japan and Singapore. It was also involved in planning five new game companies during 2016, but the companies were actually set up in 2017.

Information Systems staff members *Tanja Korhonen*, *Janne Koponen* and *Kati Haverinen* are studying for their doctoral degrees and bringing new knowledge and expertise to the whole unit via their research.

The main objective in defining the area of expertise and implementing the strategy in 2016 was to combine the expertise available in Information Systems and to determine and increase structural capital. The area of expertise of the Information Systems unit was defined as "Game and measurement applications", which naturally combines game and measurement system with data centre expertise that acts as a service base for all our operations. The long tradition of measurement expertise both in teaching and in the region's companies as well as the combining sensors, cloud services and games create new opportunities. As a part of this strategy process, RDI and education roadmaps were compiled for the school, in cooperation with RDI and education services.

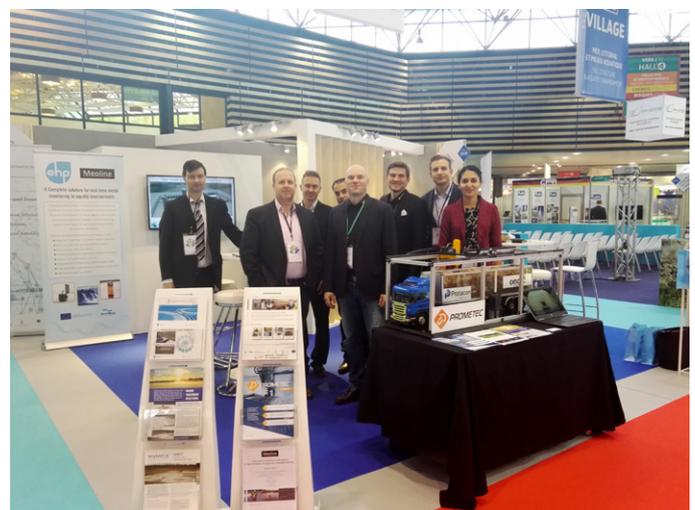
In 2016, the competences of the unit was combined to form a competitive hub of expertise, which cannot be found in other institutes of education. The core expertise allows the unit to implement advanced applications in different sectors including smart home care, activity tourism, production engineering as well as industry and the service sector. There are many uses for a game-like, gamified user interface that searches for, analyses and directs real-time cloud data which measurement devices and sensors provide. At the same time, the students will be considerably better prepared for working life and they will have a wider perspective of the sector in which they are working. They also practise working in teams of experts.



Competences are synergised to form a combination. New innovation and continuous learning occur where competences overlap; it is difficult to find an equivalent 'sensor to cloud' service platform concept in other universities, which includes students to such a great extent.



At the beginning of 2016, project expert Tero Luukkonen, who has been closely involved in the competence area's project activities, defended his doctoral thesis and gained a doctoral degree at the University of Oulu.



Representatives of CEMIS and partner companies at the Pollutec trade fair.

The most significant openings of 2016 were: the start of the Smart Systems degree in cooperation with local companies, the construction of the *Virtual Autoedu product series*, and the development of laboratory services and future areas of focus reviewed in the KALPAT project.

Commercial services were offered even more actively. Testing services (weather, vibration, EMC) sales totalled approx. 40 000 euros, software and equipment development services, approx. 100 000 euros. Investments in equipment, software and environments worth almost 100 000 euros were also made.

The school recruited a graphics teacher, a measurement technology expert, an eSports expert and an expert in project writing.

The new CEMIS programme period started on 1.1.2017. Within this programme, the LIIKUTPA project, which the unit helped to plan in 2016, began in the School of Information Systems.

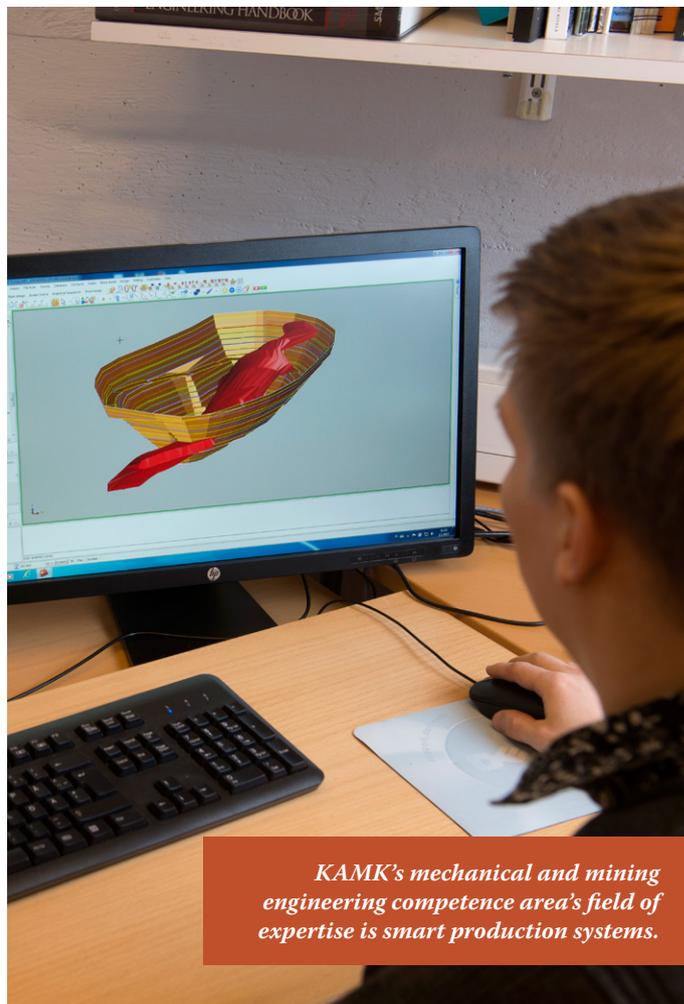
Mechanical and mining engineering as a part of KAMK's reformed organisation

At the start of 2016, KAMK reformed its organisational structure. The Mechanical and Mining Engineering competence area is now part of the education, research and service activities of the School of Engineering. The school offers degrees in Mechanical and Mining Engineering and Construction and Civil Engineering. The competence area's field of expertise is production systems. Its key figures of 2016 are 35 completed degree qualifications, 17 publications (of which 6 are peer reviewed and scientific publications) and the receipt of external RDI funding totalling approx. 700 000 euros. The external RDI funding was significant in terms of its strong proportion with basic education funding of 1.3 million euros.

Project funding was provided mainly by the ESF, ERDF and TEKES. There were three ongoing TEKES projects in the competence area: *GeoRoad* and *GeoSorbents* continued to develop strong expertise in the circular economy; and a preparatory project for the *Horizon 2020 programme*. International project applications for the Horizon 2020 programme were actively submitted but to date they have not received funding. Service business sales increased slightly compared to the previous year, to approx. 30 000 euros. Here, there is still room for improvement and thus 2017 will see the implementation of service business development actions. A new door opened with cooperation conducted with companies in the use of industrial virtual solutions, generating potential service and RDI opportunities.

Strong proof of international RDI expertise was demonstrated when *Tero Luukkonen* and *Kimmo Kemppainen* attended a solid waste management conference in Limassol, Cyprus during 23.5.–25.6.2016: 4th International Conference on Sustainable Solid Waste Management (www.cyprus2016.uest.gr). Tero Luukkonen delivered a presentation on the development of efficient absorbents by alkali-treatment of high-calcium-content fly ash from paper industry. The research was conducted as part of the *GeoSorbents* project.

The competence area's most significant opening of 2016 was the starting of robotics expertise development within project activities. KAMK's largest investment scheme, worth approx. 1.5 million euros, started on 1.3.2016. Kainuu Vocational College is also involved in the



KAMK's mechanical and mining engineering competence area's field of expertise is smart production systems.



KAMK's information system's competence area's field of expertise is game and measurement applications.

The competence area's most significant opening of 2016 was the starting of robotics expertise development within project activities. KAMK's largest investment scheme, worth approx. 1.5 million euros, started on 1.3.2016.

RoboKai project with its own subproject. Companies have provided a significant amount of funding for the project: 150 000 euros, from Katera Steel Oy, Imagon Oy, Sartorius Biohit Oyj, Suokone Oy, Jetmasters Oy and Koneistamo Alm Oy. Infrastructure planning for the future also commenced in the competence area with the partial transfer of operations to a new laboratory to be built in the Tieto 2 building.

The competence area's projects included CEMIS partners and representatives from other research and university organisations. The proportion of business funding in different projects indicates that the projects fulfilled the companies' requirements. Road map work was done in the competence area throughout the year in cooperation with RDI services.

Cooperation continued with Lapland University of Applied Sciences and Oulu Mining School in mining expertise development and planning to generate even more effective jointly delivered training and education. The objectives were also recorded in an agreement between KAMK, LAMK and the Ministry of Education and Culture, concerning the years 2017 – 2020. This activity will also be allocated strategic funding from the Ministry during the period of the contract.

In order to consolidate competence area's capacities in teaching and international level RDI activities, a full-time teacher in robotics and a principal lecturer were recruited. Both will begin their duties during 2017.

The third CEMIS programme period ended in 2016 and the new period started on 1.1.2017. Within this programme, the *KANTELI* project, which we helped to plan, began in the Mechanical and Mining Engineering competence area.

Expertise for regional business development and internationalisation – CEMIS Business Development team (CBD)

In 2016, the CBD unit continued its determined work to promote the commercial use of research and development results, to improve opportunities for international operations and to develop the operational environment of local companies in particular. The international team of experts consists of an R&D senior lecturer, in charge of directing operations and three business developers. In addition to key staff members, the team regularly includes trainees and final year students of different nationalities.

Substantial efforts were made to expand CEMIS' and companies' international cooperation networks by, e.g. participating in trade fairs, conferences, project practitioner events and by travelling for networking purposes. Large part of this work was done in CEMIS 2015-2016 programme project 'TEPA'. The most significant trade fair visit occurred in 2016 at the end of November and the beginning of December at the Cleantec sector's Pollutec trade fair in Lyon, France. CEMIS attended the fair with four SME partner companies: Aquaminerals Finland Oy, Meoline Oy, Prometec Tools Oy and W-Rix Oy. The trade fair's vast reach can be seen in its 60 000 visitors and 2 200 exhibitors. The participants felt that the trade fair was a useful and practical channel for presenting one's expertise and technologies as well as acquiring new contacts and project partner candidates. As planned, the event offered significant visibility for

the participating organization and gave them valuable contacts for future internationalization activities. In addition, the event formed an efficient way of gaining a comprehensive overview of the recent innovations, competitors and market situation in the sector.

The expansion of networks in growing market areas central to CEMIS' focal business sectors, particularly in the Middle East (Qatar and Saudi Arabia) and Latin America (Chile), continued. In addition to the trips, large surveys of the technology markets of the areas mentioned above were conducted. The expertise of the organisations in CEMIS and Finnish companies connected with international consortiums by participating in the preparation of several projects, including H2020 and Interreg BSR funding programmes. The beginning of 2017 looks interesting from a project perspective because it will be known whether the multinational *IBCOLL* project (Interreg BSR), focusing on the internationalisation of SMEs, will receive funding. Other decisions are also pending concerning H2020 project preparations that were completed in the first third of 2017. The key themes of these project preparations are measurement technologies, internationalisation of companies, business promotion, water purification solutions and the circular economy.

The commercialisation of technologies developed in CEMIS advanced in TutLi projects: *BIO IN* (MITY), *MPA* (MITY) and *Georoad* (KAMK). The projects were conducted on the following topics respectively: saliva based insulin measurement method, process analyser for bioethanol production processes and geopolymer-based natural repair solutions for road maintenance. *The WaterCare* project (*TEKES BEAM* programme) enabled the implementation of business-led water technology export project preparations.

Over the year, the CBD team's service offering was packaged into a service model and operational concept. It comprises the good practices, experiences and expertise stemming from RDI projects, service commissions and technology business development. The aim of the model and concept is to serve companies in surveying and analysing technology development needs and new business opportunities. In addition to business needs it supports the commercialisation of CEMIS' research results and international project preparations. As a part of the service model and concept the CBD team arranged service packages focusing on education to meet the needs of the private and public sectors.

In 2016, the CBD team was involved in the planning of approx. 10 projects, including national and international projects. At the start of 2017, the two-year CEMIS programme sees the CBD team as the main implementing body of the *KANTELI* project.

The Operations of VTT

In 2016, traceability services and research operations developed as expected. Year 2016 was the best year so far regarding the traceability service offerings, which grew 30% compared to last year.

When the Technical Research Centre of Finland (VTT) and the Centre for Metrology and Accreditation (MIKES) merged together 1.1.2015 and formed VTT Technical Research Centre of Finland Ltd, the former MIKES became one research area in the VTT Ltd. In 2016 there were the organisational change in the VTT Ltd and the MIKES formed an own separate research area led by Vice President *Mikko Merimaa*. Currently eight people from two different research teams (BA1609 and BA1704) from working in Kajaani.

VTT MIKES Kajaani

The MIKES Metrology Force Metrology team, BA1704 is located in Kajaani and is led by Research Team Leader *Petri Koponen*, Ph.D.

He has previously worked as a researcher in the University of Oulu, The University of Joensuu, and as a Group Manager at MIKES.

Since 2011, VTT MIKES Kajaani has operated in facilities located in the the Renforsin Ranta Business Park, which are custom-made to the needs of MIKES. The unit's most important tasks are to maintain the national measurement standards of force, torque, water flow and large masses (20 kg ... 2000 kg), to produce traceability services to Finnish industry, and participating in national and international research projects. In addition, VTT MIKES Kajaani is involved in the Ministry of Economic Affairs and Employment's metrology committee's metrology club activities with responsibility for force and water flow



In 2016, Mikko Merimaa, D.Eng, (right) started as the Vice President of VTT MIKES Metrology's research area. The Kajaani research group's manager is Petri Koponen (left).

The project also aims to decrease environmental problems caused by industry by developing process industry and mine water management solutions and new methods of efficiently using Kainuu's biomasses and their side streams according to the principles of the circular economy

clubs. The latest club meeting to take place was the Flow club on 20.9.2016. There were 17 participants.

In 2016, traceability services and research operations developed as expected. Year 2016 was the best year so far regarding the traceability service offerings, which grew 30% compared to last year.

The unit has participated actively in implementing the CEMIS development programme's joint projects. In the *LIPAT* project (Sports and Wellbeing Technologies Service Business Development) VTT MIKES Kajaani participated by improving the measurement ability, reliability and measurement repeatability of the University of Jyväskylä's sports gear testing systems by calibrating the used load cells. In addition, VTT investigated how the University of Jyväskylä's sport related measurement equipment can be further developed regarding the skiing pole tester and force measurements of the pole.

In the joint project *CleanTec*, VTT mainly worked on Work Package 1. During the work VTT further developed both visualization of the Laser Doppler Velocimetry (LDV) measurement results, and also calculation of the volume flow determined by the LDV measurement device. With the LDV, the flow profile of the D500 calibration rig was measured, and was visualized after the clack valve and the measurement results also were compared with results that were simulated with the Comsol Multiphysics software. Furthermore, different flow profiles for nozzels and flow equalizer have been calculated using the simulation software. The simulation expertise has been extended to the open source software (OpenFOAM) and utilizing of a calculation clusters. This offers more opportunities for the solving of complex flow problems.

VTT MIKES Kajaani has offered students of the region's educational institutes, periods of practical training and the chance to write engineering theses. In addition, the laboratory has offered summer jobs to young people in the region. The unit's development operations have kept the region's companies and research institutes busy.

During its first six years of operation, MIKES Kajaani has had 200–300 customers yearly, and more than 95 % are not from Kainuu region. There have been more foreign customers than customers from Kainuu, and this indicates that the location has not prevented demand.

International Cooperation

The Force team has actively participated in the European Association of National Metrology Institutes, EURAMET's activities, such as technical meetings in relation to specific physical quantities for which the team is responsible. In addition, the unit has been or is involved in three different EURAMET EU research projects: *EMRP Force*, *EMPIR Torque* and *EMPIR MultiFlowMet II*. *EMRP Force* has already ended, *EMPIR Torque* is ongoing and *EMPIR MultiFlowMet II* will begin in summer 2017. In total, there are 28 ongoing EU research projects at MIKES Metrology.

Projects

The Force metrology team has prepared and received funding or has produced service research during the years 2010–2016 in 15 different projects (Painevesi, LUMO, Analytical Photonics, Cleen/MMEA, TARRA, NICK, *EMRP Force*, BEST, Biovesi, *EMPIR Torque*, FloModNode, *Virtuaalivalmentaja*, *BIOMIT*, *LIKUTPA* and *EMPIR*

MultiFlowMet II). Of these, four received a positive project decision in 2016.

The *Virtuaalivalmentaja* (*Virtual coach*) is a project, coordinated by the University of Jyväskylä, which is creating a platform for a new and innovative healthcare and wellbeing prototype tool – a virtual coach – by developing preventative measures such as a method of testing dynamic balance based on external disturbance and a reading device for non-invasive biosensor measurements to monitor cortisol in saliva or nutrition hormones. VTT is responsible for evaluating the repeatability and reliability of the dynamic balance test.

BIOMIT and *LIKUTPA* are CEMIS' 2016–2017 development schemes. The aim of the *BIOMIT* project is to decrease industrial carbon dioxide emissions by developing measurement solutions to optimise bioenergy and mining industry processes. The project also aims to decrease environmental problems caused by industry by developing process industry and mine water management solutions and new methods of efficiently using Kainuu's biomasses and their side streams according to the principles of the circular economy. The aim of the *LIKUTPA* – New technologies and services for exercise and wellbeing project is to produce measurement and testing solutions enabling people to take care of themselves and their health, the development of public social and healthcare towards distance and self-diagnosis and the development of Finnish top sports and sports technology business operations. MIKES Metrology is participating in the projects as follows: 1) measurement quality control. Measurements are indispensable in science and without them scientific models and theories cannot be tested or challenged comprehensively. A measurement is never correct but it is an estimate of the measured value. All measurements include uncertainty, which is an estimate of the margin of error in the measurement result. A measurement error is the difference between the measurement result and the measured value. The defined measurement uncertainty defines the reliability of the result and makes the result comparable with others. If the measurement is to be of any benefit, the results must be sufficiently reliable. 2) Multi-phase modelling. This employs suitable commercial and open source tools. The aim is to learn to understand phenomena that occur in the multi-phase environment using computational flow dynamics (CFD). CFD is an effective and cheap tool for perceiving the various stages of different industrial flow processes. CFD provides information on the process' local conditions and it can help to accelerate the development of process equipment. Modelling can be used to find solutions that will, for example, make the process work more efficient and reduce emissions.

The *MultiFlowMet II* project belonging to the international *EMPIR* programme develops the reliability of multi-phase measurements. Multi-phase measurements mean flow measurements in which oil, water and gas flow simultaneously and the relationship between these components change over time. Multi-phase measuring is especially needed in oil and gas production from oil and gas deposits but such forms of measurement are increasing being used in other measurement applications. At this moment there are several commercial meter manufacturers with their own testing and calibration facilities but no comparison of these manufacturers exists. This restricts the development of multi-phase measurements and the reliability of comparing measurements conducted in different locations. The *MultiFlowMet II* project will harmonise the calibration actions



VTT MIKES Metrology maintains and develops strength, torque and large mass measurement standards in Kajaani.

and conditions of different practitioners. Another aim of the project is to harmonise uncertainty definitions for measurements. Multi-phase flow CFD modelling is also one part of the project, enabling a better understanding of the physical properties of an event. Thus it will be possible to develop better multi-phase measuring devices and make the comparison of measurement results more reliable. In water flow calibration, all of the aforementioned practices already widely exist and are comparable to each other in Europe and the rest of the world. The results and development produced in this project will enable multi-phase measuring to perform equally as well.

In the project, VTT MIKES Kajaani's role is that of unbiased invigilator of comparable measurements and to store and process the measurement results. In addition, VTT MIKES Kajaani will participate in developing testing protocols and defining measurement uncertainty for multi-phase measurements. The work completed during the project will act as a platform for the approaching ISO TC/28 standard.

Visibility

The activities of the Force team have been actively reported at EURAMET's technical meetings by physical quantity area. A peer reviewed article on the optic fibre link between the Espoo and Kajaani units, has been published.

White Rabbit Precision Time Protocol on Long-Distance Fiber Links. Dierikx EF, Wallin AE, Fordell T, Myrsky J, Koponen P, Merimaa M, Pinkert TJ, Koelemeij JC, Peek HZ, Smets R. in the publication *EEE Trans Ultrason Ferroelectr Freq Control*. Volume 63(7), 2016 s. 945-52.

Also, two presentations were delivered in 2016 on the unit's water flow calibration equipment:

New Gravimetric National Standard for Water Flow Measurements in Finland, M. Huovinen and P. Koponen. 17th International Flow measurement conference 26.9. – 30.9.2016, Sydney (oral presentation)

Water Flow Meter Calibration in NMI Laboratory of Finland, M. Huovinen and P. Koponen, 17th International Flow measurement conference 26.9. – 30.9.2016, Sydney (Poster).

Industrial IoT

VTT's industrial IoT research group (BA1609) is still focusing its local expertise on topics commenced in Kajaani. These are impulse radar technology which was deepened in work package 5 of the CEMIS Cleantec project, in which the use of impulse radar in industry was studied. Ultra Wide Band (UWB) has been developed by the BA1609 team in the *Hilla Soccer* project during 2016. At this moment, one member of the BA1609 team's staff works in Kajaani.

Impulse radar technology has been studied in the two year CEMIS Cleantec project in which material moisture analysis using impulse radar was researched. Impulse radar enables touch-free and continuous moisture measurements. In addition, the use of radar to perceive humans and measure the thickness of materials was tested. Software based on an embedded system was developed to control the radar and process the data it produces.

During the project, height measurements using impulse radar in a 3D UWB positioning system were carried out. The system was used at an indoor localisation competition organised by Microsoft. A brief publication on the integration of the localisation system and impulse radar was produced: *UWB Localization complemented by Impulse Radar, Microsoft Indoor Localization Competition, IPSN 2016*

The Operations of University of Jyväskylä

The cooperation between the University of Jyväskylä and Vuokatti Sports Institute resulting in specialist expertise and conditions has increasingly started to attract the interest of foreign research organisations and ski associations.

General review

At the end of 2016, there were nine employees in the Vuokatti Sports Technology Unit of the University of Jyväskylä. Three of them worked partly for the University of Jyväskylä and the Finnish Ski Association, the Finnish Biathlon Association or the Finnish Olympic Committee. Four Master's students graduated during the year. In autumn, 13 new Master's students started their studies. In 2016, larger ongoing projects were *Development of coaching at the Vuokatti-Ruka Sports Academy* (Regional Councils of Kainuu and North-Ostrobothnia, 250 000 euros), CEMIS, *Sports and Wellbeing Technologies Service Business Development* (Kainuu ELY Centre for Economic Development, Transport and the Environment, 164 000 euros), *Virtual Coach*

(TEKES, ERDF, 169 000 euros) and *Development of a disabled sit-ski athlete's classification system* (Ministry of Education and Culture, 70 000 euros). During 2016, six national or regional development funded project applications were submitted and one international project application which resulted in two positive ERDF and one positive TEKES ERDF decisions.

In 2016, the Vuokatti team published six original scientific articles, ten books or chapters in books, eight international congress abstracts, and was invited to deliver six presentations, two of which were international presentations.



University of Jyväskylä's coaching feedback system Coachtech at CEMIS' seminar in 2016.



Teemu Lemmettylä, who is in charge of equipment maintenance at the Finnish Ski Association, uses the ski testing system developed by the University of Jyväskylä.

International cooperation continued in disabled skiing research with the Universities of Freiburg, Salzburg, Torino and Leuven, as well as the Paralympic Committee. Biathlon research continued with KIHU Research Institute for Olympic Sports, the Finnish Biathlon Association and Salzburg University. Double poling project in cross-country skiing in cooperation with Salzburg University started at the end of the year. All the athlete measurements for the aforementioned international research were conducted in Vuokatti during 2016. Jyväskylä University participated in Vuokatti Sports Institute's internationalisation project by offering expert services in the creation of networks particularly in the direction of China, where the Winter Olympics will be held in 2022. For this reason, the Director of the Jyväskylä University's Vuokatti unit, Professor *Vesa Linnamo* visited Beijing Sport University and the China's Ski Associations in October-November 2016, together with the Head of Faculty Administration and the Head of Student Affairs of the Faculty of Sport and Health Sciences of Jyväskylä University and the head coach of the Finnish Biathlon Association. The visit resulted in a significant pending cooperation agreement between China's ski associations and Vuokatti Sports Institute as well as preparations for a cooperation agreement between Jyväskylä University's Faculty of Sport and Health Sciences and Beijing Sport University.

CEMIS' operations

Over the years Vuokatti's unique Nordic ski sports research, testing and development environment has progressed to a point where its impacts can be seen in local sports tourism. The cooperation between the University of Jyväskylä and Vuokatti Sports Institute resulting in specialist expertise and conditions has increasingly started to attract the interest of foreign research organisations and ski associations. The CEMIS consortium has been an important development environment and cooperation network in this work. The role of the University of Jyväskylä in CEMIS has been to specialise in developing individual sports and wellbeing measurements with a special focus on the needs of top sports and close cooperation with Finland's national ski sports teams as well as the Olympic Committee of Finland. Different skiing testing and measurement systems, biosensors for monitoring strain and stress, and Nordic ski sports equipment testing, among others have been developed in Vuokatti. The aim has been to produce technology and methods for the needs of demanding top sports, which if successful, can be integrated into keep-fit and wellbeing applications.

The aim of the project "*Sports and Wellbeing Technologies Service Business Development*", that was ongoing at the end of 2016 was to

promote the start-up of commercial athlete and equipment testing or develop existing commercial activity in Vuokatti. The actions specifically focused on creating new business cooperation, planning jointly funded projects, finalising and adopting new athlete and equipment testing technologies for use in Vuokatti's sports tourism service business, and to compile marketing material. The following were developed in the University of Oulu's, KAMK's and VTT MIKES Metrology's simultaneously implemented CEMIS 2015–2016 programme projects, that focused on: 1) non-invasive methods of monitoring physiological stress, strain and recovery based on saliva or sweat samples, 2) improved reliability and repeatability of equipment testing methods and 3) technologies for athlete and fitness testing in a virtual environment.

Business and project cooperation

New cooperation was set up with approx. 20 companies with which six national project applications and one international Erasmus+ application were prepared and which produced three positive regional development funding decisions. One of the new projects was the "Virtual coach for health and wellbeing professionals" (TEKES health from bits, ERDF) coordinated by the University of Jyväskylä, for which all the organisations in CEMIS applied in collaboration and which Hur Labs, Osuuskauppa Maakunta, Vuokatti Sport Testing Center, Tieto-Oskari, Yrjö and Hanna Foundation, Innokas Medical, Kuhmon lääkäripalvelu (medical service), Taukokangas, Jovicare and Laturi Corporation joined as business partners. The project started in October. The second project, "New Technology and Services for Exercise and Wellbeing" (Regional Council of Kainuu, ERDF) was also collaboratively prepared with all the organisations in CEMIS and it aims at promoting self-directed health and wellbeing monitoring with biosensor measurements and developing Vuokatti as a trailblazer in the use of technology in athlete and equipment testing. The project starts at the beginning of 2017. The University of Jyväskylä also helped Vuokatti Sports Institute to prepare the "Development of Vuokatti's International Sports Expertise Business" operational environment project (North Ostrobothnia Centre for Economic Development, Transport and the Environment, ERDF), which received a positive funding decision in June. SMEs operating near or in the environs of Vuokatti Sports Institute are involved in the project, such as Kuhmon Lääkäripalvelu (Medical Service) and Vuokatti Ski Service. The role of the University of Jyväskylä in the project is to expand international networks.

The Operations of CSC

CSC joined CEMIS in August 2016.

CSC's role is to strengthen

CEMIS' data analytics expertise.

CSC, the Finnish IT Centre for Science, is a national computing centre producing computing, data analytics and networking services for academia, research institutes, the public sector and industry. CSC is a non-profit limited company whose shares are fully owned by the Finnish state and universities, and who is governed by the Finnish Ministry of Education. CSC's datacentre is located in Kajaani.

CSC joined CEMIS in August 2016. CSC's role is to strengthen CEMIS' data analytics expertise. This role stems from CSC's mission to provide expert support in data processing and analytics, as well as environments and services. Since data analytics is often driven by developments in measurement instruments, CSC's major goal is to gain insight into measurement technology.

CSC has provided data driven solutions and expert support for science throughout its 40-year history. CSC also runs cluster and cloud computing platforms and provides tools to run big data systems. Through CSC, the CEMIS partners will have an effective high-performance computing (HPC) environment, with IO-optimized cloud services and general-purpose graphics processing unit (GPU) computing, at their disposal. In collaboration with other CEMIS

partners, CSC has started to construct a pilot environment for the secure storage of sensitive data collected with different sensors. The environment is based on the VAHTI raised level security certified ePouta cloud platform, designed for processing sensitive data. In addition to the scientific domain, CSC also works in public sector data analytics and business intelligence.

During 2016, CSC participated in planning for CEMIS joint activities 2017-2018. CSC will work in CEMIS' sub-projects, *BIOMIT* and *LIIKUTPA*, on tasks related to data analytics, sensitive data, machine learning, and computer vision. CSC also participated in the CEMIS seminar on 20.10.2016 presenting opportunities in data analytics.



CSC's datacentre in Kajaani.

Publications

During 2016 CEMIS produced in total 30 international scientific, peer-reviewed articles and 29 professional and conference articles.

In addition to that, CEMIS produced one doctoral dissertation, 4 Master's theses, 6 Master's Degrees as well as 88 Bachelor of Engineering and Bachelor of Business Administration theses.

Doctoral thesis:

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Master's theses:

Aki Ikäheimo; Effects of training background to acute psychological stress biomarkers, Jyväskylän yliopisto

Pirjo Poikkimäki; Lihasten voimantuoton yhteys tasapainokontrolliin dynaamisessa tasapainohäiriössä nuorilla miehillä ja naisilla, Jyväskylän yliopisto, in Finnish

Liisa Lamminen; Venyttelyn vaikutus tärinäaltistuksen ja kiertyneen ajoasennon aiheuttamiin alaselän ja niskan vaivoihin, Jyväskylän yliopisto, in Finnish

Jarmo Pääkkönen; Vertikaalihypyn korkeuden arviointi 3D-kihtyvyysanturilla ja lajinomaisen kuormituksen vaikutukset hyppyyn, Jyväskylän yliopisto, in Finnish

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