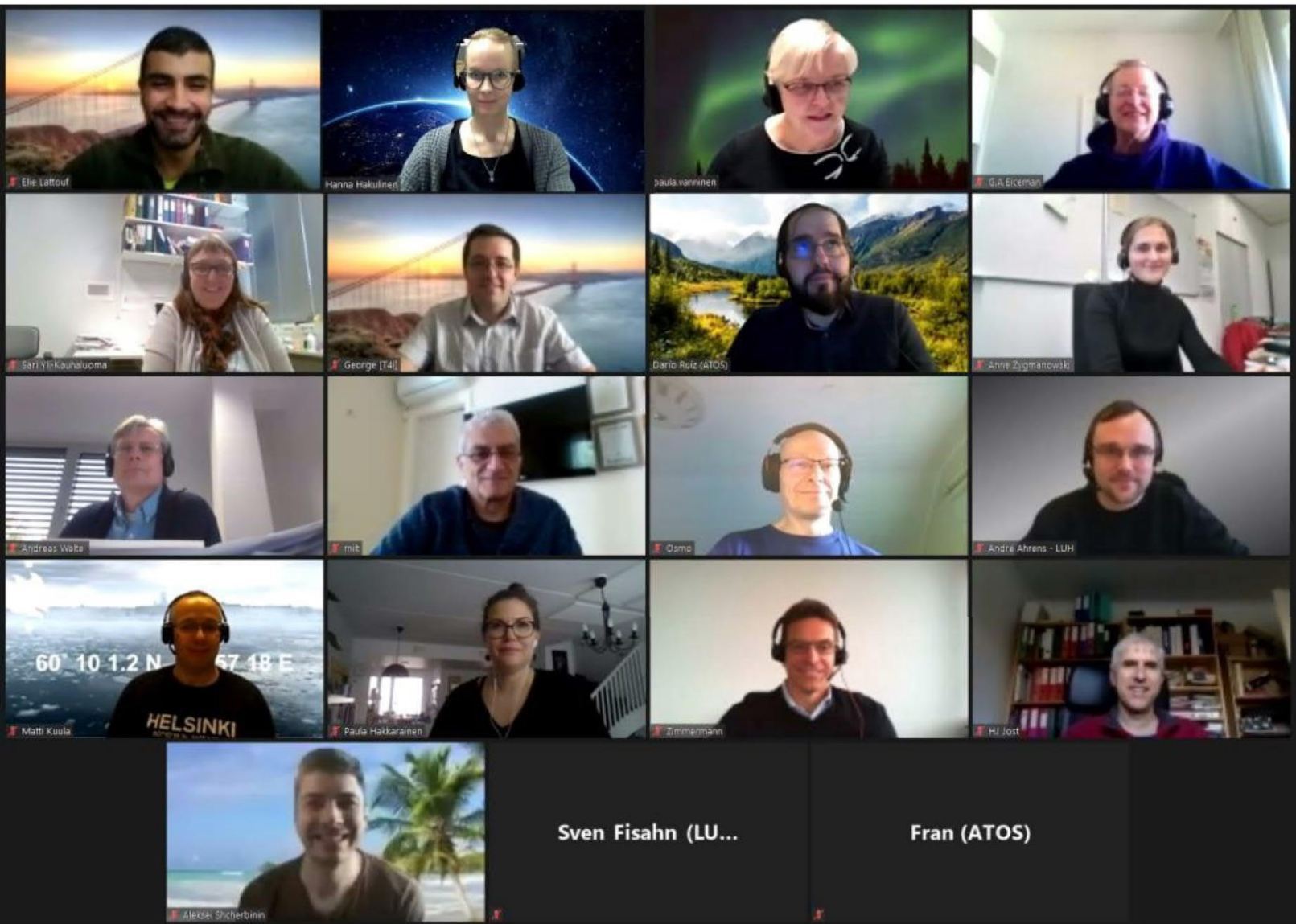
UNIVERSITY OF HELSINKI

VERIFIN FINNISH INSTITUTE FOR VERIFICATION OF THE CHEMICAL WEAPONS CONVENTION

2020

ANNUAL REPORT



2020
ANNUAL REPORT

VERIFIN
FINNISH INSTITUTE FOR VERIFICATION
OF THE CHEMICAL WEAPONS CONVENTION
DEPARTMENT OF CHEMISTRY
UNIVERSITY OF HELSINKI

Foreword

The year 2020 will be remembered as the start of the Covid-19 pandemic. It reflected strongly to the operations of VERIFIN by restricting the work performed in the laboratory and shifting the staff to work remotely as much as possible. Remote working affected the personnel differently, some loved working from home and some disliked it. However, VERIFIN adjusted and many new ways to work were developed. Remote Team- and Zoom meetings and face masks became a part of the daily life and new procedures to provide remote training for chemists in various countries were developed and successfully carried out. For me, it has been a great pleasure to see new ways of thinking arise and modes of operation be developed based on the needs that this exceptional situation has brought up. One good example was the Training Course on National Authority and Chemical Databases, which was organized remotely for 13 different time zones and countries from Asia to Central America. The trainees received new teaching material with homework daily, and those materials were discussed the following day. This allowed the participants from multiple time zones to successfully participate in the training.

Until the end of 2020, VERIFIN has trained 1619 trainees from 140 countries. The training has been mainly funded by the Ministry for Foreign Affairs of Finland and the Organization for Prohibition of Chemical Weapons Convention (the OPCW). The aim of all training activities is to improve capacity of the laboratories, their technical capability, and understanding of basic chemistry of the chemical warfare agents (CWAs). The ability to perform verification analysis of Scheduled Chemicals of the Chemical Weapons Convention (CWC), as well as other hazardous chemicals is regrettably important. As seen in the light of the recent events - namely the poisoning attacks in Malaysia, United Kingdom, and Russia, knowledgeable personnel and high-quality analytical instrumentation in the laboratories is essential. The capacity building of selected laboratories does not only help them in verification of the use of CWAs, but also in other fields of analytical chemistry related to food and environmental safety, thereby enhancing peaceful uses of chemistry. As stated often, training women is extremely important to enhance capacity of the developing countries.

Research is one of the basic pillars for our verification laboratory and training activities. It is challenging to secure funding for research, therefore collaboration with international partners is essential. During 2020, VERIFIN was part of three large EU-research projects related to safety and security. EuroBioTox is a European programme for the establishment of validated procedures for the detection and identification of biological toxins (www.eurobiotox.eu), in which the role of VERIFIN is in analysis of saxitoxin and ricin, as well as training. The goal of DAIMON, Decision Aid for Marine Munitions, and its successor DAIMON2, is to solve the problem of underwater munitions (www.daimonproject.com). New target chemicals from sediment samples have been identified, and those will be added to the list of target chemicals in coming years. Novel methods have been developed and published for aquatic biota samples. Numerous samples have been analysed, and it has been shown that CWAs accumulate in aquatic biota. Further research is needed to deeply understand and characterize biotransformation of CWAs in aquatic species. Another essential task is to determine toxicities of novel identified molecules to enable risk assessment of CWAs to aquatic biota and humans. This work will continue in the WARTOX project, funded by Academy of Finland, starting in 2021. In the new EU FET Open GIDPROvis-project

(www.GIDPROvis.eu), two original technologies introduced in GIDPROvis enable molecular augmented reality where dynamic data for volatile chemicals in air are projected live onto human vision. Radically new chemical analysers based on Gas Ion Distillation (GID) and Sequential Ion Processing (SIPRO) will be designed and engineered to separate mixtures in ambient atmospheres and identify components making the unseen world of molecules visible. While GIDPROvis is principally technology driven, aspects of emotional responses of humans to massive access to chemical information, impacts from these perceptions and human psychology will be explored in simulated, controlled visual experiences of chemical auras. Our aim is to launch a fourth generation of methodology for chemical analysis aligned intrinsically to 5G and IoT communication with miniaturized, ultra-low detection level, live data analysers to detect and identify chemicals in complex matrices. This innovative project complements the VERIFIN team with modellers, engineers, and social science experts, thus bringing the excitement among the whole team.

In 2020, the designated laboratories of the OPCW faced a new challenge when more than thousand new chemicals were added to the Annex on Chemicals in Schedule 1 of the CWC. This means enormous additional workload for the designated laboratories. VERIFIN will develop new methods and also test the existing Recommended Operating Procedures (ROPs) for their analysis. We aim to update the Blue Book in 2023 if we get support from other designated laboratories.

In 2020, VERIFIN's researchers have been focusing on understanding what a designated laboratory can do to help with investigations of allegation of use of CWAs in the framework of chemical forensics and attribution. Our aim is to create a knowledge base to focus VERIFIN's activities in this area of research. International cooperation, coordination, and harmonization are needed, but cannot be executed without considerable increase in funding and resources, as the task to develop the methods alone will be too extensive for any single country. This work will continue in years to come.

Finally, I want to express my gratitude to our personnel and colleagues worldwide for successfully getting through the exceptional year of 2020. Together we will continue the important research and training activities in the middle of these changing times.

Photo: UH

Professor Paula Vanninen
Director of VERIFIN

VERIFIN: Research and chemical disarmament

The Chemical Weapons Convention (CWC), which came into force in 1997, has until the end of 2020 been ratified by 193 countries, the State Parties of the Convention. The ultimate goal of the CWC is a world free of chemical weapons. This includes elimination of an entire category of weapons of mass destruction leading to total chemical disarmament, which must be fulfilled by each State Party to the Convention. The implementation of the Convention is coordinated by the Organisation for Prohibition of Chemical Weapons (the OPCW). Essential part of the CWC is the so-called verification annex, which sets out all of the detailed procedures and control measures including chemical methods for analysing the presence or absence of chemicals banned by the CWC in different types of samples. The Finnish Institute for Verification of the Chemical Weapons Convention (VERIFIN) has actively developed up-to-date methods for reliable analysis of CWC-relevant chemicals more than 40 years.

Essential part of scientific research is modern high-performance instrumentation and internationally recognized national accreditation to guarantee the quality of analytical results. VERIFIN has accreditation to perform analysis for biomedical specimens, as well as material and environmental samples, and is one of the qualified laboratories designated by the OPCW to receive and analyse samples from conflict areas. The instruments located at the Department of Chemistry have been successfully utilized by VERIFIN's competent personnel in scientific research, and they provide good capacity to analyse wide variety of samples in international research projects. However, to maintain the high level of performance in the future, investments for new up-to-date instrumentation capable of solving the foreseen analytical problems will be required regularly. Current and future equipment allow VERIFIN to maintain its position as a high quality designated and research laboratory amid newly emerging challenges, including development of methods for chemical forensics investigations.

The OPCW executive council agreed to add two families of highly toxic chemicals, including the agent used in Salisbury, so called Novichok, into Schedule 1 chemicals under the CWC in 2019. Shortly after this amendment was realized in June 2020, another violation against the Convention took place when Russian opposition leader Alexei Navalny was poisoned with a compound belonging to the Novichok-family. The inclusion of large number of new compounds to the Convention poses new challenges in their analysis and identification, and VERIFIN is in the frontline building preparedness for dealing with the newly scheduled chemicals and the serious threats they pose.

In recent years, the good reputation of VERIFIN has been demonstrated best by partnerships in various multinational long-term research projects funded by European Union and bilateral training programs with several African, Asian, and Middle-Eastern countries funded by the OPCW and US Department of State under their Chemical Safety and Security programs. During the exceptional times due to the Covid-19 pandemic, VERIFIN has successfully adjusted its training programs to facilitate remote learning, thus ensuring continuation of the important collaboration between selected countries.

I am convinced that VERIFIN and the Department of Chemistry will continue to profit from each other's expertise and I strongly believe that VERIFIN will continue its valuable work as a leading laboratory in research and training to support the chemical disarmament to reach the goal of world free of chemical weapons.

Photo: UH

Sari Lindblom
Rector of the University of Helsinki

Need to Reaffirm Universal Commitment to the Chemical Weapons Convention

The Chemical Weapons Convention (CWC) entered into force in 1997. It is widely considered as the most advanced disarmament agreement. The CWC aims to eliminate an entire category of weapons of mass destruction by prohibiting the development, production, acquisition, stockpiling, retention, transfer or use of chemical weapons by States Parties. The CWC has far-reaching verification procedures and with its 193 States Parties it has almost universal applicability.

The Organization for the Prohibition of Chemical Weapons (OPCW) was established to support States Parties to implement the provisions of the CWC. OPCW Technical Secretariat is well-known for its strong technical expertise, professionalism, impartiality, integrity, and competent work that it often undertakes in challenging political and security environment.

Currently we witness a growing pressure on mutually accepted global norms, principles, and agreements, which undermines the rules-based international system. This is reflected in the Chemical Weapons field by a dangerous erosion of the universal norm against the use of chemical weapons. Chemical weapons have been used in numerous occasions in conflict settings in Syria. Since 2017, a chemical weapon has been used at least three times outside of military settings, the most recently in August 2020 when Alexei Navalny was poisoned with nerve agent “Novichok” in Russia. All uses of chemical weapons constitute a blatant breach of international law and seriously undermine the rules-based international order that all states depend upon.

Our most urgent priority is to restore the respect for and preserve the integrity of the norm against the use of chemical weapons, and to ensure that those that violate it are held to account. Work towards this aim is already ongoing within the OPCW. Reinforcing the capacity of the OPCW to identify the perpetrators of the use of chemical weapons is a first, important step in combatting impunity for these abhorrent crimes.

In January 1993, Finland was among the first countries to sign the CWC, and in 1994, VERIFIN, the Finnish Institute for Verification of the Chemical Weapons Convention, became the National Authority of Finland, as required by the Convention. The most recent Government Report on Finnish Foreign and Security Policy underscores adherence to arms control agreements. The report states that the most important methods for enhancing the arms control system include supporting the implementation of agreements, securing the functioning capacity of the treaty organizations, and reacting to breaches of agreements. The report highlights the important role that VERIFIN plays in the implementation of the CWC all around the world.

VERIFIN has been instrumental in increasing the awareness and supporting the implementation of the Convention in developing countries with financial support from the Ministry for Foreign Affairs. Since 1990 VERIFIN has built capacities of laboratories in developing countries and trained almost 1600 chemists from 138 countries.

Finland and VERIFIN will continue their active engagement in chemical disarmament and non-proliferation, striving towards the ultimate goal – a world free of chemical weapons.

Photo: MFA

Kai Sauer
Undersecretary of State
Ministry for Foreign Affairs of Finland

Life continues

Owing to the pandemic, the past year has been seemingly very quiet in Kumpula campus, including the Department of Chemistry. However, remote teaching has functioned very well, teaching laboratories are open, and the safety instructions created for our teaching laboratories are widely utilized around the University. VERIFIN, which is a part of the Department of Chemistry, has been fully active during the unexpected Covid-19 time and has successfully transferred to remote training of chemists worldwide. An important Horizon 2020 FET-Open funding was received for a GIDIPROvis project, led by VERIFIN. This is the first time for the University of Helsinki to receive this highly competitive funding. In GIDPROvis, two original breakthrough technologies - Gas Ion Distillation (GID) and Sequential Ion Processing (PRO) - provide live visualization (vis) of volatile chemicals in ambient environments giving humans access to the previously unseen world of chemicals.

The Organisation for Prohibition of Chemical Weapons (OPCW) coordinates the implementation of the Chemical Weapons Convention (CWC). The convention came into force in 1997. In 2013, OPCW received the Nobel Peace Prize for its efforts in eliminating chemical weapons. Next year, 2014, the OPCW-Hague Award was established to preserve the legacy of the 2013 Nobel Peace Prize to the OPCW, and the first award was granted to VERIFIN. VERIFIN is a trusted analytical laboratory in the OPCW designated laboratory network, which also trains chemists from several developing countries, strengthening their abilities in analysis of compounds related to the CWC. VERIFIN also takes part in several international and domestic research projects and serves as the National Authority for the OPCW.

The Department of Chemistry is a reasonably big unit in the Faculty of Science, University of Helsinki. The number of employees is around 200 of which 17 are professors. We have been continuously recruiting new professors. A call for a new professorship, professor of synthetic chemistry, was recently closed with 81 applicants. Professor positions in analytical and physical chemistry will be opened soon, as well as a professorship in radiopharmaceutical chemistry. In spite of the economically challenging years, we have been able to maintain high quality of research. With new young professors, the spectrum of research topics is widening. Chemistry Department is a truly multidisciplinary institute. VERIFIN actively seeks collaboration with different subunits of the department.

The research facilities in the Department of Chemistry are of high quality. In a recent research evaluation conducted in the whole University, the societal impact of the Department was rated excellent, owing to its ambition to serve society. Active collaboration with industry, as well as several spin-off companies located in the Department were noticed, as well as the services the unit provides for authorities. VERIFIN contributes strongly to the scientific quality and societal impact of the Chemistry Department.

While the Covid-19 pandemic continues and the society is adapting to the changes it brings, VERIFIN continues on its mission to work towards peaceful resolution of conflicts without weapons of mass destruction.

Photo: UH

Heikki Tenhu
Head of the Department of Chemistry

INTRODUCTION TO VERIFIN

The cornerstones of VERIFIN are
Research, Verification, National Authority, and Training

Mission of VERIFIN

The Finnish legislation (902/2010) and Guiding Rules of VERIFIN define the main tasks of the Institute, which are to:

- act as the National Authority, specified in Article VII of the Chemical Weapons Convention (CWC)[1], for the purpose of cooperation with the Organisation for the Prohibition of Chemical Weapons (OPCW) and the other States Parties to the Convention under the guidance of the Ministry for Foreign Affairs (MFA). The Institute shall provide the MFA with expert assistance in complying with and implementing the provisions of the Convention, and see to the implementation of certain provisions of the Convention in Finland specified by the legislation.
- perform scientific research in its own scope and guide students performing pre graduate and post graduate studies
- perform research to develop analytical methods for the identification of chemicals related to the CWC
- establish appropriate capabilities for teaching of methods and for practical training
- enhance awareness of the CWC
- perform any other tasks delegated to it by the MFA of Finland

In addition, the Institute analyses samples containing chemicals related to the CWC, provides analysis services, gives training to experts from developing and other countries and develops databases on chemicals related to the CWC.

Vision

VERIFIN and its predecessor, the CW-project, have supported chemical disarmament by focusing strongly on analytical chemistry to develop tools for verification of the CWC. Methods for screening and identification of chemical warfare agents, their degradation products/metabolites, and starting materials (covering thousands of chemicals) have been developed over the years. Different matrices, including soil, air, water, decontamination solutions and biological matrices have been intensively studied. The results, published as the Recommended Operation Procedures (ROPs) and other guidelines for on-site and off-site analysis, assist the OPCW in its verification tasks. These ROPs have been updated as result of international collaboration projects; the latest Blue Book was published in 2017. The ROP methods are intended as a basis for accreditation and serve as guidelines for the designated laboratories of the OPCW or the laboratories seeking for designation. The ROPs are meant to be used in training of personnel working in the field of verification of chemical warfare agents (CWAs). The Blue Book also includes protocols for analysis of biomedical and sediment samples, and for analytes like ricin and Central Nervous System (CNS) acting chemicals such as fentanyl. The analytical methods for biomedical samples have been successfully utilized in analysing samples from victims who have been exposed to chemical warfare agents during attacks in Syria. Current and future endeavours are focusing on advancing the field of chemical forensics by developing chemical methods for

[1] Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction

attribution analysis, with a goal to find the perpetrators violating the CWC.

VERIFIN shall continue its important research in development of screening and identification methods for new potential toxins of synthetic or biological origin for analysis of environmental and biomedical samples. Main emphasis is on novel scheduled chemicals, which were included in the CWC in June 2020. Additionally, VERIFIN will continue carrying out evaluations of analytical methods for verification of riot control agents and CNS acting chemicals. The search for funding for development of attribution analysis capabilities is ongoing.

VERIFIN first received its designated laboratory status in 1998 for analysis of environmental samples. The objective of the Institute is to retain its status as a designated laboratory. The criteria for designation include requirement of an accredited quality assurance system and successful performance in the official interlaboratory proficiency tests organized by the OPCW. In 2016, VERIFIN's documentation was widened to biomedical samples and FINAS enlarged the scope of accreditation to cover also biomedical (urine and blood) samples. Evaluation according to the updated version ISO/IEC 17025:2017 took place in 2019 and FINAS performed the assessment for renewal of the accreditation remotely in May 2020. VERIFIN's management is committed to the abovementioned objective by supporting the development of the Quality System, by supporting good professional practice at the Institute, and by supporting development of testing procedures and client services. The management shall ensure that the staff achieves and maintains the necessary professional skills and competence, has the technical resources necessary, and maintains the work motivation needed to implement the quality policy. The high level of service for customers (e.g. OPCW) will be maintained at least at the same level as before. The expertise of the staff is established, maintained, and enhanced by in-house research activities to improve the existing methods and to develop new techniques for verification tasks. International collaboration between laboratories with similar interests, actively participating in the work done by the OPCW, and continuous training of the personnel will sustain the high level of competence at VERIFIN.

VERIFIN shall provide the MFA with expert assistance in complying with and implementing the provisions of the Convention by acting as National Authority and seeing to the implementation of certain provisions of the Convention in Finland.

VERIFIN is actively searching for collaboration and integration with international and national networks (e.g. national Chemical Threats Expertise Centre, national CBRNE-collaboration forum) for security purposes and for chemical disarmament. The goal of collaboration and networking is to improve preparedness for various chemical threats, including industrial accidents and accidents related to terrorism. The EU-funded TOXI-triage project (2015-2019) serves as an excellent example of an international, multi-disciplinary program where the aforementioned goals were at the core of the collaborative undertaking.

The training provided for chemists and other experts from developing countries serve as a tool to support the Finnish Government and its goal for the universal adherence of chemical disarmament, especially national implementation of the CWC. These are crucial elements in disseminating the expertise and knowledge and thereby act as security benefits of the Convention. These activities promote disarmament by enhancing capabilities and expertise related to chemical warfare agents, their chemistry, and verification analysis by training experts in the field of analytical chemistry. VERIFIN also offers

training for National Authorities. This shall improve the awareness of risks and threats posed to international trade and future developments in chemistry, and thereby promotes the development of world free of chemical weapons.

Photo: VERIFIN

Proficiency Test Course for Nigeria and Kenya at VERIFIN, 14.2.2020

RESEARCH

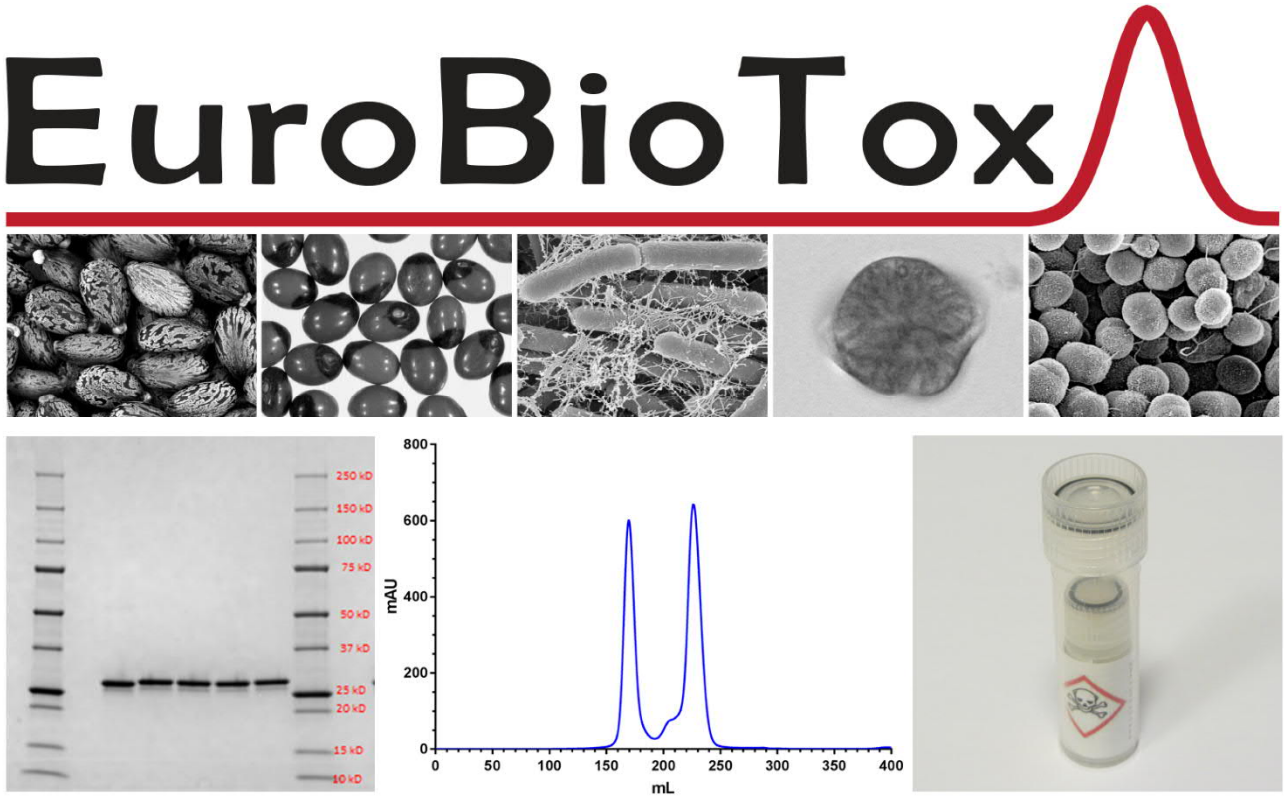
International Collaboration

EuroBioTox

The development and validation of quantitative methods for ricin and abrin toxins and saxitoxin are on research focus of the Institute. The former EU project, EQuATox conducted during 2012–2014, has strengthened the capacity of the Institute for analysis of these biotoxins. The EQuATox consortium also showed that there is a lack of robustness in European preparedness for biotoxin incidents and highlighted the need for a laboratory network to spread the information about available methods and reagents. The five-year Horizon 2020 project "European programme for the establishment of validated procedures for the detection and identification of biological toxins" (EuroBioTox) started in June 2017 and covers five toxins: saxitoxin, ricin, abrin, botulinum neurotoxin, and staphylococcus enterotoxin B.

The project will produce certified reference materials and reagents, and organize trainings and proficiency tests. In 2020, the second proficiency test for STX was organized by VERIFIN. The project is coordinated by Robert Koch Institute (RKI) in Germany. Thirteen institutions from seven countries are core members for this project. Additionally, the EuroBioTox network involves a total of 60 institutions from 23 countries. Dr. Anne Puustinen from VERIFIN is the coordinator of the training work package of the project. The practical training courses aim to increase the technical capabilities of the laboratories for the analysis of biotoxin samples through exchange of knowledge, networking, improvement of technical capacities, and harmonization of analytical methods.

EuroBioTox This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 740189



DAIMON 2

Decision Aid for Marine Munitions: Practical application (DAIMON 2) is the continuation of DAIMON (2016-2019) and CHEMSEA (2011-2014) projects. In the DAIMON project, an intelligent decision support system (DSS) was developed for efficient management of the ammunitions (both chemical and conventional) and the dumping sites. VERIFIN's role was to develop and optimize methods for analysis of CWA's and toxic explosives related chemicals from sediment and pore water samples. Additionally, sophisticated high-resolution mass spectrometry techniques were developed to identify novel CWA-related chemicals from sediment samples. VERIFIN also developed novel analytical methods for CWA related chemicals in fish and mussel tissues, as well as in in vitro metabolism studies with fish hepatocytes. In the ongoing DAIMON 2 project, the DSS will be made available to authorities dealing with the implications of the munitions dumped in the Baltic Sea. DAIMON 2 offers training in using the new tools and develops them further into standard operating procedures (SOP's) for the environmental impact assessment. The DSS will be promoted in a series of stakeholder events and trainings based on real-life scenarios created by DAIMON 2 experts. VERIFIN leads the collection of the SOPs (WP3) and participates in the DSS trainings, which will be arranged remotely due to the Covid-19 pandemic.

daimon
Decision Aid for Marine Munitions
PRACTICAL APPLICATION

EUROPEAN REGIONAL DEVELOPMENT FUND
EUROPEAN UNION

GIDPROvis

GIDPROvis (Gas Ion Distillation and Sequential Ion Processing Technologies for Identification and Visualization of Chemicals in Airborne Vapours) is a project funded by the EU's Horizon 2020 FET Open programme, where novel detector technology is to be developed by a consortium coordinated by VERIFIN. This is the first time for the University of Helsinki to receive this highly competitive funding. GIDPROvis was kicked off in October 2020 and Professor Gary Eiceman, a world leader in development of ion mobility technology, has joined the VERIFIN team as a co-leader of the highly anticipated project. In GIDPROvis, two original breakthrough technologies - Gas Ion Distillation (GID) and Sequential Ion Processing (PRO) - provide live visualization (vis) of volatile chemicals in ambient environments, providing humans access to a previously unseen world of molecules. Molecular auras in GIDPROvis are delivered by small, portable GIDPRO analysers based on high speed separation of ions derived from individual chemicals and their identification using an emerging generation of ion analysers. While GIDPROvis is principally technology driven, aspects of human emotional responses to massive access to chemical information, impacts from these perceptions, and human psychology will be explored in simulated, controlled visual experiences of chemical auras. In addition to ground-breaking research goal, GIDPROvis project has committed to engaging young generations, and these activities are well underway as two high school students from the Normal Lyceum of Helsinki joined the project in late 2020.

GIDPROvis

This project has received funding from the European Union's Horizon 2020 FET Open programme under grant agreement No [899261]

WARTOX

The WARTOX project (Chemical warfare agents in the Baltic Sea: biotransformation products and their toxicity) is a joint consortium project funded by the Academy of Finland. The key partners in the project are VERIFIN and SYKE (Finnish Environment Institute). WARTOX builds on previous projects (CHEMSEA and DAIMON) regarding the historical dumping practices of CWAs in European coastal waters. Studies carried out during the past 15 years have proven that corroded munitions containing CWAs are leaking and therefore causing potential risk to the marine environment. Thus far the research in the marine environment has focused only on intact and primary degradation products of toxic phenyl arsenic CWAs and sulphur mustard. In order to make comprehensive risk assessments, total chemical burden and characteristics of dumped CWAs and their degradation products must be known. An essential scientific aim of this study is to identify yet unknown CWA-related chemicals produced by Baltic Sea sediment microbiota. These chemicals have most likely significant impact on total CWA burden in marine environment. For environmental risk assessment, key information on bioaccumulation, toxicity thresholds and biological effects of these biodegradation products in aquatic organisms are provided by this project. Microbial community changes and biotransformation pathways are identified by amplicon sequencing, metagenomics and -transcriptomics in CWA contaminated sediments and CWA-spiked reference sediments sampled from the Baltic Sea. The biotransformation products are identified by using sophisticated structure elucidation methods in sediments and aquatic organisms. Fish cell line assays will be used to study cytotoxicity and cellular metabolism. Toxicity, bioaccumulation and sublethal biological effects will be evaluated using standard invertebrate and vertebrate biotest organisms. The expected results include an updated list of the target chemicals to be used in monitoring as well as toxicity thresholds for risk assessment. The societal aim of the project is to increase public awareness of sea-dumped munitions and to disseminate the project results to authorities and decision makers dealing with dumped munitions via internationally established networks, including input to a dedicated decision support system; national authorities responsible for maritime spatial planning such as granting permissions to various construction activities can utilize the data produced in the project in the decision making processes.

Other projects

VERIFIN collaborates also with Swedish Marine Monitoring AB. Marine Monitoring has provided VERIFIN marine biota samples collected from warfare dumping site in order to study possible contamination with chemical warfare agents and explosives. The project started in December 2017 and continued in 2020.

VERIFIN has also continued analysis of sediment samples from the Baltic Sea for Nordstream II project during 2020.

Chemical Forensics

Investigation and Identification Team (IIT) of the OPCW was launched after a decision adopted by the CSP of the OPCW in June 2018. Its mandate is to identify the perpetrators of the use of chemical weapons in specific incidents in Syria. IIT is an investigative team within the OPCW TS and it will issue report(s) with its factual findings to OPCW EC and to UNSG for their consideration. IIT is not an international tribunal or a law-enforcement agency.

VERIFIN has been part of the Chemical Forensics International Temporary Working Group (CFITWG) since 2017, and activities initiated within the working group continued during 2020, including

close collaboration with the Swedish Defence Research Agency (FOI) and others. The goal is to advance knowledge and create means for attribution analysis to eventually allow for perpetration of CWA related incidents. VERIFIN is committed to assist the OPCW in enhancing the technical capabilities and assessing the gaps in analytical requirements, and is actively participating in collaborative ventures, e.g. creating and testing quality control measures for attribution analysis and surveying the current capabilities of the designated laboratories to perform analyses relevant for chemical forensics.

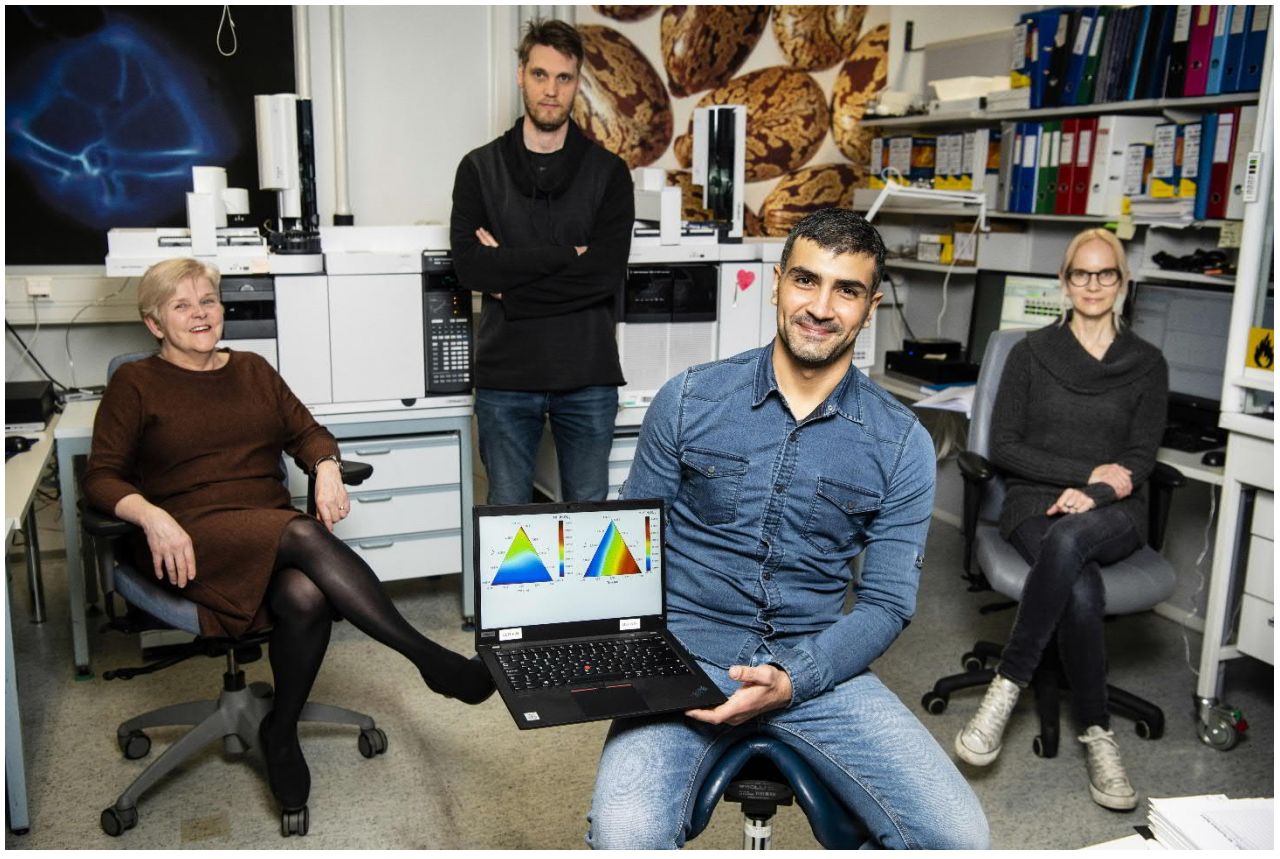


Photo: Veikko Somerpuro, UH

VERIFICATION

Accreditation

VERIFIN was accredited by FINAS (Finnish Accreditation Service) for the first time in 1996 according to EN45001 and ISO Guide 25 and in 2001 according to SFS-EN ISO/IEC 17025. The accreditation according to the standard SFS-EN ISO/IEC 17025:2005 was gained in 2007. Evaluation according to the updated version ISO/IEC 17025:2017 took place in 2019. VERIFIN is the accredited testing laboratory T073. The current scope of accreditation is "Verification of chemical weapons (flexible scope): Environmental testing, material and product testing and clinical testing" and it covers also biomedical samples (blood and urine). Accredited laboratory is committed to keep up and continuously improve its quality system that FINAS assesses regularly. Laboratory's fulfilment of the requirement of ISO/IEC 17025 means that the laboratory meets both the technical competence and management system requirements that are necessary for it to consistently deliver technically valid test results. FINAS performed the periodic visit in February 2019; six minor deficiencies from the Quality system were made. The current accreditation is valid until 25.10.2020. The visit for renewal of the accreditation will take place in May 2020.

Designated laboratory

VERIFIN has OPCW designation for both environmental and biomedical samples. The latter was received in 2017 after the Second Official OPCW Biomedical Proficiency Test (PT) among the first laboratories designated for these samples. In 2019, VERIFIN assisted the OPCW in analysis of authentic environmental samples.

As a principle, VERIFIN tries to participate in all proficiency testing programs relevant to the scope of its accreditation. In addition to the official PTs, VERIFIN also participates to the optional trace-test organised parallel with the environmental tests. The goal of the trace-test is to survey the abilities of the participating laboratories to analyse samples of very low concentrations. In 2019, VERIFIN also participated in a PT for analysis of biomedical samples.

In order to improve and expand the capabilities to analyse all CWC related chemicals, VERIFIN was a partner in the EQuATox project run from 2012 until 2014. In this project, PTs for both ricin and saxitoxin were arranged in 2013. VERIFIN has participated in four biotoxin confidence building exercises organised by the OPCW and will participate again 2020. In 2018, EuroBioTox – an EU project VERIFIN is a partner in – started a series of toxin PTs. In 2018 and 2019, VERIFIN participated in PT for ricin identification.

FINAS
Finnish Accreditation Service
T073 (EN ISO/IEC 17025)

ilac-MRA

OPCW Expert Groups

Experts of the Institute participated actively in the work of the validation groups for acceptance of spectrometric data into the OPCW Central Analytical Database (OCAD).

Cooperation between authorities

Centre of Expertise on Chemical Threats

Finland also seeks improvements for its response to chemical threats, be they weapons-related or other. In Finland, the different actors responsible for chemical threats preparedness and mitigation have joined their forces and established the Centre of Expertise on Chemical Threats, in which VERIFIN is an expert institute on chemical warfare agents' related analysis. The Centre functions as a cooperation network of key stakeholders, including expert institutions and relevant ministries. It coordinates and supports training, research and expert advice. It also provides a 24-hour emergency service that helps responsible authorities in identifying chemical dangers and assessing their consequences. This arrangement helps the use of Finnish scarce resources and thus enhances preparedness to act.

The partners are:

- Finnish Institute of Occupational Health (TTL)
- Finnish Food Safety Authority (Evira)
- VERIFIN
- Ministry of Defence / Defence Forces
- Ministry of the Interior
- National Supervisory Authority for Welfare and Health (Valvira)
- Ministry of Social Affairs and Health
- National Institute for Health and Welfare (THL)
- Finnish Safety and Chemicals Agency (Tukes)
- Ministry of Economic Affairs and Employment
- Poison Information Centre
- Helsinki Police Department
- Helsinki Rescue Department
- National Bureau of Investigation (KRP)
- Ministry of Transport and Communications / Finnish Transport Safety Agency (Trafi)
- Finnish Environment Institute

Finnish Institute for Occupational Health is coordinating the work.

Finland's first national CBRNE Strategy

The Ministry of the Interior has published the first national CBRNE Strategy which aims to prevent the misuse of chemical substances (C), biological pathogens (B), radioactive material (R), nuclear weapons (N) and explosives (E).

CBRNE threats may include the transport, use, possession and storage of hazardous substances. As a general rule, preparedness measures are the same, regardless of whether the incident is unintentional or intentional. However, the Strategy focuses more on CBRNE threats arising from deliberate intention to cause harm. One possible threat situation is the use of CBRNE substances in terror attacks.

The Strategy was prepared by a broad-based working group consisting of representatives from the Ministry of the Interior and several other ministries, central government agencies and the operational security authorities responsible for CBRNE matters, such as the police, rescue departments, the Defence Forces and Customs. A number of industrial enterprises and sectoral organisations also took part in the preparation of the Strategy. VERIFIN also participated actively in this work.

NATIONAL AUTHORITY

OPCW Declarations, Inspections, and cooperation with other National Authorities

The institute is responsible for carrying out all practical duties concerning the tasks defined by the CWC for a National Authority. These include informing the chemical industry on the obligations of the CWC, collecting the data of annual activities under the CWC, preparing national declarations for the OPCW, and escorting OPCW inspection teams during inspections.

The institute maintains a database on Finnish chemical enterprises and companies. Currently this database contains information on 1892 enterprises. In the beginning of 2020, inquiries were sent to 31 enterprises on the activities relevant to the CWC. According to the received answers, 18 enterprises processed, consumed, imported, or exported Schedule 2 or Schedule 3 chemicals. Twelve (12) Other Chemical Production Facilities (OCPF plants) produced discreet organic chemicals (DOC) over the declaration threshold of 200 tons of total annual production.

The annual declarations of the declarable past activities under the CWC were compiled according to the answers received, and they were delivered to the OPCW within the deadline of March 2020.

The inquiries of projected activities under the CWC for the year 2021 were sent to relevant enterprises in August 2020, and the corresponding declarations were sent to the OPCW within the deadline of September 2020.

During 2020, Finland received one inspection from the OPCW. The inspection was a routine inspection to a Schedule 1 facility.

The regional National Authority meeting of the Nordic and Baltic countries in Finland was cancelled due to Covid-19 pandemic.

Participation in the work of the OPCW

In 2020, VERIFIN participated remotely in all three OPCW Executive Council (EC) meetings and the Conference of States Parties (CSP). Two VERIFIN employees participated in the work of the Validation Group of the OPCW to evaluate new data to be included in the OPCW Central Analytical Database (OCAD).

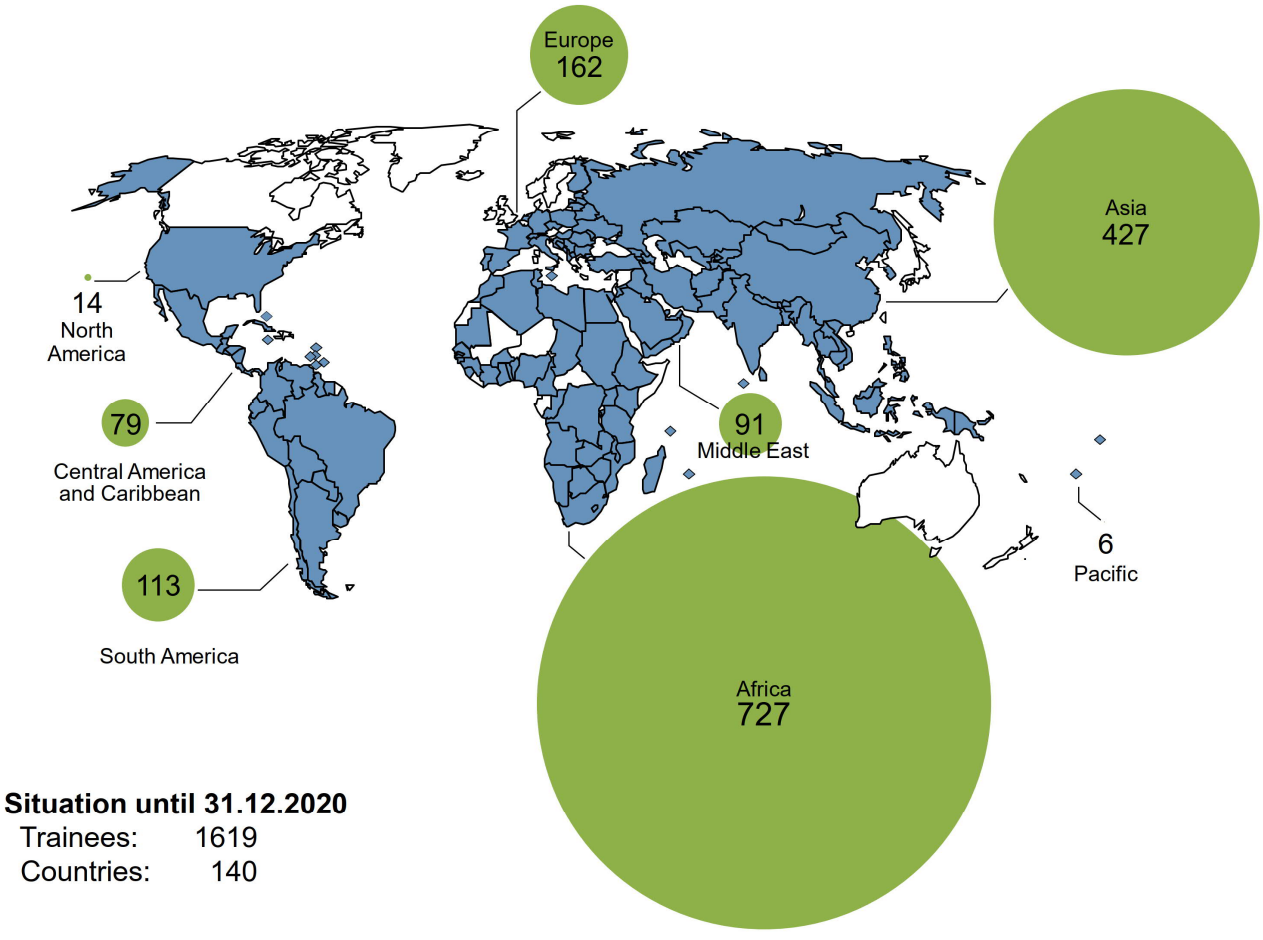
TRAINING

Training courses have been organized by VERIFIN for chemists from developing countries since 1990. The primary funding for these courses is provided by the Department for Development Policy of the Ministry for Foreign Affairs of Finland (MFA). Six training events were arranged in 2020 for 44 participants supported by UM-KEO funding. In total, VERIFIN has trained 1619 experts from 140 countries during 1990-2020. Figure below shows the number of participants and their countries.

UM-KEO training was evaluated last in 2019. The recommendations of the evaluation have been taken into account in the training in 2020 and will also be taken into account in future training.

By the end of 2020, there have been 28 Basic, 15 Advanced, 24 National Authority and Chemical Database (NACD), five Laboratory Exercises (CW-LABEX), 29 Laboratory Skills Enhancement courses (on LC-MS, NMR, Laboratory Quality Assurance and Quantitative Mass Spectrometry), three SIR courses, and nine Assistance and Protection courses. Laboratory Capacity Building Program (LCBP) has been organized in 2012-2020. Additionally, VERIFIN has arranged OPCW analytical inspector training in 1997 and 17 Analytical Skills Development courses in 2006–2017 for the OPCW. VERIFIN has also hosted 20 chemists under the OPCW Fellowship Program. The Analytical Course for the OPCW Africa Program was organized together with the OPCW, Protechnik Laboratories, and VERIFIN in South Africa six times in 2009-2014. In addition to these regular activities, there have been some occasional training events such as the International Workshops in 2003, 2007, 2011, 2015 and 2017 (arranged in Finland) and Expert Assistance Visits to Ethiopia in 2006 and to Malaysia in 2007. Moreover, VERIFIN arranged training to chemists from Qatar (twice in 2009), from Turkey (2014), and Lebanon (2015) with funding from LLNL (Lawrence Livermore National Laboratory) and US State Dept. and from Lebanon in 2015 with funding of US State Department. In 2016-2020 VERIFIN also gave training to experts from Algeria, Lebanon, Turkey, Indonesia, Malaysia, and The Philippines with funding from US State Department. This training was conducted both in the recipients' laboratories and in VERIFIN.

The LCBP and NACD courses are totally covered by the funding from the Department of Development Policy of the MFA. Normally, the OPCW sponsors other courses by funding travel and daily allowances for participants. However, due to the Covid-19 pandemic, all the courses have been conducted remotely in 2020 and there has been no travelling. In most courses, also in 2020, lecturers from the OPCW helped conducting the courses. In addition, representative from the MFA is invited to give a presentation on the Good Governance and Anti-Corruption in the NACD course. In 2020, the lecture from the MFA was sent to the NACD course participants. The whole VERIFIN staff is involved in training activities.



The world map of VERIFIN training (1990-2020)

Impact of the COVID -19 on the Training Activities

The outbreak of the Covid-19 pandemic in spring 2020 had major impact on the training activities. In 2020, all planned training was organized according to a training plan, but virtually in remote mode using Microsoft Teams or Zoom platform. Due to the exceptional training mode, the courses had to be developed almost from scratch. Also, most of the training material had to be revised and modified to fit the remote training requirements. The practical work was replaced with laboratory live demonstrations and various laboratory and written tasks given to the course participants.

Laboratory Capacity Building Programme (LCBP)

In the Laboratory Capacity Building Programme the focus is in enhancing analytical capabilities of certain laboratories. Laboratories commit themselves to the three-year training program and the training activities take place both at VERIFIN and in the recipient laboratory. The LCBP was first arranged in 2012 with laboratories from Ethiopia and Kenya. The contracts with Ethiopia and Kenya were also continued for the period 2015-2017.

Nepal was selected for a new training recipient country in the Laboratory Capacity Building Program for 2018-2020. The training with the Kenyan laboratory continued for the period of 2018-2020.

The training is planned to meet the actual needs of the recipient laboratories. The aim is to enhance the laboratory's

skills to reliably analyse CWC related chemicals from environmental samples and implement the gained knowledge and practical skills also in identifying other types of chemicals. This goal is achieved through a thorough basic training on the characteristics of the related chemicals, sample preparation, gas chromatography (GC), and gas chromatography-mass spectrometry (GC–MS). The course also includes sections on chemical safety and security, laboratory quality assurance, and liquid chromatography-mass spectrometry (LC-MS) if deemed necessary by the recipient laboratory. In 2020, one one-week on-line course was conducted for both Kenya and Nepal. The course for Kenya focused on sample preparation and analysis of pesticides, explosives, and illicit drugs. For Nepal, the main topics were sample preparation and GC-MS analysis of pesticides, reporting the results, and safety and security in the laboratory. In addition, a two-week on-line training course was arranged in November 2020. The course topics were as follows: GC-MS troubleshooting, OPCW reporting, CWA and pesticide chemistry, analysis strategy, calibration, validation, and quantitation, searching for information from open sources, sample preparation, guided GC-MS exercises, data processing (MassHunter, AMDIS), and preparation of a QC-test solution.

Training Course on National Authority and Chemical Databases (NACD)

Two-week NACD course was organized remotely in August 2020 for 13 participants. The course is aimed for persons working at the National Authorities (NA) for the Chemical Weapons Convention (CWC) or persons working closely in cooperation with the NA. The course provides information on starting the NA, on implementing national legislation, and on making declarations including data collection from the industry as well as on how to make practical arrangements for the OPCW inspections and how to escort the OPCW inspection teams. This year, special emphasis was put on the training of the new Electronic Declaration Information System (EDIS). One important aim of the NACD course is to provide an insight into fact-finding from existing databases useful in the work of the NA. The participants were form 13 different time zones and for that reason the on-line course was not sensible. Instead, the course was organized based on self-study modules and exercises related to them.

Laboratory Skills Enhancement Courses (CW-LSE)

CW-LSE courses are intense courses for chemists with recent practical experience on related topic. The aim of these courses is to strengthen the existing capabilities of the participants through theory, practical exercises, and giving insight into the current procedures used at VERIFIN. In September 2020, the CW-LSE courses were organized in parallel for CW-LSE on Laboratory Quality assurance (three participants) and for the CW-LSE on LC-MS (four participants). After negotiations with the OPCW, it was decided to arrange the courses as one-week on-line training courses. It was also agreed with the OPCW, that participants' active participation during the course would guarantee a spot in next year's course held on-site at VERIFIN in Helsinki, Finland, in the fall of 2021 if the COVID-19 outbreak is under control.

Fellowship Programme

During the fellowship project, a research fellow from developing country will be given their own research project at VERIFIN. The funding for the research fellow is received from the OPCW's Fellowship Program. The aim of the program is to assist the research fellow's home institution in the field of analytical chemistry and possibly create a long-standing relationship between the sending institute

and the institute inviting the intern. In order to be able to carry out the project, the research fellow must have sufficient educational background and experience, including adequate English language skills.

The research fellow is given access to methods and resources not available at their own institute and thus they are able to gather new knowledge and expertise and utilize those skills upon their return. These projects also benefit the development of analysis methods at VERIFIN. The research results are always reported to the OPCW. During 2003-2020, VERIFIN has hosted 20 research fellows. Due to the Covid-19 pandemic, no research fellows were selected in 2020.

Proficiency Test Course for Nigeria and Kenya with Funding from the OPCW

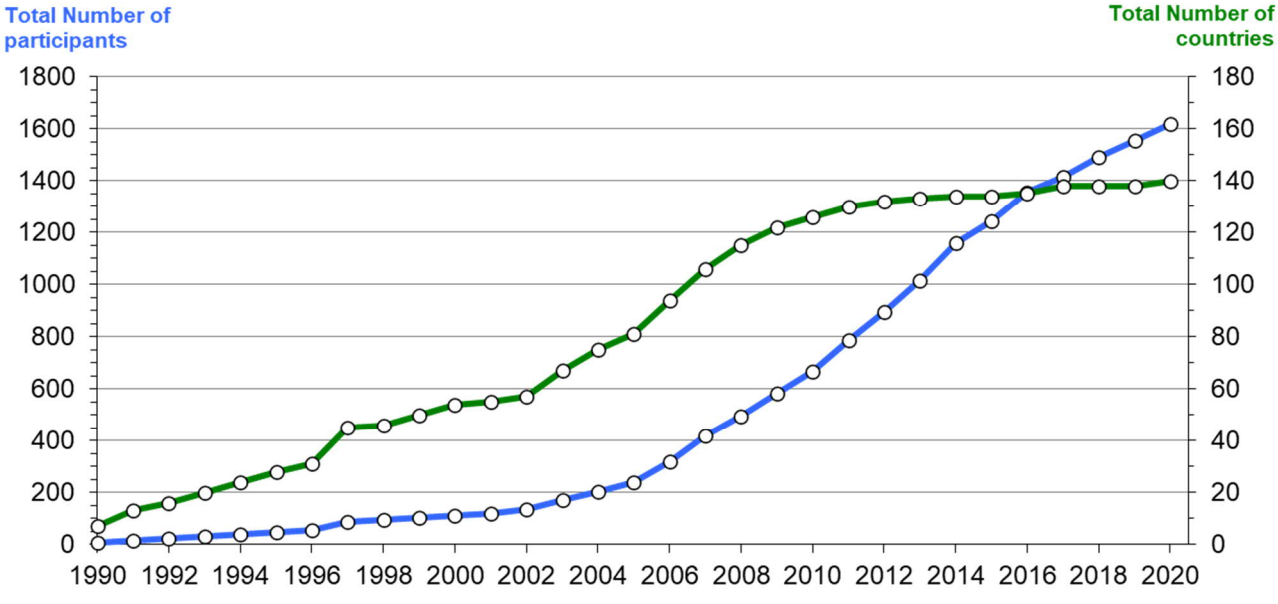
The first course for six Nigerian and Kenyan chemist was held in VERIFIN in February 2020, just before the pandemic outbreak. The OPCW granted a continuation for this training and it was started in remote mode in autumn 2020. The aim of the course is to increase the capacity of the Nigerian and Kenyan laboratories in the analysis of chemical weapons related compounds, so that the laboratories would eventually achieve status of the OPCW designated laboratory. The focus of the training so far has been the analysis of CW related chemicals and OPCW Proficiency Tests.

Training with Funding from US State Department

In 2020, VERIFIN started a new training project with analytical laboratory in Ukraine with funding from US State Department's Chemical Security Program. The project is aimed at strengthening the Ukrainian laboratory's capabilities in analysis of CWC related chemicals in environmental samples. The training will also provide tools for chemical detection, unambiguous identification, and reporting of the results. The focus of this training project is the OPCW proficiency test (PT) process.

EuroBioTox training courses

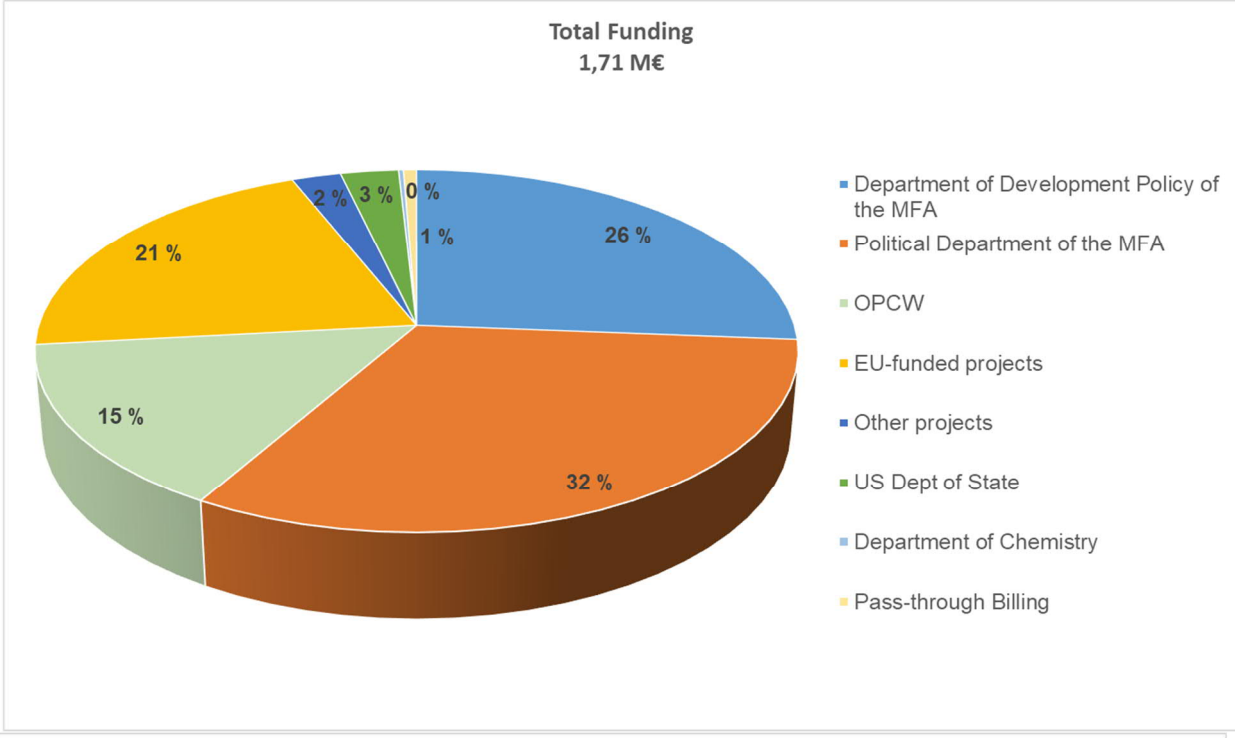
VERIFIN is the leader of the training work package of the EU Horizon 2020 project EuroBioTox: "European programme for the establishment of validated procedures for the detection and identification of biological toxins." All advanced training courses of this project that were planned for 2020 were moved to year 2021.

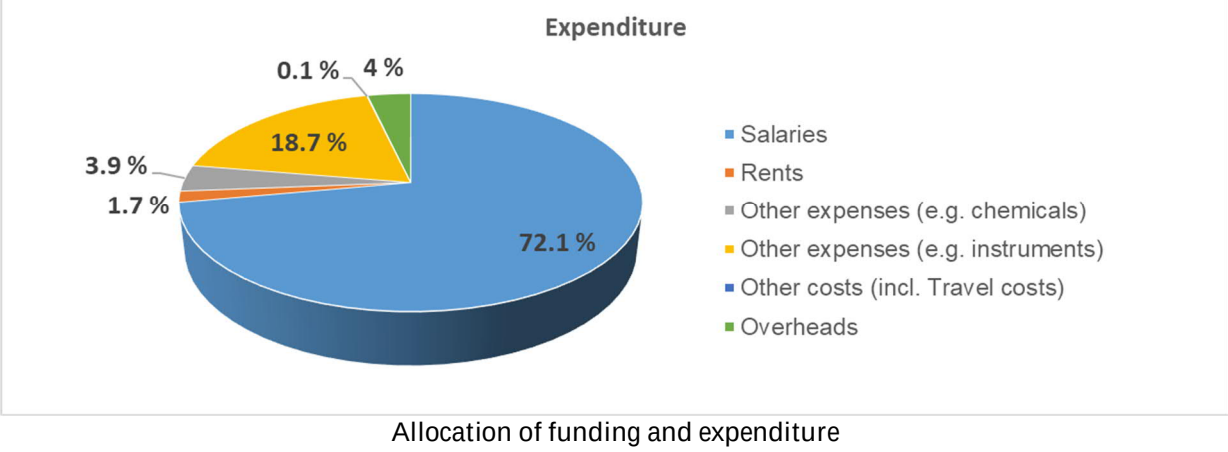


RESOURCES

Funding

VERIFIN is an institute under Department of Chemistry, Faculty of Science of University of Helsinki. In 2019, Institute has been mainly financed (45.6%) by the Ministry for Foreign Affairs of Finland (MFA). Additional outside funding is mandatory and in 2019, VERIFIN has had several collaboration projects with US Department of State, Swiss Spiez Laboratory, the OPCW, and research partners in DAIMON, DAIMON 2, EuroBioTox and TOXI-triage projects funded by EU. Funding from the Department of Development Policy of the MFA has focused on training programmes for the National Authorities and chemists from developing countries.





Allocation of funding and expenditure

Personnel

Director
Vanninen Paula, Professor, PhD

Research Director
Kauppila Tiina, PhD

Laboratory and project managers, chemists, biochemists and laboratory analysts and laboratory engineers
Aalto Sini, MSc
Eiceman Gary, PhD
Hakulinen Hanna, PhD
Heikkinen Harri, PhD
Häkkinen Vesa, MSc
Joutsiniemi Karoliina, PhD
Kiljunen Harri, MSc
Kjellberg Matti, PhD
Kuula Matti
Lattouf Elie, PhD
Minkkinen Niko
Puustinen Anne, PhD
Taure Terhi
Uusalo Reetta
Vesa Terhi
Wilenius Lauri
Yli-Kauhaluoma Sari, PhD

Students
Anttalainen Osmo, Doctoral student, University of Helsinki
Kivinen Anssi, Master student
Niemikoski Hanna, Doctoral student, University of Helsinki
Nurhazlina Hamzah, Doctoral student, University of Helsinki

Administration services
Kumpula Campus University Services

Instrumentation
Agilent GC (3)
Agilent GC-ATD-MS/NPD/µECD
Agilent GC-MS
Agilent GC-MS/MS
Agilent GC-MS/dFPD
Agilent 1200 HPLC-FLD/DAD
Bruker Avance III 500 NMR
Bruker Microflex MALDI-TOF*
Jeol JMS-700 GC–HRMS*
Shimatzu Preparative LC
ThermoFinnigan TSQ Quantum Ultra LC–MS/MS
Thermo Orbitrap Fusion LC-HRMSMS**
Bruker Avance NEO 600 NMR*
Waters Xevo TQD LC–MS/MS
Waters Xevo TQ-XS LC-MS/MS

* owned together with the Department of Chemistry

** owned together with the Department of Chemistry and with the Faculty of Pharmacy

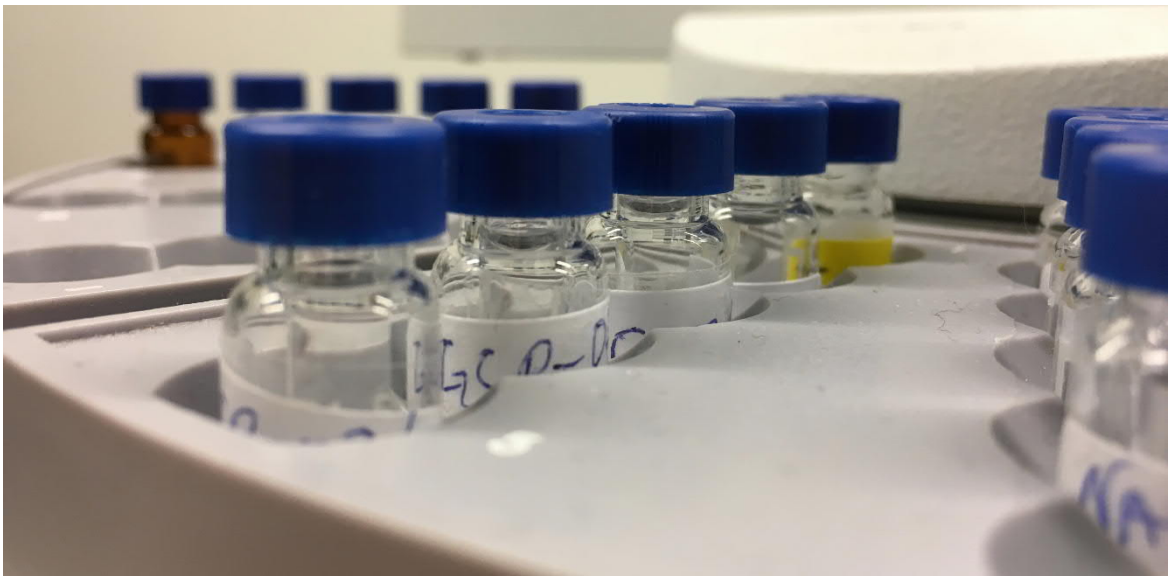


Photo: VERIFIN

Scientific and social interactions

Articles

Koso, T., Rico del Cerro, D., Heikkinen, S., Nypelö, T., Buffiere, J., Perea-Buceta, J.E., Potthast, A., Rosenau, T., Heikkinen, H., Maaheimo, H., Isogai, A., Kilpeläinen, I., King, A.W.T. (2020) 2D Assignment and quantitative analysis of cellulose and oxidized celluloses using solution-state NMR spectroscopy, Cellulose 27, 7929-7953.

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Interactions with the media

Journal entries

Paula Vanninen, Virve Pohjanpalo, Yliopistolehti, 2020
Paula Vanninen, Ville Lehtinen, 25.8.2020, MTV 3
Paula Vanninen, Hannu Aaltonen, STT, 25.8.2020
Paula Vanninen, Jussi Orell, Lännen Media, 28.8.2020
Paula Vanninen, Virpi Niemistö, Lännen Media, 4.9.2020
Paula Vanninen, Laura Halminen, HS, 2020
Paula Vanninen, Marjo Oikarinen, Lännenmedia, 25.9.2020
Paula Vanninen, Tuomas Kangasniemi. Tekniikka ja talous, 29.10.2020

Interviews on TV and in newspapers

Paula Vanninen and Hanna Niemikoski interview by Sisko Loikkanen, YLE Tiedeykkönen, January 2020, "Meriin sodan jälkeen upotetut kemialliset taisteluaineet ovat arvaamaton ympäristöuhka - myrkkyjäämiä löytynyt kalanäytteistä"

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Thesis evaluated at the Institute

Daniel Koske, Doctoral Thesis "Dumped munitions: Effects, metabolism and detection of explosive compounds and chemical war-fare agent-related chemicals in fish from the Baltic Sea", Christian-Albrechts-Universität zu Kiel, 2020.

Anssi Kivinen, Master's Thesis "Analysis of volatile organic compounds from environmental samples with solid phase microextraction arrow and GC-MS", University of Helsinki, 2020.

Matti Kuula, Master's Thesis "Räjähdysaineiden määritys sedimentistä kaasukromatografi-massapektrometrisesti", University of Helsinki, 2020

Tasks in Scientific Organizations and Bodies

Vesa Häkkinen
- Member of the OPCW Validation Group for the MS data for the OPCW Chemical Analytical Database (OCAD)

Harri Heikkinen
- Member of the OPCW Validation Group for the NMR data for the OPCW Chemical Analytical Database (OCAD)

Matti Kuula
- Member of the steering group of the Centre of Expertise on Chemical Threats
- Member of the national CBRNE-collaboration forum

Tiina Kauppila
- Member of CBRNE expert group

Hanna Niemikoski
- Member of the executive committee of Finnish mass spectrometry society

Paula Vanninen
- Member of the Temporary Working Group on Investigative Science and Technology of the Scientific Advisory Board of the OPCW
- Steering committee member of the Defence and medication sub-group of the Scientific Advisory Board for Defence, Finland (MATINE)
- Member of the national CBRNE-collaboration forum
- Member of the CBRNE Strategy working group

HOW TO REACH VERIFIN

VERIFIN is located at the Department of Chemistry in the Kumpula Campus, about 6 km north of the Helsinki city center. Entrance is through the main doors of the Chemicum building. Kumpula Campus is well connected to public transportation (e.g. buses 55, 70, 71, 73, 74, 75, 77 or trams 6 and 8) and the HSL Journey Planner (https://www.hsl.fi/en) can be used to plot the route.

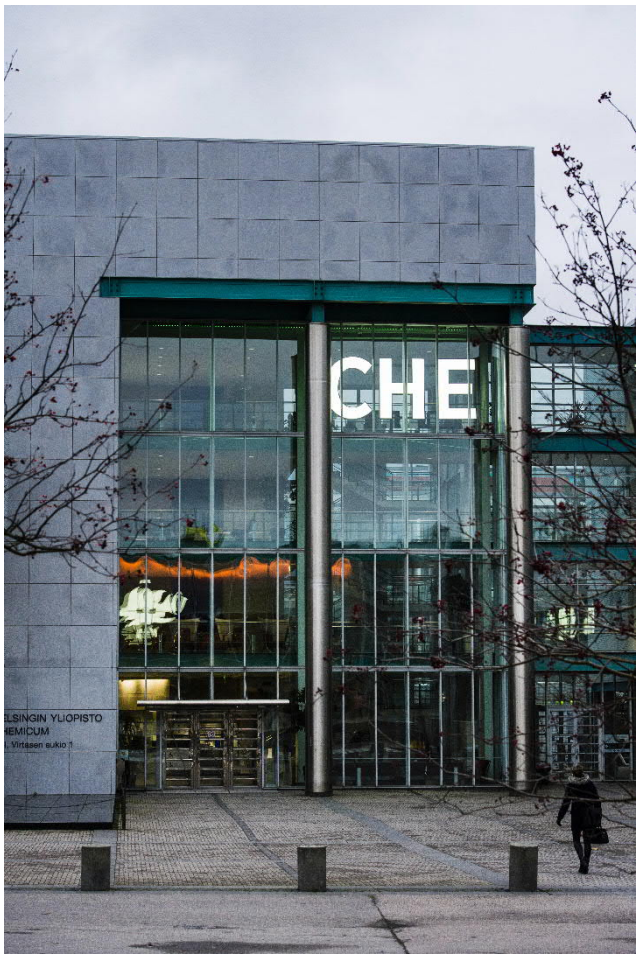

Photo: Veikko Somerpuro, UH

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UNIVERSITY OF HELSINKI

VERIFIN FINNISH INSTITUTE FOR VERIFICATION
OF THE CHEMICAL WEAPONS CONVENTION

Cover photo: Teams capture from GIDPROvis kick-off meeting, UH