Eurachem

WORKSHOP

IN CONNECTION WITH EURACHEM GENERAL ASSEMBLY 2017

"Uncertainty in Qualitative and Quantitative Analysis"

University of Cyprus
Nicosia (Lefkosia), Cyprus

29-30 May 2017

BOOK OF ABSTRACTS

Pancyprian Union of Chemists *Division of Quality Assurance*

in cooperation with

AOAC INTERNATIONAL *EUROPE SECTION OF AOAC INTERNATIONAL*

hosted at

Πανεπιστήμιο Κύπρου
University of Cyprus

https://www.ucy.ac.cy/eurachem2017

Contents

Welcome address

On behalf of the Pancyprian Union of Chemists (PUC) and the Division of Quality Assurance in particular, we would like to warmly welcome you to the Workshop on "Uncertainty in Qualitative and Quantitative Analysis". This opens the "Eurachem Week 2017" hosted in Nicosia, Cyprus. This is the second time the PUC has the honour to invite so many scientists from all over Europe and even further. For the Cypriot Chemists the occasion is important and symbolic because it is related to the 20th Anniversary of active involvement in Eurachem activities. We hope that by the end of the Workshop and the whole Week, the experience will have been as useful and important for all of you as it is for us.

The Workshop has been prepared by the Organising Committee in close co-operation with the Scientific Committee. While the former undertook all practicalities, the members of the latter contributed to the preparation of the programme, undertook the review of abstracts and constantly offered their constructive comments during the whole procedure.

The occasion of the cooperation for the first time with the Europe Section of AOAC International is important; it may indicate the starting point for cooperation on other levels as well. The Workshop is also supported by the Division of Analytical Chemistry of EuCheMS.

From the very beginning the University of Cyprus supported the whole effort; we are proud that the Workshop as well the other activities of the Week are hosted in its campus.

We warmly thank the Cyprus Tourism Organisation and all our sponsors as well as those who supported the organisation of the Workshop and the whole Week in any way; without their support, the activities could not be realised.

Special thanks to the members of the Scientific Committee for their input in the preparation of the documents and the review.

Dr Kyriacos C. Tsimillis
for the Organising Committee

Committees

Scientific Committee

Steve Ellison (UK)
Bertil Magnusson (Sweden)
David Milde (Czech Republic)
Wolfhard Wegscheider (Austria)
Ricardo Bettencourt da Silva (Portugal)
Marina Patriarca (Italy)
Ioannis Paschalidis (Cyprus)
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Eugenia Eftimie Totu (Romania)
Alex Williams (UK)
Vicki Barwick (UK)
Popi Kanari (Cyprus)
Alfredo Montes Nino (Spain)
Hilde Skår Norli (Norway)
Kyriacos Tsimillis (Cyprus)

Organising Committee

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Kyriaki Ioannou
Androulla Hasikou-Constantinides
Lambis Elia
Leontios Philotheou

In Memoriam

The Workshop is dedicated to the memory of Dr Paul De Bièvre (1933-2016) in appreciation of his overall contribution to Metrology in Chemistry and Eurachem activities and, in particular, of his support to training activities in Cyprus.
The late Paul De Bièvre was co-founder of Eurachem (1989) and its Chair during 1993-1995. He was very active in many international activities, fora and institutions dealing mainly with the science of measurement and metrology in chemistry; to mention a few of them: CITAC, IUPAC, BIPM, CCQM, IRMM. Our communication started during the very early stages of the PUC entry in Eurachem where he was invited to give lectures in Cyprus on Traceability in Chemical Measurement. The events were organised by the Cyprus Organisation for Standardisation and Control of Quality (CYS) and the PUC in Nicosia on the 29th February and 1st March 2000. It was the time when Cyprus was preparing to join the European Union and all necessary quality infrastructure had to be completed. Paul De Bièvre strongly encouraged us to take the advantage of existing opportunities for support then provided for candidate countries, indicating that "you have to take steps ahead, the window will not be open for ever!". He was quite right!
Paul visited Cyprus again to participate in the Eurachem General Assembly hosted in Nicosia in May 2002; he was also one of the speakers in the Workshop "Quality Assurance in Testing Laboratories – A need and a challenge" organised in connection with the General Assembly. He presented the topic "The EC support for Metrology in Chemistry to the EU Candidate Countries and the Mediterranean". During that presentation, he emphasised that "measurement results without statements of reliability (uncertainty) should not be taken seriously". This was anyway one of the key issues of interest for Eurachem. 15 years later, during the two coming days, our Workshop is addressing the issue of "Uncertainty in Qualitative and Quantitative Analysis".
During his visit to Cyprus in 2000, Paul, who was accompanied by his wife Lieve, spent a couple of days visiting a number of places in Cyprus. Most probably they did not expect to enjoy that sunny day on the Troodos mountains where the snow was more than 1,5 m high. The couple was very keen to get an overall taste of Cyprus, the environment, the culture, the food, the sunshine. This is why they visited Cyprus again for a holiday...
Since then, we met a number of times, in IRMM on the occasion of training courses, in Eurachem events – the last time was in Lisbon for the General Assembly of Eurachem where all past chairpersons were invited on the occasion of its 25th Anniversary.
Further to personal communication, we were all supported by his publications and later the editorials "food for thought" in ACQUAL where Paul De Bièvre had been the first Editor-in-Chief.



Dr Paul De Bièvre teaches Metrology in Chemistry (Nicosia, February-March 2000)


Paul and Lieve De Bièvre discover Cyprus (Troodos mountains, March 2000)

1997-2017:
Twenty years of active involvement of Cypriot Chemists in Eurachem

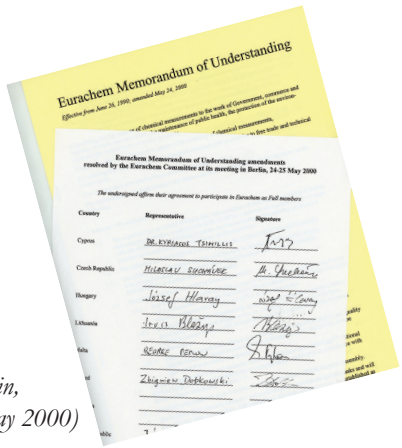
1997-2017:
Twenty years of active involvement of Cypriot Chemists in Eurachem

The 1990's was a very important decade for the laboratory infrastructure in Cyprus; it was the time when new legislation came into force and the laboratory infrastructure started to be extended with more laboratories not only in the public sector but in the private sector as well. In the meantime, some important developments took place; the Customs Union of the Republic of Cyprus with the European Union (1987) followed by the pre-accession period and the hard work to meet the task of accession achieved on the 1st May 2004. Even earlier, quality issues represented a key element in the market, with products and system certification schemes providing an advantage to both products and services. Management systems started to be introduced in many activities with certification as a mail tool, mainly against ISO 9001 standard (later also against ISO 14000 as well). Industry and tourism were the main fields of application while services followed soon thereafter. A series of training activities were carried out mostly by the then Cyprus Organisation for Standards and Control of Quality (CYS) which was later transformed to the Cyprus Organisation for the Promotion of Quality – The Cyprus Accreditation Body (CYS-CYSAB, 2002). The responsibility for standardisation and certification activities was allocated to other bodies namely the Cyprus Standardisation Body and the Cyprus Certification Company; since then, the latter provides certification services, operating as a private company in competition with other local and overseas certification bodies. The market gradually became very demanding.

In the mid - 1990's, CYS supported the establishment of a network of laboratories to facilitate the dissemination of information on quality assurance, testing and related issues. This came after the experience of the first participation in a Eurolab event, namely its Conference hosted in Florence (April 1994). This later led to the establishment of CyprusLab and its membership to Eurolab. A special event on the Accreditation of Laboratories was organised by the CYS and the PUC in October 1996 followed by the first intensive training programme (21 hours) in March-April 1997 (repeated in November 1997) on "Quality Assurance in the Food Industry". In May 2000 the Cyprus Eurachem Committee organised a 24-hour training programme on "Quality Assurance in Analytical Laboratories".

In the meantime the PUC applied to Eurachem for membership. Cyprus was represented in Eurachem for the first time in May 1997. During the General Assembly which was held in Dublin, Cyprus, represented by the PUC, was accepted as an Associate Member, together with Turkey and Malta. Three years later, Cyprus (PUC) became a Full Member of Eurachem during its General Assembly held in Berlin (May 2000). Since then, most of the members of the first Cyprus Eurachem Committee have been pioneers in quality assurance and accreditation of laboratories, working as quality managers, senior

Training activities on Accreditation and Quality Assurance (Nicosia, 1996 - 2000)



Cyprus (PUC) becomes an Associate Member of Eurachem (Dublin, May 1997); three years later it becomes a Full Member (Berlin, May 2000)

Training activities and discussions with Dr Robert Kaarls (Nicosia, December 1997)

Eurachem General Assembly and Workshop in Nicosia (May 2002)

Dr Robert Kaars was the speaker in a Seminar on Metrology and Traceability (Nicosia, March 2007)

Eurachem Workshop on Uncertainty and Compliance Assessment (Nicosia, November 2009)

Seminars on ISO/IEC DIS 17025 (Nicosia, November 2016 and February 2017)

analysts, trainers or directors of a wide range of laboratories, both in the public and the private sectors.

After joining Eurachem, Dr Robert Kaarls was the invited speaker in an event organised by CYS. In parallel, he participated in a special meeting with the Cyprus Eurachem Committee which was held to increase the awareness on the developments in Eurachem and how these could be more efficiently exploited. Dr Paul De Bièvre was the invited speaker in two events organised by CYS (February and March 2000) in cooperation with Eurachem Cyprus and Cypruslab. In 2002, PUC hosted in Nicosia, the Eurachem General Assembly and the meetings of its Working Groups. On that occasion, a regional Workshop on "Quality Assurance in Analytical Laboratories – A need and a Challenge" was organised as well. The speakers were: Robert Kaarls, Wolfhard Wegscheider, Alan Squirrell, Paul De Bièvre, Alex Williams, Nick Boley, Ioannis Papadakis, Bernd Wenclawiak, Maria Filomena Camoes, Marcus Krapp, Maire Walsh, Manfred Golze, Steve Ellison and Kyriacos Tsimillis. The event was supported by CYS, IRMM, CITAC, Eurolab and CyprusLab.

Among many other training activities that followed, reference is made to two events organised in Nicosia in cooperation with CYS-CYSAB): A seminar on "Metrology and Traceability" by Dr Robert Kaarls (March 2007) and a two-day workshop - "Introduction to Uncertainty and Uncertainty for Compliance Assessment" (November 2009). The latter was organised on the occasion of the "Accreditation Week 2009" in connection with the autumn meeting of the Executive Committee. Speakers were Steve Ellison, Vicki Warwick, Brian Brookman, Roger Wood, Elizabeth Prichard and Kyriacos Tsimillis.

During these twenty years, PUC was represented in most of the Eurachem General Assemblies and other activities, namely in the Education and Training Working Group, Workshops and Seminars, in some cases presenting posters or lectures also contributing to the drafting and commenting of publications as well as the translation of leaflets. Further to these PUC members participated in training events under TrainMiC and AcadeMiC. It was a great honour for the Cypriot Chemists that one of them, the then PUC Chair was elected as Vice-Chair of the Eurachem (Istanbul, May 2006). Two years later, Dr Kyriacos Tsimillis became the Chair of Eurachem (Athens, May 2008) for a two-year period. The PUC was represented in the Executive Committee for a long time (2002-2011 and 2015 till today).

The Division of Quality Assurance was established in 2014 and was designated to act as the Cyprus Eurachem Committee. In this framework, the Division aimed at widening its involvement in the activities of Eurachem, providing training and dissemination of information especially to young colleagues and enhancing the cooperation with the Academia. A series of training activities were organised; the most recent ones (November 2016 and February 2017) focused on the provisions of the ISO/IEC DIS 17025.

Pancyprian Union of Chemists
Division of Quality Assurance
May 2017

The Workshop

The goals of the Workshop

Nowadays, almost all human activities depend, directly or indirectly, of quantifications or qualifications performed in chemistry involving the determination of a scalar or a nominal chemical property respectively. Quantifications are performed by measurements and qualifications by examinations of nominal properties.

The measurements can only fulfil their intended purpose adequately if they are traceable to suitable references and associated with a small enough uncertainty. Measurement traceability is obtained by utilising references for the measurements or for all relevant analytical operations. For example the correction of measurement results for recovery, by that observed in the analysis of a reference material, can be used to guarantee measurements traceability to the reference value. However, this correction is only meaningful if the reference values are traceable to an adequate reference and if the measurements of recovery on the reference materials is representative of the recovery on the measurement of the sample.

The measurements uncertainty should be smaller than a target measurement uncertainty that defines the maximum admissible uncertainty. The magnitude of measurement uncertainty is particularly relevant in compliance assessment to ensure that the risks of false compliance decision is under control.

Measurement procedure validation aims at collecting evidence of the measurements fitness for the intended use, focused on measurement scope and uncertainty. After measurement procedure validation, subsequent measurements quality should be monitored through an adequate quality control that checks performance parameters assessed in the validation.

The quality of nominal properties examinations also depends on the traceability and uncertainty of the test results. The qualitative analysis reference should be adequate for the identification and the reported nominal property uncertainty should be sufficiently small. Although, traceability and uncertainty of qualitative analysis results, are concepts not as widely disseminated as for measurements, these are taken care of, but using different terminology and techniques. For example, the identification of trace levels of compounds in complex matrices by GC-MS can rely on a MS library produced in equipment with different performance characteristics from the one being used with an impact on the probability of reported identification being correct, i.e. on nominal examination uncertainty. Nominal examination procedures must also be adequately validated and subsequent tests quality monitored by an adequately designed test quality control.

This workshop will discuss all relevant concepts and their respective implementation to guarantee that measurements and examinations of nominal properties are fit for their intended purpose. It will also discuss how these concepts are implemented in accredited laboratories, taking into account the current ILAC policies and any other relevant documents from Regional Cooperation Bodies such as the European Cooperation for accreditation.

Programme

Time	MONDAY 29 MAY	
08.00	**REGISTRATION**	
09.00	**GENERAL SESSION** *Chair : David Milde, Kyriacos Tsimillis*	
09.00	Welcome - Introductory remarks	Local Organising Committee
09.10	Current Eurachem activities	David Milde, Eurachem
09.20	Approaches to evaluating measurement uncertainty	Stephen L R Ellison
09.40	Practical approaches for testing laboratories	Vicki Barwick
10.00	Traceability and uncertainty in qualitative analysis	Ricardo Bettencourt da Silva
10.20	Discussion Presentation of questions to be discussed in the breakout sessions	
10.40	**COFFEE BREAK**	
11.10	**PARALLEL SESSIONS**	
11.10	**PARALLEL SESSION I : CLINICAL AND FORENSIC** *Chair : Bertil Magnusson, Agapios Agapiou*	
11.10	Measurement and diagnostic uncertainty in Laboratory Medicine	Elvar Theodorsson
11.30	Measurement uncertainty in quantitative metabolomics	Wolfhard Wegscheider
11.50	Validation of PCR-based forensic DNA analysis methods	Johannes Hedman
12.10	Validation of chromatographic methods in forensic science – focusing on uncertainty	Robert Waldebring
12.30	Discussion	
12.40	**Contributed communications**	
12.40	Uncertaintycalc: an R written web application hosts calculation of uncertainty for real time qPCR users	Athanasios Kossyvakis

12.50	Identifying uncertainties during the determination of VOCs in breath analysis	Agapios Agapiou
11.10	**II : FOOD AND ENVIRONMENT** *Chair : Vicki Barwick, Eleni Kakouri*	
11.10	Measurement uncertainty in microbiological examinations of foods	Hilde Skår Norli
11.30	Is the capillary zone electrophoresis a sufficient technique for determination of pathogenes?	Boguslaw Buszewski
11.50	Measurement uncertainty in qualitative and quantitative wide - scope screening with LC-HRMS	Nikolaos S. Thomaidis
12.10	Uncertainties in nanoparticles research and development	Eugenia Eftimie Totu
12.30	Discussion	
12.40	**Contributed communications**	
12.40	Dietary risk assessment of nitrates in Cyprus and the relevant uncertainties	Georgios Stavroulakis
12.50	Measurement uncertainty for the assigned value of the activity of alkaline phosphatase in a lyophilized milk reference material	Marina Patriarca
13.00	**LUNCH**	
14.00	**BREAKOUT SESSIONS**	
	I. CLINICAL AND FORENSIC *Chair : Elvar Theordorsson, Stelios Giannopoulos*	
	II. FOOD AND ENVIRONMENT *Chair : Stephen L R Ellison, Hilde Skår Norli*	
15.20	**POSTERS + COFFEE**	
16.40	**GENERAL SESSION** *Chair : Elvar Theordorsson, Stephen L R Ellison*	
16.40	**Breakout Sessions Reports**	
17.15	**CLOSING OF DAY 1**	
20.30	**WORKSHOP DINNER**	

Time	TUESDAY 30 MAY	
09.00	**GENERAL SESSION** *Chair : Wolfhard Wegscheider, Eugenia Eftimie Totu*	
09.00	Underestimating uncertainty?	Bertil Magnusson
09.20	Is my uncertainty estimate reliable? Using data from CRMs, PT samples and standard methods	Marina Patriarca
09.40	Measurement uncertainty in compliance testing with a focus on EU food and feed legislation	Piotr Robouch
10.00	Codex Alimentarius – Approaches to measurement uncertainty	Andrew Damant
10.20	Discussion Presentation of questions to be discussed in the breakout sessions	
10.50	**COFFEE BREAK**	
11.20	**PARALLEL – BREAKOUT SESSIONS**	
	I. QUALITATIVE ANALYSIS *Chair: Costas Michael, R. B. Silva*	
11.20	**Communicated contributions**	
11.20	Validation and uncertainty evaluation of the identification of doping agents in sport by GC-MS/MS	Ricardo Bettencourt da Silva
11.30	Qualitative uncertainty (reliability) of chemical identification with High Resolution Mass Spectrometry	Marios Kostakis
11.40	Analytical method selectivity – in metrology and in real life	George Horvai
11.50	**Breakout session**	
	II FOOD AND ENVIROMENT *Chair : Piotr Robouch, Popi Kanari*	
11.20	**Communicated contributions**	
11.30	Determination of pesticides in drinking, surface and ground water	Spyros Nikolaou

11.40	Determination of stabilizers in nitrocellulose-based propellants before and after ageing	Elena Ioannou-Papayianni
12.50	Estimation of the measurement uncertainty based on method validation according to alternative models	Katrin Kittler
11.50	**Breakout session**	
13.00	**LUNCH**	
14.00	**POSTERS + COFFEE**	
15.20	**GENERAL SESSION** *Chair : Constantina Kapnissi-Christodoulou, Marina Patriarca*	
15.20	**Breakout Sessions Reports**	
16.00	Measurement uncertainty: Requirements set in the accreditation standards	Kyriacos Tsimillis
16.20	Future directions in measurement uncertainty	Stephen L R Ellison
16.40	Discussion	
17.15	**CLOSING OF THE WORKSHOP**	

Abstracts

Lectures

Monday 29 May

L 01

Current Eurachem Activities

David Milde

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This brief presentation will introduce Eurachem and its activities. The talk will cover Eurachem aims, membership and international cooperation, but mainly will focus on recent and forthcoming activities regarding workshops, guidance documents and information leaflets.

L 02

Approaches to measurement uncertainty evaluation

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The EURACHEM Guide for "Quantifying Uncertainty in Analytical Measurement" [1] provides guidance three main approaches to the evaluation of measurement uncertainty. The first is the fundamental principle referred to as the "law of propagation of uncertainty" [2]. In addition, two numerical methods are included; the spreadsheet-based method originally proposed by Kragten [3] and the use of Monte Carlo methods for uncertainty evaluation as described, for example, in JCGM Guide 101:2008 [4]. These approaches provide alternatives to the algebraic differentiation of the measurement model proposed in the ISO Guide to the Expression of Uncertainty in measurement. A more recent development is the use of Bayesian methods for uncertainty evaluation, as described in a recent draft JCGM guide 5].
In this presentation, strategies for the estimation of uncertainty are introduced and the strengths and weaknesses of each in different circumstances are compared, with particular attention to those in current guidance.

1. SLR Ellison and A Williams (Eds). Eurachem/CITAC guide: Quantifying Uncertainty in Analytical Measurement, Third edition, (2012) ISBN 978-0-948926-30-3. Available from www.eurachem.org
2. BIPM, IEC, IFCC, ILAC, ISO, IUPAC, IUPAP, and OIML. Evaluation of measurement data - Guide to the expression of uncertainty in measurement. Joint Committee for Guides in Metrology, JCGM 100:2008. (Also available as ISO Guide 98-3:2008)
3. J. Kragten, Calculating standard deviations and confidence intervals with a universally applicable spreadsheet technique, Analyst, 119, 2161-2166 (1994).
4. JCGM Guide 101:2008 Evaluation of measurement data - Supplement 1 to the "Guide to the expression of uncertainty in measurement" - Propagation of distributions using a Monte Carlo method. (2008). Available at http://www.bipm.org/en/publications/guides/gum.html
5. JCGM 100 201X CD Evaluation of measurement data - Guide to uncertainty in measurement

L 03

Practical approaches for testing laboratories

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Testing laboratories may be required to evaluate the measurement uncertainty for results obtained from a large number of methods, which are frequently complex multi-stage procedures. Applying the full 'GUM' approach in such situations can be impractical for a number of reasons:

- Difficulty in writing an equation that includes all influence factors – there may be many factors that affect the measurement result but don't appear directly in the calculation of the result;
- Challenges associated with isolating and quantifying individual sources of uncertainty – there may a large number of potential sources of uncertainty which are interrelated and/or poorly understood;
- The process may be too time consuming in a routine testing environment when a 'reasonable estimation' of the uncertainty is all that is required.

Alternative approaches, which make use of method performance data, have therefore been developed. This 'top down' approach requires data on method 'outputs' (e.g. variation in results obtained from replicating the whole measurement procedure) to estimate the combined effect of a number of sources of uncertainty, as opposed to data on uncertainties introduced by individual influence factors. In testing laboratories such data can generally be obtained from method validation studies and ongoing quality control.

The application of this approach is described in a number of standards and guides [for example 1, 2]. This presentation, illustrated with practical examples, will provide an overview of the requirements for the top down approach, and describe some of the challenges and limitations.

1. ISO 11352:2012 Water quality -- Estimation of measurement uncertainty based on validation and quality control data.
2. ISO 21748:2010. Guidance for the use of repeatability, reproducibility and trueness estimates in measurement uncertainty estimation.

L 04

Traceability and uncertainty in qualitative analysis

Ricardo Bettencourt da Silva

Centro de Química Estrutural da Faculdade de Ciências da Universidade de Lisboa – Campo Grande, 1749-016 Lisboa – Portugal; email - rjsilva@fc.ul.pt

The chemical characterisation of an item can be quantitative or qualitative and involves performing a measurement of a quantity or the examination of a nominal property respectively [1, 2].

The measurements in chemistry are performed after the examination of a nominal property that can be extremely reliable due to the high selectivity of the procedure in the studied matrix, such as the analysis of platinum in platinum alloys by atomic spectroscopy, or extremely challenging such as the analysis of trace levels of deltamethrin insecticide in rice by GC-MS. Nevertheless, many tests are exclusively qualitative such as the identification of ignitable liquid residues in fire debris or the presence of cocaine in the urine of an athlete.

As for measurements, the examination result must be fit for the intended use and objectively interpretable by anyone interested in the information.

An examination result is fit for the intended use if examination is traceable to an adequate examination reference and result uncertainty allows a reliable and conclusive decision on the analysed item (e.g. allows safely concluding that deltamethrin is present in the rice sample).

This communication presents some examples of how examination result traceability can be defined and of how examination uncertainty can be reported and decided to be fit-for-the-intended-use.

The Bayes theorem is a convenient theory for assessing examination results uncertainty since allow reporting examination quality in a single metric that combines the true and false positive results rates, and makes the combination of the uncertainty of independent evidences rather easy [3, 4].

The discussion is divide in two types of examinations: (1) examinations based in a measurement, such as assessing the compliance of an alloy with a minimum permissible gold content or (2) examinations that does not involves prior determinations of a quantity such as the detection of olive oil defects by sensory analysis.

1. JCGM, International Vocabulary of Metrology, 3rd edn., BIPM, 2012.
2. G. Nordin, et al., Vocabulary for nominal properties and nominal examinations, Project number 2004-023-1-700, IUPAC, 2012.
3. S. Ellison, S. Gregory, W. Hardcastle, Analyst 123 (1998) 1155-1161.
4. R. Silva, Talanta 148 (2016) 177-190.

L 05

Measurement and diagnostic uncertainty in laboratory medicine

Elvar Theodorsson

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In the words of William Osler "Medicine is a science of uncertainty and an art of probability". History, physical examination, imaging, EKG and laboratory investigations are all fraught with uncertainties frequently prompting further investigations, including laboratory methods, which usually reduce the diagnostic uncertainty. However, in extreme cases, numerous investigations may be expensive, painful and lead nowhere – aptly coined the Ulysses syndrome. Medical diagnosis must therefore rest on knowledge and skills in medicine itself combined with aptitude in the handling of diagnostic uncertainties.

Measurement uncertainty is only a part of the uncertainty that needs to be dealt with when using laboratory results in clinical medicine. Pre- and postanalytical variations need to be counted in. Amongst the most important components of preanalytical variation is the biological variation of the concentration of analytes which is usually double the measurement variation. The biological variation is the spontaneous variation of concentrations of endogenous analytes around individual set points characteristic for each patient. Other preanalytical components of variation are sampling variation, sample handling variation and sample transport variation. The postanalytical variation in the use of the measurement results depends heavily on staff knowledge and implemented clinical routines.

Work in medical laboratories depends on the same metrological principles as work in other laboratories, but is also focused on reducing and handling numerous other uncertainties.

L 06

Measurement uncertainty in quantitative metabolomics

Teresa Mairinger [a], Stephan Hann [a], Wolfhard Wegscheider [b]

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For the production of complex biological substances, modern biotechnology offers a vast tool-case of synthetic routes from an almost infinite reservoir of organisms, e.g. algae, fungi, bacteria. To this end it does not suffice to choose the right organism, but also to genetically modify this organism in order to maximize the yield of the synthesized chemical(s). In order to gain insight into the such induced changes of metabolic pathways in this production process it is necessary to measure certain key constituents of the primary metabolome, such as sugars, sugar phosphates, amino acids and organic acids in a targeted way. For further information on the extent of usage of certain pathways, intracellular metabolic rates, i.e. fluxes, can be assessed indirectly by isotope tracer experiments, most commonly based on 13C labeling of the substrate (Wiechert 2001; Sauer 2006). By combining the resulting non-naturally distributed 13C labeling patterns of metabolites together with data on extracellular rates and with biosynthetic requirements into metabolic network models, intracellular fluxes can be inferred. This field is termed as "fluxomics". Notably, the computed metabolic rates are critically dependent on the type and number of quantified species, but also on the uncertainties of isotopologue distribution measurements.

As these measurements need to be done on living organisms with highly labile hydrophilic substances major efforts are required for an appropriate sampling. As fluxomics deals i.a. with the quantification of intracellular fluxes of multiple metabolic reactions within a biological network, the labeled tracer molecule is metabolized and the heavy stable isotopes are incorporated into the downstream metabolites in a time-dependent way. Metabolism thus leads to several differently labelled species measurable – after quenching, cell extraction and derivatization – by gas (or liquid) chromatography based separation techniques with mass spectrometric detection.

The 13C patterns of the measured metabolites, expressed as so-called IFs (isotopologue fractions) can then be fitted in the stoichiometric model to obtain flux ratios, i.e. a quantitative estimate of the relative importance of the different metabolic pathways, or absolute flux values.

It is clear that such a complex process is prone to produce systematic errors. But even if these are avoided there is still "interference" from natural abundances of the isotopes from carbon and silicon stemming from the contribution of derivatization process necessary in gas chromatography, as well as sulfur. Hence, before computing "true" isoto-

pologue distributions, the intensities of the derivatized molecules need to be corrected. From our research it is clear that GUM has not been written with biological applications in mind, but we will show that the Monte Carlo approach is suitable for solving these intricate problems of modelling fluxomic results.

1. U. Sauer, Mol. Syst. Biol. 2 (2006) 62.
2. W. Wiechert, Metab. Eng. 3 (2001) 195–206.

L 07

Validation of PCR-based forensic DNA analysis methods

Johannes Hedman [a,b], Moa Lavander [c], Peter Rådström [a]

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The polymerase chain reaction (PCR) is the backbone of contemporary DNA analysis, as adopted e.g., in forensic science. PCR enables detection of just a few cells through copying of specific DNA sequences. However, sample treatment and analysis may be disturbed by impurities coming from the samples or their surroundings. All steps in the analysis chain must be controlled to assure the quality of the results. Method validation is thus necessary for all the methods employed for sampling, DNA extraction and purification, and PCR-based analysis. The focus of validation will differ depending on the nature of the method. Selectivity may for example be important for DNA extraction protocols employing cell separation, or differential lysis of epithelial cells and sperm cells. For protocols employing harsh, direct lysis, selectivity may not need to be investigated. This and other issues create a need to interpret the method validation guidelines connected with ISO 17025, originally formulated for analytical chemistry methods, for the DNA analysis chain. In this work, a PCR perspective is taken on method validation. The physical and biochemical processes governing PCR are taken into account. The proposed validation guide may be employed in forensic DNA analysis, but also in other fields with similar challenges, e.g., environmental and food/feed analysis for detection/quantification of microbial contaminants. In forensic DNA analysis, the uncertainty of the measurement is to a large extent determined by the steps leading up to PCR. On what type of surface was the stain deposited? How was sampling performed? What was the yield of the DNA extraction? These effects can be partly investigated by analysing samples with known amounts of cells/DNA, but it is difficult to mimic the full variation in casework samples. The impact of measurement uncertainty on PCR-based analysis will be discussed.

L 08

Validation of chromatographic methods in forensic science – focusing on uncertainty

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Most analytical chemists are aware of the importance of method validation. The question is usually how and when the validation should be performed and what acceptance criteria should be fulfilled. Many questions regarding how can be answered by the many different guidelines describing suitable procedures to validate analytical methods. However, since the requirements on the method differ depending on its intended use is it impossible to use the same validation procedure and acceptance criteria for all validations. In forensic science a high degree of confidence is required since the analytical results will be used in the court of law. Thus, all analytical methods must be validated and the staff using those methods must receive adequate training before a new method is implemented or an old method is used for a non-validated purpose.
In this presentation NFC's approach towards the validation of chromatographic methods, used in the field of drug analysis, will be presented. The different materials analyzed at NFC and types of analytical methods will be described. The different validation parameters e.g. specificity/selectivity, accuracy, precision, detection limit and linearity will be described and specific requirements for quantitative and qualitative methods will be discussed. Particular focus will be given to how to determine the uncertainty of quantitative methods.

L 09

Measurement uncertainty in microbiological examination of foods

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For the estimations of measurement uncertainty (MU) in microbiological examinations in food and feed, "top-down" or "global" approach are used as the contributions to the uncertainties from individual procedure steps are hardly possible to quantify accurately as the analytes are living organisms. Microorganisms can be changed, multiply or die out in a sample or diluent. Many of the relevant organisms are able to proliferate in the product, in the sample following sampling, and to a certain extent throughout the entire analytical procedure until final inoculation takes place. The contributions to the uncertainty from the various analytical steps are included in the standard deviation of the internal reproducibility of the results of the measurement process. Internal reproducibility means that a standard deviation is calculated from results obtained by repeated analyses at the same laboratory at different times, by different persons and on different batches of reagents. This talk will be based on examples given in NMKL Procedure No. 8, 2008 [1] on how to estimate MU in quantitative microbiological analysis, and to check the reliability thereof.

1. NMKL (Nordic Committee on Food Analysis) Procedure No. 8, 4th Ed, 2008: Measurement of uncertainty in quantitative microbiological examination of foods.

L 10

Is the capillary zone electrophoresis a sufficientr technique for determination of pathogens?

Boguslaw Buszewski

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Rapid detection and identification of microorganisms is a challenging and important aspect in many areas of our life, beginning with medicine, ending with industry. Unfortunately, classical methods of microorganisms' identification are based on time-consuming and labor-intensive approaches. Screening techniques require rapid and cheap grouping of bacterial isolates, however modern bioanalytics demands comprehensive bacterial studies on molecular level. The new approach to the rapid identification of bacteria is to use the electromigration techniques, especially capillary zone electrophoresis (CZE). CZE is an important technique used in the analysis of microorganisms. However, the analysis of microbial complexes using this technology still encounters several problems – uncontrolled aggregation and/or adhesion to the capillary surface. One way to resolve this issue is the CZE analysis of microbial cell with surface charge modification by bivalent metal ions (e.g. Ca2+aq, Zn2+aq). Under the above conditions, bacterial cells create compact aggregates, and fewer high-intensity signals are observed in electropherograms. The capillary electrophoresis of microbial aggregates approach with UV and matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI TOF MS) detection has been presented.
The aim of this study was to characterize the charge and surface of the bacteria in order to determine their role in adhesion and aggregation phenomena during the electrophoretic separation. The use of experimental techniques, including electrochemical and electrophoretic allowed the description of the relationship between the acid-base properties of pathogens and their behavior. In this studies was performed the identification of bacterial via spectrometric techniques.

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L 11

Measurement uncertainty in qualitative and quantitative wide - scope screening with LC-HRMS

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Liquid Chromatography with High Resolution Mass Spectrometry (LC-HRMS) is a powerful tool for the identification of known and unknown compounds in a variety of samples and it is becoming widespread not only for research proposes but also for routine analysis. The full scan capabilities, the excellent mass accuracy and high resolving power are important reasons that make HRMS the appropriate choice for wide-scope screening methods. Even though those advantages make researchers to believe that there is no error in identification and determination of compounds, many examples of misidentification of compounds have been reported due to matrix effects. The aim of this presentation is to demonstrate a methodology for the estimation of the uncertainty of HRMS measurements, in both qualitative and quantitative methods. In qualitative (target) screening methods, the uncertainty of identification (or reliability) was estimated with two approaches, contingency tables and Bayesians. The estimation of reliability is based on calculation of false detect results or the probability of having false results, respectively. From the results, a comparison of both approaches was done and the identification criteria were evaluated. In quantitative methods, the uncertainty was estimated according to the EURACHEM approach. From the validation data (certified reference materials, spiked samples), the overall uncertainty was estimated and the sources of uncertainty were evaluated. For those purposes, we used, as a demonstration example, the determination of sulfonamides in fish tissue by liquid chromatography – quadrupole / time of flight mass spectrometry (LC-QTOFMS).

L 12

Uncertainties in nanoparticles research and development

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The present paper describes some challenges related to nanoparticles from their research and development point of view. There is an increased interest in nanoparticles manufacture and applications as the high surface to mass ratio are modifying the materials properties.During the last decades a sustained research was directed towards assessment of the nanoparticles in environment, for instance. However, there is a gap in the current scientific knowledge regarding the evolution of the released nanoparticles in environment.

Numerous studies on nanoparticles present conflicting results for same type of nanoparticles but different in shape, size, dispersion degree, or conflicting results of toxicological studies. Much more, there are applying various models for data fit. But, only in few scientific works (approx. 30%) method associated uncertainty is considered. Most measurement uncertainties are related to the nanoparticles size, experimental set-up, characteristics, or for transport models.

The absence of reference materials and standard methods is the main reason for completely different procedures applied for sampling, separations, then measuring and modelling the results. Much more, even the parameters took into consideration are not the same, so any results' comparison is not possible.

There are currently applied powerful techniques for determining the nanoparticles' sizes and for their characterization, and sometimes there are associated studies on measurements uncertainty [1].Due to the high importance of the nanoparticles applications in the clinical area, there have been even considered the uncertainty calculation for the nanoparticles transport within microvasculature system [2]. Through the uncertainty propagation exercise it has been possible to put in evidence that the nanoparticles dispersion could be predicted based on each patient micro vascular system. In consequence, it could be possible at certain extent to design personalized nanoparticles for each patient.

1. A Delvallée, N Feltin, S Ducourtieux, M Trabelsi, J F Hochepied, "Toward an uncertainty budget for measuring nanoparticles by AFM", Metrologia, 2016,Vol. 53, no. 1, 41-50.
2. Tae-Rin Lee, M. Steven Greene, Zhen Jiang, Adrian M. Kopacz, Paolo Decuzzi,- Wei Chen Wing, Wing Kam Liu, "Quantifying uncertainties in the microvascular transport of nanoparticles", Biomech Model Mechanobiol. 2014, 13(3), 515–526. doi:10.1007/s10237-013-0513-0.

Contributed Communications

Monday 29 May

CC 01/P10

Uncertaintycalc: an R written web application hosts calculation of uncertainty for real time qPCR users

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Real time qPCR is the cornerstone for the scientific explosion in clinical research and diagnostics. Labs aim for the optimal performance of qPCR testing with sensitive detection and accurate quantification when meeting pathogen challenges. Testing should recognize a true increase or decrease of the pathogen load level, such as the first step toward the development of resistance or resurgence of infection. In addition, assay artifact measurements such as random variations (imprecision) around the clinical decision points should be identified.Laboratories should determine their experimental uncertainty i.e., to provide clinicians a plus-or-minus(±) value associated with the measurement result. This analytical performance characteristic is mandated by ISO lab accreditation and should be estimated from the statistical distribution of a series of measurements along with other information e.g. the use of certified reference materials with stated uncertainty would greatly facilitate this part of a method validation. The uncertainty estimate is basedprimarily on within-laboratory reproducibility.This day-to-day measure of precision will vary according to routine implementation, e.g. different reagent lots, operator skills, thermocycler performance, room temperature and humidity.

The objective of the present study was to create and implement a web tool for the calculation of uncertainty. Uncertaintycalc is written in R language using the package shiny and is hosted on a shiny server (https://Uncertaintycalc.shinyapps.io/, under development) to allow for interactive online use in a web browser. This open source web application gives guidance on the acceptable experimental approaches and allows convenient uploading of in-house quality assurance data. User data are only held temporarily and discarded as soon as the session terminates.

The default formula $\mathrm{Uc} = \sqrt{(\mathrm{CVrepro})^2 + (\mathrm{CVbias})^2 + (\mathrm{CVlinear})^2}$ calculates combined uncertainty as the sum of coefficient of variations (CV) for the following uncertainty components. The user must enter for: 1) Reproducibility (repro),measurements

from a Levy Jennings control chart and especially daily routine measurements around the clinical thresholds, 2) Bias(bias), measurements targeting nominal reference material dilutions within-run experiments (analytical result versus true or stated value) and 3) Linear study (linear)measurements to determine the linear reportable range.As errors are expected to be larger at the extreme ends of the measurement range, the online tool uses a weighted least squares straight line fitting approach to calculate standard deviation for the 'least reliable' measurements within the linear range of reference material dilution series tested.

This web application enables users to acknowledge experimental approaches for the estimation of uncertainty accompanying measurements and appreciate limitations introducing lack of confidence around critical detection levels. In this way, this interactive-process advocates rigorous adherence of laboratory practice to conformity assessment standards and quality assurance initiatives.

CC 02/P 25

Identifying uncertainties during the determination of VOCs in breath analysis

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Breath analysis is an emerging scientific field with promising medical applications. Volatile organic compounds (VOCs) of exhaled air are targeted and analysed with the use of various analytical instruments including GC-MS, PTR-MS, SIFT-MS, IMS, spectroscopic techniques, e-nose and sensors; potential differences in the emitted concentrations of specific or unspecific (pattern of compounds) biomarker(s) are related to health status or disease. Human breath is a clean, inexhaustible and non-invasive source of endogenous information; this makes it ideal for sampling especially vulnerable people and children. Despite its numerous and wide promising applications, it remains in an infant stage, as it suffers for standardised practices, presenting several qualitative and quantitative pitfalls. The sample, the size, the chemical diversity of exhaled breath volatiles, the role of confounders, the various sampling methodologies and techniques, sample treatment and data interpretation, are considered among others, important factors of uncertainties and need special attention. In this context, an overview of the critical issues employed in breath analysis are highlighted and reviewed, towards the vision of development personal care hand-held monitoring devices. The understanding of these manifold issues assists researchers to validate their experimental design, towards adopting standard practices in the field of breath gas analysis. The ultimate goal, is sometime in the near future, breath analysis to become a reliable tool in the clinical setting, both for medical experts and human individuals, for early diagnosis, clinical and personal monitoring.

1. J. Herbig, J. Beauchamp, Towards standardization in the analysis of breath gas vol atiles, *J. Breath Res.* 8 (2014) 037101.
2. J. Beauchamp, Current sampling and analysis techniques in breath research-results of a task force poll, *J. Breath Res.* 9 (2015) 047107.

CC 03/P 05

Dietary risk assessment of nitrates in Cyprus and the relevant uncertainties

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The aim of this risk assessment study was to estimate the dietary nitrate (NO3-) intake of the adolescent population in Cyprus, to compare this exposure estimate with the acceptable daily intake (ADI) =3.7 mg/ kg body weight (b.w.) per day for NO3- and to calculate the contribution rate of the major food groups (e.g. leafy vegetables) to the dietary NO3- exposure. Exposure assessment was performed by using the semi-deterministic risk assessment model "ImproRisk", which combines mean occurrence/ concentration data with food consumption data of the "Childhealth" Database of the EFSA Comprehensive Food Consumption Database, at individual level. Mean and 95th percentile dietary intake values, based on median nitrate concentrations, were 1.25 and 3.31 mg/kg b.w. per day, respectively. Around 4% of the adolescent population had a dietary NO3- intake above the ADI. As expected, lettuce and other leafy vegetables (spinach, rocket/rucola, purslane, beet leaves) contributed nearly 53% to overall NO3- exposure. The contribution accounted for the vegetables group and potatoes was calculated as 72% and 17%, respectively. ImproRisk, being a model that allows calculating individual exposure, led to more refined and accurate nitrate exposure estimates compared to the intake calculations of a previous similar study, which was based on a simple deterministic methodology that included Household Budget Survey Data for Cyprus. The uncertainties affecting the above exposure assessment were assessed and will be presented. Specifically, a number of uncertainties were identified regarding the exposure scenario and the selection of parameters used in this study, i.e. nitrate concentrations in food & water commodities and food consumption data. The uncertainties due to consumption data are the largest. Therefore, more accurate and detailed food consumption data with a larger sample size are needed in order to reduce uncertainties in the risk assessment.

CC 04/ P 12

Measurement uncertainty for the assigned value of the activity of alkaline phosphatase in a lyophilized milk reference material

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The activity of phosphatase alkaline (ALP) is considered to be the main pasteurization tracer of milk. Reg. (CE) N° 1664/2006 establishes that ISO 11816-1 is the reference method and sets a limit for bovine ALP activity in milk (<350mU/L).Today, the own check system applied by food industry has become the key factor to demonstrate adherence to legislation on food safety. The reliability of the analytical results is crucial for the effectiveness of controls and Reference Materials (RM) are essential for analytical quality assurance. Nevertheless no commercial lyophilized RM for ALP in milk were, at the moment of the study, available.

The work describes the characterization and evaluation of a RM in milk produced by the National Reference Centre for bovine milk quality,to be used for the determination of ALP with the reference method ISO 11816-1: 2013. The RM was produced at three levels of ALP activity corresponding to pasteurized, thermized and raw milk.

In summer 2014, the National Reference Laboratory (NRL) for Milk and Milk Productsin collaboration with the National Reference Centre for bovine milk quality organized the first national Proficiency Testing (PT) using these materials.The PT recruited 19 Italian laboratories (both public and private to reach the maximum possible number of participants).The EUReference Laboratory for Milk and Milk Productsjoined ittoo. This step allowed the first assignment of the titles and the uncertainties according to ISO 13528. In 2015, as a major improvement act, it was decided to organize a second round, using the same batch of samples used in 2014, thanks to their stability. This new PT involved the EU Reference Laboratory for Milk and Milk Productsand 17 well experienced NRLs from its network, with the scopeto assign more reliable reference valuesand relative uncertainties for the three levels of ALP activity. The assigned values (mU/L) wereconfirmedand a good improvement of the uncertainties was reached:

	2014 PT			2015 PT		
Samples	**n**	Assigned value (mU/L)	ux (%)	**n**	Assigned value (mU/L)	ux (%)
"60"	48	91	8.2	34	96	2.0
"600"	48	793	4.7	34	776	1.7
"6000"	96	6297	5.3	32	6041	2.1

Due to the fact that the same reference method was applied in both the rounds by all participants, the experience of the laboratories resulted to be the main source of uncertainty.

The material was fully characterized according to ISO Guide 35 and proved to be highly crono- and temperature stable, resulting an excellent candidate for internal instrumental quality control or for the organization of inter-laboratory trials for ALP in milk.

Lectures

Tuesday 30 May

L 13

Underestimating uncertainty?

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According to the GUM [1]
Although this Guide provides a framework for assessing uncertainty, it cannot substitute for critical thinking, intellectual honesty and professional skill. The evaluation of uncertainty is neither a routine task nor a purely mathematical one; it depends on detailed knowledge of the nature of the measurand and of the measurement. The quality and utility of the uncertainty quoted for the result of a measurement therefore ultimately depend on the understanding, critical analysis, and integrity of those who contribute to the assignment of its value.
Today we measurement scientists are still, in general, underestimating measurement uncertainty. An evaluation of interlaboratory comparisons [2] shows that laboratories typically underestimate uncertainty by a factor of 2, ranging of course from some who overestimate; some who obtain perfect estimates through to some who greatly underestimate.
In the author's opinion there are four main causes of underestimation:
1) incomplete definition of the measurand; 2) limited knowledge of the test object, the sample; 3) limited knowledge of the measurement technique and the possible interferences when performing measurements on this test object; and 4) difficulty in modelling the whole measurement procedure.
If all laboratories in an intercomparison use similar techniques any unknown bias for that technique, i.e. method bias, will not be revealed. However if several techniques can be used for a particular measurand and test item the method bias can also be seen. With good knowledge of the test object, including any sampling issues, and of the measurement technique most important uncertainty contributions can usually been taken into account in a model. On the other hand, if reliable experimental data from method validation and internal and external quality control are used a reasonable estimate can be obtained even with limited knowledge about the measurement and test object. This presentation will point out problems with underestimation of measurement uncertainty within analytical chemistry and show ways forward for more reliable approaches to uncertainty estimation.

1. Guide to the expression of uncertainty in Measurement. ISO, Geneva (1993). Reissued as ISO Guide 98-3 (2008), also available from www.bipm.org as JCGM 100:2008.
2. Thompson, M. & Ellison, S.L.R. Accred Qual Assur (2011) 16: 483

L 14

Is my uncertainty estimate reliable? Using data from CRMs, PT samples and standard methods

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The uncertainty of a measurement result is a key indicator of its quality and informs the end-users of the level of confidence they can rely on in making decisions based on that result. In some sectors, the measurement uncertainty is treated as part of the result and may have a critical impact on the assessment of compliance. However, the estimate of measurement uncertainty is a task for the individual laboratories, that may apply different approaches and include more or less information in their budgets, based on experience, skill and resources available to them. It is therefore not uncommon for measurement results, obtained in different laboratories for the same sample and with similar procedures, to be reported with substantially different values of uncertainty. This may not be a problem, if the estimates comply with the target uncertainty of the task at hand, provided that the estimates are reliable. In principle, the interval described by the measurement uncertainty around the measurement result should include a reference value for that measurand and failing to do so highlights a possible underestimate of the measurement uncertainty. On the other hand, measurement uncertainty estimates based on general models or prescribed values rather than on laboratory data may also be "unreliable", if they fail to represent appropriately the distribution associated with the measurement result at the chosen level of confidence. Analysis of Certified Reference Materials and participation in Proficiency Testing schemes capable to evaluate not only the measurement result but also the reported uncertainty may provide laboratories with the tools to assess the reliability of their estimates. To this aim, ISO 13528:2015 [1], on statistical methods to be applied in Proficiency Testing, now includes recommendations for the reporting and assessing of participants' measurement uncertainties. On the other hand, the provisions of ISO 21748:2010 [2] on the use of repeatability, reproducibility and trueness data from collaborative studies may not be fully understood, leading to estimates inappropriate for the level or matrix tested.

1. ISO 13528:2015. Statistical methods for use in proficiency testing by interlaboratory comparison.
2. ISO 21748:2010. Guidance for the use of repeatability, reproducibility and trueness estimates in measurement uncertainty estimation.

L 15

Measurement uncertainty in compliance testing with a focus on EU food and feed legislation

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The European Parliament & Council clearly acknowledged the importance of the single legislative framework set for the organisation of official controls: "That framework has significantly improved the efficiency of official controls, the enforcement of Union agri-food chain legislation and the level of protection against risks to human, animal and plant health and animal welfare in the Union […]. It has also provided a consolidated legal framework to support an integrated approach towards the performance of official controls along the agri-food chain" [1].
Among others, Commission Regulation (EC) 152/2009 [2] clearly specifies how to assess compliance of a feed lot taking into account measurement uncertainty. This approach is similar to the one described in the Eurachem guide on compliance assessment [3].
The European Union Reference Laboratory for Heavy Metals in feed and food (EURL-HM) organised a dedicated proficiency test to monitor the ability of National Reference Laboratories and Official Control Laboratories of EU Member States to assess the compliance of an artificially spiked palm kernel expeller material. The outcome of this exercise will be presented and further discussed.

1. Regulation (EU) 2017/625 of European Parliament & Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products.
2. Commission Regulation (EC) No 152/2009 of 27 January 2009 laying down the methods of sampling and analysis for the official control of feed.
3. S L R Ellison and A Williams (Eds). Eurachem/CITAC guide: Use of uncertainty information in compliance assessment. (First Edition (2007). Available from www.eurachem.org.
4. P. Dehouck, EURL-HM-23 Proficiency Test Report - Determination of total As, Cd, Pb, Hg and inorganic As in palm kernel expeller, EUR 28282 EN.

L 16

Codex Alimentarius - Approaches to measurement uncertainty

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The Codex Alimentarius, or "Food Code" is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission. The Commission, also known as CAC, is the central part of the Joint FAO/WHO Food Standards Programme and was established by FAO and WHO to protect consumer health and promote fair practices in food. It held its first meeting in 1963. Codex standards ensure that food is safe and can be traded. The 188 Codex members have negotiated science based recommendations in all areas related to food safety and quality: food hygiene; maximum limits for food additives; residues of pesticides and veterinary drugs; and maximum limits and codes for the prevention of chemical and microbiological contamination. Codex food safety texts are a reference in WTO trade disputes. It also contains guidelines for the management of official i.e. governmental import and export inspection and certification systems for foods. There are a number of analytical and sampling considerations which prevent the uniform implementation of legislative standards. At present there is no official guidance on how to interpret analytical results in the framework of Codex. Significantly different decisions may be taken after analysis of the "same sample". For example some countries use an "every-item-must-comply" sampling regime, others use an "average of a lot" regime, some deduct the measurement uncertainty associated with the result, others do not, some countries correct analytical results for recovery, others do not. It is essential that analytical results be interpreted in the same way if there is to be harmonization in the framework of Codex. It is stressed that this is not an analysis or sampling problem as such but an administrative problem which has been highlighted as the result of recent activities in the analytical sector.

This paper provides a brief overview of measurement uncertainty issues within the Codex Alimentarius framework. How the subject currently addressed and what the future holds.

L 17

Measurement uncertainty: Requirements set in the accreditation standards

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Measurement uncertainty is of high importance in all testing and calibration laboratories and those involved in sampling activities. Its evaluation requires good understanding of the method implemented and all factors contributing to it. On the other hand, the users of the results need to understand the meaning of uncertainty stated on testing reports and calibration certificates and, if necessary, ask for clarifications. Laboratories need to take this into account when evaluating the uncertainty of their results. Competent authorities need to consider the stated uncertainty to correlate the result with a legislative limit. The manufacturer can decide on adjustments needed. The consumer may find it difficult to understand what this "uncertain component" of the result may mean for his/her health, safety or economic rights. To facilitate communication, all successive partners/stakeholders need to be aware of the requirements of the corresponding accreditation standards thus knowing what to expect from each other. This presentation refers to the requirements of the accreditation standards for testing and calibration laboratories [1-3], proficiency testing [4] and reference material producers [5]. Since the standards are generally applicable, they do not address specific needs in each field. A number of detailed documents i.e. standards, guides etc. have been prepared to serve these needs. Reference is made to ILAC and EA providing the basis for a harmonised procedure for the peer evaluation of accreditation bodies as well as Eurachem, Eurolab etc. which are very useful both for the laboratory work and the training needs especially for newly recruited personnel.

1. ISO/IEC 17025 (2005) General requirements for the competence of testing and calibration laboratories
2. ISO/IEC DIS 17025 General requirements for the competence of testing and calibration laboratories
3. ISO 15189 (2012) Medical laboratories – Requirements for quality and competence
4. ISO/IEC 17043 (2010) Conformity assessment – General requirements for proficiency testing
5. ISO 17034 (2016) General requirements for the competence of reference material producers.

L 18

Future directions in measurement uncertainty

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The ISO Guide to the expression of Uncertainty in Measurement [1] was first published in 1993. The principles have been implemented in a variety of sectoral and simplifying guidance documents, including, for example, the EURACHEM Guide for "Quantifying Uncertainty in Analytical Measurement" [2], the more general Eurolab reports 1/2006 and 1/2007 [3,4] and a Nordtest handbook. All of these documents rely on the principle referred to as the "law of propagation of uncertainty" [1].

The simple form of the law of propagation of uncertainty that is usually used is, however, accurate only where the measurement model is approximately linear. It is also applicable only where the measurement result can be expressed as a function of input quantities, making it hard to apply in circumstances which require numerical solution. The calculation of uncertainty intervals also relies on an approximate calculation for effective degrees of freedom. Finally, it takes no account of known constraints on the value of the measurand (for example, concentrations can not be negative).

Noting these limitations, the Joint Committee on Guides for Metrology (JCGM) has been developing alternative guidance that addresses some of these issues. For example, the use of Monte Carlo methods for uncertainty evaluation is described, for example, in JCGM Guide 101:2008 [6]. A more recent development is the use of Bayesian methods for uncertainty evaluation. One implementation has been described in a recent draft JCGM guide [7]. These new directions in uncertainty evaluation can provide important new tools for a wider range of circumstances.

This presentation will introduce the principles of these newer approaches, and will report on the current directions for new guidance under consideration within JCGM.

1. Guide to the expression of uncertainty in measurement. ISO, Geneva (1993). (ISBN 92"67"10188"9) (Reprinted 1995: Reissued as ISO Guide 98"3 (2008), also available from http://www.bipm.org as JCGM 100:2008)
2. S L R Ellison and A Williams (Eds). Eurachem/CITAC guide: Quantifying Uncertainty in Analytical Measurement, Third edition, (2012) ISBN 978-0-948926-30-3. Available from www.eurachem.org
3. Eurolab Technical Report No. 1/2006. Guide to the Evaluation of Measurement Uncertainty for Quantitative Test Results. August 2006
4. Eurolab Technical Report No. 1/2007: Measurement uncertainty revisited: Alternative approaches to uncertainty evaluation (March 2007)
5. B. Magnusson, T. Näykk, H Hovind, M. Krysell. Nordtest Handbook for cal-

culation of measurement uncertainty in environmental laboratories (NT TR 537 - Edition 3.1).
6. JCGM Guide 101:2008 Evaluation of measurement data - Supplement 1 to the "Guide to the expression of uncertainty in measurement" - Propagation of distributions using a Monte Carlo method. (2008). Available at http://www.bipm.org/en/publications/guides/gum.html
7. JCGM 100 201X CD Evaluation of measurement data - Guide to uncertainty in measurement.

Contributed Communications

Tuesday 30 May

CC 05/P 27

Validation and uncertainty evaluation of the identification of doping agents in sport by GC-MS/MS

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Doping is a major problem in sports and is fought with different tools including the monitoring of athlete's fluids. Most doping analyses are qualitative, meaning that the simple presence of a forbidden substance is an infraction. The reliability of these analyses is crucial for their role in fighting doping.

The latest edition of the International Vocabulary of Metrology [1] suggests using term "examination" for qualitative analysis while measurement is used for a quantification.

Some authors have proposed several ways of estimating the examination uncertainty, being the Bayes' Theorem one of the most convenient theories for this assessment as it allows the combination of true (TP) and false positive (FP) results rates in a single metric, and the update of the uncertainty when a new evidence is made available. Bayes' Theorem can be used to report examination result uncertainty as a likelihood ratio (LR=TP/FP) or as the probability of collected evidences being correct.

One of the most popular instrumentations for the identifications of doping agents in athletes' biological samples, after adequate pre-treatment, is GC-MS/MS. Analytes are identified by the agreement between retention times and ion abundance ratios of their mass spectrum observed in samples and calibrators. The World Anti-Doping Agency (WADA) defined criteria for the identification parameters based on a general knowledge of identification performance [2].

This work presents statistical models for the agreement between retention times and ion abundance ratios based on the observed distribution of parameters, which in the case of retention times is Normal, and in abundances ratios is not-Normal. The developed computation tool was implemented in user-friendly MS-Excel files and allows estimating both TP and FP required to report the examination uncertainty.

The identification criteria estimated by the computation tool and suggested by WADA are compared.

1. JCGM, International Vocabulary of Metrology, 3rd edn., BIPM, 2012.
2. WADA,Identification Criteria for Qualitative Assays,TD2015IDCR, 2015.

CC 06/P 09

Qualitative uncertainty (reliability) of chemical identification with High Resolution Mass Spectrometry

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High Resolution Mass Spectrometry (HRMS) is becoming more and more accessible and applied in routine analyses. The high resolving power and the excellent mass accuracy of HRMS make them an excellent choice for multi-analyte screening methods. On the contrary, HRMS is not lacking of errors and there are many examples of misidentification of compounds due to matrix effects, spurious errors, and inappropriate choice of screening parameters. Moreover, the identification criteria for modern HRMS have not been clearly documented yet. The estimation of uncertainty of identification (or reliability) is a way to assess the capabilities of identification of HRMS. There are two methodologies for the estimation of reliability of identification, the contingency tables and the Bayesian methods. In the first approach, reliability is estimated through the calculation of True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN) ratios. In the Bayesian approach, the reliability is estimated for the calculation of probabilities of false detect, but also considering historical and conditional probabilities. The aim of this study is to estimate the uncertainty of identification with both approaches and discuss the identification criteria of LC-QTOFMS using the uncertainty of identification, in order to minimize the false detects. Towards that aim, fish samples (sea brass and sea bream) were spiked with sulfonamides at different concentration levels, near to the limit of identification (LoI). The experiment was repeated in intermediate precision conditions and the uncertainty of identification was estimated from the results with both approaches. The identification criteria were evaluated and discussed.

CC 07/P 11

The role of selectivity in the definition and determination of the uncertainty of analytical measurements

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According to VIM 2012 the selectivity of a measuring system is defined in the following way: selectivity property of a measuring system, used with a specified measurement procedure, whereby it provides measured quantity values for one or more measurands such that the values of each measurand are independent of other measurands or other quantities in the phenomenon, body, or substance being investigated.
This definition leaves open if it refers to a single sample or to certain samples or to any possible sample. The uncertainty of analytical measurements (as defined in QUAM 2012) characterizes a dispersion, but here again the range of samples to be considered is not specified. In real life, however, the range of possible samples (in terms of their compositions) is limited. This allows to look at selectivity and at the ensuing uncertainty in a new way.
We intend to show that selectivity cannot be defined as a property with predictive character, i.e., one cannot be perfectly confident that an analytical measurement will deliver results within tolerance limits. One can extend, however, the above definition of selectivity in such a way that the analyst can clearly see the limitations of her method with respect to selectivity. One can also derive "healthy" rules for method validation, which need to be much stricter than commonly practiced today. The estimation of method uncertainty also needs to be reconsidered. Our results cast doubt on the idea that analytical uncertainty can be expressed by standard deviations.

1. Z. Dorko, T. Verbic, G. Horvai, Talanta 132(2015) 680-684.
2. Z. Dorko, T. Verbic, G. Horvai, Talanta 139(2015) 40-49.

CC 08/P 01

Determination of pesticides in drinking, surface and ground water

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Pesticides having different structures and biological activities are widely used for agricultural and non-agricultural purposes throughout the world. Due to their widespread use, pesticides need to be determined in various environmental matrices, such as soil, water and air. A wide range of analytical techniques has been developed in order to identify the organic contaminants often present at trace levels in environmental samples. These compounds are then determined by gas or liquid chromatography using a variety of detection systems. Three different groups of pesticides most commonly used in Cyprus and in our laboratory carries out qualitative and quantitatively determination using three different kind of techniques due to the fact that the stability of each pesticides is different. The pesticides determined with GC/MS (Group A) or GC/ECD (Group B) are extracted using Liquid – Liquid extraction whereas the pesticides determined with UPLC/MS/MS (Group C) are extracted from water using Solid Phase Extraction (C18 cartridge). The three methods are used for routine analysis and are fully validated including the calculation of recovery, repeatability, intermediate precision and uncertainty.

Uncertainty was calculated using Eurachem/CITAC Guide for pesticides considered as priority substances, according to WFD 2000/60/EC and the amending Directives 2008/105/EC and 2013/39/EC. Also Directive 2009/90/EC states that % uncertainty has to be lower than 50% at parametric value (Legal Limit). During the validation uncertainty was determined in both surface and MilliQ water. Values for uncertainty in MilliQ water proved no significant statistical difference among the two matrices, however the most important component having significant contribution in the estimation of uncertainty was the laboratory intermediate precision. In case that the concentration of any of the pesticides is found to be above the legal limit, method uncertainty is recalculated using daily data for the specific compound. In addition uncertainty is included in the final result, when requested from customer or for any other reason according to ISO 17025.

CC 09/P 04

Determination of stabilizers in nitrocellulose-based propellants before and after ageing

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Smokeless powder has been developed in the 1800s in order to replace black powder and is the primary propellant in civilian and military ammunition. These types of propellants are nitrocellulose-based, divided into three different categories (single, double, triple based) each category containing key additives such as stabilizers, other energetic materials, plasticizers etc. The prediction of the lifespan of propellants is of high significance not only for economical and performance but most importantly for safety reasons. High temperatures (>30°C) or high moisture content (>65%) can lead to the degradation of stabilizers which can cause chemical instability and therefore self ignition. The National Guard Laboratory (NGL) was established in 2013 and its main purpose is to determine the stability of the propellants for the safety of civilians and military personnel. NGL uses two different techniques, Heat Flow Calorimetry (HFC) and High Performance Liquid Chromatography (HPLC) which are both validated [1]. HFC is a measure of the decomposition rate (calculated from the recorded heat flow curve) and yields information regarding the stability of propellants as well as the prediction of the lifespan [2]. Using HPLC, qualitative and quantitative determination of five initial and two daughter stabilizers present in the propellant before and after artificial ageing (the ageing of propellants is carried out artificially by HFC) is evaluated. From the results obtained separately from the abovementioned techniques is possible to predict whether the propellant is suitable for safe storage.

1. NATO Allied Ordnance Publication (NATO AOP) 48, Explosives, Nitrocellulose based propellants, stability test procedure and requirements using stabilizer depletion, Edition 2, 2008.
2. NATO Standardization Agreement STANAG 4582, Explosives, Nitrocellulose based propellants, stability test procedure and requirements using Heat Flow Calorimetry, Edition 1, 2007.

CC 10/P 32

Estimation of the measurement uncertainty based on method validation according to alternative models

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The estimation of the measurement uncertainty (MU) is to be carried out by all laboratories accredited to ISO 17025. The EURACHEM/CITAC guide for quantifying the MU in analytical measurement suggests two different approaches: i) the "bottom up" approach calculates the MU for every single source of error or uncertainty and ii) the "top down" approach determines the MU for combined contributions of error or uncertainty sources which comes from validation data. The EURL in Berlin uses an approach that combines data from a matrix comprehensive in house validation with data of a bottom up approach. The in house validation was performed according to the alternative validation model, given by Commission Decision 657/2002/EC (1).
This combined approach is discussed for selected nonsteroidal anti-inflammatory drugs based on a validation experiment with spiked milk samples. A validation according to alternative models includes the systematic variation of factors. These factors, e.g. operator, storage times and batch of materials, potentially influence uncertainty. Assuming that these factors were chosen correctly, the resulting data reflect the uncertainty of the method. The EURL in Berlin reports a concentration dependent total uncertainty. This total uncertainty is calculated by combining the uncertainty obtained from the validation based on alternative models, and the uncertainty of the spiking solution, which is estimated by a "bottom up" approach. The advantage of the alternative model is the contribution of other sources, e.g. repeatability, run and matrix, to the total uncertainty. Especially the contribution of the matrix to the uncertainty is difficult to estimate with other approaches. However, the validation data show that – depending on the analyte – its contribution cannot be neglected.

1. Commission Decision 2002/657/EC of 12 August 2002 implementing Council Directive 96/23/EC concerning the performance of analytical methods and the inter pretation of results. *Official Journal of the European Communities* L 221.

Poster Presentations

Monday 29 - Tuesday 30 May

P 02

Chiral separation of nefopam using cyclofructans and chiral ionic liquids in CE

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A chiral centre in many pharmaceutical compounds gives rise to optical activity which can make a large difference between the two enantiomers in terms of pharmacokinetics, activity and toxicity. The widely accepted limit of enantiomeric impurity in the testing of a single enantiomer is 0.1% (m/m), which, in turn, requires that analytical methods have large enantiomeric-separation power and high-detection sensitivity.

Capillary Electrophoresis (CE) is a well-established and unique type of analytical technique that has many advantages, such as versatility and efficiency. In this study, the chiral separation of nefopam hydrochloride, a centrally-acting non-opioid analgesic drug of the benzoxazocine chemical class, is demonstrated. Chiral analysis of the drug has already been reported by using the universal and well-known chiral selectors (CSs), cyclodextrins (CDs), in capillary electrophoresis. The utilization of S-β-CD as a background electrolyte (BGE) additive resulted in the baseline discrimination of the enantiomers, while the use of HP-β-CD did not provide a baseline separation. Other chiral selectors have also been used over the years, such as chondroitin sulfate A [1], erythromycin lactobionate [2], cationic CDs [3], etc.

This is the first report of nefopam enantioseparation that uses a new and a promising category of chiral selectors, the cyclofructans (CFs), as well as chiral ionic liquids (CILs), a new class of non-molecular solvents with unique properties in different areas of chemistry. The growing interest in CILs has also been observed in separation techniques, where they are used as either BGE additives or as sole CSs.

In this study, a comparison between SCF6 and SCF7 is made, and the effect of the CIL, L-Alanine tertbutyl ester lactate (L-AlaC4Lac) on both resolution and efficiency is examined. Other parameters that affect the enantioseparation are also investigated, such as BGE type and concentration, pH, CS type and concentration, CIL concentration and applied voltage. The optimum separation conditions are determined to be 2 mM SCF6, in 100 mM Tris/10 mM Borate (pH 8.00) and the time of analysis is 3.5 min. In addition, in this study, the measurement uncertainty is evaluated, in regard to precision, linearity, and limits of detection and quantitation; relevant data is presented.

1. Y. Fan, D. Yingxiang, C. Bin, F. Qingfeng, X. Guangfu, 72 (2010) 489-493.
2. X. Guangfu, D. Yingxiang, C. Bin, C. Jiaquan, 72 (2010) 289-495.
3. F. Wang, M. G. Khaledi, 19 (1998), 2095-2100.

P 03

Monitoring of treated domestic waste water quality

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Cyprus is an island experiencing severe water supply and demand imbalances particularly in summer months. This is due to the simultaneous occurrence of low precipitation, high evaporation and increased demands for irrigation and tourism.
Several strategies have been developed in Europe in general in order to face water shortages and at least two major environmental directives 91/271/EEC (UWWTD) and the Framework Directive 2000/60/EC (WFD) directly or indirectly raise the issue of waste water reuse.
All treated waste water considered for reclamation and reuse for agriculture irrigation and aquifer recharge has to comply at least with the quality requirements of directive 91/271 and take into account the Environmental Quality Standards Directive 2013/39/EE on priority substances and certain other pollutants in order to prevent deterioration of surface waters and ground water. At present there are no regulations at EU level on water quality for water reuse purposes and for this purpose the EC (DG ENV) has prepared a draft document proposing minimum quality requirements for water reuse in agricultural irrigation and aquifer recharge.
The document has been developed taking into consideration the requirements of relevant European directives, legislation and guidelines on water reuse from Member States (Cyprus, France, Greece, Italy, Portugal and Spain) and worldwide reference guidelines and regulations ISO 2015, WHO 2006, USEPA 2012, CDPH 2014 and Australian guidelines.
In Cyprus there are 36 treatment plants for urban waste treatment. Treated wastes are used for environmental purposes which include recharging aquifers, agricultural irrigation, municipal/ landscape uses, that is, irrigation of parks and other green spaces, road washing etc.
The quality of treated wastes is monitored by the determination of various parameters in order to ensure compliance with the quality requirements of the operating permits of the treatment plants. These parameters include Chemical Oxygen Demand (COD), anions, suspended solids, total phosphorus and many others such as metals and compounds from the priority substances list (Directive 2013/39/EE). The laboratory of Environmental Chemistry II and treated wastes uses validated/ accredited methods for the determination of these parameters. Validation includes precision, recovery, limit of quantification and uncertainty. Using the Eurachem/CITAGuide the uncertainty on

the results has been estimated at various concentration levels taking into consideration various components which have a significant contribution to the estimation. For the concentration levels studied, a linear relationship between uncertainty and concentration is observed for most parameters. Uncertainty values are significant in cases where the quality parameters exceed the operating permit limits of the treatment plants.
PP 03

P 06

The measurement uncertainty module in the syllabus of the certified laboratory analyst

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The laboratory Analyst, as a profession, maybe certified and as such, the syllabus of the qualification needs to be defined.
To this end, a brief presentation of the syllabus of the Laboratory Analyst is described and the topics under the measurement uncertainty module are presented in detail.
As soon as the curriculum of the qualification is developedas a common, to all interested parties, document and accepted in a European level as a certification scheme, candidates may request certification from accredited or otherwise authorized organizations.
In thepresentation, the profession of the Laboratory Analyst is defined and the rational and importance, the aims and scope of the profession are explicitly presented.
Questions like, how does the profession may be in line with the European Qualification Framework, EQF, what is the difference between accreditation, certification and qualification and which is the Professional Qualification Certification Process are briefly explained.

P 07

Determination of metals in drinking water: Accreditation and measurement uncertainty

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The State General Laboratory as the official control laboratory (Accredited by European/International Standard EN ISO/IEC 17025:2005 since 2002) implements a national monitoring program in order to ensure that the drinking water quality satisfies the requirements of the respective directive. The European Legislation Directive 98/83/ EE demands strict control and monitoring for the presence of metals in drinking water. The Cyprus National legislation goes further requiring the constant monitoring not only for the tap water distribution networks but also for the water sold in bottles, mobile water containers and vending machines. The national monitoring program covers mainly metals such as Pb, Cr, Mn, Cd, As, Se, Sb, Cu, Ni, Al, and B. The determination of these metals in bottled and drinking water is performed by inductively coupled plasma mass spectroscopy (ICP/MS Agilent 7500Ce). ICP-MS is a very powerful screening tool for trace and ultra-trace elemental analysis with high sensitivity, accuracy and precision in analytical measurements. The method of analysis is based on the Standard Method APHA 3125 B and has been accredited according to EN ISO/IEC 17025:2005 since 2009. The limits of quantification for the various metals are ranging from 0.2 μg/l to 10 μg/l and the measurement range varies from 0.2 μg/l to 100 μg/L.

The method validation included the following steps: trueness control, precision, (repeatability and intermediate precision), check of the linearity of the standard calibration curves, determination of the detection/quantitation limits and uncertainty evaluation. The results were satisfactory and within the accepted validation requirements.

The method combined standard uncertainty was estimated using the Eurachem/CITAC Guide. The contribution of each of the following sources was studied: a) the relative standard uncertainty of the method determined from interlaboratory intermediate precision tests (RSDRL), b) the uncertainty from the reference calibration curve (Uc/c), c) the uncertainty due to the method and laboratory bias, d) the uncertainty from volumetric flasks/pipettes used for the preparation of standards and samples. These components were assembled to get the combined standard measurement uncertainty. The last step involved the calculation of the expanded uncertainty by multiplying the combined standard uncertainty by a coverage factor k (k=2 at 95% confidence level). All the estimated expanded uncertainty values ranged between 4-13% for the various trace elements. The dominant contribution to uncertainty was found to be the interlaboratory intermediate precision. The expanded uncertainty is taken into consideration when the uncertainty affects compliance to a legal limit.

P 08

Estimation of the uncertainty in SNIF-NMR process for the determination of authenticity of wines and spirits

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Stable isotope techniques provide powerful analytical tools that areregularly employed in the investigation of the origin and detection of food adulteration. The present communication deals with the uncertainty estimation of the analytical processes involved in the determination of the authenticity of wines and alcoholic beverages.
The Site-specific Natural Isotope Fractionation - Nuclear Magnetic Resonance (SNIF - NMR) method [1] is the reference method for the determination of the origin of ethanol in wines (European Reg. 555/2008). The whole procedure has been officially endorsed by European Legislation and can be broken down into three basic stages: the condensation of the products to the preparation of a high-degree alcoholic distillate, the determination of its water content by the means of coulometric Karl Fischer titration, and finally the calculation of the deuterium ratios of the methyl (D/H)I and methylene (D/H)II groups of the ethanol in the distillate by SNIF-NMR.
The mathematical model of the analytical process is elaborated and the application of the procedure described in JCGM 100:2008 for the uncertainty estimation of the analysis is detailed. The uncertainty of the method is vital for the development of models that may differentiate wines that belong to different varieties or origins. Also, if D/H ratios are specified for a particular wine of origin (geographical or botanical), the uncertainty of the method should be taken into account to determine whether the product conforms to the specification.
The approach described allows for the contribution of the individual parameters underlying the analytical processesto be revealed and discussed.

1. G.J. Martin, C. Guillou, M.L. Martin, M.T. Cabanis, T. Yutthay and J. Aerny, Natural Factors of Isotope Fractionation and the Characterization of Wines, J. Agric. Food Chem., 36 (1988) 316-322.
2. N. Ogrinc, K. Bat, I.J. Kosir, T. Golob and R.Kokkinofta, Characterization of Commercial Slovenian and Cypriot Fruit Juices Using Stable Isotopes, J. Agric. Food Chem., 57 (2009) 6764-6769.

P 13

Determination of musks and phthalates in aqueous samples using dodecyldiamine-modified magnetic graphene nanoparticles

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A straightforward sample preparation method based on the dispersive solid-phase extraction followed by gas chromatography–mass spectrometry (GC/MS) is developed for the rapid, multianalyte determination of selected musks and phthalates. The extraction procedure is based on a novel magnetic graphene sorbent which is functionalized with dodecyl diamine. The functional group is chosen to improve the hydrophobic character of the synthesized material and exploit its π-π interactions as hydrophobic interactions with the analytes under study as well as to improve the dispersibility in water due to the presence of the magnetic component of the composite. The synthesis and applicability of the magnetic-graphene-C_{12}, as nanosorbent is optimized in terms of the most determining experimental conditions like pH, extraction time and temperature and desorption solvent. The proposed method was developed and optimized using distilled water and validated using three different spike levels in drinking water, surface water, underground water and seawater. The detection and quantification limits, are 0.2 and 0.5 μg/l, respectively for each individual analyte. The recoveries for each analyte ranged from 72 to 104 for phthalates and from 71 to 110 for musks. The reproducibility and repeatability of spiked samples is evaluated and the relative standard deviation values range from 3 to 20 % for musks and from 2 to 20% for phthalates for reproducibility and from 4 to 20 % for musks and from 2 to 16 % for phthalates for repeatability. The uncertainties were evaluated for a 95% confidence level for each analyte and ranged from 6 to 40% for musks and 4 to 32% for phthalates.
After three successive cycles of reuse, the recoveries of the analytes remain constant indicating good stability and reusability. The dispersive solid-phase extraction can successfully be applied for routine analysis for the determination of the target analytes in aqueous samples.

P 14

Ceria-coated silica/magnetite (Fe_3O_4@SiO_2@CeO_2) nanoparticles for the preconcentration/extraction of heavy metals in aqueous samples, using slurry introduction to ICP-AES

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A slurry suspension sampling technique is developed and optimized for the rapid microextraction and determination of heavy metals in aqueous samples using nanometer-sized ceria-coated silica–iron oxide particles and inductively coupled plasma optical emission spectrometry (ICP-OES). Magnetic-silica material is synthesized by a co-precipitation and sol–gel method followed by the ceria coating through a precipitation. The large particles are removed using a sedimentation–fractionation procedure and a magnetic homogeneous colloidal suspension of ceria-modified iron oxide–silica is produced for microextraction. The nanometer- sized particles are separated from the sample solution magnetically and analyzed with ICP-OES using a slurry suspension sampling approach. The ceria-modified iron oxide–silica does not contain any organic matter and this probably justifies the absence of matrix effect on plasma atomization capacity, when increased concentrations of slurries are aspirated. The method was optimized in terms of the most determing conditions like pH, extraction time, temperature, sorbent quantity and volume of slurry. The As, Mo, Cr, Cu, Pb, Hg, Sb, Se and V can be preconcentrated by the proposed method at pH7.0 while Mn, Cd, Co and Ni require a pH8.0. Satisfactory values are obtained for the relative standard deviations (2–6%) for repeatability and 4-8% for reproducibility, enrichment factors (14–19) and regression correlation coefficients as well as detectability, at sub-μg L^{-1} levels. The recoveries ranged from 88 to 102% for each analyte. The uncertainties were evaluated for a 95% confidence level for each metal and ranged from 8 to 31%.
The applicability of magnetic ceria for the microextraction of metal ions in combination with the slurry introduction technique using ICP is substantiated by the analysis of real water and urine samples

P 15

Determination of the origin of carobs using FT-IR and Chemometrics: preliminary results

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Fourier transform infrared (FT-IR) spectroscopy was used to verify the origin of 16 carob cultivars from Cyprus and other countries (Greece, Italy, Spain, Turkey, Jordan and Palestine). All the samples were treated under the same laboratory conditions and the analysis was performed in both the seed and the flesh. The spectra were recorded in transmittance mode from KBr pellets and studied first for the whole wavelength range of 400–4000 cm-1 and then for specific ranges (400–1500 cm-1, 1500–2500 cm-1, and 2500–4000 cm-1). First- and second- derivative were applied to the recorded spectra, which were analysed statistically using multivariate chemometric techniques, involving Principal Component Analysis and Cluster Analysis. The above methodology was able to differentiate the origin of the carobs as well their type. The results of the application of FTIR spectroscopy of carobs along with the chemometric analysis are presented and discussed. The use of appropriate algorithm must give groups of samples (e.g. as dendrogram) with confidence level greater than 85%. The uncertainty of the method is of great importance for the development of the models that may differentiate carobs of different origin. Therefore, to build such models, much larger sample sets comprising carobs from many years and harvests from different countries would be needed.

Acknowledgments: The authors would like to thank the personnel of the "Nuclear Magnetic Resonance Laboratory" of the State General Laboratory of Cyprus (Authenticity lab) for their overall contribution.

1. J.F.D.Kelly, G.Downey, Detection of Sugar Adulterants in Apple Juice Using Fourier Transform Infrared Spectroscopy and Chemometrics, J. Agric. Food Chem. 53 (2005) 3281-3286.
2. E.I. Papayianni, R.I. Kokkinofta, C.R. Theocharis, Authenticity of Cypriot Sweet Wine Commandaria using FT-IR and Chemometrics, Journal of Food Science, C1-C8 (2011).

P 16

Determination of the chemical composition of commercial carob products and evaluation of the results using Chemometrics

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Twenty commercially available carob products were analysed for the determination of carbohydrates, proteins, caffeine/theobromine, dietary fibers, fat, moisture, ash and minerals composition and the results were compared to that of domestic carob fruits, widely found in the island of Cyprus (cultivars: Koumpota, Kountourka and Tylliria). The analyses took place in an accredited laboratory using, either official or accredited/validated methods, as follows: (carbohydrates-AOAC 977.20, proteins-ISO 937-1978, AOAC 920.87-2010, AOAC 991.20-2011, dietary fibers-AACC 32-05.01 and AOAC 985.29, fat-AOAC 991.36 and AOAC 963.15, moisture-AOAC 925.10 and AACC 44-15A, ash-AOAC 14-098 and minerals-ICP/OES based on AOAC 985.01 and AOAC 984.27). The internal quality control for the above 8 different methods included the measurement of double or triplicate samples for the repeatability, external standards for the calibration and Certified Reference Materials for the recovery of the method. Additionally, for specific methods, inter-laboratory tests were applied (minerals, proteins, dietary fibers). Depending on the method, the individual results for the carob products were expressed either (a) with the measurement uncertainty expressed as a standard deviation, where no other uncertainty components were estimated or (b) with the combined uncertainty (i.e. the square root of all the sources that contributed to uncertainty such as sample preparation, standard preparation and calibration curve, method bias and precision). Finally, different chemometric techniques were applied to the above data for the differentiation of the samples. Uncertainty is important for the development of models that may differentiate carob products from different types. The results of the chemical composition of carob products and fruits along with the chemometric output are presented, compared and discussed in detail.

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P 17

Determination of chlorate in food and water: validation study and estimation of measurement uncertainty

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In a survey performed by the CVUA (Chemisches und Veterinäruntersuchungsamt) Stuttgart, samples of plant origin products were found to be positive with chlorate. Chlorate is a substance that is not approved as a pesticide [1] and therefore no specific MRL (maximum residue level) is fixed in the Regulation (EC) No 396/2005 of the European Parliament and of the Council on MRLs of pesticides or on food and feed of plant and animal origin. There are several possible pathways for contamination of food with chlorate: the illegal use as an herbicide, contaminated washing water with chlorate, the employ of chlorine dioxide or hypochlorite for the disinfection of drinking water and the disinfection of food containers. Since no previous measurements were performed in Cyprus, a wide number of water samples were gathered and analysed using LC-MS/MS. Towards this, the analytical method proposed by the European Reference Laboratory on single residue methods named after QuPPe (Quick Method for Polar Pesticides) [2], has been validated following the guidelines of the document No SANTE/2015/11945 [3]. During the validation study, the measurement uncertainty was calculated following the EURACHEM/CITAC Guide [4] and the SANTE document [3]. The results of the validation study for the determination of chlorate in food and water samples, along with the estimation of measurement uncertainty, are presented and discussed.

1. The non-inclusion of chlorates in Annex I to Directive 91/414/EEC is provided in Commission Decision No 2008/865/EC.
2. Quick Method for the Analysis of numerous Highly Polar Pesticides in Foods of Plant Origin via LC-MS/MS involving Simultaneous Extraction with Methanol (QuPPe-Method), available at: http://www.eurl-pesticides.eu/userfiles/file/EurlSRM/meth_QuPPe-PO_EurlSRM.pdf
3. Guidance document on analytical quality control and method validation procedures for pesticides residues analysis in food and feed, SANTE/11945/2015.
4. EURACHEM/CITAC Guide, Quantifying uncertainty in analytical measurement, 3rd Edition, 2012, available at: http://www.eurachem.org/images/stories/guides/pdf/QUAM2012_P1.pdf

P 18

EURACHEM: A focus for analytical chemistry in Europe

Eurachem Executive Committee: David Milde [a], Vicki Barwick [b], Ricardo J. N. Bettencourt da Silva [c], Brian Brookman [b], Ewa Bulska [d], Stephen L. Ellison [b], Joanna Z. – Hadrová [e], Bertil Magnusson [f], Marina Patriarca [g], Michael H. Ramsey [h], Lorens Sibbesen [i], Eugenia Eftimie Totu [j], Kyriacos Tsimillis [k], Isabelle Vercruysse [l], Wolfhard Wegscheider [m], Alex Williams [n]

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Eurachem (www.eurachem.org) is a network of organisations within Europe designed to a) establish a system for the international traceability of chemical measurements and b) promote good quality practices in analytical sciences. Currently represented in 32 European countries, Eurachem aims to provide a forum for analytical scientists, laboratory staff and those interested in using the results of analytical measurements to discuss common problems and develop informed and considered approaches to both technical and policy issues. Eurachem members and stakeholders meet once a year at the Eurachem General Assembly. An Executive Committee and several topical Working Groups pursue the organisation's stated goals throughout the year, often in cooperation with other organisations. Participation is open and channeled through national representatives. Eurachem's main output is authoritative guidance documents, promoted through dedicated events which are also designed to provide opportunities for collecting feedback. Beside the guides, Eurachem publishes information leaflets, i.e. short briefing documents on specific topics usually intended to inform a wide audience, including laboratory staff, managers and laboratory customers. This poster aims to summarise current Eurachem activities, inform readers about the available guidance and attract active participation.

P 19

A comparison of statistical methods to combine measurement results from different methods

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According to ISO17034, the characterization of reference materials can be carried out using four different approaches: (i) use of a primary method, (ii) use a single method, for value transfer between closely matched materials, (iii) use of one or more methods, performed by a network of competent laboratories, (iv) use of two or more independent methods in one or several laboratories. For the last two options, the measurement results from different analysis methods must often be combined to obtain the certificate value and its uncertainty. However, when the uncertainty of each method is very different, it is no recommended the use of ordinary arithmetic mean. In this context, we compared three statistical methods to combine measurement results and its uncertainties from different methods used in the certification of reference materials of Zn, Mg, Ca, Na and Fe by ICPMS and atomic absorption spectrophotometry. The combination methods were: (i) ordinary arithmetic mean [1], (ii) weighting mean (using the uncertainties) and (iii) DerSimonian-Laird (DSL) estimator [2]. The results showed that there are differences between the ordinary arithmetic mean and weighting mean of up to 0.38%. On the other hand, between DerSimmonian-Laird estimator and weighting mean, there were no greater differences, except for Mg that has a difference of only 0.02%. Furthermore, the most important differences were found between the uncertainties of the reference values, because with the ordinary arithmetic mean the uncertainties were in some cases up to 6 times higher relative to DerSimmonian-Laird method.

1. M.S. Levenson,, D.L. Banks. Journal of Research of the National Institute of Standards and Technology, 105(2000) 571-579.
2. R. DerSimonian, N. Laird. Controlled Clinical Trials, 7 (1986) 177-188.

P 20

Acid-base titration techniques: Metrological considerations

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Titrations are a group of techniques that have contributed considerably to the development of the chemical industry and to the development of the chemistry itself. Consultative Committee for Amount of Substance (CCQM) has recognized titration as one of the primary methods for determining amount of substance, which has attracted many attention by National Metrology Institutes [1]. In several studies, the uncertainty estimation for acid-base titrations is carried out using Bottom Up approach, and it is recognized that the main sources of uncertainty comes from reference material purity, instrument resolutions, calibration, repeatability, molecular weight of the species and amount of titrant [2,3]. However, Wamplfler and Rösslen found that in comparison with Top Down Approach, the most of the studies underestimate the uncertainty [4]. Based on this, we evaluated different measurement systems for acid-base titrations in order to determine which have better metrological qualities (uncertainty and bias). In a first step, we propose a new method for uncertainty estimation from the end-point detection; for this purpose, several detection systems have been studied: (i) phenolphthalein, (ii) potentiometric and (iii) conductimetric. The results indicated that potentiometric method has the lowest measurement uncertainties, however is strongly dependent to instrument resolution and or the quantities of titrant added close to the equivalence point. In a second step, gravimetric and volumetric titration systems were compared and the results showed that the uncertainty decreases about 40% when using gravimetric titrations, in the best of the cases. Finally, the evaluation of the bias of the measurement systems is done through the criterion suggested in the guide ISO 33:2015. The results showed that the bias was not significant for all the systems. However, it was observed that, the bias for the conductimetric method was approximately up to 78 times greater than potentiometric method.

1. M. J. T. Milton, et al. Metrologia 38 (4) (2001) 289–296.
2. S. L. R. Ellison, A. Williams, Eurachem, Quantifying uncertainty in analytical measurement (2012).
3. I. Kuselman, A. Shenhar, Accredit. Qual. Assur. 2 (4) (1997) 180–185.
4. B. Wampfler, M. Rösslein, Talanta 78 (1) (2009) 113–119.

P 21

Methodology in managing and minimising the uncertainty in the analysis of volatile organic compounds in breath using Gas Chromatography-Mass Spectrometry.

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The characterisation of biomarkers in breath is confounded by the variability associated with the trace concentrations at which they are observed. Our research is based currently on the use of the ReCIVA breath sampler with thermal desorption gas chromatography-mass spectrometry (GC-MS). A breath sample contains approximately 500 features with substantial numbers of these at the 10s of pg level. Control of variability at these levels is non-trivial because there are many sources of contamination at every stage of the analytical workflow, from conditioning of the equipment through to sample collection, transport and analysis. This work describes the sequence of quality assurance (QA) and quality control (QC) operations that have been developed to allow breath data to be published in a package of supporting information. The resultant data header is intended to facilitate the reuse of the breath data and inform other users about possible changes taking place; essential for future meta studies.

Archival breath samples are taken and analysed using thermal desorption GC-MS following an analytical workflow of approximately 100 steps. Sampling materials are conditioned to meet clinical infection control standards while reducing the background of exogenous VOCs present, and stored and shipped at ≤ 4°C. During sampling, background air samples and air supply blanks are randomly allocated within sample batches. Participants' breathing patterns are recorded during sampling and assessed for abnormal rhythms. Parameters such as air flow rate and pressure are evaluated and scored demonstrating the accuracy and reliability of the sampler operation. On return from the clinic, samples are dry-purged with 120 cm3 of N_2 at 60 cm3 min-1, and 6 deuterated internal standards are loaded into each sample during this process. Data registration and instrument performance is tracked through the generation of retention index ladders obtained from the daily analysis of a reference solution consisting of 8 hydrocarbons (octane to eicosane), 5 chloroalkanes, 5 alcohols and diisooctyl phthalate. The uncertainty of measurement is estimated by using the mean values of data obtained from the

reference solution analysed over a month. The resultant data (peak area, height, width and symmetry) verifies the performance criteria, and analysis only takes place when the z-scores from these tests is <3 (= 20% RSD). A vital element in the QA is the proficiency testing (PT) and training of researchers. In the PT, a participant provides 5 breath samples after taking a menthone oil capsule; 1 control and 4 over the period of 6 hours capturing the menthone washout. The results of the PT are then compared to a tested and validated set of data to confirm reproducible sample acquisition. These data and the accompanying evaluation and checks are embedded into the breath analysis data header that also records the sample custody time-line.

P 22

Novel approach to fast determination of cholesterol oxidation products in Cypriot foodstuffs using ultra-performance Liquid Chromatography-Tandem Mass Spectrometry

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This work represents the first application of UPLC-MS/MS for the analysis of Cholesterol Oxidation Products (COPs) in foodstuffs. The good performance of the particular analytical methodology comes from different relevant aspects. The use of UPLC has allowed chromatographic run time down to 4.2 min per sample, while the use of tandem mass spectrometry with triple quadrupole analyzer has allowed the acquisition of two SRM transitions per compound with good sensitivity, providing, in turn, a reliable confirmation of COPs detected in samples. The optimized method demonstrated satisfactory validation parameters, including linearity range, intra- and interday precision, LOD, LOQ, matrix effect, and recovery.Particularly, recoveries of the extraction process ranged from 86% - 98.5% when the samples were fortified at 100, 500 and 1500 ng/mL. The intra-day precisions, which were obtained from 10 consecutive runs, were lower than 1.9 %, while the day-to-day RSD values were slightly higher (1.5 % and 4.1 %). Finally,the applicability of the method was confirmed by analyzing different food samples. Particularly, this study represented a first evaluation of the extent of cholesterol oxidation in traditional Cypriot foodstuffs. In all the analyzed samples, large amounts of COPs were found, with the 7-keto and 7-OH being the most abundant COPs. The results underlined that the regular consumption of the aforementioned foods can be a source of considerable amounts of COPs in the diet of the local population in Cyprus.

P 23

Determination of six β-agonists in animal feed and muscle tissue by Liquid Chromatography-Tandem Mass Spectrometry

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β-agonists or β-andrenergic agonists are synthetic phenethanolamine compounds used as bronchodilatory and tocolytic agents for therapeutic purposes and for expansion of the muscular mass, together with a decrease in fat accumulation. In this study, the analysis of six β-agonists (Clenbuterol, Salbutamol, Ractopamine, Isoxsuprine, Tulobuterol and Brombuterol) in animal feed and muscle tissue by LC-MS/MS is presented. This procedure used solid-liquid extraction for animal feed and clean-up on Oasis MCX solid-phase extraction cartridges for muscle tissue, followed by determination of the residues by LC-MS/MS. The limits of detection for the six compounds were 0.18-0.55 ng/g in animal feed and 0.07-0.58 ng/g in muscle tissue. The extraction average recovery rates of the β-agonist drugs were in the range of 74%-110% for animal feed and 70%-100% for muscle tissue. Correlation coefficients for both feed and tissue curves were ≥0.990. The uncertainties were evaluated for a 95% confidence level were 1.20 to 45.4% for feed and 1.30-45.4% for meat.

P 24

Multi residue analysis of pesticide residues in fruits and vegetables

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The Pesticide Residues Laboratory (PRL) of the State General Laboratory (SGL) is the Official Lab for the Monitoring & Surveillance of Pesticide Residues in food and has been also nominated as the National Reference Laboratory of Pesticides Residues in food.

To cope with the requirements of the EU Regulations [1,2], Multi (MRM) and Single (SRM) residue methods are used.For the analysis of fruits and vegetables an MRM method is used based on extraction with ethyl acetate. In order to use less extraction solvent and to simplify the analytical steps, the MRM method for fruits and vegetables has been modified and since 2016 the modified method is implemented in the PR laboratory.

The improved and simplified method has been validated in accordance to the SANTE document, No SANTE/2015/11945 [3].

The expanded measurement uncertainty (MU) was calculated following the 2nd approach recommended in Appendix C of the SANTE doc [3]. In this approach the MU is calculated using the within laboratory reproducibility relative standard deviation combined with estimates of the method and the laboratory bias using Proficiency tests data applying the following equation:

$$u' = \sqrt{u'(RSD_{wR})^2 + u'(bias)^2}$$

whereas

u´ is the combined standard uncertainty
u´(RSDwR) is the within-laboratory reproducibility
u´(bias) is the uncertainty component arising from method and laboratory bias, estimated from PT data

The poster presents validation resultsand the estimation of the expanded measurement uncertainty. Cases of practical applications of MU in samples exceeding the Maximum Residue Levels (MRLs) are also presented.

1. Regulation (EC) No 396/2005 of the European Parliament and of the Council on maximum residue levels of pesticides in or on food and feed of plant and animal origin.

2. Commission Implementing Regulation (EU) 2016/662 concerning a coordinated multiannual control programme of the Union.
3. Guidance document on analytical quality control and method validation procedures for pesticides residues analysis in food and feed, SANTE/11945/2015.

P 26

Assessment of calibrators quality: Determination of chromium in marine sediments by atomic spectroscopy

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The marine environment is monitored for pollutants levels in order to assess the efficiency of environment protection policies. Heavy metals, such as chromium, are pollutants that quickly reach the water systems and, because of their toxicity, are a source of great concern.
In this work, two strategies for preparing calibrators for chromium quantification in marine sediments by atomic absorption spectroscopy were studied, where calibration curves are built by the linear least-squares regression model. This work aims at assessing the impact of calibrators preparation methodologies in the determinations and to identify which of the two studied options is the most adequate for the calibration. Calibrators were prepared by diluting the stock solution through gravimetric or volumetric dilution, where volumetric dilutions were performed using micropipettes and class A volumetric flasks.
The performance of the atomic spectrometer was checked by estimating the limit of detection and, signal variance homogeneity and linearity through the calibration range. Signal's homoscedasticity was tested using Fisher and Levene tests, and signal's linearity using the ANOVA Lack-of-fit (ANOVA-LOF) test. This work concluded that signals are homoscedastic in the studied ranges. The ANOVA-LOF allowed to conclude that all calibrators prepared by gravimetric dilution present signals with a linear behavior with chromium concentration contrary to what is observed when the calibrators are prepared by volumetry. This observation is attributed to the inadequately large uncertainty of micropipette volume measurements (relative standard uncertainties between 0.6 % and 2.2 %) when compared with atomic spectrometer repeatability (relative standard deviations ranging from 1.5 % and 8.5 %).
Algorithms for checking calibrators quality are presented to allow anticipating the need to improve calibrators preparation methodology.

1. R. B. Silva, Talanta 148 (2016) 177-190.

P 28

Validation of heavy metals determination in marine sediments: A comparison of uncertainty evaluation approaches

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Statistics point to 85 % of heavy metals released in aquatic environments are accumulated in sediments surface [1], which makes sediments the major pollution receptor in aquatic systems with regard to this type of pollutants. Marine sediments can be dredged and applied in beaches recharge transferring their contamination to the new location. Therefore, before their use, sediments must be monitored for heavy metals contamination.

The Division of Marine Chemistry and Pollution of Instituto Hidrográfico has developed procedures to determine metals in sediments by Atomic Absorption Spectrometry (AAS). In this context, the analytical procedures must be validated to check if produced measurements are fit for the intended use.

The goal of this work is to validate As, Cd, Pb and Ni determinations in marine sediments using two different microwave digestions before the quantification by AAS. The validation includes the assessment of spectrometer response linearity, and measurements precision, trueness and uncertainty in procedure's application range. The measurement procedure is considered fit for the intended use if estimated measurement uncertainty is smaller than a target value in a relevant mass fraction range [2].

The uncertainty was estimated by the "bottom-up" approach and alternative top-down approaches for comparison. The uncertainty components identified in the "bottom-up" evaluation were combined through Monte Carlo Simulations making the measurement procedure more flexible regarding calibrators quality. The sample digestion uncertainty was estimated by the differential approach for uncertainty evaluation [3].

1. Z. Zhang, L. Juying, Ecotoxicol. Environ. Saf., 126 (2016) 94-101.
2. Eurachem/CITAC, Setting and Using Target Uncertainty in Chemical Measurement, Eurachem, 2015.
3. R. B. Silva, M. J. Lino, J. R. Santos, M. F. Camões, Analyst 125 (2000) 1459-1464.

P 29

Combined use of cyclofructans and an amino acid ester-based ionic liquid for the enantioseparation of huperzine A and coumarin derivatives in CE

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Cyclofructans (CFs) and their derivatives have recently been proven to be efficient chiral selectors (CSs) for the enantioseparation of several analytes in CE, HPLC, and GC. In this study, the chiral separation ability of a number of native and derivatized CFs was examined in CE. Particularly, six different CFs, with different derivatization groups and cavity sizes [native CF-6 and CF-7, isopropyl cyclofructan-6 (IPCF-6), IPCF-7, sulfated cyclofructan-6 (SCF-6), and SCF-7] were used as CSs for the enantioseparation of huperzine A, warfarin, and coumachlor. Almost all of the examined CFs, except from SCF-6 & -7, demonstrated relatively low and sometimes no chiral separation ability for huperzine A. In an effort to improve both resolution and efficiency, the chiral ionic liquid D-Alanine tert butyl ester lactate (D-AlaC4Lac) was added into the BGE. In most of the cases, the combination of CF with D-AlaC4Lac resulted in an improvement in peak efficiency and/or resolution. When CF-6 was utilized with D-AlaC4Lac, a resolution of 1.4 was obtained, while the use of IPCF-6/D-AlaC4Lac provided a baseline enantioseparation. Although the combination of SCF-7 and 40 mM D-AlaC4Lac did not affect resolution, it dramatically increased peak efficiency from 24 000 to 117 000. In the case of warfarin and coumachlor, IPCF-6 and IPCF-7 proved to be the most effective CSs. It is, therefore, concluded that the size of the cavity and the CF derivatization are the key parameters for the chiral separation capability. It is also clear from this study that D-AlaC4Lac is necessary for improved peak efficiencies and resolutions. The method was then validated by estimating the run-to-run and batch-to-batch repeatability of the method, at the optimum conditions. Finally, by estimating the uncertainty of measurements, the particular method could be suggested for the routine analysis of pharmaceutical compounds.

P 30

Introduction and evaluation of a quality management system for medical laboratories to the Haematology Laboratory of the Nicosia General Hospital

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At the Haematology Laboratory of the Nicosia General Hospital a Quality Management System has been developed and installed based on the standard CYS EN ISO 15189:2012. Following a systematic study of the requirement of the standard and bearing in mind the particular features of the Haematological Laboratory, a Quality Manual was developed describing the laboratory policy for the implementation of the specialized requirements of the standard. Subsequently, the SOPs (Standard Operational Procedures) were developed as well as the working guidances for a detailed way of implementing the various requirements of the standard and the Quality Manual. In addition, the method protocols were prepared and the following were carried out: verification,uncertainty determination,declaration of suitability of the following methods: CBC, Microscopic Examination of the Blood Film (Morphology – Diff – Parasitology), RET by Microscopy, RDT,ESR, PT, INR, aPTT, Fbg, D-DIMER, FII,FV,FVII, FVIII, FIX, FX, FXI,FXII,FXIII, Inhibitors FVIII, Inhibitors FIX, f PS-Ag, APC, ATIII, ProtC, LA, v WF: Ag, v WF: Ac and Heparin LMW,selected for accreditation.
The verification of the methods on the existing automated analysers was carried out by using commercial control samples or pooled samples of patients at two or three levels of concentration, according to critical medical decisions borderline. The following analytical characteristics were evaluated:Repeatability, within laboratory reproducibility, accuracy, LOD (Limit of detection) and LOQ (Limit of quantitation) and estimation of the expanded uncertainty. The verification results were evaluated against the verification results of the manufacturers of the automated analysers and accepted values of the bibliography resulting in the methods suitability.
The implementation of Quality Management System illustrated the usefulness of Accreditation and gave the opportunity of evaluating the main obstacles and reaching conclusions for wider implementation of Quality Management System in the State Medical Laboratories.

1. CYS EN ISO 15189:2012, Medical laboratories - Requirements for quality and competence.

P 31

Monitoring boron concentration in seawater desalination plants in Cyprus during the past two decades

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The scarcity of potable water in Cyprus has become a matter of national emergency during the past 2 decades. This has been the result of prolonged draught periods and the absence of a national policy regarding integrated management of water resources on the island. Traditionally, potable water reserves have been solely dependent on rain-water collected in reservoirs. However, dry climatic conditions, increased demand from the tourism industry, additional requirements imposed by a diverse range of agricultural and industrial activities as well as the ever increasing domestic sector demand, have rendered the available water reserves insufficient, both quantity and quality-wise. The combined pressure to improve on water quality and quantity has led to the adoption of seawater desalination as the only sustainable means of safeguarding adequate water reserves on the island. Nowadays, the island enjoys the benefits of 4 fully operational seawater desalination plants with a total daily production capacity of 220Km3. A strict monitoring regime is applied on the produced water quality, covering a comprehensive array of chemical and microbiological parameters. Boron is one of the key chemical parameters being monitored. Its significance relates to both compliance with the European drinking water directive, as well as the government strategy on the preservation of underground water resources in Cyprus. In the context of above requirements and also bearing in mind the complex production-side design considerations for the removal of Boron from seawater, it is imperative that stringent quality control and accurately defined uncertainty are applied on all laboratory results. The different treatment stages of seawater desalination will be clearly presented and described. In addition, a series of accumulated laboratory data relating to Boron concentrations at the different stages of production will be presented and discussed. Discussion will take place in the context of compliance and associated uncertainty in cases of marginal exceedances and/or compliance. Data will be relating to the seawater desalination industry in Cyprus during the past 2 decades.

P 33

The importance of uncertainty in the process of sampling and analysing gold ores for the classification of a low-grade gold mineral resource as economically exploitable

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The most substantial parameters that define whether a Mineral Resource can be classified as economically minable are the quantity and quality of ore present (ore grade and tonnages), the mining and metallurgical process to be applied, the price of the final product, the production cost, the geographical position of the resource and the environmental and political situation.

The mineral exploration companies looking for investors are obliged to prepare a Mineral exploration assessment prior to the disclosure of the discovery of a new ore resource, according to the international Codes for Reporting of Exploration Results, Mineral Resources and Ore Reserves.

The principles governing the operation and application of these codes are Transparency, Materiality and Competence. Detail documentation should include the level of uncertainty of all the supporting data regarding the estimation of ore grades, tonnages and mineralogy of the reserve.

Hellenic Copper Mines Ltd is a Cypriot mining company that was established with main objective the exploitation of the Mineral resources of the Island and produce national wealth, respecting the environmental, the culture and with a high standard of corporate social responsibility.

As a small medium company operating exclusively in Cyprus, the company does not have the required financial resources for preparing a Mineral resource assessment for each exploration prospect in its possession. Instead the company applies its own Exploration program based on its long experience according to international industry standards.

Gold ore sampling is an important issue in Exploration, Ore Control, Process Control and Metallurgical accounting. The major problem with sampling Gold ores lies in ensuring that the sample being analysed represents accurately the character of the ore.

An important issue for accurate gold sampling is the understanding of the impact of gold grains distribution in the samples to be analysed. Recent developments in sampling procedures have demonstrated that the variance of gold content between identical subsamples depends mostly on the number of the mass distribution by size of the gold grains present.

This study will examine the sampling of gold ores in the geological formation of "gossan" in Cyprus and the sample preparation.

- Define errors associated with Gold sampling procedures
- Apply Gy's sampling theory to define the uncertainty associated with sampling of gold ores in relation to the gold grain distribution in the sample, the number of gold grains in the sample and the mass of gold grains.
- Examine the impact of gold ore grade sampling variance.

Curriculum Vitae

Vicki Barwick graduated with a degree in chemistry from the University of Nottingham in 1990. She began her career as an analytical chemist at LGC (formerly the Laboratory of the Government Chemist) working in the area of consumer product safety. She is currently the head of commercial training at LGC with responsibility for the development and delivery of quality assurance training. She has worked in education and training in relation to analytical measurement for almost 20 years. Vicki is actively involved in the Eurachem network and is currently Chair of the Education and Training Working Group and a member of the Method Validation Working Group.

Boguslaw Buszewski is a Professor of Analytical Chemistry at the Nicolaus Copernicus University in Toruń, Poland. He graduated at the Maria Curie Sklodowska University, Lublin. In 1986 he has received PhD degree and in 1992 the Doctor of Sciences (habilitation) degree. In 1994 he has received professor position in Nicolaus Copernicus University, Toruń. He has been Humboldt Fellow at Tübingen University (Germany) and visiting professor at several universities in the USA, Europe, Australia but also in Asia including Japan, China and Taiwan. His main scientific interests are concerned with chromatography and related techniques, spectroscopy, adsorption, sample preparation, environmental analysis and bioanalysis (-omics), nanotechnology and chemometrics. He is author or co-author of 15 books, 65 patents and more than 480 scientific papers (over 8.000 citations, h=49), member of the editorial boards of 26 national and international journals. Prof. Buszewski is the president of the *Central European Group for Separation Sciences* and the chairman of the *Committee of Analytical Chemistry of Polish Academy of Sciences*. He is member of Polish Academy of Sciences and was awarded by numerous national and international organizations including *Doctor Honoris Causa*.

Andrew Damant leads the Surveillance, Methods and Laboratory Policy Team at the Food Standards Agency and is responsible for Agency policy on surveillance, methods of analysis, UK national reference laboratories and official control laboratories. Andrew is the lead UK delegate to CCMAS, an official UK delegate on numerous international committees and also acts as advisor to various UK and European committees.

Stephen L R Ellison, a chemistry PhD, is based at LGC, Teddington, UK and holds the post of LGC Fellow. He has contributed to several Eurachem Working groups, and is currently Chair of the Qualitative Analysis WG and Secretary for the Measurement Uncertainty and Traceability WG. He is a co-author of the IUPAC technical Reports on Use of Recovery Information in Analytical Measurement, Single Laboratory Validation Of Methods Of Analysis, and of the latest International Harmonized Protocol for the proficiency testing of analytical chemistry laboratories. A principal author of the EURACHEM guide "Quantifying Uncertainty in Analytical Measurement", he is a recognized international expert in measurement uncertainty principles applied to analytical methods. He is a Fellow of the Royal Society of chemistry, and is currently the Chair of the RSC Analytical Methods Committee as well as a member of its Statistics and Validation sub committees. He also contributes to a range of ISO, CEN and BSI committees

involving applications of statistics applied to measurement, including JCGM Working Group 1, the committee responsible for JCGM guidance on measurement uncertainty.

Eugenia Eftimie Totu is a Professor at Department of Analytical Chemistry and Environment Engineering, Faculty of Applied Chemistry and Materials Science, University Politehnica of Bucharest (UPB), Romania, and she directs the Research Group for chemical sensors and nanocomposites for clinical usage. She received her Ph.D. in Physical Chemistry at University of Bucharest, Romania, and she was Visiting Professor at University Newcastle upon Tyne, UK. Her research interests include electrochemical advanced methods, chemical sensors, nanocomposite materials for clinical use. Her current research activity focuses on creating bio nanocomposite materials for clinical applications, including for tissue regeneration. Actually, she is Project Director of European project ERA-NET for stereolithographic technique applied in dentistry. Her activity in EURACHEM started as Romanian National delegate; she is member of EUARCHEM Education and Training Working Group (2010 to date) and also elected member of the EURACHEM Executive Committee (2010 to date).

Johannes Hedman obtained his PhD in Engineering in 2011 from Lund University in Sweden. The title of his thesis was "DNA analysis of PCR-inhibitory forensic samples". He is currently a specialist (Biology Unit) at the SKL/Swedish National Forensic Centre (NFC) in Linköping, Sweden. He has so far been a supervisor for twelve Master of Science students in project courses and thesis work and co-supervisor for two PhD students. He has also been a Chairman for the subgroup focused on Laboratory Automation and LIMS within the DNA Working Group of the European Network of Forensic Science Institutes since 2007 and a project leader for two national civil contingency projects financed by the Swedish Civil Contingencies Agency since 2014.

Bertil Magnusson started as a marine chemist looking for traces of metals in the Oceans, rivers, lakes and rain in the 70's. At that time clean room and clean sampling was something totally new in the chemical laboratory. After PhD he joined a chemical company, Eka Chemicals within AKZO-NOBEL and worked there as a specialist in analytical chemistry mainly with spectroscopy (XRF, XRD, ICP) and wet chemistry. They supported laboratories within the company in Europe and America. In 2002, he joined SP, now RISE (Research Institutes of Sweden), at the Chemistry, Materials and Surfaces Department. He works with quality in measurements including accreditation, quality control, validation, measurement uncertainty and decision making. A major part is teaching and taking part in writing guidelines from e.g. Nordtest, nordtest.info and Eurachem, eurachem.org . Another task is analysis using mainly atomic spectroscopy.

David Milde has been a Eurachem Chair since 2016 and a Czech representative in Eurachem since 2006. He is an associate professor of analytical chemistry at Palacky University in Olomouc (Czech Republic), and he obtained his PhD in analytical chemistry in 2002. Research and educational activities are focused mainly on atomic spectrometry

(AAS, ICP-MS, laser ablation), chemometrics and metrology in chemistry. He has been also working in a GMP laboratory since 2014. He is an author of more than 30 scientific papers.

Marina Patriarca obtained her MSc in Clinical Sciences and her PhD in Chemistry. She is a senior scientist at the Italian Institute for Public Health (Istituto Superiore di Sanità), Department of Food Safety, Nutrition and Public Veterinary Health. She is also the deputy head of the National Reference Laboratory for Heavy Metals in Food and responsible for the organization of proficiency tests for trace elements in biological fluids and in food. She is an advisor on metrology issues within the Quality Management System of the Department. She has been a delegate for Italy in Eurachem since 2005 and a member of the Proficiency Testing WG, the Education & Training WG and the Method Validation WG. She has also been a member of the Scientific Committee of several Eurachem Workshops since 2005 and chair of the Local Organising Committee of the 6th Eurachem Workshop on Proficiency Testing. She is also a Eurachem Executive Committee Elected Member (first elected in 2009). Since 2006 she has contributed to the TrainMiC® (Training in Metrology in Chemistry) program, promoted by the European Commission Joint Research Centre IRMM, as National Team Leader, Editorial Board member, Advisory Board member and Authorised Trainer. Finally, she is the author of more than 100 scientific papers and contributor to the development, revision and translation into Italian of several Eurachem Guides and leaflets. Her working experience involves: clinical biochemistry and food safety, with special interest devoted to trace elements; measurement quality, particularly in the areas of method validation, certification of reference materials and proficiency testing; education and training devoted to the implementation of the technical requirements of ISO/IEC 17025 and ISO/IEC 17043 for analytical laboratories, both in Italy, Europe and in developing countries (more than 100 events).

Piotr Robouch is a senior scientist of theEuropean Commissionn's Joint Research Centre in Geel. Operating manager of the European Union Reference Laboratory for Heavy Metals in feed and food (EURL-HM), he is an established trainer in metrology in chemistry. Experienced in proficiency testing, he contributed to the drafting of ISO 17043:2010 and ISO 13528:2015 standards ,as well as the Eurachem Guides on "method validation (2014)" and "measurement uncertainty (QUAM:2012)". He is a member of the Eurachem PT working group.

Ricardo Bettencourt da Silva is a Researcher of the Centro de Química Estrutural of the University of Lisbon and has been teaching analytical chemistry and metrology in chemistry at the Faculty of Sciences of the University of Lisbon. The main topics of his research are metrology and examinology in chemistry, the sciences of quantitative and qualitative evaluations in chemistry respectively. For both kinds of evaluations, detailed measurement and examination models are developed to extract reliable and more information from complex systems.

The developed tools have been used to study relevant environmental, food and forensic systems. Ricardo is active in teaching and developing these topics in national and international teaching programs, working groups and forums. He is the Portuguese delegate of Eurachem, an elected member of Eurachem Executive Committee and member of Eurachem working groups on "Measurements uncertainty and traceability" and "Qualitative Analysis". His personal website is http://webpages.fc.ul.pt/~rjsilva/.

Hilde Skår Norli served as the Secretary General of the Nordic Committee on Food Analysis, NMKL (Sept. 1997- Sept 2016). For 19 years, she coordinated this Nordic network of chemist, microbiologist and sensory analysts, elaborating analytical methods for food and feed analysis, guidelines within quality assurance and arranging workshops and seminars. She holds now a position as NRL coordinator and senior adviser at the National Veterinary Institute (NVI) in Norway. Hilde Skår Norli is Cand.Scient in analytic organic chemistry from the University in Oslo, Norway, and has been employed at a couple of private laboratories and at the Norwegian Food Safety Authority in addition to NVI.
She serves as the Chair of NordVal International, is a board member of AOAC Europe, and serve at the AOAC Statistic Committee. She has served as Director at the AOAC International Board of Directors and been involved in international fora like Codex Committee on Methods of Sampling and Analysis.
Her experience on MU in microbiological examination in foods: Hilde Skår Norli was the project leader in the elaboration of the NMKL guide: Measurement of uncertainty in quantitative microbiological examination of foods (NMKL Procedure No. 8, 2008). Further, she has assisted laboratories in MU estimations and been involved in courses on this topic in the Nordic countries.

Elvar Theodorsson did his medical training in Iceland and Norway, graduate education at the Karolinska Institute and specialist training in Clinical Chemistry at Karolinska Hospital in Stockholm, Sweden. Appointed professor of Neurochemistry at Linköping University in 1995, he currently has a h-index of 64 (ISI). Consultant work in general clinical chemistry, endocrinology, haematology and quality management and head of Laboratory medicine at Region Östergötland 1996-2001. He has served as president of the section and of the board of U.E.M.S. Medical Biopathology and as chair of the Scientific committee of the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM). He is a member of the JCTLM Working Group on Traceability, Education and Promotion (WG-TEP).

Nikolaos Thomaidis is an Associate Professor of Analytical Chemistry in the National and Kapodistrian University of Athens (NKUA) with more than 20 years dedicated work on analytical chemistry of micropollutants and contaminants (154 articles, >4200 citations, h-index of 38). He has significant research experience in the field (ultra) trace mass spectrometry of organic contaminants in food and environmental samples. He is member of the European network of reference laboratories for monitoring of

emerging pollutants (NORMAN network). LC-HRMS based targeted and non-targeted screening of environmental and food media for priority pollutants' and emerging contaminants and their transformation products is his major research line. He teaches quality systems, accreditation, method validation and measurement uncertainty methods to undergraduate and postgraduate students for more than 16 years. He manages an accredited laboratory in NKUA, offering special services to public authorities and industry. He has strong links to both industry and regulatory bodies for environmental and food quality issues.

Kyriacos C. Tsimillis holds a BSc and a PhD in Chemistry (University of Athens - 1971, 1977). His postgraduate studies were carried out at the Nuclear Research Center "Demokritos" (1972-1975). After a six-year period of lecturing at the Physical Chemistry Department of the University of Athens, he was involved in standardization and certification activities in Cyprus for twenty years followed by twelve years of active involvement in accreditation activities until his retirement (December 2013). In 2005 he became the Coordinator and in 2009 the Director of the Cyprus Accreditation Body (CYS-CYSAB). He represented the CYS-CYSAB in EA and was a member of peer evaluation teams of EA (2013-2014). Since 1997 he represents the Pancyprian Union of Chemists (PUC) in Eurachem, including a two-year period as its Chair (2008-2010) and for many years as a member of the Executive Committee; he also represented Cyprus in Eurolab and the Euromed Quality Programme. He is the author of research papers and review articles and a co-author in books on Quality. He was an invited speaker in seminars, workshops and conferences. He organized a lot of training activities and awareness events. Since 2014 he is a member of the Division of Quality Assurance of the PUC.

Robert Waldebring has more than 20 years of experience in analytical chemistry. For the last 4 years, he has been at the forensic laboratory within the Swedish police authority working with drug analysis. He mainly develops and validates analytical test methods. He performs structure elucidations on New Psychoactive Substances (NPS). For the first 16 years, he has been within the pharmaceutical industry, mainly in R&D in the field of drug substance manufacturing. He developed, validated and implemented chromatographic and spectroscopic analytical test methods. He also performed technology transfer of analytical knowledge and methods to other departments and to third-party manufacturers. He obtained his Bachelor of Science in chemical engineering.

Wolfhard Wegscheider is a Professor of General and Analytical Chemistry at the Montanuniversitaet Leoben, Austria. He received his education from the Graz University of Technology majoring in Technical Chemistry with a specialisation in Biochemistry and Food Chemistry. His diploma thesis and doctoral thesis were in Analytical Chemistry with an emphasis on trace analysis and environmental analysis. As Fulbright Scholar he worked in Denver, CO, mainly on energy-dispersive X-ray fluorescence spectrometry. Much of his research centers on the development of chemometric procedures for an-

alytical chemical problems. He is co-author of the textbook on Analytical Chemistry featuring the DAC FECS-Curriculum and a member of the editorial board and contributor to the Encyclopedia of Analytical Sciences (Academic Press). He is member of several learned societies such as GDCh, GOECh, Co-operation on International Traceability in Analytical Chemistry (CITAC) and EURACHEM where he is also a founding member of the Working Group on Education and Training, of the Working Group on Measurement Uncertainty and Traceability. In both, EURACHEM and CITAC he also served as Chairman. He is currently a Member of the Board of Directors of the Austrian Society of Analytical Chemistry – ASAC. In 2010 he has been appointed Fellow of the International Union of Pure and Applied Chemistry (IUPAC). He is a consultant to the Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management, a lead auditor in the Austrian Accreditation of Laboratories System and an Editorial Advisor of different Journals.

From 1995 to 2001 he served as a Dean of Graduate Studies of Montanuniversitaet Leoben, and from 2003 to 2011 as a Rector (President) of this Institution. Presently he is chair of the Board of Trustees of OeAD GmbH, the Austrian Agency for International Cooperation in Education and Research. W.W. is member of Statistics Committee of AOAC International for the period 2016-2019.

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