

## **The Principle of Pooled Calibrations as Alternative to Conventional Practices and Procedures of QA/QC and Metrology**

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Analytical chemistry (AC) encompasses application of virtually any apparatus that is suitable for quantitation from weighing and pH measurements to liquid-chromatography mass spectrometry and synchrotrons. All the technologies must be validated according to practices and procedures of QA/QC that have been developed by international organizations mainly for the industry over the past three decades. Introduction of QA/QC to academia is not as complete as it is to the industry, and some of the issues of these efforts to promote QA/QC in science are highlighted. Conventional methods of QA/QC and metrology have some built-in features of method validations that may provide contradictory results and disagreements even between professional laboratories. Recent results of Eurachem concur with the celebrated results of Horwitz, as they both claim that many of such discrepancies may be explained by incompetence or lack of training of laboratory staff. These findings have recently been contested, as evidence as to poor performance of apparatuses with respect to quantitation is more likely to be another source to the disputes. Introduction of the principle of pooled calibrations suggests that reproducibility can be assessed by a single laboratory. The uncertainty supplied by the manufacturer of the apparatus informs about precision, but it does not address the concept of accuracy. It is proposed that generally higher levels of uncertainty should be assigned to most apparatuses during the method validation of the laboratory, which will deliver long-lasting method validations that causes no stop in production and no disagreements between results of different laboratories.

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Prof. Andersen obtained his master's degree of X-ray Crystallography at the University of Copenhagen (1987), PhD degree of University of Copenhagen in surface-physical chemistry (1991) and post doc of University of Cambridge (U.K.), Department of Chemistry (1991). He obtained the DSc degree in electrochemical nanotechnology (2002) from the Technical University of Denmark (DTU). Prof. Andersen is former Treasurer and President of the National Danish Society of Analytical Chemistry, organizing conferences on analytical chemistry and nanotechnology, Former expert trainer to the European Commission on Analysis of heavy metals in beverages and food products EDES - COLEACP, Member of EuCheMS Division of Analytical Chemistry (DAC) since 1999 and Secretary 2009 – 2013, Head of Study Group Quality Assurance, member of Study Group Education and participated in trademarking Eurobachelor<sup>TM</sup> of analytical chemistry (2008). Scientific interests and achievements: Development of nano-typewriter, theory for flow-injection technology, theory of electrochemistry, digital-image processing, imaging of single-molecule proteins, automation and on-line analysis of chemical species by flow-injection analysis (FIA), development of methods for analysis of chemical species in solution, development of quality assurance for chemical sciences, development of consensus science, development of active-pharmaceutical ingredients containing strontium for treatment of osteoporosis, analysis by chemometrics, electrodeposition studied by in-situ scanning tunneling microscopy (*in situ* STM). He is an inventor and holds eight patents of pharmaceutical products for treatment of osteoporosis and skin conditions. Other activities include extensive collaboration with industry through construction of apparatus (*in situ* STM) and master projects of chemistry. Reviewer for many international journals of chemistry and physical chemistry. Participation as expert witness to litigations in Denmark with contents of analytical chemistry in High Court and Supreme Court. Invited speaker and member of scientific committees at international conferences on analytical chemistry. He has authored/co-authored more than 100 articles of peer-reviewed international journals of science, book chapters and course material. His research has been sponsored by the National Danish Research Council, Ib Henriksen's Foundation, P.A. Fisker's Foundation, Ole Mønsted's Foundation, The Idella Foundation, LiPlasome Pharma A/S, Nordic Bone A/S, Osteologix Inc., Mkwalo Pharma S.A., and Botswana International University of Science and Technology (BIUST). He has been teaching inorganic chemistry, organic chemistry, general chemistry, physical chemistry, analytical chemistry, and quality assurance.