



STEFAN POMMÉ

NEUTRON ACTIVATION ANALYSIS WITH K_0 -STANDARDISATION

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Background

Neutron Activation Analysis (NAA) is a sensitive and accurate tool for element analysis, complementary to non-nuclear analytical techniques. We can analyse a wide range of elements from trace concentration levels up to percents, without destroying the matrix. The method does not require drastic sample preparation, as the matrix is sampled in PE vials and irradiated as such in the neutron irradiation facilities of the BRI nuclear research reactor. Subsequent gamma-ray analysis in our spectrometry lab allows identification and quantification of the produced radioisotopes. The conversion of radioactivity to element concentrations is based on comparison with standard materials or on the so-called k_0 -standardisation method.

Objectives

- To further develop the k_0 -standardisation method for NAA, in close collaboration with scientific partners.
- To fully exploit the inherent qualities of NAA such as accuracy, traceability and multi-element capability, to ensure its position as a competitive routine chemical analysis technique.
- To acquire technical spin-off to our nuclear measurements services, enhanced support possibilities to other internal projects and be a stimulus for

professional contacts with the international scientific community.

Programme

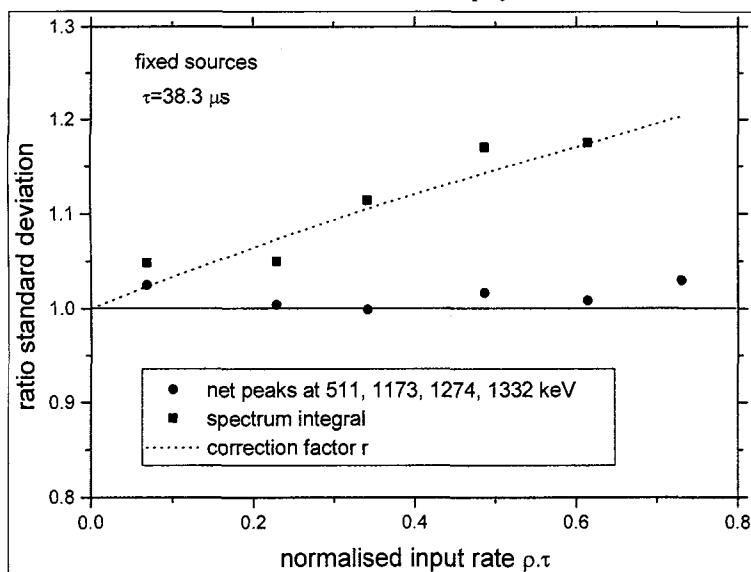
- To improve the standardisation method and the neutron field characterisation.
- To improve the statistical control on neutron activation analysis.

Achievements

Scientific work in the framework of k_0 -NAA has been pursued, in particular on the subject of nuclear counting statistics with significant pileup rejection in the spectrometer. In previous years, statistical control was achieved for most of the commonly applied γ -ray spectrometry techniques in neutron activation analysis. In 2000, we tested the DSPEC^{plus}™ digital spectrometer of PerkinElmer. We paid special attention to the novel technique for the determination of the statistical counting uncertainty in the "Zero Dead Time" spectra by means of a "variance spectrum". The main conclusion was that this method is applicable to small parts of the spectrum. We supplied a correction formula to extend its validity to an arbitrary part of the spectrum.

We made also research effort in the validation of recently determined k_0 -factors for short-lived activation products. For this purpose we analysed lichens acting as monitors for an environmental pollution study in Portugal.

Our laboratory has participated to the certification of candidate reference materials. Neutron activation analysis is well suited for certification work, since its sources of uncertainty are known and quantifiable. An industrial application of NAA was the quantification of iodine in bed ticking, the iodine being the indicator for the successful application of a fungicide.



Test results of a new technique assessing the counting uncertainty from a 'variance spectrum' with the DSPEC^{plus} digital spectrometer (PerkinElmer). The figure shows the ratio of the true (measured) statistical counting uncertainty with the value predicted from the variance spectrum as a function of the input rate (up to 50% count loss). The circles refer to the standard deviation of a limited part of the spectrum and the squares to the count integral of the entire spectrum. The dashed line shows a correction factor for overdispersion due to pileup rejection.

Partners

IRMM	Institute for Reference Materials and Measurements (Geel, Belgium).
RUG	Universiteit Gent (Gent, Belgium).
KFKI	Atomic Energy Research Institute of the Hungarian Academy of Sciences (Budapest, Hungary).
-	DSM Research BV (Geleen, The Netherlands).

ITN	Instituto Tecnológico e Nuclear (Secavém, Portugal).	date Reference Material City Waste Incineration Ash (cRM-176R) by k_0 -NAA", internal report IRMM, GE/R/RM/14/00, 2000, pp 32
NIST	National Institute of Standards and Technology (Gaithersburg, USA).	
-	École Polytechnique Montreal (Montreal, Canada).	
-	PerkinElmer Instruments	
-	Canberra Packard	

Scientific output

Publications

S. Pommé, G. Kennedy, "Pulse loss and counting statistics with a digital spectrometer", *Appl. Rad. Isot.* 52 (2000) pp. 377-380

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J. Uyttenhove, S. Pommé, B. Van Waeyenberge, "Measurement of natural gamma radiation in Belgium by means of high resolution in-situ spectrometry", *International Congress on Radiation Protection, IRPA-10, Hiroshima, Japan, May 14-19, 2000, Proceedings P-1a-14*

M.C. Lépy, T. Alitzoglou, D. Arnold, F. Bronson, R. Capote Noy, M. Décombaz, F. De Corte, R. Edelmaier, S. Klemola, M. Korun, H. Neder, T. Novotny, S. Pommé, O. Sima, F. Ugleitveit, L. Van Velzen, "EUROMET Action 428: Transfer of Ge Detectors Efficiency Calibration from Point Source Geometry to other Geometries", *Rapport CEA-R-5894, Commissariat à l'énergie atomique, Centre d'Etudes de Saclay, France (2000), pp. 60*

S. Pommé, P. Willeborts, "Neutron Activation Analysis of Al-Ag alloy for certification", *SCK•CEN External contract report, IRMM order 90938 CCR 341897, 2000, pp. 9*

S. Pommé, P. Willeborts, R. Van Ammel, "Neutron Activation Analysis of Al-Sc alloy for certification", *SCK•CEN External contract report, IRMM order 91027 CCR 347676, 2000, pp. 9*

P. Robouch, G. Arana, M. Eguskiza, M.I. Maguregui, S. Rückold, S. Pommé, "The Characterisation of the candi-

Presentations

M. Eguskiza, P. Robouch, F. De Corte, S. Pommé, "The preparation and characterization of synthetic multi-element standards for testing the performance of k_0 -NAA: the state of affairs", *16th International Conference on the Application of Accelerators in Research and Industry, CAARI 2000, Denton, Texas, USA, November 1-4, 2000*

S. Pommé, J. Uyttenhove, "Statistical precision of high-rate spectrometry with a Wilkinson ADC", *Fifth International Conference on Methods and Applications of Radioanalytical Chemistry, MARC-V, Kailua-Kona, Hawaii, USA, April 9-14, 2000*

S. Pommé, P. Robouch, M.C. Freitas, A.P. Marques, M.I. Maguregui, M. Eguskiza, "Comparison of k_0 -NAA in lichens using isotopes with short and long half-lives respectively", *BioMAP, 2nd International Workshop on Biomonitoring of Atmospheric Pollution, Praia da Vitoria, Portugal, August 28-September 3, 2000*

P. Robouch, G. Arana, M. Eguskiza, M.I. Maguregui, S. Pommé, C. Ingelbrecht, "Target Preparation and k_0 -NAA: a successful adventure", *20th World Conference of the INTDS; Targets for Particle Beams: Preparation and Use, Antwerp, Belgium, October 2-6, 2000*

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