NKS-274
ISBN 978-87-7893-347-8

GammaWorkshops 2012 Proceedings

Elisabeth Strålberg (1) (ed)
Sigurður Emil Pálsson (2)
Henrik Ramebäck (3)
Seppo Klemola (4)
Sven P. Nielsen (5)

(1) Institute for Energy Technology, Norway
(2) Icelandic Radiation Safety Authority
(3) Swedish Defence Research Agency
(4) Radiation and Nuclear Safety Authority, Finland
(5) DTU Nutech, Denmark

February 2013

Abstract

GammaWorkshops 2012 was held in Hveragerði, Iceland. 36 persons from 20 organisations in the Nordic and other European countries attended the workshops.

The accident at the Fukushima NPP in 2011 highlighted many challenges in modern gamma ray spectrometry, such as dealing with complex spectra not encountered on a routine basis, application of appropriate corrections, estimation of ground deposition and radionuclide concentrations in soils in general. The workshops therefore included work on gamma spectra of samples with fallout from Fukushima, with focus on use of libraries, applying different corrections and awareness of true coincidence summing effects. Presentations on gamma spectrometric *in situ* measurements as an alternative to soil core measurements, QA in an accredited laboratory and important background components in gamma spectrometry were also given.

The participants appreciated that the focus was on practical issues and teaching, and the overall opinion about both the lectures and practical sessions was very positive. Suggestions for future events included intercomparison exercises (samples or spectra), issues related to accreditation, Monte Carlo simulations etc.

Key words

Gamma spectrometry, *in-situ* measurements

NKS-274
ISBN 978-87-7893-347-8

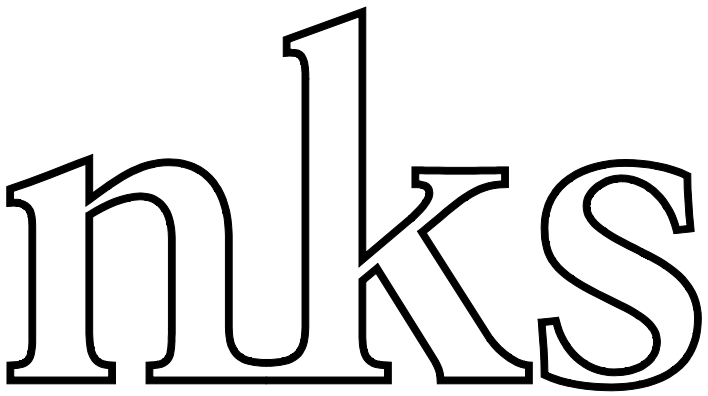
Electronic report, February 2013
NKS Secretariat
P.O. Box 49
DK - 4000 Roskilde, Denmark
Phone +45 4677 4041
www.nks.org
e-mail nks@nks.org

GammaWorkshops 2012 Proceedings

Nordic workshops for users of gamma ray spectrometry

Hveragerði, Iceland,

11-12 September 2012



Elisabeth Strålberg (ed), Sigurður Emil Pálsson, Henrik Ramebäck,
Seppo Klemola, Sven P. Nielsen

Table of contents

Introduction

Due to a sparse interaction during the last years between practioners in gamma ray spectrometry in the Nordic countries, an NKS activity was started in 2009. This GammaSem was focused on seminars relevant to gamma spectrometry. A follow up seminar was held in 2010. As an outcome of these activities it was suggested that the 2011 meeting should include a series of workshops focused on practical issues, *e.g.* different corrections needed in gamma spectrometric measurements. GammaWorkshops 2011, was held in September at DTU Risø Campus and was a huge success. Based on overwhelming feedback from the participants a new series of workshops were held in September 2012 in Hveragerði, Iceland.

The accident at the Fukushima NPP in 2011 highlighted many challenges in modern gamma ray spectrometry, such as dealing with complex spectra not encountered on a routine basis, application of appropriate corrections (such as true coincidence summing), estimation of ground deposition and radionuclide concentrations in soils in general. The previous workshop in 2011 covered some of the challenges of sampling and measuring soil cores. In 2012, the focus was on gamma spectrometric *in situ* measurements as an alternative to soil core measurements. The workshop also included work on gamma spectra of samples with fallout from Fukushima, with focus on use of libraries, applying different corrections and awareness of true coincidence summing effects.

GammaWorkshops 2012

35 persons from 20 organisations in the Nordic and other European countries attended the GammaWorkshops (se attachement 2). Most of the persons were young scientists working with gamma spectrometry. Invited lecturers were

- Dr. Sandor Tarjan from the National Food Investigation Institute in Hungary. He has helped the IAEA laboratory in Seibersdorf with gamma spectrometric analysis of samples from Fukushima, and used this experience in his lecture. He gave a comparison of three different softwares for gamma spectrometry used for analysing the Fukushima samples. He had prepared several practical exercises using these spectra, exercises that were really appreciated by the participants. Dr. Tarjan also presented one possibility for method validation for *in situ* gamma ray spectrometry representing an equivalent surface deposition.

- Dr. Tim Vidmar from SCK CEN in Belgium who assisted Dr. Tarjan during the practical exercises.

- Dr. Andrew Tyler from the Environmental Radioactivity Laboratory at the University of Stirling gave lectures about *in situ* gamma ray spectrometry, including
  - empirical calibration; demonstration of validity, conversion to air kerma
  - accounting for source burial

  - how to get more information from the spectra than from the full energy peak only
  - examples from different applications.

- Dr. Gerhard Fritz from Canberra gave a presentation about cascade summing corrections as applied in the Genie 2000 software.

- Dr. Annika Tovedal from FOI gave a presentation about background components in gamma spectrometry; *e.g.* the influence of shielding, building materials, flushing with nitrogen etc.

There were also lectures given by persons from the GammaWorkshops project board (the authors of this report):

- Dr. Sven P. Nielsen gave a lecture about quality assurance and validation of detection limits. He also lead an open discussion about user experience with different techniques (*e.g.* electric *vs.* liquid N_2-cooling, integrated electronic systems, safe working environment).

- Dr. Seppo Klemola gave an introducion about new developments in gamma ray spectrometry, including a presonal review of advances in gamma spectrometry and some recent developments at STUK.

- Dr. Henrik Ramebäck gave a lecture about other types of detectors and comparison of some of these hand-held instruments for practical use (identification, not activity determination). These instruments are often considered to be “non-expert” instruments but the comparison showed that the instruments often report wrong results and that expertise in gamma ray spectrometry is needed to reveal the right result.

The full agenda for the workshops is found in attachment 1.

Presentations were made available to the participants at the GammaWiki web site (https://www.gr.is/wiki/GammaWiki). Various references relevant for gamma spectrometry have been compiled and made available here.

The Icelandic Radiation Safety Authority (Geislavarnir ríkisins) took care of the local arrangements (Dr. Sigurður Emil Pálsson as well as Kjartan Guðnason, Óskar Halldórsson Holm and Gísli Jónsson).

Response by participants

At the end of the GammaWorkshops a feedback survey was conducted amongst the participants. The written comments included both evaluation of this year’s workshop as well as suggestions for future events.

It was appreciated that the focus was on practical issues and teaching, and the overall opinion about both the lectures and practical sessions was very positive. Suggestions for future events included intercomparison exercises (samples or spectra), issues

related to accreditation, Monte Carlo simulations etc. There were also wishes for practical exercises like the one on real spectra this year. Some examples of feedback:

- "*The practical exercises with spectra were very good and also the possibility to present and discuss the different solutions and results in a larger group is very good.*"
- *"NKS GammaWorkshops considered as very useful in our organization."*
- *"A "where are we now" workshop in connection with an intercomparison may be a good idea."*
- *"Excellent to have problem solving and examining solutions. You get to see traps to avoid!"*
- *"One very important thing with the workshop, - creating network with others."*
- *"My goals being met – good opportunity of meeting others in the same field and starting an ongoing process of collaboration."*
- *"This was my first γ-workshop (NKS) and I am impressed."*

All participants are looking forward to future events, either a seminar, a series of workshops or a combination of these.

A more detailed summary of the GammaWorkshops will be published as an NKS report as has been done with the previous related activities. These reports are all available at the NKS web site:

1. Paula Nunez (ed.) *et al*: GammaSem Proceedings - A Nordic seminar for users of gamma spectrometry - Oslo 15-16 September 2009 – Report NKS-212
2. Elisabeth Strålberg (ed.) *et al*: GammaSem Proceedings - A Nordic seminar for users of gamma spectrometry - Kjeller 28-29 September 2010 – Report NKS-224
3. Henrik Ramebäck (ed.) *et al*: GammaWorkshops Proceedings - Nordic workshops for users of gamma ray spectrometry – Risø-DTU 26-28 September 2011 – Report NKS-259

A summary of these activities follows.

GammaSem 2009 and 2010

At the first GammaSem seminar the well-known expert in gamma spectrometry, Dr. Gordon Gilmore, gave an overview of some of the most common difficulties and mistakes when using gamma spectrometry. Also, several key issues for follow-up were identified and working groups for addressing the identified problems were established. It was decided that the topics for the working groups should form the basis for the seminar in 2010, where the groups should be invited to present the results

of their work and ideas/solutions to the problems. This was thought to ensure that the identified key issues were not forgotten but followed up, and hopefully lead to solutions that will increase the performance of the individual laboratories.

Working groups established at GammaSem 2009 included:

- Uncertainties and detection limits
- True coincidence summing corrections
- Monte Carlo simulations and efficiency transfer
- Absorption (density corrections and geometries)
- Mobile gamma spectrometry systems
- Nuclear forensics (on special samples and special parts of the spectra)

At the seminar in 2009 it was also decided that the participants of the GammaSem activity should organise web sites for posting relevant information and discussion forums. This would make it easier to contact Nordic colleagues on issues related to gamma spectrometry.

At GammaSem 2010, all six working groups from GammaSem 2009 were invited to give presentations of their work accomplished during the previous year. However, only two out of six working groups gave such presentations:

- Working group on uncertainties and detection limits
- Working group on true coincidence summing corrections

The working group concept did not work out as intended. The reason for this was probably because most of the laboratories that signed up to join the working groups, signed up because they wanted to learn more about the different subjects. In combination with the fact that no funding was made available for the working groups, it was difficult to establish goals on what to achieve. Based on this, it was suggested to arrange a series of workshops covering relevant issues suggested by the participants, rather than continuing with a third seminar.

The web sites, GammaForum and GammaWiki, were also presented for the participants as possible solutions for Nordic colleagues to posting relevant information and discussion forum. During the general discussion at the end of GammaSem 2010, it was agreed to close down the GammaForum as it had not been taken into active use by the participants, but to keep GammaWiki. In the period after GammaSem 2010, GammaWiki has been regularly used by the GammaSem/Workshops organisers for posting relevant information for the participants, including links to useful references on gamma spectrometry as well as on planned events.

At GammaSem 2010 also Dr. Lars-Erik De Geer from the Swedish Defence Research Agency gave a lecture that covered aspects of true coincidence summation corrections and developments in this field accomplished at the Provisional Technical Secretariat (PTS) for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) in Vienna.

GammaWorkshops 2011

GammaWorkshops 2011 was arranged based on feedback from particpants at GammaSem 2010. Lecturers were invited to give presentations about subjects suggested by the participants at GammaSem 2010. Practical demonstrations were included in the presentations, and participants were encouraged to try to solve problems on their own (on their own computers).

Dr. Tim Vidmar from SCK CEN in Belgium talked about efficiency transfer and self-absorption corrections in gamma ray spectrometry, and true coincidence corrections in the software Genie-2000. He also provided a version of the program EFFTRAN in which efficiency transfer, self-absorption correction as well as true coincidence corrections can be done.

Dr. Menno Blaauw from Delft University of Technology in the Nederlands gave a lecture regarding true coincidence summing and also had a practical session on TCC for GammaVision users.

Dr. Tuukka Turtiainen gave a lecture on the gamma spectrometric measurements of natural radionuclides, and Dr. Kaj Heydorn gave a lecture on detection limits and the ISO-standard ISO-11929:2010

There were also lectures, and practical sessions, given by several of the GammaWorkshops organisers, including presentations of

- SMath, a freeware form solving e.g. the Bateman equations,
- an empirical correction method for self-absorption, and
- combined uncertainty calculation according to GUM (Guide to the expression of Uncertainty in Measurements) and its application to gamma ray spectrometry.

The overall opinion about both the lectures and practical sessions was very positive. It was appreciated that the focus was on practical issues and teaching. The selection of speakers was also appreciated. All participants were looking forward to a second GammaWorkshops in which issues not covered in the 2011 workshop could be included.

Concluding remarks

There is a need for continued cooperation and interaction, as well as for training, within the field of gamma spectrometry. This fact was proven through the two seminars GammaSem 2009 and 2010, and also through the GammaWorkshops in 2011 and 2012.

The participants to all these events agreed that the seminars and workshops have been extremely successful in providing a forum not otherwise present to practitioners in gamma ray spectrometry in the Nordic, as well as in neighbouring, countries. Moreover, all participants found the teaching and practical sessions very useful in learning how to deal with difficult issues relevant to gamma spectrometry. This fact is very important since only few students choose to study *e.g.* nuclear sciences at a university level. Instead many young people have to learn their professional skills within their employment. Events like the GammaSem and the GammaWorkshops have therefore helped to boost up the general knowledge regarding important issues in measurements of gamma emitting radionuclides.

The NKS workshops and seminars on gamma spectrometry are gradually building up a reputation amongst international experts. At the workshop 2012 the participants expressed a strong wish for a continuation of this work.

Short resumes of the lectures

The following section gives short resumes of the lectures given at the workshop. The available presentations and corresponding exercise material can be downloaded from the GammaWiki web site (https://www.gr.is/wiki/GammaWiki/).

Comparison of three gamma-ray spectrum evaluation software on the samples originating from Fukushima

Dr. Sandor Tarjan

The three major softwares GammaVision, Genie 2k and Winner were compared with regard to isotope identification, libraries, efficiency calibration, coincidence summing corrections, sample density corrections and decay corrections. The comparison was based on analysis of different spectra of samples contaminated with fallout from the Fukushima accident.

Dr. Tarjan then used these and other spectra for several practical exercises for the participants. The exercises (quoted below) were very much appreciated by the participants.

Task 01

In the gamma spectrum of the smear sample several unidentified peaks have been reported.

One of your colleagues proposed to extend the library because it does not contain all of the occurring radionuclide in the sample. Is it true?

Could you find any

- *random coincidence line*
- *true coincidence line*
- *X-rays and gamma coincidence line?*

The Cs-134 and Cs-137 ratio in the radioactive releases is 1:1, is it possible to use this information to the experimental determination of the TCC factor for Cs-134?

Task 02

In the gamma spectrum of the snow sample you can find the gamma lines of the Eu-155 but the software did not report it. The radiochemical separation of the Am-241 was carried out. The "Am" fraction was analysed by gsp also.

Which kind of isotopes can be identified in the spectrum of the Am fraction, how is it possible?

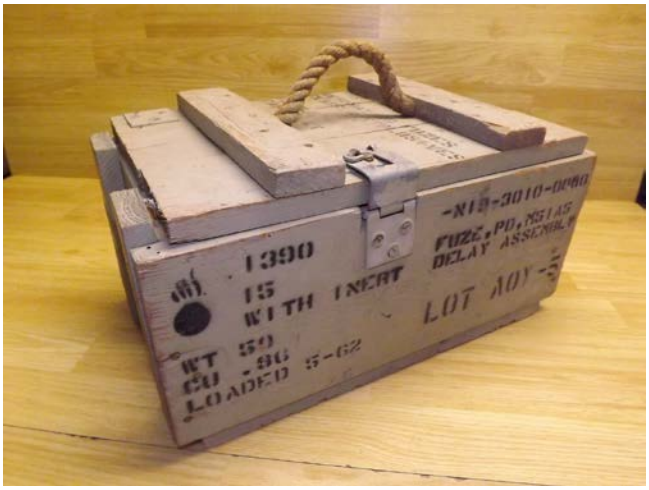
Task 03

One aerosol sample was analysed twice to check the long lived isotopes. Please identify all of the possible isotopes in the spectra.

What happened with the Co-60 isotope, how it could lose the high energy peak?

Task 04

The unusual box has been identified in the cargo line by the airport security staff. It was suspicious so they performed the routine test and they realised it is radioactive.



The civil defence obtained a gamma ray spectrum from 2 m distance and sent it to the laboratory for analysis.

Which isotopes can be identified in the spectra?

Is it a dangerous material?

Can you estimate the amount of the radioactive material?

Task 05

The U exploring team in Ethiopia discovered a mineral which has a relatively high density: 4 kg/dm^3.

They have a cooled down HPGe detector and the gamma spectra analysis have been performed quickly. They found the mineral is radioactive, but the concentration is not so high and there are some not identified peaks in the low energy part of the spectra? The calibration of the gsp system was performed by the CRM which has 2.0 kg/dm^3 density.

The Angle 3 is installed on their computer and they can transfer the efficiency, but the result of the new evaluation is not confirmed the presence of high concentration of uranium. (Geometry: diameter is 110 mm, height 20 mm, 2 mm plastic vessel on the surface of the detector).

Which is the discovered material?

In-situ gamma spectrometry, incl. demonstrations

Dr. Andrew Tyler

Mapping a deposition of gamma emitting radionuclides using only soil core sampling is both time consuming and expensive. *In-situ* gamma spectrometry can provide rapid and representative estimates of environmental radioactivity across a range of landscapes. The lecturer gave an overview of environmental controls for *in-situ* gamma spectrometry, and different approaches to calibration of *in-situ* measurements (soil cores, Monte Carlo simulations).

Accounting for variations in the vertical activity distribution is an essential issue in *in-situ* gamma spectrometry. Several methods are available for this, including different attenuation of gamma lines depending on the energy, and forward scattering (or peak to valley method). The lecturer gave an overview of these methods as well as examples from field experiments/mapping.

One possibility for method validation of the *in-situ* gamma-ray spectrometry for flat geometry – A presentation based on real experiments

Dr. Sandor Tarjan

The lecturer gave a short introduction of the basic principle for calibrating detectors for *in-situ* gamma spectrometry and the different parameters contributing to the detector calibration factor. He then gave examples from real experiments, where the calibration had been performed both mathematically using ISOCS and empirically using point sources distributed on a flat surface (20 m x 20 m).

The “point” sources for the empirical calibration were made using ink spiked with a ^{131}I reference solution. 450 pieces of 5 cm x 5 cm were printed with this ink and a random selection of the sources tested for homogeneity. Both the ISOCS and empirical *in-situ* calibrations gave good results on two different surfaces (concrete and grassland).

A similar technique was used to make reference material for surface contamination monitors (beta only). A ^{137}Cs reference solution was spiked into the ink and printed on several sheets. A selection of sheets was tested for homogeneity.

The reproducibility of this “standard” production was good, the uncertainty contribution of in-homogeneity both between and within sheets were less than 1.5 %. Also the printing technique is suitable for various matrices, i.e. plastic sheets and

aerosol filters. In the future this method will be used to produce clear alpha, beta and mix alpha and beta sheets to study the behavior of the surface and the contamination monitors as well, and an aerosol filter intercomparison will be organised.

Implementation of cascade summing corrections in Genie 2000

Dr. Gerhard Fritz

The lecturer began his presentation with some basic information about the magnitude of true coincidence summing effects for various source-detector geometries. He then gave an overview of the requirements for performing coincidence summing corrections in Genie 2000 as well as Canberra's method for characterizing a detector. In cases where the detector is not characterized, Canberra provides a "Generic Detector Characterization"-module. A description of the method for performing coincidence summing corrections in Genie 2000 was given, and finally a comparison of correction factors for different nuclides and source-detector geometries was shown.

QA, what is needed in an accredited laboratory? Validation of detection limits.

Dr. Sven P. Nielsen

The lecturer gave an overview of the requirements for laboratories accredited according to ISO/IEC 17025. In addition to multiple management requirements, there are several technical requirements regarding e.g. test and calibration methods and method validation, traceability, reference standards and reference materials etc. ISO 11929 specifies a procedure for calculation of the "decision threshold" (DT), the "detection limit" (DL) and the "limits of the confidence interval".

A case story from DTU Nutech was presented where the quality of calculations of DT and DL in Genie 2000 was tested. The software stripping function in Genie 2000 was used to generate synthetic spectra from background and calibration spectra and the result from the analyses were compared to the activity level known to be present in the synthetic spectra.

Background components

Dr. Annika Tovedal and Dr. Henrik Ramebäck

The lecturers started their presentations by asking what the participants knew about their gamma background, and how different factors could influence their background level. A short review of the origin of the most prominent background peaks was given as well as advices on different ways to reduce the background level.

The lecturers gave examples from their own laboratory at FOI in Sweden. The background was reduced significantly by raising the detector inside the lead shielding, add a layer of lead underneath the detector, use Cu-lining inside the lead shield, and flush with nitrogen to reduce the amount of radon daughters inside the shielding.

New developments – introduction

Dr. Seppo Klemola

Fabrication of the first lithium-drifted germanium detectors in 1962 (50^{th} anniversary in 2012!) was a substantial improvement in gamma spectrometry. Since then there has been several milestones (high-purity germanium, HPGe, in 1976, n-type HPGe in 1978, electrically cooled HPGe in 1985, 100% relative efficiency in 1988, 200% relative efficiency in 2000), and manufacturers still come up with new solutions and products.

The lecturer gave a personal review of developments at STUK, Finland, through the last 25 years. STUK implemented TCS corrections in routine analysis already in 1986, and among the most recent developments are UniSampo-Shaman (an expert system for nuclide identification, 2009) and LINSSI (a comprehensive database for measurement and analysis, 2010). New ongoing developments include PANDA (Particles And Non-Destructive Analysis, α/β-gated gammaspec.), UV-gamma coincidence spectrometry, and NAMIT with LINSSI (a comprehensive LIMS with advanced data management structure for gamma spectrometry).

Other types of detectors ($LaBr_3$, NaI…), comparisons for practical use, for identification not activity determination

Dr. Henrik Ramebäck

Several low-resolution hand-held instruments are used by first responders and military forces for the identification of nuclear and other radioactive materials. In 2011 FOI, Sweden, made a study on the performance with respect to identification of such instruments. Several measurements gave wrong results, both for nuclide identification and uranium categorization. The study showed that the choice of library is critical when using these so-called non-expert instruments, and that care should be taken regarding the reported radionuclide. For uranium categorization, knowledge of the sample matrix and shielding is important for a correct assessment of the material. It is important that users have available reach-back expertise for support and verification of obtained results.

Conclusion: Low-resolution instruments are NOT non-expert instruments!

User experience with new techniques (electric cooling, integrated electronic systems, safe working environment)

Dr. Sven P. Nielsen

The participants shared user experience with different techniques including electric cooling of detectors, integrated electronic systems and safe working environment in gamma laboratories.

Appendix 1 – Agenda of the NKS-B Gamma Workshops 2012

Monday, September 10

- 16:15-17:00: Departure Keflavik/Reykjavik – workshop bus

- 17:45-19:00: Visit at Hellisheiðarvirkjun geothermal plant (Iceland's largest, and soon to be the world's largest) and introduction to the CarbFix project

- 19:30: Arrival Hveragerði and Hotel Örk.

Tuesday, September 11

- 08:00-08:30: Registration and coffee

- 08:30-10:15: **Comparison of three gamma-ray spectrum evaluation software on the samples originating from Fukushima** (Dr. Sandor Tarjan, short coffee break included)
  Software: Gamma Vision, Genie 2k, Winner 6.0
  - *Isotope identification*
  - *Working libraries for goal oriented isotope identification*
    1. Possible data sources
    2. Editable and non-editable libraries
  - *Efficiency calibration and transfer of the efficiencies, LABSOCS*
  - *Corrections*
    1. Self-attenuation correction of the samples
    2. Correction of the true coincidence summing effect
    3. Decay corrections for simultaneous presence of mother and progenies
    4. Spectral interferences

- 10:15-10:30: Coffee

- 10:30-11:30: **Exercise on real spectra - different study cases** (Dr. Sandor Tarjan)
  Parallel sessions:
  1. Dr. Tim Vidmar and **Genie** users
  2. Dr. Sandor Tarjan and **GammaVision** users

- 11:30-12:30: Lunch

- 12:30-13:15: Exercise cont.

- 13:15-13:30: Coffee

- 13:30-14:45: **In-situ gamma spectrometry, incl. demonstrations** (Dr. Andrew Tyler)

Part 1: In-situ gamma spectrometry: Calibration
- *Overview – environmental controls*
- *Simple Empirical Calibration*
  1. Demonstration of validity
  2. Conversion to Air Kerma
- *Accounting* for source burial
  1. Discussion & Demonstration
- *Empirical* vs Monte Carlo simulation

- 15:00-15:30: **One possibility for method validation of the in-situ gamma-ray spectrometry for flat geometry** - A presentation based on real experiments (Dr. Sandor Tarjan)

- 15:30-16:15: **Implementation of cascade summing corrections in Genie 2000** (Dr. Gerhard Fritz)

- 19:00: Workshop dinner at Hótel Örk

Wednesday, September 12
- 08:30-09:15: **In-situ gamma spectrometry, incl. demonstrations (**Dr. Andrew Tyler)
  Part 2: Going beyond the full energy peak
  1. Spectral sensitivity (Discussion)
  2. Examples of application

- 09:30-10:15: **QA, what is needed in an accredited laboratory? Validation of detection limits** (Dr. Sven P. Nielsen)

- 10:30-11:30: **Background components** (Dr. Annika Tovedal and Dr. Henrik Ramebäck)

- 11:30-12:30: Lunch

- 12:30-13:00: **New developments – introduction** (Dr. Seppo Klemola)

- 13:00-13:30: **Other types of detectors (LaBr, NaI…), comparisons for practical use, for identification not activity determination** (Dr. Henrik Ramebäck)

- 13:45-14:30: **User experience with new techniques (electric cooling, integrated electronic systems, safe working environment)** (Dr. Sven P. Nielsen)

- 14:45-15:30: Open discussion, including feedback survey

- 15:30: Workshop closure

- 16:00: Workshop bus to Reykjavík

Appendix 2 – List of participants

Michel Ceuppens	Canberra Benelux & Scandinavia
Gerhard Fritz	Canberra GmbH Germany
Kara Morris	Canberra Industries
Bente Lauridsen	Danish Decommissioning
Jens Søgaard-Hansen	Danish Decommissioning
Kasper G. Andersson	DTU Nutech / NKS
Sven Nielsen	DTU Nutech
Annika Tovedal	FOI
Catharina Söderström	FOI
Henrik Ramebäck	FOI
Neda Tooluotalaie	FOI
Roger Kvarnström	Fortum
Stefan Isaksson	Gammadata Instrument AB
Stefan Mårtensson	Gammadata Instrument AB
Mats Skålberg	Geosigma AB
Camilla Nordhei	IFE-Halden
Knut Eitrheim	IFE-Halden
Elisabeth Strålberg	IFE-Kjeller
Trygve Bjerk	IFE-Kjeller
Gísli Jónsson	IRSA
Kjartan Guðnason	IRSA
Óskar Halldórsson Holm	IRSA
Sigurður Emil Pálsson	IRSA
Beata Varga	National Food Safety Office
Sandor Tarjan	National Food Safety Office
Alexander Mauring	NRPA
Bredo Møller	NRPA
Naeem Ul Hasan Syed	NRPA
Tim Vidmar	SCK-CEN
Asser Nyander Poulsen	SIS
Katrine Berg	SIS
Seppo Klemola	STUK
Hannele Hirvonen	Teollisuuden Voima Oyj
Mattias Olsson	Forsmarks Kraftgrupp AB
Andrew Tyler	University of Stirling

Title	GammaWorkshops 2012 Proceedings
Author(s)	Elisabeth Strålberg (1) (ed), Sigurður Emil Pálsson (2), Henrik Ramebäck (3), Seppo Klemola (4) and Sven P. Nielsen (5)
Affiliation(s)	(1)Institute for Energy Technology, (2)Icelandic Radiation Safety Authority, (3)Swedish Defence Research Agency, (4)Radiation and Nuclear Safety Authority, (5)DTU Nutech
ISBN	978-87-7893-347-8
Date	February 2013
Project	NKS-B / GammaWorkshops 2012
No. of pages	16
No. of tables	0
No. of illustrations	1
No. of references	3

Abstract

GammaWorkshops 2012 was held in Hveragerði, Iceland. 36 persons from 20 organisations in the Nordic and other European countries attended the workshops.

The accident at the Fukushima NPP in 2011 highlighted many challenges in modern gamma ray spectrometry, such as dealing with complex spectra not encountered on a routine basis, application of appropriate corrections, estimation of ground deposition and radionuclide concentrations in soils in general. The workshops therefore included work on gamma spectra of samples with fallout from Fukushima, with focus on use of libraries, applying different corrections and awareness of true coincidence summing effects. Presentations on gamma spectrometric *in situ* measurements as an alternative to soil core measurements, QA in an accredited laboratory and important background components in gamma spectrometry were also given.

The participants appreciated that the focus was on practical issues and teaching, and the overall opinion about both the lectures and practical sessions was very positive. Suggestions for future events included intercomparison exercises (samples or spectra), issues related to accreditation, Monte Carlo simulations etc.

Key words Gamma spectrometry, *in-situ* measurements