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# GammaUser 2014 Proceedings

## 6–8 October 2014 Helsinki, Finland

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## **Abstract**

Due to a sparse interaction during the last years between users of gamma ray spectrometry in the Nordic countries, a NKS activity was started in 2009. For the past 6 years, dozens of Nordic gamma spectrometry users have met each year to share their experiences and challenges. All of these meetings were supported by the Nordic Nuclear Safety Research (NKS) and organized by members from all five Nordic countries. The meetings have been well attended, popular, and rated as very useful by their participants.

GammaUser 2014 meeting was held in Helsinki, Finland. Altogether 45 persons from 16 different organisations from the Nordic and other European countries attended the seminar. 17 of the participants were personnel of the nuclear power companies working with gamma spectrometry. In connection with the meeting also an introductory course on gamma spectrometry was organized. The seminar included invited lectures, participant presentations, round table discussions and a participant feedback survey. The topics of invited lecturers covered e.g. various types of efficiency evaluations: experimental, semi-empirical and Monte Carlo calculations. The seminar also included presentations by participants. The results of the intercomparisons organized by project were presented by GammaUser project group members.

## **Key words**

Gamma spectrometry, intercomparisons, corrections

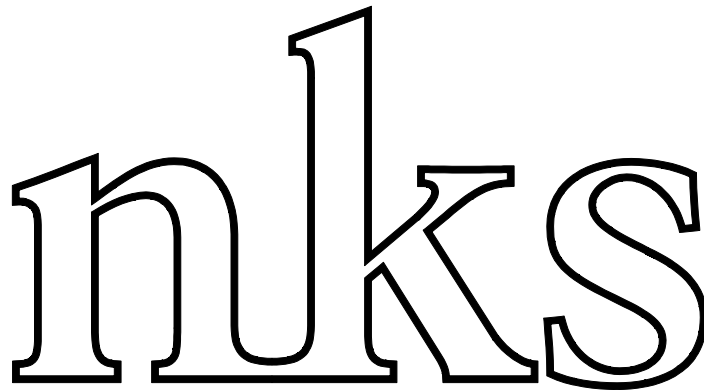
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# GammaUser 2014 Proceedings

Workshop for users of gamma-ray spectrometry

Helsinki, Finland,  
6–8 October 2014



Seppo Klemola (ed.), Óskar Halldórsson Holm, Elisabeth Strålberg, Aleksi Mattila,  
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## **Introduction**

Before 2009, interactions between Nordic users of gamma spectrometry were sparse. Expertise was acquired and built up in each lab independently. The lack of communication of peers facing similar challenges meant a loss of opportunity for learning faster, foreseeing problems, and finding good solutions. It was in response to this that a project was conceived to bring together the Nordic users of gamma spectrometry to meet and exchange ideas.

For the past 6 years, dozens of Nordic gamma spectrometry users have met each year to share their experiences and challenges. All of these meetings were supported by the Nordic Nuclear Safety Research (NKS) and organized by members of all five Nordic countries. The meetings have been well attended, popular, and rated as very useful by their participants.

The first meeting, GammaSem 2009, was held in the fall of 2009 and focused on bringing the users together for a series of theoretical lectures on issues relevant to gamma spectrometry. The large attendance surprised even the optimistic organizers and demonstrated the pent-up demand and interest in greater interaction. Participant feedback brought up more discussion topics than could be addressed at the meeting so a follow up seminar was held in 2010.

Based on participant feedback gathered at those two seminars, a further two workshops (GammaWorkshop 2011 and GammaWorkshop 2012) with a focus on practical solutions and advice were held in the following years, in 2011 at DTU Nutech, Risø Campus, and in 2012 at Hveragerði, Iceland.

Following a suggestion from the participants at the 2012 meeting it was decided to continue the meeting series and include an intercomparison exercise in the 2013 meeting (GammaTest 2013 at FOI Umeå, Sweden). At the end of the GammaTest 2013 meeting, a lively roundtable discussion among attendees gave great feedback to the organizers and other attendees alike. The organizers felt strong enthusiasm among the audience for the gamma spectrometry meetings to continue.

It was clear to the organizers that the meeting series should continue into 2014. At the same time, it was equally clear that for the 2014-meeting to be useful and relevant, the meeting would have to evolve, drawing lessons from the preceding meetings.

## **GammaUser 2014**

45 persons from 16 different organisations in the Nordic countries attended the workshop (Appendix 1). 17 of the participants were personnel of the nuclear power companies working with gamma spectrometry.

The GammaUser 2014 meeting started on Monday October 6<sup>th</sup> 2014 with an introductory course on gamma spectrometry by Henrik Ramebäck, FOI, Sweden.

The objectives of the course were to present an overview of laboratory gamma spectrometric measurements. The lecture included the origin of gamma rays, gamma ray interactions in matter, possible problems in calibrations, different systematic effects and how these can be taken care of, and background components.

The seminar on October 7<sup>th</sup> and 8<sup>th</sup> included invited lectures, participant presentations, presentations of intercomparison results, round table discussions and a participant feedback survey.

The presentations were made available to the participants at the GammaWiki web site.

Invited lecturers were:

1. Dr. Marie-Christine Lépy from the Laboratoire National Henri Becquerel (LNHB), France. Dr. Lépy is the former coordinator of the Gamma spectrometry Working Group of the International Committee for Radionuclide Metrology (ICRM). The topics of Dr. Lépy's lecture were:
  - Introduction including information about metrology at the international level
  - Efficiency calibration: experimental, Monte Carlo simulation, associated uncertainties
  - Radionuclide decay data and practical tools for gamma spectrometry
2. Dr. Tim Vidmar from Belgian Nuclear Research Centre (SCK•CEN), Belgium. Dr. Vidmar has developed the EFFTRAN software, which can be used for efficiency transfer and calculation of correction factors in gamma spectrometry. Dr. Vidmar gave three lectures:
  - MEFFTRAN, a new version of EFFTRAN for Marinelli beakers
  - Support for GammaVision in EFFTRAN (together with Trygve Bjerk)
  - EFFTRAN validation against other codes and against experimental data

Participants and persons from the GammaUser2014 project group giving a presentation:

- Daniela Pittauerova, University of Bremen, Germany
- Alexander Muring, Norwegian Radiation Protection Authority, Norway
- Mattias Olsson, Forsmarks Kraftgrupp AB, Sweden
- Laura Togneri, Fortum Power and Heat, Finland
- Aleksi Mattila, Radiation and Nuclear Safety Authority (STUK), Finland
- Gisli Jonsson, Icelandic Radiation Safety Authority (IRSA)
- Seppo Klemola, Radiation and Nuclear Safety Authority (STUK), Finland

### **Short resumes of the lectures**

The following section gives short resumes of the lectures given at the workshop.

#### **Invited talks**

##### **Marie-Christine Lepý**

In her first talk Ms. Lepý introduced the French metrology institute The Laboratoire National Henri Becquerel (LNHB), which is located in Saclay CEA Center and is in charge of radioactivity and dosimetry standards and nuclear decay data in France. She gave an overview of the basics of metrology with some remarks on the history of measurements. 50 years ago, in 1964, the General Conference on Weights and Measures (CGPM) decided the name for derived unit of activity: Becquerel. Today the mission of National Metrological Institutes is to provide users access to metrological references they need under a rigorously established traceability. At LNHB different techniques include coincidence measurements,  $4\pi\beta\text{-}\gamma$  counting, liquid scintillation counting, gas counting, alpha counting,  $^{222}\text{Rn}$  specific standard and calibration transfer by ionization chambers. LNHB photon spectrometry laboratory facilities include 10 HPGe detectors and one Si(Li) detector. Their energy range is from 100 eV to 4 MeV and

activity range from millibecquerels to gigabecquerels. LNHB has developed the ETNA software to calculate coincidence summing corrections and geometry transfer for efficiency.

Marie Christine Lépy's second lecture topic was efficiency calibration: experimental, Monte Carlo simulation and associated uncertainties. The principles of detector full-energy peak efficiency calculations were given. For accurate calculations there are still many challenges to overcome: exact knowledge of the detector parameters, attenuation coefficients, material densities, semi-conductor effects, electrical field and electrodes etc. With experimental calibration it is possible to obtain 1-2% relative uncertainty for a point source but for volume source calibration several corrective factors are involved causing larger uncertainties. Conclusions for the overall uncertainties were: 1) in general they are underestimated, 2) it is important to take each component into consideration and 3) corrective factors should be as close to 1 as possible.

Third topic was on radionuclide decay data and practical tools for gamma spectrometry. Since 1994 there has been an international cooperation to evaluate decay data: DDEP (Decay Data Evaluation Project). The objective is to provide carefully recommended nuclear and associated atomic data related to the nuclear disintegration for use in applied research and detector calibrations. The results of these DDEP evaluations are compiled and edited as a Monographie published under the auspice of the Bureau International des Poids et Mesures (BIPM). The web site <http://www.nucleide.org> was introduced as well as the LARA database at <http://laraweb.free.fr/>, which is a practical tool for spectrometry including gamma and alpha library of about 400 nuclides. Recently also coincidence summing information has been included.

### **Tim Vidmar**

First Tim Vidmar gave an introduction to the efficiency transfer method and made reference to two comparison studies of the method. Vidmar has developed a dedicated software, EFFTRAN, for efficiency transfer and additionally coincidence summing correction. The coincidence summing correction calculations of the code have been validated in the intercomparison study by Lépy. The conclusions were that EFFTRAN performs just as well or better than an "average" code and computed values agree with measured ones within their combined uncertainties. EFFTRAN was also validated in comparison of efficiencies between extended sources with the same calibrated water solution. Match between the measured and calculated efficiencies were within a couple of per cent.

Further, Vidmar demonstrated a new EFFTRAN module for import/export of efficiency values and coincidence summing correction factors into/from GammaVision in collaboration with Trygve Bjerk.

## **Participant presentations:**

### **Daniela Pittauerova: Summing gamma spectra: practical approach and examples in the environmental radioactivity**

A procedure for gamma spectra summing using Genie 2000 commands was presented, including a semi-automatic process using a batch-file script. Two examples were introduced, showing the advantages and practical use of the technique.

Long-term background spectra of three of the laboratory's detectors were studied showing sources of background gamma lines: radon and thoron progeny in the measurement chamber;

natural and artificial radionuclides contained in the detector, accessories and the shielding; and short-lived activation products formed by reactions of cosmic radiation with the detector, accessories and the shielding. The summed up spectra enabled the comparison of background in individual systems.

Summing up spectra of several following slices of a marine sediment core measured originally in high depth resolution made it possible to reduce the decision thresholds of artificial gamma emitters, which were not detectable in individual samples. Consequently, their inventories in the sediment profile could be quantified.

#### **Alexander Mauring: Effects of radon background variations on measurements of Ra-226 through its progeny**

In this study the background of HPGe detectors was found to vary significantly as function of the radon concentration in the air surrounding it, especially with regard to the count rates of <sup>222</sup>Rn daughter peaks. This effect was shown to potentially have a large impact on measured values of radon daughter activity concentration, as well as detection limits for low-level measurements. As these radionuclides are commonly used for estimating the activity of <sup>226</sup>Ra, care needs to be taken to ensure that background levels are accurately determined.

#### **Mattias Olsson: Gamma spectrometry applications at Forsmark**

Forsmark Nuclear Power Plant has three boiling water reactors. Gamma spectrometry applications are involved in several areas: process systems and their contamination, condenser off-gas and ventilation, environment, waste and free release, and whole body counting. Equipment in the counting rooms consists of Canberra detectors and software. External measurements on pipes and heat exchangers are performed with Ortec detector and software. Various systems have different challenges and e.g. correct efficiency evaluations depend on the knowledge of the system. Mobile systems can go through rough handling and wear of the equipment. On-line gas measurement systems have inflexible analysis routine and are without network connection. Difficulties of stack monitoring spectrometers are correct and traceable calibration, electric cooling, and background interpretation in case of very long counting times. In waste analysis, because of uneven distribution of radioactive materials, representative calibrations are hard to attain.

#### **Laura Togneri: Gamma spectroscopy at the Loviisa NPP**

Gamma spectroscopy at the Loviisa NPP is operated by the radiochemistry section, which consist of six persons. Responsibilities include process monitoring and radioactive release monitoring. The laboratory performs annually close to 10 000 measurements analysing the majority of the most significant nuclides. The equipment includes four HPGe detectors from Canberra integrated into the APEX system, and additionally on-line detectors at both plants and one detector in the emergency laboratory.

The two main objectives are to measure all release samples (water and air) reliably and to evaluate changes in different systems at the plant (fuel leak, leaks between systems). Power plant system-monitoring needs more trends than absolute results. In release monitoring first priority is given to reliable and conservative results. Constant learning for the whole laboratory staff is prerequisite when aiming to these objectives.

#### **Aleksi Mattila: Intercomparison sample preparation and characterization**

As a part of the GammaUser2014 workshop, participants were given a chance to analyze a physical sample containing Fukushima Dai-Ichi NPP accident fallout collected in Finland. The



samples containing small amounts of artificial activity were delivered to interested organizations during the summer 2014, with the instructions to report the results by September. In this presentation, the sample preparation and quality assurance process was described.

### **Gisli Jonsson: GammaUser2014 intercomparisons exercise**

Gísli Jónsson presented the results of the all three intercomparisons. There were altogether 16 participants registered in the intercomparisons. Five participants reported results for the physical sample. Only three set of results were received for spectrum exercises. Reference result for spectrum 1 includes the following nuclides: Be-7, K-40, Zr-95, Nb-95, Zr-97, Nb-97, Tc-99m, Mo-99, Ru-103, Rh-105, Ru-106, Te-132, I-131, I-132, I-133, Cs-134, Cs-136, Cs-137, Ba-140, La-140, Ce-141, Ce-143, Ce-144, Nd-147, U-237, Np-239. The origin for spectrum 2 was a sample containing Ac-227, most likely artificially produced.

### **Seppo Klemola: GammaUser2014 Spectrum Analysis Exercise**

The setup and a solution for the spectrum analysis exercise was presented. In the exercise spectrum from an old air filter measurement was provided together with setup and calibration data. STUK analysis results, i.e. identified radionuclides and their concentrations, were given. Additionally, the origin of the radioactivity detected in 1992 was explained.

## **Response by participants**

At the end of the meeting a survey amongst the participants was conducted. Written comments included evaluation of this meeting as well as suggestions for future events. The overall opinion was very positive. Suggestions for possible future topics include library tuning, continuation with intercomparisons, other detector types (LaBr<sub>3</sub>, NaI etc.). Again, this NKS meeting on gamma-ray spectrometry was highly appreciated by the participants. Some examples of feedback from the participants:

- *'First time on this meeting. Very happy with it. An important meeting place, everyone very positive, open and collaborative. Have learned new things.'*
- *'My favourite gamma spectrometry meeting!'*
- *'One of very few times a year that you get to meet gamma users. Useful!'*
- *'Very nice training course! Very good with long breaks for discussions!'*
- *'This workshop series is an important meeting and discussion platform for gamma spectroscopists in Nordic countries. Thanks to the organisers for preparing yet another great meeting!'*
- *'Workshop is a good place to discuss problems related to gammaspec.'*

The participants would like to see a continuation of this series of seminars/workshops. These series of NKS events have over the years been highly appreciated by Nordic users in gamma spectrometry.

## **Intercomparison exercises**

In the seminar announcement attendees were invited to participate in pre-workshop inter-comparison exercises (both with real spectra and physical samples), for which results would be presented and evaluated at the seminar. The design and conduct of the exercises are described in the following two chapters. The results of the intercomparisons were presented and discussed at the workshop, see resumes of the presentations in pages 6-7.

## **The spectrum exercise**

The spectrum exercise offered two spectra of different type to be analysed. The spectra were provided for download in zip archives in GammaWiki web-page created for the project. The first archive file contained Spectrum I in two formats: chn of Ortec and phd-format (ASCII), and additionally sample, measurement setup and calibration data. Also calibration and background spectra were provided. The given setup and calibration data was detailed enough in order for participants either to create efficiency calibration for their analysing software or to use ready-made calibration curve.

Measurement beaker data for both the sample and the calibration source included beaker inner diameter, bottom and side wall thicknesses, source material, height and density and source-detector distance. Detector (p-type coaxial) data included crystal diameter and length, core diameter and length, and additionally all absorbing layers (Ge, Al, mylar, vacuum) both on top and side. The reference activities of the ten calibration source nuclides (Co-57, Co-60, Sr-85, Y-88, Cd-109, Sn-113, Cs-137, Ce-139, Hg-203, Am-241) were given in the table. From this data participants could create efficiency calibration using computer tools, either Monte Carlo –method or efficiency transfer method.

The second archive file contained spectrum II in various formats (ORTEC chn, ORTEC spc, phd ASCII, and IEEE iec).

## **The sample exercise**

Physical samples were delivered to the registered participants using conventional mail. Sample material was powdered glass fibre air filter containing remains of recent nuclear power plant accident fallout. Air filter material was Camfil glass fibre CS 5.0. The exposed filter had been ground to a coarse powder, mixed and divided into individual samples each containing approximately 2 grams of ground filter material. Activity contents of each sample had been determined individually to ensure homogeneity.

The total artificial activity within each sample was well below 10 Bq. This ensures that the samples could be shipped and received as non-radioactive material. Participating laboratories were given the option to keep the sample material following the exercise. All the samples were provided free-of-charge.

Participants were asked to provide their results to the organizers by September. Summaries of sample preparation and quality assurance procedures and participant's results were given in two separate presentations during the workshop.

## **Previous meetings**

### **GammaSem 2009 and 2010**

At the first GammaSem seminar, the highly regarded 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 detections limits, True coincidence summing corrections, Monte Carlo simulations and efficiency transfer, Absorption (density corrections and geometries), Mobile gamma spectrometry systems and 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 organize web sites for posting relevant information and discussion forums. This would make it easier to contact Nordic colleagues on issues related to gamma spectrometry (Nunez, 2010)

At GammaSem 2010, all six working groups from GammaSem 2009 were invited to give presentations of their work accomplished during the last year. Two out of six working groups gave such presentations: Working group on uncertainties and detections limits and Working group on true coincidence summing corrections.

The working group concept did not work as well as had been hoped, possibly because of this being only the first attempt. Most of the laboratories signed up to join a working group because they wanted to learn more about the different subjects. In the future, it must be ensured that the working group also includes a domain expert willing to lead the discussion. This, in combination with the fact that no funding was made available for the working groups, made it difficult to establish goals for the group to achieve. Based on this experience, the next meetings took the form of workshops covering relevant issues suggested by the participants, rather than continuing with a third seminar.

The websites, GammaForum and GammaWiki, modeled after the enormously successful Wikipedia project, 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 unused GammaForum, but to keep GammaWiki. In the period following GammaSem 2010, GammaWiki has been regularly used by the GammaSem/Workshops organisers for posting relevant information for the participants.

Also at GammaSem 2010 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 (Strålberg, 2010).

### **GammaWorkshops 2011 and 2012**

GammaWorkshops 2011 was arranged based on feedback from participants 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 Netherlands 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 Gamma-Workshops organisers, including presentations of SMATH, a freeware form solving e.g. the Bateman equations, an empirical correction method for self-absorption, 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. (Ramebäck, 2012)

GammaWorkshops 2012 meeting was to a large extent based on the suggestions from the participants of the previous meeting in 2011. The meeting included lectures from experts within the field of gamma ray spectrometry, as well as a practical session in analyzing complex gamma ray spectra.

Dr. Sandor Tarjan presented a comparison of different software (GammaVision, Genie2k and Winner) for the evaluation of gamma ray spectra. The software packages were compared with regard to peak identification, libraries, true coincidence summing correction, self-attenuation correction and decay correction. Spectra from fallout from the Fukushima nuclear power plant accident were used in the comparison. These, and other, spectra were also used in practical exercises amongst the participants. Dr. Tarjan also discussed the possibility for validating *in situ* gamma ray spectrometric measurements. 450 'point sources' printed with ink spiked with a <sup>131</sup>I reference solution were used to get a 20 m x 20 m surface for calibration of a detector. This calibration was compared to a mathematical calibration using the ISOCS software from Canberra, and the two methods showed good agreement on two different surfaces.

Dr. Andrew Tyler gave a lecture on *in situ* gamma ray spectrometry. This method is less time consuming compared to soil sampling and subsequent laboratory measurements. However, care has to be taken both in calibration and in taking into account the variation in e.g. vertical radionuclide distribution.

Dr. Gerhard Fritz presented the implementation of cascade summing corrections in Genie 2000. The lecture included the requirements for performing TCS corrections in Genie 2000 as well as Canberra's method for detector characterisation. The method for TCS correction applied in Genie 2000 was given. Finally, a comparison of correction factors for different radionuclides and detector geometries was shown.

There were also presentations by the organisers of the GammaWorkshops: "QA, what is needed in an accredited laboratory?", "Validation of detection limits", "Background components in gamma spectrometry", "New developments", "Other types of detectors (LaBr<sub>3</sub>, NaI): comparisons with respect to identification", "User experience with new techniques: electric cooling, integrated electronics, safe working environments" (Strålberg, 2013).

### **GammaTest 2013**

37 persons from 25 different organisations in the Nordic countries attended the workshop. Most participants were young scientists who work with gamma spectrometry. Invited lecturers were professor Octavian Sima from the University of Bucharest, Romania and Dr. Tim Vidmar from SCK-CEN, Belgium. Professor Sima is one of the developers of the software GESPECOR, which can be applied for different issues in gamma ray spectrometry including efficiency calculations, efficiency transfer and for the calculation of correction factors like self attenuation and true coincidence summing. The topic of Professor Sima's lecture were 'Monte Carlo Simulations

Applied to Gamma Ray Spectrometry'. Dr. Vidmar has developed the software EFFTRAN, which can be used for efficiency transfer and calculation of correction factors in gamma spectrometry. Dr. Vidmar gave three lectures: a) 'Angular correlation and their influence on coincidence summing corrections'; b) 'The sum-peak method as a tool for radionuclide standardization'; and c) 'An example of the application of the sum-peak method- determination of  $^{176}\text{Lu}$  half life'.

There were also presentations given by persons from the GammaTest project board, as well as by participants. Dr. Sven P. Nielsen from DTU Nutech, Denmark, presented the results of the intercomparison of the real-world samples. Seppo Klemola from STUK, Finland, presented the results from the peak identification intercomparison. Trygve Bjerck and Elisabeth Strålberg from IFE, Norway, presented the results of the intercomparison comprising a sample spectrum and spectrum from a calibration of the detector as well as detector details. Dr. Sofia Jonsson from FOI, Sweden, gave a presentation on the implementation of computer codes for the calculation of efficiency transfer and correction factors in gamma spectrometry. Annika Tovedal from FOI, Sweden, gave a presentation of a gamma spectrometric method for the screening of natural radionuclides (Ramebäck, 2014).

NKS reports from all the previous seminars and workshops are available at the NKS web-site.

### Concluding remarks

The need for cooperation, interaction, and training within the field of gamma spectrometry remains. At every one of the meetings in series the audience has been polled for their interest in a continuation of the series and GammaUser 2014 is no exception. Without fail, the results of the polls have been encouraging. But for this series to continue to be relevant, it must continue to evolve.

The GammaUser 2014 participants also agreed that the meetings have been successful in providing a uniquely useful forum for users of gamma ray spectrometry in the Nordic region. Moreover, participants found lectures, practical sessions, and now at the latest meeting the intercomparisons, very useful in learning how to deal with difficult issues relevant to gamma spectrometry. This fact is very important since a very limited number of 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, GammaWorkshops, GammaTest and GammaUser have therefore helped to boost up the general knowledge regarding important issues in measurements of gamma emitting radionuclides.

The different workshops and seminars organized within the framework of NKS have gained a high reputation amongst both international experts as well as amongst the participants. At the 2014 meeting in Helsinki the participants expressed a strong wish for a continuation of this work.

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**Appendix 1 – List of participants**

<b>Name</b>	<b>Affiliation</b>
Øyvind Aas-Hansen	Norwegian Radiation Protection Authority
Jenni Alanen	Teollisuuden Voima Oyj
Bogi Brimir Árnason	Icelandic Radiation Safety Authority
Trygve Bjerk	Institute for Energy Technology
Michel Ceuppens	Canberra
Kjartan Gudnason	Icelandic Radiation Safety Authority
Eirik Gundersen	Gammadata
Esa Heikkinen	Gammadata Finland Oy
Miska Hirvelä	Fortum, Loviisa NPP
Stefan Isaksson	Gammadata Instrument AB
Gísli Jónsson	Icelandic Radiation Safety Authority
Seppo Klemola	Radiation and Nuclear Safety Authority - STUK
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Henrik Larsson	Canberra
Ari-Pekka Leppänen	Radiation and Nuclear Safety Authority - STUK
Marie-Christine Lépy	Laboratoire National Henri Becquerel
Aleksi Mattila	Radiation and Nuclear Safety Authority - STUK
Einari Mattila	Fortum, Loviisa NPP
Alexander Mauring	Norwegian Radiation Protection Authority
David Mendes	Canberra
Renata Mikalauskiene	Nature Research Centre, Lithuania
Sven Nielsen	DTU Nutech
Anne Nurminen	Teollisuuden Voima Oyj
Minna Ollas	Fortum Oy
Mattias Olsson	Forsmarks Kraftgrupp AB
Ilkka Paljakka	Fortum, Loviisa NPP
Daniela Pittauerova	University of Bremen, Germany
Henrik Ramebäck	Swedish Defence Research Agency
Jarno Saarela	Fortum Oy
Riku Savila	Fortum Oy

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Jarno Tuominen	Fortum
Arto Turpeinen	Fortum
Antti Vainonen	Radiation and Nuclear Safety Authority - STUK
Vesa-Pekka Vartti	Radiation and Nuclear Safety Authority - STUK
Tim Vidmar	SCK•CEN, Belgian Nuclear Research Centre
Raila Viitala	Teollisuuden Voima Oyj
Jarkko Ylipieti	Radiation and Nuclear Safety Authority - STUK

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## Appendix 2 – Agenda of the GammaUser 2014

### Monday 6 October

- 13:00 – 14:45 **Introductory course on gamma spectrometry**, Henrik Ramebäck (FOI, Sweden)
- 14:45 – 15:15 Break; coffee and sandwich
- 15:15 – 17:00 **Introductory course – continued**

### Tuesday 7 October

- 08:45 – 09:00 **Registration**
- 09:00 – 09:10 **Opening of GammaUser2014 workshop 2010 by Pia Vesterbacka**  
Deputy Director, Environmental Radiation Surveillance, STUK
- 09:10 – 09:15 **Practical information**, Seppo Klemola
- 09:15 – 10:15 **Invited speaker: Marie-Christine Lepý**, Laboratoire National Henri Becquerel (LNHB), France
- Introduction incl. information about metrology at the international level
  - Efficiency calibration
    - experimental
    - Monte Carlo simulation
    - associated uncertainties
- 10:15 – 11:00 Break; Coffee etc.
- 11:00 – 12:00 **Invited speaker: Marie-Christine Lepý – Continued**
- Examples of activity measurement in the medical and environment fields
  - Radionuclide decay data and practical tools for gamma spectrometry
- 12:00 – 13:00 Lunch
- 13:00 – 14:00 **Invited speaker: Tim Vidmar**, Belgian Nuclear Research Centre (SCK•CEN), Belgium
- MEFFTRAN, a new version of EFFTRAN for Marinelli beakers
  - Support for GammaVision in EFFTRAN (together with Trygve Bjerck)
  - EFFTRAN validation against other codes and against experimental data
- 14:00 – 14:30 **Participant presentations**  
**Daniela Pittauerova**, University of Bremen, Germany  
Summing gamma spectra: practical approach and examples in the environmental Radioactivity
- 14:30 – 15:00 Break; Coffee etc.

- 15:00 – 16:00     **Participant presentations** – Continued  
                         **Alexander Mauring**, Norwegian Radiation Protection Authority, Norway  
                         Effects of radon background variations on measurements of Ra-226 through its  
                         progeny  
                         **Mattias Olsson**, Forsmarks Kraftgrupp AB, Sweden  
                         Gamma spectrometry applications at Forsmark  
                         **Laura Togneri, Fortum** Power and Heat, Finland  
                         Gamma spectroscopy at the Loviisa NPP
- 16:00 – 17:00     **Visit to laboratories**
- 19:00 –             **Workshop dinner** at Zetor restaurant

### **Wednesday 8 October**

- 09:00 – 10:00     **Intercomparison results and discussions**  
                         Aleksi Mattila/Gísli Jónsson  
                         Seppo Klemola
- 10:00 – 10:30     Break; Coffee etc.
- 10:30 – 11:00     **Discussion topic: Designing libraries**
- 11:00 – 11:15     Participant feedback survey
- 11:15 – 12:00     **Round table discussion: Workshop round up and the future of gamma  
spectrometry**  
                         Meetings
- 12:00 – 12:00     End of workshop
- 12:00 –             Optional Lunch

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Abstract max. 2000 characters	<p>Due to a sparse interaction during the last years between users of gamma ray spectrometry in the Nordic countries, a NKS activity was started in 2009. For the past 6 years, dozens of Nordic gamma spectrometry users have met each year to share their experiences and challenges. All of these meetings were supported by the Nordic Nuclear Safety Research (NKS) and organized by members from all five Nordic countries. The meetings have been well attended, popular, and rated as very useful by their participants.</p> <p>GammaUser 2014 meeting was held in Helsinki, Finland. Altogether 45 persons from 16 different organisations from the Nordic and other European countries attended the seminar. 17 of the participants were personnel of the nuclear power companies working with gamma spectrometry. In connection with the meeting also an introductory course on gamma spectrometry was organized. The seminar included invited lectures, participant presentations, round table discussions and a participant feedback survey. The topics of invited lecturers covered e.g. various types of efficiency evaluations: experimental, semi-empirical and Monte Carlo calculations. The seminar also included presentations by participants. The results of the intercomparisons organized by project were presented by GammaUser project group members.</p>
Key words	Gamma spectrometry, intercomparisons, corrections