Coordinator’s Report

Gamma-Ray Spectrometry Working Group

Activity from the General Meeting of the ICRM, Vienna, June 12, 2015 up to the General Meeting of the ICRM, Buenos Aires, May 19, 2017

Gamma-ray spectrometry community comprises a large number of members, with a wide range of interests and expertise. The ICRM Gamma-Ray Spectrometry Working Group (GS WG) represents a frame for active collaboration between the ICRM members for the development of experimental and computational techniques relevant to gamma-spectrometry. It also promotes collaboration in view of disseminating knowledge in the field and provides the opportunity for testing the analytical capability of various laboratories.

Actions proposed during the meeting of the Gamma-ray spectrometry working group of the ICRM, Vienna, June 11, 2015.

A problem of major concern in gamma-ray spectrometry is the evaluation of coincidence summing correction factors. Several intercomparisons were organized by the ICRM GS-WG in order to evaluate the quality of the procedures applied to this purpose. The results were presented in several ICRM conferences and were published in Applied Radiation and Isotopes [M.-C. Lépy et al., Appl. Radiat. Isot. 68 (2010) 1407; M.-C. Lépy et al., Appl. Radiat. Isot. 70 (2012) 2112; T. Vidmar et al., Appl. Radiat. Isot. 87 (2014) 336; T. Vidmar et al., Appl. Radiat. Isot. 109 (2016) 482]. As a result of the intercomparisons, the quality of the procedures improved, the compatibility of specific codes was established, and the procedures for the evaluation of the uncertainties was refined. Despite the progress achieved, there are still some discrepancies between the results obtained with various codes and sometimes with respect to precise calibrations. Because the computation of coincidence summing corrections is a complex procedure, combining details of the decay scheme with efficiency (peak and total) dependence on the emission point throughout the source, a comparison of the final results of the correction factor cannot reveal the source of discrepancies. Therefore, an action aiming to investigate step by step the procedures used to evaluate the coincidence summing effects was proposed by O. Sima (University of Bucharest, Romania). In the first step the computation of the probability of simultaneous detection of one photon in the peak and of another (from the
same cascade) somewhere in the spectrum were required; such quantities describe the probability of removing a count from the peak of the first photon due to the second photon per one decay path including the two photons. Also the probability of simultaneous detection of both photons in the respective peaks was required; this quantity describes the summing in contribution to a peak. The computations were intended for volume sources with water and aluminum as matrices. In this first step it was proposed to exclude the shield from the experimental arrangement, whereas in the second step it should be included. Next the evaluation of the probabilities of detection of three photons in the same conditions was required. Concerning the joint emission probability of groups of photons, a perfectly balanced decay scheme with 6 levels was proposed. In one step it was assumed that X rays are not emitted following the decay, in the next EC decay was proposed for evaluation, in the presence of significant conversion electron emissions. Finally the value of $F_C$ was required for an n-type detector and also for a well-type detector.

The participants were asked to send the confirmation of their interest for the participation in this exercise.

A second action was proposed by Dr. A. Petrucci from ENEA-INMRI, Italy. During the activities carried out within the MetroMetal project, calibration standards for use in the measurement of cylindrical steel samples were prepared from steel discs; on the discs drops of radioactive solutions were placed to mimic surface sources. By placing the discs prepared in this way between identical, but not contaminated discs, various configurations with surface contamination at specific sections within a cylindrical source could be obtained. In order to use these standards for the calibration of homogeneous volume sources it is necessary to compute the efficiency transfer between the two measurement configurations. The action was intended to evaluate the efficiency transfer factors using several codes (ETNA, GESPECOR, PENELPOE, GEANT), both in the case of steel samples, as well as in the case of water samples. In order to resolve the problem a corresponding action was proposed by WG members from ENEA. Dr. Dirk Arnold (PTB, Germany), the president of ICRM, mentioned the possibility to include experimental tests of the computations, using the composite steel standards prepared by PTB and CIEMAT. The members of the WG were invited to join this action.

ENEA and LNHB offered to host workshops in 2015 and 2016 to promote the development of the actions proposed.

The number of members of the GS WG interested in participating in the two actions was too small and the actions were not organized. The rather high work load required by the first action and also the need to adapt the code for the evaluation of the coincidence
summing effects for particular cases, not immediately related to standard applications of the codes, probably demotivated some members of the group. Also, the management of the action (insistence in inviting the participants to take part) was inappropriate. Thus, dr. Octavian Sima, who proposed the action, is responsible for the failure of the action.

Despite the cancellation of the action, specific improvements in the codes for the evaluation of the coincidence summing corrections factors, including more friendly procedures to manipulate the decay data and the estimation of the uncertainty, were published by members of the GS WG.

The members of GS WG continued the effort towards more sensitive measurements, more refined calculation of the uncertainty, and addressed other problems, such as the case of inhomogeneous sources. Many of these developments were presented in the ICRM-LLRMT 2016 Conference in Seattle.

*Actions proposed during the meeting of the GS WG in Buenos Aires, May 16, 2017.*

In view of the fact that computer codes are applied more and more frequently for the evaluation of the efficiency and of the correction factors required in gamma ray spectrometry, Dr. Marie-Christine Lépy proposed an action intended to facilitate the application of generalist codes to such calculations. Indeed, for a common user of gamma-ray spectrometry, it might be difficult to prepare the geometry file or the detector file to be used in a code like GEANT4, MCNP, PENEOPE etc. The action could result in the creation of such files appropriate for specific cases, and in the development of procedures for automatic preparation of the files, using available software like CAD.

Dr. Octavian Sima proposed a simple a quick test of internal consistency of the codes applied for the evaluation of coincidence summing corrections. The test is based on exact analytical equations that relate the correction factors and the efficiencies for two vacuum volume sources, measured in vacuum, to the same quantities corresponding to the source obtained by uniting the two sources. The test does not require changes in the existing software and it is easily applied.

Dr. Marie-Christine Lépy proposed an intermediate meeting of the GS WG to be held in Paris in 2018, for the discussion of the advancement of the two cases. After the meeting, a specialized school in gamma ray spectrometry could be also organized.

An important and time consuming task of several members of the GS WG was in quality of referees of the papers to be presented in the conferences (ICRM-LLRMT, 2016, ICRM 2017). The coordinator of the GS WG highly appreciates the work done by the referees and presents special thanks to: Dirk Arnold (PTB, Germany), Michel Bruggeman (SCK-CEN, Belgium), Pierino De Felice (ENEA, Italy), John Hardy (Texas A&M, USA), Mikael Hult (IRMM, JRC, EU), Matjaz Korun (IJS, Slovenia), Marie-Christine Lépy
On behalf of the Gamma-Ray Spectrometry Working Group,

Prof. Octavian Sima (coordinator)
Physics Department, University of Bucharest
425, Atomistilor Str., Bucharest-Magurele
P.O.Box MG-11
RO-077125, Romania
e-mail: Octavian.Sima@partner.kit.edu