

Coordinator's report of the ICRM Beta-Particle Spectrometry Working Group

Scope

The Beta Particle Spectrometry Working Group is devoted to the development of the metrological aspects of beta spectrometry and its applications. This includes, but is not restricted to:

- Theory
 - Beta (β^\pm) and electron capture (ϵ) transitions
 - Theoretical shape factors and influence of the nuclear current
 - Atomic effects
- Experiments
 - Instrumentations used for beta spectrometry
 - Techniques that need beta information
 - Confidence on experimental shape factors
 - Data analysis and unfolding methods
- Simulations
 - Confidence on the physical processes: low energies, radioactive decays, atomic rearrangements
 - Comparison of the results of different codes: Geant4, Penelope, etc.
- Evaluations and dissemination
 - Confidence and uncertainties on experimental shape factors
 - Evaluation procedure for establishing recommended experimental shape factors
 - Mean energies, $\log ft$ values, database

Interested communities in radionuclide metrology are: nuclear decay data, liquid scintillation counting, ionizing chambers, 4π β - γ counting.

Working Group meeting at NPL, September 21, 2016

This meeting at NPL followed the DDEP meeting (September 19-20, 2016) and the ICRM Nuclear Decay Data Working Group meeting (morning September 21, 2016). The following topics were discussed:

- A dedicated website (http://www.nucleide.org/ICRM_BSWG.htm) was created this summer and presented at the meeting. This first version will change in accordance with the activities of the Working Group.
- The EMPIR MetroBeta project (<http://metrobeta-empir.eu/>), which addresses both theoretical and experimental approaches to improve the knowledge of beta spectra, was presented.
- Theory
 - Beta transitions
First release of the BetaShape program (<http://www.nucleide.org/logiciels.htm>), presented in detail during the DDEP meeting. Compared to the LogFT program, the calculations of beta emission properties (mean energies, $\log ft$ values) are improved, and beta and neutrino spectra are provided. A database of experimental shape factors is also included. It was decided to use the BetaShape program for future DDEP evaluations.

- Electron capture transitions
These transitions are not treated by the BetaShape program. Improved calculations are ongoing based on bound wave functions determined for the atomic exchange effect in beta transition. Preliminary results for ^{138}La published in the proceedings of the ICRM 2015 conference seem very promising.
- Nuclear structure
Inclusion of the nuclear structure in beta calculations for allowed and forbidden unique transitions is one of the main goals of WP1 within the MetroBeta project. Ryan Fitzgerald (NIST, USA) mentioned possible link with American nuclear theorists.
- **Measurements & Simulations**
 - Frédéric Juget (University Hospital of Lausanne, IRA, Switzerland) presented the current status of his beta spectrometer. Developments are ongoing in order to improve the accuracy of the measured beta spectra.
 - The measurements performed at LNHB by a PhD student (Charlène Bisch, 2011-2014) were presented. Beta spectra from ^{14}C , ^{151}Sm and ^{99}Tc decays were measured using a silicon PIPS detector. Precise Geant4 simulations and an unfolding model were developed, leading to excellent agreement with the literature for ^{14}C . A new PhD thesis should start in 2017 to improve the quality of these measurements. It was mentioned that unfolding methods already exist for NaI(Tl) detectors.
 - A decay module for Penelope, called PenNuc, was recently implemented. A Geant4 decay module, better than the existing one and using DDEP data, would be very useful for the metrology community and beyond. LNHB and NIST are interested in this development. F. Juget said that one of his colleague at CHUV, Laurent Desorgher, is involved in the Geant4 collaboration and could be of great help. It was mentioned that K. Kossert (PTB) has already looked in detail at the atomic rearrangement. A training position for six months is open at LNHB for a Master student to work on this module in 2017. This study will be coordinated by C. Thiam (cheick.thiam@cea.fr). Anyone who would like to be involved is invited to contact him.
 - A comparison of the results from Penelope and Geant4, and possibly other Monte Carlo codes, for specific detection geometries was discussed. A focus on low beta and gamma energies is recommended. Brian Zimmerman (NIST, USA) mentioned a similar study within the ICRM Life Sciences Working Group with a focus on bremsstrahlung.
 - The following beta decays will be measured with Metallic Magnetic Calorimeters within the MetroBeta project: ^{14}C , ^{36}Cl , ^{99}Tc and ^{151}Sm . Any recommendation from other ICRM Working Groups is welcome.
- **Evaluation & Dissemination**
 - A database of published experimental shape factors, as comprehensive as possible, is recommended. This database can be held at LNHB and be made available through the Working Group website. Measurements of single transition as well as cumulative beta spectra following a decay should be considered. Anyone can send to the coordinator every relevant publication to feed the database.
 - Linked to the presentation of Alejandro Sonzogni (NNDC, Brookhaven National Laboratory, USA) during the DDEP meeting, a discussion took place about the difficulties of analyzing published shape factors: different definitions of the Fermi function; different methods for establishing the experimental shape factors; definition and management of

the uncertainties; influence of the endpoint energy, the unfolding process, the source thickness, etc.

- Dissemination of the results was also discussed. The needs of the metrological community and of the medical care sector for dosimetry calculations were mentioned. The simplest solution is recommended: ASCII files of beta spectra should be associated with each DDEP evaluation and made available online on the DDEP website.

Forthcoming

The next meeting of the Working Group will be in Buenos Aires during the ICRM 2017 conference.

On behalf of the Beta-Particle Spectrometry Working Group,

Xavier Mougeot (coordinator)

CEA, LIST, Laboratoire National Henri Becquerel (LNE-LNHB)
Bât. 602 PC111, CEA-Saclay 91191 Gif-sur-Yvette Cedex, France
phone: +33 1 69 08 23 32
e-mail: xavier.mougeot@cea.fr