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**Bureau National de Métrologie – Laboratoire National Henri Becquerel (BNM-LNHB)**  
**Summary of activities in the field of Radionuclide Metrology**  
**(May 1999 to March 2001)**

**Contribution to the 16<sup>th</sup> Meeting of CCRI (Section II), 21 May to 23 May 2001**  
**By N. Coursol**

**1 – Improvements in activity measurements**

- Development of MAC3 : an electronic module for the processing of pulses delivered by a three photomultiplier liquid scintillation counting system
- Development of MTR2: a discriminator and dead-time module used in counting systems e.g. on  $4\pi\beta\text{-}\gamma$  coincidences
- Development of a main design principles of a 3-photomultiplier tubes LSC counter for the implementation of the TDCR method
- Incorporation of a liquid scintillation system in the  $\beta$  channel of the  $4\pi\beta\text{-}\gamma$  coincidence counting systems and complete processing of the  $\gamma$  spectra (coincident, non coincident)
- Study of the effect of the ionisation quenching factor kB on the calculated detection efficiency using the TDCR method, for electron-capture radionuclides (it is small) and for low-energy beta nuclides (can be important)
- Study of dead-time problems related to  $^{226}\text{Ra}$  and  $^{222}\text{Rn}$  LSC standardisation due to the presence of  $^{214}\text{Po}$  (165  $\mu\text{s}$  half-life) (on-going)
- Development of a non-destructive X- and  $\gamma$ -ray spectrometry analysis method for determining the plutonium isotopic composition (on-going)
- Development of a tunable monochromatic X-ray source (1-20) keV for low-energy X-ray spectrometry and counting (on-going)
- Efficiency and peak shape calibration of semiconductor detectors using synchrotron radiation: detailed processing of low-energy X-ray spectra and study of the response function of a HPGe detector (FWHM = 110 eV at 5,9 keV) for the low-energy range (on-going).

- Experimental tests to validate a new code for efficiency transfer and coincidence summing corrections
- Development of ETNA code for efficiency transfer and coincidence summing corrections
- Study of the influence of the geometry and components in the response of  $4\pi$ -ionisation chambers using the stochastic code "Penelope" (on-going)
- Calibration of a  $4\pi$ -ionisation chamber for the standardisation of nuclides of medical interest (on-going)
- Characterisation of a DSA device for low-level measurements
- Characterization of digital signal processors
- Sn-NTD germanium microcalorimeters operated in a dilution refrigerator at 50 mK: obtained 40 eV FWHM energy resolution for 6 keV photon associated with a 100% detection efficiency for 1 keV to 6 keV photons
- Feasibility study of activity standardization with a  $4\pi$  counting bolometer (on-going)

## 2 – Radionuclide measurements

- Submissions to the SIR:  $^{54}\text{Mn}$ ,  $^{57}\text{Co}$ ,  $^{60}\text{Co}$  and  $^{65}\text{Zn}$
- Standardization of  $^3\text{H}$ ,  $^{18}\text{F}$ ,  $^{35}\text{S}$ ,  $^{51}\text{Cr}$ ,  $^{85}\text{Sr}$ ,  $^{89}\text{Sr}$ ,  $^{90}\text{Y}$ ,  $^{153}\text{Sm}$ ,  $^{169}\text{Er}$ ,  $^{152}\text{Eu}$  and  $^{222}\text{Rn}$  solutions

## 3 – Evaluation and measurement of nuclear decay data

- Determination of the  $\gamma$ -ray emission probabilities for  $^{237}\text{Np}$ - $^{233}\text{Pa}$ ,  $^{65}\text{Zn}$  and  $^{154}\text{Eu}$  (on-going)
- Evaluation or updating decay data of  $^{59}\text{Fe}$ ,  $^{93}\text{Mo}$ ,  $^{93}\text{Nb}^{\text{m}}$ ,  $^{99}\text{Mo}$ ,  $^{99}\text{Tc}$ ,  $^{99}\text{Tc}^{\text{m}}$ ,  $^{166}\text{Ho}$ ,  $^{166}\text{Ho}^{\text{m}}$ ,  $^{169}\text{Yb}$
- Evaluation of half-life value of  $^{79}\text{Se}$  and  $^{126}\text{Sn}$
- Development of a program in order to transfer the data from NUCLÉIDE to ENSDF (on-going)
- Improvement of the interactive database for Internal Conversion Coefficients calculations and analysis
- Publication of an updated table for gamma and alpha spectrometry purposes (LARA)
- Measurement of half-life values for selected nuclides  $^{65}\text{Zn}$ ,  $^{88}\text{Y}$ ,  $^{89}\text{Sr}$ ,  $^{125}\text{I}$  (on-going)

#### 4 – International activities

##### *BIPM :*

- Member of CCRI, section II
- Member of the CCRI(II) Evaluation of the SIR- and International Equivalence-WGs
- Member of the CCRI(II) WG extension of the SIR to  $\beta$  emitters
- Member of the CCRI(II) WG on activity measurement, particularly for  $^{204}\text{Tl}$
- Participation on the CCRI(II)  $^{152}\text{Eu}$ ,  $^{89}\text{Sr}$  and  $^{238}\text{Pu}$  intercomparisons

##### *EA :*

- Co-ordination of the EA IR2 intercomparison in collaboration with the French Body COFRAC (analysis of a mixed solution of six  $\gamma$ -ray-emitters radionuclides)
- Member of the WG “Ionizing radiation and radioactivity”
- Member of Committee 2 “Calibration and testing activities”

##### *ESARDA :*

- In collaboration with IRMM, coordination of the international exercise “Pu-2000”
- Analysis of the nuclear data on uranium enrichment results obtained using methods based on the analysis of the uranium spectrum  $\text{XK}_\alpha$  region
- Realization of a U- and Pu-spectra data library (on-going)
- Member of the WG “Non-Destructive Assay”

##### *EUROMET :*

- Co-ordination of the projects n° 410 ( $^{169}\text{Yb}$ ), n° 383( $^{222}\text{Rn}$ ) and n° 428 (transfer of point source efficiencies to other geometries)
- Participation on project n° 591 ( $^{235}\text{U}$  decay data)
- Participation on the setting up of Annexe C of MRA
- French Contact Person on the field of Ionising radiation
- Rapporteur on the field of Ionising radiation (starting on May 2001)

##### *IAEA :*

- Membership of the Coordinated Research Program on “Updating of X- and  $\gamma$ -ray decay data standards for detector calibration
- Participation on Decay Data Evaluation Project (DDEP)
- Establishing reference radio-analytical procedures for the determination of low levels of radionuclides in comparison materials with assigned property values traceable to the SI of units

*ICRM :*

- Co-ordination of the Liquid Scintillation Counting Working Group
- Organisation of an intermediate meeting of the LSC-WG at Saclay, November 2000
- Chairman of the Nominating Committee
- Member of the Scientific Committees of ICRM'99 in Prague, and ICRM'01 in Braunschweig

*Others :*

- Collaboration with RC-Swierk on Liquid Scintillation Counting Method
- Collaboration with NIST on the study of dead-time problems related to  $^{226}\text{Ra}$  and  $^{222}\text{Rn}$  LSC standardisation due to the presence of  $^{214}\text{Po}$  (165  $\mu\text{s}$  half-life)
- Collaboration with IFIN on LS counting, gas measurement and on  $\gamma$ -ray spectrometry
- Collaboration with PTB on the "Table of Radionuclides"
- Collaboration with BNL (USA), the KRI(Russia), the PTB and the CIEMAT on decay data evaluation
- Collaboration with JINR/LNP, Dubna (Russia) on Internal Conversion Coefficient database
- Collaboration with VNIIM on activity measurement techniques
- Collaboration with LNMRI on activity measurement techniques
- Collaboration with the University of Sofia (Bulgary) on gas measurement methods
- Collaboration with the University of Catane (Italy) on  $\alpha$  sources for PIXE

**5 – Publications**

- *M.M. Bé, E. Browne, V. Chechev, N. Coursol, B. Duchemin, R. Helmer, J. Lamé, C. Morillon, F. Piton and E. Schönfeld*, Table de Radionucléide, volume 5, CEA/DAMRI, 91191 Gif-sur-Yvette, France. 1999, ISBN 2 7272 0200 8
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- *J. Bouchard and B. Chauvenet*, A simple, powerful  $4\pi\beta$ - $\gamma$  coincidence system based on the pulse-mixing method, Nucl. Instr. Meth. In Phys. A422 (1999) 395-399

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- *L. Pappalardo, F.P. Romano, J. de Sanoit*, Black gloss characterization of Greek Attic pottery carried out by means of the non destructive PIXE-ALPHA portable system, Proc. 2<sup>nd</sup> Intern. Congress on "Science and Technology for the safeguard of cultural heritage in the Mediterranean basin", Paris (5-9 July) 1999
- *M.N. Amiot-Péron, P. Stemmler, G. Soullié, V. Greiner, P. Populus, P. Chevallier, J.C. Protas*, Measurements of linear absorption coefficients of liquid scintillators using synchrotron radiation, Appl. Radiat. Isot. 52 (2000) 649-656
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