Contributions of IFIN-HH / Radionuclide Metrology Laboratory in nuclear decay data research

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- Presentation of IFIN-HH / DRMR / LMR
- Previous research work – nuclear data
- Current research projects about nuclear data measurements and evaluations (2012)
- **IAEA Ctr. 17442/2012: What do we want to do? How ? What do we need ? Are there some difficult problems to solve ?**

IFIN-HH: brief history (1)

- IFIN-HH: Horia Hulubei National Institute of Physics and Nuclear Engineering
- Founded by Prof. Horia Hulubei in 1949:

Horia Hulubei (1896 - 1972)

Contribution to the study of quantum diffusion of X-rays
(Ph.D. Thesis, Paris, 1933).
Supervisor: Jean Perrin (Nobel Prize).
Chairman: Marie Curie (Nobel Prize).
Founder and First Director of the Institute.

IFIN-HH: brief history (2)

- The first Romanian computer (1955)
- 10 % of the Romanian scientific output (scientific articles)
- Departments of Theoretical Physics, Applied Nuclear Physics, Life sciences and environmental physics, Radiochemistry, Nuclear engineering etc.;
- Present Facilities: Tandem accelerators, Cyclotrons, Multipurpose irradiation facility, Radioactive waste treatment plant, Radioisotopes production centre, Nuclear training center, nuclear reactor (under decommissioning) etc.
- More details (in English): www.ifin.ro

Radionuclide Metrology Laboratory (LMR)

- Founded by

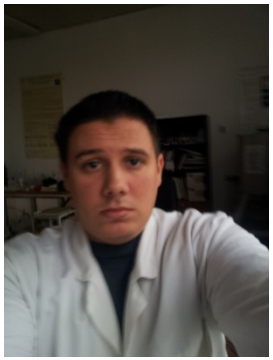
Dr. Enric Leon Grigorescu, in early 1960s;

he initiated a cooperation with CEA/LMRI-LPRI, after 1963 (Mesucora congress, Paris); since 1993, a Cooperation Agreement betweeen our laboratories was signed and constantly renewed.

Radionuclide Metrology Laboratory, in IFIN-HH/Dept. of Radioisotopes and Radiation Metrology







Present members (2012):

- Dr. Maria Sahagia (Head of LMR)
- Dr. Aurelian Luca (Deputy Head of LMR)
- Dr. Constantin Ivan (Technical-Adm.Director IFIN-HH)
- Phys. Andrei Antohe, PhD student
- Phys. Mihail-Razvan Ioan, PhD student

Radionuclide Metrology Laboratory (LMR) - 3

- IFIN-HH/LMR is the owner of primary and national (under way) standard of activity unit (Bq) in Romania
- Designated by the Romanian Bureau of Legal Metrology as participant at the CIPM-MRA ionizing radiations and at the IR-TC of EURAMET.
- Member of CIPM-CCRI(II) and ICRM.
- National level: notified (nuclear field) and accreditated (QA management) calibration and testing laboratory.

Radionuclide Metrology Laboratory (LMR) - 4

Equipments:

- -absolute activity standardization: 4πPC-γ coincidence and LSC-TDCR systems
- -relative activity standardization: γ/X-rays spectrometric systems with HP Ge and Si(Li) detectors, 4πγ ionization chamber
- Analytical balances and micro-balances
- Facilities for production of radioactive standard sources.

Radionuclide Metrology Laboratory

Customers:

- Research institutes and universities;
- Cernavoda nuclear power plant;
- **Hospitals (nuclear medicine units)-calibration of the radionuclide calibrators (usually for ^{131}I, ^{99m}Tc);**
- Laboratories from the national networks of environmental monitoring and public health security.

Research work - Nuclear data

- Workshop “ Nuclear Structure and Decay Data : Theory and Evaluation “, The Abdus Salam International Centre for Theoretical Physics (ICTP), International Atomic Energy Agency (IAEA), United Nations Educational, Scientific and Cultural Organization (UNESCO), 4-15 April 2005, Trieste, Italy (participation of A. Luca).

Collaboration with the IAEA:

- CRP 42006: Updated Decay Data Library for Actinides , **IAEA Research Contract Number: 13341 / Regular Budget Fund, Project "Improved decay data for important actinides", IFIN-HH (Romania), CSI Dr. Aurelian Luca, period 2005/09/15-2008/11/30**
- **DDEP style Evaluations: ^{234}Th, ^{236}U, ^{228}Ra, ^{211}Bi and ^{211}Po.**

- Workshop of the Decay Data Evaluation Project collaboration: DDEP-2006 (6-10 March 2006, Saclay, France), **DDEP-2008** (Bucharest, Romania), DDEP-2010 (Madrid, Spain), DDEP-2012 (8-10 Oct. 2012, Paris, France).
- „Workshop for Nuclear Structure and Decay Data Evaluators" (**ENSDF-2009**), 30 March-3 April 2009, Magurele, Romania
- Participation at the International Committee for Radionuclide Metrology (ICRM) Nuclear decay data WG (1999,2001,2009,2011).

Cooperation with CEA, LNE-LNHB / EURAMET actions (since 1998)

- Experimental determination of nuclear decay data (half-life, photon emission probability):

^{237}Np-^{233}Pa, ^{65}Zn, ^{113}Sn, ^{124}Sb;

^{186}Re, ^{177}Lu, ^{82}Sr-^{82}Rb and ^{90}Y will follow (project IFA Romania – CEA France, 2012-2015), possibility of updated evaluations

- European Metrology Research Programme, JRP ENG08 MetroFission (2010-2013), WP5. Improved nuclear decay data (JRC IRMM, CIEMAT, CEA) – Workshop on nuclear data results, June 2013, probably at IRMM, Belgium
- **PN-II-ID-PCE-2011-3-0070 „Absolute standardization and study of the decay parameters of positron emitters for PET systems. Assurance of the metrological traceability”(**IDEAS – national project) for the study of PET radionuclides: ^{68}Ga, ^{18}F, ^{67}Cu, ^{124}I.

- The Center for Radiopharmaceutical Research in IFIN-HH has a new cyclotron TR-19 and other modern equipments (2012) – important cooperation with the IAEA (Workshop at Magurele, Romania, early 2013).
- Production of ^{18}F and other radionuclides of medical use (only for research) is foreseen, but only after obtaining the necessary authorizations from the Romanian authorities (nuclear installation).

IAEA Ctr. 17442/2012 with IFIN-HH

- "Improved nuclear decay data for some new emerging medical isotopes", CSI Dr. Aurelian Luca; start 2012/07/09, duration 1 year (renewed possible, for one year).
- List of radionuclides: ^{62}Zn, ^{52}Fe, ^{89}Zr, ^{120}I (all PET), ^{230}U (α emitter)

-Limited funding (only from IAEA, 4kEUR/year) & time (one year, involvement in many projects), reduced man power (A. Luca and a young PhD student, Mihail-Razvan Ioan).

- CRP (http://www-crp.iaea.org/):

"Nuclear Data for Charged-particle Monitor Reactions and Medical Isotope Production", CRP Code F41029, period: start on 2012-07-09, end/close on 2016-07-09.

Other similar CRPs:

- F41014 Development of reference charged particle cross section database for medical radioisotope production 1995-08-01 / 1999-12-30
- F22049 Production and utilisation of Emerging Positron Emitters for Medical Applications with an Emphasis on Cu-64 and I-124, 2010-01-04 / 2014-12-31.

- **Work plan proposed** (one radionuclide/year):

1. Review of the previous nuclear data evaluations (if these are available).
2. Identification & analysis of experimental data sources: NSR (BNL,NNDC, USA), INIS IAEA, “classic” physics libraries (IFIN-HH, CEA Saclay etc.), different laboratories staff.
3. Compilation and evaluation of the decay data sets, using SAISINUC software (the most recent version) and the other DDEP tools and procedures.

4. The decay schemes will be analyzed and tested; if necessary, attempts to achieve the consistency (correct balance) will be made.

- **OUTPUTS:**

Data Tables: half-life, decay energy (Q), energy and intensity of photon, electron, positron and alpha-particle emissions, ICCs, EC transition probabilities.

Comments file: specific details of the evaluation

-Dissemination of results: Publications & presentations in international conferences , IAEA documents.

- **NEEDS:**

-Training of the PhD student.

-Additional funding (national, international).

-Our IT equipments are old (2005, IAEA project) and insufficient: we need at least one new desktop PC and a notebook, two laser printers, software.

-Limited access to online international scientific databases: problem for the Romanian scientists in 2012.

- We are counting on the support of IAEA, our collaborators from CEA, LNE-LNHB, France (working stages of Romanian scientists at LNHB) and other evaluators participating in the DDEP and NSDD networks.

Articles

- Emission probabilities of the main γ-rays of ^{237}Np in equilibrium with ^{233}Pa", A. Luca, M. Etcheverry şi J. Morel, Applied Radiation and Isotopes, Vol. 52, No. 3, pp. 481-486, 2000
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- "Results obtained in the metrological certification of a commercially available radionuclide calibrator", A.C. Razdolescu, M. Sahagia, A. Luca, S. Bercea, C. Dumitrescu şi H. Schrader, Applied Radiation and Isotopes, Vol. 56, Nr.6, pp. 957-958, 2002.

Articles

- „Determination of half-life and photon emission probabilities of ^{65}Zn”, A. Luca, M.N. Amiot, J. Morel, Applied Radiation and Isotopes, Vol. 58, Nr. 5, pp. 607-610, 2003.
- “International exercise on ^{124}Sb photon emission intensities determination”, M.-M. Bé, B. Chauvenet, M.-N. Amiot, C. Bobin, M.-C. Lépy, T. Branger, I. Lanièce, A. Luca, M. Sahagia, A.C. Wätjen, K. Kossert, O. Ott, O. Nähle, P. Dryák, J. Sochorovà, P. Kovar, P. Auerbach, T. Altzitzoglou, S. Pommé, G. Sibbens, R. Van Ammel, J. Paepen, A. Iwahara, J.U. Delgado, R. Poledna, Applied Radiation and Isotopes, vol. 68, iss. 10, pp. 2026-2030, 2010
- “Evaluation of ^{234}Th nuclear decay data”, A. Luca, Appl. Radiat. Isot. 68, issues 7-8, pp. 1591-1594, 2010.

Articles

- "New IAEA actinide decay data library", M.A. Kellett, M.-M. Be, V. Chechev, X. Huang, F.G. Kondev, A. Luca, G. Mukherjee, A.L. Nichols, A. Pearce, Journal of the Korean Physical Society, 59 (23), pp. 1455-1460, 2011.
- "Measurements of ^{64}Cu and ^{68}Ga half-lives and gamma-ray emission intensities", A. Luca, M. Sahagia, A. Antohe, Appl. Radiat. Isot. 70 (9), 1876-1880, 2012.
- "Measurements of relative photon emission intensities and nuclear decay data evaluation of ^{113}Sn", A. Luca, M.-C. Lépy, Appl. Radiat. Isot. 70 (9), 1881-1885, 2012.
- "Standardization, decay data measurements and evaluation of ^{64}Cu", M.-M. Bé, P. Cassette, M.-N. Amiot, M.C. Lépy, C. Bobin, K. Kossert, O.J. Nahle, O. Ott, C. Wanke, P. Dryak, G. Ratel, M. Sahagia, A. Luca, A. Antohe, L. Johansson, J. Keightley, A. Pearce, Appl. Radiat. Isot. 70 (9), 1894-1899, 2012.

Some Questions:

- Are there enough nuclear data available in the literature allowing us to make the evaluations ?
- Can we perform improved new measurements of the needed nuclear decay data ?
- Do we have new software tools for a better evaluation process ?
- What about the data users (nuclear medicine), what do they need ?

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- Evaluators: F. Kondev, V. Chechev, J.Tuli, E. Browne-Moreno, T.Kibedi, B.Singh and others.
- CEA Library in Saclay and National Physics Library in IFIN-HH, Romania

THANK YOU FOR YOUR ATTENTION!

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