IONIZING RADIATION METROLOGY LABORATORY FROM IFIN-HH, ROMANIA PRESENTATION

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The Institute for Atomic Physics (IAP) of Romanian Academy started its activity in 1949. It was designated as a Romanian leader in basic and applied research in Nuclear Physics, Nuclear Energy, Applications of Nuclear Technologies. Nowadays, after some restructurations, it became the „Horia Hulubei" National Institute of R&D for Physics and Nuclear Engineering, IFIN-HH.

From the very beginning, the Ionizing Radiation Metrology problems to be solved were a challenge in the Institute's activity, in direct connection with the following measurement necessities.

- Dosimetrical survey of the Basic Radiation Installations: VVRS Nuclear Reactor, Cyclotron, Betatron, Linear accelerators, Van der Graaf Tandem.
- Applications of the nuclear technologies

The IFIN-HH Nuclear Reactor was the main producer of radioisotopes, for practical applications. The measurement of activity of the obtained batches of radioisotopes, of the final products activity measurement and gestion of resulted radioactive wastes, were another metrological priorities. On the other side, for the development of uses of nuclear technologies, a Section for Applications of Nuclear Technologies, especially Radioactive Sources (ANT) was created during fifties. In this case, both types of measurements, in dosimetry and activity became soon necessary .

- The environment impact of radioactive substances.

During sixties period, before the interdiction of nuclear explosion tests in atmosphere, a significant environmental radioactivity was registerred, needing precise activity measurements. This interrest was gradually diminished untill the occurence of the Cernobil accident, when the activity measurements became again a first priority

-Personal and area dosimetry program for Cernavoda NPP deployed at IFIN-HH, during the eighties period, consisted from the design and production of radioprotection mean. Their calibration required also ionizing radiation standards.

All these practical requirements imposed the early creation of the Ionizing Radiations Metrology Laboratory (IRML), and permanent involvement to enlarge its competencies and refine the methods, in order to improve the measurement precision. The IRML response was the development of absolute standardization methods both in dosimetry and in activity measurement and their transfer to the field measurements by the development of secondary standards. The IFIN-HH, IRML role in Romanian metrology network was established through a Collaboration Protocol signed in 2005, with the National Metrology Institute, under the authority of the Romanian Bureau of Legal Metrology (BRML). It establishes the responsibility of IFIN-HH, as the owner of the Primary Standard of Activity Unit (Becquerel), and of the Reference Standard for Dose Equivalent, on national as well as international level.

BRML designated IFIN-HH as a participant in the activities of the International Committee for Weights and Measures - Mutual Recognition Arrangement (CIPM-MRA) in the field of ionizing radiations, such as presented on the CIPM-MRA, Annex A. BRML appointed IFIN-HH as a representative in the EURAMET Technical Committee for Ionizing Radiations (IR-TC).The laboratory is authorized for legal metrology activities by the BRML, which also attests IFIN-HH periodically, as a calibration laboratory for the field of ionizing radiations.

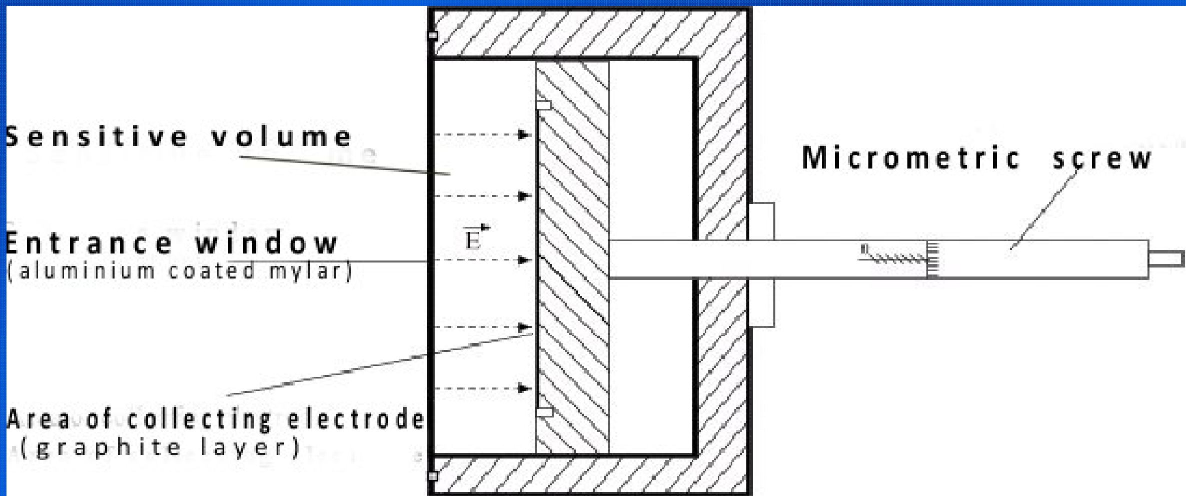

FIG. 1 SCHEME OF THE EXTRAPOLATION IONIZATION CHAMBER

2.2.2 Relative measurement methods and equipment

Spectrometric system

A spectrometry system, ORTEC product, was recently purchased and is in final testing. It contains three detection blocks:

(i) The Gamma-ray detector: coaxial HPGe type, ORTEC product, energy interval, 30 keV - 3 MeV. An improved shield, consisting from old lead, copper and a 1 mm thick tin foil is under construction

(ii) An X-ray detector: Si(Li), CANBERRA product, energy interval 1 keV-50 keV

(iii) An alpha spectrometry chamber, provided with a surface barier silicium detector, and vacuum system.

Liquid Scintillation Counting

A Liquid Scintillation Counter, based on the principle of the Triple to Double Coincidence Ratio (LSC-TDCR), was built with the contribution of the LNHB-France and RC-Poland, and consists from a detection block with three photomultipliers and associated electronics [10]. At present time, some improvements are under way: new photomultipliers, a new detection block with 6 Channel Photomultipliers (CPM), a NaI(Tl) probe for the application of the 4πLS-γ coincidence method.

The LabVIEW operation software is under installation.

All the three detection blocks are compatible (or adapted) to the analyse system, ORTEC product, consisting from a digital spectrometer, connected to a personal computer.The following software facilities are implemented: ORTEC GammaVision-32; ORTEC MAESTRO-32;GESPECOR, used for the calculation of coincidence summing corrections and transfer of efficiency calibration between various geometries and matrices.

2.2 Activity measurement methods

2.2.1 Development of methods and construction of equipment for absolute standardization.

The efforts were focused on two main directions:

4πPC-γ coincidence method

The 4πPC-γ coincidence method is used for the standardization of radionuclides emitting several coincident radiations and of pure beta emitters, by the tracing method. The first system, manually operated, was constructed during sixties; it contains a home made Proportional Counter (PC), flow type, working with pure methane and a NaI(Tl) detector. The electronics is NIM of types NE and Canberra.

An X, gamma - X, gamma coincidence detection block, provided with two thin NaI(Tl) detectors for the standardization of radionuclides, such as ^{125}I, was built.

Recently, a new 4πPC-γ coincidence system, based on the use of a PC, two NaI(Tl) detectors and new electronic modules, ORTEC type or home - IFIN-HH made, operated in a semi automatic regime, was constructed and is under testing [9].

3.RESULTS

3.1 Dosimetry measurement

According to the procedure presented at point 2.1.1, an experimental determination of the capacity values, for various electrodes distances, were determined.The experimental results are presented in Table 2.

Table 2 Experimental capacity values and comparison with theoretical calculation:

	V, V	Q_1, 10^{-10}C	Q_2, 10^{-10}C	Experimental C, 10^{-12} F	Difference fro m theory, %
0.5	100	0.06	50.39	50.33	
0.5	100	0.08	50.52	50.44	
Av				50.39	-0.2
5	100	0.0041	4.775	4.771	
5	100	0.0013	4.819	4.832	
Av				4.802	-4.1
10	100	0.012	2.097	2.085	
10	100	0.013	2.086	2.073	
Av				2.079	-17
15	100	0.0103	1.2761	1.2658	
15	100	0.0102	1.2285	1.2183	
Av				1.242	-26

The uncertainity in capacity measurements was calculated as the quadratic combination of the uncertainties due to: Q_1 , Q_2 , V, measurements and had a maximum value of 4%.

The comparison with theoretical values, emphasized that a parasite capacity, whose influence becomes more and more significant as the capacity lowers.

Thank you!