NUCLEAR METROLOGY

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The Nuclear Metrology Laboratory (Laboratório de Metrologia Nuclear - LMN) at IPEN was established in 1964. Since that time it has been involved with research in the Radionuclide and Neutron Metrology fields, and has taken part of several international comparisons sponsored by the Bureau International des Poids et Mesures (BIPM), France. In the period of 2002 to 2004, the Nuclear Metrology Laboratory had participated in 5 intercomparisons sponsored by the BIPM. The radionuclides standardized were ^{241}Am, ^{166m}Ho, ^{54}Mn, ^{204}Tl and ^{65}Zn. Our results were in goof agreement with the other laboratories.

The aim of the LMN is the development of primary standardization procedures for radionuclides used in nuclear medicine or reference standard and the measurement of gamma ray emission probabilities per decay. With this goal, the following research projects are in progress:

1- Measurement of gamma and X-ray emission probability per decay using a gamma spectrometer and coincidence system. In this case, the ^{166m}*Ho* and ^{72}Ga have been standardized in a 4p b - g coincidence system and the gamma ray emission probabilities per decay are being performed. These measurements are very important in the calibration of secondary standard systems, such as Hiperpure Germanium detectors;

2-Standardization of beta pure emissions by tracing method. The ^{45}Ca and ^{137}Cs beta pure emissions were selected to be standardized by this method, using a 4p b - g system and using ^{60}Co and ^{134}Cs as tracer;

3-Standardization of radionuclides by means of a novel 4pb-g coincidence system using plastic scintillators. This system allows simpler sample preparation and avoids use of high cost proportional counter filling gases, such as P-10 mixture. Additionally, it can handle higher counting rates when compared to conventional 4p(PC)b-g systems. The performance was tested with ^{241}Am, ^{60}Co, ^{18}F and ^{133}Ba. The results showed good agreement when compared with a conventional coincidence system employing a 4p proportional counter;

4-Automation of data acquisition and analysis for ionization chamber systems.

An electronic device combined with a friendly software interface has been developed and showed excellent linearity and reproducibility. This system has been applied for the calibration of ^{18}F and ^{153} Sm;

5-Monte Carlo simulation of activity measurements by means of 4p b -g coincidence system. The methodology for simulating all detection processes in a 4p b -g coincidence system by means of the Monte Carlo techniques developed. The goal is to predict the behavior of the observed activity as a function of the 4p b detector efficiency;

6- Standardization of radionuclides by means of 4p b -g coincidence system. In this project were standardized the radionuclides of international comparison;

7-Production of water-equivalent solid sources. The LMN is developing water-equivalent solid sources of ^{133}Ba prepared from an aqueous solution of acrylamide by polymerization by a high dose ^{60}Co irradiation.

The other LMN major activity has been in the Neutron Metrology field. The research projects in this area are the following:

Neutron spectrometry and dosimetry using neural networks. Two sets of neural networks were developed: one for obtaining neutron spectra from activation foil measurements and the other one for obtaining neutron spectra and Dose Equivalent for Bonner Spheres measurements. Both Radionuclide and Neutron Metrology fields need accurate gamma and X-ray spectrometric measurements, in order to measure transition intensities and to calibrate radioactive sources.

For this purpose two research projects are under way:

1-Determination of cascade summing correction by the Monte Carlo method. This method follows the radionuclide decay scheme from the precursor state to the final state of the daughter radionuclide. In this way the correction can be calculated for all gamma ray transitions;

2-Efficiency curve fitting of functions with covariance analysis. Several linear and non-linear functions are been studied, including results obtained by Monte Carlo.

Most of these research projects are related to MSc. and PhD. degrees obtained at the University of São Paulo.