Measurement Unit

Nuno Rombert Pinhão

The Measurement Unit (MU) provides **analytical services in the area of radioactive control of low and medium activity samples and in measurement of ions in liquid samples.**

Together with the Environment Radioactivity (ER) group (which is responsible for collection, chemical preparation of the samples and data organization), the MU carries out Portugal's obligations under Article 35 of the EURATOM Treaty which requires member states to conduct national environmental radiological survey annually.

The MU is also involved in research work and provides external analytical services to support industrial and commercial activities.

The techniques used are high resolution gamma spectrometry; gross alpha/beta counting and beta counting of specific radionuclide using gas flow proportional counters; liquid scintillation and alpha spectrometry. Ion chromatography is also used to assist in the evaluation of the residual beta activity and in characterization of liquid samples.

In 2007 the range of radioactivity measurement services provided was extended and presently includes:

- Assessment of occupational exposure to I-125 and evaluation of the effective dose of ITN workers;
- analysis of radioisotopes in water to assist in the surveillance of ITN research reactor;
- control of foodstuff, export or import products and building materials;
- analysis of gross alpha/beta and ^{3}H activities in drinking water (in collaboration with the ER group);
- measurement of ^{3}H in biological samples by liquid scintillation for cancer research; and
- alpha spectrometry on water and soils samples.

Several techniques were improved or extended:

- The range of ions measured by ion chromatography has been extended to transition metals;
- HpGe spectrometry was extended to measure X-ray and low-energy gamma emission from I-125;
- a new treatment for the detection and quantification limits in gross alpha and beta counting, taking into account interference effects, has been developed; and
- several programs have been developed for the automatic treatment of results.

In 2007 involvement in research projects expanded to include:

- An informal collaboration with Universidade de Aveiro for dating of sediment based on Pb-210 and Cs-137 content; and
- preliminary work on project *KADRWaste* involving gamma spectrometry and ion chromatography.

Finally, the MU continued work for compliance with the ISO/IEC 17025 standard:

- The development of a LIMS (Laboratory Information Management System) adapted to the needs of DPRSN;
- the definition of procedures and organization of equipment records; and
- participation in several intercomparison exercises with good results.

Training and education:

- one group element continued working on a Master thesis;
- one group member concluded his graduation in Physics Engineering;

one FC/UL student finished the final training in Physics in the MU.

Research Team

Researchers
N.R. PINHÃO, Aux. (60%)

Analysis Contractors
L. SILVA, physicist
J. ABRANTES, physics engineer
L. TORRES, chemical engineer

Technical Personnel
J.M. OLIVEIRA, Senior Technician (30%)
G. SILVA, Technician [1ª]

Informatics Consultant
J.P. SARAIVA (from August)

Students
G. CARVALHAL, FCT grantee
R. MENDES, FC/UL graduation student

I-125 Measurements for Occupational Exposure Assessment

L. Silva, N. R. Pinhão

Objectives

In ITN, I-125 is used in the production of labeled pharmaceutical compounds for cancer therapy research. Due to the volatility of iodine, there were doubts whether the radiation protection practices followed were effective in preventing exposure at limiting dose levels. The Measuremen Unit was asked to perform individual monitoring of the workers handling I-125, in order to assess the level of occupational exposure.

Results

In the present laboratory conditions, the most probable path for iodine intake is inhalation. Since on average, 30% of an iodine uptake is translocated to the thyroid and the remaining 70% directly excreted in urine, *in vitro* measurements were performed in urine samples and an appropriate sampling protocol set.

We used high resolution gamma spectrometry to analyze the X-ray and gamma spectrum of urine samples because a) HPGe detectors are readily available in our laboratory, b) the technique does not require any radiochemical preparation and, c) the minimum detectable concentration is very satisfactory. The complexity of the spectrum, however, requires careful manipulation and analysis.

I-125 decays by electron capture to an excited state of Te-125. This daughter nucleus de-excites by internal conversion (93%) and by emission of a gamma ray. The resulting spectrum shows a gamma and several X-ray peaks (figure 1) where the effect of coincidence summing and Compton photons on peak shape can be observed. We used the K_α and gamma peaks to quantify the activity of the samples.

From the activity found in the urine samples, we estimated the committed effective dose by inhalation of I-125. For a 24-hour excretion period, we found activity values of the order of one Bq and estimated the committed effective doses to be less than 0.3 μSv. Although very small, these values led to a re-evaluation and improvement of the laboratory safety conditions.

The low MDA level of the method provides an early detection of potential problems

Published Work

L. Silva and N. Pinhão "I-125 Measurements for Occupational Exposure Assessment" *2nd International Workshop on Application of the Ionizing Radiation & Nuclear Analytical Techniques in Industry, Health and Environment at High Performance*, Bucarest, 6th - 9th October, oral presentation and AIP − Conference Proceedings (in press)
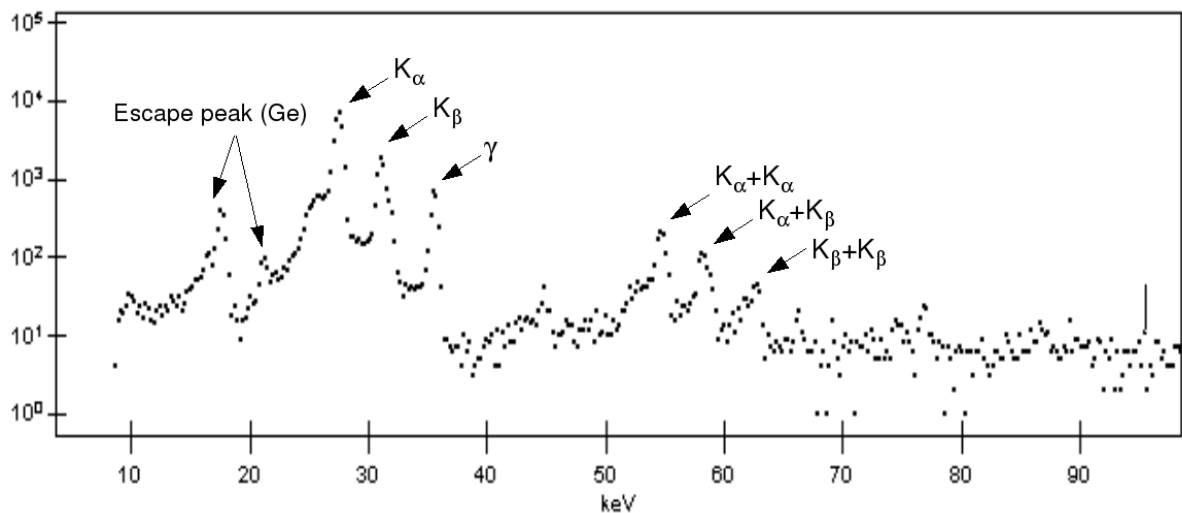

Fig. 1. Spectrum of a I-125 calibration source

Analytical Services on Radioactivity Measurement and Liquid Ion Chromatography
J. Abrantes, G. Carvalhal, J. M. Oliveira, N. R. Pinhão, L. Silva, G. Silva and L. Torres

In 2007, around 3000 measurement reports were emitted. Including analyses for calibration, quality control and intercomparison exercises, a total of 6000 analyses have been performed involving the following techniques: alpha spectrometry (20%), total alpha or beta counting techniques (22%), gamma spectrometry (23%), liquid scintillation (27%), and ion chromatography (8%). About 24% of these analyses were for the national environmental radiological survey, 18% were services for external entities, 28% for research projects, either of DPRSN or other ITN sectors, and the remaining for quality control of the techniques. It is worth mentioning that, excluding the quality control analysis, 20% of the alpha spectrometry, 2% of the gamma spectrometry analysis, 35% of the liquid scintillation and total alpha or beta counting techniques and 81% of the ion chromatography were on samples for research projects of the DPRSN, Chemistry or Physics sectors. The services provided to external entities represent a net income for ITN of over 70 kEuros. Considering the operational costs (including salaries and overheads), we estimate that the results obtained in the MU laboratories represent a net added value of over 50 kEuros.

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Measurement of Transition Metals Ions by Liquid Chromatography
L. Torres and N. R. Pinhão

We have extended the analytical capacities available by ion chromatography to include the measurement of transition metal ions – manganese (Mn^{2+}), iron (II) (Fe^{2+}), iron (III) (Fe^{3+}), cobalt (Co^{2+}), nickel, (Ni^{2+}), copper (Cu^{2+}), zinc (Zn^{2+}), cadmium (Cd^{2+}) – and lead (Pb^{2+}) by UV absorption spectroscopy. A UV/visible absorption detector was installed, which complements the existing conductivity detector. For all ions, the value of the minimum detection concentration obtainable is below 1 mg/L. Applications include the evaluation of water contamination, the control of water quality in accordance to the legal limits, and the classification of water resources as adequate for human consumption, agriculture or industrial purposes.

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Development and Implementation of a Laboratory Information Management System in DPRSN
J. Saraiva and N. R. Pinhão

A new LIMS application is being developed in DPRSN. This application combines web content management and workflow processing in a single web-based LIMS. It includes in a single application management of clients, services, equipments, procedures, laboratory records, quality control and auditing. Special attention is being given to the requirements for ISO 17025 certification. This application will replace the present databases used by the Environment Radioactivity and MLIR units and will also serve the needs of other units in DPRSN (RRSA and RPRWM). In 2007, the requirement analysis phase was completed and the required infrastructure installed.