

Highlights of 2005 and 2006 at the LNE-LNHB

F. Delaunay

International Comparisons and Tests

EUROMET 739 (^{147}Pm , ^{85}Kr , $^{90}\text{Sr}/^{90}\text{Y}$, absorbed dose to tissue and/or directional dose equivalent)

EUROMET 813 (^{60}Co air kerma and absorbed dose to water)

EUROMET 814 (^{192}Ir HDR reference air kerma)

EURADOS/CONRAD/WG2 (active personal and extremity dosimeters in heavily filtered 70 kV \approx interventional surgery)

Graphite Calorimetry

The development aims were:

- _ to build a new graphite calorimeter based on the previous model;
- _ to perfect the “constant temperature” regulation mode;
- _ to calculate better estimates of the correction factors and their associated uncertainties.

Problems were met when trying to glue the aluminised Mylar foils on the shield and the jacket. The first tryouts were not satisfying due to blisters. With more flowing glues, too much glue was absorbed in the graphite. A satisfying compromise between the gluing efficiency and the glue amount was found at the end of 2005. The new calorimeter was finally operational in the end of 2006.

The new regulation mode has been tested in two ^{60}Co beams. The ratio between the two modes is 0.9996 (with 0.06 % and 0.03 % type A standard uncertainties for adiabatic and constant temperature modes, respectively). The combined standard uncertainty is 0.25 % on the absorbed dose to graphite.

Studies on the determination of thermistors wires resistances and the effect of the impurities in the absorber has also been conducted.

TLD

The purpose was to get an evaluation on the possible accuracy of some TLDs.

The powder dosimeters have been abandoned in favour of pellets. TLD 100 and 700 (Harshaw) have been checked. The distribution standard deviation is around 0.4 %. The complete standard uncertainty for measurements is about 1 %. The individual survey of the pellets shows a slow variation of their calibration coefficient with repeated irradiation and/or annealing cycles. The fading of the signal of 20 °C stocked pellets was around 1.75 % after 28 days.

Low and medium X-rays

The purpose is to get references for the second-hand 320 kV generator beams.

The free-air ionization chamber (30+ years old) has been restored. The signal to noise ratio is better than 1000 (0.5 mGy/s) and the background noise is around 10^{-15} A.

Monte Carlo simulations (MCNP 4C) have been done to check that the photon energetic fluence doesn't change in the ionisation chamber, that the fluorescence due to the electrodes is negligible, that the shielding around the ionization chamber is enough, that the beam collimation is good enough.

The beam location has been done with radiographic films at different distances and a 5 pin-holes foil. The beam homogeneity has been checked with radiographic films and NE 2571 measurements.

A program to record and save all measurements results has been written.

The beams were not very stable (1.5 % drift on 4 h). The limitation of the generator electronic cards thermal drift solved the problem.

A first estimation of the standard uncertainty on air kerma is around 0.3 %.

ESR alanine

The purpose is to improve the ESR/Alanine measurements for radiotherapy dose level.

Prototype dosimeter pellets have been compared to pellets from different suppliers. All their angular responses have been studied (one to ten percents of variation). Their angular signal response changes with time and seems to be related with the added components (excipients) which are generally considered as neutral on the ESR signal.

A study of the radicals created under irradiation of alanine was carried out in cooperation with the University of Aix-Marseille, using such techniques as spin trapping. This study seems to confirm the existence of a predominant species (>95 %).

Brachytherapy

A new free-air ionization chamber for ^{125}I seeds has been built and is being tested. Its geometry is toroidal, with the source to be measured placed at the centre, both for increasing the detection volume and sensitivity, and decreasing the uncertainty due to source detector distance.

Air kerma standards for cobalt-60 beams

A set of new graphite cavity ionization chambers (spherical and cylindrico-spherical) has been built. These standards instruments will contribute to the determination of a new reference value for air kerma.

TPS validation

There is a concern about getting an improved traceability to absorbed dose standards of the doses delivered to patients. These doses are obtained from classical absorbed dose to water references in standard conditions and using softwares (treatment planning systems). Experimental work has been initiated in order to validate such TPS softwares, by measuring, using ionization chambers and Fricke dosimeters, dose distributions in water in complex phantoms, mixing water and combinations of bone and lung equivalent materials in simple geometries.

Publications 2005 – 2006

- J.M. Dolo, V Feugas 2005 Analysis of parameters that influence the amplitude of the ESR/alanine signal after irradiation *Applied Radiation and Isotope* **62** 273-9
- J.M. Dolo, F. Moignau 2005 Use of the entire spectrum of irradiated alanine for dosimetry *Applied Radiation and Isotope* **62** 281
- G. Douysset, J. Gouriou, F. Delaunay, L. De Werd, K. Stump, J. Micka Comparison of dosimetric standards of USA and France for HDR brachytherapy *Phys. Med. Biol.* **50** 1961-78
- J. Daures, A. Ostrowsky 2005 New constant-temperature operating mode for graphite calorimeter at LNE-LNHB *Phys. Med. Biol.* **50** 4035-52
- A. Poirier, G. Douysset 2006 Influence of ambient humidity on the current delivered by air-vented ionization chambers revisited *Phys. Med. Biol.* **51** 4995-5006
- L. Blazy, D. Baltès, J. M. Bordy, D. Cutarella, J. Gouriou, F. Delaunay, E. Leroy, A. Ostrowsky 2006 Comparison of PENELOPE Monte Carlo dose calculations with Fricke and ionization chambers measurements in heterogeneous phantoms (18 MeV electron and 12 MV photon beams) *Phys. Med. Biol.* **51** 5951-65
- L. Blazy, S. Beaumont, J.M. Bordy 2006 Use of gamma index to evaluate the dosimetric characteristics of X-ray beams in radiotherapy: implementation to a linac Monte Carlo simulation *Med. Phys.* **33** 2147
- T. Garcia, J.M. Dolo 2006 Composition of alanine pellet dosimeters: background study for low doses applications *PTB-Dos-51* 15-20
- T. Garcia, J.M. Dolo 2006 Investigations on the angular dependence of the alanine spectrum *PTB-Dos-51* 21-8