
LABORATOIRE NATIONAL
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BUREAU NATIONAL DE METROLOGIE
Laboratoire National Henri Becquerel (BNM-LNHB)
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DOSIMETRY OF PHOTONS AND CHARGED PARTICLES

Progress Report 2000-2001

B. Chauvenet

Participation in the CCRI K4 key comparison on calibration factors of ionisation chambers in terms of absorbed dose to water for ^{60}Co photons

Comparison of standards of absorbed dose to water for high-energy photon beams with METAS

A comparison was carried out with METAS in October 2000. This comparison dealt with air kerma and absorbed dose to water standards in ^{60}Co beams, and absorbed dose to water standards for high-energy x rays from accelerators (6 MV, 12 MV and 20 MV). The comparison was carried out in BNM-LNHB beams (^{60}Co and Saturne 43 accelerator), with transfer chambers from METAS. Results are under analysis.

Comparison of standards of absorbed dose to water for high-energy photon beams with NRC

This comparison was carried out in October 1998. The results were discussed and analysed, and will be presented in a paper which has been submitted to "Physics in Medicine and Biology".

EUROMET projects

Participation in EUROMET Contact Persons meetings for the preparation of CMC tables. The laboratory will participate in the proposed project of METAS on quality factors for high-energy photon beams.

Absorbed dose to graphite by calorimetry

The realisation of a new graphite calorimeter is under study to replace the present one built in 1984. We will pay special attention to vacuum gaps, and to the proportion of impurities in the core of graphite in order to decrease the corresponding correction factors.

Water calorimetry

The realisation of a water calorimeter working at 4 °C for high-energy photon dosimetry is going on.

Absorbed dose to water in high-energy X-ray beams

The medical accelerator Saturne 43 of the laboratory can produce photon beams of nine qualities (4-6-8-10-12-15-18-20-25 MV).

A new series of direct references, based on graphite calorimetry measurements and transfer to water using Fricke dosimeters, was realised for 6, 12 and 20 MV photon beams. The final report is being finished. The participation to the supplementary comparison of BIPM is planned. The results of Fricke dosimetry and calorimetry will permit to determine the variation of the radio-chemical yield G in function of beam quality.

Absorbed dose to water in high-energy electron beams

A first series of provisional references obtained using NACP and Roos chambers and applying the IAEA protocol will permit to offer calibration possibilities to customers at the end of 2001. In parallel, standards based on Fricke dosimetry measurements are being established. For this purpose, the determination of the variation of the radio-chemical yield with energy using graphite calorimetry measurements in high-energy beams (18 MeV) will begin this year.

Monte-Carlo calculations

Monte Carlo codes EGS4 and PENELOPE were used for the determination of correction factors (graphite calorimeter, ionisation chambers, Fricke dosimeters) and of photon energy spectra from the accelerator (paper to be published in "Physics in Medicine and Biology"). In addition, the energy spectrum of the cobalt-60 source was re-determined. Electron spectra are also being calculated. The new versions of EGS4, EGSNRC and PENELOPE 2000 have been received and are being tested.

Ambient dose equivalents

Direct determinations of ambient dose equivalents are being carried out in cobalt 60 and caesium 137 beams, using a cavity chamber calibrated in absorbed dose to water for ^{60}Co gamma photons and a sphere of 30 cm diameter filled of water. Such a determination was carried out in the past using a chamber calibrated in absorbed dose to water through the IAEA code of practice TRS 277 based on air kerma calibration.

Fricke dosimetry

The reproducibility of measurements carried out with Fricke solution glass ampoules sealed using laser heating is under study. The stability of the response in function of storage time will be also examined. The aim is to get Fricke dosimeters to be sent by mail for on site measurements or dosimeters storable and readily usable for internal needs of the laboratory.

ESR alanine dosimetry

Participation in IAEA CRP on « Characterization and evaluation of high dose dosimetric technics for quality assurance in radiation processing » : inter-comparison exercise of dosimetric systems used for cobalt-60 photons irradiated in a 5 MeV electron beam.

Study of influence parameters which govern the evolution of the ESR signal (temperature, humidity) from alanine powders.

Standards for brachytherapy

The study of new standards for brachytherapy (iridium 192, high rate) started. The laboratory will be equipped with a medical-type source projector.

Standards for low- and medium- energy X-ray dosimetry (BNM – LCIE)

The correction factors of air cavity chambers used as air kerma standards for low- and medium-energy x photons were improved.

The laboratory participated in EUROMET project 526 « Calibration of dosimeters used in mammography with different X-ray qualities , tube voltage from 20 to 40 kV» using its mammographic equipment.

A medical diagnostic equipment was defined to be installed in the laboratory for the calibration of dosimeters used for control during radiological examination. A G.E.M.S. MPH65 generator was acquired (40-150 kV ; tungsten rotating anode ; beams following the IEC 61267 standard).

PUBLICATIONS

J. Mazurier, Adaptation du code Monte Carlo PENELOPE pour la métrologie de la dose absorbée : caractérisation des faisceaux de photons X de haute énergie et calcul de facteurs de correction de dosimètres de référence, Thèse de l'Université Paul Sabatier de Toulouse, n° d'ordre : 3402, Rapport CEA-R-5879 (1999)

V. Feaugas-Le Berre, Caractérisation des facteurs influant sur l'évolution du signal RPE de l'alanine irradiée, Thèse de l'Université de Paris-Sud (U. F. R. Scientifique d'Orsay), n° d'ordre : 5922

J. Mazurier, F. Salvat, B. Chauvenet and J. Barthe, Simulation of photon beams from a Saturne 43 accelerator using the code PENELOPE, *Physica Medica*, vol. XV, N. 3 (1999) p. 101-110

to be published :

Jocelyne Mazurier, Jean Gouriou, Bruno Chauvenet, Jean Barthe, Calculation of perturbation correction factors for some reference dosimeters in high-energy photon beams with the Monte Carlo code PENELOPE, to be published in "Physics in Medicine and Biology"

Ken Shortt, Carl Ross, Jan Seuntjens, Frank Delaunay, Aimé Ostrowsky, Philippe Gross, Eric Leroy, Comparison of dosimetric standards of Canada and France for photons at ^{60}Co and linac energies, to be published in "Physics in Medicine and Biology"