STUDIES ON RADIATION PHENOMENA APPLIED TO MEDICAL PHYSICS

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1.- BNCT Research Facility - A BNCT research facility was projected and constructed in the experimental room of the IEA-R1m reactor of IPEN-CNEN-SP. It is intended to allow the development of studies in Radiation Physics and Radiobiology such as: - radiation field (neutrons and gammas) characterization; - development and determination of a moderators and filters configuration which adequates the radiation field to BNCT needs; - dose estimation and development of "in vitro" and "in vivo" biological studies. The facility is schematically shown in (FIG.1) It is intended to be very versatile, enabling the obtainment of both thermal and/or epithermal neutron beams from it. It consists of some cylindrical devices which serve as holders for moderators, filters, shielding and sample.

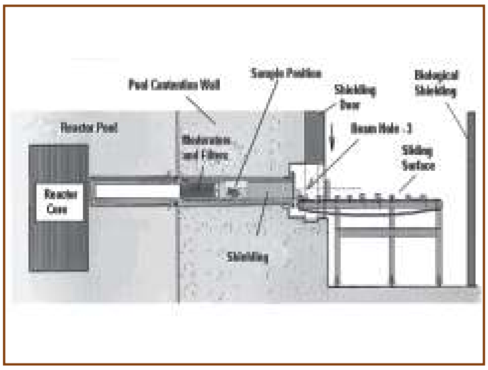

FIGURE 1 - BNCT research facility

The experimental set ups have been computer modeled for the simulation with the MCNP-4C Monte Carlo radiation transport code to better support experimental design conditions. One of the experiments which has been performed at this facility is the irradiation of DNA molecules with thermal, epithermal and fast neutrons. To minimize gamma contamination, adequate filter arrangements have been obtained using the Monte Carlo simulation. The highest thermal neutron flux so far obtained was attained with arrangement: 30 cm of air plus 17.9 cm of Pb in the filter holder and 4 cm of Pb in the sample holder. The optimal arrangement for epithermal neutron irradiation was obtained with: 37 cm of air, 1cm of Cd, 6 cm of Li, 7.7 cm of Pb and 1 cm of Pb reflector around the irradiation position. For fast neutrons the optimal arrangement was the same as for epithermal neutron except by the exclusion of Pb reflector.

2. - Chacterization of Clinical Electron Beams by Monte Carlo Simulation - The reliability of radiotherapy procedures depends among several factors on the quality of previous dose measurements in phantoms to determine the optimum condition for radiation application. Typical electron beam energy for cancer treatment ranges from 6 to 20 MeV and the percentage depth dose (PDD) are measured through the use of ionization chambers or radiographic films to obtain clinical parameters necessary for the beam characterization. To help medical physicist to evaluate dose values due to direct application of electron beams we have simulated the process using Monte Carlo methodology. Depth dose curve profile were obtained for electron beams with energies ranging from 6 MeV to 15 MeV using the MCNP-4C and EGS codes. (FIG.1) shows the comparison between measured and calculated results obtained for 2 different electron energy spectra with the same mean energy.

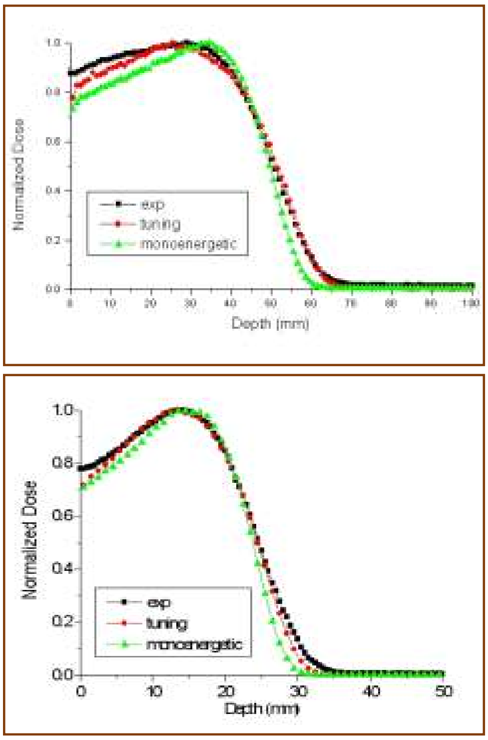

FIGURE 1 - Percentage Depth Dose for 6 and 12 MeV Electron Beams

Although some simulated results have been shown for the depth dose profile, attention must be taken to the reliability of the implemented model. Not only do the tallied volumes play an import role in the determination of the depth dose profile but also the beam characterization is far more complicated than the model so far implemented. Besides, each electron beam is highly dependent on the operation setup (electron gun, beam spreader device, collimator setup,...). Therefore its usual to adopt a backward procedure which consists on tuning the modeled electron beam to the real beam catching up the simulated results with the experimental ones.