A COMPLEMENTARY TECHNIQUE TO CALIBRATE TEPC USING MONTE CARLO TOOLS

S. Chiriotti1,2,3, D. Moro1, V. Conte1, P. Colautti3, E. D’Agostino1, E. Sterpin2 and S. Vysockie2,4

1 Belgian Nuclear Research Centre, SCK-CEN, Mol, Belgium, 2 Università Catholique de Louvain (UCL), IREC-MIRO Brussels Belgium
3 Laboratori Nazionali di Legnaro, Legnaro INFN-LNL, Legnaro, Italy, 4 Cliniques univ. St-Luc, Université Catholique de Louvain, Brussels, Belgium

E-mail: scalvare@sckcen.be

Tissue-equivalent proportional counters (TEPCs) are used in experimental microdosimetry for characterizing radiation beams in radiation protection and therapeutic beams. TEPCs measure ionizations events produced by single events in micrometric sized sites in which the ionization number is converted to energy (lineal energy $y$) by a calibration procedure that involves a constant $W$-value. On the other side, modelled TEPCs using Monte Carlo (MC) techniques give the energy absorbed inside the cavity by single events.

Objective

To calculate $^{60}$Co and $^{137}$Cs microdosimetric spectra using General-purpose MC codes, FLUKA [1] and PENEOLE [2], at different simulated sizes from 1 µm to 3 µm and compare them with experimental data.

Modelling

- Spherical TEPC filled with C3H8 modelled with FLUKA and PENEOLE
- Detailed treatment of electron and photon transport
- FLUKA, lower electron threshold: 1 keV in all materials
- PENEOLE, lower electron threshold: 50 eV in all materials

Experimental data

Experimental measurements have been carried out at INFN-LNL with a spherical TEPC [3] filled with pure propane at gas pressures between 5.5 mbar to 38.4 mbar (0.5 µm to 3.5 µm).

The pulse height spectrum is calibrated in energy by identifying characteristic features of the microdosimetric spectrum, the so-called edges. The electron edge occur when electrons are near the end of their range and have the maximum stopping power. The edge is identified using an algorithm published in [4].

Preliminary Results

- A difference of less than 2 % is found between both codes at lineal energies $y > 5$ keV/µm in the region of the electron edge.
- Higher differences are found when simulating sites smaller than 1 µm:
  - In FLUKA limitations could be due to higher electron energy threshold
  - In PENEOLE the double peak reveals the higher moments of the distribution used for small energy transfers, related to the model used rather than the physics.

Microdosimetric spectra obtained using General-purpose MC codes, FLUKA and PENEOLE, could be used as a complementary tool to validate conventional methods of calibration when considering site sites larger than 1 µm. A validation with a cylindrical geometry is under progress.