MONTE-CARLO SIMULATIONS OF THE IRRADIATOR ON A RISØ READER

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Introduction: Risø readers are used for measuring the absorbed dose in mineral grains and Thermoluminescence dosimeters (TLDs). The luminescence response is calibrated relative to irradiation with an internal Sr/Y β-source. For luminescence dating the mineral and grain size fraction commonly used is 100 micron diameter grains of Quartz, mounted on stainless steel discs. We have studied the deposited beta and photon flux and energy spectra by means of Monte Carlo simulations.

Experimental: We have simulated the irradiator from a Risø DA-20 model[1], 2009, with a Eckert&Ziegler (E&Z) source of glass encapsulated Sr [2] as shown in Figure 1.

The state-of-the-art Monte Carlo code MCNPX 2.7a was used in the simulations. The experimental setup was carefully studied and described in detail in the simulation code, as shown in Figure 1.

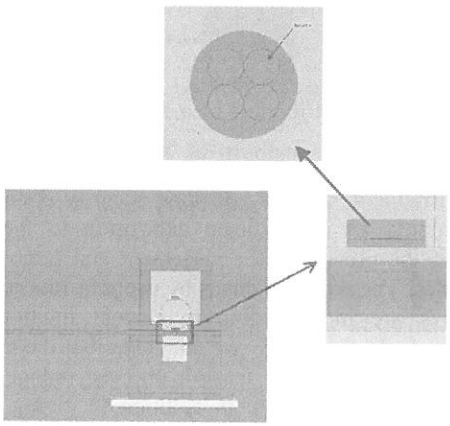

Fig. 1 – MCNPX depiction of the Risø DA-20 model, 2009 irradiator.

Electron and photon fluxes, and deposited energies were tallied in the Quartz sample. $9x10^8$ particles were ran, which allowed for a statistical error (1σ)of less than ~5%.

Results and Discussion: As shown in figure 2, the average energy of the β particles shifts from ~800 keV to ~ 640 keV indicating the significance of the interactions in this geometry (β tracks per source particle: 74;photon tracks per source particle: 1.8). The β energy distribution is significantly different as β particles interact with the surrounding source housing, capsule and filters. Bremsstrahlung accounts for 85% of the secondary photons produced. Photoelectrons account for 1% of the total electrons arriving at the sample.

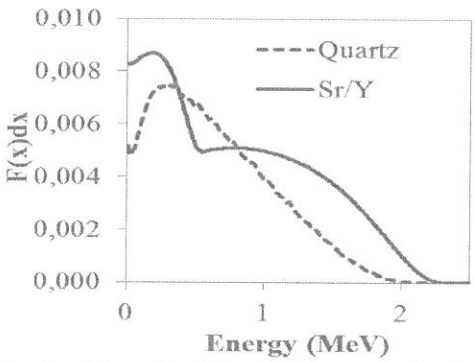

Fig. 2 – Normalized β particle energy distribution at the Sr/Y source and at the Quartz sample.

Preliminary dose rate calculations indicate a value of 174 mGy/s compared with an experimental value obtained using the material irradiated in [3] of 135 mGy/s. Mapping of spatial distributions will also be presented.

References:

1] Bøtter-Jensen, L.; Andersen, C. E.; Duller, G. A. T.; Murray, A. S. **2003**. Developments in radiation, stimulation and observation facilities in luminescence measurements. Radiation Measurements *37*, 535–541.

[2] http://www.ezag.com/fileadmin/ezag/user-uploads/isotopes/isotopes/5_industrial_sources.pdf accessed 24/08/2012

[3] Richter, D., Zink, A., Przegietka, K., Cardoso, G.O., Gouveia, M.A., Prudêncio, M.I. **2003**. Source calibrations and blind test results from the new Luminescence Dating Laboratory at the Instituto Tecnológico e Nuclear, Sacavém, Portugal. Ancient TL *21*, 1-7.

Supported by the FCT funded project PTDC/AAC-AMB/121375/2010 - VADOSE.