Practice 2 of FYSKJM4710 – X-ray dosimetry with ESR-spectroscopy

The practice takes place at the X-ray unit in the basement and in the ESR-Laboratory

Equipment: 1 Pantak HF225 X-ray unit Perspex disks

1 Wellhöfer FC65G ionization chamber Li-formate dosimeters (LiFo)

1 Standard imaging MAX4000 electrometer 1 plastic holder for ESR-dosimeters

Some copper filters and socket 1 EleXsyS 560 ESR spectrometer

Two X-ray fields should be used: 100 kV, 1.5 mm Al filter,

220 kV, 1.5 mm Al + 0.5 mm Cu filter.

Guidance on the use of the ESR spectrometer will be given.

- a) Position the ionization chamber and electrometer as in last practice. By use of the kerma calibration factor, $N_K = 43.4$ mGy/nC, and determinate the rate of absorbed dose in the air volume of the ionization chamber from the two X-ray spectra in a chosen point. Use 10 mA to enlarge the dose rate and position the chamber so that the dose rate is at least 0.7 Gy/min.
- **b**) Remove the ionization chamber from the holder. Place a LiFo dosimeter in the plastic holder, and put the holder in a position so that the alanine dosimeter is at the same position as the ionization chamber. Use the 100 kV, 1.5 mm Al filter field. Give a dose of 2 Gy (the radiation time is found from the dose rate calculated from the measure done in a)). Change the dosimeter and give 4 Gy. And at last 6 Gy to the last dosimeter. Check if the cooling water is to hot unpleasant to touch the water pipes. If it is wait 20 minutes. Then to the same procedure with the 220 kV, 1.5 mm Al + 0.5 mm Cu filter X-ray spectrum with new dosimeters. At last repeat the dose rate measurements done I a) and use the average to calculate the doses given to LiFo.
- c) Use LiFo dosimeters to measure a depth dose distribution in Perspex from the 220 keV 1.5 mm Al + 0.5 mm Cu filter field. Use one dosimeter in each point and radiate 5 dosimeters position between 0 and 7.8 cm. Use Petri dishes to position the dosimeters and make a stack of alternating dishes and Perspex.
- **d**) Do the ESR measurements in a sample glass tube and place the tube in the ESR cavity. Perform an ESR scan with help from your guide. Measure the peak-to-peak amplitude of the central resonance line. Measure the peak-to-peak value in all of the radiated dosimeters. Present the measurements in one table.

- e) Plot ESR-amplitude as function of absorbed dose in air for both radiation spectra. Calculate the linear fit (y=mx+b) by linear regression. What is the growth per Gy of the two radiation fields (two different values)? Use the strait line of the 220 keV X-ray to calculate the absorbed doses given to the LiFo dosimeters in the Perspex depth dose measurement. Plot the absorbed dose as function of thickness of Perspex between radiation source and dosimeter.
- f) Look in the table found in the compulsory task of air and LiFo. What will the relationship between the masse-energy-absorption-coefficients a measure of if CPE is present? From practice 1 (task e) did you decide the effective photon energy of each of the two X-ray qualities. Plot the relationship between the masse-energy-absorption-coefficients of air/LiFo up to the photon energies related to the 220 kV X-ray. How does the relationship vary with energy and how do you see this in relation to your observation in d)?

Hint: The ESR-amplitude gives a measurement on the number of radicals produced in a dosimeter and will be proportional with the dose in *LiFo*. The graph in task d) gives then a description of the relationship between absorbed dose i LiFo and absorbed dose in air!