Microdosimetry

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1 Data analysis report

Python programing language was used to analyze the data. In particular, the libraries numpy, pandas and matplotlib.pyplot were used to read, manipulate and visualize the data. The following analysis was done:

- extrapolation: The data was available for lineal energy values down to 0.4 kev micro-m. An extrapolation of the distribution to 0.01 kev/micro-m was done to make the results consistent with experimental convention. A linear fit was done one the data between 0.4 and 0.5 kev/micro-m and was extended to 0.01 to perform the extrapolation. The results of the extrapolation on one of the positions are presented at 1.
- Normalization: Because of the modification as a result of the extrapolation, the distribution was normalized such that it's integral is equal to 1.
- Calculation of Yf: The frequency averaged lineal energy was calculated by performing the integral 1.

$$Y_F = \int_{0.01}^{\inf} yf(y)dy \tag{1}$$

- Yd(y) distribution: This distribution was calculated using the formula for d(y) 2.

$$d(y) = \frac{yf(y)}{y_F} \tag{2}$$

- YD: The dose-averaged lineal energy was calculated by performing the integral 3.

$$Y_D = \int_{0.01}^{\inf} yd(y)dy \tag{3}$$

- The results of the previous steps are presented in 2, 3and 4.

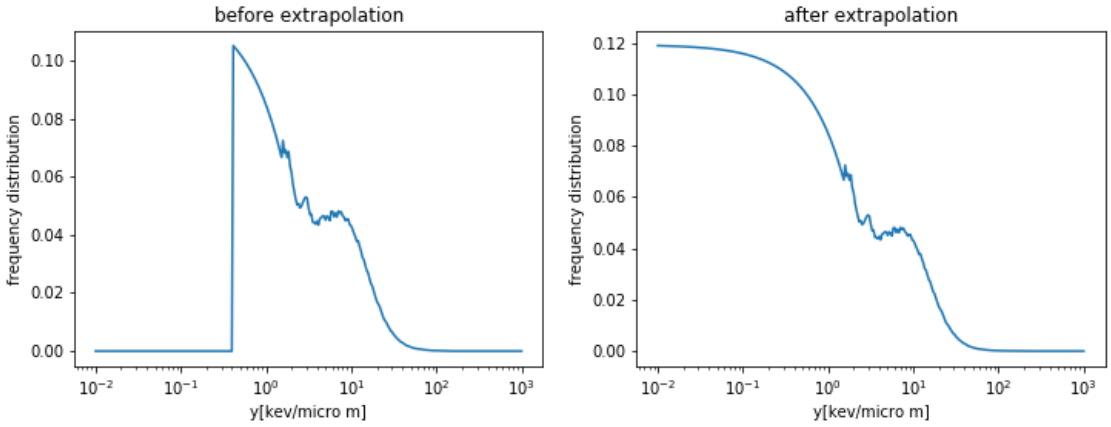

Figure 1: extrapolation illustration for position 30.5 mm.

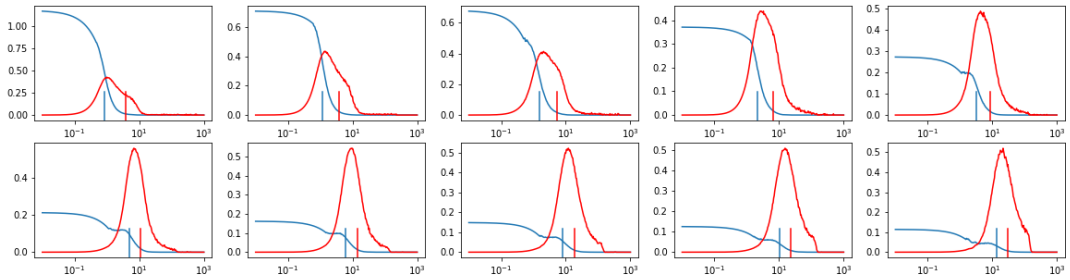

Figure 2: This figure illustrates the yd(y) and f distributions with the vertical lines representing yf and yd.

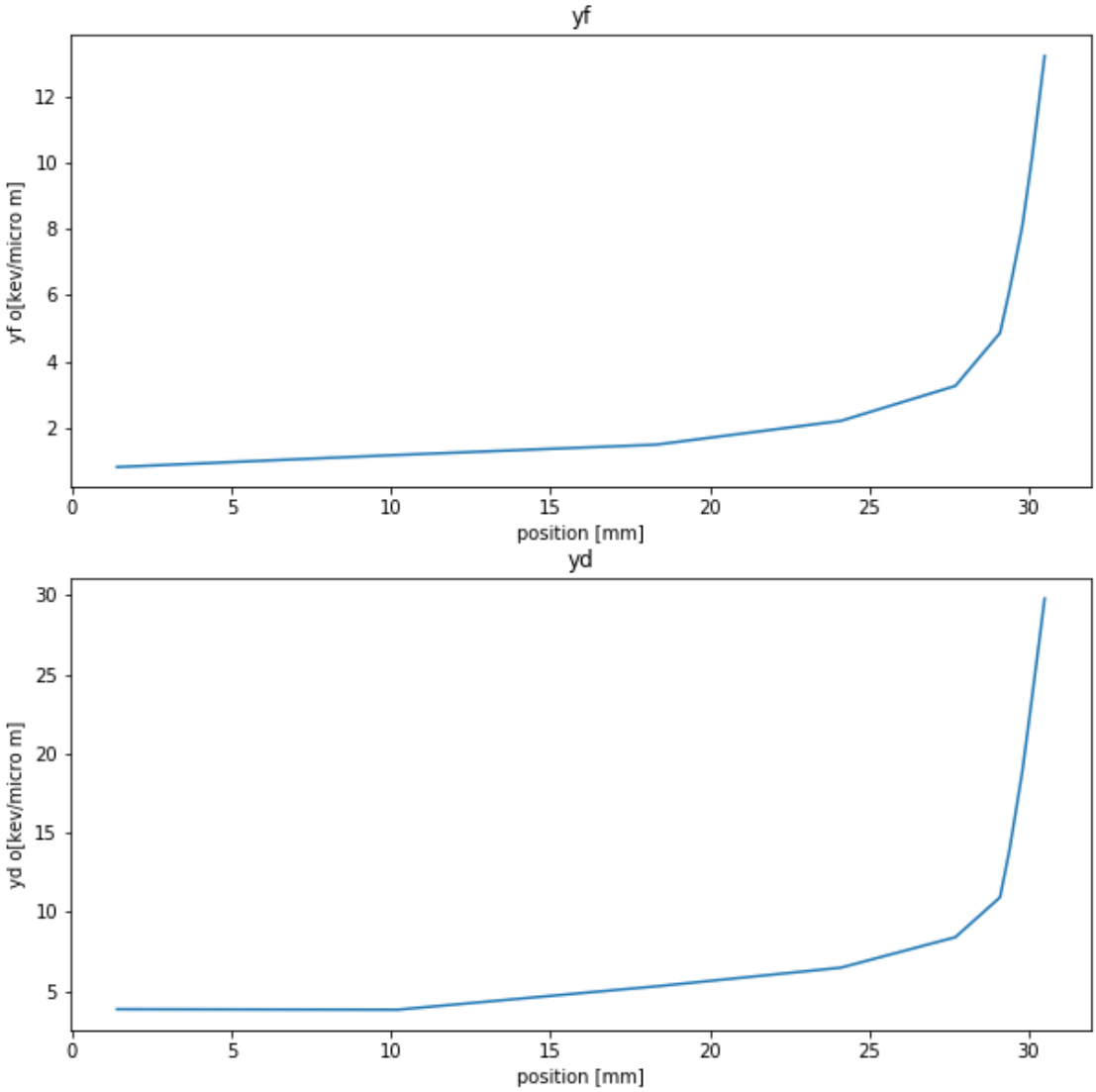

Figure 3: The evolution of yd,yf with changing position.

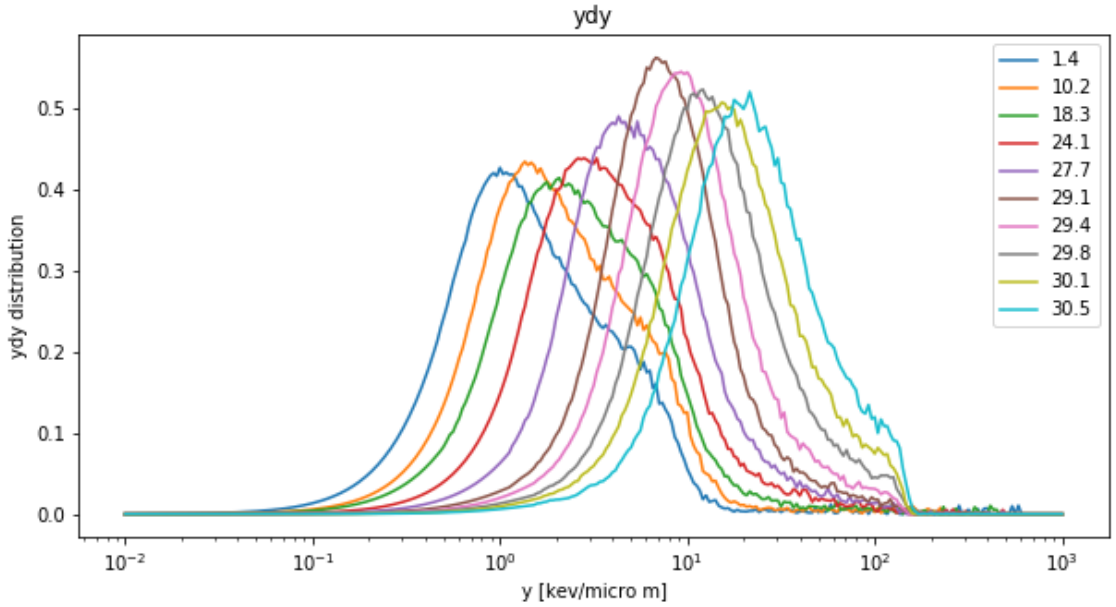

Figure 4: The change in the ydy distribution with positions is illustrated in this one graph.

- RBE: the relative biological effectiveness was calculated by integrating the dose d(y) with the biological weighting function r(y): The results are presented in 5 as they evolve with position compared to the biologically measured values. The distributions were scaled such that the rbe at the smallest position is 1.1 to compensate for the difference in the r function from original tissue to the one used in the biological experiment.

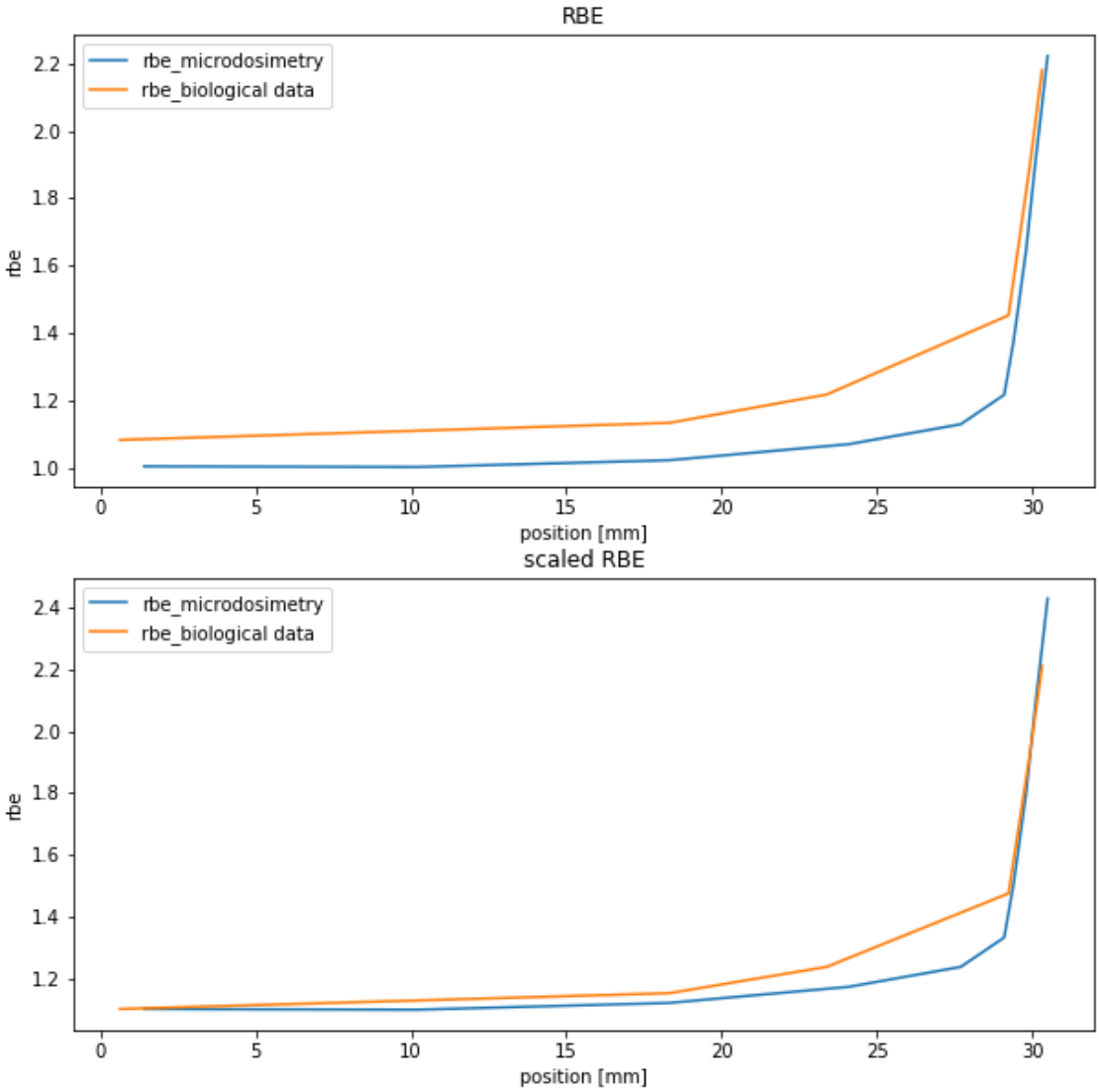

Figure 5: The microdosimetry rbe and biologically measured rbe asa function of position.

Table 1: The Yf,Yd, and RBE calculated values.

Position[mm]	Yf [keV(µm])$^{-1}$]	Yd [keV(µm])$^{-1}$]	RBE
1.4	0.82504078	3.86961519	1.00598983
10.2	1.18908344	3.83850374	1.00395998
18.3	1.49883911	5.30920229	1.02397057
24.1	2.21465535	6.48822002	1.07169706
27.7	3.26990271	8.41662113	1.1305876
29.1	4.86630978	10.93418881	1.21778037
29.4	6.16236232	13.95465372	1.3753583
29.8	8.08958768	18.87842571	1.64095972
30.1	10.11653427	23.48552699	1.90293791
30.5	13.21969079	29.79836094	2.22158655