Appendix C : RCF Image-Processing

C1 The Radiochromic Film

The electron detection was done using radiochromic film HD 810 (Nuclear Associates, Model No. 37-040 [NA02]). The composition of the film is given in Fig. C-1. The active layer reacts on exposure to ionising radiation with a color change from translucent to blue. Following the specifications of the distributor, HD-810 has a response to ionizing radiation similar to that of water in the energy range of 0.1 to 20 MeV for photons and 0.01 to 20 MeV for electrons. Mc Laughlin et al. proved that the film response to gamma radiation equals the response to energetic electrons within an uncertainty of 5% [MYS91]. The film is insensitive to radiation with λ>300 nm.

Together with the film, Nuclear Associates supplies an instruction manual. This manual includes conversion tables from optical density (O.D.) to absorbed dose (krad[1]) for three different wavelengths (400 nm, 500 nm, 580 nm) [NA02].

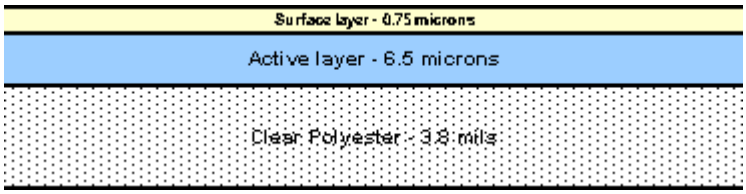

Fig. C-1 Configuration of GAFCHROMIC HD-810 dosimetry film (3.8mil = 96.5µm).

C2 Image Processing

- Scanning

The film had been cut in 50 mm × 50 mm pieces before the experiments. After exposure these pieces were scanned together with a calibrated greyscale (see Fig. C-2, absorption 0 to 2.0 O.D. in steps of 0.1). The scanning was done with an HP ScanJet ADF 6350 C (commercial flatbed scanner, 200 dpi resolution). True color auto settings were found to give best contrast.

- Color splitting

[1] (Energy) dose units 1 krad ≈ 10 Gray = 10 J/kg.

Each data-file was split into its RGB(Red-Green-Blue) components and converted into 3 arrays of integer numbers $0 \leq x \leq 255$ (describing the grey level of the respective color fraction). This was done using MathCad Plus 6.0 (MathSoft, Inc.).

- Determination of the greyscale function

Then, a step like function grey-level vs. position (Fig. C-2) on the greyscale was calculated (averaged for each greyscale step). The steps in this function were identified with the respective level of optical density (O.D.). The scaling was limited to 1 O.D., because at the darker scale steps the noise became dominant. No significant differences in this function were found for the different spectral components of one scanned greyscale.

- Conversion grey-level to O.D.

To avoid failures by the scanner lamp the greyscale-function was determined for each RCF-scan. The conversion of the RCF data led to 3 different files per exposed piece. In low-exposed films only the red part contained significant data, while in heavily exposed films the blue part offered better contrast.

- Conversion O.D. to dose numbers (krad)

For the next step of data processing a set of calibration functions was calculated from the dose calibration curves [NA02] for the different colors (400 nm, 500 nm, 580 nm). With the help of these functions the data files (O.D.) were converted into arrays of dose numbers (krad).

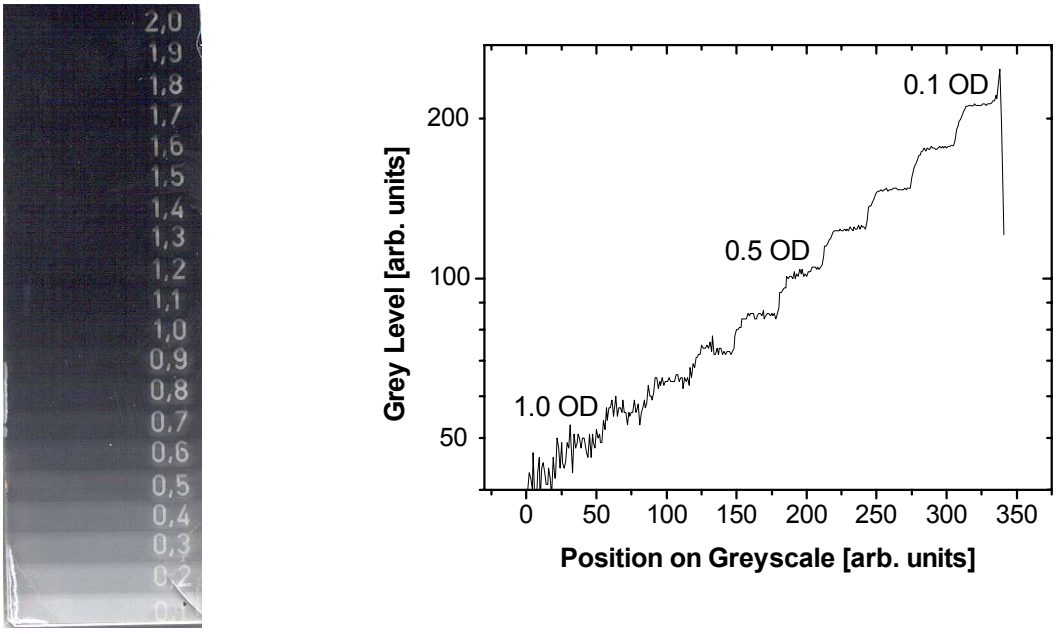

Fig. C-2 : Greyscale-scan and respective grey-level curve for the calibration to optical density.