STUDY THE DEPTH DOSE PROFILE OF THE LOW ENERGY ELECTRON ACCELERATOR

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ABSTRACT

This paper describes depth dose measurement of Low Energy Electron Accelerator (LEEA). This locally designed LEEA with the former energy of 140 keV will be upgraded to 300 keV. As the setup, the electron beam is energized by the electric field with the high voltage power supply, scanning and passing through the titanium foil to irradiate the sample. As the results, depth dose profile by the energetic beam mapping results have been obtained by using B3 radio chromic film and FWT-60 nylon dosimeters.

ABSTRAK

Kertas kajian ini menerangkan pengukuran dos kedalaman Pemecut Elektron Tenaga Rendah (LEEA). LEEA reka bentuk tempatan dengan tenaga 140 keV dahulu akan dinaik taraf kepada 300 keV. Sebagai persediaan, pancaran elektron ditenagakan oleh medan elektrik dengan bekalan kuasa voltan tinggi, mengimbas dan melalui kerajang titanium untuk menyinari sampel. Hasilnya, profil dos kedalaman oleh hasil pemetaan rasuk bertenaga telah diperoleh dengan menggunakan filem kromik radio B3 dan dosimeter nilon FWT-60.

Keywords: low energy electron accelerator, nylon dosimeters, electron beam

INTRODUCTION

A localized own developed accelerator technology so-called the low energy electron accelerator (LEEA) [1][2][3] has been upgraded from 140 keV to 300 keV as shown in figure 1. For the upgrading stage several auxiliary systems were upgraded such as insulating gas system [2], scanning power supply [3], window cooling system [5], filament power supply [6] etc. At the current stage, beam commissioning is carried out with the dose mapping profile measurement by B3 and FWT-60 (CTA). Whereby the depth dose profile mapping method and results will be described and discussed.

B3 and FWT-60 are the series of radio chromic dosimeters designed for radiation processing with the specification as shown in Table 1 and Table 2 [7][8]. It is thin and colourless films that gradually change to red and deep blue in relation to absorbed dose respectively. Colourless derivatives of the family of amino triphenyl- methane dyes can be made radio chromic, as they will change from colourless to a deeply coloured state as a function of absorbed dose. It is utilized for measuring radiation dose in gamma, electron beam or X-ray applications and industrial processes such as sterilization of medical device, crosslinking of cable and curing and coating of polymer surface and irradiation of food.

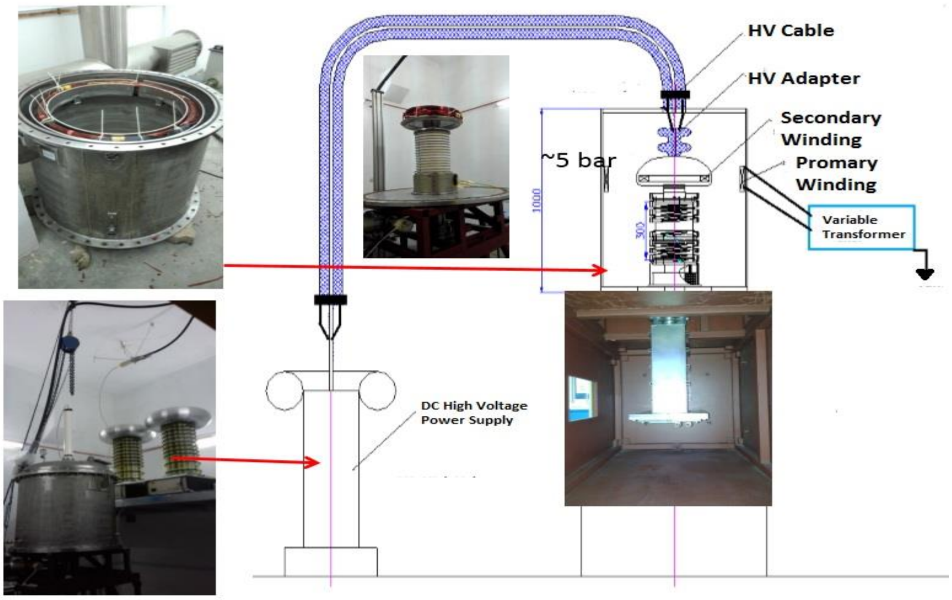

Figure 1. Low energy electron accelerator

FILM DOSIMETRY

Table 1. Specification of the B3

Parameters	Figure
Dose Range	1.0- 150 kGy (0.1-15 Mrad)
Thickness	18 µm
Wavelength of Interest	552 nm
Absorbed Dose Rate	> 0.01 Gy/s
Photon Energy Range	0.1 – 50 MeV
Electron Energy Range	70 keV – 50 MeV

Table 2. Specification of the FWT

Parameters	**Figure**
Dose Range	0.5-200 kGy (0.05-20 Mrad)
Thickness	50 µm
Wavelength of Interest	510 nm and 600 or 605 nm
Colour Build Up Time	Typically, within 1 hour
Colour Change: Unirradiated	Clear
Irradiated	Deep blue

The linearity dose response characteristic of B3 and FWT-60 as shown in figures 3 and 4, as it makes user friendly with simple measurement procedure [7][8]. In principle of B3 and FTW, its optical density is increasing by the radiation exposure. The absorbed dose is evaluated from the measured value of the increment of the optical density with the identified wavelength during irradiation. The FWT-60 will be inserted into a UV spectrophotometer and its optical density is measured by the spectrophotometer. The absorbed dose versus the length of FWT-60 is recorded by the spectrophotometer as well.

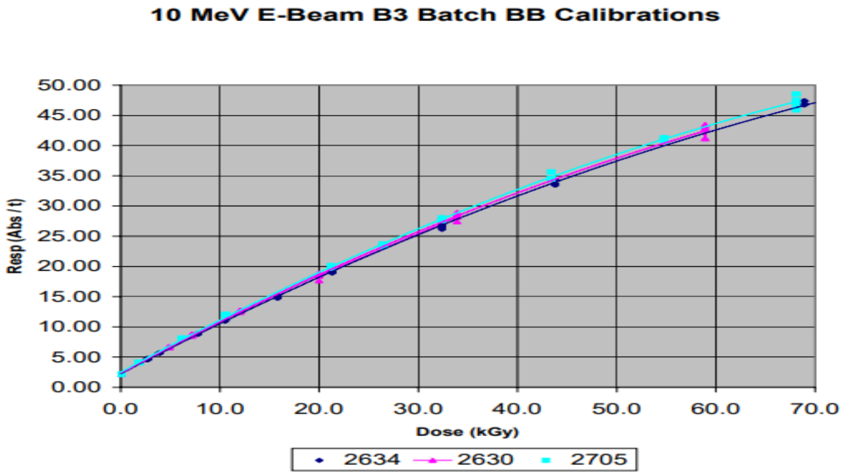

Figure 3. Typical Radiation Response of 3 Batches B3 with 10 MeV Electron Beam

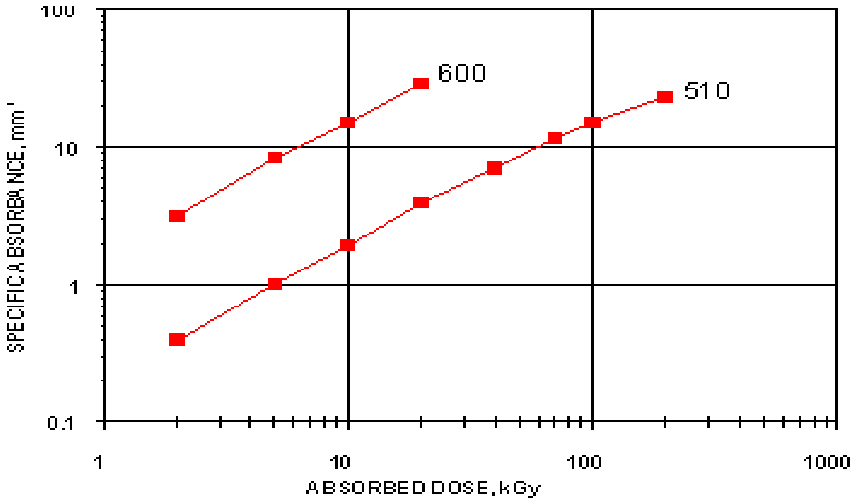

Figure 4. Typical Radiation Response of FWT-60

MEASUREMENT OF DEPTH DOSE PROFILE

Typically, the industrial electron accelerator is equipped with a magnetic scanning system in horizontal and vertical directions [3][4]. The scanning system is required to avoid the heat at the titanium window and to get a homogeneity dose profile along the titanium window. In this experiment, a desired frequency of 80 Hz at horizontal axis and 800 Hz at vertical axis are fixed. Whereby the excitation current of individual coils is set according to the beam energy [3][4]. For the dose profile measurement setup, the electron beam energy is fixed as 200 keV and excitation coil currents at horizontal axis is fixed for ~1.0 A and ~0.5 A. The B3 films have been prepared with 20 stacked sheets and FWT-60 with 7 stacked sheets. Both are held on the sample holder and moving by a conveyor with fixed speed and moving direction as shown in figure 5 and figure 6. After irradiation, the irradiated stacked B3 and stacked FWT-60 are evaluated by a UV spectrophotometer as shown in Figure 7 individually.

As the results, the depth dose profile with two kind of dosimetry films as B3 and FWT-60 with three different distances from window as 7 cm, 9 cm and 11 cm have been evaluated and studied. For the result as shown in figure 8 and figure 9, the depth dose profile of B3 and FWT-60 is decreasing with the increment of the thickness of the dosimeter. Both results are almost similar with the depth dose profile pattern. The results are within our expectation, as the dose profile is gradually decreasing with the increment of the thickness.

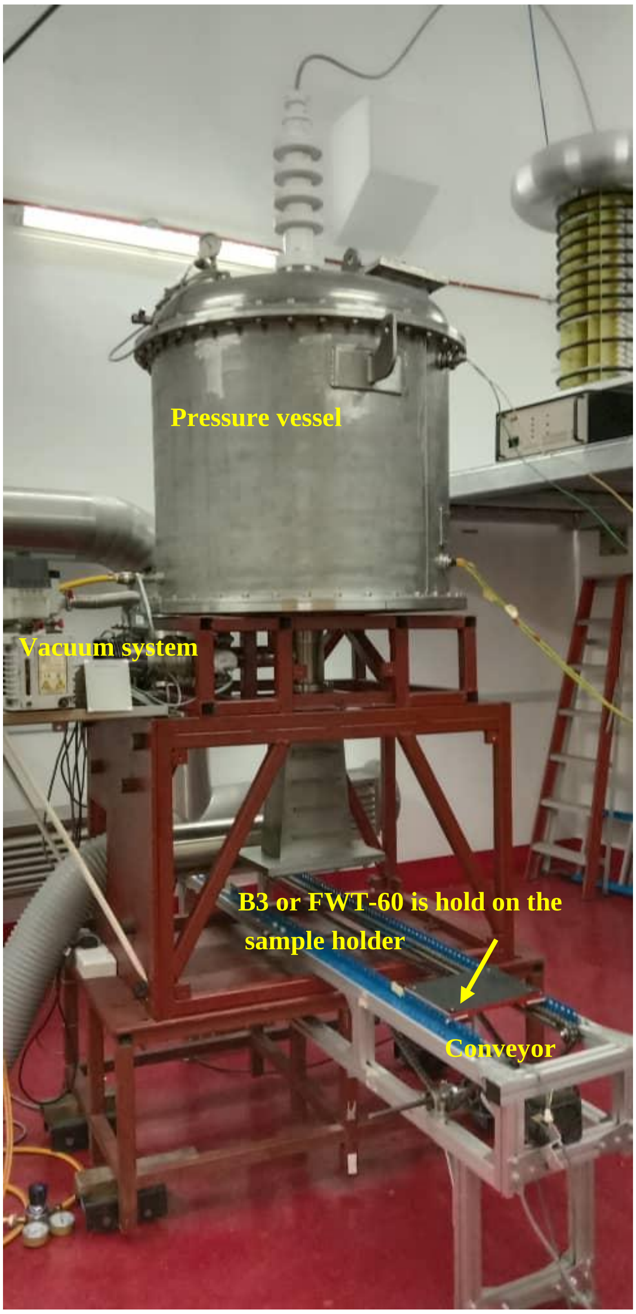

Figure 5. Irradiated B3 and FWT-60 is hold on a sample holder with a constant speed of conveyor

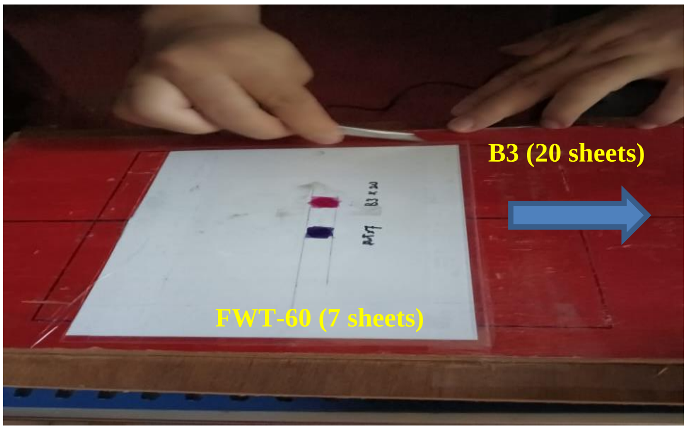

Figure 6. Moving Direction of the Stacked B3 and FWT-60

Figure 7. Model GENENSYS 5 UV- spectrophotometer

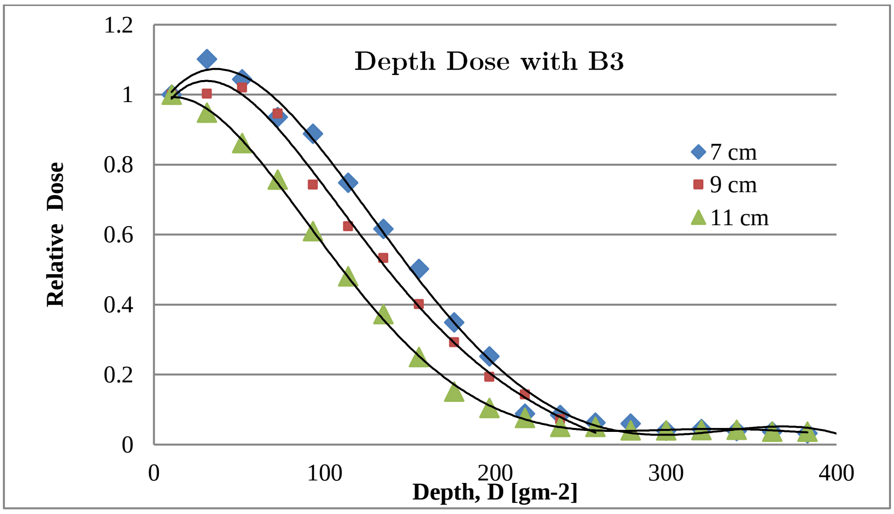

Figure 8. Depth Dose profile with B3 (Electron Beam Energy: 200 keV)

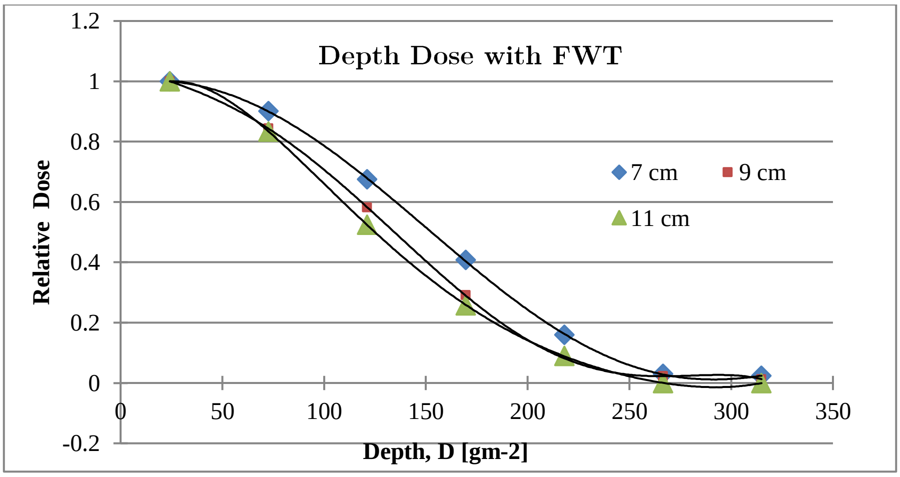

Figure 9. Depth Dose profile with FWT (Electron Beam Energy: 200 keV)

CONCLUSION

In this paper, preliminary depth dose profile of LEEA has been obtained and evaluated. In the near future, the surface absorbed dose profile with dependence of beam energy and conveyor speeds must be identified.

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8. Data sheet of FWT-60