Dose Rate and Energy Dependence of EBT, EBT2, EDR2 Films, and Mapcheck2 Diode Arrays in Beam Profiles from a Varian TrueBeam System

**Introduction:** Accurate depiction of dose distribution is paramount in radiation therapy dosimetry. Film dosimetry is widely employed in measurements and has developed rapidly over the years. It has a number of advantages over other dosimetric systems such as two-dimensional distributions and high spatial resolution. Measurements with diodes have also achieved widespread use due to their ease of use and instant feedback. In this study, the dose rate and energy dependence of dosimetric systems radiographic film (EDR2), Gafchromic films (EBT & EBT2), and MapCheck2 diode system, using regular and flattening-filter-free (FFF) profiles from a Varian TrueBeam system.

**Methods:** EBT, EBT2, EDR2 films and Mapcheck2 were exposed to open field regular beams with energies 6MV, 8MV, 10MV and 15MV and FFF beams of 6MV and 10MV from the Varian Truebeam™ linear accelerator. A field size of 20cm x 20cm was used and the films were placed at the depth of dose maximum for the various energies. The MapCheck was setup to measure profiles at 5 cm depth for all energies. Profiles measured with ionization chamber were used as a reference to compare with profiles measured using film and MapCheck2. The film images were scanned multiple times with a flat-bed scanner and the red channels data were extracted for dose-rate and energy-response effects. Dose profiles from regular beams with flattening filter were used to investigate energy response effects where the beam is hardened in the center relative to the edges. While, dose profile from FFF beams with high dose gradient from the center to the edges were used to investigate dose rate effects.

**Results:** The profiles from EBT and EBT2 films relative to chamber showed a gradually increasing energy response from center of the beam (2%) towards the field edges (10%) as shown in Fig. 1(a). The profiles from EDR2 film showed no energy response in the flat profile regions, however there was an increased energy response up to 8% in the penumbra region (Fig. 1(b)). MapCheck2 profiles showed an increasing energy response up to 3% at the edges of the beam (Fig. 1(c)). The energy response showed small dependence on beam energy within 4%. Profiles from the different films and Mapcheck2 showed negligible dose rate effects (2%) for the profiles from flattening-filter-free beams for all energies and the dose rate effects where 2% was the uncertainty due to cumulative errors of scanning reproducibility and film stability.

**Conclusion:** The EBT, EBT2 films showed stronger energy response effect in comparison with EDR and MapCheck2. The dose rate effects in the profiles from FFF beams were negligible in the previous four dosimetry systems. To achieve accurate dose measurement, energy response by these systems should be considered.

![Normalized EBT Profiles](image1)
![Normalized EDR2 Profiles](image2)
![6MV Normalized Profiles](image3)

Figure 1: (a) EBT Gafchromic film profiles relative to chamber. (b) EDR2 film profiles relative to ionization chamber for different energies. (c) Normalized dose profiles for EBT, EBT2, EDR2, and Mapcheck diode system relative to that from ionization chamber using 6 MV beams.