Using GAFCHROMIC EBT2 Dosimetry Film with the VIDAR DosimetryPRO Advantage (Red) Digitizer

1.0 Introduction

The study reported herein was undertaken to evaluate the performance of GAFCHROMIC® EBT2 dosimetry film in combination with a VIDAR DosimetryPRO Advantage (Red) film digitizer. The results provide a comparison of the VIDAR digitizer with an Epson 10000XL scanner. More importantly they give guidance to the user in the best practice in employing the VIDAR DosimetryPRO Advantage (Red) digitizer with GAFCHROMIC EBT2 dosimetry film.

2.0 Sensitometry and Dose Calibration with EBT2

Figure 1 shows the dose response of GAFCHROMIC EBT2 film (lot 071609) measured on a VIDAR DosimetryPRO Advantage (Red) digitizer and an Epson 10000XL. Both scanners provide 16-bit images. For the Epson scanner the response is given for the red color channel. The responses are shown as dose vs. optical density where OD = -$\log_{10}$(Pixel value/65535).

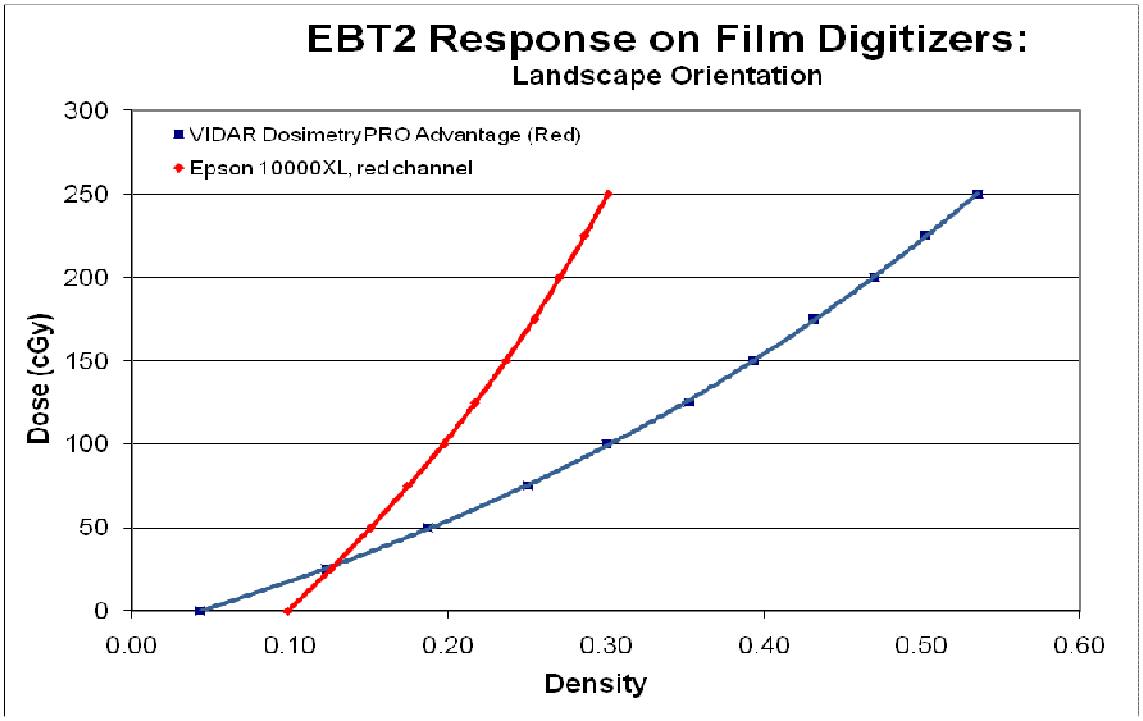

Figure 1: Dose-density response of EBT2 from VIDAR DosimetryPRO Advantage (Red) Digitizer

The response of EBT2 is superior on the VIDAR DosimetryPRO Advantage (Red) digitizer. This is undoubtedly the result of the good match between the spectral output of the LED light source and the peak spectral absorbance (approximately 630nm) of the radiochromic dye produced by exposure of the EBT2 film to radiation.

Figure 2 show the dose response of GAFCHROMIC EBT2 film (lot 071609) scanned on a VIDAR DosimetryPRO Advantage (Red) digitizer in two orientations. In landscape orientation the film is fed into the scanner so that the 10" side of an 8"x10" film is horizontal. In portrait orientation the 10" side is vertical. There is a small difference between the film response in these two orientations. This means that if a user wished to obtain the highest accuracy it would be essential to scan all films in the same orientation. The graphs in Figure 3 show that the difference in the response between the landscape and portrait orientations is much greater when EBT2 film is scanned on an Epson 10000XL scanner. With respect to differences in response due to film orientation, the performance of the VIDAR DosimetryPRO Advantage (Red) digitizer is superior to the Epson 10000XL scanner.

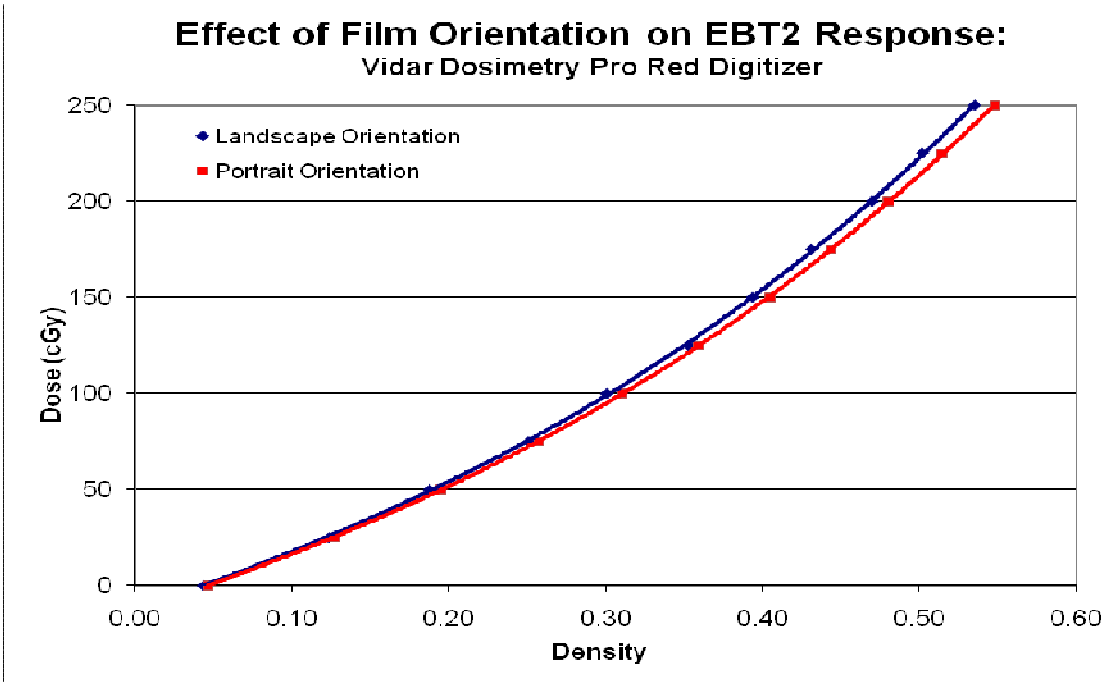

Figure 2: Response of EBT2 Film on a VIDAR DosimetryPRO Advantage (Red) digitizer in Two Scan Orientations

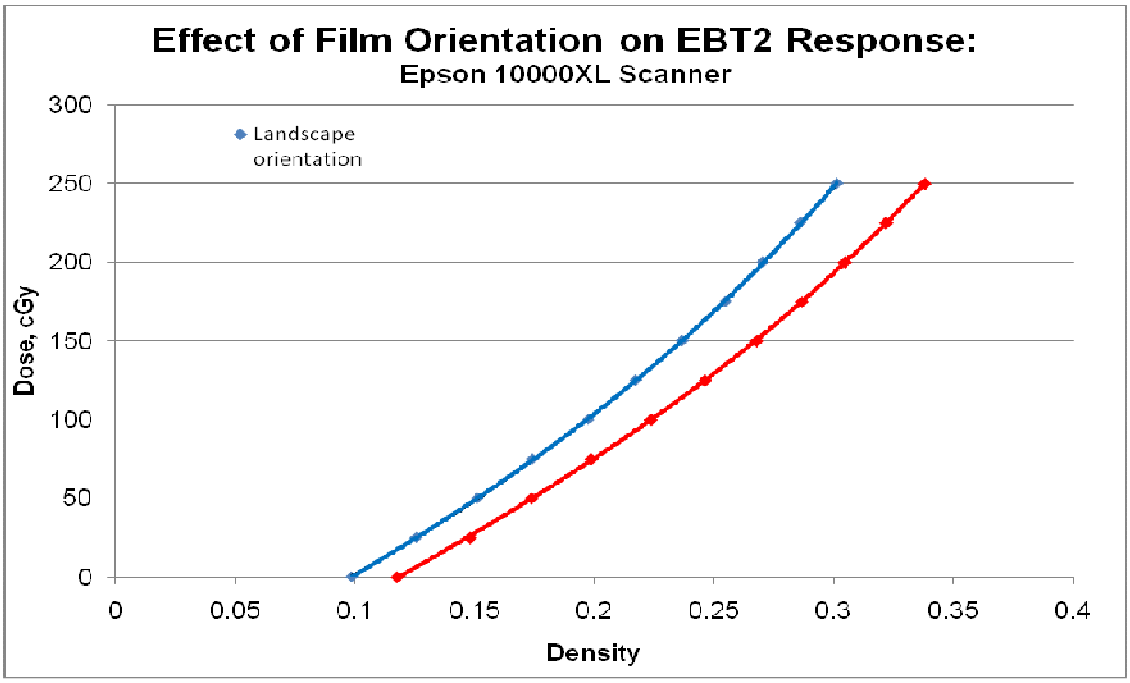

Figure 3: Response of EBT2 Film on an Epson 10000XL in Two Scan Orientations

The structure of EBT2 film is non-symmetric. This is shown in Figure 4. When EBT2 is scanned it could be oriented with either the polyester laminate or the polyester base facing the light source. The question arises of whether there is a difference in

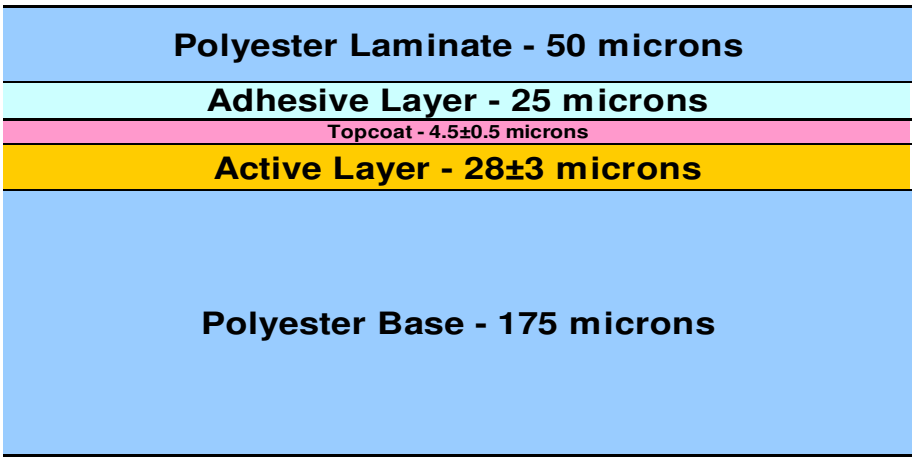

Figure 4: Configuration of GAFCHROMIC EBT2 Film

response when film is scanned in these orientations. Figure 5 shows the response of EBT2 film is scanned on the VIDAR DosimetryPRO Advantage (Red) in landscape orientation. In one instance the polyester laminate (Side 1) was facing the light source. In the other case the polyester base (Side 2) faced the light source. There is a small,

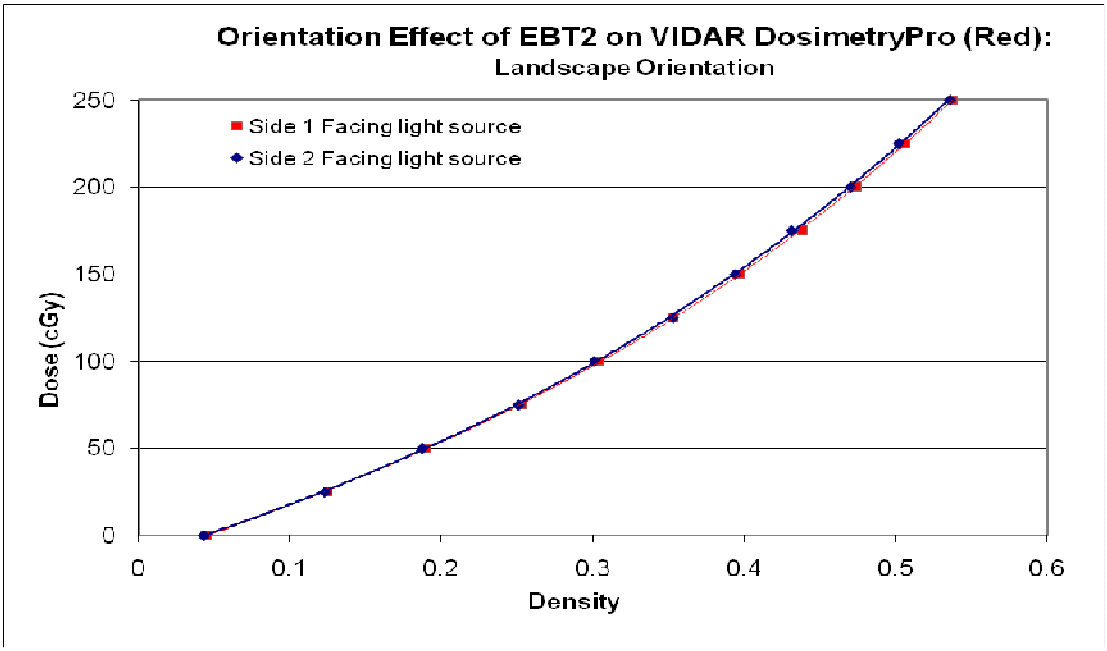

Figure 5: Response of EBT2 Scanned in Two Modes in Landscape Orientation

but significant difference of about 1%. The performance on an Epson 10000XL is very similar. To obtain the highest accuracy when making dosimetry measurements it would be advisable for a user to consistently scan EBT2 films with the same side facing the light source. The choice of which side should be closest to the light source can be left to the user. EBT2 film has a small slit marked along one edge to assist in determining which side is which. This is shown in Figure 6. When the film is viewed in landscape orientation with the slit in the top right corner, the side of the film with the polyester laminate is facing the observer.

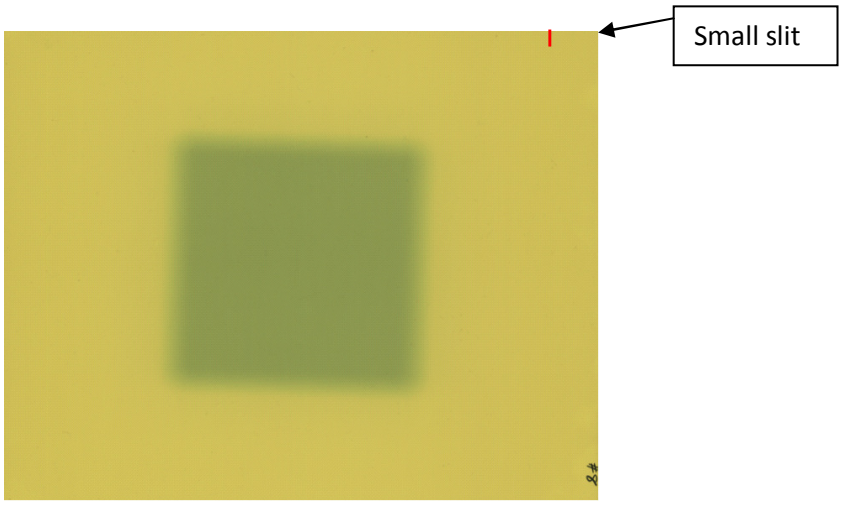

Figure 6: EBT2 is Marked with a Small Slit to Aid in Determining Film Orientation

Figure 7 shows the response of EBT2 film scanned on the VIDAR DosimetryPRO Advantage (Red) in portrait orientation. In one instance the polyester base (Side 1) was facing the light source. In the other case the polyester laminate (Side 2) faced the light source. The responses in the two orientations are identical within the repeatability of the measurement. The performance of the VIDAR DosimetryPRO Advantage (Red) digitizer in this test is superior to that of the Epson 10000XL scanner which exhibited about 3% response difference when the film was scanned in the two orientations. This suggests that it would be unnecessary for a VIDAR digitizer user to choose which side to scan. However, it would be advisable for a user to make their own measurements to confirm this result.

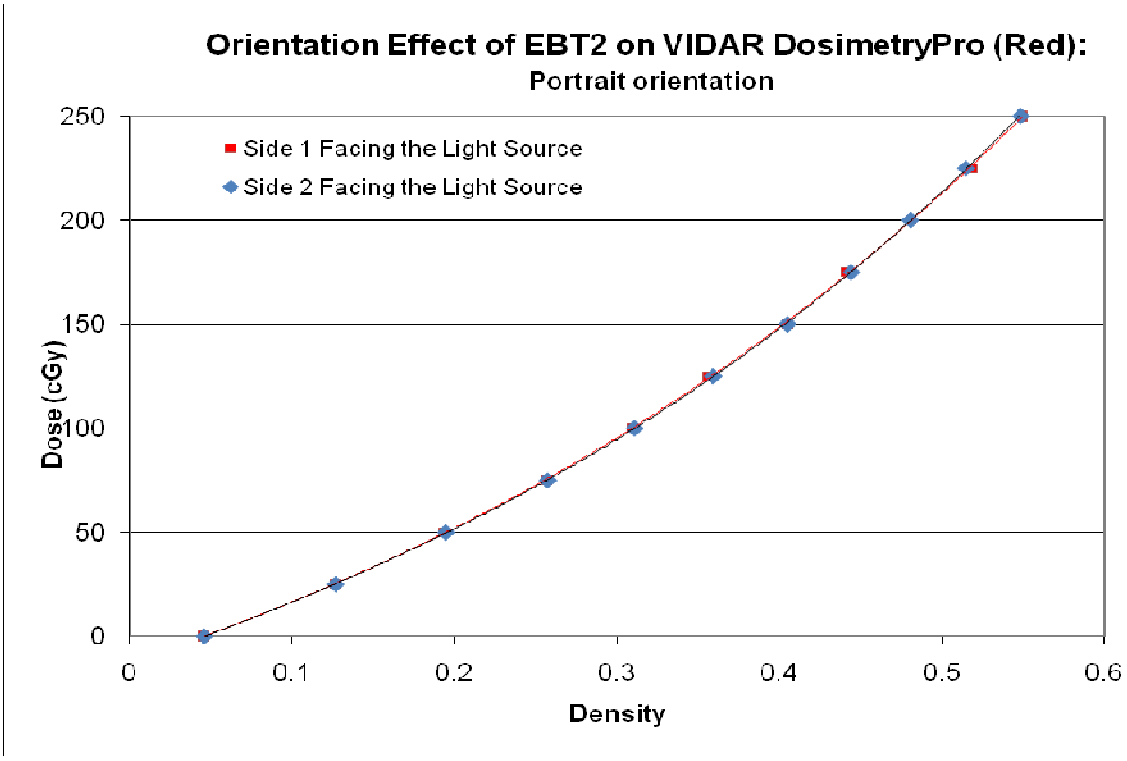

Figure 7: Response of EBT2 Scanned in Two Modes in Portrait Orientation

It is believed that the performance difference of the two digitizers stems from the polarization of light transmitted by EBT2 film. The plane of polarization of the transmitted light depends on the orientation of the film relative to the light source. Flatbed scanners exemplified by the Epson 10000XL employ several mirrors in their optical design. Since the reflectivity of a mirror is dependent on the polarization and angle of incidence of the light, the response of EBT2 film on a flatbed scanner is

inherently sensitive to the orientation of the film. As characterized in Figures 2, 5 and 7, the response of EBT2 film on the VIDAR DosimetryPRO Advantage (Red) is almost independent of film orientation. It is probable that this is the result of an optical design less prone to differences in the polarization of light and that this design is superior for digitization of EBT2 film images.

3.0 Dose Profiles of Flatfield Images

These measurements were performed to compare the performance of EBT2 scanned with the VIDAR DosimetryPRO Advantage (Red) vs. the performance with an Epson 10000XL scanner.

10cm x10cm flatfield images were exposed on EBT2 film in a linear acceleration. Each flatfield was an area of uniform exposure (uniformity approximately ±1%) at nominal doses from 25cGy to 250cGy in steps of 25cGy. The flatfield images were scanned on Epson 10000XL and a VIDAR DosimetryPRO Advantage (Red) digitizer. MIRA AP image analysis software was used to measure the response values of the scan images and construct calibration curves for each scanner. In the case of the Epson scanner, calibration data was obtained from the red color channel. Using the calibration data for the two scanners, the 200cGy flatfield images obtained for each scanner were converted to dose images.

The MIRA AP software was then used to obtain dose profiles in two directions across the flatfield dose images calculated for each scanner. The profiles from the Epson 10000XL (red channel) are shown in Figures 11. The profiles from the VIDAR DosimetryPRO Advantage (Red) are shown in Figure 12.

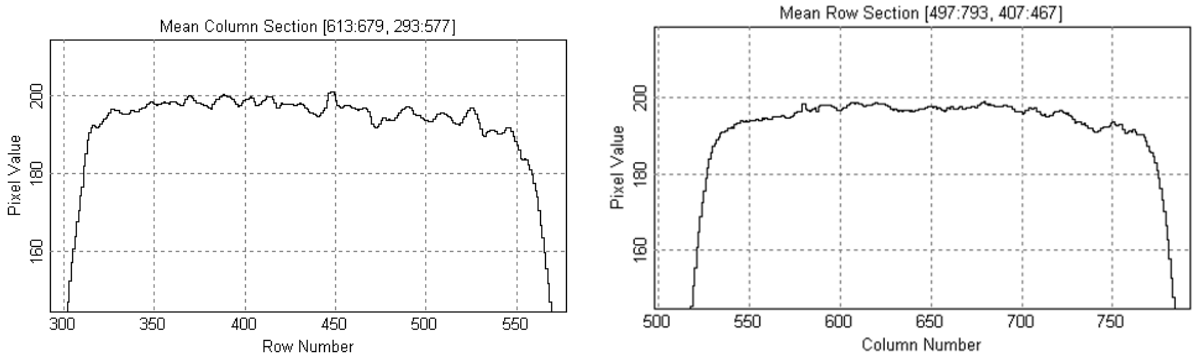

Figure11: Dose Profiles of Flatfields: Epson 10000XL Scanner (red channel)

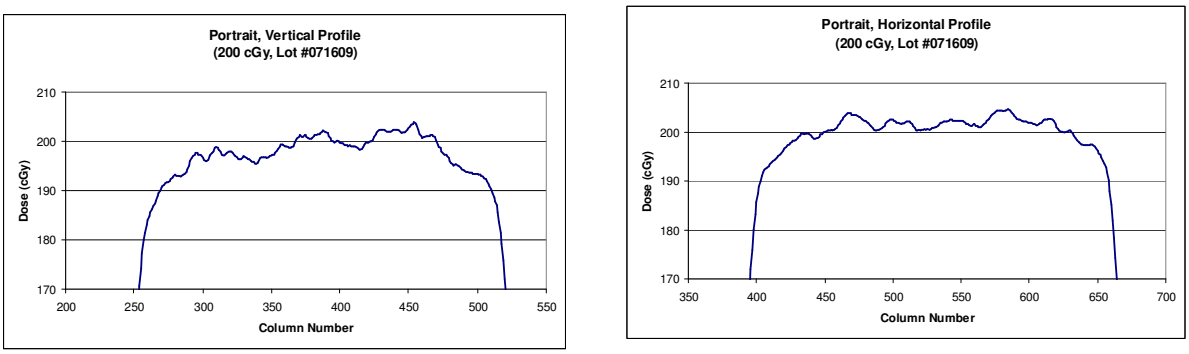

Figure 12: Dose Profiles of Flatfields: VIDAR DosimetryPRO Advantage (Red) Digitizer

The profiles from both scanners show similar characteristics. The apparent dose variations in the central portions of the profiles are about ±2%. In each case dose deviations are due to noise contribution from the scanner, from the film and from the exposure.

4.0 Discussion of the Testing Criteria

GAFCHROMIC® EBT2 dosimetry film has been developed specifically to address the needs of the medical physicist and dosimetrist working in the radiotherapy environment. Like its predecessors, EBT2 film is self-developing, but it incorporates a significant improvement in radiochromic film technology. Thus the active layer of EBT2 film contains a yellow “marker” dye. If a film digitizer can measure film response in the blue portion of the spectrum the marker dye establishes an internal reference and the blue spectrum signal can be used to correct for the effect of anomalies such as differences film response caused by small differences in the thickness of the active layer.

The VIDAR DosimetryPRO® Advantage (Red) is not an RGB imaging device. It cannot measure the absorbance of the yellow dye added to the active layer in GAFCHROMIC® EBT2 film. Therefore this digitizer cannot be used to correct the digitized signal for effect of small difference in film thickness. The data provided in this report deals only with digitizing EBT2 film utilizing the red light source in the device tested, and identifying film handling and orientation criteria to maximize the film and device as a system for film dosimetry and beam QA analysis. For reference information on the use of RGB devices with EBT2 film, please visit the International Specialty Products web site at http://online1.ispcorp.com/_layouts/Gafchromic/index.html

5.0 Conclusion

For red channel scanning and constructing calibration response data for GAFCHROMIC EBT2 dosimetry film the performance of VIDAR DosimetryPRO Advantage (Red) scanner is preferred over the Epson 10000XL scanner. The performance of the scanners is similar with respect to measuring profiles across areas of uniform exposure on EBT2 film.