

Important Steps in Performing Dosimetry with GAFCHROMIC[®] EBT Film Using a Vidar Film Scanner

1.0 Exposing Film to X-Rays

- a) Minimize exposure to light. Keep the film in the dark if you are not using it. Do not expose the film to light unnecessarily.

2.0 Scanning the films

- a) Minimize exposure to light. Keep the film in the dark if you are not using it. Do not expose the film to light unnecessarily.
- b) Do not collect scan data at less than 12-bit resolution per channel. Use 16-bit, or higher resolution if available. Do not work with 8-bit images, they provide insufficient resolution for film dosimetry.
- c) In Vidar scanners the film enters and leaves the scanner through narrow openings. The scanners also have two sets of feed rolls to transport film past a slit. One set of feed rolls is on the input side of the slit and one set is on the output side. The slit is part of the optical system for imaging the film. If the narrow openings in the film path and the two sets of rollers are not aligned, the plane in which the film moves in front of the slit may change abruptly; first as the leading edge of the film engages the feed rolls on the output side of the slit; and secondly as the trailing edge of the film disengages from the input feed rolls. The result of this movement is the appearance of bands across the image about 2-3cm from the top and bottom edges. The bands can be ignored if there is no image or calibration information in these areas.

To eliminate these bands we advise putting the EBT film in a clear plastic sleeve supplied by ISP. The sleeve is 14" long. Since the sleeve extends about 2" beyond the leading and trailing edges of the film it maintains the film in a single plane in front of the slit thus preventing the banding. **If a sleeve is to be used it must be used with every film in the set being analyzed, including the calibration film(s). This applies to any calibration film(s) that were scanned previously and have been used to develop calibration information for the current case.**

- d) At one time we advised using an optical filter to enhance the response of Vidar scanners with GAFCHROMIC[®] EBT film. While this does increase the contrast of the film image, after extensive analysis of image sets collected with and without a filter we have concluded that there is no significant practical advantage in using a filter. We no longer recommend the use of a filter.
- e) Vidar scanners have a long, diffuse light source. This gives rise to an artifact caused by light scattering making it appear that the transmission at the center of the film is greater than at the edges. When scanning a set of EBT films in a Vidar scanner **it is essential to scan a piece of**

unexposed film from the same batch of film. The image of the unexposed film will be used to correct for the artifact caused by light scattering. The effect is particularly strong for the VXR-12 and VXR-16 scanners because the light source is >15” long and is situated several inches away from the film.

- f) All films must be fed into the scanner in the same position.
- g) All films must be scanned in the same orientation.
- h) The scan-field size must be the same for all images.
- i) The spatial resolution of the all scans must be the same.
- j) For more detailed instruction see International Specialty Products QAI 365, “APPLICATION OF SCANNER FLATNESS CORRECTION TO GAFCHROMIC[®] DOSIMETRY FILM IMAGES”

3.0 Working with the scanned images using FilmQA[™]

- a) When measurement film images are imported into the software application, bring in:
 - i. All the treatment field images
 - ii. All the calibration film images
 - iii. The image of the unexposed film
- b) Create an area of interest covering most of the unexposed film image and measure the mean pixel value M_u . This is the mean of the scanner response values, not the mean of the optical density values.
- c) Divide the pixel values of all pixels in the unexposed film image by M_u . This creates a new image referred to as the “flatness correction” image.
- d) Using pixel-by-pixel image arithmetic divide the pixel values in each image (i.e. the images of the treatment film(s), the calibration film(s) and the unexposed film) by the corresponding pixel values of the flatness correction image. These are referred to as the “flattened images”.
- e) Measure the flattened calibration image(s) in areas of known dose. Measure also the unexposed film image. Plot the film response vs. dose and fit it mathematically.
- f) Use the fit to convert the treatment image(s) from scanner-value space to dose space.
- g) Analyze and evaluate the treatment field measurements vs. plan.

4.0 Examples

Figures 1-3 are shown to illustrate the importance of following the above protocol. The figures show gamma function maps of the agreement between plan and measurement. The maps are for dose tolerances of $\pm 3\%$ within 3mm. The maps are color coded. Areas in blue, green and yellow have gamma values < 1 and meet the acceptance criteria. Areas in red have gamma > 1 and fall short of the acceptance criteria.

Figure 1 depicts the gamma map when there are no adjustments made for light scattering. Only 72% of the pixels meet the test tolerance. For Figure 2, the light scattering artifact was corrected using the pixel-by-pixel correction described in Section 3.0a to 3.0d, but the dose-scanner response was fit without a measurement data at zero dose. The match between plan and measurement is greatly improved with 93% of pixels meeting the test tolerances. Inspection of the map shows that within the area directly exposed to the beam almost all pixels meet the test criteria. However, the fit was not good in the areas where the dose came principally from scattered radiation and was substantially lower than the lowest dose of the calibration exposures. This illustrates that there can be a problem if the response data is extrapolated to zero dose. Figure 3 shows the improvement that obtained by including a measurement at zero dose before curve fitting of the film response. In this case $> 99\%$ of pixels meet the test criteria.

Figure 1: Gamma function map - no correction for light scattering

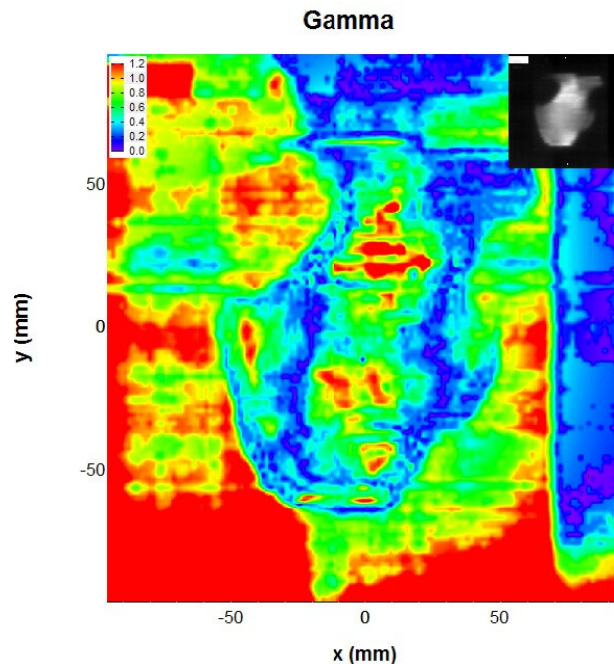


Figure 2: Gamma function map – corrected for light scattering, but no zero dose measurement

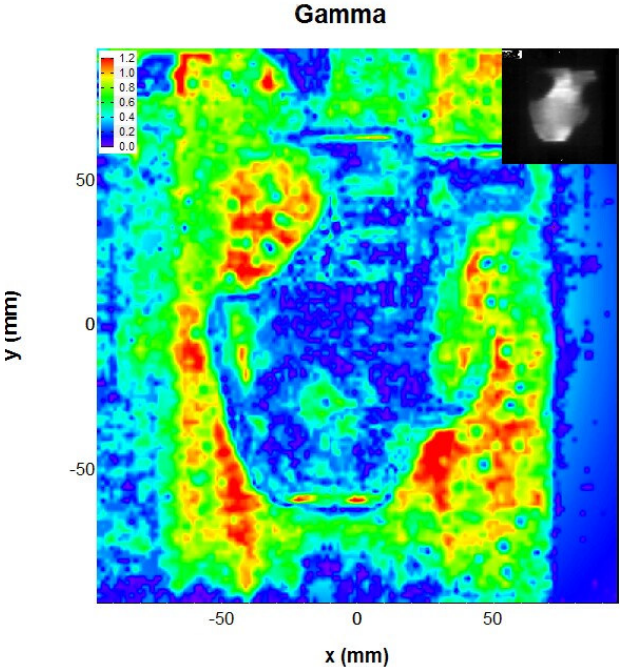
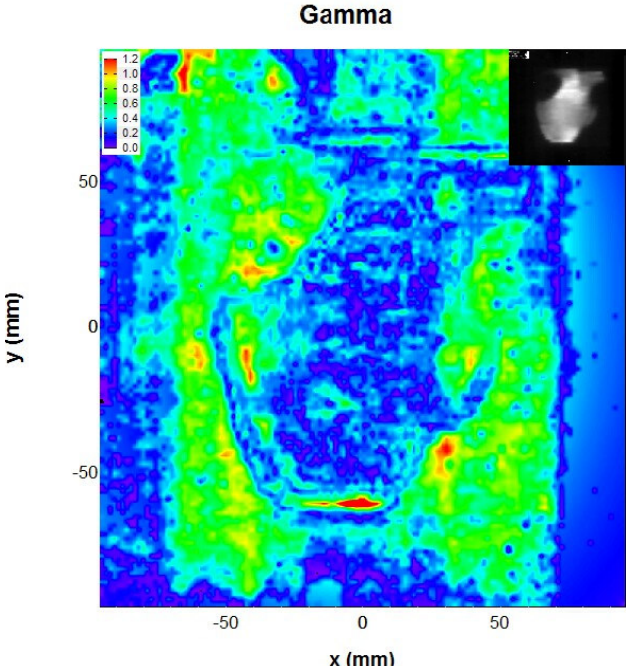


Figure 2: Gamma function map – corrected for light scattering, with zero dose measurement



The information contained in this document are intended for use only by persons having technical skills and at their own discretion and risk after they have performed necessary technical investigations, tests and evaluation of this particular protocol. While the information herein is believed to be reliable, we do not guarantee its accuracy and the user must make its own determination about the validity of this protocol. Neither ISP nor its affiliates shall be responsible for the use of this information, methods, formulation or apparatus described in this document. WE MAKE NO WARRANTY< EXPRESS OR IMPLIED< OF MERCHANTABILITY OR FITNESS OF ANY PRODUCT FOR A PARTICULAR USE OR PURPOSE. We also make no warranty against infringement of any patent by reason of user's use of any information, product, method or apparatus described in this document.