Analysing X-Ray Distributions in Papillon Therapy

Katie Ryan - katiealiceryan@gmail.com |Matt Bolt – matthew.bolt@nhs.net | Dan Love – daniel.love1@nhs.net

Background

Aim: To develop a novel method of x-ray film analysis for use with the Papillon 50 treatment machine.

Papillon therapy is a type of brachytherapy used to treat rectal cancer. There are only 4 machines capable of delivering this treatment in the UK. The best practice for analysis of x-ray distributions is still under development.

How does the Papillon 50 machine work?

A circular applicator is placed on the x-ray tube (with diameter of 22mm, 25mm or 30mm) and this is inserted into the patients rectum with the open end applicator positioned so that it surrounds the cancer.

Image 1: Papillon 50 machine.

Method

For analysis purposes we use a specific applicator with diameter of 30mm and a piece of gafchromic™ film is placed on the end of the applicator. A known dose of radiation is delivered and the irradiated film changes colour (see Figure 1).

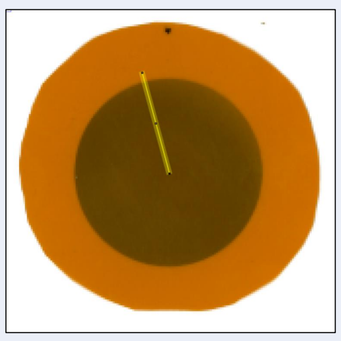

Figure 1: Irradiated gafchromic™ film with profile drawn at angle 345° from y-axis.

Once the film has been irradiated we upload a scan into ImageJ for analysis. The script begins by locating the centre of the irradiated region and draws a number of lines from the centre outwards with an angle step set by the user. The intensity of profiles of these lines are extracted and the 50% threshold (i.e. the boundary of the field) is located.

The intensities up to this 50% and the distance is then plotted along with the average (Figure 2). From this data we can calculate the percentage dose difference of the field, and the variation of this uniformity with angle.

The code then determines the field size of the x-ray beam. This is achieved by taking the radius of the irradiated film at different angles and quantifying the variation. By making the number of lines user variable, we are allowing for greater inspection of the field as we can see precisely where the discrepancies lie (if there are any).

Results

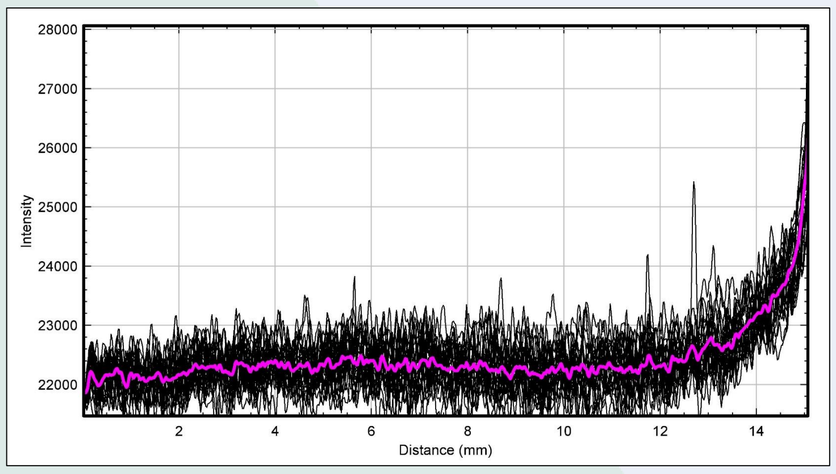

Figure 2: Intensity Profiles across the irradiated gafchromic™ film indicating variation in the field with the average in pink.

Above (Figure 2) we can see 24 different intensity profiles taken from the centre of the irradiated film outwards with the pink line showing the average. Using this data the code finds the maximum and minimum intensities of each of the profiles and calculates the percentage dose difference, percentage dose ratio and the maximum variation.

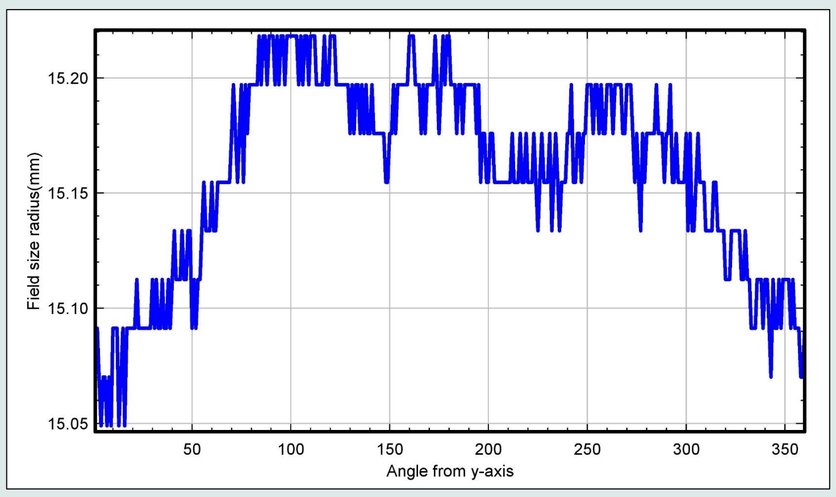

Figure 3: Variation in Field Size of the irradiated gafchromic™ film.

Figure 3 shows the different measurements of the field size from the profiles in Figure 2. As the number of profiles taken is controlled by the user, for instances like Figure 3 where we have a variation in the length, more lines can be analysed to provide more information. The x-axis is also in terms of angle subtended from the y-axis on the image so it is easier to locate the areas of interest on the film.

Next Steps and Conclusion

The next step would be determining the tolerance for the percentage dose difference by evaluating films from each applicator to determine a baseline figure.
In conclusion, while the code has been written for film analysis from the Papillon 50 brachytherapy system, there is potential to expand its use to analysis of films from Xstrahl 300 which is a superficial treatment machine. Similarly to the Papillon 50, the Xstrahl 300 uses x-rays but the applicators have a closed end and sit on the surface of the patient rather than being inserted inside the patient.