Comparison of Film and Diamond Detector Small Field Dosimetry Commissioning Measurements

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Purpose

To ascertain whether an additional correction factor for output and energy may be needed when using a micro diamond chamber for small field dosimetry measurements during commissioning through film measurement comparison.

Objectives & Tools

Objectives:

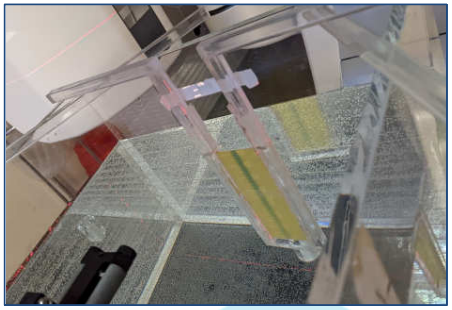
- Create a calibration curve for small field film measurements, especially for film output factors
- Measure film output factors in solid water per annual QA methods
- Develop a film holder to assist in creating film percent depth dose (PDD) curves and profiles
- Set up the 1D water tank and take film PDDs and profiles
- Obtain a microDiamond detector and take PDDs, profiles, and output factors for small fields in a 3D water tank
- Compare film and microDiamond measurements to each other and previous annual/commissioning measurements

Tools:

- Varian TrueBeam with HD120 MLCs
- Film measurements:
  - GafChromic EBT3 film
  - A custom film holder
    - Acrylic square rods and sheets
    - Superglue (acrylic cement not recommended)
  - 1D water tank (film)
  - Solid water for output factors
  - Film scanner (Epson Expression 11000XL)
- microDiamond measurements:
  - PTW 60019 microDiamond detector
  - IBA BluePhantom2 3D water tank
  - IBA scanning software
- Quadrant, an in-house QA software for comparison of PDDs and profiles

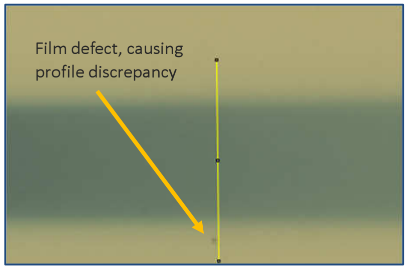
Materials & Methods

Beginning with calibration of new film, percent depth-dose curves were measured with the aid of a custom-built film holder (below) for the water tank and output factors were measured with solid water at 10cm depth and 100 SSD. This was done at square field sizes (SFS) of 0.5, 1.0, 1.5, 2.0, and 3.0 cm.



Diamond detector measurements of the same field sizes and energies followed in a water tank as well. These measurements, taken on a Varian TrueBeam with HD120 MLCs with the 6X-FFF energy, were compared to film in Quadrant.

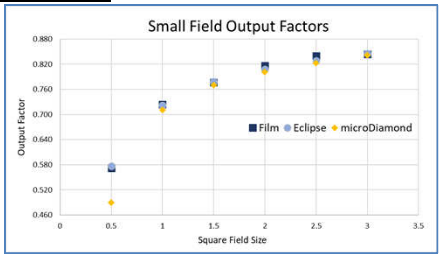
Output factors were compared between film, microDiamond, and treatment planning system values in the annual Excel document.



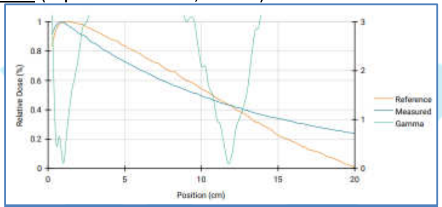
Results

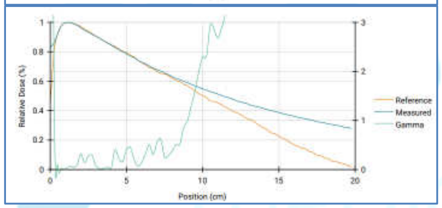
Below is analysis done either in the annual Excel document or Quadrant with a 2%/2mm criteria for passing gamma. Film is set as the reference dataset within Quadrant.

Output Factors:

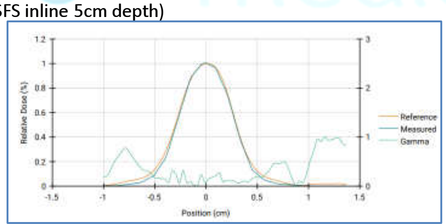


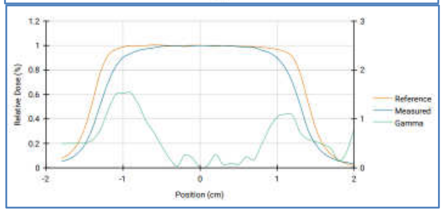
PDDs: (Top to bottom: 0.5, 2.0 SFS)





Profiles: (Top to bottom: 0.5 SFS crossline 10cm depth, 2.5 SFS inline 5cm depth)





Discussion

The agreement between the output factors measured, as shown on the graph (left), are generally within 2%, with the sole exception of the smallest field size output factor, at 15.2% disagreement between the microDiamond measurement and the treatment planning system, and a 14.4% difference between the microDiamond and the film measurements. An additional correction value may need to be applied for this field size, suggested to be on the scale of approximately 14.5%. Combined with the IAEA TRS 483 suggested correction value of 0.962, that gives a correction factor of 1.1015. The reasoning for this effect will require further investigation.

The PDD and profile agreements were processed in Quadrant. The 0.5 SFS PDD showed very little agreement with gamma, with the buildup region and dmax showing the best agreement, but gamma failure after this region was about 87.5%. However, PDD agreement improved at larger field sizes. All other PDD comparisons resulted in passing gamma of >2 until ~8 cm depth, where the PDDs diverge, and microDiamond dose is greater than the film dose at the same depth. This may be due to setup error as the film holder is made to sit on the tank and the true level of the tank may not have been exact. A future improvement on this investigation might include a new film holder, perhaps 3D printed with leveling screws.

Over 70% of profiles had agreement within a gamma passing rate of 90% or more. Shown in the results is the best and worst of the profiles. Profiles in general tended to be worse at the 5cm depth and on inline measurements. It also appears that the microDiamond suffers from slight issues when measuring penumbra. Also, the film 1.5cm by 1.5cm inline profile at 10cm depth was a major deviation in agreement, but inspection of the film scan showed a film defect at the 10cm depth.

Conclusion

Film has high resolution and is cheap to use once a film dosimetry program is established, making it a good choice for small field dosimetry. However, it may not be practical for commissioning projects at sites without a robust film dosimetry program. Therefore, it is useful to have a robust comparison between film and diamond detector measurements for small field dosimetry, as well as any appropriate corrections found. A correction factor may only be needed for the very smallest field size when using the microDiamond detector.

Contact & Acknowledgements

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