

A General analytical solution for photon beam profile deconvolution

Purpose: To develop a general analytical solution for extracting “true” photon beam profiles with minimal volume averaging effect.

Method and Materials: We have derived several analytical functions suitable for photon beam profile fitting by examining the physics process of photon dose deposition. Beam profile measured with an ionization chamber can be described by a convolution equation with a detector response function of that chamber. A general analytical solution that minimizes the volume averaging effect of large volume chambers can be developed by linking the photon dose deposition process and beam profile measurement. This work demonstrates that when dose deposition kernel and detector response function are carefully selected, photon beam profiles with minimal volume averaging effect can be easily recovered by a simple change of parameters in the analytical fitting function. Specific analytical fitting functions such as Gaussian, sum of multiple Gaussian and Lorentz functions are identified in this work along with solutions to extract the “true” beam profile.

Results: Our analysis shows that detector response can be accurately modeled by a Gaussian or Lorentz function, any of three afore-mentioned analytical fitting functions can accurately extract a “true” photon beam profile from profiles measured with a 3 mm radius ion chamber. The extracted profile perfectly matches profiles measured with a 0.8x0.8 mm² diode detector.

Conclusion: A general solution for minimizing volume averaging effect in a photon beam profile measurement with large size detectors is developed. It is found that three specific fitting functions and corresponding solutions presented in this work are ideal for recovering “true” photon beam profiles.