In a previous publication,[1] we derived an analytic expression for head scatter factors defined on the central axis using a two-component x-ray source model. The basic principles outlined in that work are also applicable at off-axis points, provided the following issues are addressed: (1) the area of the extra-focal source plane visible from the measurement point depends on off-axis distance as well as field size setting, (2) the source of primary photons is no longer always fully seen from the measurement point, (3) the primary photon energy fluence at off-axis points is a function of off-axis distance due to the shape of the flattening filter. In the present work, we propose a primary source distribution and a function describing the change in photon energy fluence with off-axis distance. Based on the two-component x-ray source model with the source distribution and function mentioned above, we have calculated in-air profiles for differently sized symmetric and asymmetric fields. The calculated data, including those in penumbra regions, agree well with measured results from Varian accelerators.

1. M. K. Yu and R. Sloboda, "Analytical representation of head scatter factors for shaped photon beams using a two-component x-ray source model," *Med. Phys.* 23, 973-984 (1996).