Purpose: The finite extension of an ionization chamber gives rise to a spatial averaging effect, known as the "volume effect". In order to provide the appropriate corrections, the response functions along its lateral and longitudinal directions are characterized using Gaussian distributions, whose standard deviations slat and slong have been determined for a large set of clinical dosimeters. Methods: Nine cylindrical ionization chambers, two parallel-plate chambers and two 2D ionization chamber arrays have been examined by scanning rectangular photon fields along their short axes. The true profiles D(x) were known from scans with a small Si diode. The ionization chambers were aligned with their symmetry axes either perpendicular or parallel to the scan direction in order to obtain slat and slong separately. In a search process, D(x) was numerically convolved with normalized one-dimensional Gaussian kernels K(x) of varying s. The best fit between the convolution product D(x) * K(x) and the measured profile M(x) of the ionization chamber was used to determine parameters slat and slong of the Gaussian kernels. Results: For both the lateral and longitudinal directions, very good agreement was found between M(x) and the convolution products of D(x) with Gaussian kernels K(x). For all chambers, their 2s values are similar to the cavity dimensions, which means that the "tails" of the Gaussian response functions reach into the exterior of the chambers, - an effect of the ranges of the secondary electrons. At higher photon energies response functions K(x) are slightly wider, but no detectable depth dependence has been observed. Conclusions: We have shown that the response functions of ionization chambers can be described by Gaussian distributions, confirming earlier observations, and we determined their standard deviations in both the lateral and longitudinal directions. Using these response functions, appropriate correction methods determined to eliminate the volume effect can be applied.