Purpose: To extract primary dose components from dose measurements, and model primary off-axis ratio and beam off-axis softening effects, and to obtain POAR and off-axis softening parameters for megavoltage beams for different energies and from different manufacturers.

Methods: Total dose is modeled as a function of scattering factors (SF) and primary dose. Using previously determined SF, the primary dose is extracted from measured beam data. Based on the primary dose, primary off-axis ratio and off-axis softening effects are modeled at off-axis points. By fitting photon beam profiles, this model provides a method to extract off-axis parameters and thus characterize primary off-axis ratio and off-axis softening effects. Photon beam profiles were measured from 15 different megavoltage x-ray beams, covering all major linear accelerator manufacturers, and are fitted by this model. The fitting algorithm is implemented by a Matlab based program.

Results: The proposed model successfully fits the measured photon beam data for various field sizes. The parameters for primary off-axis ratio and off-axis softening were successfully determined for different megavoltage photon beams. The fitting errors are within 1%.

Conclusions: The primary off-axis model has been established, and parameters were determined for different megavoltage x-ray machines and different energies. Our results suggest that the primary off-axis ratio and beam off-axis softening effects are machine and energy dependent, and do not support the generic model from literature.