Purpose: To suggest a novel analytic beam source model for a flattening filter free(FFF) beam, a multi-source model and its optimization method applicable to a treatment planning system were developed.

Methods: Previous three source model was improved by introducing off axis ratio (OAR) of primary photon fluence to generate cone shape profiles. The parameters of the model and the OAR were determined from measured head scatter factors and a measured dose profile of a 40 x 40 cm2 field size using a line search optimization technique. A new method to acquire gradient terms for OAR's was developed to enhance the speed of the optimization process. The improved model was validated with measured dose profiles from 3 x 3 cm2 to 40 x 40 cm2 field sizes at 6 and 10 MV from a TrueBeamTM STx linear accelerator. Furthermore, planar dose distributions for clinically used radiation fields were also calculated and compared with measurements using a 2D array detector using the gamma index method.

Results: All dose values for the calculated profiles agreed with the measured dose profiles within 0.5% at 6 and 10 MV beams, except for some low dose regions for larger field sizes. A slight overestimation was seen in the lower penumbra region near the field edge for the large field sizes by 1% ~ 4%. The planar dose calculations showed comparable passing rates (> 98%) when the criterion of the gamma index method was selected to be 3%/3 mm.

Conclusions: Developed source model showed good agreements between measured and calculated dose distributions. The model is easily applicable to any other linear accelerator using FFF beams as the data required include only the measured PDD, dose profiles and output factors for various field sizes, which are easily acquired during conventional beam commissioning process