

Purpose: A pencil beam algorithm (PBA), which is the most widely used dose calculation method for proton therapy, could make a considerable error in the case of complicated structure. This is because it utilizes the one-dimensional density scaling along the central axis of the pencil beam and neglects the off-axis density heterogeneity. In order to obtain accurate dose distribution in heterogeneous materials in a patient body, we have developed a novel dose calculation algorithm, delta-functional multi segmented pencil beam algorithm (DMS-PBA). In this study, the superiority of DMS-PBA to conventional PBA was verified by using phantom experiment. **Method and Materials:** An L-shaped polyethylene block, representing lateral heterogeneity, was set above polyethylene plates. Three dimensional dose distributions were measured with a simulated using two algorithms: DMS-PBA and conventional PBA. The accuracy of the calculation was evaluated by comparing the measured and calculated dose distributions. **Results:** In the measurement, hot and cold spots were detected at $z = 123, 142, 162$ mm-WEL. Conventional PBA method could reproduce none of these spots. The difference between PBA results and the measured dose amounted to 12 %. On the other hand, DMS-PBA and the measured dose generally agreed well. The hot and cold spots may be produced by the proton trajectories in different angles around the border between polyethylene and air. DMS-PBA could reproduce the detour and overreaching of proton by using “narrow” pencil beams with laterally delta-functional initial beam emittance. In addition, the computing time by DMS-PBA method in this situation was reasonable due to the less overlapped narrow pencil beams. **Conclusions:** We showed that our proposed method, DMS-PBA, could improve the accuracy of dose calculation for treatment planning of proton therapy.