

Purpose: The accuracy of spot position is essential for scanning beam proton therapy. The purpose of this work is to assess the spot position uncertainty of scanning pencil beam by analyzing the daily treatment log files of the treatment control system (TCS).

Methods: The entrance position and profiles of the pencil beam are monitored by the profile monitor. The spot positions in the treatment target are monitored by the spot position monitor. In every fraction, all spot positions are recorded in the TCS. To validate the accuracy of the spot positions in the log file, a test treatment plan containing 9 spot positions with 10 MU each was generated and delivered. The spot positions were measured with radiographic films placed at the isocenter plane and were compared with those from the treatment plan and the log file to determine the deviations. The statistics of the daily variance were then analyzed for patient data.

Results: In the same treatment session, the reproducibility of the spot position for the same spot location is within ± 0.2 mm. The spot positions measured by film agreed with those from the treatment plan within ± 1 mm and the log file within ± 0.5 mm. The maximum day-to-day variance for any given spot position is within ± 1 mm. For one field in a prostate patient with total of $\sim 35,000$ spots in 28 fractions recorded, the mean spot deviation is $(-0.15, 0.01)$ mm, the maximum displacement is $(0.84, 1.08)$ mm, and the standard deviation is $(0.14, 0.30)$ mm.

Conclusion: We have investigated the possibility of utilizing the spot positions in the TCS log file as a QA tool to monitor the day-to-day variance of the treatment delivery. The analysis tool developed here could be very useful to assess the spot position uncertainty and thus the dose uncertainty for any patient receiving scanning beam proton therapy.