Purpose: Women with intact cervical cancer with involved pelvic lymph nodes require additional boost radiation therapy to involved lymph nodes following pelvic irradiation. These boosts are particularly challenging to plan due to the need to avoid central structures, which are treated to organ tolerance with intracavitary brachytherapy. A single posterior (PA) proton beam may be an ideal treatment technique for nodal boost, which can spare the rectum, bladder and small bowel. However, appropriate margins to account for setup error and range uncertainty are unknown in this setting. The purpose of this study was to determine the margins required to account for interfractional anatomical variations and setup uncertainties during intensity modulated proton treatment (IMPT).

Methods: Five patients treated with definitive radiation therapy for cervical cancer were used retrospectively for this study. All patients received 4-5 weekly CTs during treatment. External iliac nodes were contoured by a radiation oncologist on each planning image. Rigid alignments using bony structures near the external iliac nodes are used. A single IMPT PA-beam was simulated. Ray-trace methods were used to determine the water equivalent thickness (WET) of each ray parallel to the beam path. The resulting 2D-WET matrixes were then mapped back to the planning CT image and converted back to physical depth to determine the actual margin required to cover the target.

Results: Distal margins are represented by a positive number while the opposite is true for proximal margins. The average margin mean for all patients is -0.7mm (Range -2 to 5mm). The average variation for all patients is 6mm (Range 2 to 12mm). Maximum distal and proximal margins needed to cover all fractions were 8 and 9mm, respectively.

Conclusions: We determined that a ~9mm margin would be sufficient for nodal boost IMPT, which produced excellent dosimetric results, compared to corresponding photon plans.