Purpose: Bulky (>40 cc) cervical cancer brachytherapy (BT) tumor dose conformity is often poor since the dose limitations of nearby organs at risk (OARs) prevent the radially symmetric dose distributions from covering tumor extremities. We introduce compensator-based intensity modulated brachytherapy (CIMBT), a non-invasive alternative to supplementary interstitial BT that improves the dose conformity to bulky cervical cancer tumors. CIMBT dose distributions are generated by an electronic brachytherapy (eBT) source wrapped in a novel compensator that is covered in varying thicknesses of high-Z material.

Methods: A 3-D CIMBT treatment planning system prototype was developed that simultaneously optimizes the compensator thickness distribution and the source dwell times at multiple positions. Ir-192, Xoft Axxent eBT, and CIMBT treatment plans were generated for a stage IB cervical cancer patient with a laterally and posteriorly-extended 41.3 cc high-risk clinical target volume (HR-CTV). The BT doses were escalated as high as possible without compromising the GEC-ESTRO recommended bladder, rectum, and sigmoid constraints.

Results: CIMBT improved HR-CTV D90 considerably above that of Ir-192 and eBT. D90-values for Ir-192, eBT, and CIMBT were 64, 62 and 90 Gy(EQD2), respectively. Ir-192 and eBT treatment times were comparable, and the CIMBT delivery time was greater than the eBT case by a factor of 3.4. The user could easily obtain decreased CIMBT treatment times by constraining D90 in the HR-CTV. No improvement in the dose CIMBT dose distribution was evident for compensator thicknesses greater than 100 µm of gold.

Conclusions: Compensator-based IMBT has the potential to significantly improve cervical cancer dose distributions without the need for supplementary interstitial BT. The physician will have the freedom to optimize the tradeoff between increased delivery time and tumor dose conformity with CIMBT. We expect that patient-specific compensators can be constructed rapidly in clinical situations using circuit board printing technology.