Purpose: There has been no consensus standard of care to treat recurrent cancer patients who have previously been irradiated. Pulsed low dose rate (PLDR) radiotherapy has potential to reduce normal tissue toxicities while still providing significant tumor control for recurrent cancers. This work investigates the dosimetry feasibility of PLDR radiotherapy using the RapidArc delivery technique for a dose escalation trial.

Methods: Five body sites were investigated including breast, pancreas, prostate, head and neck, and lung. RapidArc plans were generated using the Varian Eclipse system with 6, 10 and 15MV beams. Each plan consisted of two arcs and the plan was delivered 5 times to achieve a daily dose of 2Gy. The dosimetry requirement was to deliver 20cGy/arc with a 3min interval to achieve an effective dose rate of 6.7cGy/min. Monte Carlo simulations were performed to calculate the actual dose delivered to the planning target volume (PTV) considering beam attenuation/scattering and intensity modulation. The maximum, minimum and mean doses to the PTV were analyzed together with the dose volume histograms and isodose distributions.

Results: Two full arcs were necessary to achieve superior dose distributions for complex recurrent cancers to spare critical structures effectively. For 9 patients, the mean PTV dose for each arc ranged 18.9-22.6cGy/arc. For breast the minimal and the maximal PTV dose was 8.56 and 31.2cGy/arc, respectively. The RapidArc dose varied between 12.9 and 27.5cGy/arc for pancreas, 12.6 and 28.3cGy/arc for prostate, 12.1 and 30.4cGy/arc for H&N, and 16.2 and 27.6cGy/arc for lung, respectively. Good agreement was achieved between the planned doses and Matrix measurements with 95-98% passing rates.

Conclusions: Advanced image-guided radiotherapy can provide superior target coverage and normal tissue sparing for PLDR reirradiation of recurrent cancers, which can be delivered using the RapidArc technique with 10 full arcs and an effective dose rate of 3-10cGy/min.