AbstractID: 5495 Title: Intermediate Energy Photon for small field Radiosurgery dramatically improves penumbra, dose distribution homogeneity and conformality

Purpose: Stereotactic radiosurgery ensures highly conformal treatment of small volumes. When treating lesions with no microscopic extension and with efficient immobilisation, the PTV (Planned Target Volume) closely overlaps the GTV (Gross Tumour Volume). When using dedicated beam collimation devices, the radiological penumbra accounts for an additional 2 to 3mm dose gradient extending within the normal tissue. We hypothesized that, for small radiosurgery field sizes, intermediate energy photons (IEP, above orthovoltage and below megavoltage) will dramatically reduce the radiological penumbra.

Material and Methods: Monte Carlo simulation was used to investigate the dose distribution characteristics and the radiological penumbra of monoenergetic photons (100 keV to 1 MeV) in a water phantom and for various field sizes (0.5x0.5 to 4x4cm^2). A virtual unit based on a simulated optimised IEP spectrum was described in the Pinnacle^3 TPS using an extended kernel library in the kilovoltage range.

Results: Radiological penumbra below 300μm are generated for field sizes below 2x2 cm^2 at all depth and for monoenergetic photons between 200 to 400keV. The depth dose curve is steeper with a 50% relative dose at 6.5 cm depth, the dose homogeneity in the target is dramatically increased, and the dose to the bone is not increased. An 800 kV beam generated in a 0.5mm tungsten target maximizes the photon intensity in this range. Using six coincidental IEP generators allow a dose rate of 1.5Gy per minutes at 5 cm depth. Pinnacle^3 confirms the dramatic reduction in penumbra size, and the superiority of IEP over megavoltage beams for radiosurgery applications regarding dose distribution homogeneity and conformality.

Conclusions: The reduction of radiological penumbra is linked to the reduced photon scattering using small field sizes and the reduced secondary electron range using IEP. This is the first report of the use of IEP for radiosurgery.