Purpose: To develop and optimize the procedures for the precise irradiation of the hippocampal region in a rodent with minimum radiation dose to the remainder of the brain. For this purpose, VMAT-RapidArc SRS was used to irradiate one hippocampus of athymic nude (ATN) rats. Prescribed dose was verified through TLD measurements and spared brain region(s) were confirmed through immunohistochemical analysis postmortem.

Methods: Seven ATN rats, 10-12 weeks old underwent human-like radiation treatment planning followed by SRS. MRI and CT axial images of 0.8 mm thickness of the rat's skull were acquired and transferred to ECLIPSE treatment planning software where brain, right and left hippocampi were contoured. A VMAT-RapidArc plan consisting of two 3600 axial arcs and two 1200 vertex arcs irradiated the left hippocampus only to a dose of 10 Gy. Treatment was delivered using a 6 MV photon beam from a Trilogy Linac equipped with OBI. TLD measurements were performed prior to treatment using a custom made phantom that simulated the rat's brain and body. Orthogonal x-ray images taken with the OBI and co-registered to DRR images were used to adjust the rat's treatment position. One month post-irradiation, rats were sacrificed and brain dissection was performed to verify the radiation effects in the targeted and non-targeted regions.

Results: Percent differences between calculated and measured dose were ~12% which was expected due to the small field sizes (<2cm) used. Immunohistochemistry analysis revealed a significant reduction in cell population in the ipsilateral hippocampus while cell populations comparable to those in a non-irradiated subject were observed in the contralateral hippocampal region.

Conclusions: Present results demonstrate that precise irradiation of small volumes within a rat's brain can be achieved with human-like image-guided VMAT-RapidArc treatment. Postmortem analysis of the rat brain provides evidence of high-precision targeted radiation damage and dose sparing.