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## Investigation of the effect of titanium dental implants on proton therapy delivered for head tumors: experimental validation using an anthropomorphic head phantom

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To investigate the effects of metallic dental implants in the treatment of head and neck tumors with proton therapy we performed 2 experiments at the Medico-Technical Complex, JINR, Dubna. The goal of this study was to evaluate the 2 dimensional dose distribution of different, clinically treatment plans measured in an anthropomorphic phantom and compare it to treatment planing predictions. The anthropomorphic phantom manufactured by Alderson was sliced into horizontal segments. Two Titanium grade 4 implants were implanted between 2 slices. GafChromic EBT 2 films were laid between the segments which contain the implants to measure the 2D delivered dose. There were designed two different targets: the first target includes the 2 dental implants near isocenter and for the second target the proton beam is delivered through implants, those being in the plateau region of the Bragg curve.

The experimental results were compared with the treatment plans made in our in-house made 3D Treatment Planning System based on pencil beam algorithm. To quantitatively determine differences in the isodose distributions (measured and calculated), the gamma index (3mm, 3%) was calculated for each target for the matrix value in the region of high isodose (>90%): for the first target we obtained 84.3% and for the second target 86.4%. In conclusion, the uncertainties introduced by the clinically planned dose distribution are beyond reasonable limits. The microdosimetry information (absorbed dose and linear energy transfer spectra) in close proximity of the implants was investigated using solid state nuclear track detectors.

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