A Wochnik et al., J Material Sci Eng 2019, Volume 8
DOI: 10.4172/2169-0022-C2-129

3D printing in proton radiotherapy - individualized, patient-specific compensators for shallow situated tumours treatment

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In modern proton therapy facilities with pencil scanning beam technology the lowest energy of proton beam ranges typically between 60 and 70 MeV, which corresponds to the range of about 3.0-4.1 cm in water. The irradiation of superficial lesions requires application of pre-absorber to deliver more shallow spots. Typically, in such cases a range shifter (RS) is used, in form of the 4 cm thick PMMA plate, attached to the nozzle at a certain distance from the patient body. The air gap enhances beam scattering, affecting the increase of spot size and worsening the beam conformity. To prevent these effects application of printed, individualized proton compensators was proposed. Compensator, attached directly at the patient mask without any air gap between pre-absorber and patient's body allows preventing unwanted beam broadening. The possibility of designing the shape of the compensator individually for each patient allows it to be adapted to the shape, size and position of the tumor. Comparative studies for the use of both types of pre-absorbers - RS and compensator - have been implemented with the printed test cube. Water equivalent thickness, spot sizes and penumbras were investigated. It has been demonstrated that the use of individualized proton compensators allows obtaining better dose distribution in the patient's body because of better beam conformity, also reducing the spot sizes. The procedure of production of such a compensator was developed. Compensator was designed in the TPS and then printed using fused fiber filament (FFF) technology with polylactide (PLA) material.

Figure 1. a) Range Shifter (RS) attached to the beam nozzle and b) printed compensator, attached to the patient's mask.

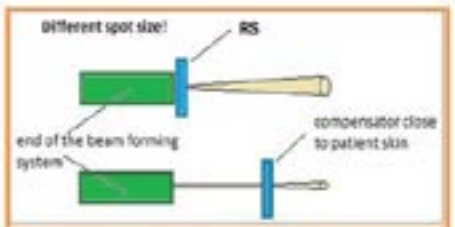

Figure 2. Beam scattering scheme for differently located preabsorbers.

Biography

A Wochnik is a PhD Student in the Proton Radiotherapy Group at the Institute of Nuclear Physics Polish Academy of Sciences in Krakow, Poland. She holds a Master Degree at the University of Science and Technology AGH in Krakow. Her research interests are 3D printing application for proton radiotherapy.

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