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First step for PET aided hadrontherapy.

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The benefit of hadrontherapy compared to conventional radiation therapy is the higher ratio between dose to tumor and dose to normal tissue. However, regarding depth dose distribution between charged particles and photons, effect of range uncertainty is more significant with charged particles. Thus, importance of understanding range uncertainty arises. There are many sources of uncertainty, such as beam range, CT – water equivalent penetration length conversion uncertainty, relative biological effectiveness (RBE) change, anatomical change of patient, etc. During hadrontherapy, positron emitting 11C and 15O are produced and the beam range can be measured with positron emission tomography (PET). However, 11C gives more PET signals than 12C and would give better analysis of beam range. 11C, which is used for PET imaging, is expected to have similar treatment characteristics compared to 12C. FLUKA simulation was done such that 11C beam energy will have 2mm intervals in water penetration depth range from 3 cm to 28cm. Additionally, one of the 12C Spread Out Bragg Peak (SOBP) plan was converted to 11C SOBP plan, and both physical and RBE weighted doses of this converted plan were calculated based on LEM I. The SOBP result shows the possibility to predict 11C RBE weighted dose based on LEM I. Additionally, we have summarized the calculations needed for developing a 11C ions based commercial treatment planning system (TPS), for both absorbed and biological dose, and found that the level of complexity is similar to 12C ions in terms of TPS implementation and database generation.

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