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Proton range verification using protoacoustics and artificial intelligence

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The thermoacoustic pressure waves generated by the proton beam in protontherapy treatments may provide information on the distribution of the deposited dose in tissues. This approach, called protoacoustics, is a promising method for proton range verification. In this work, we show with realistic simulations and artificial intelligence models how to estimate the Bragg peak (BP) location from the measured acoustic signals.

Dose calculations were performed with the open-source treatment planning system matRad, while k-Wave was used for simulating the acoustic wave propagation in 3D. A neural network (ProtoNN) was trained to estimate the Bragg peak (BP) location for each beamspot of the treatment plan from the protoacoustic measurements. The trained ProtoNN estimates the location of the Bragg peak with precision better than 1mm in less than 100ms. This may be used to generate an alert in real-time if a significant deviation from the treatment plan is found.

Plans to verify these results with experimental measurements, as well as technical challenges and opportunities in this field will be also discussed.

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