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Conception of a PG detector for hadrontherapy online monitoring

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Proton therapy is a tumor treatment taking advantage of the Bragg Peak, a very sharp peak that enable a highly localized energy deposition at the end of particle range. However, the determination of the Bragg peak position is subjected to uncertainties that requires the establishment of safety margins during the irradiation of the patient, therefore decreasing the targeting efficiency in favor of a safer treatment. An online monitoring of proton therapy would allow real-time localization of the position of the Bragg peak, thus maximizing treatment accuracy. Proton range measurement can be provided by the the detection of prompt gamma (PG), secondary particles generated almost instantaneously following a proton-matter nuclear collision.

We propose a new system for real-time imaging of the Bragg Peak, based on the time-of-flight measurement of the PG with Cerenkov-based detectors : the Prompt Gamma Time Imaging. The precision in the Bragg peak location is directly related to the time resolution of our detection system, and simulations proved that a 100 ps rms time resolution would enable to obtain a millimetric monitoring precision. Through experimental tests, the time resolution of a detection system prototype has already been estimated at 135 ps rms, that resulted in a sensitivity of 4 mm on a deviation of the Bragg peak location with only 600 PG measured.

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