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#9-104 Use of New Pixel Detector Technology for Radiotherapy Treatment Monitoring

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The application of pixel detector technology in medical imaging and radiotherapy monitoring has significantly advanced the precision and efficiency of cancer treatment. Recent innovations, particularly the integration of Timepix3-based pixel detectors, have enhanced treatment monitoring for therapies such as FLASH, carbon ion radiotherapy, and thyroid cancer treatment. These detectors enable high-resolution, real-time tracking of particle interactions, providing critical insights into dose delivery, tumor localization, and treatment adjustments.

In radiotherapy, precise beam targeting is essential for minimizing damage to healthy tissue while effectively treating the tumor. Pixel detectors, such as those used in the novel particle tracking system for carbon ion therapy, track charged nuclear fragments produced by carbon ion interactions with patient tissue. The system, composed of 28 synchronized Timepix3 pixel detectors arranged in seven units, provides nanosecond timing precision and enables the reconstruction of particle trajectories. This technology allows for the accurate localization of fragment origins and can detect positional shifts as small as 1.5 mm, ensuring precise treatment delivery across therapy fractions. Testing with clinical phantoms has confirmed the system's capability to monitor changes in patient morphology and positioning, improving treatment alignment during therapy.

In the domain of thyroid cancer, ThyroPIX utilizes Timepix3 technology in a mobile Compton camera to provide enhanced imaging of the thyroid gland during treatment monitoring. ThyroPIX offers superior spatial resolution and sensitivity compared to traditional imaging methods, enabling the detection of residual cancer cells after surgical removal of the thyroid. By measuring the position, energy, and timing of gamma photons, the system can localize the source of radiation with high precision, providing valuable information to guide treatment decisions. The absence of bulky collimators, along with its lightweight design, makes the ThyroPIX system portable and suitable for both planar and tomographic imaging, facilitating quick, accessible examinations in any part of the hospital.

These advancements in pixel detector technology are transforming radiotherapy and cancer treatment monitoring by providing real-time feedback, improving accuracy, and enabling personalized treatment. The integration of Timepix3 detectors into various therapeutic modalities highlights their promising role in enhancing the efficacy and safety of cancer treatments across different clinical settings.

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