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Nano-Imaging Trackers: A Novel Approach for High-Resolution Particle Detection

We are developing a new generation of fine-grained nuclear emulsions, known as Nano-Imaging Trackers (NITs), which serve as both target and tracking devices capable of detecting particle tracks at nanometric scales, down to tens of nanometers.

This research, conducted as part of the DAMON (Direct meAsureMent of target fragmentatiON) PRIN project within the INFN FOOT experiment, seeks to achieve the first direct measurement of target fragments produced by proton beams during hadron therapy.

Initially developed by the NEWSdm collaboration for directional dark matter searches via nuclear recoil detection, NITs utilize silver bromide (AgBr) crystals, each with an average diameter of 70 nm, embedded in a gelatin matrix composed of elements commonly found in the human body, such as carbon, oxygen, and hydrogen. The key advantage of NITs lies in their exceptionally high spatial resolution, resulting from a granularity of one sensitive element per 140 nm.

A specialized readout system has been developed to capture the data, leveraging both a fast-scanning microscope and a super-resolution optical scanning microscope.

The outcomes of pilot tests conducted between 2023 and 2025 at Trento Proton Therapy Center, CNAO and Nagoya Proton Therapy Center will be presented, showcasing the capabilities of this technology for studying proton-induced target fragmentation.

This innovative detector technology represents a significant step forward in particle detection, offering unprecedented resolution and potential for cross-disciplinary applications.

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