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From Dark Matter Searches to Proton Therapy: measuring target fragmentation with nanometric nuclear emulsions

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Proton therapy is a cancer treatment employed for deep solid tumors or those near organs at risk, that exploits the advantages of the protons'depth-dose profile. The efficacy of this therapy is currently hindered by significant uncertainties surrounding the Relative Biological Effectiveness (RBE) of proton beams. An important contribution to these uncertainties is related to the production of highly-ionizing and short ranged secondary fragments through inelastic nuclear interactions.

Data regarding the production of target fragments is limited because of the challenges involved in detecting tracks at the micro-meter scale. The DAMON (Direct meAsureMent of target fragmentatiON) project is aimed at making, for the first time ever, a direct measurement of target fragments produced by a proton beam.
To address this, a novel kind of fine-grained nuclear emulsions known as "Nano-Imaging Trackers"(NITs) have been employed as target and tracking device. NITs have been originally developed by the NEWSdm collaboration for directional dark matter search through induced nuclear recoils. The sensitive elements of NITs, AgBr crystals with an average diameter of 70 nm, are dispersed in a gelatine containing Carbon, Oxygen, Hydrogen and other elements present in the human body. The main advantage of this kind of detector is the extremely high spatial resolution which is the result of a granularity equal to 1 sensitive element per 140 nm. An R&D is on-going to optimize NITs for the study of target fragmentation.

To read-out NITs, a dedicated process has been developed exploiting both a fast scanning microscope and a super-resolution optical scanning microscope.

A first pilot test was performed in February 2023 by exposing a bulk of NITs to protons at 211 MeV. Results of this exposure will be presented in this talk, demonstrating the capabilities of this detector for the study of target fragmentation.

Collaboration

Role of Submitter

I am the presenter

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Classifica Sessioni: Applications to Industrial and Societal Challenges - Oral session (S5)

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