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Automatic Detection of Recoil Proton Track and Separation from Radiation Induced Background

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High resolution imaging of fast neutrons (>0.5 MeV) combined with energy spectroscopy is employed in variety of applications.

We have previously reported on the development and construction of a detector based on a micro-capillary bundle filled with organic liquid scintillator. The scintillation is observed by a CCD camera that will permit high resolution imaging and spectrometry by secondary ion track reconstruction, without the requirement for techniques such as Time of Flight.

At such energies, the dominant fast neutron reactions in the organic liquid scintillator are elastic scattering with hydrogen (recoil-proton) and carbon, as both elements have similar atomic density within the scintillator. The recoil-proton will travel inside the bundle and create scintillation light track within the multiple capillaries it traverses (as function of its energy), while heavier ions will deposit their energy within a radius of one or two capillaries (ca. 40 μm). A fraction of the scintillation light will travel to the end of these capillaries via total internal reflection and be registered in the optical readout system, thereby creating a projection of the proton track in the plane perpendicular to the optical axis. These proton tracks exhibit bright continuous trajectories with a Bragg peak at their end. Gamma-ray-induced electrons generate small, fainter blobs of light that appear as a multitude of blobs.

Initially, identification of proton tracks has been accomplished by visual inspection of the numerous CCD images. As this is an inefficient, labor and time-consuming task, a computerized rapid automatic track recognition procedure was developed, based on ellipsoid shape parameters analysis.

This work provides description of the capillary detector, analysis of principal features characterizing recoil proton track projections as well as background induced signal which provided basis for excellent background rejection, distinguishing a single proton track over several thousands of background blobs found in each CCD frame.

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