RIPTIDE, a proton-recoil track imaging detector for fast neutrons

P. Console Camprini[1,2], F. Leone[3,2], C. Massimi[4,2,*], A. Mengarelli[2], A. Musumarra[3,2], M.G. Pellegriti[2], C. Pisanti[4], R. Ridolfi[4,2], F. Romano[2], R. Spighi[2], N. Terranova[1,2], M. Villa[4,2]

[1.] Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Italy
[2.] Istituto Nazionale di Fisica Nucleare (INFN), Italy
[3.] University of Catania, Department of Physics and Astronomy, I-95123 Catania, Italy
[4.] University of Bologna, Department of Physics and Astronomy, I-40126 Bologna, Italy

* Corresponding author,
cristian.massimi@unibo.it

RIPTIDE is a new detector concept aiming to track fast neutrons. It is based on neutron-proton elastic collisions inside a plastic scintillator, where the neutron momentum can be measured by imaging the scintillation light [1-3]. More in detail, by stereoscopically imaging the recoil-proton tracks, the proposed apparatus provides neutron spectrometry capability, and enable the online analysis of the specific energy loss along the track (see Fig. 1). In principle, the spatial and topological event reconstruction enables particle discrimination, which is a crucial property for neutron detectors.

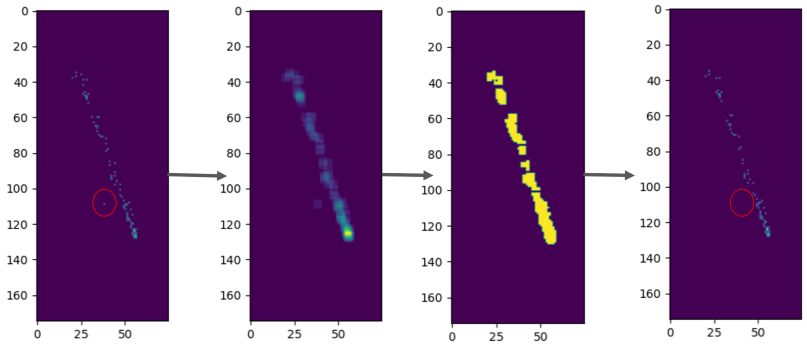

Figure. 1. Example of an analysis procedure to remove spurious signals in a reconstructed proton track obtained from MC simulations filtered with a simple optic system.

In this contribution, we report the advances on the RIPTIDE detector concept. In particular, we have developped a Geant4 optical simulation to demonstrate the possibility of reconstructing with sufficient precision the tracks and the vertices of neutron interactions inside a plastic scintillator. To realistically model the optics of the scintillation detector, monoenergetic protons were generated inside a 6x6x6 cm^3 cubic BC408 scintillator, and the ensuing optical photons were recorded on a scoring plane corresponding to the surfaces of the cube. The photons were then trasported throug an optical system to a 2x2 cm^2 photo sensitive area with 1 Megapixel. The first panel of Fig. 1 show an example of one of the 6 projections of a track on a pixellated photosensor.

Moreover, we have developed 2 different analysis procedures to reconstruct 3D tracks: one based on least square fitting and one on Principal Component Analisys. The main results of this study will be presented with a particular focus on the role of the optic system and the attainable spatial/energy resolution.

[1] A. Musumarra *et al* 2021 *JINST* **16** C12013
[2] C. Massimi *et al* 2022 *JINST* **17** C09026
[3] P. Console Camprini *et al* 2023 *JINST* **18** C01054