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#10-256 Advanced neutron detection hands-on exercises with MX-10 particle camera educational kit

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MX-10 particle camera [1] as a modified variant of the read-out interface for Timepix pixel detector is dedicated for educational purposes to demonstrate real-time detection and visualization of basic kinds of radiation as alpha, beta, gamma rays and cosmic muons. However, its use is not strictly limited to perform the fundamental exercises that are formulated in the complementary manual book Experiments Using Pixel Detector in Teaching Nuclear and Particle Physics [2], which contains detailed instructions for a set of 50 experiments practicable with Timepix detector. After necessary adaptation, MX-10 can also serve well in more advanced practices as the neutron detection experiments undoubtedly are.

The contribution presents a set of exercises, methods involved and arrangements of a compact tailor made set-up based on MX-10 edu kit to allow effective performance of neutron experiments in a quite undemanding way easily comprehensible to students. The newly developed experiments are focused on demonstration of basic interactions of neutrons with the matter to provide clear evidence on them. Specifically, the individual exercises cover the following objectives:

i) The measurement of radiation emitted by a compact a laboratory ^{241}AmBe radionuclide neutron source and the radiation induced by neutrons interacting in the surrounding materials based on observation of particle tracks resulting from interactions of neutrons and gamma rays in a bare silicon sensor of Timepix detector. The particle track analysis will be applied to recognize the type and energy of every individually interacting radiation quantum. ii) The demonstration of a highly effective way of neutron detection with an adapted sensor is shown applying suitable neutron converters of ^{6}LiF (permitting the registration of slow neutron by means of ^{6}Li(n,α) reaction) and of polyethylene (the hydrogen rich material for detection of fast neutrons by means of recoil protons). Detection of moderated and fast neutrons (in range 1 - 10 MeV) and their recognition is presented. A possibility of the spectral analysis of a mixed neutron field is also discussed.

iii) The experiments dedicated to key aspects of neutron shielding and moderation performed with the Timepix detector adapted for detection of slow and fast neutrons realized in various experimental set-ups of different types of materials (high density polyethylene, parafine, Pb, Cd, B, Li and their combination) used for shielding the detector against the radiation from the neutron source. Shielding efficiency of the particular materials is examined considering also the undesirable secondary radiation generated by neutrons interacting with shielding materials.

The lecture arises from many years of experience gained in using the MX-10 camera to teach the interaction of ionizing radiation at Czech high schools and at a number of international schools/workshops organized in 2018-2020 by the IEEE NPSS focused on representative students of high school and universities. The feedback on the hands-on exercises organized recently as a part of XXI Jorge Andre Swieca Summer School on Experimental Nuclear Physics [3] organized in Sao Paulo 2020 and the virtual IEEE NPSS Workshops on Application of Radiation Instrumentation in Jakarta [4] and Dakar [5] 2020, has proven well how the newly developed exercises help students to understand the physics of neutron interactions with matter. It is worth mentioning here that the practical exercises described in this contribution will be a part of this conference program.

References

[1] MX-10 particle camera, http://www.particlecamera.com/index.php

[2] V. Vicha. Experiments Using Pixel Detectors in Teaching Nuclear and Particle Physics, Czech Technical University, Prague 2017, ISBN 978-80-01-06108-4

[3] XXI Jorge Andre Swieca Summer School on Experimental Nuclear Physics, IPEN, Sao Paulo, 2020, event web page, http://www.sbfisica.org.br/~evjasfne/xxi/index.php/en/

[4] Virtual IEEE NPSS Workshop on Applications of Radiation Instrumentation ("Jakarta"), event web page, https://indico.cern.ch/event/954199/

[5] Virtual IEEE NPSS Workshop on Applications of Radiation Instrumentation in Dakar, event web page, https://indico.cern.ch/event/954194/

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