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Characterisation of mixed field and dosimetry using Medipix3RX detector

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Significance

The purpose of this research is to extend the use of Medipix3RX detectors fabricated by the European Centre for Nuclear Physics (CERN), Switzerland to characterise mixed radiation fields which includes particles like neutrons (thermal, intermediate, and fast), alphas, betas, photons, and muons and then use this as the base study for personalised dosimetry in medical applications such as in MARS CT scanners, and non-medical applications such, commercial flights, and near particle accelerators and hopefully for space applications like the International Space Station (ISS).

This work which involves series of projects aim to create a detector which can simultaneously detect and characterise multiple radiation types within a mixed field. Such a detector could then be used for a variety of applications, including studying the limits of radiation levels for protecting the detectors installed in the CMS cavern; dosimetry in environments containing complex radiation such as nuclear reactors and space; and feeding into other research areas featuring mixed field radiation. The results from this are useful in mixed field dosimetry application like radiation oncology in hospitals, commercial altitude flights and in outer space.

Objectives

Firstly, this work will involve carrying out a set of experiments to investigate whether MARS Medipix3RX detector's has a potential as radiation monitoring device for mixed field environments (such as particle colliders, space and aviation) which. This will indirectly help to establish the MARS Medipix3RX detector as one of the pioneers for mixed field dosimetry for accessing the dose to human in various high radiation environments mentioned above.

Secondly, it will strengthen the collaboration between the MARS group, New Zealand and other scientific organisations which plan to use the MARS Medipix3RX detector in future applications such as radiation oncology, high energy physics and aviation industry applications.

Publications in this field will contribute to the overall development of the future pixel detectors and encourage its use in various high energy physics experiments being carried out at CERN and elsewhere, in addition to this it will also ensure that MARS is at the cutting edge of radiation detection technology and research.

Method

The first part of my work will be to install the Medipix3RX detectors in the CMS experiment to measure the luminosity and monitor the beam radiation which will help us to protect the CMS from the radiation damage. The results of this work will help assess whether from the current background radiation levels are damaging to the CMS electronics and assist with the CMS experiments by providing mixed field radiation data collected by our detectors.

The subsequent part of my work will involve producing suitable conversion layers for the Medipix3RX base sensor layer and design a MARS Mixed Field Camera for detecting and characterizing helpful in detecting neutrons, in addition to a variety of different particles in a mixed radiation field. The new conversion layers will have the ability to convert neutron to different heavy particles like alphas which then can be detected.

Conclusions and future plans

Most of the damage to the CMS experiment is done by albedo neutrons which when caused due to collision activate or excite the detector material leading to hits in the detector. Thus measuring the flux and intensities of neutrons we can assess from the current background radiation levels whether they are damaging to the CMS electronics. The CMS experiments will be assisted by providing mixed field radiation data collected by our detectors.

The unique capabilities offered by the Medipix3RX detector will potentially help us to measure many different types of radiation simultaneously. And also for monitoring and quantifying the radiation dose in a range of environments containing mixed radiation fields which are made up of neutron, protons, and muons. This could be in radiation in hospitals, in planes, or even in space.
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The outcomes of the above mentioned work enable the use of the Medipix3RX detector to be extended to personalised dosimetry in medical applications such as in MARS scanners, and non-medical applications such as space travel, commercial flights, and near particle accelerators which is not possible with current dosimeters.

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