Spectroscopic X-ray imaging with detectors of the Medipix family

Project proposal
Nikhef detector R&D group
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Introduction

Pixel devices are used in modern detectors at particle accelerator experiments. Since few years the possibility to apply these systems to other fields has been of great interest.
Pixel detectors are composed of a sensor and a readout. The sensor is the layer where a particle is actually detected: here the energy transferred to the medium is converted into charge carriers. These are then drifted to the readout where they give rise to an electric signal.
The detectors of the Medipix family are pixel detectors in which a first processing of the signal takes place directly inside the single pixel. The most important feature is the possibility to estimate the amount of charge produced by the particle, which is proportional to the energy which was released. The detector thus acquires spectroscopic (i.e. energy resolving) capabilities.
When these detectors are used in the field of X-ray imaging, the possibility to add energy estimation to single X-ray photons opens a wide range of improvements with respect to conventional systems.

Project proposal A: effect of per-pixel calibration on energy resolution

Although all pixels are designed to be exact copies of each other, it is impossible that they are all manufactured the same way. Mismatches are unavoidable.
In order to ensure the best performance from a spectroscopic detector, it is important that the energy response of the pixels is as more homogeneous as possible. A pixel equalization procedure is therefore crucial.
A first pixel matrix equalization procedure is already available in the software package used to operate Medipix chips. However, this is not enough. To maximize the homogeneity of the matrix response, a per-pixel energy calibration is necessary.
Such a calibration can be performed by exploiting the (almost) monochromatic radiation emitted as fluorescences from pure metal samples excited by a primary X-ray field.
In the project the student will get familiar with this technique and will study how an energy calibration driven equalization of the pixel matrix is able to optimize the performance of the detector.

Project proposal B: operation of the CT setup

X-ray computerized tomography (X-CT) is the technique that allows to reconstruct the 3D structure of the inner part of a body imaged with X-rays. The principle of CT reconstruction is relatively simple: if an object is (X-ray) imaged from different points of view, a proper mathematical treatment of the collection of 2D images allows to estimate the 3D structure of the original object.

At Nikhef an X-ray CT setup for micro-imaging with Medipix based detectors has been recently built in order to study how these techniques can benefit from the spectroscopic capabilities of such devices.

In this project the student will get familiar with the operation of the CT setup and the detector data acquisition system for X-ray images, contributing to the collection of CT data for further analysis.