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Impact of the Pixel Pitch of the Timepix Chip Integrated to the GAMPIX Gamma Camera for Spectrometric and Imaging Performances

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Spatial localization and identification of radioactive sources is a main issue interesting Homeland Security. Gamma imaging allows reaching this need. A new gamma camera, GAMPIX, has been designed by the French Atomic Energy Commission (CEA). GAMPIX enables spatial localization of hot spots on a large energy range. Sensitivity, portability (2 kg) and ergonomics were improved in comparison with previous industrial systems. The detection system is based on the 1.4 cm side Timepix pixelated readout chip developed by the CERN and hybridized to a 1 mm thick CdTe substrate. Pixel size of the Timepix chip is 55 μm or 110 μm . Ongoing developments concern the addition of a spectrometric capability to the existing system. The challenge is the optimization of spectrometric performances while maintaining imaging performances. Our work intends to assess the impact of pixel pitch by means of simulations and experimental validation.

A large range of pixel pitch and energies were tested by MCNPX simulations. Fluorescence impact depending on pixel pitch was demonstrated. Pixel pitch impact on imaging performances was also studied. The purpose is to preserve the angular resolution of the GAMPIX gamma camera, i.e. the ability to separate radioactive sources spatially close.

Energy calibration of Timepix detectors is crucial for the optimization of spectrometric performances. The small pixel size compared to the substrate thickness induces charge depositions in several pixels, called clusters, and the shift between spectra due to different cluster sizes degrades the energy resolution. The energy calibration of our Timepix detectors was carried out in the SOLEX tunable monochromatic X-ray source (CEA).

Our developments show that the replacement of the 55 μm pixelated Timepix chip currently used in the GAMPIX gamma camera by a 110 μm pixel pitch would lead to a significant improvement in terms of spectrometric performances without degrading imaging abilities.

Country or International Organization

France

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