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Innovative X-ray detection systems based on monolithic arrays of Silicon Drift Detector

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This work reports on the development of innovative energy-dispersive X-ray detection systems based on monolithic arrays of Silicon Drift Detector (SDD). We present the adoption of SDDs in different configurations to enhance properties like detection efficiency, throughput capability, and compactness, in addition to high-energy resolution.
Regarding detection efficiency, we propose a solution to reach an effective thickness of 2 mm by the realization of a stacked structure involving two 1 mm thick 2×4 monolithic arrays of SDD, with 64 mm^2 area per pixel, placed atop each other. The goal is to increase the detection efficiency in the hard X-ray range, in particular for the SIDDHARTA experiment.
Another system configuration, ARDESIA-16, involves the use of a 1 mm monolithic 16-element SDD array, of 25 mm^2 area each, obtaining a multichannel X-ray spectrometer, optimized for synchrotron applications that require a high-count rate (> 1 Mcps per channel) and good energy resolution (e.g. below 150 eV at peaking times faster than 200 ns) for X-ray fluorescence detection (XRF) spectroscopy, X-ray absorption fine structure (XAFS) techniques and X-ray fluorescence microscopy (XFM) imaging.
The success of ARDESIA-16 has led to the study of ARDESIA-64, a 64-channel detector based on a monolithic 64-element SDD matrix, with 4 mm^2 area per pixel, with a potential total count-rate of 64 Mcps, using 1 Mcps/channel electronics. To be highlighted that the size of the detector remains unchanged.
An alternative solution to increase throughput capability with respect to ARDESIA-16 is being exploited in ASCANIO, which adopts an annular SDD configuration, with a central hole, meant to be used in a backscattering geometry configuration to optimize solid angle, resulting in an increase of the total output count rate.
The SCARLET project represents another contribution in the development of X-ray detection systems based on SDDs, with the goal of implementing a novel readout ASIC for integration with monolithic arrays of SDD by means of bump-bonding, resulting in a compact X-ray spectrometer with high-rate and high-energy resolution.
At the conference, we look forward to presenting the current state of these developments.

Summary

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