

Silicon Drift Detectors and readout ASICs for High-Resolution and High-Count Rate X-ray Spectroscopy

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This work presents the progress done in the development of multichannel X-Ray detectors based on Silicon Drift Detectors matrices and related readout ASICs.

SDDs allow to achieve state of the art performances for high-resolution and high-count rate spectroscopy. CUBE preamplifier [1] allows to reach optimal resolution performances even at high count rate i.e. at short pulse processing times.

SIDDHARTA experiment [2] uses SDDs array for spectroscopy measurements of kaonic hydrogen atoms. Detectors have to be cooled down below 100 K to reduce detector drift time i.e. time uncertainty due to random position of the interaction in the SDD. SIDDHARTA detector is based on a matrix of 2x4 squared SDDs, each of them with 64 mm² area, produced by FBK with low leakage technology. The detector is mounted on a ceramic that minimizes dead areas between modules. 8 single channel CUBE preamplifiers are used for SDDs matrix readout. ARDESIA project [3] targets the development of a detector optimized for X-ray fluorescence and X-ray absorption fine structure measurements with synchrotron light. Detector should be able to cover a solid angle large enough to collect high fluorescence signal while minimizing collected background. A good energy resolution is mandatory to increase signal to noise ratio and high count rate capability is needed to reduce measurement time. ARDESIA detection module is based on a matrix of 2x2 SDDs, whose area is 12x12 mm². ARDESIA detector has been produced into two different shapes: squared pixel of 25 mm² area, to minimize dead areas and circular pixels of $\simeq 20$ mm², to minimize drift time at temperatures close to room one. Detector is read out by a 4-channels, monolithic CUBE preamplifier, placed in the middle of the ceramic board. The whole detection module is very compact, as its area is 16x16 mm². It is possible to juxtapose together several detection modules to achieve bigger active area if this is needed. The SFERA ASIC for analog processing of the mentioned SDD detectors is also presented in this work.

1. L. Bombelli, C. Fiorini, T. Frizzi, R. Alberti, R. Quaglia, *High rate X-ray spectroscopy with "CUBE" preamplifier coupled with silicon drift detector*, IEEE 2012 NSS/MIC Conference Record.
2. R. Quaglia, et al., *Development of arrays of Silicon Drift Detectors and readout ASIC for the SIDDHARTA experiment*, in Nuclear Instruments and Methods in Physics Research A, Volume 824, Pages 449-451, July 2016.
3. R. Quaglia, et al., *New Silicon Drift Detectors and CMOS Readout Electronics for X-ray Spectroscopy from Room Temperature to Cryogenic Operations*, in proceedings of the IEEE NSS-MIC conference, San Diego, 2015.

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Electronics

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