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Development of arrays of Silicon Drift Detectors and readout ASICs for the SIDDHARTA experiment

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This work deals with the development of new Silicon Drift Detector (SDDs) and readout electronics for the upgrade of the INFN-SIDDHARTA experiment. The SIDDHARTA experiment performs a high resolution X-ray spectroscopy measurement of kaonic atoms transitions to determine the strong interaction induced shift and width of the lowest experimentally accessible level.
The detector under construction is based on a SDDs array organized in a 4×2 format with each SDD square shaped with 64 mm2 (8×8) active area, for a total area of 34×18 mm2. The SIDDHARTA apparatus requires 48 of these modules, designed and manufactured by Fondazione Bruno Kessler (FBK). The readout electronics is composed by CMOS preamplifiers (CUBEs) and by the new SFERA (SDDs Front-End Readout ASIC) circuit, which is here presented for the first time.
SFERA is a 16-channels readout ASIC designed in a 0.35 μm CMOS technology, which features in each single readout channel a high order shaping amplifier (9th order Semi-Gaussian complex-conjugate poles) and a high efficiency pile-up rejection logic.
The outputs of the channels are connected to an analog multiplexer for the external analog to digital conversion. An on-chip 12-bit SAR ADC is also available.
Preliminary measurements of the detectors in the single and in the array format will be reported. Also measurements of low X-ray energies will be reported in order to prove the possible extension of the soft X-ray range for applications in synchrotron beam lines.

Summary

Extended Abstract
This work deals with the development of new Silicon Drift Detector (SDDs) and readout electronics for the upgrade of the INFN-SIDDHARTA experiment. The SIDDHARTA experiment performs a high resolution X-ray spectroscopy measurement of kaonic atoms transitions to determine the strong interaction induced shift and width of the lowest experimentally accessible level.
The detector under construction is based on a SDDs array organized in a 4×2 format with each SDD square shaped with 64 mm2 (8×8) active area, for a total area of 34×18 mm2. The SIDDHARTA apparatus requires 48 of these modules, designed and manufactured by Fondazione Bruno Kessler (FBK). The readout electronics is composed by CMOS preamplifiers (CUBEs) and by the new SFERA (SDDs Front-End Readout ASIC) circuit, which is here presented for the first time.
SFERA is a 16-channels readout ASIC designed in a 0.35 μm CMOS technology which features in each single readout channel a high order shaping amplifier (9th order Semi-Gaussian complex poles), a fast shaper amplifier, a peak detector a baseline holder and a high efficiency pile-up rejection logic
The shaping amplifier is characterized by selectable gain and peaking times that can be selected with different configurations of an internal 256-bit register.
The available gain settings are (corresponding energy of the shaper full scale): 10 keV, 16 keV, 36 keV, 50 keV and 20000 e-. This last setting is useful when SFERA chip is used to read an SDD array coupled to a scintillator crystal in gamma-ray applications. The main shaper has peaking times of 500 ns, 1 μs, 2 μs, 3 μs, 4 μs and 6

µs (selectable) while the fast shaper has a fixed one of 200 ns.
The outputs of the channels are connected to an analog multiplexer for the external analog to digital conversion. An on-chip 12-bit SAR ADC is also available.
Preliminary measurements of the detectors in the single (8×8 mm2) and in the array format will be reported (coupled to the SFERA chip). Also measurements of low energies lines will be reported in order to prove the possible extension of the soft X-ray range of the experiment and applications in synchrotron beam lines.

Primary author: Dr QUAGLIA, Riccardo (Politecnico di Milano & INFN sez. Milano)

Co-authors: BUTT, Arslan Dawood (Politecnico di Milano & INFN sez. Milano); FIORINI, Carlo Ettore (Politecnico di Milano & INFN sez. Milano); Dr PIEMONTE, Claudio (Fondazione Bruno Kessler FBK); SCHEMBARI, Filippo (MI); GIACOMINI, Gabriele (Fondazione Bruno Kessler FBK); BELLOTTI, Giovanni (Politecnico di Milano & INFN sez. Milano); BOMBELLI, Luca (XGLab srl); Dr ZORZI, Nicola (Fondazione Bruno Kessler - FBK)

Presenter: SCHEMBARI, Filippo (MI)

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