Monolithic Arrays of Silicon Drift Detectors for High-resolution X-ray Spectroscopy at High-detection Rates

Longoni A.

Politecnico di Milano and INFN, Via Camillo Golgi 40, I-20133 Milano, Italy,
antonio.longoni@polimi.it

The Silicon Drift Detectors (SDDs) are characterized by high spectroscopic resolution (down to about 130 eV at the Kα line of ^{55}Fe, with the most recent versions of these detectors) obtained with the detector working at a temperature near to the room conditions (about –15 °C, reached by means of simple Peltier coolers) and by processing the signals with a short shaping time (of the order of one microsecond, that is about one order of magnitude shorter than that of conventional Si(Li) or PIN diode detectors). In recent years monolithic arrays of independent SDDs have been fabricated and successfully tested, while other advanced arrays, designed for specific applications, are in advanced stage of development. This talk will be meanly focused on the results obtained with arrays of SDDs and with the perspectives for the near future. In particular two ring-shaped monolithic arrays of Silicon Drift Detectors (SDD) with a hole cut in its center, specifically designed for elemental mapping applications, are presented. The X-ray excitation beam reaches the sample going through the central hole. This geometry optimizes the useful solid angle for the collection of the fluorescence from the sample. These features, together with the very high detection rate of the SDDs allow to reach high scanning rate in elemental mapping. Several application examples of a spectrometer based with one of these ring-shaped arrays of SDD are presented, while the first experimental results obtained in laboratory with a second, more advanced, version of the ring detector are introduced. A larger array of SDDs, with a total active area of about 7cm^2, is also under development for either high fluxes X-ray spectroscopy and hard X-ray imaging. The large area coupled to the high count rate capability of each single unit (up to 500.000 counts/s/channel), achieved by means of recently developed electronics, makes this device ideal for spectroscopy measurements up to tens of Mcounts/s. Monolithic arrays of SDDs coupled to a single crystal scintillator , has allowed also to achieve position resolutions in the order of 250µm in imaging applications with photon energies higher than 100keV. VLSI read-out electronics specifically designed for monolithic arrays of SDDs, developed by our research group, will be also presented and discussed.