A new collimated multichannel modular detection system based on Silicon Drift Detectors

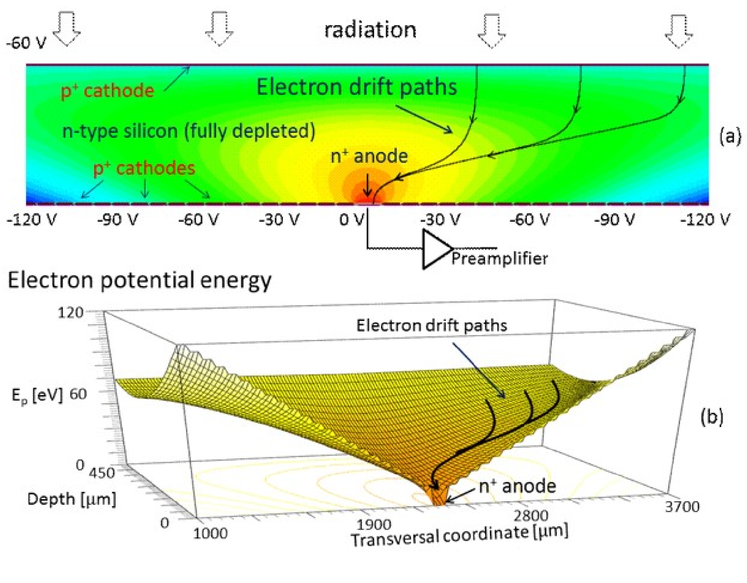
D. Cirrincione[1,2], M. Antonelli [1] G. Aquilanti [3], P. Bellutti [4,5], G. Bertuccio [6,7], G. Borghi [4,5], G. Cautero [3,1], F. Ficorella [4,5], M. Gandola [4], D. Giuressi [3], F. Mele [6,7], R. H. Menk [3,1], L. Olivi [3,1], G. Orzan [1], G. Pepponi[4], A. Picciotto [4,5], A. Rachevski [1], I. Rashevskaya [5], L. Stebel[3], G. Zampa [1], N. Zampa [1], N. Zorzi[4,5] and A. Vacchi [1,2]

1 - INFN Trieste, Trieste, Italy - 2 - University of Udine, Udine, Italy - 3 - Elettra-Sincrotrone Trieste S.C.p.A., Trieste, Italy - 4 - Fondazione Bruno Kessler, Trento, Italy - 5 - TIFPA - INFN, Trento, Italy - 6 - Politecnico di Milano, Como, Italy - 7 - INFN Milano, Milano, Italy

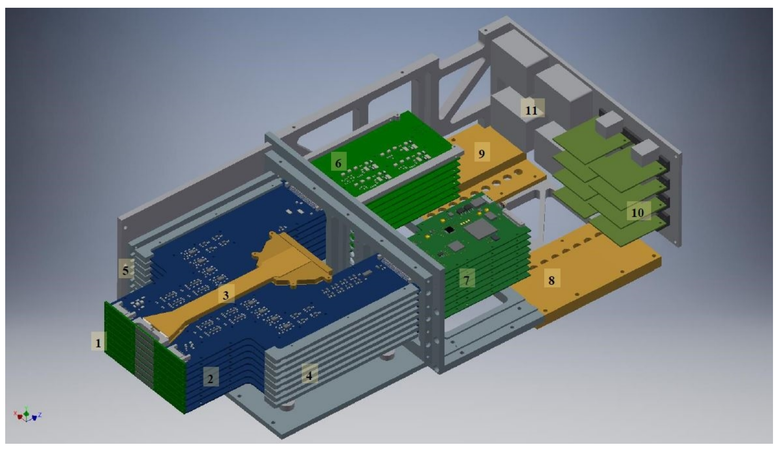
Abstract

After the manufacture and delivery of a state-of-the-art detection system for the XRF-XAFS beamline of the synchrotron light source SESAME [1, 2, 3], a new and improved detection system was realized. This new multichannel modular detection system based on Silicon Drift Detectors consists of 8 monolithic multipixel arrays, each comprising 8 SDD cells with a total area of 570 mm^2. As the previous one, this 64 channels integrated detection system includes ultra-low-noise front-end electronics, dedicated acquisition system, digital filtering, temperature control and stabilization. With respect to the SESAME version, the new instrument implements a W collimation system yielding a total collimated sensitive area of 500 mm^2. Optimized to work in an energy range of 3-30 keV, the system shows an overall energy resolution (sum of its 64 cells) below 180 eV FWHM at the 5.9 Mn Kα line at room temperature. We highlight the system performance and in particular the peak to background ratio, before and after the collimation of the sensors.

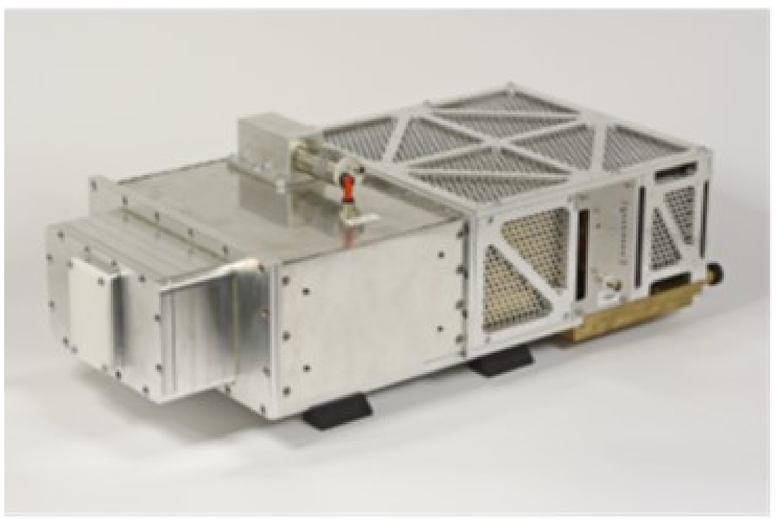
SDD & Detection System



Section of SDD sensor (1 cell) (a) and funnel-shaped potential energy of the electrons inside the cell (b) [4].

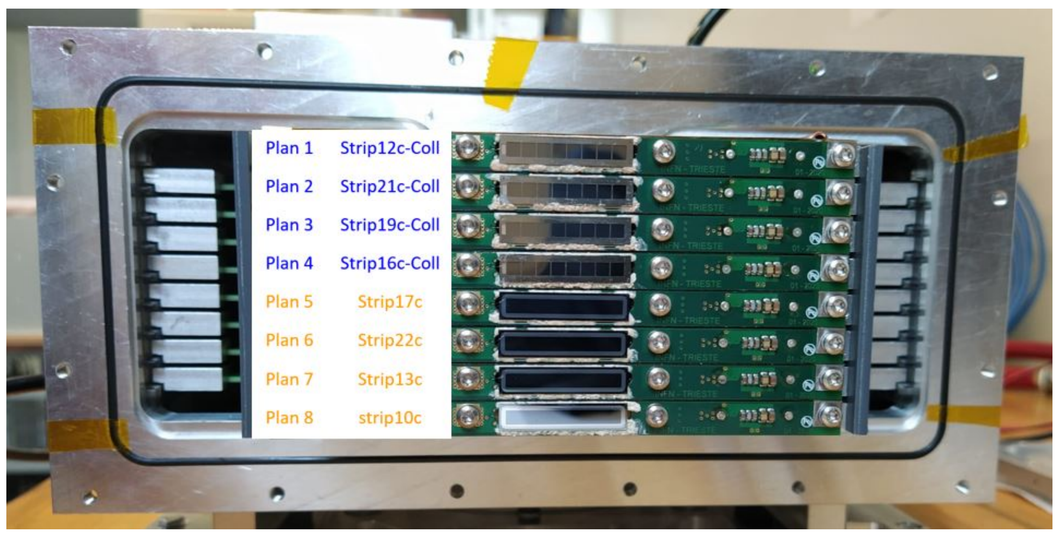


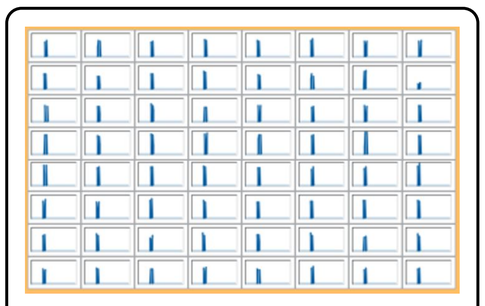
Detection system: (1) detectors, preamplifiers and detector PCBs, (2) front-end PCBs, (3) brass profile with cooling liquid flowing inside, (4) insertion guides at flanks of detecting heads, (5) rails for eight detection heads, (6) power supply and filters PCBs, (7) back-end PCBs, (8) inlet cooling distribution, (9) outlet cooling distribution, (10) ethernet PCBs, (11) power supply connectors [1, 2, 3].



The new XRF-XAFS detection system.

Half-collimated multichannel modular detection system

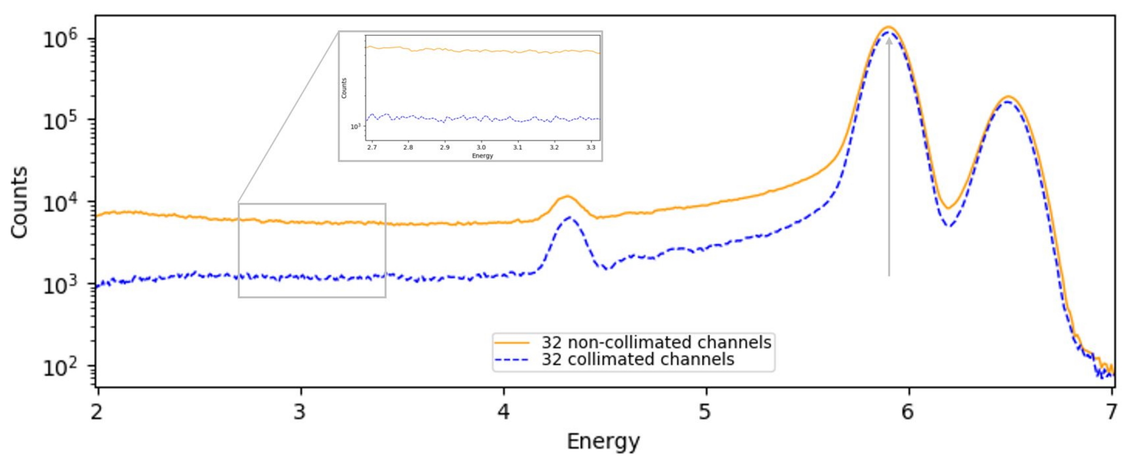




Simultaneous live acquisition of the 64 channels of the Detection System.

Particular of the half-collimated new XRF-XAFS detection system.

Comparison between 32 collimated/non-collimated channels



Intermediate test to compare system characteristics with collimated / non collimated sensors.

The mildly collimated part of the system shows better performance: in particular the peak to background ratio is 4 times better.

	32 collimated channels	32 non-collimated channels
Part of the detector system	top	bottom
Average temperature of the sensors	23 °C	23 °C
FWHM at the Mn 5.9 Kα line	174 eV	178 eV
Best channel - FWHM	159 eV	166 eV
Worst channel - FWHM	199 eV	211 eV
Acquisition time	30 min	30 min
Counts	23,01 M	29,79 M
Peak to background ratio	972	243

After this test, the remaining sensors were collimated and the entire system was optimized, highlighting the improvement in performance.

References

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Speaker: Daniela Cirrincione - INFN-TS and UNIUD - daniela.cirrincione@ts.infn.it