The XAFS Fluorescence Detector System based on 64 Silicon Drift Detectors for the SESAME Synchrotron Light Source


INTRODUCTION

The X-ray Absorption Structure (XAFS) beamlines at synchrotrons combine X-ray absorption spectroscopy (XAS) with X-ray diffraction (XRD). The beamline radiation being diffused on a double monochromator, irradiates a specimen situated between two immersion cavities. It allows to determine the local environment surrounding the absorbing atom in a specimen. On the other hand, when a specimen is optically thick to X-rays or its is highly diluted, the technique is no more sufficient and the sample fluorescence is taken advantage of to perform measurements. We are building a Fluorescence Detector System (FDS) [1,2] for SESAME synchrotron beamline (Amman, Jordan), every building block of which is properly custom designed, providing characteristics summarized in EXPERIMENTAL RESULTS and CONCLUSIONS.

SISTEM LAYOUT

The main building blocks of the system (Figure 1) are the sensors, front-end and back-end electronics, cooling elements, mechanical frame and assemble elements. The system consists of 8 independent modules (detectors heads) stacked compactly one over another along guide rails incorporated in the flanks of a nitrogen tight aluminum crate. Each detection head comprises two PCB mounted respectively at 90º. The front, the front-end PCB (Figure 2), fits a monolithic array of 8 SDDs and the corresponding 8 SIRIO [3,4] charge preamplifiers, bias filtering capacitors, the connectors to the conditioning PCB (Figure 3), and a minimal mechanical support. A custom designed cooling circuitry allows to stabilize or cool down the sensor temperature in a controlled way. The signal conditioning PCB houses a fast analogue shaping filter, which also realizes the single Reads Out Board (ROB) digital conversion of the signal, the preamplifier “close-to-saturation” detection circuit and the sensor bias filtering. The back-end electronics mounted in the rear of the aluminum crate, allows for the system configuration and slow control, the front-end control, digitization and elaboration of the analog signals, acquisition of histograms and raw data for system analysis, and the communication with the controlling computer.

Fig. 1 Fluorescence Detector System.
1: front-end PCBs; 2: conditioning PCBs; 3: power supply with cooling liquid flowing inside; 4: reading grids at flanks of detection heads; 5: channels for eight detection heads; 6: power supply and filters; 7: back-end PCBs; 8: inlet cooling distribution; 9: outlet cooling distribution; 10: Ethernet PCBs; 11: power supply connectors.

Fig. 2 Front-end PCB fits a monolithic array of 8 SDDs and the corresponding 8 SIRIO charge preamplifiers, bias filtering capacitors, the connectors to the conditioning PCB.

Fig. 3 Signal Conditioning PCB. 1: front-end PCB; 2: cooling profile; 3: back-end PCB; 4: power supply and filters; 5: output signal connectors.

Fig. 4 XAFS spectrum normalized for the two detectors near the Selenium edge (single module of 8 SDDs vs standard single element SDD (Ketek VITUS H80).